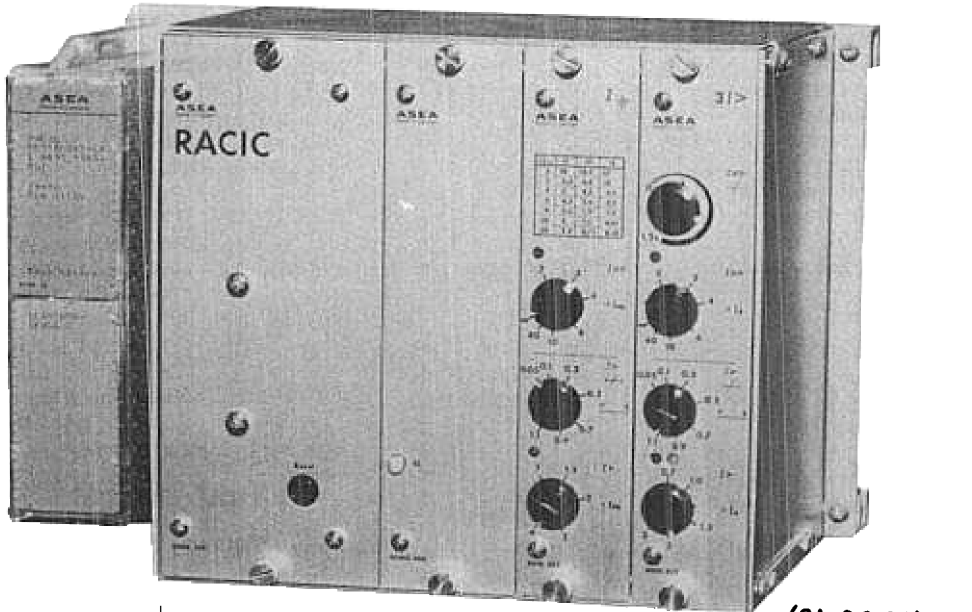
ABB Relays

UG03-2313E
User's Guide
February 1990
Changed since
Dec. 1986
Data subject to change without notice

Type RACIC
Feeder protection



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GENERAL

- Two-phase or three-phase time-overcurrent relay with start, delayed and instantaneous functions
- Earth-fault relay with start, delayed and instantaneous functions, or directional earth-fault relay with start and delayed functions and adjustable voltage release
- Definite-time or inverse characteristic for the overcurrent and the earth-fault relays
- Definite-time characteristic for the directional earth-fault relay
- Built-in medium-(trip-) duty or heavy-duty trip relay
- External connections to a test switch or to screw terminals
- Low burden on the CT's. This reduces the requirement on the overcurrent figure and hence the size and cost of the CT's
- Wide setting range, e.g. 2.8-12 A for the 5 A relay and time settings 0.3-6.6 s
- Good accuracy and low "overshoot" allows a small grading margin. This allows faster clearance times which increases personal safety and reduces material damage
- Small transient overreach of the instantaneous relay increases the possibilities to obtain instantaneous selective tripping
- Due to the high resetting ratio, the time-overcurrent relays can be set close to the maximum load current in networks with low fault currents

LIST OF CONTENTS Page

LIST OF ILLUSTRATIONS Page

DEFINITIONS

Start operation	The operation obtained instantaneously when the measured current I exceeds the set current I >.
Delayed operation	The operation obtained when the measured current I after the set time exceeds the set start operating value I >. The delay can be either definite or inverse.
Instantaneous operation	The operation obtained instantaneously when the measured current I exceeds the set value I >>. In certain cases, the function can be delayed in order to obtain the desired selectivity.
Definite-time characteristic	A delayed operation where the operating time is independent of the magnitude of the actuating quantity when this has exceeded the start operating value I >.
Inverse-time characteristic	A delayed operation where the operating time is inversely dependent of the magnitude of the actuating quantity when this has exceeded the start operating value I >. (International standards refer to three inverse time delay characteristics; normal inverse, very inverse and extremely inverse. These are defined in IEC Publication 255-4.)
I_0	Zero sequence component of the current. Arises during a earth fault.
	Zero sequence component of the voltage. Arises during a earth fault.
φ_0	Phase angle between I_0 and U_0
α	The characteristic angle of the earth-fault relay. It is identical to the phase angle between the current and voltage of the earth-fault relay to which it is extremely sensitive, i.e. when $\cos(\varphi_0 - \alpha) = 1$.
I_N	Earth current. The current which flows from the neutral point of the system to earth during an earth fault. $I_N = 3 \times I_0$
	Neutral point voltage. The voltage between the neutral point of the system and earth during a earth fault. $U_N = 3 \times U_0$
Saturation factor n	The saturation factor n of a current transformer indicates the largest multiple of the rated current up to which the composite error of the transformer conforms to the value of the accuracy class. The saturation factor depends on the magnitude of the burden and is calculated according to the following formula:

$$n = \frac{a}{b + Z}$$

where a = constant (ohms), which depends on the dimensions of the current transformer and the frequency
b = impedance (ohms) of the secondary winding
Z = impedance (ohms) of the burden for which the saturation factor is to be determined

At rated burden, the saturation factor corresponds to the accuracy limit factor.

Transient overreach

The affect of the dc component on the operating value. A portion of the dc component is transferred to the measuring circuits and causes these to operate at a lower current (calculated on the steady state) than the set current. If, for example, when the dc component is fully developed, operation takes place for a steady state current that is 0.9 times the set value, then the transient overreach of the protective relay is

$$< \frac{1-0{,}9}{0{,}9} = 0{,}11 \text{ i.e. } 11\ \%$$

APPLICATION

Overcurrent relay

The two-phase or three-phase time-overcurrent relay is used as phase short-circuit protection in radial networks. In networks with parallel feeders or networks with infeed from several points, RACIC may be used together with directional relays type RXPE 42. The operating value of RXPE 42 must be lower than the operating value of the overcurrent relay in order to secure that the directional relay operates first and does not influence the time delay. Normally, RXPE 42 is set to operate at 25-50 percent of the operating current of the overcurrent relay.

Start function

The start function is used to block other protective relays, for start of sequential events recorders and in some cases, for non-selective instantaneous tripping combined with high-speed auto-reclosing.

The setting of the start function is determined by the maximum load current and the minimum fault current in case of short-circuits within the protected zone. The overcurrent relay is normally providing back-up protection for the outgoing feeders in the subsequent station. Hence, the setting must take into consideration the minimum fault current for faults at the extreme end of the longest feeder in the subsequent station.

It should be observed that in case of two-phase short-circuits at the other side of Dy or Yd-connected power transformers, the current in two of the phases is only 50 percent of the three-phase short-circuit current. This must be taken into consideration when two-phase overcurrent relays are used.

Instantaneous function

The instantaneous function is normally set for operation at large fault currents. In order to avoid non-selective tripping, the use of the instantaneous function is limited to cases where a relatively large impedance limits the fault current. One example is a power transformer, where the instantaneous function of the overcurrent relay on the feeding side normally can be set sufficiently high to operate only in case of short-circuits on the feeder to the transformer and short-circuits in the transformer. In strong networks with rather constant fault MVA level, the instantaneous function may sometimes be used for fast tripping of close-up faults on long feeders. A short delay of the instantaneous function is used if selectivity with fuses is required.

Delayed function

Consideration must be taken to the selectivity with other protective relays in the network when selecting the time characteristic. Relays with different time characteristics should be avoided in the same network. The following is a guide when selecting the time characteristic:

DEFINITE TIME CHARACTERISTIC is suitable in most types of network, and makes it easier to do the time grading.

NORMAL INVERSE CHARACTERISTIC is suitable in networks where the fault MVA levels vary to a great extent.

VERY INVERSE CHARACTERISTIC is suitable for networks which have relatively constant fault MVA levels.

EXTREMELY INVERSE CHARACTERISTIC is suitable when co-ordination with fuses is required and when heavy switching surges can be experienced (so called cold load).

In order to obtain selective tripping of the series connected breakers in the network, the time delay setting must increase for each step towards the point of infeed. This means that the tripping times will be longer the higher up in the network the overcurrent relay is placed, but at the same time the short-circuit currents are increasing. It is therefore important that the time intervals between the different selectivity stages are the shortest possible. For RACIC with definite-time, 0.3 s is recommended as a minimum time interval when the same types of relays are used.

A suitable time interval is 0.4 s even for normal inverse, very inverse and extremely inverse characteristics at a current corresponding to the highest through-fault current or possibly the current that corresponds to the setting of the instantaneous operation if this function is used.

Earth-fault relays

0.15 - 6 A relay

This relay is used in direct earthed and low impedance earthed radial networks. The relay normally provides back-up for the earth-fault relay on the outgoing feeders in the subsequent station. Hence the current setting is determined by the minimum earth-fault current in case of a earth-fault on one of these feeders. The desired current setting can vary from 10 to 40 percent of rated current of the current transformers in direct earthed networks.

5 - 200 mA relay

This sensitive relay is used in isolated or high resistance earthed radial networks. But if, for an overhead line, the capacitive earth-fault current of the line exceeds 66 percent of the primary operating value of the relay, a directional earth-fault relay should be used. For cables a directional earth-fault relay should be used when the capacitive earth-fault current exceeds 33 percent of the operating value of the relay.

When calculating the minimum earth-fault current, requirements on relay operation for earth-faults with high fault resistance must be taken into consideration. The requirement on the efficiency factor (see page 7) normally limits the lowest setting of I_{Ns} to 15 mA when the relay is connected to a residual current transformer.

Delayed function

The time delay settings of the earth-fault relays are chosen according to the same principles as for the overcurrent relay.

Directional earth-fault relay

The sensitive directional earth-fault relay with setting range 3-120 mA is used in isolated or high resistance earthed networks with or without neutral point reactor. In isolated networks, the relay measures the capacitive current and is connected with characteristic angle $\alpha = -90^o$. In resistance earthed networks, the relay measures the resistive (active) component in the earth-fault current and is connected with characteristic angle $\alpha = 0^o$.

In resonant earthed networks (high impedance earthed networks with neutral point reactor), directional earth-fault relays are used which measures the resistive (active) component in the earth-fault current. Normally, a resistor has to be connected in parallel with the neutral point reactor to get a sufficiently high active current to the directional relay. Different methods are used, e.g. the resistor may be connected in by a time delayed neutral voltage relay after the ocurrence of a earth-fault.

Delayed function

The time delay settings of the earth-fault relays are chosen according to the same principles as for the overcurrent relay.

Requirements on the current transformers

Saturation factor

The current transformers should meet the following requirements:

- The saturation factor n ought to be larger than 10 when independent time characteristic is used
- The factor n ought to be larger than $\frac{I_k}{I_n}$ or larger than 20 when inverse time characteristic is used, where I_k is the short-circuit current of the network and I_n is the primary rated current of the current transformer
- If the instantaneous operation is used, the saturation value, calculated on the acutal burden, must be higher than the set instantaneous operation $I >>$, this means that the saturation factor n should be larger than $I >> / I_n''$ where I_n'' is the secondary rated current of the current transformer.

The demand on the current transformers of the sensitive directional earth-fault relay is, that the composite error should be so small, that measuring of the active component of the earth-current is not influenced by the capacitive component. This is secured by checking the efficiency factor, see below. In cable networks with risks for intermittent earth-faults, the current transformer has to be dimensioned so that the direct current component of the earth current would not saturate the transformer.

Efficiency factor

In isolated and high-impedance earthed systems, the fault current fed to the earth-fault relays is normally small and relays with low operating current are used. In this case, the efficiency factor of the relay should be checked.

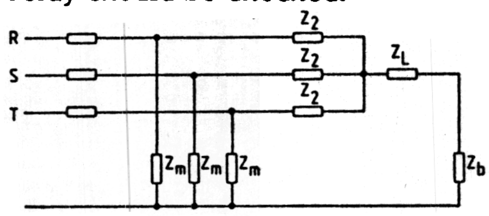


Fig. 1 Equivalent circuit for current transformers to earth-fault relay.

The efficiency factor is defined as:

$$\eta = \frac{I_r}{I_N} \times \mathcal{H} \times 100\ \%$$

where I_r = current supplied to the relay
I_N = primary earth-fault current
$\mathcal{H}$ = current transformer ratio

The efficiency factor can be calculated from the formula

$$\eta = 100 \frac{Z_m}{Z_m+Z_2+C(Z_L+Z_r)}\ \%$$

where

Z_m = magnetizing impedance of the current transformer(s)
Z_2 = resistance of the current transformer secondary winding plus resistance of wires up to the interconnection (per phase)
Z_L = resistance of wires up to the earth-fault relay (loop resistance)
Z_r = impedance (resistance) of the measuring circuit of RACIC
C = 1 for cable current transformers
C = 3 for residual connected current transformers

It should be observed that the magnetizing impedance varies with the voltage. The impedance Z_m at the secondary voltage which gives relay operation is inserted in the formula. If the angle of the impedance Z_m is not known, the value 45 degrees (lagging) can be assumed.

The requirement on η is:

η > 80 % for earth-fault relays

η > 90 % for directional earth-fault relays

Example on calculation

Current and time settings for overcurrent relays with "normal inverse" characteristic are to be determined for a radial network acc. to figure 2. Calculate the fault currents, referred to a common voltage (22 kV).

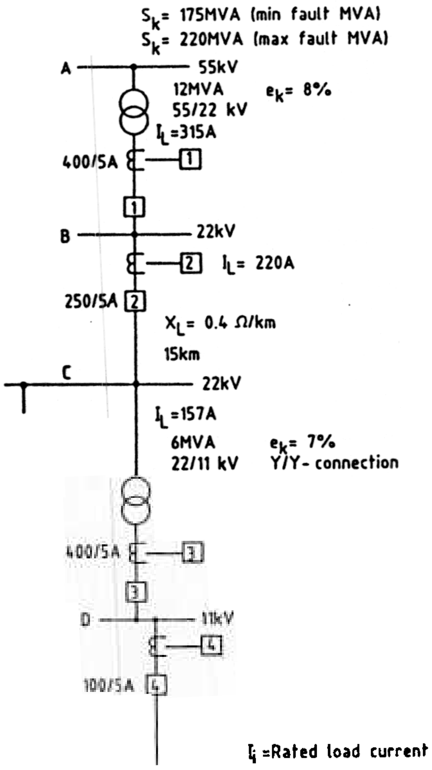


Fig. 2 Network

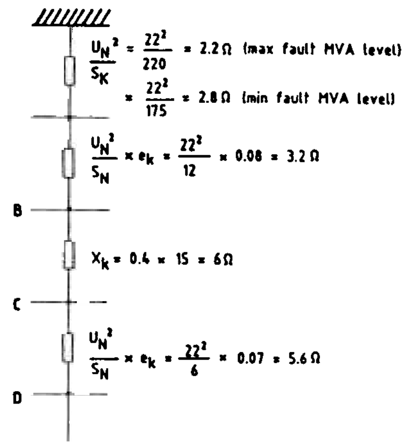


Fig. 3 Impedance network

3-phase short-circuit current $I_k = \dfrac{22}{\sqrt{3} \cdot X_k}$

$$I_{kA}\max = \frac{22}{\sqrt{3} \times 2.2} \qquad I_{kB}\max = \frac{22}{\sqrt{3}(2.2+3.2)}$$

$$I_{kA}\min = \frac{22}{\sqrt{3} \times 2.8} \qquad I_{kB}\min = \frac{22}{\sqrt{3}(2.8+3.2)}$$

Max. values		Min. values	
I_{kA}	= 5 770 A	I_{kA}	= 4 540 A
I_{kB}	= 2 350 A	I_{kB}	= 2 120 A
I_{kC}	= 1 110 A	I_{kC}	= 1 060 A
I_{kD}	= 750 A	I_{kD}	= 720 A

a) Relay 4

It is assumed that the present settings of relay 4 shall remain the same. The primary settings, refered to 22 kV, are given on the time-current chart, figure 4.

I_b (starting relay): 50 A
I_{inst} (instantaneous function): 250 A
k = 0.10

Referred to the relay side:

$$I> \; = 50 \text{ A} \times \frac{22}{11} \times \frac{5}{100} = 5 \text{ A}$$

$$I>> \; = 250 \text{ A} \times \frac{22}{11} \times \frac{5}{100} = 25 \text{ A}$$

Settings on the relay:

I_s = 4 A

$I>$ = $1.25 \times I_s$ $\left(\frac{5}{4} = 1.25\right)$

$I>>$ = $6.25 \times I_s$ $\frac{25}{4} = 6.25)$

b) Relay 3

The rated load current I_L, of the transformer is 315 A at 11 kV. Normal setting for the starting relay is $I_b = 1.6 \times I_L$ 500 A.

Hence relay settings

$$I> \; = 500 \times \frac{5}{400} = 6.25 \text{ A}$$

I_s = 4 A

I = $1.56 \times I_s$ $\left(\frac{6.25}{4} = 1.56\right)$

Referred to 22 kV, the primary starting current

$$I_b = 500 \times \frac{11}{22} = 250 \text{ A.}$$

The instantaneous function must be blocked to obtain selectivity for faults on the outgoing feeders from D.
For the time function, choose K = 0.05, see time-current chart figure 4.

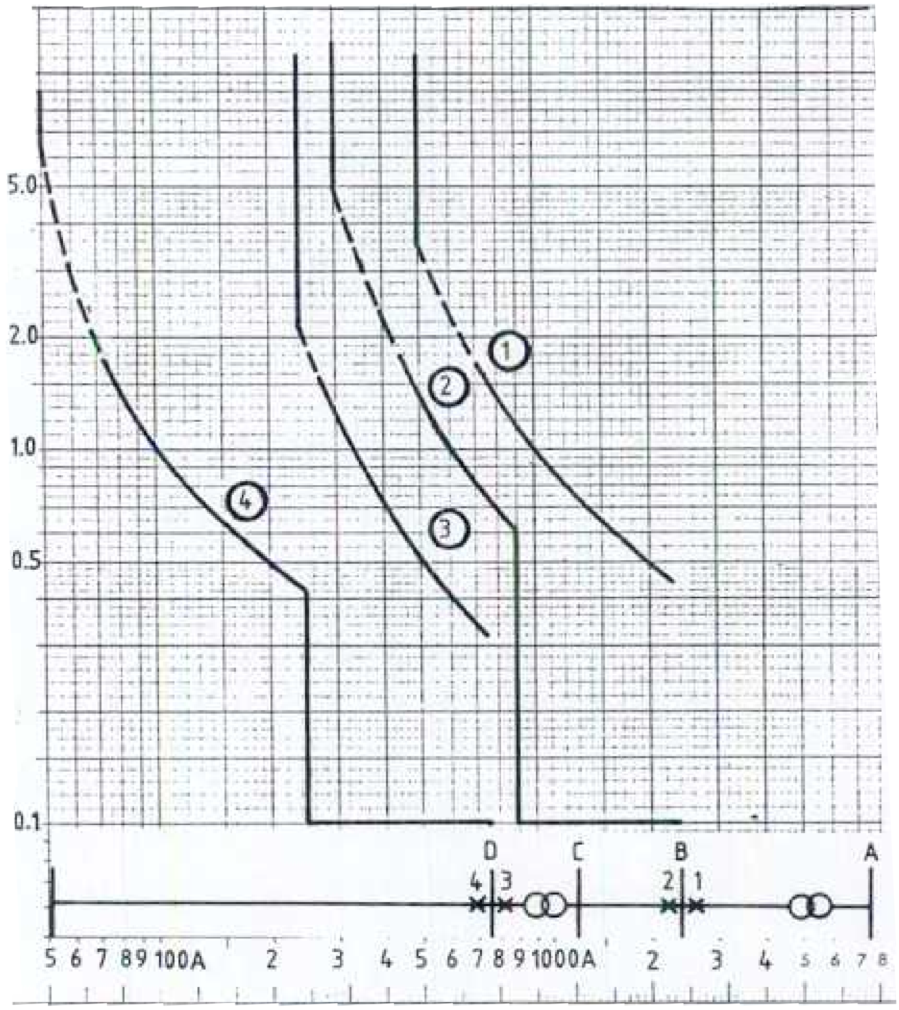


Fig. 4 Time-current chart

c) Relay 2

Relay 2 provides back-up protection in case of faults on bus D. Hence, calculate min. 2-phase fault current for faults on bus D:

$I_{kmin} = 720 \times \frac{\sqrt{3}}{2}$ 620 A

Primary setting of the starting relay:

I_b 0.7 x I_{kmin} = 0.7 x 620 = 430 A

Choose starting relay setting I_b = 300 A to obtain good margin to the transmitted current I_L = 220 A. The instantaneous function must be selective against relay 3. Choose I_{inst} = 1.2 x 750 = 900 A. Choose k = 0.10, see time-chart figure 4.

Set relay operating currents:

$I > \; = 300 \times \frac{5}{250} = 6$ A

$I >> \; = 900 \times \frac{5}{250} = 18$ A

$I_s \; = 4$ A

$= 1.5 \times 4$ A

$I >> \; = 4.5 \times 4$ A

d) Relay

Preimary setting of the starting relay:

$I_b = 315 \times 1.6 = 500$ A

The relay provides back-up for faults up to breaker 3. For faults close to breaker 3 the safety factor in case of 2-phase-faults becomes

$$\frac{720 \times \frac{\sqrt{3}}{2}}{500} = 1.25$$

Choose k = 0.10, see time-chart fig. 4.

The instantaneous function can not be used.

DESIGN

The RACIC is built-up of components from the COMBIFLEX modular system. The transformer module on the rear of the relay, and the test switch, are screwed directly to apparatus bars. The RG-modules have p.c. boards with finger contacts which are inserted in a board connector of a mother board. The mother board interconnects the different units with each other. The depth of the entire assembly is max. 240 mm, of which max. 70 mm are behind the apparatus bars. The relay is available in two versions, A and B.

Version A

Version A incorporates a test switch and its modular dimensions are 4S 36C. All connections to the relay are made by COMBIFLEX socket-equipped leads. The output trip relay has heavy-duty contacts.

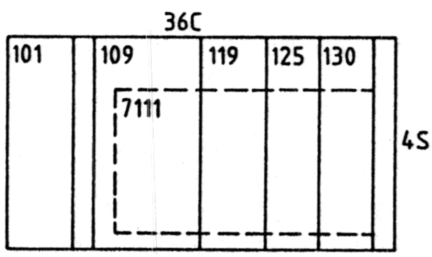


Fig. 5 Version A

101 Test switch type RTXP 18
109 Output module type RGKK 100
119 DC-DC converter of type RGMD 060
125 Earth-fault relay (type RGIB 051) or directional earth-fault relay (type RGPA 052)
130 Time-overcurrent relay (type RGIA 052 for two-phase or type RGIA 053 for three-phase)
711 Transformer module type RTTE (on the rear of RACIC)

Version B

Version B is not provided with test switch. Its modular dimensions are 4S 30C and all external leads (4 mm^2) are connected to screw-type terminals. This version has no output contact for initiating the start functions of the overcurrent and the earth-fault relays. It can be delivered with a trip relay with either medium-(trip-) duty contacts or heavy-duty contacts.

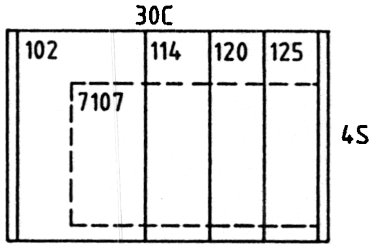


Fig. 6 Version B

102 Output module type RGKK 120
114 DC-DC converter type RGMD 060
120 Time-overcurrent unit type RGIB 051 or type RGPA 052
125 Time-overcurrent unit type RGIA 052 or type RGIA 053
7107 Transformer module type RTTE (on the rear of RACIC)

Test switch

The test switch, type RTXP 18, constitutes a part of the COMBI-TEST testing system and is described in detail in Catalogue B03-9510E.

Output module

Type RGKK 100 is used in version A and type RGKK 120 in version B. These modules contain the output relays and push-buttons for resetting of all LED indications. The relay coils are connected to the mother board via finger contacts on the p.c. board. Version A output module has its contacts connected to a RTXG type connector on the rear of RACIC. Some of these contacts are further connected to the test switch. On the p.c. board are four jumpers that can be cut off when the instantaneous and the delayed functions not should activate the common tripping relay, see fig. 7. On a label on the backside of the face plate are space to mark cut off jumpers, see fig. 8. Version B output module has its contact connected to a screw-type terminal block on the rear of RACIC.

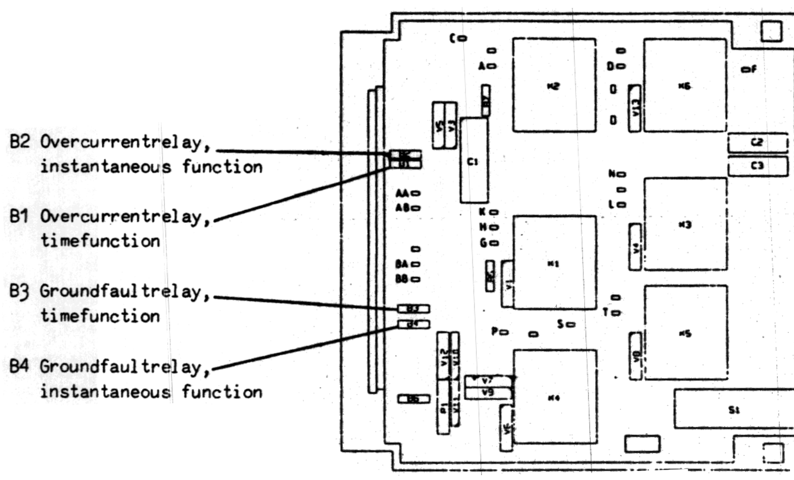


Fig. 7 P.c-card in the output module

JUMPER	FUNCTION	OPEN
1	Trip OC $I>$	
2	Trip OC $I>>$	
3	Trip GF $I>$	
4	Trip GF $I>>$	

Fig. 8 Rating plate

DC-DC converter

The RGMD 060 converts the dc supply into ac which is then transformed, rectified and smoothed to ±24 V dc. The actual auxiliary supply is thus adapted to the electronic circuits. Furthermore, the input and output are galvanically isolated from each other in the transformer which contributes to the suppression of any transients in the auxiliary voltage applied to the modules. A built-in auxiliary relay indicates any loss of the auxiliary supply and a yellow LED indicates when this supply is of normal character.

Earth-fault relay

Type RGIB 052 contains circuits for the start, delayed and instantaneous functions. Three potentiometers, for selecting the current and time settings, and two LEDs, for indicating the delayed and instantaneous functions, are located on the face plate.

Directional earth-fault relay

The type RGPA 052 contains the circuits for the start and delayed functions. Three potentiometers, for selecting the current, voltage and time settings, and two LEDs, for indicating the start and delayed functions, are located on the face plate.

Overcurrent relay

Type RGIA 052, contains circuits for the two-phase overcurrent relays start and delayed functions. Two potentiometers, for selecting the current and time settings, and two LEDs, for indicating the start and delayed functions, are located on the face plate.

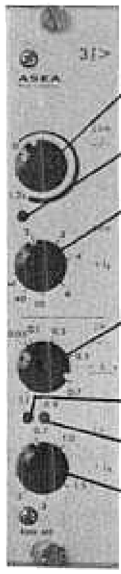
The type RGIA 053, contains circuits for the two- and three-phase overcurrent relays start, delayed and instantaneous functions. Four potentiometers, for selecting the current and time settings, and three LEDs, for indicating the delayed, start and instantaneous functions, are located on the face plate.

Transformer module

The RTTE module is mounted on the rear of the relay. It contains the input transformers and matching components mounted on a p.c. board. Depending on what variant it is included in, it has three or four current transformers and, when a directional earth-fault relay is incorporated, also a voltage transformer. The primary windings of the transformers are connected to a terminal block having screw type terminals. In version A the circuits are also connected to the test switch. The secondary circuits are connected via ribbon cable to the mother board.

Setting mechanics and indications

Overcurrent relay



Instantaneous time setting
Setting range: 0-1.2 s

Indication, instantaneous operation

Instantaneous setting I >>
Setting range: (2-40) x I_s
(Operation blocked in position

Time setting
Definite-time setting range: (0.05-1.1) x 2 s or x 6 s
Inverse-time setting range: (0.05-1.1) x t_1, t_2 or t_3 see Technical data, figures 13-15

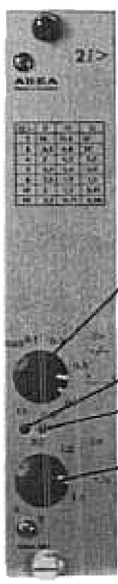
Indication, delayed operation

Indication, start function

Start setting I >
Setting range: (0.7-3) x I_s

Fig. 9

The LEDs are reset with the pushbutton on the output module.



Time setting
Definite-time setting range: (0.05-1.1) x 2 s or x 6 s
Inverse-time setting range: (0.05-1.1) x t_1, t_2 or t_3, see Technical data, figures 13-15

Indication, delayed operation

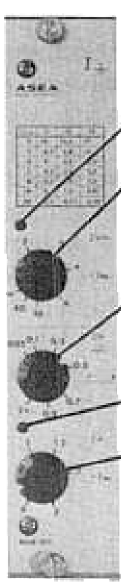
Indication, start function

Start setting I >
Setting range: (0.7-3) x I_s

Fig. 10

The LEDs are reset with the pushbutton on the output module.

Earth-fault relay



Indication, instantaneous operation

Instantaneous setting I >>
Setting range: (2-40) x I_{Ns}.
(Operation is blocked in position ∞)

Time setting
Definite-time setting range: (0.05-1.1) x 6 s
Inverse time setting range: (0.05-1.1) x t_1, t_2 or t_3, see Technical data, figures 13-15

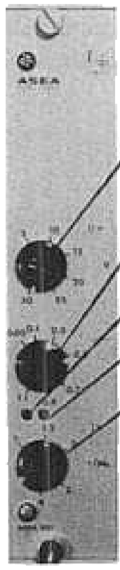
Indication, delayed operation

Start setting I >
Setting range: (1-4) x I_{Ns}

Fig. 11

The LEDs are reset with the pushbutton on the output module.

Directional earth-fault relay



Voltage setting U >
Setting range: 5-30 V

Time setting
Definite time setting range: (0.05-1.1) x 6 s

Indication, delayed operation

Indication, start function

Start setting I >
Setting range: (1-4) x I_{Ns}.

The LED is reset with the pushbutton on the output module.

Fig. 12

Technical data

Time-overcurrent relay

Scale constant I_s	1 A or 4 A	
Rated frequency	50-60 Hz	
Overload capacity:		
continuous	10 x I_s, maximum 20 A	
for 1 s	100 x I_s maximum 350 A	
Power consumption per phase in metering circuits when		
$I = I_s$	$I_s = 1$	4 A
Version A	approx. 20	200 mVA
Version B	approx. 10	70 mVA

Start operation:
(Only version A has an output relay for the start operation)

Operate value I >	Adjustable (0.7-3) x I_s, i.e. 0.7-3 A or 2.8-12 A
Operate time when	
I = 1.3 x I >	35 ms
3 x I >	20 ms
10 x I >	15 ms
Reset time when	
I = 2 x I >	35 ms
20 x I >	75 ms
Reset ratio	> 90 %
Transient overrecah	< 5 %

Delayed operation:

Definite time	Adjustable 0.1-2.2 or 0.3-6.6 s (accuracy class 2.5)
Inverse time	Normal, very or extremely inverse, time factor adjustable from 0.05 to 1.1 (accuracy class 5 in current range 2-20 x I >)

Retardation time when	def. time	normal inv.	very inv.	extremely inverse
I = 10 x I >	50	40	30	30 ms
Recovery and reset time when I = 10 x I >	75	75	75	75 ms

Instantaneous operation (only 2 and 3Ø version):	
Operate value I >>	Adjustable (2-40) x I_s and infinite
Retardation time when I = 3 x I >>	20 ms
Reset time when I = 3 x I >>	45 ms
10 x I >>	55 ms
Reset ratio	> 90 %
Transient overreach	< 10 %

1) The times are valid for trip relay with medium-(trip-) duty contacts. With heavy-duty contact the times will be about 30 ms longer.

Earth-fault relay

Scale constant I_{Ns}	5, 15, 50 mA or 0.15, 0.5, 1.5 A
Rated frequency	50-60 Hz
Overload capacity:	
continuous	0.15, 0.5, 1 A or 5, 10, 20 A for each respective scale constant
for 1 s	175 x I_{Ns}
Power consumption in metering circuit when I = I_{Ns}	I_{Ns} = 5, 15, 50 mA 0.15, 0.5, 1.5 A
Version A	ca 3, 3, 4 3, 7, 35 mVA
Version B	ca 3, 3, 4 3, 4, 12 mVA

Start operation:
(Only version A has an output relay for the start operation)

Operate value I >	Adjustable (1-4) x I_{Ns}
Operate time when I = 1.3 x I >	30 ms
3 x I >	20 ms
10 x I >	15 ms
Reset time when I = 2 x I >	30 ms
20 x I >	60 ms
Reset ratio	> 90 %
Transient overreach	< 5 %

Delayed operation

Definite time	Adjustable 0.3-6.6 s (accuracy class 2.5)
Inverse time	Normal, very or extremely inverse, time factor adjustable 0.05-1.1 (accuracy class 5 in current range 2-20 x I >)

Operate time 1) when	I=1.3 x	3 x	10x I >>
delay = 0	40	30	20 ms
= 1.2 s	1.2-1.4	1.2-1.4	1.2-1.4 s

	def. time	normal inv.	very inv.	extremely inverse
Retardation time when $I = 10 \times I>$	50	40	30	30 ms
Recovery and reset time $I = 10 \times I>$	55	55	55	55 ms

Instantaneous operation

Operate value $I>>$	Adjustable (2-40) x I_{Ns}
Operate time [1] when	
$I = 1.3 \times I>>$	30 ms
$3 \times I>>$	20 ms
$10 \times I>>$	15 ms
Reset time when	
$I = 3 \times I>>$	35 ms
$10 \times I>>$	50 ms
Reset ratio	> 90 %
Transient overreach	< 10 %

1) The times are valid for trip relay with medium-(trip-) duty contacts. With heavy-duty contact the times will be about 30 ms longer.

Directional earth-fault relay

Scale constant I_{Ns}	3, 10 and 30 mA
Characteristic angle α	0^{o} or -90^{o}
Rated voltage U_n	110 V
Rated frequency	50 or 60 Hz
Releasing voltage $U>$	Setting range 5-30 V

Overload capacity:	
Current circuit,	
continuous	1 A
for 1 s	20 A
Voltage circuit	140 V

Power consumption:				
current circuit, $I=I_{Ns}$	I_{Ns}	= 3	10	30 mA
	approx.	0.015	0.02	0.04
voltage circuit, $U=U_n$	approx. 1 VA			

Start operation

(only version A has an output relay for the start operation)

Operate value $I>$	Adjustable (1-4) x I_{Ns}
Operates when	$I_N \times \cos(\varphi_0 - \alpha) > I>$ and $U_N > U>$
Operate time when	
$1.3 \times I>$	120 ms
$3 \times I>$	70 ms
Reset time when	
$1.3 - 3 \times I>$	60-100 ms
Reset ratio	> 90 %
Transient overreach	< 5 %

	Delayed operation		
	Independent time	Adjustable 0.3-6.6 s + starting functions operating time	
	Retardation time	60 ms at 3 x I >	
	Recovery time	110 ms at 3 x I >	
	Reset time	110 ms at 3 x I >	
Miscellaneous	Permissible ambient temperature	-25 to +55°C	
	Auxiliary voltage	24, 32,48, 60, 110, 125, 220 or 250 V dc	
	Permissible variation in auxiliary voltage	-20 to +10 % of nominal value	
	Permissible ripple	± 6 % of nominal value	
	Power consumption auxiliary voltage EL	max 10 W	
	Dielectric test voltage:		
	current circuit	2500 V, 50 Hz, 1 min	
	voltage circuit	2000 V, 50 Hz, 1 min	
	Impulse voltage test	5 kV, 1,2/50 us, 0,5 J	
	Disturbance test:		
	operating frequency	500 V, 50 Hz, 2 min	
	common mode	2.5 kV, 1 MHz, 2 s	
	transverse mode	2.5 kV, 1 MHz, 2 s	
	spark test	4-8 kV, 2 min	
	Dimensions		
	Version A	4S 36 C	
	Version B	4S 30C	
	Weight	max 10 kg	
Contact data	Breaking capacity	trip-duty	heavy-duty
	Max. system voltage dc/ac	250 V	450/400 V
	Current carrying capacity (for already closed contact):		
	200 ms/1 s	-/15 A	55/30 A
	Continuous	5 A	6 A
	Making and conducting capability		
	L/R > 10 ms:		
	200 ms/1 s	30/10 A	30/20 A
	Breaking capacity:		
	AC, P.F. > 0.1 max 250 V	8 A	20 A
	DC, L/R < 40 ms, max		
	48 V	1 A	18 A
	110 V	0.4 A	3 A
	125 V	0.3 A	2.5 A
	220 V	0.2 A	1 A
	250 V	0.15 A	0.8 A

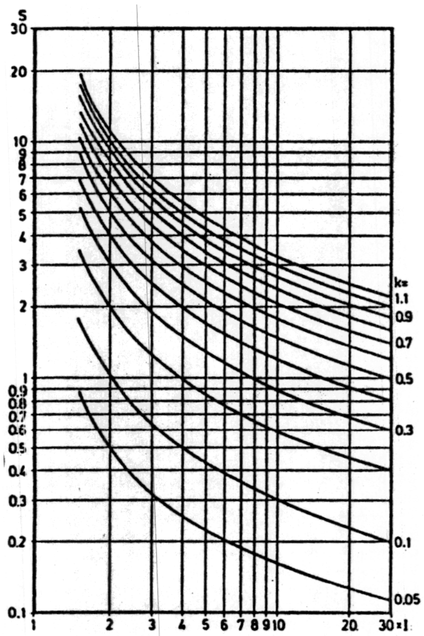


Fig. 13 Normal inverse, t_1

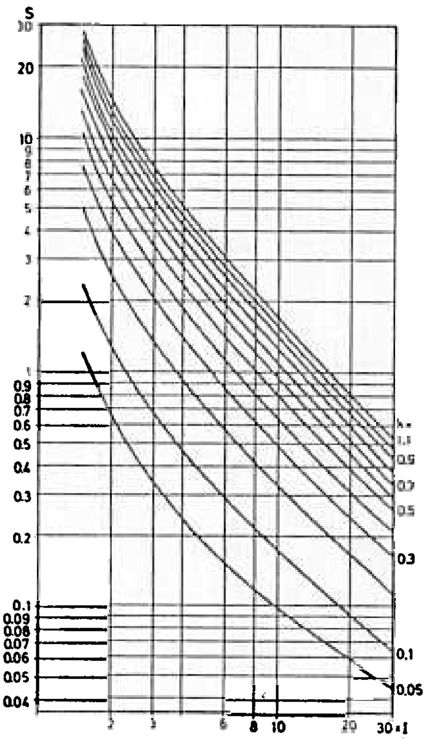


Fig. 14 Very inverse, t_2

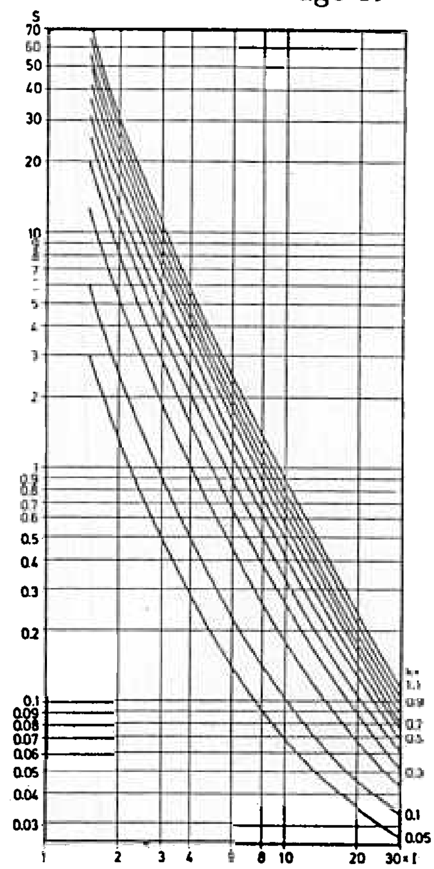


Fig. 15 Extremely inverse, t_3

Mounting and dimensions

RACIC is mounted on apparatus bars and has then the size 4S 36C (177.8 x 251.5 mm) for version A and 4S 30C (177.8 x 209.5 mm) for version B.

The relay may be installed in a number of ways:

- directly surface-mounted on a panel, see RK 926-100E, page 7
- in a 19" equipment frame for cubicle or panel mounting, for panel mounting, see B03-9382E
- in a relay case type RHGX 12 for flush or semi-flush mounting on a panel, see B03-9382E
- in a surface-mounted frame with front-connected screw-terminals, see Fig. 15
- in a panel cutout for flush-mounting (only version B), see Fig. 16

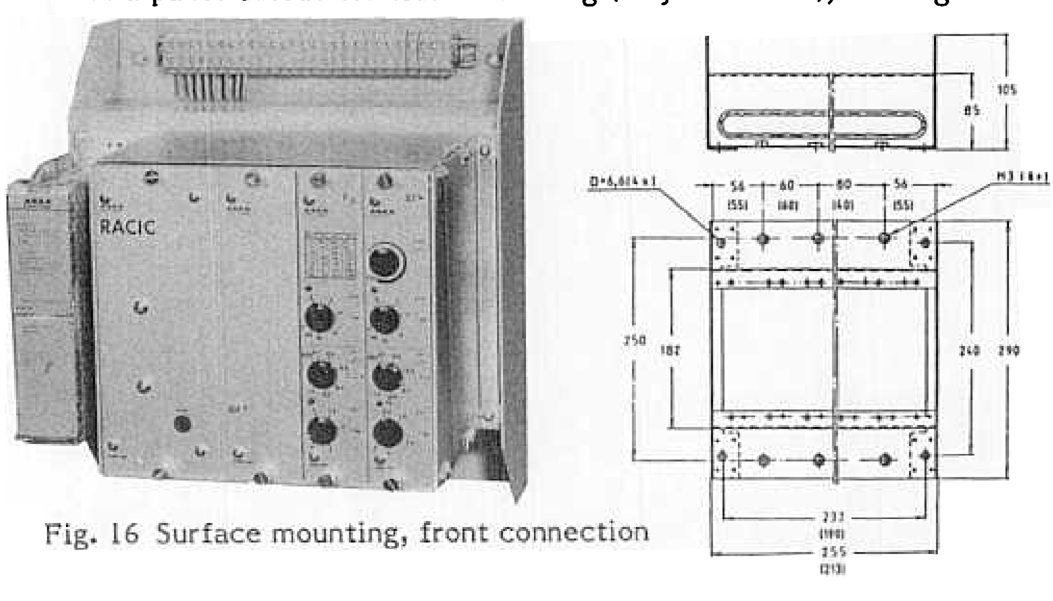
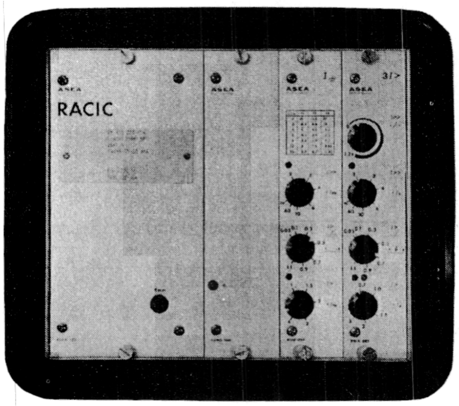
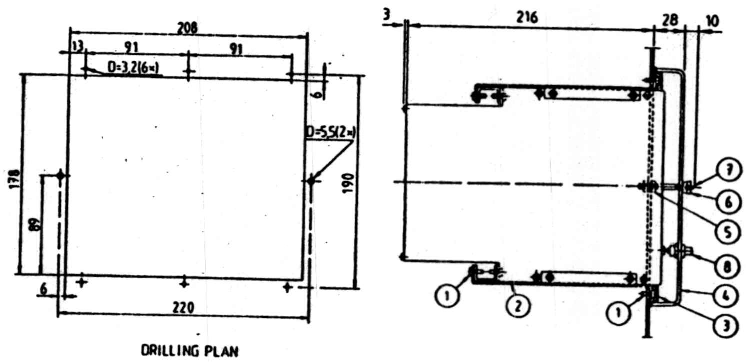


Fig. 16 Surface mounting, front connection





1 Make the cutout for the relay and the drilling for the screws; see front view (6 screws for D = 3.2 mm and 2 for D = 5.5 mm)
2 Tighten the two stud bolts 7 to the holes D = 5.5 and lock with the lock nuts 5
3 Tighten the mounting plates 2 with self-tapping screws 1 to the apparatus bars
4 Insert the relay and fasten it with six self-tapping screws 1 (D = 3.2)
5 Wriggle on the rubber gasket 3
6 Insert and lock the pushbutton 8 in the plastic cover 4
7 Put the plastic cover on and fasten the nuts 6 to the stud bolts 7
8 The nuts 6 may be dealed on the stud bolts 7 via a cutout

Fig. 17 Flush mounting, rear connection

Connections

RACIC is connected according to the diagrams for each particular variant. The applicable circuit diagram accompanies the relay on delivery.

In version A, connections are made to the RTXP 18 test switch in position 101 and to the RTXG connector in position 109.

Figure 18 shows the postion of all terminals to which connections are to be made according to the terminal diagrams. The connections are made with COMBIFLEX 20 A socket leads to the test switch and with 10 A socket leads to the connector.

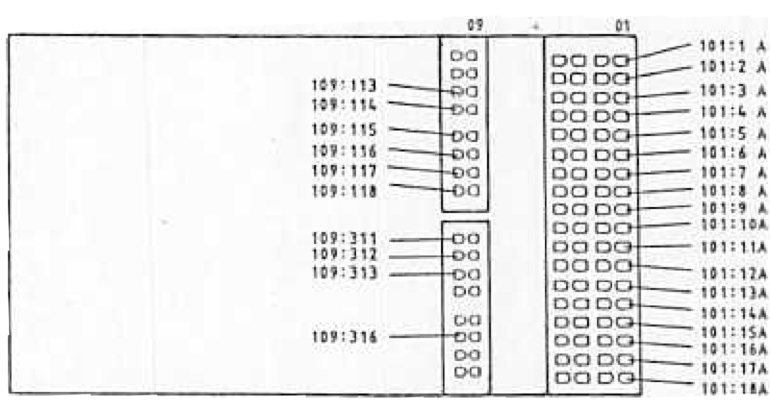
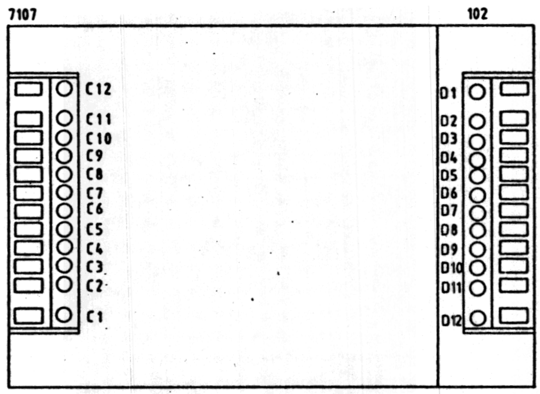


Fig. 18 Connection guide, version A

In version B, connections are made to screw terminals in terminal blocks C and D. Figure 19 shows the positions of all terminals to which connections are to be made according to the terminal diagrams. Cables with a cross-section of up to 4 mm^2 can be connected.



Terminal	At I_{NS}		
C7	5 mA	0.15 A	3 mA
C8	15 mA	0.5 A	10 mA
C9	50 mA	1.5 A	30 mA

Fig. 19 Connection guide, version B

OPERATION

Overcurrent relay

The time-overcurrent relay with overcurrent unit type RGIA 053 is either of the two-phase or three-phase type and it has start, delayed and instantaneous function. The input circuits for phase S are not included in the two-phase version.

The time-overcurrent relay with overcurrent unit type RGIA 052 is of two-phase type with start- and delayed functions.

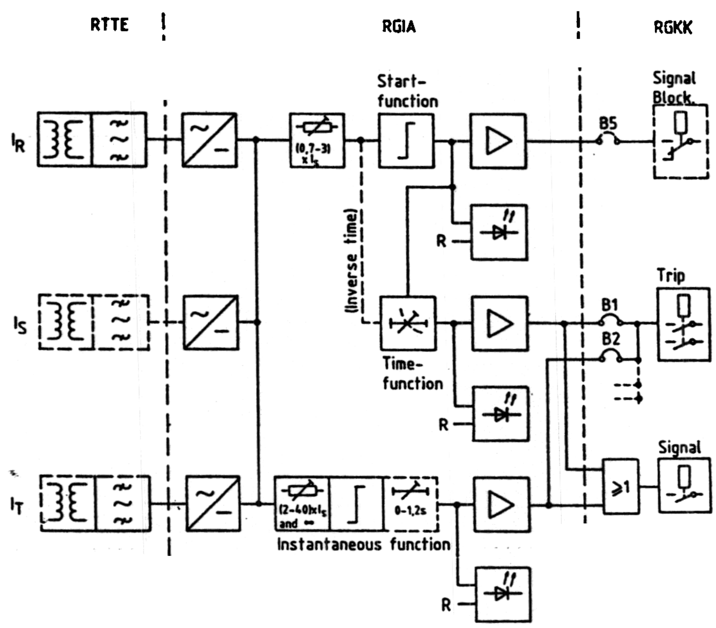


Fig. 20 Overcurrent relay, block diagram

The incoming phase currents are stepped down in the input transformers, converted into voltages, filtered, rectified and smoothed. The filter reduces the relay's sensitivity to the dc component and to transients in the current. A voltage, proportional to the highest phase current, is applied to two level detectors; one for the start and delayed functions and one for the instantaneous function.

The first level detector can be adjusted 0.7 to 3 times the relay scale constant I_S. When the set operating value has been exceeded, the starting function is initiated. In the case of version A of RACIC, also an output relay is then activated and a yellow LED lights up. At the same time, an adjustable timing circuit which has either an definite-time or an inverse time characteristic, is energised. After expiration of the set time, the output relays picks up and a red LED lights up. The tripping relay is common to both the overcurrent relay and the earth-fault relay.

The jumpers B1 and B2 in fig. 20 can be cut off when the instantaneous and delayed functions not should activate the common tripping relay, see also fig. 7.

The other level detector is for the instantaneous function and is adjustable between 2 and 40 and infinite times the scale constant I_S. On operation, the same output relays are activated as during the delayed function simultaneously as a red LED lights up. Operation is normally instantaneous but, to enable matching to fuses, the time delay can be set 0-1.2 s.

Earth-fault relay

This is a single phase time-overcurrent relay which has start, delayed and instantaneous functions.

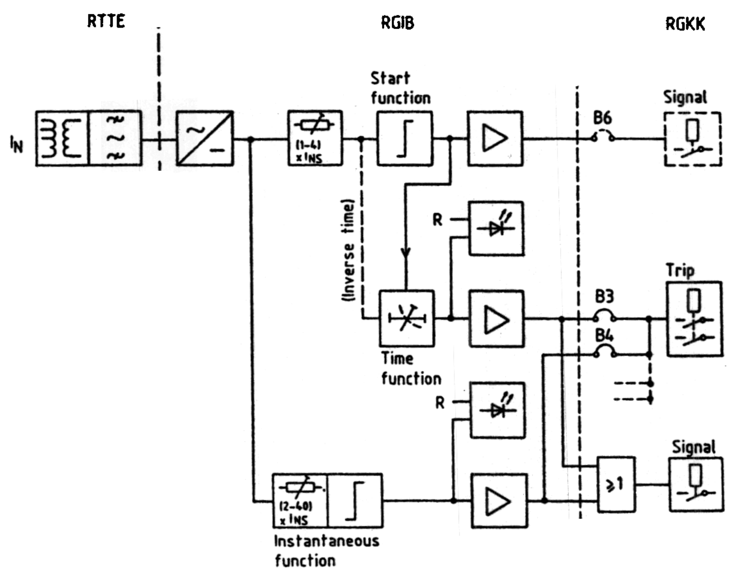


Fig. 21 Earth-fault relay, block diagram

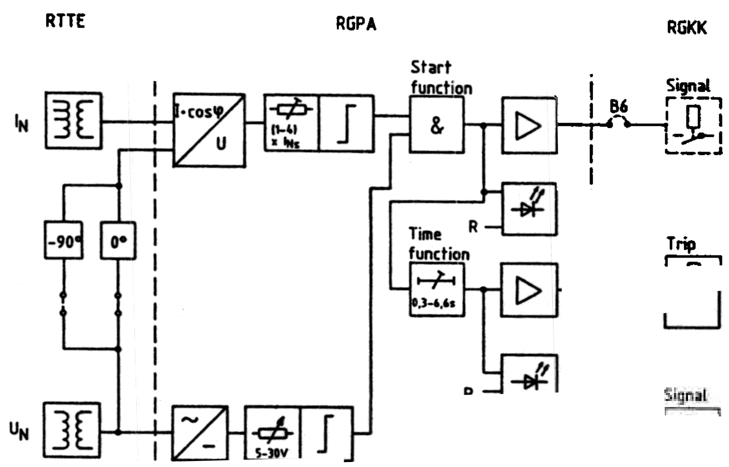
The incoming earth current I_N, is stepped down in an input transformer, converted into a voltage, filtered, rectified and smoothed and then applied to two level detectors in the same manner as with the overcurrent relay. One of the level detectors can be adjusted to 1 to 4 times the scale constant I_{NS}. When the set operating value has been exceeded, the start function is initiated. In the case of version A of RACIC, an output relay is then activated at the same time as an adjustable timing circuit, which has either an definite-time or an inverse time-characteristic, is energized. After expiration of the set time, the output relays picks up and a red LED lights up. The tripping relay is common to both the earth-fault relay and the overcurrent relay.

The jumpers B3 and B4 in fig. 21 can be cut off when the instantaneous and time functions not should activate the common tripping relay, see also fig. 20.

The other level detector is for the instantaneous function and is adjustable between 2 and 40 and infinite times the scale constant I_{NS}. On operation, the same output relays picks up as with the delayed function, simultaneously as a red LED lights up.

Directional earth-fault relay

The directional earth-fault relay has start and delayed functions and an adjustable voltage release. The earth-current I_N and the neutral point voltage U_N are stepped down in the input transformers and are applied to a circuit which produces a dc voltage proportional to I_N x cos φ_0. This applies when measuring the resistive component of the earth current. When measuring the capacitive component, the voltage is phase displaced 90° (capacitive) to make the dc voltage proportional to I_N x cos (φ_0 - 90°), i.e., I_N x sin φ_0.



The input transformer in the current circuit has an airgap so as not to be saturated by earth currents containing a dc component.

The measured signal is forwarded to a level detector adjustable 1-4 times the scale constant I_{NS}. When I_N x cos (φ_0 - α) > the set value, an output voltage is obtained and applied to an AND circuit. A level detector in the voltage circuit is also connected to the AND circuit. This detector is adjustable 5-20 V and produces an output voltage when U_N is greater than set value. When voltage appears on the two inputs of the AND circuit, the start function is initiated. In version A of RACIC, an output relay is then activated. At the same time, an adjustable timing circuit (definite-time) is energised. After expiration of the set time, the output relays picks up and a red LED lights up. The tripping relay is common to both the earth-fault relay and the overcurrent relay. The jumper B3 in fig. 22 can be cut off when the delayed function not should activate the common tripping relay.

RECEIVING, HANDLING AND STORAGE

These relays are shipped in cartons designed to protect them from damage when not included as part of a cubicle or control panel. Upon receipt the relay should be inspected for physical damage.

It is recommended that the relay be replaced in its shipping carton after inspection for delivery to jobsite. Also the relay should preferably be left in its shipping carton until time for actual installation.

The relay is not critical as to humidity. But general prudence suggests that it be stored in a dry, moderate temperature environment.

COMMISSIONING

Caution

RACIC contains CMOS components sensistive to static electricity. Units removed from the assembly should be handled according to the rules relating to such components. Units must not be removed or inserted without first ensuring that the auxiliary power supply is switched off.

Test equipment

The following equipment is necessary:

- Relay testing set, type SVERKER (or similar)
- Primary testing set (where applicable)
- Universal instrument (of analog type for polarity tests)
- Timer
- RTXH test plug handle with test leads
- RTXM ammeter test plug
- Reducing plugs (for version 2)
- Intermediate transformer, e.g. 40/4 V (1/10 A)
- Adjustable resistor, approx. 100 ohms > 100 W
- Capacitors 1 μF + 2 x 3 μF (for earth-fault relay with $\alpha = -90^{\circ}$)
- Phase sequence indicator (where applicable)
- Phase angle indicator (where applicable)
- Adjustable resistor approximatly 2500 ohm > 20 W (for earth-fault relay with $\alpha = 0$).

Furthermore, instruments which show the power direction and the magnitude of the active and reactive power, should be available at the plant.

Visual inspection

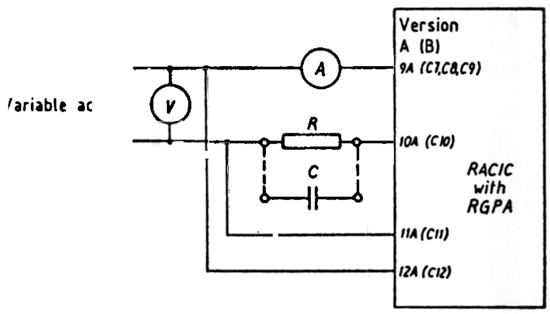
Check that the equipment has not been damaged during transport, that it is appropriate for the actual auxiliary power supply and that the settings are correct.

Secondary injection test

The secondary injection test, for ensuring that the relay operates correctly, is performed best from the test switch in the case of version A. Version B must be tested from the screw-terminal block. In the latter case, it is essentail that the relay is isolated from external circuits such as current and voltage transformers, trip coils etc. (This is done automatically in version A.)

- With the exception of the value for the instantaneous operation, set all the values (current, time etc.) according to the applicable selectivity plan. Set the instantaneous function to infinite
- Wire up the testing set, instruments, timers etc. (For SVERKER test set, refer to RK 916-300E. For the directional earth-fault relay, refer also to figure 23).
- Check that the correct auxiliary power supply is applied to the relay (ensure that the polarity is also correct).
- Adjust the current to a value where operation takes place. Read off and make a note of the pick-up and drop-out values. Ensure that the appropriate LEDs light up and that the contact functions are correct.
  In the case of a directional relay, ensure that no operation takes place when the voltage connections are interchanged.

Set the scale to 2 x the operating value and apply the current momentarily. Read off the operating time. Relays with inverse-time characteristic should be tested at one or two further multiples of the operating value.
Set the instantaneous function to the desired value. Increase the current successively and determine the lowest current value which, when switched-in instantaneously, causes instantaneous operation.
Make a note of all the measured values. They should be used as comparative values for future maintenance tests.



V Greater than set release voltage (5-30 V) for operation and max 140 V continuous.
R When testing RGPA with $\varphi = 0^{\circ}$
C When testing RGPA with $\varphi = -90^{\circ}$

Guide values for R and C

I_{Ns}	R	C
3 mA	> 2.5 kohm	< 1 µF
10 mA	> 1 kohm	< 3 µF
30 mA	> 400 ohm	< 8 µF

Fig. 23 Secondary test with SVERKER test set

Checking external connections and operations

External connections and operations can be checked in many different ways. Normally, all items are "dead" during the commissioning stage and there are therefore good possibilities of gaining access to both the primary and secondary circuits. If the plant is entirely or partly energized, the tests must be matched to suit such conditions. Unless stated otherwise, the following instructions refer to a "dead" plant where circuit-breakers etc., can be operated at will.

Insulation test

Insulation tests on the system of conductors are not normally included in the commissioning procedures, if such tests are to be made, all earth connections must be removed (e.g. in the secondary circuits of the current transformers).

If only the insulation between the conductor system and earth is to be tested and the test voltage is max. 1000 V, normal protective relay equipment need not be disconnected. If a higher test voltage is used, or if the insulation between separate sections of the conductor system is to be checked, the relay equipment should first be disconnected or one should ensure that it will not be influenced in a detrimental manner. After completion of the test, all temporary changes in connections must be restored.

Overcurrent and earth-fault relays

Primary tests

If a high-current testing set is available, several circuits can be tested simultaneously.

- Connect the testing set to one phase of the primary circuit
- Close all circuit-breakers that are to be tripped by the relay
- Adjust the current to the primary operating value of the relay
- Ensure that the relay trips the correct circuit-breaker and that the correct alarms, indications, blockings etc., are obtained
- If possible, also check the secondary current flowing through the relay. This is best done with the aid of an ammeter and an ammeter test plug via the test switch. Check the ratio of the current transformers
- Repeat the test on all phases

Primary tests with a secondary testing set

- Connect the test set to the primary circuit
- Increase the current to a value which the test set can withstand continuously
- Measure the secondary current flowing through the relay
- Check the ratio
- Repeat the test on all phases
- Move the test set and connect it to the current terminals of the secondary. Open the current circuit towards the current transformers and feed the relay only
- Close all appropriate circuit-breakers
- Increase the current until the relay operates
- Ensure that the relay trips the correct breaker

Directional earth-fault relay

Primary tests with primary testing set

Tests with a primary test set cannot normally cause the operation of a directional relay since the directional voltage will be far too low.

Test with secondary test set, e.g. SVERKER

Same as with non-directional relay but, when connecting the secondary supply, connect the voltage to the appropriate secondary voltage terminals. N.B. first open the circuits leading out to the voltage transformers. In principle, the connections are similar to those shown in Fig. 23 referring to the secondary test.

Checking polarity

Since the relay is directionally sensitive, it is essential that all transformers are connected correctly with respect to polarity, according to the circuit diagram. Polarity can be checked with the aid of a flashlight battery and a universal instrument.

Connect the positive terminal of the instrument to S1 and the negative to S2 (the appropriate range depends on the ratio). Connect the positive pole of the battery to P1 and the negative for a short instance to P2. When the circuit is closed, the pointer of the instrument should deflect in the positive direction. When the circuit is interrupted the pointer should deflect against the stop.

Test with ohmmeter

Measure the loop resistance of the secondary current circuits. The resistance should be between 0.5 and 1 ohm in a 5 A circuit. The incoming current terminals of the relay are suitable measuring points. Check that the resistance remains constant or decreases slightly when a test plug handle is inserted in the test switch or any other relay incorporated in the current circuit. Check all phases.

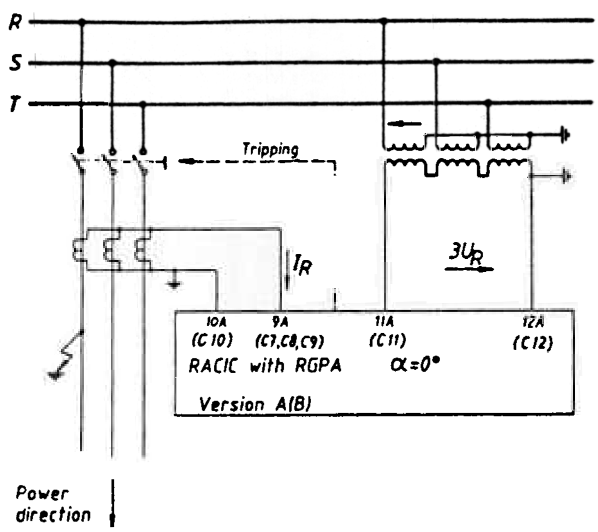
Directional tests in energized plant

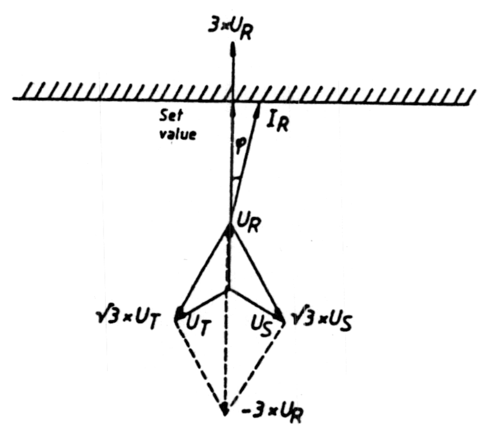
This test can be made in different ways, some of which will be dealt with here.

The more realistic the test is, the securer will be the directional test. Furthermore, all tests should be made in a manner which causes the relay to operate. The reason for this is that, if the relay does not operate, the cause may be due to other factors than incorrect direction. Prior to making the test, the tripping circuits of the protective relay are to be blocked unless it is desired to trip the line. A check should also be made to see if any other protective relays are affected by the reconnections that are to be made. If such is the case, these must also be blocked.

If uncertainty arises regarding the correct identity of the current and voltage phases at the terminals where the reconnections are to be made, and at the relay, appropriate measures must be taken to eliminate such uncertainty, e.g. by making use of a phase-angle indicator. The reliability of the test depends entirely on how the connections, the phase and polarity checks have been made. Bear in mind that great care must be exercised in cases when reconnections are to be made on the secondary side of the transformers while the line is energized.

The directional earth-fault relay, is available with a characteristic angle of 0°, intended for use in high ohmic resistance earthed networks, or a characteristic angle of -90° intended for isolated (capacitive earthed) networks. Note that the voltage input of the protective relay must be connected to an open-delta connected transformer group to enable the simulation of earth faults as mentioned below. If the input is connected to a transformer that bridges a neutral-point resistor, a proper primary test must be made or a check must be made of the connection.





Operation when $I_R \times \cos(\varphi - \alpha) >$ set value

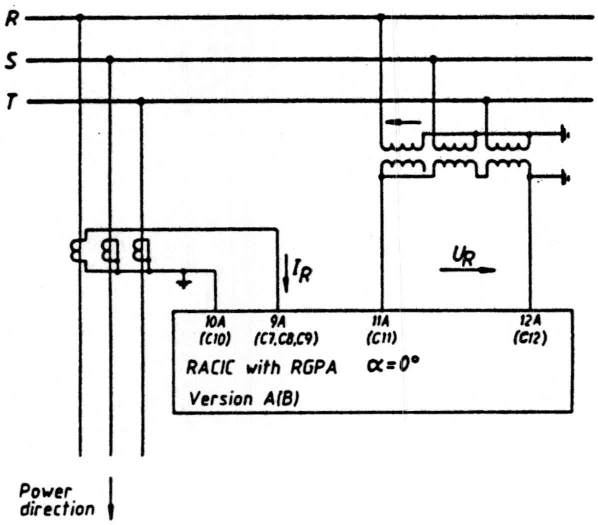
Fig. 24 Checking direction during a real earth-fault in resistance earthed network

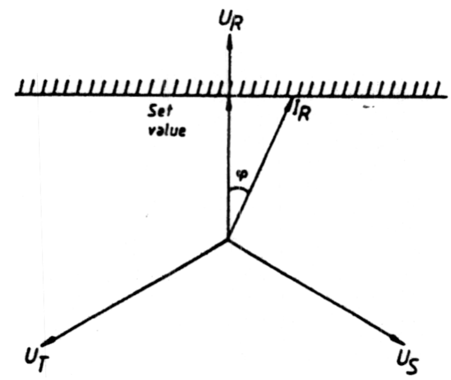
High resistance earthed networks

With this type of earthing, there are many apportunities for making a proper primary test since the fault current will be limited to a known value, often a few tenfold amperes. One phase is connected to earth on the outside of the current transformers, refer to figure 24, thus maintaining the tripping circuit intact. When the breaker is closed, the relay should operate and trip the breaker again. This is a realistic and good method for obtaining a reliable test of the direction of operation but one must bear in mind any neutral-point voltage relay (which may be incroporated) will operate if the fault is not cleared sufficiently fast. Furthermore, the voltage to earth in the other phases will be raised during the test resulting in an increased risk for a double earth fault. However, this condition prevails during each earth fault and the network has to withstand it. The test method cannot, therefore, be considered as too severe. To minimize the risks of damage, the earth fault should be routed via a strong line, which can withstand the short-circuit current, until the short-circuit relay trips, if a double earth fault should occur.

In addition to the absolutely reliable check of the direction, the test is also advantageous in the sense that it is independent of the transformer arrangement. (Summating current or cable current transformers, open delta or voltage transformer at the neutral point).

If it is underirable or impossible to make the test during an actual fault, certain possibilities exist for simulating faults. The following method can be used if the relay is connected to summating current transformers and open delta and if the secondary terminal blocks are accessible.





Operation when $I_R \times \cos(\varphi - \alpha)$ > set value

Fig. 25 Checking direction during a simulated earth-fault in resistance earthed network

A earth fault in the R phase is simulated in the following manner (refer to figure 25). Bypass the R-phase in the open delta winding of the voltage transformers so that only the S and T phases apply voltage to the relay. The polarised voltage of the relay will then be U_R. Depending on the direction of the active power, the following reconnections must be made in the current circuits before making the test. If the direction of active power is the same as the desired operating direction, short-circuit and disconnect the S and T phases in the summating current connection. The relay is thus supplied with current from the R-phase (I_R). The relay should operate if the active power is greater than the reactive power ($\varphi = 0 - 45^\circ$ ind.) and if the current is greater than 1.5 times the set operating value.

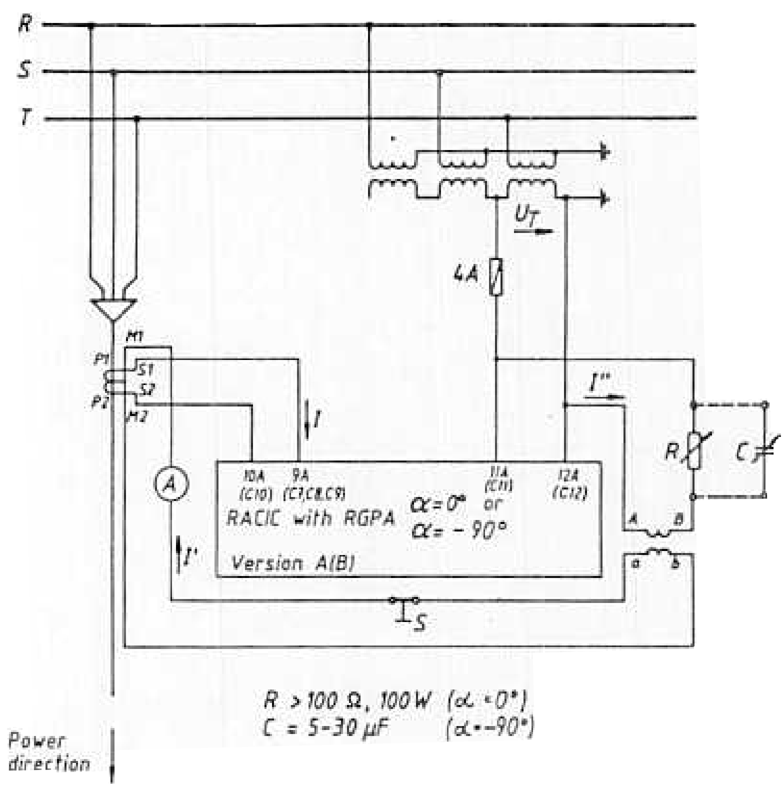
If the active power is of the reversed direction to that of the desired operating direction, the R-phase in the current transformer is to be short circuited and disconnected. The relay receives current from the S and T phase ($- I_R$) and should operate.

When the protective relay is connected to a cable current transformer, the former cannot be supplied with current from one or two phases and other methods must therefore be adopted. If the voltage circuit is supplied from an open delta, the following method can be used: To initiate the current conditions which prevail during an actual earth-fault, reconnections as shown in figure 23 must be made. A voltage, $U_T \approx 37$ V, will then be applied to the relay provided that the network is operating in the normal manner and that the ratio of the voltage transformer is

$$\frac{U_h}{\sqrt{3}} \;/\; \frac{110}{3}$$

Via a resistor R, connect an auxiliary current transformer T(25-50 VA) to the same voltage source. Check the polarity of the transformer. Its ratio should be approx. 10/1 and its voltage rating on the primary side should be > 40 V. During the initial stages of the test, the resistor R should be set to its maximum value.

In the case of high ohmic earthed networks, current flows through a separate conductor which runs through the cable current transformer. Modern cable current transformers already incorporate such a conductor and this has M1 and M2 terminals. If these terminals are used, the polarity of the P1-P2 terminals must be checked against the M1 and M2 terminals. (Refer to "Checking polarity").



Checking the direction when connected to cable current transformers in resistance or capacitive earthed networks

When the secondary circuit of the auxiliary transformer is closed by means of pushbutton S, the resistance decreases and the relay should operate when the current I reaches the value set on the relay. Ammeter A indicates the primary operating value. If, with the available equipment, it is difficult to attain operating current, several turns of a test lead can be threaded through the cable current transformer. 10 turns and 1 A is equivalent to a 10 A earth-fault current in the cable.

Isolated networks

If the maximum capacitive earth-fault current is of moderate magnitude (max. a few tenfold amperes), the same realistic primary test as used for high ohmic resistance earthed networks can be made. The same rules regarding care are also applicable in this case. When the relay is connected to a summating current transformer or open delta, tests with simulated earth-faults can also be made in this case. However, the reconnections will be somewhat different since a characteristic angle of -90° is used in these networks. Refer to figure 26.

A earth-fault in the R-phase can be simulated as follows: Bypass the R-phase in the open delta winding of the voltage transformers so that only S and T phases apply voltage to the relay. The polarised voltage of the relay will then be U_R. If the active and the reactive power have the same direction as the desired operating direction, and the phase displacement is inductive, the R and S phases in the summating current connection are to be short circuited and disconnected so that the relay receives only I_T current. The relay should operate when $\varphi = 0\text{-}45^{\circ}$ ind., and when the current is 1.5 times greater than the set value.

If the direction of both the active and reactive power is in reverse to the desired direction of operation, phase T should instead be short circuited and disconnected so that the relay receives only $-I_T$ current, in which case the relay should operate. When the relay is connected to cable current transformers, the only difference when comparing with high resistance earthed networks is that the series resistor R is replaced by an appropriately large capacitor C (5-30 μF).

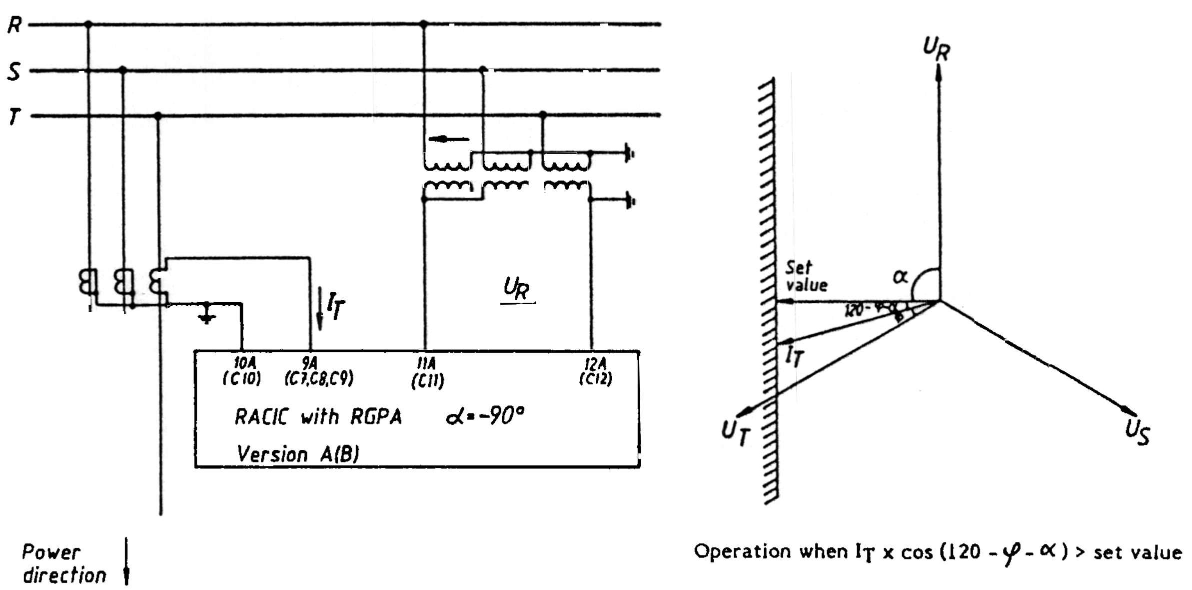


Fig. 27 Checking direction during a simulated earth-fault in isolated (capacitive earthed) network

Final check

Check that:

- all temporary modifications to connections are restored
- all terminal blocks are closed
- all indicators are reset
- all units are screwed securely in position

If the feeder can be energized and loaded and a version A RACIC is used, the current in the test switch should also be measured with the aid of a RTXM ammeter plug. The phase currents should be the same and correspond to the load current. The current in the neutral should be as small as possible but > 0. In the case of directional relays, the neutral point voltage is also to be measured. If the network is free from faults, this voltage should be low but > 0 V.

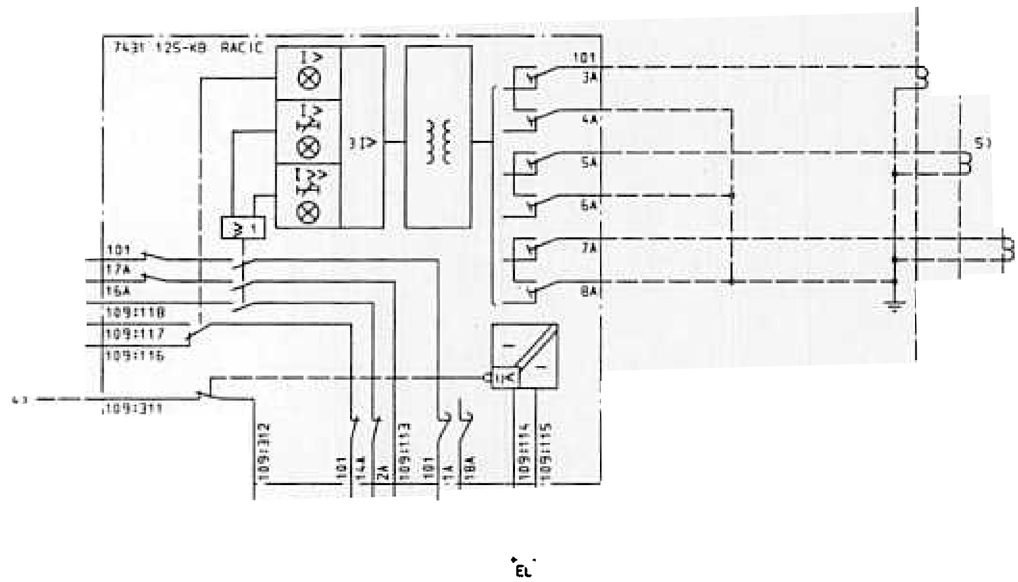
CONNECTION DIAGRAMS

The table below shows available versions and variants of RACIC.

Version A = with test switch
Version B = no test switch

Version	Time characteristic	Heavy-duty trip relay	Overcurrent relay with instantaneous function	Connection diagram 7431	Page
Three-phase overcurrent relay					
A	Definite	X	X	125-KBA	33
B	Definite	X	X	123-KBA	33
B	Definite		X	123-KBA	33
A	Inverse	X	X	125-KBA	33
B	Inverse	X	X	123-KBA	33
B	Inverse		X	123-KBA	33
Three-phase overcurrent relay and earth-fault relay					
A	Definite	X	X	125-ABA	34
B	Definite	X	X	123-ABA	34
B	Definite		X	123-ABA	34
A	Inverse	X	X	125-ABA	34
B	Inverse	X	X	123-ABA	34
B	Inverse		X	123-ABA	34
Three-phase overcurrent relay and directional earth-fault relay [1)]					
A	Definite	X	X	126-ABA	35
B	Definite	X	X	124-ABA	35
B	Definite		X	124-ABA	35
A	Inverse	X	X	126-ABA	35
B	Inverse	X	X	124-ABA	35
B	Inverse		X	124-ABA	35
Two-phase overcurrent relay and earth-fault relay					
A	Definite	X	X	125-EBA	36
B	Definite	X	X	123-EBA	36
B	Definite		X	123-EBA	36
A	Inverse	X	X	125-EBA	36
B	Inverse	X	X	123-EBA	36
B	Inverse		X	123-EBA	36
A	Definite	X			37
B	Definite	X			37
B	Definite				37
A	Inverse	X			37
B	Inverse	X			37
B	Inverse				37
A	Definite	X	X	126-EBA	38
B	Definite	X	X	124-EBA	38
B	Definite		X	124-EBA	38
A	Inverse	X	X	126-EBA	38
B	Inverse	X	X	124-EBA	38
B	Inverse		X	124-EBA	38
A	Definite	X		126-KBA	39
B	Definite	X		124-KBA	39
B	Definite			124-KBA	39
A	Inverse	X		126-KBA	39
B	Inverse	X		124-KBA	39
B	Inverse			124-KBA	39

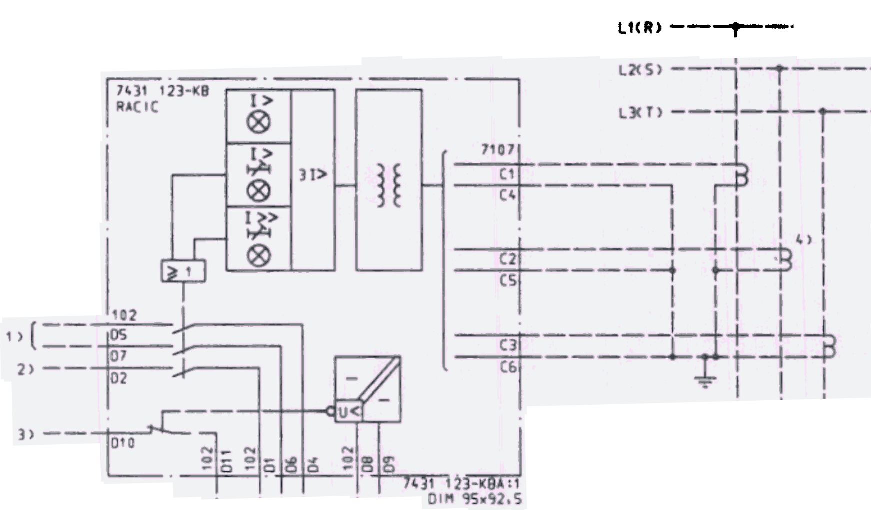
1) Directional earth-fault relays always have a definite-time-lag characteristic.



1) TRIP ETC.

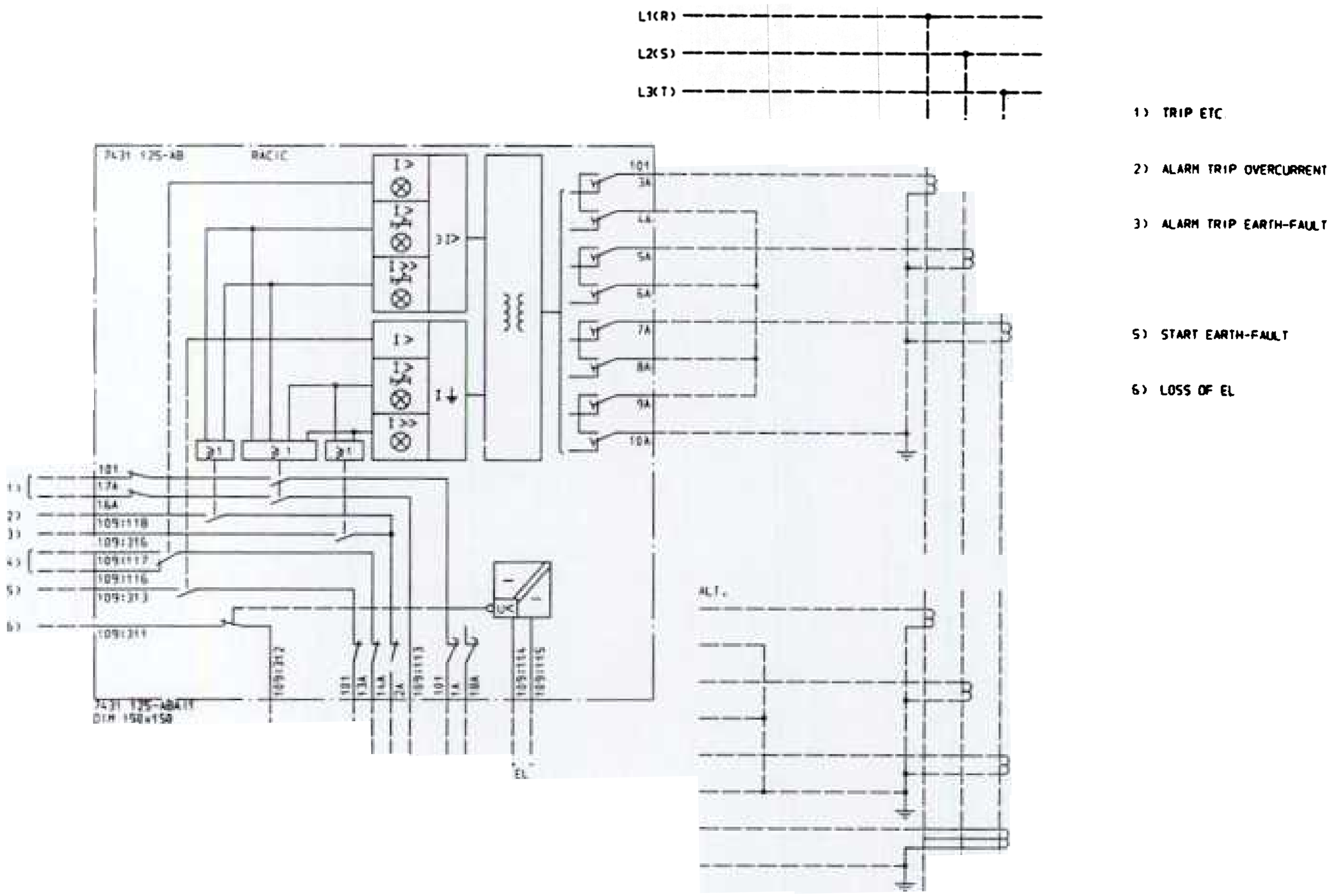
5) ONLY AT 3-PHASE CONNECTION

Connection diagram 7431 125-KBA

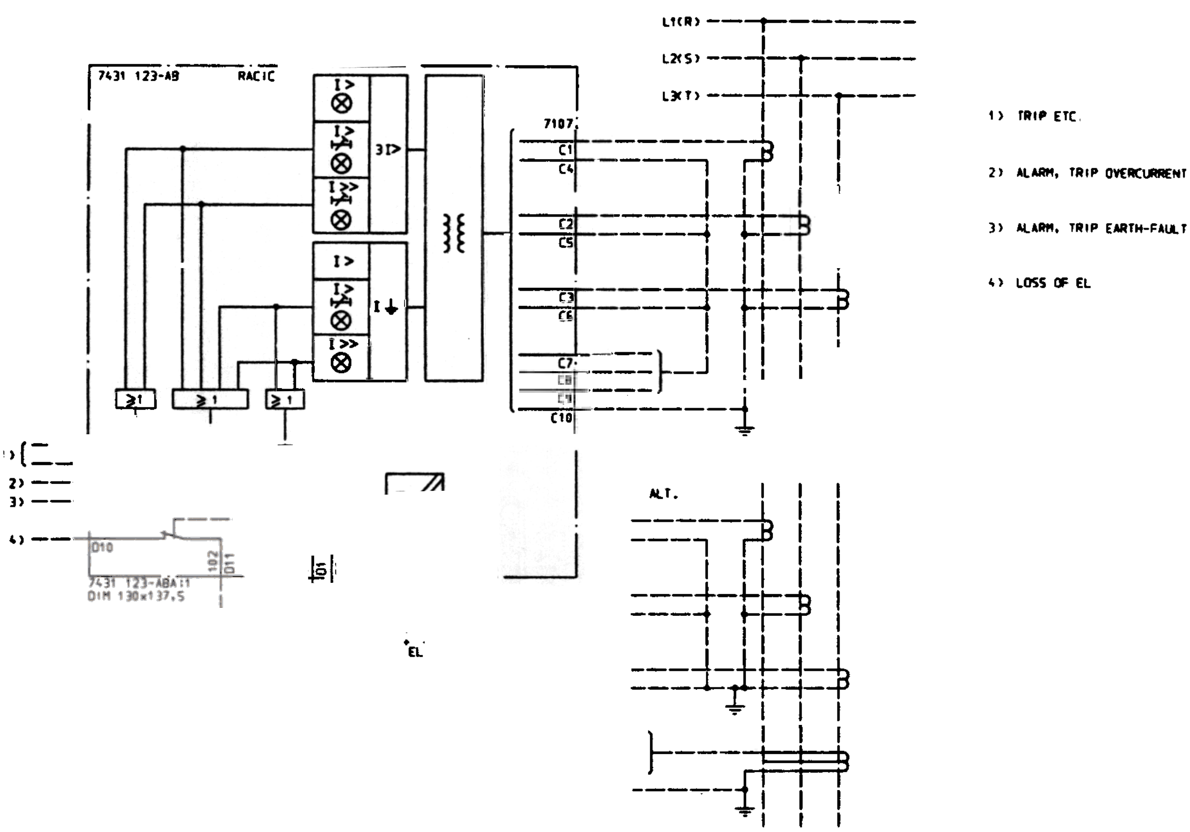


2) ALARM, TRIP OVERCURRENT

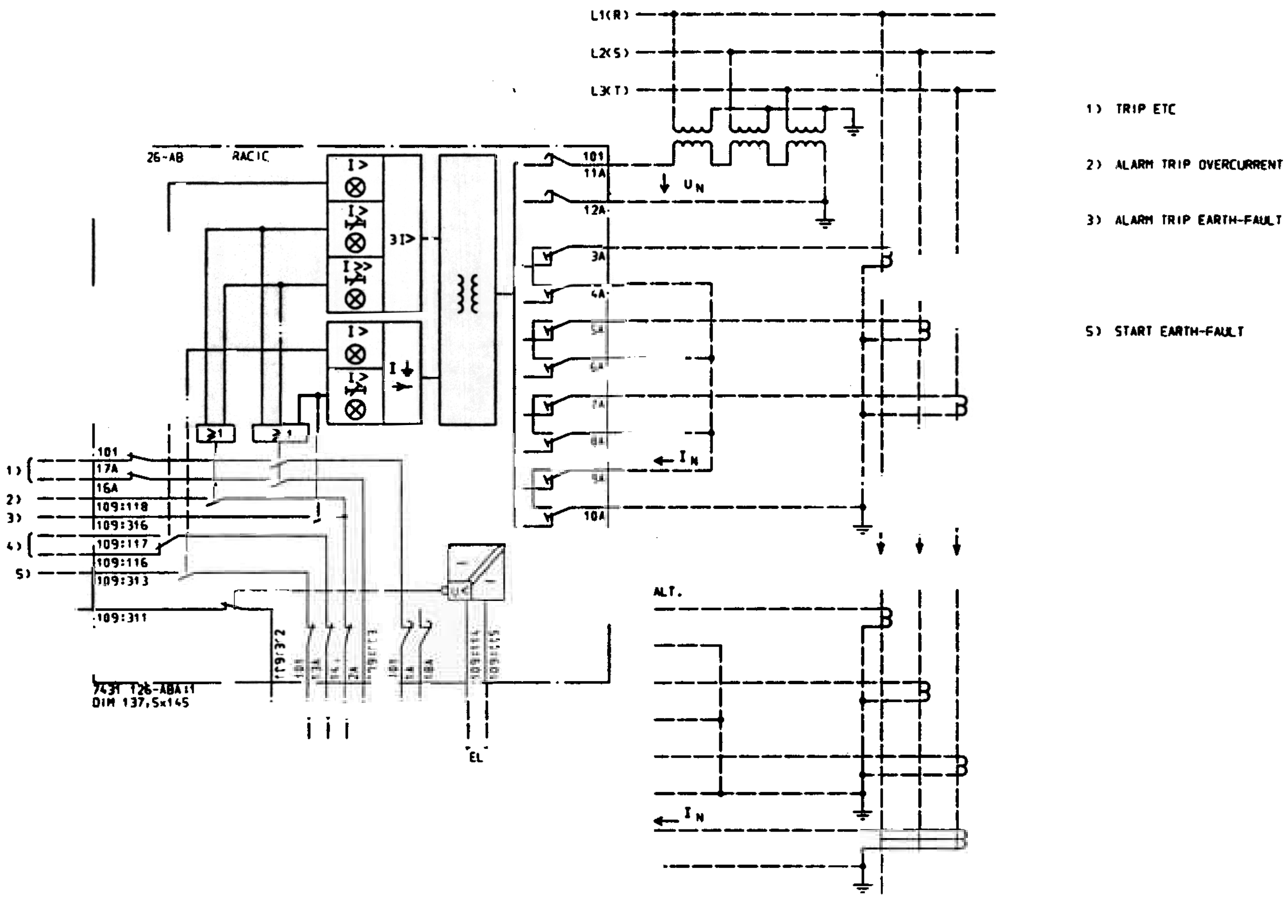
3) LOSS OF EL



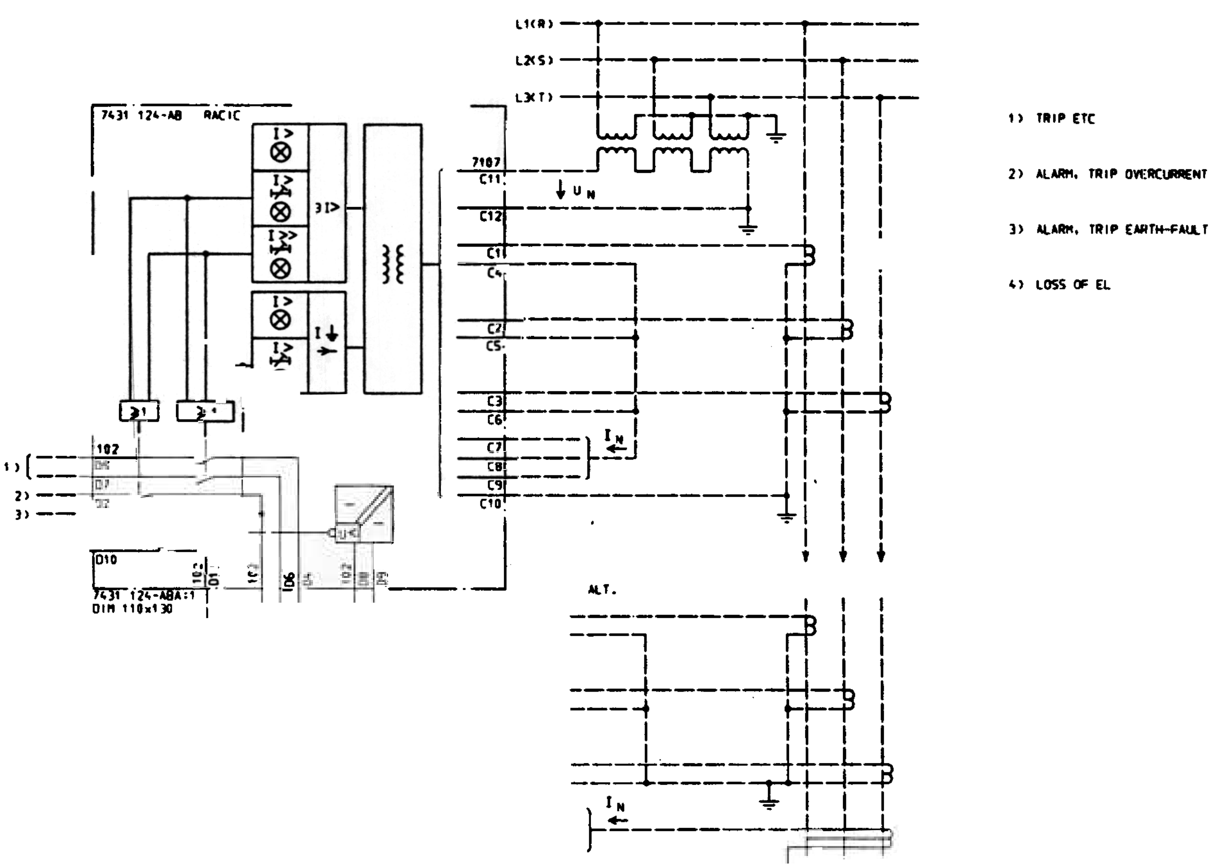
Connection diagram 7431 125-ABA

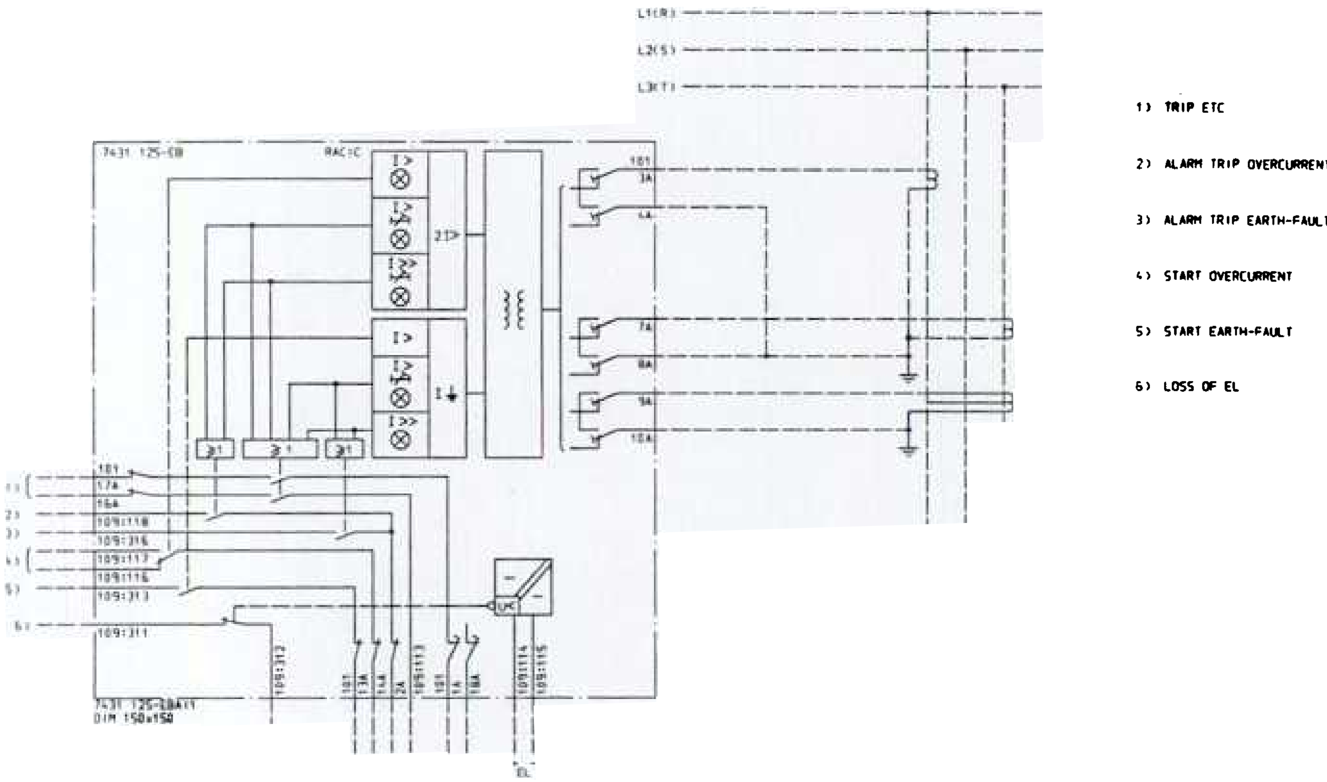


Connection diagram 7431 123-ABA

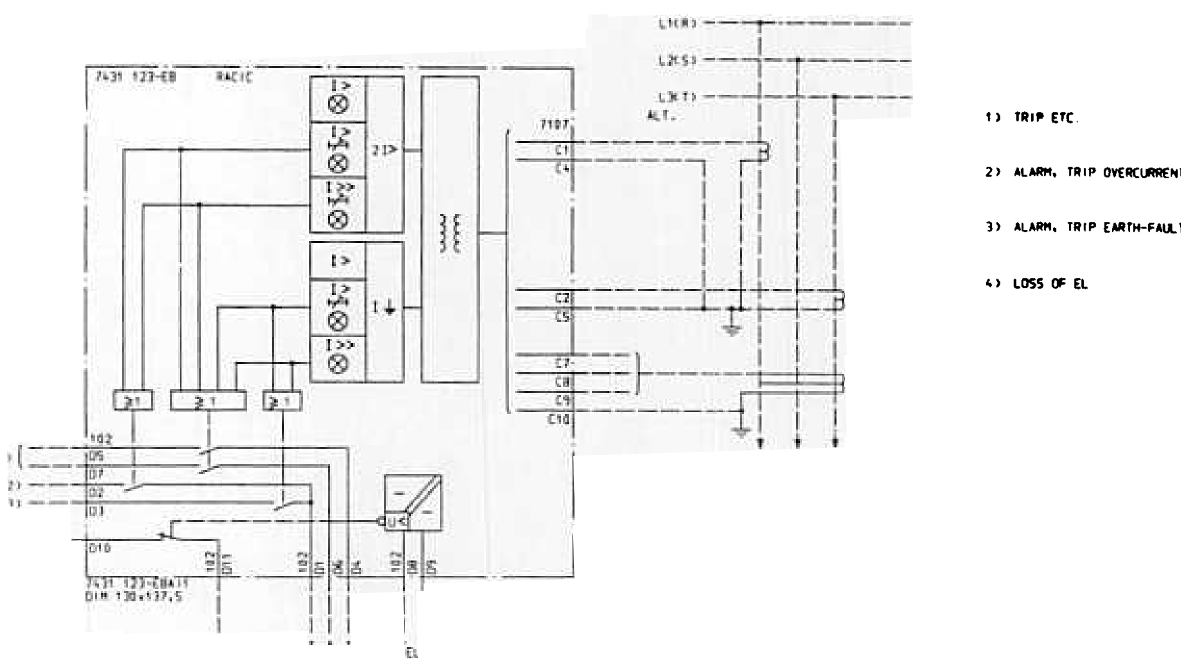


Connection diagram 7431 126-ABA

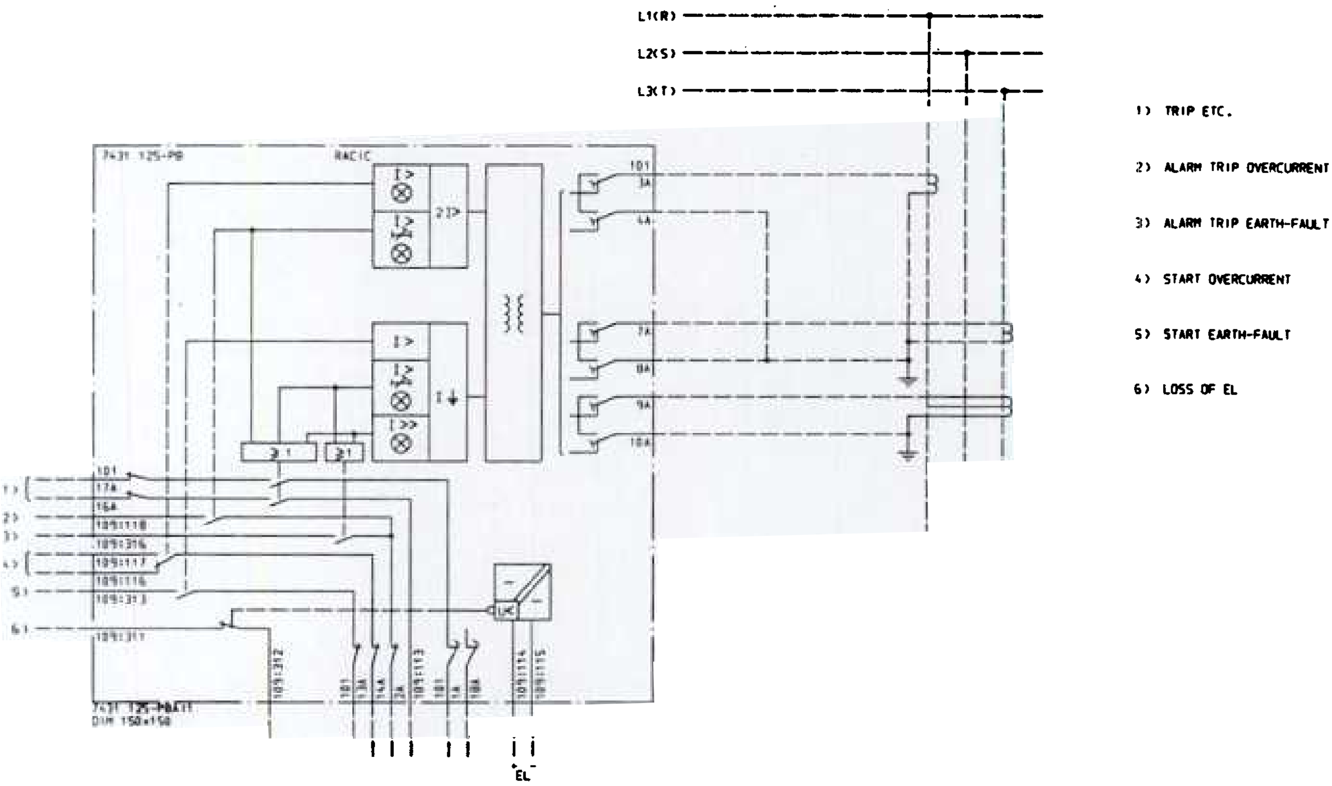




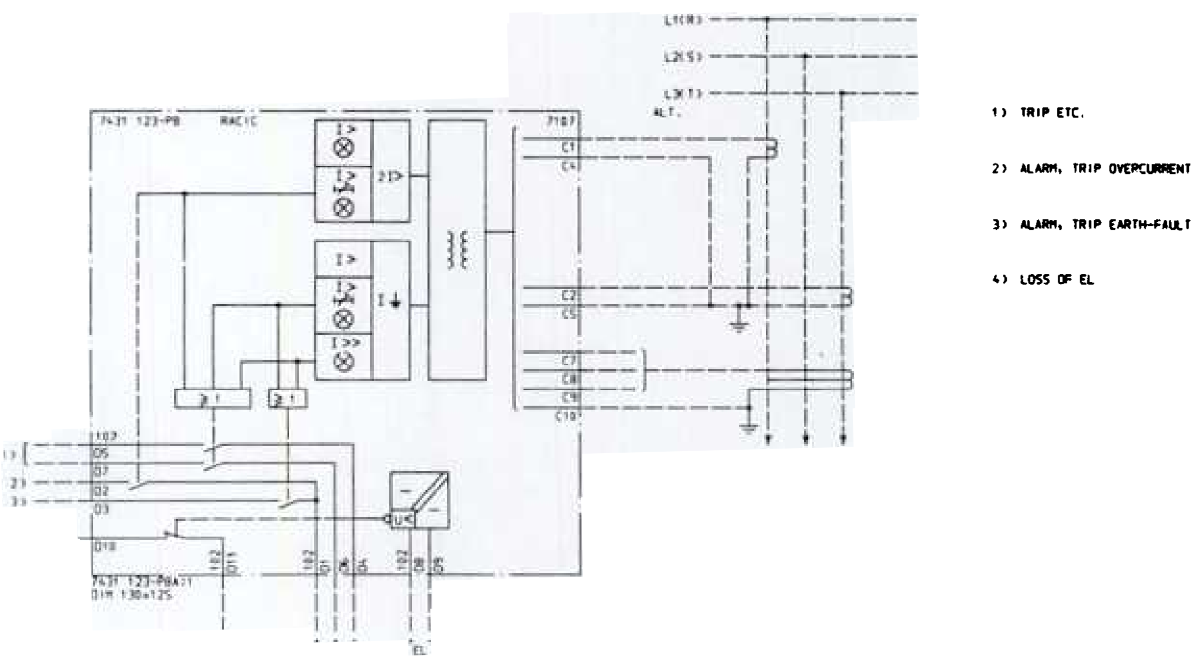
Connection diagram 7431 125-EBA



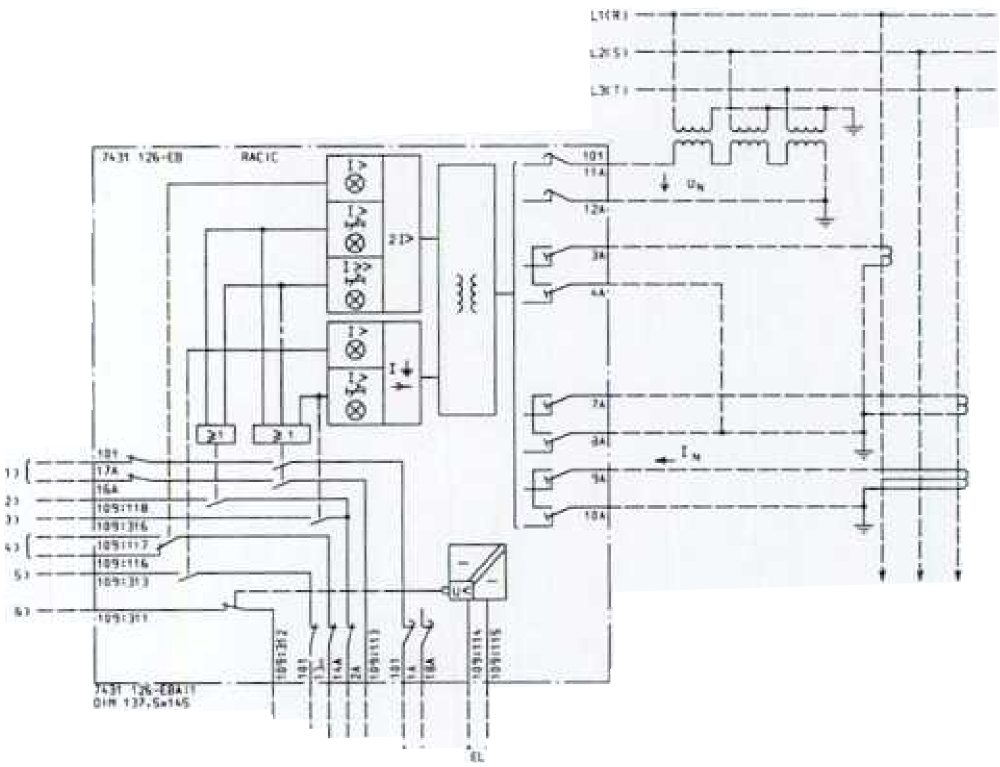
Connection diagram 7431 123-EBA



Connection diagram 7431 125-PBA



Connection diagram 7431 123-PBA



1) TRIP ETC.

2) ALARM TRIP OVERCURRENT

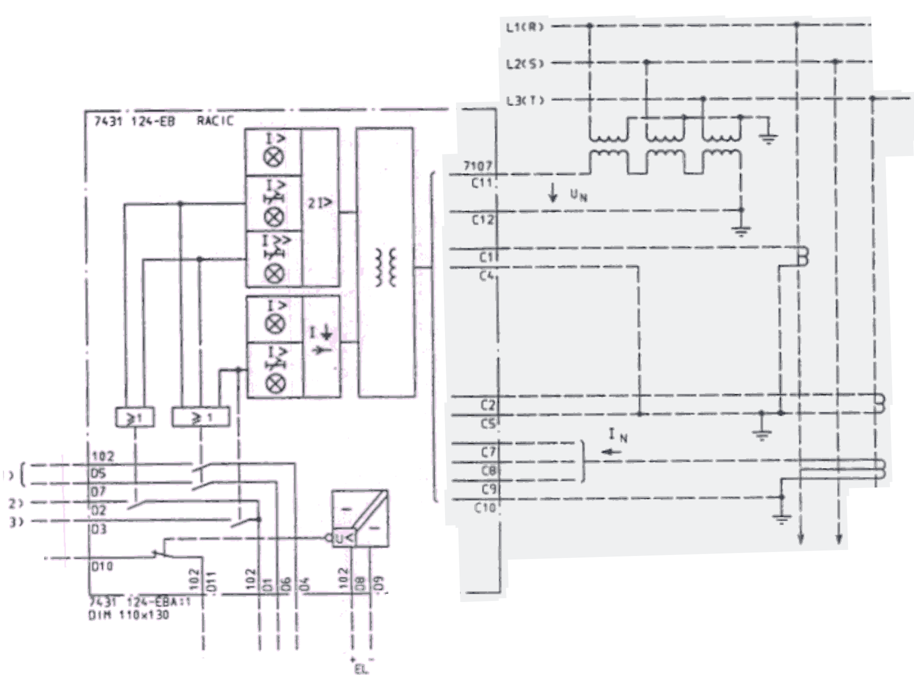
3) ALARM TRIP EARTH-FAULT

4) START OVERCURRENT

5) START EARTH-FAULT

6) LOSS OF EL

Connection diagram 7431 126-EBA



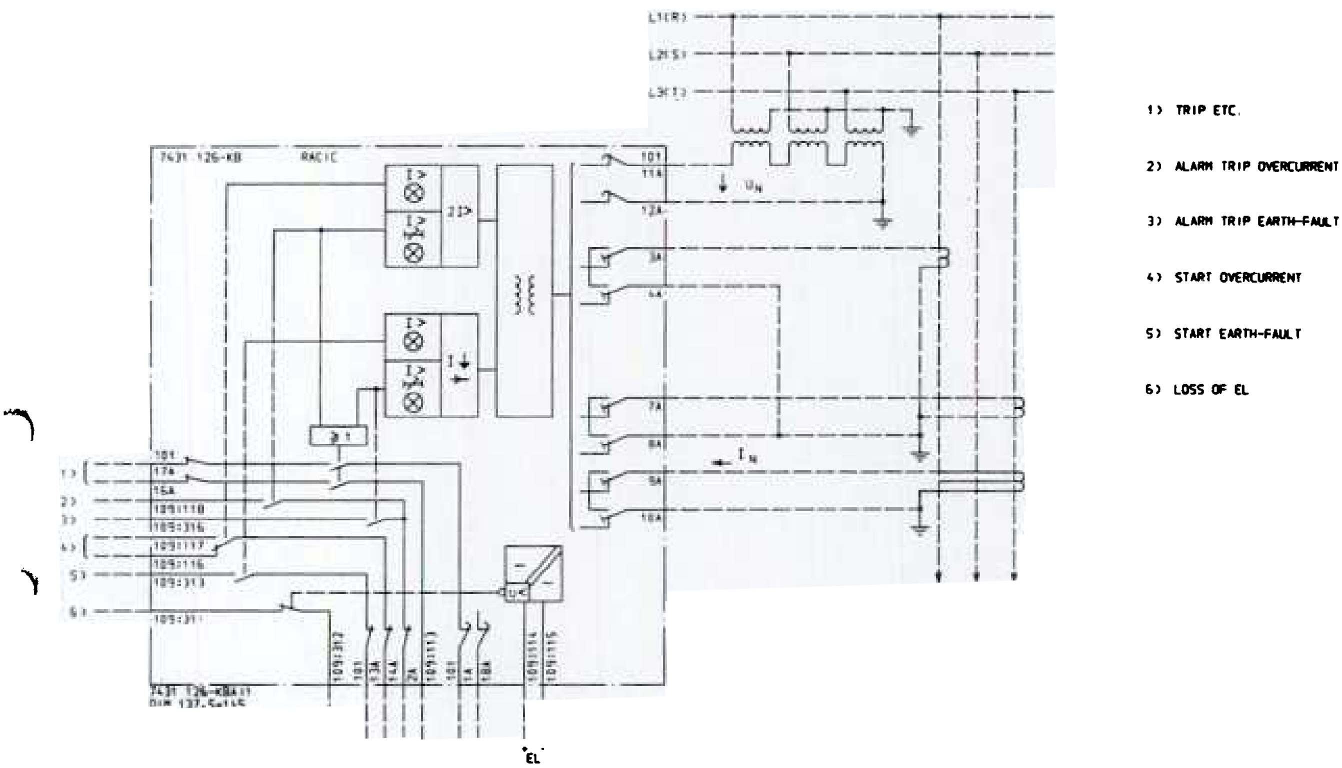
1) TRIP ETC.

2) ALARM, TRIP OVERCURRENT

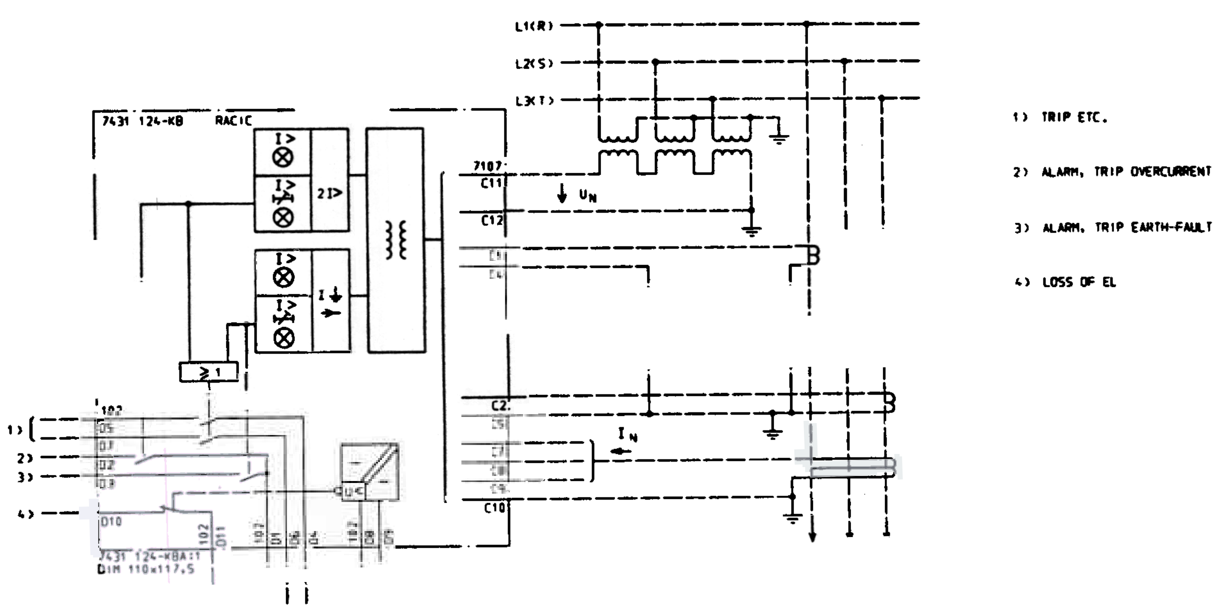
3) ALARM, TRIP EARTH-FAULT

4) LOSS OF EL

Connection diagram 7431 124-EBA



Connection diagram 7431 126-KBA



Connection diagram 7431 124-KBA

ABB Relays

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