Green Premium is the only label that allows you to effectively develop and promote an environmental policy whilst preserving your business efficiency. This ecolabel guarantees compliance with up-to-date environmental regulations, but it does more than this.

Schneider Electric’s Green Premium ecolabel is committed to offering transparency, by disclosing extensive and reliable information related to the environmental impact of its products:

**RoHS**
Schneider Electric products are subject to RoHS requirements at a worldwide level, even for the many products that are not required to comply with the terms of the regulation. Compliance certificates are available for products that fulfil the criteria of this European initiative, which aims to eliminate hazardous substances.

**REACH**
Schneider Electric applies the strict REACh regulation on its products at a worldwide level, and discloses extensive information concerning the presence of SVHC (Substances of Very High Concern) in all of its products.

**PEP: Product Environmental Profile**
Schneider Electric publishes complete set of environmental data, including carbon footprint and energy consumption data for each of the lifecycle phases on all of its products, in compliance with the ISO 14025 PEP ecopassport program. PEP is especially useful for monitoring, controlling, saving energy, and/or reducing carbon emissions.

**EoLI: End of Life Instructions**
Available at the click of a button, these instructions provide:
- Recyclability rates for Schneider Electric products.
- Guidance to mitigate personnel hazards during the dismantling of products and before recycling operations.
- Parts identification for recycling or for selective treatment, to mitigate environmental hazards/ incompatibility with standard recycling processes.

Over 75% of Schneider Electric manufactured products have been awarded the Green Premium ecolabel.
Compliance with international standards

The residual-current relays comply with all the major standards worldwide, in particular those dealing with:

- residual-current protection: IEC 60755 and IEC 60947-2 annex M for the protection of life and property. The Vigirex range is also certified by the independent KEMA laboratories. It has successfully passed test sequences MI/MII/MIII/MIV of standard IEC 60947-2 (annex M).
- installation: IEC 60364
- electromagnetic compatibility (EMC): IEC 61000
- coordination of insulation: IEC 60664.

and North-American standards dealing with:

- ground fault protection: UL 1053 and CSA C22.2 N° 144 (protection of equipment and property) (RH10, RH21 and RH99 up to 240 V).

Vigirex
All Schneider Electric’s expertise in earth leakage protection

- A very wide range of applications.
- Guaranteed efficiency of all protection chain components for complete safety.
- Optimised continuity of supply and protection of people and equipment, unmatched on the market.
Complete range of devices for protection and monitoring

Designed for all types of distribution systems and all voltages.
Wide range of auxiliary supply voltages.
Wide setting and operating possibilities.
Wide range of compatible sensors up to 3200 A:
- A type closed toroids: TA30, PA50, IA80, MA120, SA200 and GA300
- OA type split toroids: TOA80 and TOA120
- rectangular sensors L1, L2.

For all types of installations
Vigirex relays are designed to operate with all electrical switchgear devices on the market.

Protection

Circuit monitoring

Installation monitoring
The protection relays interrupt the supply of power to the monitored system in the event of a fault.

They protect:
- people against direct and indirect contact
- equipment and property against fire.

They store the residual-current fault in memory and order opening of the associated circuit breaker when the set residual operating current $I_{\Delta n}$ is overrun. Depending on the relay, the threshold $I_{\Delta n}$ is fixed, user-selectable or adjustable.

They reset automatically when the fault is no longer present.

When used in conjunction with an auto-reclosing controller, they protect against earth faults caused by insulation failures on:
- telephone relays
- radio repeaters
- special applications.

Vigirex relays can be used at all levels of an installation: LV incomers, power distribution, industrial control and final distribution.

They are designed for AC installations implementing IT, TT and TN-S earthing arrangements and are suitable for voltages up to 1000 V and frequencies from 50/60 Hz up to 400 Hz.
Absolute protection of life and property

The overrun of leakage current thresholds may represent a threat to life and property if it is not immediately located. Through permanent monitoring of this overrun, the Vigirex range makes the protection efficient.

Maximum safety
Vigirex residual current devices (RCDs) with appropriate settings provide effective protection of life and property. The characteristics of the relay/toroid combination ensure reliable measurements.

Class 2 front panel insulation
Class II insulated front panel certification for the entire range as per standards IEC/EN 60664-1 and NFC 15-100.

Operation guaranteed in less than 40 ms
Schneider Electric guarantees the safe clearing of faults by Vigirex relays set to 30 mA and combined with any of its circuit breakers rated up to 630 A.

Overvoltage category IV
The reinforced insulation of Vigirex relays (overvoltage category IV, i.e. the most severe category) makes direct connection possible at the head of the installation or on the upstream busbars without any additional galvanic isolation.

Continuous self-monitoring
Vigirex relays continuously monitor the power supply, relay/toroid link and internal electronics. Failure of the detection circuit is signalled and may be used to trip the circuit breaker. The LEDs on the front panel can also be used to check operation at any time.

Settings protected by a lead-sealable cover or password
Access to settings can be protected by a cover with a lead seal. The test and reset buttons remain accessible on the front panel of the relay. For RHU and RMH relays, settings are protected by a password through the keyboard.

A three-step process

1. Detection with associated toroid
2. Alarm with the Vigirex relay
Optimum continuity of service

The entire range offers numerous settings possibilities that may be used to create many selectivity levels, from the incomer to the final output circuits.

With Vigirex, unnecessary downtime is eliminated.

Diagnosis of installation faults
The indication relays are used to:
- monitor electrical insulation faults,
- prevent outages,
- initiate preventive maintenance.

Minimise outages
Correct setting of the residual current devices (RCDs) ensures total selectivity for insulation faults in the installation, i.e. only the faulty section is shut down. Elimination of most cases of RCD nuisance tripping ensures both safety and continuity of service, two indispensable features for users.

Reduced tripping tolerance
Vigirex relays trip between 0.8 to 1 x IΔn, thus increasing immunity to nuisance tripping by 60% compared to the earth leakage protection requirements of standard IEC 60947-2.

During circuit energisation, the inverse-time tripping curve makes it possible to avoid nuisance tripping of the earth leakage protection system by false zero phase sequence currents caused by:
- high transient currents of certain loads (e.g. motors, LV / LV transformers),
- the charging of capacitances between active conductors and earth.

Frequency filtering and true RMS measurement
Frequency filtering by Vigirex residual current relays ensures maximum protection against insulation faults and a particularly high level of continuity of service.

Frequency converters such as variable speed drives generate high levels of high-frequency leakage currents. During normal operation, these leakage currents are not a danger to users. The residual current relay measures all types of signals and calculates the true RMS value weighted to allow for frequency filtering.

Test and reset
To monitor the protection or indication system, the relay includes a complete test function with or without tripping of the protection device. Moreover, the purpose of the test is to check:
- the output contacts,
- the display (RHURHUs and RMH),
- the LEDs,
- the internal electronics.

Centralised test
One or more relays can be tested remotely, with or without tripping the associated breaking device.

Protection with the circuit breaker

3
Formats for all installation systems

Schneider Electric Moulded Circuit Breaker format devices in the Vigirex range can be mounted on a DIN rail (RH10, RH21, RH68, RH86, RH99 and RH197) or on a universal mounting plate using mounting lugs (RH10, RH21 RH68, RH86 and RH99). The 72 x 72 mm front-panel mount devices (RH10, RH21, RH68, RH86, RH99, RH197, RMH, RUs and RHU) are mounted on panels, doors or front plates using clips.

<table>
<thead>
<tr>
<th>Installation system</th>
<th>Suitable format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main LV switchboard</td>
<td>Front-panel mount</td>
</tr>
<tr>
<td>Power distribution switchboard</td>
<td>instrument zone</td>
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<tr>
<td></td>
<td>modular-device zone</td>
</tr>
<tr>
<td>Motor Control Centre (MCC)</td>
<td></td>
</tr>
<tr>
<td>Automatic control panel or machine panel</td>
<td></td>
</tr>
<tr>
<td>Final distribution enclosures</td>
<td></td>
</tr>
</tbody>
</table>

RHU
- Panel device.
- Adjustable tripping threshold from 30 mA to 30 A.
- Adjustable pre-alarm of the tripping threshold value.
- New HMI with keyboard unit display by LED.
- Modbus communication RS485-SL.

DIN device
with mounting lugs secured to a mounting plate

Clip-in toroid and plug-in connectors
Plug-in connectors allow easy and secure disconnection for switchboard acceptance dielectric tests. DIN-format Vigirex relays can be equipped with a toroid of 30 to 50 mm in diameter.
Our efforts are based on a Quality Management System to enhance the effectiveness of our processes, the goal being to ensure continuous improvement in compliance with standard ISO 9001: 2000.

Our quality objectives are built into our products right from the design phase. We are committed to implementing the five key points of our quality policy:

- measurement of customer satisfaction
- solidly built products
- control of the manufacturing process
- management of development projects
- commitment of all those involved.

CE marking
The CE marking, created by European legislation, is designed to provide assurance that the product is not dangerous, non-polluting and immune to electromagnetic disturbances (EMC directive).

A never-ending commitment
Environmental protection, a reduction in raw materials consumed, controlled energy consumption and product recycling are taken into account right from the beginning of the design phase and on all the Group’s production sites.

During design, Schneider Electric uses high-performance tools to assess and reduce the impact of its products on the environment throughout their life cycles.

EIME (Environmental Information and Management Explorer) CAD software assists designers in selecting materials and designing products.

Production units certified ISO 14001
The production unit benefits from the environmental-management system set up on each ISO 14001 certified site to guarantee continuous progress.

Easy sorting and recycling
The plastics used are marked to ensure easy identification for sorting and recycling. If burned, no polluting substances are released.
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Vigirex

Functions and characteristics
Smart Panel integration
Installation recommendations
Dimensions and connections
Wiring diagrams
Additional characteristics
Catalogue numbers
Other informations

> User guide RHU

> User guide RMH

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## Functions and characteristics

### Selection guide

#### Protection relays[^2]

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<th>RH10</th>
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<th>RH68</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Vigirex products are type A[^1], devices, also covering the requirements of type AC devices.</td>
<td></td>
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</tr>
</tbody>
</table>

#### Functions

| Protection | □    | □    | □    |
| Local indications | □    | □    | □    |
| Remote indications (hard-wired) | □    | □    | □    |
| Remote indications (via communication) | □    | □    | □    |
| Display of measurements | □    | □    | □    |

#### Wiring

| Optimum continuity of service | □    | □    | □    |
| Optimum safety (failsafe) | □    | □    | □    |

#### Mounting

| DIN rail | □    | □    | □    |
| Front-panel mount | □    | □    | □    |

#### Rated operational voltage

| 1 DC voltage range from 12 to 48 V | □    | □    | □    |
| 1 DC voltage range from 24 to 130 V | □    | □    | □    |
| 5 AC voltage ranges from 12 to 525 V | □    | □    | □    |
| 4 AC voltage ranges from 48 to 415 V | □    | □    | □    |
| 1 AC voltage range from 220 to 240 V | □    | □    | □    |
| 2 AC voltage ranges from 110 to 240 V | □    | □    | □    |

#### Thresholds

| Fault (IΔn) | 1 fixed instantaneous threshold | 2 user-selectable thresholds | 6 user-selectable thresholds |
|            | choose from 0.03 A to 1 A | 0.03 A or 0.3 A | from 0.03 A to 3 A |
| Alarm | □    | □    | □    |
| Pre-alarm | □    | □    | □    |

#### Time delay

| Fault | Instantaneous | 1 user-selectable time delay | Instantaneous for IΔn = 0.03 A |
|       |              | instantaneous or 0.06 s | to 1 s |
|       |              | Instantaneous | for IΔn = 0.3 A |
|       |              | 8 user-selectable time delay | instantaneous to 4.5 s |
| Alarm | □    | □    | □    |
| Pre-alarm | □    | □    | □    |

#### Display and indications

| Voltage presence (LED and/or relay)[^2] | □    | □    | □    |
| Threshold overrun fault (LED) | □    | □    | □    |
| alarm (LED and relay) | □    | □    | □    |
| pre-alarm (LED and relay) | □    | □    | □    |
| Leakage current (digital) | □    | □    | □    |
| Settings (digital) | □    | □    | □    |

#### Test with or without actuation of output contacts

| Local | □    | □    | □    |
| Remote (hard-wired) | □    | □    | □    |
| Remote (hard-wired for several relays) | □    | □    | □    |
| Remote (via communication) | □    | □    | □    |

#### Communication

| Suitable for supervision | □    | □    | □    |

#### Characteristics


#### Sensors

| Schneider Electric A and TOA toroids[^4] | up to 630 A | □    | □    |
| Schneider Electric rectangular sensors | up to 3200 A | □    | □    |

[^1]: Type A relay up to IΔn = 5 A.
[^2]: Relay with output contact requiring local, manual reset after fault clearance.
[^3]: Depending on the type of wiring (optimum continuity of service or optimum safety).
[^4]: See characteristics page A-34.
### Functions and characteristics

#### Selection guide

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<th>RHUs or RHU</th>
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<td><img src="image2.png" alt="RH99" /></td>
<td><img src="image3.png" alt="RH197M" /></td>
<td><img src="image4.png" alt="RH197P" /></td>
<td><img src="image5.png" alt="RHUs or RHU" /></td>
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<table>
<thead>
<tr>
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<th>b b b</th>
<th>b b b b b</th>
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<thead>
<tr>
<th>Wiring</th>
<th>Optimum continuity of service</th>
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<th>b b b b b</th>
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<th>b b b</th>
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<td>Front-panel mount</td>
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<th>1 DC voltage range from 12 to 48 V</th>
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<tr>
<td></td>
<td>1 DC voltage range from 24 to 130 V</td>
<td>b b</td>
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</tbody>
</table>

| 5 AC voltage ranges from 12 to 525 V | b b |
| 4 AC voltage ranges from 48 to 415 V | b b |
| 1 AC voltage range from 220 to 240 V | b b |
| 2 AC voltage ranges from 110 to 240 V | b b |

<table>
<thead>
<tr>
<th>Thresholds</th>
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<th>choose from 0.03 A to 1 A</th>
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<td>2 user-selectable thresholds</td>
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<td></td>
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<td>6 user-selectable thresholds</td>
<td>from 0.03 A to 3 A</td>
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<td>19 user-selectable thresholds</td>
<td>from 0.03 A to 30 A</td>
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<td></td>
<td>9 user-selectable thresholds</td>
<td>from 0.03 A to 30 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19 user-selectable thresholds</td>
<td>from 0.03 A to 30 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 user-selectable thresholds</td>
<td>from 0.03 A to 30 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19 user-selectable thresholds</td>
<td>from 0.03 A to 30 A</td>
</tr>
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<table>
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<th>Alarm</th>
<th>Fixed:</th>
<th>50 % IΔn or 100 % IΔn</th>
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<td></td>
<td>1 adjustable threshold</td>
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<th>Pre-alarm</th>
<th>1 adjustable time delay</th>
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<tr>
<td></td>
<td>instantaneous instantaneous</td>
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<table>
<thead>
<tr>
<th>Display and indications</th>
<th>Voltage presence (LED and/or relay)</th>
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<th>[6] b b b</th>
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<tbody>
<tr>
<td></td>
<td>Threshold overrun fault (LED)</td>
<td>b b b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>alarm (LED and relay)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pre-alarm (LED and relay)</td>
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<tr>
<td></td>
<td>leakage current (digital)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>settings (digital)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>test with or without actuation of output contacts</td>
<td>[7]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Local</th>
<th>Remote (hard-wired)</th>
<th>Remote (hard-wired for several relays)</th>
<th>Remote (via communication)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>except RHUs</td>
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<thead>
<tr>
<th>Communication</th>
<th>Suitable for supervision</th>
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<td></td>
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<td>A and TOA toroids up to 630 A</td>
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<td></td>
<td>Schneider Electric</td>
<td>rectangular sensors up to 3200 A</td>
</tr>
</tbody>
</table>

---

### Notes:

- [1] Type A relay up to IΔn = 5 A.
- [3] Depending on the type of wiring (optimum continuity of service or optimum safety).
## Functions and characteristics

### Selection guide

### Monitoring relays [2]

<table>
<thead>
<tr>
<th></th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
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<tr>
<td>All Vigirex products are type A devices, also covering the requirements of type AC devices.</td>
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#### Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>RH99</th>
<th>RH197M</th>
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<td>Protection</td>
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<tr>
<td>Local indications</td>
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<td></td>
<td></td>
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<tr>
<td>Remote indications (hard-wired)</td>
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<td></td>
</tr>
<tr>
<td>Remote indications (via communication)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Display of measurements</td>
<td></td>
<td>![5]</td>
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#### Wiring

<table>
<thead>
<tr>
<th>Requirement</th>
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<th>RH197M</th>
<th>RH197P</th>
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<tr>
<td>Optimum safety (failsafe)</td>
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</table>

#### Mounting

<table>
<thead>
<tr>
<th>Type</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
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<tr>
<td>DIN rail</td>
<td>![5]</td>
<td>![5]</td>
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</tr>
<tr>
<td>Front-panel mount</td>
<td></td>
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<td>![5]</td>
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</table>

#### Rated operational voltage

<table>
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<th>Voltage Range</th>
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<tr>
<td>DC voltage range from 12 to 48 V</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
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<tr>
<td>DC voltage range from 24 to 130 V</td>
<td>![5]</td>
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<tr>
<td>AC voltage range from 12 to 525 V</td>
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<tr>
<td>AC voltage range from 48 to 415 V</td>
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<tr>
<td>AC voltage range from 220 to 240 V</td>
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<tr>
<td>AC voltage range from 110 to 240 V</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

#### Thresholds

<table>
<thead>
<tr>
<th>Threshold Type</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault (IΔn)</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>19 user-selectable thresholds from 0.03 A to 30 A</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Fixed: 50 % IΔn or 100 % IΔn</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Alarm</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>9 user-selectable time delay instantaneous to 4.5 s</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Pre-alarm</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Time delay</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Fault</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>7 user-selectable time delay instantaneous to 4.5 s</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Alarm</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>9 user-selectable time delay instantaneous to 4.5 s</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Pre-alarm</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

#### Display and indications

<table>
<thead>
<tr>
<th>Display and indication</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage presence (LED and/or relay)</td>
<td>![7]</td>
<td>![7]</td>
<td>![7]</td>
</tr>
<tr>
<td>Threshold overrun</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>fault (LED)</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>alarm (LED and relay)</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>pre-alarm (LED and relay)</td>
<td></td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Leakage current (digital)</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Settings (digital)</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

#### Test with or without actuation of output contacts

<table>
<thead>
<tr>
<th>Test with or without actuation of output contacts</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Remote (hard-wired)</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Remote (hard-wired for several relays)</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>Remote (via communication)</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

#### Communication

<table>
<thead>
<tr>
<th>Communication</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable for supervision</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

#### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>page A-33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>page A-27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>page A-27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sensors

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>RH99</th>
<th>RH197M</th>
<th>RH197P</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 630 A</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
<tr>
<td>up to 3200 A</td>
<td>![5]</td>
<td>![5]</td>
<td>![5]</td>
</tr>
</tbody>
</table>

---

[1] Type A relay up to IΔn = 5 A.
[2] Relay with output contact that automatically resets after fault clearance.

www.schneider-electric.com
### Functions and characteristics

#### Selection guide

<table>
<thead>
<tr>
<th>RHUs or RHU</th>
<th>RMH</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="rhus.png" alt="RHUs.png" /></td>
<td><img src="rmh.png" alt="RMH.png" /></td>
</tr>
</tbody>
</table>

- **Protection**
  - Local indications
  - Remote indications (hard-wired)
  - Remote indications (via communication) (except RHUs)

- **Display of measurements**
  - 12 measurement channels

- **Wiring**
  - Optimum continuity of service
  - Optimum safety (failsafe)

- **Mounting**
  - DIN rail
  - Front-panel mount

- **Rated operational voltage**
  - 1 DC voltage range from 12 to 48 V
  - 1 DC voltage range from 24 to 130 V
  - 5 AC voltage ranges from 12 to 525 V
  - 4 AC voltage ranges from 48 to 415 V
  - 1 AC voltage range from 220 to 240 V
  - 2 AC voltage ranges from 110 to 240 V

- **Thresholds**
  - Fault (IΔn): 19 user-selectable thresholds from 0.03 A to 30 A
  - Alarm: 9 user-selectable thresholds from 0.03 A to 30 A (fixed: 50 % IΔn or 100 % IΔn, 1 adjustable threshold/channel from 0.03 A to 30 A)
  - Pre-alarm: 1 adjustable threshold/channel from 0.015 A to 30 A

- **Time delay**
  - Fault: 7 user-selectable time delay instantaneous to 4.5 s
  - Alarm: 9 user-selectable time delay instantaneous to 4.5 s (1 adjustable time delay/channel instantaneous to 4.5 s)
  - Pre-alarm: 1 adjustable time delay/channel instantaneous to 4.5 s

- **Display and indications**
  - Voltage presence (LED and/or relay)
  - Threshold overrun fault (LED) (alarm (LED and relay), pre-alarm (LED and relay))
  - Leakage current (digital) by bargraph
  - Settings (digital)
  - Test with or without actuation of output contacts

### Sensors

- Schneider Electric A and TOA toroids up to 630 A
- Schneider Electric rectangular sensors up to 3200 A

---

[5] Depending on the type of wiring (optimum continuity of service or optimum safety).
[8] With actuation of contacts only.
Vigirex relays measure the earth-leakage current in an electrical installation via their associated toroids. Vigirex relays may be used for:
  - residual-current protection (RH10, RH21, RH68, RH86, RH99)
  - earth-leakage monitoring (RMH or RH99)
  - residual-current protection and earth-leakage monitoring (RH197, RHUs and RHU).

### Residual-current protection relay

Protection relays control the interruption of the supply of power to the monitored systems to protect:
  - people against indirect contact and, in addition, against direct contact
  - property against fire hazards
  - motors.

A relay trips the associated circuit breaker when the set residual operating current \( I_{\Delta n} \) is overrun.

Depending on the relay, the threshold \( I_{\Delta n} \) can be fixed, user-selectable or adjustable and the overrun can be signalled by a digital display of the measured current or a LED.

The leakage current is displayed:
  - for the RH197, on a bargraph made up of 4 LEDs indicating levels corresponding to 20, 30, 40 and 50 % of \( I_{\Delta n} \)
  - for the RHUs and RHU, by digital display of the value of the leakage current.

Circuit breaker tripping can be either instantaneous or delayed. On some relays, it is possible to adjust the time delay.

The protection relays store the residual-current fault in memory. Once the fault has been cleared and the output contact has been manually reset, the relay can be used again.

### Earth-leakage monitoring relays

These relays may be used to monitor drops in electrical insulation due to ageing of cables or extensions in the installation.

Continuous measurement of leakage currents makes it possible to plan preventive maintenance on the faulty circuits. An increase in the leakage currents may lead to a complete shutdown of the installation.

The control signal is issued by the relay when the residual-current operating threshold is overrun.

Depending on the relay, the threshold can be adjustable or user-selectable and the overrun can be signalled via a LED, a bargraph or a digital display of the measured current.

The leakage current is displayed:
  - for the RH197, on a bargraph made up of 4 LEDs indicating levels corresponding to 20, 30, 40 and 50 % of \( I_{\Delta n} \)
  - for the RMH, by digital display of the value of the leakage current.

The control signal can be either instantaneous or delayed. On some relays, it is possible to adjust the time delay.

Earth-leakage monitoring relays do not store the residual-current fault in memory and their output contact is automatically reset when the fault is cleared.

When used in conjunction with a PLC controller (Zelio, ...), they protect against earth faults due to insulation failures. Typical applications include telephone relay and radio repeater stations. In the event of a transient fault, this system can be used to automatically restore the supply of electrical power to an unattended station, thereby increasing availability and continuity of service.

### Use

Vigirex relays may be used for protection and maintenance at all levels in the installation. Depending on the relays, they may be used in TT, IT or TNS low-voltage AC installations for voltages up to 1000 V and frequencies from 50/60 Hz up to 400 Hz.

Vigirex protection relays are suitable for use with all electrical switchgear devices available on the market.
Compliance with standards

Vigirex relays are designed to comply with the following standards:
- IEC/EN 60755: general rules for residual-current protection devices
- IEC/EN 60947-2 annex M: low-voltage switchgear and controlgear, part 2 (circuit breakers)
- IEC/EN 60947-5-1: low-voltage switchgear and controlgear, part 5-1 (electromechanical devices)
- IEC/EN 61000-4-2: electrostatic-discharge immunity test
- IEC/EN 61000-4-3: radiated, radio-frequency, electromagnetic-field immunity test
- IEC/EN 61000-4-4: electrical fast transient/burst immunity test
- IEC/EN 61000-4-5: surge immunity test
- IEC/EN 61000-4-6: immunity to conducted disturbances, induced by radio-frequency fields
- CISPR 11: limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radiofrequency equipment
- mandatory for CE marking:
  - EN 61000-6-2: immunity to industrial environments
  - EN 50081-1: emissions for commercial and residential environments
  - IEC/EN 60664-1: insulation coordination for equipment within low-voltage systems, part 1
  - EN 50102: degrees of protection provided by electrical enclosures against external mechanical impact
  - IEC 60364 and NF C 15100: installation rules for low-voltage electrical distribution
- UL 1053 and CSA 22.2 No. 144: relays RH10, RH21 and RH99 up to and including 220/240 V comply with these standards.

Ground fault sensing and relaying equipment UL 1053 and CSA 22.2 No. 144 for North American and North American influenced markets

The basic standard used to investigate products in this category is UL1053 "Ground-Fault Sensing and Relaying Equipment".

The Listing Mark of Underwriters Laboratories Inc. on the products is the only method provided by UL to identify products manufactured under its Listing and Follow Up Service.

The Listing Mark for these products includes the name and/or symbol of Underwriters Laboratories Inc., (as illustrated on the label) together with the word "LISTED", a control number and the following product name "Ground Fault Sensing and Relaying Equipment".

This category covers ground fault current sensing devices, relaying equipment, or combinations of ground fault current sensing devices and relaying equipment which will operate to cause a disconnecting means to function at predetermined values of ground fault current in accordance with the National Electrical Code, ANSI/NFPA70.

The RH99, RH21 and RH10 (M and P) ground fault relays are control powered ground-fault protection devices used to protect an electrical distribution system from ground faults. The relay receives input from sensors, processes the information and if necessary closes output contacts which will cause the associated protection device to trip.

The product is a class 1 combination ground fault current sensor and relay. This equipment is intended to operate devices with shunt trip coils such as moulded case circuit breakers, moulded case switches and the like, which constitute the disconnecting means, by opening all ungrounded conductors at predetermined values of ground fault current.

This product is designed to protect circuits of not more than 600 V AC, 50/60 Hz only. The relay should be marked with the following electrical ratings, for the two types M and P:
- type M: DIN format (Acti 9 type fast mounting or screw mounting)
- type P: front-panel mount (on panel, door, etc.)
- ratings:
  - fixed $\Delta I_n$ threshold (a number of choices) and no time delay (instantaneous) or selectable $\Delta I_n$ threshold from 0.03 to 30 A and user-selectable time delay from 0 to 4.5 s (see settings on pages A-24 to A-33)
- input voltages:
  - AC: 20 to 24 V AC, 48 V AC, 110 to 130V AC or 220 to 240 V AC, 50/60 Hz, or DC: 12 to 48 V DC
- maximum consumption: 4 W.
General characteristics

Environmental withstand capacity
Vigirex relays meet the environmental requirements contained in the following standards:
- IEC/EN 60068-2-30: damp heat, equipment not operating; relative humidity 95 % at 55 °C (hot and humid climate)
- IEC/EN 60068-2-52: salt mist; KB test severity level 2
- IEC/EN 60068-2-56: damp heat, equipment operating; 48 h, environment category C2.
They may consequently be used in all parts of the world.

Degree of pollution
Vigirex relays are suitable for operation in the most severe industrial environments. They meet the requirements of degree of pollution 3 as per standard IEC/EN 60664-1 and IEC/EN 60947-1 for low-voltage switchgear and controlgear.

Ambient temperature
Vigirex relays are designed for use in ambient temperatures from -35 °C to +70 °C. Relays equipped with a digital display (RHU, RHUs, RMH) or bargraph (RH197) are limited to -25 °C to +55 °C.
Start-up should be carried out within the temperature range indicated above.
The temperature range for device storage, in the original packing, is:
- between -55 °C and +85 °C for Vigirex RH10 to RH99
- between -40 °C and +85 °C for Vigirex RH197, RHUs, RHU and RMH.

Reinforced insulation for direct connection to upstream distribution system
The reinforced insulation of Vigirex relays (overvoltage category IV, the most severe) makes possible, without any additional galvanic isolation:
- direct connection of the relay power supply to the upstream circuit (connection upstream of an LV incoming device such as a Masterpact circuit breaker, for example)
- direct connection to the upstream busbars.

Insulation class
All Vigirex relays, whether DIN or front-panel mount format, have class II insulated fronts as per standards IEC/EN 60664-1 and NF C 15100.
The communication outputs on the RHU and RMH relays are also class II.

Degree of protection
According to standards EN 60529 (IP degree of protection) and EN 50102 (IK external mechanical impact protection), the devices are rated IP40 and IK07 for the front face through a door or on a front plate, IP30 for the other faces and IP20 for connections.
Vigirex relays comply with environmental-protection regulations.

**Vibration withstand capacity**

Vigirex relays meet the requirements of Veritas and Lloyd’s (vibration test from 2 to 13.2 Hz ±1 mm and from 13.2 to 100 Hz – 0.7 g).

**Labels and markings**

- UL, CE and as per IEC 60947-2 annex M, EAC and CCC marking
- Vigirex relay supply voltage
- Product part number
- The origin (Schneider Electric) and the connection terminals (see pages A-16 to A-22) are indicated on the product.

**Recycling**

The packaging is made of recyclable cardboard. Vigirex relays comply with environmental-protection regulations:

- moulded parts are made of thermoplastic materials:
  - 10 % fibreglass reinforced polycarbonate (PC10FV) for DIN cases and front-panel mount cases
  - the composition is indicated on the parts
  - when disposed of, these materials do not produce polluting substances, even when burned.

**Maximum safety**

Protection of persons against direct contact is ensured by an overall breaking time for the faulty circuit of less than 40 milliseconds:

- Residual-current relays guarantee the protection of persons against direct contact by acting in less than 40 ms when set to a residual operating current of 30 mA and when used with Schneider Electric breakers with a maximum rating of 630 A.

The protection of life and property against indirect contact is ensured by optimised measurement of the residual current.

The tolerances on the protection threshold $I_n$ are less than those specified in the residual-current protection standard:

According to standard IEC 60947-2 annex M, instantaneous tripping must take place between 0.5 and 1 x $I_n$. Vigirex relays trip between 0.8 and 1 x $I_n$, thus increasing immunity to nuisance tripping by 60%.

![Operating tolerances for the protection threshold $I_n$](DB425386.eps)

Gain in immunity to nuisance tripping with Vigirex.
Inverse-time tripping curve:
When circuits are energised, the inverse-time tripping curve avoids nuisance tripping due to short, transient phase-sequence currents, which are caused by:
- the high transient currents caused by certain loads (e.g. motors, LV/LV transformers, etc.)
- the charging of capacitances between live conductors and earth.

![Curve 1: inverse-time tripping curve as per IEC 60947-2 annex M.](image1)
![Curve 2: tripping curve with fixed threshold I = IΔn.](image2)
![Curve 3: transient zero phase-sequence current upon load energisation.](image3)

Zone of optimised continuity of service due to the inverse-time tripping curve.
Non-tripping zone (curve 2).

Frequency filtering:
Frequency converters (e.g. variable-speed drives) implementing IGBTs (Insulated Gate Bipolar Transistor) generate significant levels of high-frequency (HF) leakage currents.
During normal operation (no fault), these capacitive HF leakage currents flowing in the installation conductors do not represent a danger for users. In general, residual-current protection relays are sensitive to these HF natural leakage currents.
If an insulation fault occurs downstream of the frequency converter, the fault current comprises a HF-current component. These HF fault currents do not produce the same physiological effects on the human body as 50/60 Hz currents (see IEC 60479).

![Gain in immunity to nuisance tripping with Vigirex.](image4)
Frequency filtering on the Vigirex range of residual-current protection relays is designed to provide:
- maximum protection if an insulation fault occurs
- continuity of service that has been specially optimised for this type of load.

**Rms measurements of earth-leakage currents**
Rms measurement of fault currents provides the residual-current protection relays with the means to measure all types of signals and to calculate the weighted true rms value depending on the frequency filtering.

**Rms measurement of earth-leakage currents, frequency filtering, the reduced tolerances on the protection threshold and the inverse-time tripping curve built into the Vigirex relays optimise protection of life and property and enhance the continuity of service.**

### Continuous self-monitoring of Vigirex relays

Vigirex relays carry out continuous monitoring of:
- the relay/toroid link (RH10, RH21, RH68, RH86, RH99, RH197, RHU and RMH)
- the link between the RMH relay and the RM12T multiplexer
- the power supply
- the internal electronics.

In the event of problem, the fault or voltage-presence output contact on the protection relays (RH10, RH21, RH68, RH86, RH99, RH197, RHUs and RHU) is actuated. The cause of the fault must be cleared.

### Two wiring techniques for protection relays

Two different wiring techniques are recommended:
- the first places a premium on safety. The voltage-presence contact on the Vigirex residual-current protection relay (RH10, RH21, RH68, RH86, RH99 or RHUs and RHU) is wired in series with the fault contact. This technique ensures failsafe operation.
- the second technique places a premium on continuity of service if the supply to the residual-current relay is cut.

See the wiring diagrams in chapter D.
Test and reset

Test
According to standards IEC 60364 and NF C 15100, a periodic test is required to check correct operation of the residual-current protection system.

The purpose of the test is to check:
- the output contacts:
- the complete protection system with actuation of the output contacts (this shuts down the installation)
- the protection system without actuation of the output contacts ("no trip" test) to maintain the installation up and running.
- correct operation of the display (RHU, RHU, RMH and the RH197 bargraph), the LEDs and the internal electronics.

Reset
Whatever the test mode, a reset clears the fault stored in memory and resets the LEDs and the relay status condition.

Test and reset modes

<table>
<thead>
<tr>
<th>Four possible modes</th>
<th>Actuation of output contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local via button in front</td>
<td>No[1]</td>
</tr>
<tr>
<td>Remote 1 relay</td>
<td>Yes[2]</td>
</tr>
<tr>
<td>a number of relays</td>
<td>No[1]</td>
</tr>
<tr>
<td>Via communication</td>
<td>Yes[2]</td>
</tr>
</tbody>
</table>

[1] Except for RMH.
[2] Except for the RMH/RH197M.

Easy switchboard acceptance tests

During acceptance of a switchboard and prior to dielectric testing, isolation of the residual-current relays by disconnecting the supply is mandatory.

Vigirex relays are supplied via a plug-in connector for easy and secure connection and disconnection.

All connections for the front-panel mount relays of the Vigirex range use plug-in connectors.

Supply connections for the DIN and front-panel mount formats.

Formats for all installation systems

Vigirex relays are available in two formats:
- front-panel mount format 72 x 72 mm (RH10, RH21, RH86P, RH99, RH197P, RHUs, RHU, RMH)

On the DIN-format relays, it is possible to simply clip in:
- the toroids 30 mm and Ø50 mm
- three mounting lugs for relay installation on mounting plates in control cabinets.

Supply connections for the DIN and front-panel mount formats.

<table>
<thead>
<tr>
<th>Installation system</th>
<th>Suitable format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main LV switchboard</td>
<td>Front-panel mount</td>
</tr>
<tr>
<td>Power distribution switchboard:</td>
<td>Front-panel mount</td>
</tr>
<tr>
<td>instrumentation zone</td>
<td>DIN</td>
</tr>
<tr>
<td>modular-device zone</td>
<td>Front-panel mount</td>
</tr>
</tbody>
</table>
Functions and characteristics

General characteristics

Formats for all installation systems (cont.)

DIN device.

DIN device with clip-in toroid.

Front-panel mount device.

Motor Control Centre (MCC).

Covers

All Vigirex relays, except RHU/RHUs and RMH, are equipped with lead-sealable covers to block access to settings while maintaining access to the device test and reset buttons.

Vigirex relays RHU/RHUs and RMH are protected by a password on the display.
It is possible to divide the installation into a number of groups of circuits and to protect each group using the suitable residual-current device. The many fault, alarm and pre-alarm settings and time delays available in the Vigirex range makes it easy to integrate the residual-current relays at all levels in the electrical installation.

Coordination between the upstream and downstream devices in an installation makes it possible to cut the supply (by the protection relay) exclusively in the part of the installation where the fault occurred.

Implementing selectivity

Selectivity between upstream and downstream residual-current devices is necessarily of the current and time type. It is ensured by correctly adjusting:
- the operating-current settings
- the non-operating and overall breaking times.

The following general selectivity rules ensure correct operation:

- in terms of the current, the setting for the upstream device must be double that of the downstream device (in accordance with the standardised rules for the operating / non-operating currents)
- in terms of the time, the non-operating time (time delay) for the upstream device must be greater than the total time (the intentional residual-current device delay and the breaking time of the breaking device) for the downstream device

These two conditions are summed up here:

- upstream $I_{\Delta n} > 2 \times$ downstream $I_{\Delta n}$
- upstream non-operating time $\Delta T >$ downstream total time $\Delta T$.

Note: a residual-current device does not limit the fault current. That is why current selectivity alone is not possible.

The time/current curves indicate the operating-current values of the Vigirex devices depending on their standardised characteristics. When superimposed, the curves indicate the protection settings required to ensure total selectivity (see the curves pages E-43 to E-46).

The Vigirex devices, combined with Schneider Electric breaking devices (switches, circuit breakers), have successive operating-current and time-delay settings that enhance the selectivity rules mentioned above.

Selectivity rules

<table>
<thead>
<tr>
<th>System</th>
<th>Setting</th>
<th>Ratio $I_{\Delta n}$</th>
<th>Time delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>Downstream</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigirex</td>
<td>Schneider RCD</td>
<td>1.5</td>
<td>1 setting apart, except [1]</td>
</tr>
<tr>
<td>Schneider RCD</td>
<td>Vigirex</td>
<td>2</td>
<td>1 setting apart, except [6]</td>
</tr>
<tr>
<td>Vigirex</td>
<td>Vigirex</td>
<td>1.25</td>
<td>1 setting apart [1]</td>
</tr>
</tbody>
</table>

[1] A difference of two settings is required for the 0.25 s setting (i.e. the 0.5 s and the 0.25 s settings).

Note: for further information, see chapter E.

The Schneider Electric residual-current protection ranges (earth-leakage protection function on Masterpact circuit breaker control units, Vigicompact, Acti 9 RCDs, etc.) are internally consistent and designed for combined use to ensure selectivity for insulation faults.
Electromagnetic disturbances

Vigirex relays are immune to:
- overvoltages produced by switching (e.g. lighting circuits)
- overvoltages produced by atmospheric disturbances
- radio-frequency waves emitted by devices such as mobile telephones, radio transmitters, walky-talkies, radar, etc.
- electrostatic discharges produced directly by users.

To guarantee immunity, Vigirex relays are tested in compliance with the following standards:
- IEC/EN 60947-2: low-voltage switchgear and controlgear, part 2 circuit breakers
- IEC/EN 61000-4-1: overview of the IEC/EN 61000-4 series
- IEC/EN 61000-4-2: electrostatic-discharge immunity test
- IEC/EN 61000-4-3: radiated, radio-frequency, electromagnetic-field immunity test
- IEC/EN 61000-4-4: electrical fast transient/burst immunity test
- IEC/EN 61000-4-5: surge immunity test
- IEC/EN 61000-4-6: immunity to conducted disturbances, induced by radio-frequency fields
- CISPR 11: limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radiofrequency equipment.

The high immunity levels of Vigirex relays ensure optimum safety without nuisance tripping.

Behaviour during micro-outages in the auxiliary supply

Vigirex relays are not affected by micro-outages lasting less than 60 ms.
The maximum break time during micro-outages complies with standard IEC/EN 60947-2 annex M.
Functions and characteristics

Description

Relay marking
1. Type of relay.
11. Sensitivity (RH10M): $I_{\Delta n} (A) / \Delta t (s)$.
14. Relay class.

Controls
7. Press and hold the Reset button, then press the Test button to test the device without actuating the output contacts.
12. Test button.
13. Reset button.

Indications
5. Green voltage-presence LED (on).

<table>
<thead>
<tr>
<th>LED status</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>on</td>
<td>Normal operation</td>
</tr>
<tr>
<td>fault</td>
<td>Fault current detected</td>
</tr>
<tr>
<td></td>
<td>Relay/sensor link fault</td>
</tr>
<tr>
<td></td>
<td>No voltage or device not in service</td>
</tr>
<tr>
<td></td>
<td>Malfunction detected</td>
</tr>
</tbody>
</table>

Key:
- off
- green (or red)
- flashing.

Settings
15. Threshold and time-delay selectors (RH21): $I_{\Delta n} (A) / \Delta t (s)$
Three possible settings:
- 0.03 A sensitivity, instantaneous
- 0.3 A sensitivity, instantaneous
- 0.3 A sensitivity, 0.06 s delay

16. Time-delay selector (RH99): $\Delta t (s)$
Nine possible settings (instantaneous – 0.06 s – 0.15 s – 0.25 s – 0.31 s – 0.5 s – 0.8 s – 1 s – 4.5 s).

17. Threshold selector (RH99): $I_{\Delta n} (A)$
Nine possible settings (0.03 A – 0.1 A – 0.3 A – 0.5 A – 1 A – 3 A – 5 A – 10 A – 30 A).

Connection
2. Sensor.
3. Plug-in supply.
8. Fault contact.
9. Voltage-presence contact.
Functions and characteristics

Description

RH197M relays

Relay marking

A Type of relay.
B Customer marking zone (circuit identification).
C Relay class.

Controls

H Press and hold the Reset button, then press the Test button to test the device without actuating the output contacts.
J Test button.
K Reset button.

Indications

L Green voltage-presence LED (on).
M Yellow alarm LEDs \( I_\Delta n \): 20, 30, 40 and 50 %.
N Red insulation-fault LED (fault).

<table>
<thead>
<tr>
<th>LED status</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on</td>
</tr>
<tr>
<td></td>
<td>fault</td>
</tr>
<tr>
<td></td>
<td>Normal operation</td>
</tr>
<tr>
<td></td>
<td>Fault current detected</td>
</tr>
<tr>
<td></td>
<td>Faulty sensor/relay link</td>
</tr>
<tr>
<td></td>
<td>No power or device not working</td>
</tr>
</tbody>
</table>

Key:
- off
- green
- flashing.

Settings

O Dip switch:
- Ne/Nd switch used to select the operating mode:
- failsafe mode: position Ne
- non-failsafe mode: position Nd
- “Auto/Manual” switch used to select fault relay reset mode
  - in “Manual” position: latching relay requiring the Reset button to be pressed after fault clearing
  - in “Auto” position: automatic reset of fault relay (after fault clearing)
- 10 resets are possible according to the following algorithm:
  - 1st reset: 30 s after the fault
  - 2nd reset: 1 min. after the fault
  - 3rd reset: 2 min. after the fault
  - 4th reset: 4 min. after the fault
  - 5th reset: 8 min. after the fault
  - 6th reset: 16 min. after the fault
  - 7th reset: 32 min. after the fault
  - 8th reset: 64 min. after the fault
  - 9th reset: 128 min. after the fault
  - 10th reset: 256 min. after the fault
- The trip counter is reset 30 minutes after fault relay reset.
- At 50 % - 100 % (setting by Dip switch at 50 % of \( I_\Delta n \) or 100 % of \( I_\Delta n \)).
- Selector gain for \( I_\Delta n \).

P Threshold \( I_\Delta n \) (A): 19 possible settings (0.03 A – 0.05 A – 0.075 A – 0.1 A – 0.15 A – 0.2 A – 0.3 A – 0.5 A – 0.75 A – 1 A – 1.5 A – 2 A – 3 A – 5 A – 7.5 A – 10 A – 15 A – 20 A – 30 A).
- Time-delay selector \( \Delta t \) (s): 7 possible settings (instantaneous – 0.06 s – 0.15 s – 0.31 s – 0.5 s – 1 s – 4.5 s).

Connection

D Plug-in supply.
E Fault contact.
F Alarm contact.
G Remote reset/test.
H Sensor.
Functions and characteristics

Description

Relay marking
A  Type of relay.
D  Customer marking zone (circuit identification).
H  Sensitivity (RH10P): \( I_{\Delta n} (A) / \Delta t (s) \).
I  Relay class.

Controls
E  Test button.
F  Reset button.
G  Press and hold the Reset button, then press the Test button to test the device without actuating the output contacts.

Indications
B  Green voltage-presence LED (on).
C  Red insulation-fault LED (fault).

<table>
<thead>
<tr>
<th>LED status</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>on</td>
<td>Normal operation</td>
</tr>
<tr>
<td>off</td>
<td>Fault current detected</td>
</tr>
<tr>
<td>flashing</td>
<td>Relay/sensor link fault</td>
</tr>
<tr>
<td></td>
<td>No voltage or device not in service</td>
</tr>
<tr>
<td></td>
<td>Malfunction detected</td>
</tr>
</tbody>
</table>

Key:
- off
- green (or red)
- flashing

Settings
J  Threshold and time-delay selectors (RH21): \( I_{\Delta n} (A) / \Delta t (s) \)
Three possible settings:
- 0.03 A sensitivity, instantaneous
- 0.3 A sensitivity, instantaneous
- 0.3 A sensitivity, 0.06 s delay

K  Time-delay selector (RH99): \( \Delta t (s) \)
Nine possible settings (instantaneous − 0.06 s − 0.15 s − 0.25 s − 0.31 s − 0.5 s − 0.8 s − 1 s − 4.5 s).

L  Threshold selector (RH99): \( I_{\Delta n} (A) \)
Nine possible settings (0.03 A − 0.1 A − 0.3 A − 0.5 A − 1 A − 3 A − 5 A − 10 A − 30 A).

Connection
All connections for front-panel mount relays are of the plug-in type.
M  Fault contact.
N  Sensor.
O  Plug-in supply.
P  Voltage-presence contact.
Q  Remote reset/test.

Connections on the back of the relay.
Functions and characteristics

**Description**

**RH197P relays**

---

**Relay marking**
- **A**: Type of relay.
- **D**: Customer marking zone (circuit identification).
- **I**: Relay class.

**Controls**
- **E**: Test button.
- **F**: Reset button.

**Indications**
- **B**: Green voltage-presence LED (on).
- **C**: Red insulation-fault LED (fault).
- **R, S, T, U**: Yellow alarm LEDs for \( I_{\Delta n} \) reaching 50, 40, 30 and 20\% (respectively) of the \( I_{\Delta n} \) setting. When 70\% of the \( I_{\Delta n} \) setting is reached, all the yellow alarm LEDs (R, S, T, U) and the red insulation-fault LED flash.

**LED status**

<table>
<thead>
<tr>
<th>LED status</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>on</td>
<td>Fault current detected</td>
</tr>
<tr>
<td>fault</td>
<td>Relay/sensor link fault</td>
</tr>
<tr>
<td>off</td>
<td>No voltage or device not in service</td>
</tr>
<tr>
<td>flashing</td>
<td></td>
</tr>
</tbody>
</table>

**Settings**
- **K**: Time-delay selector:
  - 7 possible settings (instantaneous – 0.06 s – 0.15 s – 0.31 s – 0.5 s – 1 s – 4.5 s).
- **L**: Threshold selector:
  - 19 possible settings (0.03 A – 0.05 A – 0.075 A – 0.1 A – 0.15 A – 0.2 A – 0.3 A – 0.5 A – 0.75 A – 1 A – 1.5 A – 2 A – 3 A – 5 A – 7.5 A – 10 A – 15 A – 20 A – 30 A).
- **X**: Ne/Nd switch used to select the operating mode:
  - failsafe mode: position Ne
  - non-failsafe mode: position Nd
- **Y**: “Auto/Manual” switch used to select fault relay reset mode
  - in “Manual” position: latching relay requiring the Reset button to be pressed after fault clearing
  - in “Auto” position: automatic reset of fault relay (after fault clearing)
- **V** and **W**: Gain selector for threshold selector 12 (\( I_{\Delta n} \)):
  - The \( I_{\Delta n} = 0.030 \) A setting is not modified by the gain selector.

**Connection**

All connections for front-panel mount relays are of the plug-in type.
- **M**: Plug-in supply.
- **N**: Fault contact.
- **O**: Alarm contact.
- **P**: Remote reset/test.
- **Q**: Sensor.
- **V** - **W**: Gain selector for threshold selector 12 (\( I_{\Delta n} \)).

**Position of V and W**

**Actual trip threshold \( I_{\Delta n} (A) \)**

<table>
<thead>
<tr>
<th>Position of V and W</th>
<th>Actual trip threshold ( I_{\Delta n} (A) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>x100</td>
<td>( I_{\Delta n} (A) )</td>
</tr>
<tr>
<td>x10</td>
<td>10 ( I_{\Delta n} (A) )</td>
</tr>
<tr>
<td>x10</td>
<td>100 ( I_{\Delta n} (A) )</td>
</tr>
<tr>
<td>x1</td>
<td>( I_{\Delta n} (A) )</td>
</tr>
</tbody>
</table>
Functions

The Vigirex RHU is used together with a toroid (open or closed) or a rectangular sensor.

Vigirex RHU:
- Measures the earth-leakage current detected by the toroid.
- Displays the earth-leakage current.
- Trips the installation protection circuit breaker through an MN or MX release if the earth-leakage current exceeds the threshold $I_{ΔN}$ for a time greater than the delay $Δt$.
- Activates a pre-alarm when the earth-leakage current on a circuit exceeds pre-alarm threshold.
- Activates an alarm when the earth-leakage current on a circuit exceeds alarm threshold.
- Integrates perfectly in the Smart Panel architecture system by communicating with the Modbus communication (Except RHUs which is without communication).

HMI Description and Navigation Principles

Overview

<table>
<thead>
<tr>
<th>Legend</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>LCD screen</td>
<td>Displays the parameter settings and the measurement values.</td>
</tr>
<tr>
<td>B</td>
<td>Status LEDs</td>
<td>Indicates power on, status of alarm, pre-alarm, and communication.</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>Allows to navigate</td>
</tr>
</tbody>
</table>

Status LED

<table>
<thead>
<tr>
<th>Status LED</th>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>Green</td>
<td>Is switched on when the Vigirex relay is powered.</td>
</tr>
<tr>
<td>Alarm</td>
<td>Red</td>
<td>Is switched on when an alarm is active.</td>
</tr>
<tr>
<td>Pre-alarm</td>
<td>Orange</td>
<td>Is switched on when a pre-alarm is active.</td>
</tr>
<tr>
<td>COM</td>
<td>Green</td>
<td>Blinks when the Vigirex relay detects or sends a Modbus frame.</td>
</tr>
</tbody>
</table>

Navigation Buttons

<table>
<thead>
<tr>
<th>Button</th>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
</table>
| Validation | OK  | Allows to:
- Modify parameter.
- Select an item.
- validate current setting.
- start test mode.
- exit test mode at the end of the test. |
| Down   |        | Allows to move to:
- next screen.
- next menu item.
- Allows to decrease the numerical value while setting the parameters. |
| Up     |        | Allows to move to:
- previous screen.
- previous menu item.
- Allows to increase the numerical value while setting the parameters. |
| Home   |        | Allows to access the home menu. |

Connection

- Terminal block to connect the pre-alarm contact and the alarm contact
- Terminal block to connect the toroid and the Test/Reset contacts
- Terminal block to connect the power supply and voltage presence contact
- Modbus SL port

User guide RHU DOCA0107EN. Instruction sheet RHU NHA34634.
Functions
The Vigirex RMH is used together with a Vigirex RM12T and toroid (open or closed) or a rectangular sensor.

Vigirex RMH:
- Measures the earth-leakage current detected by the toroids (12 maximum).
- Displays the earth-leakage current.
- Activates a pre-alarm when the earth-leakage current on a circuit exceeds its pre-alarm threshold.
- Activates an alarm when the earth-leakage current on a circuit exceeds its alarm threshold.
- Integrates perfectly in the Smart Panel architecture system by communicating with the Modbus communication.

Alarm Detection
An alarm is active when the measured earth-leakage current is greater than the set alarm threshold (I alarm) on at least one toroid for a period of time greater than the set alarm delay (t alarm in milliseconds or seconds) for that particular toroid.

When an alarm is active:
- the ALARM and PRE-AL LED are switched on.
- When only one alarm is detected, the Metering screen of the corresponding toroid is displayed, and the earth-leakage current value blinks.
- When more than one alarm are detected, the Alarm screen is displayed.

Pre-Alarm Detection
A pre-alarm is active when the measured earth-leakage current is greater than the set pre-alarm threshold on at least one channel for a period of time greater than the set pre-alarm trip delay (t pre-alarm in milliseconds or seconds) for that particular toroid.

When a pre-alarm is active:
- the PRE-AL LED is switched on and the displayed value blinks.
- When only one pre-alarm is detected, the Metering screen of the corresponding toroid is displayed, and the earth-leakage current value blinks.
- When more than one alarm are detected, the Pre-alarm screen is displayed.

HMI Description and Navigation Principles

Legend Display Description
A LCD screen Displays the parameter settings and the measurement values.
B Status LEDs Indicates power on, status of alarm, pre-alarm, and communication
C Navigation buttons Allows to navigate

Status LED

<table>
<thead>
<tr>
<th>Status LED</th>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>Green</td>
<td>Is switched on when the Vigirex relay is powered.</td>
</tr>
<tr>
<td>Alarm</td>
<td>Red</td>
<td>Is switched on when an alarm is active.</td>
</tr>
<tr>
<td>Pre-alarm</td>
<td>Orange</td>
<td>Is switched on when a pre-alarm is active.</td>
</tr>
<tr>
<td>COM</td>
<td>Green</td>
<td>Blinks when the Vigirex relay detects or sends a Modbus frame.</td>
</tr>
</tbody>
</table>

Navigation Buttons

<table>
<thead>
<tr>
<th>Button</th>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validation</td>
<td>OK</td>
<td>Allows to: select an item. modify parameter. validate current setting. start test mode. exit test mode at the end of the test.</td>
</tr>
<tr>
<td>Down</td>
<td>△</td>
<td>Allows to move to: next screen. next menu item. Allows you to decrease the numerical value.</td>
</tr>
<tr>
<td>Up</td>
<td>▽</td>
<td>Allows to move to: previous screen. previous menu item. Allows to increase the numerical value.</td>
</tr>
<tr>
<td>Home</td>
<td></td>
<td>Allows to access the home menu.</td>
</tr>
</tbody>
</table>
Connections on the back side of the RMH.

Front of RM12T multiplexer.

Connection
- **D**: Terminal block to connect the pre-alarm contact and the alarm contact.
- **E**: Terminal block to connect the RM12T multiplexer.
- **F**: Terminal block to connect the power supply and voltage presence contact.
- **G**: Modbus SL port.

RM12T multiplexer connection
- **T**: Sensors (12 measurement channels).
- **U**: RMH relay.
- **V**: Supply.
Compatibility with toroids

Vigirex RH10, RH21, RH68, RH86, RH99, RH197, RHUs, RHU and RMH relays may be used with the following sensors:
- closed toroids (A type)
- split toroids (OA type)
- rectangular sensors (L type).

Adaptation to installations

- Closed toroids are suitable for new installations up to 630 A.
- Certain toroids may be mounted on DIN rails, plates or brackets, clipped onto the Vigirex relay or tied to the cables (see page B-5).
- New split toroids (from 80 to 120 mm) facilitate installation in existing systems up to 250 A. Thank to a trigger, it’s very useful to open the toroid, put the cables and re-close the toroid.
- These toroids could be installed directly on plates or as a modular product through a specific part.
- Rectangular sensors are for busbars in installations with currents ≤ 3200 A.

Compatibility with rectangular sensors

The RH10, RH21, RH68, RH86, RH99, RH197, RHUs, RHU and RMH relays may be used with rectangular sensors (L type) 280 x 115 mm and 470 x 160 mm. The Vigirex sensitivity must be set to ≥ 300 mA.

Withstand capacity for high residual-current faults

Tests guarantee accurate measurements after a high phase-sequence current flowing through the toroid during a short-circuit between a phase and the PE conductor.

Temperature ranges

- The temperature range for toroid operation is:
  - A / OA type toroids: -35 °C / +70 °C
  - rectangular sensors: -35 °C / +80 °C
- The temperature range for toroid storage is:
  - A / OA type toroids: -55 °C / +85 °C
  - L type rectangular sensors: -55 °C / +100 °C.
Functions and characteristics

Characteristics
Protection relays with output contact requiring local manual reset after a fault

Vigirex relays

General characteristics

Monitored distribution system: LV AC / System voltage 50/60/400 Hz

System earthing arrangement TT, TNS, IT

A, AC type class as per IEC 60947-2 appendix M [1]

Operating-temperature range -35 °C / +70 °C

Storage-temperature range -55 °C / +85 °C

Electrical characteristics as per IEC 60755 and EN 60755, IEC 60947-2 and EN 60947-2, UL 1053 and CSA C22.2 N° 144 for RH10 to 99 with Ue

Power supply: rated operational voltage Ue

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC</td>
<td>12 to 48 V DC</td>
<td>50/60 Hz / DC</td>
</tr>
<tr>
<td>12 to 24 V DC</td>
<td>50/60 Hz / DC</td>
<td></td>
</tr>
<tr>
<td>48 V AC</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>48 V AC - 24 to 130 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>48 V AC - 24 to 105 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>48 V AC - 24 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>110 to 415 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>110 to 240 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>220 to 240 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>380 to 415 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>440 to 525 V</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Ue - 12 to 24 V DC</td>
<td>55 % to 120 % Ue [2]</td>
<td></td>
</tr>
<tr>
<td>Ue - 48 V AC - 24 to 130 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Ue - 48 V AC - 24 to 105 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Ue - 48 V AC - 24 V DC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Ue - 110 to 415 V</td>
<td>70 % to 110 % Ue</td>
<td></td>
</tr>
<tr>
<td>Ue &gt; 415 V</td>
<td>70 % to 110 % Ue</td>
<td></td>
</tr>
</tbody>
</table>

Overvoltage category 4

RATED impulse withstand voltage up to Ue = 525 V AC

<table>
<thead>
<tr>
<th>Impulse Voltage (kV)</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V AC</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>48 V AC - 24 to 105 V DC</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>48 V AC - 24 V DC</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>110 to 415 V</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>110 to 240 V</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>220 to 240 V</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>380 to 415 V</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>440 to 525 V</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Maximum consumption

<table>
<thead>
<tr>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 VA</td>
<td>4 VA</td>
</tr>
<tr>
<td>4 W</td>
<td>4 W</td>
</tr>
</tbody>
</table>

Insensitive to micro-outages ≤ 60 ms

Maximum break time on toroid failure (as per standard IEC 60947-2)

Leakage-current measurements

<table>
<thead>
<tr>
<th>Measurement Range</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mA to 60 A</td>
<td>±7 %</td>
<td></td>
</tr>
<tr>
<td>15 mA to 60 A</td>
<td>±7 %</td>
<td></td>
</tr>
<tr>
<td>15 mA to 60 A</td>
<td>±7 %</td>
<td></td>
</tr>
<tr>
<td>15 mA to 60 A</td>
<td>±7 %</td>
<td></td>
</tr>
</tbody>
</table>

Threshold IΔn

<table>
<thead>
<tr>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03 A - 0.05 A - 0.1 A - 0.25 A</td>
<td>2 user-selectable thresholds 0.03 A or 0.3 A</td>
</tr>
<tr>
<td>0.3 A - 0.5 A</td>
<td>2 user-selectable thresholds 0.03 A or 0.3 A</td>
</tr>
<tr>
<td>1 fixed threshold</td>
<td>2 user-selectable thresholds 0.03 A or 0.3 A</td>
</tr>
</tbody>
</table>

Fault current detection

<table>
<thead>
<tr>
<th>Time delay Δt</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>instantaneous</td>
<td>instantaneous</td>
<td>instantaneous</td>
</tr>
<tr>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Δt settings (s)

<table>
<thead>
<tr>
<th>Maximum non-operating time at 2 IΔn (s)</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Setting

<table>
<thead>
<tr>
<th>Maximum current detection range</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 % IΔn to 100 % IΔn</td>
<td>80 % IΔn to 100 % IΔn</td>
<td></td>
</tr>
<tr>
<td>instantaneous</td>
<td>instantaneous</td>
<td></td>
</tr>
<tr>
<td>80 % IΔn to 100 % IΔn</td>
<td>80 % IΔn to 100 % IΔn</td>
<td></td>
</tr>
<tr>
<td>instantaneous</td>
<td>instantaneous</td>
<td></td>
</tr>
</tbody>
</table>

Maximum total time at 5 IΔn

<table>
<thead>
<tr>
<th>Maximum total time at 5 IΔn [4] (s)</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Alarm

<table>
<thead>
<tr>
<th>Output contact</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>changeover with latching</td>
<td>changeover with latching</td>
<td>changeover with latching</td>
</tr>
<tr>
<td>test with or without actuation of the output contacts</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>time delay Δt</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Δt alarm settings</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum non-operation time at 2 IΔn</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum operating time at 5 IΔn</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Time delay Δt</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Δt alarm settings</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum non-operation time at 2 IΔn</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum operating time at 5 IΔn</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Setting</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Output contact</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power supply link</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electronics</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Test with or without actuation of the output contacts and output-contact reset following a fault</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Local</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Remote (hard-wired) (10 m maximum)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Remote (hard-wired for several relays) (10 m maximum)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Remote (via communication)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Self-monitoring

<table>
<thead>
<tr>
<th>Relay/sensor link</th>
<th>AC</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
</tr>
<tr>
<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
</tr>
<tr>
<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
</tr>
<tr>
<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
</tr>
</tbody>
</table>

[1] Type A relays up to 5 A.
[2] 80 % to 120 % Ue if Ue < 20 V.
[3] 80 % to 110 % Ue if Ue < 28 V.
[5] < 10 % of IΔn: display = 0 and > 200 % of IΔn: display = SAT.
## Functions and characteristics

### Characteristics

**Protection relays with output contact requiring local manual reset after a fault**

<table>
<thead>
<tr>
<th>RH68</th>
<th>RH86</th>
<th>RH99</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated impulse withstand voltage up to Ue = 525 V AC</strong></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Overvoltage category</strong></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Rate operational voltage Ue</strong></td>
<td>Ue &gt; 415 V: 70 % to 110 % Ue</td>
<td>Ue &gt; 415 V: 70 % to 110 % Ue</td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>UL 1053 and CSA C22.2 N° 144 for RH10 to 99</td>
<td>UL 1053 and CSA C22.2 N° 144 for RH10 to 99</td>
</tr>
<tr>
<td><strong>Electrical characteristics as per IEC 60755 and EN 60755, IEC 60947-2 and EN 60947-2, A, AC type class as per IEC 60947-2 appendix M</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System earthing arrangement</strong></td>
<td>TT, TNS, IT</td>
<td>TT, TNS, IT</td>
</tr>
<tr>
<td><strong>General characteristics</strong></td>
<td>Vigirex relays RH10 RH21</td>
<td>Vigirex relays RH10 RH21</td>
</tr>
<tr>
<td><strong>Operational voltage</strong></td>
<td>55 % to 120 % Ue</td>
<td>55 % to 120 % Ue</td>
</tr>
<tr>
<td><strong>Leakage-current measurements</strong></td>
<td>Measurement range from 15 mA to 60 A</td>
<td>Measurement range from 15 mA to 60 A</td>
</tr>
<tr>
<td><strong>Maximum break time on toroid failure (as per standard IEC 60947-2)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Insensitive to micro-outages</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum consumption</strong></td>
<td>AC 4 VA</td>
<td>AC 4 VA</td>
</tr>
<tr>
<td><strong>following a fault</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output-contact reset</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Test with or without actuation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electronics continuous</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply continuous</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remote (via communication)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remote (hard-wired) (10 m maximum)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hysteresis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output contact</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Setting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum detection time at 5 I alarm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum non-detection time at 2 I alarm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Δt alarm settings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Alarm-current detection range</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output contact changeover with latching</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Setting</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1. Maximum time to clear the fault current when combined with a Schneider Electric circuit breaker or switch rated ≤ 630 A.
2. Depending on version.
## Functions and characteristics

### Characteristics

Protection relays with output contact requiring local manual reset after a fault

### Vigirex relays

#### General characteristics
- Monitored distribution system: LV AC / System voltage
- System earthing arrangement: A, AC type class as per IEC 60947-2 appendix M
- Operating-temperature range: 85 % to 110 % Ue
- Storage-temperature range: -25 °C / +55 °C

#### Electrical characteristics as per IEC 60755 and EN 60755, IEC 60947-2 and EN 60947-2, UL 1053 and CSA C22.2 No. 144 for RH10 to 99 with Ue ≤ 220 V

<table>
<thead>
<tr>
<th>Power supply: rated operational voltage Ue</th>
<th>12 to 24 V AC</th>
<th>-12 to 48 V DC</th>
<th>50/60 Hz / DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V AC - 24 to 130 V DC</td>
<td>-12 to 48 V DC</td>
<td>50/60 Hz / DC</td>
<td></td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>-12 to 48 V DC</td>
<td>50/60 Hz / DC</td>
<td></td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>50/60 Hz / DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>50/60 Hz / DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>50/60 Hz / DC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational voltage tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ue : 12 to 24 V AC - 12 to 48 V DC</td>
</tr>
<tr>
<td>Ue : 48 V AC - 24 to 130 V DC</td>
</tr>
<tr>
<td>Ue : 48 to 415 V</td>
</tr>
<tr>
<td>Ue : 110 to 415 V</td>
</tr>
<tr>
<td>Ue &gt; 415 V</td>
</tr>
</tbody>
</table>

- Overvoltage category: Uimp (kV) for RHU (Alarm for RHU)
- Rated impulse withstand voltage up to Ue ≤ 525 V AC
- In-sensitive to micro-outages < 60 ms
- Maximum break time on toroid failure (as per standard IEC 60947-2)
- Leakage-current measurements

<table>
<thead>
<tr>
<th>Measurement range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement accuracy</td>
</tr>
<tr>
<td>Display measurement</td>
</tr>
<tr>
<td>Display refresh time</td>
</tr>
</tbody>
</table>

#### Fault current detection

<table>
<thead>
<tr>
<th>Threshold Δn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault-current detection range</td>
</tr>
<tr>
<td>Time delay Δt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Δt settings (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum non-operating time at 2 Δn (s)</td>
</tr>
<tr>
<td>Maximum operating time at 5 Δn (s) (residual-current relay alone)</td>
</tr>
<tr>
<td>Maximum total time at 5 Δn (s)</td>
</tr>
<tr>
<td>Setting</td>
</tr>
<tr>
<td>Output contact</td>
</tr>
</tbody>
</table>

#### Alarm

<table>
<thead>
<tr>
<th>I alarm threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm-current detection range</td>
</tr>
<tr>
<td>Time delay Δt alarm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Δt alarm settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum non-detection time at 2 I alarm</td>
</tr>
<tr>
<td>Maximum detection time at 5 I alarm</td>
</tr>
<tr>
<td>Setting</td>
</tr>
<tr>
<td>Output contact</td>
</tr>
<tr>
<td>Hysteresis</td>
</tr>
</tbody>
</table>

### Test with or without actuation of the output contacts and output-contact reset following a fault

| Local |
| Remote (hard-wired) (10 m maximum) |
| Remote (hard-wired for several relays) (10 m maximum) |
| Remote (via communication) |

### Self-monitoring

<table>
<thead>
<tr>
<th>Relay/sensor link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
</tr>
<tr>
<td>Electronics</td>
</tr>
</tbody>
</table>

---

[1] Type A relays up to 5 A.
[2] Maximum time to clear the fault current when combined with a Schneider Electric circuit breaker or switch rated ≤ 630 A.
[4] 80 % to 110 % Ue if Ue ≤ 28 V.
[6] < 20 % of Δn: display = 0 and > 200 % of Δn: display = SAT.
### Functions and characteristics

#### Protection relays with output contact requiring local manual reset after a fault

### Characteristics

<table>
<thead>
<tr>
<th>RH197M</th>
<th>RH197P</th>
<th>RHUs and RHU</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/60/400 Hz ≤ 1000 V</td>
<td>50/60/400 Hz ≤ 1000 V</td>
<td>50/60/400 Hz ≤ 1000 V</td>
</tr>
<tr>
<td>TT, TNS, IT</td>
<td>TT, TNS, IT</td>
<td>TT, TNS, IT</td>
</tr>
<tr>
<td>-25 °C / +55 °C</td>
<td>-25 °C / +55 °C</td>
<td>-25 °C / +55 °C</td>
</tr>
<tr>
<td>-40 °C / +85 °C</td>
<td>-40 °C / +85 °C</td>
<td>-40 °C / +85 °C</td>
</tr>
</tbody>
</table>

- **Self-monitoring Relay/sensor link after a fault**
- **Output-contact reset**
- **Test with or without actuation** (Pre-Alarm for RHU)
- **Alarm (Alarm for RHU)**
- **Fault current detection**
- **Leakage-current measurements**
- **Measurement range**
- **Maximum break time on toroid failure (as per standard IEC 60947-2)**
- **Insensitive to micro-outages**
- **Maximum consumption AC**
- **Overvoltage category tolerances**
- **Operational voltage**
- **Power supply:**
  - Electronics
  - Remote (via communication)
  - Remote (hard-wired for several relays) (10 m maximum)
  - Remote (hard-wired) (10 m maximum)
- **Hysteresis**
- **Output contact**
- **Setting**
- **Maximum detection time at 5 I alarm**
- **Maximum non-detection time at 2 I alarm**
- **Δt alarm settings**
- **Time delay Δt alarm**
- **Fault-current detection range**
- **Display refresh time**
- **Display measurement**
- **Measurement accuracy**

#### Electronics

- **Power supply**
  - DC
- **Remote (via communication)**
- **Remote (hard-wired for several relays) (10 m maximum)**
- **Remote (hard-wired) (10 m maximum)**
- **Hysteresis**
- **Output contact**
- **Setting**
- **Maximum detection time at 5 I alarm**
- **Maximum non-detection time at 2 I alarm**
- **Δt alarm settings**
- **Time delay Δt alarm**
- **Fault-current detection range**
- **Display refresh time**
- **Display measurement**
- **Measurement accuracy**

#### System earthing arrangement

- **Monitored distribution system: LV AC / System voltage**

#### General characteristics

- **Vigirex relays**
  - 60 ms
- **Electronics**
  - Remote (via communication)
  - Remote (hard-wired for several relays) (10 m maximum)
  - Remote (hard-wired) (10 m maximum)
- **Hysteresis**
- **Output contact**
- **Setting**
- **Maximum detection time at 5 I alarm**
- **Maximum non-detection time at 2 I alarm**
- **Δt alarm settings**
- **Time delay Δt alarm**
- **Fault-current detection range**
- **Display refresh time**
- **Display measurement**
- **Measurement accuracy**

#### Power supply:

- **Ue > 415 V**
- **Ue: 110 to 415 V**
- **Ue: 48 to 415 V**
- **Ue: 48 V AC - 24 to 130 V DC**
- **440 to 525 V AC 50/60 Hz**
- **380 to 415 V AC 50/60 Hz**
- **220 to 240 V AC 50/60 Hz**
- **110 to 130 V AC 50/60 Hz**
- **48 V AC - 24 to 130 V DC 50/60 Hz / DC**
- **12 to 24 V AC / 12 to 48 V DC 50/60 Hz / DC**

#### Storage-temperature range

- **-25 °C / +55 °C**

#### Operating-temperature range

- **-25 °C / +55 °C**

#### A, AC type class as per IEC 60947-2 appendix M

#### System earthing arrangement

- **Monitored distribution system: LV AC / System voltage**

#### General characteristics

- **Vigirex relays**
  - 60 ms
- **Electronics**
  - Remote (via communication)
  - Remote (hard-wired for several relays) (10 m maximum)
  - Remote (hard-wired) (10 m maximum)
- **Hysteresis**
- **Output contact**
- **Setting**
- **Maximum detection time at 5 I alarm**
- **Maximum non-detection time at 2 I alarm**
- **Δt alarm settings**
- **Time delay Δt alarm**
- **Fault-current detection range**
- **Display refresh time**
- **Display measurement**
- **Measurement accuracy**
## Characteristics
Protection relays with output contact requiring local manual reset after a fault

### Vijirex relays

<table>
<thead>
<tr>
<th>Characteristics of output contacts as per standard IEC 60947-5-1</th>
<th>Rated thermal current (A)</th>
<th>Min. load 10 mA at 12 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated operational current (A)</td>
<td>Minimum load</td>
<td>AC12 AC13 AC14 AC15 DC12 DC13</td>
</tr>
<tr>
<td>24 V</td>
<td>6</td>
<td>6 5 5 6 2</td>
</tr>
<tr>
<td>48 V</td>
<td>6</td>
<td>6 5 5 6 2</td>
</tr>
<tr>
<td>110-130 V</td>
<td>6</td>
<td>6 4 4 0.6 -</td>
</tr>
<tr>
<td>220-240 V</td>
<td>6</td>
<td>6 4 4 - -</td>
</tr>
<tr>
<td>380-415 V</td>
<td>-</td>
<td>- - - - -</td>
</tr>
<tr>
<td>440 V</td>
<td>-</td>
<td>- - - - -</td>
</tr>
<tr>
<td>660-690 V</td>
<td>-</td>
<td>- - - - -</td>
</tr>
</tbody>
</table>

### Display and indications
- Voltage presence (LED and/or relay)[1]
- Threshold overrun fault (LED)
- Alarm (LED and relay)
- Leakage current and settings (digital)

### Setting protection
- Sealeable cover

### Communication
- Suitable for supervision (internal bus)
- DIN
- Front-panel mount

### Mechanical characteristics
- Dimensions: 6 modules x 9 mm
- Weight: 0.3 kg
- Insulation class (IEC 60664-1):
  - Front face: 2
  - Communication output: 2
- Degree of protection IP (IEC 60529):
  - Front face: IP40
  - Other faces: IP30
- Connections: IP20
- Mechanical impact on front face IK (EN 50102):
  - IK07 (2 joules)
- Sinusoidal vibrations (Lloyd's and Veritas):
  - 2 to 13.2 Hz ±1 mm
  - 13.2 to 100 Hz ± 0.7 g
- Fire (IEC 60695-2-10)
- Damp heat, equipment not in service (IEC 60068-2-30):
  - 28 cycles +25 °C / +65 °C / RH 95 %
- Damp heat, equipment in service (IEC 60068-2-56):
  - 48 hours, Environment category C2
- Degree of pollution (IEC 60664-1):
  - 3
- Electromagnetic compatibility (IEC 60664-1):
  - Electrostatic discharges (IEC 61000-4-2):
    - Level 4
  - Radiated susceptibility (IEC 61000-4-3):
    - Level 3
  - Low-energy conducted susceptibility (IEC 61000-4-4):
    - Level 4
  - High-energy conducted susceptibility (IEC 61000-4-5):
    - Level 4
  - Radiofrequency interference (IEC 61000-4-6):
    - Level 3
  - Conducted and radiated emissions (CISPR11):
    - Class B

### Sensors and accessories
- Sensors: A, TOA type toroids
- L type rectangular sensors for IDN ≥ 300 mA
- Cables:
  - Relay/sensor link via standard twisted pair (not supplied)

---

[1] Depending on the type of wiring (optimum continuity of service or optimum safety).
[2] Compatibility for both relay and sensor.
## Characteristics

Protection relays with output contact requiring local manual reset after a fault

### RH197

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Functions and characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 modules x 9 mm - H 89 mm</td>
<td>28 cycles +25 °C / +55 °C / RH 95 %</td>
</tr>
<tr>
<td>0.3 kg</td>
<td>48 hours, Environment category C2</td>
</tr>
<tr>
<td>2</td>
<td>KB test, severity 2</td>
</tr>
<tr>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>-</td>
<td>Level 4</td>
</tr>
<tr>
<td>-</td>
<td>Level 3</td>
</tr>
<tr>
<td>-</td>
<td>Level 4</td>
</tr>
<tr>
<td>-</td>
<td>Level 3</td>
</tr>
<tr>
<td>-</td>
<td>Class B</td>
</tr>
</tbody>
</table>

### RHUs and RHU

<table>
<thead>
<tr>
<th>DIN</th>
<th>Front-panel mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 cycles +25 °C / +55 °C / RH 95 %</td>
<td>28 cycles +25 °C / +55 °C / RH 95 %</td>
</tr>
<tr>
<td>48 hours, Environment category C2</td>
<td>48 hours, Environment category C2</td>
</tr>
<tr>
<td>KB test, severity 2</td>
<td>KB test, severity 2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Level 4</td>
<td>Level 4</td>
</tr>
<tr>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td>Level 4</td>
<td>Level 4</td>
</tr>
<tr>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td>Class B</td>
<td>Class B</td>
</tr>
</tbody>
</table>

- **Characteristics**
  - Protection relays with output contact requiring local manual reset after a fault

- **Functions and characteristics**
  - DIN: 8 modules x 9 mm - H 89 mm
  - Front-panel mount: 72 x 72 mm
  - Weight: 0.3 kg
  - Protection level: IP40, IP30, IK07 (2 joules)
  - Frequency range: 2 to 13.2 Hz ±1 mm and 13.2 to 100 Hz - 0.7 g
  - Operating conditions: 28 cycles +25 °C / +55 °C / RH 95 %
  - Environment category: C2
  - Test: KB test, severity 2
  - Level: 3
  - Class: B

- **Protection**
  - (RHU only) sealable cover by password on the display
Functions and characteristics

Characteristics
Monitoring relays with output contact that automatically resets after fault clearance

Vigirex relays

General characteristics
- Monitored distribution system: LV AC / System voltage
- System earthing arrangement
- A, AC type class as per IEC 60947-2 appendix M
- Operating-temperature range
- Storage-temperature range

Electrical characteristics
- Power supply: rated operational voltage Ue
  - 12 to 24 V AC - 12 to 48 V DC 50/60 Hz / DC
  - 110 to 130 V AC 50/60 Hz
  - 220 to 240 V AC 50/60 Hz
  - 380 to 415 V AC 50/60 Hz
  - 440 to 525 V AC 50/60 Hz
- Operational voltage tolerances
  - Ue: 12 to 24 V AC -12 to 48 V DC
  - Ue > 415 V
- Overvoltage category
  - Rated impulse withstand voltage up to Ue = 525 V AC
  - Uimp (kV)
- Insensitive to micro-outages ≤ 60 ms
- Maximum break time on toroid failure (as per standard IEC 60947-2)
- Leakage-current measurements
  - Measurement range
  - Measurement accuracy
  - Measurement time for 1 channel
  - Measurement time for 12 channels
- Display measurement
- Display refresh time

Alarm
- IΔn threshold
- Alarm-current detection range
- Time delay Δt alarm
- Δt alarm settings (s)
- Maximum non-detection time at 2 IΔn (2 I alarm for RMH) (s)
- Maximum detection time at 5 IΔn (5 I alarm for RMH) (s)
- Setting
- Output contact
- Hysteresis
- I pre-alarm threshold
- Pre-alarm current detection range
- Time delay Δt pre-alarm
- Accuracy
- Setting
- Output contact
- Hysteresis

Test with or without activation of output contacts
- Local
- Remote (hard-wired) (10 m maximum)
- Remote (hard-wired for several relays) (10 m maximum)
- Remote (via communication)

Self-monitoring
- Relay/sensor link
- Sensor/multiplexer RM12T and RM12T/RMH link
- Power supply
- Electronics

[1] 80 % to 120 % Ue if Ue < 20 V.
[3] < 20 % of IΔn: display = 0 and > 200 % of IΔn: display = SAT.
## Characteristics

Monitoring relays with output contact that automatically resets after fault clearance

<table>
<thead>
<tr>
<th>RH99</th>
<th>RHUs and RHU</th>
<th>RMH and RM12T associated</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/60/400 Hz ≤ 1000 V TT, TNS</td>
<td>50/60/400 Hz ≤ 1000 V TT, TNS, IT</td>
<td>50/60/400 Hz ≤ 1000 V TT, TNS</td>
</tr>
<tr>
<td>-35 °C / +70 °C</td>
<td>-25 °C / +55 °C</td>
<td>-25 °C / +55 °C</td>
</tr>
<tr>
<td>-55 °C / +85 °C</td>
<td>-40 °C / +85 °C</td>
<td>-40 °C / +85 °C</td>
</tr>
<tr>
<td>55 % to 120 % Ue&lt;sup&gt;[2]&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 % to 110 % Ue</td>
<td>70 % to 110 % Ue</td>
<td>70 % to 110 % Ue&lt;sup&gt;[2]&lt;/sup&gt;</td>
</tr>
<tr>
<td>70 % to 110 % Ue</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>8 VA</td>
<td>8 VA</td>
</tr>
<tr>
<td>4 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from 15 mA to 60 A</td>
<td>from 15 mA to 60 A</td>
<td>from 15 mA to 60 A on 12 measurement channels</td>
</tr>
<tr>
<td>±7 %</td>
<td>±7 %</td>
<td>±10 %</td>
</tr>
<tr>
<td>-</td>
<td>&lt; 200 ms</td>
<td>&lt; 200 ms</td>
</tr>
<tr>
<td>-</td>
<td>&lt; 2.4 s (&lt; n x 200 ms if n toroids)</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>from 20 %&lt;sup&gt;3&lt;/sup&gt; to 200 % of IΔn</td>
<td>from 20 %&lt;sup&gt;3&lt;/sup&gt; to 200 % of IΔn</td>
</tr>
<tr>
<td>9 user-selectable thresholds</td>
<td>2 s</td>
<td>2 s</td>
</tr>
<tr>
<td>0.03 A - 0.1 A - 0.3 A - 0.5 A - 1 A - 3 A - 5 A - 10 A - 30 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 % IΔn to 100 % IΔn</td>
<td>80 % IΔn à 100 % IΔn</td>
<td>80 % IΔn à 100 % IΔn</td>
</tr>
<tr>
<td>instantaneous for IΔn = 0.03 A</td>
<td>instantaneous for IΔn = 0.03 A</td>
<td>instantaneous for IΔn = 0.03 A</td>
</tr>
<tr>
<td>9 user-selectable time delays: instantaneous to 4.5 s</td>
<td>1 adjustable time delay to 4.5 s in 10 ms steps</td>
<td>1 adjustable delay/channel instantaneous to 4.5 s in 10 ms steps</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>0.015</td>
<td>0.13</td>
<td>0.23</td>
</tr>
<tr>
<td>selector keypad</td>
<td>keypad</td>
<td>keypad</td>
</tr>
<tr>
<td>changeover changeover changeover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>none</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>alarm contact deactivated at 80 % of I alarm threshold</td>
<td>alarm contact deactivated at 80 % of I alarm threshold</td>
</tr>
<tr>
<td>-</td>
<td>1 adj. threshold from 20 to 100 % IΔn 0.015 A to 1 A in 0.001 A steps 1 A to 30 A in 0.1 A steps</td>
<td>1 adj. threshold/channel from 20 to 100 % IΔn 0.015 A to 1 A in 0.001 A steps 1 A to 30 A in 0.1 A steps</td>
</tr>
<tr>
<td>80 % IΔn à 100 % IΔn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>instantaneous for IΔn = 0.03 A</td>
<td>instantaneous for IΔn = 0.03 A</td>
<td>instantaneous for IΔn = 0.03 A</td>
</tr>
<tr>
<td>1 adjustable time delay to 4.5 s in 10 ms steps</td>
<td>1 adjustable delay/channel instantaneous to 4.5 s in 10 ms steps</td>
<td>1 adjustable delay/channel instantaneous to 4.5 s in 10 ms steps</td>
</tr>
<tr>
<td>0</td>
<td>0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>0.015</td>
<td>0.13</td>
<td>0.23</td>
</tr>
<tr>
<td>keypad keypad keypad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>changeover changeover changeover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>80 % I pre-alarm to 100 % I pre-alarm</td>
<td>80 % I pre-alarm to 100 % I pre-alarm</td>
</tr>
<tr>
<td>-</td>
<td>1 adjustable delay/instantaneous to 4.5 s in 10 ms steps</td>
<td>1 adjustable delay/channel instantaneous to 4.5 s in 10 ms steps</td>
</tr>
<tr>
<td>-</td>
<td>0/-20 % for all settings not including polling time</td>
<td>0/-20 % for all settings not including polling time</td>
</tr>
<tr>
<td>-</td>
<td>keypad keypad keypad</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>YES YES YES</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>pre-alarm contact deactivated at 70 % of I pre-alarm threshold</td>
<td>pre-alarm contact deactivated at 70 % of I pre-alarm threshold</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>continuous</td>
<td>continuous</td>
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<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
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<tr>
<td>continuous</td>
<td>continuous</td>
<td>continuous</td>
</tr>
</tbody>
</table>
Vigirex relays

Electrical characteristics (cont.)

<table>
<thead>
<tr>
<th>Characteristics of output contacts as per standard IEC 60947-5-1</th>
<th>Rated thermal current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum load</td>
<td>Utilisation category</td>
</tr>
<tr>
<td>Rated operational current (A)</td>
<td>24 V</td>
</tr>
<tr>
<td></td>
<td>110-130 V</td>
</tr>
<tr>
<td></td>
<td>220-240 V</td>
</tr>
<tr>
<td></td>
<td>250 V</td>
</tr>
<tr>
<td></td>
<td>380-415 V</td>
</tr>
<tr>
<td></td>
<td>440 V</td>
</tr>
<tr>
<td></td>
<td>660-690 V</td>
</tr>
</tbody>
</table>

Display and indications

- Voltage presence (LED and/or relay)
- Threshold overrun alarm (LED and relay)
- Pre-alarm (LED and relay)
- Leakage current and settings (digital)

Setting protection

Communication

- Suitable for supervision (internal bus)

Mechanical characteristics

Dimensions

- Weight
- Insulation class (IEC 60664-1)
- Degree of protection IP (IEC 60529)
- Mechanical impact on front face IK (EN 50102)
- Sinusoidal vibrations (Lloyd’s and Veritas)

Fire (IEC 60695-2-1)

- Damp heat, equipment not in service (IEC 60068-2-30)
- Damp heat, equipment in service (IEC 60068-2-56)
- Salt mist (IEC 60068-2-52)
- Degree of pollution (IEC 60664-1)

Electromagnetic compatibility

- Electrostatic discharges (IEC 61000-4-2)
- Radiated susceptibility (IEC 61000-4-3)
- Low-energy conducted susceptibility (IEC 61000-4-4)
- High-energy conducted susceptibility (IEC 61000-4-5)
- Radiofrequency interference (IEC 61000-4-6)
- Conducted and radiated emissions (CISPR11)

Sensors and accessories

- Sensors: A, TOA type toroids, L type rectangular sensor for IDn ≥ 300 mA
- Cables: Relay/sensor link via standard twisted pair not supplied

[1] Compatibility for both relay and sensor.
## Characteristics

Monitoring relays with output contact that automatically resets after fault clearance (cont.)

<table>
<thead>
<tr>
<th>RH99</th>
<th>RHUs and RHU</th>
<th>RMH and RM12T associated RMH</th>
<th>RM12T</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

### Electrical characteristics (cont.)

- **Characteristics of output contacts as per standard IEC 60947-5-1**
  - **Rated thermal current (A)**
    - 10 mA at 12 V: AC12, AC13, AC14, AC15, DC12, DC13
    - 6 mA at 24 V: AC12, AC13, AC14, AC15, DC12, DC13
  - **Minimum load**
    - 10 mA at 12 V: AC12, AC13, AC14, AC15, DC12, DC13
    - 6 mA at 24 V: AC12, AC13, AC14, AC15, DC12, DC13
  - **Rated operational current (A)**
    - Utilisation category 24 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 110-130 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 220-240 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 250 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 380-415 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 440 V: AC12, AC13, AC14, AC15, DC12, DC13
    - Utilisation category 660-690 V: AC12, AC13, AC14, AC15, DC12, DC13

### Display and indications

- **Voltage presence (LED and/or relay)**
- **Threshold overrun alarm (LED and relay)**
- **Pre-alarm (LED and relay)**

### Leakage current and settings (digital)

### Setting protection

### Communication

- **Suitable for supervision (internal bus)**

### Mechanical characteristics

- **Dimensions**
- **Weight**
- **Insulation class (IEC 60664-1)**
- **Front face**
- **Communication output**
- **Degree of protection IP (IEC 60529)**
- **Front face**
- **Other faces**
- **Connections**
- **Mechanical impact on front face IK (EN 50102)**
- **Sinusoidal vibrations (Lloyd's and Veritas)**
- **Fire (IEC 60695-2-1)**
- **Environment**
  - **Damp heat, equipment not in service (IEC 60068-2-30)**
  - **Damp heat, equipment in service (IEC 60068-2-56)**
  - **Salt mist (IEC 60068-2-52)**
  - **Degree of pollution (IEC 60664-1)**
- **Electromagnetic compatibility**
  - **Electrostatic discharges (IEC 61000-4-2)**
  - **Radiated susceptibility (IEC 61000-4-3)**
  - **Low-energy conducted susceptibility (IEC 61000-4-4)**
  - **High-energy conducted susceptibility (IEC 61000-4-5)**
  - **Radiofrequency interference (IEC 61000-4-6)**
  - **Conducted and radiated emissions (CISPR11)**
- **Sensors and accessories**
  - **Sensors A, TOA type toroids**
  - **L type rectangular sensor for IΔn**
  - **u 300 mA**
- **Cables Relay/sensor link via standard twisted pair not supplied**

### Compatibility for both relay and sensor.

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---

**RH99**
- **RHUs and RHU**
- **RMH and RM12T associated RMH**
- **RM12T**

---

### DIN

- **Front-panel mount**
  - 6 modules x 9 mm: 72 x 72 mm
  - 2 modules x 9 mm: 72 x 72 mm
  - IP40: IP40
  - IP30: IP30
  - IP20: IP20
  - IK07 (2 joules): IK07 (2 joules)
  - 2 to 13.2 Hz ±1 mm and 13.2 to 100 Hz – 0.7 g

### Front-panel mount (RHU only)

- **Front-panel mount**
  - 12 modules x 9 mm: 72 x 72 mm
  - 6 modules x 9 mm: 72 x 72 mm
  - 2 modules x 9 mm: 72 x 72 mm
  - IP40: IP40
  - IP30: IP30
  - IP20: IP20
  - IK07 (2 joules): IK07 (2 joules)
  - 2 to 13.2 Hz ±1 mm and 13.2 to 100 Hz – 0.7 g

### Environment category C2

- **KB test, severity 2**
  - Level 4
  - Level 3
  - Level 4
  - Level 3
  - Class B
  - Class B

- **Level 3**
  - Class B
  - Class B
  - Class B

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**Schneider Electric**

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**A-33**
Functions and characteristics

Characteristics

Sensors

Associated relays
Monitoring relays
Protection relays

Use
New installations and extensions
Renovation and extensions

General characteristics
Monitored distribution system
Insulation level Ui
Closed sensor
Split sensor
Operating-temperature range
Storage-temperature range
Degree of protection

Electrical characteristics
Transformation ratio
Overvoltage category
Rated impulse withstand voltage Uimp (kV)

Sensor characteristics
Rated operational current Ie (A)
Conductor max. size per phase (mm² copper)
Rated short-time withstand current Icw kA/0.5 s
Residual short-circuit withstand current IΔw kA/0.5 s

Mechanical characteristics
Type of sensor
TA30 toroid
PA50 toroid
IA80 toroid
MA120 toroid
SA200 toroid
GA300 toroid
TOA80 toroid
TOA120 toroid
L1 rectangular sensor
L2 rectangular sensor

Wiring
Wire size (mm²) for resistance R = 3 Ω
0.22
0.75
1
1.5

Mounting
Clip-on mounting on rear of Vigirex relay
Symmetrical DIN rail (horizontal or vertical mounting)
Plain, slotted or profiled plate
On cable
On busbars
Opening / closing (number of operation)

Environment
Damp heat, equipment not in service (IEC 60068-2-30)
Damp heat, equipment in service (IEC 60068-2-56)
Salt mist (IEC 60068-2-52)
Degree of pollution (IEC 60664-1)

[1] With RH10, RH21, RH99, RH197, RHUs and RHU, IΔn must be ≥ 300 mA
[2] From 0.5 to 2.5 mm².
## Characteristics

### Sensors

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A type closed toroid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOA type split toroid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L type rectangular sensor [1]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Functions and characteristics

**A-35**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sensors</th>
<th>Sensors</th>
<th>Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. link length (m)</td>
<td>18</td>
<td>18</td>
<td>28 cycles +25 °C / +55 °C / RH 95 %</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td>48 hours, environment category C2</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>80</td>
<td>KB test, severity 2</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max. link length (m)</th>
<th>Max. link length (m)</th>
<th>Max. link length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA30, PA50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TA30, PA50, IA80, MA120</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TA30, PA50, IA80, MA120, SA200</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IA80, MA120, SA200, GA300</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>28 cycles +25 °C / +55 °C / RH 95 %</td>
</tr>
<tr>
<td>10 maximum</td>
<td>48 hours, environment category C2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>KB test, severity 2</td>
<td></td>
</tr>
</tbody>
</table>

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Smart Panel integration

Communication
RH99, RHU and RMH communication ........................................... B-2

Enerlin’X digital system
Overview .......................................................................................... B-4

FDM121 switchboard display ............................................. B-6

IFE interface
IFE switchboard server ......................................................... B-8
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Dimensions and connection .................................................. D-1
Wiring diagrams ........................................................................ E-1
Additional characteristics .................................................... F-1
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**Communication**

**RH99, RHU and RMH**

**Vigirex RHU in Communication Architecture**

- A IFM (LV434000)
- B Vigirex relay RHU
- C Vigirex sensor
- D Cable for Modbus SL - 1 x RJ45 and 1 x Free wires

**Vigirex RMH in Communication Architecture**

- A IFM (LV434000)
- B Vigirex relay RMH
- C Vigirex sensor (up to 12 sensors)
- D Cable for Modbus SL - 1 x RJ45 and 1 x Free wires
- E Vigirex RM12T multiplexer

**Vigirex RH99M/P**

- A IFE gateway (LV34001)
- B FDM121 (TRV00121)
- C IO Module (LV434063)
- D ULP cable
- E Breaker ULP cord
- F RH99

**ULP system**

is a fast communication link dedicated to circuit breaker monitoring and control. Based on a RS485 physical liaison with cable segments up to 5 meters, it is well adapted to severe environment. A choice of 6 pre-connectorized cables with different length is provided.

**IFE interface**

**ULP to Ethernet interface module**

Provides and IP address to any circuit breaker fitted with an ULP port. The IFE interface makes all available data from the circuit breaker accessible from an Ethernet compatible display (FDM128), a PC with common browser, or IFE switchboard server which generates its own web pages.

**IFM**

**ULP to Modbus Interface module**

Makes all available data of a circuit breaker fitted with an ULP port accessible via a Modbus network. IFM acts as a Modbus slave, accessible from a Modbus master (IFE switchboard server, Acti 9 Smartlink Ethernet or Com’X).

**I/O**

**I/O application module**

I/O is dedicated to circuit breaker with ULP liaison. It provides the monitoring and control of any application around the circuit breaker (lighting or load control, cooling system, pulse metering acquisition...).
Overview of functions

Communication provides a means to identify the device, indicate status conditions, control the device, set the protection and alarms and analyse the instantaneous and maximum residual currents to assist operation and maintenance. It involves the transmission of data (bits or words) in real time, periodically or on request.

Note: a complete description of the communication system and the protocol are provided in the RHU or RMH user guide.

<table>
<thead>
<tr>
<th>Remote control</th>
<th>RHU</th>
<th>RMH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device identification</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address set</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Type of device</td>
<td>RHU</td>
<td>RMH</td>
</tr>
<tr>
<td><strong>Status indications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-alarm</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Alarm</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test with actuation of the output contacts</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Test without actuation of the output contacts</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Output-contact reset following a fault</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Alarm-display memory reset</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td><strong>Protection settings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I pre-alarm threshold</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Pre-alarm time delay</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Alarm threshold</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Alarm time delay</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Alarm reset</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Toroid selection</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td><strong>Operating and maintenance aids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm threshold value</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Mesured earth leakage as percentage of alarm threshold value</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Maximum leakage current</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Fault readings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malfunction detected</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>RMH/RM12T link fault</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Saturation of fault-current measurements</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Sensor link fault</td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>
Enerlin’X digital system
Overview

Enerlin’X communication system provides access to status, electrical values and devices control using Ethernet and Modbus SL communication protocols.

Ethernet has become the universal link between switchboards, computers and communication devices inside the building. The large amount of information which can be transferred makes the connection of Enerlin’X digital system to hosted web services of Schneider Electric a reality. More advantages are offered to integrators thanks to configuration web pages available remotely or on the local Ethernet network.

Modbus SL is the most widely used communication protocol in industrial networks. It operates in master-slave mode. The devices (slaves) communicate one after the other with a gateway (master).
### Enerlin’X digital devices and displays

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Port (to device)</th>
<th>Port (to server)</th>
<th>Inputs</th>
<th>Outputs</th>
<th>Cial. Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Com’X 210</strong></td>
<td>Energy data logger + Ethernet Gateway</td>
<td>Ethernet</td>
<td>Ethernet cable</td>
<td>64 devices: 6 binary, 2 analog</td>
<td>-</td>
<td>EBX210</td>
</tr>
<tr>
<td><strong>Com’X 510</strong> 24 V DC + PoE</td>
<td>Energy server + Ethernet Gateway</td>
<td>Ethernet</td>
<td>Modbus Master, Zigbee &amp; other Ethernet devices (Modbus TCP)</td>
<td>-</td>
<td>-</td>
<td>EBX510</td>
</tr>
<tr>
<td><strong>FDM128</strong></td>
<td>Ethernet LCD colour touch screen</td>
<td>-</td>
<td>Ethernet</td>
<td>-</td>
<td>-</td>
<td>LV434128</td>
</tr>
<tr>
<td><strong>FDM121</strong></td>
<td>LCD display for circuit breaker</td>
<td>ULP</td>
<td>Ethernet</td>
<td>1 circuit breaker</td>
<td>-</td>
<td>TRV00121</td>
</tr>
<tr>
<td><strong>IFE</strong> Switchboard server</td>
<td>Switchboard server</td>
<td>Modbus Master &amp; ULP</td>
<td>Ethernet</td>
<td>20 circuit breakers</td>
<td>-</td>
<td>LV434002</td>
</tr>
<tr>
<td><strong>IFE</strong> interface</td>
<td>Ethernet interface for circuit breakers</td>
<td>ULP</td>
<td>Ethernet</td>
<td>1 circuit breaker</td>
<td>-</td>
<td>LV434001</td>
</tr>
<tr>
<td><strong>IFM</strong></td>
<td>Modbus interface for circuit breaker</td>
<td>ULP</td>
<td>Modbus Slave</td>
<td>1 circuit breaker</td>
<td>-</td>
<td>LV434000</td>
</tr>
<tr>
<td><strong>I/O</strong></td>
<td>Input/Output application module for circuit breaker</td>
<td>ULP</td>
<td>ULP</td>
<td>6 binary, 1 analog (PT100 sensor)</td>
<td>3</td>
<td>LV434063</td>
</tr>
<tr>
<td><strong>Acti 9 Smartlink SI B Ethernet wireless</strong></td>
<td>Ethernet server for I/O and Modbus slave devices</td>
<td>Ethernet</td>
<td>Modbus Master &amp; Wireless to PowerTag</td>
<td>14 binary, 2 analog</td>
<td>7</td>
<td>A9XMA08</td>
</tr>
<tr>
<td><strong>Acti 9 Smartlink Modbus slave</strong></td>
<td>Modbus interface with Input/Output functions</td>
<td>-</td>
<td>Modbus Slave</td>
<td>22 binary</td>
<td>11</td>
<td>A9XMSB11</td>
</tr>
</tbody>
</table>

**Ethernet Gateway or Interface**: routes an internal traffic (ULP or other protocol) to the Internet, the outgoing messages are coded with Modbus TCP/IP protocol.

**Server (Switchboard, Energy)**: routes the internal traffic to the Internet. Other complementary functions such as data logging and storage. Provides devices status and energy trends on internal web pages...
Smart Panel integration

FDM121 switchboard display

Micrologic measurement capabilities come into full play with the FDM121 switchboard display. It connects to COM option (BCM ULP) via a breaker ULP cord and displays Micrologic information. The result is a true integrated unit combining a circuit breaker and a Power Meter. Additional operating assistance functions can also be displayed.

FDM121
An FDM121 switchboard display unit can be connected to a ULP IMU using a prefabricated cord to display all measurements, alarms, histories and event tables, maintenance indicators, management of installed devices on a screen. The result is a veritable 96 x 96 mm Power Meter.

The FDM121 display unit requires a 24 V DC power supply. The FDM121 is a switchboard display unit that can be integrated in the Compact NSX100 to 630 A, Powerpact H/J/L/P/R, compact NS or Masterpact systems. It uses the sensors and processing capacity of the Micrologic trip unit. It is easy to use and requires no special software or settings. It is immediately operational when connected to the Compact NS by a simple cord. Also, it provides monitoring and control with the use of the I/O application module, the motor mecanism module, or the Breaker Status module.

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The FDM121 display unit connects to the Compact NSX by a simple cord and displays Micrologic information. The FDM121 is a true integrated unit combining a circuit breaker and a Power Meter. Additional operating assistance functions can also be displayed.

Display of Micrologic measurements and alarms
The FDM121 is intended to display Micrologic 5 / 6 measurements, alarms and operating information. It cannot be used to modify the protection settings. Measurements may be easily accessed via a menu. All user-defined alarms are automatically displayed. The display mode depends on the priority level selected during alarm set-up:

- high priority: a pop-up window displays the time-stamped description of the alarm and the orange LED flashes
- medium priority: the orange “Alarm” LED goes steady on
- low priority: no display on the screen.

All faults resulting in a trip automatically produce a high-priority alarm, without any special settings required. In all cases, the alarm history is updated. Micrologic saves the information in its non-volatile memory in the event of an FDM121 power failure.

Status indications and remote control
When the circuit breaker is equipped with the Breaker Status Module, the FDM121 display can also be used to view circuit breaker status conditions:

- O/F: ON/OFF
- SD: trip indication

When the circuit breaker system is equipped with the I/O Application module, the FDM121 can monitor and control:

- cradle management
- circuit breaker operation
- light and load control
- custom application.

When the circuit breaker system is equipped with the motor mechanism module, the FDM121 offers remote closing and opening control.

Main characteristics
- 96 x 96 x 30 mm screen requiring 10 mm behind the door (or 20 mm when the 24 V power supply connector is used).
- White backlighting.
- High resolution: excellent reading of graphic symbols.
- Alarm LED: flashing orange for alarm pick-up, steady orange after operator reset if alarm condition persists.
- Operating temperature range -10 °C to +55 °C.
- CE / UL / CSA marking (pending).
- 24 V DC power supply, with tolerances 24 V -20 % (19.2 V) to 24 V +10 % (26.4 V).

The FDM121 is connected to the communication network, the 24 V DC can be supplied by the communication system wiring system.

Connection
The FDM121 is equipped with:

- a 24 V DC terminal block:
  - plug-in type with 2 wire inputs per point for easy daisy-chaining
  - power supply range of 24 V DC -20 % (19.2 V) to 24 V DC +10 % (26.4 V).

A 24 V DC type auxiliary power supply must be connected to a single point on the ULP system. The FDM121 display unit has a 2-point screw connector on the rear panel of the module for this purpose. The ULP module to which the auxiliary power supply is connected distributes the supply via the ULP cable to all the ULP modules connected to the system and therefore also to Micrologic.
Connections

- Compact NSX is connected to the ULP devices (FDM121 display, IFM, IFE or I/O) unit via the NSX cord.
- Cord available in three lengths: 0.35 m, 1.3 m and 3 m.
- ULP lengths up to 10 m possible using extensions.

Smart Panel integration

FDM121 switchboard display

- two RJ45 jacks.
- The Micrologic connects to the internal communication terminal block on the Compact NSX via the NSX cord. Connection to one of the RJ45 connectors on the FDM121 automatically establishes communication between the Micrologic and the FDM121 and supplies power to the Micrologic measurement functions.
- When the second connector is not used, it must be fitted with a line terminator.

Navigation

- Five buttons are used for intuitive and fast navigation.
- The "Context" button may be used to select the type of display (digital, bargraph, analogue).
- The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.).

Screens

Main menu

- When powered up, the FDM121 screen automatically displays the ON/OFF status of the device.

Quick view

Access to detailed information

- "Alarms" displays active alarms and the alarm history.
- "Services" provides access to the operation counters, energy and maximeter reset function, maintenance indicators, identification of modules connected to the internal bus and FDM121 internal settings (language, contrast, etc.).

Communication components and FDM121 connections
IFE interface
IFE switchboard server

Description
The IFE interface and IFE switchboard server enable LV circuit breakers as Masterpact NT/NW, Compact NSX or Powerpact to be connected to an Ethernet network.

IFE interface: ref. LV434001
Provides an Ethernet access to a single LV circuit breaker.

Function
Interface - one circuit breaker is connected to the IFE interface via its ULP port.

IFE switchboard server: ref. LV434002
Provides an Ethernet access up to 20 LV circuit breakers.

Functions
- Interface - one circuit breaker is connected to the IFE interface via its ULP port.
- Server: several circuit breakers on a Modbus network are connected via the IFE switchboard server master Modbus port.
- Collects and provides web pages from multiple IP devices (other IFE LV434002, Smartlink Ethernet, PM5000 Ethernet…).

IFE interface, IFE switchboard server features
- Dual 10/100 Mbps Ethernet port for simple daisy chain connection.
- Device profile web service for discovery of the IFE interface, IFE switchboard server on the LAN.
- ULP compliant for localization of the IFE interface in the switchboard.
- Ethernet interface for Compact, Masterpact and Powerpact circuit breakers.
- Gateway for Modbus-SL connected devices (IFE switchboard server only).
- Embedded set-up web pages.
- Embedded monitoring web pages.
- Embedded control web pages.
- Built-in e-mail alarm notification.
- Automatic recovering of Smartlink I/O configurations, allowing contextual I/O status display on web pages (IFE switchboard server only).

Mounting
The IFE interface, IFE switchboard server are DIN rail mounting devices. A stacking accessory enables the user to connect several IFMs (ULP to Modbus interfaces) to an IFE switchboard server without additional wiring.

24 V DC power supply
The IFE interface, IFE switchboard server must always be supplied with 24 V DC. The IFMs stacked to an IFE switchboard server are supplied by the IFE switchboard server, thus it is not necessary to supply them separately. It is recommended to use an UL listed and recognized limited voltage/limited current or a class 2 power supply with a 24 V DC, 3 A maximum.

IFE interface, IFE switchboard server firmware update
The firmware can be updated using:
- FTP
- customer engineering tool
- Ecoreach software.

Required circuit breaker communication modules
The connection to IFE interface or IFE switchboard server requires a communication module embedded into the circuit breaker:
- Compact NS, Powerpact P, Powerpact R: BCM ULP communication module
- Compact NSX: NSX cord and/or BSCM module
- Masterpact NT/NW or Compact NS, Powerpact P, Powerpact R (Fixed electrically operated): BCM ULP communication module
- Drawout Masterpact NT/NW or a withdrawable Compact NS, Powerpact P, Powerpact R: BCM ULP and its respective I/O (Input/Output) application module. All connection configurations for Masterpact NT/NW, Compact NS, Powerpact P, Powerpact R require the breaker ULP cord. The insulated NSX cord is mandatory for system voltages greater than 480 V AC. When the second ULP RJ45 connector is not used, it must be closed with an ULP terminator (TRV00880).
General characteristics

Environmental characteristics

Conforming to standards  UL 508, UL 60950, IEC 60950, 60947-6-2
Certification  cULus, GOST, FCC, CE
Ambient temperature  -20 to +70°C (-4 to +158 °F)
Relative humidity  5–85 %
Level of pollution  Level 3
Flame resistance  ULV0

Mechanical characteristics

Shock resistance  1000 m/s²
Resistance to sinusoidal vibrations  5 Hz < f < 8.4 Hz

Electrical characteristics

Resistance to electromagnetic discharge  Conforming to IEC/EN 61000-4-3
Immunity to radiated fields  10 V/m
Immunity to surges  Conforming to IEC/EN 61000-4-5
Consumption  120 mA at 24 V input

Physical characteristics

Dimensions  72 x 105 x 71 mm (2.83 x 4.13 x 2.79 in.)
Mounting  DIN rail
Weight  162.5 g (0.41 lb)
Degree of protection of the installed I/O application module  On the front panel (wall mounted enclosure): IP4x
Connectors: IP2x
Other parts: IP3x
Connections  Screw type terminal blocks

Technical characteristics - 24 V DC power supply

Power supply type  Regulated switch type
Rated power  72 W
Input voltage  100–120 V AC for single phase
200–500 V AC phase-to-phase
PFC filter  With IEC 61000-3-2
Output voltage  24 V DC
Power supply out current  3 A

Note: it is recommended to use an UL listed/UL listed recognized limited voltage/Limited current or a class 2 power supply with a 24 V DC, 3 A maximum.

IFE interface, IFE switchboard server web page description

Monitoring web page

Real time data
Device logging

Control web page

Single device control

Diagnostics web page

Statistics
Device information
IMU information
Read device registers
Communication check

Maintenance web page

Maintenance log
Maintenance counters

Setup web page

Device localization/name
Ethernet configuration (dual port)
IP configuration
Modbus TCP/IP filtering
Serial port
Date and time
E-mail server configuration
Alarms to be e-mailed
Device list
Device logging
Device log export
SNMP parameters
Documentation links
Preferences
Advanced services control
User accounts
Web page access
Smart Panel integration

IFM Modbus interface

Function
A IFM - Modbus communication interface - is required for connection of a Masterpact or Compact to a Modbus network as long as this circuit breaker is provided with a ULP (Universal Logic Plug) port. The port is available on respectively a BCM ULP or BSCM embedded module.
The IFM is defined as an IMU (Intelligent Modular Unit) in the ULP connection System documentation.

Once connected, the circuit breaker is considered as a slave by the Modbus master. Its electrical values, alarm status, open/close signals can be monitored or controlled by a Programmable Logic Controller or any other system.

Characteristics
ULP port
2 RJ45 sockets, internal parallel wiring.
- Connection of a single circuit breaker (eventually via its I/O application module).
- A ULP line terminator or an FDM121 display unit must be connected to the second RJ45 ULP socket.
The RJ45 sockets deliver a 24 VDC supply fed from the Modbus socket.
Built-in test function, for checking the correct connection to the circuit breaker and FDM121 display unit.

Modbus slave port
- Top socket for screw-clamp connector, providing terminals for:
  - 24 VDC input supply (0 V, +24 V)
  - Modbus line (D1, D2, Gnd).
- Lateral socket, for Din-rail stackable connector.
Both top and lateral sockets are internally parallel wired.
- Multiple IFM can be stacked, thus sharing a common power supply and Modbus line without individual wiring.
- On the front face:
  - Modbus address setting (1 to 99): 2 coded rotary switches
  - Modbus locking pad: enables or disable the circuit breaker remote control and modification of IFM parameters.
- Self adjusting communication format (Baud rate, parity).
Catalogue numbers

<table>
<thead>
<tr>
<th>Type</th>
<th>Set of</th>
<th>Cat. no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFM -Modbus communication interface module</td>
<td>-</td>
<td>LV434000</td>
</tr>
<tr>
<td>Stacking accessories if more than 1 IFM</td>
<td>10</td>
<td>TRV00217</td>
</tr>
<tr>
<td>ULP line terminator</td>
<td>-</td>
<td>TRV00880</td>
</tr>
<tr>
<td>Connector Modbus adaptor</td>
<td>-</td>
<td>LV434211</td>
</tr>
<tr>
<td>2-wire RS 485 isolated repeater module (Modbus network outside the switchboard)</td>
<td>-</td>
<td>TRV00211</td>
</tr>
</tbody>
</table>

Technical characteristics

<table>
<thead>
<tr>
<th>IFM Modbus communication interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>18 x 72 x 96 mm</td>
</tr>
<tr>
<td>Maximum number of stacked IFM</td>
<td>12</td>
</tr>
<tr>
<td>Degree of protection of the installed module</td>
<td>IP4x</td>
</tr>
<tr>
<td>Part projecting beyond the escutcheon</td>
<td></td>
</tr>
<tr>
<td>Other module parts</td>
<td>IP3x</td>
</tr>
<tr>
<td>Connectors</td>
<td>IP2x</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-25...+70°C</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>24 V DC -20%+10 % (19.2...26.4 V DC)</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>21 mA/24 V DC at 20°C</td>
</tr>
<tr>
<td>Maximum</td>
<td>30 mA/19.2 V DC at 60°C</td>
</tr>
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</table>

Certification

<table>
<thead>
<tr>
<th>CE</th>
<th>IEC/EN 60947-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL</td>
<td>UL 508 - Industrial Control Equipment</td>
</tr>
<tr>
<td>CSA</td>
<td>No. 142-M1987 - Process Control Equipment</td>
</tr>
<tr>
<td></td>
<td>CAN/CSA C22.2 No. 0-M91 - General requirements - Canadian Electrical Code Part</td>
</tr>
<tr>
<td></td>
<td>CAN/CSA C22.2 No. 14-05 - Industrial Control Equipment</td>
</tr>
</tbody>
</table>

Simplified IFM installation

Stacking IFM

Stacking accessories Up to 12 stacked IFM

Stacking an IFE interface + gateway with IFMs
I/O application module description

Description
The I/O input/output application module for LV breaker is one of the components of ULP architecture. Built in functionalities and applications enhance control and monitoring needs.
ULP system architecture including I/O modules can be built without any restrictions using a wide range of circuit breakers:
- Masterpact MTZ1/MTZ2/MTZ3,
- Compact NS1600b-3200,
- Compact NS630b-1600,
- Compact NSX100-630 A.

The I/O application module is compliant with the ULP system specifications. Two I/O application modules can be connected in the same ULP architecture.

I/O input/output interface for LV breaker resources
The I/O application module resources are the following:
- 6 digital inputs that are self powered for either NO and NC dry contact or pulse counter,
- 3 digital outputs that are bistable relay (5 A maximum),
- 1 analog input for Pt100 temperature sensor.

Pre-defined applications
Pre-defined applications improve the IMU approach (Intelligent Modular Unit) in a simple way.
A 9-position rotary switch on the front of the I/O module allows to select the pre-defined applications. Each position is assigned to a pre-defined application except position 9 which allows the user to define a specific application by means of the customer engineering tool. The switch is set in factory to the pre-defined application 1.
For each application the input/output assignment and the wiring diagram are pre-defined. No additional setting with the customer engineering tool is required. The I/O and other resources not assigned to the predefined applications are free for user specific applications.

User applications
The user applications with the corresponding resources are defined by means of Ecoreach engineering tool. They use the resources not assigned to the predefined applications. User applications may be required for:
- Protection improvement,
- Circuit breaker control,
- Motor control,
- Energy management,
- Monitoring.

24 Vdc power supply
The I/O module can be supplied with a 24 Vdc AD power supply or with any other 24 Vdc power supply having the same characteristics.

Mounting
The I/O is a DIN rail mounting device.

Setting locking pad
The setting locking pad on the front panel of the I/O enables the setting of the I/O by Ecoreach engineering tool.
### General characteristics

#### Environmental characteristics

<table>
<thead>
<tr>
<th>Conforming to standards</th>
<th>UL 508, UL 60950, IEC 60950, IEC 60947-6-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certification</td>
<td>cULus, GOST, FCC, CE</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-20 to +70 °C (-4 to +158 °F)</td>
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<tr>
<td>Relative humidity</td>
<td>5 - 85 %</td>
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<tr>
<td>Level of pollution</td>
<td>Level 3</td>
</tr>
<tr>
<td>Flame resistance</td>
<td>ULV0</td>
</tr>
</tbody>
</table>

#### Mechanical characteristics

| Shock resistance         | 1000 m/s²                                      |
|                         | Resistance to sinusoidal vibrations            | 5 Hz < f < 8.4 Hz |

#### Electrical characteristics

| Resistance to electromagnetic discharge | Conforming to IEC/EN 61000-4-3 |
| Immunity to radiated fields            | 10 V/m                          |
| Immunity to surges                     | Conforming to IEC/EN 61000-4-5   |
| Consumption                            | 165 mA                          |

#### Physical characteristics

| Dimensions                | 71.7 x 116 x 70.6 mm |
| Mounting                  | DIN rail             |
| Weight                    | 229.5 g (0.51 lb)    |
| Degree of protection      | On the front panel (wall mounted enclosure): IP4x |
|                         | I/O parts: IP3x      |
|                         | Connectors: IP2x     |
| Connections               | Screw type terminal blocks |

### Components

#### I/O Application module

**Note:** for a length greater than 10 m (33 ft) and up to 300 m (1,000 ft), it is mandatory to use a shielded twisted cable. The shield cable is connected to the I/O functional ground of the I/O application module.

#### Digital inputs

<table>
<thead>
<tr>
<th>Digital output type</th>
<th>Bistable relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated load</td>
<td>5 A at 250 Vac</td>
</tr>
<tr>
<td>Rated carry current</td>
<td>5 A</td>
</tr>
<tr>
<td>Maximum switching voltage</td>
<td>380 Vac, 125 Vdc</td>
</tr>
<tr>
<td>Maximum switch current</td>
<td>5 A</td>
</tr>
<tr>
<td>Maximum switching power</td>
<td>1250 VA, 150 W</td>
</tr>
<tr>
<td>Minimum permissible load</td>
<td>10 mA at 5 V DC</td>
</tr>
<tr>
<td>Contact resistance</td>
<td>30 mΩ</td>
</tr>
<tr>
<td>Maximum operating frequency</td>
<td>18000 operations/hr (Mechanical)</td>
</tr>
<tr>
<td></td>
<td>1800 operations/hr (Electrical)</td>
</tr>
<tr>
<td>Digital output relay protection by an external fuse</td>
<td>External fuse of 5 A or less</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>10 m (33 ft)</td>
</tr>
</tbody>
</table>

#### Analog inputs

I/O application module analog input can be connected to a Pt100 temperature sensor.

<table>
<thead>
<tr>
<th>Range</th>
<th>-30 to 200 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-22 to 392 °F</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±2 °C from -30 to 20 °C</td>
</tr>
<tr>
<td></td>
<td>±1 °C from 20 to 140 °C</td>
</tr>
<tr>
<td></td>
<td>±2 °C from 140 to 200 °C</td>
</tr>
<tr>
<td></td>
<td>±3.6 °F from -22 to 68 °F</td>
</tr>
<tr>
<td></td>
<td>±1.8 °F from 68 to 284 °F</td>
</tr>
<tr>
<td></td>
<td>±3.6 °F from 284 to 392 °F</td>
</tr>
<tr>
<td>Refresh interval</td>
<td>5 s</td>
</tr>
<tr>
<td></td>
<td>5 s</td>
</tr>
</tbody>
</table>

---

**Diagram:**

- **A:** 24 Vdc power supply terminal block.
- **B:** Digital input terminal block: 6 inputs, 3 commons and 1 shield.
- **C:** 6 input status LEDs.
- **D:** Analog input status LED.
- **E:** 3 output status LEDs.
- **F:** I/O application module identification labels.
- **G:** Sealable transparent cover.
- **H:** Analog input terminal block.
- **I:** Digital output terminal blocks.
- **J:** ULP status LED.
- **K:** Test/reset button (accessible with cover closed).
- **L:** Setting locking pad.
- **M:** Application rotary switch: 1 to 9.
- **N:** Switch for I/O addressing (I/O 1 or I/O 2).
- **O:** ULP connectors.
Customer engineering tool: Ecoreach software

Key Features

Build
I want to test & deliver a “ready to commission” panel
- Device Discovery
- Switchboard setting & testing
- Communication
- Test & Reports
- Save my project & reports

Commission
I want to “shorten” my commissioning time
- Device Discovery
- Multi Device Configuration
- Communication
- Test & Reports
- Save my project & reports

Maintain
I want to ensure “continuity” of services in “safe conditions”
- Settings consistency check
- Firmware upgrade
- Standard Diagnostic data
- Save my project & reports

Panel builders
Simple & easy software to set up and test a panelboard with smart phones

Electrical contractors & system integrator
Shorten commissioning time and speed up SAT delivery with easy-to-use software

Facility managers
Software to track installation changes & diagnostic features for preventive maintenance
Installation recommendations

Relays and associated toroids .................................................. C-2

Possible installation positions
RH10-21-68-86-99M/P, RH197M/P, RHUs, RHU and RMH ............. C-4
A and OA type toroids and rectangular sensors ............................ C-5

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Installation recommendations

Relays and associated toroids

Residual-current protection relay

Modular format (DIN rail mount)

RH10M, RH21M, RH68M, RH86M, RH99M.

Modular format (with mounting accessories[1])

RH10M, RH21M, RH99M.

[1] Supplied as option, to be clipped into relay for installation on a mounting plate.

Front-panel mount format

Monitoring relays

Modular format

RH68M, RH86M, RH99M.
[1] Supply as an option.

Front-panel mount format

The Vigirex RMH always requires a RM12T multiplexer.

Toroids

Closed from 30 to 300 mm

Split (for retrofit)

Rectangular sensors

Selection and compatibility of toroids and rectangular sensors

<table>
<thead>
<tr>
<th>Type of sensor</th>
<th>Type of Vigirex relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed toroid</td>
<td>Split toroid</td>
</tr>
<tr>
<td>TA30</td>
<td>-</td>
</tr>
<tr>
<td>PA90</td>
<td>TOA80</td>
</tr>
<tr>
<td>IA90</td>
<td>TOA120</td>
</tr>
<tr>
<td>IA120</td>
<td>-</td>
</tr>
<tr>
<td>SA200</td>
<td>-</td>
</tr>
<tr>
<td>GA300</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

[1] See restrictions in table below.

Sensor restrictions table

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>A type closed toroid</td>
<td>no restrictions</td>
</tr>
<tr>
<td>OA type split toroid</td>
<td>no restrictions</td>
</tr>
<tr>
<td>L type rectangular sensors</td>
<td>( I_{\text{op}} \geq 0.3 \text{ A} )</td>
</tr>
</tbody>
</table>
**Possible installation positions**

**RH10-21-68-86-99M/P, RH197M/P, RHUs, RHU and RMH**

### Modular format

- YES
- YES
- YES

### Front-panel mount format

- YES
- YES
- YES

### Relay mounting possibilities

**Mounting of modular format relays RH10M-21M-68M-86M-99M-RH197M**
- The relay can be mounted in three ways:
  - on a DIN rail (only this mounting for RH197M)
  - on a mounting plate using 3 M4 screws (not supplied) and 3 removable mounting accessories (supplied).

**Mounting of front-panel mount relays RH10P-21P-86P-99P, RHUs, RHU and RMH**
- No special tools are required to mount the relay. Simply insert the device through the cutout. The size of the cutout complies with standard DIN 43700.
- Front panel thickness: 1 mm minimum / 2.5 mm maximum.
- The relay clips onto the panel.

**Mounting of relay RH197P**
- No tools are required to mount and secure the relay in position. Simply insert the device through the cutout and tighten the clamp by turning the knurled nut.
- The size of the cutout complies with standard DIN 43700.
- Front panel thickness: 1 mm minimum / 4 mm maximum.

**Mounting of RM12T multiplexer**
- The multiplexer must always be mounted on a DIN rail.
Toroid mounting possibilities

On DIN rail (TA30, PA50, IA80 and MA120) using supplied accessories

On a plate (TA30, PA50, IA80, MA120, SA200, GA300, TOA80 and TOA120) or bracket

<table>
<thead>
<tr>
<th>Screw Ø4</th>
<th>Screw Ø5</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA30</td>
<td>IA80</td>
</tr>
<tr>
<td>PA50</td>
<td>MA120</td>
</tr>
<tr>
<td>IA80</td>
<td>SA200</td>
</tr>
<tr>
<td>MA120</td>
<td>GA300</td>
</tr>
<tr>
<td>SA200</td>
<td>TOA80</td>
</tr>
<tr>
<td>GA300</td>
<td>TOA120</td>
</tr>
</tbody>
</table>

Clipped on the back of the relay (TA30 and PA50)

Tied to cables (IA80, MA120, SA200 and GA300), cable-ties not supplied

Cable-ties with 9 mm maximum width and 1.5 mm maximum thickness

Tied to cables (rectangular sensors)

On bars with chocks (rectangular sensors)
## Installation recommendations

### Relays and sensors

<table>
<thead>
<tr>
<th>Product, terminal or screw</th>
<th>Cable type</th>
<th>Terminal capacity (mm²)</th>
<th>Conduct. size</th>
<th>Stripping</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH10M, RH21M, RH68M, RH86M and RH99M</td>
<td>Rigid Flexible Flexible with ferrule</td>
<td>Rigid/flexible min. max. min. max. min. max. (mm) (inch) (N.m) (In-lbs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RH197M</td>
<td>RHUs and RHU</td>
<td>Bus</td>
<td>24 V, 0 V twisted pair</td>
<td>L&lt;10 m</td>
<td>22-12</td>
</tr>
<tr>
<td>RH197P</td>
<td>RMH</td>
<td>Bus</td>
<td>24 V, 0 V twisted pair</td>
<td>22-12</td>
<td>6</td>
</tr>
<tr>
<td>RM12T</td>
<td>RM12T</td>
<td>Bus</td>
<td>24 V, 0 V twisted pair</td>
<td>22-12</td>
<td>6</td>
</tr>
<tr>
<td>Toroid and sensors</td>
<td>TA30 and PA50</td>
<td>twisted Cu/Al</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
</tr>
<tr>
<td>IA80 to GA300</td>
<td>twisted Cu/Al</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
</tr>
<tr>
<td>TOA80 - TOA120</td>
<td>twisted Cu/Al</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
</tr>
<tr>
<td>L1, L2</td>
<td>twisted Cu/Al</td>
<td>0.5</td>
<td>2.5</td>
<td>0.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Note:** RHU only.
Installation recommendations

Connection

Relays and sensors

Connection of relays

Modular format

Front-panel mount format

Connection of toroids

TA30 and PA50 closed toroids (connectors supplied)

IA80, MA120, SA200 and GA300 closed toroids


Connection
Toroids and rectangular sensors

Connection of toroids (cont.)
TOA80 and TOA120 split toroids (Ø5 mm round lugs not supplied)

Connection of rectangular sensors and conductor layout

L1: frame 280 x 115 mm
Busbars with 70 mm spacing

2 bars 50 x 10 mm (1600 A)
The neutral can be located on the right or the left.

L2: frame 470 x 160 mm
Busbars with 115 mm spacing

4 bars 100 x 5 mm (3200 A)
The neutral can be located on the right or the left.

Note: connect M1 and M2 with Vigirex.
Installation recommendations

Selection and installation instructions for toroids and rectangular sensors

Cable layout

Centre the cables within the toroid

Do not bend cables near the toroids

Do not bend cables near the sensors

toroid Ø ≥ 2 x total cable Ø

Single-phase or three-phase loads with several cables per phase

Selection of toroids according to circuit power

3P + N copper cables

<table>
<thead>
<tr>
<th>Rated operational current (Ie)</th>
<th>Max. cross-section/phase</th>
<th>Toroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 A</td>
<td>16 mm²</td>
<td>TA30</td>
</tr>
<tr>
<td>85 A</td>
<td>25 mm²</td>
<td>PA50</td>
</tr>
<tr>
<td>160 A</td>
<td>70 mm²</td>
<td>IA80 or TOA80</td>
</tr>
<tr>
<td>250 A</td>
<td>120 mm²</td>
<td>MA120 or TOA120</td>
</tr>
<tr>
<td>400 A</td>
<td>2 x 185 mm²</td>
<td>SA200</td>
</tr>
<tr>
<td>630 A</td>
<td>2 x 240 mm²</td>
<td>GA300</td>
</tr>
<tr>
<td>1600 A</td>
<td>4 x 240 mm²</td>
<td>L1</td>
</tr>
</tbody>
</table>

Selection of rectangular sensors according to circuit power

3P + N copper bars

<table>
<thead>
<tr>
<th>Rated operational current (Ie)</th>
<th>Max. cross-section/phase</th>
<th>Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600 A</td>
<td>2 bars 50 x 10 mm²</td>
<td>L1</td>
</tr>
<tr>
<td></td>
<td>2 bars 100 x 5 mm²</td>
<td>L2</td>
</tr>
<tr>
<td>3200 A</td>
<td>4 bars 100 x 5 mm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 bars 125 x 5 mm²</td>
<td></td>
</tr>
</tbody>
</table>

Note: Y ≥ 25 cm for 280 x 115 mm sensor.
Note: Y ≥ 30 cm for 470 x 160 mm sensor.
Installation recommendations

Selection and installation instructions for toroids and rectangular sensors

Immunisation with respect to false zero-sequence currents
(tested at 6 In as per IEC 60947-2 annex M)

The addition of a shielding ring prevents nuisance tripping with TA30, PA50, IA80 and MA120 toroids for the settings indicated in table below

For circuits with high transient currents (6 In)

<table>
<thead>
<tr>
<th>Sensor</th>
<th>In</th>
<th>Maximum cross-section per phase</th>
<th>IΔn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>With shielding ring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA30</td>
<td>65 A</td>
<td>16 mm²</td>
<td>30 mA</td>
</tr>
<tr>
<td>PA50</td>
<td>85 A</td>
<td>25 mm²</td>
<td>30 mA</td>
</tr>
<tr>
<td>IA80</td>
<td>160 A</td>
<td>70 mm²</td>
<td>100 mA</td>
</tr>
<tr>
<td>MA120</td>
<td>250 A</td>
<td>120 mm²</td>
<td>100 mA</td>
</tr>
<tr>
<td><strong>Without shielding ring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA200</td>
<td>400 A</td>
<td>2 x 185 mm²</td>
<td>300 mA</td>
</tr>
<tr>
<td>GA300</td>
<td>630 A</td>
<td>2 x 240 mm²</td>
<td>300 mA</td>
</tr>
<tr>
<td>TOA80</td>
<td>85 A</td>
<td>95 mm²</td>
<td>100 mA</td>
</tr>
<tr>
<td>TOA120</td>
<td>250 A</td>
<td>240 mm²</td>
<td>1 A</td>
</tr>
<tr>
<td>L1</td>
<td>1600 A</td>
<td>4 x 240 mm² / or 2 copper bars 100 x 5 mm²</td>
<td>500 mA</td>
</tr>
<tr>
<td>L2</td>
<td>3200 A</td>
<td>2 copper bars 125 x 10 mm²</td>
<td>500 mA</td>
</tr>
</tbody>
</table>

Connection between Vigrex relays and sensors

Vigirex relays must be connected to the sensors as indicated:

- **Cross-section (Cu)**
  - **Maximum length**
  - **Toroids**
    - 0.22 mm²
      - 18 m
    - 0.75 mm²
      - 60 m
    - 1 mm²
      - 80 m
    - 1.5 mm²
      - 100 m
  - **Rectangular sensors**
    - 0.5 mm² min. / 2.5 mm² max.
      - 10 m

[1] Wire size for resistance R maximum = 3 W.

**Cable type**

Standard twisted pair (not to be run alongside power cables).

In highly disturbed environments:

**Wiring**

Shielded twisted pair (not to be run alongside power cables).

The shielding must be earthed at both ends by connection to the equipotential bonding circuit.

The cable between the toroid and the relay should be as short as possible.

If this is not sufficient, use a transformer with high frequency (HF) shielding.

Auxiliary power supply via external transformer.
Dimensions and connection

Dimensions
and RM12T relays................................................................. D-3
A type closed toroids................................................................. D-4
OA type split toroids and rectangular sensors ......................... D-5

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Catalogue numbers ............................................................... G-1
Mounting on a DIN rail


Mounting on a mounting plate


Plate drilling layout

Door cutout

Mounting on a DIN rail

Mounting on a mounting plate

[1] For IP4 requirements.
[2] For RH197M.
Front-panel mount relays (cutout complying with standard DIN 43700)


**Dimensions**

- **RH197P**
- **RHUs, RHU, RMH**
- **RM12T**

**DIN rail mounting only**

- **RM12T**

For IP4 requirements.

---

[1] For IP4 requirements.
Dimensions and connection

Dimensions
A type closed toroids

TA30 and PA50 toroids

Secured to the back of the relay

<table>
<thead>
<tr>
<th>Type</th>
<th>ØA</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA30</td>
<td>9.4</td>
<td>32.5</td>
<td>63</td>
<td>44</td>
<td>74.5</td>
<td>60</td>
<td>-</td>
<td>9</td>
<td>98</td>
<td>50</td>
</tr>
<tr>
<td>PA50</td>
<td>50.4</td>
<td>45</td>
<td>88</td>
<td>57</td>
<td>100</td>
<td>86</td>
<td>11</td>
<td>22</td>
<td>96</td>
<td>60</td>
</tr>
</tbody>
</table>

IA80, MA120, SA200 and GA300 toroids

IA80 and MA120

<table>
<thead>
<tr>
<th>Type</th>
<th>ØA</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA80</td>
<td>80</td>
<td>122</td>
<td>44</td>
<td>150</td>
<td>80</td>
<td>55</td>
<td>40</td>
<td>126</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td>MA120</td>
<td>118</td>
<td>164</td>
<td>39</td>
<td>190</td>
<td>140</td>
<td>-</td>
<td>126</td>
<td>163</td>
<td>125</td>
<td>30</td>
</tr>
</tbody>
</table>

SA200 and GA300

<table>
<thead>
<tr>
<th>Type</th>
<th>ØA</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA200</td>
<td>196</td>
<td>256</td>
<td>46</td>
<td>274</td>
<td>120</td>
<td>90</td>
<td>60</td>
<td>254</td>
<td>104</td>
<td>37</td>
</tr>
<tr>
<td>GA300</td>
<td>291</td>
<td>360</td>
<td>46</td>
<td>390</td>
<td>120</td>
<td>90</td>
<td>60</td>
<td>369</td>
<td>104</td>
<td>37</td>
</tr>
</tbody>
</table>
**Dimensions and connection**

**Dimensions**

OA type split toroids and rectangular sensors

### TOA80 and TOA120 toroids

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions (mm)</th>
<th>A</th>
<th>ØB</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOA80</td>
<td></td>
<td>177</td>
<td>80</td>
<td>28</td>
<td>108</td>
<td>235</td>
<td>156</td>
</tr>
<tr>
<td>TOA120</td>
<td></td>
<td>225</td>
<td>120</td>
<td>50</td>
<td>150</td>
<td>303</td>
<td>205</td>
</tr>
</tbody>
</table>

### Rectangular sensors

**L1:** frame 280 x 115 mm

**L2:** frame 470 x 160 mm
Dimensions and connection
Wiring diagrams

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Wiring diagrams


All diagrams are shown with circuits de-energised, all devices open and relays in released position.

**RH10M, RH21M, RH68M, RH86M and RH99M wiring with MX shunt release**

- L: lamp
- MX: shunt release
- Q: circuit breaker protecting the main circuit
- Q: DPN circuit breaker

**RH10M, RH21M, RH68M, RH86M and RH99M:**
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $I_{Δn} > 500$ mA)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact.

**Note:** for the RH99 earth leakage monitor use the “fault” contact 31, 32, 34.

---

**RH10P, RH21P, RH86P and RH99P wiring with MX shunt release**

- L: lamp
- MX: shunt release
- Q: circuit breaker protecting the main circuit
- Q: DPN circuit breaker

**RH10P, RH21P, RH86P and RH99P:**
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $I_{Δn} > 500$ mA)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact.

**Note:** for the RH99 earth leakage monitor use the “fault” contact 31, 32, 34.
Wiring diagrams

RH10, RH21, RH68, RH86 and RH99M

Wiring for optimum safety


All diagrams are shown with circuits de-energised, all devices open and relays in released position.

MN: undervoltage release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH10M, RH21M, RH68M, RH86M and RH99M:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if IDn ≥ 500 mA)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact.

Note: for the RH99 earth leakage monitor use the “fault” contact 31, 32, 34.

RH10P, RH21P, RH86P and RH99P wiring with MN undervoltage release

MN: undervoltage release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH10MP, RH21P, RH86P and RH99P:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if IDn ≥ 500 mA)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact.

Note: for the RH99 earth leakage monitor use the “fault” contact 31, 32, 34.
Wiring diagrams

Wiring diagrams
RH86, RH99 monitor
Auto-reclosing application for unattended stations

RH86M, RH99M monitor wiring with ATm auto-reclosing controller

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Zelio Logic: Programmable logic controller
H: red light
MT: motor mechanism module
MX: shunt release
Q₁: circuit breaker protecting the main circuit
Q₄ to Q₆: DPN circuit breakers
RH86M, RH99M monitor:
A₁-A₂: auxiliary power supply
T₁-T₂: A or TOA type toroid or rectangular sensor (if IΔn ≥ 500 mA)
11-14: “voltage-presence” contact
26-25: relay test
27-25: “fault” reset
31-32-34: “fault” contact
S₁ et S₂: single-pole switch
SD: auxiliary fault indication contact
T: sensor.

RH86P, RH99P monitor wiring with ATm auto-reclosing controller

Zelio Logic: Programmable logic controller
H: red light
MT: motor mechanism module
MX: shunt release
Q₁: circuit breaker protecting the main circuit
Q₄ to Q₆: DPN circuit breakers
RH86P, RH99P monitor:
A₁-A₂: auxiliary power supply
T₁-T₂: A or TOA type toroid or rectangular sensor (if IΔn ≥ 500 mA)
11-14: “voltage-presence” contact
26-25: relay test
27-25: “fault” reset
31-32-34: “fault” contact
S₁ et S₂: single-pole switch
SD: auxiliary fault indication contact
T: sensor.

Additional information
- the SD auxiliary contact is mandatory
- manual operation of the MT motorised operating mechanism always overrides the ATm3 auto-reclosing controller
- use a single power supply (L/N) for all inputs (I), the ATm3 and the MX auxiliary.
RH197M wiring for optimum continuity of service

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Switch setting:

L1: lamp and audio alarm
MX: shunt release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197M:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if IΔn ≥ 500 mA)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact

See page E-11

Warning
The supply for A1-A2 must be different from that of the MX shunt release.

L1: lamp and audio alarm
MX: shunt release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197M:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if IΔn ≥ 500 mA)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact

See page E-11
Wiring diagrams

RH197M wiring for optimum continuity of service

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Switch setting:

L1: lamp and audio alarm
MN: undervoltage release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197M:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $\Delta n < 500 \text{ mA}$)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact

See page E-11

RH197M wiring for optimum safety

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Switch setting:

L1: lamp and audio alarm
MN: undervoltage release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197M:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $\Delta n < 500 \text{ mA}$)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact

See page E-11
RH197P wiring for optimum continuity of service

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Switch setting:

L1: lamp and audio alarm
MX: shunt release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197P:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $I_{Δn} \leq 500$ mA)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact

RH197P wiring for optimum safety

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

Switch setting:

Warning
The supply for A1-A2 must be different from that of the MX shunt release.

L1: lamp and audio alarm
MX: shunt release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker
RH197P:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if $I_{Δn} \leq 500$ mA)
- 41-44: “alarm contact”
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact
**RH197P wiring for optimum continuity of service**

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

**Switch setting:**

- **L1:** lamp and audio alarm
- **MN:** undervoltage release
- **Q1:** circuit breaker protecting the main circuit
- **Q2:** DPN circuit breaker
- **RH197P:**
  - A1-A2: auxiliary power supply
  - T1-T2: A or TOA type toroid or rectangular sensor (if \( I_{\Delta n} \leq 500 \text{ mA} \))
  - 41-44: “alarm contact”
  - 26-25: relay test
  - 27-25: “fault” reset
  - 31-32-34: “fault” contact

---

**RH197P wiring for optimum safety**

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

**Switch setting:**

- **L1:** lamp and audio alarm
- **MN:** undervoltage release
- **Q1:** circuit breaker protecting the main circuit
- **Q2:** DPN circuit breaker
- **RH197P:**
  - A1-A2: auxiliary power supply
  - T1-T2: A or TOA type toroid or rectangular sensor (if \( I_{\Delta n} \leq 500 \text{ mA} \))
  - 41-44: “alarm contact”
  - 26-25: relay test
  - 27-25: “fault” reset
  - 31-32-34: “fault” contact
RHUs and RHU wiring with MX shunt release: optimum continuity of service

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

L1: lamp and audio alarm
L2: lamp
MX: shunt release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker

RHUs and RHU:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if \( I_{\Delta n} \geq 0.5 \) A)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact
- 41-44: “alarm contact”.

RHUs and RHU wiring with MN undervoltage release: optimum safety

L1: lamp and audio alarm
MN: undervoltage release
Q1: circuit breaker protecting the main circuit
Q2: DPN circuit breaker

RHUs and RHU:
- A1-A2: auxiliary power supply
- T1-T2: A or TOA type toroid or rectangular sensor (if \( I_{\Delta n} \geq 0.5 \) A)
- 11-14: “voltage-presence” contact
- 26-25: relay test
- 27-25: “fault” reset
- 31-32-34: “fault” contact
- 41-44: “alarm contact”.

[1] RHU only.
RMH wiring with RM12T multiplexer

All diagrams are shown with circuits de-energised, all devices open and relays in released position.

**L1, L2:** lamp and audio alarm
**L3:** lamp
**QA:** switchboard incoming circuit breaker for the main circuit
**QB:** circuit breaker protecting the RMH and RM12T power supply circuit
**Q1 to Q12:** circuit breakers on main outgoing circuits 1 to 12
**T:** transformer with 220/240 V secondary (if required), rating $\geq 4$ VA
**T1 to T12:** earth leakage current measurement toroids for circuits 1 to 12 (or rectangular sensor if $I_{Δn} \geq 0.5$ A).

**RM12T multiplexer**
- **terminals 1 to 12 and 15 to 20:** connection of toroids
- **terminals 21 to 24:** connection of RMH earth leakage monitor
- **terminals 25 to 26:** auxiliary power supply.

**RMH earth leakage monitor**
- **A1-A2:** auxiliary power supply
- **11-14:** “voltage-presence” contact
- **21 to 24:** connection of RM12T multiplexer
- **31-32-34:** “alarm” contact
- **41-44:** “pre-alarm” contact.
Connection of test and remote reset functions

Cable
The cable must not exceed 10 m in length.
Use a cable with 3 twisted wires.

Contacts
Use pushbuttons with low-level contacts suitable for the minimum load of 1 mA at 4 V.

Connection of RH10, RH21, RH99, RH197, RHUs and RHU power supply

Q3


T: class 2 isolation transformer mandatory:
- for $V_{A1,A2} < 24$ V AC for RH10, RH21 and RH99
- for $V_{A1,A2} = 48$ V AC for RH197P

The DC power supply must be galvanically isolated from the AC power system.
Additional characteristics

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<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>the conducting mass of the Earth, whose electric potential at any point is conventionally taken as zero.</td>
</tr>
<tr>
<td>Earth electrode</td>
<td>conductive part that can be incorporated in a particular conductive environment, for example concrete or coke in electrical contact with earth.</td>
</tr>
<tr>
<td>Earth-fault current</td>
<td>current flowing to earth due to an insulation fault.</td>
</tr>
<tr>
<td>Earthing resistance</td>
<td>or in fact the &quot;overall earthing resistance&quot;: resistance between the main earthing terminal (terminal or bar to which the PE protective conductors are connected) and earth.</td>
</tr>
<tr>
<td>Earth-leakage current</td>
<td>current flowing from the live parts to earth or extraneous conductive parts in the absence of an insulation fault.</td>
</tr>
<tr>
<td>Equipotential bonding</td>
<td>electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential.</td>
</tr>
<tr>
<td>Exposed conductive part</td>
<td>a conductive part which can readily be touched and which is not normally live, but which may become live under fault conditions.</td>
</tr>
<tr>
<td>Intentional leakage current</td>
<td>current flowing to earth or extraneous conductive parts via intentionally installed components (resistors or capacitors), in the absence of an insulation fault.</td>
</tr>
<tr>
<td>Isolated system</td>
<td>system with an autonomous supply of power, not connected to utility power.</td>
</tr>
<tr>
<td>Natural leakage current</td>
<td>current flowing to earth or extraneous conductive parts via the insulation, in the absence of an insulation fault.</td>
</tr>
<tr>
<td>Protective conductor PE</td>
<td>a conductor required by some measures for protection against electric shock for electrically connecting any of the following parts: exposed conductive parts, extraneous conductive parts, main earthing terminal, earth electrode, earthed point of the source or artificial neutral, metallic parts of the building structure that are not part of an electrical device, protected by equipotential bonding, if they are simultaneously accessible.</td>
</tr>
<tr>
<td>Residual current</td>
<td>vector sum of the instantaneous values of the current in all the live conductors of a circuit at a given point in an electrical installation.</td>
</tr>
<tr>
<td>Zero volt (reference)</td>
<td>measurement reference point for differences in potential (voltage measurements, often in monitoring circuits).</td>
</tr>
<tr>
<td>Acronym/ French</td>
<td>Acronym/ English</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>DDR RCD</td>
<td>DDR RCD</td>
</tr>
<tr>
<td>DPCC SCPD</td>
<td>DPCC SCPD</td>
</tr>
<tr>
<td>dv/dt</td>
<td>dv/dt</td>
</tr>
<tr>
<td>IGBT IGBT</td>
<td>IGBT IGBT</td>
</tr>
<tr>
<td>IT</td>
<td>IT</td>
</tr>
<tr>
<td>Filtre RFI RFI filter</td>
<td>Filtre RFI RFI filter</td>
</tr>
<tr>
<td>SLT System earthing arrangement</td>
<td>SLT System earthing arrangement</td>
</tr>
<tr>
<td>TN TN</td>
<td>TN TN</td>
</tr>
<tr>
<td>TN-C TN-C</td>
<td>TN-C TN-C</td>
</tr>
<tr>
<td>TN-C-S TN-C-S</td>
<td>TN-C-S TN-C-S</td>
</tr>
<tr>
<td>TN-S TN-S</td>
<td>TN-S TN-S</td>
</tr>
<tr>
<td>TT TT</td>
<td>TT TT</td>
</tr>
<tr>
<td>CEM / EM EMC / EM</td>
<td>CEM / EM EMC / EM</td>
</tr>
<tr>
<td>GFP GFP</td>
<td>GFP GFP</td>
</tr>
<tr>
<td>NEC NEC</td>
<td>NEC NEC</td>
</tr>
<tr>
<td>THDI THDI</td>
<td>THDI THDI</td>
</tr>
<tr>
<td>Valeur efficace RMS</td>
<td>Valeur efficace RMS</td>
</tr>
</tbody>
</table>
The physiological effects of electric current on people (muscle tetanisation, internal and external burns, ventricular fibrillation and cardiac arrest) depend on a number of different factors, namely the physiological characteristics of the human being, the environment (humid or dry, for example) and the characteristics of the current flowing through the body.

**IEC standard 60479**

The experts of the International Electrotechnical Committee (IEC) have studied the problem in view of harmonising opinions on the worldwide level and establishing a standard (IEC 60479) that scientifically and practically determines the effects of electric current on the human body.

**Importance of the amperage**

The diagram below presents the effect of alternating current on the human body.

The diagram below presents the effect of alternating current on the human body.

![Diagram showing time/current zones](attachment:DB425537.eps)

*Time/current zone (IEC 60 479-1).*

The risk of the person not letting go, breathing arrest or cardiac fibrillation increases proportionally to the time the person is exposed to the electric current.

- **Zone 1**
  - 0.5 mA is the perception threshold. This corresponds to the perception of a current flowing through the body for an unlimited duration. The possible discomfort is not defined.

- **Zone 2**
  - there are no dangerous physiological effects up to the let-go threshold (line b).

- **Zone 3** (between line b and curve c1)
  - there is generally no organic damage, but the discomfort felt by the person in this case is significant

- **Zone 4** (to the right of curve c1)
  - in addition to the effects inflicted in zone 3, there may be physiological effects such as cardiac arrest, breathing arrest and severe burns. In particular, the probability of ventricular fibrillation is:
    - approximately 5 %, between the curves c1 and c2
    - less than 50 % between the curves c1 and c3
    - greater than 50 % beyond curve c3.

**Protection using Vigirex RCDs**

Protection of persons
Importance of the current frequency

Standard IEC 60479-1 § 3 and -2 § 4 defines the sensitivity of the human body to fibrillation depending on the frequency of the current.

Current thresholds depending on the frequency

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Perception (mA)</th>
<th>Let-go (mA)</th>
<th>Fibrillation (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>2</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>0.5</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>100</td>
<td>0.5</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>300</td>
<td>0.6</td>
<td>12</td>
<td>180</td>
</tr>
<tr>
<td>1000</td>
<td>1</td>
<td>17</td>
<td>560</td>
</tr>
<tr>
<td>3000</td>
<td>2</td>
<td>23</td>
<td>-</td>
</tr>
<tr>
<td>5000</td>
<td>4</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td>10000</td>
<td>6</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>&gt;10000</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Installation standard IEC 60364

Touch voltage/ disconnecting time

Standard IEC 60479 defines the effects of an electric current flowing through the human body.

The installation standards IEC 60364 (NF C 15-100 in France), in chapter 4-41, establish the mandatory safety rules for low-voltage electrical installations:

- by translating the current / exposure time values in the previous curve into a set of touch voltage / contact time values that must not be exceeded. The values depend on the environment conditions (humid or dry) in the installation
- by defining the techniques and operational diagrams to be used to avoid (or manage) the dangerous voltages resulting from an insulation fault.
- They define the dangerous limit values UL for the touch voltage:
  - UL = 50 V for a dry environment (generally the case).
- As a result, there are two operating modes in a low-voltage installation:
  - operation with an operational voltage under the limit value, i.e. no particular action is required if an insulation fault occurs
  - operation with an operational voltage greater than the touch voltage (generally the case), where, if an insulation fault occurs, the dangerous part of the installation must be automatically disconnected within a given time limit (see the table below).

Maximum disconnecting time of protection device(s)

(according to table 41A of standard IEC 60364)

<table>
<thead>
<tr>
<th>Ph-N voltage (V)</th>
<th>AC current</th>
<th>DC current</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_0 \leq 50$ V</td>
<td>5 s</td>
<td>5 s</td>
</tr>
<tr>
<td>$50 \text{ V } U_0 \leq 120$ V</td>
<td>0.8 s</td>
<td>5 s</td>
</tr>
<tr>
<td>$120 \text{ V } U_0 \leq 230$ V</td>
<td>0.4 s</td>
<td>5 s</td>
</tr>
<tr>
<td>$230 \text{ V } U_0 \leq 400$ V</td>
<td>0.2 s</td>
<td>0.4 s</td>
</tr>
<tr>
<td>$U_0 &gt; 400$ V</td>
<td>0.1 s</td>
<td>0.1 s</td>
</tr>
</tbody>
</table>

The installation standards of specific countries interpret this table according to the applicable system earthing arrangement.
The standards and regulations distinguish two types of potentially dangerous contacts and indicate the corresponding protection techniques.

**Direct contact**: contact of a person with live conductors (phase or neutral) or with conductive parts that are habitually live. Protection against direct contact is normally provided by insulation of the live parts using barriers, screens or enclosures (as per standard IEC 60364-4-41 or NF C 15-100). These systems are preventive in nature and may fail. That is why additional protection is installed, in the form of a high-sensitivity RCD that automatically breaks the circuit. The operating threshold is set to 30 mA for AC current (IEC 60364-4-41 or NF C 15-100) and 60 mA for DC current. The sensitivity of RC protection devices, designed to limit the current flowing through the body to a maximum of 30 mA, provides a very high level of safety and maintains a good continuity of service.

**Indirect contact**: contact of a person with exposed conductive parts that are normally not live, but may become live by accident. This situation is due to failure of the insulation for a device or conductor, resulting in an insulation fault. The electrical risk depends on the touch voltage between the exposed conductive parts of the faulty equipment and earth or other exposed conductive parts located nearby. The design of protection devices based on the physiological thresholds stipulated in IEC standard 60479 and complying with the rules defined in standard IEC 60364 has made it possible to create safe electrical installations.

**Comparison between 10 mA and 30 mA sensitivities**
An RCD set to 10 mA will trip somewhat more quickly than an RCD set to 30 mA. But a 10 mA setting significantly increases the risk of disturbing the continuity of service due to nuisance tripping caused by natural leakage currents.
In defining the required protection where dangerous faults are managed by automatically interrupting the supply, the installation standards propose various system earthing arrangements.

For further information, see the Cahiers Techniques documents 172, 173 and 178.

For low-voltage electrical distribution systems, there are three types of system earthing arrangements.

The earth-fault current is:
- dangerous and comparable to a short-circuit: TN system or IT 2nd fault with the exposed conductive parts connected to a single earth electrode
- dangerous but limited by the earthing impedances: TT system or IT 2nd fault with separate earth electrodes
- not dangerous and very low (in fact limited by the natural leakage impedance): IT system first fault.

Use of an RCD protection device is in fact necessary only when the insulation-fault current is dangerous but low. That is why RCD protection is virtually mandatory in TT systems, but is used in the others only when the other protection systems are not effective.

**TT system**

In this system:
- the source neutral is connected to an earth electrode separate from that of the exposed conductive parts
- all the exposed conductive parts protected by a given breaking device must be connected to the same earth electrode.

**Characteristics**
- The insulation-fault current is low and limited by the earthing resistances (a few amperes)
- An insulation fault may create a risk of electrocution: the TT system requires immediate breaking of the current
- The SCPD overcurrent protection devices cannot provide protection against insulation faults because the current is too low. An RCD, designed to monitor insulation faults, is required.

**Using RCDs**

An RCD must be installed at the head of the installation.

**RCD threshold settings** (see section 531.2.4.2 in standard IEC 60364)

The mandatory rule in setting the threshold is \( I_{\Delta n} \leq U_r / R \), where:
- \( U_r \) is the rated safety voltage for the electrical installation
- \( R \) is the resistance of the earth electrode for the exposed conductive parts downstream of the RCD.

**Maximum resistance of the earth electrode as a function of the rated residual operating current for the RCD**

<table>
<thead>
<tr>
<th>RCD rated residual operating current (( I_{\Delta n} ))</th>
<th>Maximum resistance of the earth electrode (( \Omega ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low sensitivity</td>
<td></td>
</tr>
<tr>
<td>20 A</td>
<td>2.5</td>
</tr>
<tr>
<td>10 A</td>
<td>5</td>
</tr>
<tr>
<td>5 A</td>
<td>10</td>
</tr>
<tr>
<td>3 A</td>
<td>17</td>
</tr>
<tr>
<td>Medium sensitivity</td>
<td></td>
</tr>
<tr>
<td>1 A</td>
<td>50</td>
</tr>
<tr>
<td>500 mA</td>
<td>100</td>
</tr>
<tr>
<td>300 mA</td>
<td>167</td>
</tr>
<tr>
<td>100 mA</td>
<td>500</td>
</tr>
<tr>
<td>High sensitivity</td>
<td></td>
</tr>
<tr>
<td>( \leq 30 \text{ mA} )</td>
<td>( &gt; 500 )</td>
</tr>
</tbody>
</table>

Note: If the earthing resistance is \( > 500 \text{ W} \), the RCD is set to 30 mA.

**RCD time delays**

**Maximum disconnecting time of protection device(s)** (according to table 41A extract of standard IEC 60364)

<table>
<thead>
<tr>
<th>SLT</th>
<th>TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph-N voltage (V)</td>
<td>AC current</td>
</tr>
<tr>
<td>50 V &lt; ( U_r ) ≤ 120 V</td>
<td>0.3 s</td>
</tr>
<tr>
<td>120 V &lt; ( U_r ) ≤ 230 V</td>
<td>0.2 s</td>
</tr>
<tr>
<td>230 V &lt; ( U_r ) ≤ 400 V</td>
<td>0.07 s</td>
</tr>
<tr>
<td>( U_r &gt; 400 \text{ V} )</td>
<td>0.04 s</td>
</tr>
</tbody>
</table>

To ensure selectivity between the RCD protection devices, an operating time not exceeding one second is permitted by standard IEC 60364 for distribution circuits.
In this system:
- the low-voltage neutral point of each source is directly earthed
- all the exposed conductive parts of the installation are connected to earth (and to the neutral) by a protection conductor:
  - PE, separate from the neutral (the TN-S system)
  - PEN, the same as the neutral (the TN-C system).

Characteristics
- The fault current is high, limited only by the cable impedances (a few amperes)
- An insulation fault may create a risk of electrocution: the TN system requires virtually immediate breaking because an insulation fault is comparable to a single-phase phase-to-neutral short-circuit. SCPD devices may be used to protect against insulation faults if they comply with the operating times imposed by the standard. The mandatory breaking times are indicated in the table below.

Using RCDs (only for TN-S)

Maximum disconnecting time of protection device(s) (according to table 41A of standard IEC 60364)

<table>
<thead>
<tr>
<th>SLT</th>
<th>Ph-N voltage (V)</th>
<th>AC current</th>
<th>DC current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50 V &lt; U₀ ≤ 120 V</td>
<td>0.8 s</td>
<td>5 s</td>
</tr>
<tr>
<td>2</td>
<td>120 V &lt; U₀ ≤ 230 V</td>
<td>0.4 s</td>
<td>5 s</td>
</tr>
<tr>
<td>3</td>
<td>230 V &lt; U₀ ≤ 400 V</td>
<td>0.2 s</td>
<td>0.4 s</td>
</tr>
<tr>
<td>4</td>
<td>U₀ &gt; 400 V</td>
<td>0.1 s</td>
<td>0.1 s</td>
</tr>
</tbody>
</table>

If the loop impedance is too high (long cables) or the source short-circuit power is too low (operation on engine generator set power), use of a low-sensitivity RCD may be worthwhile.

- **RCD threshold settings**
  - for long cables, the operating current is provided by the zero-sequence short-circuit current, which may be estimated, by default, as \( I_{Δn} = \frac{0.8 U₀}{R_{ph} + R_{PE}} \)
  - Note: there are no setting constraints, even if the loop impedance is high (it rarely exceeds one tenth of an ohm). As a result, it is rarely necessary to set the current under 1000 A.
  - This operating principle for RCDs is similar to that imposed by the NEC, called Ground Fault Protection (see protection against fire hazards, page F-11), because the goal is in fact to control, in the TN-S system, the impedance of the fault loop (see the expert guide no. 2 GFP).
  - for operation on engine generator set power, the previous calculation remains valid if the output circuit in question has a low rating compared to that of the engine generator set, otherwise the operating threshold must be set to \( I_{Δn} ≤ 3 I_{nc} \).

- **RCD time delays**
  - The RCDs must operate within the times stipulated in the table above.

---

**TN system**

- the low-voltage neutral point of each source is directly earthed
- all the exposed conductive parts of the installation are connected to earth (and to the neutral) by a protection conductor:
  - PE, separate from the neutral (the TN-S system)
  - PEN, the same as the neutral (the TN-C system).

Characteristics
- The fault current is high, limited only by the cable impedances (a few amperes)
- An insulation fault may create a risk of electrocution: the TN system requires virtually immediate breaking because an insulation fault is comparable to a single-phase phase-to-neutral short-circuit. SCPD devices may be used to protect against insulation faults if they comply with the operating times imposed by the standard.
  - The mandatory breaking times are indicated in the table below.

Using RCDs (only for TN-S)

Maximum disconnecting time of protection device(s) (according to table 41A of standard IEC 60364)

<table>
<thead>
<tr>
<th>SLT</th>
<th>Ph-N voltage (V)</th>
<th>AC current</th>
<th>DC current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50 V &lt; U₀ ≤ 120 V</td>
<td>0.8 s</td>
<td>5 s</td>
</tr>
<tr>
<td>2</td>
<td>120 V &lt; U₀ ≤ 230 V</td>
<td>0.4 s</td>
<td>5 s</td>
</tr>
<tr>
<td>3</td>
<td>230 V &lt; U₀ ≤ 400 V</td>
<td>0.2 s</td>
<td>0.4 s</td>
</tr>
<tr>
<td>4</td>
<td>U₀ &gt; 400 V</td>
<td>0.1 s</td>
<td>0.1 s</td>
</tr>
</tbody>
</table>

If the loop impedance is too high (long cables) or the source short-circuit power is too low (operation on engine generator set power), use of a low-sensitivity RCD may be worthwhile.

- **RCD threshold settings**
  - for long cables, the operating current is provided by the zero-sequence short-circuit current, which may be estimated, by default, as \( I_{Δn} = \frac{0.8 U₀}{R_{ph} + R_{PE}} \)
  - Note: there are no setting constraints, even if the loop impedance is high (it rarely exceeds one tenth of an ohm). As a result, it is rarely necessary to set the current under 1000 A.
  - This operating principle for RCDs is similar to that imposed by the NEC, called Ground Fault Protection (see protection against fire hazards, page F-11), because the goal is in fact to control, in the TN-S system, the impedance of the fault loop (see the expert guide no. 2 GFP).
  - for operation on engine generator set power, the previous calculation remains valid if the output circuit in question has a low rating compared to that of the engine generator set, otherwise the operating threshold must be set to \( I_{Δn} ≤ 3 I_{nc} \).

- **RCD time delays**
  - The RCDs must operate within the times stipulated in the table above.
IT system

In this system:
- the transformer neutral is:
  - either unearthed (isolated neutral)
  - or earthed via a high impedance (impedant neutral)
- the exposed conductive parts in the installation are:
  - all interconnected and connected to the same earth electrode
  - interconnected in groups and each group is connected to a given earth electrode.

Characteristics
- The first insulation fault does not generally require breaking of the circuit. The fault must be detected, indicated and repaired before a second insulation fault occurs on another live conductor, in which case breaking must be immediate
- IT system 2nd fault with earth electrodes not interconnected
  The required protection system is identical to that for the TT system with one or more earth electrodes
- IT system 2nd fault with earth electrodes interconnected
  The required protection system is identical to that for the TN-S system.

Using RCDs
- IT system for the 1st fault
  If medium-sensitivity devices are used, they must be set to at least double the current flowing for a first fault

Note: the 1st fault current can reach 1 A depending on the size of the distribution system (see Cahier Technique document 178).
RCDs are an effective means to provide protection against fire hazards because control over the level of leakage current is the only way to manage this risk.

For the TT, IT and TN-S systems, the risk of electrical fire hazards is eliminated by a 300 mA RCD.

Analysis of the risk

- In the 1980s and 1990s, a study carried out by an insurance company in Germany on fires on industrial and commercial premises revealed that:
  - the cost was extremely high, reaching several hundred million euros
  - the cost increased 600 %, i.e. much faster than the increase in the GNP (> 2 times faster over 20 years).

It is necessary to become aware of the dangers of fire hazards not only in terms of safety, but also in terms of cost.

An analysis of the situation showed that electricity was an important factor (the cause of approximately 40 % of fire accidents).

- The analysis showed furthermore that there are two main causes:
  - the 1st major cause is the creation of electrical arcs and arc tracking due to humidity. These arcs can develop only with impedant fault loops (> 0.6 Ω) and appear only when insulation faults occur or stray currents flow. Very little energy is required to launch the phenomenon (a few joules), i.e. an insulation-fault current or a stray current > 300 mA represent a real risk of fire.
  - the 2nd cause is related to uncontrolled temperature rise caused by incorrectly set protective devices or incorrectly calculated fault-loop impedances (due primarily to age or lack of installation maintenance). Because the thermal-protection devices did not operate correctly, excessive temperature rise due to overcurrents or a short-circuit resulted in a fire.

Tests have shown that a very low insulation-fault current (a few mA) can develop and, starting at 300 mA, cause the start of a fire in an environment of damp dust.

- the 2nd cause is related to uncontrolled temperature rise caused by incorrectly set protective devices or incorrectly calculated fault-loop impedances (due primarily to age or lack of installation maintenance). Because the thermal-protection devices did not operate correctly, excessive temperature rise due to overcurrents or a short-circuit resulted in a fire.
Installation standards

- Installation standard IEC 60364 § 32 defines the various building categories. In particular, section 322.5 characterises buildings according to the types of risks:
  - BE2: risk of fire
  - BE3: risk of explosion.

- It stipulates the special requirements for these building categories as well as:
  - in § 482.2.10, the use of RCDs set to 500 mA, (soon to be replaced by 300 mA)
  - in § 482.2.13, the interdiction to use the TN-C system.

- Generally speaking, it recommends the use of RCDs for all types of low-voltage installations as the means to prevent fire hazards.

- The National Electrical Code (NEC), the installation standard in the United States, requires use of GFP. According to NEC, the TN-S system cannot manage the impedance of the insulation-fault loop (typically the case for the second cause of a fault causing a fire). The purpose of the GFP device is to break the circuit before the fault can produce a high, destructive current. The threshold may be set from a few hundred amperes up to 1200 A.

  **Note:** GFP protection, for thresholds up to 250 A, can be provided by Vigirex RCDs.

---

**Poorly managed fault loop in a NEC system.**
Earth-leakage current

Cable leakage capacitance

The stray capacitance of the cables is the cause of a continuous leakage current, called the “natural leakage current”, because a part of the current in the capacitors does not return to the source in the live conductors.

Continuous leakage current due to stray capacitances of conductors (dotted lines).

This leakage current “spreads” throughout the entire installation.

The general level of the capacitance between a cable and earth is 150 pF/m.

For three-phase equipment, any dissymmetry between the phases reinforces these phenomena.

Load leakage capacitance

Non-linear loads, primarily those with static rectifiers, draw low-frequency and high-frequency harmonics. To limit the electromagnetic disturbances and comply with the EM requirements contained in the IEC 61000 standards, these loads are equipped with RFI filters that are directly earthed.

These filters increase the continuous earth-leakage current.

This leakage current is called the “intentional leakage current”.

Note: this phenomenon is amplified by the presence of low-frequency harmonic voltages which increase the flow of common-mode currents.

Capacitances between live conductors and earth.

The capacitors installed at the input of electronic equipment have a capacitance of approximately 10 to 100 nF.

Note: in the IT system, additional precautions must be taken when installing RFI filters.

Leakage capacitance / approximate values

<table>
<thead>
<tr>
<th>Component</th>
<th>Differential-mode capacitance</th>
<th>Common-mode capacitance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard cable</td>
<td>20 pF/m</td>
<td>150 pF/m</td>
</tr>
<tr>
<td>(not shielded)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shielded cable</td>
<td>30 pF/m</td>
<td>200 pF/m</td>
</tr>
<tr>
<td>Frequency converter</td>
<td>100 µF x 10</td>
<td>10 to 100 nF</td>
</tr>
<tr>
<td>PC, printer, cash</td>
<td>10 µF x 10</td>
<td>10 nF</td>
</tr>
<tr>
<td>register</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorescent</td>
<td>1 µF /10 W (compensation</td>
<td>1 nF</td>
</tr>
<tr>
<td>lighting</td>
<td>capacitor)</td>
<td>(electronic ballast)</td>
</tr>
</tbody>
</table>
The environment and the loads of a low-voltage electrical distribution system generate three major types of disturbances that impact on the earth-leakage currents in the system.

### Overvoltages

Lightning, switching overvoltages

<table>
<thead>
<tr>
<th>Type</th>
<th>Amplitude (xUn) or kV</th>
<th>Duration</th>
<th>Frequency or rise time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation fault</td>
<td>&lt; 1.7</td>
<td>30 - 1000 ms</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Switching</td>
<td>2 - 4</td>
<td>1 - 100 ms</td>
<td>1 - 200 kHz</td>
</tr>
<tr>
<td>Lightning</td>
<td>2 to 8 kV [1]</td>
<td>1 - 100 µs</td>
<td>1 µs</td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>8 kV</td>
<td>1-10 µs</td>
<td>25 ns</td>
</tr>
</tbody>
</table>


These overvoltages, via the natural leakage capacitance of the system, cause more or less high transient leakage currents.

### Harmonic currents

These low and high-frequency currents may reach high values (see the harmonic spectrum in the diagram opposite). These harmonic currents must be taken into account when calculating the natural and/or intentional earth-leakage current and setting a threshold for RCDs that does not provoke malfunctions.

### Waveform of the fault currents

In addition to the earth-leakage current problems, fault currents with a DC component may arise if an insulation fault occurs. The RCD must not be “disturbed” or “blinded” by this type of fault.

### Consequences for use of RCDs

These phenomena create considerable earth-leakage currents (transient or continuous). The RCD must not react to these leakage currents when they are not dangerous.

It is necessary to adjust the protection setting for people for indirect contacts, taking into account the prospective leakage current.
Vigirex devices are primarily intended to protect life and property on industrial, commercial or similar sites.

Vigirex RCDs implement:
- an electronic relay supplied by an auxiliary source
- measurements using a separate toroid.

When there is no insulation fault, the vector sum of the currents flowing in the live conductors is equal to zero.

If an insulation fault occurs, the sum is no longer equal to zero and the fault current creates in the toroid a magnetic field which generates a current on the secondary winding.

This current is monitored by a measurement circuit and, if it overruns the set threshold for a time greater than the set intentional time delay, the relay orders the current-breaking device to open.

Vigirex devices comply with standard IEC 60755 (the general standard governing RCDs) and with standard IEC 60947-2 annex M.

These standards define the various device characteristics and the necessary tests for the products.

![RCD operating principle.](DB425560.eps)

**RCD operating principle.**

**RCD sensitivity levels**

Electronic relays offer wide setting ranges for the sensitivity and the time delay. The installation standards characterise the required RCD sensitivity depending on the need for protection.

**Sensitivity depending on the different needs**

<table>
<thead>
<tr>
<th>High sensitivity</th>
<th>Medium sensitivity</th>
<th>Low sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 mA</td>
<td>100 mA to 3 A</td>
<td>&gt; 10 A</td>
</tr>
</tbody>
</table>

**RCD operating / non-operating current**

The standards indicate the preferred values for the residual operating current settings.

Operating current $I_{\Delta n}$ in A:

- $0.006 – 0.01 – 0.03 – 0.1 – 0.3 – 0.5 – 1 – 3 – 10 – 30$.

To take into account the tolerances (temperature, dispersion of components, etc.), the standards indicate that an RCD device set to an $I_{\Delta n}$ value must:

- **not operate** for all fault currents $\leq I_{\Delta n}/2$
- **operate** for all fault currents $\geq I_{\Delta n}$.

![RCD operating / non-operating current](DB425568.eps)

The technologies employed for Vigirex devices guarantee dependable non-operation up to 0.8 $I_{\Delta n}$.

Standard IEC 60947-2 annex M allows manufacturers to indicate the level of non-operation if it differs from the general rule.
Measurement of residual currents
The main difficulties for industrial RCDs lie in ensuring high-quality measurements.
- The measurement of fault currents in the presence of linear loads is not difficult:
  - the frequency of the fault current is 50/60 Hz
  - leakage currents are generally low
- However, the measurement of fault currents in the presence of non-linear loads requires RCDs capable of:
  - discriminating between the fault current and leakage currents
  - not being "blinded" by the DC components.
Toroid characteristics

The toroids used for Vigirex devices enable the electronic relay to measure the different zero-sequence currents flowing in the monitored circuit.

They are designed to:
- measure currents
- withstand overvoltages
- withstand short-circuit currents.

Measurement of zero-sequence currents

Measurement dynamics

The necessary measurement dynamics require a special magnetic circuit to measure very low currents and correct adaptation of the impedance (to avoid saturation) when measuring higher currents.

To that end, the correct compromise is required between:
- a material with high magnetic permeability $\mu_r$ and the saturation phenomena
- toroid size (cross-sectional area) and acceptable dimensions
- a high number ($n$) of turns and:
  - sufficiently low resistance
  - sufficient signal amplitude (gain $1/n$).

Measurement limits

When a three-phase current flows through the measurement toroid and there is no insulation fault (the sum of the currents is equal to zero), a secondary current equivalent to a false zero-sequence fault current is created. This is due to leakage flows caused by manufacturing tolerances. It is necessary to qualify this phenomenon by indicating the rated operational current for a given zero-sequence leakage current.

Table indicating the limits for $I_{\Delta n} / \text{rated current}$

See page B-9.

Note: strict compliance with the installation rules for the cables passing through the toroid is indispensable.

The addition of a "regulator sleeve" for the magnetic field considerably increases the rated operational current.

Measurement of disturbed currents

Waveform capture of currents comprising low-frequency harmonics is not a problem for the toroids.

The main difficulty is to measure current with a DC component, which can saturate the magnetic circuit and reduce the sensitivity of measurements. In this case, there is the risk that a dangerous fault current might not be detected. To avoid this problem and ensure that the toroid provides an accurate output signal, it is necessary to use a magnetic material that does not have a horizontal saturation curve, with low residual induction $B_r$.

This is the means to ensure type A measurements.
Short-circuit withstand capacity

The RCD must be sized for the short-circuit currents corresponding to the controlled protection device, at the point in the installation where it is placed. Standard IEC 60947-2 annex M requests that the various short-circuit currents that the RCD must support be declared to ensure correct operation without damage to the interconnected devices.

- Isc: rated short-circuit current
- Icw: rated short-time withstand current
- IΔw: rated conditional residual short-circuit withstand current.

Note: the requested characteristics are required for an RCD-circuit breaker combination. For an RCD-switch combination, more in-depth study is required if the fault current that must be interrupted is greater than 6 In (where In is the switch rating).

For the Vigirex range, Schneider guarantees practical values, consistent with the characteristics of the monitored circuits and the protection circuit breakers.

<table>
<thead>
<tr>
<th>Vigirex with TA 30, PA 50, IA 80, MA120 toroids combined with a Schneider Electric brand circuit breaker, rated ≤630 A</th>
<th>Vigirex with SA 200 and GA 300 toroids combined with a Compact NS630b to 3200 A or a Masterpact MTZ circuit breaker up to 6300 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icw</td>
<td>100 kA/0.5 s</td>
</tr>
<tr>
<td>Isc</td>
<td>150 kA</td>
</tr>
<tr>
<td>IΔw</td>
<td>85 kA/0.5 s</td>
</tr>
</tbody>
</table>

In light of the above, the combination of a Vigirex device with a Compact NS or Masterpact circuit breaker ensures perfect operation and is guaranteed whatever the system earthing arrangement (particularly for TN-S).

Overvoltage withstand capacity

The overvoltage withstand capacity of Vigirex devices is tested to comply with the requirements in standard IEC 60947-1 appendix H (which reuses those in standard IEC 60664-1 on insulation coordination).

- Impulse withstand voltage
- Overvoltage withstand voltage

The distribution-system voltage and the position of the device in the system determine the overvoltage levels to which the electrical devices may be subjected (see table H1 in standard IEC 60947-1).

A Vigirex device (relay + toroid) may be installed at the head of an installation. Schneider Electric consequently guarantees the overvoltage withstand capacity of the toroids for the maximum levels in a low-voltage distribution system up to the maximum permissible rated voltage (1000 V).

<table>
<thead>
<tr>
<th>Rated installation voltage</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>230/400 V</td>
<td>Head of the LV installation</td>
</tr>
<tr>
<td>400/690 V</td>
<td>On the distribution circuits</td>
</tr>
<tr>
<td>.../1000 V</td>
<td>Near the loads</td>
</tr>
</tbody>
</table>

Head of the LV installation

<table>
<thead>
<tr>
<th>Rated installation voltage</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>230/400 V</td>
<td>6 kV</td>
</tr>
<tr>
<td>400/690 V</td>
<td>8 kV</td>
</tr>
<tr>
<td>.../1000 V</td>
<td>12 kV</td>
</tr>
</tbody>
</table>

Overvoltage withstand capacity

<table>
<thead>
<tr>
<th>Rated installation voltage</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 4</td>
<td>4</td>
</tr>
<tr>
<td>Category 3</td>
<td>3</td>
</tr>
<tr>
<td>Category 2</td>
<td>2</td>
</tr>
</tbody>
</table>

Vigirex implementation

The characteristics listed below are specified.

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Supply (for Us &gt; 48 V)</th>
<th>Relay output contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference voltage</td>
<td>1000 V</td>
<td>525 V</td>
</tr>
<tr>
<td>Category</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Uimp</td>
<td>12 kV</td>
<td>8 kV</td>
</tr>
</tbody>
</table>

www.schneider-electric.com
Characteristics of measurement relays: immunity to natural leakage currents

Vigirex relays implement four techniques:

- to manage the leakage-current measurements without causing nuisance tripping
- and ensure the protection of persons by tripping immediately if a dangerous fault occurs.

Filtering of harmonic frequencies

- Non-dangerous leakage currents
  - frequency converters cause the most specific leakage currents to analyse. The voltage waveform generated by the frequency converter and in particular the voltage fronts caused by IGBT switching result in the flow of high-frequency leakage currents in the supply cables.

Flow of leakage currents in a frequency converter.

These currents may reach levels of several tens or hundreds of milliamperes (rms value).

- Dangerous faults
  - Standard IEC 60479 indicates the sensitivity of the human body depending on the frequency. Consequently, the table in question shows that:
  - protection for people at the power frequencies 50/60 Hz is the most critical case
  - the use of filters corresponding to the "desensitisation curve" ensures perfect safety.

The figure below shows the result of the filters on Vigirex in reducing the effects of the harmonic currents and malfunctions due to transient currents.

1. Frequency factor for the fibrillation threshold (IEC 60749-2).
2. Limiting values of the natural leakage currents downstream of a rectifier.
Rms measurements
Vigirex devices carry out rms measurements on the zero-sequence currents. This is the means to:
- accurately measure the harmonic currents and avoid nuisance tripping due to non-dangerous currents with high crest factors
- correctly calibrate the energies of the fault currents because, for both fire hazards and the protection of property, it is the energy of the fault current that must be taken into account.

Curve $I_{\Delta n}$ / non-delayed relay times
Protection for people requires the use of non-delay type relays. These relays must comply with standards to ensure safety.
Standards IEC 60947-2 annex M and IEC 60755 indicate the preferred values for the operating-current setting.
They stipulate the maximum break time depending on the residual fault current.
See table B in B.4.2.4.1 in standard IEC 60947-2 annex M.

<table>
<thead>
<tr>
<th>If</th>
<th>$I_{\Delta n}$</th>
<th>$2 \cdot I_{\Delta n}$</th>
<th>$5 \cdot I_{\Delta n}$</th>
<th>$10 \cdot I_{\Delta n}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time $T_{ps}$</td>
<td>0.3 s</td>
<td>0.15 s</td>
<td>0.04 s</td>
<td>0.04 s</td>
</tr>
</tbody>
</table>

Key:
- Time $T_{ps}$: total time required to break the current (including the time for the associated protection device to open)
- If: leakage current
- $I_{\Delta n}$: residual operating current setting

For devices set to 30 mA, $5 \cdot I_{\Delta n}$ can be replaced by 0.25 A, in which case $10 \cdot I_{\Delta n}$ is replaced by 0.5 A.

Vigirex uses this type of response curve to manage the false fault currents caused by switching in of loads (transformers, motors).

Schneider Electric guarantees all the above break times for a Vigirex combined with its circuit breakers rated up to ≤ 630 A, particularly when set to 30 mA.

Guaranteed non-operation up to 0.8 $I_{\Delta n}$
This function equipping Vigirex relays significantly increases (from 0.5 $I_{\Delta n}$ to 0.8 $I_{\Delta n}$) the immunity of relays to continuous leakage currents, both natural and intentional.
Characteristics of measurement relays: measurement of disturbed currents containing DC components

If an insulation fault occurs downstream of a rectifier, a current containing a DC component is created. The protection devices must remain operational in spite of the DC component.

Classification depending on the residual current to be monitored

The standards define three classifications of residual-current protection depending on the current that must be analysed:

- **AC type**: for sinusoidal AC current.
- **A type**: for AC current with a DC component. These devices are suitable for the detection of rectified single-phase currents.
- **B type**: for DC current. These devices are suitable for all types of current and are required, in particular, for rectified three-phase currents.

Waveforms of the test currents for A-type RCDs.
Selection of industrial RCDs

Schneider Electric has carried out large numbers of tests to characterise user needs. A complete analysis of the phenomena involved is available in Cahier Technique document 204. The table below (copied from chapter 6 of CT document 204) sums up the information: it indicates the type of RCD to be used depending on the system earthing arrangement, the equipment to be monitored and the type of protection required.

### Summary table

<table>
<thead>
<tr>
<th>Type of circuit</th>
<th>Application</th>
<th>Diagram</th>
<th>Suitable type of RCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode-based single-phase rectifier</td>
<td>■ frequency converters, variable-speed drives</td>
<td><img src="DB126074" alt="DB126074" /></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>■ supplies for DC circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCR-based single-phase rectifier</td>
<td>■ variable-speed drives</td>
<td><img src="DB126075" alt="DB126075" /></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>■ battery chargers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation devices</td>
<td>■ light dimmer</td>
<td><img src="DB126076" alt="DB126076" /></td>
<td>AC</td>
</tr>
<tr>
<td></td>
<td>■ heating regulator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC/AC converter with single-phase supply</td>
<td>■ variable-speed drives</td>
<td><img src="DB126077" alt="DB126077" /></td>
<td>A</td>
</tr>
<tr>
<td>AC/AC converter with three-phase supply</td>
<td>■ variable-speed drives</td>
<td><img src="DB126078" alt="DB126078" /></td>
<td>B (if no risk of fault on the DC bus)</td>
</tr>
<tr>
<td></td>
<td>■ welding machines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Protection

<table>
<thead>
<tr>
<th></th>
<th>Against indirect contact</th>
<th>Against direct contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply and installation characteristics</td>
<td>Three-phase No double insulation of DC bus</td>
<td>With double insulation of DC bus</td>
</tr>
<tr>
<td>SLT: TT or IT with exposed conductive parts not interconnected</td>
<td>B type, low sensitivity ($\geq 300$ mA)</td>
<td>A type, low sensitivity ($\geq 300$ mA)</td>
</tr>
<tr>
<td>SLT: TN-S</td>
<td>A type, low sensitivity ($\geq 300$ mA) $^{[1]}$</td>
<td>A type (30 mA) or B type (30 mA) if the braking resistance is accessible</td>
</tr>
<tr>
<td>SLT: IT</td>
<td>A type, low sensitivity ($\geq 300$ mA) $^{[1]}$</td>
<td>A type 30 mA</td>
</tr>
</tbody>
</table>

$^{[1]}$ The insulation fault is equivalent to a short-circuit. Tripping should normally be ensured by the short-circuit protection, but use of an RCD is recommended if there is any risk the overcurrent protection will not operate.
Characteristics of the relay / toroid combination: measurement integrity

The integrity of measurements depends on the capacity of the RCD to handle the various disturbances on the distribution system. The generic standard for EMC is IEC 61000-6-2 which defines the minimum immunity level. The test standards in the IEC 61000 series define the various requirement levels. Standard IEC 60947-2 annex M determines the required level for RCDs with separate toroids. Schneider has established for the Vigirex RCDs its own requirements that are similar or more demanding than those in the standard. The table below lists the required tests.

<table>
<thead>
<tr>
<th>Description of phenomena</th>
<th>Test standard</th>
<th>Standardised tests as per IEC 60947-2 annex M</th>
<th>Vigirex tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharges, due to the accumulation of static electricity, can lead to malfunctions and destruction.</td>
<td>Electrostatic-discharge immunity test</td>
<td>8 kV contact 8 kV in air</td>
<td>8 kV contact 15 kV in air</td>
</tr>
<tr>
<td>Radiated EM fields (radio-telephones, transmitters) can disturb operation of devices.</td>
<td>Radiated (radio-frequency) EM field immunity test</td>
<td>10 V /m 80 to 1000 MHz modulated at 1 kHz</td>
<td>12 V /m 80 to 1000 MHz modulated at 1 kHz</td>
</tr>
<tr>
<td>Switching of LV devices (contactors, contact bouncing, breaking of inductive loads, etc.) may cause malfunctions and destruction.</td>
<td>Electrical fast transients/bursts immunity test</td>
<td>4 kV on supply 2 kV on I/O 5 kHz fast burst/transient lasting 15 ms every 300 ms</td>
<td>4 kV on supply 2 kV on I/O 5 kHz fast burst/transient lasting 15 ms every 300 ms</td>
</tr>
<tr>
<td>Atmospheric overvoltages. Switching of MV devices may cause malfunctions and destruction.</td>
<td>Surge immunity test</td>
<td>On supply &gt; 100 V AC 4 kV between line and earth 4 kV between lines</td>
<td>On supply &gt; 100 V AC 4 kV between line and earth 4 kV between lines</td>
</tr>
<tr>
<td>EM fields (radio-telephones, transmitters) can cause HF currents resulting in device malfunctions.</td>
<td>Immunity test for conducted disturbances induced by radio-frequency fields</td>
<td>150 kHz to 80 MHz modulated at 1 kHz</td>
<td>10 V 150 kHz to 80 MHz modulated at 1 kHz</td>
</tr>
<tr>
<td>Faults on the distribution system may cause malfunctions.</td>
<td>Voltage-dip immunity test</td>
<td>Specific RCD-device tests</td>
<td>-</td>
</tr>
</tbody>
</table>
Voltage-dip withstand capacity
Standard IEC 60947-2 annex M defines precise criteria for the voltage-dip withstand capacity of RCDs that depend on the supply voltage. To guarantee safety, even if the auxiliary source fails, the RCD must operate correctly to 70% of the rated auxiliary-source voltage.
Vigirex devices comply with the standard.
- Operation under downgraded voltage conditions (see the characteristics on pages A-26 to A-35). Additional standard functions are built in to make the protection as dependable as possible:
  - failsafe operation is possible, see relay wiring
  - a voltage LED provides a local indication that voltage is not present.
Continuity of service: RCD device selectivity

Selectivity is ensured between the RCDs by using time-delay type RCDs.

Standardised characteristics of time-delay type RCDs

The standards governing RCDs define two categories for time-delay type RCDs.
- **RCD with a time delay ≤ 0.06 s**
  - These devices generally have a single, non-adjustable time delay. They are intended to ensure selectivity with non-time-delay type RCDs. The standards impose the following characteristics:
    - **non-operating time**
      - Time delay set for 2 \( I_{\Delta n} \); must not exceed 0.06 s
    - **operating time** (relay alone)
      - Must be indicated by the manufacturer
    - **total time** (relay plus breaking device)
      - The manufacturer must indicate the associated device and guarantee maximum total times not exceeding those in the table below.

<table>
<thead>
<tr>
<th>( If = I_{\Delta n} )</th>
<th>( 2 I_{\Delta n} )</th>
<th>( 5 I_{\Delta n} )</th>
<th>( 10 I_{\Delta n} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Tps</td>
<td>0.5 s</td>
<td>0.2 s</td>
<td>0.15 s</td>
</tr>
</tbody>
</table>

**Key:**
- Time Tps: total time required to break the current
- \( I_{\Delta n} \): residual operating current setting.
- Note: if the threshold is set to < 30 mA, the relay must operate immediately.

When set to I, Vigirex relays comply with the requirements for these time-delay type RCDs.
- **RCD with time delay > 0.06 s**
  - These are primarily industrial time-delay type RCDs used to ensure several levels of selectivity.
    - **preferred non-operating times** (in s)
      - The standard proposes the following time delays: 0.1 – 0.2 – 0.3 – 0.4 – 0.5 – 1.
      - The operating time must be indicated on the relay and guaranteed by the manufacturer.
    - **operating time** (relay alone)
      - Must be indicated and guaranteed by the manufacturer
    - **total time** (relay plus breaking device)
      - This time may be indicated by the manufacturer.

Vigirex RCDs

Vigirex RCDs offer a wide range of time delays and comply with the tests imposed by standard IEC 60947-2 annex M.
- **Minimum non-operating time**: indicated by the position of the delay setting dial on the front of the relay, as shown in the diagram opposite.
- **Operating time / total time**: indicated in the tables for device characteristics. For setting I (0.06 s) and the other time-delay settings, Schneider Electric guarantees the total times for Vigirex relays combined with Schneider Electric-brand breaking devices (switches, circuit breakers).

Implementing selectivity

Selectivity between upstream and downstream RCDs is necessarily of the current and time type.
It is ensured by correctly adjusting:
- the operating-current settings
- the total times.

The following general selectivity rules ensure correct operation:
- in terms of the current, the setting for the upstream device must be **double** that of the downstream device (in accordance with the standardised rules for the operating / non-operating currents)
- in terms of the time, the non-operating time (time delay) for the upstream device must be greater than the total time (the intentional RCD-device delay and the breaking time of the breaking device) for the downstream device.

These two conditions are summed up here:
- upstream \( I_{\Delta n} \geq 2 \times \) downstream \( I_{\Delta n} \)
- upstream non-operating time \( \Delta t \geq \) downstream total time \( \Delta t \).
For this reason, it is advised to use RCDs complying with the preferred standardised values.

**Note:** an RCD does not limit the fault current and for this reason, current selectivity alone is not sufficient.

The time/current curves indicate the operating-current values of the Vigirex devices depending on their standardised characteristics. When superposed, the curves indicate the protection settings required to ensure total selectivity (see the curves on pages E-43 to E-46).

The Vigirex devices, combined with Schneider Electric breaking devices (switches, circuit breakers), have successive operating-current and time-delay settings that enhance the selectivity rules mentioned above.

### Vigirex selectivity rules

<table>
<thead>
<tr>
<th>System (Schneider Electric breaking device + RCD)</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>Downstream</td>
</tr>
<tr>
<td>Vigirex</td>
<td>Schneider RCD</td>
</tr>
<tr>
<td>Schneider RCD device</td>
<td>Vigirex</td>
</tr>
</tbody>
</table>

$^{[1]}$ A difference of two settings is required for the 0.25 s setting (i.e. the 0.5 s and the 0.25 s settings).

Schneider Electric guarantees the coordination of a Vigirex RCD / Compact NSX circuit-breaker combination with all other RCDs as long as the general setting rules or those specific to Vigirex relays are observed.

**Example of settings for selectivity:**

A Vigirex RHU relay set to $I\Delta n = 0.1 A / \Delta t = 1 s$ (tripping curve 2) combined with a Compact NSX630 ensures total selectivity with a Vigirex RH99 set to $I\Delta n = 0.03 A / \Delta t = 0.8 s$ (tripping curve 1) combined with a Compact NSX250.

### Summary of RCD settings depending on the system earthing arrangement

RCD tripping/immunity depending on the load and the system earthing arrangement

<table>
<thead>
<tr>
<th>System earthing arrangement</th>
<th>TT</th>
<th>TN-S</th>
<th>TN-C</th>
<th>IT (1\textsuperscript{st} fault)</th>
<th>IT (2\textsuperscript{nd} fault)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I fault</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Very low</td>
<td>-</td>
</tr>
<tr>
<td>Typical value</td>
<td>A few Amps</td>
<td>A few kA</td>
<td>A few kA</td>
<td>Less than 1 A</td>
<td>-</td>
</tr>
<tr>
<td>Protection of persons</td>
<td>RCD</td>
<td>Circuit breaker</td>
<td>Circuit breaker</td>
<td>1\textsuperscript{st} fault not necessary</td>
<td>IT becomes TT or TN</td>
</tr>
<tr>
<td>Additional protection of persons</td>
<td>-</td>
<td>RCD</td>
<td>-</td>
<td>-</td>
<td>Idem TN</td>
</tr>
<tr>
<td>Threshold</td>
<td>y UL/R</td>
<td>3 to 250 A</td>
<td>-</td>
<td>If RCD &gt; 2 x first-fault leakage current</td>
<td>Idem TT or TN</td>
</tr>
<tr>
<td>Time delay</td>
<td>&lt; 1 s $^{[1]}$</td>
<td>&lt; 0.4 s as per U0</td>
<td>-</td>
<td>-</td>
<td>Idem TT or TN</td>
</tr>
<tr>
<td>Protection against fire hazards</td>
<td>RCD</td>
<td>RCD</td>
<td>-</td>
<td>RCD</td>
<td>RCD</td>
</tr>
<tr>
<td>Threshold</td>
<td>300 mA</td>
<td>300 mA</td>
<td>-</td>
<td>300 mA</td>
<td>300 mA</td>
</tr>
<tr>
<td>Time delay</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

$^{[1]}$ See table page F-5.
Special protection

Vigirex devices may be easily adapted to special protection applications given:
- the wide range of operating-current and time-delay settings
- the measurement toroids are separate
- the device is not part of the circuit-breaking function.

Additional information on RCD protection of persons

**TT system with multiple earth electrodes**

An RCD must be installed at the head of each part of the distribution system where the exposed conductive parts of the loads are connected to a separate earth electrode. This is because dangerous currents may flow without tripping the RCD at the head of the installation.

**Setting of RCD at the head (where applicable)**

Installation of an RCD at the head is mandatory if the insulation of the upstream part of the installation is not rated class 2.

A fault downstream of the RCD at the head must be taken into account under the worst-case conditions. The value that must be taken into account is the maximum value of the earth electrodes (Rmax). The mandatory rule is \( I_{\Delta n} \leq U_i / R_u \max \).

The downstream RCDs at the head of each group of loads must be set depending on the earthing resistance of each group of loads. The setting must also take into account selectivity with the upstream RCD(s).

**IT system 2nd fault, neutral protection**

For protection of the neutral conductor, an RCD can replace a trip unit for the neutral pole (4P circuit breaker with 3P tripping) if the RCD \( I_{\Delta n} \) setting is less than or equal to \( 0.15 \times \) the permissible current in the neutral conductor (see IEC 60364 - 474.3.2.2). The RCD interrupts all the live conductors, including the neutral.
Protection of property

Protection of loads
A minor insulation fault can rapidly develop and turn into a short-circuit causing major damage and even the destruction of the load. A medium-sensitivity RCD (a few amperes) provides suitable protection by shutting down the load before major damage can occur.

- **RCD threshold settings**
  From 3 to 30 A depending on the type of load

- **RCD time delays**
  1 second is a typical value.

Motor applications
Use of a Vigirex relay on a motor feeder avoids major damage if an insulation fault occurs (rewinding of stators, insulation breakdown, etc.). The modular product design makes for easy installation in drawers.

Protection of parallel-connected generators
An insulation fault inside the metal casing of an engine generator set risks severely damaging the generator. The fault must be rapidly detected and cleared. What is more, if other generators are connected in parallel, they will supply the fault and may provoke tripping due to an overload. Continuity of service is no longer ensured.

An RCD installed on the generator circuit is the means to:
- rapidly disconnect the faulty generator and maintain continuity of service
- intervene on the control circuits of the faulty generator to shut it down and reduce the risk of damage.

The RCD must be installed as close as possible to the protection device for each engine generator set (see the diagram). The diagram is of the TN-S type for the generator set considered as a load and of the TN-C type for the generator sets considered as generators.

- If a fault occurs on generator 1:
  - a zero-sequence fault current flows in PE1 Id1 + Id2 because sources 1 and 2 supply the fault.
  - this current is detected by RCD1 which immediately disconnects generator 1 (circuit breaker CB1 opens).
- This current is not detected by RCD2 because of the TN-C system.

RCD threshold settings
From 3 to 100 A depending on the rating of the engine generator set.

RCD time delays
Instantaneous or short time delay (< 100 ms).
Example of protection using RCDs

The diagram below shows a low-voltage distribution system (TT system) in a one-story building containing a number of workshops. The measured resistance of the earth electrodes is 1 Ω for the transformer, 1 Ω for the engine-generator set, 5 Ω for workshop A and 10 Ω for workshop B. Workshop B has machines with high intentional leakage currents (filters, etc.). The limiting touch voltage is 50 V, corresponding to a normal environment.

Distribution diagram with selectivity.

The RCD settings as shown in the diagram:
- provide for the safety of life and property
- ensure total selectivity in the event of an insulation fault in the installation
- eliminate any problems concerning malfunctions due to natural leakage current.
Requirements of standards

Protection against indirect contact

An RCD (indicated in the diagram on page F-28) must be installed at the head of the installation (see page F-26).

The authorised settings are:
- **operating current threshold**
  
  The maximum setting is \( I_{\Delta n} = 50 \text{ V/10 } \Omega = 5 \text{ A} \)

  **Note:** even though the earthing resistance of the main LV switchboard is 1 W, the RCD at the head of the installation must protect against faults occurring downstream wherever their position and the greatest earth resistance must therefore be considered, i.e. 10 W. (see page F-26)

- **non-operating time (time delay)**
  
  The non-operating time must not exceed \( \Delta t = 1 \text{ s} \) (see page F-25).

Protection against direct contact

Protection against direct contact must mainly be provided on circuits supplying the users in the workshops, in particular for the outlets. It is provided by instantaneous high-sensitivity 30 mA RCDs.

Protection implementation

Taking leakage currents into account

The leakage currents must be measured or estimated. Tables provide estimates for various loads (see page F-12) and for computer hardware (see page F-39).

The minimum setting for an RCD is:
\[ I_{\Delta n} > 2 \times I_L \] (where \( I_L \) is the total leakage current downstream of the RCD).

- On the circuits supplying power outlets, the leakage current must therefore be limited to \( I_L < 30 \text{ mA/2} = 15 \text{ mA} \)

  e.g. downstream of the 30 mA ID63, no more than 4 PCs can be installed (from the table on page F-39, the estimated leakage current for a PC is 3.5 mA, giving \( 4 \times 3.5 \) for 4 PCs = 14 mA < 15 mA)

- On the other circuits, the RCD thresholds are set to provide protection against direct contact. The sum of the leakage currents must be less than \( I_{\Delta n/2} \)

  e.g. downstream of the NSX250 in Workshop B, there are 20 frequency converters equipped with 100 nF filters (see page F-12), corresponding to a leakage current of approximately 21 mA per converter. The sum of the leakage currents is therefore 420 mA. The Vigicompact must therefore be set to at least 2 x IL, i.e. 1 A.

Taking selectivity into account (see page F-24)

- **Current-based selectivity**

  The following two conditions must be satisfied:

  - \( I_{\Delta n} \) of upstream RCD > 2 \( I_{\Delta n} \) of downstream RCD (selectivity requirement)
  - \( I_{\Delta n} \) of upstream RCD > 2 \( I_L \) (leakage current requirement)

  e.g. the Vigicompact NSX250 is upstream of Acti 9 and Vigicompact C60 or iC60 RCDs set to 30 mA or 300 mA. The total leakage current is estimated to be 420 mA.

  The 1 A setting satisfies both earth leakage and selectivity requirements

- **Time-based selectivity**

  The following condition must be satisfied:

  upstream non-operating time > downstream total operating time (relay + breaking device).

  Given that downstream protection is provided by Acti 9 and Vigicompact devices, it is sufficient to set the upstream Vigicompact time delay one setting higher, i.e. setting 1 (60 ms).

  **Check**

  The Vigicompact protection settings determined in this way must still satisfy the requirements of the standards as indicated above for the operating current threshold and non-operating time.

  e.g. the protection of persons against indirect contact in Workshop B complies if:

  \[ I_{\Delta n} < 5 \text{ A} \text{ and } \Delta t < 1 \text{ s} \]

  The Vigicompact settings of \( I_{\Delta n} = 1 \text{ A} \) and \( \Delta t = 60 \text{ ms} \) are therefore compliant.

  **Note 1:** with RCDs from the Vigirex, Vigicompact and Acti 9 range, the maximum time delay is 1 s; the \( \Delta t \) condition is therefore always satisfied.

  **Note 2:** if the operating current condition is not satisfied, a Vigirex RCD can be used.

  e.g. the RCD at the head of the installation must normally be set to meet the general selectivity requirements for RCDs, i.e. 6A, however this is not compatible with the protection of persons (5 A) for this installation. By using a Vigirex RCD, this problem is avoided because special characteristics of Vigirex RCDs ensure selectivity down to 1.5 \( I_{\Delta n} \) downstream, i.e. 4.5 A.
The fault current on the transformer incomer can be calculated two ways:
- by measuring the sum of the currents in the live conductors (3 Ph + N)
- by measuring the fault current directly on the earthing conductor.

The latter method is useful because at the head of sizeable installations, the cables or busbars are large and it is difficult to install the measurement toroid.

Installation of the Vigirex measurement toroid at the head of an installation.

<table>
<thead>
<tr>
<th>Rectangular sensor</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement toroid on earthing conductor</td>
<td>Size of toroid Easy installation at any time</td>
<td>“Custom” solution Special toroid mounting and wiring outside the switchboard On-site tests</td>
<td>Good solution for existing installations Possible only with RCDs with separate toroid</td>
</tr>
</tbody>
</table>

Note: the rectangular sensors in the Vigirex range are specifically designed for this type of installation.

Multi-source diagram with TT system

At this level in the installation and in the event of an insulation fault, continuity of service is obtained by:
- selectivity between the RCDs for faults on the output circuits
- source redundancy for faults on the main busbars.

The sources must not be disconnected simultaneously.

Each source has a separate earth electrode

The measurement toroid for the header RCD is positioned in the same manner as for a single source.
- The two sources are never coupled

This is the typical situation for a normal source with an engine generator set as a backup source.

Each RCD monitors the fault current in the part of the installation in which it is installed.

- The two sources may be coupled

It is not possible to use the system presented above because if a fault occurs, each of the measurement toroids for the RCDs detects only a part of the fault current, i.e. the protection of persons is not correctly ensured.

To correctly set up protection using an RCD, the two earth electrodes must both be run through the measurement toroids for the two header RCDs.

This diagram is in fact identical to that for a single-source system with two parallel-connected transformers (as concerns insulation faults).

Note: in the event of a fault, even when the sources are not coupled, the two protection devices trip. There is no selectivity in clearing the faulty source.

This system downgrades the continuity of service.
The sources are connected to the same earth electrode

Caution is required in setting up the RCDs.

- The two sources are never coupled

Installation of the toroids at points A ensures correct monitoring of the insulation fault and selectivity in clearing the faulty part of the installation.

- The two sources may be coupled

The same conditions (each source has an earthing conductor, two sources with a closed coupling) means the measurement toroids must be installed at point B, on the common earth electrode.

This system has the same disadvantages, i.e. no selectivity in clearing the sources.

IMPORTANT

Coupling may be carried out by a source coupling device (the most frequent case), particularly when there is a DC bus downstream.

Example. DC bus shared by a number of rectifiers.

Multi-source diagram with TN system

Use of RCDs at the head of an installation with the TN system for the protection of persons is uncommon. The reason for their use can be the long length of cables and/or the low Isc value.

It is possible to use them for the protection of property when the fault impedance is not controlled. The functional diagram is identical to that for a multi-source TT system with a single earth electrode. The limiting conditions mentioned above are identical (except for the fact that the sensitivity of the settings is very low and thus not comparable with the natural leakage currents or the coupling currents). The main limiting factor is the possible flow of neutral current in the earthing circuits. To ensure selectivity and avoid malfunctions, each situation must be carefully studied.

For further information, see guide no. 2 “Ground Fault Protection”.

Multi-source diagram with TN system.
Recommendations for toroid installation
For measurements of residual currents using RCDs with separate toroids, a number of simple rules must be observed to avoid nuisance tripping, i.e.:
- install the conductors in the measurement toroids
- take into account the operational current of the toroids
- install the toroid on a straight section of the conductors
- use a magnetic ring if:
  - transient currents are high (≈ 6 In where In is the maximum permissible continuous current for the toroid)
  - the application requires high sensitivity (e.g. IΔn = 30 mA)
  - the nominal current of the application is in the neighbourhood of the maximum permissible current of the toroid.
Further information is provided on these rules in the section on device installation.

Rated operational current of the sensors
Particular precautions may be required for toroid installation. This is because high currents “but not an insulation fault” can locally saturate the magnetic circuit of the toroid, creating abnormal flows that are interpreted on the secondary winding as zero-sequence currents.
The rated operational current for the toroids used with Vigirex devices:
- is indicated for the minimum setting value at 30 mA
- takes into account inrush currents (up to 6 In).

Selection of toroids and rectangular sensors depending on the power circuit
See page B-9.
Example 1. A motor feeder (30 kW/57 A at 400 V) must be monitored by a Vigirex device with a toroid having a minimum diameter of 30 mm (TA30).
This means that the device may be set to 30 mA instantaneous without risk of nuisance tripping.
The rated operational current must be taken into account to avoid nuisance tripping, however, higher currents will not damage the toroid.
Example 2. On the motor feeder mentioned in example 1, the inrush current is, in fact, significantly higher than 6 In.
To avoid possible tripping, it may be necessary to:
- use a toroid having a larger diameter
- set up a time delay complying with the safety rules (< 1 s) and selectivity requirements for the upstream RCDs.
These two measures may be implemented simultaneously.
Disturbed environments

Measurements in disturbed environments may require special precautions:
- greater distance between the toroid wires and power circuits
- use of shielded, twisted cables with the shielding connected at each end.
It is necessary to check that equipotential bonding exists between the exposed conductive parts to which the shielding is connected on the toroid side and those to which the shielding is connected on the Vigirex side.
If that is not the case, the shielding may act as the equipotential bond for the low-frequency currents and that is not its job. There is the risk that the cable may be damaged and/or the Vigirex device may malfunction. A PE conductor is required for equipotential bonding.
- Reduction to the shortest length possible for the cable between the toroid and the relay
- Use of a dedicated supply with galvanic isolation to eliminate conducted disturbances.
Combinations of RCDs

It is possible to combine different types of RCDs (type AC, A and B)?

To confirm the validity of the combination, it is necessary to check the type of insulation fault downstream that the RCD combination will have to monitor. If each of the RCDs in the combination is compatible with all the possible types of faults, selectivity between the RCDs is ensured, even when different types are employed, as long as the selectivity rules are observed.

The table below sums up the possible combinations:

<table>
<thead>
<tr>
<th>Possible combinations of RCD types</th>
<th>Optimised solutions for type B fault</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCD1 type</td>
<td></td>
</tr>
<tr>
<td>[1] AC or A or B</td>
<td>A or B</td>
</tr>
<tr>
<td>[1] B</td>
<td>A</td>
</tr>
<tr>
<td>RCD2 type</td>
<td></td>
</tr>
<tr>
<td>[1] AC or A or B</td>
<td>A or B</td>
</tr>
<tr>
<td>[1] B</td>
<td>B</td>
</tr>
<tr>
<td>Type of fault</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

[1] Capable of handling the fault.

Technical comments

Analysis of a combination with a type A RCD1 upstream of a type B RCD2 in the event of a type B insulation fault.

Even if it is not dangerous, a type B insulation fault causes the flow of DC current that may exceed 6 mA (the limiting value for DC current for type A RCDs). This DC current may saturate the magnetic circuit of the measurement toroid for RCD1, thus blocking detection and relay actuation if a dangerous fault occurs in another part of the installation. This blocking of detection does not depend on the RCD1 current setting, which may be significantly higher than that for RCD2 (for example, \( I_{\Delta n1} = 30 \text{ A}, I_{\Delta n2} = 30 \text{ mA} \)).

Solutions

The use of type B RCDs is specific to certain loads. For this reason, there are two solutions to eliminate the flow of DC current on the distribution system:

- Isolate the loads in question using an isolating transformer.
- Isolate the loads likely to cause a type B fault using class 2 insulation.

The two solutions may be implemented simultaneously.

Implementation examples.

Note: If an isolating transformer is used, selectivity between RCD1 and RCD2 is of course excellent.
RCD-device settings in installations with high leakage currents

**TT system**

- **Maximum current setting \( I_{\Delta n1} \)**
  
  It is first necessary to check the earthing resistance (\( R_T \)) of the exposed conductive parts of the connected loads. The maximum setting value for RCD \( I_{\Delta n1} \) is provided by \( U_l / R_T \), (where \( U_l \) is equal to 50 V for standard environments and 25 V for humid environments).

- **Minimum current setting \( I_{\Delta n2} \)**
  
  It is then necessary to determine for the various parts of the installation protected by a given RCD the natural leakage current (low because the leakage capacitances are balanced) and the intentional leakage current (caused by the load filters). The table below provides typical values for the leakage currents of loads causing particularly high levels of disturbances.

  **Table for leakage currents**

<table>
<thead>
<tr>
<th>Electrical equipment</th>
<th>Measured leakage current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fax machine</td>
<td>0.5 to 1</td>
</tr>
<tr>
<td>Printer</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Workstation (UC, screen and printer)</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Photocopy machine</td>
<td>0.5 to 1.5</td>
</tr>
<tr>
<td>Floor heating</td>
<td>1 mA / kW</td>
</tr>
<tr>
<td>Single-phase and three-phase filters</td>
<td>1 mA / load</td>
</tr>
</tbody>
</table>

  **Computer equipment as per standard IEC 60950**

<table>
<thead>
<tr>
<th>Class</th>
<th>All equipment</th>
<th>Maximum leakage current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>Class 1</td>
<td>Portable</td>
<td>0.75</td>
</tr>
<tr>
<td>Class 1</td>
<td>A-type fixed or mobile</td>
<td>3.5</td>
</tr>
<tr>
<td>Class 1</td>
<td>B-type fixed</td>
<td>3.5 or 5 % In</td>
</tr>
</tbody>
</table>

- \( I_{\Delta n2} \ll I_{\Delta n1} \) (slightly disturbed system)

  There are no problems with malfunctions if the selectivity rules are observed.

- \( I_{\Delta n2} \approx I_{\Delta n1} \) to avoid nuisance tripping. There are three possible solutions:
  - segment the installation to reduce the leakage currents in each part
  - install an isolating transformer for sets of loads causing particularly high levels of disturbances
  - set up the TN-S system for all or a part of the installation. This is possible if the disturbing loads can be identified and located (the case for computer equipment).
IT system

The major characteristic of the IT system is its capacity to continue operation after a first insulation fault. However, this insulation fault, though not dangerous, causes a leakage current in the natural capacitances (high because unbalanced) and intentional capacitances. This current may reach or exceed 1 A. If RCDs are required, they must imperatively be set to a value double that of the leakage current (see § 531.2.5 of standard IEC 60364-553).

<table>
<thead>
<tr>
<th>System leakage capacitance (μF)</th>
<th>1st fault current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.07</td>
</tr>
<tr>
<td>5</td>
<td>0.36</td>
</tr>
<tr>
<td>30</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Table drawn from figure 5 in the Cahier Technique document 178.

Note: 1 μF is the typical leakage capacitance of 1 km of four-core cable.

For a load causing high leakage currents, the installation segmenting technique mentioned above is often used.

Distribution system in a factory with a TNS segment for the management IT system. IMD: insulation-monitoring device.
An isolation fault causes a zero-sequence leakage current and, depending on the system earthing arrangement, tripping of the protection device specified by the installation rules.

But a zero-sequence current can also be caused by:
- intentional leakage current, e.g. a high-frequency filter installed between the system and earth
- non-dangerous leakage currents, e.g. a progressive insulation fault or an insulation fault on the neutral conductor.

These two types of leakage current do not create dangerous situations and the continuity of service must be maintained, consequently the protection devices must not react and operation must continue.

These currents can, however:
- degenerate and become dangerous (risk of fire or electrocution), and as a result force the operator to shut down the dangerous part of the installation
- create disturbances on the distribution system leading to the malfunction of sensitive equipment.

Measurement of the leakage current is the means to prevent the risk of a dangerous fault.

Monitoring the neutral conductor in TN-S systems

In the TN-S system, the neutral conductor is connected to the PE at the head of the installation. The neutral conductor can be accidentally earthed due to an insulation fault.

- **Safety of life and property**
  
  There is no problem because no dangerous touch voltages are created given that the natural voltage of the neutral conductor is the same as that of the PE.

- **Power quality**
  
  In the TN-S system, accidental earthing of the neutral conductor can cause malfunctions due to the flow of currents from the neutral conductor to the protective conductor and the exposed conductive parts. This type of fault in fact transforms the TN-S system into a TN-C, which is forbidden for the supply of sensitive equipment.

---

**Tolerance for an insulation fault on the neutral conductor depending on the system earthing arrangement**

<table>
<thead>
<tr>
<th></th>
<th>TN-C</th>
<th>TN-S</th>
<th>TT</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Forbidden</td>
<td>OK</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>sensitive to EM</td>
<td>PE and neutral</td>
<td>But PE and neutral must not be in contact</td>
<td>No problem even if PE and neutral are in contact</td>
<td>No problem even if PE and neutral are in contact</td>
</tr>
<tr>
<td>disturbances</td>
<td>are the same</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Insulation fault on the neutral conductor. The system is TN-C upstream of A.
Consequences of an isolation fault on the neutral conductor

In the TN-S system, an earth fault on the neutral causes:
- “noise” in the earthing circuits for sensitive equipment
- emission of EM fields (disturbances).

Note: the currents in the exposed conductive parts are zero-sequence currents, i.e. with significant EM radiation. What is more, computer equipment is sensitive. A force of 1 A at a distance of one meter disturbs the screen of a PC.
- differences in potential between the 0V of the different equipment.

Effects of a fault on the neutral conductor in the TN-S system.

The gravity of these phenomena is increased by:
- the presence of non-linear loads with high THDI values
- the presence, often significant, of third-order harmonics and their multiples.

In this case, the neutral current represents from 50 to over 100 % of the current in the phases.

These new constraints require the use of a device to monitor the zero-sequence currents.
Measurement of leakage currents

Management of leakage currents
RMH and RM12T devices provide the means to monitor circuit loading and equipment layout and make sure the leakage currents are distributed correctly and do not disturb the protection system.

Table for leakage currents

<table>
<thead>
<tr>
<th>Electrical equipment</th>
<th>Measured leakage current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fax machine</td>
<td>0.5 to 1</td>
</tr>
<tr>
<td>Printer</td>
<td>&lt; 1</td>
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<tr>
<td>Workstation (UC, screen and printer)</td>
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<td>Floor heating</td>
<td>1 mA / kW</td>
</tr>
<tr>
<td>Single-phase and three-phase filters</td>
<td>1 mA / load</td>
</tr>
</tbody>
</table>

Computer equipment as per standard IEC 60950

<table>
<thead>
<tr>
<th>Class</th>
<th>Equipment Type</th>
<th>Maximum leakage current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>All equipment</td>
<td>0.25</td>
</tr>
<tr>
<td>1</td>
<td>Portable</td>
<td>0.75</td>
</tr>
<tr>
<td>1</td>
<td>A-type fixed or mobile[^1]</td>
<td>3.5</td>
</tr>
<tr>
<td>1</td>
<td>B-type fixed[^2]</td>
<td>3.5 or 5 % In</td>
</tr>
</tbody>
</table>

\[^1\] A-type equipment: equipment intended for connection to the electrical installation of building via a non-industrial outlet, a non-industrial connector or both.

\[^2\] B-type equipment: equipment intended for connection to the electrical installation of building via an industrial outlet, an industrial connector or both in compliance with standard IEC 60309 or similar national standards.

In addition to sensitive equipment and loads, the lighting circuits must also be monitored.

The starters for fluorescent lighting have more or less significant levels of natural leakage current. Damage to a starter often causes a major increase in the leakage current.
RHUs and RHU application diagram

Small distribution systems

The RHUs and RHU may be used to measure the leakage currents.

Selection table

<table>
<thead>
<tr>
<th>Products</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHUs or RHU</td>
<td>LV481000 to LV481003</td>
</tr>
<tr>
<td>A-type toroids [1]</td>
<td>50437 to 50442</td>
</tr>
<tr>
<td>TOA-type toroids [2]</td>
<td>50420 or 50421</td>
</tr>
</tbody>
</table>


In this case, the diameter of the toroid is generally much smaller than [1].

Setting

Depending on the leakage currents of the supplied equipment, from 30 mA to 1 A.

Installation

- Head of LV distribution system

Small distribution systems.

- The natural leakage currents caused by lighting are significant and interfere with insulation monitoring of the monitored equipment. Measurements are made directly on the monitored equipment.
RMH application diagram

Computer rooms

### Selection table

<table>
<thead>
<tr>
<th>Products</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMH</td>
<td>LV481004</td>
</tr>
<tr>
<td>RM12T</td>
<td>28566</td>
</tr>
<tr>
<td>A-type toroids[^1]</td>
<td>50437 to 50442</td>
</tr>
<tr>
<td>TOA-type toroids[^2]</td>
<td>50420 or 50421</td>
</tr>
</tbody>
</table>

[^1]: New.  
[^2]: Renovation.

[^1]: In this case, the diameter of the toroid is generally much smaller than [^2].

**Setting**

These relays are installed in situations where the leakage currents can be high, up to 5% of the rated load current:

- a few amperes for the shielding earthing
- from 0.3 to 1 A for each device and the lighting.
Leakage-current monitoring using RCDs

Selection table

<table>
<thead>
<tr>
<th>Products</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMH</td>
<td>LV481004</td>
</tr>
<tr>
<td>RM12T</td>
<td>28566</td>
</tr>
<tr>
<td>A-type toroids</td>
<td>50437 to 50442</td>
</tr>
<tr>
<td>TOA-type toroids</td>
<td>50420 or 50421</td>
</tr>
</tbody>
</table>

[1] In this case, the diameter of the toroid is generally much smaller than [2].

- Check on the overall leakage current, from 1 to a few amperes
- Check on the distribution of the leakage currents in each distribution system,
  \[ I_{\text{leakage}} = 300 \text{ mA to 1 A} \]
- Fluorescent lighting from 0.3 to 1 A.

If there is a significant difference between each supply, reconsider the supply for the workstations.
**Instantaneous relay, \( I_{\Delta n} \) setting = 30 mA**

1. Non-operating time.
2. Operating time.

**Frequency filtering**

Example
At 50 Hz, the tripping threshold is \( I_{\Delta n} \).
At 900 Hz, the tripping threshold is \( k \times I_{\Delta n} \) (where \( k = 5 \)).
Additional characteristics

Tripping curves and frequency filtering
RH197M

Instantaneous relay, $I_{\Delta n}$ setting = 30 mA

Non-operating time.
Operating time.

Frequency filtering

Example
At 50 Hz, the tripping threshold is $I_{\Delta n}$.
At 900 Hz, the tripping threshold is $k \times I_{\Delta n}$ (where $k = 5$).

Instantaneous relay, $I_{\Delta n}$ setting > 30 mA

Total break time.

Delayed relay for $I_{\Delta n} > 30$ mA
**Instantaneous relay, $I\Delta n$ setting = 30 mA**

1. Non-operating time.
2. Operating time.

**Instantaneous relay, $I\Delta n$ setting > 30 mA**

3. Total break time.

---

**Frequency filtering**

Example

At 50 Hz, the tripping threshold is $I\Delta n$.

At 900 Hz, the tripping threshold is $k \times I\Delta n$ (where $k = 5$).
Additional characteristics

Tripping curves and frequency filtering
RHUs and RHU

Instantaneous relay, $I_{\Delta n}$ setting = 30 mA

Frequency filtering

Delayed relay for $I_{\Delta n} > 30$ mA

1. Non-operating time.
2. Operating time.
3. Total break time.
Catalogue numbers

Residual-current protection relays .................................. G-2
Residual-current protection relays
or monitoring relays............................................................... G-4
Toroids and rectangular sensors,
communication module, accessories................................... G-5
## RH10 with local manual fault reset

**System to be protected**  
LV $\leq$ 1000 V

### RH10M
- **Sensitivity**: 0.03 A - instantaneous  
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56100
- **Front-panel mount.**

### RH10P
- **Sensitivity**: 0.05 A - instantaneous  
- **Power supply**: 110 to 130 V AC, 50/60 Hz  
- **Catalogue number**: 56120
- **DIN-rail mount.**

### Sensitivity 0.3 A - instantaneous
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56160

### Sensitivity 0.1 A - instantaneous
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56150

### RH21 with local manual fault reset

**System to be protected**  
LV $\leq$ 1000 V

### RH21M
- **Sensitivity**: 0.03 A - instantaneous  
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56160
- **DIN-rail mount.**

### RH21P
- **Sensitivity**: 0.3 A - instantaneous or with 0.06 s time delay  
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56260
- **Front-panel mount.**

### Sensitivity 0.3 A - instantaneous
- **Power supply**: 12 to 24 V AC, 12 to 48 V DC, 50/60 Hz  
- **Catalogue number**: 56260
Residual-current protection relays

**RH68 with local manual fault reset**

- System to be protected: LV ≤ 1000 V
- RH68M
- DIN-rail mount.

**Sensitivity 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>220 to 240 V AC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH68M</td>
<td></td>
<td></td>
<td>56168</td>
</tr>
</tbody>
</table>

**RH86 with local manual fault reset**

- System to be protected: LV ≤ 1000 V
- RH86M
- RH86P
- DIN-rail mount. Front-panel mount.

**Sensitivity 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>220 to 240 V AC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH86M</td>
<td></td>
<td></td>
<td>56500</td>
</tr>
</tbody>
</table>

**RH99 with local manual fault reset**

- System to be protected: LV ≤ 1000 V
- RH99M
- RH99P
- DIN-rail mount. Front-panel mount.

**Sensitivity 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>12 to 24 V AC - 12 to 48 V DC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH99M</td>
<td></td>
<td></td>
<td>56170</td>
</tr>
<tr>
<td>RH99P</td>
<td></td>
<td></td>
<td>56270</td>
</tr>
</tbody>
</table>

**RH197 with local manual or automatic fault reset**

- System to be protected: LV ≤ 1000 V
- RH197M
- RH197P
- DIN-rail mount. Front-panel mount.

**Alarm: 50 % of fault threshold - instantaneous**

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>48 V AC - 24 to 130 V DC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH197M</td>
<td></td>
<td></td>
<td>56515</td>
</tr>
<tr>
<td>RH197P</td>
<td></td>
<td></td>
<td>56505</td>
</tr>
</tbody>
</table>

**Fault: sensitivity 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>48 V AC - 24 to 130 V DC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH197M</td>
<td></td>
<td></td>
<td>56515</td>
</tr>
<tr>
<td>RH197P</td>
<td></td>
<td></td>
<td>56505</td>
</tr>
</tbody>
</table>

**Alarm: 100 % of fault threshold - instantaneous**

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>48 V AC - 24 to 130 V DC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH197M</td>
<td></td>
<td></td>
<td>56515</td>
</tr>
<tr>
<td>RH197P</td>
<td></td>
<td></td>
<td>56505</td>
</tr>
</tbody>
</table>

**Fault: sensitivity 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>48 V AC - 24 to 130 V DC</th>
<th>50/60 Hz</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH197M</td>
<td></td>
<td></td>
<td>56515</td>
</tr>
<tr>
<td>RH197P</td>
<td></td>
<td></td>
<td>56505</td>
</tr>
</tbody>
</table>

[1] Selected via a switch.

Residual-current protection relays

RHUs with local manual fault reset

System to be protected: LV ≤ 1000 V

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>Power supply</th>
<th>LV481000</th>
<th>LV481001</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 to 130 V AC</td>
<td>110 to 130 V AC</td>
<td>50/60 Hz</td>
<td>LV481002</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>220 to 240 V AC</td>
<td>50/60 Hz</td>
<td>LV481003</td>
</tr>
</tbody>
</table>

RHU with local manual fault reset (communicating)

System to be protected: LV ≤ 1000 V

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>Power supply</th>
<th>LV481002</th>
<th>LV481003</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 to 130 V AC</td>
<td>110 to 130 V AC</td>
<td>50/60 Hz</td>
<td>LV481002</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>220 to 240 V AC</td>
<td>50/60 Hz</td>
<td>LV481003</td>
</tr>
</tbody>
</table>

Monitoring relays

RH99 with automatic fault reset

System to be protected: LV ≤ 1000 V

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>Power supply</th>
<th>LV481000</th>
<th>LV481001</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>50/60 Hz</td>
<td>LV481002</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>110 to 130 V AC</td>
<td>50/60 Hz</td>
<td>LV481003</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>220 to 240 V AC</td>
<td>50/60 Hz</td>
<td>LV481004</td>
</tr>
</tbody>
</table>

RMH and multiplexer RM12T (communicating)

System to be monitored: LV ≤ 1000 V

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>Power supply</th>
<th>LV481004</th>
</tr>
</thead>
<tbody>
<tr>
<td>220 to 240 V AC</td>
<td>220 to 240 V AC</td>
<td>50/60 Hz</td>
</tr>
</tbody>
</table>
Toroids and rectangular sensors, communication module, accessories

Sensors
Closed toroids, A type

<table>
<thead>
<tr>
<th>Type</th>
<th>Ie (A)</th>
<th>Inside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA30</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>PA50</td>
<td>85</td>
<td>50</td>
</tr>
<tr>
<td>IA80</td>
<td>160</td>
<td>80</td>
</tr>
<tr>
<td>MA120</td>
<td>250</td>
<td>120</td>
</tr>
<tr>
<td>SA200</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>GA300</td>
<td>630</td>
<td>300</td>
</tr>
</tbody>
</table>

Accessory for closed toroids

<table>
<thead>
<tr>
<th>Type</th>
<th>Inside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic ring For TA30 toroid</td>
<td>56055</td>
</tr>
<tr>
<td>Magnetic ring For PA50 toroid</td>
<td>56056</td>
</tr>
<tr>
<td>Magnetic ring For IA80 toroid</td>
<td>56057</td>
</tr>
<tr>
<td>Magnetic ring For MA120 toroid</td>
<td>56058</td>
</tr>
</tbody>
</table>

Split toroids, OA-type

<table>
<thead>
<tr>
<th>Type</th>
<th>Ie (A)</th>
<th>Inside diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOA80</td>
<td>160</td>
<td>80</td>
</tr>
<tr>
<td>TOA120</td>
<td>250</td>
<td>120</td>
</tr>
</tbody>
</table>

Rectangular sensors

<table>
<thead>
<tr>
<th>Inside dimensions (mm)</th>
<th>Ie (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 1600 280 x 115</td>
<td>56053</td>
</tr>
<tr>
<td>L2 3200 470 x 160</td>
<td>56054</td>
</tr>
</tbody>
</table>

Communication module

- Cable for Modbus serial link 1 x RJ45 and free wires at other end - Cable 3 m: W3A8306D30
- Connector Modbus adaptor: LV434211

Accessories

- 1 screws bag for RH

Note: sensor-relay link, twisted cable not supplied (see “Installation and connection” chapter).