ABB Network Partner AB

RXLK 2H and RALK Overexcitation relay and protection assemblies

User´s Guide

1MRK 509 008-UEN

Replaces
Version 1
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General

When power transformers and generators are overexcited, stray flux will flow into non-laminated parts not designed to carry magnetic flux. The currents induced in these parts can cause excessive heating and severe damage. The overexcitation protection RALK effectively prevents such damage and, at the same time, allows full utilisation of the protected object.

The COMBIFLEX® overexcitation protection RALK monitors the magnitude of excitation by measuring the ratio between the voltage and the frequency (V/Hz). RALK is a single-phase overexcitation protection with measuring relay RXLK 2H. RXLK 2H is a micro-processor based time-overexcitation relay with continuous settings for operate values and time delays. The relay has two measuring stages, both with a wide setting range. Five different inverse time characteristics plus definite time delay for stage 1 and definite time delay for stage 2 makes the protection generally applicable for all power systems. The setting range is 0,2 to 9,6 V/Hz.

All RALK protections are:

- mounted in the COMBIFLEX® modularised system
- available with or without test switch
- available with or without DC-DC converter
- available with or without additional heavy duty tripping relay

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1 Application

1.1 General

When the laminated core of a power transformer is subjected to a magnetic flux density beyond the design limits, stray flux will flow into non-laminated components not designed to carry flux. The currents induced in these parts can cause excessive heating and severe damage to the insulation in adjacent parts in a relatively short time.

According to the IEC standards, the power transformers shall be able to deliver rated current continuously at an applied voltage of 105 % of the rated voltage (at rated frequency). For special cases, the purchaser may specify that the transformer should be capable of operation up to 110 % of the rated voltage at no load. Step-up transformers for generator-transformer blocks must be able to withstand 1,4 times rated voltage (at rated frequency) at the terminal to which the generator is connected for 5 seconds.

Even the laminated flux path of a generator will saturate when the machine is subjected to overexcitation. The stray flux will penetrate into non-laminated parts and can cause harmful heating, e.g. in slot wedges and stator core assembly components.

The general equation for the induced voltage in a coil:

$$E = 4{,}44 \cdot f \cdot A \cdot N \cdot B \text{ (V)}$$

where

f = frequency (Hz)

A = cross-sectional area of the core (m^2)

N = number of winding turns

B= flux density (Tesla)

can be written $B = K \cdot \frac{E}{f}$, where K is a constant.

Hence the flux density is proportional to the ratio between the voltage and the frequency.

Overvoltage, or underfrequency, or a combination of both will result in an excessive flux density level, which is denominated overfluxing or overexcitation.

The capability of a transformer or generator to withstand overexcitation can be given in the form of a thermal capability curve, i.e. a diagram which shows the permissible time as a function of the level of overexcitation. The overexcitation capability curve is influenced by the design of the generators and transformers. It is generally somewhat different for generators and transformers, and it is often different for transformers from different manufacturers.

Fig. 1 shows an example of capability curves for a generator and the block transformer. The curves are valid for overexcitation after continuous service with full load.

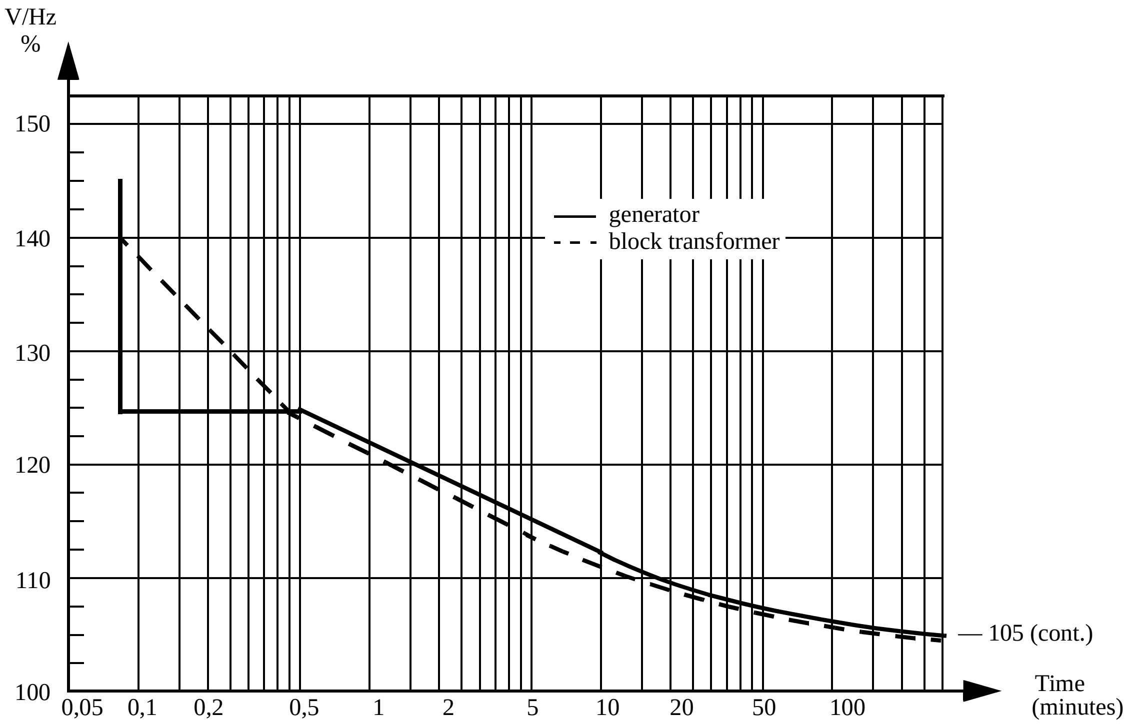


Fig. 1 Example of capability curves for generator and block transformer

The greatest risk for overexcitation occur in power stations when the generator-transformer block is disconnected from the rest of the network. Overexcitation can occur during start-up and shut-down of the generator if the field current is not properly adjusted. Loss-of-load or load-shedding can also result in overexcitation if the voltage control fails to reduce the field current or if the machine is running with manual control of the field current.

In power stations, tripping with a short definite time delay is often desired during the start-up and running-down of the generator. One version of RALK has a separate time stage, which is released via a digital input to the relay when the generator breaker is open (see Section 9).

Loss-of-load or load-shedding at a transformer substation can result in overexcitation of the transformer if the local voltage control is insufficient or out of order.

Low frequency in a system separated from the network (islanding) can result in overexcitation if the voltage regulating system maintains normal voltage.

1.2 Setting calculations

The capability curves of the units which are to be protected by the same over-excitation protection must be drawn with the same basic voltage. For a generator-transformer block, the capability curve of the generator, the step-up transformer and the auxiliary block transformer (when included) are suitably drawn with rated generator voltage as basic voltage (100 % excitation at rated frequency).

The inverse time characteristics, type 1 to 5, which are available with the RXLK 2H relay, are shown in Section 5, Technical Data.

Example of setting calculation

Rated generator voltage: 15 kV, 50 Hz

Ratio of the voltage transformer:

$$\frac{16}{\sqrt{3}} \Big/ \frac{0,11}{\sqrt{3}} \text{ kV}$$

Rated generator secondary voltage: $15000 \cdot \frac{0,11}{16} = 103$ V

Relay connected to line-to-line voltage: 103 V

Rated generator V/Hz on secondary side: 103/50 = 2,06 V/Hz.

Capability curve of generator and step-up transformer according to Fig.1 above.

The operate time of the inverse characteristics is given as a function of the ratio U/f ⁄(U/f)set. With max. permissible continuous overexcitation 105%, select setting 104 % of rated generator V/Hz.

(U/f)set = 2,06 ·1,04 = 2,14 V/Hz

Calculate the ratio M = U/f ⁄(U/f)set for some points on the capability curve:

U/f %	125	120	115	112,5	110
M	1,20	1,15	1,10	1,08	1,06
Permissible time (s)	20	60	170	300	1000

Consider the points M = 1,1 and M = 1,2 on the inverse characteristics type 1 to 5. Inverse time characteristic type 3 with k = 1 corresponds well with the required operate time for the two points. For M = 1,08 the operate time will be:

$$t = e^{-\frac{108-115}{4,8858}} = 4,19 min = 250 s$$

For M = 1,06 the operate time is 380 s. Hence characteristic type 3 with setting k = 1 will protect the transformer.

The part of the generator capability curve below the operate region of the inverse characteristic is protected by stage 2 with the start function set slightly below 125 %, say 122,5 % and definite time delay 20 s. Hence the start function for stage 2 is set at:

$$2{,}06 \cdot 1{,}225 = 2{,}52 \text{ V/Hz}$$

Fig. 2 shows the capability curves of the generator and the transformer together with the set operate characteristics of RALK.

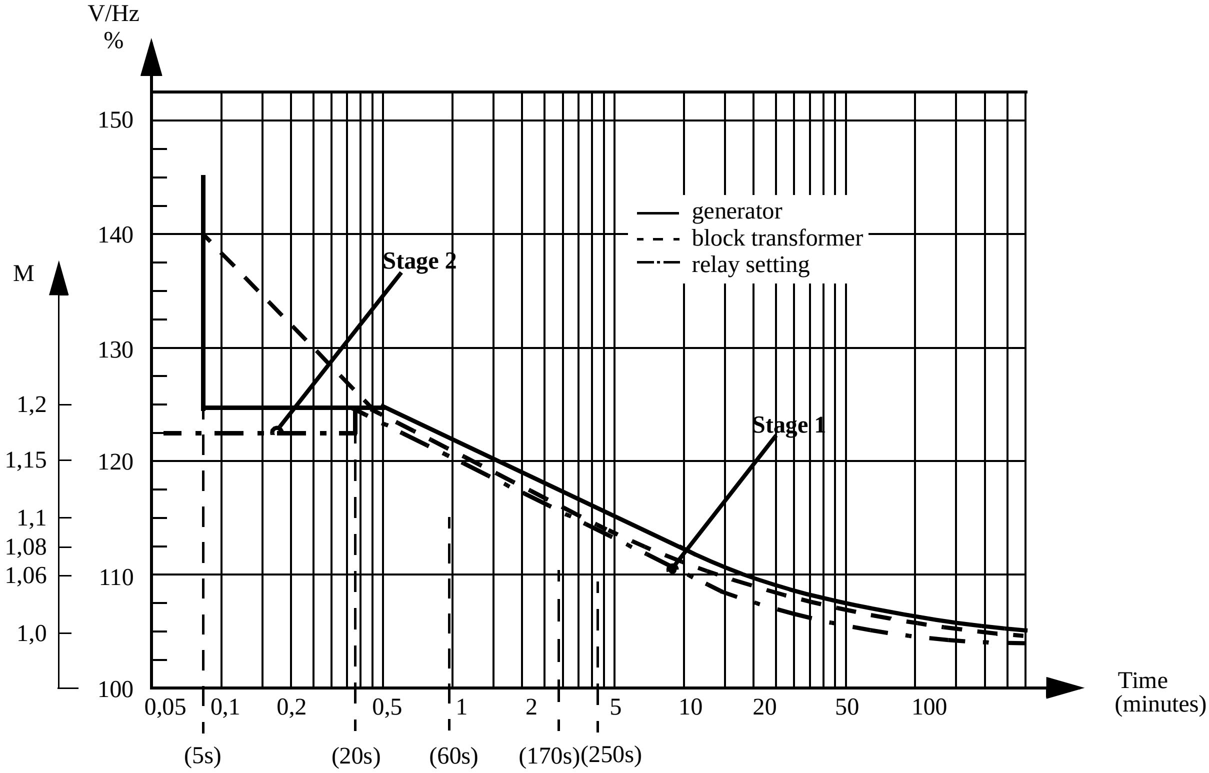


Fig. 2 Selected operate characteristic of RALK 1

2 Measurement Principles

The RXLK 2H relay constitutes the measuring unit of RALK. The functional diagram in fig. 3 illustrates the mode of operation. For setting of operate values, see Section 4.

To provide a suitable voltage for the measurement circuits, the relay is provided with an input transformer. The output voltage of the transformer is scaled by setting of dip-switches before it is filtered with a lopes filter with a cut-off frequency equal to 180 Hz.

The filtered voltage is applied to the zero detector and the frequency is calculated in the microprocessor. To avoid unstable values, a mean value of the frequency is calculated on the four latest zero-crossings.

The voltage is rectified before it is sampled with a frequency tracked sample rate of 16 samples/cycle with a maximum sample rate of 1000 samples/s. The voltage ripple is then reduced with a moving average value filter.

The V/Hz value is calculated from the moving average values of the voltage and the frequency. The calculated value is compared to the set operate values of the V/Hz stage one and stage two. The start functions are activated when the measured value reaches the set operate values for stage one or two. For stage one, inverse-time or definite-time delay can be selected. For stage two only definite-time delay is available.

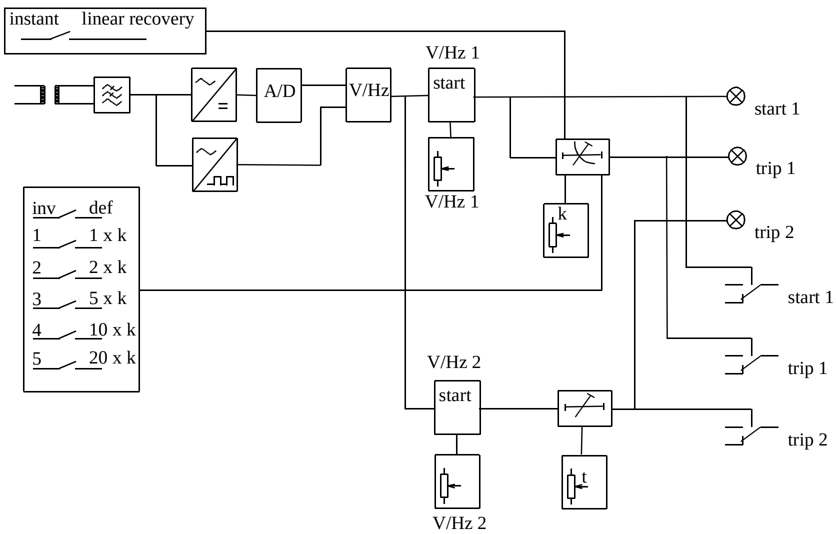


Fig. 3 Functional diagram illustrating the mode of operating of the RXLK 2H relay

The V/Hz stage one can be set to instantaneous or linear recovery. If stage one is set to instantaneous recovery, the accumulated V/Hz value resets to zero instantaneously when the calculated V/Hz value is below set operate value. When it is set to linear recovery, the accumulated V/Hz value decreases with 0,2/k% of trip level per second for inverse-time delay and with 0,2/t% of trip level per second for definite-time delay when the calculated V/Hz value is below set operate value.

When the processor starts, it executes a self test sequence. If the processor fails to start in a proper way the LEDs will indicate by flashing according to fig. 4 or the “In service” LED will not be lit. The program in the microprocessor is executed in a fixed loop with a constant loop time. The loop is supervised by an internal watchdog which initiates a program restart if the program malfunctions.

Test sequence:	**Test error indication:**
Config. registers	All LEDs flash in clockwise rotation
RAM	“Trip 1” flashes
ROM	“Trip 2” flashes
A/D	“Trip 1” and “Trip 2” flash

Fig. 4 Self test error indication of the RXLK 2H relay

The reset button has two functions, LED check and resetting the LEDs. When the button is depressed, the “Start”, “Trip 1” and “Trip 2” LEDs are lit and the “In service” LED is switched off, in order to check the LEDs. When the button is released the “Start”, “Trip 1” and “Trip 2” LEDs are reset to show the current status and “In service” LED is relit.

The binary input, which can be used for remote resetting of the “Trip 1” and “Trip 2” LED’s, is galvanically separated from the electronic measurement circuits with an opt-coupler.

The frequency dependence of the V/Hz functions and the influence of harmonics are shown in Section 5.

3 Design

The transformer overexcitation protection type RALK is designed for single-phase application. Each protection is available with or without test switch RTXP 18, DC-DC converter RXTUG 22H or tripping relay RXME 18. There is also one variant equipped with time relay RXKL 1, auxiliary relay RXMB 1 and signal relay RXSF 1. This variant is used when tripping with short time delay is requested when the generator breaker is open.

All the protections are built up by modules in the COMBIFLEX® modular system mounted on apparatus bars. The connections to the protections are done by COMBIFLEX® socket equipped leads.

The type of modules and their physical position and the modular size of the protection are shown in the *Buyer´s Guide* and in the Circuit Diagram of the respective protection. The following modules can be included.

3.1 Test switch

The test switch RTXP 18 is a part of the COMBITEST testing system described in the *Buyer´s Guide*, document No. 1MRK 512 001-BEN. A complete secondary testing of the protection can be performed by using a test-plug handle RTXH 18, connected to a test set. When the test-plug handle is inserted into the test switch, preparations for testing are automatically carried out in a proper sequence, i.e. blocking of tripping circuits, short-circulating of current circuits, opening of voltage circuits and making the protection terminals available for secondary testing. Test switch RTXP 18 has the modular dimensions 4U 6C.

All input currents can be measured by a test plug RTXM connected to an ammeter. The tripping circuits can be blocked by a trip-block plug RTXB and the protection can be totally blocked by a block-plug handle RTXF 18.

3.2 DC-DC converter

The DC-DC converter RXTUG 22H converts the applied battery voltage to an alternating voltage which is then transformed, rectified, smoothed and in this application regulated to ±24 V DC. The auxiliary voltage is in that way adapted to the measuring relays. In addition, the input and output validates will be galvanically separated, which contributes to damping of possible transients in the auxiliary voltage supply to the measuring relays. The converter has a built-in signal relay and a green LED for supervision of the output voltage.

RXTUG 22H has the modular dimensions 4U 6C. It is described in the *Buyer´s Guide*, document No. 1MRK 513 001-BEN.

3.3 Measuring relay

The volt-per-Hertz relay RXLK 2H is a static, microprocessor-based relay with two voltage-per-Hertz stages; V/Hz 1 and V/Hz 2. The relay consists mainly of an input transformer for voltage adaptation and isolation, filter circuits, digital-analog converter, microprocessor, MMI consisting of programming switches and potentiometers and LEDs for start, trip and in-service indications, and three output relays, each with a change-over contact, for the start and trip functions of stage 1 and for the trip function of stage 2 respectively. The relay also has a binary input for remote resetting of the LED indications for “Trip 1” and “Trip 2”.

The relay can be connected for two rated voltages. The operate values of the stages 1 and 2 are set by potentiometers and programming switches in the front. Stage 1 can be set for inverse-time delay based on five different characteristics or for definite-time delay. Stage 2 can be set for definite-time delay.

RXLK 2H has the modular dimensions 4U 6C.

3.4 Tripping relay

The auxiliary relay RXME 18 is used as a tripping relay. It has two heavy duty make contacts and a red flag. The flag will be visible when the armature picks up and is manually reset by a knob in the front of the relay. Typical operate time is 35 ms.

RXME 18 has the modular dimensions 2U 6C. The relay is described in the *Buyer´s Guide*, document No. 1MRK 508 015-BEN.

3.5 Time relay

The time relay RXKL 1 is a dc or ac voltage operated, high-precision, digital time relay utilizing a microprocessor for the time functions. The set pick-up delayed time is 20 ms to 99 hours. The relay has two change-over contacts.

RXKL 1 has the modular dimensions 2U 6C. The relay is described in the *Buyer´s Guide*, document No. 1MRK 508 002-BEN.

3.6 Auxiliary relay

The auxiliary relay RXMB 1 consists mainly of two PCB-mounted card relays, each with two make contacts and one break contact. Typical operate time is 4-5 ms.

RXMB 1 has the modular dimensions 2U 6C. The relay is described in the *Buyer´s Guide*, document No. 1MRK 508 006-BEN.

3.7 Signal relay

The signal relay RXSF 1 consists of two electromechanical relays, each with two make contacts, one break contact and a red flag. The flag will be visible when the armature picks up and is manually reset by a knob in the front of the relay. Typical operate time is 20-25 ms.

RXSF 1 has the modular dimensions 2U 6C. The relay is described in the *Buyer´s Guide*, document No. 1MRK 508 015-BEN.

4 Setting and connection

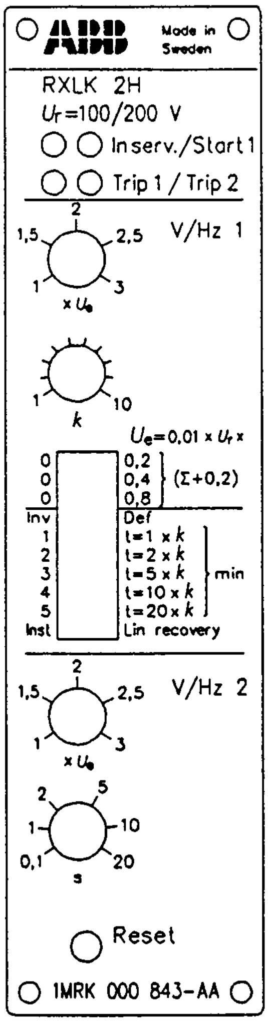


Fig. 5 Front layout

Rated voltage of the relay U_r (100/200 V)

<u>LED indicators</u>:
In serv. (green): indicates relay in service.
Start 1 (yellow): indicates operation of V/Hz 1 (no time delay).
Trip 1 (red): indicates operation of V/Hz 1 after the set time delay.
Trip 2 (red): indicates operation of V/Hz 2 after the set time delay.

<u>V/Hz 1:</u>
Potentiometer (P1) for setting of the operate value for the function V/Hz 1.

Potentiometer (P2) for setting of the inverse time factor or definite time delay for the function V/Hz 1.

10-pole programming switch (S1) for setting of the scale-constant U_e, time-delay characteristic or definite-time delay and recovery functions.

<u>V/Hz 2:</u>
Potentiometer (P3) for setting of the operate value for the function V/Hz 2.

Potentiometer (P4) for setting of the time-delay for the function V/Hz 2.

Reset push-button

4.1 Installation

The RXLK 2H relay requires a dc-dc converter type RXTUG for auxiliary supply ±24 V. Connection of voltage RL shall be made only when the binary input is used.
Observe that the relay has two rated voltages U_r (100 or 200 V) depending on if the voltage is connected to 324-325 (low) or 323-325 (high) see fig. 6.

NOTE! The auxiliary voltage supply should be interrupted or the output circuits should be blocked to avoid the risk of unwanted alarm or tripping, before the relay is plugged into or withdrawn from its terminal base.

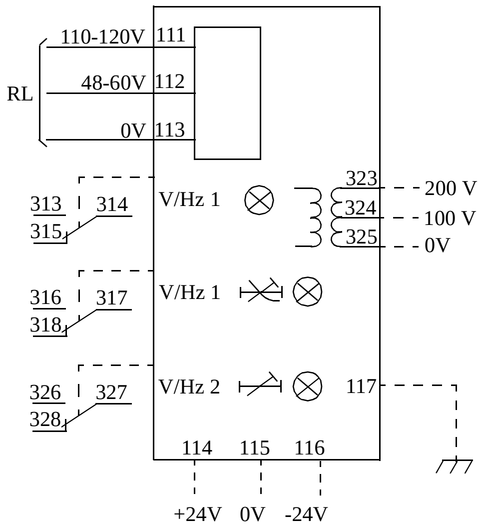


Fig. 6 Terminal diagram

4.2 Settings

All settings can be changed while the relay is in normal service.

1. Setting of the scale-constant U_e.
U_e is common for both stages, V/Hz 1 and V/Hz 2, and is set with the programming switches S1:1, S1:2 and S1:3. Setting range (0,2 to 1,6) x 0,01 x rated voltage U_r. (U_r = 100 or 200 V. Connection, see Terminal Diagram)

2. Setting of the operate value for stage V/Hz 1.
The operate value is set with potentiometer P1 according to
V/Hz 1 = P1 x U_e.

3. The time delay characteristic of stage V/Hz 1.
This stage has six time characteristics, which are programmed on programming switches S1:4 to S1:9.
Definite-time delay.
Set the programming switch S1:4 to position "Def". Switches S1:5 to S1:9 are used for the setting, t = (1, 2, 5, 10, 20) x k min, and potentiometer P2 is used for the adjustment k = 1 - 10. The minimum time delay is 1 min and the maximum time delay is 200 min.
Inverse-time delay.
Set switch S1:4 to position "Inv". The five different inverse-time characteristics are shown in Section 5.
By setting the selector switch S1 a precedence order is applied, from top (S1:5) to bottom (S1:9). That is, if the "Inverse Type 1" characteristic is selected, it overrides the settings of switches S1:6 to S1:9. Another example; if the "Inverse Type 5" characteristic shall be used, the switches S1:5 to S1:8 must all be in the right hand side position.
After setting the time characteristic, the time factor k is adjusted with potentiometer P2.

4. Setting of the operate value for stage V/Hz 2.
The operate value is set with potentiometer P3 according to
V/Hz 2 = P3 x U_e.

5. The time delay of stage V/Hz 2.
The time delay for stage V/Hz 2 has definite-time characteristic. The minimum value is 0,1 s and the maximum value is 20 s. The setting is done with potentiometer P4.

6. Setting of instantaneous or linear recovery
The time counter of stage V/Hz 1 can be set to instantaneous or linear recovery with switch S1:10.
In the linear recovery mode the time counter decreases with (0,2/k %) per second for the inverse-time delay or (0,2/t %) per second for the definite-time delay.

7. The binary input.
The binary input is used for remote reset of the LED indicators. The function is activated when a voltage is applied to input RL.

4.3 Indication

There are four LED indicators. The trip indicators seal-in and are reset manually by the ”Reset” push-button, while the start indicator resets automatically when the relay resets.

When the ”Reset” push-button is depressed during normal operating conditions, all LEDs except "In serv." will light up.

When connecting RXLK 2H to the supply voltage, the relay performs a self test. The ”In serv.” LED is alight, after performing the self test and when the relay is ready for operation. In case of a fault, the LEDs will start flashing.

4.4 Tripping and start outputs

The RXLK 2H relay has one start and one tripping output for stage V/Hz 1, and one tripping output for stage V/Hz 2. Each output is provided with one change-over contact. All outputs reset automatically when the measured value decreases below the resetting value of the relay.

4.5 ESD

The relay contains electronic circuits which can be damaged if exposed to static electricity. Always avoid to touch the circuit board when the relay cover is removed during the setting procedure.

5 Technical data for relay RXLK 2H

Voltage input

Rated voltage U_r	100/200 V
Scale constant U_e	(0,2-1,6) x Ur x 0,01 V/Hz (in steps of 0,2)
Setting range V/Hz 1 100 V 200 V Setting range V/Hz 2 100 V 200 V	0,2-4,8 V/Hz 0,4-9,6 V/Hz 0,2-4,8 V/Hz 0,4-9,6 V/Hz
Power consumption at U_r = 100 V U = lowest U_e U = highest U_e	2 mVA 210 mVA
Overload capacity continuously during 10 s	3,5 x U_r (Max. 500 V AC for COMBIFLEX) 4,0 x U_r (Max. 500 V AC for COMBIFLEX)

Start and trip functions

Volt / Hertz function	Stage V/Hz 1	Stage V/Hz 2
Operating range	5-100 Hz (2-5 and 100-150 Hz with lower accuracy)	
Setting range	(1-3) x U_e (0,2-9,6 V/Hz)	
Frequency dependence within the range of: 44-66 Hz 4-100 Hz 2-150 Hz	< 1,0% < 4,5% < 17%	
Typical operate time at 50 Hz: (before operation 0,9 x start value) V/Hz = 1,1 x start value V/Hz = 1,3 x start value V/Hz = 1,5 x start value	Start function 50 ms 45 ms 40 ms	Trip function t = 0,1 s 80 ms 70 ms 65 ms
Typical reset time at 50 Hz: (after operation 0,9 x start value) V/Hz = 1,1 x start value V/Hz = 1,5 x start value V/Hz = 2,0 x start value	 50 ms 45 ms 40 ms	
Consistency of operate value at: 2 Hz 5 Hz 20 Hz 50 Hz 100 Hz 150 Hz	< 2,0% < 1,5% < 1,0% < 0,5% < 0,5% < 0,5%	
Reset ratio within the range of: 5-100 Hz 2-150 Hz	> 95 % > 94 %	
Recovery time at 50 Hz	< 70 ms	
Overshoot time at 50 Hz	< 35 ms	
Influence of harmonics: 100 / 120 Hz, 20% 150 / 180 Hz, 20% 250 / 300 Hz, 20%	< 1% < 6% < 3%	

Time functions

Time function	Stage V/Hz 1		Stage V/Hz 2
Time delay	Inverse time and Definite time		Definite time
Setting range	5 curves k = 1-10 see fig. 7-11	t = k x 1, 2, 5, 10 or 20 min k = 1-10 (1-200 min)	0,1-20 s
Accuracy at 50 Hz	Curves 1-4 0,5% of X[1] and 0,5% of the theoreti- caltime and ±100 ms Curve 5 1,0% of X[1] and 1,0% of the theoreti- cal time and ±100 ms	0,5% of the theoreti- cal time and ±100 ms	0,5% of the theoreti- cal time and ±100 ms
Consistency	< 0,5%	< 0,5%	< 0,5%
Reset mode	Instantaneous or linear recovery		–
Formula for linear recovery	0,2/ k % / s	0,2/ t % / s	

1. (X = actual U/f divided by set operate value)

Auxiliary DC voltage supply

Auxiliary voltage EL for RXTUG 22H Auxiliary voltage for the relay	24-250 V DC, ±20% ±24 V (from RXTUG 22H)
Power consumption at RXTUG 22H input 24-250 V before operation after operation without RXTUG 22H ±24 V before operation after operation	 Max. 5,5 W Max. 6,5 W Max. 2,0 W Max. 3,0 W

Binary input

Binary input voltage RL		48-60 V and 110-220 V DC, -20% to +10%
Power consumption	48-60 V 110-220 V	Max. 0,3 W Max. 1,5 W

Output relays

Contacts		3 change-over
Maximum system voltage		250 V AC / DC.
Current carrying capacity	continuous during 1 s	5 A 15 A
Making capacity at inductive load with L/R >10 ms	during 200 ms during 1 s	30 A 10 A
Breaking capacity AC, max. 250 V, cos φ > 0,4 DC, with L/R < 40 ms 48 V 110 V 220 V 250 V		 8 A 1 A 0,4 A 0,2 A 0,15 A

Electromagnetic compatibility (EMC), immunity tests

All tests are done together with the DC/DC-converter, RXTUG 22H

Test	Severity	Standard
Surge	1 and 2 kV, normal service 2 and 4 kV, destructive test	IEC 61000-4-5, class 3 IEC 61000-4-5, class 4
AC injection	500 V, AC	SS 436 15 03, PL 4
Power frequency magnetic field	1000 A/m	IEC 61000-4-8
1 MHz burst	2,5 kV	IEC 60255-22-1, class 3
Spark	4-8 kV	SS 436 15 03, PL 4
Fast transient	4 kV	IEC 60255-22-4, class 4
Electrostatic discharge In normal service with cover on	 8 kV (contact) 15 kV (air) 8 kV, indirect application	 IEC 60255-22-2, class 4 IEC 60255-22-2, class 4 IEC 61000-4-2, class 4
Radiated electromagnetic field	10 V/m, 26-1000 MHz	IEC 61000-4-3, level 3
Conducted electromagnetic	10 V, 0,15-80 MHz	IEC 61000-4-6, level 3
Interruptions in auxiliary voltage 110 V DC, no resetting for interruptions	2-200 ms < 40 ms	IEC 60255-11

Electromagnetic compatibility (EMC), emission tests

Test	Severity	Standard
Conducted	0,15-30 MHz, class A	EN 50081- 2
Radiated	30-1000 MHz, class A	EN 50081- 2

Insulation tests

Test	Severity	Standard
Dielectric Circuit to circuit and circuit to earth Over open contact	 2,0 kV AC, 1 min 1,0 kV AC, 1 min	 IEC 60255-5
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

Mechanical tests

Test	Severity	Standard
Vibration	Response: 2,0 g, 10-150-10 Hz Endurance: 1,0 g, 10-150-10 Hz, 20 sweeps	IEC 60255-21-1, class 2 IEC 60255-21-1, class 1
Shock	Response 5 g, 11 ms, 3 pulses Withstand: 15 g, 11 ms, 3 pulses	IEC 60255-21-2, class 1
Bump	Withstand: 10 g, 16 ms, 1000 pulses	IEC 60255-21-2, class 1
Seismic	X axis: 3,0 g, 1-35-1 Hz Y axis: 3,0 g, 1-35-1 Hz Z axis: 2,0 g, 1-35-1 Hz	IEC 60255-21-3, class 2, extended (Method A)

Temperature range

Storage	-20 °C to +70 °C
Permitted ambient temperature	-5 °C to +55°C

Weight and dimensions

Equipment	Weight	Height	Width
RXLK 2H without RXTUG 22H	0,7 kg	4U	6C

Inverse time characteristic type 1 RATUB (Fig. 7)

This characteristic is similar to the previous ABB type RATUB protection. The curve follows the formula:

$$t(s) = \frac{0,18 \cdot k}{(X-1)^2}$$

where

k is a settable constant 1 to 10.

X is overexcitation according to the formula:

X = U/f⁄(U/f)set

Inverse characteristic type 2-4 (Fig. 8-10)

Inverse time curve follows the formula according to ANSI-standard.

$$t = e^{-\frac{(X \cdot 100) - K1}{C}}$$ in minutes

where:

Type	K1	C
Inv 2	108,75 + (k-1) x 2,5	2,449
Inv 3	115 + (k-1) x 2,5	4,8858
Inv 4	113,5 + (k-1) x 2,5	3,04

X = U/f⁄(U/f)set

k = a settable constant 1 to 10.

Inverse characteristic type 5

Characteristic type 5 is shown in fig. 11.

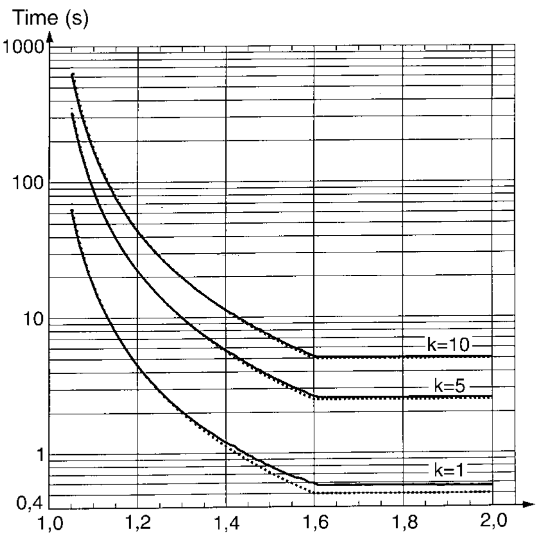


Fig. 7 Inverse characteristic type 1 (RATUB)

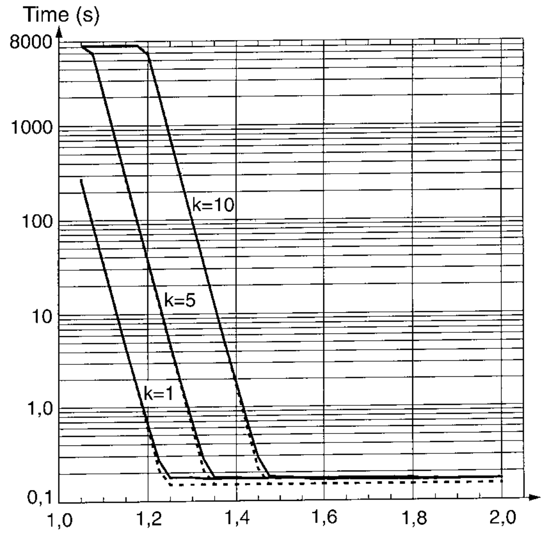


Fig. 8 Inverse characteristic type 2

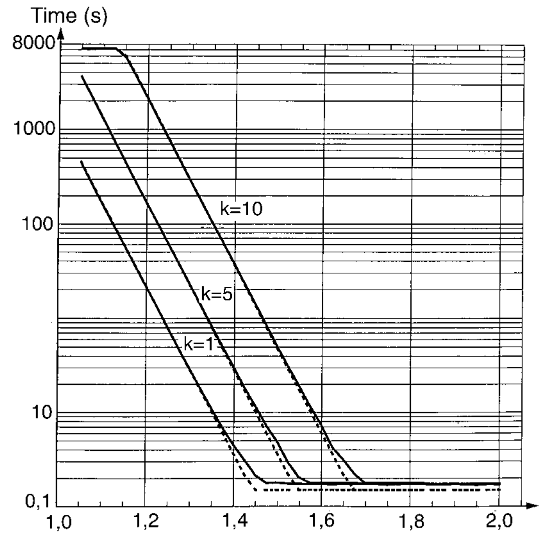


Fig. 9 Inverse characteristic type 3

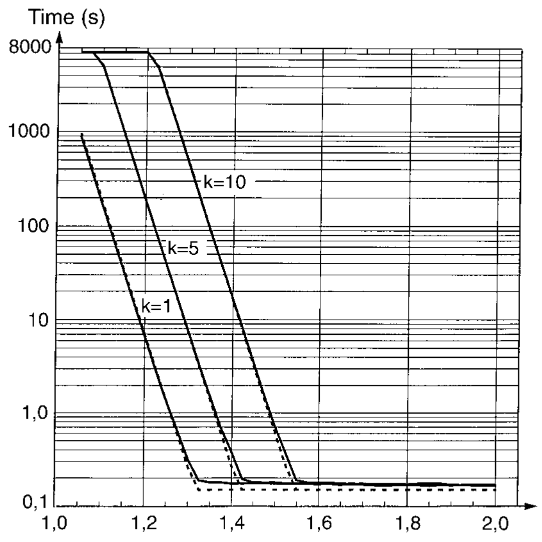


Fig. 10 Inverse characteristic type 4

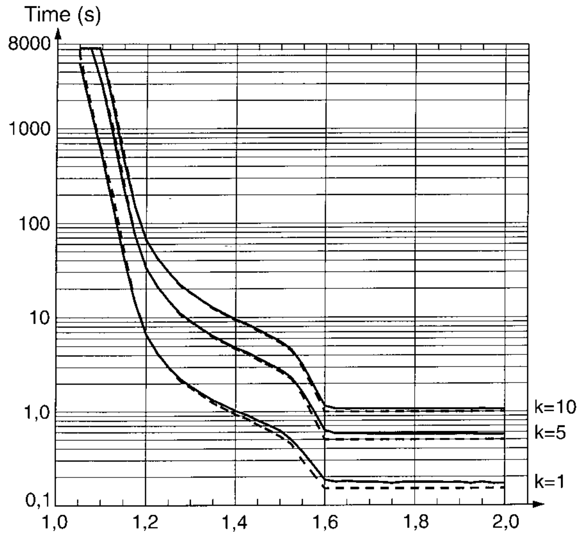


Fig. 11 Inverse characteristic type 5
Measured curve = Solid line
Theoretical curve = Dotted line

6 Receiving, Handling and Storage

6.1 Receiving and Handling

Remove the protection package from the transport case and make a visual inspection for transport damages. Check that all screws are firmly tightened and all relay elements are securely fastened.

Check that all units are included in accordance with the apparatus list.

Normal ESD (Electrostatic Discharge) precautions for microprocessor relays should be observed when handling the relays.

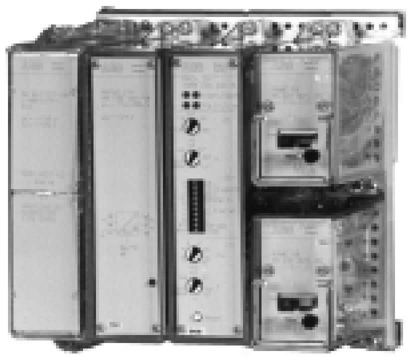
6.2 Storage

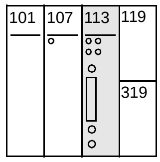
If the protection package is to be stored before installation, this must be done in a dry and dust-free place, preferably in the original transport case.

7 Testing and Commissioning

7.1 Installation

The relays and the RXTUG 22H DC-DC converter are plugged into COMBIFLEX® terminal bases type RX 4 or RX 2H. The terminal bases and the RTXP test switch, when included, are fixed on apparatus bars to make up the protection assembly.





101 RTXP 18
107 RXTUG 22H
113 RXLK 2H
119 RXME 18
319 RXME 18

Fig. 12 RALK overexcitation protection, acc. to Circuit diagram 1MRK 001 034-EA

The protection assembly can be mounted in the following ways:

- on apparatus bars
- in a 19” equipment frame
- in RHGX case
- in RHGS case

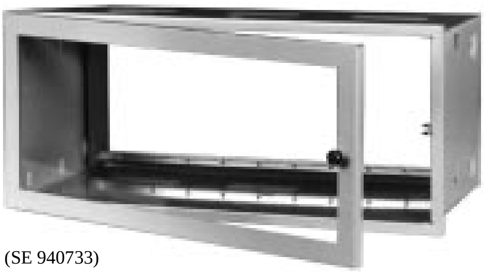
The height and width of the protection assembly are given in the circuit diagram with height (U) and width (C) modules, where U = 44,45 mm and C = 7 mm. The depth of the protection assembly, including space for the connection wires, is approximately 200 mm.

All internal connections are made and the protection assembly is tested before delivery from factory.

Equipment frames and relay cases.
Detailed information on the COMBIFLEX® connection and installation components is given in Catalogue 1MRK 513 003-BEN. Information on the relay mounting system is given in Catalogue 1MRK 514 001-BEN.

RHGS cases for 19” cubicle mounting or surface mounting
This type of case can be used for all common ways of mounting. The RHGS cases are available in three different sizes, which can be combined with mounting accessories to get maximum flexibility. The cases can also be combined together with the protections in the 500 range.

RHGS 30



(SE 940733)

Fig. 13 RHGS case

RHGX cases for flush- or semi-flush panel mounting
The RHGX cases are available in five sizes. The case, a metal box open at the back, has a flange (with a rubber sealing strip) at the front which acts as a stop when the case is inserted into a front panel opening. At the front of the case there is a door with a window and a rubber seal.

RHGX 8

(SE 81702)

Fig. 14 RHGX case

19” equipment frames
These types of equipment frames are used for cubicle mounting or panel mounting of plug-in units in the COMBIFLEX® range. The frames are available in 3 sizes:

- 4U (17” x 19”)
- 8U (14” x 19”)
- 12U (21” x 19”)

for mounting 20, 40 and 60 module seats respectively.

Size: 4U 19”

(SE 96399)

Fig. 15 19” equipment frame

Connections

The external connections (dotted lines on the terminal and circuit diagrams) are made with leads with 20 A COMBIFLEX® sockets to the RTXP 18 test switch and with 10 A sockets to the relay terminal bases.

Each unit in the protection assembly has a unique item designation. The item designations are based on a coordinate system of U and C modules, where the first figure stands for the U module position starting from the top and the next two figures stand for the C module position, starting from the left-hand side - seen from the front side of the protection assembly. The RTXP test switch in Fig. 16 has item designation 101, where the first figure stands for the U module position and the next two figures stand for the C module designation.

The terminal designations include the item designation number of the unit followed by the terminal number marked on the rear of the terminal socket.

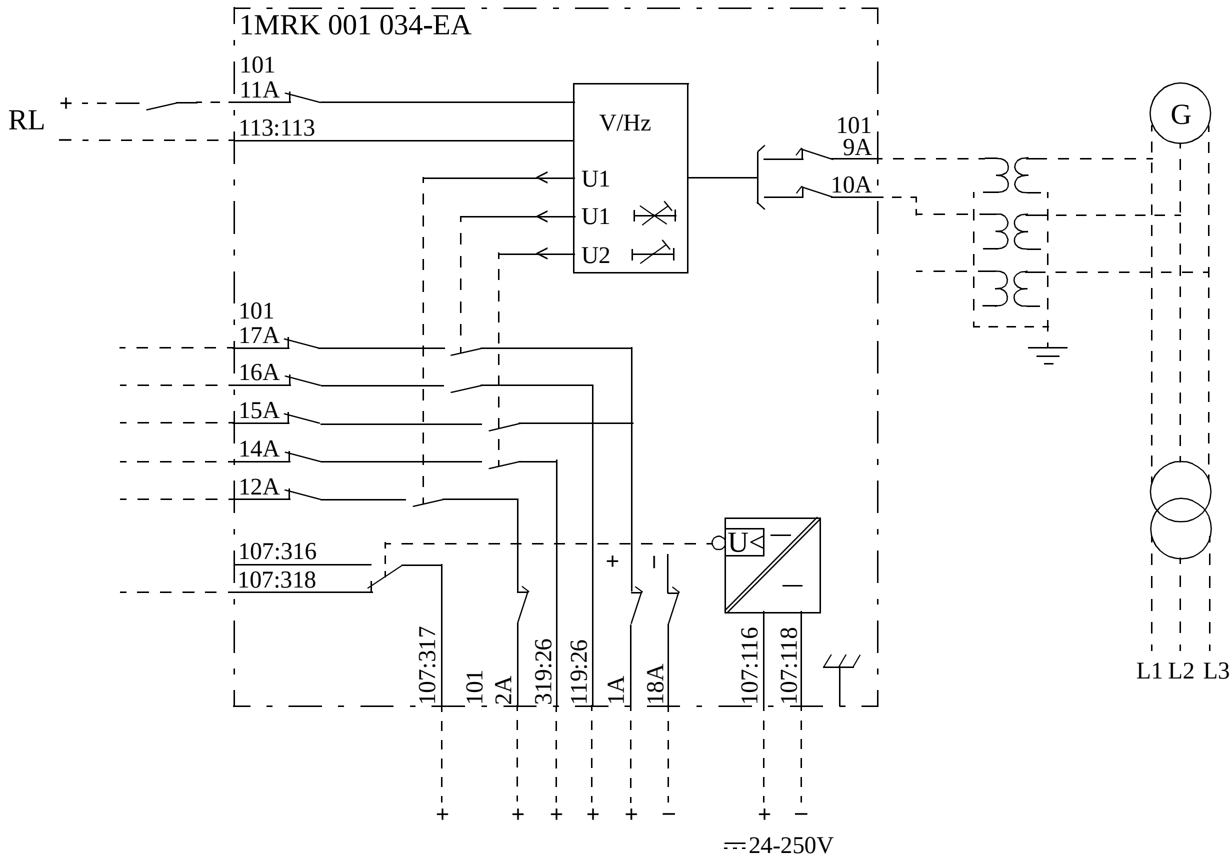


Fig. 16 Terminal diagram 1MRK 001 034-EAA

For plug-in units size 2H an additional figure 1 or 3 defines if the terminal is in the upper resp. lower part of the assembly. Compare terminal designations 107:118 and 107:318 in Fig. 17.

Fig. 17 shows the rear of protection assembly RALK, Order No. 1MRK 001 034-EA. The position of the terminals, which are used for external connections according to connection diagram 1MRK 001 034-EAA, is shown.

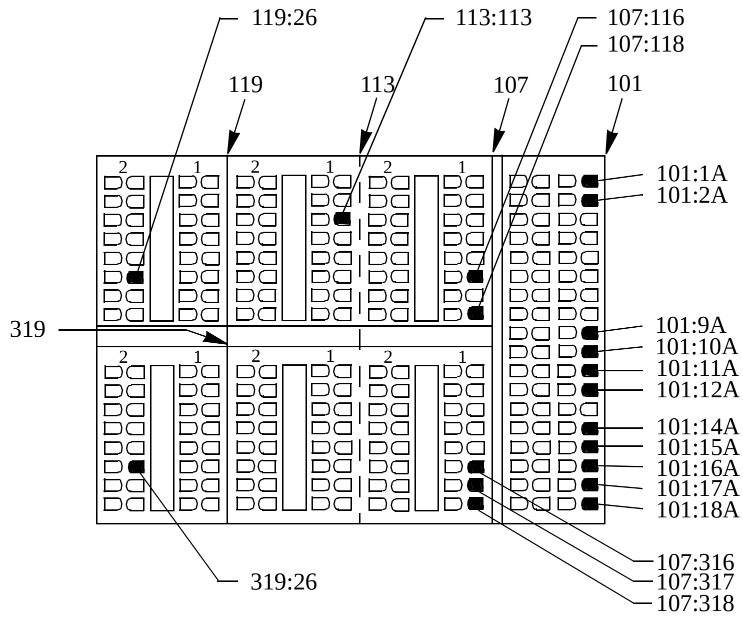


Fig. 17 Location of the terminals shown on diagram 1MRK 001 034-EAA

7.2 Testing

Secondary injection testing

The standard relays (Ordering Numbers 1MRK 001 0xx-xA) are provided with the COMBITEST test switch type RTXP 18.

When the test-plug handle RTXH 18 is inserted into the test switch, preparations for testing are automatically carried out in the proper sequence, i.e. blocking of the tripping circuits, opening of the voltage transformer circuits and making relay terminals accessible for testing from the terminals on the test-plug handle.

When the test-plug handle is in intermediate position, only the tripping circuits are open. When the test-plug handle is fully inserted, the relay is completely disconnected from the voltage transformers and ready for secondary injection testing. Test terminals 1 and 18 are not open when the test-plug handle is inserted.

Relays not provided with test switches have to be tested in the proper way from external circuit terminals.

When the frequency of the supply voltage is stable and close to rated value (50 or 60 Hz), the V/Hz relays can conveniently be tested with a single-phase test set with variable voltage output, e.g. the SVERKER test set with a built-in timer.

Suitable test equipment:

- Test set SVERKER
- Multimeter or voltmeter, Class 0.5 or better
- RTXH 18 test-plug handle with test leads

Fig. 18 shows as an example the connection of test set SVERKER for secondary testing of RALK 1, Connection Diagram 1MRK 001 034-EAA. When testing, the actual circuit diagram of the protection, which shows the internal connections, should also be available.

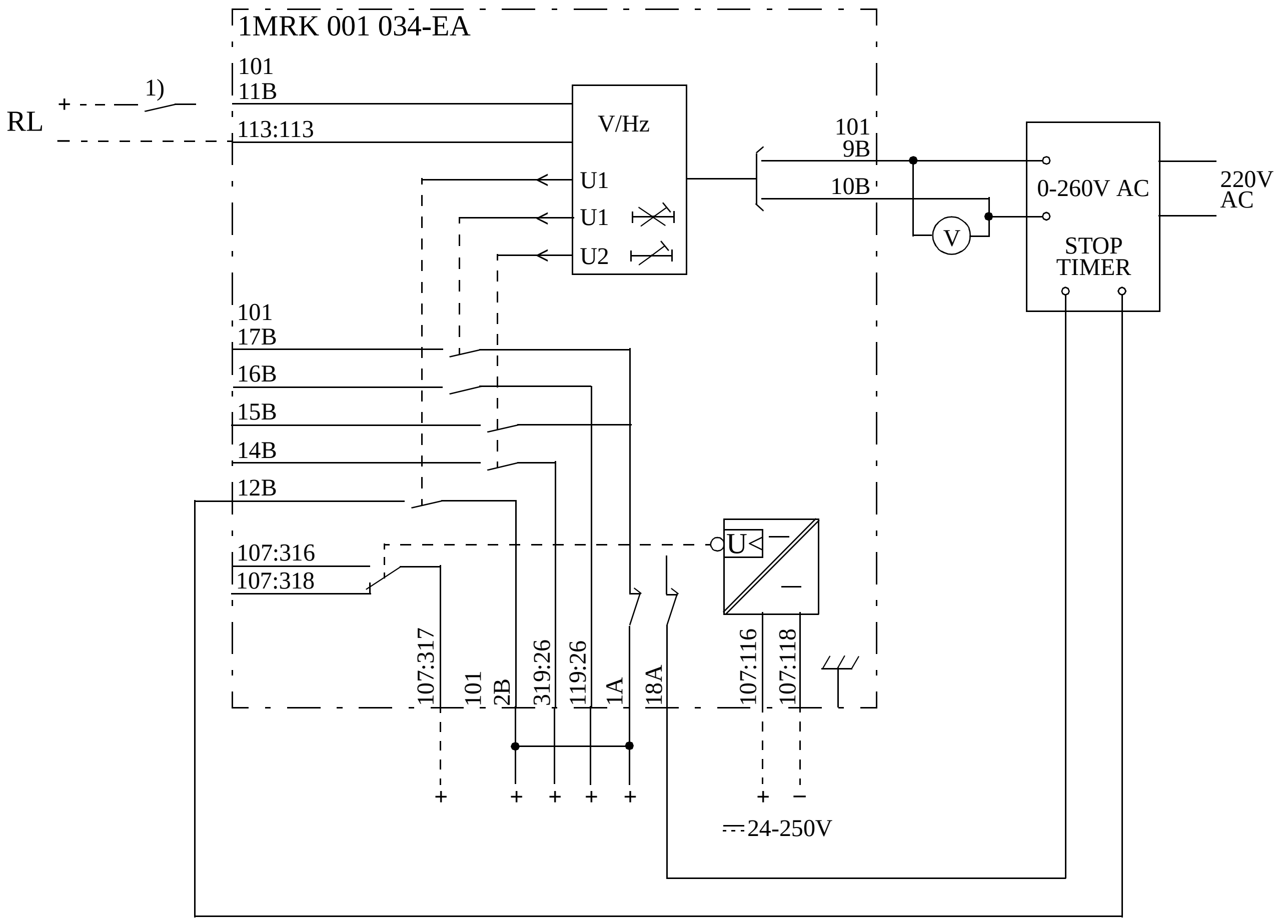


Fig. 18 Connection of test apparatus to RALK 1. Test handle RTXH 18 inserted

1. Connect the test set and the voltmeter acc to Fig.18. Insert the test-plug handle into the test switch. Check that auxiliary voltage is connected to terminals 101:1A and 101:18A. Interconnect terminals 1 and 2 on the test handle to get output voltage to test terminal 12 when the start function for stage 1 is activated.

2. Make the appropriate settings of V/ Hz for the start function of stages 1 and 2. For stage 1, select definite time delay or the appropriate type of inverse characteristic and time factor k. For stage 2, set the selected definite time delay. Set the switch S1:10 to position “Inst“. Instructions for the setting of the switches and potentiometers on the front of the RXLK 2H relay are given in Section 4, “Setting and connection”.

3. The operate voltage for a given V/Hz setting is equal to the product U/f x f. The start function for stage 1 in the example in Section 1.2, with the setting 2,14 V/Hz, is to operate at 2,14 x 50 = 107 V when tested at 50,0 Hz.

4. Increase the injection voltage slowly until the start relay for stage 1 operates (output voltage on test terminal 12). Also check that the LED indicator for start is activated when stage 1 operates. Check the resetting value.

5. Move the timer stop wire to test terminal 17. If definite time delay is selected for stage 1, increase the injection voltage to 1,5 times the start value and check the time delay. If inverse time delay is selected, check the operate time at two points on the inverse time characteristic, e.g. at voltages corresponding to M = 1,1 and 1,3. Check that the LED indicator for time delayed tripping is activated.

6. Move the timer stop wire to test terminal 16 and check that output voltage is obtained when stage 1 operates and voltage is supplied to terminal 119:26

7. Move the timer stop wire to test terminal 15. Reduce temporarily the time delay of stage 2 to minimum value and slowly increase the injection voltage to check the start value of stage 2. Check the reset value.

8. Restore the correct time setting of the timer for stage 2. Increase the injection voltage to 1,5 times the start value and check the time delay. Move the timer stop wire to test terminal 14 and check that output voltage is obtained when stage 2 operates and voltage is supplied to terminal 319:26.

9. Activate the binary input (voltage RL+ to terminal 11B) on the test switch and check that the start and trip indicating LED’s reset.

10. Set switch S1:10 to the correct position in accordance with the setting plan.

7.3 Commissioning

The commissioning work includes a check of all external circuits connected to the protection and a check of the voltage ratio for the voltage transformers.

The DC circuits and tripping circuits should be checked, including operation of the circuit breaker(s).

8 Maintenance

Under normal conditions, the over-excitation protection relays require no special maintenance. The covers should be mounted correctly in position and the holes for the resetting knobs sealed with plastic plugs.

In exceptional cases, burned contacts on the output relays can be dressed with a diamond file.

Under normal operating conditions and when the surrounding atmosphere is of non-corrosive nature, it is recommended that the relays be routine tested every four to five years.

9 Circuit and terminal diagrams

The table below shows the different variants of the overexcitation protection type RALK**.**

Type	Test-switch	DC-DC con-verter	Tripping relays	Ordering No. 1MRK 001	Circuit Diagram 1MRK 001	Terminal diagram 1MRK 001	Diagram
RALK 1	x			033-BA	034-BA	034-BAA	On request
RALK 1		x		033-CA	034-CA	034-CAA	On request
RALK 1	x	x		033-DA	034-DA	034-DAA	On request
RALK 1	x	x	x	033-EA	034-EA	034-EAA	Fig. 19, 20
RALK 1 *)	x	x	x	033-EL	034-EL	034-ELA	Fig. 21, 22

*) variant with a separate time stage released from a digital input.

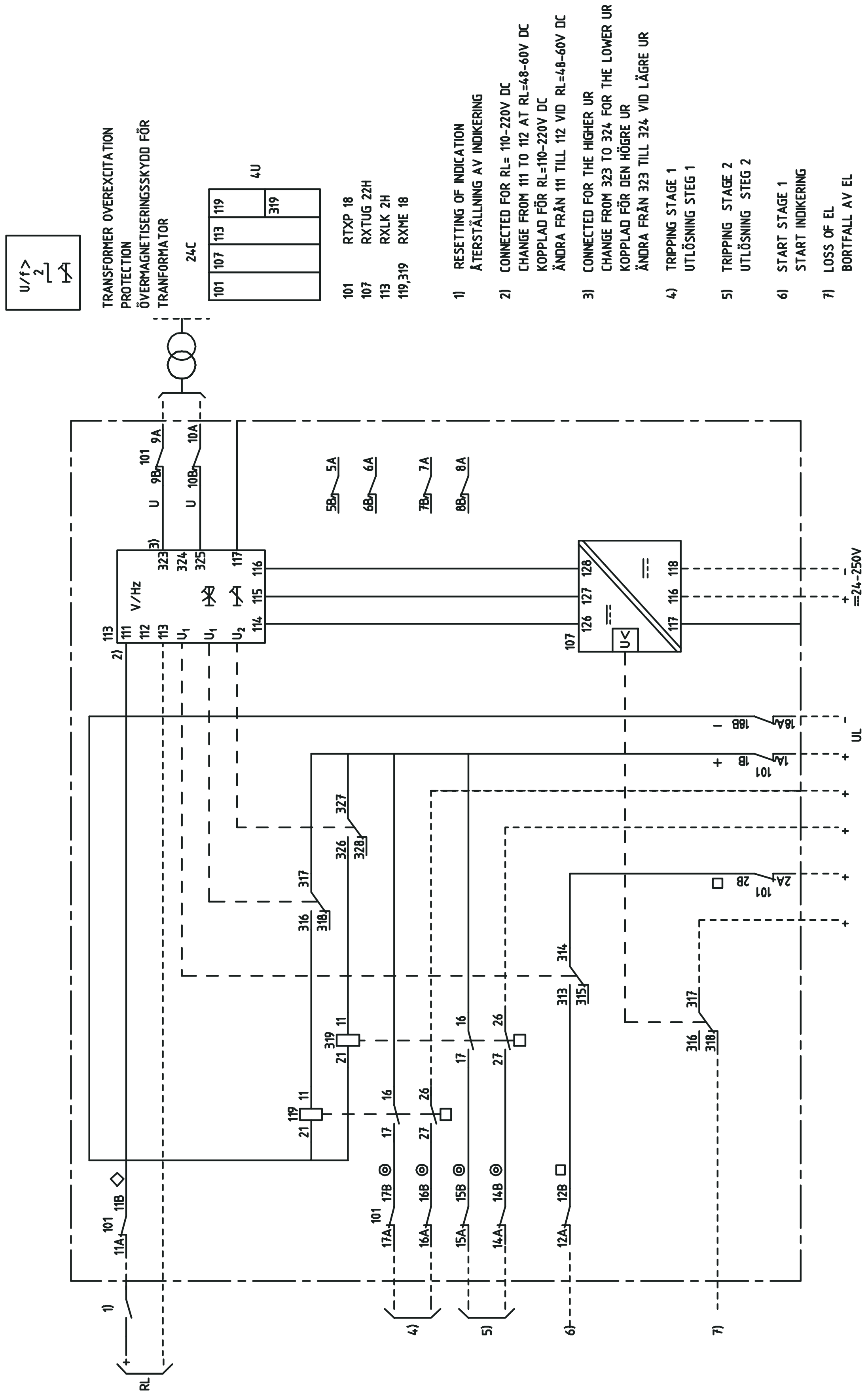


Fig. 19 Circuit diagram 1MRK 001 034-EA

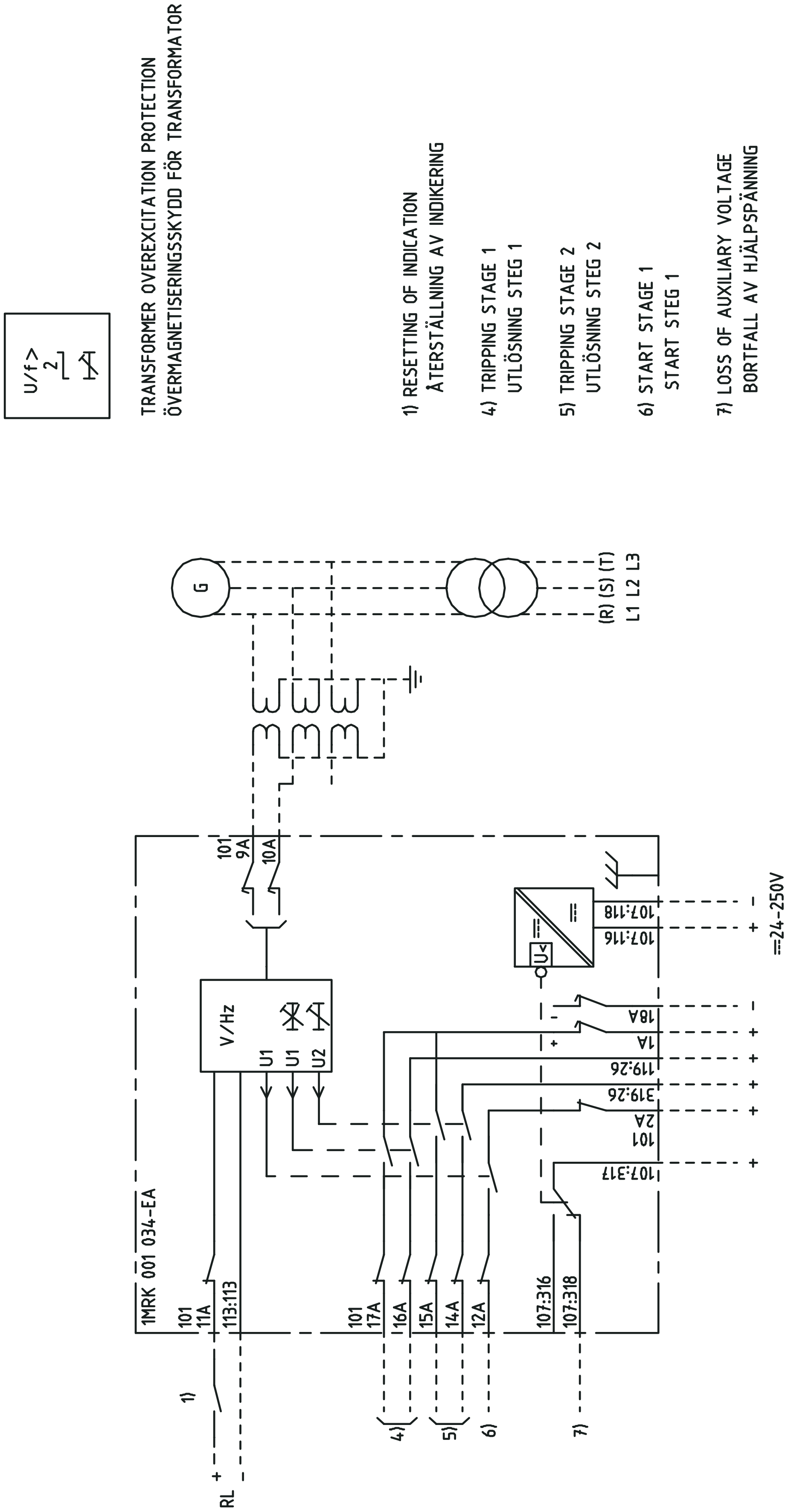


Fig. 20 Terminal diagram 1MRK 001 034-EAA

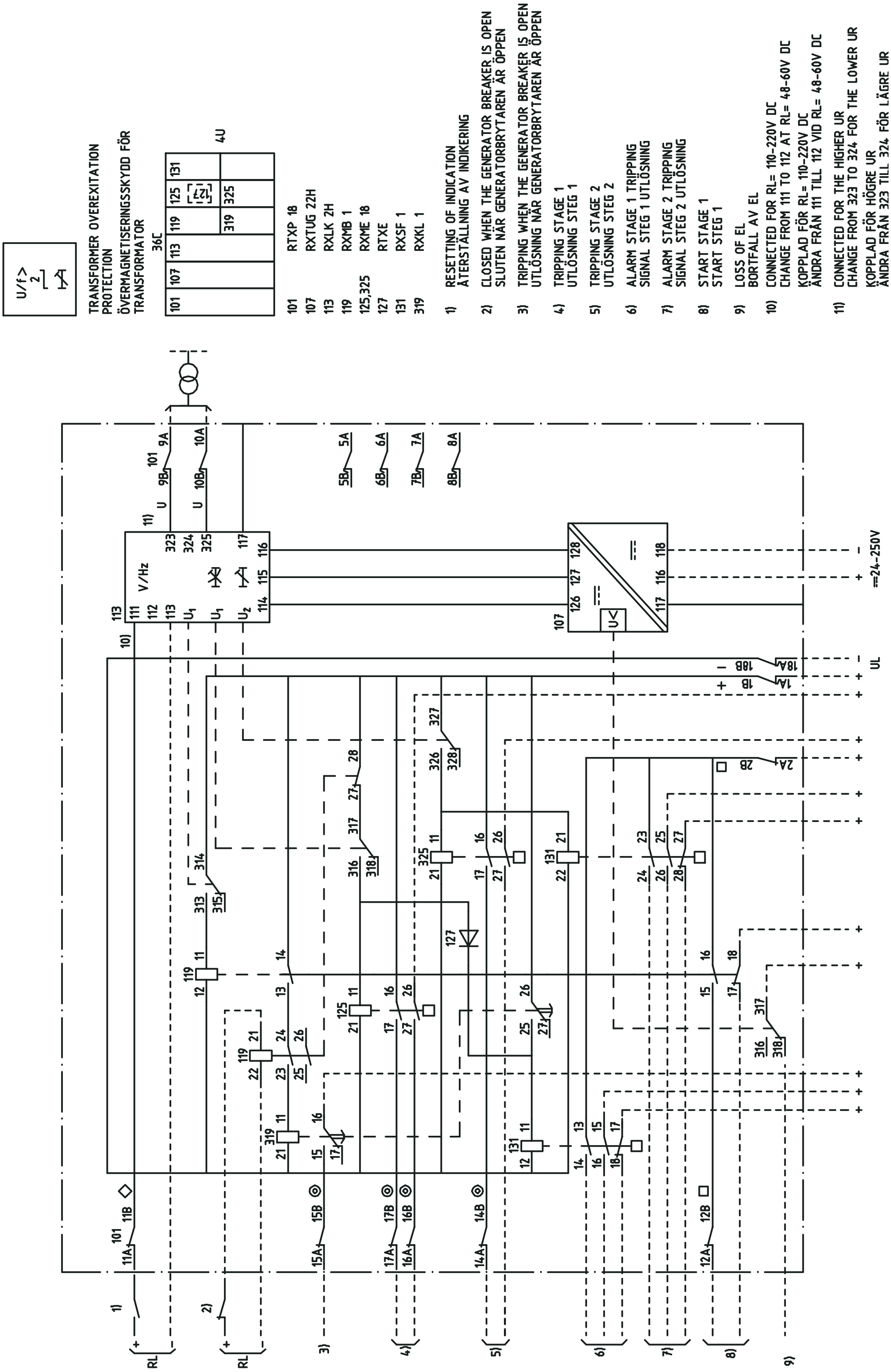


Fig. 21 Circuit diagram 1MRK 001 034-EL

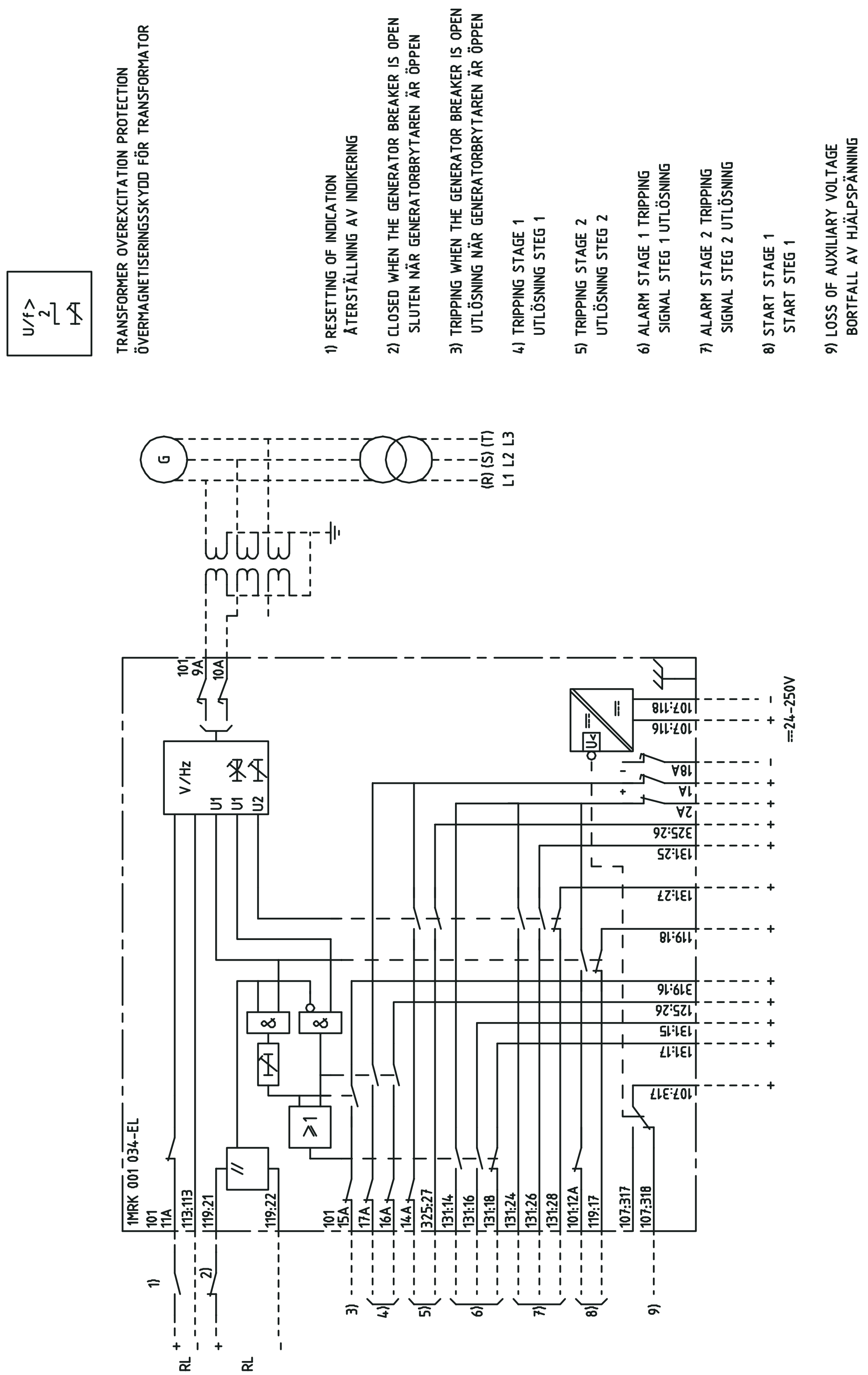


Fig. 22 Terminal diagram 1MRK 001 034-ELA

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