BBC
BROWN BOVERI

Motor Protection Relays
Types ITX192 and ITX193

Instruction for Installation and Operation

Contents :-

1. Application

The solid-state motor protection relays types ITK192 and ITK193 supersede the very successful ITK162 and ITK163. Their main field of application is the protection of machines, but they are also used for the protection of power transformers and cables. The technical data of the relays is given in data sheet CH-ES 63-31.2.

The ITK192 comprises the following kinds of protection:-

- phase fault
- inadmissibly long running-up time or blocked rotor (asynchronous motors)
- thermal overload

In addition, the ITK193 also includes:-

- negative phase-sequence
- ground fault

The relays are supplied in the BBC size 1 relay casing, which can be adapted on site for either semi-flush or surface mounting. The relay itself can be simply withdrawn from its casing. The kinds of protection which are included are all that are required for machines of medium rating. For larger units (from about 2 to 3 MVA), we recommend an additional biassed differential relay of equivalent mechanical design (type D202, data sheet CH-ES 61-66.03).

2. Determining the settings

In order to select the correct design of relay for the application, the data of the protected unit must be known at the time of ordering or when designing the protection scheme. Before commencing commissioning this data should be checked and the relay set accordingly.

2.1 Data of the protected unit (motor or transformer)

The following data are required to determine the relay settings:-

- rated voltage
- rated current
- rated power
- rated frequency
- nature of the system earthing
- insulation class
- thermal time constant
- time constant in the absence of forced cooling (locked rotor in the case of machines)
- c.t. ratio
- the auxiliary supply available in the plant

2.2 Settings to be performed on the relay (setting instructions)

2.2.1 Current setting I_E (tap setting)

The relay is designed for connection to c.t's of either 1 A or 5 A rating. Its rated current I_n is determined by the position of the link E (see section 10 , Fig.12). With the link E in the upper position I_n = 1 A and in the lower postion I_n = 5 A. The values of all the frontplate settings are referred to the current setting I_E, which can be selected for each current input between 0·3 and 1·2 x I_n on the rotary step switches (eb) (see section 10, Fig.13/14). The effective current setting should correspond to the rated current of the protected unit referred to the primary circuit. The secondary current can be matched in steps between 0·3 and 1·2 A with I_n = 1 A and between 1·5 and 6 A with I_n = 5 A.

setting factor k		0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,1	1,2
I_E for	I_n = 1 A	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,1	1,2
	I_n = 5 A	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0

Table 1 - Possible current settings I_E in A

Intermediate values can be achieved by appropriately compensating the frontplate settings (I≫, I> , I_2 and I_o). When measuring all three phase currents, the rotary step switches (eb) have identical settings. In the case of the ITX193 there is the possibility of using the phase S (yellow) unit to measure the neutral current I_o (the soldered link bi connects k and l, see section 10, Fig.13/14).

Since the setting range for earth faults is 0·2 to 0·8 x I_E (0,015 to 0,15 x I_E for ITX193-432), the following secondary earth fault currents can be set in relation to the rated current I_n and the setting factor k:-

	setting range in A			
	ITX193		ITX193-432	
k (I_o)	I_n = 1 A	I_n = 5 A	I_n = 1 A	I_n = 5 A
0,3	0,06...0,24	0,3...1,2	0,0045...0,045	0,0225...0,225
0,4	0,08...0,32	0,4...1,6	0,006 ...0,06	0,03 ...0,3
0,5	0,10...0,40	0,5...2,0	0,0075...0,075	0,0375...0,375
0,6	0,12...0,48	0,6...2,4	0,009 ...0,09	0,045 ...0,45
0,7	0,14...0,56	0,7...2,8	0,0105...0,105	0,0525...0,525
0,8	0,16...0,64	0,8...3,2	0,012 ...0,12	0,06 ...0,6
0,9	0,18...0,72	0,9...3,6	0,0135...0,135	0,0675...0,675
1,0	0,20...0,80	1,0...4,0	0,015 ...0,15	0,075 ...0,75
1,1	0,22...0,88	1,1...4,4	0,0165...0,165	0,0825...0,825
1,2	0,24...0,96	1,2...4,8	0,018 ...0,18	0,09 ...0,9

Table 2 - Earth fault current setting range

2.2.2 General setting instructions, example of calculation

The following section gives a guide to setting the relay, taking as an example a typical HV asynchronous motor.

Motor data:-

rated power	S_N	= 2,33 MVA
rated voltage	U_N	= 6 kV
rated frequency	f_N	= 50 Hz
rated current	I_N	= 225 A
max. continuous rating	$I_{max\ th}$	= $1{\cdot}2 \times I_N$
normal operating current	I_B (186)	= $0{\cdot}83 \times I_N$
starting current	I_A	= $5 \times I_N$
starting time	t_A	= 12 s
permissible blocked rotor time	t_E	= 20 s ($t_E > t_A$)
time constant	$\tau\nearrow_{mot}$	= 45 min
time constant when stationary	$\tau_{\searrow mot}$	= 120 min
c.t. ratio	r	= 300/1 A
permissible number of consecutive starts		= 3 when cold, 2 when hot

System data:-

The neutral of the system is grounded via a resistance, such that the maximum earth fault current (earth fault at the terminals of the motor) is I_{OPmax} = 200 A.

Relay data:-

The motor protection relay ITX193-332 has been chosen on the basis of the amount of protection specified.

auxiliary supply	U_H	= 48 to 250 V d.c.
starting time setting range	$t_{I>}$	= 2 to 20 s
time constant	$\tau\nearrow$	= 40 min (same or less than the protected unit)

time constant when stationary	$\tau\downarrow$	$= 3 \times \tau\uparrow$
negative phase-sequence tripping delay	t_{I2}	= 4 s
earth fault tripping delay	t_{Io}	= 150 ms
tripping contacts	2 normally-open	
current inputs	I_n	= 1 A connection

The relay is to be connected to measure the currents in two phases and in the neutral according to Fig.6 (section 10).

Determining the current setting (for phases R and T):-

relay rated current: I_n = 1 A (corresponding to c.t. ratio 300/1 A, r = 300)

$$k \text{ then becomes: } \frac{I_N}{r \times I_n} = \frac{225}{300 \times 1} = 0{\cdot}75,$$

selected value: $k = 0{\cdot}7$

The deviation from the exact k setting is small and must be taken into account above all by the setting of the overload protection (correction factor kc).

$$I_E = k \times I_n = 0{\cdot}7 \text{ A}$$

The correction factor kc is calculated as follows:-

$$kc = \frac{I_N}{I_E \times r} = \frac{225}{0{\cdot}7 \times 300} = 1{\cdot}07$$

Phase fault protection, $I\gg$:-

The pick-up value is usually chosen to be 30 % to 50 % higher than the maximum starting current I_A.

$$I\gg = 1{\cdot}3 \ldots 1{\cdot}5 \times \frac{I_A}{r \times k \times I_n} \times I_E = \qquad 1{\cdot}5 \times \frac{5 \times 225}{300 \times 0{\cdot}7 \times 1}$$

$$= 8 \times I_E$$

The transient current peaks (caused by switching over the motor connection) are suppressed by a timer (50 ms) in the relay. The amplitude and the duration of the starting current must be checked in the course of commissioning, and in the event that they are found to be excessive the pick-up setting can be somewhat increased.

By means of an external signal, it is possible to halve the pick-up value of the instantaneous trip (section 10, Fig. 2, terminals A21 and A20).

Inadmissibly long running-up time, $I>$:-

In the example under consideration, the pick-up value can be chosen between 2 and 4 I_E (setting range 0·8 to 4 x I_E). A delay of 15 s is chosen for $t_{I>}$, i.e. about 1·2 x t_A but $< t_E$, so that correct tripping is assured in the case of a blocked rotor.

For motors with $t_E < t_A$, the blocked rotor protection can be achieved by halving the operating time $t_{I>}$ depending on whether the motor is stationary or not. To halve the operating time a centrifugal switch must be fitted to the motor which applies an auxiliary voltage to terminals A22 and A23 and energises an auxiliary relay within the protection when the motor is stationary. The auxiliary voltage (U_s) available in the plant for this purpose must be stated when ordering (see also section 5.1).

Overload $\Delta \vartheta$:-

The temperature differential $\Delta\vartheta$ (protected unit to ambient) is set so that the temperature difference representing the maximum continuous load is not exceeded. Significant for the steady-state temperature modelled in the relay are:-

At normal operating current I_B :

$$\Delta\vartheta_B\ (\%) = \left(\frac{I_B}{I_N} \times kc\right)^2 .\ 100 = (0{,}83 \times 1{,}07)^2 .\ 100 = 79\ \%$$

At rated current I_N :

$$\Delta\vartheta_N\ (\%) = (1 \times kc)^2 .\ 100 = (1 \times 1{,}07)^2 .\ 100 = 115\ \%$$

At the max. permissible continuous current :

$$\Delta\vartheta_{max}\ (\%) = \left(\frac{I_{max\ th}}{I_N} \times kc\right)^2 .\ (1·2 \times 1·07)^2 .\ 100 = 165\ \%$$

The thermal trip setting $\Delta\vartheta$ must be set a little higher than the steady-state temperature differential $\Delta\vartheta_{max}$ at the maximum permissible continuous current.

The value chosen is $\Delta\vartheta = 180\ \%$

The alarm stage $\Delta\vartheta_1$ signals when 80 % of the set $\Delta\vartheta$ has been reached. The alarm stage allows time for the load to be reduced and thus prevent tripping of the motor.

Checking the modelled temperature in the relay with successive starts:-

It is now necessary to check that the relay with the settings as chosen remains stable for the permissible number of starts.

The maximum starting time (t_A) and the maximum starting current are used for calculation. The time between the starting attempts can be neglected. The temperature modelled by the relay will be somewhat lower in practice, because a start at maximum starting current I_A requires less time than t_A.

- Temperature rise from cold (n= 3 starts):

$$\Delta\vartheta\ (\%) = n \times \left(\frac{I_A}{I_N} \times kc\right)^2 \times \frac{t_A\ (s)}{\tau\uparrow\ (min) \times 60} \times 100 =$$

$$= 3 \times (\ 5 \times 1,07)^2 \times \frac{12}{40 \times 60} \times 100 = 43\ \%$$

- Temperature rise when hot (n = 2 starts):

The hot condition is usually defined as the steady-state temperature rise $\Delta\vartheta_N$ at the rated current I_N of the motor.

$$\Delta\vartheta\ (\%) = \Delta\vartheta_N + n \times \left(\frac{I_A}{I_N} \times kc\right)^2 \times \frac{t_A\ (s)}{\tau\uparrow (min) \times 60} \times 100 =$$

$$= 115 + 2 \times (\ 5 \times 1,07)^2 \times \frac{12}{40 \times 60} \times 100 =$$

$$= 115\% + 2 \times 14,3\ \% = 143,6\ \%$$

Thus with a setting of $\Delta\vartheta$= 180 % even two successive starts with the motor hot will not cause tripping of the overload protection. In practice it is permissible to insert the temperature rise in normal operation $\Delta\vartheta_E$.

– Temperature rise commencing from the temperature rise in normal operation:

When inserting the temperature rise in normal operation $\Delta\vartheta_B$ (%) $= (\frac{I_B}{I_N} \times kc)^2 \times 100$ the calculation becomes:-

$$\Delta\vartheta\ (\%) = \Delta\vartheta_B + n \times (\frac{I_A}{I_N} \times kc)^2 \times \frac{t_A\ (s)}{\tau\!\nearrow (min) \times 60} \times 100 =$$

$$= 79 + 2 \times (5 \times 1{,}07)^2 \times \frac{12}{40 \times 60} \times 100 =$$

$$= 79\ \% + 28{,}6\ \% = 107{,}6\ \%$$

This case also does not cause maloperation of the protection.

The corresponding temperature rise and tripping time can be determined from the temperature rise and cooling curves. It is then possible to establish the temperature rise and cooling down of the thermal replica in the relay for the time constant chosen and for intermittent operation of the protected unit.

<u>Negative phase-sequence protection, I_2</u>

NPS protection is only included in the ITX193. It protects in particular the rotor against the effects of asymmetrical phase currents or the interruption of a phase (e.g. an open-circuit line).

A standard setting is:

$$I_2 = 0{\cdot}3 \times I_E \quad \text{and} \quad t_{I2} = 4\ s$$

Other values of time delay t_{I2} are possible (1,2,3 s) on request.

The setting can be varied, however, in the range 0·25 to 0·5 x I_E, the time delay being fixed at 4 s (the model ITX193-432 has 0·1 to 0·5 x I_E and t_{I2} fixed at 5s).

With the exception of a few special cases, this time delay is short enough to afford adequate protection in the event of loss of phase or reversed phase rotation.

Earth fault protection, I_o:

Earth fault protection is included only in the ITX193 models. The detection of earth faults is performed by a separate measuring unit fed by the interposing input c.t. otherwise used for phase S (terminals 3 and 4). In the case of the ITX193-432, the soldered connections of the special toroid c.t. used must not be changed. The separate setting range switch eb (see Fig.14) for the I_o measurement increases the total setting range and thus also the sensitivity (see section 2.2.1, table 2).

The setting is influenced by the following factors:-

- c.t. arrangement (measurement in the neutral of the c.t's or by means of a core-balance c.t.)
- c.t. ratio referred to the maximum possible earth fault current
- capacitance to ground of the protected system

In order to detect earth faults near the star-point of the stator winding, the earth fault protection should have a sensitive setting. On the other hand, where the neutral current is obtained from a parallel arrangement of the phase c.t's, attention must be paid to the possibility of spurious neutral currents due to unequal c.t. behaviour, particularly if there is d.c. off-set during the starting surge. This danger scarcely exists in the case of a core-balance c.t. The distribution of the capacitance to ground of the system can produce neutral currents in the healthy feeders during an earth fault which can cause mal-operation should the relay setting be too sensitive. Wherever possible, core-balance c.t's should be used for the earth fault measurement. Using a core-balance c.t., earth faults down to 5 % of I_{OPmax} can be measured, providing the c.t. characteristics (behaviour at low current levels) and the system capacitances (neutral current during an external fault) permit.

The settings generally when measuring in two phases with a separate earth fault measurement as shown in Fig.6 of section 10 are:-

- $I_o = 0{\cdot}2$ to $0{\cdot}8 \times I_E$, set using the range switch eb in the same way as for the phase measurements R and T. For the case of the example, the value chosen is:

$$I_o = 0,2 \times I_E$$

Primary earth fault currents will thus be detected down to:

$$I_{OP} = r \times I_o \times I_E = r \times 0,2 \times k \times I_n = 300 \times 0,2 \times 0,7 \times 1 = 42 \text{ A}$$

This corresponds to 19 % of the maximum earth fault current I_{OPmax} of 225 A.

With a neutral c.t. having the same ratio as the phase c.t's (r = 300) and settings of:

$$I_o = 0,2 \times I_E; \quad k = 0,3 \text{ (max. sensitivity)}$$

earth faults will be detected down to:

$$I_{OP} = r \times I_o \times k \times I_n = 300 \times 0,2 \times 0,3 \times 1 = 18 \text{ A}$$

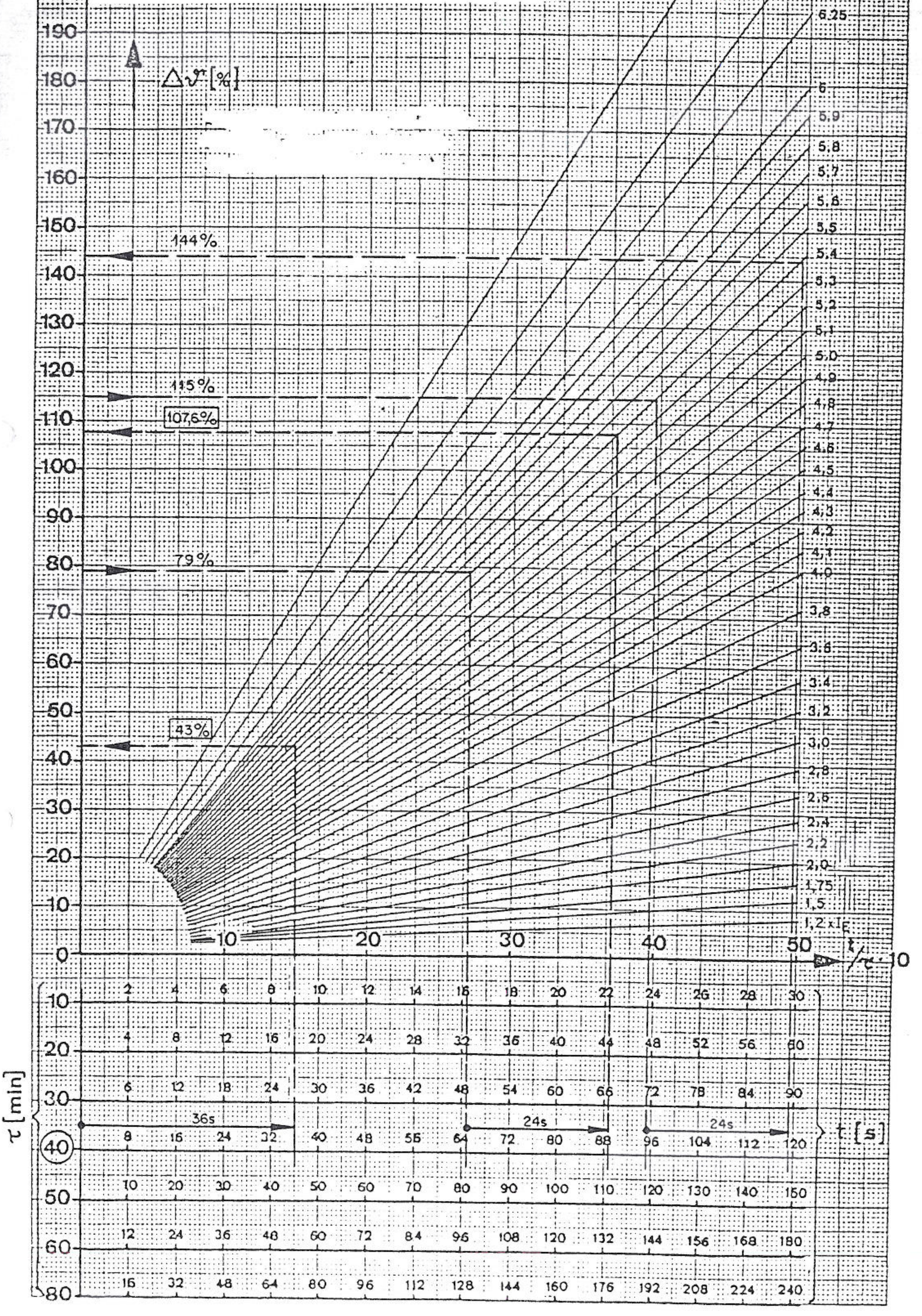
(8 % of I_{OPmax})

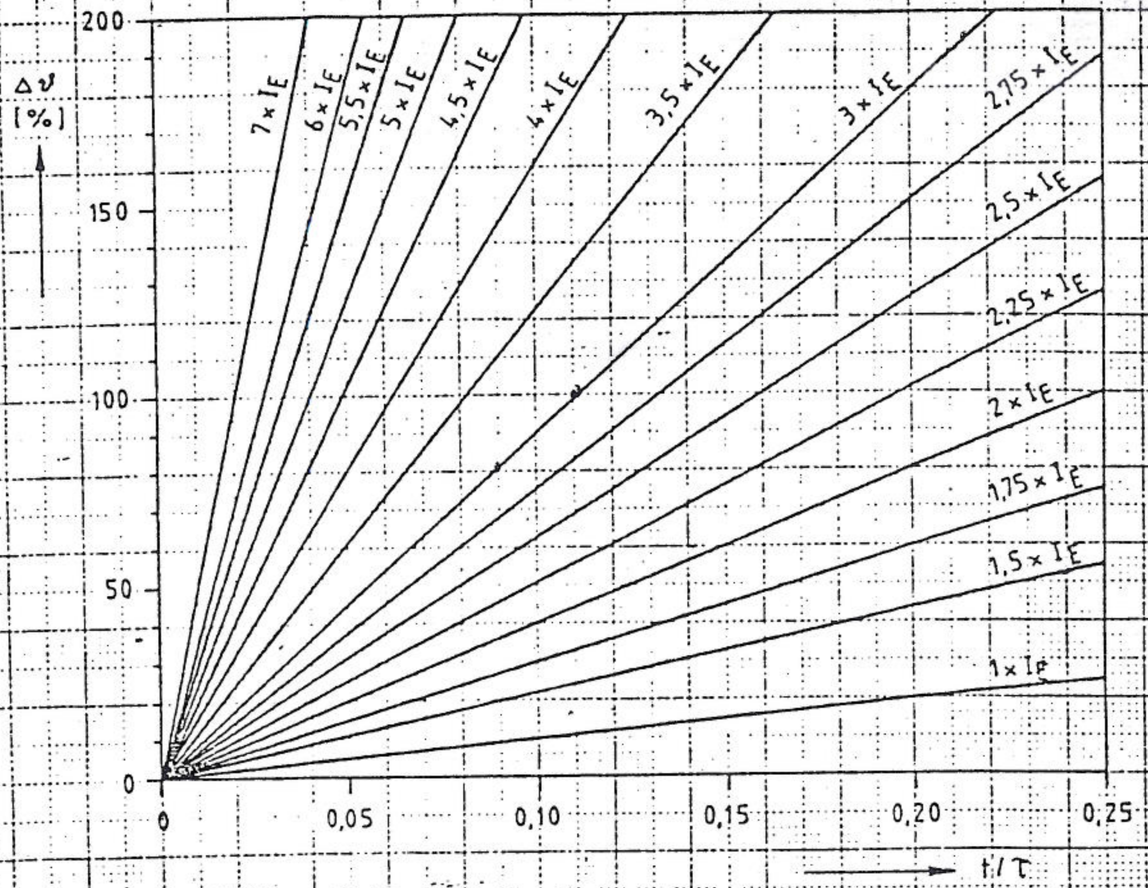
The time delay t_{Io} is fixed at 0,15 s. A longer time delay (0,3 or 0,6 s) may be of advantage when the measurement is in the neutral of the phase c.t's and this should be stated when ordering.

The I_o setting of the ITX193-432 is more sensitive by a factor of 14, the range being 0,015 to 0,15 x I_E.
This range multiplied by the factor K = 0,3 represents the maximum sensitivity 4,5 mA referred to a rated current of I_n = 1 A.
The time delay of this model is t_{Io} = 5 s.

Fig. 1 - Temperature rise curves for I ≥ I>

(The values entered are of the example in section 2.2.2.)





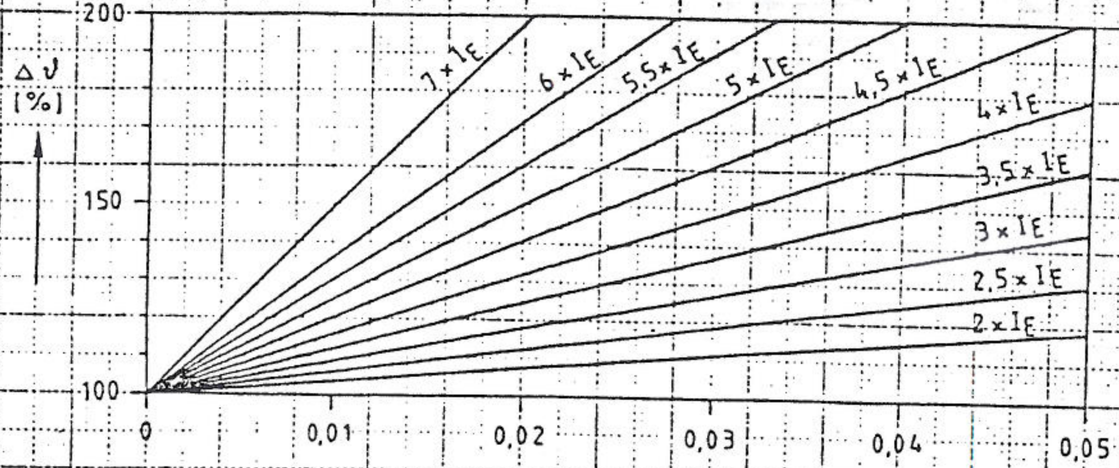
τ [min]	t [min] of heating
10	0,5 1 1,5 2 2,5
20	0,5 1 1,5 2 2,5 3 3,5 4 4,5 5
30	0,5 1 1,5 2 2,5 3 3,5 4 4,5 5 5,5 6 6,5 7 7,5
40	1 2 3 4 5 6 7 8 9 10
50	2,5 5 7,5 10 12,5
60	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
80	1,25 2,75 4 5,25 6,75 8 9,25 10,75 12 13,25 14,75 16 17,25 18,75 20

Fig. 2 - Temperature rise curves for $I \geq I_{start}$ starting from cold

$(\Delta \vartheta_0 = 0)$

$$\Delta \vartheta\,[\%] = f(t/\tau,\ I/I_E)$$

$$\Delta \vartheta\,[\%] = (I/I_E)^2 \cdot \frac{t}{\tau} \cdot 100$$

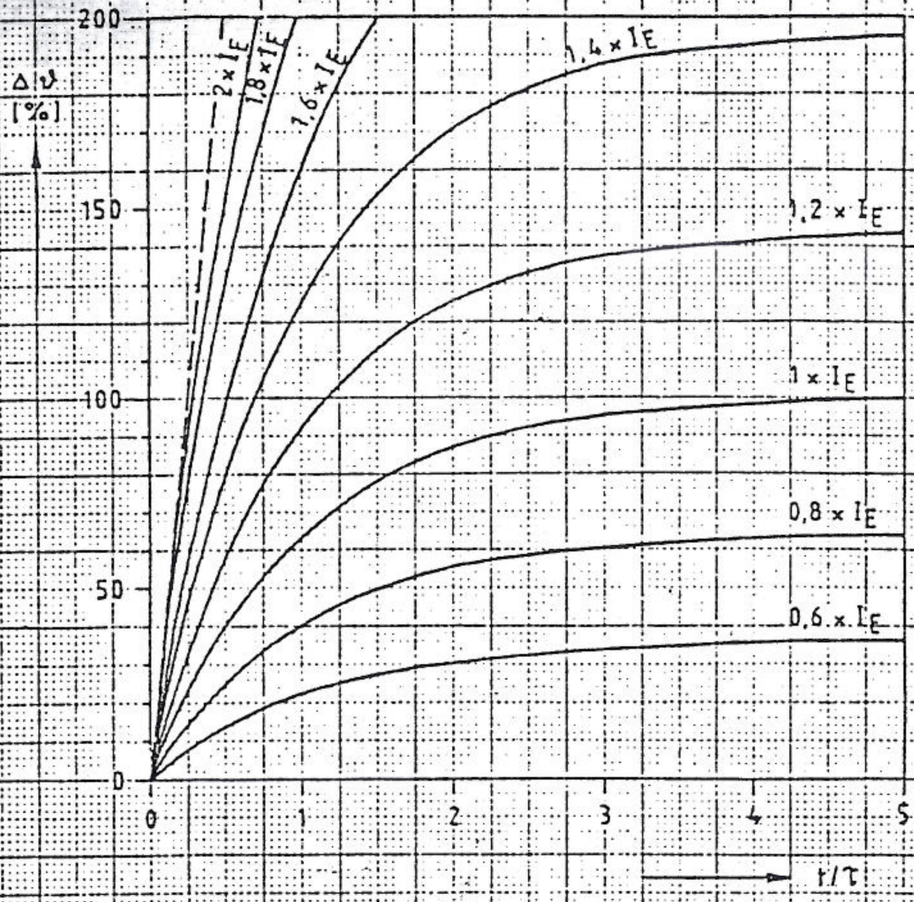


τ [min]	t [s] of heating									
10	3	6	9	12	15	18	21	24	27	30
20	6	12	18	24	30	36	42	48	54	60
30	9	18	27	36	45	54	63	72	81	90
40	12	24	36	48	60	72	84	96	108	120
50	15	30	45	60	75	90	105	120	135	150
60	18	36	54	72	90	108	126	144	162	180
80	24	48	72	96	120	144	168	192	216	240

Fig. 3 - Temperature rise curves for $I \geq I_{start}$ starting from the normal operating temperature ($\Delta \vartheta_0 = 100\%$)

$$\Delta \vartheta\,[\%] = f(t/\tau,\ I/I_E;\ \Delta \vartheta_0 = 100\%)$$

$$\Delta \vartheta\,[\%] = [1 + (I/I_E)^2 \cdot \frac{t}{\tau}] \cdot 100$$



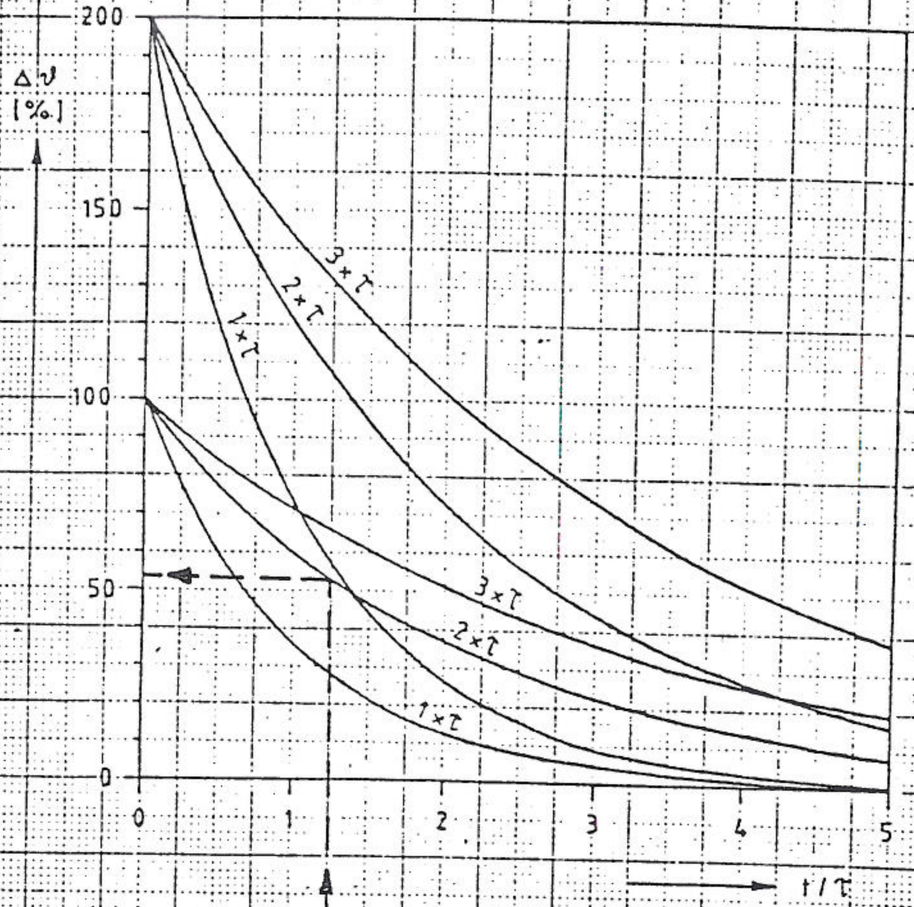
τ [min]	t [min]									
10	5	10	15	20	25	30	35	40	45	50
20	10	20	30	40	50	60	70	80	90	100
30	15	30	45	60	75	90	105	120	135	150
40	20	40	60	80	100	120	140	160	180	200
50	25	50	75	100	125	150	175	200	225	250
60	30	60	90	120	150	190	210	240	270	300
80	40	80	120	160	200	240	280	320	360	400

Fig. 4 - Temperature rise curves for $I \leq I_{start}$ starting from cold

$$\Delta\vartheta\,[\%] = f(t/\tau,\ I/I_E)$$

$$\Delta\vartheta\,[\%] = (I/I_E)^2$$

$$\Delta\vartheta\,[\%] = (I/I_E)^2 \cdot (1-e^{-t/\tau}) \cdot 100$$



τ [min]	t [min] of cooling									
10	5	10	15	20	25	30	35	40	45	50
20	10	20	30	40	50	60	70	80	90	100
30	15	30	45	60	75	90	105	120	135	150
40	20	40	60	80	100	120	140	160	180	200
50	25	50	75	100	125	150	175	200	225	250
60	30	60	90	120	150	180	210	240	270	300
80	40	80	120	160	200	240	280	320	360	400

Fig. 5 - Cooling curves for I = 0, commencing at $\Delta\vartheta_0$ = 100 % and 200 % and in relation to the cooling time constant τ_ϑ

$(\tau = 1\times, 2\times, 3\times)\tau$

$\Delta\vartheta\ [\%] - f(\Delta\vartheta_0, t/\tau, (\tau)$

$\Delta\vartheta\ [\%] = \Delta\vartheta_0\ [\%] \cdot e^{-t/(\tau}$

2.3 Symbols and abreviations

Motor

U_N (V)	rated voltage
f_N (Hz)	rated frequency
I_N (A)	rated current
I_B (A)	max. operating current (if unknown, use I_N)
$I_{max\ th}$ (A)	max. permissible continuous rating
I_A (A)	max. starting current
r	c.t.ratio
t_A (S)	max. permissible motor running up time
t_E (S)	max. permissible blocked rotor time
$_{mot}$ (min)	heating time constant of the stator (mean. value)
$_{mot}$ (min)	cooling time constant with motor stationary
n	number of starting attempts

Relay

I_n	(A)	rated current (1 A or 5 A depending on position of link B)
f_n	(Hz)	rated frequency (50 or 60 Hz, state when ordering)
I_E	(A)	set current
k		setting factor (0,3 to 1,2 in steps of 0,1)
k_c		correction factor $\left(\frac{I_N}{I_E} \cdot \frac{1}{r}\right)$, deviation of set current
$\tau\nearrow$	(min)	heating time constant of the relay (10, 20 to 80 min)
$\tau\searrow$	(min)	cooling time constant
I_{start}	(A)	pick-up current of protection against prolonged start and also current at which overload protection is switched to adiabatic integration.
t_{I2}	(s)	time delay of NPS protection (1, 2, 3, 4 s), 5 s for ITX193-432
t_{I_0}	(ms)	time delay of the earth fault protection (75, 150, 300 ms), 5 s for ITX193-432
$I\gg$		pick-up value of the phase fault protection (4 to 20 x I_E or 2 to 10 x I_E)

I_2 (in % of I_E)	pick-up value of the NPS protection referred to I_E
$I_{OP\,max}$	max. primary earth fault current for a solid fault at the terminals of the motor.
I_0	earth fault setting
U_H	Auxiliary voltage supply for electronic circuits
U_S	Changeover voltage for contactors; i.e system voltage
$\Delta\vartheta$ (%)	temperature rise or fall
$\Delta\vartheta_0$ (%)	starting temperature
$\Delta\vartheta_B$ (%)	steady-state temperature modelled in the relay at the normal operating current of the motor
$\Delta\vartheta_N$ (%)	steady-state temperature modelled in the relay at the rated current of the motor
$\Delta\vartheta_{max}$ (%)	steady-state temperature at the max. permissible continuous current of the motor
$\Delta\vartheta_1$ (%)	pick-up value of the overload alarm stage
$\Delta\vartheta_2$ (%)	operating value of the overload protection

3. Checks upon receipt

Unpacking, visual checks

Where the equipment has been damaged during transport the last carrier must be notified in writing immediately. A report should also be sent to BBC, Baden, Switzerland, Dept. KSK-BT. The type designation, the serial number (e.g. HE 884254-222/70) and the order number are printed on the nameplate inside the relay. This data should be entered on the delivery note before returning unserviceable equipment.

4. Installation and wiring

4.1 Location and ambient conditions

The equipment is designed only for indoor installation. Since every piece of equipment can be damaged or destroyed, if its permissible data is exceeded, the location should be free from

> air contamination (dust, aggressive substances), excessive vibration, extremes of temperature and humidity, electrical surges and strong magnetic fields.

Please refer to and observe the technical data in the data sheet CH-ES 63-31.2.

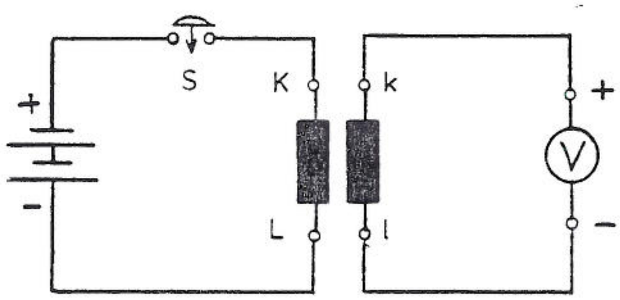
The relay is not influenced by the position of mounting, however, it is intended for vertical mounting (instrument and labelling on the frontplate). The relay casing is normally supplied for semi-flush mounting, but can be simply modified for surface mounting terminals at the rear by re-positioning the mounting frame from the front edge of the casing to the rear (section 10. fig. 11.). An additional frame and set of terminals is required for surface mounting and connections at the front. The supplementary terminals must be connected to the terminals at the rear of the casing. A dimensioned drawing and the panel cutout can be seen in section 10.

4.2 Relay connections

The relay is connected to either two or three c.t's having secondary ratings of either 1 A or 5 A. The positions of the corresponding links on the current input terminals at the rear of the relay determine the relay rated current (see also section 10, Fig.12). Some connection diagrams are given in section 10 (Figures 5/6/7); further examples are contained in data sheet CH-ES 63-31.2.

4.2.1 C.t. polarity

The NPS protection requires that the c.t's be connected correctly. The c.t. polarity should correspond to the connection diagram. The designations of the terminals can be checked in the following manner. Connect a d.c. source of about 4 V (battery) to the terminals K and L and a polarized voltmeter to the secondary terminals k and l. Closing the switch S will produce a positive deflection on the voltmeter providing the c.t. polarity is correct.



4.2.2 Supply

The auxiliary supply (U_H) is connected to the terminals A1 and A2 of the electronic connector. This is either a d.c. or an a.c. depending on the relay model. The correct polarity must be observed in the case of d.c. (+ to A1 and - to A2).
The grounding of the relay case shall be done by connecting the earthing screw.

5. Commissioning

5.1 Checks prior to commissioning

5.1.1 Checking the wiring

First check the wiring to the c.t's, the auxiliary circuits and the signalling circuits against the certified plant drawings.

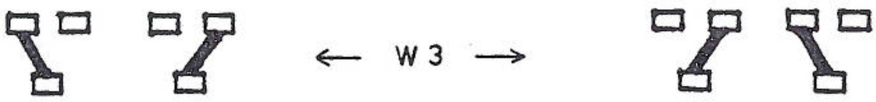
5.1.2 Checking the auxiliary supply voltage.

The rated value of the auxiliary supply in the plant must correspond to the value printed on the frontplate (U_H) of the relay. Check that the permissible variation given in the data sheet is not exceeded. In the case of d.c., check the polarity. In the case of a.c. (110/220 V, 50/60 Hz), check that the soldered link Y32 on subprint SP3 (E7) corresponds to the rated voltage of the plant. In position a-b the auxiliary supply U_H is 110 V a.c. and in position a-c 220 V a.c.

5.1.3 Checking the remaining relay data and the tripping circuit

The remaining variable data printed on the relay (τ, t_{I_o} etc.) must be compared with the specified plant data.

The potentially-free contacts A5-A7 and A6-A8 can be arranged either as normally-open or normally-closed, depending on the position of the soldered link W3 (see section 10, component drawing E2). Attention must be paid, if a normally-closed contact is used for tripping, that unwanted tripping does not take place when the relay is withdrawn.



normally-open tripping contacts

normally-closed tripping contacts

5.1.4 Checking the selected running-up time

The positions of the soldered links for the setting range of the starting current surge delay time $t_{I>}$ are given in the following table.

setting range	factor	soldered links (PCB E2)
0,2-2 s	0,2	d-e, a-c, g-i
2-20s	2	d-f, a-b, g-h
20-200s	20	d-f, a-c, g-h

5.1.5 Earth fault protection

Depending on the arrangement of the c.t's, the soldered link on PCB E2 must be connected as follows.

E/F detection by	soldered links (PCB E2)
neutral current measurement I_o (only ITX193)	k-l m-o o-m-F
phase units ITX193 and all ITX192	k-m o-n

5.1.6 Range switching during running-up

If it is required that the delay time or the pick-up current of the phase fault protection be switched by an external signal during running-up, the series resistors R181 and R205 must be matched to the system voltage U_S. (see section 10, component drawing PCB E2). Normally, U_S is specified when ordering and the adjustment made in the works.

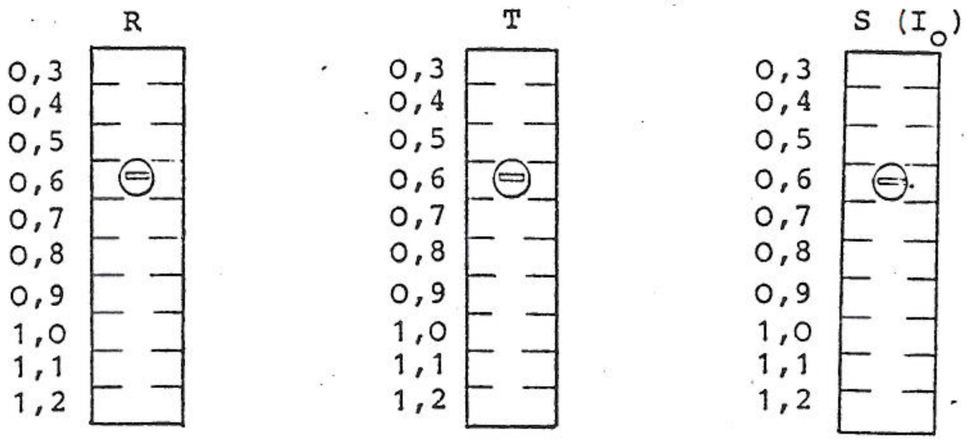
U_S DC	R181, R205
24 V	shorting link
48 V	3,9 k 0,25 W
60 V	5,6 k 1 W
110 V	12 k 2 W
125 V	15 k 2 W
220 V	27 k 2 W
250 V	33 k 2 W

5.1.7 Blocking the phase and earth fault protections

The I>> protection can be blocked by withdrawing the shorting plug S545 (PCB E2). Conversely, if overcurrent protection is required, it must be checked that the shorting plug is in place. A further possibility is to insert the plug in the upper position S546, in which case the earth fault measurement is blocked when the I>> unit picks up. This facility enables a mal-operation to be avoided in cases where, because of too weak c.t's, false neutral currents are generated during the starting current surge or phase faults.

5.1.8 Setting and checking the rotary step switches

The rotary selector switches should be adjusted with a suitable screwdriver. The adjustment knobs of the switches are rotated clockwise or anti-clockwise until they engage in the next higher or lower position. After setting, the slots of the knobs should be horizontal and the knobs should be engaged so that their head is in the same place as the edge of the switch body.



5.1.9 Modifying the relay on site

A number of changes to the function of the relay, achieved by correspondingly positioning soldered links in relation to the application, have been described in the previous sections. Particular care should be taken when soldering should the position of a soldered link need to be changed. In some cases recalibration is also necessary.

It is recommended that these changes only be carried out by especially trained BBC personnel. Please contact your BBC representative.

Damage due to interference by unqualified personnel results in loss of guarantee.

5.2 Inserting the relay and switching on the auxiliary supply

- The auxiliary supply must be switched off before attempting to insert the relay.
- Insert the relay carefully into the casing, being sure to push it fully home after the contact pressure of the connectors is felt.

- Switch on the auxiliary supply. The relay is operational providing the voltage supervision assumes the quiescent state and its normally-closed alarm contact opens (terminals A18 and A19).
- Test the LED signals of relays equipped with them by pressing the button brl (section 10, Fig. 9). All the LED's on the frontplate (ha...) must light up.
- A deflection may be observed on the instrument hi due to the thermal replica not being fully discharged.
- Switching on or switching off the auxiliary supply must not cause and of the LED signals to light up (checking the security of the relay when energising and de-energising it).

5.3 Measuring the relay currents

The phase currents can amongst other possibilities be measured at the relay terminals. The phases and their direction (phase rotation) must be as prescribed to ensure correct operation of the NPS protection.

When measuring the currents, the usual precautions must be taken to avoid open-circuiting the c.t. secondaries.

5.4 Functional check

It is possible to test all the functions of the relay with the aid of a single-phase a.c. source. In this case the pick-up value of the NPS protection can be determined by connecting phases R and T in series. The NPS current measured is then directly proportional to the current supplied to the relay.

After the functional test has been completed, the overload protection must be reset by simultaneously depressing the buttons br1 and br2. The time required for resetting is dependent of the time constant τA. The instrument hi indicates the discharge of the thermal replica in the relay.

6. Operation and maintenance

The relay requires no maintenance. It should however, as is usual with all safety equipment, be tested from time to time. To ensure continued operation of the relay, precautions should be taken that at no time does the auxiliary supply U_H exceed the permissible variation (continuous supervision via teminals A18-A19).

In order that the information of the optical signals, where fitted, be of value, it should be included in the operating routines that the reset button be depressed following tripping or signalling by the relay and recording of the signal information.

7. Fault finding

If incorrect behaviour of the relay is observed in operation, it should first be checked that this is indeed due to the relay and not to some external influence.

The main causes of relay failure are the following:-

7.1 Failure of the auxiliary supply

Observation: No response from the relay

Causes:
- no voltage at terminals A1 and A2
- reversed polarity in the case of d.c. supply
- open-circuit fuse Si (see section 10, Fig. 15)
- failure of the electronic supply circuit with visual damage

7.2 Incorrect settings

Observation: The response of the relay is either too sensitive or too insensitive

Causes:
- the relay rated current I_N does not correspond to the rated current of the c.t's
- one or more of the rotary step switches (eb) are not fully positioned (clicked in in absolutely horizontal position) or are set incorrectly. In such cases, the overload protection $\Delta\vartheta$ exhibits an obviously incorrect delay time.

7.3 Mal-operation of the NPS protection

Observation: The relay trips far below its rated current.

Causes:
- c.t. connections reversed
- reversed phase-rotation of the system
- different settings of the rotary step switches of the phases

7.4 Mal-operation of the earth fault protection

Observation: As 7.3

Causes:
- setting too sensitive
- the earth fault input (terminals 3 and 4) is not in the neutral of the c.t's, but measures phase current

8. Special designs

The various models of the motor protection relay with regard to function, signals and auxiliary supply can be found on page 4 of the data sheet CH-ES 63-31.2 E.

The special design ITX193-432 has the following addition features:-

- there is no phase S measurement, this is reserved solely for earth fault measurement
- higher NPS protection sensitivity:
  $I_2 = 0{\cdot}1$ to $0{\cdot}5 \times I_E$ and $t_{I2} = 5$ s
- a special toroid input c.t. is used for earth fault measurement and the setting range is:
  $I_o = 0{\cdot}015$ to $0{\cdot}15 \times I_E$ and $t_{Io} = 5$ s

9. Ancillary equipment and spares

The model and serial number must be quoted when ordering spares (e.g. auxiliary tripping relay). Where several relays are installed in a plant, one or more complete relays should be kept in reserve.

10. Annexes

- Examples of connection diagrams Figures 6 to 8
- Photographs Figures 9 to 13
- Component postion diagram of PCB E2, Fig. 14
- Circuit diagrams ....
- Dimensioned drawings ....

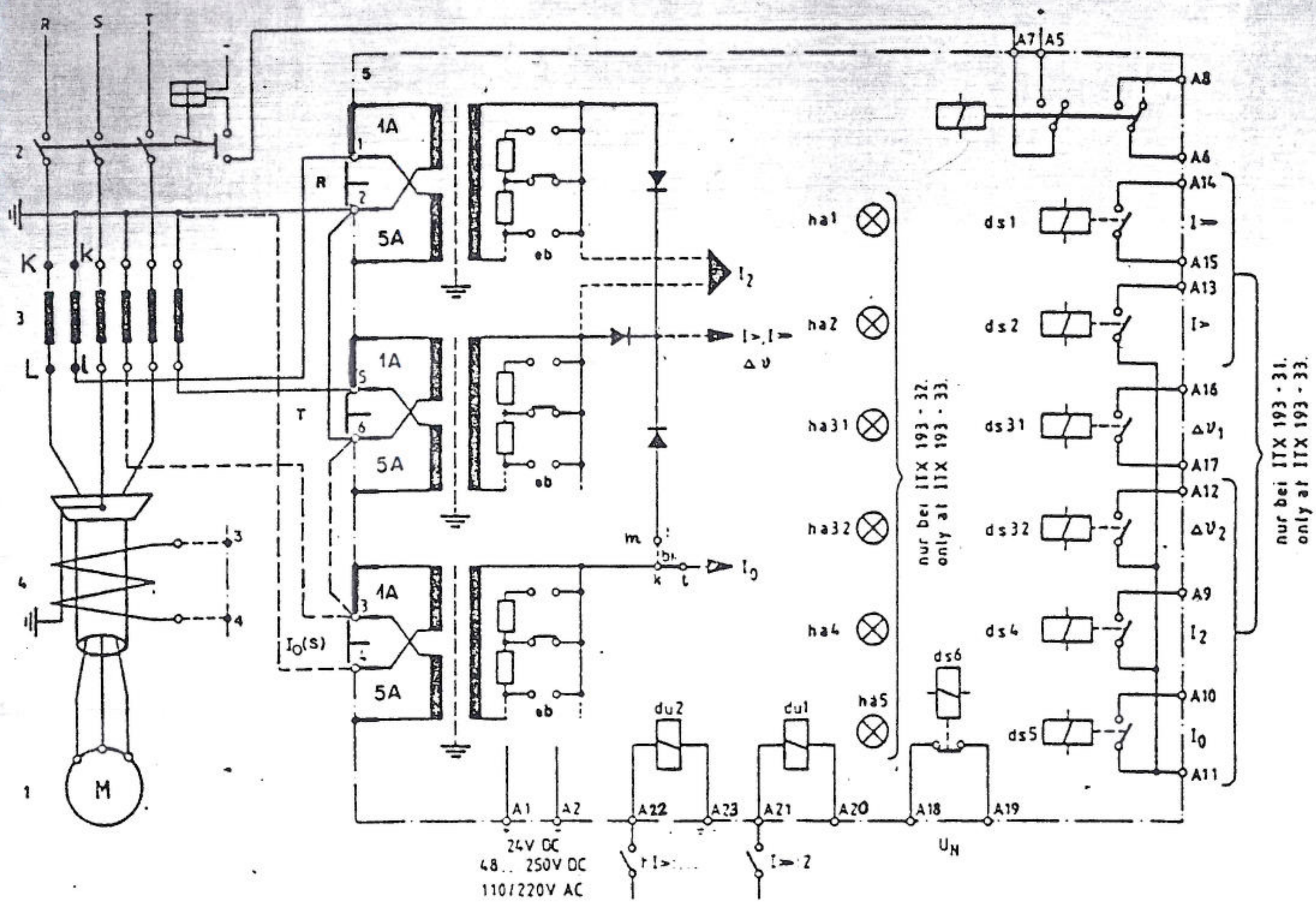


Figure 6: Connection diagram for motor protection relay type ITX 193

a) Two phase measurement (isolated networks): full lines

b) Thre phase measurement (grounded or resistance earthed networks): all c.ts connected, full and dotted lines
Soldering bridge: k - m (bi)

1 motor

2 circuit breaker

3 current transformers

4 cable transformer

5 Protection relay typ ITX 193

All other symbols are explained in data sheet CH-ES 63-31.2

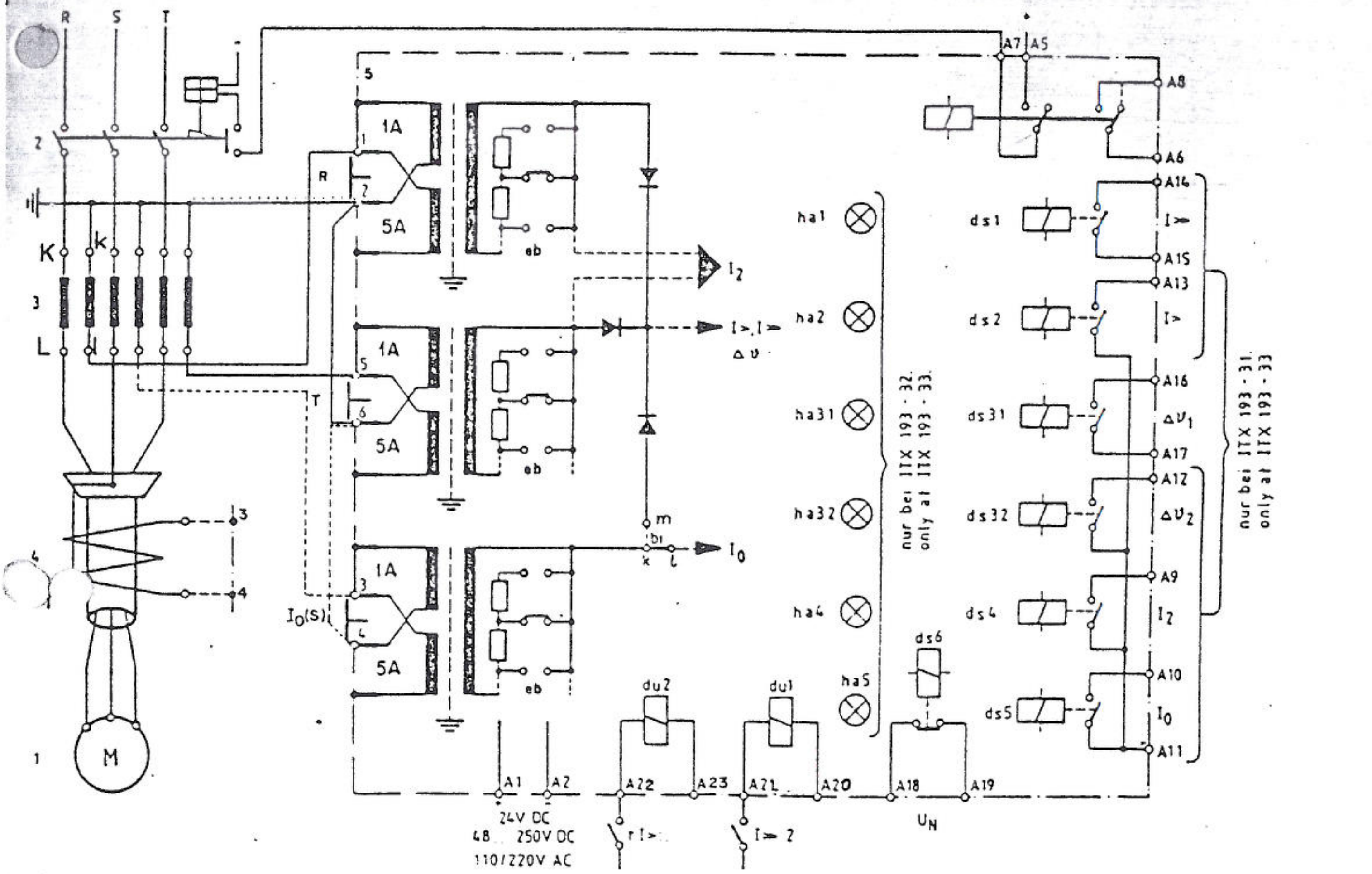


Figure 7: Connection diagram for motor protection relay type ITX 193

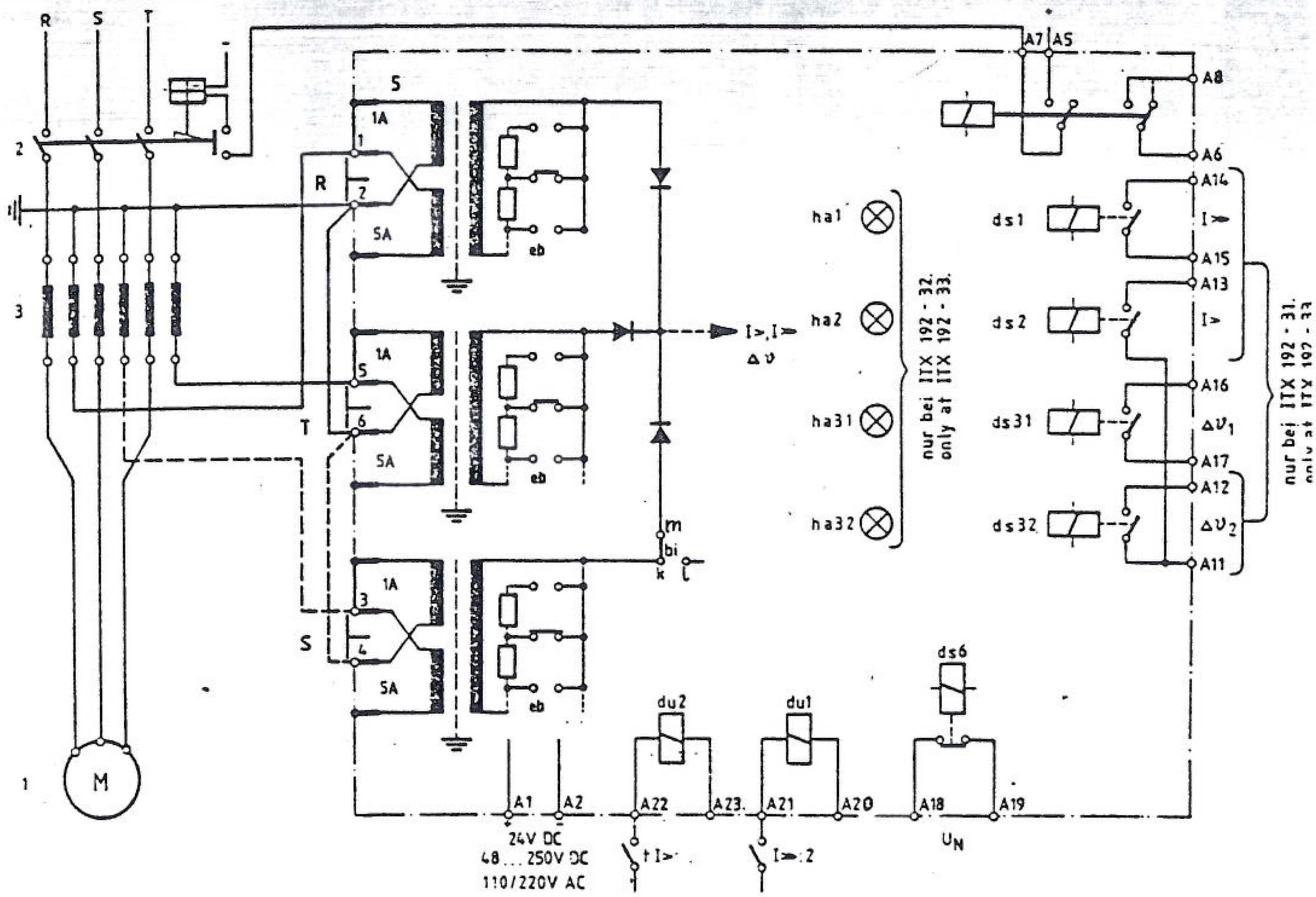
Two phase measurement, with separated earthfault detection, bridge k-l

a) With two phase c.t's (R,T) - full lines and a separated cable c.t (item 4) connected to relay input of S(terminals 3 and 4)

b) With three c.t's relay input phase S(I_O) connected into the ground connections of the c.t's (full-and dotted lines are connected)

1....5 like figure 6 Connection diagram for motor protection relay type ITX 193

All other symbols are explained in data sheet CH-ES 63-31.2



<u>Figure 8 :</u> Connection diagram for motor protection relay type ITX 192

Two phase measurement (isolated networks): full lines

1 motor
2 circuit breaker
3 current transformers
4 cable transformer
5 Protection relay typ ITX 193
All other symbols are explained in data sheet CH-ES 63-31.2

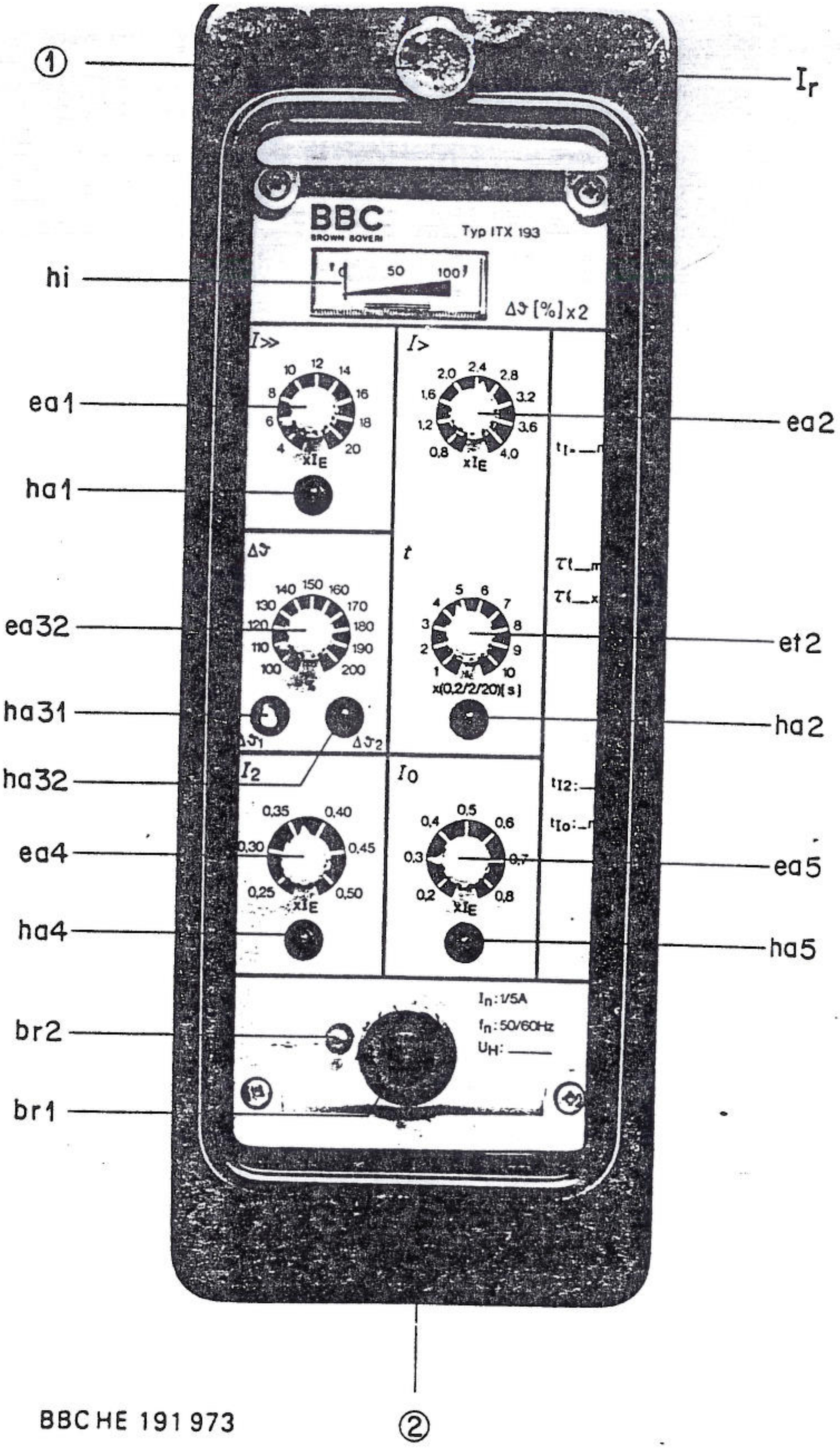


Fig.9 - Front view of the motor protection relay type ITX193

ea	pick-up value setting	ea5, ha5	earth fault protection
et	time delay setting	br1	signal lamp reset button
ha	signal lamps (LED)	br2+br1	thermal replica reset
ea1, ha1	phase fault protection	hi	instrument
ea2,et2,ha2	prolonged start protection	1	front cover fixing screw
ha31	overload alarm	2	holes for panel mounting screws
ea32, ha32	overload trip	I_r	mounting frame
ea4, ha4	NPS protection		

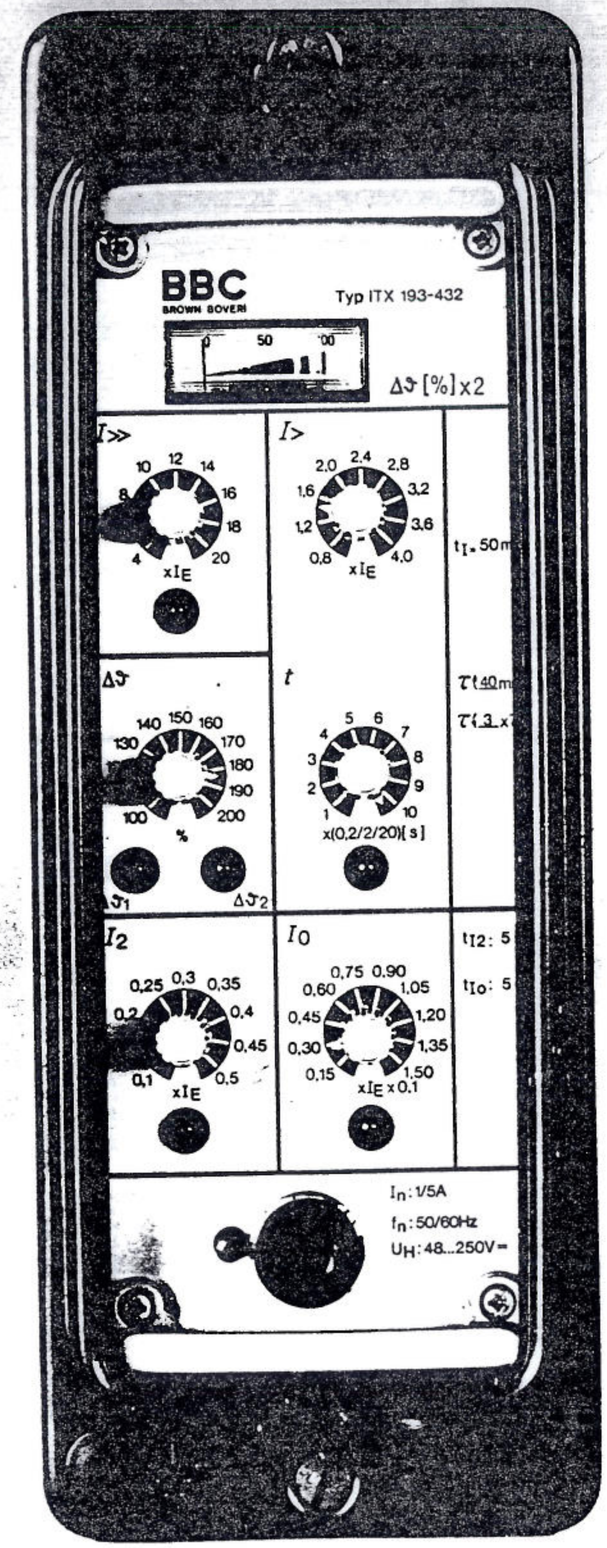
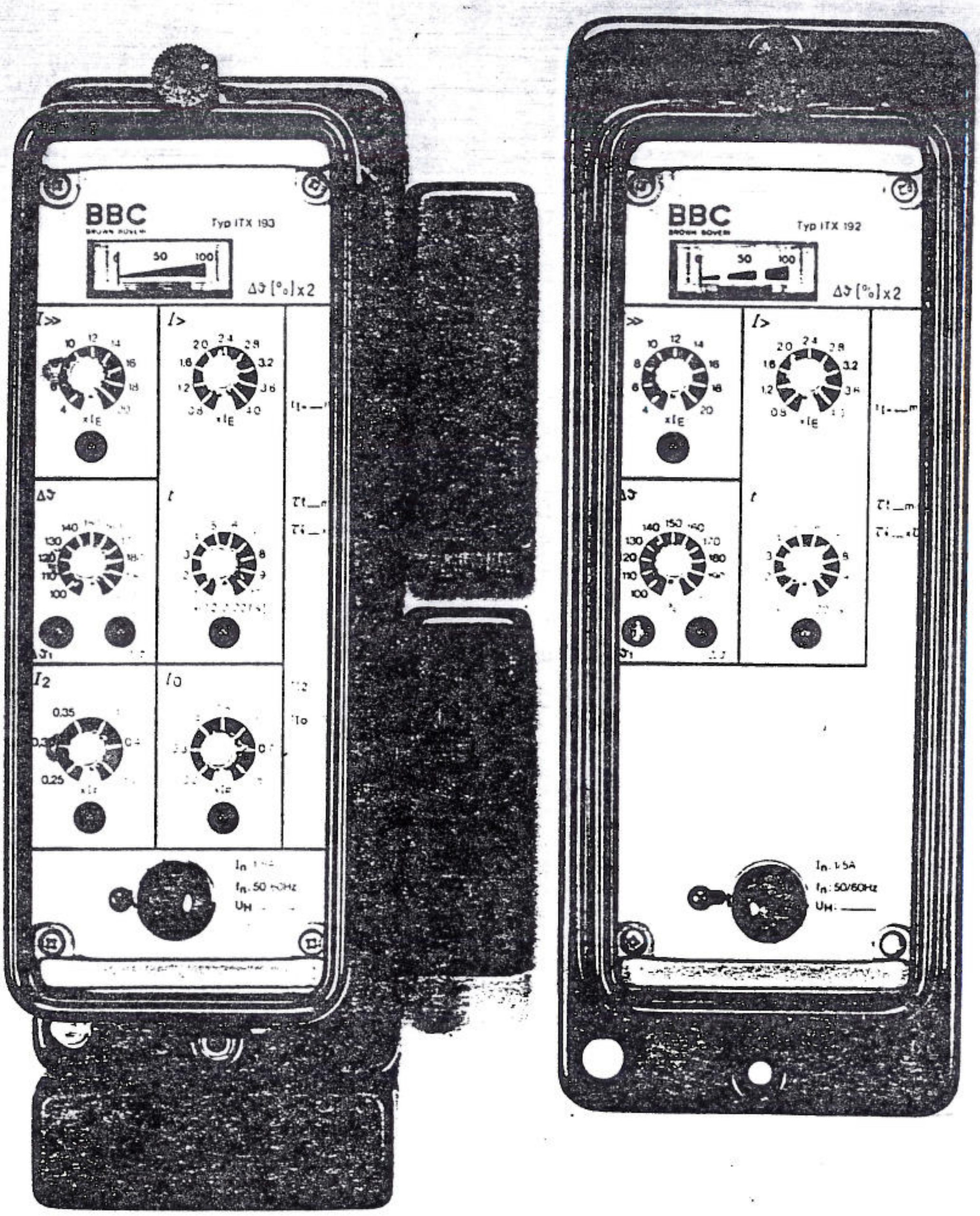


Fig. 10 Front fiew of the motor protection relay type ITX193-432



BBC 197024

Fig. 11 - Front views of the motor protection relays ITX193 and ITX192

left: surface mounting and front connections

right: semi-flush mounting and rear connections

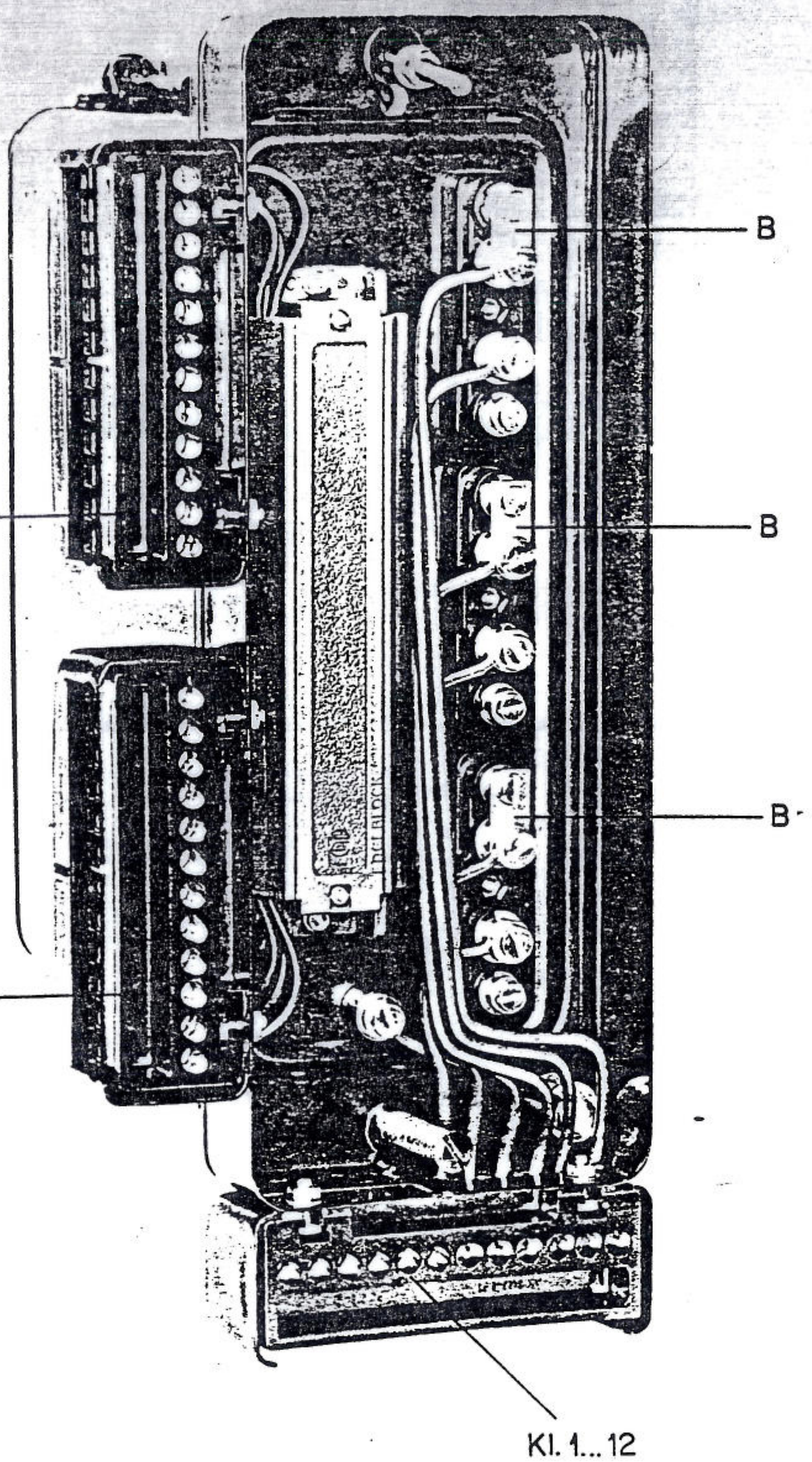


Fig. 12 - Rear view of the motor protection relay ITX192 (193) in a casing for surface mounting and front connections

Kl·1-12 = terminals 1 to 6 for the current connections

A1, A2 = terminals A1 to A24

B = shorting links, mounted for I_n = 1Amp

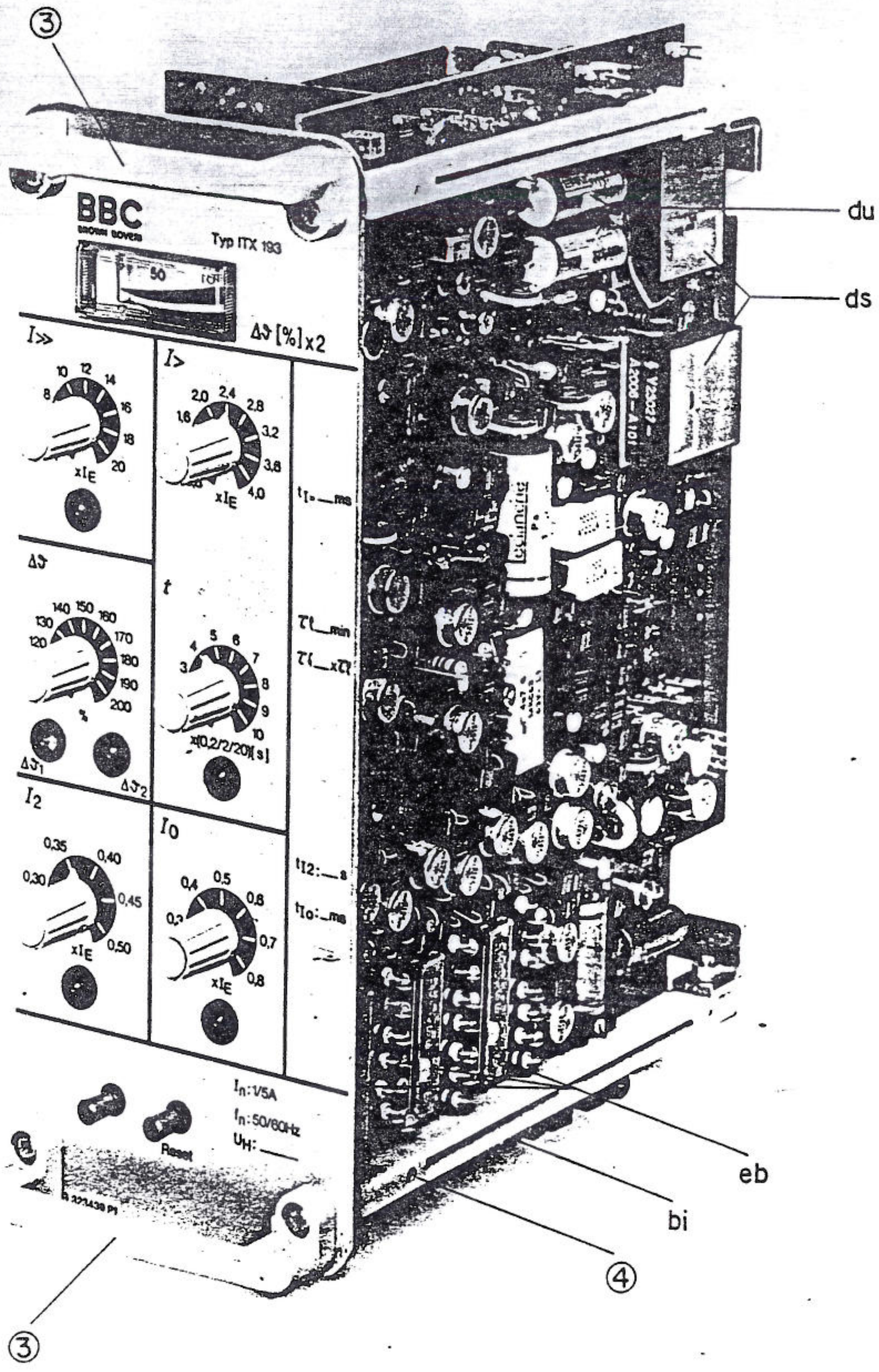
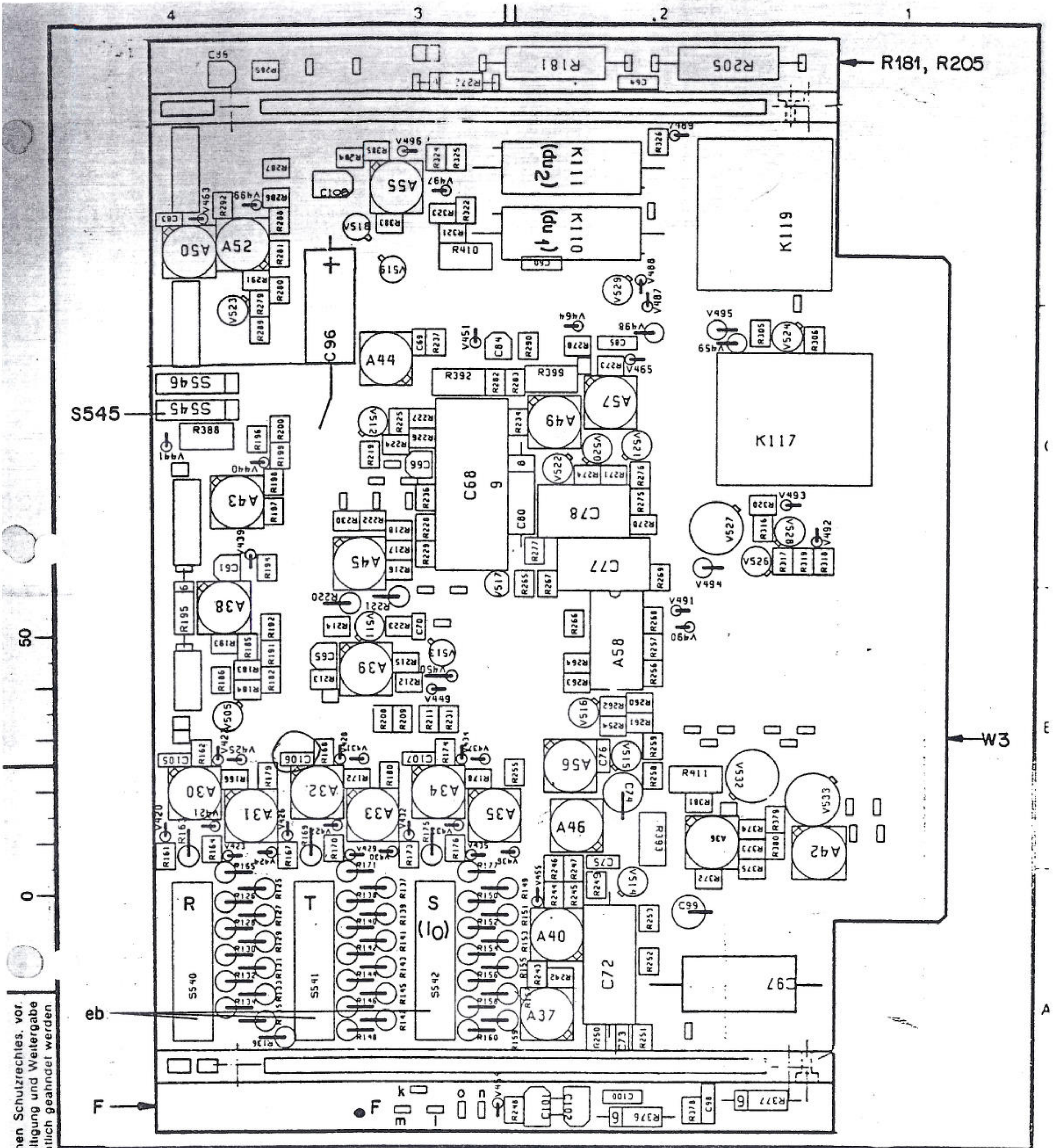


Fig. 13 - Motor protection relay ITX193 withdrawn from its case

eb	setting switch	3	handles
du...	auxiliary input relay	4	guide rails
ds...	auxiliary signalling relay	bi	soldered link



Aus-gestellt	80.02.06	Pol.	Geprüft	80-02-06		Norm-geprüft		Frei-gegeben	

Entstand aus:	Ersatz für	Ersetzt durch	
			Ohne sep. Stückliste ☐
			Sep. SL gleicher Nr. ☒
			Sep. SL anderer Nr. ☐

Änd			Änd		Änd		Maßstab
B	80.02.06						1:1
C	80.05.21						
D	80-11-13 (8150)						
E	81-01-14 (8780)						
							Zust. Stelle

BBC
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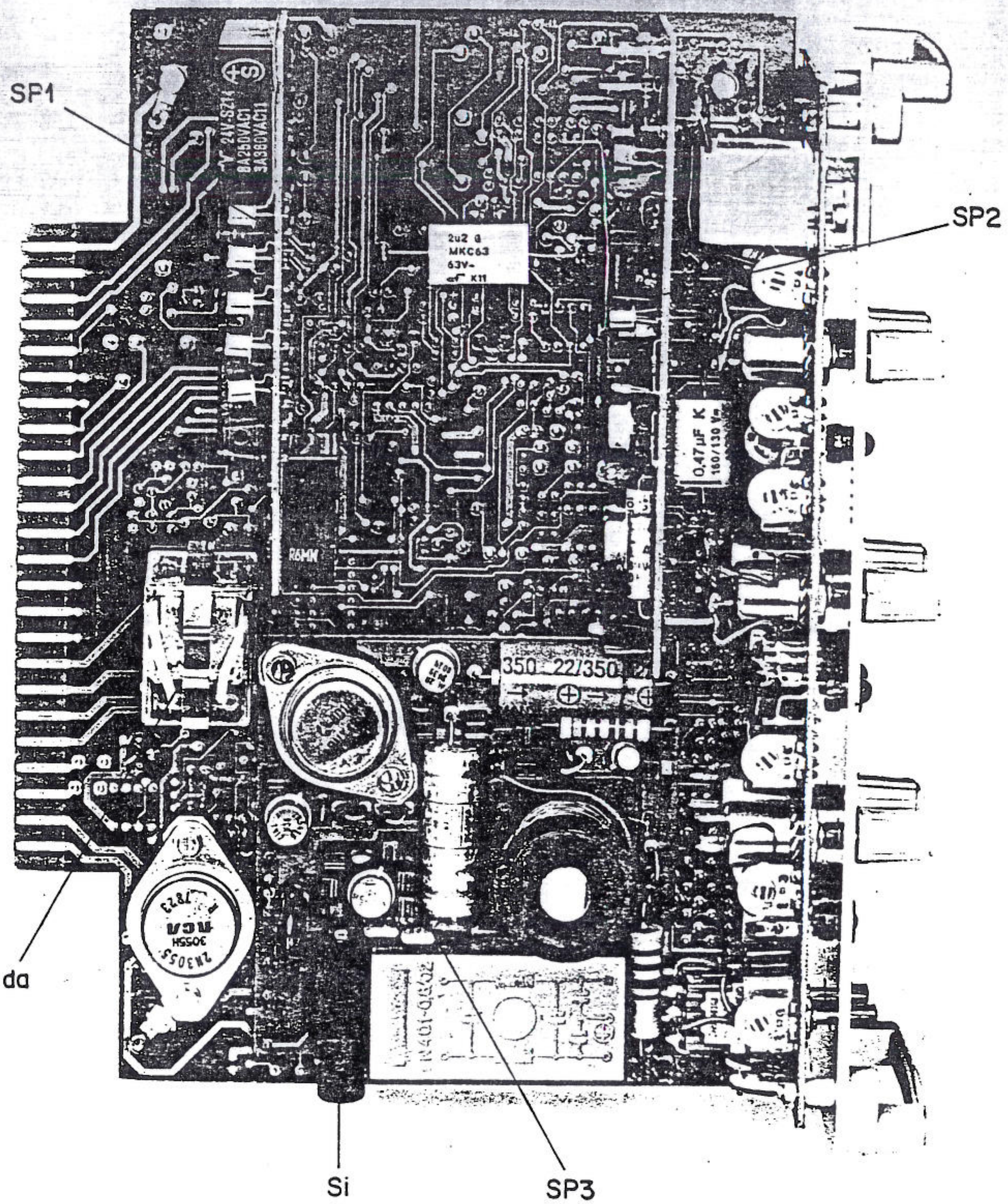
Titel ITX 192/193

Component drawing PCB E2

CH - ES 83-31.2 E page 37

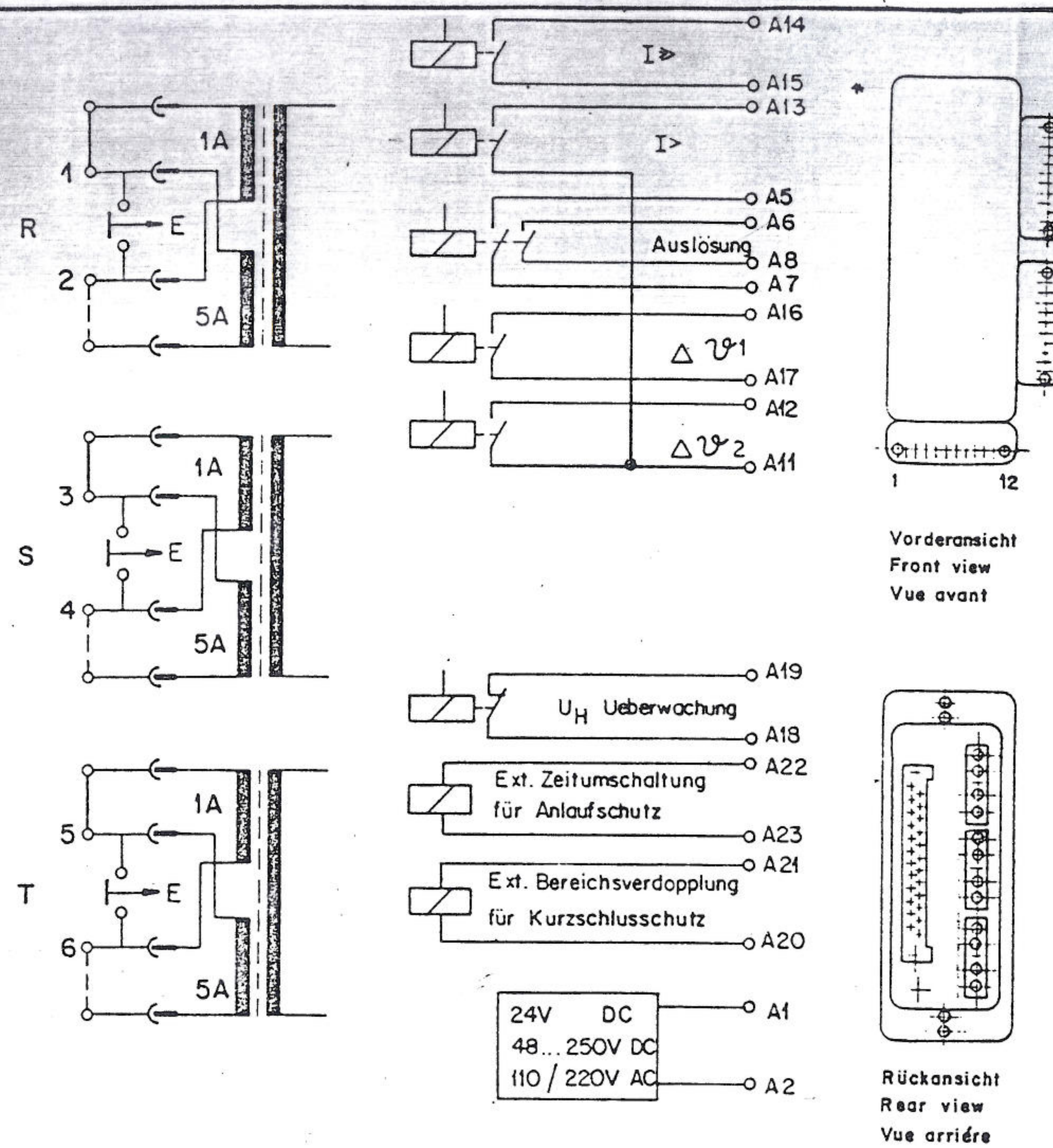
Format	Sprache	Blatt-Nr	Anz. Blatt
A 4	D	3	3



BBC 197026

Fig. 8 - Motor protectionrelay ITX193 with interposing c.t's removed

da	auxiliary tripping relay
SP1	sub-print with auxiliary signalling relay
SP2	sub-print for NPS and earth fault measurement
SP3	sub-print for the auxiliary supply (48 to 250 V d.c.models)
Si	fuse (0.5 A slow) if d.c. supply

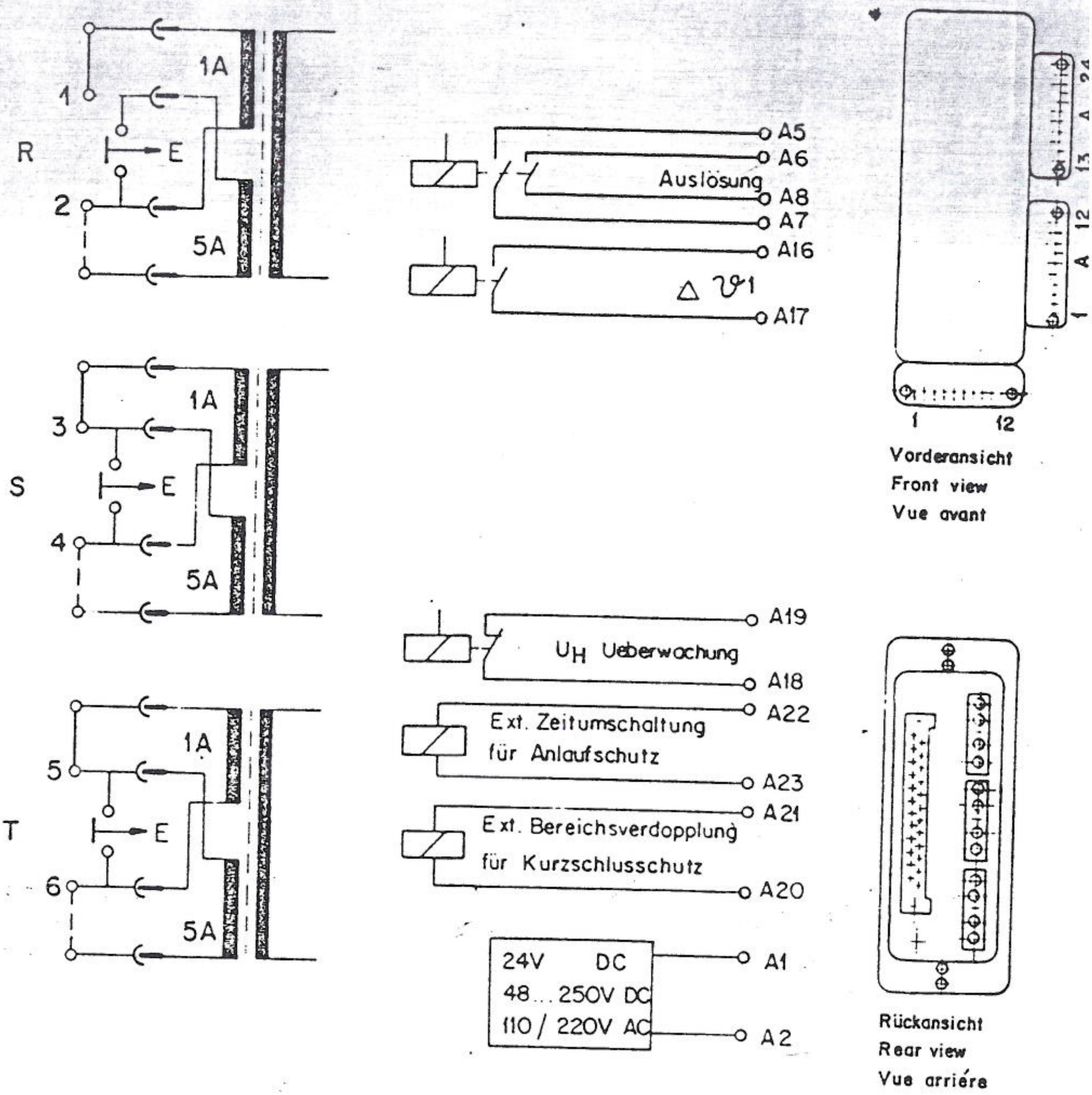


* Klemmen für vorderseitigen Anschluss, nur geliefert wenn verlangt.
  Gleichbezeichnete Klemmen sind verbunden.

* Terminals for front connection, only supplied if ordered.
  Terminals of the same designation are connected.

* Bornes pour raccordement avant, livrées seulement sur commande.
  Les bornes de même désignation sont reliées.

A.80.07.23 (8668) B 81-01-23 (8780)	Motorschutzrelais Typ ITX 192-211/-212/-213 ITX 192-231/-232/-233	WBZ
	Protection for electric motors typs ITX 192-211/-212/-213 ITX 192-231/-232/-233	Gezeichnet 79-10-03 Lorenz Geprüft 79-11-15 Gesehen 79-11-15
BBC	Protection des moteurs électriques	

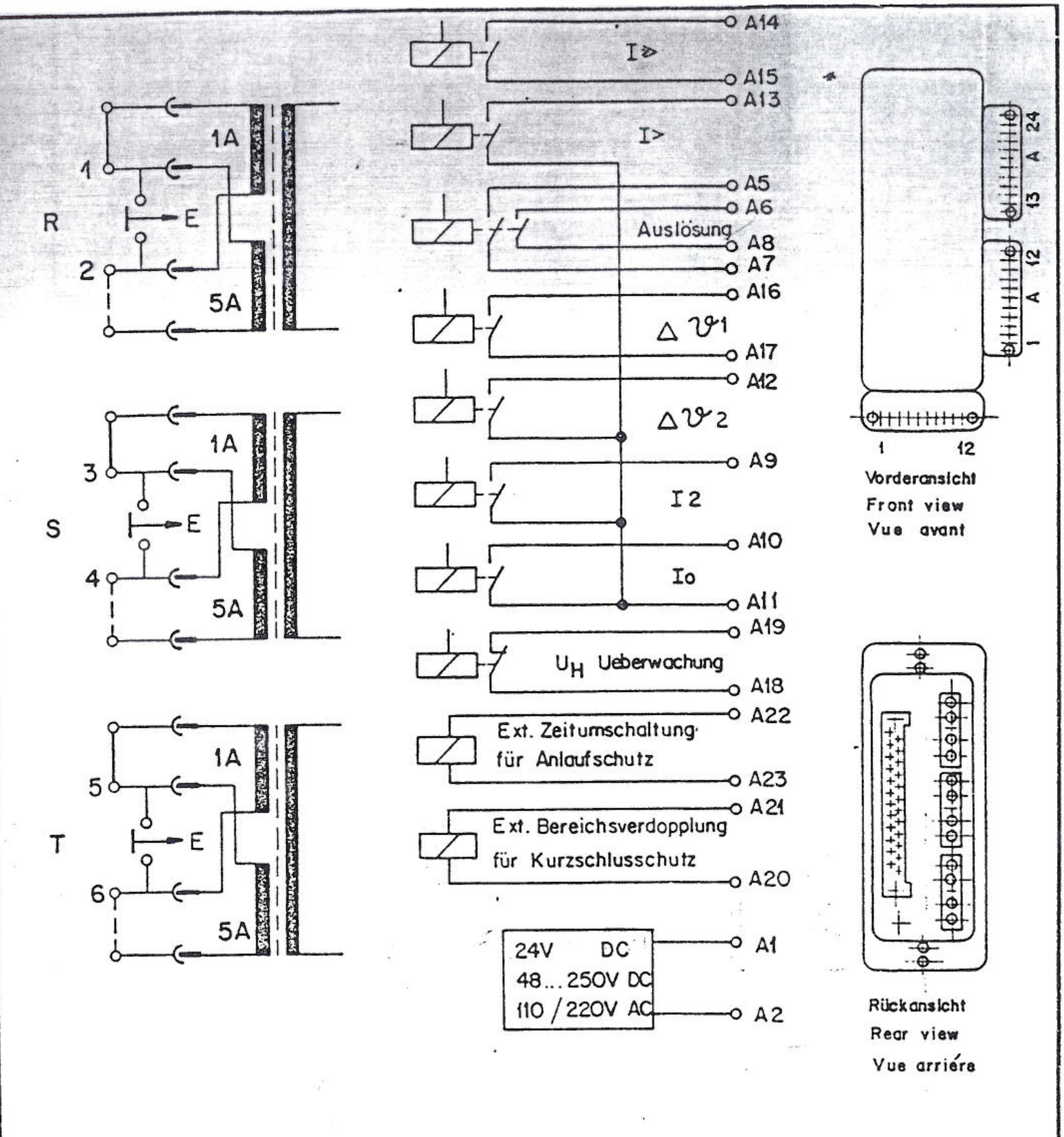


* Klemmen für vorderseitigen Anschluss, nur geliefert wenn verlangt
Gleichbezeichnete Klemmen sind verbunden.

* Terminals for front connection, only supplied if ordered.
Terminals of the same designation are connected.

* Bornes pour raccordement avant, livrées seulement sur commande.
Les bornes de même désignation sont reliées.

A. 80.07.23(8668) B 81-01-23(8780)	Motorschutzrelais Typ IT 192-221/-222/223 ITX 193-321/322/323	WBZ
	Protection for electric motors typs IT 192-221/222/223 ITX 193-321/322/323	Gezeichnet 79-10 03 Lorenz Geprüft 79-11-15 Gesehen
BBC	Protection des moteurs électriques	

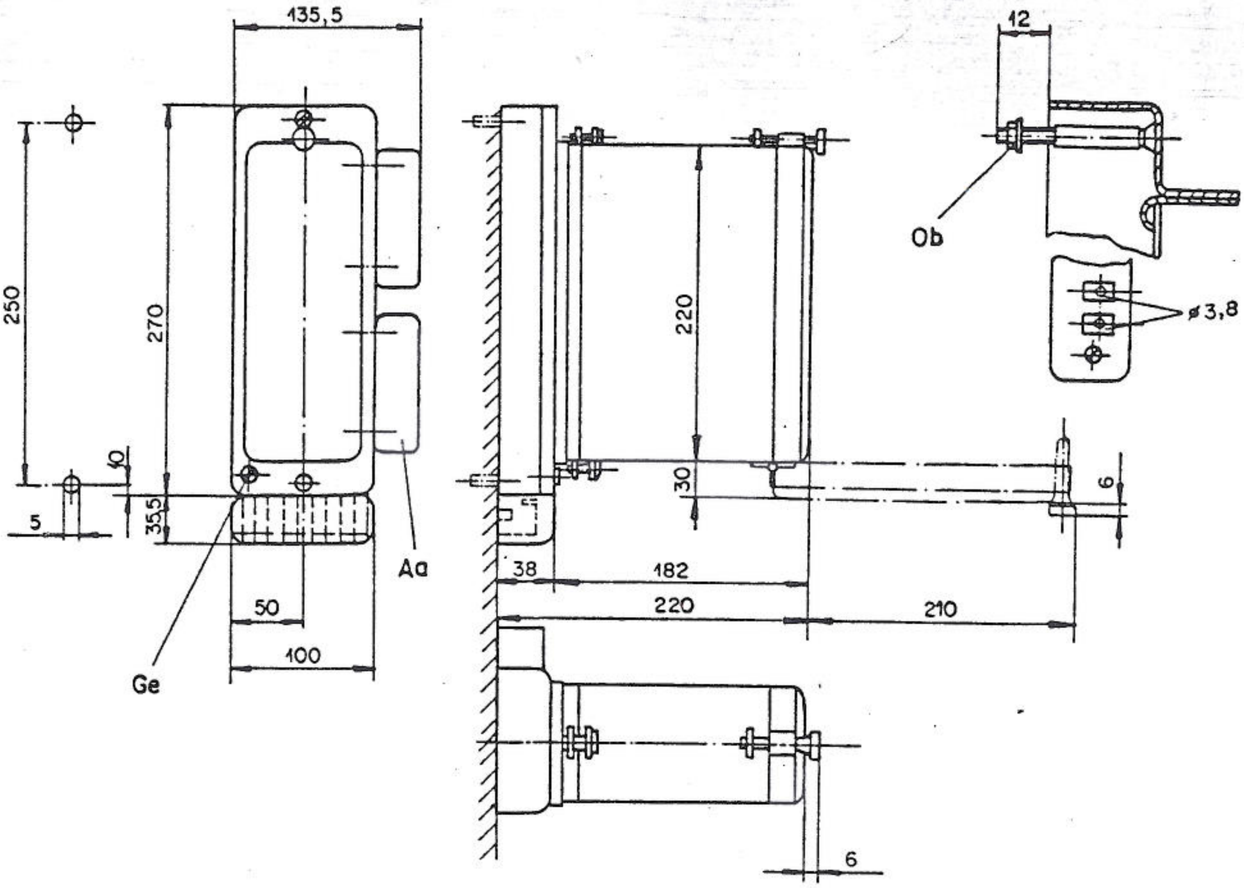


* Klemmen für vorderseitigen Anschluss, nur geliefert wenn verlangt.
Gleichbezeichnete Klemmen sind verbunden.

* Terminals for front connection, only supplied if ordered.
Terminals of the same designation are connected.

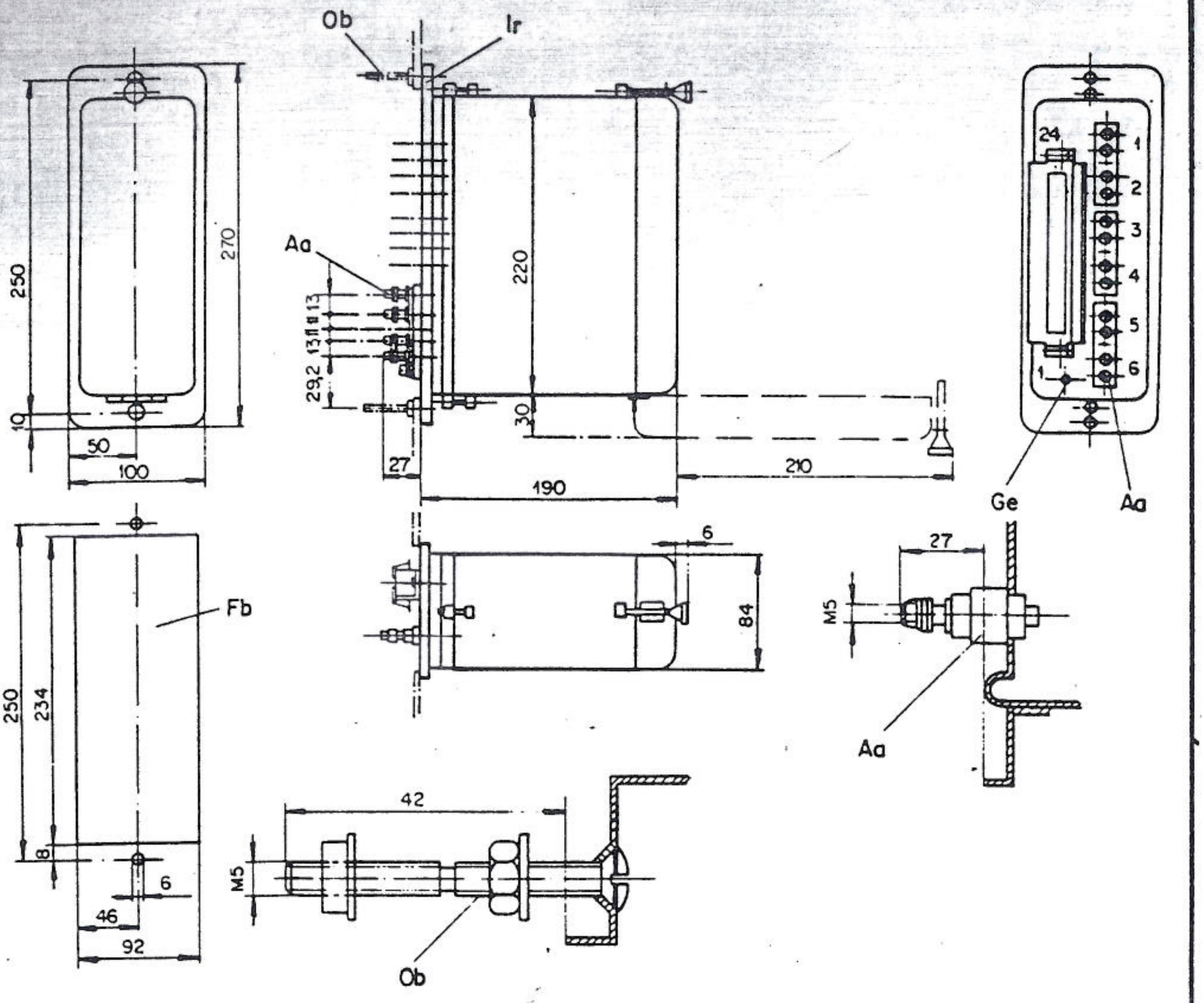
* Bornes pour raccordement avant, livrées seulement sur commande.
Les bornes de même désignation sont reliées.

A. 80.07.23 (8668) B81-01-23 (8780) C81-01-24 (8933)	Motorschutzrelais Typ ITR 193-331/-332/-333/-432 193-311/-312/-313	WBZ
	Protection for electric motors typs ITR 193-331/-332/-333/-432 193-311/-312/-313	Gezeichnet 79-10-03 Lorenz Geprüft 79-11-15 Gesehen
BBC BROWN BOVERI	Protection des moteurs electriques Type ITR 193-331/-332/-333/-432	HESG 438 77



Aa	Anschlussklemmen Anzahl nach Schaltbild max. 36	Aa	Terminals Number see diagram max. 36	Aa	Bornes Nombre voir schéma max. 36
	Aufbaumontage siehe HESG 438 827		For surface mounting see HESG 438 827		Montage en saillie voir HESG 438 827
Ge	Erdungsschraube M5	Ge	Earth screw M5	Ge	Vis de mise à la terre M5
Ob	Befestigungsschraube	Ob	Fixing screw	Ob	Vis de fixation

	Gehäuse für ausziehbare Relais Aufbau-Montage, Anschlüsse vorne	WBZ
	Casing for plug-in relays surface mounting, front connections	Gezeichnet 79-10-01 Lorenz Geprüft 79-11-15 Gesehen
BBC BROWN BOVERI	Boitier pour relais embrochables Montage en saillie, connexions avant.	HESG 438 780



Aa	Anschlussklemmen Anzahl nach Schaltbild max. 36	Aa	Terminals Number see diagramm max. 36	Aa	Bornes nombre voir schéma max. 36
Fb	Schalttafelausschnitt	Fb	Hole in switchboard	Fb	Ouverture dans le panne
Ir	Befestigungsrahmen Umstellung für Aufbau-Montage jederzeit möglich Aufbaumontage siehe HESG 438 828	Ir	Fixing frame Frame can be readjusted for surface mounting Surface mounting sec HESG 438 828	Ir	Cadre de fixation Déplacement du cadrep po montage en saillie est toujours possible Montage en saillie voir HESG 438 828
Ob	Befestigungsschraube	Ob	Fixing screw	Ob	Vis de fixation
Ge	Erdungsschraube M5	Ge	Earth screw M5	Ge	Vis de mise à la terre

Gehäuse für ausziehbare Relais
Aufbau-Montage, Anschlüsse hinten

Casing for plug-in relays
Surface mounting, rear terminal

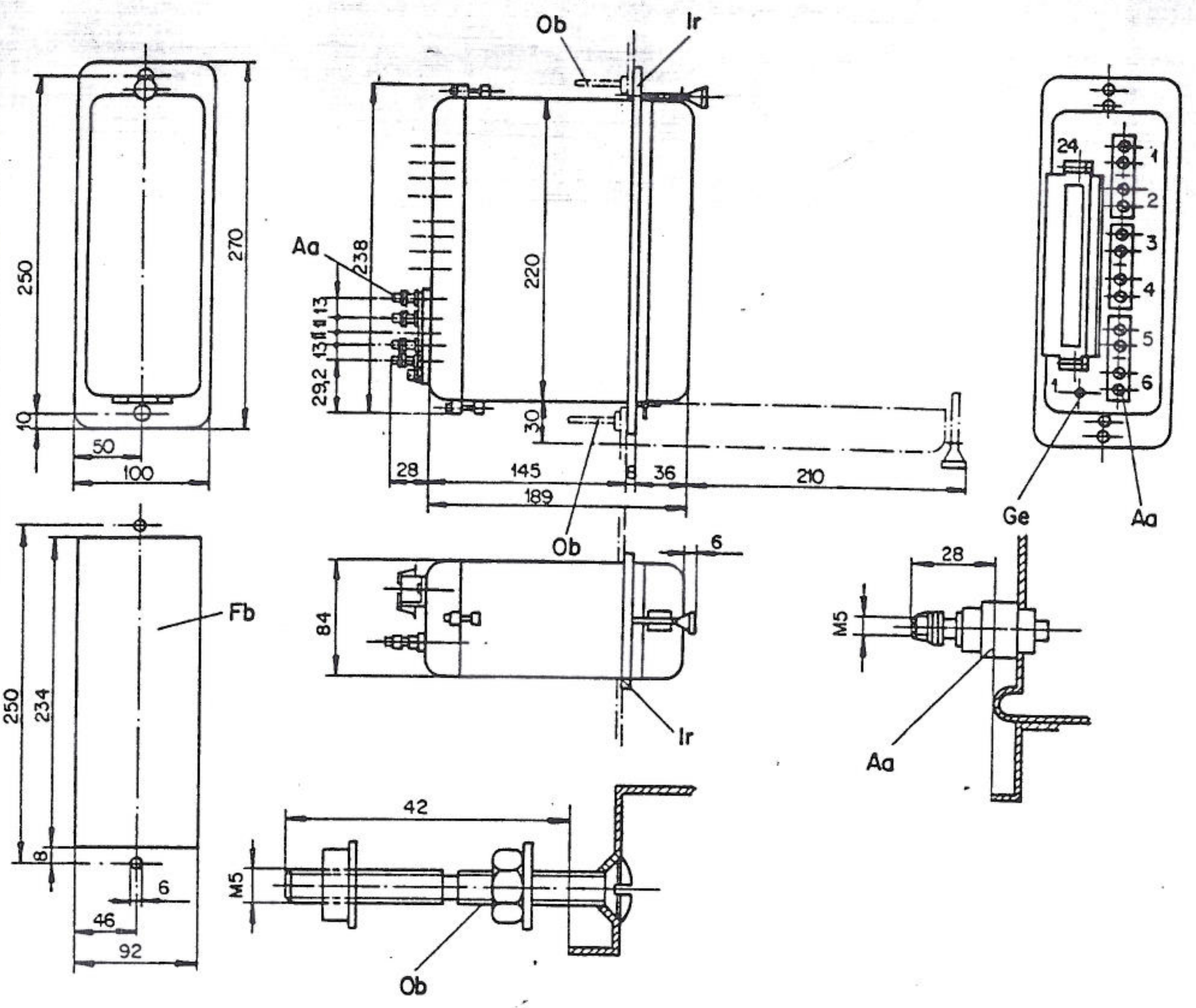
Boitier pour relais embrochables
Montage en saillie bornes à l'arriere

WBZ

Gezeichnet 79-09-28 Lorenz
Geprüft 79-11-15
Gesehen

BBC
BROWN BOVERI

HESG 438 827



Aa Anschlussklemmen Anzahl nach Schaltbild max. 36	Aa Terminals Number see diagramm max. 36	Aa Bornes nombre voir schéma max. 36
Fb Schalttafelausschnitt	Fb Hole in switchboard	Fb Ouverture dans le panne
Ir Befestigungsrahmen Umstellung für Aufbau- Montage jederzeit möglich Aufbaumontage siehe HESG 438 827	Ir Fixing frame Frame can be readjusted for surface mounting Surface mounting sec HESG 438 827	Ir Cadre de fixation Déplacement du cadrep po montage en saillie est toujours possible Montage en saillie voi: HESG 438 827
Ob Befestigungsschraube	Ob Fixing screw	Ob Vis de fixation
Ge Erdungsschraube M5	Ge Earth screw M5	Ge Vis de mise à la terre

	Gehäuse für ausziehbare Relais Einbau-Montage, Anschlüsse hinten	WBZ
	Casing for plug-in relays Flush mounting, rear terminals	Gezeichnet 79-09-28 Lorenz Geprüft 79-11-15 Kü Gesehen
BBC BROWN BOVERI	Boitier pour relais embrochables Montage encastré, bornes à l'arriere	HESG 438 828

Q 200 380 P 51