GE Power Management

Digital Protection for Electrical Machines

MIG

Instructions
GEK-106304

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: _____

_____

_____

_____

_____

IMPORTANT: LIST OF MESSAGES DISPLAYED BY THE MIG

PERMANENT SCROLLING	
Ia	Phase A current
Ib	Phase B current
Ic	Phase C current
IN	Ground current
I1	Positive sequence current
I2	Negative sequence current
TH	Thermal image
NSTARTS	Number of starts
TTs	Time to restart

KEY BY KEY MENU	
Ia	Phase A current
Ib	Phase B current
Ic	Phase C current
IN	Ground current
I1	Positive sequence current
I2	Negative sequence current
TH	Thermal image
NSTARTS	Number of starts
TTs	Time to restart
DATE/TIME	Date and time of the unit
LTU	Last trip unit
PH/N	Last trip phase
VALUE (FUNCTION)	Current value during the trip

INFORMATION	**Status**
MOD	Model
VER	Version
D T	Date-time
IDEN	Identification
Ia	Phase A current
Ib	Phase B current
Ic	Phase C current
I1	Ground current
I2	Positive sequence current
IN	Negative sequence current
TH	Thermal image
NSTARTS	Number of starts
TTs	Time to restart
INP1	Digital input 1
INP2	Digital input 2
OUT1	Digital output 1
OUT2	Digital output 2
OUT3	Digital output 3
OUT4	Digital output 4
B 52 B	Breaker terminal B

MAIN SETTINGS	Main Settings

GENERAL	General Settings
STA	Protection status (in service/out of service)
FRQ	Frequency
FLC	Rated load current
PWD	Password
ADD	Address
BAUD	Communication Baudrate

F37	Function 37
ENABLE 37	Enable function 37
TRIP 37	Trip permission for 37
TAP 37	Tap 37
TIME 37	Definite time 37

F46P	Function 46P
ENABLE 46P	Enable function 46P
TRIP 46P	Trip permission for 46P
TAP 46P	Tap 46P
CURV 46P	Curve 46P
K 46P	Constant 46P
TIME 46P	Definite time 46P

F48	Function 48
ENABLE 48	Enable function 48
TRIP 48	Trip permission for 48
TAP 48	Tap 48
TIME 48	Definite time 48

F49	Function 49
ENABLE 49	Enable function 49
TRIP 49	Trip permission for 49
TAP 49	Tap 49
ALARM 49	Alarm 49
T1	Heating constant
T2	Cooling constant
K1	Inverse sequence multiplier

F50P	Function 50P
ENABLE 50P	Enable function 50P
TRIP 50P	Trip permission for 50P
TAP 50P	Tap 50P
TIME 50P	Timer 50P

F50N	Function 50N
ENABLE 50N	Enable function 50N
TRIP 50N	Trip permission for 50N
TAP 50N	Tap 50N
TIME 50N	Timer 50N

F51P	Function 51P
ENABLE 51P	Enable function 51P
TRIP 51P	Trip permission for 51P
TAP 51P	Tap 51P
CURV 51P	Curve 51P
DIAL 51P	Dial 51P
TIME 51P	Definite time 51P

F51N	Function 51N
ENABLE 51N	Enable function 51N
TRIP 51N	Trip permission for 51N
TAP 51N	Tap 51N
CURV 51N	Curve 51N
DIAL 51N	Dial 51N
TIME 51N	Definite time 51N

F66	Function 66
ENABLE 66	Enable function 66
OPER 66	Operation permission for 66
N STARTS	Maximum number of starts allowed for one hour
TTR	Time between starts

F87R	Function 87R
ENABLE 87R	Enable function 87R
TRIP 87R	Trip permission for 87R
K	Percentage slope
S	Idiff sensitivity
K1	3 Iog sensitivity

ADVANCED SETTINGS	Advanced Settings

GENERAL ADVANCED	General Advanced
TAB	Active table
TRIP MIN TIME	Minimum tripping time

F37 T2	Function 37 Table 2
ENABLE 37 T2	Enable function 37 Table 2
TRIP 37 T2	Permission to trip 37 Table 2
TAP 37 T2	Tap 37 Table 2
TIME 37 T2	Definite time 37 Table 2

F46P T2	Function 46P Table 2
ENABLE 46P T2	Enable function 46P Table 2
TRIP 46P T2	Permission to trip 46P Table 2
TAP 46P T2	Tap 46P Table 2
CURV 46P T2	Curve 46P Table 2
K 46P T2	Constant 46P Table 2
TIME 46P T2	Definite time 46P Table 2

F48 T2	Function 48 Table 2
ENABLE 48 T2	Enable function 48 Table 2
TRIP 48 T2	Permission to trip 48 Table 2
TAP 48 T2	Tap 48 Table 2
TIME 48 T2	Definite time 48 Table 2

F49 T2	Function 49 Table 2
ENABLE 49 T2	Enable function 49 Table 2
TRIP 49 T2	Permission to trip 49 Table 2
TAP 49 T2	Tap 49 Table 2
ALARM 49 T2	Alarm 49 Table 2
T1 T2	Heating constant Table 2
T2 T2	Cooling constant Table 2
K1 T2	Inverse sequence multiplier Table 2

F50P T2	Function 50P Table 2
ENABLE 50P T2	Enable function 50P Table 2
TRIP 50P T2	Permission to trip 50P Table 2
TAP 50P T2	Tap 50P Table 2
TIME 50P T2	Timer 50P Table 2

F50N T2	Function 50N Table 2
ENABLE 50N T2	Enable function 50N Table 2
TRIP 50N T2	Permission to trip 50N Table 2
TAP 50N T2	Tap 50N Table 2
TIME 50N T2	Timer 50N Table 2

F51P T2	Function 51P Table 2
ENABLE 51P T2	Enable function 51P Table 2
TRIP 51P T2	Permission to trip 51P Table 2
TAP 51P T2	Tap 51P Table 2
CURV 51P T2	Curve 51P Table 2
DIAL 51P T2	Dial 51P Table 2
TIME 51P T2	Definite time 51P Table 2

F51N T2	Function 51N Table 2
ENABLE 51N T2	Enable function 51N Table 2
TRIP 51N T2	Permission to trip 51N Table 2
TAP 51N T2	Tap 51N Table 2
CURV 51N T2	Curve 51N Table 2
DIAL 51N T2	Dial 51N Table 2
TIME 51N T2	Definite time 51N Table 2

F66 T2	Function 66 Table 2
ENABLE 66 T2	Enable function 66 Table 2
OPER 66 T2	Operation permission function 66 Table 2
N STARTS T2	Maximum number of starts allowed for one hour Table 2
TTR T2	Time to restart Table 2

F87R T2	Function 87R Table 2
ENABLE 87R T2	Enable function 87R Table 2
TRIP 87R T2	Permission to trip function 87R Table 2
K T2	Percentage slope Table 2
S T2	Idiff sensitivity Table 2
K1 T2	3 Iog sensitivity Table 2

OPERATIONS	Operations
RESET	LED reset and auxiliary contacts
RST EMERG	Reset of unit 49, maximum number of starts and time to restart
ACT TABLE 1	Table 1 activation
ACT TABLE 2	Table 2 activation
OPEN BREAKER	Open breaker
RST OPENINGS	Reset of the number of starts

DATE TIME	Date-time
YXX	Allows to modify the year
MXX	Allows to modify the month
DXX	Allows to modify the day
HXX	Allows to modify the hour
MXX	Allows to modify the minutes

FURTHER TEXTS ON THE DISPLAY	
Y	Yes
N	No

Possible values for the STA setting (protection status)	
RDY	In service
DIS	Out of service

Possible values for settings CURV 51P, CURV 51N, CURV 51P T2 o CURV 51N T2 (Curve of unit 51)	
INV	Inverse curve
VI	Very inverse curve
EI	Extremely inverse curve
TDE	Definite time
USU	User curve

When confirming the settings, we will find the following messages:	
CNF	Confirmation
OK	Successful operation
ERROR	Operation not completed

TABLE OF CONTENTS

1. GETTING STARTED

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

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

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

1.1. INSPECTION CHECKLIST

- Open the relay packaging and inspect the relay for physical damage.
- View the faceplate relay model number and verify that the relay is the correct 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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E-mail: info.pm@indsys.ge.com

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

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

1.2. M+PC SOFTWARE

1.2.1. HARDWARE AND SOFTWARE REQUIREMENTS

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

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

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

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

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

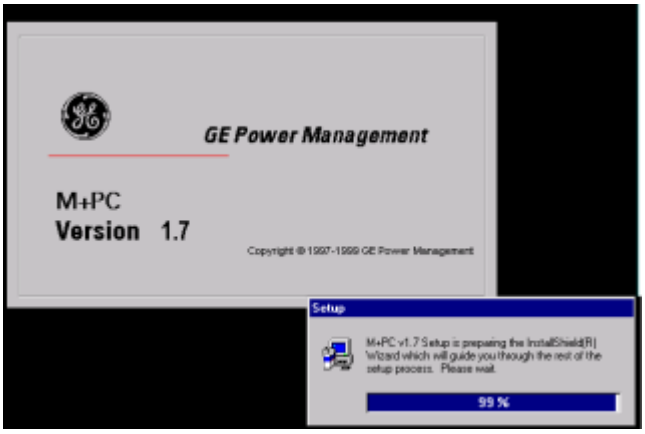
Contextual help can be accessed from any M+PC screen by pressing F1.

1.2.2. SOFTWARE INSTALLATION

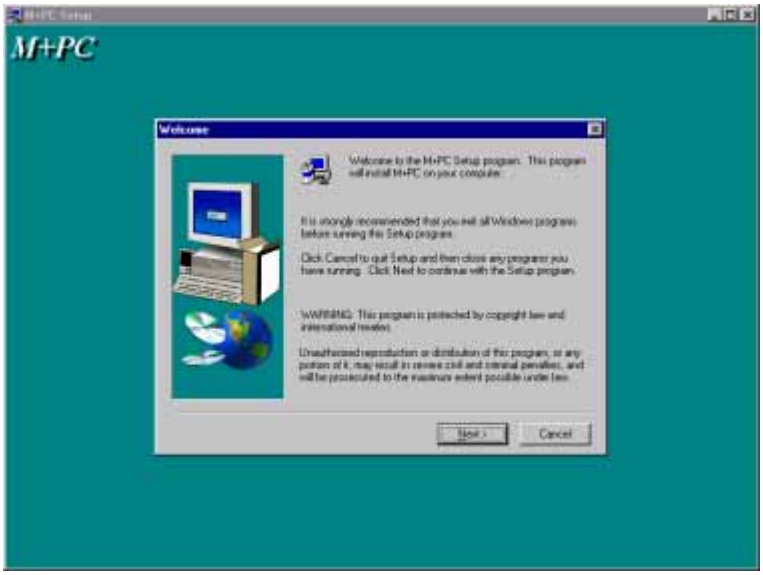
Refer to the following instructions to install the M+PC software:

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

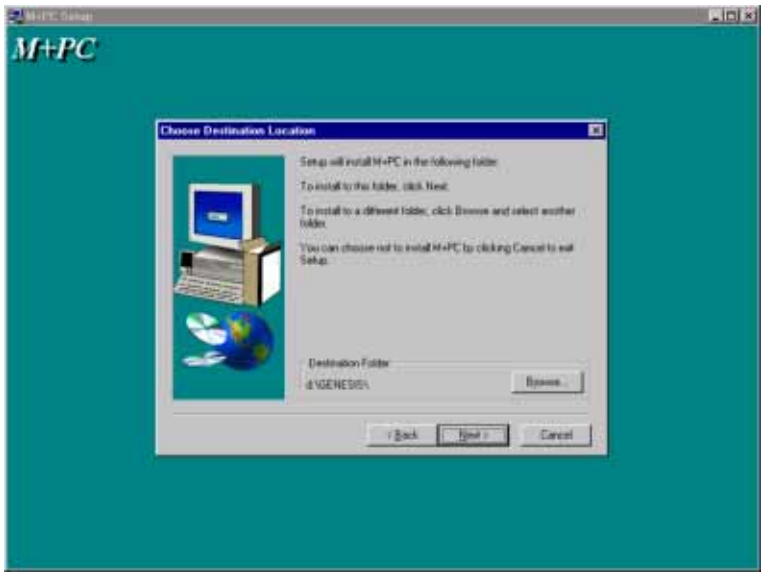
You will see the following screen:



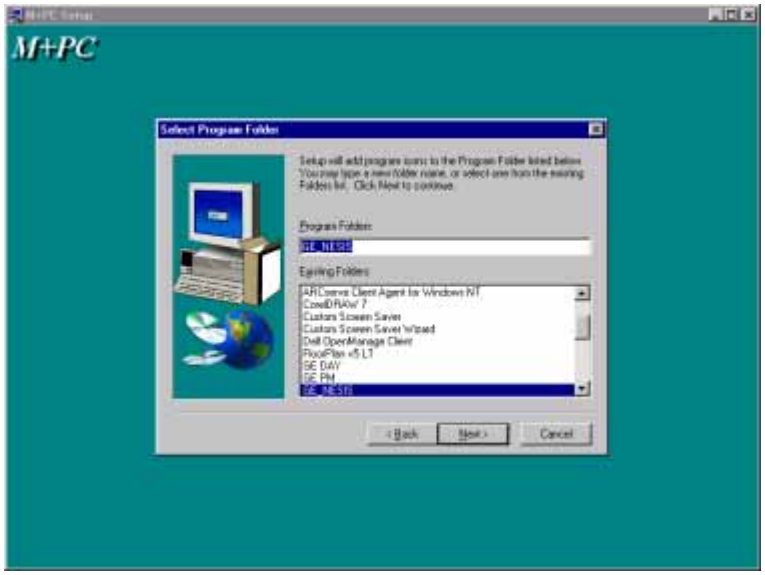
4. Follow the on-screen instructions to install the M+PC software. When the Welcome window appears, click on Next to continues with the installation procedure.



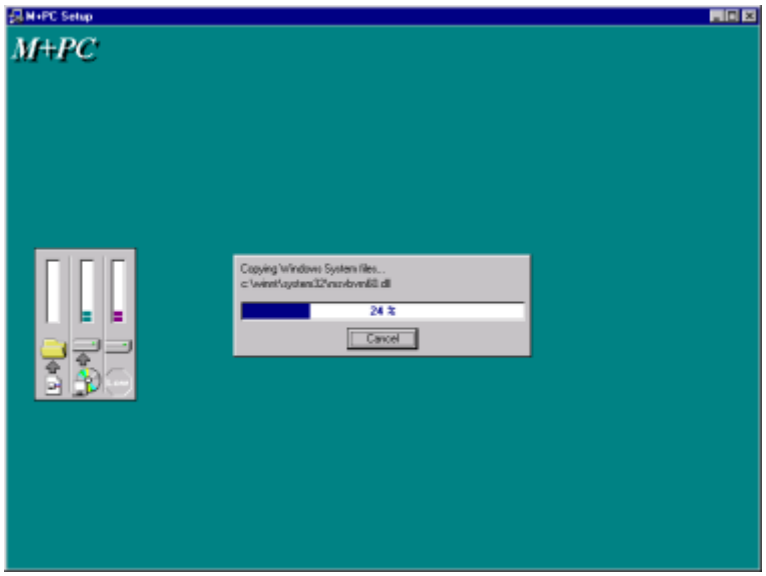
5. When the Choose Destination Location window appears and if the software is not to be located in the default directory, click Browse and type in the complete path name including the new directory name.



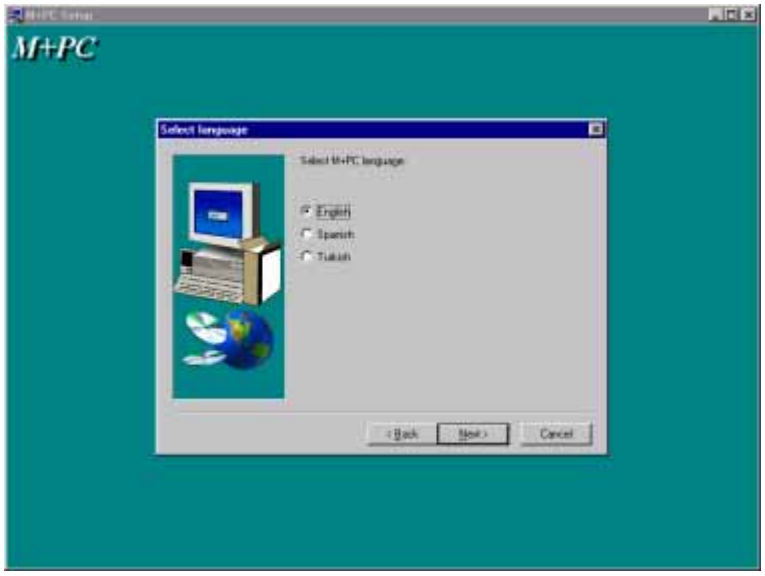
6. Click Next to continue with the installation procedure.
7. The default program group where the application will be added to is shown in the Selected Program Folder window. If it is desired that the application be added to an already existing program group, choose the group name from the list shown.



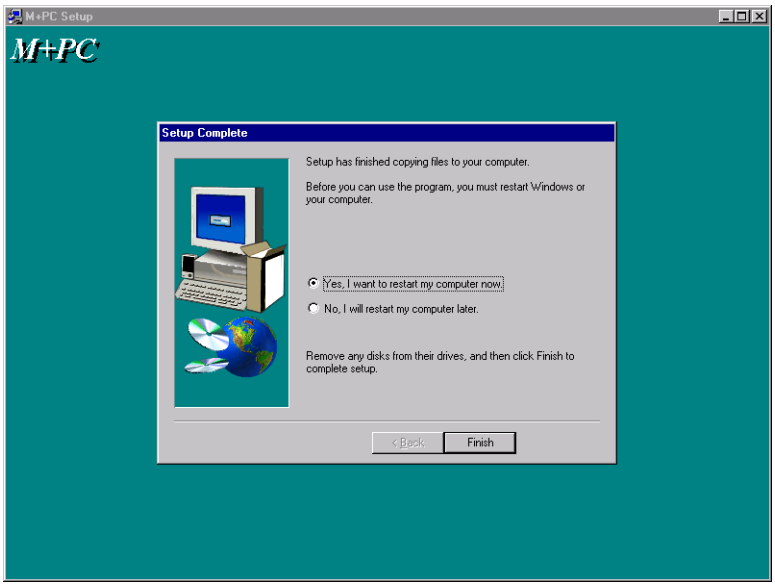
8. Click Next to begin the installation process, and all the necessary program files will be copied into the chosen directory.



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



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



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

1.3. M-RELAY FAMILY HARDWARE

1.3.1. MOUNTING & WIRING

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

1.3.2. COMMUNICATIONS

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

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

1.3.3. FACEPLATE KEYPAD & 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.

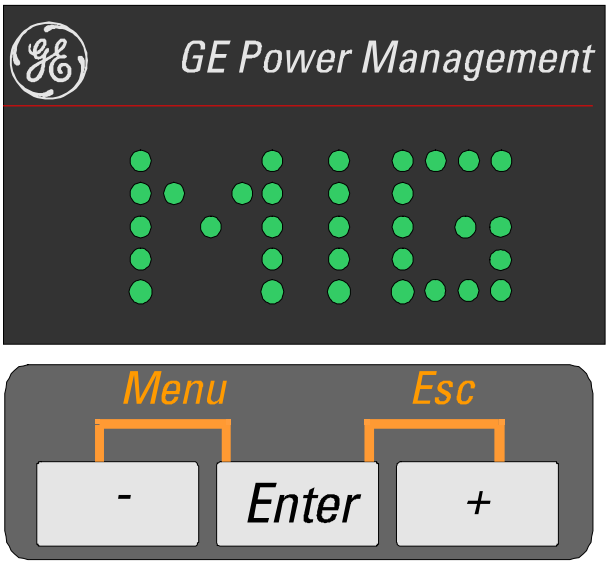


Figure 1.1 MIG KEYPAD AND DISPLAY

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

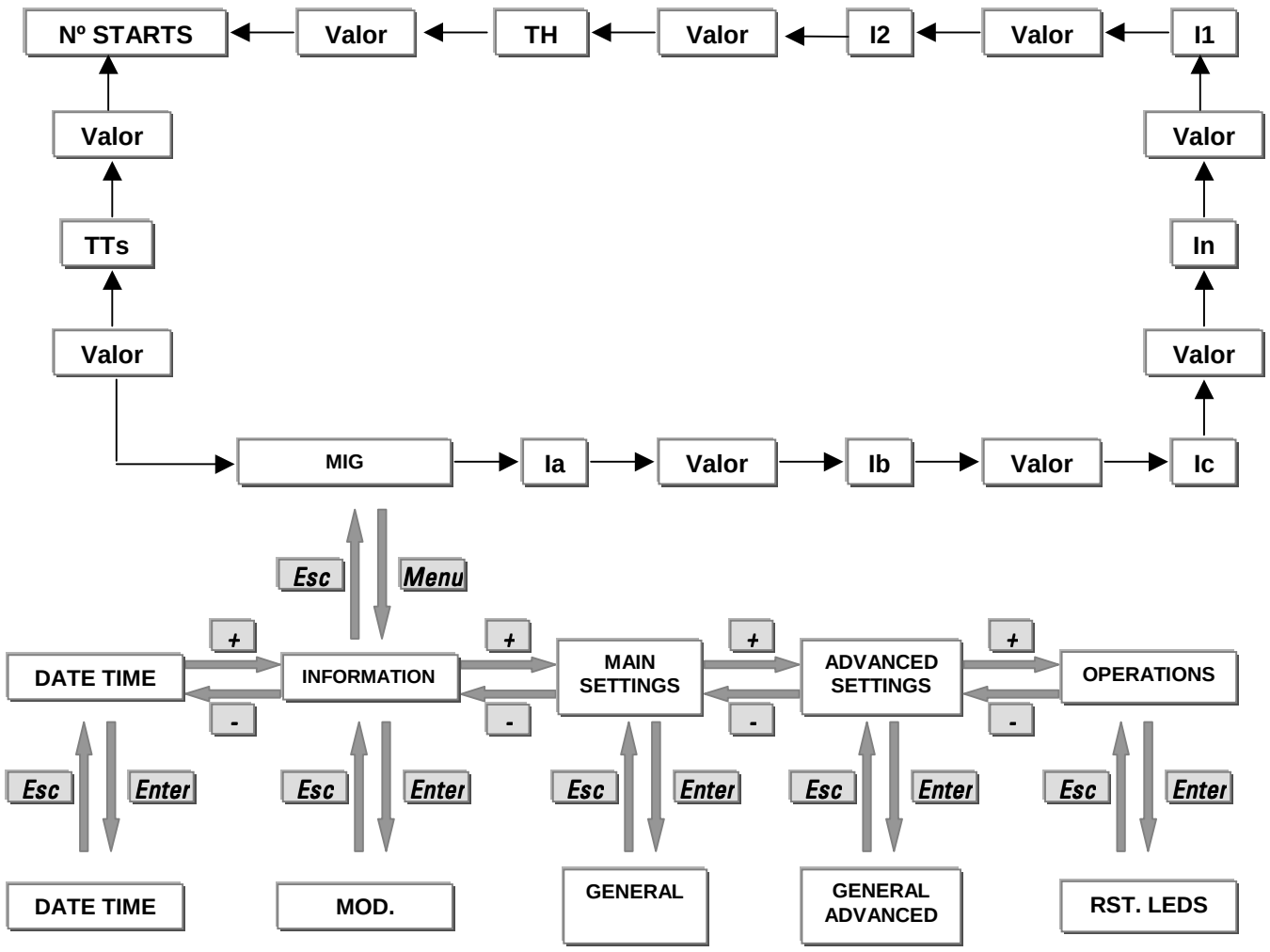


Figure 1.2. MOVING THROUGH THE HIERARCHICAL MENU

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 values measured by the relay.

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

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

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. PRODUCT DESCRIPTION

2.1. INTRODUCTION

2.1.1. GENERAL OVERVIEW

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

1. Main Protection for Medium and Low Power Generators.
2. Backup protection for higher power generators.
3. Main Protection for Medium and High power motors
4. Backup overcurrent protection for power Transformers (for any power level).
5. Restricted Ground Fault Differential Protection.
6. Differential protection for motors, if the motor CTs are in differential connection.
7. Protection and Supervision of the Thermal status for cables, power transformers and grounding resistances.

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 MIG 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.

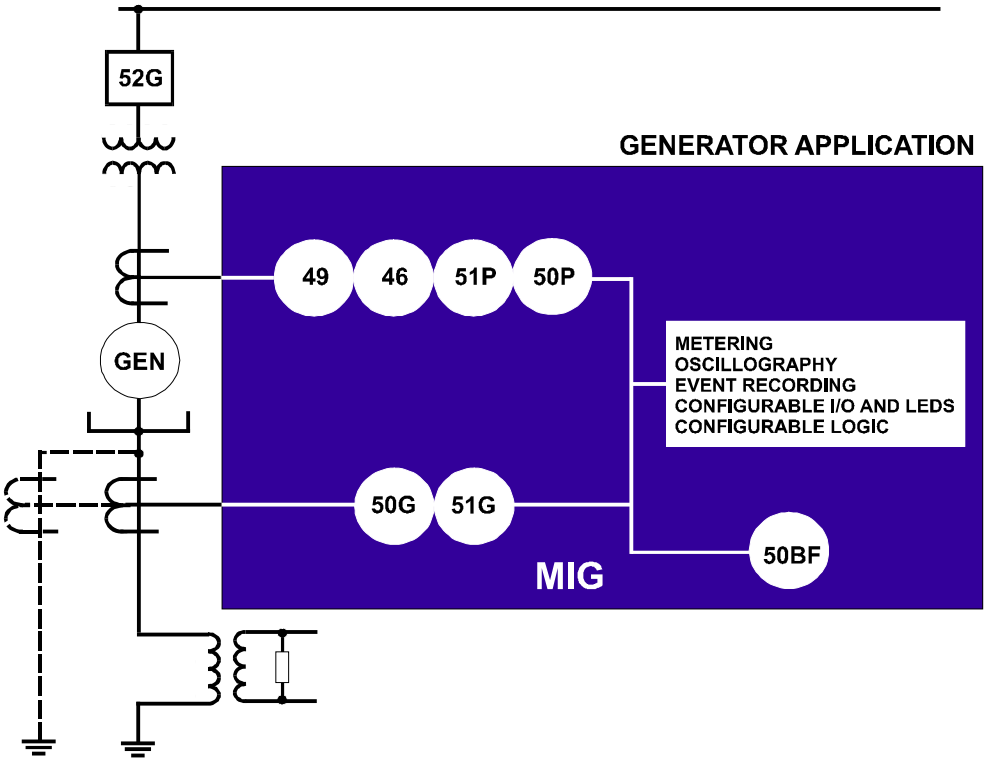


Figure 2.1. SINGLE LINE DIAGRAM SHOWING MIG FUNCTIONS

2.2. OVERCURRENT UNITS

2.2.1. PHASE TIME OVERCURRENT UNIT (51P)

A Phase Time Overcurrent unit is provided in the MIG. 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, which can be used for both three-phase overcurrent and ground units.

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

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

Where:

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

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

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

The general formula for all ANSI curves is as follows:

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

Where:

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

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

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

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

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

Where:

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

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

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

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. PHASE INSTANTANEOUS OVERCURRENT UNITS (50P)

The phase instantaneous overcurrent unit, 50P, can be enabled/disabled and set independently from the timed overcurrent unit. 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.

2.2.3. GROUND TIME OVERCURRENT UNIT (51N)

The Ground Time Overcurrent unit offers the same setting possibilities as the Phase Time Overcurrent unit. The ground current signal is taken from the generator's neutral CT.

2.2.4. GROUND INSTANTANEOUS OVERCURRENT UNIT (50N)

The MIG relay provides a Ground Instantaneous Overcurrent Unit, 50N. The settings and ranges available for these units are the same than the ones described for the Phase Instantaneous Overcurrent Unit, 50P.

The ground signal can be taken from the generator's ground CT (post or toroidal), as a residual connection of the phase CTs, or through a toroidal CT including the three phase currents.

2.3. THERMAL IMAGE UNIT (49)

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.

The thermal unit measures the three phase currents of the motor. The algorithm to calculate the thermal image value is based on the positive and negative sequence values, I_1 and I_2 as follows:

$$I_{eq} = \sqrt{\frac{I_1^{2\,o} + K_1 * I_2^2}{I_{pickup}^2}}$$

Where K1 is a constant that overvalues the effect of the negative sequence I2 component, and is selectable between 1 and 8.

The negative sequence is included in the above formula in order to protect the generator from the effects caused by the system light unbalanced currents, such as the ones produced by load unbalance. High negative sequence values, such as those produced by uncleared external faults (phase-to-phase or phase-to-ground), long lasting loss of a phase, etc. will be detected by function 46 in a faster way, as it works with a different algorithm. The phenomena that cause a supplementary overheating in the machine are described in section 2.4.

The resulting time for reaching an overheating condition due to Ieq including both overload and unbalance is defined by the following equation:

$$t = \tau * Ln \left. \frac{I_{eq}^2}{I_{eq}^2 - 1} \right|$$

Where:

τ Generator's time constant at In

T Operation time at Ieq

2.4. NEGATIVE SEQUENCE UNIT (46)

The MIG relay incorporates a negative sequence protection function in order to detect system conditions that can cause unbalanced three-phase currents in the generator. As previously mentioned, these unbalances can be of higher magnitude than the load unbalance.

If line currents are not balanced, using the symmetrical components we can verify that negative sequence current components are generated. This component rotates in the opposite way to the rotor. The flux produced by this current seen from the rotor, has a frequency that is twice the synchronous speed as a result of the inverse rotation combined with the direct rotation of the rotor. This flux induces currents with twice the nominal frequency, whose pelicular effect makes them fluctuate through the rotor surface, and in a slighter way, through the winding. The resulting overheating can reach extremely high in a short time. The result of this fact is a quick damage of isolating elements, as well as the loss of

Therefore, the overheating limit for the rotor is defined by:

$$k = I_{eq}^{2} * t$$

Where:

K Constant that depends on the design and size of the generator according to standards (e.g. ANSI C50.13)

t Time in seconds

I_{eq} I_2 / FLC

I_2 RMS value of the negative sequence current

FLC Generator's rated current

2.5. UNDERCURRENT (37)

Due to its high resolution, the undercurrent unit can be used to perform a stop or sequential trip of a generator in service. Its minimum setting value corresponds to the minimum level of loss in empty of the majority of generators (of diverse types).

This unit can be enabled independently and set as required. As other functions, its setting is based on the rated current (FLC). Function 37 will not operate if its setting is below 5% of the value set for FLC, even if the current has fallen below the setting.

2.6. LOCKED ROTOR (48)

When the machine is in a stand-by condition, a sudden increase of the current value above the set limit would cause a trip, avoiding an unnoticed connection to the system. The machine start

2.7. RESTRICTED GROUND DIFFERENTIAL UNIT (87R)

This unit detects ground faults in solidly grounded generators, through resistance and high impedance reactance.

This unit calculates $3I_{O\ terminal}$ current from the measured phase currents, and measures the generator ground $3I_{Oneutral}$ current from the generator, present in the corresponding input. The difference between both values is the differential current I_{diff}, a value that must exceed a user-programmable value (setting) in order to activate the protection unit.

$$I_{diff} = 3I_{0termina}I - 3I_{0neutral}$$

This partial output is supervised by a percentage function, whose purpose is to avoid undesired operation caused by CT saturation in a severe external fault situation, or by a mistake in the CTs in stable load condition.

This supervision was usually performed using an external stabilization resistor, where that the unbalance must exceed a certain level to produce a trip. This solution has the inconvenience of reducing the protection sensitivity.

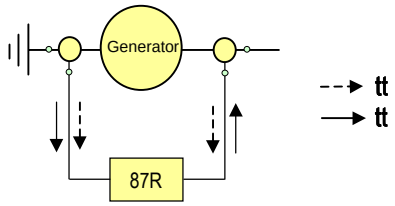
This is why the 87R unit incorporates this supervision function, which compares the I_{diff} magnitude with the maximum phase current $I_{\varnothing max}$, present all times. This slope defines the protection unit sensitivity, and is determined by a setting K. Therefore:

$$K = \frac{I_{diff}}{I_{\phi max}}$$

The sensitivity and resolution of this unit allow fault detection in high impedance systems, that is, where the fault currents may not exceed 10 A (primary).

The basic settings of this unit are the I_{diff} level, the percentage slope K, and the tripping timer.

The scheme connection for this unit is as follows:



2.8. MAXIMUM NUMBER OF STARTS (66)

Due to the existing similarities between generators and motors, the majority of functions included in the MIG apply to both types of machines. However, the present function is used specifically in motor protection.

This unit avoids damage to the motor caused by the cumulative effect of an excessive number of starts in a short period of time. The unit prevents the motor from being started more than a selected number of times during an hour. If this unit operates, the relay output will remain open during a minimum programmable time, in order to ensure a recovery time for the motor. Once this time has expired, the output will remain active while the time window includes a number of starts equal to or higher than the allowed maximum number of starts (setting).

The maximum number of starts that can be stored in the time window is 10. In case of a higher number of starts, the oldest would be removed and replaced by the newest one.

This unit operates only if the motor is stopped, in order to avoid a new start. The unit will never operate while the motor is running.

As regards the detection of starts, the motor is considered to be stopped when the average current of the three phases is below 5% of the value set for FLC. A start is detected when, being the motor stopped (according to the above definition), the average current of the three phases rises above 5% of FLC.

2.9. EVENTS

The MIG stores a historical record with the last 24 events. Each event contains the event description, date and time (4 ms accuracy), the current values in phases and ground at 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 24 (maximum number of events stored), this means that from all the produced events, only the last 24 are stored.

This event record is stored in a capacitor backed up RAM memory.

The whole MIG 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 event format is displayed as follows

Date/Time	Event name	I_a	I_b	I_c	I_n	I_2	Status information

The following table shows a list of all possible events:

37 Pickup/Drop out
50P Pickup/Drop out
50N Pickup/Drop out
48 Pickup/Drop out
51P Pickup/Drop out
51N Pickup/Drop out
46 Pickup/Drop out
49 Pickup/Drop out
37 Trip
50P Trip
50N Trip
48 Trip
51P Trip
51N Trip
46 Trip
49 Trip
66 Operation
General trip
37 Trip enable/disable by digital input
50P Trip enable/disable by digital input
50N Trip enable/disable by digital input
48 Trip enable/disable by digital input
51P Trip enable/disable by digital input
51N Trip enable/disable by digital input
46 Trip enable/disable by digital input
49 Trip enable/disable by digital input
66 operation enable/disable by digital input
General trip enable/disable by digital input
Protection status in service/out of service (READY)
Digital output 1 active/non active
Digital output 2 active/non active
Digital output 3 active/non active
Digital output 4 active/non active
Digital input 1 active/non active
Digital input 2 active/non active
Settings change disabled by digital input active/non active
Trip operation by digital input
52B open/closed
Close breaker operation
Breaker (52) closed
Table 2 selection by digital input
Oscillo trigger by digital input
Oscillo trigger by command
Breaker failure to open
Settings change
EEPROM failure
User settings/Factory settings
Reset latch aux
Tripping command
Trip by stop

2.10. OSCILLOGRAPHY

The MIG 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 values of phase (Ia, Ib, Ic) and ground (IN) currents. 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
  - Table 2 selection by digital input
  - E2prom failure
  - Default settings/User's settings
- Date and time
- Model
- Number of oscillo

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 capacitor backed up RAM memory.

The whole MIG 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.

2.11. MULTIPLE SETTINGS GROUPS

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

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

MAIN SETTINGS

General Settings

Function 37 Settings

Function 46 Settings

Function 48 Settings

Function 49 Settings

Function 50P Settings

Function 50N Settings

Function 51P Settings

Function 51N Settings

Function 66 Settings

Function 87R Settings

ADVANCED SETTINGS

General Advanced Settings

Function 37 Settings (Table 2)

Function 46 Settings (Table 2)

Function 48 Settings (Table 2)

Function 49 Settings (Table 2)

Function 50P Settings (Table 2)

Function 50N Settings (Table 2)

Function 51P Settings (Table 2)

Function 51N Settings (Table 2)

Function 66 Settings (Table 2)

Function 87R Settings (Table 2)

User Curve

Event Mask

Oscillography Mask

2.12. MEASUREMENT AND SELF-TEST

2.12.1. MEASUREMENT

Scrolling Screen

The MIG displays sequentially the following measures:

- Phase and ground currents (I_a, I_b, I_c, I_n)
- Positive sequence current (I_1)
- Negative sequence current (I_2)
- Thermal Image (Th)
- Number of starts
- Time to activate function 66 (TTs)

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

Key-to-key Screen

By pressing the Enter key on the MIG keypad, the unit displays the same measures as above. Besides, it will display also the information about the last trip, including:

- Last trip date and time
- Last protection unit that tripped
- Phase and/or ground involved in the trip
- Fault current

2.12.2. 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.

2.13. USER INTERFACE

2.13.1. LED TARGETS

There are 6 LED Targets in the faceplate of the MIG. The first one is green and has the 'READY' (relay in service) fixed meaning (cannot be configured); the second one is red and fixed for trip, while the other 4 are red and can be configured by the user. The default configuration of the LEDs is shown in figure 2.13.1.

Figure 2.13.1 MIG 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.
- **THERMAL TRIP**: Points out that the trip has been issued by the Thermal Image Unit (49).
- **OVERCURRENT**: Points out that the trip has been issued by one of the Overcurrent Units (50P, 50N, 51P, 51N)
- **UNBALANCE**: Points out that the trip has been issued by the Current Unbalance unit (46).
- **PICKUP**: Points out that at least one of the protective units has picked up.

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

2.13.2. KEYPAD AND DISPLAY

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

2.13.3. COMMUNICATIONS PORTS

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

2.13.4. SOFTWARE

MIG 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).

2.14. MODEL LIST. ORDER CODES

The MIG has a draw-out construction, 4U high and ¼ of a 19" rack wide. The MIG 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 MIG 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, MIN, 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 MIG and 2 MIV modules), while the M100 case can hold a maximum of 16'' in total module length (i.e. 4 MIFs, 2 MIG 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

MIG	P	-	-	-	E	0	0	0	-	0	0	-	DESCRIPTION
		A											ANSI Curves
		I											IEC Curves
													Phases:
			1										CT In = 1A (0.1-2.4 A)
			5										CT In = 5A (0.5-12 A)
													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)
													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 **

** 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).

2.15. TECHNICAL SPECIFICATIONS.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

2.15.1. PROTECTION FUNCTIONS

PHASE AND GROUND TIME OVERCURRENT (51P, 51N)

Current	Fundamental
Pickup level	0.1 – 2.4 FLC in steps of 0.01
Drop out level	97-98% of the pickup level
Accuracy	3% in the complete range
Curves	IEC or ANSI inverse, very inverse, extremely inverse, user defined (depending on model).
	Definite time 0.00 to 99.99 s in steps of 0.01 s
Reset type	Instantaneous
Timer accuracy	±50 ms or 3% for I > 1.2 times the pickup level

PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50P, 50N)

Current	Fundamental
Pickup level	0.1 – 30 FLC in steps of 0.01
Drop out level	97-98% of the pickup level
Accuracy	3% in the complete range
Overreach	< 2%
Timer	0.00 to 99.99 s in steps of 0.01 s
Reset type	Instantaneous
Timer accuracy	+50ms for timer set to 0 ms
	±20 ms or 3% of total time for timer set to > 0 ms

THERMAL IMAGE (49)

Current	Equivalent fundamental
Tap level	0.1 – 2.4 FLC in steps of 0.01
Reset type	97-98% of the tap level
Accuracy	3% in the complete range
Heating constant τ_1	3 to 600 minutes in steps of 1 minute
Heating constant τ_2	1 to 6 times τ_1 in steps of 1 τ_1
Overload alarm	70-100% of I_{tap} in steps of 1% I_{tap}
Tripping time accuracy	5% for times over 5 s.
Negative sequence constant K	1 to 8 in steps of 1

CURRENT UNBALANCE (46)

Current	Negative sequence fundamental
Pickup level	0.05 to 0.99 FLC in steps of 0.01
Curve	Defined in section 2.4.
	Definite time
K Constant	1 to 100 in steps of 1
Definite time range	0.00 to 99.99 s in steps of 0.01 s
Tripping time accuracy	±250 ms or 5%

LOCKED ROTOR (48)

Current	Fundamental
Pickup level	1.1 to 10 FLC in steps of 0.01
Timing	0.00 to 99.99 s in steps of 0.01 s
Tripping time accuracy	±250 ms or 5%

UNDERCURRENT (37)

Current	Fundamental
Pickup level	0.1 to 0.99 FLC in steps of 0.1
Timing	0.00 to 99.99 s in steps of 0.01 s
Tripping time accuracy	±250 ms or 5%

MAXIMUM NUMBER OF STARTS (66)

Current	Fundamental
Pickup level	0 to 10 in steps of 1
Start blocking timer	0 to 100 minutes in steps of 1 min.
Tripping time accuracy	±250 ms or 5%

RESTRICTED GROUND DIFFERENTIAL (87R)

Current	Fundamental
Minimum $3I_{og}$ Sensitivity (S)	2% In
Minimum $3I_{on}$ sensitivity (K_1)	2% In
Timer	0.00 - 99.99 s
Tripping time accuracy	±500 ms or 5%

2.15.2. METERING FUNCTIONS

Accuracy	±3% in the range of 0.5 to 2 I_n

2.15.3. INPUTS

AC CURRENT

Secondary rated current	1 or 5 A depending on the selected model
Frequency	50/60 Hz (selectable by setting)
Consumption	< 0.2 VA at secondary In
Maximum permissible current	100 In during 1 second 4 In continuously

DIGITAL INPUTS

Voltage contacts	300 Vdc maximum in permanence
Acknowledgement time	< 4 ms

2.15.4. POWER SUPPLY

LOW RANGE

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

HIGH RANGE

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

2.15.5. OUTPUTS

TRIPPING CONTACTS

Contact Capacity

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

OUTPUT RELAYS

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

Maximum ranges for 100000 operations:

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

VOLTAGE	MAKE AND CARRY (Continuous)	MAKE AND CARRY 0.2 seconds	BREAK	MAXIMUM LOAD
AC Inductive				
FP = 0.4				
120 Vac	16 A	48 A	11.2 A	1344 VA
250 Vac	16 A	48 A	11.2 A	2800 VA

2.15.6. COMMUNICATIONS

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

2.15.7. AMBIENT CONDITIONS

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

2.15.8. TYPE TESTS AND CERTIFICATIONS

The MIG system complies with the following standards, which include the standards required by Community Directive 89/336 for the CE marking, in line with European standards. It also complies with the European directive requirements for low voltage, and the environmental and operating requirements established in ANSI standards C37.90, IEC 255-5, IEC 255-6 and IEC 68.

Test	Standard	Class
Insulation Test Voltage:	IEC 60255-5	2kV, 50/60 Hz 1 min
Surge Test Voltage:	IEC 60255-5	5 kV, 0.5 J. (3 positive pulses and 3 negative.)
1 MHz Interference:	IEC 60255-22-1	III
Electrostatic Discharge:	IEC 60255-22-2	IV
	EN 61000-4-2	8 kV in contact, 15 kV through air.
Radiointerference:	IEC 60255-22-3:	III
		40 MHz, 151 MHz, 450 MHz and cellular phone.
Radiated Electromagnetic fields with amplitude modulation.	ENV 50140	10 V/m
Radiated Electromagnetic fields with amplitude modulation. Common mode.	ENV 50141	10 V/m
Radiated Electromagnetic fields with frequency modulation.	ENV 50204	10 V/m
Fast Transients:	ANSI/IEEE C37.90.1	IV
	IEC 60255-22-4	IV
	BS EN 61000-4-4	IV
Magnetic fields at industrial frequency:	EN 61000-4-8	30 AV/m
Power Supply interruptions:	IEC 60255-11	

Test	Standard	Class
Temperature:	IEC 57 (CO) 22	
RF Emission:	EN 55011	B
Sinusoidal Vibration:	IEC 60255-21-1	II
Shock:	IEC 60255-21-2	I

2.15.9. PRODUCTION TESTS

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

2.15.10. APPROVALS

- Manufactured under an ISO9001Registered system.
- CE Marking.

3. HARDWARE

3.1. DESCRIPTION

3.1.1. RELAY IDENTIFICATION

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

Figure 3.1. FACEPLATE AND IDENTIFICATION OF MIG RELAY

3.1.2. PANEL CUTOUT

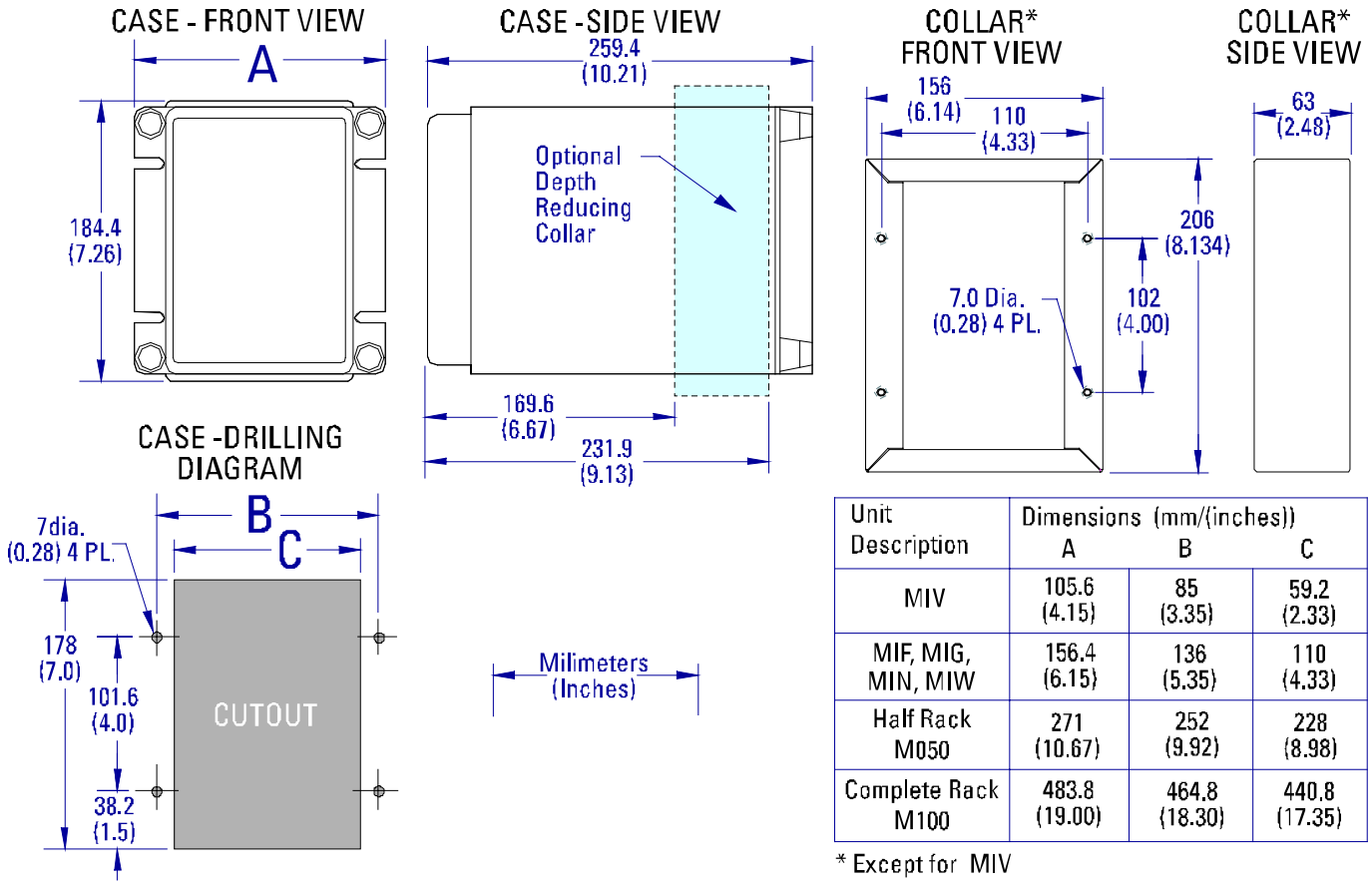
The MIG case is made from corrosion resistant stainless steel. Case dimensions, along with panel cutout details for panel mounting are shown in figure 3.2.

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

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

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

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



Unit Description	Dimensions (mm/(inches)) A	B	C
MIV	105.6 (4.15)	85 (3.35)	59.2 (2.33)
MIF, MIG, MIN, MIW	156.4 (6.15)	136 (5.35)	110 (4.33)
Half Rack M050	271 (10.67)	252 (9.92)	228 (8.98)
Complete Rack M100	483.8 (19.00)	464.8 (18.30)	440.8 (17.35)

* Except for MIV

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

3.1.3. MODULE WITHDRAWAL / INSERTION

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

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

Figure 3-3: MIG 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.

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 MIG relay.

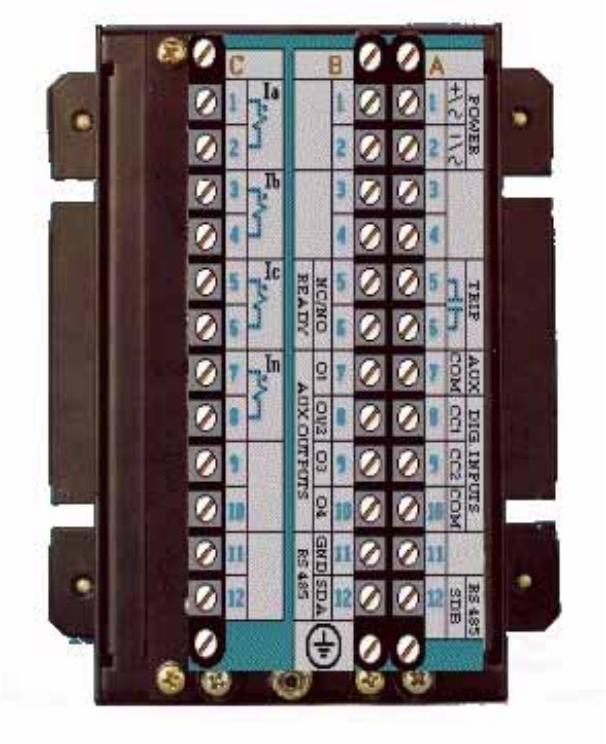


Figure 3-4 MIG RELAY - REAR VIEW

3.2. WIRING

3.2.1. TYPICAL WIRING DIAGRAM

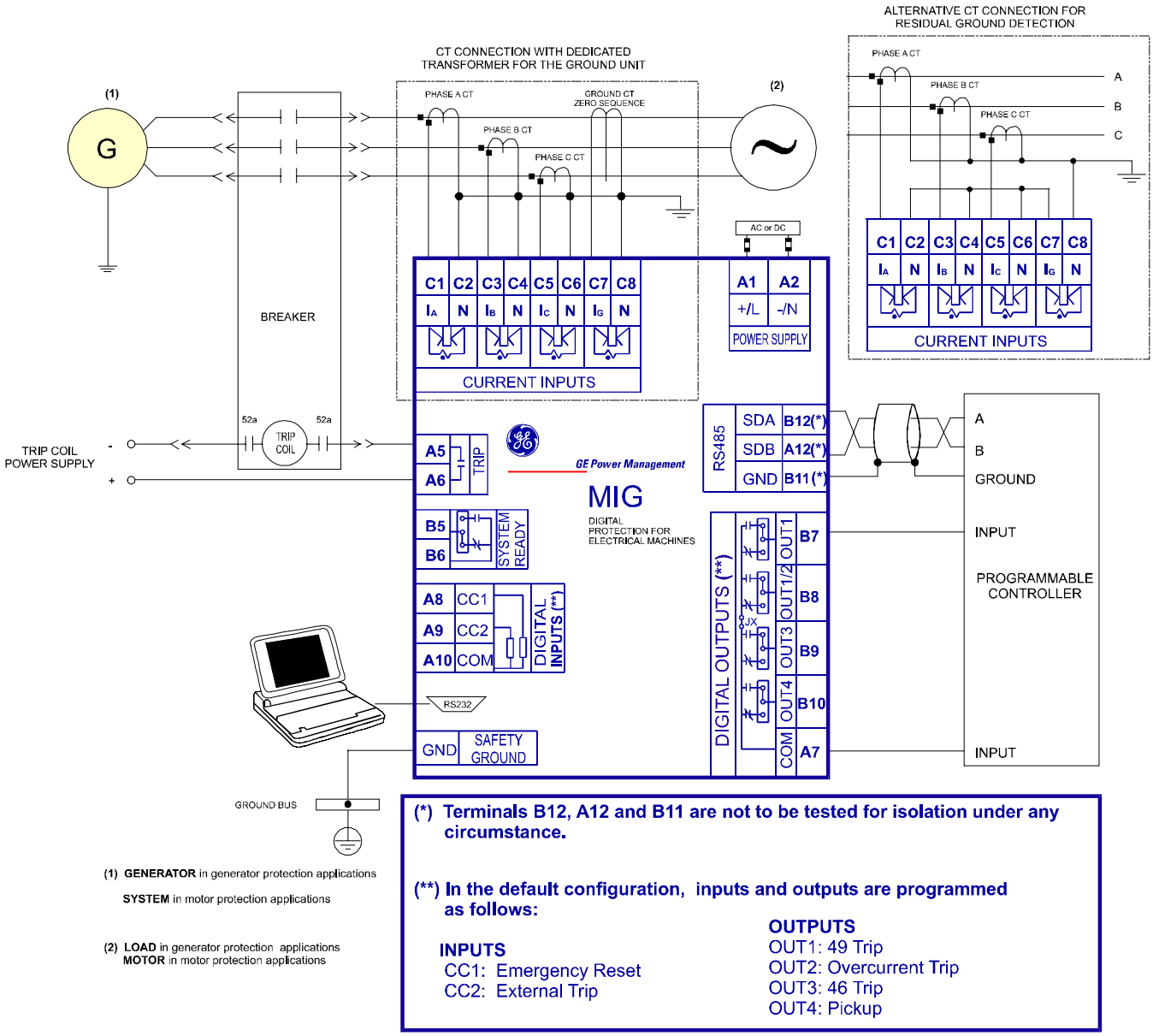


Figure 3-5 TYPICAL WIRING DIAGRAM FOR MIG RELAY

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

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 DAMAGE OR INADEQUATE 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.

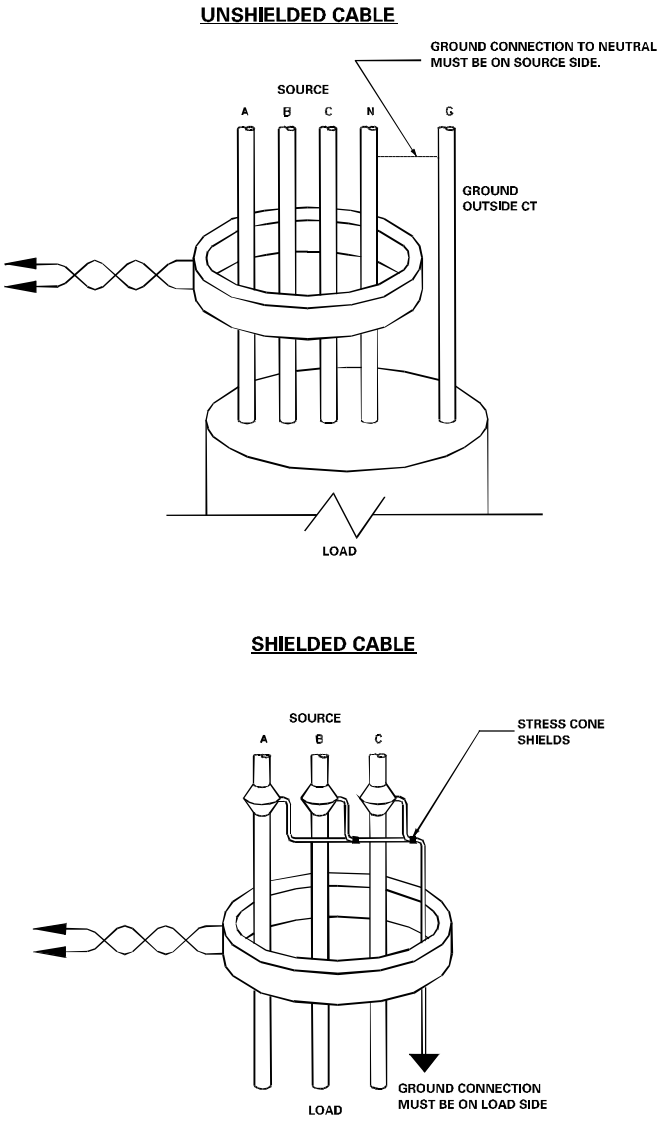


Figure 3-7 ZERO SEQUENCE CORE BALANCE CT INSTALLATION

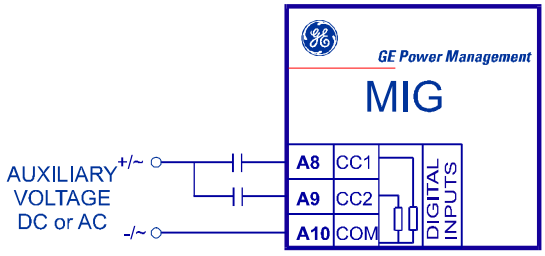


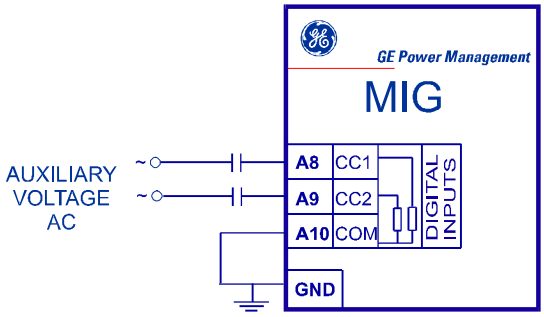
Figure 3-8 CONTACT INPUTS CONNECTIONS

The MIG 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.



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

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

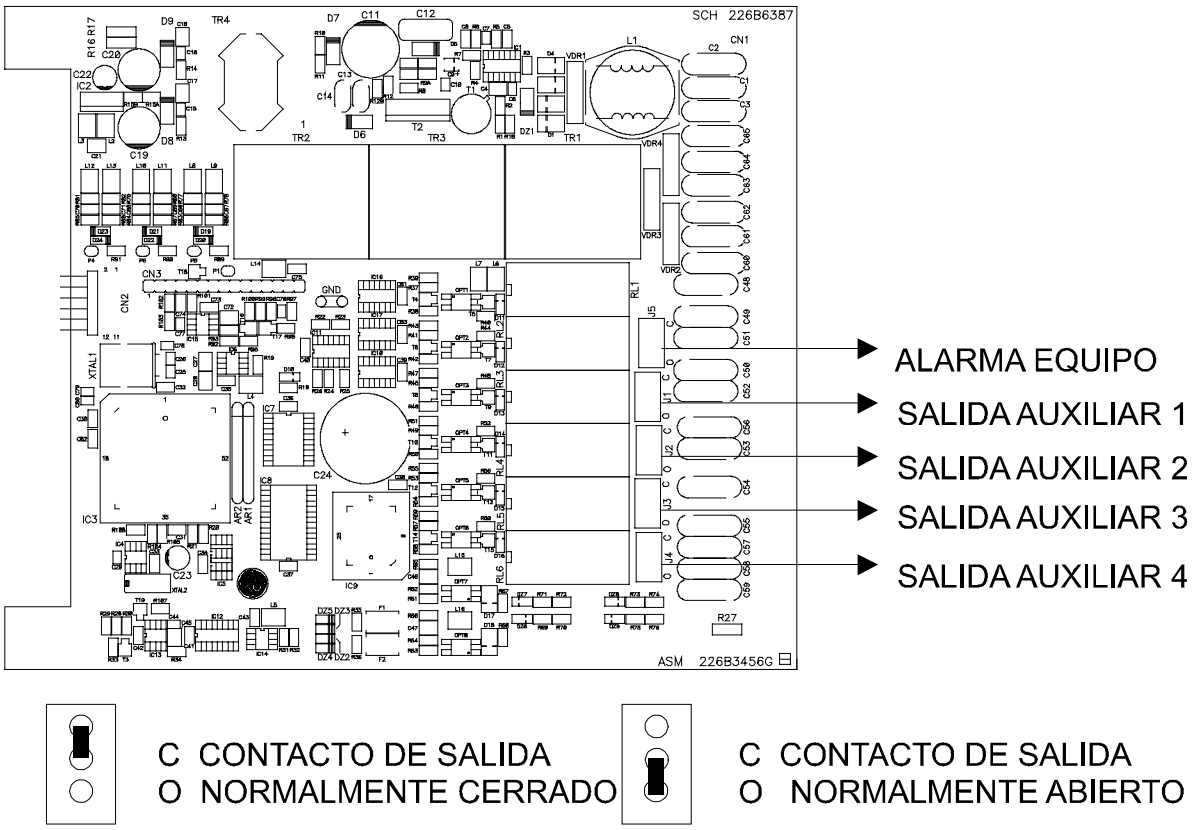
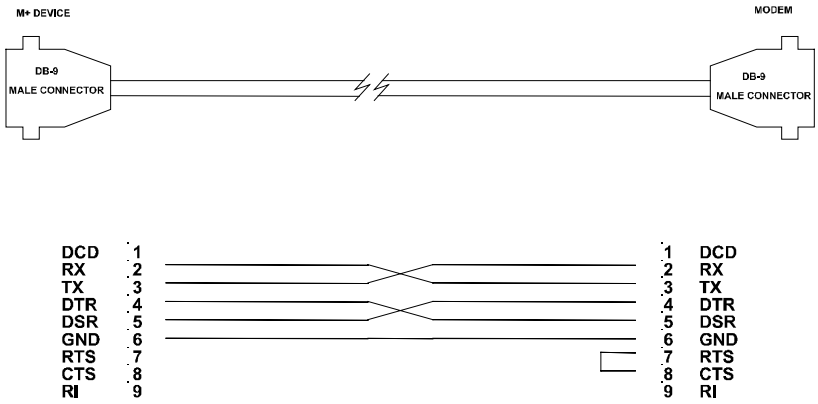


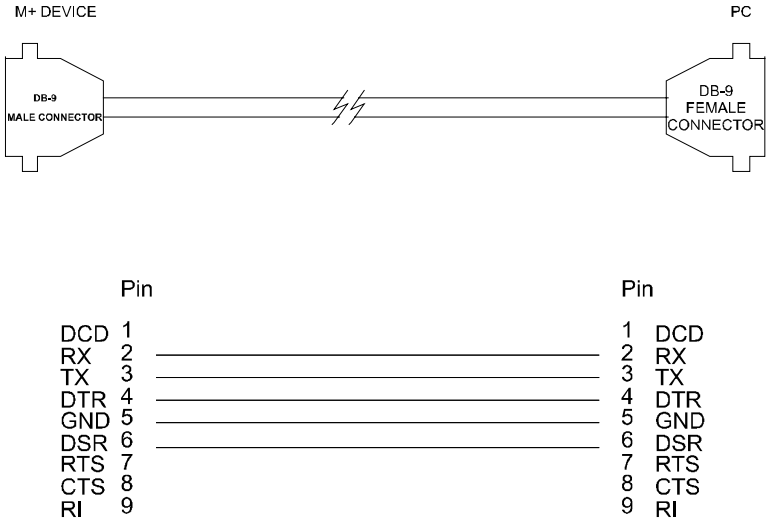
Figure 3-9 PCB SCHEME SHOWING THE JUMPERS TO CONFIGURE THE OUTPUT CONTACTS (NC / NO)

3.2.6. RS232 FACEPLATE COMMUNICATIONS PORT

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 3-10 shows the communications cable configuration.



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



RELAY - PC CONNECTION WIRE FOR RS-232 FRONT PORT

Figure 3-10 RS232 FACEPLATE PORT CONNECTION

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.

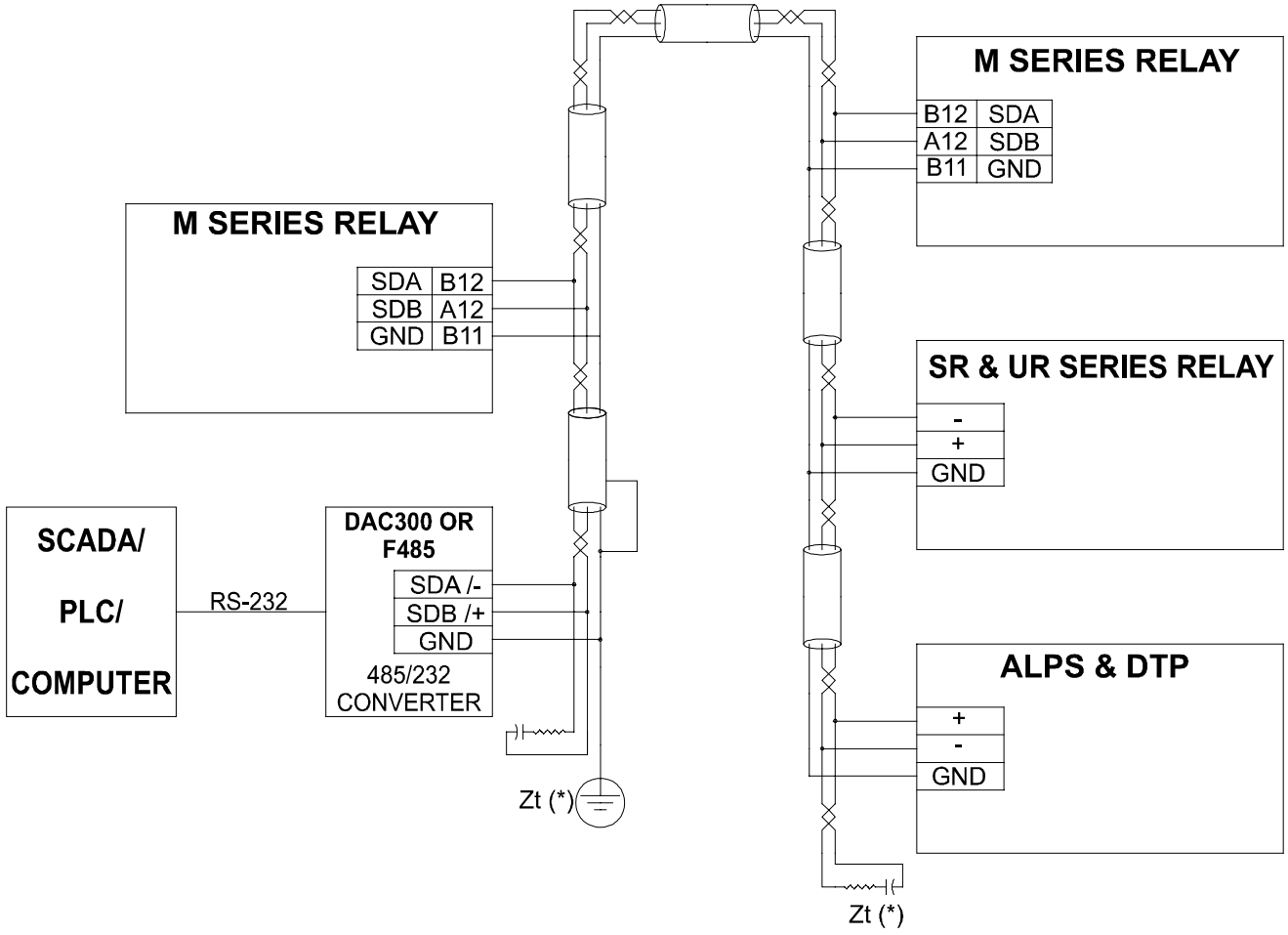


Figure 3-10 RS485 SERIAL CONNECTION (B6366H5)

4. HUMAN INTERFACE

4.1. M+PC SOFTWARE INTERFACE

The M+PC software provides a graphical user interface (GUI) as one of two Human interfaces to a MIG 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 MIG relay, locally or remotely, using a modem and the telephone line. In off-line mode, you can prepare a file of the device's parameter settings for eventual downloading to the device. Another application of the off-line mode is personal training on the relay. In on-line mode, you can communicate with the device in real-time, access to all the information in the device, modify settings, retrieve registered data and perform commands.

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

4.1.1. STARTING THE PROGRAM

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

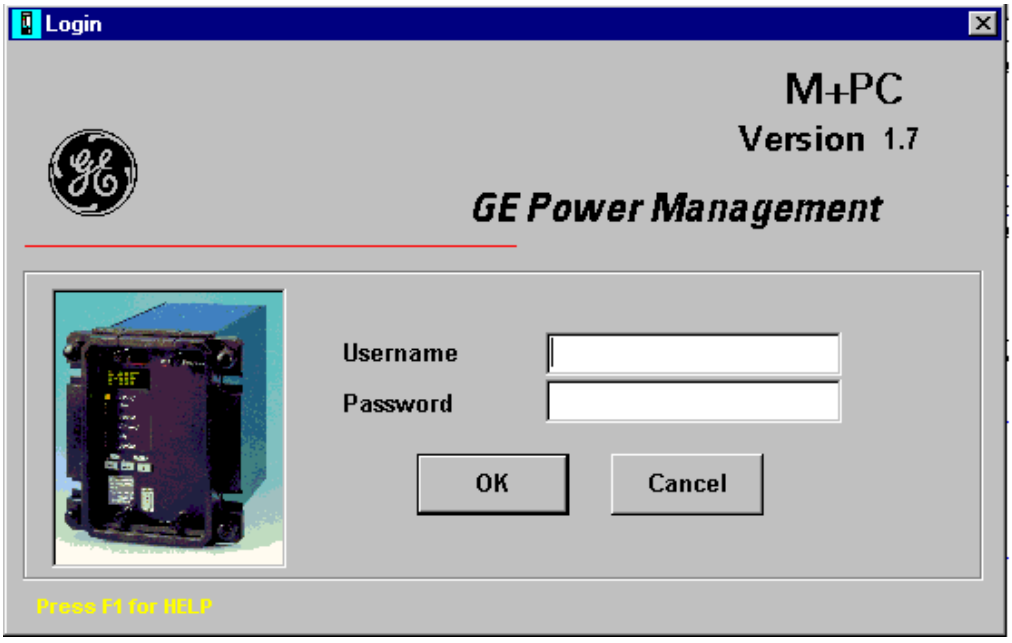


Figure 4.1: STARTING THE PROGRAM

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

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.

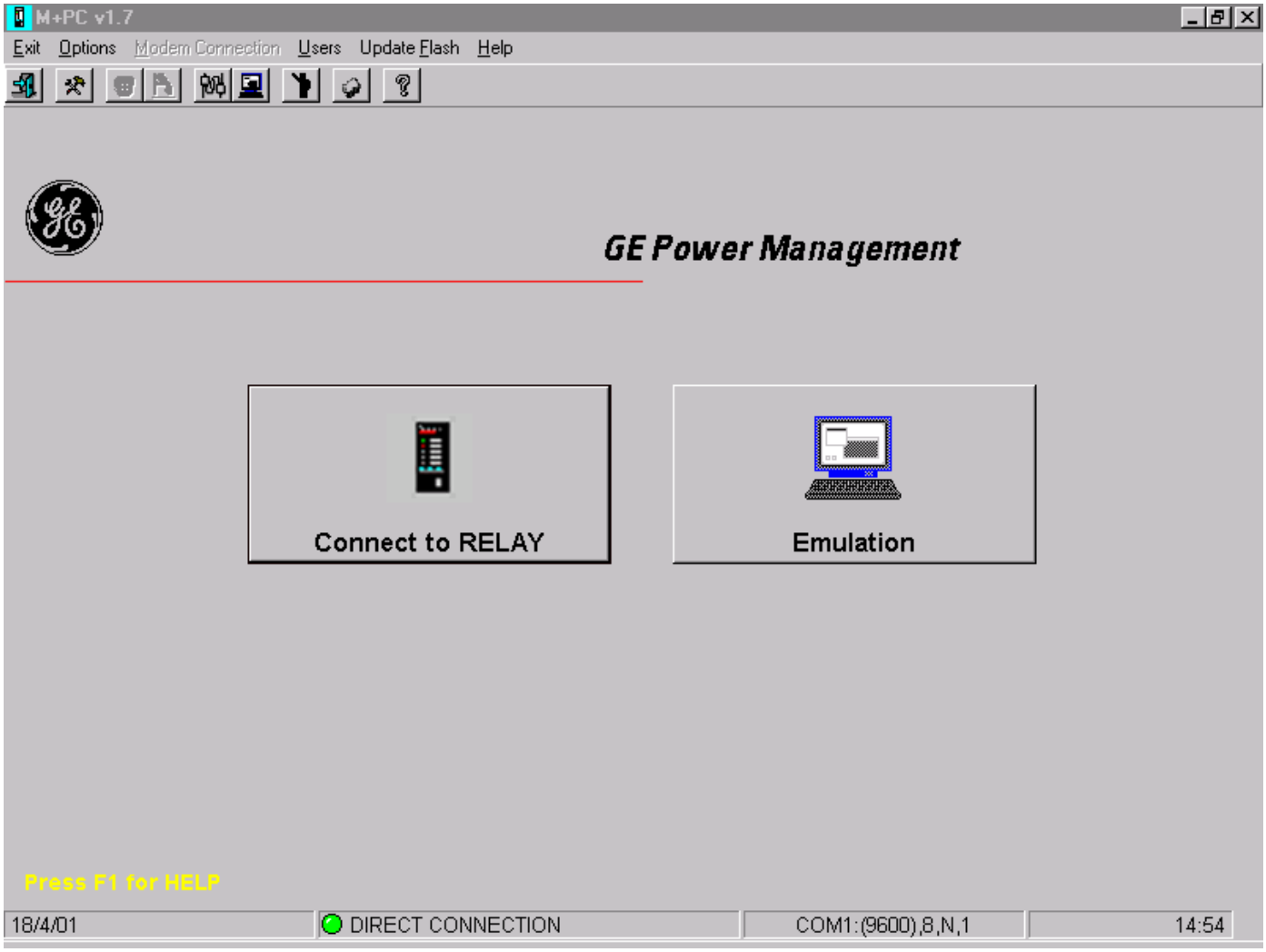


Figure 4.2: START WINDOW

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

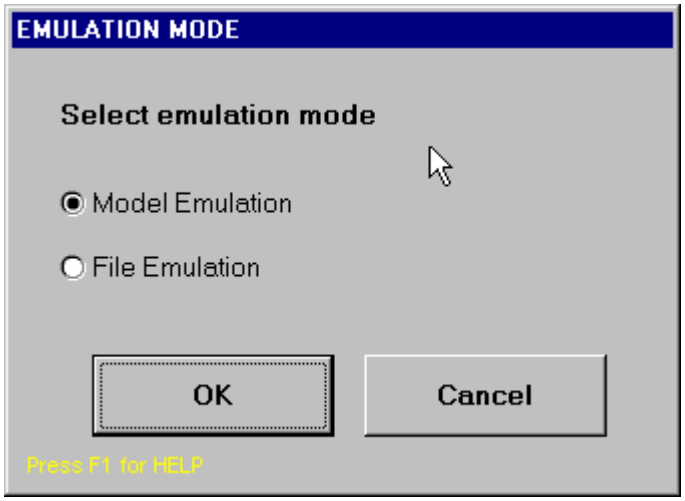
The EMULATION mode allows to simulate the connection to a particular relay even if the physical relay is not available. This mode allows the user to:

- 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:

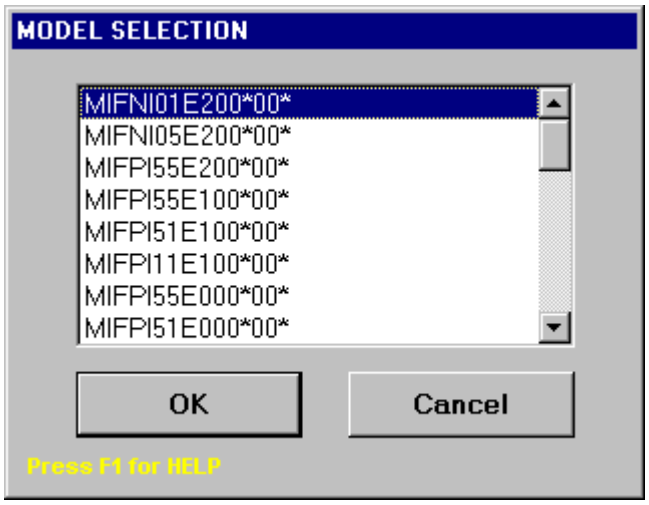
1. Model Emulation.
2. File Emulation.



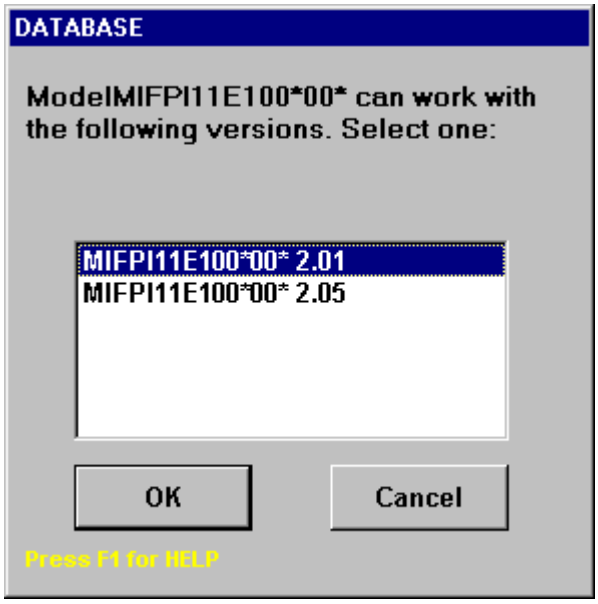
The following sections detail the operation of each model:

4.1.3.1. MODEL EMULATION.

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



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



4.1.3.2. FILE EMULATION.

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

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

4.1.4. OPTIONS MENU

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

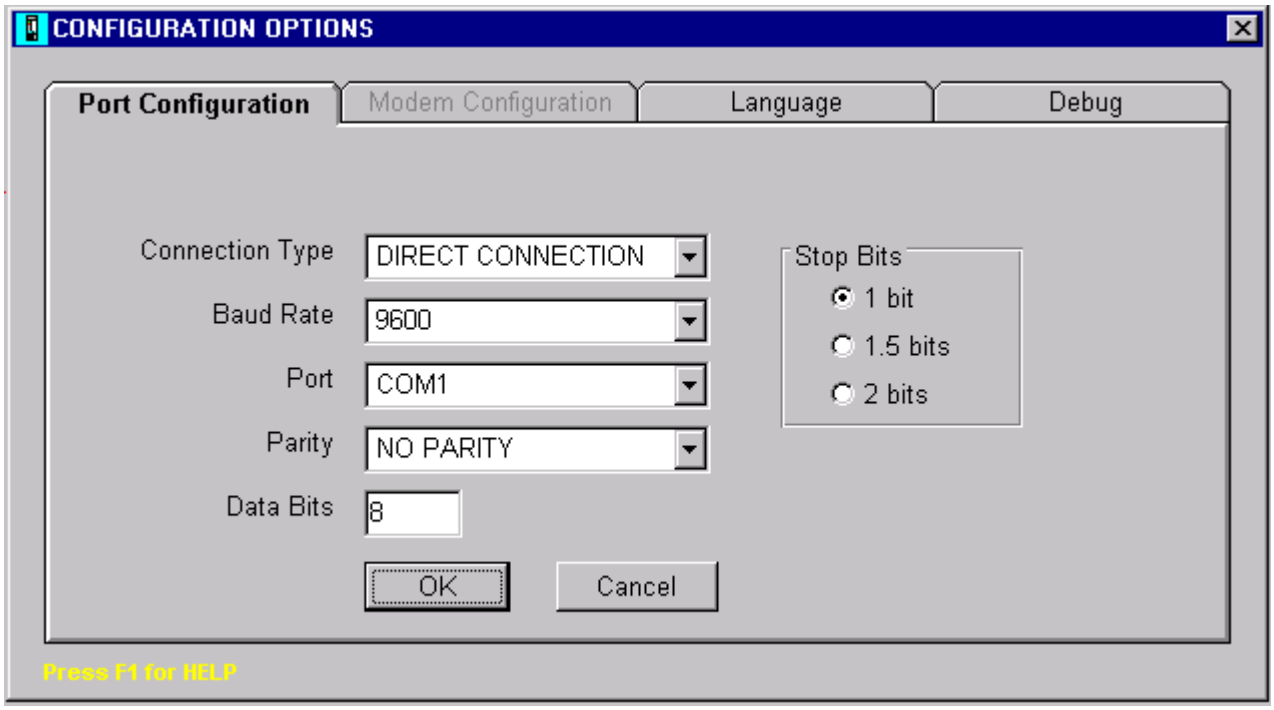


Figure 4.3: OPTIONS MENU - PORT CONFIGURATION TAB.

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

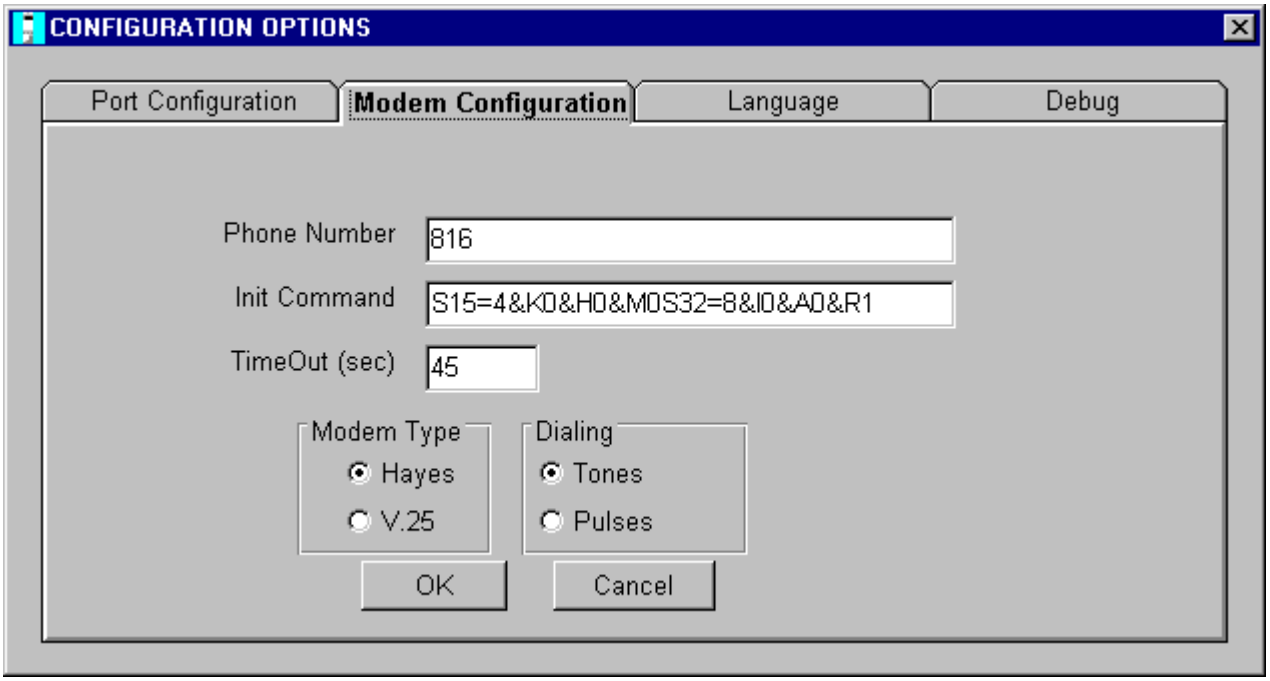


Figure 4.4: OPTIONS MENU - MODEM CONFIGURATION TAB

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

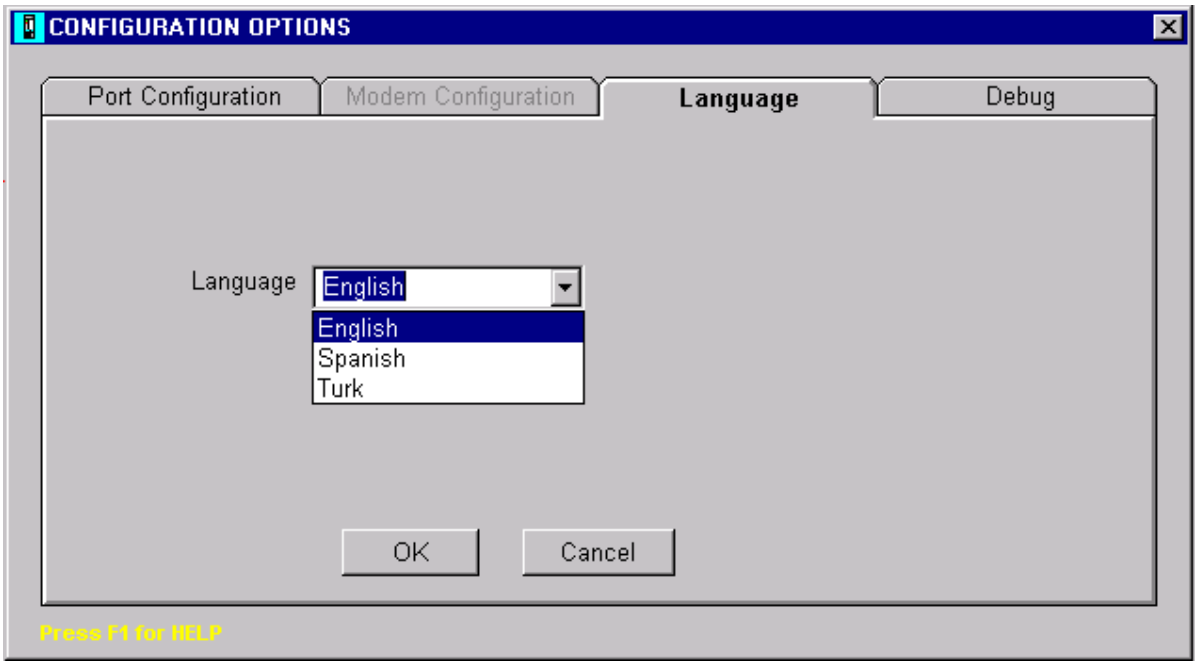


Figure 4.5: OPTIONS MENU - LANGUAGE TAB

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

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

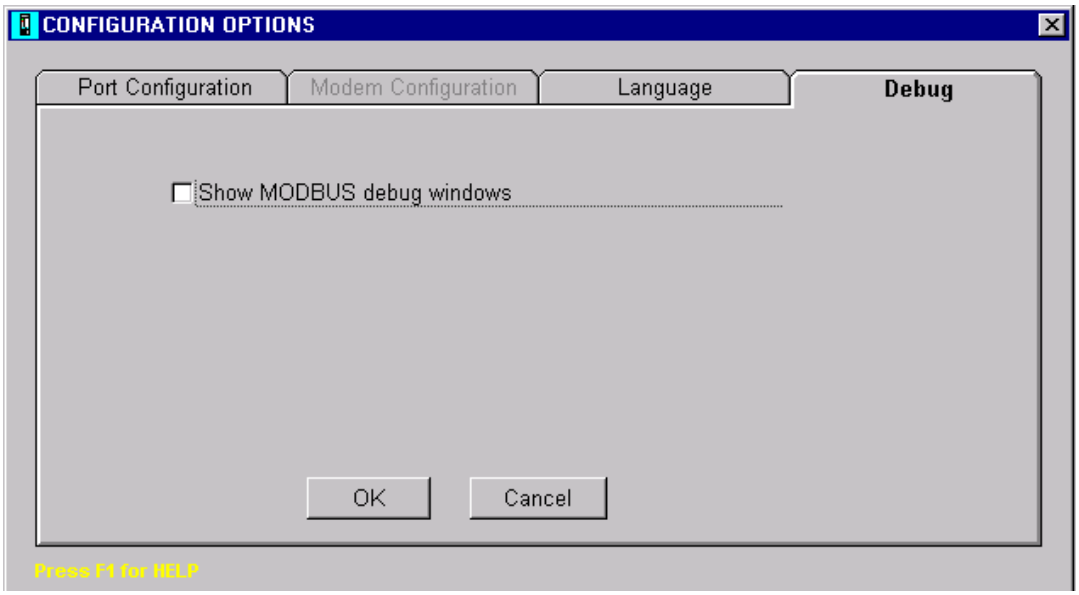


Figure 4.6: OPTIONS MENU - DEBUG TAB.

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.

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

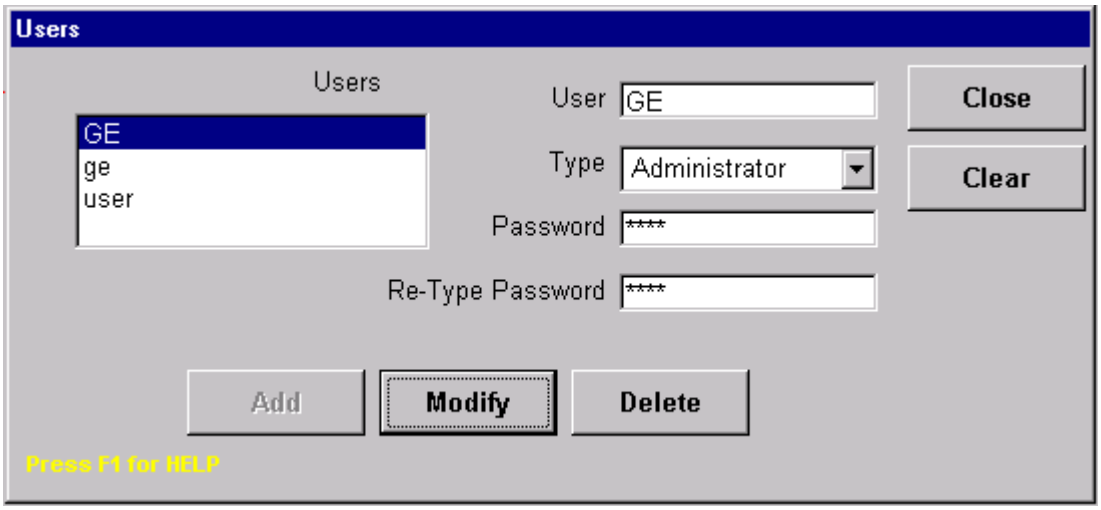


Figure 4.7: USERS MANAGEMENT.

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

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

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

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

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

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

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

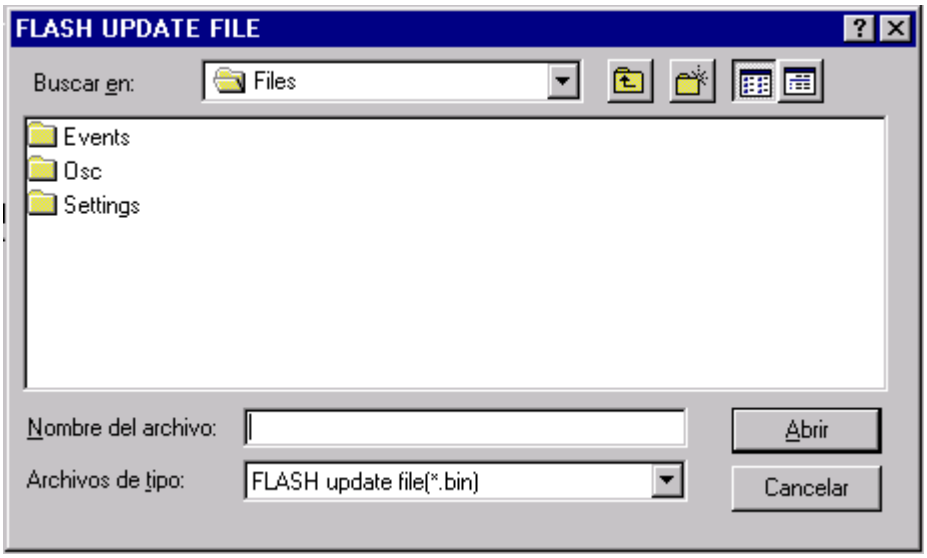
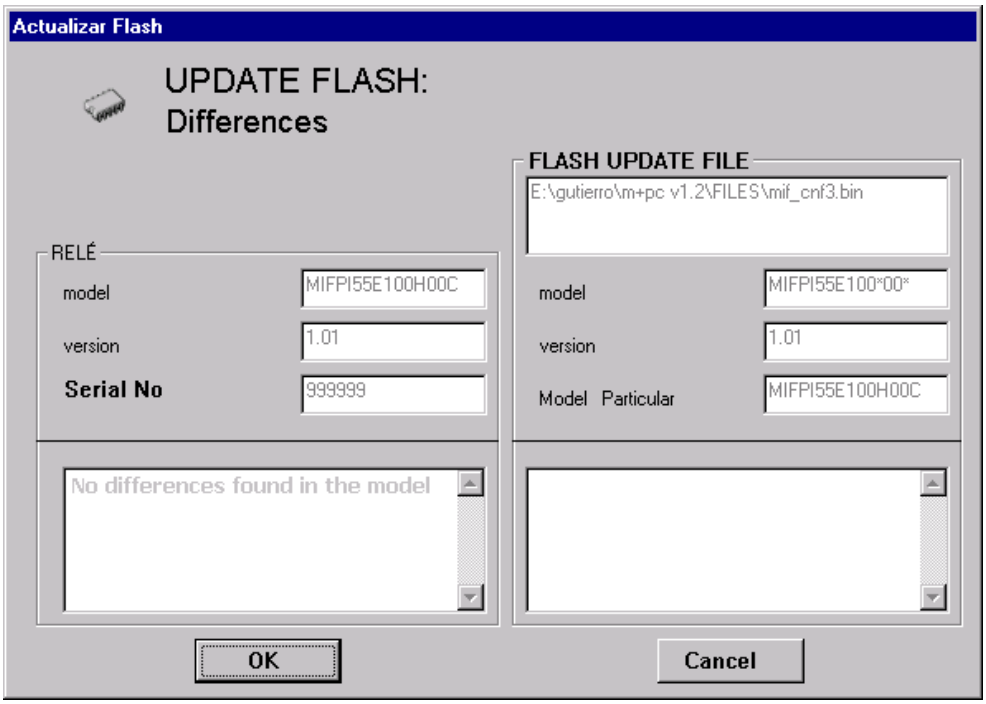


Figure 4.8. FLASH MEMORY UPDATE

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



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

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

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

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

We must take into account that the Flash memory update may involve a change in the MODBUS® memory map, 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 MIG 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:

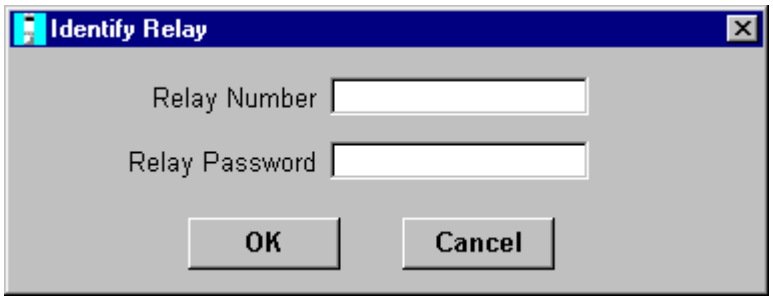


Figure 4.9: DEVICE IDENTIFICATION WINDOW

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 MIG Feeder protection relay, the device information shown is:
- Phase and Ground Actual Current Metering.
- Status of the Target LEDs located on the faceplate of the relay.
- Status of all the Contact Inputs and Outputs (the active status is shown in red, and the inactive status in green).
- Date and Time in the relay.

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

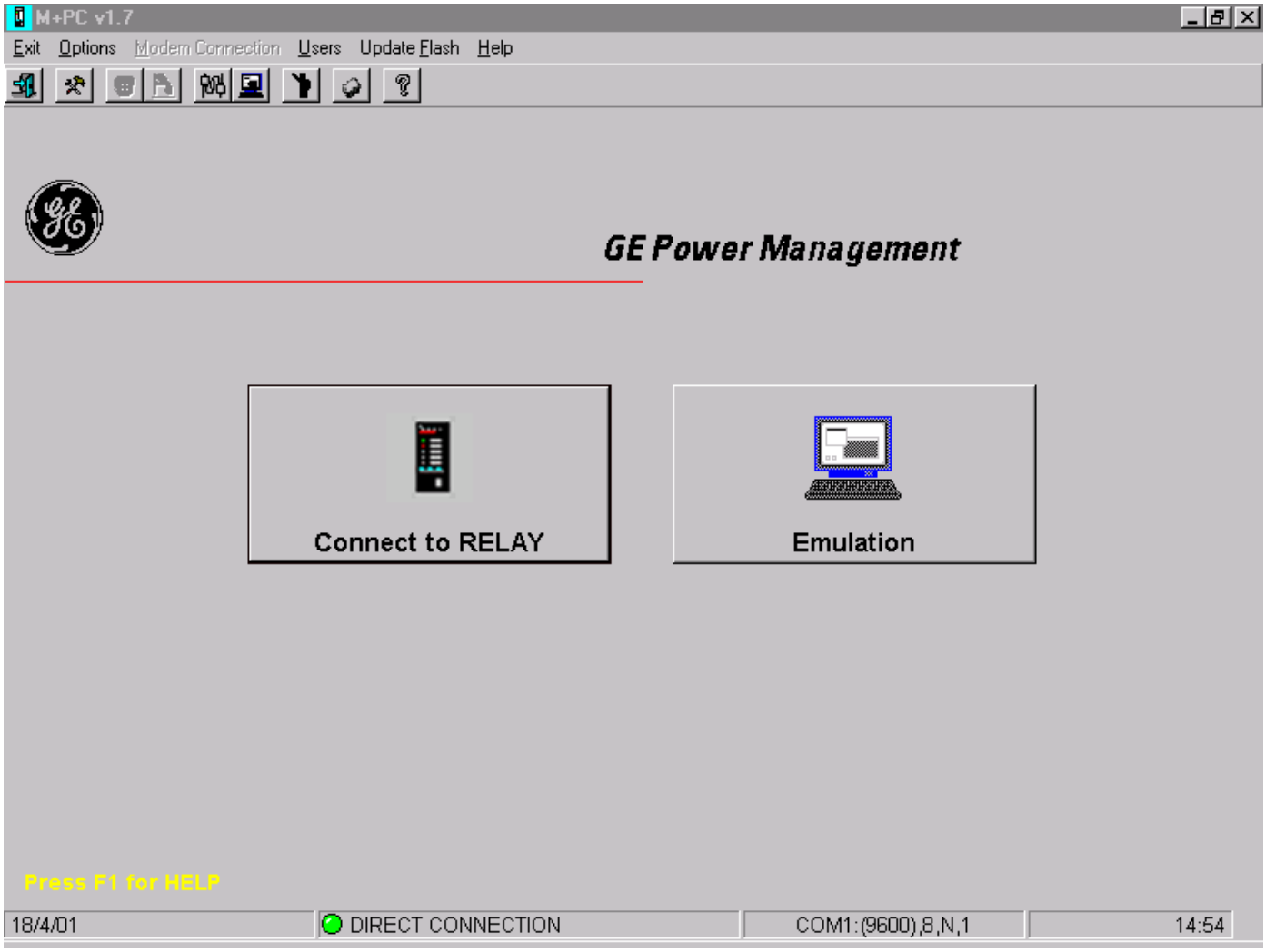


Figure 4.10 MAIN WINDOW (FRONT VIEW)

- The Status bar, on the lower part of the window shows the operation more (Relay Connection or Emulation). It also shows the name of the settings file open (if any) and the version of the program. For those processes that require retrieving big pieces of information from the relay and take long communication time, a percentage bar is shown to let the user follow it up.

- On the right hand side of the window there are a set of buttons that allow access to all the information in the relay. Clicking on any of these buttons, a new sub-set of buttons, associated to the button clicked, will be shown. A complete description of all these set and sub-set of buttons is given in following sections in this instruction manual.

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

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

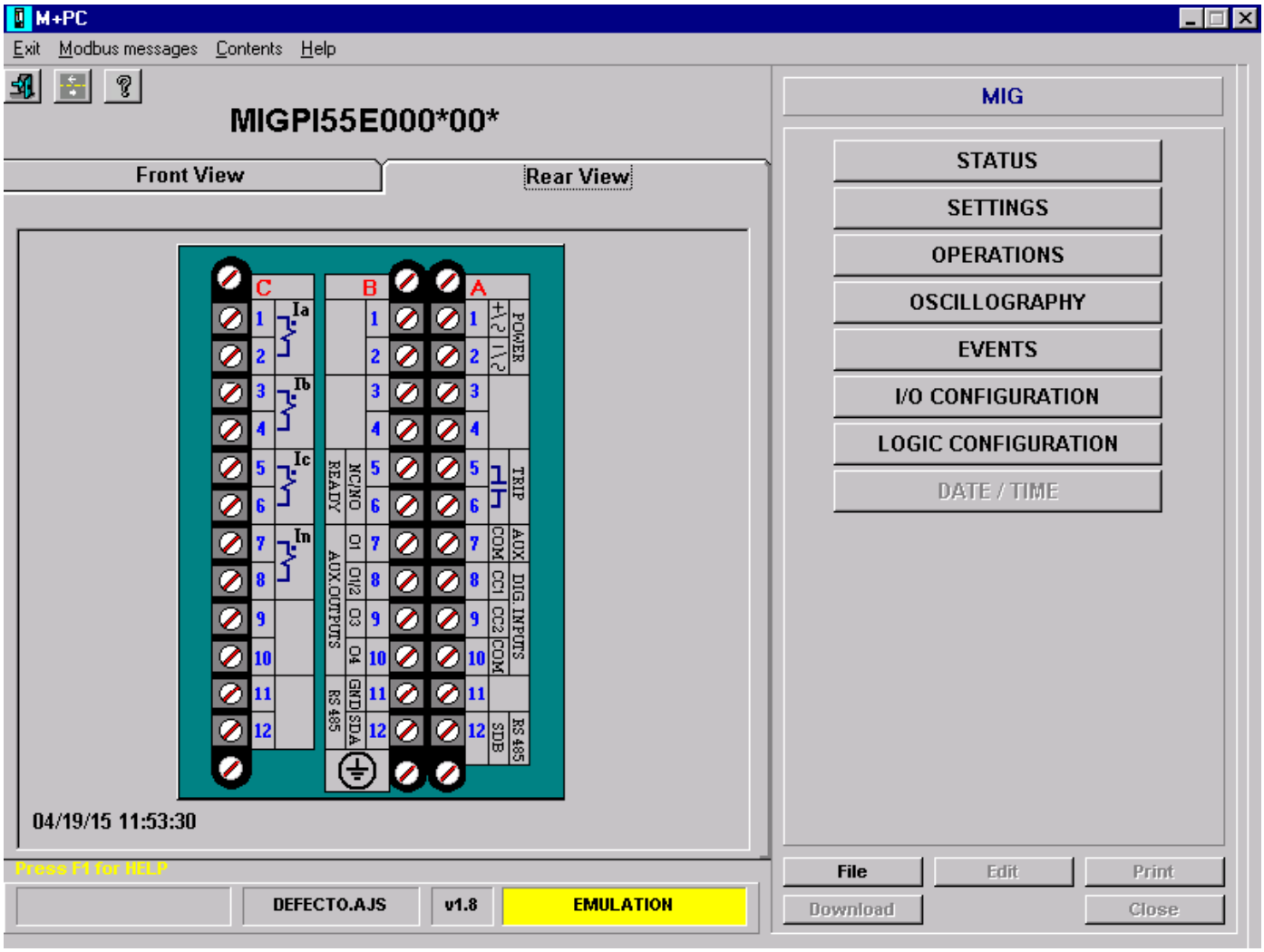


Figure 4.11: MAIN WINDOW (REAR VIEW).

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

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

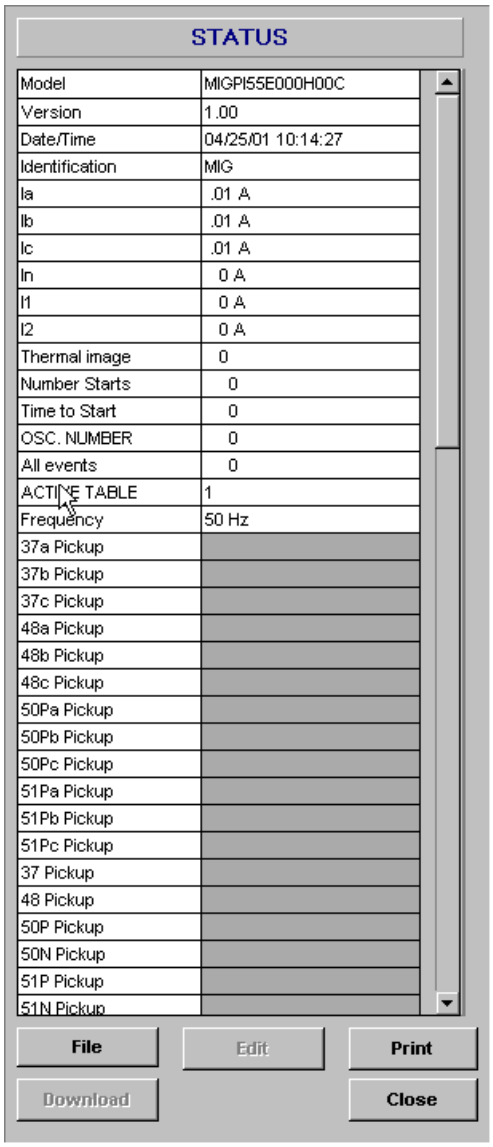


Figure 4.12: TABLE SHOWING INTERNAL RELAY STATUS.

4.1.10. SETTINGS MENU

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

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

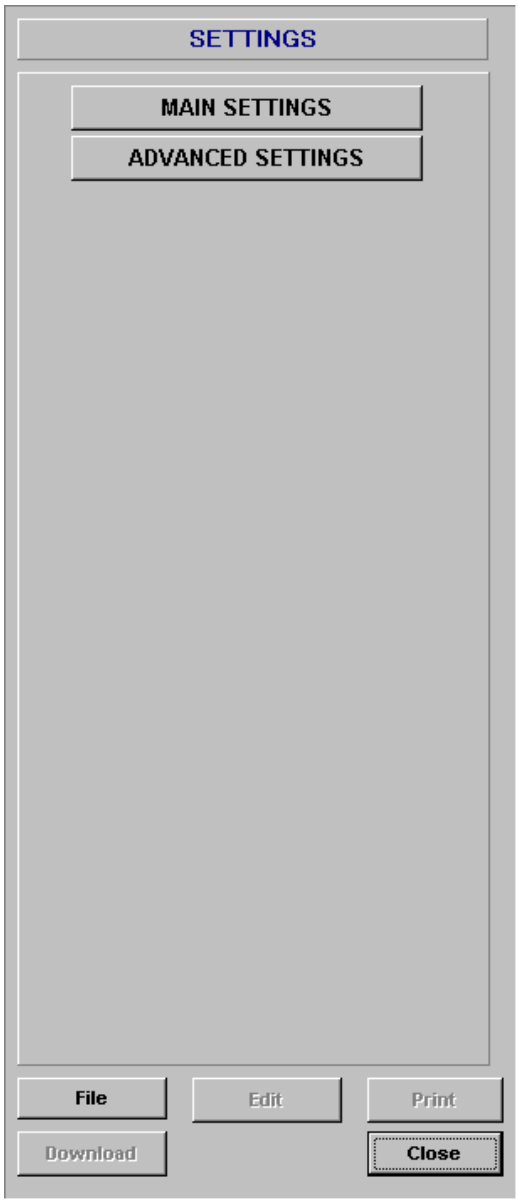


Figure 4.13: SETTINGS MENU.

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

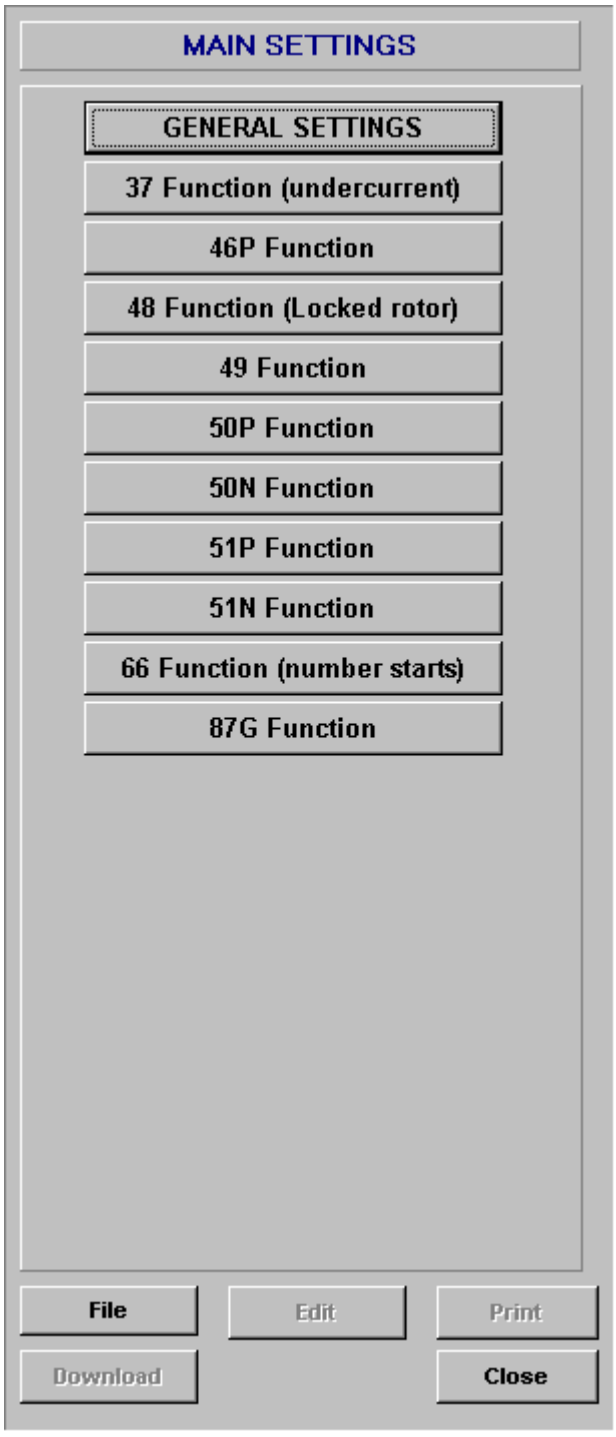


Figure 4.14: MAIN SETTINGS.

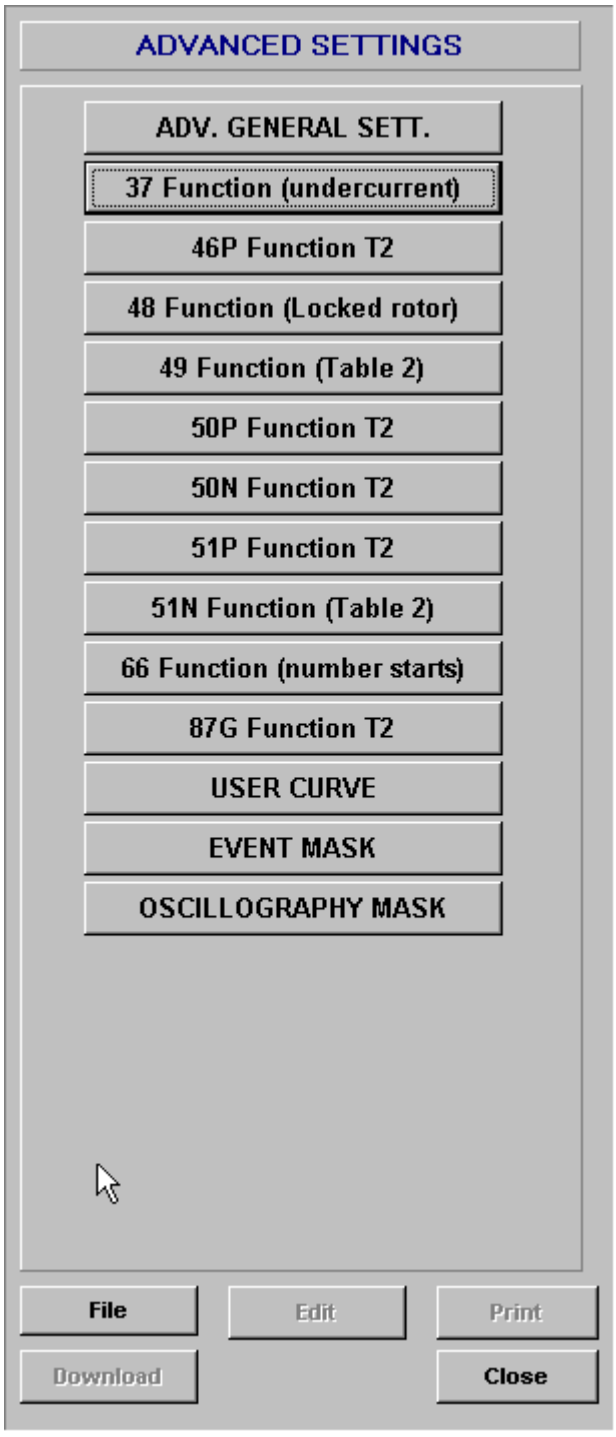


Figure 4.15: ADVANCED SETTINGS.

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

- Select the settings group (in the example, the 51P Function in a MIG 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).

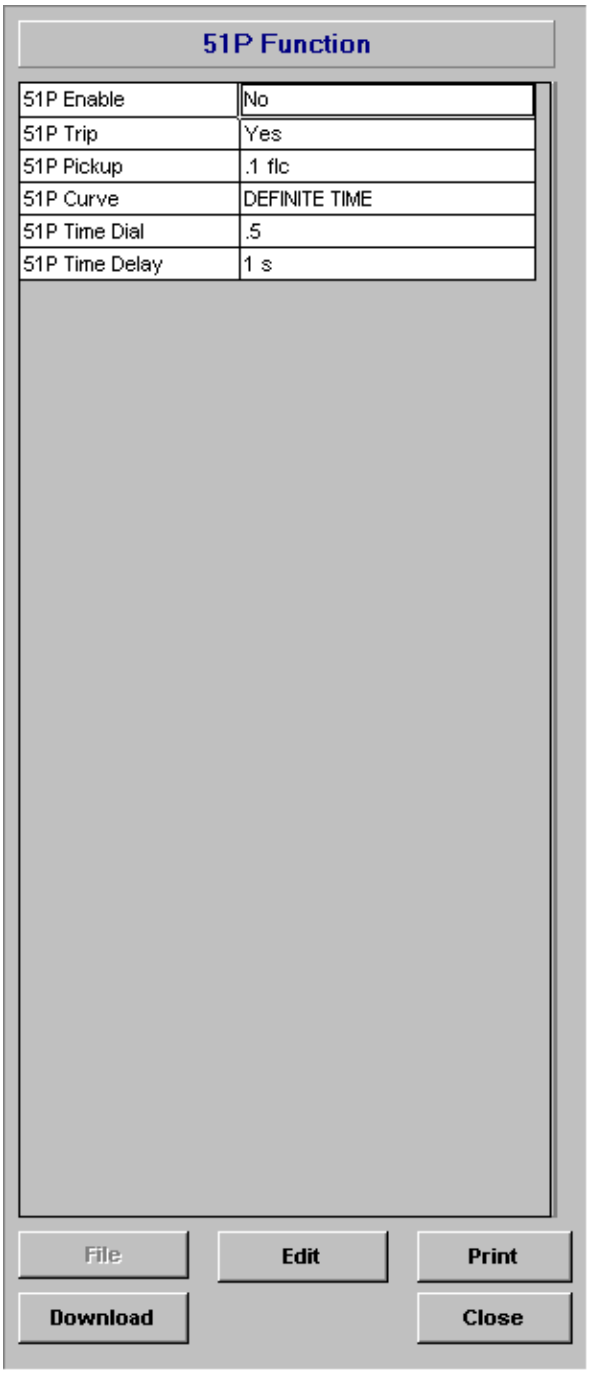


Figure 4.16: SETTINGS SUB-MENU FOR 51P FUNCTION.

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.

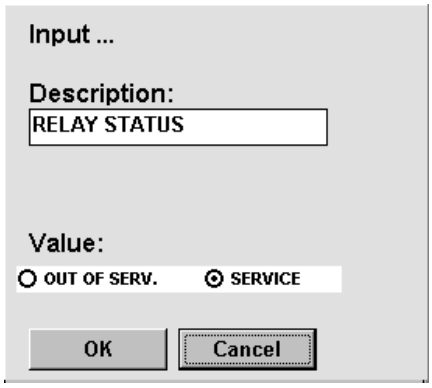


Figure 4.17: LOGIC SETTING

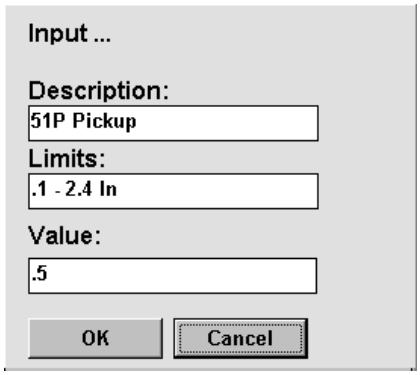


Figure 4.18: NUMERIC SETTING

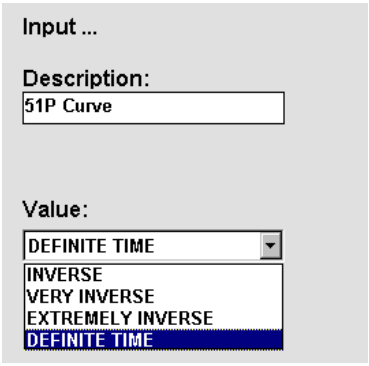


Figure 4.19: SET OF OPTIONS

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.

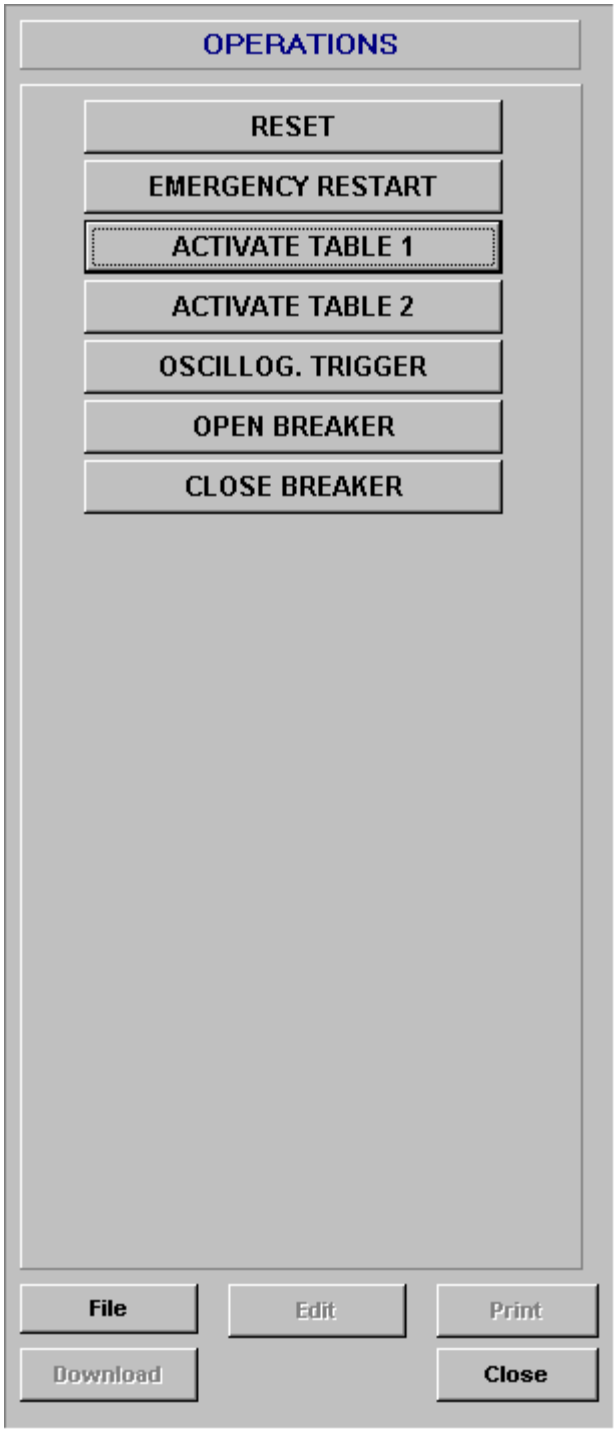
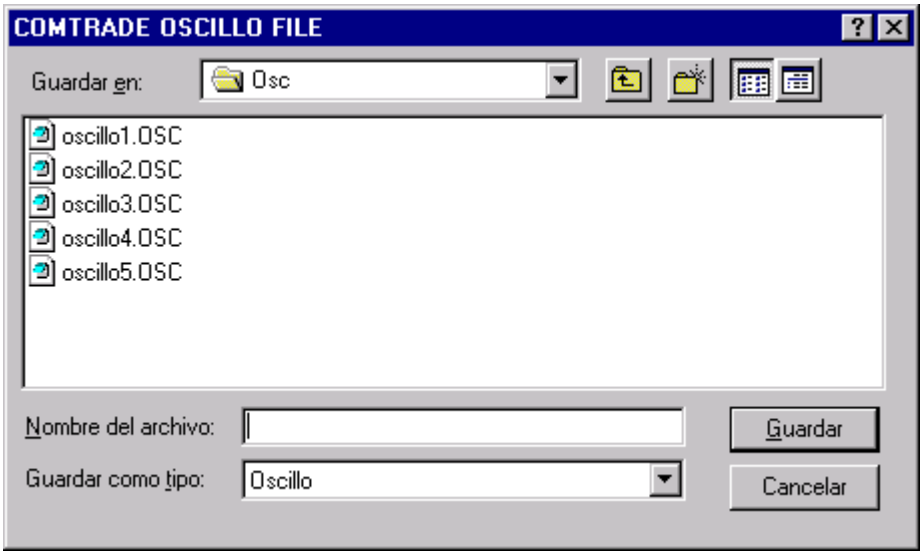


Figure 4.20: OPERATIONS MENU.

4.1.13. OSCILLOGRAPHY MENU

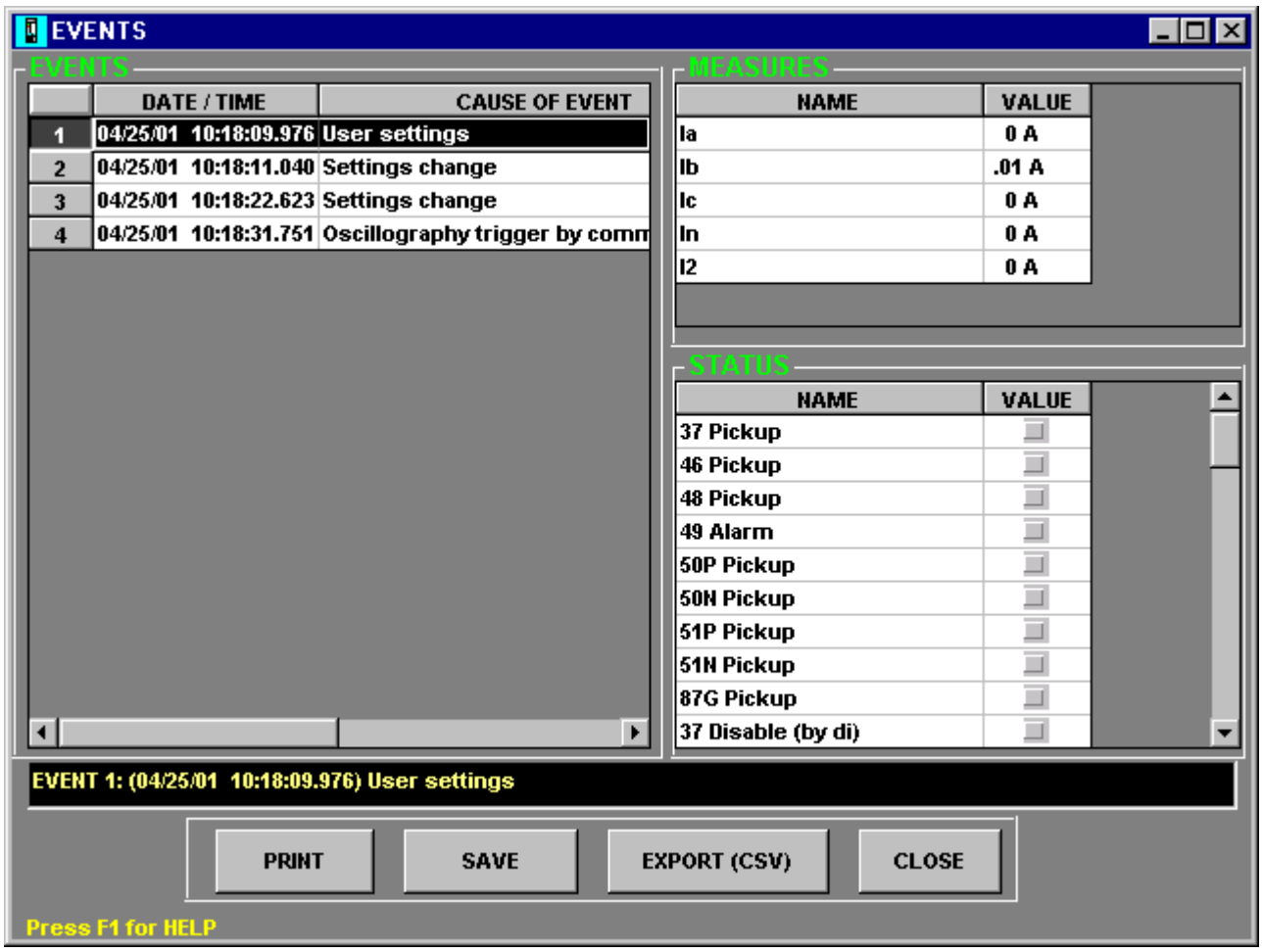
By clicking on the OSCILLOGRAPHY button in the MAIN MENU, the user can start the process to retrieve the Oscillography record stored in the MIG. The program will request the path and filename where the file is to be stored, by means of the following form:



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

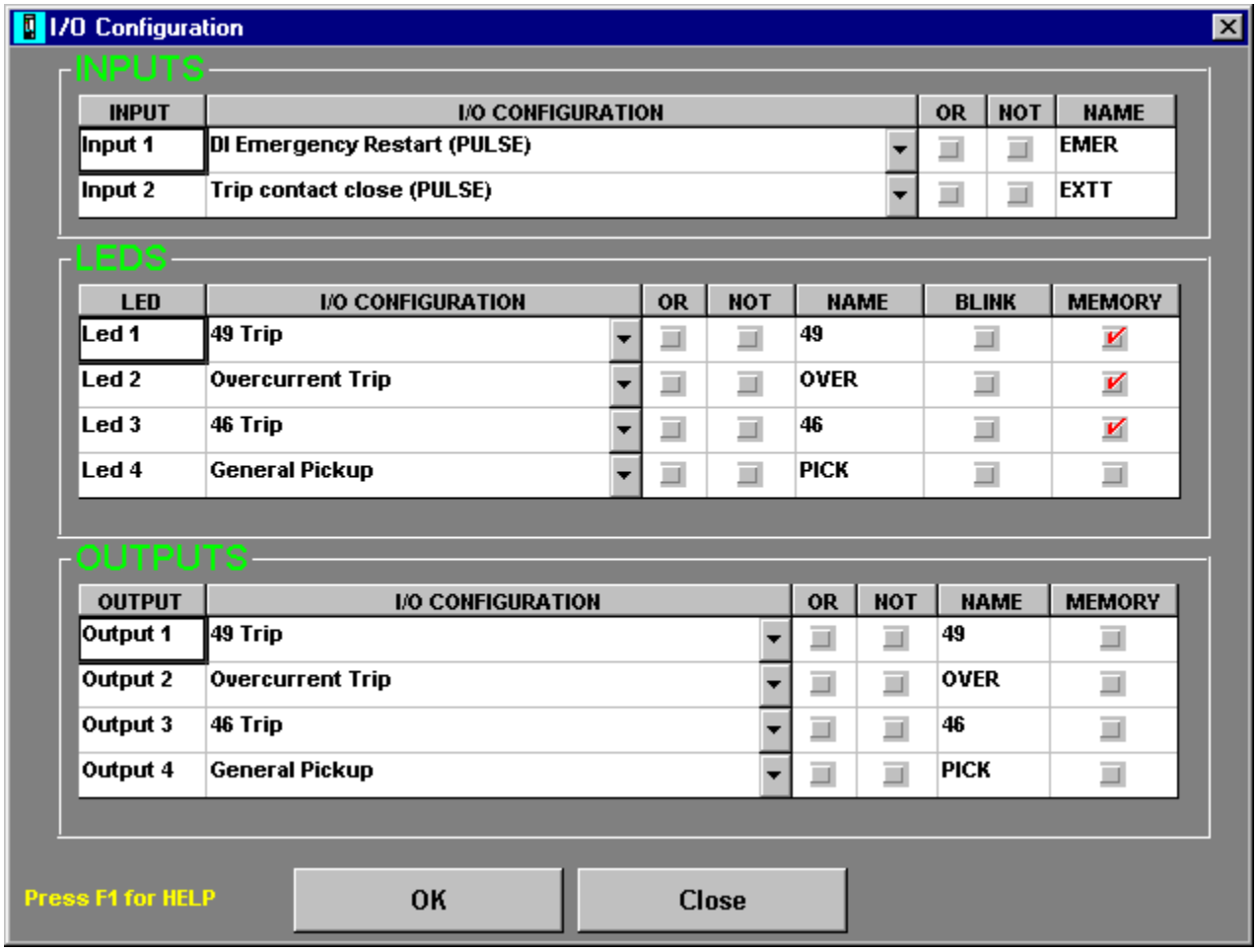
By clicking on the EVENTS button in the MAIN MENU, all the stored events will be retrieved (up to 32). Each event record is labelled with date, time (with 4msec. resolution), the cause of the event (pickup, trip of a certain function, etc.), and a list of the status of all inputs, outputs and functions during the event. Additionally, the current values for all phases and ground during the event are also shown.



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

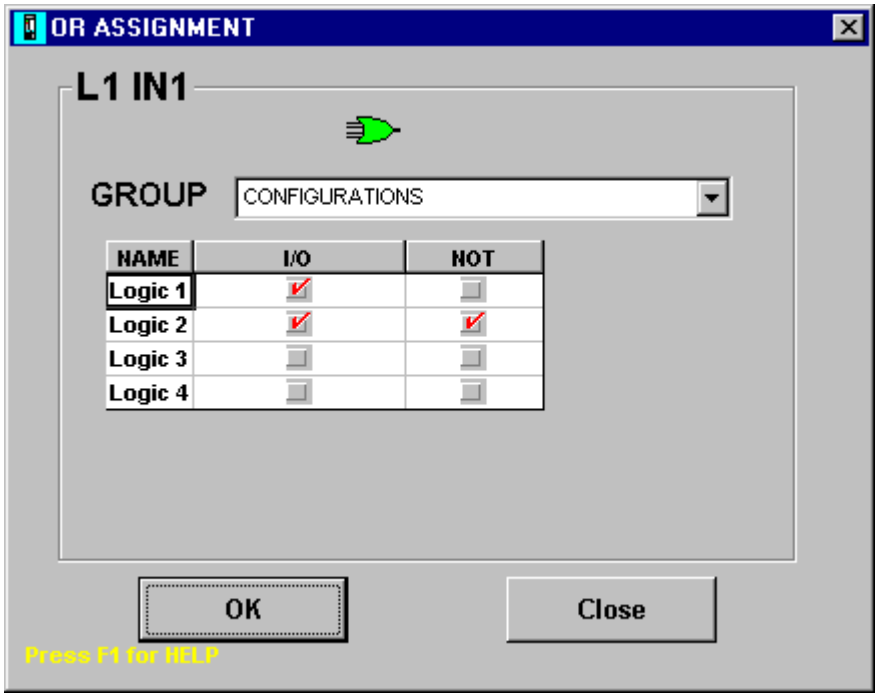
In this menu, the user can configure inputs, outputs and LEDs.

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. SETTINGS

5.1. SETTINGS STRUCTURE

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

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

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

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

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

Check that the relay number and password in the MIG 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
Full Load Current	FLC	FLC	1.00	0.1-2.4 A	0.01
			5.00	0.5-10 A	0.01
Password	---	PWD	1	1 - 255	
Address	---	ADD	1	1 - 255	1
Communication Baudrate	---	BAUD	9600	300, 600, 1200, 2400, 4800, 9600, 19200	NA

5.2.2. PHASE / GROUND TOC SETTINGS (51P / 51N)

	M+PC	HMI	DEFAULT	RANGE	STEP
Phase TOC Function	**51P Function**	**F51P**			
51P Enable	Enable	Enable	NO	Y/N	NA
51P Permission to Trip	51P Trip Permission	TRIP 51P	No	Y/N	NA
51P Tap / Pickup Value	51P Pickup	TAP 51P	0.1 FLC	0.1-2.4 FLC (Ph)	0.01
51P Curve Type	51P Curve Type	CURV 51P	T.DE	INV, V.I., E.I., T.DE, USU	NA
51P Time Dial	51P Time Dial	DIAL 51P	0.5	0.05 - 2.00 (IEC curves)	0.01
			5	0.5 - 20.0 (ANSI curves)	0.01
51P Definite Time Delay	51P Definite Time	TIME 51P	1 s.	0 - 99.99 s.	0.01 s.
Ground TOC Function	**51N Function**	**F51N**			
51N Enable	Enable	Enable	NO	Y/N	NA
51N Permission to Trip	51N Trip Permission	TRIP 51N	No	Y/N	NA
51N Tap / Pickup (for 1/5 A ground)	51N Pickup	TAP 51N	0.1 In (Ground)	0.1 - 2.4 In (Gnd)	0.01 In (Gnd)
51N Tap / Pickup (for sensitive ground)	51N Pickup	TAP 51N	0.005 A	0.005-0.12 A	0.001 A
51N Curve Type	51N Curve Type	CURV 51N	T.DE	INV, V.I., E.I., T.DE, USU	NA
51N Time Dial	51N Time Dial	DIAL 51N	0.5	0.05 - 2.00 (IEC curves)	0.01
			5	0.5 - 20.0 (ANSI curves)	0.01
51N Definite Time Delay	51N Definite Time	TIME 51N	1 s.	0 - 99.99 s.	0.01 s.

5.2.3. PHASE / GROUND IOC SETTINGS (50P / 50N)

	M+PC	HMI	DEFAULT	RANGE	STEP
Phase IOC Setting	**50P Function**	**F50P**			
50P Enabling	Enable	Enable	NO	Y/N	NA
50P Permission to Trip	50P Trip Permission	TRIP 50P	No	Y/N	NA
50P Tap / Pickup	50P Pickup	TAP 50P	In (Phase)	0.1 - 30 FLC	0.1
50P Time Delay	50P Time Delay	TIME 50P	0 s.	0 - 99.99 s.	0.01 s.
Ground IOC Setting	**50N Function**	**F50N**			
50N Enabling	Enable	Enable	NO	Y/N	NA
50N Permission to Trip	50N Trip Permission	TRIP 50N	No	Y/N	NA
50N Tap / Pickup (for 1/5 A ground)	50N Pickup	TAP 50N	1 In (Ground)	0.1 - 30 In (Gnd)	0.1 In (G)
50N Tap / Pickup (for sensitive ground)	50N Pickup	TAP 50N	0.005 A	0.005-0.12 A	0.01 A 0.02
50N Time Delay	50N Time Delay	TIME 50N	0 s.	0 - 99.99 s.	0.01 s.

5.2.4. UNDERCURRENT SETTINGS (37)

	M+PC	HMI	DEFAULT	RANGE	STEP
Undercurrent Setting	**37 Function**	**F37**			
37 Enabling	Enable 37	Enable 37	NO	Y/N	NA
37 Permission to Trip	37 Trip Permission	TRIP 37	No	Y/N	NA
37 Tap / Pickup	37 Pickup	TAP 37	0.1 In	0.1 – 0.99 FLC	0.1
37 Time Delay	37 Time Delay	TIME 37	1 s.	0 - 99.99 s.	0.01 s.

5.2.5. CURRENT UNBALANCE SETTINGS (46P)

	M+PC	HMI	DEFAULT	RANGE	STEP
Current Unbalance Setting	**46P Function**	**F46P**			
46P Enabling	Enable 46P	Enable 46P	NO	Y/N	NA
46P Permission to Trip	46P Trip Permission	TRIP 46P	No	Y/N	NA
46P Tap / Pickup	46P Pickup	TAP 46P	0.1 In	0.05 – 0.99 FLC	0.01
Type of curve 46P	Curve 46P	CURV 46P	TDEF	TDEF/CURVA	NA
Constant K	K 46P	K 46P	1	1-100	1
Definite time 46P	Definite Time 46P	TIME 46P	0.1 s.	0 - 99.99 s.	0.01 s.

5.2.6. LOCKED ROTOR (48)

	M+PC	HMI	DEFAULT	RANGE	STEP
Locked Rotor Setting	**48 Function**	**F48**			
48 Enabling	Enable 48	Enable 48	NO	Y/N	NA
48 Permission to Trip	48 Trip Permission	TRIP 48	No	Y/N	NA
48 Tap / Pickup	48 Pickup	TAP 48	1.01 FLC	1.01 – 10 FLC	0.01
48 Time Delay	48 Time Delay	TIME 48	0.1 s.	0.10 - 99.99 s.	0.01 s.

5.2.7. THERMAL IMAGE SETTINGS (49)

	M+PC	HMI	DEFAULT	RANGE	STEP
Thermal Image (49)	**49 Function**	**F49**			
F49 Enabling	Enable 49	ENABLE	NO	Y/N	NA
Permission to Trip	49 Trip Permission	TRIP 49	NO	Y/N	NA
49 Tap / Pickup (on FLC)	49 Pickup	TAP 49	1 In	0.1 - 2.4 FLC	0.01
Overload Percent Alarm	49 Alarm Level	ALARM 49	80 %	70% - 100% ITH	1%
Heating Time Constant $\tau 1$	T1	T1	6 min	3 - 600 min.	1 min
Cooling Time Constant $\tau 2$	T2	T2	$1\tau 1$	1 - 6 times $\tau 1$	1
K1 Constant	K1	K1	1	1 – 8	1

5.2.8. MAXIMUM NUMBER OF STARTS (66)

	M+PC	HMI	DEFAULT	RANGE	STEP
Maximum number of starts	**66 Function**	**F66**			
66 Enabling	Enable 66	Enable 66	NO	Y/N	NA
66 Permission to Operate	66 Oper. Permission	OPER 66	NO	Y/N	NA
No. Starts per hour	No. Starts	No START	5	0-10	1
Block reset time (STOP-START)	Restart Time	TTR	10 min	0 – 100 min	1

5.2.9. RESTRICTED GROUND DIFFERENTIAL (87R)

	M+PC	HMI	DEFAULT	RANGE	STEP
Restricted Ground Differential	**87R Function**	**F87R**			
87R Enabling	Enable 87R	Enable 87R	NO	Y/N	NA
87R Permission to Trip	87R Trip Permission	TRIP 87R	No	Y/N	NA
Differential current (I_{diff})	S 87R	S 87R	0.3 In	0.02 – 0.3 In	0.01 In
Percentage slope (K)	K	K	10	1-100	1
87R Time Delay	T	T	0.0 s.	0.0 - 99.99 s.	0.01 s.

5.3. ADVANCED SETTINGS

5.3.1. GENERAL SETTINGS

	M+PC	HMI	DEFAULT	RANGE	STEP
GENERAL ADVANCED SETTINGS	**GENERAL ADVANCED SETTINGS**	**GENERAL ADVANCED**			
Identification	IDENTIFICATION	---	MIG	Text	NA
Active Table	ACTIVE TABLE	TAB	1	1-2	NA
Minimum tripping time	MIN TRIP TIME	MIN TRIP TIME	100 ms	50-300 ms	1 ms

5.3.2. PHASE / GROUND TOC SETTINGS (51P / 51N) (TABLE 2)

	M+PC	HMI	DEFAULT	RANGE	STEP
Phase TOC Function Table 2	**51P Function T2**	**F51P T2**			
51P Enable Table 2	Enable T2	Enable T2	NO	Y/N	NA
51P Permission to Trip Table 2	51P Trip Permission T2	TRIP 51P T2	No	Y/N	NA
51P Tap / Pickup Value Table 2	51P Pickup T2	TAP 51P T2	0.1 In (Phase)	0.1-2.4 FLC (Ph)	0.01
51P Curve Type Table 2	51P Curve Type	CURV 51P	T.DE	INV, V.I., E.I., T.DE, USU	NA
51P Time Dial Table 2	51P Time Dial T2	DIAL 51P T2	0.5	0.05 - 2.00 (IEC curves)	0.01
			5	0.5 - 20.0 (ANSI curves)	0.01
51P Definite Time Delay Table 2	51P Definite Time T2	TIME 51P T2	1 s.	0 - 99.99 s.	0.01 s.
Ground TOC Function Table 2	**51N Function**	**F51N**			
51N Enable Table 2	Enable T2	Enable T2	NO	Y/N	NA
51N Permission to Trip Table 2	51N Trip Permission T2	TRIP 51N T2	No	Y/N	NA
51N Tap / Pickup (for 1/5 A ground) Table 2	51N Pickup T2	TAP 51N T2	0.1 In (Ground)	0.1 - 2.4 In (Gnd)	0.01 In (Gnd)
51N Tap / Pickup (for sensitive ground) Table 2	51N Pickup T2	TAP 51N T2	0.005 A	0.005-0.12 A	0.001 A
51N Curve Type Table 2	51N Curve Type T2	CURV 51N T2	T.DE	INV, V.I., E.I., T.DE, USU	NA
51N Time Dial Table 2	51N Time Dial T2	DIAL 51N T2	0.5	0.05 - 2.00 (IEC curves)	0.01
			5	0.5 - 20.0 (ANSI curves)	0.01

	M+PC	HMI	DEFAULT	RANGE	STEP
51N Definite Time Delay Table 2	51N Definite Time T2	TIME 51N T2	1 s.	0 - 99.99 s.	0.01 s.

5.3.3. PHASE / GROUND IOC SETTINGS (50P / 50N)

	M+PC	HMI	DEFAULT	RANGE	STEP
Phase IOC Setting Table 2	**50P Function T2**	**F50P T2**			
50P Enabling Table 2	Enable T2	Enable T2	NO	Y/N	NA
50P Permission to Trip Table 2	50P Trip Permission T2	TRIP 50P T2	No	Y/N	NA
50P Tap / Pickup Table 2	50P Pickup T2	TAP 50P T2	In (Phase)	0.1 - 30 FLC	0.1
50P Time Delay Table 2	50P Time Delay T2	TIME 50P T2	0 s.	0 - 99.99 s.	0.01 s.
Ground IOC Setting Table 2	**50N Function T2**	**F50N T2**			
50N Enabling Table 2	Enable T2	Enable T2	NO	Y/N	NA
50N Permission to Trip Table 2	50N Trip Permission T2	TRIP 50N T2	No	Y/N	NA
50N Tap / Pickup (for 1/5 A ground) Table 2	50N Pickup T2	TAP 50N T2	1 In (Ground)	0.1 - 30 In (Gnd)	0.1 In (G)
50N Tap / Pickup (for sensitive ground) Table 2	50N Pickup	TAP 50N	0.005 A	0.005-0.12 A	0.001 A
50N Time Delay Table 2	50N Time Delay T2	TIME 50N T2	0 s.	0 - 99.99 s.	0.01 s.

5.3.4. UNDERCURRENT SETTINGS (37)

	M+PC	HMI	DEFAULT	RANGE	STEP
Undercurrent Setting Table 2	**37 Function T2**	**F37 T2**			
37 Enabling Table 2	Enable 37 T2	Enable 37 T2	NO	Y/N	NA
37 Permission to Trip Table 2	37 Trip Permission T2	TRIP 37 T2	No	Y/N	NA
37 Tap / Pickup Table 2	37 Pickup T2	TAP 37 T2	0.1 In	0.1 – 0.99 FLC	0.1
37 Time Delay Table 2	37 Time Delay T2	TIME 37 T2	1 s.	0 - 99.99 s.	0.01 s.

5.3.5. CURRENT UNBALANCE SETTINGS (46P)

	M+PC	HMI	DEFAULT	RANGE	STEP
Current Unbalance Setting Table 2	**46P Function T2**	**F46P T2**			
46P Enabling Table 2	Enable 46P T2	Enable 46P T2	NO	Y/N	NA
46P Permission to Trip Table 2	46P Trip Permission T2	TRIP 46P T2	No	Y/N	NA
46P Tap / Pickup Table 2	46P Pickup T2	TAP 46P T2	0.1 In	0.05 – 0.99 FLC	0.01
Type of curve 46P Table 2	Curve 46P T2	CURV 46P T2	TDEF	TDEF/CURVA	NA
Constant K Table 2	K 46P T2	K 46P T2	1	1-100	1
Definite time 46P Table 2	Definite Time 46P T2	TIME 46P T2	0.1 s.	0 - 99.99 s.	0.01 s.

5.3.6. LOCKED ROTOR (48)

	M+PC	HMI	DEFAULT	RANGE	STEP
Locked Rotor Setting Table 2	**48 Function T2**	**F48 T2**			
48 Enabling Table 2	Enable 48 T2	Enable 48 T2	NO	Y/N	NA
48 Permission to Trip Table 2	48 Trip Permission T2	TRIP 48 T2	No	Y/N	NA
48 Tap / Pickup Table 2	48 Pickup T2	TAP 48 T2	1.01	1.01 – 10 FLC	0.01
48 Time Delay Table 2	48 Time Delay T2	TIME 48 T2	0.1 s.	0.10 - 99.99 s.	0.01 s.

5.3.7. THERMAL IMAGE SETTINGS (49)

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

	M+PC	HMI	DEFAULT	RANGE	STEP
Cooling Time Constant $\tau 2$ Table 2	T2 T2	T2 T2	$1\tau 1$	1 - 6 times $\tau 1$	1
K1 Constant Table 2	K1 T2	K1 T2	1	1 – 8	1

5.3.8. MAXIMUM NUMBER OF STARTS (66)

	M+PC	HMI	DEFAULT	RANGE	STEP
Maximum number of starts Table 2	**66 Function T2**	**F66 T2**			
66 Enabling Table 2	Enable 66 T2	Enable 66 T2	NO	Y/N	NA
66 Permission to Operate Table 2	66 Oper. Permission T2	OPER 66 T2	NO	Y/N	NA
No. Starts per hour Table 2	No. Starts T2	No START T2	5	0-10	1
Block reset time (STOP-START) Table 2	Restart Time T2	TTR T2	10 min	0 – 100 min	1

5.3.9. RESTRICTED GROUND DIFFERENTIAL (87R)

	M+PC	HMI	DEFAULT	RANGE	STEP
Restricted Ground Differential Table 2	**87R Function T2**	**F87R T2**			
87R Enabling Table 2	Enable 87R T2	Enable 87R T2	NO	Y/N	NA
87R Permission to Trip Table 2	87R Trip Permission T2	TRIP 87R T2	No	Y/N	NA
Differential current (I_{diff}) Table 2	S 87R T2	S 87R T2	0.3 In	0.02 – 0.3 In	0.01 In
Percentage slope (S) Table 2	K T2	K T2	10	1-100	1
87R Time Delay Table 2	T T2	T T2	0.0 s.	0.0 - 99.99 s.	0.01 s.

5.4. CONFIGURATION SETTINGS

5.4.1. CONFIGURATION SETTINGS

SETTING	DEFAULT	RANGE
CFG1	-	CONFIG. SETTINGS
CFG2	-	CONFIG. SETTINGS
CFG3	-	CONFIG. SETTINGS
CFG4	-	CONFIG. SETTINGS

5.4.2. INPUT ASSIGNMENT SETTINGS

SETTING	DEFAULT	RANGE
CFG E.D. 1	-	INPUT ASSIGN.
CFG E.D. 2	-	INPUT ASSIGN.

5.4.3. OUTPUT ASSIGNMENT SETTINGS

SETTING	DEFAULT	RANGE
AUX 1	THERMAL TRIP	OUTPUT ASSIGN.
AUX 2	OVERCURRENT	OUTPUT ASSIGN.
AUX 3	UNBALANCE	OUTPUT ASSIGN.
AUX 4	PICKUP	OUTPUT ASSIGN.

5.4.4. LED ASSIGNMENT SETTINGS

SETTING	DEFAULT	RANGE
LED 1	THERMAL TRIP	LED ASSIGN
MEMORY LED 1	YES	YES/NO
LED 2	OVERCURRENT	LED ASSIGN
MEMORY LED 2	YES	YES/NO
LED 3	UNBALANCE	LED ASSIGN
MEMORY LED 3	YES	YES/NO
LED 4	PICKUP	LED ASSIGN
MEMORY LED 4	NO	YES/NO

5.5. EVENTS MASKS

Event masks have two possible settings, YES or NO. If an action (e.g. the trip of a protection function) is set as YES, when the trip takes place an event will be generated. If it is set as NO, no event will be generated.

	M+PC	DEFAULT	RANGE	STEP
Event masks	**Event masks**			
37 Pickup/Drop out	37 Pickup	YES	Y/N	NA
46 Pickup/Drop out	46 Pickup	YES	Y/N	NA
48 Pickup/Drop out	48 Pickup	YES	Y/N	NA
49 Pickup/Drop out	49 Pickup	YES	Y/N	NA
50P Pickup/Drop out	50P Pickup	YES	Y/N	NA
50N Pickup/Drop out	50N Pickup	YES	Y/N	NA
51P Pickup/Drop out	51P Pickup	YES	Y/N	NA
51N Pickup/Drop out	51N Pickup	YES	Y/N	NA
87R Pickup/Drop out	87R Pickup	YES	Y/N	NA
37 Inhibition activation/deactivation	37 Inhibition (by DI)	YES	Y/N	NA
46 Inhibition activation/deactivation	46 Inhibition (by DI)	YES	Y/N	NA
48 Inhibition activation/deactivation	48 Inhibition (by DI)	YES	Y/N	NA
49 Inhibition activation/deactivation	49 Inhibition (by DI)	YES	Y/N	NA
50P Inhibition activation/deactivation	50P Inhibition (by DI)	YES	Y/N	NA
50N Inhibition activation/deactivation	50N Inhibition (by DI)	YES	Y/N	NA
51P Inhibition activation/deactivation	51P Inhibition (by DI)	YES	Y/N	NA
51N Inhibition activation/deactivation	51N Inhibition (by DI)	YES	Y/N	NA
87R Inhibition activation/deactivation	87R Inhibition (by DI)	YES	Y/N	NA
Inhibition activation / deactivation by digital input	Trip inhibition by DI	YES	Y/N	NA
37 Function trip	37 Trip	YES	Y/N	NA
46 Function trip	46 Trip	YES	Y/N	NA
48 Function trip	48 Trip	YES	Y/N	NA
49 Function trip	49 Trip	YES	Y/N	NA
50P Function trip	50P Trip	YES	Y/N	NA

	M+PC	DEFAULT	RANGE	STEP
50N Function trip	50N Trip	YES	Y/N	NA
51P Function trip	51P Trip	YES	Y/N	NA
51N Function trip	51N Trip	YES	Y/N	NA
87R Function trip	87R Trip	YES	Y/N	NA
Trip by stop	Trip by stop	YES	Y/N	NA
Function 66 Operation	Operation 66	YES	Y/N	NA
General Trip	General Trip	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 active	Output 2	YES	Y/N	NA
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
Emergency Reset	EMER	YES	Y/N	NA
Close Breaker	Close Breaker	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
52B Open/Closed by Digital Input	52B Breaker	YES	Y/N	NA (2)
52 Open/Closed	Closed breaker	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

5.6. INTERNAL STATUSES

STATUS	STATUS	STATUS
	Pickup 51P-C	Trip 46
Model	Pickup 37	Trip 49
Version	Pickup 48	Trip by stop
Date - Time	Pickup 50P	Operation 66
Identification	Pickup 50N	Alarm
Ia	Pickup 51P	Trip
Ib	Pickup 51N	Output 1
Ic	Pickup 46	Output 2
In	Alarm 49	Output 3
I1	General Pickup	Output 4
I2	Trip 37-A	Input 1
Thermal Image (Th)	Trip 37-B	Input 2
Number of Starts	Trip 37-C	READY
Time to restarts	Trip 48-A	Trip LED
Oscillo number	Trip 48-B	LED 1
Event number	Trip 48-C	LED 2
Active table	Trip 50P-A	LED 3
Frequency	Trip 50P-B	LED 4
Pickup 37-A	Trip 50P-C	Logic 1
Pickup 37-B	Trip 51P-A	Logic 2
Pickup 37-C	Trip 51P-B	Logic 3
Pickup 48-A	Trip 51P-C	Logic 4
Pickup 48-B	Trip 37	Table Change
Pickup 48-C	Trip 48	Settings change inhibition
Pickup 50P-A	Trip 50P	52 Closed
Pickup 50P-B	Trip 50N	Local
Pickup 50P-C	Trip 51P	EEPROM Failure
Pickup 51P-A	Trip 51N	User settings
Pickup 51P-B	Trip 87R	

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 Phase and Ground TOC (Time Delayed Overcurrent) functions (51P / 51N) is the same for both functions: 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.

5.7. TIME SYNCHRONIZATION

MIG 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. I/0 CONFIGURATION

6.1. INPUT CONFIGURATION

6.1.1. DESCRIPTION OF INPUTS

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

Input 1: Emergency Reset

Input 2: External Trip.

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

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

No definition	Input not assigned

37 disabled	37 trip disabled
50P disabled	50P trip disabled
50N disabled	50N trip disabled
48 disabled	48 trip disabled
51P disabled	51P trip disabled
51N disabled	51N trip disabled
87R disabled	87R trip disabled
46 disabled	46 trip disabled
49 disabled	49 trip disabled
66 disabled	66 operation disabled
Trip disabled	Trip of all functions is disabled

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
Emergency reset input (PULSE)	Emergency reset activation
General input	Generic function that may be used in logic configuration.

6.2. OUTPUTS AND LEDS CONFIGURATION

6.2.1. DESCRIPTION OF OUTPUTS AND LEDS

The MIG 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	49 Trip	No
2	Overcurrent Trip	No
3	46 Trip	No
4	Pickup	No

The default LED configuration is as follows:

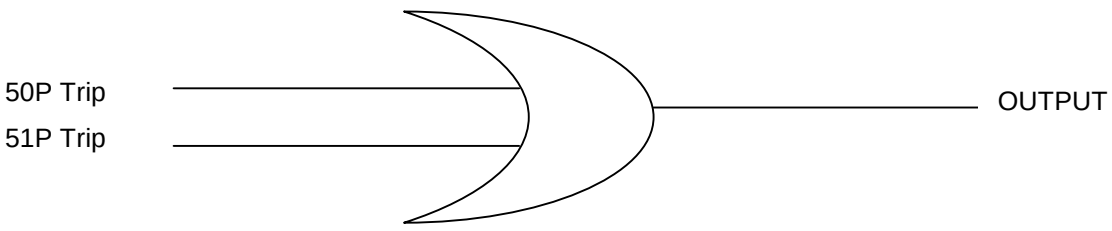
LED	CONFIGURATION	MEMORY
1	49 Trip	Yes
2	Overcurrent Trip	Yes
3	46 Trip	Yes
4	Pickup	No

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

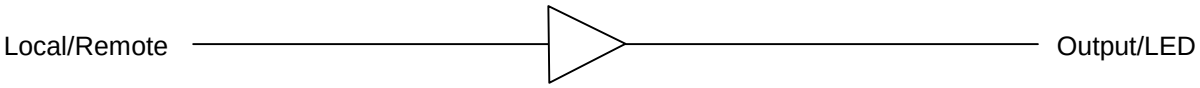
In order to assign several functions to an output/LED, first we must activate the OR button, click on the I/O CONFIGURATION frame and select the desired group, then select the desired functions. In order to negate a function, select the NOT button. Finally, click on the OK button.

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 phase trip to an output or LED, we must program the output or LED with 50P trip, and 51P trip.



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. FUNCTIONS ASSIGNABLE TO OUTPUTS AND LEDS

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

Overcurrent trip	Trip of any overcurrent protection functions
Phase trip	Any trip of 50P, 51P functions
Ground trip	Any trip of 50N, 51N functions
Phase A trip	Trip of any Phase A unit
Phase B trip	Trip of any Phase B unit
Phase C trip	Trip of any Phase C unit

37a Trip	Trip of Phase A 37 unit
37b Trip	Trip of Phase B 37 unit
37c Trip	Trip of Phase C 37 unit
48a Trip	Trip of Phase A 48 unit
48b Trip	Trip of Phase B 48 unit
48c Trip	Trip of Phase C 48 unit
50Pa Trip	Trip of Phase A 50P unit
50Pb Trip	Trip of Phase B 50P unit
50PcTrip	Trip of Phase C 50P unit
51Pa Trip	Trip of Phase A 51P unit
51Pb Trip	Trip of Phase B 51P unit

51PcTrip	Trip of Phase C 51P unit
37 trip	37 function trip
46 trip	46 function trip
48 trip	48 function trip
49 trip	49 function trip
50P trip	50P function trip
50N trip	50N function trip
51P trip	51P function trip
51N trip	51N function trip
87R trip	87R function trip
Trip by Stop	Trip caused by a stop
66 Operation	Operation of function 66
General trip	Any trip of the above mentioned functions

37a Pickup	Pickup of Phase A 37 unit
37b Pickup	Pickup of Phase B 37 unit
37c Pickup	Pickup of Phase C 37 unit
48a Pickup	Pickup of Phase A 48 unit
48b Pickup	Pickup of Phase B 48 unit
48c Pickup	Pickup of Phase C 48 unit
50Pa Pickup	Pickup of Phase A 50P unit
50Pb Pickup	Pickup of Phase B 50P unit
50PcPickup	Pickup of Phase C 50P unit
51Pa Pickup	Pickup of Phase A 51P unit
51Pb Pickup	Pickup of Phase B 51P unit
51PcPickup	Pickup of Phase C 51P unit
37 pickup	37 function pickup
46 pickup	46 function pickup
48 pickup	48 function pickup
49 pickup	49 function pickup
50P pickup	50P function pickup
50N pickup	50N function pickup
51P pickup	51P function pickup
51N pickup	51N function pickup
87R pickup	87R function pickup
66 Operation	Operation of function 66
General pickup	Any pickup of the above mentioned functions

37a Virtual trip	Virtual trip of Phase A 37 unit
37b Virtual trip	Virtual trip of Phase B 37 unit
37c Virtual trip	Virtual trip of Phase C 37 unit
48a Virtual trip	Virtual trip of Phase A 48 unit
48b Virtual trip	Virtual trip of Phase B 48 unit
48c Virtual trip	Virtual trip of Phase C 48 unit
50Pa Virtual trip	Virtual trip of Phase A 50P unit
50Pb Virtual trip	Virtual trip of Phase B 50P unit
50PcVirtual trip	Virtual trip of Phase C 50P unit
51Pa Virtual trip	Virtual trip of Phase A 51P unit
51Pb Virtual trip	Virtual trip of Phase B 51P unit
51PcVirtual trip	Virtual trip of Phase C 51P unit
37 virtual trip	37 function virtual trip
46 virtual trip	46 function virtual trip
48 virtual trip	48 function virtual trip
49 virtual trip	49 function virtual trip
50P virtual trip	50P function virtual trip
50N virtual trip	50N function virtual trip
51P virtual trip	51P function virtual trip
51N virtual trip	51N function virtual trip
87R virtual trip	87R function virtual trip
Virtual Trip by Stop	Virtual trip by stop
66 virtual trip	66 function virtual trip
General virtual trip	Any virtual trip of the above mentioned functions

Input 1	Digital input 1
Input 2	Digital input 2
52 Closed	

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
Close Breaker	Active when the close breaker operation is performed

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. LOGIC CONFIGURATION

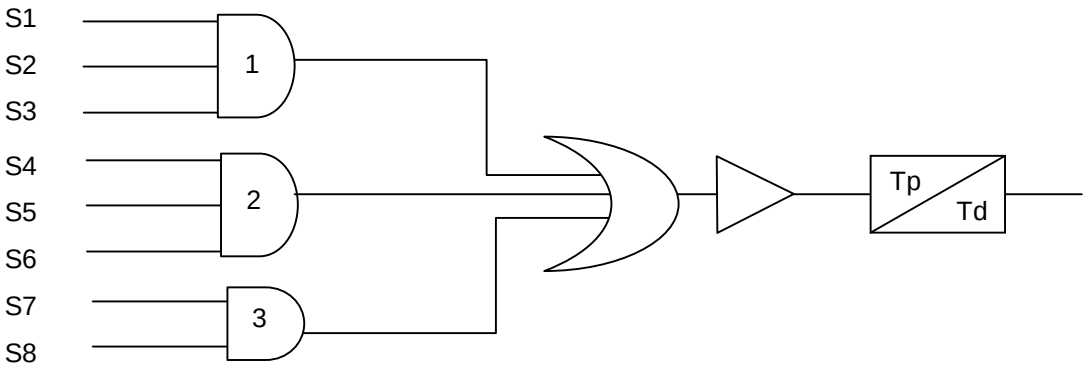
7.1. LOGIC DESCRIPTION

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

The default logic configuration is the following:

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

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



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

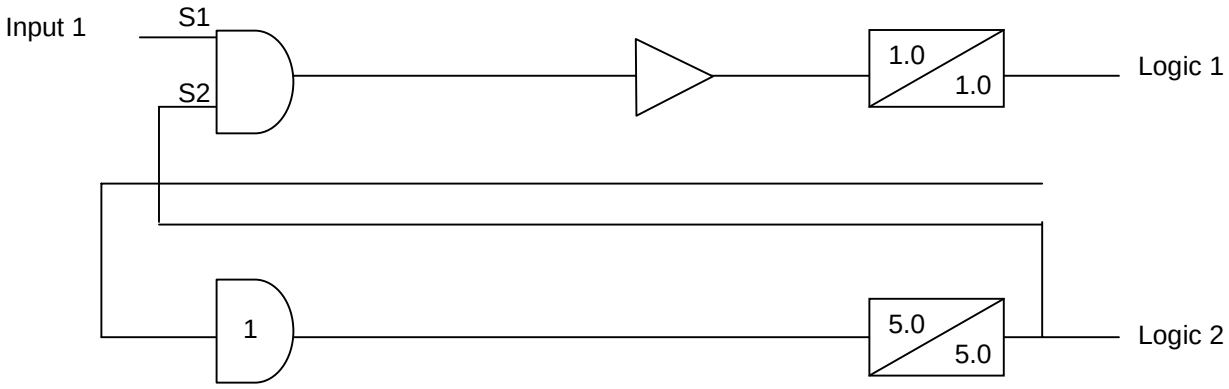
To configure a logic box, we can proceed in the same way as for the outputs/LEDs configuration per signal. If we want to assign more than one function to each signal, the functions must be in the same group, and the OR button must be activated, press the option E/S CONFIGURATION, select the desired group,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

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

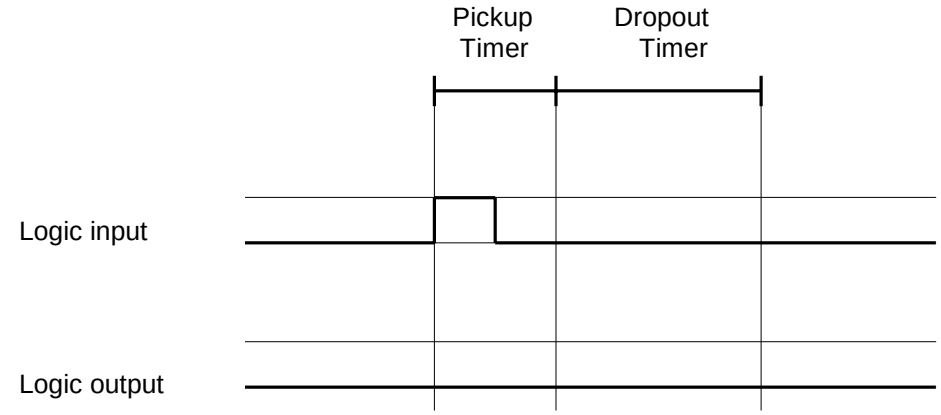
IMPORTANT NOTE

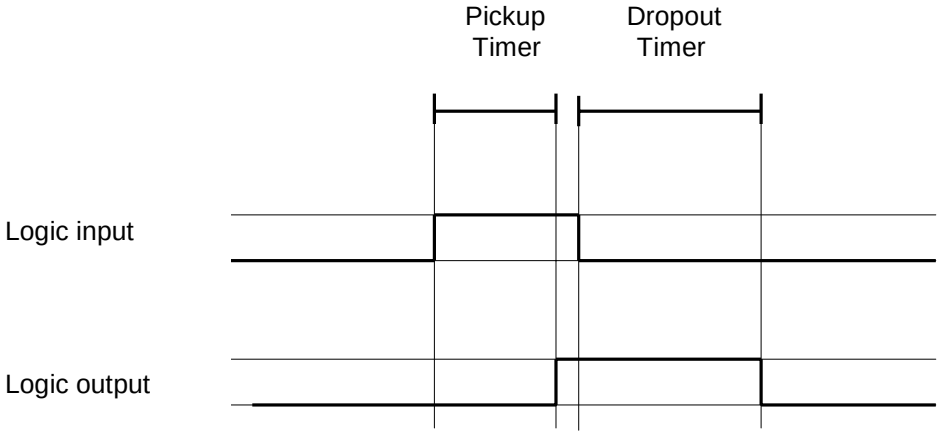
Signals must be used in order, starting with S1. If we wish to use more than one signal in the same AND, use S2 first and then S3. If we wish to use another AND use AND 2 first, and then AND 3.

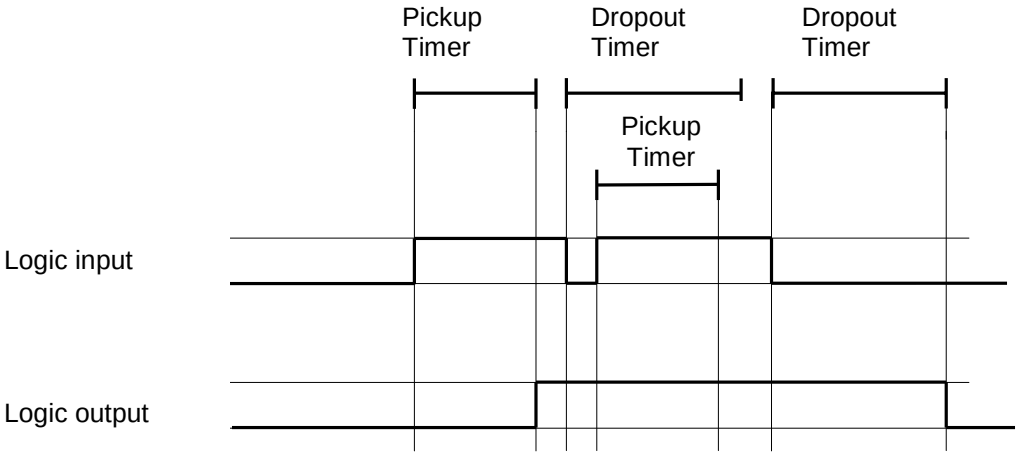
For example, we can configure the following logic, where Input 1 is the RESET signal:



Time diagram for the logic configuration:







7.2. LOGIC FUNCTIONS

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

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

Overcurrent trip	Trip of any overcurrent protection functions
Phase trip	Any trip of 50P, 51P functions
Ground trip	Any trip of 50N, 51N functions
Phase A trip	Trip of any Phase A unit
Phase B trip	Trip of any Phase B unit
Phase C trip	Trip of any Phase C unit

37a Trip	Trip of Phase A 37 unit
37b Trip	Trip of Phase B 37 unit
37c Trip	Trip of Phase C 37 unit

48a Trip	Trip of Phase A 48 unit
48b Trip	Trip of Phase B 48 unit
48c Trip	Trip of Phase C 48 unit

50Pa Trip	Trip of Phase A 50P unit
50Pb Trip	Trip of Phase B 50P unit
50Pc Trip	Trip of Phase C 50P unit

51Pa Trip	Trip of Phase A 51P unit
51Pb Trip	Trip of Phase B 51P unit
51Pc Trip	Trip of Phase C 51P unit

37 trip	37 function trip
46 trip	46 function trip
48 trip	48 function trip

49 trip	49 function trip
50P trip	50P function trip
50N trip	50N function trip
51P trip	51P function trip
51N trip	51N function trip
87R trip	87R function trip

Trip by Stop	Trip caused by a stop
66 Operation	Operation of function 66
General trip	Any trip of the above mentioned functions

37a Pickup	Pickup of Phase A 37 unit
37b Pickup	Pickup of Phase B 37 unit
37c Pickup	Pickup of Phase C 37 unit

48a Pickup	Pickup of Phase A 48 unit
48b Pickup	Pickup of Phase B 48 unit
48c Pickup	Pickup of Phase C 48 unit

50Pa Pickup	Pickup of Phase A 50P unit
50Pb Pickup	Pickup of Phase B 50P unit
50PcPickup	Pickup of Phase C 50P unit

51Pa Pickup	Pickup of Phase A 51P unit
51Pb Pickup	Pickup of Phase B 51P unit
51PcPickup	Pickup of Phase C 51P unit

37 pickup	37 function pickup
46 pickup	46 function pickup
48 pickup	48 function pickup
49 pickup	49 function pickup
50P pickup	50P function pickup
50N pickup	50N function pickup
51P pickup	51P function pickup
51N pickup	51N function pickup
87R pickup	87R function pickup
66 Operation	Operation of function 66

General pickup	Any pickup of the above mentioned functions

37a Virtual trip	Virtual trip of Phase A 37 unit
37b Virtual trip	Virtual trip of Phase B 37 unit
37c Virtual trip	Virtual trip of Phase C 37 unit

48a Virtual trip	Virtual trip of Phase A 48 unit
48b Virtual trip	Virtual trip of Phase B 48 unit
48c Virtual trip	Virtual trip of Phase C 48 unit

50Pa Virtual trip	Virtual trip of Phase A 50P unit
50Pb Virtual trip	Virtual trip of Phase B 50P unit
50PcVirtual trip	Virtual trip of Phase C 50P unit

51Pa Virtual trip	Virtual trip of Phase A 51P unit
51Pb Virtual trip	Virtual trip of Phase B 51P unit
51PcVirtual trip	Virtual trip of Phase C 51P unit

37 virtual trip	37 function virtual trip
46 virtual trip	46 function virtual trip
48 virtual trip	48 function virtual trip
49 virtual trip	49 function virtual trip
50P virtual trip	50P function virtual trip
50N virtual trip	50N function virtual trip
51P virtual trip	51P function virtual trip
51N virtual trip	51N function virtual trip
87R virtual trip	87R function virtual trip
Virtual Trip by Stop	Virtual trip by stop
66 virtual trip	66 function virtual trip
General virtual trip	Any virtual trip of the above mentioned functions

37 inhibition input	37 function inhibition input
46 inhibition input	46 function inhibition input
48 inhibition input	48 function inhibition input
49 inhibition input	49 function inhibition input
50P inhibition input	50P function inhibition input
50N inhibition input	50N function inhibition input

51P inhibition input	51P function inhibition input
51N inhibition input	51N function inhibition input
87R inhibition input	87R function inhibition input
66 inhibition input	66 function inhibition input
General inhibition input	Any inhibition input of the above mentioned functions

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

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

Settings change disabled	Active means that settings or tables can not be change. It is only possible to switch to T2 by digital input Table change

52 Closed	Closed breaker

Table change	Set means that active table is T2

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

ACTIVE TABLE	T1 or T2

E2PROM failure	Active when an E2prom management failure is detected

Local/Remote	LOCAL when the HMI is on the MAIN SETTINGS, ADVANCED SETTINGS, or OPERATIONS menu

User settings	When the default settings are being used, this function will be green; when settings are modified by the user, it will turn red

8. KEYPAD AND DISPLAY

8.1. FACEPLATE KEYPAD

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

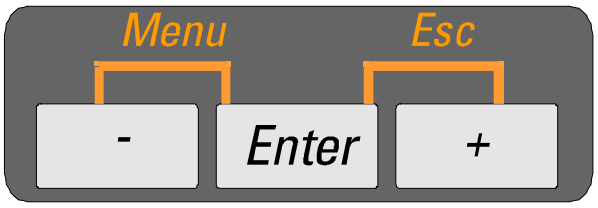


Figure 8.1. KEYPAD

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 MIG 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.

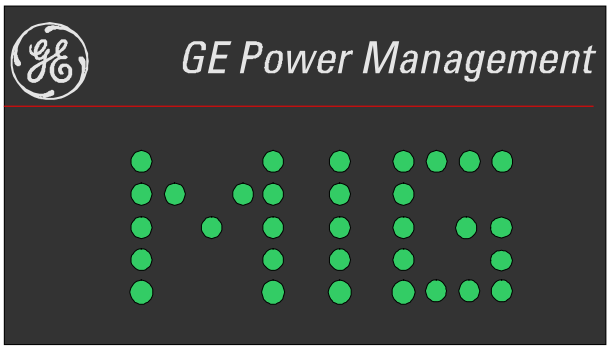


Figure 8.2. ALPHANUMERIC DISPLAY

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 (Ia, Ib, Ic, IN 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 (MIG) and a series of actual values (Ia, Ib, Ic, IN and TH (Thermal Image)).

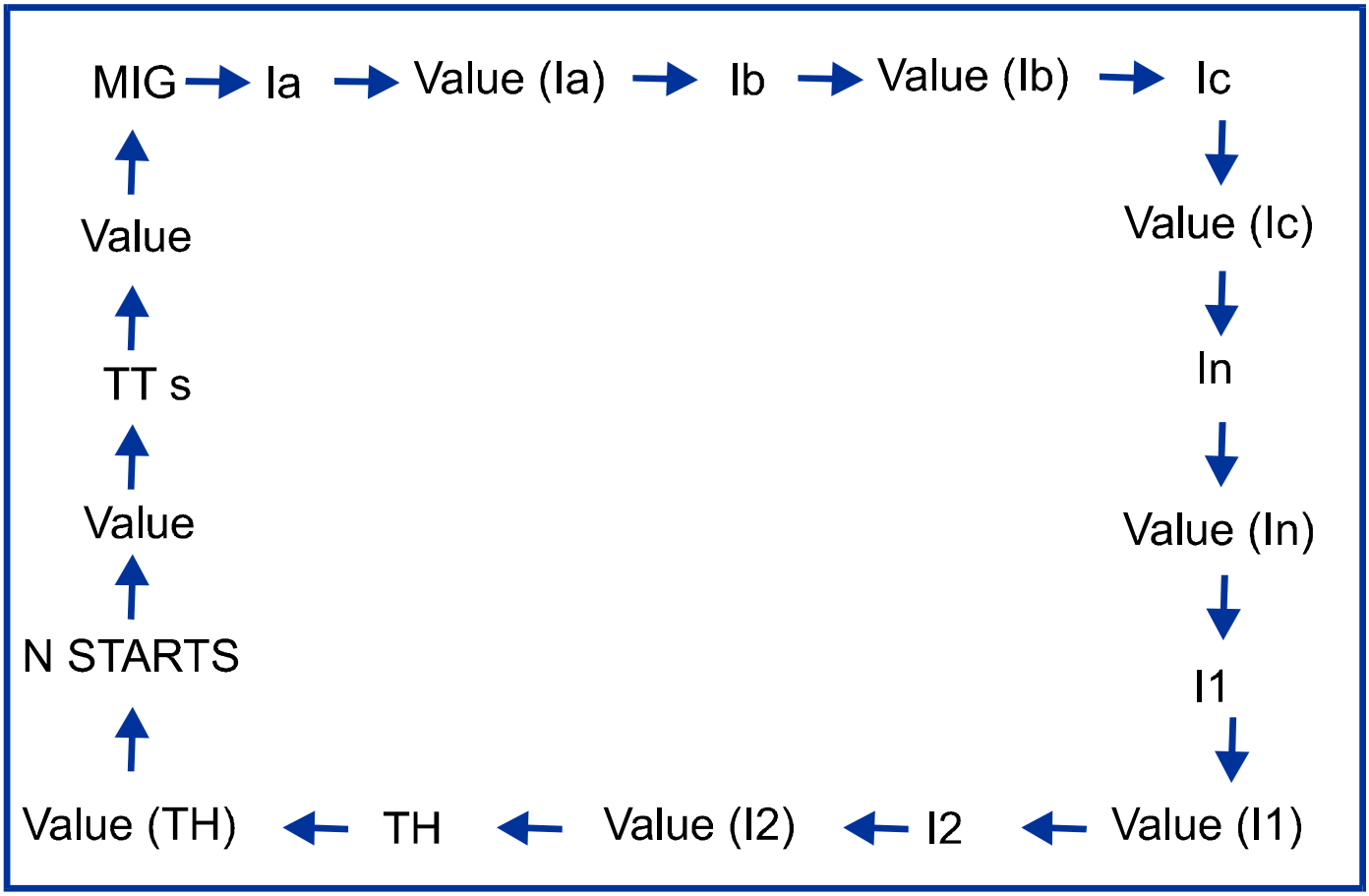


Figure 8.3. SCROLLING WHILE THE KEYPAD IS NOT USE

The mnemonics used in figure 8.3 are the following:

Ia:	Phase A current
Ib:	Phase B current
Ic:	Phase C current
In:	Ground current
I1:	Positive sequence current
I2:	Negative sequence current
TH:	Thermal image
NSTARTS:	No. of starts
TTS:	Time to restart

Value (Ia): Measure in amps of Phase A current

Value (Ib): Measure in amps of Phase B current

Value (Ic): Measure in amps of Phase C current

Value (In): Measure in amps of the ground current

Value (I1): Measure in amps of the positive sequence current

Value (I2): Measure in amps of the negative sequence current

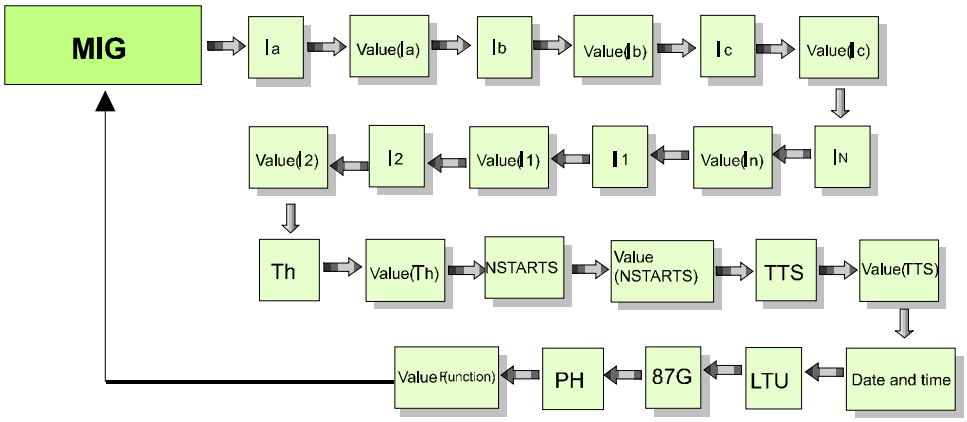
Value (Th): Measure of the thermal image level in %

Value (TTS): Measure of the time left for the next start in seconds

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

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

In this mode, the user has access to the same information shown during the "scrolling", plus the date and time, protection unit that caused the last trip, and the faulted phase(s) during the last trip.



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

FIGURE 8-4. GENERAL INFORMATION SCREEN SEQUENCE. KEY-TO-KEY MENU FOR MIG MODELS

The mnemonics used on figure 8.4 are as follows:

Date and Time:	Current date and time
LTU:	Last trip unit
Value (function):	Shows the protection function that caused the trip
PH/N:	Shows the faulted phase (or ground) in the last trip
Value (trip)	Shows the current value during the last trip

8.3.2. MODE 2: ENTER THE MENUS, PRESSING “ENTER” AND “-” SIMULTANEOUSLY:

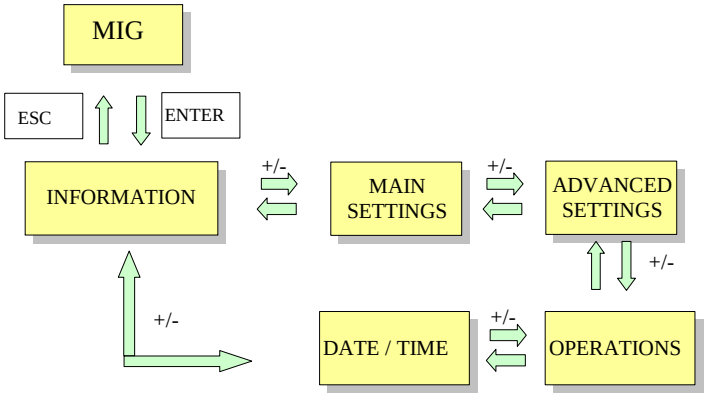


Figure 8.5. SELECT MENU FROM THE STEADY STATE

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

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

8.4. INFORMATION MENU

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

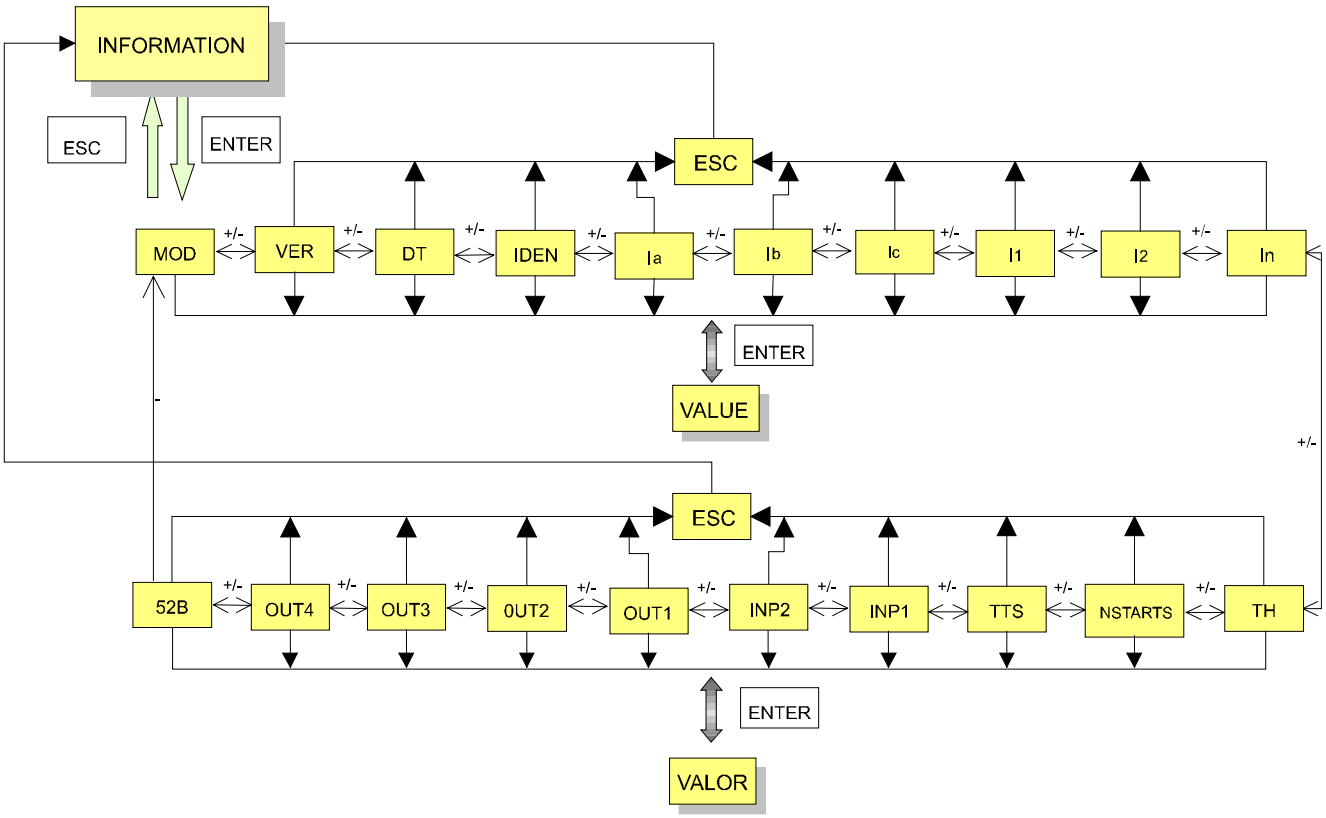


Figure 8.6. DISPLAY & KEYPAD HANDLING FROM INFORMATION MENU

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 meanings:

MOD	Relay Model number
VER	Firmware version installed in the relay.
D T	Relay Date and Time.
IDEN	Identification.
Ia, Ib, Ic, IN, TH, **NSTARTS, TTs**	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.

B 52 B Terminal 52 B.

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8.5. MAIN SETTINGS MENU

Keypad and Display handling to access the Main Settings menu:

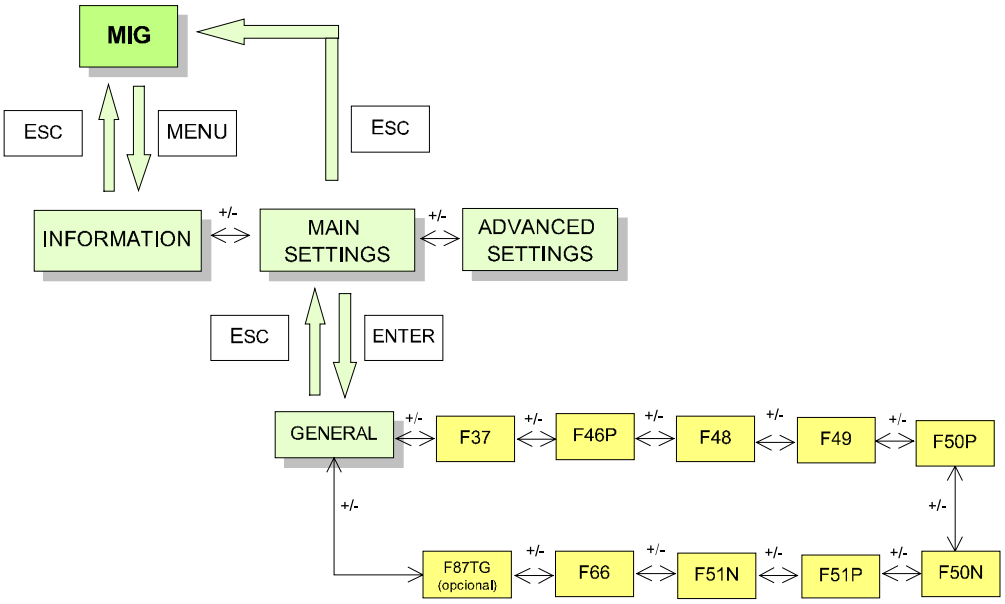


Figure 8.7. KEYPAD AND DISPLAY HANDLING TO ACCESS MAIN SETTINGS

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	Main settings	
F37	Unit 37	Phase undercurrent
F46P	Unit 46P	Negative sequence
F48	Unit 48	Locked Rotor
F49	Unit 49	Thermal image
F50P	Unit 50P	Phase instantaneous overcurrent
F50N	Unit 50N	Ground instantaneous overcurrent
F51P	Unit 51P	Phase time overcurrent
F51N	Unit 51N	Ground time overcurrent
F66	Unit 66	Maximum number of starts
F87R	Unit 87R	Restricted ground differential

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

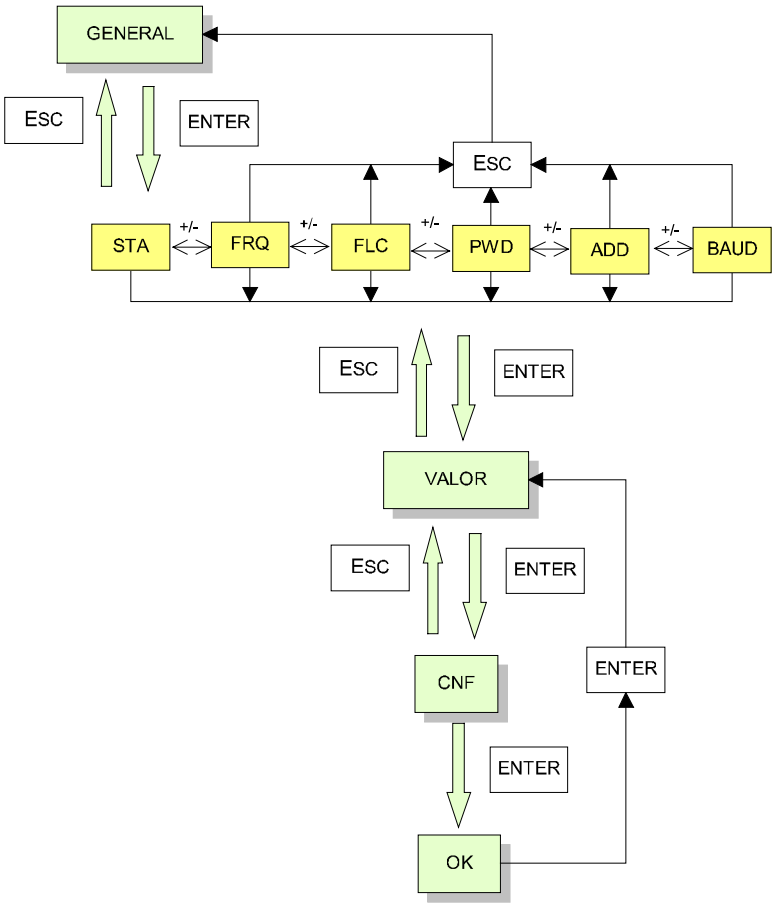


Figure 8.8. KEYPAD AND DISPLAY HANDLING FROM GENERAL SETTINGS HEADING

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	Protection status	
	Range:	RDY	In service
		DIS	Out of service
FRQ	FREQUENCY	Frequency	
	Range:	50	50 Hz
		60	60 Hz

FLC	FULL LOAD CURRENT	Current at rated load	
	Range:	0.5 – 10 A	
PWD	PASSWORD	Password	
	Range:	1-255	
ADD	ADDRESS	Communication address	
	Range:	1-255	
BAUD	Baudrate	Communications baudrate	
	Range:	0.3	300 bauds
		0.6	600 bauds
		1.2	1200 bauds
		2.4	2400 bauds
		4.8	4800 bauds
		9.6	9600 bauds
		19.2	19200 bauds
CNF	Confirmation	OK	Validates the selected value

From the F37 heading, the following key strokes and displays are possible:

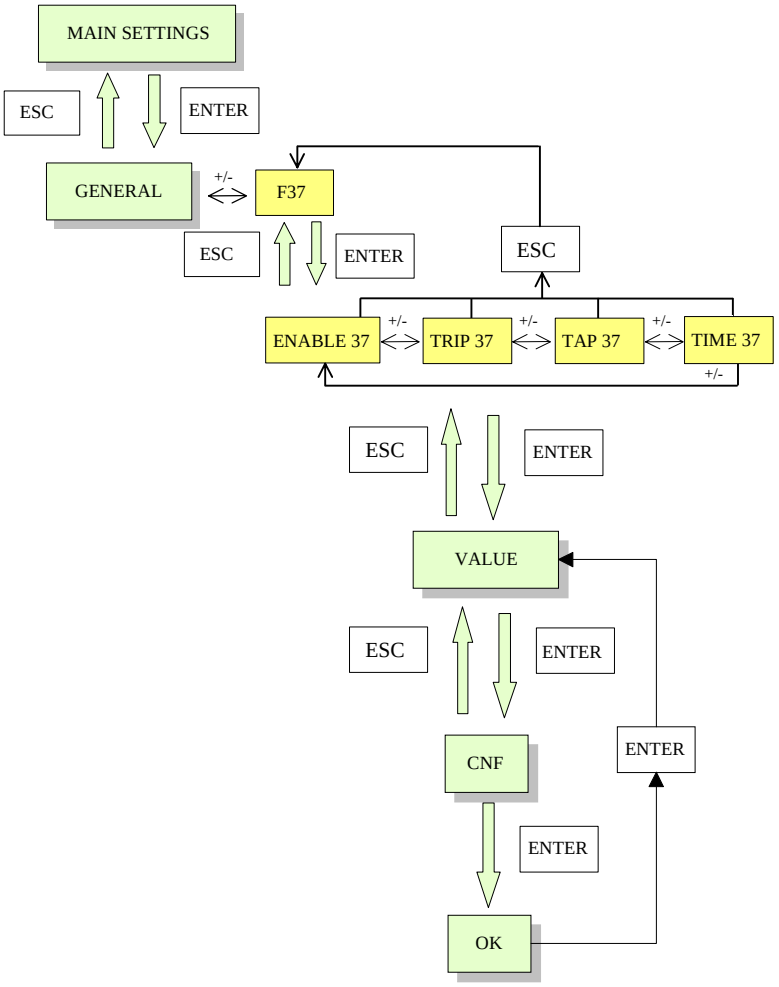


Figure 8.9. KEYPAD AND DISPLAY HANDLING FROM THE F37 HEADING

Press Enter to access the different settings corresponding to the F37 function: ENABLE 37, TRIP 37, TAP 37 and TIME 37. 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:

ENABLE 37:	Enable unit 37	Range:	Y(YES)/N(NO)	
TRIP 37:	Trip permission 37	Range:	Y(YES)/N(NO)	
TAP 37:	Tap 37	Range:	0.10...0.99 In	Step: 0.1
TIME 37:	Definite time 37	Range:	0.0...99.99 s	Step: 0.01s

From the **F46P** heading, the following key strokes and displays are possible:

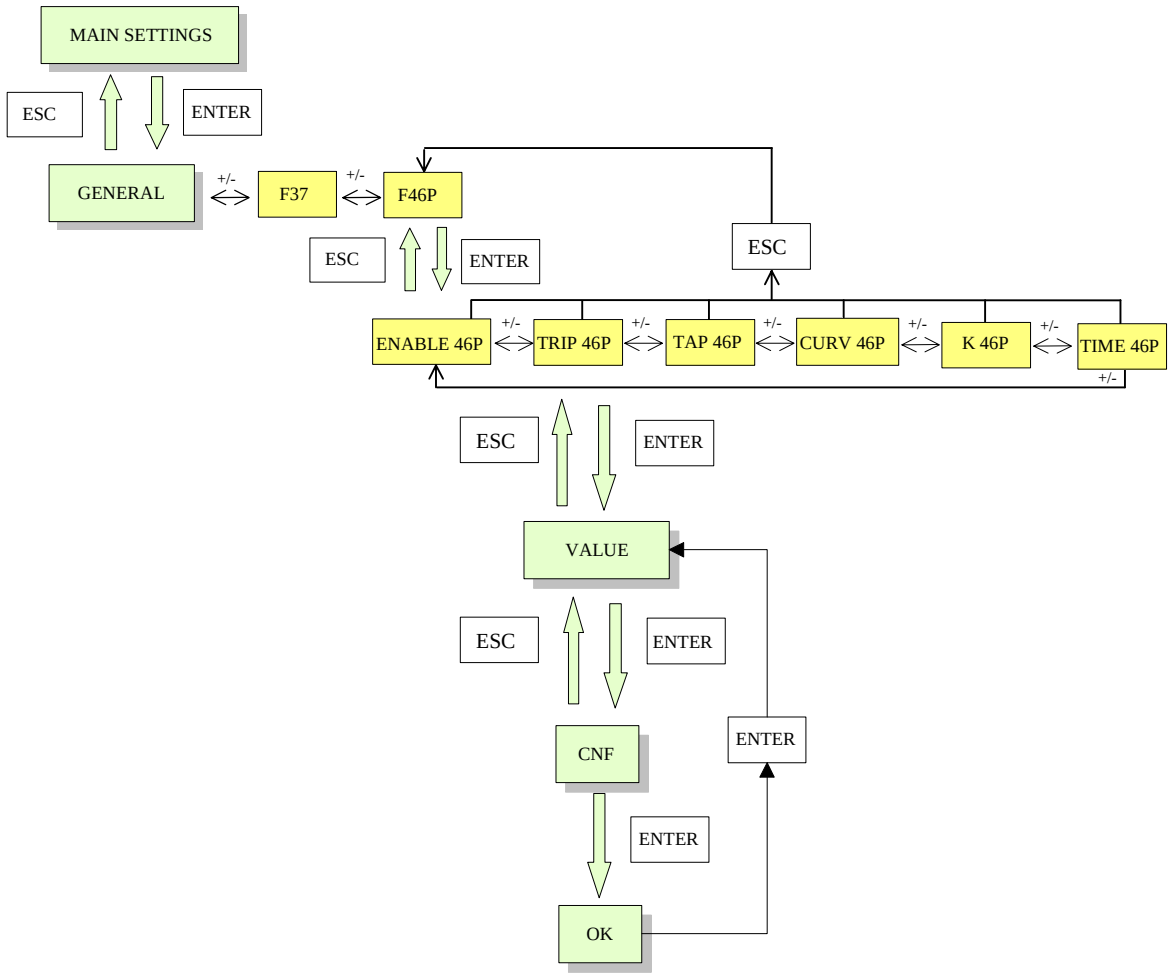


Figure 8.10. KEYPAD AND DISPLAY HANDLING FROM THE F46P HEADING

Press Enter to access the different settings corresponding to the F46P function.

The mnemonics in figure 8.10 stand for:

ENABLE 46P:	Enable unit 46P	Range:	Y(YES)/N(NO)	
TRIP 46P:	Trip permission 46P	Range:	Y(YES)/N(NO)	
TAP 46P:	Tap 46P	Range:	0.05...0.99 In	Step: 0.01
CURV 46P:	46P curve	Range:	TDEF/CURVA	
K 46P:	K constant 46P	Range:	1...100	Step: 1
TIME 46P:	Definite time 46P	Range:	0.0...99.99 s	Step: 0.01s

From the **F48** heading, the following key strokes and displays are possible:

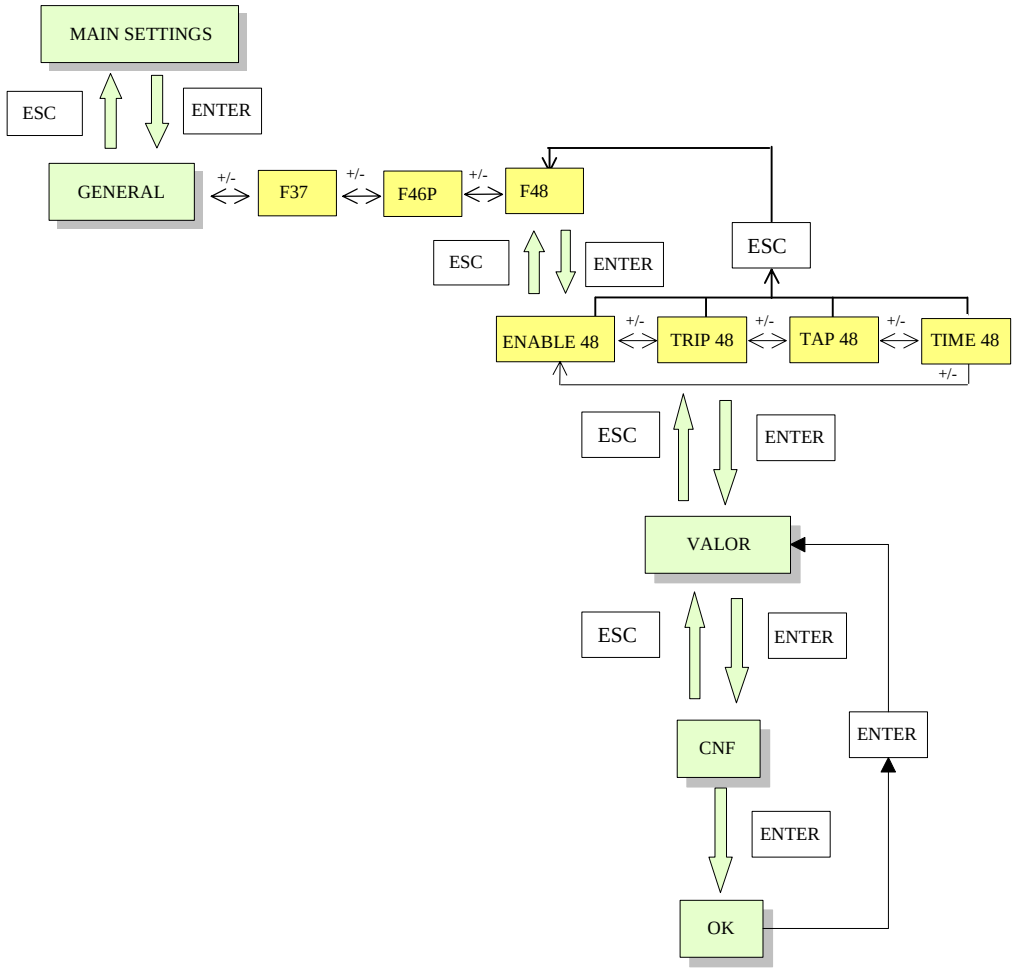


Figure 8.11. KEYPAD AND DISPLAY HANDLING FROM THE F48 HEADING

Press Enter to access the different settings corresponding to the F48 function.

The mnemonics in figure 8.11 stand for:

ENABLE 48:	Enable unit 48	Range:	Y(YES)/N(NO)	
TRIP 48:	Trip permission 48	Range:	Y(YES)/N(NO)	
TAP 48:	Tap 48	Range:	1.01...10 In	Step: 0.01
TIME 48:	Timer 48	Range:	0.1...99.99 s	Step: 0.01s
CNF:	Confirmation			
OK:	Validates the selected value			

From the **F49** heading, the following key strokes and displays are possible:

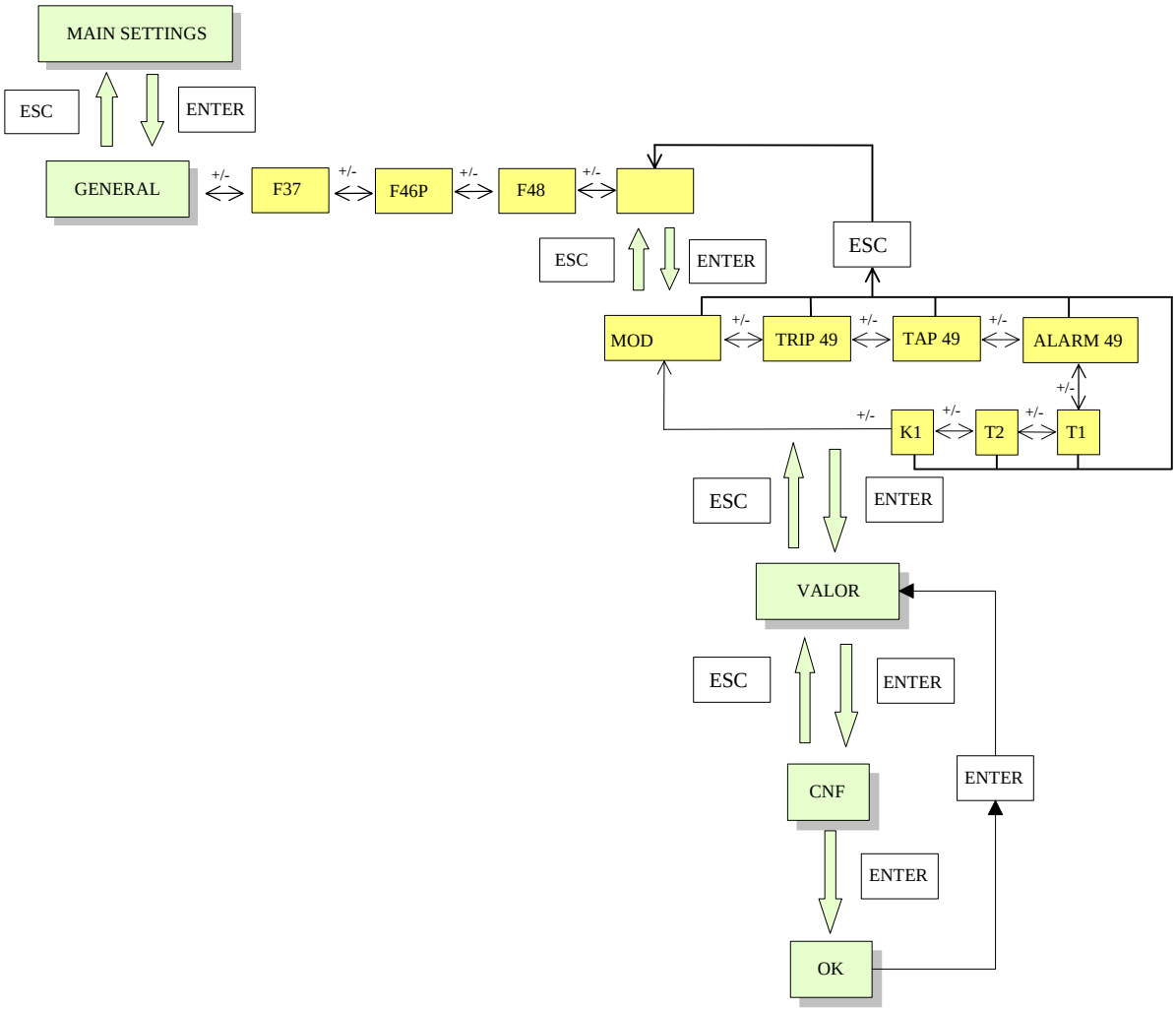


Figure 8.12. KEYPAD AND DISPLAY HANDLING FROM THE F49 HEADING

Press Enter to access the different settings corresponding to the F49 function.

The mnemonics in figure 8.12 stand for:

ENABLE 49:	Enable unit 49	Range:	Y(YES)/N(NO)	
TRIP 49:	Trip permission 49	Range:	Y(YES)/N(NO)	
TAP 49:	Tap 49	Range:	0.01...2.4 FLC	Step: 0.01
ALARM 49:	Alarm 49	Range:	70...100%	Step: 1
T1:	Heating constant	Range:	3...600 min	Step: 1
T2:	Cooling constant	Range:	1...6 T1	Step: 1
K1:	Negative sequence val.	Range:	1...8	Step: 1
CNF:	Confirmation			
OK:	Validates the selected value			

From the **F50P** or **F50N** headings, the following key strokes and displays are possible:

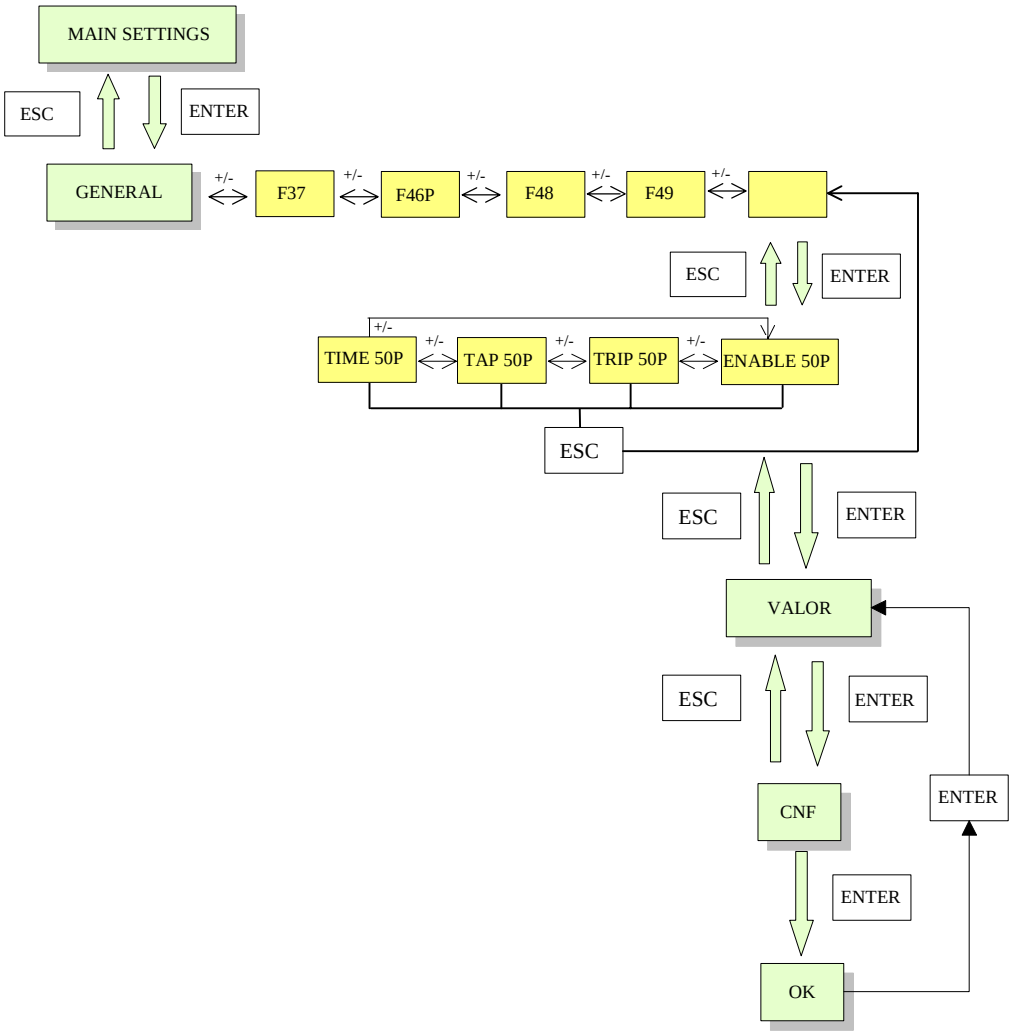


Figure 8.13. KEYPAD AND DISPLAY HANDLING FROM THE F50P HEADING

Press Enter to access the different settings corresponding to the F50P function.

The mnemonics in figure 8.13 stand for:

ENABLE 50P:	Enable unit 50P	Range:	Y(YES)/N(NO)	
TRIP 50P:	Trip permission 50P	Range:	Y(YES)/N(NO)	
TAP 50P:	Tap 50P	Range:	0.1...30 FLC	Step: 0.1
TIME 50P:	Timer 50P	Range:	0.0...99.99 s	Step: 0.01s
CNF:	Confirmation			
OK:	Validates the selected value			

From the **F51P** or **F51N** headings, the following key strokes and displays are possible:

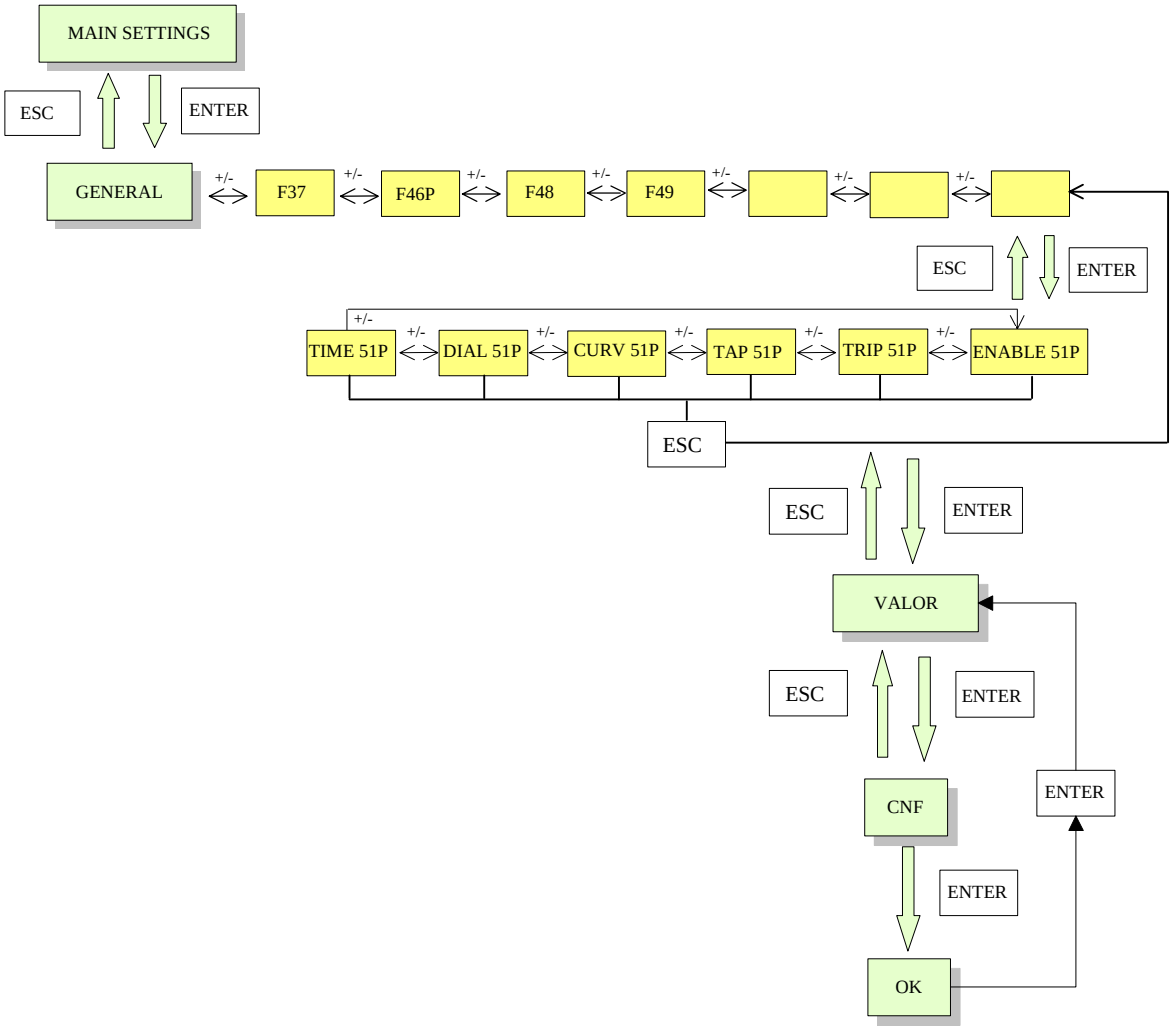


Figure 8.14. KEYPAD AND DISPLAY HANDLING FROM THE F51P HEADING

Press Enter to access the different settings corresponding to the F51P function.

The mnemonics in figure 8.14 stand for:

ENABLE 51P:	Enable unit 51P	Range:	Y(YES)/N(NO)
TRIP 51P:	Trip permission 51P	Range:	Y(YES)/N(NO)
TAP 51P:	Tap 51P	Range:	0.1...2.4 FLC Step: 0.1
CURV 51P:	Type of curve 51P	Range:	INV, VERY INV, EXTR. INV, TDEF, USU
DIAL 51P:	Curve dial 51P	Range:	0.5...2.0 (IEC) Step: 0.01
			0.5...20 (ANSI) Step: 0.01
TIME 51P:	Timer 51P	Range:	0.0...99.99 s Step: 0.01s
CNF:	Confirmation		
OK:	Validates the selected value		

From the **F66** heading, the following key strokes and displays are possible:

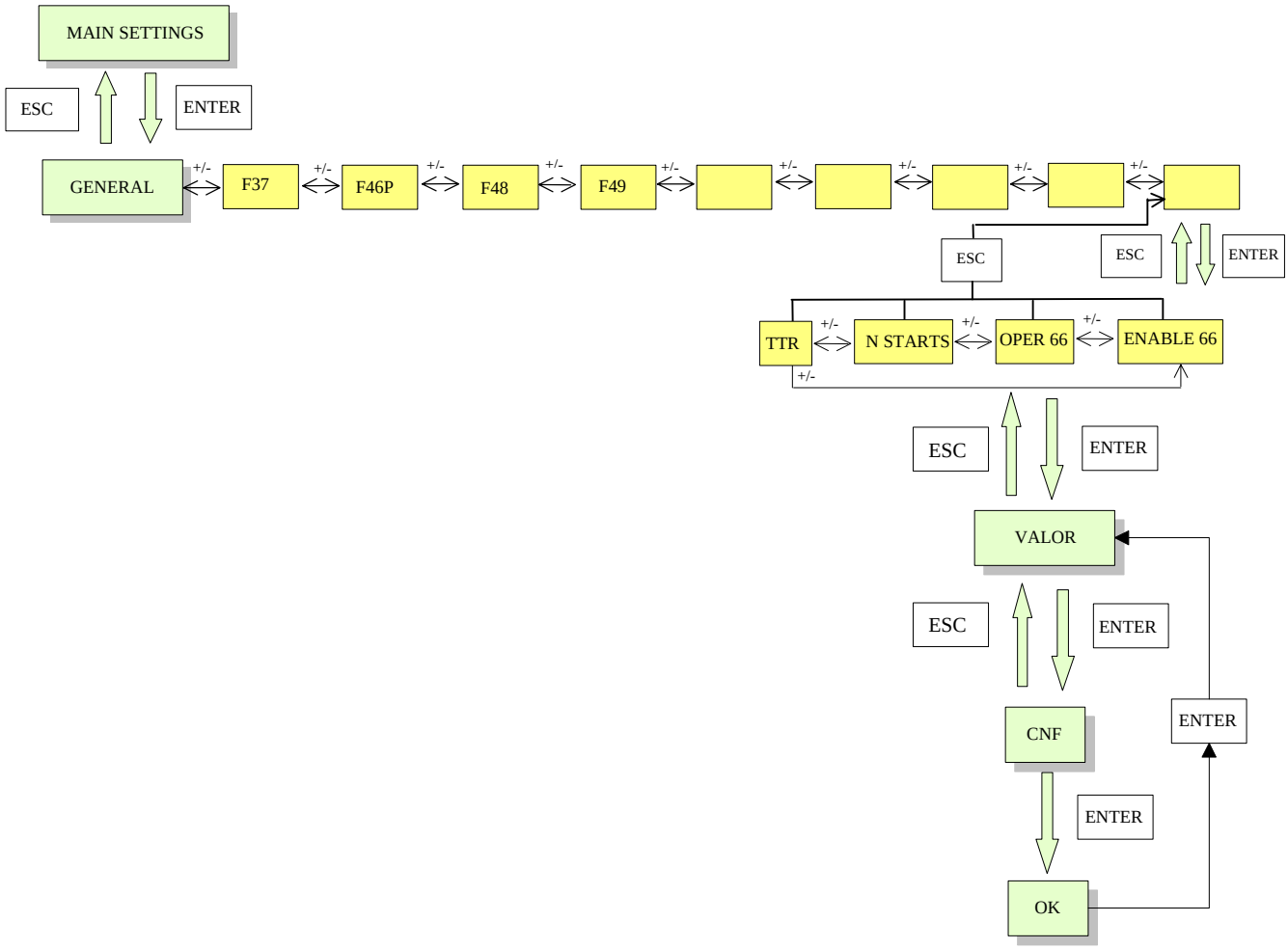


Figure 8.15. KEYPAD AND DISPLAY HANDLING FROM THE F66 HEADING

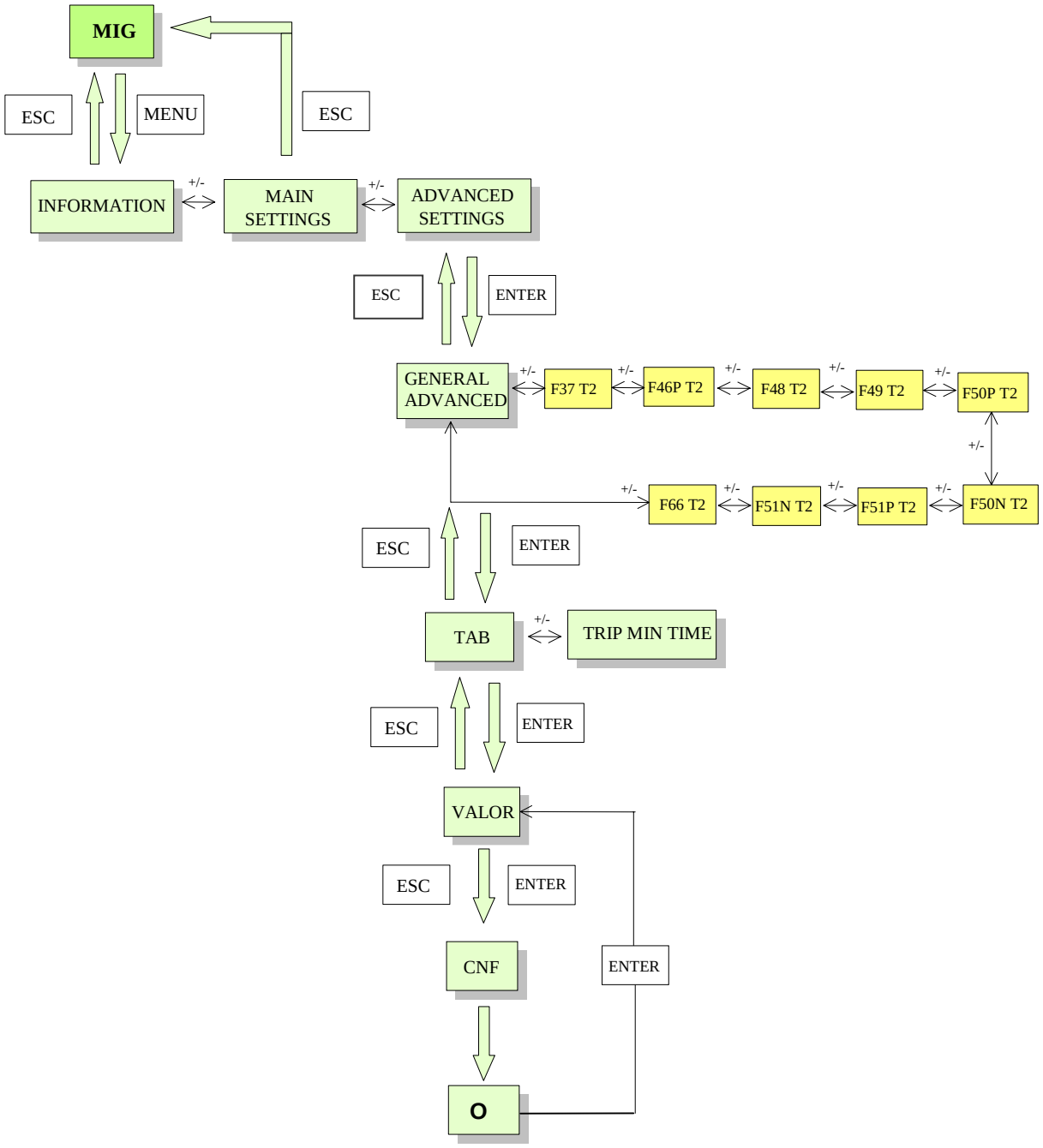
Press Enter to access the different settings corresponding to the F66 function.

The mnemonics in figure 8.15 stand for:

ENABLE 66:	Enable unit 66	Range: Y(YES)/N(NO)	
OPER 66:	Operation permission 66	Range: Y(YES)/N(NO)	
N STARTS:	Maximum number of starts/hour	Range: 0...10	Step: 1
TTR :	Time to restart	Range: 0.0...100 min	Step: 1 min
CNF:	Confirmation		
OK:	Validates the selected value		

8.6. ADVANCED SETTINGS MENU

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



+

Figure 8.16. 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 8.16 stand for:

ADVANCED SETTINGS→ Advanced settings

GENERAL ADVANCED→ General advanced settings

F37 T2→	Unit 37 (Table 2)
F46 T2→	Unit 46 (Table 2)
F48 T2→	Unit 48 (Table 2)
F49 T2→	Unit 49 (Table 2)
F50P T2→	Unit 50P (Table 2)
F50N T2→	Unit 50N (Table 2)
F51P T2→	Unit 51P (Table 2)
F51N T2→	Unit 51N (Table 2)
F66 T2→	Unit 66 (Table 2)
CURV→	User curve
CNF→	Confirmation
OK→	Validates the selected value

8.7. OPERATIONS MENU

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

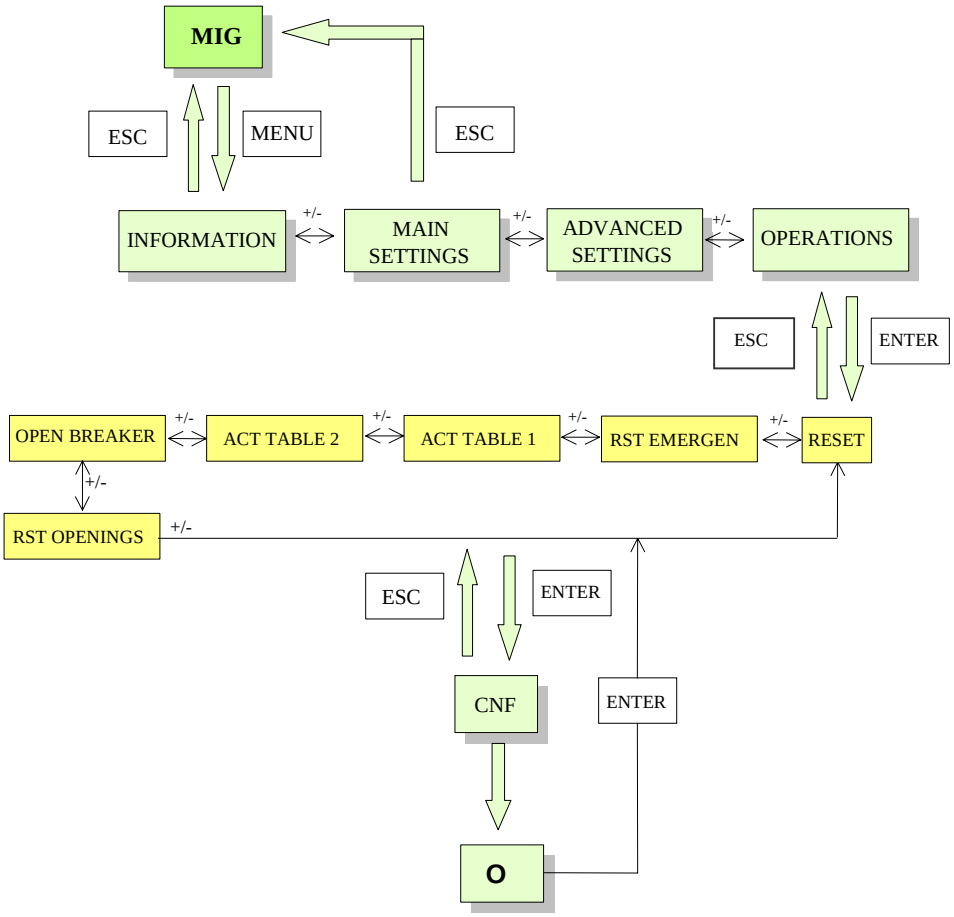


Figure 8.17. KEYPAD AND DISPLAY USE IN THE OPERATIONS MENU

The mnemonics in figure 8.17 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
RST EMERGEN	Reset Command for the Thermal Image Unit, Number of starts and time to restart.
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
CNF	CONFIRM OK Confirm that the command must be executed.

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:

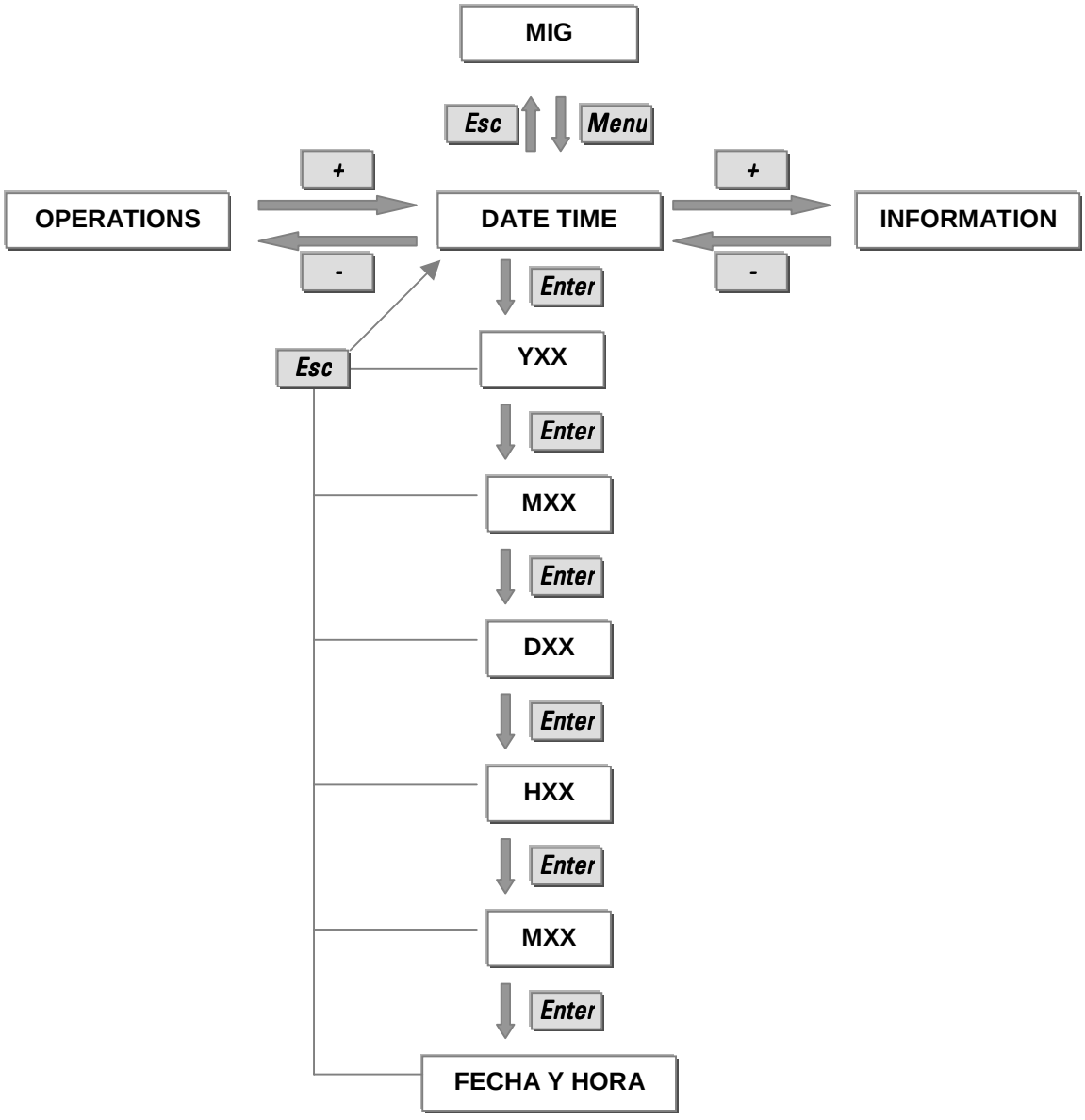


Figure 8.18. KEYPAD AND DISPLAY USE TO SET THE DATE AND TIME IN THE RELAY

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 TARGET LEDS

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

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

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

9. RELAY COMMISSIONING

9.1. VISUAL INSPECTION

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

9.2. COMMENTS ON THE TEST EQUIPMENT

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

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

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

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

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

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

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.

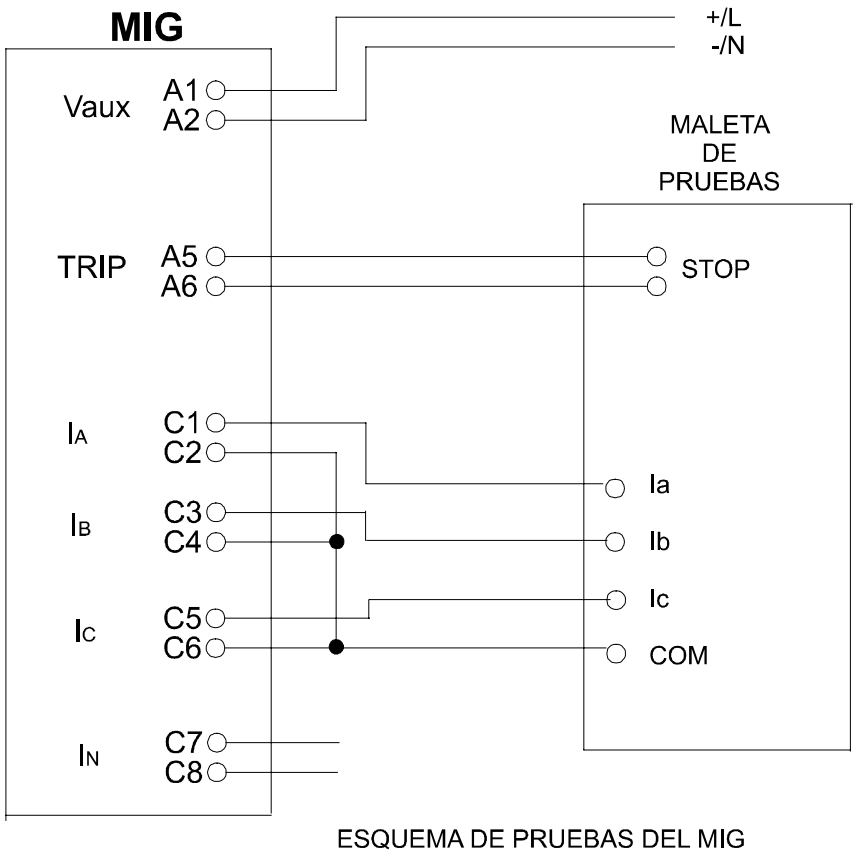


Figure 9-1 TEST CONNECTIONS FOR MIG RELAY

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: 51P, 50P, 46 and 49, setting their pickups and times to the minimum value possible. Inject to the relay on phase A and B a current equal to 2 x In (phase), making the relay trip and to close all the auxiliary outputs corresponding to the functions enabled.

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

Voltage test and maximum consumption is shown below:

Model "F" (24 - 48 Vdc)

Voltage (Vdc)	Maximum Consumption (mA)
18	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 MIG relay has a large number of settings, an exhaustive list of all the settings necessary for each test will not be given here. Just the specific settings required for each test are indicated, and it can be supposed that the other settings do not affect the test being performed.

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

9.9. CONTACT INPUTS

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

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

Repeat this test at minimum and maximum admissible voltage.

9.10. CONTACT OUTPUTS

The default configuration of outputs and LEDs is as follows:

TERMINALS

B5-B6	Alarm	
A5-A6	Trip	
B7-A7	(Out1)	49 Trip
B8-A7	(Out2)	50/51 Trip
B9-A7	(Out3)	46 Trip
B10-A7	(Out4)	Pickup

LEDs

READY

TRIP

THERM TRIP (49)

OVERCURRENT (50/51)

UNBALANCE (46)

PICKUP

Outputs and LEDs can be checked during the following tests:

9.11. RELAY METERING

9.11.1. CURRENT METERING

PHASE CURRENT

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

Phase	1	2	3	4
Ia (Amps)		0.5 x In (phase)		
Ib (Amps)	0.1 x In (phase)		1 x In (phase)	
Ic (Amps)				2 x In (phase)

Check that the relay measures Ia, Ib and Ic with accuracy better than 5%.

If the test were carried out at 50 Hz, repeat at 60 Hz (if at 60 Hz, repeat at 50 Hz).

GROUND CURRENT

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

	1	2
In (Amps)	0.1 x In (ground)	5 x In (ground)

Check that the relay measures the current 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. PHASE IOC SETTING UNIT (50P)

Enable only 50P 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 within 60 ms.

The test should be carried out for phases A, B and C.

9.13. GROUND IOC SETTING UNIT (50N)

Enable only 50N 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.

9.14. PHASE TOC UNIT (51P)

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. The tests are carried out for different phases. Each point is tested with a different pick up and dial in order to test the whole range of the relay.

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

9.14.1. IEC INVERSE CURVE

Set the relay as follows:

51P Settings Group	
Curve	INVERSE
Time Dial	1

- Apply 0.9 times the pickup current into phase A 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:

51P Settings Group	
Curve	VERY INVERSE
Time Dial	1

- · Apply 0.9 times the pickup current into phase B 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:

51P Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	0.5

- · Apply 0.9 times the pickup current into phase C 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:

51P Settings Group	
Curve	INVERSE
Time Dial	10

- · Apply 0.9 times the pickup current into phase A 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:

51P Settings Group	
Curve	VERY INVERSE
Time Dial	10

- · Apply 0.9 times the pickup current into phase B 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:

51P Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	5

- · Apply 0.9 times the pickup current into phase C 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:

51P Settings Group	
Curve	DEFINITE TIME
Time Dial	1.0

- Apply 0.9 times the pickup current into phase A 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. GROUND TOC UNIT (51N)

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

9.15.1. IEC INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	INVERSE
Time Dial	1

- · Apply 0.9 times the pickup current at the ground terminals 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.

9.15.2. IEC VERY INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	VERY INVERSE
Time Dial	1

- · Apply 0.9 times the pickup current at the ground terminals 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.

9.15.3. IEC EXTREMELY INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	0.5

- · Apply 0.9 times the pickup current at the ground terminals 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

9.15.4. ANSI INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	INVERSE
Time Dial	10

- · Apply 0.9 times the pickup current at the ground terminals 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.

9.15.5. ANSI VERY INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	VERY INVERSE
Time Dial	10

- · Apply 0.9 times the pickup current at the ground terminals 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.

9.15.6. ANSI EXTREMELY INVERSE CURVE

· Set the relay as follows:

51N Settings Group	
Curve	EXTREMELY INVERSE
Time Dial	5

- · Apply 0.9 times the pickup current at the ground terminals 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

9.15.7. DEFINITE TIME

· Set the relay as follows:

51N Settings Group	
Curve	DEFINITE TIME
Time Dial	1.0

- Apply 0.9 times the pickup current at the ground terminals 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.

9.16. THERMAL IMAGE UNIT (49)

This unit considers direct and inverse components, generating a I_{eq} value, and using the logarithmic curve derived from the equation below:

$$t = Tau \quad 1 * \ln \left| \frac{\left(\frac{Ieq}{Tap} \right)^2}{\left(\frac{Ieq}{Tap} \right)^2 - 1} \right|$$

Where:

$$Ieq = \sqrt{I_1^2 + K_1 * I_2^2}$$

9.16.1. DIRECT SEQUENCE TEST

Note: The numerical examples are for In = 5 A

1. Enable 49 function only.
2. Set the relay as follows:

49 Settings Group	
FLC	In (5 A)
Tap / Pickup	0.1 FLC (0.5 A)
Heating Time Constant T1	9 min.
K1	2

3. Apply pure direct sequence In (IN to each phase). The relay should trip in 5.4 s (±5%).

$$Ieq = \sqrt{I_1^2 + K_1 * I_2^2} = 5\,A$$

$$t = 9 * 60 * \ln \left| \frac{\left(\frac{5}{0.5} \right)^2}{\left(\frac{5}{0.5} \right)^2 - 1} \right| = 180 * \ln \left| \frac{100}{99} \right| = 5.4s$$

9.16.2. INVERSE SEQUENCE TEST

Apply 0.5 X In pure direct sequence current (0.5 x In to each phase). The relay should trip in 10.92 s (±5%).

$$Ieq = \sqrt{I_1^2 + K_1 * I_2^2} = \sqrt{2 * 2.5^2} = 3.54\,A$$

$$t = 9 * 60 * \ln \left| \frac{\left(\frac{3.54}{0.5}\right)^2}{\left(\frac{3.54}{0.5}\right)^2 - 1} \right| = 180 * \ln \left| \frac{50}{49} \right| = 10.92\ s$$

9.16.3. SINGLE-PHASE SIGNAL TEST

Apply 1.2 x In only to phase A. The relay should trip in 11.37 s (±5%).

$$I_1 = I_2 = {I_a}/{3} = {6}/{3} = 2\,A$$

$$Ieq = \sqrt{I_1^2 + K_1 * I_2^2} = \sqrt{4 + 2 * 4} = 3.46\ A$$

$$t = 9 * 60 * \ln \left| \frac{\left(\frac{3.46}{0.5}\right)^2}{\left(\frac{3.46}{0.5}\right)^2 - 1} \right| = 180 * \ln \left| \frac{48}{47} \right| = 11.37\ s$$

9.17. LOCKED ROTOR (48)

Enable only unit 48.

Set the relay as follows:

FLC = In

48 Tap = 2 x FLC

T = 4 s

Check the following:

- Apply 90% of 48 Tap; the relay should not trip.
- Apply 110% of 48 Tap; the relay should trip in 4s ±500 ms.
- Apply 90% of 48 Tap; the unit should drop out.

9.18. UNDERCURRENT UNIT (37)

This unit will trip when the current level is between two thresholds, being the upper limit Tap 37, and the lower limit 5% of FLC.

Enable only Unit 37.

Set (for In=5 A):

FLC = 1.2 * In = 1.2 * 5 A = 6 A

Upper limit: TAP 37 = 0.27 $\Rightarrow$ 0.27*6 A = 1.62 A

Lower limit: 5% FLC = 5% 6 A = 0.3 A

t = 1 s

Check the following for the lower limit:

- Apply 90% of the lower limit; 90% 0.3 A = 0.27 A; the relay should not trip.
- Apply 110% of the lower limit; 110% 0.3 A = 0.333 A. Acceptable time range is between 1.00 and 1.06 sec.
- Apply 90% of the lower limit; 90% 0.3 A = 0.27 A; the unit will drop out.

Check the following for the upper limit:

- Apply 110% of the lower limit; 110% 1.62 A = 1.78 A; the relay should not trip.
- Apply 90% of the lower limit; 90% 1.62 A = 1.46 A. Acceptable time range is between 1.00 and 1.06 sec.
- Apply 110% of the lower limit; 110% 1.62 A = 1.78 A; the unit will drop out.

9.19. NEGATIVE SEQUENCE – UNBALANCE (46)

WARNING: Currents to be applied are negative sequence currents.

This unit can be set for operating with a definite time, or according to the following equation:

$$t = \frac{K}{\left|\frac{I_2}{FLC}\right|^2}$$

The TAP46 setting fixes a value below which the relay will not trip.

There is also a fix non-tripping time between 230-250 ms.

DEFINITE TIME MODE:

Enable only Unit 46.

Set the Unit as follows:

FLC = In

TAP 46 = 0.1 x FLC

Curve type = TDEF

t = 1 s

Check the following:

- Apply 95% of TAP 46; the relay should not trip.
- Apply 105% of TAP 46; acceptable tripping time range is between 1.00 and 1.06 sec.

INVERSE TIME MODE:

Enable only Unit 46.

Set the Unit as follows:

FLC = In

TAP 46 = 0.8 x FLC

Curve type = CURVA

K = 1

Check the following:

- Apply 1 x FLC; the relay should trip in 1.00 seconds (according to the above equation).
- Apply 0.7 x FLC; wait for 2.5 sec. and check that the unit does not trip.

9.20. MAXIMUM NUMBER OF STARTS AND TIME TO RESTART (66)

This units disconnects the motor when a selectable number of consecutive starts is reached within one hour. The detected starts are entered in a time window, and they are removed after an hour. The unit will operate when the number of starts in the time window reaches the selected maximum.

We must take into account that the maximum number of starts stored is 10. If more than 10 starts take place within one hour, the oldest will be removed and replaced by the most recent.

The relay detects that a motor starts when the average current of the three phases is higher than 5% of the FLC setting, and stops when the average falls below 7%.

Verification of the number of starts and minimum time with tripping output.

Enable only Unit 66.

The numerical example is for In = 5 A

Set the unit as follows:

FLC = 0.1 x In = 0.5 A

NSTARTS (Maximum number of starts/hour allowed) = 5

TTR (Time to restart) = 1 min.

Check the following:

- Apply once the FLC setting (0.5 A), maintain for at least 100 ms and remove.
- Check that the tripping contact is active for 1 minute.
- Repeat these steps 4 times.
- Apply current for the fifth time and maintain it.
- Check that the unit does not operate.
- Remove current. In the moment the unit will operate and will stay for one minute.

Verification of the Time Window of one hour

- Apply once the FLC setting (0.5 A), maintain for at least 100 ms and remove.
- Check that the tripping contact is active for 1 minute.
- Repeat these steps 4 times.
- Apply current for the fifth time. The unit will operate
- Check that the unit drops out after one hour.

9.21. 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.

9.22. 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.

9.22.1. GENERAL SETTINGS

	M+PC	HMI	SETTING	RANGE	STEP
GENERAL SETTINGS	**GENERAL SETTINGS**	**GENERAL**			
Relay Status	RELAY STATUS	STA		RDY / DIS	NA
Frequency	FREQUENCY	FRQ		50/60 Hz	NA
Full Load Current	FLC	FLC		0.1-2.4 A	0.01
				0.5-10 A	0.01
Password	---	PWD		1 - 255	
Address	---	ADD		1 - 255	1
Communication Baudrate	---	BAUD		300, 600, 1200, 2400, 4800, 9600, 19200	NA

9.22.2. PHASE / GROUND TOC SETTINGS (51P / 51N)

	M+PC	HMI	SETTING	RANGE	STEP
Phase TOC Function	**51P Function**	**F51P**			
51P Enable	Enable	Enable		Y/N	NA
51P Permission to Trip	51P Trip Permission	TRIP 51P		Y/N	NA
51P Tap / Pickup Value	51P Pickup	TAP 51P		0.1-2.4 FLC (Ph)	0.01
51P Curve Type	51P Curve Type	CURV 51P		INV, V.I., E.I., T.DE, USU	NA
51P Time Dial	51P Time Dial	DIAL 51P		0.05 - 2.00 (IEC curves)	0.01
				0.5 - 20.0 (ANSI curves)	0.01
51P Definite Time Delay	51P Definite Time	TIME 51P		0 - 99.99 s.	0.01 s.
Ground TOC Function	**51N Function**	**F51N**			
51N Enable	Enable	Enable		Y/N	NA
51N Permission to Trip	51N Trip Permission	TRIP 51N		Y/N	NA
51N Tap / Pickup (for 1/5 A ground)	51N Pickup	TAP 51N		0.1 - 2.4 In (Gnd)	0.01 In (Gnd)
51N Tap / Pickup (for sensitive ground)	51N Pickup	TAP 51N		0.005-0.12 A	0.001 A
51N Curve Type	51N Curve Type	CURV 51N		INV, V.I., E.I., T.DE, USU	NA

	M+PC	HMI	SETTING	RANGE	STEP
51N Time Dial	51N Time Dial	DIAL 51N		0.05 - 2.00 (IEC curves)	0.01
				0.5 - 20.0 (ANSI curves)	0.01
51N Definite Time Delay	51N Definite Time	TIME 51N		0 - 99.99 s.	0.01 s.

9.22.3. PHASE / GROUND IOC SETTINGS (50P / 50N)

	M+PC	HMI	SETTING	RANGE	STEP
Phase IOC Setting	**50P Function**	**F50P**			
50P Enabling	Enable	Enable		Y/N	NA
50P Permission to Trip	50P Trip Permission	TRIP 50P		Y/N	NA
50P Tap / Pickup	50P Pickup	TAP 50P		0.1 - 30 FLC	0.1
50P Time Delay	50P Time Delay	TIME 50P		0 - 99.99 s.	0.01 s.
Ground IOC Setting	**50N Function**	**F50N**			
50N Enabling	Enable	Enable		Y/N	NA
50N Permission to Trip	50N Trip Permission	TRIP 50N		Y/N	NA
50N Tap / Pickup (for 1/5 A ground)	50N Pickup	TAP 50N		0.1 - 30 In (Gnd)	0.1 In (G)
50N Tap / Pickup (for sensitive ground)	50N Pickup	TAP 50N		0.005-0.12 A	0.001 A
50N Time Delay	50N Time Delay	TIME 50N		0 - 99.99 s.	0.01 s.

9.22.4. UNDERCURRENT SETTINGS (37)

	M+PC	HMI	SETTING	RANGE	STEP
Undercurrent Setting	**37 Function**	**F37**			
37 Enabling	Enable 37	Enable 37		Y/N	NA
37 Permission to Trip	37 Trip Permission	TRIP 37		Y/N	NA
37 Tap / Pickup	37 Pickup	TAP 37		0.1 – 0.99 FLC	0.1
37 Time Delay	37 Time Delay	TIME 37		0 - 99.99 s.	0.01 s.

9.22.5. CURRENT UNBALANCE SETTINGS (46P)

	M+PC	HMI	SETTING	RANGE	STEP
Current Unbalance Setting	**46P Function**	**F46P**			
46P Enabling	Enable 46P	Enable 46P		Y/N	NA
46P Permission to Trip	46P Trip Permission	TRIP 46P		Y/N	NA
46P Tap / Pickup	46P Pickup	TAP 46P		0.05 – 0.99 FLC	0.01
Type of curve 46P	Curve 46P	CURV 46P		TDEF/CURVA	NA
Constant K	K 46P	K 46P		1-100	1
Definite time 46P	Definite Time 46P	TIME 46P		0 - 99.99 s.	0.01 s.

9.22.6. LOCKED ROTOR (48)

	M+PC	HMI	SETTING	RANGE	STEP
Locked Rotor Setting	**48 Function**	**F48**			
48 Enabling	Enable 48	Enable 48		Y/N	NA
48 Permission to Trip	48 Trip Permission	TRIP 48		Y/N	NA
48 Tap / Pickup	48 Pickup	TAP 48		1.01 – 10 FLC	0.01
48 Time Delay	48 Time Delay	TIME 48		0.10 - 99.99 s.	0.01 s.

9.22.7. THERMAL IMAGE SETTINGS (49)

	M+PC	HMI	SETTING	RANGE	STEP
Thermal Image (49)	**49 Function**	**F49**			
F49 Enabling	Enable 49	ENABLE		Y/N	NA
Permission to Trip	49 Trip Permission	TRIP 49		Y/N	NA
49 Tap / Pickup (on FLC)	49 Pickup	TAP 49		0.1 - 2.4 FLC	0.01
Overload Percent Alarm	49 Alarm Level	ALARM 49		70% - 100% ITH	1%
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
K1 Constant	K1	K1		1 – 8	1

9.22.8. MAXIMUM NUMBER OF STARTS (66)

	M+PC	HMI	SETTING	RANGE	STEP
Maximum number of starts	**66 Function**	**F66**			
66 Enabling	Enable 66	Enable 66		Y/N	NA
66 Permission to Operate	66 Oper. Permission	OPER 66		Y/N	NA
No. Starts per hour	No. Starts	No START		0-10	1
Block reset time (STOP-START)	Restart Time	TTR		0 – 100 min	1

9.22.9. RESTRICTED GROUND DIFFERENTIAL (87R)

	M+PC	HMI	SETTING	RANGE	STEP
Restricted Ground Differential	**87R Function**	**F87R**			
87R Enabling	Enable 87R	Enable 87R		Y/N	NA
87R Permission to Trip	87R Trip Permission	TRIP 87R		Y/N	NA
Differential sensitivity (S)	S	S		0.02 – 0.3 In	0.01 In
Step sensitivity (K1)	K1	K1		0.02 – 0.3 In	0.01 In
87R Time Delay	T	T		0.0 - 99.99 s.	0.01 s.
87R Percentage slope	K	K		0.1 – 1.2	0.1

9.23. ADVANCED SETTINGS

9.23.1. GENERAL SETTINGS

	M+PC	HMI	SETTING	RANGE	STEP
GENERAL ADVANCED SETTINGS	**GENERAL ADVANCED SETTINGS**	**GENERAL ADVANCED**			
Identification	IDENTIFICATION	---		Text	NA
Active Table	ACTIVE TABLE	TAB		1-2	NA
Minimum tripping time	MIN TRIP TIME	MIN TRIP TIME		50-300 ms	1 ms

9.23.2. PHASE / GROUND TOC SETTINGS (51P / 51N) (TABLE 2)

	M+PC	HMI	SETTING	RANGE	STEP
Phase TOC Function Table 2	**51P Function T2**	**F51P T2**			
51P Enable Table 2	Enable T2	Enable T2		Y/N	NA
51P Permission to Trip Table 2	51P Trip Permission T2	TRIP 51P T2		Y/N	NA
51P Tap / Pickup Value Table 2	51P Pickup T2	TAP 51P T2		0.1-2.4 FLC (Ph)	0.01
51P Curve Type Table 2	51P Curve Type	CURV 51P		INV, V.I., E.I., T.DE, USU	NA
51P Time Dial Table 2	51P Time Dial T2	DIAL 51P T2		0.05 - 2.00 (IEC curves)	0.01
				0.5 - 20.0 (ANSI curves)	0.01
51P Definite Time Delay Table 2	51P Definite Time T2	TIME 51P T2		0 - 99.99 s.	0.01 s.
Ground TOC Function Table 2	**51N Function**	**F51N**			
51N Enable Table 2	Enable T2	Enable T2		Y/N	NA
51N Permission to Trip Table 2	51N Trip Permission T2	TRIP 51N T2		Y/N	NA
51N Tap / Pickup (for 1/5 A ground) Table 2	51N Pickup T2	TAP 51N T2		0.1 - 2.4 In (Gnd)	0.01 In (Gnd)
51N Tap / Pickup (for sensitive ground) Table 2	51N Pickup T2	TAP 51N T2		0.005-0.12 A	0.001 A
51N Curve Type Table 2	51N Curve Type T2	CURV 51N T2		INV, V.I., E.I., T.DE, USU	NA
51N Time Dial Table 2	51N Time Dial T2	DIAL 51N T2		0.05 - 2.00 (IEC curves)	0.01
				0.5 - 20.0 (ANSI curves)	0.01

	M+PC	HMI	SETTING	RANGE	STEP
51N Definite Time Delay Table 2	51N Definite Time T2	TIME 51N T2		0 - 99.99 s.	0.01 s.

9.23.3. PHASE / GROUND IOC SETTINGS (50P / 50N)

	M+PC	HMI	SETTING	RANGE	STEP
Phase IOC Setting Table 2	**50P Function T2**	**F50P T2**			
50P Enabling Table 2	Enable T2	Enable T2		Y/N	NA
50P Permission to Trip Table 2	50P Trip Permission T2	TRIP 50P T2		Y/N	NA
50P Tap / Pickup Table 2	50P Pickup T2	TAP 50P T2		0.1 - 30 FLC	0.1
50P Time Delay Table 2	50P Time Delay T2	TIME 50P T2		0 - 99.99 s.	0.01 s.
Ground IOC Setting Table 2	**50N Function T2**	**F50N T2**			
50N Enabling Table 2	Enable T2	Enable T2		Y/N	NA
50N Permission to Trip Table 2	50N Trip Permission T2	TRIP 50N T2		Y/N	NA
50N Tap / Pickup (for 1/5 A ground) Table 2	50N Pickup T2	TAP 50N T2		0.1 - 30 In (Gnd)	0.1 In (G)
50N Tap / Pickup (for sensitive ground) Table 2	50N Pickup	TAP 50N		0.005-0.12 A	0.001 A
50N Time Delay Table 2	50N Time Delay T2	TIME 50N T2		0 - 99.99 s.	0.01 s.

9.23.4. UNDERCURRENT SETTINGS (37)

	M+PC	HMI	SETTING	RANGE	STEP
Undercurrent Setting Table 2	**37 Function T2**	**F37 T2**			
37 Enabling Table 2	Enable 37 T2	Enable 37 T2		Y/N	NA
37 Permission to Trip Table 2	37 Trip Permission T2	TRIP 37 T2		Y/N	NA
37 Tap / Pickup Table 2	37 Pickup T2	TAP 37 T2		0.1 – 0.99 FLC	0.1
37 Time Delay Table 2	37 Time Delay T2	TIME 37 T2		0 - 99.99 s.	0.01 s.

9.23.5. CURRENT UNBALANCE SETTINGS (46P)

	M+PC	HMI	SETTING	RANGE	STEP
Current Unbalance Setting Table 2	**46P Function T2**	**F46P T2**			
46P Enabling Table 2	Enable 46P T2	Enable 46P T2		Y/N	NA
46P Permission to Trip Table 2	46P Trip Permission T2	TRIP 46P T2		Y/N	NA
46P Tap / Pickup Table 2	46P Pickup T2	TAP 46P T2		0.05 – 0.99 FLC	0.01
Type of curve 46P Table 2	Curve 46P T2	CURV 46P T2		TDEF/CURVA	NA
Constant K Table 2	K 46P T2	K 46P T2		1-100	1
Definite time 46P Table 2	Definite Time 46P T2	TIME 46P T2		0 - 99.99 s.	0.01 s.

9.23.6. LOCKED ROTOR (48)

	M+PC	HMI	SETTING	RANGE	STEP
Locked Rotor Setting Table 2	**48 Function T2**	**F48 T2**			
48 Enabling Table 2	Enable 48 T2	Enable 48 T2		Y/N	NA
48 Permission to Trip Table 2	48 Trip Permission T2	TRIP 48 T2		Y/N	NA
48 Tap / Pickup Table 2	48 Pickup T2	TAP 48 T2		1.01 – 10 FLC	0.01
48 Time Delay Table 2	48 Time Delay T2	TIME 48 T2		0.10 - 99.99 s.	0.01 s.

9.23.7. THERMAL IMAGE SETTINGS (49)

	M+PC	HMI	SETTING	RANGE	STEP
Thermal Image (49) Table 2	**49 Function T2**	**F49 T2**			
F49 Enabling Table 2	Enable 49 T2	ENABLE T2		Y/N	NA
Permission to Trip Table 2	49 Trip Permission T2	TRIP 49 T2		Y/N	NA
49 Tap / Pickup (on FLC) Table 2	49 Pickup T2	TAP 49 T2		0.1 - 2.4 FLC	0.01
Overload Percent Alarm Table 2	49 Alarm Level T2	ALARM 49		70% - 100% ITH	1%
Heating Time Constant τ1	T1 T2	T1 T2		3 - 600 min.	1 min

	M+PC	HMI	SETTING	RANGE	STEP
Table 2					
Cooling Time Constant τ2 Table 2	T2 T2	T2 T2		1 - 6 times τ1	1
K1 Constant Table 2	K1 T2	K1 T2		1 – 8	1

9.23.8. MAXIMUM NUMBER OF STARTS (66)

	M+PC	HMI	SETTING	RANGE	STEP
Maximum number of starts Table 2	**66 Function T2**	**F66 T2**			
66 Enabling Table 2	Enable 66 T2	Enable 66 T2		Y/N	NA
66 Permission to Operate Table 2	66 Oper. Permission T2	OPER 66 T2		Y/N	NA
No. Starts per hour Table 2	No. Starts T2	No START T2		0-10	1
Block reset time (STOP-START) Table 2	Restart Time T2	TTR T2		0 – 100 min	1

9.23.9. RESTRICTED GROUND DIFFERENTIAL (87R)

	M+PC	HMI	SETTING	RANGE	STEP
Restricted Ground Differential Table 2	**87R Function T2**	**F87R T2**			
87R Enabling Table 2	Enable 87R T2	Enable 87R T2		Y/N	NA
87R Permission to Trip Table 2	87R Trip Permission T2	TRIP 87R T2		Y/N	NA
Differential sensitivity (S) Table 2	S T2	S T2		0.02 – 0.3 In	0.01 In
Step sensitivity (K1) Table 2	K1 T2	K1 T2		0.02 – 0.3 In	0.01 In
87R Time Delay Table 2	T T2	T T2		0.0 - 99.99 s.	0.01 s.
87R Percentage slope Table 2	K T2	K T2		0.1 – 1.2	0.1

9.24. CONFIGURATION SETTINGS

9.24.1. CONFIGURATION SETTINGS

SETTING	SETTING	RANGE
CFG1		CONFIG. SETTINGS
CFG2		CONFIG. SETTINGS
CFG3		CONFIG. SETTINGS
CFG4		CONFIG. SETTINGS

9.24.2. INPUT ASSIGNMENT SETTINGS

SETTING	SETTING	RANGE
CFG E.D. 1		INPUT ASSIGN.
CFG E.D. 2		INPUT ASSIGN.

9.24.3. OUTPUT ASSIGNMENT SETTINGS

SETTING	SETTING	RANGE
AUX 1		OUTPUT ASSIGN.
AUX 2		OUTPUT ASSIGN.
AUX 3		OUTPUT ASSIGN.
AUX 4		OUTPUT ASSIGN.

9.24.4. LED ASSIGNMENT SETTINGS

SETTING	SETTING	RANGE
LED 1		LED ASSIGN
MEMORY LED 1		YES/NO
LED 2		LED ASSIGN
MEMORY LED 2		YES/NO
LED 3		LED ASSIGN
MEMORY LED 3		YES/NO
LED 4		LED ASSIGN
MEMORY LED 4		YES/NO

9.25. EVENTS MASKS

Event masks have two possible settings, YES or NO. If an action (e.g. the trip of a protection function) is set as YES, when the trip takes place an event will be generated. If it is set as NO, no event will be generated.

	M+PC	SETTING	RANGE	STEP
Event masks	**Event masks**			
37 Pickup/Drop out	37 Pickup		Y/N	NA
46 Pickup/Drop out	46 Pickup		Y/N	NA
48 Pickup/Drop out	48 Pickup		Y/N	NA
49 Pickup/Drop out	49 Pickup		Y/N	NA
50P Pickup/Drop out	50P Pickup		Y/N	NA
50N Pickup/Drop out	50N Pickup		Y/N	NA
51P Pickup/Drop out	51P Pickup		Y/N	NA
51N Pickup/Drop out	51N Pickup		Y/N	NA
87R Pickup/Drop out	87R Pickup		Y/N	NA
37 Inhibition activation/deactivation	37 Inhibition (by DI)		Y/N	NA
46 Inhibition activation/deactivation	46 Inhibition (by DI)		Y/N	NA
48 Inhibition activation/deactivation	48 Inhibition (by DI)		Y/N	NA
49 Inhibition activation/deactivation	49 Inhibition (by DI)		Y/N	NA
50P Inhibition activation/deactivation	50P Inhibition (by DI)		Y/N	NA
50N Inhibition activation/deactivation	50N Inhibition (by DI)		Y/N	NA
51P Inhibition activation/deactivation	51P Inhibition (by DI)		Y/N	NA
51N Inhibition activation/deactivation	51N Inhibition (by DI)		Y/N	NA
87R Inhibition activation/deactivation	87R Inhibition (by DI)		Y/N	NA
Inhibition activation / deactivation by digital input	Trip inhibition by DI		Y/N	NA
37 Function trip	37 Trip		Y/N	NA
46 Function trip	46 Trip		Y/N	NA
48 Function trip	48 Trip		Y/N	NA
49 Function trip	49 Trip		Y/N	NA
50P Function trip	50P Trip		Y/N	NA

	M+PC	SETTING	RANGE	STEP
50N Function trip	50N Trip		Y/N	NA
51P Function trip	51P Trip		Y/N	NA
51N Function trip	51N Trip		Y/N	NA
87R Function trip	87R Trip		Y/N	NA
Trip by stop	Trip by stop		Y/N	NA
Function 66 Operation	Operation 66		Y/N	NA
General Trip	General Trip		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		Y/N	NA
Trip operation by digital input	Trip operation by input		Y/N	NA
Trip operation by command	Trip operation by com.		Y/N	NA
Auxiliary digital output latch reset	Reset latch aux		Y/N	NA
Emergency Reset	EMER		Y/N	NA
Close Breaker	Close Breaker		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
52B Open/Closed by Digital Input	52B Breaker		Y/N	NA (2)
52 Open/Closed	Closed breaker		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

10. INSTALLATION AND MAINTENANCE

10.1. INSTALLATION

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

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

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

Given that the design of the MIG 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 periodical program of tests is highly recommended. The unit incorporates built-in diagnostic functions that permit immediate identification with only the aid of the keypad and display, the detection of some of the most likely circuit failures. Testing the unit is recommended at intervals of 2 years or more. Although the built-in diagnosis does not reduce the average time between failures, it does increase the availability of the protection because it allows a drastic reduction in the average interruption time involved in detecting and repairing the fail.

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

10.4. CLEANING INSTRUCTIONS

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

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

11. ANNEX 1. HARMONIC FILTERING

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

GENERAL PRINCIPLE OF OPERATION.

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

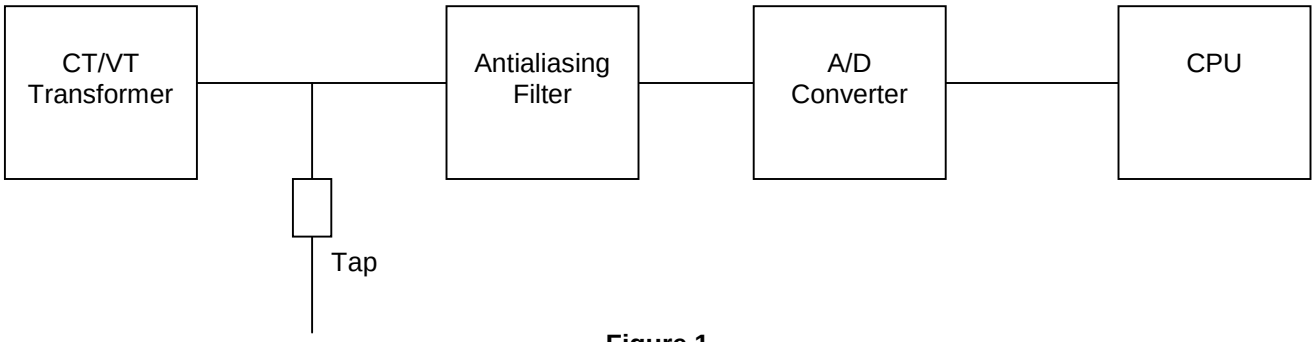


Figure 1

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

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

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

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

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

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

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

DIGITAL FILTER

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

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

The MIG 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 MIG 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.

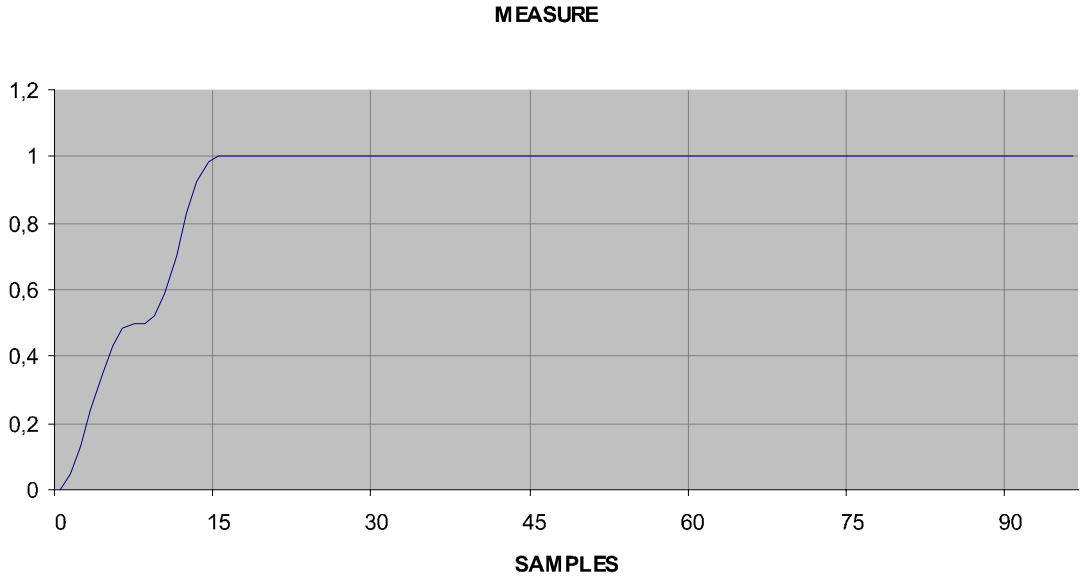


Figure 2

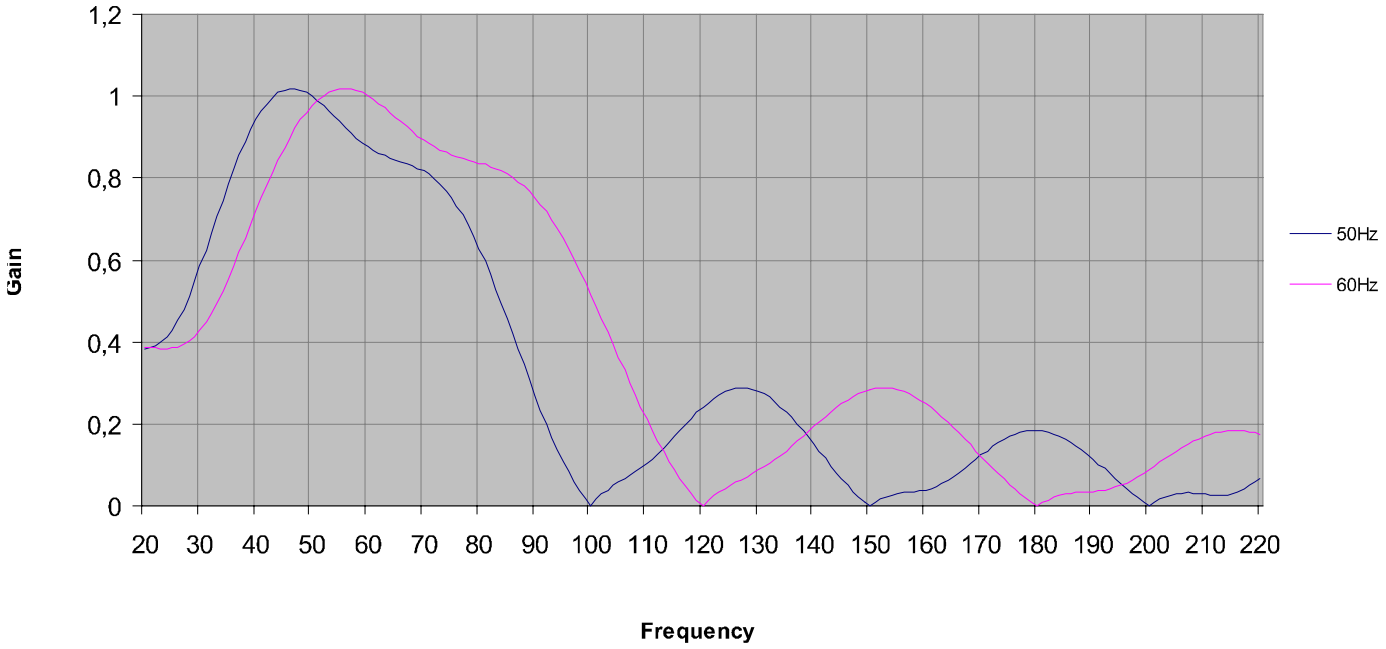


Figure 3

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.

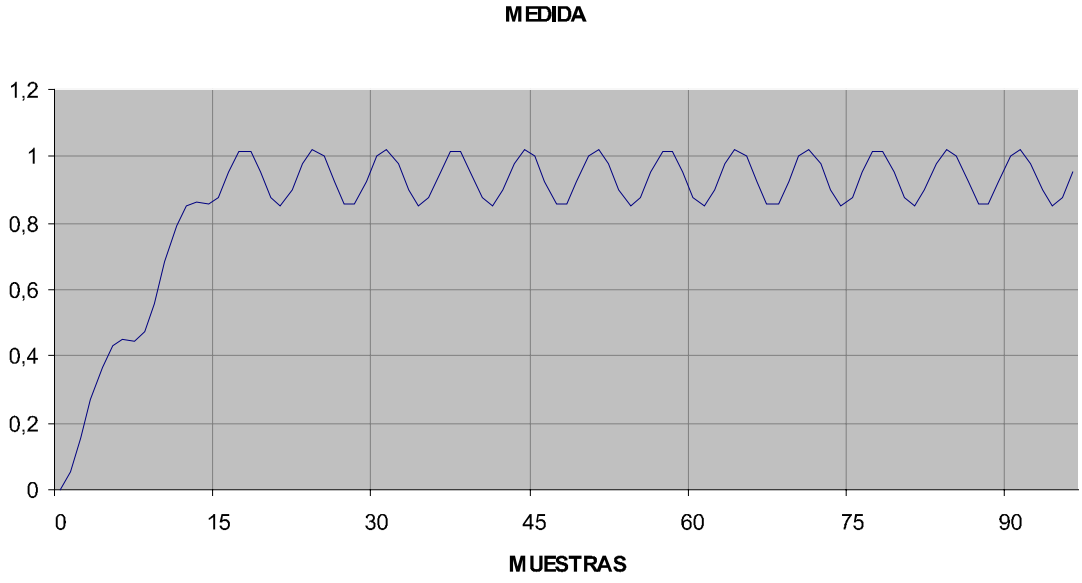


Figure 4

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

MEASURE AT FREQUENCIES BELOW THE RATED FREQUENCY (FREQUENCY TRACKING)

As already mentioned, the digital filter is related to the fundamental frequency, so higher multiple frequency values are annulled

During the start-up of generators, the voltage frequency in terminals and currents that can appear in the event of a fault, will depend on the machine speed. During the start-up process, the machine will rotate at very low speed, and therefore, the obtained DFT measure will be affected, as it works on values that are related to the fundamental frequency.

In order to guarantee the correct operation of the protection units during this transitory process of acceleration, the MIG relay incorporates a metering capability for maximum values (not RMS), that is applied to the protection units not using I1, I2 and I0 values only during this acceleration process. Once an admissible speed is reached (closed to the nominal speed), the system will automatically switch the metering technique to the DFT. These protection units are the overcurrent units, locked rotor and number of starts.

All protection units measure phase by phase and sample by sample using both metering techniques separately. When the obtained values are very close to each other and steady, then the system switches to DFT.

12. ANNEX 2. THERMAL IMAGE UNIT

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.

12.1. 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.

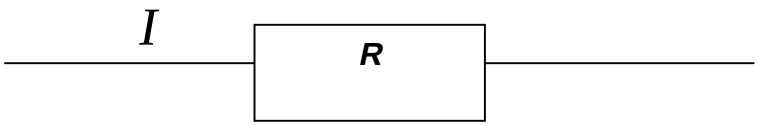
For regular overloading situations, heating is the main concern, leaving apart the dynamic effects.

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.

12.2. 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 (θa):



Being:

R = Ohm Resistance (W)

I = Current flowing through the element. (Amps)

m = Mass of the element (kg)

Ce = Specific Heat (Jul/kg/ºC)

θ = Element Temperature over ambient temperature (ºC)

a = Heat Transmission Coefficient, (adding conduction and convection effects (w/m2/ºC))

S = Element Surface (m2)

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:

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

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:

$$I' = I / I_{\infty}$$

Where:

θ_0: Initial temperature.

τ: Heating Constant, defined as: m * Ce / (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]):

$$\theta_\infty = I_\infty / \alpha$$

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

$$t = \tau * \ln \frac{I^2 - \alpha * \theta_0}{I^2 - \alpha * \theta} |$$

Introducing the following variable change:

$$\theta' = \theta / \theta_\infty$$

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

$$\theta' = I'^2 * (1 - e^{-t/\tau}) + \theta'_0 * e^{-t/\tau}$$

$$t = \tau * \ln \frac{I'^2 - \theta'_0}{I^2 - \theta'} |$$

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

$$I' = I / I_\infty$$

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

$$t = \tau * \ln \frac{I'^2 - \theta'_0}{I^2 - \theta'} |$$

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”:

$$t = \tau * \ln \frac{I'^2 - v^2}{I'^2 - 1} |$$

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.

12.3. 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.

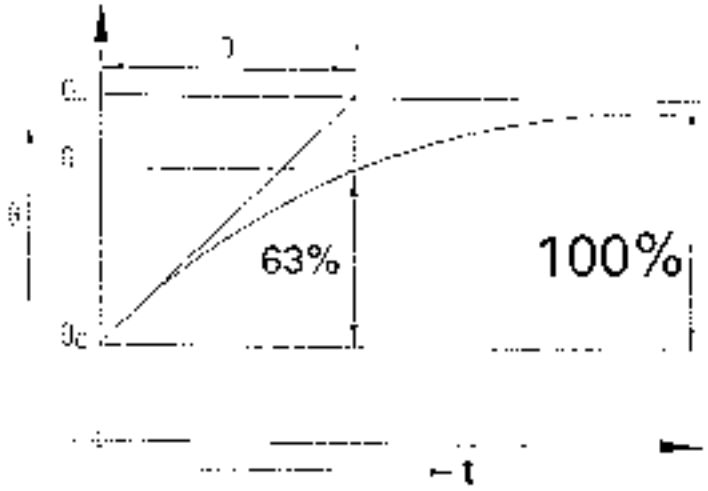
Equation [9] evaluation requires extensive computing resources, and thus, is not directly implemented in the protection relay. Instead, an iterative algorithm that mimics very closely the real equation is used.

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 MIG THERMAL CURVES

The equation for the temperature given before was:

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

The MIG 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 MIG 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” (the greater current value from the current in the three phases) is represented by the letter Ieq, and this is the value that the relay shows corresponding to the thermal image of the protected element. The relay is running the thermal image for the three phases, but only the greater value is shown in the display, as it is the one that will cause the trip.

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), MIG 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 $\tau 1$.

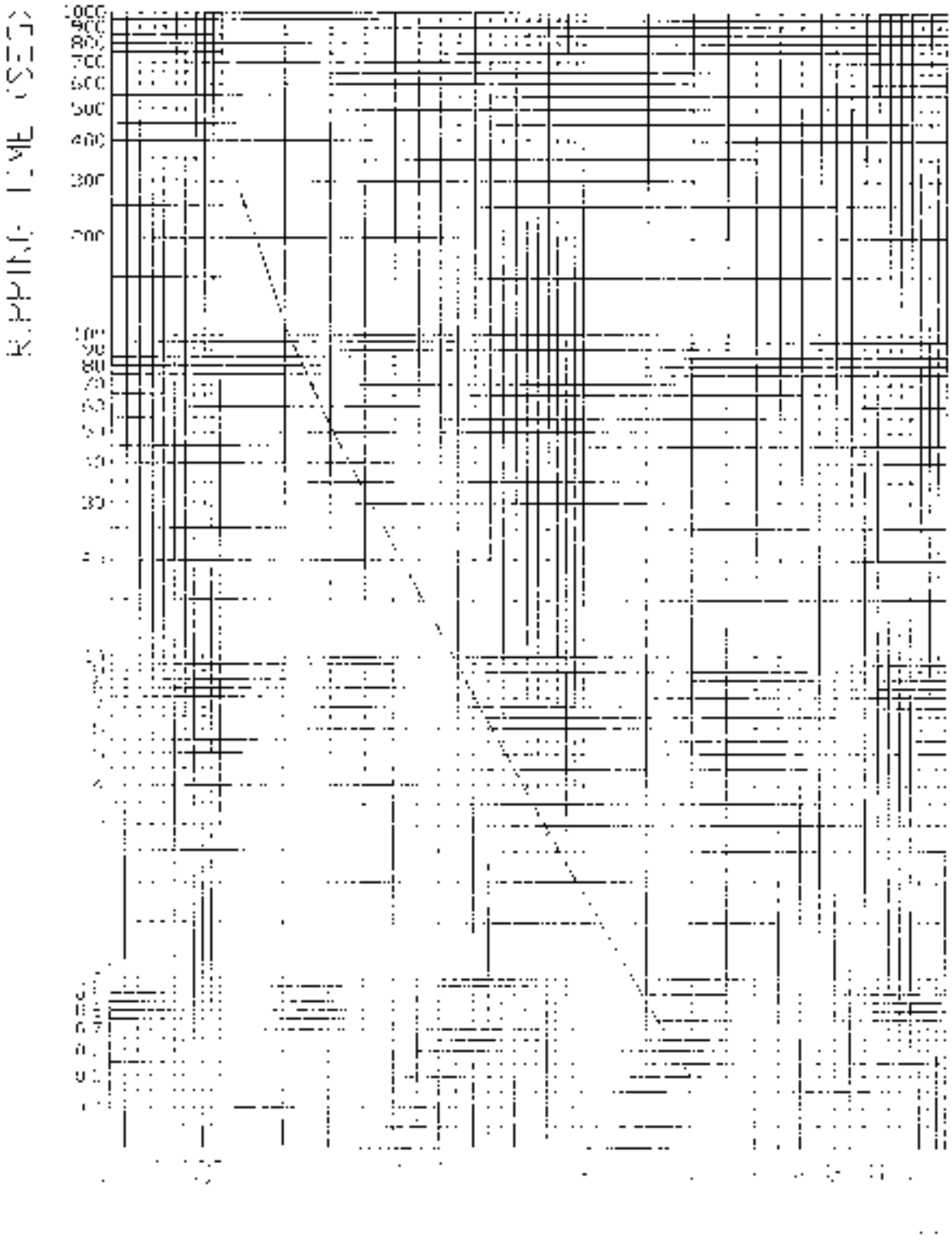


Figure A-1.1. THERMAL CURVE FOR τ1 = 3 MINUTES.

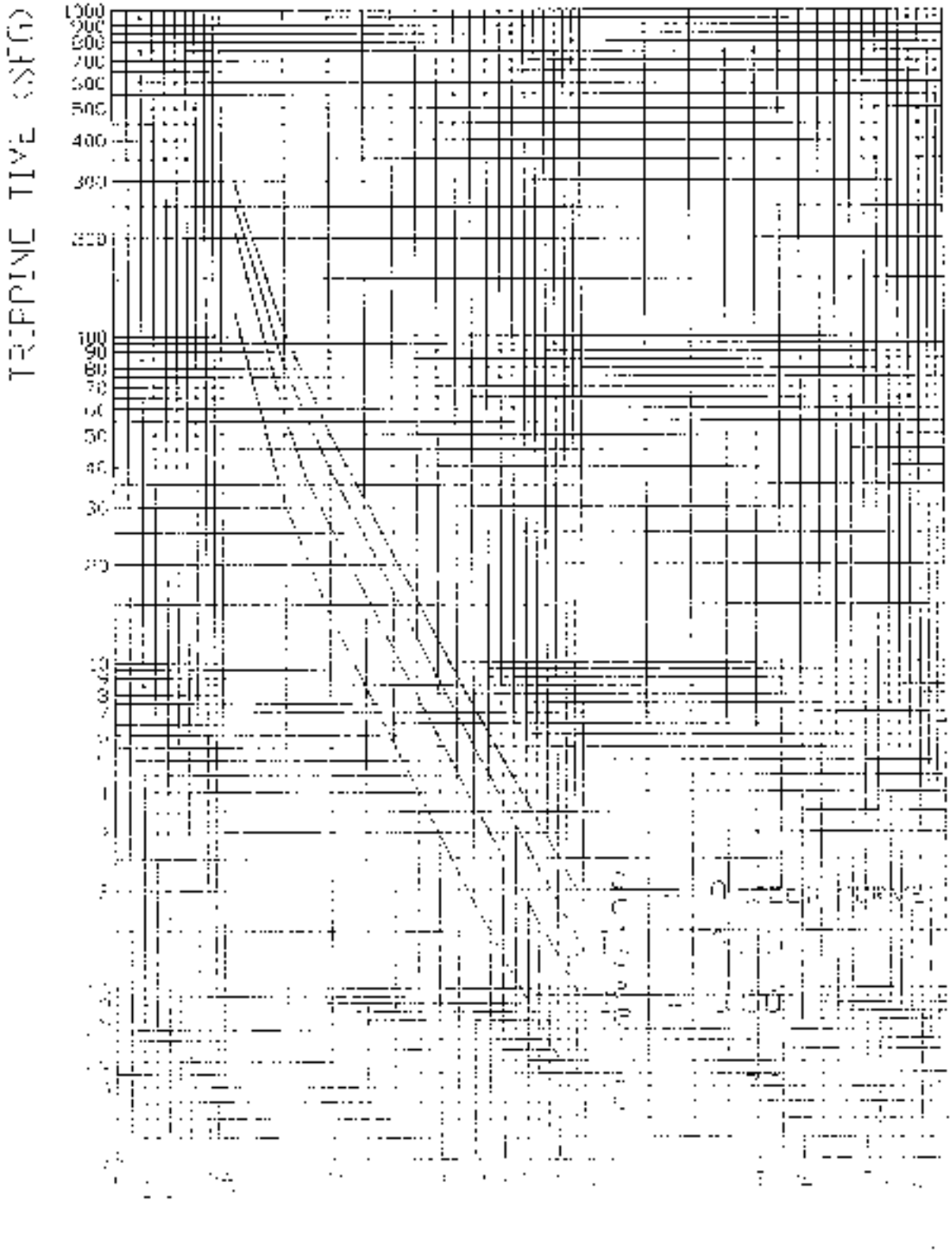


Figure A-1.2. THERMAL CURVES FOR τ1 = 3 MIN.

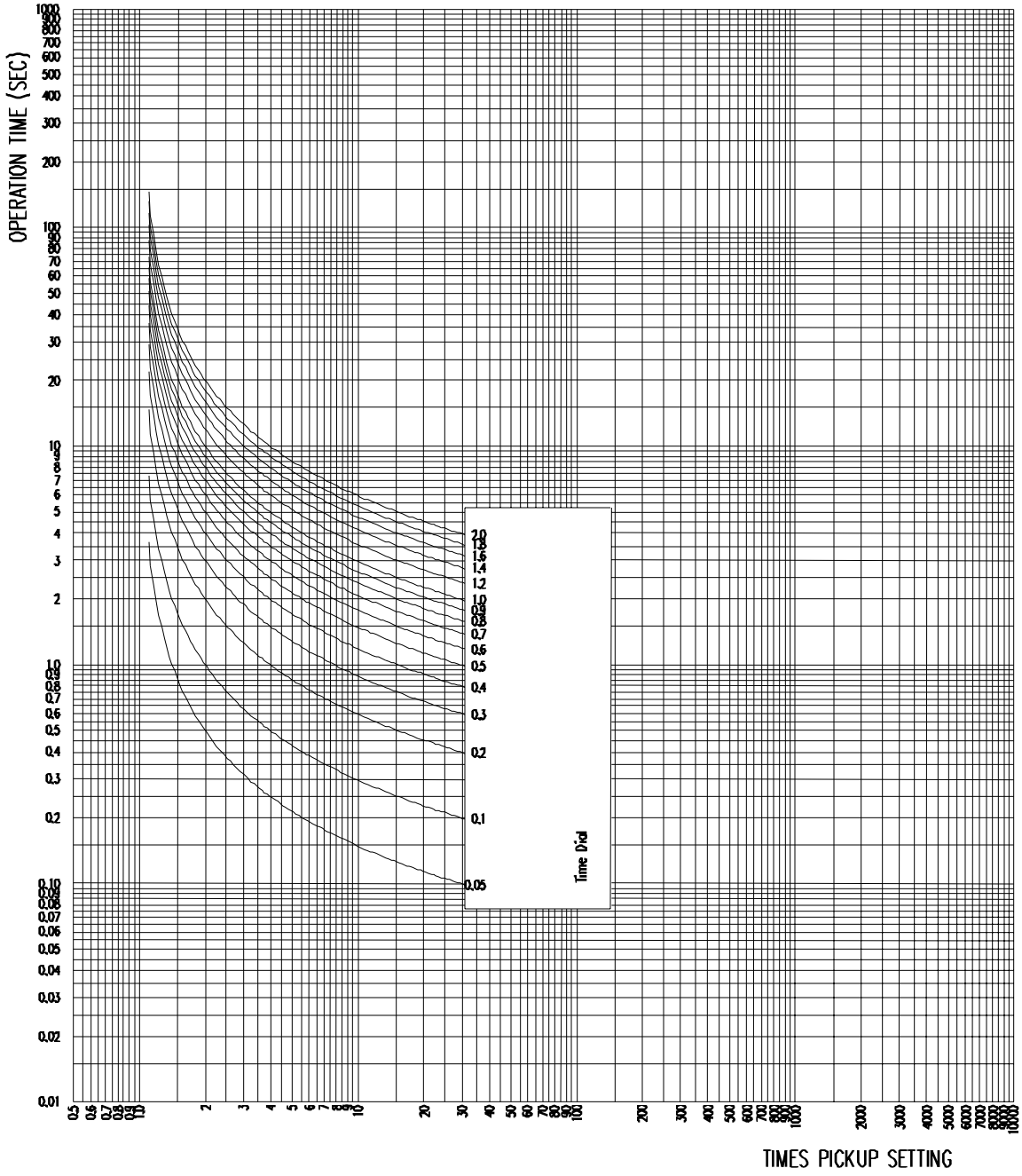


Figure A-2.1 INVERSE CURVES

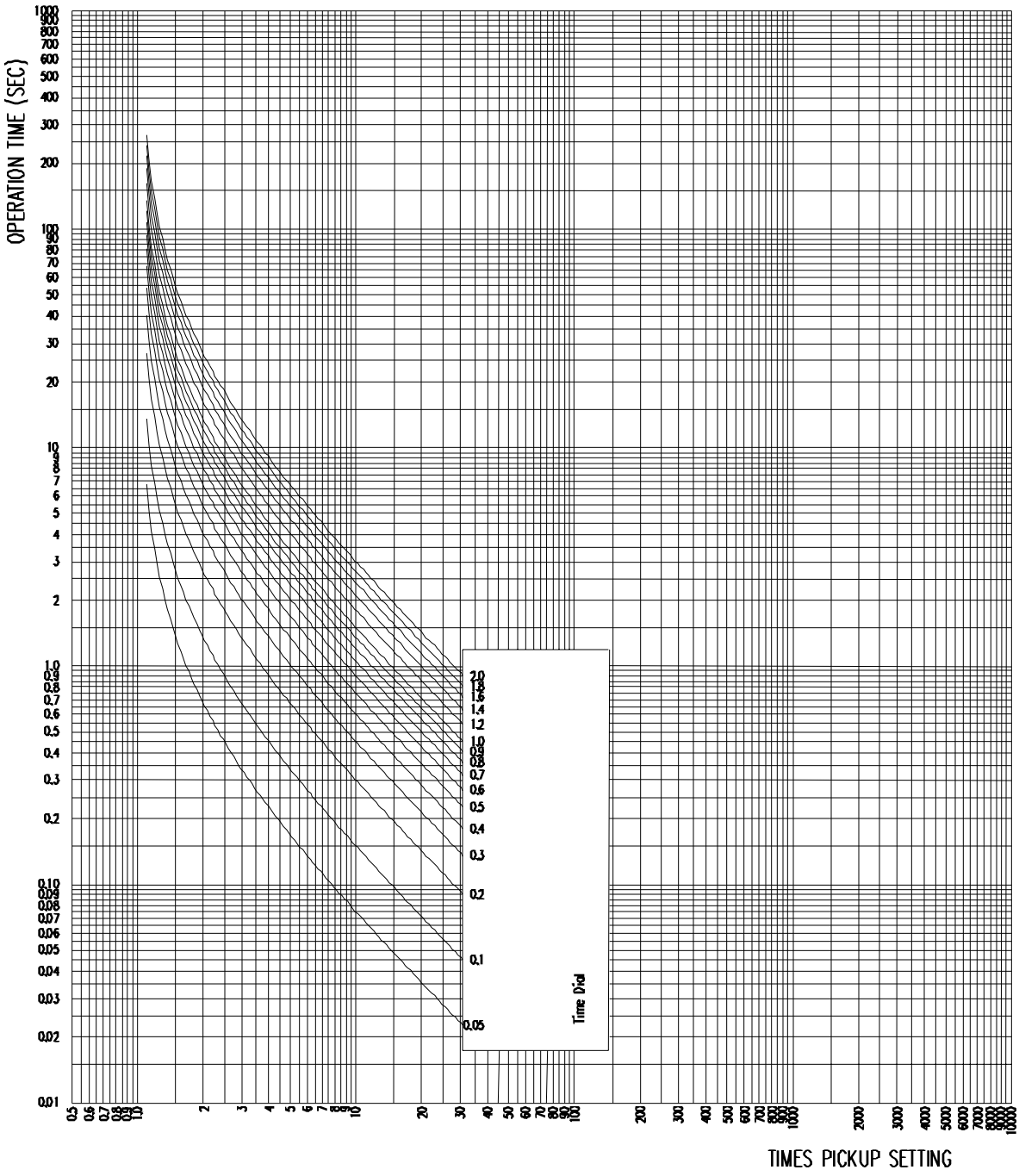


Figure A-2.2 VERY INVERSE CURVES

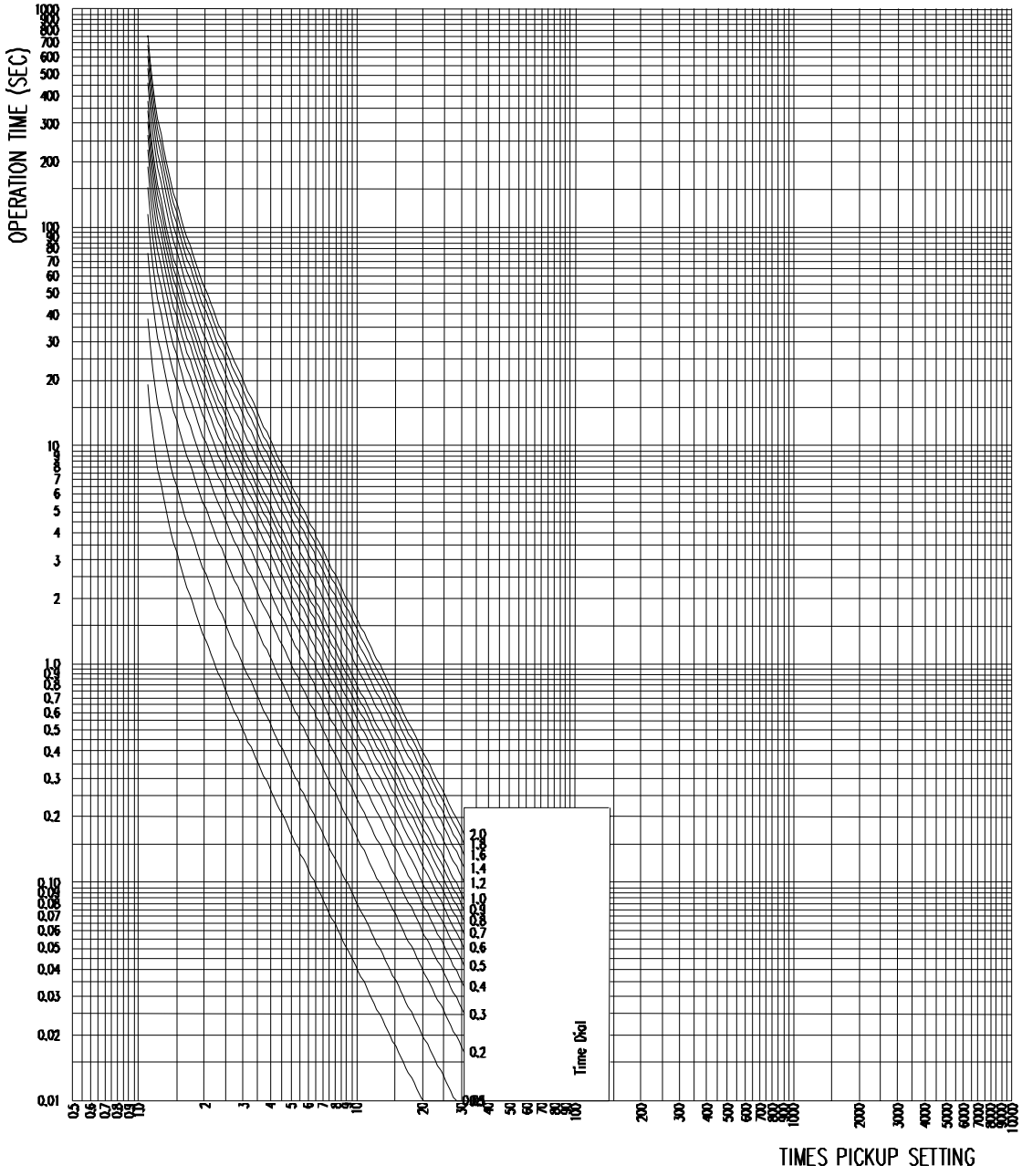


Figure A-2.3 EXTREMELY INVERSE CURVES

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

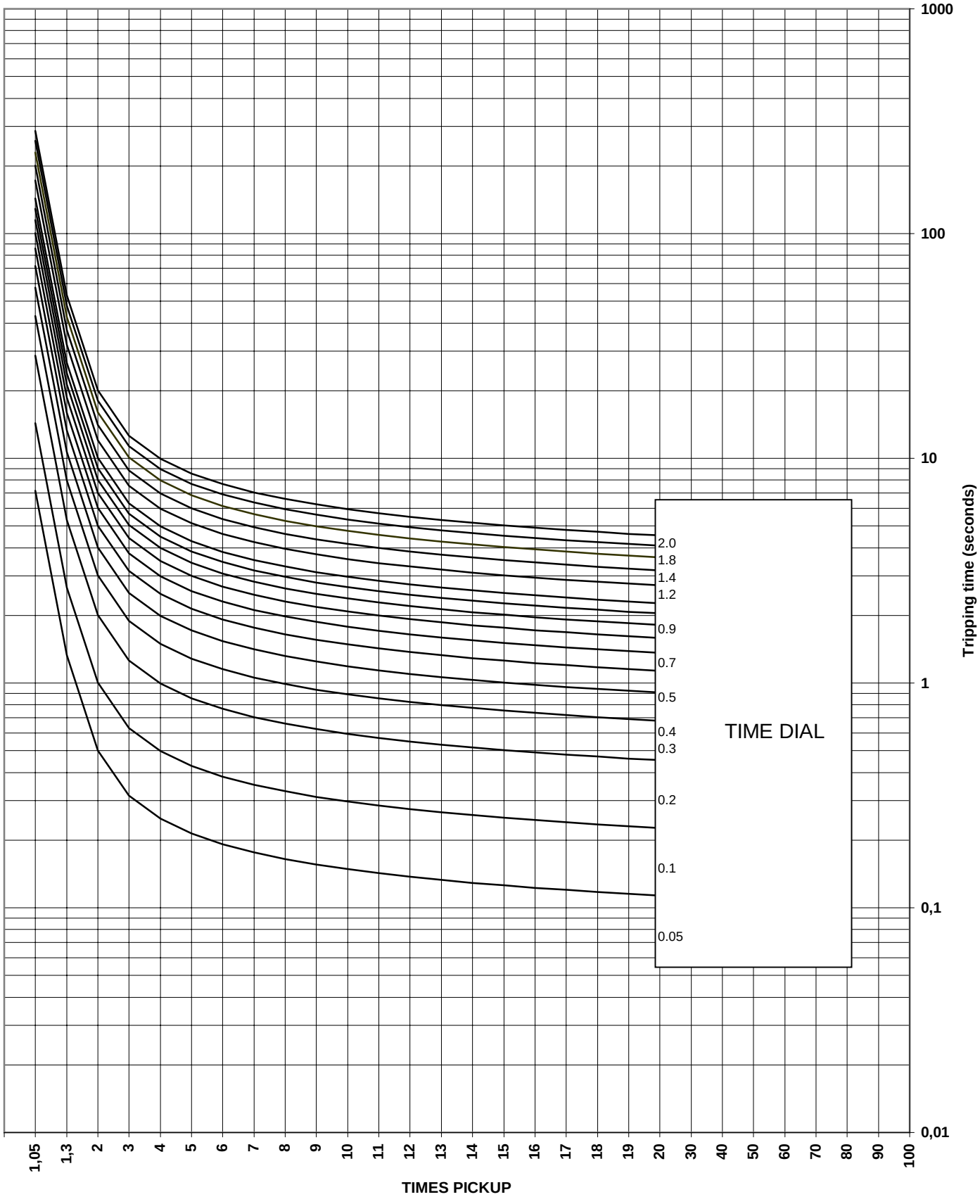
The general equation for all IEC/B142 curves is as follows:

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

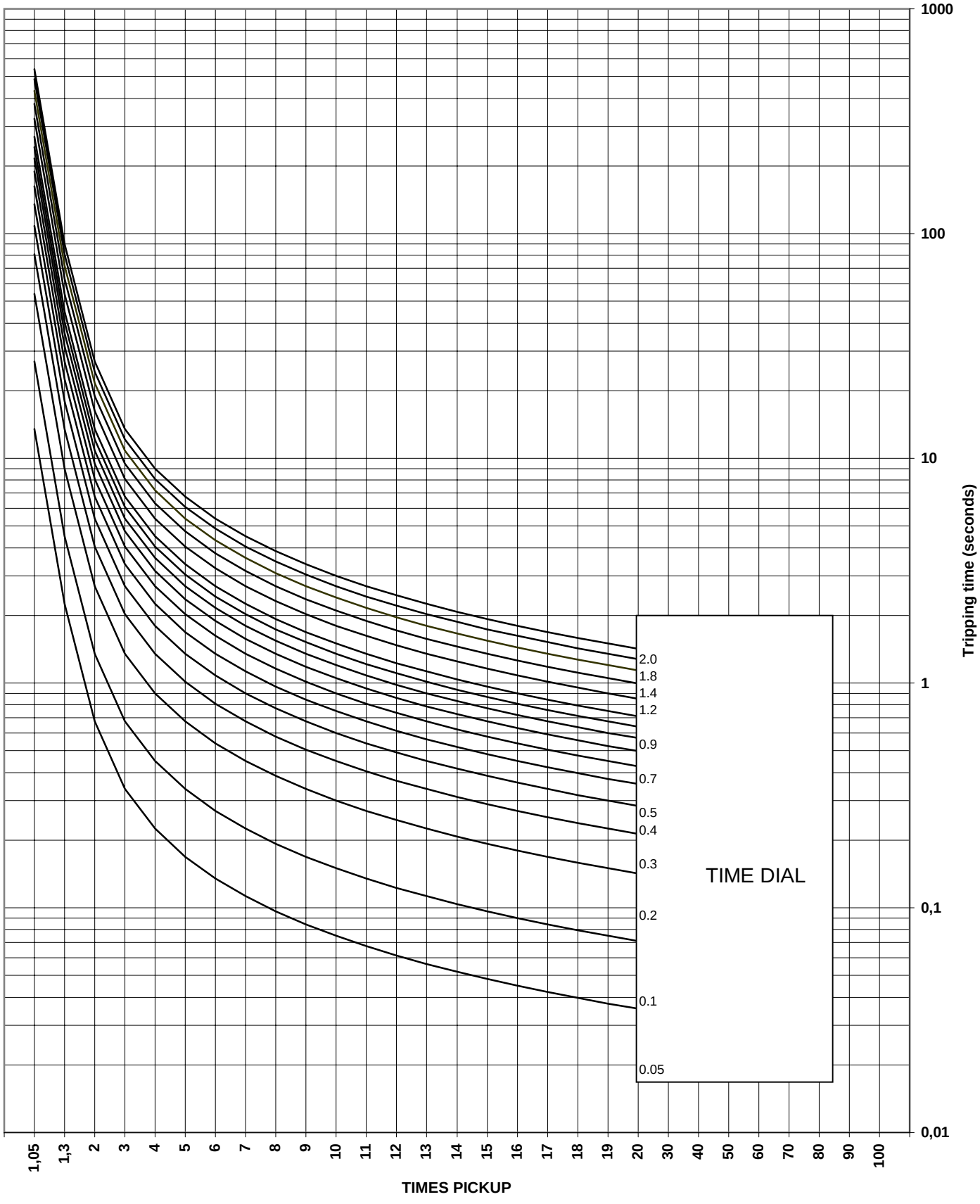
Where:

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

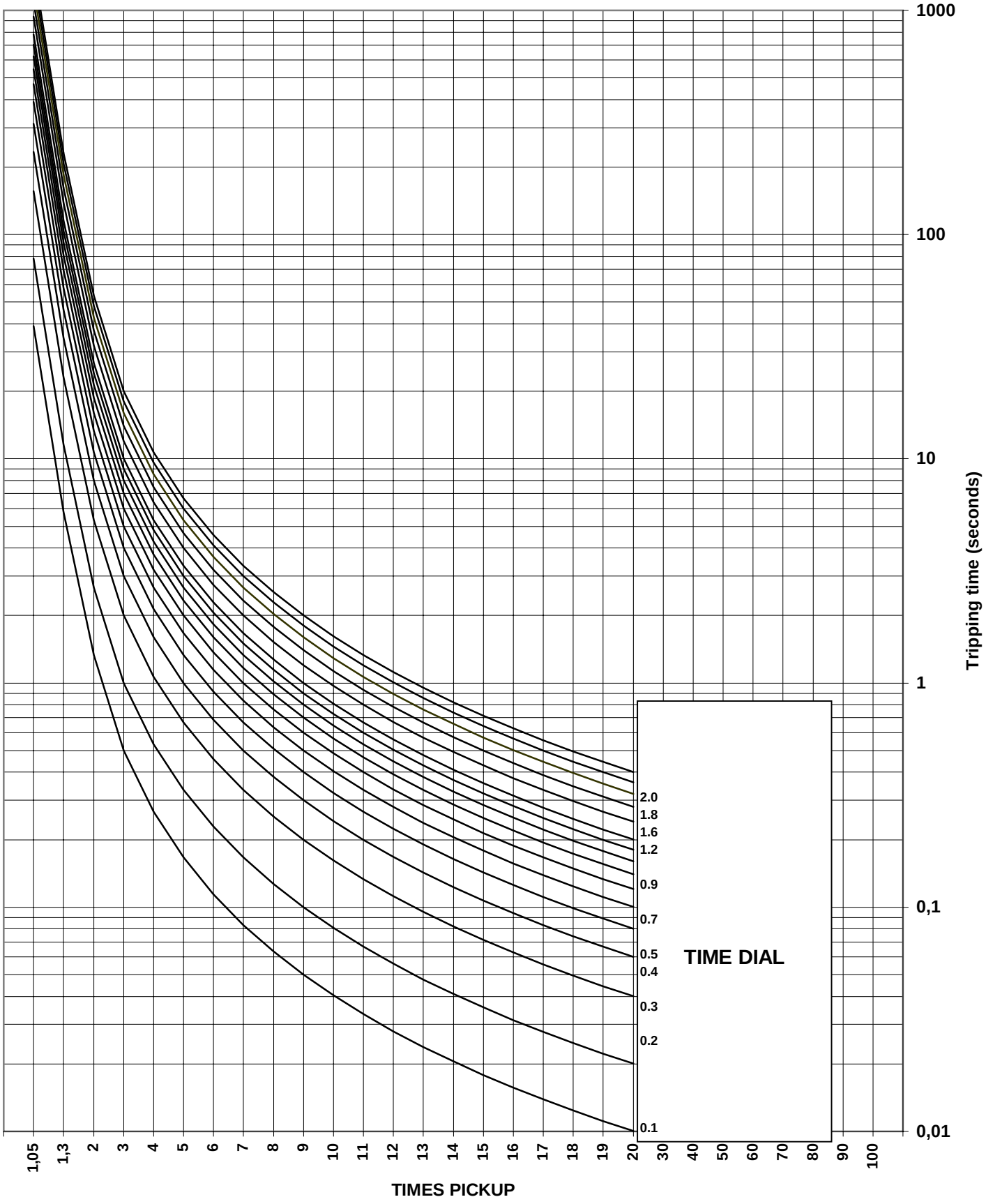


TABLE A2-2. TRIP TIMES (IN SECONDS) FOR ANSI CURVES

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

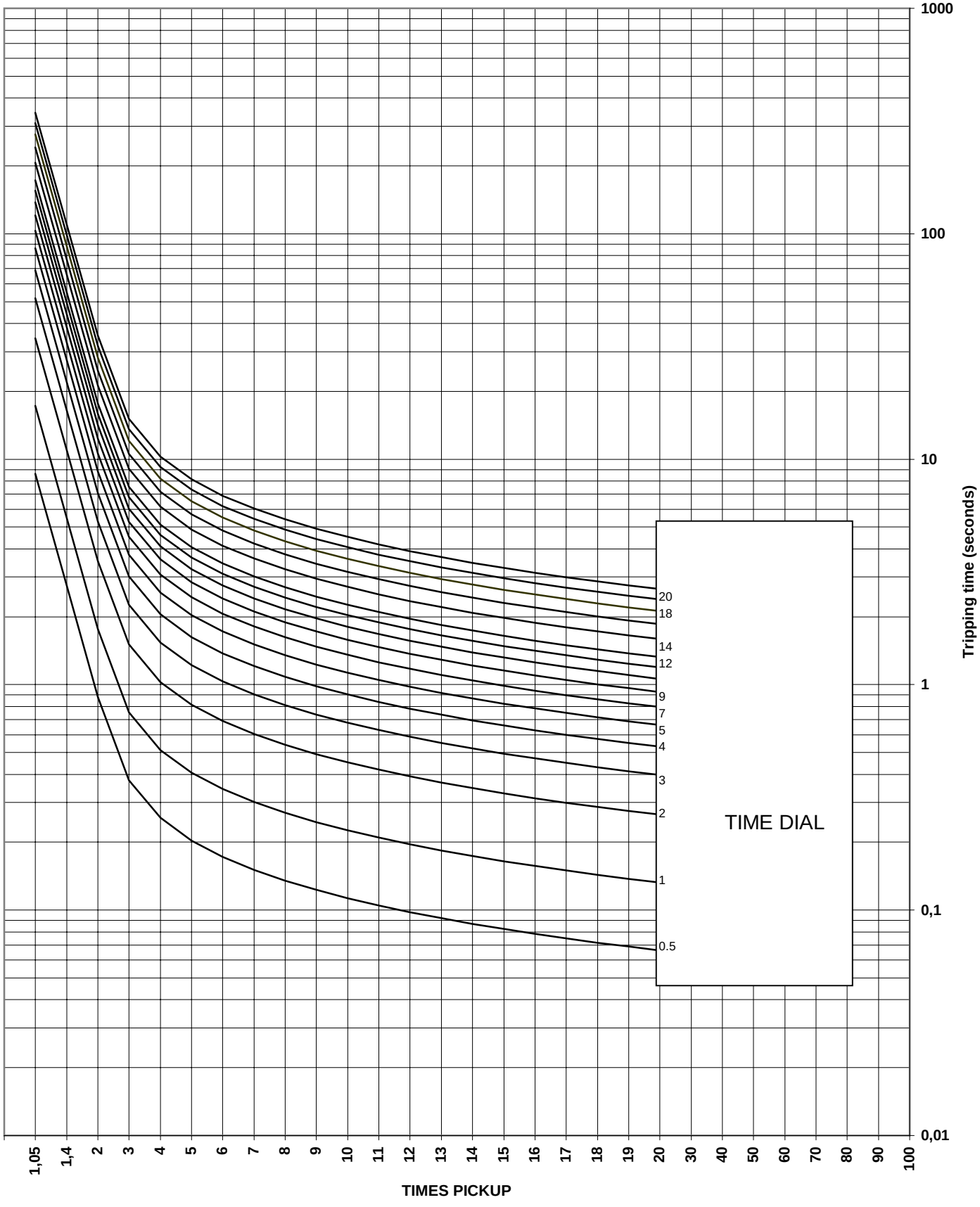
The general equation for all ANSI curves is as follows:

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

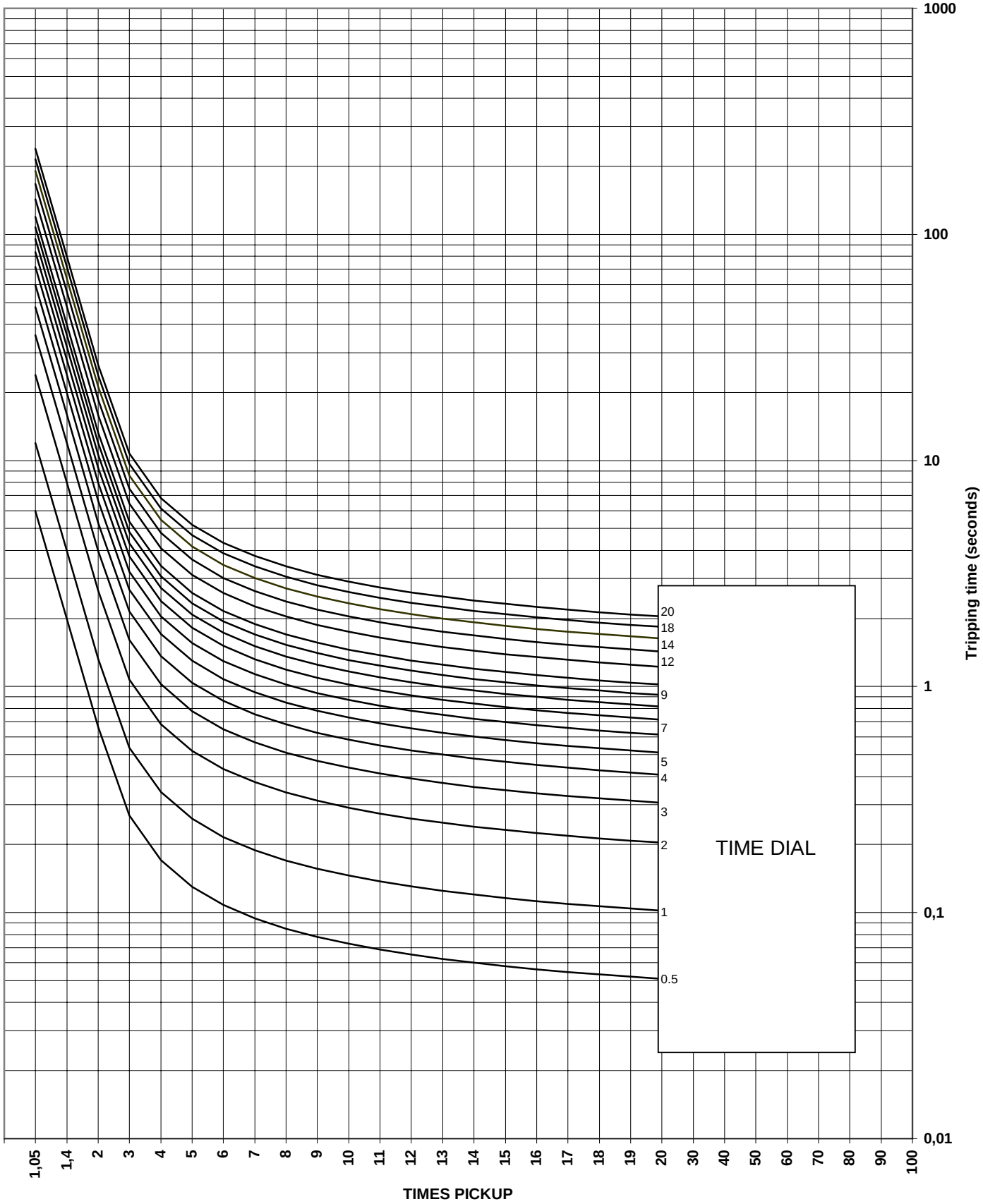
Where:

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

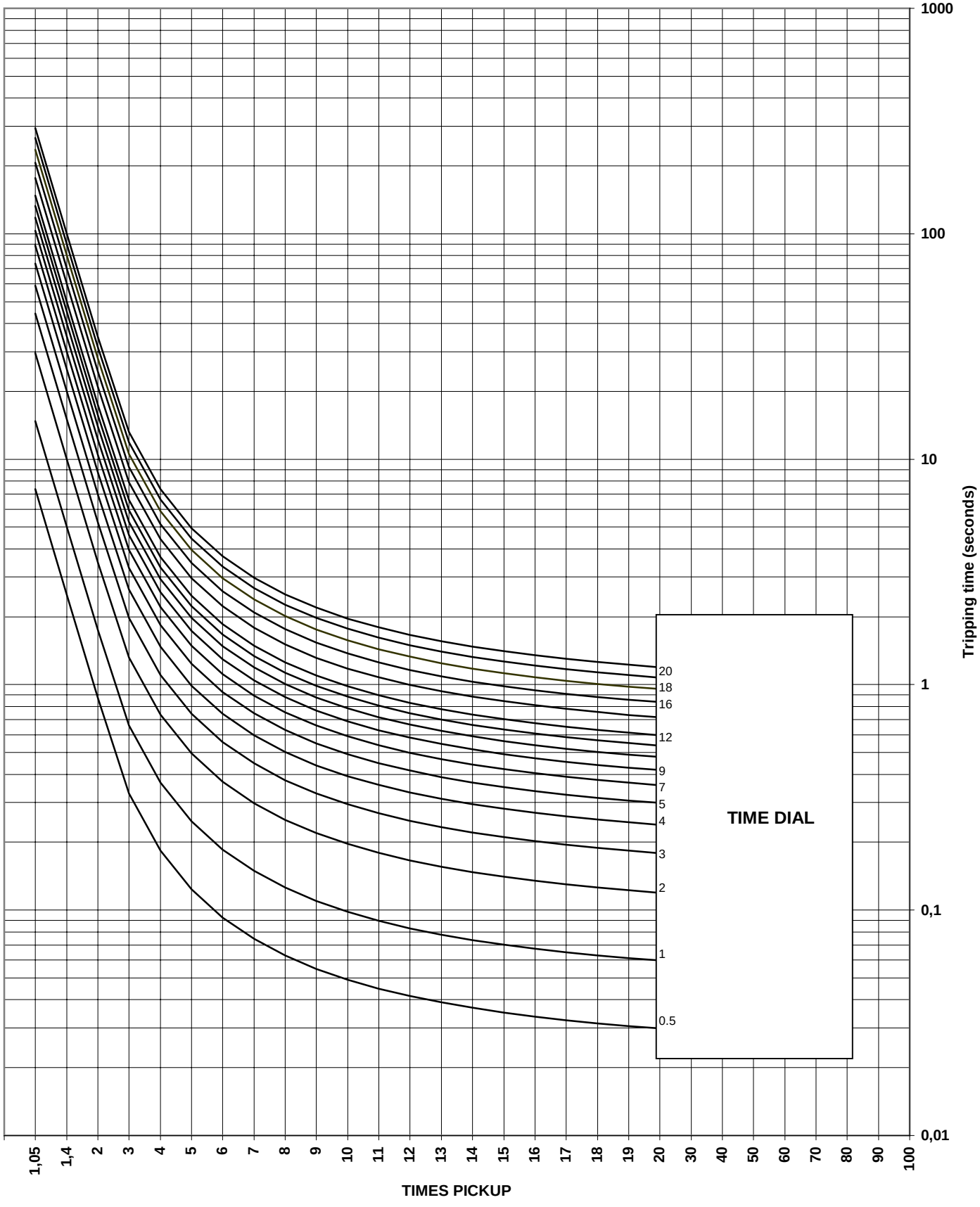
ANSI INVERSE



ANSI VERY INVERSE



ANSI EXTREMELY INVERSE



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