ABB Network Partner AB

RXEDK 2H and RAEDK
Time over/undervoltage relay and protection assemblies

User´s Guide

1MRK 509 004-UEN
Replaces
Version 1
August 1997

General

Over/undervoltage protection assemblies type RAEDK are available in a number of variants for measurement of one-, two- or three-phase power system ac-voltages. The relays are suitable for protection and control applications. The relays provide two-stage over- and/or under-voltage protection in a very compact packaging allowing many possible mechanical assemblies. I.e. 19” rack-mounting or various forms of panelmounting using the COMBIFLEX® mounting details.

The RXEDK 2H voltage relay element used is characterised by a wide setting range, high setting resolution, low burden on the input voltage transformer, built in timing ranges, selectable inverse or definite time, high reset ratio, high continuous overload rating and built in LED indication of operation, starting and tripping of the two stages.

The possibility of specifying built-in frequency filters enhances the application range. E.g., there are versions to measure voltages of specific frequencies occurring in the power system, e.g. 150-180 Hz. A bandpass filter for 50-60 Hz is also available.

Products based on the RXEDK 2H measuring relays are available as assemblies of measurement relays. Versions having optional additional devices are also available. E.g. a test switch type RTXP 18 is available as an option, a DC-DC converter RXTUG 22H and a tripping relay RXME 18 are other standard options. A number of standardized protective packages are thus available. Standard schematics are provided for ease of protection selection and for user maintenance and servicing guidance. Protection assemblies combining different COMBIFLEX® modules may be specified and built in similar arrangements.

List of contents

1 Application ... 3
1.1 Over-voltage protection ... 3
1.2 Undervoltage protection ... 4
1.3 Stator earth fault protection ... 5
1.4 Neutral point overvoltage protection ... 5
1.5 Voltage relays for various ”control and supervision” applications ... 6

2 Measurement principles ... 7

3 Design ... 9
3.1 Test switch ... 9
3.2 DC-DC converter ... 9
3.3 Measuring relay ... 9
3.4 Tripping relay ... 10

4 Setting and Connection ... 11
4.1 Connection ... 11
4.2 Settings ... 12
4.3 Indication ... 13
4.4 Tripping and start outputs ... 13
4.5 ESD ... 13

5 Technical data for relay RXEDK 2H ... 14

6 Receiving, Handling and Storage ... 22
6.1 Receiving and Handling ... 22
6.2 Storage ... 22

7 Installation, Testing and Commissioning ... 23
7.1 Installation ... 23
7.2 Testing ... 26
7.3 Commissioning ... 29

8 Maintenance ... 29

9 Circuit and terminal diagrams ... 30

1 Application

Voltage relays are used in power systems for many different applications. The RXEDK 2H single-phase relay is provided with several new design features, optional filters and wide setting-flexibilities that makes it suitable in practically all possible applications for over- and under-voltage relays. The relay has two setting levels (steps), selectable for over or undervoltage. Thus one step can be for overvoltage and the other for undervoltage. Both steps may be set for instantaneous or definite time-delayed operation. One step (U1) can be set for inverse time-delay as an alternative to the definite time delay function available for both steps. Standard relays for 50-60 Hz, 16 $^{2}/_{3}$, 50-60 sharp and 150-180 Hz versions are available, using a built in filter. The standard 50-60 Hz relay has a flat frequency response characteristic to cover a wide frequency range.

The RAEDK assemblies of single-phase relay elements are available in a multitude of standard packages, with or without test-switch and with or without DC/DC power supply. Single-, two- or three-phase RAEDK packages are available. Depending on the application requirements, a suitable standard package may thus be selected. Special schemes may also be built up, based on combinations of COMBIFLEX® plug-in modules.

Typical applications include single or multiple RXEDK 2H phase elements measuring two-stage overvoltage or combined over and undervoltage protection for system voltage supervision and various single relay element neutral point or broken delta overvoltage applications for earth-fault detection. The relays may be used for directly grounded systems as well as high impedance or unearthed power systems.

1.1 Over-voltage protection

Overvoltage relay protection at power system frequencies supplements surge protection for transient overvoltages due to switching or atmospheric disturbances. Overvoltage stresses insulation on powerlines, cables and electrical apparatus, electrical machines etc.

For transformers and transmission lines, overvoltage protection may be used to detect excessive voltages. A single overvoltage setting level is frequently used, either as an instantaneous or time-delayed protection function. Two overvoltage set levels are often used as well. One high set level may be instantaneous and the other lower set may be time-delayed, depending on the requirements for the specific application. A feature of the RXEDK 2H relay is its low transient overreach, which is of importance when using the instantaneous function.

For transformers an instantaneous voltage “flash-over” protection on the low voltage winding will detect high overvoltages occurring for faults between the high voltage and the low voltage winding. This may be used when the low voltage winding is not solidly earthed. An overvoltage relay may be used for over-excitation protection in cases where the system frequency is not varying, otherwise V/Hz relays, e.g type RALK are recommended.

For generator protection an overvoltage relay is typically used to protect the machine in case of defective operation of the voltage regulating system or during manual control operation with the regulator out of service. Sudden loss of load could also result in excessive overvoltages, that necessitates over voltage protection since the rated overvoltage capability of the machine is easily exceeded. The ability of the standard 50-60 Hz relay to operate over a wide frequency range is an advantage for generator applications.

Synchronous motors are also a source for possible overvoltages and are therefore often provided with an overvoltage relay.

A feature of the RXEDK 2H is the possibility of using the inverse time-voltage function (for U1, i.e. step 1) in which a faster operating time is obtained depending on the magnitude of the voltage-excursion. Thus a single inverse over-voltage function may provide an alterative to a traditional two-step combination of an instantaneous and definite time-delayed overvoltage protection. Alternatively, the inverse function of U1 may be used for undervoltage and the U2 for instantaneous or definite time delayed overvoltage protection.

Since the RXEDK 2H is provided with two independently settable steps (U1 and U2) that may be used independently for overvoltage or undervoltage protection, good application flexibility is obtained over a wide range of voltages. The scale ranges of 5-480, 1-120 or 0.1-12 V are available in three versions.

The overvoltage protection may be implemented having the relays connected to instrument transformers connected to provide either phase to neutral or phase-phase voltage. The number of single phase RXEDK 2H elements needed for protection is determined by the actual application needs. In less critical applications a single phase relay, connected to phase-phase voltage, may be sufficient. In more critical applications, a three-phase relay assembly, i.e. RAEDK 3 should be used.

1.2 Undervoltage protection

Undervoltage relays are often used to disconnect motors when a busbar undervoltage condition is detected, to prevent problems with high inrush-currents simultaneously with at system voltage recovery. Synchronous motors may quickly come out of synchronism and must be quickly disconnected when undervoltage conditions occur. When several asynchronous motors are connected to a busbar the recovery of voltage after an undervoltage dip will cause a new inrush current that may cause upstream relay tripping. Single phase relays connected phase to phase are often used for asynchronous motors whereas positive sequence undervoltage relays are often recommended for large synchronous motors.

The undervoltage function may also be used to supervise the initiation of bus transfer, e.g for motors. The relay measures the bus residual voltage and transfers the supply to an alternate source, when the voltage is below an acceptable level.

Undervoltage relays are also used for generators in order to detect abnormal operating conditions.

Undervoltage relays may be used as back-up to other protective relays in case of fault conditions difficult to detect based on impedance or current. Undervoltage is often used as a starting or ”check” criteria for other methods of fault-detection. For example the combination of undervoltage and overcurrent relays may be used for back-up protection of generators or in distribution networks as an undervoltage controlled overcurrent protection. This allows the overcurrent relays to be set more sensitive than otherwise would be possible, i.e. below rated load current.

The RXEDK 2H undervoltage relay may thus be combined with other measuring elements in the COMBIFLEX® series to provide enhanced protection methods. The undervoltage criteria is for example used together with the directional and overcurrent information in the type RAGPK relay to provide loss of excitation protection for generators.

1.3 Stator earth fault protection

An overvoltage function is used as a stator earth fault relay. Depending on the machine generated third harmonic voltage and the degree of damping of the relay response to the third harmonic voltage, different sensitivities can be achieved. The machine and system generated third harmonic voltage appears at the neutral point and limits the possible overvoltage relay setting in order to ensure security for unfaulted system conditions. For a standard 50-60 Hz relay a voltage relay setting may have to be reduced to a smaller portion (e.g. 60-70%) of the winding, whereas a relay provided with a 50-60 Hz bandpassfilter that effectively reduce the influence of the third harmonic component can provide more coverage or up to about 95% of the winding. RXEDK 2H is available with or without filters. Typically the 1-120 V range is selected for this application.

For the above mentioned application of RXEDK 2H it is possible to use the inverse time-delayed characteristic in order to provide a faster operating time for ”heavier” faults. Alternatively the definite time-delay is used. The set time-delay is to be coordinated with other ground fault relays in the system to provide selectivity.

In order to provide full stator earth fault protection for the complete winding, in case of generators connected to the system via step-up transformers, a third harmonic undervoltage relay may be used at the machine neutral. The RXEDK 2H relay may be supplied with a tuned filter for measurement of the third harmonic voltage. Typically the 0.1 to 12 V range is selected for this application.

1.4 Neutral point overvoltage protection

Neutral point voltage protection is used as a back-up protection for earth faults in low- and high-impedance earthed systems.

For many parts of the power system it is possible to arrange zero-sequence or neutral point overvoltage protection. To obtain the voltage necessary, different sources can be used. A broken delta connection of

three-phase voltage transformer secondary windings are often used to provide residual zero-sequence voltage (3U0). Another possible source is single voltage transformer located at an available neutral point.

The standard 50-60 Hz RXEDK 2H relay without a filter to damp the third harmonic voltage is normally set at about 20 % of the neutral voltage obtained for a solid fault at the potential transformer terminal. If a lower setting is desired, e.g 5-10 % of the maximum voltage obtained for a fully developed ground fault, the 50-60 Hz sharp filter is recommended in order to prevent operation due to the normal system third harmonic voltage. Either inverse or definite time-delayed protection may be used. The time delay must be set to coordinate with other available ground fault relays for selectivity reasons.

1.5 Voltage relays for various ”control and supervision” applications

Voltage relays are often used to provide information about various voltage conditions in different relaying schemes e.g. to indicate ”low voltage”, ”out of service” or ”breaker open” situations.

One application is to use an undervoltage relay to compare the difference between two voltages, i.e. a voltage transformer differential connection. This is sometimes used to indicate synchronism, by comparing the two voltages across a breaker before permitting closing. This is not recommended when there may be a large phase angle difference between those voltages, but may be an inexpensive ”synchro-check” method often used together with the information of the voltage level at each side of the breaker, i.e. live-bus, live-line voltage elements.

Voltage relays are sometimes used to switch capacitors in and out (VAR control) for voltage regulation in power systems.

It is not uncommon to use voltage relays for load-shedding applications. Upon a given percentage undervoltage a certain load is shed in order to try to maintain the normal system operating voltage level and thus preventing a system collapse.

Two voltage relays may be used to provide selection of neutral point voltage for example when there is a double bus system and to connect the selected voltage to protective relays requiring neutral point voltage for operation.

In some systems a no-voltage indication is used to trip all circuit breakers on the bus and thus prepare the system for automatic and manual local or remote supervisory control restoration after a disturbance. This tripping is coordinated with all other protective relays to ensure that it trips last on such a disturbance.

A single voltage relay may be used to prevent motor starting in case of low voltage on the bus.

The RXEDK 2H relay provides two setting levels which may be used independently for different “control” functions.

2 Measurement principles

The RXEDK 2H relay constitutes the measuring unit of RAEDK. For setting of operate values, see Section 4.

The functional diagram in fig.1 illustrates the mode of operation of the RXEDK 2H relay.

To provide a suitable voltage for the electronic measuring circuit, the relay is provided with an input-transformer. The output-voltage of the transformer is scaled with dip-switches before it is filtered with a band-pass filter. The relay can be ordered with different filters according to fig. 5-8.

The voltage is rectified before it is sampled with a sampling rate of 1000 samples/s. The voltage ripple is then reduced with a moving average filter. The start function operates when the voltage has reached the set voltage value.

The filtered voltage value is compared to the set operate values of the stages U1 and U2. The start or trip functions are activated when the filtered voltage value reaches the set operate values for stage U1 or U2. For stage U1, inverse-time or definite-time delay can be selected. For stage U2 only definite-time delay is available.

The frequency dependence of the voltage measuring functions and the influence of harmonics are shown in the technical data section.

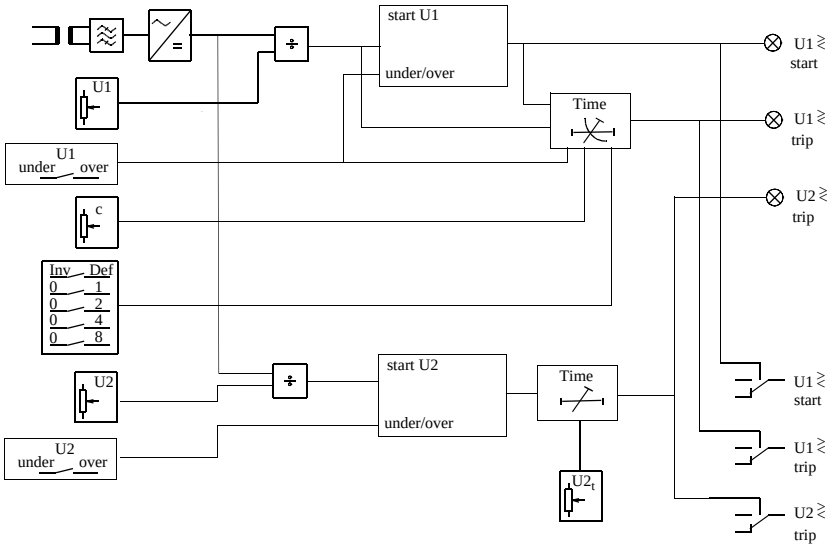


Fig. 1 Functional diagram illustrating the mode of operating of the RXEDK 2H relay

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. 2 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:**
Register configuration	All LEDs flash in clockwise rotation
RAM	“U1 Trip” flashes
ROM	“U2 Trip” flashes
A/D	“U1 Trip” and “U2 Trip” flash

Fig. 2 Self test error indication of the RXEDK 2H relay

The reset button has two functions, LED check and resetting the LEDs. When the button is pressed, the “U1 Start”, “U1 Trip” and “U2 Trip” LEDs are lit and the “In service” LED is switched off, in order to check the LEDs. When the button is released the “U1 Start”, “U1 Trip” and “U2 Trip” LEDs are reset to show the actual status and “In service” LED is relit.

The binary input can be used for remote resetting of the “U1 Trip” and “U2 Trip” LEDs. The binary input is galvanically separated from the electronic measurement circuit with an opto-coupler.

3 Design

The over/undervoltage protection type RAEDK is designed in a number of variants for one-, two- or three-phase voltage protection. Each protection assembly is available with or without test switch RTXP 18, DC-DC converter RXTUG 22H or tripping relay RXME 18.

All protection assemblies are built up by modules in the COMBIFLEX® modular system and mounted on apparatus bars. The electrical connections to the protection assemblies are made by leads equipped with COMBIFLEX® sockets.

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 Terminal and Circuit Diagrams for each of respective protection. One or more of 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 Guid*e, document No. 1MRK 512 001-BEN. A complete secondary testing of the protection can be performed by using a test-plug handle RTXP 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-circuiting of current circuits, opening of voltage circuits and making the protection terminals available for secondary testing. RTXP 18 has the modular dimensions 4U 6C.

All input voltages can be measured from the test-plug or from the current measuring plug RTXM connected to a voltmeter. 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 voltages 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 time over/undervoltage relay RXEDK 2H is a static microprocessor-based relay with two voltage stages U1 and U2. It consists mainly of an input transformer for voltage adaption 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 U1 and for the trip function of stage U2 respectively. The relay has also a binary input for remote resetting of the LED indications for “U1 Trip” and “U2 Trip”.

The relay can be connected for two rated voltages. There are three variants of the relay with regard to rated voltages and four variants with regard to frequency characteristics. The operate values of the stages U1 and U2 are set by potentiometers and programming switches in the front. The two stages can independently of each other be programmed for over- or undervoltage function. Stage U1 can be set for definite-time or inverse-time delay, and stage U2 for definite-time delay.

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

3.4 Tripping relay

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

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

4 Setting and Connection

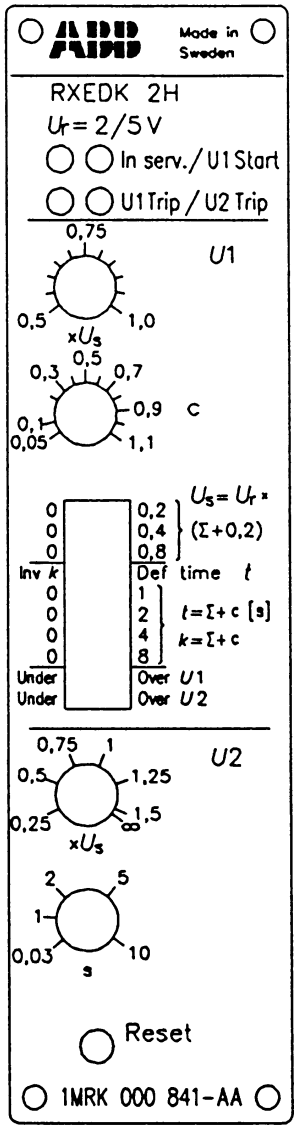


Fig. 3 Front layout

Rated voltage U_r (available variants: 2/5 V, 20/50 V or 100/200 V
16 Hz: 2/5 V or 20/50 V
16 Hz alternative version: 20/50 V)

LED indicators:
In serv. (green): indicates relay in service.
Start (yellow): indicates operation of U1 (no time delay).
Trip U1 (red): indicates operation of U1 after the set time delay.
Trip U2 (red): indicates operation of U2 after the set time delay.

U1:
Potentiometer (P1) for setting of the operate value for the function U1.

Potentiometer (P2) for setting of the definite time delay or inverse time factor for the function U1.

10-pole programming switch (S1) for setting of the scale-constant U_S, time delay characteristics, inverse time factor k, def.time delay t and over-/undervoltage functions.

U2:
Potentiometer (P3) for setting of the operate value for the function U2.

Potentiometer (P4) for setting of the definite time-delay for the function U2. *)

Reset push-button

*) The setting ranges are different for the different variants of the relay
All variants except 16 Hz: 30 ms - 10 s
16 Hz: 80 ms - 10 s
16 Hz alternative version: 80 ms - 10 s

4.1 Connection

The RXEDK 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 (2/5 V, 20/50 V or 100/200 V) depending on if the voltage is connected to 324-325 (low) or 323-325 (high), see fig. 4

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.

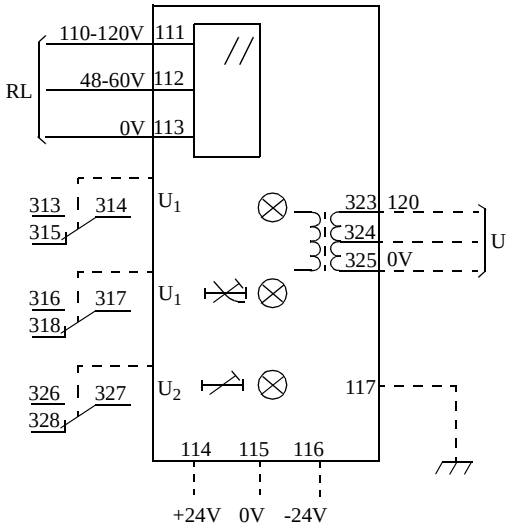


Fig. 4 Terminal diagram

4.2 Settings

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

1. Setting of the scale-constant U_S.
U_S is common for both the stages U1 and U2, and is set with the programming switches S1:1, S1:2 and S1:3 and by connecting the voltage input to the wanted U_r. The setting range is from 0,2 to 1,6 times the rated voltage U_r.

2. Setting of the operate value for stage U1.
The operate value is set with the potentiometer P1 according to
$U1 = P1 \times U_s$.

3. The time delay characteristic of stage U1.
This stage has two time characteristics, definite- or inverse-time delay, which are programmed on the programming switches S1:4 to S1:8.
Definite-time delay.
Set the programming switch S1:4 in position "Def. time t=", where $t=\Sigma+c$. Switches S1:5 to S1:8 are used for the main adjustment, Σ = 0 - 15 s, and potentiometer P2 is used for the fine adjustment c = 0,05 - 1,1 s. The minimum time delay is 50 ms and the maximum time delay is 16,1 s.
Inverse-time delay.
Set switch S1:4 in position "Inv". The inverse time factor k = 0,05-16,1, is set with switches S1:5 to S1:8 and with potentiometer P2 in the same way as for the definite-time delay, t.

4. Setting of the operate value for stage U2.
The operate value is set with potentiometer P3 according to $U2 = P3 \times U_s$. This function can be blocked by setting potentiometer P3 to ”∞”.

5. The time delay of stage U2.
The time delay for stage U2 has a definite-time characteristic. The setting is done with potentiometer P4. *) (see previous page)

6. Setting of over- or undervoltage functions
Stages U1 and U2 can be set to over- or undervoltage function independently of each other, by the setting of switches S1:9 for U1 and S1:10 for U2.

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

4.3 Indication

There are four LED indicators. The trip indicators seal-in and are reset manually by the ”Reset” push-button or electrically via the binary input, 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 RXEDK 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 RXEDK 2H relay has one start and one tripping output for stage U1, and one trip output for stage U2. Each output is provided with one change-over contact. All outputs reset automatically when the voltage decreases to a value 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 RXEDK 2H

Voltage input

Rated voltage U_r		2/5 V or 20/50 V or 100/200 V For 16 2/3 Hz 2/5 V or 20/50 V For 16 2/3 Hz alternative version 20/50 V	
Scale constant $U_{s,}$		(0,2-1,6) x U_r (in steps of 0,2)	
Setting ranges			
Stage U1	2/5 V	0,2-3,2 V/0,5-8 V	
	20/50 V	2-32 V/5-80 V	
	100/200 V	10-160 V/20-320 V	
Stage U2	2/5 V	0,1-4,8 V/0,25-12V	
	20/50 V	1-48 V/2,5-120 V	
	100/200 V	5-240 V/10-480 V	
Effective voltage range U		(0,25-2,0) x U_s	
Rated frequency f_r		50-60 Hz	16 2/3Hz
		Filter opt.:	
		50-60 Hz, flat std see fig 5	see fig. 8
		50-60 Hz, sharp see fig 6	
		150-180 Hz, sharp see fig 7	
Frequency range		40-1000 Hz	15-150 Hz
Power consumption			
U = lowest U_s		2 mVA	
U = highest U_s		210 mVA	
Overload capacity	continuously	3,5 x U_r (Max. 500 V AC for COMBIFLEX)	
	during 10 s	4,0 x U_r (Max. 500 V AC for COMBIFLEX)	

Start and trip functions for standard, 50 Hz sharp and 150-180 Hz sharp

Voltage function	**Stage U1**	**Stage U2**
Scale range	(0,5-1,0) x U_s	(0,25-1,5) x U_s
Measuring mode	Over/Under voltage	
Operate time	Start function	t = 0,03 s
Over-voltage (typical)		
U = 0 => 1,1 x op. value	45 ms	45 ms
U = 0 => 1,5 x op. value	40 ms	40 ms
U = 0,9 => 1,1 x op. value	35 ms	35 ms
U = 0,9 => 1,5 x op. value	30 ms	30 ms
U = 0,9 => 2,0 x op. value	25 ms	25 ms
Under-voltage (typical)		
U = 1,1 => 0,9 x op. value	35 ms	35 ms
U = 1,1 => 0,5 x op. value	30 ms	30 ms
U = 1,1 => 0 x op. value	25 ms	25 ms
Reset time, Over-voltage (typical)	Start function	t = 0,03 s
U = 1,5 => 0,9 x op. value	35 ms	35 ms
U = 1,5 => 0 x op. value	45 ms	45 ms
Consistency of the operate value	< 0,5%	
Reset ratio over/under	> 95% / <105%	
Recovery time	< 50 ms	
Overshoot time	< 25 ms	
Frequency dependence within		
frequency range 50 Hz, ±5%	< 0,5%	
frequency range 60 Hz, ±5%	< 1,0%	
Operate value at 150 Hz	App. 1,45 x op. value at 50 Hz	
Influence of harmonics		
100 / 120 Hz, 5%	< 2%	
150 / 180 Hz, 20%	< 6%	
250 / 300 Hz, 20%	< 3%	

Time functions for standard, 50 Hz sharp and 150-180 Hz sharp

Time function	**Stage U1**	**Stage U2**
Time delay	Definite time and inverse time	Definite time
Setting range Definite time, Def. time Inverse time, Inv Formula for inverse time Overvoltage function Undervoltage function	 t = 0,05-16,1 s k = 0,05-16,1 t = k / (a - 1) t = k / (1 - a) k = Inverse time factor a = Over / under-voltage times operate value	 0,03-10 s –
Accuracy Definite time Inverse time Consistency	1% and ±10 ms 1% of the over/under-voltage and ±10 ms or 3% of the operate time and ±30 ms < 0,5%	1% and ±10 ms – < 0,5%

Filter option, deviation from technical data for RXEDK 2H, standard

	Filter options	
	50-60 Hz, sharp	**150-180 Hz, sharp**
Operate time for start function over-voltage (typical) U = 0 => 1,1 x op. value U = 0 => 1,5 x op. value	 90 ms 70 ms	 65 ms 50 ms
Reset ratio for over-voltage	> 95%	
Recovery time	< 50 ms	< 50 ms
Overshoot time	< 35 ms	< 30 ms
Frequency dependence within frequency range ±5%	< 15%	< 15%
Influence of harmonics 50, 60 Hz, 100% 100, 120 Hz, 100% 150, 180 Hz, 100% 250, 300 Hz, 100%	 – < 3% < 3% < 1%	 < 1% < 2% – < 2%

Start and trip functions 16 2/3 Hz

Voltage function	**Stage U1**	**Stage U2**
Scale range	(0,5-1,0) x U_s	(0,25-1,5) x U_s
Measuring mode	Over/Under voltage	
Operate time,	Start function	t = 0,08 s
Over-voltage (typical)		
U = 0,9 => 1,1 x op. value	75 ms	75 ms
U = 0,9 => 1,5 x op. value	55 ms	55 ms
U = 0,9 => 2,0 x op. value	50 ms	50 ms
Under-voltage (typical)		
U = 1,1 => 0,9 x op. value	75 ms	75 ms
U = 1,1 => 0,5 x op. value	55 ms	55 ms
U = 1,1 => 0 x op. value	50 ms	50 ms
Reset time, Over-voltage (typical)	Start function	t = 0,08 s
U = 1,1 => 0,9 x op. value	85 ms	85 ms
U = 1,1 => 0,5 x op. value	60 ms	60 ms
U = 1,1 => 0 x op. value	50 ms	50 ms
Consistency of the op. value	< 1,0%	
Reset ratio Over/Under	> 95% / < 105%	
Recovery time over-voltage		
U = 1,1 => 0 x op. value	< 60 ms	
U = 2,0 => 0 x op. value	< 90 ms	
Overshoot time	< 60 ms	
Frequency dependence within		
frequency range 15,00-18,33 Hz	< 2,0%	
Influence of harmonics:		
33 1/3 Hz, 5%	< 2%	
50 Hz, 20%	< 5%	
83 1/3 Hz, 20%	< 3%	

Time functions 16 2/3 Hz

Time function	**Stage U1**	**Stage U2**
Time delay	Definite time and inverse time	Definite time
Setting range		
Definite time, Def. time	t = 0,05-16,1 s	0,08-10 s
Inverse time, Inv	k = 0,05-16,1	–
Formula for inverse time		
Overvoltage function	t = k / (a - 1) *) t = k / ($a^{0,5}$ - 1)	
Undervoltage function	t = k / (1 - a) *) t = k / (1 - $a^{0,5}$)	
	k = Inverse time factor	
	a = Over / under-voltage times operate value	
	*) 16 2/3 Hz alternative version	
Accuracy		
Definite time	1% and ±30 ms	1% and ±30 ms
Inverse time	1% of the over/under-voltage and ±30 ms or 3% of the operate time and ±60 ms	–
Consistency	< 0,5%	< 0,5%

Auxiliary DC voltage supply

Auxiliary voltage EL for RXTUG 22H	24-250 V DC, ±20%	
Auxiliary voltage to the relay	±24 V (from RXTUG 22H)	
Power consumption at RXTUG 22H input	Standard	other filters
24-250 V before operation	Max. 4,5 W	Max. 5,5 W
after operation	Max. 6,0 W	Max. 6,5 W
without RXTUG 22H		
±24 V before operation	Max. 1,3 W	Max. 2,0 W
after operation	Max. 3,0 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
RXEDK 2H without RXTUG 22H	0,7 kg	4U	6C

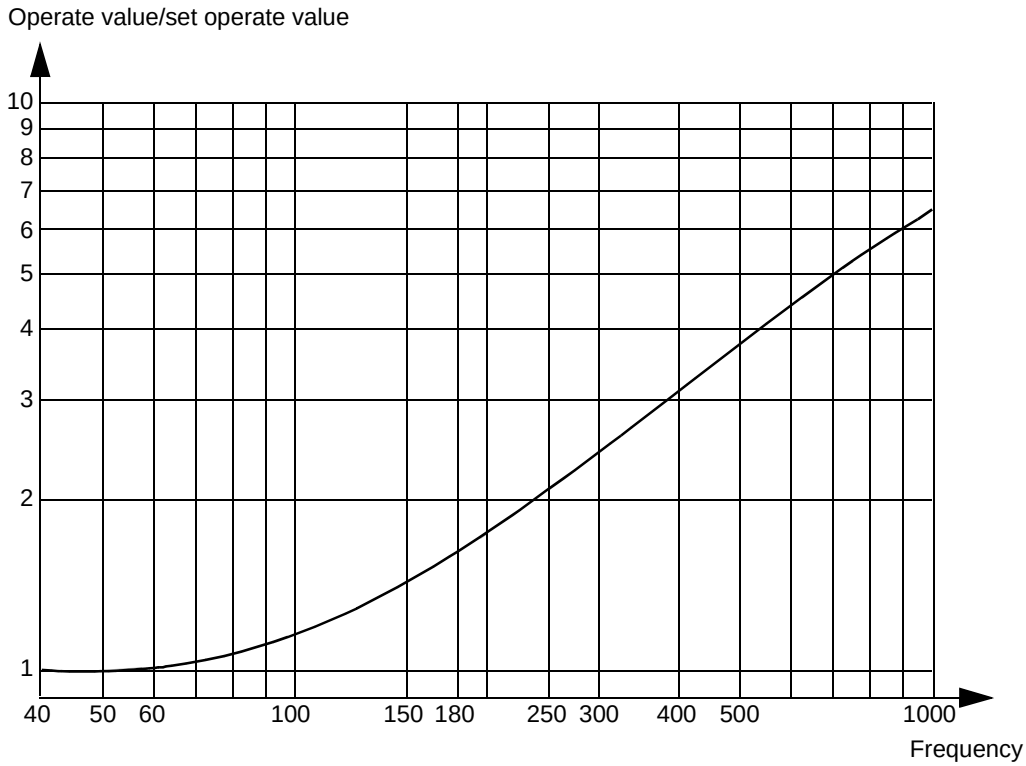


Fig. 5 Typical frequency characteristic for RXEDK 50-60 Hz, standard, valid for U ≤ 2,0 x Us.

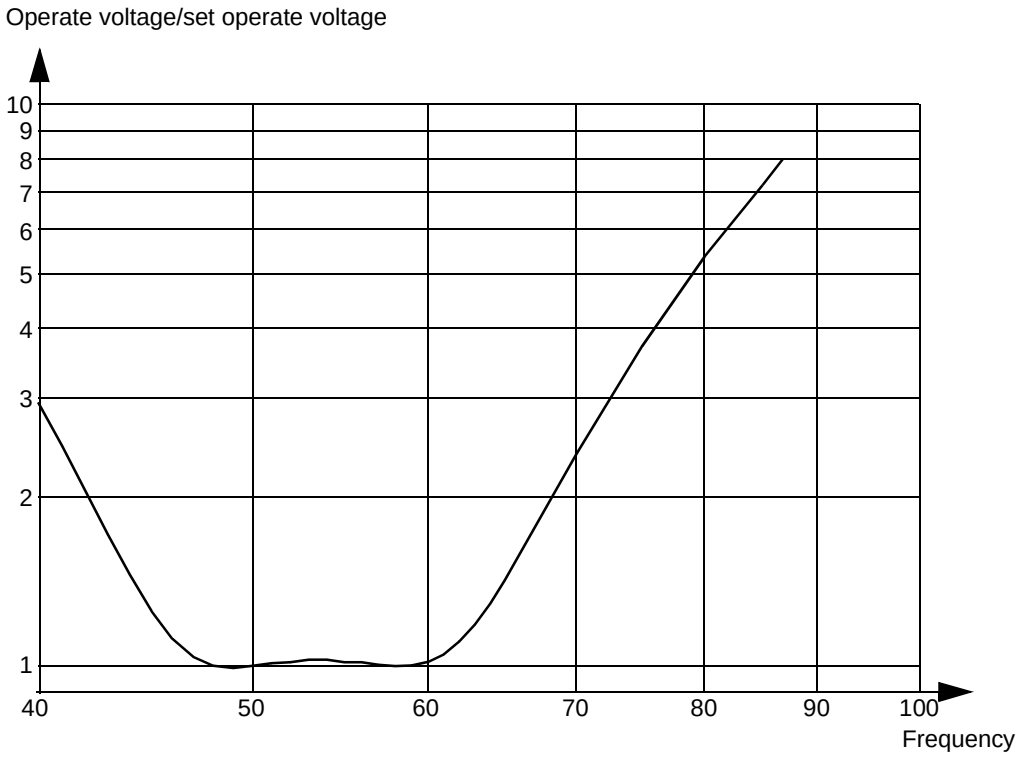


Fig. 6 Typical frequency characteristic for RXEDK 50-60 Hz, sharp, valid for U ≤ 2,0 x Us.

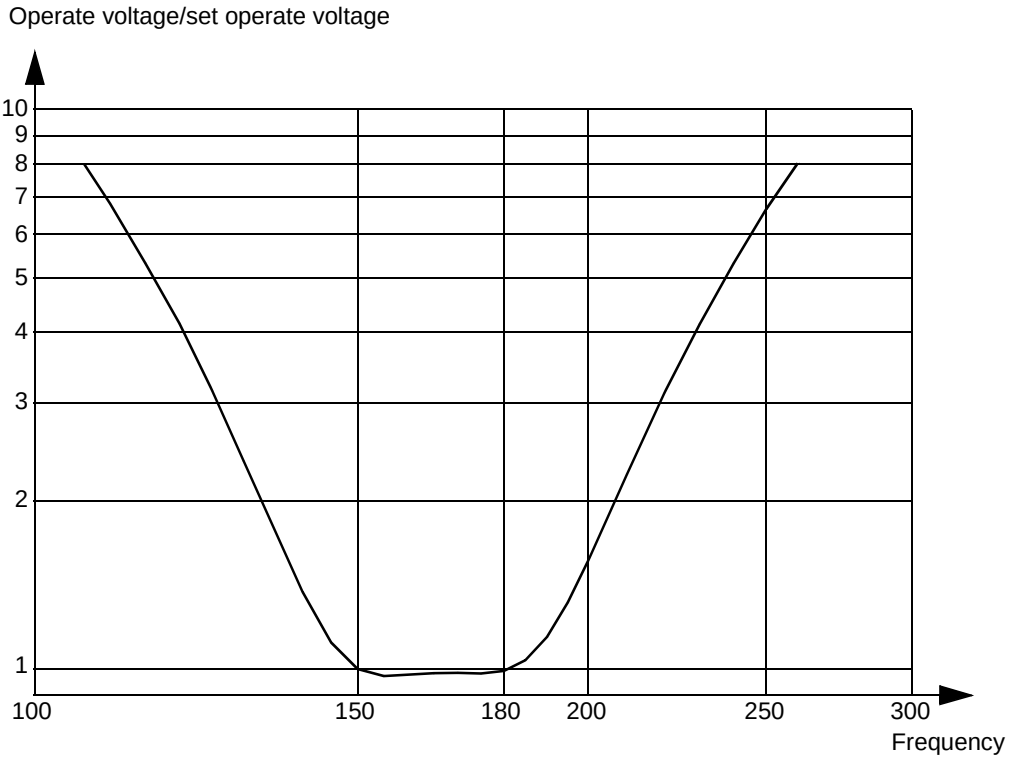


Fig. 7 Typical frequency characteristic for RXEDK 150-180 Hz, sharp, valid for U ≤ 2,0 x Us

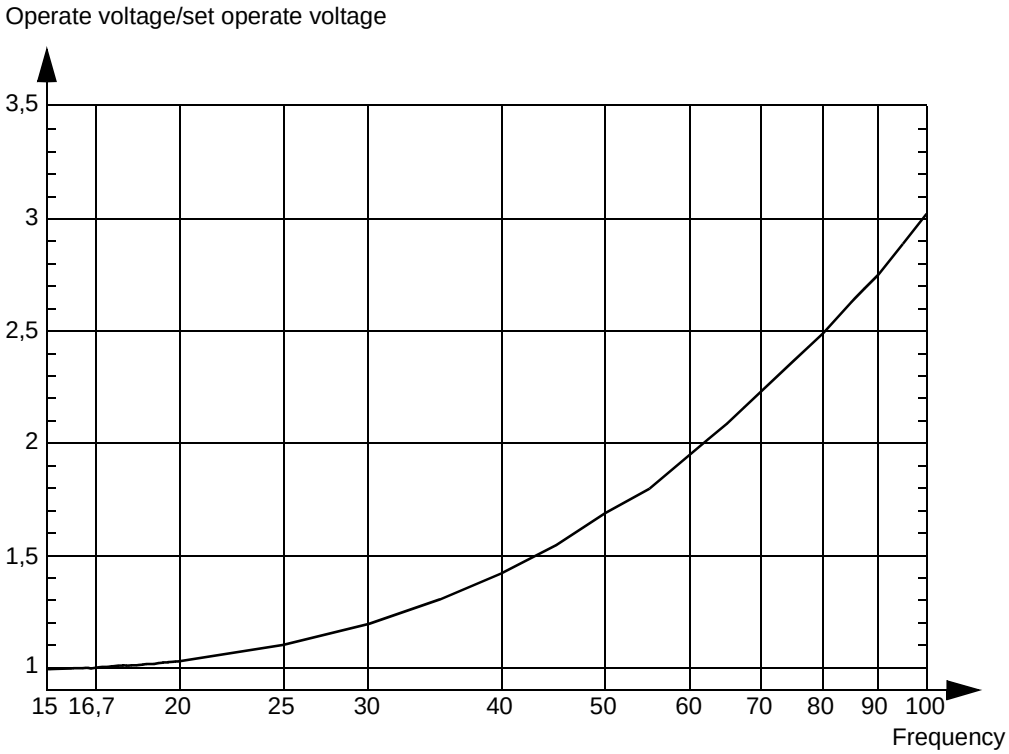


Fig. 8 Typical frequency characteristic for RXEDK 16 2/3Hz, flat, valid for U ≤ 2,0 x Us.

Inverse time characteristic

Stage U1 is programmable for definite time or inverse time characteristic. The inverse time characteristic, see fig. 9, follows the formula below:

Overvoltage function: $t = k/(a-1)$ (s)

Undervoltage function: $t = k/(1-a)$ (s)

(For 16 2/3 Hz alternative version:

Overvoltage function: $t = k / (a^{0,5}-1)$

Undervoltage function: $t = k / (1-a^{0,5})$)

where k = inverse time factor

a = U/U1

U = measured voltage

U1 = over/undervoltage operate value

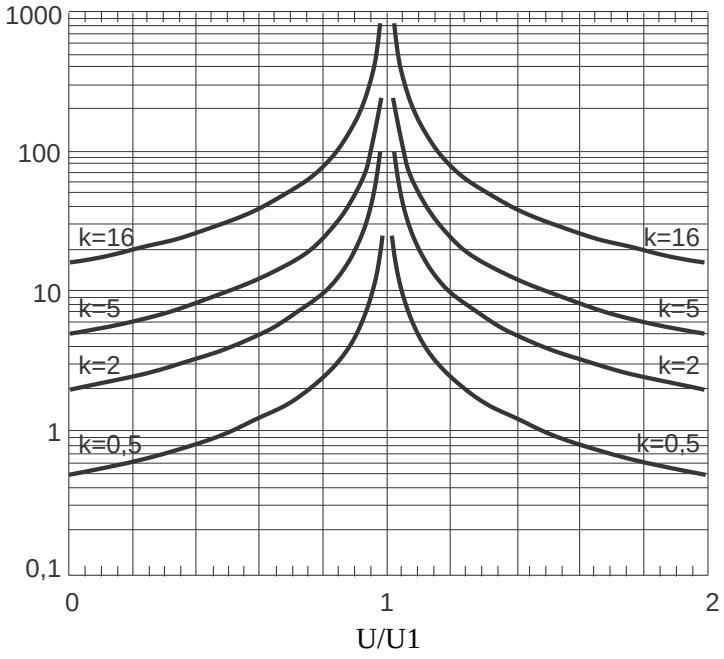


Fig. 9 Inverse time characteristic

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 Installation, 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 18 test switch, when included, are fixed on apparatus bars to make up the protection assembly.

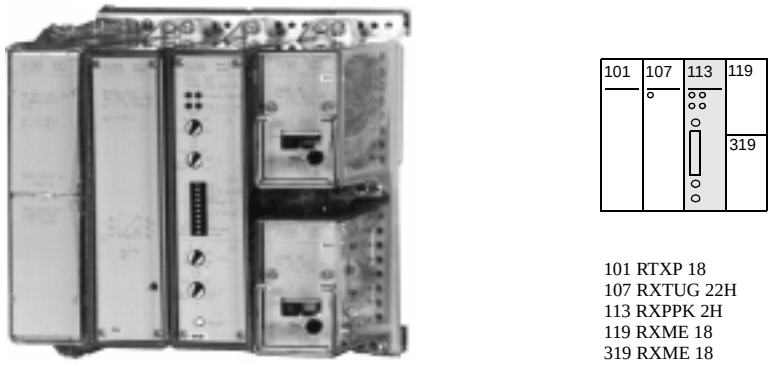


Fig. 10 RAEDK 1 single-phase voltage protection.

The protection assembly can be mounted in the following ways:

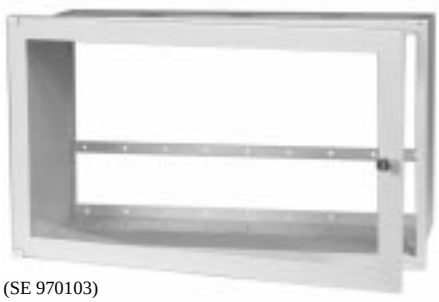
- on apparatus bars
- in a 19” equipment frame
- in RHGX case
- in RHGS case

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 30



(SE 970103)

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.

Fig. 11 RHGS case

RHGX 8

(SE 81702)

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.

Fig. 12 RHGX case

Size: 4U 19”

(SE 96399)

1**9” 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.

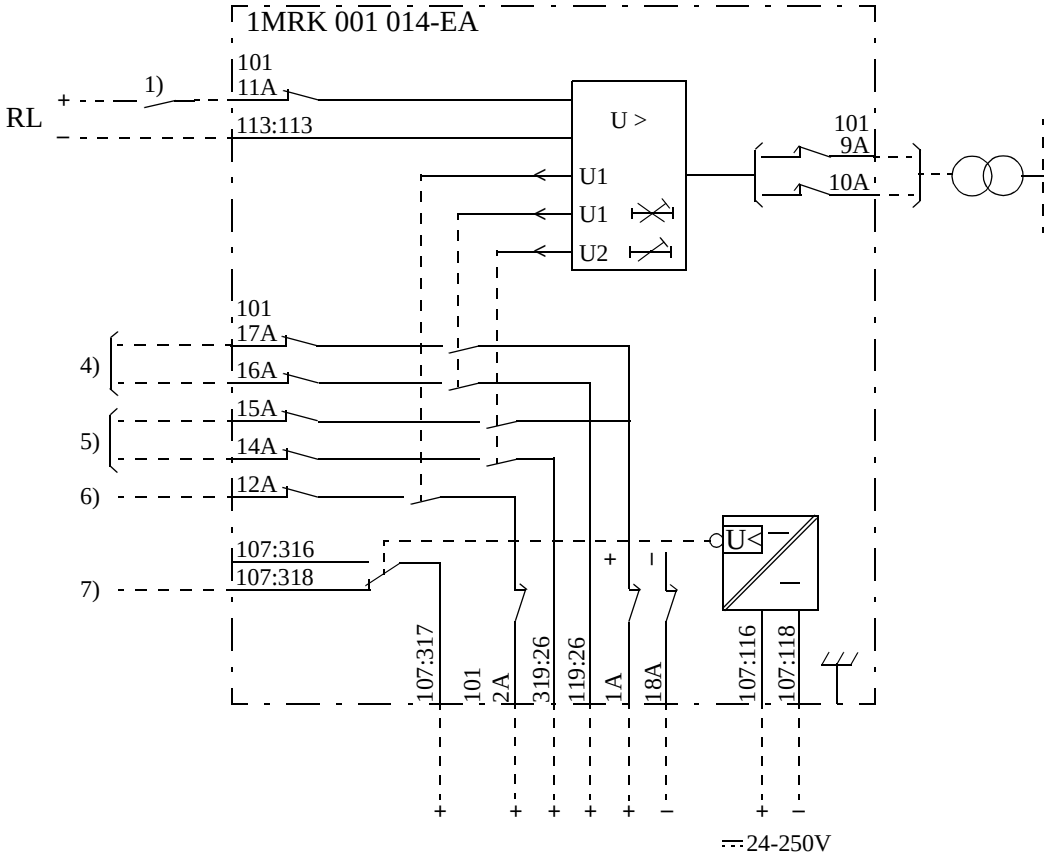
Fig. 13 19” equipment frame

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. 14 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.



1) Resetting of indication
4) Tripping Stage 1
5) Tripping Stage 2
6) Start Stage 1
7) Loss of auxiliary voltage

Fig. 14 Terminal diagram 1MRK 001 014-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. 15.

Fig. 15 shows the rear of protection assembly RAEDK 1, Order No. 1MRK 001 013-EA. The position of the terminals, which are used for external connections according to connection diagram 1MRK 001 014-EAA, is shown.

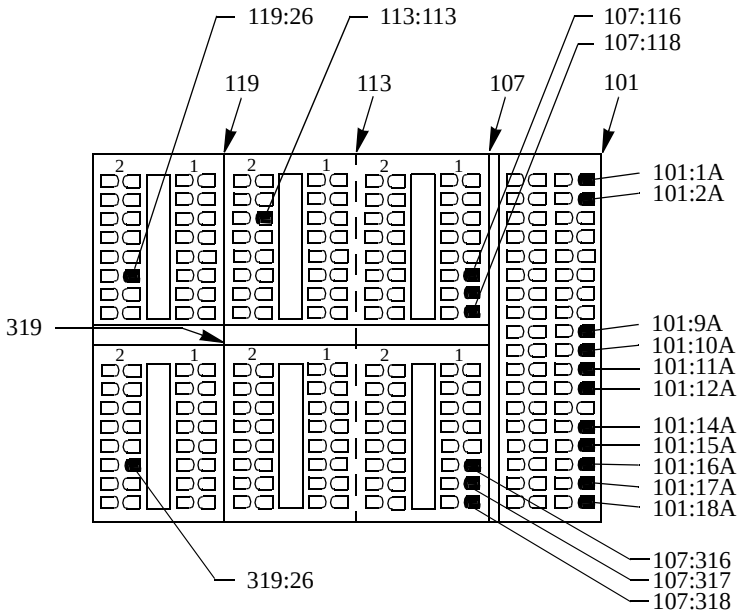


Fig. 15 Location of the terminals shown on diagram 1MRK 001 014-EAA

7.2 Testing

Secondary injection testing

The standard relays (Order No's 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 VT circuits and making relay terminals accessible for testing.

When the test handle is in intermediate position, only the tripping circuits are open. When the test handle is fully inserted, the relay is completely disconnected from the current transformers and ready for secondary injection testing.

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

The RAEDK two- and three-phase protection is provided with individual measuring elements type RXEDK 2H for each phase. The protection can be conveniently tested with a single-phase test set, 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 with test leads

Fig. 16 shows as an example, the connection of test set SVERKER for secondary testing of a single-phase voltage protection RAEDK, Connection Diagram 1MRK 001 014-EAA. When testing a specific protection, the actual circuit diagram, which shows the wiring between the plug-in components and their connections, should also be available.

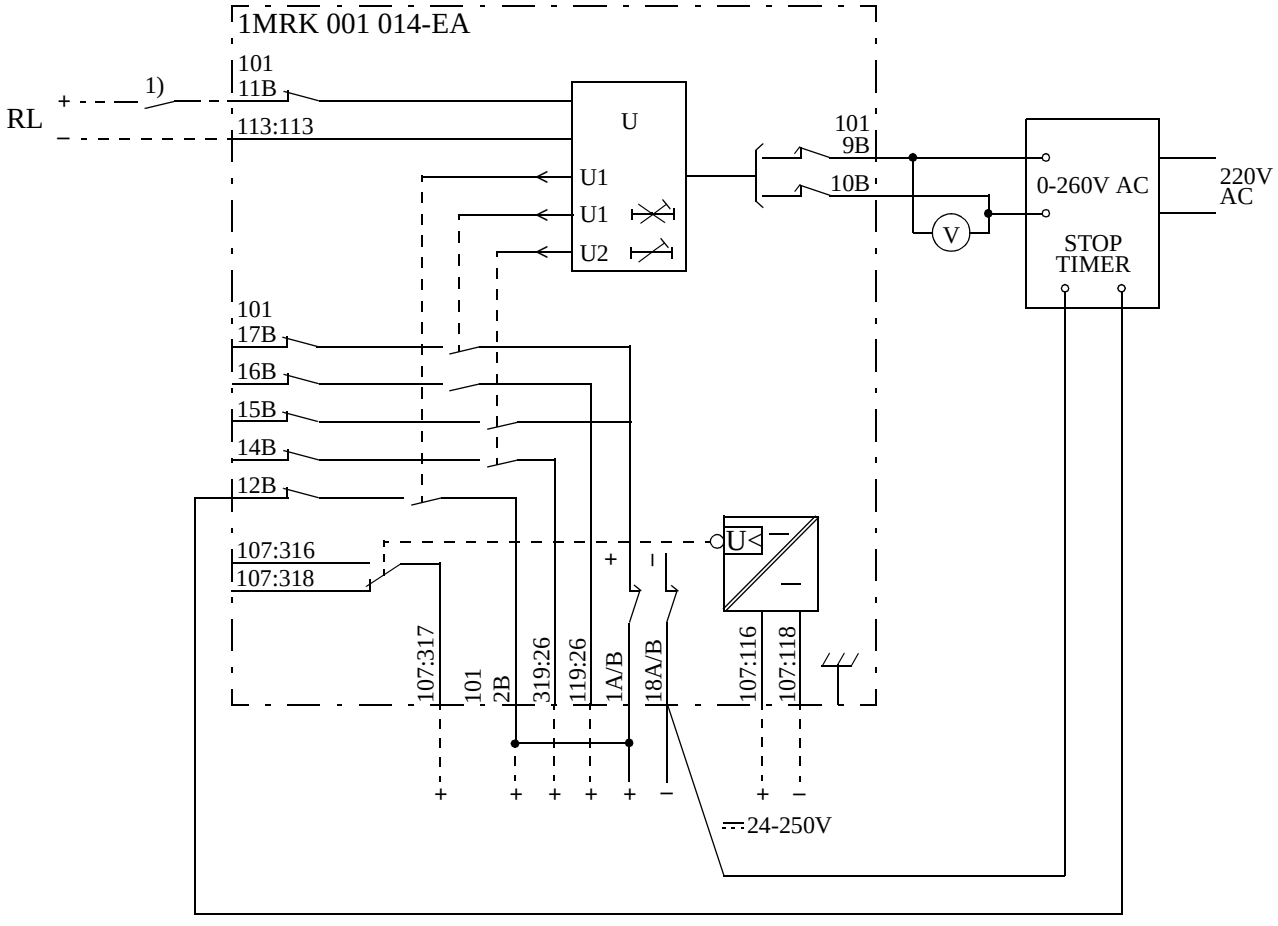


Fig. 16 Connection of test apparatus to a typical protective relay RAEDK 1.

1. Insert the test-plug handle into the test switch. Connect the test set and the voltmeter acc to Fig. 16. Auxiliary voltage shall be 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 U1 start function output relay is activated.

2. Select over-voltage or under-voltage function for stages U1 and U2 and make the appropriate settings of the start voltage for the stages. Instructions for the setting of the switches and potentiometers on the front of the RXEDK 2H relay are given in Section 4, “Setting and Connection”.

3. Slowly increase the injection voltage up the start level for over-voltage function or decrease slowly the voltage to start level for undervoltage function and adjust the potentiometer setting. Check that the LED indicator for U1 Start operates. Check the reset value.

4. Select definite or inverse time for stage U1 and make the appropriate settings of the time delay. Move the timer stop wire to test terminal 17. For over-voltage function and definite time delay, check the operate time at 1,5 · set start voltage. For undervoltage function and definite time delay, check the operate time when the voltage is reduced from 1,1 · set start value to zero. For inverse time characteristics, check two points on the inverse curves, e.g. at 1,2 and 1,4 · set start value for the over-voltage function and when instantly changing the voltage from 1,1 · set start value to 0,8 and 0,6 · set start value for the under-voltage function. The inverse time curves of the relay may be calculated using the mathematical formulas available in Technical Data. Check that the LED indicator for U1 operates.

5. Move the timer stop wire to test terminal 15. Set the timer for stage U2 temporarily to min value and check the start and reset value of stage U2. Set the timer and check the time delay when injecting 1,5 · set start value.

6. Move the timer stop wire to test terminal 14 and check that trip output is obtained when stage U2 operates and voltage is supplied to terminal 119:26.

7. Check operation of the binary input by connecting voltage +RL to test terminal 11, which will reset the LEDs after operation.

8. Remove the test handle and check that all indicating LEDs and flags are reset. Insert the plastic plug in the hole of the resetting push-button.

For a two- or three-phase voltage protection, each phase is tested in the same way as described above.

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 RAEDK voltage protection relays require no special maintenance. The covers should be mounted correctly into 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 over/under voltage protection RAEDK**.**

Type	Func-tion	Test-switch	DC-DC con-verter	Tripping relays	Ordering No. 1MRK 001	Circuit Diagram 1MRK 001	Terminal diagram 1MRK 001	Diagram
RAEDK 1	1 U	x			013-BA	014-BA	014-BAA	On request
RAEDK 1	1 U		x		013-CA	014-CA	014-CAA	On request
RAEDK 1	1 U	x	x		013-DA	014-DA	014-DAA	On request
RAEDK 1	1 U	x	x	x	013-EA	014-EA	014-EAA	Fig. 17, 18
RAEDK 2	2 U	x			013-GA	014-GA	014-GAA	On request
RAEDK 2	2 U		x		013-HA	014-HA	014-HAA	On request
RAEDK 2	2 U	x	x		013-KA	014-KA	014-KAA	On request
RAEDK 2	2 U	x	x	x	013-LA	014-LA	014-LAA	Fig. 19, 20
RAEDK 3	3 U	x			013-NA	014-NA	014-NAA	On request
RAEDK 3	3 U		x		013-YA	014-YA	014-YAA	On request
RAEDK 3	3 U	x	x		013-PA	014-PA	014-PAA	On request
RAEDK 3	3 U	x	x	x	013-ZA	014-ZA	014-ZAA	Fig. 21, 22

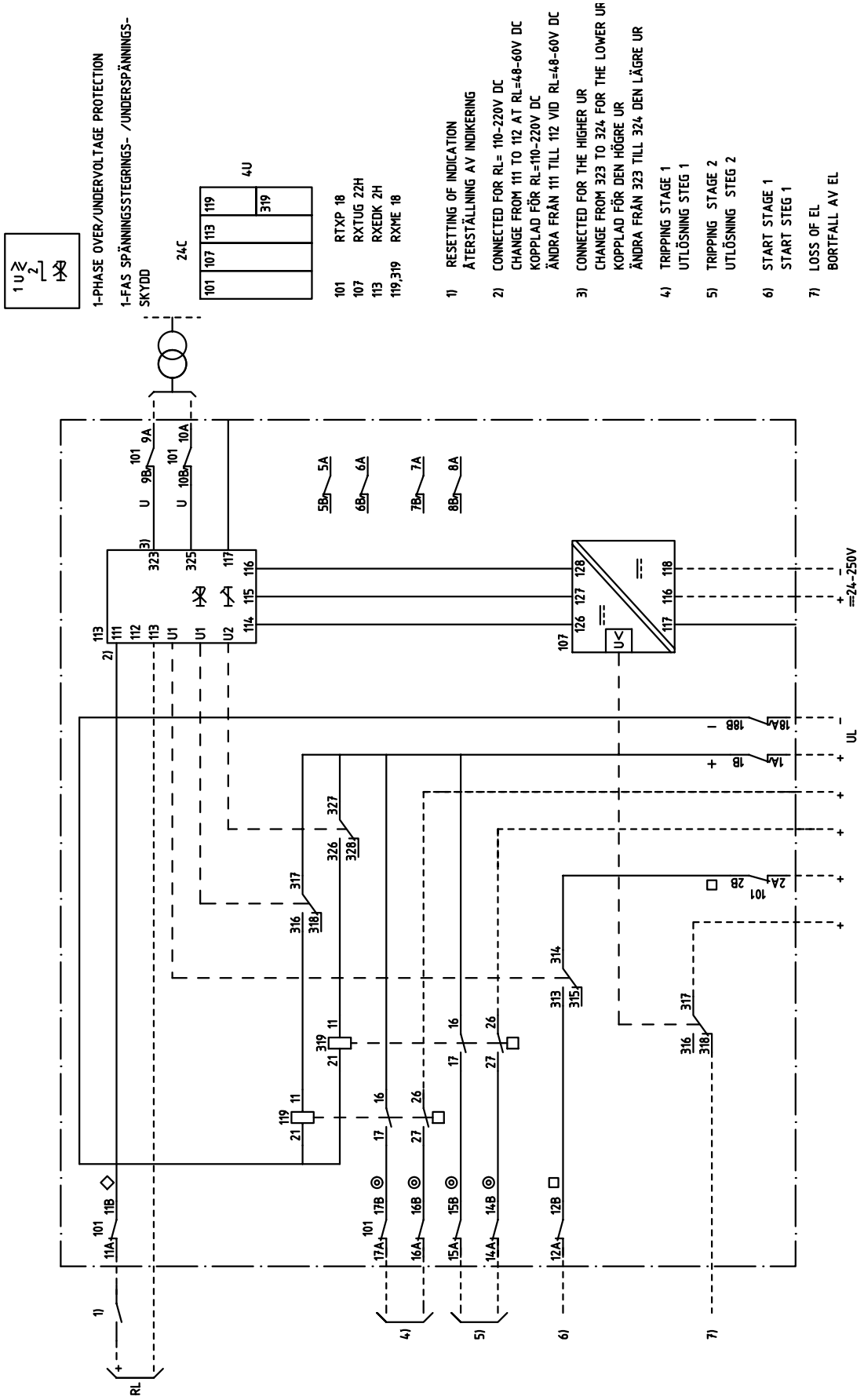


Fig. 17 Circuit diagram 1MRK 001 014-EA

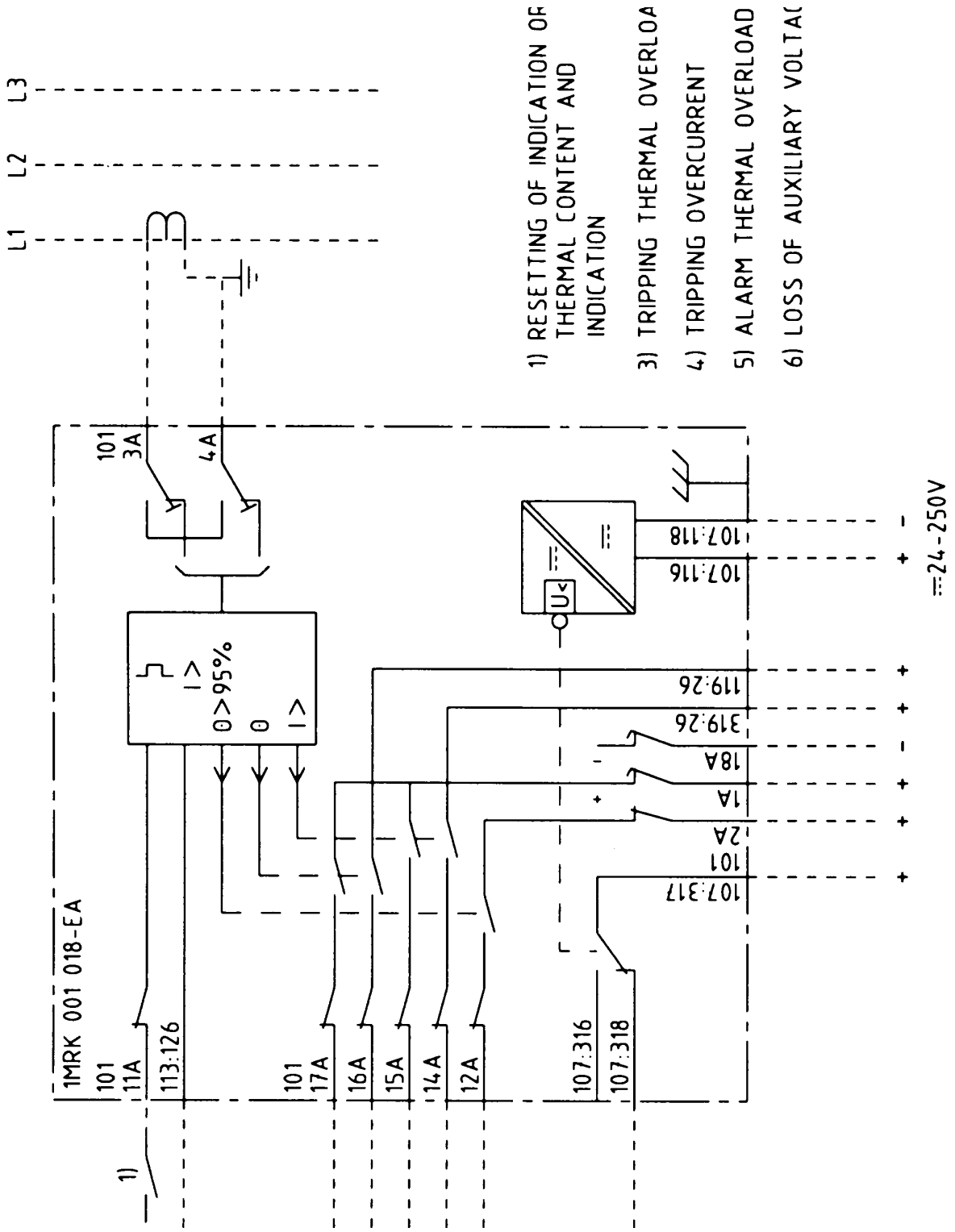


Fig. 18 Terminal diagram 1MRK 001 014-EAA

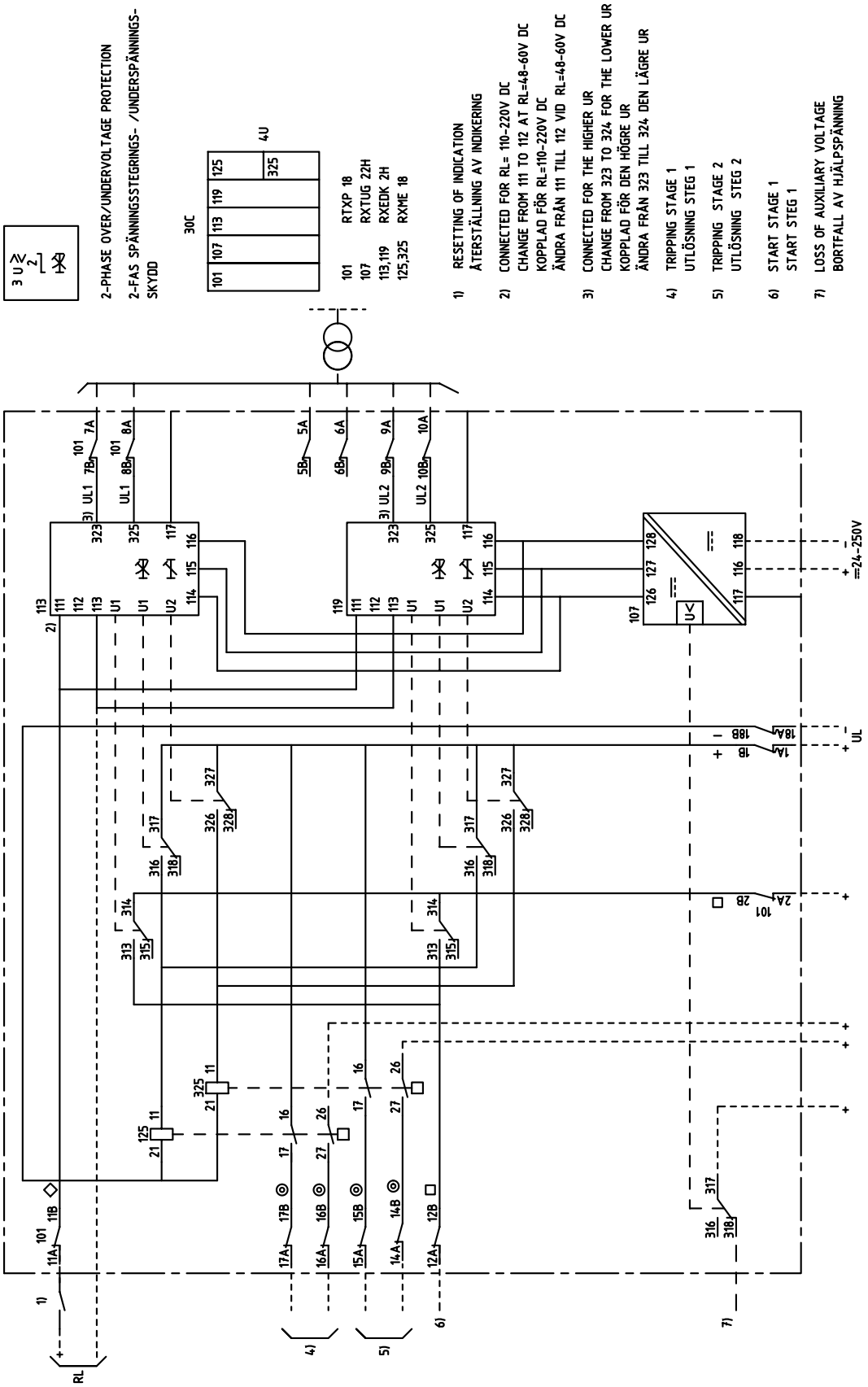


Fig. 19 Circuit diagram 1MRK 001 014-LA

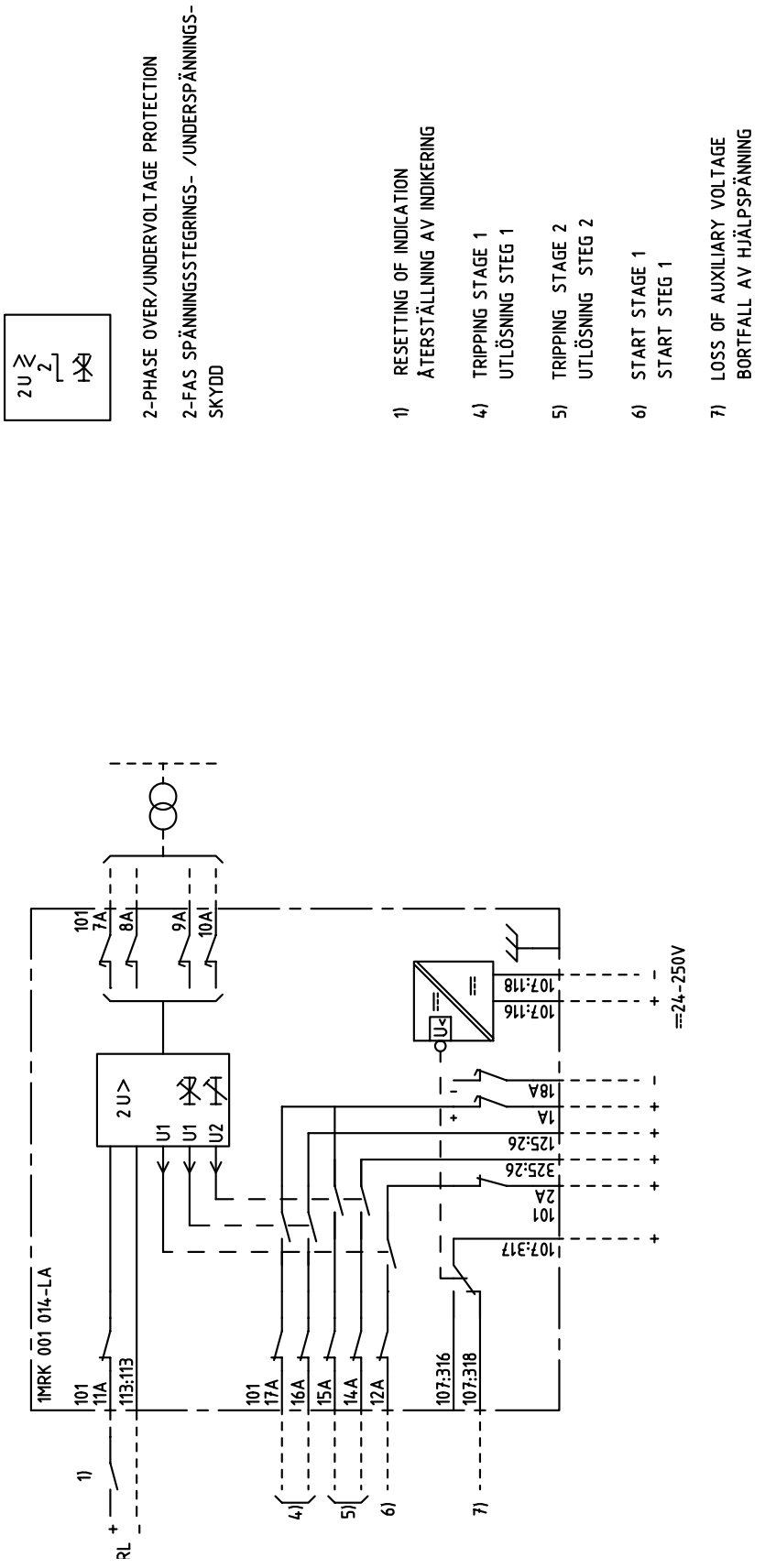


Fig. 20 Terminal diagram 1MRK 001 014-LAA

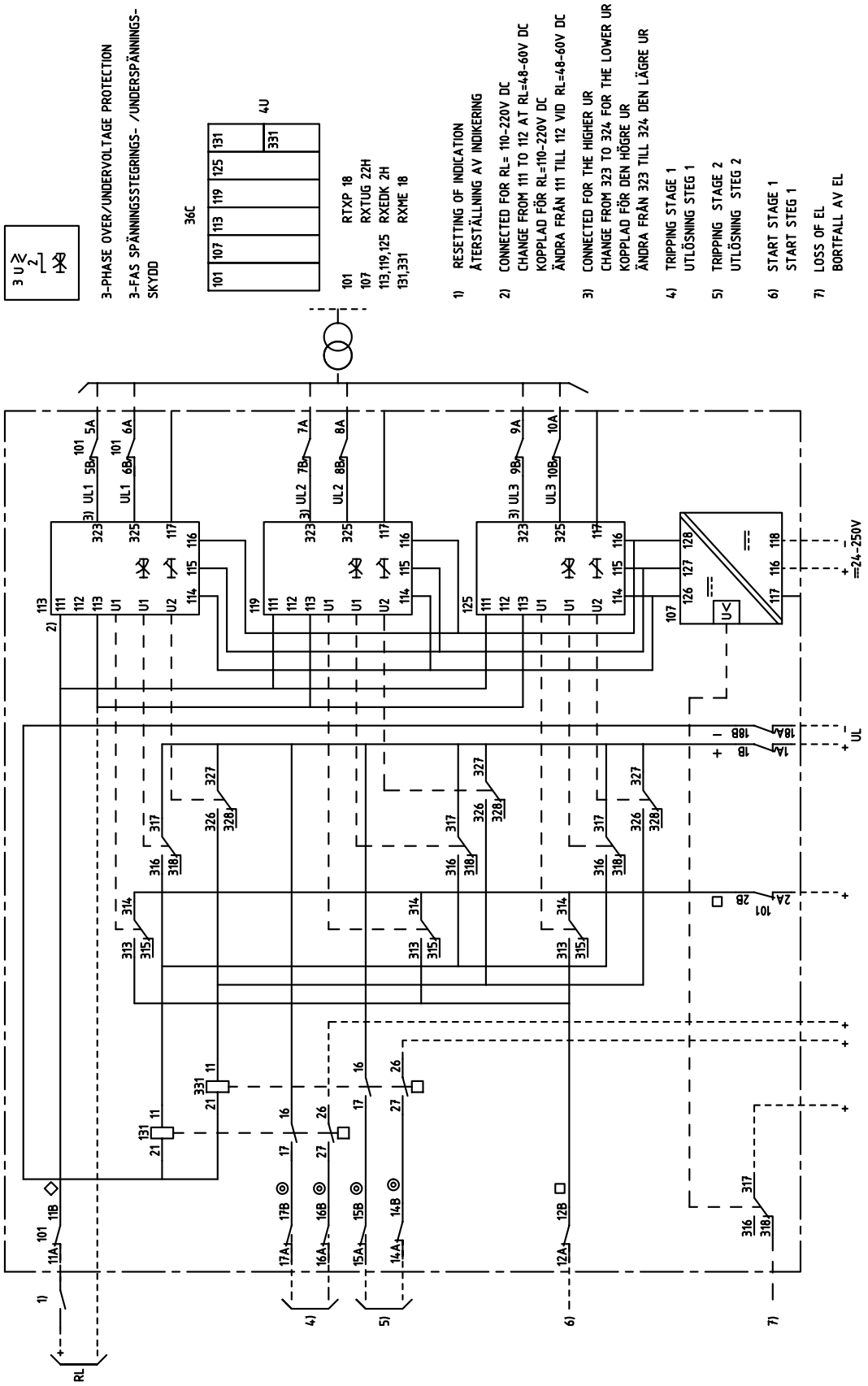


Fig. 21 Circuit diagram 1MRK 001 014-ZA

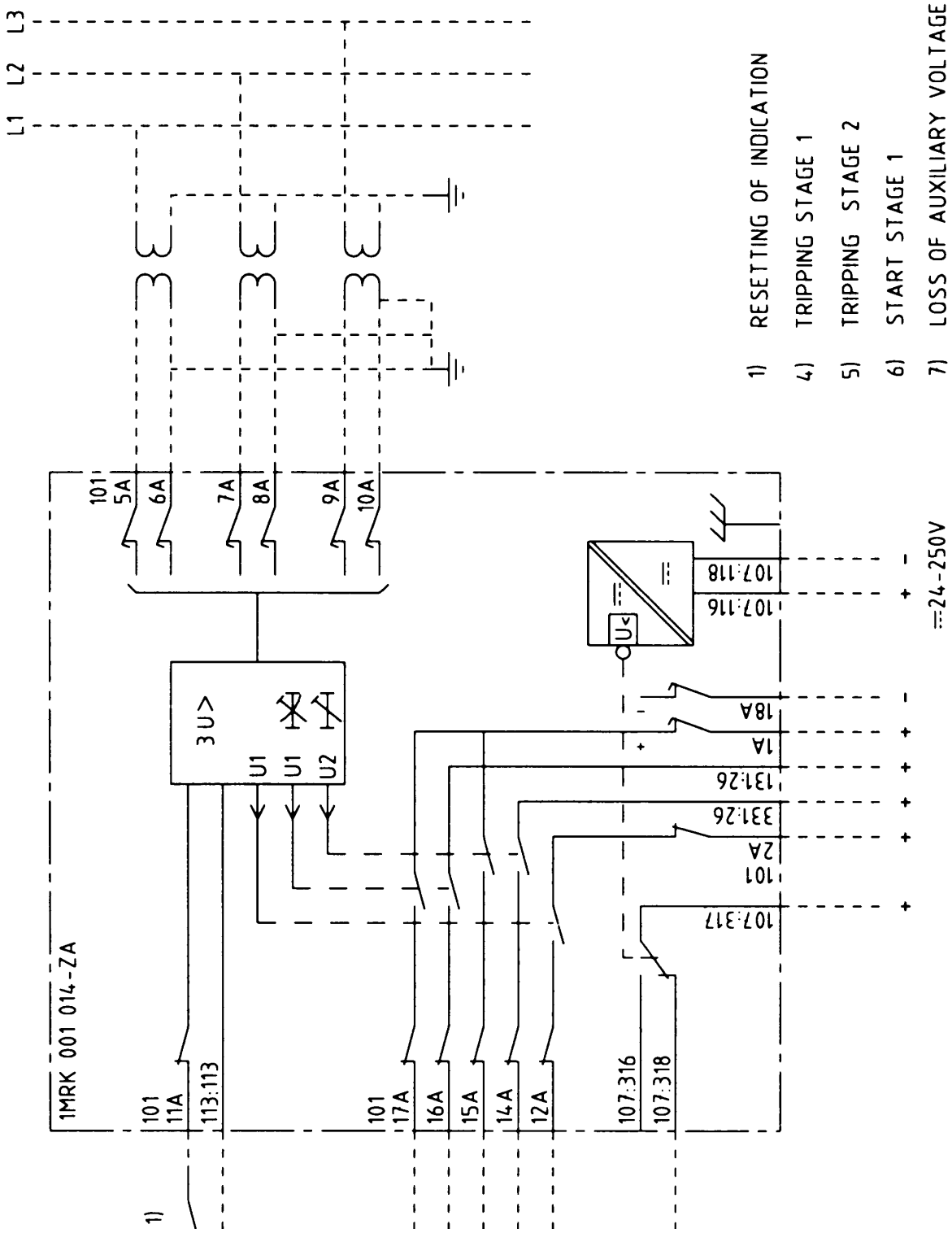


Fig. 22 Terminal diagram 1MRK 001 014-ZAA

ABB Network Partner AB
S-721 71 Västerås
Sweden
Tel +46 21 321300
Fax +46 21 146918