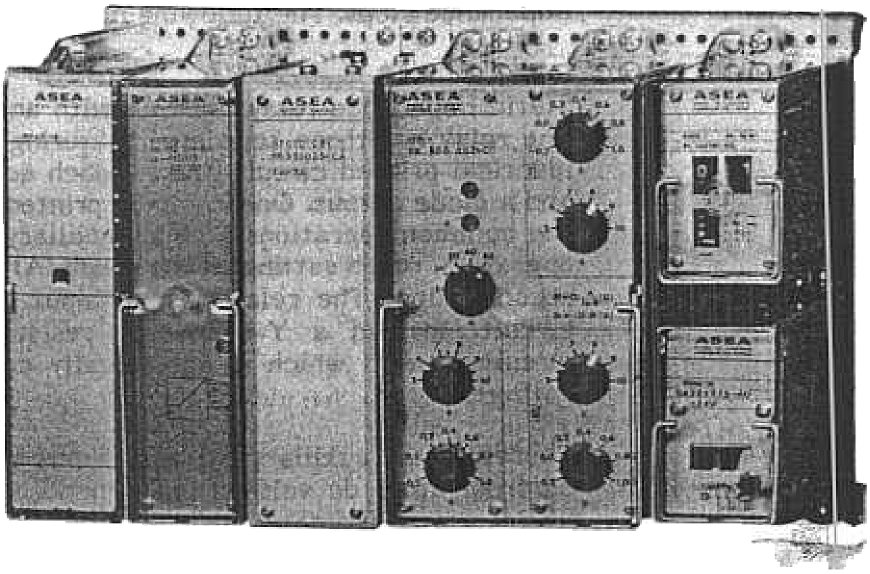
UG03-3213E
User's Guide
January 1985
Replaces:
RK 654-300E
RK 556-301E
Data subject to change without notice

ABB Relays

Type RAKZB
Three-phase impedance relay



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Application

RAKZB is a three phase impedance relay with many different applications. Due to the adjustable reach both in the forward and reverse direction the relay is very suitable as line protection or as start relay in distance protection.

RAKZB can be used instead of the overcurrent protection for cables, transformers or bus bars at varying short-circuit currents. The relay can also be used as back-up protection for generators-transformer units and as underexcitation protection for generators.

RAKZB can be obtained with either modified lens characteristic or with a circular characteristic. The lens is used for long lines and heavy burden to obtain enough margin between the reach of the relay and the load impedance. The characteristic angle is either 60° or 75°. RAKZB is equipped with a reconnection relay, which when activated switches the voltage measuring circuits to measure phase-to-neutral voltages.

CONTENT Page:

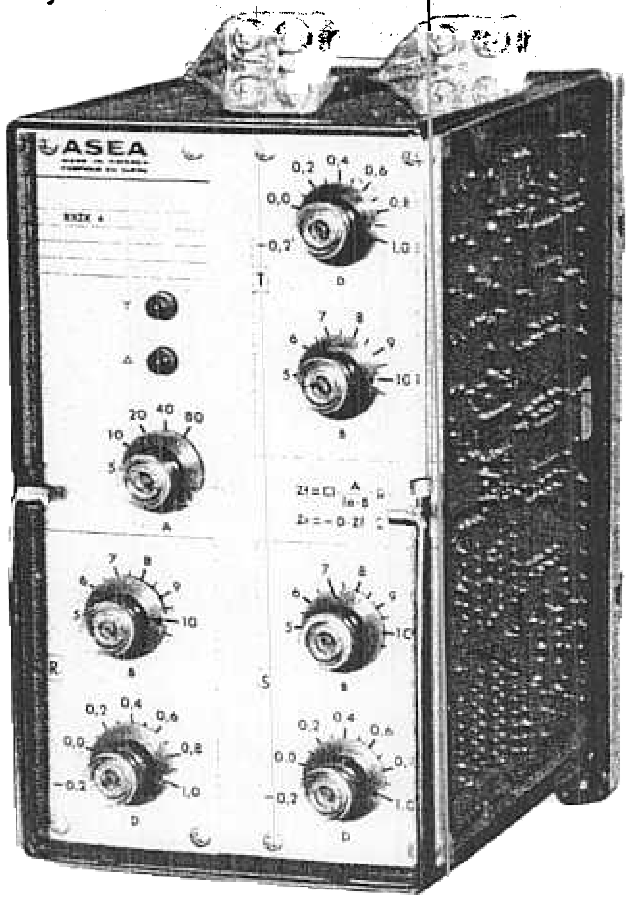
A ground-fault relay which activates this reconnection relay is included in one version of RAKZB. For the other versions one can use a separate external ground current relay to control the reconnection relay. A LED marked "Δ" indicates when the relay measures phase-to-phase voltage. A LED marked "Y" indicates when the relay measures voltage to neutral. A blocking relay which when activated, prevents operation for fuse failure and power swings.

DESIGN

RAKZB can be obtained in different versions for one or two impedance steps. The following modules are included:

RXZK 4
Static impedance relay built up with analogous and digital circuits. The relay has three separate measuring circuits (R, S, T) on three identical printed circuit boards, each equipped with an output relay and a diode output. One common printed circuit board takes care of the common operations such as auxiliary voltage supply, blocking of operation, rough setting of the reach (A) and the voltage circuit Δ/Y reconnection. The relay has no input transformers in the voltage circuit. Instead a Y-connected resistance chain in the voltage circuit is used which is galvanically connected with the auxiliary voltage circuit.

Therefore the auxiliary voltage circuit must be galvanically separated from other dc voltage and ground. On the relay there are two LEDs which indicate the connection of the relay: Δ or Y. The operate value of the relay is set with knobs on the front of the relay.



A - one knob for stepwise (5, 10, 20, 40, 80 ohm) rough setting of the reach in the forward direction

B - three knobs, one for each measuring circuit R, S, T for continuous fine adjustment (4.5 to 10.5) of the reach in forward direction

D - three knobs, one for each measuring circuit R, S, T for continuous setting (-0.2 to +1.0) of the reach in the reverse direction

Fig. 1 Setting knobs A,B,D and LEDs on RXZK 4 (790180)

RXME 18
Auxiliary relay with indicating flag and two normally open contacts. Used in the trip circuit.

RXKE 1
Time-lag relay with two normally open contacts. Used to delay the trip function.

RXIG 2
Current relay which measures the zero sequent current and has two transfer contacts. Used to control the reconnection relay to switch the voltage circuit from the phase-to-phase voltage(Δ) to the voltage to neutral (Y) at ground-faults.

RXSF 1
Alarm relay with indicating flags and normally open contacts. Used in the trip circuits of the two step version. At the start operation of the impedance steps RXSF 1 also gives alarm.

RXTUG 2H
Dc/Dc converter with galvanically separated inputs and outputs. Used to supply the electronic circuit with auxiliary voltage.

RTQTC 061
A transformer module which contains three airgap transformers for the current circuit. The module can be obtained for the current I_a = 0.5 A, 1 A, 2.5 A or 5 A.

RTXP 18
Test switch. At testing the test switch RTXH 18 is inserted into this test device. The test device has sequence controlled contacts. When the test handle is inserted into the test device the alarm and trip circuits are opened. Thereafter the current transformers circuits are short-circuited. Then the measuring current and the measuring voltage supply to the relay is interrupted. The test device and the test handle are included in the test system COMBITEST.

MODE OF OPERATION

The operation is determined both by the connection and type of fault. In resonant grounded networks the relay normally is Δ-connected and operates for two- or three phase faults. In solidly grounded networks the relay normally is Δ-connected but will be Y-connected by a ground current relay at ground-faults.

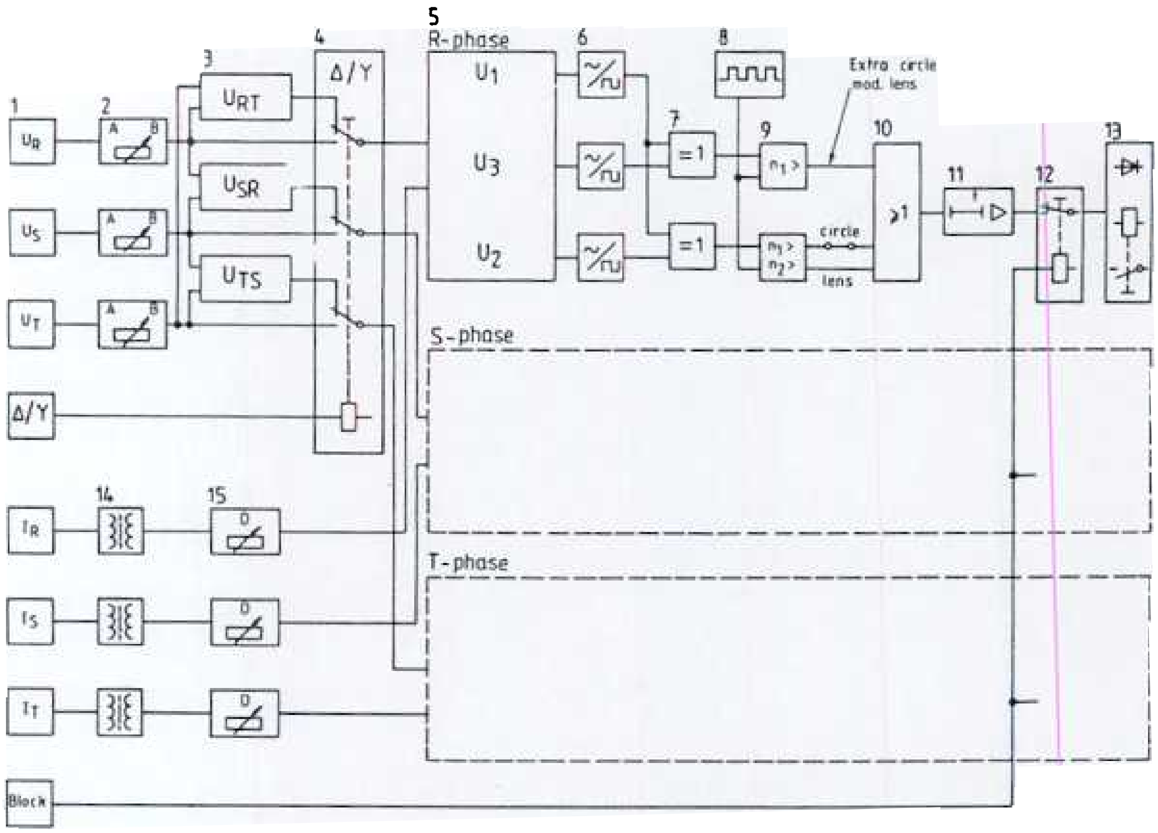
The voltage phases R, S, T and the neutral N are connected directly to the star-connected voltage divider in RXZK 4.

In the transformer unit RTQTC 061 the current is fed over a model impedance and a current which is proportional to the voltage is obtained which then is supplied to RXZK 4.

In the voltage circuit (3) phase-to-phase voltages are originated by subtraction of the phase voltages e.g. $U_{RT} = U_R - U_T$.

Through the external controllable Δ/Y reconnection relay (4) the voltage to neutral or the phase-to-phase voltage is conveyed to the measuring units for each phase.

Block diagram type RXZK4 + RTQTC 061



1. Measuring and control inputs
2. Setting circuit for the reach
3. Voltage circuit "subtraction circuit"
4. Δ /Y-reconnection relay
5. Analog signal processor
6. Square wave converter
7. Phase comparator (exclusive - OR)
8. Pulse generator (Oscillator)
9. Pulse counter
10. Summation point
11. Drive circuit with reset delay
12. Circuit for output blocking
13. Output relay and diode output
14. Airgap transformer
15. Circuit for setting of the compensation degree

Fig. 2 Block diagram

The quantities U1, U2 and U3 are developed in the analog signal processor (5) according to the formulae:

$$U_1 = IZ_f - U \quad U_2 = IZ_r - U$$

$$U_3 = \frac{U_1 + U_2}{2} = I \times \frac{Z_f + Z_r}{2} - U$$

The operation of the relay is based on the relative difference of the angle between the vectors U1, U2 and U3.

U1 and U2 gives a circular or lens characteristic while U3 gives the modified lens characteristic.

The three measuring quantities derived in block (5) are converted in the square wave converter (6) into square wave signals and fed to the phase comparator circuit (7) which controls the pulse counters (9) so that these obtain a number of pulses from the oscillator (8). The phase angle measurement is done with the pulse generator (8) and two binary counters (9), one for the circle or lens and the other for the extra circle in the modified lens characteristic. The counters are preset for a certain number of pulses. If any of the counters in a phase reaches its limit value (some redundancy) this puls is locked in and output signal is obtained over a relay contact or diode output. The relay can be blocked by an external signal. It can also be blocked if the auxiliary voltage will be too low or if the current will be lower than 0.2 I_a.

The relay has a setting D which determines the reverse reach Zr.
$Z_r = -DZf$.

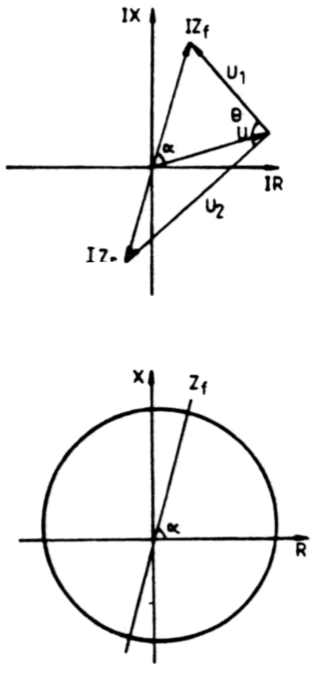


Fig. 3 Circular characteristic
$90^o < \arg U_2 - \arg U_1 < 270^o$

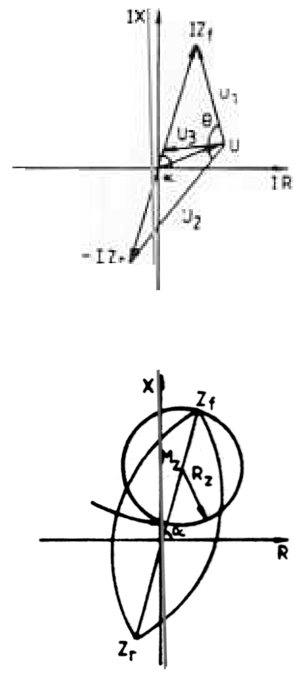


Fig. 4 Modified lens characteristic
$135^o < \arg U_2 - \arg U_1 < 225^o$
and that
$90^o < \arg U_3 - \arg U_1 < 270^o$

Recommended operate curves for different applications

a = 3-phase fault and normal duty
b = states 2-phase fault and when K=1, also 1-phase fault

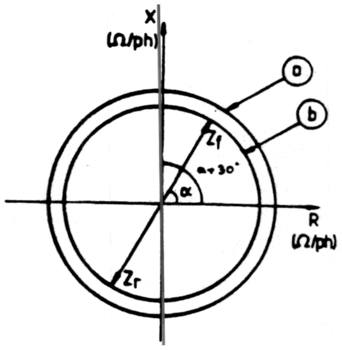


Fig. 5. Normally the circular characteristic is used. I the figure $Z_r = Z_f$ and $\alpha = 60^o$

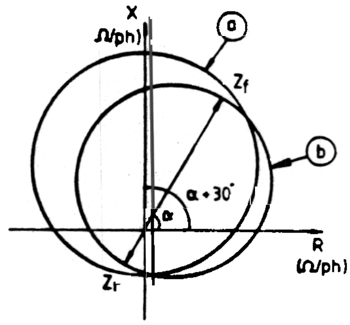


Fig. 6. The offset characteristic is used when different reaches in the forward and reverse direction are required.
In the figure $Z_r = + 0.2\ Z_f$ and $\alpha = 60^o$

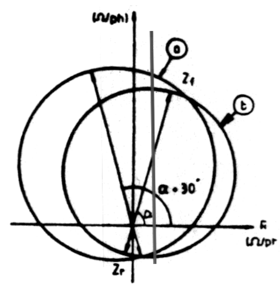


Fig. 7. To obtain better margin between the reach of the relay and the load impedance, in some cases a relay with the characteristic angle $\alpha = 75^o$ is preferred.
In the figure $Z_r = + 0.2\ Z_f$

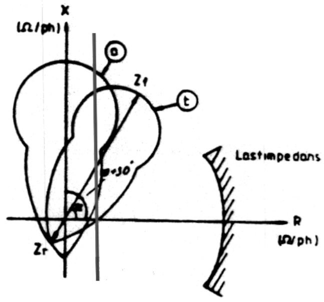


Fig. 8. In long lines the modified lens characteristic may be preferred which also gives a better margin between the reach of the relay of the load impedance.
In the figure $Z_r = + 0.2\ Z_f$ and $\alpha = 60\ ^o$

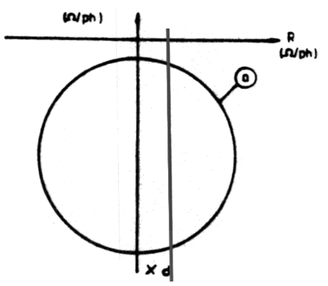
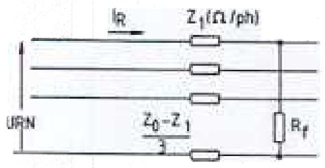
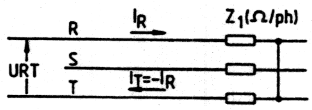
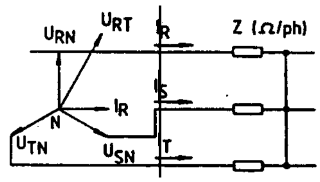


Fig. 9. As underexcitation protection select a relay with $\alpha = 60^o$ and reversed relay current.
In the figure $Z_r = 0,2\ Z_f$.

Table 1. Measuring quantities and reaches at different types of faults.

Type of fault	1-phase fault			2-phase fault			3-phase fault		
Diode indication	Y			△			△		
Example on fault current and voltage fed to the relay									
Measuring voltage	U_{RN}	U_{SN}	U_{TN}	U_{RT}	U_{SR}	U_{TS}	U_{RT}	U_{SR}	U_{TS}
Measuring current	I_R	I_S	I_T	I_R	I_S	I_T	I_R	I_S	
Measuring circuit in RXZK 4	R	S	T	R	S	T	R		
Measuring angle	α			α			$\alpha+30°$		
Factor C1	$\frac{0.2 \times f}{1+K}$			$\frac{0.2 \times f}{2}$			$\frac{0.2 \times f}{\sqrt{3}}$		
Relay reach in direction of measuring angle	$Z_f = \frac{0,2 \times f}{1+K} \times \frac{A}{B \times I_a}$ (Ω/ph)			$Z_f = \frac{0,2 \times f}{2} \times \frac{A}{B \times I_a}$ (Ω/ph)			$Z_f = \frac{0,2 \times f}{\sqrt{3}} \times \frac{A}{B \times I_a}$ (Ω/ph)		

f = rated frequency $K = \left|\frac{Z_0 - Z_1}{3Z_1}\right|$ Z_0 = zero sequence impedance

Z_1 = positive sequence impedance

Table 2 Limits of reaches as a function of type of fault and different values of the current I_a

Current I_a	At 3φ-fault 50 Hz ohms/phase	At 2φ-fault 50 Hz ohms/phase
0,5A	5,4-204	4,8-178
1A	2,7-102	2,4-89
2,5A	1,1-41	0,95-35,6
5A	0,54-20,4	0,48-17,8

Table 3. Design of circular and modified lens characteristic. The circle is obtained with 1 as centre. The modified lens is obtained with a combination of 3 circles with 2,3 and 4 as centra.

Centre	Equations for the coordinations of the centra	Equations for the radii of the circles
	$R = \frac{Z_f}{2}(1-D)\cos\alpha$ $X = \frac{Z_f}{2}(1-D)\sin\alpha$	$r = \frac{(1+D)\ Z_f}{2}$
2	$R = \frac{Z_f}{2}\left[(1-D)\cos\alpha - (1+D)\sin\alpha\right]$ $X = \frac{Z_f}{2}\left[(1-D)\sin\alpha + (1+D)\cos\alpha\right]$	$r = \frac{(1+D)\ Z_f}{\sqrt{2}}$
3	$R = \frac{Z_f}{4}(3-D)\cos\alpha$ $X = \frac{Z_f}{4}(3-D)\sin\alpha$	$r = \frac{(1+D)\ Z_f}{}$
4	$R = \frac{Z_f}{2}\left[(1-D)\cos\alpha + (1+D)\sin\alpha\right]$ $X = \frac{Z_f}{2}\left[(1-D)\sin\alpha - (1+D)\cos\alpha\right]$	$r = \frac{(1+D)\ Z_f}{\sqrt{2}}$

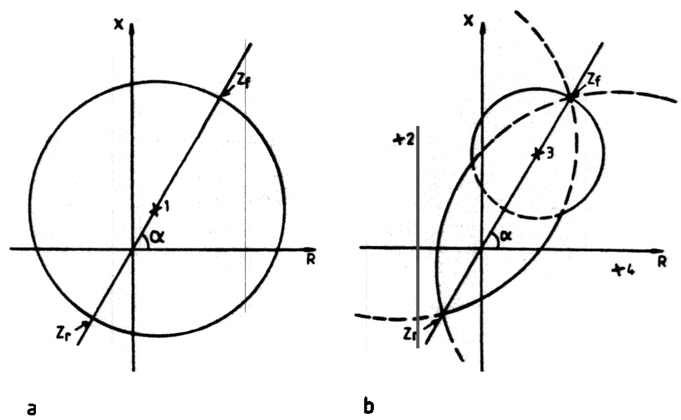


Fig 10 Circular (a) and modified lens(b) characteristics

INSTALLATION

On acceptance, the relay should be inspected with respect to physical damage and, thereafter, should be stored in its box in a dry space and in a temperature of between 10-25°C until it is to be installed.

All internal connections between the units are already made on delivery and only the external connections remain to be made.

Protective relays which are supplied ready-installed in a relay cubicle are jointly tested with the other components in the cubicle. Additional joint tests during installation are not necessary. This simplifies installation and permits rapid commissioning.

RAKZB is to be connected according to the terminal diagrams.

MAINTENANCE

Under normal conditions, RAKZB requires no special maintenance but should be protected against dust, moisture and corrosive atmosphere. The covers should be mounted correctly in place and the holes in the covers blanked off with removable plastic plugs.

When inserting or removing units, as when resetting, reconnection etc., care must be taken to prevent unwanted operation. Normally, the relay should be disconnected but it is often sufficient to block the trip circuit with an RTXB type trip-block plug, which is inserted in the test switch.

In exceptional cases, burned contacts can be dressed with a diamond file or a very fine cut file. Emery cloth or the like should not be used, as grains of emery can become affixed to the contacts and cause malfunction. Under normal operate conditions and in non-corrosive atmospheres, maintenance tests are recommended every second year.

SETTING, TESTING AND COMMISSIONING

Equipment for the tests

For the test recommended here, the following equipment is suitable:

- o Secondary injection testing set, e.g. type TURH, see information RK 915-300 E.
- o Multi-purpose instrument.
- o Time-recorder, e.g. AEG Sekundenmesser.
- o Test-plug handle type RTXH 18.
- o Trip-block plug type RTXB.
- o Ammeter test plug type RTXM.
- o Variable resistor
- o Capacitor

Check and testing

The following checks, settings and tests are made before the relay can be put into service:

- o General inspection
- o General check of connections
- o Setting of the relay
- o Secondary injection test of the relay
- o Primary tests
- o Test on dc circuits

General inspection

Check that all components according to the circuit diagram and apparatus list are included and that there is no visible damage on the relay. also check that the plug-in units have the correct data (rated voltages, impedance range and time-scales) acc. to the apparatus list.

General check of connection

Check that the external wiring is in accordance with the circuit diagram. The polarity of the auxiliary voltage connected to the relay should be checked. Check also carefully that phase currents and voltages are correctly connected to the relay.

Check that the current ratio of the CT's and the voltage ratio of the VT's stated on the rating plates of the transformers correspond to the values stated in the drawings.

It is assumed that the external circuits have already been checked with regard to insulation between phases and between phases and ground.

Measure the resistance of the current circuits from the cubicle terminals. At 5 A rated secondary currents a resistance of 0.5-1 ohm would be expected for the external circuits. For the internal circuits in the cubicle a very low resistance value should be measured.

Check also that no interruption of the current circuits occur when the RTXH 18 test-plug handle is inserted and withdrawn from the RTXP 18 test switch.

Setting of the relay

General

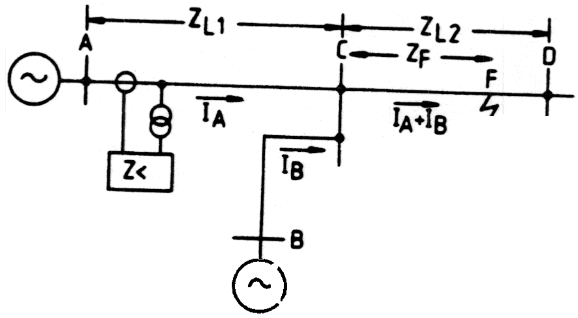
The impedances in the network are converted to the secondary side of the instrument transformers by means of the formula:

$$Z_{sec} = \frac{U_{sec}}{U_{prim}} \times \frac{I_{prim}}{I_{sec}} \times Z_{prim}$$

In a network with lines tied at an intermediate location as shown in Fig. 11 consideration has to be taken to the increase in measured impedance due to the power fed into the system at the teed-point. In case of a fault at point F, the relay at point A senses the impedance

$$Z = Z_{L1} + \left(\frac{I_A + I_B}{I_A}\right) Z_F = Z_{L1} + \left(1 + \frac{I_B}{I_A}\right) Z_F$$

where I_A and I_B are the fault currents from station A and B respectively, Z_{L1} is the impedance of the first line section and Z_F is the impedance of the second line section up to the fault location.



Point A

$$Z_{Fault} = Z_{L1} + \left(1 + \frac{I_B}{I_A}\right) Z_F$$

Fig. 11 Impedances in network with intermediate infeed

Determination of setting factors

Impedance setting

a) Determine settings Z_f and Z_r which make the relay operate for all relevant faults within the protected zone. Generally, the proper values of Z_f and Z_r are most easily found by geometrical design.
The operate characteristic of RAKZB with modified lens characteristic can be designed with the aid of the formulae in Table 3.

b) Check that the operate characteristic gives sufficient margin against the load impedance.

If RAKZB can be reconnected to measure phase-to-neutral voltages and phase currents, the 3-phase reach of the relays should under all load conditions as a maximum be equal to 50 per cent of the load impedance.

The minimum load impedance $Z_{load\,(min)}$ in ohms per phase is calculated from the formula

$$Z_{load\,(min)} = \frac{U^2}{S_{max}}$$

where

U = line voltage in kV

S_{max} = max. apparent load in MVA

c) Calculate the ratio $\frac{A}{B}$

$$\frac{A}{B} = Z_f \times \frac{I_a \times \sqrt{3}}{0.2 \times f}$$ where Z_f is the forward reach in ohms/phase for 3-phase faults

d) Choose a setting factor A equal to or less than 10 times the calculated ratio $\frac{A}{B}$ (nearest settable number)

e) Insert the selected value of A in the formula acc. to c) above and calculate the B-factor.

f) Insert the calculated figures for A and B in the formula and check that the chosen value Z_f is obtained, i.e.

$$Z_f = \frac{f \times 0.2}{I_a \times \sqrt{3}} \times \frac{A}{B}$$ ohms/phase for 3-phase faults

The time-lag is set on relay RXKE 1, pos. 331.

Example on calculation

Example 1

RAKZB as back-up short-circuit protection for generator

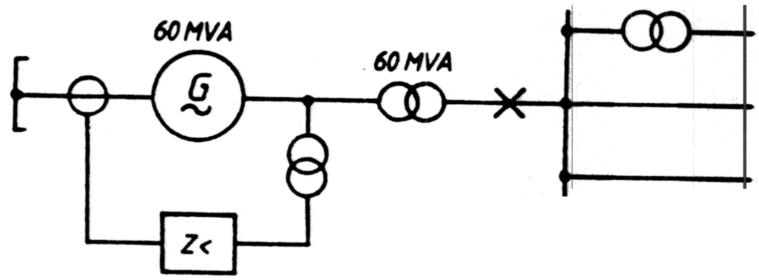


Fig. 12 RAKZB as back-up S/C protection for generator

Data:
Rated frequency = 50 Hz

Ratio of voltage transformers: $\frac{16}{\sqrt{3}} / \frac{0.1}{\sqrt{3}}$ kV

Ratio of current transformers: 2500/5A

Short-circuit voltage of step-up transformer: 10 %

Current scale factor of RAKZB, $I_a = 5A$

For this application, a circular characteristic with $Z_r = -Z_f$ (fig. 5) should be used due to the phase shift of the apparent fault impedance in case of faults on the high voltage side.

Assume that RAKZB is set to 70 % of the 3-phase load impedance and that the relay is Δ-connected.

$$Z_{load} = \frac{U^2}{S} = \frac{16^2}{60} = 4.27 \text{ ohms/phase}$$

Primary setting: $4.27 \times \frac{70}{100} = 2.99$ ohms/phase

Secondary setting:

$$Z = \frac{100}{16000} \times \frac{2500}{5} \times 2.99 = \underline{9.33} \text{ ohms/phase}$$

$$\frac{A}{B} = 9.33 \times \frac{5 \times \sqrt{3}}{0.2 \times 50} = \underline{8.1}$$

Chose A = 80

$$B = \frac{0.2 \times 50 \times 80}{5 \times \sqrt{3} \times 9.34} = \underline{9.9}$$

Check:

$$\frac{0.2 \times 50}{5 \times \sqrt{3}} \times \frac{80}{9.9} = 9.33 \text{ ohms/phase}$$

Example 2

<u>RAKZB as back-up impedance protection for line</u>

Data:

= 3.8 + j 30 ohms/phase

= 32 + j 110 ohms/phase

R_f = 20 ohms (at earth-faults)

S = 150 MVA (maximum)

where

positive-sequence impedance of the protected zone in ohms/phase

zero-sequence impedance of the protected zone in ohms/phase

R_f = additional fault resistance (arc and towering foot resistance)

S = apparent power

U_{prim}/U_{sec}: $\frac{220\,000}{\sqrt{3}}$ / $\frac{110}{\sqrt{3}}$ v, 50 Hz

I_{prim}/I_{sec}: 400/1A, 50 Hz

The reverse reach shall be limited to about 10 ohms/phase.

RAKZB is assumed to have rated current 1A, modified lens characteristic, $\alpha = 60^\circ$, and relay for reconnection to Y-mode in case of ground-faults.

Min. load impedance:

$$Z_{load\ (min)} = \frac{U^2}{S_{max}} = \frac{220^2}{150} = \underline{323 \text{ ohms/phase}}$$

$$Z_{sec} = \frac{110}{220\,000} \times \frac{400}{1} \times Z_{prim} = 0.2 \times Z_{prim}$$

Secondary impedances:

$$Z_{1L} = (3.8 + j\,30) \times 0.2 = 0.76 + j\,6 = 6.05 \quad \underline{/83^\circ} \text{ ohms/phase}$$

$$= (32 + j\,110) \times 0.2 = 6.4 + j\,22 = 22.9 \quad \underline{/74^\circ} \text{ ohms/phase}$$

$R_f = 20 \times 0.2 = 4$ ohms

Loop impedance in case of earth-fault with $R_f = 20$ ohms primary:

$$Z_{loop} = Z_1 + \frac{Z_0 - Z_1}{3} + R_f \text{ (see table 1)}$$

$$Z_{loop} = \frac{2Z_1 + Z_0}{3} + R_f$$

$$Z_{loop} = \frac{2\,(0.76 + j\,6) + 6.4 + j\,22}{3} + 4$$

$$= 6.64 + j\,11.33 = 13.1 \quad \underline{/60^\circ} \text{ ohms}$$

$$Z_{(load)\ min} = 323 \times 0.2 = 64.6 \text{ ohms/phase}$$

A loop impedance setting of 13.1 ohms for single-phase faults coresponds to $Z_f = \frac{13.1}{2} = 6.55$ ohms per phase for 2-phase faults.

The following points on the R-X diagram (fig. 13) are established:

A $Z = 6.55 \ \underline{/60^\circ}$ ohms/phase on the 2-phase characteristic

B $Z = 6.05 \ \underline{/83^\circ}$ ohms/phase on the 2-phase characteristic and 3-phase characteristic

C $R = 4$ ohms loop resistance for single-phase fault to cover close up earth-faults, corresponding to $\frac{4}{2} = 2$ ohms/phase on the 2-phase characteristic

D $X_{reverse} < 2$ ohms/phase

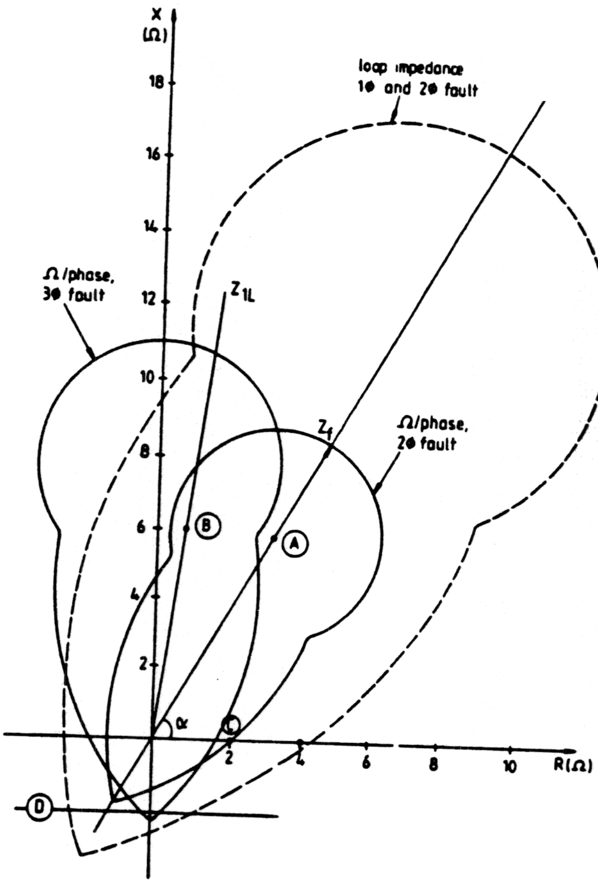


Fig. 13 Selected operate characteristic for RAKZB

The point R = 2 ohms/phase and the requirement $X_{reverse}$ = 2 ohms/phase determine the operate characteristic and result in a setting which overreaches the required zone. However, the load impedance is far beyond the 3-phase reach, and the setting therefore gives no load encroachment problems.

Setting factors:

$$\frac{A}{B} = Z_f \times \frac{I_a \times \sqrt{3}}{0.2 \times 50}$$

$$= 11 \times \frac{1 \times \sqrt{3}}{0.2 \times 50} = 1.9$$

(Z_f = 11 ohm/ph for 3-phase faults is taken from Fig. 13)

Choose A = 10

$$B = \frac{0.2 \times 50}{1 \times \sqrt{3}} \times \frac{10}{11} = 5.25$$

Check

$$Z_f = \frac{0.2 \times 50}{1 \times \sqrt{3}} \times \frac{10}{5.25} \; 11 \text{ ohm/ph}$$

Secondary injection test

The relay is provided with the COMBITEST test switch type RTXP 18 acc. to Catalogue B03-9510 E. The contact in the current circuits switch without interposing break and the contacts in the tripping circuits open when the test plug handle is inserted. The contacts are arranged in such a way that the relay is supplied with currents and voltages when the test plug handle is in the intermediate position.

When the test plug handle is fully inserted (the test position) all contacts in the test switch, except for the auxiliary d.c. supply of the relay, are open and by-passing bars interconnect adjacent contact blocks in the current circuits thereby short circuiting the secondary circuits of the instrument current transformers. When it is in the intermediate position, only the tripping circuits are opened. Consequently, when the test plug handle is fully inserted, the relay is completely disconnected from the instrument transformers.

A catch which holds the test plug handle in the intermediate position must be actuated to remove the test plug handle.

The operating characteristic of the measuring elements shall be checked by secondary injection. The measurements can be performed as described in Test Instruction RK 654-101 E Checking of impedance relay RAKZB with the aid of test set type TURH.

The directional test described below is suitably carried out before the operate characteristics of the relay are checked and adjusted by secondary injection testing. Approximate settings in accordance with the calculated values are sufficiently accurate when performing the directional test.

Directional test

A directional test shall be carried out before the commissioning is finalized. The test should be carried out with the line in service and with a load of more than 0.2 x rated load. The load should preferrably be slightly inductive in first quadrant of the R-X diagram.

The test is carried out as follows:

Put in blocking pins type RXTB, in terminals 16 and 17 of the test device RTXP 18 to prevent tripping.

Switch the RAKZB relay to measure phase impedance, by activating the Δ/Y reconnection relay in RXZK 4.

Check that the diode marked "Y" on the RXZK 4 relay is lit.

Note carefully the setting of factor D on the RAKZB relay if the directional test is made after the secondary injection test. Set D = 0.1 for all three phases.

Connect a variable resistor (R), a capacitor (C) and a voltmeter (V) to the test wires of an RTXM ammeter test plug and to the neutral voltage terminal as shown in Fig. 14. Insert the RTXM test plug in the R-phase voltage terminal of the RTXP 18 test switch.

The circuit gives a forward phase shift of the R-phase voltage to the relay, i.e. the phase R measuring element will have its characteristic angle tilted in direction of the R-axis. A capacitance value is chosen which gives a phase shift roughly equal to the difference between the characteristic angle of the relay and the angle of the load impedance, see the table below.

Resistance (ohm)	Capacitance (μF)	Phase shift (°) 50 Hz	60 Hz
	2	58	53
	3	47	41
1000	4	38	33
	6	28	24
	Shorted	0	0
2200	6	14	11

Reduce the voltage Um until the ratio between Um and the current to the relay correspond to the set forward reach Z_f expressed in ohms per phase. If the load current is flowing in the forward direction (same direction as Z_f) the impedance relay should operate.

If no function is obtained, pull out the RTXM test plug and the RTXP pins. Insert the RTXH 18 test handle in the test switch to short-circuit the current circuits. Reverse the current to phase R of RAKZB by interchanging the wires to terminals 3B and 4B on the RTXP 18 test device.

Note: Ensure that the wire on the protection side i.e. B side are changed and not on the A side as this will give an open current transformer secondary, which is very dangerous.

Pull out the handle, insert the RTXP blocking pins and the RTXM test pin and repeat the test.

The same test is made for phase S and T.

Reset the factor D to its proper value.

If the load current is flowing in the reverse direction, the connections which give operation of the relay are first established for all three phases. The wires to terminals 3B-8B are then interchanged as described above.

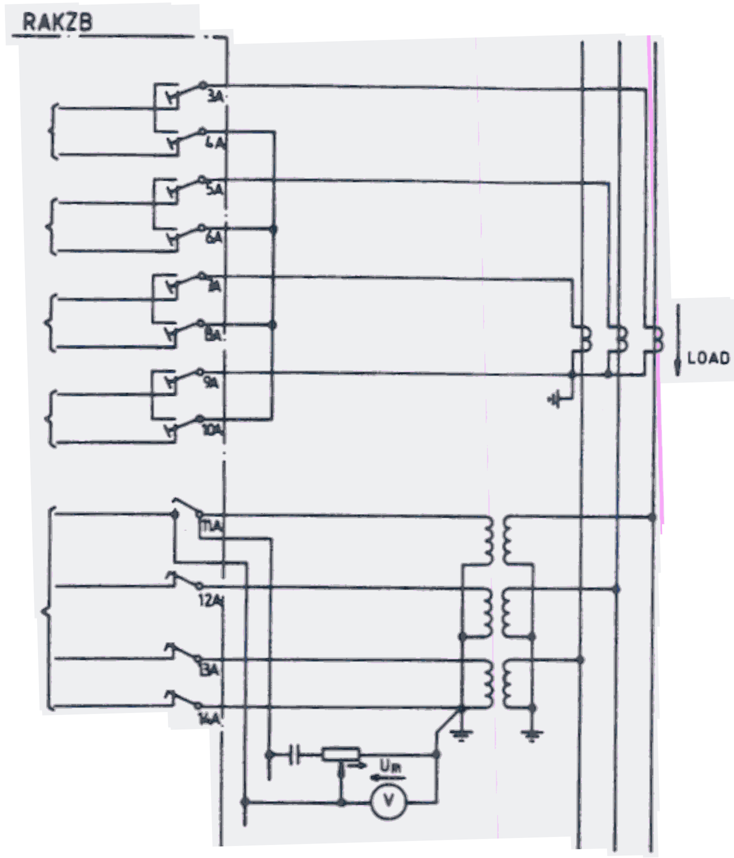


Fig. 14 Connections for directional test of RAKZB acc. to diagram 7422 005-CB.

Note: Test terminals 9-12 are for some versions of RAKZB used for the voltage circuits!

Test on dc circuits

The dc circuits for trip and alarm functions should be checked. The trip circuits should, if possible, be checked by tripping the associated breaker(s) when the relay operates.

Reset the indicating flags.

The impedance protection can now be put into service.

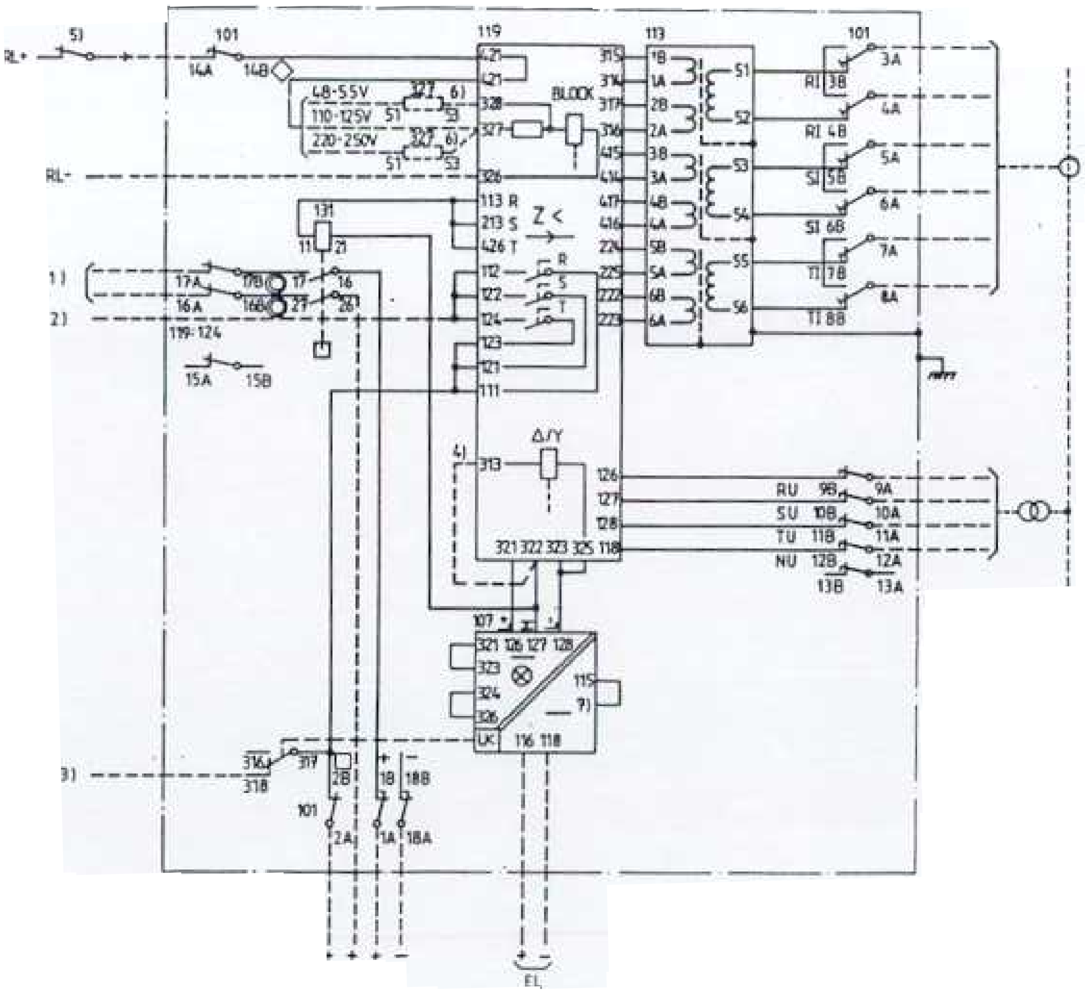
TECHNICAL DATA

Rated voltage U_n	110 V, 50 or 60 Hz
Characteristic angle	60^o alternativity 75^o
Operate characteristic	Circular or modified lens (fig. 5-9)
Modified lens minor/major axis ratio	
Current scale factor I_a	0.5, 1, 2.5 or 5 A
Lowest operate current	
Reach setting formulae in forward direction Z_f	See table 1
in reverse direction Z_r	$Z_r = -D \times Zf$ $D = -0.2$ to $+1$
Setting range	See table 2
Accuracy	$< \pm 10$ % Z_f
Reset ratio	< 103 %
Transient overreach at $I > I_a$	< 20 %
Operate time at $0.1 < Z_s/Z_f < 100$ $0.5 < I/I_a < 30$	12-32 ms across the contacts 5-25 ms across the diode outputs
Reset time	40-65 ms
Permitted auxiliary voltage deviation	-20 % to +10 %
Permitted ambient temperature	-10^o to $+55^oC$
Percent change in operate value per % auxiliary voltage change	No change between -20 % and +10 % of rated value
per ^oC temperature change	< 0.2 %
Overload capacity continuous/1 s	$3 \times I_a/70 \times I_a$
Power consumption	
Current measuring circuit	0.05 VA/phase at $I = I_a$
Voltage measuring circuit	0.24 VA/phase at U_n
Auxiliary voltage circuit	12 W (incl. RXTUG 2H
Auxiliary voltage dc	
Electronic circuits EL	24, 48, 55, 110, 125 or 250 V

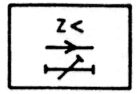
Relay circuits RL	48-55, 110-125 or 220-250 V (for external blocking)	
Diode outputs	24 V, dc, max. load 1.5 W (63 mA)	
<u>Contacts</u>	<u>RXME 18</u>	<u>RXZK 4</u>
Max. system voltage dc/ac	450/400 V	250/250 V
Current carrying capacity (for already closed contact):		
200 ms/1 s	55/30 A	-/15 A
continuous	6 A	5 A
Making and conducting capacity L/R > 10 ms:		
200 ms/1 s	30/20 A	30/10 A
Breaking capacity:		
ac, P.F. > 0.1 max 250 V	20 A	-
P.F. > 0.4 max 250 V	-	8.0 A
dc L/R < 40 ms at U_n		
24 V	20 A	2.0 A
48 V	18 A	1.0 A
55 V	15 A	0.8 A
110 V	3 A	0.4 A
125 V	2.5 A	0.3 A
220 V	1 A	0.2 A
250 V	0.8 A	0.15 A
Insulation tests		
Dielectric test 50 Hz, 1 min:		
voltage circuits to contact circuits and ground	2.0 kV	
current circuits to other circuits and ground	2.5 kV	
Impulse voltage test, 1,2/50 us, 0,5 J, both polarites	5.0 kV	
Disturbance tests		
1 MHz burst test, 2 s, common mode/transverse mode	2,5/1 kV	
Dimension/Weight		
Version -AC	4S 36C, 4,9 kg	
-BB	4S 36C, 5.1 kg	
-CB	4S 42C, 5.9 kg	
-DB	4S 60C, 9.5 kg	

Reference

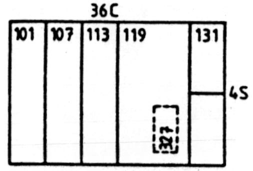
Checking of RAKZB with test set TURH	Instr. RK 654-101E
Time-delay relay data table	B03-1603E
Pickup time-delay relay, RXKE 1	B03-1613E
Test system COMBITEST	B03-9510E
Mounting and connection	B03-9301E
Dimensions	B03-9382E



Circuit diagram 7422 005-AC (RK 654 001-AC)



3-PHASE SHORT-CIRCUIT PROTECTION
3-FAS KORTSLUTNINGSSKYDD



101	RTXP 18
107	RXTUG 2H
113	RTQTC 061
119	RXZK 4
131	RXME 18
327	RTXE 6)

1) TRIPPING OF CB ETC.
UTL. AV BRYTARE MM.

2) ALARM ETC.
SIGNAL MM.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

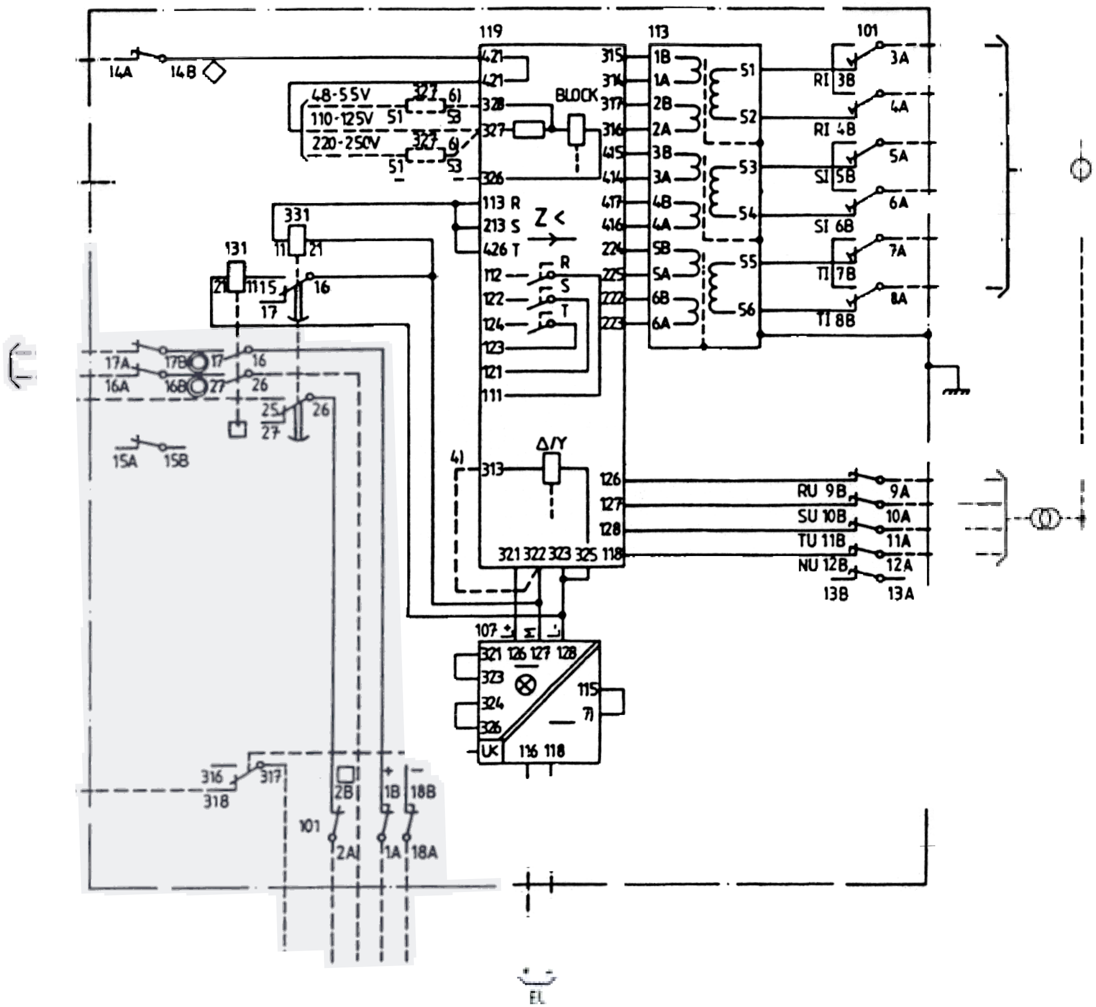
4) CONNECTED WHEN RXZK 4 ARE MEASURING PHASE-VOLTAGE (Y)
ANSLUTEN NÄR RXZK 4 MÄTER FASSPÄNNING (Y)

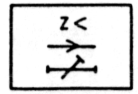
5) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE

6) RTXE INCLUDED AT RL=48-55V OR 220-250V
RTXE INGÅR VID RL=48-55V ELLER 220-250V

7)

TERMINAL UTTAG	AT AUX. VOLTAGE EL VID HJÄLPSPÄNNING EL		
114	24V	RESP.	110V DC
113	48V		125V DC
112	55V		220V DC
111			250V DC





-PHASE DEL
PROTECTION
3-FAS FÖRDRÖJT KORTSLUTNINGS
SKYDD

36C

101	107	113	119	131
			327	331

101 TXP
107 RXTUG
TGTI
RXZK
RXME
RXKE
TXE

RIPPING OF CB TC.
TL. AV BRYTARE HM

ALARM ETC.
SIGNAL MH.

ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPANNINGSBORTFAL

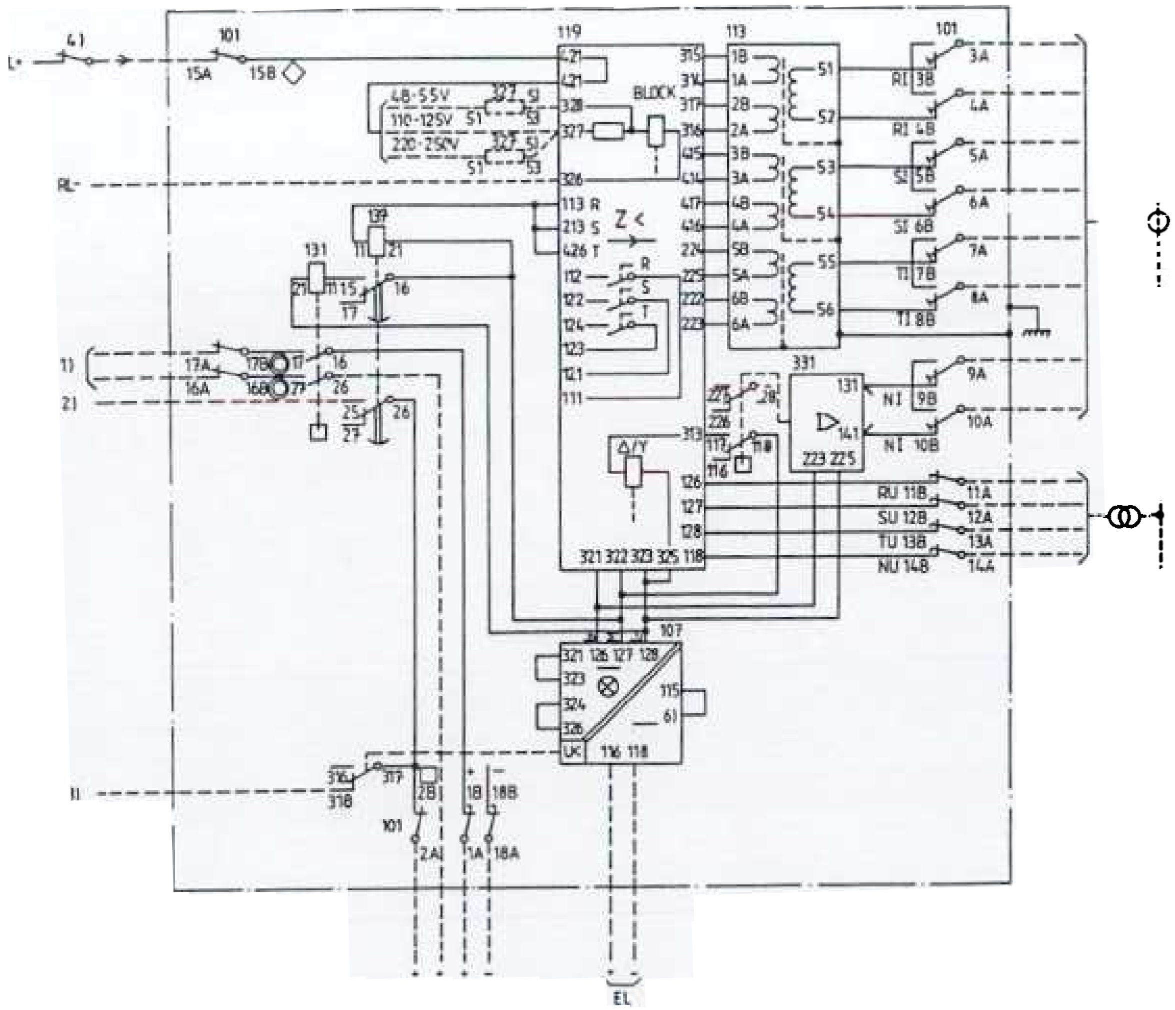
CONNECTED WHEN RXZK 4 ARE
MEASURING PHASE-VOLTAGE (
ANSLUTEN NÄR RXZK 4 MÄT
FASSPANNING (Y)

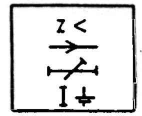
BLOCKING RELAY IN BLOCKING
POSITION
BLOCKERINGSRELÄ I BLOCKERANDE
LÄGE

RTXE INCLUDED A
OR 220-250V
RTXE INGÅR VID
ELLER 220-250V

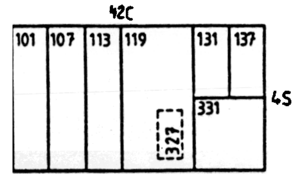
TERMINAL ~~UTTAG~~	AT AUX. VOLTAGE EL ~~VID HJÄLPSPÄNNING EL~~		
114	24V	RESP.	110V DC
113	48V		125V DC
112	55V		220V DC
111			250V DC

ircui agram 7422 005-BB RK 654 00 -BB





3-PHASE DELAYED SHORT-CIRCUIT PROTECTION AND EARTH-FAULT PROT.
3-FAS FÖRDRÖJT KORTSLUTN.-SKYDD OCH JORDFELSSKYDD



101	RTXP 18
107	RXTUG 2H
113	RTQTC 061
119	RXZK 4
131	RXME 18
137	RXKE 1
327	RTXE 5)
331	RXIG 2

1) TRIPPING OF CB ETC.
UTL. AV BRYTARE MM.

2) ALARM ETC.
SIGNAL MM.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

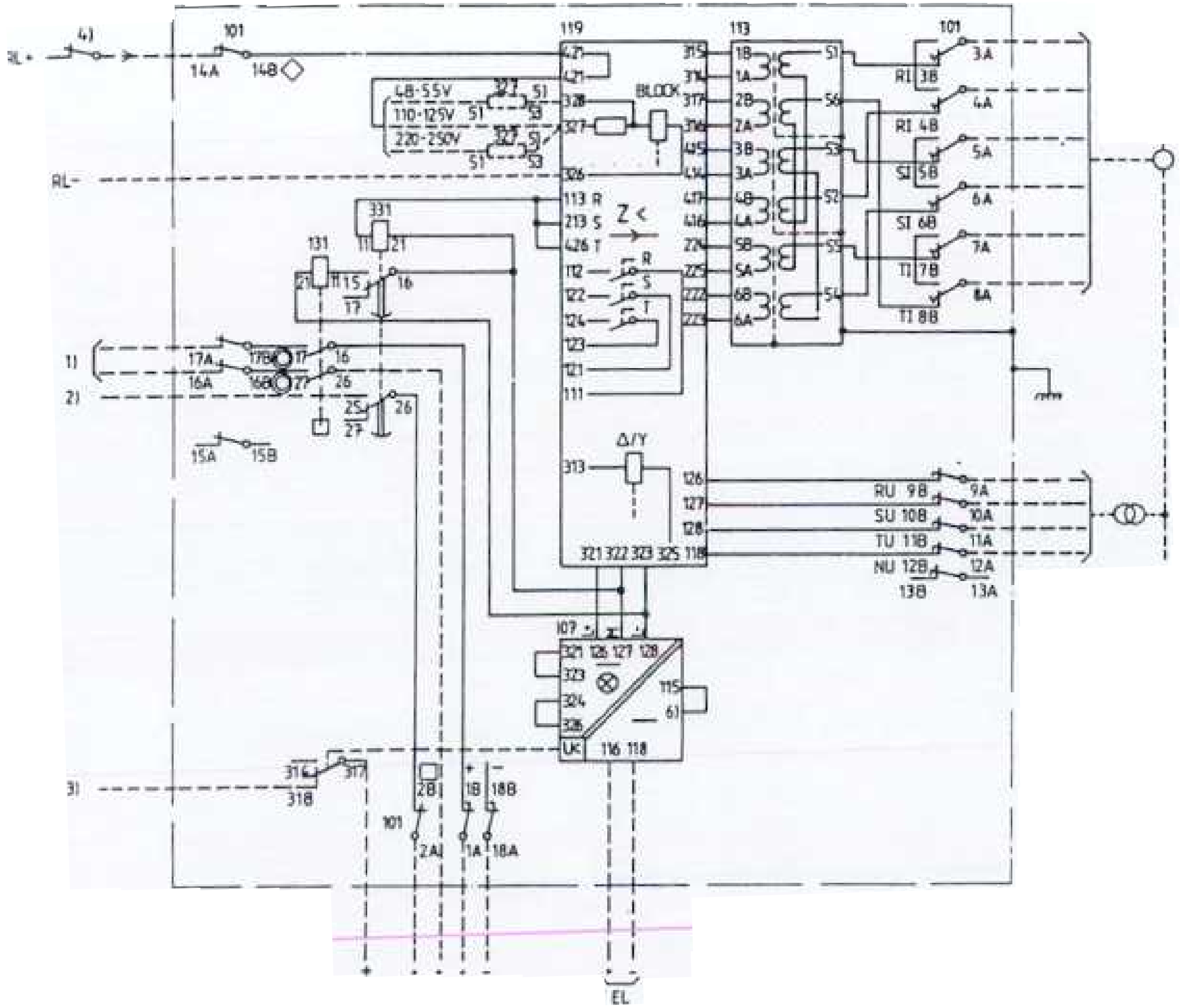
4) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGRELÄ I BLOCKERANDE LÄGE

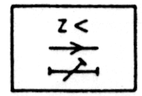
5) RTXE INCLUDED AT RL = 48-55V
OR 220-250V
RTXE INGÅR VID RL = 48-55V
ELLER 220-250V

6)

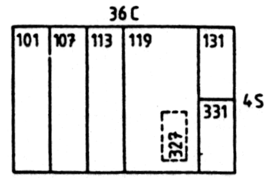
TERMINAL UTTAG	AT AUX. VOLTAGE EL VID HJÄLPSPÄNNING EL		
114	24V	RESP.	110V DC
113	48V		125V DC
112	55V		220V DC
111			250V DC

Circuit diagram 7422 005-CB (RK 654 001-CB)





3-PHASE DELAYED SHORT-CIRCUIT PROTECTION
3-FAS FÖRDRÖJT KORTSLUTNINGS-SKYDD



101	RXTP 18
107	RXTUG 2H
113	RTQTC 062
119	RXZK 4
131	RXME 18
331	RXKE 1
327	RTXE 51

1) TRIPPING OF CB ETC.
UTL. AV BRYTARE MM.

2) ALARM ETC.
SIGNAL MM.

3) ALARM LOSS AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

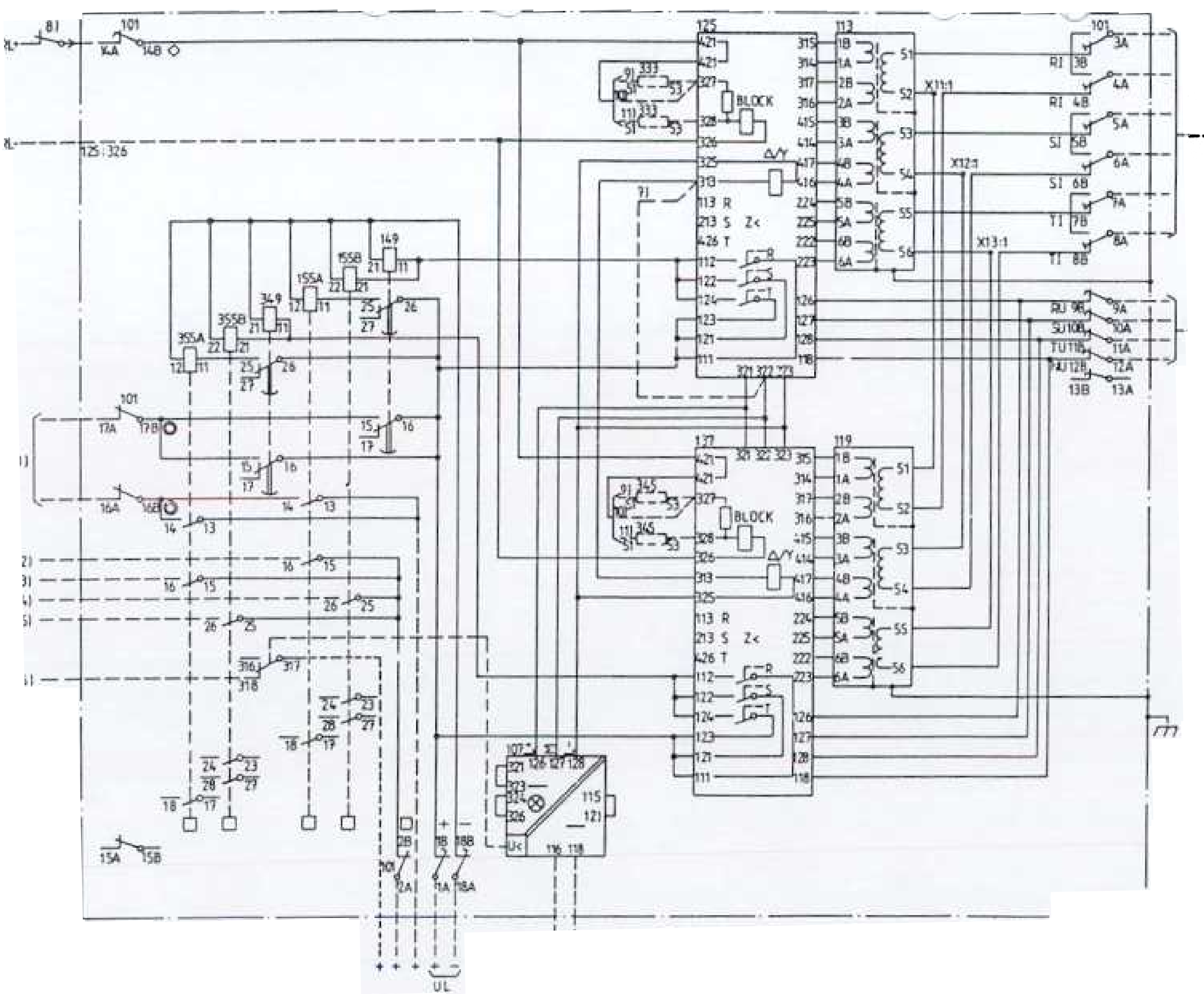
4) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINSRELÄ I BLOCKERANDE LÄGE

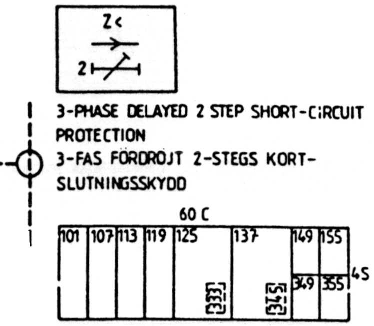
5) RTXE INCLUDED AT RL=48-55V OR 220-250V
RTXE INGÅR VID RL=48-55V ELLER 220-250V

6)

TERMINAL UTTAG	AT AUX. VOLTAGE EL VID HJÄLPSPÄNNING EL		
114	24V	RESP.	110V DC
113	48V		125V DC
112	55V		220V DC
111			250V DC

Circuit diagram 7422 005-EB (RK 654 001-EB)





3-PHASE DELAYED 2 STEP SHORT-CIRCUIT PROTECTION
3-FAS FÖRDRÖJT 2-STEGS KORT-SLUTNINGSSKYDD

1) TRIPPING OF CB:S ETC.
UTLÖSN. AV BRYTARE MM
2) ALARM TRIPPING STEP 1
SIGNAL UTLÖSNING STEG 1
3) ALARM TRIPPING STEP 2
SIGNAL UTLÖSNING STEG 2
4) ALARM START STEP 1
SIGNAL START STEG 1
5) ALARM START STEP 2
SIGNAL START STEG 2
6) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL
7) CONNECTED WHEN RXZK 4 ARE MEASURING PHASE VOLTAGE (Y)
ANSLUTEN NÄR RXZK 4 MÄTER FASSPÄNNING (Y)
8) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE
9) FÖRB. VID/WIRING AT RL = 220-250V
10) FÖRB VID/WIRING AT RL = 110-125V
11) FÖRB VID/WIRING AT RL = 48-55V
12)

TERMINAL UTTAG	AT AUX. VOLTAGE EL VID HJÄLPSPÄNNING EL
114	24 RESP 110V
113	48 RESP 125V
112	55 RESP 220V
111	250V

Circuit diagram 7422 006-DB (RK 654002-DB)

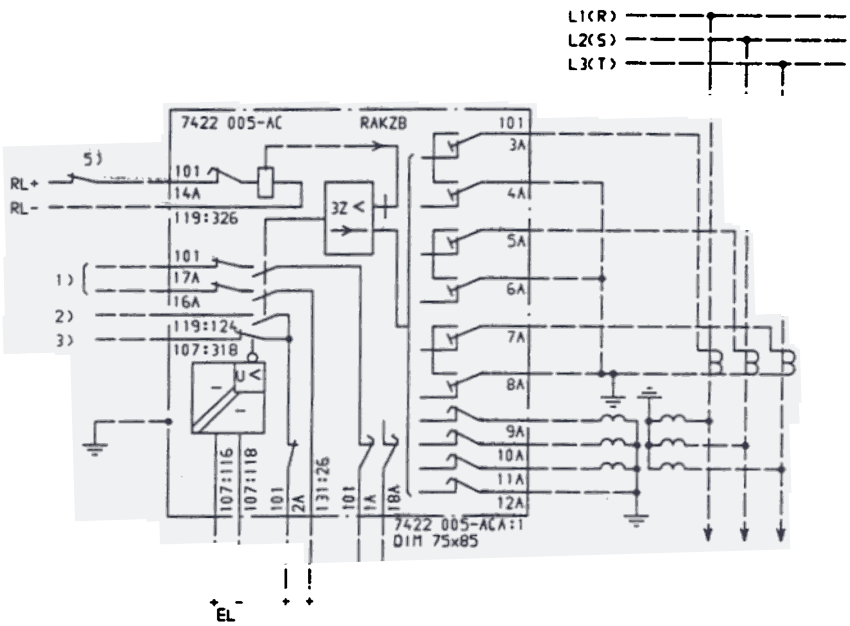
3-PHASE SHORT-CIRCUIT PROTECTION
3-FAS KORTSLUTNINGSSKYDD

1) TRIPPING OF CB ETC.
UTLÖSNING AV BRYTARE M.M.

2) ALARM ETC.
SIGNAL M.M.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

5) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE



Terminal diagram 7422 005-ACA (RK 654 001-AC)

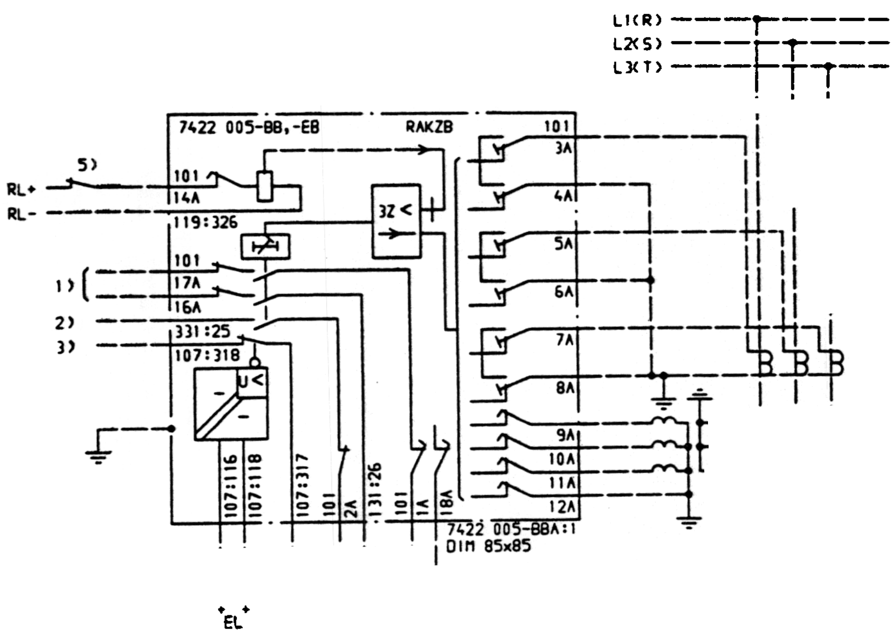
3-PHASE DELAYED SHORT-CIRCUIT
PROTECTION
3-FAS FÖRDRÖJT KORTSLUTNINGSSKYDD

1) TRIPPING OF CB ETC.
UTLÖSNING AV BRYTARE M.M.

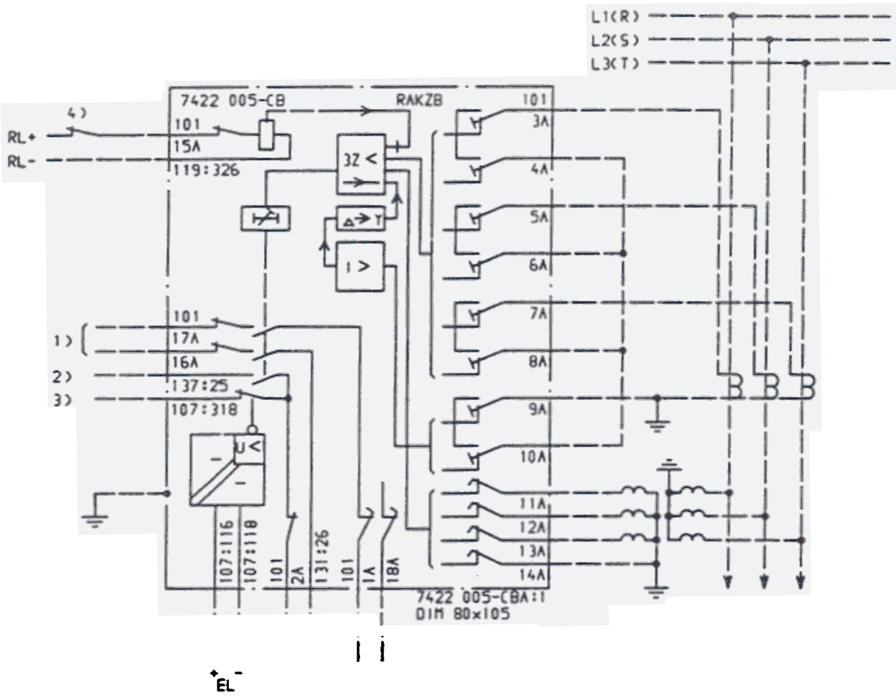
2) ALARM ETC.
SIGNAL M.M.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

5) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE



Terminal diagram 7422 005-BBA (RK 654001-BB)



3-PHASE DELAYED SHORT-CIRCUIT PROTECTION
3-FAS FÖRDRÖJT KORTSLUTNINGSSKYDD

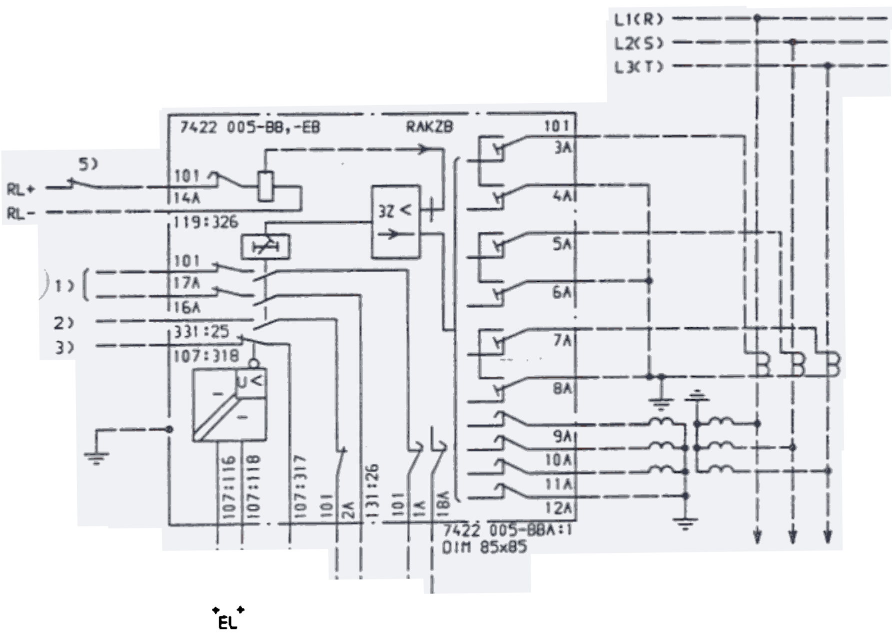
1) TRIPPING OF CB ETC.
UTLÖSNING AV BRYTARE M.M.

2) ALARM ETC.
SIGNAL M.M.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

4) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE

Terminal diagram 7422 005-CBA (RK 654 001-CB)



3-PHASE DELAYED SHORT-CIRCUIT PROTECTION
3-FAS FÖRDRÖJT KORTSLUTNINGSSKYDD

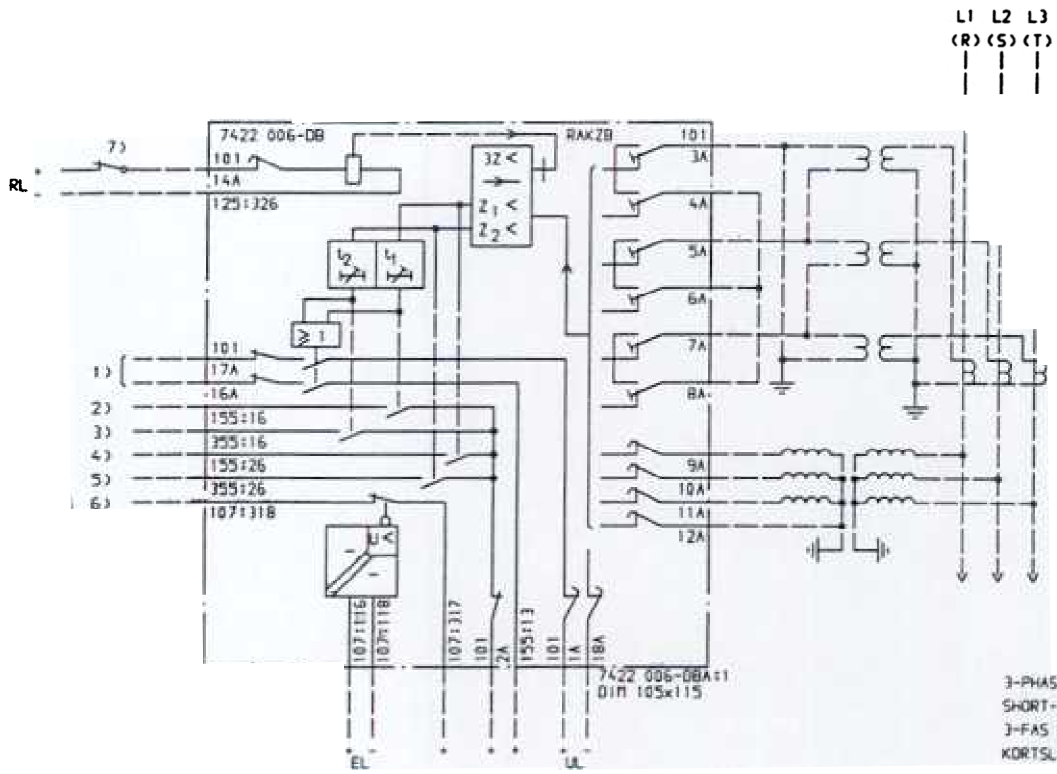
1) TRIPPING OF CB ETC.
UTLÖSNING AV BRYTARE M.M.

2) ALARM ETC.
SIGNAL M.M.

3) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJÄLPSPÄNNINGSBORTFALL

5) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELÄ I BLOCKERANDE LÄGE

Terminal diagram 7422 005-BBA (RK 654 001-EB)



3-PHASE DELAYED 2 STEP
SHORT-CIRCUIT PROTECTION
3-FAS FÖRDRÖJT 2 STEGS
KORTSLUTNINGSSKYDD

Terminal diagram 7422 006-DBA (RK 654 002-DB)

1) TRIPPING OF CB ETC.
UTLÖSNING AV BRYTARE MM

ALARM TRIPPING STEP 1
SIGNAL UTLÖSNING STEG

ALARM TRIPPING STEP 2
SIGNAL UTLÖSNING STEG 2

ALARM START STEP 1
SIGNAL START STEG 1

5) ALARM START STEP 2
SIGNAL START STEG 2

6) ALARM LOSS OF AUXILIARY VOLTAGE
SIGNAL HJALPSPANNINGSBORTFALL

7) BLOCKING RELAY IN BLOCKING POSITION
BLOCKERINGSRELA I BLOCKERANDE LAGE

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