ABB Relays

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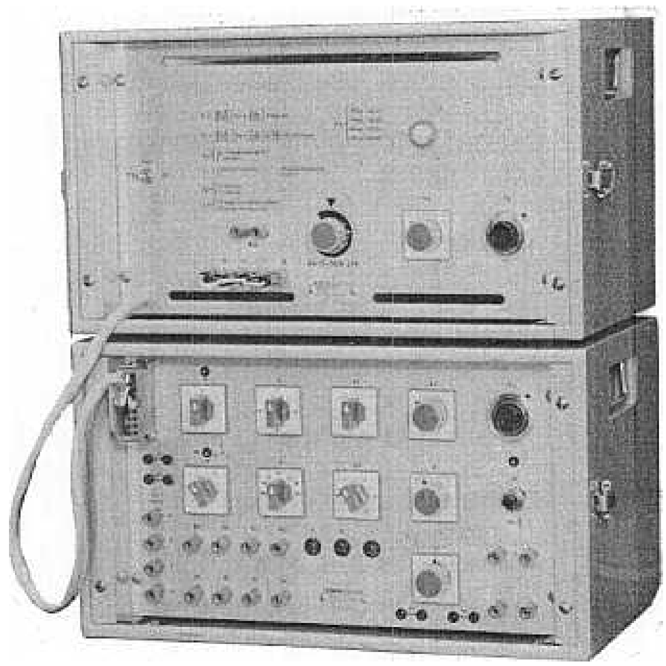
Type TURH
Protective Relay Test Set



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Application

- Static and dynamic tests on protective relays easily performed
- Single-phase and three-phase measurements possible
- Calibrated settings give accurate results without need for voltage and current instruments
- Built-in phase–angle meter
- Compact portable unit for cost-saving field and laboratory testing

PROTECTIVE RELAY TEST SET TYPE TURH

LIST OF CONTENTS

1 INTRODUCTION

The protective relay test set type TURH is intended for secondary testing during commissioning and for routine testing of primarily static distance relays and impedance measuring relays. The test set can also be used for secondary testing of several other types of relays, for example directional relays, voltage relays and current relays. The test set is of three-phase design to enable the user to simulate the most common types of faults when testing three-phase protective relays. The measuring quantities supplied to the tested object are created via a real impedance in the test set in the same way as it occurs during actual service conditions for impedance measuring relays.

A test of quotient measuring relays, for example distance relays, demands current and voltages that model the state of the power system. During static tests, those quantities can be obtained either in a synthetical manner, or through modelling the power system. A synthetized test method means that the currents and the voltages are not linked to each other via any impedance, they are obtained by using phase shifting connections or through the use of the natural phase displacements of the three-phase system.

It can be necessary to synthetically develop measuring quantities during a test of quotient measuring relays to keep the volume of a test set down when a relatively large output power is desired. That is needed when for example testing electro-mechanical protective relays. However, the synthetical method can cause distorsion in the wave-forms of one or several measuring quantities due to short-comings of the test set itself, or due to the effect of the use of different voltage supplies to develop currents and voltages, respectively. Such effects can for example be different phases with different harmonics or distorsion. Consequently, these distorsions do not correspond to existing harmonics in a power system and therefore a certain measuring error can be expected when applying a synthetical test method.

Static protective relays should therefore be tested with a method that involves measurement with a true impedance. The major reason for that is the fact that such relays do not have a large power consumption.

2 DERIVATION OF MEASURING QUANTITIES

The three-phase test set has in each phase a transactor and a resistance in series with each other. See the principal schematic illustrated in Fig. 1. The reactance (X1) of the transactor L and the resistance (R1) of the resistor R are of equal value. The phase voltage and the phase current of the primary circuit of the test set will therefore be phase-displaced 45° in relation to each other. The secondary winding of the transactor is equipped with terminals and the resistor has taps so that a part of the voltage over the resistor can be added to a part of the voltage of the secondary winding of the transactor. This summation voltage constitutes together with the voltages derived in a similar way in the two other phases, a symmetrical three-phase secondary voltage system.

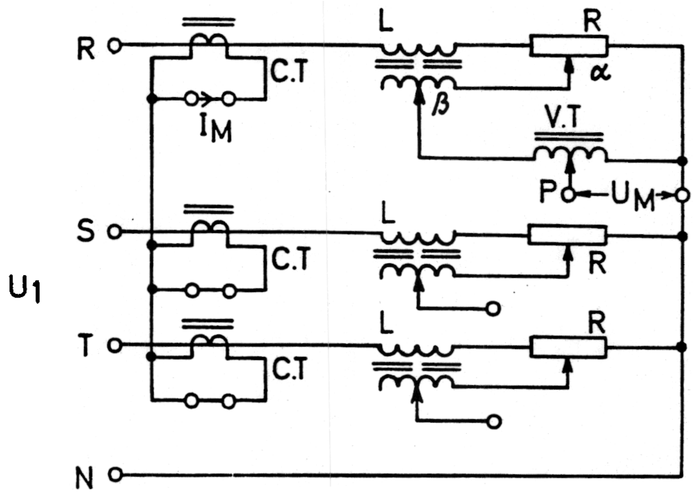

Figure 1: Principal schematic of the three-phase test set type TURH when set for testing R-N fault.

Since the resistive and reactive components of the summation voltage can be regulated independently from each other, the amplitude and the phase angle in relation to the primary current can be regulated. The amplitude can in such a way be altered between zero and the magnitude of the supply voltage in a similar way for all the three phases simultaneously. In addition, the phase angle can be altered between 0 and almost 90 $^{\circ}$ which corresponds to the first quadrant in an impedance diagram. With the use of the secondary winding of the transactor, the reacitve component of the voltage can be phase shifted 180 $^{\circ}$, and then a phase angle between 0 and -90° can be obtained, which corresponds to the fourth quadrant in an impedance diagram.

The source current for measuring purposes is obtained from the secondary windings of three current transformers, one in each phase. Through reconnections on the primary and the secondary sides, the ratios of the current transformers can be altered to obtain an adaption to rated current or to any other desired current level within the range of the test set. In addition, the choice of fault type influences the connection of the secondary current circuit. Only one phase current is obtained for single-phase faults and one line-to-line current is developed at two-phase faults. Three phase currents are obtained at three-phase faults. The direction of the current can also be altered by 180 $^{\circ}$ thus yielding the second and third quadrants in an impedance diagram, by proper combination with the transactor winding.

Fig. 2a – 2d illustrate the relation between currents and voltages for different kinds of fault according to the above mentioned principles.

Fig. 2a

Primary voltage

Primary current

Fig. 2b
Three-phase fault

Secondary voltage
$-90^{\circ} \leq \arg U_2 \leq 90^{\circ}$
$0 \leq U_2 \leq U_1$

Secondary current
$\arg I_2 = 0^{\circ}$ or 180°

Fig. 2c
Two-phase fault

Secondary voltage
$-90^{\circ} \leq \arg U_2 \leq 90^{\circ}$
$0 \leq U_2 \leq U_1$

Secondary current
$\arg I_2 = 0^{\circ}$ or 180°

Fig. 2d
Single-phase fault

Secondary voltage
$-90^{\circ} \leq \arg U_2 \leq 90^{\circ}$
$0 \leq U_2 \leq U_1$

Secondary current
$\arg I_2 = 0^{\circ}$ or 180°

Figure 2: Source currents and voltages.

The test set also incorporates an auto-transformer to allow the amplitude of the voltage to be altered in only one or two phases. The auto-transformer has terminals for certain percentages of the total supply voltage. The alteration is done by reconnection between different terminals with the switch P. The choice of the type of fault controls the connection of the auto-transformer to that secondary voltage which constitutes the source voltage for the selected and set type of fault. When using the auto-transformer, the secondary voltage system will no longer be symmetrical, which is illustrated in Fig. 3.

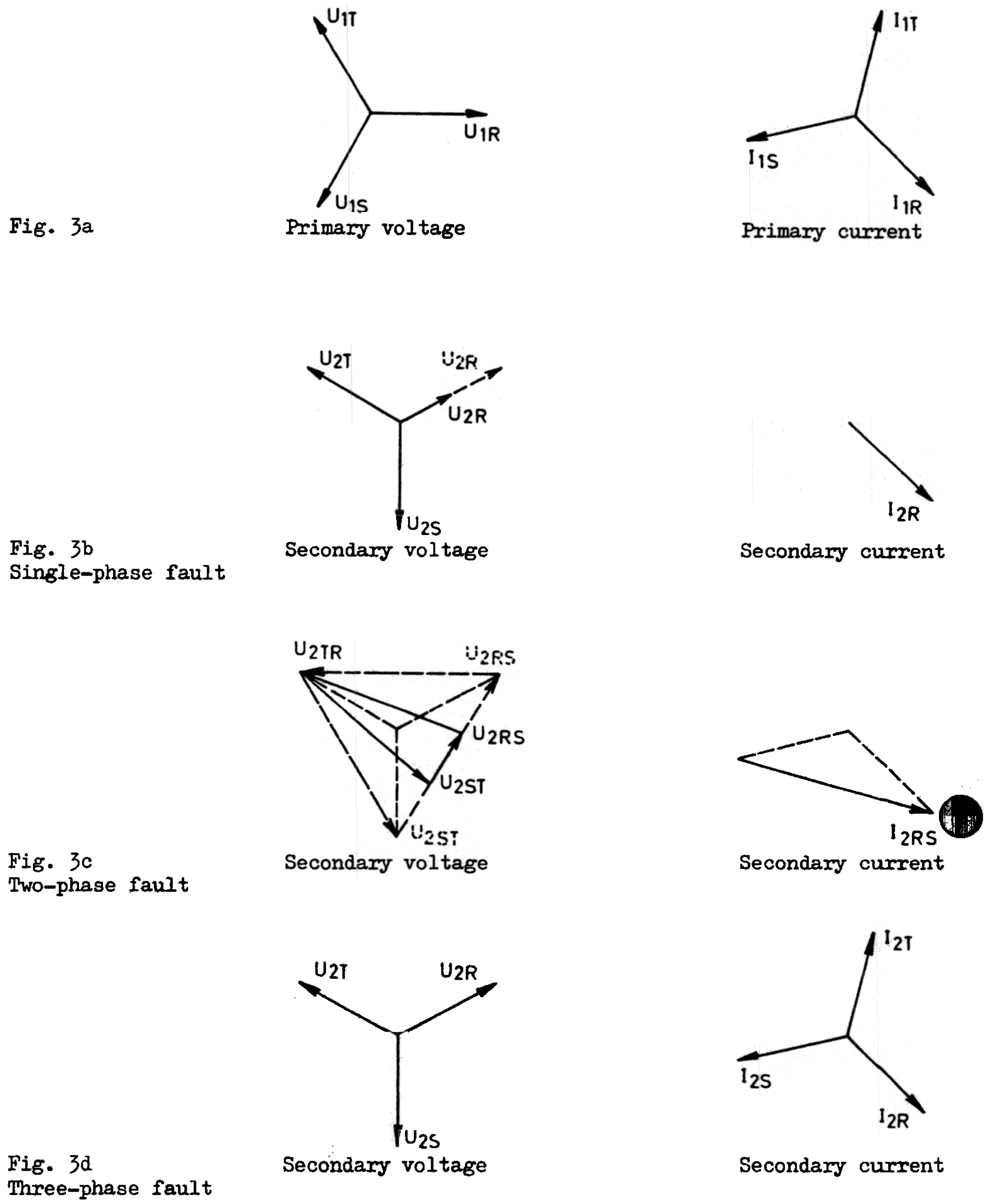

Figure 3: Source currents and voltages when using the built-in auto-transformer

Summarizing the above mentioned section, and utilizing Fig. 1, a principal formula can be stated for the measuring quantities:

$$P(\alpha R1 \pm j\beta X1)\frac{U1/\sqrt{3}}{Z1}$$

$$\pm \frac{U1/\sqrt{3}}{Z1 \times \mathcal{H}}$$

$$\pm \mathcal{H}\, P(\alpha R1 \pm j\beta X1) \Leftrightarrow R_M = \pm \mathcal{H}\, P\alpha R1 \qquad X_M = \pm \mathcal{H}\, P\beta X1$$

$$\arg(Z_M) = \pm \arctan \frac{\beta}{\alpha} \qquad \text{or} \qquad 180^\circ \pm \arctan \frac{\beta}{\alpha}$$

Where U_M, I_M, Z_M are output source quantities from the test set

P = the ratio of the voltage transformer

α and β = proportionality constants $0 \leq \alpha \leq 1$, $0 \leq \beta \leq 1$

R1, X1 and Z1 = R1 + jX1 are primary phase impedances

U1 = supply voltage

$\mathcal{H} = \frac{I_1}{I_2}$ is the ratio of the current transformer.

3 DESCRIPTION OF TEST SET CIRCUITRY AND COMPONENTS

3.1 Design

The components of the test set are housed in two equally large portable cases of standardized 19" design with the height 291 mm and the depth 304 mm. The fronts of the cases contain all operating controls, switches, terminals, indicating lamps, and fuses for convenient use. But the controls are also frontmounted to allow protection of all projecting parts with lids, which are fitted during transport of the cases. One of the cases is intended to be put on top of the other and the connection between the two cases is done with an easy-to-use snap-in connector device.

One of the cases contains the resistors of the primary circuit in addition to some setting controls that are connected to the resistors and one variable resistor with connecting terminals on the front plate. This resistor can as later will be shown be used as a series resistor to give continous current variation. The case, which carries a plate stating "Belongs to TURH", is also equipped with a fan for advanced cooling as the power

generated in the resistors is rather high.
A thermostat controls the fan when the fan-switch is in position OFF.

NOTE The fan motor shall always be on when the test set is to be used.

The second case, which carries a plate which is marked TURH, incorporates all additional circuitry, components, setting controls, etc. This case can, by this arrangement, be used without the above mentioned case when performing tests on current and voltage relays. The single main case can also be used alone for a rapid, single check of impedance relays by just measuring a limited number of points on the operating characteristic of the impedance relay.

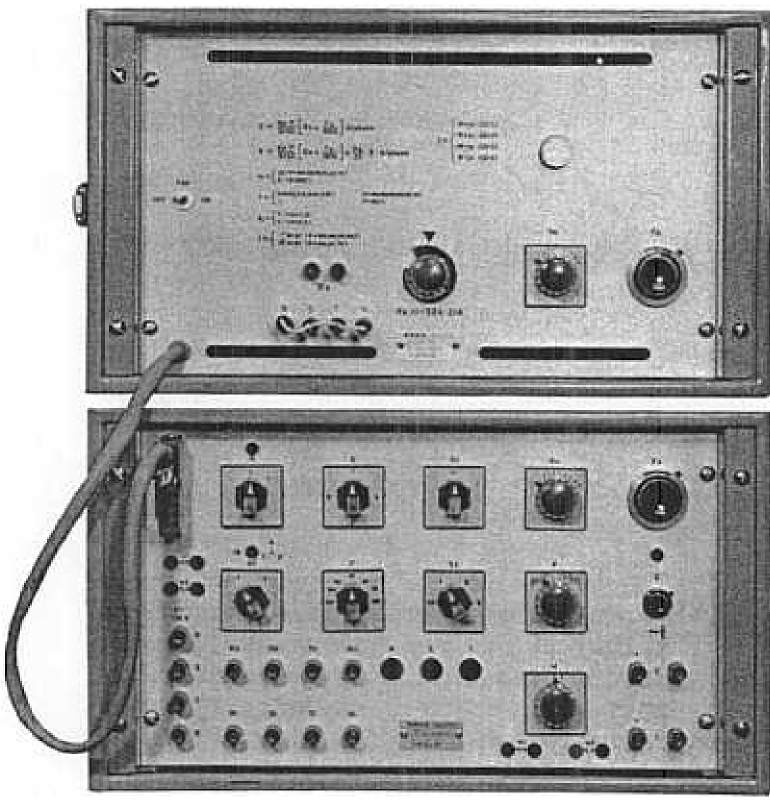

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Figure 4: The two cases of the three-phase protective relay test set type TURH. The main case at the bottom.

3.2 Resistor units

The resistance of the primary circuit is derived by a number of series connected fixed resistors, which is illustrated in Fig. 5. The total resistance in the resistor chain is 16.67 ohms. The secondary voltage is obtained from the moveable contact of a potentiometer (F_R). The other two terminals of the potentiometer can be connected to different positions along the resistor chain by using a reconnecting switch (G_R). As also can be seen from Fig. 5, the switch G_R, which has ten positions, is used for a coarse setting of the voltage. Fig. 5 shows also that F_R, which is a ten-turn precision potentiometer with a scale graduated in one thousand scale parts, performs the finer regulation of the setting. The switch and the potentiometers used for the coarse and the fine settings, respectively, are arranged in such a way that a regulation is obtained simultaneously with exactly the same amount of resistance in all three phases.

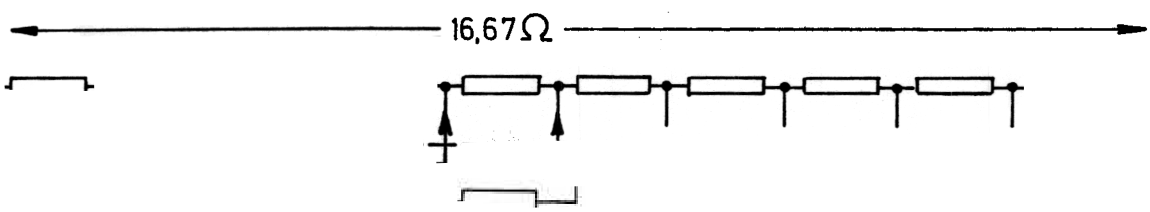


Figure 5: Resistor unit

3.3 Series resistors

At the front of the resistor unit there are also four output terminals for the primary current neutral point. Normally this terminals shall be shortcircuited.
A variable and a fixed resistor according to the figure below are mounted in the "top case" of the testing set. The terminals to the resistors are situated on the front plate. The extra resistances can be used in series with the feeding voltage source in one phase to the test set. The primary current can then be continously variated over a certain range. The secondary current can then with aid of the current ratio setting in steps and the variable resistor be continously changed over the entire specified range.

The resistors can of course be used for other purposes only bearing in mind that the maximum current capability is 2,15

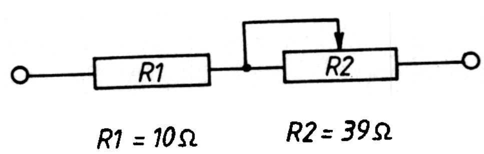


Figure 6

3.4 Transactor units

Transactors are used to obtain the reactive voltage contribution to the secondary voltage as it is desirable to have a galvanic separation between the primary and the secondary circuits at the same time. The transactors, each one having a primary impedance of 16.67 ohms, have a secondary winding with several systematically arranged terminals. The two end-terminals of a potentiometer (F_X) are connected between two transactor terminals which are located closest together by using a control switch (G_X). The secondary voltage is obtained from the moveable contact of the potentiometer and by this arrangement a coarse and a fine setting are also obtained for the reactive voltage contribution, which is illustrated by Fig. 7. G_X and F_X are physically arranged in the same manner as G_R and F_R. In such a way the setting possibilities, resolution etc. are therefore equal for the resistive and the reactive voltage components contributing to the secondary voltage.

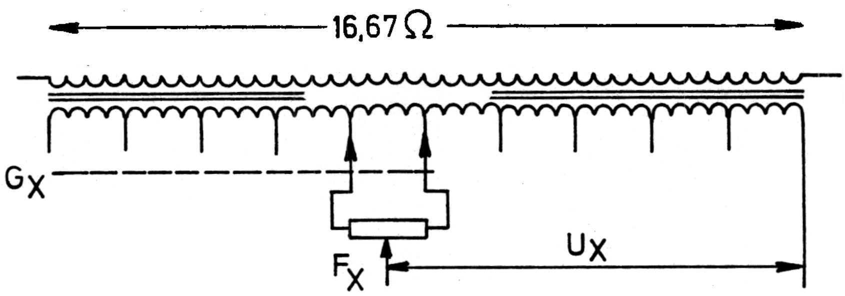


Figure 7: Transactor unit

3.5 Current transformers

The current transformers have several terminals on each of the windings so that different current ratios can easily be selected to adapt the secondary current to the rated current or to any other required current level during the testing. At nominal supply voltage, the secondary source current will be approximately equal to 0.85 times the product of the settings of the switches S1 and S2. However, the source current is at two-phase faults $\sqrt{3}$ times larger or approximately 1.5 times (S1 x S2). The switch S1 has two positions, 0.4 and 1, respectively, and is used for reconnecting the primary winding of the current transformer. Due to the fewer turns of the primary winding at S1 = 0.4, the output power is reduced from 5 VA to 0.5 VA. The setting S1 = 0.4 should therefore only be used together with the S2-settings of 0.5 and 1. The table below lists permissible burden calculated in ohms for different combinations of current settings.

The following table is applicable at nominal supply voltage (50 Hz) for secondary currents and the current transformer loads. The current will be 0.9 times the values listed in the table at a frequency of 60 Hz.

Control switch pos.			Secondary source current		Permissible source power	Allowable burden
S1	S2	S1 x S2	Single and three-phase faults (A)	Two-phase faults (A)	(VA/phase)	(ohms/phase)
0.4	0.5			0.30	0.5	
0.4	1			0.60	0.5	
1	0.5			0.75	5	
	1	1		1.	5	5
	2	2		3.	5	1.25
	5	5		7.	5	0.20
	10	10	8.5	15	5	0.05

The secondary windings of the current transformers are connected in different ways by using the fault type selector switch (F) so that various currents can be routed to the test-object. Consequently, only one phase current is transmitted to the object during a single-phase fault, simultaneously as the secondary sides of the transformers of the two other phases are short circuited and isolated from the source current output terminals. During a two-phase fault, two phase currents are added to one line-to-line current, which then is directed to the test-object while the transformer of the third phase is short circuited and isolated from the current output.

NOTE Current outputs which are not connected to a test-object should always be kept short circuited.

3.6 Voltage transformers

The voltage transformer is designed as an auto-transformer and there is only one transformer in the test set. Desired voltage reduction is selected by the switch P, which has the settings 1, 0.25, 0.05, 0.01 and 0.002. The setting indicates the ratio between the secondary and the primary voltages of the transformer. The end-position terminals of the transformer are changed by the fault type selector switch (F) to that secondary voltage which for the actually selected type of fault constitutes the source voltage to the test-object.

If a single-phase fault R-N is simulated, the transformer VT is then connected to the phase voltage U_{RN}. This voltage can now be reduced by the switch P, while the other two phase voltages are not influenced. The three-phase measuring voltage system will then not any longer be symmeterical.

At a two-phase fault, for example an R-S fault, the transformer is connected to the voltage U_{RS} which now can be reduced symmetrically around the midpoint of the winding of the voltage transformer and by that arrangement, the resultant main voltage system will be symmetrical.

NOTE VT is disconnected at a three-phase fault so that the output voltage is independent of the P-setting.

3.7 Setting switches and other controls

The fronts of the test set contain several controls, terminals, etc. The various functions of the setting switches etc. are listed below. (See also Fig. 4.)

H — Switch for connecting on and off the supply voltage (1 and 0, respectively). A light-emitting diode indicates if the voltage is connected to the test set. The switch has two contacts, one break contact (h1) and one make contact (h2), connected to terminals at the front. The contacts can be used for rough time measurement and similar operations.

Q — Switch for phase shifting of the current and/or the reactive voltage component of the secondary voltage thereby giving all quadrants in the impedance diagram.

Position	1	on the switch corresponds to quadrant	1
"	2	"-	2
"	3	"-	3
"	4	"-	4

S1 and S2 — Setting of secondary source current. The current is approximately 0.85 x S1 x S2 at single-phase and three-phase faults and approximately 1.5 x S1 x S2 at two-phase faults.

The switch S1 has the positions 0.4 and 1.
The switch S2 has the positions 0.5, 1, 2, 5, and 10.

The product of S1 and S2 should only be set to the values 0.2, 0.4, 0.5, 1, 2, 5, and 10.

Coarse setting in ten steps of the reactive component of the secondary voltage. Scale: 0, 1, 2, ... 9.

Continuous fine setting of the reactive component of the secondary voltage. Scale: 0 - 1000.

G_R Coarse setting in ten steps of the resistive component of the secondary voltage. Scale: 0, 1, 2, ... 9.

F_R Continuous fine setting of the resistive component of the secondary voltage. Scale: 0 - 1000.

F Fault type selector switch.

The scale of the switch is marked with the settable types of faults being R-N, S-N, T-N, R-S, S-T, T-R, and R-S-T.

P Setting of the ratio of the voltage transformer.

The scale is marked with 1, 0.25, 0.05, 0.01, 0.002.

NOTE The voltage transformer is disconnected at three-phase fault test.

M Alteration of the value of the secondary voltage from full voltage (position 0) to set value (position 1). The switch can be used for check of a test-object with memory circuit when a rapid regulation of the voltage from nominal value to the selected value is requested. The switch has, in the same way as the switch H, one break contact (m1) and one make contact (m2) connected to terminals at the front.

AF With the switch AF in position 1, the light-emitting diode, located above AF, is on if all the three phases are supplied with voltage. The light-emitting diode is turned off if one or several phases are missing supply voltage. If the switch is set in position 2, the light-emitting diode is lit if the phase rotation is R, S, T. The diode is dark if the phase rotation should be the reverse.

The front contains in addition to above mentioned setting controls, in the lower left hand part, terminals for connection of the supply voltage R, S, T, and N. The supply voltage should be three-phase 110 V alternating voltage. A little further to the right, terminals for source voltages and currents are located. Those terminals are marked RU, SU, TU, NU, and RI, SI, TI, NI, respectively.

Further down in the middle, fuses for protection of the precision potentiometer (F_R and F_X) are located. The fuses are applied to protect the potentiometers at a possible short circuit of the voltage outputs. The fuses should be rated 300 mA and 110 V alternating voltage.

FAN With the fan-switch in position "ON" the fan is on when voltage is supplied to the testing set. In position "OFF" the fan is controlled by a thermostat. The fan should always be on when the testing set is used.

On the front of the resistor unit there is also a knob for the variable series resistor.

3.8. Phase angle measuring unit

The protective relay test set has been equipped with a phase angle measuring unit to allow measurement of the phase angle between one current and one voltage. The unit has two polarity-marked inputs that are also galvanically separated for the two measuring quantities. A ten-turn precision potentiometer (D) is located above the inputs. The potentiometer is fitted with a knob and a scale in addition to a light-emitting diode for indication.

When using the phase angle measuring unit, the measuring quantities are connected via the unit to the test-object. The potentiometer D is turned till the light-emitting diode is just turned on or turned off. The value now indicated on the scale is divided by 5 (at 50 Hz) to obtain the value of the phase angle in degrees. At 60 Hz the phase angle will be equal to 1.2D/5.

NOTE 0.5 V is the lowest input voltage within the tolerance range.

The operating principle of the phase angle measuring unit is explained in the following. All input quantities are transformed, amplified and converted to digital pulse trains. Pulses corresponding to the phase displacement between the two signals are developed with the use of logic circuits. The pulses are integrated and the output voltage of the integrator is compared with a reference voltage. The amplitude of the reference voltage can be changed by the potentiometer D. A light-emitting diode for indication is connected in the comparator circuit.

If the output voltage of the integrator is lower than the reference voltage, the light-emitting diode is dark, but if the output voltage is higher than the reference voltage, the light-emitting diode will be turned on. To obtain a correct reading, the limit position for the on and off positions of the diode should be located, and in that case the integrator and reference voltages are equal. From the above mentioned relations can be seen that if the light-emitting diode at a certain measuring occasion should be dark from the beginning, the potentiometer setting should be reduced to reach the limit between dark and lit diode, and the vice versa.

4 TEST SET OPERATING INSTRUCTION

The formulas for the output source quantities of the test set will in reality be somewhat different from the above stated principle formulas. This depends on that the proportionality constants and scale constants have been applied so that a convenient reading of the scales can be done. In addition, consideration has been taken to the internal resistance of the transactor by introducing an extra term for the resistance in the formula. The real formulas, that are also stated on the front plate of the top position case according to Fig. 4, will then be:

$$\frac{K_F \times P}{S1 \times S2} \left(G_X + \frac{F_X}{1000}\right) \quad \text{ohms/phase}$$

$$R = \frac{K_F \times P}{S1 \times S2} \left(G_R + \frac{F_R}{1000}\right) + \frac{K_Q}{20} X \quad \text{ohms/phase}$$

$$\begin{array}{ll} R + jX & (Q = 1) \\ -R + jX & (Q = 2) \\ -R - jX & (Q = 3) \\ R - jX & (Q = 4) \end{array}$$

$$I \approx \begin{cases} S1 \times S2 \ \text{A} & (F = R\text{-}N,\ S\text{-}N,\ T\text{-}N,\ R\text{-}S\text{-}T) \\ \sqrt{3} \times S1 \times S2 \ \text{A} & (F = R\text{-}S,\ S\text{-}T,\ T\text{-}R) \end{cases}$$

The above mentioned formulas are applicable to the power frequency 50 Hz. At a frequency of 60 Hz the formulas listed below should instead be used.

$$X_{60} = 1.2 \frac{K_F \times P}{S1 \times S2} \left(G_X + \frac{F_X}{1000}\right) \quad \text{ohms/phase}$$

$$\frac{K_F \times P}{S1 \times S2} \left(G_R + \frac{F_R}{1000}\right) + \frac{K_Q}{20} \quad X_{60} \quad \text{ohms/phase}$$

This formula is applicable to the current

$$I_{60} = 0.9\ I_{50}$$

where

K_F	is a proportionality constant, see below.
P	is setting of switch P (1, 0.25, 0.05, 0.01, 0.002). However, P should at three phase fault (F = R-S-T), be 1 in the formulas, independent on the position of the switch.
S1 x S2	is the product of the settings of the switches S1 and S2. The product set is allowed to have the values 0.2, 0.4, 0.5, 1, 2, 5, and 10.
G_R and G_X	are the settings of the switches G_R and G_X (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).
F_R and F_X	are the settings of the potentiometers F_R and F_X (0, 1, 2, ... 1000).

1 if the switch Q is set equal to 1 or 3.

-1 if the switch Q is set equal to 2 or 4.

Q is the position of the switch Q.

F is the position of the switch F

The value of the proportionality constant K_F can occasionally have different values depending on the type of fault which is set and/or if the test-object is of single-phase or three-phase design. A single-phase impedance relay is often graduated in loop impedance, while a three-phase relay is calibrated in phase impedance, ohms/phase.

When the test set is set for single-phase fault measurement, a loop impedance is obtained on the output which is

$$\frac{U_M}{I_M} = 5 \frac{P}{S1 \times S2} \left[\left(G_R + \frac{F_R}{1000}\right) + \frac{K_Q}{20} \left(G_X + \frac{F_X}{1000}\right) + j\left(G_X + \frac{F_X}{1000}\right) \right] \text{ohms}$$

That means that K_F should be equal to 5 if the test-object is calibrated for loop impedance (a single-phase relay). When performing a single-phase fault measurement on a three-phase protective relay, which is graduated in omhs/phase, K_F will have another value.

The return path of a current consists at a single-phase fault on a transmission line, of the ground together with possible grounding wires. The impedance in the return path will therefore not necessarily be equally large, or have the same phase angle as the impedance in the phase wire out to the fault location. A three-phase protective relay, designed for operation on short circuits and ground faults, has therefore, as a rule, the possibility of so called zero-sequence compensation. That allows the reach along the line to be the same for different kinds of fault types. With a zero-sequence compensation (K_N), the reach of the protective relay is changed during ground fault measurements so that the relay measures a loop impedance being $(1 + K_N)Z$, where Z is the set impedance in ohms/phase. If K_N is a pure scalar, that means that the protective relay will not compensate for possible phase angle differences between the impedances of the forward and return wires, the output quantities of the test set can be expressed in ohms/phase if K_F is set equal to $5/(1 + K_N)$. Especially when $K_N = 1$, $K_F = 2.5$ and that value has been stated on the front of the test set. However, another condition allowing K_F to be set equal to $5/(1 + K_N)$ is that the protective relay reach in resistive direction should be proportionalized in the same way as the reach of the relay in reactive direction.

K_F cannot be set equal to $5/(1+K_N)$ when testing protective relays where K_N can be altered in magnitude and angle. The test should therefore most suitably be performed on a basis of loop impedance with $K_F = 5$. In addition to the above given instructions, references are also made to the specific Test Instructions issued for various individual protective relays.

When testing a two-phase fault, a loop impedance can be obtained from the test set. It is

$$\frac{U_M}{I_M} = \frac{5P}{S1 \times S2}\left[\left(G_R + \frac{F_R}{1000}\right) + \frac{K_Q}{20}\left(G_X + \frac{F_X}{1000}\right) + j\left(G_X + \frac{F_X}{1000}\right)\right] \text{ohms}$$

However, the loop impedance at two-phase faults is twice the phase impedance and the proportionality factor will therefore be $K_F = 2.5$ when the output quantities of the test set is expressed in ohms/phase.

When testing at three-phase faults, a test set provides phase impedance which is

$$\frac{U_M}{I_M} = \frac{5P}{S1 \times S2}\left[\left(G_R + \frac{F_R}{1000}\right) + \frac{K_Q}{20}\left(G_X + \frac{F_X}{1000}\right) + j\left(G_X + \frac{F_X}{)}\right)\right] \text{ohms/ph}$$

The proporitonality constant will then be $K_F = 5$ when the output quantities of the test set are expressed in ohms/phase.

The formulas state directly the magnitude and angle of the measured impedance. No additonal instruments are therefore normally required when testing impedance measuring relays. The accuracy of the test set when reading directly from the scales is of such standard that the test set is an excellent tool for convenient use during commissioning and routine checks of the majority of protective relays. If extremely accurate tests must be performed, external instruments of good accuracy (class 0.5) can be connected in the current and voltage circuits and the loop impedance equal to $\frac{U_M}{I_M}$ be calculated from the instrument readings. In such a case, the angle between current and voltage can be measured with good accuracy by the use of the built-in phase angle measuring unit.

5
EXAMPLES ON APPLICATION

5.1
Testing directions

Some examples on how to use the test set are listed below. The testing directions illustrate the use of the main case (the lower case in Fig. 4) separately and how the operating ranges can be extended by various connections and supplies to the test set. It is also permissible to use other types of connections if the following rules are followed.

The supply current per phase is not allowed to exceed 3.6 A. Currents above that value can cause saturation of the transactors. That also means that the voltage over the transactor is not allowed to exceed 3.6 x 16.67 = 60 V (50 Hz).

2 The line-to-line voltage between some phase inputs is not allowed to exceed 110 V plus 10 %. In addition must be pointed out that the indicator system naturally will not any longer have the intended function when the supply voltage is not connected in a three-phase mode. Please do observe that also the indicating light-emitting diode for the on/off switch (H) can in that case maloperate.

5.2
Single-phase testing of voltage relays

The main case of the test set type TURH is only needed for this type of testing. The connection can be arranged according to some of the figures 8a, 8b, or 8c shown below. Do please observe that the special connection device type RTXG with jumpers according to the applicable figures, should be connected to the terminal base to which the other case of type TURH normally should have been connected. In addition, the current outputs should be short circuited and the switch F should be put in position R-S-T. When using this connection, the maximum permissible supply voltage is 110 V plus 10 %.

A connection according to Fig. 8a should be chosen if the desired source voltage range should be between 0 and 100 V. When connecting the test set according to Fig. 8b, the range will be 55 - 155 V, and when using a connection according to Fig. 8c, a source voltage range between 110 - 210 V will be obtained. Figures 8a, 8b, and 8c illustrate the difference between the three different types of connections.

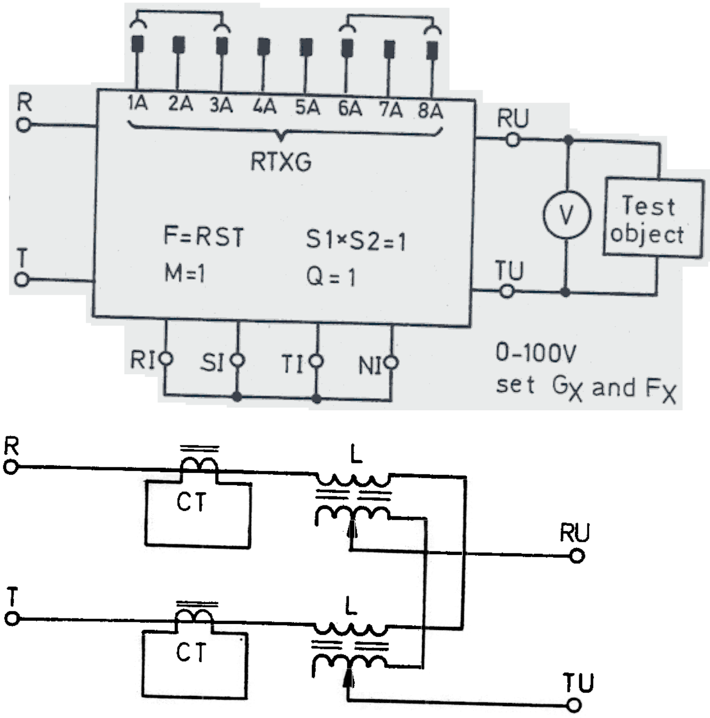


Fig. 8a

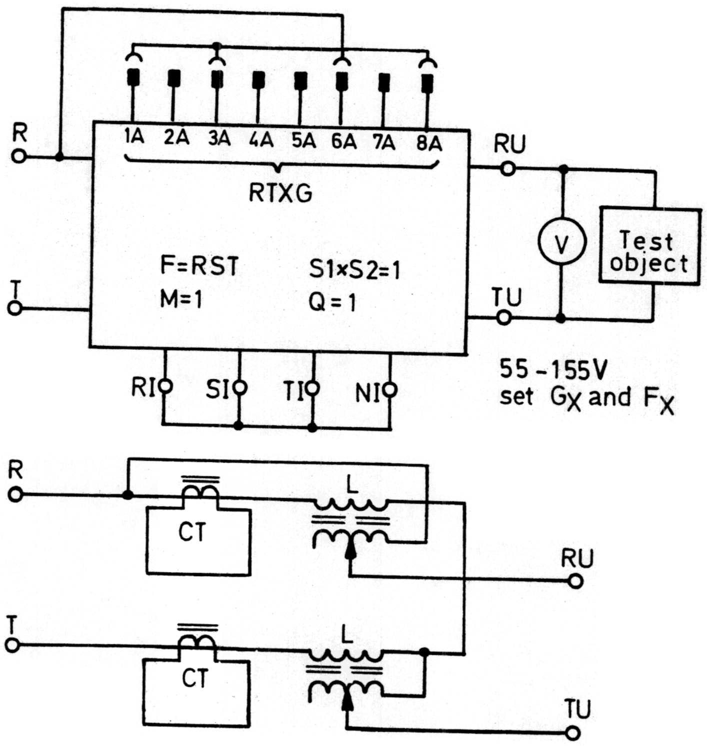


Fig. 8b

Figure 8: Connections for single-phase testing of voltage relays.

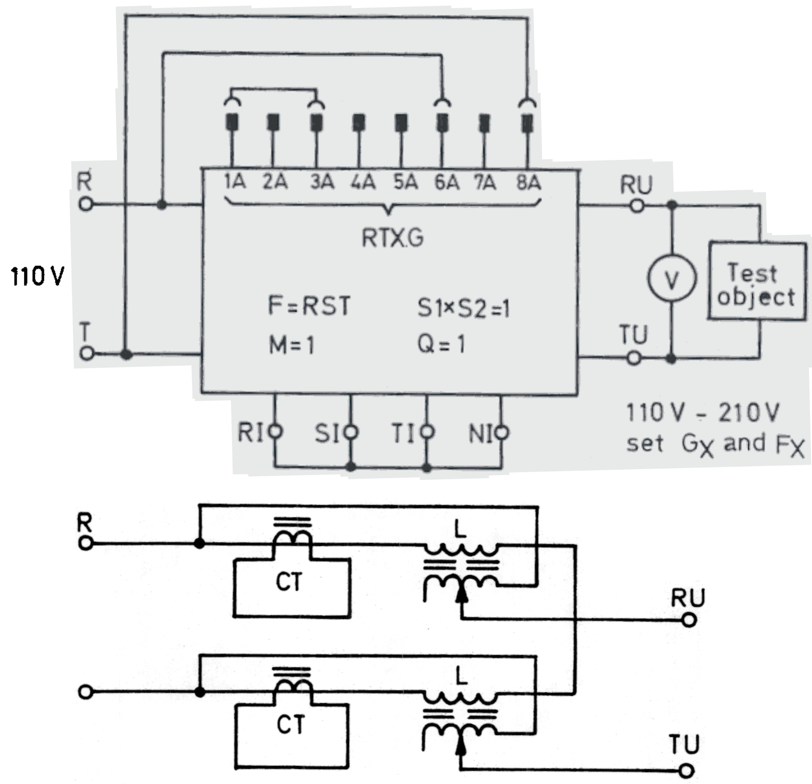


Fig. 8c

Figure 8: Connections for single-phase testing of voltage relays.

5.3
Single-phase testing of current relays

The main case of the test set can be used separately for this type of testing. The testing should then be done according to some of the alternatives shown below in figures, 9a, 9b or 9c. As the main case does not have any built-in possibility of continuous current alteration, the current is only changed in steps, the test set must be series connected to a variable resistance or a variable voltage supply to allow the current to be varied continuously. Please observe the jumpers of the connection device type RTXG., which must be connected to the terminal base to which the connection for the other case normally should have been done.

It should also be noted that the connection of the load and the position of the switch F are different for the various connection alternatives. A connection according to alternative 9.a is chosen for source currents between 0.1 - 10 A. Alternative 9b is chosen for a range of 0.2 - 20 A and alternative 9c is chosen for an output range of 0.3 - 30 A. Please observe that the total supply current is not allowed to exceed 3 x 3.6 = 11 A when using alternative 9c as there otherwise will be a risk that the transactors will saturate.

If both cases are used during the test, the internal variable resistor can be used for continous current variation. Se fig 10.

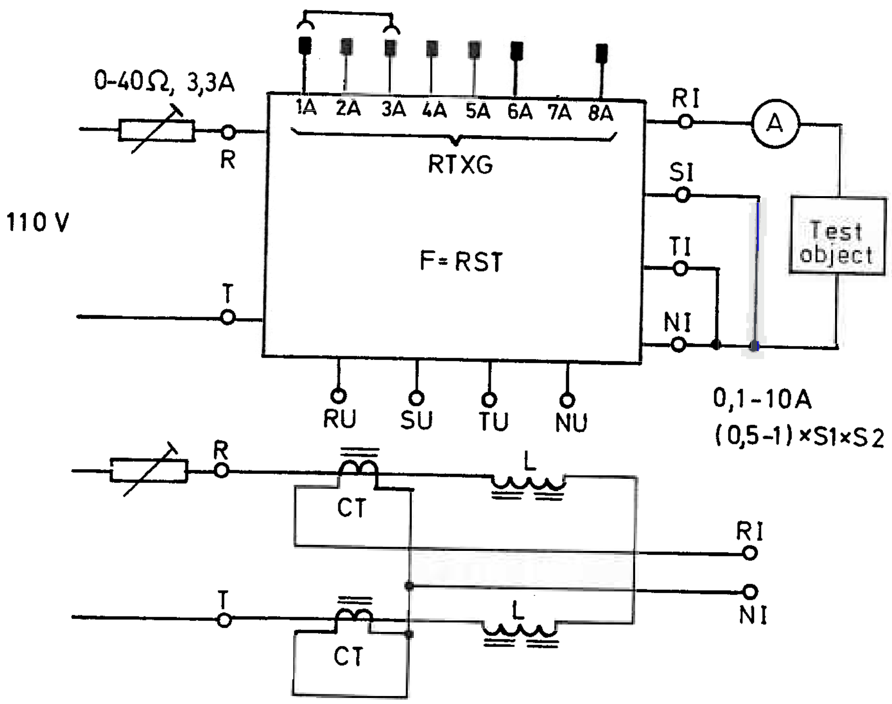


Fig. 9a

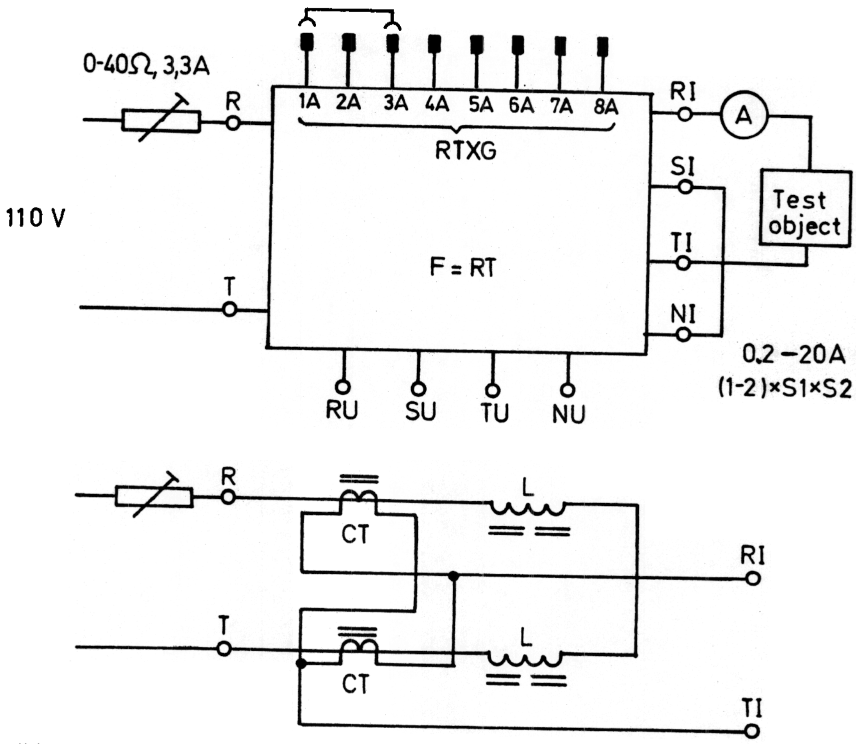
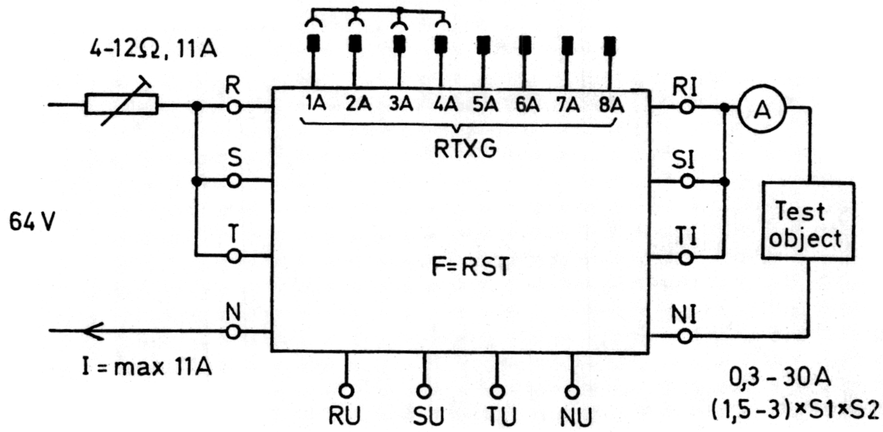


Fig. 9b

Figure 9:Connections for single-phase testing of current relays, using only one test case



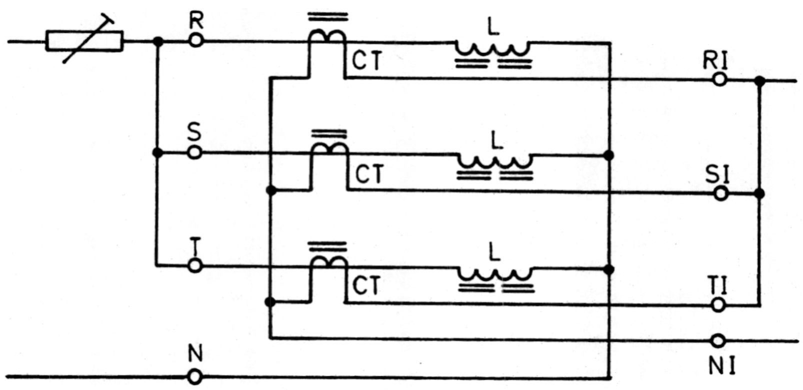


Fig. 9c

Figure 9: Connections for single-phase testing of current relays.

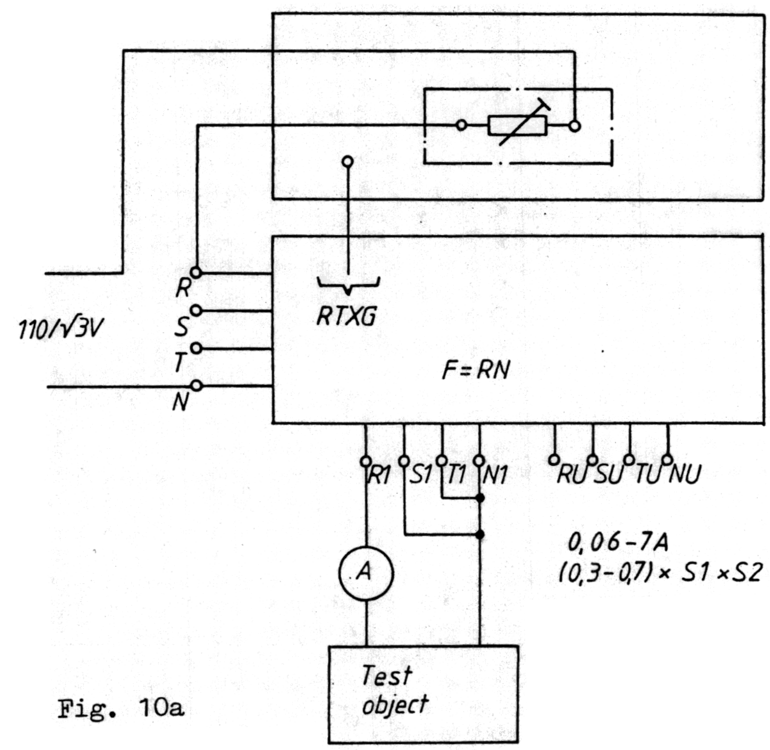


Fig. 10a

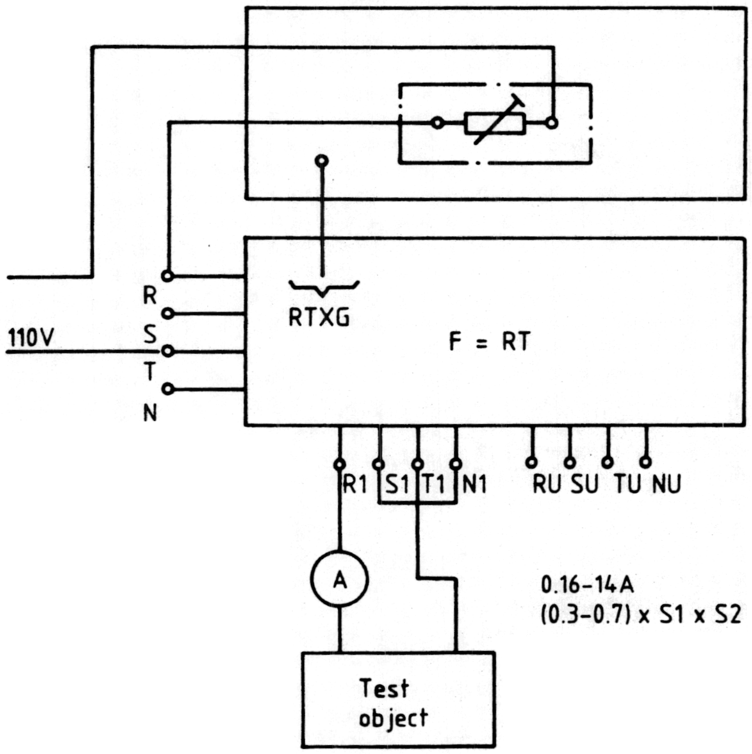


Figure 10: Connections for single-phase testing of current relays, using both test cases.

5.4 Testing of impedance relays

A single-phase impedance relay can be checked at 90 ° or - 90 ° when using only the main case which then should be connected according to Fig. 11.

When tests and checks are made of three-phase impedance relays, both cases are used and then the normal connection according to Fig. 12a should be used. The reading should be done on the scales and then the impedance value can be calculated using the formulas. If operating times are measured, the auxiliary contact of the switch H should be used to start the timer and a tripping contact on the test object should be used to stop the timer.

As mentioned above, external instruments can also be used to measure the amplitude of the source quantities. The built-in phase angle measuring unit can also be used to measure the phase angle between the output quantities. See the connection according to Fig. 12b .

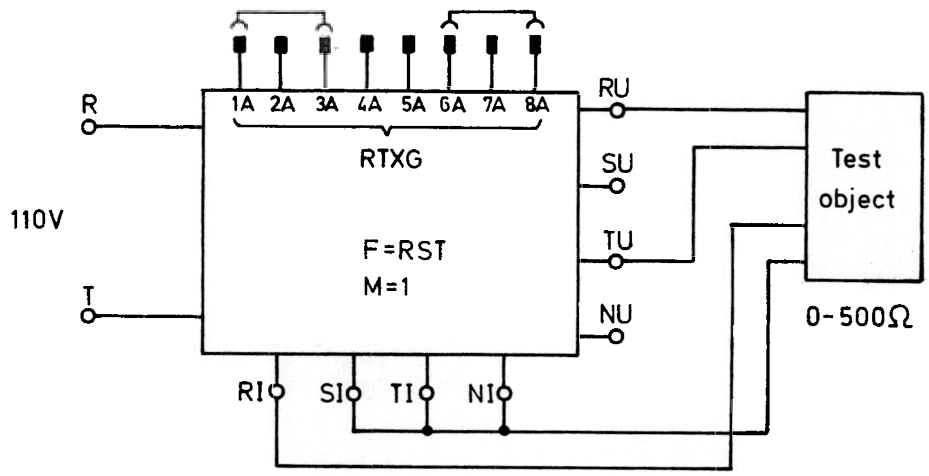


Figure 11: Connections for test of single-phase impedance relays.

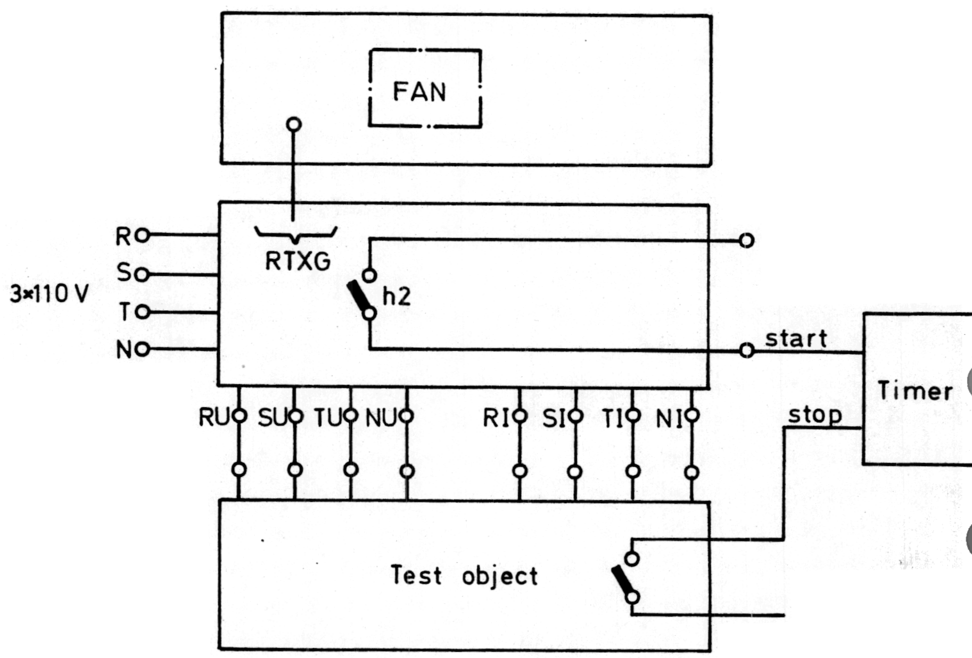


Figure 12a: Connections for test of three-phase impedance relays.

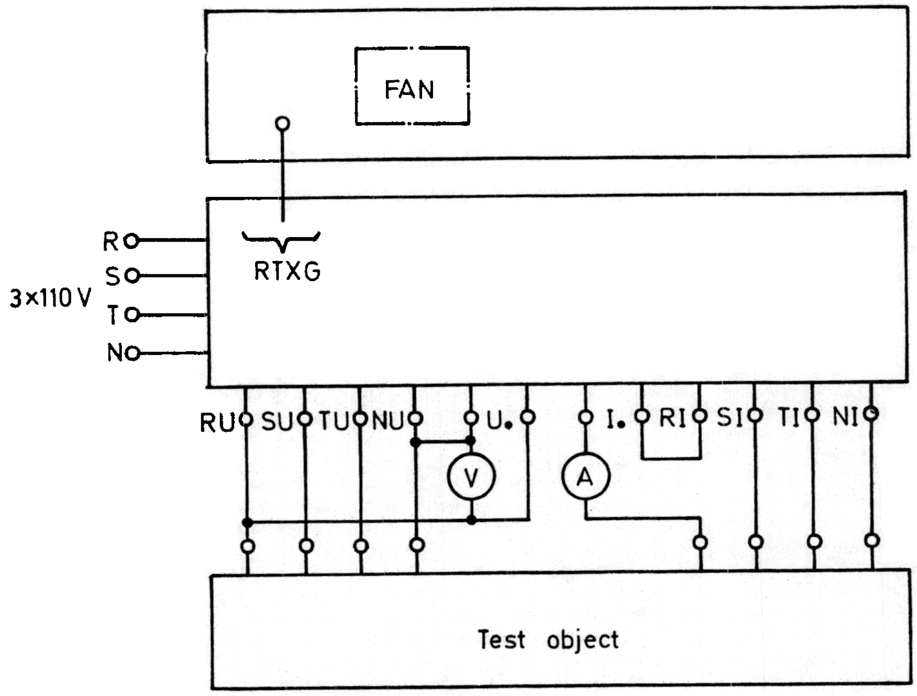


Figure 12b: Connections for test of three-phase impedance relays when external instruments are used.

6
SEPARATE AUXILIARY TRANSFORMER

If a local three-phase supply of 110 V is not available, the test set can also be supplied via a separate auxiliary transformer. The auxiliary transformer consists of three single-phase transformers housed in a case having the approximate dimensions 190 x 390 x 230 mm. The weight is about 30 kgs. The photo 52758 in Fig. 13 on page 27 shows the unit with the lid opened.

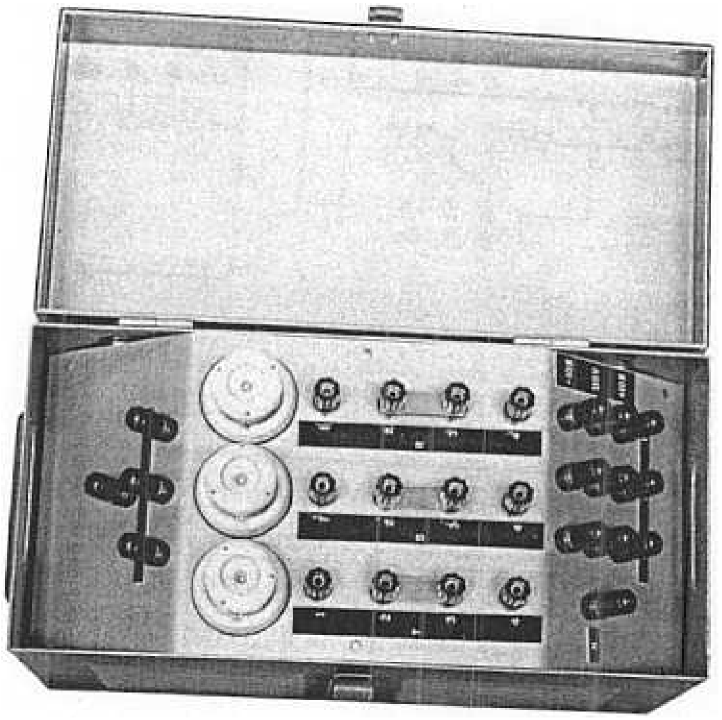
The transformers are connected in D/Y-0 according to the enclosed drawing 7407 021. The ratio of the windings is 2 x 210 V/64 V and the total rating is about 200 VA per phase. The primary winding is divided in two sections which can be connected in series or parallel by means of connecting strips. Series connection is used when the supply voltage is 380 V - 460 V. Parallel connection is used when the supply voltage is 190 V - 230 V. On the secondary side, the transformers have terminals for 110 V and 110 V ± 10 %. The primary side of the transformers are fused with 2A fuses.

7 TECHNICAL DATA

General	Permissible temperature range	-5 ° to +55 °
	Physical dimensions	2 cases each 508 mm wide, 291 mm high and 309 mm deep
	Weight reactance unit (main case) resistor unit	 27 kg 20 kg
Supply quantities	Input voltage	Three-phase 110 V + 10 % 50 Hz (60 Hz)
	Power	Approximately 200 VA/phase
	A separate auxiliary transformer for other input voltages 210 V ± 10 % or 420 V ± 10 % can be obtained for use together with TURH.	
Source quantities	Output voltage	0 - 110 V, three-phase
	Output power of the voltage system	5 VA/phase
	Output current	0.2, 0.4, 0.5, 1, 2, 5, and 10 A nominal current per phase (two or three times the above mentioned values can be obtained when testing single-phase relays)
	Output power of the current system	5 VA/phase for 0.5, 1, 2, 5, and 10 A 0.5 VA/phase for 0.2 and 0.4 A (in a single-phase mode the output power can be twice or three times the above stated values)
Impedance	Three-phase, reactive Three-phase, resistive Resolution	0 - 250 (0-300) ohms/phase 0 - 250 ohms/phase 0.5 - 25 milliohms dependent on current setting
	Two-phase, reactive Two-phase, resistive Resolution	0 - 125 (0 - 150) ohms/phase 0 - 125 ohms/phase 0.25 - 12.5 milliohms dependent on current setting
	Single-phase, reactive Single-phase, resistive Resolution	0 - 125 (0 - 150) ohms/phase 0 - 125 ohms/phase 0.25 - 12.5 milliohms dependent on current setting
	Phase angle	0 - 360 °
	Accuracy impedance angle	 ± 4 % of set value $Z = \sqrt{R^2 + X^2}$ ± 4 °

Phase angle measuring unit

Supply voltage	64 V + 30 % - 20 % a.c. or 110 V + 10 % - 35 % d.c. Sufficient supply voltage will normally be obtained from the test set without any extra connection of external supply.
Current input	0.2 - 10 A
Voltage input	0.5 - 110 V
Accuracy	$\pm 1.5^{\circ}$, 1- 20 V, 0.5 - 5 A $\pm 2.5^{\circ}$, 0.5 - 110 V, 0.2 - 10 A



(52758)

Figure 13: Separate auxiliary transformer unit for extending input supply range of protective relay test set type TURH (52758).

ASEA	Nätanslutningsenhet för provningsapparat Supply Transformer for Test Sets	7407 021
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		forts. bl. -
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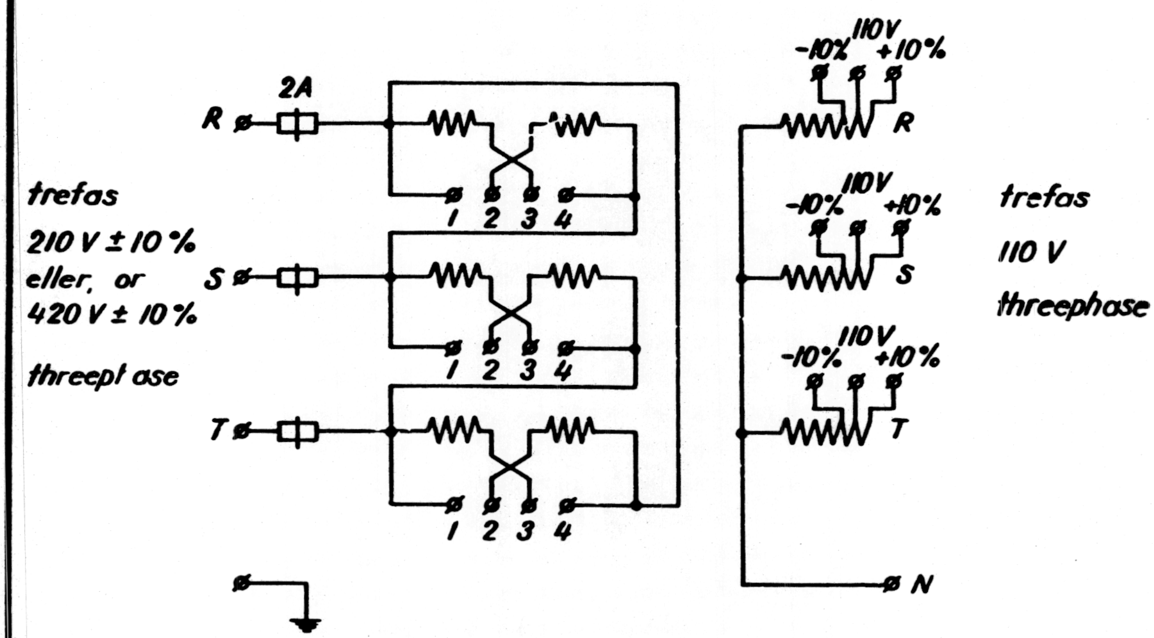

Inspänning Input	Koppling Connection	Uttagsbultar Terminals	Utspänning Output
190 V 210 V 230 V	1 2 3 4 (1–2, 3–4)	110 V + 10 % 110 V 110 V - 10 %	110 V
380 V 420 V 460 V	1 2 3 4 (2–3)	110 V + 10 % 110 V 110 V - 10 %	110 V

Transformator omsättning
Transformer ratio 2 × 210 V/64 V. 50 Hz, 200 VA.

Not	Ändringar	Införd
1	Fr. "Transf. for Testing set."	76.47