MRVT Mk 3
Mains Protection Relay

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Contents

1. INTRODUCTION. ................................................................................................. 1

2. APPLICATION. .................................................................................................. 2

3. FEATURES AND CHARACTERISTICS.................................................................. 2

4. DESIGN.............................................................................................................. 3

4.1. CONNECTIONS............................................................................................. 3

4.1.1. Analogue input circuits........................................................................ 3

4.1.2. Output relays.......................................................................................... 3

4.1.4. Remote data communication. ............................................................. 4

4.2. FRONT PANEL............................................................................................ 4

4.2.1. Display .................................................................................................. 4

4.2.2. LED indicators....................................................................................... 5

4.2.3. Push buttons.......................................................................................... 5

4.3. CODE JUMPERS........................................................................................ 6

4.3.1. Password programming ...................................................................... 7

4.3.2. Alarm and Trip relay function ............................................................ 7

5. WORKING PRINCIPLES. .................................................................................. 8

5.1. ANALOGUE CIRCUITS............................................................................ 8

5.2. DIGITAL CIRCUITS.................................................................................. 8

5.3. POWER SUPPLY..................................................................................... 8

5.4. VOLTAGE SUPERVISION......................................................................... 8

5.4.1. Selection Delta/Star Connection of the Input Transformers .............. 9

6. OPERATION...................................................................................................... 10

6.1. LAYOUT OF THE CONTROL ELEMENTS.............................................. 10

6.2. RELAY SETTING PRINCIPLES.............................................................. 10

6.2.1. Password protected parameter adjustment ....................................... 11

7. SETTING PROCEDURE. .................................................................................. 12

7.1. NOMINAL FREQUENCY........................................................................... 12

7.2. VOLTAGE PROTECTION......................................................................... 13

7.2.1. Low Set Undervoltage U< Trip Value.............................................. 13

7.2.2. Low Set Undervoltage tU< Trip Delay ............................................ 13

7.2.3. High Set Undervoltage U<< Trip Value........................................... 13

7.2.4. High Set Undervoltage tU<< Trip Delay .......................................... 13

7.2.5. Low Set Overvoltage U> Trip Value................................................ 14

7.2.6. Low Set Overvoltage tU> Trip Delay .............................................. 14

7.2.7. High Set Overvoltage U>> Trip Value............................................. 14

7.2.8. High Set Overvoltage tU>> Trip Delay ............................................ 14

7.3. BLOCKING OF PROTECTION FUNCTIONS (BLOCKING INPUT) ......... 15

7.4. DISPLAY OF VOLS AS PRIMARY VOLTAGE .......................................... 15

7.5. DELTA/STAR SWITCH OVER................................................................. 15

7.6. DISPLAY OF THE ACTIVATION (FLSH/NOFL).................................... 16

7.7. PARAMETER SWITCH .............................................................................. 16

7.8. COMMUNICATION SETTINGS............................................................... 17

7.8.1. Slave Address.................................................................................... 17

7.8.2. Baud Rate.......................................................................................... 17

7.8.3. Parity.................................................................................................. 17

7.9. FAULT RECORDER.................................................................................. 17

7.9.1. Number of the fault recordings......................................................... 17

7.9.2. Adjustment of trigger occurrences.................................................... 18
8. INDICATION OF MEASURED VALUES AND FAULT DATA ................................................... 22

8.1. INDICATION OF MEASURED VALUES ........................................................................ 22
8.2. INDICATION OF FAULT DATA .................................................................................. 22
  8.2.1. Fault Memory ....................................................................................................... 22
8.3. FAULT RECORDING .................................................................................................. 23
8.4. TEST TRIP ................................................................................................................ 24
8.5. RESET ....................................................................................................................... 24
  8.5.1 Hand reset ............................................................................................................. 24
  8.5.2. Auto-reset at Power Up ...................................................................................... 24

9. RELAY CASE .............................................................................................................. 24

9.1. INDIVIDUAL CASE .................................................................................................. 24
9.2. RACK MOUNTING .................................................................................................. 24
9.3. TERMINAL CONNECTIONS ................................................................................... 24

10. TEST AND MAINTENANCE ....................................................................................... 25

11. TECHNICAL DATA .................................................................................................... 25

11.1. MEASURING INPUT CIRCUITS ............................................................................. 25
11.2. AUXILIARY POWER SUPPLY .............................................................................. 25
11.3. COMMON DATA .................................................................................................... 25
11.4. ACCURACIES ......................................................................................................... 26
11.5. OUTPUT CONTACT RATINGS ............................................................................. 26
11.6. TYPE TESTS .......................................................................................................... 27
11.7. HOUSING ............................................................................................................... 30
11.8. TERMINAL CONNECTION DETAILS .................................................................. 31

12. ORDER FORM ........................................................................................................... 32
1. Introduction.

The application of powerful microprocessors opens a new chapter for power system protective relaying. The digital processing of measured values and the ability to perform complex arithmetic and logic operations, give digital protection relays significant performance and flexibility improvements over their traditional analogue counterparts. Additional advantages - very small power consumption, adaptability, self-supervision, fault diagnosis through fault data recording, smaller physical construction and selectable relay characteristics - all combine to allow the implementation of accurate and highly reliable protection schemes at a significantly reduced financial burden.

The development of microprocessor based protective relays and their introduction into the market has been stimulated by the recent trend to replace analogue with digital equipment. This modern trend has prompted the development of a new P&B protective relay family - the MR relay series. This comprehensive family of protection relays can satisfy the demands of even the most complex protection schemes:

- MRI - Overcurrent Relay (Independent time/I.D.M.T + earth + directional facilities)
- MRI-V - Voltage Dependent Overcurrent Relay
- MREF - Restricted Earth Fault Relay
- MRAR - Auto-Reclosing Relay
- MRMF - Mains Failure Relay
- MRVT - Voltage Protection
- MRFT - Frequency Protection
- MIROS - Vector Surge or Rate of Change of Frequency
- MRNS - Negative Sequence Relay
- MRRP - Power Relay
- MRCS - Check Synchronising Relay
- MRFF - Field Failure Relay
- MRDG - Differential Relay

The superiority of digital protective relaying over traditional analogue devices, as embodied by the MR relay family, is summarised by the following features:

- Integration of many protective functions in a single compact case
- High accuracy owing to digital processing
- Digital relay setting with very wide setting ranges and fine setting steps
- Comfortable setting procedure through extensive human - relay dialogue
- Measured values and fault data indication by means of alpha-numeric display
- Data exchange with DCS/SCADA by means of RS485
- Operational reliability through self-supervision

A similar but simplified range, with reduced functions and without display, is also available. The MIRI - overcurrent and earth fault relays, and the MIRV - undervoltage, overvoltage and neutral voltage displacement relays. To complement the MR series, a range of Auxiliary, Timing and Tripping devices are also available.
2. Application.

The MRVT is an universal mains decoupling relay that covers the protection requirements of most utilities for the mains parallel operation with co-generation schemes. The protective functions of the MRVT are summarised as follows:

- Over and Under Voltage Protection
- Voltage supervision with two stage under and over voltage detection.
- Independent time settings for voltage supervision.

3. Features and characteristics.

- Complete digital processing of the sampled measured values.
- Digital filtering of the measured values by using discrete Fourier analysis to suppress the high frequency harmonics and dc component induced by faults or system operation.
- Extremely wide setting ranges with fine setting steps
- Two Parameter Sets
- Unauthorised user access control through password protection
- User defined password.
- Continuous self-supervision of software and hardware.
- Outstanding design flexibility for easy selection of appropriate operational scheme for numerous applications
- Numerical display of setting values, actual measured values and memorised fault data etc.
- Display of measuring values as primary quantities
- Storage of trip values and switching-off time ($t_{CBFP}$) of 5 fault occurrences (fail-safe of voltage)
- Recording of up to eight fault occurrences with time stamp
- Ability to block individual functions by the external blocking input
- Programmable Output Relays
- Display Of Date and Time
- Suppression of Indication after an activation
- Serial data communication facilities via RS485.
- Wide voltage range for DC or AC power supply.
- Withdrawable modules with automatic short circuit of C.T. inputs.
4. Design.

4.1. Connections.
Application Diagram;

4.1.1. Analogue input circuits.

The constantly monitored measuring values are galvanically decoupled, filtered and finally fed to the analogue/digital converter. The protection unit receives these analogue input signals of the voltages via separate input transformers. The measuring circuits can be applied in star or delta configuration (See Section 5.4.1)

4.1.2. Output relays.

The **MRVT** has five output relays, with single or dual pole change-over contacts as detailed in the previous diagram and summarised below:

- Relay 1 (dual pole)
- Relay 2 (dual pole)
- Relay 3 (dual pole)
- Relay 4 (single pole)
- Self-supervision alarm relay (single pole)

All the relays, with the exception of the self supervision relay, are programmable. Details on how to program them can be found in Section 7.14.
4.1.4. Remote data communication.

The MRVT have an RS485 interface for remote data communication with a control centre. The unit provides the following information:

- Status signals
- Self supervision alarm signal
- Actual measured values
- Relay settings
- Fault signalling

P&B Protocol is supplied as standard although Slave MODBUS RTU protocol can be supplied upon request.

4.2. Front panel.

The front panel of the MRVT (comprise the following operation and indication elements:

- Alphanumeric display
- 5 push buttons for setting and other operations
- Up to 17 LEDs for measured value indication and setting

4.2.1. Display.

The measured and set values, and recorded fault data, are shown alphanumerically on the display. The meaning of the displayed values is easily interpreted from the LED indicators on the front panel.

Front Panel MRVT
4.2.2. LED indicators.

The LEDs left of the display indicate measuring or tripping values. The purpose of the corresponding LED is to be identified according to the inscription above the LEDs (e.g. f, for frequency).

All LEDs are bi-coloured LEDs, (except the RS, min and max LEDs), the green indicating measuring and the red for fault indication.

The LED marked with the letters RS, is used to indicate serial data communication. The LED lights if the serial interface is active.

The LEDs to the left of the display indicate measuring or tripping values. The purpose of the corresponding LED is identified by the adjacent inscription, (e.g. L2 for Voltage in phase 2).

The full list of LEDs are as follows:-

<table>
<thead>
<tr>
<th>LED</th>
<th>Indicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Voltage Phase 1</td>
</tr>
<tr>
<td>L2</td>
<td>Voltage Phase 2</td>
</tr>
<tr>
<td>L3</td>
<td>Voltage Phase 3</td>
</tr>
<tr>
<td>⌚</td>
<td>Date And Time</td>
</tr>
<tr>
<td>RS</td>
<td>Serial Address</td>
</tr>
<tr>
<td>FR</td>
<td>Fault Recording</td>
</tr>
<tr>
<td>P2</td>
<td>Parameter Switch</td>
</tr>
<tr>
<td>D/Y</td>
<td>Delta/Star Switch</td>
</tr>
<tr>
<td>U&lt;</td>
<td>Low Set Undervoltage</td>
</tr>
<tr>
<td>tU&lt;</td>
<td>Time Delay for Low Set Undervoltage</td>
</tr>
<tr>
<td>U&lt;&lt;</td>
<td>High Set Undervoltage</td>
</tr>
<tr>
<td>tU&lt;&lt;</td>
<td>Time Delay for High Set Undervoltage</td>
</tr>
<tr>
<td>U&gt;</td>
<td>Low Set Overvoltage</td>
</tr>
<tr>
<td>tU&gt;</td>
<td>Time Delay for Low Set Overvoltage</td>
</tr>
<tr>
<td>U&gt;&gt;</td>
<td>High Set Overvoltage</td>
</tr>
<tr>
<td>T_U&gt;&gt;</td>
<td>Time Delay for High Set Overvoltage</td>
</tr>
<tr>
<td>1/3</td>
<td>1-phase or 3-phase tripping</td>
</tr>
<tr>
<td>fN</td>
<td>Nominal Frequency</td>
</tr>
</tbody>
</table>

4.2.3. Push buttons.

The front panel contains five push buttons used for setting, measuring and other user functions.

The individual setting and measuring values can be selected in turn by pressing the <SELECT> / <RESET> push button. This button also resets the relay if pressed for approximately 3 seconds.

The <UP> and <DOWN> push buttons are for incrementing and decrementing any selected parameter. Continuous pressing of these push buttons will cause the parameter to change at an increased rate.

The <ENTER> push button is used to transfer the indicated value to the internal parameter memory. An unintended or unauthorised change of the selected parameter can be avoided through the password protection facility.

The <TRIP> push button is used to test the output relay circuits, both for tripping and signalling. This operation is also password protected.
4.3. Code Jumpers.

Behind the front panel of the MRVT are two code jumpers used to preset the following functions:

- Password programming
- Reset functions

The following figure shows the position and designation of the code jumpers.

Note. If you have a Surface Mount Board (with Wide range power supplies) there will be two extra jumpers. These jumpers are used to choose the input voltage for the external reset and the blocking input. The two jumpers should always be the same.

Jumper 4 – Input voltage upto 240V
Jumper 5 – Input voltage upto 110V
4.3.1. Password programming.

The MRVT relay are normally delivered with the pre-set password "^_^_^_", they can be reprogrammed using the removable code jumper J1. After power on and the pressing of any push button, the MRVT relay enquires for a new password with the text <PSW?> appearing on the display. A new password is then entered by pressing a combination of <SELECT>, <UP>, <DOWN> or <ENTER>, as chosen by the user. After the new password has been given, the relay module is extracted from its case and code jumper J1 removed.

4.3.2. Alarm and Trip relay function.

The following function of the MRVT relays may be pre-set using jumper J3.

- Manual or Automatic reset of the output relays
- Password (see section 4.3.1.)

Code jumper J3 - OFF
All output relays will be reset automatically after tripping, once the fault has been cleared.

Code jumper J3 - ON
All output relays remain activated and must be reset manually by pressing the <RESET> push button, after the fault has been cleared.

Summarising the coding possibilities

<table>
<thead>
<tr>
<th>Code jumper</th>
<th>Function</th>
<th>Code jumper Position</th>
<th>Operation Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>Password</td>
<td>OFF</td>
<td>Normal position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>Password programming</td>
</tr>
<tr>
<td>J2</td>
<td>Not used</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>J3</td>
<td>Reset</td>
<td>OFF</td>
<td>Output relays will be reset</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ON</td>
<td>automatically.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Output relays will be reset</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>manually.</td>
</tr>
</tbody>
</table>
5. Working principles.

5.1. Analogue circuits.

The incoming voltages from the external voltage transformers are converted to internal signals in proportion to the voltages, via the internal input transducers and shunt resistors. The noise signals caused by inductive and capacitive coupling are suppressed by an analogue RC filter circuit. The analogue signals are fed to the A/D converter of the micro-processor and transformed to digital signals through sample-hold circuits. The analogue signals are sampled with a sampling frequency of $16 \times$ the fundamental frequency, namely a sampling rate of 1.25 mS for every measured quantity at 50Hz.

5.2. Digital circuits.

The essential component of the MRVT relay is a powerful micro-controller. All of the operations, from the analogue digital conversion to the relay trip decision, are carried out by the micro-controller digitally. The relay program, located in EPROM, allows the CPU of the micro-controller to calculate the voltage values in order to detect a possible fault.

For the calculation of the measured values, an efficient digital filter, based on the Fourier Analysis (DFFT - Discrete Fast Fourier Transformation), is applied to suppress high frequency harmonics and DC components caused by fault induced transients or other system disturbances. The actual calculated values are compared with the relay settings. When a measured value exceeds the starting value the unit starts the corresponding time delay calculation. When the set time delay has elapsed, a trip signal is given.

The relay setting values for all parameters are stored in EEPROM, so that the actual relay settings cannot be lost, even in the event of auxiliary supply interruption. The micro-processor is supervised through a built in "Watch-dog" timer. Should a failure occur the watch-dog timer resets the micro-processor and gives an alarm signal via the self supervision output relay.

5.3. Power supply.

A wide range auxiliary power supply is available:

\[
V_{aux} = \begin{cases} 
16V & \text{to } 360V \text{ DC} \\
16V & \text{to } 270V \text{ AC}
\end{cases}
\]

5.4. Voltage Supervision.

The MRVT Relay has applications in the protection of Generators and other electrical equipment’s requiring protection against under and over voltage.

The relay is equipped with a two stage, independent, three phase overvoltage ($U_{>,U_{>>}}$) and undervoltage ($U_{<,U_{<<}}$) characteristic, with completely separate time and voltage settings.

In Delta connection, the phase to phase voltages, and in Star connection, the phase to neutral voltages, are continuously compared with the pre-set thresholds.

For overvoltage supervision, the highest voltage of each phase is relevant, whilst for undervoltage supervision, the lowest voltage in each phase is relevant.
5.4.1. Selection Delta/Star Connection of the Input Transformers.

All connections to the input voltage transformers are available. The nominal voltage of the unit is the nominal voltage of the input transformers. Dependent upon the application, the input transformers can be connected in either Star or Delta configuration.

The connection for the phase to phase voltage is the delta connection. In star connection the measuring voltage is reduced by \( \frac{1}{\sqrt{3}} \). During parameter setting the connection configuration can be set.

*Note: The appropriate setting (Star or Delta) must be set on the relay. In the star mode voltages V1, V2, V3, V12, V23, & V31 may be displayed. However, in the delta mode voltages V12, V23, & V31 may only be displayed.*

**Input Transformers in Star Configuration**

**Input Transformers in Delta Configuration**
6. Operation.

6.1. Layout of the control elements.
All control elements required for the operation and adjustment of the MRVT are located on the front panel. They are divided according to function into the three following groups:

- **Alphanumeric Display**: Indication of parameter set values, actual measured values and recorded fault data.
- **LED's**: Indication of selected parameters and measured quantities.
- **Push Buttons**: Selection of parameter to be adjusted, quantity to be measured and adjustment of parameter values. Where:
  - **<SELECT / RESET>** Selection of the parameter to be set and the relay quantities to be measured. Continuous pressing as the reset function.
  - **<UP>** Increment of the setting values for the parameter selected.
  - **<DOWN>** Decrement of the setting values for the parameter selected.
  - **<ENTER>** Storage of the setting values for the selected parameter.
  - **<TRIP>** Testing of the output relay circuits.

6.2. Relay setting principles.
There are up to twenty one relay parameters which can be set by the user:

- U< Undervoltage Threshold
- U<< Undervoltage Threshold (Highset)
- U> Overvoltage Threshold
- U>> Overvoltage Threshold (Highset)
- tU< Undervoltage Time Delay
- tU<< Undervoltage Time Delay (Highset)
- tU> Overvoltage Time Delay
- tU>> Overvoltage Time Delay (Highset)
- 1/3 1-phase or 3-phase tripping
- Fn Nominal Frequency
- RS Serial Interface No
- FR Fault Recorder
- ☕ Date and Time

By pressing the <SELECT/RESET> push button, the parameter to be modified is reached. This set value may then be increased or decreased by pressing the <UP> or <DOWN> buttons respectively. The selected set value is only stored after pressing the <ENTER> push button and inputting the correct password. This means that adjustment of the unit is only possible by authorised users.
6.2.1. Password protected parameter adjustment.

The adjustment of all relay settings are password protected, however, to enable ease of adjustment, for authorised users, application of the password is usually only required once for multiple parameter adjustment. The following step by step sequence is given to illustrate the implementation of the password protection facility, where a new relay setting is to be applied:

- After the present setting value has been selected and changed using the <UP>, <DOWN> push buttons, the <ENTER> push button should be pressed.
- The message <SAV?> appears on the display, to confirm that the new setting value is to be saved.
- After pressing <ENTER> again, the password will be requested. The message <PSW?> is displayed.
- After the password has been given correctly, as indicated by the message <SAV!>, the new setting value may be stored by pressing the <ENTER> push button for at least 3 seconds. The new setting parameter then reappears on the display.

A password consists of four push button operations. The pressed push buttons and their sequence define the password. If the four push buttons are defined by the following symbols:

- <SELECT> = S
- <DOWN> = ∨
- <UP> = ∧
- <ENTER> = E

Then a password "∨E∧S" is achieved by the following sequence:

<DOWN> <ENTER> <UP> <SELECT>.

After a password is given correctly, parameter setting is permitted for five minutes. Subsequent parameter setting made within the five minute period after the password was inputted, does not require renewed password entry. Furthermore, the valid period for parameter setting is automatically extended for a further 5 minutes after each push button operation.

If no push button is pressed within the 5 minute period then the validity of the password will be suspended. To enter further parameters after this period re-application of the password is required.

During the 5 minute period when changes may be made, a new set value, acknowledged by <SAV?> then <SAV!>, may be stored by pressing <ENTER> for approximately 3 seconds.
7. Setting Procedure.

In this section the setting of all relay parameters is described in detail:

7.1. Nominal frequency.

For proper functioning it is necessary to first adjust the rated frequency. For this a distinction has to be made between the settings, v=50Hz / f=50Hz / v=60Hz / f=60Hz.

The difference lies in the method of voltage measurement. With a setting “v=50Hz” or “v=60Hz” the voltage measurement is independent of the existing frequency. This means that the voltage can be correctly measured between 30 Hz and 80 Hz without adverse effects from the frequency.

With the setting “f=50Hz” or “f=60Hz” the measured voltage value is influenced by the frequency.

<table>
<thead>
<tr>
<th>Setting</th>
<th>v=50</th>
<th>f=50</th>
<th>v=60</th>
<th>f=60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Frequency</td>
<td>50Hz</td>
<td>50Hz</td>
<td>60Hz</td>
<td>60Hz</td>
</tr>
<tr>
<td>Influence on voltage measurement</td>
<td>None</td>
<td>0.5 to 1% per Hz error</td>
<td>none</td>
<td>0.5 to 1% per Hz error</td>
</tr>
<tr>
<td>Fault Recorder</td>
<td>Recording distorted</td>
<td>Recording Correct</td>
<td>Recording distorted</td>
<td>Recording Correct</td>
</tr>
<tr>
<td>Influence on all other functions</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

The difference in settings is required for the fault recorder. If the fault recorder is to be used the setting must be “f=50Hz” or “f=60Hz”. The different designations “f” or “v” have no influence on any other functions.

During setting of the nominal frequency a value in Hz is shown on the display.
7.2. Voltage Protection.

The setting procedure is guided by two coloured LED’s. During the setting of the voltage thresholds, the LED’s \( U_\text{<} \), \( U_\text{<<} \), \( U_\text{>} \), \( U_\text{>>} \) are lit green. During the setting of the time delays \( t_{U_\text{<}} \), \( t_{U_\text{<<}} \), \( t_{U_\text{>}} \), \( t_{U_\text{>>}} \) the LED’s are illuminated red.

7.2.1. Low Set Undervoltage \( U_\text{<} \) Trip Value.

During the setting of this value the \( U_\text{<} \) LED will light up. The range for this relay depends upon the voltage rating for the relay.

If the rated voltage is 100V then the range is 2 to 200V in 1V Steps.
If the rated voltage is 230V then the range is 2 to 460V in 1V Steps.
If the rated voltage is 400V then the range is 2 to 800V in 1V Steps.

This function can be inhibited by setting the value to “EXIT”.

7.2.2. Low Set Undervoltage \( t_{U_\text{<}} \) Trip Delay.

During the setting of this value the \( t_{U_\text{<}} \) LED will light up. The range for the Trip delay is 0.04 to 50s.

- In the range 0.04s to 1.00s it is in steps of 0.02s.
- In the range 1.00s to 2.00s it is in steps of 0.05s.
- In the range 2.00s to 5.00s it is in steps of 0.1s.
- In the range 5.00s to 10.00s it is in steps of 0.2s.
- In the range 10.00 to 20.00s it is in steps of 0.5s.
- In the range 20.00s to 50.00s it is in steps of 1.00s.

7.2.3. High Set Undervoltage \( U_\text{<<} \) Trip Value.

During the setting of this value the \( U_\text{<<} \) LED will light up. The range for this relay depends upon the voltage rating for the relay.

If the rated voltage is 100V then the range is 2 to 200V in 1V Steps.
If the rated voltage is 230V then the range is 2 to 460V in 1V Steps.
If the rated voltage is 400V then the range is 2 to 800V in 1V Steps.

This function can be inhibited by setting the value to “EXIT”.

7.2.4. High Set Undervoltage \( t_{U_\text{<<}} \) Trip Delay.

During the setting of this value the \( t_{U_\text{<<}} \) LED will light up. The range for the Trip delay is 0.04 to 50s.

- In the range 0.04s to 1.00s it is in steps of 0.02s.
- In the range 1.00s to 2.00s it is in steps of 0.05s.
- In the range 2.00s to 5.00s it is in steps of 0.1s.
- In the range 5.00s to 10.00s it is in steps of 0.2s.
- In the range 10.00 to 20.00s it is in steps of 0.5s.
- In the range 20.00s to 50.00s it is in steps of 1.00s.
7.2.5. Low Set Overvoltage U> Trip Value.

During the setting of this value the U> LED will light up. The range for this relay depends upon the voltage rating for the relay.

If the rated voltage is 100V then the range is 2 to 200V in 1V Steps.
If the rated voltage is 230V then the range is 2 to 460V in 1V Steps.
If the rated voltage is 400V then the range is 2 to 800V in 1V Steps.

This function can be inhibited by setting the value to “EXIT”.

7.2.6. Low Set Overvoltage tU> Trip Delay.

During the setting of this value the tU> LED will light up. The range for the Trip delay is 0.04 to 50s.
   In the range 0.04s to 1.00s it is in steps of 0.02s.
   In the range 1.00s to 2.00s it is in steps of 0.05s.
   In the range 2.00s to 5.00s it is in steps of 0.1s.
   In the range 5.00s to 10.00s it is in steps of 0.2s.
   In the range 10.00 to 20.00s it is in steps of 0.5s.
   In the range 20.00s to 50.00s it is in steps of 1.00s.

7.2.7. High Set Overvoltage U>> Trip Value.

During the setting of this value the U>> LED will light up. The range for this relay depends upon the voltage rating for the relay.

If the rated voltage is 100V then the range is 2 to 200V in 1V Steps.
If the rated voltage is 230V then the range is 2 to 460V in 1V Steps.
If the rated voltage is 400V then the range is 2 to 800V in 1V Steps.

This function can be inhibited by setting the value to “EXIT”.

7.2.8. High Set Overvoltage tU>> Trip Delay.

During the setting of this value the tU>> LED will light up. The range for the Trip delay is 0.04 to 50s.
   In the range 0.04s to 1.00s it is in steps of 0.02s.
   In the range 1.00s to 2.00s it is in steps of 0.05s.
   In the range 2.00s to 5.00s it is in steps of 0.1s.
   In the range 5.00s to 10.00s it is in steps of 0.2s.
   In the range 10.00 to 20.00s it is in steps of 0.5s.
   In the range 20.00s to 50.00s it is in steps of 1.00s.
7.3. Blocking Of Protection Functions (Blocking Input).

The blocking function of the MRVT can be set according to requirement. By applying the auxiliary voltage to 55 and 56, the functions chosen by the user can be blocked. Setting of the parameter should be done as follows:

1.) When pressing push buttons <ENTER> and <TRIP> at the same time the message "BLOC" is displayed (i.e. the respective function is blocked) or "NO_B" (i.e. the respective function is not blocked). The LED allocated to the first protection function U< is illuminated.

2.) By pressing push buttons <VALUE UP> and <VALUE DOWN> the value displayed can be changed.

3.) The changed value is stored by pressing <ENTER> and entering the password.

4.) By pressing the <SELECT/RESET> push button, any further protection function which can be blocked is displayed.

5.) Thereafter the blocking menu is left by pressing <SELECT/RESET> again.

If the <SELECT/RESET> button is pressed again the blocking menu is left and the assignment menu is accessed.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>Display</th>
<th>LED/Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>U&lt;</td>
<td>Low Set Undervoltage</td>
<td>BLOC</td>
<td>red</td>
</tr>
<tr>
<td>U&lt;&lt;</td>
<td>High Set Undervoltage</td>
<td>BLOC</td>
<td>red</td>
</tr>
<tr>
<td>U&gt;</td>
<td>Low Set Overvoltage</td>
<td>NO_B</td>
<td>red</td>
</tr>
<tr>
<td>U&gt;&gt;</td>
<td>High Set Overvoltage</td>
<td>NO_B</td>
<td>red</td>
</tr>
</tbody>
</table>

Table 7.3.. Default settings of both parameter sets.

7.4. Display of Volts as Primary Voltage.

The residual voltage can be shown as a primary measurement. For this the parameter of the transformer ratio of the VT has to be set accordingly. If the parameter is set to “sec” the measuring value is shown as rated secondary voltage.

Example.
The voltage transformer used is 10kv/100V. The transformer ratio is 100 and this value has to be set accordingly. If the rated secondary voltage is to be shown the parameter is set to 1.

7.5. Delta/Star Switch Over.

Depending on the mains voltage conditions the input voltage transformer can be operated in delta or star connection.
7.6. Display of the Activation (FLSH/NOFL).

If after an activation the existing voltage drops again below the pickup value (e.g. \( U > \)) without a trip being initiated then the LED (\( U > \)) signals that an activation has occurred by flashing fast. The LED keeps flashing until it is reset again via the RESET button. The flashing can be suppressed when the parameter is set to NOFL.

7.7. Parameter Switch.

The relay is able to store two different sets of setting parameters. This could be used, for example, in planned alternative network configurations where different characteristics may be required for coordination purposes.

It is possible to change between the two parameter sets either over the communications port, using suitable software, when the parameter switch is set at "SET 1" or "SET 2" or by using the available digital inputs. The MRVT has two inputs, the blocking input and the reset input. By selecting the parameter switch to "BLOC", the blocking input can be used to choose the parameter set. Alternatively by selecting the parameter switch to "RST" the reset input can be used to change the parameter set. This is summarised below.

<table>
<thead>
<tr>
<th>Software Parameter</th>
<th>Blocking input used as</th>
<th>RESET input used as</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET 1</td>
<td>Blocking input</td>
<td>RESET input</td>
</tr>
<tr>
<td>SET 2</td>
<td>Blocking input</td>
<td>RESET input</td>
</tr>
<tr>
<td>BLOC</td>
<td>Parameter set change over</td>
<td>RESET input</td>
</tr>
<tr>
<td>RST</td>
<td>Blocking input</td>
<td>Parameter set change over</td>
</tr>
</tbody>
</table>

When settings SET1 or SET2 are used, the parameter set is activated by software by pressing the \(<\text{SELECT/RESET}>\) button when the P2 LED is lit. Terminals 53, 54 and 55 are then available as external inputs for RESET or BLOCKING:

The setting BLOC uses the BLOCKING input (terminals 54, 55) for the change over procedure and the setting RST uses the RESET input (terminals 53, 54) for this procedure. When aux. Voltage is applied to one of these two external inputs, then the parameter set is changed over from Set 1 to Set 2. When parameter set 2 is active, LED P2 lights up. If the aux. Voltage is disconnected, it automatically changes over to parameter set 1 again.

Important Note:

When functioning as parameter change over facility, the external input RESET is not available for resetting. When using the external input BLOCKING the protection functions must be deactivated by software blocking separately (refer to Section 7.3.).

7.8.1. Slave Address.

This setting range 1 to 32, with a default setting of 1, identifies the relay to the XCell unit (or any software capable of communicating to a Data highway) to which the RS485 Data Highway of the MRVT is connected.

7.8.2. Baud Rate.

This value determines the speed at which the relay communicates through its RS485 port. It can be set to 1200, 4800, 9600 or 19200 Baud with a default setting of 9600. If you have chosen an MRVT relay with MODBUS Comms Protocol you are able to change this setting, otherwise it is set to 9600 and cannot be changed.

7.8.3. Parity.

The following three parity settings are available:

- "even" = even parity
- "odd" = odd parity
- "no" = no parity check.

Again this setting is only available if you have a relay with MODBUS comms protocol.


The MRVT is equipped with a fault recorder (see Section 6.4.3.). Three parameters can be determined.

7.9.1. Number of the fault recordings.

The number of max. recordings requested has to be determined in advance. There is a choice of 2, 4 or 8 recordings and the duration of the individual fault recordings are dependent upon the number chosen, as shown below:

- 2 recordings for a duration of 8 s (or 6.66s at 60Hz)
- 4 recordings for a duration of 4 s (or 3.33s at 60Hz)
- 8 recordings for a duration of 2 s (or 1.66s at 60Hz)

If the fault recorder is to be used the nominal frequency should be set to either “f=50Hz” or “f=60Hz”.

7.9.2. Adjustment of trigger occurrences.

There is a choice between four different occurrences:

- **P_UP (PickUP)**: Storage is initiated after recognition of a general activation.
- **TRIP**: Storage is initiated after a trip has occurred.
- **A_PI (After Pickup)**: Storage is initiated after the last activation threshold was fallen short of.
- **TEST**: Storage is initiated by the RESET function.

7.9.3. Pre-trigger time ($T_{pre}$)

The time setting $T_{pre}$ determines the period of time prior to the trigger occurrence which should be recorded as well. It is possible to adjust the time between 0.05s and 8s. With keys $<+>$ and $<->$ the values can be changed and with $<ENTER>$ be saved.

7.10. Adjustment of the clock.

When adjusting the date and time the $\odot$ LED lights up and the clock setting parameters are displayed on the alpha-numeric display. Each setting is accessed using the $<SELECT/RESET>$ button. The adjustment method is as follows:

**Date:**
- Year $Y=00$
- Month $M=00$
- Day $D=00$

**Time:**
- Hour $h=00$
- Minute $m=00$
- Second $s=00$

The clock starts with the set date and time as soon as the supply voltage is switched on. The time is safe guarded against short-term voltage failures (min. 6 minutes).
7.11. Programming Of Output Relays.

Output relays 1-4 of the MRVT are normally de-energised and can be assigned as alarm or tripping relays to the overcurrent functions. The fifth output relay is not assignable and is provided as a permanent alarm relay for self-supervision, and is normally energised. The assignment of the output relays is similar to the setting of parameters, however, only whilst in the assignment mode. The assignment mode is accessible via the blocking mode, see above.

When the protection function is highlighted by pressing the <SELECT/RESET> button the value LED refers to the ALARM output and the time delay LED refers to the TRIP output.

Now one or several of the four output relays can be assigned to the protection function chosen as either an alarm or trip relay. Indication ‘1_ _ _’ means that output relay 1 is assigned to this protection function. When the display shows ‘ _ _ _ _’, no alarm relay is assigned to this protection function. The assignment of output relays 1,2,3 & 4 to the protection function can be changed by pressing value up and value down push buttons. The selected assignment can be stored by pressing push button <ENTER> and subsequent input of the password.

By repeated pressing of the <SELECT/RESET> push button and assignment of the relays all parameters can be assigned separately to the relays. The assignment mode can be terminated at any time by pressing the <SELECT/RESET> push button for approximately 3 seconds.

### EXAMPLE

<table>
<thead>
<tr>
<th>Relay Number</th>
<th>Outputs</th>
<th>Relays</th>
<th>Display-indication</th>
<th>LED Illuminated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal Number</td>
<td>29-34</td>
<td>35-40</td>
<td>41-46</td>
<td>47,49,51</td>
</tr>
<tr>
<td>Function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U&lt; alarm Tripping</td>
<td></td>
<td></td>
<td>X</td>
<td>_ _ _ _</td>
</tr>
<tr>
<td>tU&lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U&lt;&lt; alarm Tripping</td>
<td></td>
<td></td>
<td>X</td>
<td>_ _ _ _</td>
</tr>
<tr>
<td>tU&lt;&lt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U&gt; alarm Tripping</td>
<td></td>
<td></td>
<td>X</td>
<td>_ _ _ _</td>
</tr>
<tr>
<td>tU&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U&gt;&gt; alarm Tripping</td>
<td></td>
<td></td>
<td>X</td>
<td>_ _ _ _</td>
</tr>
<tr>
<td>tU&gt;&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

X=Default Values.
### 7.12. Setting Summary

<table>
<thead>
<tr>
<th>LED</th>
<th>RANGE</th>
<th>STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>If Un = 100V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undervoltage Low Set Trip Value</td>
<td>U&lt;</td>
<td>2 to 200V (EXIT)</td>
</tr>
<tr>
<td>Undervoltage Low Set Trip Delay</td>
<td>tU&lt;</td>
<td>0.04 to 50s (EXIT)</td>
</tr>
<tr>
<td>Undervoltage High Set Trip Value</td>
<td>U&lt;&lt;</td>
<td>2 to 200V (EXIT)</td>
</tr>
<tr>
<td>Undervoltage High Set Trip Delay</td>
<td>tU&lt;&lt;</td>
<td>0.04 to 50s (EXIT)</td>
</tr>
<tr>
<td>Overvoltage Low Set Trip Value</td>
<td>U&gt;</td>
<td>2 to 200V (EXIT)</td>
</tr>
<tr>
<td>Overvoltage Low Set Trip Delay</td>
<td>tU&gt;</td>
<td>0.04 to 50s (EXIT)</td>
</tr>
<tr>
<td>Overvoltage High Set Trip Value</td>
<td>U&gt;&gt;</td>
<td>2 to 200V (EXIT)</td>
</tr>
<tr>
<td>Overvoltage High Set Trip Delay</td>
<td>tU&gt;&gt;</td>
<td>0.04 to 50s (EXIT)</td>
</tr>
</tbody>
</table>

| **If Un = 230V** | | |
| Undervoltage Low Set Trip Value | U< | 2 to 460V (EXIT) | 1v |
| Undervoltage Low Set Trip Delay | tU< | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Undervoltage High Set Trip Value | U<< | 2 to 460V (EXIT) | 1v |
| Undervoltage High Set Trip Delay | tU<< | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Overvoltage Low Set Trip Value | U> | 2 to 460V (EXIT) | 1v |
| Overvoltage Low Set Trip Delay | tU> | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Overvoltage High Set Trip Value | U>> | 2 to 460V (EXIT) | 1v |
| Overvoltage High Set Trip Delay | tU>> | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |

| **If Un = 400V** | | |
| Undervoltage Low Set Trip Value | U< | 2 to 800V (EXIT) | 1v |
| Undervoltage Low Set Trip Delay | tU< | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Undervoltage High Set Trip Value | U<< | 2 to 800V (EXIT) | 1v |
| Undervoltage High Set Trip Delay | tU<< | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Overvoltage Low Set Trip Value | U> | 2 to 800V (EXIT) | 1v |
| Overvoltage Low Set Trip Delay | tU> | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |
| Overvoltage High Set Trip Value | U>> | 2 to 800V (EXIT) | 1v |
| Overvoltage High Set Trip Delay | tU>> | 0.04 to 50s (EXIT) | 0.01 to 2.0s ** |

| Transformer Ratio | 1.01 to 6500 (SEC) | 0.01 to 50 ** |
| Switch Group | Δ=Delta, Y = Star |
| Pick Up LED Flash | FLUSH or NOFL |

**These have different steps across the range. See the corresponding section to see where the range has the particular steps.**
<table>
<thead>
<tr>
<th>LED</th>
<th>RANGE</th>
<th>STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Frequency</td>
<td>fN</td>
<td>v=50, f=50, v=60, f=60</td>
</tr>
</tbody>
</table>

**COMMUNICATION**

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>RS</th>
<th>1-32</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud Rate</td>
<td>RS</td>
<td>1200, 2400, 4800 or 9600</td>
<td></td>
</tr>
<tr>
<td>Parity Check</td>
<td>RS</td>
<td>Even, Odd, No</td>
<td></td>
</tr>
</tbody>
</table>

**FAULT RECORDING**

<table>
<thead>
<tr>
<th>No Of Fault Occurrences</th>
<th>FR</th>
<th>2, 4, 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger Signal</td>
<td>FR</td>
<td>TEST, P_UP, A_PR, TRIP</td>
</tr>
<tr>
<td>Pre Trigger Time</td>
<td>FR</td>
<td>0.05 to 8s</td>
</tr>
<tr>
<td>Date</td>
<td>☑</td>
<td>Year, Month, Day</td>
</tr>
<tr>
<td>Time</td>
<td>☑</td>
<td>Hour, Minute, Second</td>
</tr>
</tbody>
</table>

** These have different steps across the range. See the corresponding section to see where the range has the particular steps.
7.13. Setting value calculation.
In order to ensure that protection relays form an integral part of any system, a full protection co-
ordination study should normally be undertaken which considers both upstream and downstream
equipment. Further details may be obtained by contacting P&B Engineering.

8. Indication of measured values and fault data.

8.1. Indication of measured values.

Any one of the following measured quantities may be indicated on the display during normal service
by pressing the <SELECT> button:

- Voltages - LED's L1, L2 and L3 are green
- In Star Connection - All 3 Phases and Neutral
- In Delta Connection - All 3 Phases

The relevant operating values of the individual measured quantities are indicated in the display. The
shown measured values refer to the rated current.

8.2. Indication of fault data.
Visual indication of faults detected by the relay is given on the front panel. The L1, L2, & L3 LEDs
are used to indicate/specify fault events.

When a relay function is initiated by a fault, the corresponding function LED lights up yellow. At the
same time, the phase LED(s) flash(es) red to indicate the faulty phase(s). When the time delay is
reached, the relay is tripped, the LED(s) for the faulty phase(s) turn to a constant red. The function
LED remains alight.

After the occurrence of a trip, fault data may be displayed by repeatedly pressing the <SELECT>
key. After all faults been indicated, the LEDs return to red indicating the fault event. By pressing the
<SELECT/RESET> button for approximately 3 seconds the relay is reset to its original status. If
however, the relay was initiated by the occurrence of a fault, which then fell below a detectable level,
a slowly flashing LED is displayed. This can also be reset using the <SELECT/RESET> button.

8.2.1. Fault Memory.

The fault data is stored in memory, and can record for a maximum of five fault occurrences. When a
new trip occurs the oldest data is written over (FIFO-First in First out). The trip values are stored as
well as the status of the LEDs. Fault values and LED status are indicated when the <UP> or
<DOWN> are pressed. To return to normal indication press the <SELECT/RESET> button.

When the <DOWN> button is pressed the latest fault data is shown. By repeatedly pressing the
<DOWN> button the last but one fault data is shown. By pressing the <UP> button the earlier fault
data is shown. For indication of fault data sets the abbreviations FLT1 etc are used on the display.
FLT1 means the latest fault data set recorded. By pressing the <SELECT/RESET> button when FLT#
is on the display you can scroll through the fault data.

To delete the stored trip press the <SELECT/RESET> and <DOWN> for about 3 seconds. The
display will show “WAIT”.

8.3. Fault Recording.

The MRVT has a fault recorder which records the measured analogue values as instantaneous values. The instantaneous values:

\[ V_{L1}, V_{L2}, V_{L3} \text{ for star connection} \]
\[ V_{12}, V_{23}, V_{31} \text{ for delta connection} \]

are scanned at a rate of 1.25ms (at 50 Hz) and 1.041ms (at 60Hz) and saved in a cyclic buffer. It is possible to store 2 - 8 fault occurrences with a total recording time of 16s per channel.

Via the RS485 interface the data can be read and processed by means of a PC. The data is graphically edited and displayed. Binary tracks are recorded as well, e.g. starting and trip.

When the relay is energised or trips, all fault data and times are stored in a non-volatile memory. The MRVT is provided with a fault value recorder for a maximum eight fault occurrences. In the event of additional trips the oldest data set is always written over.

For fault indication the trip values are recorded and also the status of LED’s are stored. Fault values are indicated when push buttons <VALUE DOWN> or <VALUE UP> are pressed during normal measuring value indication.

- Normal measuring values are selected by pressing the <SELECT/RESET> button.
- When then the <VALUE DOWN> button is pressed, the latest fault data set is shown. By repeated pressing the <VALUE DOWN> button the last but one fault data set is shown etc. For indication of fault data sets abbreviations FLT1, FLT2, FLT3, ...are displayed (FLT1 means the latest fault data set recorded). At the same time the parameter set active at the occurrence is shown.
- By pressing <SELECT/RESET> the fault measuring values can be scrolled.
- By pressing <VALUE UP> it can be scrolled back to a more recent fault data set. At first FLT8, FLT7, ...are always displayed. When fault recording is indicated (FLT1 etc), the LED’s flash in compliance with the stored trip information, i.e. those LED’s which showed a continuous light when the fault occurred are now blinking to indicate that it is not a current fault. LED’s which were blinking during trip conditions, (element had picked up) just briefly flash.
- If the relay is still in trip conditions and not yet reset (TRIP is still displayed), no measuring values can be shown.
- To delete the trip store, the push button combination <SELECT/RESET> AND <VALUE DOWN> has to be pressed for about 3s. The display shows “wait”.

Recording scheme of the fault recorder with lead time.
Recorded Fault Values :-

<table>
<thead>
<tr>
<th>Value Displayed</th>
<th>Relevant LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase voltage L1, L2, L3</td>
<td>L1, L2, L3</td>
</tr>
<tr>
<td>Phase tp Phase L12, L23, L31</td>
<td></td>
</tr>
</tbody>
</table>

Time Stamp

Date:
- Y = 99
- M = 04
- D = 20

Time:
- h = 11
- m = 59
- s = 13

8.4. Test Trip.

The whole tripping circuit of the protection system may be tested by simulating a fault with the <TRIP> push button. This button is also used to interrogate the relay for its software version number. A single press reveals the first half of the software version number and a second press reveals the second half. A third press will be responded to by <PSW?>. Entering the correct password will be responded to by <TRI?>. Pressing <TRIP> again energises all output relays in turn with a delay time of 1 second. All relays will stay energised until manually reset. This operation overrides any blocking functions.

8.5. Reset.

There are two ways in which to reset the MRVT relay:

8.5.1 Hand reset.
By pressing the <SELECT/RESET> for approximately 3 seconds the relay is reset.

8.5.2. Auto-reset at Power Up.
After loss of supply voltage and upon its reconnection the unit resets itself and displays P&B. This resetting of the unit does not effect the set parameters which are stored in an EEPROM.

9. Relay case.
The MRVT is delivered in an individual case for flush mounting.

9.1. Individual case.
The MRVT is supplied in a UK manufactured industry standard drawout case suitable for flush mounting. For case dimension and cut-out, refer to Technical Data.

9.2. Rack mounting.
MRVT relays may be supplied mounted in 19” racks if specified by the user.

9.3. Terminal connections.
The MRVT plug in module is supplied in a case which has a very compact plug and socket connector.
10. Test and maintenance.

For testing the voltage supervision function the input transformers are injected with a test voltage. By changing the test voltages and measuring the tripping time the voltage supervision can be tested. For testing of the frequency supervision function the voltages connected to the input transformers have to be as near as the value of Vn as possible. By changing the frequency of this test voltage and measuring the trip time the frequency supervision can be tested. A portable test case can be supplied which is suitable for testing the MRVT.

All measuring input circuits of the MRVT are of static design and the relay functions are fully digitised. Thus, the MRVT has no particular demand on maintenance.


**Rated Data**

- Rated voltage, Vn: 100V, 230V or 400V
- Rated frequency, fn: 40 - 70Hz

**Power consumption**

- Voltage circuit: < 1 VA

**Withstand**

- Voltage Circuit: 2 x Vn

Blocking of frequency measurement Below 11%

11.2. Auxiliary power supply.

Vaux = 16-360V DC / 16-270V AC 50/60Hz

Power Consumption

- Quiescent: @ 24V and 110V - Approx. 3W
- Operating: @ 24V and 110V - Approx. 6W

11.3. Common data.

- Drop Off/Pick Up ratio: >97% for U>; <103% for U<
- Drop Off time: 30mS
- Time Lag error: ±10mS
- Interruption Time: 50mS, after which data may be lost

Factors effecting delay times:- No influences could be measured.
11.4. Accuracies.

<table>
<thead>
<tr>
<th>Function</th>
<th>Parameter</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>U&lt;/U&lt;&lt;</td>
<td>U&lt;/U&lt;&lt;</td>
<td>± 1% of set value or ±0.3 &amp; Rated Voltage</td>
</tr>
<tr>
<td>U&lt;/U&lt;&lt;</td>
<td>tU&lt;&lt; tU&lt;&lt;</td>
<td>± 1% or ±15mS</td>
</tr>
<tr>
<td>U&gt;/U&gt;&gt;</td>
<td>U&gt;/U&gt;&gt;</td>
<td>± 1% of set value or ±0.3 &amp; Rated Voltage</td>
</tr>
<tr>
<td>U&gt;/U&gt;&gt;</td>
<td>tU&gt; tU&gt;&gt;</td>
<td>± 1% or ±15mS</td>
</tr>
</tbody>
</table>

11.5. Output contact ratings.

- Number of relays = 5
- Contacts = contacts for trip relays as detailed in application diagrams
  1 change over contact for self supervision relays

Maximum breaking capacity
- 250V AC / 1500VA / continuous current 6A

for DC voltage:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Ohmic</th>
<th>L/R = 4 ms</th>
<th>L/R = 7 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 V DC</td>
<td>0.3 A / 90 W</td>
<td>0.2 A / 63 W</td>
<td>0.18 A / 54 W</td>
</tr>
<tr>
<td>250 V DC</td>
<td>0.4 A / 100 W</td>
<td>0.3 A / 70 W</td>
<td>0.15 A / 40 W</td>
</tr>
<tr>
<td>110 V DC</td>
<td>0.5 A / 55 W</td>
<td>0.4 A / 40 W</td>
<td>0.2 A / 22 W</td>
</tr>
<tr>
<td>60 V DC</td>
<td>0.7 A / 42 W</td>
<td>0.5 A / 30 W</td>
<td>0.3 A / 17 W</td>
</tr>
<tr>
<td>24 V DC</td>
<td>6 A / 144 W</td>
<td>4.2 A / 100 W</td>
<td>2.5 A / 60 W</td>
</tr>
</tbody>
</table>

Max. rated making current: 64A (IEC65)
- Mechanical life span: $3 \times 10^6$ operating cycles
- Electrical life span: $2 \times 10^5$ operating cycles at 220 V AC / 6A
- Contact material: Silver Cadmium Oxide (AgCdO)
## 11.6. Type Tests.

<table>
<thead>
<tr>
<th></th>
<th>Functional Tests</th>
<th>Internal Design Specifications &amp; Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Climatic Tests

<table>
<thead>
<tr>
<th></th>
<th>Test Description</th>
<th>Specification/Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Temperature Dry Cold (Relay operational)</td>
<td>IEC60068-2-1 -20 deg C, 96 hours</td>
</tr>
<tr>
<td>C2</td>
<td>Temperature Dry Cold</td>
<td>IEC60068-2-1 -40 deg C, 96 hours</td>
</tr>
<tr>
<td>C3</td>
<td>Temperature Dry Heat (Relay operational)</td>
<td>IEC60068-2-2 70 deg C, 96 hours</td>
</tr>
<tr>
<td>C4</td>
<td>Temperature Dry Heat (Relay operational)</td>
<td>IEC60068-2-2 85 deg C, 96 hours</td>
</tr>
<tr>
<td>C5</td>
<td>Damp Heat Steady State (Relay operational)</td>
<td>IEC60068-2-3 93% @ 40 deg C, 56 days</td>
</tr>
</tbody>
</table>

### Enclosure

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>Enclosure</td>
<td>IEC 529</td>
</tr>
</tbody>
</table>

### Mechanical

(> Relay operational)

<table>
<thead>
<tr>
<th></th>
<th>Test Description</th>
<th>Specification/Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Vibration</td>
<td>IEC60255-21-1</td>
</tr>
<tr>
<td></td>
<td>Class I Vibration response (relay operational)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vibration response (relay operational)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Hz~150 Hz - peak displacement 0.035 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>below 58/60 Hz, 0.5 g above, 1 sweep cycle in each axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vibration endurance (relay de-energised)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Hz~150 Hz 1 g, 20 sweep cycles in each axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(160 minutes at 1 octave/min)</td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td>Shock &amp; Bump</td>
<td>IEC60255-21-1</td>
</tr>
<tr>
<td></td>
<td>Class I Shock response (relay operational)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shock response (relay operational)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 g 11 ms 3 pulses in each axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shock withstand (relay de-energised)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 g 11 ms 3 pulses in each axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bump (relay de-energised)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 g 16 ms 1000 pulses in each axis</td>
<td></td>
</tr>
<tr>
<td>M3</td>
<td>Seismic</td>
<td>IEC60255-21-1</td>
</tr>
<tr>
<td></td>
<td>Class I Method A single axis sine sweep</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Hz~35 Hz – below 8/9 Hz 3.5 mm peak displacement horizontal axis, 1.5 mm vertical axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>above 8/9 Hz 1 g horizontal, 0.5 g vertical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 sweep cycle in each axis</td>
<td></td>
</tr>
</tbody>
</table>
### Electrical

<table>
<thead>
<tr>
<th></th>
<th>Test Description</th>
<th>Standard(s)</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E1</strong></td>
<td>Insulation resistance &gt;100MΩ</td>
<td>IEC60255-5</td>
<td>500 Vdc, 5 sec between all terminals &amp; case earth, between terminals of independent circuits including contact circuits and across open contacts</td>
</tr>
<tr>
<td><strong>E2</strong></td>
<td>DC &amp; AC Supply Voltage (Relay operational)</td>
<td>IEC60255-6</td>
<td>Voltage range, upper &amp; lower limit continuous withstand, ramp up &amp; down over 1 minute</td>
</tr>
<tr>
<td><strong>E3</strong></td>
<td>Voltage Dips, Short Interruptions &amp; Voltage variations immunity (Relay operational)</td>
<td>IEC60255-11, IEC 1000-4-11</td>
<td>3 dips &amp; 3 interruptions at 10 sec intervals of duration between 10mS and 500mS at zero crossings &amp; at other points on wave variation: 100% to 40% over 2s, hold for 1s, return to 100% over 2s</td>
</tr>
<tr>
<td><strong>E4</strong></td>
<td>Ripple in dc supply (Relay operational)</td>
<td>IEC60255-11</td>
<td>12% ac ripple</td>
</tr>
<tr>
<td><strong>E5</strong></td>
<td>Dielectric Test (Relay de-energised)</td>
<td>IEC60255-5</td>
<td>Series C of table 1: 2.0 kV 50Hz, 1 minute between all terminals &amp; case earth 2.0 kV 50Hz, 1 minute between terminals of independent circuits including contact circuits. 1.0 kV 50Hz, across open contacts, 1 minute.</td>
</tr>
<tr>
<td><strong>E6</strong></td>
<td>High Voltage Impulse (Relay de-energised)</td>
<td>IEC60255-5</td>
<td>5 kV peak 1.2/50μS, 0.5J - 3 positive, 3 negative between all terminals to case earth between independent circuits</td>
</tr>
<tr>
<td><strong>E7</strong></td>
<td>VT input Thermal Withstand</td>
<td></td>
<td>2x Vn, continuous</td>
</tr>
<tr>
<td><strong>E9</strong></td>
<td>Contact performance &amp; endurance tests</td>
<td>IEC60255-14, IEC60255-23</td>
<td></td>
</tr>
</tbody>
</table>
## Electromagnetic Compatibility

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Description</th>
<th>Standard</th>
<th>Class/Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Electrical fast Transient/Burst (Relay operational)</td>
<td>IEC60255-22-4, IEC601000-4-4</td>
<td>Class IV-4.0kv All Circuits. 1 minute each polarity</td>
</tr>
<tr>
<td>R2</td>
<td>Oscillatory Waves 1 Mhz Burst (Relay operational)</td>
<td>IEC60255-22-1</td>
<td>Class III longitudinal 2.5 kVpeak, 2sec between independent circuits &amp; case earth transverse 1.0 kVpeak, 2sec across terminals of the same circuit</td>
</tr>
<tr>
<td>R3</td>
<td>Electrostatic Discharge (Relay operational)</td>
<td>IEC60255-22-2</td>
<td>Class III 15kV air discharge with cover in place, 8 kV contact with cover removed - 10 discharges, both polarities at 1 sec intervals</td>
</tr>
<tr>
<td>R4</td>
<td>Conducted Disturbance RF fields (Relay operational)</td>
<td>IEC61000-4-6</td>
<td>0.15 to 80 Mhz Severity Level 10Vrms +sweeps 0.05-0.15MHz &amp; 80-100MHz</td>
</tr>
<tr>
<td>R5</td>
<td>Radiated e-m field from digital portable telephones (Relay operational)</td>
<td>ENV 50204</td>
<td>900 &amp; 1890MHz at 10V/m</td>
</tr>
<tr>
<td>R6</td>
<td>Radiated RF e-m field immunity test (Relay operational)</td>
<td>IEC60255-22-3</td>
<td>Class III test method A +sweep 500-1000mhz or IEC 1000-4-3 80-1000mhz severity 10V/m 80% modulated 1 kHz</td>
</tr>
<tr>
<td>R7</td>
<td>Surge Immunity capacitively coupled (relay operational)</td>
<td>IEC61000-4-5 Class 5 Test level 4</td>
<td>short circuit combination wave generator 1.2uS/50uS open circuit 8uS/20uS short circuit, + &amp; - polarity phase shifting 0~360° ac line phase angle repetition rate 1 per minute Power supply, ct &amp; vt circuits – 4kV common mode 2 ohm source 2kV differential mode 12 ohm source Output relays 42ohm source Comms 2 ohm screen to earth only</td>
</tr>
<tr>
<td>R8</td>
<td>Power Frequency Magnetic Field (Relay operational)</td>
<td>IEC61000-4-8</td>
<td>1000A/m for 1 sec 100A/m for 1 minute in each of 3 axes</td>
</tr>
<tr>
<td>R9</td>
<td>Power Frequency Interference on communications circuits (Relay operational)</td>
<td>EA TS48-5 class 3, Table 2, Appendix A(i)</td>
<td>For circuit length 100-1000 metres (0.1% unbalanced)</td>
</tr>
<tr>
<td>R10</td>
<td>Power Frequency interference on other circuits except 50 Hz inputs (Relay operational)</td>
<td>EATS 48-5 Appendix A(ii)</td>
<td>All output contact circuits.</td>
</tr>
<tr>
<td>R11</td>
<td>Pulse Magnetic Field (Relay operational)</td>
<td>IEC 1000-4-9</td>
<td>6.4/16uS, 1000A/m</td>
</tr>
<tr>
<td>R14</td>
<td>Conducted &amp; Radiated RF Interference Emission (Relay operational)</td>
<td>EN55022 or EN55011 or EN50081-2 IEC60255-25</td>
<td>Class A interference limits</td>
</tr>
<tr>
<td>R15</td>
<td>Power frequency, conducted common mode</td>
<td>IEC 1000-4-16 IEC60255-22-7</td>
<td>D.C. to 150kHz Test Level 4 300V at 16 2/3Hz and 50Hz</td>
</tr>
</tbody>
</table>

**Weight** = Approx 2Kg
11.7. Housing.

Throughout the MR series range a modular housing system has been employed, utilising the latest high quality UK manufactured industry standard case components. This approach affords maximum flexibility for both the relay scheme designer and the maintenance engineer. The relay modules are fully withdrawable for ease of maintenance and where applicable incorporate automatic short-circuiting CT connections to avoid dangerous open circuit CT overvoltages. A clear plastic front cover is provided for inspection purposes.

**MRVT** units are supplied in standard height (179mm=7in.) cases, complying with IEC 297 size 4U.

The rigid case wall is manufactured from a single sheet of hot dipped galvanised steel coated externally with Plastisol PVC and internally with a low gloss alkyd paint finish. This construction technique provides improved thermal transfer characteristics over plastic walled cases and combines exceptional corrosion and flame resilience with good electromagnetic and electrostatic screening properties allowing many relays to be freely situated in close proximity and hazardous environments. When the relay is inserted a leaf spring along the top edge of the module makes contact with a solidly bonded nickel plated steel strip on the interior of the case, providing excellent earth continuity. This strip is brought out at the rear of the case, above the terminal block, where it forms a separate earthing terminal. A rigid front mounting flange is provided allowing the entire range of standard cases to be flush mounted without alteration. These flanges are also used to mount the relay inspection cover which is secured by thumbscrews. Securely bonded channels can be provided on the top and bottom surfaces toward the rear of the case allowing large rigid assemblies to be created by the use of joining strips located in these channels.

This uniform but highly flexible housing system integrates excellent mechanical strength with good electrical practice in industry standard sizes.
11.8. Terminal Connection Details.

The rear terminal block accepts both pre-insulated screw and push-on blade type connectors which may be used singly or in combination. Each terminal has 1 screw type and 2 blade type connectors.

**Screw:** Each connection uses a 4mm (M4) screw outlet and accepts standard L-shaped ring type connectors designed for 4mm screws.

**Blade:** Each connection facilitates 2 pre-insulated push-on blades 4.8mm wide 0.8mm thick complying with BS5057.

**Combinations:** Each terminal will accept either;

- 2 ring type connectors
- or 2 push-on blade type connectors
- or 1 ring type connector & 1 push-on blade type connector

![Rear terminal block connections diagram](image)

*All information subject to change without notice*

Publication number MRVT Mk 3 Issue 1
12. Order Form.

Digital Multifunctional Relay

<table>
<thead>
<tr>
<th>MR</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Rated Measurement Voltage</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 V (110V)</td>
<td>1</td>
</tr>
<tr>
<td>230 V (240V)</td>
<td>2</td>
</tr>
<tr>
<td>400 V (415V)</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>19&quot; Rack</td>
<td>A</td>
</tr>
<tr>
<td>Flush Mounting</td>
<td>D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication Protocol</th>
<th>Modbus</th>
<th>M</th>
</tr>
</thead>
</table>

Note P&B Protocol is standard.

PBSI Ltd Trading as

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Manchester.
M12 5NG.

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Fax: 0161-230-6464