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INSTRUCTIONS FOR COMMISSIONING AND MAINTENANCE OF rms OVERCURRENT PROTECTION RELAYS WITH COMMUNICATION USING DIGITAL SIGNAL PROCESSING

RMS/RMST 7992

I. FUNCTIONS AND APPLICATIONS

I.1. PRINCIPLES AND APPLICATIONS OF THE RMS 7992

The RMS 7992 series devices are intended to provide three- phase electrical network monitoring to detect short-circuits of all types, between phases or between phase and earth. Of modular design, they fit perfectly into the PROCOM architecture or can be used independently in any other conventional protection scheme.

Making use of microprocessor digital technology, the RMS 7992 uses the principle of waveform sampling to calculate the harmonic current spectra up to 7th harmonic using Fast Fourier transformation (F.F.T.).

These highly powerful principles and methods provide in particular a phase by phase measurement of the harmonic pollution of the currents flowing in three-phase networks and establish the operating criteria as the true rms value of these currents, reconstituted from the sum of the squares of the harmonics.

$$I\,RMS = \frac{1}{\sqrt{2}}\sqrt{I^2H1 + I^2H2 \ldots\ldots\ldots + I^2H7}$$

IH1 represents the amplitude of the fundamental and IH2 to IH7 those of the harmonics.

In addition, the user has the ability to eliminate ,by on-site programming, the contribution of one or more harmonics if he considers them to be undesirable . Thus, the influence of the 3rd harmonic may be eliminated from the earth fault measurement carried out by the relay.

The RMS 7992 is designed for the protection of all types of electrical power equipment and more particularly, transformers and feeders. For this purpose, it carries out 4 separate measurements, 3 overcurrent and the earth fault current. These units have 2 current levels each with wide setting ranges:

.a low-set level with a multi-curve time/current operating characteristic providing the on-site programmable choice of inverse time, very inverse time, extremely inverse and independent time curves,
.an independent time high-set level. The adjustments and the choice of curves on the earth fault unit are independent of those chosen for the overcurrent units.

As an option, the RMS 7992 can be equipped with an alarm relay "C" controlled by the overcurrent and earth fault instantaneous thresholds.

In addition,the RMST 7992 includes a thermal image unit for the protection of power transformers and feeders against overloads. On this relay, the output relay "C" can be controlled by a variable thermal alarm as a function of the thermal image unit threshold. This being the case, the output relay can still be controlled by the instantaneous overcurrent and earth fault thresholds as on the RMS 7992.

RMS 7992 SERIES RELAYS

PROTECTION	*FUNCTIONS*	*RELAY*
Overcurrent, multi-curve, 3 phase + earth-fault, 2 output units + 1 optional alarm unit from the instantaneous levels I>, Io>, I>>, Io>>	*I> - TI> - I>> - tI>> - Io> - tIo> - Io>> - tIo>> ANSI codes : (50) - (51) - (50N) - (51N)*	*RMS 7992*
Overcurrent, multi-curve, 3 phase + earth fault + thermal image, 2 output units + 1 optional alarm unit from the instantaneous levels I>, Io>, I>>, Io>> or the thermal image alarm unit	*I> - tI> - I>> - tI>> - Io> - tIo> - Io>> - tIo>> - tIth> t∝Ith> ANSI codes : (50) - (51) - (50N) - (51N) - (49)*	*RMST 7992*

1.2. BASIC APPLICATION EXAMPLE

- Overcurrent protection against phase faults

On the primary side of transformers, it is recommended that an overcurrent relay be used which has a time-delayed low-set unit and an instantaneous high-set level.

The low-set unit is set to coordinate with the protections situated downstream, so as to provide back-up protection and to detect low level internal faults. The type of time/current characteristic for this relay (independent, inverse, very inverse or extremely inverse time on the RMS series relays) is generally chosen to be identical to that of the other overcurrent relays in the installation. However, it is often possible to achieve correct co-ordination between dependent time relays and independent time relays. As a typical example, Figure 1 shows the combination of an inverse-time relay located on the primary and an independent-time relay, with two levels and two time delays used on the secondary of a transformer.

The use of the inverse-time characteristic is sometimes preferable in the following circumstances:
- the outgoing feeders on the secondary side of the transformer are protected by fuses (see Figure 2);
- the mode of operation results in the possibility of considerable overloads for several seconds (for instance, re-acceleration of motors);
- magnetising currents following transformer switch-on are of high amplitude and decay slowly.

In addition, the instantaneous high-set is set slightly above the secondary side symmetrical three-phase short circuit current (+20% approx.). Set in this way, the unit remains stable for any fault occurring on the low voltage side; there is therefore no possibility of instantaneous maloperation for a downstream fault. On the other hand, it operates very rapidly in the event of a violent internal fault on the transformer or on the cable on the primary side . It should be noted that the rms value measured by the RMS relay does not take the DC components of the primary currents into account and results in a high immunity to overreach often caused by these DC components.

The use of the instantaneous high-set unit for the protection of power transformers results in a considerable reduction in the operating time of the upstream protection devices for the range of currents that can cause instantaneous operation.
As a result of this, it is also possible to reduce the short- circuit withstand capacity of power supply cables.

FIGURE 1 - CO-ORDINATION BETWEEN INVERSE TIME AND INDEPENDENT TIME RELAYS

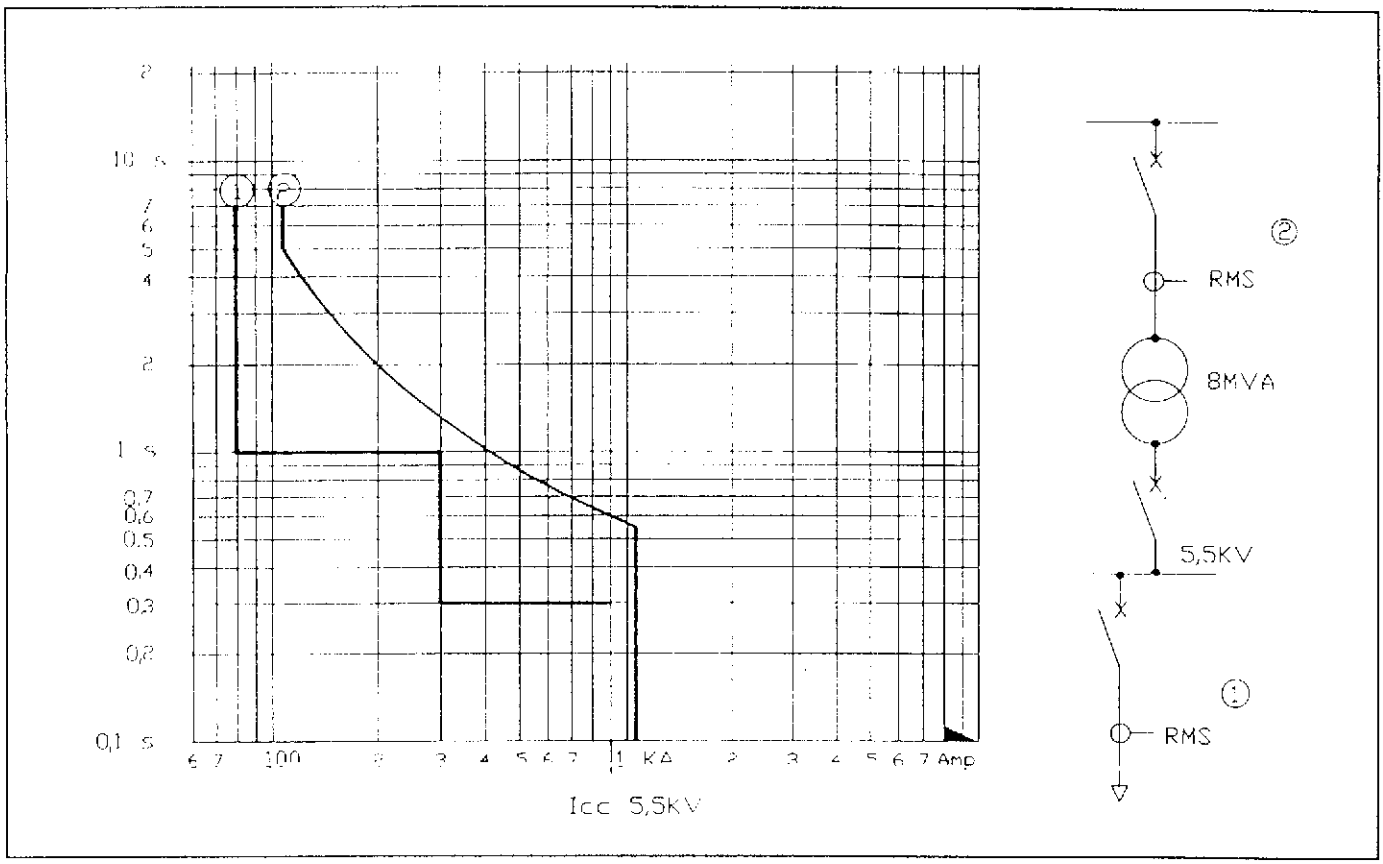
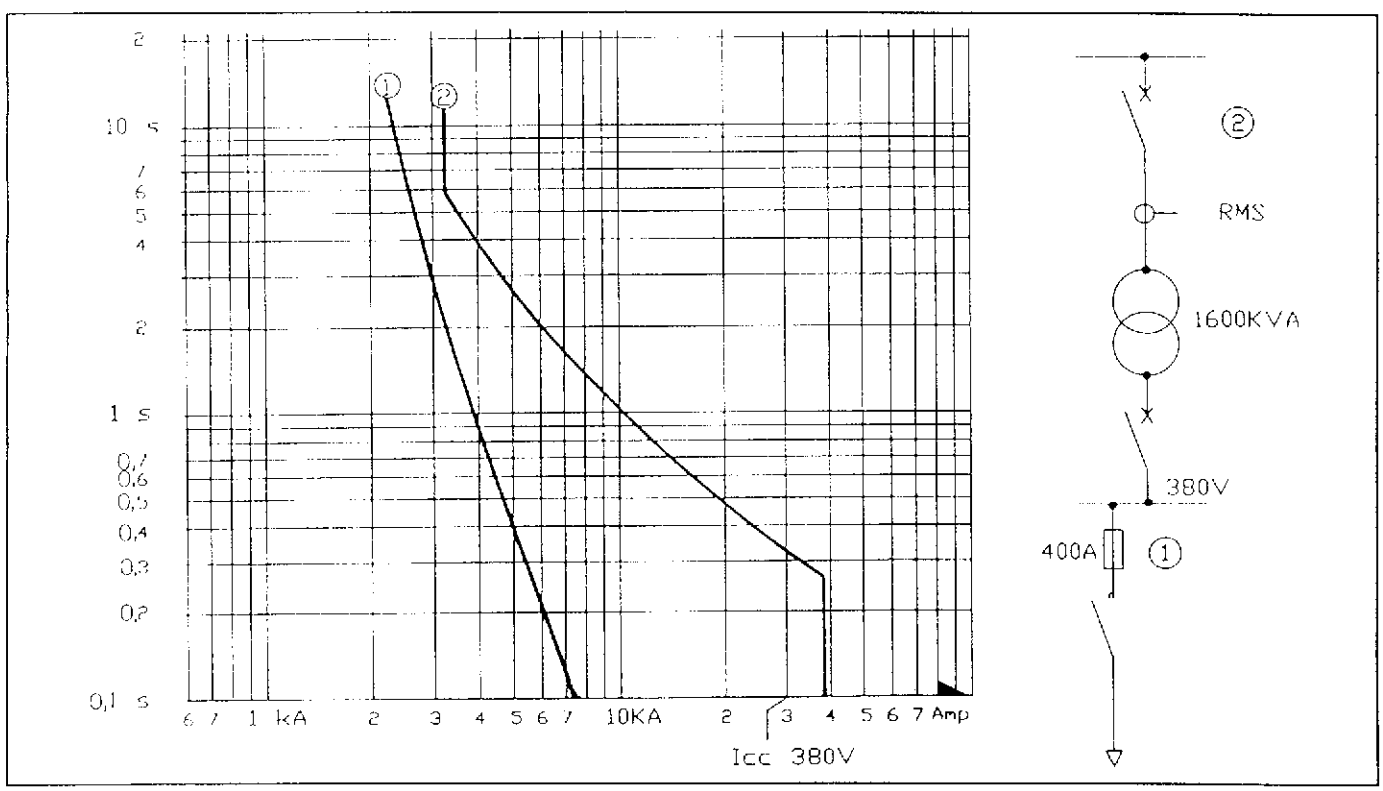
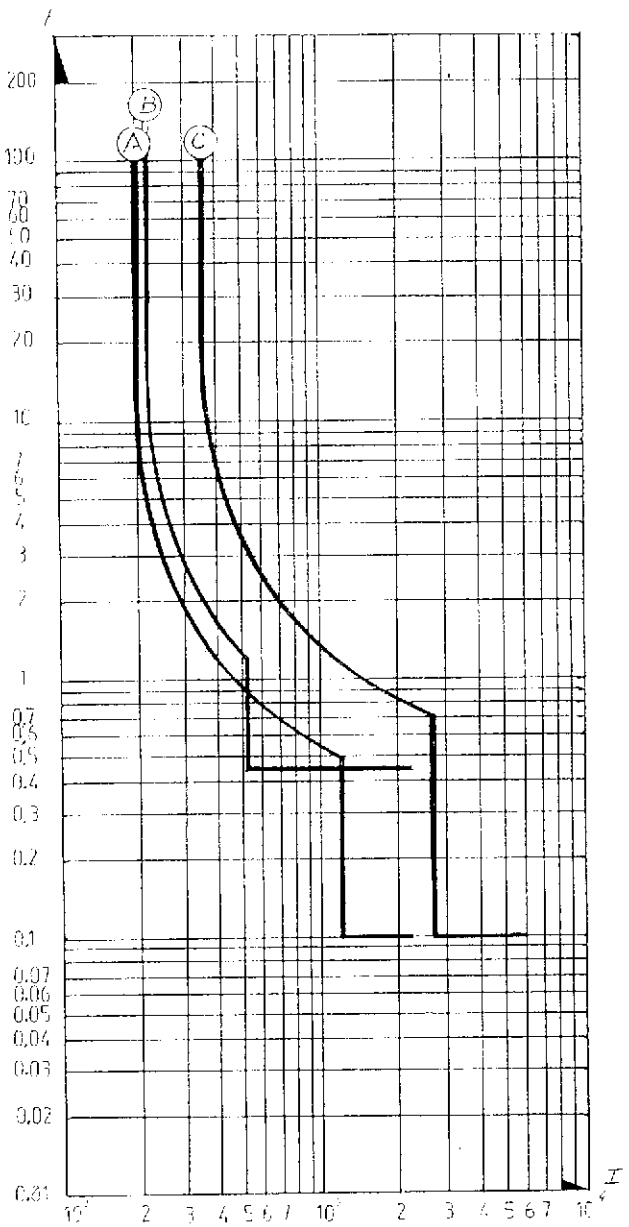
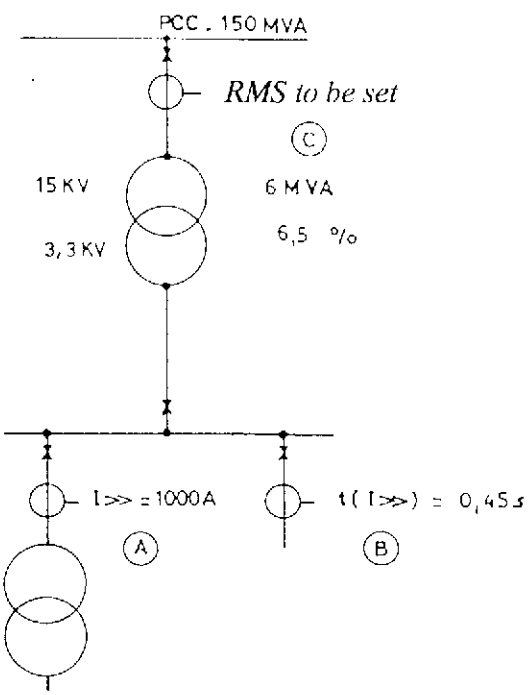


FIGURE 2 - CO-ORDINATION BETWEEN FUSES AND INVERSE TIME RELAYS



I.3. SETTING EXAMPLE





a) Calculation of the maximum short-circuit current through the 6 MVA transformer for a bolted fault at 3.3 kV

. *Short-circuit power - Infinite 15 kV network:*

$$PCC\ InF = \frac{6\ MVA \times 100}{6.5} = 92.3\ MVA$$

. *True short-circuit power (corrected for the true short-circuit power of the 15 kV/150 MVA network):*

$$PCC = \frac{PCC\ InF \times 150}{150 + PCC\ InF} = 57.14\ MVA$$

. *Maximum short-circuit current (referred to 15 kV level):*

$$ICC = \frac{PCC}{15\sqrt{3}} = \frac{57.14}{15\sqrt{3}} = 2{,}200\ A$$

b) Adjustment of the high-set unit I>>

$I>> = 1.2 \times ICC = 2{,}640\ A$

On the secondary of the CT:

$$I>>\ \frac{2{,}640 \times 5}{250} = 52.8\ A$$

$$I>>\ \frac{52.8}{5} = 10.56\ IN\ relay$$

A setting of 11 IN is thus chosen for the high-set instantaneous unit.

c) Adjustment of the low-set unit I>

The inverse time characteristic is selected, since it is most suited to the characteristics of the protections installed downstream (see curves).

The current level I> is fixed at 1.4 x In transformer (to allow long-duration overloads to flow and to co-ordinate with the downstream protection) i.e. I> = 1.4 x 230 A = 322 A.

The current transformer ratio being 250 A/5 A, the RMS 7991 is set to I> = 1.3 x In CT = 1.3 x 250 A = 325 A.

The time delay t(I>) allows a co-ordination step of 0.3 s as compared to the relay with the longest operating time at the maximum 3.3 kV short-circuit (0.45 s).

At 2,200 A, the operating time of the relay is thus equal to0.45 s + 0.3 s = 0.75 s.

2,200 A represents 2200/(1.3 x 250) = 2200/325 = 6.77 times the setting current.

Referring to the curves on Page 28, a setting of 0.65 s is selected which allows 6.77 times the setting current to pass (325 A) for a time of 0.75 seconds.

1.4. COMMUNICATIONS

The RMS 7992 communicates with the outside world in 3 main ways:

. Local communication (see paragraph IV)

The man/machine interface is provided via a keyboard mounted on the unit which enables variables to be set or the reading of all quantities registered, calculated or measured by the RMS 7992.

An easy-to-read LCD display gives the electrical quantities in real primary values.

. Digital communication

The RMS 7992 case is equipped with two (serial) digital communication channels of the RS 232 C/DB 25 or current loop (0-20 mA) types, selected via a switch accessible to the operator.

The RS 232/DB 25 socket provides a direct connection (galvanic or by optical fibre) from the relay to an IBM PC microcomputer.

The current loop sockets (0-20 mA) are used for the integration of the relay into a communications network controlled by a PC or other equipment (please consult us). All information available locally, measurements or parameters may be transmitted remotely. When an event such as relay tripping or operation of the "trace" button takes place, the effective values of the phase and earth fault currents, calculated from approximately 3.5 seconds before the event to one second afterwards, are made available to the master system (see I.5.2. Connection Details).

. Communication by logic on/off channels

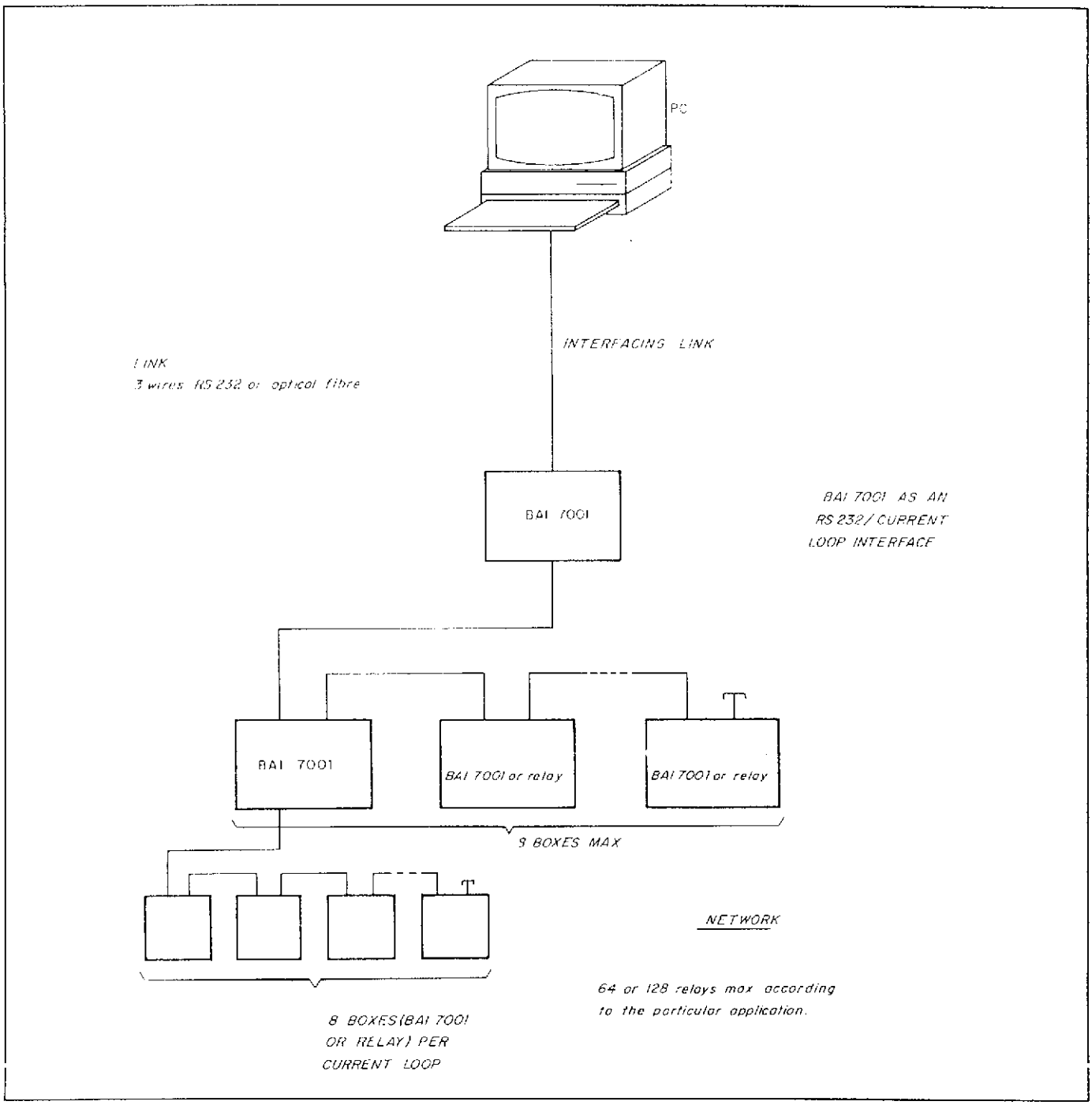
The RMS 7992 is equipped with electromagnetic output relays for alarm, tripping or load-shedding functions:

- Self-monitoring : by a volt free contact from the "watchdog"
- Alarm : by the instantaneous operation of the (C) relay indicating that the threshold has been reached :
.RMS 7992 : high-set or low-set threshold(s)
.RMST 7992 : high-set or low-set threshold(s) or thermal alarm threshold.

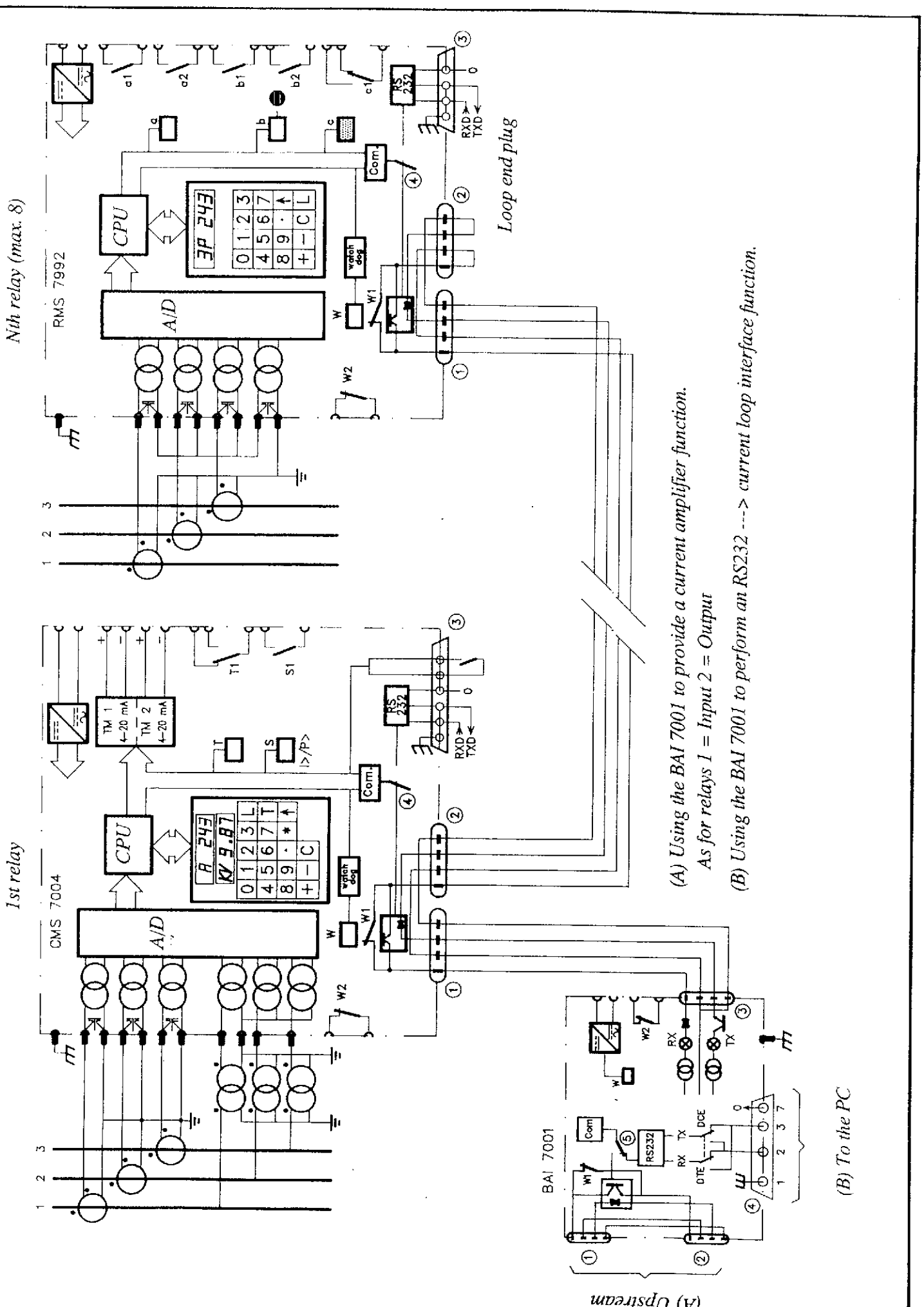
- Tripping or load shedding: two output relays with high power contacts are used to control the power equipment, contactors or circuit-breakers. The routing of the high-set level, low-set level, phase and earth functions to each of these relays is entirely programmable by the user. Whereas the operation of the relay is systematically indicated by a flashing of the LC indicator, a mechanical flag is also used to show the operation of the "B" output unit. Indication of the phase having caused the operation of the relay is obtained from the LCD display.

I.5. EXAMPLE OF INTEGRATION INTO A COMMUNICATIONS NETWORK

I.5.1 GENERAL STRUCTURE OF A PROCOM NETWORK



I.5.2. CONNECTION DETAILS



II. DESCRIPTION OF MECHANICAL INSTALLATION

II.1 INTRODUCTION

The figures on Page 11 and 12 show the different data relating to the mounting and physical installation of the relay.

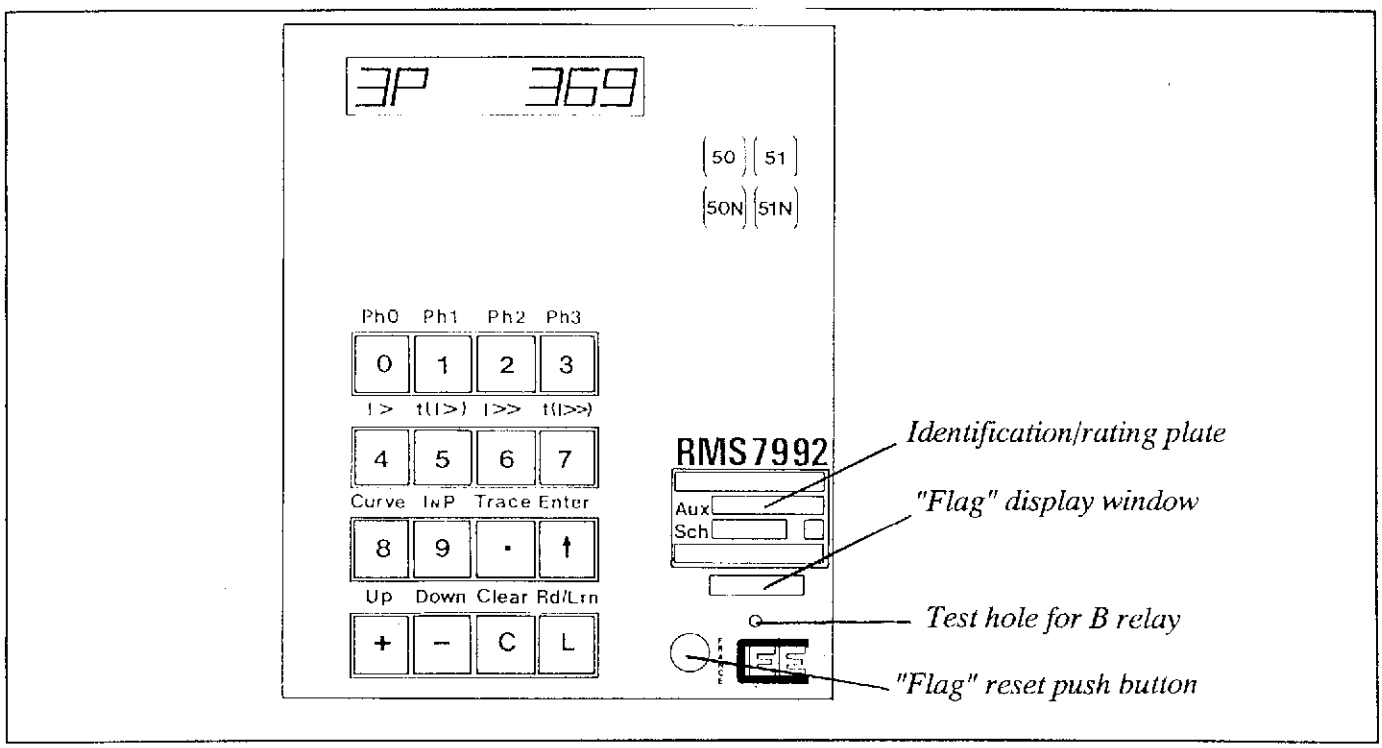
All parts necessary for the mounting of the relay (in the version ordered) are part of the package as supplied, including the screws for the terminals.

The "current" inputs on the bases are equipped with an automatic CT short-circuiting system for when the relay is withdrawn from the base. To ensure the correct opening of the short-circuiters, it is very important after plugging in, to fully screw home the fixing rods . The use of a flat 3.5 screwdriver is required for this .

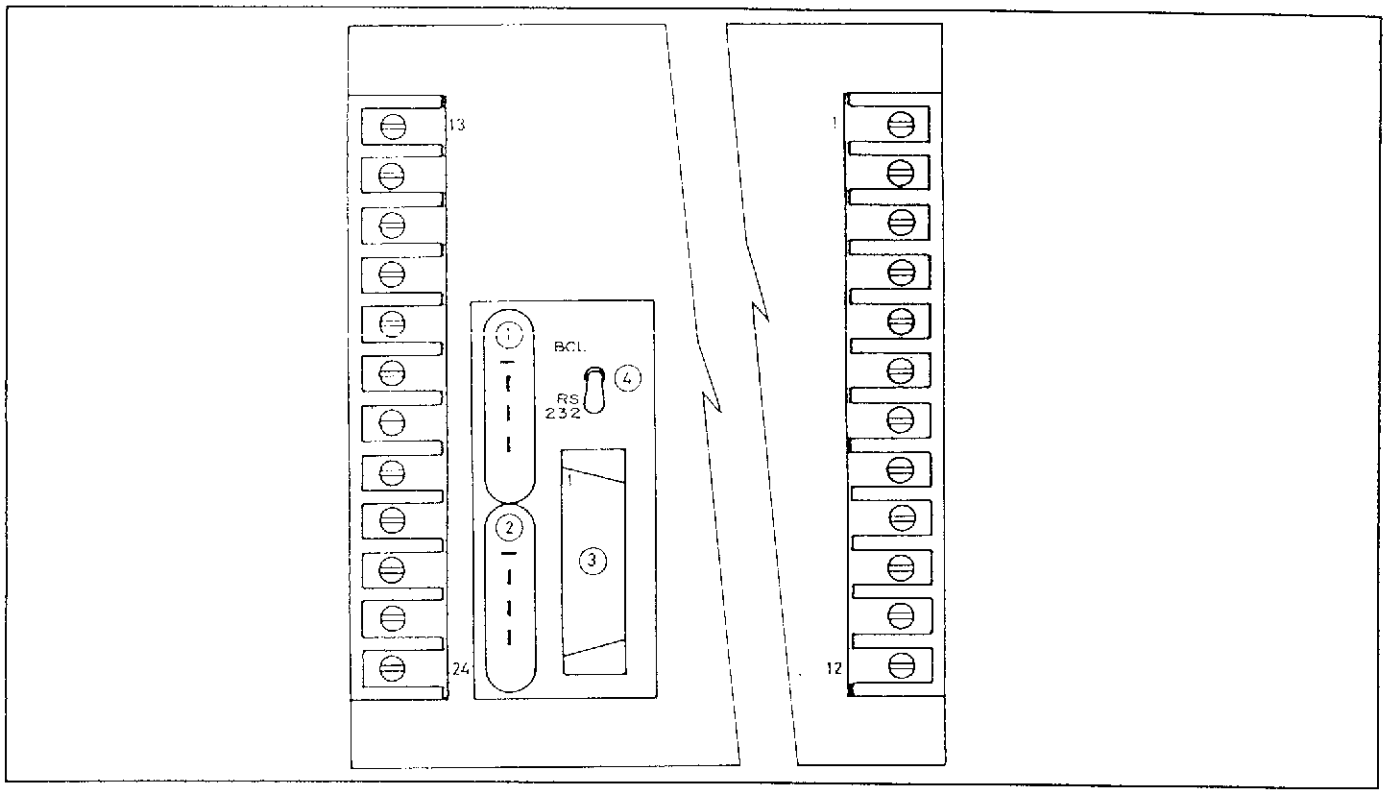
CAUTION : all relays are delivered complete with a lead-seal applied after the final factory inspection. The lead seals should only be broken when the units are put into service by personnel qualified for such an operation.
It is important before any operation to ensure that the relays have not suffered any mechanical damage.
When plugging the equipment in, check that the "current loop" plug locking clips are horizontal so as not to obstruct the operation.

IMPORTANT: WE STRONGLY ADVISE AGAINST TESTING THE RELAY WITHOUT ITS BASE BY USING STANDARD COMMERCIALLY-AVAILABLE PLUGS OR LEADS DIRECTLY INTO THE FEMALE CONNECTORS OF THE RELAY .

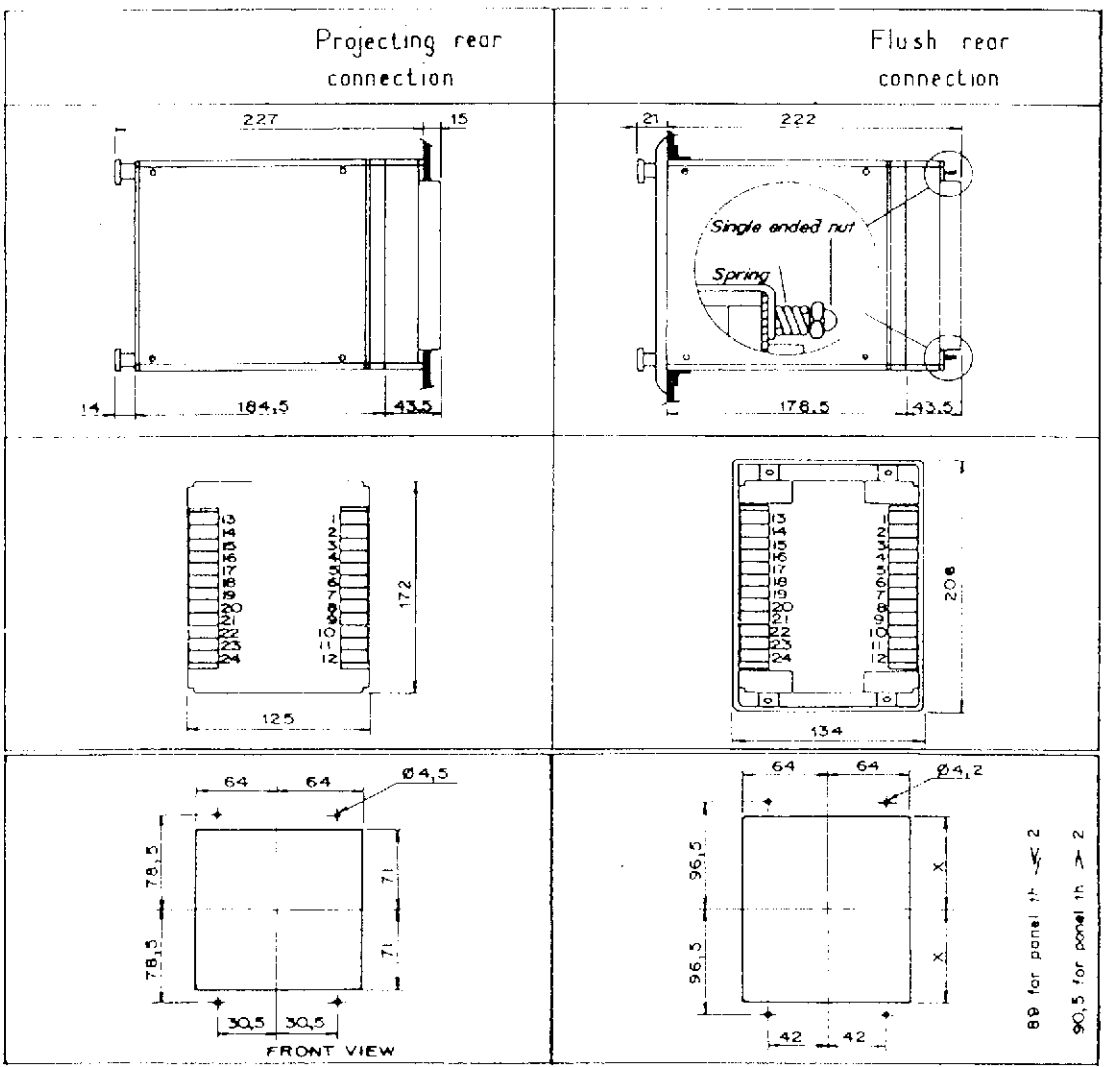
II.2. FRONT VIEW OF THE RELAY



II.3. REAR VIEW OF THE RELAY



II.4. CUT-OUT AND DIMENSIONS



III. ELECTRICAL INSTALLATION

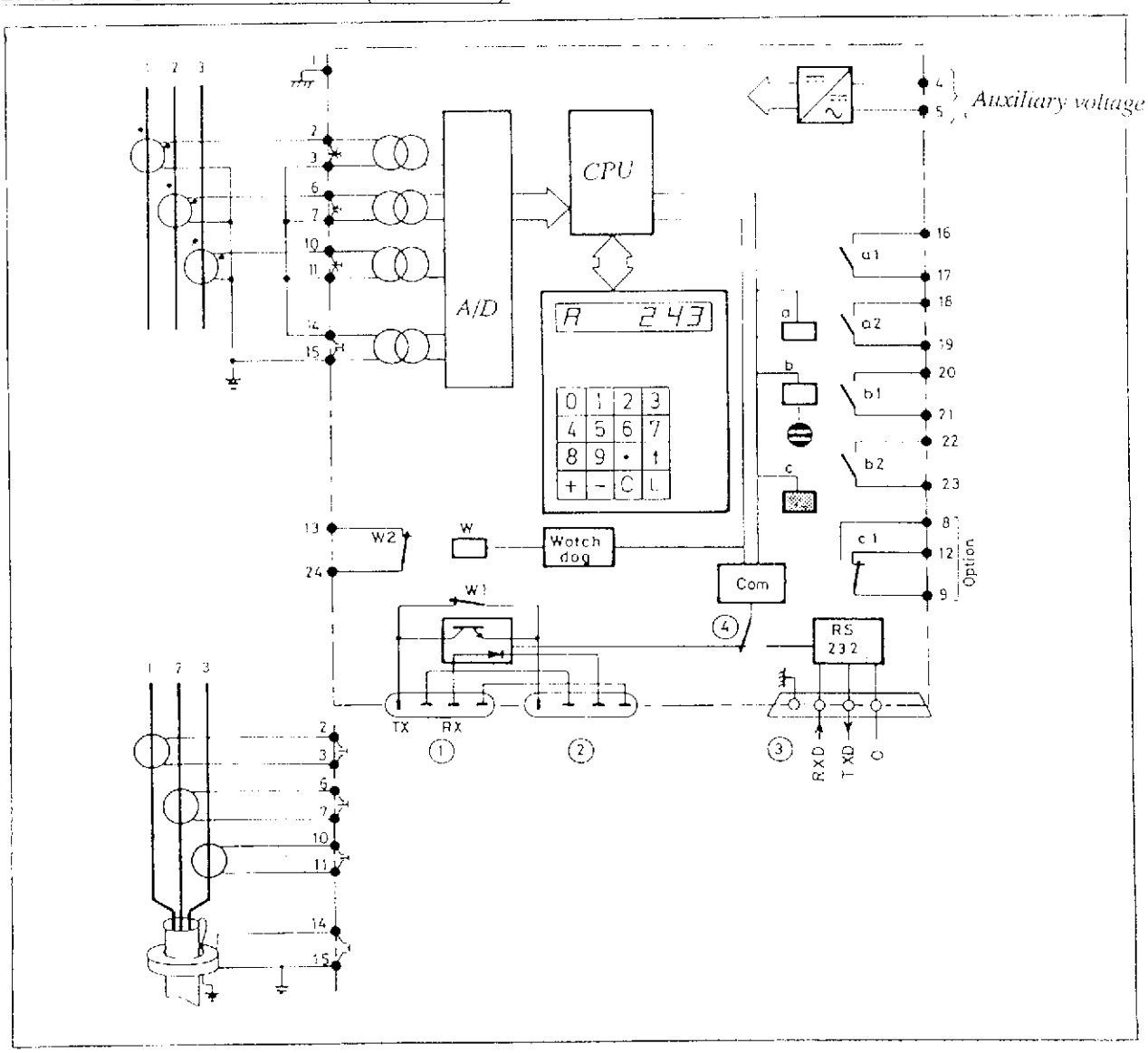
III.1. INTRODUCTION

Using the connection diagram in Figure III.2. (and on the communications network diagram where appropriate), make the various connections using the terminal references given in Figure III.3.
The diagrams on Pages 13, 14 and 15 represent respectively the power and communications connections.

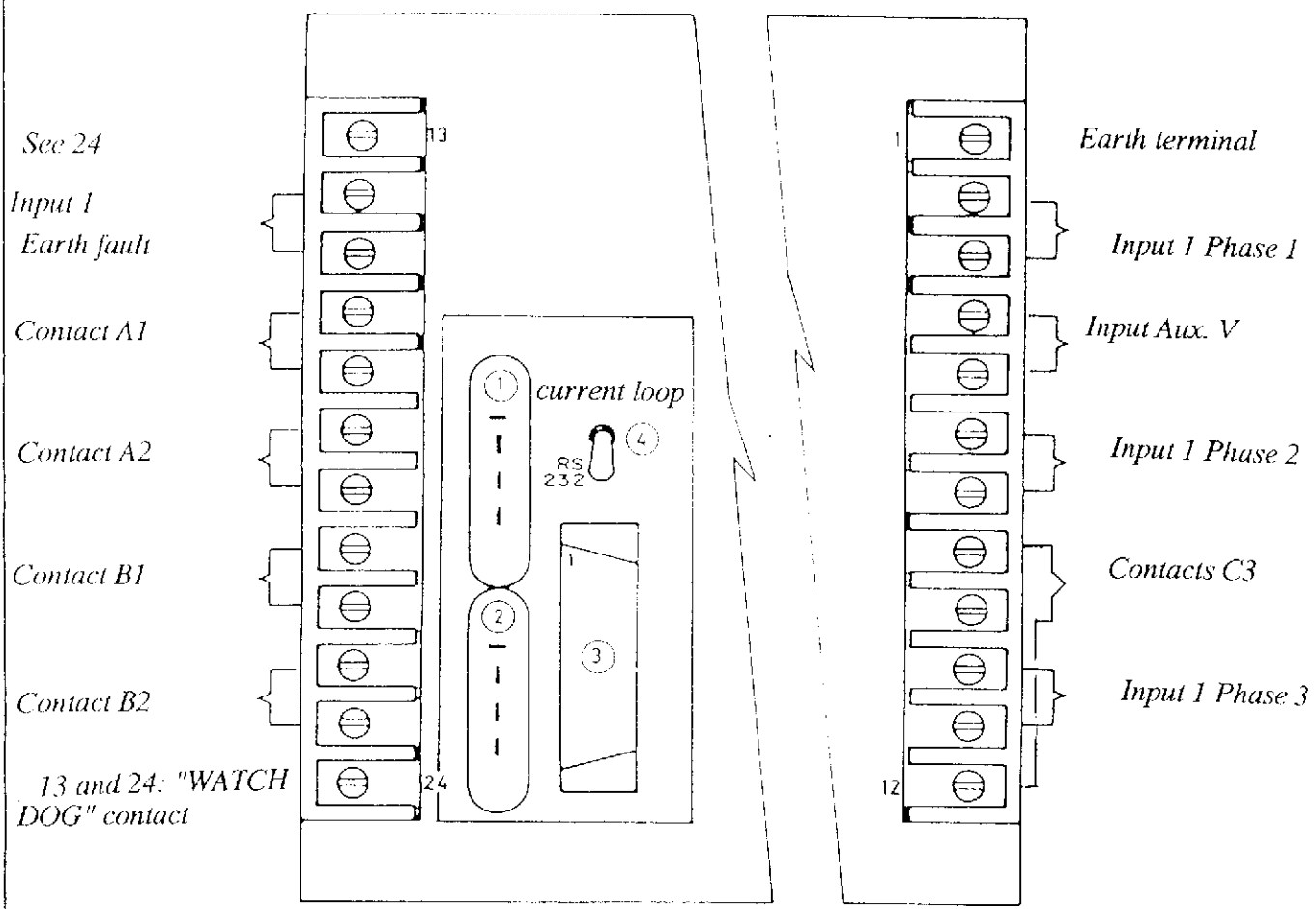
RECOMMENDATIONS

Before commissioning, it is important to check that:
- the current transformers have a rated current the same as that indicated on the relay rating plate, and have a minimum
- the frequency of the network is identical to that programmed on the relay (see chapters IV.2 and IV.3);
- the wiring connections agree with the diagram;
the auxiliary voltage is the same as that indicated on therating plate;
- the relay is correctly plugged in, and that the fixing rods are fully screwed in;
- the tripping connections are correct.

III.2. CONNECTION DIAGRAM (RMS 7992)



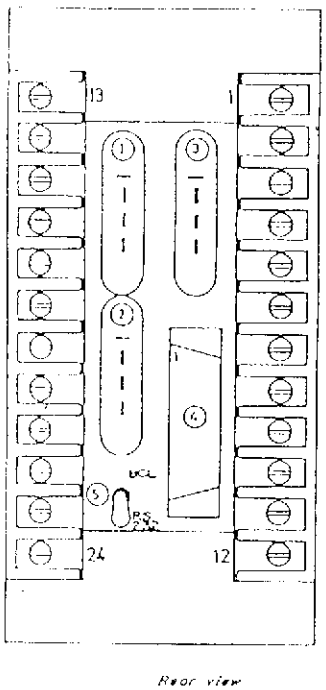
III.3. DESCRIPTION OF TERMINAL BLOCKS



CONNECTORS 1 AND 2 are dedicated to current loop communication

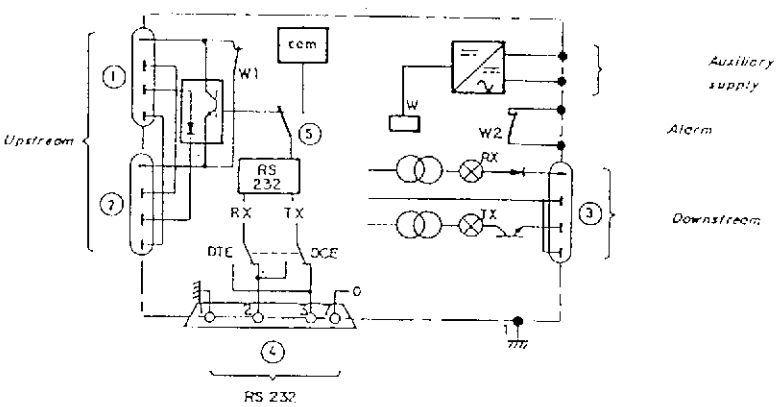
PLUG 1 : INPUT from the master or the UPSTREAM device
PLUG 2 : OUTPUT to the DOWNSTREAM relay or END-OF-LOOP PLUG
3 : dedicated to communications via RS 232C
4 : current loop or RS 232 selector switch

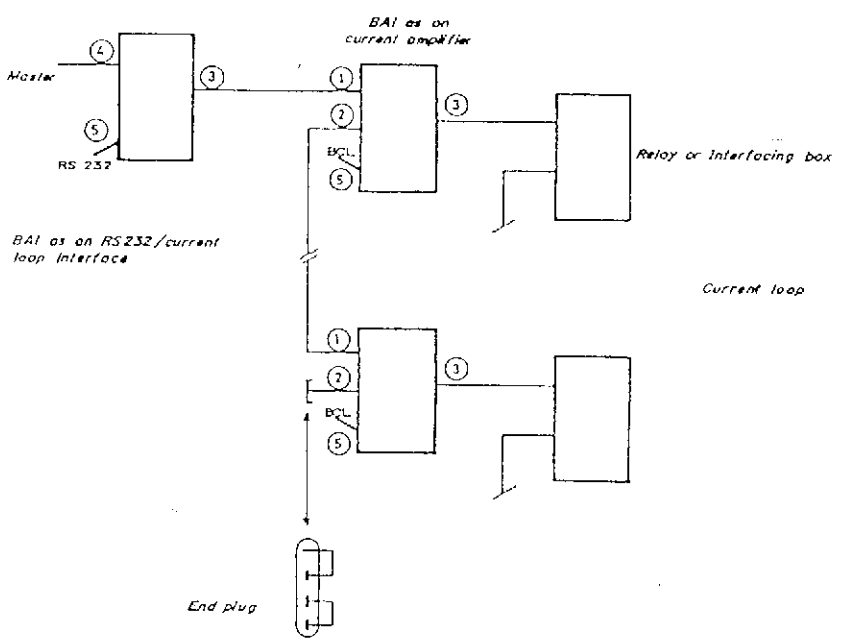
III.4. INSTALLATION OF COMMUNICATION

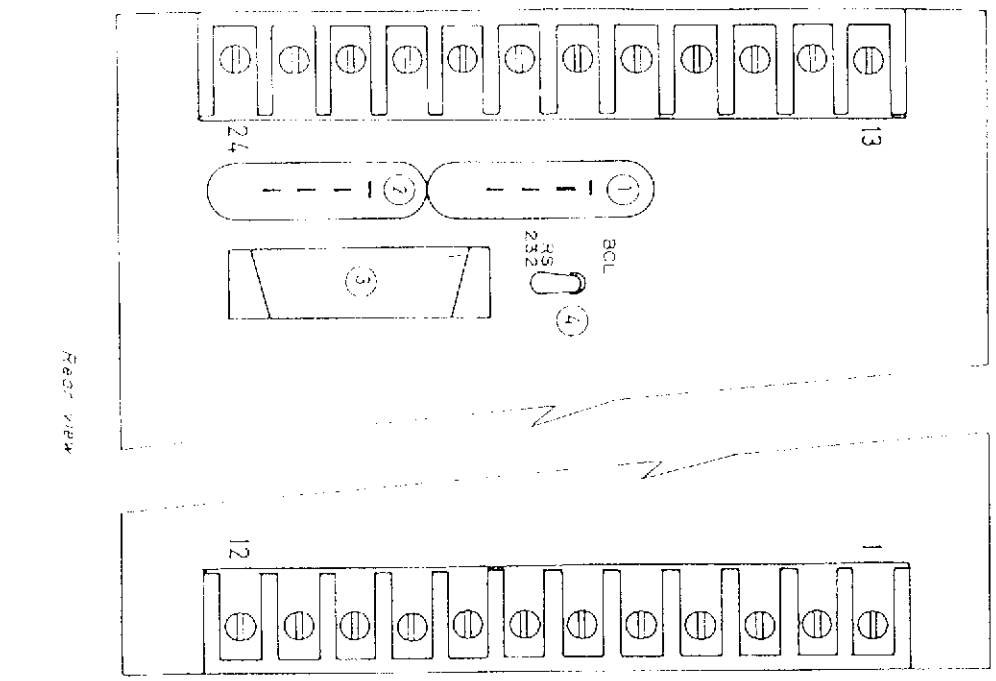


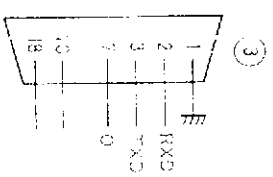
Rear view

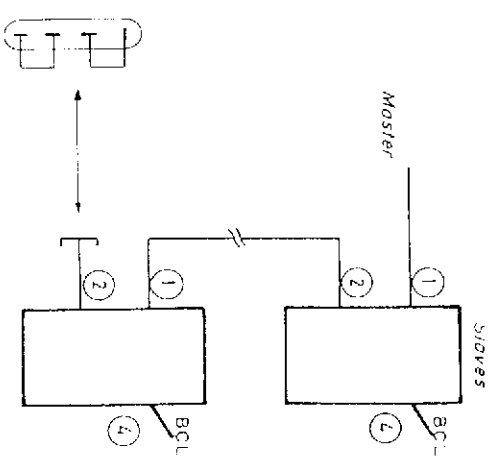
BAI 7001






24
13
12
1
RS 232
BCL
Rear view

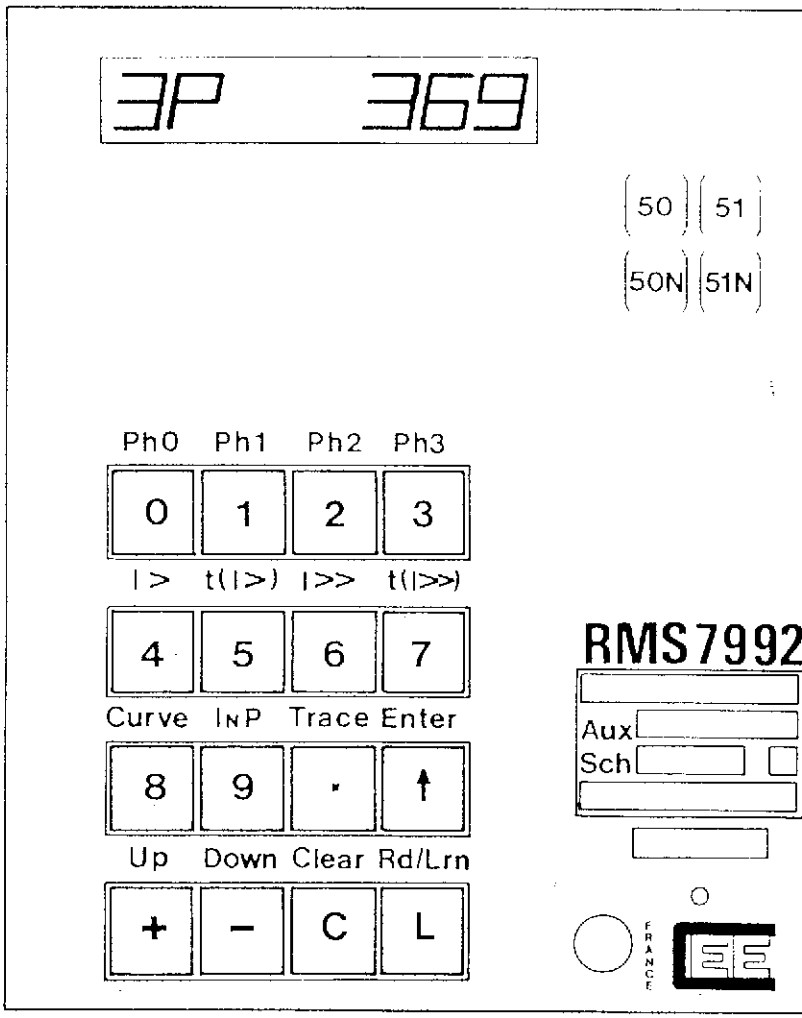

RXD
TXD
Record


End plug
Master
Slaves
BCL
RS 232
Master
Current loop

IV. DISPLAY , SETTING OF VARIABLES

IV.1. DEFAULT MODE

The Man <--> Relay dialogue is carried out by means of the display and the keyboard in two modes:
- Read Mode,
- Variable Setting Mode.
The "L" key is used to change from one to the other.
In each mode, the values are organised into main headings.
The "+" and "-" keys are used to scroll throught he various values under a main heading.
The "C" key is used :
- to delete data that is not validated in Variable Setting Mode;
- to return to the input point of a heading in Variable Setting Mode;
- to acknowledge a fault.
The ↑ key is intended for the validation of variable setting or "freezing" the trace.



IV.2. READ MODE

The Read Mode is used to consult all variables , but not for modifying them .
To consult a variable or measurement : press the key corresponding to the heading containing it (e.g. 4 for I>) and then the "+" or "-" key to scroll the heading.
In this mode, heading changes are made by pressing on any other heading key.

If the keyboard is not used for 15 min, the display will return automatically to the "default value": the three phase mean current.

NOTE: THE ACCURACY OF THE CURRENT MEASUREMENTS <25% OF IN (OVERCURRENT) OR 2.5% (EARTH FAULT) IS NOT GUARANTEED.

QUANTITIES ACCESSIBLE IN READ MODE

PHO	KEY 0	PH1	KEY 1	PH2	KEY 2	PH3	KEY 3	
	0 E		1 E		2 E		3 E	Total programmed RMS current
	0 1		1 1		2 1		3 1	Fundamental RMS current
	0 2		1 2		2 2		3 2	2nd harmonic RMS current
	0 3		1 3		2 3		3 3	3rd harmonic RMS current
	0 4		1 4		2 4		3 4	4th harmonic RMS current
	0 5		1 5		2 5		3 5	5th harmonic RMS current
	0 6		1 6		2 6		3 6	6th harmonic RMS current
	0 7		1 7		2 7		3 7	7th harmonic RMS current
			1 8		2 8		3 8	Thermal state in % (RMST 7992 only)

I>	KEY 4	t(I>)	KEY 5	I>>	KEY 6	t(I>>)	KEY 7	
	0 4 0		0 5 0		0 6 0		0 7 0	Earth fault setting values
	0 4 1		0 5 1		0 6 1		0 7 1	Programming of earth fault output relays
	P 4 0		P 5 0		P 6 0		P 7 0	Overcurrent unit setting values
	P 4 1		P 5 1		P 6 1		P 7 1	Programming of overcurrent output relays
	8 4 0				8 6 0			Thermal Alarm (840) and thermal trip (860) setting values
	8 4 1				8 6 1			Programming of thermal alarm (841) and thermal trip (861) output relays

CURVE	KEY 8	
	0 8	Earth fault curve type
	P 8	Overcurrent curve type
	8 8	Time constant τ in minutes (RMST 7992 only)

TRACE	KEY	
	E .	Slave address
	5 .	Transmission speed

IN·P	KEY 9			
	0 9	Earth fault primary rated current	(residual connection	: line primary IN setting value
	P 9	Line primary rated current	(from 100 turn core-balanced CT	: 100A obligatory setting
	9 9	Rated frequency (50 or 60Hz)		

IV.3. VARIABLE SETTING MODE (Lrn)

This mode is used to set the device to the values determined by the co-ordination study.
Entering and leaving this mode is done by pressing the "L" key, the choice of a main heading and then the scrolling of the various variables taking place using a procedure identical to that used in Read Mode.
A valid variable value is identified by a dash inserted between the code and the value - any value outside the range will be automatically replaced by the minimum or maximum (depending on the case) when pressing the ↑ key.

NB: an example on Page 19 illustrates the programming sequence for I> threshold and then the I>> threshold .

SET OF CODES that may be read in the Variable Setting Mode. To enter this mode press "L" and then choose a main heading.

PHO	KEY O	PH1	KEY 1	PH2	KEY 2	PH3	KEY 3
<-->	LO	<-->	L1	<-->	L2	<-->	L3
	LOH1		L1H1		L2H1		L3H1
	LOH2		L1H2		L2H2		L3H2
	LOH3		L1H3		L2H3		L3H3
	LOH4		L1H4		L2H4		L3H4
	LOH5		L1H5		L2H5		L3H5
	LOH6		L1H6		L2H6		L3H6
	LOH7		L1H7		L2H7		L3H7
I>	KEY 4	t(I>)	KEY 5	I>>	KEY 6	t(I>>)	KEY 7
<-->	L4	<-->	L5	<-->	L6	<-->	L7
	L040		L050		L060		L070
	L041		L051		L061		L071
	LP40		LP50		LP60		LP70
	LP41		LP51		LP61		LP71
	L840				L860		
	L841				L861		
CURVE	KEY 8	INP	KEY	SPECIAL FUNCTIONS	KEY		
<-->	L8	<-->	L9	<-->	L.		
	L08		(L09		LL.		
	LP8	INP	(LP9		LE.		
	L88	FN	L99		L5.		

Passing from one main heading to another can only take place at the entry/exit point referenced by "<-->", as in Read Mode, by pressing the corresponding key.
Scrolling within the headings takes place by using the "+" and "-" keys.

Example :

	Key pressed	*Display*	
		X X X X X	
	L	*L*	
	4	*L 4*	
	+	*L 0 4 0 X X X*	
	+	*L 0 4 1 X X X*	
or ---------->	+	*L P 4 0 0. 5*	
---------->	*C*	*L 4*	*Return ot point of entry*
---------->	*2*	*L P 4 0 2*	
	.	*L P 4 0 2 .*	
	5	*L P 4 0 2 . 5*	
	If the value is not correct :		
	[↑]	*L P 4 0 2 . 5*	
	If incorrect :		
	C	*L P 4 0 0 . 5*	*Recall the old valid value*
	2	*L P 4 0 2*	
	.	*L P 4 0 2 .*	
	4	*L P 4 0 2 . 4*	
	[↑]	*L P 4 0 - 2 . 4*	
	C	*L 4*	*Return to the point of entry*
	6	*L 6*	
	etc		
	C		
	L	*3 P X X X*	*Return to the default display*

Note : so as to facilitate programming and to reduce the risk of errors, certain keys have been made inoperative.

The complete list of the authorised values is given hereafter.

HEADING		VARIABLE	POSSIBLE VALUES	MEANING	COMMENTS
L0	LOH1 to LOH7	Programming of total RMS value used by the threshold units and display	0 1	Harmonic not taken into account Harmonic taken into account	H1 programmed to O is prohibited
L1 L2 L3	ditto	ditto	ditto	ditto	ditto
L4 I> th> 	L040 L041 LP40 LP41 L840 L841	Earth-fault low set threshold Output relay controlled by the unit Phase fault low-set threshold Output unit controlled by this unit Thermal alarm setting threshold)RMST Output unit controlled by this unit) 7992	0.05 to 0.04 0,1,2,3,(4,5,6) 0.5 to 4 0,1,2,3,(4,5,6) 0.8 to 1 0.4	Selection of output relays O None 4 C 1 A 5 A and C 2 B 6 B and C 3 A and B	In multiples of IN - step : 0.01 In multiples of IN - step : 0.1 In multiples of Ith - step : 0.05
L5 t(I>) 	L050 L051 LP50 LP51	Value of time delay of low-set earth fault unit Output relay controlled by this unit Value of time delay of low-set overcurrent unit Output relay controlled by this unit	O.5 to 30 1, 2, 3 0.1 to 30 1, 2, 3	Selection of output relays 1 - A 2 - B 3 - A and B	In seconds - step : 0.05 (0.1 to 3) or 0.5 (3 to 30) ditto
L6 I>> Ith> 	 L060 L061 LP60 LP61 L860 L861	 Earth-fault high-set threshold Output relay controlled by this unit Overcurrent high-set threshold Output relay controlled by this unit Thermal setting threshold)RMST Output unit controlled by this unit) 7992	 0.2 to 2.5 0,1,2,3,(4,5,6) 2 to 25 0,1,2,3,(4,5,6) 0.5 to 1.2 0,1,2	Selection of output relays 0 None 1 A 4 C 2 B 5 A and C 3 A and B 6 B and C	 In multiples of IN - step : 0.05 In multiples of IN - step : 0.5 In multiples of IN - step : 0.05
L7 t(I>>) 	 L070 L071 LP70 LP71	 Value of time delay of high-set earth-fault unit Output relay controlled by this unit Value of time delay of high-set overcurrent unit Output relay controlled by this unit	 0.1 to 3 0,1,2,3 0.1 to 3 0,1,2,3	Selection of output relays 0 None 1 - A 2 - B 3 - A and B	 In seconds - step : 0.05 ditto
L8 Curves Time constant	 L08 LP8 L88	 Earth-fault curve type Overcurrent curve type Time constant τ RMST 7992	 0,1,2,3,4 4 to 180	0 Independent time 1 Independent time 2 Inverse 3 Very inverse 4 Extremely inverse	0.1 to 3 step : 0.05 3 to 30 step : 0.5)) time defined at 10 x I> setting) 4 to 180 minutes step of 1 minute
L9 INP FN	 L09 LP9 L99	 Value of CT primary rated current for residual connection / 100A setting on 100 turn core-balanced CT Value of CT rated primary rated current Rated frequency	 1 to 7500/100 1 to 7500 50 to 60Hz		) step : 1))
L. 	LL. LE.	 Slave address (communication)	 001 to 255	Locked trace	Pressing ↑ locks the trace step : 1
	L5.	Communication speed	1, 2, 3	1 = 1200 bauds 2 = 2400 bauds 3 = 4 800 bauds	Speed expressed in Bauds

IV.4. SIGNALLING FUNCTIONS

RMS 7992 RELAY

Alarm:
- In the event that the I> or Io> threshold is exceeded, the display flashes and indicates the phase involved in the fault, as well as the value of the current. If the current falls below the threshold, the display stops flashing.

Trip:
- In the event that the time delay units tI>, tI>>, tIo> or tIo>> trip, the display flashes and a line appears followed by the value of the current at the instant of fault apparition. This value is memorised. The key "C" cancels the trip in the event that the fault disappears and re-sets the "trace" function (see Paragraph 5).

E.g.: 17 - 262: Fault current of 262 A eliminated on phase 1 by the high-set time-delay unit (7).

After disappearance of the fault, any other phenomenon causing tripping will be recorded in the place of the preceding one, whether or not the first fault has been cancelled.

RMST 7992 RELAY

The signalling functions are identical to those described for the RMS 7992 except for the thermal unit.

Thermal image alarm:
- In the event that the thermal alarm threshold is exceeded (64% or 100% - see chapter V.7.2.) and provided that this unit has been programmed to the "C" relay, the display flashes and automatically indicates the phase involved in the fault, as well as the value of the thermal state.
Note: During this period, if the level I> or Io> is reached, the display of the fault current takes priority and replaces the thermal state.

- If the thermal state decays and falls below the alarm level, the display stops flashing.

Thermal image trip:
- In the event that the thermal image trip level is exceeded (114%), the display flashes, a line appears followed by the value 114 corresponding to the thermal image trip level. The key "C" cancels the display flashing provided that the thermal state is less than 107% and re-sets the "trace" function (see Paragraph 5).

SUMMARY OF DISPLAY CODES

X4 - current level : alarm
X5 - current level : tI> or tIo> trip
X7 - current level : tI>> or tIo>> trip
X8 - thermal state % : alarm
X8 - 114 : thermal trip

IV.5. "TRACE" FUNCTION

The RMS is provided with a revolving memory system in which the rms value of the phase and earth fault currents are recorded every 35 ms. The memory size corresponds to a recording period of approximately 4.5 s.
Tripping or pressing ↑ in LL mode has the effect of "freezing" the recording and enables reading, on the communication system, of the current values 3.5 seconds before the initialisation and 1 second afterwards. A dash appears on the right hand side to specify that the trace has been "frozen". Exceeding another threshold, an order received from the communication channel or pressing C in the "default" mode has the effect of restarting the trace recording again (the dash disappears).

IV.6. SELF-MONITORING FUNCTION

The RMS 7992 relays are provided with a self-monitoring system which operates in 3 modes:
- detection of loss of auxiliary voltage;
- detection of peripheral failure by the microprocessor;
- detection of failure of the microprocessor by the watchdog.

Upon applying the auxiliary voltage, the WD (watchdog) relay picks up and the microdiagnostics begin:
0, displays
1, Internal RAM
2, External RAM
3, Serial BUS
4, Time base
5, EEPROM
6, PROM.

- When the complete sequence is successfully completed, all of the diagnostics references are present on the display followed by a dash.
- If the diagnostic test fails, the display remains frozen on the number of the appropriate test, everything flashes, and the WD drops out.

V. SWITH-ON AND TESTING

V.1. PRIOR CHECKS

These are intended to verify that the equipment has not been subject to damage during transport or storage and provides proof of the correct operation at the setting values.
These simple checks require a minimum of equipment, namely:
- a current source equipped with a timer and an automatic injection cut-off system as well as a source of auxiliary voltage;
- the test results are all expressed with a tolerance making allowance for the normal site test conditions.

If the equipment does not have an automatic cut-off system, it is advisable to stop current injection as soon as the expected phenomenon occurs.

In view of the universal nature of the programming of the output relays, it will be necessary, in order to perform a complete check, to modify certain variables and so it is advisable to note the following values before testing:

P41	---
P51	---
P61	---
P71	---
041	---
051	---
061	---
071	---
840	---
841	---
860	---
861	---

When testing a RMST 7992 relay, the testing of the low-set and high-set, overcurrent and earth fault levels, (chapters V.4, V.5, V.6) is done with the thermal unit out of service:
861 = 0 and, if necessary, the thermal alarm unit out of service: 841 = 0.

V.2. REVIEW OF THE PROGRAMMING POSSIBILITIES OF THE OUTPUT RELAYS

					Option : alarm unit		
	Code	*No relay 0*	*A or B 1 or 2*	*A and B 3*	*C 4*	*A and C 5*	*B and C 6*
PHASES							
Instantaneous low-set I>	*P41*	*X*	*X*	*X*	*X*	*X*	*X*
Time delay low set t(I>)	*P51*	*Not auth*	*X*	*X*	*Not auth*	*Not auth*	
Instantaneous high-set I>>	*P61*	*X*	*X*	*X*	*X*	*X*	*X*
Time delay high-set t(I>>)	*P71*	*X*	*X*	*X*	*Not auth*	*Not auth*	
Thermal alarm (RSMT 7992) Ith>	*841*	*X*	*Not auth*	*Not auth*	*X*	*Not auth*	*Not auth*
Thermal trip (RMST 7992) Ith>	*861*	*X*	*X*	*Not auth*	*Not auth*	*Not auth*	
EARTH FAULT							
Instantaneous low-set I>	*O41*	*X*	*X*	*X*	*X*	*X*	*X*
Time delay low-set	*O51*	*Not auth*	*X*	*X*	*Not auth*	*Not auth*	
Instantaneous high-set t(I>>)	*O61*	*X*	*X*	*X*	*X*	*X*	*X*
Time delay high-set t(I>>)	*O71*	*X*	*X*	*X*	*Not auth*	*Not auth*	

**Not auth : not authorized*

This table shows that time delay units may not be put out of service.

V.3. SWITCH-ON

Check that everything takes place as described in Paragraph IV.

V.4. TESTING THE LOW-SET OVERCURRENT LEVEL

SEQUENCE OF OPERATIONS TO BE PERFORMED	*RESULTS TO BE OBTAINED*
- Set P41 to 1 *P51 to 2* *P61 to 0* *P71 to 0*	
- Testing the operating level *. Connect the current source to 2-3, 6-7, or 10-11* *. Place a timer on one of the A contacts.* *. Progressively increase the current up to the threshold. The threshold corresponds to 100% of setting for the independent time curves (types 0 and 1) and to 110% of setting for the inverse time type curves (type 2, 3 and 4).*	*The A contact changes state when the injected current is equal to the threshold +/- 10%*
- Testing the time delay *. Connect a B contact to trip the source* *. Pre-(adjust the current to ten times the setting (inverse time) or >1.5 times the setting (independent time)* *. Cut off the injection and reset the timer* *. Inject the current*	*The contact of A changes state instantaneously, the contact of B changes state after the time delay +/- 10%*
- If necessary, for relays with the alarm unit (C)à, programme this to the overcurrent low-set unit (P41 = 5	*The contacts of C change state instantaneously when the injected current is equal to the setting +/- 10%*

V.5. TESTING THE HIGH-SET OVERCURRENT LEVEL

SEQUENCE OF OPERATIONS TO BE PERFORMED	RESULTS TO BE OBTAINED
- Set P41 to 0 P51 to 2 P61 to 1 P71 to 0	
- Testing the operating level . Connect the current source to 2-3, 6-7, or 10-11 . Connect an A contact to trip the source - Pre-adjust the current to 0.9 x threshold . Inject the current for about 1 second . Pre-adjust the current to 1.1 x threshold	The A contact should not change state Automatic trip
- Testing the time delay	
- Set P41 to 0 P51 to 2 P61 to 0 P71 to 1 . pre-adjust the current to 1.5 x threshold . Connect an A contact to trip the source . Inject the current	The A contact should change state after the time delay +/- 10%
- If necessary, for relays with the alarm unit (C), programme this to the overcurrent high-set unit (P61 = 5)	The contacts of C change state instantaneously when the injected current is equal to 1.1 x the setting

CAUTION :

- *When the earth fault unit of the relay is supplied from residually connected CTs, the programmed primary rated current (Key 9 Code 09) is the primary rated line current.*
- *When the earth fault unit of the relay is supplied from a 100 turn core-balance CT, the programmed primary rated current must be 100 A, such that the earth fault current is displayed in amps. The different thresholds being expressed in % of primary rated current, a setting of X% of 100 A corresponds to the true value in amps.*

Example: setting Io> at 0.07 IN --> Io> = 0.07 x 100 A = 7 A

V.6. TESTING THE EARTH-FAULT UNIT

LOW-SET AND TIME DELAY

- *Set* 041 to 1
  051 to 2
  061 to 0
  071 to 0

- *Source to 14-15 or through the primary of the core-balance CT*

PROCEDURE IDENTICAL TO THAT FOR TIIE OVERCURRENT UNITS

HIGH-SET 1 AND TIME DELAY 2

1.Set *041 to 0)*
051 to 2)
061 to 1)
071 to 0)
) PROCEDURE IDENTICAL TO THAT FOR THE
) OVERCURRENT UNITS

2.Set *041 to 0)*
051 to 2)
061 to 0)
071 to 1)

NB: Reset the relay to the condition noted prior to the tests.

V.7. TESTING THE THERMAL IMAGE UNIT (RMST 7992 only)

- *Put the thermal image threshold (Ith) in service and programmed to relay A or B (861 = 1 or 2).*
- *If needed, inhibit the overcurrent thresholds in order totest the thermal image curve:*

.I> to its maximum setting, i.e. 4 IN	*--> LP40 = 4*
.I> out of service	*--> LP41 = 0*
.I>> out of service	*--> LP61 = 0*
.II>> out of service	*--> LP71 = 0*

V.7.1. TESTING THE COLD CURVE AT 2 Ith

The operating curves are defined by the formula

$$t(s) = \tau \, Ln \, \frac{(I/Ith)^2 - (Ip/Ith)^2}{(I/Ith)^2 - (K)^2}$$

where τ = *thermal time constant expressed in seconds*
I = *measured current*
Ith = *relay threshold current*
Ip = *initial load current*
K = *relay threshold = 1.07, i.e.* K^2 *=114% displayed upon tripping*

at 2 Ith and for initial load current of zero, we have:

$$t(s) = \frac{\tau \, Ln\,(2)^2}{(2)^2 - (1.07)^2} \simeq 0.335\,\tau$$

SEQUENCE OF OPERATIONS TO BE PERFORMED	*RESULTS TO BE OBTAINED*
- Connect the current source to 2-3, 6-7, or 10-11 *- Pre-adjust the current to 2 Ith* *- The source will start the timer and the relay will stop the source and the timer* *- Check the relay thermal state (code 18 phase 1, 28 phase 2 and 38 phase 3). If this is not zero, interrupt the Vaux for a few seconds in order to start from a zero thermal state (Ip = 0)* *- Re-set the timer* *- Inject 2 Ith* *- Cancel the fault using the C key* *- Return to the pre-tests settings*	*Relay output contact A or B should change state after a time t(s) = 0.335 , where is expressed in seconds.* *Tolerance +/- 10%*

NOTE :

I. When the current is injected, it is possible to read the thermal state of the phase concerned. The relay should trip for a thermal state equal to K^2 = 114%. Following tripping, the display should flash and show the value 114. The thermal state as displayed is a function of the applied rms current squared. For example, for a current equal to 0.8 Ith present for a time > 5 seconds, the display value will be equal to $(0.8)^2$ = 0.64, i.e. 64%.

II. The relay re-sets when the display thermal state is 107%.

V.7.2. TESTING THE THERMAL ALARM (UNIT C)

The thermal alarm unit has a threshold αIth adjustable from 0.8 to 1 Ith in steps of 0.05. At this threshold, - αIth the corresponding thermal state for the operation of the C relay is given by the following table

Ith	*: 0.8*	*0.85*	*0.9*	*0.95*	*1*
thermal state	*: 64%*	*72%*	*81%*	*90%*	*100%*

The operating curves of the thermal alarm unit are hence defined by the formula:

$$t(s) = \frac{\tau \, Ln \, (I/Ith)^2 - (Ip/Ith)^2}{(I/Ith)^2 - (1)}$$

Example: for a Ith = 0.8 setting, an overload = 2 Ith and an initial load current of 0, we have

$$t\ alarm\ (s) = \frac{\tau \, Ln \, (2/0.8)^2}{(2/0.8)^2 - (1)^2}$$

$$approximately \frac{\tau \, Ln \, (2.5)^2}{(2.5)^2 - (1)^2}$$

$$\underline{t\ alarm\ (s) \cong 0.174\ \tau}$$

By setting 841 = 4, it is possible to test the tripping time using the C relay.

V.8. COMMUNICATIONS TESTING

- If the relay is connected into a current loop, after having identified its address, perform an interrogation from the central system (check that the plugs are properly connected and that the switch on the rear is in the BCL position).

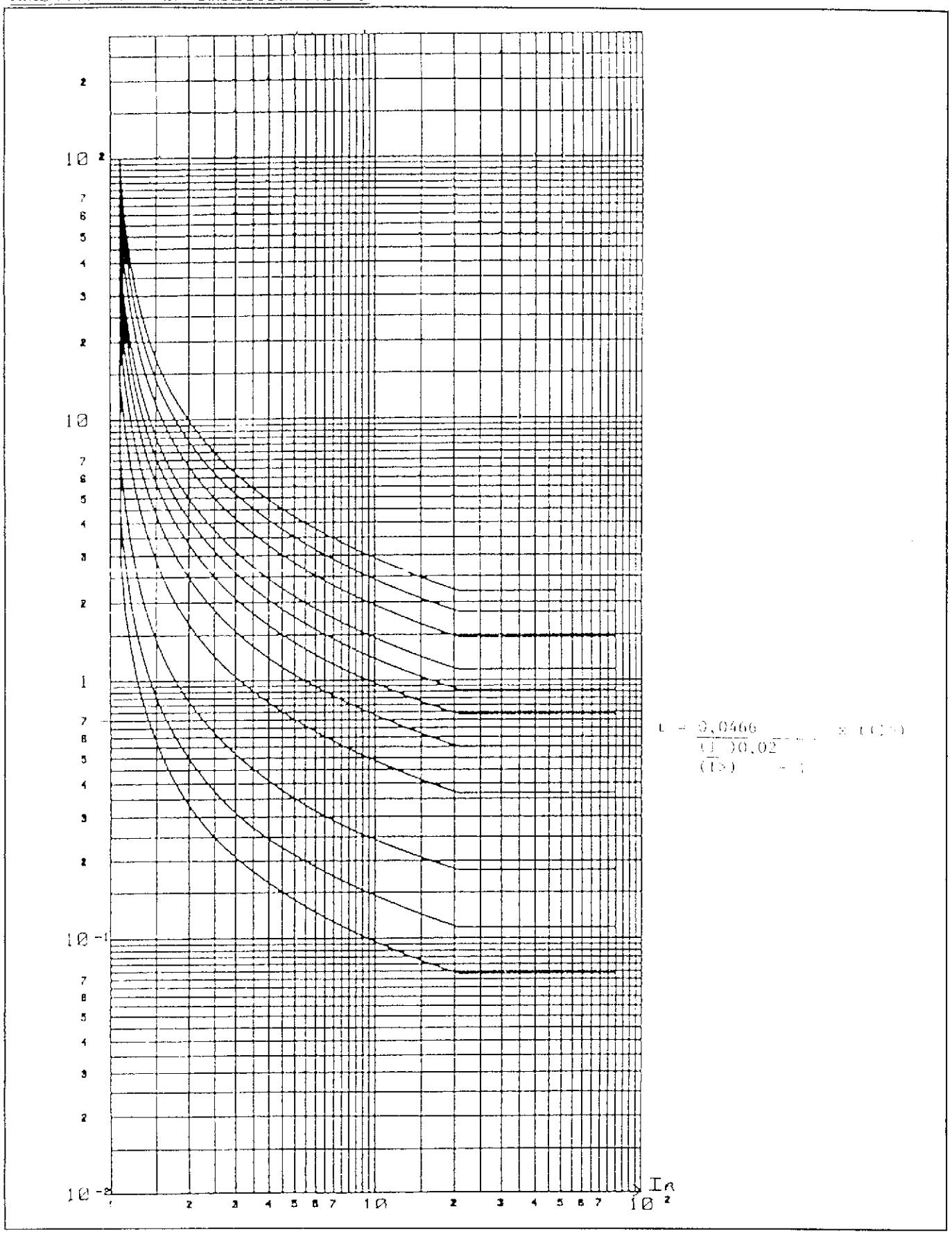
- If the relay is isolated, connect a PC directly via the RS 232-C (check that the switch on the rear is in the RS 232 position) and carry out an interrogation using the C.E.E. PROCOM software.

In both cases, it should be possible to read the settings as well as the measurements carried out by the RMS. A cross check between the local RMS display and the values on the PC being the best proof of correct operation.

If possible, simulate a fault condition and check that the central system "sees" this.

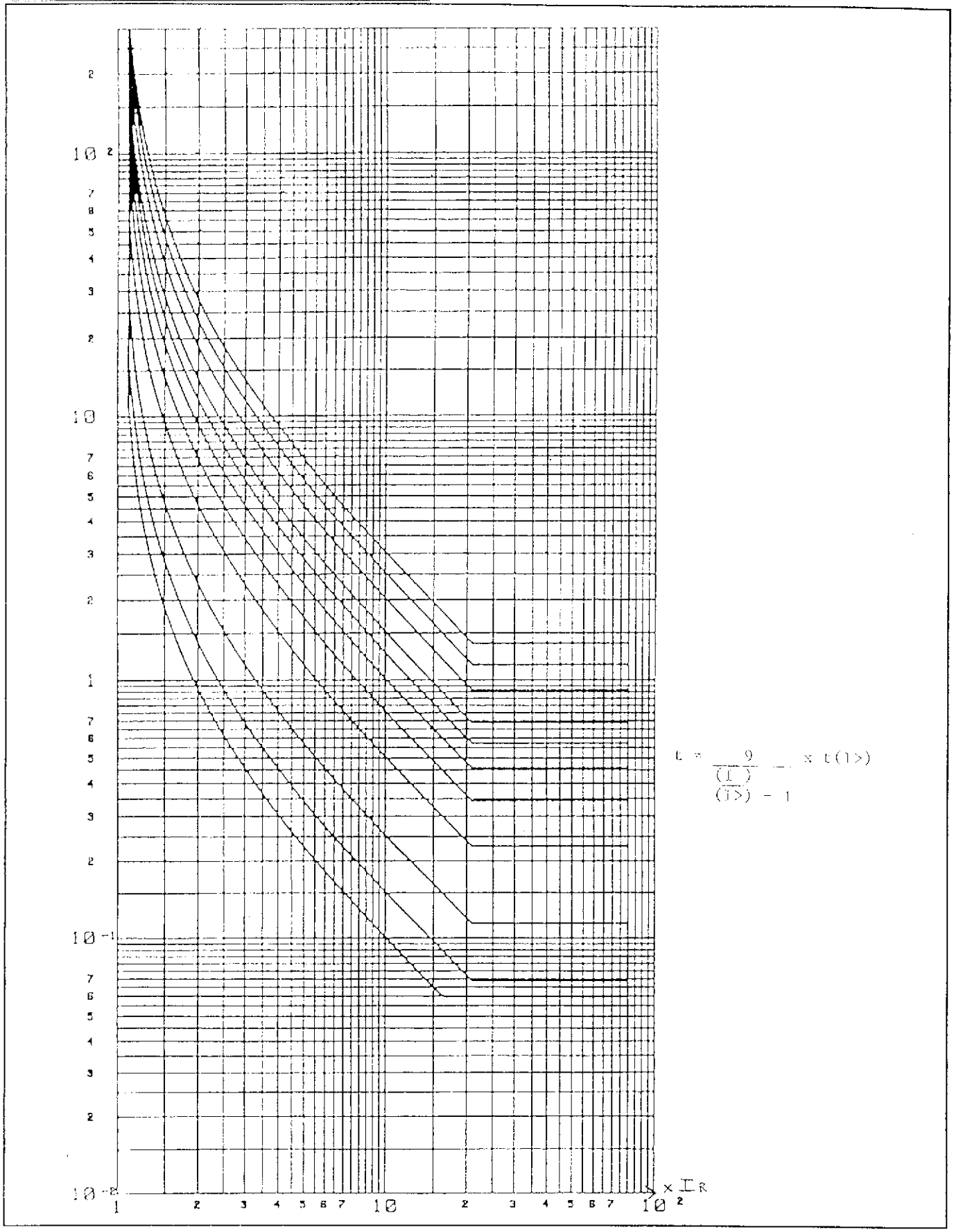
V.9. APPENDIX 1

RMS 7992 INVERSE CHARACTERISTIC



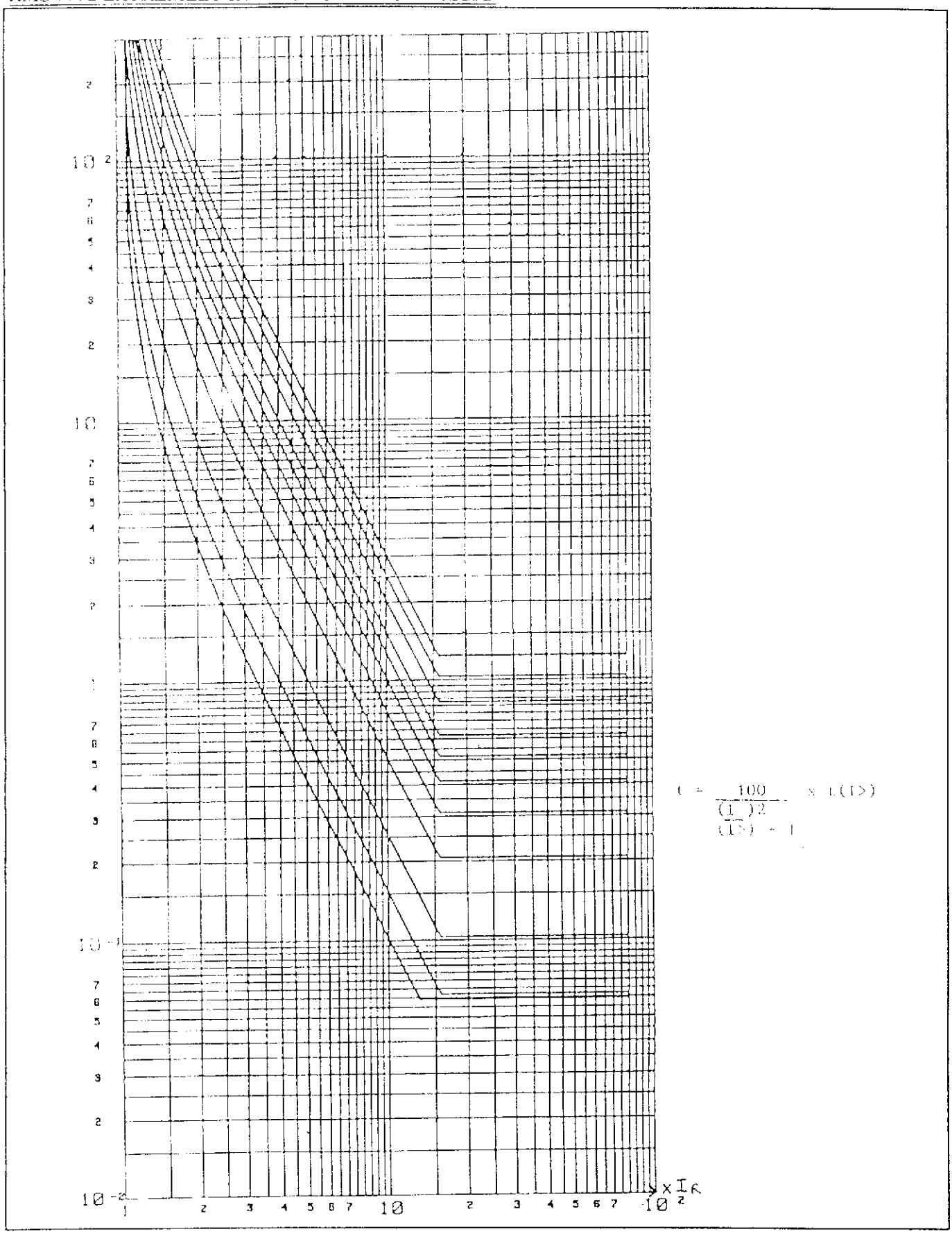
V.9. APPENDIX 2

RMS 7992 VERY INVERSE CHARACTERISTIC



V.9. APPENDIX 3

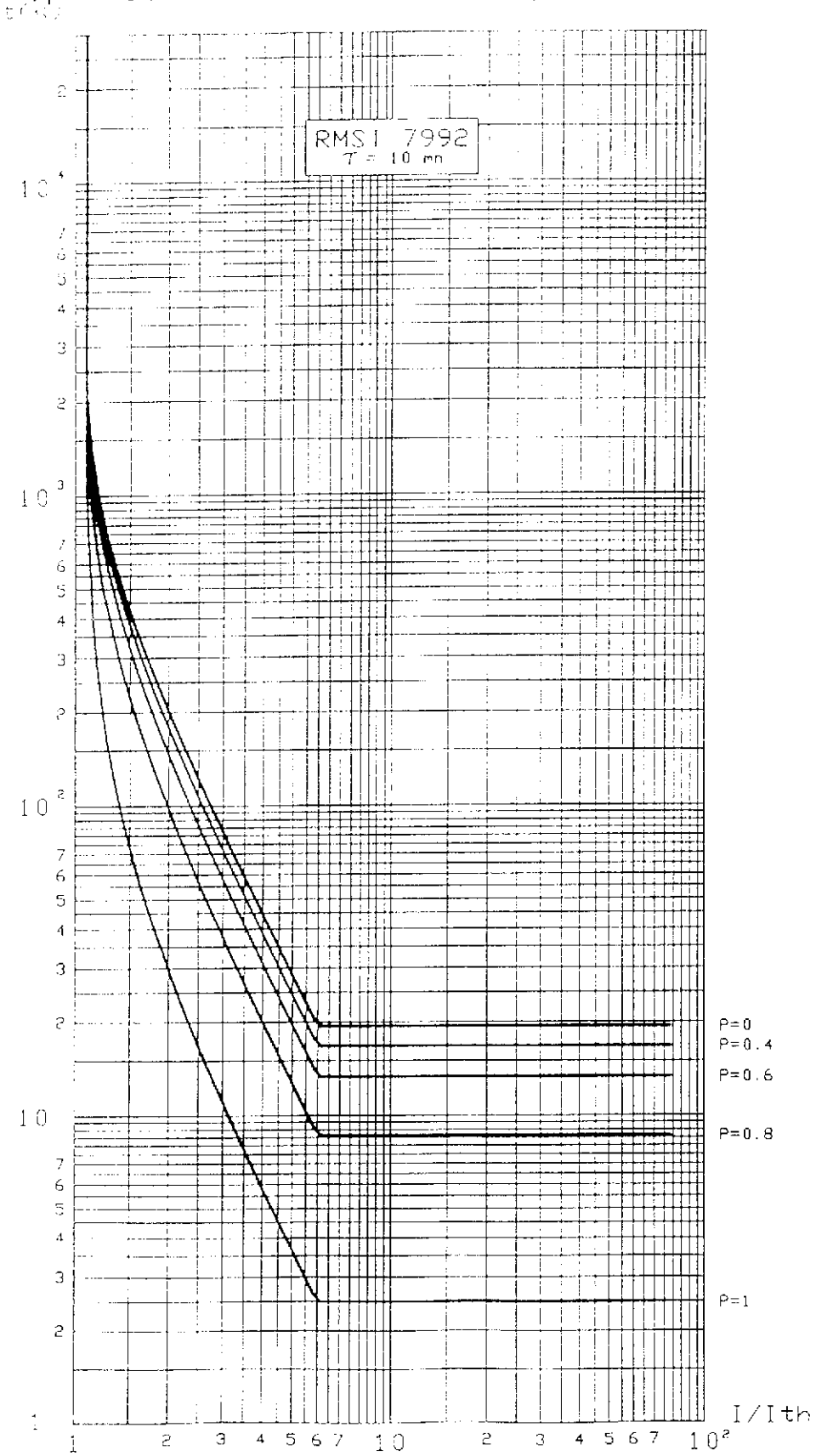
RMS 7992 EXTREMELY INVERSE CHARACTERISTIC



V.9. APPENDIX 4

RMST 7992 THERMAL IMAGE CHARACTERISTIC

For other values of τ, multiply the time dispayed on these curve by $\tau/10$



VI. ABNORMAL SITUATIONS

- The display does not light up: check the current drawn on the auxiliary supply, knowing that P = approximately 8 W dc or 13 VA.

- The relay operates but the circuit-breaker does not trip: check the continuity of the tripping system.

- Non-operation or too-high threshold: check that the relay is correctly plugged in and that the fixing rods are fully screwed in.

- Permanent operation of the earth fault unit in residual connection : check the wiring and polarity of the CTs.

- Non-operation of the earth-fault unit on core-balance CT: check the wiring of the cable earth screen.

- Poor communications. Check: the plugs, the switch position, the slave address.