GE Power Management

Protection, Monitoring, Analysis, and Energy Management Numerical System

SMOR-B

Instructions
GEK 105593C

ISO 9000 Registered ISO 9000

SMOR_B 1000/7000 QUICK REFERENCE GUIDE

Description	User	Limits
COMMON SETTINGS TO ALL TABLES		
General Settings Group		
RELAY STATUS		In/Out of service
IDENTIFICACION		20 ASCII characters
RATED VOLTAGE (PH-PH)		90-200
FREQUENCY		50/60 Hz
CT PHASE RATIO		1-4000
CT GROUD RATIO		1-4000
VT LINE RATIO		1-4000
* VT BUSBAR RATIO		1-4000
DEMAND TIME		15/30/60 min
PHASE ROTATION SELECTION		ABC/CBA
Breaker Settings Group		
BREAKER NUMBER		4 ASCII characters
FAIL TO OPEN TIME		0.05-1 sg.
FAIL TO CLOSE TIME		0.05-5 sg.
ACCUMULABLE I2t LIMIT		1-999999 kA^2s
INTG. I2t TIME SELECTOR		Fixed / Measured
I2t INTEGRATION TIME		0.03-0.25 sg.
MAXIMUM TRIPS IN 1 HOUR		1-50
Active Table Settings Group		
# OF ACTIVE SETTINGS TABLE		1-3
COLD PICK-UP PERMISSION		No / Yes
CHANGE TO TABLE 3 TIME		Max. Reclose time/240 sg.
RETURN FROM TABLE 3 TIME		Safety Time / 1800 sg.
Oscillography Mask Settings Group		
NUMBER OF PRE-FAULT CYCLES		2-10
PICK-UP 51 PT		Enabled/Disabled
PICK-UP 51 NT		Enabled/Disabled
PICK-UP 50 PH		Enabled/Disabled
PICK-UP 50 PL		Enabled/Disabled
PICK-UP 50 NH		Enabled/Disabled
PICK-UP 50 NL		Enabled/Disabled
PICK-UP 46 PT		Enabled/Disabled
PICK-UP 81 0		Enabled/Disabled
PICK-UP 81 U		Enabled/Disabled
PICK-UP 27 P		Enabled/Disabled
PICK-UP 59 P		Enabled/Disabled
PICK-UP 59 NH		Enabled/Disabled
PICK-UP 59 NL		Enabled/Disabled
EXTERNAL TRIGGER		Enabled/Disabled
COMUNICATIONS TRIGGER		Enabled/Disabled
TRIP 51 PT		Enabled/Disabled
TRIP 51 NT		Enabled/Disabled
TRIP 50 PH		Enabled/Disabled
TRIP 50 PL		Enabled/Disabled
TRIP 50 NH		Enabled/Disabled
TRIP 50 NL		Enabled/Disabled
TRIP 46 PT		Enabled/Disabled
TRIP 81 0		Enabled/Disabled
TRIP 81 U		Enabled/Disabled
TRIP 27 P		Enabled/Disabled
TRIP 59 P		Enabled/Disabled
TRIP 59 NH		Enabled/Disabled
TRIP 59 NL		Enabled/Disabled
Function Permission Settings Group		
51 PT FUNCTION PERMISSION		Not allowed/Allowed
51 NT FUNCTION PERMISSION		Not allowed/Allowed
50 PH FUNCTION PERMISSION		Not allowed/Allowed
50 PL FUNCTION PERMISSION		Not allowed/Allowed
50 NH FUNCTION PERMISSION		Not allowed/Allowed

* Disregard for SMOR7000

Description	User	Limits
50 NL FUNCTION PERMISSION		Not allowed/Allowed
46 PT FUNCTION PERMISSION		Not allowed/Allowed
81 O FUNCTION PERMISSION		Not allowed/Allowed
81 U FUNCTION PERMISSION		Not allowed/Allowed
27 P FUNCTION PERMISSION		Not allowed/Allowed
59 P FUNCTION PERMISSION		Not allowed/Allowed
59 NH FUNCTION PERMISSION		Not allowed/Allowed
59 NL FUNCTION PERMISSION		Not allowed/Allowed
51 PT TRIP PERMISSION		Enabled/Disabled
51 NT TRIP PERMISSION		Enabled/Disabled
50 PH TRIP PERMISSION		Enabled/Disabled
50 PL TRIP PERMISSION		Enabled/Disabled
50 NL TRIP PERMISSION		Enabled/Disabled
50 NH TRIP PERMISSION		Enabled/Disabled
46 PT TRIP PERMISSION		Enabled/Disabled
81 O TRIP PERMISSION		Enabled/Disabled
81 U TRIP PERMISSION		Enabled/Disabled
27 P TRIP PERMISSION		Enabled/Disabled
59 P TRIP PERMISSION		Enabled/Disabled
59 NH TRIP PERMISSION		Enabled/Disabled
59 NL TRIP PERMISSION		Enabled/Disabled
INDEPENDENT SETTINGS FOR EACH TABLE		
51 PT Function Settings Group		
51 / 67 P PICK-UP		1.00-12.00 A
CURVE		Inv./M Inv./E Inv./Def. Time
TIME DIAL		0.05-1.00
DEFINITE TIME SETTING		0.00-100.00 sg
51 NT Function Settings Group		
51 / 67 N PICK-UP		0.20-2.40 A
CURVE		Inv./M Inv./E Inv./Def. Time
TIME DIAL		0.05-1.00
DEFINITE TIME SETTING		0.00-100.00 sg
50 PH Function Settings Group		
50 / 67 P PICK-UP		1.00-160.00 A
TIME DELAY		0.00-60.00 sg
50 PL Function Settings Group		
50 / 67 P PICK-UP		1.00-160.00 A
TIME DELAY		0.00-60.00 sg
50 NH Function Settings Group		
50 / 67 N PICK-UP		0.20-32.00 A
TIME DELAY		0.00-60.00 sg
50 NL Function Settings Group		
50 / 67 N PICK-UP		0.20-32.00 A
TIME DELAY		0.00-60.00 sg
46 PT Function Settings Group		
51 / 67 N PICK-UP		0.10-4.00 A
CURVE		Inv./M Inv./E Inv./Def. Time
TIME DIAL		0.05-1.00
DEFINITE TIME SETTING		0.00-100.00 sg
81 Function Settings Group		
81 U PICK-UP		40.00-70.00 Hz
UNDERFREQUENCY TIME DELAY		0.00-100.00 sg
81 O PICK-UP		40.00-70.00 Hz
OVERFREQUENCY TIME DELAY		0.00-100.00 sg
UNDERVOLTAGE SUPERVISION		40-110 %
Voltage Settings Group		
UNDERVOLTAGE PICK-UP (27 P)		10.00-260.00 V
27 P TIME DELAY		0.03-100.00 sg
OVERVOLTAGE PICK-UP (59 P)		10.00-260.00 V
59 P TIME DELAY		0.03-100.00 sg

Description	User	Range
OVERVOLTAGE PICK-UP (59 NH)		3.00-100.00 V
59 NH TIME DELAY		0.03-100.00 sg
OVERVOLTAGE PICK-UP (59 NL)		3.00-100.00 V
59 NL TIME DELAY		0.03-100.00 sg
Directionality Settings Group		
51 PT DIRECTIONAL		Not allowed/Allowed
51 NT DIRECTIONAL		Not allowed/Allowed
50 PH DIRECTIONAL		Not allowed/Allowed
50 PL DIRECTIONAL		Not allowed/Allowed
50 NH DIRECTIONAL		Not allowed/Allowed
50 NL DIRECTIONAL		Not allowed/Allowed
CHARACTERISTIC ANGLE – PHASE		-90.00º - +90.00º
CHARACTERISTIC ANGLE – GROUND		-90.00º - +90.00º
LOSS VOLTAGE LOGIC		Block/Permission
Recloser Settings Group		
RECLOSER PERMISSION		Not allowed/Allowed
NUMBER OF CYCLES		1-4
RESET TIME		0-600 sg
HOLD MODE SELECTION		NO/YES
HOLD MODE TIME		0-100 sg
1ST RECLOSE TIME		0.10-100.00 sg
2ND RECLOSE TIME		0.10-100.00 sg
3RD RECLOSE TIME		0.10-100.00 sg
4TH RECLOSE TIME		0.10-100.00 sg
RECLOSE CONDITIONS		0-4
		0-No Condition
		1-Inhib. Input
		* 2-Voltage only on
		* 3-Voltage on busbar
		* 4-Voltage on both sides
RECLOSE PERMISSION AFTER 51 PT		Enabled/Disabled
RECLOSE PERMISSION AFTER 51 NT		Enabled/Disabled
RECLOSE PERMISSION AFTER 50 PH		Enabled/Disabled
RECLOSE PERMISSION AFTER 50 PL		Enabled/Disabled
RECLOSE PERMISSION AFTER 50 NH		Enabled/Disabled
RECLOSE PERMISSION AFTER 50 NL		Enabled/Disabled
RECLOSE PERMISSION AFTER 46 PT		Enabled/Disabled
RECLOSE PERMISSION AFTER 81 U		Enabled/Disabled
RECLOSE PERMISSION AFTER 81 O		Enabled/Disabled
RECLOSE PERMISSION AFTER 27 P		Enabled/Disabled
RECLOSE PERMISSION AFTER 59 P		Enabled/Disabled
RECLOSE PERMISSION AFTER 59 NH		Enabled/Disabled
RECLOSE PERMISSION AFTER 59 NL		Enabled/Disabled
RECLOSE PERMISSION WITH AN INPUT		Enabled/Disabled
TRIP PERMISSION 51 PT AFTER 79		Enabled/Disabled
TRIP PERMISSION 51 NT AFTER 79		Enabled/Disabled
TRIP PERMISSION 50 PH AFTER 79		Enabled/Disabled
TRIP PERMISSION 50 PL AFTER 79		Enabled/Disabled
TRIP PERMISSION 50 NH AFTER 79		Enabled/Disabled
TRIP PERMISSION 50 NL AFTER 79		Enabled/Disabled
TRIP PERMISSION 46 PT AFTER 79		Enabled/Disabled
TRIP PERMISSION 81 U AFTER 79		Enabled/Disabled
TRIP PERMISSION 81 O AFTER 79		Enabled/Disabled
TRIP PERMISSION 27 P AFTER 79		Enabled/Disabled
TRIP PERMISSION 59 P AFTER 79		Enabled/Disabled
TRIP PERMISSION 59 NH AFTER 79		Enabled/Disabled
TRIP PERMISSION 59 NL AFTER 79		Enabled/Disabled

NOTE: Pick-up settings correspond to a range C relay:

1 - 12 A	Phases
0.2 - 2.4 A	Ground

GE Power Management

SMOR_B 1000/7000 QUICK REFERENCE GUIDE

* MODEL LIST

SMOR _ _ _ 1 _ 2 1 _ _ 00B	DESCRIPTION
	FAMILY
0	3xIph + Ig (without voltage functions)
1	3xIph + Ig + 3xV
4	3xIph + Ig + 3xV (ungrounded system)
6	3xIph + Ig + Ig2 + 3xV
7	3xIph + Ig + 3xV + Vo (dedicated)
	COMMUNICATIONS INTERFACE
0	RS232
1	Plastic F.O. + RS232
2	Glass F.O. + RS232
3	RS232+RS485
	RANGES
*	* Ranges (see table)
	MMI LAGUAGE
M	Spanish
D	English
	EXPANSION
0	Without expansion board
1	With expansion board
	AUXILIARY VOLTAGE
A	48 Vdc
H	110 / 250 Vdc

* RANGES

MODELS		A	B	C	D	E	F	G	H
1/7	Phase	1-12	0.2-2.4	1-12	1-12	1-12	0.5-6	0.5-6	2-16
	Ground	1-12	0.2-2.4	0.2-2.4	0.5-6	0.1-1.2	0.2-2.4	0.1-1.2	0.2-2.4
4	Phase		0.2-2.4	1-12					
	Ground		0.005-0.1	0.005-0.1					
6	Phase			1-12	1-12				
	Ground			0.2-2.4	0.2-2.4				
	Ground 2			0.025-0.3	0.5-6				

* INPUTS / OUTPUTS

- Without expansion board:
  - 6 digital inputs (two groups of 3 inputs with one common in each group).
  - 2 groups of 4 configurable outputs with one common in each group.
  - 2 trip contacts.
  - 2 close contacts.
  - 1 alarm contact
- With expansion board:
  - 12 digital inputs (4 groups of 3 inputs with one common in each group).
  - 2 groups of 4 configurable outputs with one common in each group.
  - 4 configurable outputs electrically isolated.
  - 2 trip contacts.
  - 2 close contacts.
  - 1 alarm contact.
  - 2 coil supervision circuits.

* COEFFICIENTS FOR INVERSE CURVES

$$time = TD\left[\frac{K}{M^{a} - 1}\right]$$

CURVE	K	a
Inverse	0.13	0.02
Very Inverse	16	1
Extremely Inverse	96	2

* DEFAULT LEDS CONFIGURATION (STANDARD MODEL)

LED	CONFIGURATION	NMEMONIC	MEMORY	MODE
1	Phase A Trip	ƒA TRIP	YES	FIXED
2	Phase B Trip	ƒB TRIP	YES	FIXED
3	Phase C Trip	ƒC TRIP	YES	FIXED
4	Ground Trip	GRN TRIP	YES	FIXED
5	Function 51/67 Trip	51/67 TRIP	YES	FIXED
6	Function 50/67 Trip	50/67 TRIP	YES	FIXED
7	Function 46 PT Trip	46 TRIP	YES	FIXED
8	Voltage Functions Trip	27/59/59N TRIP	YES	FIXED
9	Frequency Functions Trip	81 TRIP	YES	FIXED
10	Recloser Out of Service	79 OUT OF SERVICE	NO	FIXED
11	Reclose in progress	79 IN PROGRESS	NO	FIXED
12	Recloser LockOut	79 LOCKOUT	NO	FIXED
13	52 Open	52 OPEN	NO	FIXED
14	Coil Supervision Alarm	COIL SUPERV.	NO	FIXED
15	Critical Alarm	CRITICAL ALARM	NO	FIXED
16	Remote Mode	REMOTE MODE	NO	BLINK.

* DEFAULT INPUTS CONFIGURATION (STANDARD MODEL)

INPUT	CONFIGURATION	CONTACT	COMMON
CC1	Breaker input 52/b	C9	D10
CC2	Recloser Block	D9	D10
CC3	Recloser UnBlock	C10	D10
CC4	50 P Block	C11	D12
CC5	50 N Block	D11	D12
CC6	Recloser Inhibit	C12	D12
CC7	Reclose Initiate	E9	F10
CC8	Phase Directional Blocking	F9	F10
CC9	Ground Directional Blocking	E10	F10
CC10	Oscillography Trigger	E11	F12
CC11	Active Table Select 0	F11	F12
CC12	Active Table Select 1	E12	F12

* CONFIGURABLE INPUTS OPTIONS:

- Recloser Block (L)
- Recloser Unblock (P)
- Reclose Inhibition (L)
- PT Secondary MCB Tripping (L)
- Active Table Select 0 (L)
- Open Command (P)
- Phase Directional Blocking (L)
- Phase Instantaneous Blocking (L)
- Phase Units Blocking (L)
- Voltage Uniis Blocking (L)
- 46 PT Unit Blocking (L)
- Recloser Block (P)
- Reclose Initiate (P)
- Oscillography External Trigger (P)
- Fail To Open Pickup (P)
- Active Table Select 1 (L)
- Close Command (P)
- Ground Directional Blocking (L)
- Ground Instantaneous Blocking (L)
- Ground Units Blocking (L)
- 81U/81O Units Blocking (L)
- General Blocking (L)

NOTE: (L) indicates Level input.
(P) indicates Pulse input.

* DEFAULT OUTPUTS CONFIGURATION (STANDARD MODEL)

OUTPUT	CONFIGURATION	CONTACT	COMMON
S1	51/67 P Pick-Up	C4	C6
S2	51/67 N Pick-Up	D4	C6
S3	46 PT Trip	C5	C6
S4	81 Trip	D5	C6
S5	27 / 59 Trip	C7	D6
S6	Last Trip	D7	D6
S7	Reclose In Progress	C8	D6
S8	Recloser Out of Service	D8	D6
S9	51/67 P Trip	E1	F1
S10	50/67 P Trip	E2	F2
S11	51/67 N Trip	E3	F3
S12	50/67 N Trip	E4	F4

* CONFIGURABLE OUTPUTS OPTIONS:

Program Initiates	81O Pickup	51 Phase A Trip	Trips not allowed
Settings Change	27P Pickup	51 Phase B Trip	I with 52 open
Write Counters	59P Pickup	51 Phase C Trip	52 maintenance Al.
Cnfg. Change	59NH Pickup	50H Phase A Trip	Coil 1 Cont. Failure
External Trigger	59NL Pickup	50H Phase B Trip	Coil 1 DC supply Fail.
Communic. Trigger		50H Phase C Trip	Coil 2 Cont. Failure
		50L Phase A Trip	Coil 2 DC supply Fail.
		50L Phase B Trip	Closed Trip
			Contacts
Reclose Command	51 Phase A Pickup	50L Phase C Trip	Active Table 1
79 Block Command.	51 Phase B Pickup	27P AB Trip	Active Table 2
79 Unblock Comma.	51 Phase C Pickup	27P BC Trip	Active Table 3
Open Command	50H Phase A Pickup	27P CA Trip	
Close Command	50H Phase B Pickup	59P AB Trip	
	50H Phase C Pickup	59P BC Trip	New Events
	50L Phase A Pickup	59P CA Trip	
	50L Phase B Pickup		52 Status
Activation Input 1	50L Phase C Pickup	79 Out of Service	
Activation Input 2	27P AB Pickup	Reclose in progress	52 Failed to Open
Activation Input 3	27P BC Pickup	Reclose initiate	52 Failed to Close
Activation Input 4	27P CA Pickup	Ext. Reclose Initiate.	Directional A
Activation Input 5	59P AB Pickup	Reclose Inhibit.	Directional B
Activation Input 6	59P BC Pickup		Directional C
	59P CA Pickup	Last Trip	Directional N
		79 Ready	
Activation Input 7	51 PT Trip	Lockout: Fail to open	AND 1
Activation Input 8	51 NT Trip	Lockout: Repet. Trip	AND 2
Activation Input 9	50 PH Trip	Lockout: No cond.	AND 3
Activation Input 10	50 PL Trip	Lockout: Faulty 79	AND 4
Activation Input 11	50 NH Trip	Global Lockout	AND 5
Activation Input 12	50 NL Trip		AND 6
	46 PT Trip		AND 7
	81 U Trip	Recloser Block	AND 8
51PT Pickup	81 O Trip		AND 9
51NT Pickup	27 P Trip	Parallel E2PROM Al.	AND 10
50PH Pickup	59 P Trip	Serial E2PROM Al.	AND 11
50PL Pickup	59 NH Trip	In/Out of Service	AND 12
50NH Pickup	59 NL Trip	Default general	AND 13
		Sett.	
50NL Pickup		Default Table 1 Sett.	AND 14
46PT Pickup		Default Table 2 Sett.	AND 15
81U Pickup		Default Table 3 Sett.	AND 16

NOTE: By using the INF key on the MMI you can see the status of the shadowed signals. Measurements and communication estates are also available.

* CONFIGURATION SETTINGS (7169)

SETTING	RANGE	DEFAULT
REMOTE PORT BAUD RATE	1200-115200 bauds	19200 bauds
REMOTE – STOP BITS	1-2	1
LOCAL PORT BAUD RATE	1200-19200 bauds	19200 bauds
LOCAL – STOP BITS	1-2	1
LOCAL SETTINGS	No Per/Per	Per
REMOTE SETTINGS	No Per/Per	Per
LOCAL OPERATIONS	No Per/Per	Per
REMOTE OPERATIONS	No Per/Per	Per
UNIT NUMBER	1 – 255	1
PASSWORD	0-99999	1
t TIMEOUT	0-86400	0

* SMOR_B SOFTWARE

GE_INTRO: Relay Configuration .
GE_LOCAL: Settings, Events, Status.
GE_OSC: Oscillography analysis.

* COMMUNICATIONS

SMOR_B	PC DB 9	MODEM
3	2	3
2	3	2
1	4	4*
5	5	5

* Join 6 and 7 points too.

Anything you can't find?

Anything not clear enough?

IF YOU HAVE ANY COMMENT ON THE CONTENTS OF THE PRESENT MANUAL, KINDLY FAX US A COPY OF THIS PAGE TOGETHER WITH A COPY OF THE PAGE WHERE YOU HAVE FOUND THE PROBLEM, TO THE FAX NUMBER +34 94 485 88 45 FILLING IN THE QUESTIONAIRE BELOW. WE WILL BE HAPPY TO SOLVE YOUR DOUBTS, AND WE THANK YOU FOR HELPING US IMPROVE THIS MANUAL.

Company: ______________________________

Name: ______________________________

Address: ______________________________

Phone: ____________________ ***Fax:*** ____________________

E-mail: ______________________________

Description of your question or suggestion:

Manual GEK code: ______________________________

____

____

____

____

TABLE OF CONTENTS

LIST OF FIGURES

1. GENERAL DESCRIPTION AND APPLICATION

1.1. GENERAL DESCRIPTION

The SMOR system is a microprocessor based multifunction protection, control and measurement unit. The SMOR uses a set of algorithms to create a general purpose protection and monitoring unit for power systems.

The SMOR system is supplied in a 19'' rack case 2 units high. Figure 1 shows a diagram for panel drilling installation.

All the information and settings of the unit are accessible by means of a computer connected to the serial port (RS232 or fiber-optic) or using the man-machine interface (MMI), which includes a 20 character keypad and a two line liquid crystal display (LCD) with 16 character on each line, located on the front of the relay.

This protection system includes the following functions:

a) Protection:

- 6 overcurrent units arranged in the following way:
  - 3 phase units:
    - 51PT, Instantaneous, Inverse or definite time.
    - 50PH, Instantaneous or definite time.
    - 50PL, Instantaneous or definite time.
  - 3 ground units:
    - 51NT, Instantaneous, Inverse or definite time.
    - 50NH, Instantaneous or definite time.
    - 50NL, Instantaneous or definite time.
- Independent directional supervision adjustment for each overcurrent functions.
- Negative sequence overcurrent
- Three-phase over and undervoltage
- Ground overvoltage (2 levels). NOTE: Only for the SMOR7000 model an open delta input is available.
- Over and under frequency

b) Monitoring and Register

- Current measurement for each phase and ground.
- Negative sequence current measurement.
- Measurement of line to line voltages.
- Measurement of active and reactive power along with power factor.
- Frequency measurement.
- Breaker status.
- LED indicators - 17 LED display (16 of which can be configured by the user).
- Breaker supervision for failure-to-open or failure-to-close (optional, mounted in the additional board).
- Breaker health monitoring ($\Sigma I^2 t$) per phase.
- Phase rotation sequence selection (ABC or CBA).
- Maximeter for current and active power.
- Built in self-checking unit.

c) Analysis:

- Load profile recorder.
- Event recorder.
- Oscillography recorder.

d) Control:

- Command of associated breaker.
- Operation failure detection (opening or closing).
- Automatic recloser that can be programmed for up to 4 shots.
- 3 setting tables.
- Cold load pickup logic.
- IRIG-B time synchronization.
- Configurable inputs and outputs.
- Internal logic that can be configured by the user (based on AND, NOT, OR gates).

e) Communication Interfaces

- Three communication ports, one on the front of the relay and two located on the rear.
- Man machine interface (MMI) consisting of a keyboard (20 key) and an alphanumerical display (2 lines x 16 char.).
- Windows™ based GE-INTRO configuration software and GE-LOCAL communication software. Both programs are part of the GE-NESIS (General Electric NEtwork Substation Integrated System).

2. OPERATING PRINCIPLES

2.1. PROTECTION FUNCTIONS

2.1.1. OVERCURRENT UNITS

SMOR system includes the following overcurrent units, all of which can be set and used independently:

- **Phase overcurrent (for three phases):**

Time delayed	51 PT (Instantaneous, definite or inverse time)
Instantaneous, High level	50 PH (Instantaneous or definite time delayed)
Instantaneous, Low level	50 PL (Instantaneous or definite time delayed)

- **Ground overcurrent:**

Time delayed	51 NT (Instantaneous, definite or inverse time)
Instantaneous, High level	50 NH (Instantaneous or definite time delayed)
Instantaneous, Low level	50 NL (Instantaneous or definite time delayed)

Any unit can be set to be directional or non-directional, independently.

- **Negative sequence overcurrent:**

Time delayed	46 PT (Instantaneous, definite or inverse time)

The timed units can be selected using Inverse, Very Inverse, Extremely Inverse curves, or definite time characteristic. These inverse time curves are shown in Figures 2, 3 and 4 and follow the equation:

$$t = TD \left[\frac{K}{M^{\alpha} - 1} \right]$$

in which:

t = Time in seconds
TD = Time Dial of the curve (0.05 for the lower curve of the family and 1 for the upper curve)
M = Multiples of the pickup value

K, α are coefficients which identify the selected curve and which correspond to the following table:

Curve	Characteristic	K	α
1	Inverse	0.13	0.02
2	Very inverse	16	1
3	Extremely inverse	96	2

2.1.2. DIRECTIONAL SUPERVISION SETTING

The SMOR system has three phase directional units and one ground directional unit. They are completely independent on each other, being used to supervise (assuming they are adjusted to do so) the tripping of the phase and ground overcurrent units, according to the direction of the detected fault (they do not affect the trip of the negative sequence overcurrent unit). The directional supervision can be adjusted independently for each of the overcurrent functions of the SMOR system, both for phases and ground.

The phase directional units are polarized by phase-to-phase voltages, while the ground directional unit is polarized by zero sequence voltage. The characteristic angle of the unit can be independently set for the phase and ground units.

To protect against loss of polarization voltage, the system includes adjustable fuse-failure logic. This logic allows to either block the operation of the units or to convert the directional units into non-directional. The selection is done through a setting. The fuse failure function operates on two different conditions (OR logic):

- Operation of undervoltage detectors (adjusted at 3.5 volts)
- Activation of a digital input connected to the voltage MCB.

2.1.3. VOLTAGE UNITS

- Phase over and under voltage:
  - Under voltage: 27P
  - Over voltage: 59P

The three-phase under and overvoltage units operate under conditions of under or over voltage (depending on the unit) in any of the three phases. **Both units are adjusted and operate on phase-to-phase voltage values,** calculated from the phase-to-ground voltages applied to the unit.

- Ground overvoltage:
  - High Setting: 59 NH
  - Low Setting: 59 NL

There are two ground overvoltage units. The SMOR7000 model has a dedicated open-delta input. In all other models the voltage is calculated from the phase to ground inputs.

2.1.4. FREQUENCY UNITS

- Underfrequency : 81U
- Overfrequency: 81O

The under and over frequency units are measured on one phase (phase B).

2.2. MONITORING AND REGISTERING FUNCTIONS.

2.2.1. MEASUREMENT

The SMOR system offers the following metering capabilities:

- Three-phase and ground current.
- Negative sequence current.
- Phase-to-phase voltages.
- Active and reactive power.
- Power factor.
- Frequency.

The RMS value for currents and voltages is calculated for each phase, and the phase-to-phase voltages are calculated from the phase to ground voltages. The active and reactive power are also computed on these values. The active and reactive power, and the power factor are only shown as three-phase values.

These measurements can be accessed locally on the liquid crystal display (LCD) on the front of the relay, or via the GE-LOCAL communication software.

The SMOR unit has a demand register, as well as a maximeter register for current and active power. For the demand register, the maximum and average RMS current are calculated over a selected period of 15, 30 or 60 minutes corresponding to the last 24, 48 or 96 hours respectively. The maximeter register computes the maximum value for current and power for periods which are the same as those selected for the demand register.

2.2.2. ASSOCIATED BREAKER STATUS

SMOR system monitors breaker status associated to the unit with a digital input (52/b). The breaker status can be accessed using the local MMI or the communication software, which shows the breaker status in real time through a visual simulation of the line.

2.2.3. LED INDICATORS.

An internal states matrix stores the digital information for all the units (inputs, pick-ups, alarms, etc). The digital signals on this matrix are grouped in groups of 16 signals; there are 10 groups; It is a 10 x 16 matrix; the final group corresponds to the 16 AND gates definable using the programmable logic of GE-INTRO software.

The SMOR unit has a total of 17 LED indicators, one fixed bicolor assigned to the critical alarm function of the unit and 16 red LED indicators, arranged in two columns of 8 LEDs. They can be configured using the GE-INTRO configuration software to any of the user definable alarms (32 protection alarms and 16 communication alarms) assigned from among the protection and communication states. To define each alarm, the user can use 16 inputs OR gates. All the inputs to an OR gate must belong to the same group in the states matrix. Similarly, each LED can be configured to have memory in the absence of auxiliary power supply (the status of the LED with memory is registered on the EEPROM memory). They can also be configured to blink when turned on.

There is a test option for the LEDs, lighting them all up when the TARGET RESET button is pressed. When this button is held down the LED indicators are reset.

The SMOR units are supplied from the manufacturer with the following default configuration of the LEDs:

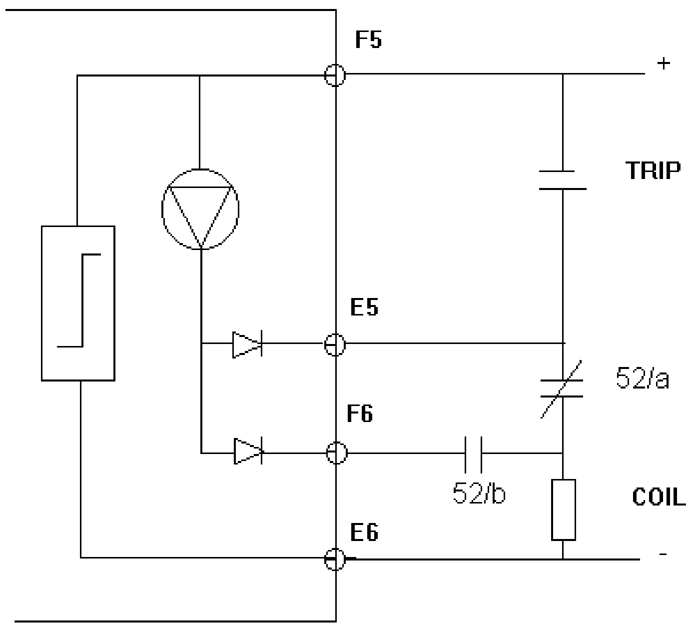
COLUMN			
LED Nº	**LEFT**	**LED**	**RIGHT**
1	Phase A trip	9	Frequency trip (81)
2	Phase B trip	10	Recloser out of service
3	Phase C trip	11	Reclose in progress
4	Ground trip	12	Recloser in lockout status
5	Timed Overcurrent trip	13	Circuit Breaker Open
6	Instantaneous Overcurrent trip	14	Coil supervision alarm
7	Negative sequence trip	15	Unit alarm
8	Voltage trip (27/59/59N)	16	Remote communication mode

2.2.4. SUPERVISION OF TRIP AND CLOSING CIRCUITS

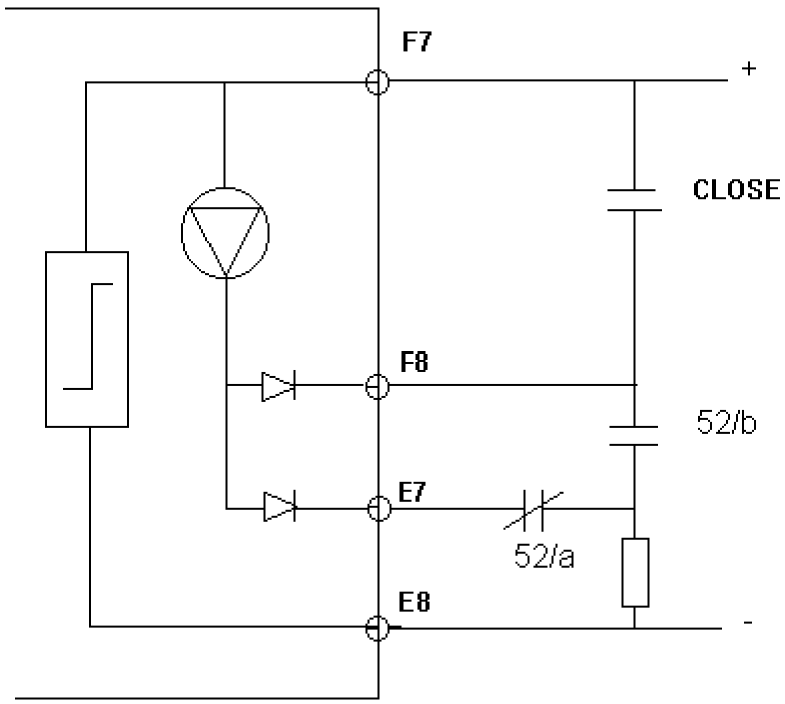
On the optional expansion board there are two complete supervision circuits for the trip and/or closing coil of the breaker (one input for each coil). These supervision inputs monitor both the battery voltage and the continuity of the tripping or closing circuits, monitoring the flow of a small current injected into the circuit.

The unit independently identifies in the event recorder and states matrix the continuity of each coil ("coil continuity alarm") and the loss of voltage to command the breaker ("coil DC supply alarm.")

Circuit supervision is carried out on a permanent basis, regardless of whether the breaker is in the open or closed status, since the supervision circuit is connected both to contact 52/a and 52/b of the breaker. For the supervision to be carried out correctly, the supervision circuits must be connected to the tripping or closing coils as shown in the following diagrams:



TRIP CIRCUIT SUPERVISION



CLOSE CIRCUIT SUPERVISION

2.2.5. BREAKER HEALTH MONITORING

To supervise the breaker health, SMOR system calculates and stores, for each operation, the accumulated values for the square of the current multiplied by the opening time of the breaker (ΣI^2t) on each of the three phases. If the nominal current is not exceeded, as is the case for a manual opening command with no fault current, the relay uses the nominal current value instead of the measured value.

The value I^2t is accumulated and stored independently for each phase. These values can be accessed either by local MMI or by GE-LOCAL communication software.

The function has an "Integration Time Selector" setting which can be used to assign a fixed opening time (given by another "Integration Time" setting). Otherwise it allows the unit to measure this time from the moment the opening command is given until the moment when the breaker opens.

The "Accumulative Current Limit" setting establishes a threshold for the breaker's interruption capability (it is advisable to set this to the limit supplied by the manufacturer). When this threshold is passed on any of the three phases, the system gives an alarm. In addition, the system incorporates a counter for the number of opening operations carried out.

The purpose of this function is to allow maintenance to be carried out in a more accurate method than using fixed time periods. Once this maintenance operation has been carried out, the values for both the I^2t and number of opening operations, can be reset to zero.

In order to be able to take into account the history of the breaker, in the case where the breakers were already in use before the installation of the relay, the system allows to set an initial value for the ΣI^2t and the number of opening operations carried out. Similarly, these values can be adjusted to a given value in order to take into account the operations carried out during the protection testing.

2.2.6. PHASE ROTATION SEQUENCE SELECTION

The SMOR system works correctly with any phase sequence selection ABC or CBA without the need to change the wiring of the external transformers, since there is a setting which allows the selection of the phase rotation sequence.

2.2.7. SELF-CHECKING FUNCTIONS.

Thanks to its digital technology, the SMOR system incorporates self-checking functions which guarantee the correct performance of the unit and will block the operation in case of internal errors.

These self monitoring checks are carried out both when the unit is started up and during normal operation. The checks are carried out on the internal power supply, program memory (ROM), working memory (RAM), oscillographic memory (RAM) and settings and calibration memory (EEPROM).

In addition there is a hardware test for the LED indicators, which light them all up when the button TARGET RESET is pressed. If the button is kept pressed down for more than one second the memory for all the indicators is reset.

2.3. ANALYSIS FUNCTIONS.

The SMOR system includes an event recorder and an oscillographic recorder with 1 msec. time tag resolution. So as not to lose the date and time setting or the oscillographic recorder information, the unit uses a capacitor as backup for the internal clock and register memory. This allows the information to be kept for at least 24 hours from the moment the power supply is lost.

2.3.1. EVENT RECORDER

The SMOR system keeps a record of the last 144 events and stores the following information: date and time (1 msec. resolution), the type of event, current and voltages measured at the time the event occurred, and the internal states matrix of the unit.

This event recorder is stored in a non-volatile memory and can be maintained indefinitely, even with no power supply.

The relay generates an event when any of the following signals changes its status:

Index	State
0.0	Program initiates
0.1	Settings change
0.2	Write counters
0.3	Configuration change
0.4	External trigger
0.5	Communications Trigger
0.6	
0.7	
1.0	Reclose command
1.1	79 block command
1.2	79 unblock command
1.3	Open command
1.4	Close command
1.5	
1.6	
1.7	
2.0	Activation input 1
2.1	Activation input 2
2.2	Activation input 3
2.3	Activation input 4
2.4	Activation input 5
2.5	Activation input 6
2.6	
2.7	
3.0	Activation input 7
3.1	Activation input 8
3.2	Activation input 9
3.3	Activation input 10
3.4	Activation input 11
3.5	Activation input 12
3.6	
3.7	
4.0	51PT Pick-up

Index	State
4.1	51NT Pick-up
4.2	50PH Pick-up
4.3	50PL Pick-up
4.4	50NH Pick-up
4.5	50NL Pick-up
4.6	46PT Pick-up
4.7	81U Pick-up
5.0	81O Pick-up
5.1	27P Pick-up
5.2	59P Pick-up
5.3	59NH Pick-up
5.4	59NL Pick-up
5.5	
5.6	
5.7	
8.0	51PT Trip
8.1	51NT Trip
8.2	50PH Trip
8.3	50PL Trip
8.4	50NH Trip
8.5	50NL Trip
8.6	46PT Trip
8.7	81U Trip
9.0	81O Trip
9.1	27P Trip
9.2	59P Trip
9.3	59NH Trip
9.4	59NL Trip
9.5	
9.6	
9.7	
C.0	79 out of service
C.1	
C.2	Reclose initiate
C.3	External reclose initiate
C.4	Reclose inhibit
C.5	
C.6	Last trip
C.7	79 Ready
D.0	Lockout: Failed to open
D.1	Lockout:Repetitive tripping
D.2	Lockout:No conditions to reclose
D.3	Lockout:Faulty reclose
D.4	Global Lockout
D.5	
D.6	
D.7	Recloser block
E.0	

Index	State
E.1	Parallel EEPROM alarm
E.2	Serial EEPROM alarm
E.3	Out of service
E.4	Default General settings
E.5	Default Table 1 settings
E.6	Default Table 2 settings
E.7	Default Table 3 settings
F.0	
F.1	Tripping not permitted
F.2	Current with open breaker
F.3	52 maintenance alarm
F.4	Coil 1 continuity failure
F.5	Coil 1 DC supply failure
F.6	Coil 2 continuity failure
F.7	Coil 2 DC supply failure
10.0	
10.1	Active table 1
10.2	Active table 2
10.3	Active table 3
10.4	
10.5	
10.6	
10.7	
11.0	52 Status
11.1	
11.2	52 failed to open
11.3	52 failed to close
11.4	Directional A
11.5	Directional B
11.6	Directional C
11.7	Directional N

2.3.2. OSCILLOGRAPHY REGISTER

The SMOR unit stores 4 oscillography records, with a resolution of 16 samples per cycle. Each register has a maximum capacity of 66 cycles. The number of pre-fault cycles can be selected from 2 to 10 cycles. Each of the records includes the following information:

- **Instantaneous values for voltage and current inputs** (I_A, I_B, I_C, I_N, V_A, V_B, V_C, V_{busbar})
- **Digital information**:

  - Status of protection functions
  - Status of digital inputs.
  - Recloser signals

- **Date and time**.

- **Causes that generated the oscillographic register.**

They may be the following:

0: 51 PT PICK-UP	10: 51 PT TRIP
1: 51 NT PICK-UP	11: 51 NT TRIP
2: 50 PH PICK-UP	12: 50 PH TRIP
3: 50 PL PICK-UP	13: 50 PL TRIP
4: 50 NH PICK-UP	14. 50 NH TRIP
5: 50 NL PICK-UP	15: 50 NL TRIP
6: 46 PT PICK-UP	16: 46 PT TRIP
7:	17:
8: 81U PICK-UP	18: 81U TRIP
9: 81O PICK-UP	19: 81O TRIP
A. 27P PICK-UP	1A: 27 TRIP
B: 59P PICK-UP	1B: 59 TRIP
C: 59 NH PICK-UP	1C: 59 NH TRIP
D: 59 NL PICK-UP	1D: 59 NL TRIP
E: EXTERNAL TRIGGER	1E
F: COMM. TRIGGER.	1F

- **Active settings table.**

There is a mask that can be configured and that determines which functions or internal trips start the oscillography. It also can either be started by a configurable digital input, by communications or directly from the MMI.

The oscillography records are retrieved and converted into a COMTRADE IEEE standard format file using the GE-LOCAL communications program. They can be visualized using the GE-OSC program, or any other program that accepts the COMTRADE IEEE C37.111-1991 International Standard format or ASCII files (for example EXCEL™).

2.4. CONTROL

2.4.1. ASSOCIATED BREAKER COMMAND

Using a local interface (MMI) or using a personal computer connected to the serial port with the GE-LOCAL communications software, it is possible to open or close the line breaker using the tripping or closing contacts of the SMOR unit.

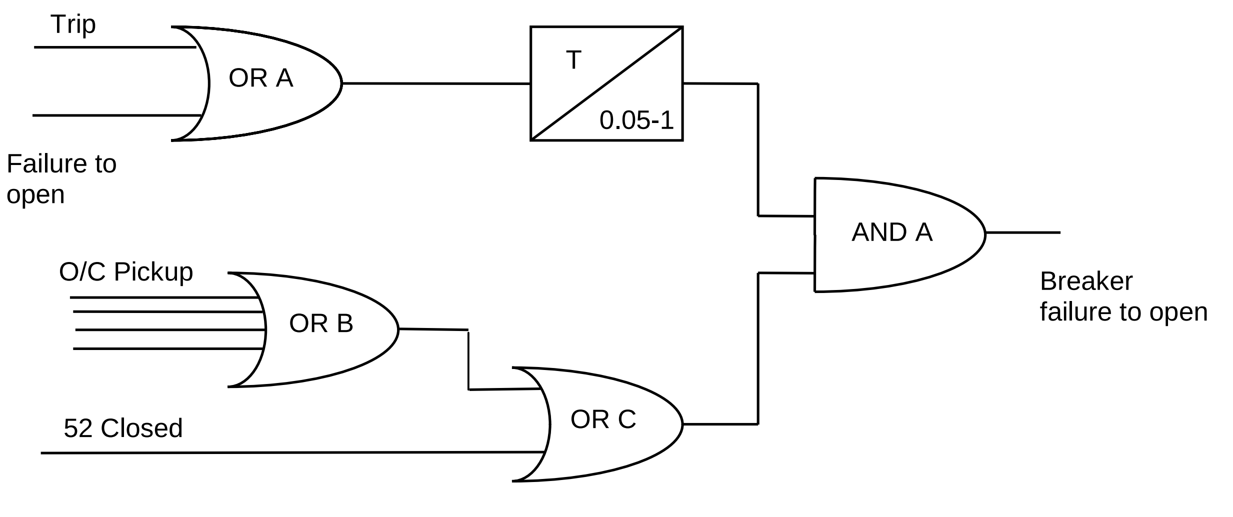
2.4.2. OPERATION FAILURE DETECTION

The SMOR unit detects breaker failure-to-open and also failure-to-close conditions.

When a closing command is issued, a timer starts. This timer can be set to a value for "MAXIMUM CLOSURE TIME", programming it for the maximum time expected for the closing of the breaker. If this timer produces an output (when time exceeds the setting) it issues an alarm which indicates that the breaker has not closed in the expected time. If the breaker closes before this time, the timer is stopped by the opening of a contact 52/b which is wired to the digital input associated with this function, and the alarm is not turned on.

If the contact 52/b is not wired to the SMOR system, no voltage is applied when the breaker is open (contact 52/b closed). In this case the timer does not start when the breaker closing signal is issued, and therefore the failure-to-close detection function cannot operate.

As far as the failure-to-open detection is concerned, the SMOR unit is provided with a logic activated by the OR of the trip of any of the internal protection units in which a trip is permitted and by the activation of a failure-to-open input. Once the OR-A gate has been activated, the failure-to-open unit will act if the breaker remains closed at the end of the time period set for "MAXIMUM OPENING TIME", or if any of the overcurrent units of the SMOR are still picked up (outputs OR-B and OR-C). This arrangement corresponds to the following logical diagram:



Breaker Failure-to-open function logic

2.4.3. RECLOSER

The SMOR system recloser allows up to 4 attempts to reclose the line breaker.

For each of these attempts it is possible to set independently the time that should elapse before the reclosing order is issued. In addition, it is possible to set which functions can initiate the recloser, and, after a given reclosing, which functions can trip the breaker again. This makes it possible to implement certain protection arrangements which required special wiring and functions in conventional units. For example, if the user wants the first protection trip to be instantaneous and the second, after the reclosure, to be timed, in order to allow time for the fuses of a feeder to blow. To do this, you only have to set the unit to allow only timed trips after the first reclosure.

It may also be desirable for the reclosing function to be carried out only in certain circumstances, for instance when there is a trip due to a current unbalance (activation of the negative sequence unit), but not when it is due to an instantaneous unit.

At this point we should mention that the RECLOSE INITIATION comes into operation following a trip that has been programmed to generate reclosing. The system also allows the possibility of initiating the recloser by the activation of a digital input. In this way it is possible to co-ordinate reclosing with other protection operations.

The recloser has a setting called "MAX TRIPS 1h" (maximum number of trips in one hour) (included in the group of breaker settings), which can be set between 1 and 50 trips per hour. This setting prevents damage of the breaker in certain cases, such as a storm for example, in which the protection could be tripping and reconnecting an excessive number of times. To limit the number of operations, the relay creates a time window of 1 hour in which it registers the number of trips that occur in that period. This window moves continuously so that it always indicates the number of trips that have occurred in the hour up to the present moment. If the number of trips exceeds the setting, the recloser stops working (and moves to the lock-out status shown in figure 5).

From now on we will use the term "lock-out" instead of block to distinguish the situations in which blocking occurs due to the activation of an input or by setting, by the desire of the user (the only ones in which we use the term blocking) from any other type of blocking (no reclosing conditions, permanent fault, etc.).

There is another setting called "RESET TIME" which is the time the unit waits after a successful reclosing before returning to the reset/ready status. This is also the time which the recloser waits before returning to the reset/ready status following a manual closure. From now on we will refer to this value as the reset time.

The system allows the possibility of programming a series of conditions which must be fulfilled for the reclosing to occur. These conditions are :

Condition **0**: Reclosing always occurs.
Condition **1**: While the input "Reclose inhibit" is active there is no reclose. Reclose takes place when this input is deactivated.
Condition **2**: Reclosing occurs when there is voltage only on the busbar side.
Condition **3**: Reclosing occurs when there is voltage on the busbar side, regardless of the presence of voltage on the line side.
Condition **4**: Reclosing occurs when there is voltage on the line and on the busbar side.

NOTE: The level of voltage both for the line and for the busbar is 80% of rated voltage.

If the "**HOLD MODE**" is set to "**YES**", the recloser waits for the time set in the "HOLD TIME" setting for the reclosing condition selected in the "RECLOSE CONDITIONS" setting to be fulfilled. If this reclosing condition is not fulfilled in this time, the recloser goes to the "lockout" status.

If the "**HOLD MODE**" is set to "**NO**", the recloser does not take into account the time programmed in the "HOLD TIME" setting. See figure 5.

Recloser logic.

Figure 5, which shows the states diagram of the recloser, will help to understand this section. For those who are not familiar with this type of representation the following paragraphs give a summary of how a states diagram works.

The states diagram uses circles to represent each state of the recloser. In each circle there is a text with a description of the actions the recloser has to carry out (wait, close, start timer, etc) or the name of the state ("**lock-out**", for example).

The double circle shows where the states diagram starts, which in this case is the "**lock-out**" state and coincides with the end of the recloser function.

Each circle has at least one exit arrow and one input arrow. The exit arrow is called "transition" and has some conditions associated with it. This means that for the recloser to pass from this state to the next one, the conditions indicated in the transition must be fulfilled. The logical condition AND is shown by a dot (·), and the logical condition OR is represented by the plus sign (+). The complement or negation is represented by a bar situated above the condition. The transitions which refer to times occur at the end of the time period indicated in the previous state.

We will now give an example of how the recloser works using a "normal" sequence for only one programmed reclosing attempt.

Let us suppose that the starting point is the "lock-out" status and that the breaker is open. Then a manual closing command is issued, the breaker closes and the automate passes to the next state in which it starts the reset timer. When this time has passed successfully (without the occurrence of any reclose initiation), the recloser checks the blocking signal. If there is no block, the recloser resets itself, getting ready for the first reclosing attempt. This means that the unit has to get ready to count the time for the first reclosing attempt, to initiate the recloser only for the programmed functions and to get ready to trip after the reclosure only for the functions allowed to trip after the first reclosure.

It then passes to the reset state and leaves this state when the first reclose initiation occurs, whether it is external (IRE) or internal. To simplify things, let us imagine that we are in the most common situation which shows the reclose initiation as being internal.

The recloser initiates the first reclosing timer if the following three conditions are met : that the breaker opens after the trip, the protection system does not issue a trip signal and the last programmed reclosing attempt has not occurred. After this time the unit checks whether any reclosing condition has been programmed. If none has been programmed, or if it has been programmed and the condition is met, a reclosing command is issued immediately and the Closing Time is started. (Tclose).

If the breaker closes successfully, the unit will detect that the breaker has closed and will start the reset time. After this time, assuming there is no failure, the recloser will return to the initial reset state and will be ready to carry out a complete new reclosing cycle.

For the most general case of "n" reclosing attempts, from the last state (start reset time) the cycle would be repeated until it reaches the n programmed reclosing attempt, assuming the fault persists. If the last reclosing is attempted unsuccessfully, the unit will go into the lock-out status and will only change this status by means of a manual breaker closing.

The SMOR reclosing unit has been designed to achieve the following objectives:

- **To increase safety**. In any "anomalous" situation the recloser goes into lock-out.

- **To make it independent of the protection functions**. The only protection function required by the recloser is the breaker FAILURE TO OPEN and the detection of a TRIP condition and its corresponding RECLOSE INITIATION.

- **To offer maximum flexibility**. By means of settings made using the communication software, keyboard or digital inputs it is possible to generate almost any imaginable reclosing scheme.

Figure 5 shows the recloser states diagram.

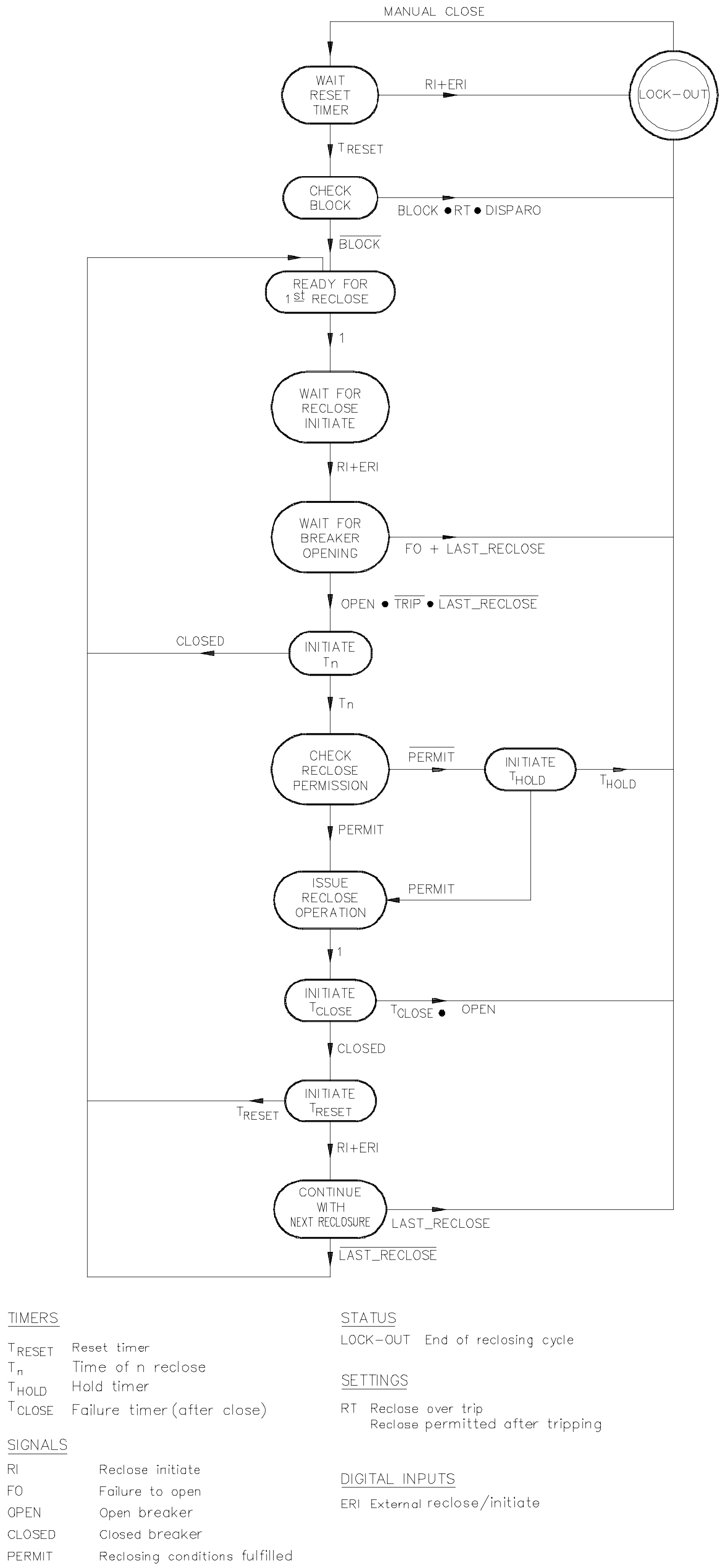


FIGURE 5 RECLOSER STATES DIAGRAM (226B2200H1) (SUMMARISED)

2.4.4. TABLES OF SETTINGS

The SMOR system has 3 independent setting tables, stored in non-volatile memory, so that information is kept even when there is no auxiliary voltage. Only one setting table is active at a given time and this is the table which the system uses to run the different functions included in it.

Of all the settings which exist for the SMOR unit, there are various groups (corresponding to General Settings, Breaker, Active Table, Oscillography masks and Functions Permission) which are generic and are therefore common to all the setting tables, while the rest of the settings are presented separately for each table.

There is an "ACTIVE TABLE" setting which determines the settings table which is active at a given moment.

The settings table can be changed by means of up to 2 digital inputs, referred to as "TABLE SELECTION-0" and "TABLE SELECTION-1" which allow up to 4 combinations from 0 to 3. To do this it is necessary to configure (using GE-INTRO software) two inputs to have these meanings. For applications which require less tables (up to 2) it is possible to use only one input.

The selected combination is obtained from the binary coding of the 2 inputs mentioned (see following table). The 0-0 means selecting the table indicated in the "ACTIVE TABLE" setting, and numbers 0-1 to 1-1 select tables 1 to 3 respectively (remembering that table 3 is always associated to the cold load pick-up, which has maximum priority, see section 2.4.5).

Table Selection INPUT-1	Table Selection INPUT-0	Active Table
0	0	Selected by setting
0	1	1
1	0	2
1	1	3

NOTE: if the inputs are programmed and used, energizing them, this selection has priority over the "ACTIVE TABLE" setting and the table which is in fact used is determined by the status of the digital inputs.

2.4.5. COLD LOAD PICK-UP.

The SMOR system includes this function to avoid the unwanted operation of the overcurrent functions when high current levels are produced when energizing a line which has been open for a long period of time.

This function is carried out by means of the automatic change to settings table number 3 when the breaker has been open for a period of time greater than the programmed time for this function using the "t CHANGE TABLE". The status of the breaker is detected by means of a 52/b contact on the breaker itself. The pick-up values for table number 3 should be set to an appropriate value so that the protection system will not trip in a cold load energization.

When the breaker closes (contact 52/b opens) it starts a timer whose threshold is set to the "warm-up" value of the load. When this "t RETURN TABLE" expires the protection system changes automatically from settings table number 3 to the settings table which is active at that moment. This time allows the normal line load to be restored to its permanent value.

This function can be disabled by means of the "COLD LOAD PICK-UP PERMISSION" setting (“CLP PERMISSION”).

2.4.6. TIME SYNCHRONIZATION.

The SMOR system includes an input for time synchronization. This input requires the connection of a device to supply a demodulated IRIG-B output. In this way coordinated universal time is measured to a high degree of precision and this makes it possible to tag the events generated by the unit with a resolution of one millisecond.

The use of this input makes it possible to correlate data obtained from different units thanks to synchronization with GPS satellites. In this way it is possible to obtain very useful information for analysis, cross-referencing the information provided by different units for a given incident.

Alternatively, it is possible to synchronize units by means of communications, using the GE-LOCAL communications software, or manually by means of the MMI. If the IRIG-B input is used it has priority over time setting by communications, since the time read by IRIG-B is much more accurate.

2.4.7. CONFIGURABLE INPUTS AND 0UTPUTS

2.4.7.1. Digital Inputs

The SMOR system has 6 digital inputs (two groups of 3 inputs with one common in each group). The inputs can be configured by the user by means of the GE-INTRO configuration program. Using the optional expansion board it is possible to increase the number of inputs up to a total of 12 (4 groups of 3 inputs with one common in each group. See the external connections diagram in figure 7) This optional board has 6 additional inputs which can also be configured.

The inputs are configured using GE-INTRO configuration software. One of the following meanings can be assigned to any input: (For more detail about the configuration of the inputs, see GE-INTRO Instruction Book).

Function	P/N
• Unused input	
• Breaker 52b	L
• Recloser block	L
• Recloser block	P
• Recloser unblock	P
• Reclose initiate	P
• Reclose inhibit	P
• External trigger	P
• PT secondary MCB tripping	L
• Open fail pickup	P
• Active table select0	L
• Active table select1	L
• Open command	P
• Close command	P
• Phase directional blocking	L
• Ground directional blocking	L
• Phase instantaneous blocking	L
• Ground instantaneous blocking	L
• Phase units blocking	L
• Ground units blocking	L
• Voltage units block	L
• Frequency units blocking	L
• Negative sequence units blocking	L
• General blocking	L

(L) indicates Level input
(P) indicates Pulse input

NOTE: The block inputs for the directional units eliminate the directional supervision, converting the units into non-directional overcurrent functions while the corresponding input is active.

There is also the IRIG-B synchronization input already mentioned.
The diagram of external connections, in figure 7, shows the default input configuration.

2.4.7.2. Outputs

The SMOR system has 13 outputs as follows:

- 2 trip
- 2 close
- 1 alarm
- 2 groups of 4 configurable outputs with one common per group.

The model with optional expansion board has 4 more outputs, which are configurable and electrically separate. (See external connections in figure 7)

The outputs are configured using the GE-INTRO configuration software.

The technical characteristics of the outputs are shown in section 4.

The configurable outputs can be programmed using logic based on the internal protection states (pick-ups, trips, alarms, etc.) The SMOR has 132 different internal states, and these can be used to carry out logical operations NOT, AND and OR, which gives to the unit a great flexibility.

The output configuration is done by using different levels. At the first level it is possible to use AND gates of up to 16 signals (see section 3). The output is incorporated into the states matrix so that it can in turn be used in next AND gates of up to 16 inputs. This process can continue until the 16 ANDs are used.

Once the AND gates have been configured it is possible to create a second level with OR gates of 16 inputs limited to the established groups of bytes, and whose logical outputs are assigned to physical outputs of the unit.

The default output configuration is included in the diagram of external connections in figure 7.

2.5. MAN-MACHINE INTERFACE (MMI)

The SMOR system includes as standard a 20 key keyboard and a 2 line liquid crystal display (LCD) with 16 characters per line. This display has highly reliable LED diode back lighting (the screen brightness can be adjusted on the rear of the front board).

By means of this interface the user can change the settings, visualize measurements, carry out operations and access information stored in the unit. The functions of this local interface and how to use it are described in the section KEYBOARD AND DISPLAY.

2.6. REMOTE COMMUNICATIONS

The relay has 2 serial gates and three connectors. Gate 1 can be reached from the front of the relay in connector 1 (PORT 1 connector) or from the back (PORT 2 connector). The second gate can be reached from connector 3 (PORT 3 connector) which is located on the rear.

There are different models each with a different physical connection for the PORT 3 connector (RS-232 or fiber-optic). In the "RS232" models the three connectors are RS232. In the "RS232 and fiber-optic" models the PORT1 and PORT2 connectors are RS232 while the PORT3 connector is replaced by a fiber-optic connector.

The PORT 1 connector has priority over the PORT 2 connector and is selected when the DCD (Data Carrier Detect) signal is activated. Figure 8 shows how to make the connections to a personal computer.

Gate 1 (PORT 1 and PORT 2 connectors) and 2 (PORT 3 connector) are independent and the unit can serve them simultaneously.

The communications protocol is the same as that used for the rest of the GE digital protection systems and requires the use of the GE-LOCAL software. The instruction book for this program, which facilitates dialogue with the relay, is supplied with the unit. The protocol is reliable and allows communication with different protection systems. It guarantees very efficient data transfer (especially for the oscillography and other large files) along with error detection and automatic communication recovery.

The status of the local/remote communication is indicated on the front of the unit by LED indicator 16 (the last LED in the right-hand column.) Local communication refers to communication via the keyboard/display (local display showing any information except for the initial SMOR GENERAL ELECTRIC screen), or via communications gate 1 (PORT 1, PORT2 connectors), and remote communication refers to connection via gate 2 (PORT 3 rear connector).

Local and remote communications can exist at the same time, although there is only one possibility for changing settings and carrying out operations, since this can only be done with the communication which has priority (local communication) while the other is limited only to accessing information. When the local communication is interrupted, either by the disconnection of PORT 1 connector or because the MMI is on the initial screen (a situation which can be caused intentionally, or automatically if no key has been pressed for 15 minutes), the remote communication recovers the ability to modify settings and carry out operations.

TABLE 4. INTERNAL PROTECTION STATES MATRIX (INTERNAL SIGNALS AVAILABLE FOR OUTPUTS AND LED CONFIGURATION BY USING OR, AND AND NOT GATES.)

Index	STATE
0.0	Program initiate
0.1	Settings change
0.2	Write counters
0.3	Configuration change
0.4	External trigger
0.5	Communications trigger
0.6	
0.7	
1.0	Reclose command
1.1	79 block command
1.2	79 unblock command
1.3	Open command
1.4	Close command
1.5	
1.6	
1.7	
2.0	Input 1
2.1	Input 2
2.2	Input 3
2.3	Input 4
2.4	Input 5
2.5	Input 6
2.6	
2.7	
3.0	Input 7
3.1	Input 8
3.2	Input 9
3.3	Input 10
3.4	Input 11
3.5	Input 12
3.6	
3.7	
4.0	51PT Pickup
4.1	51NT Pickup
4.2	50PH Pickup
4.3	50PL Pickup
4.4	50NH Pickup
4.5	50NL Pickup
4.6	46PT Pickup
4.7	81U Pickup
5.0	81O Pickup
5.1	27P Pickup
5.2	59P Pickup
5.3	59NH Pickup
5.4	59NL Pickup
5.5	

Index	STATE
5.6	
5.7	
6.0	51PT a Pickup
6.1	51PT b Pickup
6.2	51PT c Pickup
6.3	50PH a Pickup
6.4	50PH b Pickup
6.5	50PH c Pickup
6.6	50PL a Pickup
6.7	50PL b Pickup
7.0	50PL c Pickup
7.1	27P ab Pickup
7.2	27P bc Pickup
7.3	27P ca Pickup
7.4	59P ab Pickup
7.5	59P bc Pickup
7.6	59P ca Pickup
7.7	
8.0	51PT Trip
8.1	51NT Trip
8.2	50PH Trip
8.3	50PL Trip
8.4	50NH Trip
8.5	50NL Trip
8.6	46PT Trip
8.7	81U Trip
9.0	81O Trip
9.1	27P Trip
9.2	59P Trip
9.3	59NH Trip
9.4	59NL Trip
9.5	
9.6	
9.7	
A.0	51PT a Trip
A.1	51PT b Trip
A.2	51PT c Trip
A.3	50PH a Trip
A.4	50PH b Trip
A.5	50PH c Trip
A.6	50PL a Trip
A.7	50PL b Trip
B.0	50PL c Trip
B.1	27P ab Trip
B.2	27P bc Trip
B.3	27P ca Trip
B.4	59P ab Trip
B.5	59P bc Trip
B.6	59P ca Trip

Index	STATE
B.7	
C.0	79 out of service
C.1	Reclose in progress
C.2	Reclose initiate
C.3	External reclose initiate
C.4	Reclose inhibit
C.5	
C.6	Last trip
C.7	79 Ready
D.0	Lockout: Failed to open
D.1	Lockout: Repetitive tripping
D.2	Lockout: No conditions to reclose
D.3	Lockout: Faulty recloser
D.4	Global lockout
D.5	
D.6	
D.7	Recloser block
E.0	
E.1	Parallel EEPROM alarm
E.2	Serial EEPROM alarm
E.3	Out of service
E.4	Default general settings
E.5	Default table 1 settings
E.6	Default table 2 settings
E.7	Default table 3 settings
F.0	
F.1	Tripping not permitted
F.2	Current with open breaker
F.3	52 maintenance alarm
F.4	Coil 1 continuity failure
F.5	Coil 1 DC supply failure
F.6	Coil 2 continuity failure
F.7	Coil 2 DC supply failure
10.0	Closed trip contacts
10.1	Active table 1
10.2	Active table 2
10.2	Active table 3
10.4	
10.5	
10.6	New events
10.7	
11.0	52 status
11.1	
11.2	52 failed to open
11.3	52 failed to close
11.4	Directional A
11.5	Directional B
11.6	Directional C
11.7	Directional N

Index	STATE
12.0	AND1
12.1	AND2
12.2	AND3
12.3	AND4
12.4	AND5
12.5	AND6
12.6	AND7
12.7	AND8
13.0	AND9
13.1	AND10
13.2	AND11
13.3	AND12
13.4	AND13
13.5	AND14
13.6	AND15
13.7	AND16

3. SETTINGS

This section describes the settings incorporated in the SMOR unit, and the procedure for changing them. First a complete list of the SMOR settings is shown, together with their limits, units and corresponding steps (the column marked DEFAULT indicates that this is the setting on the relay when it leaves the factory). This is followed by individual comments for those settings which require more detailed explanation.

It is possible to see the settings or to modify them manually, using the keyboard and display, or by means of a computer connected to any of the serial ports. To modify the settings by means of the keyboard, go to section 8 "KEYBOARD AND DISPLAY". To modify the settings by computer follow these instructions:

- Make sure that the available connection cable coincides with the diagram in figure 8, depending on whether the serial port of your computer is DB9 or DB25.
- Connect the cable between the relay (or modem) and the serial port of your computer.
- Run the GE-LOCAL software. For more details on the installation and use of the GE-LOCAL software see the GE-LOCAL instruction book.
- Make sure that the program configuration communication parameters coincide with those of the SMOR unit. More specifically, these parameters for the communication configuration of the local MMI are as follows:

  - **COMMUNICATION BAUD RATE** (for the relay depending on which port is being used (local or remote))

  - **STOP BIT** (for the relay depending on which port is being used (local or remote))

To modify or view the unit's configuration parameters go to the configuration menu, corresponding to section 8 "KEYBOARD AND DISPLAY".

When connecting to the unit, check that the relay number and password coincide with those which appear on the unit's configuration menu.

The SMOR system has 3 settings tables stored in non-volatile memory, and these can be selected by settings or configurable inputs. There is also a set of independent settings, common to all the tables. The following categories contain the settings common to the 3 tables:

GENERAL
BREAKER
ACTIVE TABLE
OSCILLOGRAPHY
PERMISSIONS FOR EACH FUNCTION

The remaining categories, shown below, contain the settings which can be selected independently for each of the 3 tables:

- Function 51 PT (Phase Time delayed overcurrent (Inverse or definite time))
- Function 51 NT (Ground Time delayed overcurrent (Inverse or definite time))
- Function 50 PH (High Phase instantaneous level (can be definite time))
- Function 50 PL (Low Phase instantaneous level (can be definite time))
- Function 50 NH (High Ground instantaneous level (can be definite time))
- Function 50 NL (Low Ground instantaneous level (can be definite time))
- Function 46 PT (Negative sequence (Inverse or definite time))
- Function 81O/U (Frequency)
- Function 27/59P/59NH/59NL (Voltage)
- Directionality
- Recloser

It should be noted that in order to simplify setting the unit and for safety reasons, all settings related to the configuration of the unit (configurable inputs and outputs, alarms configuration and LEDs) have been removed from the keyboard/display and communications software. To carry out these configurations the GE-INTRO configuration software must be run.

The following settings are common to all tables:

TABLE 5. COMMON SETTINGS TO ALL TABLES

Description	Limits	Default	Interval
General Settings Group			
Relay status	In/out of service	In service	NA
Identification	20 ASCII characters	No Id.	NA
Frequency	50 / 60 Hz	50 Hz	NA
Rated Voltage (ph-ph)	90-220	110	1
CT Phase Ratio	1-4000	1	1
CT Ground Ratio	1-4000	1	1
VT Line Ratio	1-4000	1	1
VT Busbar Ratio	1-4000	1	1
Demand Time	15/30/60 min	60 min	NA
Phase rotation selection	ABC / CBA	ABC	NA
Breaker Settings Group			
Breaker Number	4 ASCII characters	0000	NA
Fail to Open time	0.05 - 1s	0.5s	0.01s
Fail to Close time	0.05 - 5s	1s	0.01s
Accumulable I2t Limit	1 - 999999 kA^2s	99999 kA^2s	1
Intg I2t Time selector	Fixed / measured	Fixed	NA
I2t Integr. time	0.03 - 0.25s	0.06s	0.01s
Maximum trips in 1 hour	1 - 50	50	1
Active Table Settings			
# of Active Settings Table	1 - 3	1	1
Cold pick-up permission	NO/YES	NO	NA
Change to Table 3 time	Reclose time-240s	60s	1s
Return from Table 3 time	Reset time-1800s	120s	1s
Oscillography Mask			
Number of pre-fault cycles	2 - 10	2	1
Oscillo. triggers :			
Pick-up 51 PT	Enabled/disabled	Enabled	NA
Pick-up 51 NT	Enabled/disabled	Enabled	NA
Pick-up 50 PH	Enabled/disabled	Enabled	NA
Pick-up 50 PL	Enabled/disabled	Enabled	NA
Pick-up 50 NH	Enabled/disabled	Enabled	NA
Pick-up 50 NL	Enabled/disabled	Enabled	NA
Pick-up 46 PT	Enabled/disabled	Enabled	NA
Pick-up 81 U	Enabled/disabled	Enabled	NA
Pick-up 81 O	Enabled/disabled	Enabled	NA
Pick-up 27 P	Enabled/disabled	Enabled	NA
Pick-up 59 P	Enabled/disabled	Enabled	NA
Pick-up 59 NH	Enabled/disabled	Enabled	NA
Pick-up 59 NL	Enabled/disabled	Enabled	NA
External Trigger	Enabled/disabled	Enabled	NA
Communications Trigger	Enabled/disabled	Enabled	NA
Trip 51 PT	Enabled/disabled	Enabled	NA
Trip 51 NT	Enabled/disabled	Enabled	NA
Trip 50 PH	Enabled/disabled	Enabled	NA

Description	Limits	Default	Interval
Trip 50 PL	Enabled/disabled	Enabled	NA
Trip 50 NH	Enabled/disabled	Enabled	NA
Trip 50 NL	Enabled/disabled	Enabled	NA
Trip 46 PT	Enabled/disabled	Enabled	NA
Trip 81 U	Enabled/disabled	Enabled	NA
Trip 81 O	Enabled/disabled	Enabled	NA
Trip 27 P	Enabled/disabled	Enabled	NA
Trip 59 P	Enabled/disabled	Enabled	NA
Trip 59 NH	Enabled/disabled	Enabled	NA
Trip 59 NL	Enabled/disabled	Enabled	NA
Function Permission Group			
51 PT Function Permission	Not allowed/allowed	Not allowed	NA
51 NT Function Permission	Not allowed/allowed	Not allowed	NA
50 PH Function Permission	Not allowed/allowed	Not allowed	NA
50 PL Function Permission	Not allowed/Allowed	Not allowed	NA
50 NH Function Permission	Not allowed/Allowed	Not allowed	NA
50 NL Function Permission	Not allowed/Allowed	Not allowed	NA
46 PT Function Permission	Not allowed/Allowed	Not allowed	NA
81 U Function Permission	Not allowed/Allowed	Not allowed	NA
81 O Function Permission	Not allowed/Allowed	Not allowed	NA
27 P Function Permission	Not allowed/Allowed	Not allowed	NA
59 P Function Permission	Not allowed/Allowed	Not allowed	NA
59 NH Function Permission	Not allowed/Allowed	Not allowed	NA
59 NL Function Permission	Not allowed/Allowed	Not allowed	NA
Functions allowed to trip			
51 PT Trip Permission	Not allowed/Allowed	Allowed	NA
51 NT Trip Permission	Not allowed/Allowed	Allowed	NA
50 PH Trip Permission	Not allowed/Allowed	Allowed	NA
50 PL Trip Permission	Not allowed/Allowed	Allowed	NA
50 NH Trip Permission	Not allowed/Allowed	Allowed	NA
50 NL Trip Permission	Not allowed/Allowed	Allowed	NA
46 PT Trip Permission	Not allowed/Allowed	Allowed	NA
81 U Trip Permission	Not allowed/Allowed	Allowed	NA
81 O Trip Permission	Not allowed/Allowed	Allowed	NA
27 P Trip Permission	Not allowed/Allowed	Allowed	NA
59 P Trip Permission	Not allowed/Allowed	Allowed	NA
59 NH Trip Permission	Not allowed/Allowed	Allowed	NA
59 NL Trip Permission	Not allowed/Allowed	Allowed	NA

The independent settings for each table are as follows:

TABLE 6. INDEPENDENT SETTINGS FOR EACH TABLE

Independent for each table	Limits	Default	Interval
51 PT Function			
51 / 67 P Pick-up	1.00 - 12.00 A	2.00 A	0.01 A
Curve	In/M Inv /E Inv /Def. time	INV	NA
Time Dial	0.05 - 1.00	1.00	0.01
Definite Time Setting	0.00 - 100.00	10.00	0.01 s
51 NT Function			
51 / 67 N Pick-up	0.2 - 2.4 A	1.00 A	0.01 A
Curve	In / M Inv / E Inv / Def. t	INV	NA
Time Dial	0.05 - 1.00	1.00	0.01
Definite Time Setting	0.00 - 100.00	10.00	0.01 s
50 PH Function			
50 / 67 P Pick-up	1 - 160 A	10.00 A	0.01 A
Time Delay	0.00 - 60.00 s	0.00 s	0.01 s
50 PL Function			
50 / 67 P Pick-up	1 - 160 A	10.00 A	0.01 A
Time Delay	0.00 - 60.00 s	0.00 s	0.01 s
50 NH Function	0.2 - 32 A	10.00 A	0.01 A
50 / 67 N Pick-up	0.00 - 60.00 s	0.00s	0.01 s
Time Delay			
50 NL Function			
50 / 67 N Pick-up	0.2 - 32 A	10.00 A	0.01 A
Time Delay	0.0 - 60 s	0.00s	0.01 s
46 PT Function			
46 Pick-up	0.1 - 4 A	0.20 A	0.01 A
Curve	In / M Inv / E Inv /Def. t	DEFINITE T.	NA
Time Dial	0.05 - 1.00	1.00	0.01
Definite Time Setting	0.00 - 100.00	10.00	0.01 s
81 Settings Group			
Pick-up 81U	40.00 - 70.00 Hz	49.00 Hz	0.01 Hz
Underfrequency timer	0.00 - 100.00	1.00 s	0.01 s
Pick-up 810	40.00 - 70.00 Hz	51.00 Hz	0.01 Hz
Overfrequency timer	0.00 - 100.00	2.00s	0.01s
Undervoltage supervision	35 - 110%	40%	1%
Voltage Settings Group			
Undervoltage pick-up (27P)	10 - 260 V	40.00V	1 V
27P Time Delay	0.03 - 100.00	1.00s	0.01s
Overvoltage pick-up (59P)	10 - 260 V	100.00 V	1V
59P Time Delay	0.03 - 100.00	1.00s	0.01s
Overvoltage pick-up (59NH)	3 - 100 V	50.00 V	1 V
59NH Time Delay	0.03 - 100.00	1.00s	0.01s
Overvoltage pick-up (59NL)	3 - 100 V	40.00 V	1V
59NL Time Delay	0.03 - 100.00	1.00 s	0.01 s
Directionality Settings Group			
51 PT directional	Perm. / Not Perm.	Not Perm.	NA
51 NT directional	Perm. / Not Perm	Not Perm.	NA
50 PH directional	Perm. / Not Perm	Not Perm.	NA
50 PL directional	Perm. / Not Perm	Not Perm.	NA

Independent for each table	Limits	Default	Interval
50 NH directional	Perm. / Not Perm	Not Perm.	NA
50 NL directional	Perm. / Not Perm	Not Perm.	NA
Characteristic Angle - Phase	-90º - +90º	45º	1º
Characteristic Angle - Ground	-90º - +90º	-45º	1º
Loss Voltage Logic	Block/ Permission	Permission	NA
Recloser Settings Group			
Recloser Permission	NO/YES	NO	NA
Number of Cycles	1 - 4	1	1
Reset Time	0 - 600 s	10	1 s
Hold mode Selection	NO/YES	NO	NA
Hold mode Time	0 - 100s	10	1s
1st Reclose Time	0.10 - 100.00 s	1s	0.01s
2nd Reclose Time	0.10 - 100.00 s	1s	0.01s
3rd Reclose Time	0.10 - 100.00 s	1s	0.01s
4th Reclose Time	0.10 - 100.00 s	1s	0.01s
Reclose Conditions	0 -4	0	NA
	0 No condition		
	1. Inhib. Input		
	2. Voltage only on busbar		
	3. Voltage on busbar		
	4. Voltage on both sides		
Permitted Reclosures			
After 51 PT	Enabled/Dis.	Enabled	NA
After 51 NT	Enabled/Dis.	Enabled	NA
After 50 PH	Enabled/Dis.	Enabled	NA
After 50 PL	Enabled/Dis.	Enabled	NA
After 50 NH	Enabled/Dis.	Enabled	NA
After 50 NL	Enabled/Dis.	Enabled	NA
After 46 PT	Enabled/Dis.	Enabled	NA
After 81 U	Enabled/Dis.	Enabled	NA
After 81 O	Enabled/Dis.	Enabled	NA
After 27 P	Enabled/Dis.	Enabled	NA
After 59 P	Enabled/Dis.	Enabled	NA
After 59 NH	Enabled/Dis.	Enabled	NA
After 59 NL	Enabled/Dis.	Enabled	NA
With an Input	Enabled/Dis.	Enabled	NA
Trips Mask after 1st reclose			
Trip 51PT After reclosing	Enabled/Dis.	Enabled	NA
Trip 51NT After reclosing	Enabled/Dis.	Enabled	NA
Trip 50PH After reclosing	Enabled/Dis.	Enabled	NA
Trip 50PL After reclosing	Enabled/Dis.	Enabled	NA
Trip 50NH After reclosing	Enabled/Dis.	Enabled	NA
Trip 50NL After reclosing	Enabled/Dis.	Enabled	NA
Trip 46PT After reclosing	Enabled/Dis.	Enabled	NA
Trip 81U After reclosing	Enabled/Dis.	Enabled	NA
Trip 81O After reclosing	Enabled/Dis.	Enabled	NA
Trip 27P After reclosing	Enabled/Dis.	Enabled	NA
Trip 59P After reclosing	Enabled/Dis.	Enabled	NA
Trip 59NH After reclosing	Enabled/Dis.	Enabled	NA
Trip 59NL After reclosing	Enabled/Dis.	Enabled	NA

COMMENTS ABOUT THE SETTINGS :

1. The "IDENTIFICATion" setting allows you to input a name for the unit (for example, a name connected with where it is located) with a maximum of 20 ASCII characters.

2. The "DEMAND TIME" (demand integration time) setting allows the selection of the integration interval between 15, 30 or 60 minutes. The total length for the record register is immediately defined when this selection is made. The length is 24 hours for 15 minutes, 48 hours for 30 and 96 hours for 60.

3. The "ACTIVE TABLE" setting for setting the number of the active settings table allows you to select which of the three settings tables on the SMOR unit is active at a given moment. This selection can also be carried out by means of digital inputs configured for this purpose. If there is a disagreement between this setting and the input selection, the last one has priority over the table selection via setting.

4. To set the Breaker aging monitor function it is first necessary to set the "kI^2t OP. MODE" (operation mode) setting. If this is selected as "measured" no other setting is required, since the time used for the calculation is the time measured by the unit from the trip order until the detection of a successful Breaker opening. If the fixed mode is selected it is necessary to set the subsequent "I^2t INTegration TIME" setting, using the time desired for the calculations.

5. The cold load pick-up function "CLP PERMISSION" setting (if selected) requires the setting of the times to change to and to return from table 3. These two settings are conditioned by the times set for the recloser, in order to prevent unwanted operations of this function during a reclose cycle. Therefore the minimum setting value for the change to table 3 will be the greatest of the settings for the reclosing times, and the minimum value for the time to return from table 3 will be the value set as the reset time for the recloser.

6. The "PREFAUL CYCLES" setting is the number of cycles before the oscillography trigger that the system register (between 2 and 10 cycles). In any case the total number of cycles for an oscillography register is preset at 66 cycles, regardless of the setting for the number of pre-fault cycles.

7. The difference between the "Function Permission" and "Trip Permission" settings is that, while the Function Permission settings permit or completely disable the function, the Trip Permission setting allow the possibility of enabling or disabling only the trips, thus allowing the function to remain active and capable of generating events, alarms and signals.

8. The settings procedure for all the timed Overcurrent functions (51PT, 51NT, 46PT) is identical. In all cases it is necessary to set the "- - - PICK-UP" pick-up threshold first, and then the type of timing chosen, "CURVE" setting. If any of the inverse, very inverse and extremely inverse curves are selected, the curve dial value in the "TIME DIAL" setting will be relevant; on the other hand, if the definite time setting is used the time dial setting is ignored and the "DEFINITE TIME" setting is used.

9. The ranges for the Overcurrent units shown in the previous table (Table 6) correspond to a base range of 0.2 - 2.4 A, with 5 A transformers for the phase units and 1 A for the ground units. In the case of the voltage units the ranges shown correspond to a nominal voltage $100/\sqrt{3}$ to $220/\sqrt{3}$ Vac. The other possible ranges are defined in the model selection table. The variation in setting ranges among different models in the same family only affects the Overcurrent functions (51PT, 51NT, 50PH, 50PL, 50NH, 50NL, 46PT). The instantaneous and negative sequence setting ranges maintain the same relation than the timing units as described.

10. In the frequency group, the "INHIBITion Voltage" (minimum voltage supervision) setting establishes not only the voltage threshold below which the frequency functions are inoperative, but it also establishes the value below which no frequency measurement is shown for the unit.

11. The maximum and minimum voltage units are set, calculated and displayed as phase-to-phase voltages, even if the unit is connected phase to ground.

12. In the reclose settings group, the "INIT 79 X - - -" reclose permission setting masks indicate the functions with trips that can initiate the recloser, and the setting is valid for either of the programmed cycles. In the same way, the "- - - TRIP AFTer 79" trip permission settings masks allow the identification of those functions whose trip is permitted after any of the reclosing attempts.

The names used to describe the settings both for the local MMI and the communications program is limited by the space available for the identifying texts. For reference, the following is a table of the names used for each setting in the local display and the GE-LOCAL software.

SETTINGS COMMON TO ALL TABLES:

TABLE 7

Description	MMI/GE-LOCAL
General Settings Group	**GENERAL SETTINGS**
Relay status	RELAY STATUS
Identification.	IDENTIFICAT:
Frequency	FREQUENCY
Rated Voltage (ph-ph)	NOMINAL VOLTAGE
CT Phase Ratio	PHASE CT RATIO
CT Ground Ratio	GROUND CT RATIO
VT Line Ratio	LINE VT RATIO
VT Busbar Ratio	BUS VT RATIO
Demand Time	DEMAND TIME
Phase rotation selection	PHASE ROTATION
YBreaker Settings Group	**BREAKER SETTINGS**
Breaker Number	BREAKER NUMBER
Fail to Open time	t FAIL TO OPEN
Fail to Close time	t TAIL TO CLOSE
Accumulable I^2t Limit	KI2T LIMIT
Intg I^2t Time selector	KI2T OP. MODE
I^2t Integr. time	KI2T INT. TIME
Maximum trips in 1 hour	MAX TRIPS 1h
Active Table Settings	**ACTIVE TABLE SET**
# of Active Settings Table	ACTIVE TABLE
Cold Load Pick-up permiss.	CLP PERMISSION
Change to Table 3 time	t CHANGE TABLE
Return from Table 3 time	t RETURN TABLE
Oscillography Mask	**OSCILLOS MASK**
Number of pre-fault cycles	PREFAULT CYCLES
Signals that trigger the osc:	
Pick-up 51 PT	51PT PICKUP
Pick-up 51 NT	51NT PICKUP
Pick-up 50 PH	50PH PICKUP
Pick-up 50 PL	50PL PICKUP
Pick-up 50 NH	50NH PICKUP
Pick-up 50 NL	50NL PICKUP
Pick-up 46 PT	46PT PICKUP
Pick-up 81 U	81U PICKUP
Pick-up 81 O	81O PICKUP
Pick-up 27 P	27P PICKUP
Pick-up 59 P	59P PICKUP
Pick-up 59 NH	59NH PICKUP
Pick-up 59 NL	59NL PICKUP
External Trigger	EXTERNAL TRIGGER
Communications Trigger	COMM. TRIGGER
Trip 51 PT	51PT TRIP
Trip 51 NT	51NT TRIP
Trip 50 PH	50PH TRIP
Trip 50 PL	50PL TRIP
Trip 50 NH	50NH TRIP
Trip 50 NL	50NL TRIP
Trip 46 PT	46PT TRIP
Trip 81 U	81U TRIP
Trip 81 O	81O TRIP
Trip 27	27P TRIP
Trip 59	59P TRIP
Trip 59 NH	59NH TRIP

Description	MMI/GE-LOCAL
Trip 59 NL	59NL TRIP
YFunction Permission Group	**FUNCTION PERMIT**
51 PT Function Permission	51PT FUNCTION
51 NT Function Permission	51NT FUNCTION
50 PH Function Permission	50PH FUNCTION
50 PL Function Permission	50PL FUNCTION
50 NH Function Permission	50NH FUNCTION
50 NL Function Permission	50NL FUNCTION
46 PT Function Permission	46PT FUNCTION
81 U Function Permission	81U FUNCTION
81 O Function Permission	81O FUNCTION
27 P Function Permission	27P FUNCTION
59 P Function Permission	59P FUNCTION
59 NH Function Permission	59NH FUNCTION
59 NL Function Permission	59NL FUNCTION
51 PT Trip Permission	51PT TRIP
51 NT Trip Permission	51NT TRIP
50 PH Trip Permission	50PH TRIP
50 PL Trip Permission	50PL TRIP
50 NH Trip Permission	50NH TRIP
50 NL Trip Permission	50NL TRIP
46 PT Trip Permission	46PT TRIP
81 U Trip Permission	81U TRIP
81 O Trip Permission	81O TRIP
27 P Trip Permission	27P TRIP
59 P Trip Permission	59P TRIP
59 NH Trip Permission	59NH TRIP
59 NL Trip Permission	59NL TRIP

The independent settings for each table (identified on the local MMI as T1, T2, T3 in the second line of the heading in each settings group) are:

TABLE 8

Description	MMI/GE-LOCAL
51 PT Function	**51PT FUNCTION**
51 / 67 P Pick-up	51/67 P PICKUP
Curve	CURVE
Time Dial	TIME DIAL
Definite Time Setting	DEFINITE TIME t
51 NT Function	**51NT FUNCTION**
51 / 67 N Pick-up	51/67 N PICKUP
Curve	CURVE
Time Dial	TIME DIAL
Definite Time Setting	DEFINITE TIME t
50 PH Function	**50PH FUNCTION**
50 / 67 P Pick-up	50/67 P PICKUP
Time Delay	TIME DELAY
50 PL Function	**50PL FUNCTION**
50 / 67 P Pick-up	50/67 P PICKUP
Time Delay	TIME DELAY
50 NH Function	**50NH FUNCTION**
50 / 67 N Pick-up	50/67 N PICKUP
Time Delay	TIME DELAY
50 NL Function	**50NL FUNCTION**
50 / 67 N Pick-up	50/67 N PICKUP
Time Delay	TIME DELAY
46 PT Function	**46PT FUNCTION**
46 Pick-up	46 PICKUP
Curve	CURVE
Time Dial	TIME DIAL
Definite Time Setting	DEFINITE TIME t
81 Settings Group	**81 FUNCTION**
Pick-up 81U	81U PICKUP
Underfrequency timer	TIME DELAY U
Pick-up 810	81O PICKUP
Overfrequency timer	TIME DELAY O
Undervoltage supervision	INHIBIT V.
Voltage Settings Group	**27/59 FUNCTION**
Undervoltage pick-up (27P)	27P PICKUP
27P Time Delay	TIME DELAY 27P
Overvoltage pick-up (59P)	59P PICKUP
59P Time Delay	TIME DELAY 59P
Overvoltage pick-up (59NH)	59NH PICKUP
59NH Time Delay	TIME DELAY 59NH
Overvoltage pick-up (59NL)	59NL PICKUP
59NL Time Delay	TIME DELAY 59NL
Directionality Settings Group	**DIRECTIONAL SET.**
51 PT directional	51PT DIRECTIONAL
51 NT directional	51NT DIRECTIONAL
50 PH directional	50PH DIRECTIONAL
50 PL directional	50PL DIRECTIONAL
50 NH directional	50NH DIRECTIONAL
50 NL directional	50NL DIRECTIONAL
Characteristic Angle - Phase	PHASE ANGLE
Characteristic Angle - Ground	GROUND ANGLE
Loss Voltage Logic	V LOSS LOGIC
Recloser Settings Group	**RECLOSER**

Description	MMI/GE-LOCAL
Recloser Permission	79 STATUS
Number of Cycles	NUMBER OF CYCLES
Reset Time	RESET TIME
Hold mode Selection	HOLD MODE
Hold mode Time	HOLD TIMER
1st Reclose Time	1s RECLOSE DELAY
2nd Reclose Time	2n RECLOSE DELAY
3rd Reclose Time	3r RECLOSE DELAY
4th Reclose Time	4t RECLOSE DELAY
Reclose Conditions	RECL. CONDITIONS
Permitted Reclosures	
After 51 PT	INIT 79 x 51PT
After 51 NT	INIT 79 x 51NT
After 50 PH	INIT 79 x 50PH
After 50 PL	INIT 79 x 50PL
After 50 NH	INIT 79 x 50NH
After 50 NL	INIT 79 x 50NL
After 46 PT	INIT 79 x 46PT
After 81 U	INIT 79 x 81U
After 81 O	INIT 79 x 81O
After 27 P	INIT 79 x 27P
After 59 P	INIT 79 x 59P
After 59 NH	INIT 79 x 59NH
After 59 NL	INIT 79 x 59NL
With an Input	INIT 79 x INPUT
Trips Mask after 1st reclose	
Trip 51PT After reclose	51PT TRIP AFT 79
Trip 51NT After reclose	51NT TRIP AFT 79
Trip 50PH After reclose	50PH TRIP AFT 79
Trip 50PL After reclose	50PL TRIP AFT 79
Trip 50NH After reclose	50NH TRIP AFT 79
Trip 50NL After reclose	50NL TRIP AFT 79
Trip 46PT After reclose	46PT TRIP AFT 79
Trip 81U After reclose	81U TRIP AFT 79
Trip 81O After reclose	81O TRIP AFT 79
Trip 27P After reclose	27P TRIP AFT 79
Trip 59P After reclose	59P TRIP AFT 79
Trip 59NH After reclose	59NH TRIP AFT 79
Trip 59NL After reclose	59NL TRIP AFT 79

4. TECHNICAL CHARACTERISTICS

4.1. MODEL LIST

SMOR	*	*	*	1	*	2	1	*	*	0	0	B	
													Family:
	0												• 3x Iph + Ig (Without voltage functions)
	1												• 3x Iph + Ig + 3xV
	4												• 3x Iph + Ig + 3xV - ungrounded system
	7												• 3x Iph + Ig + 3xV + Vo (dedicated)
													Communications interface:
		0											• RS232
		1											• Plastic F.O. + RS232
		2											• Glass F.O. + RS232
		3											• RS232 + RS485
													Ranges
			[1]										• See table [1]
													Communications Protocols
				1									• P1, P2, P3: Mlink
				2									• P1, P2: Mlink ; P3: ModBus RTU
													MMI language
					M								• Spanish
					D								• English
													I/O Expansion board
								0					• Without expansion board
								1					• With expansion board
													Auxiliary voltage
									A				• 48 Vdc
									F				• 24-48 Vdc
									G				• 48-125 Vdc
									H				• 110 - 250 Vdc
													Options (special models)
										0	0		Standard model
										0	3		Energy metering and modified 79 logic
										0	4		½ rack 4 units high model
										0	6		½ rack model with energy metering

TABLE [1] - RANGES								
MODELS		**A**	**B**	**C**	**D**	**E**	**F**	**G**
SMOR 1/7-B	**PHASE**	1-12 A	0,2-2,4 A	1-12A	1-12 A	1-12 A	0,5-6 A	0,5-6 A
	GROUND	1-12 A	0,2-2,4 A	0,2-2,4 A	0,5-6 A	0,1-1,2	0,2-2,4	0,1-1,2
SMOR 4-B	**PHASE**		0,2-2,4 A	1-12 A				
	GROUND		0,005-	0,005-				
	PHASE			1-12 A	1-12 A			
SMOR 6-B	**GROUND**			0,2-2,4 A	0,2-2,4			
	GROUND			0,025-	0,5-6A			

4.2. TECHNICAL CHARACTERISTICS

MECHANICAL

- Metal casing 19 inches rack case 2 units high
- IP51 Grade Protection (as per IEC 529)
- Local MMI with LCD screen consisting of 2 rows of 16 characters and 20 key keyboard
- Rear connection by means of 4 strips of 12 terminals each (6 strips with optional I/O expansion board)
- Dimensions : 437 x 164 x 88 mm
- Weight: net 6 kg. Shipping 7 kg.

ELECTRICAL

- **Frequency**: 50 or 60 Hz (selectable by setting)
- **Nominal current**: 1 or 5 A (Different models)
- **Nominal voltage**: 100/√3 to 220/√3 Vac
- **Auxiliary voltage**: 48 Vdc or 110-250 Vdc (Different models)
- **Operational range** 80% to 120% of nominal values
- **Digital input voltage**: 48, 110-250 Vdc (Different models)

- **Thermal capacity:**
  Current circuits
  - Permanent 4 x In
  - 3 s duration 50 x In
  - 1 s duration 100 x In

  Voltage circuits
  - Permanent 2 x Un
  - 1 min. duration 3.5 x Un

- **Temperature ranges**
  - Operating -20º C to + 55ºC
  - Storage -40ºC to + 65ºC

- **Humidity** Up to 95% without condensation

- **Tripping contacts**:
  - Rated voltage/Maximum opening voltage: 250/440 Vac
  - Rated current/Closing current: 16/25 A
  - Operating power: 4000 VA
  - Mechanic life: 30×10^6 ops

- **Auxiliary & alarm contacts:**
  - Operating power: 4760 VA
  - Operating voltage: 380/250 Vac/Vdc
  - Continuous operating current 8 A
  - Mechanic life: 10^7 ops
  - Electrical life, full load: 10^5 ops

- **Circuits burden**
  - Current circuits 0.5 VA to In = 5 A
    0.1 VA to In = 1 A and In = 0.2 A
  - Voltage circuits: 0.2 VA to Un = 63.5 V

- **Consumption:**
  -Auxiliary voltage 12 W idle state
  16 W all relays activated
  -Digital inputs 8 mA (1 W for Vaux = 125 Vdc)

- **Accuracy:**

-Voltage and current	5%
-Timers	5% or 30ms (whichever is greater)
- Error index	Class E-5 as per IEC 255-4

- **Repetitivity**

-Operating value	1%
-Operating time	2% or 30ms (whichever is greater)

COMMUNICATIONS

- RS232 using DB9 female connector (2 or 3 connectors depending on model)

- Mode : Half duplex.

- 1 mm plastic fiber-optic (depending on model)

Typical power output :	-8 dBm
Receiver sensitivity	-39 dBm
Numeric aperture N.A.	0.5
Wave length	660 nm (visible red)
HFBR-4516 type connector	

- Glass fiber-optic 62.5/125 (depending on model):

Typical power output:	-17.5 dBm
Receiver sensitivity	-25.4 dBm
Numeric aperture N.A.	0.2
Wave length	820 nm (near infrared)
SMA type connector	

STANDARDS

The SMOR system complies with the following standards, which include the GE insulation and electromagnetic compatibility standard and the standards required by Community Directive 89/336 for the EC market, in line with European standards. It also complies with the European directive requirements for low voltage, and the environmental and operating requirements established in ANSI standards C37.90, IEC 255-5, IEC 255-6 and IEC 68.

Test	Standard	Class
•Insulation test voltage	IEC 255-5	600V, 2kV 50/60Hz 1min.
•Impulse Voltage Withstand	IEC 255-5	5kV,0.5 J
•1 MHz interference	IEC 255-22-1	III
•Electrostatic discharge	IEC 255-22-2 EN 61000-4-2	IV 8kV
•Immunity to radio interference	IEC 255-22-3	III
•Electromagnetic fields radiated with amplitude modulation	ENV 50140	10 V/m
•Electromagnetic fields radiated with amplitude modulation. Common mode	ENV 50141	10 V/m
•Electromagnetic fields radiated with frequency modulation	ENV 50204	10 V/m

•Fast transients	IEC 255-22-4 EN 61000-4-4	IV
•Magnetic fields at industrial frequency	EN 61000-4-8	30 Av/m
•RF emission	EN 55011	B

5. HARDWARE DESCRIPTION

CAUTION

The SMOR contains electronic components that could be damaged by electrostatic discharge if those currents flow through certain terminals of the components. The main source of electrostatic discharge currents is the human body, especially in conditions of low humidity, carpeted floors and isolating shoes. Where these conditions exist, care should be exercised when removing and handling the modules. The persons handling the modules should make sure that their body charge has been discharged, by touching some surface at ground potential before touching any of the components on the modules.

5.1. PHYSICAL DESCRIPTION

5.1.1. CASE

The SMOR's case is made from stainless steel and consists of the main body and a covering lid. The main body of the case contains the blocks of terminals necessary to carry out the external connections and guides to support the trays which contain the internal parts of the relay. The trays can be pulled out in order to facilitate the maintenance and servicing of the relay.

5.1.2. ELECTRICAL CONNECTIONS

All the electrical connections for voltage, current, digital input and output relays are made using the blocks of terminals fixed to the rear part of the case. The connections required for the unit's communications are made using three DB-9 type connectors, one on the front and two on the rear when using communication option RS-232. One of these connectors is replaced by the corresponding fiber-optic connector in the models which include this option.

5.1.3. INTERNAL CONSTRUCTION

Internally the SMOR unit is divided into 2 trays and a case. The case consists of the case with the blocks of terminals described above. Inside the lower tray are located the CT and VT which are connected to the CPU by a frontal bus.

The lower tray carries the magnetic module and a printed circuit board which contains the power supply, the digital inputs and also the trip outputs and auxiliary outputs on the basic version (model without expansion board).

The upper tray carries the board with the protection system CPU and the board with the communications. This tray can also carry as an option the input and output expansion board.

The front panel consists of a covered keyboard and a board which carries the alphanumeric display, the LEDs and the Reset button. The model number (see list of models in Chapter 4) and the technical characteristics of the unit are situated on the front panel of the relay.

The 16 indicator LEDs can be identified using labels which can be placed beside them.

A frontal bus is responsible for the connections between the boards described above. Both trays can be pulled out. To do so you first have to release the front panel which is fixed to the case with two screws and pull it out, removing the flat cable which connects it to the CPU. It is then possible to remove the frontal bus.

The blocks of terminals situated on the rear of the case are identified with the letters A, B, C and D, and optionally E and F, as shown in figure 9. In addition, each terminal is identified with a number.

The communications connectors are situated on left-hand side of the front and on the right-hand side of the rear of the case. The front port is labeled as PORT 1 and the rear ports as PORT 2 and PORT3. The IRIG-B connection is made using a block of two additional terminals.

5.2. OPERATING THEORY

The SMOR unit measures voltage and current signals, carries out complex calculations using internal data, stores relevant events, activates trip relays and generates information which can be used to determine the status of the power system to which it is connected. The functionality of the SMOR can be divided into the following sections :

- Magnetic module
- CPU board
- Power supply
- Keyboard and display

5.2.1. MAGNETIC MODULE

The magnetic module carries out two essential functions : galvanic insulation and scaling analog input signals. In the case of voltage transformers it scales the input voltage so that internally the unit works with voltages which are greatly below the input voltages. In the case of current transformers the input current for the primary winding is converted into a scaled voltage in the secondary winding of the transformer. Each voltage and current transformer must be linear in the whole measurement range of the relay. The voltages supplied by the input transformers are applied directly to the CPU signal processing board.

5.2.2. CPU BOARD

The SMOR uses two 16-bit microprocessors operating at a clock frequency of 20 MHz. One of these microprocessors is used to carry out relay communications and the other to carry out the calculations which are necessary for the protection functions. The microprocessor chosen is designed to carry out input and output calculations and operations at very high speed. The use of two microprocessors is especially recommendable so as to make the protection and communication functions totally independent of each other inside the unit itself, and thereby increase the reliability of the system.

The analogue-digital converter converts the voltage inputs into their digital equivalent with a resolution of 10 bits.

The unit's code is stored in non-volatile EPROM memory while the settings and events are stored in non-volatile EEPROM memory. The data related to the oscillography is stored in RAM memory which is maintained using a capacitor, thus avoiding the loss of information when the unit is disconnected.

A high resolution real time clock is used to time-tag the events and ensure an appropriate post-fault analysis can be done, with a resolution of one millisecond. This clock can be synchronized externally using an IRIG-B type input.

The input and output functions are divided between the two microprocessors. The serial ports, the keyboard and the display are controlled by the communications microprocessor. External communications are processed by a serial communications controller circuit which contains a universal asynchronous transceiver (DUART). The digital inputs and outputs are processed by the protection microprocessor.

The SMOR contains 6 independent circuits to process digital inputs. These circuits check the presence or absence of input voltage and are designed to insulate them electrically from the microprocessor, thus increasing the reliability of the system.

On the front of the relay there is a set of 17 LEDs, one of which is fixed and indicates the operating status of the unit, and the rest are user-configurable by means of GE-INTO software.

The button situated on the front can be used to check the status of the LEDs and to reset the trip indicators. In order to reset the indicators, simply press the button for 3 seconds.

5.2.3. POWER SUPPLY

The SMOR power supply can be of two types, depending on the model: 48 Vdc or 110/250 Vdc. The operating margin of the power supply is ± 20% and it is galvanically insulated from the rest of the relay's circuits. The power supply provides ± 12 Vdc to supply the analog part and the output relays and + 5 Vdc for the digital circuits.

5.2.4. KEYBOARD AND DISPLAY

The SMOR display is an LCD display (liquid crystal) and consists of two rows of 16 characters each and can be seen in the window situated on the front of the unit. The intensity of the display can be adjusted by using an adjustable resistance situated on the rear of the front board. The keyboard consists of a set of twenty covered keys.

6. ACCEPTANCE TESTS

There follows a list of tests which can be used to check that the unit is fully operational. For a more limited test for the reception of units we recommend carrying out only the tests listed in sections: 6.2, 6.5, 6.8, 6.9, 6.10, 6.11 and 6.12.

6.1. CONNECTIONS AND NECESSARY EQUIPMENT

Necessary equipment:

- 3 voltage sources and 3 current sources, mutually dephasable
- One DC voltage power supply
- One chronometer
- One multimeter
- One auxiliary relay to simulate a Breaker
- Optionally, it is advisable to have a PC available, with the GE_LOCAL software installed and the data base file related to the appropriate SMOR relay.

Connect the relay as indicated in the external connections diagram, Figure 7.

Connect 3 current sources.

The first is connected to phase A on terminals A1 and A2. The second source is connected to phase B (terminals B1-B2) and the third one to phase C (terminals A3-A4), connecting the return of the three phases to the ground current input (terminals B3-B4).

3 voltage sources also need to be connected to phases A (terminals A5 and A6), B (terminals B5 and B6) and C (terminals A7 and A8).

For safety reasons, the external protection earth terminal should be securely grounded.

Supply the unit through terminals A10 and B10 at the nominal DC voltage.

An auxiliary relay is used to simulate the operation of a Breaker. The opening coil will be connected to relay trip output (terminals A11 and B11). The Closing coil of the auxiliary relay will be connected to the reclose output (terminals C1 and D1). In order for the relay to be able to detect the status of the Breaker, a 52/b contact of the auxiliary relay (a contact which is open when the relay is closed) must be wired to the 52/b input on the SMOR relay (terminals C9 and D10).

Jumpers and switches are used to simulate the Closing of the external contacts.

6.2. VISUAL INSPECTION

Check that the relay has not suffered any kind of damage due to transport and handling.

Check that all the screws are sufficiently tight and that the terminal strips have not been damaged in any way.

Check that the information on the characteristics plate coincide with those of the ordered model.

6.3. INSULATION TESTS

Progressively apply 2000 rms volts for the initial test across all the short-circuited terminals of a group and the case, for one second.

During the tests A9 and B9 terminals must be grounded for safety reasons

The independent groups on the relay are as follows:

Group 1:	A10,B10	Power supply
Group 2:	A5 to A8, B5 to B8	Voltage transformers
Group 3:	A1 to A4, B1 to B4	Current transformers
Group 4:	C9, C10, D9, D10	Inputs group 1
	C11,C12, D11, D12	Inputs group 2
Group 5:	A11, B11	Trip 1
Group 6:	A12, B12	Trip 2
Group 7:	C1, D1	Reclose 1
Group 8	C2, D2	Reclose 2
Group 9	C3, D3	Unit alarm
Group 10:	C4 to C6, D4 and D5	Outputs Group 1 (outputs 1 to 4)
Group 11:	C7, C8, D6 to D8	Outputs Group 2 (outputs 5 to 8)

For models with expansion board, add the following groups:

Group 12:	E9, E10, F9 and F10	Inputs Group 3
	E11,E12,F11 and F12	Inputs Group 4
Group 13	E5, E6, F5 and F6	Coil 1 and 2 supervision
	E7, E8, F7 and F8	
Group 14:	E1, F1	Output 9
Group 15:	E2, F2	Output 10
Group 16:	E3, F3	Output 11
Group 17:	E4, F4	Output 12

6.4. INDICATORS

Check that pressing the TARGET RESET button with the relay connected to a power supply, all the indicators light up.

6.5. POWER SUPPLY

- The relay is connected to a power supply at nominal minimum voltage. Enable the following functions: 51P, 51N, 50PH, 50PL, 59P, 81O and 46, and set them to their minimum pick-up value and time delays. Inject to the relay in phases A and B a current equal to 2xIn(phase) at nominal AC voltage, making the relay to trip, closing all his auxiliary outputs corresponding to the mentioned outputs.
- The status of the ALARM output relay will be checked. It should remain open. At these conditions, the relay can communicate with the PC. Check this point requesting the relay model from the PC.

With the relay tripped, consumption is measured, being as follow:

Model "A" (48 Vdc)

Voltage (Vdc)	Maximum consumption (mA)	
	No expansion	Expansion
38	350	500
48	280	355
58	250	315

Model "H" (110/250 Vdc)

Voltage (Vdc)	Maximum consumption (mA)	
	No expansion	Expansion
88	170	220
125	120	150
300	55	70

6.6. COMMUNICATIONS

The test is to check that the 3 connectors in the relay allow communication with the relay. To do this it is necessary to use a computer and a connector suitable to establish the connections between PC and relay which are shown in figure 8.

The communication parameters which have to be set for the computer are the relay's default settings, as follows:

Relay number:	1
Remote port baud rate:	19200
Local port baud rate:	19200
Remote stop bits:	1
Local stop bits:	1

This test is carried out at the minimum and maximum voltage that the relay will allow (± 20% of the nominal voltages).

6.7. RELAY SETTING

When it leaves the factory the relay has some default settings, which are the starting point for the following tests.

Since the SMOR system has a large number of settings, an exhaustive list of all the settings necessary for each test is not given here. The specific settings required for each test are indicated, and it can be supposed that the other settings do not affect the test in question. For example, when testing the Overcurrent function, the recloser and the directional control functions, etc, are disabled.

6.8. INPUTS

6.8.1. DIGITAL INPUTS

- Apply the nominal voltage in order to each of the inputs (CC1 to CC6) and, for models with expansion board, (CC1 to CC12).
- Each test checks that the corresponding input is activated and that the remaining inputs (to which no voltage is applied) are not activated. Use a PC and the GE_LOCAL software to easily check which inputs get active.
- Repeat this test at minimum and maximum voltage

6.8.2. SYNCHRONIZATION INPUT IRIG-B

- Connect the output of an IRIG-B unit with decoded output to the IRIG-B input of the SMOR relay. Special care must be taken when making the connection because the input is polarized.
- Check that the time measured by the two units is the same.

6.9. OUTPUTS

- Check that all the outputs are open
- Set the Failure to open timer to the maximum. Perform an opening command and check that during the failure to open time the Trip-1 (A11-B11) and Trip-2 (A12-B12) output contacts are closed.

- Set the Failure to close timer to the maximum. Perform a closing command and check that during the failure to open time the Reclose-1 (C1-D1) and Reclose-2 (C2-D2) output contacts are closed.
- Enable only 51P function, and set it to its minimum value. Inject a current to phase A equal to 2xIn(phase) to trip the relay. Check that S1 auxiliary output (C4-C6) closes and also S9 (E1-F1) if an expansion board exists.
- Enable only 51N function, and set it to its minimum value. Inject a current to the ground input equal to 2xIn(ground) to trip the relay. Check that S2 auxiliary output (D4-C6) closes and also S11 (E3-F3) if an expansion board exists.
- Enable only 46 function, and set it to its minimum value. Inject a current to phase A equal to 2xIn(phase) to trip the relay. Check that S3 auxiliary output (C5-C6) closes.
- Enable only 81O function, and set it to its minimum value. Inject nominal voltage on phase B voltage input, at nominal frequency to trip the relay. Check that S4 auxiliary output (D5-C6) closes.
- Enable only 59P function, and set it to its minimum value. Inject nominal voltage on phase A voltage input, at nominal frequency to trip the relay. Check that S5 auxiliary output (C7-D6) closes.
- With the recloser out of service check that output S8 (D8-D6) is closed. Set the recloser in service and check the S8 opens. Set the recloser to one reclosing attempt with a 5 sec time delay, without reclosing condition checking and a reset time equal to 10 sec. Enable only 51P function and make the relay to trip. Check that S7 closes (C8-D6) during the 5 sec the recloser lasts. Before 10 sec make the relay to trip again and check the recloser moves to the lockout status, closing output number S6 (D7-D6).
- Remove the Power Supply to the relay and check that the Alarm contact (C3-D3) closes. Set the power supply back to the relay and check that the Alarm contact opens.

6.10. CHECKING RELAY MEASUREMENTS

6.10.1. CURRENT AND VOLTAGE MEASUREMENT

- Set the relay in the following way :

General Settings Group	
Frequency	50 Hz
CT Phase ratio	1
CT Ground ratio	1
PT line phase ratio	1000
PT busbar phase ratio	1000

VOLTAGES

- Apply the following voltage values to the relay :

V	Angle	1	2	3	4	5	6
Van	0	0	1	10	50	100	150
Vbn	120	0	1	10	50	100	150
Vcn	240	0	1	10	50	100	150

- Check that the relay measures Vab, Vbc, Vac with an accuracy of at least 5%.
- Repeat the test for 60 Hz.

PHASE CURRENTS

- Inject the following current values into the relay:

I (Amp)	Angle	1	2	3	4
Ia	45	0.1xIn	0.5xIn	1xIn	2xIn
Ib	165	0.1xIn	0.5xIn	1xIn	2xIn
Ic	285	0.1xIn	0.5xIn	1xIn	2xIn

(In is the nominal or rated current for the relay phase current inputs, 5 or 1 Amp)

- Check that the relay measures Ia, Ib, Ic with an accuracy of at least 5%.
- Repeat the test for 60 Hz.

GROUND CURRENTS

- Inject the following current values into the relay:

I (Amp)	Angle	1	2	3	4
Iground	0	0.1xIn(gnd)	0.5xIn(gnd)	1xIn(gnd)	5xIn(gnd)

(In is the nominal or rated current for the relay ground current input, 5 or 1 Amp)

- Check that the relay measures Iground with an accuracy of at least 5%.
- Repeat the test for 60 Hz.

6.10.2. FREQUENCY MEASUREMENT

- Apply 110V at 50 Hz through the voltage input corresponding to phase B.
- Check that the frequency measured by the relay is inside the range of 49.97 and 50.03 Hz.

NOTE : Check that the inhibition voltage of the frequency units is lower than the applied voltage. If not, the unit does not measure the frequency.

6.11. RECLOSER

Recloser Settings Group	
79 Status	Permitted
Number of cycles	4
Reset Time	10 sec
Hold Mode	NO
Hold Timer	15 sec
1st Reclose Delay	2.1 sec
2nd Reclose Delay	4.1 sec
3rd Reclose Delay	6.1 sec
4th Reclose Delay	8.1 sec
Recl. Conditions	Inh. Input

Enable only 51PL function, and set its pick up and timer to the minimum value possible.

6.11.1. CHECKING RECLOSER CYCLE

- After setting the relay, close the Breaker and wait 10 sec. After this time the recloser is ready to start the reclose cycle.
- Force a 50 PL trip and check that relay recloses in 2.1 sec.
- Before 10 sec force a 50 PL trip and check that relay recloses in 4.1 sec.
- Before 10 sec force a 50 PL trip and check that relay recloses in 6.1 sec.
- Before 10 sec force a 50 PL trip and check that relay recloses in 8.1 sec.
- Before 10 sec force a 50 PL trip and check that the recloser goes to lockout, closing the auxiliary output S6 (D7-D6).

6.11.2. CHECKING THE RECLOSER BLOCK

- Close the breaker and wait 10 sec. After this time the recloser is ready to start a new reclosing cycle. Energize input CC2 (D9-D10) (pulse signal) to block the recloser.
- Force a 50PL trip and check the recloser does not reclose.
- Close the breaker. Energize CC3 input (C10-D10) (pulse signal) to unblock the recloser. Force a 50PL trip and check that the recloser closes in 2.1 sec.

6.11.3. CHECKING RECLOSER INHIBITION

- Enable the Hold Mode in the recloser settings. Close the Breaker and wait 10 sec. After this time the recloser is ready to start the reclosing cycle.
- Force a trip and wait for the 1st reclose to take place.
- Energize CC6 input (C12-D12) (Reclose inhibit) and force a 50 PL trip.
- After 12 sec. de-energize CC6 input and check that at that moment the relay recloses.
- Activate CC6 input (Reclose inhibit) and force a 50 PL trip.
- After 18 sec de-energize CC6 input and check that the relay does not reclose. The recloser should be in LOCKOUT.

6.11.4. CHECKING RECLOSE INITIATION

(Only for models with expansion board)

- Close the Breaker and wait 10 sec. After this time the recloser is ready to start the reclosing cycle.
- Force a 50PL trip and wait for the 1st reclose to take place.
- Before 10 sec energize CC7 input (Reclose Initiation) and check that after 4.1 sec (corresponding to the 2nd reclose) the relay recloses again.

6.12. INSTANTANEOUS PHASE OVERCURRENT UNIT, HIGH LEVEL (50PH)

- Enable only 50PH function and the related trip.
- Set its time delay and pick up to the minimum possible.
- With 0.9 times the pick up current the relay should not trip.
- With 1.1 times the pick up current the relay should trip instantaneously in between 10 to 50 ms.
- With 4 times the pick up current the relay should trip instantaneously in between 10 to 40 ms.
- The test should be carried out for phases A, B and C.

6.13. INSTANTANEOUS PHASE OVERCURRENT UNIT, LOW LEVEL (50PL)

- Enable only 50PL function and the related trip.
- Set its time delay and pick up to the minimum possible.
- With 0.9 times the pick up current the relay should not trip.

- With 1.1 times the pick up current the relay should trip instantaneously in between 10 to 50 ms.
- With 4 times the pick up current the relay should trip instantaneously in between 10 to 40 ms.
- The test should be carried out for phases A, B and C.

6.14. INSTANTANEOUS GROUND OVERCURRENT UNIT, HIGH LEVEL (50NH)

- Enable only 50NH function and the related trip.
- Set its time delay and pick up to the minimum possible.
- With 0.9 times the pick up current the relay should not trip.
- With 1.1 times the pick up current the relay should trip instantaneously in between 10 to 50 ms.
- With 4 times the pick up current the relay should trip instantaneously in between 10 to 40 ms.

6.15. INSTANTANEOUS GROUND OVERCURRENT UNIT, LOW LEVEL (50NL)

- Enable only 50NL function and the related trip.
- Set its time delay and pick up to the minimum possible.
- With 0.9 times the pick up current the relay should not trip.
- With 1.1 times the pick up current the relay should trip instantaneously in between 10 to 50 ms.
- With 4 times the pick up current the relay should trip instantaneously in between 10 to 40 ms.
- The test should be carried out for phases A, B and C.

6.16. PHASE TIME OVERCURRENT UNIT (51PT)

The 4 curves (Inverse, Very Inverse, Extremely inverse and Definite time) are tested with three points for each curve (one not-to-trip and two to trip). This gives us a total of 12 points for each protection unit. The tests are carried out for different phases. Each point is tested with a different pick up and dial in order to test the whole range of the relay.

Enable only 51PT function and its related trip, and set the pick up to the minimum possible.

INVERSE CURVE

- Set the relay as follows:

51PT Settings Group	
Curve	INVERSE
Time Dial	1

- Apply 0.9 times the pick up current into phase A and the relay should not trip.
- Apply 1.5 times the pick up current and the relay should trip in 15.96 sec. Acceptable time range between 14.24 and 18.28 sec.
- Apply 5 times the pick up current and the relay should trip in 3.97 sec. Acceptable time range between 3.85 and 4.10 sec.

VERY INVERSE CURVE

- Set the relay as follows:

51PT Settings Group	
Curve	VERY INVERSE
Time Dial	0.5

- Apply 0.9 times the pick up current into phase B and the relay should not trip.
- Apply 1.5 times the pick up current and the relay should trip in 16 sec. Acceptable time range between 13.91 and 18.82 sec.

- Apply 5 times the pick up current and the relay should trip in 2.03 sec. Acceptable time range between 1.88 and 2.13 sec.

EXTREMELY INVERSE CURVE

- Set the relay as follows:

51PT Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	0.05

- Apply 0.9 times the pick up current into phase C and the relay should not trip.
- Apply 1.5 times the pick up current and the relay should trip in 3.87 sec. Acceptable time range between 3.24 and 4.65 sec.
- Apply 5 times the pick up current and the relay should trip in 0.20 sec. Acceptable time range between 0.16 and 0.24 sec.

DEFINITE TIME

- Set the relay as follows:

51PT Settings Group	
Curve	DEFINITE TIME
Time Dial	1.0

- Apply 0.9 times the pick up current into phase A and the relay should not trip.
- Apply 1.1 times the pick up current and the relay should trip in 1 sec. Acceptable time range between 0.97 and 1.03 sec.
- Apply 4 times the pick up current and the relay should trip in 1 sec. Acceptable time range between 0.97 and 1.03 sec.

6.17. GROUND TIME OVERCURRENT UNIT (51NT)

Enable only 51NT function and its related trip, and set the pick up to the minimum possible.

INVERSE CURVE

- Set the relay as follows:

51NT Settings Group	
Curve	INVERSE
Time Dial	1

- Apply 0.9 times the pick up current into phase A and the relay should not trip.
- Apply 1.5 times the pick up current and the relay should trip in 16 sec. Acceptable time range between 14.24 and 18.28 sec.
- Apply 5 times the pick up current and the relay should trip in 4 sec. Acceptable time range between 3.87 and 4.10 sec.

VERY INVERSE CURVE

- Set the relay as follows:

51NT Settings Group	
Curve	VERY INVERSE
Time Dial	0.5

- Apply 0.9 times the pick up current into phase B and the relay should not trip.

- Apply 1.5 times the pick up current and the relay should trip in 16 sec. Acceptable time range between 13.91 and 18.82 sec.
- Apply 5 times the pick up current and the relay should trip in 2.03 sec. Acceptable time range between 1.88 and 2.13 sec.

EXTREMELY INVERSE CURVE

- Set the relay as follows:

51NT Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	0.05

- Apply 0.9 times the pick up current into phase C and the relay should not trip.
- Apply 1.5 times the pick up current and the relay should trip in 3.87 sec. Acceptable time range between 3.24 and 4.65 sec.
- Apply 5 times the pick up current and the relay should trip in 0.20 sec. Acceptable time range between 0.16 and 0.24 sec.

DEFINITE TIME

- Set the relay as follows:

51PT Settings Group	
Curve	DEFINITE TIME
Time Dial	1.0

- Apply 0.9 times the pick up current into phase A and the relay should not trip.
- Apply 1.1 times the pick up current and the relay should trip in 1 sec. Acceptable time range between 0.97 and 1.03 sec.
- Apply 4 times the pick up current and the relay should trip in 1 sec. Acceptable time range between 0.97 and 1.03 sec.

6.18. PHASE DIRECTIONAL UNIT (67PL)

Instantaneous trips (50PL, low level) are forced to test the directionality of the relay.

4 points are tested:

- One located clearly inside the no-tripping zone
- One situated clearly within the tripping zone.
- Another no-trip located at 5º from the upper limit of the no-tripping zone.
- Another no-trip located at 5º from the lower limit of the no-tripping zone.

Enable only 50PL function and its related trip, and set its pick up and time delay to the minimum possible

- Set the relay as follows:

Directionality Settings Group	
51 PT Directional	NO
51NT Directional	NO
50PH Directional	NO
50PL Directional	YES
50NH Directional	NO
50NL Directional	NO
Phase Angle	45
Ground Angle	-45
V Loss Logic	Permission

PHASE A DIRECTIONAL TEST

- Apply 4 times the pick up current at 0º on phase A. Positive is applied to terminal A1 and negative to terminal A2.
- Apply 60 V at 0º on phase C. Positive is applied to terminal A7 and negative to terminal A8.
- Check that relay does not trip.
- Gradually reduce the voltage to 4 V and check that relay still does not trip.
- Reduce the voltage to 2.5 V and check that relay trips.
- Apply 60 V at 180º on phase C.
- Check that relay trips.
- Apply 60 V at 320º on phase C.
- Check that relay does not trip.
- Apply 60 V at 130º on phase C.
- Check that relay does not trip.

PHASE B DIRECTIONAL TEST

- Apply 4 times the pick up current at 0º on phase B. Positive is applied to terminal B1 and negative to terminal B2.
- Apply 60 V with 0º on phase A. Positive is applied to terminal A5 and negative to terminal A6.
- Check that relay does not trip.
- Gradually reduce the voltage to 4 V and check that relay still does not trip.
- Reduce the voltage to 2.5 V and check that relay trips.
- Apply 60 V at 180º on phase A.
- Check that relay trips.
- Apply 60 V at 320º on phase A.
- Check that relay does not trip.
- Apply 60 V at 130º on phase A.
- Check that relay does not trip.

PHASE C DIRECTIONAL TEST

- Apply 4 times the pick up current at 0º on phase C. Positive is applied to terminal A3 and negative to terminal A4.
- Apply 60 V at 0º on phase B. Positive is applied to terminal B5 and negative to terminal B6.
- Check that relay does not trip.
- Gradually reduce the voltage to 4 V and check that relay still does not trip.
- Reduce the voltage to 2.5 V and check that relay trips.
- Apply 60 V at 180º on phase B.
- Check that relay trips.
- Apply 60 V at 320º on phase B.
- Check that relay does not trip.
- Apply 60 V at 130º on phase B.
- Check that relay does not trip.

6.19. GROUND DIRECTIONAL UNIT (67NL)

Instantaneous trips (50NL, low level) are forced to test the directionality of the relay.

4 points are tested:

One located clearly inside the no-tripping zone
One located clearly within the tripping zone.
Another no-trip located at 5º from the upper limit of the no-tripping zone.
Another no-trip located at 5º from the lower limit of the no-tripping zone.

- Set the relay as follows:

Directionality Settings Group	
51 PT Directional	NO
51NT Directional	NO
50PH Directional	NO
50PL Directional	NO
50NH Directional	NO
50NL Directional	YES
Phase Angle	45º
Ground Angle	-45º
V Loss Logic	Permission

- Apply 4 times the pick up current at 0º to the Ground current inputs. Positive is applied to terminal B3 and negative to terminal B4.
- Apply 60 V at 0º on phase B. Positive is applied to terminal B5 and negative to terminal B6.
- Check that relay does not trip.
- Gradually reduce the voltage to 45 V and check that relay still does not trip.
- Reduce the voltage to 2.5 V and check that relay trips.
- Apply 60 V at 180º on phase B.
- Check that relay trips.
- Apply 60 V at 230º on phase B.
- Check that relay does not trip.
- Apply 60 V at 40º on phase B.
- Check that relay does not trip.

6.20. UNDERFREQUENCY UNIT (81U)

- Set the relay as follows:

81 Function Settings Group	
81U Pick up	47.5 Hz
Time Delay 81U	2 sec
Inhibit V	35%

- Enable only 81U function and its related trip.
- Apply 110 Vac on phase B, varying the frequency from 46 Hz to 54 Hz (inclusive), at intervals of 1 Hz (switch the voltage source OFF before changing the frequency).
- Measure the operation time. This should be between 1.9 and 2.1 s, when the frequency is 46 Hz and 47 Hz. For the other frequencies the relay should not trip.
- Apply 36 Vac on phase B, at a frequency of 46 Hz. The relay should not trip, due to the voltage supervision.

6.21. OVERFREQUENCY UNIT (81O)

- Set the relay as follows:

81 Function Settings Group	
81O Pick up	52.5 Hz
Time Delay 81U	2 sec
Inhibit V	35%

- Enable only 81O function and its related trip.
- Apply 110 Vac on phase B, varying the frequency from 46 Hz to 54 Hz (inclusive), at intervals of 1 Hz (switch the voltage source OFF before changing the frequency).
- Measure the operation time. This should be between 1.9 and 2.1 s, when the frequency is 53 Hz and 54 Hz. For the other frequencies the relay should not trip.

- Apply 36 Vac on phase B, at a frequency of 54 Hz. The relay should not trip, due to the voltage supervision.

6.22. UNDERVOLTAGE UNIT (27)

- Enable only 27P function and its related trip.
- Set the relay as follows:

27/'59 Functions Settings Group	
27P Pick up	10 V (ph-ph) (5.77 V ph-gnd)
Time Delay 27P	0.20 sec

- Apply on the three phases of the relay 6.4 Vac and check that the relay does not trip.
- Apply 5.2 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 0.18 and 0.22 sec.

- Set the relay as follows:

27/'59 Functions Settings Group	
27P Pick up	100 V (ph-ph) (57.7 V ph-gnd)
Time Delay 27P	4.0 sec

- Apply on the three phases of the relay 60.5 Vac and check that the relay does not trip.
- Apply 54.8 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 3.9 and 4.1 sec.

6.23. OVERVOLTAGE UNIT (59)

- Enable only 59P function and its related trip.
- Set the relay as follows:

27/'59 Functions Settings Group	
59P Pick up	10 V (ph-ph)
Time Delay 59P	0.20 sec

- Apply on phase A of the relay 9 Vac and check that the relay does not trip.
- Apply 11 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 0.18 and 0.22 sec.

- Set the relay as follows:

27/'59 Functions Settings Group	
27P Pick up	100 V (ph-ph) (57.7 V ph-gnd)
Time Delay 27P	4.0 sec

- Apply on phase A of the relay 95 Vac and check that the relay does not trip.
- Apply 105 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 3.9 and 4.1 sec.

- Repeat both tests for phases B and C.

6.24. ZERO SEQUENCE OVERVOLTAGE UNIT, HIGH LEVEL (59 NH)

- Enable only 59NH function and its related trip.
- Set the relay as follows:

27/’59 Functions Settings Group	
59NH Pick up	3 V
Time Delay 59NH	0.20 sec

- Apply on phase A of the relay 2.7 Vac and check that the relay does not trip.
- Apply 3.3 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 0.18 and 0.22 sec.

- Set the relay as follows:

27/’59 Functions Settings Group	
59NH Pick up	100 V
Time Delay 59NH	4.0 sec

- Apply on phase A of the relay 95 Vac and check that the relay does not trip.
- Apply 105 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 3.9 and 4.1 sec.

6.25. ZERO SEQUENCE OVERVOLTAGE UNIT, LOW LEVEL (59 NL)

- Enable only 59NL function and its related trip.
- Set the relay as follows:

27/’59 Functions Settings Group	
59NL Pick up	3 V
Time Delay 59NL	0.20 sec

- Apply on phase A of the relay 2.7 Vac and check that the relay does not trip.
- Apply 3.3 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 0.18 and 0.22 sec.

- Set the relay as follows:

27/’59 Functions Settings Group	
59NL Pick up	100 V
Time Delay 59NL	4.0 sec

- Apply on phase A of the relay 95 Vac and check that the relay does not trip.
- Apply 105 Vac and check that the relay trips.
- Check that for this trip, the operating time is in between 3.9 and 4.1 sec.

6.26. BREAKER MAINTENANCE

- Set the relay as follows :

Breaker Settings Group	
KI2T Operation Mode	FIXED
KI2T Integration Time	0.1 sec

- Reset all the counters on the relay.
- Enable 50PL function and its related trip. Set its pick up and time delay to the minimum possible.
- Force 2 trips, one below the nominal current and one above :
  Trip-1 : 0.8 x In (phase) flowing through phases A, B and C.
  Trip-2 : 1.2 x In (phase) flowing through phases A, B and C.

- Check on the relay that the number of opening operations is 2, and the number of accumulated amperes is between 5700 and 6400 kA^2s (exact value 6100) for In(phase) = 5 Amp.

6.27. COMMANDS.

- The following tasks have to be carried out :

1. Breaker **OPENING** : Use communications to give a breaker opening command and check that the breaker opens.
2. Breaker **CLOSING**. Use communications to give a breaker closing command and check that the breaker closes.
3. **SYNCHRONIZATION**. Use communications to synchronize the relay with the date/time on the PC. Check that the relay is indeed synchronized.
4. **DELETE EVENTS**. Use communications to erase all the events and check it has been done.
5. **BLOCK THE RECLOSER**:
   - Use communications to block the recloser.
   - Close the breaker and wait 10 sec. After this time the recloser is ready to initiate a reclosing cycle (if it is not blocked).
   - Force a trip and check that the relay does not reclose.

6.- **UNBLOCK THE RECLOSER**:
   - With the recloser enabled, issue this command to the relay. This command cancels the previous one (recloser block).
   - Force a trip and check the relay recloses after 2 sec (corresponding to the first programmed reclose).

6.28. PHASE ROTATION ABC - CBA

- Set the relay for the phase sequence ABC.
- Apply the following currents to the relay:

  Ia = In (phase) at 0°
  Ib = In (phase) at -120°
  Ic = In (phase) at -240°

- Check that the relay reads these values correctly, and I2=0 Amps (negative sequence)
- Set the relay for phase sequence CBA
- Check that the relay reads the values correctly, but now I2=In (phase).

6.29. MONITORING TRIP CIRCUITS: UNDERVOLTAGE

(Only for models with expansion board)

COIL 1:

- Apply nominal minimum voltage (38 Vdc for "A" models and 88 Vdc for "H" models) to the voltage supervision input for coil 1. Positive is applied to terminal F5 and negative to terminal E6.
- Check using GE_LOCAL software that the "Coil 1 DC Supply Failure" signal in the internal Status of the relay is not active.
- Remove the voltage applied to the above mentioned input.
- The "Coil 1 DC Supply Failure" signal will become active.

COIL 2:

- Repeat the previous test for coil 2. Positive should be applied to terminal F7 and negative to terminal E8. The signal to be checked is "Coil 2 DC Supply Failure".

6.30. MONITORING TRIP CIRCUITS : COIL FAILURE

(Only for models with expansion board)

COIL 1:

- Short-circuit terminals E5, F6 and E6 (common).
- Apply nominal minimum voltage (38 Vdc for "A" models and 88 Vdc for "H" models) to the voltage supervision input for coil 1. Positive is applied to terminal F5 and the negative to terminal E6.
- Check using GE_LOCAL software that the "Coil 1 Continuity Failure" signal in the internal Status of the relay is not active.
- Remove the short-circuit between terminals E5 and E6.
- The "Coil 1 Continuity Failure" signal will not become active.
- Remove the short-circuit between terminals F6 and E6.
- After 1 sec, the "Coil 1 Continuity Failure" signal will become active.

COIL 2:

- Repeat the previous test for coil 2. Positive is applied to terminal F7 and negative to terminal E8. The terminals corresponding to terminals E5, F6 and E6 will be E7, F8 and E8 respectively. The signal to be checked is "Coil 2 Continuity Failure"

Table 11. *Customer's settings*

Description	MMI/GE-LOCAL	USER VALUES
General Settings Group	**GENERAL SETTINGS**	
Relay status	RELAY STATUS	
Identification	IDENTIFICAT:	
Frequency	FREQUENCY	
Rated Voltage	NOMINAL VOLTAGE	
CT Phase Ratio	PHASE CT RATIO	
CT Ground Ratio	GROUND CT RATIO	
VT Line Ratio	LINE VT RATIO	
VT Busbar Ratio	BUS VT RATIO	
Demand Time	DEMAND TIME	
Phase rotation selection	PHASE ROTATION	
Breaker Settings Group	**BREAKER SETTINGS**	
Breaker Number	BREAKER NUMBER	
Fail to Open time	t FAIL TO OPEN	
Fail to Close time	t TAIL TO CLOSE	
Accumulable I2t Limit	KI2T LIMIT	
Intg I2t Time selector	KI2T OP. MODE	
I2t Integr. time	KI2T INT. TIME	
Maximum trips in 1 hour	MAX TRIPS 1h	
Active Table Settings	**ACTIVE TABLE SET**	
# of Active Settings Table	ACTIVE TABLE	
Cold pick-up permission	CLP PERMISSION	
Change to Table 3 time	t CHANGE TABLE	
Return from Table 3 time	t RETURN TABLE	
Oscillography Mask	**OSCILLOS MASK**	
Number of pre-fault cycles	PREFAULT CYCLES	
Oscillo. triggers :		
Pick-up 51 PT	51PT PICKUP	
Pick-up 51 NT	51NT PICKUP	

Description	MMI/GE-LOCAL	USER VALUES
Pick-up 50 PH	50PH PICKUP	
Pick-up 50 PL	50PL PICKUP	
Pick-up 50 NH	50NH PICKUP	
Pick-up 50 NL	50NL PICKUP	
Pick-up 46 PT	46PT PICKUP	
Pick-up 81 U	81U PICKUP	
Pick-up 81 O	81O PICKUP	
Pick-up 27 P	27P PICKUP	
Pick-up 59 P	59P PICKUP	
Pick-up 59 NH	59NH PICKUP	
Pick-up 59 NL	59NL PICKUP	
External Trigger	EXTERNAL TRIGGER	
Communications Trigger	COMM. TRIGGER	
Trip 51 PT	51PT TRIP	
Trip 51 NT	51NT TRIP	
Trip 50 PH	50PH TRIP	
Trip 50 PL	50PL TRIP	
Trip 50 NH	50NH TRIP	
Trip 50 NL	50NL TRIP	
Trip 46 PT	46PT TRIP	
Trip 81 U	81U TRIP	
Trip 81 O	81O TRIP	
Trip 27	27P TRIP	
Trip 59	59P TRIP	
Trip 59 NH	59NH TRIP	
Trip 59 NL	59NL TRIP	
Function Permission Group	**FUNCTION PERMIT**	
51 PT Function Permission	51PT FUNCTION	
51 NT Function Permission	51NT FUNCTION	
50 PH Function Permission	50PH FUNCTION	
50 PL Function Permission	50PL FUNCTION	
50 NH Function Permission	50NH FUNCTION	
50 NL Function Permission	50NL FUNCTION	
46 PT Function Permission	46PT FUNCTION	
81 U Function Permission	81U FUNCTION	
81 O Function Permission	81O FUNCTION	
27 P Function Permission	27P FUNCTION	
59 P Function Permission	59P FUNCTION	
59 NH Function Permission	59NH FUNCTION	
59 NL Function Permission	59NL FUNCTION	
51 PT Trip Permission	51PT TRIP	
51 NT Trip Permission	51NT TRIP	
50 PH Trip Permission	50PH TRIP	
50 PL Trip Permission	50PL TRIP	
50 NH Trip Permission	50NH TRIP	
50 NL Trip Permission	50NL TRIP	
46 PT Trip Permission	46PT TRIP	
81 U Trip Permission	81U TRIP	
81 O Trip Permission	81O TRIP	
27 P Trip Permission	27P TRIP	
59 P Trip Permission	59P TRIP	
59 NH Trip Permission	59NH TRIP	
59 NL Trip Permission	59NL TRIP	

Independent settings for each table

Description	MMI/GE-LOCAL	USER VALUES
51 PT Function	**51PT FUNCTION**	
51 / 67 P Pick-up	51/67 P PICKUP	
Curve	CURVE	
Time Dial	TIME DIAL	
Definite Time Setting	DEFINITE TIME t	
51 NT Function	**51NT FUNCTION**	
51 / 67 N Pick-up	51/67 N PICKUP	
Curve	CURVE	
Time Dial	TIME DIAL	
Definite Time Setting	DEFINITE TIME t	
50 PH Function	**50PH FUNCTION**	
50 / 67 P Pick-up	50/67 P PICKUP	
Time Delay	TIME DELAY	
50 PL Function	**50PL FUNCTION**	
50 / 67 P Pick-up	50/67 P PICKUP	
Time Delay	TIME DELAY	
50 NH Function	**50NH FUNCTION**	
50 / 67 N Pick-up	50/67 N PICKUP	
Time Delay	TIME DELAY	
50 NL Function	**50NL FUNCTION**	
50 / 67 N Pick-up	50/67 N PICKUP	
Time Delay	TIME DELAY	
46 PT Function	**46PT FUNCTION**	
46 Pick-up	46 PICKUP	
Curve	CURVE	
Time Dial	TIME DIAL	
Definite Time Setting	DEFINITE TIME t	
81 Settings Group	**81 FUNCTION**	
Pick-up 81U	81U PICKUP	
Underfrequency timer	TIME DELAY U	
Pick-up 810	81O PICKUP	
Overfrequency timer	TIME DELAY O	
Undervoltage supervision	INHIBIT V.	
Voltage Settings Group	**27/59 FUNCTION**	
Undervoltage pick-up (27P)	27P PICKUP	
27P Time Delay	TIME DELAY 27P	
Overvoltage pick-up (59P)	59P PICKUP	
59P Time Delay	TIME DELAY 59P	
Overvoltage pick-up (59NH)	59NH PICKUP	
59NH Time Delay	TIME DELAY 59NH	
Overvoltage pick-up (59NL)	59NL PICKUP	
59NL Time Delay	TIME DELAY 59NL	
Directionality Settings Group	**DIRECTIONAL SET.**	
51 PT directional	51PT DIRECTIONAL	
51 NT directional	51NT DIRECTIONAL	
50 PH directional	50PH DIRECTIONAL	
50 PL directional	50PL DIRECTIONAL	
50 NH directional	50NH DIRECTIONAL	
50 NL directional	50NL DIRECTIONAL	
Characteristic Angle - Phase	PHASE ANGLE	
Characteristic Angle - Ground	GROUND ANGLE	
Loss Voltage Logic	V LOSS LOGIC	
Recloser Settings Group	RECLOSER	
Recloser Permission	79 STATUS	
Number of Cycles	NUMBER OF CYCLES	

Description	MMI/GE-LOCAL	USER VALUES
Reset Time	RESET TIME	
Hold mode Selection	HOLD MODE	
Hold mode Time	HOLD TIMER	
1st Reclose Time	1s RECLOSE DELAY	
2nd Reclose Time	2n RECLOSE DELAY	
3rd Reclose Time	3r RECLOSE DELAY	
4th Reclose Time	4t RECLOSE DELAY	
Reclose Conditions	RECL. CONDITIONS	
Permitted Recloses		
After 51 PT	INIT 79 x 51PT	
After 51 NT	INIT 79 x 51NT	
After 50 PH	INIT 79 x 50PH	
After 50 PL	INIT 79 x 50PL	
After 50 NH	INIT 79 x 50NH	
After 50 NL	INIT 79 x 50NL	
After 46 PT	INIT 79 x 46PT	
After 81 U	INIT 79 x 81U	
After 81 O	INIT 79 x 81O	
After 27 P	INIT 79 x 27P	
After 59 P	INIT 79 x 59P	
After 59 NH	INIT 79 x 59NH	
After 59 NL	INIT 79 x 59NL	
With an Input	INIT 79 x INPUT	
Trips Mask after 1st reclose		
Trip 51PT After reclose	51PT TRIP AFT 79	
Trip 51NT After reclose	51NT TRIP AFT 79	
Trip 50PH After reclose	50PH TRIP AFT 79	
Trip 50PL After reclose	50PL TRIP AFT 79	
Trip 50NH After reclose	50NH TRIP AFT 79	
Trip 50NL After reclose	50NL TRIP AFT 79	
Trip 46PT After reclose	46PT TRIP AFT 79	
Trip 81U After reclose	81U TRIP AFT 79	
Trip 81O After reclose	81O TRIP AFT 79	
Trip 27P After reclose	27P TRIP AFT 79	
Trip 59P After reclose	59P TRIP AFT 79	
Trip 59NH After reclose	59NH TRIP AFT 79	
Trip 59NL After reclose	59NL TRIP AFT 79	

7. INSTALLATION AND MAINTENANCE

7.1. INSTALLATION

The relay should be installed in a clean, dry and dust-free place, with no vibrations. It should also be well-lit to facilitate inspection and testing.

The relay should be mounted on a vertical surface. Figure 1 shows the diagram for panel drilling for panel mounting.

Given that the design of the SMOR unit is based on high performance digital technology it is not necessary to recalibrate the relay. However if the tests show that it is necessary to readjust the relay, it is recommended that the unit should be returned to the manufacturer to have this done.

7.2. CONNECTION TO GROUND AND SUPPRESSION OF DISTURBANCES

A9 and B9 terminals (see figure 7) should be connected to ground so that the disturbance suppression circuits in the system work correctly. This connection should be as short as possible (preferably 25 cm or less) to guarantee maximum protection. In this way the capacitors which are internally connected between the inputs and ground divert high frequency disturbances directly to ground without passing through the electronic circuits, with the result that the circuits are perfectly protected.

In addition this connection also guarantees the physical safety of the personnel who have to touch the relay, since the whole casing is connected to ground.

7.3. MAINTENANCE

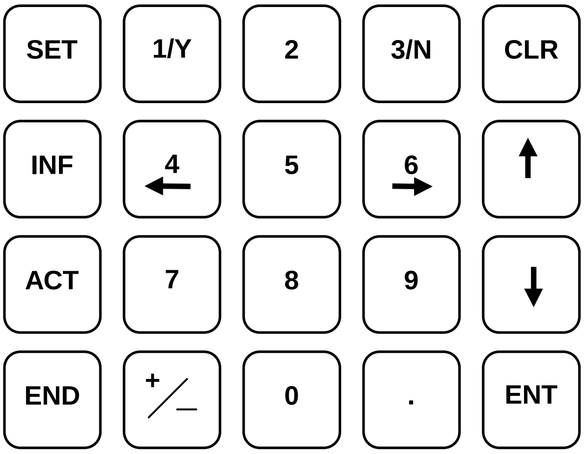
Given the important role that the protection relays play in the operation of any installation, a periodic program of tests is highly recommended. The unit incorporates built-in diagnostic functions which permit immediate identification with only the aid of the keyboard and display, the detection of some of the most likely circuit failures. Testing the unit is recommended at intervals of 2 years or more. Although the built-in diagnosis does not reduce the average time between failures, it does increase the availability of the protection because it allows a drastic reduction in the average interruption time involved in detecting and repairing the fault.

The set of tests which can be carried out to test that all the features of the SMOR unit function properly is described in detail in the chapter entitled ACCEPTANCE TESTS.

Since most of the protection and communications functions are integrated in two separate programs, it is unlikely that faults will occur due to problems of wear or ageing which are typical in electromechanical, analog or hybrid protection systems. Moreover, a failure in the communications processor does not affect the protection functions, which are implemented by a dedicated processor.

8. KEYBOARD AND DISPLAY

The SMOR has a 20 key keyboard and a liquid crystal DISPLAY with 32 characters, divided into two rows of 16 each. The following diagram shows the appearance of the SMOR Keyboard:



The keyboard program uses menus to access the different relay functions. These functions are divided into five large groups, each of which is accessed using a different key. These groups are the following:

Information: Provides data about the status of the relay, alarms, breaker status, record of currents, events record, etc. This menu is accessed using the **INF** key.

Operations: Permits opening and closing of the breaker, blocking and unblocking the recloser, and synchronizing the date and time on the relay. This menu is accessed by pressing the **ACT** key.

Settings: Permits consulting and changing all the relay settings. This menu is accessed by pressing the **SET** key.

Configuration menu: Permits access to the system configuration and the modification of the passwords, access, communication speeds, etc. This menu is accessed by keying in the code "**7169**" In order to access this mode the relay should be on the main screen.

Single key menu: By pressing the **ENT** key the SMOR can be operated in a simplified mode. It is not necessary to remove the methacrylate cover on the front of the relay to access this mode.

When at rest the SMOR shows the following message on the DISPLAY:

SMOR **GENERAL ELECTRIC**

This is the point from which the five groups mentioned above can be selected. In order to select a different group you must return to this screen and press the key which corresponds to that group.

Once inside a group it is not possible to select a different one. Movement inside a group is carried out using the following keys : **ENT, CLR,** and the **up, down, left, right arrows.** Their function is as follows :

ENT: Accepts the option that is shown on the screen at that moment. The equivalent of going down one level in the menu tree.

CLR: Abandons the option that is shown on the screen at that moment. The equivalent of going up one level in the menu tree.

UP / DOWN ARROW: Change options. The equivalent of a horizontal movement within a menu. When the required option appears on the screen it can be selected with the **ENT** key.

LEFT / RIGHT ARROWS: Show the different possibilities of a given setting. It is not used for all settings. When the required option appears on the screen it can be selected with the **ENT** key.

8.1. MENU TREE.

The SMOR has different menus, divided into levels. Level 0 is the initial screen. Level 1 of the menus is accessed by pressing the corresponding group key (SET, INF, etc). Moving within a given level is done by using the UP and DOWN arrows. It is possible to go down to levels 2 and 3 by pressing the **ENT** key. Press **CLR** to go up a level within the menu tree. Level 1 for each of the five groups is shown in the following table:

Group	Level 1	Description
SET	• VIEW SETTINGS • MODIFY SETTINGS • MODIFY COUNTERS	• View settings • Change settings • Change counters
INF	• STATUS	• Show the status of the relay
ACT	• SET DATE/TIME • BLOCK RECLOSER • UNBLOCK RECLOSER • COMM. TRIGGER • RESET I MAXIMETER • RESET POT MAXIMETER • OPEN BREAKER • CLOSE BREAKER	• Change date and time on the relay • Block the recloser • Unblock the recloser • Trigger oscillography by communication • Reset current (I) maximeter • Reset power maximeter • Open the breaker • Close the breaker
ENT	• I2 • Ia • In • Vab • P • COS PHI • FREQUENCY • TRIPS IN 1 HOUR • I. MAXIMETER • I2t A COUNTER • I2t B COUNTER • I^2t C COUNTER • Nº OPENINGS • Nº RECLOSURES • POT. MAXIMETER	• Show negative sequence current in Amps referred to primary • Show phase A current in Amps referred to the primary. • Show ground current in Amps referred to the primary • Show voltage between phases AB in kV referred to the primary • Show Active Power in MW • Show Power factor • Show frequency in Hz • Show the number of trips in the last hour • Show current (I) maximeter • Show the accumulated Amps counter for phase A • Show the accumulated Amps counter for phase B • Show the accumulated Amps counter for phase C • Show the number of opening operations carried out • Show the number of reclosing cycles carried out • Show power demand meter

Group	Level 1	Description
ENT	• 79 STATUS • PROTEC. STATUS • ACTIVE TABLE • STATUS 52 • DIRECTION A • DIRECTION B • DIRECTION C • DIRECTION N • DATE & TIME • KEEP PRESSED BLOCK RECLOSER • KEEP PRESSED UNBLOCK RECLOSER	• Show the recloser status • Show the status of the protection system (in / out of service) • Show the active settings table # • Show the breaker status • Show the status (permission / block) of the directional unit for Phase A • Show the status (permission / block) of the directional unit for Phase B • Show the status (permission / block) of the directional unit for Phase C • Show the status (permission / block) of the directional unit for Ground. • Shows date and time of unit • Keeping ENT key pressed down blocks the recloser • Keeping ENT key pressed down unblocks the recloser
Configuration unit **7169**	• NET. BAUDRATE • NET. STOP BITS • LOC. BAUDRATE • LOC. STOP BITS • LOCAL SETTINGS • REM SETTINGS • LOC. OPERATION • REM OPERATIONS • UNIT NUMBER • PASSWORD • t TIMEOUT	• Communication baud rate on remote network communications • Stop bits, remote network communications • Baud rate of local communication • Stop bits, local communications • Local settings changes allowed/not allowed • Remote settings changes allowed/not allowed • Local operations allowed/not allowed • Remote operations allowed/not allowed • Shows the unit number of the relay • Allows modification of relay password • Communication failure time

.2. SETTINGS GROUP

This group allows the visualization and modification of the SMOR settings. It is accessed by pressing the **SET** key when the SMOR is in the initial screen. When the **SET** key is pressed the following message appears on the screen:

VIEW PROTECTION SETTINGS

When the UP/DOWN arrows are pressed the message changes to:

MODIFY PROTECTION SETTINGS

The menu tree for the SMOR settings is shown in the following table. Note that to go down a level in the tree you have to press the **ENT** key and that to go up you have to press the **CLR** key.

Level 1	Level 2	Level 3	Valid range
• **VIEW PROTECTION SETTINGS** • **MODIFY PROTECTION SETTINGS**	• **GENERAL SETTINGS**	RELAY STATUS	In / Out of service
		IDENTIFICAT:	20 character alphanumeric string
		FREQUENCY NOMINAL VOLTAGE PHASE CT RATIO GROUND CT RATIO LINE VT RATIO BUS VT RATIO DEMAND TIME PHASE ROTATION	50/60 Hz 90-220 v 1-4000 in steps of 1 1-4000 in steps of 1 1-4000 in steps of 1 1-4000 in steps of 1 15-30-60 min ABC - CBA
	• **BREAKER SETTINGS**	BREAKER NUM t FAIL TO OPEN t FAIL TO CLOSE KI^2t LIMIT KI^2t OP MODE	4 character alphanumeric string 0.05 - 1 in steps of 0.01 0.05 - 1 in steps of 0.01 1 - 999.999 kA^2s in steps of 1 MEASURED - FIXED
		KI^2t INT. TIME MAX TRIPS 1h	0.03 - 0.25 s in steps of 0.01 1 - 50 in steps of 1
	• **ACTIVE TABLE SET**	ACTIVE TABLE CLP PERMISSION t CHANGE TABLE t RETURN TABLE	1-3 Permitted - Not permitted 0 - 240 s in steps of 1s. 0 - 1800 s in steps of 1 s.
	• **OSCILLOS MASK**	PREFAULT CYCLES 51PT PICK-UP 51NT PICK-UP 50PH PICK-UP 50PL PICK-UP	2 - 10 Enabled/Dis. Enabled/Dis. Enabled/Dis. Enabled/Dis.

Level 1	Level 2	Level 3	Valid range
		50NH PICK-UP	Enabled/Dis.
		50NL PICK-UP	Enabled/Dis.
		46PT PICK-UP	Enabled/Dis.
		81U PICK-UP	Enabled/Dis.
		81O PICK-UP	Enabled/Dis.
		27P PICK-UP	Enabled/Dis.
		59P PICK-UP	Enabled/Dis.
		59NH PICK-UP	Enabled/Dis.
		59NL PICK-UP	Enabled/Dis.
		EXTERNAL TRIGGER	Enabled/Dis.
		COMM. TRIGGER	Enabled/Dis.
		51PT TRIP	Enabled/Dis.
		51NT TRIP	Enabled/Dis.
		50PH TRIP	Enabled/Dis.
		50PL TRIP	Enabled/Dis.
		50NH TRIP	Enabled/Dis.
		50NL TRIP	Enabled/Dis.
		46PT TRIP	Enabled/Dis.
		81U TRIP	Enabled/Dis.
		81O TRIP	Enabled/Dis.
		27P TRIP	Enabled/Dis.
		59P TRIP	Enabled/Dis.
		59NH TRIP	Enabled/Dis.
		59NL TRIP	Enabled/Dis.
	• **FUNCTION PERMIT**	51PT FUNCTION	Permitted-Not P.
		51NT FUNCTION	Permitted-Not P.
		50PH FUNCTION	Permitted-Not P.
		50PL FUNCTION	Permitted-Not P.
		50NH FUNCTION	Permitted-Not P.
		50NL FUNCTION	Permitted-Not P.
		46PT FUNCTION	Permitted-Not P.
		81U FUNCTION	Permitted-Not P.
		81O FUNCTION	Permitted-Not P.
		27P FUNCTION	Permitted-Not P.
		59P FUNCTION	Permitted-Not P.
		59NH FUNCTION	Permitted-Not P.
		59NL FUNCTION	Permitted-Not P.
		51PT TRIP	Permitted-Not P.
		51NT TRIP	Permitted-Not P.
		50PH TRIP	Permitted-Not P.
		50PL TRIP	Permitted-Not P.
		50NH TRIP	Enabled - Disabled
		50NL TRIP	Enabled - Disabled
		46PT TRIP	Enabled - Disabled
		81U TRIP	Enabled - Disabled
		81O TRIP	Enabled - Disabled
		27P TRIP	Enabled - Disabled
		59P TRIP	Enabled - Disabled
		59NH TRIP	Enabled - Disabled
		59NL TRIP	Enabled - Disabled
	51PT FUNCTION TX	51/67P PICKUP	1 - 12 A in steps of 0.01.
		CURVE	Inverse - Very inv.- Extrem. inv. - Definite t
		TIME DIAL	0.05 - 1.00 s in steps of 0.01.

Level 1	Level 2	Level 3	Valid range
		DEFINITE TIME t	0.00 - 100.00 s in steps of 0.01.
	51NT FUNCTION TX	51/67P PICKUP CURVE TIME DIAL DEFINITE TIME t	0.2 - 2.4 A in steps of 0.01. Inverse - Very inv.- Extrem. inv. - Definite t 0.05 - 1.00 s in steps of 0.01. 0.00 - 100.00 s in steps of 0.01.
	50PH FUNCTION TX	50/67P PICKUP TIME DELAY	1 - 160 A in steps of 0.01. 0.00 - 60 s in steps of 0.01.
	50PL FUNCTION TX	50/67P PICKUP TIME DELAY	1 - 160 A in steps of 0.01. 0.00 - 60 s in steps of 0.01.
	50NH FUNCTION TX	50/67N PICKUP TIME DELAY	0.2 - 32 A in steps of 0.01. 0.00 - 60 s in steps of 0.01.
	50NL FUNCTION TX	50/67N PICKUP TIME DELAY	0.2 - 32 A in steps of 0.01. 0.00 - 60 s in steps of 0.01.
	46PT FUNCTION TX	• 46PT PICKUP • CURVE • TIME DIAL • DEFINITE TIME t	• 0.1 - 4 A in steps of 0.01. • Inverse - Very Inv.- Extrem. inv. - definite t • 0.05 - 1.00 s in steps of 0.01. • 0.00 - 100.00 s in steps of 0.01.
	81 FUNCTION TX	• 81U PICKUP • TIME DELAY U • 81O PICKUP • TIME DELAY O • INHIBIT V	• 40 - 70 Hz in steps of 0.01. • 0.00 - 100.00 s in steps of 0.01. • 40 - 70 Hz in steps of 0.01. • 0.00 - 100.00 s in steps of 0.01. • 35 - 110 % in steps of 1%
	27/59 FUNCTION TX	• 27P PICKUP • TIME DELAY 27P • 59P PICKUP • TIME DELAY 59P • 59NH PICKUP • TIME DELAY 59NL	• 10 - 260 V in steps of 1. • 0.03 - 100.00 s in steps of 0.01. • 10 - 260 V in steps of 1. • 0.03 - 100.00 s in steps of 0.01. • 3 - 100 V in steps of 1. • 0.03 - 100.00 s in steps of 0.01.

Level 1	Level 2	Level 3	Valid range
		• 59NL PICKUP • TIME DELAY 59NH	• 3 - 100 V in steps of 1. • 0.03 - 100.00 s in steps of 0.01.
	DIRECTIONAL SET. TX	• 51PT DIRECTIONAL • 51NT DIRECTIONAL • 50PH DIRECTIONAL • 50PL DIRECTIONAL • 50NH DIRECTIONAL • 50NL DIRECTIONAL • PHASE ANGLE • GROUND ANGLE • V LOSS LOGIC	• Permitted - Not permitted • Permitted - Not permitted • Permitted - Not permitted • Permitted - Not permitted • Permitted - Not permitted • Permitted - Not permitted • -90º - +90º in steps of 1º • -90º - +90º in steps of 1º • Permission - Block
	• **RECLOSER TX**	• 79 STATUS • NUMBER OF CYCLES • RESET TIME • HOLD MODE • HOLD TIMER • 1s RECLOSE DELAY • 2n RECLOSE DELAY • 3r RECLOSE DELAY • 4t RECLOSE DELAY • RECL. CONDITIONS • INIT 79x 51PT • INIT 79x 51NT • INIT 79x 50PH • INIT 79x 50PL • INIT 79x 50NH • INIT 79x 50NL	• Permitted - Not permitted • 1 - 4 • 0 - 600 s in steps of 1. • Yes - No • 0 - 100 s in steps of 1. • 0.10 - 100 s in steps of 0.01. • 0.10 - 100 s in steps of 0.01. • 0.10 - 100 s in steps of 0.01. • 0.10 - 100 s in steps of 0.01. • NONE - INH INP - VB ONLY - VB - VB & VL • Enabled - Disabled • Enabled - Disabled • Enabled - Disabled • Enabled - Disabled • Enabled - Disabled • Enabled - Disabled

Level 1	Level 2	Level 3	Valid range
		• INIT 79x 46PT • INIT 79x 81U • INIT 79x 81O • INIT 79x 27P • INIT 79x 59P • INIT 79x 59NH • INIT 79x 59NL • INIT 79x INPUT • 51PT TRIP AFT 79 • 51NT TRIP AFT 79 • 50PH TRIP AFT 79 • 50PL TRIP AFT 79 • 50NH TRIP AFT 79 • 50NL TRIP AFT 79 • 46PT TRIP AFT 79 • 81U TRIP AFT 79 • 81O TRIP AFT 79 • 27P TRIP AFT 79 • 59P TRIP AFT 79 • 59NH TRIP AFT 79 • 59NL TRIP AFT 79	• Enabled - Disabled • Enabled - Disabled
• **MODIFY COUNTERS PROTECTION**	• **I2t A COUNTER** • **I2t B COUNTER** • **I2t C COUNTER** • **N° OPENINGS** • **N° RECLOSURES**		

The SMOR has a group of settings which are common to all the tables and others which are specific to each settings table. In the table above TX means T1 or T2 or T3. The user can input different values for different tables.

The common settings are:

- GENERAL SETTINGS
- BREAKER SETTINGS
- ACTIVE TABLE SET
- OSCILLOS MASK
- FUNCTION PERMIT

The rest of the settings groups apply to each table independently. There are groups for each table, for example, RECLOSER T1, T2, T3, which are recloser settings for each of the possible tables.

The steps to be taken in order to change any setting are as follows:

1. Press the SET key.
2. Select the option MODIFY SETTINGS.
3. Select the required setting in the menu trees.
4. ENTER the value to be modified (or select the required value from the list of available settings using LEFT/RIGHT ARROW keys).
5. Press the **ENT** key. To repeat the setting for a setting in the same group repeat steps 3 to 5.
6. Press the **END** key.
7. The relay will request confirmation of the change by means of the following message:

CONFIRM? **Y/N**

8. If you want to confirm this change press the **1/Y** key. (If not, press **3/N**).
9. The relay will then show the following message on the screen:

SETTINGS CHANGE **EXECUTED**

10. Press the **CLR** key repeatedly in order to return to the initial screen.

If the setting entered is outside the limits of the range allowed for that setting, the relay will not accept the change and will show the following message:

SETTING **OUT OF RANGE**

Some settings do not require you to key in a numeric value, but to choose an option from a series of possibilities. In this case the options can be viewed using the LEFT/RIGHT ARROW keys.

Example : Configure the DEMAND TIME as 15 minutes.

To make this change we will start from the rest screen and take the following steps:

Pressed key	Screen status	Notes
	SMOR GENERAL ELECTRIC	Start from the rest screen.
SET	**VIEW PROTECTION SETTINGS**	Enter level 1
↑	**MODIFY PROTECTION SETTINGS**	Move through options in level 1
ENT	**GENERAL SETTINGS**	Enter level 2
ENT	**RELAY STATUS IN SERV ----------**	Enter level 3. IN SERV is the factory setting for RELAY STATUS. The actual value is on the left and the new value is on the right.
↓	**PHASE ROTATION ABC -------------**	Move through options in level 3.
↓	**DEMAND TIME 60 -------------**	Look for the required setting
←	**DEMAND TIME 60 30_**	Move through options in level 3.
←	**DEMAND TIME 60 15_**	The required entry is found
ENT	**DEMAND TIME 60 15**	Accept entry 15
END	**CONFIRM? (Y/N)**	Ask for confirmation.
Y	**SETTINGS CHANGE EXECUTED**	Change done
CLR	**RELAY STATUS IN SERV -------**	Return to settings list
CLR	**GENERAL SETTINGS**	Go up to level 2
CLR	**MODIFY PROTECTION SETTINGS**	Go up to level 1
CLR	**SMOR GENERAL ELECTRIC**	Reset status

8.3. INFORMATION GROUP.

This group provides information about the status of the SMOR. Press the INF key in the main menu to access this group. The information group consists of the following sub-groups:

- **Status**

Press the INF key to access this subgroup in the same way as in the operation in the settings group. This takes us to level 1 in the menus. When this sub-group has been selected (in this case it is the only option) we press the **ENT** key to see the contents (down to level 3). In this level we can move through the contents by using the UP/DOWN arrows. Press the **CLR** key repeatedly to leave the information group and return to the stand-by screen.

SMOR
GENERAL ELECTRIC

INF

STATUS

Status.

The SMOR allows you to view the status of certain internal values of the relay. From the status menu we press the **ENT** key. By pressing the **UP arrow** key we can move through the status menu and obtain the following information :

Screen	Possible values
MODEL SMOR11C11D111H00B	Vary according to model
DATA BASE SMOR0010	Vary according to model
PROT VERSION 2.0126:03:97	Vary according to model
COMM. VERSION 2.4425:04:97	Vary according to model
I2	
Ia	
Ib	
Ic	
In	
Vab	
Vbc	
Vca	
Vn	
P	
Q	
COS PHI	
FREQUENCY	
TRIP IN 1 HOUR	
I. MAXIMETER	
I2t A COUNTER	
I2t B COUNTER	
I2t C COUNTER	
Nº OPENINGS	
Nº RECLOSURES	
POT MAXIMETER	
51PT PICKUP	YES - NO
51NT PICKUP	YES - NO
50PH PICKUP	YES - NO
50PL PICKUP	YES - NO
50NH PICKUP	YES - NO
50NL PICKUP	YES - NO
46P PICKUP	YES - NO
81U PICKUP	YES - NO
81O PICKUP	YES - NO
27P PICKUP	YES - NO
59P PICKUP	YES - NO

Screen	Possible values
59NH PICKUP	YES - NO
59NL PICKUP	YES - NO
79 STATUS	IN /OUT OF SERVICE
PROTEC. STATUS	IN / OUT OF SERVICE
ACTIVE TABLE	1:TABLE 1: 2:TABLE 2 3:TABLE 3
STATUS 52	OPEN - CLOSE
DIRECTION A	PERMISSION - BLOCK
DIRECTION B	PERMISSION - BLOCK
DIRECTION C	PERMISSION - BLOCK
DIRECTION G	PERMISSION - BLOCK
REM CONNECTION	IN / OUT OF SERVICE
LOCAL CONNECTION	IN / OUT OF SERVICE
DATE / TIME STATUS	CORRECT
E2PROM COMM	CORRECT
COMM SETTINGS	USER - DEFAULT
PROTECTION LINK	YES - NO
DATE & TIME	(SHOWS DATE & TIME)

8.4. OPERATIONS GROUP.

This group allows you to operate the breaker from the keyboard, and also to block or unblock the recloser and to synchronize the time on the unit. To access this group, press the **ACT** key when the SMOR is in the stand-by screen. This takes you to the operations menu and shows the first item on the menu:

SET
DATE/TIME

This shows that the first item on the operations menu is the function for entering the date and time for the relay. When the **UP/DOWN ARROW** keys are pressed the rest of the items on the operations menu appear. After locating the required operation use the **ENT** key to select it.

To avoid carrying out operations by mistake the keyboard program requires confirmation of the operation selected. To confirm, press the **1/Y** key and then **ENT.** To abort the operation press the **3/N** key and then **ENT.** Pressing **CLR** is the equivalent of pressing the **3/N** key and then **ENT**, aborting the operation.

If the command is confirmed the result of the operation appears on the screen. With either ENT or CLR you can accept this message and return to the operations menu.

By way of example, this would be the process for opening the breaker starting from the operations menu;

OPEN BREAKER | **ENT** | **CONFIRM? (Y/N)** | **1/Y** | **PERFORMED**

If the breaker had not opened the result of the operation shown on the screen would have been "NOT PERFORMED".

The SMOR can perform the following operations:

- Set date/time
- Block recloser
- Unblock recloser
- Oscillography triggering
- Reset current maximeter

- Reset power maximeter
- Open Breaker
- Close Breaker

Note that the command UNBLOCK RECLOSER only unblocks the recloser if it was blocked due to a previous block command, not due to other causes that block the recloser (system conditions, settings, inputs, etc.)

8.5. SINGLE KEY OPERATION

The SMOR has a simplified operation mode which can be used by pressing the **ENT** key. This mode allows access to certain information about the relay without the need to remove the external methacrylate cover. Operation is by pressing the **ENT** key repeatedly. This mode can only be accessed from the stand-by screen. The information available in this mode is shown in order in the following table:

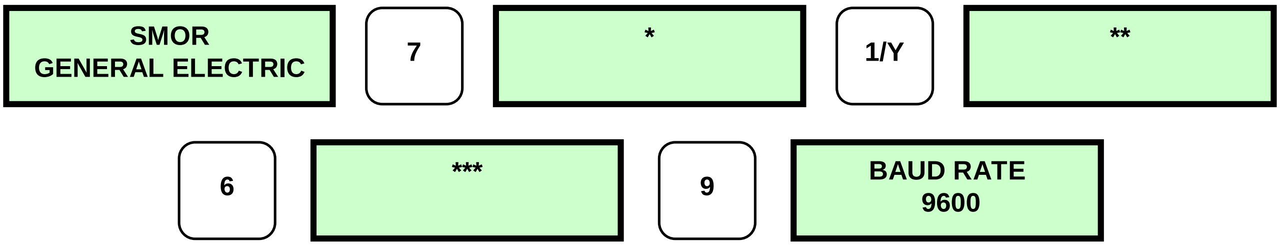
Magnitude
I2
Ia
In
Vab
P
COS PHI
FREQUENCY
TRIPS IN 1 HOUR
I. MAXIMETER
I2t A COUNTER
I2t B COUNTER
I2t C COUNTER
N° OPENINGS
N° RECLOSURES
POT. MAXIMETER
STATUS 79
PROTEC. STATUS
ACTIVE TABLE
STATUS 52
DIRECTION A
DIRECTION B
DIRECTION C
DIRECTION N
DATE & TIME
KEEP PRESSED BLOCK RECLOSER
KEEP PRESSED UNBLOCK RECLOSER

8.6. CONFIGURATION MENU.

The SMOR has a configuration menu which can only be accessed by means of the keyboard. The aim is to select the way in which the SMOR interacts with the exterior.

To enter the configuration menu, start from the stand-by screen and use the keyboard to enter a four figure code. If the code is correct, entry to the configuration unit is permitted. If not it returns to the stand-by screen.

The code is unique for all the SMOR relays and is not intended to be a password, but rather a simple safety measure to avoid accidental changes to the configuration. This code is **7169**, chosen to coincide with the ASCII code for the initials GE. This is how to enter the configuration unit from the stand-by screen:



The value and meaning of the settings are explained below. Note that movement between the options in this group is with the right/left arrow keys.

- **NET. BAUDRATE :** The speed in bauds which the SMOR will use for serial communications through the remote port. The possible speeds are between 1200 and 19200 bauds.
- **NET.STOP BITS :** The number of stop bits which are added to each byte which is transmitted on the serial line. It is treated as a binary logic setting selected by means of the logic key **1/Y** for 1 and **3/N** for 2.
- **LOC. BAUDRATE :** as above but for local communications.
- **LOC. STOP BITS :** As above but for local communications.
- **LOCAL SETTINGS :** Settings changes by local communications (allowed/not allowed).
- **REM SETTINGS :** Settings changes by remote communications (allowed/not allowed).
- **LOC OPERATIONS :** Operations being performed by local communications (computer directly connected) (allowed/not allowed).
- **REM OPERATIONS :** Operations being performed by remote communications (e.g. modem) (allowed/not allowed).
- **UNIT NUMBER :** Each SMOR is identified by a unit number which it uses to identify the messages which are sent to it on the remote communications line. This number can be between 1 and 255.
- **PASSWORD :** To prevent unauthorized persons from communicating with the relay via a communications program and changing the settings or performing operations, the relay has a password. This password can only be seen on the relay display and takes the form of a number between 0 and 99999.
- **t TIME-OUT :** Set to 0 if the relay is not working in a DDS integrated system. Set to the maximum time between two synch signals coming from the PC host, when the relay is working in a DDS integrated system. If a new synch signal is not received in this time the relay will report an error.

FIGURES

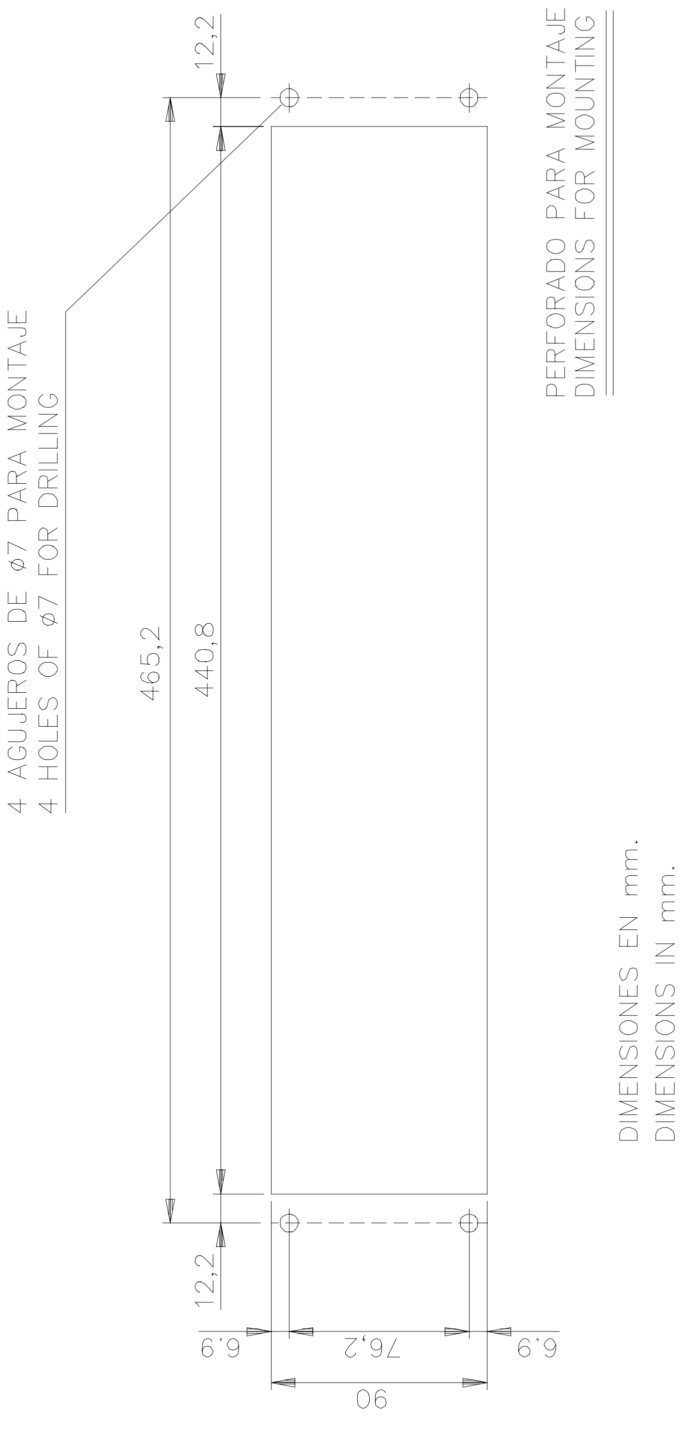


FIGURE 1. PANEL DRILLING DIMENSIONS FOR 19'' RACK MODELS (226B6086H10).

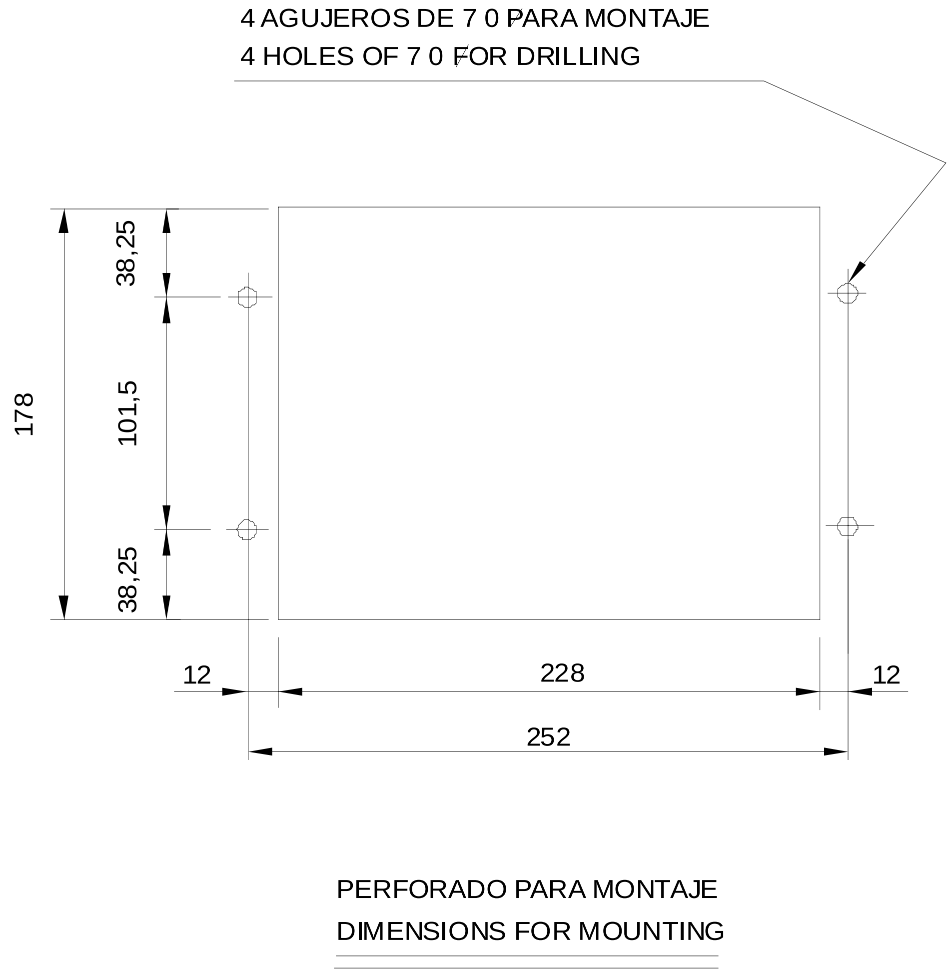


FIGURE 2. PANEL DRILLING DIMENSIONS FOR 1/2 RACK MODELS

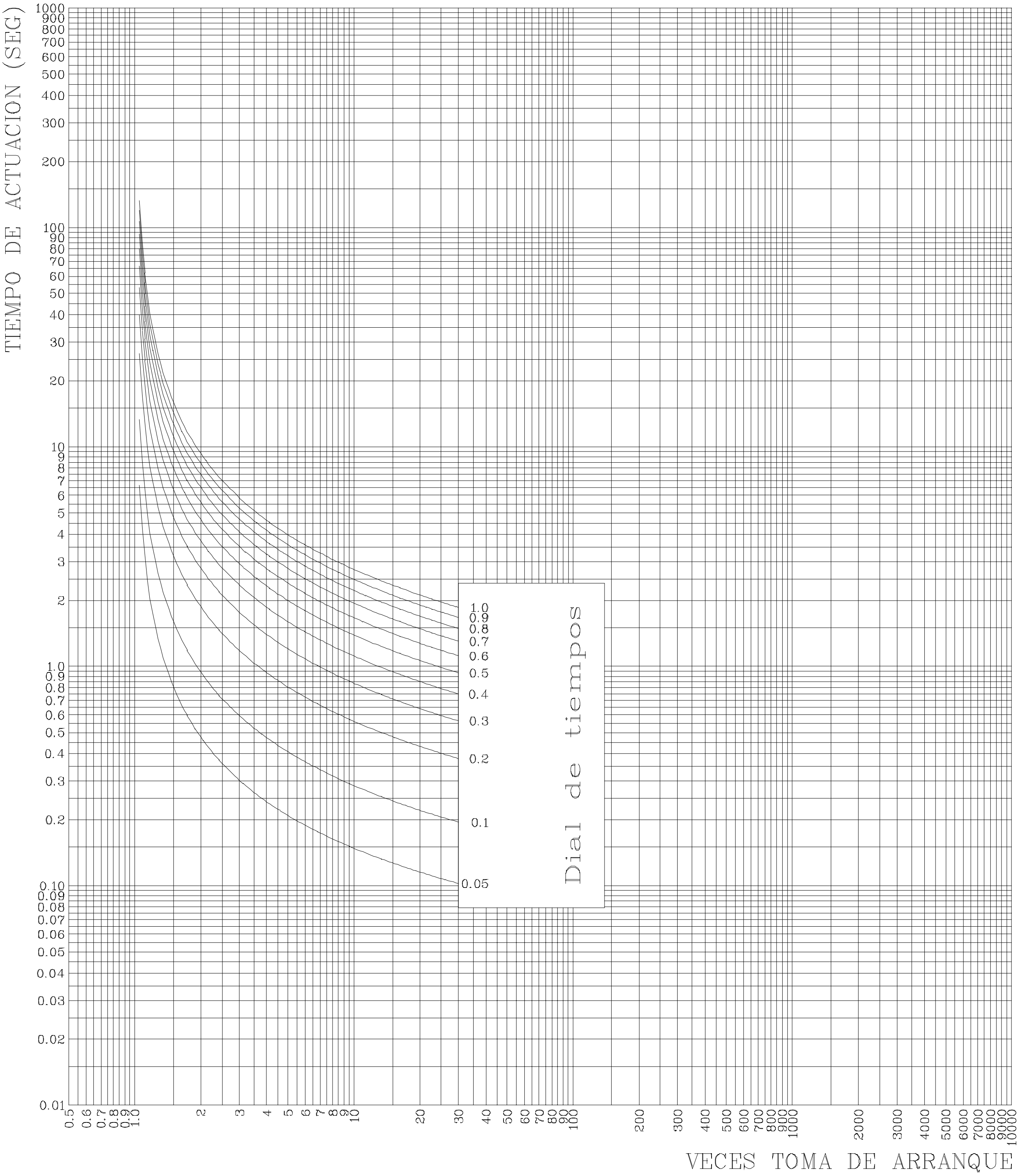


FIGURE 3. INVERSE CHARACTERISTIC OPERATING CURVE (226B7414H1).

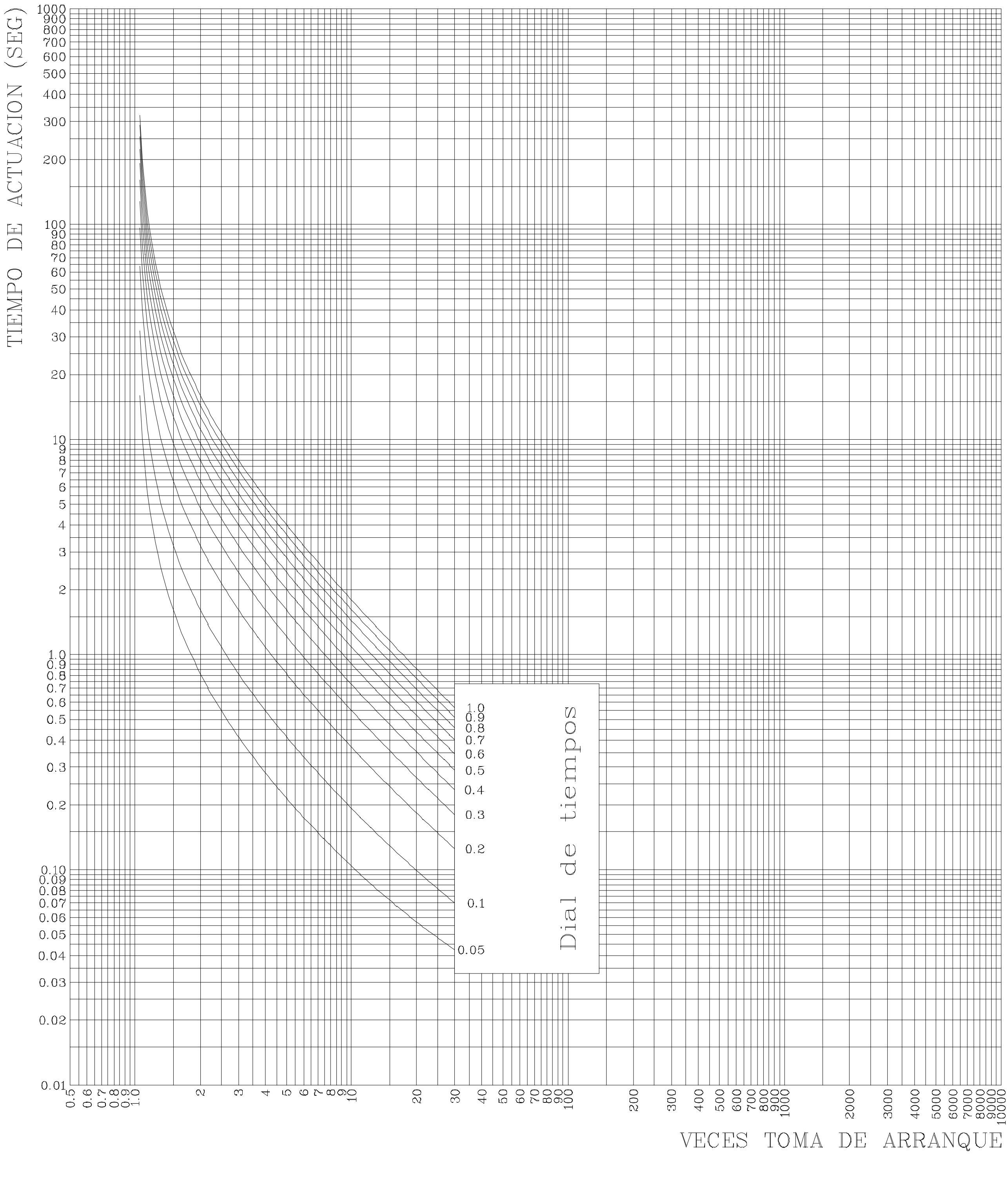


FIGURE 4. VERY INVERSE CHARACTERISTIC OPERATING CURVE (226B7414H2).

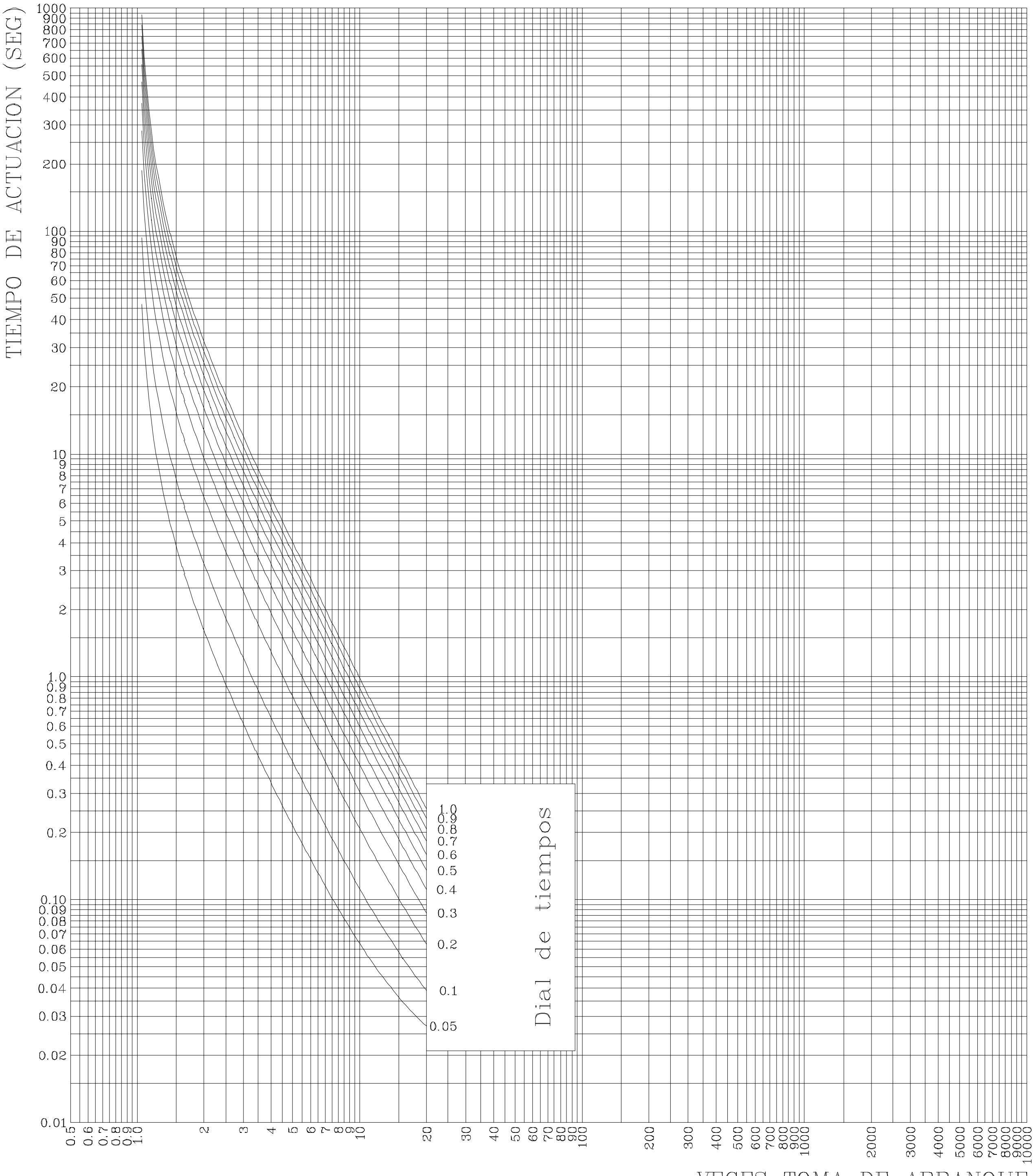
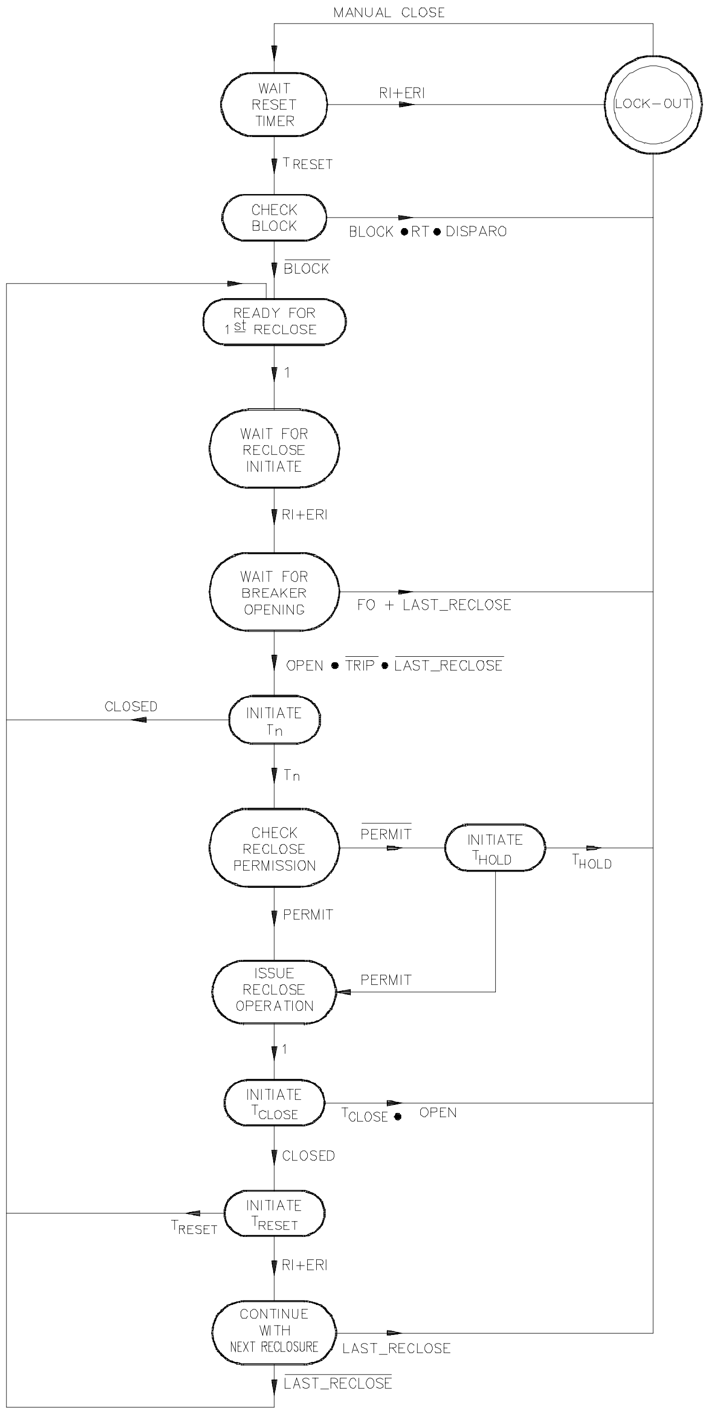


FIGURE 5. EXTREMELY INVERSE CHARACTERISTIC OPERATING CURVE (226B7414H3).



TIMERS

T_{RESET} Reset timer
T_n Time of n reclose
T_{HOLD} Hold timer
T_{CLOSE} Failure timer (after close)

SIGNALS

RI Reclose initiate
FO Failure to open
OPEN Open breaker
CLOSED Closed breaker
PERMIT Reclosing conditions fulfilled

STATUS

LOCK–OUT End of reclosing cycle

SETTINGS

RT Reclose over trip
Reclose permitted after tripping

DIGITAL INPUTS

ERI External reclose/initiate

FIGURE 6. RECLOSER PROGRAM FLOWCHART (226B2200H1)

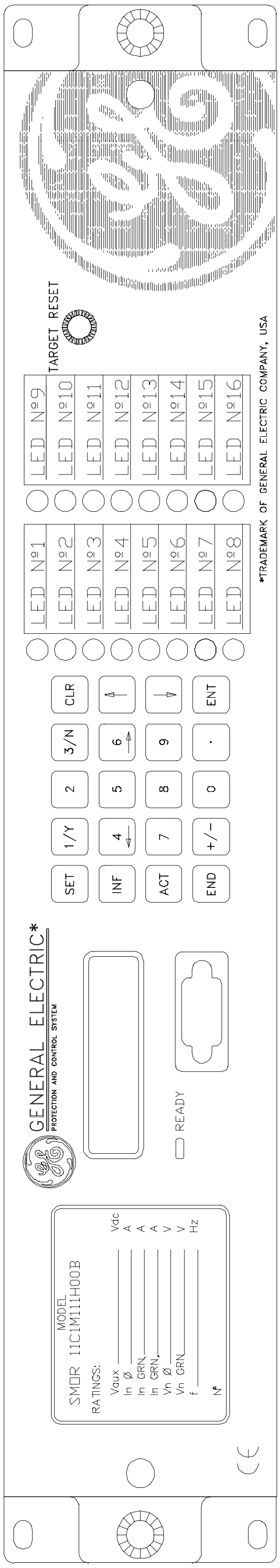


FIGURE 7. FRONT VIEW FOR 19'' RACK MODELS (226B7412H9)

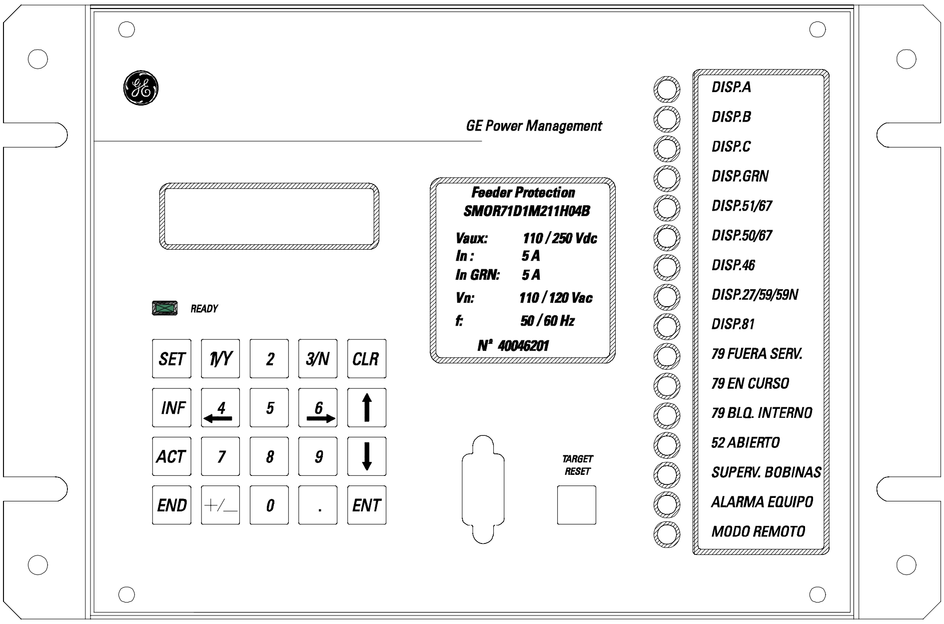


FIGURE 8. FRONT VIEW FOR 1/2 RACK MODELS

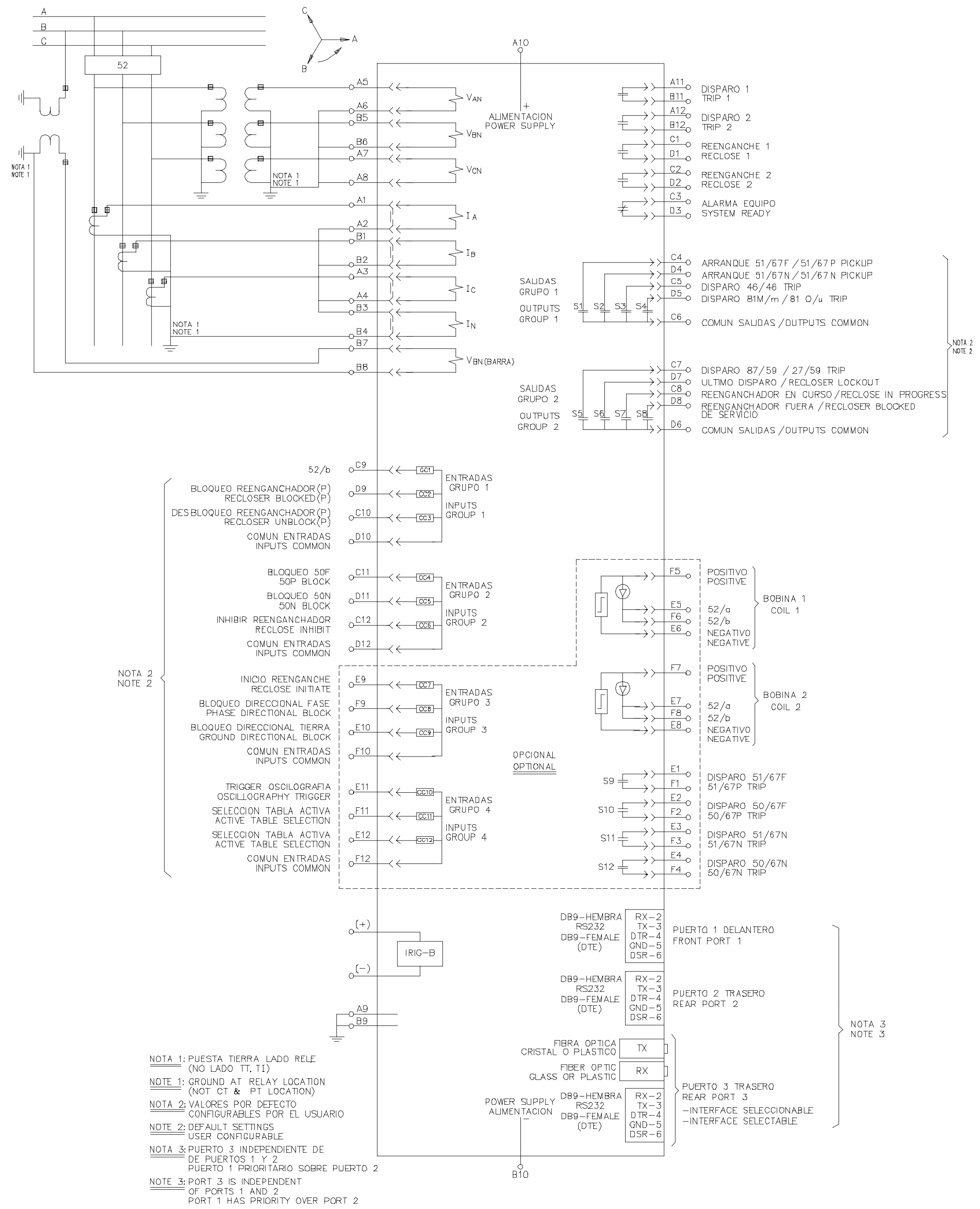


FIGURE 9. EXTERNAL CONNECTIONS FOR 19’’ MODELS (189C4101H1)

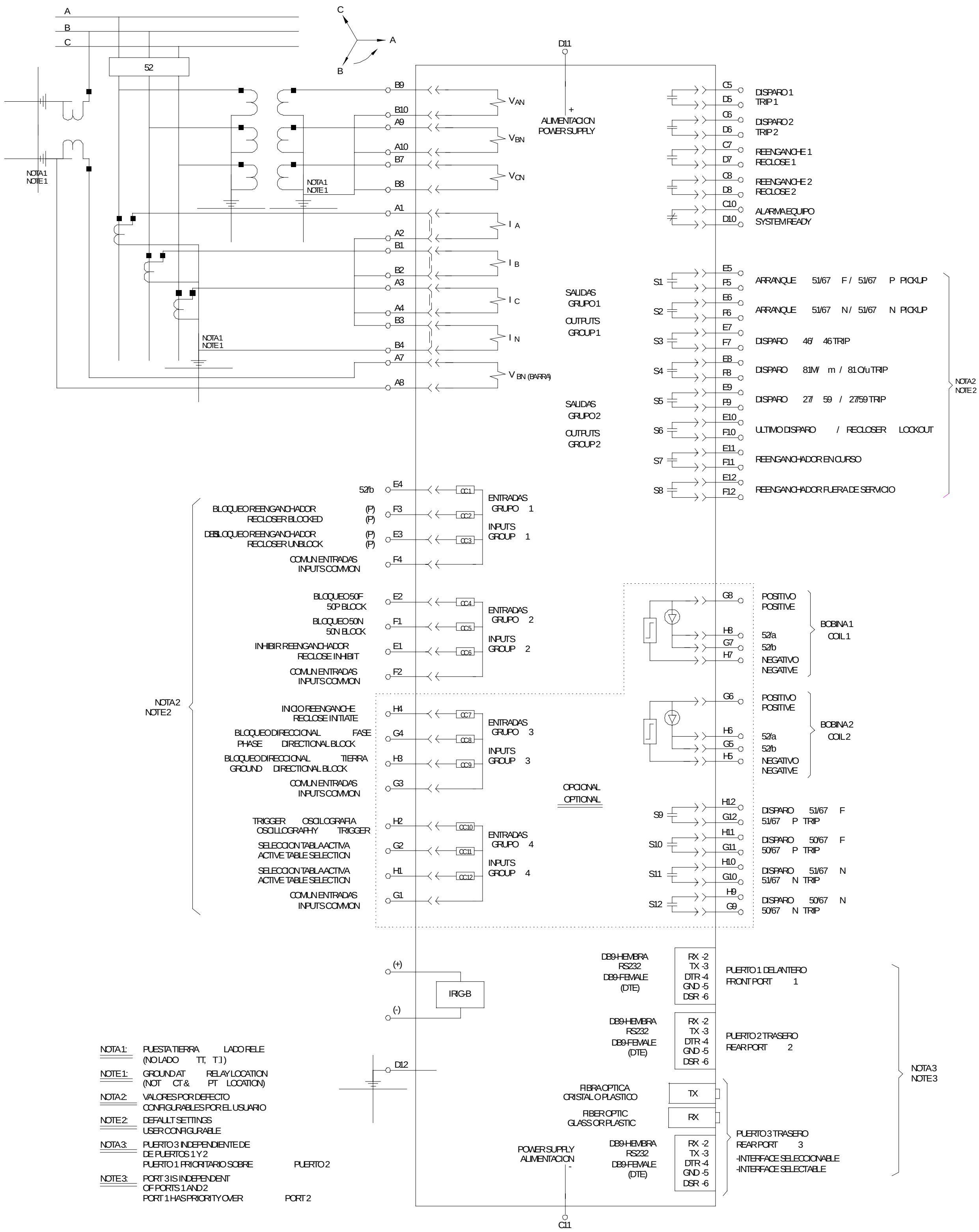


FIGURE 10. EXTERNAL CONNECTIONS FOR ½ RACK MODELS

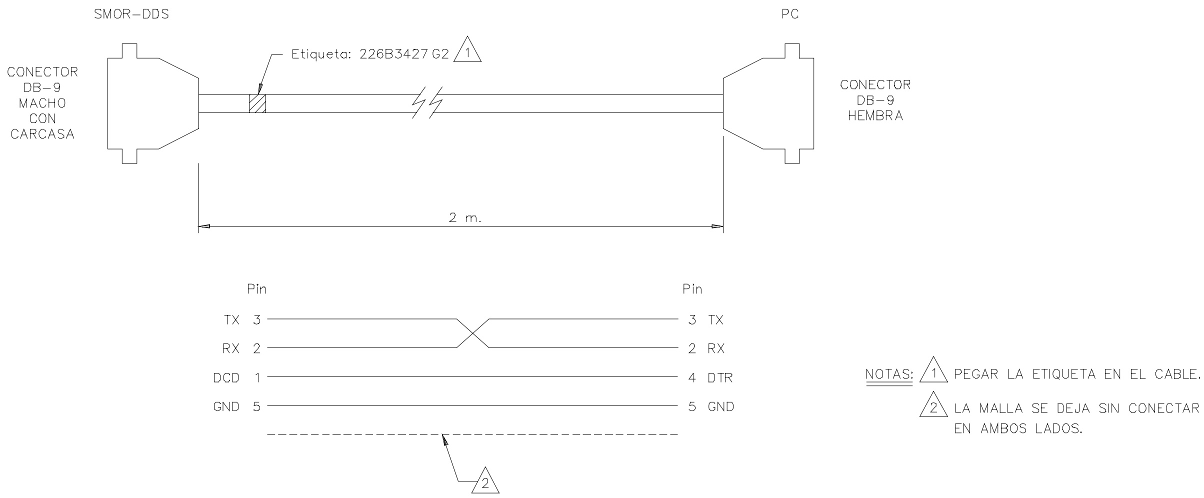


FIGURE 11. RS232 CONNECTION (SMOR-B WITH PC)

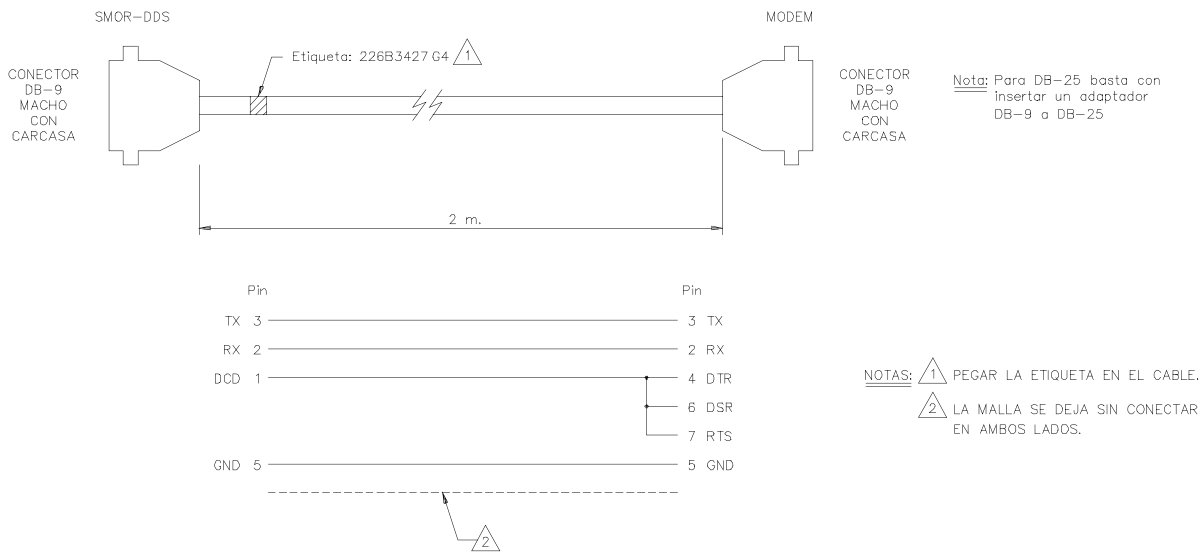


FIGURE 12. RS232 CONNECTION (SMOR-B WITH MODEM)

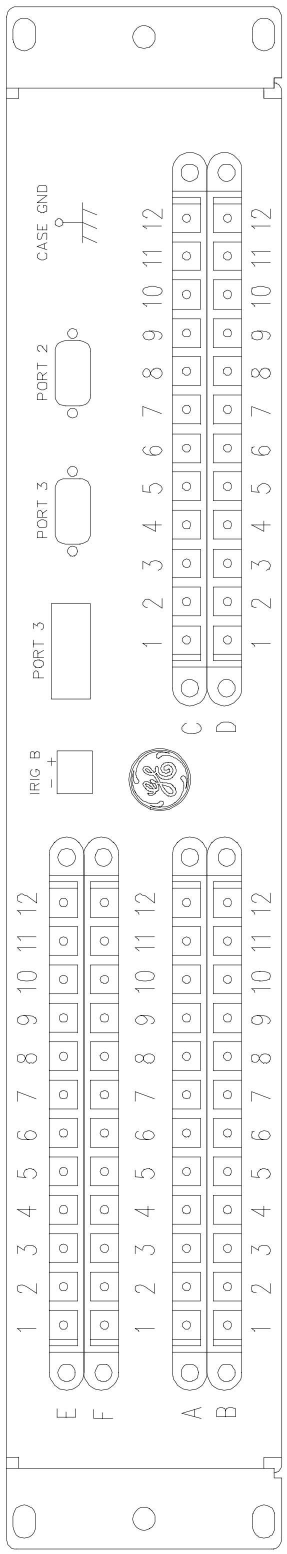


FIGURE 13. REAR VIEW FOR 19'' MODELS (226B7412H10)

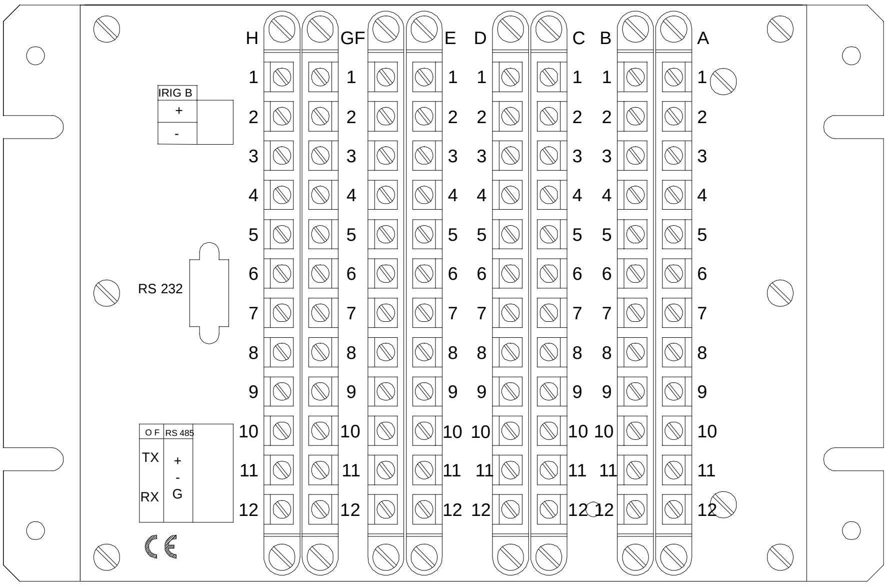


FIGURE 14. REAR VIEW FOR ½ RACK MODELS

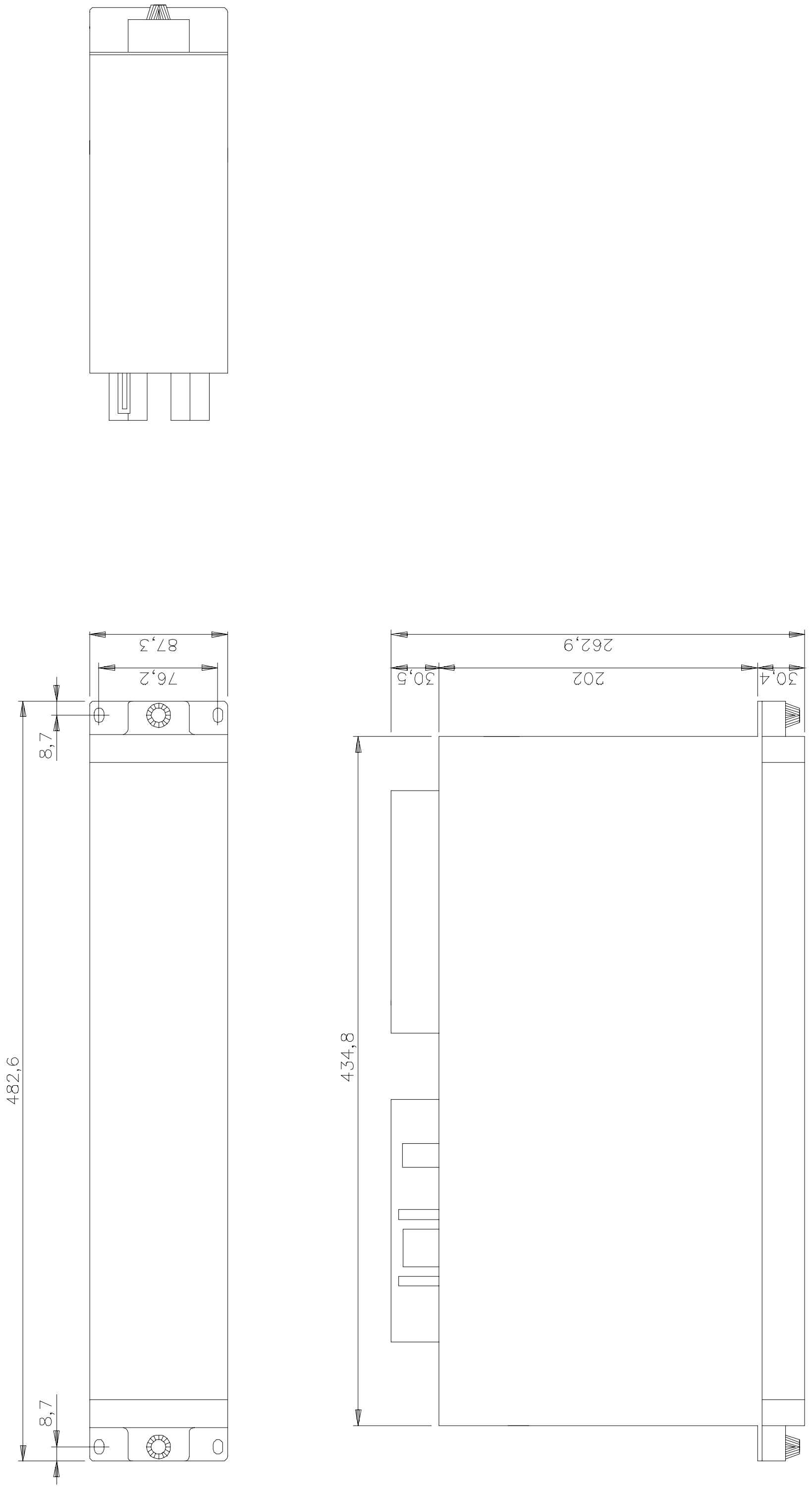


FIGURE 15. DIMENSIONS DIAGRAM FOR 19’’ MODELS (226B6086H10)

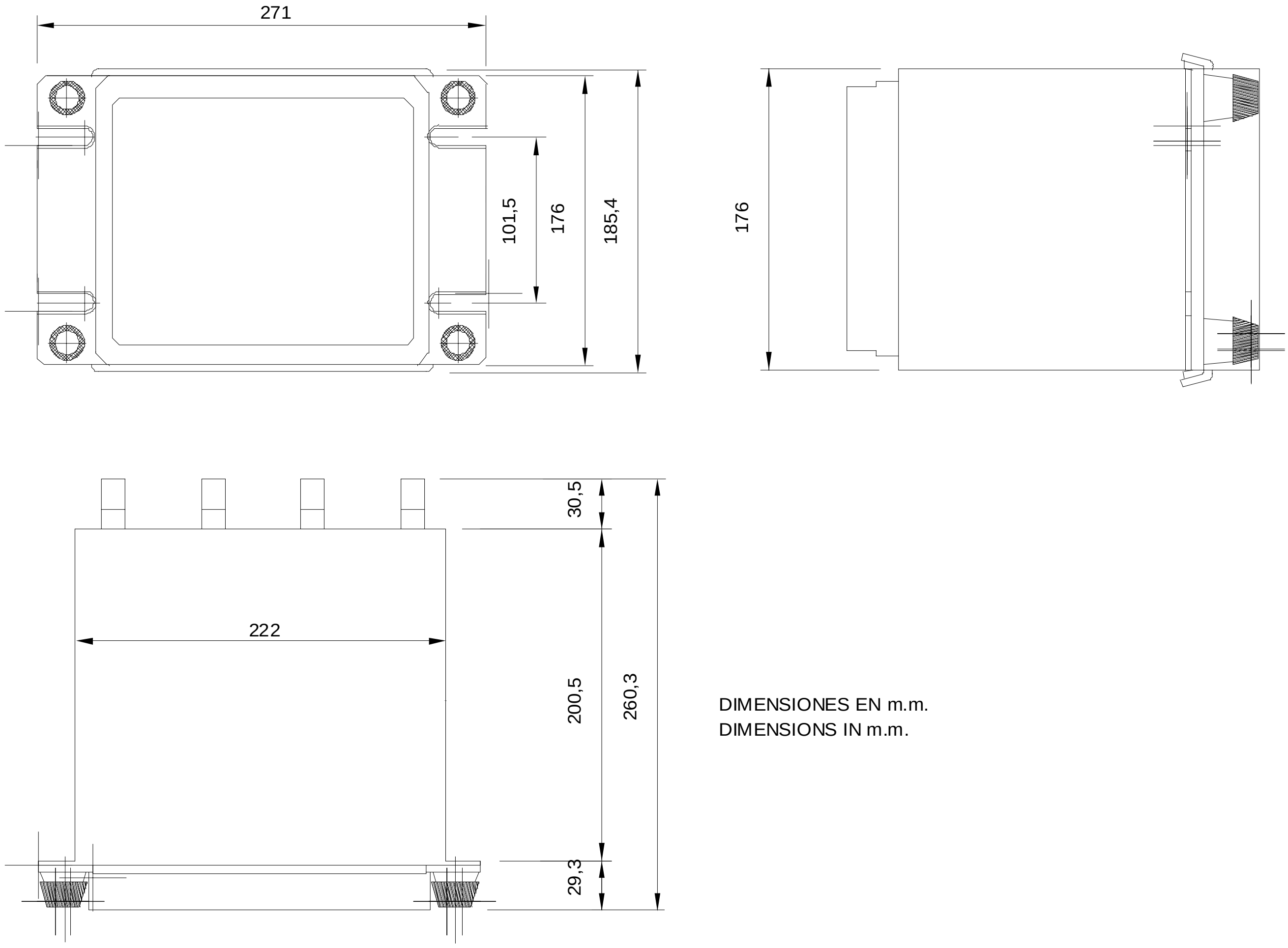


FIGURE 16. DIMENSIONS DIAGRAM FOR ½ RACK MODELS