Compact current relay and protection assemblies

RXHL 411 and RAHL 411

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Features

Three phase compact current relay for:

- **Phase overcurrent protection, three stages**
- **Thermal overload protection, one stage**
- **Earth-fault overcurrent protection, three stages**
- **Breaker failure protection**
- **Automatic reclosing (option)**
- Phase and earth fault overcurrent protection functions with
  - Three stages, the first stage has selectable time delay; definite or inverse. The second and the third stage have definite time delay
  - Logic for detection and clearance of intermittent faults
- Thermal overload protection
  - Stage with alarm and trip level
  - Thermal time constant settable within a wide range
- Breaker-failure protection
  - Start of the breaker failure protection both from internal and external protection functions
  - Re-trip initiated from external start
  - Back-up trip if settable current levels are exceeded after a settable delay
- General characteristics for the relay
  - There are two groups of parameters settable and readable through the HMI
  - The dialog with the relay can be made in English or Swedish
  - There are two binary inputs for blocking or enabling of selected functions. The binary inputs can also be used for change of setting groups
  - There are five binary output relays, which can be independently configured for the different protection functions
  - Service values (primary/secondary) and disturbance information can be presented through the HMI
  - Start, trip can be presented through the HMI
  - The relay has self-supervision with output error signal
  - Testing of the output relays and operation of the binary inputs can be performed through the HMI
- Options
  - Three phase autoreclosing with up to four shots. The autoreclosing can co-operate with an intentional overreach function in order to increase probability of successful reclosing, protect fuses and/or to reduce thermal stress
  - An additional binary I/O module can be added (4 additional inputs and 4 additional outputs)

General

Compact current relay RXHL 411

The compact current relay RXHL 411 has a wide application range from main to back-up protection for feeders and lines, transformers, capacitor banks, electric boilers as well as for generators and motors.

The relay can also be used as a stand alone breaker-failure protection.

Functions

Overcurrent protection

Application

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

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

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

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

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

Design

The overcurrent protection has a low set stage with inverse or definite time delayed function. The inverse time characteristics are provided with minimum operate time for improved selectivity in certain applications. The low set stage also has a reset time logic for detection of intermittent faults. If the protection starts and the fault current drops the reset of the function will be made gradually so that the integrated fault current time area will be remembered for some time. In case of an intermittent fault every re-strike of the fault will increase the integrated current-time area so that the fault can be tripped.

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

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

1 Definite time delayed

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

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

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

Thermal overload protection

Application

When load currents exceed the permitted continuous current there is a risk that the conductor or the insulation will be subject to permanent damage due to the overheating. The thermal overload protection effectively prevents such damage and at the same time, allows full utilization of the protected object.

The thermal overload protection is mainly applicable to the protection of motors, transformers and cables as the ambient factors (ambient temperature, cooling, etc) are relatively constant. The temperature of the conductor is mainly dependent on the current.

The overload protection can also be used for overhead lines. In these cases, it must however be realised that the temperature estimation of the conductor can have relatively large errors due to the ambient conditions, such as wind etc.

Design

The thermal overload protection has an alarm and a trip function. The thermal formula is according to IEC 60255-8. The thermal function is provided with a wide parameter setting range for improved selectivity.

The thermal time constant, τ, is defined as the time required by the protected object to reach θ = 63% of the steady-state temperature, θ_s, when the object in question is supplied with a constant current.

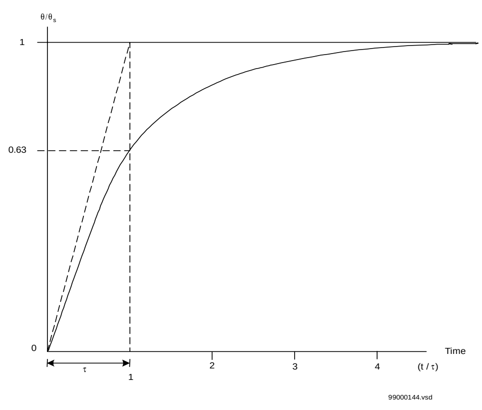

Figure 1: Definition of thermal time constant

Thermal operating time formula:

$$t = \tau \cdot \ln \frac{I^2 - I_p^2}{I^2 - I_b^2}$$

Where:

t = operate time

τ = set time constant

I_p = load current before the overload occurs

I = load current

I_b = set operate current

Earth-fault protection

Application

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

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

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

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

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

In many applications a directional function of the residual overcurrent protection is desirable. In such cases the measuring relay can be used in combination with the directional relay RXPDK 23H, that will provide enable criteria in case of earth-faults in the forward direction.

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

It is also possible to use the protection as a multi-stage earth-fault current line protection where the first stage has instantaneous function and covers most of the protected line. The second stage has a short delay (about 0.4 s) and covers the rest of the line. The third stage has a longer delay and will give relatively rapid and selective fault clearance of high resistive phase to earth-faults.

Design

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

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

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

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

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

LOG-curve according to RXIDG relay manufactured by ABB.

Breaker-failure protection

Application

Breaker-failure protection is required to give a rapid back-up protection when the primary circuit-breaker does not break properly at e.g. a short-circuit in the network. In such a case all adjacent breakers are tripped by the breaker-failure protection. A simple and reliable way to secure the isolation of a fault is to check the appearance of fault current after a time. The time should be long enough to enable the circuit-breaker to operate.

Design

The breaker failure function can be activated from internal protection functions as well as from external protections via binary input. In many power systems the relay therefore is very suitable as a back-up protection for HV-lines with the integrated breaker failure protection as one of the most important back-up protection functions. A separate breaker failure protection relay is not needed in this case.

The operate values of the two current measuring elements, phase currents and neutral current are settable within a wide setting range. The measurement is stabilised against the DC-transient that can cause unwanted operation with saturated current transformers. Time measurement is the same for both measuring elements. The timer which operates trip logic for adjacent circuit-breakers.

Automatic reclosing function (Option)

Application
Automatic reclosing is a well-established method to restore the service of a power line after a transient fault. The majority of line faults are flashover arcs, which are transient by nature. When the power line is switched off by operation of the protection and line circuit-breakers, the arc de-ionizes and the contact recovers voltage withstand at a somewhat variable rate. So a certain line dead time is needed. But then line service can resume by the automatic reclosing of the line circuit-breakers. Select the length of the dead time to enable good probability of fault arc de-ionization and successful reclosing.

Design
The three-phase automatic reclosing function is built up by logical elements. The automatic reclosing function co-operates with the other functions in the protection, the trip function and the circuit-breakers. The automatic reclosing function can be selected to give either a high-speed automatic reclosing or a delayed automatic reclosing. Up to four reclosing shots can be selected. Via the binary input the automatic reclosing function can be blocked.

Intentional overreach trip function (Option)

Application
Note: This function is not separately available. It is an addition to the automatic reclosing function.

The probability of a successful high-speed automatic reclosing is significantly increased if the fault time is short. Therefore there might be a need for an intentional overreach, that is high speed trip even for faults outside the normal high set zone. In this way the interruption time can be reduced, on the other hand more customers will be interrupted, for non-selective trips. This arrangement has to be compared with selective trips by the time delayed stage, followed by a reclosing of a permanent fault and another time delayed trip.

Design
The intentional overreach function is built up on logical elements. The intentional overreach function co-operates with the start functions in the overcurrent protection and the automatic reclosing function. Time delay is used for fuse selectivity.

Miscellaneous

Active setting groups

Application
Different settings of protection functions enable convenient change of network operational conditions, for example switching between normal and emergency situations. The user can change the active setting group at any time, locally by means of local HMI or by activation of the corresponding binary input to the “ChActGrp” function.

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

Self-supervision

Application
The self-supervision function includes the following functions;

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

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

Binary I/O module (Option)

Application
In applications where many functions in the relay are activated, the optional binary I/O module can be useful; for example to arrange

selectivity to block. With this module included the relay will be provided with 4 additional binary inputs and 4 additional binary outputs.

Local HMI

Application

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

Trip value recording

Application

At power system faults the relay records the primary trip values and they can be presented in the local HMI.

The recorded values are always from the last disturbance.

Design description

Compact current relay RXHL 411

The compact current relay RXHL 411 constitutes the measuring relay of RAHL 411 and is available in four different variants.

The compact current relay RXHL 411 is a protective class II equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precaution such as double insulation or reinforced insulation are provided.

RXHL 411 is a three-phase static, microprocessor-based relay with four input current transformers for galvanic insulation. The input signals are connected to D/A-converters and then filtered. The signals are sampled in the A/D-converter and read into the microprocessor. The unfiltered input signals are also connected to zero-detectors and read into the microprocessor. All settings of the relay will be done in the local HMI.

The relay is provided with three LED’s; one for start, one for trip and one for “in service”. The relay is provided with two or six binary inputs and five or nine binary outputs, the binary inputs are galvanically separated from the electronics with opto-couplers. The binary outputs consist of electromechanical relays, each with one change over contact. RXHL 411 requires a DC/DC-converter for the auxiliary voltage supply +/-24 V; RXTUG 22H is recommended. The relay is delivered with 4-short-circuiting connectors RTXK for mounting on the rear of the terminal base. The connectors will automatically short-circuit the input currents when the relay is removed from the terminal base.

RXHL 411	Basic version, terminal diagram figure 2
RXHL 411	Basic version together with automatic reclosing function, terminal diagram figure 2
RXHL 411	Basic version together with binary I/O module, terminal diagram figure 3
RXHL 411	Basic version together with automatic reclosing function and binary I/O module, terminal diagram figure 3

Terminal diagrams

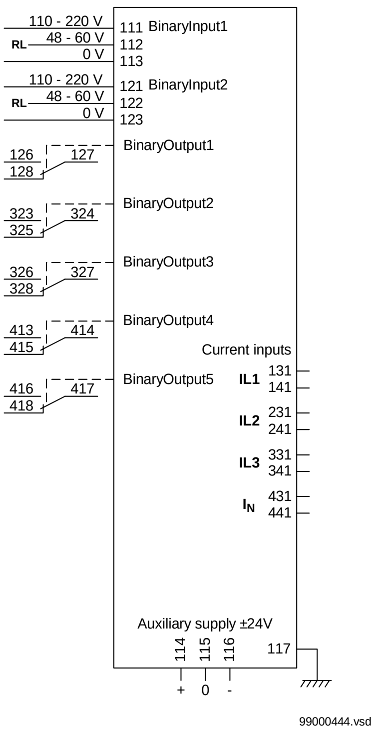

Figure 2: RXHL 411 basic version

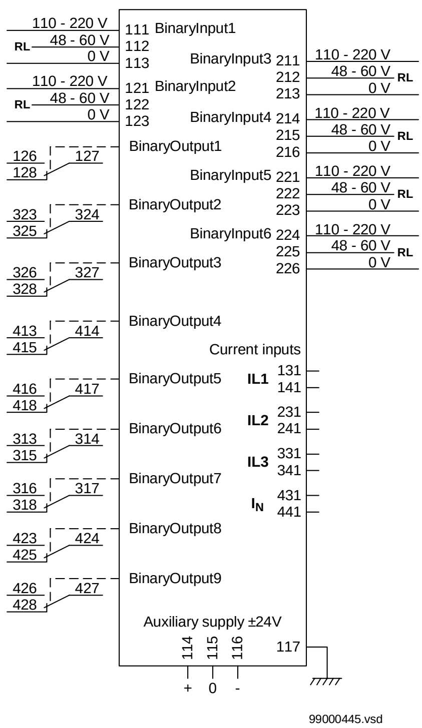

Figure 3: RXHL 411 with binary I/O module

Time characteristics

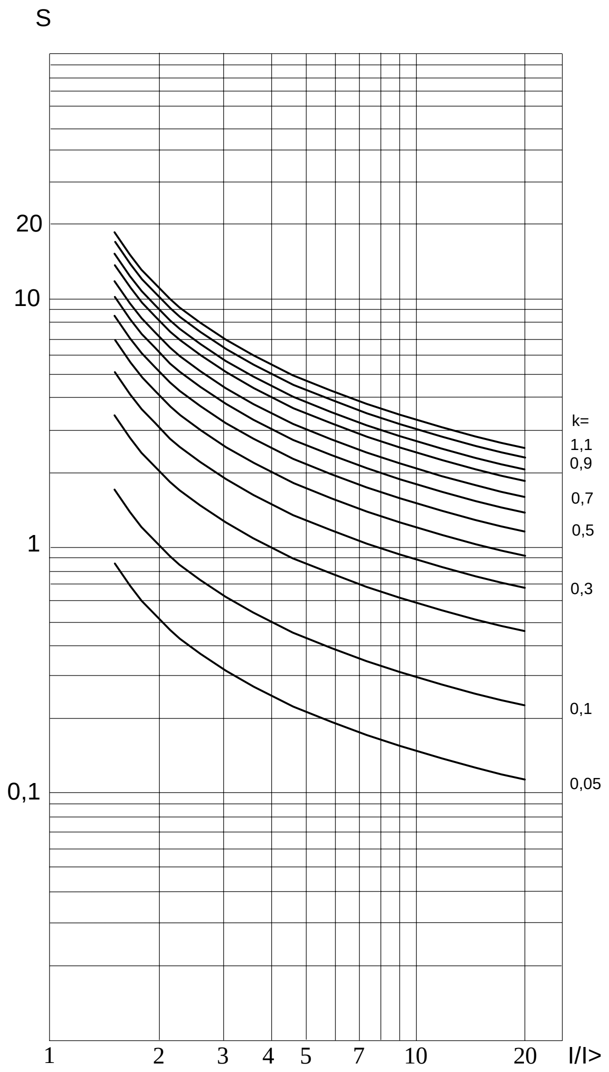

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Figure 4: Normal inverse time characteristic

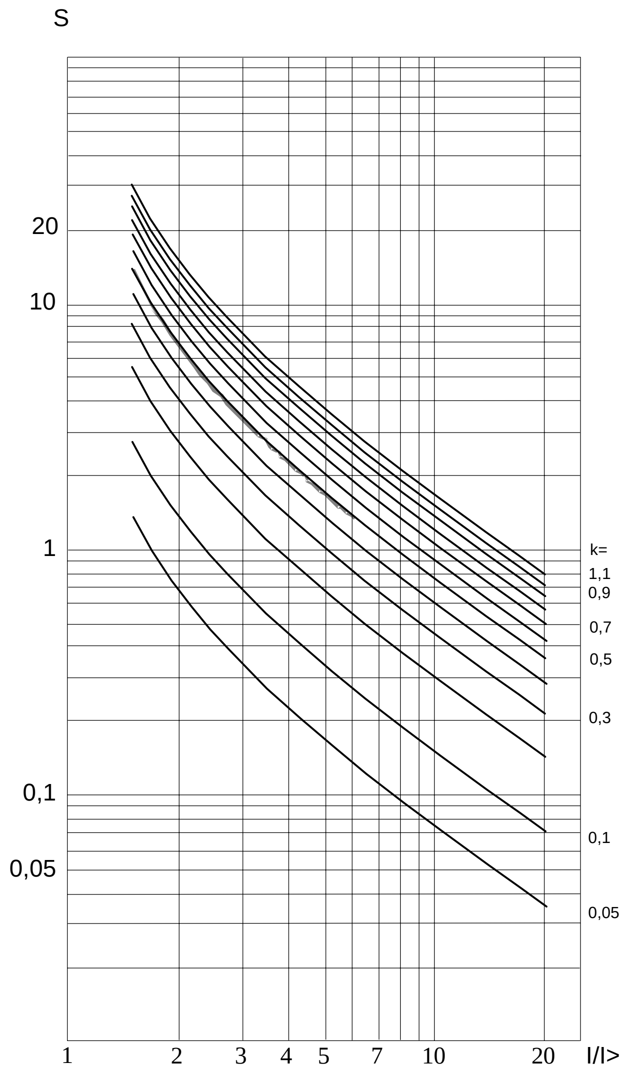

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Figure 5: Very inverse characteristic

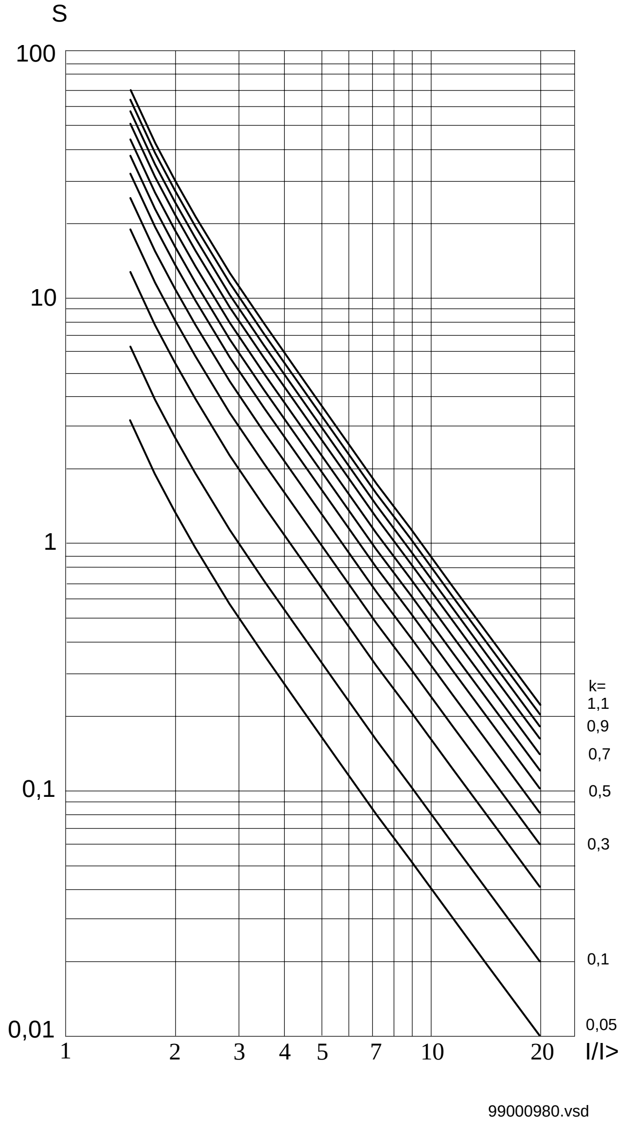


Figure 6: Extremely inverse time characteristic

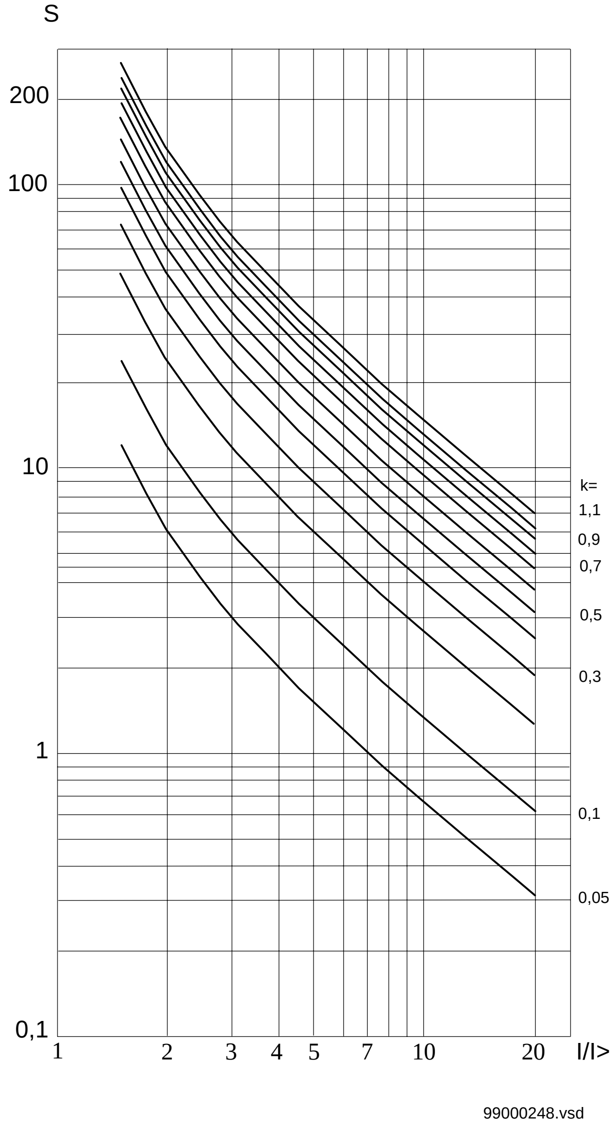


Figure 7: Long-time inverse characteristic

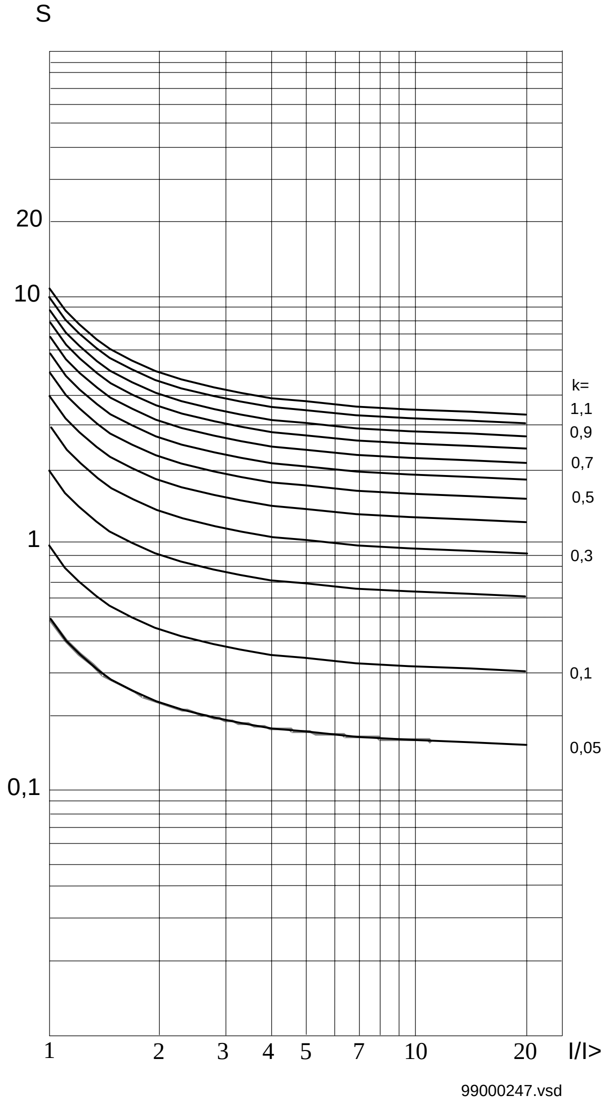


Figure 8: RI inverse time characteristic

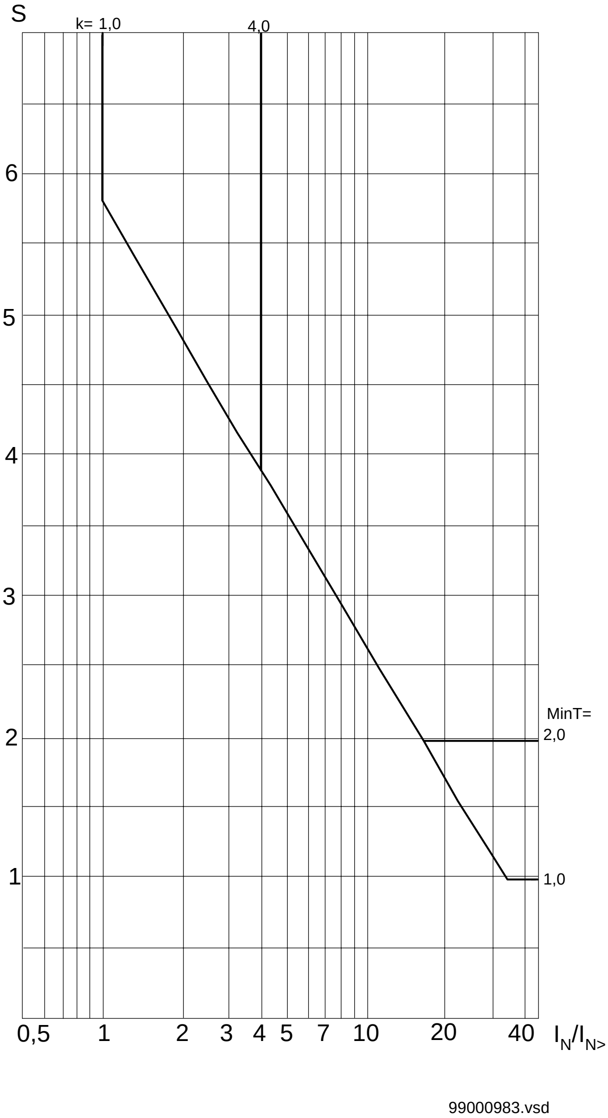


Figure 9: Logarithmic inverse time (IDG) characteristic

Typical frequency dependence

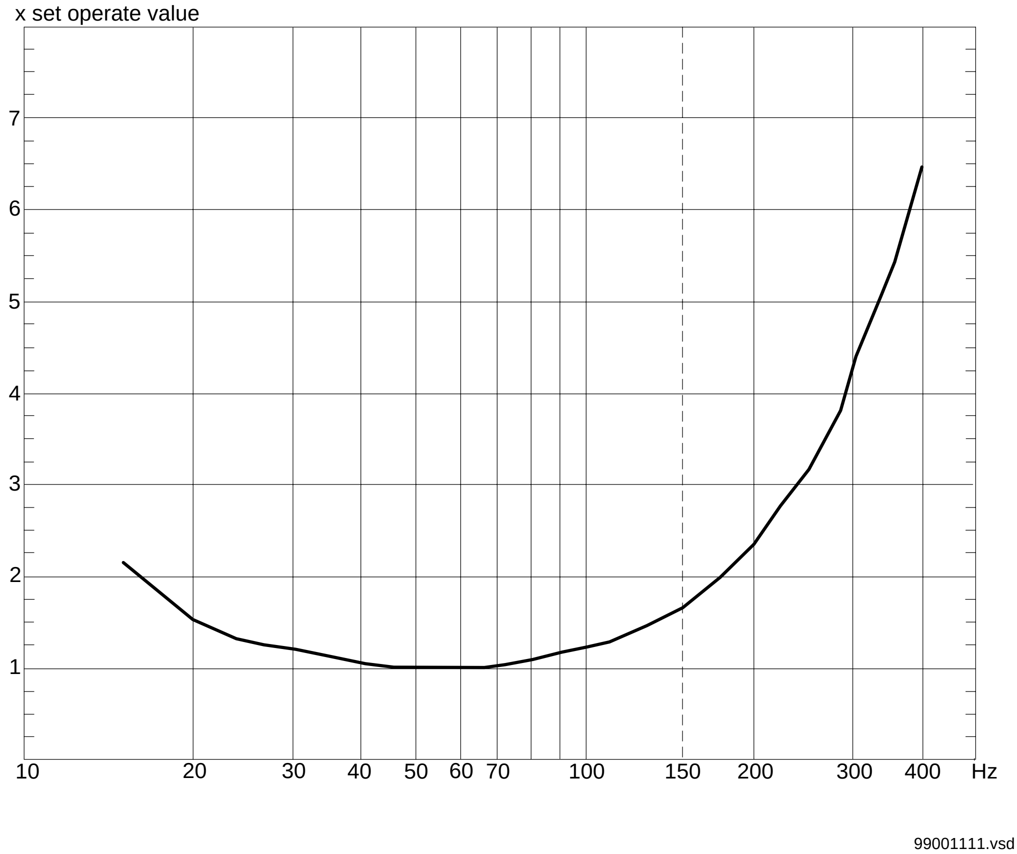


Figure 10: Typical frequency dependence

Technical data

Table 1: Current inputs

Rated phase current I_r		1 A or 5 A	
Rated neutral current IN_r	For I_r = 1 A	0.1 A or 1 A	
	For I_r = 5 A	0.1 A, 1 A or 5 A	
Setting range for the over-current protection	Stage I>	I_r = 1 A	0.2-3.0 A
		I_r = 5 A	1-15 A
	Stage I>>	(1.0-20) x set operate value I>	
	Stage I>>>	(1.0-20) x set operate value I>	
Setting range for the thermal overload protection	Stage IΘ>	(0.5-1.0) x set operate value I>	
	Thermal heat content Θ	40-200%, $I_b = I\Theta> \times \sqrt{\Theta_{set}/100}$	
Setting range for the earth fault protection	Stage I_N>	IN_r = 0.1 A	10-250 mA
		IN_r = 1 A	0.1-2.5 A
		IN_r = 5 A	0.5-12.5 A
	Stage I_N>>	(1.0-20) x set operate value I_N>	
	Stage I_N>>>	(1.0-20) x set operate value I_N>	
Effective phase current range		(0.04-60) x I_r	
Effective earth current range		(0.05-50) x IN_r	
Rated frequency F_r		50 and 60 Hz	
Frequency range		40-60 Hz/50-70 Hz	
Power consumption, per phase at rated current	I_r = 1 A	< 30 mVA	
	I_r = 5 A	< 150 mVA	
Power consumption, per phase at rated neutral current	IN_r = 0.1 A	< 15 mVA	
	IN_r = 1 A	< 30 mVA	
	IN_r = 5 A	< 150 mVA	
Overload capacity for phase current input	I_r = 1 A continously	4 A	
	I_r = 5 A continously	20 A	
	I_r = 1 A during 1 s	100 A	
	I_r = 5 A during 1 s	350 A	

Overload capacity for neutral current input	IN_r = 0.1 A continously	0.4 A
	IN_r = 1 A continously	4 A
	IN_r = 5 A continously	20 A
	IN_r = 0.1 A during 1 s	10 A
	IN_r = 1 A during 1 s	100 A
	IN_r = 5 A during 1 s	350 A

Table 2: Binary inputs, basic version

Inputs		Rated values
Binary inputs		2
Binary input voltage RL		48-60 V DC and 110-220 V DC, -20% to +10%
Power consumption	48-60 V DC	< 0.3 W / input
	110-220 V DC	< 1.0 W / input

Table 3: Output relays, basic version

Outputs			Rated values
Contacts			5 change-over
Maximum system voltage			250 V AC/DC
Current carrying capacity		Continuous	5 A
		During 1 s	15 A
Making capacity at inductive load with L/R >10 ms		During 200 ms	30 A
		During 1 s	10 A
Breaking capacity	AC, cos φ> 0.4	max. 250 V	8 A
	DC, L/R < 40 ms	48 V	1 A
		110 V	0.4 A
		220 V	0.2 A
		250 V	0.15 A

Table 4: Binary inputs, basic version with binary I/O option

Inputs		Rated values
Binary inputs		6
Binary input voltage RL		48-60 V DC and 110-220 V DC, -20% to +10%
Power consumption	48-60 V DC	< 0.3 W / input
	110-220 V DC	< 1.0 W / input

Table 5: Output relays, basic version with binary I/O option

<table>
<tr><th colspan="3">Outputs</th><th>Rated values</th></tr>
<tr><td colspan="3">Contacts</td><td>9 change-over</td></tr>
<tr><td colspan="3">Maximum system voltage</td><td>250 V AC/DC</td></tr>
<tr><td colspan="2" rowspan="2">Current carrying capacity</td><td>Continuous</td><td>5 A</td></tr>
<tr><td>During 1 s</td><td>15 A</td></tr>
<tr><td colspan="2" rowspan="2">Making capacity at inductive load with L/R >10 ms</td><td>During 200 ms</td><td>30 A</td></tr>
<tr><td>During 1 s</td><td>10 A</td></tr>
<tr><td rowspan="5">Breaking capacity</td><td>AC, cos φ> 0.4</td><td>max. 250 V</td><td>8 A</td></tr>
<tr><td rowspan="4">DC, L/R < 40 ms</td><td>48 V</td><td>1 A</td></tr>
<tr><td>110 V</td><td>0.4 A</td></tr>
<tr><td>220 V</td><td>0.2 A</td></tr>
<tr><td>250 V</td><td>0.15 A</td></tr>
</table>

Table 6: Auxiliary DC voltage supply, basic version

<table>
<tr><th colspan="3">Power consumption</th><th>Rated values</th></tr>
<tr><td colspan="3">Auxiliary voltage EL for RXTUG 22H</td><td>24-250 V DC, +/-20%</td></tr>
<tr><td colspan="3">Auxiliary voltage for the relay</td><td>+/-24 V (from RXTUG 22H)</td></tr>
<tr><td rowspan="4">Power consumption with back-light on</td><td rowspan="2">With RXTUG 22H, input 24-250 V</td><td>Before operation</td><td>< 5.0 W</td></tr>
<tr><td>After operation</td><td>< 7.0 W</td></tr>
<tr><td rowspan="2">Without RXTUG 22H, +/-24 V</td><td>Before operation</td><td>< 2.7 W</td></tr>
<tr><td>After operation</td><td>< 4.3 W</td></tr>
<tr><td colspan="3">Power consumption, back-light.</td><td>Approximately 0.5 W</td></tr>
</table>

Table 7: Auxiliary DC voltage supply, basic version with binary I/O option

<table>
<tr><th colspan="3">Power consumption</th><th>Rated values</th></tr>
<tr><td colspan="3">Auxiliary voltage EL for RXTUG 22H</td><td>24-250 V DC, +/-20%</td></tr>
<tr><td colspan="3">Auxiliary voltage for the relay</td><td>+/-24 V (from RXTUG 22H)</td></tr>
<tr><td rowspan="4">Power consumption with back-light on</td><td rowspan="2">With RXTUG 22H, input 24-250 V</td><td>Before operation</td><td>< 5.5 W</td></tr>
<tr><td>After operation</td><td>< 8.5 W</td></tr>
<tr><td rowspan="2">Without RXTUG 22H, +/-24 V</td><td>Before operation</td><td>< 3.0 W</td></tr>
<tr><td>After operation</td><td>< 5.5 W</td></tr>
<tr><td colspan="3">Power consumption, back-light.</td><td>Approximately 0.5 W</td></tr>
</table>

Table 8: Electromagnetic compatibility (EMC), immunity test

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

Table 9: Electromagnetic compatibility (EMC), emission tests

All tests are performed together with the DC/DC-converter, RXTUG 22H		
Test	**Severity**	**Standard**
Conducted	0.15-30 MHz, class A	EN 50081-2
Radiated	30-1000 MHz, class A	EN 50081-2

Table 10: CE-demand

Test	Reference standard
Immunity	EN 50082-2
Emission	EN 50081-2
Low voltage directive	EN 50178

Table 11: Insulation tests

Test		Severity	Standard
Dielectric	Current circuit to circuit and current circuit to earth	2.5 kV AC, 1 min	IEC 60255-5
	Circuit to circuit and circuit to earth	2.0 kV AC, 1 min	
	Over open contact	1.0 kV AC, 1 min	
Impulse voltage		5 kV, 1.2/50 μs, 0.5 J	IEC 60255-5
Insulation resistance		> 100 MΩ at 500 V DC	IEC 60255-5

Table 12: Mechanical test

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

Table 13: Climatic conditions

Climatic condition	Partially weather protected locations, switch-gear environment, class 3K3
Storage	-40° C to +70° C
Permitted ambient temperature	-5° C to +55° C

Table 14: Weight and dimensions

Equipment	Weight	Height	Width
Relay without RXTUG 22H	Approximately 1.3 kg	4U	12C

Table 15: Service values

Function		Phase-current	Neutral-current
Main CT ratio	Primary value	1.00 A-100 kA	1.00 A-100 kA
	Secondary value	0.40 A-10.0 A	0.40 A-10.0 A

Function		Phase-current	Neutral-current
Phase and neutral current (1A and 5A)	Secondary current	0.00-9.99 A	
		10.0-99.9 A	
		100-999 A	
	Primary current	0.00 -9.99 A, kA, MA	
		10.0-99.9 A, kA	
		100-999 A, kA	
Neutral current (0.1 A)	Secondary current	-	0-199 mA
		-	0.20-9.99 A
	Primary current	-	0-199 mA
		-	0.20-9.99 A
		-	0-9.99 kA, MA
		-	10-99.9 A, kA
		-	100-999 A, kA
Frequency F_r	50 Hz	40.0-60.0 Hz	-
	60 Hz	50.0-70.0 Hz	-
	Accuracy	+/- 0.1 Hz	-
Thermal heat content		0-250%	-
Automatic reclosing function		Off, Unready, Ready, Shot1, Shot2, Shot3, Shot4, RecIT, RclTBlk, Unsucce, Blocked	
		Shot 1	0-2997
		Shot 2-4	0-8991
		Unsucce	0-2997

Table 16: Overcurrent protection

Overcurrent protection	Stage I>	Stage I>>	Stage I>>>
Setting range	(0.2-3.0) x I_r	(1.0-20) x I>	(1.0-20) x I>
Limiting errors of set operate value for current measuring 50/60 Hz	< 3%	< 3%	< 3%
Consistency of set operate value 50/60 Hz	< 1%	< 1%	< 1 %
Typical reset ratio	95%		
Typical operate time I = 0 => 3 x set operate value	40 ms		
Typical reset time I = 3 => 0 x set operate value	45 ms		
Transient over-reach L/R = 50, 100, 200 and 500 ms	< 5%		

Overcurrent protection		Stage I>	Stage I>>	Stage I>>>
Typical overshoot time		30 ms		
Recovery time at I = 3 x set operate value		< 55 ms		
Frequency dependency	F_r = 50 Hz (45-55 Hz)	< 5%		
	F_r = 60 Hz (54-66 Hz)	< 5%		
	150/180 Hz	Typical 1.5/2.0 x set operate value		
	250/300 Hz	Typical 3.0/4.0 x set operate value		
Influence of harmonics	100/120 Hz, 10%	< 2%		
	150/180 Hz, 20%	< 6%		
	250/300 Hz, 20%	< 3%		
Temperature dependence within range -5° C to +55° C		< 2%		

Table 17: Time functions for overcurrent protection

Time function			Stage I>	Stage I>>	Stage I>>>
Time delay			Inverse or definite time (NI, VI, EI, LI and RI)	Definite time	Definite time
Setting range, definite time			0-20 s		
Accuracy, definite time			+/– 30 ms		
Setting range, inverse time			k = 0.05-1.1	-	-
Min time, inverse time			0-2.0 s	-	-
Accuracy, inverse time[a)]	NI, VI, EI, LI[b)]	2.0 x $I>_{set}$	12.5% and +/-30 ms	-	-
		5.0 x $I>_{set}$	7.5% and +/-30 ms		
		10.0 x $I>_{set}$	5% and +/-30 ms		
		20.0 x $I>_{set}$	5% and +/-30 ms		
	RI	1.0 - 1.3 x $I>_{set}$	12.5% and +/-30 ms	-	-
		1.3 - 20.0 x $I>_{set}$	5% and +/-30 ms		
Linear reset time			0-500 s	-	-

a) A percentage value of theoretical time and a definite time delay

b) According to IEC 60225-3, signed error 5.

Table 18: Thermal overload protection

Thermal overload protection	Thermal stage
Setting range IΘ>	(0.5-1.0) x I>
Operating range	6 times IΘ>
Setting range, thermal constant τ	0-120 min

Thermal overload protection	Thermal stage	
Thermal heat content	Θ	
Setting range, Θ_{set}	Alarm level	40-200%
	Trip level	40-200%
Reset level	< 2% lower thermal content than operate level	
Maximum thermal heat content	250%	
Thermal start-up content	0-99%	
Operate time	Thermal equation follows the IEC equation: $t = \tau \cdot \ln \frac{I^2 - I_p^2}{I^2 - I_b^2}$ t = operate time τ = set time constant I_p = load current before the overload occurs I = load current I_b = set operate current Θ_{set} = alarm or trip level $I_b = I\Theta> \times \sqrt{\Theta_{set} / 100}$	
Accuracy operate time	I = +/-1% t = +/-(1% of theoretical time and 50 ms)	

Table 19: Earth-fault protection

Earth-fault protection	Stage I_N>	Stage I_N>>	Stage I_N>>>
Setting range	(0.1-2.5) x IN_r	(1.0-20) x I_N>	1.0-20) x I_N>
Limiting errors of set operate value for current measuring 50/60 Hz	< 3%	< 3%	< 3%
Consistency of set operate value 50/60 Hz	< 1%	< 1%	< 1%
Typical reset ratio	95%		
Typical operate time I = 0 => 3 x set operate value	40 ms		
Typical reset time I = 3 => 0 x set operate value	45 ms		
Transient over-reach L/R = 50, 100, 200 and 500 ms	< 5%		
Typical overshoot time	30 ms		
Recovery time at I = 3 x set operate value	< 55 ms		

Earth-fault protection		**Stage I_N>**	**Stage I_N>>**	**Stage I_N>>>**
Frequency dependency	F_r = 50 Hz (45-55 Hz)	< 5%		
	F_r = 60 Hz (54-66 Hz)	< 5%		
	150/180 Hz	Typical 1.5/2.0 x set operate value		
	250/300 Hz	Typical 3.0/4.0 x set operate value		
Influence of harmonics	100/120 Hz, 10%	< 2%		
	150/180 Hz, 20%	< 6%		
	250/300 Hz, 20%	< 3%		
Temperature dependency within range -5° C to +55° C		< 2%		

Table 20: Time functions for earth-fault protection

Time function			**Stage I_N>**	**Stage I_N>>**	**Stage I_N>>>**
Time delay			Inverse, definite or logarithmic time (NI, VI, EI, LI, RI and Log)	Definite time	Definite time
Setting range, definite time			0-20 s		
Accuracy, definite time			+/-30 ms		
Setting range, inverse time			k = 0.05-1.1	-	-
Min time, inverse time			0-2.0 s	-	-
Accuracy, inverse time[a]	NI, VI, EI, LI[b]	2.0 x $I>_{set}$	12.5% and +/-30 ms	-	-
		5.0 x $I>_{set}$	7.5% and +/-30 ms		
		10.0 x $I>_{set}$	5% and +/-30 ms		
		20.0 x $I>_{set}$	5% and +/-30 ms		
	RI	1.0-1.3 x $I>_{set}$	12.5% and +/-30 ms		
		1.3-20.0 x $I>_{set}$	5% and +/-30 ms		
Setting range, logarithmic time (IDG)			k = 1-4	-	-
Min time, logarithmic time			1.0-2.0 s	-	-
Formula, logarithmic time			$t = 5.8-1.35 \times \ln (I/I_{Nset})$	-	-
Accuracy, logarithmic time			+/-50 ms overall	-	-
Linear reset time			0-500 s	-	-
[a] A percentage value of theoretical time and a definite time delay					
[b] According to IEC 60255-3, signed error 5					

Table 21: Breaker failure protection

Function	Setting range
Activates by trip signals from	I>, I>>, I>>>, Θ>, I_N>, I_N>>, I_N>>> external start and intentional overreach trip
Activation level, overcurrent function	50-200% of set overcurrent function, I>
Activation level, earth-fault function	50-200% of set earth-fault function, I_N>
Operate time, back-up trip	0.10-1.00 s
Overshoot time	< 30 ms

Table 22: Automatic reclosing function

Function	Setting range	
Reclosing program	3-phase reclosing	
Activates by trip signals from	I>, I>>, I>>>, I_N>, I_N>>, I_N>>> and intentional overreach trip	
Number of reclosing shots	1-4	
Open time before reclosing	Dead-time shot 1	0.2-60 s
	Dead-time shot 2	1.0-300 s
	Dead-time shot 3	1.0-300 s
	Dead-time shot 4	1.0-300 s
Reclaim time	10-300 s	
Reclosing pulse	50-200 s (depending on new start pulse)	
Binary input: automatic reclosing	On-off	
Binary input: CB closed	Yes, closed 5 s before start	
Binary input: CB ready	Yes	
Binary input: block automatic reclosing	Yes, reset delay 5 s	

Table 23: Intentional overreach trip function

Function	Setting range
Operation criteria	Before first reclosing
Activates by start signals from	I>, I>> and I>>>
Time delay for fuse selectivity	0.00-10.0 s

Diagrams

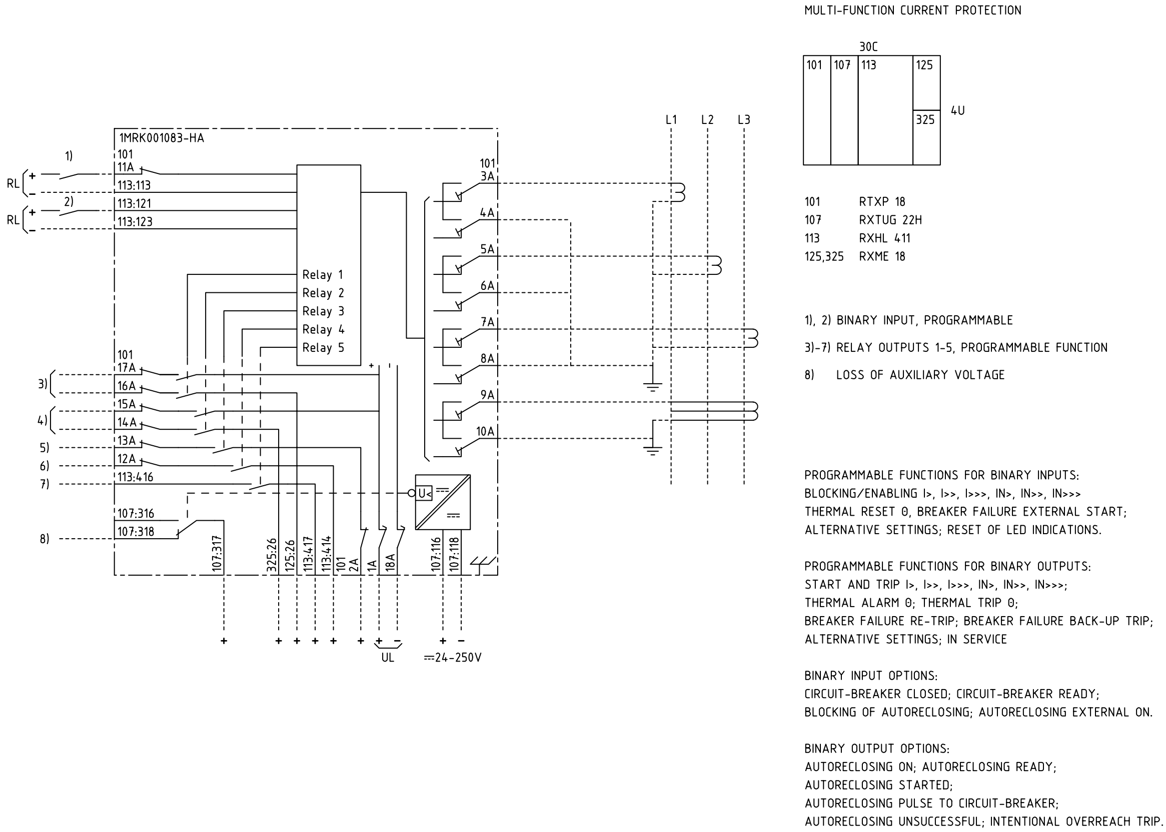


Figure 11: Terminal diagram 1MRK 001 083-HAA

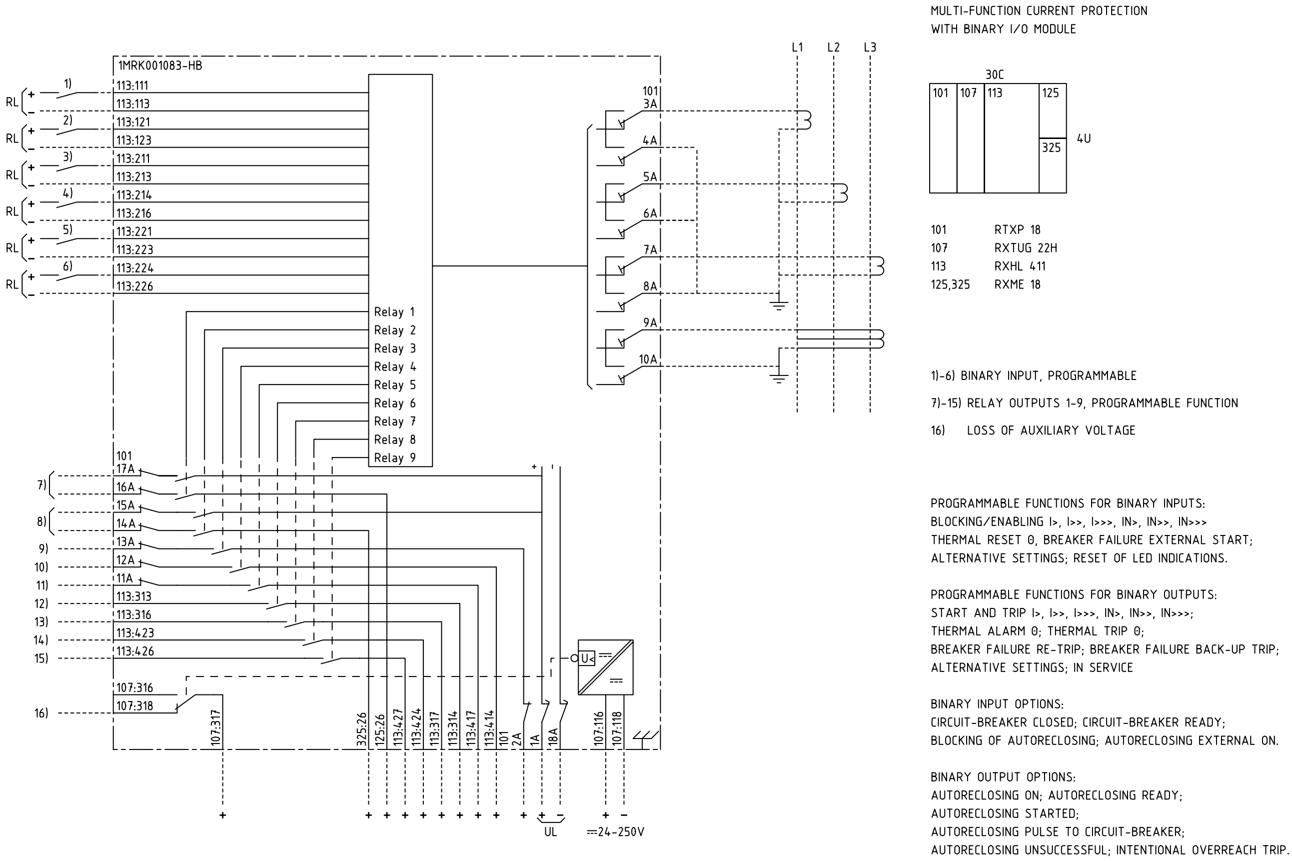


Figure 12: Terminal diagram 1MRK 001 083-HBA

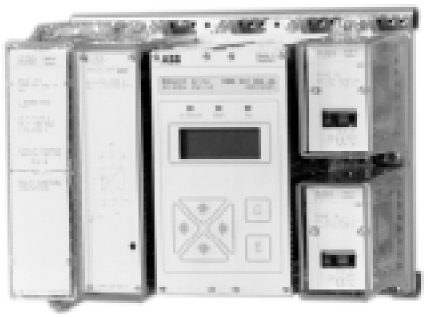
Protection assemblies

Compact current protection assembly RAHL

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

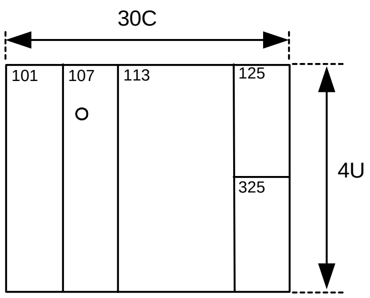
The basic version of the measuring relay has 5 binary outputs and 2 binary inputs. The binary I/O option includes 4 additional inputs and 4 additional outputs. Protections are normally available with output logic with heavy duty contacts, relay RXME 18 with indicating flag, and can upon request be completed with an output logic of free choice. Output relays are connected to separate auxiliary voltage. The interface voltage for enable or block impulses can be connected to either 48-60 V DC or 110-220 V DC by connecting the voltage circuit to separate terminals. At delivery all relays are connected for 110-220 V DC.

All the protections in the COMBIFLEX® modular system are mounted on apparatus bars. The connections to the protections are done by COMBIFLEX® socket equipped leads. All internal connections are made and the protection assembly is tested before delivery from factory. The type of modules and their physical position and the modular size of the protection are shown in the diagrams of the respective protection. Figure 13 shows an example of a protection assembly.



se980096

Figure 13: Protection assembly example

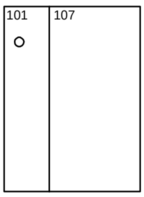
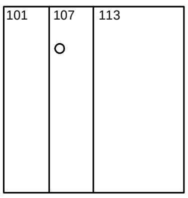


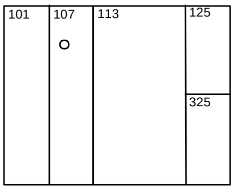
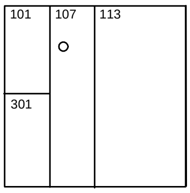
101 RTXP 18
107 RXTUG 22H
113 RXHL
125 RXME 18
325 RXME 18

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

Protection assemblies

The table below shows the different variants of the compact current relay RXHL 411 in protection assemblies type RAHL 411.

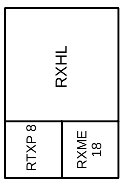
RAHL 411 protection assembly variants	Ordering No.	RXHL 411 options	Circuit diagram	Terminal diagram	Available diagrams
 101 RXTUG 22H 107 RXHL	1MRK 001 082-FA	Basic version	1MRK 001 083-FA	1MRK 001 083-FAA	On request
		With binary I/O	1MRK 001 083-FB	1MRK 001 083-FBA	On request
 101 RTXP 18 107 RXTUG 22H 113 RXHL	1MRK 001 082-GA	Basic version	1MRK 001 083-GA	1MRK 001 083-GAA	On request
		With binary I/O	1MRK 001 083-GB	1MRK 001 083-GBA	On request

RAHL 411 protection assembly variants	Ordering No.	RXHL 411 options	Circuit diagram	Terminal diagram	Available diagrams
 101 RTXP 18 107 RXTUG 22H 113 RXHL 125 RXME 18 325 RXME 18	1MRK 001 082-HA	Basic version	1MRK 001 083-HA	1MRK 001 083-HAA a)	b)
		With binary I/O	1MRK 001 083-HB	1MRK 001 083-HBA a)	b)
 101 RTXP 8 107 RXTUG 22H 113 RXHL 301 RXME 18	1MRK 001 082-KA	Basic version	1MRK 001 083-KA	1MRK 001 083-KAA	On request
	1MRK 001 082-LA c)		1MRK 001 083-LA c)	1MRK 001 083-LAA c)	b)
		With binary I/O	1MRK 001 083-KB	1MRK 001 083-KBA	On request
			1MRK 001 083-LB c)	1MRK 001 083-LBA c)	b)

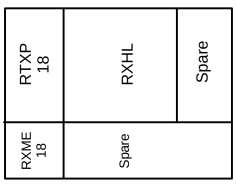
a) Terminal diagrams available in technical overview brochure for RXHL 411 and RAHL 411
b) Terminal and circuit diagrams available in installation and commissioning manual for RXHL 411 and RAHL 411
c) Selection of phase and neutral current must be the same, $I_r = IN_r = 1$ A or $I_r = IN_r = 5$ A

Mounting alternatives

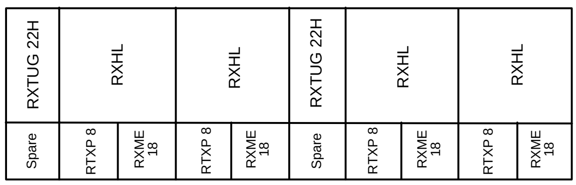
The protection assemblies described in the table above can be supplied in RHGX or RHGS cases. RXHL 411 compact current relay can also be supplied in the following mounting alternatives.



Mounting of RXHL 411 in RHGS 6.



Mounting of RXHL 411 in RHGS 12.



Mounting of RXHL 411 in RHGS 30 with dual power supplies RXTUG 22H, individual test switches and optional tripping relays.

Ordering of RAHL protections

Basic data to specify

RAHL protection Quantity: ☐ 1MRK 001 082- ____

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

AC inputs

Rated phase current I_r = 1 A, rated neutral current IN_r = 0,1 A	☐	1MRK 000 322-FA
Rated phase current I_r = 1 A, rated neutral current IN_r = 1 A	☐	1MRK 000 322-FB
Rated phase current I_r = 5 A, rated neutral current IN_r = 0,1 A	☐	1MRK 000 322-FC
Rated phase current I_r = 5 A, rated neutral current IN_r = 1 A	☐	1MRK 000 322-FD
Rated phase current I_r = 5 A, rated neutral current IN_r = 5 A	☐	1MRK 000 322-FE

Options

Functions

Automatic reclosing function with intentional overreach trip function included	☐	1MRK 000 200-BA
Binary I/O module (inputs 4/outputs 4)	☐	1MRK 000 322-ET

Auxiliary voltage for included auxiliary relay

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

Mounting alternatives	**Size**		
Apparatus bars (always included)			
Equipment frame without door	4U 19”	☐	1MRK 000 137-GA
Equipment frame with door	4U 19”	☐	1MRK 000 137-KA
RHGX 4	4U 12C	☐	RK 927 001-AB
RHGX 8	4U 24C	☐	RK 927 002-AB
RHGX 12	4U 36C	☐	RK 927 003-AB
RHGX 20	4U 60C	☐	RK 927 004-AB

RHGS 30	6U x 1/1 19” rack	☐	1MRK 000 315-A
RHGS 12	6U x 1/2 19” rack	☐	1MRK 000 315-B
RHGS 6	6U x 1/4 19” rack	☐	1MRK 000 315-C

Accessories

User documentation RXHL 411 and RAHL 411

Operator’s manual	Quantity:	☐	1MRK 509 050-UEN
Technical reference manual	Quantity:	☐	1MRK 509 051-UEN
Installation and commissioning manual	Quantity:	☐	1MRK 509 052-UEN

Ordering of RXHL relays

Functions included in basic version

Three-phase overcurrent protection, I>, I>>, I>>>

Three-phase thermal overload protection, Θ>

Earth-fault protection, I_N>, I_N>>, I_N>>>

Breaker failure protection, phases and neutral detection

Local Human Machine Interface (HMI)

Two groups of setting parameter

Service value reading (primary or secondary values)

Basic data to specify

RXHL 411, includes basic functions	Quantity:		1MRK 001 894-AA

AC inputs

Rated phase current I_r = 1 A, rated neutral current IN_r = 0,1 A	☐	1MRK 000 322-FA
Rated phase current I_r = 1 A, rated neutral current IN_r = 1 A	☐	1MRK 000 322-FB
Rated phase current I_r = 5 A, rated neutral current IN_r = 0,1 A	☐	1MRK 000 322-FC
Rated phase current I_r = 5 A, rated neutral current IN_r = 1 A	☐	1MRK 000 322-FD
Rated phase current I_r = 5 A, rated neutral current IN_r = 5 A	☐	1MRK 000 322-FE

Options

Functions

Automatic reclosing function with intentional overreach trip function included	☐	1MRK 000 200-BA
Binary I/O module (inputs 4/outputs 4)	☐	1MRK 000 322-ET

Accessories

User documentation RXHL 411 and RAHL 411

Operator’s manual	Quantity:		1MRK 509 050-UEN
Technical reference manual	Quantity:		1MRK 509 051-UEN
Installation and commissioning manual	Quantity:		1MRK 509 052-UEN

References

Related documents

Document related to COMBIFLEX© assemblies	Identity number
Buyer's guide, Connection and installation components in COMBIFLEX©	1MRK 513 003-BEN
Buyer's guide, Relay accessories and components	1MRK 513 004-BEN
Buyer's guide, Test system COMBITEST	1MRK 512 001-BEN
Buyer's guide, DC-DC converter	1MRK 513 001-BEN
Buyer's guide, Auxiliary relays	1MRK 508 015-BEN

Documents related to RXHL 411 and RAHL 411	Identity number
Technical overview brochure	1MRK 509 049-BEN
Connection and setting guide (only RXHL 411)	1MRK 509 049-WEN
Operator's manual	1MRK 509 050-UEN
Technical reference manual	1MRK 509 051-UEN
Installation and commissioning manual	1MRK 509 052-UEN

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