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INSTRUCTIONS FOR THE COMMISSIONING AND MAINTENANCE

OF DIGITAL GENERATOR PROTECTION

GMS 7001

M.1813/A.XE - 01/96

I - PRINCIPLES AND APPLICATIONS

GMSx 7001 series relays are designed to protect synchronous generators connected to three phase 50 Hz or 60 Hz networks driven by any type of prime mover : steam turbines, water turbines, gas turbines, diesel engines, gas engines.

Using microprocessor technology, the GMSx 7001 samples the applied signals and produces current and voltage vectors using (F.F.T.) Fast Fourier Transform: from the resulting values the relay derives the symmetrical components, real power and the apparent impedance of the network connected to the generator.

The GMSx 7001 is remarkable firstly because of its wide range of operating frequency (8 Hz - 70 Hz) making it particularly suitable to supervise generators of which the frequency can vary widely (run up or over speed of hydro generators, island networks with low short circuit power, ...) , and secondly due to its insensitivity to 3rd harmonic voltages and currents which allows it to use low earth fault settings.

The GMSx 7001 comprises :

The GMS 7001, used when the 3 phase voltages are available (3VTs) and when the zero sequence voltage, manufactured by an internal summation, is used as a characteristic value in the operation of the relay.

The GMSH 7001, used when the 2 phase to phase voltages are available and when zero sequence current is used as a characteristic value in the operation of the relay.

The GMSV 7001, used when the 2 phase to phase voltages are available and when zero sequence voltage, from a star point or open delta vt, is used as a characteristic value in the operation of the relay.

The GMSx 7001 groups together all of the protection functions normally required on a generator with the exception of the stator differential protection (kept separate in order to ensure redundancy in the protection system) and the detection of insulation faults in the rotor which uses special operating principles and measurement quantities.

The following table summarises the protection functions covered by the GMSx 7001 family:

Functions	ANSI code	GMS 7001	GMSH 7001	GMSV 7001
.Thermal Image Overload	49	x	x	x
.Negative phase sequence overcurrent	46	x	x	x
.Field failure (loss of excitation)	40	x	x	x
.Under impedance	21	x	x	x
.Over current	51	x	x	x
.Over voltage	59	x	x	x
.Over fluxing (v/f)	24	x	x	x
.Under voltage	27	x	x	x
.Under and over frequency	81	x	x	x
.Reverse power	32-1	x	x	x
.Under and over power	32-2	x	x	x
.Neutral displacement over voltage	59G	x		x
.Earth fault	64		x	

Thermal image overload (49)

The GMSx 7001 produces a thermal image of the generator from an appropriate combination of the positive and negative phase sequence components of the stator current.

The equivalent thermal current I is given by the formula:

$$I = \sqrt{I_{Pos}^2 + K^2 I_{Neg}^2}$$

where I_{Pos}: positive phase sequence current,

I_{Neg}: negative phase sequence current,

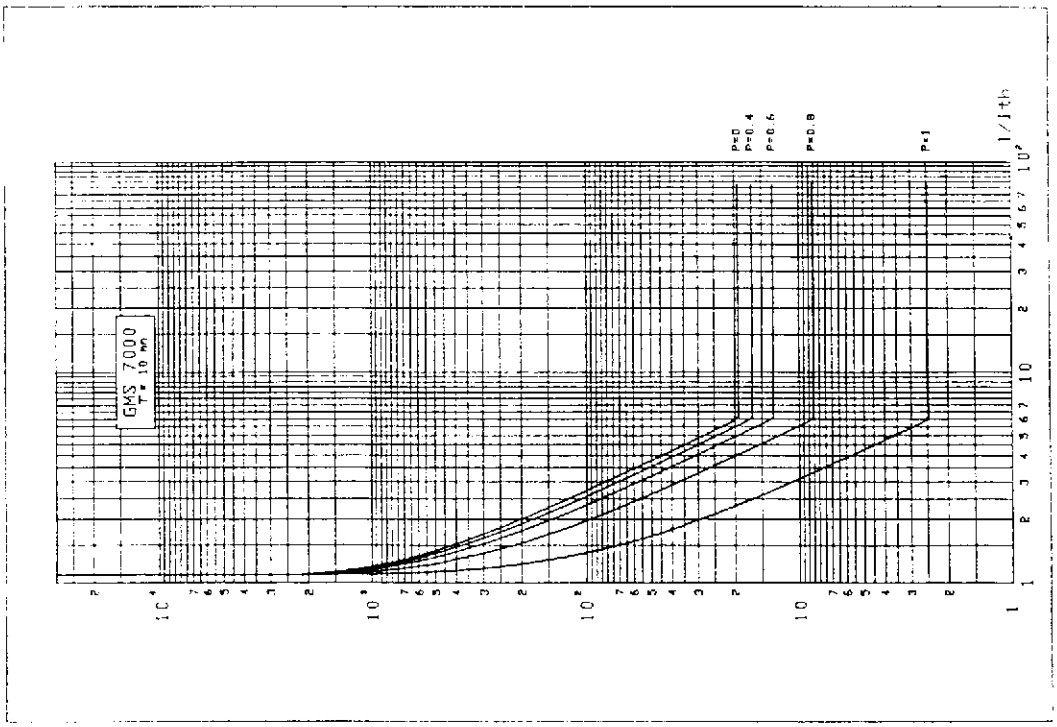
K^2: weighting factor for the negative phase sequence current heating effect,
adjustable from 4 to 16.

The heat exchanges in the machine as well as pre-load conditions are allowed for in the form of a thermal time constant τ adjustable from 4 to 240 minutes. A thermal alarm adjustable from 80 to 100% of the rated thermal state is provided.

See the thermal image operating curves in Fig 1.

Fig 1. - Thermal Image (49) - IEC 255-8 thermal image operating curve

For other values of τ multiply the times given by the curves by $\tau/10$



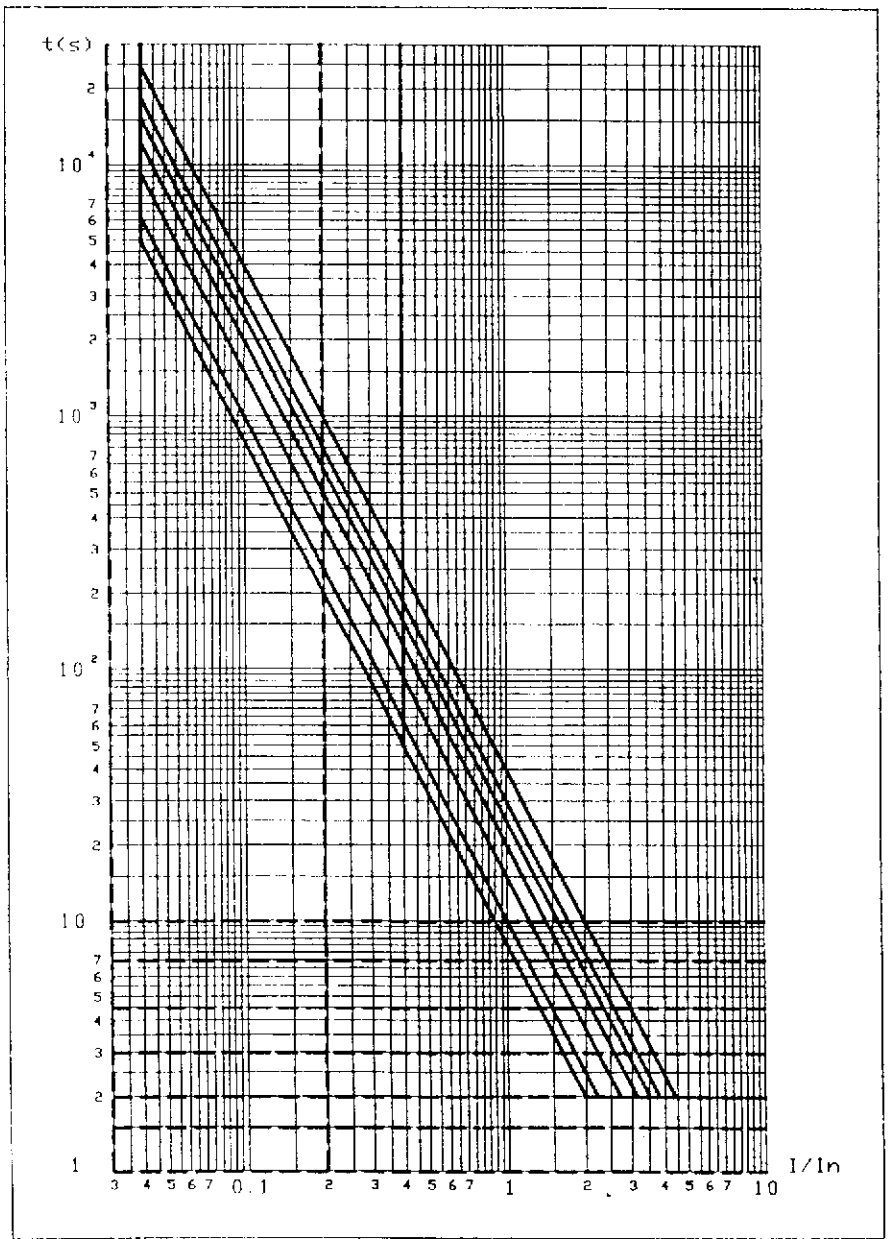
Negative phase sequence over current (46)

The GMSx 7001 protects the rotor against these unbalanced conditions by an inverse time over current characteristic which follows the above law exactly with a constant C, adjustable from 8 to 40 seconds (See figure 2). This function is also equipped with a start operating level, adjustable from 4 to 40% In, and a definite time alarm level, adjustable from 3 to 20 % In, completes the protection.

Formula for the inverse time curve : $(I_{Neg} / In)^2 * t = C$

where : I_{Neg} : negative phase sequence currents
t : generator withstand (seconds)
C : constant related to the type of generator (seconds)

Figure N°2 NEGATIVE PHASE SEQUENCE OVER CURRENT (46) - Current/time operating characteristic

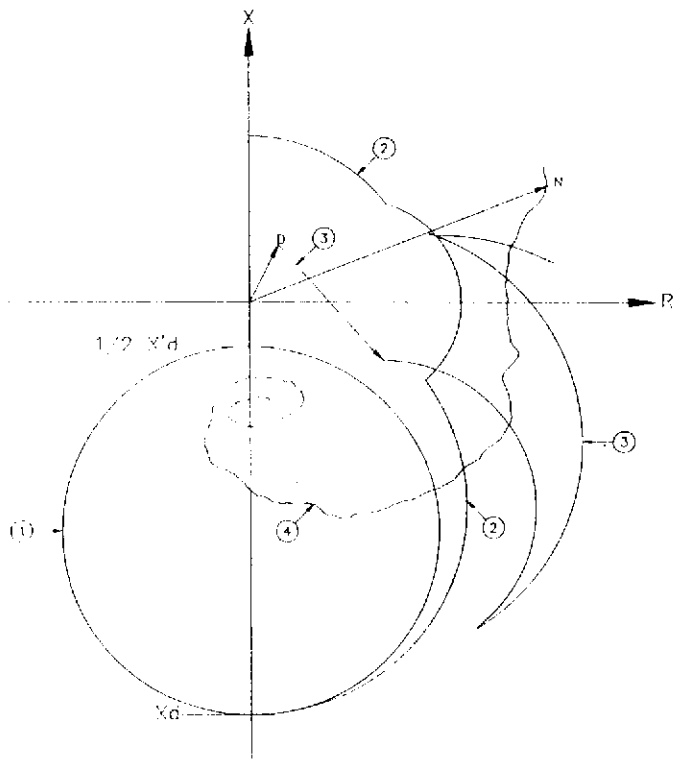


Field failure / Loss of excitation (40)

These devices use the measurement of the internal impedance of the generator to protect it against field failure. To this end, the operating characteristic represented on an R-X impedance diagram is an admittance circle offset and centred on the negative X axis (induction machine). The offset with respect to the origin is generally fixed to half of transient reactance X'd and the diameter is equal to the secondary synchronous impedance Xd less the offset X'd/2 (See figure 3)

The offset is adjustable from 8 to 40% ZN, the diameter from 50 to 300% ZN.

Figure N°3 Field Failure / Loss of excitation function [40]



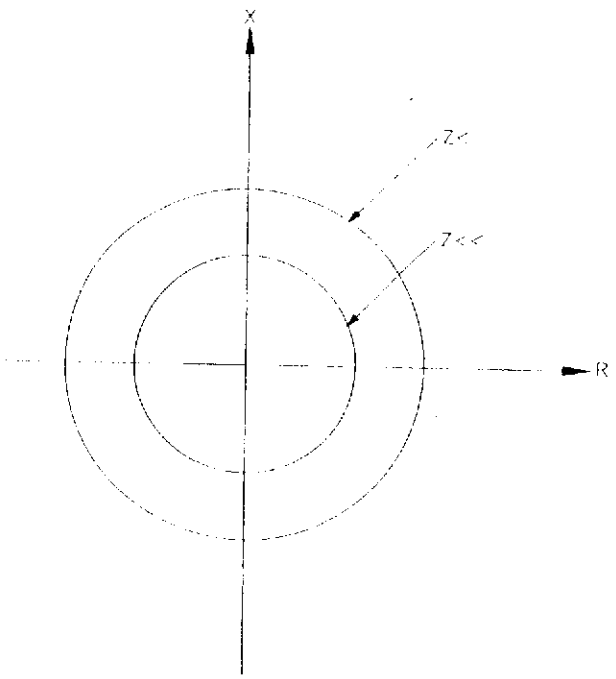
1 GMS characteristic
2 Generator capability limits
3 locus of the apparent impedance during and after the elimination of a fault
4 locus of the apparent impedance following field failure

Under.impedance (21)

The GMSx 7001 uses an "Under impedance" function to ensure adequate monitoring of the machine and of its network against phase faults since the "impedance" value is independent of the level of current.
In order to ensure stability for faults occurring on the secondary of unit transformers, the operating characteristic of the relay is represented by a circle centred at the origin on an R-X diagram.
Two separate impedance operating levels (2 concentric circles) are provided (see figure n°4)
In addition, secure operation is ensured due to a current threshold, adjustable from 0.1 In to 0.4 In, supervising tripping.

Z< adjustable from 40 to 200% ZN
Z<< adjustable from 10 to 50% ZN

Figure N°4 Under impedance function [21] Operating characteristic



Over current (51)

This function is available in the GMSx 7001 to complement the "Under impedance" (21) function in order to improve the coordination between the various protections for faults distant to the generator which result in initial fault currents limited to approximately 3 In.
Coordination with " dependent time " type relays is easily obtained by using a suitable current/time operating characteristic.

. Inverse time curve (NI) - Figure 5
. Very inverse time curve (VI) - Figure 6
. Extremely inverse time curve (EI) - Figure 7
with I> adjustable from 0.5 to 2 IN
I>> adjustable from 1 to 10 IN

Figure 5 - Inverse time curve (NI)

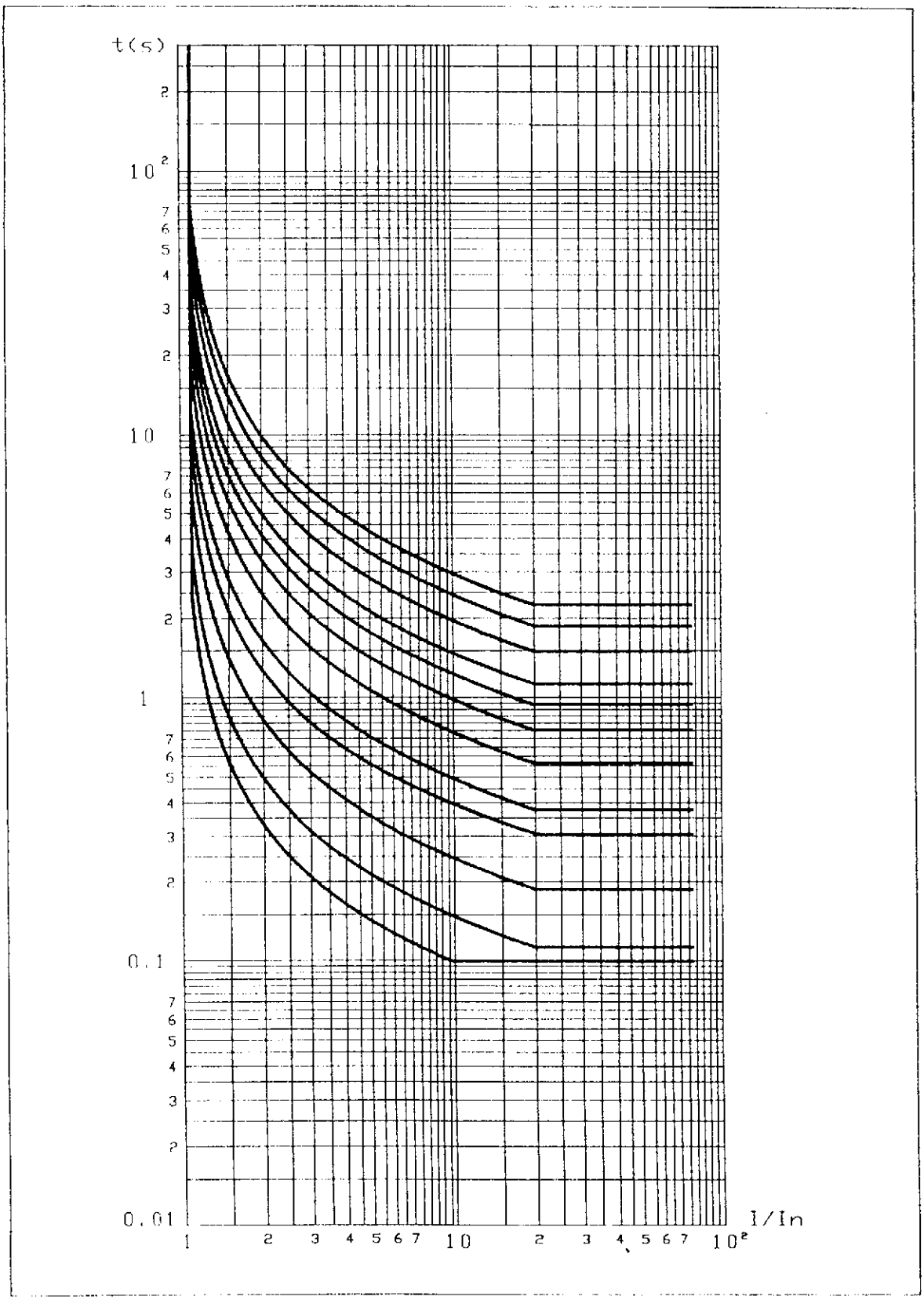


Figure 6 - Very inverse time curve (VI)

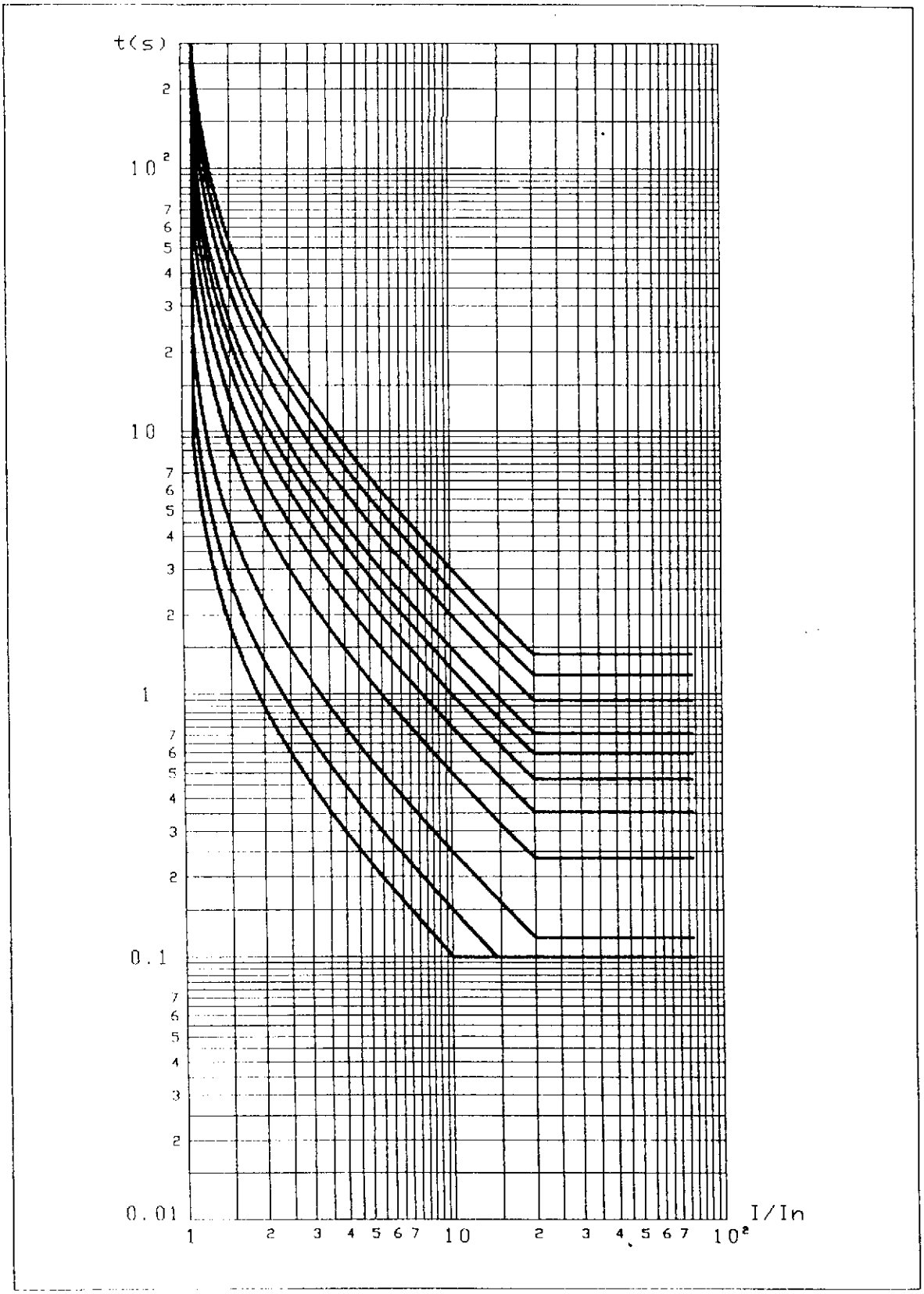
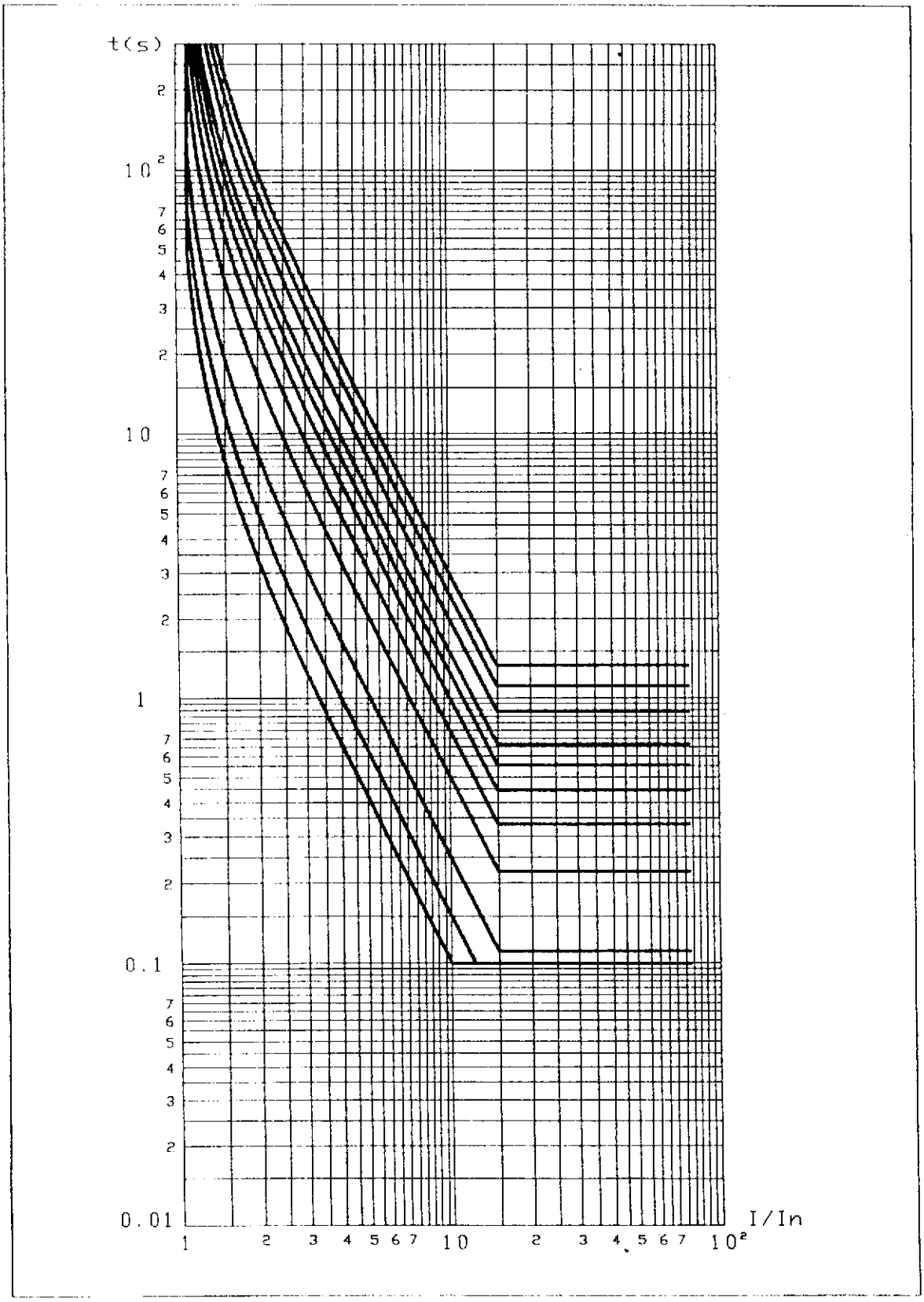


Figure 7 - Extremely inverse time curve (EI)



Over voltage (59)

The GMSx 7001 is equipped with an "Over voltage" function with two operating levels providing a time delayed protection for low levels of over voltages (limited to less than approximately 120/130% of the rated voltage) and a fast protection for higher over voltages.(GMS 7001: three phase detection, GMSH 7001 and GMSV 7001: two phase detection).
The two voltage threshold settings V> and V>> are adjustable from 70 to 150% of Vn.

Over fluxing (24)

These devices monitor the image of the flux density Φ by generating a U/f> threshold setting of 50 to 150% order to protect the generators and the transformers against overfluxing.

Under and Over frequency (81)

The GMSx7001 supplement the mechanical protection with a 2 operating level frequency function, adjustable as "Over" or "Under" frequency between 44Hz and 66Hz.

Reverse power (32-1)

These devices protect the prime mover thanks to a "Reverse power" function using a summation of the three single phase powers in the GMS 7001 and using the 2 wattmeter method in the GMSH 7001 and GMSV 7001
This threshold is adjustable from 1 to 10% Sn

Under and Over power (32-2)

The GMSx 7001 can send an alarm to the operator or can assist certain control sequences upon the real power exceeding a given operating level.
This function can be configured as "Over power" or "Under power" by the operator, with a setting range of 30 to 120% Sn.

Neutral displacement over voltage (59 G)

The GMS 7001 recreates the zero sequence voltage by summing the 3 phase voltages supplied by voltage transformers connected to the generator terminals.
The GMSV 7001 has a special input designed to be supplied by zero sequence voltage from a transformer connected to the generator star point.
The "Neutral displacement over voltage" provided by these relays is equipped with two separate operating levels which can be used as alarm and trip functions.
Digital filtering enables the effect of 3rd harmonic voltages to be eliminated.
The operating levels are adjustable from 3 to 15% Vn and 6 to 30% Vn.

Earth fault (64)

The GMSH 7001 protects the generators against phase to earth faults using its "Earth fault" function. By using a toroid, the GMSH 7001 can detect fault currents of 1 A, and remain insensitive to the influence of 3rd harmonic currents thanks to digital filtering techniques (setting range 1 to 20A).
When using the residual connection of 3 line cts, or the connection to a star point ct, the setting range is 5 to 100%IN.

Communications

.Local communication
Dialogue between the user and the equipment is ensured by means of a 16 key keyboard and a 16 digit display, which may be used to set up and read back all of the quantities, recorded, calculated or measured by the device.
Alarms and trip conditions are indicated by LEDs on the front plate, as well as on the display.

Communication by digital channels
The GMSx 7001 case is equipped with 2 serial digital communications channels type :
-1 RS-232-C/DB9 on the face plate enables the relay to be directly connected to a PC
-1 (0-20mA) current loop (2 sockets) enables the relays to be connected into a communications network.

.Communication by "all or nothing" channels
-Inputs : The GMSx 7001 relays accept two volt free contact inputs which control the temporary inhibition of certain functions whilst the contact remains closed (generator run up sequences, etc....) See Paragraph IV-3
-Outputs: The device is fitted with 3 trip output units (A-B-C) , 2 alarm and signal relays (D-E) and a watchdog relay (W).

II DESCRIPTION OF MECHANICAL INSTALLATION

II-1 Introduction

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

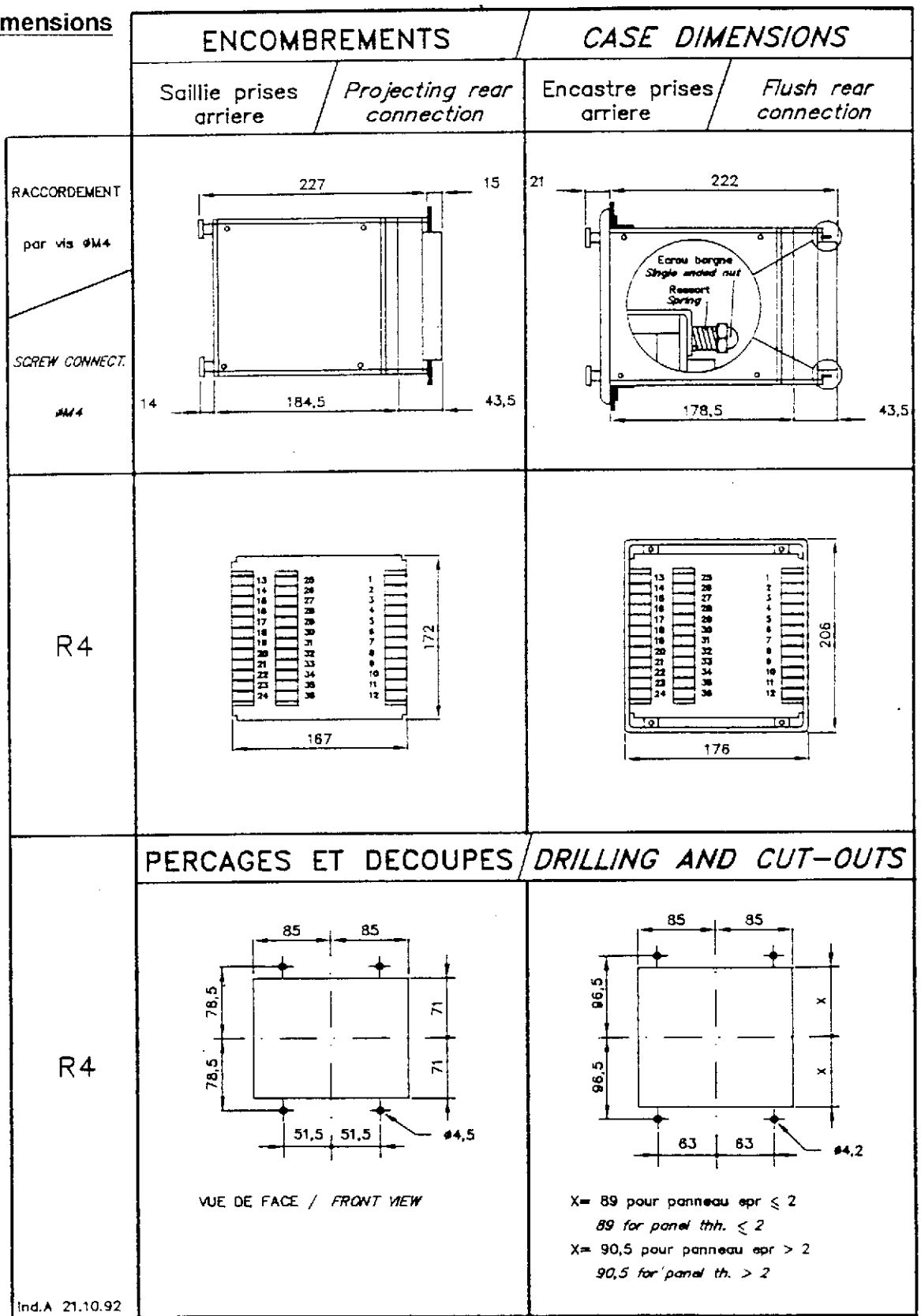
When plugging the relay in, check that the "current loop" plug locking clips are horizontal so as not to obstruct the operation.

After plugging in, it is important to fully screw home the fixing rods, which can be done by using a flat 3.5 mm screwdriver.

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.

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 Physical dimensions



III ELECTRICAL INSTALLATION

III-1 Introduction

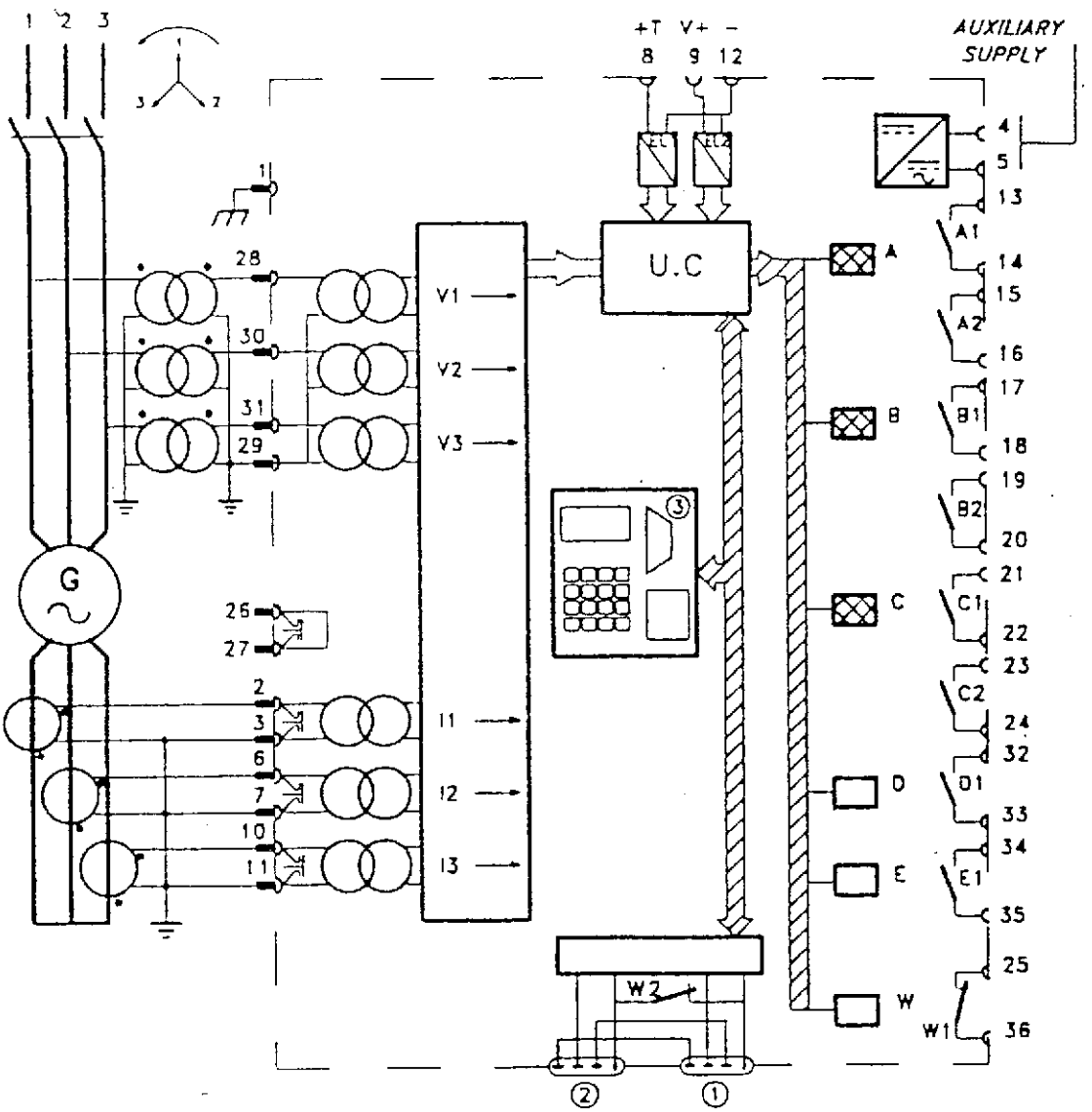
Using the connection diagram in Paragraph III-2 (and the communications network diagram where appropriate), make the various connections using the terminal references given in Paragraph III-3.

RECOMMENDATIONS

Before commissioning, it is important to check that:
- the potential transformers have a secondary rated voltage the same as that indicated on the relay rating plate,
- the current transformers have a secondary rated current the same as that indicated on the relay rating plate,
- the frequency of the network is identical to that indicated
on the rating plate,
- the wiring connections agree with the diagram,
- the auxiliary voltage and its operating range are well within the range indicated on the rating plate,
- the relay is correctly plugged in, and that the fixing rods
are fully screwed in,

III-2 - Wiring diagram GMS 7001

ERRATUM

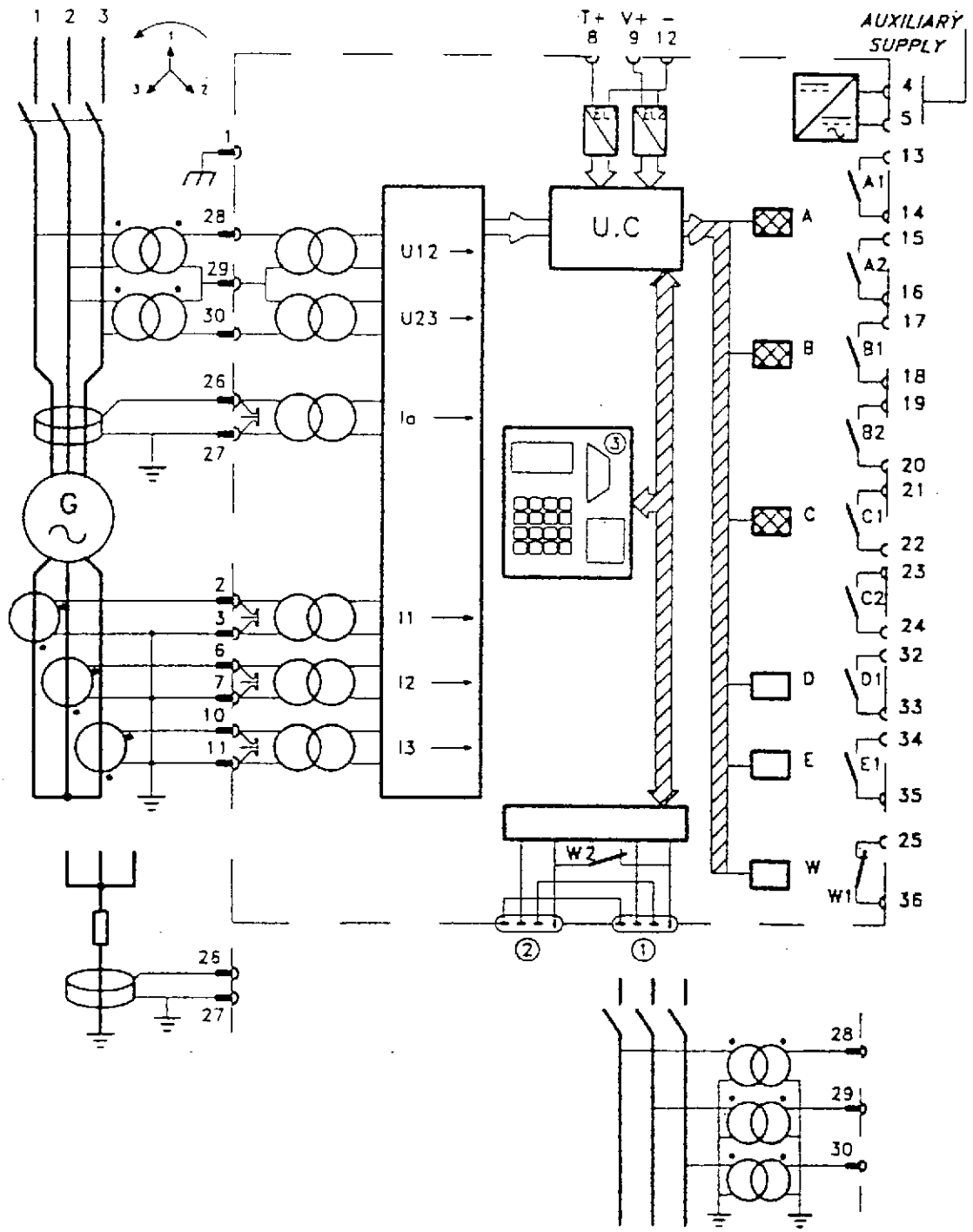


ERRATUM:

The original wiring diagram contained within this document is incorrect (re. polarity of CTs). This attached diagram replaces the original and shows the correct CT polarity.

III.2 - Wiring diagram GMSH 7001

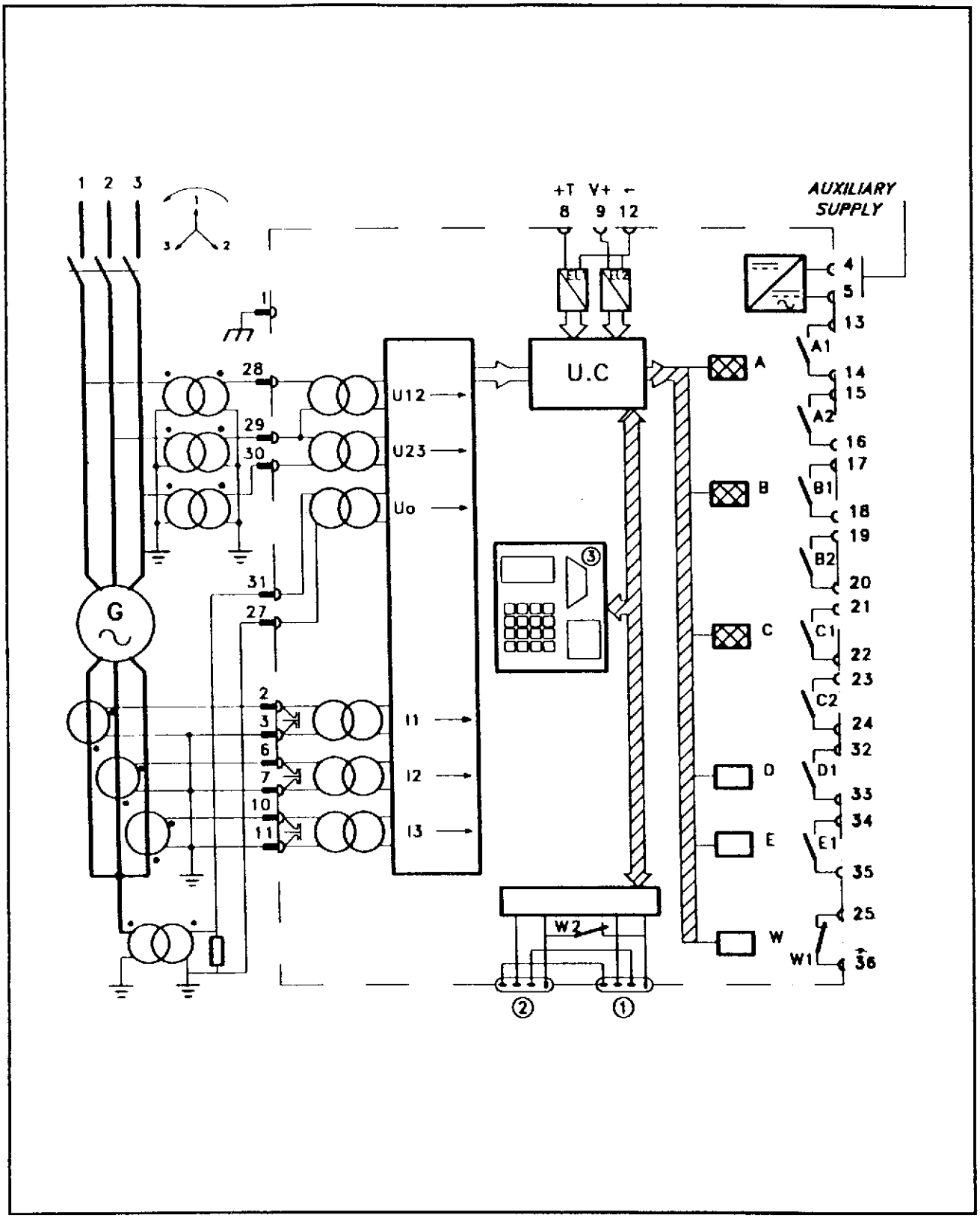
ERRATUM



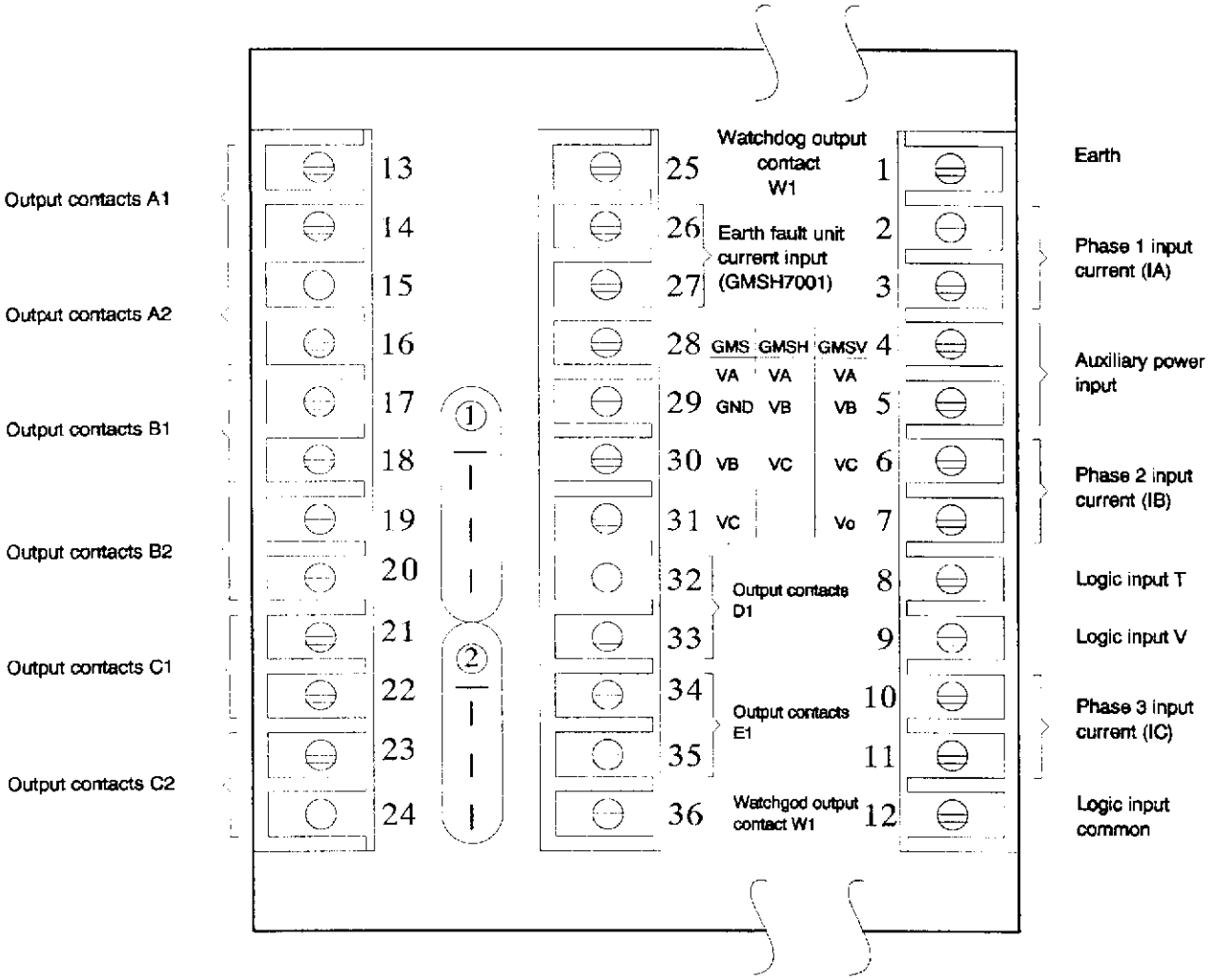
ERRATUM:

The original wiring diagram contained within this document is incorrect (re. polarity of CTs). This attached diagram replaces the original and shows the correct CT polarity.

III.2 - Wiring diagram GMSV 7001

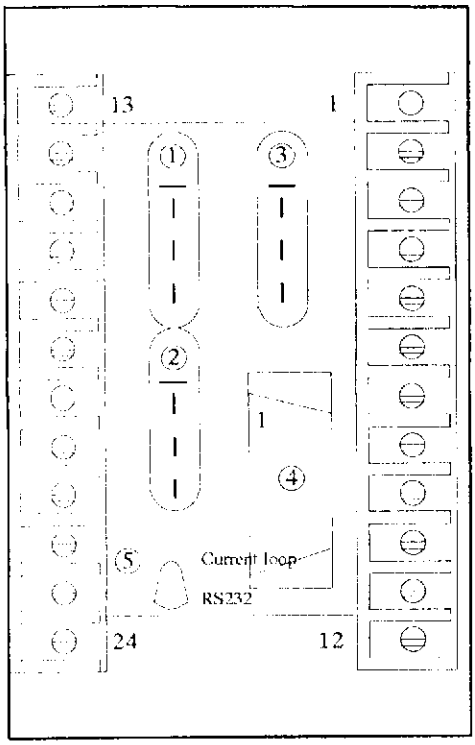


III-3 Description of terminal blocks



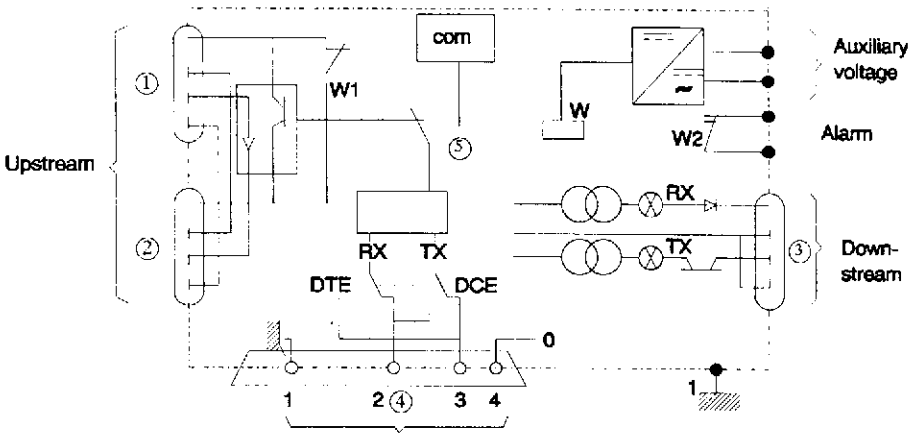
Connectors 1 and 2 are dedicated to upstream current loop communication (slave)
-Plug 1: Input from the master or the upstream device
-Plug 2 : Output to the downstream device or end-of-loop plug

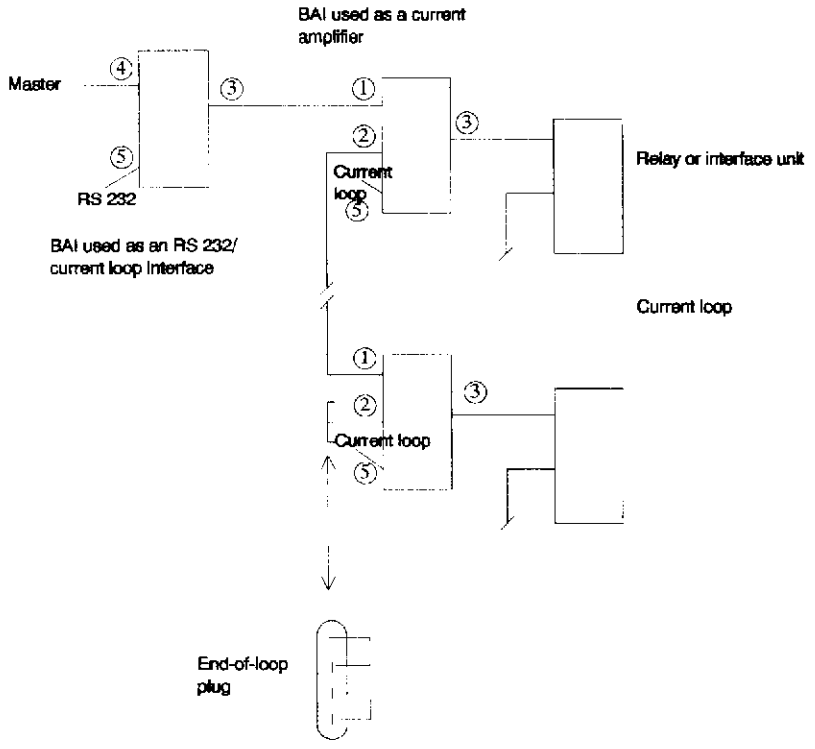
III-4 Communications installation



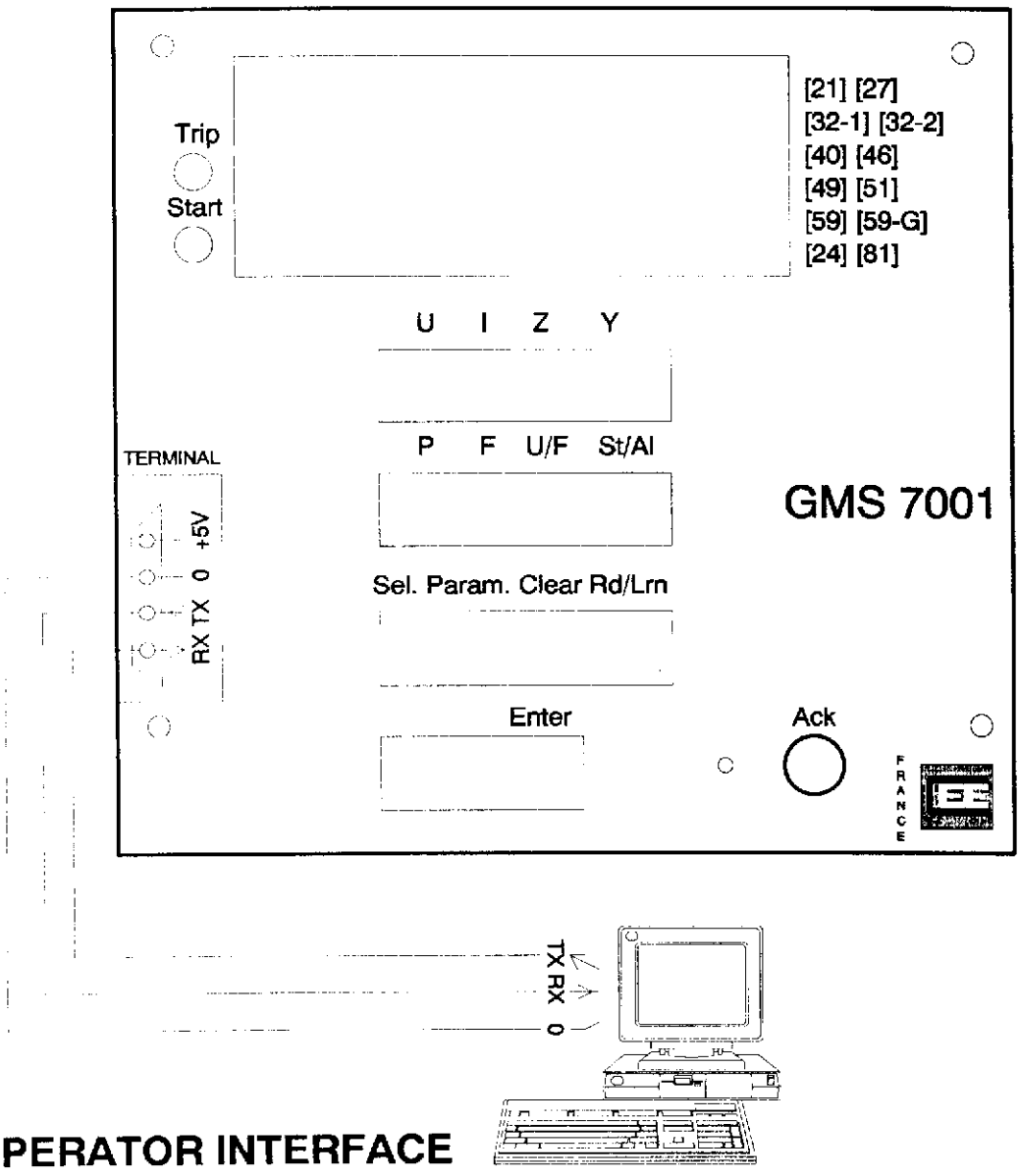
Rear view

BAI 7001





III-5 Connection to a terminal



IV - OPERATOR INTERFACE

IV-1 - Local operator interface

The GMS parameters can be read and set locally in two ways :
-by directly using the keys and the display on the unit
-by using an alphanumeric display or a PC computer running a terminal emulation software program via the RS232 - 9 pin on the front plate

IV-1-1 Reading and setting using the keys and the display

The keys can be used in two modes :
READ (READING MODE) or SETTING (SETTING MODE)

Repeated use of the [*](Rd/Lrn) key moves from one mode to the other.

When the unit is switched on, the relay is in the read mode and the display selects the average voltage VMEAN.

IV-1-1-1 Reading using the keys

The data related to the rated values, measurements and programmed functions are grouped together under 8 headings in order that they can be selected and read quickly.

List of the 8 headings

Heading	Key	Data		
		rated	measurement	functions
voltage	V	x	x	U>,U>>,U<, Vo>,Vo>>
current	I	x	x	ITHA>, ITH> I>,I>>,I2>, I2>>, Io>(GMSH7001)
impedance	Z		x	Z<,Z<<
field failure	Y			Y<
power	P		x	RP>,P< or P>
frequency	F	x	x	F1<,/F1>,F2<, F2>,U/F>
flux	U/F			U/F>
General parameters	Param	rated values and general parameters		

Data selection operating mode

-A heading is selected by pressing the corresponding key. The first value under the heading appears on the display.
-by using the keys [+] or [-] the list of all the values under the heading can be scrolled in either direction

IV-1-1-2- Setting parameters using the keys and the display

Setting mode is selected by pressing the [Rd/Lrn] key. The display shows the message [LEARNING MODE].

In this position, the user may or may not be able to change settings depending upon whether or not a three figure general password has previously been declared (see chapter IV-5 - Passwords).

In this mode, the selection or modification of settings is carried out as follows :
-Choose the characteristic value using the key [U/I/Z/....]
The relay displays the selected heading (ex : [U] ---->[VOLTAGE SETTINGS]).
-Choose a sub heading using the [+] and [-] keys. Each time the relay displays a new sub heading
-Select the sub heading using the [sel] key. The relay displays the first value in this sub heading.
-Choose a parameter using the [+] and [-] keys. Each time the relay displays a new parameter. It is possible to exit the sub heading without changing anything by using the [Clear] key.
-Delete the selected parameter using the [Enter] key.
-Use the keys to enter the new value. The figures entered are right justified in the format reserved for the parameter and the decimal point is automatically added if required.
-The new value is confirmed by using the [Enter] key.
-Return to the sub heading selection by using the [Clear] key, then to the read mode by the [Clear] and [Rd/Lrn] keys.

The example on the next page illustrates the method.

This relay setting method is really only of interest when a specific setting needs to be changed. When all the functions of a relay need to be set, it is better to use a terminal as this is easier and provides assistance to the operator.

The following example shows the sequence of operations to change the first over voltage threshold from 1.3 UN to 1.1 UN :

KEYS USED	DISPLAY
[Rd/Lrn]	[LEARNING MODE]
[U]	[VOLTAGE SETTINGS]
[+]	[U> 59-1 SETTINGS]
[Sel]	[U> Un L* 1.30]
[Enter]	[U> Un L -.--]
[1] [1] [0]	[U> Un L 1.10]
[Enter]	[U> Un L* 1.10]
[Clear]	[U> 59-1 SETTINGS]
[Clear]	[VOLTAGE SETTINGS]
[Rd/Lrn]	[READING MODE]

SETTING TABLES

The following tables summarise the allowable settings from the key board (limits, setting steps, procedure summaries.....).

SETTING OF RATED VALUES AND GENERAL FUNCTIONS

LEARNING MODE	PARAM MODE		Param , + or - keys , access then confirm using the Enter key
	minimum	**maximum**	comments
UN KV L*	UN KV L* 0.10	UN KV L* 100.00	Setting the primary rated voltage (in steps of 0.01 Kv)
IN A L*	IN A L* 10	IN A L* 10000	Setting the primary rated current (in steps of 1 KA)
FN HZ L*	FN HZ L* 50	FN HZ L* 60	Setting the rated frequency Press + or -
F1 L*	F1> L*	F1< L*	Setting the F1 under and over frequency function. Press + or -
DF1 HZ L*	DF1 HZ L* 0.20	DF1 HZ L* 0.40	Setting the F1 pick-up/drop off ratio (in steps of 0.05Hz)
F2 L*	F2> L*	F2< L*	Setting the F2 under and over frequency function. Press + or -
DF2 HZ L*	DF2 HZ L* 0.20	DF2 HZ L* 0.40	Setting the F2 pick-up/drop off ratio (in steps of 0.05Hz)
U[59] L*	U[59] L* PH/N	U[59] L* PH/PH	Setting the [59] function use of either phase to neutral or phase to phase voltages. Press + or -.
U[27] L*	U[27] L* PH/N	U[27] L* PH/PH	Setting the [27] function use of either phase to neutral or phase to phase voltages. Press + or -.
P[32-2] L*	P[32-2] L* P<	P[32-2] L* P>	Setting the [32-2] function (under or over power). Press + or -.

	minimum	**maximum**	comments
IO> A/IN L*	IO> A/IN L* A	IO> A/IN L* IN	Setting the [64] function connection to a toroid or to three Cts (GMSH 7001 only). Press + or -.
ADDRESS L*	ADDRESS L* 1	ADDRESS L* 255	Setting the unit address (in steps of 1).
BAUDRATE L*	BAUDRATE L* 1200	BAUDRATE L* 4800	Setting the communication transmission speed. Press + or -.
PARITY L*	PARITY L* NONE	PARITY L* ODD	Setting the communication parity: NONE, EVEN, ODD.. Press + or -.
PASSWORD L*	PASSSWORD L* ON	PASSWORD L* OFF	Setting the password option: Press + or -.
PASSWORD L*	PASSSWORD L* 000	PASSWORD L* 999	Setting the 3 digit password. Enter the number.

PROTECTION FUNCTION SETTING

THERMAL IMAGE OVERLOAD : thermal alarm function [49-1]

LEARNING MODE	PARAM MODE	ITH 49-1 SETTINGS	I , + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
ITHA ITH L*	ITHA ITH L* 0.80	ITHA ITH L* 1.00	Setting the thermal overload alarm in multiples of the thermal current (or the thermal state); in steps of 0.01
ITHA ABC L*	ITHA ABC L* 000	ITHA ABC L* 111	Configuration of the output relays A, B or C (0 = not connected to the output relay, 1 = connected to the output relay).
ITHA DE L*	ITHA DE L* 00	ITHA DE L* 11	Configuration of the output relays D or E (0 = not connected to the output relay, 1 = connected to the output relay).
ITHA PTV L*	ITHA PTV L* 000	ITHA PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

THERMÀL IMAGE OVERLOAD : trip function [49-2]

LEARNING MODE	CURRENT SETTINGS	ITH 49-2 SETTINGS	I , + or - keys Sel , + or - keys. Access then confirm using then Enter key

heading	minimum	maximum	comments
IB K/2 L*	IB K/2 L* 4	IB K/2 L* 16	Setting the coefficient K controlling the influence of negative phase sequence currents on the current IB in the thermal state calculation; (in steps of 2)
ITH> IN L*	ITH> IN L* 0.50	ITH> IN L* 1.20	Setting the threshold in multiples of the ct rated current ; (in steps of 0.05)
TITH MN L*	TITH MN L* 4	TITH MN L* 240	Setting the thermal time constant expressed in minutes (in steps of 1 minute).
ITHABCDE L*	ITHABCDE L* 00000	ITHABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
ITH PTV L*	ITH PTV L* 000	ITH PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

UNDER AND OVER FREQUENCY function F1 threshold [81-1]

LEARNING MODE	FREQ. SETTINGS	F1 81-1 SETTINGS	F , + or - keys Sel , + or - keys. Access then confirm using then Enter key

heading	minimum	maximum	comments
F1< HZ L*	F1< HZ L* 44.00	F1< HZ L* 66.00	Setting the F1 under frequency function threshold (in steps of 0.05 Hz).
TF1< S L*	TF1< S L* 0.20	TF1< S L* 99.99	Setting the definite time delay for the F1 threshold. (in steps of 0.01 s).
F1<ABCDE L*	F1<ABCDE L* 00000	F1<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
F1< PTV L*	F1> PTV L* 000	F1< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OR

F1< HZ L*	F1< HZ L* 44.00	F1< HZ L* 66.00	Setting the F1 over frequency function threshold (in steps of 0.05 Hz).
TF1< S L*	TF1< S L* 0.20	TF1< S L* 99.99	Setting the definite time delay of the F1 threshold.(in steps of 0.01 s).
F1<ABCDE L*	F1<ABCDE L* 00000	F1<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
F1< PTV L*	F1> PTV L* 000	F1< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

UNDER AND OVER FREQUENCY function F2 threshold [81-2]

LEARNING MODE	FREQ. SETTINGS	F2 81-2 SETTINGS	F , + or - keys Sel, + or - keys. Access then confirm using then Enter key

heading	minimum	maximum	comments
F2< HZ L*	F2< HZ L* 44.00	F2< HZ L* 66.00	Setting the F2 under frequency function threshold (in steps of 0.05 Hz).
TF2< S L*	TF2< S L* 0.20	TF2< S L* 99.99	Setting the definite time delay of the F2 threshold.(in steps of 0.01 s).
F2<ABCDE L*	F2<ABCDE L* 00000	F2<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
F2< PTV L*	F2> PTV L* 000	F2< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OR

F2< HZ L*	F2< HZ L* 44.00	F2< HZ L* 66.00	Setting the F2 over frequency function threshold (in steps of 0.05 Hz).
TF2< S L*	TF2< S L* 0.20	TF2< S L* 99.99	Setting the definite time delay of the F2 threshold.(in steps of 0.01 s).
F2<ABCDE L*	F2<ABCDE L* 00000	F2<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
F2< PTV L*	F2> PTV L* 000	F2< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OVER VOLTAGE low-set threshold function [59-1]

LEARNING MODE	VOLTAGE SETTINGS	U> 59-1 SETTINGS	U , + or - keys Sel , + or - keys. Access then confirm using then Enter key

heading	minimum	maximum	comments
U> UN L*	U> UN L* 0.70	U> UN L* 1.50	Setting the low-set threshold (in steps of 0.01Vn or Un).
TU> S L*	TU> S L* 0.10	TU> S L* 10.00	Setting the low-set threshold definite time delay.(in steps of 0.01 s).
U> ABCDE L*	U> ABCDE L* 00000	U> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
U> PTV L*	U> PTV L* 000	U> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OVER VOLTAGE high-set threshold function [59-2]

LEARNING MODE	VOLTAGE SETTINGS	U> 59-2 SETTINGS	U , + or - keys Sel , + or - keys. Access then confirm using then Enter key

heading	minimum	maximum	comments
U>> UN L*	U>> UN L* 0.70	U>> UN L* 1.50	Setting the high-set threshold (in steps of 0.01Vn or Un).
U>>ABCDE L*	U>>ABCDE L* 00000	U>> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
U>> PTV L*	U>> PTV L* 000	U>> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

UNDER VOLTAGE function [27]

LEARNING MODE	VOLTAGE SETTINGS	U> 27 SETTINGS	U , + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
U< UN L*	U< UN L* OR	U< UN L* AND	Setting the logic control of the three voltages. Press + or - for OR or AND .
U< UN L*	U< UN L* 0.20	U< UN L* 1.20	Setting the threshold (in steps of 0.01Vn or Un).
TU< S L*	TU< S L* 0.10	TU< S L* 10.00	Setting the definite time delay. (in steps of 0.01 s).
U< ABCDE L*	U< ABCDE L* 00000	U< ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
U< PTV L*	U< PTV L* 000	U< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

EARTH FAULT function [64]

LEARNING MODE	CURRENT SETTINGS	IO> 64 SETTINGS	I , + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
IO> L*	IO> A L* 1.0	IO> A L* 20.0	Setting the earth fault current in Amps when connected to a 100 turn toroid.
	OR		
IO> L*	IO> IN L* 0.050	IO> IN L* 1.000	Setting the earth fault current in multiples of IN when connected to the residual of 3 cts.
IO>CURVE L*	IO>CURVE L* DT	IO>CURVE L* EI	Setting the curve type. Press + or - to select curve types DT, NI, VI, EI.
TIO> S L*	TIO> S L* 0.10	TIO> S L* 10.00	Setting the time delay for definite time curves DT (1).(in steps of 0.01s).
	OR		
TIO> S L*	TIO> S L* 0.10	TIO> S L* 3.00	Setting the time delay at 10 Ir for dependent time (inverse) curves. (in steps of 0.05s).
IO> ABCDE L*	IO> ABCDE L* 00000	IO> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
IO> PTV L*	IO> PTV L* 000	IO> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

NEGATIVE PHASE SEQUENCE OVER CURRENT alarm function [46-1]

LEARNING MODE	CURRENT SETTINGS	I2> 46-1 SETTINGS	i , + or - keys
			Sel , + or - keys. Access then confirm using the Enter key

heading	minimum maximum		comments
I2> IN L*	I2> IN L* 0.03	I2> IN L* 0.20	Setting the alarm threshold (in steps of 0.01 IN).
TI2> F/A L*	TI2> F/A L* F	TI2> F/A L* A	Setting the type of time delay for the alarm threshold I2>. Press + or - for fixed or adjustable.
TI2> A S L*	TI2> A S L* 1.0	TI2> A S L* 10.0	Setting the adjustable definite time delay for the alarm threshold I2> (in steps of 1s).
I2> ABCDE L*	I2> ABCDE L* 00000	I2> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
I2> PTV L*	I2> PTV L* 000	I2> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

NEGATIVE PHASE SEQUENCE OVER CURRENT trip function [46-2]

LEARNING MODE	CURRENT SETTINGS	I2>> 46-2 SETTINGS	i , + or - keys
			Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
I2 C S L*	I2 C S L* 8	I2 C S L* 40	Setting the operating curve time constant C (in steps of 1s). Alarm and trip thresholds.
I2>> IN L*	I2>> IN L* 0.04	I2>> IN L* 0.40	Setting the trip threshold (in steps of 0.01 IN).
I2>> ABC L*	I2>> ABC L* 000	I2> ABC L* 111	Configuration of the output relays A, B, or C (0 = not connected to the output relay, 1 = connected to the output relay).
I2>> DE L*	I2>> DE L* 00	I2>> DE L* 11	Configuration of the output relays D or E (0 = not connected to the output relay, 1 = connected to the output relay).
I2>> PTV L*	I2>> PTV L* 000	I2>> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

NEUTRAL DISPLACEMENT OVER VOLTAGE alarm function [59-G1]

LEARNING MODE	VOLTAGE SETTINGS	VO>59-G1 SETTINGS	U, + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
VO> VN L*	VO> VN L* 0.03	VO> VN L* 0.15	Setting the alarm threshold (in steps of 0.01 Vn).
TVO> S L*	TVO> S L* 0.10	TVO> S L* 10.00	Setting the definite time delay for the alarm threshold (in steps of 0.01s).
VO>ABCDE L*	VO>ABCDE L* 00000	VO>ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
VO> PTV L*	VO> PTV L* 000	VO> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

NEUTRAL DISPLACEMENT OVER VOLTAGE trip function [59-G2]

LEARNING MODE	VOLTAGE SETTINGS	VO>>59-G2 SETTINGS	U, + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
VO>> VN L*	VO>> VN L* 0.06	VO>> VN L* 0.30	Setting the trip threshold (in steps of 0.01 Vn).
TVO>> S L*	TVO>> S L* 0.10	TVO>> S L* 10.00	Setting the definite time delay for the trip threshold (in steps of 0.01s).
VO>> ABC L*	VO>> ABC L* 000	VO>> ABC L* 111	Configuration of the output relays A, B, or C (0 = not connected to the output relay, 1 = connected to the output relay).
VO>> DE L*	VO>> DE L* 00	VO>> DE L* 11	Configuration of the output relays D or E (0 = not connected to the output relay, 1 = connected to the output relay).
VO>> PTV L*	VO>> PTV L* 000	VO>> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

REVERSE POWER function [32-1]

LEARNING MODE	POWER SETTINGS	RP>32-1 SETTINGS	P, + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
RP> SN L*	RP> SN L* 0.010	RP> SN L* 0.200	Setting the reverse power threshold in multiples of Sn (in steps of 0.005 Sn).
TRP> S L*	TRP> S L* 0.20	TRP> S L* 99.99	Setting the definite time delay (in steps of 0.01s).
RP>ABCDE L*	RP>ABCDE L* 00000	RP>ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
RP> PTV L*	RP> PTV L* 000	RP> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

UNDER AND OVER POWER function [32-2]

LEARNING MODE	POWER SETTINGS	RP>32-2 SETTINGS	P, + or - keys
			Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
P< SN L*	P< SN L* 0.30	P< SN L* 1.10	Setting the under power threshold in multiples of Sn (in steps of 0.01 Sn).
TP< S L*	TP< S L* 0.20	TP< S L* 99.99	Setting the definite time delay (in steps of 0.01s).
P<ABCDE L*	P<ABCDE L* 00000	P<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
P< PTV L*	P< PTV L* 000	P< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.
			OR
P> SN L*	P> SN L* 0.30	P> SN L* 1.10	Setting the over power threshold in multiples of Sn (in steps of 0.01 Sn).
TP> S L*	TP> S L* 0.20	TP> S L* 99.99	Setting the definite time delay (in steps of 0.01s).
P>ABCDE L*	P>ABCDE L* 00000	P>ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
P> PTV L*	P> PTV L* 000	P> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OVER CURRENT low-set threshold function [51-1]

LEARNING MODE	CURRENT SETTINGS	I> 51-1 SETTINGS	I , + or - keys Sel , + or - keys. Access then confirm using the Enter key

SELECT.

heading	**minimum maximum**	comments
I> IN L*	I> IN L* 0.50	I> IN L* 2.0	Setting the low-set threshold (in steps of 0.1 In).
I> CURVE L*	I> CURVE L* DT	I> CURVE L* EI	Setting the type of curve. Use + or - to scroll between the curve types DT, NI, VI, EI.
TI> S L*	TI> S L* 0.10	TI> S L* 100.00	Setting the time delay for definite time curve DT (in steps of 0.01s).
	OR		
TI> S L*	TI> S L* 0.10	TI> S L* 3.00	Setting the time delay at 10 Ir for dependent time (inverse) curves.(in steps of 0.05s).
I> ABCDE L*	I> ABCDE L* 00000	I> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).Configuration A = 1 is obligatory
I> PTV L*	I> PTV L* 000	I> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational. Configuration P = 1 is obligatory.

OVER CURRENT high-set threshold function [51-2]

LEARNING MODE	CURRENT SETTINGS	I>> 51-2 SETTINGS	I , + or - keys
			Sel , + or - keys. Access then confirm using the Enter key

SELECT.

heading	**minimum maximum**		comments
I>> IN L*	I>> IN L* 1.00	I>> IN L* 10.00	Setting the high-set threshold (in steps of 0.25 In).
TI>> S L*	TI>> S L* 0.10	TI>> S L* 10.00	Setting the definite time delay for the high-set threshold (in steps of 0.01s).
I>> ABCDE L*	I>> ABCDE L* 00000	I>> ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
I>> PTV L*	I>> PTV L* 000	I>> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

LOSS OF EXCITATION function [40]

LEARNING MODE	ADMIT SETTINGS	Y< 40 SETTINGS	Y , + or - keys Sel, + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
X1 ZN L*	X1 ZN L* 0.50	X1 ZN L* 3.00	Setting of the circle diameter X1 = (Xd - X'd/2) (in steps of 0.01 Zn)
X2 ZN L*	X2 ZN L* 0.08	X2 ZN L* 0.40	Setting the circle offset X2 = X'd/2 (in steps of 0.01 Zn)
TY< S L*	TY< S L* 0.10	TY< S L* 10.00	Setting of tripping time (in steps of 0.01s)
Y< ABCDE L*	Y< ABCD L* 00000	Y< ABCDE L* 11111	Configuration of the output relays A B C D or E = 0 : not connected to the output relay ; 1 : connected to the output relay
Y< PTV L*	Y< PTV L* 000	Y< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

* Xd and X'd must be set to the synchronous direct axis reactance and transient direct axis reactance of the machine multiplied by a factor :
I_N (CT) / I_N(machine) x U_N (machine) / U_N (Y.T)

UNDER IMPEDANCE low-set function [21-1]

LEARNING MODE	IMPED. SETTINGS	Z< 21-1 SETTINGS	Z, + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
Z< ZN L*	Z< ZN L* 0.40	Z< ZN L* 2.00	Setting the low-set threshold in multiples of Zn (in steps of 0.05 Zn).
TZ< S L*	TZ< S L* 0.10	TZ< S L* 100.00	Setting the definite time delay for the under impedance low-set threshold (in steps of 0.1s).
Z<ABCDE L*	Z< ABCDE L* 00000	Z< ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
Z< PTV L*	Z< PTV L* 000	Z< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.
IZ> IN L*	IZ> IN L* 0.10	IZ> IN L* 0.40	Setting the over current threshold (in steps of 0.05 In).

UNDER IMPEDANCE high-set function [21-2]

LEARNING MODE	IMPED. SETTINGS	Z< 21-1 SETTINGS	Z, + or - keys
			Sel , + or - keys. Access then confirm using the Enter key

heading	minimum maximum		comments
Z<< ZN L*	Z<< ZN L* 0.10	Z<< ZN L* 0.50	Setting the high-set threshold in multiples of Zn (in steps of 0.05 Zn).
TZ<< S L*	TZ<< S L* 0.1	TZ<< S L* 100.00	Setting the definite time delay for the under impedance high-set threshold (in steps of 0.1s).
Z<<ABCDE L*	Z<<ABCDE L* 00000	Z<<ABCDE L* 11111	Configuration of the output relays A, B, C, D or E (0 = not connected to the output relay, 1 = connected to the output relay).
Z>> PTV L*	Z<< PTV L* 000	Z<< PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

OVER FLUXING U/F> function [24]

LEARNING MODE	FLUX SETTINGS	U/F [24] SETTINGS	U/F , + or - keys Sel , + or - keys. Access then confirm using the Enter key

heading	minimum	maximum	comments
U/F> [N] L*	U/F> [N] L* 0.50	U/F> [N] L* 1.50	Setting the trip threshold (in steps of 0.05 Un/Fn)
TU/F> S L*	TU/F> S L* 0.20	TU/F> S L* 99.99	Setting the definite time delay for the trip threshold (in steps of 0.01s).
U/F> ABC L*	U/F> ABC L* 000	U/F> ABC L* 111	Configuration of the output relays A, B or C (0 = not connected to the output relay, 1 = connected to the output relay).
U/F> DE L*	U/F> DE L* 00	U/F> DE L* 11	Configuration of the output relays D or E (0 = not connected to the output relay, 1 = connected to the output relay).
U/F> PTV L*	U/F> PTV L* 000	U/F> PTV L* 110	Condition of the trip logic switches P, T and V; V switch non operational.

IV-I-2 - Use of a terminal to display and set parameters via the RS232 port on the front plate

IV-1-2-1 - Hardware and software required

GMS 7001 relays have an RS232/9 pin socket on the front plate, identical to that used on the AMS7001/7002, used to connect to and to configure the relay.

The relay parameters may be set using a simple alphanumeric terminal or PC type computer running a terminal emulation software program.

The serial port is configured as follows :

- connection : see GMS wiring diagrams
- speed : 1200 bauds
- parity : even
- number of bits : 7
- stop bit : 1
- character echo by the relay
- type of terminal : VT100

The following software is recommended :

- LAMSTEL : C.E.E. software for communicating with AMS, GMS, ... relays

This list is not exhaustive.

IV-1-2-2 - Parameter reading and setting

A three-figure password can be set via the keyboard in order to protect the settings *(see chapter IV-5 : password)*.

When a terminal is first connected, and an [Enter] sequence is sent, a message is displayed, showing :

- the GMS software type and version
- the date and time
- the command awaited characters [?>].

Commands are chains of characters validated by [Enter].
A command is completed or cancelled using the [ESCAPE] key
Parameters are displayed in response to commands beginning V
(VG-VU-VI...).
Parameters are set in response to commands beginning P (PG-PU-PI...).
The carriage return key [↵] deletes the last character.
The use of control X [^X] deletes the line.

There is a help function for general commands and for each setting value. This help function is activated by the [?] command.

The following pages illustrate the setting and display options provided by the GMS operating software.

NB : the PTV settings of any heading must be programmed as follows:
- P : indicates a permanent activation of the function
- T : indicates a temporary deactivation of the function when the logic input EL1 is activated.
- The V option is not used.

**** Message d'attente de commande / Command awaited message**
GMS_7001 V1.00
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02:05:32
?>

**** Visualisation de l'aide : commande [?] / See help : command [?]**

?>?
****Aide / Help****
PG : Paramètre les nominaux et les fonctions générales / Sets rated values and general functions
PU : Paramètre les tensions / Sets voltages
PI : Paramètre les courants / Sets currents
PZ : Paramètre les impédances / Sets impedances
PP : Paramètre les puissances / Sets powers
PF : Paramètre les fréquences / Sets frequencies
PUF : Paramètre le flux / Sets flux
PY : Paramètre les réactances / Sets reactances
PC : Paramètre la communication / Sets communication
PDATE : Paramètre la date / Sets the date
PTIME : Paramètre l'heure / Sets the time
JBUSAV : Commutation en JBUS sur la face avant / Switches to JBUS on the front plate
M : Visualise les mesures / Displays measurements
ETAT : Visualise l'octet d'état / Displays the state octet
TS : Visualise les TS / Displays *the digital inputs*
RST : Reset l'application / Resets the application
VG : Visualise les nominaux / Displays rated values
VU : Visualise les tensions / Displays voltages
VI : Visualise les courants / Displays currents
VZ : Visualise les impédances / Displays impedances
VP : Visualise les puissances / Displays powers
VF : Visualise les fréquences / Displays frequencies

VUF : Visualise le flux / Displays flux
VY : Visualise les réactances / Displays reactances
VC : Visualise la configuration / Displays the configuration
? : Visualise l'aide / Displays the help function
ESC : Annule la commande / Cancels the command
← : Efface le dernier caractère / Deletes the last character
^X : Efface la ligne / Deletes the line
? : Aide d'un paramètre / Help for a setting
CR : Valide la commande / Validates the command
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02:05:32

**** Display function configuration : command [vc]**

The configuration of the output relays for all functions and their associated PTV switches can be displayed using this command.

?>vc
****Configuration / Configuration****

Fonct. / Funct.	Relais / Relay	Commut / Switch
U>	:C	
I>	:A	

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02:05:44

****Display settings by heading : commands [vu/vi/...]**

?>vu
****Tensions / Voltages****

U>	Seuil / Threshold	: 130
	Tempo /Time delay	: 2.00
	Relais / Relay	: C
	PTV	: P
U>>	Seuil / Threshold	: 140
	Relais / Relay	:
	PTV :	
U<	Seuil / Threshold	: 80
	Tempo / Time delay	: 2.00
	Fonc. / Funct.	: OU / OR
	Relais / Relay	:
	TV :	

```
vo>     Seuil / Threshold       : 10
        Tempo / Time delay      : 2.00
        Relais / Relay          :
        PTV             :
VO>>    Seuil / Threshold       : 20
        Tempo / Time delay      : 0.20
        Relais / Relay          :
        PTV             :
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02:06:02

?>vi
**Courant / Current**
ITHA>   Seuil / Threshold       :  90
        Relais / Relay          :
        PTV             :
ITH>    Ajust / Adjust          :  100
        K^2                     :  8
        Cste                    :  4
        Relais / Relay          :
        PTV             :
I>      Seuil / Threshold       :  100
        Tempo / Time delay      :  2.00
        Type / Type             :  NI
        Relais / Relay          :  A
        PTV                     :  P
I>>     Seuil / Threshold       :  200
        Tempo / Time delay      :  0.20
        Relais / Relay          :
        PTV             :
I2>     Seuil / Threshold       :  10
        Tempo / Time delay      :  2.00
        Type / Type             :  AJUS
        Relais / Relay          :
        PTV             :
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02:06:11
```

?>vz
****Impédances / Impedances****

Z<	Seuil / Threshold	:	100
	Tempo / Time delay	:	2.00
	IZ>	:	20
	Relais / Relay	:	
	PTV :		
Z<<	Seuil / Threshold	:	40
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV :		

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02:06:19

?>vy
****Réactances / Reactances****

Diamètre X1 / Diameter X1		:	150
Décalage X2 / Offset X2		:	20
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV :		

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02:06:24

?>vp
****Puissances / Powers****

RP>	Seuil / Threshold	:	10
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV :		
P>/P<	Seuil / Threshold	:	50
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV :		

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02:06:27

?>vf
****Fréquences / Frequencies****

F1>/F1<	Seuil / Threshold	:	48.00
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV	:	
F>/F2<	Seuil / Threshold	:	52.00
	Tempo / Time delay	:	2.00
	Relais : Relay	:	
	PTV	:	

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02:06:32

?>vuf
****Flux / Flux****

U/F>	Seuil / Threshold	:	120
	Tempo / Time delay	:	2.00
	Relais / Relay	:	
	PTV	:	

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02:06:36

?>vg
****Paramètres généraux / General settings****

UN	:	17320
IN	:	1000
FN	:	50
F[81-1]	:	F1<
Retour F1 / Reset F1	:	30
F[81-2]	:	F2
Retour F2 / Reset F2	:	30
U[59]	:	PH/N
U[27]	:	PH/N
P[32]	:	P>

GMS_7001 V1.00
Jeudi 12/01/1995 / Thursday 12/01/1995
02:06:43

****Display conditions : commands(ts/etat/m/..]**

Displays the condition of the 2 inputs, T and V (all or nothing inputs-ETOR), the crossing of the various thresholds (TS) and the condition of the output units (Relays).

```
?>ts
**TS / TS**
ETOT / AorN inputs  :
TS / Thres          :
Relais / Relays     :
                    The [enter] key updates the display
ETOR / AorN inputs  :
TS / Thres          :
Relais / Relays     :
                    The [escape] key exits the command

GMS  7001 V1.00
Jeudi 12/01/1995 / Thursday 12/01/1995
02:07:17

?>m
**Visualise les mesures / Display measurements**
IO(A)          : 0
IMean          : 254
IA             : 257
IB             : 243
IC             : 261
I2             : 10
VO(V)          : 0
UMean          : 20016
VA             : 11576
VB             : 11521
VC             : 11535
UAB            : 20028
UBC            : 20017
UCA            : 20003
Theta(%)       : 80
F(1/100Hz)     : 4999
P(KW)          : 8800
Q(KVAR)        : 349
S(KVA)         : 8807
Z1(%Zn)        : 1.35
Z2             : 1.35
Z3             : 1.36
                    ** The [enter] key updates the display
```

IO(A) : 0
IMean : 254
IA : 251
IB : 240
IC : 262
I2 : 13
VO(V) : 0
UMean : 20016
VA : 11576
VB : 11521
VC : 11535
UAB : 20028
UBC : 20017
UCA : 20003
Theta(%) : 81
F(1/100Hz) : 4999
P(KW) : 8800
Q(KVAR) : +360
S(KVA) : 8807
Z1(%Zn) : 1.35
Z2 : 1.35
Z3 : 1.36

** The [escape] key exits the command

GMS_7001 V1.00
Jeudi 12/01/1995 / Thursday 12/01/1995
02:07:33

?>état / conditions
****Etat global / Overall condition****
Evénement à traiter / Event to be processed
Réinitialisation du relais / Reboot relay
Défaut présent / Fault present
Trace bloquée / Trace blocked
Paramètres modifiés / Modified settings

** The [escape] key exits the command

GMS_7001 V1.00
Jeudi 12/01/1995 / Thursday 12/01/1995
02:07:59

****Setting functions : commands [pu/pi/pz/...]**

```
?>pu
**Tensions / Voltages**
U>      Seuil / Threshold     : 130      **for help use [?] after having
        Tempo / Time delay    : 2.00     deleted the setting
        Relais / Relay        : C
        PTV                   : P        **P : Permanently active
                                         function/ T : Temporary
U>>     Seuil / Threshold     : 140
        Relais / Relay        :
        PTV                   :
U<      Seuil / Threshold     : 80
        Tempo / Time delay    : 2.00
        Fonction / Function   : OU / OR
                                         **The [escape] key exits from
                                         the command
GMS_7001 V1.00
Jeudi 12/01/1995 / Thursday 12/01/1995
02:08:24
?>
```

IV-2- Remote operation

The GMS7001 relay is equipped with a communications channel (2 x 0-20mA current loop plugs) at the back of the relay case.

Using these plugs, the case may be inserted into a communications network supervised by a PC or other device (please consult us).

All information needed to implement remote communication is given in the document: User Manual - GMS communications tables.

IV-3- Operation of P.T.V. switches

The P, T and V switches provided with all protection have the following functions:

- The **P** setting indicates a permanent **activation** of the function
- The **T** setting indicates a temporary **deactivation** of the function.
  This deactivation comes into effect when the logic input EL1 is activated (terminals 8 - 12)
- The V setting is not available

The following table summarises the keyboard and terminal programming of switches P, T and V.

	Relay keyboard/display	Terminal
Function out of service	P = 0	-
Function in service	P = 1	P
Function not deactivated by logic input EL1	T = 0	-
Function deactivated by logic input EL1	T = 1	T

IV-4 - Fault mode

IV-4-1 - Indication that a threshold has been crossed

When a threshold on a pre-programmed function is crossed, the orange Start LED to the left of the display comes on.

This LED signal is not latched and the Start light goes out if the value falls below the threshold value again.

On the terminal, there is a permanent record of function thresholds that have been crossed which may be referred to using the [TS] command.

IV-4-2 - Alarm or trip display

When a relay operates, the red Trip LED comes on and ALARM or TRIP is displayed, followed by the function which gave rise to the alarm or trip, This information is latched (memorised). If a new event (alarm or trip) occurs, the preceding indication is replaced by the new one.

On the terminal, the function causing the trip, as well as the output relay, can be consulted by using the [TS] command, but in this case the information is not memorised.

NB : 3 functions are defined as alarms (thermal image overload ITHA>, neutral displacement over voltage Vo>, earth fault I2>), the other functions are trips.

IV-4-3 - Display of the electrical value at moment of an alarm or trip

A single operation of the Ack key, accessible with the front plate on, displays the value which caused the alarm or trip to operate (except for the field failure [loss of excitation] and over fluxing U/F> functions).

In the case of a trip, the displayed value corresponds to the electrical value at the instant of the trip.
In the case of an alarm, the displayed value corresponds to the electrical quantity that is being monitoried (THETA, I2, Vo) *(see chapter IV-4-4).*

Using the Ack key a second time resets the display to the read mode for the last value consulted.

If another output relay operates before the display has been acknowledged, the new function replaces the preceding one.

IV-4-4 - Alarm memorisation

If several trips occur in succession, it is the last which is memorised. In the case of multiple alarms, information relating to the nature of the intervening alarms is memorised and may be referred to using the Ack key.

The 3 alarms (ITHA, I2> and Vo>) are memorised until they are acknowledged by the Ack key or by a trip. If the latter applies, the trip replaces the displayed alarm.
The corresponding electrical value (THETA, I2 and Vo) may be consulted without removing the front plate.

Example : 2 alarms occur at different moments (I2> alarm,
then an ITHA alarm)
the display reads : ALARM followed by I2>
then the display reads : ALARM followed by ITHA
By repetitively pressing the Ack key, we see :

	ALARM ITHA	Alarm display
Ack	THETA 0.95	Permanent display of value associated with fault
Ack	ALARM I2>	Alarm display
Ack	I2> A 123	Permanent display of value associated with fault
Ack	UMEAN KV 12.00	Return to the READ mode value displayed before the alarm

IV-4-5 - Looking up the most recent events (start-up, alarms and trip) using the St/Al key accessible with the front plate removed

By using the ST/AL key and the [+] key, the 5 most recent events can be consulted (start-ups, alarms or trips). There are 3 lists comprising 5 possible events.

No 1 corresponds to the first event on the list, the last number to the most recent event.

Here the electrical value displayed for the alarms is the value memorised at the instant of the alarm

IV-5 - Password

The operator may choose to install a password restricting any setting function. This is a three figure password.

When a password has been installed, access is only authorised in read mode and the password must be known in order to put the password function out of service.

ATTENTION: if the password is lost, it will no longer be possible to gain access to settings and to put this function out of service.
Only by returning the relay to the factory may this function be changed.

Programming and de-programming the password via the keyboard

In read mode, the Param heading informs the operator as to whether or not a password is in use.
(PASSWORD = ON or OFF)

Programming

In programming mode, the Param heading, proceed as follows:

PASSWORD = OFF (Choose ON)
\+ key
PASSWORD = *** (key in the password from 000 to 999)
Return to read mode

Access to settings

To gain access to the LEARN mode, type in the password after pressing the Rd/Lrn key.

Suppressing the password

To suppress the password, choose

PASSWORD = OFF then return to read mode

Programming and de-programming the password via the terminal

The VG command informs the operator whether or not the password is in use (PASSWORD = ON or OFF). Without a password (PASSWORD = OFF), or after having entered the password, the opening message is preceded by the number 1, with a password it is preceded by a 0.

Programming

PG command : enter PASSWORD = ON
then after entry
PW command : type in the PASSWORD with 3 figures (000 to 999) then enter.

Access to parameters

Type in the PASS command followed by the password: 3 successive attempts are allowed. Access to different settings is authorised. The password must be entered once more to gain access to settings, when the terminal keyboard has been inactive for about 20 minutes or after the EXIT command.

Suppressing the password

PG command : enter PASSWORD = OFF

IV-6 - Setting tables

Two separate tables of parameters (tables 1 and 2) are available in the GMSx7001 relays.

It is possible to change between tables via the terminal and via the current loop rear communications network, but not via the unit keyboard.

Reading the current setting table

The current table may be read directly on the relay under the settings heading (Param. key) and on the terminal under the general settings heading (Vg command).

Changing the settings table

The settings table may be changed from the terminal and using the PTB.

Changing the table switches all the settings from one table to the other.

V - TESTING - COMMISSIONING

V-1 - Introduction

These tests are intended to ensure that the equipment has not suffered any damage during transport or storage and confirms correct operation at the set values.

In addition to electrical tests, the equipment should also be physically examined to ensure it is in sound mechanical condition.

V-2 - Preliminary checks

Before commissioning, it is important to check :
- the correct polarity of the current and voltage transformers. On the connection diagrams, the dots marked next to the transformers represent the P1 or S1 sides.
- the communication plugs, at the rear of the unit, are correctly in place.

V-3 - Switching on the auxiliary supply

When the auxiliary supply is switched on, the device goes through the following sequences :

- sequence of microdiagnostics	:	DIAG
- start-up period	:	INIT
- display of device name and its version	:	GMS-7001 V-2.00
- display of the mean voltage		U MEAN V

At the end of these sequences, the self-monitoring system and the associated W relay are active (W1 contact open).

The self-monitoring system operates in 3 modes:
- detection of the loss of the auxiliary voltage
- detection of the failure of the microprocessor by the watchdog
- detection of the failure of a peripheral device by the microprocessor by the execution of microdiagnostic routines

The self-monitoring system warns the operator of a fault by closing the W1 contact - device terminals 25 and 36 and displays, if the display is operating, the type of fault (RAM - CAN - PROM fault - etc...).

NB : During the microdiagnostics phase [DIAG], the watchdog relay is activated (W1 contact open), during the start-up phase [INIT], the watchdog relay is deactivated (W1 contact closed).

V-4 - Setting the device

Having determined the settings of the various protection functions, taking into account the characteristics of the machine and instrument transformers, follow the procedure outlined in chapter IV.

Also to be determined :
- the configuration of the trip matrix connecting the protection functions to the output relays,
- any operational restrictions during the start-up period (under functions in particular).

Before carrying out tests, it is preferable to restrict all functions (switch P = 0) and to perform tests function by function.

To make things easier, it is advisable to program the device using the terminal, as programming using the keyboard is usually only used to modify certain values.

V-5 - Testing the device, necessary test equipment

These tests require a minimum amount of test equipment, namely :
- a single phase voltage source, frequency variable from 45 to 65 Hz,
- a single phase current source,
  - the phase difference between the two generators should be adjustable from 0 to 360 degrees,
  - the voltage/current injection set needs to have a timer and automatic supply cut-off system,
  - an auxiliary power supply,
  - an ammeter, a voltmeter and a frequency meter.

All tests are carried out single phase.

A test closer to actual normal operating conditions would involve using a three-phase injection system (test values without negative phase sequence or earth fault components etc...).

A high level of measurement accuracy may only be achieved when using test sources having good electrical characteristics and accurate measurement devices.

IMPORTANT : It is formally prohibited to test this equipment without its base by plugging standard commercially available plugs or leads into the female sockets at the rear of the relay.

Before disconnecting the wiring to the device, the current transformer secondaries must be short-circuited.

Remark concerning the display of alarm and trip conditions:

The most recent alarm or trip condition only replaces the preceding one on the GMS display if a new output relay is brought into action.

Remark concerning the duration of current injection:

In order to avoid dangerously overloading the current inputs, the test current must be switched off automatically when the corresponding output relay operates.

V-5-1 TESTING THE OVERCURRENT FUNCTION (51)

CONNECTIONS

Current source connected to 2-3, 6-7, or 10-11 depending upon the phase being tested (or the three phases in series)

Steps to be taken	Expected results
The I> threshold is always connected to the a relay	
I> Progressively increase the current until the chosen current threshold is reached	The Start LED lights up at 100% of the setting
tI> -Preset the injected current to 10 times the setting for inverse time (NI, VI, EI curves) and at least 1.5 times the setting for definite time (DT curve) -Cut the current and then switch it back on NOTE: -even though the Start LED comes on at 100% of the setting for inverse time curves, the effective point at which timing commences is 110%. -other points on the inverse time curves can be checked against those on fig 5-6 and 7 or calculated given that : $t(s) = \frac{T}{(I/I>)^{\alpha} - 1}$ x the tI> setting where T=0.046 α=0.02 (NI) inverse T=9 α=1 (VI) very inverse T=100 α=2 (EI) extremely inverse	At the end of the set time delay : -the a relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears -the fault current value is available (Ack key)
I>> -Program the I>> function to one of the output relays As the I> function cannot be disconnected the Start LED will come on at the I> or I>> setting, whichever is the lower.	
tI>> -Check that the tI> time delay is much greater than tI>>. -Preset the injected current to at least 1.5 times the I>> threshold -Cut the current and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears -the fault current value is available (Ack key)

V-5-2 TESTING THE NEGATIVE PHASE SEQUENCE OVERCURRENT FUNCTION (46)

CONNECTIONS

Current source connected one of the phases 2-3, 6-7, or 10-11 in order to generate negative phase sequence. In this case the negative phase sequence current I_2 is equal to 1/3 of the injected current

Steps to be taken	Expected results
I_2> -Program the tI_2> function to one of the output relays -Progressively increase the current I tI> (fixed or adjustable) -Preset the injected current to at least 1.5 times the setting -Cut the current and then switch it back on	The Start LED lights up at a an injected current of 3 times the I_2> setting At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message ALARM followed by the function under test appears
I_2>> -Program the tI_2>> function to one of the output relays -Progressively increase the current tI_2>> -Temporarily set the I> threshold to 2IN in order that this function does not operate during the test -Check the C constant setting in seconds. -Preset the injected current I to 3 x 0.5IN -Cut the current and then switch it back on $t = \frac{C}{(0.5)^2} = C \times 4^*$ * consult the curves on fig. 2	The Start LED lights up at a an injected current of 3 times the I_2> setting At the end of the time delay t=Cx4 (C= set time constant in s) : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears -the negative phase sequence fault current is available (Ack key)

V.5.3. TESTING THE THERMAL IMAGE FUNCTION (49)

CONNECTIONS

Current source connected to one phase 2-3, 6-7 or 10-11 in order to generate equal positive and negative phase sequence currents equal to 1/3 I of the injected current

Steps to be taken	Expected results
Formula for the thermal current : $ITH = \sqrt{IPOS^2 + K^2 INeg^2}$ For a single phase injection : IPOS = INEG = 1/3I (I = current to be injected) $ITH = \sqrt{\left(\frac{I}{3}\right)^2 + K^2\left(\frac{I}{3}\right)^2} = \frac{I}{3}\sqrt{1+K^2}$ $I = \frac{3}{\sqrt{1+K^2}} ITH$ ITHA> (alarm threshold) and ITH> (trip thresold= We recommend the test at 3ITH. Taking into account the thermal setting coefficient (ITH/IN) and the nominal current of the unit, the current to be injected is : $\boxed{I = \frac{3}{\sqrt{1+K^2}} \times 3 \times \frac{ITH}{IN} \times IN}$ Nota 1 : If $K^2 = 8$ I = 3ITH - Program the ITHA> function to one of the output relays - Program the ITH> function to one of the output relays other than that chosen for ITHA> - Preset the injected current I according to above formula - Cut the current, then switch off the auxiliary supply in order to reset the thermal image to zero - Switch back on the auxiliary supply and then the injected current - Monitor the thermal state displayed on the unit	- The ITHA> function should trip when the thermal state equals the setting (80 to 100%) - The message ALARM followed by the name of the function being tested should appear - The Start and Trip LEDs should come on simultaneously The ITH> function should trip when the tthermal stage reaches 114%
- Measure the time delay tITH> for a zero preload current (cold condition) (consult the curves of fig.1)	The measured time delay should be equal to : $t(s) = \tau Ln \frac{3^2}{3^2 - 1,07^2}$ t(s) = τ Ln 1,145 Example : if τ = 10min or 600s, t = 81s
Nota 2 : if you want to measure the time delay of the alarm unit ITHA> (0.8 at 1) at 3ITH, the time equation becomes :	$t(s) = tLn \frac{3^2}{3^2 - ITHA>}$

V-5-4 TESTING THE EARTH FAULT OVERCURRENT FUNCTION (64) (GMSH7001 ONLY)

CONNECTIONS

Current source connected to 26 - 27 (residual connection), or to the primary of the toroid connected to terminals 26 - 27 (connection to a toroid)

Steps to be taken	Expected results
The earth fault input can be connected in two ways : -residually connected to three line cts (range 5 to 100%IN with IN = 1 or 5A) -to the secondary of a 100 turn toroid (range 1 to 20A) These different configurations, even if they are adjustable, involve different devices (different earth fault input cts)	
Io> -Program the tIo> function to any of the output relays -Progressively increase the current until the chosen threshold is reached **Caution** : with the toroid connection, if the injection is done directly into terminals 26 - 27 the injected current has to be divided by 100, i.e. a range of 10mA to 200mA.	The Start LED lights up at 100% of the setting
tIo> -Preset the injected current to 10 times the setting for inverse time (NI, VI, EI curves) and at least 1.5 times the setting for definite time (DT curve) -Cut the current and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears -the fault current value is available (Ack key)
NOTE: - even though the Start LED comes on at 100% of setting for inverse time curves, the effective point at which timing commences is 110%. -other points on the inverse time curves can be checked against those on fig 5-6 and 7 or calculated using the same formulas given for the overcurrent function [51]	

V-5-5 TESTING THE UNDER AND OVER VOLTAGE FUNCTIONS [59] , [27]

CONNECTIONS

Voltage source connected between 28 - 30 - 31 together and 29 (GMS7001), connected between 28 - 30 together and 29 (GMSH7001 and GMSV7001) *

Steps to be taken	Expected results
Depending upon the model, 3 or 2 voltage inputs are connected in parallel in order to conveniently test the OR function of the under voltage element [27]. This test is carried out by applying phase to neutral voltages to the GMS7001. With the GMSV/GMSH7001 it is obligatory to use phase to phase voltages.	
U> -Program only the function under test to any of the output relays -Progressively increase the voltage until the chosen threshold is reached	The Start LED lights up at 100% of the setting
tU> -Preset the injected voltage to at least 1.2 times the setting -Cut the voltage and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears The fault voltage is available (Ack key)
U>> -Program only the function under test to any of the output relays -Progressively increase the voltage until the chosen threshold is reached	The Start and trip LEDs should come on at 100% of the setting The selected relay should pick up The Start LED lights up at 100% of the setting
U< -Program only the function under test -Apply a voltage higher than the threshold and then progressively decrease the voltage until the chosen threshold is reached	
tU< -Preset the injected voltage to UN and then switch off the voltage	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears The fault voltage value is available (Ack key)
Note: if the AND function is used with the under voltage element it is possible to check each phase individually	

V-5-6 TESTING THE NEUTRAL DISPLACEMENT OVER VOLTAGE FUNCTIONS [59G]

CONNECTIONS

Voltage source connected between 28 - 30 - 31 together and 29 (GMS7001), connected between 31 and 27 (dedicated input for the measurement of the zero sequence voltage on the GMSV7001) *

Steps to be taken	Expected results
With the GMS7001, the 3 voltage inputs are connected in parallel in order to generate a zero sequence voltage 3Vo proportional to the V0> and Vo>> thresholds.	
Vo> Program only the function under test to any of the output relays Progressively increase the voltage until the chosen threshold is reached	The Start LED lights up at 100% of the setting
tVo> -Preset the injected voltage to at least 1.5 times the setting -Cut the voltage and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message ALARM followed by the function under test appears
Vo>> Program only the function under test to any of the output relays Progressively increase the voltage until the chosen threshold is reached	
tVo>> Preset the injected voltage to at least 1.5 times the setting -Cut the voltage and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the trip LED should come on -the message TRIP followed by the function under test appears The zero sequence fault voltage is available (Ack key)

(*) SPLC7186 : replace 29 by 20 and 30-31 by 22-23

V-5-7 TESTING THE UNDER AND OVER FREQUENCY FUNCTIONS [81]

CONNECTIONS

Variable frequency voltage source connected between 29 - 30 or 29 - 31 GMS7001 (VB or VC), connected between 29 - 28 or 29 - 30 GMSH7001 or GMSV7001 (VAB or VBC)*

Steps to be taken	Expected results
The frequency is only measured using the phase 1 (VA) voltage applied to the GMS7001. The programming of the F1 and F2 thresholds as either over or under functions as well as the setting of the hysteresis is carried out under the general parameter heading. Note how these have been programmed before starting the testing. F1/2>/< -Program only the function under test -Apply rated voltage at rated frequency -Progressively increase or decrease the frequency until the chosen threshold is reached	The Start LED lights up when the setting is reached
tF1/2>/< -If the test set can handle it, this test is carried out by instantaneously switching the frequency from rated frequency to a frequency outside the confirmed threshold -Apply FN and then F outside the confirmed threshold	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears
- When the output relay has operated, check the programmed reset hysteresis	The value of the frequency during the fault is available (Ack key)

(*) SPEC7186 : replace 29 by 20 and 30-31 by 22-23

V-5-8 TESTING THE OVER FLUX FUNCTION [24]

CONNECTIONS

Variable frequency voltage source connected between 29 - 30 or 29 - 31 GMS7001 (VB or VC), connected between 29 - 30 GMSH7001 or GMS7001 (VBC)*

Steps to be taken	Expected results
The relay takes the ratio U/F where the value for U is taken as the phase to phase voltage UBC or U23 = V2 - V3 With the GMS7001, in the single phase mode, the injected voltage is the phase to neutral voltage and the ratio U/F = V2/F or V3/F. This means that it is necessary to inject a phase to neutral voltage V2 or V3 multiplied by √3 in order to simulate a three phase connection. For the GMSH/GMSV7001, the injected voltage is the phase to phase voltage and no correction is required. U/F> -Program only the function under test	
Voltage operation -Inject a low level of voltage Ue at the devices rated frequency (F=FN) -Progressively increase the voltage Ue* until the chosen threshold is reached $Ue = U> \times \frac{F}{FN} = U> \times 1 = U>$	The Start LED lights up at the calculated setting
Frequency operation -Inject a voltage with a frequency of, for example, 10% below the rated frequency (45Hz for 50Hz) -Progressively increase the voltage Ue* until the threshold, which has been reduced by 10, is reached $Ue = U> \times \frac{F}{FN} = U> \times \frac{45}{50} = 0.9U>$ * multiply the injected voltage Ue by √3 for the GMS7001	The Start LED lights up at the calculated setting
tU/F> -Use the rated frequency -Preset a voltage Ue1 of at least 15%UN -Preset a voltage Ue2 at a value above the threshold -Change from Ue1 to Ue2 **Note** : if the change from Ue1=0 to Ue2 is used, the measured time will be higher than the set time because the frequency tracking function (at approximately 5% of UN) takes a certain amount of time to come into operation.	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears

(*) SPEC7186 : replace 29 by 20 and 30-31 by 22-23

V-5-9 TESTING THE UNDER IMPEDANCE FUNCTION [21]

CONNECTIONS

Use the connection given in figure a.
The under impedance function is tested phase by phase (Z1,Z2,Z3 for the GMS7001, Z1 and Z2 for the GMSH and GMSV7001).

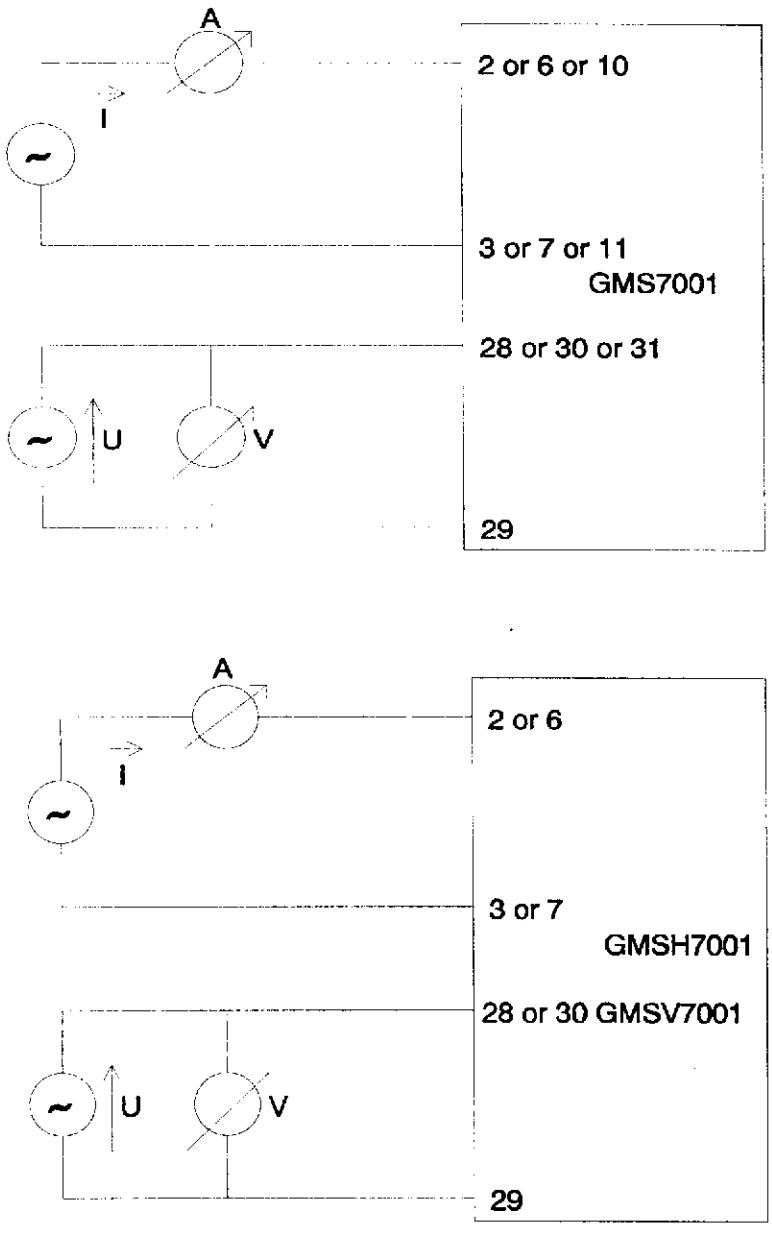
Steps to be taken	Expected results
The following uses the impedance Z1 but is equally applicable to Z2 and Z3. The impedance Z1 is measured as follows : $Z1 = V1 - V2 / I1 - I2$ In single phase operation : GMS7001 V2 = 0 I2 = 0 Z1 = V1/I1 GMSH/GMSV7001 I2 = 0 Z1 = V1 - V2 / I1 The impedance is directly proportional to V1 and I1 for the GMS7001. For the GMSH and GMSV7001 the impedance is √3 higher. **Caution :** This is a current threshold IZ> below which the protection is inoperable. There is no voltage threshold and if V=0, Z=0 and the threshold of the protection becomes the current threshold IZ>. In addition, the IZ> threshold is proportional to I1 - I2. To check this threshold in single phase operation, it is necessary to inject a current √3 higher. Z< -Program only the function under test -Temporarily set the I> threshold to its maximum (2IN) -Apply rated voltage VN on one phase (GMS7001) or UN/√3 (GMSH and GMSV7001) -Inject a low level of current on the corresponding phase and progressively increase the current until Z = Z< (look at the Z measurement) Example : $Z< = 1.25\ ZN\ \ I1 = \frac{1}{1.25} = 0.8IN$	The Start LED lights up at the calculated setting
tZ< -Preset the current to at least 1.2 the theoretical current threshold whilst checking that the tI> time delay is greater than tZ< (in the event that the I> threshold is exceeded) -Switch off the injection and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears

V-5-9 TESTING THE UNDER IMPEDANCE FUNCTION [21] Continued

CONNECTIONS

Use the connection given in figure a.
The under impedance function is tested phase by phase
(Z1,Z2,Z3 for the GMS7001, Z1 and Z2 for the GMSH and GMSV7001).

Steps to be taken	Expected results
	The value of the fault impedance is available (Ack key
IZ> -Switch off the test voltage -Inject a low level of current on the corresponding phase and progressively increase the current	The "Start" LED lights up at a current equal to √3 the threshold



- Figure a -
Connection for testing the under impedance protection [Z1]

(*) SPEC7186 : replace 29 by 20 and 28-30-31 by 21-22-23

V-5-10 TESTING THE OVER AND UNDER POWER FUNCTIONS [32-2]

CONNECTIONS

Use the connection given in figure b. (currents in series, voltages in parallel) Connected in single phase, the 2 quantities U and 1 are in phase.

Steps to be taken	Expected results
With the GMS7001, which uses the 3 wattmeter power measurement method, single phase injection (currents in series, voltages in parallel) is the same as three phase injection. With the GMSH7001 or GMSV7001, which use the 2 wattmeter power measurement method, single phase injection is not the same as three phase injection and it is necessary to use a correction factor K=√3/2 such that P single phase threshold = √3/2 P three phase. P> or P< -Program only the function under test -Apply rated voltage U=VN or UN depending upon the GMS -Progressively increase or decrease the current until the chosen threshold with : I trip = x% Pn x In (GMS7001) I trip = x% Pn x In x √3/2 (GMSH and GMSV7001)	The Start LED lights up at the setting
tP> or tP< -Preset the injected current to at least 1.5 the current threshold -Switch off the injection and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears The value of the fault power is available (Ack key)
Note : the under power function is allowed to operate for all levels of power less than P< (zero or negative active power). The P< function will operate for reverse power conditions.	

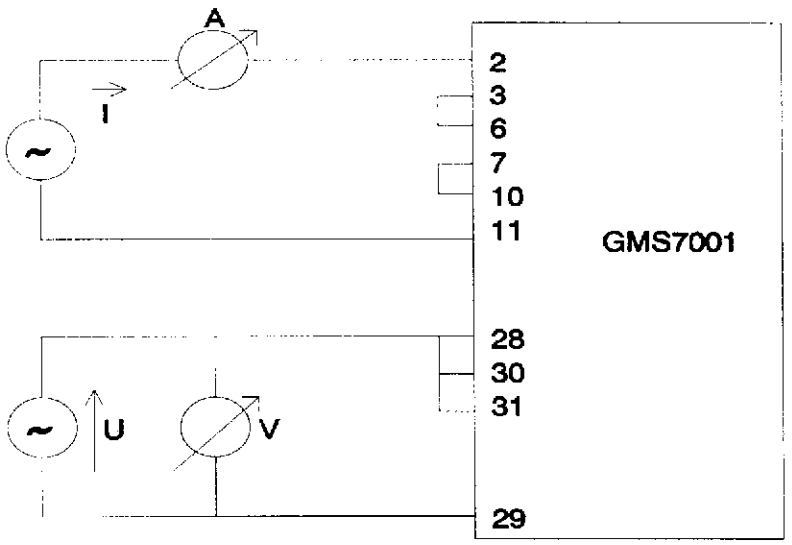
V-5-11 TESTING THE REVERSE POWER FUNCTIONS [32-1]

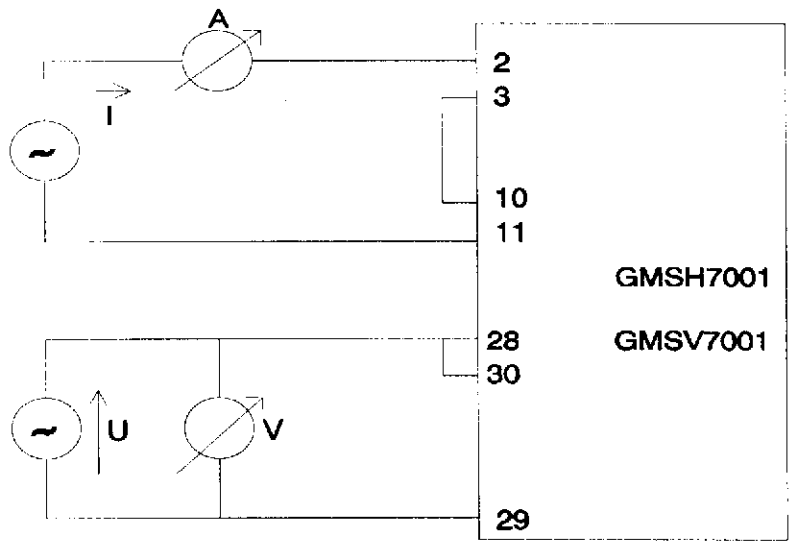
CONNECTIONS

Use the connection given in figure b. (currents in series, voltages in parallel) Connected in single phase, the 2 quantities U and 1 are 180° out of phase.

Steps to be taken	Expected results
With the GMS7001, which uses the 3 wattmeter power measurement method, single phase injection (currents in series, voltages in parallel) is the same as three phase injection. With the GMSH7001 or GMSV7001, which use the 2 wattmeter power measurement method, single phase injection is not the same as three phase injection and it is necessary to use a correction factor K=√3/2 such that P single phase threshold = √3/2 P three phase threshold. RP> -Program only the function under test -Apply rated voltage U=VN or UN depending upon the GMS -Progressively increase or decrease the current until the chosen threshold with : I trip = x% Pn x In (GMS7001) I trip = x% Pn x In x √3/2 (GMSH and GMSV7001)	The Start LED lights up at the calculated setting
tRP> -Preset the injected current to at least 1.5 the current threshold -Switch off the injection and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears The value of the fault power is available (Ack key)

-over or under power : U and I in phase
-reverse power : U and I 180° out of phase





P single phase threshold = √3/2 three phase
2 wattmeter method

- Figure b -
Connection for testing the over or under power and reverse power protection [32-2] [32-1]

(*) SPEC7186 : replace 29 by 20 and 28-30-31 by 21-22-23

V-5-12 TESTING THE LOSS OF EXCITATION FUNCTION [40]

CONNECTIONS

Use the connection given in figure c.

The protection function is tested single phase. The current I has to be 90° leading with respect to the voltage U.

Steps to be taken	Expected results
The trip circle is calculated using the impedance Z = V1 - V2 / I1 - I2 By injecting a single voltage and a single current (I1 for example), we have : GMS7001 V2 = 0 I2 = 0 Z = V1/I1 GMSH/GMSV7001 I2 = 0 Z = V1 - V2 / I1 The influence of the voltage is more important with the GMSH and GMSV (ratio √3). **Caution** : This is a fixed voltage threshold equal to 16%UN below which the protection is inoperable. **Calculation of the operating thresholds** The test involves finding the offset X2 = Xd/2 of the circle such that the value X1 + X2 = Xd (offset increased by the circle diameter) (fig. d). When operating with a fixed input voltage Ue, the unit trips at a current of : $I/IN = \frac{(Ue/Un) \times 100}{X2}$ for X'd/2 and $I/IN = \frac{(Ue/Un) \times 100}{X1 + X2}$ for Xd with Ue injected divided by √3 for the GMSH7001 and GMSV7001. Example X1=160 , X2 =40 , Ue=VN (GMS7001), Ue = UN/√3 (GMSH/GMSV7001) $I/IN = \frac{100}{40} = 2.5$ for X'd/2 $I/IN = \frac{100}{160 + 4} = 0.5$ for Xd	

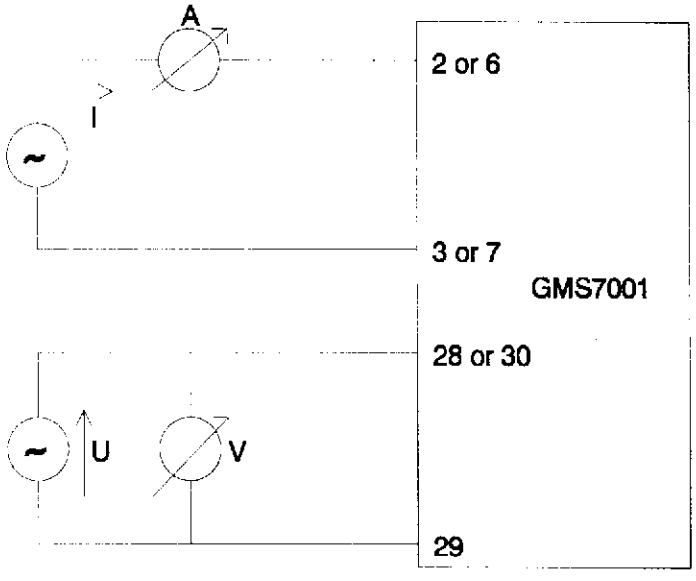
V-5-12 TESTING THE LOSS OF EXCITATION FUNCTION [40] Continued

CONNECTIONS

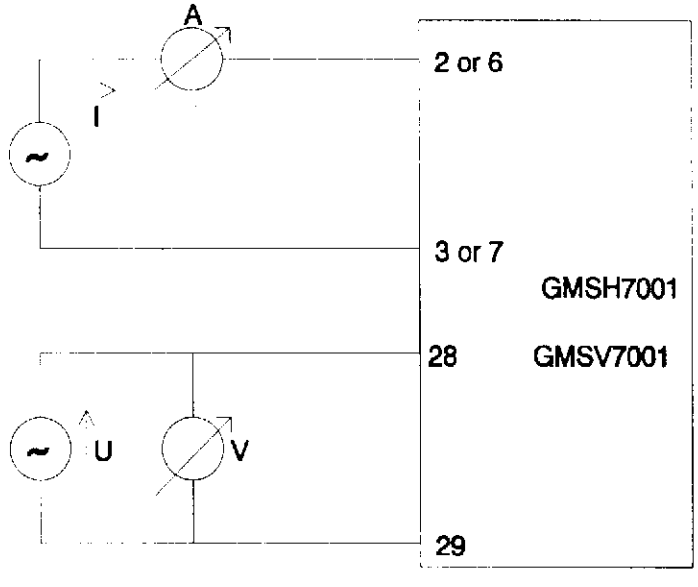
Use the connection given in figure c.

The protection function is tested single phase. The current I has to be 90° leading with respect to the voltage U.

Steps to be taken	Expected results
The point Xd = X1 + X2 is found by starting from zero and increasing the current until 0.5IN -The point X'd/2 = X2 is found by injecting a current I higher than the threshold (2.5IN) and reducing the current to the threshold	
Caution : this last test is difficult to carry out. In reality, the injection of a current above 2IN leads to the tripping of the tI> element and can not be put out of service. In order to see the tY> element trip, it is necessary to either set tI> to its maximum or operate at a reduced voltage (if U = 50%UN, the injected currents are divided by 2).	
Y< -Program only the function under test -Manipulate the current as indicated above	The Start LED lights up at the calculated setting
tY< -Preset the injected current so as to be within the trip circle -Switch off the injection and then switch it back on	At the end of the set time delay : -the selected relay should pick up -the Trip LED should come on -the message TRIP followed by the function under test appears Check the time delay



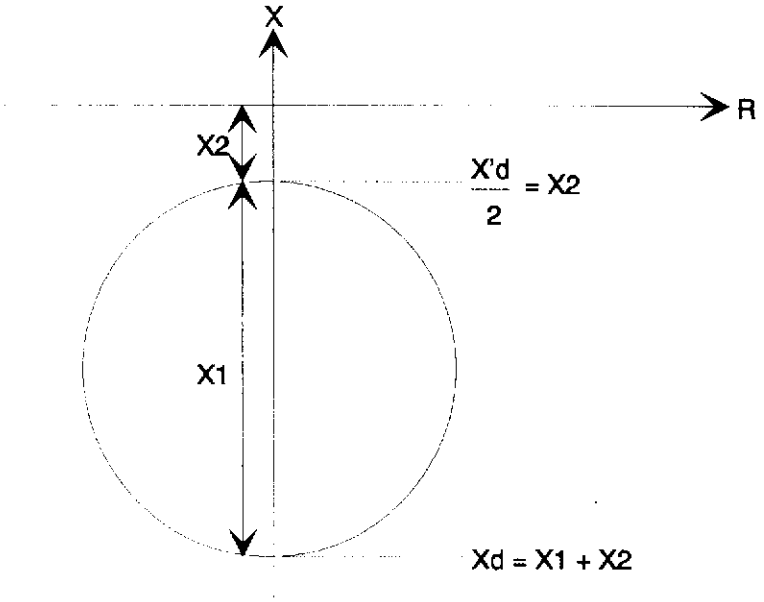
I 90° leading with respect to U



I 90° leading with respect to U

- Figure c -
Connection for testing the loss of excitation protection [40]

(*) SPEC7186 : replace 29 by 20 and 28-30-31 by 21-22-23



- Figure d -

V-5-13 TESTING THE DIGITAL INPUTS

CONNECTIONS

Terminal 12 to the -ve of the auxiliary supply. Terminal 8 (EL1 : T input) to terminal 9 (EL2 : V input) temporarily connected to the +ve of the auxiliary supply.
Note: the allowable variation in the voltage on the 2 inputs is the same as for the auxiliary supply. These two inputs are not polarised, they can be connected to an ac supply.

Steps to be taken	Expected results
EL1 logic input : T input When the T parameter is programmed for a given function, this function is inoperative whilst EL1 (T input) is live. -Permit the operation of a protection function (P parameter active) -Program the T temporary inhibition parameter connected to the T input (P and T parameters active) -Activate the selected protection by crossing the threshold -Connect terminal 8 of the T input to +ve of the auxiliary supply When using an ac auxiliary supply, terminal 12 (common) should be connected to one side of the supply, terminals 8 and 9 to the other side.	The associated output relay operates The function is instantaneously deactivated and the associated output relay drops off.

V-6 Commissioning using primary values

All secondary injection test equipment must be removed before commissioning the relay.

To start with, all of the protective functions, except for the overcurrent protection which can not be deactivated, must be put out of service. During primary tests, the protective functions will be activated one after the other.

Before proceeding with 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 power of 5 VA;5P,10,
- the frequency of the network is identical to that indicated on the relay rating plate;
- the auxiliary voltage is the same as that indicated on the rating plate (20 to 66V or 38 to 250V),
- the relay is correctly plugged in, and that the 4 fixing rods are fully screwed in,
- the rear connected communications sockets are correctly plugged in,
- the trip, control and signalling wiring is correct.

Checking the current connections

It is possible to read the 3 line currents IA, IB and IC. Compare the magnitude of these currents against those actually circulating.

The level of negative phase sequence current I2 can be read. Its value depends upon the correct connection of the line current transformers. If the three line currents have the same value consult the values below :

-normal connection	$I2 \cong 0$
-two phases crossed or correctly wired but incorrect phase sequence	$I2 = I$
-one phase missing	$I2 = 1/3\ I$
-two phases missing	$I2 = 1/3\ I$
-one or two transformers reversed	$I2 = 2/3\ I$

Checking the voltage connections

It is possible to read the measured voltages (GMS7001 : 3 phase to neutral voltages VA, VB and VC, GMSH/GMSV7001 : 2 phase to phase voltages VAB and VBC). Compare the magnitude of these voltages against those actually present.

The level of the phase sequence voltages is not available and so the active power (display) and reactive and apparent powers (terminal) need to be read when the machine is on load in order to confirm that the connections are correct.

If the values appear incorrect when they are read it is necessary to physically check the wiring of the transformers.

VI - MAINTENANCE

-The display does not light up : check the drain given that P = approx 10W or 15VA.

-The relay operates but the circuit breaker does not trip : check the trip circuit wiring

-Threshold will not operate or is too high : check that the relay is fully plugged in and that the fixing rods are screwed in.

-Continuous operation of the residually connected earth fault element (GMSH7001) : check the wiring and the polarity of the cts.

-Toroid (GMSH7001) connected earth fault element will not operate : check the wiring of the cable sheath

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