Low-voltage residual-current protection relays

Merlin Gerin Vigirex

Catalogue 2003
General contents

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Catalogue numbers 107
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 4000 A:
- A-type closed toroids: TA30, PA50, IA80, MA120, SA200 and GA300
- OA-type split toroids: POA and GOA
- Rectangular sensors.

For all types of installations
Vigirex relays are designed to operate with all electrical switchgear devices on the market.
Complete range of devices for protection and monitoring

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 for the protection of life and property
- installation: IEC 60364
- electromagnetic compatibility (EMC): IEC 61000
- coordination of insulation: IEC 60864

and North-American standards dealing with UL:
- ground fault protection: UL 1053
  (protection of equipment and property).

Vigirex residual-current relays, with associated toroids, measure the earth-leakage current in the electrical installation. They provide:
- residual-current protection: RH10, RH21 and RH99
- earth-leakage monitoring: RH99 and RMH
- residual-current protection and earth-leakage monitoring: RHUs and RHU.

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.

The monitoring relays indicate overruns of leakage current thresholds. 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.
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.

Circuit breakers Vigirex
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, the most severe) 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 in front can also be used to check operation at any time.

Class II front insulation
All Vigirex relays, whether DIN or front-panel mount format, have class II insulated fronts as per standards IEC/EN 60664-1 and NFC 15-100.

Settings protected by a lead-sealable cover
Access to settings can be protected by a cover with a lead seal. The test and reset buttons remaining accessible on the front of the relay.
Detection

Eliminate unnecessary downtime

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

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

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

Rms measurements of earth-leakage currents
The residual-current protection relay measures all types of signals and calculates the true rms value weighted to allow for frequency filtering.

Alarm

Test and reset
To monitor the protection or indication system, the relay includes:
- a complete test function with tripping of the protection device
- a test without tripping, if necessary.

Protection

433E1200.fm/6
Minimise outages

The entire range offers numerous setting possibilities that may be used to create many discrimination levels, from the incomer to the final output circuits. Correct setting of the residual-current devices (RCDs) ensures total discrimination 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.

Diagnosis of installation faults

The indication relays are the means to:
- monitor drops in electrical insulation
- prevent outages
- initiate preventive maintenance.

Tests with or without tripping

The purpose of the test is to check:
- the output contacts
- the display (RHU/RHUs and RMH)
- the LEDs
- the internal electronics.
Formats for all applications

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<td>or machine panel</td>
<td>DIN with mounting lugs</td>
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<tr>
<td>Final-distribution enclosure</td>
<td>DIN</td>
</tr>
</tbody>
</table>

DIN device mounted on a rail

DIN device with mounting lugs secured to a mounting plate

Front-panel mount device

Clip-in toroids 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 toroids from 30 to 50 mm in diameter.
Formats for all installation systems
Multi 9 format devices of the Vigrex range (RH10, RH21 and RH99), can be mounted on a DIN rail or on a universal mounting plate using the mounting lugs.
The 72 x 72 mm front-panel mount devices (RH10, RH21, RH99, RMH, RHU and RHUs) are mounted on panels, doors or front plates using clips.

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

Compatibility
The range is completely compatible with existing products.

Certified quality: ISO 9001 - 2000
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.
Functions and characteristics

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<tr>
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<td>■</td>
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<tr>
<td>Remote indications (hard-wired)</td>
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<tr>
<td>Display of measurements</td>
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</tr>
</tbody>
</table>

**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 | ■ |
| 8 AC voltage ranges from 12 to 525 V | ■ |
| 4 AC voltage ranges from 48 to 415 V | - |

**Thresholds**

| Fault (Iun)     | 1 fixed instantaneous threshold choose from 0.03 A to 1 A |
|                | 0.03 A or 0.3 A |
| Alarm           | - |
| Pre-alarm       | - |

**Time delays**

| Fault     | Instantaneous |
|           | Instantaneous for I\(\text{un}\) = 0.03 A |
|           | 1 user-selectable time delay instantaneous or 0.06 s for I\(\text{un}\) = 0.3 A |
| 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 and 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 (internal bus) | - |

**Characteristics**

| page 433E2400.fm/32 | page 433E2400.fm/32 |

**Sensors**

| Merlin Gerin A, O, E toroids (3) | ■ |
| Merlin Gerin rectangular sensors | ■ |

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(1) Relay with output contact requiring local, manual reset after a fault.
(2) Relay with output contact that automatically resets after fault clearance.
(3) Mandatory with an RMH (multiplexing for the 12 toroids).
(4) Mandatory with an RM12T (multiplexing for the 12 toroids).
(5) Depending on the type of wiring (optimum continuity of service or optimum safety).
(6) See characteristics page 433E2400.fm/40.
### Monitoring relays (2)

<table>
<thead>
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<table>
<thead>
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<th>RHUs and RHU</th>
<th>RH99</th>
<th>RMH</th>
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<tr>
<td>9 user-selectable thresholds from 0.03 A to 30 A</td>
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<tr>
<td>1 adjustable threshold from 0.03 A to 30 A</td>
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<tr>
<td>9 user-selectable time delays instantaneous to 4.5 s</td>
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<td>-</td>
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<tr>
<td>1 adjustable time delay instantaneous to 5 s</td>
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<td>- except RHUs</td>
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</tbody>
</table>

- 12 measurement channels
- 220 to 240 V AC
- 1 adjustable threshold/channel from 0.03 A to 30 A
- 1 adjustable time delay/channel instantaneous to 5 s
- 1 adjustable time delay/channel instantaneous to 5 s

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**Note:**
- **RH99** and **RHUs** are suitable for general monitoring applications.
- **RMH** is specifically designed for high-power applications requiring extended measurement capabilities.

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**Merlin Gerin**

13 décembre 2002

433E2100.fm/13
Operation and use

Functions and characteristics

Function
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, RH99)
- earth-leakage monitoring (RMH or RH99)
- residual-current protection and earth-leakage monitoring (RHUs or 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.
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 digital display of the measured current or a LED.
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 Multi 9 ATm3 or ATm7 auto-reclosing controller (Schneider Electric catalogue numbers 18306 and 18307 respectively), 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: 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 NFC 15-100: installation rules for low-voltage electrical distribution
- UL 1053: relays RH10, RH21 and RH99 up to 220/240 V are designed to comply with standard UL1053.

Ground fault sensing and relaying equipment UL 1053

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 (Multi 9 type fast mounting or screw mounting)
- type P: front-panel mount (on panel, door, etc.)
- ratings:
  - fixed I\(\Delta n\) threshold (a number of choices) and no time delay (instantaneous) or selectable I\(\Delta n\) threshold from 0.03 to 30 A and user-selectable time delay from 0 to 4.5 s (see settings on pages 433E2400.fm/32 to 37)
- 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 (cont.)

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 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 -55 °C to +85 °C.

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 NFC 15-100. 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.
General characteristics (cont.)

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
- Vigirex relay supply voltage
- product part number
- the origin (Schneider Electric) and the connection terminals (see pages 433E2300.fm/24 to 28) 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)
- the composition is indicated on the parts (e.g. PCFV for fibreglass reinforced polycarbonate)
- 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 Merlin Gerin or Telemecanique 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, 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 %.

![Graph showing operating tolerances for the protection threshold I∆n](image)

Operating tolerances for the protection threshold I∆n:
1. Standards.
2. Vigirex.

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.

![Diagram of inverse-time tripping curve]

Curve 1: inverse-time tripping curve as per IEC 60947-2.
Curve 2: tripping curve with fixed threshold \( I = I_{\text{th}} \).
Curve 3: transient zero phase-sequence current upon load energisation.

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).

![Graph of ventricular fibrillation threshold]

Variation in the ventricular-fibrillation threshold depending on the frequency from 50/60 Hz up to 1000 Hz.

Gain in immunity to nuisance tripping with Vigirex.
Functions and characteristics

General characteristics (cont.)

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, RH99, 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, RH99, 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, 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 3.
Functions and characteristics

General characteristics (cont.)

Test and reset

Test
According to standards IEC 60364 and NFC 15-100, 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 (RHUs, RHU and RMH), 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></td>
<td>No</td>
</tr>
<tr>
<td>Local via button in front</td>
<td>■</td>
</tr>
<tr>
<td>Remote</td>
<td>■(1)</td>
</tr>
<tr>
<td>a number of relays</td>
<td>■(1)</td>
</tr>
<tr>
<td>Via communication</td>
<td>■(RHU/RMH)</td>
</tr>
</tbody>
</table>

(1) Except for RMH.

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.
Connections for the front-panel mount relays in the Vigirex range also 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, RH99, RHUs, RHU, RMH)
- DIN format (RH10, RH21, RH99).

On the DIN-format relays, it is possible to simply clip in:
- the toroids ∅ 30 mm and ∅ 50 mm
- three mounting lugs for relay installation on mounting plates in control cabinets.

<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></td>
</tr>
</tbody>
</table>
Functions and characteristics

General characteristics (cont.)

Formats for all installation systems (cont.)

Covers
All Vigirex relays are equipped with lead-sealable covers to block access to settings while maintaining access to the device test and reset buttons.
Discrimination between residual-current devices

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 discrimination

Discrimination 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 discrimination 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 $I_n \Delta n 
\geq 2 \times$ downstream $I_n 
- upstream non-operating time $\Delta T_u \geq$ downstream total time $\Delta T_d$

Note: a residual-current device does not limit the fault current. That is why current discrimination 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 discrimination (see the curves pages 433E2500.fm/42 and 43).

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

Discrimination 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</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).

Note: for further information, see chapter 4.

The Merlin Gerin residual-current protection ranges (earth-leakage protection function on Masterpact circuit breaker control units, Vigicompact, Multi 9 RCDs, etc.) are internally consistent and designed for combined use to ensure discrimination for insulation faults.
Electromagnetic compatibility

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.
**Functions and characteristics**

**Description**

RH10M, RH21M and RH99M relays

---

**Relay marking**
1. Type of relay.
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).

---

**LED status**

<table>
<thead>
<tr>
<th>on</th>
<th>fault</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="on" alt="LED" /></td>
<td>Normal operation</td>
</tr>
<tr>
<td><img src="off" alt="LED" /></td>
<td>Fault current detected</td>
</tr>
<tr>
<td><img src="green" alt="LED" /></td>
<td>Relay/sensor link fault</td>
</tr>
<tr>
<td><img src="red" alt="LED" /></td>
<td>No voltage or device not in service</td>
</tr>
<tr>
<td><img src="flashing" alt="LED" /></td>
<td>Malfunction detected</td>
</tr>
</tbody>
</table>

**Key:**
- ![LED](on) green (or red)
- ![LED](flashing)

**Settings**

15. Threshold and time-delay selectors (RH21)
   - 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)
   - 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)
   - 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 (cont.)**

**RH10P, RH21P and RH99P relays**

**Relay marking**
1. Type of relay.
2. Customer marking zone (circuit identification).
4. Relay class.

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

**Indications**
2. 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>

**Settings**
10. Threshold and time-delay selectors (RH21)
   Three possible settings:
   - 0.03 A sensitivity, instantaneous
   - 0.3 A sensitivity, instantaneous
   - 0.3 A sensitivity, 0.06 s delay
11. Time-delay selector (RH99)
   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).
12. Threshold selector (RH99)
   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.
13. Fault contact.
15. Plug-in supply.
16. Voltage-presence contact.
Functions and characteristics

### Description (cont.)

#### RHUs and RHU relays

**Relay marking**
- 1 Type of relay.
- 13 Relay class.

**Controls**
- 6 Setting modification button.
- 7 Enter button.
- 8 Test/reset button.
- 9 Right arrow.
- 10 Down arrow.

**Indications**
- 2 Alarm LED.
- 3 Fault LED.
- 4 Digital display (3 digits) for measurements and settings.
- 5 Unit LEDs for current measurements and settings.
- 11 LEDs for displayed settings (alarm current, alarm time delay, fault current, fault time delay).
- 12 LEDs for the type of measurement (leakage current, leakage current as percentage of fault threshold or maximum leakage current measured since last reset).

<table>
<thead>
<tr>
<th>LEDs</th>
<th>Measurement LEDs</th>
<th>Digital display (3 digits)</th>
<th>Setting LEDs</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>alarm</td>
<td>fault</td>
<td>I, % (IΔn), max</td>
<td>units</td>
<td>I alarm, t alarm (s), IΔn, tΔn (s)</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>30</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>80</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>100</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>888</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>T TOR</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>E Er</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>SAT</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>OFF</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>On</td>
</tr>
</tbody>
</table>

Case for a RHU relay set to I alarm = 70 mA and IΔn = 90 mA.

**Key:**
- ● off
- ● (●) green (or red)
- ● ● flashing
- ● ● flashing display.

**Connection**

All connections for front-panel mount relays are of the plug-in type.
- 14 Alarm contact.
- 15 Test/Reset.
- 16 Voltage-presence contact.
- 17 Supply.
- 18 Communication bus (RHU only).
- 19 Sensor.
- 20 Fault-current contact.

Connections on the back of the relay.
Functions and characteristics

RMH relay and RM12T multiplexer

Relay marking
1 Type of relay.

Controls
6 Setting modification button.
7 Enter button.
8 Test/reset button.
9 Right arrow.
10 Down arrow.

Indications
2 Pre-alarm LED.
3 Alarm LED.
4 Digital display (3 digits) for measurements and settings.
5 Unit LEDs for current measurements and settings.
11 LEDs indicating displayed settings (pre-alarm current, pre-alarm time delay, alarm current, alarm time delay).
12 LEDs indicating the type of measurement (leakage current, leakage current as percentage of fault threshold or maximum leakage current measured since last reset).
13 Number(s) of concerned channel(s).

<table>
<thead>
<tr>
<th>LEDs</th>
<th>Concerned channel(s)(1)</th>
<th>Measurement LEDs</th>
<th>Digital display (3 digits)</th>
<th>Setting LEDs</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-al.</td>
<td>alarm</td>
<td>I, % (I (\Delta n)), max</td>
<td>units</td>
<td>I pre-al., I pre-al. (s)</td>
<td>I alarm, t alarm (s)</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>30</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>80</td>
</tr>
<tr>
<td>● ●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>---</td>
</tr>
<tr>
<td>● ●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>---</td>
</tr>
<tr>
<td>● ●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>100</td>
</tr>
<tr>
<td>● ●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>---</td>
</tr>
<tr>
<td>● ●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>888</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>TOR</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>Er, Er0, Er1</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>Er2</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>SAT</td>
<td>Leakage current greater than 60 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>Adr</td>
<td>Connection via internal bus: channel to be addressed flashes No connection via internal bus: message disappears after 30 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>OFF</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>On</td>
</tr>
<tr>
<td>●</td>
<td>●</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>●</td>
<td>●</td>
<td>Test with actuation of the alarm and pre-alarm output contacts</td>
</tr>
</tbody>
</table>

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

(1) In red.
**Functions and characteristics**

**Description**

RMH relay and RM12T multiplexer (cont.)

---

**RMH connection**

- All connections for front-panel mount relays are of the plug-in type.
- 14 Pre-alarm contact.
- 15 Voltage-presence contact.
- 16 Supply.
- 17 RM12T multiplexer.
- 18 Communication bus.
- 19 Alarm contact.

**RM12T multiplexer connection**

- 20 Sensors (12 measurement channels).
- 21 RMH relay.
- 22 Supply.

---

Connections on the back of the RMH.

Front of RM12T multiplexer.
Functions and characteristics

Description (cont.)
RHU and RMH communication

Vigirex RHU and RMH relays integrate perfectly in the SMS PowerLogic power management system by communicating with Digipact protocols. A communication interface is available for other networks:
- Modbus
- Profibus
- Ethernet, etc.

RHU and RMH relays are equipped for communication via an internal bus to enable remote management via the DC150 data concentrator.
Functions and characteristics

Overview of functions
Communication is the means to:
- identify the device
- indicate status conditions (read)
- control the device (write)
- set up the protection and alarms (read and write)
- analyse the instantaneous and maximum residual currents to assist operation and maintenance (read).
The system transmits data (bits or words).
The information is transmitted:
- in real time
- periodically
- on request.

Note: a complete description of the communication system and the protocol are provided in the manual for the DC150 data concentrator.

<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 by the DC150</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Type of device</strong></td>
<td>RHU</td>
<td>RMH</td>
</tr>
<tr>
<td><strong>Status indications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RHU alarm / RMH pre-alarm</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>RHU fault / RMH 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>Fault threshold</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Fault time delay</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>Leakage current</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Leakage current as percentage of fault threshold</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Maximum leakage current</td>
<td>■</td>
</tr>
<tr>
<td>Fault readings</td>
<td>Malfunction detected</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>RMH/RM12T link fault</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Saturation of fault-current measurements</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Sensor link fault</td>
<td>■</td>
</tr>
</tbody>
</table>
Functions and characteristics

Description (cont.)

Sensors

Compatibility with toroids
Vigirex RH10, RH21, RH99, RHU and RMH relays may be used with the following sensors:
- closed or split toroids (A, OA type)
- E type toroids (existing installations):
  - TE (Ø30 mm) and PE (Ø50 mm): total compatibility
  - IE (Ø80 mm), ME (Ø120 mm) and SE (Ø200 mm): the Vigirex sensitivity must be set to a value ≥ 300 mA.

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 433E3100.fm/49)
- split toroids facilitate installation in existing systems up to 400 A and may be installed on plates or brackets
- rectangular sensors are for busbars in installations with currents ≤ 4000 A.

Compatibility with rectangular sensors
The RH10, RH21, RH99 relays may be used with rectangular sensors 280 x 115 mm and 470 x 160 mm. The Vigirex sensitivity must be set to ≥ 500 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 and OA type toroids: -35°C / +70°C
  - rectangular sensors: -35°C / +80°C
- the temperature range for toroid storage is:
  - A and OA type toroids: -55°C / +85°C
  - rectangular sensors: -55°C / +100°C
**Functions and characteristics**

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

<table>
<thead>
<tr>
<th>Vigirex relays</th>
<th>RH10</th>
<th>RH21</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General characteristics</strong></td>
<td>50/60/400 Hz ≤ 1000 V</td>
<td>50/60/400 Hz ≤ 1000 V</td>
</tr>
<tr>
<td>Monitored distribution system: LV AC / System voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System earthing arrangement</td>
<td>TT, TNS, IT</td>
<td>TT, TNS, IT</td>
</tr>
<tr>
<td>A, AC type class as per IEC 60947-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating-temperature range</td>
<td>-35°C / +70°C</td>
<td>-35°C / +70°C</td>
</tr>
<tr>
<td>Storage-temperature range</td>
<td>-55°C / +85°C</td>
<td>-55°C / +85°C</td>
</tr>
</tbody>
</table>

**Electrical characteristics as per IEC 60755 and EN 60755, IEC 60947-2 and EN 60947-2, UL 1053**

<table>
<thead>
<tr>
<th>Power supply: rated operational voltage Ue</th>
<th>12 to 24 V AC</th>
<th>50/60 Hz / DC</th>
</tr>
</thead>
<tbody>
<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>50/60/400 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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational voltage tolerances</th>
<th>Ue: 12 to 24 V AC -12 to 48 V DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V &lt; Ue &lt; 415 V</td>
<td>55 % to 120 % Ue (1)</td>
</tr>
<tr>
<td>Ue &gt; 415 V</td>
<td>70 % to 110 % Ue</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overvoltage category</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated impulse withstand voltage up to Ue = 525 V AC</td>
<td>Uimp (kV)</td>
</tr>
<tr>
<td>Maximum consumption</td>
<td>4 VA</td>
</tr>
<tr>
<td>DC</td>
<td>4 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault current detection</th>
<th>Threshold Iₙn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>1 fixed threshold</td>
</tr>
<tr>
<td>Measurement accuracy</td>
<td>0.03 A - 0.05 A - 0.1 A - 0.15 A</td>
</tr>
<tr>
<td>Display refresh time</td>
<td>0.25 A - 0.3 A - 0.5 A - 1 A</td>
</tr>
<tr>
<td></td>
<td>2 user-selectable thresholds 0.03 A or 0.3 A</td>
</tr>
</tbody>
</table>

| Fault-current detection range | 80 % Iₙn to 100 % Iₙn |
| Time delay ∆t | instantaneous |
|
| At settings | 0 s |
| Maximum non-operating time at 2 Iₙn | 0.015 s |
| Maximum operating time at 5 Iₙn (residual-current relay alone) | 0.015 s |
| Maximum total time at 5 Iₙn (4) | 0.04 s |
| Setting | none |
| Output contact | changeover with latching |

<table>
<thead>
<tr>
<th>Alarm</th>
<th>I alarm</th>
<th>threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time delay ∆t alarm</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Maximum non-detection time at 2 Iₙn</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Maximum detection time at 5 Iₙn</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Setting</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test with or without actuation of the output contacts and output-contact reset following a fault</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
</tr>
<tr>
<td>Remote (hard-wired) (10 m maximum)</td>
</tr>
<tr>
<td>Remote (hard-wired for several relays) (10 m maximum)</td>
</tr>
<tr>
<td>Remote (via communication)</td>
</tr>
</tbody>
</table>

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

(1) 80 % to 120 % Ue if Ue < 20 V.
(2) -15 % during energisation.
(3) < 10 % of Iₙn: display = 0 and > 200 % of Iₙn: display = SAT.
(4) Maximum time to clear the fault current when combined with a Schneider Electric circuit breaker or switch rated < 630 A.
# Functions and characteristics

## Protection relays with output contact requiring local manual reset after a fault (cont.)

### RH99

- 50/60/400 Hz < 1000 V
- TT, TNS, IT
- -35°C / +70°C
- -55°C / +85°C
- RH99 RHUs and RHU
- 50/60/400 Hz < 1000 V
- TT, TNS, IT
- Site
- -35°C / +55°C
- -55°C / +85°C
- RHUs and RHU

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>RH99</th>
<th>RHUs and RHU</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% to 120% Ue&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>55% to 110% Ue</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70% to 110% Ue</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IV</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>4 VA</td>
<td>-</td>
<td>4 VA</td>
</tr>
<tr>
<td>4 W</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10% to 200% of I&lt;sub&gt;n&lt;/sub&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>± 10% of I&lt;sub&gt;n&lt;/sub&gt;</td>
<td>2 s</td>
<td>-</td>
</tr>
<tr>
<td>9 user-selectable thresholds</td>
<td>-</td>
<td>-</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>80% I&lt;sub&gt;n&lt;/sub&gt; to 100% I&lt;sub&gt;n&lt;/sub&gt;</td>
<td>1 adjustable threshold</td>
</tr>
<tr>
<td>Instantaneous for I&lt;sub&gt;n&lt;/sub&gt; = 0.03 A</td>
<td>instantaneous for I&lt;sub&gt;n&lt;/sub&gt; = 0.03 A</td>
<td>0.03 A to 1 A in 0.001 A steps</td>
</tr>
<tr>
<td>9 user-selectable time delays</td>
<td>1 adjustable time delay</td>
<td>1 A to 30 A in 0.1 A steps</td>
</tr>
<tr>
<td>Instantaneous to 4.5 s</td>
<td>instantaneous to 5 s in 10 ms steps</td>
<td>80% I&lt;sub&gt;alarm&lt;/sub&gt; to 100% I&lt;sub&gt;alarm&lt;/sub&gt;</td>
</tr>
<tr>
<td>0 s</td>
<td>0 s</td>
<td>0.06 s ≤ Δt</td>
</tr>
<tr>
<td>0.06 s</td>
<td>0.06 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.15 s</td>
<td>0.15 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.25 s</td>
<td>0.25 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.31 s</td>
<td>0.31 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.5 s</td>
<td>0.5 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.8 s</td>
<td>0.8 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>1 s</td>
<td>1 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>4.5 s</td>
<td>4.5 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>0.04 s</td>
<td>0.04 s</td>
<td>same as for RH99</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>keypad</td>
</tr>
<tr>
<td>Changeover with latching</td>
<td>Changeover with latching</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>1 adjustable threshold</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>0.015 A to 1 A in 0.001 A steps</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>1 A to 30 A in 0.1 A steps</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>0.015 A &lt; I alarm &lt; 30 A</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>80% I alarm to 100% I alarm</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>1 adjustable time delay</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>instantaneous to 5 s in 10 ms steps</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>0 s</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>0.06 s ≤ Δt</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>same as for I&lt;sub&gt;n&lt;/sub&gt;</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>keypad or internal bus</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>NO without latching</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>Alarm deactivated at 70% of I alarm threshold</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Continuous</td>
<td>Continuous</td>
<td>-</td>
</tr>
<tr>
<td>Continuous</td>
<td>Continuous</td>
<td>RUH only</td>
</tr>
<tr>
<td>Continuous</td>
<td>Continuous</td>
<td>-</td>
</tr>
<tr>
<td>Continuous</td>
<td>Continuous</td>
<td>-</td>
</tr>
</tbody>
</table>
### Functions and characteristics

**Protection relays with output contact requiring local manual reset after a fault (cont.)**

#### Characteristics

**Vigirex relays**

**Electrical characteristics as per IEC 60755 and EN 60755, IEC 60947-2 and EN 60947-2, UL 1053 (cont.)**

<table>
<thead>
<tr>
<th>Characteristics of output contacts as per standard IEC 60947-5-1</th>
<th>RH10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated thermal current (A)</td>
<td>8A</td>
</tr>
<tr>
<td>Minimum load</td>
<td>10 mA at 12 V</td>
</tr>
<tr>
<td>Utilisation category</td>
<td>AC12 AC13 AC14 AC15 DC12 DC13</td>
</tr>
<tr>
<td>24 V</td>
<td>6 6 5 5 6 2</td>
</tr>
<tr>
<td>48 V</td>
<td>6 6 5 5 2 -</td>
</tr>
<tr>
<td>110 V</td>
<td>6 6 4 4 0.6 -</td>
</tr>
<tr>
<td>220-240 V</td>
<td>6 6 4 4 - -</td>
</tr>
<tr>
<td>250 V</td>
<td>- - 0.4 - -</td>
</tr>
<tr>
<td>380-415 V</td>
<td>5 - - - -</td>
</tr>
<tr>
<td>440 V</td>
<td>- - - - -</td>
</tr>
<tr>
<td>660-690 V</td>
<td>- - - - -</td>
</tr>
</tbody>
</table>

**Display and indications**

- Voltage presence (LED and/or relay) (1)
- Threshold overrun: fault (LED)
- Leakage current and settings (digital)

**Setting protection:** sealable cover enabling local reset and test

**Communication**

- Suitable for supervision (internal bus)

**Mechanical characteristics**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>72 x 72 mm</th>
<th>6 modules x 9 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.3 kg</td>
<td>0.3 kg</td>
</tr>
<tr>
<td>Insulation class (IEC 60664-1)</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Front face</td>
<td>IP40</td>
<td>IP40</td>
</tr>
<tr>
<td>Communication output</td>
<td>IP30</td>
<td>IP30</td>
</tr>
<tr>
<td>Degree of protection IP (IEC 60529)</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>Front face</td>
<td>IK07 (2 joules)</td>
<td>IK07 (2 joules)</td>
</tr>
<tr>
<td>Sinusoidal vibrations (Lloyd's and Veritas)</td>
<td>2 to 13.2 Hz ±1 mm and 13.2 Hz ±0.7 g</td>
<td>2 to 13.2 Hz ±1 mm and 13.2 Hz ±0.7 g</td>
</tr>
<tr>
<td>Fire (IEC 60695-2-1)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Environment**

- Damp heat, equipment not in service (IEC 60068-2-30) 28 cycles +25°C / +55°C / RH 95%
- Damp heat, equipment in service (IEC 60068-2-56) 48 hours, Environment category C2
- Salt mist (IEC 60668-2-52) KB test, severity 2
- Degree of pollution (IEC 60664-1) 3

**Electromagnetic compatibility (2)**

- 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

| Heat loss                          | 3.52 MJ    | 4.45 MJ |

**Sensors and accessories**

<table>
<thead>
<tr>
<th>Sensors (3)</th>
<th>A, OA type toroids</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>for I&lt;sub&gt;n&lt;/sub&gt; &gt; 500 mA</td>
<td>Merlin Gerin rectangular sensors</td>
<td>-</td>
</tr>
<tr>
<td>Cables</td>
<td>Relay/sensor link via standard twisted pair</td>
<td>-</td>
</tr>
</tbody>
</table>

---

1. Depending on the type of wiring (optimum continuity of service or optimum safety).
2. Compatibility for both relay and sensor.
3. Compatibility with E type toroids in existing installations (see restrictions in chapter 3, Installation and connection).
## Functions and characteristics

### Protection relays with output contact requiring local manual reset after a fault (cont.)

<table>
<thead>
<tr>
<th>RH21</th>
<th>RH99</th>
<th>RHUs and RHU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>10 mA at 12 V</td>
<td>10 mA at 12 V</td>
<td>10 mA at 12 V</td>
</tr>
<tr>
<td>AC12</td>
<td>AC13</td>
<td>AC14</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Front-panel mount

- DIN
- RHU only

<table>
<thead>
<tr>
<th>Front-panel mount DIN</th>
<th>Front-panel mount DIN</th>
<th>Front-panel mount DIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 x 72 mm</td>
<td>6 modules x 9 mm</td>
<td>72 x 72 mm</td>
</tr>
<tr>
<td>0.3 kg</td>
<td>0.3 kg</td>
<td>0.3 kg</td>
</tr>
<tr>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>IP40</td>
<td>IP40</td>
<td>IP40</td>
</tr>
<tr>
<td>IP30</td>
<td>IP30</td>
<td>IP30</td>
</tr>
<tr>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>IK07 (2 joules)</td>
<td>IK07 (2 joules)</td>
<td>IK07 (2 joules)</td>
</tr>
<tr>
<td>2 to 13.2 Hz ±1 mm</td>
<td>2 to 13.2 Hz ±1 mm</td>
<td>2 to 13.2 Hz ±1 mm</td>
</tr>
<tr>
<td>and 13.2 to 100 Hz – 0.7 g</td>
<td>and 13.2 to 100 Hz – 0.7 g</td>
<td>and 13.2 to 100 Hz – 0.7 g</td>
</tr>
<tr>
<td>28 cycles +25°C / +55°C / RH 95 %</td>
<td>28 cycles +25°C / +55°C / RH 95 %</td>
<td>28 cycles +25°C / +55°C / RH 95 %</td>
</tr>
<tr>
<td>KB test, severity 2</td>
<td>KB test, severity 2</td>
<td>KB test, severity 2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Level 4</td>
<td>Level 4</td>
<td>Level 4</td>
</tr>
<tr>
<td>Level 3</td>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td>Level 4</td>
<td>Level 4</td>
<td>Level 4</td>
</tr>
<tr>
<td>Level 3</td>
<td>Level 3</td>
<td>Level 3</td>
</tr>
<tr>
<td>Class B</td>
<td>Class B</td>
<td>Class B</td>
</tr>
<tr>
<td>3.52 MJ</td>
<td>4.45 MJ</td>
<td>3.52 MJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.52 MJ</td>
</tr>
</tbody>
</table>

---

Schneider Electric

Merlin Gerin
Square D

4 décembre 2002

433E2400.fm/35
**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 |

**Operating-temperature range**

**Storage-temperature range**

**Electrical characteristics**

**Power supply:**

- rated operational voltage $U_e$
  - 12 to 24 V AC
  - 12 to 24 V DC
  - 48 V AC
  - 48 V DC
  - 50/60 Hz
  - 50/60 Hz

**Operational voltage tolerances**

- $U_e$: 12 to 24 V AC
- $U_e$: 12 to 48 V DC

**Overvoltage category**

**Rated impulse withstand voltage**

- up to $U_e = 525$ V AC
- $U_{imp}$ (kV)

**Maximum consumption**

- AC
- DC

**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 refresh time**

**Alarm**

**I alarm threshold**

**Alarm-current detection range**

**Time delay $\Delta t$ alarm**

**$\Delta t$ alarm settings**

**Maximum non-detection time at 2 $I$ alarm (2 $I$ alarm for RMH)**

**Maximum detection time at 5 $I$ alarm (5 $I$ alarm for RMH)**

**Setting**

**Output contact**

**Hysteresis**

**Pre-alarm**

**I pre-alarm threshold**

**Pre-alarm current detection range**

**Time delay $\Delta t$ 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 % $U_e$ if $U_e < 20$ V.

(2) -15 % during energisation.
## Functions and characteristics

### Characteristic monitoring relays with output contact that automatically resets after fault clearance (cont.)

<table>
<thead>
<tr>
<th>RH99</th>
<th>RMH and RM12T combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/60/400 Hz ≤ 1000 V</td>
<td>50/60/400 Hz ≤ 1000 V</td>
</tr>
<tr>
<td>TT, TNS</td>
<td>TT, TNS</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-35°C / +70°C</td>
<td>-25°C / +55°C</td>
</tr>
<tr>
<td>-55°C / +85°C</td>
<td>-55°C / +85°C</td>
</tr>
</tbody>
</table>

### Characteristics

- **55 % to 120 % Ue**<sup>(1)</sup>
- **70 % to 110 % Ue**
- **IV**
- **8**
- **4 VA**
- **4 W**

### 9 user-selectable thresholds

<table>
<thead>
<tr>
<th>0.03 A - 0.1 A - 0.3 A - 0.5 A - 1 A - 3 A - 5 A - 10 A - 30 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 % I alarm to 100 % I alarm (instantaneous for I alarm = 0.03 A)</td>
</tr>
<tr>
<td>9 user-selectable time delays: instantaneous to 4.5 s</td>
</tr>
<tr>
<td>0 s</td>
</tr>
<tr>
<td>-</td>
</tr>
<tr>
<td>0.015 s</td>
</tr>
</tbody>
</table>

### Changeover

<p>| 0.015 A to 60 A on 12 measurement channels | ± 10 % of I alarm |
| &lt; 200 ms | &lt; 2.4 s (&lt; n x 200 ms if n toroids) |
| 2 s | 80 % I alarm to 100 % I alarm (instantaneous for I alarm = 0.03 A) |
| 1 adjustable threshold/channel | 1 adjustable delay/channel |
| 0.03 A to 1 A in 0.001 A steps | instantaneous to 5 s in 10 ms steps |
| 1 A to 30 A in 0.1 A steps | 80 % I alarm to 100 % I alarm (instantaneous for I alarm = 0.03 A) |
| 0.2 s | 1 adjustable delay/channel |
| 2.4 s | instantaneous to 5 s in 10 ms steps |
| 2.4 s + (1.2 × Δt alarm) | 80 % I alarm to 100 % I alarm (instantaneous for I alarm = 0.03 A) |
| keypad or internal bus | other time delays |
| changeover | changeover |
| none | alarm contact deactivated at 70 % of I alarm threshold |
| 1 adjustable threshold/channel | 1 adjustable delay/channel |
| 0.015 A to 1 A in 0.001 A steps | instantaneous to 5 s in 10 ms steps |
| 1 A to 30 A in 0.1 A steps | 80 % I pre-alarm to 100 % I pre-alarm |
| 0.015 A &lt; I pre-alarm &lt; I alarm &lt; 30 A | 1 adjustable delay/channel |
| 80 % I pre-alarm to 100 % I pre-alarm | instantaneous to 5 s in 10 ms steps |
| 0/-20 % for all settings not including polling time | 0/-20 % for all settings not including polling time |
| keypad or internal bus | keypad or internal bus |
| NO | NO |
| pre-alarm contact deactivated at 70 % of I pre-alarm threshold | pre-alarm contact deactivated at 70 % of I pre-alarm threshold |</p>
<table>
<thead>
<tr>
<th>and reset of alarm-display memory (digital and LED)</th>
<th>and reset of alarm-display memory (digital and LED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>continuous</td>
<td>continuous</td>
</tr>
<tr>
<td>continuous</td>
<td>continuous</td>
</tr>
<tr>
<td>continuous</td>
<td>continuous</td>
</tr>
</tbody>
</table>
Functions and characteristics

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

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></td>
</tr>
<tr>
<td>Rated operational current (A)</td>
<td>Utilisation category</td>
</tr>
<tr>
<td>24 V</td>
<td></td>
</tr>
<tr>
<td>48 V</td>
<td></td>
</tr>
<tr>
<td>110 V</td>
<td></td>
</tr>
<tr>
<td>220-240 V</td>
<td></td>
</tr>
<tr>
<td>250 V</td>
<td></td>
</tr>
<tr>
<td>380-415 V</td>
<td></td>
</tr>
<tr>
<td>440 V</td>
<td></td>
</tr>
<tr>
<td>660-690 V</td>
<td></td>
</tr>
<tr>
<td>Display and indications</td>
<td>Voltage presence (LED and/or relay)</td>
</tr>
<tr>
<td></td>
<td>Alarm setting overrun (LED and relay)</td>
</tr>
<tr>
<td></td>
<td>Pre-alarm setting overrun (LED and relay)</td>
</tr>
<tr>
<td></td>
<td>Leakage current and settings (digital)</td>
</tr>
</tbody>
</table>

Setting protection: sealable cover enabling local reset and test

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)

Electromagnetic compatibility (1)

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)

Heat loss

Sensors and accessories

Sensors (2)
A, OA type toroids
Merlin Gerin rectangular relays
for \( I_n > 500 \text{ mA} \)

Cables
Relay/sensor link via standard twisted pair not supplied

(1) Compatibility for both relay and sensor.
(2) Compatibility with E type toroids in existing installations
(see restrictions in chapter 3, “Installation and connection”).
## Functions and characteristics

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

<table>
<thead>
<tr>
<th>RH99</th>
<th>RMH associated with RM12T</th>
<th>RMH + RM12T</th>
<th>RM12T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>10 mA at 12 V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AC12</td>
<td>AC13</td>
<td>AC14</td>
<td>AC15</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>DC12</td>
<td>6</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>DC13</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
<td>5</td>
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<tr>
<td></td>
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<td>2</td>
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<td>6</td>
<td>6</td>
<td>4</td>
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<td>2</td>
<td>2</td>
</tr>
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<td></td>
<td>6</td>
<td>4</td>
<td>4</td>
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<tr>
<td></td>
<td>4</td>
<td>0.6</td>
<td>0.6</td>
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<tr>
<td></td>
<td>5</td>
<td>4</td>
<td>4</td>
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<td></td>
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</tr>
</tbody>
</table>

#### RH99
- Front-panel mount: DIN
  - 72 x 72 mm
  - 6 modules x 9 mm
  - 0.3 kg
  - 0.3 kg
  - 0.3 kg
  - II
  - II
  - II
  - IP40
  - IP40
  - IP40
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 3.52 MJ
  - 4.45 MJ
  - 4.45 MJ
  - 4.45 MJ

#### RMH
- Front-panel mount: DIN
  - 72 x 72 mm
  - 6 modules x 9 mm
  - 0.3 kg
  - 0.3 kg
  - 0.3 kg
  - II
  - II
  - II
  - IP40
  - IP40
  - IP40
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
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  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20
  - IP20

#### RMH + RM12T
- Front-panel mount: DIN
  - 72 x 72 mm
  - 6 modules x 9 mm
  - 0.3 kg
  - 0.3 kg
  - 0.3 kg
  - II
  - II
  - II
  - IP40
  - IP40
  - IP40
  - IP20
  - IP20
  - IP20
  - IP20
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 3.52 MJ
  - 4.45 MJ
  - 4.45 MJ
  - 4.45 MJ

#### RM12T
- Front-panel mount: DIN
  - 72 x 72 mm
  - 6 modules x 9 mm
  - 0.3 kg
  - 0.3 kg
  - 0.3 kg
  - II
  - II
  - II
  - IP40
  - IP40
  - IP40
  - IP20
  - IP20
  - IP20
  - IP20
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 28 cycles +25°C / ±55°C / RH 95%
  - 3.52 MJ
  - 4.45 MJ
  - 4.45 MJ
  - 4.45 MJ
## Functions and characteristics

### Sensors

#### Associated relays
- Monitoring relays
- Protection relays

#### Use
- New installations and extensions
- Renovation and extensions

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

#### Electrical characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation ratio</td>
<td></td>
</tr>
<tr>
<td>Rated short-time withstand current $I_{cw}$</td>
<td>$100 \text{ kA/0.5 s}$</td>
</tr>
<tr>
<td>Residual short-circuit withstand current $I_{\Delta w}$</td>
<td>$85 \text{ kA/0.5 s}$</td>
</tr>
<tr>
<td>Overvoltage category</td>
<td></td>
</tr>
<tr>
<td>Rated impulse withstand voltage $U_{imp}$</td>
<td>(kV)</td>
</tr>
</tbody>
</table>

#### Sensor characteristics

- Rated operational current $I_e$ (A)
- Conductor max. size per phase (mm$^2$ copper)

#### Mechanical characteristics

- Type of sensor
  - TA30 toroid
  - PA50 toroid
  - IA80 toroid
  - MA120 toroid
  - SA200 toroid
  - GA300 toroid
  - POA toroid
  - GOA toroid
  - Rectangular sensor

### Wiring

<table>
<thead>
<tr>
<th>Wire size (mm$^2$)</th>
<th>Resistance $R = 3 \Omega$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

### 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

### 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)
- Heat loss (MJ)

---

(1) For $I_{\Delta n} \leq 500 \text{ mA with RH10, RH21 and RH99.}$

(2) From 0.5 to 2.5 mm$^2$. 

---
### Functions and characteristics

#### Sensors (cont.)

<table>
<thead>
<tr>
<th>A type closed toroid</th>
<th>OA type split toroid</th>
<th>Rectangular sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH99, RMH</td>
<td>RH99, RMH</td>
<td>RH99 (1)</td>
</tr>
<tr>
<td>RH10, RH21, RH99, RHUs and RUH</td>
<td>RH10, RH21, RH99, RHUs and RUH</td>
<td>RH10, RH21, RH99 (1)</td>
</tr>
</tbody>
</table>

- LV 50/60/400 Hz 1000 V |
- -35° C / +70° C |
- -35° C / +85° C |
- IP30 (connections IP20) |

<table>
<thead>
<tr>
<th>Dimensions ∅ (mm)</th>
<th>Weight (kg)</th>
<th>Dimensions ∅ (mm)</th>
<th>Weight (kg)</th>
<th>Inside dimensions (mm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.120</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>0.200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>80</td>
<td>0.420</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>120</td>
<td>0.590</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>200</td>
<td>1.320</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>300</td>
<td>2.230</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- - 46 | 1.300 | - |
- - 110 | 3.200 | - |
- - - | - | 280 x 115 | 13.26 |
- - - | - | 470 x 160 | 21.16 |

<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>18</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>10 (2)</td>
<td>-</td>
</tr>
<tr>
<td>80</td>
<td>10 (2)</td>
<td>-</td>
</tr>
</tbody>
</table>

- TA30, PA50 |
- TA30, PA50, IA80, MA120 |
- TA30, PA50, IA80, MA120, SA200 |
- IA80, MA120, SA200, GA300 |

- 28 cycles +25° C / +55° C / RH 95 % |
- 48 hours, Environment category C2 |
- KB test, severity 2 |

<table>
<thead>
<tr>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.42</td>
<td>3.19</td>
</tr>
</tbody>
</table>
Functions and characteristics

Tripping curves and frequency filtering
RH10, RH21 and RH99

Instantaneous relay

![Graph showing tripping curves for instantaneous relay]

1. Non-operating time.
2. Operating time.
3. Total break time.

Delayed relay

![Graph showing tripping curves for delayed relay]

Frequency filtering

![Graph showing frequency filtering]

Example
At 50 Hz, the tripping threshold is IΔn.
At 900 Hz, the tripping threshold is k x IΔn (where k = 5).
Functions and characteristics

Tripping curves and frequency filtering (cont.)
RHUs and RHU

**Instantaneous relay**

- 1: Non-operating time.
- 2: Operating time.
- 3: Total break time.

**Delayed relay**

**Frequency filtering**

- k x I's

- I's 30 mA
- I's 30 A

---

Schneider Electric

Merlin Gerin

Square 3

4 décembre 2002

433E2500.0m/43
Vigirex

Installation and connection

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Installation and connection

Relays and associated toroids

Residual-current protection relay

Multi 9 format (DIN rail mount)

RH10M.  RH21M.  RH99M.

Multi 9 format (with mounting accessories (1))

RH10M.  RH21M.  RH99M.

(1) Supplied as standard, to be clipped into relay for installation on a mounting plate.

Front-panel mount format

RH10P.  RH21P.  RH99P.

RHUs and RHU.
## Monitoring relays

### Multi 9 format

<table>
<thead>
<tr>
<th>Mounting accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH99M.</td>
</tr>
<tr>
<td>RM12T.</td>
</tr>
<tr>
<td>RH99M.</td>
</tr>
</tbody>
</table>

### Front-panel mount format

The Vigirex RMH always requires an RM12T multiplexer.

### Toroids

#### Closed from 30 to 300 mm

- A toroid.
- GA300 toroid.
- OA toroid.

#### Split (for retrofitting)

- RH99P.
- RMH.

### Rectangular sensors

- 280 x 115 mm.
- 470 x 160 mm.

### 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>RH10, RH21 and RH99</td>
</tr>
<tr>
<td>Split toroid</td>
<td>RHUs, RHU and RMH</td>
</tr>
<tr>
<td>Rectangular sensor</td>
<td>EI80, ME120 and SE200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>A type closed toroid</td>
<td>RH10, RH21 and RH99</td>
</tr>
<tr>
<td>OA type split toroid</td>
<td>no restrictions</td>
</tr>
<tr>
<td>E type closed toroid TE30 and PE50</td>
<td>no restrictions</td>
</tr>
<tr>
<td>IE80, ME120 and SE200</td>
<td>no restrictions</td>
</tr>
<tr>
<td>Rectangular sensors</td>
<td>I_{n} &gt; 0.3 A</td>
</tr>
</tbody>
</table>

*(1) See restrictions in table below.

E toroids have not been included in the new range but are compatible with Vigirex relays subject to the following restrictions.

### Sensor restrictions table

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>A type closed toroid</td>
<td>RH10, RH21 and RH99</td>
</tr>
<tr>
<td>OA type split toroid</td>
<td>no restrictions</td>
</tr>
<tr>
<td>E type closed toroid TE30 and PE50</td>
<td>no restrictions</td>
</tr>
<tr>
<td>IE80, ME120 and SE200</td>
<td>no restrictions</td>
</tr>
<tr>
<td>Rectangular sensors</td>
<td>I_{n} &gt; 0.5 A</td>
</tr>
</tbody>
</table>

*(1) See restrictions in table below.*
### Installation and connection

#### Possible installation positions

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

<table>
<thead>
<tr>
<th>Possible installation positions</th>
<th>Multi 9 format</th>
<th>RH10, RH21 and RH99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front-panel mount format</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

#### Relay mounting possibilities

**Mounting of Multi 9 format relays RH10M-21M-99M**

The relay can be mounted in three ways:
- on a DIN rail
- on a mounting plate using 3 M4 screws (not supplied) and 3 removable mounting accessories (supplied)
- on a slotted mounting plate with M4 clip-on nuts (part no. 05114: 20 nuts).

**Mounting of front-panel mount relays RH10P-21P-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 RM12T multiplexer**

The multiplexer must always be mounted on a DIN rail.
Installation and connection

Possible installation positions (cont.)
A and OA type toroids and rectangular sensors

**Toroid mounting possibilities**

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

- **On a plate (TA30, PA50, IA80, MA120, SA200, GOA and POA) or bracket**
  - Screws not supplied
  - Screw Ø4 | Screw Ø5
    | TA30 | IA80 |
    | PA50 | MA120 |
    | SA200 | POA - GOA |

- **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 and connection

Dimensions
RH10M, RH21M and RH99M relays

Mounting on a DIN rail

Mounting on a mounting plate

Door cutout

(1) For IP4 requirements.
### Installation and connection

#### Dimensions (cont.)

**RH10P, RH21P, RH99P, RHUs, RHU, RMH and RM12T relays**

**Front-panel mount relays (cutout complying with standard DIN 43700)**

**RH10P, RH21P and RH99P**

- Door cutout

**RHUs, RHU and RMH**

- Door cutout

**DIN rail mounting only**

**RM12T**

- Door cutout

(1) For IP4 requirements.
Installation and connection

Dimensions (cont.)
A-type closed toroids

**TA30 and PA50 toroids**

- TA30: ØA 30, B 31, C 60, D 53, E 82, F 59, G 13, H 97, J 50
- PA50: ØA 50, B 45, C 88, D 66, E 108, F 86, G 20, H 14, J 98, K 60

**IA80, MA120 and SA200 toroids**

- IA80: ØA 80, B 122, C 44, D 150, E 80, F 55, G 126, H 65, J 35
- MA120: ØA 120, B 164, C 44, D 190, E 80, F 55, G 166, H 65, J 35
- SA200: ØA 196, B 256, C 46, D 274, E 120, F 90, G 254, H 104, J 37

**GA300 toroid**

- GA300: ØA 299, B 29, C 344
Dimensions (cont.)

OA split toroids and rectangular sensors

### POA and GOA toroids

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions (mm)</th>
<th>Tightening torque (mdaN/lb-in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ØA</td>
<td>ØB</td>
</tr>
<tr>
<td>POA</td>
<td>46</td>
<td>148</td>
</tr>
<tr>
<td>GOA</td>
<td>110</td>
<td>224</td>
</tr>
</tbody>
</table>

### Rectangular sensors

- **Frame 280 x 115 mm**
- **Frame 470 x 160 mm**
## Installation and connection

### Relays and sensors

<table>
<thead>
<tr>
<th>Product, terminal or screw</th>
<th>Cable type</th>
<th>Terminal capacity (mm²)</th>
<th>Conduct. size AWG</th>
<th>Stripping size</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rigid</td>
<td>Flexible</td>
<td>Flexible with ferrule</td>
<td>(mm)</td>
<td>(inch)</td>
</tr>
<tr>
<td></td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
<td>max.</td>
<td>min.</td>
</tr>
<tr>
<td>RH10M, RH21M and RH99M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11, 14</td>
<td>0.2</td>
<td>4</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>31, 32, 34</td>
<td>0.2</td>
<td>4</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>A1, A2</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>T1, T2</td>
<td>twisted pair</td>
<td>0.14</td>
<td>1.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>25, 26, 27</td>
<td>3 twisted wires L&lt;10 m</td>
<td>0.14</td>
<td>1.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>RH10P, RH21P and RH99P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11, 14</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>31, 32, 34</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>A1, A2</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>T1, T2</td>
<td>twisted pair</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>25, 26, 27</td>
<td>3 twisted wires L&lt;10 m</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>RHUs and RHU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1, A2</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>11, 14</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>31, 32, 34</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>41, 44</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>T1, T2</td>
<td>twisted pair</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>25, 26, 27</td>
<td>3 twisted wires L&lt;10 m</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Bus (1) 24 V, 0 V</td>
<td>twisted pair</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>RMH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1, A2</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>11, 14</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>31, 32, 34</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>41, 44</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>21, 22</td>
<td>twisted pair L&lt;10 m</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>23, 24</td>
<td>twisted pair L&lt;10 m</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Bus (1) 24 V, 0 V</td>
<td>twisted pair</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>RM12T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 toroid connections 1 to 12 and 15 to 20</td>
<td>1 twisted pair/toroid L&lt;10 m</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>0.25</td>
</tr>
<tr>
<td>Toroids and rectangular sensors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ø30 mm to 200 mm connectors supplied with TA30 and PA50</td>
<td>twisted Cu/Al</td>
<td>0.2</td>
<td>2.5</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>GA300 2 Faston connectors 6.35 x 0.8 mm supplied with the product</td>
<td>twisted Cu/Al</td>
<td>-</td>
<td>1.5</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>POA - GOA Ø 5 mm round lugs not supplied:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1, S2</td>
<td>twisted Cu/Al</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shunt</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tightening of 2 half-toroids</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mounting on a mounting plate</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Rectangular sensors M2, M3 twisted pair L<10 m:
- 0.5 2.5 0.5 2.5 0.5 2.5 20-14 8 to 9 .33 - -

(1) RHU only.
Connection of relays

Multi 9 format

Front-panel mount format

Connection of toroids

TA30 and PA50 closed toroids (connectors supplied)

IA80, MA120 and SA200 closed toroids

(1) See table page 433E3100.fm/54.

(1) See table page 433E3100.fm/54.
Installation and connection

Connection
Toroids and rectangular sensors

Connection of toroids (cont.)

GA300 closed toroid (2 Faston connectors 6.35 x 0.8 mm supplied) POA and GOA split toroids (Ø 5 mm round lugs not supplied)

Connection of rectangular sensors and conductor layout

Frame 280 x 115 mm
Busbars with 70 mm spacing

Frame 470 x 160 mm
Busbars with 115 mm spacing

Nota :
connect M2 and M3 with Vigirex.

(1) See table page 433E3100.fm/54.
(2) Depending on the lug.

4 cables 240 mm² (1600 A)
Installation and connection

Selection and installation instructions for toroids and rectangular sensors

**Cable layout**

- Centre the cables within the toroid.
- Toroid Ø ≥ 2 x total cable Ø.
- Do not bend cables near the toroids.
- Do not bend cables near the sensors.
- Do not bend bars near the sensors.

**Selection of toroids according to circuit power**

<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>25 mm²</td>
<td>TA30</td>
</tr>
<tr>
<td>85 A</td>
<td>50 mm²</td>
<td>PA50 or POA</td>
</tr>
<tr>
<td>160 A</td>
<td>95 mm²</td>
<td>IA80</td>
</tr>
<tr>
<td>250 A</td>
<td>240 mm²</td>
<td>MA120 or GOA</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></td>
</tr>
</tbody>
</table>

**Selection of rectangular sensors according to circuit power**

<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 100 x 5 mm²</td>
<td>280 x 115 mm</td>
</tr>
<tr>
<td>4000 A</td>
<td>2 bars 125 x 10 mm²</td>
<td>470 x 160 mm</td>
</tr>
</tbody>
</table>

**Nota:**
- Y ≥ 25 cm for 280 x 115 mm sensor.
- Y ≥ 30 cm for 470 x 160 mm sensor.
Selection and installation instructions for toroids and rectangular sensors (cont.)

Special precautions
The current can be increased by adding a magnetic sleeve to guide the leakage flux

<table>
<thead>
<tr>
<th>Magnetic sleeve (soft steel e &gt; 1 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L &gt; toroid Ø</td>
</tr>
<tr>
<td>L = 80 mm</td>
</tr>
<tr>
<td>TA30</td>
</tr>
<tr>
<td>PA50</td>
</tr>
<tr>
<td>IA80</td>
</tr>
</tbody>
</table>

Selection of toroids according to circuit power
3P + N copper cables

<table>
<thead>
<tr>
<th>Rated operational current (Ie) with shielding around cables</th>
<th>Max. cross-section/phase</th>
<th>Toroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 A</td>
<td>25 mm²</td>
<td>TA30</td>
</tr>
<tr>
<td>150 A</td>
<td>50 mm²</td>
<td>PA50 or POA</td>
</tr>
<tr>
<td>225 A</td>
<td>95 mm²</td>
<td>IA80</td>
</tr>
<tr>
<td>400 A</td>
<td>240 mm²</td>
<td>MA120 or GOA</td>
</tr>
<tr>
<td>630 A</td>
<td>2 x 185 mm²</td>
<td>SA200</td>
</tr>
<tr>
<td>800 A</td>
<td>2 x 240 mm²</td>
<td>GA300</td>
</tr>
</tbody>
</table>

Connection between Vigrex relays and sensors
Vigrex relays must be connected to the sensors as indicated:

<table>
<thead>
<tr>
<th>Cross-section (Cu)</th>
<th>Maximum length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toroids</td>
<td></td>
</tr>
<tr>
<td>0.22 mm² (1)</td>
<td>18 m</td>
</tr>
<tr>
<td>0.75 mm² (1)</td>
<td>60 m</td>
</tr>
<tr>
<td>1.0 mm² (1)</td>
<td>80 m</td>
</tr>
<tr>
<td>1.5 mm² (1)</td>
<td>100 m</td>
</tr>
<tr>
<td>Rectangular sensors</td>
<td></td>
</tr>
<tr>
<td>0.5 mm² min. / 2.5 mm² max.</td>
<td>10 m</td>
</tr>
</tbody>
</table>

(1) Wire size for resistance R maximum = 3 Ω.

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.
Wiring diagrams
RH10, RH21 and RH99
Wiring for optimum continuity of service

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

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

- **L**: lamp
- **MX**: shunt release
- **Q**: circuit breaker protecting the main circuit
- **Q**: 1 A circuit breaker, curve C or D
- **RH10M, RH21M and RH99M**:
  - **A1-A2**: auxiliary power supply
  - **T1-T2**: A or OA type toroid or rectangular sensor (if \( I_{\Delta N} > 500 \text{ mA} \))
  - **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 and RH99P wiring with MX shunt release**

- **L**: lamp
- **MX**: shunt release
- **Q**: circuit breaker protecting the main circuit
- **Q**: 1 A circuit breaker, curve C or D
- **RH10P, RH21P and RH99P**:
  - **A1-A2**: auxiliary power supply
  - **T1-T2**: A or OA type toroid or rectangular sensor (if \( I_{\Delta N} > 500 \text{ mA} \))
  - **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.
Installation and connection

Wiring diagrams
RH10, RH21 and RH99 (cont.)
Wiring for optimum safety

RH10M, RH21M and RH99M wiring with MN undervoltage release

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
Q₃: 1 A circuit breaker, curve C or D

RH10M, RH21M and RH99M:
- A₁-A₂: auxiliary power supply
- T₁-T₂: A or OA type toroid or rectangular sensor (if I∆n > 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 and RH99P wiring with MN undervoltage release

MN: undervoltage release
Q₁: circuit breaker protecting the main circuit
Q₂: DPN circuit breaker
Q₃: 1 A circuit breaker, curve C or D

RH10MP, RH21P and RH99P:
- A₁-A₂: auxiliary power supply
- T₁-T₂: A or OA type toroid or rectangular sensor (if I∆n > 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.
All diagrams are shown with circuits de-energised, all devices open and relays in released position.

**ATm3:** auto-reclosing controller  
**H:** red light  
**MT:** motor mechanism module  
**MX:** shunt release  
**Q1:** circuit breaker protecting the main circuit  
**Q2:** 1 A circuit breaker, curve C or D  
**Q3** to **Q5:** DPN circuit breakers

**RH99M monitor:**
- **A1-A2:** auxiliary power supply  
- **T1-T2:** A or OA type toroid or rectangular sensor (if I∆n > 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.

**RH99P monitor wiring with ATm auto-reclosing controller**

**ATm3:** auto-reclosing controller  
**H:** red light  
**MT:** motor mechanism module  
**MX:** shunt release  
**Q1:** circuit breaker protecting the main circuit  
**Q2:** 1 A circuit breaker, curve C or D  
**Q3** to **Q5:** DPN circuit breakers

**RH99P monitor:**
- **A1-A2:** auxiliary power supply  
- **T1-T2:** A or OA type toroid or rectangular sensor (if I∆n > 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 ATm 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.
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: 1 A DPN circuit breaker, curve C or D

RHUs and RHU:
- A₁-A₂: auxiliary power supply
- T₁-T₂: O or OA type toroids
- 11-14: "voltage-presence" contact
- 26-25: relay test
- 27-25: relay reset
- 31-32-34: "fault" contact
- 41-44: "alarm contact"
- 24 V, 0 V, +, –: internal communication bus.

(1) RHU only.

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
Q₃: 1 A DPN circuit breaker, curve C or D

RHUs and RHU:
- A₁-A₂: auxiliary power supply
- T₁-T₂: O or OA type toroids
- 11-14: "voltage-presence" contact
- 26-25: relay test
- 27-25: relay reset
- 31-32-34: "fault" contact
- 41-44: "alarm contact"
- 24 V, 0 V, +, –: internal communication bus.

(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
- **T1 to T12**: earth leakage current measurement toroids for circuits 1 to 12
- **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
  - 41-44: "pre-alarm" contact
  - 24 V, 0 V, +, -: internal communication bus
  - T: transformer with 220/240 V secondary (if required), rating > 4 VA

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

Wiring diagrams (cont.)
Communication bus, test and remote reset functions, power supply

Connection between Vigirex RHU or RMH and the communication bus

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

Internal bus
Coloured cable, Digipact type or twisted pair (0.75 to 2.5 mm²) not to be run alongside power cables.

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 and RH99 power supply

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

T : Class 2 isolation transformer mandatory for $V_{AC} < 24$ V AC
## Technical aspects

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Technical aspects

Definitions and glossary

**Earth**: the conducting mass of the Earth, whose electric potential at any point is conventionally taken as zero.

**Earth electrode**: conductive part that can be incorporated in a particular conductive environment, for example concrete or coke in electrical contact with earth.

**Earth-fault current**: current flowing to earth due to an insulation fault.

**Earthing resistance** or in fact the "overall earthing resistance": resistance between the main earthing terminal (terminal or bar to which the PE protective conductors are connected) and earth.

**Earth-leakage current**: current flowing from the live parts to earth or extraneous conductive parts in the absence of an insulation fault.

**Equipotential bonding**: electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential.

**Exposed conductive part**: a conductive part which can readily be touched and which is not normally live, but which may become live under fault conditions.

**Intentional leakage current**: current flowing to earth or extraneous conductive parts via intentionally installed components (resistors or capacitors), in the absence of an insulation fault.

**Isolated system**: system with an autonomous supply of power, not connected to utility power.

**Natural leakage current**: current flowing to earth or extraneous conductive parts via the insulation, in the absence of an insulation fault.

**Protective conductor PE**: 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.

**Residual current**: 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.

**Zero volt** (reference): measurement reference point for differences in potential (voltage measurements, often in monitoring circuits).
### Technical aspects

#### Definitions and glossary (cont.)

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<th>Acronym/ French</th>
<th>Acronym/ English</th>
<th>Definition</th>
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<tr>
<td>DDR</td>
<td>RCD</td>
<td>Residual-current device. A mechanical device or set of devices intended to open contacts when the residual current reaches a set value under the specified conditions.</td>
</tr>
<tr>
<td>DPCC</td>
<td>SCPD</td>
<td>Short-circuit protective device.</td>
</tr>
<tr>
<td>dV/dt</td>
<td></td>
<td>Variation in the voltage as a function of time (term generally reserved for fast variations, on the order of 1000 V/ms).</td>
</tr>
<tr>
<td>IGBT</td>
<td>IGBT</td>
<td>Insulated gate bipolar transistor.</td>
</tr>
<tr>
<td>IT</td>
<td>IT</td>
<td>In the IT system, all the live parts are either isolated from earth or connected to earth at one point via an impedance. The exposed conductive parts of the electrical installation are earthed.</td>
</tr>
<tr>
<td>Filtre RFI</td>
<td>RFI filter</td>
<td>An RFI filter limits radio-frequency disturbances. RFI: Radio-frequency interference.</td>
</tr>
<tr>
<td>SLT</td>
<td>System earthing arrangement</td>
<td>System earthing arrangement (sometimes referred to as the earthing system).</td>
</tr>
<tr>
<td>TN</td>
<td>TN</td>
<td>In the TN system, a point in the supply system is directly connected to earth. The exposed conductive parts of the electrical installation are connected to this point via protective conductors.</td>
</tr>
<tr>
<td>TN-C</td>
<td>TN-C</td>
<td>The TN-C system is a TN system in which the neutral and protection functions are combined in a single conductor (PEN) throughout the installation.</td>
</tr>
<tr>
<td>TN-C-S</td>
<td>TN-C-S</td>
<td>The TN-C-S system is a TN system in which the neutral and protection functions are combined in a single conductor (PEN) in a part of the installation (upstream of the TN-S system).</td>
</tr>
<tr>
<td>TN-S</td>
<td>TN-S</td>
<td>The TN-S system is a TN system in which a protective conductor separate from the neutral is used throughout the installation.</td>
</tr>
<tr>
<td>TT</td>
<td>TT</td>
<td>In the TT system, a point in the supply system is directly connected to earth. The exposed conductive parts of the electrical installation are connected to earth electrodes that are electrically separate from that for the supply system.</td>
</tr>
<tr>
<td>CEM / EM</td>
<td>EMC / EM</td>
<td>Electromagnetic compatibility (EMC) is the aptitude of a device or system to operate in its electromagnetic (EM) environment satisfactorily and without itself producing unacceptable electromagnetic disturbances for its environment.</td>
</tr>
<tr>
<td>GFP</td>
<td>GFP</td>
<td>Ground fault protection System used to measure zero-sequence currents that flow if a fault occurs in the TN-S system (used in the United States).</td>
</tr>
<tr>
<td>NEC</td>
<td>NEC</td>
<td>National electrical code Installation standard published by an association in the United States.</td>
</tr>
<tr>
<td>THDI</td>
<td>THDI</td>
<td>Total harmonic distortion of current.</td>
</tr>
<tr>
<td>Valeur efficace</td>
<td>RMS</td>
<td>Root mean square value.</td>
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</tbody>
</table>
Technical aspects

Protection using Vigirex RCDs
Protection of persons

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.

![Diagram showing time/current zones](image)

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.
  - b - 10 mA let-go threshold: current threshold at the asymptote of the “let-go curve” for an infinite time.
  - c₁ - 30 mA ventricular-fibrillation threshold: up to this threshold, there is no risk of ventricular fibrillation (i.e. no risk of cardiac arrest) for an infinite time.

- **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 c₂ and c₃
    - Greater than 50 % beyond curve c₃.
**Technical aspects**

**Protection using Vigirex RCDs**  
Protection of persons (cont.)

---

**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>$50$ V &lt; $U_0 \leq 120$ V</td>
<td>0.8 s</td>
<td>3 s</td>
</tr>
<tr>
<td>$120$ V &lt; $U_0 \leq 230$ V</td>
<td>0.4 s</td>
<td>3 s</td>
</tr>
<tr>
<td>$230$ V &lt; $U_0 \leq 400$ 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.
**Technical aspects**

**Protection using Vigirex RCDs**

**Protection of persons (cont.)**

---

**Type of contact**

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.

**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.

- **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.

---

**Direct contact.**

**Comparison between 10 mA and 30 mA.**

**Indirect contact.**
Technical aspects

Protection using Vigirex RCDs
(cont.)

System earthing arrangements

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.

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 \( I_{\Delta n} < \frac{U_L}{R} \), where:
- \( U_L \) 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>&lt; 30 mA</td>
<td>&gt; 500</td>
</tr>
</tbody>
</table>

Note: if the earthing resistance is > 500 \( \Omega \), 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 ((s))</td>
</tr>
<tr>
<td>50 V &lt; ( U_L ) &lt; 120 V</td>
<td>0.3 s</td>
</tr>
<tr>
<td>120 V &lt; ( U_L ) &lt; 230 V</td>
<td>0.2 s</td>
</tr>
<tr>
<td>230 V &lt; ( U_L ) &lt; 400 V</td>
<td>0.07 s</td>
</tr>
<tr>
<td>( U_L ) &gt; 400 V</td>
<td>0.04 s</td>
</tr>
</tbody>
</table>

To ensure discrimination between the RCD protection devices, an operating time not exceeding 5 second is permitted for distribution circuits.
Protection using Vigirex RCDs
System earthing arrangements (cont.)

TN system
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 (V)</th>
<th>TN</th>
<th>AC current</th>
<th>DC current</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 V &lt; U ≤ 120 V</td>
<td>0.8 s</td>
<td>5 s</td>
<td></td>
</tr>
<tr>
<td>120 V &lt; U ≤ 230 V</td>
<td>0.4 s</td>
<td>5 s</td>
<td></td>
</tr>
<tr>
<td>230 V &lt; U ≤ 400 V</td>
<td>0.2 s</td>
<td>0.4 s</td>
<td></td>
</tr>
<tr>
<td>U &gt; 400 V</td>
<td>0.1 s</td>
<td>0.1 s</td>
<td></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 $I_{\Delta n} = 0.8 \frac{U_0}{R_{ph} + R_{PE}}$
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 433E4100.fm/75), 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 $I_{\Delta n} \leq 3 I_{N}$

■ RCD time delays
The RCDs must operate within the times stipulated in the table above.
Technical aspects

Protection using Vigirex RCDs
System earthing arrangements (cont.)

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 179).
Technical aspects

Protection using Vigirex RCDs
(cont.)
Protection of property: fire hazards

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.

Origin of fires in buildings.

Fire 37 %
Lightning 1 %
Explosion 1 %
Cigarette 6 %
Electricity 41 %
Accident 7 %
Other 7 %

Start of fire
Damp dust
id << 300 mA

Small discharge
Metal part
Damp dust
id << 300 mA

Insulation
Conductor
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.
Technical aspects

Protection using Vigirex RCDs
(cont.)
Disturbances in distribution systems

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 (not shielded)</td>
<td>20 pF/m</td>
<td>150 pF/m</td>
</tr>
<tr>
<td>Shielded cable</td>
<td>30 pF/m</td>
<td>200 pF/m</td>
</tr>
<tr>
<td>Frequency converter</td>
<td>x 100 µF (with rectifier)</td>
<td>10 to 100 nF</td>
</tr>
<tr>
<td>PC, printer, cash register</td>
<td>x 10 µF (with rectifier)</td>
<td>10 nF</td>
</tr>
<tr>
<td>Fluorescent lighting</td>
<td>1 µF /10 W (compensation capacitor)</td>
<td>1 nF (electronic ballast)</td>
</tr>
</tbody>
</table>
Technical aspects

Protection using Vigirex RCDs
Disturbances in distribution systems (cont.)

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
  - Residual current following operation of a switch.

  ![Residual current following operation of a switch.](image)

  Example of a common-mode disturbance.

  ![Load](image)

  Overvoltage

  Harmonic spectrum of the current.

  ![Harmonic spectrum of the current.](image)

  Overvoltages / approximate values

<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>≤ 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>

(1) Depending on the position in the installation.

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 (to be modified).

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

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

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 $\Delta n$ 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 $\Delta n$ value must:
- **not operate** for all fault currents $\leq \Delta n/2$
- **operate** for all fault currents $> \Delta n$.

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

Standard IEC 60947-2 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.
Technical aspects

Vigirex devices (cont.)

Residual-current measurements

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 433E3100.fm/57.

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.
Technical aspects

Vigirex devices
Residual-current measurements (suite)

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 requests that the various short-circuit currents that the RCD must support be declared to ensure correct operation without damage to the interconnected devices.

- \( I_{sc} \): rated short-circuit current
- \( I_{cw} \): rated short-time withstand current
- \( I_{\Delta w} \): 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 \( I_n \) (where \( I_n \) 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 (&lt; 630 \text{ A} )</th>
<th>Vigirex with SA 200 and GA 300 toroids combined with a Compact NS630b to 3200 ( \text{A} ) or a Masterpact NT or NW circuit breaker up to 6300 ( \text{A} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{cw} )</td>
<td>100 kA/0.5 s</td>
</tr>
<tr>
<td>( I_{sc} )</td>
<td>150 kA</td>
</tr>
<tr>
<td>( I_{\Delta w} )</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

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>Head of the LV installation</td>
<td>On the distribution circuits</td>
</tr>
<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>
<tr>
<td>Category</td>
<td>IV</td>
</tr>
</tbody>
</table>

Vigirex implementation
The characteristics listed below are specified.

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Supply (for ( U_s &gt; 48 \text{ 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>IV</td>
<td>IV</td>
</tr>
<tr>
<td>( U_{imp} )</td>
<td>12 kV</td>
<td>8 kV</td>
</tr>
</tbody>
</table>
Technical aspects

Vigirex devices
Residual-current measurements (cont.)

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 IΔn / 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 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.

<table>
<thead>
<tr>
<th>If = IΔn</th>
<th>1.5Δn</th>
<th>2Δn</th>
<th>5Δn</th>
<th>10Δn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Tps</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 Tps: total time required to break the current (including the time for the associated protection device to open)
- If: leakage current
- IΔn: residual operating current setting

For devices set to 30 mA, 5 IΔn can be replaced by 0.25 A, in which case 10 IΔn 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 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 IΔn**

This function equipping Vigirex relays significantly increases (from 0.5 IΔn to 0.8 IΔn) 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></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>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- battery chargers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation devices</td>
<td>- light dimmer</td>
<td>AC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- heating regulator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC/AC converter with single-phase</td>
<td>- variable-speed drives</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC/AC converter with three-phase</td>
<td>- variable-speed drives</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>supply</td>
<td>- welding machines</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Protection

<table>
<thead>
<tr>
<th>Supply and installation characteristics</th>
<th>Against indirect contact</th>
<th>Against direct contact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Three-phase</td>
<td>Single-phase</td>
</tr>
<tr>
<td>Equipment and installation characteristics</td>
<td>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 (≥ 300 mA)</td>
<td>A type, low sensitivity (≥ 300 mA)</td>
</tr>
<tr>
<td>SLT: TN-S</td>
<td>A type, low sensitivity (≥ 300 mA)</td>
<td></td>
</tr>
<tr>
<td>SLT: IT</td>
<td>A type, low sensitivity (30 mA)</td>
<td></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 determines the required level for RCDs with separate torroids. 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>Code</th>
<th>Standardised tests as per IEC 60947-2</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>IEC 61000-4-2</td>
<td>8 kV contact</td>
<td>8 kV contact</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>IEC 61000-4-3</td>
<td>8 kV contact</td>
<td>15 kV in air</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>IEC 61000-4-4</td>
<td>8 kV contact</td>
<td>15 kV in air</td>
</tr>
<tr>
<td>Atmospheric overvoltages, switching of MV devices may cause malfunctions and destruction.</td>
<td>Surge immunity test</td>
<td>IEC 61000-4-5</td>
<td>8 kV contact</td>
<td>15 kV in air</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>IEC 61000-4-6</td>
<td>8 kV contact</td>
<td>15 kV in air</td>
</tr>
<tr>
<td>Faults on the distribution system may cause malfunctions.</td>
<td>Voltage-dip immunity test</td>
<td>IEC 61000-4-11</td>
<td>8 kV contact</td>
<td>15 kV in air</td>
</tr>
</tbody>
</table>

Note: (1) V AC < 48 V, the Vigirex does not have a supply transformer.
Technical aspects

Vigirex devices
Residual-current measurements (cont.)

Voltage-dip withstand capacity
Standard IEC 60947-2 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 433E2400.fm/32 to 39). 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 discrimination

Discrimination 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 discrimination 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>I_{\Delta n}</th>
<th>0.5 s</th>
<th>0.2 s</th>
<th>0.15 s</th>
<th>0.15 s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time T_{ps}</td>
<td>2 I_{\Delta n}</td>
<td>5 I_{\Delta n}</td>
<td>10 I_{\Delta n}</td>
<td></td>
</tr>
</tbody>
</table>

**Key:**
- Time T_{ps}: 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 discrimination.
  - 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.

- **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 1 (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 discrimination**

Discrimination 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 discrimination 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} ≥ 2 x downstream I_{\Delta n}
- upstream non-operating time \( \Delta T \) ≥ 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 discrimination 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 discrimination (see the curves on pages 433E2500.fm/42 and 43).

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

**Vigirex discrimination 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>Schneider RCD device</td>
<td>Vigirex</td>
</tr>
<tr>
<td>Ratio $I_{An}$</td>
<td>Time delay</td>
</tr>
<tr>
<td>1.5</td>
<td>1 setting apart, except (^{(1)})</td>
</tr>
<tr>
<td>2</td>
<td>1 setting apart, except (^{(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).

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

**Example:** A Vigirex RHU relay set to $I_{An} = 100$ mA / $\Delta T = 1$ s combined with a Compact NS630 ensures total discrimination with a Vigirex RH99 set to $I_{An} = 30$ mA / $\Delta T = 0.8$ s combined with a Compact NS250.

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

<table>
<thead>
<tr>
<th>RCD tripping/immunity depending on the load and the system earthing arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System earthing arrangement</strong></td>
</tr>
<tr>
<td>I fault</td>
</tr>
<tr>
<td>Typical value</td>
</tr>
<tr>
<td>Protection of persons</td>
</tr>
<tr>
<td>Additional protection of persons</td>
</tr>
<tr>
<td>Threshold</td>
</tr>
<tr>
<td>Time delay</td>
</tr>
<tr>
<td>Protection against fire hazards</td>
</tr>
<tr>
<td>Threshold</td>
</tr>
<tr>
<td>Time delay</td>
</tr>
</tbody>
</table>
**Technical aspects**

**Vigirex devices**

Implementation (cont.)

---

**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 ($R_{max}$).

The mandatory rule is $I_{\Delta n} \leq \frac{U_L}{R_{max}}$.

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 discrimination 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.

RCD threshold settings, the maximum authorised value is 50 V/1.5 Ω i.e. 33.3 A.

**Note:** even though the $R_T$ value at the MLVS is 1 Ω, the RCD must also ensure protection for a downstream fault (e.g. on the incoming of a secondary switchboard).

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

Vigirex devices (cont.)

Applications

Requirements of standards

Protection against indirect contact

An RCD must be installed at the head of the installation (see page 433E4100.fm/90).

The authorised settings are:

- **Operating current threshold**
  the maximum setting is $I_{\Delta n} = 50 \text{ V}/10 \text{ \Omega} = 5 \text{ A}$

  *Note:* even though the earthing resistance of the main LV switchboard is $1 \text{ \Omega}$, the RCD at the head of the installation must protect against faults occurring downstream whatever their position and the greatest earth resistance must therefore be considered, i.e. $10 \text{ \Omega}$.

- **Non-operating time (time delay)**
  the non-operating time must not exceed $\Delta t = 1 \text{ s}$ in order to ensure discrimination (see page 433E4100.fm/88).

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 433E4100.fm/76) and for computer hardware (see page 433E4100.fm/103).

The minimum setting for an RCD is:

- $I_{\Delta n} > 2 I_{L}$ (where $I_{L}$ is the total leakage current downstream of the RCD)
- on the circuits supply 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 433E4100.fm/103. the estimated leakage current for a PC is 3.5 mA, giving $4 \times 3.5 \text{ mA} = 14 \text{ mA} < 15 \text{ mA}$)
- 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 NS250 in Workshop B, there are 20 frequency converters equipped with 100 nF filters (see page 433E4100.fm/76), 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 $2 \times I_{L}$, i.e. 1 A.

Taking discrimination into account (see page 433E4100.fm/88)

- **Current-based discrimination**
  The following two conditions must be satisfied:
  - $I_{\Delta n}$ of upstream RCD > $2 I_{\Delta n}$ of downstream RCD (discrimination requirement)
  - $I_{\Delta n}$ of upstream RCD > $2 I_{L}$ (leakage current requirement)
  e.g. the Vigicompact NS250 is upstream of Multi 9 and Vigicompact C60 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 discrimination requirements

- **Time-based discrimination**
  The following condition must be satisfied:
  upstream non-operating time > downstream total operating time (relay + breaking device).
  Given that downstream protection is provided by Multi 9 and Vigicompact devices, it is sufficient to set the upstream Vigicompact time delay one setting higher, i.e. setting I (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:
  - $I_{\Delta n} < 5 \text{ A}$ 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 Multi 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 discrimination requirements for RCDs. i.e. 6A, however this is not compatible with the protection of persons (5A) for this installation. By using a Vigirex RCD, this problem is avoided because special characteristics of Vigirex RCDs ensure discrimination down to $1.5 I_{\Delta n}$ downstream, i.e. 4.5 A.
Technical aspects

Vigirex devices
Applications (cont.)

Single-source diagram RCD at the head of an installation

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></th>
<th>Rectangular sensor</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard solution Tests in factory</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 new installations</td>
</tr>
<tr>
<td>2</td>
<td>on earthing conductor</td>
<td></td>
<td></td>
<td></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:
- discrimination 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 are never coupled.

- 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 discrimination in clearing the faulty source. This system downgrades the continuity of service.

The two sources may be coupled.
Technical aspects

Vigirex devices

Applications (cont.)

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 discrimination in clearing the faulty part of the installation.

The two sources are never coupled.

■ 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 discrimination in clearing the sources.

The two sources may be coupled.

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.

Coupling via the load and DC bus.

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 discrimination 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.

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 switching-in currents (up to 6 In).

**Selection of toroids and rectangular sensors depending on the power circuit**

See page 433E3100.fm/57.

Example 1. A motor feeder (150 kW/280 A at 400 V) must be monitored by a Vigirex device with a toroid having a minimum diameter of 200 (SA200).

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 switching-in current is, in fact, significantly higher than 6 In.

To avoid possible tripping, it may be necessary to:
- use the same toroid, but with a metal sleeve to canalise the flow (see the table page 433E3100.fm/58)
- use a toroid having a larger diameter
- set up a time delay complying with the safety rules (< 1 s) and discrimination requirements for the upstream RCDs.

These three 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.
Technical aspects

Vigirex devices (cont.)
Questions and answers

Combinations of RCDs

Is it possible to ensure discrimination between 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, discrimination between the RCDs is ensured, even when different types are employed, as long as the discrimination 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>AC or A or B</td>
<td>A or B</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>AC or A or B</td>
<td>A or B</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>B + isolating Tr or A + class II insulation</td>
</tr>
<tr>
<td>AC</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>B</td>
</tr>
</tbody>
</table>

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∆n1 = 30 A, I∆n2 = 30 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 this type of fault using class II insulation.

The two solutions may be implemented simultaneously.

Implementation examples.

Note: if an isolating transformer is used, discrimination 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.

  If $I_I$ is the value in question, the minimum setting $I_{\Delta n2}$ of the RCDs is $2I_I$.

  **Note:** with the specific factory setting and the operating tolerances under worst-case conditions (temperature, auxiliary-source voltage, etc.), Vigirex can be used with a guaranteed non-operating threshold of $0.8I_{\Delta n}$. The minimum setting for a Vigirex device can be as low as $I_I/0.8$, i.e. $1.25 \times I_I$.

  **Maximum leakage current ($mA$)**

  | Class II | All equipment | 0.25 |
  | Class I  | Portable      | 0.75 |
  | Class I  | A-type fixed or mobile | 3.5 |
  | Class I  | B-type fixed    | 3.5 or 5 % $I_I$ |

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

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

  $I_{\Delta n2} = I_{\Delta n1}$ 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).
**Technical aspects**

**Vigirex devices**

**Questions and answers (cont.)**

**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.

![Diagram of IT system with IMD, FLD, UPS, MLVS, and TNS segments](image)

Distribution system in a factory with a TNS segment for the management IT system.  
**IMD:** insulation-monitoring device.  
**FLD:** fault-locating device.
Leakage-current monitoring using RCDs

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.

<table>
<thead>
<tr>
<th>Equipment sensitive to EM disturbances</th>
<th>TN-C</th>
<th>TN-S</th>
<th>TT</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forbidden PE and neutral are the same</td>
<td>OK</td>
<td>Excellent</td>
<td>Excellent</td>
<td></td>
</tr>
<tr>
<td>But PE and neutral must not be in contact</td>
<td>Excellent</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>
<td></td>
</tr>
</tbody>
</table>

Insulation fault on the neutral conductor. The system is TN-C upstream of A.
Leakage-current monitoring using RCDs (cont.)

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.

![Diagram of TN-S system]

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 30 to over 50 % 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>
</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 / kW</td>
</tr>
</tbody>
</table>

**Computer equipment as per standard IEC 60950**

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

<table>
<thead>
<tr>
<th>Class I</th>
<th>B-type fixed (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable</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.
Technical aspects

Leakage-current monitoring using RCDs (cont.)

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>28573 or 28560</td>
</tr>
<tr>
<td>A-type toroids (1)</td>
<td>50437 to 50442</td>
</tr>
<tr>
<td>OA-type toroids (2)</td>
<td>50485 or 50486</td>
</tr>
</tbody>
</table>

(1) New. (2) Renovation.

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

Setting
Depending on the tolerance level of the supplied equipment with respect to leakage current, from 30 mA to 1 A, earth leakage may not be monitored on the lighting system.

Small distribution systems.
Technical aspects

Leakage-current monitoring using RCDs (cont.)

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>28563</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>OA-type toroids (2)</td>
<td>50485 or 50486</td>
</tr>
</tbody>
</table>

New. Renovation.

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

Setting

The thresholds may be high (5 %):

- a few amperes for the shielding earthing
- from 0.3 to 1 A for each device and the lighting.

\[ \text{RMH} \]

Computer room.

Main equipotential-bond link

\[ \text{Central unit} \]

Printer

Console

Disk unit

Room lighting

Air-conditioning

Computer room

Lighting

RM12T

RMH

Central unit

Console

Disk unit

Room lighting

Air-conditioning

Computer room

4 décembre 2002

Schneider Electric
Technical aspects

Leakage-current monitoring using RCDs (cont.)

PC network

Selection table

<table>
<thead>
<tr>
<th>Products</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMH</td>
<td>28563</td>
</tr>
<tr>
<td>RM12T</td>
<td>28566</td>
</tr>
<tr>
<td>A-type toroids (1)</td>
<td></td>
</tr>
<tr>
<td>OA-type toroids (2)</td>
<td>50437 or 50442</td>
</tr>
</tbody>
</table>

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

- 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.
Vigirex

Catalogue numbers

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>2</td>
</tr>
<tr>
<td>Functions and characteristics</td>
<td>11</td>
</tr>
<tr>
<td>Installation and connection</td>
<td>45</td>
</tr>
<tr>
<td>Technical aspects</td>
<td>65</td>
</tr>
<tr>
<td>Residual-current protection relays</td>
<td>108</td>
</tr>
<tr>
<td>Monitoring relays</td>
<td>110</td>
</tr>
<tr>
<td>Sensors</td>
<td>111</td>
</tr>
</tbody>
</table>
### RH10 with local manual fault reset

<table>
<thead>
<tr>
<th>System to be protected</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV &lt; 1000 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sensitivity 0.03 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56100</td>
<td>56200</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56110</td>
<td>56210</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56120</td>
<td>56220</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56130</td>
<td>56230</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56140</td>
<td>56240</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56150</td>
<td>56250</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.05 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56101</td>
<td>56201</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56111</td>
<td>56211</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56121</td>
<td>56221</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56131</td>
<td>56231</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56141</td>
<td>56241</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56151</td>
<td>56251</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.1 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56102</td>
<td>56202</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56112</td>
<td>56212</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56122</td>
<td>56222</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56132</td>
<td>56232</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56142</td>
<td>56242</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56152</td>
<td>56252</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.15 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56103</td>
<td>56203</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56113</td>
<td>56213</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56123</td>
<td>56223</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56133</td>
<td>56233</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56143</td>
<td>56243</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56153</td>
<td>56253</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.25 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56104</td>
<td>56204</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56114</td>
<td>56214</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56124</td>
<td>56224</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56134</td>
<td>56234</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56144</td>
<td>56244</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56154</td>
<td>56254</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.3 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56105</td>
<td>56205</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56115</td>
<td>56215</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56125</td>
<td>56225</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56135</td>
<td>56235</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56145</td>
<td>56245</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56155</td>
<td>56255</td>
</tr>
</tbody>
</table>

#### Sensitivity 0.5 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56106</td>
<td>56206</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56116</td>
<td>56216</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56126</td>
<td>56226</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56136</td>
<td>56236</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56146</td>
<td>56246</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56156</td>
<td>56256</td>
</tr>
</tbody>
</table>

#### Sensitivity 1 A - instantaneous

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH10M</th>
<th>RH10P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC</td>
<td>56107</td>
<td>56207</td>
</tr>
<tr>
<td>48 V AC</td>
<td>56117</td>
<td>56217</td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td>56127</td>
<td>56227</td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td>56137</td>
<td>56237</td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td>56147</td>
<td>56247</td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td>56157</td>
<td>56257</td>
</tr>
</tbody>
</table>
## RH21 with local manual fault reset

**System to be protected**  
LV \( \leq 1000 \text{ V} \)

**Sensitivity**  
- 0.03 A - instantaneous  
- 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  
  - 56160  
  - 56260

- 48 V AC  
  - 50/60 Hz  
  - 56161  
  - 56261

- 110 to 130 V AC  
  - 50/60 Hz  
  - 56162  
  - 56262

- 220 to 240 V AC  
  - 50/60/400 Hz  
  - 56163  
  - 56263

- 380 to 415 V AC  
  - 50/60 Hz  
  - 56164  
  - 56264

- 440 to 525 V AC  
  - 50/60 Hz  
  - 56165  
  - 56265

## RH99 with local manual fault reset

**System to be protected**  
LV \( \leq 1000 \text{ V} \)

**Sensitivity**  
- 0.03 A to 30 A - instantaneous or with 0 to 4.5 s time delay

**Power supply**  
- 12 to 24 V AC - 12 to 48 V DC  
  - 50/60 Hz  
  - 56170  
  - 56270

- 48 V AC  
  - 50/60 Hz  
  - 56171  
  - 56271

- 110 to 130 V AC  
  - 50/60 Hz  
  - 56172  
  - 56272

- 220 to 240 V AC  
  - 50/60/400 Hz  
  - 56173  
  - 56273

- 380 to 415 V AC  
  - 50/60 Hz  
  - 56174  
  - 56274

- 440 to 525 V AC  
  - 50/60 Hz  
  - 56175  
  - 56275

## RHUs with local manual fault reset

**System to be protected**  
LV \( \leq 1000 \text{ V} \)

**Alarm:** sensitivity 15 mA to 30 A - instantaneous or with 0 to 5 s time delay  
**Fault:** sensitivity 30 mA to 30 A - instantaneous or with 0 to 5 s time delay

**Power supply**  
- 48 V AC  
  - 50/60 Hz  
  - 28570  
  - 28576

- 110 to 130 V AC  
  - 50/60 Hz  
  - 28575  
  - 28574

- 220 to 240 V AC  
  - 50/60/400 Hz  
  - 28573  
  - 28569

- 380 to 415 V AC  
  - 50/60 Hz  
  - 28568  
  - 28566

**RHU with local manual fault reset (communicating)**

**System to be protected**  
LV \( \leq 1000 \text{ V} \)

**Alarm:** sensitivity 15 mA to 30 A - instantaneous or with 0 to 5 s time delay  
**Fault:** sensitivity 30 mA to 30 A - instantaneous or with 0 to 5 s time delay

**Power supply**  
- 48 V AC  
  - 50/60 Hz  
  - 28570  
  - 28576

- 110 to 130 V AC  
  - 50/60 Hz  
  - 28569  
  - 28566

- 220 to 240 V AC  
  - 50/60/400 Hz  
  - 28568  
  - 28566

- 380 to 415 V AC  
  - 50/60 Hz  
  - 28568  
  - 28566
### Catalogue numbers

#### Monitoring relays

**RH99 with automatic fault reset**

<table>
<thead>
<tr>
<th>System to be monitored</th>
<th>RH99M</th>
<th>RH99P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV ≤ 1000 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sensitivity 0.03 A - instantaneous**

**Sensitivity 0.1 A to 30 A - instantaneous or with 0 s to 4.5 s time delay**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>RH99M</th>
<th>RH99P</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 to 24 V AC - 12 to 48 V DC 50/60 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 V AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110 to 130 V AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220 to 240 V AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>380 to 415 V AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>440 to 525 V AC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### RMH and Multiplexer RM12T (communicating)

<table>
<thead>
<tr>
<th>System to be monitored</th>
<th>RM12T</th>
<th>RMH</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV ≤ 1000 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pre-Alarm: sensitivity 15 mA to 30 A - instantaneous or with 0 to 5 s time delay**

**Alarm: sensitivity 30 mA to 30 A - instantaneous or with 0 to 5 s time delay**

<table>
<thead>
<tr>
<th>Single-phase power supply</th>
<th>RM12T</th>
<th>RMH</th>
</tr>
</thead>
<tbody>
<tr>
<td>220 to 240 V AC 50/60/400 Hz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Sensors

### Closed toroids, A-type

<table>
<thead>
<tr>
<th>Type</th>
<th>Inside diameter (mm)</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA30</td>
<td>30</td>
<td>50437</td>
</tr>
<tr>
<td>PA50</td>
<td>50</td>
<td>50438</td>
</tr>
<tr>
<td>IA80</td>
<td>80</td>
<td>50439</td>
</tr>
<tr>
<td>MA120</td>
<td>120</td>
<td>50440</td>
</tr>
<tr>
<td>SA200</td>
<td>200</td>
<td>50441</td>
</tr>
<tr>
<td>GA300</td>
<td>300</td>
<td>50442</td>
</tr>
</tbody>
</table>

### Split toroids, OA-type

<table>
<thead>
<tr>
<th>Type</th>
<th>Inside diameter (mm)</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>POA</td>
<td>46</td>
<td>50485</td>
</tr>
<tr>
<td>GOA</td>
<td>110</td>
<td>50486</td>
</tr>
</tbody>
</table>

### Rectangular sensors

<table>
<thead>
<tr>
<th>Inside dimensions (mm)</th>
<th>Catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>280 x 115</td>
<td>consult us</td>
</tr>
<tr>
<td>470 x 160</td>
<td>consult us</td>
</tr>
</tbody>
</table>

*Note: sensor-relay link: twisted cable not supplied (see "Installation and connection" chapter).*