GE Power Management

Digital Feeder Protection for Single-phase or Ground Applications

MIF N

Instructions
GEK-106298A

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: _____

_____

_____

_____

_____

Local HMI menu map:

DEFAULT SCROLLING MENU: Ia, Ib, Ic, IN, TH — MENU — ENTER

INFORMATION	MAIN SETTINGS		ADV. SETTINGS		OPERATIONS	DATE/TIME
I	GENERAL	STATUS	GEN	TAB	RESET	
TH		FRQ		TRIP MIN TIME	RST THERMAL	
DATE / TIME		PWD	F 51 T2	TRIP 51 T2	ACT TABLE 1	
LT UNIT		ADD		TAP 51 T2	ACT TABLE 2	
LT DATE/TIME		BAUD		CURV 51 T2	OPEN BREAKER	
RESET	F 51	TRIP 51		DIAL 51 T2	RST OPENINGS	
		TAP 51		TIME 51 T2	RST I2T	
INP1		CURV 51	F50H T2	TRIP 50H T2		
INP2		DIAL 51		TAP 50H T2		
OUT1		TIME 51		TIME 5PH T2		
OUT2	F 50H	TRIP 50H	F50L T2	TRIP 50L T2		
OUT3		TAP 50H		TAP 50L T2		
OUT4		TIME 50H		TIME 50L T2		
COLD LOAD	F 50L	TRIP 50L	F 49 T2	TRIP 49 T2		
B52A		TAP 50L		TAP 49 T2		
B52B		TIME 50L		ALARM 49 T2		
BF ACTIVE		TRIP 49		T1 T2		
I^2 ALARM	F 49	TAP 49		T2 T2		
I^2 VALUE		ALARM 49	CURV	A		
OPENINGS		T1		B		
		T2		P		
				Q		
				K		
			I^2	I^2 MAX		
			CLP	CLP ENABLE		
				T IN		
				T OUT		
				K 50P		
				K 51P		
			BF	BF ENABLE		
				BF TIME		

NOTE:
The map lines are crossed as follows:

→ Enter
← Escape

→ +
← -

The RESET operation can be performed by pressing the ENTER key during 3 seconds.

MIF Curve Parameters:

IEC CURVES

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

	A	P	Q	B	K
Inverse - C	80	2	1	0	0
Very inverse- B	13.5	1	1	0	0
Extrem. inverse - A	0.14	0.02	1	0	0

D = dial ; V= I / Itap

ANSI CURVES

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

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

M = dial ; V= I / Itap

Input configuration signals:

NOT ASSIGNED
INHIB 50L
CLOSE TRIP CONTACT (P)
RESET LEDS (P)
BREAKER 52A *(only option 2)*
INHIB 50H
INHIB 49
TABLE CHANGE
ACTIV. OSCILLO (P)
BREAKER 52B *(only option 2)*
INHIB 51
INHIB TRIP
INHIB. SETTING CHANGE
GENERAL INPUT

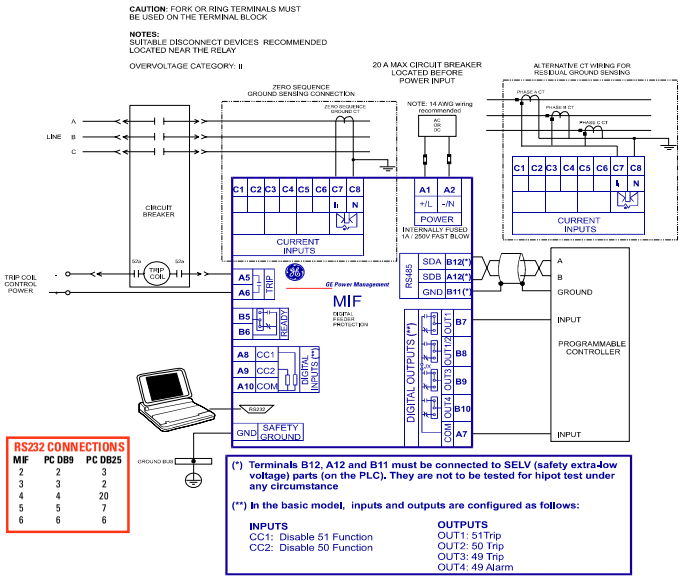
***NOTE**: (P) stands for Pulse activation*

Output configuration signals:

NO DEFINITION
LOGIC 1 *(only option 2)*
LOGIC 2 *(only option 2)*
LOGIC 3 *(only option 2)*
LOGIC 4 *(only option 2)*
50 TRIP
50H TRIP
50L TRIP
51 TRIP
49 TRIP
GENERAL TRIP
50H PICKUP
50L PICKUP
51 PICKUP
49 ALARM
PICKUP
50H VIRTUAL TRIP
50L VIRTUAL TRIP
51 VIRTUAL TRIP
49 VIRTUAL TRIP
GENERAL VIRTUAL TRIP
INPUT 1
INPUT 2
BREAKER 52 STATUS
BREAKER FAILURE *(only option 2)*
I2 ALARM *(only option 2)*
COLD LOAD PICKUP *(only option 2)*
READY
ACTIVE TABLE
E2PROM FAILURE
LOCAL/REMOTE
USER SETTINGS

***NOTE:** Virtual Trip: Trip not affected by inhibitions.*

External Connections:



GE Power Management

MIF N

Digital Feeder Protection
Quick Reference Guide

Getting Started:

- ■□ Power the device at its rated voltage shown on the faceplate. The READY LED will remain switched off, showing that the unit is not yet in service.
- ■□ Connect the unit to a computer using a direct wire (without crossing transmission-reception).
- ■□ Install M+PC software.
- ■□ Once installed, run the software. The default password for entering M+PC is **7169**. Leave the UserName field blank.
- ■□ In case of using a communications port different from COM1 in the computer, click on the OPTIONS menu and enter the port that is being used.
- ■□ Click on RELAY CONNECTION. Enter **1** as address (unit number) and **1** as password.
- ■□ Set the MIF with the desired settings of the different protection units.
- ■□ Finally, put the unit in service, by setting the RELAY STATUS setting in GENERAL SETTINGS as RDY (ready).

After completing these steps, the READY LED will turn on showing that the unit is in service.

For complete information about the MIF N, please refer to instruction manual GEK-106298 (English) or GEK-106299 (Spanish).

TECHNICAL SUPPORT:

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

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E-mail: info.pm@indsys.ge.com
www.geindustrial.com/pm

SETTINGS:

MAIN SETTINGS / ADVANCED SETTINGS

DESCRIPTION		HMI	DEFAULT	RANGE
GENERAL SETTINGS		GENERAL		
RELAY STATUS		STA	DIS	RDY-DIS
FREQUENCY		FRQ	50	50 - 60 Hz
PASSWORD		PWD	1	1 - 255
ADDRESS		ADD	1	1 - 255
BAUDRATE		BAUD	9.6	0.3 - 19.2
FUNCTION 51		F51P		
TRIP 51		TRIP 51	NO	YES - NO
PICKUP 51 (Ground 1/5 A)		TAP 51	0.5	0.1 - 2.4 x In
PICKUP 51 (Sensitive ground)		TAP 51	0.005	0.005 - 0.12 A
CURVE 51		CURV 51	TDE	INV, VI, EI, TDE, USU
DIAL 51 (IEC)		DIAL 51	0.5	0.05-2.00
DIAL 51 (ANSI)		DIAL 51	5.00	0.5-20.0
DEFINITE TIME 51		TIME 51	1	0 - 99.99 s.
FUNCTION 50H		F50H		
TRIP 50H		TRIP 50H	NO	YES - NO
PICKUP 50H (Ground 1/5 A)		TAP 50H	1	0.1 - 30 x In
PICKUP 50H (Sensitive ground)		TAP 50H	0.005 A	0.005 - 1.5 A
TIME 50H		TIME 50H	0	0 - 99.99 s.
FUNCTION 50L		F50L		
TRIP 50L		TRIP 50L	NO	YES - NO
PICKUP 50L (Ground 1/5 A)		TAP 50L	1	0.1 - 30 x In
PICKUP 50L (Sensitive ground)		TAP 50H	0.005 A	0.005 - 1.5 A
TIME 50L		TIME 50L	0	0 - 99.99 s.
FUNCTION 49		F49		
TRIP 49		TRIP 49	NO	YES -NO
PICKUP 49		TAP 49	1.00	0.1 - 2.4 x In
ALARM LEVEL 49		ALARM 49	80%	70%-100%
HEATING CONSTANT		T1	6	3 - 600 min.
COOLING CONSTANT		T2	1	1 - 6 times T1
GENERAL ADVANCED SETTINGS		GENERAL ADV.		
IDENTIFICATION			MIF	
ACTIVE TABLE		TAB	1	1 - 2
TRIP MINIMUM TIME		TRIP MIN TIME	100	50 - 300 ms.
FUNCTION 51	TABLE 2	F51 T2		
TRIP 51	TABLE 2	TRIP 51 T2	NO	YES - NO
PICKUP 51 (Ground 1/5 A)	TABLE 2	TAP 51 T2	0.5	0.1 - 2.4 x In
PICKUP 51 (Sens. ground)	TABLE 2	TAP 51 T2	0.005	0.005 - 1.5 A
CURVE 51	TABLE 2	CURVE 51 T2	TDE	INV, VI, EI, TDE, USU
DIAL 51 (IEC)	TABLE 2	DIAL 51 T2	0.5	0.05-2.00
DIAL 51 (ANSI)	TABLE 2	DIAL 51 T2	5.00	0.5-20.0
DEFINITE TIME 51	TABLE 2	TIME 51 T2	1	0 - 99.99 s.
FUNCTION 50H	TABLE 2	F50H T2		
TRIP 50H	TABLE 2	TRIP 50H T2	NO	YES - NO
PICKUP 50H (Ground 1/5 A)	TABLE 2	TAP 50H T2	1	0.1 - 30 x In
PICKUP 50H (Sens. ground)	TABLE 2	TAP 50H T2	0.005	0.005-1.5 A
TIME 50H	TABLE 2	TIME 50H T2	0	0 - 99.99 s.
FUNCTION 50L	TABLE 2	F50L T2		
TRIP 50L	TABLE 2	TRIP 50L T2	NO	YES - NO
PICKUP 50L (Ground 1/5 A)	TABLE 2	TAP 50L T2	1	0.1 - 30 x In
PICKUP 50L (Sens. ground)	TABLE 2	TAP 50H T2	0.005	0.005-1.5 A
TIME 50L	TABLE 2	TIME 50L T2	0	0 - 99.99 s.
FUNCTION 49	TABLE 2	F49 T2		
TRIP 49	TABLE 2	TRIP 49 T2	NO	YES -NO
PICKUP 49	TABLE 2	TAP 49 T2	1.00	0.1 - 2.4 x In
ALARM LEVEL 49	TABLE 2	ALARM 49 T2	80.0%	70%-100%
HEATING CONSTANT	TABLE 2	T1 T2	6	3 - 600 min
COOLING CONSTANT	TABLE 2	T2 T2	6	1 - 6 timesT1

SETTINGS FOR OPTION 1 OR 2 ONLY / OPTION 2 ONLY

DESCRIPTION	HMI	DEFAULT	RANGE
USER CURVE	CURV		
A $T = \frac{A*D}{V^P - Q} + B*D + K$	A	0.05	0 - 125
B	B	0	0 - 3
P *D: Dial*	P	0.04	0 - 3
Q *V: I/I tap*	Q	1	0 - 2
K	K	0	0 - 1.999
EVENT MASKS			
PICKUP 50H		YES	YES- NO
PICKUP 51		YES	YES- NO
PICKUP 50L		YES	YES- NO
ALARM 49		YES	YES - NO
INHIBIT 50H		YES	YES - NO
INHIBIT 50L		YES	YES - NO
INHIBIT 51		YES	YES - NO
INHIBIT 49		YES	YES - NO
INHIBIT TRIP		YES	YES - NO
TRIP 50H		YES	YES - NO
TRIP 51		YES	YES - NO
TRIP 50L		YES	YES - NO
TRIP 49		YES	YES - NO
GENERAL TRIP		YES	YES - NO
PROTECTION STATUS		YES	YES - NO
OUTPUT 1		YES	YES - NO
OUTPUT 2		YES	YES - NO
OUTPUT 3		YES	YES - NO
OUTPUT 4		YES	YES - NO
DIGITAL INPUT 1		YES	YES - NO
DIGITAL INPUT 2		YES	YES - NO
INHIB. SETTING CHANGE		YES	YES - NO
TRIP COMMAND BY INPUT		YES	YES - NO
TRIP COMMAND BY COMMUNICATIONS		YES	YES - NO
RESET OUTPUTS		YES	YES - NO
TABLE CHANGE		YES	YES - NO
ACT. OSCILLO BY DIGITAL INPUT		YES	YES - NO
ACT. OSCILLO BY COMMUNICATIONS		YES	YES - NO
COLD LOAD PICKUP		YES	YES - NO
BREAKER 52A		YES	YES - NO
BREAKER 52B		YES	YES - NO
BREAKER STATUS		YES	YES - NO
FAILURE TO OPEN		YES	YES - NO
ALARM I2		YES	YES - NO
SETTINGS CHANGE		YES	YES - NO
E2PROM FAILURE		YES	YES - NO
USER SETTINGS		YES	YES - NO
OSCILLOGRAPHY MASKS			
OSCILLO BY COMMUNICATIONS		NO	YES - NO
OSCILLO BY DIGITAL INPUT		NO	YES - NO
OSCILLO BY TRIP		NO	YES - NO
OSCILLO BY PICKUP		NO	YES - NO
52 MAINTENANCE	I 2		
MAXIMUM LIMIT	I 2 MAX	999	0 - 999 KA2
COLD LOAD PICKUP	CLP		
FUNC. COLD LOAD PICKUP	CLP ENABLE	NO	YES - NO
CHANGE TO COLD LOAD TIME	T IN	2	0 - 60 s.
BACK TO NORMAL LOAD TIME	T OUT	2	0 - 60 s.
50P PICKUP MULTIPLIER	K 50P	1	1 - 5
51P PICKUP MULTIPLIER	K 51P	1	1 - 5
BREAKER FAILURE TO OPEN	BF		
FAILURE TO OPEN ENABLE	BF ENABLE	NO	YES - NO
FAILURE TO OPEN TIME	BF TIME	400	50 - 999 ms.

MODEL LIST

MIF N * 0 * E *00 * 00 *

N	Single phase or ground relay
A	ANSI curves
I	IEC curves
1	Ground CT In = 1 A (0.1-2.4 A)
5	Ground CT In = 5 A (0.5-12 A)
N	Sensitive ground: CT In = 1 A (0.005-0.12 A)
0	No options, basic unit
1	Option 1 (see page 2 for details)*
2	Option 2 (see page 2 for details)**
F	24-48 VDC (Range: 19~58 Vdc) Power Supply
H	110-250 VDC (Range: 88~300 Vdc) Power Supply 120-230 VAC (Range: 88~264 Vac) Power Supply
C	Individual relay
S	Mounted in an M+ system ***

* Configurable I/O/LEDs, event recording, oscillography

** Option 1 + cold load pickup, breaker failure to open, breaker health, configurable logic

*** If relays are to be mounted in an M+ system, then either an M050 half 19'' rack or M100 full 19'' rack case must be ordered. The M050 and M100 racks are provided at no additional cost based on the number of relays ordered.

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TABLE OF CONTENTS

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 model ordered.
- 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.

GE Power Management contact information:

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Avda. Pinoa, 10
48170 Zamudio, Vizcaya (Spain)
Phone: +34 94-485 88 00, Fax: +34 94-485 88 45
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215, Anderson Avenue
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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:

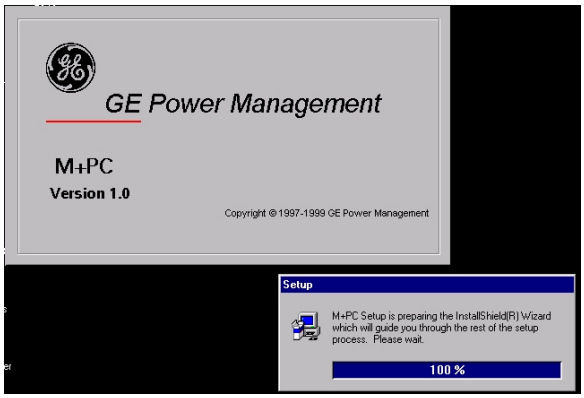
Processor:	Intel® Pentium recommended
Memory:	16 Mb minimum
Hard Drive:	10 Mb free space required before installation of M+PC software
O/S:	Windows® 95, Windows® 98 or Windows® NT 4.0, SP 3 or higher.
Hardware:	CD-ROM drive or 3,5" Floppy disk drive.
	Unused communications port (i.e. COM1)

1.2.2. SOFTWARE INSTALLATION

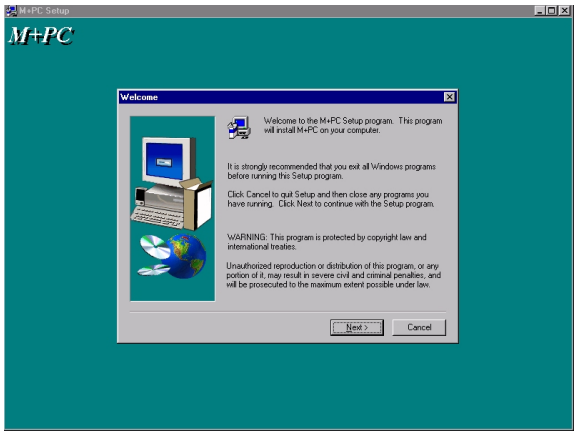
Refer to the following instructions to install the M+PC software:

1. Start the **Windows**® program.
2. Insert the M+PC software CD (or Floppy disk) into the CD ROM drive (or Floppy disk 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) or a:\SETUP.EXE if you are using the floppy disk drive (assuming your Floppy disk drive is configured as the 'A:' unit) and press **Enter.**

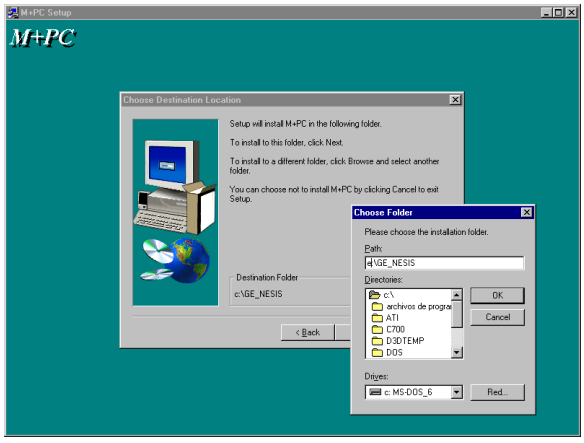
You will see the following screen:



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.

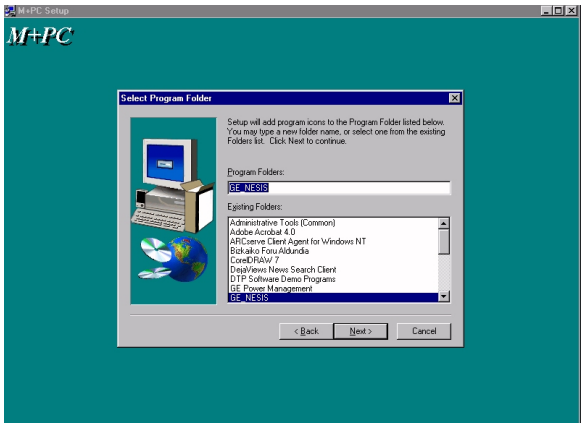


5. When the **Choose Destination Location** window appears and if the software is not to be located in the default directory, click **Browse** and type in the complete path name including the new directory name.

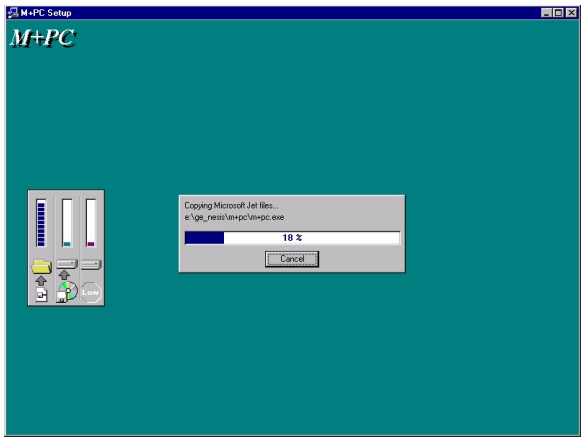


6. Click **Next** to continue with the installation procedure.

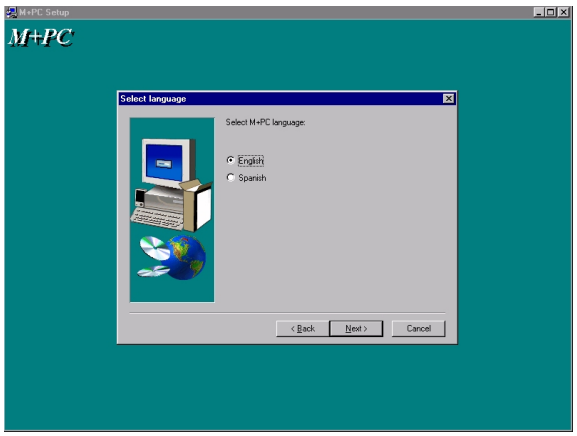
7. The default program group where the application will be added to is shown in the **Selected Program Folder** window. If it is desired that the application be added to an already existing program group, choose the group name from the list shown.



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 **English** or **Spanish**.



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 mm^2 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 & 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.

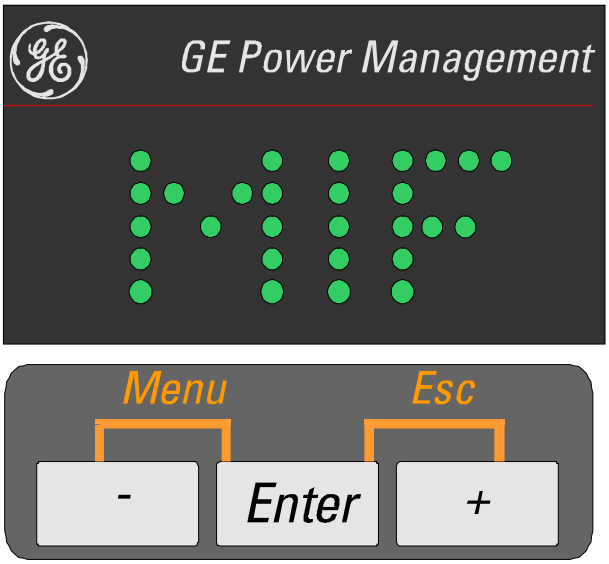


Figure 1.1 MIF KEYPAD AND DISPLAY

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

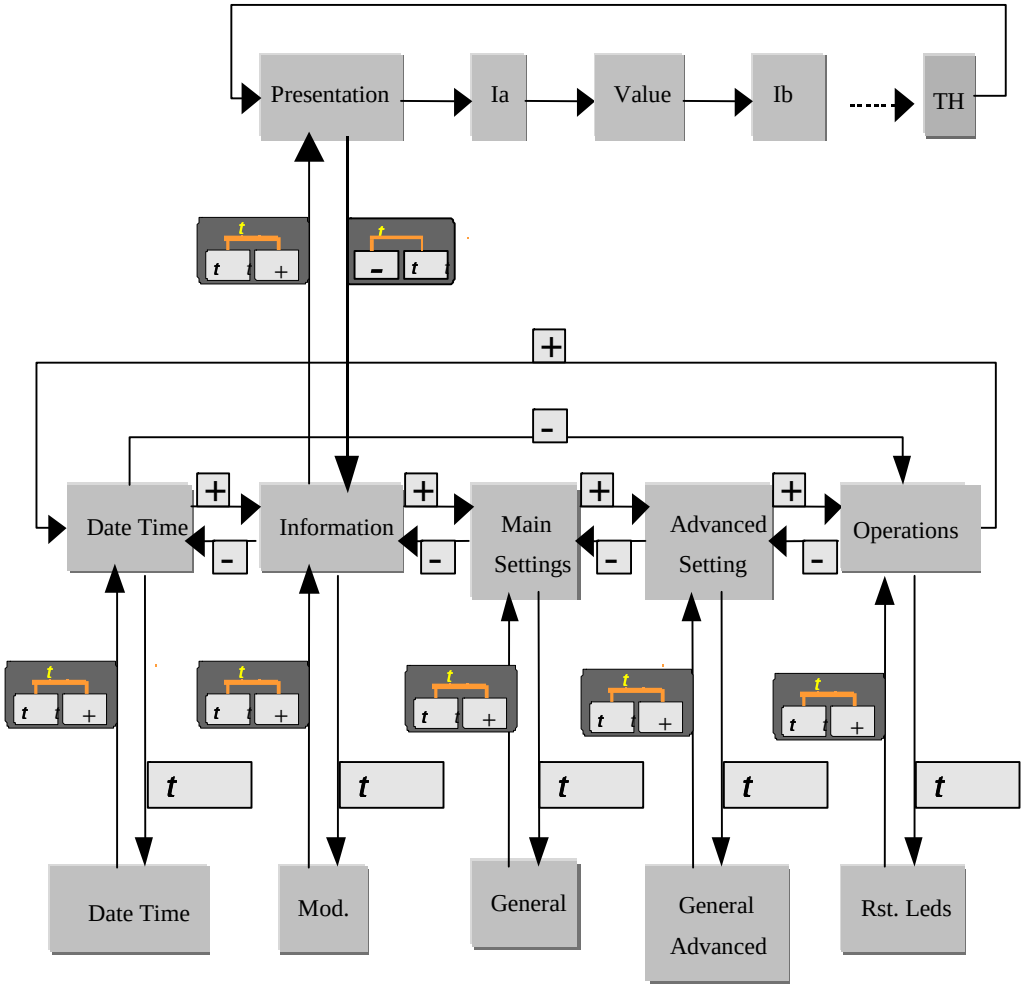


Figure 1.2. MOVING THROUGH THE HIERARCHICAL MENU

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 value for each phase (I_a, I_b, I_c) and the Thermal Image value (in percentage).

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.

Refer to Chapter 8 – Keypad and Display, for more information on the use of the local keypad and display to access information and change settings.

2.1 INTRODUCTION

2.1.1. GENERAL OVERVIEW

The MIF relay is a microprocessor-based relay designed for the following applications:

1. Main Protection for Medium and Low voltage feeders.
2. Main Protection for Medium size Motors.
3. Main Protection for Medium and Low power Transformers (less than 10MVA).
4. Differential Protection for Motors, if a CT differential connection is available.
5. Backup Protection for power Transformers (for any power level).
6. Backup Protection for Generators.
7. Backup Protection for Transmission lines.
8. Backup Protection for substation bus bars.
9. Thermal Image Protection/Supervision for Cables, Power Transformers, Grounding Resistors and Generation Units.

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 MIF 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.

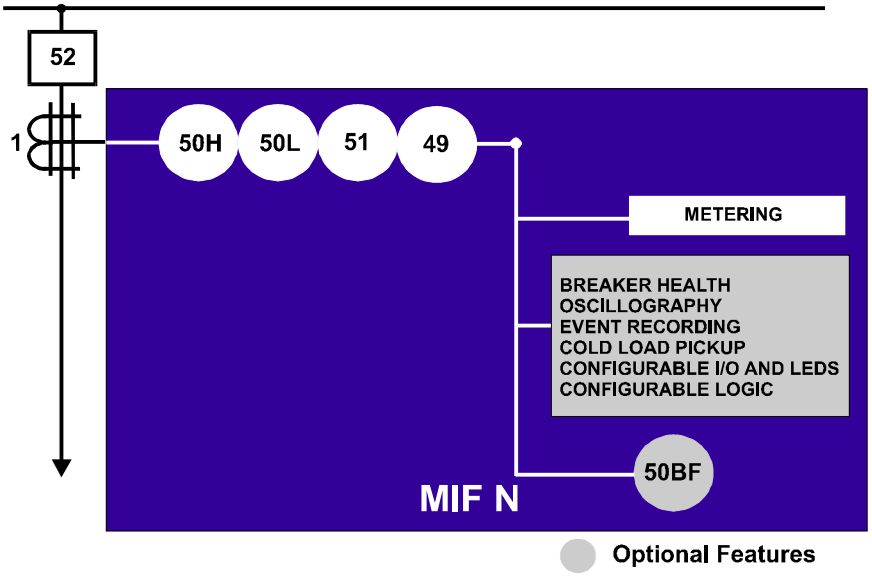


Figure 2.1. SINGLE LINE DIAGRAM SHOWING MIF FUNCTIONS

2.2 OVERCURRENT UNITS

2.2.1. TIME OVERCURRENT UNIT (51)

A Time Overcurrent unit is provided in the MIF. 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.

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

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

Where:

	A	P	Q	B	K
Inverse (IEC Curve A)	0.14	0.02	1	0	0
Very Inverse (IEC Curve B)	13.5	1	1	0	0
Extremely Inverse (IEC Curve C)	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	=	$I / I_{pickup\ setting} > 1.05$
I	=	Input Current
T	=	Operate Time (sec)
A, P, Q, B, K	=	Constants defined in the standard, as follows:

The settings available for the phase time overcurrent unit allows to: enable/disable the unit; set the pickup value (between 0.1 – 2.4 times the rated current in case of 1/5 A ground, or 0.005-0.12 A in case of sensitive ground) and set the current/time operating characteristic (type and time dial).

Note: The relay will use either IEC or ANSI curves, depending on the model.

2.2.2. INSTANTANEOUS OVERCURRENT UNITS (50H, 50PL)

The MIF provides 2 instantaneous overcurrent units, 50H ('H' for high pickup) and 50L ('L' for low pickup). Each one can be enabled/disabled and set independently. The settings from these units allow to set the pickup value from 0.1 to 30 times the rated current (or 0.005-1.5 A in case of sensitive ground models), and the time delay from 0.00 to 99.99 seconds.

2.3 THERMAL IMAGE UNIT

A Thermal Image Unit is included among the relay functions. This unit provides protection against overheating due to overloading conditions. The operating time curve is set from the time curve family available, as a function of the time constant $\tau 1$ (settable between 3 and 600 minutes). The cooling time constant $\tau 2$ can be set between 1 and 6 times the heating time constant $\tau 1$. Refer to Annex 1 for a detailed explanation on the operating principles of this unit.

2.4 COLD LOAD PICKUP (AVAILABLE ONLY IN OPTION 2 MODELS)

This unit avoids undesired operation of the overcurrent units in case of high currents produced when energising a line that has been open during a long period of time.

This unit detects when the current value is lower than 4% of the rated current (In). In this moment, a timer (T IN) is started.

If the currents return to values above 4% In before the timer countdown has finished, the unit returns to its original status.

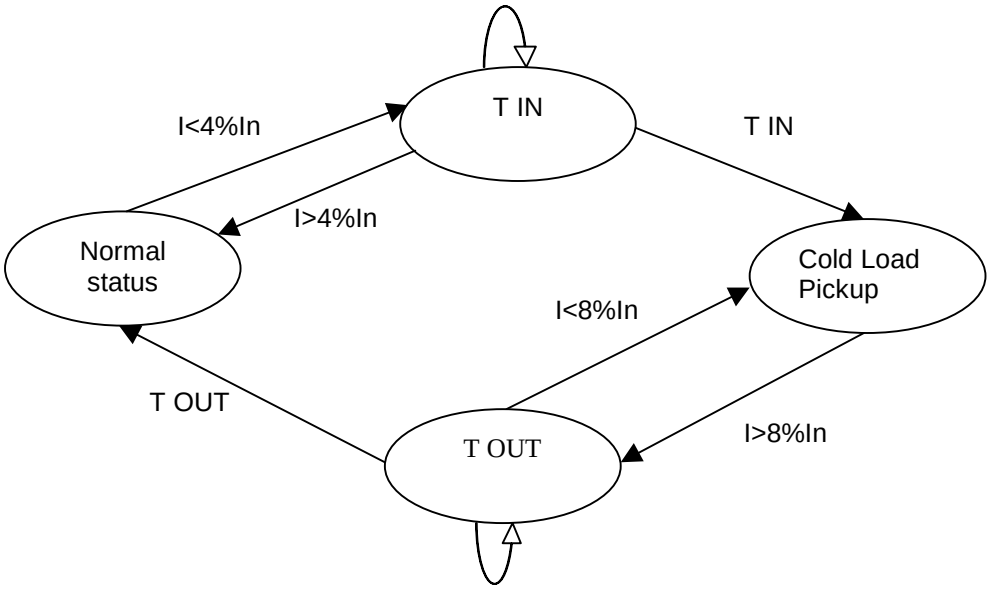
When the timer countdown has finished, the tap settings of the instantaneous units (50H and 50L) is multiplied by a constant K50P, and the TOC (51) tap settings are multiplied by a constant K51. A status signal turns on indicating that the Cold Load Pickup is enabled, and the corresponding event is generated.

For exiting the CLP status, when the current value is above 8% In, a T OUT timer is started.

If the current value falls below 8% In before the timer countdown has finished, the unit remains in CLP status.

If the timeout finishes and current value is still above 8% of In, the CLP status is disabled and the relay returns to its original settings. The CLP status signal is deactivated, and the corresponding event is generated.

The T IN and T OUT timer values, as well as the multiplying constants K50P and K51, and the function permission are settings associated to the COLD LOAD PICKUP. These settings are included in the ADVANCED SETTINGS group. They will be described in detail in the SETTINGS section.



In, rated current
I, measured current

2.5 BREAKER FAILURE TO OPEN (AVAILABLE ONLY IN OPTION 2 MODELS)

This unit produces an alarm if the breaker does not open after a tripping command.

This unit can be enabled independently from having an input that indicates the breaker health:

If a breaker health input is enabled:

After a trip, the following conditions are checked:
1. If the breaker is closed, the BREAKER FAILURE function is started.
2. If the breaker is open, the unit checks the current. If the current is over 8% of the rated current, the BREAKER FAILURE function is started.

After the BREAKER FAILURE pickup, a timer is started. When the timer countdown finishes, if the function is not disabled, the FAILURE TO OPEN status signal is activated, and the corresponding event is generated.
The Breaker Failure to Open signal is reset when the breaker is open and there is no current.

If a breaker health input is not enabled:

After a trip, the unit checks whether the current value is over 8% of the rated current. In this case, a timer is started. When the timer countdown finishes, if the current value has not fallen below 4% of the rated current, the FAILURE TO OPEN status signal is activated, and the corresponding event is generated.

The Breaker Failure to Open signal is reset when the current value rises above 8% of the rated current after having fallen below 4% of it.

The settings associated to BREAKER FAILURE TO OPEN are the function permission and the timer value. They are included in the ADVANCED SETTINGS group. They will be described in the SETTINGS section.

2.6 I^2 COUNTER (AVAILABLE ONLY IN OPTION 2 MODELS)

This counter is intended for breaker maintenance. It accumulates the breaker ageing produced by a trip or a breaker opening. In order to incorporate the breaker history, in case of second-hand breakers, the system allows assigning an initial value to the accumulated Amps and to the number of opening operations.

There is one I^2 counter, where every time a trip or a breaker opening is produced, the counter value is increased (in secondary value). If the tripping current is lower than the rated current, the accumulated value will be the rated current.

When the counter reaches or exceeds a limit value (setting), an **I2 ALARM** signal will be produced in the unit status, and the corresponding event will be generated.

There is also a Breaker Opening counter available, only for information purposes.

The I^2 counter, and the number of openings counter are stored in non-volatile memory RAM with battery.

The setting associated to the I^2 COUNTER is the limit value of the counter that will produce the I^2 ALARM. This setting is included in the ADVANCED SETTINGS group, and is described in detail in the SETTINGS section.

Both the I^2 and the Number of Openings counters can receive an operation command to modify their contents. From the M+PC program, a valid value can be set for any of these two fields. The valid range for the I^2 counter is from 0.000 to 999.000, and for the “Number of Openings” counter it is from 0 to 999.

From the keypad and display it is only possible to set both fields to zero.

2.7 EVENTS (AVAILABLE IN OPTION 1 AND OPTION 2 MODELS)

The MIF stores a historical record with the last 32 events. Each event contains the event description, date and time (4 ms accuracy), the current value in that moment, 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 32 (maximum number of events stored), this means that from all the produced events, only the last 32 are stored.

This event record is stored in a non-volatile memory RAM with battery.

The whole MIF functionality related to events is performed from the M+PC software.

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.

The following table shows a list of all possible events:

DESCRIPTION	OPTION 1	OPTION 2
50H Pickup/Drop out	Yes	Yes
50L Pickup/Drop out	Yes	Yes
51 Pickup/Drop out	Yes	Yes
49 Pickup/Drop out	Yes	Yes
50H Trip	Yes	Yes
50L Trip	Yes	Yes
51 Trip	Yes	Yes
49 Trip	Yes	Yes
General trip	Yes	Yes
50H Trip enable/disable by digital input	Yes	Yes
50L Trip enable/disable by digital input	Yes	Yes
51 Trip enable/disable by digital input	Yes	Yes
49 Trip enable/disable by digital input	Yes	Yes
General trip enable/disable by digital input	Yes	Yes
Protection status in service/out of service	Yes	Yes
Digital output 1 active/non active	Yes	Yes
Digital output 2 active/non active	Yes	Yes
Digital output 3 active/non active	Yes	Yes
Digital output 4 active/non active	Yes	Yes
Digital input 1 active/non active	Yes	Yes
Digital input 2 active/non active	Yes	Yes
Settings change disabled by digital input active/non active	Yes	Yes
Trip operation by digital input	Yes	Yes
Trip operation by command	Yes	Yes
Auxiliary digital output latch reset	Yes	Yes
52B open/closed	No	Yes
52A open/closed	No	Yes
52 open/closed	No	Yes
Table 2 selection by digital input	Yes	Yes
Oscillo trigger by digital input	Yes	Yes
Oscillo trigger by command	Yes	Yes
Breaker failure to open	No	Yes
I^2 Alarm	No	Yes
Cold load pickup/drop out	No	Yes
Settings change	Yes	Yes

DESCRIPTION	OPTION 1	OPTION 2
E2PROM failure	Yes	Yes
User settings/Factory settings	Yes	Yes

OPTION 1 : MIFN*0*E100*00*
OPTION 2 : MIFN*0*E200*00*

2.8 OSCILLOGRAPHY (AVAILABLE IN OPTION 1 AND OPTION 2 MODELS)

The MIF 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), including the following information:

- Instantaneous current value. The 2 first cycles are pre-fault cycles.
- Digital information:
  - Pickups (protection functions*)
  - Trip inhibition by digital input (protection functions*)
  - Trips (protection functions*)
  - Ready (protection in service)
  - Auxiliary digital outputs
  - Digital inputs
  - Breaker 52A, Breaker 52B, Status 52 (only OPTION 2 model)
  - Breaker opening failure (only OPTION 2 model)
  - I^2 alarm (only OPTION 2 model)
  - Cold load pickup (only OPTION 2 model)
  - Table 2 selection by digital input
  - E2prom failure
  - Default settings/User's settings
- Date and time
- Model
- Number of oscillo
- Current value (I) in the moment of the oscillography trigger
- Active table in the moment of the oscillography trigger
- Unit's settings when retrieving the oscillography record.

The number of oscillo is a circular counter that increases with each generated oscillo. This value appears on the relay status and is used only for informative purposes.

The oscillography record is stored in a non-volatile memory RAM with battery.

The whole MIF functionality related to oscillography is performed from the M+PC program. The oscillography record obtained is stored on the PC in a COMTRADE-IEEE C37.111-1991 format.

There are four possible causes that can produce an oscillography trigger:

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

In the ADVANCED SETTINGS group, there is a sub-group called OSCILLOGRAPHY MASKS, from where the above mentioned causes can be masked. They are detailed in the SETTINGS section.

*Protection functions: 50H, 50L, 51, 49, general

2.9 MULTIPLE SETTINGS GROUPS

Two independent Settings Groups are available in the permanent (non-volatile) memory of the MIF 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 in OPTION 1 and OPTION 2 models.*

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 MIF relay. For those users who need to use the full functionality of the relay, the Advanced Settings must be used.

2.10 MEASUREMENT AND SELF-TEST

Measurement

The MIF provides actual values for current and for Thermal Image. The accuracy is 3% in the complete range.

Self-Test

The self-monitoring tests are carried out both when the unit is started up and during normal operation. Any internal problem detected by the self-monitoring function will issue an alarm and the READY output contact will be activated, meaning that a critical failure has occurred.

2.11 USER INTERFACE

LED Targets

There are 6 LED Targets in the faceplate of the MIF. 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 in OPTION1 and OPTION2 models. The default configuration of the LEDs is shown in figure 2.2

Figure 2.2 MIF-N 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. 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.
- **51 TRIP:** Points out that the trip has been issued by protection unit 51.
- **50 TRIP:** Points out that the trip has been issued by protection unit 50H/50L.
- **49 ALARM:** Points out that the alarm level for unit 49 has been reached.
- **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.

Keypad and Display

A three-key keypad allows access to the MIF 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.

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 MIF 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.

Software

MIF 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 (in models where these features are available).

2.12 MODEL LIST. ORDER CODES

The MIF has a draw-out construction, 4U high and ¼ of a 19" rack wide. The MIF 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 MIF relays (or different types of M family relays) in the same case. 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, MIM, MIG 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 MIF and 2 MIV modules), while the M100 case can hold a maximum of 16'' in total module length (i.e. 4 MIFs, 2 MIF and 4 MIVs, or 8 MIV modules). A system comprised of several M family relays in the same case is called an M+ System.

The information required to completely specify the relay is provided in the following table:

Table 2.1: - ORDER CODES

MIF	-	-	0	-	E	-	0	0	-	0	0	-	DESCRIPTION
	N												One-phase or ground
		A											ANSI Curves
		I											IEC Curves
													Ground:
				1									CT In = 1A (0.1-2.4 A)
				5									CT In = 5A (0.5-12 A)
				N									Sensitive ground In = 1 A (0.005-0.12 A)
						0							No options, basic unit
						1							Option 1(*)
						2							Option 2 (*)
													Power Supply:
									F				24-48 Vdc (Range: 19~58 Vdc)
									H				110-250 Vdc (Range: 88~300 Vdc) 120-230 Vac (Range: 88~264 Vac)
												C	Individual relay
												S	Mounted in a M+ System **

* **OPTION 1**: Configurable I/O, Event recording, oscillography
OPTION 2: Includes all OPTION 1 features, plus Cold load pickup, breaker failure to open protection, breaker health, configurable Logic.

** 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).

2.13 TECHNICAL SPECIFICATIONS.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

2.13.1. PROTECTION UNITS

TIME OVERCURRENT (51)

Current:	Fundamental
Pickup Level:	0.1 – 2.4 times In (rated current) in steps of 0.01 x In (if 1/5 A magnetic module models) 0.005-0.12 A in steps of 0.001 A (if sensitive magnetic module model)
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	±1% at In ±3% in the complete range
Curve Shapes:	IEC (B.S.) A/B/C or ANSI Inverse, Very Inverse or Extremely Inverse (depending on model) Time delayed (0.00 to 99.99 sec. in steps of 0.01 sec.
Time Dial:	0.05 to 2 in steps of 0.01 for IEC curves 0.5 to 20 in steps of 0.1 for ANSI curves
Reset Type:	Instantaneous
Timing Accuracy:	±5% of operate time or ±30 ms. (whichever is greater) for I > 1.30 times the Actual Pickup Level.

INSTANTANEOUS OVERCURRENT (50H, 50L)

Current:	Fundamental
Pickup Level:	0.1 to 30.0 times In (rated current) in steps of 0.1 x In.(for 1/5 A magnetic module models) 0.005 to 1.5 A (for sensitive magnetic module models)
Dropout Level:	97% to 98% of Pickup
Level Accuracy:	±1% at In ±3% in the complete range
Overreach:	< 2%
Time Delay:	0.00 to 100 sec. in steps of 0.01 s
Reset Type:	Instantaneous
Operate Time:	Between 20 and 30 ms for I> 1.5 x Actual Pickup @ 60 Hz
Timing Accuracy:	±5% of operate time or ±30 ms. (whichever is greater) for I > 1.5 times the Actual Pickup

THERMAL IMAGE UNIT (49)

Current:	Fundamental
Pickup Level:	0.10 to 2.40 In in steps of 0.01 x In (for 1/5 A magnetic module models) 0.005 to 1.5 A in steps of 0.001 A (for sensitive magnetic module models)
Dropout Level:	Between 97% and 98% of Pickup Level
Level Accuracy:	±1% at In ±3% in the complete range
Heating Constant τ1:	From 3 to 600 min in steps of 1 min.
Cooling Constant τ2:	From 1 to 6 times τ1 in steps of 1.
Thermal Image Alarm:	From 70% to 100% I_{pickup} in steps of 1%
Timing Accuracy:	5% for operate times greater than 2 sec.

2.13.2. METERING FUNCTIONS

FUNDAMENTAL CURRENT

Accuracy:	±1% at In ±3% in the complete range

2.13.3. INPUTS

AC CURRENT

Secondary Rated Current:	1m 5 A depending on the selected model., or 50 mA for sensitive ground models
Frequency:	50 / 60 Hz ±3 Hz (The unit can be set to 50 or 60 Hz)
Relay Burden:	< 0.2 VA @ In secondary
Current Withstand:	4 x In continuously. 100 x In for 1 sec.

DIGITAL INPUTS

Voltage Level:	300 Vdc maximum
Recognition Time:	< 4 ms

LOW RANGE

Rated DC Voltage:	24 to 48 Vdc
Min./Max. DC Voltage:	19 / 60 Vdc

HIGH RANGE

Rated DC Voltage:	110 to 250 Vdc
Min./Max. DC Voltage:	88 / 300 Vdc
Rated AC Voltage:	120 to 230 Vac @ 50 – 60 Hz
Min./Max. AV Voltage:	88 / 264 Vac @ 50 – 60 Hz
Power Consumption:	Max. = 10 W
Proper backup time (date, time and log memory) without power supply voltage	> 1 week

2.13.5. OUTPUTS

OUTPUT RELAYS

Configuration:	6 Electro-Mechanical Form C
Contact Material:	Silver alloy suited for inductive loads
Maximum Operating Voltage:	400 Vac
Continuous Mode Current:	16 A
Make and Carry:	30 A
Breaking:	4000 VA

Max. Ratings for 100.000 operations:

VOLTAGE	MAKE&CARRY CONTINUOUS	MAKE&CARRY 0.2 sec	BREAK	MAX LOAD
DC 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
DC Inductive (L/R=40ms)				
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	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 PF = 0.4				
120 Vac	16 A	48 A	16 A	720 VA
250 Vac	16 A	48 A	16 A	1250 VA

2.13.6. COMMUNICATIONS

FACEPLATE PORT	RS232	300, 600, 1200, 2400, 4800, 9600 or 19200 bps, Modbus® RTU
REAR PORT	RS485	300, 600, 1200, 2400, 4800, 9600 or 19200 bps, Modbus® RTU

2.13.7. ENVIRONMENTAL

Operating Temperatures:	-20º C to +60º C
Ambient Storage Temperatures:	-40º C to +80º C
Use	Indoor use only
Maximum relative humidity	95%
Altitude	2000 m. Max
Pollution Degree	2

2.13.8. TYPE TESTS & CERTIFICATIONS

The **MIF** 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.

The MIF is also **UL** and **CSA** certified.

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: 40 MHz, 151 MHz, 450 MHz and cellular phone.	III
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

2.13.9. PRODUCTION TESTS

Insulation Test: IEC255-5 (Tested on CTs, Power Supply terminals, Contact Inputs and Contact Outputs)

2.13.10. APPROVALS

- Manufactured under an ISO9001Registered system.
- CE Marking.
- UL Certified
- CSA Certified

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 MIF RELAY

3.1.2. PANEL CUTOUT

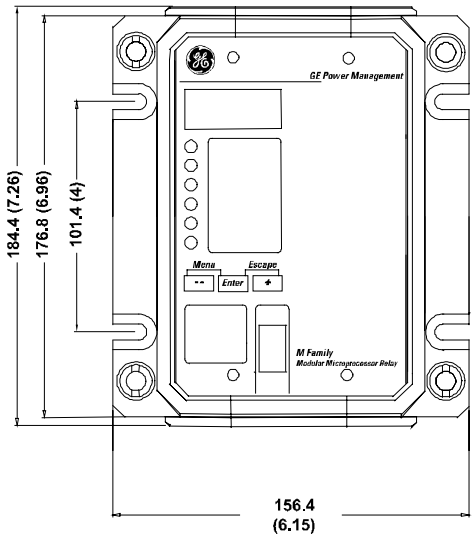
The MIF case is made from **corrosion resistant stainless steel**. Case dimensions, along with panel cutout details for panel mounting are shown in figure 3.2.

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

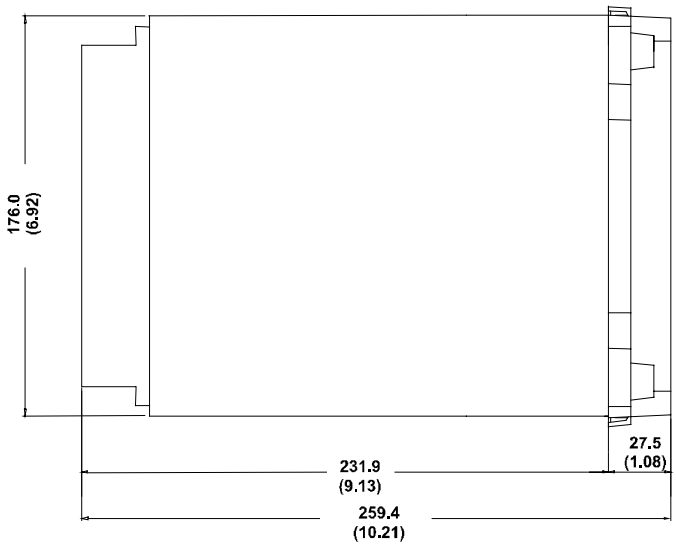
The relay is provided with a plastic lid that fits over the faceplate, sealing the relay hermetically, avoiding dust coming into the relay.

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.

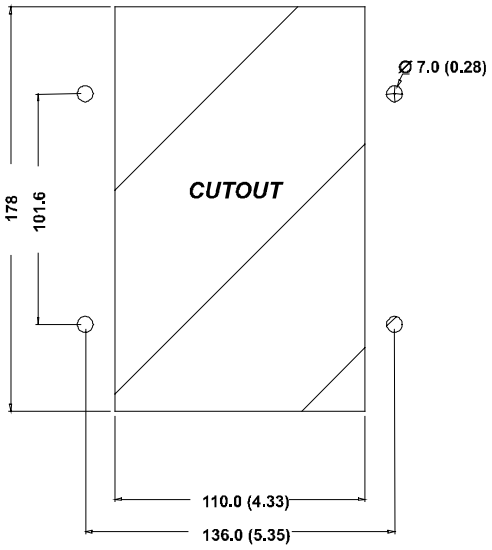
FRONT VIEW



SIDE VIEW



PANEL MOUNTING



Note: dimensions shown in mm (inches)

Figure 3-2B. MOUNTING AND DIMENSIONS DRAWING

3.1.3. MODULE WITHDRAWAL / INSERTION

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

The modular design of the relay allows for the withdrawal and insertion of the module.

Figure 3-3: MIF 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 MIF relay.

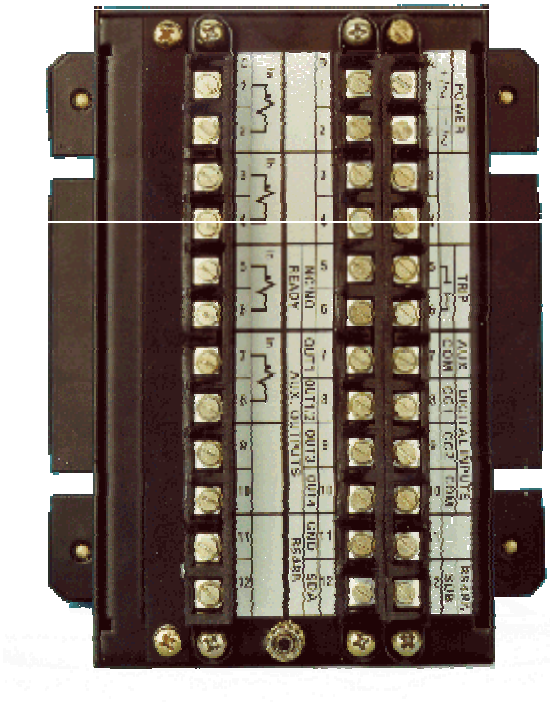


Figure 3-4 MIF RELAY - REAR VIEW

3.2 WIRING

3.2.1. TYPICAL WIRING DIAGRAM

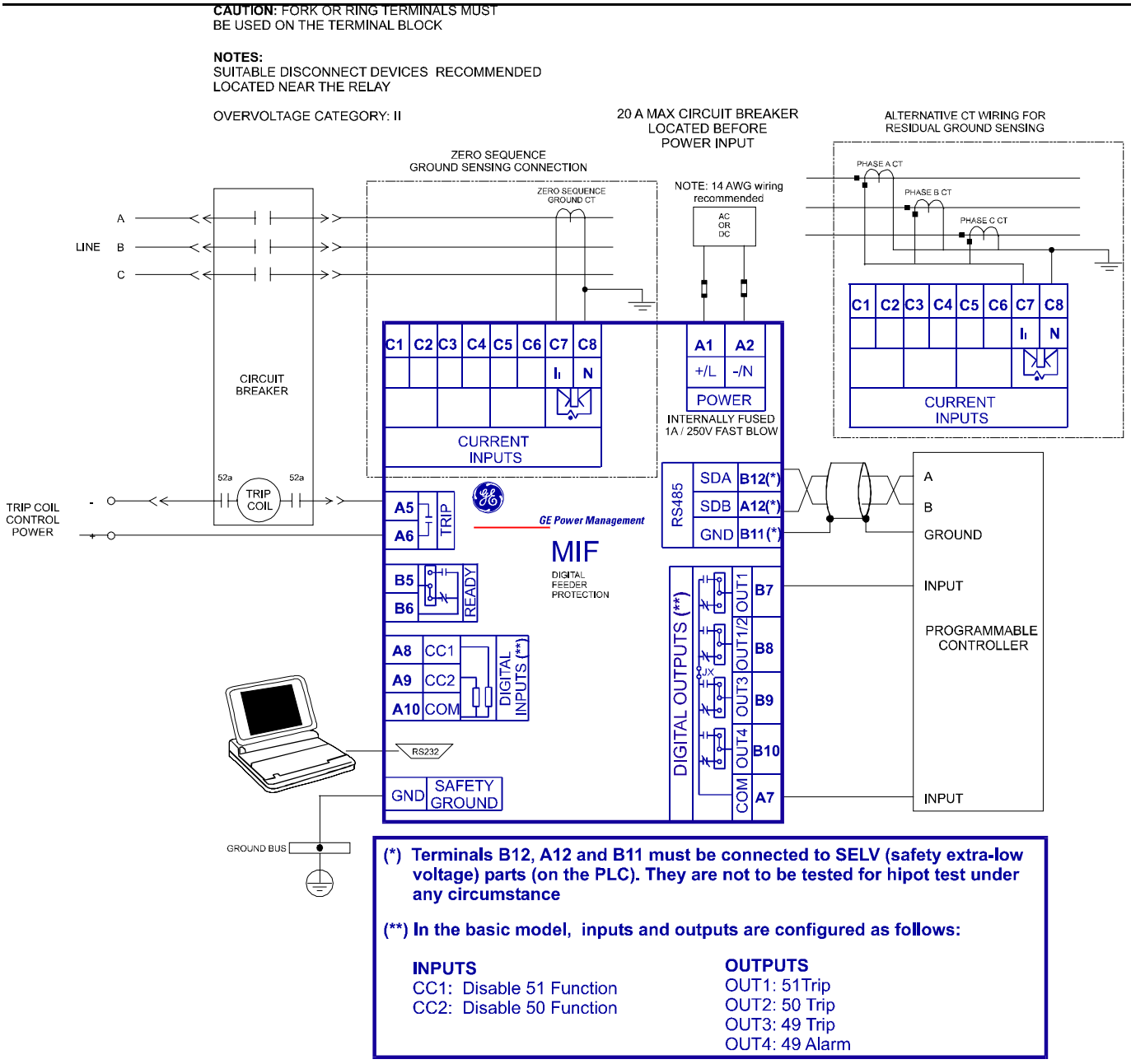


Figure 3-5 TYPICAL WIRING DIAGRAM FOR MIF RELAY

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 120/230 Vac	88~300 Vdc 88~264 Vac

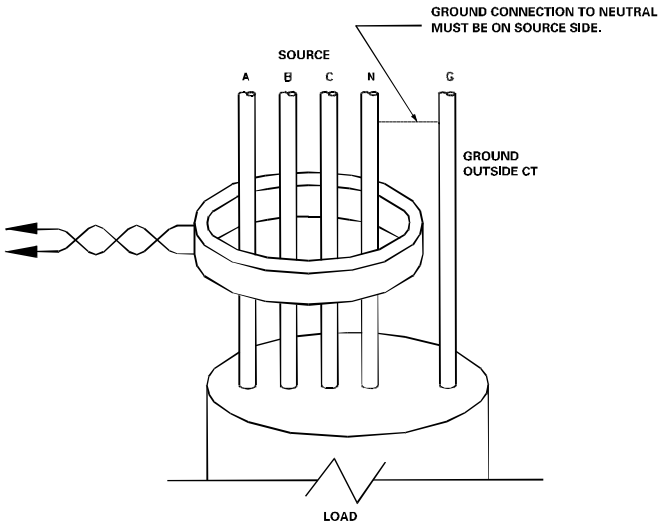
3.2.3. AC CURRENT TRANSFORMER INPUTS

Each AC current input has an isolating transformer and an automatic mechanism that shorts the input when the module is withdrawn from the chassis. There are no internal ground connections on the current inputs. Current transformers with 1 A or 5 A rated secondary current may be used.

CAUTION: VERIFY THAT YOUR RELAY MODEL CORRESPONDS TO YOUR RATED SECONDARY CURRENT. UNMATCHED CTS MAY RESULT IN EQUIPMENT CMAGE OR INADEQUETE PROTECTION.

The exact placement of a zero sequence CT, so that ground fault current will be detected, is shown below. Twisted pair cabling on the zero sequence CT is recommended.

UNSHIELDED CABLE



SHIELDED CABLE

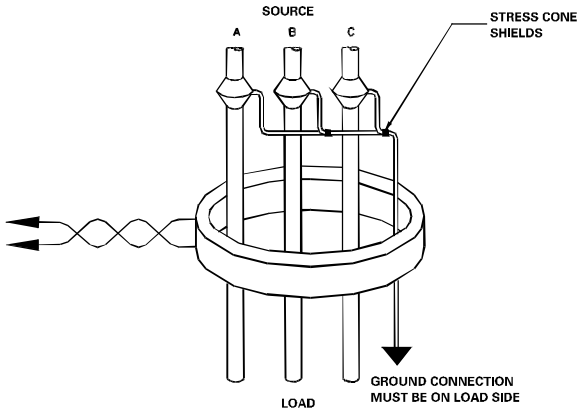


Figure 3-6 ZERO SEQUENCE CORE BALANCE CT INSTALLATION

3.2.4. CONTACT INPUTS / OUTPUTS

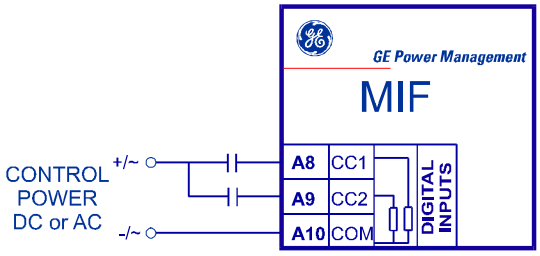


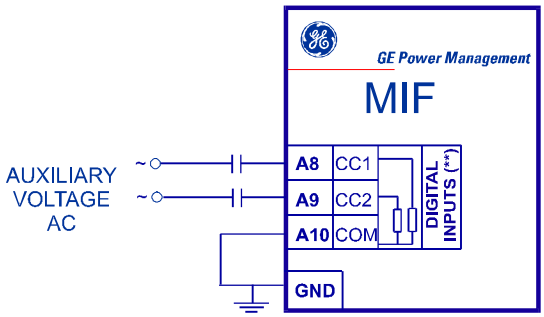
Figure 3-7 CONTACT INPUTS CONNECTIONS

The MIF 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 high 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.



3.2.5. 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 MIF output terminal. For each output relay it is possible to select which state is preferred to have at the MIF terminals, NC (normally closed) or NO (normally open).

Figure 3-10 shows the PCB of a MIF relay, and the location of the jumpers used to select the configuration of each output contact (NO or NC).

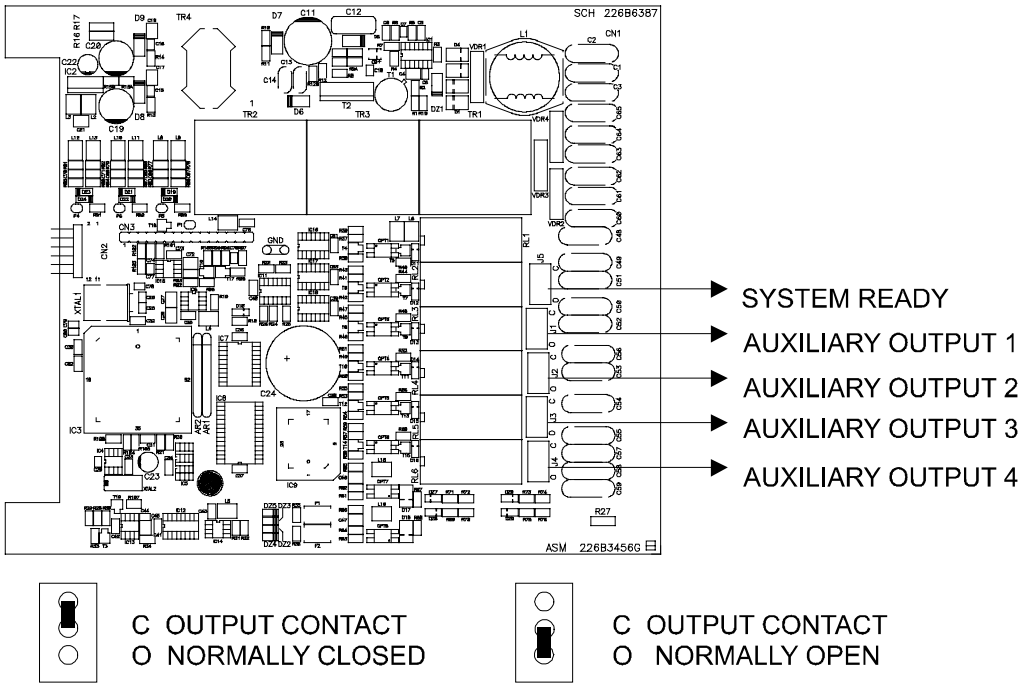
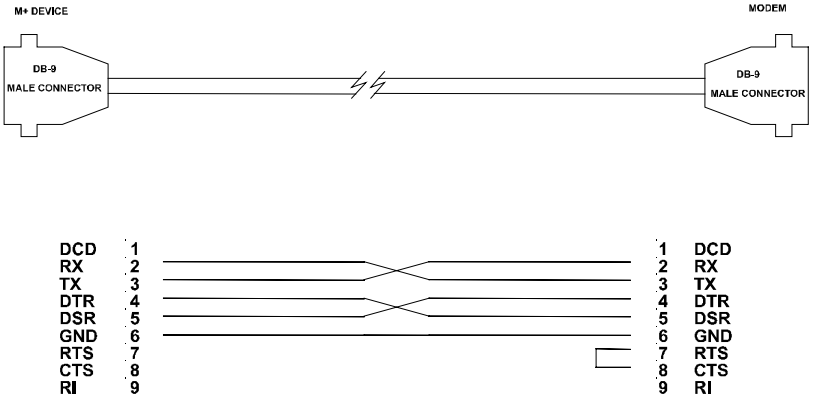
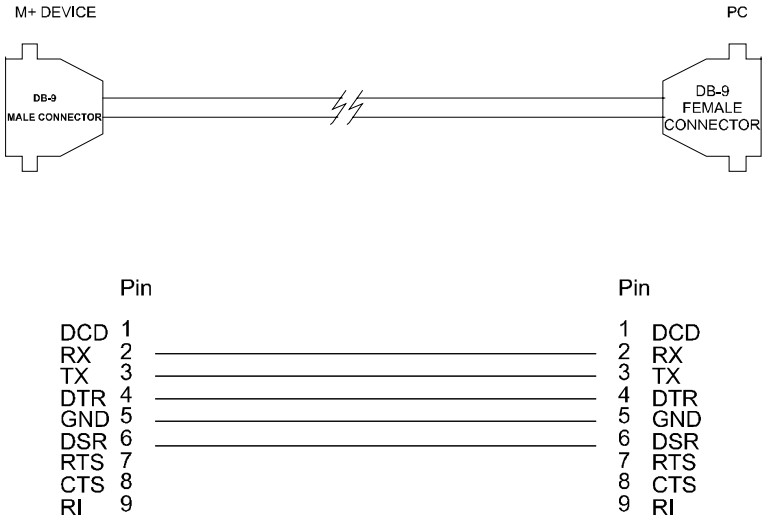


Figure 3-8 PCB SCHEME SHOWING THE JUMPERS TO CONFIGURE THE OUTPUT CONTACTS (NC / NO)

A 9-pin RS232C serial port is located on the relay's faceplate for programming with a portable (personal) computer. All that is required to use this interface is a personal computer running the M+PC software. Figure 3-9 shows the communications cable configuration.



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



RELAY - PC CONNECTION WIRE FOR RS-232 FRONT PORT

Figure 3-9 RS232 FACEPLATE PORT CONNECTION

3.2.7. 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.

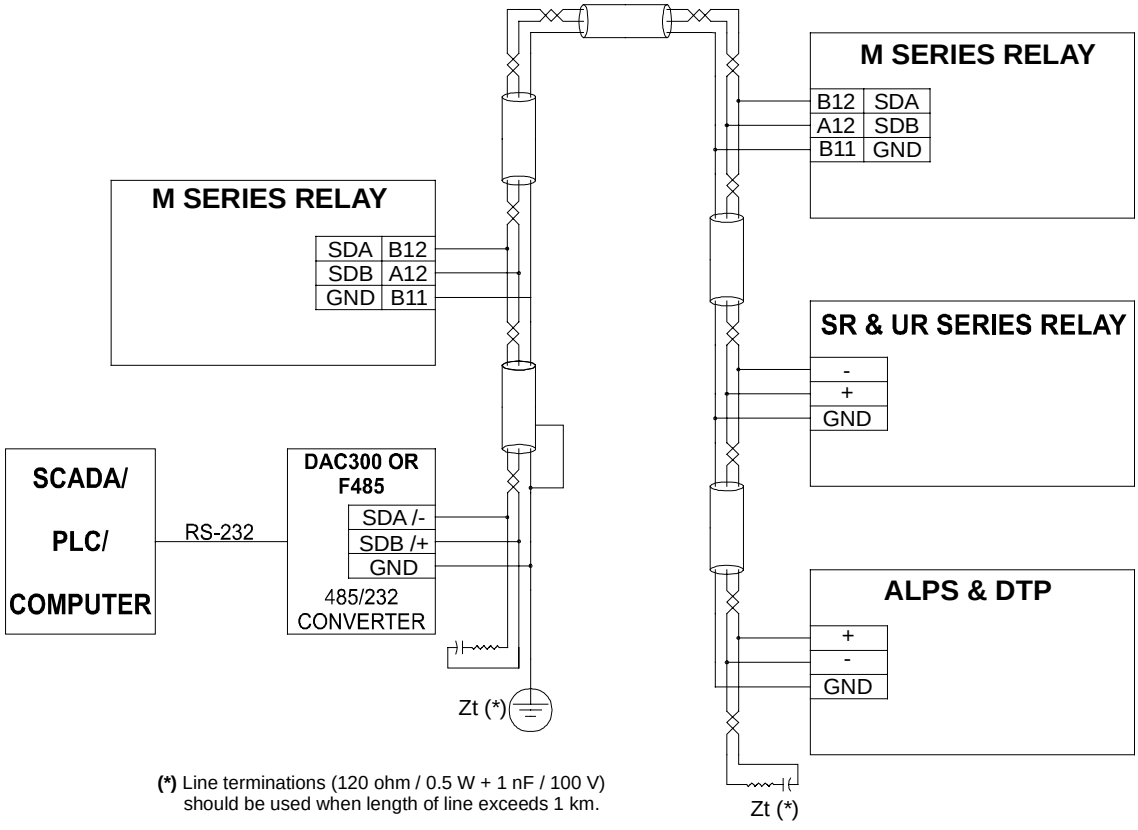


Figure 3-10 RS485 SERIAL CONNECTION (B6366H5)

4.1 M+PC SOFTWARE INTERFACE

The M+PC software provides a graphical user interface (GUI) as one of two Human interfaces to a MIF 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 MIF 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® or NT® (Service Pack 3.0 or higher) 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.

4.1.2. START WINDOW

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.

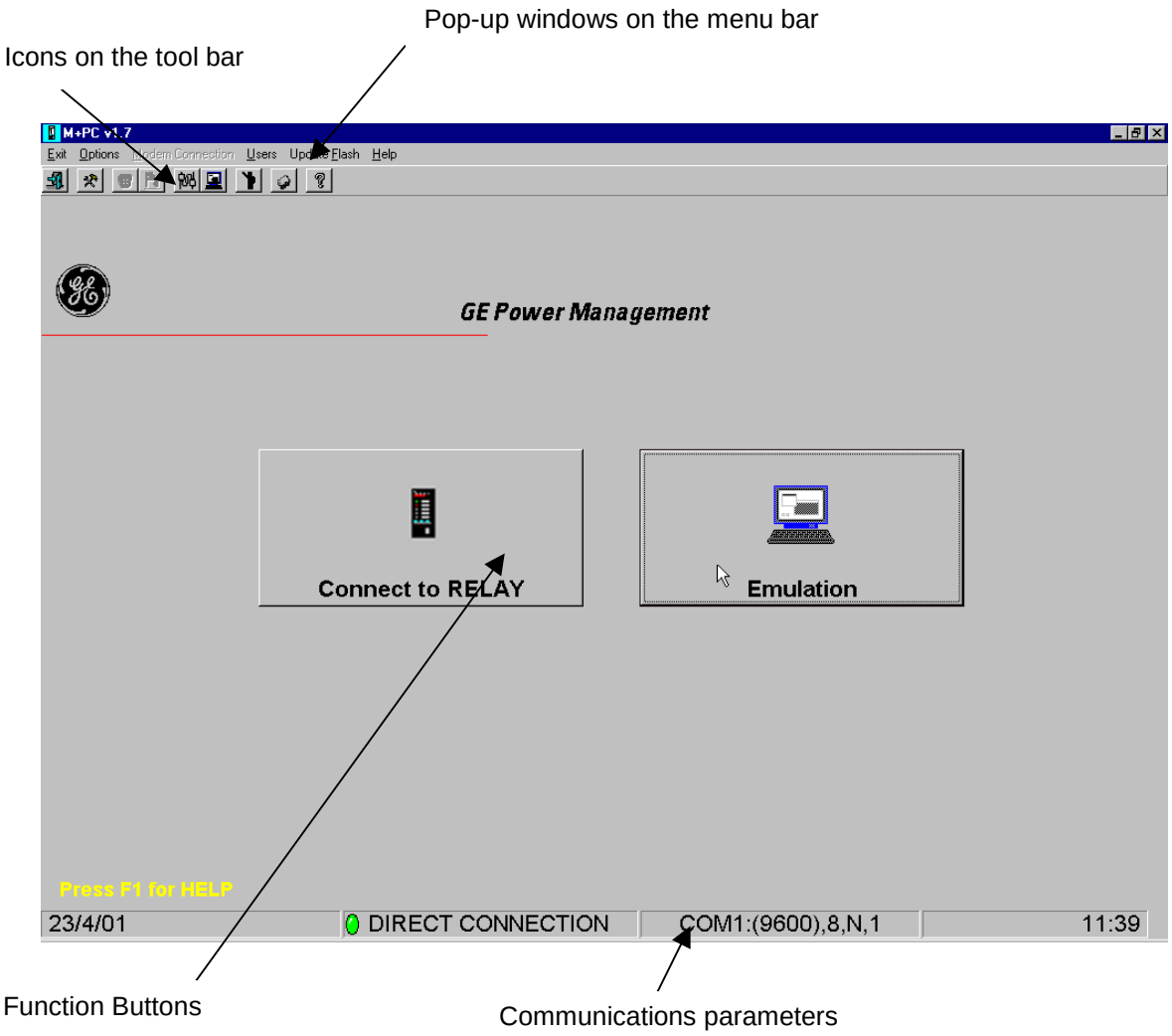


Figure 4.2: START WINDOW

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

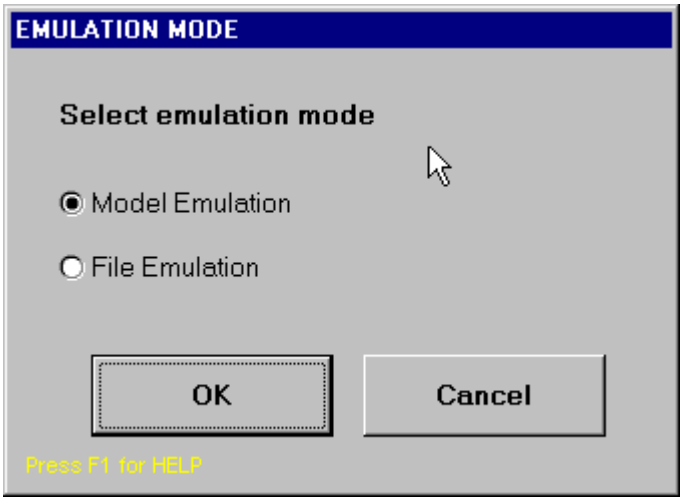
The EMULATION mode allows to simulate the connection to a particular relay even if the physical relay is not available. This mode allows the user to:

- 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:

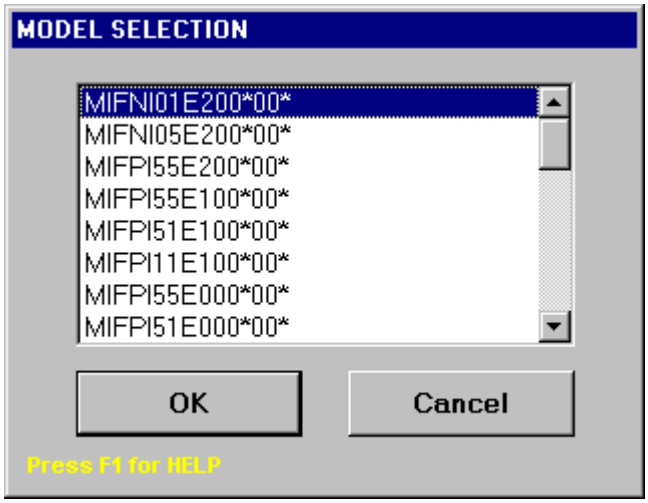
Model Emulation.
File Emulation.



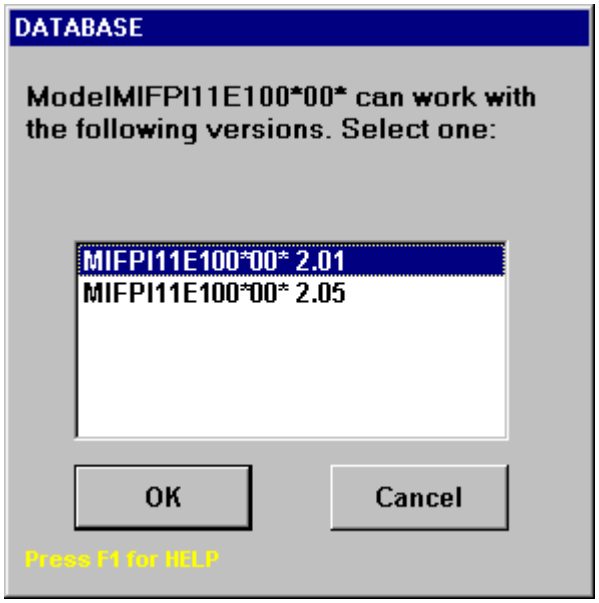
The following sections detail the operation of each model:

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:

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.

Oscillography Files: These files are created when retrieving oscillography. The file will include the relay model, the relay settings, and the oscillography information.

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.

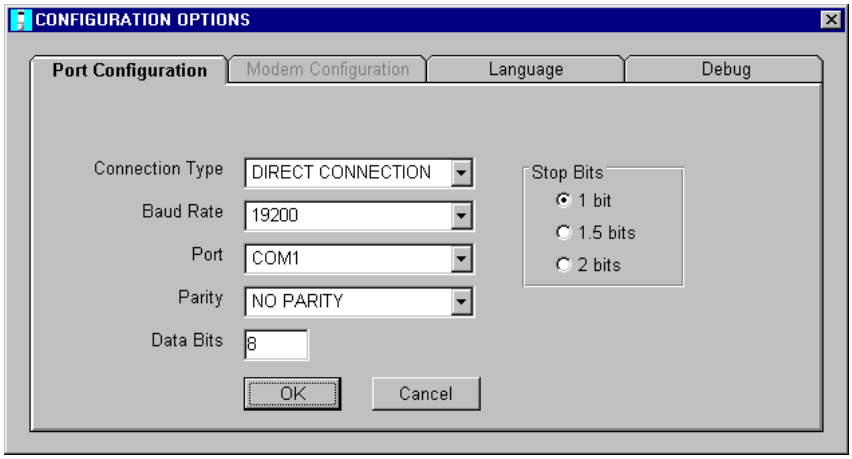


Figure 4.3: OPTIONS MENU – PORT CONFIGURATION TAB.

- "**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.

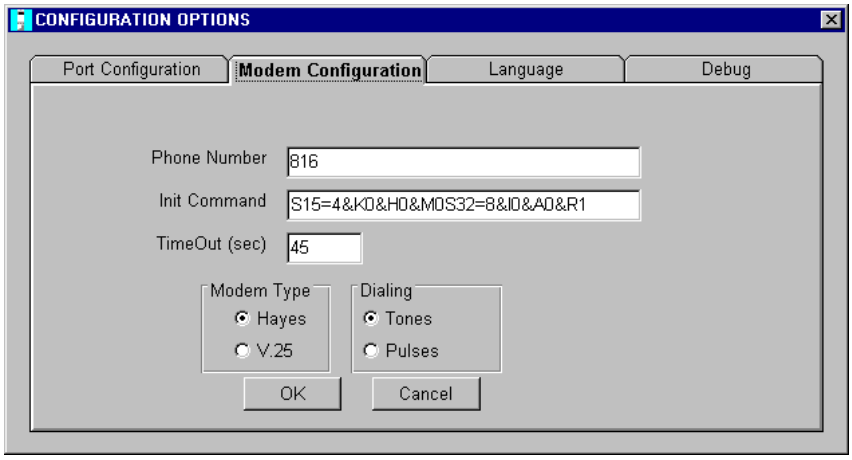


Figure 4.4: OPTIONS MENU - MODEM CONFIGURATION TAB

- "**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.

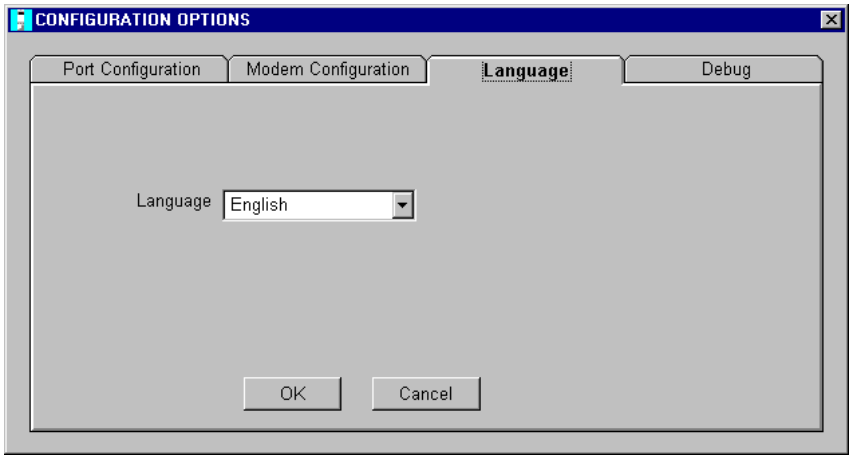


Figure 4.5: OPTIONS MENU - LANGUAGE TAB

- Use this window to select the language you want to use, English or Spanish. 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 MIF and the computer, to analyse the communications network.

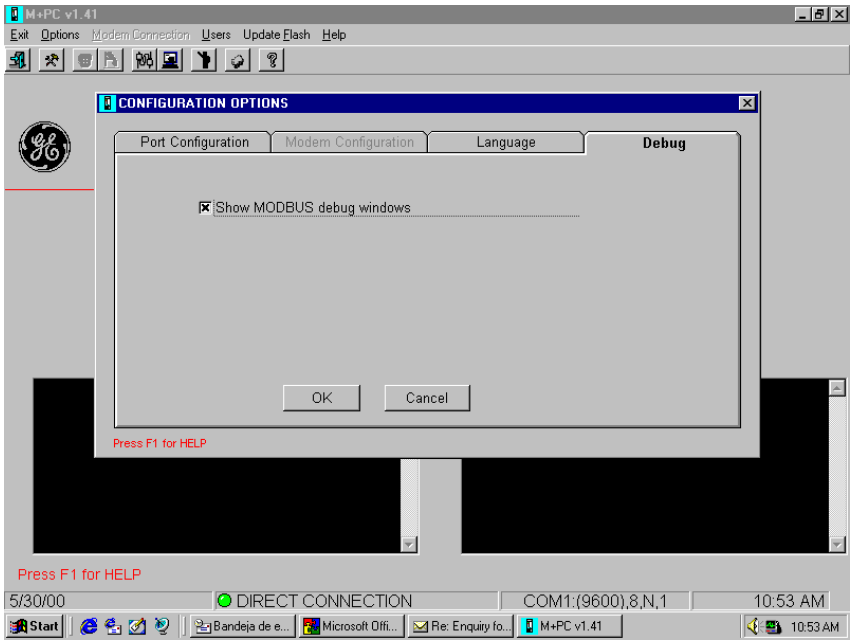


Figure 4.6: OPTIONS MENU - DEBUG TAB.

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.

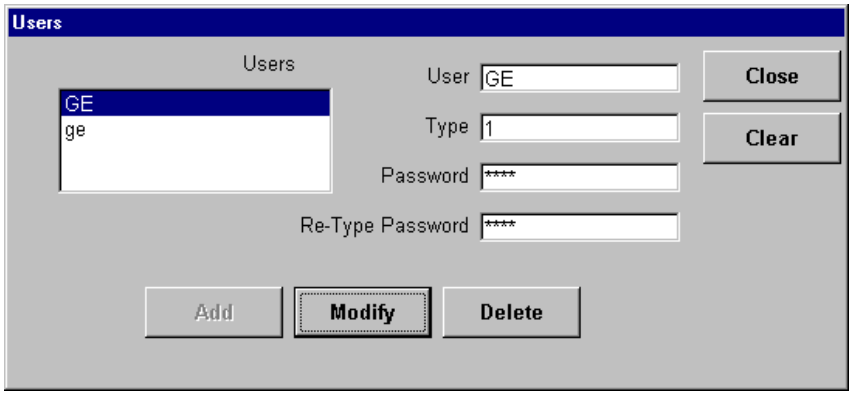


Figure 4.7: USERS MANAGEMENT.

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.

ELIMINATE: 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.

4.1.6. FLASH MEMORY UPDATE

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

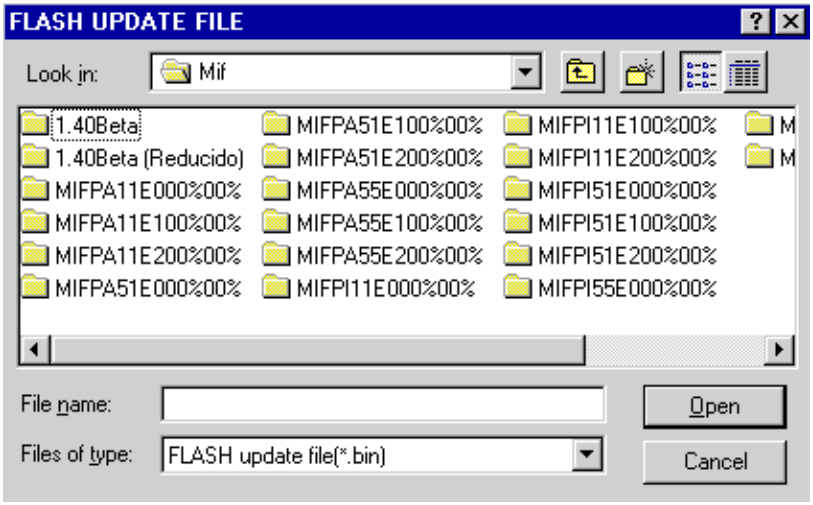
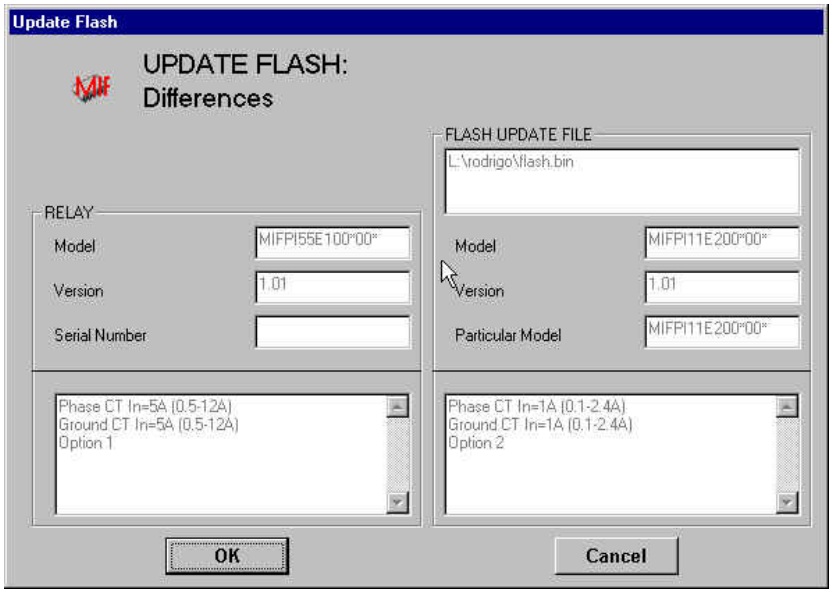


Figure 4.8. FLASH MEMORY UPDATE

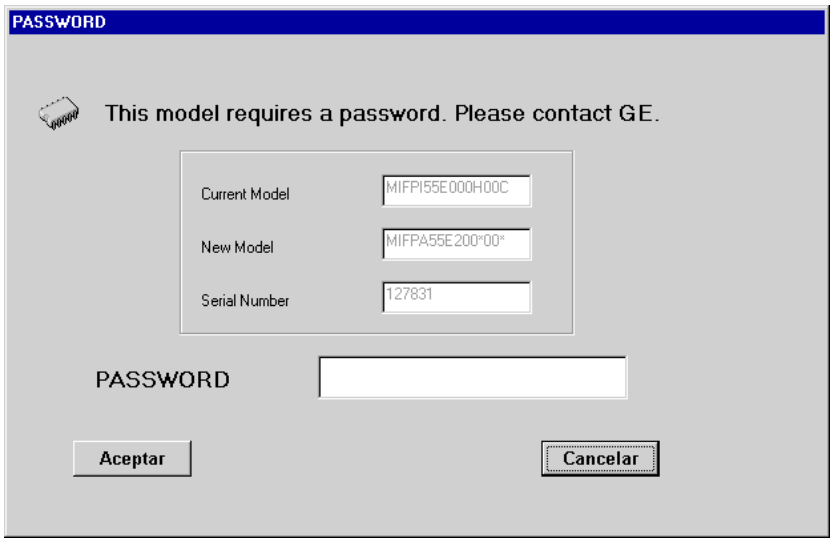
Here, we select the file we will use to update the FLASH memory, and the following screen will be displayed, showing details of the old model and the new model:



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:

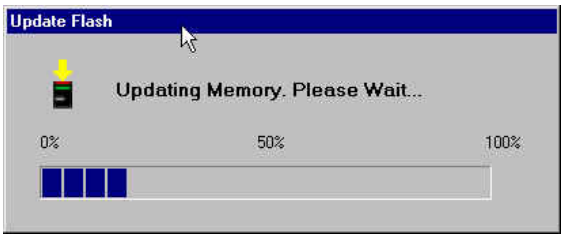
- Serial number of the unit.
- Current model option (before memory update)
- Desired model option (after memory update).

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.

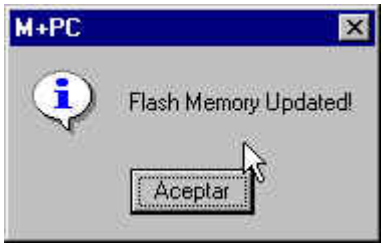


If the update does not intend to change the functionality of the relay, the program will not request a password.

After completing the previous screen, and during the loading process the following screen will be displayed:



Finally, when the process has been completed, we will see the following screen:



We must take into account that the Flash memory update may involve a change in the MODBUS® memory map, although this does not necessarily involve an update to a higher model (OPTION 1 or 2). 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 MIF relays.

Additionally, when a Flash memory update is performed, the loading program will enter the default settings. This means that the user will need to adapt the settings to the real situation of the protected device.

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:

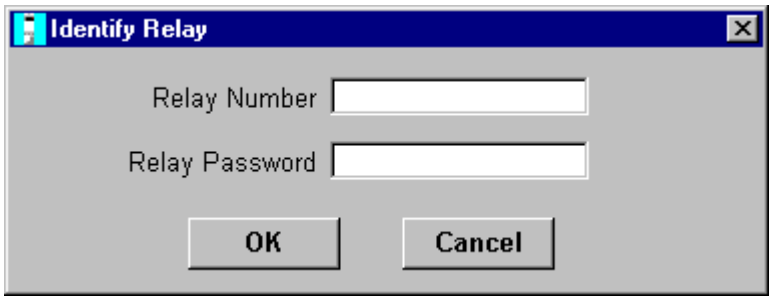


Figure 4.9: DEVICE IDENTIFICATION WINDOW

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 MIF Feeder protection relay, the device information shown is:
    - 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.

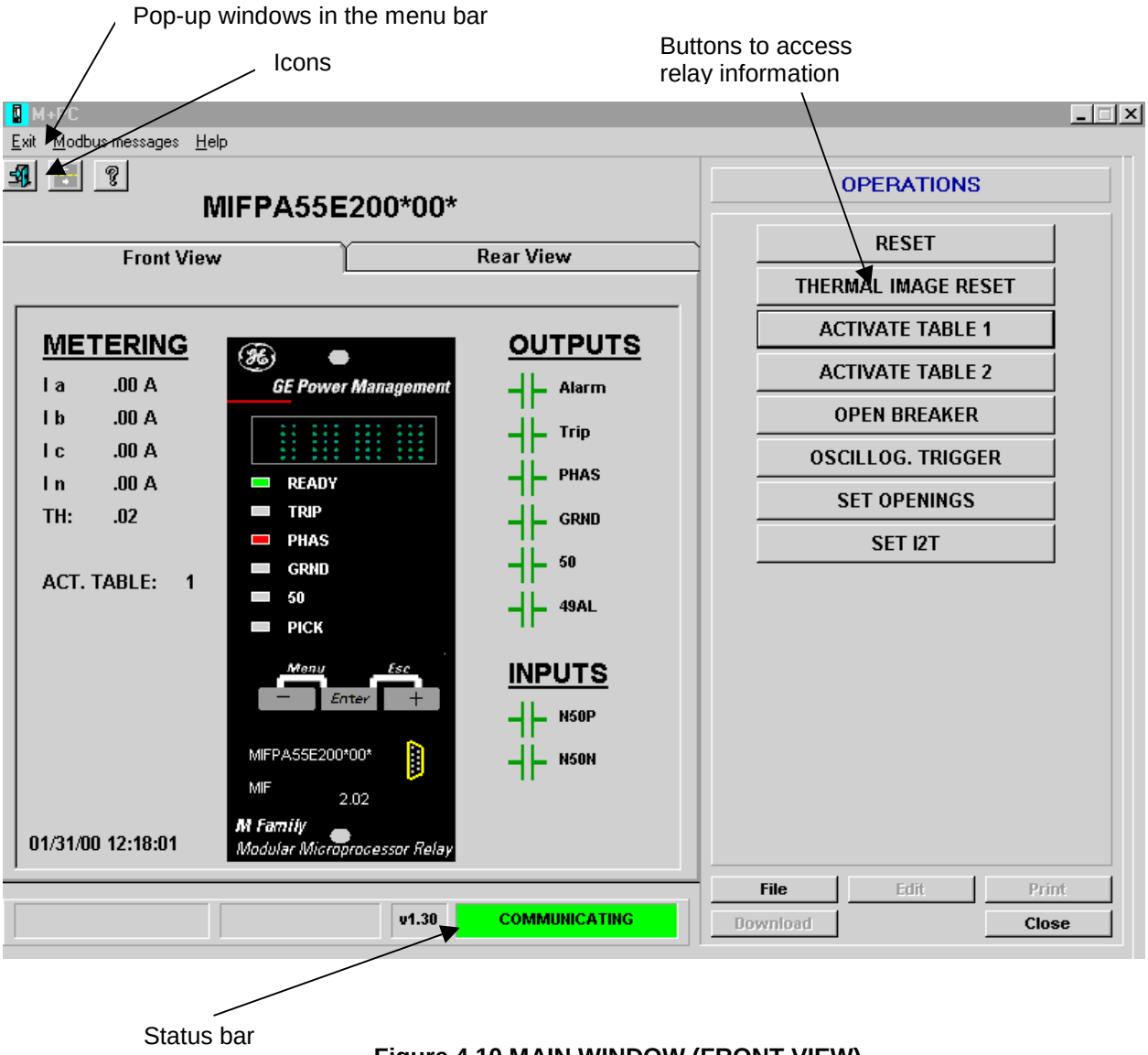


Figure 4.10 MAIN WINDOW (FRONT VIEW)

- 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.

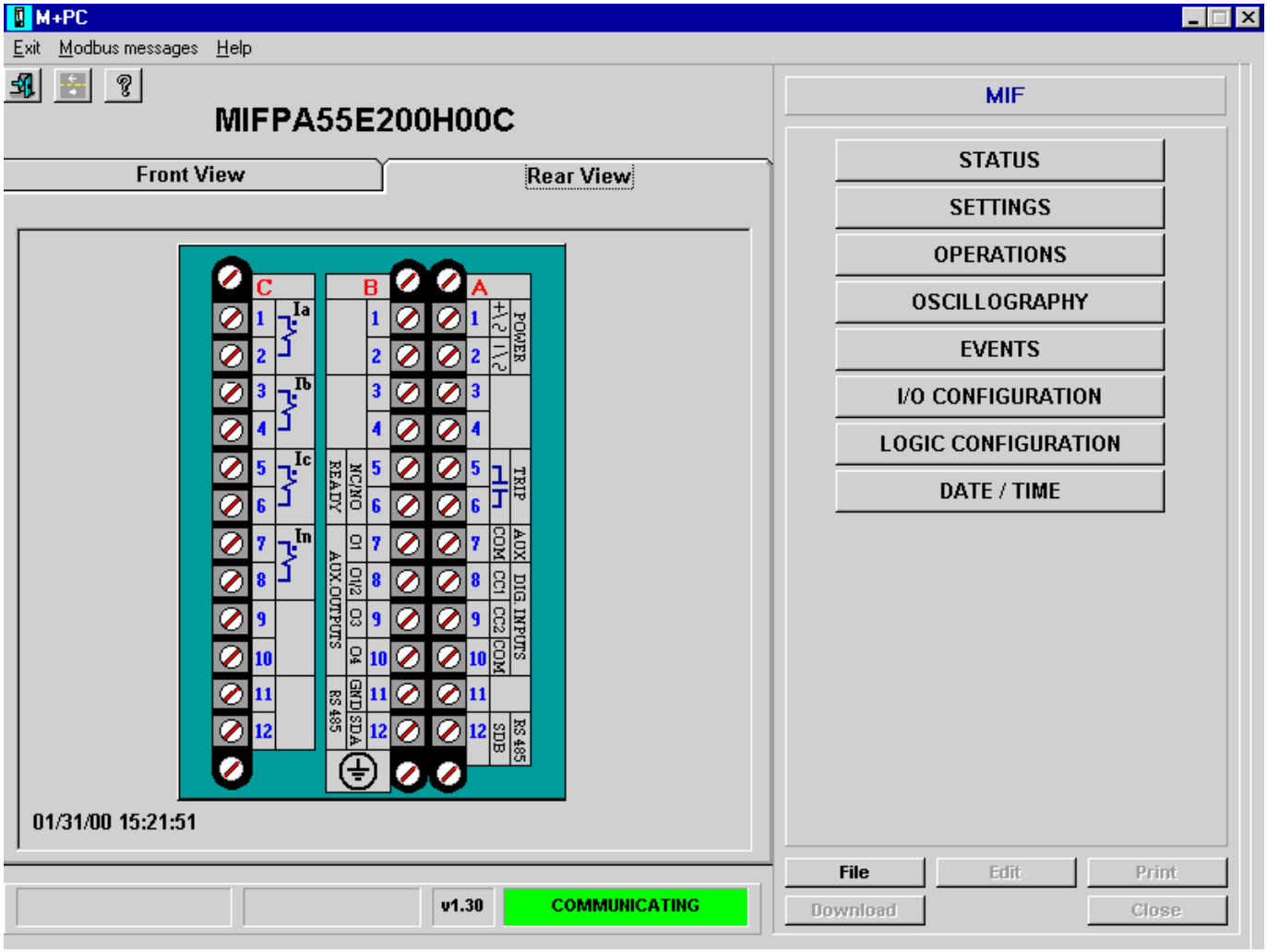


Figure 4.11: MAIN WINDOW (REAR VIEW).

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 current value
- 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.

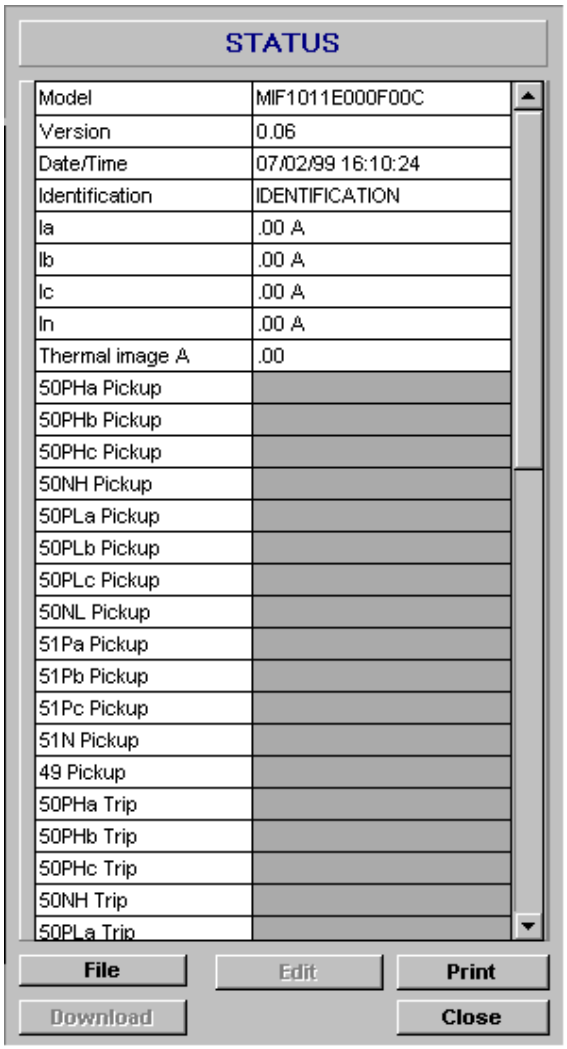


Figure 4.12: TABLE SHOWING INTERNAL RELAY STATUS

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.

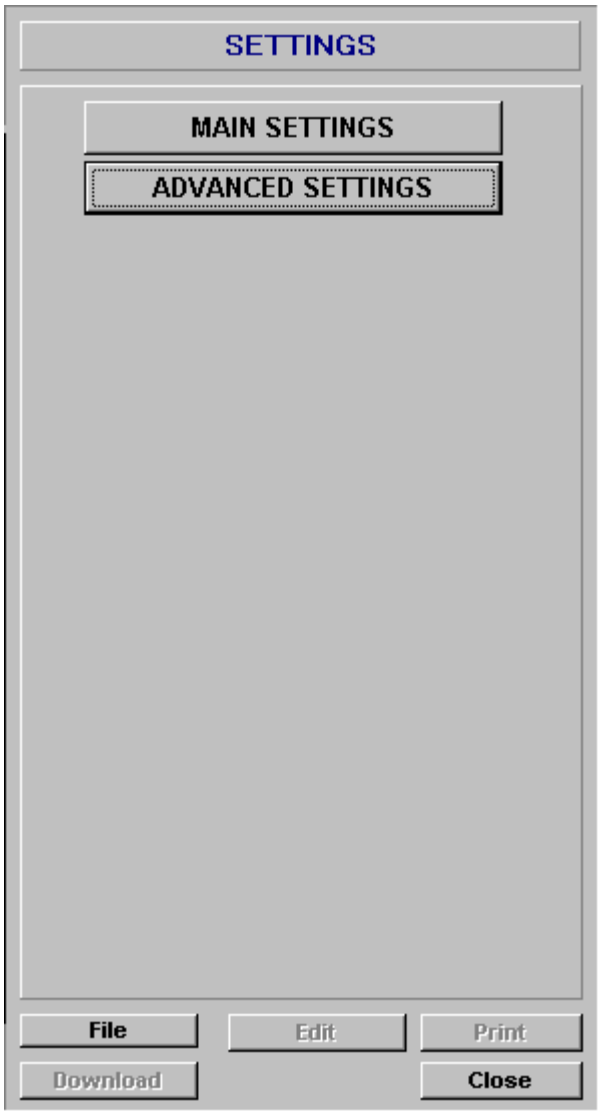


Figure 4.13: SETTINGS MENU.

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

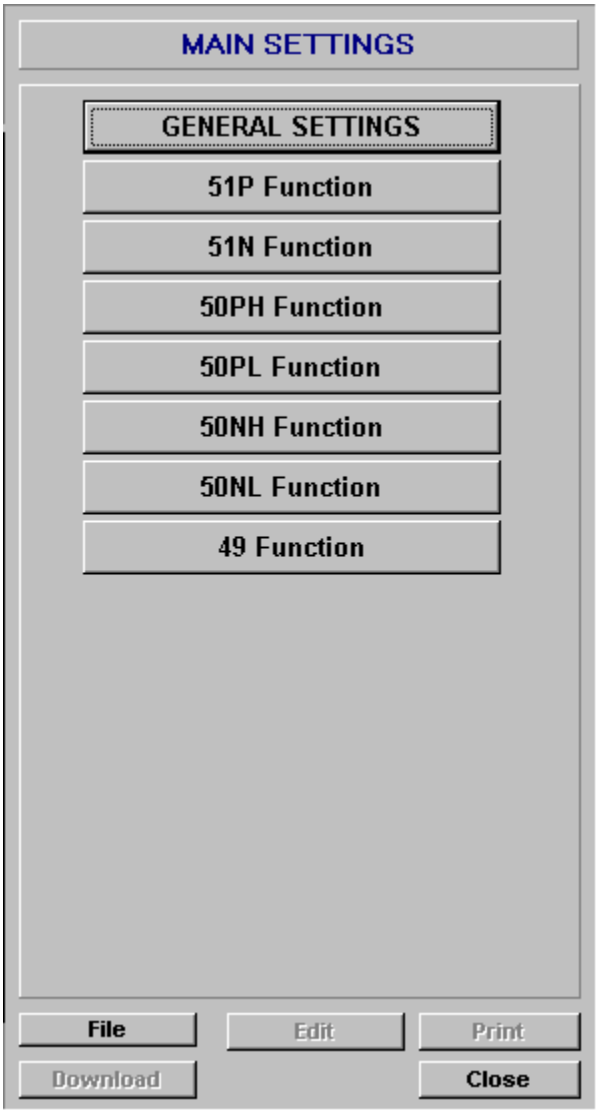


Figure 4.14: MAIN SETTINGS.

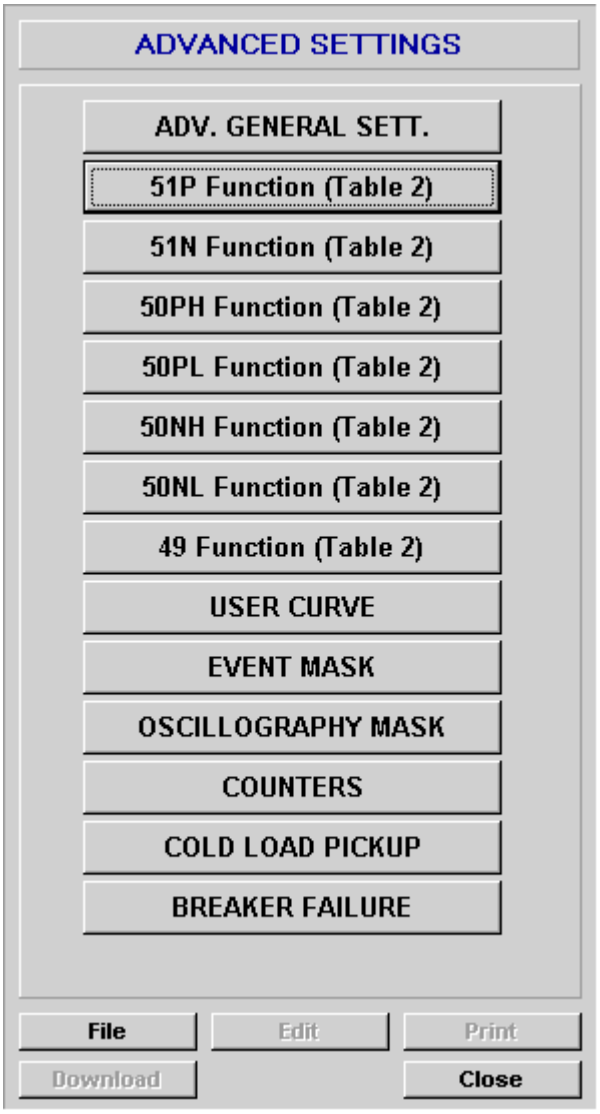


Figure 4.15: ADVANCED SETTINGS.

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 51 Function in a MIF 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).

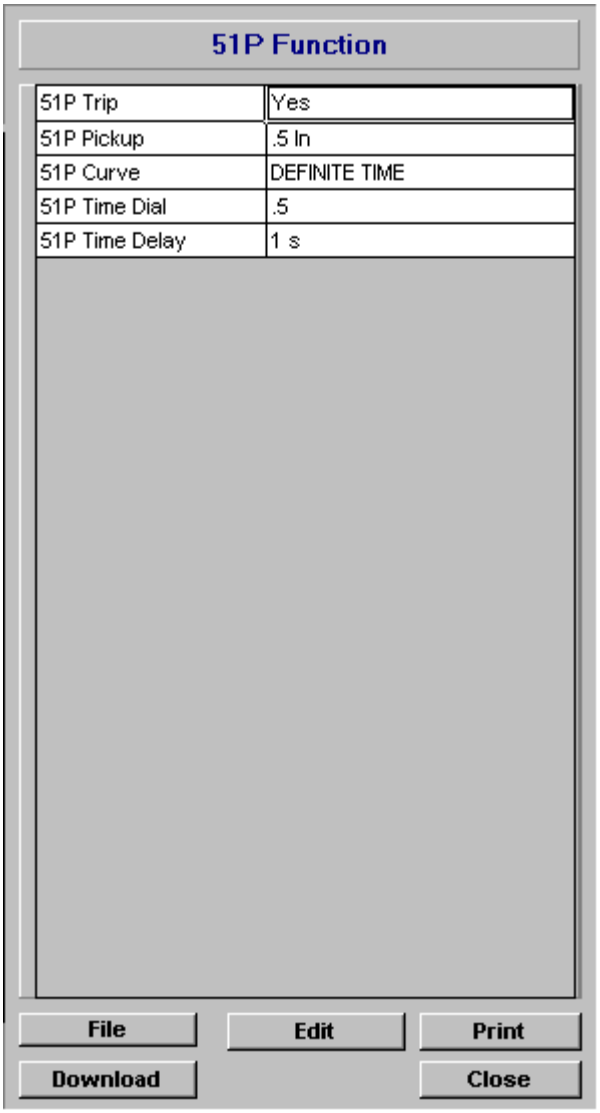


Figure 4.16: SETTINGS SUB-MENU FOR 51 FUNCTION.

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.

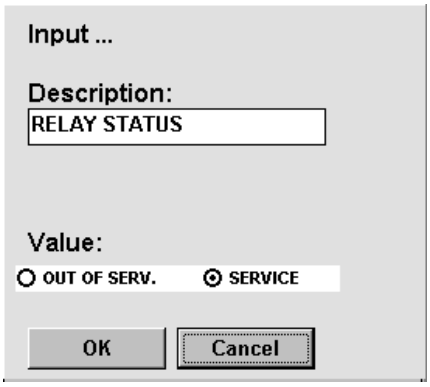


Figure 4.17: LOGIC SETTING

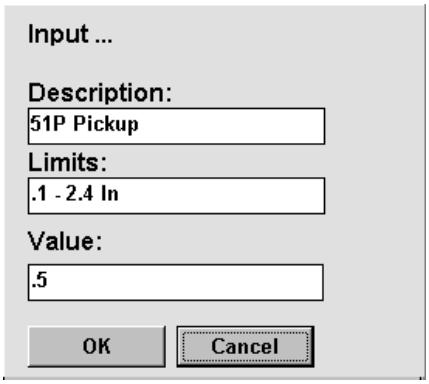


Figure 4.18: NUMERIC SETTING

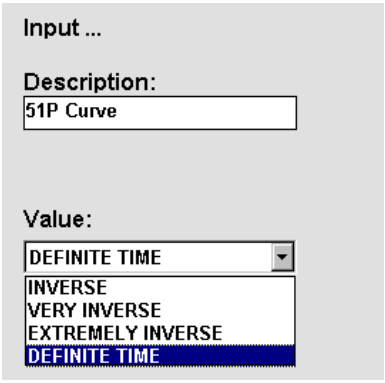


Figure 4.19: SET OF OPTIONS

4.1.11. ADVANCED SETTINGS MENU

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 User's Curve functions, Events Mask, Oscillography Mask, I2T Counter, Cold load pickup, and Breaker failure to open.

The User's Curve parameters A, B, P, Q and K, can be set either from the PC or the relay keypad, while the rest of Advanced Settings can only be set from the PC.

4.1.12. OPERATIONS MENU

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.

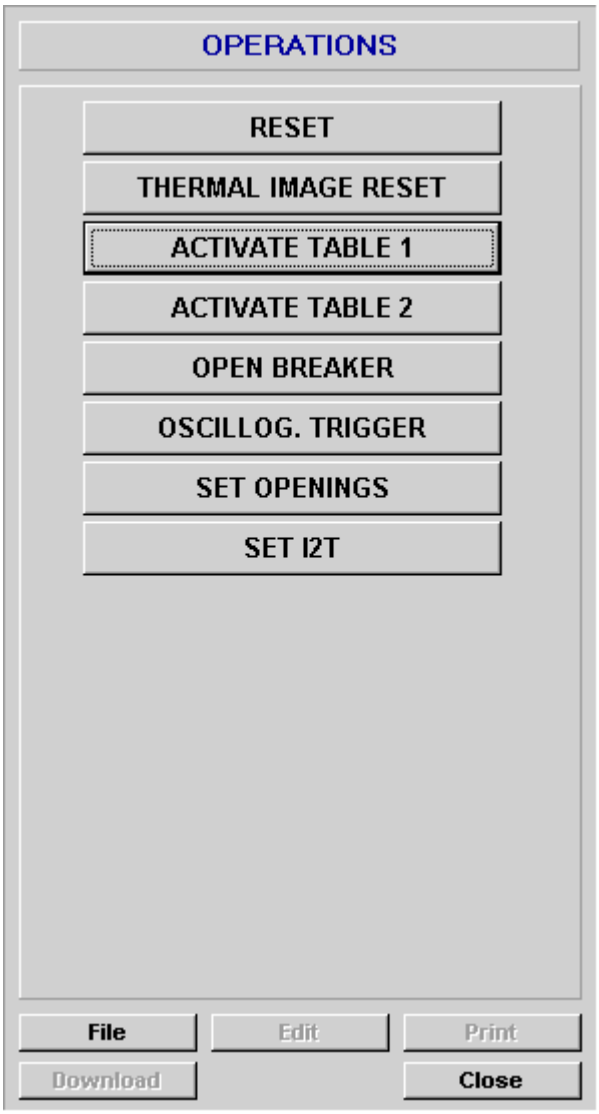
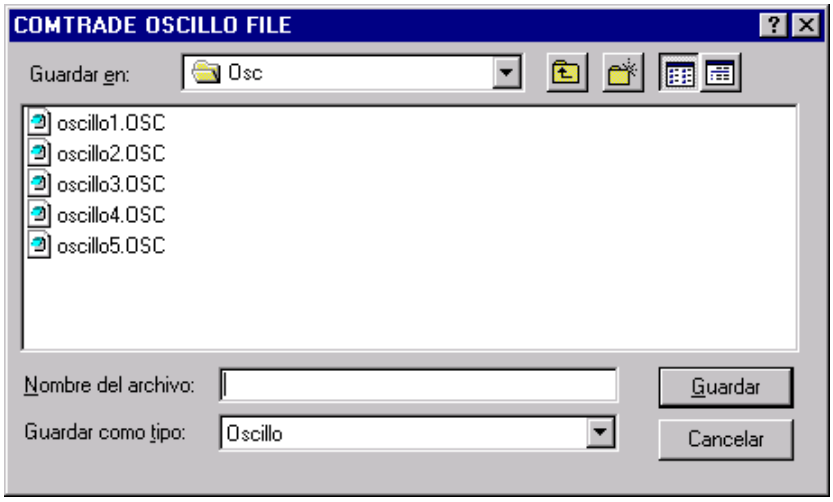


Figure 4.20: OPERATIONS MENU.

4.1.13. OSCILLOGRAPHY MENU

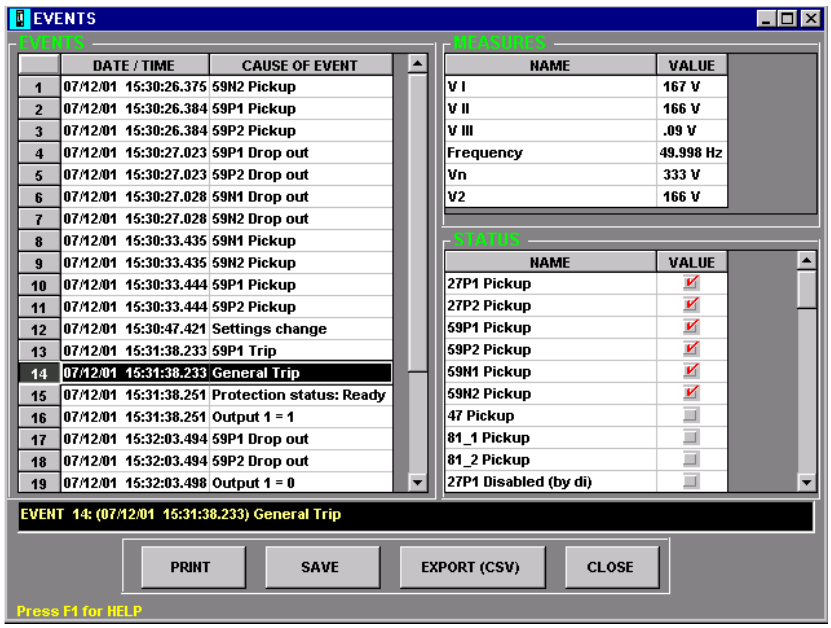
By clicking on the OSCILLOGRAPHY button in the MAIN MENU, the user can start the process to retrieve the Oscillography record stored in the MIF. The program will request the path and filename where the file is to be stored, by means of the following form:



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 32). Each event record is labelled with date, time (with 4msec. 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 current value during the event is also shown.

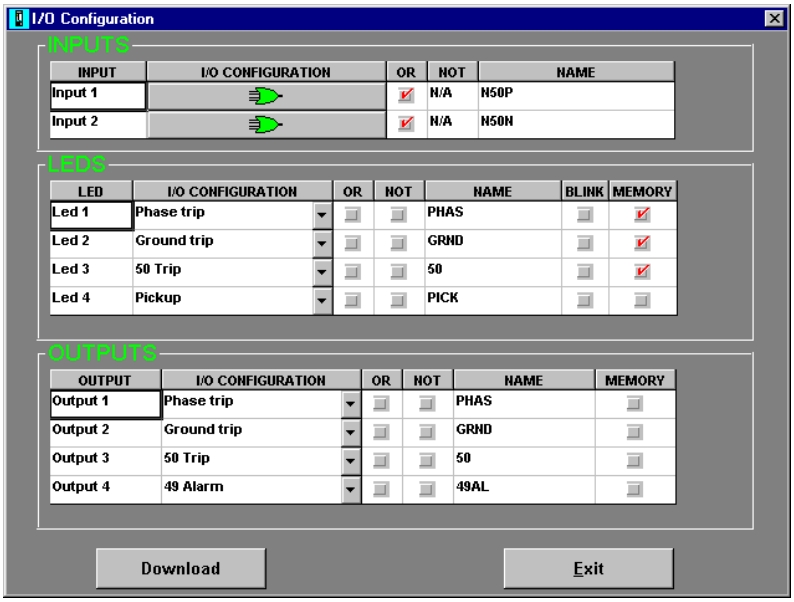


The event list can be printed or stored in a file.

4.1.15. I/O CONFIGURATION MENU

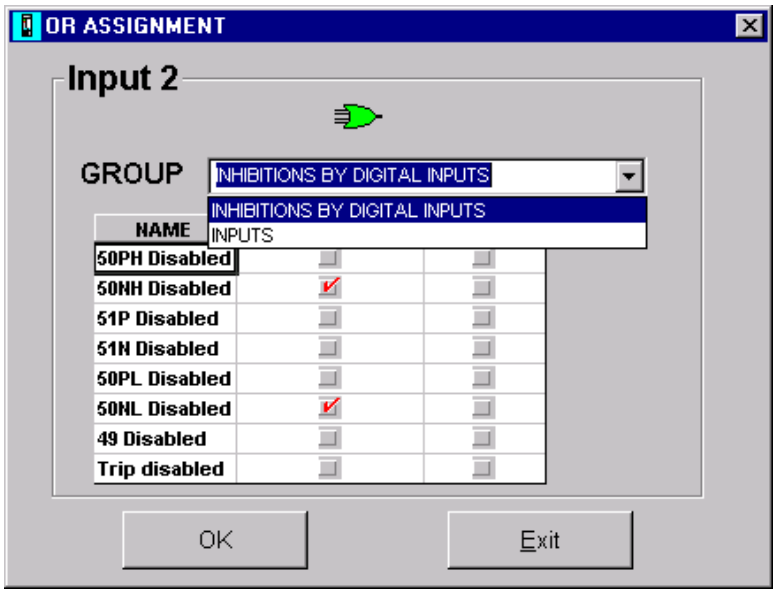
In this menu, the user can configure inputs, outputs and LEDs.

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.

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.

5.1 SETTINGS STRUCTURE

All the settings of the MIF 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 MIF 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 with OPTION 1 or 2*), 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 chapter 6. 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 MIF 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. GENERAL SETTINGS

	M+PC	HMI	DEFAULT	RANGE	STEP
GENERAL SETTINGS	**GENERAL SETTINGS**	**GENERAL**			
Relay Status	RELAY STATUS	STA	DIS	RDY / DIS	NA
Frequency	FREQUENCY	FRQ	50 Hz	50/60 Hz	NA
Password	---	PWD	1	1 – 255	
Address	---	ADD	1	1 – 255	1
Communications Speed	---	BAUD	9600	300, 600, 1200, 2400, 4800, 9600, 19200	NA

5.2.2. TOC SETTINGS (51)

	M+PC	HMI	DEFAULT	RANGE	STEP
TOC Function (51)	**51 Function**	**F51**			
51 Permission to Trip	51 Trip Permission	TRIP 51	No	Y/N	NA
51 Tap / Pickup (for 1/5 A ground)	51 Pickup	TAP 51	0.5 In (Ground)	0.1 – 2.4 In (Gnd)	0.01 In (Gnd)
51 Tap / Pickup (for sensitive ground)	51 Pickup	TAP 51	0.005 A	0.005-0.12 A	0.001 A
51 Curve Type	51 Curve Type	CURV 51	T.DE	INV, V.I., E.I., T.DE	NA
51 Time Dial	51 Time Dial	DIAL 51	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
51 Definite Time Delay	51 Definite Time	TIME 51	1 s.	0 – 99.99 s.	0.01 s.

5.2.3. IOC SETTINGS (50H / 50L)

	M+PC	HMI	DEFAULT	RANGE	STEP
IOC High Set.	**50H Function**	**F50H**			
50H Permission to Trip	50H Trip Permission	TRIP 50H	No	Y/N	NA
50H Tap / Pickup (for 1/5 A ground)	50H Pickup	TAP 50H	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)
50H Tap / Pickup (for sensitive ground)	50H Pickup	TAP 50H	0.005 A	0.005-0.12 A	0.001 A
50H Time Delay	50H Time Delay	TIME 50H	0 s.	0 – 99.99 s.	0.01 s.
IOC Low Setting	**50L Function**	**F50L**			
50L Permission to Trip	50L Trip Permission	TRIP 50L	No	Y/N	NA
50L Tap / Pickup (for 1/5 A ground)	50L Pickup	TAP 50L	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)

	M+PC	HMI	DEFAULT	RANGE	STEP
50L Tap / Pickup (for sensitive ground)	50L Pickup	TAP 50L	0.005 A	0.005-0.12 A	0.001 A
50L Time Delay	50L Time Delay	TIME 50L	0 s.	0 – 99.99 s.	0.01 s.

5.2.4. THERMAL IMAGE SETTINGS (49)

	M+PC	HMI	DEFAULT	RANGE	STEP
Thermal Image (49)	**49 Function**	**F49**			
Permission to Trip	49 Trip Permission	TRIP 49	NO	Y/N	NA
49 Tap / Pickup	49 Pickup	TAP 49	1 In	0.1 – 2.4 In	0.01 In
Overload Percent Alarm	49 Alarm Level	ALARM 49	80 %	70% – 100% ITH	1%
Heating Time Constant $\tau 1$	T1	T1	6	3 – 600 min.	1 min
Cooling Time Constant $\tau 2$	T2	T2	1	1 – 6 times $\tau 1$	1

5.3 ADVANCED SETTINGS

5.3.1. GENERAL SETTINGS

	M+PC	HMI	DEFAULT	RANGE	STEP
General Settings (Adv.)	**GENERAL SET. ADV.**	**GENERAL ADVANCED**			
Identification	IDENTIFICATION	---	MIF	Text	NA
Active Table	ACTIVE TABLE	TAB	1	1 – 2	NA
Trip Contact - Minimum time closed.	TRIP MINIMUM TIME	TRIP MIN TIME	100 ms.	50 – 300 ms.	1 ms.

5.3.2. TOC SETTINGS (51) (TABLE 2)

	M+PC	HMI	DEFAULT	RANGE	STEP
TOC Fun. Table 2	**51 Function (Table 2)**	**F51 T2**			
51 Permission to Trip	51 Trip Permission T2	TRIP 51 T2	No	Y/N	NA
51 Tap / Pickup Value (1/5 A ground)	51 Pickup T2	TAP 51 T2	0.5 In	0.1 – 2.4 In	0.01 In
51 Tap / Pickup Value (sensitive ground)	51 Pickup T2	TAP 51 T2	0.005 A	0.005-0.12 A	0.001 A
51 Curve Type	51 Curve Type T2	CURV 51 T2	T.DE	INV, V.I., E.I., T.DE	NA
51 Time Dial	51 Time Dial T2	DIAL 51 T2	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
51 Definite Time Delay	51 Definite Time T2	TIME 51 T2	1 s.	0 – 99.99 s.	0.01 s.

5.3.3. IOC SETTINGS (50H / 50L) (TABLE 2)

	M+PC	HMI	DEFAULT	RANGE	STEP
IOC High Set Table 2	**50H Function (Table 2)**	**F50H T2**			
50H Permission to Trip	50H Trip Permission T2	TRIP 50H T2	No	Y/N	NA
50H Tap / Pickup (1/5 A ground)	50H Pickup T2	TAP 50H T2	1 In	0.1 – 30 In	0.1 In
50H Tap / Pickup Value (sensitive ground)	50H Pickup T2	TAP 50H T2	0.005 A	0.005-0.12 A	0.001 A
50H Time Delay	50H Time Delay T2	TIME 50H T2	0 s.	0 – 99.99 s.	0.01 s.
IOC Low Set Table 2	**50L Function (Table 2)**	**F50L T2**			
50L Permission to Trip	50L Trip Permission T2	TRIP 50L T2	No	Y/N	NA
50L Tap / Pickup (1/5 A ground)	50L Pickup T2	TAP 50L T2	1 In	0.1 – 30 In	0.1 In
50L Tap / Pickup Value (sensitive ground)	50L Pickup T2	TAP 50L T2	0.005 A	0.005-0.12 A	0.001 A
50L Time Delay	50L Time Delay T2	TIME 50L T2	0 s.	0 – 99.99 s.	0.01 s.

5.3.4. THERMAL IMAGE SETTINGS (49) (TABLE 2)

	M+PC	HMI	DEFAULT	RANGE	STEP
Thermal Image Table 2	**49 Function (Table 2)**	**F49 T2**			
Permission to Trip	49 Trip Permission T2	TRIP 49 T2	NO	Y/N	NA
49 Tap / Pickup	49 Pickup T2	TAP 49 T2	1 In	0.1 – 2.4 In	0.01 In
Overload Percent Alarm	49 Alarm Level T2	ALARM 49 T2	80 %	70% – 100% ITH	
Heating Time Constant τ1	T1 T2	T1 T2	6	3 – 600 min.	1 min.
Cooling Time Constant τ2	T2 T2	T2 T2	1	1– 6 times τ1	1

5.3.5. USER'S CURVE

	M+PC	HMI	DEFAULT	RANGE	STEP
Parameters	**USU Function**				
A	A	A	0.05	0-125	0.001
B	B	B	0	0-3	0.001
P	P	P	0.04	0-3	0.001
Q	Q	Q	1	0-2	0.001
K	K	K	0	0-1.999	0.001

5.3.6. EVENTS AND OSCILLOGRAPHY MASKS

The events masks and oscillography masks groups are available only in models with OPTION 1 or 2. Events masks showing a 2 in the end of the row are available only in MIF models with OPTION 2.

	M+PC	DEFAULT	RANGE	STEP
Event masks	Event masks			
50H Pickup/Drop out	50H Pickup	YES	Y/N	NA
50L Pickup/Drop out	50L Pickup	YES	Y/N	NA
51 Pickup/Drop out	51 Pickup	YES	Y/N	NA
49 Alarm Pickup/Drop out	49 Alarm	YES	Y/N	NA
50H Trip	50H Trip	YES	Y/N	NA
50L Trip	50L Trip	YES	Y/N	NA
51 Trip	51 Trip	YES	Y/N	NA
49 Trip	49 Trip	YES	Y/N	NA
General trip	General trip	YES	Y/N	NA
50H Trip enable/disable by digital input	50H disabled	YES	Y/N	NA
50L Trip enable/disable by digital input	50L disabled	YES	Y/N	NA
51 Trip enable/disable by digital input	51 disabled	YES	Y/N	NA
General Trip enable/disable by digital input	Trip disabled	YES	Y/N	NA
Protection status: in service/out of service	Protection status	YES	Y/N	NA
Digital output1 active/non active	Output 1	YES	Y/N	NA
Digital output 2 active/non	Output 2	YES	Y/N	NA

	M+PC	DEFAULT	RANGE	STEP
active				
Digital output 3 active/non active	Output 3	YES	Y/N	NA
Digital output 4 active/non active	Output 4	YES	Y/N	NA
Digital input 1 active/non active	Digital input 1	YES	Y/N	NA
Digital input 2 active/non active	Digital input 2	YES	Y/N	NA
Settings change disabled by digital input	Settings change disabled	YES	Y/N	NA
Trip operation by digital input	Trip operation by input	YES	Y/N	NA
Trip operation by command	Trip operation by com.	YES	Y/N	NA
Auxiliary digital output latch reset	Reset latch aux	YES	Y/N	NA
52 B open/closed	Breaker 52 A	YES	Y/N	NA (2)
52 A open/closed	Breaker 52 B	YES	Y/N	NA (2)
52 open/closed	Breaker status	YES	Y/N	NA (2)
Table 2 selection by digital input	Active table change	YES	Y/N	NA
Oscillo trigger by digital input	Oscillo trig by input	YES	Y/N	NA
Oscillo trigger by command	Oscillo trig by com.	YES	Y/N	NA
Breaker failure to open	Breaker failure to open	YES	Y/N	NA (2)
I2 Alarm	I2 Alarm	YES	Y/N	NA (2)
Settings change	Settings change	YES	Y/N	NA
E2prom failure	e2prom failure	YES	Y/N	NA
User settings/Factory settings	User settings	YES	Y/N	NA

5.3.7. OSCILLOGRAPHY MASKS

	M+PC	DEFAULT	RANGE	STEP
Oscillography masks	**Oscillography masks**			
Oscillo by communications	Oscillo by communic.	NO	Y/N	NA
Oscillo by digital input	Oscillo by Digital Input	NO	Y/N	NA
Oscillo by tripping	Oscillo by tripping	NO	Y/N	NA
Oscillo by pickup	Oscillo by pickup	NO	Y/N	NA

The following three groups are only available in MIF models with OPTION 2:

5.3.8. I2 COUNTER

	M+PC	HMI	DEFAULT	RANGE	STEP
Counter	**I2 Counter**				
I2 limit	I2 limit	I2T MAX	999.000	0-999.000 kA2	0.001 kA2

5.3.9. BREAKER FAILURE TO OPEN

	M+PC	HMI	DEFAULT	RANGE	STEP
Breaker failure to open	**Breaker failure to open**		**BF**		
Breaker failure to open enable	Breaker failure function	BF ENABLE	NO	Y/N	NA
Fail to open timer	Fail to open timer	BF TIME	400	50-999 ms	1 ms

5.3.10. COLD LOAD PICKUP

	M+PC	HMI	DEFAULT	RANGE	STEP
Cold load pickup	**Cold load pickup**	**CLP**			
Cold load pickup enable	Cold load pickup function	CLP ENABLE	NO	Y/N	NA
Pickup time	T IN	T IN	2	0-60 s	0.001 s
Drop out time	T OUT	T OUT	2	0-60 s	0.001 s
Constant. 50P pickup	K 50P	K 50P	1	1-5	0.01
Constant 51 pickup	K 51	K 51	1	1-5	0.01

COMMENTS ON SETTINGS:

1. The ACTIVE TABLE setting, in the Advanced General Settings, selects which of the two settings tables is active at a given time. Its default value is 1 (TABLE 1).

2. The procedure to set the TOC (Time Delayed Overcurrent) function (51) is the following: First, the pickup value must be set (PICKUP); Then, using the CURVE TYPE (current versus time tripping characteristic curve), the type of time delay preferred is selected, either DEFINITE TIME, or any of the three inverse curves; If the choice is any of the inverse curves (Inverse, Very Inverse or Extremely Inverse), then the relay takes into account the TIME DIAL setting, to identify which of the curves in the family (there are 195 different curves for each curve type, depending on the Time Dial Selected) must use; If the current versus time tripping characteristic is DEFINITE TIME, then the Time Dial setting is ignored and the time delay used is the specified in DEFINITE TIME setting.

5.4 TIME SYNCHRONIZATION

MIF 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.

6.1 INPUT CONFIGURATION (ONLY FOR OPTION 1 AND OPTION 2 MODELS)

6.1.1. DESCRIPTION OF INPUTS

The MIF incorporates 2 digital inputs, which can be configured using the M+PC software. The default input configuration is as follows:

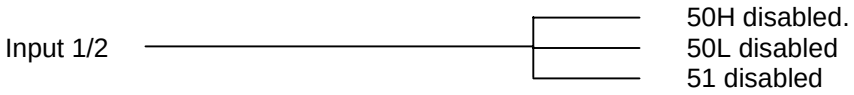
Input 1: 51 disabled
Input 2: 50H disabled & 50L disabled.

All functions not defined as PULSE are LEVEL inputs.
The minimum operation time for a valid PULSE input is over 0.015 seconds.

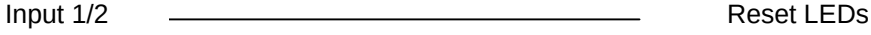
Inputs functions are divided in 2 groups with up to eight functions per group, besides the *No definition* function. Up to eight functions can be configured for the same input, provided that they are all in the same group. Functions belonging to different groups need to be assigned to different inputs.

In order to configure an input with more than one function from the same group, first we must activate the **OR** button, click on the **I/O CONFIGURATION** option and select the desired group, then select the desired functions. For negating a function, select the **NOT** button. Finally, click the **OK** button.

For example, if we want only the thermal function to trip, we can disable the rest of functions, or we can assign the rest of the disabled functions to one digital input, using an OR.



If we want to reset LEDs using a digital input, we must assign the LED reset function to one digital input



6.1.2. INPUT FUNCTIONS

The following table shows the list of functions that can be assigned to each input. The table is divided into three groups:

No definition	Input not assigned

50H disabled	50H trip disabled
50L disabled	50L trip disabled
51 disabled	51 trip disabled
49 disabled	49 trip disabled
Trip disabled	Trip of all functions is disabled

Breaker 52 a	This function set means breaker close
Breaker 52 b	This function set means breaker open
Trip contact close (PULSE)	This function allows activating the trip output
Table change	Enabled means that the active table is T2 Disabled means that active table is the General Settings table
Settings change disabled	Enabled means that settings and active table can not be changed. It is only possible to switch to T2 through digital input Table change
Reset (PULSE)	This function allows LED and output Latch reset
Oscillo trigger (PULSE)	This function allows to activate the oscillo function
General input	Generic function that may be used in logic configuration.

6.2 OUTPUTS AND LEDS CONFIGURATION (ONLY FOR OPTION 1 AND OPTION 2 MODELS)

6.2.1. DESCRIPTION OF OUTPUTS AND LEDS

The MIF incorporates 4 configurable outputs and 4 LED indicators, which can only be configured by M+PC software.

The default configuration for outputs is as follows:

OUTPUT	CONFIGURATION	MEMORY
1	51 trip	No
2	50H trip	No
3	50L Trip	No
4	49 Alarm	No

The default LED configuration is as follows:

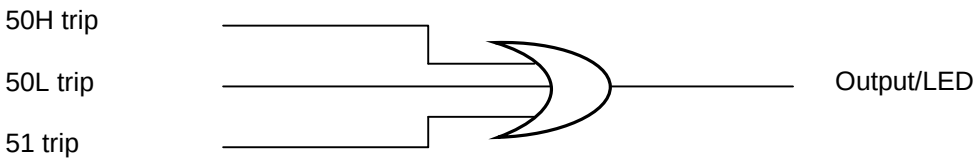
LED	CONFIGURATION	MEMORY
1	51 trip	Yes
2	50 trip	Yes
3	49 Alarm	Yes
4	Pickup	No

Functions that can be assigned to Outputs/LEDs are divided in eight groups, besides the *No definition* function. Functions belonging to the same group can be assigned to the same output/LED. Functions of different groups need to be assigned to different outputs/LEDs.

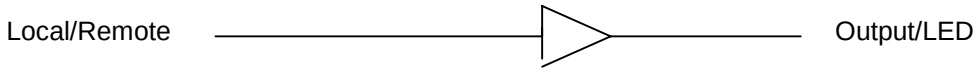
In order to assign several functions to an output/LED, first we must activate the **OR** button, click on the **I/O CONFIGURATION** frame and select the desired group, then select the desired functions. In order to negate a function, select the **NOT** button. Finally, click on the **OK** button.

Now you can invert all the logic by selecting the general NOT button. Outputs can be memorised, and LEDs can be set to be fixed or blinking.

If we want to assign a trip to an output or LED, we must program the output or LED with 50H pickup, 50L pickup and 51 functions.



If we want an output or LED to be active when function is Remote, we must program the output or LED with the Local/Remote function inverted with NOT.



We must remember not to include functions from different groups in an OR type logic.

6.2.2. OUTPUTS AND LEDS FUNCTIONS

The list of functions that can be assigned to the different outputs and LEDs is divided in the following groups:

No definition	Output or LED not assigned

Logic 1	Output signal of logic 1
Logic 2	Output signal of logic 2
Logic 3	Output signal of logic 3
Logic 4	Output signal of logic 4

50 trip	Any trip of 50H, 50L functions

50H trip	50H function trip
50L trip	50L function trip
51 trip	51 function trip
49 trip	49 function trip
General trip	Any trip of the above mentioned functions

50H pickup	50H function pickup
50L pickup	50L function pickup
51 pickup	51 function pickup
49 Alarm	49 function pickup
Pickup	Pickup of any of the above mentioned functions

50H virtual trip	Trip condition for 50H function exists
50L virtual trip	Trip condition for 50L function exists
51 virtual trip	Trip condition for 51 function exists
49 virtual trip	Trip condition for 49 function exists
General virtual trip	Any virtual trip of the above mentioned functions

Input 1	Digital input 1
Input 2	Digital input 2

Breaker failure to open	Output of the breaker failure to open function, when it is enabled
Breaker status	When BF function is enabled and breaker is connected to input1/2
I2 Alarm	Output of the I^2 counter function
Cold load pickup	Output of the Cold load pickup function, when it is enabled
E2prom failure	Active when a failure is detected in e2prom management
User settings	This function is green when the default settings are active and red when the user's settings are active

READY	Active when the relay is in service and at least one function has trip enabled

ACTIVE TABLE	T1 or T2
Local/Remote	It's local when the HMI is inside the MAIN SETTINGS or ADVANCED SETTINGS menu or OPERATIONS menu

When trip conditions exist for a protection unit, the relay operates a virtual trip of this unit. If it is not disabled by setting or Digital Input, the trip occurs.

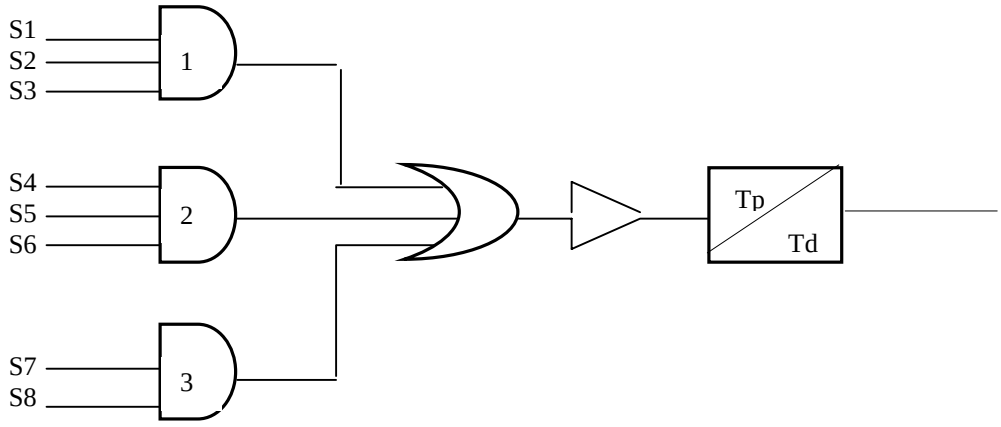
7.1.1. LOGIC DESCRIPTION

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:



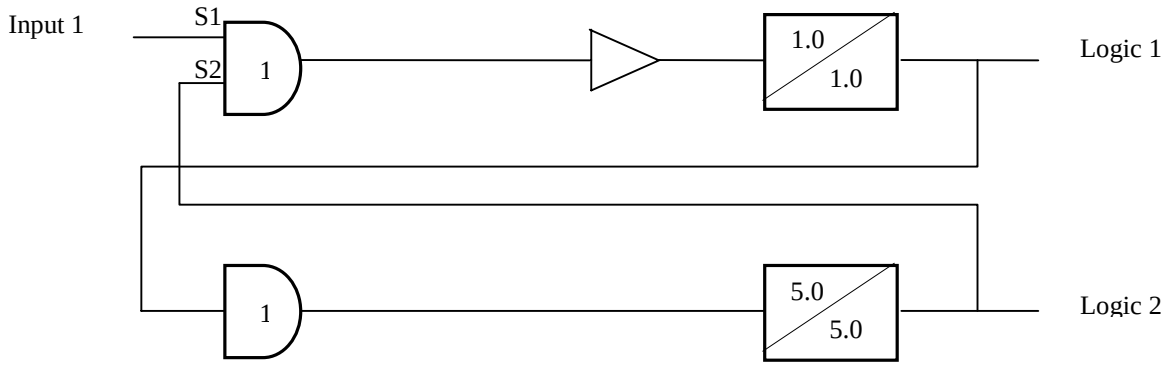
Each signal (S1...S8) has the same structure as the outputs/LEDs.

To configure a logic box, we can proceed in the same way as for the outputs/LEDs configuration per signal.

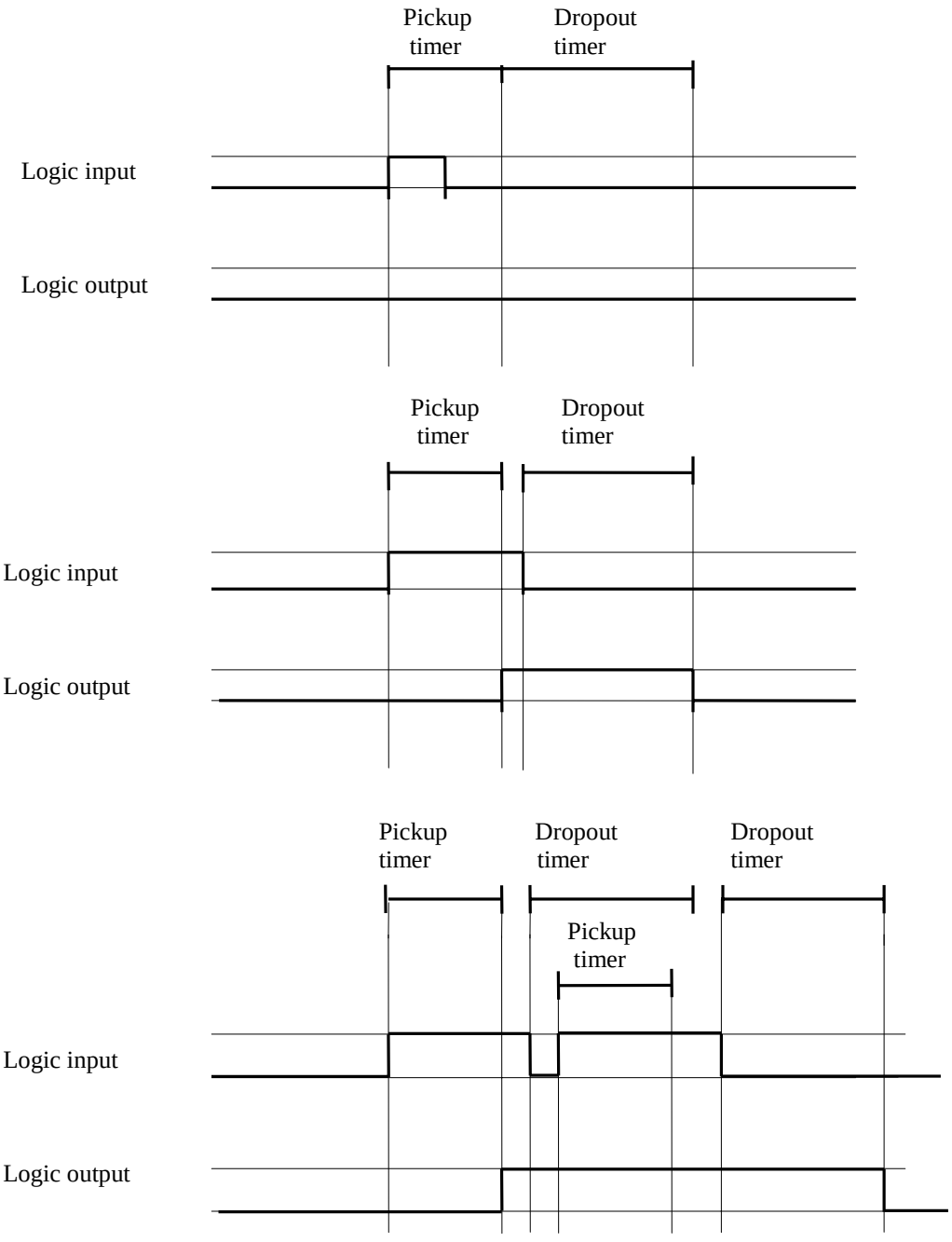
There are two timers, pickup and dropout timers, that can be assigned to each logic box.

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:



7.1.2. LOGIC FUNCTIONS

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

No definition	Output or LED not assigned

Logic 1	Output signal of logic 1
Logic 2	Output signal of logic 2
Logic 3	Output signal of logic 3
Logic 4	Output signal of logic 4

50 trip	Any trip of 50H, 50L functions

50H trip	50H function trip
50L trip	50L function trip
51 trip	51 function trip
49 trip	49 function trip
General trip	Any trip of the above mentioned functions

50H pickup	50H function pickup
50L pickup	50L function pickup
51 pickup	51 function pickup
49 Alarm	49 function pickup
Pickup	Pickup of any of the above mentioned functions

50H virtual trip	Trip condition for 50H function exists
50L virtual trip	Trip condition for 50L function exists
51 virtual trip	Trip condition for 51 function exists
49 virtual trip	Trip condition for 49 function exists
General virtual trip	Any virtual trip of the above mentioned functions

50H trip disable	Trip inhibition for 50H function
50L trip disable	Trip inhibition for 50L function
51 trip disable	Trip inhibition for 51 function
49 trip disable	Trip inhibition for 49 function
Trip disable	All trips inhibited

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

Generic input	Generic input function
Settings change inhibition	When this function is active, settings and tables cannot be modified. It is only possible to activate Table 2 using the Table Change digital input
52a	Active with closed breaker
52b	Active with open breaker
Table Change	Activating this function, the active table is T2. When it is deactivated, the active table is the one selected in the Active Table setting

Breaker failure to open	Output of the breaker failure to open function, when it is enabled
Breaker status	When BF function is enabled and breaker is connected to input1/2
I^2 Alarm	Output of the I^2 counter function
Cold load pickup	Output of the Cold load pickup function, when it is enabled
E2prom failure	Active when a failure is detected in e2prom management
User settings	This function is green when the default settings are active and red when the user's settings are active

READY	Active when the relay is in service and at least one function has trip enabled

ACTIVE TABLE	T1 or T2
Local/Remote	It's local when the HMI is inside the MAIN SETTINGS or ADVANCED SETTINGS menu or OPERATIONS menu

8.1 FACEPLATE KEYPAD

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

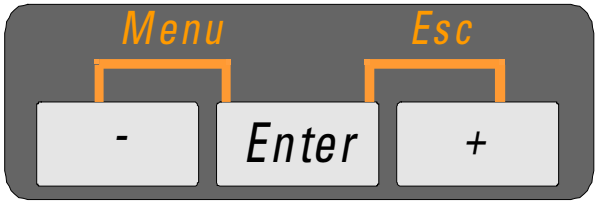


Figure 8.1. KEYPAD

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 MIF 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.

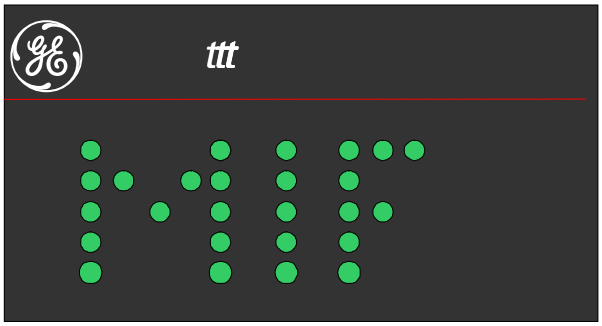


Figure 8.2. ALPHANUMERIC DISPLAY

Messages in the display are shown in English language. If the keypad is not in use during 15 minutes, the relay will automatically perform an scrolling through the most relevant measures (I and TH (Thermal Image)).

8.3 MAIN STRUCTURE

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

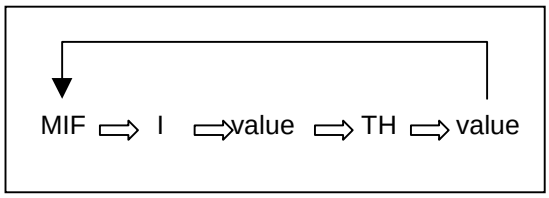


Figure 8.3. SCROLLING WHILE THE KEYPAD IS NOT USE

The relay can leave the steady state in two ways:

- **1ST WAY:** The **ENTER** key is pressed. The relay moves to the **ONE KEY OPERATION** mode:

The **ONE KEY OPERATION** menu allows the user to access the same information shown by the automatic scrolling during steady state plus Date and Time and Last Trip Information (Function that tripped (LTU = Last Trip Unit), and fault current value).

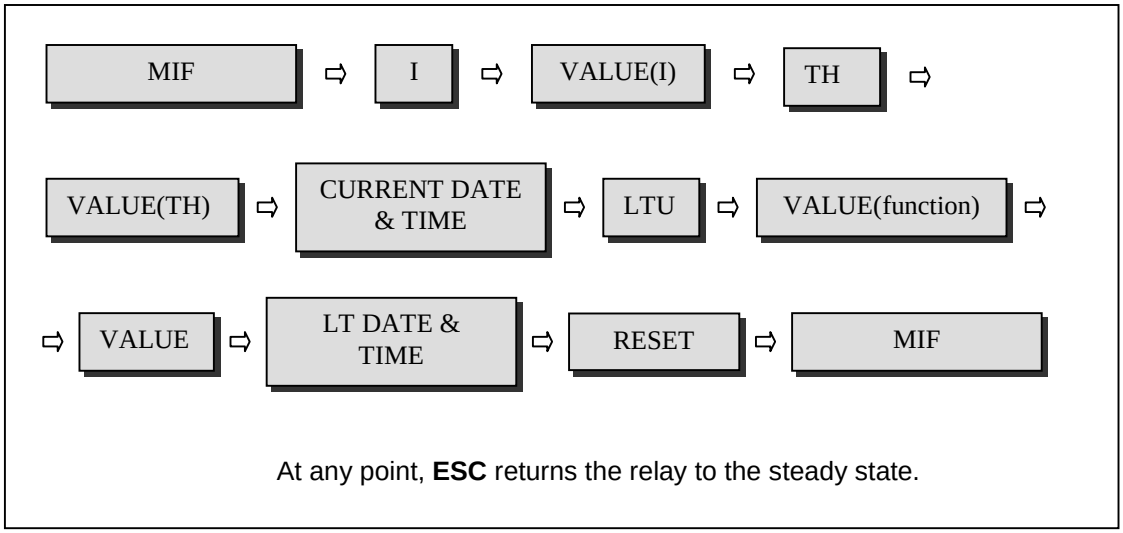


Figure 8.4. ONE KEY OPERATION MENU

The mnemonics used in the figure have the following meanings:

I	Current.
Value (I)	Measured current.
TH →	Thermal Image.
Value (TH)	Thermal Image Level Percentage Metering.
CurrentDate & Time	Current Date and Time in the relay.

LTU	Function that caused the last trip (LAST TRIP UNIT).
Value (function)	Shows which unit caused the last trip.
LT Date & Time	Shows the last trip date and time
Value	Shows the last trip current (Amps).
RESET	Resets the LEDs and latch of auxiliary contacts (models 1 and 2).

• **2ND WAY**: From steady state, select **MENU**, pressing "**Enter"** and "**-**" simultaneously:

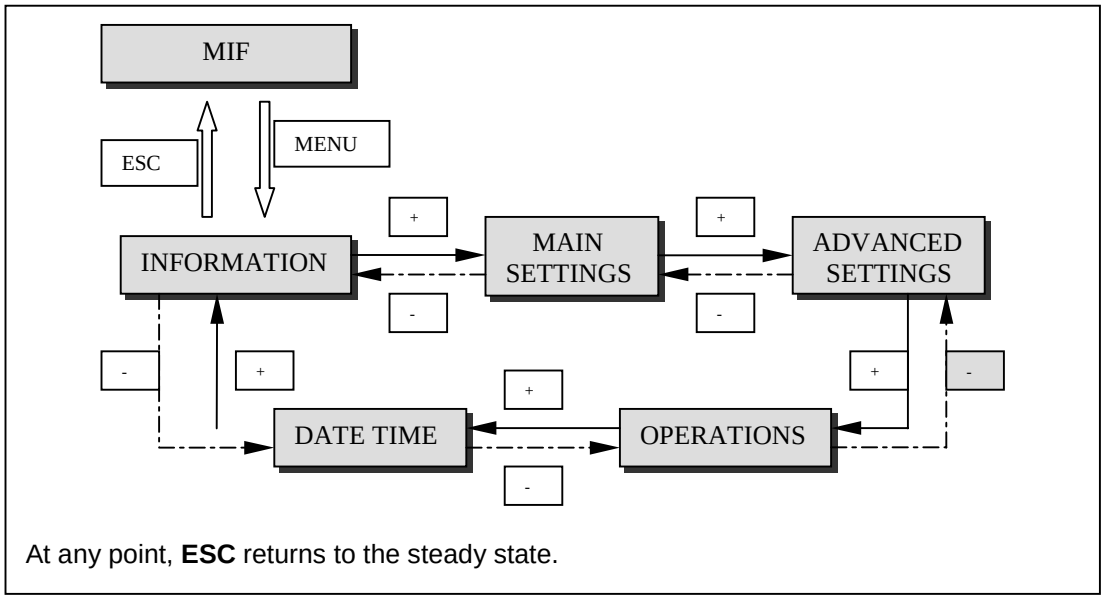


Figure 8.5. SELECT MENU FROM THE STEADY STATE

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

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.

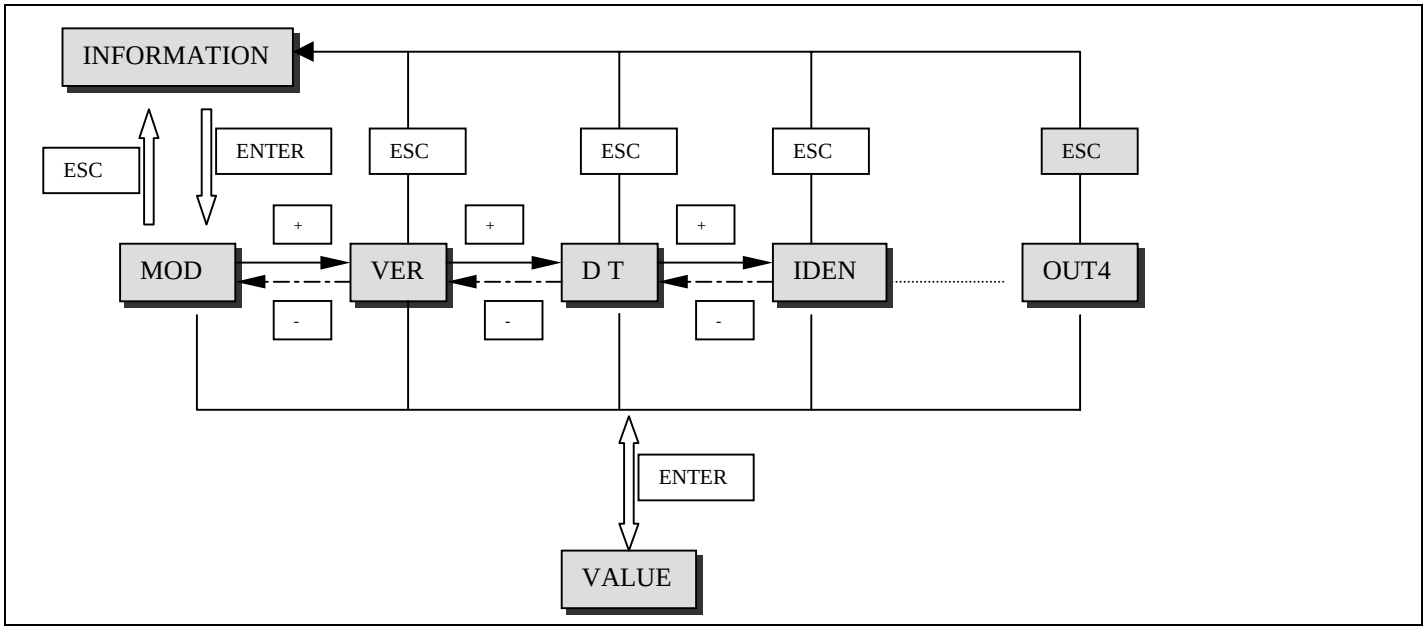


Figure 8.6. DISPLAY & KEYPAD HANDLING FROM INFORMATION MENU

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 meaning:

MOD	Relay Model number
VER	Firmware version installed in the relay.
D T	Relay Date and Time.
IDEN	Identification.
I, TH	Currents and Thermal Image.
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.

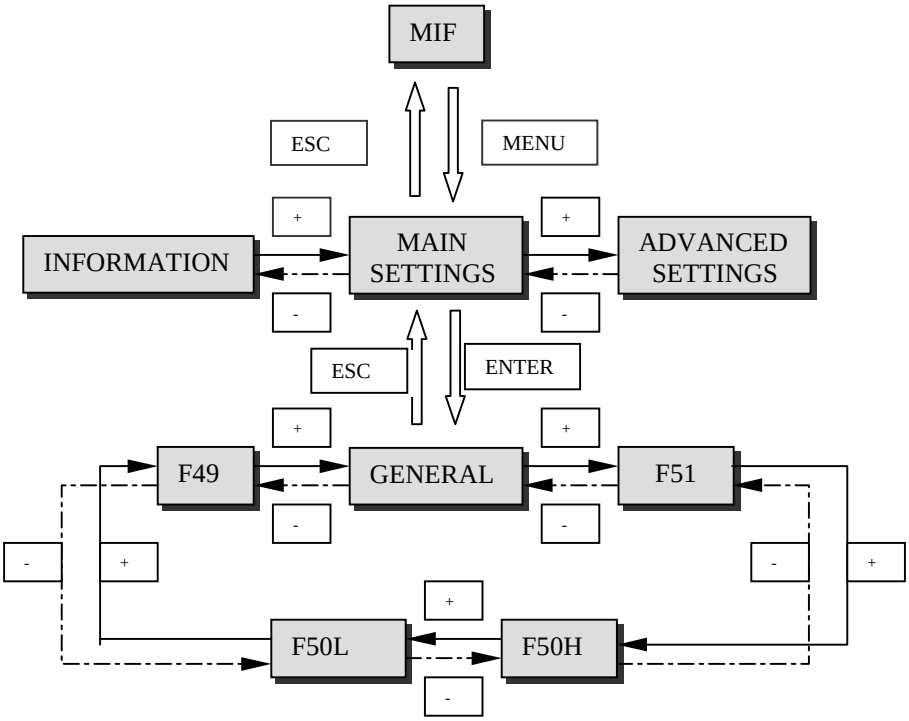
The following mnemonics will appear only in OPTION 2 models:

COLD LOAD	Cold load pickup enabled.
B 52 A	Terminal 52 A.
B 52 B	Terminal 52 B.
BF ACTIVE	Breaker failure to open.
I^2 ALARM	I2t alarm
I^2 VALUE	I2t accumulated value
OPENINGS	Number of openings

.

8.5 MAIN SETTINGS MENU

Keypad and Display handling to access the Main Settings menu:



At any point, **Esc** returns to the previous level. (i.e. from **FXXX** to **Main Settings**).

Figure 8.7. KEYPAD AND DISPLAY HANDLING TO ACCESS MAIN SETTINGS

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	General Settings.
F51	Time Overcurrent Function (51).
F50H	Instantaneous Overcurrent, High Setting.
F50L	Instantaneous Overcurrent, Low Setting.
F49	Thermal Image Function

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

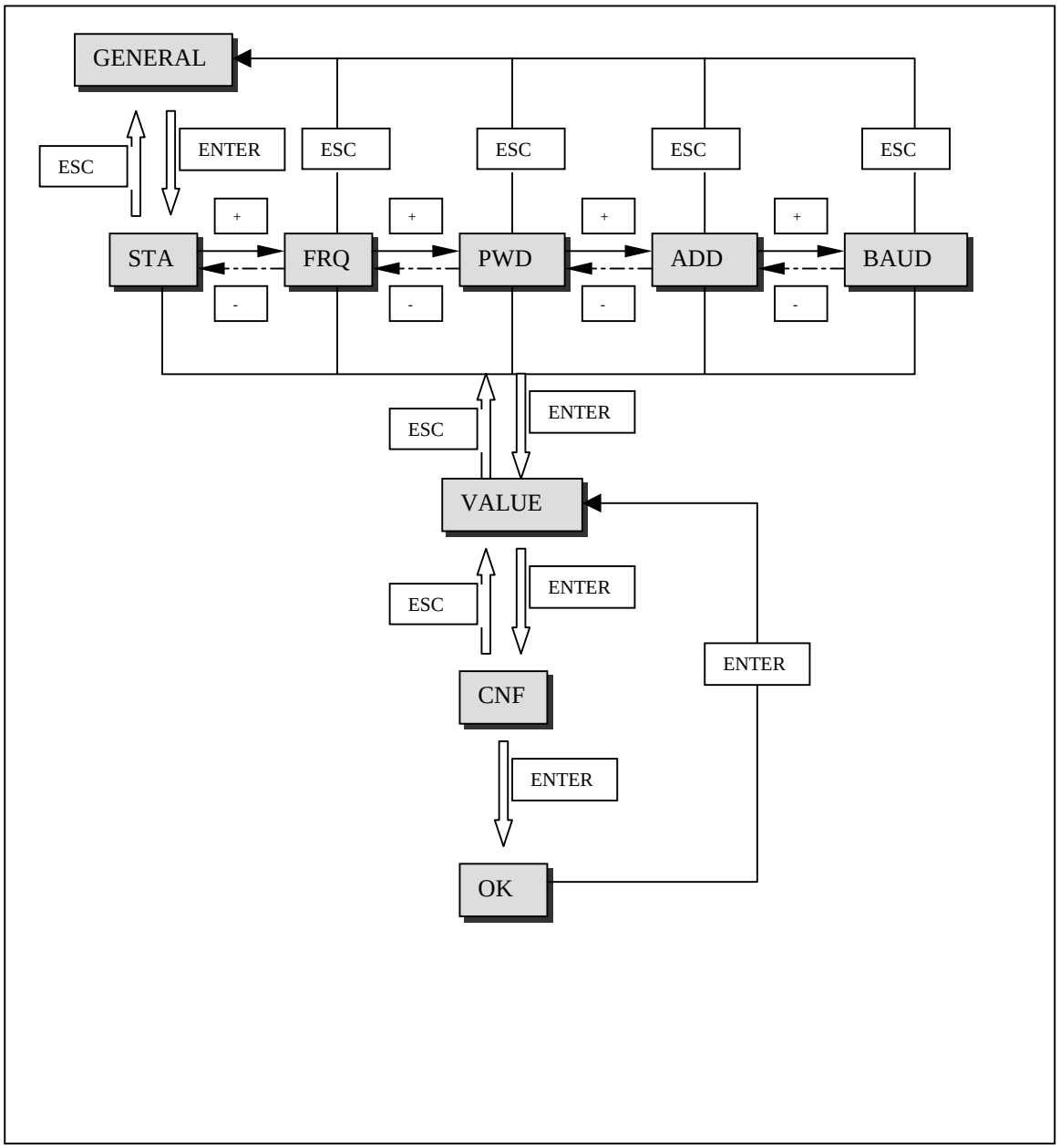


Figure 8.8. KEYPAD AND DISPLAY HANDLING FROM GENERAL SETTINGS HEADING

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 (in service/out of service).
- Range:
  RDY Ready (in service).
  DIS Disabled (out of service).

FRQ FREQUENCY System Frequency.
- Range:
  - 50 50 Hz.
  - 60 60 Hz.

PWD PASSWORD Relay Password (to change settings, perform commands from the PC.)
- Range:
  1, 2, 3, ... 255

ADD ADDRESS Communications Address.
- Range:
  1, 2, 3, ... 255

BAUD BAUD Communications Speed.
- 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 CONFIRM OK Validate the new value for the setpoint.

From the **F51** heading, the following key strokes and displays are possible:

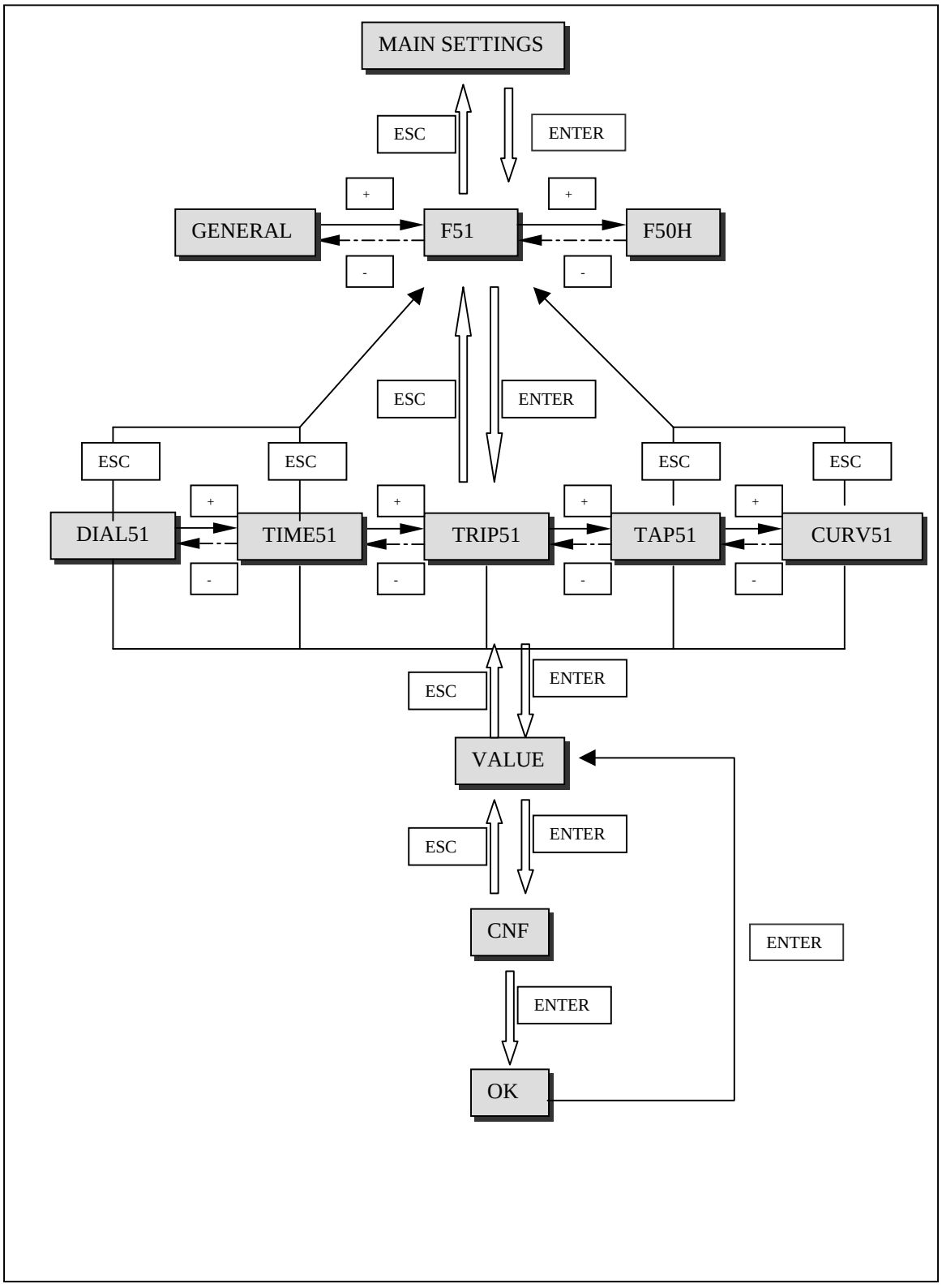


Figure 8.9. KEYPAD AND DISPLAY HANDLING FROM THE F51 HEADING

Press **Enter** to access the different settings corresponding to the **F51** function: **TRIP51**, **TAP51**, **CURV51**, **DIAL51** and **TIME51**. Pressing "+" and "-" move through these settings headings until the display shows the one you want to change. Select it by pressing **Enter**. At this point, the actual value for that setting is shown, blinking. Pressing "+" and "-" change this value to the appropriate one. Press **Enter** and the relay will ask for your confirmation. To confirm the change press **Enter**.

The mnemonics in figure 8.9 stand for:

TRIP 51	51 Permission to trip	- Range: Y/N.
TAP 51	51 Pickup	- Range: 0.10 to 2.40 x In, Step: 0.01 x In.
CURV 51	51 Curve Type - Range:	INV Inverse VI Very Inverse EI Extremely Inverse TDE Definite Time USU User's Curve
DIAL 51	51 Time Dial	Range: 0.05 to 2.00 s. Step: 0.01 s.
TIME 51	51 Definite Time Delay	Range: 0.00 to 99.99 s. Step: 0.01 s.
CNF	CONFIRM	OK Validate the assigned value.

In the case of sensitive ground models, the range for setting TAP 51N is as follows:

TAP 51	51 tap	Range: 0.005-0.12 A	Step: 0.001 A

***NOTE**: The relay will use IEC or ANSI curves depending on the model.*

From the **F50H** heading, the following key strokes and displays are possible:

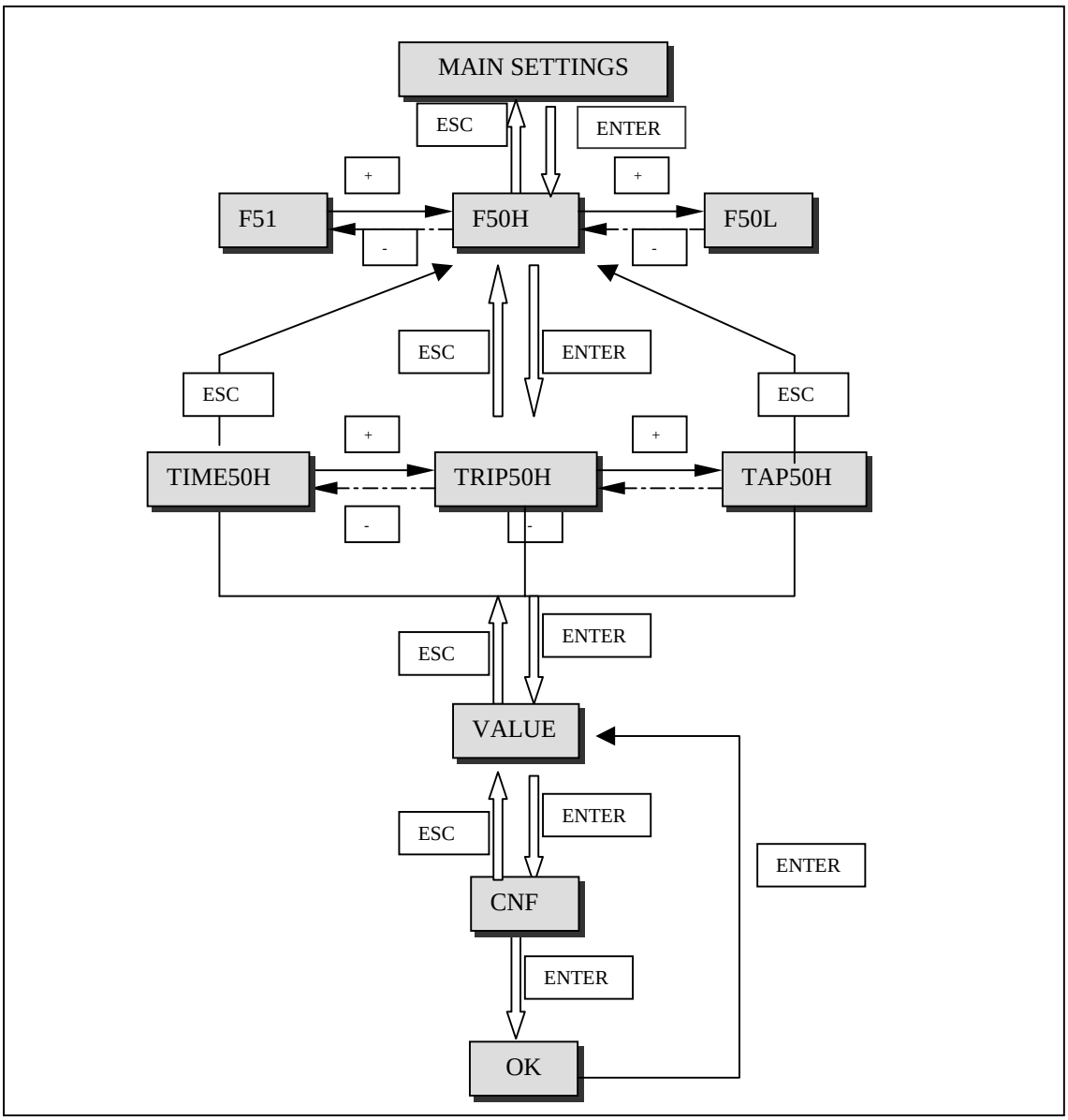


Figure 8.10. KEYPAD AND DISPLAY HANDLING FROM THE F50H HEADING

Press **Enter** to access the different settings corresponding to the **F50H** function: **TRIP50H**, **TAP50H** and **TIME50H**. Pressing "+" and "-" move through these settings headings until the display shows the one you want to change. Select it by pressing **Enter**. At this point, the actual value for that setting is shown, blinking. Pressing "+" and "-" change this value to the appropriate one. Press **Enter** and the relay will ask for your confirmation. To confirm the change press **Enter**.

The mnemonics in figure 8.10 stand for:

TRIP 50H	50H Permission to Trip	Range: Y/N.
TAP 50H	50H Current Pickup	Range: 0.10 to 30.0 x In Step: 0.1 x In.
TIME 50H	50H Time Delay	Range: 0.00 to 99.99 s. Step: 0.01 s.
CNF	CONFIRM	OK Validate the value selected.

The display and keypad handling for the other Instantaneous Overcurrent Function **F50L,** are identical to the one just described.

In case of sensitive ground, the range for settings TAP 50H/TAP 50L is as follows:

Range: 0.005-1.5 A Step: 0.001 A

The display and keypad use for the Thermal Image function (F49) is as follows:

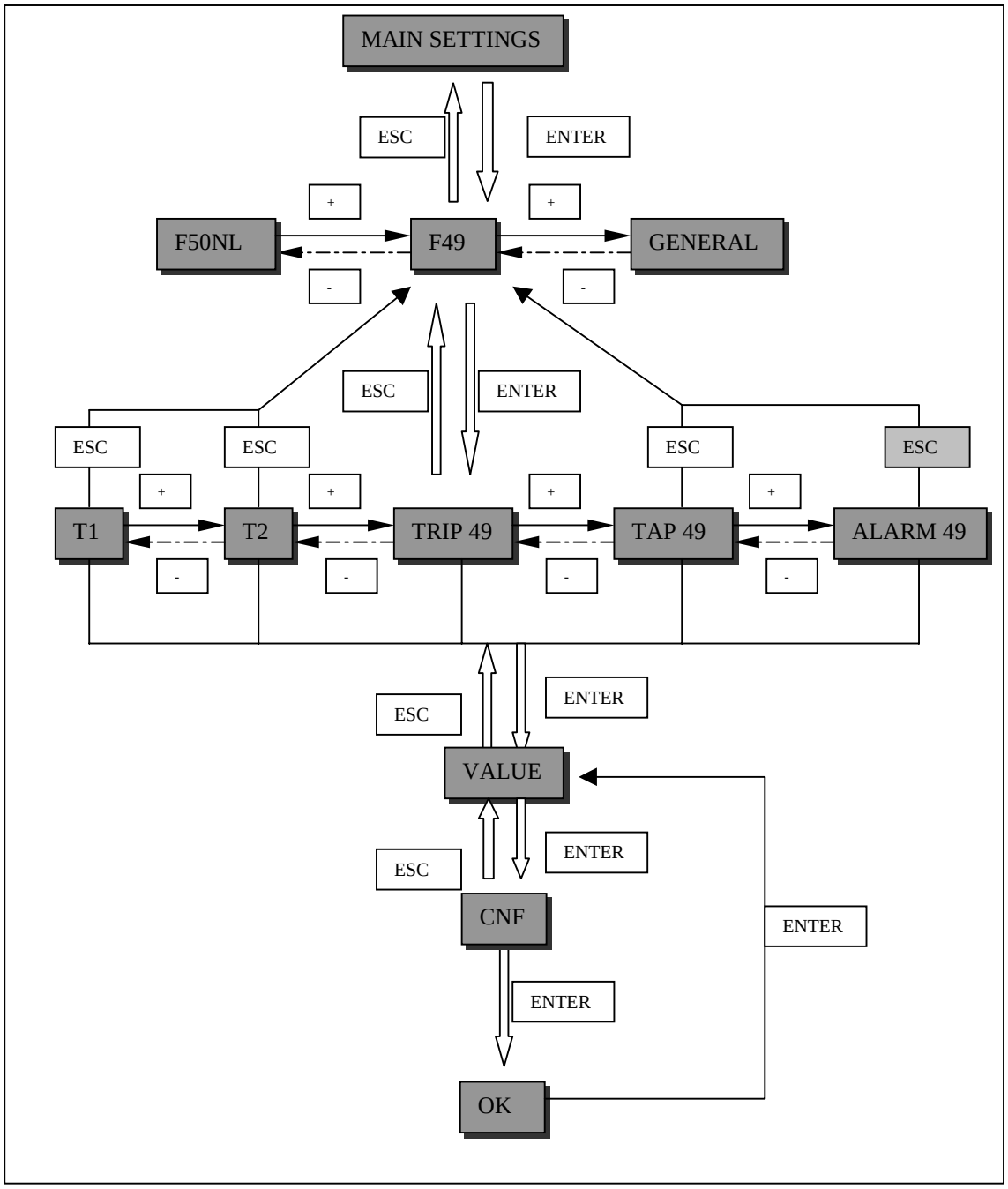


Figure 8.11. KEYPAD AND DISPLAY HANDLING FROM THE F49 HEADING

Press **Enter** to access the different settings corresponding to the **F49** function: **TRIP49**, **TAP49**, **ALARM49**, **T1** and **T2**. Pressing "+" and "-" move through these settings headings until the display shows the one you want to change. Select it by pressing **Enter**. At this point, the actual value for that setting is shown, blinking. Pressing "+" and "-" change this value to the appropriate one. Press **Enter** and the relay will ask for your confirmation. To confirm the change press **Enter**.

The mnemonics in figure 8.11 stand for:

TRIP 49	Permission to Trip	Range: Y / N.
TAP 49	49 Current Pickup	Range: 0.10 to 2.40 x In Step: 0.01 x In (for 1/5 A ground) Range: 0.005...0.12 A Step: 0.001 A (for sensitive ground)
ALARM 49	49 Alarm Threshold	Range: 70 to 100% ITH Step: 1.
T1	Heating Time Constant	Range: 3 to 600 min Step: 1 min.
T2	Cooling Time Constant	Range: 1 to 6 times T1 Step: 1.
CNF	CONFIRM	OK Validate the value selected.

8.6 ADVANCED SETTINGS MENU

The display and keypad use for the Advanced Settings is as follows:

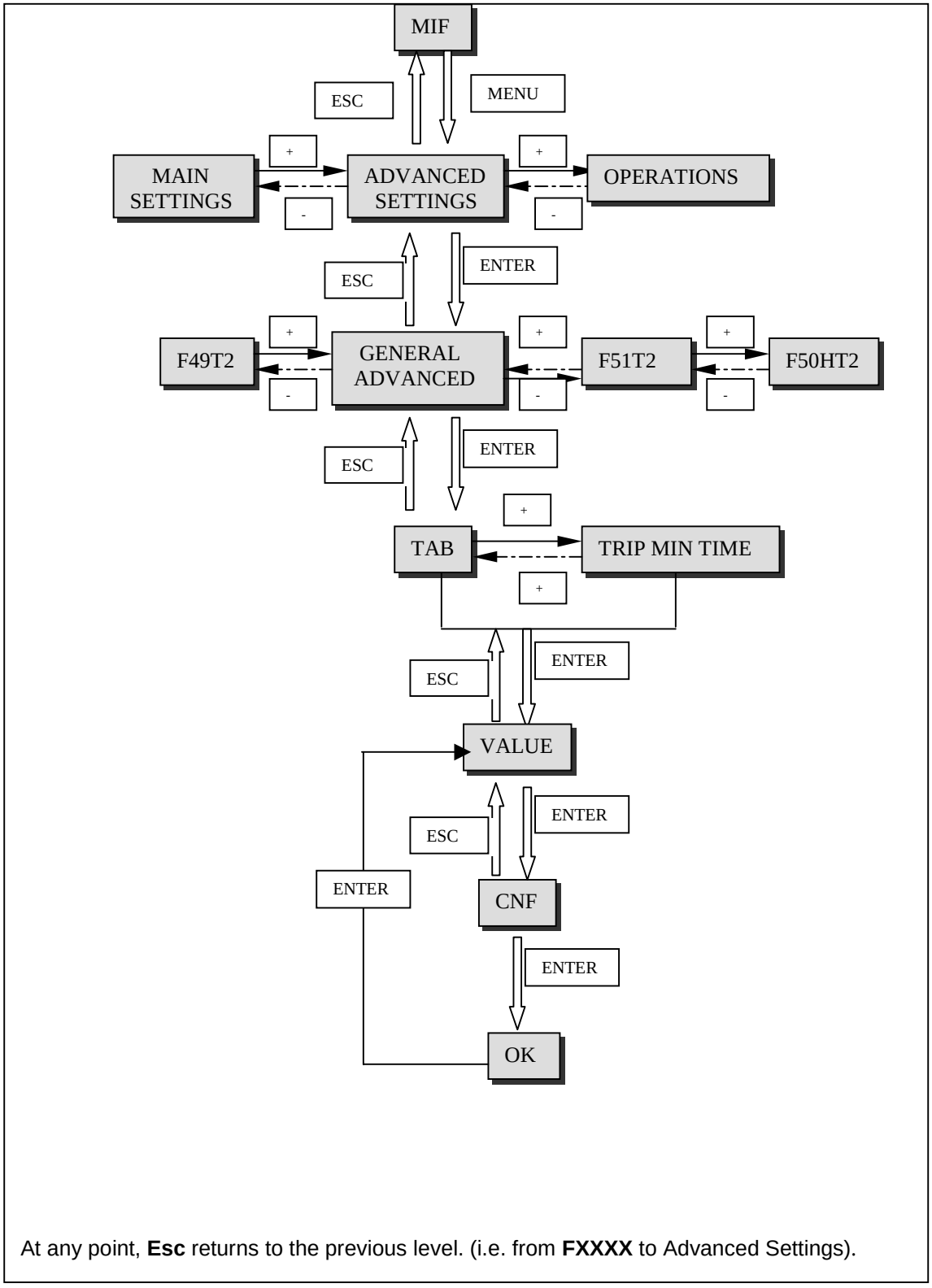


Figure 8.12. KEYPAD AND DISPLAY HANDLING FROM ADVANCED SETTINGS

Press **Enter** to access the different settings corresponding to the General Advanced Settings: **TAB** and **TRIP MIN TIME**. Pressing "+" and "-" move through these settings headings until the display shows the one you want to change. Select it by pressing **Enter**. At this point, the actual value for that setting is shown, blinking. Pressing "+" and "-" change this value to the appropriate one. Press **Enter** and the relay will ask for your confirmation. To confirm the change press **Enter**.

The mnemonics in figure 8.12 stand for:

ADVANCED SETTINGS	Advanced Settings Menu.
GENERAL ADVANCED	General Advanced Settings.
F51 T2	Time Overcurrent Function (51) – Table 2.
F50H T2	Instantaneous Overcurrent High Set. Function (50H) - Table 2.
F50L T2	Instantaneous Overcurrent Low Set. Function (50L) - Table 2.
F49 T2	Thermal Image Function (49) - Table 2.
TAB - Range:	Active Table. 1 Table 1. 2 Table 2.
TRIP MIN TIME - Range:	Minimum time that the output contact is closed. 50 to 300 ms Step: 1 ms.
CNF	CONFIRM OK Validate the value selected.

The other setting headings at the same level than General Advanced Settings are **F51 T2**, **F51N T2**, **F50H T2**, **F05PL T2**, **F50NH T2**, **F50NL T2** and **F49 T2**, where **T2** means **TABLE 2**. The use of the keypad and display for all these functions is identical to the previously described for the corresponding function in the table number one.

Mnemonics appearing in the ADVANCED SETTINGS group, only for OPTION 2 models:

I^2		I^2 counter	
	I^2 MAX	Alarm level for I^2	
		0 – 999.0 kA2	Step: 0.001
CLP		Cold load pickup	
	CLP ENABLE	Permission CLP	
		Y (YES) / N (NO)	
	T IN	Pickup timer setting	
		1 – 60 seg.	Step: 0.001
	T OUT	Drop out timer setting	
		1 – 60 seg.	Step: 0.001
	K 5OP	Multiplier for 50 tap	
		1 – 5	Step: 0.01
	K 51	Multiplier for 51 tap	
		1 – 5	Step: 0.01
BF		Breaker failure to open	
	BF ENABLE	Permission BF	
		Y (YES) / N (NO)	
	BF TIME	Breaker failure to open time	
		50 – 999 msec.	Step: 1 msec.

8.7 OPERATIONS MENU

The use of the keypad and display in the Operations Menu of the MIF relay is as follows:

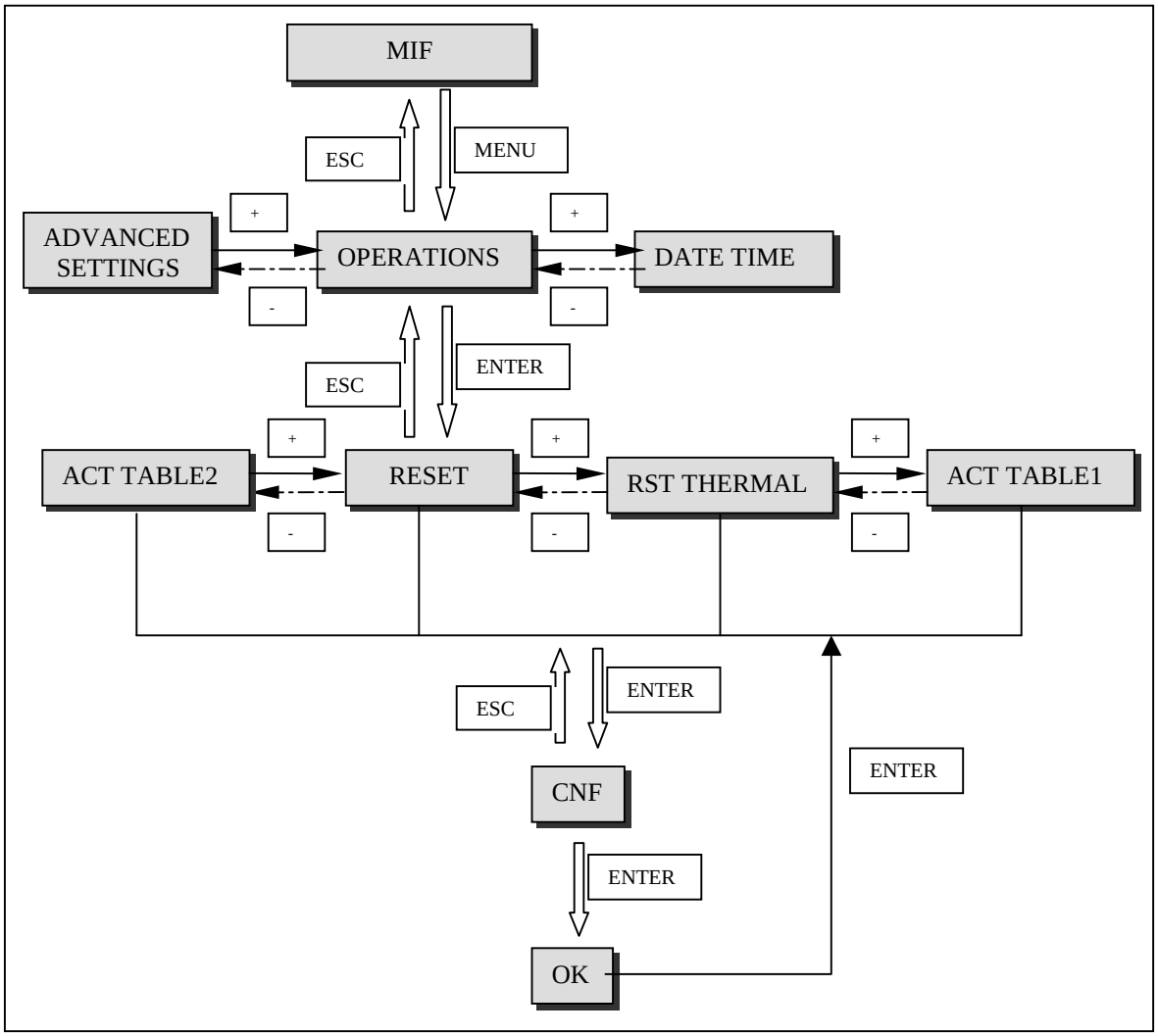


Figure 8.13. KEYPAD AND DISPLAY USE IN THE OPERATIONS MENU

The mnemonics in figure 8.13 stand for:

OPERATIONS	Commands or Operations to be performed from the relay.
RESET	Reset Command for the faceplate Target LEDs *and latching of auxiliary contacts in OPTION 1 and OPTION 2 models.*
RST THERMAL	Reset Command for the Thermal Image Unit.
ACT TABLE1	Set Table 1 as the Active Table.
ACT TABLE2	Set Table 2 as the Active Table.
OPEN BREAKER	Breaker opening.
RST OPENINGS	Reset openings (OPTION 2 models).
RST I^2	Reset of accumulated value of I^2t counter (OPTION 2 models).
CNF	CONFIRM OK Confirm that the command must be executed.

Once the operation to be performed has been found, using the "+" and "-" keys, press **Enter** to select it, and then press **Enter** again to confirm that the command must be executed. Then the text OK will appear in the display.

8.8 DATE AND TIME MENU

To set a given Date and Time in the internal clock of the relay follow the flow chart shown in figure 8.14:

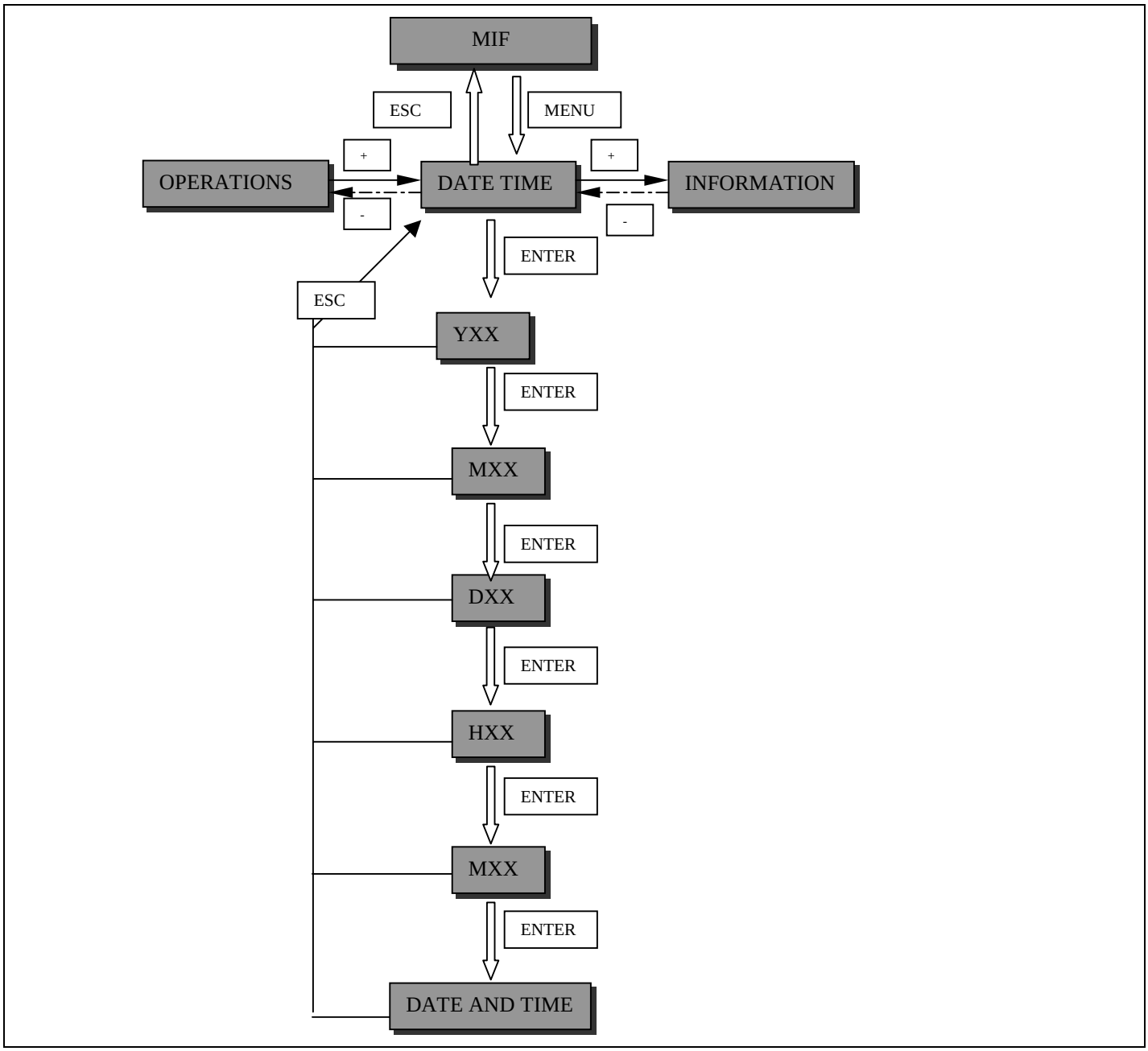


Figure 8.14. KEYPAD AND DISPLAY USE TO SET THE DATE AND TIME IN THE RELAY

Select the display showing **DATE TIME** pressing "+" and "-", and press **Enter** to select this option. The first value to be change is the year. Press "+" and "-" to set the year desired and press **Enter** to move to the next field as the flow chart indicates.

The mnemonics used are:

DATE TIME	Relay Date and Time.
YXX (YEAR)	Set the Year Information in the relay internal clock.
MXX (MONTH)	Set the Month Information in the relay internal clock.
DXX (DAY)	Set the Day Information in the relay internal clock.
HXX (HOUR)	Set the Hour Information in the relay internal clock.
MXX (MINUTE)	Set the Minutes Information in the relay internal clock.
DATE AND TIME	The Date and Time just set in the relay is shown.

8.9 RESETTING THE THERMAL IMAGE UNIT

To reset the Thermal Image Unit using the faceplate keypad and display follow the flow chart shown in figure 8.13. Look for the **RST THERMAL** heading in the display. Press **Enter**. A confirmation message will be shown, CNF. To confirm that you really want to reset the Thermal Image Unit press **Enter**. The thermal Image unit will be reset and the message **OK** will be shown to point out that the operation has been executed successfully. To return to the second level press **Enter**, as figure 8.13 indicates.

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

8.10 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 (in OPTION 1 and OPTION 2 models).

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.

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.

There follows a list of tests that can be used to check that the unit is fully operational. For a more limited test for the reception of units we recommend carrying out only the tests listed in sections: 9.5, 9.8, 9.10, 9.11, 9.12, 9.13, 9.14, 9.15, 9.16, 9.17, 9.18 and 9.19.

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

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.

9.4 WIRING AND NECESSARY EQUIPMENT

Necessary equipment:

- 1 AC current source.
- 1 DC voltage power supply.
- 1 Stop-watch.
- 1 Multi-meter.
- Optionally, it is advisable to have a PC available, with the M+PC software installed.
- Relay wiring diagram.

Connect the relay as shown in figure 9.1.

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

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

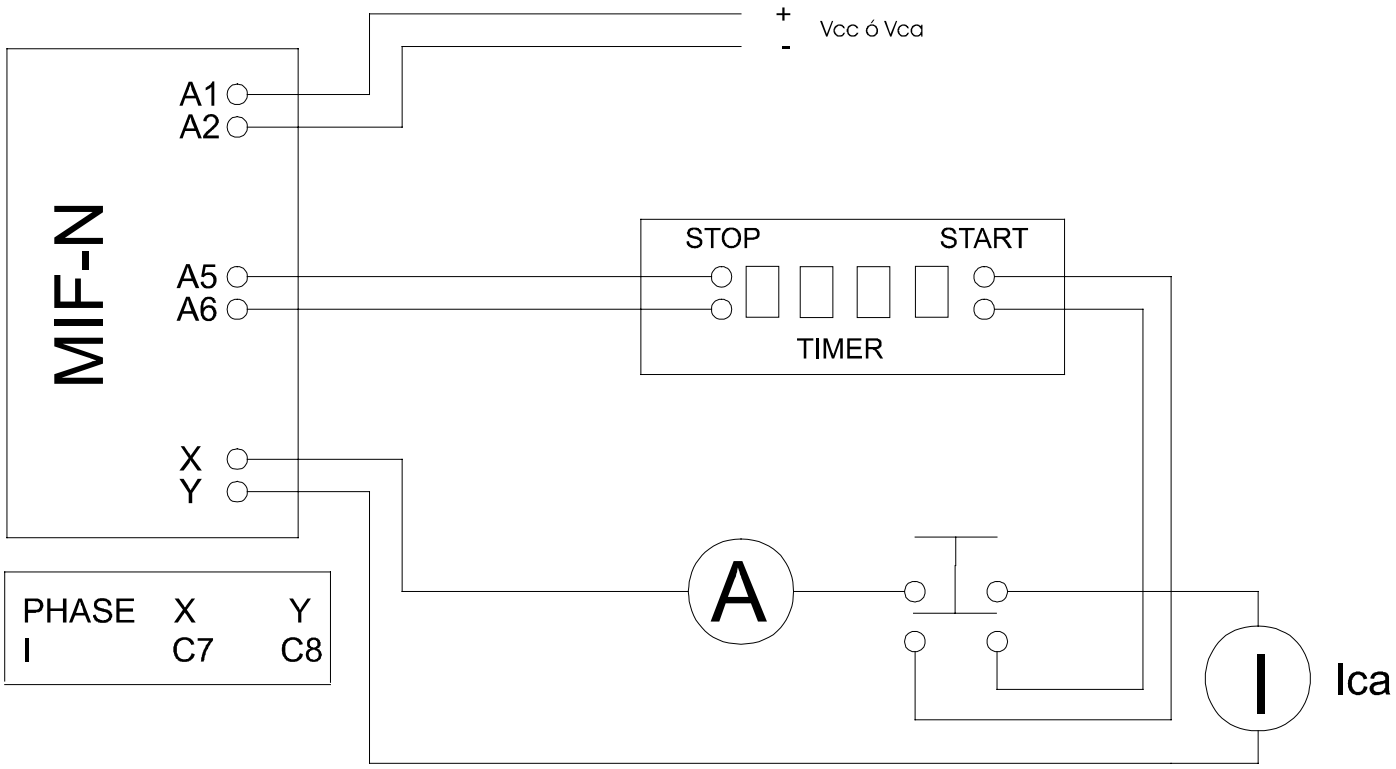


Figure 9-1 TEST CONNECTIONS FOR MIF RELAY

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: 51, 50H, 50L and 49, setting their pickups and times to the minimum value possible. Inject to the relay a current equal to 2 x In, making the relay to 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	650
48	300
58	265

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	165
230	95

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 MIF 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 (A8-A10 and A9-A10).
- 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

- Check that all the outputs are open.
- Enable only 51 function, and set its pickup and time delay to the minimum values. Inject a current terminals equal to 2 x In to trip the relay. Check that the trip output (terminals A5-A6) and auxiliary output OUT1 (terminals A7-B7) close, and the **PICKUP, TRIP** and **TIME** LEDs light up.
- Enable only 50 function, and set its pickup to the minimum value. Inject a current through phase A terminals equal to 2 x In (phase) to trip the relay. Check that the trip output (terminals A5-A6) and auxiliary output OUT3 (terminals B9-A7) close, and the **PICK UP, INST** and **TRIP** LEDs light up.
- Enable only function 49, and set its pickup to the minimum value. Inject a current through phase A terminals equal to 2 x In (phase) making the relay trip. Check that the trip output (terminals A5-A6) and auxiliary output OUT4 (terminals B10-A7) close, and the **PICK UP** and **TRIP** LEDs light up.
- Remove the Power Supply from the relay and check that the Alarm Output Contact (terminals B5-B6) closes. Set the power supply back to the relay terminals and check that the Alarm Output Contact opens.

9.11 RELAY METERING

9.11.1. CURRENT METERING

CURRENT

- Set the relay to the same frequency than the AC source used and apply the following currents:

	1	2	3	4
I (Amps)	0.1 x In	0.5 x In	1 x In	2 x In

- Check that the relay measures Ia, Ib and Ic with an accuracy better than 3%.
- If the test were carried out at 50 Hz, repeat at 60 Hz (if at 60 Hz, repeat at 50 Hz).

9.12 IOC HIGH SETTING UNIT (50H)

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

9.13 IOC LOW SETTING UNIT (50L)

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

9.14 TOC UNIT (51)

The 3 curves IEC or ANSI (Inverse, Very Inverse, Extremely Inverse) and the Definite Time are tested with three points for each curve (one “no-trip point” and two “trip points”). This gives us a total of 12 points for each protection unit. Each point is tested with a different pick up and dial in order to test the whole range of the relay.

Enable 51 function only, and set its current pickup value to the minimum possible.

9.14.1. IEC INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	INVERSE
Time Dial	1

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 15.3 and 19.7 sec.
- Apply 5 times the pickup current and the relay should trip between 4.1 and 4.5 sec.

9.14.2. IEC VERY INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	VERY INVERSE
Time Dial	1

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 23.4 and 31.8 sec.
- Apply 5 times the pickup current and the relay should trip between 3.1 and 3.6 sec.

9.14.3. IEC EXTREMELY INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	0. 5

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 27 and 39 sec.
- Apply 5 times the pickup current and the relay should trip between 1.5 and 1.85 sec.

9.14.4. ANSI INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	INVERSE
Time Dial	10

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 36.2 and 51.3 sec.
- Apply 5 times the pickup current and the relay should trip between 3.88 and 4.27 sec.

9.14.5. ANSI VERY INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	VERY INVERSE
Time Dial	10

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 26.72 and 37.27 sec.
- Apply 5 times the pickup current and the relay should trip between 2.46 and 2.75 sec.

9.14.6. ANSI EXTREMELY INVERSE CURVE

- Set the relay as follows:

51 Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	5

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.5 times the pickup current and the relay should trip between 17.19 and 23.58 sec.
- Apply 5 times the pickup current and the relay should trip between 1.14 and 1.34 sec.

9.14.7. DEFINITE TIME

- Set the relay as follows:

51 Settings Group	
Curve	DEFINITE TIME
Definite Time Delay	1.0

- Apply 0.9 times the pickup current and the relay should not trip.
- Apply 1.1 times the pickup current and the relay should trip in 1.0 sec. Acceptable time range is between 1.00 and 1.06 sec.
- Apply 4 times the pickup current and the relay should trip in 1.0 sec. Acceptable time range is between 1.00 and 1.06 sec.

9.15 THERMAL IMAGE UNIT (49)

1. Enable 49 function only.

2. Set the relay as follows:

49 Settings Group	
Tap / Pickup	0.4 x In
Heating Time Constant T1	3 min.
Cooling Time Constant T2	1 times T1

3. Apply the following currents and check that the operating time is within the given range:

   If your relay is 5 Amps rated current:

Relay Rated Current (Amps)	Applied Current (Amps)	Times the tap set in the relay	Operating time (sec.)
5	4.0	2	48.5 – 53.6
	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

   If your relay is 1 Amps rated current:

Relay Rated Current (Amps)	Applied Current (Amps)	Times the tap set in the relay	Operating time (sec)
1	0.8	2	48.5 - 53.6
	2.0	5	7.06 - 7.80
	4.0	10	1.77 - 1.95

5 Repeat the test with a Heating Time Constant equal to 60 minutes. Check that the operating values are within the given range:

   If your relay is 5 Amps rated current:

Relay Rated Current (Amps)	Applied Current (Amps)	Times the tap set in the relay	Operating time (sec.)
5	4.0	2	960 - 1072
	10.0	5	141 - 156
	20.0	10	35.4 - 39

   If your relay is 1 Amps rated current:

Relay Rated Current (Amps)	Applied Current (Amps)	Times the tap set in the relay	Operating time (sec.)
1	0.8	2	960 - 1072
	2.0	5	141 - 156
	4.0	10	35.4 - 39

Note: You must reset the Thermal Image Unit after each test, to start the following one from the same cold status.

9.16 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.

9.17 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.

9.17.1. MAIN SETTINGS

	M+PC	HMI	USER VALUE	RANGE	STEP
GENERAL SETTINGS	**GENERAL SETTINGS**	**GENERAL**			
Relay Status	RELAY STATUS	STA		RDY / DIS	NA
Frequency	FREQUENCY	FRQ		50/60 Hz	NA
Password	---	PWD		1 – 255	
Address	---	ADD		1 – 255	1
Communications Speed	---	BAUD		300, 600, 1200, 2400, 4800, 9600, 19200	NA
TOC Function	**51 Function**	**F51**			
51 Permission to Trip	51 Trip Permission	TRIP 51		Y/N	NA
51 Tap / Pickup Value	51 Pickup	TAP 51		0.1-2.4 In (Ph)	0.01 In (Ph)
51 Curve Type	51 Curve Type	CURV 51		INV, V.I., E.I., T.DE	NA
51 Time Dial	51 Time Dial	DIAL 51		0.05 – 2.00 (IEC)	0.01
				0.5 – 20.0 (ANSI)	0.01
51 Definite Time Delay	51 Definite Time	TIME 51		0 – 99.99 s.	0.01 s.
IOC High Setting	**50H Function**	**F50H**			
50H Permission to Trip	50H Trip Permission	TRIP 50H		Y/N	NA
50H Tap / Pickup	50H Pickup	TAP 50H		0.1 – 30 In (Ph)	0.1 In (Ph)
50H Time Delay	50H Time Delay	TIME 50H		0 – 99.99 s.	0.01 s.
IOC Low Setting	**50L Function**	**F50L**			
50L Permission to Trip	50L Trip Permission	TRIP 50L		Y/N	NA
50L Tap / Pickup	50L Pickup	TAP 50L		0.1 – 30 In (Ph)	0.1 In (Ph)
50L Time Delay	50L Time Delay	TIME 50L		0 – 99.99 s.	0.01 s.
Thermal Image (49)	**49 Function**	**F49**			
Permission to Trip	49 Trip Permission	TRIP 49		Y/N	NA
49 Tap / Pickup	49 Pickup	TAP 49		0.1 – 2.4 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	49 Alarm Level	ALARM 49		70% – 100% ITH	
Heating Time Constant $\tau 1$	T1	T1		3 – 600 min.	1 min
Cooling Time Constant $\tau 2$	T2	T2		1 – 6 times $\tau 1$	1

	M+PC	HMI	USER VALUE	RANGE	STEP
General Settings (Adv.)	**GENERAL SET. ADV.**	**GENERAL ADVANCED**			
Identification	IDENTIFICATION	---		Text	NA
Active Table	ACTIVE TABLE	TAB		1 – 2	NA
Trip Contact - Minimum time closed.	TRIP MINIMUM TIME	TRIP MIN TIME		50 – 300 ms.	1 ms.
TOC (Table 2)	**51 Function (Table 2)**	**F51 T2**			
51 Permission to Trip	51 Trip Permission T2	TRIP 51 T2		Y/N	NA
51 Tap / Pickup Value	51 Pickup T2	TAP 51 T2		0.1 – 2.4 In (Ph)	0.01 In (P)
51 Curve Type	51 Curve Type T2	CURV 51 T2		INV, V.I.,E.I., TDE	NA
51 Time Dial	51 Time Dial T2	DIAL 51 T2		0.05 – 2.00 (IEC)	0.01
				0.5 – 20.0 (ANSI)	0.01
51 Definite Time Delay	51 Definite Time T2	TIME 51 T2		0 – 99.99 s.	0.01 s.
IOC High Set Table 2	**50H Function (Table 2)**	**F50H T2**			
50H Permission to Trip	50H Trip Permission T2	TRIP 50H T2		Y/N	NA
50H Tap / Pickup	50H Pickup T2	TAP 50H T2		0.1 – 30 In (Ph)	0.1 In (Ph)
50H Time Delay	50H Time Delay T2	TIME 50H T2		0 – 99.99 s.	0.01 s.
IOC Low Set Table 2	**50L Function (Table 2)**	**F50L T2**			
50L Permission to Trip	50L Trip Permission T2	TRIP 50L T2		Y/N	NA
50L Tap / Pickup	50L Pickup T2	TAP 50L T2		0.1 – 30 In (Ph)	0.1 In (Ph)
50L Time Delay	50L Time Delay T2	TIME 50L T2		0 – 99.99 s.	0.01 s.
Thermal Image Table 2	**49 Function (Table 2)**	**F49 T2**			
Permission to Trip	49 Trip Permission T2	TRIP 49 T2		Y/N	NA
49 Tap / Pickup	49 Pickup T2	TAP 49 T2		0.1 – 2.4 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	49 Alarm Level T2	ALARM 49 T2		70% – 100% ITH	
Heating Time Constant $\tau 1$	T1 T2	T1 T2		3 – 600 min.	1 min.
Cooling Time Constant $\tau 2$	T2 T2	T2 T2		1– 6 times $\tau 1$	1
USER'S CURVE					
A	A	A		0-125	0.001
B	B	B		0-3	0.001
P	P	P		0-3	0.001
Q	Q	Q		0-2	0.001
K	K	K		0-1.999	0.001

The events masks and oscillography masks groups are available only in models with OPTION 1 or 2. Events masks showing a 2 in the end of the row are available only in MIF models with OPTION 2.

	M+PC	USER VALUE	RANGE	STEP
Event masks	Event masks			
50H Pickup/Drop out	50H Pickup		Y/N	NA
50L Pickup/Drop out	50L Pickup		Y/N	NA
51 Pickup/Drop out	51 Pickup		Y/N	NA
49 Alarm Pickup/Drop out	49 Alarm		Y/N	NA
50H Trip	50H Trip		Y/N	NA
50L Trip	50L Trip		Y/N	NA
51 Trip	51 Trip		Y/N	NA
49 Trip	49 Trip		Y/N	NA
General trip	General trip		Y/N	NA
50H Trip enable/disable by digital input	50H disabled		Y/N	NA
50L Trip enable/disable by digital input	50L disabled		Y/N	NA
51 Trip enable/disable by digital input	51 disabled		Y/N	NA
49 Trip enable/disable by digital input	49 disabled		Y/N	NA
General Trip enable/disable by digital input	Trip disabled		Y/N	NA
Protection status: in service/out of service	Protection status		Y/N	NA
Digital output1 active/non active	Output 1		Y/N	NA
Digital output 2 active/non active	Output 2		Y/N	NA
Digital output 3 active/non active	Output 3		Y/N	NA
Digital output 4 active/non active	Output 4		Y/N	NA
Digital input 1 active/non active	Digital input 1		Y/N	NA
Digital input 2 active/non active	Digital input 2		Y/N	NA
Settings change disabled by digital input	Settings change disabled	YES	Y/N	NA
Trip operation by digital input	Trip operation by input		Y/N	NA
Trip operation by command	Trip operation by com.	YES	Y/N	NA
Auxiliary digital output latch reset	Reset latch aux		Y/N	NA
52 B open/closed	Breaker 52 A		Y/N	NA (2)
52 A open/closed	Breaker 52 B		Y/N	NA (2)
52 open/closed	Breaker status		Y/N	NA (2)
Table 2 selection by digital input	Active table change		Y/N	NA
Oscillo trigger by digital input	Oscillo trig by input		Y/N	NA
Oscillo trigger by command	Oscillo trig by com.		Y/N	NA
Breaker failure to open	Breaker failure to open		Y/N	NA (2)
I2 Alarm	I2 Alarm		Y/N	NA (2)
Settings change	Settings change		Y/N	NA
E2prom failure	e2prom failure		Y/N	NA
User settings/Factory settings	User settings		Y/N	NA
Cold load pickup enabled	Cold load pickup		Y/N	NA (2)
Oscillography masks	**Oscillography masks**			
Oscillo by communications	Oscillo by communic.		Y/N	NA
Oscillo by digital input	Oscillo by Digital Input		Y/N	NA
Oscillo by tripping	Oscillo by tripping		Y/N	NA
Oscillo by pickup	Oscillo by pickup		Y/N	NA

The following three groups are only available in MIF models with OPTION 2:

	M+PC	HMI	USER VALUE	RANGE	STEP
Counter	**I2 Counter**				
I2 limit	I2 limit	I2T MAX		0-999.000 kA2	0.001 kA2
Breaker failure to open	**Breaker failure to open**	**BF**			
Breaker failure to open enable	Breaker failure to open function	BF ENABLE		Y/N	NA
Fail to open timer	Fail to open timer	BF TIME		50-999 ms	1 ms
Cold load pickup	**Cold load pickup**	**CLP**			
Cold load pickup enable	Cold load pickup function	CLP ENABLE		Y/N	NA
Pickup time	T IN	T IN		0-60 s	0.001 s
Drop out time	T OUT	T OUT		0-60 s	0.001 s
Cte. 50P pickup	K 50P	K 50P		1-5	0.01
Cte. 51 pickup	K 51	K 51	1	1-5	0.01

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 MIF 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 3.5) 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 periodic 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 MIF 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.

11.1 INTRODUCTION

Protective relays are devices designed to detect and eliminate defects or faults in the Power System. The elimination of the fault is carried out by the opening of the circuit breaker or breakers that supply power to the fault.

Faults in the Power System usually create very high current situations on lines, generators, transformers, etc. These high currents are much greater than the rated currents for which these equipment were designed, introducing an additional stress and possible direct damage, as a consequence of the thermal and dynamic effects of the high short-circuit currents.

Due to this fact, the most common protective device is the overcurrent relay. Its operating principle is to detect if the current in the system is under or above a set level, and depending on the current level, issue an instantaneous trip or a fixed time delayed trip. There are overcurrent relays that include a current versus time tripping characteristic curve, that makes the relay to trip faster for high currents and following an inverse I vs. t equation, trip slower for lower fault currents.

Operating times range from tens of milliseconds to some seconds for slower operation curves.

However, for some applications, this type of protective relay has some limitations.

In the case of two transformers, operating in parallel, feeding a distribution bus bar, working both of them at 70% of rated load: if an overcurrent relay is installed on each transformer, and due to any reason, one transformer is out of service, the other one will work at 140% of rated load.

Under these circumstances, the relay on the transformer that is in service will trip after a relatively short time, taking the transformer out of service, and leaving the bus bar without any supply.

However, transformers are designed to withstand an overload condition like the described one for some minutes, without any deterioration, allowing during this time to the substation operator to take the appropriate actions to restore the situation and take the transformer back in service, before the other one gets over heated.

The Thermal Image protection is especially applicable to this situations, due to its operating principle. In general, it is a standard backup protection for many protection schemes, for almost any device, motors, generators, cables, etc.

11.2 OPERATING PRINCIPLE

The thermal relays, based on the direct measure of the device/machine temperature present some difficulties when trying to measure the temperature of the sensitive elements of the device/machine to protect (i.e. windings in a transformer). The temperature is measured on the surrounding zones (i.e. oil, isolators, etc) loosing effectiveness due to the high thermal inertia.

Due to this reason, thermal image relays are used. These relays use mathematical algorithms (derive from physical models and equations) to simulate the heating of the machine, taking electrical magnitudes (currents) as inputs to the algorithm.

For regular overloading situations, heating is the main concern, leaving apart the dynamic effects.

Thermal Image relays operate when the computed temperature (Thermal Image of the machine) reaches a level considered to be dangerous. Compared with an overcurrent relay, the thermal image relay does not start when a fault is detected, but it is continuously operating, computing the thermal status of the protected piece of equipment. The operating time depends on the thermal status and current flowing at a given point in time until the limit temperature is reached. The starting temperature depends on the previous “history” of the machine, the current measured and the amount of time it has been applied. In this sense, it can be said that Thermal Image relays have memory, as they remember the previous status of the machine, and start computing temperature based on that status.

After an overload condition, the protection simulates the cooling process of the machine using a separate time constant.

11.3 ALGORITHMS

Thermal Image algorithms are based on the heating/cooling process of a resistive element due to the current flowing through it. Let us assume a temperature reference (θ_a):

Being:

R = Ohm Resistance (Ω)

I = Current flowing through the element. (Amps)

m = Mass of the element (kg)

C_e = Specific Heat (Jul/kg/ºC)

θ = Element Temperature over ambient temperature (ºC)

a = Heat Transmission Coefficient, (adding conduction and convection effects ($w/m^2/ºC$))

S = Element Surface (m^2)

Disregarding the radiation transmission (that at temperatures under 400 ºC is much lower that the considered effects, being this assumption a conservative one from the protection point of view), the differential equation describing the heating process of the element can be written as:

$$I^2 * R * dt = (m * C_e * d\theta) + (a * S * \theta * dt) \qquad [1]$$

We can read this equation as: the heat generated on the resistance during a differential period of time (dt), is used to rise the element temperature and to rise the ambient temperature.

This separated variables differential equation can be easily integrated, getting the following expression:

$$\theta = \frac{I^2(1 - e^{-t/\tau})}{\alpha + \theta_0 * e^{-t/\tau}} \qquad [2]$$

Where:

$\theta_{0:}$ Initial temperature.

τ : Heating Constant, defined as: m * C_e / (a * S), according to the defined parameters. It indicates the heating speed of the element (it is the amount of time it takes to reach the 63% of the final temperature.)

α : Parameter which a value equal to: a * S / R

Obviously, the derived equation describes the temperature evolution for both, a heating process and a cooling process.

The final temperature value θ_∞, for a permanent current I_∞, will be (according to [2]):

$$\theta_\infty = I_\infty / \alpha \qquad [3]$$

In equation [2], solving for time, you get:

$$t = \tau * \ln \frac{I^2 - \alpha * \theta_0}{I^2 - \alpha * \theta} \qquad [4]$$

Introducing the following variable change:

$$\theta' = \theta / \theta_\infty \qquad [5]$$

that implies to refer temperatures to the steady state value, equations [2] and [4] can be written as :

$$\theta' = I'^2 * \left(1 - e^{-t/\tau}\right) + \theta_0' * e^{-t/\tau} \qquad [6]$$

$$t = \tau * \ln \frac{I'^2 - \theta'_0}{I^2 - \theta'} \qquad [7]$$

where I' represents the current value in per unit, based on the permanent current, this is:

$$I' = I / I_\infty \qquad [8]$$

To compute the tripping time, substitute in [7], with $\theta' = 1$, and you get:

$$t = \tau * \ln \frac{I'^2 - \theta'_0}{I^2 - 1} \qquad [9]$$

It is necessary that I > 1.

Equation [9], can also be written as a function of current, in p.u., if it has been maintained permanently (in other case, it is necessary to compute the equivalent current), that is represented by the letter "**v**":

$$t = \tau * \ln \frac{I'^2 - v^2}{I'^2 - 1} \qquad [10]$$

Equation [10], represents the basic tripping algorithm for a thermal image relay, that for a given τ and I_∞, can be drawn, in general using a logarithm plane, using "v" as the parameter, as shown in figures A-1.1 and A-1.2.

DIGITAL TECHNOLOGY AND THERMAL IMAGE RELAYS

It is clear that digital technology characteristics fit the thermal image applications.

The use of relatively simple algorithms, together with the ability to show relevant information (Thermal Image value, currents metering, fault information) and the integration of additional protection functions in the same relay (inverse or definite time overcurrent) co-ordinated with the thermal image function, allows to design high performance protective devices.

Besides that, thanks to the digital technology possibilities, more accurate models can be used, taking into account radiation effects, and other heating sources different that Joule effect.

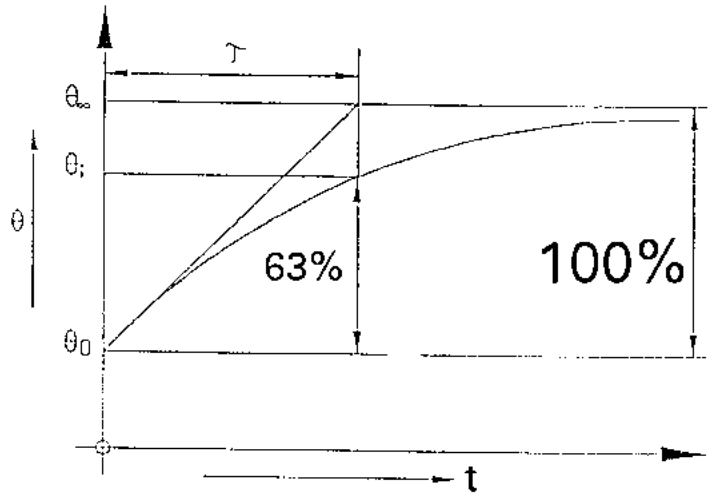
Equation [9] evaluation requires extensive computing resources, and thus, is not directly implemented in the protection relay. Instead, an iterative algorithm that mimics very closely the real equation is used.

For some applications, the use of separate time constants can be useful. For motors, it can be useful to use a time constant for normal conditions, and a different one, much lower, for locked rotor conditions (as the heat transmission capability gets reduced when the machine is not spinning).

11.4 THERMAL CURVE

The time needed for an element to rise its temperature (from an initial temperature θ_0) the 63% of θ (θ is the temperature difference between the initial and the final temperature) is called “Time Constant”, and it is represented by the letter τ. Using an equation, it is the time it takes to reach an intermediate temperature θi where:

$$\theta_i = \theta_0 + (\theta_\infty - \theta_0) * 0.63$$



If θ_0 is the temperature origin, at a given time, the temperature can be written as:

$$\theta = \theta N * (1 - e^{(1/\tau)}) * (I / IN)^2$$

Where:

θ	:	Temperature increase at a given time
θN	:	Rated temperature (temperature reached if I = IN)
IN	:	Protected element rated current
I	:	Current flowing through the protected element
T	:	Time
τ	:	Time constant

11.5 MIF THERMAL CURVES

The equation for the temperature given before was:

$$\theta = \theta N * (1 - e^{(1-\tau)}) * (I / IN)^2 .....(1)$$

The MIF uses an equation, in which the tripping time is a function of the current flowing through the protected element, thus eliminating all references to the temperatures. The heating time constant τ is the MIF is designated as $\tau 1$.

By means of the keypad (or M+PC program), a tap/pickup current must be set in the relay. If the current is greater than the programmed tap current, the thermal protection will trip after a period of time given by the following equation:

$$t = \tau_1 * \ln(I'^2 / I'^2 - 1))$$

Where:

t = Tripping time.
$\tau 1$= Heating time constant.
$I' = I / I_{tap}$
I =Current through the element.
I_{tap} = Programmed tap/pickup current in the relay.

This equation can only be applied if the relay starts from a thermal zero status, that is, from a condition at which a current I = 0 was flowing through it. If the relay had stabilised at a condition at which a given current was flowing through it, the value of which is smaller than the rated current, and at a given moment the current increases up to a value greater than the rated current, the tripping time from the moment the increase takes place is given by the equation:

$$t = \tau_1 * \ln \frac{I^2 - I_e^2}{I^2 - 1} |$$

Where:

I_e = Ime / I_{tap}
Ime = Current at which the protected element had stabilised.
I_{tap} = Programmed tap current.

and the rest of the symbols have the same meaning as in the previous equation.

In the curves, the “Thermal Equivalent Current” is represented by the letter Ieq, and this is the value that the relay shows corresponding to the thermal image of the protected element.

When the protected element cools down, the time constant (Cooling Time Constant) may be different than the heating time constant. For motors and generators applications, the heat transfer between the machine and the ambient, it different depending on if the machine is stopped or if it is spinning. To detect this stopped motor or generator (or in general, protected element disconnected), MIF relay uses an internal current level detector, fixed to 15% In. If the current flowing through the element is lower than this value, the relay will consider that the element is disconnected and will use in its algorithms and equations a different “Cooling” time constant $\tau 2$. This time constant is

a setting in the relay, and its range is from 1 to 6 times the heating time constant $\tau 1$. If the current is greater than 15% In, the element will be considered to be connected (spinning), and then, the cooling time constant will be $\tau 1$.

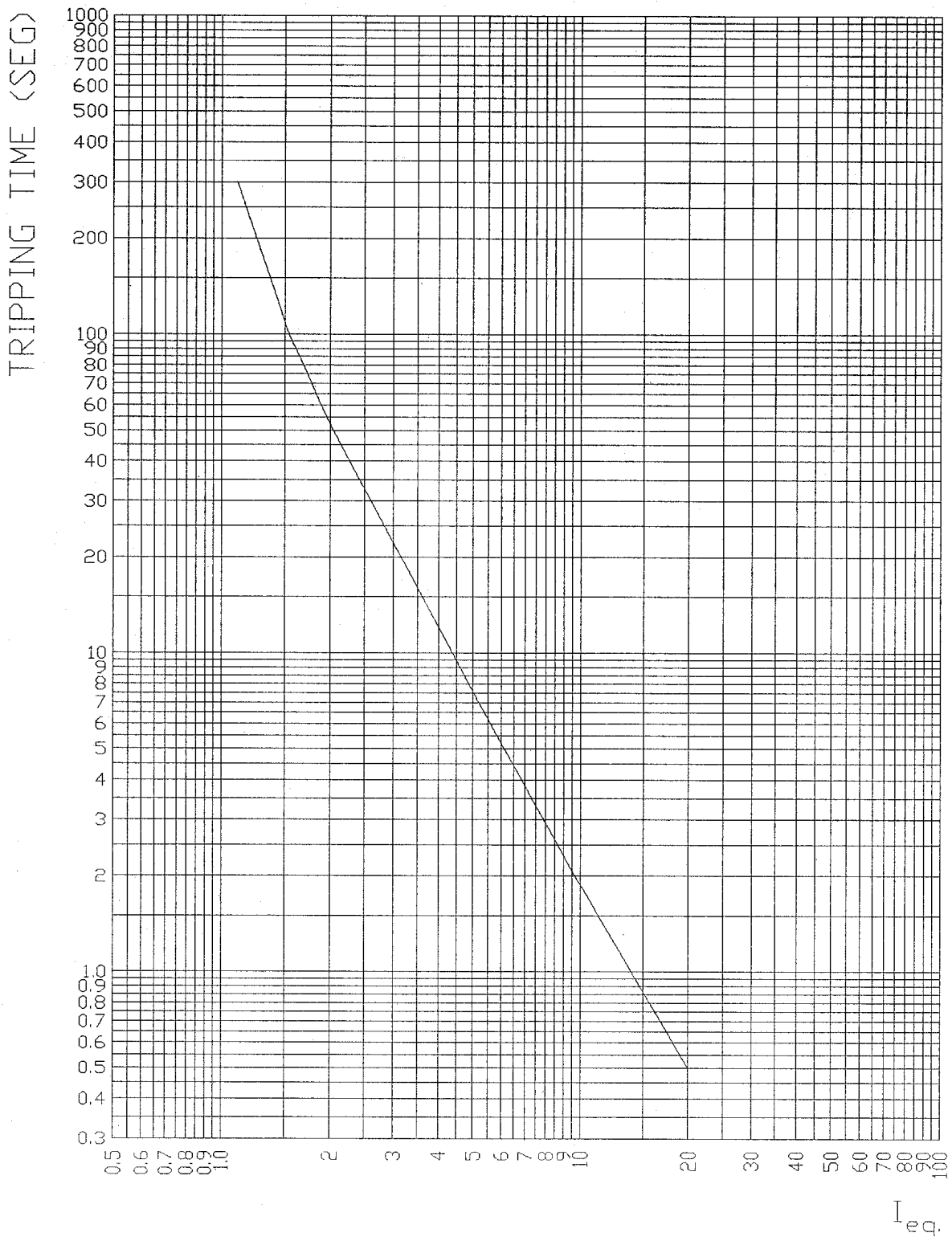


Figure A-1.1. THERMAL CURVE FOR τ1 = 3 MINUTES.

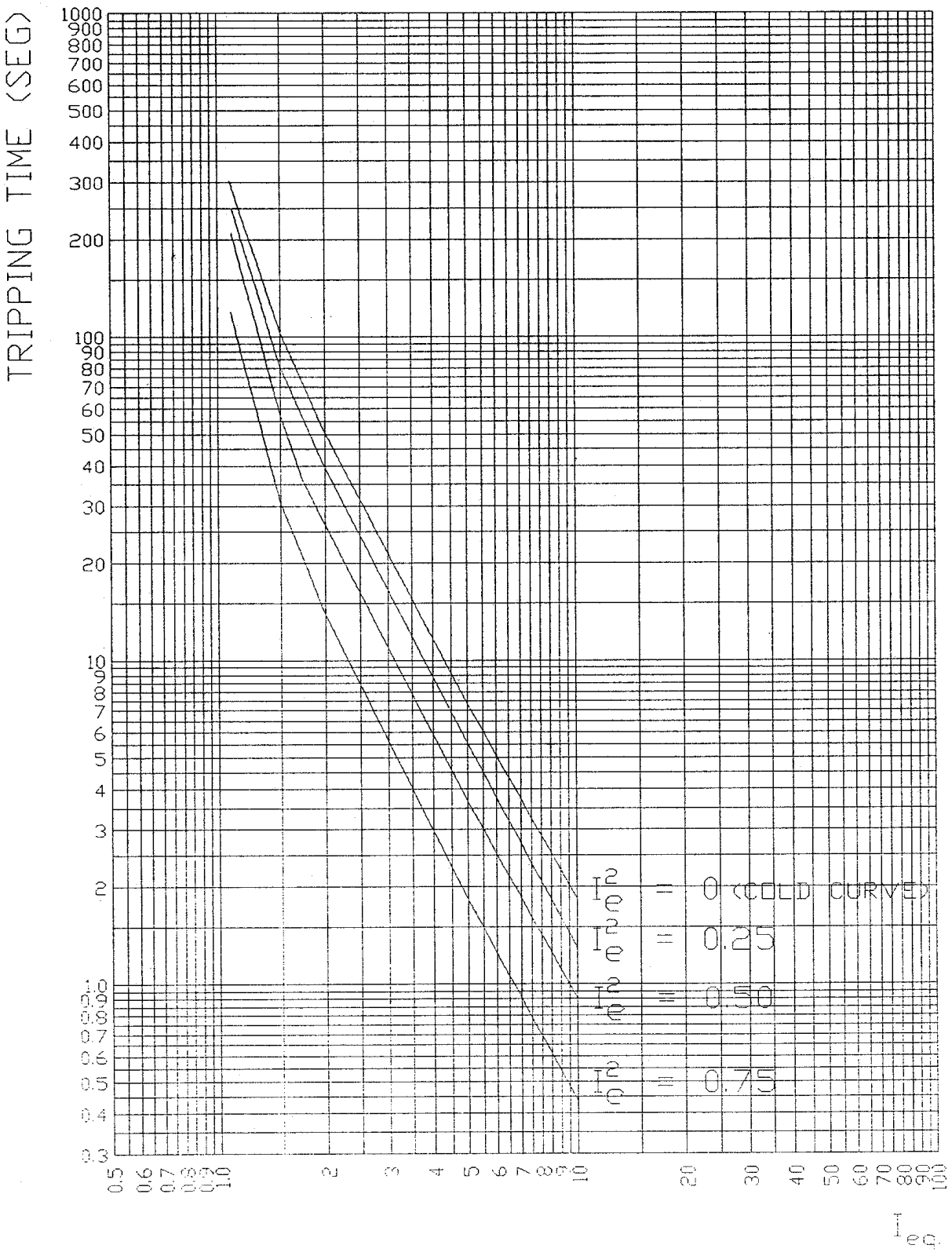


Figure A-1.2. THERMAL CURVES FOR τ1 = 3 MIN.

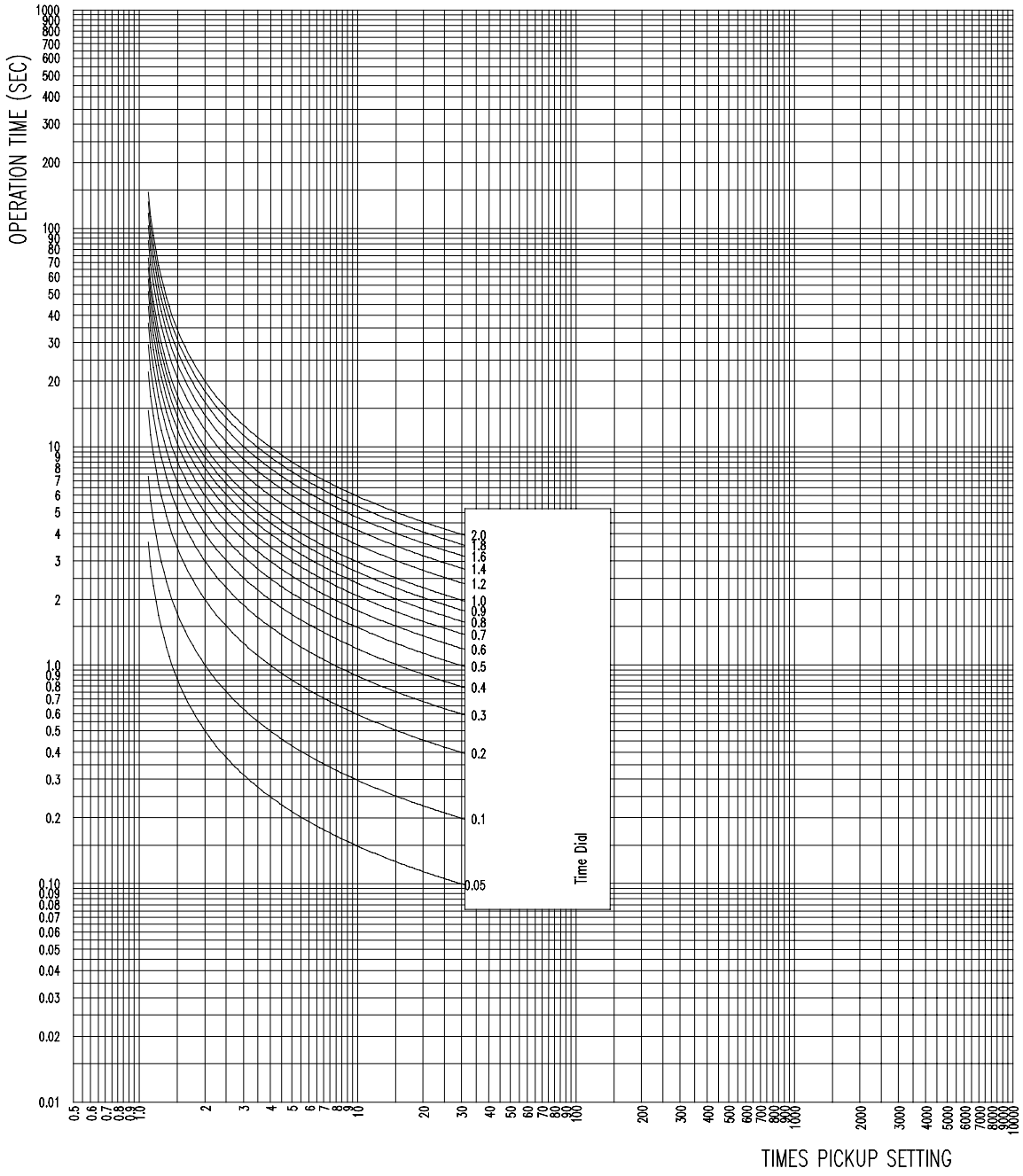


Figure A-2.1 INVERSE CURVES

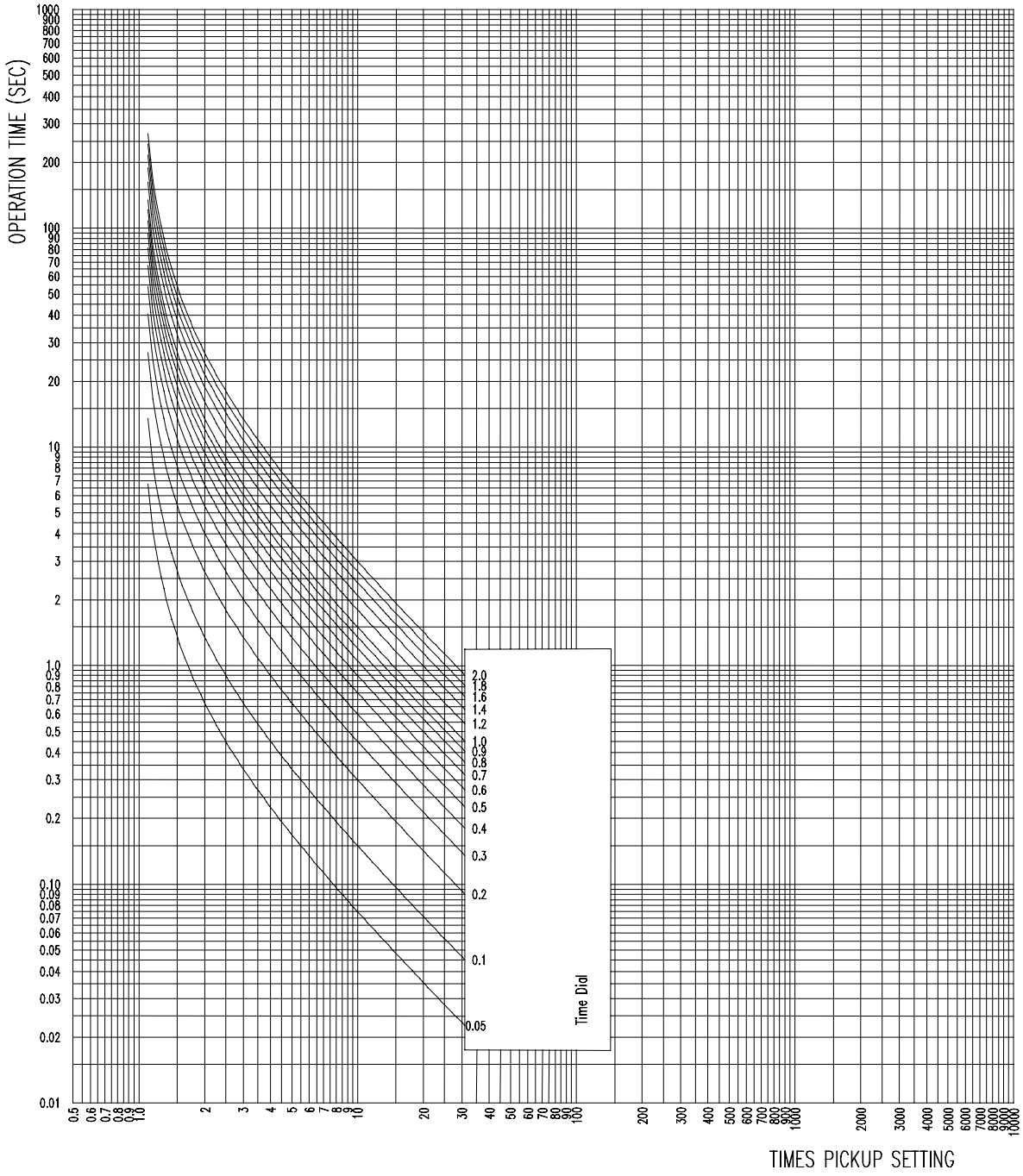


Figure A-2.2 VERY INVERSE CURVES

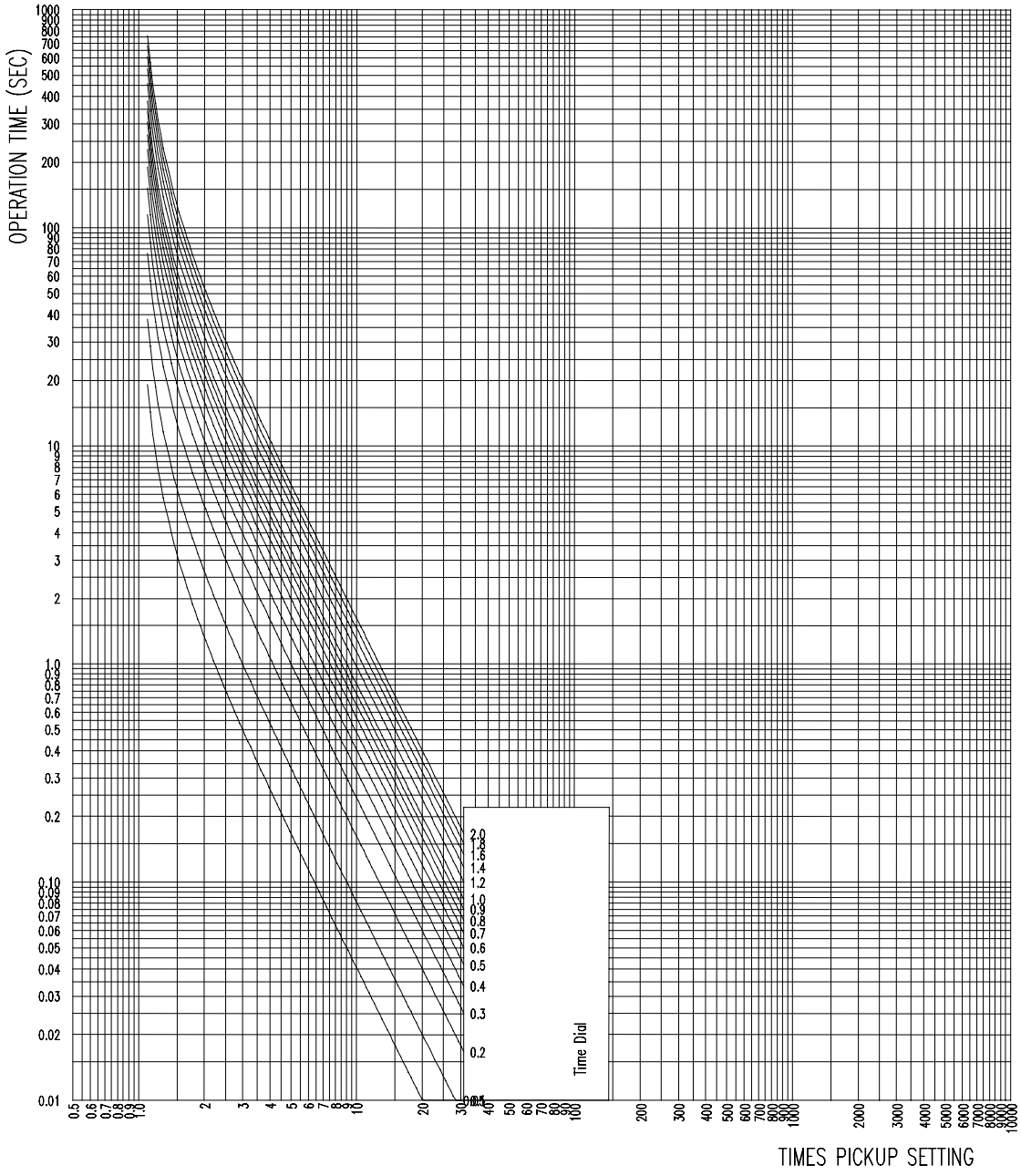


Figure A-2.3 EXTREMELY INVERSE CURVES

TABLE A2-1. TRIP TIMES (IN SECONDS) FOR BS142 CURVES

Times the tap	Dial 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

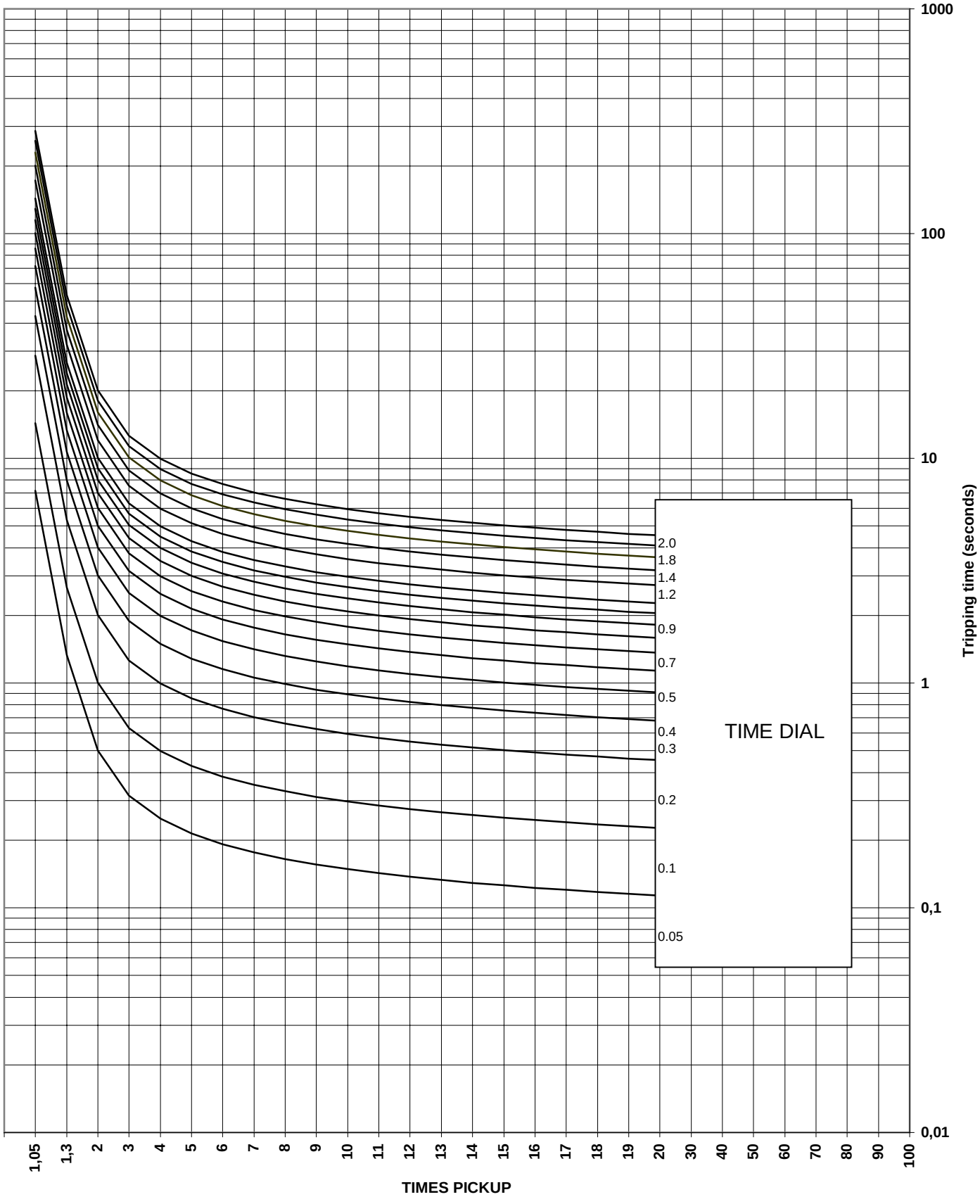
The general equation for all IEC/B142 curves is as follows:

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

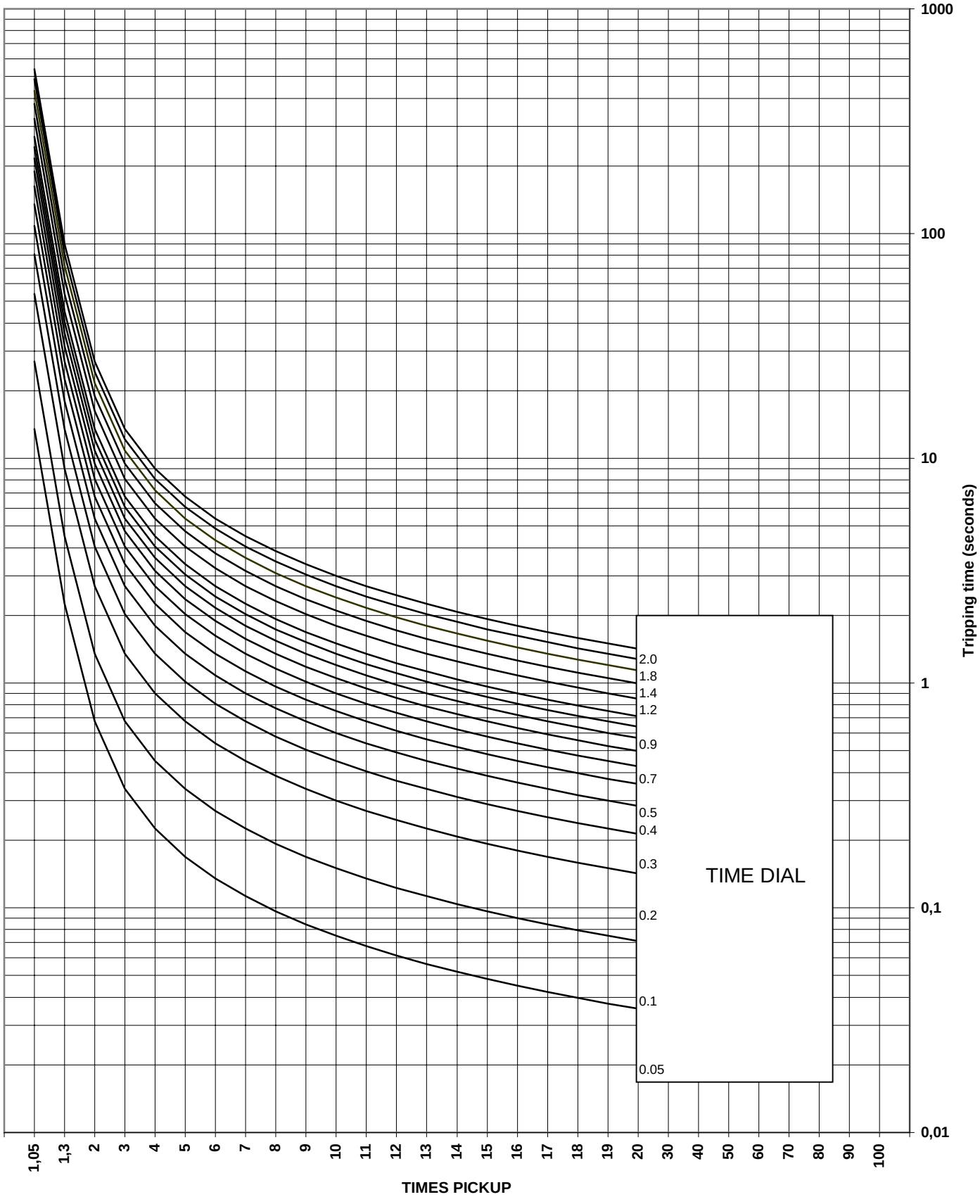
Where:

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

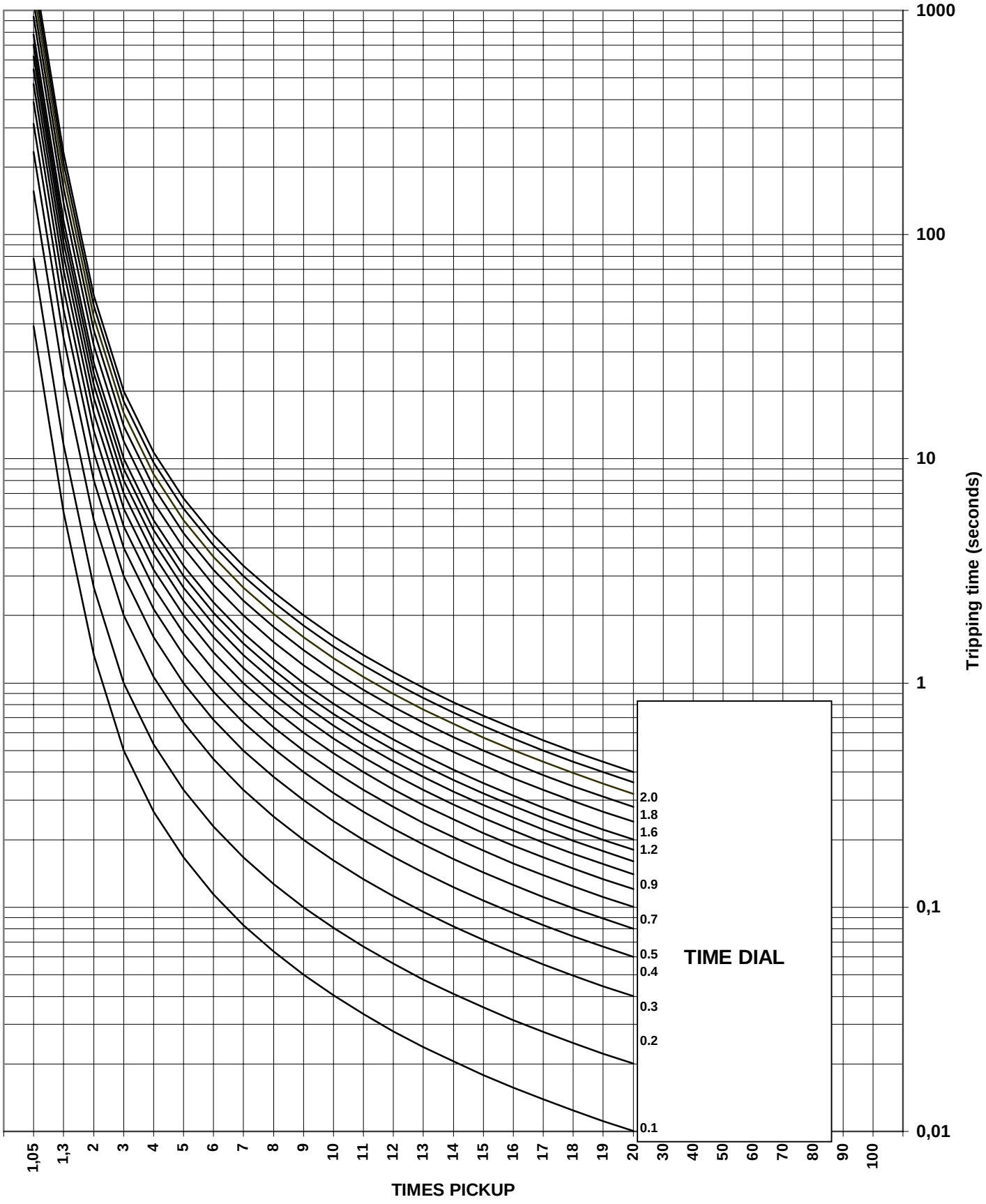


TABLE A2-2. TRIP TIMES (IN SECONDS) FOR ANSI CURVES

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

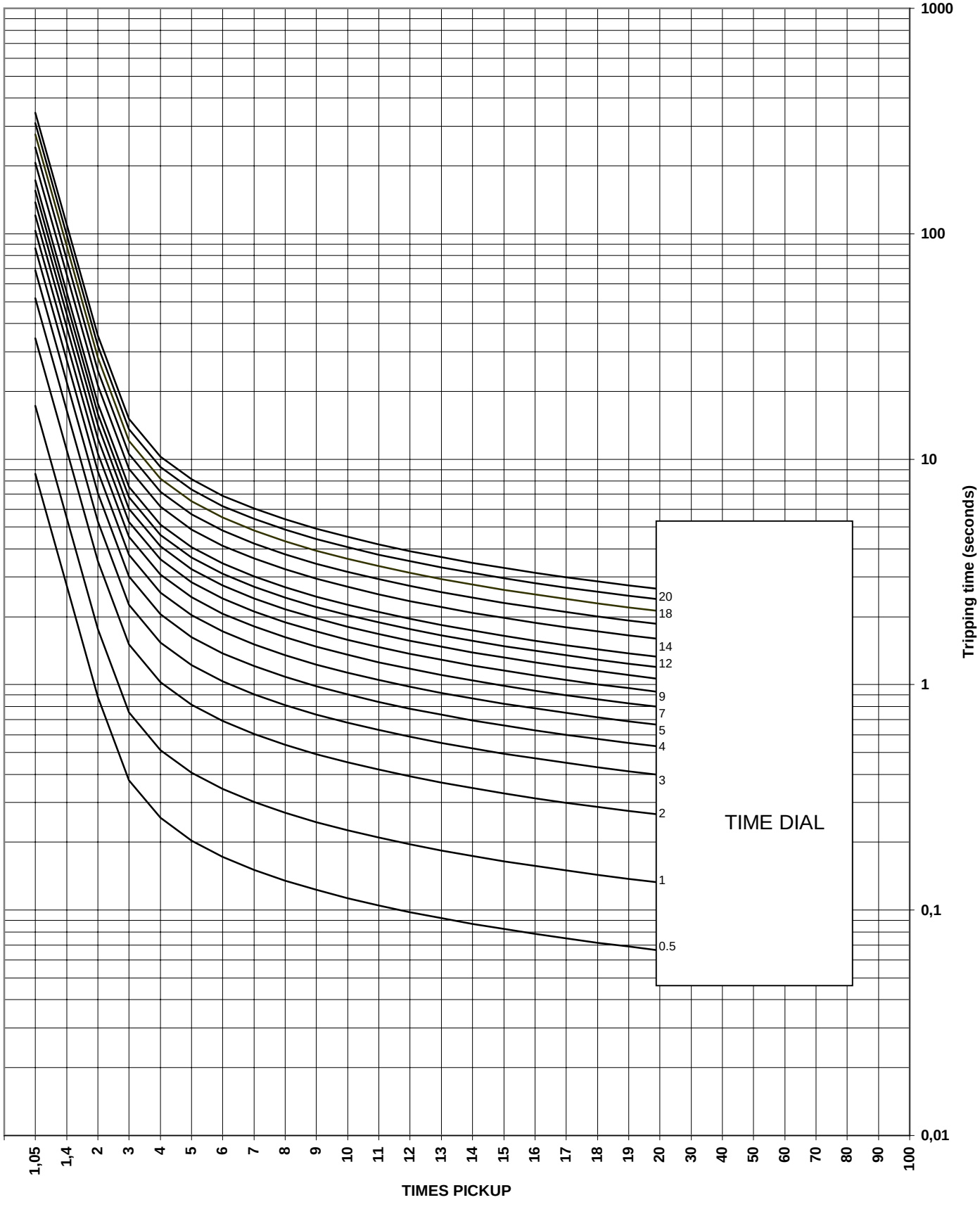
The general equation for all ANSI curves is as follows:

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

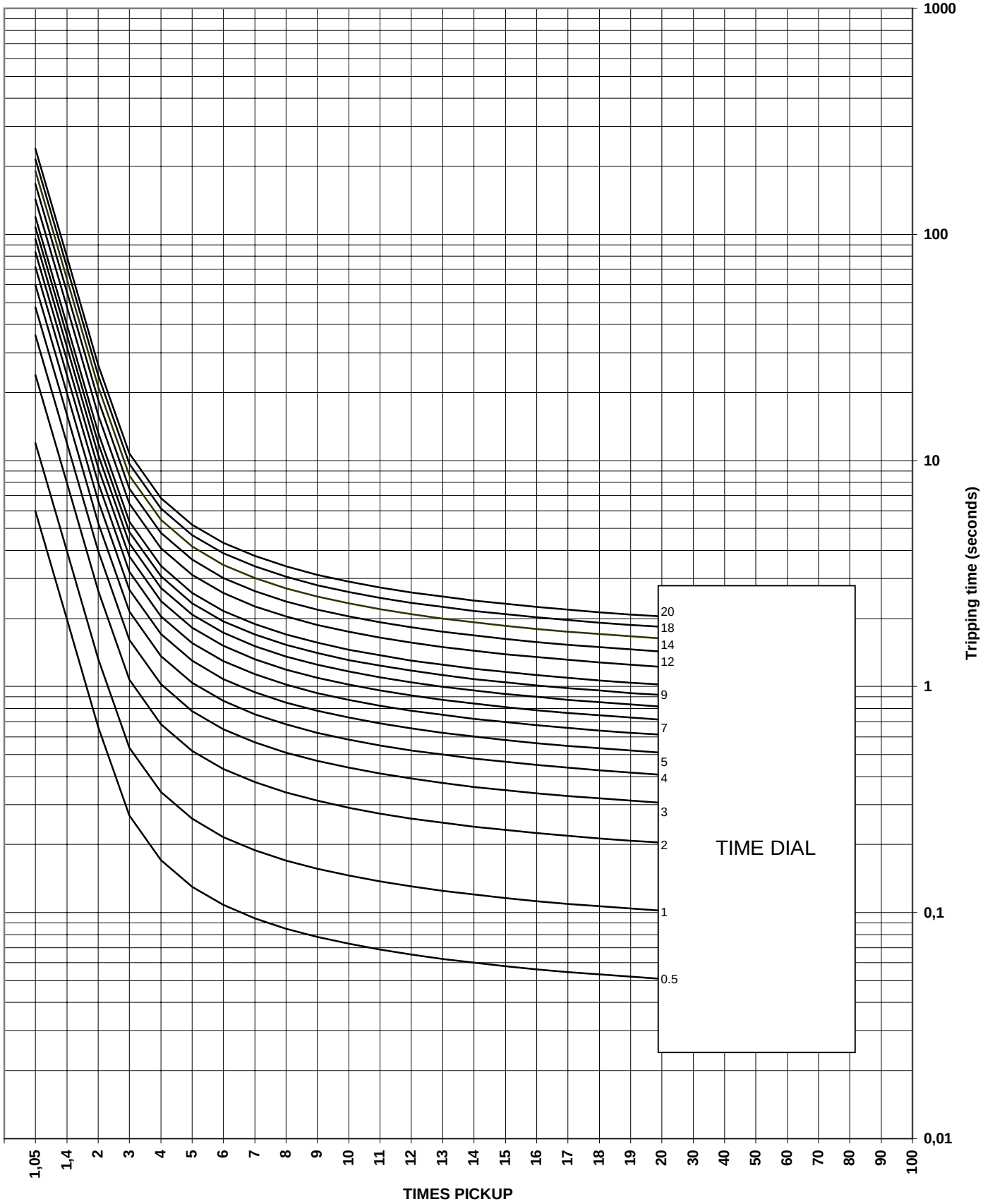
Where:

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

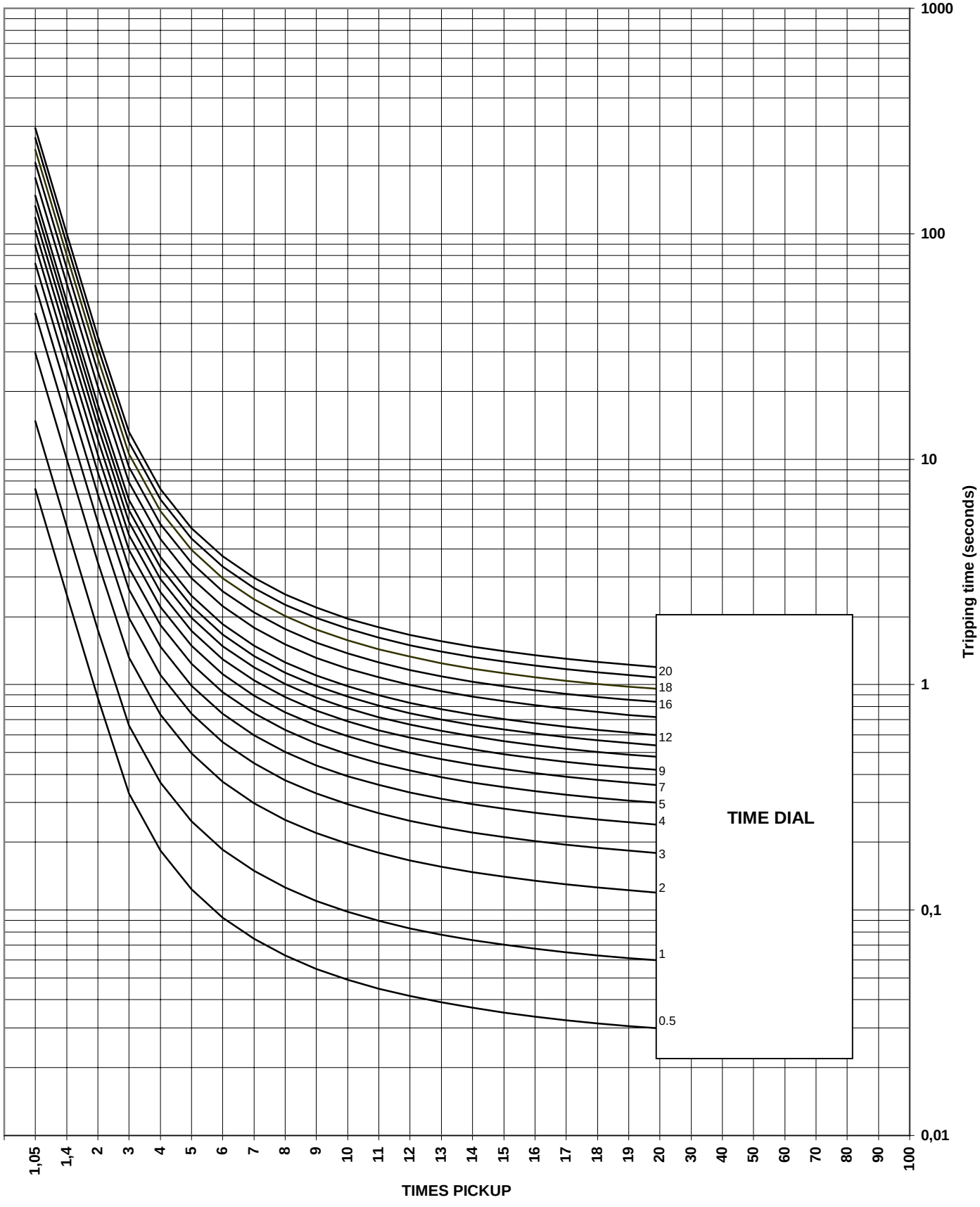
ANSI INVERSE



ANSI VERY INVERSE



ANSI EXTREMELY INVERSE



13.1 READ ACTUAL VALUES OR SETTINGS

The Modbus® function to use is function code 03HEX, (READ HOLDING REGISTERS). The request command is built as follows:

Request:

FIELD	LENGHT
Slave (Relay) Address	1 Byte
Function Code	1 Byte (03H)
Data Starting Address (high byte first – low byte after)	1 Word
Number of registers (hi-lo)	1 Word
CRC	1 Word

Answer:

FIELD	LENGHT
Slave (Slave) Address	1 Byte
Function Code	1 Byte
Number of bytes	1 Byte
Registers values (hi-lo)	(Num. Of bytes/2) Words
CRC	1 Word

Example:

Request:

ADDRESS	FUNCTION	STARTING ADDRESS	#REGS	CRC
01	03	04 FE	00 4B	65 3D

Answer:

ADDRESS	FUNCTION	BYTES	DATA0	...	DATA74	CRC
01	03	96	50 0D		02 00	84 D5

13.2 COMMANDS

Commands are executed in two steps: selection and confirmation. First, a selection command is sent, to verify if it is possible to carry it out). If so, on the second step is used to send the confirmation. The structure of both commands is the same, the only difference is the corresponding code.

The Modbus® function code used is 10HEX (PRESET MULTIPLE SETPOINTS). As it is a writing process, it is necessary to specify the address where the command will be written. The address is 0000H for all commands.

SELECTION:

Request:

FIELD	LENGTH
Slave (Relay) Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word (0000H)
Number of Registers (hi-lo)	1 Word (0001H)
Number of Bytes	1 Byte (01 * 2 = 02H)
Registers Values	1 Word * 1 -> Register#1: Command Code (lo-hi)
CRC	1 Word

Answer:

FIELD	LENGTH
Slave (Relay) Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word (0000H)
Number of Registers (hi-lo)	1 Word (0003H)
CRC	1 Word

Example:

To activate Table 2, the opening command is 15DEC (000FH -> 0F 00 (lo-hi)):

ADDRESS	FUNCTIÓN	STARTING ADDRESS	#REGS	#BYTES	DATA0	CRC
01	10	00 00	00 01	02	0F 00	A3 A0

Answer:

ADDRESS	FUNCTIÓN	STARTING ADDRESS	#REGS	CRC
01	10	00 00	00 01	01 C9

CONFIRMATION:

Request:

FIELD	LENGTH
Slave Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word (0000H)
Number of Registers (hi-lo)	1 Word (0003H)
Number of Bytes	1 Byte (03 * 2 = 06H)
Registers Values	1 Word * 3 -> Register#1: Command Code (lo-hi).

FIELD	LENGTH
	Register#2: Relay Password (lo-hi) Register#3: Constant value 0000H
CRC	1 Word

Answer:

FIELD	LENGTH
Slave Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word (0000H)
Number of registers (hi-lo)	1 Word (0003H)
CRC	1 Word

Example:

In order to confirm the TABLE 2 selection, use code 16DEC (0010H). This time, it is necessary to send the relay password.

Request:

ADDRESS	FUNTION	STARTING ADDRESS	#REGS	#BYTES	DATA0	DATA1	DATA2	CRC
01	10	00 00	00 03	06	10 00	01 00	00 00	E5 EC

Answer:

ADDRESS	FUNTION	STARTING ADDRESS	#REGS	CRC
01	10	00 00	00 03	80 08

COMMANDS CODES

NAME	ENGLISH	SELECTION	CONFIRMATION
RL	LED RESET	09	0A
RIt	THERMAL IMAGE	03	04
AcT1	ACTIVATE TABLE 1	0D	0E
AcT2	ACTIVATE TABLE 2	0F	10
Settings	SELECT/CONFIRM	01	02

13.3 TIME SYNCHRONIZATION

To synchronise the relay to a given date and time, the command has the following particularities:

- A broadcast message is sent (Slave Address = 00 H).
- The Date and Time information is included in the message.
  Date/Time format is 6 bytes length, stating the number of milliseconds since 1/1/1996, at 00:00:00.000 hours.
- As it is a broadcast message, no answer is received from the slaves.

FIELD	LENGTH
Slave Address	1 Byte (Broadcast = 00H)
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word (0000H)
Number of Registers (hi-lo)	1 Word (0004H)
Number of Bytes	1 Bytes (04 * 2 = 08H)
Registers values	1 Word * 4 → Register#1 : Command Code (lo-hi). Register#2 - #4 : Date and Time (INTEL format, lowest bytes first).
CRC	1 Word

Example:

For May, 31st 1999, 10:01:04.224 hrs = 107,690,464,000 milliseconds since 1/1/1996, 00:00:00.000

107,690,464,000 DEC = 00 19 12 DA 13 00 HEX = 00 13 DA 12 19 00 (lowest bytes first).

ADDRESS	FUNCTION	STARTING ADDRESS	#REGS	#BYTES	COMMAND	VALUE	CRC
00	10	00 00	00 04	08	FE 00	00 13 DA 12 19 00	EC FC

13.4 SETTINGS CHANGE

The following three steps must be observed:

1. Execute a selection command, using the corresponding code. (Refer to Commands for more details).
2. Setting Change.
3. Execute a confirmation command, using the corresponding code. (Refer to Commands for more details).

To change a setting, the function code is 10HEX (PRESET MULTIPLE REGISTERS)

FIELD	LENGTH
Slave Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word
Number of registers (hi-lo)	1 Word (N)
Number of bytes	1 Byte (N*2)
Registers Values (hi-lo)	1 Word * N
CRC	1 Word

Answer:

FIELD	LENGTH
Slave Address	1 Byte
Function Code	1 Byte (10H)
Starting Address (hi-lo)	1 Word
Number of Registers (hi-lo)	1 Word
CRC	1 Word

Example:

Setting change selection (like a command):

Request:

ADDRESS	FUNCTION	START	#REGS	#BYTES	DATA0	CRC
01	10	0000	0001	02	0100	A7C0

Answer:

ADDRESS	FUNCTION	START	#REGS	CRC
01	10	0000	00 01	01C9

Settings Change:

Request:

ADDRESS	FUNCTION	START	#REGS	#BYTES
01	10	0118	0008	10

DATA0	DATA1	DATA2	DATA3	DATA4
5445	5354	0000	0000	0000

DATA5	DATA6	DATA7	CRC
0000	0000	0000	98BB

Data0 => 5445 (TE)
Data1 => 5354 (ST)
Data2 => 0000 (End of text. The rest of characters are not considered).

Answer:

ADDRESS	FUNCTION	START	#REGS	CRC
01	10	0118	0008	4034

Setting change confirmation (like a command):

Request:

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

Answer:

ADDRESS	FUNCTION	START	#REGS	CRC
01	10	0000	00 03	8008

13.5 ERROR MESSAGES

When any of the commands shown are not successfully performed and the slave generates an error, the following message is received from the slave:

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

The possible error codes are:

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

13.6 MODBUS MEMORY MAP

This memory map shows the location of the different internal data. This information will be useful for those advanced users that want to integrate the relay in a Protection and Control System under the Modbus® protocol.

13.6.1. MEMORY MAP FOR OPTION 0 MODELS

13.6.1.1. Relay Settings

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0124		IDEN	IDENTIFICATION	16	F3					
0134		TRIP MIN TIME	TRIP MIN TIME	4	F2	50	300	100	1	ms
013C	0	TAB	ACTIVE TABLE	2	F4					
013E	0	STA	RELAY STATUS	2	F4					
013E	1	FRQ	FREQUENCY	2	F10					
0140	0	TRIP 51	51 Trip	2	F4					
0140	1	TRIP 51N	51N Trip	2	F4					
0140	2	TRIP 50H	50H Trip	2	F4					
0140	3	TRIP 50L	50L Trip	2	F4					
0140	4	TRIP 50NH	50NH Trip	2	F4					
0140	5	TRIP 50NL	50NL Trip	2	F4					
0140	6	TRIP 49	49 Trip	2	F4					
0142		TAP 51	51 Pickup	4	F2	0.10	2.40	0.50	100	In
0146		CURV 51	51 Curve	2	F7					
0148		DIAL 51	51 Time Dial	4	F2	0.05	2	0.50	100	
014C		TIME 51	51 Time Delay	4	F2	0	99.99	1	100	s
0150		TAP 51N	51N Pickup	4	F2	0.10	2.40	0.50	100	In
0154		CURV 51N	51N Curve	2	F7					
0156		DIAL 51N	51N Time Dial	4	F2	0.05	2	0.50	100	
015A		TIME 51N	51N Time Delay	4	F2	0	99.99	1	100	s
015E		TAP 50H	50H Pickup	4	F2	0.10	30	1	10	In
0162		TIME 50H	50H Time Delay	4	F2	0	99.99	0	100	s
0166		TAP 50L	50L Pickup	4	F2	0.10	30	1	10	In
016A		TIME 50L	50L Time Delay	4	F2	0	99.99	0	100	s
016E		TAP 50NH	50NH Pickup	4	F2	0.10	30	1	10	In
0172		TIME 50NH	50NH Time Delay	4	F2	0	99.99	0	100	s
0176		TAP 50NL	50NL Pickup	4	F2	0.10	30	1	10	In
017A		TIME 50NL	50NL Time Delay	4	F2	0	99.99	0	100	s
017E		TAP 49	49 Pickup	4	F2	0.10	2.40	1	100	In
0182		ALARM 49	49 Alarm level	4	F2	70	100	80	1	%
0186		T1	T1	4	F2	3	600	6	1	min
018A		T2	T2	4	F2	1	6	1	1	T1
018E	0	TRIP 51 T2	51 Trip T2	2	F4					
018E	1	TRIP 51N T2	51N Trip T2	2	F4					
018E	2	TRIP 50H T2	50H Trip T2	2	F4					
018E	3	TRIP 50L T2	50L Trip T2	2	F4					
018E	4	TRIP 50NH T2	50NH Trip T2	2	F4					
018E	5	TRIP 50NL T2	50NL Trip T2	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
018E	6	TRIP 49 T2	49 Trip (table 2)	2	F4					
0190		TAP 51 T2	51 Pickup T2	4	F2	0.10	2.40	0.50	100	In
0194		CURV 51 T2	51 Curve T2	2	F7					
0196		DIAL 51 T2	Dial 51 T2	4	F2	0.05	2	0.50	100	
019A		TIME 51 T2	51 Time Delay T2	4	F2	0	99.99	1	100	s
019E		TAP 51N T2	51N Pickup T2	4	F2	0.10	2.40	0.50	100	In
01A2		CURV 51N T2	51N Curve T2	2	F7					
01A4		DIAL 51N T2	51N Time Dial T2	4	F2	0.05	2	0.50	100	
01A8		TIME 51N T2	51N Definite Time T2	4	F2	0	99.99	1	100	s
01AC		TAP 50H T2	50H Pickup T2	4	F2	0.10	30	1	10	In
01B0		TIME 50H T2	50H Time Delay T2	4	F2	0	99.99	0	100	s
01B4		TAP 50L T2	50L Pickup T2	4	F2	0.10	30	1	10	In
01B8		TIME 50L T2	50L Time Delay T2	4	F2	0	99.99	0	100	s
01BC		TAP 50NH T2	50NH Pickup T2	4	F2	0.10	30	1	10	In
01C0		TIME 50NH T2	50NH Time Delay T2	4	F2	0	99.99	0	100	s
01C4		TAP 50NL T2	50NL Pickup T2	4	F2	0.10	30	1	10	In
01C8		TIME 50NL T2	50NL Time Delay T2	4	F2	0	99.99	0	100	s
01CC		TAP 49 T2	49 Pickup T2	4	F2	0.10	2.40	1	100	In
01D0		ALARM 49 T2	49 Alarm level (T2)	4	F2	70	100	80	1	%
01D4		T1 T2	T1 T2	4	F2	3	600	6	1	min
01D8		T2 T2	T2 T2	4	F2	1	6	1	1	T1
01DC		A	A	4	F2	0	125	0.05	10000	s
01E0		B	B	4	F2	0	3	0	10000	s
01E4		P	P	4	F2	0	3	0.04	10000	
01E8		Q	Q	4	F2	0	2	1	10000	
01EC		K	K	4	F2	0	2	0	10000	s

13.6.1.2. Relay Status

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0388		D T	Date/Time	6	F1					
038E		ver	Version	6	F3					
0394		mod	Model	16	F3					
03A4		iden	Identification	16	F3					
03B4		LTU	Last trip function	4	F3					
03B8		Z2	Last phase trip	4	F3					
03BC		Z3	Last trip current	4	F2					
03D2	0	LD	Trip LED	2	F4					
03D2	1	LR	READY	2	F4					
03D2	2	L1	LED 1	2	F4					
03D2	3	L2	LED 2	2	F4					
03D2	4	L3	LED 3	2	F4					
03D2	5	L4	LED 4	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
03D4	0	a 50HA	50Ha Pickup	2	F4					
03D4	1	a 50HB	50Hb Pickup	2	F4					
03D4	2	a 50HC	50Hc Pickup	2	F4					
03D4	3	a 50HN	50NH Pickup	2	F4					
03D4	4	a 50LA	50La Pickup	2	F4					
03D4	5	a 50LB	50Lb Pickup	2	F4					
03D4	6	a 50LC	50Lc Pickup	2	F4					
03D4	7	a 50LN	50NL Pickup	2	F4					
03D4	8	a 51 A	51a Pickup	2	F4					
03D4	9	a 51 B	51b Pickup	2	F4					
03D4	10	a 51 C	51c Pickup	2	F4					
03D4	11	a 51 N	51N Pickup	2	F4					
03D4	12	a 49	49 Alarm	2	F4					
03D6	0	d 50HA	50H Trip	2	F4					
03D6	1	d 50HB	50L Trip	2	F4					
03D6	2	d 50HC	50NH Trip	2	F4					
03D6	3	d 50HN	50NL Trip	2	F4					
03D6	4	d 50LA	51 Trip	2	F4					
03D6	5	d 50LB	51N Trip	2	F4					
03D6	6	d 50LC	49 Trip	2	F4					
03D6	7	d 50LN	49 Trip	2	F4					
03D6	8	d 51 A	49 Trip	2	F4					
03D6	9	d 51 B	49 Trip	2	F4					
03D6	10	d 51 C	49 Trip	2	F4					
03D6	11	d 51 N	51N Trip	2	F4					
03D6	12	d 49	51N Trip	2	F4					
03D8	0	id50H	50H Virtual trip	2	F4					
03D8	1	id50NH	50NH Virtual trip	2	F4					
03D8	2	id51	51 Virtual trip	2	F4					
03D8	3	id51N	51N Virtual trip	2	F4					
03D8	4	id50L	50L Virtual trip	2	F4					
03D8	5	id50NL	50NL Virtual trip	2	F4					
03D8	6	id49	49 Virtual trip	2	F4					
03D8	7	idGEN	General virtual trip	2	F4					
03DA	0	a 50H	50H Pickup	2	F4					
03DA	1	a 50NH	50NH Pickup	2	F4					
03DA	2	a 51	51 Pickup	2	F4					
03DA	3	a 51N	51N Pickup	2	F4					
03DA	4	a 50L	50L Pickup	2	F4					
03DA	5	a 50NL	50NL Pickup	2	F4					
03DA	6	aa49	49 Alarm	2	F4					
03DA	7	a GEN	Pickup	2	F4					
03DA	8	me50H	50H Disabled	2	F4					
03DA	9	me50NH	50NH Disabled	2	F4					
03DA	10	me51	51 Disabled	2	F4					
03DA	11	me51N	51N Disabled	2	F4					
03DA	12	me50L	50L Disabled	2	F4					
03DA	13	me50NL	50NL Disabled	2	F4					
03DA	14	me49	49 Disabled	2	F4					
03DA	15	meGEN	Trip disabled	2	F4					
03DC	0	d 50H	50H Trip	2	F4					
03DC	1	d 50NH	50NH Trip	2	F4					
03DC	2	d 51	51 Trip	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
03DC	3	d 51N	51N Trip	2	F4					
03DC	4	d 50L	50L Trip	2	F4					
03DC	5	d 50NL	50NL Trip	2	F4					
03DC	6	dd49	49 Trip	2	F4					
03DC	7	d GEN	General trip	2	F4					
03DC	8	d	TRIP	2	F4					
03DC	9	al	ALARM	2	F4					
03DC	10	OUT1	Output1	2	F4					
03DC	11	OUT2	OutpuT2	2	F4					
03DC	12	OUT3	Output3	2	F4					
03DC	13	OUT4	Output4	2	F4					
03DC	14	INP1	Input1	2	F4					
03DC	15	INP2	InpuT2	2	F4					
03DE	14	F1	E2prom failure	2	F4					
03DE	15	AU	User Settings	2	F4					
03E0	0	prot	Protection	2	F4					
03E0	3	T AC	ACTIVE TABLE	2	F4					
03E0	4	frec	Frequency	2	F10					
03E0	5	LOCREM	Local/Remote	2	F4					
03E0	13	DISPHA	Phase trip	2	F4					
03E0	14	DISNEU	Ground trip	2	F4					
03E0	15	DISP50	50 Trip	2	F4					
03E2		Ia	Ia	4	F2					
03E6		Ib	Ib	4	F2					
03EA		Ic	Ic	4	F2					
03EE		In	In	4	F2					
03F2		TH	Thermal image	4	F2					

13.6.2. MEMORY MAP FOR OPTION 1 MODELS

13.6.2.1. Relay Settings

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0124		IDEN	IDENTIFICATION	16	F3					
0134		TRIP MIN TIME	MINIMUM TRIP TIME	4	F2	50	300	100	1	ms
013C	0	TAB	ACTIVE TABLE	2	F4					
013E	0	STA	RELAY STATUS	2	F4					
013E	1	FRQ	FREQUENCY	2	F10					
0140	0	TRIP 51	51 Trip	2	F4					
0140	1	TRIP 51N	51N Trip	2	F4					
0140	2	TRIP 50H	50H Trip	2	F4					
0140	3	TRIP 50L	50L Trip	2	F4					
0140	4	TRIP 50NH	50NH Trip	2	F4					
0140	5	TRIP 50NL	50NL Trip	2	F4					
0140	6	TRIP 49	49 Trip	2	F4					
0142		TAP 51	51 Pickup	4	F2	0.10	2.40	0.50	100	In
0146		CURV 51	51 Curve	2	F7					
0148		DIAL 51	51 Time Dial	4	F2	0.05	2	0.50	100	
014C		TIME 51	51 Time Delay	4	F2	0	99.99	1	100	s

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0150		TAP 51N	51N Pickup	4	F2	0.10	2.40	0.50	100	In
0154		CURV 51N	51N Curve	2	F7					
0156		DIAL 51N	51N Time Dial	4	F2	0.05	2	0.50	100	
015A		TIME 51N	51N Time Delay	4	F2	0	99.99	1	100	s
015E		TAP 50H	50H Pickup	4	F2	0.10	30	1	10	In
0162		TIME 50H	50H Time Delay	4	F2	0	99.99	0	100	s
0166		TAP 50L	50L Pickup	4	F2	0.10	30	1	10	In
016A		TIME 50L	50L Time Delay	4	F2	0	99.99	0	100	s
016E		TAP 50NH	50NH Pickup	4	F2	0.10	30	1	10	In
0172		TIME 50NH	50NH Time Delay	4	F2	0	99.99	0	100	s
0176		TAP 50NL	50NL Pickup	4	F2	0.10	30	1	10	In
017A		TIME 50NL	50NL Time Delay	4	F2	0	99.99	0	100	s
017E		TAP 49	49 Pickup	4	F2	0.10	2.40	1	100	In
0182		ALARM 49	49 Alarm level	4	F2	70	100	80	1	%
0186		T1	T1	4	F2	3	600	6	1	min
018A		T2	T2	4	F2	1	6	1	1	T1
018E	0	TRIP 51 T2	51 Trip T2	2	F4					
018E	1	TRIP 51N T2	51N Trip T2	2	F4					
018E	2	TRIP 50H T2	50H Trip T2	2	F4					
018E	3	TRIP 50L T2	50L Trip T2	2	F4					
018E	4	TRIP 50NH T2	50NH Trip T2	2	F4					
018E	5	TRIP 50NL T2	50NL Trip T2	2	F4					
018E	6	TRIP 49 T2	49 Trip (table 2)	2	F4					
0190		TAP 51 T2	51 Pickup T2	4	F2	0.10	2.40	0.50	100	In
0194		CURV 51 T2	51 Curve T2	2	F7					
0196		DIAL 51 T2	Dial 51 T2	4	F2	0.05	2	0.50	100	
019A		TIME 51 T2	51 Time Delay T2	4	F2	0	99.99	1	100	s
019E		TAP 51N T2	51N Pickup T2	4	F2	0.10	2.40	0.50	100	In
01A2		CURV 51N T2	51N Curve T2	2	F7					
01A4		DIAL 51N T2	51N Time Dial T2	4	F2	0.05	2	0.50	100	
01A8		TIME 51N T2	51N Definite Time T2	4	F2	0	99.99	1	100	s
01AC		TAP 50H T2	50H Pickup T2	4	F2	0.10	30	1	10	In
01B0		TIME 50H T2	50H Time Delay T2	4	F2	0	99.99	0	100	s
01B4		TAP 50L T2	50L Pickup T2	4	F2	0.10	30	1	10	In
01B8		TIME 50L T2	50L Time Delay T2	4	F2	0	99.99	0	100	s
01BC		TAP 50NH T2	50NH Pickup T2	4	F2	0.10	30	1	10	In
01C0		TIME 50NH T2	50NH Time Delay T2	4	F2	0	99.99	0	100	s
01C4		TAP 50NL T2	50NL Pickup T2	4	F2	0.10	30	1	10	In
01C8		TIME 50NL T2	50NL Time Delay T2	4	F2	0	99.99	0	100	s
01CC		TAP 49 T2	49 Pickup T2	4	F2	0.10	2.40	1	100	In

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
01D0		ALARM 49 T2	49 Alarm level (T2)	4	F2	70	100	80	1	%
01D4		T1 T2	T1 T2	4	F2	3	600	6	1	min
01D8		T2 T2	T2 T2	4	F2	1	6	1	1	T1
01DC		A	A	4	F2	0	125	0.05	10000	s
01E0		B	B	4	F2	0	3	0	10000	s
01E4		P	P	4	F2	0	3	0.04	10000	
01E8		Q	Q	4	F2	0	2	1	10000	
01EC		K	K	4	F2	0	2	0	10000	s
021C	0	O1	Oscillo by communic.	2	F4					
021C	1	O2	Oscillo by digital input	2	F4					
021C	2	O3	Oscillo by tripping	2	F4					
021C	3	O4	Oscillo by pickup	2	F4					
021E	0	A50H	50H Pickup	2	F4					
021E	1	A 50NH	50NH Pickup	2	F4					
021E	2	A51	51 Pickup	2	F4					
021E	3	A51N	51N Pickup	2	F4					
021E	4	A 50L	50L Pickup	2	F4					
021E	5	A 50NL	50NL Pickup	2	F4					
021E	6	A 49	49 Alarm	2	F4					
021E	8	IE50H	50H disabled	2	F4					
021E	9	IE50NH	50NN disabled	2	F4					
021E	10	I E51	51 disabled	2	F4					
021E	11	I E51N	51N disabled	2	F4					
021E	12	IE50L	50L disabled	2	F4					
021E	13	IE50NL	50NL disabled	2	F4					
021E	14	I E49	49 disabled	2	F4					
021E	15	D INH	Trip disabled	2	F4					
0220	0	D 50H	50H Trip	2	F4					
0220	1	D 50nh	50NH Trip	2	F4					
0220	2	D51	51 Trip	2	F4					
0220	3	D51n	51N Trip	2	F4					
0220	4	D 50L	50L Trip	2	F4					
0220	5	D 50nl	50NL Trip	2	F4					
0220	6	D49	49 Trip	2	F4					
0220	7	DISGEN	General trip	2	F4					
0220	9	E PROT	Protection status	2	F4					
0220	10	aux1	Output 1	2	F4					
0220	11	aux2	Output 2	2	F4					
0220	12	aux3	Output 3	2	F4					
0220	13	aux4	Output 4	2	F4					
0220	14	ENT1	Digital Input 1	2	F4					
0220	15	ENT2	Digital Input 2	2	F4					
0222	1	ihca	Settings change disabled	2	F4					
0222	2	ORD D	Trip operation by input	2	F4					
0222	6	C TAB	Active table change	2	F4					
0222	7	Gosc	Oscillography trigger by digital input	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0222	10	CFG2	Oscillo trigg by comm	2	F4					
0222	13	C AJUS	Settings change	2	F4					
0222	14	CFG3	e2prom Failure	2	F4					
0222	15	Adef	User settings	2	F4					
0236		AED1	Input 1	8	F3					
023E		AED2	Input 2	8	F3					
0246		ASD1	Output 1	8	F3					
024E		ASD2	Output 2	8	F3					
0256		ASD3	Output 3	8	F3					
025E		ASD4	Output 4	8	F3					
0266		A L1	Led 1	8	F3					
026E		A L2	Led 2	8	F3					
0276		A L3	Led 3	8	F3					
027E		A L4	Led 4	8	F3					

13.6.2.2. Relay Status

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0388		D T	Date/Time	6	F1					
038E		ver	Version	6	F3					
0394		mod	Model	16	F3					
03A4		iden	Identification	16	F3					
03B4		LTU	Last trip function	4	F3					
03B8		Z2	Last phase trip	4	F3					
03BC		Z3	Last trip current	4	F2					
03D2	0	LD	Trip LED	2	F4					
03D2	1	LR	Alarm LED	2	F4					
03D2	2	L1	LED 1	2	F4					
03D2	3	L2	LED 2	2	F4					
03D2	4	L3	LED 3	2	F4					
03D2	5	L4	LED 4	2	F4					
03D4	0	a 50HA	50Ha Pickup	2	F4					
03D4	1	a 50HB	50Hb Pickup	2	F4					
03D4	2	a 50HC	50Hc Pickup	2	F4					
03D4	3	a 50HN	50NH Pickup	2	F4					
03D4	4	a 50LA	50La Pickup	2	F4					
03D4	5	a 50LB	50Lb Pickup	2	F4					
03D4	6	a 50LC	50Lc Pickup	2	F4					
03D4	7	a 50LN	50NL Pickup	2	F4					
03D4	8	a 51 A	51a Pickup	2	F4					
03D4	9	a 51 B	51b Pickup	2	F4					
03D4	10	a 51 C	51c Pickup	2	F4					
03D4	11	a 51 N	51N Pickup	2	F4					
03D4	12	a 49	49 Alarm	2	F4					
03D6	0	d 50HA	50H Trip	2	F4					
03D6	1	d 50HB	50L Trip	2	F4					
03D6	2	d 50HC	50NH Trip	2	F4					
03D6	3	d 50HN	50NL Trip	2	F4					
03D6	4	d 50LA	51 Trip	2	F4					
03D6	5	d 50LB	51N Trip	2	F4					
03D6	6	d 50LC	49 Trip	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
03D6	7	d 50LN	49 Trip	2	F4					
03D6	8	d 51 A	49 Trip	2	F4					
03D6	9	d 51 B	49 Trip	2	F4					
03D6	10	d 51 C	49 Trip	2	F4					
03D6	11	d 51 N	51N Trip	2	F4					
03D6	12	d 49	51N Trip	2	F4					
03D8	0	id50H	50H Virtual trip	2	F4					
03D8	1	id50NH	50NH Virtual trip	2	F4					
03D8	2	id51	51 Virtual trip	2	F4					
03D8	3	id51N	51N Virtual trip	2	F4					
03D8	4	id50L	50L Virtual trip	2	F4					
03D8	5	id50NL	50NL Virtual trip	2	F4					
03D8	6	id49	49 Virtual trip	2	F4					
03D8	7	idGEN	General virtual trip	2	F4					
03DA	0	a 50H	50H Pickup	2	F4					
03DA	1	a 50NH	50NH Pickup	2	F4					
03DA	2	a 51	51 Pickup	2	F4					
03DA	3	a 51N	51N Pickup	2	F4					
03DA	4	a 50L	50L Pickup	2	F4					
03DA	5	a 50NL	50NL Pickup	2	F4					
03DA	6	aa49	49 Alarm	2	F4					
03DA	7	a GEN	Pickup	2	F4					
03DA	8	me50H	50H Disabled	2	F4					
03DA	9	me50NH	50NH Disabled	2	F4					
03DA	10	me51	51 Disabled	2	F4					
03DA	11	me51N	51N Disabled	2	F4					
03DA	12	me50L	50L Disabled	2	F4					
03DA	13	me50NL	50NL Disabled	2	F4					
03DA	14	me49	49 Disabled	2	F4					
03DA	15	meGEN	Trip disabled	2	F4					
03DC	0	d 50H	50H Trip	2	F4					
03DC	1	d 50NH	50NH Trip	2	F4					
03DC	2	d 51	51 Trip	2	F4					
03DC	3	d 51N	51N Trip	2	F4					
03DC	4	d 50L	50L Trip	2	F4					
03DC	5	d 50NL	50NL Trip	2	F4					
03DC	6	dd49	49 Trip	2	F4					
03DC	7	d GEN	General trip	2	F4					
03DC	8	d	TRIP	2	F4					
03DC	9	al	ALARM	2	F4					
03DC	10	OUT1	Output1	2	F4					
03DC	11	OUT2	OutpuT2	2	F4					
03DC	12	OUT3	Output3	2	F4					
03DC	13	OUT4	Output4	2	F4					
03DC	14	INP1	Input1	2	F4					
03DC	15	INP2	InpuT2	2	F4					
03DE	0	EDGEN	General input	2	F4					
03DE	1	EDICAJ	Settings change disabled	2	F4					
03DE	2	EDODIS	Trip contact close	2	F4					
03DE	3	EDRLED	Reset	2	F4					
03DE	6	EDCTAB	Table change	2	F4					
03DE	7	EDTOSC	Oscillo trigger	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
03DE	14	F1	E2prom failure	2	F4					
03DE	15	AU	User Settings	2	F4					
03E0	0	prot	Protection	2	F4					
03E0	3	T AC	ACTIVE TABLE	2	F4					
03E0	4	frec	Frequency	2	F10					
03E0	5	LOCREM	Local/Remote	2	F4					
03E0	13	DISPHA	Phase trip	2	F4					
03E0	14	DISNEU	Ground trip	2	F4					
03E0	15	DISP50	50 Trip	2	F4					
03E2		Ia	Ia	4	F2					
03E6		Ib	Ib	4	F2					
03EA		Ic	Ic	4	F2					
03EE		In	In	4	F2					
03F2		TH	Thermal image	4	F2					
041A		OS	OSC. NUMBER	2	F5					
041C		Sn	New events	2	F5					
041E		St	All events	2	F5					

13.6.3. MODBUS MAP FOR OPTION 2 MODELS

13.6.3.1. Relay settings

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0124		IDEN	IDENTIFICATION	16	F3					
0134		TRIP MIN TIME	MINIMUM TRIP TIME	4	F2	50	300	100	1	ms
0138		BF TIME	FAIL TO OPEN TIMER	4	F2	50	999	400	1	ms
013C	0	TAB	ACTIVE TABLE	2	F4					
013E	0	STA	RELAY STATUS	2	F4					
013E	1	FRQ	FREQUENCY	2	F10					
0140	0	TRIP 51	51 Trip	2	F4					
0140	1	TRIP 51N	51N Trip	2	F4					
0140	2	TRIP 50H	50H Trip	2	F4					
0140	3	TRIP 50L	50L Trip	2	F4					
0140	4	TRIP 50NH	50NH Trip	2	F4					
0140	5	TRIP 50NL	50NL Trip	2	F4					
0140	6	TRIP 49	49 Trip	2	F4					
0142		TAP 51	51 Pickup	4	F2	0.10	2.40	0.50	100	In
0146		CURV 51	51 Curve	2	F7					
0148		DIAL 51	51 Time Dial	4	F2	0.05	2	0.50	100	
014C		TIME 51	51 Time Delay	4	F2	0	99.99	1	100	s
0150		TAP 51N	51N Pickup	4	F2	0.10	2.40	0.50	100	In
0154		CURV 51N	51N Curve	2	F7					
0156		DIAL 51N	51N Time Dial	4	F2	0.05	2	0.50	100	
015A		TIME 51N	51N Time Delay	4	F2	0	99.99	1	100	s
015E		TAP 50H	50H Pickup	4	F2	0.10	30	1	10	In
0162		TIME 50H	50H Time Delay	4	F2	0	99.99	0	100	s
0166		TAP 50L	50L Pickup	4	F2	0.10	30	1	10	In
016A		TIME 50L	50L Time Delay	4	F2	0	99.99	0	100	s
016E		TAP 50NH	50NH Pickup	4	F2	0.10	30	1	10	In

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0172		TIME 50NH	50NH Time Delay	4	F2	0	99.99	0	100	s
0176		TAP 50NL	50NL Pickup	4	F2	0.10	30	1	10	In
017A		TIME 50NL	50NL Time Delay	4	F2	0	99.99	0	100	s
017E		TAP 49	49 Pickup	4	F2	0.10	2.40	1	100	In
0182		ALARM 49	49 Alarm level	4	F2	70	100	80	1	%
0186		T1	T1	4	F2	3	600	6	1	min
018A		T2	T2	4	F2	1	6	1	1	T1
018E	0	TRIP 51 T2	51 Trip T2	2	F4					
018E	1	TRIP 51N T2	51N Trip T2	2	F4					
018E	2	TRIP 50H T2	50H Trip T2	2	F4					
018E	3	TRIP 50L T2	50L Trip T2	2	F4					
018E	4	TRIP 50NH T2	50NH Trip T2	2	F4					
018E	5	TRIP 50NL T2	50NL Trip T2	2	F4					
018E	6	TRIP 49 T2	49 Trip (table 2)	2	F4					
0190		TAP 51 T2	51 Pickup T2	4	F2	0.10	2.40	0.50	100	In
0194		CURV 51 T2	51 Curve T2	2	F7					
0196		DIAL 51 T2	Dial 51 T2	4	F2	0.05	2	0.50	100	
019A		TIME 51 T2	51 Time Delay T2	4	F2	0	99.99	1	100	s
019E		TAP 51N T2	51N Pickup T2	4	F2	0.10	2.40	0.50	100	In
01A2		CURV 51N T2	51N Curve T2	2	F7					
01A4		DIAL 51N T2	51N Time Dial T2	4	F2	0.05	2	0.50	100	
01A8		TIME 51N T2	51N Definite Time T2	4	F2	0	99.99	1	100	s
01AC		TAP 50H T2	50H Pickup T2	4	F2	0.10	30	1	10	In
01B0		TIME 50H T2	50H Time Delay T2	4	F2	0	99.99	0	100	s
01B4		TAP 50L T2	50L Pickup T2	4	F2	0.10	30	1	10	In
01B8		TIME 50L T2	50L Time Delay T2	4	F2	0	99.99	0	100	s
01BC		TAP 50NH T2	50NH Pickup T2	4	F2	0.10	30	1	10	In
01C0		TIME 50NH T2	50NH Time Delay T2	4	F2	0	99.99	0	100	s
01C4		TAP 50NL T2	50NL Pickup T2	4	F2	0.10	30	1	10	In
01C8		TIME 50NL T2	50NL Time Delay T2	4	F2	0	99.99	0	100	s
01CC		TAP 49 T2	49 Pickup T2	4	F2	0.10	2.40	1	100	In
01D0		ALARM 49 T2	49 Alarm level (T2)	4	F2	70	100	80	1	%
01D4		T1 T2	T1 T2	4	F2	3	600	6	1	min
01D8		T2 T2	T2 T2	4	F2	1	6	1	1	T1
01DC		A	A	4	F2	0	125	0.05	10000	s
01E0		B	B	4	F2	0	3	0	10000	s
01E4		P	P	4	F2	0	3	0.04	10000	
01E8		Q	Q	4	F2	0	2	1	10000	
01EC		K	K	4	F2	0	2	0	10000	s
01F0		CnAc	I2t Counter	4	F2	0	999	0	1000	kA2

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
01F4		CnAp	Number of openings	4	F5	0	999	0	1	
01F8		I2T MAX	Maximum counter	4	F2	0	999	999	1000	kA2
01FC	0	O1	Oscillo by communic.	2	F4					
01FC	1	O2	Oscillo by digital input	2	F4					
01FC	2	O3	Oscillo by tripping	2	F4					
01FC	3	O4	Oscillo by pickup	2	F4					
01FE	0	sAPCOM	Trip operation by command	2	F4					
01FE	1	sRLATC	Reset latch aux	2	F4					
0200	0	A50H	50H Pickup	2	F4					
0200	1	A 50NH	50NH Pickup	2	F4					
0200	2	A51	51 Pickup	2	F4					
0200	3	A51N	51N Pickup	2	F4					
0200	4	A 50L	50L Pickup	2	F4					
0200	5	A 50NL	50NL Pickup	2	F4					
0200	6	A 49	49 Alarm	2	F4					
0200	8	IE50H	50H disabled	2	F4					
0200	9	IE50NH	50NN disabled	2	F4					
0200	10	I E51	51 disabled	2	F4					
0200	11	I E51N	51N disabled	2	F4					
0200	12	IE50L	50L disabled	2	F4					
0200	13	IE50NL	50NL disabled	2	F4					
0200	14	I E49	49 disabled	2	F4					
0200	15	D INH	Trip disabled	2	F4					
0202	0	D 50H	50H Trip	2	F4					
0202	1	D 50nh	50NH Trip	2	F4					
0202	2	D51	51 Trip	2	F4					
0202	3	D51n	51N Trip	2	F4					
0202	4	D 50L	50L Trip	2	F4					
0202	5	D 50nl	50NL Trip	2	F4					
0202	6	D49	49 Trip	2	F4					
0202	7	DISGEN	General trip	2	F4					
0202	9	E PROT	Protection status	2	F4					
0202	10	aux1	Output 1	2	F4					
0202	11	aux2	Output 2	2	F4					
0202	12	aux3	Output 3	2	F4					
0202	13	aux4	Output 4	2	F4					
0202	14	ENT1	Digital Input 1	2	F4					
0202	15	ENT2	Digital Input 2	2	F4					
0204	1	ihca	Settings change disabled	2	F4					
0204	2	ORD D	Trip operation by input	2	F4					
0204	4	ED 52B	Breaker 52B	2	F4					
0204	5	ED 52A	Breaker 52A	2	F4					
0204	6	C TAB	Active table change	2	F4					
0204	7	Gosc	Oscillography trigger by digital input	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
0204	8	Fapr	Breaker failure to open	2	F4					
0204	9	est INTE	Breaker status	2	F4					
0204	10	STOC	Oscillo trigg by comm	2	F4					
0204	11	A CNT	I2 Alarm	2	F4					
0204	12	CLPs	Cold load Pickup	2	F4					
0204	13	C AJUS	Settings change	2	F4					
0204	14	SE2P	e2prom Failure	2	F4					
0204	15	Adef	User settings	2	F4					
0206	1	BF ENABLE	User settings	2	F4					
0206	0	CLP ENABLE	Cold Load Pickup Function	2	F4					
0208		t1	T_IN	4	F2	0	60	2	1000	s
020C		T2	T_OUT	4	F2	0	60	1	1000	s
0210		k1	K50P	4	F2	1	5	1	100	
0214		k2	K51	4	F2	1	5	1	100	

13.6.3.2. Relay Status

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
048A		D T	Date/Time	6	F1					
0490		ver	Version	6	F3					
0496		mod	Model	16	F3					
04A6		iden	Identification	16	F3					
04B6		LTU	Last trip function	4	F3					
04BA		Z2	Last phase trip	4	F3					
04BE		Z3	Last trip current	4	F2					
04D4	0	LD	Trip LED	2	F4					
04D4	1	LR	Alarm LED	2	F4					
04D4	2	L1	LED 1	2	F4					
04D4	3	L2	LED 2	2	F4					
04D4	4	L3	LED 3	2	F4					
04D4	5	L4	LED 4	2	F4					
04D4	8	c1	Logic 1	2	F4					
04D4	9	c2	Logic 2	2	F4					
04D4	10	c3	Logic 3	2	F4					
04D4	11	c4	Logic 4	2	F4					
04D6	0	a 50HA	50Ha Pickup	2	F4					
04D6	1	a 50HB	50Hb Pickup	2	F4					
04D6	2	a 50HC	50Hc Pickup	2	F4					
04D6	3	a 50HN	50NH Pickup	2	F4					
04D6	4	a 50LA	50La Pickup	2	F4					
04D6	5	a 50LB	50Lb Pickup	2	F4					
04D6	6	a 50LC	50Lc Pickup	2	F4					
04D6	7	a 50LN	50NL Pickup	2	F4					
04D6	8	a 51 A	51a Pickup	2	F4					
04D6	9	a 51 B	51b Pickup	2	F4					
04D6	10	a 51 C	51c Pickup	2	F4					
04D6	11	a 51 N	51N Pickup	2	F4					
04D6	12	a 49	49 Alarm	2	F4					
04D8	0	d 50HA	50H Trip	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
04D8	1	d 50HB	50L Trip	2	F4					
04D8	2	d 50HC	50NH Trip	2	F4					
04D8	3	d 50HN	50NL Trip	2	F4					
04D8	4	d 50LA	51 Trip	2	F4					
04D8	5	d 50LB	51N Trip	2	F4					
04D8	6	d 50LC	49 Trip	2	F4					
04D8	7	d 50LN	49 Trip	2	F4					
04D8	8	d 51 A	49 Trip	2	F4					
04D8	9	d 51 B	49 Trip	2	F4					
04D8	10	d 51 C	49 Trip	2	F4					
04D8	11	d 51 N	51N Trip	2	F4					
04D8	12	d 49	51N Trip	2	F4					
04DA	0	id50H	50H Virtual trip	2	F4					
04DA	1	id50NH	50NH Virtual trip	2	F4					
04DA	2	id51	51 Virtual trip	2	F4					
04DA	3	id51N	51N Virtual trip	2	F4					
04DA	4	id50L	50L Virtual trip	2	F4					
04DA	5	id50NL	50NL Virtual trip	2	F4					
04DA	6	id49	49 Virtual trip	2	F4					
04DA	7	idGEN	General virtual trip	2	F4					
04DC	0	a 50H	50H Pickup	2	F4					
04DC	1	a 50NH	50NH Pickup	2	F4					
04DC	2	a 51	51 Pickup	2	F4					
04DC	3	a 51N	51N Pickup	2	F4					
04DC	4	a 50L	50L Pickup	2	F4					
04DC	5	a 50NL	50NL Pickup	2	F4					
04DC	6	aa49	49 Alarm	2	F4					
04DC	7	a GEN	Pickup	2	F4					
04DC	8	me50H	50H Disabled	2	F4					
04DC	9	me50NH	50NH Disabled	2	F4					
04DC	10	me51	51 Disabled	2	F4					
04DC	11	me51N	51N Disabled	2	F4					
04DC	12	me50L	50L Disabled	2	F4					
04DC	13	me50NL	50NL Disabled	2	F4					
04DC	14	me49	49 Disabled	2	F4					
04DC	15	meGEN	Trip disabled	2	F4					
04DE	0	d 50H	50H Trip	2	F4					
04DE	1	d 50NH	50NH Trip	2	F4					
04DE	2	d 51	51 Trip	2	F4					
04DE	3	d 51N	51N Trip	2	F4					
04DE	4	d 50L	50L Trip	2	F4					
04DE	5	d 50NL	50NL Trip	2	F4					
04DE	6	dd49	49 Trip	2	F4					
04DE	7	d GEN	General trip	2	F4					
04DE	8	d	TRIP	2	F4					
04DE	9	al	ALARM	2	F4					
04DE	10	OUT1	Output1	2	F4					
04DE	11	OUT2	OutpuT2	2	F4					
04DE	12	OUT3	Output3	2	F4					
04DE	13	OUT4	Output4	2	F4					
04DE	14	INP1	Input1	2	F4					
04DE	15	INP2	InpuT2	2	F4					
04E0	0	EDGEN	General input	2	F4					

ADDRESS	BIT	NAME	DESCRIPTION	LENGTH	FORMAT	MIN	MAX	DEFAULT	SCALE	UNITS
04E0	1	EDICAJ	Settings change disabled	2	F4					
04E0	2	EDODIS	Trip contact close	2	F4					
04E0	3	EDRLED	Reset	2	F4					
04E0	4	B 52B	Breaker 52b	2	F4					
04E0	5	B 52A	Breaker 52a	2	F4					
04E0	6	EDCTAB	Table change	2	F4					
04E0	7	EDTOSC	Oscillo trigger	2	F4					
04E0	8	B FAIL	Breaker failure to open	2	F4					
04E0	9	EST52	Breaker Status	2	F4					
04E0	10	COTOSC	Breaker Status	2	F4					
04E0	11	I2T ALARM	I2 Alarm	2	F4					
04E0	12	COLD LOAD	Cold load pickup	2	F4					
04E0	13	CAMAJU	Cold load pickup	2	F4					
04E0	14	F1	E2prom failure	2	F4					
04E0	15	AU	User Settings	2	F4					
04E2	0	prot	Protection	2	F4					
04E2	1	bSuc	Events	2	F4					
04E2	3	T AC	ACTIVE TABLE	2	F4					
04E2	4	frec	Frequency	2	F10					
04E2	5	LOCREM	Local/Remote	2	F4					
04E2	13	DISPHA	Phase trip	2	F4					
04E2	14	DISNEU	Ground trip	2	F4					
04E2	15	DISP50	50 Trip	2	F4					
04E4		Ia	Ia	4	F2					
04E8		Ib	Ib	4	F2					
04EC		Ic	Ic	4	F2					
04F0		In	In	4	F2					
04F4		TH	Thermal image	4	F2					
04F8		I2T VALUE	I2t Counter	4	F2					
04FC		OPENINGS	Number of openings	4	F5					
0500		OS	OSC. NUMBER	2	F5					
0502		Sn	New events	2	F5					
0504		St	All events	2	F5					

13.7 FORMATS

Format	Format Type	Value	Format Definition
F1	DATE/TIME		Milliseconds since 1/1/1996 at 00:00:00.000 hours
F2	IEEE FLOATING POINT (32 bits)		
F3	STRING		
F4	BIT		
F5	UNSIGNED 16 BIT INTEGER		
F6	UNSIGNED 16 BIT INTEGER – ENUMERATION	1	300
		2	600
		4	1200
		8	2400
		13	4800
		32	9600
		64	19200
F7	UINT16-ENUMERATION	1	INVERSE
		2	VERY INVERSE
		4	EXTREMELY INVERSE
		8	DEFINITE TIME
		16	USER CURVE
F8	BIT-ENUMERATION	0	FALSE
		1	TRUE
F10	BIT-ENUMERATION	0	50 Hz
		1	60 Hz
F11	UNSIGNED 16 BIT INTEGER – ENUMERATION	8192	Trip operation by command
		8194	Reset auxiliary latched outputs
		8224	Pickup 50H
		8225	Drop out 50H
		8226	Pickup 50NH
		8227	Drop out 50NH
		8228	Pickup 51
		8229	Drop out 51
		8230	Pickup 51N
		8231	Drop out 51N
		8232	Pickup 50L
		8233	Drop out 50L
		8234	Pickup 50NL
		8235	Drop out 50NL
		8236	Alarm 49
		8237	Drop out alarm 49
		8240	50H disabled by digital input
		8241	50H enabled
		8242	50NH disabled by digital input
		8243	50NH enabled
		8244	51 disabled by digital input
		8245	51 enabled
		8246	51N disabled by digital input
		8247	51N enabled
		8248	50L disabled by digital input

Format	Format Type	Value	Format Definition
		8249	50L enabled
	w	8250	50NL disabled by digital input
		8251	50NL enabled
		8252	49 enabled
		8253	49 disabled by digital input
		8254	Trip enabled
		8255	Trip disabled by digital input
		8256	50H Trip
		8258	50NH Trip
		8260	51 Trip
		8262	51N Trip
		8264	50L Trip
		8266	50NL Trip
		8268	49 Trip
		8270	General Trip
		8274	Protection status: in service
		8275	Protection status: out of service
		8276	Output 1 = 1
		8277	Output 1 = 0
		8278	Output 2 = 1
		8279	Output 2 = 0
		8280	Output 3 = 1
		8281	Output 3 = 0
		8282	Output 4 = 1
		8283	Output 4 = 0
		8284	Input 1 = 1
		8285	Input 1 = 0
		8286	Input 2 = 1
		8287	Input 2 = 0
		8290	Settings change disabled by digital input
		8291	Settings change enabled
		8292	Trip operation by digital input
		8296	52B = 1
		8297	52B = 0
		8298	52A = 1
		8299	52A = 0
		8300	Active table: Table 2
		8301	Active table: Settings Table
		8302	Oscillography trigger by digital input
		8304	Breaker failure to open
		8306	52 Status=1
		8307	52 Status=0
		8308	Oscillography trigger by communications
		8310	I2 Alarm
		8312	Cold load pickup
		8313	Dropout Cold load pickup
		8314	Settings change
		8316	E2prom failure
		8318	User settings
		8319	Factory settings
F12	SIGNED 16 BIT INTEGER		

DATE AND TIME

Milliseconds since 1/1/1996, at 00:00:00.000 hours.
This format is 6 bytes length, INTEL format, (lowest byte first)

Example:

For May, 31st 1999, 10:01:04.224 hrs = 107,690,464,000 milliseconds since 1/1/1996, 00:00:00.000

107,690,464,000 DEC = 00 19 12 DA 13 00 HEX = 00 13 DA 12 19 00 (lowest bytes first)

13.8 COMMAND CODES

NAME	DESCRIPTION	SELECTION	CONFIRMATION	VALUE	CURRENT (see map)	BROADCAST	MIF MODELS
Settings	SETTINGS	01	02	No	--	No	0, 1, 2
RIt	THERMAL IMAGE	03	04	No	--	No	0, 1, 2
RL	RESET	09	0A	No	--	No	0, 1, 2
AcT1	ACTIVATE TABLE1	0D	0E	No	--	No	0, 1, 2
AcT2	ACTIVATE TABLE2	0F	10	No	--	No	0, 1, 2
OSC	OPEN/CLOSE OSCILLOGRAPHY	11	12	No	--	No	1, 2
SUCt	OPEN/CLOSE EVENTS	13	14 (+VALUE)	Yes*	Number of events to delete	No	1, 2
A OS	ACTIVATE OSCILLOGRAPHY	17	18	No	--	No	1,2
RAPER	SET NUMBER OPENINGS	35	36 (+VALUE)	Yes*	Number of openings	No	2
RCONT	SET I2 COUNTER	37	38 (+VALUE)	Yes*	I2 Counter	No	2
SYNC	TIME SYNC.	FE (+VALUE)	--	Yes*	Date/Time	Yes	0, 1, 2

Some operations require a value in order to be executed. For example, in order to synchronize one or several relays we must command an operation indicating which type of command we would like to execute, but we must also indicate the desired date and time. In this same way, if we wish to set the value of a counter, we will need to indicate the type of command as well as the new value for the counter.

In order to send the new value, we can suggest the current value in the device. This value is in the map, on the CURRENT column of the Operations table. We must take into account that if the referenced variable is a setting (for example, in the case of counters), this value will have a minimum and a maximum to be taken into account.

Finally, some operations involving values can be performed in broadcast, that is, the same operation can be sent to all the MIF units simultaneously. In this case, the operation value will be sent in the selection command, as it does not need any password or confirmation. If we are not using broadcast, the operation value will be sent in the confirmation command (in INTEL format, i.e. LSW-MSW), and it will be necessary to add the relay password. For example, for setting the number of openings to 2, if the previous value was 10, the command would be the following:

Selection of a command for establishing the number of openings:

DIRECCIÓN	FUNCIÓN	INICIO	#REGS	#BYTES	COMANDO	CRC
01	10	00 00	00 01	02	2F 00	BA 60

Answer:

DIRECCIÓN	FUNCIÓN	INICIO	#REGS	CRC
01	10	00 00	00 01	01 C9

Reading of the current value of the number of openings counter:

ADDRESS	FUNCTION	START	#REC	CRC
01	03	04 FC	00 02	05 0B

Answer (the current value is 10, in hexadecimal 0x0A):

ADDRESS	FUNCTION	#BYTES	VALUE	CRC
01	03	04	0A 00 00 00	F9 EB

Establish new value (=2) of the number of openings counter:

ADDRESS	FUNCTION	START	#REC	#BYTES	COMMAND	PASSW	VALUE	CRC
01	10	00 00	00 05	0A	30 00	01 00 00 00	02 00 00 00	C1 37

Answer:

ADDRESS	FUNCTION	START	#REC	CRC
01	10	00 00	00 05	00 0A

13.9 EVENTS

13.9.1. EVENTS READING

In order to read the relay events, fist we must read the memory position that defines “Total Events”, that is, the number of events recorded by the relay since the last deletion.

We must take into account that only the last 32 events will be accessible, even if the counter shows a higher number.

On the other hand, for all MIF units, each stored event has a size of 32 bytes.

If we wish to read the relay events, fist we will need to send a command for opening Events, marked by the “Suct” operation. This operation is performed as any other operation. In the following example we can see how we could send this “Events Opening” command:

ADDRESS	FUNCTION	START	#REC	#BYTES	COMMAND	CRC
01	10	00 00	00 01	02	13 00	AB 60

Answer:

ADDRESS	FUNCTION	START	#REC	CRC
01	10	00 00	00 01	01 C9

In the following table we can read the Events values from the start position defined in the relay map. We must take into account that the start position will be different for each relay model:

MODEL (OPTION)	START POSITION
0	No events
1	0450
2	0536

This way, each event will be located in the following positions:

EVENT	POSITIÓN
1	START
2	START + (32 bytes * 1)
3	START + (32 bytes* 2)
4	START + (32 bytes* 3)
...	...
32	START + (32 bytes* 31)

For each of the addressed events, we must take the values of each variable. These values will be located in the following positions, referred to the event initiation:

BIT	DESCRIPTION	FORMAT
0	Event Code	F5
16	Date/Time	F1
64	Ia	F2
96	Ib	F2
128	Ic	F2
160	In	F2
192	Trip operation by	F4

BIT	DESCRIPTION	FORMAT
	command	
193	Reset latch aux	F4
208	50H Pickup	F4
209	50NH Pickup	F4
210	51 Pickup	F4
211	51N Pickup	F4
212	50L Pickup	F4
213	50NL Pickup	F4
214	49 Alarm	F4
216	50H disabled	F4
217	50NN disabled	F4
218	51 disabled	F4
219	51N disabled	F4
220	50L disabled	F4
221	50NL disabled	F4
222	49 disabled	F4
223	Trip disabled	F4
224	50H Trip	F4
225	50NH Trip	F4
226	51 Trip	F4
227	51N Trip	F4
228	50L Trip	F4
229	50NL Trip	F4
230	49 Trip	F4
231	General trip	F4
233	Protection status	F4
234	Output 1	F4
235	Output 2	F4
236	Output 3	F4
237	Output 4	F4
238	Digital Input 1	F4
239	Digital Input 2	F4
241	Settings change disabled	F4
242	Trip operation by input	F4
244	Breaker 52B	F4
245	Breaker 52A	F4
246	Active table change	F4
247	Oscillography trigg by DI	F4
248	Breaker failure to open	F4
249	Breaker status	F4
250	Oscillo trigg by comm	F4
251	I2 Alarm	F4
252	Cold load Pickup	F4
253	Settings change	F4
254	e2prom Failure	F4
255	User settings	F4

The events window is started at 0, that is, if we read an event index that does not store any value, we will read 32 bytes started at 0x00.

Finally, we must close the events window. When doing this, we must indicate how many events we would like to delete. This way, if we do not want to delete any event, we will send a 0 (UINT16):

ADDRESS	FUNCTION	START	#REC	#BYTES	COMMAND	PASSW	VALUE(=0)	CRC
01	10	00 00	00 04	08	14 00	01 00 00 00	00 00	F0 56

Answer:

ADDRESS	FUNCTION	START	#REC	CRC
01	10	00 00	00 04	C0 7D

However, in this example we will delete three events:

ADDRESS	FUNCTION	START	#REC	#BYTES	COMMAND	PASSW	VALUE(=3)	CRC
01	10	00 00	00 04	08	14 00	01 00 00 00	03 00	F0 A6

Answer:

ADDRESS	FUNCTION	START	#REC	CRC
01	10	00 00	00 04	00 7E

13.10 OSCILLOGRAPHY

13.10.1. OSCILLOGRAPHY READING

In order to read oscillography data, we must first send a command to open the oscillography record:

ADDRESS	FUNCTION	START	#REC	#BYTES	COMMAND	CRC
01	10	00 00	00 01	02	11 00	AA 00

If there aren't any data, we will receive a NACK (MODBUS® error 07):

ADDRESS	FUNCTION	ERROR	CRC
01	90	07	0D C2

Otherwise, the relay will recognize the command and will prepare data for reading. The relay will answer the following sequence when data is ready to be read:

ADDRESS	FUNCTION	START	#REC	CRC
01	10	00 00	00 01	01 C9

Once the oscillography window opening command has been executed, we will be able to access the required records. This information is divided into three blocks:

1. **General oscillography data**: Date and time, number of samples per second, total number of samples, line frequency and oscillo index.

3. **Current values and active table in the moment of the oscillography trigger.**

3. **Finally, oscillography data**, formed by a certain number of samples of the current values and status. The length of each of these records will be of 14 bytes for a MIF unit.

The memory positions for this data vary according to the MIF number, as shown below:

13.10.2. MODEL 0:

No oscillography available

13.10.3. MODEL 1:

GENERAL OSCILLOGRAPHY DATA. (0x1310)				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
1310		Date/Time	6	F1
1316		Samples per second	2	F5
1318		Number of samples	2	F5
131A		Line frequency	2	F5
131C		Oscillography index	2	F5

VALUES OF CURRENT AT TRIGGER TIME. (0x1300)				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
1300		Ia at trigger time	4	F2
1304		Ib at trigger time	4	F2
1308		Ic at trigger time	4	F2
130C		In at trigger time	4	F2

OSCILLOGRAPHY DATA. (0x0880). Record length is 14 bytes				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
RECORD #1				
880		Ia	2	F12
882		Ib	2	F12
884		Ic	2	F12
886		In	2	F12
888	0	50H Pickup	2	F4
888	1	50NH Pickup	2	F4
888	2	51 Pickup	2	F4
888	3	51N Pickup	2	F4
888	4	50L Pickup	2	F4
888	5	50NL Pickup	2	F4
888	6	49 Alarm	2	F4
888	7	Pickup	2	F4
888	8	50H Disabled	2	F4
888	9	50NH Disabled	2	F4
888	10	51 Disabled	2	F4
888	11	51N Disabled	2	F4
888	12	50L Disabled	2	F4
888	13	50NL Disabled	2	F4
888	14	49 Disabled	2	F4
888	15	Trip disabled	2	F4
88A	0	50H Trip	2	F4
88A	1	50NH Trip	2	F4
88A	2	51 Trip	2	F4
88A	3	51N Trip	2	F4
88A	4	50L Trip	2	F4
88A	5	50NL Trip	2	F4
88A	6	49 Trip	2	F4
88A	8	TRIP	2	F4
88A	9	READY	2	F4
88A	10	Output1	2	F4
88A	11	OutpuT2	2	F4
88A	12	Output3	2	F4
88A	13	Output4	2	F4
88A	14	Input1	2	F4
88A	15	InpuT2	2	F4
88C	6	Table change	2	F4
88C	14	E2prom failure	2	F4
88C	15	User Settings	2	F4
RECORD #2				
88E		Ia	2	F12
890		Ib	2	F12
892		Ic	2	F12

OSCILLOGRAPHY DATA. (0x0880). Record length is 14 bytes				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
894		In	2	F12
896	0	50H Pickup	2	F4
896	1	50NH Pickup	2	F4
896	2	51 Pickup	2	F4
896	3	51N Pickup	2	F4
896	4	50L Pickup	2	F4
896	5	50NL Pickup	2	F4
896	6	49 Alarm	2	F4
896	7	Pickup	2	F4
896	8	50H Disabled	2	F4
896	9	50NH Disabled	2	F4
896	10	51 Disabled	2	F4
896	11	51N Disabled	2	F4
896	12	50L Disabled	2	F4
896	13	50NL Disabled	2	F4
896	14	49 Disabled	2	F4
896	15	Trip disabled	2	F4
898	0	50H Trip	2	F4
898	1	50NH Trip	2	F4
898	2	51 Trip	2	F4
898	3	51N Trip	2	F4
898	4	50L Trip	2	F4
898	5	50NL Trip	2	F4
898	6	49 Trip	2	F4
898	8	TRIP	2	F4
898	9	READY	2	F4
898	10	Output1	2	F4
898	11	OutpuT2	2	F4
898	12	Output3	2	F4
898	13	Output4	2	F4
898	14	Input1	2	F4
898	15	InpuT2	2	F4
89A	6	Table change	2	F4
89A	14	E2prom failure	2	F4
89A	15	User Settings	2	F4
RECORD #3				
89C		Ia	2	F12
...	...	...	...	...
RECORD #4				
8AA		Ia	2	F12
...	...	...	...	...
RECORD n. Number of records or samples is defined in General Oscillography Data.				
880+((n-1)*14d)	...	Ia	...	...

GENERAL OSCILLOGRAPHY DATA. (0x13F8)				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
13F8		Date/Time	6	F1
13FE		Samples per second	2	F5
1400		Number of samples	2	F5
1402		Line frequency	2	F5
1404		Oscillography index	2	F5

VALUES OF CURRENT AT TRIGGER TIME. (0x13E6)				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
13E6		Ia at trigger time	4	F2
13EA		Ib at trigger time	4	F2
13EE		Ic at trigger time	4	F2
13F2		In at trigger time	4	F2
13F6	3	Active table at trigger time	2	F2

OSCILLOGRAPHY DATA. (0x0966). Record length is 14 bytes				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
RECORD #1				
966		Ia	2	F12
968		Ib	2	F12
96A		Ic	2	F12
96C		In	2	F12
96E	0	50H Pickup	2	F4
96E	1	50NH Pickup	2	F4
96E	2	51 Pickup	2	F4
96E	3	51N Pickup	2	F4
96E	4	50L Pickup	2	F4
96E	5	50NL Pickup	2	F4
96E	6	49 Alarm	2	F4
96E	7	Pickup	2	F4
96E	8	50H Disabled	2	F4
96E	9	50NH Disabled	2	F4
96E	10	51 Disabled	2	F4
96E	11	51N Disabled	2	F4
96E	12	50L Disabled	2	F4
96E	13	50NL Disabled	2	F4
96E	14	49 Disabled	2	F4
96E	15	Trip disabled	2	F4
970	0	50H Trip	2	F4
970	1	50NH Trip	2	F4
970	2	51 Trip	2	F4
970	3	51N Trip	2	F4
970	4	50L Trip	2	F4
970	5	50NL Trip	2	F4
970	6	49 Trip	2	F4
970	8	TRIP	2	F4
970	9	READY	2	F4
970	10	Output1	2	F4
970	11	OutpuT2	2	F4

OSCILLOGRAPHY DATA. (0x0966). Record length is 14 bytes				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
970	12	Output3	2	F4
970	13	Output4	2	F4
970	14	Input1	2	F4
970	15	InpuT2	2	F4
972	5	Breaker 52a	2	F4
972	4	Breaker 52b	2	F4
972	9	Breaker Status	2	F4
972	8	Breaker failure to open	2	F4
972	11	I2 Alarm	2	F4
972	12	Cold load pickup	2	F4
972	6	Table change	2	F4
972	14	E2prom failure	2	F4
972	15	User Settings	2	F4
RECORD #2				
974		Ia	2	F12
976		Ib	2	F12
978		Ic	2	F12
97A		In	2	F12
97C	0	50H Pickup	2	F4
97C	1	50NH Pickup	2	F4
97C	2	51 Pickup	2	F4
97C	3	51N Pickup	2	F4
97C	4	50L Pickup	2	F4
97C	5	50NL Pickup	2	F4
97C	6	49 Alarm	2	F4
97C	7	Pickup	2	F4
97C	8	50H Disabled	2	F4
97C	9	50NH Disabled	2	F4
97C	10	51 Disabled	2	F4
97C	11	51N Disabled	2	F4
97C	12	50L Disabled	2	F4
97C	13	50NL Disabled	2	F4
97C	14	49 Disabled	2	F4
97C	15	Trip disabled	2	F4
97E	0	50H Trip	2	F4
97E	1	50NH Trip	2	F4
97E	2	51 Trip	2	F4
97E	3	51N Trip	2	F4
97E	4	50L Trip	2	F4
97E	5	50NL Trip	2	F4
97E	6	49 Trip	2	F4
97E	8	TRIP	2	F4
97E	9	READY	2	F4
97E	10	Output1	2	F4
97E	11	OutpuT2	2	F4
97E	12	Output3	2	F4
97E	13	Output4	2	F4
97E	14	Input1	2	F4
97E	15	InpuT2	2	F4
980	4	Breaker 52b	2	F4
980	5	Breaker 52a	2	F4
980	6	Table change	2	F4

OSCILLOGRAPHY DATA. (0x0966). Record length is 14 bytes				
MEMORY ADDRESS	**BIT**	**DESCRIPTION**	**LENGTH**	**FORMAT**
980	8	Breaker failure to open	2	F4
980	9	Breaker Status	2	F4
980	11	I2 Alarm	2	F4
980	12	Cold load pickup	2	F4
980	14	E2prom failure	2	F4
980	15	User Settings	2	F4
RECORD #3				
982		Ia	2	F12
...	...	...	...	...
RECORD #4				
990		Ia	2	F12
...	...	...	...	...
RECORD n. Number of records or samples is defined in General Oscillography Data.				
966+((n-1)*14d)	...	.Ia	...	...
...	...	...	...	...

Once the oscillography data has been read and stored, we will proceed to close the oscillography window. In order to do this, we will send the Oscillography record close command. The information will continue to be stored in the relay. However, it will store only one oscillography window, and when an oscillography record is generated, it automatically deletes the previous one.

DIRECCIÓN	FUNCIÓN	INICIO	#REGS	#BYTES	COMANDO	CLAVE	CRC
01	10	00 00	00 03	06	12 00	01 00 00 00	E4 0E

Answer:

DIRECCIÓN	FUNCIÓN	INICIO	#REGS	CRC
01	10	00 00	00 03	80 08

If we wish to connect the relay to a remote PC, it will be necessary to previously link two modems to the telephone line. The modem on the relay side will receive the call, and the modem on the PC side will make the call.

This way, both modems will be configured in different ways: the modem on the PC side will receive the commands from the PC for starting or ending communication, and therefore it will make the call. The modem connected to the relay will not receive any command from it; it will only accept communication whenever it is requested. Therefore, this last modem will be configured in “dumb” mode, which means that it does not receive commands, and is in auto-reply mode.

The M+PC is a DCE device (Tx=3, Rx=2 signals), so as regards TX and RX it works as a modem (which is also a DCE device). Therefore, it is not necessary to cross the TX and RX signals in direct connection to the PC, which is a DTE device (TX=2, RX=3 signals). However, in case of a connection via modem, it will be necessary to cross the wire in the relay by means of a null modem, so that RX and TX signals are inverted, as we will be connecting two DCE devices.

In addition, we must check whether the relay is directly connected to the modem via its RS232 port, or via an RS232/RS485 converter. In this last case, we will have to verify whether the converter output is DTE or DCE, and use a null modem in the second case. For example, the DAC300 converter incorporates two ports, a DCE and a DTE. In the case of a F485 converter, an internal selector detects whether it is connected directly to a modem or relay (DCE) or to a PC (DTE).

As regards the modem-modem, PC-modem, and Relay-modem communication baud rates, in the first cases, it is recommended to be set at the same baud rate as the relay. The baud rate between relay and modem will always be the one set for the relay.

In case of communication problems between both modems, it is recommended to reduce the line baud rate.

14.1 HAYES MODEM

In order to establish communication between two HAYES modems, both of them must accept HAYES commands. This is compulsory, as the PC will send specific commands for this type of modem. We must place the AT command before every command. It is possible to group several commands inside an only command line (e.g. ATB1 and ATE1 equals ATB1E1).

However, we must take into account that each manufacturer will implement only one sub-group of the HAYES commands, and therefore we cannot indicate an initiation command valid for every equipment. It is the customer's responsibility to determine which commands are accepted by a particular modem.

As a general rule, it is recommended to disable any data compression, hardware protocols, flux control or error control. Some modems allow a command, e.g. &Q0, which selects the direct asynchronous mode.

The local modem configuration, that is, the configuration of the modem that makes the call, will be performed by M+PC software, by means of the provided initiation command. In order to configure the remote modem (connected to the relay), we need a communications program that allows sending HAYES commands. Any Windows® version includes a program called HYPERTERMINAL (HYPERTRM.EXE) which allows to send HAYES commands by the selected serial port. Besides, we can use any communications program allowing sending commands, such as Procomm Plus or LAPLink. Once the modem is connected to the selected port in the program, and after setting the communication parameters, we can send the required commands.

Later in this document we will detail the configuration that must be entered in some HAYES modems already tested.

14.2 V.25BIS MODEM

M+PC software allows the modem making the call to accept V.25bis commands. In this case, the modem on the relay side could be either HAYES or V.25bis, as it will not need to process any relay command.

The configuration of this kind of modem is performed by means of microswitches that set its operation. This way, the software window for entering the modem initiation commands will only be operative if a HAYES modem has been selected.

14.3 SAMPLES OF SETTINGS FOR PARTICULAR MODEMS

In the following sections, we will detail some communications parameters, already tested for the following modems.

14.3.1. SPORTSTER FLASH X2 MODEM (HAYES)

Initiation commands for the modem on the PC side:

We will add the following commands to the default configuration:

&An	Enable/disable the ARQ result codes	Disable the ARQ result codes	&A0
&Hn	Sets the flux control for the data transfer (TD).	Flux control disabled	&H0
&In	Sets the software flux control for the data reception (RD).	Software flux control disabled.	&I0
&Kn	Enable/Disable data compression	Data compression disabled	&K0
&Mn	Sets the error control (ARQ) for 1200 bps and higher.	Normal mode, error control disabled	&M0
&Rn	Configures the hardware flux control for data reception (DR) and transfer request (RTS)	Modem ignores RTS.	&R1
S15	Record with bit representation.	Disable ARQ/MNP for V.32/V.32bis.	S15=4
S32	Record with bit representation.	Disable V.34. modulation	S32=8

Initiation commands for the modem on the RELAY side

The following options must be added to the default configuration:

&An	Enable/disable the ARQ result codes	ARQ result codes are disabled	&A0
&Dn	Control the DTR operations	About DTR control.	&D0
&Hn	Sets the flux control for the data transfer (TD).	Flux control disabled	&H0
&In	Sets the software flux control for the data reception (RD).	Software flux control disabled.	&I0
&Kn	Enable/Disable data compression	Data compression disabled	&K0
&Mn	Sets the error control (ARQ) for 1200 bps and higher.	Normal mode, error control disabled	&M0
&Rn	Configures the hardware flux control for data reception (DR) and transfer request (RTS)	Modem ignores RTS.	&R1
S0	Sets the number of rings necessary for answering in automatic answering mode	The modem will answer to the first ring.	S0=1
S15	Record with bit representation.	Disable ARQ/MNP for V.32/V.32bis.	S15=4
S32	Record with bit representation.	Disable V.34. modulation	S32=8

14.3.2. ZOOM PKT14.4

Initiation commands for the PC modem:

Commands:
B0 E0 L1 M1 N1 Q0 T V0 W0 X1 Y0
&C1&D2&G0&J0&K3&Q5&R1&S0&T5&X0&Y0

S Registers:

S00:001	S01:000	S02:043	S03:013	S04:010	S05:008	S06:002	S07:050	S08:002	S09:006
S10:014	S11:095	S12:050	S18:000	S25:005	S26:001	S36:007	S37:000	S38:020	S44:020
S46:138	S48:007	S95:000							

Initiation commands for the Relay modem:

Commands:
B1 E0 L1 M1 N1 Q0 T V0 W0 X4 Y0
&C1 &D3 &G0 &J0 &K0 &Q5 &R1 &S1 &T4 &X0 &Y0

S Registers:

S00:001	S01:000	S02:043	S03:013	S04:010	S05:008	S06:002	S07:050	S08:002	S09:006
S10:014	S11:095	S12:050	S18:000	S25:005	S26:001	S36:007	S37:000	S38:020	S44:020
S46:138	S48:007	S95:000							

14.3.3. MODEM SATELSA MGD-2400-DHE (V.25BIS)

In this case, the modem initial configuration is set by changing the microswitches located in three sets on the bottom of the units.

LOCATION OF MODEM MICROSWITCHES ON THE PC SIDE

Set 1

Nº	DESCRIPTIÓN	VALUE
1	112 ETD/OFF ON: Circuit 112 connected to ETD OFF: Circuit 112 connected to ETD	ON
2	112 ETD/ON ON: 108 circuit forced to CLOSED. OFF: 108 circuit follows ETD's 108 circuit	OFF
3	105 ETD/ON ON: Circuit 105 forced to CLOSED. OFF: Circuit 105 follows ETD's 105circuit	ON
4	TXA/TXB in a peer-to-peer line (PP) ON: In PP transfers through high channel. OFF: In PP transfers through low channel.	OFF
5&6	Baud ate selection for data transfer ON-ON 1200 OFF-ON 2400 ON-OFF Automatic. OFF-OFF Automatic.	ON-OFF
7&8	Automatic disconnection. ON-ON No automatic disconnection. OFF-ON Circuit 105. ON-OFF Circuit 109. OFF-OFF Circuits 105 and 109.	ON-OFF

Set 2

No.	DESCRIPTION	VALUE
1	Synchronous format of protocol V25bis in option 108.2. ON: Character oriented format (BSC). OFF: Bit oriented format (HDLC).	ON
2&3	Asynchronous character format for data transfer ON-ON 8 OFF-ON 9 ON-OFF 10 OFF-OFF 11	ON-OFF
4	Reception permission for remote loop 2 ON: Not permitted. OFF: Permitted.	OFF
5&6	Exploitation mode. ON-ON Point-to-point line OFF-ON Automatic call as per 108.1. ON-OFF RTC line without automatic call. OFF-OFF Automatic call as per 108.2.	OFF-OFF
7	Number of calls for automatic answer ON: 1 call. OFF: 2 calls.	ON
8	112 ETD/OFF ON: Asynchronous operation. OFF: Synchronous operation.	ON

Set 3

No	DESCRIPTIONº	VALUE
1&2	Transmission timer selection. ON-ON 114 OFF-ON 113 ON-OFF 114/5 OFF-OFF 113	ON-ON
3	RTC Dialing system ON: Multi-frequency dialing. OFF: Loop opening pulse dialing	ON
4	Status of circuit 109, during protocol V.25bis in RTC, option 108.2. ON: Status of circuit 108 remains. OFF: Remains open.	OFF
5	Selection, when starting, of manual or automatic answering mode. ON: Automatic. OFF: Manual.	OFF
6	Protocol selection. ON: HAYES Protocol. OFF: V.25bis Protocol.	OFF
7&8	Modem transmission level. ON-ON -6 dBm OFF-ON -10 dBm ON-OFF -6 dBm OFF-OFF -15 dBm	ON-ON

LOCATION OF MODEM MICROSWITCHES ON THE RELAY SIDE

Set 1

Nº	DESCRIPTIÓN	VALUE
1	112 ETD/OFF ON: Circuit 112 connected to ETD OFF: Circuit 112 connected to ETD	ON
2	112 ETD/ON ON: 108 circuit forced to CLOSED. OFF: 108 circuit follows ETD's 108 circuit	ON
3	105 ETD/ON ON: Circuit 105 forced to CLOSED. OFF: Circuit 105 follows ETD's 105circuit	ON
4	TXA/TXB in a peer-to-peer line (PP) ON: In PP transfers through high channel. OFF: In PP transfers through low channel.	ON
5&6	Baud rate selection for data transfer. ON-ON 1200 OFF-ON 2400 ON-OFF Automatic. OFF-OFF Automatic.	ON-OFF
7&8	Automatic disconnection. ON-ON No automatic disconnection. OFF-ON Circuit 105. ON-OFF Circuit 109. OFF-OFF Circuits 105 and 109.	OFF-OFF

Set 2

Nº	DESCRIPTIÓN	VALUE
1	Synchronous format of protocol V25bis in option 108.2. ON: Character oriented format (BSC). OFF: Bit oriented format (HDLC).	ON
2&3	Asynchronous character format for data transfer ON-ON 8 OFF-ON 9 ON-OFF 10 OFF-OFF 11	ON-OFF
4	Reception permission for remote loop 2 ON: Not permitted. OFF: Permitted.	OFF
5&6	Exploitation mode. ON-ON Point-to-point line OFF-ON Automatic call as per 108.1. ON-OFF RTC line without automatic call. OFF-OFF Automatic call as per 108.2.	ON-OFF
7	Number of calls for automatic answer ON: 1 call. OFF: 2 calls.	OFF
8	112 ETD/OFF ON: Asynchronous operation. OFF: Synchronous operation.	ON

Set 3

Nº	DESCRIPCIÓN	VALOR
1&2	Transmission timer selection. ON-ON 114 OFF-ON 113 ON-OFF 114/5 OFF-OFF 113	ON-ON
3	RTC Dialling system ON: Multi-frequency dialling. OFF: Loop opening pulse dialling	OFF
4	Status of circuit 109, during protocol V.25bis in RTC, option 108.2. ON: Status of circuit 108 remains. OFF: Remains open.	OFF
5	Selection, when starting, of manual or automatic answering mode. ON: Automatic. OFF: Manual.	ON
6	Protocol selection. ON: HAYES Protocol. OFF: V.25bis Protocol.	OFF
7&8	Modem transmission level. ON-ON -6 dBm OFF-ON -10 dBm ON-OFF -6 dBm OFF-OFF -15 dBm	ON-ON

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

15.1 GENERAL PRINCIPLE OF OPERATION.

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

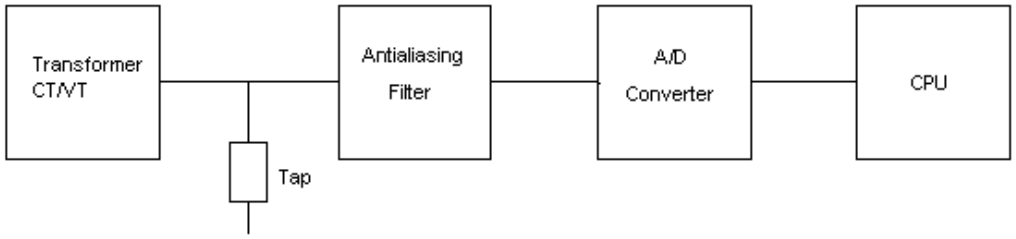


Figure 1

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 MIF, 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 MIF, 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.

15.2 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 MIF relay.

The MIF 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 MIF 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.

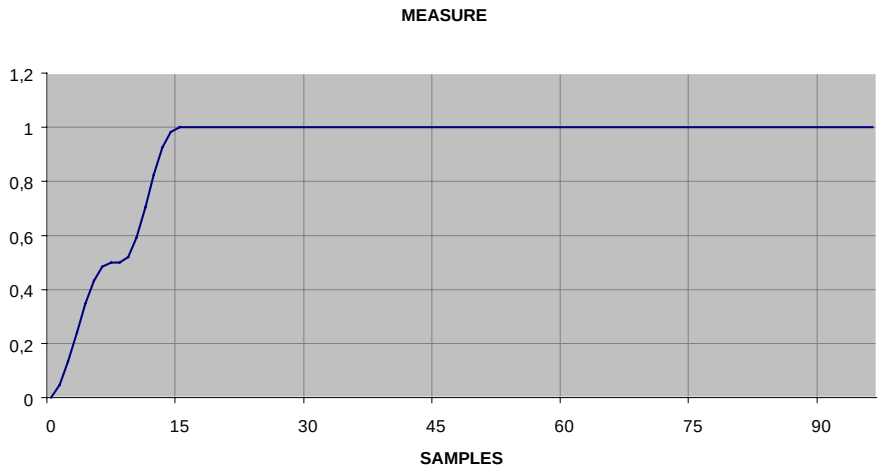


Figure 2

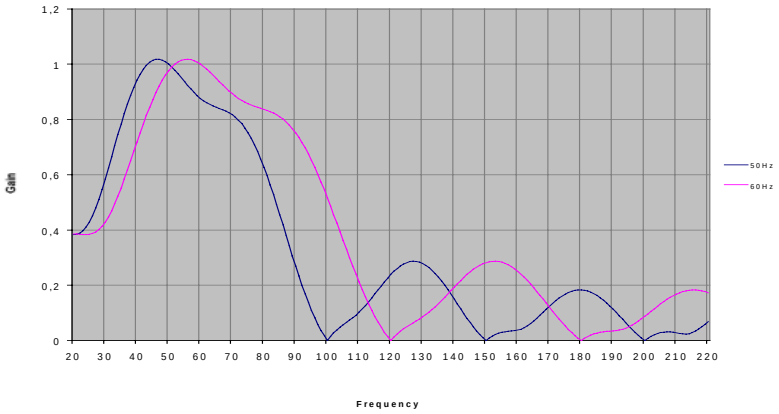


Figure 3

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.

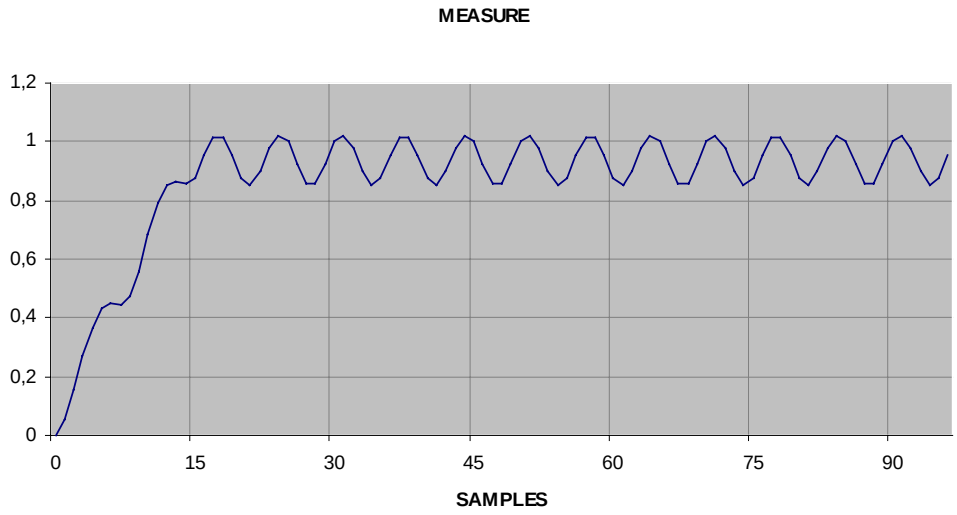


Figure 4

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

NAME	DESCRIPTION	OPTION 0	OPTION 1	OPTION 2
Model	Relay model	✓	✓	✓
Version	Flash version	✓	✓	✓
Date/Time	Current date and time	✓	✓	✓
Identification	Value entered in the “identification” field (advanced settings group)	✓	✓	✓
I	current	✓	✓	✓
Thermal Image	Thermal image	✓	✓	✓
50H Pickup	50H unit pickup	✓	✓	✓
50L Pickup	50L unit pickup	✓	✓	✓
51 Pickup	51 unit pickup	✓	✓	✓
49 Alarm	49 unit alarm	✓	✓	✓
Pickup	It is enabled when any of the protection functions trip is permitted	✓	✓	✓
50H Disabled	Inhibition of 50H unit trip by digital input	✓	✓	✓
50L Disabled	Inhibition of 50L unit trip by digital input	✓	✓	✓
51 Disabled	Inhibition of 51 unit trip by digital input		✓	✓
49 Disabled	Inhibition of 49 unit trip by digital input		✓	✓
Trip disabled	General trip inhibition by digital input		✓	✓
50H Virtual trip*	50H unit virtual trip	✓	✓	✓
50L Virtual trip*	50L unit virtual trip	✓	✓	✓
51 Virtual trip*	51 unit virtual trip	✓	✓	✓
49 Virtual trip*	49 unit virtual trip	✓	✓	✓
General virtual trip*	General virtual trip	✓	✓	✓
50H Trip	50H unit trip	✓	✓	✓
50L Trip	50L unit trip	✓	✓	✓
51 Trip	51 unit trip	✓	✓	✓
49 Trip	49 unit trip	✓	✓	✓
50 Trip	Any 50 unit trip (50H, 50L, 50NH, 50NL)	✓	✓	✓
Trip	General trip	✓	✓	✓
Protection	Entered value in the “relay status” setting (general settings group)	✓	✓	✓
Events	Number of events produced since the last time they were deleted		✓	✓
Active table	Shows which table is active (table 1 or table 2)	✓	✓	✓
Frequency	Frequency value entered in the “Frequency” setting (general settings group)	✓	✓	✓
Alarm	Alarm contact status. This contact is enabled when “Protection” is out of service, or when all trips are disabled (either by setting or by digital input).	✓	✓	✓
Output 1	Status of Auxiliary Output 1	✓	✓	✓
Output 2	Status of Auxiliary Output 2	✓	✓	✓
Output 3	Status of Auxiliary Output 3	✓	✓	✓
Output 4	Status of Auxiliary Output 4	✓	✓	✓
Input 1	Status of Digital Input 1	✓	✓	✓
Input 2	Status of Digital Input 2	✓	✓	✓
Ready	Status of the READY LED. Same as for the alarm	✓	✓	✓

NAME	DESCRIPTION	OPTION 0	OPTION 1	OPTION 2
	contact.			
Trip LED	TRIP LED status	✓	✓	✓
LED 1	LED 1 status	✓	✓	✓
LED 2	LED 2 status	✓	✓	✓
LED 3	LED 3 status	✓	✓	✓
LED 4	LED 4 status	✓	✓	✓
Logic 1	Output status of logic 1			✓
Logic 2	Output status of logic 2			✓
Logic 3	Output status of logic 3			✓
Logic 4	Output status of logic 4			✓
Table change	Shows whether the Table 2 selection by digital input is active. If so, Table 2 is shown; if not, the set table is activated.		✓	✓
Settings change disabled	Shows whether the Settings Change is inhibited by digital input. If so, it is not possible to change settings or command operations from the PC or the MMI. The table change is permitted by digital input.		✓	✓
Cold load pickup	Shows whether the cold load pickup is activated.			✓
Breaker 52a	Status of the breaker terminal A.			✓
Breaker 52b	Status of the breaker terminal B			✓
Breaker status	Breaker status			✓
Breaker failure	Indicates a breaker failure			✓
Counter	Value of the I^2 counter			✓
Number of openings	Number of openings			✓
I2 Alarm	Active when I^2 counter value exceeds the counter maximum limit, set in the BREAKER FAILURE TO OPEN group of settings.			✓
Local/remote	Active when the MMI is on the settings or operations menu.	✓	✓	✓
E2prom failure	Active when an e2prom failure is detected	✓	✓	✓
User Settings	Active when the default settings are replaced by user's settings.	✓	✓	✓

* Virtual trips are outputs of the corresponding protection units. These will become real trips if the trip permissions for those units are enabled.

MOD 0: MIFN*0*E000*00*
MOD 1: MIF N*0*E100*00*
MOD 2: MIF N*0*E200*00*