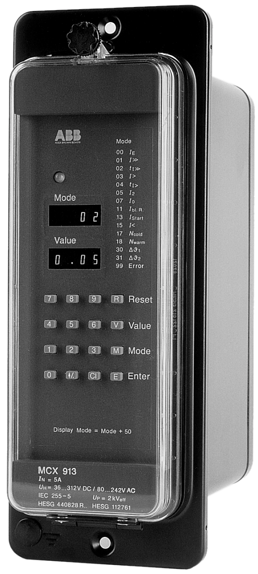
Multifunctional relay MCX912/913

1MRB520124-Ben

Issued: July 1998
Changed: since April 1989
Data subject to change without notice



Features

- Plug-in microprocessor controlled multifuncional relay with automatic shorting of c.t. circuits when the relay is withdrawn from its casing
- Measuring connections phase by phase to the main c.t. to form the maximum value of the phase currents and the neutral current (I_0 internal)
- Alternative: Measuring connections to two main c.t. (phase R and T) and a separate current input (I_0 external) to a neutral c.t. (phase S or I_0)
- The measured values are digitally processed by a microprocessor
- Ability to combine a large number of protective functions in one unit
- The various protective functions can be freely selected and allocated to the various auxiliary relays by means of the software tripping matrix (blocked, start signal, tripping, tripping with latching)
- Wide setting ranges for the various protective functions
- Exact quartz-controlled timers
- Thermal replica with two separately adjustable time constants and two independently adjustable pickup values (warning and trip)
- If the supply voltage fails, the state of the thermal replica is memorized
- Memory for tripping value and time run
- Setting by keyboard
- Two four-figure LED displays, showing: all settings, momentary value of the measured values, number of motor starts, trips, elapsed times, etc.
- Comprehensive self-monitoring, indication of readiness to operate
- Supply from battery 36 – 312 V DC (or 18 – 36 V DC) or from single-phase mains 80 – 242 V, 50/60 Hz

Application

The relay type MCX is designed for following protection purposes:

- Rotating AC machines, specially for asynchronous motors
- Large power transformers and distribution transformers
- Line- and cable feeders

It provides a large number of protection functions for detection of not only electrical faults, but also inadmissible operational states.

Application (cont'd)

Table 1: Recommended scope of protection for various objects

	Protected object			
Protective function	**Motor**	**Transformer**	**Generator (small units)**	**Cable, line**
Short-circuit protection	l	l	l	l
Starting protection Locked rotor protection	l			
Negative sequence protection	l		l	
Overload protection	l	l	l	l
Earth fault protection	l	(l)[2]	l	(l)[3]
Protection against low load	(l)[1]			
Backup protection Overcurrent protection	l	l	l	l
Corresponding value of the function selector (mode 47)	1	10 (11)	5	17 (13)

(l) only under certain conditions
[1] Under definite operating conditions
[2] When the transformer winding is not earthed
[3] In earthed radial networks

The detection of faults or the recognition of critical states is based on the evaluation of the phase currents through the protected object.

By combining various protective functions (19 possibilities) the relay can be used to replace several conventional relays. See some examples in Table 1.

Design

The principle of the relay's operation is explained below in relation to the block diagram (Fig. 4).

- Input current transformers isolate the measuring signals from the relay circuit and adapt the internal signal to a proper level.
- The signals pass bandpass filters which suppress harmonics.
- The pickup values for the various functions are related to setting current IE, which corresponds to the primary load current of the protected object (c.t. ratio compensation).
- The phase current signals are rectified and combined for detection of maximum value.
- The earth fault signal I_0 is formed by vectorial summation, the NPS-signal I_2 is derived from a negative-sequence filter.
- All generated signals: I, I_0 and I_2 then pass an A/D converter and are finally processed in digital form by the microprocessor.

Short-circuit protection ($I>>_{1,2}$) and Overcurrent protection ($I>_{1,2,3}$)

With the three independent overcurrent-time functions, $I>_{1,2,3}$, together with the functions, $I>_{1,2}$, it is possible to obtain time and current grading of tripping. They are also separately adjustable. The functions $I>_{1,2,3}$ are always activated in combination with I_{start} function. When I_{start} has reset I> functions are released.

It is thus possible to distinguish between short-circuit currents and service currents of the same order of magnitude (e.g. the starting current of a motor). When used with transformers, undesired tripping due to inrush currents is prevented. For the short-circuit protection transient overcurrents which may occur in service, such as those caused by switching operations, can be overridden by a short time-lag.

Earth fault protection

The measured signal for earth fault protection is detected by either internal formation when three phases are connected (see wiring diagram, Fig. 5) or by use of an external neutral current transformer (see Fig. 6). With this arrangement a very sensitive earth fault detection can be obtained.

Negative phase sequence protection

Asymmetrical main voltages, unbalanced loads or phase failures cause a negative-sequence current. This signal can be derived from three phases. If the relay is wired to only two phase currents, the neutral current is taken into account. For I_0 more than 0,25 x set value the negative-sequence protection is blocked.

Motor starting protection

Motor starting procedures are protected by the following functions:

- I_{start} with I_2 Tstart measurement
  The product will be built as long as the set value of I_{start} is exceeded. A tripping takes place when I^2T exceeds the set value I^2T_{start}. The advantage of this feature is that motor starts can be completed with different starting times. They come up by unstable system voltages. For the tripping characteristic see also Fig. 2.
- Locked rotor protection
  When the stalling time of a motor is shorter than the normal starting time, a speed governor is necessary and will release a trip signal only when the rotor is not moving.
- Counter for motor starts
  This function consists of counters, one for cold starts and one for warm starts and a setting level for the warm condition ($\Delta\vartheta_3$). A timer t_{N-1} is adjustable for the required cooling time to permit another start. The function trips when the accepted number of starts has exceeded the set number N_{warm} or N_{cold}.

Thermal overload protection

The thermal overload protection is based on the thermal replica of the protected object. Any thermal stress that is too high or lasts too long must be prevented, otherwise it must be expected that the insulation of the protected object may be damaged and the useful life shortened.

In steady-state operation, a motor heats up according to an exponential function to an ultimate value, because heat is continuously being dissipated to the surroundings, e.g. coolant. More interesting than the absolute temperature attained is the temperature rise when operating at rated load.

The temperature rise is monitored in relays MCX91., in two stages ($\Delta\vartheta_1$, $\Delta\vartheta_2$). The stage $\Delta\vartheta_1$ can be used to give a warning. The reset value for $\Delta\vartheta_1$ is 5% lower than the set value. $\Delta\vartheta_2$ is employed for tripping. The tripping signal is applied until the temperature has dropped below the $\Delta\vartheta_2$ value as given by the setting $H\Delta\vartheta$.

The temperature rise of the protected object is calculated from the maximum value of the phase currents. Two time constants can be set: a heating time constant, $\tau\uparrow$, for currents with forced cooling and a cooling time constant. $\tau\downarrow$, when the machine is stationary. For currents $\geq 2\ I_E$ adiabatic heating is simulated.

Fig. 1 shows the various tripping characteristics. In terms of the current and the selected time constant, it is possible to read off the time taken to reach a definite temperature rise.

$$\frac{t}{\tau\uparrow} = f\ \ (I/IE,\ \Delta\vartheta)$$

$$\frac{t}{\tau\uparrow} = \ln\frac{(I/IE)^2}{(I/IE)^2 - \Delta\vartheta\cdot 10^{-2}} \quad for\ 0{,}1IE \leq I \leq 2IE$$

$$\frac{t}{\tau\uparrow} = \frac{\Delta\vartheta}{100\cdot(I/IE)^2} \quad with\ \ \Delta\vartheta\ \ in\,\%\ \ \ for\ I \geq 2IE$$

The tripping times can be determined with the help of the above curves (see Fig.1) and the parameters $\Delta\vartheta$ = 5% to 200%.

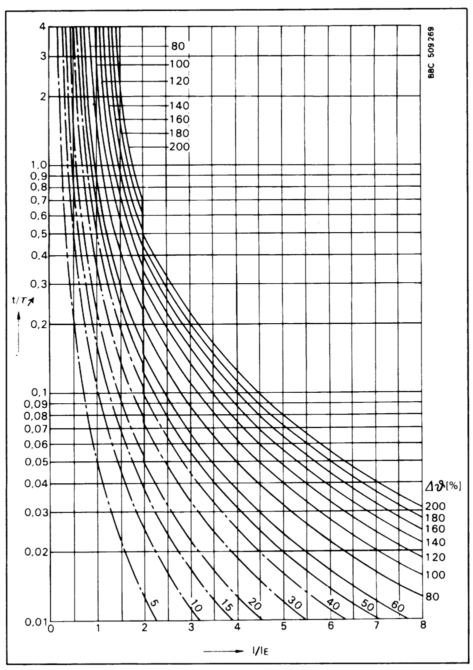


Fig. 1 Tripping characteristics from the cold state ($\Delta\vartheta_0$ = 0)

Design (cont'd)

Setting, Tripping and Signalling

SETTING:
On the relay front selection and value setting of protection function is provided with a keyboard. When pressing a button two numerical LED displays show the entered number. Settings can be made at any time even when the relay is in operation. All settings can be memorized in a nonvolatile memory which means that no auxiliary supply is necessary to keep the values stored. The storing procedure is executed by entering a password.

TRIPPING:
The relay operates the control circuits via four contactors. For a selection for which the protection function gets a contactor output, (tripping or signalling contactor type) the relay has a free programmable MATRIX. The user can influence the interlinking between tripping signals and the contactors according to the designed protection scheme. A number determines whether the corresponding contactor is operated or not.
See Fig. 3.

SIGNALLING:
In case of a tripping action, the displays show the particular protection function with a flashing of mode and value number. Events are then memorized in chronological order. Resetting of indications is done by pressing the reset push-button.

INDICATIONS:
The relay is able to show actual load conditions, such as load currents or thermal status of the protected feeder, on its display. The short-circuit function can display the real short-circuit current which has exceeded the set value. If the relay picks-up and resets later, without a trip, the last time run will be memorized. All the possible memory-values are selected for display by separate mode numbers.

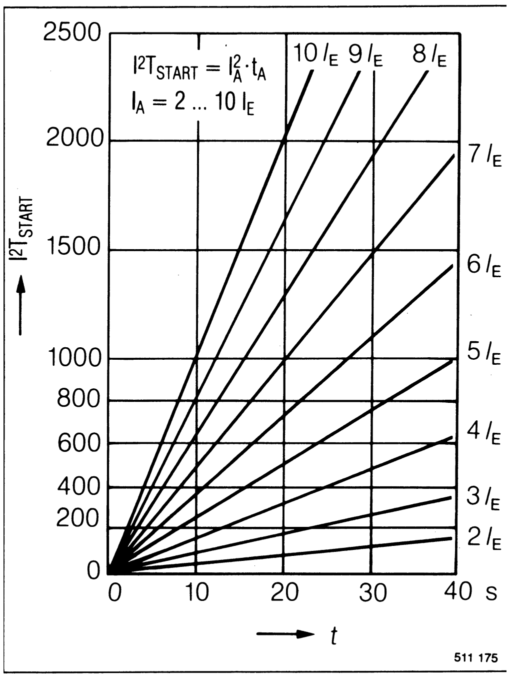


Fig. 2 Setting/tripping characteristic for I^2 x T_{start}

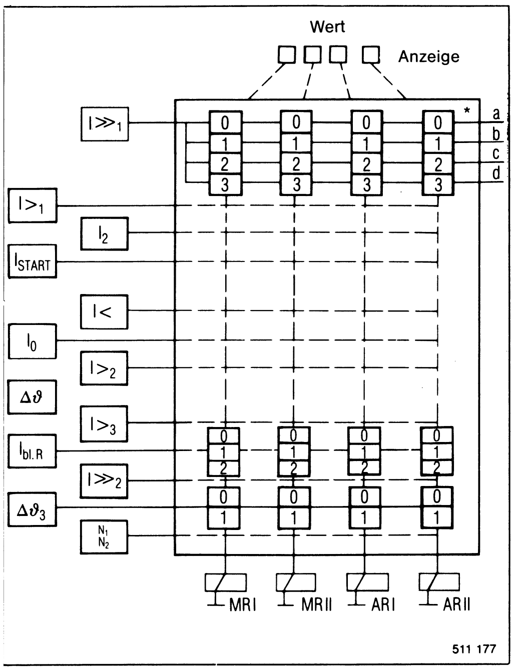


Fig. 3 Software tripping matrix

Table 2: Setting values for the various protective function

Mode	Setting	Symbol	Setting range	Unit	Resolution
00	Setting current	I_E	0.30 to 1.20	I_{NR}	0.01
01	Short-circuit prot. 1	$I>>_1$	0; 2 to 20	I_E	0.1
02	Timelag	$tI>>_1$	0.00 to 9.99	S	0.01
03	Overcurrent prot.	$I>_1$	0; 0.8 to 8	I_E	0.1
04	Timelag	$tI>_1$	0.1 to 200	S	0.1/1
05	NSP prot.	I_2	0; 0.1 to 0.5	I_E	0.01
06	Timelag	tI_2	0.1 to 200	S	0.1/1
07	Earth fault prot: int. ext.	I_0 I_0	0; 0.2 to 1 (0; 0.2 to 4)/k	I_E I_E	0.01 0.01 (0.001)
08	Timelag int./ext.	tI_0	0.01 to 100	S	0.01/0.1
09	I_0 INT/EXT	–	1 = INT, 0 = EXT	1	1
10	I_0 c.t. ratio k = 5 for MCX912-1; k = 25 for MCX912-5	k*)	K = 1 for MCX913;	1	1
11	Locked rotor prot.	I_{blR}	0; 0.8 to 8.0	I_E	0.1
12	Timelag	t_{blR}	0.1 to 200	S	0.1/1
13	Starting prot.	I_{start}	0; 0.8 to 8.0	I_E	0.1
14	I^2T perm. for start	I^2T_{start}	1 to 9999	$I_E{}^2S$	0.1/1
15	Prot. against low load	I<	0; 0.3 to 3.0	I_E	0.1
16	Timelag	tI<	0.1 to 200	S	0.1/1
17	No. of motor starts from cold	N_{cold}	0; 1 to 10	1	1
18	No. of motor starts from warm state	N_{warm}	0; 1 to 10	1	1
19	Time for N = N-1	t_{N-1}	1 to 9999	S	1
20	Temperature rise $\Delta\vartheta_3$	$\Delta\vartheta_3$	0; 50 to 200	%	1
21	Start with overheating	N_S	0, 1, 2	1	1
30	Temperature rise $\Delta\vartheta_1$	$\Delta\vartheta_1$	0; 50 to 200	%	1
31	Temperature rise $\Delta\vartheta_2$	$\Delta\vartheta_2$	0; 50 to 200	%	1
32	Reset for $\Delta\vartheta_2$	$H\ \Delta\vartheta$	1 to 100	%	1
33	Heating time constant	$\tau\uparrow$	1 to 200	min	1
34	Cooling time constant	$\tau\downarrow$	1 to 999	min	1
35	$\Delta\vartheta_0$ automatic	$\Delta\vartheta_0$	0 to 200	%	1
39	$\Delta\vartheta_0$ manual	$\Delta\vartheta_0$	0 to 200	%	1
40	Setting time of mean value of current	k_{TE}	0=8 min, 1=15 min 2=30 min	1	1
41	Short-circuit prot. 2	$I>>_2$	0; 2 to 20	I_E	0.1
42	Timelag	$tI>>_2$	0.00 to 9.99	S	0.01
43	Overcurrent prot. 2	$I>_2$	0; 0.8 to 8	I_E	0.1
44	Timelag	$tI>_2$	0.1 to 200	S	0.1/1
45	Overcurrent prot. 3	$I>_3$	0; 0.8 to 8	I_E	0.1
46	Timelag	$tI>_3$	0.1 to 200	S	0.1/1
47	Function selection		1 to 19	1	1
98	Elapsed-time counter			10 h	0.1/1
99	Fault annunciation	see instruction 1MRB520112-Uen-B			

I_{NR} = Rated current of relay (1 A or 5 A)

Technical data

Input

Rated current I_{NR}	1 A or 5 A
Rated frequency f_N	50 or 60 Hz
Load capacity of measuring inputs MCX913 Phase continuously for 10 s for 1 s dynamic (peak value)	 4 I_N 30 I_N 100 I_N 250 I_N
I_0 of MCX912-1 continuously for 10 s for 1 s dynamic (peak value)	 1 I_N 6 I_N 20 I_N 50 I_N
I_0 of MCX912-5 continuously for 10 s for 1 s dynamic (peak value)	 0.2 I_N 1.2 I_N 4 I_N 10 I_N
Consumption of measuring inputs at I_N = 1 A MCX913 Phase I_0 of MCX912-1/-5	 0.07 VA 0.38 VA at 1 A
Consumption of measuring inputs at I_N = 5 A MCX913 Phase	 0.7 VA

Measuring elements

Setting ranges	see Table 2

Current functions

±5% of the set value	
Accuracy of pickup values for I<: under reference conditions and for I^2t: single-phase measurement	 ±10% when I << 0.8 x I_F ±10%
Variation of pickup values with temperature	< 0.1%/K
Variation of pickup values with frequency in range for all other pickup values:	45 to 55 Hz (f_N = 50 Hz) or for I_2: < 0.015 I_E/Hz with balanced 55 to 65 Hz (f_N = 60 Hz) three-phase infeed at I = I_E (deviation proportional to I) < ±0.5%/Hz
Reset ratio	> 95% (for I <: > 110% when I < ≥ 0.3 x I_E; 105% when I < ≥ 0.8 x I_E
Response time of measuring elements	< 40 ms for a jump from 0 to 1.5 x pickup value incl. attraction time of tripping relay
Reset time of measuring elements	< 50 ms for a reduction from 1.5 x pickup value to 0, incl. dropout time of tripping relay

Thermal replica

Accuracy of pickup values	±10% of the set value (under reference conditions)
Reset values $\Delta\vartheta_1$ $\Delta\vartheta_2$ $\Delta\vartheta_3$	$\Delta\vartheta_1$ - 5% $\Delta\vartheta_2$ - H $\Delta\vartheta$ (adjustable) $\Delta\vartheta_3$ - 5%

Timers

Accuracy of the set time-lags	±0.05% ±10 ms quartz accuracy and time constants (for t_{N-1}: ±0.05% ± 1 s)

Auxiliary supply

Input voltage ranges Consumption	36 – 312 V DC and 80 – 242 V DC, 50/60 Hz or 18 – 36 V DC < 13 W max. (tripped)
Voltage range of the blocking input (E1 ... E5)	18 – 36 V DC (Ri> 4 kΩ) 36 – 75 V DC (Ri> 7 kΩ) 82 –156 V DC (Ri> 17 kΩ) 165 –312 V DC (Ri> 35 kΩ)

Contact data and signals	**Tripping contacts**	**Signalling contacts**	**Frontplate signals**
Rated voltage	300 V DC or AC	250 V DC or AC	availability green LED
Making current (0.5 s)	30 A	5 A	mode display four-digit
Continuous rating	10 A	1.5 A	value display LED display
Making capacity at	110 V DC	3300 W	550 W
Breaking capacity, L/R =	1 A, U ≤ 120 V DC		
40 ms, 2 contacts in series	0.3 A, U ≤ 250 V DC		

General data

Ambient conditions Temperature range operation Standard	 –10... + 55 °C IEC 255-6 (1988)
Insulation tests Dielectric insulation voltage[1]	 2 kV, 1kV (across open contacts) 1 min
Standard	IEC255-5 (1977), VDE0160Kl.4. VDE0411Kl. VDE0435 part 303 Kl. C, BS 142-1966 ANSI/IEEE C37.90-1978 (2 UN + 1kV)
Impulse voltage[1]	1,2/50 µs, 0,5 Joule Cl. 3; 5 kV
Standard	IEC255-5 (1977), VDE0110 Kl.C VDE0432, VDE0435, part 303
Electromagnetic Compatibility:	EMC

Mechanical design

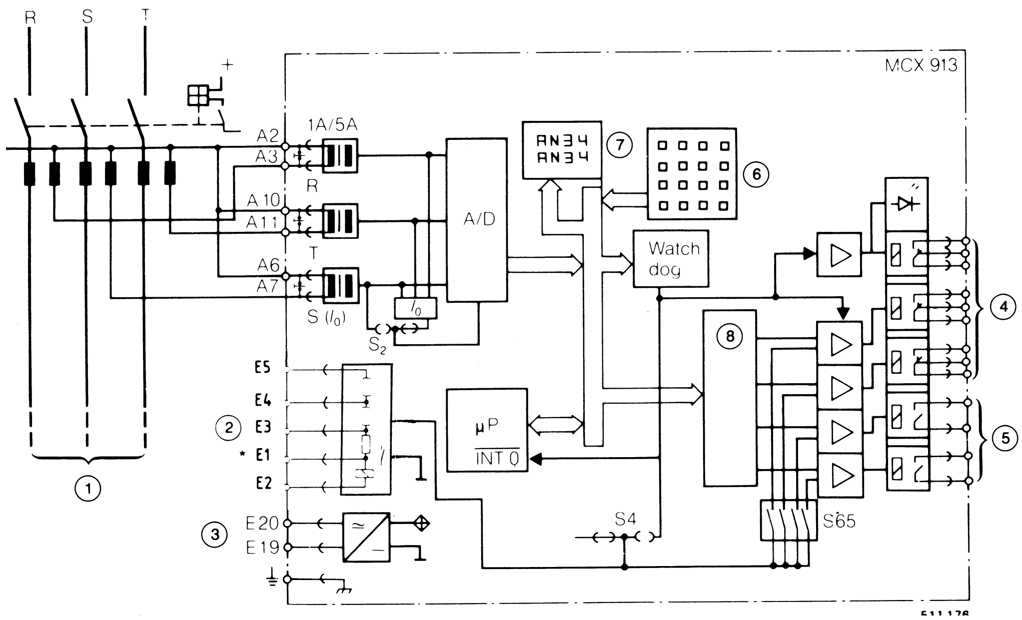
Plug-in relay in standard casing	ABB series 900 size 1 see dimensioned drawing Figures 7 to 10
Protection casing terminals	IP52 IP10
Mass	2.9 kg

Technical data (cont'd)

Test type	Test values applied to MCX types		Standards
EMISSION	0,15 – 30 and 30 – 1000 MHz (conducted and radiated)		EN50081-2 (1994) EN55011(CISPR11) EN55022(CISPR22)Cl.A
Relay type	MCX912 / MCX913		
IMMUNITY			EN50082-2 (1995)
RFI[2] conducted (80% am)	10 V, 0,15 – 80 MHz		ENV50141 ENC 1000-4-6
DC power port	3 V, 47 – 68 MHz	10 V, 0,15 – 80 MHz	IEC 1000-4-6
RFI radiated	10 V/m, 80 - 1000 MHz (80% am[4]) 10 V/m, 900 MHz, (pm[5])		ENV50140 (IEC1000-4-3) ENV50204
Relay type	MCX912 MCX913-x-x-0	MCX913-x-x-1	
ESD[3] contact / air Relay type	4/8 kV MCX912-x-x-0 MCX913-x-x-0	6/8 kV MCX912-x-x-1 MCX913-x-x-1	EN61000-4-2(IEC1000-4-2)
Fast transients Relay type DC power port all other ports	MCX912 / MCX913 4 kV 2 kV		EN61000-4-4(IEC1000-4-4)
Power frequency magnetic field	300 A/m permanent		EN61000-4-8 (IEC1000-4-8)

[1] For repetition, reduced values apply as per IEC 255-5 Art 6.6 and 8.6
[2] RFI Radio frequency interference (Radio-frequency electromagnetic field)
[3] ESD Electrostatic discharge
[4] am amplitude modulated
[5] pm pulse modulated

Diagrams



1 Protected unit
2 Blocking input
3 Aux. supply
4 Aux. signalling relay
5 Aux. tripping relays
6 Keypad
7 Display
8 Tripping matrix

Fig. 4 Block diagram of the overcurrent/overload relay type MCX for the protection of motors

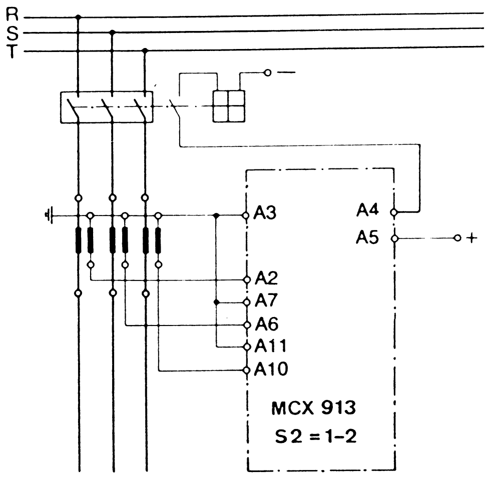


Fig. 5 Wiring diagram for earthfault detection (I_0 internal)

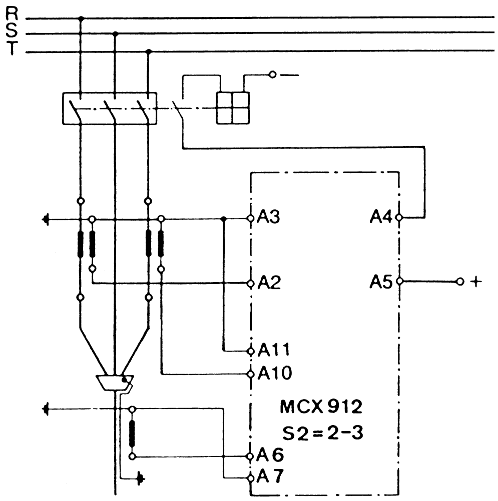


Fig. 6 Wiring diagram for earthfault detection with core balance transformer (I_0 external)

Dimensions

Standard ABB Size 1 casing (in mm)

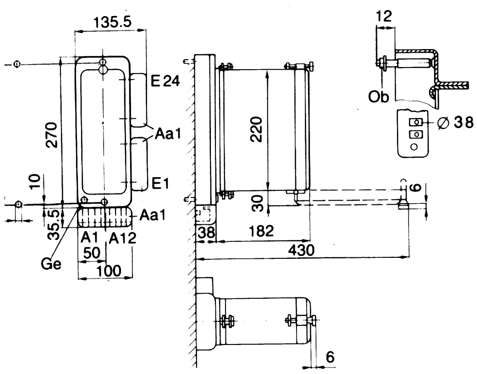


Fig. 7 Flush mounting, rear connection

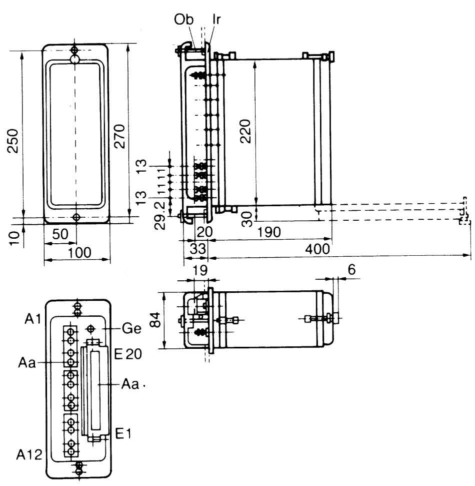


Fig. 8 Surface mounting, rear connection

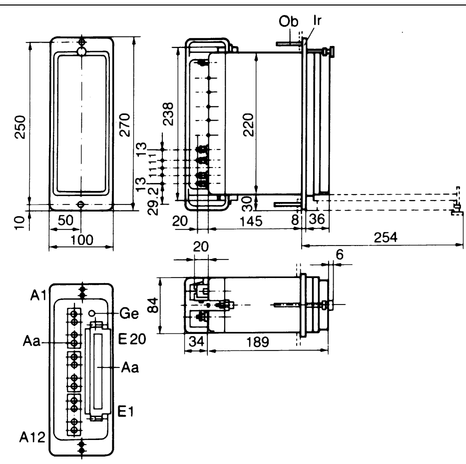


Fig. 9 Surface mounting, front connection

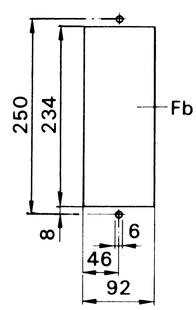


Fig. 10 Hole in panel for relays in Fig. 7 and 8

Legend

Aa = Rear terminals, number according to circuit diagram
Aa1= Front terminals, number according to circuit diagram
A... Terminal screw M4
E... Electronic plug connector
Ir = Mounting frame, modification for surface mounting possible
Ob = Fixing screw M5
Ge = Earthing screw M4
Fb = Panel cutout

Sample specification

Three phase microprocessor based multifuncional protection relay, with freely selectable combinations of protection functions. The function types and setting ranges shall be applicable for detection of most common faults in medium - and high voltage networks.

Special attention is to be given to the protection of asynchronous motors.

The sensitive earth fault function shall allow use in isolated and compensated networks via one of the c.t. inputs.

The setting ranges shall be very large and set values have high accuracy and long time stability.

All settings shall be made with a keyboard in conjunction with numerical LED indications.

The relay shall be designed so that a continuous display of service - and tripping values can be selected. Tripping and signalling contactors shall be programmable by means of a software tripping matrix. All contactors shall be blocked selectively from outside with a remote signal to design different schemes (e.g. directional protection or for motors).

A comprehensive self-supervision, capable of detecting hardware and software failures with local and remote alarm facilities shall also be included.

The auxiliary power supply can fluctuate in a wide tolerance range and shall not affect the reliability. The relay shall be fully withdrawable, to simplify commissioning and service.

Ordering

Please specify:

- Type designation
- Quantity
- Ordering No.
- Rated current
- Rating frequency
- Auxiliary voltage
- Mounting of case

Explanation to type designation:

Type designation MCX91 x – x – x – x

Three identical current inputs (basic version)	3	MCX91 **x** – x – x – x
Increased sensitivity to I_0 (I_0 external)	2	
Rated current 1 A	1	MCX91 x – **x** – x – x
Rated current 5 A	5	
Rated frequency 50 Hz	5	MCX91 x – x – **x** – x
Rated frequency 60 Hz	6	
Aux. voltage 36 – 312 V DC and 80 – 242 V AC	1	MCX91 x – x – x – **x**
18 – 36 V DC	0	

Ordering Example:
The version for 5 A, frequency of 50 Hz with sensitive detection of I_0, DC supply 312 V DC and a case for flush mounting, rear terminals has the following designation:
MCX912 - 5 - 5 - 1, Ord.Nr. HESG 440 830 R51

Ordering table

Type designation Mounting of case:	Ordering No. Flush mounting, rear terminals	Type designation Mounting of case:	Ordering No. Surface mounting front terminals
MCX912-1-5-0	HESG 441 442 R51	MCX912-1-5-0	HESG 441 442 R151
MCX912-1-5-1	HESG 440 829 R51	MCX912-1-5-1	HESG 440 829 R151
MCX912-5-5-0	HESG 441 443 R51	MCX912-5-5-0	HESG 441 443 R151
MCX912-5-5-1	HESG 440 830 R51	MCX912-5-5-1	HESG 440 830 R151
MCX912-1-6-0	HESG 441 442 R53	MCX912-1-6-0	HESG 441 442 R153
MCX912-1-6-1	HESG 440 829 R53	MCX912-1-6-1	HESG 440 829 R153
MCX912-5-6-0	HESG 441 443 R53	MCX912-5-6-0	HESG 441 443 R153
MCX912-5-6-1	HESG 440 830 R53	MCX912-5-6-1	HESG 440 830 R153
MCX913-1-5-0	HESG 441 440 R51	MCX913-1-5-0	HESG 441 440 R151
MCX913-1-5-1	HESG 440 827 R51	MCX913-1-5-1	HESG 440 827 R151
MCX913-5-5-0	HESG 441 441 R51	MCX913-5-5-0	HESG 441 441 R151
MCX913-5-5-1	HESG 440 828 R51	MCX913-5-5-1	HESG 440 828 R151
MCX913-1-6-0	HESG 441 440 R53	MCX913-1-6-0	HESG 441 440 R153
MCX913-1-6-1	HESG 440 827 R53	MCX913-1-6-1	HESG 440 827 R153
MCX913-5-6-0	HESG 441 441 R53	MCX913-5-6-0	HESG 441 441 R153
MCX913-5-6-1	HESG 440 828 R53	MCX913-5-6-1	HESG 440 828 R153

Reference

Publication: CH-ES 22-33.10D German
CH-ES 22-33.10E English

Operating instruction: 1MRB520112-Uen English
1MRB520112-Ude German

Operating instruction (abridged):
1MRB520230-Ude German
1MRB520230-Uen English
CH-ES 82-33.11F French
CH-ES 82-33.11S Spanish

Reference list: 1MRB520235-Ren German/English/French

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Printed in Switzerland (9809-0600-0)