Compact current relay and protection assemblies
RXHL 401 and RAHL 401

Features
Three phase compact current relay for:
- Phase overcurrent protection, three stages
- Earth-fault overcurrent protection, three stages
- Phase and earth fault overcurrent protection functions with
  - Three stages, the first stage has selectable time delay; definite or inverse. The second and the third stage have definite time delay
  - Logic for detection and clearance of intermittent faults
- General characteristics for the relay
  - There are two groups of parameters settable and readable through the HMI
  - The dialog with the relay can be made in English or Swedish
  - There are two binary inputs for blocking or enabling of selected functions. The binary inputs can also be used for change of setting groups
- There are five binary output relays, which can be independently configured for the different protection functions
- Service values (primary/secondary) and disturbance information can be presented through the HMI
- Start, trip can be presented through the HMI
- The relay has self-supervision with output error signal
- Testing of the output relays and operation of the binary inputs can be performed through the HMI
General

Compact current relay RXHL 401
The compact current relay RXHL 401 has a wide application range from main to back-up protection for feeders and lines, transformers, capacitor banks, electric boilers as well as for generators and motors.
Functions

Overcurrent protection

Application

In radially fed power networks the phase overcurrent function can be used as main or back-up short circuit protection for lines and transformers. The time current characteristic (definite time or any of the inverse time characteristics) should be chosen according to common practice in the network. Normally the same time current characteristic is used for all phase overcurrent relays in the network. This includes phase overcurrent protection for lines, transformers and other equipment. The measuring relay offers great flexibility in the choice of time characteristic.

There is a possibility to use phase overcurrent protection in meshed systems as short circuit protection for lines. It must however be realised that the setting of a short circuit protection system in meshed networks, can be very complicated and a large number of fault current calculations are required. There are situations where there is no possibility to achieve selectivity with a protection system based on phase overcurrent relays in a meshed system. In combination with impedance relays or line differential protections, phase overcurrent relays can serve as back-up short circuit protection for parts of the lines.

For shunt capacitors, shunt reactors, motors and other similar equipment phase overcurrent protection can serve as main or back-up short circuit protection. Also for these applications the time characteristics should be chosen so that co-ordination with other overcurrent protection in the power system can be made.

As the short circuit current level will change depending on the switching state in the power system, there is a great benefit to be able to change parameter-setting groups when the switching state in the system is changed. The measuring relay will enable this.

The blocking option can be used to decrease fault time for some fault points (for example busbars) in radially fed networks.

Design

The overcurrent protection has a low set stage with inverse or definite time delayed function. The inverse time characteristics are provided with minimum operate time for improved selectivity in certain applications.

The low set stage also has a reset time logic for detection of intermittent faults. If the protection starts and the fault current drops the reset of the function will be made gradually so that the integrated fault current time area will be remembered for some time. In case of an intermittent fault every re-strike of the fault will increase the integrated current-time area so that the fault can be tripped.

The overcurrent protection has two high set stages with definite time delayed function. The overcurrent protection is designed for low transient overreach which allows extended reach and smaller setting margins.

The following characteristics are selectable for the low set stage (diagrams are shown in the chapter “Design description”):

1. Definite time delayed
2. Inverse time delayed:
   - Normal inverse (NI)
   - Very inverse (VI)
   - Extremely inverse (EI)
   - Long time inverse (LI)
   - RI inverse (RI)

NI, VI, EI and LI according to IEC 60255-3.

RI-curve according to old electromechanical relays manufactured by ASEA.

Earth-fault protection
Application
The earth-fault protection is non-directional and based on a measurement of the residual current. It is mainly used in solidly and low impedance grounded networks. In high impedance grounded networks, the size of the network and national standards are the factors determining whether the protection can be used. The high set stages are used in the similar way as they are in the phase overcurrent protection, but only in solidly and low impedance grounded networks.

In solidly grounded networks the earth-fault currents can be of the same order of magnitude as the short-circuit currents.

Earth-faults with high fault resistance can be detected by measuring the residual current. This type of protection provides maximum sensitivity to high resistive earth-faults. It is often required to clear the earth-faults with residual currents of magnitudes which are as low as 50-100A.

In high-impedance grounded networks a sensitive non-directional earth-fault overcurrent function can be used as a protection for cross country faults. This is due to the fact that there is a risk that cross-country faults will not activate directional earth-fault overcurrent relays.

In some systems a medium impedance resistive system grounding is used. The neutral point resistor will give an earth-fault current, larger than the capacitive earth-fault current of the lines and cables in the system. If the system is operated radially the non-directional earth-fault overcurrent protection can be used as earth-fault line protection.

The following characteristics are selectable for the low set stage (diagrams are shown in the chapter “Design description”):

1. Definite time delayed
2. Inverse time delayed:
   - Normal inverse (NI)
   - Very inverse (VI)
   - Extremely inverse (EI)
   - Long time inverse (LI)
   - RI inverse (RI)
   - Logarithmic inverse (LOG)

NI, VI, EI and LI according to IEC 60255-3.
RI-curve according to old electromechanical relays manufactured by ASEA.
LOG-curve according to RXIDG relay manufactured by ABB.

Design
The earth-fault protection has a low set stage with inverse or definite time delayed function. The inverse time characteristics are provided with minimum operate time for improved selectivity in certain applications. The low set stage also has a reset time logic for detection of intermittent faults. If the protection starts and the fault current drops the reset of the function will be made gradually so that the integrated fault current time area will be remembered for some time. In case of an intermittent fault every re-strike of the fault will increase the integrated current-time area so that the fault can be tripped. The earth-fault protection has two high set stages with definite time delayed function. The earth-fault protection is designed for low transient-overreach which allows extended reach and smaller setting margins.

Both inverse time characteristics protection as well as three step definite time characteristics are used. If inverse time characteristics are used with equal currents and time settings for all residual current protections in the system. Selectivity is usually achieved as long as there are more than two bays carrying fault current to each substation.

It is also possible to use the protection as a multi-stage earth-fault current line protection where the first stage has instantaneous function and covers most of the protected line. The second stage has a short delay (about 0.4 s) and covers the rest of the line. The third stage has a longer delay and will give relatively rapid and selective fault clearance of high resistive phase to earth-faults.
Active setting group
Application
Different settings of protection functions enable convenient change of network operational conditions, for example switching between normal and emergency situations. The user can change the active setting group at any time, locally by means of local HMI or by activation of the corresponding binary input to the “ChActGrp” function.

Design
The relay has basically two sets of independent setting groups built-in, which contain all setting parameters for overcurrent and earthfault protections. The function has a binary input signal that enables the user to change active group and also a binary output signal for indication of which setting group is active.

Self-supervision
Application
The self-supervision function includes the following functions;

- Checksum verification of ROM contents during start-up.
- RAM verification during start-up.
- Normal micro-processor watchdog function, continuously.
- Internal communication error handler, continuously.

An output error signal from the function is available to configure to a binary output.

Local HMI
Application
The local HMI (Human-Machine-Interface) serves as an information unit, presenting service values and information from the last two recorded disturbances. The current status of all binary input signals are also available.

Trip value recording
Application
At power system faults the relay records the primary trip values and they can be presented in the local HMI. The recorded values are always from the last disturbance.
Design description

Compact current relay RXHL 401
The compact current relay RXHL 401 constitutes the measuring relay of RAHL 401.

The compact current relay RXHL 401 is a protective class II equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precaution such as double insulation or reinforced insulation are provided.

RXHL 401 is a three-phase static, microprocessor-based relay with four input current transformers for galvanic insulation. The input signals are connected to D/A-converters and then filtered. The signals are sampled in the A/D-converter and read into the microprocessor. The unfiltered input signals are also connected to zero crossing detectors and read into the microprocessor. All settings of the relay will be done in the local HMI.

The relay is provided with three LED's; one for start, one for trip and one for “in service”. The relay is provided with two binary inputs and five binary outputs, the binary inputs are galvanically separated from the electronics with opto-couplers. The binary outputs consist of electromechanical relays, each with one change over contact. RXHL 401 requires a DC/DC-converter for the auxiliary voltage supply +/-24 V; RXTUG 22H is recommended. The relay is delivered with 4-shortcircuiting connectors RTXK for mounting on the rear of the terminal base. The connectors will automatically short-circuit the input currents when the relay is removed from the terminal base.

Terminal diagrams

Figure 1: RXHL 401
Time characteristics

Figure 2: Normal inverse time characteristic

Figure 3: Very inverse characteristic

Figure 4: Extremely inverse time characteristic

Figure 5: Long-time inverse characteristic
Figure 6: RI inverse time characteristic

Figure 7: Logarithmic inverse time (IDG) characteristic

Frequency characteristic

Figure 8: Frequency characteristic
Technical data

Table 1: Current inputs

<table>
<thead>
<tr>
<th>Rated phase current $I_r$</th>
<th>1 A or 5 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated neutral current $IN_r$</td>
<td>For $I_r = 1$ A 0.1 A or 1 A For $I_r = 5$ A 0.1 A, 1 A or 5 A</td>
</tr>
</tbody>
</table>

Setting range for the overcurrent protection

<table>
<thead>
<tr>
<th>Stage</th>
<th>$I_r = 1$ A</th>
<th>0.2-3.0 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>$I_r = 5$ A</td>
<td>1-15 A</td>
</tr>
<tr>
<td>Stage &gt;</td>
<td>(1.0-20) x set operate value $I_r$</td>
<td></td>
</tr>
<tr>
<td>Stage &gt;&gt;</td>
<td>(1.0-20) x set operate value $I_r$</td>
<td></td>
</tr>
</tbody>
</table>

Setting range for the earth fault protection

<table>
<thead>
<tr>
<th>Stage</th>
<th>$IN_r = 0.1$ A</th>
<th>10-250 mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>$IN_r = 1$ A</td>
<td>0.1-2.5 A</td>
</tr>
<tr>
<td>Stage</td>
<td>$IN_r = 5$ A</td>
<td>0.5-12.5 A</td>
</tr>
<tr>
<td>Stage &gt;&gt;</td>
<td>(1.0-20) x set operate value $IN_r$</td>
<td></td>
</tr>
<tr>
<td>Stage &gt;&gt;</td>
<td>(1.0-20) x set operate value $IN_r$</td>
<td></td>
</tr>
</tbody>
</table>

Effective phase current range

(0.04-60) x $I_r$

Effective earth current range

(0.05-50) x $IN_r$

Rated frequency $F_r$

50 and 60 Hz

Frequency range

40-60 Hz/50-70 Hz

Power consumption, per phase at rated current

| $I_r = 1$ A | < 30 mVA |
| $I_r = 5$ A | < 150 mVA |

Power consumption, at rated neutral current

| $IN_r = 0.1$ A | < 15 mVA |
| $IN_r = 1$ A | < 30 mVA |
| $IN_r = 5$ A | < 150 mVA |

Overload capacity for phase current input

| $I_r = 1$ A continuously | 4 A |
| $I_r = 5$ A continuously | 20 A |
| $I_r = 1$ A during 1 s | 100 A |
| $I_r = 5$ A during 1 s | 350 A |

Overload capacity for neutral current input

| $IN_r = 0.1$ A continuously | 0.4 A |
| $IN_r = 1$ A continuously | 4 A |
| $IN_r = 5$ A continuously | 20 A |
| $IN_r = 0.1$ A during 1 s | 10 A |
| $IN_r = 1$ A during 1 s | 100 A |
| $IN_r = 5$ A during 1 s | 350 A |

Table 2: Binary inputs

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Rated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary inputs</td>
<td>2</td>
</tr>
<tr>
<td>Binary input voltage RL</td>
<td>48-60 V DC and 110-220 V DC, -20% to +10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>48-60 V DC &lt; 0.3 W / input</td>
</tr>
<tr>
<td></td>
<td>110-220 V DC &lt; 1.0 W / input</td>
</tr>
</tbody>
</table>
### Table 3: Output relays

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Rated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contacts</td>
<td>5 change-over</td>
</tr>
<tr>
<td>Maximum system voltage</td>
<td>250 V AC/DC</td>
</tr>
<tr>
<td>Current carrying capacity</td>
<td>5 A</td>
</tr>
<tr>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>During 1 s</td>
<td>15 A</td>
</tr>
<tr>
<td>Making capacity at inductive</td>
<td>30 A</td>
</tr>
<tr>
<td>load with L/R &gt; 10 ms</td>
<td>10 A</td>
</tr>
<tr>
<td>AC, cos φ &gt; 0.4</td>
<td>8 A</td>
</tr>
<tr>
<td>DC, L/R &lt; 40 ms</td>
<td></td>
</tr>
<tr>
<td>48 V</td>
<td>1 A</td>
</tr>
<tr>
<td>110 V</td>
<td>4 A</td>
</tr>
<tr>
<td>220 V</td>
<td>0.2 A</td>
</tr>
<tr>
<td>250 V</td>
<td>0.15 A</td>
</tr>
</tbody>
</table>

### Table 4: Auxiliary DC voltage supply

<table>
<thead>
<tr>
<th>Power consumption</th>
<th>Rated values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary voltage EL for RXTUG 22H</td>
<td>24-250 V DC, +/-20%</td>
</tr>
<tr>
<td>Auxiliary voltage for the relay</td>
<td>+/-24 V (from RXTUG 22H)</td>
</tr>
<tr>
<td>With RXTUG 22H, input 24-250 V Before operation</td>
<td>&lt; 5.0 W</td>
</tr>
<tr>
<td>Without RXTUG 22H, +/-24 V Before operation</td>
<td>&lt; 2.7 W</td>
</tr>
<tr>
<td>After operation</td>
<td>&lt; 7.0 W</td>
</tr>
<tr>
<td>After operation</td>
<td>&lt; 4.3 W</td>
</tr>
<tr>
<td>Power consumption, back-light</td>
<td>Approximately 0.5 W</td>
</tr>
</tbody>
</table>

### Table 5: Electromagnetic compatibility (EMC), immunity test

<table>
<thead>
<tr>
<th>Test</th>
<th>Severity</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surge</td>
<td>1 and 2 kV</td>
<td>IEC 61000-4-5, class 3</td>
</tr>
<tr>
<td>AC injection</td>
<td>500 V AC</td>
<td>SS 436 15 03, PL 4</td>
</tr>
<tr>
<td>Power frequency magnetic field</td>
<td>1000 A/m</td>
<td>IEC 61000-4-8</td>
</tr>
<tr>
<td>1 MHz burst</td>
<td>2.5 kV</td>
<td>IEC 60255-22-1, class 3</td>
</tr>
<tr>
<td>Spark</td>
<td>4-8 kV</td>
<td>SS 436 15 03, PL 4</td>
</tr>
<tr>
<td>Fast transient</td>
<td>4 kV</td>
<td>IEC 60255-22-4, class 4</td>
</tr>
<tr>
<td>Electrostatic discharge at normal service</td>
<td>6 kV (contact)</td>
<td>IEC 60255-22-2, class 3</td>
</tr>
<tr>
<td>with cover on</td>
<td>8 kV (air)</td>
<td>IEC 60255-22-2, class 3</td>
</tr>
<tr>
<td></td>
<td>6 kV, indirect application</td>
<td>IEC 61000-4-2, class 3</td>
</tr>
<tr>
<td>Radiated electromagnetic field</td>
<td>10 V/m, 80-1000 MHz</td>
<td>IEC 61000-4-3, Level 3</td>
</tr>
<tr>
<td>Radiated pulse electromagnetic field</td>
<td>10 V/m, 900 MHz</td>
<td>ENV 50204</td>
</tr>
<tr>
<td>Conducted electromagnetic</td>
<td>10 V, 0.15-80 MHz</td>
<td>IEC 61000-4-6, Level 3</td>
</tr>
<tr>
<td>Interruptions in auxiliary voltage</td>
<td>2-200 ms</td>
<td>IEC 60255-11</td>
</tr>
<tr>
<td>No reset for interruptions</td>
<td>24 V DC</td>
<td>&lt; 20 ms</td>
</tr>
<tr>
<td></td>
<td>110 V DC</td>
<td>&lt; 70 ms</td>
</tr>
<tr>
<td></td>
<td>250 V DC</td>
<td>&lt; 300 ms</td>
</tr>
</tbody>
</table>
Table 6: Electromagnetic compatibility (EMC), emission tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Severity</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted</td>
<td>0.15-30 MHz, class A</td>
<td>EN 50081-2</td>
</tr>
<tr>
<td>Radiated</td>
<td>30-1000 MHz, class A</td>
<td>EN 50081-2</td>
</tr>
</tbody>
</table>

Table 7: CE-demand

<table>
<thead>
<tr>
<th>Test</th>
<th>Reference standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunity</td>
<td>EN 50082-2</td>
</tr>
<tr>
<td>Emission</td>
<td>EN 50081-2</td>
</tr>
<tr>
<td>Low voltage directive</td>
<td>EN 50178</td>
</tr>
</tbody>
</table>

Table 8: Insulation tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Severity</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric</td>
<td>Current circuit to circuit and current circuit to earth</td>
<td>2.5 kV AC, 1 min</td>
</tr>
<tr>
<td></td>
<td>Circuit to circuit and circuit to earth</td>
<td>2.0 kV AC, 1 min</td>
</tr>
<tr>
<td></td>
<td>Over open contact</td>
<td>1.0 kV AC, 1 min</td>
</tr>
<tr>
<td>Impulse voltage</td>
<td>5 kV, 1.2/50 ms, 0.5 J</td>
<td>IEC 60255-27</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt; 100 MΩ at 500 V DC</td>
<td>IEC 60255-27</td>
</tr>
</tbody>
</table>

Table 9: Mechanical test

<table>
<thead>
<tr>
<th>Test</th>
<th>Severity</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>Response: 1 g, 1-150-10 Hz</td>
<td>IEC 60255-21-1, class 2</td>
</tr>
<tr>
<td></td>
<td>Endurance: 1 g, 10-150-10 Hz, 20 sweeps</td>
<td>IEC 60255-21-1, class 1</td>
</tr>
<tr>
<td>Shock</td>
<td>Response: 5 g, 11 ms, 3 pulses</td>
<td>IEC 60255-21-2, class 1</td>
</tr>
<tr>
<td></td>
<td>Withstand: 15 g, 11 ms, 3 pulses</td>
<td>IEC 60255-21-2, class 1</td>
</tr>
<tr>
<td>Bump</td>
<td>Withstand: 10 g, 16 ms, 1000 pulses</td>
<td>IEC 60255-21-2, class 1</td>
</tr>
<tr>
<td>Seismic</td>
<td>X-axis: 3 g, 1-50-1 Hz</td>
<td>IEC 60255-21-3, class 2, extended (Method A)</td>
</tr>
<tr>
<td></td>
<td>Y-axis: 3 g, 1-50-1 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Z-axis: 2 g, 1-50-1 Hz</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Climatic conditions

<table>
<thead>
<tr>
<th>Climatic condition</th>
<th>Partially weather protected locations, switchgear environment, class 3K3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>-40° C to +70° C</td>
</tr>
<tr>
<td>Permitted ambient temperature</td>
<td>-5° C to +55° C</td>
</tr>
</tbody>
</table>

Table 11: Weight and dimensions

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Weight</th>
<th>Height</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay without RXTUG 22H</td>
<td>Approximately 1.3 kg</td>
<td>4U</td>
<td>12C</td>
</tr>
</tbody>
</table>
### Table 12: Service values

<table>
<thead>
<tr>
<th>Function</th>
<th>Phase-current</th>
<th>Neutral-current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main CT ratio</td>
<td>1.00 A-100 kA</td>
<td>1.00 A-100 kA</td>
</tr>
<tr>
<td>Secondary value</td>
<td>0.40 A-10.0 A</td>
<td>0.40 A-10.0 A</td>
</tr>
<tr>
<td>Phase and neutral current (1A and 5A)</td>
<td>Primary current</td>
<td>0.00 -9.99 A</td>
</tr>
<tr>
<td></td>
<td>10.0-99.9 A</td>
<td>100-999 A</td>
</tr>
<tr>
<td></td>
<td>Secondary current</td>
<td>0.00-9.99 A, kA, MA</td>
</tr>
<tr>
<td></td>
<td>10.0-99.9 A, kA</td>
<td></td>
</tr>
<tr>
<td>Neutral current (0.1 A)</td>
<td>Secondary current</td>
<td>0-199 mA</td>
</tr>
<tr>
<td></td>
<td>0.20-9.99 A</td>
<td>100-999 A, kA</td>
</tr>
<tr>
<td>Frequency Fr</td>
<td>50 Hz</td>
<td>40.0-60.0 Hz</td>
</tr>
<tr>
<td></td>
<td>60 Hz</td>
<td>50.0-70.0 Hz</td>
</tr>
<tr>
<td>Accuracy</td>
<td>+/- 0.1 Hz</td>
<td></td>
</tr>
</tbody>
</table>

### Table 13: Overcurrent protection

<table>
<thead>
<tr>
<th>Overcurrent protection</th>
<th>Stage I&gt;</th>
<th>Stage I&gt;&gt;</th>
<th>Stage I&gt;&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting range</td>
<td>(0.2-3.0) x I</td>
<td>(1.0-20) x I&gt;</td>
<td>(1.0-20) x I&gt;</td>
</tr>
<tr>
<td>Limiting errors of set operate value for current measuring 50/60 Hz</td>
<td>&lt; 3%</td>
<td>&lt; 3%</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Consistency of set operate value 50/60 Hz</td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Typical reset ratio</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical operate time I = 0 =&gt; 3 x set operate value</td>
<td>40 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical reset time I = 3 =&gt; 0 x set operate value</td>
<td>45 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient over-reach L/R = 50, 100, 200 and 500 ms</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical overshoot time</td>
<td>30 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery time at I = 3 x set operate value</td>
<td>&lt; 55 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency dependency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F₁ = 50 Hz (45-55 Hz)</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F₁ = 60 Hz (54-66 Hz)</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150/180 Hz</td>
<td></td>
<td>Typical 1.5/2.0 x set operate value</td>
<td></td>
</tr>
<tr>
<td>250/300 Hz</td>
<td></td>
<td>Typical 3.0/4.0 x set operate value</td>
<td></td>
</tr>
<tr>
<td>Influence of harmonics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100/120 Hz, 10%</td>
<td>&lt; 2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150/180 Hz, 20%</td>
<td>&lt; 6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250/300 Hz, 20%</td>
<td>&lt; 3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature dependence within range -5° C to +55° C</td>
<td>&lt; 2%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 14: Time functions for overcurrent protection

<table>
<thead>
<tr>
<th>Time function</th>
<th>Stage I&gt;</th>
<th>Stage I&gt;&gt;</th>
<th>Stage I&gt;&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time delay</td>
<td>Inverse or definite time (NI, VI, EI, LI and RI)</td>
<td>Definite time</td>
<td>Definite time</td>
</tr>
<tr>
<td>Setting range, definite time</td>
<td>0-20 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy, definite time</td>
<td>+/- 30 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting range, inverse time</td>
<td>x = 0.05-1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min time, inverse time</td>
<td>0-2.0 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy, inverse time</td>
<td>Ni, VI, El, LI</td>
<td>2.0 x Iₜₑₛₜ</td>
<td>12.5% and +/- 30 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0 x Iₜₑₛₜ</td>
<td>7.5% and +/- 30 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.0 x Iₜₑₛₜ</td>
<td>5% and +/- 30 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.0 x Iₜₑₛₜ</td>
<td>5% and +/- 30 ms</td>
</tr>
<tr>
<td>RI</td>
<td>1.0 - 1.3 x Iₜₑₛₜ</td>
<td>12.5% and +/- 30 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 - 20.0 x Iₜₑₛₜ</td>
<td>5% and +/- 30 ms</td>
<td></td>
</tr>
<tr>
<td>Linear reset time</td>
<td>0-500 s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) A percentage value of theoretical time and a definite time delay
b) According to IEC 60225-3, signed error 5.

### Table 15: Earth-fault protection

<table>
<thead>
<tr>
<th>Earth-fault protection</th>
<th>Stage Iₜₑ&gt;</th>
<th>Stage Iₜₑ&gt;&gt;&gt;</th>
<th>Stage Iₜₑ&gt;&gt;&gt;&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting range</td>
<td>(0.1-2.5) x Iₑ</td>
<td>(1.0-20) x Iₑ&gt;</td>
<td>1.0-20) x Iₑ&gt;</td>
</tr>
<tr>
<td>Limiting errors of set operate value for current measuring 50/60 Hz</td>
<td>&lt; 3%</td>
<td>&lt; 3%</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Consistency of set operate value 50/60 Hz</td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Typical reset ratio</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical operate time I = 0 =&gt; 3 x set operate value</td>
<td>40 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical reset time I = 3 =&gt; 0 x set operate value</td>
<td>45 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient over-reach L/R = 50, 100, 200 and 500 ms</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical overshoot time</td>
<td>30 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery time at I = 3 x set operate value</td>
<td>&lt; 55 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency dependency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fₑ = 50 Hz (45-55 Hz)</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fₑ = 60 Hz (54-66 Hz)</td>
<td>&lt; 5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150/180 Hz</td>
<td></td>
<td>typical 1.5/2.0 x set operate value</td>
<td></td>
</tr>
<tr>
<td>250/300 Hz</td>
<td></td>
<td>typical 3.0/4.0 x set operate value</td>
<td></td>
</tr>
<tr>
<td>Influence of harmonics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100/120 Hz, 10%</td>
<td>&lt; 2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150/180 Hz, 20%</td>
<td>&lt; 6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250/300 Hz, 20%</td>
<td>&lt; 3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature dependency within range -5°C to +55°C</td>
<td>&lt; 2%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compact current relay and protection assemblies | 1MRK 509 062-BEN Revision: B 13
Table 16: Time functions for earth-fault protection

| Time function | Stage Iₕ> | Stage Iₕ>>> | Stage Iₕ>>>>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time delay</td>
<td>Inverse, definite or logarithmic time (NI, VI, EI, LI, RI and Log)</td>
<td>Definite time</td>
<td>Definite time</td>
</tr>
<tr>
<td>Setting range, definite time</td>
<td>0-20 s</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accuracy, definite time</td>
<td>+/- 30 ms</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Setting range, inverse time</td>
<td>k = 0.06-1.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Min time, inverse time</td>
<td>0-2.0 s</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accuracy, inverse time</td>
<td></td>
<td>12.5% and +/- 30 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NI, VI, EI, LI</td>
<td>2.0 x Iₕset</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0 x Iₕset</td>
<td>7.5% and +/- 30 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.0 x Iₕset</td>
<td>5% and +/- 30 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.0 x Iₕset</td>
<td>5% and +/- 30 ms</td>
</tr>
<tr>
<td>RI</td>
<td>1.0-1.3 x Iₕset</td>
<td>12.5% and +/- 30 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3-20.0 x Iₕset</td>
<td>5% and +/- 30 ms</td>
</tr>
<tr>
<td>Setting range, logarithmic time (IDG)</td>
<td>k = 1-4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Min time, logarithmic time</td>
<td>1.0-2.0 s</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Formula, logarithmic time</td>
<td>t = 5.8-1.35 x ln (I/Iₕset)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Accuracy, logarithmic time</td>
<td>+/- 50 ms overall</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Linear reset time</td>
<td>0-500 s</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

a) A percentage value of theoretical time and a definite time delay
b) According to IEC 60255-3, signed error 5
Diagrams

Figure 9: Terminal diagram 1MRK 001 083-CBA

3-PHASE OVERCURRENT AND EARTH-FAULT PROTECTION

1, 2) BINARY INPUT, PROGRAMMABLE
3-10) RELAY OUTPUTS 1-5, PROGRAMMABLE FUNCTION
8) LOSS OF AUXILIARY VOLTAGE

PROGRAMMABLE FUNCTIONS FOR BINARY INPUTS:
- Blocking/Enabling: In, In+, In++, In+, In+++
- Alternative settings; reset of LED indications.

PROGRAMMABLE FUNCTIONS FOR BINARY OUTPUTS:
- Start and Trip: In, In+, In++, In+, In+++
- Alternative settings; in service
Protection assemblies

Compact current protection assembly RAHL
The protection assemblies are of protective class I equipment in which protection against electric shock does not rely on basic insulation only, but which includes additional safety precautions in such a way that accessible conductive parts are connected to protective earth. The protections are based on the compact current relay RXHL. Test device RTXP 8, RTXP 18 and DC/DC-converter RXTUG 22H can also be included for specific application requirements. Test device, RTXP 8 and RTXP 18 are tools for relay testing. DC/DC-converter RXTUG 22H can be used either separately for a single protection or to feed other protections of the same relay family. With RXTUG 22H all requirements concerning emission and immunity disturbances with this protection assembly will be met.

The measuring relay has 5 binary outputs and 2 binary inputs. Protections are normally available with output logic with heavy duty contacts, relay RXME 18 with indicating flag, and can upon request be completed with an output logic of free choice. Output relays are connected to separate auxiliary voltage. The interface voltage for enable or block impulses can be connected to either 48-60 V DC or 110-220 V DC by connecting the voltage circuit to separate terminals. At delivery all relays are connected for 110-220 V DC.

All the protections in the COMBIFLEX® modular system are mounted on apparatus bars. The connections to the protections are done by COMBIFLEX® socket equipped leads. All internal connections are made and the protection assembly is tested before delivery from factory. The type of modules and their physical position and the modular size of the protection are shown in the diagrams of the respective protection. Figure 10 shows an example of a protection assembly.

The height and width of the protection assembly are given in the circuit diagram with height (U) and width (C) modules, where $U = 44.45$ mm and $C = 7$ mm. The depth of the protection assembly, including space for the connection wires, is approximately 200 mm.

Protection assemblies
The table below shows the different variants of the compact current relay RXHL 401 in protection assemblies type RAHL 401.

<table>
<thead>
<tr>
<th></th>
<th>4U</th>
<th>30C</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>107</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>325</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RXME 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTXP 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RXTUG 22H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RXHL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RXME 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RXME 18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10: Protection assembly example
### RAHL 401 protection assembly variants

<table>
<thead>
<tr>
<th>Ordering No.</th>
<th>Circuit diagram</th>
<th>Terminal diagram</th>
<th>Available diagrams</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MRK 001 082-AB</td>
<td>1MRK 001 083-AB</td>
<td>1MRK 001 083-ABA</td>
<td>On request</td>
</tr>
</tbody>
</table>

- **a)** Terminal diagrams available in technical overview brochure for RXHL 401 and RAHL 401
- **b)** Terminal and circuit diagrams available in installation and commissioning manual for RXHL 401 and RAHL 401
- **c)** Selection of phase and neutral current must be the same, \( I_r = I_N = 1 \text{ A} \) or \( I_r = I_N = 5 \text{ A} \)

---

![Diagram](99000967.wmf)

![Diagram](99000968.wmf)

![Diagram](99000969.wmf)

![Diagram](99000970.wmf)

---

a) Terminal diagrams available in technical overview brochure for RXHL 401 and RAHL 401
b) Terminal and circuit diagrams available in installation and commissioning manual for RXHL 401 and RAHL 401
c) Selection of phase and neutral current must be the same, \( I_r = I_N = 1 \text{ A} \) or \( I_r = I_N = 5 \text{ A} \)
**Mounting alternatives**

The protection assemblies described in the table above can be supplied in RHGX or RHGS cases. RXHL 401 compact current relay can also be supplied in the following mounting alternatives.

- Mounting of RXHL 401 in RHGS 6.
- Mounting of RXHL 401 in RHGS 12.
- Mounting of RXHL 401 in RHGS 30 with dual power supplies RXTUG 22H, individual test switches and optional tripping relays.
Ordering of RAHL protections

Basic data to specify

RAHL protection Quantity: 1MRK 001 082-____

Desired wording on the lower half of the test switch max. 13 lines with 14 characters per line.

Rated AC inputs

Rated phase current $I_p = 1$ A, rated neutral current $I_N = 0,1$ A  1MRK 000 322-FA
Rated phase current $I_p = 1$ A, rated neutral current $I_N = 1$ A  1MRK 000 322-FB
Rated phase current $I_p = 5$ A, rated neutral current $I_N = 0,1$ A  1MRK 000 322-FC
Rated phase current $I_p = 5$ A, rated neutral current $I_N = 1$ A  1MRK 000 322-FD
Rated phase current $I_p = 5$ A, rated neutral current $I_N = 5$ A  1MRK 000 322-FE

Options

Auxiliary voltage for included auxiliary relay

RXME 18, 24 V DC  RK 221 825-AD
RXME 18, 48-55 V DC  RK 221 825-AH
RXME 18, 110-125 V DC  RK 221 825-AN
RXME 18, 220-250 V DC  RK 221 825-AS

Mounting alternatives

Apparatus bars (always included)

<table>
<thead>
<tr>
<th>Size</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4U 19&quot;</td>
<td>1MRK 000 137-GA</td>
</tr>
<tr>
<td>4U 24C</td>
<td>1MRK 000 137-KA</td>
</tr>
<tr>
<td>4U 12C</td>
<td>RK 927 001-AB</td>
</tr>
<tr>
<td>4U 26C</td>
<td>RK 927 002-AB</td>
</tr>
<tr>
<td>4U 36C</td>
<td>RK 927 003-AB</td>
</tr>
<tr>
<td>4U 60C</td>
<td>RK 927 004-AB</td>
</tr>
<tr>
<td>U x 1/1 19&quot; rack</td>
<td>1MRK 000 315-A</td>
</tr>
<tr>
<td>6U x 1/2 19&quot; rack</td>
<td>1MRK 000 315-B</td>
</tr>
<tr>
<td>6U x 1/4 19&quot; rack</td>
<td>1MRK 000 315-C</td>
</tr>
</tbody>
</table>

Accessories

User documentation RXHL 401 and RAHL 401

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator's manual</td>
<td></td>
<td>1MRK 509 063-UEN</td>
</tr>
<tr>
<td>Technical reference manual</td>
<td></td>
<td>1MRK 509 064-UEN</td>
</tr>
<tr>
<td>Installation and commissioning manual</td>
<td></td>
<td>1MRK 509 065-UEN</td>
</tr>
</tbody>
</table>
Ordering of RXHL relays

Included functions

Three-phase overcurrent protection, I>, I>>, I>>>
Earth-fault protection, IN>, IN>>, IN>>>
Local Human Machine Interface (HMI)
Two groups of setting parameter
Service value reading (primary or secondary values)

Basic data to specify

RXHL 401, includes basic functions  Quantity: 1MRK 001 977-AA

AC inputs

Rated phase current $I_r = 1$ A, rated neutral current $I_{N_r} = 0,1$ A  1MRK 000 322-FA
Rated phase current $I_r = 1$ A, rated neutral current $I_{N_r} = 1$ A  1MRK 000 322-FB
Rated phase current $I_r = 5$ A, rated neutral current $I_{N_r} = 0,1$ A  1MRK 000 322-FC
Rated phase current $I_r = 5$ A, rated neutral current $I_{N_r} = 1$ A  1MRK 000 322-FD
Rated phase current $I_r = 5$ A, rated neutral current $I_{N_r} = 5$ A  1MRK 000 322-FE

Accessories

User documentation RXHL 401 and RAHL 401

Operator’s manual  Quantity: 1MRK 509 063-UEN
Technical reference manual  Quantity: 1MRK 509 064-UEN
Installation and commissioning manual  Quantity: 1MRK 509 065-UEN
References

Related documents

Document related to COMBIFLEX® assemblies
Buyer’s guide, Connection and installation components in COMBIFLEX®
Buyer’s guide, Relay accessories and components
Buyer’s guide, Test system COMBITEST
Buyer’s guide, DC-DC converter
Buyer’s guide, Auxiliary relays

Documents related to RXHL 401 and RAHL 401
Technical overview brochure
Connection and setting guide (only RXHL 401)
Operator’s manual
Technical reference manual
Installation and commissioning manual
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