GE Power Management


# Directional Ground Protection

# MIN

## Instructions

## GEK-106306

ISO 9000 Registered ISO 9000

# *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


**1. GETTING STARTED 5**

**1.1. INSPECTION CHECKLIST 6**
**1.2. M+PC SOFTWARE 7**
1.2.1. HARDWARE AND SOFTWARE REQUIREMENTS 7
1.2.2. SOFTWARE INSTALLATION 8
**1.3. M-RELAY FAMILY HARDWARE 12**
1.3.1. MOUNTING & WIRING 12
1.3.2. COMMUNICATIONS 12
1.3.3. FACEPLATE, KEYPAD AND DISPLAY 12
**1.4. USING THE KEYPAD AND DISPLAY 13**
1.4.1. HIERARCHICAL MENUS 13

**2. PRODUCT DESCRIPTION 15**

**2.1. INTRODUCTION 15**
2.1.1. GENERAL OVERVIEW 15
**2.2. MIN MODEL E PROTECTION UNITS (FOR GROUNDED SYSTEMS) 17**
2.2.1. GROUND TIME OVERCURRENT UNITS (51NH, 51NL) 17
2.2.2. GROUND INSTANTANEOUS OVERCURRENT UNITS (50NH, 50NL) 20
2.2.3. DIRECTIONAL UNITS (67N) 21
**2.3. MODEL S PROTECTION UNITS (ISOLATED GROUND OR PETERSEN COIL SYSTEMS) 24**
2.3.1. OVERCURRENT UNITS FOR ISOLATED GROUND (67IG) 24
2.3.2. OVERCURRENT UNITS FOR PETERSEN COIL (67PC) 25
**2.4. EVENTS 27**
**2.5. OSCILLOGRAPHY 30**
**2.6. SETTING TABLES 33**
**2.7. MONITORING AND METERING FEATURES 34**
2.7.1. MEASUREMENT 34
**2.8. USER INTERFACE 35**
2.8.1. LED TARGETS 35
2.8.2. KEYPAD AND DISPLAY 36
2.8.3. COMMUNICATIONS PORTS 36
2.8.4. SOFTWARE 36
**2.9. M FAMILY 37**
**2.10. MODEL LIST. ORDER CODES 38**
**2.11. TECHNICAL SPECIFICATIONS. 39**
2.11.1. PROTECTION UNITS MODEL E 39
2.11.2. PROTECTION UNITS MODEL S 40
2.11.3. METERING FUNCTIONS 41
2.11.4. INPUTS 41
2.11.5. POWER SUPPLY 42
2.11.6. OUTPUTS 43
2.11.7. COMMUNICATIONS 43
2.11.8. AMBIENT CONDITIONS 44
2.11.9. TYPE TESTS AND CERTIFICATIONS 44
2.11.10. PRODUCTION TESTS 45
2.11.11. APPROVALS 45

**3. HARDWARE 47**

**3.1. DESCRIPTION 47**
3.1.1. RELAY IDENTIFICATION 47
3.1.2. PANEL CUTOUT 48
3.1.3. MODULE WITHDRAWAL / INSERTION 49
3.1.4. WIRING AND INTERNAL CONNECTIONS 50
3.1.5. REAR TERMINAL ASSIGNMENTS 50
**3.2. WIRING 51**
3.2.1. TYPICAL WIRING DIAGRAM 51
3.2.2. CONTROL POWER 53
3.2.3. CONTACT INPUTS/OUTPUTS 53
3.2.4. OUTPUT CONTACTS CONFIGURATION 53
3.2.5. RS232 FACEPLATE COMMUNICATIONS PORT 55
3.2.6. RS485 COMMUNICATIONS PORT 56

**4. HUMAN INTERFACE 57**

**4.1. M+PC SOFTWARE INTERFACE 57**
4.1.1. STARTING THE PROGRAM 57
4.1.2. START WINDOW 58
4.1.3. EMULATION 59
4.1.4. OPTIONS MENU 61
4.1.5. USERS MANAGEMENT MENU 64
4.1.6. FLASH MEMORY UPDATE 65
4.1.7. DEVICE IDENTIFICATION WINDOW 67
4.1.8. M+PC PROGRAM MAIN WINDOW 67
4.1.9. RELAY STATUS MENU 70
4.1.10. SETTINGS MENU 73
4.1.11. ADVANCED SETTINGS MENU 76
4.1.12. OPERATIONS MENU 77
4.1.13. OSCILLOGRAPHY MENU 78
4.1.14. EVENTS MENU 79
4.1.15. INPUT/OUTPUT CONFIGURATION MENU 80
4.1.16. LOGIC CONFIGURATION 82
4.1.17. SEND DATE/TIME 83

**5. SETTINGS 85**

**5.1. SETTINGS STRUCTURE 85**
**5.2. MAIN SETTINGS 86**
5.2.1. MODEL E 86
5.2.2. MODEL S 88
**5.3. ADVANCED SETTINGS 90**
5.3.1. MODEL E 90
5.3.2. MODEL S 95
**5.4. TIME SYNCHRONIZATION 99**

**6. INPUT AND OUTPUT CONFIGURATION 101**

**6.1. INPUT CONFIGURATION 101**
6.1.1. INPUT DESCRIPTION 101
6.1.2. INPUT FUNCTIONS 102
**6.2. OUTPUT AND LED CONFIGURATION 103**
6.2.1. DESCRIPTION OF OUTPUTS AND LEDS 103
6.2.2. FUNCTIONS FOR OUTPUTS AND LEDS 105

**7. LOGIC CONFIGURATION 107**

**7.1. LOGIC DESCRIPTION 107**
**7.2. LOGIC FUNCTIONS 110**
7.2.1. MODEL E 110
7.2.2. MODEL S 112

**8. KEYPAD AND DISPLAY 115**

**8.1. FACEPLATE KEYPAD 115**
**8.2. ALPHANUMERIC DISPLAY 115**
**8.3. MAIN STRUCTURE 116**
8.3.1. MODE 1: KEY-TO-KEY MODE PRESSING THE ENTER KEY: 117
8.3.2. MODE 2: ENTER THE MENUS, PRESSING “ENTER” AND “-” SIMULTANEOUSLY: 119
**8.4. INFORMATION MENU 120**
8.4.1. MODEL E 120
8.4.2. MODEL S 121
**8.5. MAIN SETTINGS MENU 123**
8.5.1. MODEL E 123
8.5.2. MODEL S 129
**8.6. ADVANCED SETTINGS MENU 134**
8.6.1. MODEL E 134
8.6.2. MODEL S 136
**8.7. OPERATIONS MENU 138**
**8.8. DATE AND TIME MENU 139**
**8.9. RESETTING THE TARGET LEDS 140**

**9. RELAY COMMISSIONING 141**

**9.1. VISUAL INSPECTION 141**
**9.2. COMMENTS ON THE TEST EQUIPMENT 141**
**9.3. INSULATION TESTS 142**
**9.4. WIRING AND NECESSARY EQUIPMENT 143**
**9.5. TARGET LEDS 145**
**9.6. POWER SUPPLY TEST 145**
**9.7. COMMUNICATIONS 146**
**9.8. RELAY SETTING 146**
**9.9. CONTACT INPUTS 146**
**9.10. CONTACT OUTPUTS 147**
**9.11. RELAY METERING 148**

9.11.1. CURRENT AND VOLTAGE METERING 148
**9.12. MODEL S: ISOLATED GROUND UNIT (67IG) 149**
**9.13. MODEL S: PETERSEN COIL UNIT (67PC) 150**
**9.14. MODEL E - 50NH AND 50NL OVERCURRENT UNITS 151**
**9.15. MODEL E - 51NH AND 51NL OVERCURRENT UNITS 152**
9.15.1. IEC INVERSE CURVE 152
9.15.2. IEC VERY INVERSE CURVE 152
9.15.3. IEC EXTREMELY INVERSE CURVE 153
9.15.4. ANSI INVERSE CURVE 153
9.15.5. ANSI VERY INVERSE CURVE 154
9.15.6. ANSI EXTREMELY INVERSE CURVE 154
**9.16. MODEL E - 67N1 AND 67N2 OVERCURRENT UNITS 155**
9.16.1. DUAL POLARIZATION 157
**9.17. TIME SYNCHRONIZATION 159**
**9.18. USER SETTINGS 160**
**9.19. MAIN SETTINGS 160**
9.19.1. MODEL E 160
9.19.2. MODEL S 162
**9.20. ADVANCED SETTINGS 164**
9.20.1. MODEL E 164
9.20.2. MODEL S 168

**10. INSTALLATION AND MAINTENANCE 171**

**10.1. INSTALLATION 171**
**10.2. GROUND CONNECTION AND DISTURBANCES SUPPRESSION 171**
**10.3. MAINTENANCE 171**
**10.4. CLEANING INSTRUCTIONS 171**

**11. ANNEX 1. HARMONIC FILTERING 173**

**12. ANNEX 2 TIME-CURRENT CURVES FOR 51P AND 51N UNITS 177**

**12.1. TRIP TIMES (IN SECONDS) FOR BS142 CURVES 177**
**12.2. TRIP TIMES (IN SECONDS) FOR ANSI CURVES 182**

**13. ANNEX 3. MODBUS MEMORY MAP 187**

**13.1. READING VALUES 187**
**13.2. COMMAND EXECUTION 188**
**13.3. SYNCHRONIZATION 190**
**13.4. WRITING SETTINGS 191**
**13.5. EVENTS 193**
**13.6. OSCILLOGRAPHY 198**
13.6.1. MODEL E 199
13.6.2. MODEL S 202
**13.7. ERRORS 205**
**13.8. USED FORMATS 206**

# 1. GETTING STARTED

To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.


**CAUTION: THE OPERATOR OF THIS INSTRUMENT IS ADVISED THAT IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED IN THIS MANUAL, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED**

**INSTALLATION MUST BE ACCORDING TO THE NATIONAL ELECTRIC CODE OF THE APPROPRIATE COUNTRY**

## 1.1. INSPECTION CHECKLIST

- Open the relay packaging and inspect the relay for physical damage.
- View the faceplate relay model number and verify that the relay is the correct ordered model.
- Ensure that the mounting screws have been included with the relay.
- For product information, instruction manual updates, and the latest software updates, please visit the GE Power Management Home Page (www.geindustrial.com/pm).

***Note: If there is any physical damage noticed on the relay, or any of the contents listed are missing, please contact GE Power Management immediately.***

**GENERAL ELECTRIC POWER MANAGEMENT S.A**

**Avda. Pinoa, 10**

**48170 Zamudio, Vizcaya (Spain)**

**Phone: +34 94-485 88 00, Fax: +34 94-485 88 45**

**E-mail: gepm.help@indsys.ge.com**

**GENERAL ELECTRIC POWER MANAGEMENT**

**215, Anderson Avenue**

**L6E 1B3 Markham, ON (CANADA)**

**Phone: +1 905 294 6222, Fax: +1 905 201 2098**

**E-mail: info.pm@indsys.ge.com**

**The information provided herein does not intend to cover all details of variations of the described equipment nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.**

**Should you wish to receive additional information, or for any particular problem that cannot be solved by referring to the information contained herein, please contact GENERAL ELECTRIC POWER MANAGEMENT.**

## 1.2. M+PC SOFTWARE

### 1.2.1. HARDWARE AND SOFTWARE REQUIREMENTS

The faceplate keypad + display or the M+PC software interface can be used to communicate with the relay. The M+PC software interface is the preferred method to edit settings and view actual values because the PC monitor can display more information in a simple comprehensible format.

The following minimum requirements must be met for the M+PC software to properly operate on a PC:

| | |
|---|---|
| Processor: | Intel® Pentium recommended |
| Memory: | 16 Mb minimum |
| Hard Drive: | 10 Mb free space required before installation of M+PC software |
| O/S: | Windows® 95, Windows® 98, Windows® NT 4.0, SP 3 or higher, Windows® 2000 or Windows® Millennium. |
| Hardware: | CD-ROM drive or 3,5” Floppy disk drive. |
| | Unused communications port (i.e. COM1) |

The M+PC help file has been developed using Microsoft® HTMLHelp technology. In order to view this powerful file format, it is necessary to have installed a help files viewer, included with M+PC software. Besides, this file viewer requires Microsoft® Internet Explorer (version 3.02 or higher) to be installed in the computer. However, Microsoft® Internet Explorer does not need to be the default system browser.

The M+PC distribution includes Internet Explorer version 3.02 under the “ie” folder.

**Contextual help can be accessed from any M+PC screen by pressing F1.**

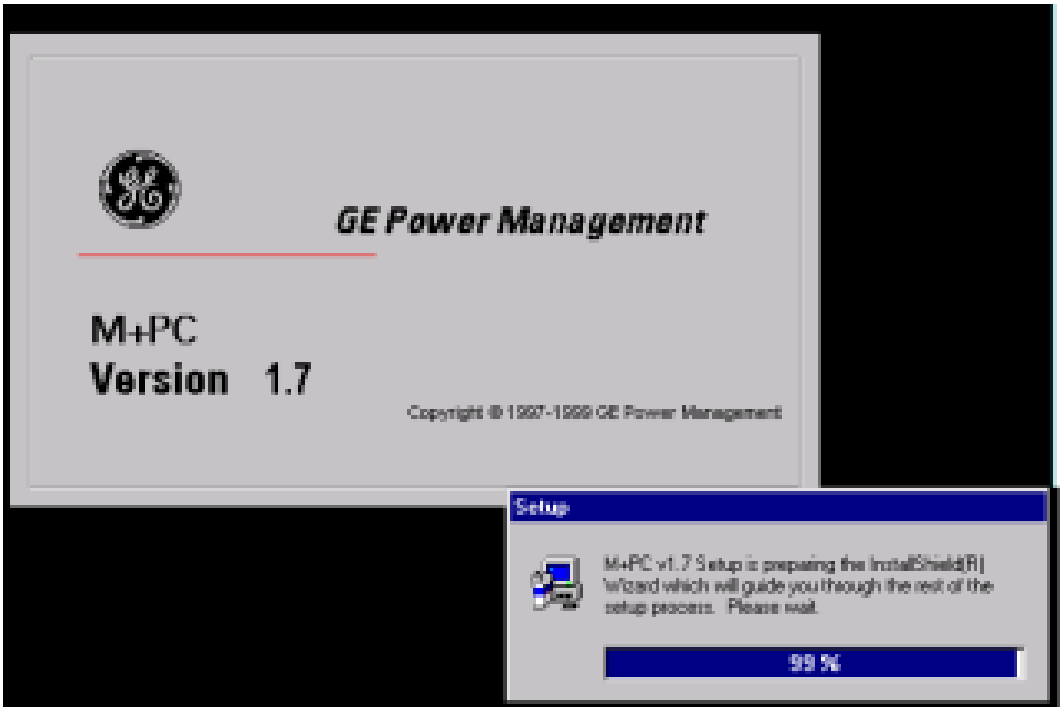
### 1.2.2. SOFTWARE INSTALLATION

M+PC software can be installed either from the GE Power Management Products CD, from our website at www.GEIndustrial.com/pm or from a specific CD-ROM.

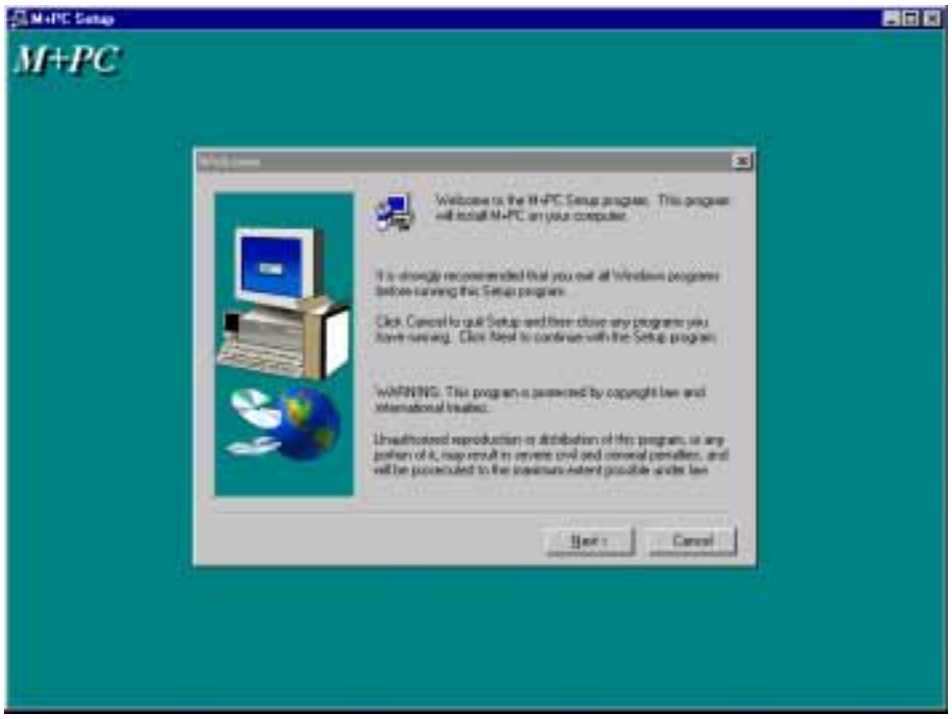
Refer to the following instructions to install the M+PC software:

1. Start Windows®.
2. Insert the M+PC software CD into the CD ROM drive.
3. If the installation program does not start automatically, from the Windows® **Start** menu, choose **Run**, type d:\SETUP.EXE (assuming your CD ROM driver is configured as the 'D:' unit and press **Enter**.

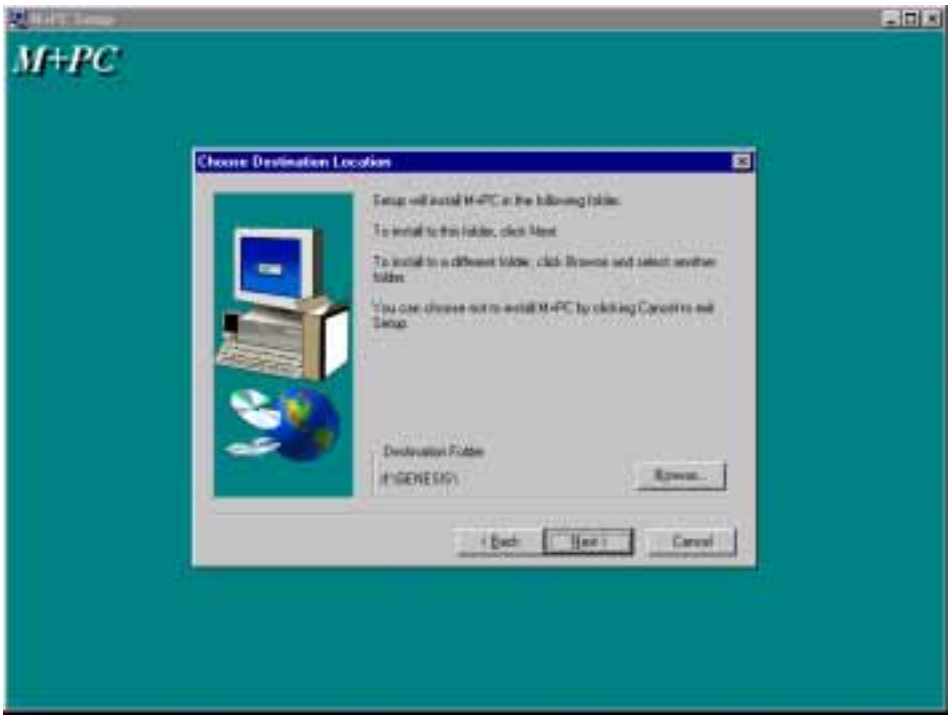
You will see the following screen:



4. Follow the on-screen instructions to install the M+PC software. When the Welcome window appears, click on Next to continues with the installation procedure.

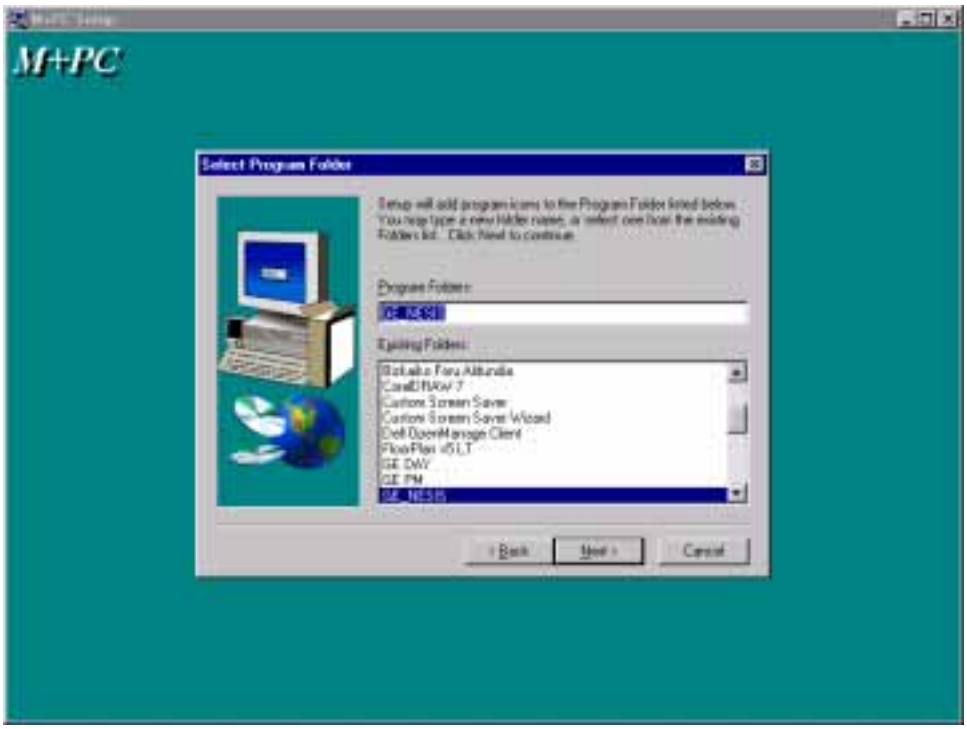



5. When the Choose Destination Location window appears and if the software is not to be located in the default directory, click Browse and type in the complete path name including the new directory name.

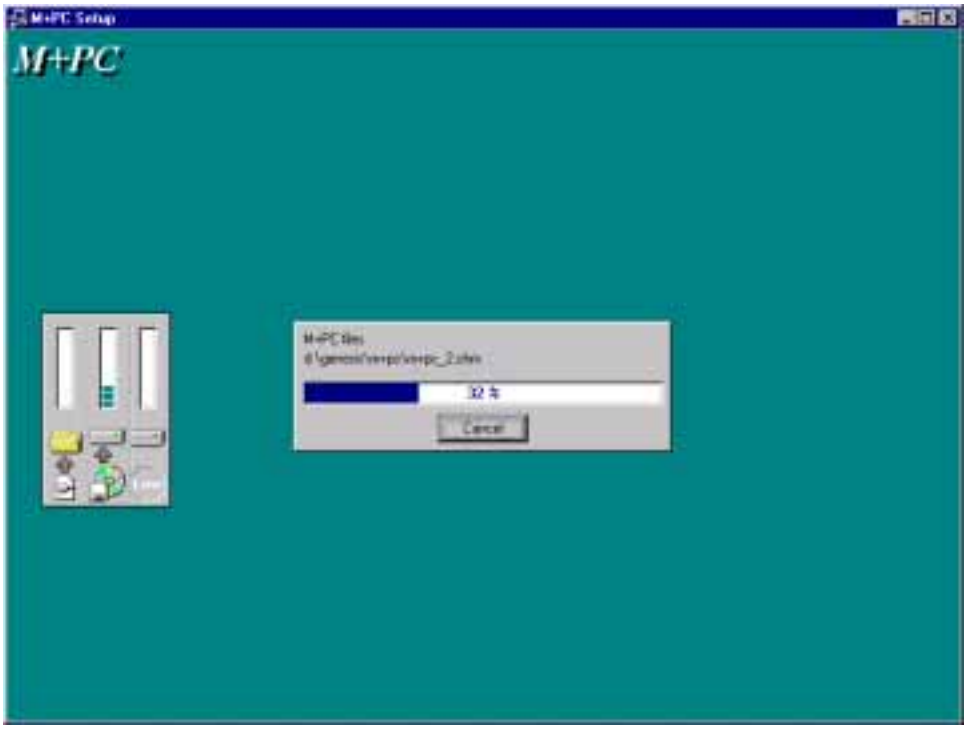



6. Click **Next** to continue with the installation procedure.

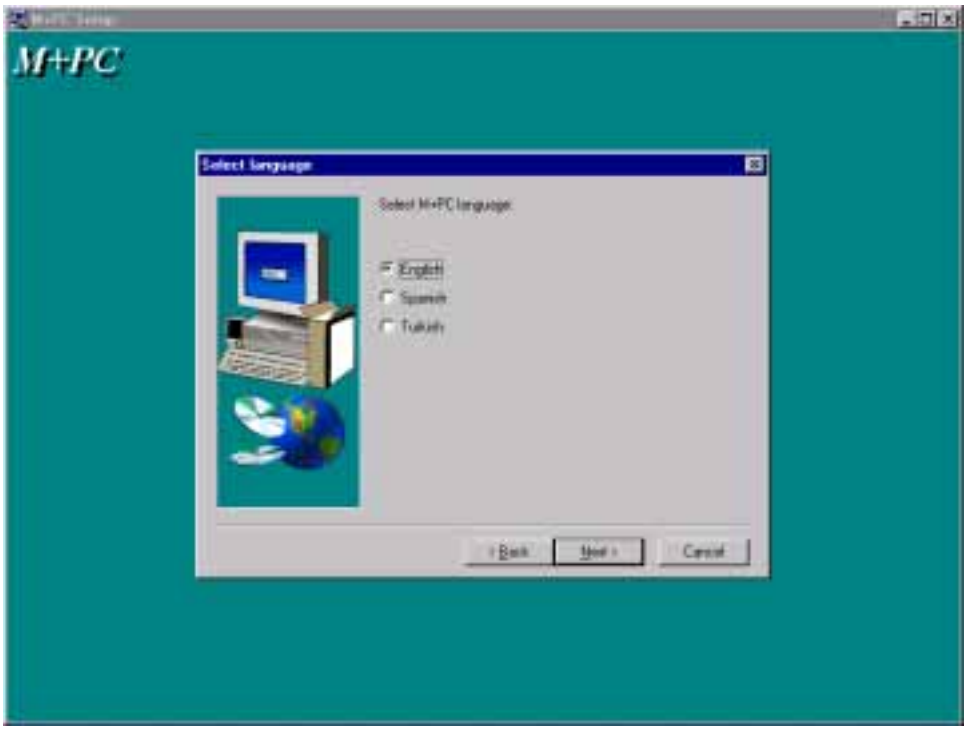
7. The default program group where the application will be added to is shown in the Selected Program Folder window. If it is desired that the application be added to an already existing program group, choose the group name from the list shown.



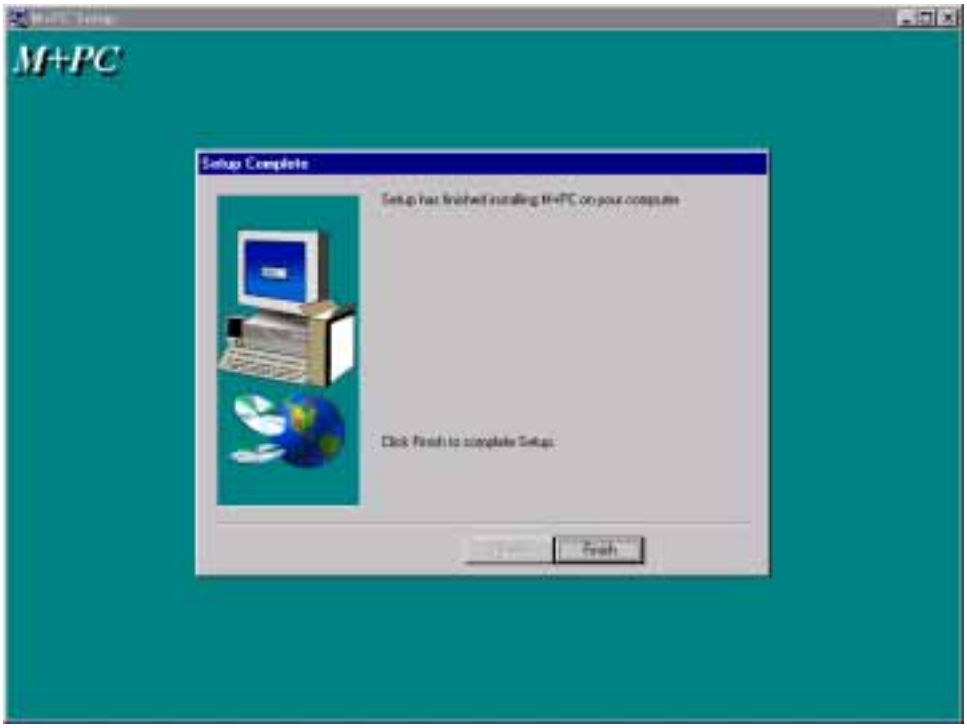

8. Click **Next** to begin the installation process, and all the necessary program files will be copied into the chosen directory.



9. To finish with the installation process, using your mouse select the language by clicking on the desired language.




10. Subsequently, double click on the M+PC software icon to activate the application.




Refer to the HUMAN INTERFACES chapter in this manual and the M+PC software Help program for more information about the M+PC software interface.

## 1.3. M-RELAY FAMILY HARDWARE

### 1.3.1. MOUNTING & WIRING

Please refer to the HARDWARE chapter for detailed relay mounting and wiring instructions. Review all WARNINGS and CAUTIONS.

### 1.3.2. COMMUNICATIONS

The M+PC software can communicate to the relay via the faceplate RS232 port, or the rear panel RS485. To communicate with the relay via the faceplate RS232 port, a standard “straight through” serial cable is used. The DB9 male end is connected to the relay and the db9 or DB25 female end is connected to the PC COM1 or COM2 port as described in the HARDWARE chapter.

To communicate with the relay rear RS485 port from a computer RS232 port, an RS232/RS485 converter box is needed. We recommend to use the F485 converter, manufactured by GE. This converter box is connected to the computer using a “straight through” serial cable. A shielded twisted pair (20, 22 or 24 AWG according to the American standards; 0.25, 0.34 or 0.5 mm2 according to the European standards) cable is used to connect the converter box to the relay rear communications terminals. The converter box (+, -, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in a RC network (i.e. 120 ohm, 1 nF) as described in the HARDWARE chapter.

### 1.3.3. FACEPLATE, KEYPAD AND DISPLAY

Display messages are organised into menus under the main headings: **Information, Main Settings, Advanced Settings, Operations and Date/Time**. A 3-key keypad and a 3.5-character display (shown below) are used as elementary local HMI.

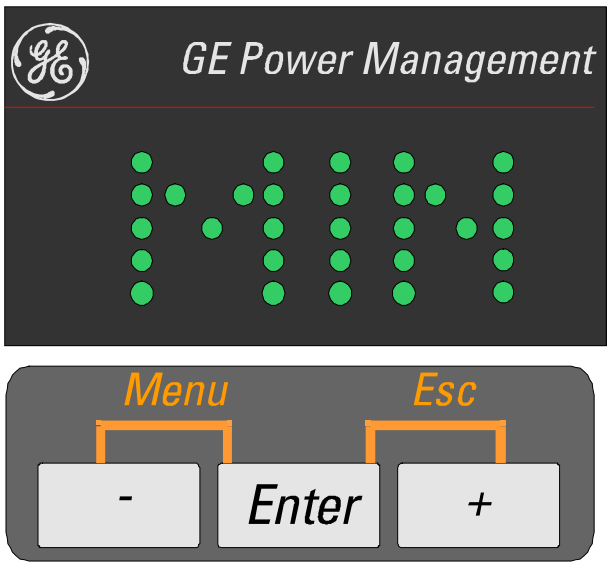



**Figure 1.1 MIN KEYPAD AND DISPLAY**

Using this keypad it is possible to access all the different menus in the relay, to view settings and measurements, and to change settings.

## 1.4. USING THE KEYPAD AND DISPLAY

### 1.4.1. HIERARCHICAL MENUS

The navigation and hierarchical menu shown below corresponds to MIN model S and intends to be only an example. For more detailed information on the navigation menus of MIN relays, please refer to Chapter 8: Keypad and Display.

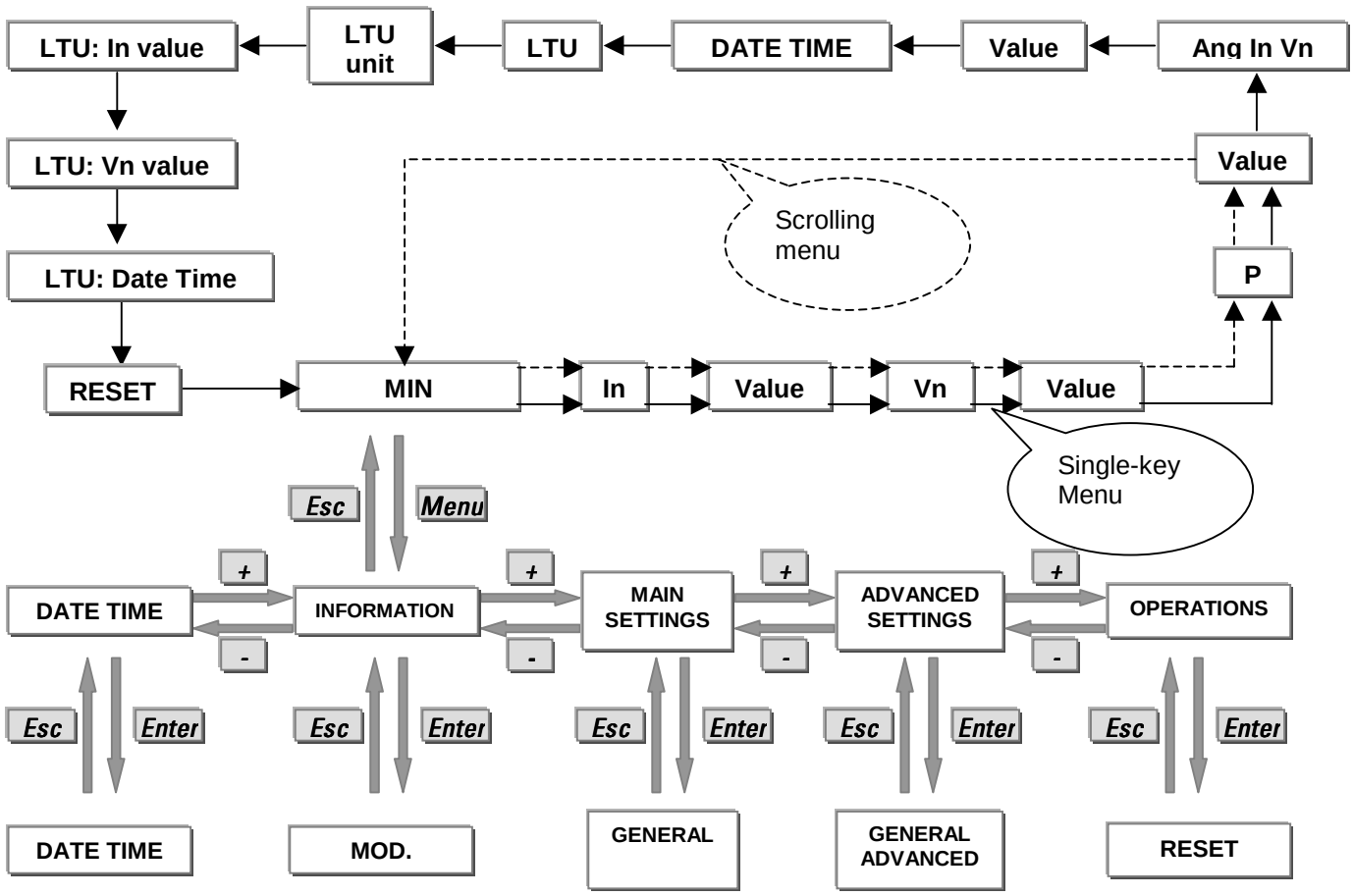



**Figure 1.2. MOVING THROUGH THE HIERARCHICAL MENU**

As shown in figure 1.2, there are 3 hierarchical levels to access the information in the relay.

The first level is an automatic scrolling menu that shows the current values measured by the relay.

Pushing simultaneously **"-"** and **"Enter"** keys the second level is accessed (this is indicated by the **"Menu"** text labelled over the **"-"** and **"Enter"** keys). To access information within the same hierarchical level (horizontal movement) push **"+"** or **"-".** To access the third level push the **"Enter"** key when the desired heading is shown in the display.

To return back to the previous level (from the third to the second level, or from the second to the first one) push **"+" and "Enter"** keys simultaneously. This is indicated by the **"Esc"** text labelled over the **"+"** and **"Enter"** keys.

***NOTE**: For pressing simultaneously the **"-"** and "**Enter**" or **"+"** and "**Enter**" keys, it is easier to press with the thumb between the two keys.*

# 2. PRODUCT DESCRIPTION

## 2.1. INTRODUCTION

### 2.1.1. GENERAL OVERVIEW

The MIN is a microprocessor-based protection relay. It incorporates protection features against ground overcurrents that can be supervised by directional units, for grounded systems (model E) or isolated ground or Petersen Coil systems (model S).

Negligible over-travel and a high drop out to pick up ratio (>97%), along with the possibility of adjust a time delay for the instantaneous units, allow optimal co-ordination without compromising selectivity.

Both faceplate RS232 port and rear RS485 port may be used to connect a PC for programming settings, monitoring actual values and for retrieving stored information (list of events, oscillography, etc.). All serial ports use the Modbus® RTU protocol and may be connected to system computers with baud rates from 300, 600, 1200, 4800, 9600 and 19200 bps. The rear RS485 port can be converted into an RS232 port or into a fibre optic (plastic or glass) serial port by using the GE DAC300 module. The M+PC communication software is the Windows® based program used to communicate with the relay.

The MIN uses flash memory technology, which allows field upgrading (through M+PC software) as new features are added. This upgrade can be performed only through the communications port on the front of the unit.

The following single line diagram (figure 2.1) illustrates the relay functionality using ANSI (American National Standards Institute) device numbers.

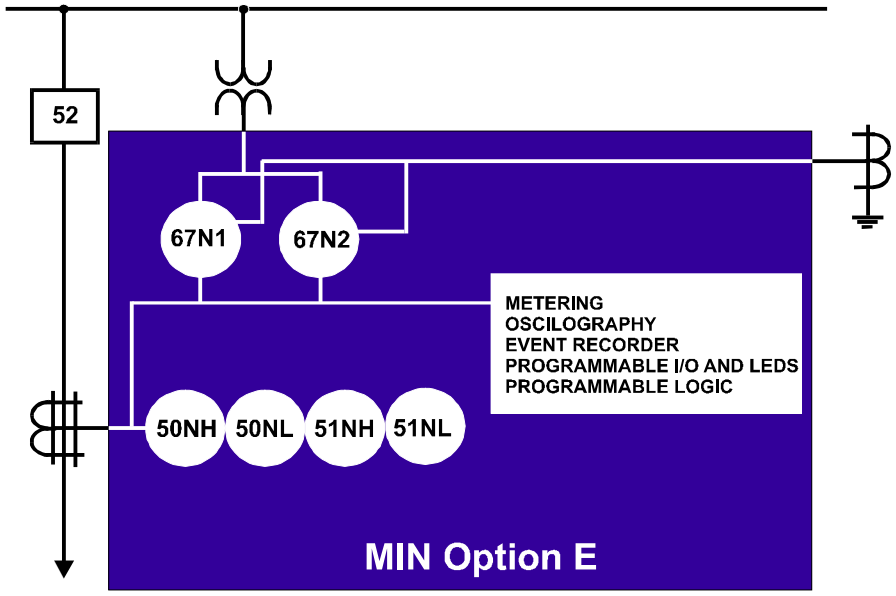



**Figure 2.1. SINGLE LINE DIAGRAM SHOWING MIN FUNCTIONS for MODEL E**

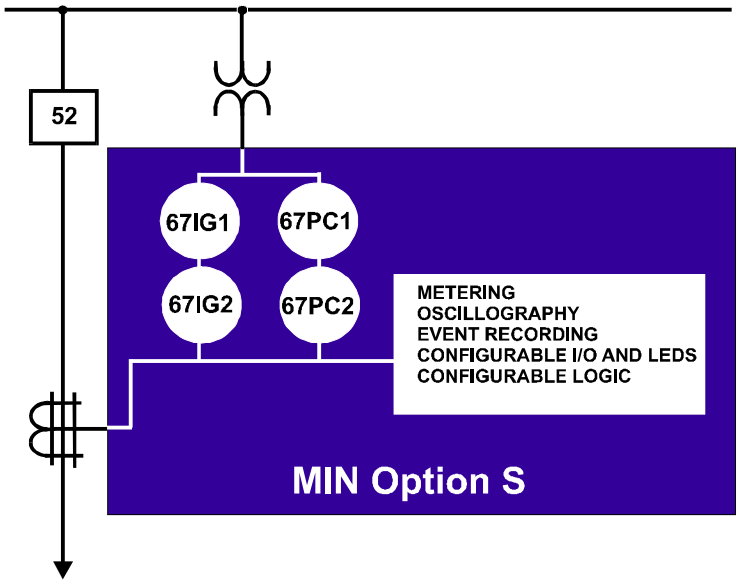



**Figure 2.2. SINGLE LINE DIAGRAM SHOWING MIN FUNCTIONS for MODEL S**

## 2.2. MIN MODEL E PROTECTION UNITS (FOR GROUNDED SYSTEMS)

The MIN for grounded system applications incorporates the following features:

- 2 overcurrent units timed by curve or by definite time (51NH and 51NL)
- 2 overcurrent units timed to a definite time (50NH and 50NL)
- 2 directional units (67N1 and 67N2) to supervise the operation of any of the four mentioned overcurrent units.

### 2.2.1. GROUND TIME OVERCURRENT UNITS (51NH, 51NL)

Two independent ground time overcurrent units are provided in the MIN, 51NH (H: high pickup) and 51NL (L: low pickup). The relay offers the following 4 current/time operation characteristics: Definite Time, Inverse Curve, Very Inverse Curve and Extremely Inverse Curve. One group of curves complies with the criteria specified in the IEC255-4 Standard and in British Standard BS142, while another group (defined in the same unit) complies with ANSI C37.90 standards. A time dial can be applied to any of these curves to optimize co-ordination with other devices in the net. Additionally, there is a possibility to define a User's Curve, assigning the desired values to parameters A, P, Q, B and K. Using the directional units described later, it is possible to make these overcurrent units directional. In this case, **once the trip is produced, it will not be reset after a loss of directionality, but only when the current level falls under the pickup value.**

The general formula for IEC/B142 curves is as follows:

$$T = \frac{A * D}{V^{P} - Q} + B * D + K$$

Where:

| CURVE NAME | A | P | Q | B | K |
|---|---|---|---|---|---|
| Inverse (IEC Curve C) | 0.14 | 0.02 | 1 | 0 | 0 |
| Very Inverse (IEC Curve B) | 13.5 | 1 | 1 | 0 | 0 |
| Extremely Inverse (IEC Curve A) | 80 | 2 | 1 | 0 | 0 |

D =Time Dial setting (set in the relay by user).

$V = I / I_{pickup\ setting} > 1.05$

The general formula for all ANSI curves is as follows:

$$T = M * \left[ A + \frac{B}{(V - C)} + \frac{D}{(V - C)^2} + \frac{E}{(V - C)^3} \right]$$

Where:

| CURVE NAME | A | B | C | D | E |
|---|---|---|---|---|---|
| Extremely Inverse | 0.0399 | 0.2294 | 0.5000 | 3.0094 | 0.7222 |
| Very Inverse | 0.0615 | 0.7989 | 0.3400 | -0.2840 | 4.0505 |
| Inverse | 0.0274 | 2.2614 | 0.3000 | -4.1899 | 9.1272 |

M =Time Dial setting (set in the relay by user).

V = I / $I_{pickup\ setting}$ > 1.05

The general formula for the user's curve is as follows:

$$T = \frac{A * D}{V^P - Q} + B * D + K$$

Where:

| PARAMETERS | A | B | P | Q | K |
|---|---|---|---|---|---|
| Range | 0 - 125 | 0-3 | 0-3 | 0-2 | 0-1.999 |
| Step | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Unit | Sec. | Sec. | NA | NA | Sec. |
| Default value | 0.05 | 0 | 0.04 | 1 | 0 |

D = Time Dial setting (set in the relay by user).

V = I / $I_{pickup\ setting}$ . The equation is valid for 1.05<V<20. From 20 on, the curve turns flat.

I = Input Current

T = Operate Time (sec)

A, P, Q, B, K = Constants defined in the standard, as follows:

The settings available for the ground time overcurrent units are as follows (duplicated for 51NH and 51NL):

**Enable unit 51N (ENABLE 51N):** Determines whether the unit is operative and can generate pickup and tripping events (when the trip is also enabled), that can be configured to close outputs, lit LEDs or trigger the oscillography.

**Enable unit 51N trip (TRIP 51N):** Allows the unit to trip. If we want this unit to generate a trip and close the tripping contact we must first enable the unit (previous setting) and then its trip. If the unit is enabled but the trip is not, the unit will produce digital pickup and virtual trip signals (when the unit has picked up and the timing has expired), that can be used to close outputs, lit LEDs or trigger the oscillography; but the unit will not close the general trip contact (not programmable).

**Enable the directionality of 51N (DIR 51N):** If we want to use a directional supervision, this setting determines whether this supervision is made by **67N1** or **67N2** unit, or whether **NO** directional supervision is required.

**Polarization Loss Logic (POL LOSS 51N):** This setting defines the behaviour of the unit against a polarization loss (Vp and /or Ip lower than 5% of rated V and/or I). For Vp, we take 3.5 V as the 5% of rated V. Depending on the application, we might prefer to block the unit in the event of a polarization loss, or to make the unit non directional, so that it can trip if detecting an overcurrent condition without a directional supervision.

In the case of using a dual polarisation, if we select V or I (V+I), when one of the polarization magnitudes is lost, the other one takes control to determine the direction of the fault. Only when both magnitudes are lost, the unit refers to the POL LOSS setting to determine whether the unit should act as non directional or block its trips.

If the selected dual polarization is V and I (V*I), when one of the magnitudes is lost the unit refers to the POL LOSS setting to determine whether to act as non directional or block its trips.

**Overcurrent pickup level (TAP 51N):** This is the ground current value that must be exceeded for the unit to pick up. It expressed in times the rated current.

**Type of Curve (CURV 51N):** Type of curve that will be used to define the temporisation of the unit. It can be selected between Inverse, Very Inverse, Extremely Inverse, Definite Time and User Curve. The user curve is selected in the Advanced Settings group, by assigning values to parameters A, B, P, Q and K of the equation.

Depending on the selected model, MIN*A******** or MIN*I*********, the relay will use ANSI or IEC curves.

**Curve Dial (DIAL 51N):** It selects the curve to be used, inside the selected curve family.

**Definite Time (TIME 51N):** In case of selecting Definite Time in the Curve Type setting, we must fix this setting to the desired time between the unit pickup and the trip.

### 2.2.2. GROUND INSTANTANEOUS OVERCURRENT UNITS (50NH, 50NL)

The instantaneous overcurrent units, 50NH and 50NL, can be enabled/disabled and set independently from the timed overcurrent units. The settings from these units allow to set the pickup value from 0.1 to 30 times the rated current, and the time delay from 0.00 to 99.99 seconds.

The ground signal can be taken from the ground current transformer of the generator/transformer (post or toroidal type), calculated as a residual connection of the phase current transformers, or by a toroidal CT grouping the three phase currents.

Using units 67N1 and 67N2, detailed later, it is possible to add directionality, independently, to units 50NH and 50NL.

Once the unit has tripped, it will not be reset after a loss of directionality.

The settings available for the ground instantaneous overcurrent units are as follows (duplicated for 50NH and 50NL):

**Enable unit 50N (ENABLE 50N):** Determines whether the unit is operative and can generate pickup and tripping events (when the trip is also enabled), that can be configured to close outputs, lit LEDs or trigger the oscillography.

**Enable unit 50N trip (TRIP 50N):** Allows the unit to trip. If we want this unit to generate a trip and close the tripping contact we must first enable the unit (previous setting) and then its trip. If the unit is enabled but the trip is not, the unit will produce digital pickup and virtual trip signals (when the unit has picked up and the timing has expired), that can be used to close outputs, lit LEDs or trigger the oscillography; but the unit will not close the general trip contact (not programmable).

**Enable the directionality of 50N (DIR 50N):** If we want to use a directional supervision, this setting determines whether this supervision is made by **67N1** or **67N2** unit, or whether **NO** directional supervision is required.

**Polarization Loss Logic (POL LOSS 50N):** This setting defines the behaviour of the unit against a polarization loss (Vp and /or Ip lower than 5% of rated V and/or I). For Vp, we take 3.5 V as the 5% of rated V. Depending on the application, we might prefer to block the unit in the event of a polarization loss, or to make the unit non directional, so that it can trip if detecting an overcurrent condition without a directional supervision.

In the case of using a dual polarisation, if we select V or I (V+I), when one of the polarization magnitudes is lost, the other one takes control to determine the direction of the fault. Only when both magnitudes are lost, the unit refers to the POL LOSS setting to determine whether the unit should act as non directional or block its trips.

If the selected dual polarization is V and I (V*I), when one of the magnitudes is lost the unit refers to the POL LOSS setting to determine whether to act as non directional or block its trips.

**Overcurrent pickup level (TAP 50N):** This is the ground current value that must be exceeded for the unit to pick up. It expressed in times the rated current.

**Definite Time (TIME 50N):** In case of selecting Definite Time in the Curve Type setting, we must fix this setting to the desired time between the unit pickup and the trip.

### 2.2.3. DIRECTIONAL UNITS (67N)

MIN model E incorporates two directional units, 67N1 and 67N2. These units can be used to supervise the operation of any overcurrent unit (51NH, 51NL, 50NH, 50NL).

The available settings are as follows:

**Characterisitic Angle (ANG 67N):** This angle is used to move the polarization voltage. Positive angles indicate a forward movement (counterclockwise), and negative angles indicate rewinding (clockwise). The polarization magnitude, once rotated, defines the maximum pair line. Vn rotated this angle points the semiplane corresponding to a reverse fault, REV. (-Vn) rotated this angle points the semiplane corresponding to a forward fault (FWD). A typical setting can be –45º, as shown in figure 2-3.

**Direction of the directional unit (DIR 67N):** Indicates the direction for which the unit will allow a trip. Depending on this setting, the unit will activate for faults in one direction or the opposite. This feature allows the unit to be used both in tripping and blocking schemes. The possible settings are FORWARD or REVERSE.

**Polarization (POL 67N):** This setting defines the type of polarization that will be used. The MIN allows to use voltage polarization (Vn) and or current polarization (Ip). The possible setting values are: Vn (only voltage polarization), Ip (only current polarization), Vn*Ip (voltage and current polarization), and Vn+Ip (voltage or current polarization). Option Vn*Ip enables a trip only when both polarization magnitudes allow it. Option Vn+Ip enables the trip when any of the two magnitudes allows it.

If the previous setting (DIR 67N) is adjusted as FWD (forward) and the selected type of polarization is V+I, then the unit will trip when any of the polarization magnitudes indicate a forward direction.

If the previous setting (DIR 67N) is adjusted as REV (reverse) and the selected type of polarization is V+I, then the unit will trip when any of the polarization magnitudes indicate a reverse direction.

If the polarization type is V*I, then the unit will only trip when both magnitudes coincide with the direction selected in the DIR 67N setting.

The directional unit has two output signals associated in the list of signals for configuration of outputs, LEDs, and for their use in the configurable logic: Block 67N and Pickup 67N.

**Block 67N (67 DISABLED):** Indicates that the unit is blocked either by a digital input or because the level of operation (In) or polarization (Vn and/or Ip) magnitudes is not high enough.

**Pickup 67N (67 PICKUP):** Indicates that the unit is giving permission, that is, that the angle relations between the operation magnitude and the polarization magnitude are present according to the selected conditions.

**OPERATION PRINCIPLES WITH VOLTAGE POLARIZATION**

Operation magnitude: $In = 3I_0$, measured at the input terminals.

Polarization magnitude: $-3V_0$, measured at the input terminals and rotated 180º internally.

The relay receives the ground current, In, and the ground voltage, Vn, through the inputs defined in the external wiring diagram, and with the indicated polarities, that is , positive of In in terminal C1 (1 A rated current input) and positive of Vn in C7.

Figure 2.3 shows the operation of the directional unit for a Phase A fault to ground, where the Phase A current is increased in magnitude and is delayed with reference to its Voltage by an angle approximately equal to the protected line, while Va voltage falls or even disappears if the fault is close, and the fault resistance is very low.

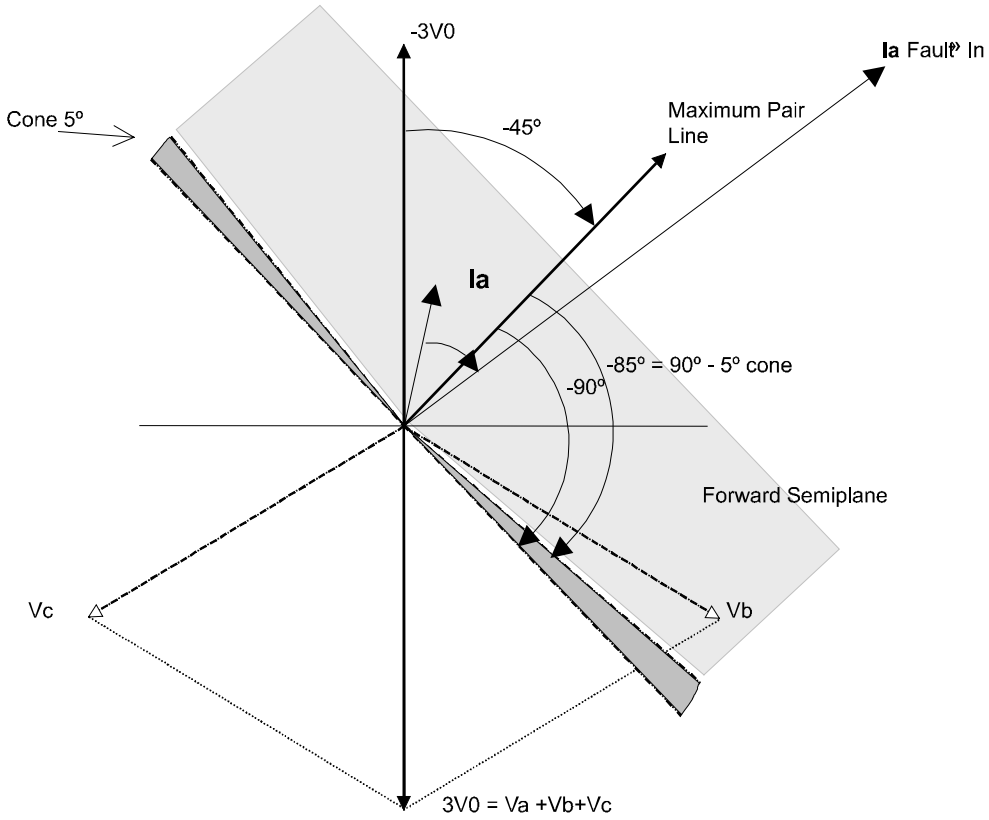



**Figure 2.3. Voltage Polarization**

The voltage polarization algorithm uses –Vn, that is, -(Va+Vb+Vc) = -3Vo, as a substitute for the voltage of the faulted phase. This magnitude can be rotated the desired angle to fix the maximum pair line and define the operative semiplane of the unit, following the rule that positive angles are counterclockwise. A typical setting is –45º, as shown in the figure. The operative semiplane is limited to +/-85º of the maximum pair line. Every time the operation magnitude, In, is inside this semiplane, the unit will consider that the direction is forward. In case the direction setting is FWD, the Pickup 67 signal will be active.

The minimum acceptable values, both for the polarization and operation magnitudes, have been taken as the 5% of the rated value. This means: The minimum In current for the unit to operate is 5% of the rated current (1 or 5 A); the minimum polarization voltage for the unit to operate is 5% of the rated phase-to-ground voltage, fixed in 3.5 V.

The voltage-polarized directional unit needs a typical time of 1 cycle (20ms @ 50 Hz) to polarize; this fact must be kept in mind when the overcurrent units are programmed adjusting the **Polarization loss (POL LOSS)** setting as PERMITTED. In this situation, it may occur, especially in testing processes, that the unit trips after faults in the opposite direction when voltage and current are applied at the same time starting from zero. As there is no previous polarization voltage, the overcurrent unit is ready to trip after any overcurrent situation (as stated by the POL LOSS setting), while the directional unit will need a complete cycle to polarize and indicate the right direction. If the current value is high enough to activate the overcurrent unit without a set time delay, the unit will trip before the directional function blocks the trip. In cases where this situation is foreseen, it is recommended to program the **POL LOSS** setting as BLOCKED or, otherwise, set a small time delay for the overcurrent unit in order for the directional unit to polarize and block the trip.

**OPERATION PRINCIPLES WITH CURRENT POLARIZATION**

Operation magnitude: In = $3I_0$, measured at the input terminals.

Polarization magnitude: Ip, measured at the input terminals.

In order to perform the current directional comparison, the relay uses as polarization magnitude the current value measured in the Ip input, terminals C5-C6, with input or “positive” through C5. This current is taken from the grounding of the source neutral (transformer or generator).

The direction is considered to be forward when the angle between both magnitudes is lower than 85º. Otherwise, the fault is considered to be reverse.

While any of the two magnitudes (operation and polarization) is under 5% of the corresponding rated current (1 or 5 A), the unit will be blocked and the 67 DISABLED signal will be active.

## 2.3. MODEL S PROTECTION UNITS (ISOLATED GROUND OR PETERSEN COIL SYSTEMS)

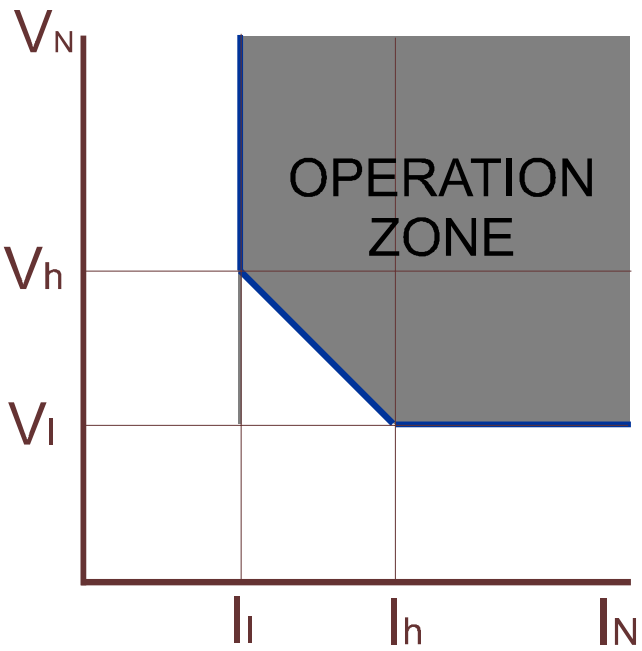
The MIN model for isolated ground or Petersen Coil systems incorporates two protection units, for isolated ground applications, called 67IG1 and 67IG2, or for Petersen Coil applications, 67PC1 and 67PC2.

The type of application must be selected in the General Settings group. If an Isolated Ground application is selected, then the unit will use 67IG1 and 67IG2 units. If a Petersen Coil application is selected, the unit will use 67PC1 and 67PC2 units.

### 2.3.1. OVERCURRENT UNITS FOR ISOLATED GROUND (67IG)

Two units for isolated ground 67IG1 and 67IG2 are independent. Their operation is based on the detection of a current value higher than the setting, with a supervision of neutral voltage. This allows to set the unit in a very sensitive way, with a very low current level, ensuring that the unit will not operate for very small mistakes of angle or CT ratio, as there is a voltage verification higher than the set value.

This verification of magnitudes is shown in the figure below:




IH, IL, VH and VL values that define the operation zone of the unit are selectable and independent for units 67IG1 and 67IG2. “H” magnitudes must be higher than “L” values. The relay will display and error message if we try to set an IH value lower or equal than IL, or VH lower or equal to VL.

67IG1 and 67IG2 units can be supervised by a directional unit, whose operation is the same as for 50N/51N units.

Once the unit has tripped, it will not be reset after a loss of directionality.

Using the input values of the relay, In and Vn, if the point (In,Vn) is inside the operation zone and if the directional unit (if enabled) allows it, the unit will pickup and starts the countdown of the set time delay. If a directional block appears during the countdown, the unit is reset. When the delay expires, the unit will trip. Once it has tripped, the relay cannot be blocked by the directional unit, and the trip will remain until the fault disappears, for a minimum time that is defined using the TRIP MIN TIME setting, in the General Setting group, inside Advanced Settings.

After the trip, a "Time to Instantaneous" timer is started, so that all pickups produced during this time cause an instantaneous trip. This means that, if after a trip the breaker is reclosed and the fault remains, or reappears after a few seconds, the trip will be instantaneous. If we wouldn't like to use this functionality, we only need to set the TIME TO INSTANTANEOUS timer to zero. Once the set time has expired, the unit goes back to normal operation.

The available settings for 67IG1 and 67IG2 units are the following:

**Enable unit 67IG (ENABLE 67IG):** Determines whether the unit is operative and can generate pickup and tripping events (when the trip is also enabled), that can be configured to close outputs, lit LEDs or trigger the oscillography.

**Enable unit 67IG trip (TRIP 67IG):** Allows the unit to trip. If we want this unit to generate a trip and close the tripping contact we must first enable the unit (previous setting) and then its trip. If the unit is enabled but the trip is not, the unit will produce digital pickup and virtual trip signals (when the unit has picked up and the timing has expired), that can be used to close outputs, lit LEDs or trigger the oscillography; but the unit will not close the general trip contact (not programmable).

**Time Delay for unit 67IG (TIME 67IG):** This setting determines the delay between the unit pickup and the trip, with a range of 0 to 99.99 seconds.

**Direction of the Directional Unit (DIR 67IG):** If we want to use a directional supervision, this setting must be set as **FWD** forward (In and Vn in opposite semiplanes, if the characteristic angle is zero) as explained before, or **REV** reverse, if the permission is in the opposite direction, or **NO** for no directional supervision.

**Time of deviation to instantaneous (TTI 67IG):** Time after the trip during which the protection units are instantaneous. It must be set to zero if we don't want to use this functionality..

**VH, VL, IH, IL:** These are the In and Vn values that define the plan in the operating zone, as already described. H and L stand for High and Low, therefore Vh and Ih must always be higher than Vl and Il.

**Characteristic Angle (ANG 67IG):** If we want to use directional supervision, this setting determines the angle that will rotate the polarization magnitude for defining the maximum pair line, which is the vector that will direct the operation semiplane. Positive values rotate counterclockwise. For rotating clockwise, we must select a negative value. As phase-to-ground fault currents in an isolated ground system are capacitive and therefore advanced 90º to the phase voltage, an adequate setting for this angle can be +90º.

### 2.3.2. OVERCURRENT UNITS FOR PETERSEN COIL (67PC)

MIN model S can be used in protection applications against ground faults in Petersen Coil systems. For this purpose, we must select Petersen as application in the APPLICATION setting inside the GENERAL SETTINGS group. This way, we have two protection units specifically developed for Petersen Coil systems.

These two units 67PC1 and 67PC2 are independent. Their operation is based on the detection of a current value higher than the setting, with a supervision of neutral voltage. This allows to set the unit in a very sensitive way, with a very low current level, ensuring that the unit will not operate for very small mistakes of angle or CT ratio, as there is a voltage verification higher than the set value.

Once the unit has tripped, this will be reset when the current, voltage or power (if the power algorithm is selected) fall below the pickup value. The loss of directionality will not cause a reset.

The power is calculated according to the following equation:

$$P = Vn * In * \cos(\varphi - \text{set } \varphi)$$

These units can also be supervised by a directional unit, as in the previously described case.

The available settings for 67PC1 and 67PC2 units are the following:

**Enable unit 67PC (ENABLE 67PC):** Determines whether the unit is operative and can generate pickup and tripping events (when the trip is also enabled), that can be configured to close outputs, lit LEDs or trigger the oscillography.

**Enable unit 67PC trip (TRIP 67PC):** Allows the unit to trip. If we want this unit to generate a trip and close the tripping contact we must first enable the unit (previous setting) and then its trip. If the unit is enabled but the trip is not, the unit will produce digital pickup and virtual trip signals (when the unit has picked up and the timing has

expired), that can be used to close outputs, lit LEDs or trigger the oscillography; but the unit will not close the general trip contact (not programmable).

**Enable the Power Supervision 67PC (POWER 67PC):** This setting must be active if we want the real power supervision algorithm to be used.

**Time Delay for unit 67PC (TIME 67PC):** This setting determines the delay between the unit pickup and the trip, with a range of 0 to 99.99 seconds.

**Direction of the Directional Unit (DIR 67PC):** If we want to use a directional supervision, this setting must be set as **FWD** forward (In and Vn in opposite semiplanes, if the characteristic angle is zero) as explained before, or **REV** reverse, if the permission is in the opposite direction, or **NO** for no directional supervision.

**Pickup Voltage, Pickup Current:** Vn and In values that must be exceeded for the unit to pickup.

**Characteristic Angle (ANG 67PC):** If we want to use directional supervision, this setting determines the angle that will rotate the polarization magnitude for defining the maximum pair line, which is the vector that will direct the operation semiplane. Positive values rotate counterclockwise. For rotating clockwise, we must select a negative value. As ground fault currents in a Petersen Coil system are purely resistive (if the neutralizer is perfectly sintonized to the capacity of the system so that it compensates it with the Petersen Coil inductance) and therefore in phase with Va voltage, an adequate setting for this angle can be 0º. This is the set φ angle in the power calculation equation.

**Opening Cone 67PC (CONE 67PC):** Directional units, as already described, typically fix the operation semiplane to +/-90º from the maximum pair line. In directional units, this angle uses to be corrected by 5º, so that the operative semiplane stays at +/-85º from the maximum pair line. In 67PC units, this angle is selectable between 0º and 45º.

**Power 67PC (P 67PC):** If we want to use the power supervision algorithm, this setting determines the minimum required power for the unit to operate. For the unit to pickup it is also necessary that Vn and In values are higher than their respective settings.

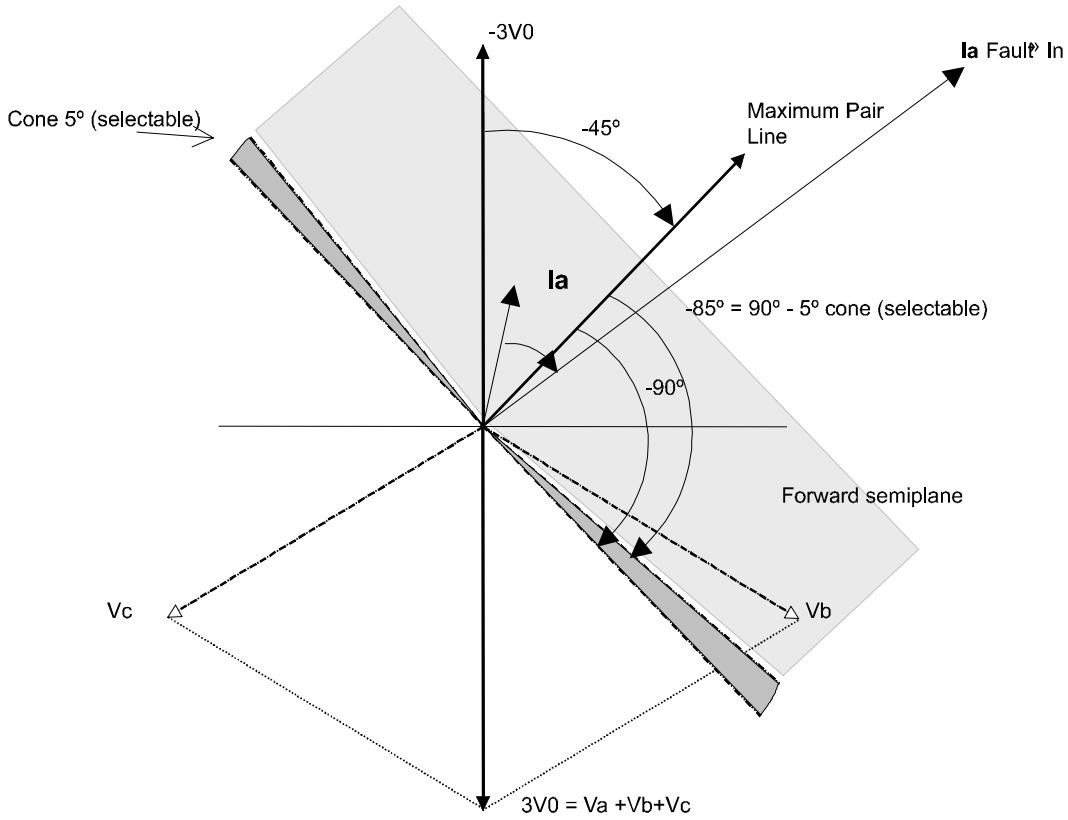



**Figure 2.4. Directional for units 67PC1 and 67PC2. Selectable Cone**

## 2.4. EVENTS

The MIN stores a historical record with the last 24 events. Each event contains the event description, date and time (1 ms accuracy), analog metering values at that moment (ground current, polarization current and ground voltage for model E; ground current and voltage for model S), and a summary of the status signals that can produce events, and whether they were activated or not in that moment.

In the M+PC there is a field called "**EVENTS**", where the user can check how many events have been produced since the last time that Events where deleted. If this number is higher than 24 (maximum number of events stored), this means that from all the produced events, only the last 24 are stored.

This event record is stored in a capacitor backed up RAM memory. This capacitor is charged while the relay is powered and is slowly discharged when the power is removed, maintaining the internal clock circuits and the RAM memory. The use of a capacitor avoids the need of maintenance that a battery would involve.

The whole MIN functionality related to events is performed from the M+PC software. It is possible to export the list of events, with the current values and associated internal flags, to a CSV format file (comma separated values), for its further analysis using different editors such as Excel, etc.

Inside the ADVANCED SETTINGS group, there is a sub-group called EVENT MASKS, from where the different causes that can produce events can be masked. They are detailed in the SETTINGS section. If an event mask is active, the event will not be issued and therefore it will not be stored in the event record.

Events are only accessible using M+PC software.

The following table shows a list of all possible events. In the case that two opposite situations occur, such as the pickup/dropout of a function, two events are issued, one for the pickup and another for the dropout.

| EVENTS - MODEL E | |
|---|---|
| 1 | Pickup/dropout unit 50NH |
| 2 | Pickup/dropout unit 50NL |
| 3 | Pickup/dropout unit 51NH |
| 4 | Pickup/dropout unit 51NL |
| 5 | Activation/deactivation unit 67N1 |
| 6 | Activation/deactivation unit 67N2 |
| 7 | Activation/deactivation of inhibition of unit 50NH by digital input |
| 8 | Activation/deactivation of inhibition of unit 50NL by digital input |
| 9 | Activation/deactivation of inhibition of unit 51NH by digital input |
| 10 | Activation/deactivation of inhibition of unit 51NL by digital input |
| 11 | Activation/deactivation of inhibition of unit 67N1 by digital input |
| 12 | Activation/deactivation of inhibition of unit 67N2 by digital input |
| 13 | Activation/deactivation of trip inhibition by digital input |
| 14 | Trip of unit 50NH |
| 15 | Trip of unit 50NL |
| 16 | Trip of unit 51NH |
| 17 | Trip of unit 51NL |
| 18 | General trip (of any protection unit) |
| 19 | Blocking/unblocking unit 67N1 |
| 20 | Blocking/unblocking unit 67N2 |
| 21 | Activation/deactivation of the protection. (for being activated, the relay must be in service (READY), and at least one of the protection units must be activated) |

| EVENTS - MODEL E | |
|---|---|
| 22 | Activation/deactivation of Auxiliary Output 1 |
| 23 | Activation/deactivation of Auxiliary Output 2 |
| 24 | Activation/deactivation of Auxiliary Output 3 |
| 25 | Activation/deactivation of Auxiliary Output 4 |
| 26 | Activation/deactivation of Digital Input 1 |
| 27 | Activation/deactivation of Digital Input 2 |
| 28 | Activation/deactivation of the settings change inhibition by digital input |
| 29 | Activation of the trip by digital input |
| 30 | Activation of the trip by command |
| 31 | LED and latched outputs reset |
| 32 | Close breaker operation |
| 33 | Table change by digital input (see section 5, Settings) |
| 34 | Oscillography trigger by digital input |
| 35 | Oscillography trigger by communications |
| 36 | 52B open/closed. (digital input status) |
| 37 | Breaker status (note 1)<br>(For MIN units, it coincides with the digital input status. Other units such as MIF use current detectors to determine the breaker status if a 52B input is not configured. |
| 38 | Settings Change |
| 39 | EEPROM Error |
| 40 | Activation/deactivation of user settings (it is activated when the user first modifies a setting) |

| EVENTS – MODEL S | |
|---|---|
| 1 | Pickup/dropout unit 67IG1 |
| 2 | Pickup/dropout unit 67IG2 |
| 3 | Pickup/dropout unit 67PC1 |
| 4 | Pickup/dropout unit 67PC2 |
| 5 | Activation/deactivation of inhibition of unit 67IG1 by digital input |
| 6 | Activation/deactivation of inhibition of unit 67IG2 by digital input |
| 7 | Activation/deactivation of inhibition of unit 67PC1 by digital input |
| 8 | Activation/deactivation of inhibition of unit 67PC2 by digital input |
| 9 | Activation/deactivation of trip inhibition by digital input |
| 10 | Trip of unit 67IG1 |
| 11 | Trip of unit 67IG2 |
| 12 | Trip of unit 67PC1 |
| 13 | Trip of unit 67PC2 |
| 14 | General Trip (of any protection unit) |
| 15 | Activation/deactivation of the protection: for the protection to be activated, the relay must be in service (READY) and at least one of the protection units must be active |
| 16 | Activation/deactivation of auxiliary output 1 |
| 17 | Activation/deactivation of auxiliary output 2 |
| 18 | Activation/deactivation of auxiliary output 3 |
| 19 | Activation/deactivation of auxiliary output 4 |
| 20 | Activation/deactivation of digital input 1 |
| 21 | Activation/deactivation of digital input 2 |
| 22 | Activation/deactivation of the settings change inhibition by digital input |
| 23 | Activation of the trip by digital input |
| 24 | Activation of the trip by command |
| 25 | LED and latched outputs reset |
| 26 | Close breaker operation |
| 27 | Table change by digital input (see section 5, Settings) |
| 28 | Oscillography trigger by digital input |
| 29 | Oscillography trigger by communications |
| 30 | 52B open/closed. (digital input status) |
| 31 | Breaker status (note 1)<br>(For MIN units, it coincides with the digital input status. Other units such as MIF use current detectors to determine the breaker status if a 52B input is not configured. |
| 32 | Settings Change |
| 33 | EEPROM Error |
| 34 | Activation/deactivation of user settings (it is activated when the user first modifies a setting) |

## 2.5. OSCILLOGRAPHY

The MIN stores an oscillography record, with a resolution of 8 samples per cycle, and a length of 24 cycles (the 2 first being pre-fault cycles), every time the oscillography is triggered.

The oscillography record is stored in capacitor backed up RAM memory, that maintains the information during more than one week in the event of lack of power supply.

Oscillography is retrieved using M+PC software and is stored on the PC in a COMTRADE-IEEE C37.111-1991 format.

There are several reasons that can produce an oscillography trigger. They can be activated and deactivated by the user. For this purpose, the ADVANCED SETTINGS group incorporates a sub-group called OSCILLOGRAPHY MASKS, from where the user can mask the selected causes. The reasons for an oscillography trigger are:

- Pickup of one of the protection functions
- Trip of one of the protection functions
- Oscillography trigger by communications
- Oscillography trigger by digital input

The oscillography record includes the following information:

| **OSCILLOGRAPHY RECORD - MODEL E** | | |
|---|---|---|
| **Analog Channels** | | |
| 1 | In 1A | Ground current channel In 1 A (A) |
| 2 | In 5A | Ground current channel In 5 A (A) |
| 3 | Ip | Polarization current channel Ip (A) |
| 4 | Vn | Polarization voltage channel (ground voltage) Vn (V) |
| **Digital Channels** | | |
| 1 | 50NH pickup | Pickup of unit 50NH |
| 2 | 50NL pickup | Pickup of unit 50NL |
| 3 | 51NH pickup | Pickup of unit 51NH |
| 4 | 51NL pickup | Pickup of unit 51NL |
| 5 | 67N1 pickup | Pickup of unit 67N1 |
| 6 | 67N2 pickup | Pickup of unit 67N2 |
| 7 | General Pickup | General pickup (of any protection unit) |
| 8 | 50NH Disable (by di) | Disable unit 50NH by digital input |
| 9 | 50NL Disable (by di) | Disable unit 50NL by digital input |
| 10 | 51NH Disable (by di) | Disable unit 51NH by digital input |
| 11 | 51NL Disable (by di) | Disable unit 51NL by digital input |
| 12 | 67N1 Disabled (by di) | Disable unit 67N1 by digital input |
| 13 | 67N2 Disabled (by di) | Disable unit 67N2 by digital input |
| 14 | DI all functions Disabled | Disable all protection units by digital input |
| 15 | 50NH Trip | Trip of unit 50NH |
| 16 | 50NL Trip | Trip of unit 50NL |
| 17 | 51NH Trip | Trip of unit 51NH |
| 18 | 51NL Trip | Trip of unit 51NL |

| OSCILLOGRAPHY RECORD - MODEL E | | |
|---|---|---|
| 19 | General trip | General trip (of any protection unit) |
| 20 | 67N1 disable | Disable unit 67N1 by lack of current/voltage level |
| 21 | 67N2 disable | Disable unit 67N2 by lack of current/voltage level |
| 22 | TRIP | Trip |
| 23 | READY | Relay in Service |
| 24 | Output 1 | Auxiliary output 1 |
| 25 | Output 2 | Auxiliary output 2 |
| 26 | Output 3 | Auxiliary output 3 |
| 27 | Output 4 | Auxiliary output 4 |
| 28 | Input 1 | Digital input 1 |
| 29 | Input 2 | Digital input 2 |
| 30 | Breaker 52B | Breaker 52B contact input |
| 31 | Breaker Closed | Breaker closed (in the MIN it is the 52B status) |
| 32 | Table change | Table change |
| 33 | EEPROM failure | EEPROM failure |
| 34 | User settings | User settings |
| **Other Information** | | |
| Date and time | | |
| Model | | |

| OSCILLOGRAPHY RECORD - MODEL S | | |
|---|---|---|
| **Analog Channels** | | |
| 1 | In | Ground current channel (A) |
| 2 | Vn | Ground voltage channel Vn (V) |
| **Digital Channels** | | |
| 1 | 67IG1 pickup | Pickup of unit 67IG1 |
| 2 | 67IG2 pickup | Pickup of unit 67IG2 |
| 3 | 67PC1 pickup | Pickup of unit 67PC1 |
| 4 | 67PC2 pickup | Pickup of unit 67PC2 |
| 5 | General pickup | General pickup (of any protection unit) |
| 6 | 67IG1 Disable (by di) | Disable unit 67IG1 by digital input |
| 7 | 67IG2 Disable (by di) | Disable unit 67IG2 by digital input |
| 8 | 67PC1 Disable (by di) | Disable unit 67PC1 by digital input |
| 9 | 67PC2 Disable (by di) | Disable unit 67PC2 by digital input |
| 10 | DI all functions disable | Disable all protection units by digital input |
| 11 | 67IG1 Trip | Trip of unit 67IG1 |
| 12 | 67IG2 Trip | Trip of unit 67IG2 |
| 13 | 67PC1 Trip | Trip of unit 67PC1 |
| 14 | 67PC2 Trip | Trip of unit 67PC2 |
| 15 | General Trip | General trip (of any protection unit) |
| 16 | TRIP | Trip |
| 17 | READY | Relay in service |
| 18 | Output 1 | Auxiliary output 1 |
| 19 | Output 2 | Auxiliary output 2 |
| 20 | Output 3 | Auxiliary output 3 |
| 21 | Output 4 | Auxiliary output 4 |
| 22 | Input 1 | Digital input 1 |
| 23 | Input 2 | Digital input 2 |
| 24 | Breaker 52B | Breaker 52B contact input |
| 25 | Breaker Closed | Breaker closed (in the MIN it is the 52B status) |
| 26 | Table change | Table change |
| 27 | EEPROM failure | EEPROM failure |
| 28 | User settings | User settings |
| **Other Information** | | |
| Date and time | | |
| Model | | |

## 2.6. SETTING TABLES

Two independent Settings Groups are available in the permanent (non-volatile) memory of the MIN relay. Only one of the two is active at a given time. User can select which settings group is active using a setting, sending a command to the relay from the communications program, or by a digital input.

Settings are divided in two different categories: Main Settings and Advanced Settings. This makes setting the relay extremely simple for those users who want to use just the Main functions of the MIN relay. For those users who need to use the full functionality of the relay, the Advanced Settings must be used.

| **MODEL E** | |
|---|---|
| **MAIN SETTINGS** | **ADVANCED SETTINGS** |
| General Settings | General Advanced Settings |
| Function 50NH Settings | Function 50NH Settings (Table 2) |
| Function 50NL Settings | Function 50NL Settings (Table 2) |
| Function 51NH Settings | Function 51NH Settings (Table 2) |
| Function 51NL Settings | Function 51NL Settings (Table 2) |
| Function 67N1 Settings | Function 67N1 Settings (Table 2) |
| Function 67N2 Settings | Function 67N2 Settings (Table 2) |
| | User Curve |
| | Event Mask |
| | Oscillography Mask |
| **MODEL S** | |
| **MAIN SETTINGS** | **ADVANCED SETTINGS** |
| General Settings | General Advanced Settings |
| Function 67IG1 Settings | Function 67IG1 Settings (Table 2) |
| Function 67IG2 Settings | Function 67IG2 Settings (Table 2) |
| Function 67PC1 Settings | Function 67PC1 Settings (Table 2) |
| Function 67PC2 Settings | Function 67PC2 Settings (Table 2) |
| | Event Mask |
| | Oscillography Mask |

## 2.7. MONITORING AND METERING FEATURES

### 2.7.1. MEASUREMENT

#### 2.7.1.1. SCROLLING SCREEN

The MIN displays sequentially the following measures:

| MODEL E | MODEL S |
|---|---|
| Ground current, $I_n$ | Ground current, $I_n$ |
| Polarization current ($I_p$) | Ground Voltage ($V_n$) |
| Ground Voltage ($V_n$) | Active Power (P) |
| Apparent Power (S) | |

Current measures are displayed in secondary values and their accuracy is ±3% in the complete range.

The metering information is displayed through the front display in a scrolling menu.

#### 2.7.1.2. SINGLE-KEY SCREEN

By pressing the Enter key on the MIN keypad, the unit displays the same metering information as above. Besides, it will display also the following information:

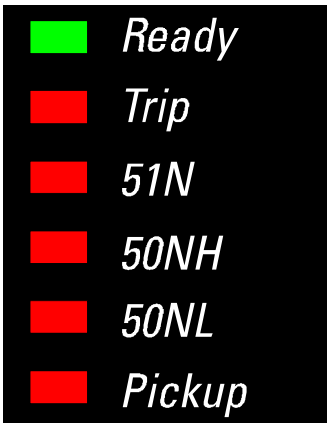
| MODEL E | MODEL S |
|---|---|
| Angle In, Vn (see Note 1) | Angle In, Vn (see Note 1) |
| Angle In, Ip | Current date / time |
| Current date / time | Last trip unit (protection function that has tripped) |
| Last trip unit (protection function that has tripped) | In and Vn values during the trip |
| In, Ip and Vn values during the trip | Last trip date and time |
| Last trip date and time | Reset (if we press the Enter key for more than 3 seconds while the RESET message is on the display, LEDs and latched outputs will be reset). |
| Reset (if we press the Enter key for more than 3 seconds while the RESET message is on the display, LEDs and latched outputs will be reset). | |

***Note 1**: A displayed value of 90º indicates that In is 90º behind Vn. Assuming a counterclockwise rotation, the voltage phasor could point 12 (in the clock), while the current phasor points 3. Displayed angles are always positive.*

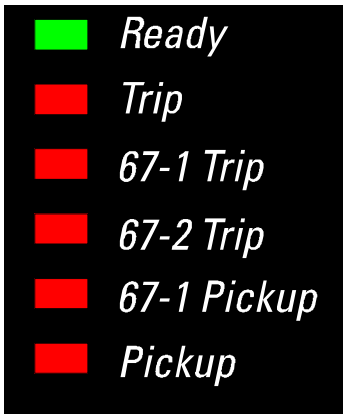
## 2.8. USER INTERFACE

### 2.8.1. LED TARGETS

There are 6 LED Targets in the faceplate of the MIN. The first one is green and has the 'READY' (relay in service) fixed meaning (cannot be configured); the second one is red and fixed for trip, while the other 4 are red and can be configured by the user. The default configuration of the LEDs is as follows:




**MIN-E LEDs DEFAULT CONFIGURATION**




**MIN-S LEDs DEFAULT CONFIGURATION**

The meaning of each LED is as follows:

- **READY**: The relay is powered up, its power supply is receiving Vdc or Vac, and all the internal circuits are working properly. **The relay status setting is set as "RDY" (ready) and at least one of the protection functions is enabled, its trip is also enabled, and it is not inhibited by a digital input**. This LED not being lit in the previous mentioned conditions indicates lack of auxiliary supply voltage or an internal HW/SW critical failure condition.
- **TRIP**: The relay has issued a trip, activating the corresponding tripping output contact.
- **51N**: 51N unit has tripped (51NH or 51NL)
- **50NH**: 50NH unit has tripped
- **50NL**: 50NL unit has tripped
- **67-1 Trip**: 67-1 unit has tripped (67IG1 or 67PC1)
- **67-2 Trip**: 67-2 unit has tripped (67IG2 or 67PC2)
- **67-1 Pickup**: 67-1 unit has picked up (67IG1 or 67PC1)
- **PICKUP**: Points out that at least one of the protective units has picked up.

LEDs associated to tripping functions are latched and once they have been lit up, they remain lit up until the ENTER key is pressed for more than 3 seconds (RESET) provided that the trip condition has disappeared. The LED associated to function pickup is auto-reset type, and lights up while the pickup condition (current above setting) exists.

### 2.8.2. KEYPAD AND DISPLAY

A three-key keypad allows access to the MIN relay information and allows settings change. Measurement data (actual values), last trip information (fault report) and settings are shown on the 3.5 characters dots-display. Only by using a PC, the M+PC program and a communications cable the user can access to all the internal information in the relay, as the list of events and oscillography data cannot be shown on the small faceplate display. Access to I/O configuration and logical configuration is also possible only via PC.

### 2.8.3. COMMUNICATIONS PORTS

The faceplate RS232 and the rear RS485 port provides an easy to use Human interface. All serial ports use the Modbus® RTU protocol and may be connected to system computers with baud rates from 300 to 19200 bps. Up to 32 MIN relays can be connected (daisy-chained) on the same communication circuit. Each relay must be assigned a different Modbus Address (using a setting) if multiple relays are connected on the same circuit.

### 2.8.4. SOFTWARE

MIN units are supply together with M+PC software, a Windows® based software allowing communication with the relay for data view and retrieval, as well as oscillography, I/O configuration and logical configuration.

The last version available of this software can be found at http://www.geindustrial.com/pm/software/min/index.htm

## 2.9. M FAMILY

M Family relays offer the possibility to be combined in a customized system, offering similar features to those supplied with higher functionality relays. An M+ system offers the advantage of each relay being independent, with its own power supply, tripping contacts, etc., offering higher flexibility and dependability in the case of an eventual failure. If one of the unit fails, the rest of the system is not affected and continues to operate normally.

Each M product is built as a stand alone draw-out module containing all functionally required elements such as CT/VTs, I/O, power supply, CPU etc. MIF, MIN, MIN and MIW products are built in 4'' wide modules, while MIV and MIR products are built in 2'' wide modules. These modules can be plugged into an M050 half 19'' rack case or an M100 full 19'' rack case. M050 cases can hold a maximum of 8'' in total module length (i.e. 2 MIF modules or 1 MIN and 2 MIV modules), while the M100 case can hold a maximum of 16'' in total module length (i.e. 4 MIFs, 2 MIN and 4 MIVs, or 8 MIV modules).

If you want to have several M Family relays in an M system, you must select the models finished in S, and include in your order an M050 or M100 case. This way, you will not receive spare relays, but all mounted in system.

Some application examples for this kind of systems are:

**Cogeneration**: Combination of a MIF (overcurrent) + MIV (voltage and frequency) + M050 rack

**Transformers**: MIF-P (50P/51P) + MIF-N (50N/51N) + MIF-N (cube protection) + M100 rack

**Generators**: MIG (machine protection) + MIV (voltage and frequency) + MIF (overcurrent) + M100 rack

**Feeders**: MIN (50/51 directional phase A) + MIN (50/51 directional phase B) + MIN (50/51 directional ground)

## 2.10. MODEL LIST. ORDER CODES

The MIN has a draw-out construction, 4U high and ¼ of a 19" rack wide. The MIN relays can be mounted in ¼ rack cases, one relay per case, or as an alternative they can be supplied in half or full 19'' rack cases, including several MIN relays (or different types of M family relays) in the same case.

The information required to completely specify the relay is provided in the following table. MIN units incorporate a double current input, one for 1 A rated current and another for 5 A. This way, we reduce the number of different models to be ordered as spares.

**Table 2.1: - ORDER CODES**

| MIN | - | - | 0 | - | E | 0 | 0 | 0 | - | 0 | 0 | - | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **N** | | | | | | | | | | | | Basic model |
| | **L** | | | | | | | | | | | | With logic for teleprotection schemes (see Note 1) |
| | | **A** | | | | | | | | | | | ANSI Curves |
| | | **I** | | | | | | | | | | | IEC Curves (see Note 2) |
| | | | | | | | | | | | | | **Application** |
| | | | | **E** | | | | | | | | | Grounded system (In = 1 or 5 A) |
| | | | | **S** | | | | | | | | | Isolated ground / Petersen Coil |
| | | | | | | | | | | | | | **Power Supply:** |
| | | | | | | | | | **F** | | | | 24-48 Vdc (Range: 19~58 Vdc) |
| | | | | | | | | | **H** | | | | 110-250 Vdc (Range: 88~300 Vdc)<br>110-240 Vac (Range: 88~264 Vac) |
| | | | | | | | | | | | | **C** | Individual relay |
| | | | | | | | | | | | | **S** | Mounted in a M+ System (see Note 3) |

***Note 1:*** *Teleprotection schemes require two MIN units to be installed, one at each end of the line, and to connect them using a signal transmission system (contact status). They allow to clear line faults very quickly, when both units detect the fault in the same direction, towards the line. Implemented schemes are POTT, POTT1 (adds a supervision with the block units), Block and Hybrid (with signal echo and weak terminal tripping function).*

***Note 2:*** *For Isolated Ground/Petersen Coil applications (model S), which doesn't incorporate 51N units, this option must always be an **"I"**.*

***Note 3:*** *If relays are to be mounted in an M+ system, then either an M050 half 19'' rack or M100 full 19'' must be ordered. The M050 and M100 racks are provided at no additional cost.*

**ACCESSORIES**

A depth reducing collar can be ordered separately. This collar reduces the mounting depth in 63 mm (2.48 inches).

## 2.11. TECHNICAL SPECIFICATIONS.

**SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE**

### 2.11.1. PROTECTION UNITS MODEL E

**GROUND TIME OVERCURRENT (51NH, 51NL)**

| | |
|---|---|
| Current | Fundamental |
| Pickup level | 0.1 – 2.4 In in steps of 0.01 |
| Dropout level | 97-98% of the pickup level |
| Accuracy | 3% in the whole range. 1% typical at rated current. |
| Curves | IEC or ANSI (depending on model) |
| | Adjustable to: inverse, very inverse, extremely inverse, user curve. |
| | Timing: 0.00 to 99.99 s in steps of 0.01 s. |
| Reset type | Instantaneous |
| Timing accuracy | 5% of the operation time or 30 ms (whichever is greater) for In > 1.5 times the pickup level. |

**GROUND INSTANTANEOUS OVERCURRENT (50NH, 50NL)**

| | |
|---|---|
| Current | Fundamental |
| Pickup level | 0.1 – 30 In in steps of 0.01 |
| Dropout level | 97-98% of the pickup level |
| Accuracy | 3% in the whole range. 1% typical at rated current. |
| Overreach | < 2% |
| Timing | 0.00 to 99.99 s in steps of 0.01 s |
| Reset type | Instantaneous |
| Timing accuracy | 5% of the operation time or 30 ms (whichever is greater) for In > 1.5 times the pickup level. |

**DIRECTIONAL UNIT (67N1, 67N2)**

| | |
|---|---|
| Current and voltage | Fundamental |
| Polarization | Voltage (Vn) and or current (Ip) for model E. |
| | Selectable between (Vn), (Ip), (Ip and Vn), (Ip or Vn). |
| Characteristic angle | -90º to +90º in steps of 1º. |
| Angle measure accuracy | ±5º in the range of 20%-200% of In and Vn. |
| Operation time | Typical: 1 network cycle. (20ms @ 50Hz, 17ms @ 60Hz) |

**GROUND TIME OVERCURRENT (67IG1, 67IG2)**

| | |
|---|---|
| Current and voltage | Fundamental |
| Pickup level | Current: 0.005 – 0.4 A in steps of 0.001 A |
| | Voltage: 2 – 70 V in steps of 0.01 V |
| Dropout level | 97-98% of the pickup level |
| Accuracy | 3% in the whole range. 1% typical at rated value. |
| Reset type | Instantaneous |
| Timing accuracy | 5% of the operation time or 30 ms (whichever is greater) for In and Vn > 1.5 times the pickup level. |

**INTRINSIC DIRECTIONAL UNIT**

| | |
|---|---|
| Current and voltage | Fundamental |
| Polarization | By Vn voltage. |
| Characteristic angle | -90º to +90º in steps of 1º. |
| Angle measuring accuracy | ±5º in the range of 20%-200% of In and Vn. |
| Operation time | Typical: 1 network cycle (20ms at 50Hz, 17ms at 60Hz) |

**GROUND TIME OVERCURRENT FOR PETERSEN COIL (67PC1, 67PC2)**

| | |
|---|---|
| Current, voltage and power (optional) | Fundamental |
| Pickup level | Current: 0.005 – 0.4 A in steps of 0.001 A |
| | Voltage: 2 – 70 V in steps of 0.01 V |
| | Power: 0.01 – 4.5 W |
| Dropout level | 97-98% of the pickup value |
| Accuracy | 3% in the whole range. 1% typical at rated value. |
| Reset type | Instantaneous |
| Timing Accuracy | 5% of the operation time or 30 ms (whichever is greater) for In, Vn and P > 1.5 times the pickup level. |

**INTRINSIC DIRECTIONAL UNIT**

| | |
|---|---|
| Current and Voltage | Fundamental |
| Polarization | By Vn voltage |
| Characteristic angle | 0º to +180º in steps of 1º. |
| Operation plane definition cone opening | 0º to 45º in steps of 1º. |
| Angle measuring accuracy | ±5º in the range of 20%-200% of In and Vn. |
| Operation time | Typical: 1 network cycle. (20ms at 50Hz, 17ms at 60Hz) |

### 2.11.3. METERING FUNCTIONS

| | |
|---|---|
| Accuracy | ±3% in the whole range. 1% typical at rated value. |

### 2.11.4. INPUTS

**AC CURRENT**

| | |
|---|---|
| Secondary rated current | **Model E** |
| | Channel 1: 1 A, terminals C1–C2 |
| | Channel 2: 5 A, terminals C3–C4 |
| | Channel 3: 5 A (polarization by current), terminals C5–C6 |
| | **Model S** |
| | Channel 1: 1 A, terminals C5–C6 |
| Frequency | 50/60 Hz (selectable by setting) |
| Consumption | < 0.2 VA at secondary rated current |
| Maximum permissible current | 100 times the rated current during 1 second |
| | 4 times the rated current continuously |

**AC VOLTAGE**

| | |
|---|---|
| Secondary rated voltage | *Model E* |
| | Channel 4: 110/120 V CA, terminals C7–C8 |
| | *Model S* |
| | Channel 2: 110/120 V CA, terminals C7–C8 |
| Frequency | 50/60 Hz |
| Consumption | < 0.2 VA @ secondary rated voltage |
| Maximum permissible voltage | 440 Vca permanent |

**DIGITAL INPUTS**

| | |
|---|---|
| Wet contacts | 300 Vdc maximum in permanence |
| Acknowledgement time | < ¼ cycle |
| | For pulse input: 1 cycle. |

### 2.11.5. POWER SUPPLY

**LOW RANGE**

| | |
|---|---|
| DC Rated Voltage | 24 to 48 Vdc |
| Maximum/minimum DC voltage | 19/60 Vdc |

**HIGH RANGE**

| | |
|---|---|
| DC Rated Voltage | 110 to 250 Vdc |
| Maximum/minimum DC Voltage | 88/300 Vdc |
| AC Rated Voltage | 110 to 220 Vac @ 48-62 Hz |
| Maximum/minimum AC Voltage | 88/264 Vac @ 48-62 Hz |
| Consumption | max. 10W |
| Maintenance of records (date, time and event memory) without auxiliary voltage | > 1 week |

## 2.11.6. OUTPUTS

**TRIPPING CONTACTS**

**Contact Capacity**

| | |
|---|---|
| Maximum operation voltage | 440 Vac |
| Continuous: | 16 A |
| Make and Carry: | 48 A |
| Breaking capacity: | 4000 VA |

**OUTPUT RELAYS**

| | |
|---|---|
| Configuration: | 6 commuted electromechanical |
| Contact material: | Silver alloy for inductive loads |

**Maximum ranges for 100000 operations:**

| VOLTAGE | MAKE AND CARRY (Continuous) | MAKE AND CARRY 0.2 seconds | BREAK | MAXIMUM LOAD |
|---|---|---|---|---|
| **CC Resistive** | | | | |
| 24 Vdc | 16 A | 48 A | 16 A | 384W |
| 48 Vdc | 16 A | 48 A | 2.6 A | 125W |
| 125 Vdc | 16 A | 48 A | 0.6 A | 75 W |
| 250 Vdc | 16 A | 48 A | 0.5 A | 125 W |
| **CC Inductive** | | | | |
| 24 Vdc | 16 A | 48 A | 8 A | 192 W |
| 48 Vdc | 16 A | 48 A | 1.3 A | 62 W |
| 125 Vdc | 16 A | 48 A | 0.3 A | 37.5 W |
| 250 Vdc (L/R=40ms) | 16 A | 48 A | 0.25 A | 62.5 W |
| **AC Resistive** | | | | |
| 120 Vac | 16 A | 48 A | 16 A | 1920 VA |
| 250 Vac | 16 A | 48 A | 16 A | 4000 VA |
| **AC Inductive** | | | | |
| FP = 0.4 | | | | |
| 120 Vac | 16 A | 48 A | 11.2 A | 1344 VA |
| 250 Vac | 16 A | 48 A | 11.2 A | 2800 VA |

## 2.11.7. COMMUNICATIONS

| | | |
|---|---|---|
| FRONT PORT | RS232 | 300, 600, 1200, 2400, 4800, 9600 and 19200 bps, Modbus® RTU |
| REAR PORT | RS485 | 300, 600, 1200, 2400, 4800, 9600 and 19200 bps, Modbus® RTU |

### 2.11.8. AMBIENT CONDITIONS

| | |
|---|---|
| Operation temperature range | -20º C to +60º C |
| Storage temperature range | -40º C to +80º C |

### 2.11.9. TYPE TESTS AND CERTIFICATIONS

**The MIN system complies with the following standards, which include the standards required by Community Directive 89/336 for the CE marking, 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 60255-5 | 2kV, 50/60 Hz 1 min |
| **Surge Test Voltage:** | IEC 60255-5 | 5 kV, 0.5 J. (3 positive pulses and 3 negative.) |
| **1 MHz Interference:** | IEC 60255-22-1 | III |
| **Electrostatic Discharge:** | IEC 60255-22-2 | IV |
| | EN 61000-4-2 | 8 kV in contact, 15 kV through air. |
| **Radiointerference:** | IEC 60255-22-3: | III |
| | | 40 MHz, 151 MHz, 450 MHz and cellular phone. |
| **Radiated Electromagnetic fields with amplitude modulation.** | ENV 50140 | 10 V/m |
| **Radiated Electromagnetic fields with amplitude modulation. Common mode.** | ENV 50141 | 10 V/m |
| **Radiated Electromagnetic fields with frequency modulation.** | ENV 50204 | 10 V/m |
| **Fast Transients:** | ANSI/IEEE C37.90.1 | IV |
| | IEC 60255-22-4 | IV |
| | BS EN 61000-4-4 | IV |
| **Magnetic fields at industrial frequency:** | EN 61000-4-8 | 30 AV/m |
| **Power Supply interruptions:** | IEC 60255-11 | |
| **Temperature:** | IEC 57 (CO) 22 | |
| **RF Emission:** | EN 55011 | B |
| **Sinusoidal Vibration:** | IEC 60255-21-1 | II |
| **Shock:** | IEC 60255-21-2 | I |

### 2.11.10. PRODUCTION TESTS

**Insulation Test**: IEC255-5 (Tested on CTs, Power Supply terminals, Contact Inputs and Contact Outputs) 2500 Vrms, 50 Hz, 1 s.

### 2.11.11. APPROVALS

- Manufactured under an ISO9001Registered system.
- CE Marking.

# 3. HARDWARE

## 3.1. DESCRIPTION

### 3.1.1. RELAY IDENTIFICATION

The complete model number of the relay is shown on the faceplate. Figure 3.1 shows the faceplate of the relay.


**Figure 3.1. FACEPLATE AND IDENTIFICATION OF MIN RELAY**

### 3.1.2. PANEL CUTOUT

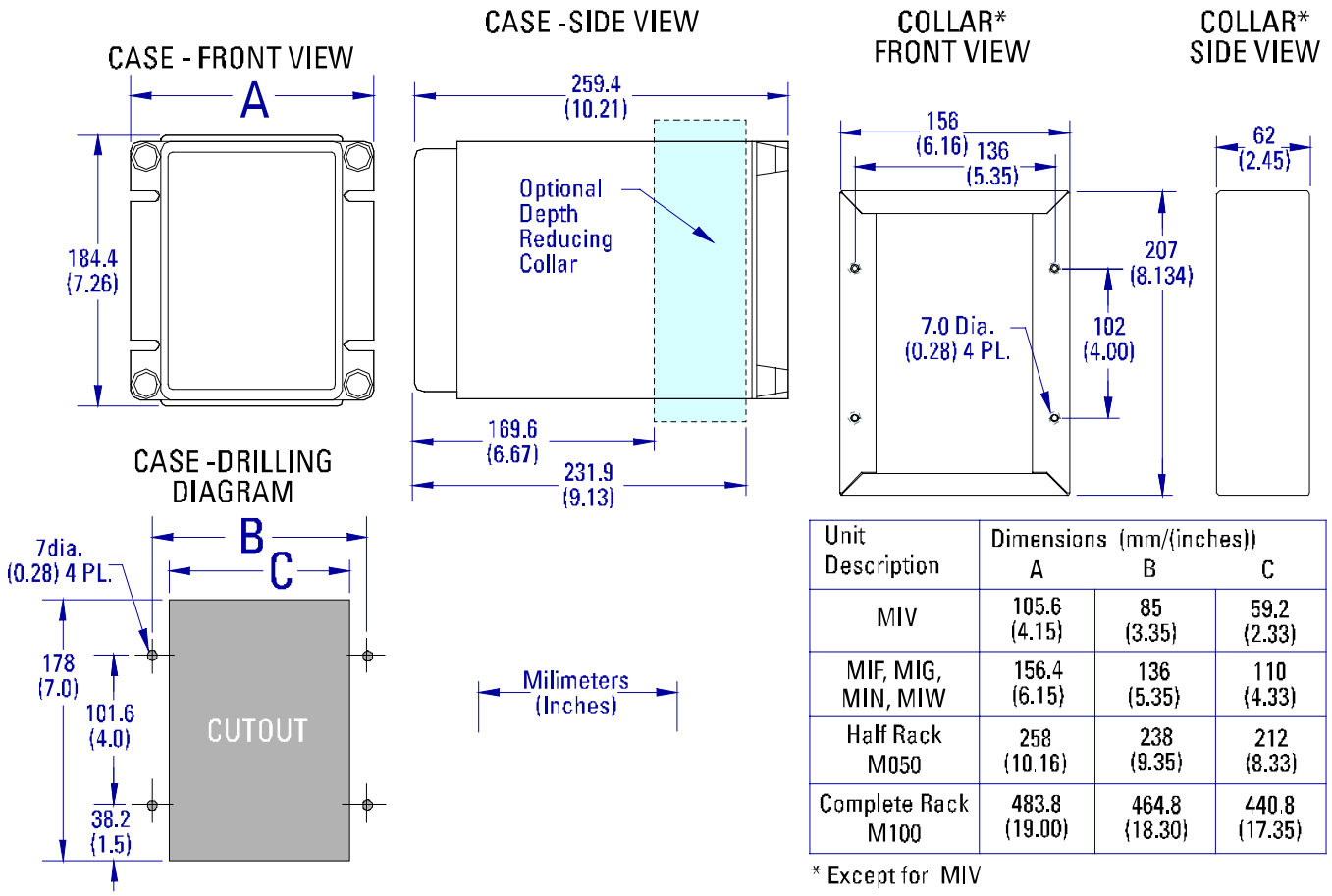
The MIN case is made from corrosion resistant stainless steel. Case dimensions, along with panel cutout details for panel mounting are shown in figure 3.2.

The modular design allows the relay to be easily upgraded or repaired by a qualified person.

The relay is provided with a plastic lid that fits over the faceplate, sealing the relay hermetically, avoiding dust coming into the relay.

The relay must be mounted such that the faceplate sits semi-flush with the panel or switchgear door, allowing the operator access to the keypad and the RS232 communications port. The relay is secured to the panel with the use of four screws supplied with the relay.

**Note**: Dimensions are shown in mm, and in inches between parenthesis.




| Unit Description | Dimensions (mm/(inches)) A | B | C |
|---|---|---|---|
| MIV | 105.6 (4.15) | 85 (3.35) | 59.2 (2.33) |
| MIF, MIG, MIN, MIW | 156.4 (6.15) | 136 (5.35) | 110 (4.33) |
| Half Rack M050 | 258 (10.16) | 238 (9.35) | 212 (8.33) |
| Complete Rack M100 | 483.8 (19.00) | 464.8 (18.30) | 440.8 (17.35) |

* Except for MIV

**Figure 3-2A. MOUNTING AND DIMENSIONS DRAWING FOR M FAMILY UNITS**

### 3.1.3. MODULE WITHDRAWAL / INSERTION

The modular design of the relay allows for the withdrawal and insertion of the hardware module, without the need to short circuit the current inputs, as its rear connector is specially designed to connect short-circuit bars to these inputs when the module is extracted.

**WARNING: MODULE WITHDRAWAL AND INSERTION SHALL ONLY BE PERFORMED BY DULY QUALIFIED SERVICE PERSONNEL WHEN CONTROL POWER HAS BEEN REMOVED FROM THE UNIT**

**Figure 3-3: MIN HARDWARE MODULE WITHDRAWAL / INSERTION**

**WITHDRAWAL**: Remove the methacrylate cover on the faceplate, loosing the four screws located on the four corners of the cover. Then loose the small screws that keep the faceplate in place and pull from the knobs located on the upper and lower side of the faceplate. Before performing this action **control power must be removed from the relay**. Current inputs are automatically shorted back in the terminal block when the module is withdrawn.

**INSERTION**: Proceed inversely to the withdrawal procedure. Press the module firmly in the case, using the knobs, until it is completely inserted. Once this is done, bolt the screws of the faceplate and replace the control power. Check if the relay is fully operative. Finally, replace the methacrylate cover.

### 3.1.4. WIRING AND INTERNAL CONNECTIONS

The electrical connection with the substation AC/DC wires is done on the three terminal blocks, at the rear part of the relay case. Each terminal block has 12 terminals (M3, 3 mm diameter).

Current inputs are also located on one of the three terminal blocks, at the rear. This terminal block is designed to withstand the secondary currents of the substation CTs. The internal wires taking the currents are of greater section than the rest of the internal wires for the relay inputs. They have been designed to have the shortest length possible, to minimise the burden in the primary CTs. Internal connections are done through pressing terminals. The internal current wires are separated from the rest, to minimise the magnetic coupling (associated to high input currents) on other internal wires carrying weaker signals.

### 3.1.5. REAR TERMINAL ASSIGNMENTS

The terminal blocks are identified by a letter located in the upper part, beside the terminal block. There are three terminal blocks, and have been assigned the letters A, B and C respectively, in order to avoid confusions while wiring external cables.

For each terminal block, the wiring screws (1 to 12) have been labelled with their corresponding number.

Figure 3-4 shows the location and identification of the terminals blocks at the rear of the MIN relay.

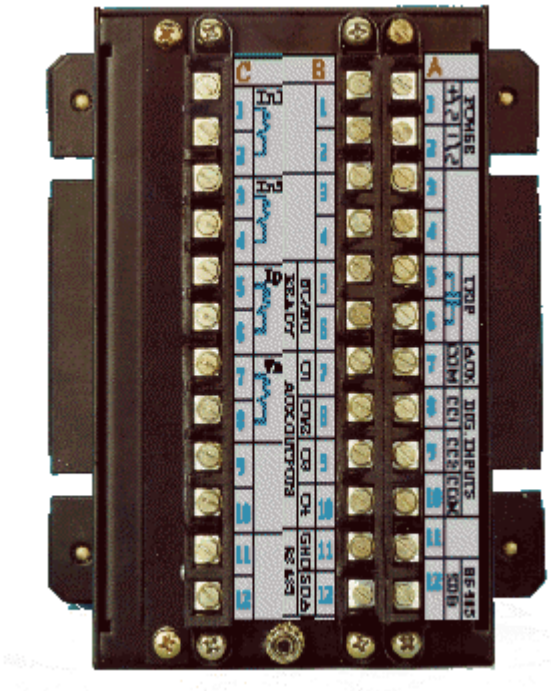



**Figure 3-4 MIN RELAY - REAR VIEW**

## 3.2. WIRING

### 3.2.1. TYPICAL WIRING DIAGRAM

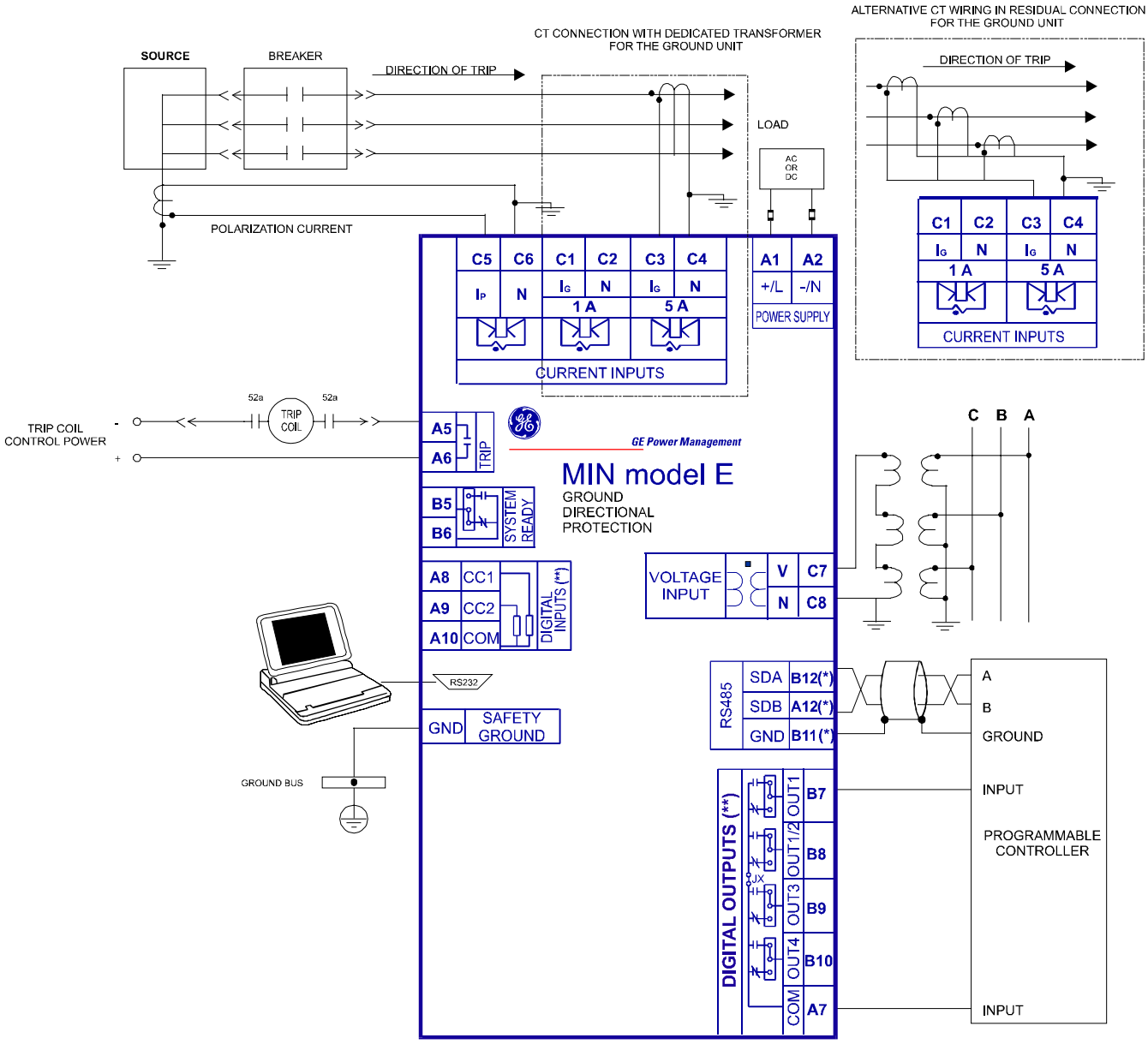



**Figure 3-5 TYPICAL WIRING DIAGRAM FOR MIN RELAY MODEL E**

Model E: Ground current will be connected to terminals C3-C4 when the CT is rated at 5 A secondary, and to terminals C1-C2 when the rated current is 1 Amp.

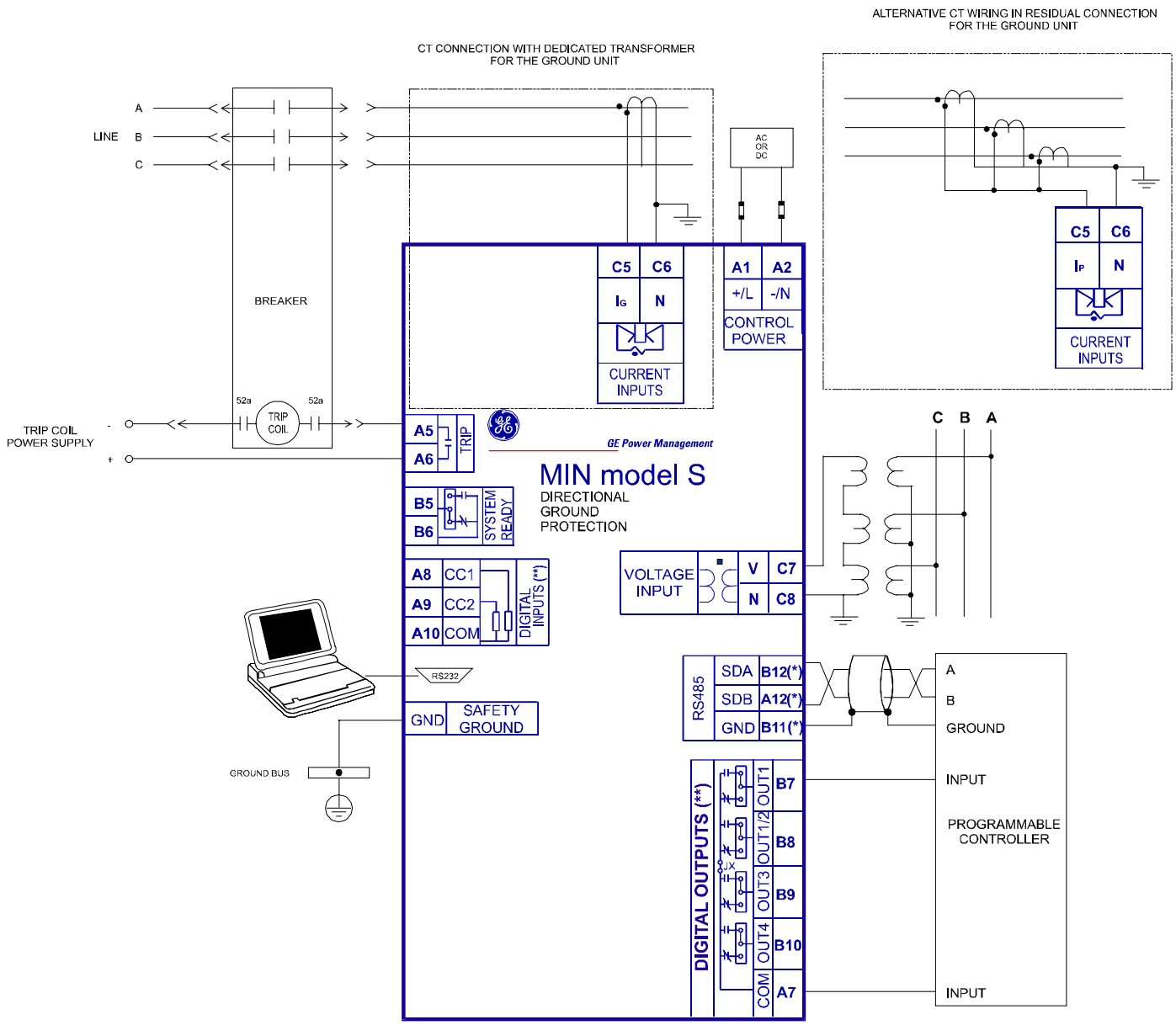



**Figure 3-6 TYPICAL WIRING DIAGRAM FOR MIN RELAY MODEL S**

Model S: Ground current will be connected to terminals C5-C6.

### 3.2.2. CONTROL POWER

**CAUTION: CONTROL POWER SUPPLIED TO THE RELAY MUST MATCH THE RATED VOLTAGE OF THE RELAY. IF THE VOLTAGE IS APPLIED TO THE WRONG TERMINALS, DAMAGE MAY OCCUR.**

***Table 3-1: Control Power Voltage Range***

| RANGE | RATED VOLTAGE | OPERATION RANGE |
|---|---|---|
| F | 24/48 Vdc | 19.2~57.6 Vdc |
| H | 110/250 Vdc<br>120/230 Vac | 88~300 Vdc<br>88~264 Vac |

### 3.2.3. CONTACT INPUTS/OUTPUTS

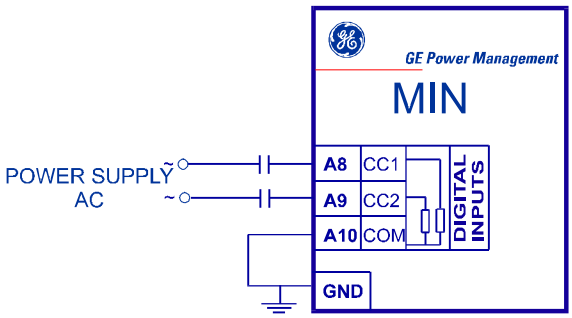
**Figure 3-8 CONTACT INPUTS CONNECTIONS**

The MIN relay works with 'wet contacts'. A wet contact has one side connected to the positive terminal of an external DC power supply. The other side of this contact is connected to the required contact input terminal (A8 or A9). In addition, the negative side of the external source must be connected to the relay common (negative) terminal (A10). The maximum external voltage source voltage for this arrangement is 300 Vdc.

The voltage threshold at which an input will detect a closed contact input depends on the relay model. For low voltage range relays (F model), the threshold is set to 12 Vdc. For higher voltage range relays (H model), the voltage threshold is 75 Vdc.

In case of using AC voltage, it must be ensured that there is no appreciable voltage (less than 10 Vac) between the input common terminal, A10, and the ground terminal. The AC system must be line/neutral type, and not line/line, ensuring that the neutral and ground do not differ in more than 10 Vac. The reason for this is that there might be enough current circulating through the EMC filtering capacitors on these inputs to cause undesired activation.

If it is not possible to ensure the previous conditions, the connection shown below can be used, where lines are wired only to inputs (A8 and A9), and the common (A10) is connected to the unit ground terminal.




### 3.2.4. OUTPUT CONTACTS CONFIGURATION

All output relays are form C relays. Only one of the two states of the form C relay is connected to the MIN output terminal. For each output relay it is possible to select which state is preferred to have at the MIN terminals, NC (normally closed) or NO (normally open).

Figure 3-9 shows the PCB of a MIN relay, and the location of the jumpers used to select the configuration of each output contact (NO or NC).

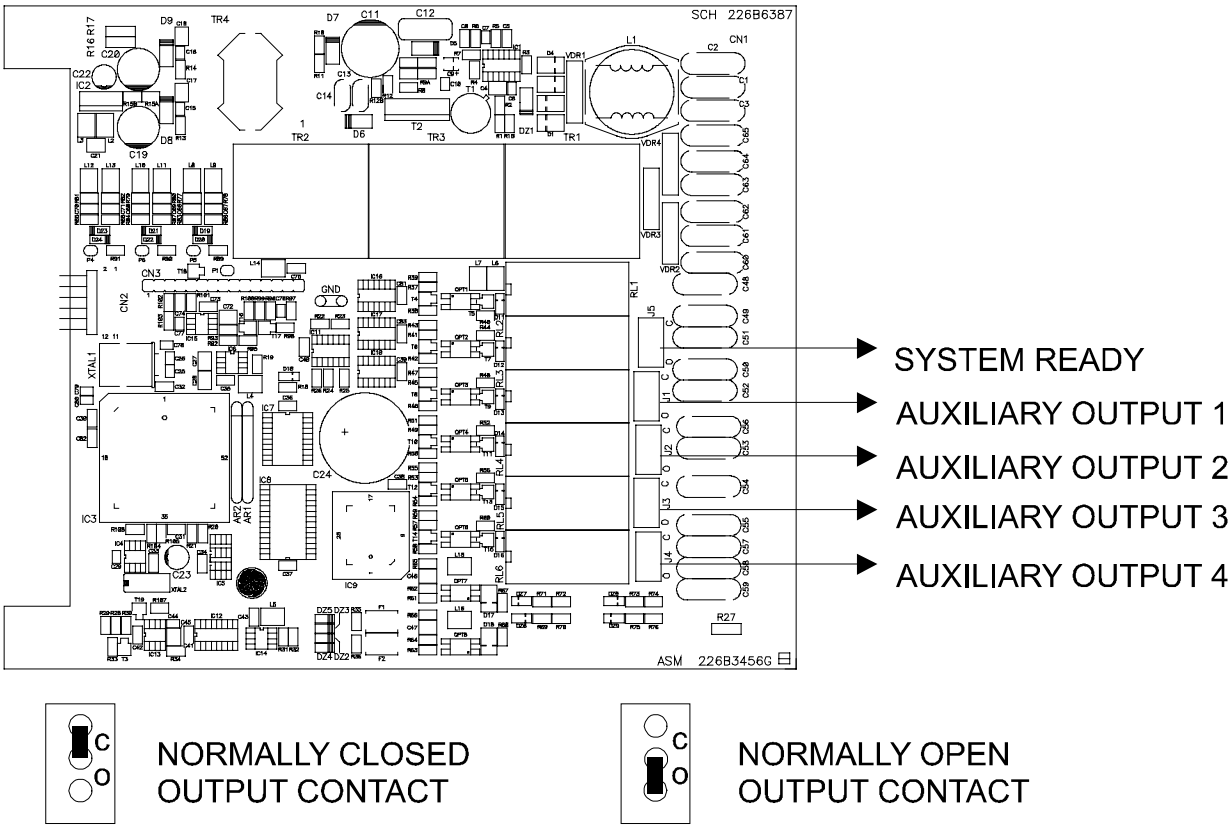
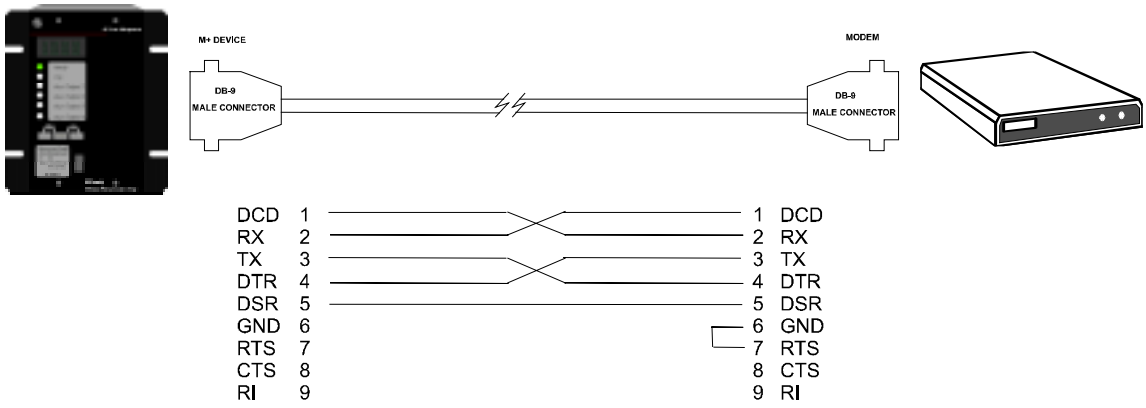


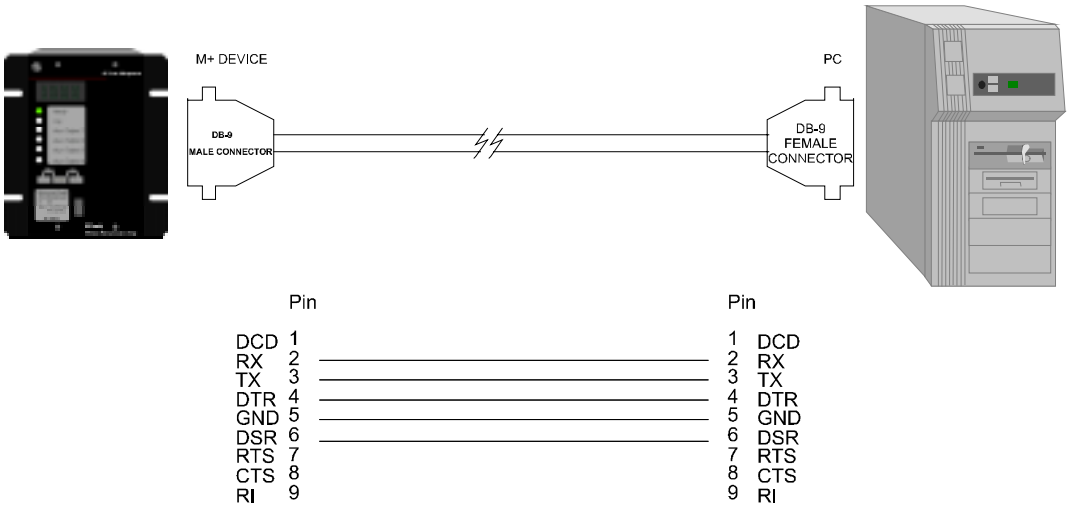

**Figure 3-9 PCB SCHEME SHOWING THE JUMPERS TO CONFIGURE THE OUTPUT CONTACTS (NC / NO)**

### 3.2.5. RS232 FACEPLATE COMMUNICATIONS PORT

A 9-pin RS232 serial port is located on the relay's faceplate for programming with a portable (personal) computer using M+PC software. Figure 3-10 shows the communications cable configuration for connecting the relay to a telephone modem or a PC. The PC connection is direct, without any cable crossing. The connection to a modem requires a series of connections. These connections must be done either in the cable, or using a direct cable with the addition of a Null Modem connector.




RELAY-MODEM CONNECTION WIRE, FOR RS-232 FRONT PORT




RELAY - PC CONNECTION WIRE FOR RS-232 FRONT PORT

**Figure 3-10 RS232 FACEPLATE PORT CONNECTION**

### 3.2.6. RS485 COMMUNICATIONS PORT

In addition to the RS232 port on the faceplate, the relay provides the user with an additional RS485 communication port. RS485 data transmission and reception are accomplished over a single twisted pair with transmit and receive data alternating over the same two wires. Through the use of these port, continuous monitoring and control from a remote computer, SCADA system or PLC is possible.

To minimise errors from noise, the use of shielded twisted pair wire is recommended. For a correct operation, polarity must be respected, although if it is not so, there is no danger to damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result confusing sometimes, as the RS485 standard refers only to terminals named “A” and “B”, although many devices use terminals named “+” and “-”. As a general rule, terminals “A” should be connected to terminals “-”, and terminals “B” to “+”. There are exceptions to this rule, such as ALPS and DTP-B relays. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. To avoid loop currents, the shield should be grounded at one point only. Each relay should also be daisy chained to the next one in the link. A maximum of 32 relays can be connected in this manner without exceeding driver capability. For larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel to more than 32. Do not use other connection configuration different than the recommended.

Lightning strikes and ground surge currents can cause large momentary voltage differences between remote ends of the communication link. For this reason, surge protection devices are internally provided. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

(*) Impedance at each end (120 Ohm + 1nF), for large distances (1 Km.)

**Figure 3-10 RS485 SERIAL CONNECTION (B6366H5)**

# 4. HUMAN INTERFACE

## 4.1. M+PC SOFTWARE INTERFACE

The M+PC software provides a graphical user interface (GUI) as one of two Human interfaces to a MIN relay. The alternate Human interface is implemented via the device's faceplate keypad and display (refer to chapter 6 for more information on the use of the keypad). The M+PC software interface can be used while disconnected (i.e. off-line or simulation mode) or connected (i.e. on-line) to a MIN relay, locally or remotely, using a modem and the telephone line. In off-line mode, you can prepare a file of the device's parameter settings for eventual downloading to the device. Another application of the off-line mode is personal training on the relay. In on-line mode, you can communicate with the device in real-time, access to all the information in the device, modify settings, retrieve registered data and perform commands.

The M+PC software can be run from any computer supporting Microsoft® Windows 95, 98, NT® (Service Pack 3.0 or higher), 2000 or Millennium, and the latest version can be downloaded from the GE Power Management Internet site http://www.geindustrial.com/pm. This chapter provides a brief description of the M+PC software interface use. The M+PC Help menu provides this same information on-line.

### 4.1.1. STARTING THE PROGRAM

To start the M+PC software program double click on the program icon (if a direct access has been created) or select the program from the Start Windows® menu. Once started, the following Login window will appear:

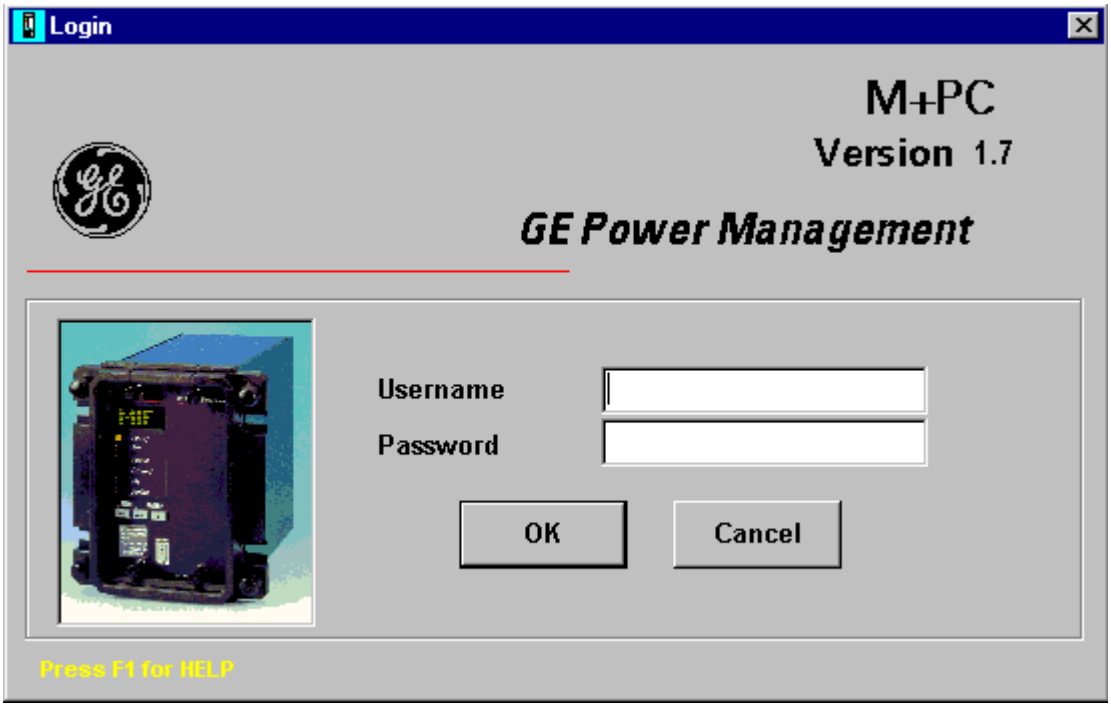



**Figure 4.1: STARTING THE PROGRAM**

The User Name and Password must be entered in this window. This data must be properly entered to access the program functions, both for the off-line and on-line operation modes. The factory default values for this fields are: Username: none (leave the box empty); Password: 7169 (it corresponds with the ASCII codes for 'G' 'E'). Users management (add, modify or eliminate users) must be done by a user with a Management access level (user type: 1). This is done using the Users option within the Main Menu.

Once the correct Username and Password have been entered and the OK button clicked, the Start Window will appear. In this window, the desired operation mode must be selected: 'on-line', this is relay connection, or 'off-line', for simulation mode.

M+PC software uses the same structure for all its windows. This structure is shown in the following figure. There are three different ways to access the M+PC functions: clicking on the desired item on the upper menu bar (pop-up windows); clicking on the icons located on the tool-bar, just below the menu bar (a small help window appears when the mouse pointer is on any icon); clicking on different function buttons that appear on the central part of the window.

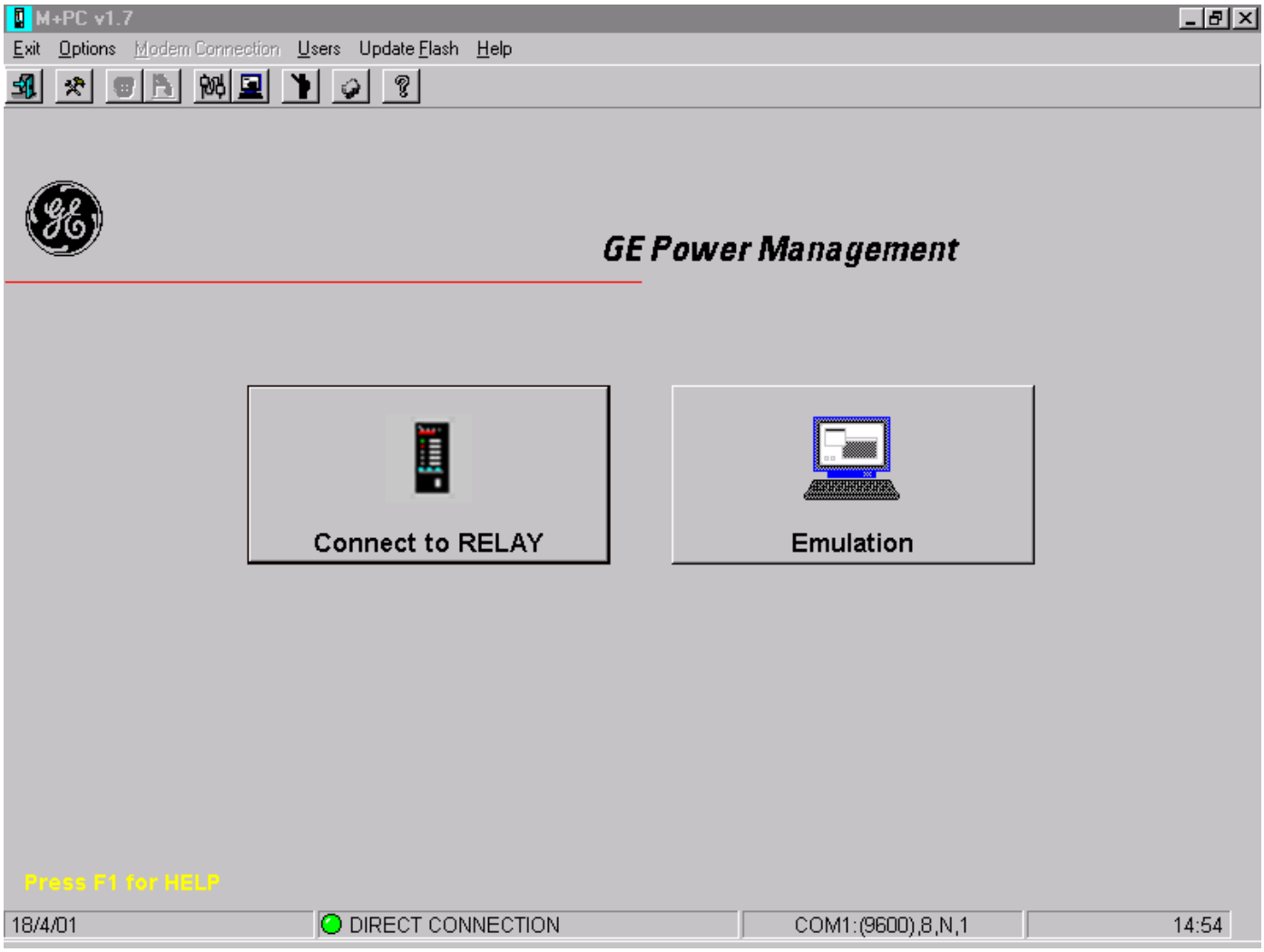



**Figure 4.2: START WINDOW**

Clicking on the function buttons "**Relay Connection**" and "**Emulation**", the corresponding operation mode is selected, "on-line" and "off-line" respectively. For the "Emulation" operation mode, the access is immediate, whilst for the "Relay Connection", the communications parameters must be properly set. These parameters are shown in the lower bar of the window.

For example, COM 1: (9600), 8, N, 1 stands for:

| | | |
|---|---|---|
| COM 1 | : | PC Communications port number 1. |
| 9600 | : | Communications speed = 9600 bauds. |
| 8 | : | Number of Data bits = 8 |
| N | : | No Parity. |
| 1 | : | Number of Stop Bits = 1. |

These parameters can be modified in the Options menu (or clicking on the corresponding icon on the tool bar).

### 4.1.3. EMULATION

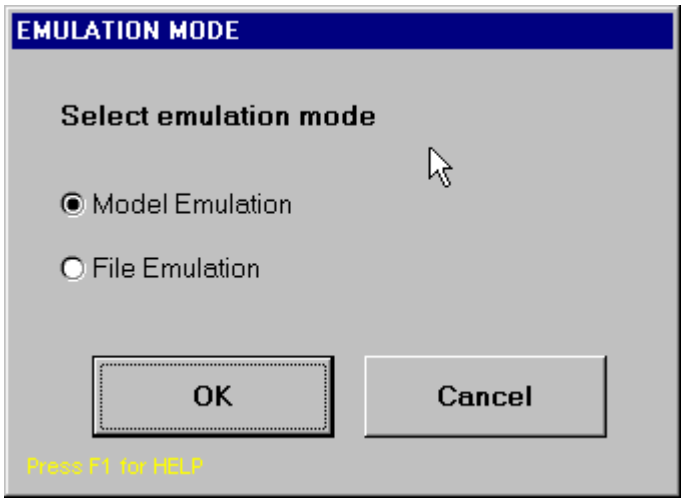
The EMULATION mode allows to simulate the connection to a particular relay even if the physical relay is not available. This mode allows the user to:

- View status, settings, and protection units incorporated in the selected relay unit.
- Create settings files for a quick configuration of the relay once it is connected to the PC.
- Besides, it can be used to program a relay with options retrieved from another unit.

The emulation mode is selected from the M+PC Start window:

There are two kinds of emulation available:

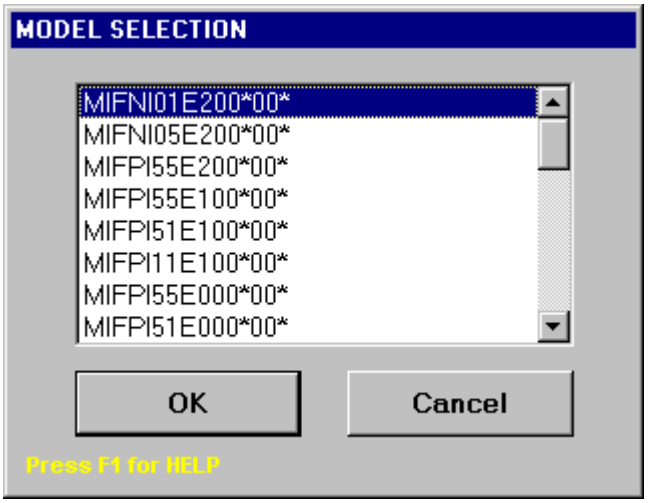
1. Model Emulation.
2. File Emulation.



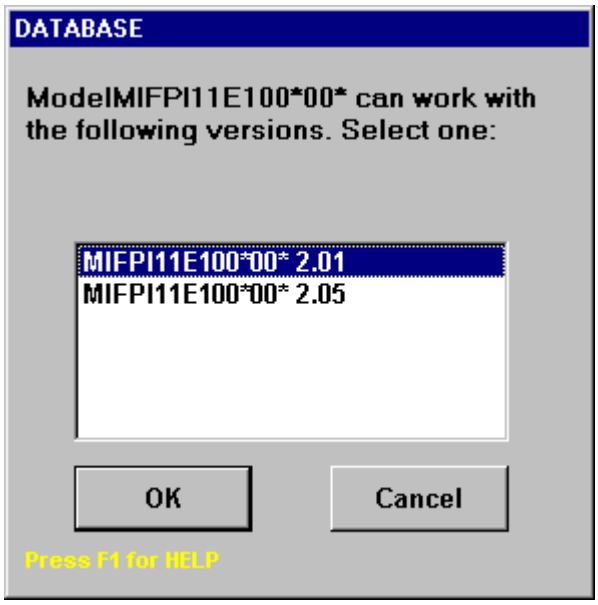

The following sections detail the operation of each model:

#### *4.1.3.1. MODEL EMULATION.*

If the Model Emulation is selected, the program will display a menu with all M Family models available for emulation. The required information for emulating a model is contained in the file M+PC.MOD. If you cannot find the desired relay model, please contact GE Power Management.




If there is more than one firmware version for the same model, the system will display a list of options, so that the user can select the desired version



#### *4.1.3.2. FILE EMULATION*

M+PC offers also the option to emulate a file. The available files can be selected among the different files created in the M+PC while connected to a relay, as follows:

1. **Settings Files**: These files are saved from the FILE option in the M+PC main window. The file will include information about the model, as well as all the settings stored in the relay, that is, the memory map.
2. **Oscillography Files**: These files are created when retrieving oscillography. The file will include the relay model, the relay settings, and the oscillography information.
3. **Event Files**: These files can be saved while connected to a relay. The file includes the relay model, the relay settings (memory map) and the events present in the relay.

### 4.1.4. OPTIONS MENU

The Options Menu opens a window with four tabs. The first tab allows communications port configuration, the second tab is for modem configuration, the third allows language selection and the last one is used for trouble shooting and communications debug.

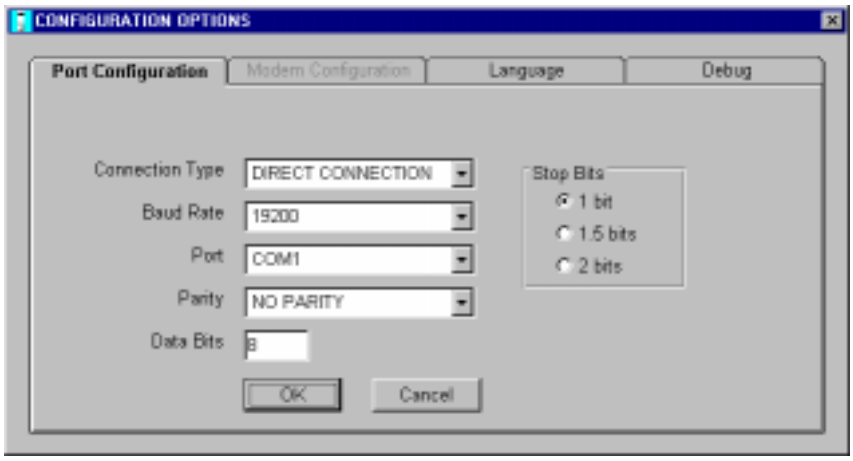



**Figure 4.3: OPTIONS MENU - PORT CONFIGURATION TAB.**

- "**Port Configuration**" tab allows modifying the communications parameters. These parameters, as mentioned before, are: connection type (direct connection or modem), speed, computer port to be used, parity, number of data bits and number of stop bits.

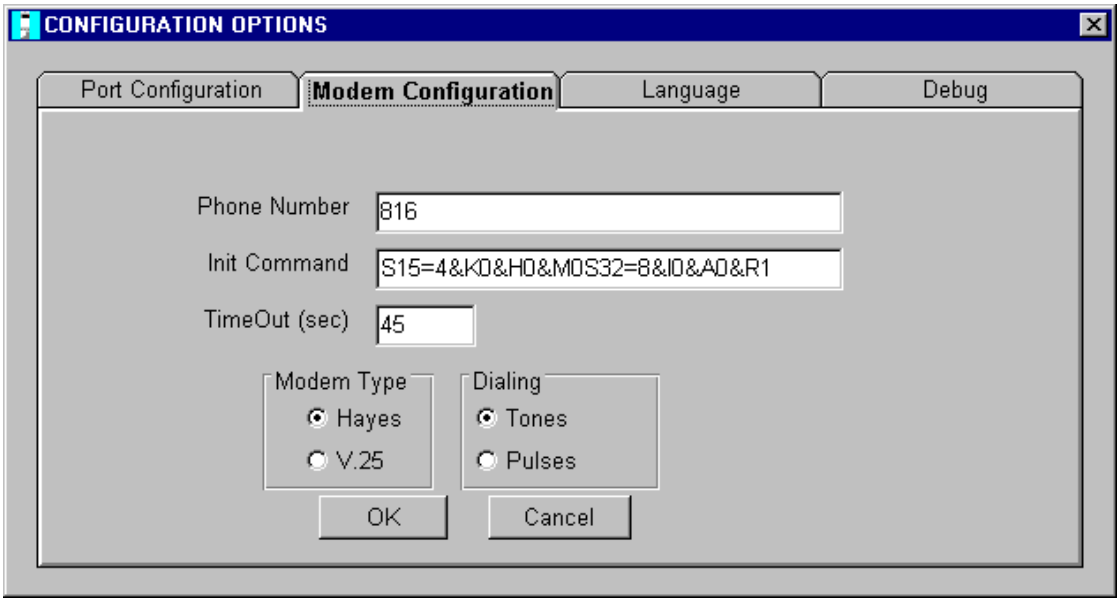



**Figure 4.4: OPTIONS MENU - MODEM CONFIGURATION TAB**

- "**Modem Configuration**" is accessible if the connection type selected in the "Port Configuration" is 'Modem'. If the connection type is 'Direct Connection', this tab is inactive and cannot be accessed. The parameters to be configured in this tab are: Modem Type: Hayes compatible or V.25; Telephone number to dial; Modem Initialisation String; Waiting Time; Dialling Mode: Pulse or Tones.


**Figure 4.5: OPTIONS MENU - LANGUAGE TAB**

- Use this window to select the language you want to use from the menu. This choice is recorder in the configuration file of the M+PC program, so your language selection is used next times you run the program.

- The **Debug** Tab allows monitoring all the communication messages being sent between the MIN and the computer, to analyse the communications network.

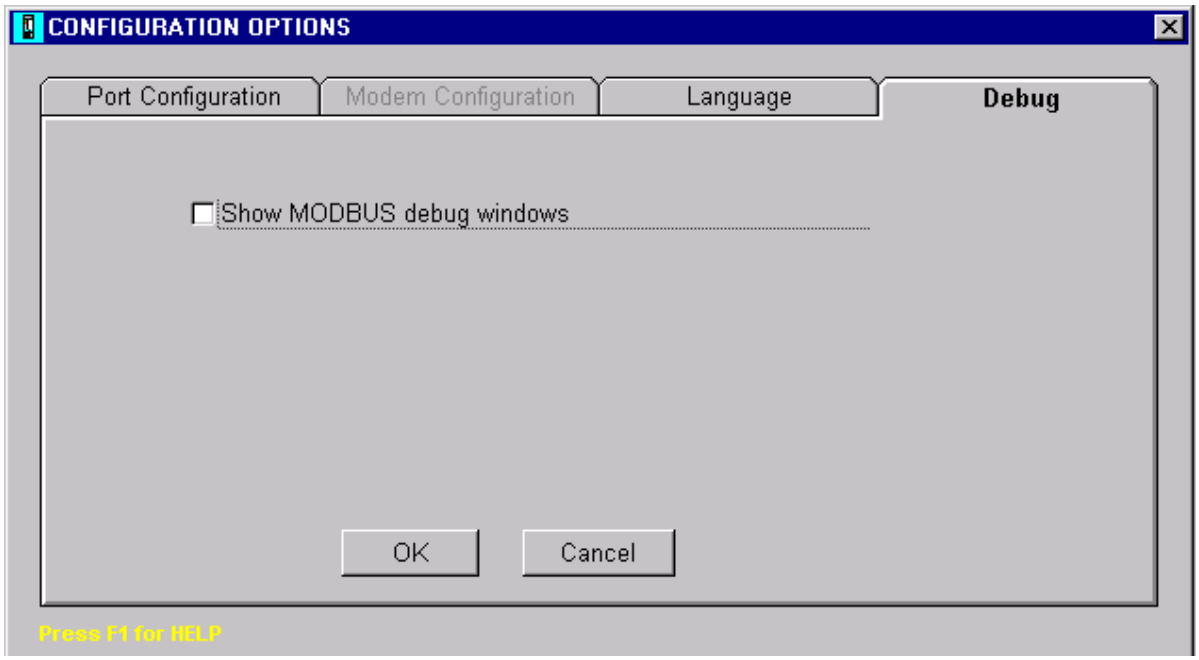



**Figure 4.6: OPTIONS MENU - DEBUG TAB**

Once the Options Menu has been checked, you can proceed to “Relay Connection”, directly or through a modem.

In general, the off-line (Emulation) mode and the on-line (Relay Connection) mode are almost identical, so the most complete one (Relay Connection) will be described. The only differences for the Emulation mode are that the access is immediate, without checking the relay model identification, and that the operation in this mode is obviously limited to file management. In the Emulation mode it is not possible to perform operations that require data retrieving from a relay.

### 4.1.5. USERS MANAGEMENT MENU

This menu allows adding new users to the M+PC program, with the corresponding passwords and accessing levels.

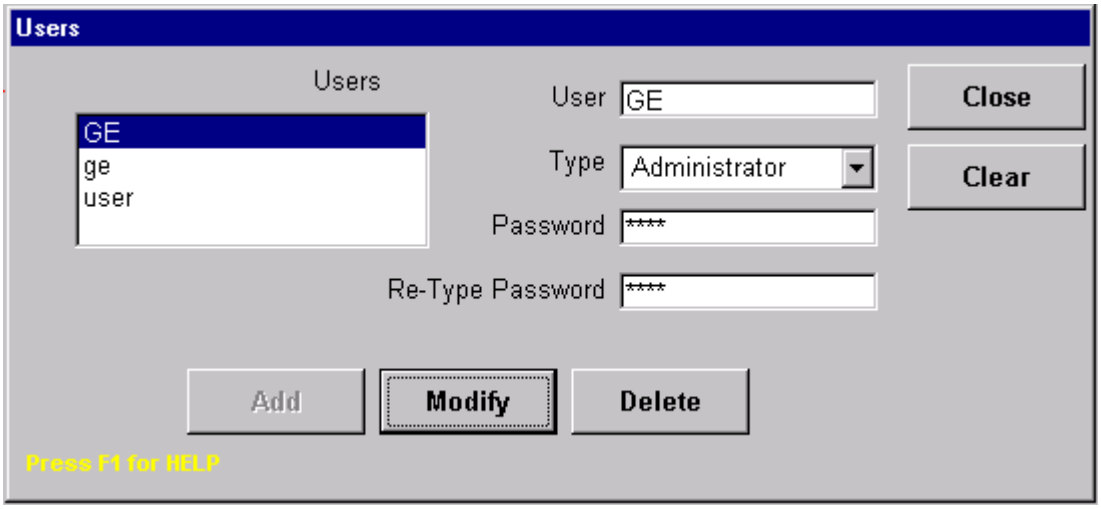



**Figure 4.7: USERS MANAGEMENT**

In this Users Management window, the program manager can add, eliminate or modify user names, passwords and access levels:

**MODIFY**: To modify a user's properties, first it must be selected from the users list and then the information associated to that user can be changed. Clicking on the MODIFY PROPERTIES button, all the changes will be stored. If the password is being changed, it must be entered twice, to assure it has been properly entered.

**ADD**: To empty the properties in a window click on the clear button, or enter in the user box the name of the new user. The first property is User Type. This must be entered as a number as follows:

1. Program/Users Manager. Allows modifying Users properties.
2. Normal/Regular User. For this type of user, the access levels are defined by the Program/Users Manager.

The password must be entered twice, to avoid misspelling. While the password is being entered, the password characters are not displayed in the screen and are substituted by the "*" character. The password can be left blank (empty box), in this case it is not necessary to repeat it. When the Add button is clicked, the new user properties are stored.

**DELETE**: To Delete a User it is necessary to select it from the users list and then click on Eliminate. The User identified by the Username GE or Users Manager, cannot be eliminate, though it is possible to modify its password.

In the START WINDOW (figure 4.2), we click on the “Flash Update” option to start the Flash Memory Update program.

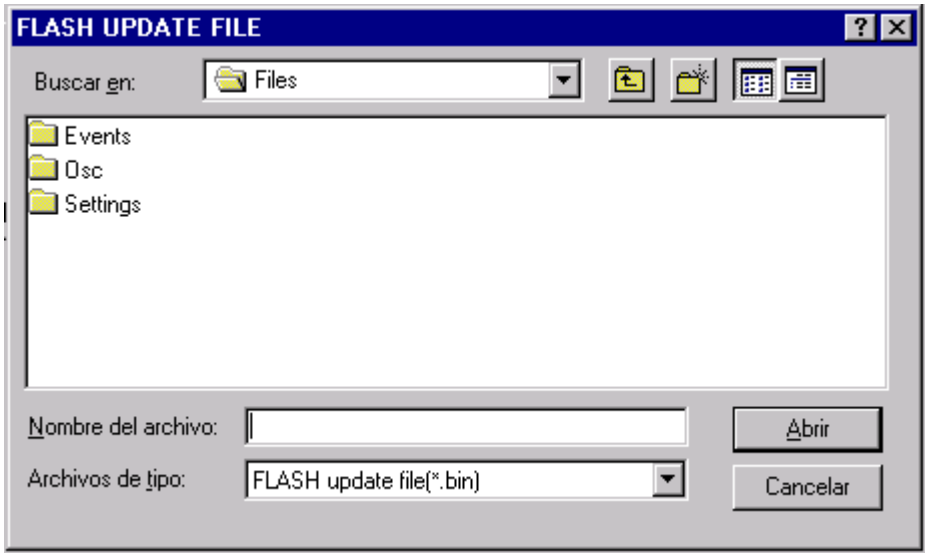
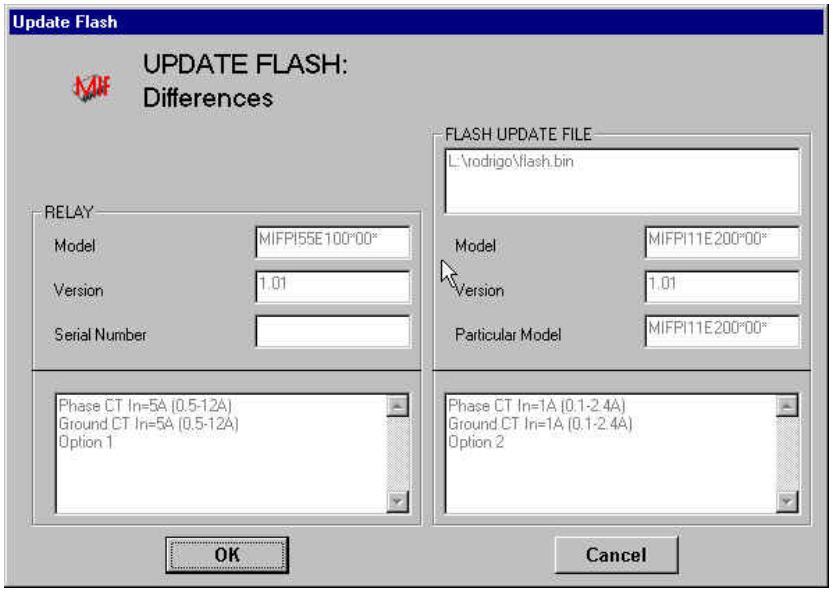



**Figure 4.8. FLASH MEMORY UPDATE**

Here, we select the file we will use to update the FLASH memory, and the following screen will be displayed, showing details of the old model and the new model:



If we are trying to update to a model option with higher functionality (see OPTION 1 and OPTION 2 in the model list), the program will request a password. This password can be obtained by placing an order to GE Power Management. In the order, the following three parameters must be clearly indicated:

- Serial number of the unit.
- Current model option (before memory update)
- Desired model option (after memory update).

In case there are several units to be updated, all the serial numbers shall be indicated, and a different password will be assigned for each unit.

If the update does not intend to change the functionality of the relay, the program will not request a password.

We must take into account that the Flash memory update may involve a change in the MODBUS® memory map. This may result a critical issue when the relay is integrated in a system, and the user must take into account the modifications that are to be performed in the memory map access programs for MIN relays.

When a Flash memory update is performed, depending on the new firmware, the unit can either keep the existing settings, if they are fully compatible, or entering the default settings for this new firmware version.

For this reason, it is recommended to do the following before a Flash memory update:

- Retrieve the unit settings and save them to a file
- Print the settings file
- Update the firmware
- Load the original settings using the saved file

If the new firmware doesn't accept the settings, use the printed file to restore them.

**WARNING**

If the power supply is cut during the update process, the unit may result damaged, and it will need to be returned to factory for repair.

It is strongly recommended to ensure that the PC is correctly grounded, and that the unit communicates correctly before starting the update.

### 4.1.7. DEVICE IDENTIFICATION WINDOW

Once the “Relay Connection” button has been clicked, a Device Identification window appears, needed to identify the relay the computer must access to communicate with:

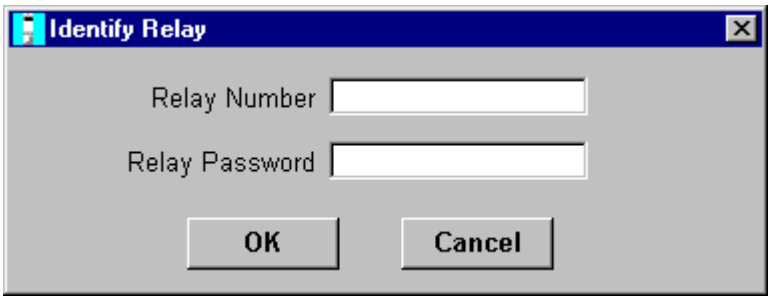



**Figure 4.9: DEVICE IDENTIFICATION WINDOW**

The parameters in this window are: Relay Number and Relay Password. The Relay Number is a device number in between 1 and 255. This number (like an address) must match the Relay Number entered in the relay itself (which can only be modified using the relay keypad). The Relay Password must match the password entered in the relay itself, (which can only e modified using the relay keypad) to have access to operations and settings change. If the user does not know the relay password, or enters a wrong password, the connection between the computer and the relay will be established, but the access level will be ‘monitoring’; this means that the user will not be able to perform any settings change or operation. The relay password can only be changed on the relay itself, using the relay keypad.

The factory default parameters are Relay Number = 1; Relay Password = 1.

Once these parameters have been entered and the OK button clicked, the computer will try to establish communication with the relay.

### 4.1.8. M+PC PROGRAM MAIN WINDOW

Once the communication has been established between computer and relay, the Main Window of the M+PC program appears. The structure of the window, from which all functions of an M-family relay can be accessed, is maintained through the entire program.

The main window comprises the following three working zones:

- Pop-up windows and icons, as explained for the Start window.
- Graphic Information windows. There are two windows/tabs available, for FRONT VIEW and REAR VIEW, containing graphic information on the device. By default, the program will display the FRONT VIEW tab, showing a front view of the device and the most important information (refreshed on-line) of the relay. In the example, for a MIN Feeder protection relay, the device information shown is:
- Phase and Ground Actual Current Metering.
- Status of the Target LEDs located on the faceplate of the relay.
- Status of all the Contact Inputs and Outputs (the active status is shown in red, and the inactive status in green).
- Date and Time in the relay.

Clicking on the REAR VIEW tab you access to the second graphic information window. The default information in REAR VIEW shows the rear terminals of the relay properly labelled, which can be useful for wiring the device. Once this tab has been selected, its information will be shown until you click on the FRONT VIEW tab.

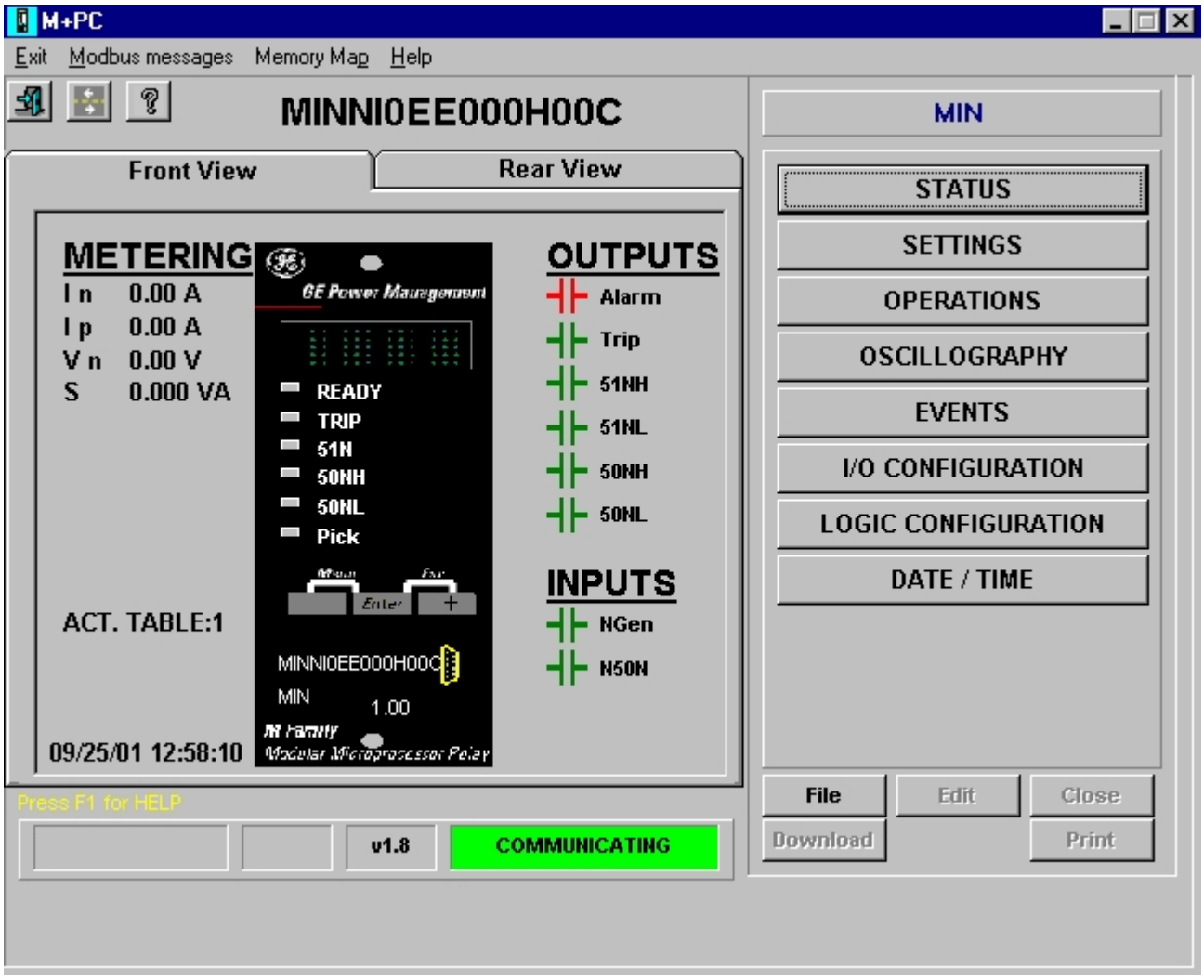



**Figure 4.10 MAIN WINDOW (FRONT VIEW)**

- The Status bar, on the lower part of the window shows the operation more (Relay Connection or Emulation). It also shows the name of the settings file open (if any) and the version of the program. For those processes that require retrieving big pieces of information from the relay and take long communication time, a percentage bar is shown to let the user follow it up.
- On the right hand side of the window there are a set of buttons that allow access to all the information in the relay. Clicking on any of these buttons, a new sub-set of buttons, associated to the button clicked, will be shown. A complete description of all these set and sub-set of buttons is given in following sections in this instruction manual.

In the lower right hand side, there is a different set of buttons. Depending on the set of buttons shown above, some or all buttons in the lower part will be available. Only the ones that can be accessed at a given time are active. The buttons available in the lower right part are:

- **File**: Allows the use of files, for those functions (i.e. settings management) that may need them.
- **Send**: To send a group of settings or all the relay settings to the device.
- **Edit**: To edit individual settings.
- **Print**: Allows to print the settings values associated to a menu.

- **Close**: Closes the active menu and returns to the previous one.

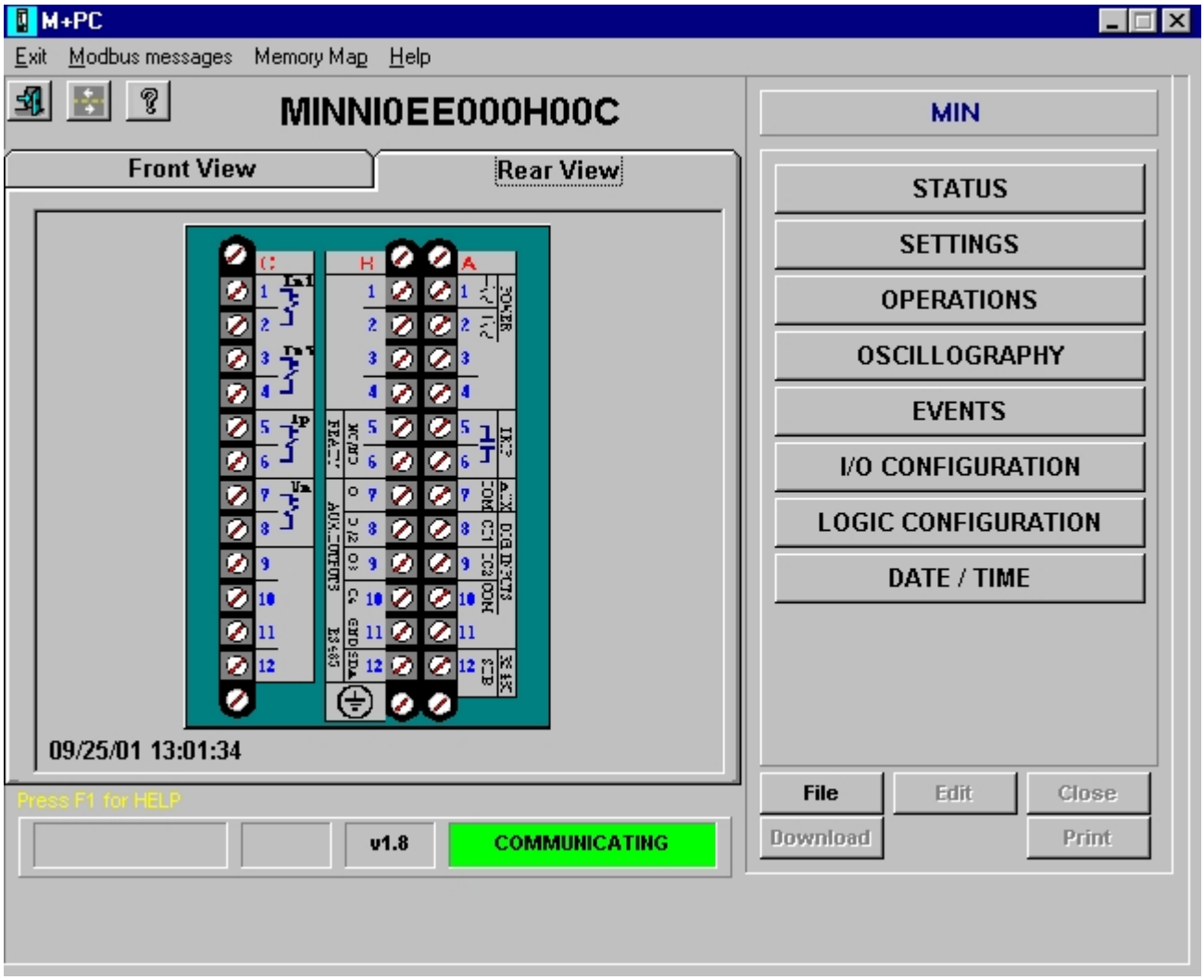



**Figure 4.11: MAIN WINDOW (REAR VIEW)**

### 4.1.9. RELAY STATUS MENU

Clicking on the Status button you access the Relay Status Menu. In this menu a table showing internal relay information, as functions status and measurements is shown. There is a vertical scrolling bar to move this table up and down, to reach the information needed:

- Relay model number and firmware version.
- Relay Date and Time.
- Actual values of currents (phase and ground).
- Protection functions status (Pickup / Trip for each function).
- Active Settings table number.
- Contact Inputs and Outputs status, and Target LEDs status.
- Information from the self-testing functions of the device.

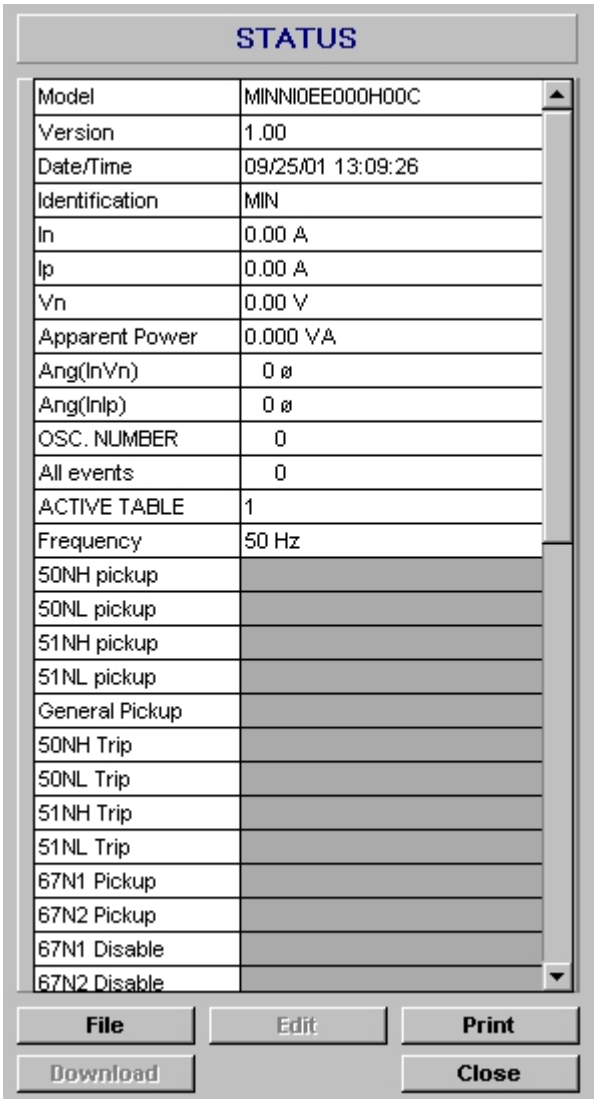



**Figure 4.12: TABLE SHOWING INTERNAL RELAY STATUS.**

The complete STATUS list is as follows:

| STATUS MIN model E |
|---|
| Model |
| Version |
| Date and time |
| Identification |
| In |
| Ip |
| Vn |
| Apparent power |
| Angle InVn |
| Angle InIp |
| Oscillo number |
| Event number |
| Active table |
| Frequency |
| Pickup 50NH |
| Pickup 50NL |
| Pickup 51NH |
| Pickup 51NL |
| General pickup |
| Trip 50NH |
| Trip 50NL |
| Trip 51NH |
| Trip 51NL |
| Activation 67N1 |
| Activation 67N2 |
| Block 67N1 |
| Block 67N2 |
| Alarm contact |
| Trip contact |
| Output 1 |
| Output 2 |
| Output 3 |
| Output 4 |
| Input 1 |
| Input 2 |
| LED ready |
| LED trip |
| LED 1 |
| LED 2 |
| LED 3 |

| STATUS MIN model S |
|---|
| Model |
| Version |
| Date and time |
| Identification |
| In |
| Vn |
| Active power |
| Angle InVn |
| Oscillo number |
| Event number |
| Active table |
| Frequency |
| Pickup 67IG1 |
| Pickup 67IG2 |
| Pickup 67PC1 |
| Pickup 67PC2 |
| General pickup |
| Trip 67IG1 |
| Trip 67IG2 |
| Trip 67PC1 |
| Trip 67PC2 |
| Alarm contact |
| Trip contact |
| Output 1 |
| Output 2 |
| Output 3 |
| Output 4 |
| Input 1 |
| Input 2 |
| LED ready |
| LED trip |
| LED 1 |
| LED 2 |
| LED 3 |
| LED 4 |
| Logic 1 |
| Logic 2 |
| Logic 3 |
| Logic 4 |
| Table change |

| STATUS MIN model E |
|---|
| LED 4 |
| Logic 1 |
| Logic 2 |
| Logic 3 |
| Logic 4 |
| Table change |
| Settings change inhibition |
| 52 closed |
| Local |
| E2prom failure |
| User settings |

| STATUS MIN model S |
|---|
| Settings change inhibition |
| 52 closed |
| Local |
| E2prom failure |
| User settings |
| |
| |
| |
| |
| |
| |

### 4.1.10. SETTINGS MENU

Clicking on the Settings button, you access the Settings Menu. At a first step, you access the same sub-menu for all M family relays, that shows all relay settings divided in two groups: Main Settings and Advanced Setting. The first group comprises the basic settings (main protection functions) needed to use the relay, whilst the second group includes more advanced settings (double settings table, customised curves, etc.), only needed if more complex protection schemes are required.

The objective of this division is to make as easy as possible the use of the relay for those users that just require the basic functionality of the M family relay.

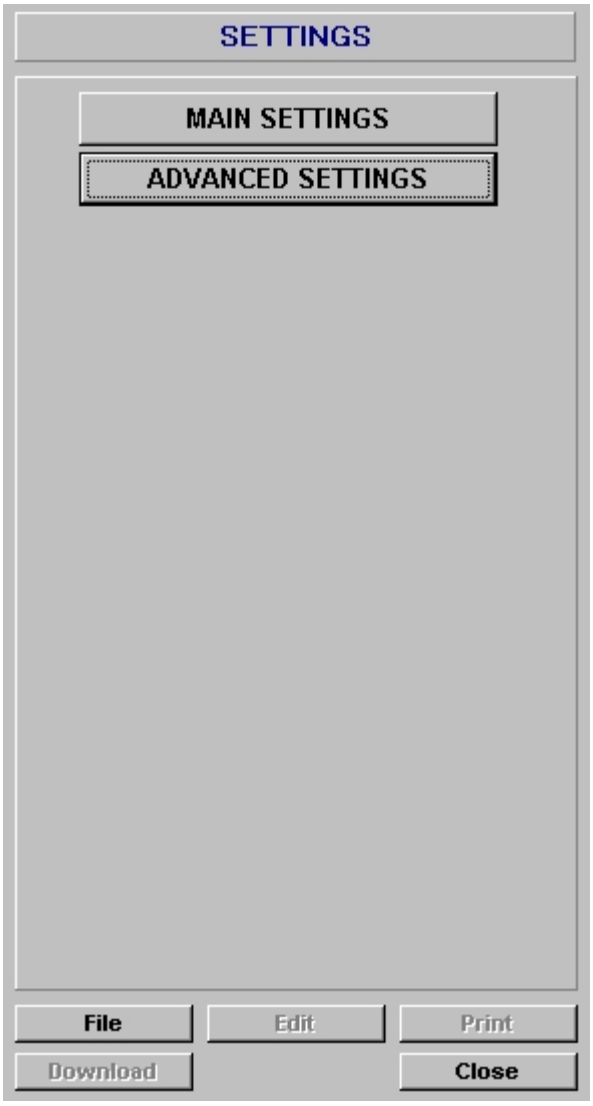



**Figure 4.13: SETTINGS MENU**

Clicking on any of these buttons, Main Settings or Advanced Settings, you access the corresponding sub-menu:


**Figure 4.14: MAIN SETTINGS.**

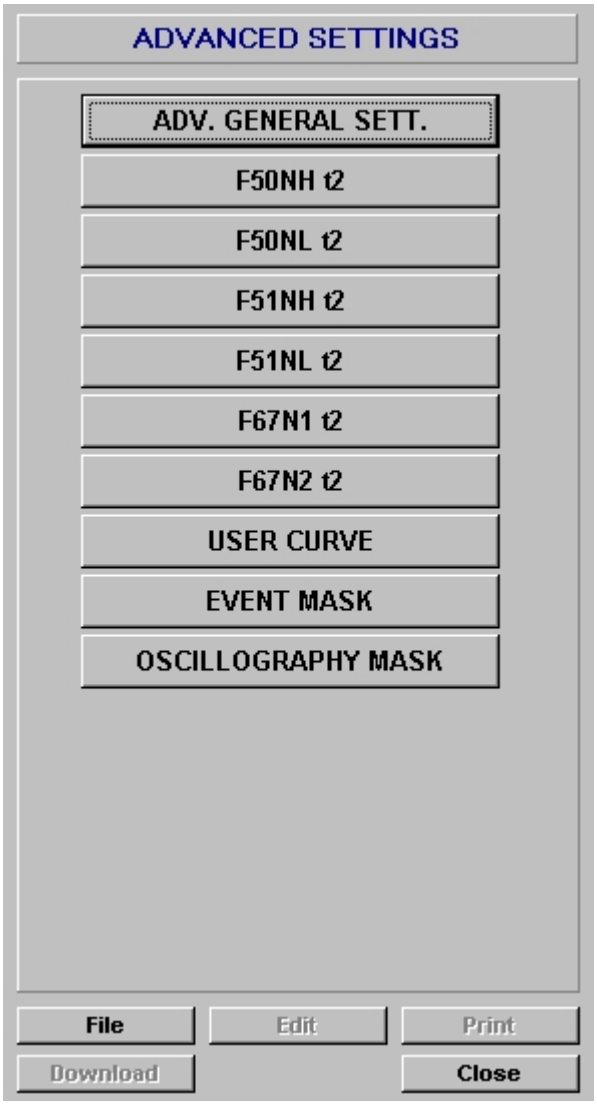



**Figure 4.15: ADVANCED SETTINGS**

Once in the corresponding sub-menu, either Main Settings or Advanced Settings, the procedure to enter and modify any setting value is the same:

- Select the settings group (in the example, the 51P Function in a MIN Feeder Protection relay has been selected)
- Edit the setting double-clicking on it.
- Modify the value of the setting (see figure 4.16 to 4.18).
- Confirm/Accept the modified value.
- **Send** the settings to the relay (or save them on a file, if working in Emulation mode, to send the settings later on).

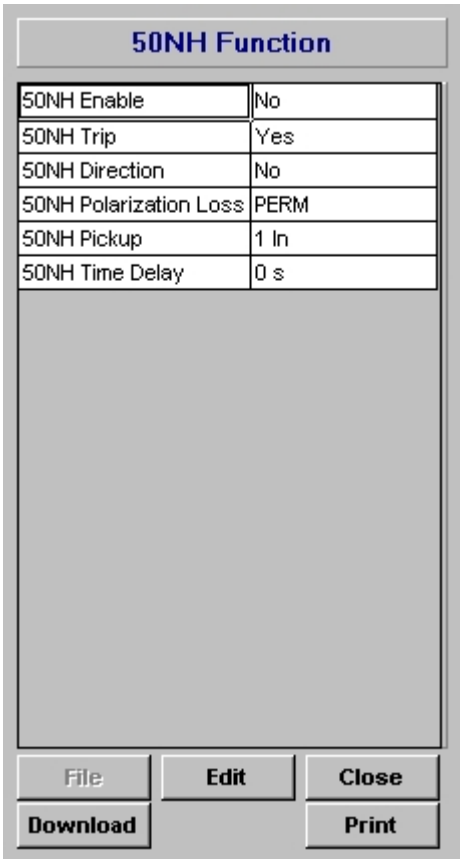



**Figure 4.16: SETTINGS SUB-MENU FOR 50NH FUNCTION**

Mainly, there are four different setting formats:

- **Boolean/Logic Settings** (only two choices). For this type of setting, the two possible options are shown for the user to select which one is the appropriate, clicking with the mouse on the option desired.
- **Numerical Settings**. For this type of setting, a number must be entered. The program shows the minimum and maximum value for each setting, and any value out of the corresponding range will not be accepted by the program.
- **Settings with a set of options**. For this type of setting, a pop-up window is shown, containing all possible values. Select the appropriate one clicking on it.
- **Text Setting**: A text box is shown.

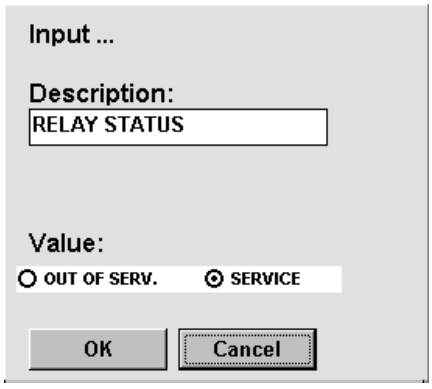



**Figure 4.17: LOGIC SETTING**

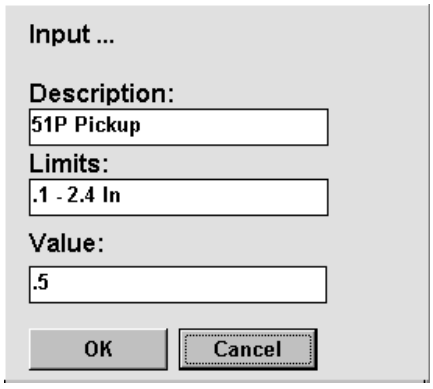



**Figure 4.18: NUMERIC SETTING**

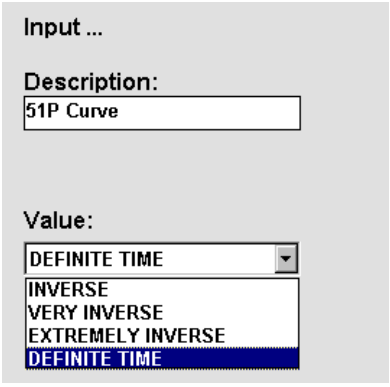



**Figure 4.19: SET OF OPTIONS**

The different possibilities of the Advanced Settings Menu are similar to those of the Main Settings, with the exception of the fact that the Advanced Settings Menu includes the Active Table Selection, minimum tripping time, user curve, event mask and oscillography mask. All these functions are accessible both through the M+PC software or the relay HMI, with the exception of the masks, which can only be accessed by communications.

#### *4.1.11.1. OSCILLOGRAPHY MASK*

Oscillography masks are as follows:

| Oscillography Mask | Option |
|---|---|
| Osc. Trigger by communications | YES/NO |
| Osc. Trigger by digital input | YES/NO |
| Osc. Trigger by a trip | YES/NO |
| Osc. Trigger by pickup | YES/NO |

#### *4.1.11.2. EVENT MASK*

The maskable events are detailed in section 2.4.

Clicking on the Operations button, the Operations Menu is accessed. A sub-menu listing all possible operation commands is shown. Clicking on the desired button, the command is initiated. To perform an operation, depending on the command type, two steps will be followed. First, the command is selected; and second, after asking the user for confirmation, it is sent to the relay.

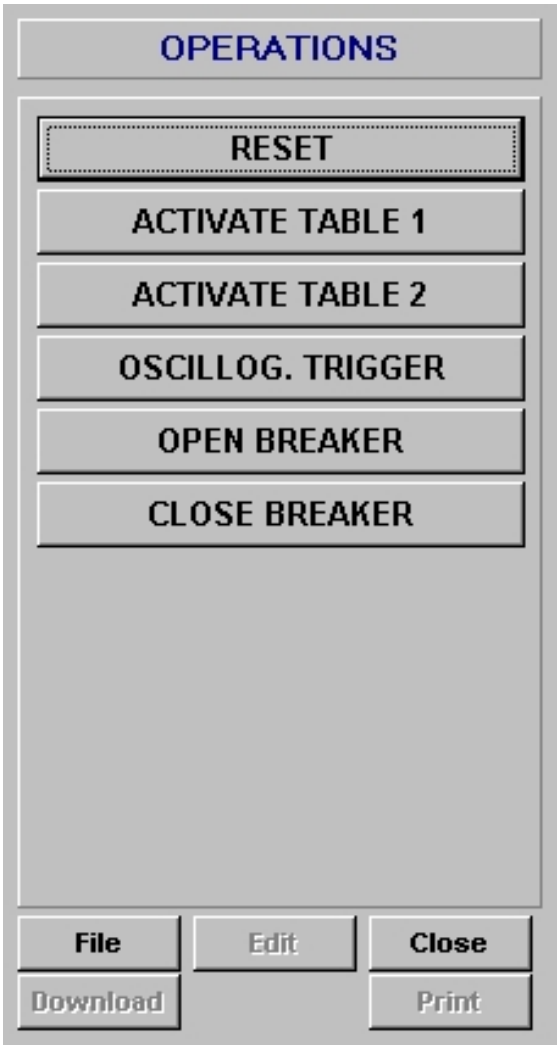
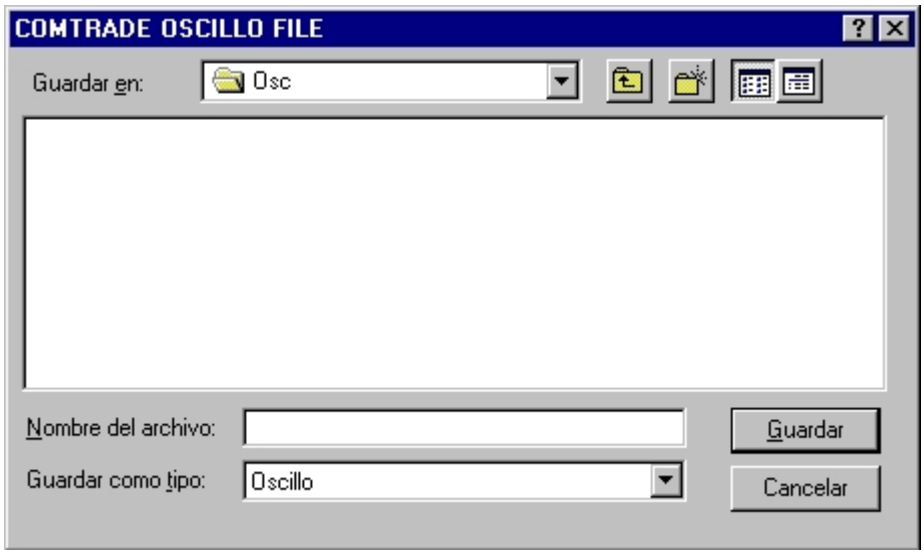



**Figure 4.20: OPERATIONS MENU**

### 4.1.13. OSCILLOGRAPHY MENU

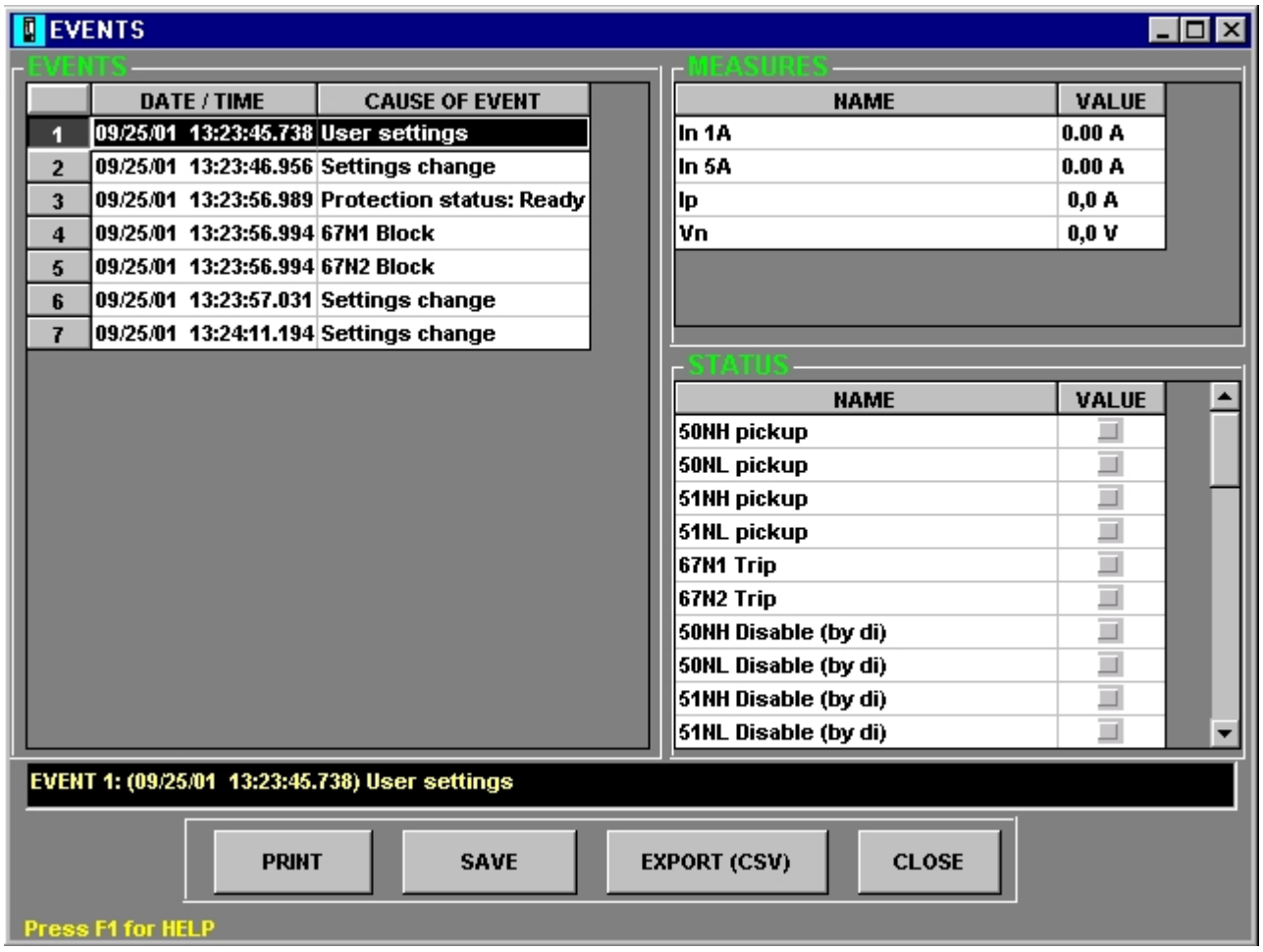
By clicking on the OSCILLOGRAPHY button in the MAIN MENU, the user can start the process to retrieve the Oscillography record stored in the MIN. The program will request the path and filename where the file is to be stored, by means of the following form:




This file can be viewed using the GE-OSC software. The use of this software is described in Instruction Manual GEK-105596.

### 4.1.14. EVENTS MENU

By clicking on the **EVENTS** button in the MAIN MENU, all the stored events will be retrieved (up to 24). Each event record is labelled with date, time (with 1 ms. resolution), the cause of the event (pickup, trip of a certain function, etc.), and a list of the status of all inputs, outputs and functions during the event. Additionally, the neutral current and the polarization current and voltage values are shown (Model E).

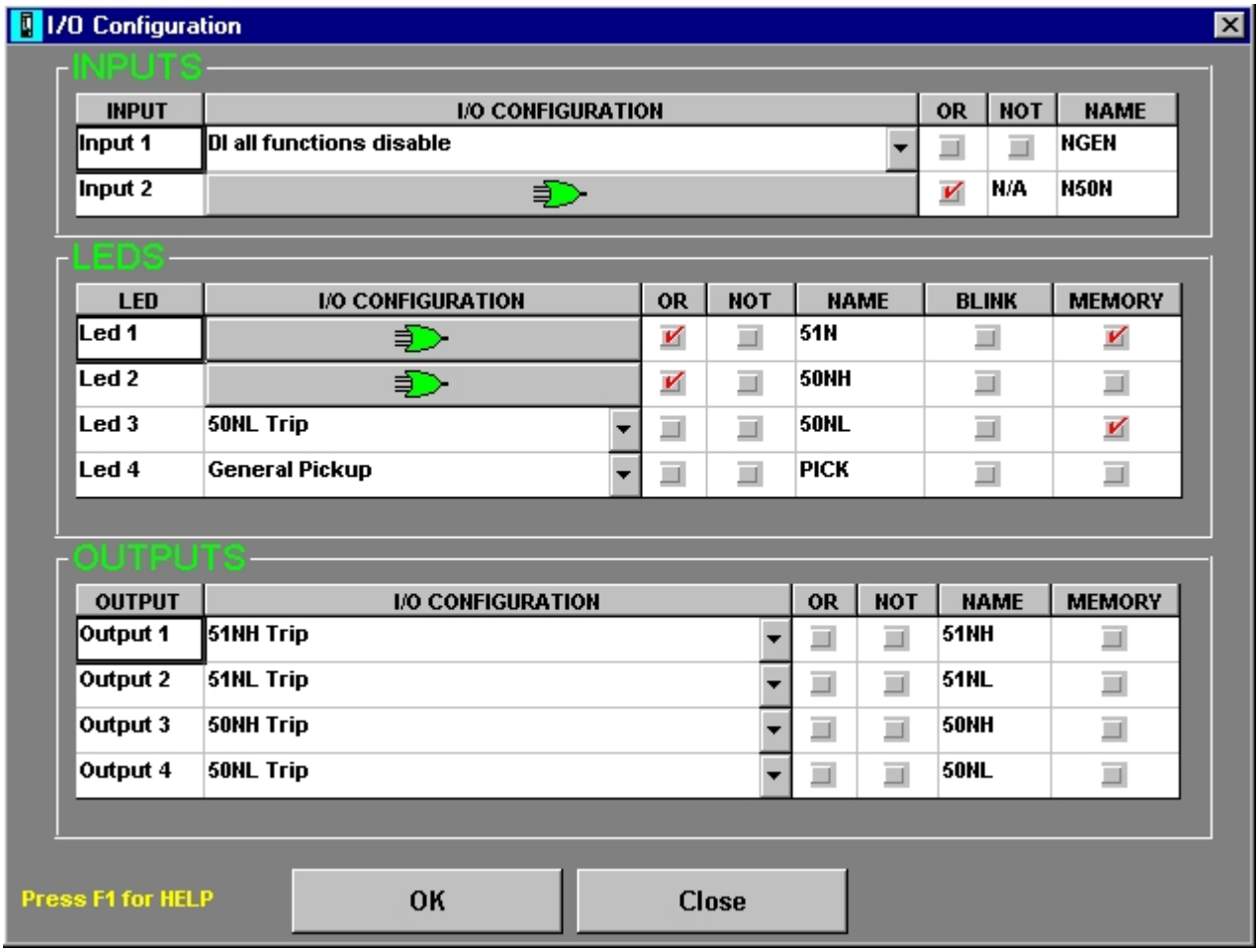



The event list can be printed, saved to a file for editing them later on using M+PC software, or exported to a CSV format file (comma separated values), so that they can be edited using a different software.

### 4.1.15. INPUT/OUTPUT CONFIGURATION MENU

In this menu, the user can configure inputs, outputs and LEDs.

When clicking on the I/O CONFIGURATION button in the MAIN MENU, the following form will be displayed. Here, we can start assigning meanings to the different inputs, outputs and LEDs.

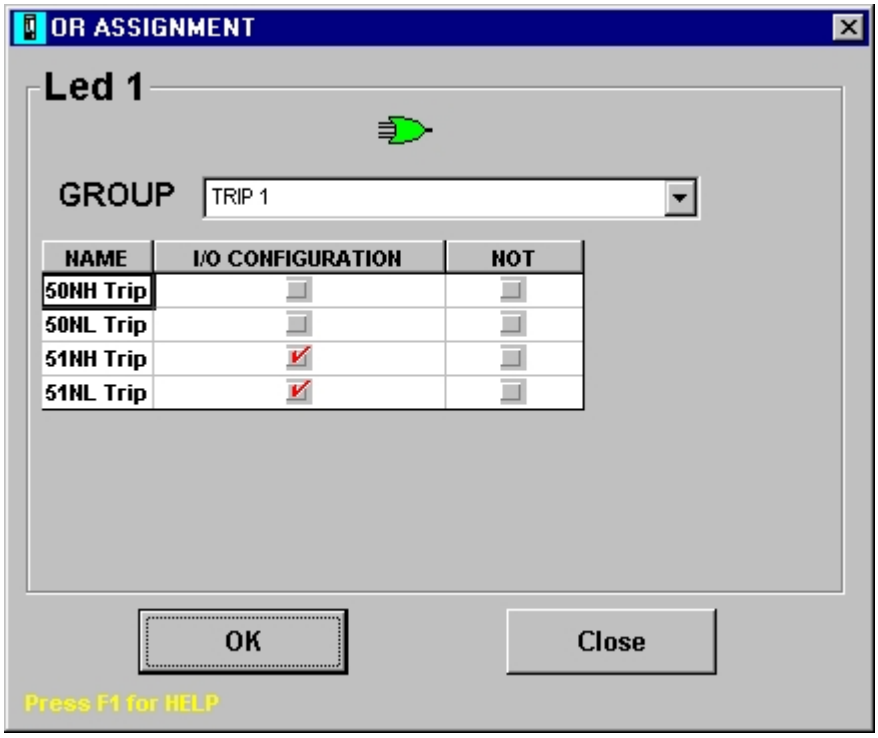



Each input, output and LED can be assigned an individual function (status bit) or an OR of a group of functions. Functions can also be assigned to virtual inputs and outputs, in order to allow great flexibility when creating complex logics.

Using basic algebra rules, it is possible to create AND gates as follows:

Signal1 AND Signal2 = NOT (NOT (Signal1) OR NOT (Signal"))

When selecting an OR action, the following screen will be displayed:

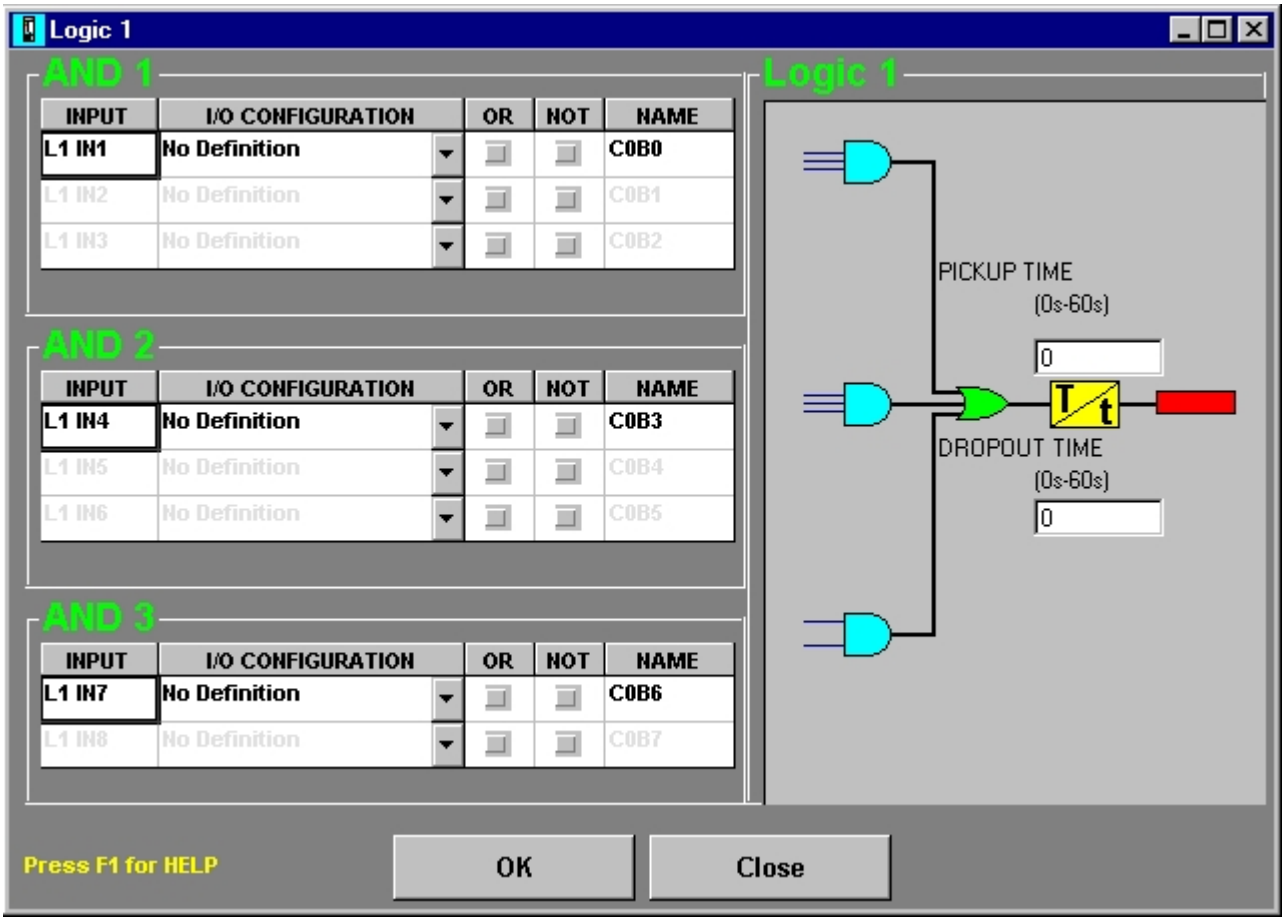



In this screen we can assign those functions that will be part of the OR.

### 4.1.16. LOGIC CONFIGURATION

There are 4 logic circuits available, incorporating AND, NOT and OR gates and timers, with the structure shown in the figure below. For accessing the configuration of this logic from the main menu, we must click on the LOGIC CONFIGURATION option and then select the concrete logic to be programmed.

When selecting one of the logics, we will see a new window where we can assign up to 8 inputs to the logic circuit. Each of these inputs can be formed by a single function or status, or be the result of another logic.




In the previous screen we assign the statuses that will be part of the LOGIC OR.

In addition, we can also assign a mnemotechnical name to each of these assignments.

We can also define the activation and deactivation times, that is, the time that the logic result must remain in order to consider a change.

### 4.1.17. SEND DATE/TIME

When selecting the “Send Date/Time” option, a window will be displayed where we will find two different options:

1. Send the PC date/time, that is, synchronise the unit to the PC
2. Enter a date/time and then send it to the relay.

Once the new date/time have been sent, we can close the window and check the information in the relay or in the status graph.

# 5. SETTINGS

## 5.1. SETTINGS STRUCTURE

All the settings of the MIN relay, together with the procedure to change their value, are described in this chapter. First of all, a complete list of settings is shown, including ranges, units, step and factory default value. Then, the settings requiring more detailed comments are individually explained.

The MIN relay provides two settings tables (table 2 is accessible in the ADVANCED SETTINGS group), stored in E2PROM memory (permanent memory). Using a setting or through a communications command (or through a digital input in models), it is possible to select which table is active, and then used by the relay protection algorithms.

Settings can be accessed and modified either using the relay faceplate keypad, or using a computer connected to the relay through any of the relay communications ports, and the M+PC program. The use of the keypad to modify settings is described in the section “KEYPAD AND DISPLAY”. If the computer is used to handle the settings, the following steps must be considered:

1. Make sure your communication cable matches the scheme shown in figure 3.9.
2. Connect the communications cable between the relay (or modem) and the computer serial port.
3. Run the M+PC program. The procedure to install and use the M+PC program is described in section 1.2.2. SOFTWARE INSTALLATION and in section 4. HUMAN INTERFACE.
4. Make sure that the communications parameters in the relay match the M+PC configuration settings. The communications parameters shown in the relay faceplate display, within the configuration menu are:

   - COMMUNICATION SPEED
   - PASSWORD (please refer to section 4.1.5.)
   - RELAY NUMBER

For instructions on how to check and modify M+PC program communications parameters please refer to chapter 4. HUMAN INTERFACE.

Check that the relay number and password in the MIN display match the numbers entered in the dialog window of the M+PC, after clicking on Relay Connection.

## 5.2. MAIN SETTINGS

### 5.2.1. MODEL E

#### 5.2.1.1. GENERAL SETTINGS GROUP

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| | **GENERAL SETTINGS** | **GENERAL** | | | |
| Relay status | RELAY STATUS | STA | DIS | RDY / DIS | NA |
| Frequency | FREQUENCY | FRQ | 50 Hz | 50/60 Hz | NA |
| Type of transformer | SELEC. TRAFO 1/5 A | IN | 1 A | 1/5 A | NA |
| Password | --- | PWD | 1 | 1 to 255 | 1 |
| Address | --- | ADD | 1 | 1 to 255 | 1 |
| Communication Baudrate | --- | BAUD | 9600 | 300, 600, 1200, 2400, 4800, 9600, 19200 | NA |

#### 5.2.1.2. UNIT 50 SETTINGS

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 50NH** | **F50NH** | **F50NH** | | | |
| Enable Unit 50NH | Enable 50NH | ENABLE 50NH | NO | Y/N | NA |
| Enable 50NH trip | Trip 50NH | TRIP 50NH | YES | Y/N | NA |
| 50NH Directional supervision | Directional permission 50NH | DIR 50NH | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NH | Polarization loss 50NH | POL LOSS 50NH | PER | BLK/PER | NA |
| Pickup level 50NH | Pickup 50NH | TAP 50NH | 1 In | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NH | TIME 50NH | 0 s | 0-99.99 s | 0.01 s |
| **Unit 50NL** | **Unit 50NL** | **F50NL** | | | |
| Enable Unit 50NL | Enable 50NL | ENABLE 50NL | NO | Y/N | NA |
| Enable trip 50NL | Trip 50NL | TRIP 50NL | YES | Y/N | NA |
| 50NL directional supervision | Directional permission 50NL | DIR 50NL | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NL | Polarization loss 50NL | POL LOSS 50NL | PER | BLK/PER | NA |
| Pickup level 50NL | Pickup 50NL | TAP 50NL | 1 In | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NL | TIME 50NL | 0 s | 0-99.99 s | 0.01 s |

### 5.2.1.3. UNIT 51 SETTINGS

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 51NH** | **F51NH** | **F51NH** | | | |
| Enable Unit 51NH | Enable 51NH | ENABLE 51NH | NO | Y/N | NA |
| Enable trip 51NH | Trip 51NH | TRIP 51NH | YES | Y/N | NA |
| 51NH directional supervision | Directional permission 51NH | DIR 51NH | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NH | Polarization loss 51NH | POL LOSS 51NH | PER | BLK/PER | NA |
| Pickup level 51NH | Pickup 51NH | TAP 51NH | 0.5 In | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NH | CURV 51NH | TDE | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NH | DIAL 51NH | 0.5<br>5.0 | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NH | TIME 51NH | 1 s | 0 to 99.99 s | 0.01 s |
| **Unit 51NL** | **Unit 51NL** | **F51NL** | | | |
| Enable Unit 51NL | Enable 51NL | ENABLE 51NL | NO | Y/N | NA |
| Enable trip 51NL | Trip 51NL | TRIP 51NL | YES | Y/N | NA |
| Directional supervision 51NL | Directional permission 51NL | DIR 51NL | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NL | Polarization loss 51NL | POL LOSS 51NL | PER | BLK/PER | NA |
| Pickup level 51NL | Pickup 51NL | TAP 51NL | 0.5 In | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NL | CURV 51NL | TDE | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NL | DIAL 51NL | 0.5<br>5.0 | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NL | TIME 51NL | 1 s | 0 to 99.99 s | 0.01 s |

### 5.2.1.4. UNIT 67 SETTINGS

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67N1** | **F67N1** | **F67N1** | | | |
| Characteristic angle 67N1 | Characteristic angle 67N1 | ANG 67N1 | -45 degrees | -90 to +90 degrees | 1 degree |
| Direction 67N1 | Direction 67N1 | DIR 67N1 | FWD | NO/FWD/REV | NA |
| Polarization 67N1 | Polarization 67N1 | POL 67N1 | VOLTAGE | VOLTAGE<br>CURRENT<br>V+I (V ó I)<br>V*I (V e I) | NA |
| **Unit 67N2** | **F67N2** | **F67N2** | | | |
| Characteristic angle 67N2 | Characteristic angle 67N2 | ANG 67N2 | -45 degrees | -90 TO +90 degrees | 1 degree |
| Direction 67N2 | Direction 67N2 | DIR 67N2 | FWD | NO/FWD/REV | NA |
| Polarization 67N2 | Polarization 67N2 | POL 67N2 | VOLTAGE | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |

### 5.2.2.1. GENERAL SETTINGS GROUP

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| | **GENERAL SETTINGS** | **GENERAL** | | | |
| Relay status | RELAY STATUS | STA | DIS | RDY / DIS | NA |
| Frequency | FREQUENCY | FRQ | 50 Hz | 50/60 Hz | NA |
| Application (Isolated ground/Petersen Coil) | App | APP | UNG | UNG/PET | NA |
| Password | --- | PWD | 1 | 1 to 255 | 1 |
| Relay address | --- | ADD | 1 | 1 to 255 | 1 |
| Communication baudrate | --- | BAUD | 9600 | 300, 600, 1200, 2400, 4800, 9600, 19200 | NA |

### 5.2.2.2. ISOLATED GROUND 67 UNITS SETTINGS

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67IG1** | **Unit 67IG1** | **F67IG1** | | | |
| Enable Unit 67IG1 | Enable 67IG1 | ENABLE 67IG1 | N | Y/N | NA |
| Enable trip 67IG1 | Trip 67IG1 | TRIP 67IG1 | Y | Y/N | NA |
| Time 67IG1 | Time 67IG1 | TIME 67IG1 | 1 | 0 to 99.99 s | 0.01 |
| Direction 67IG1 | Direction 67IG1 | DIR 67IG1 | FWD | NO/FWD/REV | NA |
| Time to instantaneous 67IG1 | Time to instantaneous 67IG1 | TTI 67IG1 | 1 | 0 to 99.99 s | 0.01 |
| Higher voltage 67IG1 | Higher voltage 67IG1 | VH 67IG1 | 20 | 2 to 70 V | 0.01 |
| Lower voltage 67IG1 | Lower voltage 67IG1 | VL 67IG1 | 2 | 2 to 70 V | 0.01 |
| Higher current 67IG1 | Higher current 67IG1 | IH 67IG1 | 0.025 | 0.005 to 0.4 A | 0.001 |
| Lower current 67IG1 | Lower current 67IG1 | IL 67IG1 | 0.005 | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67IG1 | Characteristic angle 67IG1 | ANG 67IG1 | 90 | -90 to +90 degrees | 1 |
| **Unit 67IG2** | **Unit 67IG2** | **F67IG2** | | | |
| Enable Unit 67IG2 | Enable 67IG2 | ENABLE 67IG2 | N | Y/N | NA |
| Enable trip 67IG2 | Trip 67IG2 | TRIP 67IG2 | Y | Y/N | NA |
| Time 67IG2 | Time 67IG2 | TIME 67IG2 | 1 | 0 to 99.99 s | 0.01 |
| Direction 67IG2 | Direction 67IG2 | DIR 67IG2 | FWD | NO/FWD/REV | NA |
| Time to instantaneous 67IG2 | Time to instantaneous 67IG2 | TTI 67IG2 | 1 | 0 to 99.99 s | 0.01 |
| Higher voltage 67IG2 | Higher voltage 67IG2 | VH 67IG2 | 20 | 2 to 70 V | 0.01 |
| Lower voltage 67IG2 | Lower voltage 67IG2 | VL 67IG2 | 2 | 2 to 70 V | 0.01 |
| Higher current 67IG2 | Higher current 67IG2 | IH 67IG2 | 0.025 | 0.005 to 0.4 A | 0.001 |
| Lower current 67IG2 | Lower current 67IG2 | IL 67IG2 | 0.005 | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67IG2 | Characteristic angle 67IG2 | ANG 67IG2 | 90 | -90 to +90 degrees | 1 |

### 5.2.2.3. PETERSEN COIL 67 UNITS SETTINGS

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67PC1** | **Unit 67PC1** | **F67PC1** | | | |
| Enable Unit 67PC1 | Enable 67PC1 | ENABLE 67PC1 | N | Y/N | NA |
| Enable trip 67PC1 | Trip 67PC1 | TRIP 67PC1 | Y | Y/N | NA |
| Enable power supervision 67PC1 | POWER 67PC1 | POWER 67PC1 | Y | Y/N | NA |
| Time 67PC1 | Time 67PC1 | TIME 67PC1 | 1 | 0 to 99.99 s | 0.01 |
| Direction 67PC1 | Direction 67PC1 | DIR 67PC1 | FWD | NO/FWD/REV | NA |
| Pickup voltage 67PC1 | Pickup voltage 67PC1 | V 67PC1 | 2 | 2 to 70 V | 0.01 |
| Pickup current 67PC1 | Pickup current 67PC1 | I 67PC1 | 0.005 | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67PC1 | Characteristic angle 67PC1 | ANG 67PC1 | 0 | 0 to +180 degrees | 1 |
| Opening cone 67PC1 | Opening cone 67PC1 | CONE 67PC1 | 5 | 0 to 45 degrees | 1 |
| Power 67PC1 | Power 67PC1 | P 67PC1 | 0.01 | 0.01 to 4.5 w | 0.01 |
| **Unit 67PC2** | **Unit 67PC2** | **F67PC2** | | | |
| Enable Unit 67PC2 | Enable 67PC2 | ENABLE 67PC2 | N | Y/N | NA |
| Enable trip 67PC2 | Trip 67PC2 | TRIP 67PC2 | Y | Y/N | NA |
| Enable power supervision 67PC2 | POWER 67PC2 | POWER 67PC2 | Y | Y/N | NA |
| Time 67PC2 | Time 67PC2 | TIME 67PC2 | 1 | 0 to 99.99 s | 0.01 |
| Direction 67PC2 | Direction 67PC2 | DIR 67PC2 | FWD | NO/FWD/REV | NA |
| Pickup voltage 67PC2 | Pickup voltage 67PC2 | V 67PC2 | 2 | 2 to 70 V | 0.01 |
| Pickup current 67PC2 | Pickup current 67PC2 | I 67PC2 | 0.005 | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67PC2 | Characteristic angle 67PC2 | ANG 67PC2 | 0 | 0 to +180 degrees | 1 |
| Opening cone 67PC2 | Opening cone 67PC2 | CONE 67PC2 | 5 | 0 to 45 degrees | 1 |
| Power 67PC2 | Power 67PC2 | P 67PC2 | 0.01 | 0.01 to 4.5 w | 0.01 |

## 5.3. ADVANCED SETTINGS

### 5.3.1. MODEL E

#### 5.3.1.1. GENERAL ADVANCED SETTINGS GROUP

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **GENERAL ADVANCED SETTINGS** | **GENERAL ADVANCED** | **GENERAL ADVANCED** | | | |
| Identification | IDENTIFICATION | | MIN | | |
| Active settings table | ACTIVE TABLE | TAB | 1 | 1/2 | NA |
| Trip minimum time | T. MIN. TRIP | TRIP MIN TIME | 100 | 50-300 ms | 1 |

#### 5.3.1.2. UNIT 50 SETTINGS TABLE 2

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 50NH T2** | **F50NH t2** | **F50NH T2** | | | |
| Enable Unit 50NH T2 | Enable 50NH T2 | ENABLE 50NH T2 | NO | Y/N | NA |
| Enable trip 50NH T2 | Trip 50NH T2 | TRIP 50NH T2 | YES | Y/N | NA |
| Directional supervision 50NH T2 | Directional permission 50NH T2 | DIR 50NH T2 | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NH T2 | Polarization loss 50NH T2 | POL LOSS 50NH T2 | PER | BLK/PER | NA |
| Pickup level 50NH T2 | Pickup 50NH T2 | TAP 50NH T2 | 1 In | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NH T2 | TIME 50NH T2 | 0 s | 0-99.99 s | 0.01 s |
| **Unit 50NL T2** | **Unit 50NL t2** | **F50NL T2** | | | |
| Enable Unit 50NL T2 | Enable 50NL T2 | ENABLE 50NL T2 | NO | Y/N | NA |
| Enable trip 50NL T2 | Trip 50NL T2 | TRIP 50NL T2 | YES | Y/N | NA |
| Directional supervision 50NL T2 | Directional permission 50NL T2 | DIR 50NL T2 | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NL T2 | Polarization loss 50NL T2 | POL LOSS 50NL T2 | PER | BLK/PER | NA |
| Pickup level 50NL T2 | Pickup 50NL T2 | TAP 50NL T2 | 1 In | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NL T2 | TIME 50NL T2 | 0 s | 0-99.99 s | 0.01 s |

### 5.3.1.3. UNIT 51 SETTINGS TABLE 2

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 51NH T2** | **F51NH t2** | **F51NH T2** | | | |
| Enable Unit 51NH T2 | Enable 51NH T2 | ENABLE 51NH T2 | NO | Y/N | NA |
| Enable trip 51NH T2 | Trip 51NH T2 | TRIP 51NH T2 | YES | Y/N | NA |
| Directional supervision 51NH T2 | Directional permission 51NH T2 | DIR 51NH T2 | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NH T2 | Polarization loss 51NH T2 | POL LOSS 51NH T2 | PER | BLK/PER | NA |
| Pickup level 51NH T2 | Pickup 51NH T2 | TAP 51NH T2 | 0.5 In | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NH T2 | CURV 51NH T2 | TDE | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NH T2 | DIAL 51NH T2 | 0.5<br>5.0 | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NH T2 | TIME 51NH T2 | 1 s | 0 to 99.99 s | 0.01 s |
| **Unit 51NL T2** | **Unit 51NL t2** | **F51NL T2** | | | |
| Enable Unit 51NL T2 | Enable 51NL T2 | ENABLE 51NL T2 | NO | Y/N | NA |
| Enable trip 51NL T2 | Trip 51NL T2 | TRIP 51NL T2 | YES | Y/N | NA |
| Directional supervision 51NL T2 | Directional permission 51NL T2 | DIR 51NL T2 | NO | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NL T2 | Polarization loss 51NL T2 | POL LOSS 51NL T2 | PER | BLK/PER | NA |
| Pickup level 51NL T2 | Pickup 51NL T2 | TAP 51NL T2 | 0.5 In | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NL T2 | CURV 51NL T2 | TDE | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NL T2 | DIAL 51NL T2 | 0.5<br>5.0 | 0.05 TO 2.0<br>0.5 TO 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NL T2 | TIME 51NL T2 | 1 s | 0 to 99.99 s | 0.01 s |

### 5.3.1.4. UNIT 67 SETTINGS TABLE 2

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67N1 T2** | **F67N1 t2** | **F67N1 t2** | | | |
| Characteristic angle 67N1 T2 | Characteristic angle 67N1 T2 | ANG 67N1 T2 | -45 degrees | -90 TO +90 degrees | 1 degree |
| Direction 67N1 T2 | Direction 67N1 T2 | DIR 67N1 T2 | FWD | NO/FWD/REV | NA |
| Polarization 67N1 T2 | Polarization 67N1 T2 | POL 67N1 T2 | VOLTAGE | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |
| **Unit 67N2 T2** | **F67N2 t2** | **F67N2 t2** | | | |
| Characteristic angle 67N2 T2 | Characteristic angle 67N2 T2 | ANG 67N2 T2 | -45 degrees | -90 TO +90 degrees | 1 degree |
| Direction 67N2 T2 | Direction 67N2 T2 | DIR 67N2 T2 | FWD | NO/FWD/REV | NA |
| Polarization 67N2 T2 | Polarization 67N2 T2 | POL 67N2 T2 | VOLTAGE | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |

#### *5.3.1.5. USER CURVE*

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **USER CURVE** | **CURV** | | | | |
| A | A | A | 0.05 s. | 0 to 125 s. | 0.0001 |
| B | B | B | 0 s. | 0 to 3 s. | 0.0001 |
| P | P | P | 0.04 | 0 to 3 | 0.0001 |
| Q | Q | Q | 1 | 0 to 2 | 0.0001 |
| K | K | K | 0 s. | 0 to 1.999 s. | 0.001 |

### *5.3.1.6. EVENT MASK (ONLY M+PC)*

Event masks have two possible settings, YES and NO. If an action (for example the trip of a protection unit) is set as YES, when it occurs it will generate an event. If it is set as NO, no event will be created.

| | M+PC | DEFAULT | RANGE |
|---|---|---|---|
| Pickup/dropout of unit 50NH | Pickup 50NH | Yes | Yes / No |
| Pickup/dropout of unit 50NL | Pickup 50NL | Yes | Yes / No |
| Pickup/dropout of unit 51NH | Pickup 51NH | Yes | Yes / No |
| Pickup/dropout of unit 51NL | Pickup 51NL | Yes | Yes / No |
| Pickup/dropout of unit 67N1 | Pickup 67N1 | Yes | Yes / No |
| Pickup/dropout of unit 67N2 | Pickup 67N2 | Yes | Yes / No |
| Enable/disable the inhibition of unit 50NH (by digital input) | Inhibition 50NH (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 50NL (by digital input) | Inhibition 50NL (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 51NH (by digital input) | Inhibition 51NH (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 51NL (by digital input) | Inhibition 51NL (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 67N1 (by digital input) | Inhibition 67N1 (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 67N2 (by digital input) | Inhibition 67N2 (by DI) | Yes | Yes / No |
| Enable/disable the trip inhibition (by digital input) | Disable trip (by DI) | Yes | Yes / No |
| Unit 50NH trip | Trip 50NH | Yes | Yes / No |
| Unit 50NL trip | Trip 50NL | Yes | Yes / No |
| Unit 51NH trip | Trip 51NH | Yes | Yes / No |
| Unit 51NL trip | Trip 51NL | Yes | Yes / No |
| Unit 67N1 block | Block 67N1 | Yes | Yes / No |
| Unit 67N2 block | Block 67N2 | Yes | Yes / No |
| General Trip | General trip | Yes | Yes / No |
| Activation/deactivation of the protection | Protection Status | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 1 | Output 1 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 2 | Output 2 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 3 | Output 3 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 4 | Output 4 | Yes | Yes / No |
| Activation/deactivation of Digital input 1 | Digital input 1 | Yes | Yes / No |
| Activation/deactivation of Digital input 2 | Digital input 2 | Yes | Yes / No |
| Activation/deactivation of the Settings Change inhibition by digital input | Settings Change inhibit | Yes | Yes / No |
| Trip command activation by digital input | Trip command by input | Yes | Yes / No |
| Trip command activation by command | Trip command by command | Yes | Yes / No |
| Latched output reset | Reset latch aux | Yes | Yes / No |
| Close breaker | Close breaker | Yes | Yes / No |
| Table change | Table change | Yes | Yes / No |
| Oscillography trigger by digital input | Osc. Trigger by DI | Yes | Yes / No |
| Oscillography trigger by communications | Osc. Trigger by comm. | Yes | Yes / No |
| 52B open/closed by digital input | Breaker 52B | Yes | Yes / No |
| 52 Open/closed | Closed breaker | Yes | Yes / No |
| Settings change mask | Settings change | Yes | Yes / No |
| EEPROM error mask | e2prom failure | Yes | Yes / No |
| User settings activation/deactivation mask | User settings | Yes | Yes / No |

#### *5.3.1.7. OSCILLOGRAPHY MASKS (ONLY M+PC)*

| | M+PC | DEFAULT | RANGE |
|---|---|---|---|
| Oscillography by communications | Oscillo by com. | No | Yes / No |
| Oscillo by digital input | Oscillo by digital input | No | Yes / No |
| Oscillo by trip | Oscillo by trip | No | Yes / No |
| Oscillo by pickup | Oscillo by pickup | No | Yes / No |

#### 5.3.2.1. GENERAL ADVANCED SETTINGS GROUP

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **GENERAL ADVANCED SETTINGS** | **GENERAL ADVANCED** | **GENERAL ADVANCED** | | | |
| Identification | IDENTIFICATION | | MIN | | |
| Active settings table | ACTIVE TABLE | TAB | 1 | 1/2 | NA |
| Trip minimum time | T. MIN. TRIP | TRIP MIN TIME | 100 | 50-300 ms | 1 |

#### 5.3.2.2. ISOLATED GROUND 67 UNITS SETTINGS TABLE 2

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67IG1 T2** | **Unit 67IG1 T2** | **F67IG1 T2** | | | |
| Enable Unit 67IG1 T2 | Enable 67IG1 T2 | ENABLE 67IG1 T2 | N | Y/N | NA |
| Enable trip 67IG1 T2 | Trip 67IG1 T2 | TRIP 67IG1 T2 | Y | Y/N | NA |
| Time 67IG1 T2 | Time 67IG1 T2 | TIME 67IG1 T2 | 1 | 0 a 99.99 s | 0.01 |
| Direction 67IG1 T2 | Direction 67IG1 T2 | DIR 67IG1 T2 | FWD | NO/FWD/REV | NA |
| Time to instantaneous 67IG1 T2 | Time to instantaneous 67IG1 T2 | TTI 67IG1 T2 | 1 | 0 a 99.99 s | 0.01 |
| Higher voltage 67IG1 T2 | Higher voltage 67IG1 T2 | VH 67IG1 T2 | 20 | 2 a 70 V | 0.01 |
| Lower voltage 67IG1 T2 | Lower voltage 67IG1 T2 | VL 67IG1 T2 | 2 | 2 a 70 V | 0.01 |
| Higher current 67IG1 T2 | Higher current 67IG1 T2 | IH 67IG1 T2 | 0.025 | 0.005 a 0.4 A | 0.001 |
| Lower current 67IG1 T2 | Lower current 67IG1 T2 | IL 67IG1 T2 | 0.005 | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67IG1 T2 | Characteristic angle 67IG1 T2 | ANG 67IG1 T2 | 90 | -90 a +90 degrees | 1 |
| **Unit 67IG2 T2** | **Unit 67IG2 T2** | **F67IG2 T2** | | | |
| Enable Unit 67IG2 T2 | Enable 67IG2 T2 | ENABLE 67IG2 T2 | N | Y/N | NA |
| Enable trip 67IG2 T2 | Trip 67IG2 T2 | TRIP 67IG2 T2 | Y | Y/N | NA |
| Time 67IG2 T2 | Time 67IG2 T2 | TIME 67IG2 T2 | 1 | 0 a 99.99 s | 0.01 |
| Direction 67IG2 T2 | Direction 67IG2 T2 | DIR 67IG2 T2 | FWD | NO/FWD/REV | NA |
| Time to instantaneous 67IG2 T2 | Time to instantaneous 67IG2 T2 | TTI 67IG2 T2 | 1 | 0 a 99.99 s | 0.01 |
| Higher voltage 67IG2 T2 | Higher voltage 67IG2 T2 | VH 67IG2 T2 | 20 | 2 a 70 V | 0.01 |
| Lower voltage 67IG2 T2 | Lower voltage 67IG2 T2 | VL 67IG2 T2 | 2 | 2 a 70 V | 0.01 |
| Higher current 67IG2 T2 | Higher current 67IG2 T2 | IH 67IG2 T2 | 0.025 | 0.005 a 0.4 A | 0.001 |
| Lower current 67IG2 T2 | Lower current 67IG2 T2 | IL 67IG2 T2 | 0.005 | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67IG2 T2 | Characteristic angle 67IG2 T2 | ANG 67IG2 T2 | 90 | -90 a +90 degrees | 1 |

### *5.3.2.3. PETERSEN COIL 67 UNITS SETTINGS TABLE 2*

| | M+PC | HMI | DEFAULT | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67PC1 T2** | **Unit 67PC1 T2** | **F67PC1 T2** | | | |
| Enable Unit 67PC1 T2 | Enable 67PC1 T2 | ENABLE 67PC1 T2 | N | Y/N | NA |
| Enable trip 67PC1 T2 | Trip 67PC1 T2 | TRIP 67PC1 T2 | Y | Y/N | NA |
| Enable power supervision 67PC1 T2 | POWER 67PC1 T2 | POWER 67PC1 T2 | Y | Y/N | NA |
| Time 67PC1 T2 | Time 67PC1 T2 | TIME 67PC1 T2 | 1 | 0 a 99.99 s | 0.01 |
| Direction 67PC1 T2 | Direction 67PC1 T2 | DIR 67PC1 T2 | FWD | NO/FWD/REV | NA |
| Pickup voltage 67PC1 T2 | Pickup voltage 67PC1 T2 | V 67PC1 T2 | 2 | 2 a 70 V | 0.01 |
| Pickup current 67PC1 T2 | Pickup current 67PC1 T2 | I 67PC1 T2 | 0.005 | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67PC1 T2 | Characteristic angle 67PC1 T2 | ANG 67PC1 T2 | 0 | 0 a +180 degrees | 1 |
| Opening cone 67PC1 T2 | Opening cone 67PC1 T2 | CONE 67PC1 T2 | 5 | 0 a 45 degrees | 1 |
| Power 67PC1 T2 | Power 67PC1 T2 | P 67PC1 T2 | 0.01 | 0.01 a 4.5 w | 0.01 |
| **Unit 67PC2 T2** | **Unit 67PC2 T2** | **F67PC2 T2** | | | |
| Enable Unit 67PC2 T2 | Enable 67PC2 T2 | ENABLE 67PC2 T2 | N | Y/N | NA |
| Enable trip 67PC2 T2 | Trip 67PC2 T2 | TRIP 67PC2 T2 | Y | Y/N | NA |
| Enable power supervision 67PC2 T2 | POWER 67PC2 T2 | POWER 67PC2 T2 | Y | Y/N | NA |
| Time 67PC2 T2 | Time 67PC2 T2 | TIME 67PC2 T2 | 1 | 0 a 99.99 s | 0.01 |
| Direction 67PC2 T2 | Direction 67PC2 T2 | DIR 67PC2 T2 | FWD | NO/FWD/REV | NA |
| Pickup voltage 67PC2 T2 | Pickup voltage 67PC2 T2 | V 67PC2 T2 | 2 | 2 a 70 V | 0.01 |
| Pickup current 67PC2 T2 | Pickup current 67PC2 T2 | I 67PC2 T2 | 0.005 | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67PC2 T2 | Characteristic angle 67PC2 T2 | ANG 67PC2 T2 | 0 | 0 a +180 degrees | 1 |
| Opening cone 67PC2 T2 | Opening cone 67PC2 T2 | CONE 67PC2 T2 | 5 | 0 a 45 degrees | 1 |
| Power 67PC2 T2 | Power 67PC2 T2 | P 67PC2 T2 | 0.01 | 0.01 a 4.5 w | 0.01 |

### *5.3.2.4. EVENT MASK (ONLY M+PC)*

Event masks have two possible settings, YES and NO. If an action (for example the trip of a protection unit) is set as YES, when it occurs it will generate an event. If it is set as NO, no event will be created.

| | M+PC | DEFAULT | RANGE |
|---|---|---|---|
| Pickup/dropout of unit 67IG1 | Pickup 67IG1 | Yes | Yes / No |
| Pickup/dropout of unit 67IG2 | Pickup 67IG2 | Yes | Yes / No |
| Pickup/dropout of unit 67PC1 | Pickup 67PC1 | Yes | Yes / No |
| Pickup/dropout of unit 67PC2 | Pickup 67PC2 | Yes | Yes / No |
| Enable/disable the inhibition of unit 67IG1 (by digital input) | Inhibition 67IG1 (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 67IG2 (by digital input) | Inhibition 67IG2 (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 67PC1 (by digital input) | Inhibition 67PC1 (by DI) | Yes | Yes / No |
| Enable/disable the inhibition of unit 67PC2 (by digital input) | Inhibition 67PC2 (by DI) | Yes | Yes / No |
| Activation/deactivation of inhibition del trip (by digital input) | Inhibit trip (by DI) | Yes | Yes / No |
| Unit 67IG1 | Trip 67IG1 | Yes | Yes / No |
| Unit 67IG2 | Trip 67IG2 | Yes | Yes / No |
| Unit 67PC1 | Trip 67PC1 | Yes | Yes / No |
| Unit 67PC2 | Trip 67PC2 | Yes | Yes / No |
| General trip | General trip | Yes | Yes / No |
| Activation/deactivation of the protection | Protection Status | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 1 | Output 1 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 2 | Output 2 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 3 | Output 3 | Yes | Yes / No |
| Activation/deactivation of Auxiliary output 4 | Output 4 | Yes | Yes / No |
| Activation/deactivation of Digital input 1 | Digital input 1 | Yes | Yes / No |
| Activation/deactivation of Digital input 2 | Digital input 2 | Yes | Yes / No |
| Activation/deactivation of the Settings Change inhibition by digital input | Settings Change inhibit | Yes | Yes / No |
| Trip command activation by digital input | Trip command by input | Yes | Yes / No |
| Trip command activation by command | Trip command by command | Yes | Yes / No |
| Latched output reset | Reset latch aux | Yes | Yes / No |
| Close breaker | Close breaker | Yes | Yes / No |
| Table change | Table change | Yes | Yes / No |
| Oscillography trigger by digital input | Osc. Trigger by DI | Yes | Yes / No |
| Oscillography trigger by communications | Osc. Trigger by comm. | Yes | Yes / No |
| 52B open/closed by digital input | Breaker 52B | Yes | Yes / No |
| 52 Open/closed | Closed breaker | Yes | Yes / No |
| Settings change mask | Settings change | Yes | Yes / No |
| EEPROM error mask | e2prom failure | Yes | Yes / No |
| User settings activation/deactivation mask | User settings | Yes | Yes / No |

### *5.3.2.5.*

#### *5.3.2.6. OSCILLOGRAPHY MASK (ONLY M+PC)*

| | M+PC | DEFAULT | RANGE |
|---|---|---|---|
| Oscillo by communications | Oscillo by comm. | No | Yes / No |
| Oscillo by digital input | Oscillo by digital input | No | Yes / No |
| Oscillo by trip | Oscillo by trip | No | Yes / No |
| Oscillo by pickup | Oscillo by pickup | No | Yes / No |

**COMMENTS ON THE SETTINGS:**

The ACTIVE TABLE setting, part of the advanced settings group, allows to select which of the two setting tables of the MIN is active in a certain moment. By default, the active table will be TABLE 1.

## 5.4. TIME SYNCHRONIZATION

MIN relay includes an internal clock to time tag events. This clock can be synchronised with the computer clock using the M+PC software program. It can also be set to a given Date and Time using the faceplate keypad.

# 6. INPUT AND OUTPUT CONFIGURATION

## 6.1. INPUT CONFIGURATION

### 6.1.1. INPUT DESCRIPTION

The MIN incorporates 2 digital inputs, which can be configured using M+PC software. The default configurations are:

**Model E**:

Input 1: Disable all protection units

Input 2: Disable units 50N (50NH and 50NL)

**Model S**:

Input 1: Disable all protection units

Input 2: Breaker 52b (breaker status).

All functions are LEVEL inputs, except for those indicated as PULSE (following section).

The minimum operation time for a valid PULSE input is higher than 0.015 seconds.

The input functions are divided in groups with a maximum of 8 functions per group, besides the “No Definition” function. Up to 8 functions can be assigned to the same input, provided that they are part of the same group. Functions belonging to different groups must be assigned to different inputs.

In order to program an input assigning more than one function (all of them part of the same group), we must first activate the OR button, click on the **I/O CONFIGURATION** tab and select the group that includes the desired functions. To deny a function, we must select the NOT button. Finally, press OK.

***As an example, in the default configuration for MIN E models, input 2 disables protection units 50NH and 50NL. This input has been programmed as follows:***

***In the dialog box that is displayed when pressing OR, select the MASK DI 1 group, and in this group, select INHIBIT 50NH and INHIBIT 50NL. As a result, every time that digital input 2 is activated, this two protection units are simultaneously disabled.***

The following table includes the list of functions that can be assigned to each input depending on the relay model.

#### *6.1.2.1. MODEL E*

| M+PC | Operation |
|---|---|
| No definition | Input not defined |
| Inhibit 50NH | Trip inhibition for unit 50NH |
| Inhibit 50NL | Trip inhibition for unit 50NL |
| Inhibit 51NH | Trip inhibition for unit 51NH |
| Inhibit 51NL | Trip inhibition for unit 51NL |
| Inhibit 67N1 | Inhibition of unit 67N1 |
| Inhibit 67N2 | Inhibition of unit 67N2 |
| General inhibition | General block of all protection units |
| Trip inhibition | Trip inhibition |
| Status 52b | Status of contact 52b, active with open breaker |
| Trip contact close (PULSE) | This function allows to activate the trip output |
| Change table | The activation of this function involves that the active table is T2. When it is deactivated, the active table is the one adjusted in the ACTIVE TABLE setting. |
| Inhibit setting change | When this function is active, the settings cannot be modified. It is only possible to activate Table 2 using the “Change Table” Digital input. |
| Reset (PULSE) | This function allows to reset the LED indicators and latch outputs. |
| Oscillo trigger (PULSE) | Oscillography trigger |
| Generic input | General purpose input used in the logic configuration |

#### *6.1.2.2. MODEL S*

| M+PC | Operation |
|---|---|
| No Definition | Input not defined |
| Inhibit 67IG1 | Trip inhibition for unit 67IG1 |
| Inhibit 67IG2 | Trip inhibition for unit 67IG2 |
| Inhibit 67PC1 | Trip inhibition for unit 67PC1 |
| Inhibit 67PC2 | Trip inhibition for unit 67PC2 |
| Input general inhibition | General block of all protection units |
| Trip inhibition | Trip inhibition |
| Status 52b | Status of contact 52b, active with open breaker |
| Trip contact close (PULSE) | This function allows to activate the trip output |
| Change table | The activation of this function involves that the active table is T2. When it is deactivated, the active table is the one adjusted in the ACTIVE TABLE setting. |
| Inhibit setting change | When this function is active, the settings cannot be modified. It is only possible to activate Table 2 using the “Change Table” Digital input. |
| Reset (PULSE) | This function allows to reset the LED indicators and latch outputs. |
| Oscillo trigger (PULSE) | Oscillography trigger |
| Generic input | General purpose input used in the logic configuration |

## 6.2. OUTPUT AND LED CONFIGURATION

### 6.2.1. DESCRIPTION OF OUTPUTS AND LEDS

The MIN incorporates 6 outputs and 6 LEDs. Four of the outputs and four of the LED indicators are user programmable and can be configured using M+PC software. The two first LEDs are fixed for READY (in service) and TRIP. The outputs that cannot be configured are assigned to ALARM (system alarm) and TRIP.

The trip LED is lit up when the TRIP contact closes.

When the READY LED is turned off, the ALARM contact is closed, showing that the unit is not in service (its protection units have not been set/enabled), that the unit has no auxiliary voltage, or that there is a problem that prevents the unit from working properly.

The default configuration of the outputs is the following:

| OUTPUT | MODEL E | MODEL S |
|---|---|---|
| | CONFIGURATION | CONFIGURATION |
| 1 | Trip 51NH | Trip 67-1 |
| 2 | Trip 51NL | Trip 67-2 |
| 3 | Trip 50NH | Pickup 67-1 |
| 4 | Trip 50NL | Pickup of any unit |

The default configuration for LEDs is as follows:

| LED | MODEL E | | MODEL S | |
|---|---|---|---|---|
| | CONFIGURATION | MEMORY | CONFIGURATION | MEMORY |
| 1 | Trip 51N | Yes | Trip 67-1 | Yes |
| 2 | Trip 50NH | Yes | Trip 67-2 | Yes |
| 3 | Trip 50NL | Yes | Pickup 67-1 | No |
| 4 | Pickup of any unit | No | Pickup of any unit | No |

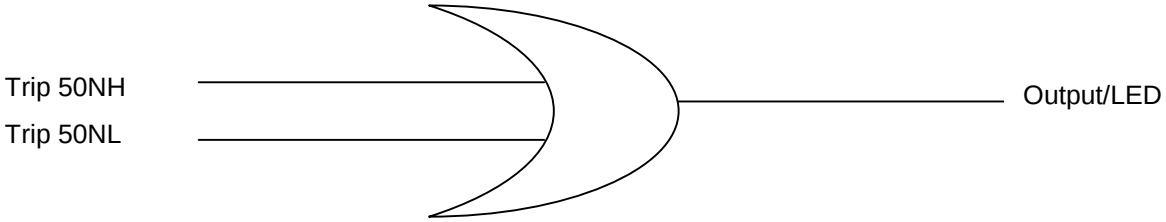
In the configuration for model S, 67-1 refers to 67IG1 or 67PC1, depending on the selected application, and the same occurs with 67-2.

Functions that can be assigned to outputs/LEDs are divided in groups, besides the “No Definition” function. Functions belonging to the same group can be assigned to the same output or LED. Functions belonging from different groups must be assigned to different outputs/LEDs.

In order to assign more than one function to an output or LED, we must activate the OR button, click on the OR gate icon that will be displayed, and select the group that includes the desired functions. In order to negate a function, we will select the NOT button. Finally, press OK.

In order to negate the logic, select the general NOT button. Outputs can be memorized, and LEDs can be configured to be fix or blinking, with or without memory.

***Taking as an example Model E, for assigning the 50N trip (that is, the trip of both units 50NH and 50NL) to an output or LED, we must program it with functions "Trip 50NH" and "Trip 50NL".***



## 6.2.2. FUNCTIONS FOR OUTPUTS AND LEDS

The following list shows the functions that can be assigned to each input depending on the model. The list is separated in groups.

### *6.2.2.1. MODEL E*

| Group | Function | Description |
|---|---|---|
| No definition | No definition | Output or LED not configured |
| Configurations | Logic 1 | Logic 1 block output signal |
| | Logic 2 | Logic 2 block output signal |
| | Logic 3 | Logic 3 block output signal |
| | Logic 4 | Logic 4 block output signal |
| Trip 1 | Trip 50NH | Trip of unit 50NH |
| | Trip 50NL | Trip of unit 50NL |
| | Trip 51NH | Trip of unit 51NH |
| | Trip 51NL | Trip of unit 51NL |
| Pickup 1 | Activation 67N1 | Activation of unit 67N1 |
| | Activation 67N2 | Activation of unit 67N2 |
| | Pickup 50NH | Pickup of unit 50NH |
| | Pickup 50NL | Pickup of unit 50NL |
| | Pickup 51NH | Pickup of unit 51NH |
| | Pickup 51NL | Pickup of unit 51NL |
| Trip 2 | General trip | General trip |
| Pickup 2 | General pickup | General pickup |
| Int. Trip 1 | Virtual trip 50NH | Virtual trip of unit 50NH |
| | Virtual trip 50NL | Virtual trip of unit 50NL |
| | Virtual trip 51NH | Virtual trip of unit 51NH |
| | Virtual trip 51NL | Virtual trip of unit 51NL |
| Int. Trip 2 | General virtual trip | General virtual trip |
| Various 1 | Block 67N1 | Block of unit 67N1 caused by lack of magnitudes |
| | Block 67N2 | Block of unit 67N2 caused by lack of magnitudes |
| Inputs / Outputs | Input 1 | Digital input 1 |
| | Input 2 | Digital input 2 |
| Various 1 | 52 closed | Breaker status |
| | E2prom failure | Activates when a failure is detected in the E2prom management |
| | User settings | When the default settings are active this function is inactive; when the user modifies any setting, the function is active |
| LEDs | Ready | Activates when the relay is in service and at least one of the protection units is enabled to trip. |
| Miscellaneous 2 | Breaker close | Activates when the close breaker operation is executed |
| Various 2 | Table 2 Active | Activates when the setting table 2 is selected |
| | Local | Is LOCAL when the HMI is in the MAIN SETTINGS, ADVANCED SETTINGS, or OPERATIONS menu. |

When trip conditions exist for any protection unit, a virtual trip is produced. If the unit is not disabled by setting or by digital input, a trip is produced.

#### *6.2.2.2. MODEL S*

| Group | Function | Description |
|---|---|---|
| No definition | No definition | Output or LED not configured |
| Configurations | Logic 1 | Logic block 1 output signal |
| | Logic 2 | Logic block 2 output signal |
| | Logic 3 | Logic block 3 output signal |
| | Logic 4 | Logic block 4 output signal |
| Trip 2 | Trip 67IG1 | Trip of unit 67IG1 |
| | Trip 67IG2 | Trip of unit 67IG2 |
| | Trip 67PC1 | Trip of unit 67PC1 |
| | Trip 67PC2 | Trip of unit 67PC2 |
| | General trip | General trip |
| Pickup 2 | Pickup 67IG1 | Pickup of unit 67IG1 |
| | Pickup 67IG2 | Pickup of unit 67IG2 |
| | Pickup 67PC1 | Pickup of unit 67PC1 |
| | Pickup 67PC2 | Pickup of unit 67PC2 |
| | General pickup | General pickup |
| Int. trip 2 | Virtual trip 67IG1 | Virtual trip of unit 67IG1 |
| | Virtual trip 67IG2 | Virtual trip of unit 67IG2 |
| | Virtual trip 67PC1 | Virtual trip of unit 67PC1 |
| | Virtual trip 67PC2 | Virtual trip of unit 67PC2 |
| | General virtual trip | General virtual trip |
| Inputs / Outputs | Input 1 | Digital input 1 |
| | Input 2 | Digital input 2 |
| Various 1 | 52 closed | Breaker status |
| | E2prom failure | Activates when a failure is detected in the e2prom management |
| | User settings | When the default settings are active, this function is inactive; when settings are modified by the user, the function is activated. |
| LEDs | Ready | Activates when the relay is in service and at least one of the protection units is enabled to trip |
| Miscellaneous 2 | Breaker close | Activates when the close breaker operation is executed. |
| Various 2 | Table 2 Active | Active when the setting table 2 is selected |
| | Local | Is LOCAL when the HMI is in the MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu. |

When trip conditions exist for any protection unit, a virtual trip is produced. If the unit is not disabled by setting or by digital input, a trip is produced.

# 7. LOGIC CONFIGURATION

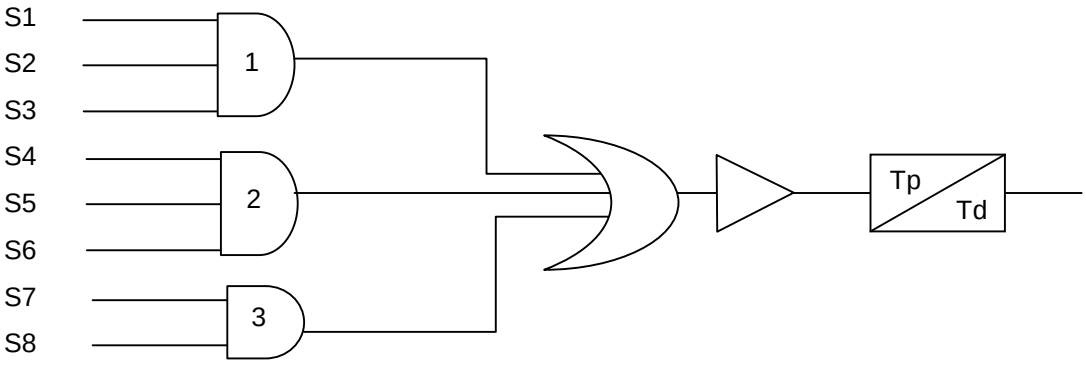
## 7.1. LOGIC DESCRIPTION

Using the M+PC software, we can configure 4 different logics.

The default logic configuration is the following:

| LOGIC | CONFIGURATION | PICKUP TIMER | DROPOUT TIMER |
|---|---|---|---|
| 1 | S1 = Not defined | 0 | 0 |
| 2 | S1 = Not defined | 0 | 0 |
| 3 | S1 = Not defined | 0 | 0 |
| 4 | S1 = Not defined | 0 | 0 |

Logic functions are divided in several groups, besides Not defined function. We can configure up to eight signals in the same Logic box with the following structure:




Each signal (S1...S8) has the same structure as the outputs/LEDs.

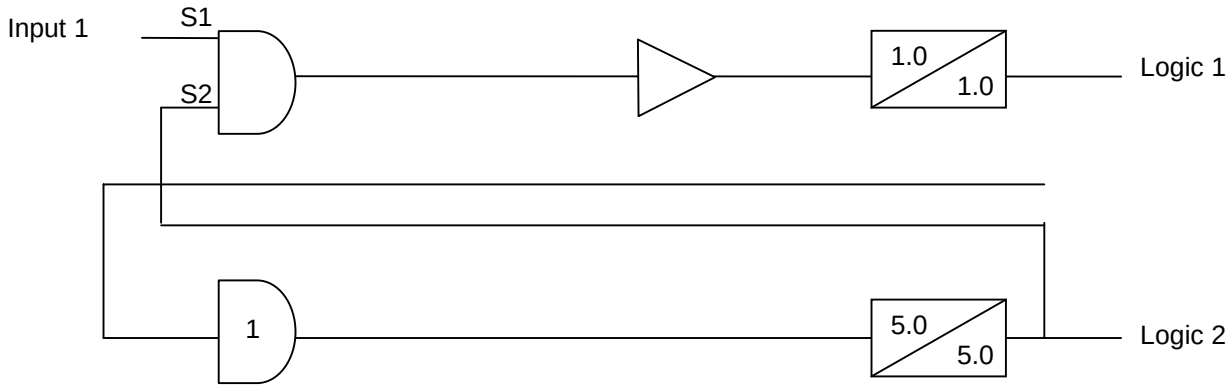
To configure a logic box, we can proceed in the same way as for the outputs/LEDs configuration per signal. If we want to assign more than one function to each signal, the functions must be in the same group, and the OR button must be activated, press the option E/S CONFIGURATION, select the desired group, etc.

There are two timers, pickup and dropout timers, that can be assigned to each logic box.

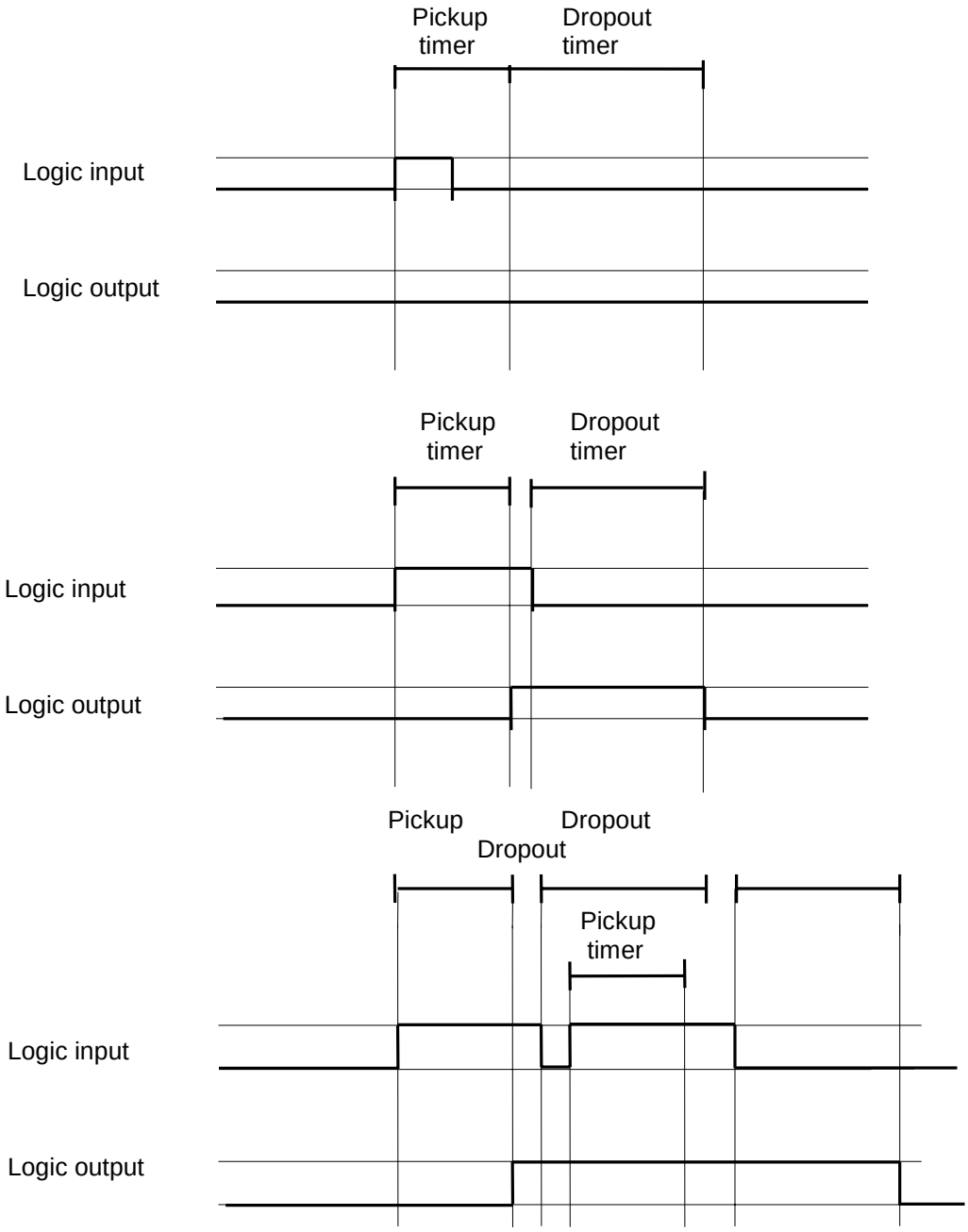
***IMPORTANT NOTE***

***Signals must be used in order, starting with S1. If we wish to use more than one signal in the same AND, use S2 first and then S3. If we wish to use another AND use AND 2 first, and then AND 3.***

For example, we can configure the following logic, where Input 1 is the RESET signal:



Time diagram for the logic configuration:



## 7.2. LOGIC FUNCTIONS

The list of functions that can be assigned in the configurable logic is divided in the following groups:

### 7.2.1. MODEL E

| Group | Function | Description |
|---|---|---|
| No definition | No definition | Output or LED not configured |
| Configuration | Logic 1 | Logic block 1 output signal |
| | Logic 2 | Logic block 2 output signal |
| | Logic 3 | Logic block 3 output signal |
| | Logic 4 | Logic block 4 output signal |
| Trip 1 | Trip 50NH | Trip of unit 50NH |
| | Trip 50NL | Trip of unit 50NL |
| | Trip 51NH | Trip of unit 51NH |
| | Trip 51NL | Trip of unit 51NL |
| Pickup 1 | Activation 67N1 | Activation of unit 67N1 |
| | Activation 67N2 | Activation of unit 67N2 |
| | Pickup 50NH | Pickup of unit 50NH |
| | Pickup 50NL | Pickup of unit 50NL |
| | Pickup 51NH | Pickup of unit 51NH |
| | Pickup 51NL | Pickup of unit 51NL |
| Trip 2 | General trip | General trip |
| Pickup 2 | General pickup | General pickup |
| Int. trip 1 | Virtual trip 50NH | Virtual trip of unit 50NH |
| | Virtual trip 50NL | Virtual trip of unit 50NL |
| | Virtual trip 51NH | Virtual trip of unit 51NH |
| | Virtual trip 51NL | Virtual trip of unit 51NL |
| Int. trip 2 | General virtual trip | General virtual trip |
| Various 0 | Block 67N1 | Block of unit 67N1 caused by lack of magnitudes |
| | Block 67N2 | Block of unit 67N2 caused by lack of magnitudes |
| Mask permissions 1 | Enable 50NH | Enable unit 50NH |
| | Enable 50NL | Enable unit 50NL |
| | Enable 51NH | Enable unit 51NH |
| | Enable 51NL | Enable unit 51NL |
| Mask di 2 | General inhibition input | General inhibition input |
| Inputs / Outputs | Output 1 | Digital output 1 |
| | Output 2 | Digital output 2 |
| | Output 3 | Digital output 3 |
| | Output 4 | Digital output 4 |
| | Input 1 | Digital input 1 |
| | Input 2 | Digital input 2 |
| Inputs | Generic input | Generic input |
| | Settings change inhibition | Settings change inhibition |
| | Table change | Table change |
| Various 1 | 52 closed | 52B input |

| Group | Function | Description |
|---|---|---|
| | E2prom failure | Activates when a failure is detected in the E2prom management |
| | User settings | When the default settings are active, this function is inactive; when the user modifies any settings, this function is activated. |
| LEDs | Ready | Activates when the relay is in service and at least one unit is enabled to trip. |
| Miscellaneous 2 | Breaker close | Activates when the close breaker operation is executed |
| Various 2 | Active table | T1 or T2 |
| | Local | Is LOCAL when the HMI (relay keypad and display) is in the MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu. |

***Note**: The Virtual Trip signal refers to the protection unit trip, that is, the unit has been picked up and its timer has expired. This signal, after checking whether it is affected by a block, activates the trip contact. If there is a block, or the unit trip is disabled by a setting, this virtual trip signal does not progress to the trip contact.*

### 7.2.2. MODEL S

| Group | Function | Description |
|---|---|---|
| **No definition** | No definition | Output or LED not configured |
| **Configurations** | Logic 1 | logic block 1 output signal |
| | Logic 2 | logic block 2 output signal |
| | Logic 3 | logic block 3 output signal |
| | Logic 4 | logic block 4 output signal |
| **Trip 2** | Trip 67IG1 | Trip of unit 67IG1 |
| | Trip 67IG2 | Trip of unit 67IG2 |
| | Trip 67PC1 | Trip of unit 67PC1 |
| | Trip 67PC2 | Trip of unit 67PC2 |
| | General trip | General trip |
| **Pickup 2** | Pickup 67IG1 | Pickup of unit 67IG1 |
| | Pickup 67IG2 | Pickup of unit 67IG2 |
| | Pickup 67PC1 | Pickup of unit 67PC1 |
| | Pickup 67PC2 | Pickup of unit 67PC2 |
| | General pickup | General pickup |
| **Int. trip 2** | Virtual trip 67IG1 | Virtual trip of unit 67IG1 |
| | Virtual trip 67IG2 | Virtual trip of unit 67IG2 |
| | Virtual trip 67PC1 | Virtual trip of unit 67PC1 |
| | Virtual trip 67PC2 | Virtual trip of unit 67PC2 |
| | General virtual trip | General virtual trip |
| **Mask permissions 2** | Enable 67IG1 | Enable unit 67IG1 |
| | Enable 67IG2 | Enable unit 67IG2 |
| | Enable 67PC1 | Enable unit 67PC1 |
| | Enable 67PC2 | Enable unit 67PC2 |
| **Mask di 2** | General inhibition input | General inhibition input |
| **Inputs / Outputs** | Output 1 | Digital output 1 |
| | Output 2 | Digital output 2 |
| | Output 3 | Digital output 3 |
| | Output 4 | Digital output 4 |
| | Input 1 | Digital input 1 |
| | Input 2 | Digital input 2 |
| **Inputs** | Generic input | Generic input |
| | Settings change inhibition | Settings change inhibition |
| | Table change | Active when the setting table is changed |
| **Various 1** | 52 closed | 52 unit status |
| | E2prom failure | Activates when a failure is detected in the E2prom management |
| | User settings | When the default settings are active, this function is inactive; when the user modifies any settings, this function is activated. |
| LEDs | Ready | Activates when the relay is in service and at least one unit is enabled to trip. |
| Miscellaneous 2 | Breaker close | Activates when the close breaker operation is executed |
| Various 2 | Active table | T1 or T2 |
| | Local | Is LOCAL when the HMI (relay keypad and display) is in the MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu. |

***Note**: The Virtual Trip signal refers to the protection unit trip, that is, the unit has been picked up and its timer has expired. This signal, after checking whether it is affected by a block, activates the trip contact. If there is a block, or the unit trip is disabled by a setting, this virtual trip signal does not progress to the trip contact.*

# 8. KEYPAD AND DISPLAY

## 8.1. FACEPLATE KEYPAD

MIN faceplate keypad comprises three keys, as shown in figure 8.1.

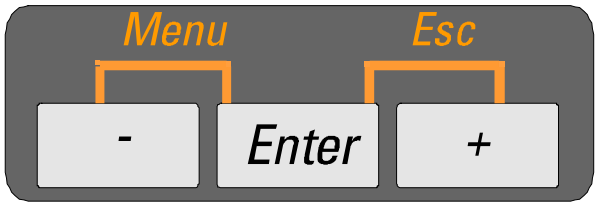



**Figure 8.1. KEYPAD**

As described in section 1.4.1 Hierarchical Menu, "**Menu**" function is activated when the **"-"** and **"Enter"** keys are simultaneously pressed. The Menu function takes us to the second level within the hierarchical structure of the device settings. To access the third level press the **Enter** key when the desired menu is shown in the display. To return to the previous level (from the third level to the second one, or from the second level to the first one) you must activate the **Esc** function. This is done by pressing the **"Enter"** and **"+"** keys simultaneously.

## 8.2. ALPHANUMERIC DISPLAY

The faceplate display of the MIN relay is a 3.5 characters alphanumeric (can display letters and numbers) display. It is a LEDs matrix type display. Using the display you can view different types of data, as settings, trip information, alarms, etc.

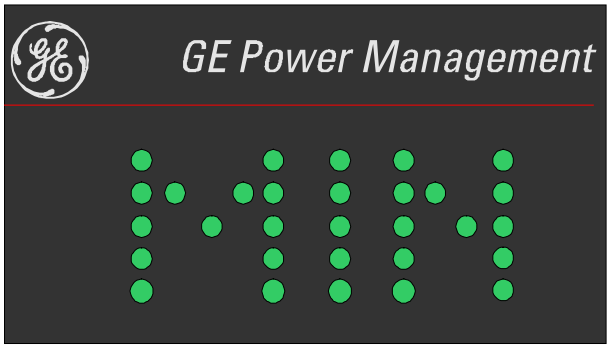



**Figure 8.2. ALPHANUMERIC DISPLAY**

Messages in the display are shown in English language. If the keypad is not in use during 15 minutes, the relay will automatically perform a scrolling through the most relevant measures.

## 8.3. MAIN STRUCTURE

If the keypad is not in use, during steady state, the faceplate display shows the relay model identification (MIG) and a series of actual values (Ia, Ib, Ic, IN and TH (Thermal Image)).

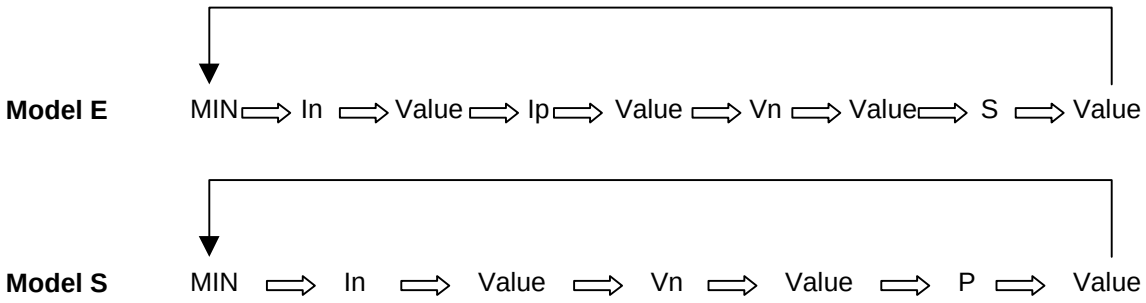



**Figure 8.3. SCROLLING WHILE THE KEYPAD IS NOT USE**

The mnemonics used in figure 8.3 are the following:

| **Model E** | |
|---|---|
| In: | Ground current |
| Value (In): | Ground current measure in amperes |
| Ip: | Polarization current |
| Value (Ip): | polarization current measure in amperes |
| Vn: | Ground voltage |
| Value (Vn): | Ground voltage measure in volts |
| S: | Apparent Power |
| Value (S): | Apparent power measure in VA |

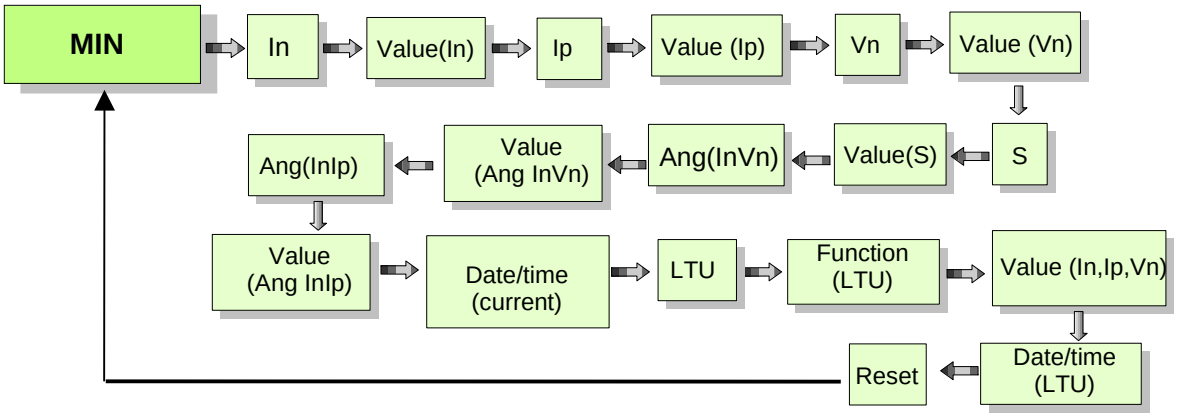
| **Model S** | |
|---|---|
| In: | Ground current |
| Value (In): | Ground current measure in miliamperes |
| Vn: | Ground voltage |
| Value (Vn): | Ground voltage measure in volts |
| P: | Active power |
| Value (P): | Active power measure in Watts |

**There are two different operation modes for exiting the standby status:**

### 8.3.1. MODE 1: KEY-TO-KEY MODE PRESSING THE ENTER KEY:

**Model E**

In this mode, the user has access to the same information shown during the “scrolling”, plus the angle between In and Vn, and between In and Ip, date and time, protection unit that caused the last trip, and the faulted phase(s) during the last trip. In the end there is a RESET option. When this message is displayed, if we keep the ENTER key pressed for more than three seconds, we reset the LEDs and latched outputs.




**By pressing ESC we will return to the stand-by status**

**FIGURE 8-4. GENERAL INFORMATION SCREEN SEQUENCE. KEY-TO-KEY MENU FOR MIN E MODELS**

The mnemonics used on figure 8.4 are as follows:

| | |
|---|---|
| **In:** | Ground current |
| **Value (In)** | Ground current measure in amperes |
| **Ip:** | Polarization current |
| **Value (Ip)** | Polarization current measure in amperes |
| **Vn:** | Ground voltage |
| **Value (Vn)** | Ground voltage measure in volts |
| **S:** | Apparent power |
| **Value (S)** | Apparent power measure in VA |
| **Ang (InVn):** | Angle between ground current and ground voltage |
| **Value (Ang InVn):** | Measure in degrees of the angle between ground current and ground voltage |
| **Ang (InIp):** | Angle between ground current and polarization current |
| **Value (Ang InIp):** | Measure in degrees of the angle between ground current and polarization current |
| **Date time:** | Current date and time |
| **LTU:** | Beginning of the information about the last trip (Last Trip Unit) |
| **Function (LTU)**: | Shows which protection unit has caused the last trip |
| **Value (In, Ip, Vn):** | Value of In, Ip and Vn during the last trip. |
| **Date and time:** | Last trip date and time. |

**Model S**

***In this mode, the user has access to the same information shown during the "scrolling", plus the angle between In and Vn, date and time, protection unit that caused the last trip, and the faulted phase(s) during the last trip. In the end there is a RESET option. When this message is displayed, if we keep the ENTER key pressed for more than three seconds, we reset the LEDs and latched outputs.***

**By pressing ESC we will return to the stand-by status**

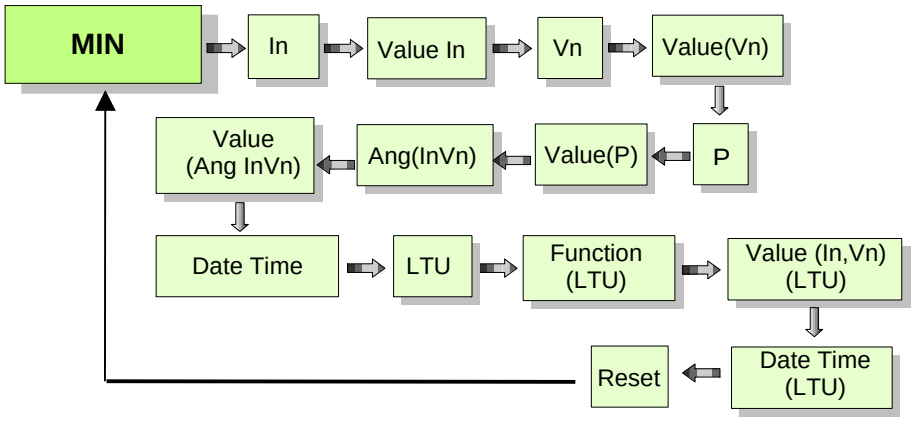



**FIGURE 8-5. GENERAL INFORMATION SCREEN SEQUENCE. KEY-TO-KEY MENU FOR MIN S MODELS**

The mnemonics used on figure 8.5 are as follows:

| | |
|---|---|
| **In:** | Ground current |
| **Value (In)** | Ground current measure in miliamperes |
| **Vn:** | Ground voltage |
| **Value (Vn)** | Ground voltage measure in volts |
| **P:** | Active power |
| **Value (P)** | Active power measure in watts |
| **Ang (InVn):** | Angle between In and Vn |
| **Value (Ang InVn):** | Measure in degrees of the angle between In and Vn |
| **Date Time:** | Displays current date and time |
| **LTU:** | Beginning of the last trip information (Last Trip Unit) |
| **Function (LTU):** | Displays the protection unit that has caused the last trip |
| **Value (In, Vn):** | Shows the values of In and Vn during the last trip |
| **Date and Time (LTU):** | Last trip date and time. |

### 8.3.2. MODE 2: ENTER THE MENUS, PRESSING "ENTER" AND "-" SIMULTANEOUSLY:

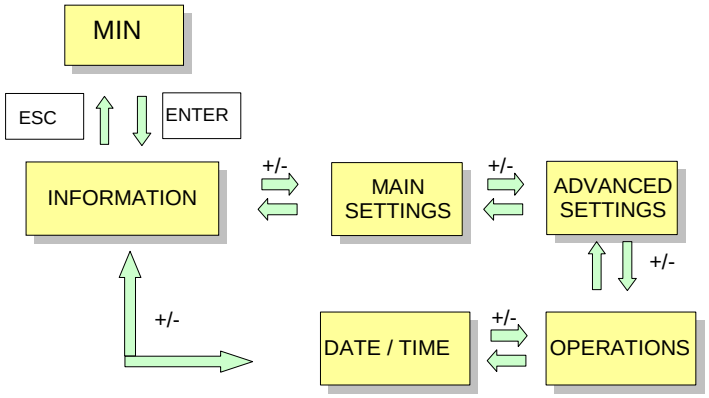



**Figure 8.6. SELECT MENU FROM THE STEADY STATE**

The mnemonics used in the previous figure have the following meanings:

| | |
|---|---|
| **INFORMATION** | Shows information about the internal status of the device. |
| **MAIN SETTINGS** | Access to the Main Settings of the relay. |
| **ADVANCED SETTINGS** | Access to the Advanced Settings of the relay. |
| **OPERATIONS** | Access to the Commands menu of the device. |
| **DATE TIME** | Access to the relay Date and Time. |

## 8.4. INFORMATION MENU

The information menu accesses internal data in the relay, as the status of the contact inputs, contact outputs, AC inputs, firmware version and relay date and time.

### 8.4.1. MODEL E

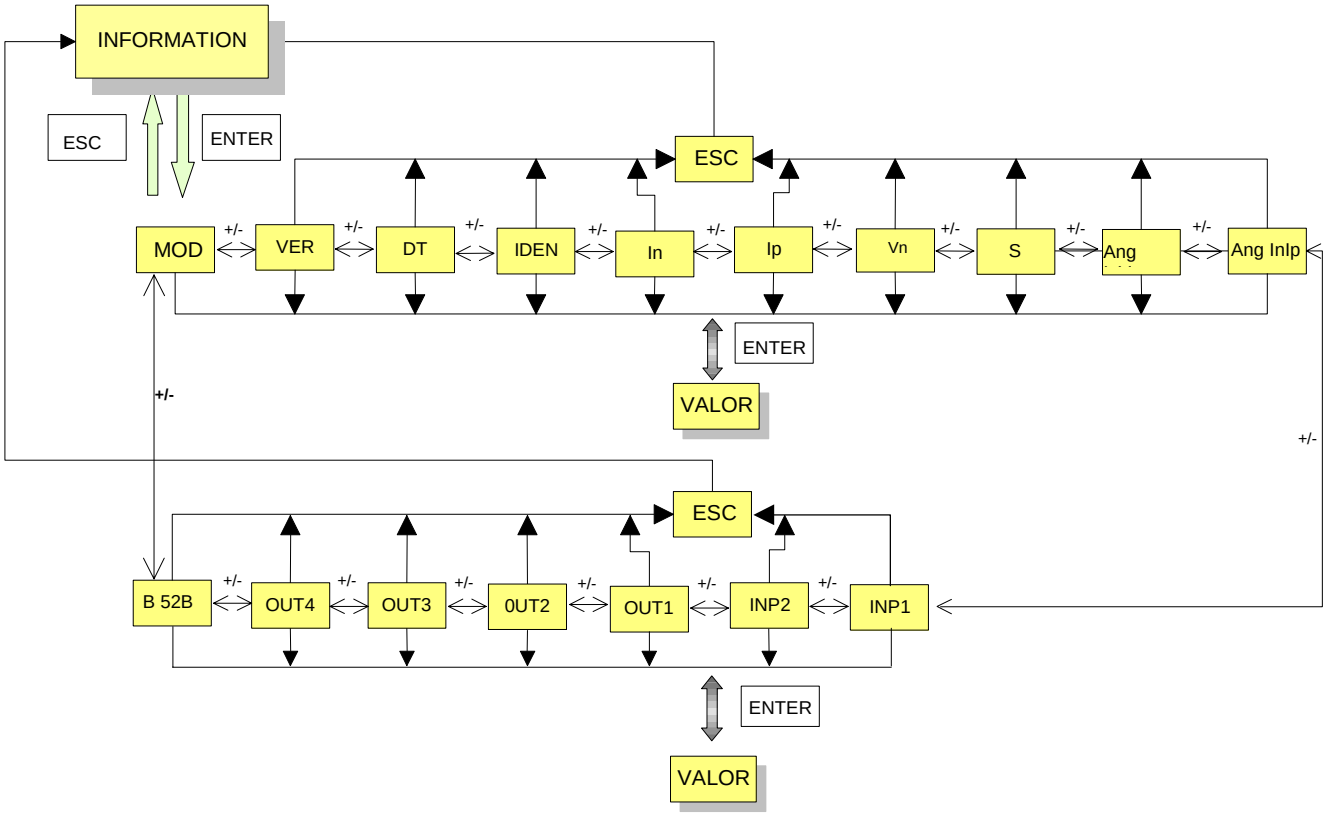



**Figure 8.7. DISPLAY & KEYPAD HANDLING FROM INFORMATION MENU FOR MIN MODEL E**

To access the Information menu it is necessary to select Menu (pressing "**Enter**" and **"-"** simultaneously), and then press Enter when the display shows INFORMATION. Movement through the different options in this menu is done with the "+" and "-" keys.

Once on the desired item of the menu, pressing Enter the corresponding value is shown in the faceplate display.

The mnemonics used in the previous figure have the following meanings:

| | |
|---|---|
| **MOD** | Relay Model number |
| **VER** | Firmware version installed in the relay. |
| **D T** | Relay Date and Time. |
| **IDEN** | Identification. |
| **In, Ip, Vn, S, Ang InVn, Ang InIp** | Previously described. |

| | |
|---|---|
| **INP1** | Contact Input # 1 status. |
| **INP2** | Contact Input # 2 status. |
| **OUT1** | Contact Output #1 status. |
| **OUT2** | Contact Output #2 status. |
| **OUT3** | Contact Output #3 status. |
| **OUT4** | Contact Output #4 status. |
| **B 52 B** | Terminal 52 B. |

.

### 8.4.2. MODEL S

**Figure 8.7. DISPLAY & KEYPAD HANDLING FROM INFORMATION MENU FOR MIN MODEL S**

To access the Information menu it is necessary to select Menu (pressing "**Enter**" and **"-"** simultaneously), and then press Enter when the display shows INFORMATION. Movement through the different options in this menu is done with the "+" and "-" keys.

Once on the desired item of the menu, pressing Enter the corresponding value is shown in the faceplate display.

The mnemonics used in the previous figure have the following meanings:

| | |
|---|---|
| **MOD** | Relay Model number |
| **VER** | Firmware version installed in the relay. |
| **D T** | Relay Date and Time. |
| **IDEN** | Identification. |
| **In, Vn, P, Ang InVn** | Previously described. |
| **INP1** | Contact Input # 1 status. |
| **INP2** | Contact Input # 2 status. |
| **OUT1** | Contact Output #1 status. |
| **OUT2** | Contact Output #2 status. |
| **OUT3** | Contact Output #3 status. |
| **OUT4** | Contact Output #4 status. |
| **B 52 B** | Terminal 52 B. |

## 8.5. MAIN SETTINGS MENU

### 8.5.1. MODEL E

Keypad and Display handling to access the Main Settings menu:

Pressing ESC from any of the F---- screens, we return to Main Settings

Pressing ENT from any of the F---- screens, we access the settings of that function.

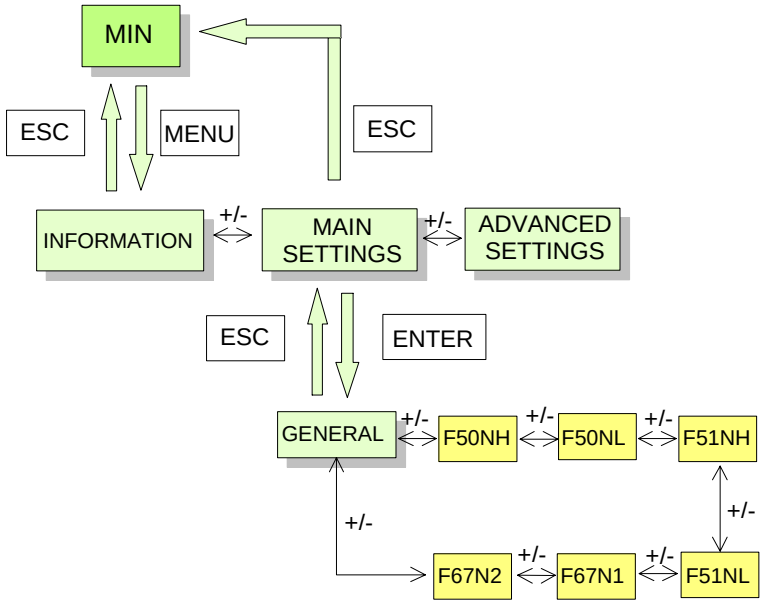



**Figure 8.7. KEYPAD AND DISPLAY HANDLING TO ACCESS MAIN SETTINGS of MIN RELAYS MODEL E**

From the Main Settings heading, the General Settings heading is reached pressing **Enter**. From this point, movement through all the different headings in the same level is done pressing **"+"** and **"-"** keys.

The different headings in the same level than General Settings are:

| | | |
|---|---|---|
| **GENERAL** : | Main settings | |
| **F50NH** : | Unit 50N | Ground instantaneous overcurrent, high level |
| **F50NL**: | Unit 50N | Ground instantaneous overcurrent, low level |
| **F51NH** : | Unit 51N | Ground time overcurrent, high level |
| **F51NL**: | Unit 51N | Ground time overcurrent, low level |
| **F67N1**: | Unit 67N | Directional supervision, unit 1 |
| **F67N2**: | Unit 67N | Directional supervision, unit 2 |

From the General Settings heading, pressing Enter, the following headings are shown:

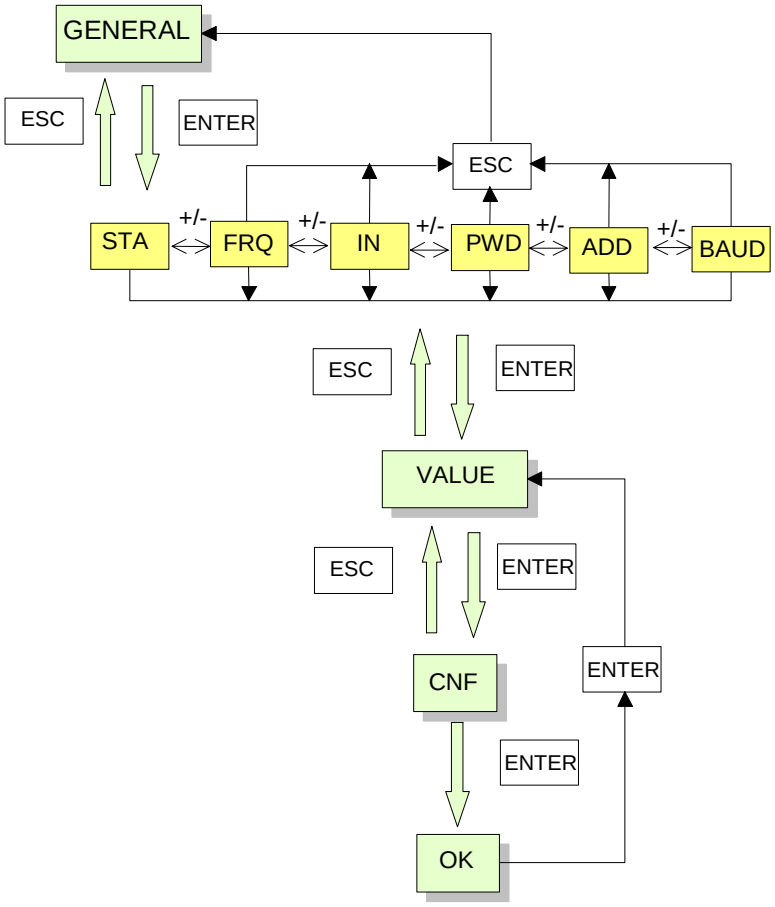



**Figure 8.8. KEYPAD AND DISPLAY HANDLING FROM GENERAL SETTINGS HEADING**

Once the desired heading is displayed, pressing Enter the actual value of the setpoint is shown, blinking. To modify this value press “+” and “-”. To accept the value modification press Enter again and confirm your change.

The mnemonics in the figure stand for:

| | | |
|---|---|---|
| **STA** | STATUS | Relay status |
| Range: | | |
| | RDY | In service |
| | DIS | Out of service |
| **FRQ** | FREQUENCY | Frequency |
| Range: | | |
| | 50 | 50 HZ. |
| | 60 | 60 HZ. |
| **IN** | IN | Rated current of the Ground current input channel |
| Range: | | |
| | 1 A | |
| | 5 A | |
| **PWD** | PASSWORD | Password. |
| Range: | 1,2,3,... 255 | |
| **ADD** | ADDRESS | Communications address |
| Range: | 1,2,3,... 255 | |
| **BAUD** | BAUD | Baudrate |
| Range: | | |
| | 0.3 | 300 bauds. |
| | 0.6 | 600 bauds. |
| | 1.2 | 1200 bauds. |
| | 2.4 | 2400 bauds. |
| | 4.8 | 4800 bauds. |
| | 9.6 | 9600 bauds. |
| | 19.2 | 19200 bauds. |
| **CNF** | CONFIRMATION.. | Validates the selected value |
| | | Pressing ENTER, an OK message will be displayed, and pressing ENTER again we return to the numerical value. |

From **F50NH** and **F50NL** we can access the following options:

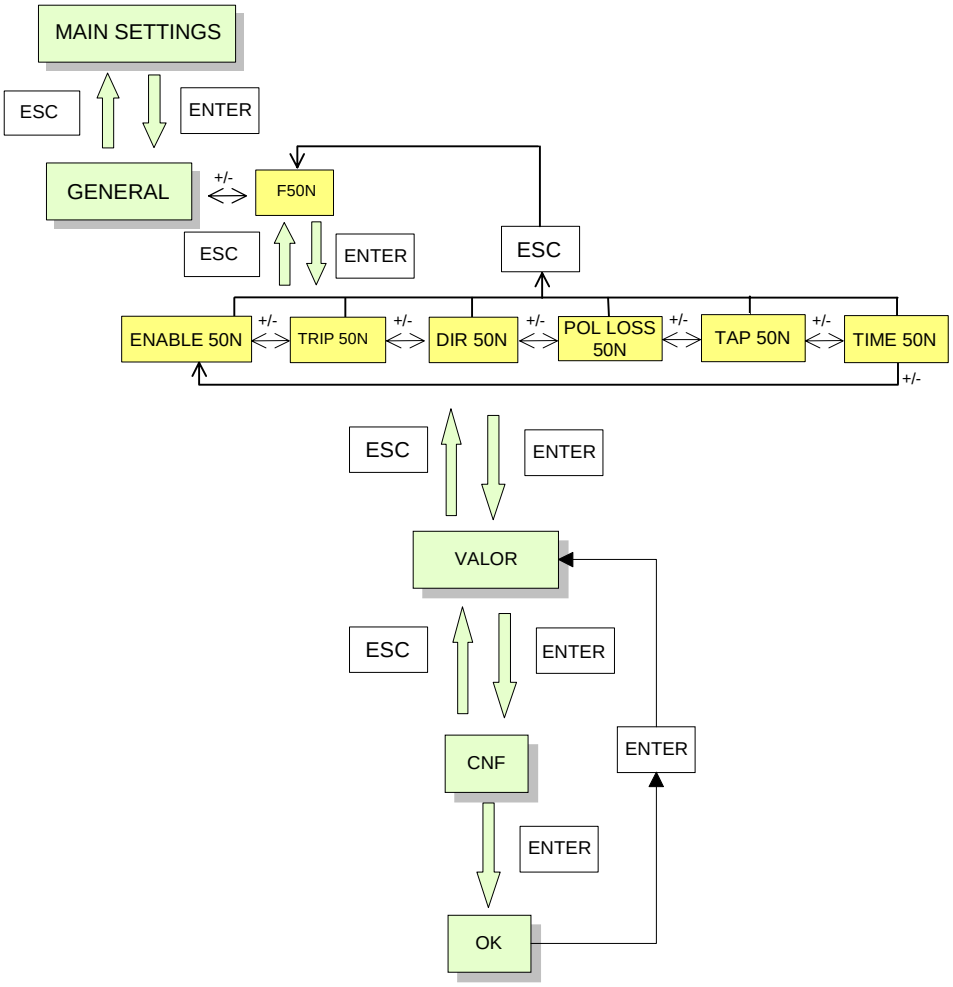



**Figure 8.9. SCREEN SEQUENCE FROM F50N**

Once the desired heading is displayed, pressing Enter the actual value of the setpoint is shown, blinking. To modify this value press “+” and “-”. To accept the value modification press Enter again and confirm your change.

The mnemonics appearing on the figure are the following:

| | | | | |
|---|---|---|---|---|
| **ENABLE 50N:** | Enable unit 50N | Range: | Y/N | |
| **TRIP 50N:** | Trip permission 50N | Range: | Y/N | |
| **DIR 50N:** | Directional permission 50N | Range: | NO/67N1/67N2 | |
| **POL LOSS 50N:** | Directional magnitude loss for 50N | Range: | BLK(BLOCK) / PER(PERMISSION) | |
| **TAP 50N:** | Pickup 50N | Range: | 0.1...30 In | Step: 0.01 |
| **TIME 50N:** | Definite time 50N | Range: | 0...99.99 s | Step: 0.01 s |

From **F51NH** and **F51NL** screens we can access the following options**:**

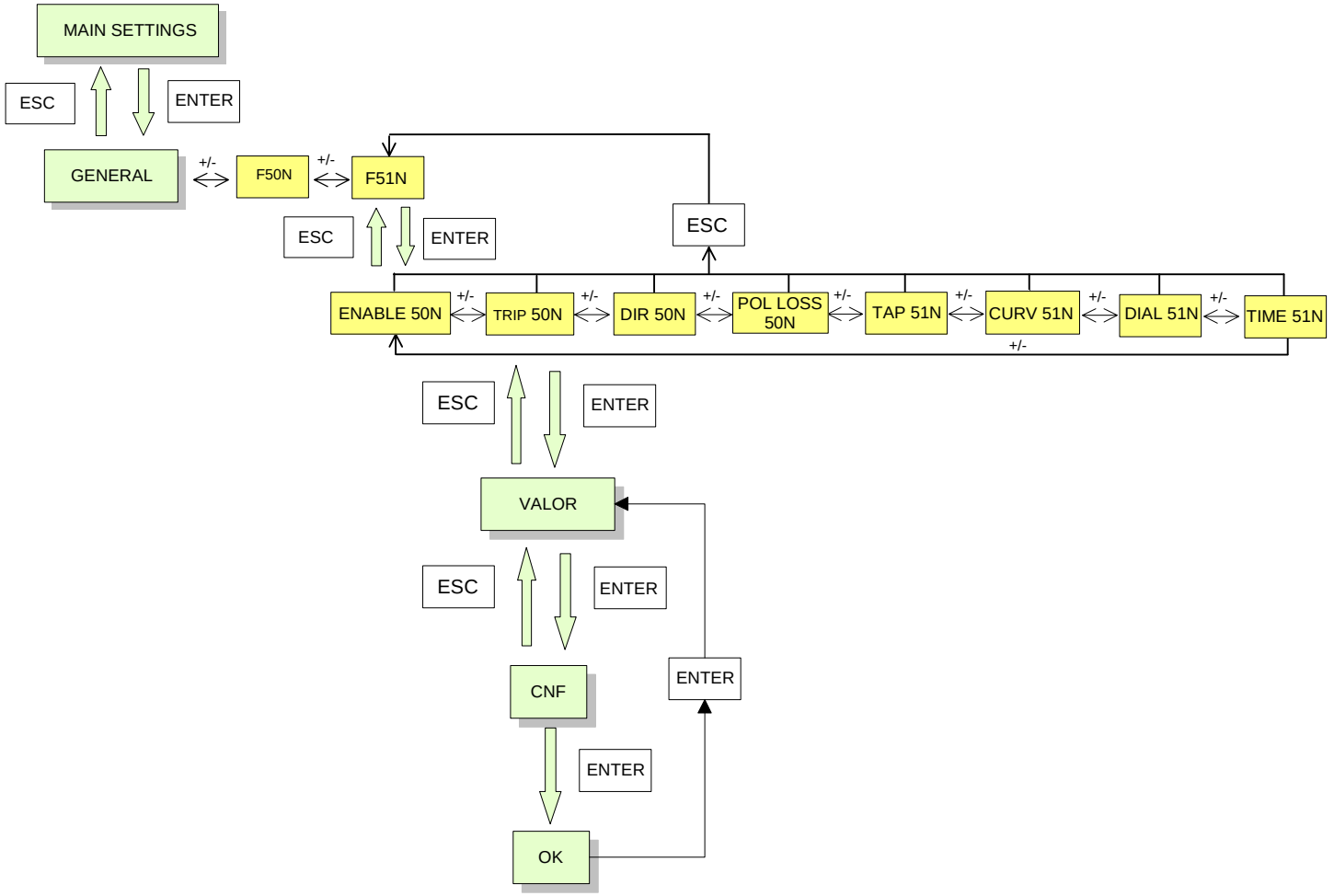



**Figure 8.10. SCREEN SEQUENCE FROM F51NH AND F51NL**

Once the desired heading is displayed, pressing Enter the actual value of the setpoint is shown, blinking. To modify this value press “+” and “-”. To accept the value modification press Enter again and confirm your change.

The mnemonics appearing on the figure are the following:

| | | | | |
|---|---|---|---|---|
| **ENABLE 51N**: | Enable unit 51N | Range: | Y/N | |
| **TRIP 51N**: | Trip permission 51N | Range: | Y/N | |
| **DIR 51N**: | Directional permission 51N | Range: | NO/67N1/67N2 | |
| **POL LOSS 51N**: | Directional magnitude loss for 51N | Range: | PER(PERMISSION)/ BLK(BLOCK) | |
| **TAP 51N** | Pickup 51N | Range: | 0.1...2.4 In | Step: 0.01 |
| **CURV 51N** | Curve 51N | Range: | INV/VI/EI/TDE/USU | |
| **DIAL 51N**: | Time dial 51N | Range: | IEC 0.05..2.0 | Step: 0.01 |
| | | | ANSI 0.5...20.0 | Step: 0.01 |
| **TIME 51N**: | Definite time 51N | Range: | 0...99.99 s | Step: 0.01s |

From **F67N1** and **F67N2** screens we can access the following options:

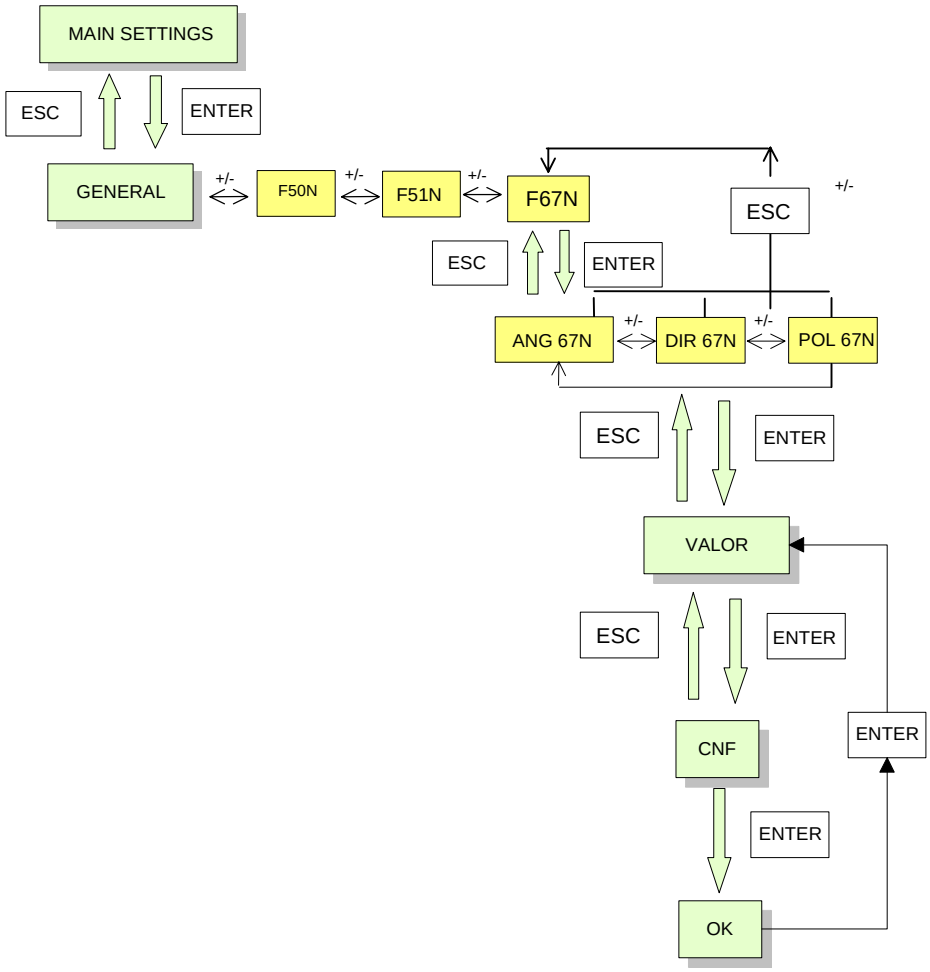



**Figure 8.11 SCREEN SEQUENCE FROM F67N1 and F67N2**

Once the desired heading is displayed, pressing Enter the actual value of the setpoint is shown, blinking. To modify this value press “+” and “-”. To accept the value modification press Enter again and confirm your change.

The mnemonics appearing on the figure are the following:

| | | |
|---|---|---|
| **ANG 67N** | Characteristic angle 67N | Range: -90...90 degrees |
| **DIR 67N** | Direction 67N | Range: NO/FWD(FORWARD)/REV(REVERSE) |
| **POL 67N** | Polarization 67N | Range: V / I / V + I / V * I |
| **CNF** | Confirmation | |

Keypad and Display handling to access the Main Settings menu:

Pressing ESC from any of the F---- screens, we return to Main Settings

Pressing ENT from any of the F---- screens, we access the settings of that function.

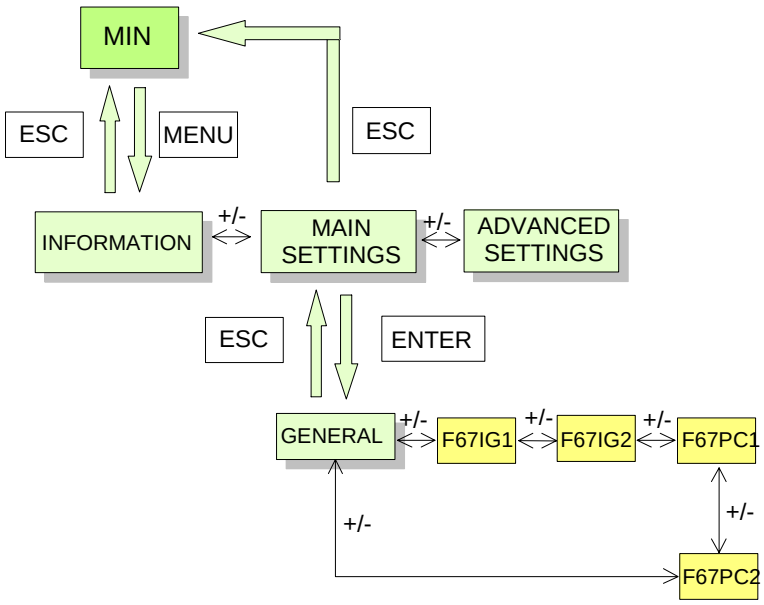



**Figure 8.9. MAIN SETTING SCREENS FOR MIN MODEL S**

The mnemonics appearing on the figure are the following:

**GENERAL**: Main Settings

**F67IG1**: Isolated ground directional overcurrent, unit 1

**F67IG2**: Isolated ground directional overcurrent, unit 2

**F67PC1**: Petersen Coil directional overcurrent, unit 1

**F67PC2**: Petersen Coil directional overcurrent, unit 2

From the GENERAL screen inside MAIN SETTINGS, and pressing ENTER, we can access the following option:

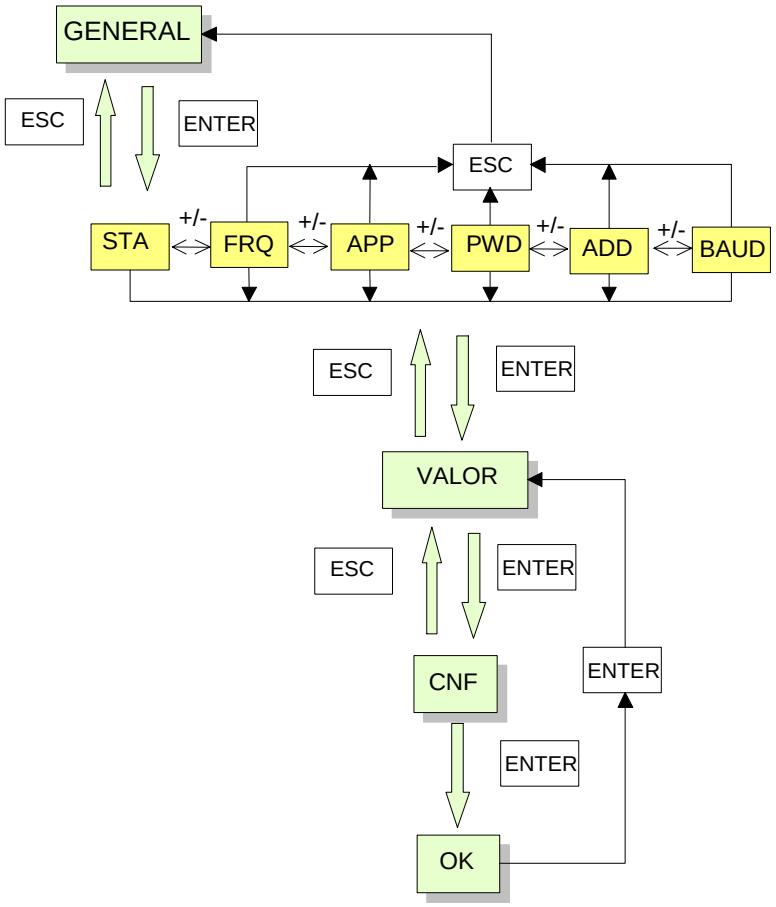



**Figure 8.8. GENERAL SETTINGS**

The mnemonics appearing on the figure are the following:

| | | |
|---|---|---|
| **STA** | STATUS | Relay status. |
| Range: | | |
| | RDY | In service |
| | DIS | Out of service |
| **FRQ** | FREQUENCY | Frequency |
| Range: | | |
| | 50 | 50 HZ. |
| | 60 | 60 HZ. |
| **APP** | APPLICATION | Application type (Isolated ground or Petersen Coil) |
| Range: | | |
| | UNG | UNGROUNDED |
| | PET | PETERSEN |

| | | |
|---|---|---|
| **PWD** | PASSWORD | Password. |
| Range: | 1,2,3,... 255 | |
| **ADD** | ADDRESS | Communications address. |
| Range: | 1,2,3,... 255 | |
| **BAUD** | BAUD | Baudrate. |
| Range: | | |
| | 0.3 | 300 bauds. |
| | 0.6 | 600 bauds. |
| | 1.2 | 1200 bauds. |
| | 2.4 | 2400 bauds. |
| | 4.8 | 4800 bauds. |
| | 9.6 | 9600 bauds. |
| | 19.2 | 19200 bauds. |
| **CNF** | CONFIRMATION. | Validates the selected value. |

From **F67IG1** and **F67IG2** we can access the following options:

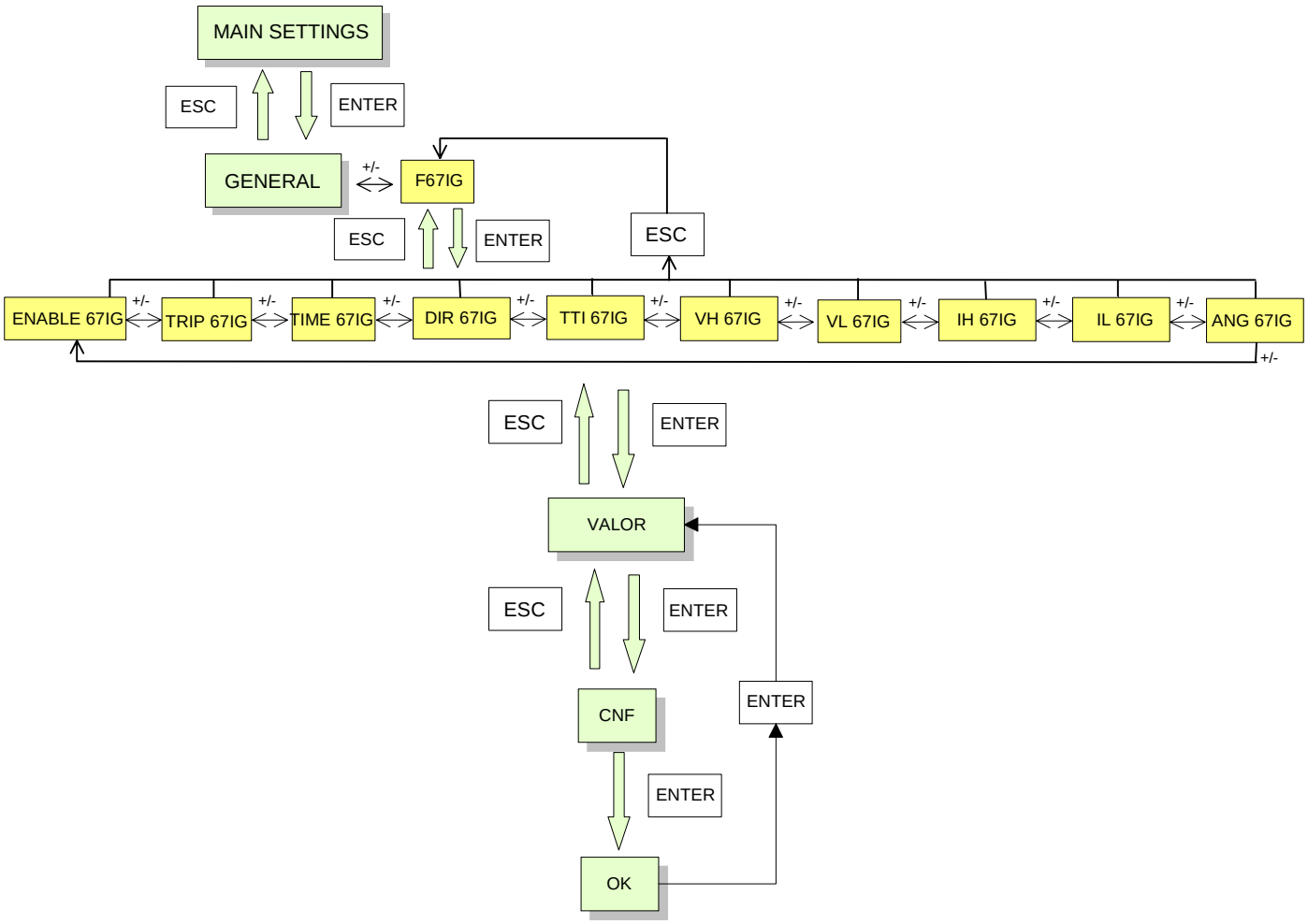



**Figure 8.9. SCREEN SEQUENCE FROM F67IG1 and F67IG2**

The mnemonics appearing on the figure are the following:

| | | | | |
|---|---|---|---|---|
| **ENABLE 67IG**: | Enable unit 67IG | Range: | Y/N | |
| **TRIP 67IG**: | Trip permission 67IG | Range: | Y/N | |
| **TIME 67IG**: | Timer unit 67IG | Range: | 0...99.99 s | Step: 0.01 s |
| **DIR 67IG:** | Direction 67IG | Range: | NO/FWD/REV | |
| **TTI 67IG**: | Deviation time to instantaneous | Range: | 0..99.99 s | Step: 0.01 s |
| **VH 67IG**: | Voltage high 67IG | Range: | 2..70 V | Step: 0.01 V |
| **VL 67IG**: | Voltage low 67IG | Range: | 2..70 V | Step: 0.01 V |
| **IH 67IG**: | Current high 67IG | Range: | 5..400 mA | Step: 0.001 mA |
| **IL 67IG**: | Current low 67IG | Range: | 5..400 mA | Step: 0.001 mA |
| **ANG 67IG**: | Characteristic angle 67IG | Range: | -90..90 | Step: 1 degree |

From **F67PC1** and **F67PC2** we can access the following options:

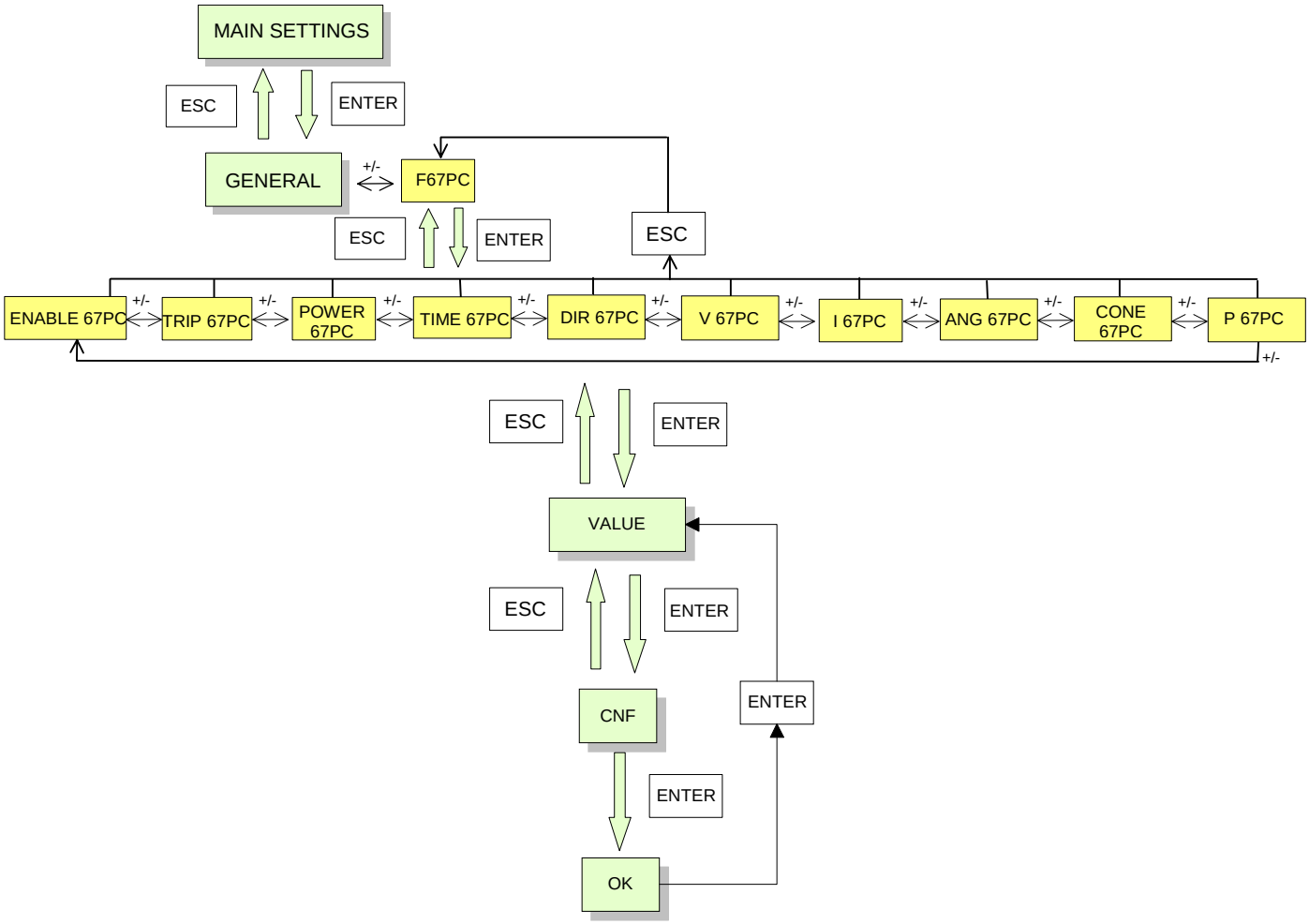



**Figure 8.9. SCREEN SEQUENCE FROM F67PC1 and F67PC2**

The mnemonics appearing on the figure are the following:

| | | | | |
|---|---|---|---|---|
| **ENABLE 67PC**: | Enable unit 67PC | Range: | Y/N | |
| **TRIP 67PC**: | Trip permission 67PC | Range: | Y/N | |
| **POWER 67PC:** | Enable power supervision 67PC | Range: | Y/N | |
| **TIME 67PC:** | Timer 67PC | Range: | 0..99.99 s | Step: 0.01 s |
| **DIR 67PC**: | Direction 67PC | Range: | NO/FWD/REV | |
| **V 67PC**: | Pickup voltage 67PC | Range: | 2..70 V | Step: 0.01 V |
| **I 67PC**: | Pickup current 67PC | Range: | 5..400 mA | Step: 0.001 A |
| **ANG 67PC**: | Characteristic angle 67PC | Range: | 0..180 degrees | Step: 1 degree |
| **CONE 67PC**: | Opening cone 67PC | Range: | 0..45 degrees | Step: 1 degree |
| **P 67PC**: | Power 67PC | Range: | 0.01..4.5 W | Step: 0.01 W |

## 8.6. ADVANCED SETTINGS MENU

### 8.6.1. MODEL E

Accessible options from ADVANCED SETTINGS:

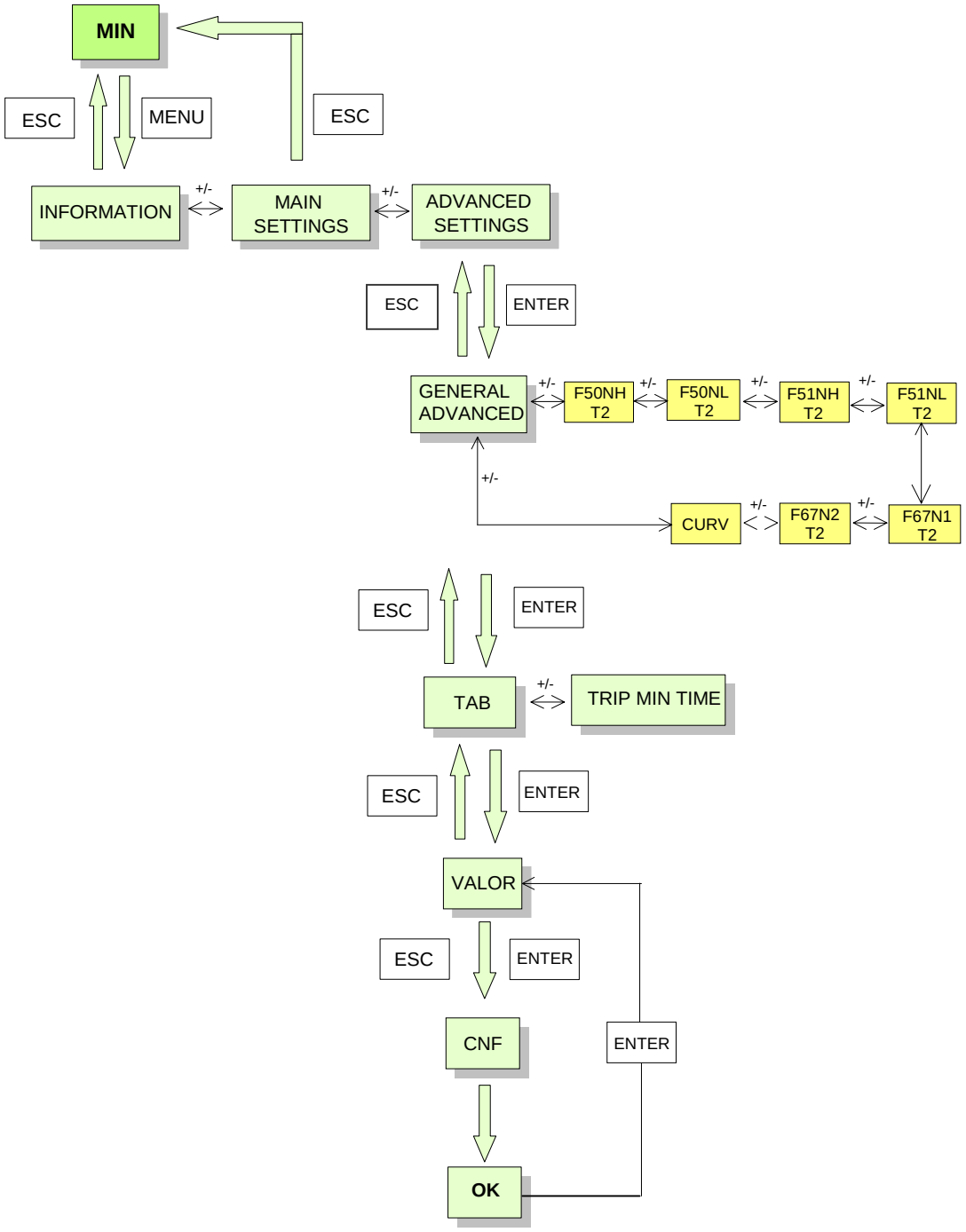



**Figure 8.16 SCREEN SEQUENCE FROM THE ADVANCED SETTINGS FOR MODEL E**

We can return to ADVANCED SETTINGS by pressing ESC from any F---- screen

The mnemonics appearing on this figure are:

| | |
|---|---|
| **ADVANCED SETTINGS** | Advanced settings |
| **GENERAL ADVANCED** | General Advanced settings |
| **F50NH T2** | Unit 50NH (Table 2) |
| **F50NL T2** | Unit 50NL (Table 2) |
| **F51NH T2** | Unit 51NH (Table 2) |
| **F51NL T2** | Unit 51NL (Table 2) |
| **F67N1 T2** | Unit 67N1 (Table 2) |
| **F67N2 T2** | Unit 67N2 (Table 2) |
| **CURV** | User curve (Table 2) |
| **CNF** | Confirmation. Validates the selected value |

From the ADVANCED SETTINGS option, pressing ENTER we access the GENERAL ADVANCED SETTINGS group. From this menu, pressing “+” and “-“, we can access the different functions in Setting Table 2.

From GENERAL ADVANCED SETTINGS, pressing ENTER we access TAB and TRIP MIN TIME, and we can modify these values.

The following screens are for F---- T2, corresponding to setting table 2. The screen sequence and meaning are the same as for the table 1.

### 8.6.2. MODEL S

Available screens from the ADVANCED SETTINGS option:

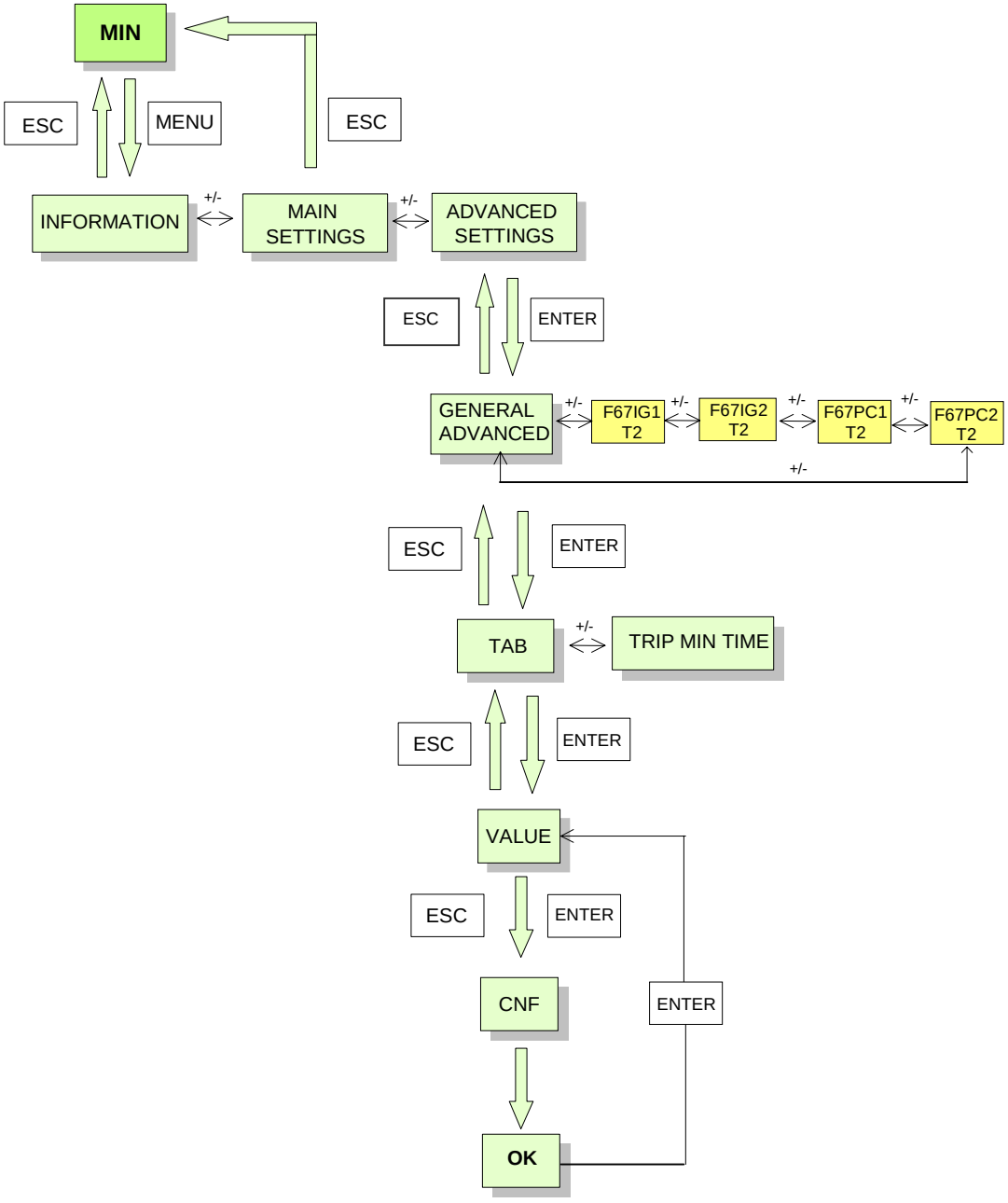



**Figure 8.16 SCREEN SEQUENCE FOR THE ADVANCED SETTINGS, MODEL S**

Pressing ESC from any F---- screen we return to ADVANCED SETTINGS

The mnemonics on this figure are the following:

| | |
|---|---|
| **ADVANCED SETTINGS** | Advanced settings |
| **GENERAL ADVANCED** | General advanced settings |
| **F67IG1 T2** | Unit 67IG 1 (Table 2) |
| **F67IG2 T2** | Unit 67IG 2 (Table 2) |
| **F67PC1 T2** | Unit 67PC 1 (Table 2) |
| **F67PC2 T2** | Unit 67PC 2 (Table 2) |
| **CNF** | Confirmation. Validates the selected value |

From the ADVANCED SETTINGS option, pressing ENTER we access the GENERAL ADVANCED SETTINGS group. From this menu, pressing “+” and “-“, we can access the different functions in Setting Table 2.

From GENERAL ADVANCED SETTINGS, pressing ENTER we access TAB and TRIP MIN TIME, and we can modify these values.

The following screens are for F---- T2, corresponding to setting table 2. The screen sequence and meaning are the same as for the table 1.

## 8.7. OPERATIONS MENU

The available options in the operations menu are as follows:

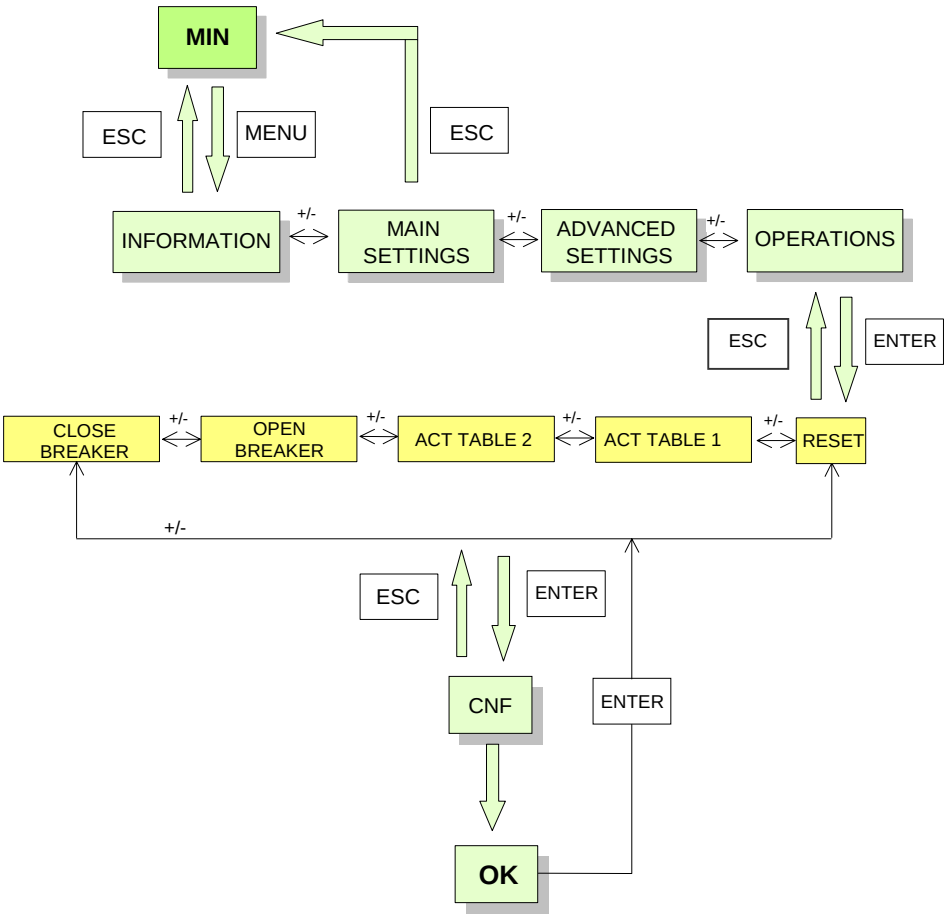



**Figure 8.17 OPERATIONS – SEQUENCE OF SCREENS**

| | |
|---|---|
| **OPERATIONS** | Operations |
| **RESET** | LED and auxiliary latch reset |
| **ACT TABLE 1** | Table 1 activation |
| **ACT TABLE 2** | Table 2 activation |
| **OPEN BREAKER** | Breaker opening |
| **CLOSE BREAKER** | Breaker closing |
| **CNF** | Confirmation. |

## 8.8. DATE AND TIME MENU

Screen sequence for configuration of date and time:

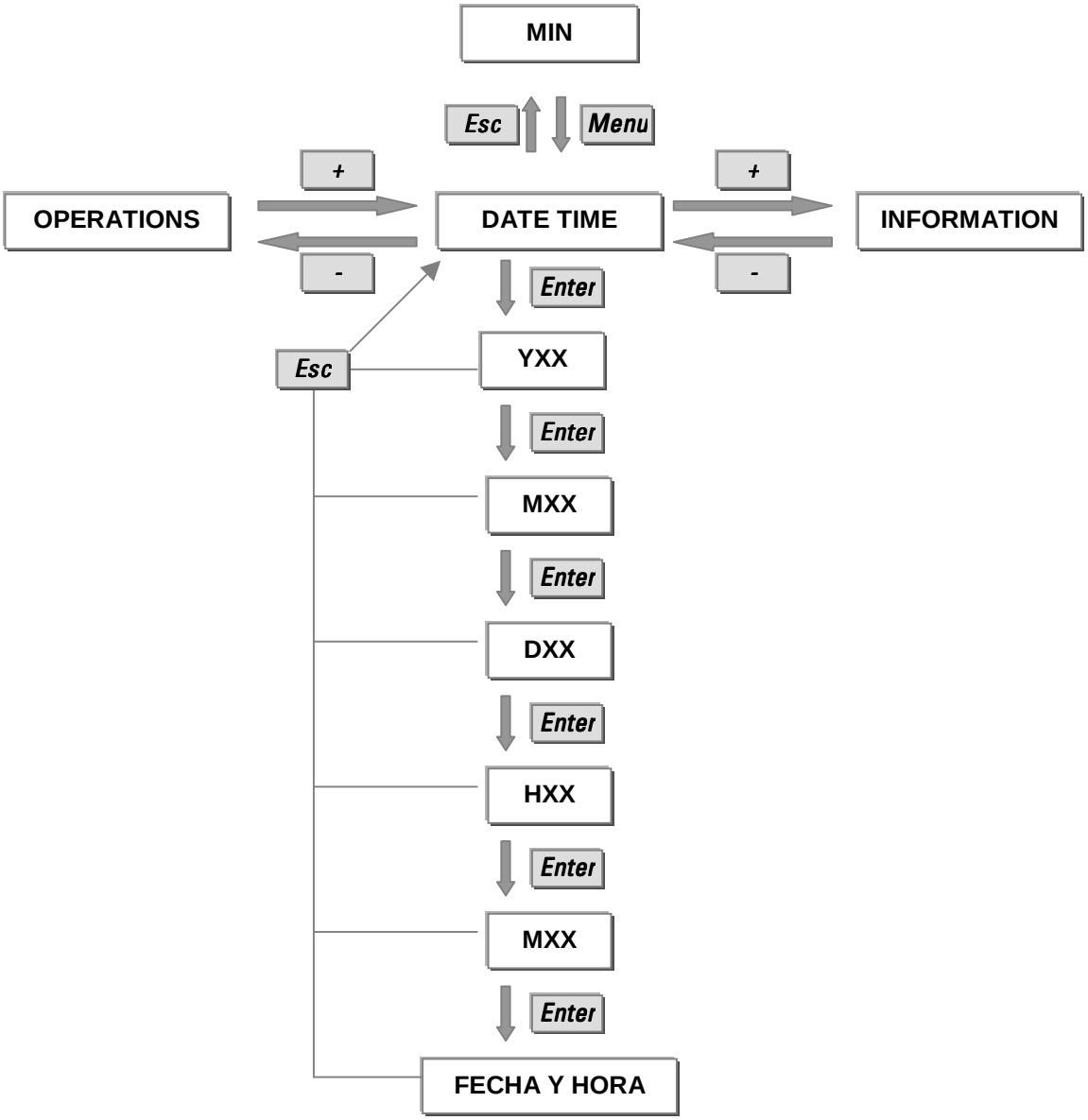



**Figure 8.14. DATE-TIME – SEQUENCE OF SCREENS**

| | |
|---|---|
| **DATE TIME** | Date and time. |
| **YXX(YEAR)** | Allows to modify the year. |
| **MXX (MONTH)** | Allows to modify the month. |
| **DXX (DAY)** | Allows to modify the day. |
| **HXX (HOUR)** | Allows to modify the hour. |
| **MXX (MINUTE)** | Allows to modify the minutes. |
| **DATE AND TIME** | Displays the updated date and time with the modifications |

## 8.9. RESETTING THE TARGET LEDS

There are three ways to reset the faceplate target LEDs using the relay keypad:

1. Starting from the Steady State scrolling display press Enter for more than three seconds. All LEDs will light up (LEDs test) and reset. To check that all LEDs are operative, press Enter and release it before three seconds. By doing that, all LEDs will light up but will not be reset.
2. Follow figure 8.13 and look for the RST LEDS message in the display. Press Enter. The confirmation message will be shown CNF. Press Enter to confirm that you really want to reset the LEDs. All Target LEDs will be reset and the message OK will be shown, to point out that the operation has been performed successfully. To return to the second level, press Enter.
3. RESET LEDS digital input.

It is also possible to reset the Target LEDs from the computer, using the M+PC program. Enter in the Operations Menu of the M+PC program and select the corresponding button.

If an input is configured as LED RESET, when the input is activated the LEDs and latched outputs are reset.

# 9. RELAY COMMISSIONING

## 9.1. VISUAL INSPECTION

Unpack the relay and verify that no parts are broken and that the relay has not suffered any damage during transit. Verify that the model number indicated on the faceplate corresponds to the model ordered.

## 9.2. COMMENTS ON THE TEST EQUIPMENT

All devices that work with alternating current are influenced by frequency. Since a non-sinusoidal waveform results from a fundamental frequency wave plus a series of harmonics of this fundamental wave, it can be concluded that devices working with alternating current (relays) are influenced by the applied waveform.

In order to correctly test relays that operate under alternating current, it is fundamental to use a sinusoidal current and/or voltage wave. The purity of the sinusoidal wave (the lack of harmonics) cannot be expressed in a specific form for a given relay. Each relay that is provided with tuned circuits, R-L and R-C circuits or non-linear elements (such a inverse time overcurrent relays) will be affected by non-sinusoidal waveforms.

These relays respond to the current waveform in a different way from most AC ampere-meters. If the power supply network that is used for the test contains a considerable amount of harmonics, the ampere-meter and relay responses will be different.

The relays are calibrated by the manufacturer using a 50 or 60 Hz power supply network with minimum harmonic contents. When the reception or installation tests are carried out, a power supply network with a harmonic-free waveform must be used.

Ampere-meters and stop-watches that are used for carrying out the test must be calibrated and their accuracy must be better than that of the relay. The power supply network used for the tests must remain stable, mainly at levels close to the test pick-up current, as well as for the time for which the relay operates according to the curve under test.

It is important to stress that the test accuracy depends on the power supply network conditions as well as on the instruments used. Functional tests carried out under inappropriate power supply conditions or using inappropriate instruments can be used for making sure that the relay works roughly correctly and, therefore, for verifying its characteristics in an approximate manner.

The following tests allow to check the complete functionality of the MIN. If we wish to do a reduced test for the reception, it is recommended to perform the tests described in sections 9.3, and 9.6 to 9.17.

## 9.3. INSULATION TESTS

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

The independent groups on the relay are as follows:

| | | |
|---|---|---|
| **Group 1:** | A1, A2 | Power Supply |
| **Group 2:** | C1 to C8 | Current Transformers |
| **Group 3:** | A8, A9, A10 | Contact Inputs |
| **Group 4:** | A5, A6 | Trip |
| **Group 5:** | B7, B8, B9, B10, A7 | Contact Outputs |
| **Group 6:** | B5, B6 | System alarm |
| **Group 7:** | A3, A4, A11, B1, B2, B3, B4, C9, C10, C11, C12 | Unused terminals |

**In case of performing this test on all terminals at the same time, have in mind that the consumption will increase, due to the impedance of the capacitors inside the relay, used to derive high frequency surges to ground. The consumption will be approximately, 3 mA at 2000 Volts for each input.**

***NOTE: Do not test insulation on terminals B12, A12 and B11 (RS485).***

**In case of using AC voltage for the activation of digital inputs, and having connected the inputs common (A10) with the ground terminal, it is necessary to remove this connection before testing insulation on group 3.**

**FOR SAFETY REASONS, THE EXTERNAL PROTECTION EARTH TERMINAL SHOULD BE SECURELY GROUNDED.**

## 9.4. WIRING AND NECESSARY EQUIPMENT

Necessary equipment:

- 1 AC current source, and 1 AC voltage source with possibility of controlling the angle between them.

  If we wish to test the current polarization we must have a second current source with possibility of controlling the angle between both currents.
- · 1 DC or AC voltage power supply for feeding the unit and activating the digital inputs.
- · 1 Stop-watch.
- · 1 Multi-meter.
- · Optionally, it is advisable to have a PC available, with the M+PC software installed.
- · Relay wiring diagram.

Supply the unit through terminals A1 and A2 at the rated DC voltage.

Connect the unit according to the following figures, depending on the MIN model.

For models E, connect the current source corresponding to the operation magnitude (In) to terminals C1-C2 for 1 A rated current models, or to terminals C3-C4 for 5 A rated current models.

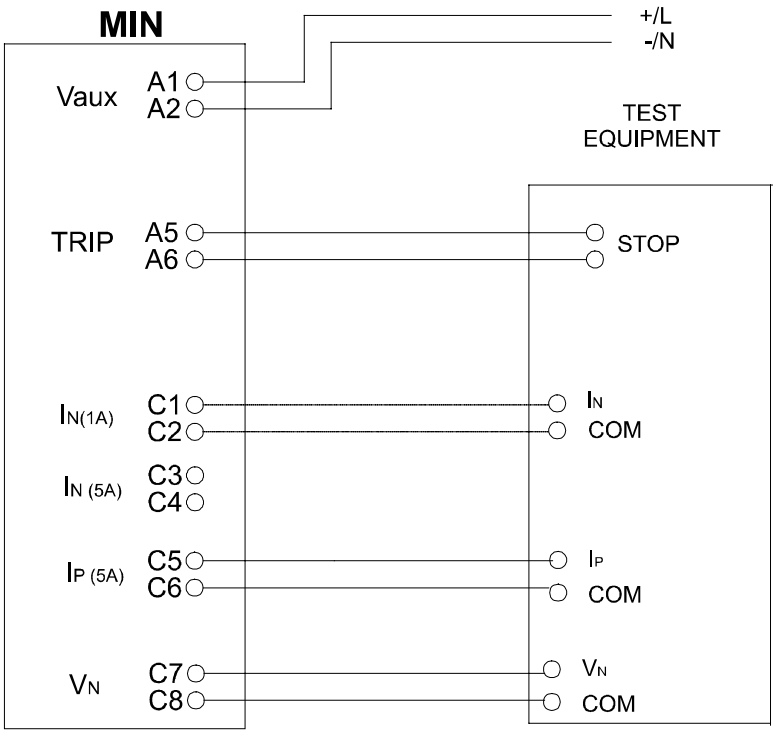



**Figure 9-1 TEST CONNECTIONS FOR MIN RELAY MODEL E**

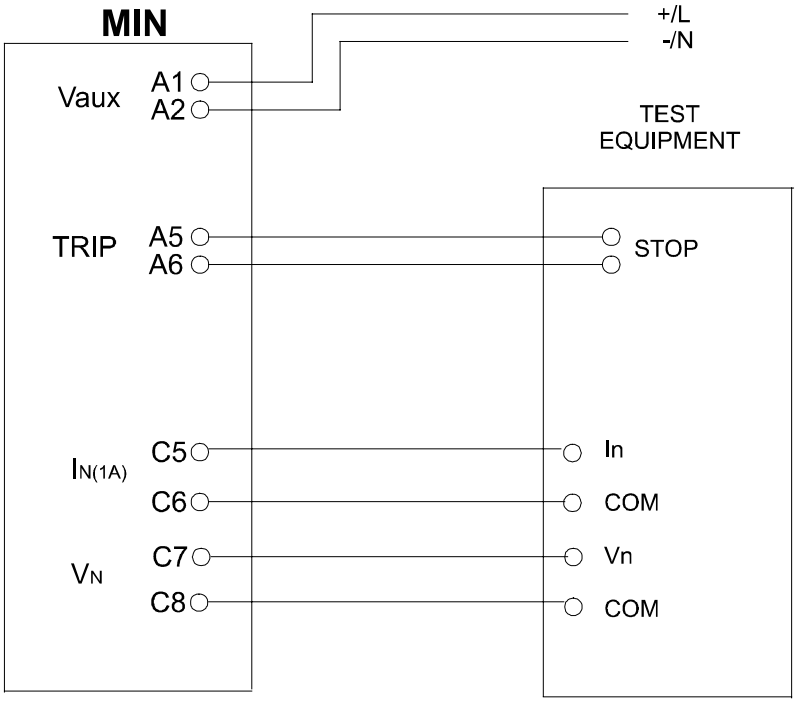



Figure 9-2 TEST CONNECTIONS FOR MIN RELAY MODEL S

## 9.5. TARGET LEDS

Check that pressing the Enter key, all the faceplate target LEDs light up and reset if the key is kept pressed for more than 3 seconds.

## 9.6. POWER SUPPLY TEST

Connect the relay to a power supply at rated minimum voltage. Enable the following functions: Model E: 51NH, 51NL, 50NH and 50NL. Model S: 67IG1, 67IG2 or 67PC1, 67PC2, setting their pickups and times to the minimum possible value.

Inject current and voltage to the relay, making the relay trip and to close all the auxiliary outputs corresponding to the functions enabled.

Under this tripping conditions check that the ALARM (READY) output is open, and that the relay can communicate with the PC. Check this point requesting the relay model number from the PC.

Voltage test and maximum consumption is shown below:

**Model "F" (24 - 48 Vdc)**

| Voltage (Vdc) | Maximum Consumption (mA) |
|---|---|
| 18 | 900 |
| 48 | 300 |
| 58 | 250 |

**Model "H" (110 - 250 Vdc 120-230 Vac)**

| Voltage (Vdc) | Maximum Consumption (mA) |
|---|---|
| 88 | 130 |
| 110 | 105 |
| 250 | 55 |
| **Voltage (Vac)** | **Maximum Consumption (mA)** |
| 120 | 200 |
| 230 | 140 |

## 9.7. COMMUNICATIONS

The test consists on checking that the 2 communications ports in the relay (the faceplate RS232 and the rear RS485) work properly. To perform this test is it necessary to use a computer and a connector suitable to establish the connection between the PC and the relay (refer to figure 3.10). If the faceplate port is used, a straight through cable is needed. If the rear RS485 port is used, an RS485/RS232 converter is needed.

The communications parameters that have to be set in the computer are the relay default settings, as follows:

| | |
|---|---|
| Relay Number: | 1 |
| Communications speed: | 9.600 |
| Number of Stop bits: | 1 |

Using the M+PC program, communicate with the relay and in the **Status** window check that the communications are not lost at any time. Perform this test on both communications ports.

This test is carried out at the minimum and maximum voltage that the relay allows (± 20% of the rated voltage).

## 9.8. RELAY SETTING

When the relay is shipped from our factory, it has a default set of settings, which are the starting point for the following tests.

Since the MIN relay has a large number of settings, an exhaustive list of all the settings necessary for each test will not be given here. Just the specific settings required for each test are indicated, and it can be supposed that the other settings do not affect the test being performed.

We must take into account that these tests are only valid for the default factory configuration. Different configurations involving modifications in certain elements, such as different contact configuration, will require a subsequent modification of the test procedure.

## 9.9. CONTACT INPUTS

Sequentially apply the rated voltage to each input CC1 and CC2 .

Check that when voltage is applied to one contact input, only this input gets active, and the other one remains inactive. Use the INFORMATION menu on the faceplate or a PC and the M+PC program to easily check which input gets active for each test.

Repeat this test at minimum and maximum admissible voltage.

## 9.10. CONTACT OUTPUTS

The default configuration of outputs and LEDs is as follows:

**TERMINALS**

| OUTPUTS | MODEL E | MODEL S |
|---|---|---|
| B5-B6 | ALARM | ALARM |
| A5-A6 | TRIP | TRIP |
| B7-A7 (OUT1) | TRIP 51NH | TRIP 67IG1 or 67PC1 |
| B8-A7 (OUT2) | TRIP 51NL | TRIP 67IG2 or 67PC2 |
| B9-A7 (OUT3) | TRIP 50NH | PICKUP 67IG1 or 67PC1 |
| B10-A7 (OUT4) | TRIP 50NL | GENERAL PICKUP |

| LEDS | MODEL E | MODEL S |
|---|---|---|
| LED1 | READY | READY |
| LED2 | TRIP | TRIP |
| LED3 | TRIP 51N (H or L) | TRIP 67IG1 or 67PC1 |
| LED4 | TRIP 50NH | TRIP 67IG2 or 67PC2 |
| LED5 | TRIP 50NL | PICKUP 67IG1 or 67PC1 |
| LED6 | GENERAL PICKUP | GENERAL PICKUP |

Outputs and LEDs can be checked running the following tests:

## 9.11. RELAY METERING

### 9.11.1. CURRENT AND VOLTAGE METERING

Apply the following current and voltage values at the set frequency (50 or 60 Hz) and check that the relay measures both magnitudes with an accuracy of 5%. The following table shows the maximum and minimum values expected for each applied value.

**Model E:**

| Magnitude | Min. | Value | Max. | Min. | Value | Max. | Min. | Value | Max. |
|---|---|---|---|---|---|---|---|---|---|
| In (input 1A) | 0.47 | **0.5** | 0.53 | 0.95 | **1** | 1.05 | 1.9 | **2** | 2.1 |
| In (input 5A) | 2.37 | **2.5** | 2.63 | 4.75 | **5** | 5.25 | 9.5 | **10** | 10.5 |
| Ip (5A) | 2.37 | **2.5** | 2.63 | 4.75 | **5** | 5.25 | 9.5 | **10** | 10.5 |
| Vn | 9.5 | **10** | 10.5 | 15.2 | **16** | 16.8 | 19 | **20** | 21 |

**Model S:**

| Magnitude | Min. | Nom. | Max. | Min. | Nom. | Max. | Min. | Nom. | Max. |
|---|---|---|---|---|---|---|---|---|---|
| In (1A) | 0.023 | **0.025** | 0.026 | 0.047 | **0.050** | 0.053 | 0.114 | **0.120** | 0.126 |
| Vn | 9.5 | **10** | 10.5 | 15.2 | **16** | 16.8 | 19 | **20** | 21 |

Apply the rated current and a voltage value next to 63 Vac with an arbitrary phase shift and check that the angle measure has an accuracy of +/5%.

Repeat the test with the operation current and the polarization current, in case of using polarization by current.

## 9.12. MODEL S: ISOLATED GROUND UNIT (67IG)

Set the unit as follows:

| GROUP: GENERAL | |
|---|---|
| SETTING | VALUE |
| STA | RDY (ready) |
| APP | UNG (ungrounded) |
| **GROUP: 67IG1** | |
| ENABLE 67IG1 | Y (yes) |
| TRIP 67IG1 | Y (yes) |
| TIME 67IG1 | 0 seg. |
| DIR 67IG1 | FWD (forward) |
| TTI 67IG1 | 0 s |
| VH 67IG1 | 3 V |
| VL 67IG1 | 2 V |
| IH 67IG1 | 0.010 A |
| IL 67IG1 | 0.005 A |
| ANG 67IG1 | 90º |

Apply a voltage of 30V at 0º and a current of 0.100 A at –90º (retarded 90º), and check that the relay trips. This situation simulates a fault in phase A in the direction of the trip, for which Va voltage decreases, a Vn of 180º appears and a capacitive In (90º in front of Va) appears.

Apply a voltage of 30V at 0º and a current of 0.100 A at 90º (90º ahead), and check that the relay doesn't trip. This situation simulates a similar fault to the previous one, but on the opposite direction.

Increase the current angle, forwarding it and check that the relay trips for an approximate value of 185º ahead (175º behind).

## 9.13. MODEL S: PETERSEN COIL UNIT (67PC)

Disable the trip of 67IG units.

Set the relay as follows:

| GROUP: GENERAL | |
|---|---|
| STA | RDY (ready) |
| APP | PC (Petersen Coil) |
| **GROUP: 67PC1** | |
| ENABLE 67PC1 | Y (yes) |
| TRIP 67PC1 | Y (yes) |
| POWER 67PC1 | N (no) |
| TIME 67PC1 | 0 seg. |
| DIR 67PC1 | FWD (forward) |
| V 67PC1 | 2 V |
| I 67PC1 | 0.005 A |
| ANG 67PC1 | 0º |
| CONE 67PC1 | 5º |
| P 67PC1 | 0.01 W |

Apply a voltage of 30V at 0º and a current of 0.100 A at 180º, and check that the relay trips. This situation simulates a fault in phase A in the direction of the trip, for which Va voltage decreases, a Vn of 180º appears and a purely resistive In (in phase with Va) appears.

Apply a voltage of 30V at 0º and a current of 0.100 A at 0º, and check that the relay doesn't trip. This situation simulates a similar fault to the previous one, but on the opposite direction.

Increase the current angle, forwarding it and check that the relay trips for an approximate value of 95º ahead.

## 9.14. MODEL E - 50NH AND 50NL OVERCURRENT UNITS

Set the relay as follows:

| GROUP: GENERAL | |
|---|---|
| STA | RDY (ready) |
| IN | 1 A or 5 A (depending on the application) |
| **GROUP: 50NH** | |
| ENABLE 50NH | Y |
| TRIP 50NH | Y |
| DIR 50NH | NO |
| POLE LOSS 50NH | PER |
| TAP 50NH | 1 x In |
| TIME 50NH | 1 s. |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.1 times the set current. The relay must trip in a range of 1 to 1.06 sec.

Proceed in the same way with unit 50NL.

## 9.15. MODEL E - 51NH AND 51NL OVERCURRENT UNITS

The three IEC or ANSI curves (inverse, very inverse, extremely inverse) will be tested, as well as the definite time, with two points per curve (one for no-trip and two for trip).

***For this test enable only the protection and trip for unit 50NH (or NL)***

### 9.15.1. IEC INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 1 |
| CURV 51NH | INV |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s. |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 15.3 to 19.7 sec.

Repeat the test for unit 51NL.

### 9.15.2. IEC VERY INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 1 |
| CURV 51NH | VI (Very Inverse) |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 23.4 to 31.8 sec.

Repeat the test for unit 51NL.

### 9.15.3. IEC EXTREMELY INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 0.5 |
| CURV 51NH | EI (Extremely Inverse) |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 27 to 39 sec.

Repeat the test for unit 51NL.

### 9.15.4. ANSI INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 10 |
| CURV 51NH | INV |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 36.2 to 51.3 sec.

Repeat the test for unit 51NL.

### 9.15.5. ANSI VERY INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 10 |
| CURV 51NH | VI (Very Inverse) |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s. |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current to phase B and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 26.72 to 37.27 sec.

Repeat the test for unit 51NL.

### 9.15.6. ANSI EXTREMELY INVERSE CURVE

Set the relay as follows:

| GROUP: 51NH | |
|---|---|
| ENABLE 51NH | Y |
| TRIP 51NH | Y |
| DIR 51NH | NO |
| POLE LOSS 51NH | PER |
| DIAL 51NH | 5 |
| CURV 51NH | EI (Extremely Inverse) |
| TAP 51NH | 1 x In |
| TIME 50NH | 1 s |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip.
Apply 1.5 times the set current. The relay must trip in a range of 17.19 to 23.58 sec.

Repeat the test for unit 51NL.

## 9.16. MODEL E - 67N1 AND 67N2 OVERCURRENT UNITS

Set the relay as follows:

| GROUP: GENERAL | |
|---|---|
| STA | RDY (ready) |
| IN | 1 A or 5 A (depending on the application) |
| **GROUP: 50NH** | |
| ENABLE 50NH | Y |
| TRIP 50NH | Y |
| DIR 50NH | 67N1 |
| POLE LOSS 50NH | BLQ |
| TAP 50NH | 1 x In |
| TIME 50NH | 0 s |
| **GROUP: 67N1** | |
| ANG 67N1 | -45º |
| DIR 67N1 | FWD (Forward) |
| POL 67N1 | V (Vn voltage) |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip, as the current doesn't reach the set value.
Apply 1.1 times the set current. The relay does not trip, as the directional unit is blocked.

Apply a voltage of 30V at 0º and a current of 1.1 times the set current at 225º (180º + 45º) behind the voltage, and check that the relay trips. This situation simulates a fault in phase A in the direction of the trip, for which Va voltage decreases, a Vn of 180º appears, and also a In shifted a characteristic angle of 45º behind Va (line impedance and fault).

Apply a voltage of 30V at 0º and a current of 1.1 times the set current at 45º behind voltage, and check that the relay doesn't trip. This situation simulates a similar fault to the previous one, but on the opposite direction.

Increase the current angle, rewinding it and check that the relay trips for an approximate value of 140º behind.

Repeat the test starting on 45º behind, and forward the current checking that the relay trips when the angle is 50º ahead.

In order to test the polarization by current, modify the settings for unit 67N1 as follows:

| GROUP: 67N1 | |
|---|---|
| ANG 67N1 | -45º |
| DIR 67N1 | FWD (Forward) |
| POL 67N1 | I (Ip current) |

Depending on the selected IN, apply current to terminals C1-C2 (1 A) or C3-C4 (5 A).
Apply 0.9 times the set current and check that the relay doesn't trip, as the current doesn't reach the set value.
Apply 1.1 times the set current. The relay does not trip, as the directional unit is blocked.

Apply 1.1 times the set current (operation magnitude) and a current of 1 Amp in phase with the previous one, to terminals C5-C6 (polarization magnitude), and check that the relay trips.

Apply 1.1 times the set current (operation magnitude) and a current of 1 Amp at 180º of the previous one, to terminals C5-C6 (polarization magnitude), and check that the relay does not trip.

Reduce the angle between both currents and check that the relay trips when this angle is approximately 85º.

The operation of unit 67N2 is tested in a similar way.

### 9.16.1. DUAL POLARIZATION

Once we have understood how these units operate, we can use the following tables to verify the operation of the dual polarization (current and voltage, current or voltage), as well as both operation current inputs (1 A and 5 A).

Set the relay as follows:

| GENERAL SETTINGS | | F50NH | | F67N1 | |
|---|---|---|---|---|---|
| RELAY STATUS | RDY | ENABLE 50NH | Yes | ANG 67N1 | -45º |
| FREQUENCY | 50 | TRIP 50NH | Yes | DIR 67N1 | FWD |
| In | 1 A | DIR 50NH | 67N1 | POL 67N1 | U+I |
| | | LOSS POL50NH | PER | | |
| | | TAP 50NH | 0.9 In | | |
| | | TIME 50NH | 0 s | | |

Perform the operations included in the following table, and check the status of the trip contact:

| TEST | IN1 (Amp,ang) | Ip (Amp,ang) | Vn (V,ang) | Ipol | Vpol | TRIP |
|---|---|---|---|---|---|---|
| 1 | 1, 45º | 5, 45º | 40, -90º | FWD | FWD | YES |
| 2 | 1, 45º | 5, 225º | 40, -90º | REV | FWD | YES |
| 3 | 1, 45º | 0 | 40, -90º | - | FWD | YES |
| 4 | 1, 45º | 5, 45º | 40, 90º | FWD | REV | YES |
| 5 | 1, 45º | 5, 45º | 0 | FWD | - | YES |
| 6 | 1, 45º | 5, 225º | 40, 90º | REV | REV | NO |
| 7 | 1, 45º | 0 | 0 | - | - | YES |
| 8 | 1, 45º | 0 | 40, 90º | - | REV | NO |
| 9 | 1, 45º | 5, 225º | 0 | REV | - | NO |
| 10 | 1, 130º a 125º | 0 | 40, -90º | - | FWD | YES |
| 11 | 1, 320º a 325º | 0 | 40, -90º | - | FWD | YES |
| 12 | 1, 130º a 125º | 5, 45º | 0 | FWD | - | YES |
| 13 | 1, 320º a 325º | 5, 45º | 0 | FWD | - | YES |

## 9. RELAY commissioning

Set the relay as follows

| GENERAL SETTINGS | | F50NH | | F67N2 | |
|---|---|---|---|---|---|
| RELAY STATUS | RDY | ENABLE 50NH | Y | ANG 67N1 | -45º |
| FREQUENCY | 50 | TRIP 50NH | Y | DIR 67N1 | REV |
| In | 5 A | DIR 50NH | 67N2 | POL 67N1 | U+I |
| | | POL LOSS50NH | BLK | | |
| | | TAP 50NH | 0.9 In | | |
| | | TIME 50NH | 0 s | | |

Perform the operations included in the following table, and check the status of the trip contact:

| TEST | IN5 (Amp,ang) | Ip (Amp,ang) | Vn (V,ang) | Ipol | Vpol | TRIP |
|---|---|---|---|---|---|---|
| 1 | 5, 45º | 5, 45º | 40, -90º | FWD | FWD | NO |
| 2 | 5, 45º | 5, 225º | 40, -90º | REV | FWD | YES |
| 3 | 5, 45º | 0 | 40, -90º | - | FWD | NO |
| 4 | 5, 45º | 5, 45º | 40, 90º | FWD | REV | YES |
| 5 | 5, 45º | 5, 45º | 0 | FWD | - | NO |
| 6 | 5, 45º | 5, 225º | 40, 90º | REV | REV | YES |
| 7 | 5, 45º | 0 | 0 | - | - | NO |
| 8 | 5, 45º | 0 | 40, 90º | - | REV | YES |
| 9 | 5, 45º | 5, 225º | 0 | REV | - | YES |
| 10 | 5, 130º a 135º | | 40, -90º | - | REV | YES |
| 11 | 5, 315º a 320º | 0 | 40, -90º | - | REV | YES |
| 12 | 5, 130º a 135º | 5, 45º | 0 | REV | - | YES |
| 13 | 5, 315º a 320º | 5, 45º | 0 | REV | - | YES |

## 9.17. TIME SYNCHRONIZATION

Synchronise the relay date and time with the PC, using the M+PC communications program. Check using the keypad and display that the relay is actually in synchronism with the computer.

## 9.18. USER SETTINGS

The following pages intend to be useful to register the user settings. They can be used as a guide or template, to record the relay settings, in case your company does not provide a proprietary form sheet.

## 9.19. MAIN SETTINGS

### 9.19.1. MODEL E

#### 9.19.1.1. GENERAL SETTINGS GROUP

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| | **GENERAL SETTINGS** | **GENERAL** | | | |
| Relay status | RELAY STATUS | STA | | RDY / DIS | NA |
| Frequency | FREQUENCY | FRQ | | 50/60 Hz | NA |
| Type of transformer | SELEC. TRAFO 1/5 A | IN | | 1/5 A | NA |
| Password | --- | PWD | | 1 to 255 | 1 |
| Address | --- | ADD | | 1 to 255 | 1 |
| Communication Baudrate | --- | BAUD | | 300, 600, 1200, 2400, 4800, 9600, 19200 | NA |

#### 9.19.1.2. UNIT 50 SETTINGS

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 50NH** | **F50NH** | **F50NH** | | | |
| Enable Unit 50NH | Enable 50NH | ENABLE 50NH | | Y/N | NA |
| Enable 50NH trip | Trip 50NH | TRIP 50NH | | Y/N | NA |
| 50NH Directional supervision | Directional permission 50NH | DIR 50NH | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NH | Polarization loss 50NH | POL LOSS 50NH | | BLK/PER | NA |
| Pickup level 50NH | Pickup 50NH | TAP 50NH | | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NH | TIME 50NH | | 0-99.99 s | 0.01 s |
| **Unit 50NL** | **Unit 50NL** | **F50NL** | | | |
| Enable Unit 50NL | Enable 50NL | ENABLE 50NL | | Y/N | NA |
| Enable trip 50NL | Trip 50NL | TRIP 50NL | | Y/N | NA |
| 50NL directional supervision | Directional permission 50NL | DIR 50NL | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NL | Polarization loss 50NL | POL LOSS 50NL | | BLK/PER | NA |
| Pickup level 50NL | Pickup 50NL | TAP 50NL | | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NL | TIME 50NL | | 0-99.99 s | 0.01 s |

### 9.19.1.3. UNIT 51 SETTINGS

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 51NH** | **F51NH** | **F51NH** | | | |
| Enable Unit 51NH | Enable 51NH | ENABLE 51NH | | Y/N | NA |
| Enable trip 51NH | Trip 51NH | TRIP 51NH | | Y/N | NA |
| 51NH directional supervision | Directional permission 51NH | DIR 51NH | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NH | Polarization loss 51NH | POL LOSS 51NH | | BLK/PER | NA |
| Pickup level 51NH | Pickup 51NH | TAP 51NH | | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NH | CURV 51NH | | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NH | DIAL 51NH | | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NH | TIME 51NH | | 0 to 99.99 s | 0.01 s |
| **Unit 51NL** | **Unit 51NL** | **F51NL** | | | |
| Enable Unit 51NL | Enable 51NL | ENABLE 51NL | | Y/N | NA |
| Enable trip 51NL | Trip 51NL | TRIP 51NL | | Y/N | NA |
| Directional supervision 51NL | Directional permission 51NL | DIR 51NL | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NL | Polarization loss 51NL | POL LOSS 51NL | | BLK/PER | NA |
| Pickup level 51NL | Pickup 51NL | TAP 51NL | | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NL | CURV 51NL | | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NL | DIAL 51NL | | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NL | TIME 51NL | | 0 to 99.99 s | 0.01 s |

### 9.19.1.4. UNIT 67 SETTINGS

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67N1** | **F67N1** | **F67N1** | | | |
| Characteristic angle 67N1 | Characteristic angle 67N1 | ANG 67N1 | | -90 to +90 degrees | 1 degree |
| Direction 67N1 | Direction 67N1 | DIR 67N1 | | NO/FWD/REV | NA |
| Polarization 67N1 | Polarization 67N1 | POL 67N1 | | VOLTAGE<br>CURRENT<br>V+I (V ó I)<br>V*I (V e I) | NA |
| **Unit 67N2** | **F67N2** | **F67N2** | | | |
| Characteristic angle 67N2 | Characteristic angle 67N2 | ANG 67N2 | | -90 TO +90 degrees | 1 degree |
| Direction 67N2 | Direction 67N2 | DIR 67N2 | | NO/FWD/REV | NA |
| Polarization 67N2 | Polarization 67N2 | POL 67N2 | | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |

### 9.19.2.1. GENERAL SETTINGS GROUP

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| | **GENERAL SETTINGS** | **GENERAL** | | | |
| Relay status | RELAY STATUS | STA | | RDY / DIS | NA |
| Frequency | FREQUENCY | FRQ | | 50/60 Hz | NA |
| Application (Isolated ground/Petersen Coil) | App | APP | | UNG/PET | NA |
| Password | --- | PWD | | 1 to 255 | 1 |
| Relay address | --- | ADD | | 1 to 255 | 1 |
| Communication baudrate | --- | BAUD | | 300, 600, 1200, 2400, 4800, 9600, 19200 | NA |

### 9.19.2.2. ISOLATED GROUND 67 UNITS SETTINGS

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67IG1** | **Unit 67IG1** | **F67IG1** | | | |
| Enable Unit 67IG1 | Enable 67IG1 | ENABLE 67IG1 | | Y/N | NA |
| Enable trip 67IG1 | Trip 67IG1 | TRIP 67IG1 | | Y/N | NA |
| Time 67IG1 | Time 67IG1 | TIME 67IG1 | | 0 to 99.99 s | 0.01 |
| Direction 67IG1 | Direction 67IG1 | DIR 67IG1 | | NO/FWD/REV | NA |
| Time to instantaneous 67IG1 | Time to instantaneous 67IG1 | TTI 67IG1 | | 0 to 99.99 s | 0.01 |
| Higher voltage 67IG1 | Higher voltage 67IG1 | VH 67IG1 | | 2 to 70 V | 0.01 |
| Lower voltage 67IG1 | Lower voltage 67IG1 | VL 67IG1 | | 2 to 70 V | 0.01 |
| Higher current 67IG1 | Higher current 67IG1 | IH 67IG1 | | 0.005 to 0.4 A | 0.001 |
| Lower current 67IG1 | Lower current 67IG1 | IL 67IG1 | | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67IG1 | Characteristic angle 67IG1 | ANG 67IG1 | | -90 to +90 degrees | 1 |
| **Unit 67IG2** | **Unit 67IG2** | **F67IG2** | | | |
| Enable Unit 67IG2 | Enable 67IG2 | ENABLE 67IG2 | | Y/N | NA |
| Enable trip 67IG2 | Trip 67IG2 | TRIP 67IG2 | | Y/N | NA |
| Time 67IG2 | Time 67IG2 | TIME 67IG2 | | 0 to 99.99 s | 0.01 |
| Direction 67IG2 | Direction 67IG2 | DIR 67IG2 | | NO/FWD/REV | NA |
| Time to instantaneous 67IG2 | Time to instantaneous 67IG2 | TTI 67IG2 | | 0 to 99.99 s | 0.01 |
| Higher voltage 67IG2 | Higher voltage 67IG2 | VH 67IG2 | | 2 to 70 V | 0.01 |
| Lower voltage 67IG2 | Lower voltage 67IG2 | VL 67IG2 | | 2 to 70 V | 0.01 |
| Higher current 67IG2 | Higher current 67IG2 | IH 67IG2 | | 0.005 to 0.4 A | 0.001 |
| Lower current 67IG2 | Lower current 67IG2 | IL 67IG2 | | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67IG2 | Characteristic angle 67IG2 | ANG 67IG2 | | -90 to +90 degrees | 1 |

### *9.19.2.3. PETERSEN COIL 67 UNITS SETTINGS*

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67PC1** | **Unit 67PC1** | **F67PC1** | | | |
| Enable Unit 67PC1 | Enable 67PC1 | ENABLE 67PC1 | | Y/N | NA |
| Enable trip 67PC1 | Trip 67PC1 | TRIP 67PC1 | | Y/N | NA |
| Enable power supervision 67PC1 | POWER 67PC1 | POWER 67PC1 | | Y/N | NA |
| Time 67PC1 | Time 67PC1 | TIME 67PC1 | | 0 to 99.99 s | 0.01 |
| Direction 67PC1 | Direction 67PC1 | DIR 67PC1 | | NO/FWD/REV | NA |
| Pickup voltage 67PC1 | Pickup voltage 67PC1 | V 67PC1 | | 2 to 70 V | 0.01 |
| Pickup current 67PC1 | Pickup current 67PC1 | I 67PC1 | | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67PC1 | Characteristic angle 67PC1 | ANG 67PC1 | | 0 to +180 degrees | 1 |
| Opening cone 67PC1 | Opening cone 67PC1 | CONE 67PC1 | | 0 to 45 degrees | 1 |
| Power 67PC1 | Power 67PC1 | P 67PC1 | | 0.01 to 4.5 w | 0.01 |
| **Unit 67PC2** | **Unit 67PC2** | **F67PC2** | | | |
| Enable Unit 67PC2 | Enable 67PC2 | ENABLE 67PC2 | | Y/N | NA |
| Enable trip 67PC2 | Trip 67PC2 | TRIP 67PC2 | | Y/N | NA |
| Enable power supervision 67PC2 | POWER 67PC2 | POWER 67PC2 | | Y/N | NA |
| Time 67PC2 | Time 67PC2 | TIME 67PC2 | | 0 to 99.99 s | 0.01 |
| Direction 67PC2 | Direction 67PC2 | DIR 67PC2 | | NO/FWD/REV | NA |
| Pickup voltage 67PC2 | Pickup voltage 67PC2 | V 67PC2 | | 2 to 70 V | 0.01 |
| Pickup current 67PC2 | Pickup current 67PC2 | I 67PC2 | | 0.005 to 0.4 A | 0.001 |
| Characteristic angle 67PC2 | Characteristic angle 67PC2 | ANG 67PC2 | | 0 to +180 degrees | 1 |
| Opening cone 67PC2 | Opening cone 67PC2 | CONE 67PC2 | | 0 to 45 degrees | 1 |
| Power 67PC2 | Power 67PC2 | P 67PC2 | | 0.01 to 4.5 w | 0.01 |

## 9.20. ADVANCED SETTINGS

### 9.20.1. MODEL E

#### 9.20.1.1. GENERAL ADVANCED SETTINGS GROUP

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **GENERAL ADVANCED SETTINGS** | **GENERAL ADVANCED** | **GENERAL ADVANCED** | | | |
| Identification | IDENTIFICATION | | | | |
| Active settings table | ACTIVE TABLE | TAB | | 1/2 | NA |
| Trip minimum time | T. MIN. TRIP | TRIP MIN TIME | | 50-300 ms | 1 |

#### 9.20.1.2. UNIT 50 SETTINGS TABLE 2

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 50NH T2** | **F50NH t2** | **F50NH T2** | | | |
| Enable Unit 50NH T2 | Enable 50NH T2 | ENABLE 50NH T2 | | Y/N | NA |
| Enable trip 50NH T2 | Trip 50NH T2 | TRIP 50NH T2 | | Y/N | NA |
| Directional supervision 50NH T2 | Directional permission 50NH T2 | DIR 50NH T2 | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NH T2 | Polarization loss 50NH T2 | POL LOSS 50NH T2 | | BLK/PER | NA |
| Pickup level 50NH T2 | Pickup 50NH T2 | TAP 50NH T2 | | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NH T2 | TIME 50NH T2 | | 0-99.99 s | 0.01 s |
| **Unit 50NL T2** | **Unit 50NL t2** | **F50NL T2** | | | |
| Enable Unit 50NL T2 | Enable 50NL T2 | ENABLE 50NL T2 | | Y/N | NA |
| Enable trip 50NL T2 | Trip 50NL T2 | TRIP 50NL T2 | | Y/N | NA |
| Directional supervision 50NL T2 | Directional permission 50NL T2 | DIR 50NL T2 | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 50NL T2 | Polarization loss 50NL T2 | POL LOSS 50NL T2 | | BLK/PER | NA |
| Pickup level 50NL T2 | Pickup 50NL T2 | TAP 50NL T2 | | 0.1 to 30 In | 0.01 |
| Time for trip | Time 50NL T2 | TIME 50NL T2 | | 0-99.99 s | 0.01 s |

#### 9.20.1.3. UNIT 51 SETTINGS TABLE 2

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 51NH T2** | **F51NH t2** | **F51NH T2** | | | |
| Enable Unit 51NH T2 | Enable 51NH T2 | ENABLE 51NH T2 | | Y/N | NA |
| Enable trip 51NH T2 | Trip 51NH T2 | TRIP 51NH T2 | | Y/N | NA |
| Directional supervision 51NH T2 | Directional permission 51NH T2 | DIR 51NH T2 | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NH T2 | Polarization loss 51NH T2 | POL LOSS 51NH T2 | | BLK/PER | NA |
| Pickup level 51NH T2 | Pickup 51NH T2 | TAP 51NH T2 | | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NH T2 | CURV 51NH T2 | | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NH T2 | DIAL 51NH T2 | | 0.05 to 2.0<br>0.5 to 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NH T2 | TIME 51NH T2 | | 0 to 99.99 s | 0.01 s |

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 51NL T2** | **Unit 51NL t2** | **F51NL T2** | | | |
| Enable Unit 51NL T2 | Enable 51NL T2 | ENABLE 51NL T2 | | Y/N | NA |
| Enable trip 51NL T2 | Trip 51NL T2 | TRIP 51NL T2 | | Y/N | NA |
| Directional supervision 51NL T2 | Directional permission 51NL T2 | DIR 51NL T2 | | NO/67N1/67N2 | NA |
| Polarization magnitude loss 51NL T2 | Polarization loss 51NL T2 | POL LOSS 51NL T2 | | BLK/PER | NA |
| Pickup level 51NL T2 | Pickup 51NL T2 | TAP 51NL T2 | | 0.1 to 2.4 In | 0.01 |
| Type of curve | Curve 51NL T2 | CURV 51NL T2 | | INV/VI/EI/TDE/ USU | NA |
| Curve dial IEC<br>ANSI | Dial 51NL T2 | DIAL 51NL T2 | | 0.05 TO 2.0<br>0.5 TO 20.0 | 0.01<br>0.01 |
| Time for trip | Time 51NL T2 | TIME 51NL T2 | | 0 to 99.99 s | 0.01 s |

#### *9.20.1.4. UNIT 67 SETTINGS TABLE 2*

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67N1 T2** | **F67N1 t2** | **F67N1 t2** | | | |
| Characteristic angle 67N1 T2 | Characteristic angle 67N1 T2 | ANG 67N1 T2 | | -90 TO +90 degrees | 1 degree |
| Direction 67N1 T2 | Direction 67N1 T2 | DIR 67N1 T2 | | NO/FWD/REV | NA |
| Polarization 67N1 T2 | Polarization 67N1 T2 | POL 67N1 T2 | | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |
| **Unit 67N2 T2** | **F67N2 t2** | **F67N2 t2** | | | |
| Characteristic angle 67N2 T2 | Characteristic angle 67N2 T2 | ANG 67N2 T2 | | -90 TO +90 degrees | 1 degree |
| Direction 67N2 T2 | Direction 67N2 T2 | DIR 67N2 T2 | | NO/FWD/REV | NA |
| Polarization 67N2 T2 | Polarization 67N2 T2 | POL 67N2 T2 | | VOLTAGE<br>CURRENT<br>V+I (V or I)<br>V*I (V and I) | NA |

### *9.20.1.5. USER CURVE*

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **USER CURVE** | **CURV** | | | | |
| A | A | A | | 0 to 125 s. | 0.0001 |
| B | B | B | | 0 to 3 s. | 0.0001 |
| P | P | P | | 0 to 3 | 0.0001 |
| Q | Q | Q | | 0 to 2 | 0.0001 |
| K | K | K | | 0 to 1.999 s. | 0.001 |

### *9.20.1.6. EVENT MASK (ONLY M+PC)*

Event masks have two possible settings, YES and NO. If an action (for example the trip of a protection unit) is set as YES, when it occurs it will generate an event. If it is set as NO, no event will be created.

| | M+PC | SETTING | RANGE |
|---|---|---|---|
| Pickup/dropout of unit 50NH | Pickup 50NH | | Yes / No |
| Pickup/dropout of unit 50NL | Pickup 50NL | | Yes / No |
| Pickup/dropout of unit 51NH | Pickup 51NH | | Yes / No |
| Pickup/dropout of unit 51NL | Pickup 51NL | | Yes / No |
| Pickup/dropout of unit 67N1 | Pickup 67N1 | | Yes / No |
| Pickup/dropout of unit 67N2 | Pickup 67N2 | | Yes / No |
| Enable/disable the inhibition of unit 50NH (by digital input) | Inhibition 50NH (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 50NL (by digital input) | Inhibition 50NL (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 51NH (by digital input) | Inhibition 51NH (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 51NL (by digital input) | Inhibition 51NL (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 67N1 (by digital input) | Inhibition 67N1 (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 67N2 (by digital input) | Inhibition 67N2 (by DI) | | Yes / No |
| Enable/disable the trip inhibition (by digital input) | Disable trip (by DI) | | Yes / No |
| Unit 50NH trip | Trip 50NH | | Yes / No |
| Unit 50NL trip | Trip 50NL | | Yes / No |
| Unit 51NH trip | Trip 51NH | | Yes / No |
| Unit 51NL trip | Trip 51NL | | Yes / No |
| Unit 67N1 block | Block 67N1 | | Yes / No |
| Unit 67N2 block | Block 67N2 | | Yes / No |
| General Trip | General trip | | Yes / No |
| Activation/deactivation of the protection | Protection Status | | Yes / No |
| Activation/deactivation of Auxiliary output 1 | Output 1 | | Yes / No |
| Activation/deactivation of Auxiliary output 2 | Output 2 | | Yes / No |
| Activation/deactivation of Auxiliary output 3 | Output 3 | | Yes / No |
| Activation/deactivation of Auxiliary output 4 | Output 4 | | Yes / No |
| Activation/deactivation of Digital input 1 | Digital input 1 | | Yes / No |
| Activation/deactivation of Digital input 2 | Digital input 2 | | Yes / No |
| Activation/deactivation of the Settings Change inhibition by digital input | Settings Change inhibit | | Yes / No |
| Trip command activation by digital input | Trip command by input | | Yes / No |
| Trip command activation by command | Trip command by command | | Yes / No |
| Latched output reset | Reset latch aux | | Yes / No |
| Close breaker | Close breaker | | Yes / No |
| Table change | Table change | | Yes / No |
| Oscillography trigger by digital input | Osc. Trigger by DI | | Yes / No |

| | M+PC | SETTING | RANGE |
|---|---|---|---|
| Oscillography trigger by communications | Osc. Trigger by comm. | | Yes / No |
| 52B open/closed by digital input | Breaker 52B | | Yes / No |
| 52 Open/closed | Closed breaker | | Yes / No |
| Settings change mask | Settings change | | Yes / No |
| EEPROM error mask | e2prom failure | | Yes / No |
| User settings activation/deactivation mask | User settings | | Yes / No |

#### *9.20.1.7. OSCILLOGRAPHY MASKS (ONLY M+PC)*

| | M+PC | SETTING | RANGE |
|---|---|---|---|
| Oscillography by communications | Oscillo by com. | | Yes / No |
| Oscillo by digital input | Oscillo by digital input | | Yes / No |
| Oscillo by trip | Oscillo by trip | | Yes / No |
| Oscillo by pickup | Oscillo by pickup | | Yes / No |

### 9.20.2.1. GENERAL ADVANCED SETTINGS GROUP

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **GENERAL ADVANCED SETTINGS** | **GENERAL ADVANCED** | **GENERAL ADVANCED** | | | |
| Identification | IDENTIFICATION | | | | |
| Active settings table | ACTIVE TABLE | TAB | | 1/2 | NA |
| Trip minimum time | T. MIN. TRIP | TRIP MIN TIME | | 50-300 ms | 1 |

### 9.20.2.2. ISOLATED GROUND 67 UNITS SETTINGS TABLE 2

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67IG1 T2** | **Unit 67IG1 T2** | **F67IG1 T2** | | | |
| Enable Unit 67IG1 T2 | Enable 67IG1 T2 | ENABLE 67IG1 T2 | | Y/N | NA |
| Enable trip 67IG1 T2 | Trip 67IG1 T2 | TRIP 67IG1 T2 | | Y/N | NA |
| Time 67IG1 T2 | Time 67IG1 T2 | TIME 67IG1 T2 | | 0 a 99.99 s | 0.01 |
| Direction 67IG1 T2 | Direction 67IG1 T2 | DIR 67IG1 T2 | | NO/FWD/REV | NA |
| Time to instantaneous 67IG1 T2 | Time to instantaneous 67IG1 T2 | TTI 67IG1 T2 | | 0 a 99.99 s | 0.01 |
| Higher voltage 67IG1 T2 | Higher voltage 67IG1 T2 | VH 67IG1 T2 | | 2 a 70 V | 0.01 |
| Lower voltage 67IG1 T2 | Lower voltage 67IG1 T2 | VL 67IG1 T2 | | 2 a 70 V | 0.01 |
| Higher current 67IG1 T2 | Higher current 67IG1 T2 | IH 67IG1 T2 | | 0.005 a 0.4 A | 0.001 |
| Lower current 67IG1 T2 | Lower current 67IG1 T2 | IL 67IG1 T2 | | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67IG1 T2 | Characteristic angle 67IG1 T2 | ANG 67IG1 T2 | | -90 a +90 degrees | 1 |
| **Unit 67IG2 T2** | **Unit 67IG2 T2** | **F67IG2 T2** | | | |
| Enable Unit 67IG2 T2 | Enable 67IG2 T2 | ENABLE 67IG2 T2 | | Y/N | NA |
| Enable trip 67IG2 T2 | Trip 67IG2 T2 | TRIP 67IG2 T2 | | Y/N | NA |
| Time 67IG2 T2 | Time 67IG2 T2 | TIME 67IG2 T2 | | 0 a 99.99 s | 0.01 |
| Direction 67IG2 T2 | Direction 67IG2 T2 | DIR 67IG2 T2 | | NO/FWD/REV | NA |
| Time to instantaneous 67IG2 T2 | Time to instantaneous 67IG2 T2 | TTI 67IG2 T2 | | 0 a 99.99 s | 0.01 |
| Higher voltage 67IG2 T2 | Higher voltage 67IG2 T2 | VH 67IG2 T2 | | 2 a 70 V | 0.01 |
| Lower voltage 67IG2 T2 | Lower voltage 67IG2 T2 | VL 67IG2 T2 | | 2 a 70 V | 0.01 |
| Higher current 67IG2 T2 | Higher current 67IG2 T2 | IH 67IG2 T2 | | 0.005 a 0.4 A | 0.001 |
| Lower current 67IG2 T2 | Lower current 67IG2 T2 | IL 67IG2 T2 | | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67IG2 T2 | Characteristic angle 67IG2 T2 | ANG 67IG2 T2 | | -90 a +90 degrees | 1 |

### *9.20.2.3. PETERSEN COIL 67 UNITS SETTINGS TABLE 2*

| | M+PC | HMI | SETTING | RANGE | STEP |
|---|---|---|---|---|---|
| **Unit 67PC1 T2** | **Unit 67PC1 T2** | **F67PC1 T2** | | | |
| Enable Unit 67PC1 T2 | Enable 67PC1 T2 | ENABLE 67PC1 T2 | | Y/N | NA |
| Enable trip 67PC1 T2 | Trip 67PC1 T2 | TRIP 67PC1 T2 | | Y/N | NA |
| Enable power supervision 67PC1 T2 | POWER 67PC1 T2 | POWER 67PC1 T2 | | Y/N | NA |
| Time 67PC1 T2 | Time 67PC1 T2 | TIME 67PC1 T2 | | 0 a 99.99 s | 0.01 |
| Direction 67PC1 T2 | Direction 67PC1 T2 | DIR 67PC1 T2 | | NO/FWD/REV | NA |
| Pickup voltage 67PC1 T2 | Pickup voltage 67PC1 T2 | V 67PC1 T2 | | 2 a 70 V | 0.01 |
| Pickup current 67PC1 T2 | Pickup current 67PC1 T2 | I 67PC1 T2 | | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67PC1 T2 | Characteristic angle 67PC1 T2 | ANG 67PC1 T2 | | 0 a +180 degrees | 1 |
| Opening cone 67PC1 T2 | Opening cone 67PC1 T2 | CONE 67PC1 T2 | | 0 a 45 degrees | 1 |
| Power 67PC1 T2 | Power 67PC1 T2 | P 67PC1 T2 | | 0.01 a 4.5 w | 0.01 |
| **Unit 67PC2 T2** | **Unit 67PC2 T2** | **F67PC2 T2** | | | |
| Enable Unit 67PC2 T2 | Enable 67PC2 T2 | ENABLE 67PC2 T2 | | Y/N | NA |
| Enable trip 67PC2 T2 | Trip 67PC2 T2 | TRIP 67PC2 T2 | | Y/N | NA |
| Enable power supervision 67PC2 T2 | POWER 67PC2 T2 | POWER 67PC2 T2 | | Y/N | NA |
| Time 67PC2 T2 | Time 67PC2 T2 | TIME 67PC2 T2 | | 0 a 99.99 s | 0.01 |
| Direction 67PC2 T2 | Direction 67PC2 T2 | DIR 67PC2 T2 | | NO/FWD/REV | NA |
| Pickup voltage 67PC2 T2 | Pickup voltage 67PC2 T2 | V 67PC2 T2 | | 2 a 70 V | 0.01 |
| Pickup current 67PC2 T2 | Pickup current 67PC2 T2 | I 67PC2 T2 | | 0.005 a 0.4 A | 0.001 |
| Characteristic angle 67PC2 T2 | Characteristic angle 67PC2 T2 | ANG 67PC2 T2 | | 0 a +180 degrees | 1 |
| Opening cone 67PC2 T2 | Opening cone 67PC2 T2 | CONE 67PC2 T2 | | 0 a 45 degrees | 1 |
| Power 67PC2 T2 | Power 67PC2 T2 | P 67PC2 T2 | | 0.01 a 4.5 w | 0.01 |

### *9.20.2.4. EVENT MASK (ONLY M+PC)*

Event masks have two possible settings, YES and NO. If an action (for example the trip of a protection unit) is set as YES, when it occurs it will generate an event. If it is set as NO, no event will be created.

| | M+PC | SETTING | RANGE |
|---|---|---|---|
| Pickup/dropout of unit 67IG1 | Pickup 67IG1 | | Yes / No |
| Pickup/dropout of unit 67IG2 | Pickup 67IG2 | | Yes / No |
| Pickup/dropout of unit 67PC1 | Pickup 67PC1 | | Yes / No |
| Pickup/dropout of unit 67PC2 | Pickup 67PC2 | | Yes / No |
| Enable/disable the inhibition of unit 67IG1 (by digital input) | Inhibition 67IG1 (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 67IG2 (by digital input) | Inhibition 67IG2 (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 67PC1 (by digital input) | Inhibition 67PC1 (by DI) | | Yes / No |
| Enable/disable the inhibition of unit 67PC2 (by digital input) | Inhibition 67PC2 (by DI) | | Yes / No |
| Activation/deactivation of inhibition del trip (by digital input) | Inhibit trip (by DI) | | Yes / No |
| Unit 67IG1 | Trip 67IG1 | | Yes / No |
| Unit 67IG2 | Trip 67IG2 | | Yes / No |
| Unit 67PC1 | Trip 67PC1 | | Yes / No |
| Unit 67PC2 | Trip 67PC2 | | Yes / No |
| General trip | General trip | | Yes / No |
| Activation/deactivation of the protection | Protection Status | | Yes / No |
| Activation/deactivation of Auxiliary output 1 | Output 1 | | Yes / No |
| Activation/deactivation of Auxiliary output 2 | Output 2 | | Yes / No |
| Activation/deactivation of Auxiliary output 3 | Output 3 | | Yes / No |
| Activation/deactivation of Auxiliary output 4 | Output 4 | | Yes / No |
| Activation/deactivation of Digital input 1 | Digital input 1 | | Yes / No |
| Activation/deactivation of Digital input 2 | Digital input 2 | | Yes / No |
| Activation/deactivation of the Settings Change inhibition by digital input | | | Yes / No |
| Trip command activation by digital input | | | Yes / No |
| Trip command activation by command | | | Yes / No |
| Latched output reset | | | Yes / No |
| Close breaker | | | Yes / No |
| Table change | | | Yes / No |
| Oscillography trigger by digital input | | | Yes / No |
| Oscillography trigger by communications | | | Yes / No |
| 52B open/closed by digital input | | | Yes / No |
| 52 Open/closed | | | Yes / No |
| Settings change mask | | | Yes / No |
| EEPROM error mask | | | Yes / No |
| User settings activation/deactivation mask | | | Yes / No |

### *9.20.2.5. OSCILLOGRAPHY MASK (ONLY M+PC)*

| | M+PC | SETTING | RANGE |
|---|---|---|---|
| Oscillo by communications | Oscillo by comm. | | Yes / No |
| Oscillo by digital input | Oscillo by digital input | | Yes / No |
| Oscillo by trip | Oscillo by trip | | Yes / No |
| Oscillo by pickup | Oscillo by pickup | | Yes / No |

# 10. INSTALLATION AND MAINTENANCE

## 10.1. 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.

Operational conditions as defined in section 5 must not be exceeded in any case.

The relay should be mounted on a vertical surface. Figure 3.2 shows the diagram for panel drilling for panel mounting.

Given that the design of the MIN 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.

## 10.2. GROUND CONNECTION AND DISTURBANCES SUPPRESSION

Threaded plug labelled as GND (refer to figure 3.4) 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.

## 10.3. MAINTENANCE

Given the important role that the protection relays play in the operation of any installation, a periodical program of tests is highly recommended. The unit incorporates built-in diagnostic functions that permit immediate identification with only the aid of the keypad 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 fail.

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

## 10.4. CLEANING INSTRUCTIONS

In case of detecting accumulated pollution, the unit can be cleaned with a clean cloth dry or slightly dampened with a cleaner containing alcohol.

Abrasive cleaners must be avoided, as these can damage the metallic surface or the electrical connection elements.

# 11. ANNEX 1. HARMONIC FILTERING

The present document intends to give an overview on how the MIN relay deals with analog signals, in order to help determine whether the relay is appropriate for certain applications.

**GENERAL PRINCIPLE OF OPERATION.**

MIN relays, as the rest of our digital relays, are based on the following functional diagram:

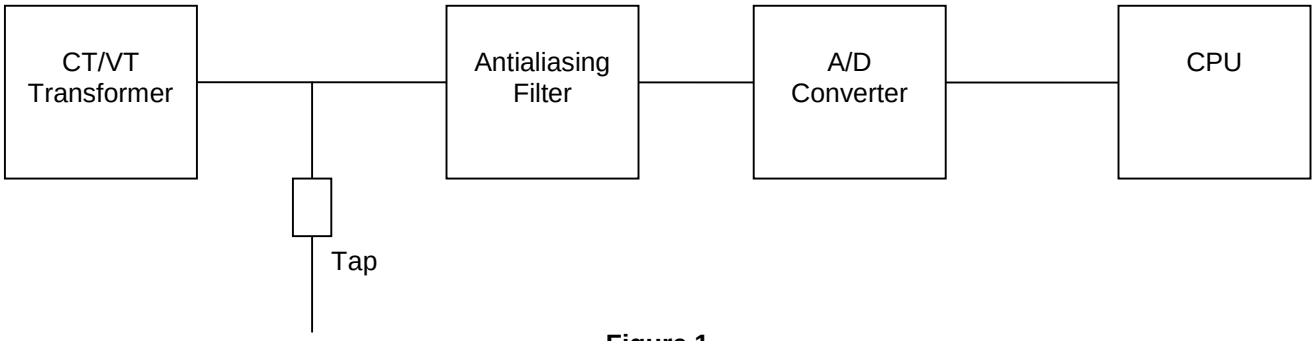



**Figure 1**

Each of these blocks has its own functionality inside the general operation of the unit, as follows:

- **Transformer (CT/VT):** It adapts the analog current and/or voltage signals to low level signals that can be used by electronic devices. Additionally, they provide isolation between the environment and the relay.
- **Tap**: It turns current signals into voltage signals, which are better managed. Do not confuse with the tap setting in the relay.
- **Antialiasing Filter**: It prevents high frequency signals (which cannot be recognised digitally) from entering the analog-digital converter. The maximum breaking frequency for this filter is determined by the Nyquis criterion, which states that the maximum frequency that can be recognised when sampling a signal is less than half the sampling frequency.

  In the MIG, the sampling is 16 times per cycle, that is, 800 Hz for a frequency set to 50 Hz, and 960 Hz for a frequency set to 60 Hz.

  On the other hand, in order to obtain a reliable oscillography record, it is important to have a high breaking frequency in this filter.

  This filter does not intend to filter the harmonics, this is better done digitally.

  In the MIG, the antialiasing filter has a breaking frequency of approx. 260 Hz.
- **Analog-Digital Converter**: It turns the analog signals into digital, so that they can be managed by a microcontroller.
- **CPU**: It is the digital signal-processing unit; it takes tripping decisions, etc.

  The CPU performs the DFT for current and voltage signals in order to obtain the vectors representing each signal, which are used for all further calculations in the relay protection functions.

## DIGITAL FILTER

The first operation performed by the CPU with the voltage and/or current signal samples is the DFT.

The Discrete Fourier Transformation consists in decomposing a signal into a series of sinusoidal signals with frequencies that are multiples of the fundamental frequency. If after this operation, we take the fundamental frequency signal, and we disregard the rest of signals (harmonics), we will get a harmonic filter. This action is performed by the MIN relay.

The MIN uses a complete cycle recursive DFT, that is, for each sample it calculates the phasor from the previous sample phasor and the difference between the current sample and the previous cycle sample. This makes the relay require a complete cycle to obtain the correct measure value.

In the following figure (figure 2), we can see how the measure is established from a signal value that changes from 0 to 1.

Figure 3 shows the answer from the digital filter with the frequency. The figure shows how all the high level harmonics are eliminated. This makes the MIN suitable for applications where it is necessary to filter any type of harmonic, for example, the 2nd and 3rd, which are the most commonly found in electrical lines.

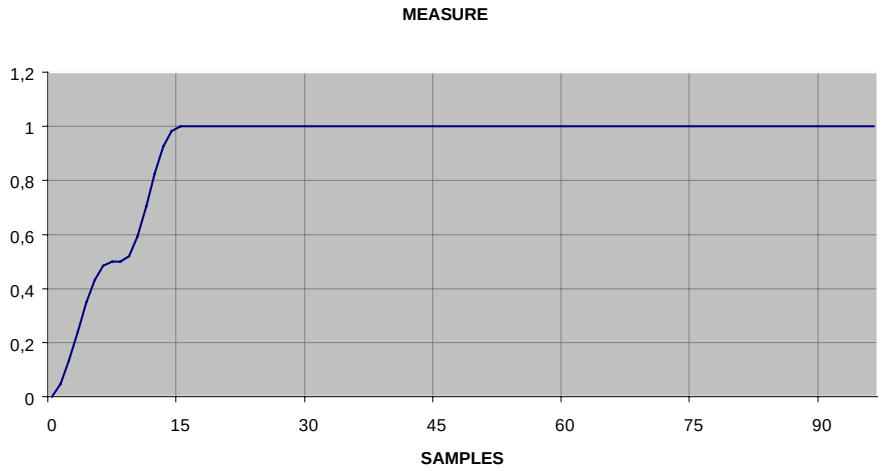



**Figure 2**

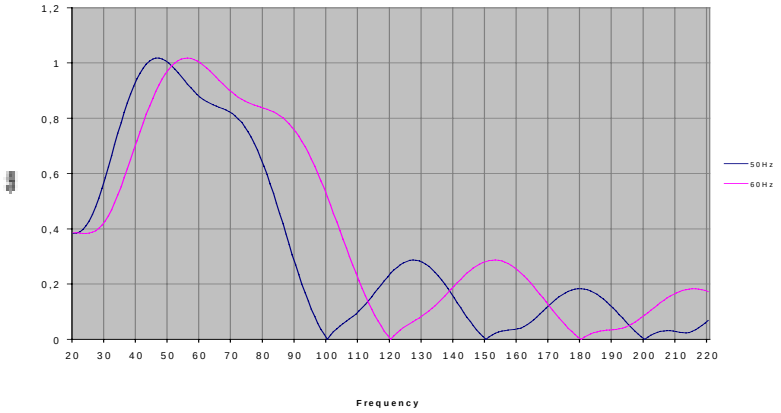



**Figure 3**

Figure 3 can experience small variations for frequencies that are not the fundamental and its harmonics, as the measure varies for these frequencies. As an example, we can see in figure 4 how a relay measure varies when it is set to 50 Hz, and it is being applied 60 Hz.

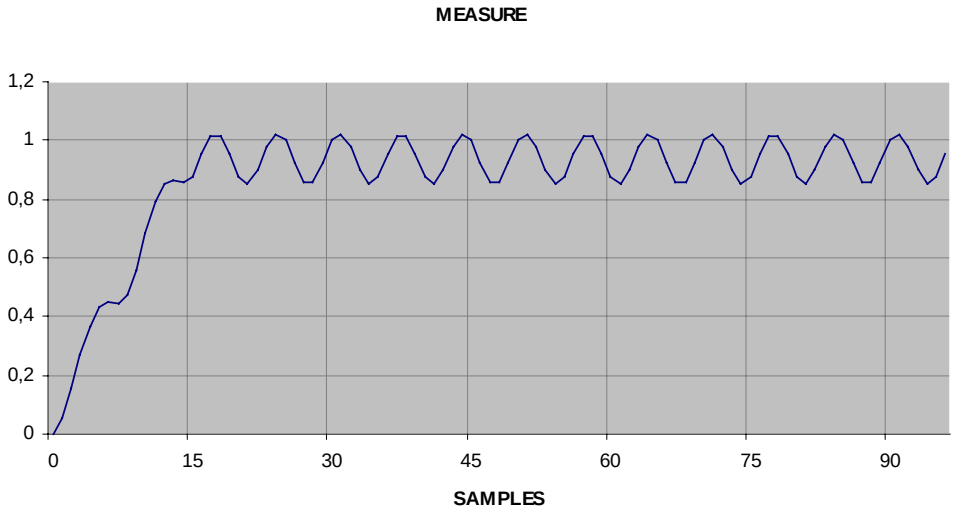



**Figure 4**

This case will never occur for the fundamental frequency and its harmonics, where the filter gain is always 1 and 0 respectively.

# 12. ANNEX 2 TIME-CURRENT CURVES FOR 51P AND 51N UNITS

## *12.1. TRIP TIMES (IN SECONDS) FOR BS142 CURVES*

| Times | Dial | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **the tap** | 0.05 | 0.10 | 0.20 | 0.30 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 1.20 | 1.40 | 1.60 | 1.80 | 2.00 |
| **INVERSE BS 142** | | | | | | | | | | | | | | | | |
| **1.05** | 7.17 | 14.34 | 28.68 | 43.02 | 57.36 | 71.70 | 86.04 | 100.38 | 114.72 | 129.06 | 143.40 | 172.08 | 200.76 | 229.44 | 258.12 | 286.80 |
| **1.50** | 0.86 | 1.72 | 3.44 | 5.16 | 6.88 | 8.60 | 10.32 | 12.04 | 13.76 | 15.47 | 17.19 | 20.63 | 24.07 | 27.51 | 30.95 | 34.39 |
| **2.00** | 0.50 | 1.00 | 2.01 | 3.01 | 4.01 | 5.01 | 6.02 | 7.02 | 8.02 | 9.03 | 10.03 | 12.03 | 14.04 | 16.05 | 18.05 | 20.06 |
| **3.00** | 0.32 | 0.63 | 1.26 | 1.89 | 2.52 | 3.15 | 3.78 | 4.41 | 5.04 | 5.67 | 6.30 | 7.56 | 8.82 | 10.08 | 11.34 | 12.60 |
| **4.00** | 0.25 | 0.50 | 1.00 | 1.49 | 1.99 | 2.49 | 2.99 | 3.49 | 3.98 | 4.48 | 4.98 | 5.98 | 6.97 | 7.97 | 8.96 | 9.96 |
| **5.00** | 0.21 | 0.43 | 0.86 | 1.28 | 1.71 | 2.14 | 2.57 | 3.00 | 3.42 | 3.85 | 4.28 | 5.14 | 5.99 | 6.85 | 7.70 | 8.56 |
| **6.00** | 0.19 | 0.38 | 0.77 | 1.15 | 1.53 | 1.92 | 2.30 | 2.69 | 3.07 | 3.45 | 3.84 | 4.60 | 5.37 | 6.14 | 6.91 | 7.67 |
| **7.00** | 0.18 | 0.35 | 0.71 | 1.06 | 1.41 | 1.76 | 2.12 | 2.47 | 2.82 | 3.17 | 3.53 | 4.23 | 4.94 | 5.64 | 6.35 | 7.06 |
| **8.00** | 0.16 | 0.33 | 0.66 | 0.99 | 1.32 | 1.65 | 1.98 | 2.31 | 2.64 | 2.97 | 3.30 | 3.96 | 4.62 | 5.27 | 5.93 | 6.59 |
| **9.00** | 0.16 | 0.31 | 0.62 | 0.93 | 1.25 | 1.56 | 1.87 | 2.18 | 2.49 | 2.80 | 3.12 | 3.74 | 4.36 | 4.99 | 5.61 | 6.23 |
| **10.00** | 0.15 | 0.30 | 0.59 | 0.89 | 1.19 | 1.49 | 1.78 | 2.08 | 2.38 | 2.67 | 2.97 | 3.56 | 4.16 | 4.75 | 5.35 | 5.94 |
| **VERY INVERSE BS 142** | | | | | | | | | | | | | | | | |
| **1.05** | 13.50 | 27.00 | 54.00 | 81.00 | 108.00 | 135.00 | 162.00 | 189.00 | 216.00 | 243.00 | 270.00 | 324.00 | 378.00 | 432.00 | 486.00 | 540.00 |
| **1.50** | 1.35 | 2.70 | 5.40 | 8.10 | 10.80 | 13.50 | 16.20 | 18.90 | 21.60 | 24.30 | 27.00 | 32.40 | 37.80 | 43.20 | 48.60 | 54.00 |
| **2.00** | 0.68 | 1.35 | 2.70 | 4.05 | 5.40 | 6.75 | 8.10 | 9.45 | 10.80 | 12.15 | 13.50 | 16.20 | 18.90 | 21.60 | 24.30 | 27.00 |
| **3.00** | 0.34 | 0.68 | 1.35 | 2.03 | 2.70 | 3.38 | 4.05 | 4.73 | 5.40 | 6.08 | 6.75 | 8.10 | 9.45 | 10.80 | 12.15 | 13.50 |
| **4.00** | 0.23 | 0.45 | 0.90 | 1.35 | 1.80 | 2.25 | 2.70 | 3.15 | 3.60 | 4.05 | 4.50 | 5.40 | 6.30 | 7.20 | 8.10 | 9.00 |
| **5.00** | 0.17 | 0.34 | 0.68 | 1.01 | 1.35 | 1.69 | 2.03 | 2.36 | 2.70 | 3.04 | 3.38 | 4.05 | 4.73 | 5.40 | 6.08 | 6.75 |
| **6.00** | 0.14 | 0.27 | 0.54 | 0.81 | 1.08 | 1.35 | 1.62 | 1.89 | 2.16 | 2.43 | 2.70 | 3.24 | 3.78 | 4.32 | 4.86 | 5.40 |
| **7.00** | 0.11 | 0.23 | 0.45 | 0.68 | 0.90 | 1.13 | 1.35 | 1.58 | 1.80 | 2.03 | 2.25 | 2.70 | 3.15 | 3.60 | 4.05 | 4.50 |
| **8.00** | 0.10 | 0.19 | 0.39 | 0.58 | 0.77 | 0.96 | 1.16 | 1.35 | 1.54 | 1.74 | 1.93 | 2.31 | 2.70 | 3.09 | 3.47 | 3.86 |
| **9.00** | 0.08 | 0.17 | 0.34 | 0.51 | 0.68 | 0.84 | 1.01 | 1.18 | 1.35 | 1.52 | 1.69 | 2.03 | 2.36 | 2.70 | 3.04 | 3.38 |
| **10.00** | 0.08 | 0.15 | 0.30 | 0.45 | 0.60 | 0.75 | 0.90 | 1.05 | 1.20 | 1.35 | 1.50 | 1.80 | 2.10 | 2.40 | 2.70 | 3.00 |
| **EXTREMELY INVERSE BS 142** | | | | | | | | | | | | | | | | |
| **1.05** | 39.02 | 78.05 | 156.10 | 234.15 | 312.20 | 390.24 | 468.29 | 546.34 | 624.39 | 702.44 | 780.49 | 936.59 | 1092.7 | 1248.8 | 1404.9 | 1561.0 |
| **1.50** | 3.20 | 6.40 | 12.80 | 19.20 | 25.60 | 32.00 | 38.40 | 44.80 | 51.20 | 57.60 | 64.00 | 76.80 | 89.60 | 102.40 | 115.20 | 128.00 |
| **2.00** | 1.33 | 2.67 | 5.33 | 8.00 | 10.67 | 13.33 | 16.00 | 18.67 | 21.33 | 24.00 | 26.67 | 32.00 | 37.33 | 42.67 | 48.00 | 53.33 |
| **3.00** | 0.50 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 | 12.00 | 14.00 | 16.00 | 18.00 | 20.00 |
| **4.00** | 0.27 | 0.53 | 1.07 | 1.60 | 2.13 | 2.67 | 3.20 | 3.73 | 4.27 | 4.80 | 5.33 | 6.40 | 7.47 | 8.53 | 9.60 | 10.67 |
| **5.00** | 0.17 | 0.33 | 0.67 | 1.00 | 1.33 | 1.67 | 2.00 | 2.33 | 2.67 | 3.00 | 3.33 | 4.00 | 4.67 | 5.33 | 6.00 | 6.67 |
| **6.00** | 0.11 | 0.23 | 0.46 | 0.69 | 0.91 | 1.14 | 1.37 | 1.60 | 1.83 | 2.06 | 2.29 | 2.74 | 3.20 | 3.66 | 4.11 | 4.57 |
| **7.00** | 0.08 | 0.17 | 0.33 | 0.50 | 0.67 | 0.83 | 1.00 | 1.17 | 1.33 | 1.50 | 1.67 | 2.00 | 2.33 | 2.67 | 3.00 | 3.33 |
| **8.00** | 0.06 | 0.13 | 0.25 | 0.38 | 0.51 | 0.63 | 0.76 | 0.89 | 1.02 | 1.14 | 1.27 | 1.52 | 1.78 | 2.03 | 2.29 | 2.54 |
| **9.00** | 0.05 | 0.10 | 0.20 | 0.30 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 1.20 | 1.40 | 1.60 | 1.80 | 2.00 |
| **10.00** | 0.04 | 0.08 | 0.16 | 0.24 | 0.32 | 0.40 | 0.48 | 0.57 | 0.65 | 0.73 | 0.81 | 0.97 | 1.13 | 1.29 | 1.45 | 1.62 |

## ANNEX 2. TIME-CURRENT CURVES FOR MIN

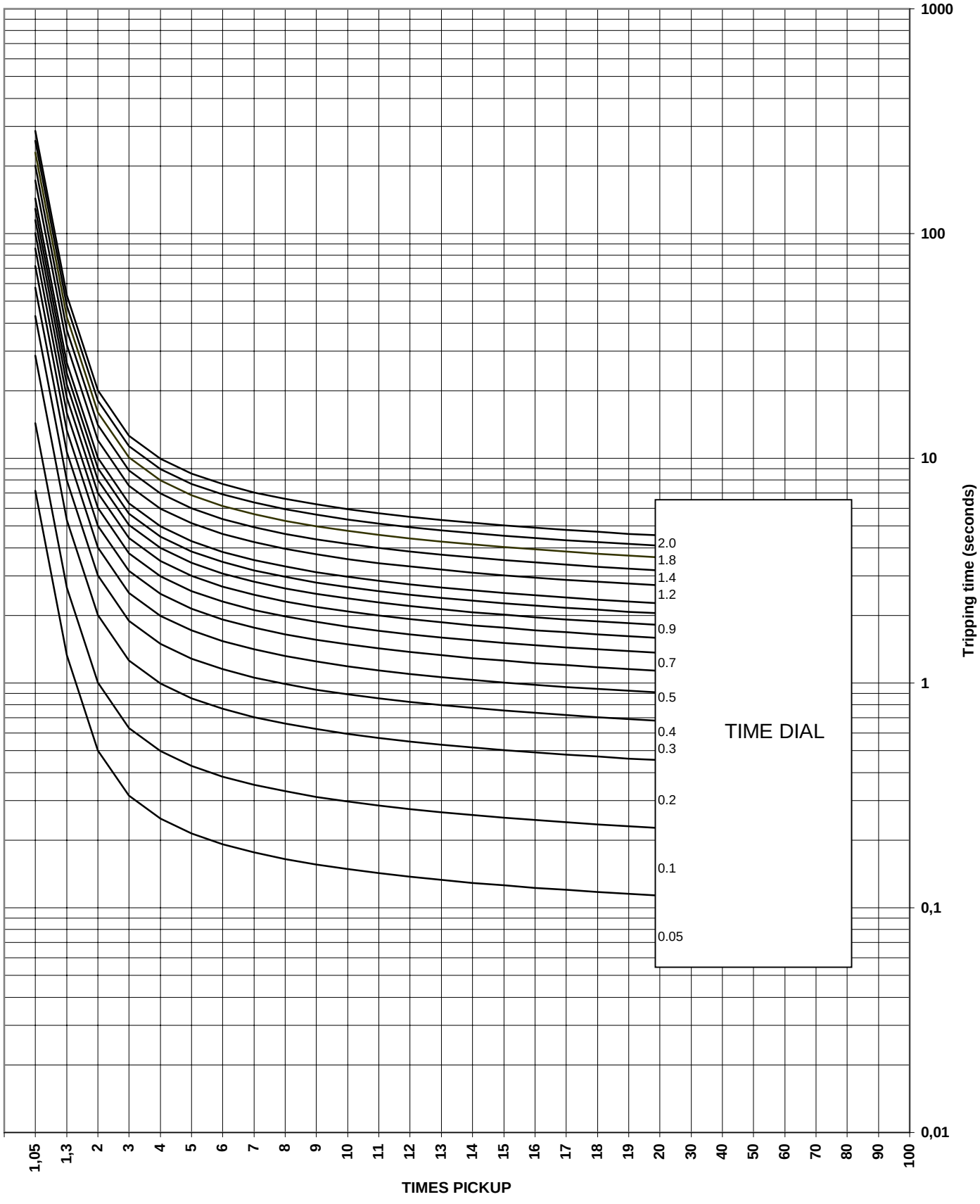
The general equation for all IEC/B142 curves is as follows:

$$T = \frac{A * D}{V^{P} - Q} + B * D + K$$

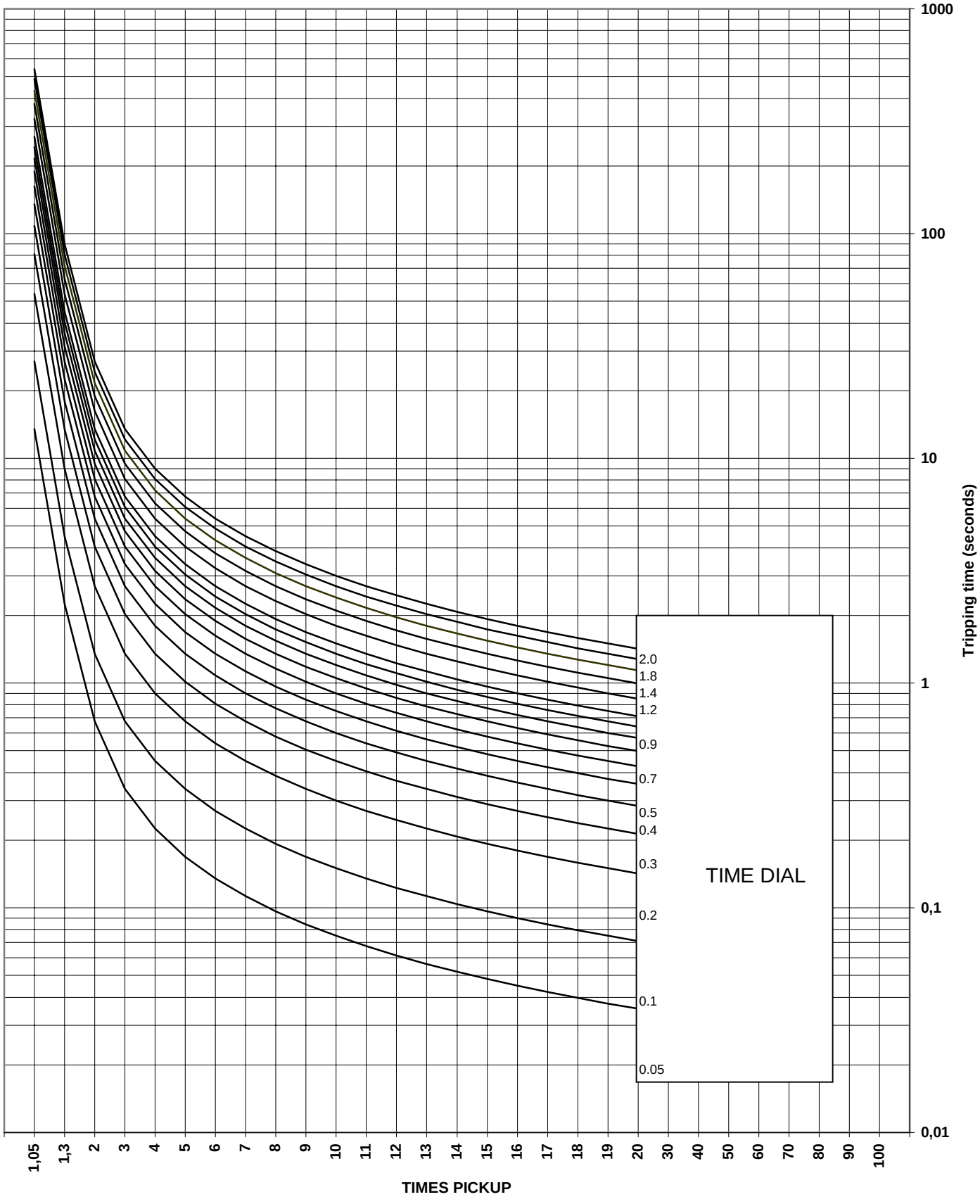
Where:

| CURVE NAME | | A | P | Q | B | K |
|---|---|---|---|---|---|---|
| Extremely inverse | IEC Curve C | 80 | 2 | 1 | 0 | 0 |
| Very inverse | IEC Curve B | 13.5 | 1 | 1 | 0 | 0 |
| Inverse | IEC Curve A | 0.14 | 0.02 | 1 | 0 | 0 |

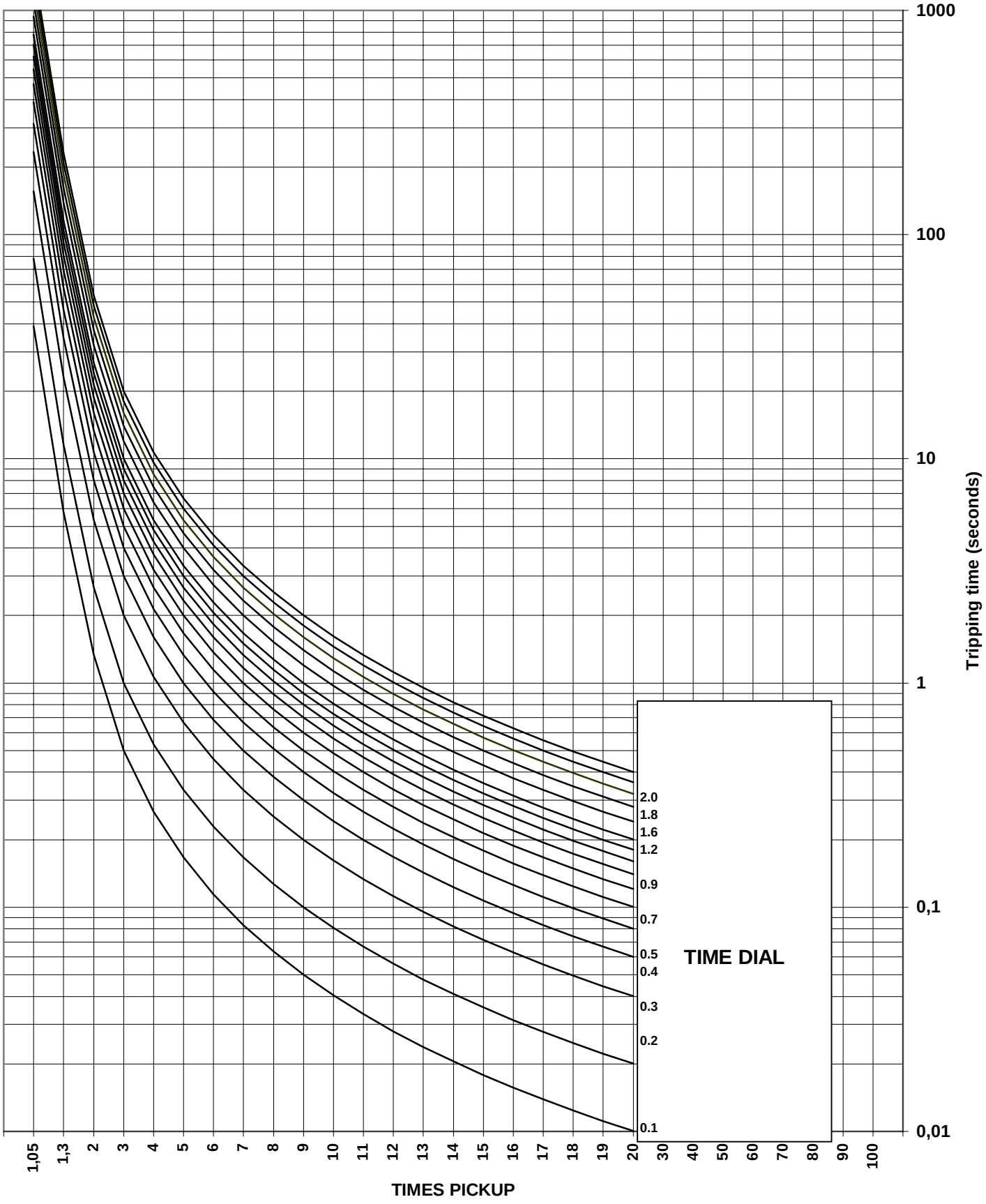
# BS142 INVERSE



# BS142 VERY INVERSE



# BS142 EXTREMELY INVERSE



## 12.2. TRIP TIMES (IN SECONDS) FOR ANSI CURVES

| Times the tap | Dial 0.5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **INVERSE ANSI** | | | | | | | | | | | | | | | | |
| **1.05** | 8.61 | 17.23 | 34.46 | 51.69 | 68.91 | 86.14 | 103.37 | 120.60 | 137.83 | 155.06 | 172.29 | 206.74 | 241.20 | 275.66 | 310.12 | 344.57 |
| **1.50** | 2.14 | 4.28 | 8.57 | 12.85 | 17.14 | 21.42 | 25.71 | 29.99 | 34.27 | 38.56 | 42.84 | 51.41 | 59.98 | 68.55 | 77.12 | 85.68 |
| **2.00** | 0.88 | 1.77 | 3.53 | 5.30 | 7.06 | 8.83 | 10.59 | 12.36 | 14.12 | 15.89 | 17.66 | 21.19 | 24.72 | 28.25 | 31.78 | 35.31 |
| **3.00** | 0.38 | 0.75 | 1.51 | 2.26 | 3.02 | 3.77 | 4.52 | 5.28 | 6.03 | 6.79 | 7.54 | 9.05 | 10.55 | 12.06 | 13.57 | 15.08 |
| **4.00** | 0.26 | 0.51 | 1.03 | 1.54 | 2.05 | 2.56 | 3.08 | 3.59 | 4.10 | 4.61 | 5.13 | 6.15 | 7.18 | 8.20 | 9.23 | 10.25 |
| **5.00** | 0.20 | 0.41 | 0.81 | 1.22 | 1.63 | 2.03 | 2.44 | 2.85 | 3.25 | 3.66 | 4.07 | 4.88 | 5.70 | 6.51 | 7.32 | 8.14 |
| **6.00** | 0.17 | 0.34 | 0.69 | 1.03 | 1.38 | 1.72 | 2.07 | 2.41 | 2.76 | 3.10 | 3.44 | 4.13 | 4.82 | 5.51 | 6.20 | 6.89 |
| **7.00** | 0.15 | 0.30 | 0.60 | 0.91 | 1.21 | 1.51 | 1.81 | 2.11 | 2.42 | 2.72 | 3.02 | 3.62 | 4.23 | 4.83 | 5.43 | 6.04 |
| **8.00** | 0.14 | 0.27 | 0.54 | 0.81 | 1.08 | 1.35 | 1.62 | 1.89 | 2.16 | 2.43 | 2.70 | 3.24 | 3.79 | 4.33 | 4.87 | 5.41 |
| **9.00** | 0.12 | 0.25 | 0.49 | 0.74 | 0.98 | 1.23 | 1.48 | 1.72 | 1.97 | 2.21 | 2.46 | 2.95 | 3.44 | 3.93 | 4.43 | 4.92 |
| **10.00** | 0.11 | 0.23 | 0.45 | 0.68 | 0.90 | 1.13 | 1.36 | 1.58 | 1.81 | 2.03 | 2.26 | 2.71 | 3.16 | 3.62 | 4.07 | 4.52 |
| **VERY INVERSE ANSI** | | | | | | | | | | | | | | | | |
| **1.05** | 5.97 | 11.94 | 23.88 | 35.82 | 47.76 | 59.70 | 71.64 | 83.58 | 95.52 | 107.46 | 119.40 | 143.28 | 167.17 | 191.05 | 214.93 | 238.81 |
| **1.50** | 1.57 | 3.13 | 6.27 | 9.40 | 12.54 | 15.67 | 18.80 | 21.94 | 25.07 | 28.21 | 31.34 | 37.61 | 43.88 | 50.15 | 56.41 | 62.68 |
| **2.00** | 0.66 | 1.33 | 2.65 | 3.98 | 5.30 | 6.63 | 7.95 | 9.28 | 10.60 | 11.93 | 13.25 | 15.90 | 18.55 | 21.20 | 23.85 | 26.50 |
| **3.00** | 0.27 | 0.54 | 1.07 | 1.61 | 2.15 | 2.68 | 3.22 | 3.76 | 4.30 | 4.83 | 5.37 | 6.44 | 7.52 | 8.59 | 9.66 | 10.74 |
| **4.00** | 0.17 | 0.34 | 0.68 | 1.02 | 1.36 | 1.71 | 2.05 | 2.39 | 2.73 | 3.07 | 3.41 | 4.09 | 4.78 | 5.46 | 6.14 | 6.82 |
| **5.00** | 0.13 | 0.26 | 0.52 | 0.78 | 1.04 | 1.30 | 1.56 | 1.82 | 2.08 | 2.34 | 2.60 | 3.12 | 3.64 | 4.16 | 4.68 | 5.20 |
| **6.00** | 0.11 | 0.22 | 0.43 | 0.65 | 0.86 | 1.08 | 1.30 | 1.51 | 1.73 | 1.95 | 2.16 | 2.59 | 3.03 | 3.46 | 3.89 | 4.32 |
| **7.00** | 0.09 | 0.19 | 0.38 | 0.57 | 0.76 | 0.94 | 1.13 | 1.32 | 1.51 | 1.70 | 1.89 | 2.27 | 2.64 | 3.02 | 3.40 | 3.78 |
| **8.00** | 0.08 | 0.17 | 0.34 | 0.51 | 0.68 | 0.85 | 1.02 | 1.19 | 1.36 | 1.53 | 1.70 | 2.04 | 2.38 | 2.72 | 3.06 | 3.40 |
| **9.00** | 0.08 | 0.16 | 0.31 | 0.47 | 0.62 | 0.78 | 0.94 | 1.09 | 1.25 | 1.41 | 1.56 | 1.87 | 2.19 | 2.50 | 2.81 | 3.12 |
| **10.00** | 0.07 | 0.15 | 0.29 | 0.44 | 0.58 | 0.73 | 0.87 | 1.02 | 1.17 | 1.31 | 1.46 | 1.75 | 2.04 | 2.33 | 2.62 | 2.91 |
| **EXTREMELY INVERSE ANSI** | | | | | | | | | | | | | | | | |
| **1.05** | 7.37 | 14.75 | 29.49 | 44.24 | 58.98 | 73.73 | 88.48 | 103.22 | 117.97 | 132.72 | 147.46 | 176.95 | 206.4 | 235.9 | 265.4 | 294.9 |
| **1.50** | 2.00 | 4.00 | 8.00 | 12.00 | 16.00 | 20.00 | 24.01 | 28.01 | 32.01 | 36.01 | 40.01 | 48.01 | 56.01 | 64.01 | 72.02 | 80.02 |
| **2.00** | 0.87 | 1.74 | 3.49 | 5.23 | 6.98 | 8.72 | 10.47 | 12.21 | 13.95 | 15.70 | 17.44 | 20.93 | 24.42 | 27.91 | 31.40 | 34.89 |
| **3.00** | 0.33 | 0.66 | 1.32 | 1.98 | 2.64 | 3.30 | 3.96 | 4.62 | 5.28 | 5.93 | 6.59 | 7.91 | 9.23 | 10.55 | 11.87 | 13.19 |
| **4.00** | 0.18 | 0.37 | 0.74 | 1.10 | 1.47 | 1.84 | 2.21 | 2.58 | 2.94 | 3.31 | 3.68 | 4.42 | 5.15 | 5.89 | 6.62 | 7.36 |
| **5.00** | 0.12 | 0.25 | 0.49 | 0.74 | 0.99 | 1.24 | 1.48 | 1.73 | 1.98 | 2.23 | 2.47 | 2.97 | 3.46 | 3.96 | 4.45 | 4.95 |
| **6.00** | 0.09 | 0.19 | 0.37 | 0.56 | 0.74 | 0.93 | 1.11 | 1.30 | 1.48 | 1.67 | 1.85 | 2.23 | 2.60 | 2.97 | 3.34 | 3.71 |
| **7.00** | 0.07 | 0.15 | 0.30 | 0.45 | 0.60 | 0.75 | 0.89 | 1.04 | 1.19 | 1.34 | 1.49 | 1.79 | 2.09 | 2.38 | 2.68 | 2.98 |
| **8.00** | 0.06 | 0.13 | 0.25 | 0.38 | 0.50 | 0.63 | 0.75 | 0.88 | 1.01 | 1.13 | 1.26 | 1.51 | 1.76 | 2.01 | 2.26 | 2.51 |
| **9.00** | 0.05 | 0.11 | 0.22 | 0.33 | 0.44 | 0.55 | 0.66 | 0.77 | 0.88 | 0.99 | 1.10 | 1.32 | 1.54 | 1.76 | 1.97 | 2.19 |
| **10.00** | 0.05 | 0.10 | 0.20 | 0.29 | 0.39 | 0.49 | 0.59 | 0.69 | 0.79 | 0.88 | 0.98 | 1.18 | 1.38 | 1.57 | 1.77 | 1.96 |

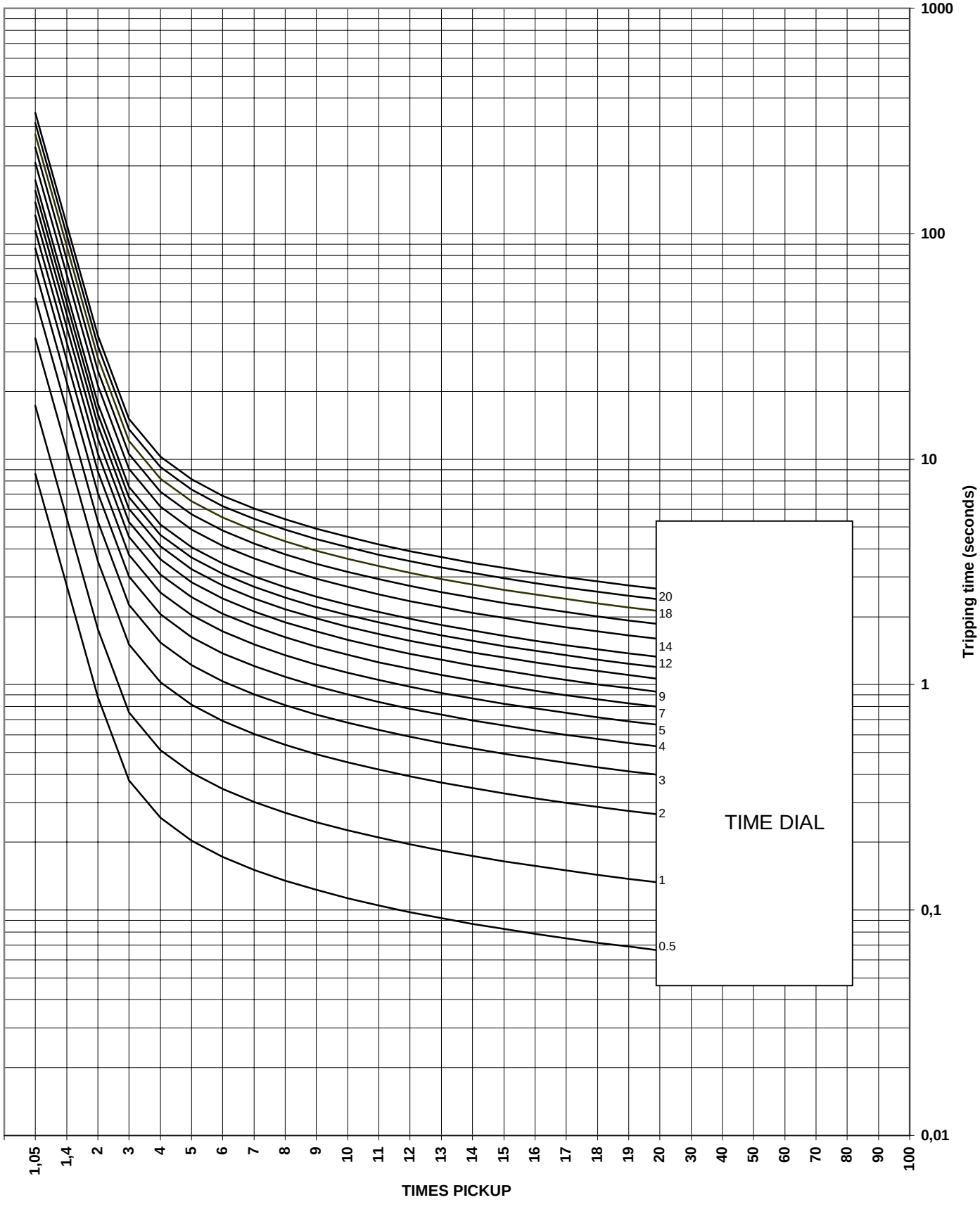
The general equation for all ANSI curves is as follows:

$$T = M * \left[ A + \frac{B}{(V - C)} + \frac{D}{(V - C)^2} + \frac{E}{(V - C)^3} \right]$$

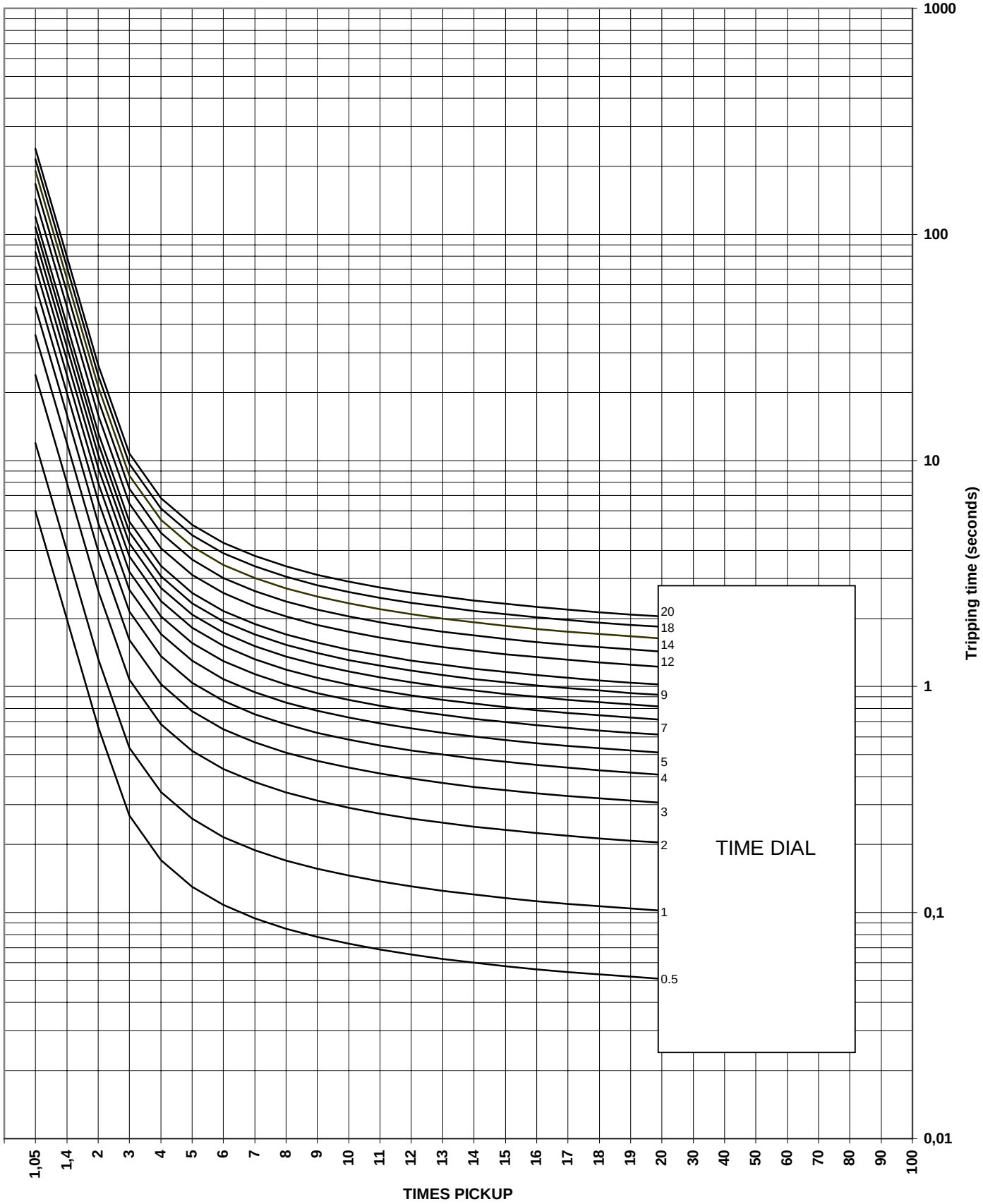
Where:

| CURVE NAME | A | B | C | D | E |
|---|---|---|---|---|---|
| Extremely inverse | 0.0399 | 0.2294 | 0.5000 | 3.0094 | 0.7222 |
| Very inverse | 0.0615 | 0.7989 | 0.3400 | -0.2840 | 4.0505 |
| Inverse | 0.0274 | 2.2614 | 0.3000 | -4.1899 | 9.1272 |

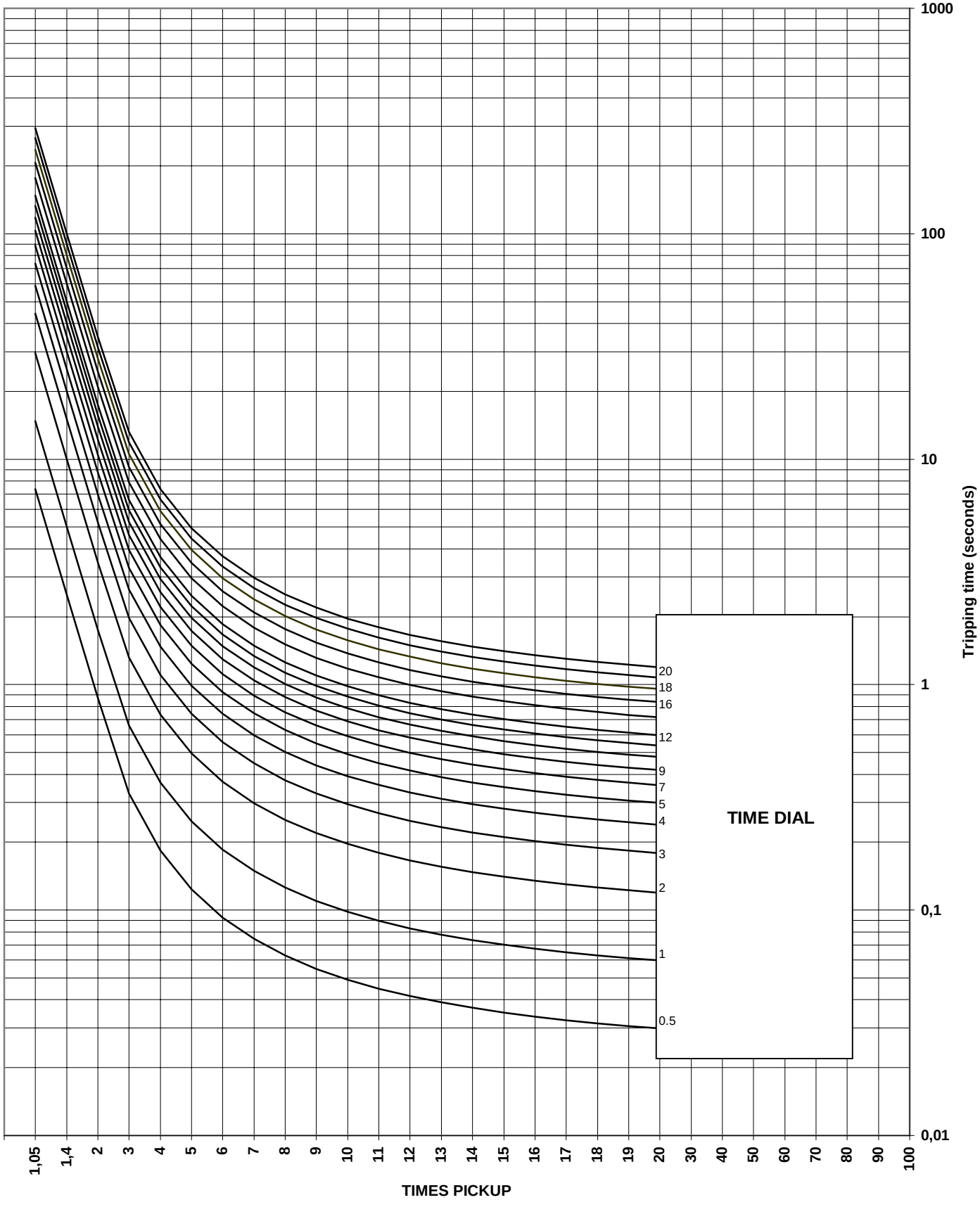
# ANSI INVERSE



# ANSI VERY INVERSE



# ANSI EXTREMELY INVERSE



# 13. ANNEX 3. MODBUS MEMORY MAP

This annex describes the fundamentals about the communication with MIN units using ModBus® protocol. The references to memory addresses can vary depending on the model, or between different firmware versions; for this reason, you must make sure that you have the appropriate memory map for your MIN model and firmware version.

To make this easy, the M+PC software supplied with M Family units incorporates, in versions 1.8 and higher, a tool that allows to extract the memory map of any M Family unit (MIF, MIV, MIG, MIN, MIW, etc.) connected to the PC.

## 13.1. READING VALUES

The MODBUS® function used in this case is number 3 (READ HOLDING REGISTERS). The message request command is generated as follows:

***Request:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (03H) |
| Beginning address | 1 word (High Byte– Low Byte) |
| Nº records | 1 word (High Byte– Low Byte) |
| CRC | 1 word |

***Reply:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte |
| No. of bytes | 1 Byte |
| Value of the records | No. of bytes/2 words |
| CRC | 1 word |

***Example:***

***Request:***

Reading of 75 records (150 bytes) beginning from address 04FE (1278).

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 03 | 04FE | 004B | 653D |

**Reply:**

| ADDRESS | FUNCTION | BYTES | DATA0 | ... | DATA74 | CRC |
|---|---|---|---|---|---|---|
| 01 | 03 | 96 | 500D | | 0200 | 84 D5 |

## 13.2. COMMAND EXECUTION

Commands are executed in two steps: selection and confirmation. First, we must send the command or operation selection command, to verify that it is available. If so, we will send the confirmation. The structure for both commands is the same, the only variation is the associated code.

The MODBUS® function code used for the execution of operations is 16 (10H) in the hexadecimal value associated to the function (PRESET MULTIPLE SETPOINTS). As it is a writing, we must give an address where the command will be written. By default this address is 0 (0000H) for all commands.

The implemented commands are as follows:

| COMMAND | SELECTION (HEX) | CONFIRMATION (HEX) |
|---|---|---|
| LEDs and latched outputs reset | 08 | 09 |
| Change to Table 1 | 0D | 0E |
| Change to Table 2 | 0F | 10 |
| Oscillography trigger | 17 | 18 |
| Open breaker | 07 | 08 |
| Close breaker | 39 | 3A |
| Time synchronization | FE | N/A |
| Setting change | 01 | 02 |

**SELECTION:**

***Request:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning | 1 word (0000H) (High byte – low byte) |
| No. of records | 1 word (0001H) (High byte – low byte) |
| No. of bytes | 1 Bytes (02H) |
| Value of the records | Record1=>Command code (High byte – low byte) |
| CRC | 1 word |

***Reply:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning address | 1 word (0000H) (High byte – low byte) |
| No. of records | 1 word (0003H) (High byte – low byte) |
| CRC | 1 word |

***Example:***

We send the command corresponding to the group of values. For example, if we want to activate Table 2, the opening command will be 0FH.

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | DATA0 | CRC |
|---|---|---|---|---|---|---|
| 01 | 10 | 0000 | 00 01 | 02 | 0F00 | A3A0 |

***Reply:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 0000 | 0001 | 01C9 |

**CONFIRMATION:**

***Request:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning | 1 word (0000H) (High byte – low byte) |
| No. of records | 1 word (0003H) (High byte – low byte) |
| No. of bytes | 1 Byte (06H) |
| Value of records | Record1=>Command code (High byte – low byte).<br>Record2=>Relay password (High byte – low byte).<br>Record3=>Constant value 0000H |
| CRC | 1 word |

***Reply:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning address | 1 word (0000H) (High byte – low byte) |
| No. of records | 1 word (0003H) (High byte – low byte) |
| CRC | 1 word |

***Example:***

To confirm the activation of table 2, the operation code used will be 10 00H. In this case, it is necessary to send the relay password.

***Request:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | DATA0 | DATA1 | DATA2 | CRC |
|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 03 | 06 | 10 00 | 01 00 | 00 00 | E5EC |

***Reply:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 03 | 8008 |

## 13.3. SYNCHRONIZATION

To synchronize a relay we use a command with the following characteristics:

We execute in broadcast, that is, we send the message to all the units in the network (relay address = 00H).
We include the date and time in the message. The length of the date and time format is 6 bytes, indicating the number of milliseconds passed from a base date, 1/1/96 at 00:00:00.000.
When we broadcast a message, we do not get an answer from the relay.

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte (00H – Broadcast) |
| Function | 1 Byte (10H) |
| Beginning | 1 word (0000H) (High byte – low byte) |
| No. of records | 1 word (0004H) (High byte – low byte) |
| No. of bytes | 1 Byte (08H) (High byte – low byte) |
| Value of the records | Record1=>Command code (High byte – low byte).<br>Record2..4=>Date and time. |
| CRC | 1 word |

**Example**

For sending the date and time of the 31st of May, 1999 at 10:01:04.224, that is, 107,690,464,224 milliseconds from the base date/time:

107,690,464,224 Decimal = 00 19 12 DA 13 E0 Hexadecimal.

Reordering for sending the lowest size byte first: E0 13 DA 12 19 00

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | COMMAND | VALUE | CRC |
|---|---|---|---|---|---|---|---|
| 00 | 10 | 00 00 | 00 04 | 08 | FE 00 | E0 13 DA 12 19 00 | ECFC |

## 13.4. WRITING SETTINGS

There are three steps to write a settings:

1. Executing a selection command using code 01 00H. (See command execution).
2. Changing the setting
3. Executing a confirmation command using code (See command execution).

For modifying a setting, we will use function 10H (PRESET MULTIPLE REGISTERS de MODBUS®)

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning | 1 word (High byte – low byte) |
| No. of records | 1 word (High byte – low byte) |
| No. of bytes | 1 Byte |
| Value of the records | (High byte – low byte) |
| CRC | 1 word |

***Reply:***

| FIELD | LENGTH |
|---|---|
| Relay address | 1 Byte |
| Function | 1 Byte (10H) |
| Beginning address | 1 word |
| No. of records | 1 word |
| CRC | 1 word |

**Example**:

**In this example, we will modify the Identification setting of a relay that stores this information in position 0118H of its memory map. The relay identification is an ASCII text of 16 characters.**

**1. SETTING CHANGE SELECTION (LIKE A COMMAND)**

***Request:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | DATA0 | CRC |
|---|---|---|---|---|---|---|
| 01 | 10 | 0000 | 0001 | 02 | 0100 | A7C0 |

***Reply:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 0000 | 00 01 | 01C9 |

## 2. SETTING CHANGE

***Request:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES |
|---|---|---|---|---|
| 01 | 10 | 0118 | 0008 | 10 |

| DATA0 | DATA1 | DATA2 | DATA3 | DATA4 |
|---|---|---|---|---|
| 5052 | 5545 | 4241 | 0049 | 4341 |

| DATA5 | DATA6 | DATA7 | CRC |
|---|---|---|---|
| 5449 | 4F4E | 2020 | 3AE1 |

Data0 => 5052 (“P””R”)
Data1 => 5545 (“U””E”)
Data2 => 4241 (“B””A”)
Data3 => 00xx (End of text. The rest of characters are not considered)

***Reply:***

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 0118 | 0008 | 4034 |

**SETTING CHANGE CONFIRMATION (LIKE A COMMAND):**

**Request**:

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | DATA0 | DATA1 | DATA2 | CRC |
|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 0000 | 0003 | 06 | 0200 | 0100 | 0000 | E69E |

**Reply**:

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 0000 | 00 03 | 8008 |

## 13.5. EVENTS

If we want to read the relay events, first we must read the memory position that defines “Total events”, which contains the number of events recorded by the relay since the last relay deletion. Only the last 24 events will be accessible, even if the counter indicates a higher number.

The size for each stored event will be 32 bytes.

The first step consists in sending the event opening command:

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | COMMAND | CRC |
|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 01 | 02 | 13 00 | AB 60 |

Reply:

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 01 | 01 C9 |

Then we read the event values starting from the start position defined in the relay map, which in version 1.00 are:

| Model | Start | Length |
|---|---|---|
| MIN-E | 0636 | 864 |
| MIN-S | 0632 | 864 |

Each event will be located in the following position:

| EVENT | POSITION |
|---|---|
| 1 | Start address |
| 2 | Start address + (32 bytes) * 1 |
| 3 | Start address + (32 bytes) * 2 |
| 4 | Start address + (32 bytes) * 3 |
| ... | ... |
| 5 | Start address + (32 bytes) * 23 |

For each event, the following information is provided, depending on the model:

| BIT | Format | MODEL E | MODEL S |
|---|---|---|---|
| 0 | F5 | Event code | Event code |
| 16 | F1 | Date and time | Date and time |
| 64 | F2 | In (input 1 A) | - |
| 96 | F2 | In (input 5 A) | - |
| 128 | F2 | Ip | In |
| 160 | F2 | Vn | Vn |
| 192 | F4 | Trip command by communications | Trip command by communications |
| 193 | F4 | LED and latch reset | LED and latch reset |
| 202 | F4 | Close command | Close command |
| 212 | F4 | Block 67N1 | |
| 213 | F4 | Block 67N2 | |
| 217 | F4 | Protection in service | Protection in service |
| 218 | F4 | Output 1 | Output 1 |
| 219 | F4 | Output 2 | Output 2 |
| 220 | F4 | Output 3 | Output 3 |
| 221 | F4 | Output 4 | Output 4 |
| 222 | F4 | Input 1 | Input 1 |
| 223 | F4 | Input 2 | Input 2 |
| 225 | F4 | Setting change inhibition by input | Setting change inhibition by input |
| 226 | F4 | Trip command by Input | Trip command by Input |
| 228 | F4 | Input 52b | Input 52b |
| 230 | F4 | Table change by input | Table change by input |
| 231 | F4 | oscillo trigger by input | Oscillo trigger by input |
| 233 | F4 | Breaker closed | Breaker closed |
| 234 | F4 | Oscillo trigger by communications | Oscillo trigger by communications |
| 237 | F4 | Setting change | Setting change |
| 238 | F4 | E2PROM Error | E2PROM Error |
| 239 | F4 | User settings | User settings |
| 240 | F4 | Pickup 50NH | |
| 241 | F4 | Pickup 50NL | |
| 242 | F4 | Pickup 51NH | |
| 243 | F4 | Pickup 51NL | |
| 244 | F4 | Pickup 67N1 | |
| 245 | F4 | Pickup 67N2 | |
| 248 | F4 | | Pickup 67IG1 |
| 249 | F4 | | Pickup 67IG2 |
| 250 | F4 | | Pickup 67PC1 |
| 251 | F4 | | Pickup 67PC2 |
| 256 | F4 | 50NH inhibit by input | |
| 257 | F4 | 50NL inhibit by input | |
| 258 | F4 | 51NH inhibit by input | |
| 259 | F4 | 51NL inhibit by input | |
| 260 | F4 | 67N1 inhibit by input | |
| 261 | F4 | 67N2 inhibit by input | |
| 264 | F4 | | 67IG1 inhibit by input |
| 265 | F4 | | 67IG2 inhibit by input |
| 266 | F4 | | 67PC1 inhibit by input |
| 267 | F4 | | 67PC2 inhibit by input |
| 271 | F4 | General inhibit by input | General inhibit by input |
| 272 | F4 | Trip 50NH | |
| 273 | F4 | Trip 50NL | |
| 274 | F4 | Trip 51NH | |
| 275 | F4 | Trip 51NL | |
| 280 | F4 | | Trip 67IG1 |

| BIT | Format | MODEL E | MODEL S |
|---|---|---|---|
| 281 | F4 | | Trip 67IG2 |
| 282 | F4 | | Trip 67PC1 |
| 283 | F4 | | Trip 67PC2 |
| 287 | F4 | General trip | General trip |

The event window is initiated at 0; this means that if we read an event index that doesn't store any value, we will read 32 bytes initiated at 0x00.

The codes for the different events are listed in the following tables:

| EVENTS - MODEL E | |
|---|---|
| 8438/8439 | Pickup/dropout unit 50NH |
| 8440/8441 | Pickup/dropout unit 50NL |
| 8442/8443 | Pickup/dropout unit 51NH |
| 8444/8445 | Pickup/dropout unit 51NL |
| 8458/8459 | Activation/deactivation of unit 67N1 |
| 8460/8461 | Activation/deactivation of unit 67N2 |
| 8446 | Activation/deactivation of the inhibition of unit 50NH by digital input |
| 8447 | Activation/deactivation of the inhibition of unit 50NL by digital input |
| 8448 | Activation/deactivation of the inhibition of unit 51NH by digital input |
| 8449 | Activation/deactivation of the inhibition of unit 51NL by digital input |
| 8462 | Activation/deactivation of the inhibition of unit 67N1 by digital input |
| 8463 | Activation/deactivation of the inhibition of unit 67N2 by digital input |
| 8254/8255 | Activation/deactivation of the trip inhibition by digital input |
| 8450 | Trip function 50NH |
| 8451 | Trip function 50NL |
| 8452 | Trip function 51NH |
| 8453 | Trip function 51NL |
| 8270 | General trip (of any function) |
| 8454/8455 | Block/unblock function 67N1 |
| 8456/8457 | Block/unblock function 67N2 |
| 8274/8275 | Activation/deactivation of the protection (to be activated, the relay must be in service (READY) and at least one of the protection units must be activated). |
| 8276/8277 | Activation/deactivation of auxiliary output 1 |
| 8278/8279 | Activation/deactivation of auxiliary output 2 |
| 8280/8281 | Activation/deactivation of auxiliary output 3 |
| 8282/8283 | Activation/deactivation of auxiliary output 4 |
| 8284/8285 | Activation/deactivation of digital input 1 |
| 8286/8287 | Activation/deactivation of digital input 2 |
| 8290/8291 | Activation/deactivation of the settings change inhibition by digital input |
| 8292 | Activation of trip command by digital input |
| 8192 | Activation of trip command by command |
| 8194 | LEDs and latched outputs reset |
| 8425 | Breaker close operation |
| 8300 | Table change by digital input (see section 5, Settings) |
| 8302 | oscillography trigger by digital input |
| 8308 | Oscillography trigger by communications |
| 8296/8297 | 52B Closed (1)/Open (0). (status of digital input) |
| 8306/8307 | Breaker closed (1)/Open (0) (for the MIN it coincides with the status of the digital input. Other units, such as MIF, use current detectors to determine the breaker status in case an input is not programmed as 52B) |
| 8314 | Setting change |
| 8316 | EEPROM Error |
| 8318/8319 | User settings/Factory settings |

| EVENTS – MODEL S | |
|---|---|
| 8464/8465 | Pickup/dropout unit 67IG1 |
| 8466/8467 | Pickup/dropout unit 67IG2 |
| 8468/8469 | Pickup/dropout unit 67PC1 |
| 8470/8471 | Pickup/dropout unit 67PC2 |
| 8472 | Activation/deactivation of the inhibition of unit 67IG1 by digital input |
| 8473 | Activation/deactivation of the inhibition of unit 67IG2 by digital input |
| 8474 | Activation/deactivation of the inhibition of unit 67PC1 by digital input |
| 8475 | Activation/deactivation of the inhibition of unit 67PC2 by digital input |
| 8254/8255 | Activation/deactivation of the trip inhibition by digital input |
| 8476 | Trip function 67IG1 |
| 8477 | Trip function 67IG2 |
| 8478 | Trip function 67PC1 |
| 8479 | Trip function 67PC2 |
| 8270 | General trip (of any function) |
| 8274/8275 | Activation/deactivation of the protection. (to be activated, the relay must be in service (READY) and at least one of the protection units must be activated). |
| 8276/8277 | Activation/deactivation of auxiliary output 1 |
| 8278/8279 | Activation/deactivation of auxiliary output 2 |
| 8280/8281 | Activation/deactivation of auxiliary output 3 |
| 8282/8283 | Activation/deactivation of auxiliary output 4 |
| 8284/8285 | Activation/deactivation of digital input 1 |
| 8286/8287 | Activation/deactivation of digital input 2 |
| 8290/8291 | Activation/deactivation of the logic by digital input |
| 8292 | Activation of trip command by digital input |
| 8192 | Activation of trip command by command |
| 8194 | LEDs and latched outputs reset |
| 8425 | Breaker close operation |
| 8300 | Table change by digital input (see section 5, Settings) |
| 8302 | oscillography trigger by digital input |
| 8308 | Oscillography trigger by communications |
| 8296/8297 | 52B Closed (1)/Open (0). (status of digital input) |
| 8306/8307 | Breaker closed (1)/Open (0) (for the MIN it coincides with the status of the digital input. Other units, such as MIF, use current detectors to determine the breaker status in case an input is not programmed as 52B) |
| 8314 | Setting change |
| 8316 | EEPROM Error |
| 8318/8319 | User settings/Factory settings |

Finally we must close the events window. When closing this window we must indicate how many events we want to delete. If we don't want to delete any event, we will send a 0 (VALUE field).

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | COMMAND | VALUE | CRC |
|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 04 | 08 | 14 00 | 00 00 | F0 56 |

Reply:

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 04 | C0 7D |

For closing the window deleting 3 events:

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | COMMAND | VALUE | CRC |
|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 04 | 08 | 14 00 | 03 00 | F0 56 |

Reply:

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 04 | 00 7E |

## 13.6. OSCILLOGRAPHY

In order to read the oscillography information, we must first send a record opening command.

| ADDRESS | FUNCTION | BEGINNING | #REGS | #BYTES | COMMAND | CRC |
|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 01 | 02 | 11 00 | AA 00 |

If there are no oscillography records available, we will get a NACK (MODBUS error 07).

| ADDRESS | FUNCTION | ERROR | CRC |
|---|---|---|---|
| 01 | 90 | 07 | 0D C2 |

Otherwise, the relay will recognize the command and prepare the information for reading. The relay will reply with the following sequence when the information is ready to be read.

| ADDRESS | FUNCTION | BEGINNING | #REGS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 01 | 01 C9 |

Once the oscillography window opening command is executed, we will be able to access the records that contain all the necessary information. This information is divided in three blocks:

1. Samples of the analog (currents and voltages) and digital channels
2. RMS values of analog channels and active table in the moment of the oscillography trigger (trigger report)
3. Additional data to create the COMTRADE format files, such as: Date and time, sampling frequency, number of samples, line frequency, oscillo number (configuration).

The memory positions that store this information can vary depending on the relay model or firmware version:

| Model | Sample Beginning | Length | Report Beginning | Length | Configuration Beginning | Length |
|---|---|---|---|---|---|---|
| MIN-E | 09C6 | 3456 | 1746 | 18 | 1758 | 16 |
| MIN-S | 09C2 | 3456 | 1742 | 18 | 1754 | 16 |

When using M+PC for retrieving the map, the information is shown as follows:

| Model | Beginning | Length |
|---|---|---|
| MIN-E | 09C6 \| 1746 \| 1758 | 3456 \| 18 \| 16 |
| MIN-S | 09C2 \| 1742 \| 1754 | 3456 \| 18 \| 16 |

### 13.6.1. MODEL E

For the first block, that contains the samples of the analog and digital channels, the structure is as follows:

| OSCILLOGRAPHY DATA. (0x09C6). The length of each record is 18 bytes | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **MODEL E** | **LENGTH** | **FORMAT** |
| **FIRST RECORD** | | | | |
| 9C6 | | In (1 A) | 2 bytes | F12 |
| 9C8 | | In (5 A) | 2 bytes | F12 |
| 9CA | | Ip | 2 bytes | F12 |
| 9CC | | Vn | 2 bytes | F12 |
| 9CE | 0 | Pickup 50NH | 1 bit | F4 |
| 9CE | 1 | Pickup 50NL | 1 bit | F4 |
| 9CE | 2 | Pickup 51NH | 1 bit | F4 |
| 9CE | 3 | Pickup 51NL | 1 bit | F4 |
| 9CE | 4 | Pickup 67N1 | 1 bit | F4 |
| 9CE | 5 | Pickup 67N2 | 1 bit | F4 |
| 9CE | 15 | Alarm 49 | 1 bit | F4 |
| 9D0 | 0 | Disable 50NH by input | 1 bit | F4 |
| 9D0 | 1 | Disable 50NL by input | 1 bit | F4 |
| 9D0 | 2 | Disable 51NH by input | 1 bit | F4 |
| 9D0 | 3 | Disable 51NL by input | 1 bit | F4 |
| 9D0 | 4 | Disable 67N1 by input | 1 bit | F4 |
| 9D0 | 5 | Disable 67N2 by input | 1 bit | F4 |
| 9D0 | 15 | General disable by input | 1 bit | F4 |
| 9D2 | 0 | Trip 50NH | 1 bit | F4 |
| 9D2 | 1 | Trip 50NL | 1 bit | F4 |
| 9D2 | 2 | Trip 51NH | 1 bit | F4 |
| 9D2 | 3 | Trip 51NL | 1 bit | F4 |
| 9D2 | 15 | General trip | 1 bit | F4 |
| 9D4 | 4 | 67N1 Blocked | 1 bit | F4 |
| 9D4 | 5 | 67N2 Blocked | 1 bit | F4 |
| 9D4 | 8 | Trip contact | 1 bit | F4 |
| 9D4 | 9 | Alarm | 1 bit | F4 |
| 9D4 | 10 | Output 1 | 1 bit | F4 |
| 9D4 | 11 | Output 2 | 1 bit | F4 |
| 9D4 | 12 | Output 3 | 1 bit | F4 |
| 9D4 | 13 | Output 4 | 1 bit | F4 |
| 9D4 | 14 | Input 1 | 1 bit | F4 |
| 9D4 | 15 | Input 2 | 1 bit | F4 |
| 9D6 | 4 | Input 52B | 1 bit | F4 |
| 9D6 | 9 | Breaker status | 1 bit | F4 |
| 9D6 | 6 | Table change by Input | 1 bit | F4 |
| 9D6 | 14 | E2PROM failure | 1 bit | F4 |
| 9D6 | 15 | User settings | 1 bit | F4 |
| **SECOND RECORD** | | | | |
| 9D8 | | In (1 A) | 2 bytes | F12 |
| 9DA | | In (5 A) | 2 bytes | F12 |
| 9DC | | Ip | 2 bytes | F12 |
| 9DE | | Vn | 2 bytes | F12 |
| 9E0 | 0 | Pickup 50NH | 1 bit | F4 |
| 9E0 | 1 | Pickup 50NL | 1 bit | F4 |
| 9E0 | 2 | Pickup 51NH | 1 bit | F4 |
| 9E0 | 3 | Pickup 51NL | 1 bit | F4 |
| 9E0 | 4 | Pickup 67N1 | 1 bit | F4 |

| OSCILLOGRAPHY DATA. (0x09C6). The length of each record is 18 bytes | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **MODEL E** | **LENGTH** | **FORMAT** |
| 9E0 | 5 | Pickup 67N2 | 1 bit | F4 |
| 9E0 | 15 | Alarm 49 | 1 bit | F4 |
| 9E2 | 0 | Disable 50NH by input | 1 bit | F4 |
| 9E2 | 1 | Disable 50NL by input | 1 bit | F4 |
| 9E2 | 2 | Disable 51NH by input | 1 bit | F4 |
| 9E2 | 3 | Disable 51NL by input | 1 bit | F4 |
| 9E2 | 4 | Disable 67N1 by input | 1 bit | F4 |
| 9E2 | 5 | Disable 67N2 by input | 1 bit | F4 |
| 9E2 | 15 | General disable by input | 1 bit | F4 |
| 9E4 | 0 | Trip 50NH | 1 bit | F4 |
| 9E4 | 1 | Trip 50NL | 1 bit | F4 |
| 9E4 | 2 | Trip 51NH | 1 bit | F4 |
| 9E4 | 3 | Trip 51NL | 1 bit | F4 |
| 9E4 | 15 | General trip | 1 bit | F4 |
| 9E6 | 4 | 67N1 Blocked | 1 bit | F4 |
| 9E6 | 5 | 67N2 Blocked | 1 bit | F4 |
| 9E6 | 8 | Trip contact | 1 bit | F4 |
| 9E6 | 9 | Alarm | 1 bit | F4 |
| 9E6 | 10 | Output 1 | 1 bit | F4 |
| 9E6 | 11 | Output 2 | 1 bit | F4 |
| 9E6 | 12 | Output 3 | 1 bit | F4 |
| 9E6 | 13 | Output 4 | 1 bit | F4 |
| 9E6 | 14 | Input 1 | 1 bit | F4 |
| 9E6 | 15 | Input 2 | 1 bit | F4 |
| 9E8 | 4 | Input 52B | 1 bit | F4 |
| 9E8 | 9 | Breaker status | 1 bit | F4 |
| 9E8 | 6 | Table change by Input | 1 bit | F4 |
| 9E8 | 14 | E2PROM failure | 1 bit | F4 |
| 9E8 | 15 | User settings | 1 bit | F4 |
| **THIRD RECORD** | | | | |
| 9EA | | In (1 A) | 2 bytes | F12 |
| ... | ... | ... | ... | ... |
| **FOURTH RECORD** | | | | |
| 9FC | | In (1 A) | 2 bytes | F12 |
| ... | ... | ... | ... | ... |
| **RECORD 192.** | | | | |
| 1734 | | In (1 A) | 2 bytes | F12 |
| ... | ... | ... | ... | ... |

The second data block contains the oscillo report, that is, the RMS values of the analog signals in the moment of the trigger. If the trigger is produced by a trip, these values will match the fault values.

The structure of this block is shown in the following list:

| VALUES DURING THE OSCILLOGRAPHY TRIGGER | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **DESCRIPTION** | **LENGTH (bytes)** | **FORMAT** |
| 1746 | | In (1 A) during the trigger | 4 | F2 |
| 174A | | In (5 A) during the trigger | 4 | F2 |
| 174E | | Ip during the trigger | 4 | F2 |
| 1752 | | Vn during the trigger | 4 | F2 |
| 1756 | | Active table | 2 | F5 |

The third and last block contains the rest of information necessary for the generation of COMTRADE format files. It has the following structure:

| GENERAL OSCILLOGRAPHY DATA | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **DESCRIPTION** | **LENGTH** | **FORMAT** |
| 1758 | | Date and time | 6 | F1 |
| 175E | | Number of samples per second | 2 | F5 |
| 1760 | | Number of samples | 2 | F5 |
| 1762 | | Line frequency | 2 | F5 |
| 1764 | | Oscillo index | 2 | F5 |

### 13.6.2. MODEL S

For the first block, that contains the samples of analog and digital channels, the structure is as follows:

| OSCILLOGRAPHY INFORMATION. (0x09C6). The length of each record is 18 bytes | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **MODEL E** | **LENGTH** | **FORMAT** |
| **FIRST RECORD** | | | | |
| 9C2 | | - | 2 bytes | F12 |
| 9C4 | | - | 2 bytes | F12 |
| 9C6 | | In | 2 bytes | F12 |
| 9C8 | | Vn | 2 bytes | F12 |
| 9CA | 8 | Pickup 67IG1 | 1 bit | F4 |
| 9CA | 9 | Pickup 67IG2 | 1 bit | F4 |
| 9CA | 10 | Pickup 67PC1 | 1 bit | F4 |
| 9CA | 11 | Pickup 67PC2 | 1 bit | F4 |
| 9CA | 15 | Pickup General | 1 bit | F4 |
| 9CC | 8 | Disable 67IG1 by input | 1 bit | F4 |
| 9CC | 9 | Disable 67IG2 by input | 1 bit | F4 |
| 9CC | 10 | Disable 67PC1 by input | 1 bit | F4 |
| 9CC | 11 | Disable 67PC2 by input | 1 bit | F4 |
| 9CC | 15 | General disable by input | 1 bit | F4 |
| 9CE | 8 | Trip 67IG1 | 1 bit | F4 |
| 9CE | 9 | Trip 67IG2 | 1 bit | F4 |
| 9CE | 10 | Trip 67PC1 | 1 bit | F4 |
| 9CE | 11 | Trip 67PC2 | 1 bit | F4 |
| 9CE | 15 | General trip | 1 bit | F4 |
| 9D0 | 8 | Trip Contact | 1 bit | F4 |
| 9D0 | 9 | Alarm | 1 bit | F4 |
| 9D0 | 10 | Output 1 | 1 bit | F4 |
| 9D0 | 11 | Output 2 | 1 bit | F4 |
| 9D0 | 12 | Output 3 | 1 bit | F4 |
| 9D0 | 13 | Output 4 | 1 bit | F4 |
| 9D0 | 14 | Input 1 | 1 bit | F4 |
| 9D0 | 15 | Input 2 | 1 bit | F4 |
| 9D2 | 4 | Input 52B | 1 bit | F4 |
| 9D2 | 9 | Breaker status | 1 bit | F4 |
| 9D2 | 6 | Table change by Input | 1 bit | F4 |
| 9D2 | 14 | E2PROM failure | 1 bit | F4 |
| 9D2 | 15 | User settings | 1 bit | F4 |
| **SECOND RECORD** | | | | |
| 9D4 | | - | 2 bytes | F12 |
| 9D6 | | - | 2 bytes | F12 |
| 9D8 | | In | 2 bytes | F12 |
| 9DA | | Vn | 2 bytes | F12 |
| 9DC | 8 | Pickup 67IG1 | 1 bit | F4 |
| 9DC | 9 | Pickup 67IG2 | 1 bit | F4 |
| 9DC | 10 | Pickup 67PC1 | 1 bit | F4 |
| 9DC | 11 | Pickup 67PC2 | 1 bit | F4 |
| 9DC | 15 | Pickup General | 1 bit | F4 |
| 9DE | 8 | Disable 67IG1 by input | 1 bit | F4 |
| 9DE | 9 | Disable 67IG2 by input | 1 bit | F4 |
| 9DE | 10 | Disable 67PC1 by input | 1 bit | F4 |
| 9DE | 11 | Disable 67PC2 by input | 1 bit | F4 |

| OSCILLOGRAPHY INFORMATION. (0x09C6). The length of each record is 18 bytes | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **MODEL E** | **LENGTH** | **FORMAT** |
| 9DE | 15 | General disable by input | 1 bit | F4 |
| 9E0 | 8 | Trip 67IG1 | 1 bit | F4 |
| 9E0 | 9 | Trip 67IG2 | 1 bit | F4 |
| 9E0 | 10 | Trip 67PC1 | 1 bit | F4 |
| 9E0 | 11 | Trip 67PC2 | 1 bit | F4 |
| 9E0 | 15 | General trip | 1 bit | F4 |
| 9E2 | 8 | Trip contact | 1 bit | F4 |
| 9E2 | 9 | Alarm | 1 bit | F4 |
| 9E2 | 10 | Output 1 | 1 bit | F4 |
| 9E2 | 11 | Output 2 | 1 bit | F4 |
| 9E2 | 12 | Output 3 | 1 bit | F4 |
| 9E2 | 13 | Output 4 | 1 bit | F4 |
| 9E2 | 14 | Input 1 | 1 bit | F4 |
| 9E2 | 15 | Input 2 | 1 bit | F4 |
| 9E4 | 4 | Input 52B | 1 bit | F4 |
| 9E4 | 9 | Breaker status | 1 bit | F4 |
| 9E4 | 6 | Table change by Input | 1 bit | F4 |
| 9E4 | 14 | E2PROM failure | 1 bit | F4 |
| 9E4 | 15 | User settings | 1 bit | F4 |
| **THIRD RECORD** | | | | |
| 9E6 | | - | 2 bytes | F12 |
| 9E8 | | - | 2 bytes | F12 |
| 9EA | | In | 2 bytes | F12 |
| ... | ... | ... | ... | ... |
| **FOURTH RECORD** | | | | |
| 9F8 | | - | 2 bytes | F12 |
| 9FA | | - | 2 bytes | F12 |
| 9FC | | In | 2 bytes | F12 |
| ... | ... | ... | ... | ... |
| **RECORD 192.** | | | | |
| 1730 | | - | 2 bytes | F12 |
| 1732 | | - | 2 bytes | F12 |
| 1734 | | In | 2 bytes | F12 |
| ... | ... | ... | ... | ... |

The second data block contains the oscillo report, that is, the RMS values of the analog signals in the moment of the trigger. If the trigger is produced by a trip, these values will match the fault values.

The structure of this block is as follows:

| VALUES DURING THE OSCILLOGRAPHY TRIGGER. | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **DESCRIPTION** | **LENGTH (bytes)** | **FORMAT** |
| 1742 | | In during the trigger | 4 | F2 |
| 1746 | | Vn during the trigger | 4 | F2 |
| 174A | | Active table | 2 | F5 |

The third and last block contains the necessary information for creating a COMTRADE format file, and has the following structure:

| GENERAL OSCILLOGRAPHY DATA. | | | | |
|---|---|---|---|---|
| **MEMORY POSITION** | **BIT** | **DESCRIPTION** | **LENGTH** | **FORMAT** |
| 1754 | | Date and time | 6 | F1 |
| 175A | | Number of samples per second | 2 | F5 |
| 176C | | Number of samples | 2 | F5 |
| 176E | | Line frequency | 2 | F5 |
| 1770 | | Oscillo index | 2 | F5 |

Once the oscillography information has been read and saved, we will close this window in the relay. For this purpose, we send the oscillography file closing command. The information will continue to be stored in the relay, as closing the window doesn't involve the elimination of the information. However, only one oscillography window is stored, and when a new one is created, the previous one is deleted.

| ADDRESS | FUNCTION | BEGINNING | #RECORDS | #BYTES | COMMAND | PASSWORD | CRC |
|---|---|---|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 03 | 06 | 12 00 | 01 00 00 00 | E4 0E |

Reply from the relay:

| ADDRESS | FUNCTION | BEGINNING | #RECORDS | CRC |
|---|---|---|---|---|
| 01 | 10 | 00 00 | 00 03 | 80 08 |

## 13.7. ERRORS

When any of the previous commands cause and error in the slave, the following string is received:

| ADDRESS | FUNCTION+ 80H | ERROR CODE | CRC |
|---|---|---|---|
| 01 | 90 | 07 | 0D C2 |

The error code field can show the following values:

| | |
|---|---|
| 01 | ILLEGAL FUNCTION |
| 02 | ILLEGAL DATA ADDRESS |
| 03 | ILLEGAL DATA VALUE |
| 04 | SLAVE DEVICE FAILURE |
| 05 | ACK. |
| 06 | SLAVE BUSY |
| 07 | NEGATIVE ACKNOWLEDGE |
| 08 | MEMORY PARITY ERROR |

## 13.8. USED FORMATS

| FORMAT | DESCRIPTION | VALUE | VALUETEXT |
|---|---|---|---|
| F1 | DATE/TIME | | Milliseconds from 1/1/1996 at 00:00:00.000. |
| F2 | FLOAT 32 (INTEL) IEEE (32 bits) | | See the example after the table. |
| F3/ARRAY | TEXT | | |
| F4/BIT | *BIT* | | |
| | BIT **SOURCE CT 1/5A** | 0 | 1 Amp |
| | | 1 | 5 Amp |
| | BIT **Polarization Loss** | 0 | Block |
| | | 1 | Allow |
| | BIT **67N Direction** | 0 | Forward |
| | | 1 | Reverse |
| | BIT **Enables** | 0 | Not allowed |
| | | 1 | Allowed |
| | BIT **Status** | 0 | Inactive |
| | | 1 | Active |
| | BIT **Active table** | 0 | Table 1 |
| | | 1 | Table 2 |
| | BIT **Relay Status** | 0 | Out of service |
| | | 1 | In service |
| | BIT **Application** | 0 | Isolated |
| | | 1 | Petersen |
| | BIT **POWER 67PC** | 0 | No |
| | | 1 | Yes |
| F5 | ENTERO SIN SIGNO 16 BIT | | |
| F6/ ENUMERADO | ENTERO SIN SIGNO 16 BIT – **ENUMERADO – BAUDIOS** | 1 | 300 |
| | | 2 | 600 |
| | | 4 | 1200 |
| | | 8 | 2400 |
| | | 13 | 4800 |
| | | 32 | 9600 |
| | | 64 | 19200 |
| | ENTERO SIN SIGNO 16 BIT – **ENUMERADO – TIPO CURVA** | 1 | INVERSE |
| | | 2 | VERY INVERSE |
| | | 4 | EXTREMELY INVERSE |
| | | 8 | DEFINITE TIME |
| | | 16 | USER CURVE |
| | ENTERO SIN SIGNO 16 BIT – **ENUMERADO – ADDRESS** | 1 | NO |
| | | 2 | 67N1 |
| | | 4 | 67N2 |
| | ENTERO SIN SIGNO 16 BIT – **ENUMERADO – 67N POLARIZING** | 1 | Voltage |
| | | 2 | Current |
| | | 4 | Current or Voltage |
| | | 8 | Current and Voltage |
| | ENTERO SIN SIGNO 16 BIT – **ENUM. – 67N SENTIDO DIRECC.** | 1 | No |
| | | 2 | Forward |
| | | 4 | Reverse |

| FORMAT | DESCRIPTION | VALUE | VALUETEXT |
|---|---|---|---|
| F12 | ENTERO CON SIGNO 16 BIT | | |

***ANSI/IEEE Std 754-1985 IEEE Standard for Binary Floating-Point Arithmetic as Single format.***

The equation defined by the standard is

$$\textbf{Decimal VALUE} = (-1)^{s} * 2^{e-127} * 1.m$$

In order to obtain s, e and m, we must proceed as in the following example:

If the data read from the memory is: 33 F3 C7 42.

1º - Place the data with the MSB in the beginning and the LSB in the end (turn it around): 42 C7 F3 33
2º - Convert the number to binary:
0100 0010 1100 0111 1111 0011 0011 0011
3º - The first bit is ***s***. In this case **s**=0
4º - The next 8 bits are ***e***. In this case **e**=133
5º - The rest of bits are ***m***. In this case **m**=100 0111 1111 0011 0011 0011 (in decimal approx. 0.565)

(The bit weights to calculate **m** are 0.5; 0.25; 0.125; 0.0625; 0.03125; 0.015625; 0.0078125 ....)

Therefore **Decimal value = $(-1)^{0} * 2^{133-127} * 1.565 =$ 100.16 Amps**

## MODEL E MAP

| MEM. | BIT | LENGTH | NAME | FORMAT | | TYPE |
|---|---|---|---|---|---|---|
| 0134 | | 16 | IDENTIFICATION | ARRAY BYTES | RW | GENERAL ADVANCED SETTINGS |
| 0144 | | 4 | T. MIN. TRIP | FLOAT32(INTEL) | RW | GENERAL ADVANCED SETTINGS |
| 0148 | 0 | 2 | ACTIVE TABLE | BIT | RW | GENERAL ADVANCED SETTINGS |
| 014A | 0 | 2 | RELAY STATUS | BIT | RW | GENERAL SETTINGS |
| 014A | 1 | 2 | FREQUENCY | BIT | RW | GENERAL SETTINGS |
| 014C | 1 | 2 | TRANSFORMER SELEC 1/5 A | BIT | RW | GENERAL SETTINGS |
| 0150 | 0 | 2 | Enable 50NH | BIT | RW | Function 50NH |
| 0150 | 1 | 2 | Enable 50NL | BIT | RW | Function 50NL |
| 0150 | 2 | 2 | Enable 51NH | BIT | RW | Function 51NH |
| 0150 | 3 | 2 | Enable 51NL | BIT | RW | Function 51NL |
| 0152 | 0 | 2 | Trip 50NH | BIT | RW | Function 50NH |
| 0152 | 1 | 2 | Trip 50NL | BIT | RW | Function 50NL |
| 0152 | 2 | 2 | Trip 51NH | BIT | RW | Function 51NH |
| 0152 | 3 | 2 | Trip 51NL | BIT | RW | Function 51NL |
| 0154 | 11 | 2 | Directional permission 50NH | ENUMERADO | RW | Function 50NH |
| 0156 | 0 | 2 | Polarization loss 50NH | BIT | RW | Function 50NH |
| 0158 | | 4 | Pickup 50NH | FLOAT32(INTEL) | RW | Function 50NH |
| 015C | | 4 | Time 50NH | FLOAT32(INTEL) | RW | Function 50NH |
| 0160 | | 2 | Directional permission 50NL | ENUMERADO | RW | Function 50NL |
| 0162 | 0 | 2 | Polarization loss 50NL | BIT | RW | Function 50NL |
| 0164 | | 4 | Pickup 50NL | FLOAT32(INTEL) | RW | Function 50NL |
| 0168 | | 4 | Time 50NL | FLOAT32(INTEL) | RW | Function 50NL |
| 016C | | 2 | Directional permission 51NH | ENUMERADO | RW | Function 51NH |
| 016E | 0 | 2 | Polarization loss 51NH | BIT | RW | Function 51NH |
| 0170 | | 4 | Pickup 51NH | FLOAT32(INTEL) | RW | Function 51NH |
| 0174 | | 2 | Curve 51NH | ENUMERADO | RW | Function 51NH |
| 0176 | | 4 | Dial 51NH | FLOAT32(INTEL) | RW | Function 51NH |
| 017A | | 4 | Time 51NH | FLOAT32(INTEL) | RW | Function 51NH |
| 017E | | 2 | Directional permission 51NL | ENUMERADO | RW | Function 51NL |
| 0180 | 0 | 2 | Polarization loss 51NL | BIT | RW | Function 51NL |
| 0182 | | 4 | Pickup 51NL | FLOAT32(INTEL) | RW | Function 51NL |
| 0186 | | 2 | Curve 51NL | ENUMERADO | RW | Function 51NL |
| 0188 | | 4 | Dial 51NL | FLOAT32(INTEL) | RW | Function 51NL |
| 018C | | 4 | Time 51NL | FLOAT32(INTEL) | RW | Function 51NL |
| 0190 | | 4 | Characteristic angle 67N1 | FLOAT32(INTEL) | RW | Function 67N1 |
| 0194 | 0 | 2 | Direction 67N1 | BIT | RW | Function 67N1 |
| 0196 | | 2 | Polarization 67N1 | ENUMERADO | RW | Function 67N1 |
| 0198 | | 4 | Characteristic angle 67N2 | FLOAT32(INTEL) | RW | Function 67N2 |
| 019C | 0 | 2 | Direction 67N2 | BIT | RW | Function 67N2 |
| 019E | | 2 | Polarization 67N2 | ENUMERADO | RW | Function 67N2 |
| 0214 | 0 | 2 | Enable 50NH T2 | BIT | RW | Function 50NH T2 |
| 0214 | 1 | 2 | Enable 50NL T2 | BIT | RW | Function 50NL T2 |
| 0214 | 2 | 2 | Enable 51NH T2 | BIT | RW | Function 51NH T2 |
| 0214 | 3 | 2 | Enable 51NL T2 | BIT | RW | Function 51NL T2 |
| 0216 | 0 | 2 | Trip 50NH T2 | BIT | RW | Function 50NH T2 |

| MEM. | BIT | LENGTH | NAME | FORMAT | | TYPE |
|---|---|---|---|---|---|---|
| 0216 | 1 | 2 | Trip 50NL T2 | BIT | RW | Function 50NL T2 |
| 0216 | 2 | 2 | Trip 51NH T2 | BIT | RW | Function 51NH T2 |
| 0216 | 3 | 2 | Trip 51NL T2 | BIT | RW | Function 51NL T2 |
| 0218 | 11 | 2 | Directional permission 50NH T2 | ENUMERADO | RW | Function 50NH T2 |
| 021A | 0 | 2 | Polarization loss 50NH T2 | BIT | RW | Function 50NH T2 |
| 021C | | 4 | Pickup 50NH T2 | FLOAT32(INTEL) | RW | Function 50NH T2 |
| 0220 | | 4 | Time 50NH T2 | FLOAT32(INTEL) | RW | Function 50NH T2 |
| 0224 | | 2 | Directional permission 50NL T2 | ENUMERADO | RW | Function 50NL T2 |
| 0226 | 0 | 2 | Polarization loss 50NL T2 | BIT | RW | Function 50NL T2 |
| 0228 | | 4 | Pickup 50NL T2 | FLOAT32(INTEL) | RW | Function 50NL T2 |
| 022C | | 4 | Time 50NL T2 | FLOAT32(INTEL) | RW | Function 50NL T2 |
| 0230 | | 2 | Directional permission 51NH T2 | ENUMERADO | RW | Function 51NH T2 |
| 0232 | 0 | 2 | Polarization loss 51NH T2 | BIT | RW | Function 51NH T2 |
| 0234 | | 4 | Pickup 51NH T2 | FLOAT32(INTEL) | RW | Function 51NH T2 |
| 0238 | | 2 | Curve 51NH T2 | ENUMERADO | RW | Function 51NH T2 |
| 023A | | 4 | Dial 51NH T2 | FLOAT32(INTEL) | RW | Function 51NH T2 |
| 023E | | 4 | Time 51NH T2 | FLOAT32(INTEL) | RW | Function 51NH T2 |
| 0242 | | 2 | Directional permission 51NL T2 | ENUMERADO | RW | Function 51NL T2 |
| 0244 | 0 | 2 | Polarization loss 51NL T2 | BIT | RW | Function 51NL T2 |
| 0246 | | 4 | Pickup 51NL T2 | FLOAT32(INTEL) | RW | Function 51NL T2 |
| 024A | | 2 | Curve 51NL T2 | ENUMERADO | RW | Function 51NL T2 |
| 024C | | 4 | Dial 51NL T2 | FLOAT32(INTEL) | RW | Function 51NL T2 |
| 0250 | | 4 | Time 51NL T2 | FLOAT32(INTEL) | RW | Function 51NL T2 |
| 0254 | | 4 | Characteristic angle 67N1 T2 | FLOAT32(INTEL) | RW | Function 67N1 T2 |
| 0258 | 0 | 2 | Direction 67N1 T2 | BIT | RW | Function 67N1 T2 |
| 025A | | 2 | Polarization 67N1 T2 | ENUMERADO | RW | Function 67N1 T2 |
| 025C | | 4 | Characteristic angle 67N2 T2 | FLOAT32(INTEL) | RW | Function 67N2 T2 |
| 0260 | 0 | 2 | Direction 67N2 T2 | BIT | RW | Function 67N2 T2 |
| 0262 | | 2 | Polarization 67N2 T2 | ENUMERADO | RW | Function 67N2 T2 |
| 02D8 | 0 | 4 | A | FLOAT32(INTEL) | RW | USER CURVE |
| 02DC | | 4 | B | FLOAT32(INTEL) | RW | USER CURVE |
| 02E0 | | 4 | P | FLOAT32(INTEL) | RW | USER CURVE |
| 02E4 | | 4 | Q | FLOAT32(INTEL) | RW | USER CURVE |
| 02E8 | | 4 | K | FLOAT32(INTEL) | RW | USER CURVE |
| 02EC | 0 | 2 | Oscillo by comm. | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 1 | 2 | Oscillo by digital input | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 2 | 2 | Oscillo by trip | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 3 | 2 | Oscillo by pickup | BIT | RW | OSCILLOGRAPHY MASK |
| 02EE | 0 | 2 | Trip order by command | BIT | RW | EVENT MASK |
| 02EE | 1 | 2 | Reset latch aux | BIT | RW | EVENT MASK |
| 02EE | 10 | 2 | Breaker close | BIT | RW | EVENT MASK |
| 02F0 | 4 | 2 | Block 67N1 | BIT | RW | EVENT MASK |
| 02F0 | 5 | 2 | Block 67N2 | BIT | RW | EVENT MASK |
| 02F0 | 9 | 2 | Protection status | BIT | RW | EVENT MASK |
| 02F0 | 10 | 2 | Output 1 | BIT | RW | EVENT MASK |

| MEM. | BIT | LENGTH | NAME | FORMAT | | TYPE |
|---|---|---|---|---|---|---|
| 02F0 | 11 | 2 | Output 2 | BIT | RW | EVENT MASK |
| 02F0 | 12 | 2 | Output 3 | BIT | RW | EVENT MASK |
| 02F0 | 13 | 2 | Output 4 | BIT | RW | EVENT MASK |
| 02F0 | 14 | 2 | Digital input 1 | BIT | RW | EVENT MASK |
| 02F0 | 15 | 2 | Digital input 2 | BIT | RW | EVENT MASK |
| 02F2 | 1 | 2 | Setting change inhibit | BIT | RW | EVENT MASK |
| 02F2 | 2 | 2 | Trip order by input | BIT | RW | EVENT MASK |
| 02F2 | 4 | 2 | Breaker 52B | BIT | RW | EVENT MASK |
| 02F2 | 6 | 2 | Table change by digital input | BIT | RW | EVENT MASK |
| 02F2 | 7 | 2 | Osc. Trigger by DI | BIT | RW | EVENT MASK |
| 02F2 | 9 | 2 | Breaker closed | BIT | RW | EVENT MASK |
| 02F2 | 10 | 2 | Osc. Trigger by comm. | BIT | RW | EVENT MASK |
| 02F2 | 13 | 2 | Settings change | BIT | RW | EVENT MASK |
| 02F2 | 14 | 2 | e2prom failure | BIT | RW | EVENT MASK |
| 02F2 | 15 | 2 | User settings | BIT | RW | EVENT MASK |
| 02F4 | 0 | 2 | Pickup 50NH | BIT | RW | EVENT MASK |
| 02F4 | 1 | 2 | Pickup 50NL | BIT | RW | EVENT MASK |
| 02F4 | 2 | 2 | Pickup 51NH | BIT | RW | EVENT MASK |
| 02F4 | 3 | 2 | Pickup 51NL | BIT | RW | EVENT MASK |
| 02F4 | 4 | 2 | Activation 67N2 | BIT | RW | EVENT MASK |
| 02F4 | 4 | 2 | Activation 67N1 | BIT | RW | EVENT MASK |
| 02F6 | 0 | 2 | Inhibition 50NH (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 1 | 2 | Inhibition 50NL (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 2 | 2 | Inhibition 51NH (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 3 | 2 | Inhibition 51NL (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 4 | 2 | Inhibition 67N1 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 5 | 2 | Inhibition 67N2 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 15 | 2 | Trip inhibit (by DI) | BIT | RW | EVENT MASK |
| 02F8 | 0 | 2 | Trip 50NH | BIT | RW | EVENT MASK |
| 02F8 | 1 | 2 | Trip 50NL | BIT | RW | EVENT MASK |
| 02F8 | 2 | 2 | Trip 51NH | BIT | RW | EVENT MASK |
| 02F8 | 3 | 2 | Trip 51NL | BIT | RW | EVENT MASK |
| 02F8 | 15 | 2 | General trip | BIT | RW | EVENT MASK |
| 0570 | | 6 | Date and time | DATE/TIME | RO | STATUS |
| 0576 | | 6 | Version | ARRAY BYTES | RO | STATUS |
| 057C | | 16 | Model | ARRAY BYTES | RO | STATUS |
| 058C | | 16 | Identification | ARRAY BYTES | RO | STATUS |
| 05C0 | 0 | 2 | LED Trip | BIT | RO | STATUS |
| 05C0 | 1 | 2 | READY | BIT | RO | STATUS |
| 05C0 | 2 | 2 | LED 1 | BIT | RO | STATUS |
| 05C0 | 3 | 2 | LED 2 | BIT | RO | STATUS |
| 05C0 | 4 | 2 | LED 3 | BIT | RO | STATUS |
| 05C0 | 5 | 2 | LED 4 | BIT | RO | STATUS |
| 05C0 | 8 | 2 | Logic 1 | BIT | RO | STATUS |
| 05C0 | 9 | 2 | Logic 2 | BIT | RO | STATUS |
| 05C0 | 10 | 2 | Logic 3 | BIT | RO | STATUS |
| 05C0 | 11 | 2 | Logic 4 | BIT | RO | STATUS |
| 05C2 | 4 | 2 | Block 67N1 | BIT | RO | STATUS |
| 05C2 | 5 | 2 | Block 67N2 | BIT | RO | STATUS |

| MEM. | BIT | LENGTH | NAME | FORMAT | | TYPE |
|---|---|---|---|---|---|---|
| 05C2 | 8 | 2 | Trip | BIT | RO | STATUS |
| 05C2 | 9 | 2 | Alarm | BIT | RO | STATUS |
| 05C2 | 10 | 2 | Output 1 | BIT | RO | STATUS |
| 05C2 | 11 | 2 | Output 2 | BIT | RO | STATUS |
| 05C2 | 12 | 2 | Output 3 | BIT | RO | STATUS |
| 05C2 | 13 | 2 | Output 4 | BIT | RO | STATUS |
| 05C2 | 14 | 2 | Input 1 | BIT | RO | STATUS |
| 05C2 | 15 | 2 | Input 2 | BIT | RO | STATUS |
| 05C4 | 1 | 2 | Settings change inhibit | BIT | RO | STATUS |
| 05C4 | 6 | 2 | Table change | BIT | RO | STATUS |
| 05C4 | 9 | 2 | 52 closed | BIT | RO | STATUS |
| 05C4 | 14 | 2 | e2prom failure | BIT | RO | STATUS |
| 05C4 | 15 | 2 | User settings | BIT | RO | STATUS |
| 05C6 | 3 | 2 | Active table | BIT | RO | STATUS |
| 05C6 | 4 | 2 | Frequency | BIT | RO | STATUS |
| 05C6 | 5 | 2 | Local | BIT | RO | STATUS |
| 05D0 | 0 | 2 | Pickup 50NH | BIT | RO | STATUS |
| 05D0 | 1 | 2 | Pickup 50NL | BIT | RO | STATUS |
| 05D0 | 2 | 2 | Pickup 51NH | BIT | RO | STATUS |
| 05D0 | 3 | 2 | Pickup 51NL | BIT | RO | STATUS |
| 05D0 | 4 | 2 | Activation 67N1 | BIT | RO | STATUS |
| 05D0 | 5 | 2 | Activation 67N2 | BIT | RO | STATUS |
| 05D0 | 15 | 2 | General Pickup | BIT | RO | STATUS |
| 05D8 | 0 | 2 | Trip 50NH | BIT | RO | STATUS |
| 05D8 | 1 | 2 | Trip 50NL | BIT | RO | STATUS |
| 05D8 | 2 | 2 | Trip 51NH | BIT | RO | STATUS |
| 05D8 | 3 | 2 | Trip 51NL | BIT | RO | STATUS |
| 05DC | 15 | 4 | In | FLOAT32(INTEL) | RO | STATUS |
| 05E8 | | 4 | Ip | FLOAT32(INTEL) | RO | STATUS |
| 05EC | | 4 | Vn | FLOAT32(INTEL) | RO | STATUS |
| 05F0 | | 4 | Apparent power | FLOAT32(INTEL) | RO | STATUS |
| 05F8 | | 4 | Ang(InVn) | FLOAT32(INTEL) | RO | STATUS |
| 05FC | | 4 | Ang(InIp) | FLOAT32(INTEL) | RO | STATUS |
| 0604 | | 2 | Oscillo number | UINT16(INTEL) | RO | STATUS |
| 0608 | | 2 | Total events | UINT16(INTEL) | RO | STATUS |
| 0636 | | 864 | ALL EVENTS | BUFFER | RW | ALL EVENTS |
| 9C6\|1746\|1758 | | 3456\|18\|16 | OSCILLOGRAPHY | BUFFER | RW | OSCILLOGRAPHY |

## MODEL S MAP

| MEM. | BIT | LONG | NAME | FORMAT | | TIPO |
|---|---|---|---|---|---|---|
| 0134 | | 16 | IDENTIFICATION | ARRAY BYTES | RW | GENERAL ADVANCED SETTINGS |
| 0144 | | 4 | TRIP MIN TIME | FLOAT32(INTEL) | RW | GENERAL ADVANCED SETTINGS |
| 0148 | 0 | 2 | ACTIVE TABLE | BIT | RW | GENERAL ADVANCED SETTINGS |
| 014A | 0 | 2 | RELAY STATUS | BIT | RW | GENERAL SETTINGS |
| 014A | 1 | 2 | FREQUENCY | BIT | RW | GENERAL SETTINGS |
| 014E | 1 | 2 | APPLICATION | BIT | RW | GENERAL SETTINGS |
| 0150 | 8 | 2 | Enable 67IG1 | BIT | RW | Function 67IG1 |
| 0150 | 9 | 2 | Enable 67IG2 | BIT | RW | Function 67IG2 |
| 0150 | 10 | 2 | Enable 67PC1 | BIT | RW | Function 67PC1 |
| 0150 | 11 | 2 | Enable 67PC2 | BIT | RW | Function 67PC2 |
| 0152 | 8 | 2 | Trip 67IG1 | BIT | RW | Function 67IG1 |
| 0152 | 9 | 2 | Trip 67IG2 | BIT | RW | Function 67IG2 |
| 0152 | 10 | 2 | Trip 67PC1 | BIT | RW | Function 67PC1 |
| 0152 | 11 | 2 | Trip 67PC2 | BIT | RW | Function 67PC2 |
| 01A0 | 0 | 4 | Time 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01A4 | | 2 | Direction 67IG1 | ENUMERADO | RW | Function 67IG1 |
| 01A6 | | 4 | Deviation time to instantaneous 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01AA | | 4 | High Voltage 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01AE | | 4 | Low voltage 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01B2 | | 4 | High current 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01B6 | | 4 | Low current 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01BA | | 4 | Characteristic angle 67IG1 | FLOAT32(INTEL) | RW | Function 67IG1 |
| 01BE | | 4 | Time 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01C2 | | 2 | Direction 67IG2 | ENUMERADO | RW | Function 67IG2 |
| 01C4 | | 4 | Deviation time to instantaneous 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01C8 | | 4 | High voltage 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01CC | | 4 | Low voltage 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01D0 | | 4 | High current 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01D4 | | 4 | Low current 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01D8 | | 4 | Characteristic angle 67IG2 | FLOAT32(INTEL) | RW | Function 67IG2 |
| 01DC | 0 | 2 | POWER 67PC1 | BIT | RW | Function 67PC1 |
| 01DE | | 4 | Time 67PC1 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01E2 | | 2 | Direction 67PC1 | ENUMERADO | RW | Function 67PC1 |
| 01E4 | | 4 | Pickup voltage 67PC1 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01E8 | | 4 | Pickup current 67PC1 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01EC | | 4 | Characteristic angle 67PC1 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01F0 | | 4 | Opening cone 67PC1 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01F4 | | 4 | Pow 67PC2 | FLOAT32(INTEL) | RW | Function 67PC1 |
| 01F8 | 0 | 2 | POWER 67PC2 | BIT | RW | Function 67PC2 |
| 01FA | | 4 | Time 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |
| 01FE | | 2 | Direction 67PC2 | ENUMERADO | RW | Function 67PC2 |
| 0200 | | 4 | Pickup voltage 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |
| 0204 | | 4 | Pickup current 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |
| 0208 | | 4 | Characteristic angle 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |
| 020C | | 4 | Opening cone 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |

| MEM. | BIT | LONG | NAME | FORMAT | | TIPO |
|---|---|---|---|---|---|---|
| 0210 | | 4 | Power 67PC2 | FLOAT32(INTEL) | RW | Function 67PC2 |
| 0214 | 8 | 2 | Enable 67IG1 T2 | BIT | RW | Function 67IG1 T2 |
| 0214 | 9 | 2 | Enable 67IG2 T2 | BIT | RW | Function 67IG2 T2 |
| 0214 | 10 | 2 | Enable 67PC1 T2 | BIT | RW | Function 67PC1 T2 |
| 0214 | 11 | 2 | Enable 67PC2 T2 | BIT | RW | Function 67PC2 T2 |
| 0216 | 8 | 2 | Trip 67IG1 T2 | BIT | RW | Function 67IG1 T2 |
| 0216 | 9 | 2 | Trip 67IG2 T2 | BIT | RW | Function 67IG2 T2 |
| 0216 | 10 | 2 | Trip 67PC1 T2 | BIT | RW | Function 67PC1 T2 |
| 0216 | 11 | 2 | Trip 67PC2 T2 | BIT | RW | Function 67PC2 T2 |
| 0264 | 0 | 4 | Time 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 0268 | | 2 | Direction 67IG1 T2 | ENUMERADO | RW | Function 67IG1 T2 |
| 026A | | 4 | Deviation time to instantaneous 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 026E | | 4 | High voltage 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 0272 | | 4 | Low voltage 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 0276 | | 4 | High current 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 027A | | 4 | Low current 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 027E | | 4 | Characteristic angle 67IG1 T2 | FLOAT32(INTEL) | RW | Function 67IG1 T2 |
| 0282 | | 4 | Time 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 0286 | | 2 | Direction 67IG2 T2 | ENUMERADO | RW | Function 67IG2 T2 |
| 0288 | | 4 | Deviation time to instantaneous 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 028C | | 4 | High voltage 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 0290 | | 4 | Low voltage 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 0294 | | 4 | High current 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 0298 | | 4 | Low current 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 029C | | 4 | Characteristic angle 67IG2 T2 | FLOAT32(INTEL) | RW | Function 67IG2 T2 |
| 02A0 | 0 | 2 | POWER 67PC1T2 | BIT | RW | Function 67PC1 T2 |
| 02A2 | | 4 | Time 67PC1 T2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02A6 | | 2 | Direction 67PC1 T2 | ENUMERADO | RW | Function 67PC1 T2 |
| 02A8 | | 4 | Pickup voltage 67PC1 T2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02AC | | 4 | Pickup current 67PC1 T2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02B0 | | 4 | Characteristic angle 67PC1 T2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02B4 | | 4 | Opening cone 67PC1 T2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02B8 | | 4 | Power 67PC2 | FLOAT32(INTEL) | RW | Function 67PC1 T2 |
| 02BC | 0 | 2 | POWER 67PC2T2 | BIT | RW | Function 67PC2 T2 |
| 02BE | | 4 | Time 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02C2 | | 2 | Direction 67PC2 T2 | ENUMERADO | RW | Function 67PC2 T2 |
| 02C4 | | 4 | Pickup voltage 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02C8 | | 4 | Pickup current 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02CC | | 4 | Characteristic angle 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02D0 | | 4 | Opening cone 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02D4 | | 4 | Power 67PC2 T2 | FLOAT32(INTEL) | RW | Function 67PC2 T2 |
| 02D8 | | 4 | A | FLOAT32(INTEL) | RW | USER CURVE |
| 02DC | | 4 | B | FLOAT32(INTEL) | RW | USER CURVE |
| 02E0 | | 4 | P | FLOAT32(INTEL) | RW | USER CURVE |
| 02E4 | | 4 | Q | FLOAT32(INTEL) | RW | USER CURVE |
| 02E8 | | 4 | K | FLOAT32(INTEL) | RW | USER CURVE |

| MEM. | BIT | LONG | NAME | FORMAT | | TIPO |
|---|---|---|---|---|---|---|
| 02EC | 0 | 2 | Oscillo by comm. | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 1 | 2 | Oscillo by digital input | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 2 | 2 | Oscillo by trip | BIT | RW | OSCILLOGRAPHY MASK |
| 02EC | 3 | 2 | oscillo by pickup | BIT | RW | OSCILLOGRAPHY MASK |
| 02EE | 0 | 2 | Trip order by COMMAND | BIT | RW | EVENT MASK |
| 02EE | 1 | 2 | Reset latch aux | BIT | RW | EVENT MASK |
| 02EE | 10 | 2 | Breaker close | BIT | RW | EVENT MASK |
| 02F0 | 9 | 2 | Protection status | BIT | RW | EVENT MASK |
| 02F0 | 10 | 2 | Output 1 | BIT | RW | EVENT MASK |
| 02F0 | 11 | 2 | Output 2 | BIT | RW | EVENT MASK |
| 02F0 | 12 | 2 | Output 3 | BIT | RW | EVENT MASK |
| 02F0 | 13 | 2 | Output 4 | BIT | RW | EVENT MASK |
| 02F0 | 14 | 2 | Digital input 1 | BIT | RW | EVENT MASK |
| 02F0 | 15 | 2 | Digital input 2 | BIT | RW | EVENT MASK |
| 02F2 | 1 | 2 | Settings change inhibit | BIT | RW | EVENT MASK |
| 02F2 | 2 | 2 | Trip order by input | BIT | RW | EVENT MASK |
| 02F2 | 4 | 2 | Breaker 52B | BIT | RW | EVENT MASK |
| 02F2 | 6 | 2 | Table change by digital input | BIT | RW | EVENT MASK |
| 02F2 | 7 | 2 | Osc. trigger by DI | BIT | RW | EVENT MASK |
| 02F2 | 9 | 2 | Breaker closed | BIT | RW | EVENT MASK |
| 02F2 | 10 | 2 | Osc. Trigger by comm. | BIT | RW | EVENT MASK |
| 02F2 | 13 | 2 | Settings change | BIT | RW | EVENT MASK |
| 02F2 | 14 | 2 | e2prom failure | BIT | RW | EVENT MASK |
| 02F2 | 15 | 2 | User settings | BIT | RW | EVENT MASK |
| 02F4 | 8 | 2 | Pickup 67IG1 | BIT | RW | EVENT MASK |
| 02F4 | 9 | 2 | Pickup 67IG2 | BIT | RW | EVENT MASK |
| 02F4 | 10 | 2 | Pickup 67PC1 | BIT | RW | EVENT MASK |
| 02F4 | 11 | 2 | Pickup 67PC2 | BIT | RW | EVENT MASK |
| 02F6 | 8 | 2 | Inhibition 67IG1 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 9 | 2 | Inhibition 67IG2 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 10 | 2 | Inhibition 67PC1 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 11 | 2 | Inhibition 67PC2 (by DI) | BIT | RW | EVENT MASK |
| 02F6 | 15 | 2 | Trip inhibition (by DI) | BIT | RW | EVENT MASK |
| 02F8 | 8 | 2 | Trip 67IG1 | BIT | RW | EVENT MASK |
| 02F8 | 9 | 2 | Trip 67IG2 | BIT | RW | EVENT MASK |
| 02F8 | 10 | 2 | Trip 67PC1 | BIT | RW | EVENT MASK |
| 02F8 | 11 | 2 | Trip 67PC2 | BIT | RW | EVENT MASK |
| 02F8 | 15 | 2 | General trip | BIT | RW | EVENT MASK |
| 0570 | | 6 | Date and time | DATE/TIME | RO | STATUS |
| 0576 | | 6 | Version | ARRAY BYTES | RO | STATUS |
| 057C | | 16 | Model | ARRAY BYTES | RO | STATUS |
| 058C | | 16 | Identification | ARRAY BYTES | RO | STATUS |
| 05C0 | 0 | 2 | LED Trip | BIT | RO | STATUS |
| 05C0 | 1 | 2 | READY | BIT | RO | STATUS |
| 05C0 | 2 | 2 | LED 1 | BIT | RO | STATUS |
| 05C0 | 3 | 2 | LED 2 | BIT | RO | STATUS |
| 05C0 | 4 | 2 | LED 3 | BIT | RO | STATUS |
| 05C0 | 5 | 2 | LED 4 | BIT | RO | STATUS |
| 05C0 | 8 | 2 | Logic 1 | BIT | RO | STATUS |

| MEM. | BIT | LONG | NAME | FORMAT | | TIPO |
|---|---|---|---|---|---|---|
| 05C0 | 9 | 2 | Logic 2 | BIT | RO | STATUS |
| 05C0 | 10 | 2 | Logic 3 | BIT | RO | STATUS |
| 05C0 | 11 | 2 | Logic 4 | BIT | RO | STATUS |
| 05C2 | 8 | 2 | Trip | BIT | RO | STATUS |
| 05C2 | 9 | 2 | Alarm | BIT | RO | STATUS |
| 05C2 | 10 | 2 | Output 1 | BIT | RO | STATUS |
| 05C2 | 11 | 2 | Output 2 | BIT | RO | STATUS |
| 05C2 | 12 | 2 | Output 3 | BIT | RO | STATUS |
| 05C2 | 13 | 2 | Output 4 | BIT | RO | STATUS |
| 05C2 | 14 | 2 | Input 1 | BIT | RO | STATUS |
| 05C2 | 15 | 2 | Input 2 | BIT | RO | STATUS |
| 05C4 | 1 | 2 | Settings change inhibit | BIT | RO | STATUS |
| 05C4 | 6 | 2 | Table change | BIT | RO | STATUS |
| 05C4 | 9 | 2 | 52 Closed | BIT | RO | STATUS |
| 05C4 | 14 | 2 | e2prom failure | BIT | RO | STATUS |
| 05C4 | 15 | 2 | User settings | BIT | RO | STATUS |
| 05C6 | 3 | 2 | Active table | BIT | RO | STATUS |
| 05C6 | 4 | 2 | Frequency | BIT | RO | STATUS |
| 05C6 | 5 | 2 | Local | BIT | RO | STATUS |
| 05D0 | 8 | 2 | Pickup 67IG1 | BIT | RO | STATUS |
| 05D0 | 9 | 2 | Pickup 67IG2 | BIT | RO | STATUS |
| 05D0 | 10 | 2 | Pickup 67PC1 | BIT | RO | STATUS |
| 05D0 | 11 | 2 | Pickup 67PC2 | BIT | RO | STATUS |
| 05D0 | 15 | 2 | Pickup General | BIT | RO | STATUS |
| 05D8 | 8 | 2 | Trip 67IG1 | BIT | RO | STATUS |
| 05D8 | 9 | 2 | Trip 67IG2 | BIT | RO | STATUS |
| 05D8 | 10 | 2 | Trip 67PC1 | BIT | RO | STATUS |
| 05D8 | 11 | 2 | Trip 67PC2 | BIT | RO | STATUS |
| 05DC | 15 | 4 | In | FLOAT32(INTEL) | RO | STATUS |
| 05EC | | 4 | Vn | FLOAT32(INTEL) | RO | STATUS |
| 05F4 | | 4 | Active power | FLOAT32(INTEL) | RO | STATUS |
| 05F8 | | 4 | Ang(InVn) | FLOAT32(INTEL) | RO | STATUS |
| 0604 | | 2 | Oscillo number | UINT16(INTEL) | RO | STATUS |
| 0608 | | 2 | Total events | UINT16(INTEL) | RO | STATUS |
| 0632 | | 864 | ALL EVENTS | BUFFER | RW | ALL EVENTS |
| 9C2\|1742\|1754 | | 3456\|18\|16 | OSCILLOGRAPHY | BUFFER | RW | OSCILOGRAFIA |