Restricted earth fault protection
RADHD

Features
- Primary side fault sensitivity down to 2-5% of main CT rating
- High speed operation, 10-20 ms
- Secure operation, not affected by CT saturation
- Trip or flag indication relay included

Application
The RADHD relay is used for providing a high speed restricted earth fault protection for transformers and reactors.

The relay is connected to a CT in the neutral point of the transformer and residually connected CT’s in the phases. Applications are not limited by CT saturation for external or internal faults. The saturation voltage of the involved CT’s must be at least twice the selected operating value of the RADHD relay and CT ratio correction can normally not be accepted. A non-linear resistor is used at the CT summation point to protect the CT’s from high peak voltages during internal faults.

A short circuit current often contains a dc component that is larger in one phase than in the other two. In most cases this direct current, having a time constant of, for example, 10 to 300 ms, causes the current transformer to become saturated, which means that it is not capable of transforming correctly either the ac or the dc component. A restricted earth fault relay would therefore, if no special measures were taken, sense an “earth fault current” that does not exist on the primary side.

The RADHD relay therefore contains a filter circuit which will attenuate the dc component. Practical experience has shown that a relay setting, according to formula (1), is sufficient to secure correct relay operation even for the most extreme transient CT saturation.

\[ U_s > I_2 r_2 \]  
\[ (1) \]

Observe also \[ U_s < \text{about} \, \frac{1}{2} U_k \]  
\[ (2) \]

where:
- \( U_s \) = Operate voltage setting
- \( I_2 \) = Secondary current at maximum through-fault current
- \( r_2 \) = Sum of maximum secondary CT and lead resistance up to junction point
- \( U_k \) = CT saturation voltage
Application (cont’d)
When an earth fault current occurs, a voltage is rapidly generated across the relay circuit. To prevent this voltage from becoming too high, the relay is connected in parallel with a voltage dependent resistor. The relay operates when the primary earth fault current, \( I_f \), amounts to:

\[
I_f > N(i_r + \Sigma_{i_m} + i_{res})
\]  

(3)

where:

- \( N \) = Turns ratio of the current transformer
- \( i_r \) = Relay operating current (normally 20 mA)
- \( \Sigma_{i_m} \) = The sum of the magnetizing current at the operating voltage \( U_s \) for all current transformers involved
- \( i_{res} \) = Current through the non-linear resistor at the voltage \( U_s \), see Fig. 1.

Design
The RADHD relay is available in 6 variants, all with 2 reconnectible operate values, Us1 and Us2, and in 2 variants with operate value adjustable at a tapped resistor. The operate value, Us1, is obtained when terminal 101:3B is connected to 107:13. The operate value Us2 is obtained when terminal 101:3B is connected to 107:18. When delivered, RADHD is connected for the operate value, Us1. The basic version includes RTXP 18 test switch, RXTLA 1 rectifier module, RXTCA 1 capacitor module and RXID 1 overcurrent relay.

The RXID 1 is an instantaneous electromechanical overcurrent relay containing one heavy-duty and two medium-(trip)duty contacts (make contact). It has fixed operate value. The relay current-measuring circuit is fed through a short-circuiting connector RTXK so that the current transformer secondary circuit is automatically short-circuited when the relay is removed from the terminal base.

RADHD is available in variants with a trip relay RXME 18 with heavy duty contacts, or with a flag relay RXSF 1 with light-duty contacts.

Figure 1: Current voltage characteristics for the non-linear resistors. In the range 10-200 V, 50 Hz the maximum current is approx. 1-30 mA.
### Technical data

<table>
<thead>
<tr>
<th>Operate voltage $U_{s1}/U_{s2}$</th>
<th>Maximum continuous voltage $U_{s1}/U_{s2}$</th>
<th>Approx. current at operation $I_r$</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image-url" alt="Image of table content" /></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Rated frequency | 50 or 60 Hz |
| Operate time (first trip contact) | 10-20 ms |
| Auxiliary dc voltage | 24, 48-55, 110-125, 220-250 V |
| Permitted ambient temperature | -25 to +55°C |

#### Insulation Tests
Dielectric test, 50 Hz, 1 min:
- voltage circuits to contact circuits and earth: 2.0 kV
- current circuits to other circuits and earth: 2.5 kV

<table>
<thead>
<tr>
<th>Contacts</th>
<th>RXID</th>
<th>RXSF 1</th>
<th>RXME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of contacts (terminals No.)</td>
<td>(1 make)</td>
<td>+ 2 make</td>
<td>3 make</td>
</tr>
<tr>
<td>Max. system voltage dc/ac within a contact set V</td>
<td>450/400</td>
<td>300/250</td>
<td>450/400</td>
</tr>
<tr>
<td>Current-carrying capacity (for already closed contact)</td>
<td><img src="image-url" alt="Image of table content" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Making and conducting capacity L/R &gt; 10 ms, 200 ms/1 s</td>
<td><img src="image-url" alt="Image of table content" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking capacity ac P.F. &gt; 0.1 max. 250 V A</td>
<td><img src="image-url" alt="Image of table content" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dc L/R &lt; 40 ms max. 20 A at $U_{s1}$</td>
<td>24 V</td>
<td>48 V</td>
<td>55 V</td>
</tr>
<tr>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>1.0</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Restricted earth fault protection

Figure 2: Terminal diagram No. 7417 005-BAA

Figure 3: Terminal diagram No. 7417 032-CAA
Ordering

Specify:
- Quantity
- Ordering No.
- Rated frequency
- Auxiliary dc voltage
- Operate value, \( U_s \)
- Ordering No., non-linear resistor
- Desired wording on the lower half of the test switch face plate max. 13 lines with 14 characters per line.

Mounting:
- RADHD is provided on apparatus bars.
When additional mounting is required specify a 4U equipment frame for 19" rack mounting or a type RHGX

Ordering table

<table>
<thead>
<tr>
<th>Operate voltage ( U_s )</th>
<th>Output relay</th>
<th>Size</th>
<th>Weight kg</th>
<th>Ordering No.</th>
<th>Circuit diagram</th>
<th>Terminal diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-100 V</td>
<td></td>
<td>4U 18C</td>
<td>2.3</td>
<td>RK 646 007-AA</td>
<td>7417 005-AA</td>
<td>7417 005-AAA</td>
</tr>
<tr>
<td>19-100 V</td>
<td></td>
<td>4U 18C</td>
<td>2.6</td>
<td>RK 646 007-BA</td>
<td>7417 005-BA</td>
<td>7417 005-BAA</td>
</tr>
<tr>
<td>19-100 V</td>
<td></td>
<td>4U 18C</td>
<td>2.6</td>
<td>RK 646 007-CB</td>
<td>7417 005-CB</td>
<td>7417 005-CBA</td>
</tr>
<tr>
<td>10 or 15 V</td>
<td></td>
<td>4U 24C</td>
<td>3.0</td>
<td>RK 646 007-DA</td>
<td>7417 005-DA</td>
<td>7417 005-DAA</td>
</tr>
<tr>
<td>10 or 15 V</td>
<td></td>
<td>4U 24C</td>
<td>3.0</td>
<td>RK 646 007-EA</td>
<td>7417 005-EA</td>
<td>7417 005-EAA</td>
</tr>
<tr>
<td>100-400 V</td>
<td></td>
<td>4U 18C</td>
<td>2.6</td>
<td>RK 646 006-AA(1)</td>
<td>7417 032-AA</td>
<td>7417 032-AAA</td>
</tr>
<tr>
<td>100-400 V</td>
<td></td>
<td>4U 18C</td>
<td>2.6</td>
<td>RK 646 016-CA(2)</td>
<td>7417 032-CA</td>
<td>7417 032-CAA</td>
</tr>
</tbody>
</table>

(1) See technical data, operate value table; state fixed rating
(2) Includes resistor unit with a non-linear resistor and an adjustable resistor mounted on a 19" apparatus plate \( H \times W = 177 \times 482 \text{ mm} = 4U \times 19" \)
(3) State factory setting

Accessories

Non-linear resistors

<table>
<thead>
<tr>
<th>Operate voltage</th>
<th>Ordering No.</th>
<th>Resistor on 4U 19&quot; apparatus plate 177 x 482 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-400 V</td>
<td>1MRK 002 059-B</td>
<td>RK 795 101-LA</td>
</tr>
</tbody>
</table>
## References

<table>
<thead>
<tr>
<th>RADHD User’s Guide</th>
<th>1MDU04008-EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power transformer protection</td>
<td>AG03-5005</td>
</tr>
</tbody>
</table>
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