Digital Energy
Multilin

MIFII

Digital Feeder Protection with Recloser

Instruction Manual

GEK-106237Q

GE
Digital Energy

MIFII

Digital Feeder Protection with
Recloser
Instruction manual
GEK-106237Q

Order Code
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1

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

IMPORTANT WARNING: For upgrading the relay firmware to version 4.00 or later, it is mandatory that the EnerVista MII Setup version is 1.10 or higher. For firmware version 5.00 or later, the EnerVista MII Setup version must be 2.10 or later. Otherwise it may result in damage to the relay.

It will take a few seconds for the relay to restart after the completion of the update process. Therefore, before unplugging the relay, please make sure that the relay main screen shows the analog inputs values.

1

Open the relay packaging and inspect the relay for physical damage.

Check the label at the side of the relay and check that the relay model is the same model ordered.

Figure 1–1: RELAY IDENTIFICATION LABEL (A4454P3)

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 Multilin Home Page (www.GEdigitalenergy.com/multilin).

Note: If there is any physical damage detected on the relay, or any of the contents listed are missing, please contact GE Multilin immediately at:

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The information provided herein does not intend to cover all details of variations of the 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 MULTILIN.

1

The EnerVista MII SETUP 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 EnerVista MII SETUP software to properly operate on a PC:

- Pentium® class or higher processor (Pentium® II 300 MHz or higher recommended)

- Windows® NT 4.0 (Service Pack 3 or higher), Windows® 2000, Windows® XP

- Internet Explorer® 5.0 or higher

- 64 MB of RAM (128 MB recommended)

- 40 MB of available space on system drive and 40 MB of available space on installation drive

- RS232C serial and Ethernet port for communications to the relay

The ground screw shown in the following figure must be correctly grounded.
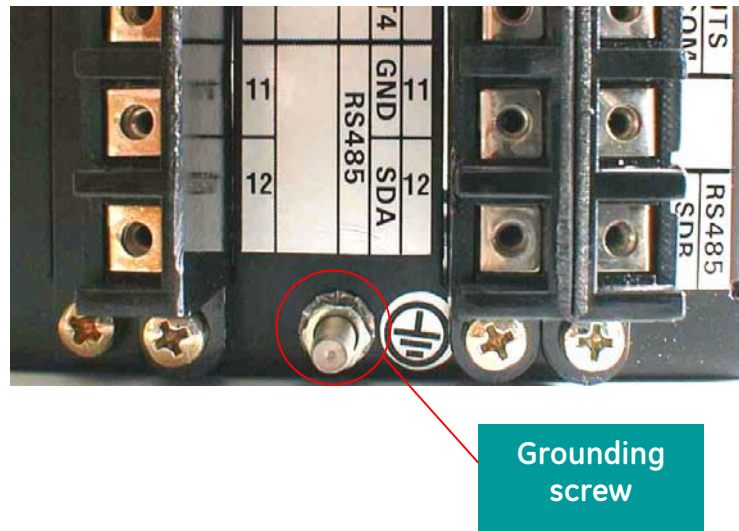
Grounding screw

Figure 1–2: GROUNDING SCREW LOCATION

If you want to communicate with the relay using a computer through the front serial port, please ensure that the computer is properly grounded.

In case of using a portable computer, it is recommended to have it disconnected from its power supply, as in many cases they are not correctly grounded and this may damage either the computer or the relay. If the computer is not properly grounded the firmware upgrade process can be interrupted due to loss of communications.

GE Multilin will not be responsible for any damage in the relay or connected equipment whenever this elemental safety rule is not followed.

After ensuring the minimum requirements for using ENERVISTA MII Setup are met (see previous section), use the following procedure to install the ENERVISTA MII Setup from the enclosed GE ENERVISTA CD.

1. Insert the GE ENERVISTA CD into your CD-ROM drive.

2. Click the **Install Now** button and follow the installation instructions to install the no-charge ENERVISTA software.

3. When installation is complete, start the ENERVISTA Launchpad application.

4. Click the **IED Setup** section of the **Launch Pad** window.

Figure 1–3: ENERVISTA LAUNCH PAD WINDOW

5. In the ENERVISTA Launch Pad window, click the **Add Product** button and select the relay from the Install Software window as shown below. Select the "Web" option to ensure the most recent software release, or select "CD" if you do not have a web connection, then click the **Add Now** button to list software items for the corresponding relay model.

1
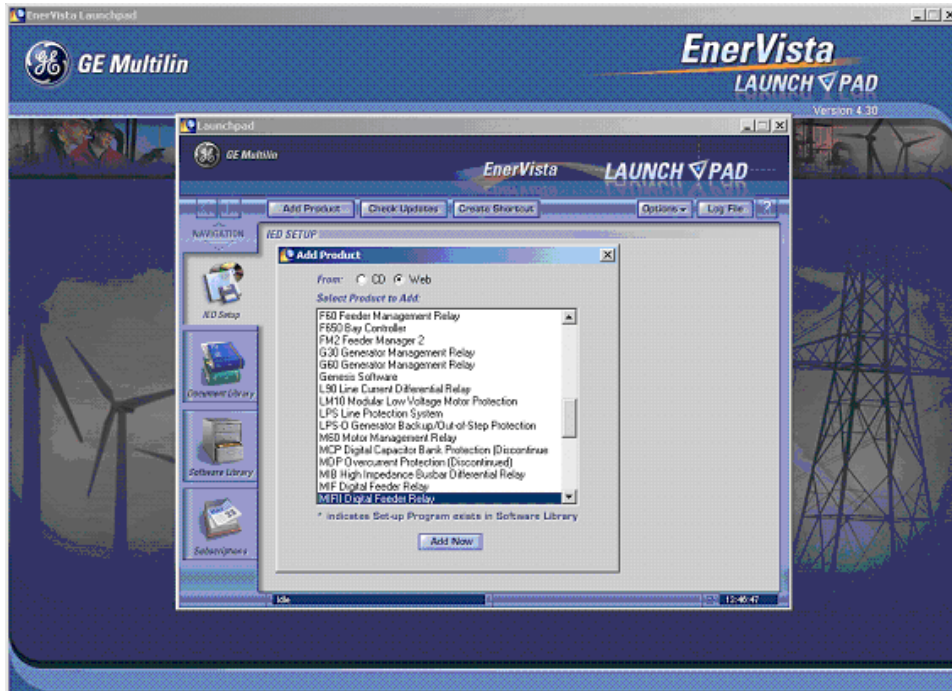
Figure 1–4: ADD PRODUCT

6. If "Web" option is selected, choose from the list the software program related to the specific model and click the **Download Now** button to obtain the installation program.

7. When ENERVISTA detects that there is already a version of the program in the Software Library, you can choose whether to install it directly or to check for more versions.
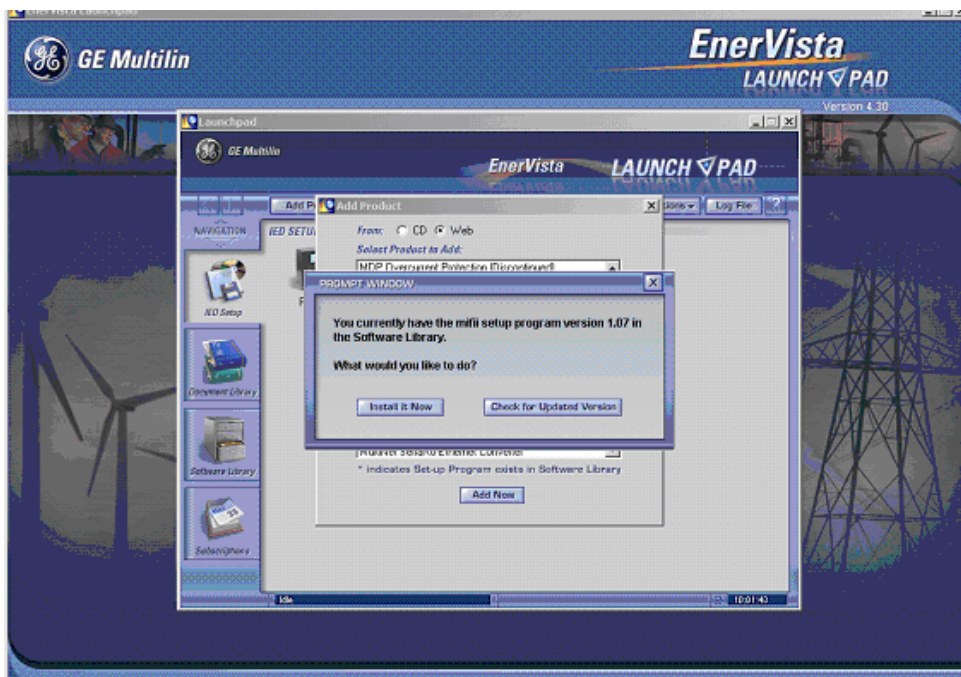
Figure 1–5: CHECK FOR UPDATED VERSIONS?

1

8. If we click the "Check for Updated Versions" button, the program will proceed to search for the different versions of set-up program from the Web.
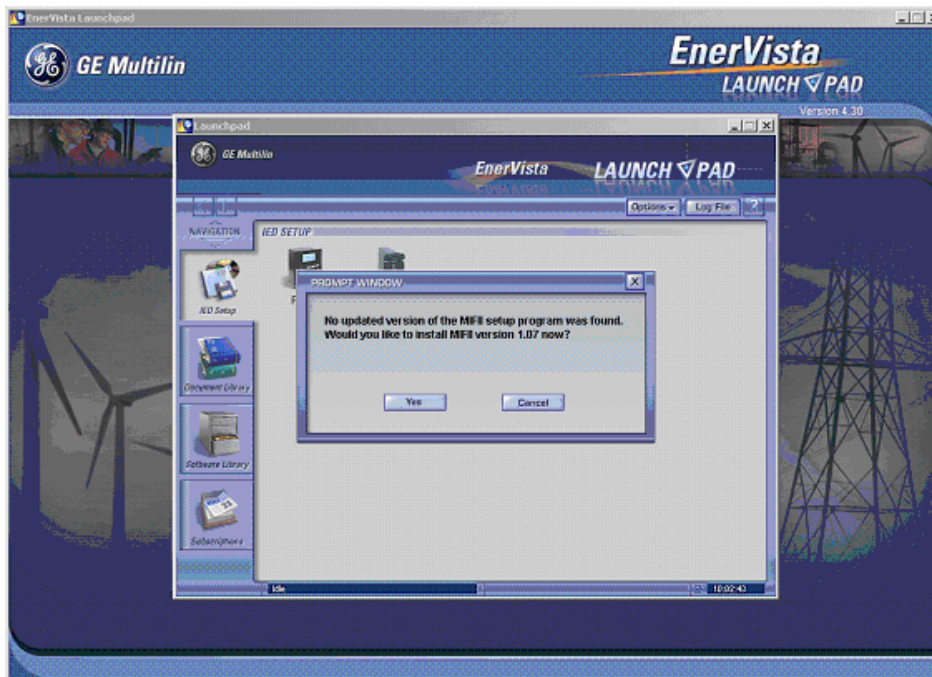
9. ENERVISTA Launchpad will obtain the installation program from the Web. If the version you already have is the last one on the Web, the following screen will appear
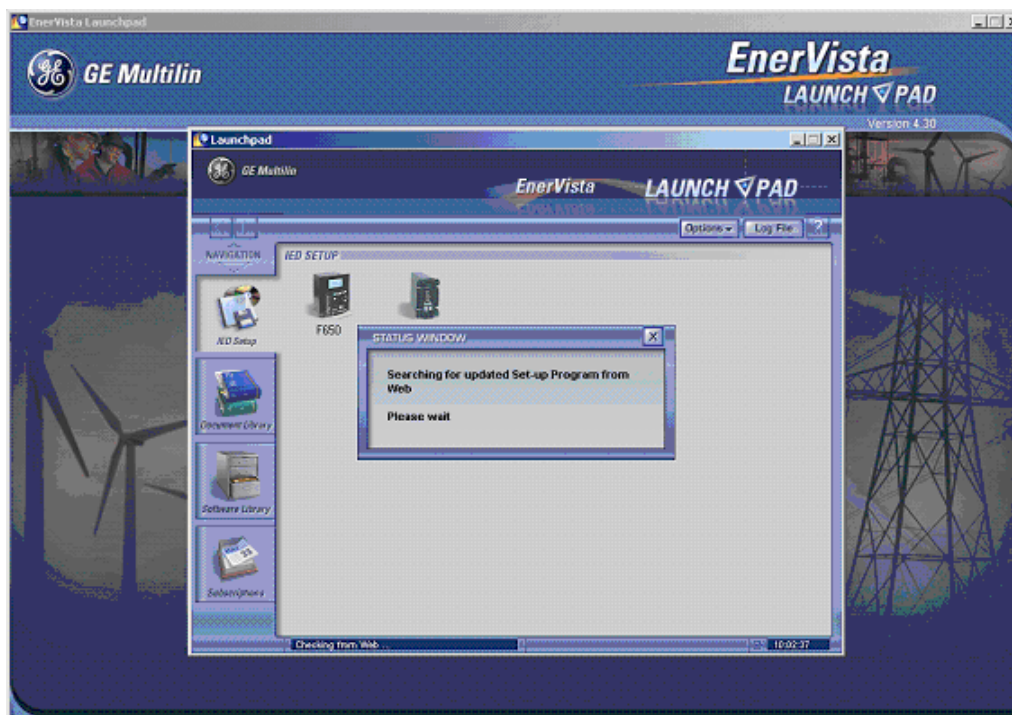
10. If there were more versions on the Web, ENERVISTA will then show the user the different setup programs available for upgrade, with their version, size and release date.

11. Double-click the installation program once its download is complete, to install the EnerVista MII SETUP software.

12. Select the complete path, including the new directory name, where the EnerVista MII SETUP will be installed.

1

13. Click on **Next** to begin the installation. The files will be installed in the directory indicated and the installation program will automatically create icons and add EnerVista MII SETUP to the Windows start menu.

14. Follow the on-screen instructions to install the EnerVista MII SETUP software. When the **Welcome** window appears, click on **Next** to continue with the installation procedure.
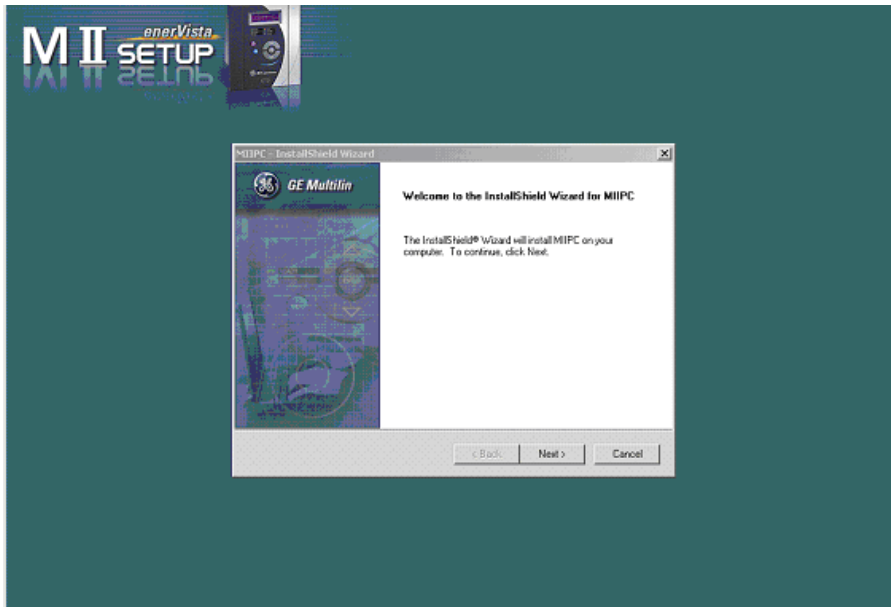
Figure 1–6: WELCOME TO INSTALLATION WINDOW

15. When the **Choose Destination Location** window appears, and if the software is not to be located in the default directory, click **Change…** and type in the complete path name including the new directory name and click **Next** to continue with the installation procedure.
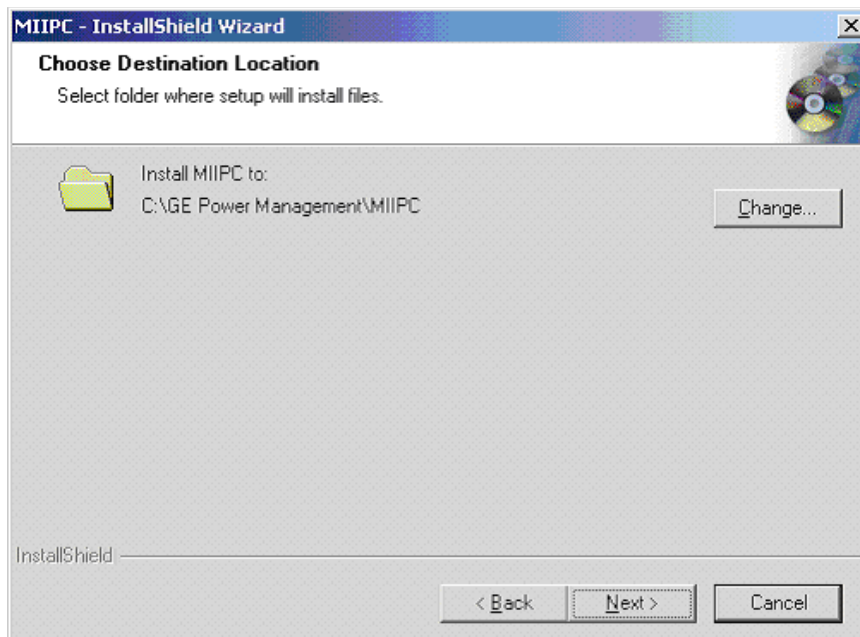
Figure 1–7: CHOOSE DESTINATION LOCATION WINDOW

16. The default program group where the application will be added to is shown in the **Selected Program Folder** window. Click **Next** to begin the installation process, and all the necessary program files will be copied into the chosen directory.
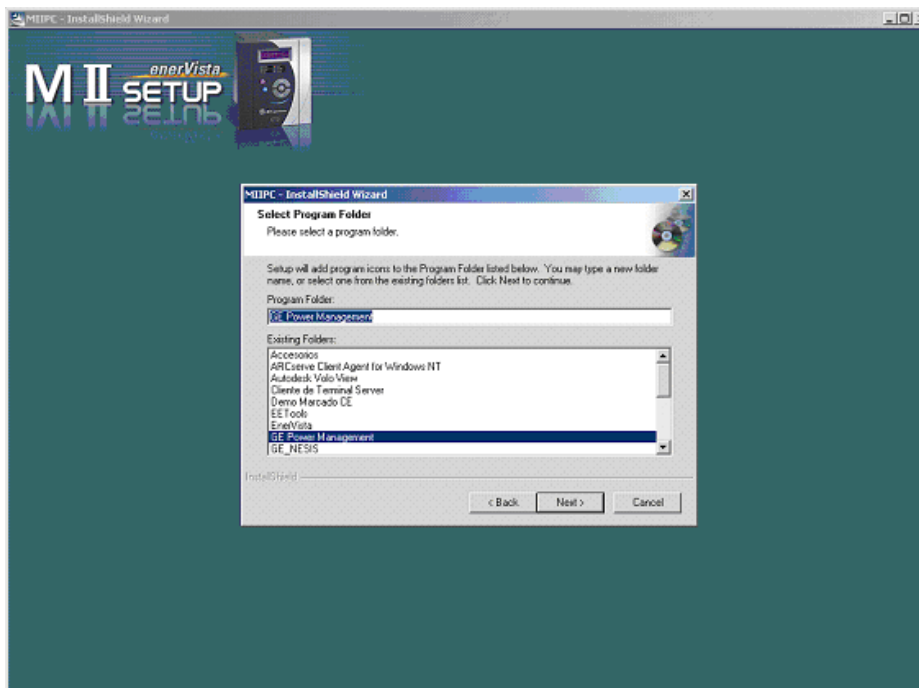
Figure 1–8: PROGRAM FOLDER

17. To finish with the installation process, select the desired language for startup
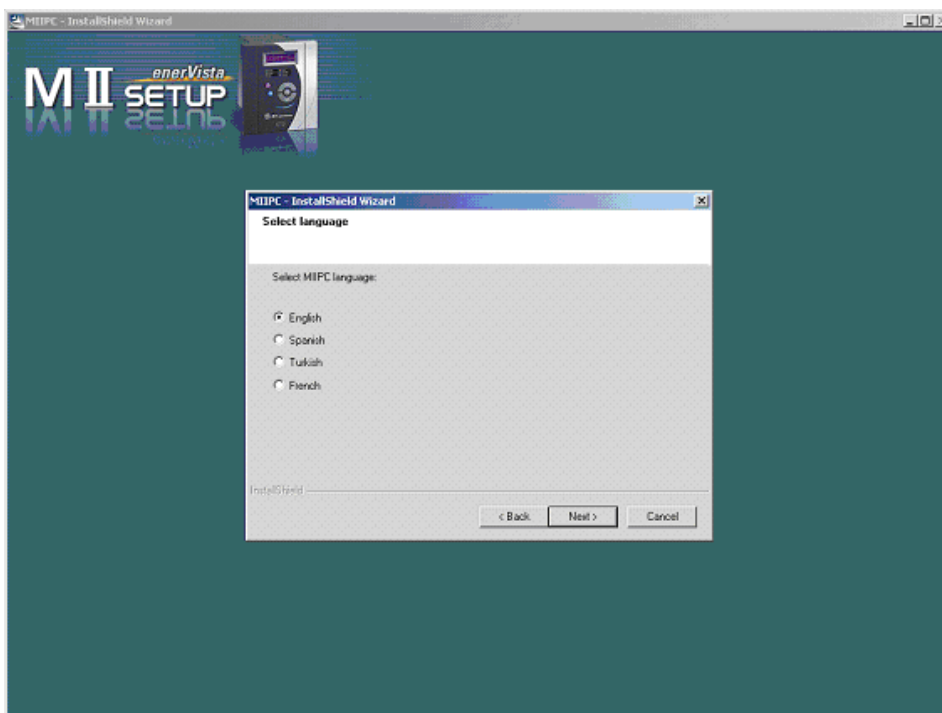
Figure 1–9: LANGUAGE SELECTION

1

18. Click **Finish** to end the installation. The MII device will be added to the list of installed IEDs in the ENERVISTA Launchpad window, as shown below.
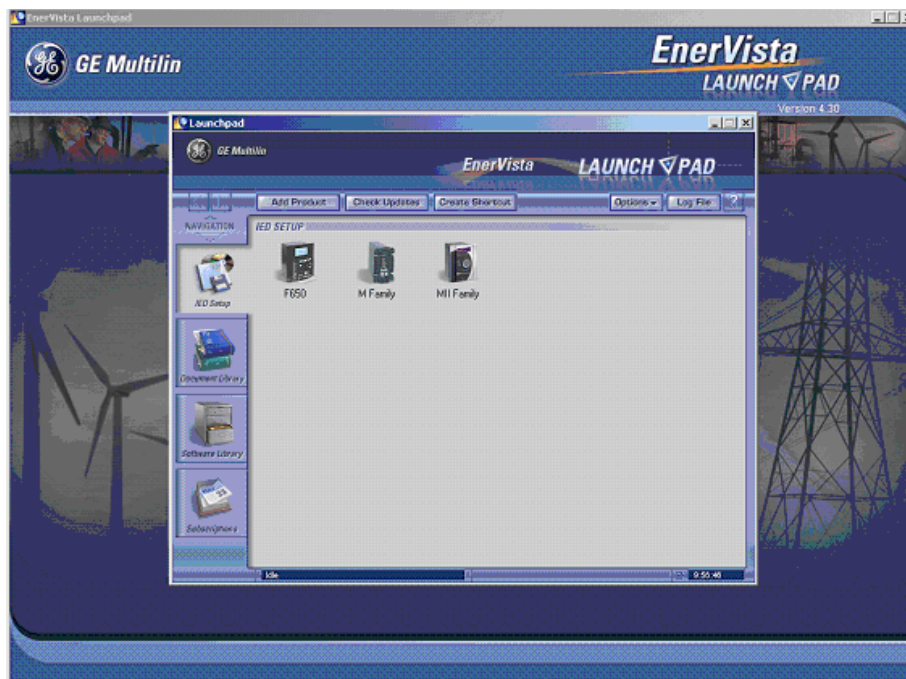
Please refer to the HARDWARE chapter for detailed relay mounting and wiring instructions. Review all **WARNINGS and CAUTIONS.**

1.3.2 COMMUNICATIONS

The EnerVista MII SETUP software can communicate to the relay via the faceplate RS232 port, or the rear panel RS485 port. To communicate with the relay via the 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's RS485 port from a computer's RS232 port, a RS232/RS485 converter box is required. GE Multilin offers F485, DAC300 and RS232/485 converters. This converter box is connected to the computer using a "straight through" serial cable. A shielded twisted pair (20, 22 or 24 AWG; 0.25, 0.34 or 0.5 mm^2) cable is used to connect the converter box to the relay rear communication terminals. The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communication 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 organized into menus under the main headings: Actual Values, Main Settings, Advanced Settings, Operations and Change Date&Time. A 5-key keypad and a 16x2 character LCD display (shown below) are used as elementary local HMI.

Figure 1–10: RELAY KEYPAD AND DISPLAY

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

1
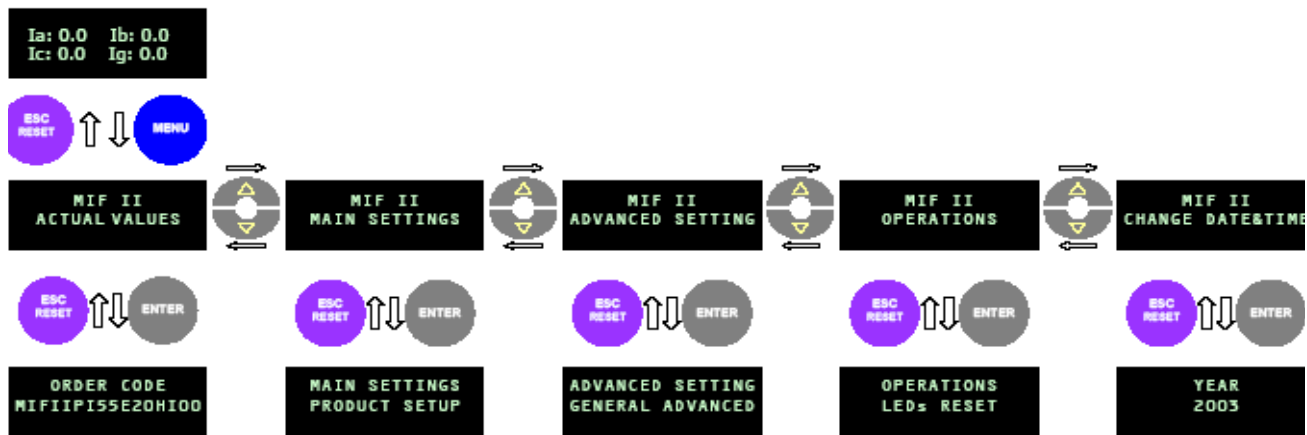
Figure 1−11: MOVING THROUGH THE HIERARCHICAL MENU (

As shown in Figure 1−11:, there are 3 hierarchical levels to access the information in the relay. The first level (Main screen) shows the current value for each phase (I_a, I_b, I_c, I_g)

Pressing the Menu button accesses the second level. To access information within the same hierarchical level (horizontal movement), push the up/down arrow buttons. To access the third level push the "**Enter**" button 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 the "ESC/ RESET" button.

Refer to chapter 8, for more information on the use of the local keypad and display to access information and change settings.

2

PROTECTION

- Phase time overcurrent (51P)

- Two Phase instantaneous overcurrent (high level and low level) (50P-1, 50P-2)

- Ground time overcurrent (51G)

- Two ground instantaneous overcurrent (high level and low level) (50G-1, 50G-2)

- Thermal Image (49)

- Cold load pickup (available only in Option 2 models)

- Breaker failure to open (available only in Option 2 models)

- Breaker health (available only in Option 2 models)

- I^2 Counter (available only in Option 2 models)

CONTROL

- 4 shot autorecloser for tripolar applications (available only in Option R models)

- 2 Setting groups

- Open/close breaker operations

METERING

- Phase and ground currents

- Thermal image

INPUTS/OUTPUTS

- 4 Current inputs (3 phases, 1 ground)
- Programmable digital inputs and outputs (available only in Option 1 and Option 2 models)

2

COMMUNICATIONS

- Front RS232 port
- Rear RS485 port

USER INTERFACE

- 2x16 LCD Display
- 6 LEDs (4 programmable with Option 1 and Option 2 models)

SECURITY

- Access password for setting changes
- Local access priority

OTHERS

- 1 Oscillography record (available only in Option 1 and Option 2 models)
- 32 Event recorder (available only in Option 1 and Option 2 models)
- Configurable Logic (available only in Option 2 models)

MIFII is a microprocessor-based protection relay designed for the following applications:

- Main Protection for Medium and Low voltage feeders.
- Main Protection for Medium size Motors.
- Main Protection for Medium and Low power Transformers (less than 10MVA).
- Differential Protection for Motors, if a CT differential connection is available.
- Backup Protection for power Transformers (for any power level).
- Backup Protection for Generators.
- Backup Protection for Transmission lines.
- Backup Protection for substation busbars.
- Thermal Image Protection/Supervision for Cables, Power Transformers, Grounding Resistors and Generation Elements.

Negligible over-travel and a high dropout to pick-up ratio (97% typical), along with the possibility of adjusting a time delay for the instantaneous elements, allow optimal coordination without compromising selectivity.

Both front 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 of the standard model 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 fiber optic (plastic or glass) serial port by using GE Multilin **DAC300, F485** or **RS232/485** module, or any other standard converter. The EnerVista MII SETUP communication software is the Windows® based program used to communicate with the relay. A password system has been implemented to restrict setting changes to non-authorized users, both by relay keypad and PC software.

A special model with IEC60870-5-103 protocol is also available, which uses the rear port with 9600 and 19200 bps baud rates.

MIFII uses flash memory technology, which allows field upgrades (through EnerVista MII SETUP software) as new features are added. Upgrades can only be performed through the communications port on the front of the unit.

The following one line (single line) diagram (Figure 2–1:) illustrates the relay functionality using ANSI (American National Standards Institute) device numbers.
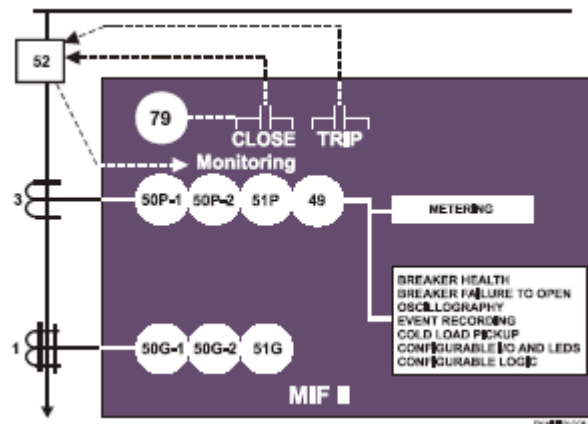
Figure 2–1: ONE LINE (SINGLE LINE) DIAGRAM SHOWING MIFII FUNCTIONS

2

MII family relays have several security features to restrict rear port operation when an operator is making changes by the local port or relay keypad, and/or to block access to setting changes for non-authorized users.

The relay has an access priority system, giving priority to local access over remote access. The access mode is **Local** either when the relay display is inside MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu, or when the front port (RS232) communication is established. When the access is local by the RS232 port, the back port is disabled and the relay will not serve any petition or command sent by the rear port. When the access is local by keypad, the back port is not disabled, and actual values can be read, but setting changes and operations will not be allowed by the back port.

Setting changes, either by keypad and display or by communications, are **password protected**: the user has to enter a password to change any setting. When the password is entered, the password protection is disabled and the user can change any setting freely. Thirty minutes after the last setting change performed, or when the ESC/RESET key is pressed for three seconds or more, the relay returns automatically to the password protected status and will ask for the password again if a new attempt to change settings is made.

2

A Phase Time Overcurrent unit is provided in the relay. There are three possibilities for the curve selection, depending on the selected model.

IEC curves comply with the criteria specified in the IEC255-4 Standard and British Standard BS142

ANSI curves comply with ANSI C37.90 standards

IAC curves simulate the behaviour of GE IAC relays.

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 elements.

In order to avoid undesired trips, time overcurrent elements will not pickup till a value of 1.05 * Set value.

Due to design criteria, actual pickup level has been INTENTIONALLY set to +5% over the set value to ensure that even in the worst case scenario the relay will NEVER TRIP under the intended setting.This meets IEC international standards.

2.4.1.1 IEC CURVES

The general formula for IEC/BS142 curves is as follows:

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

Where:

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

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

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

2.4.1.2 ANSI CURVES

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
Inverse	0.0274	2.2614	0.3000	-4.1899	9.1272
Very Inverse	0.0615	0.7989	0.3400	-0.2840	4.0505
Extremely Inverse	0.0399	0.2294	0.5000	3.0094	0.7222

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

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

2

2.4.1.3 IAC CURVES

The general formula of IAC Curve is as follows:

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

Where:

TDM: Time Dial Multiplier (Set in the Relay by User)

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

2.4.1.4 USER CURVES

The general formula for the user curve is as follows:

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

Where:

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:

PARAMETERS	A	B	P	O	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

Settings available for the phase time overcurrent unit allows the user 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, IAC or ANSI curves, depending on the model. Refer to Appendix B for a deeper explanation of the curves.

2.4.2 PHASE INSTANTANEOUS OVERCURRENT ELEMENTS (50P1, 50P2)

MIFII provides 2 phase instantaneous overcurrent elements, 50P1 ('H' for high pickup) and 50P2 ('L' for low pickup). Each one can be enabled/disabled and set independently. Settings from these elements allow to set the pickup value from 0.1 to 30 times the rated current, and the time delay from 0.00 to 600.00 seconds.

2.4.3 GROUND TIME OVERCURRENT ELEMENT (51G)

The Ground Time Overcurrent element offers the same setting possibilities as the Phase Time Overcurrent element. The ground current can be obtained from a residual connection on the CTs. For a more sensitive ground current detection, a window type (zero sequence) CT, taking the three phases inside its windows can be used. Refer to figure 3-6 for more details.

2.4.4 GROUND INSTANTANEOUS OVERCURRENT ELEMENTS (50G1, 50G2)

The MIFII relay provides 2 Ground Instantaneous Overcurrent Elements, 50G1 ('1' for High pickup) and 50G2 ('2' for Low pickup). Settings and ranges available for these elements are the same ones described for the Phase Instantaneous Overcurrent Elements, 50P1 and 50P2.

2

A Thermal Image Element is included among the relay functions. This unit provides protection against overheating due to overloading conditions. The operating time curve is set from the time curve family, as a function of the time constant $T1$ (settable between 3 and 600 minutes). The cooling time constant $T2$ can be set between 1 and 6 times the heating time constant $T1$. Refer to Appendix A for a detailed explanation on the operating principles of this element.

The MIFII autorecloser allows producing up to four selectable reclosure 'shots' prior to locking out. Thanks to the use of masks, the user can choose which conditions will produce the reclose initiation and what protection functions will be enabled in each recloser shot. This allows implementing protection schemes that would require special wiring and functions in conventional equipment.

As an example of application, the user may want the first protection trip to be for instantaneous overcurrent, and the next trip to be timed over current, in order to allow a time for output fuses to burn of a feeder branch. For this purpose, it is necessary to disable the IOC element after the first shot.

The reclose initiation can be started by a trip or from the physical input AR INITIATE. There are settings for selecting which protection function and/or if physical input will initiate the autorecloser.

Also, settings are available for selecting which protection functions will be enabled after every autorecloser shot.

2.6.2 RECLOSER STATUSES

The following diagram describes the different possible statuses for the recloser and the transitions between statuses.
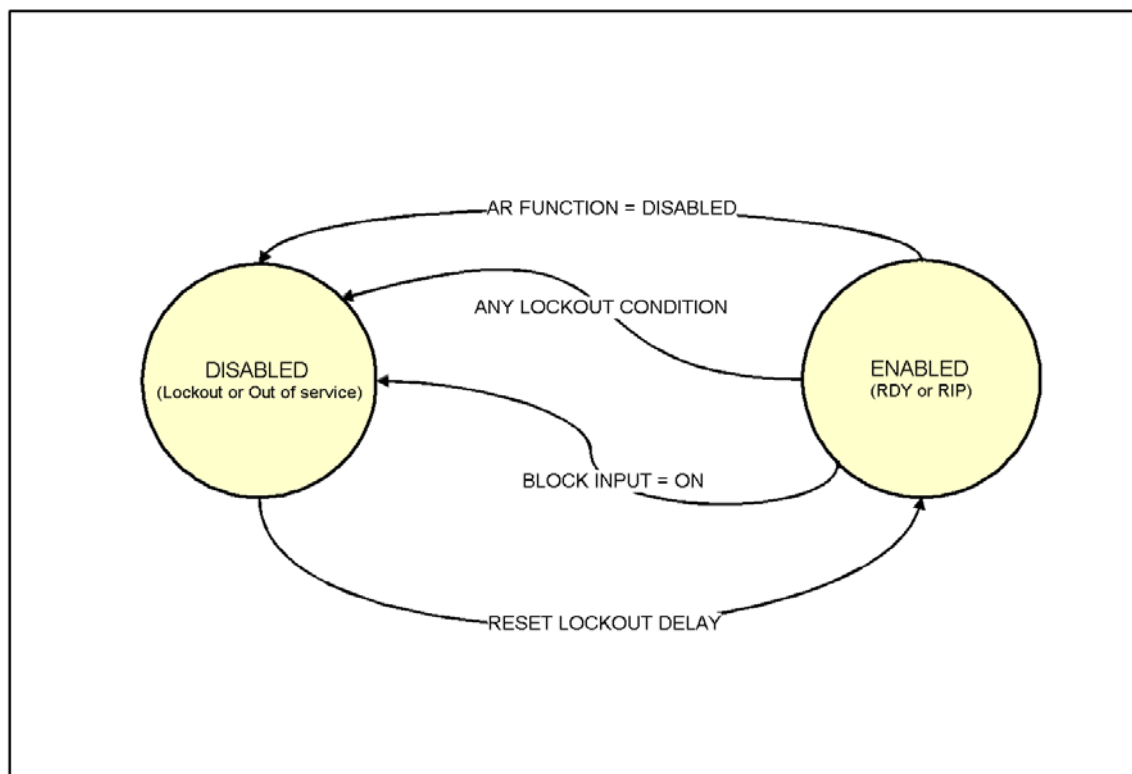
Figure 2–2: AUTORECLOSER GENERAL STATUS DIAGRAM
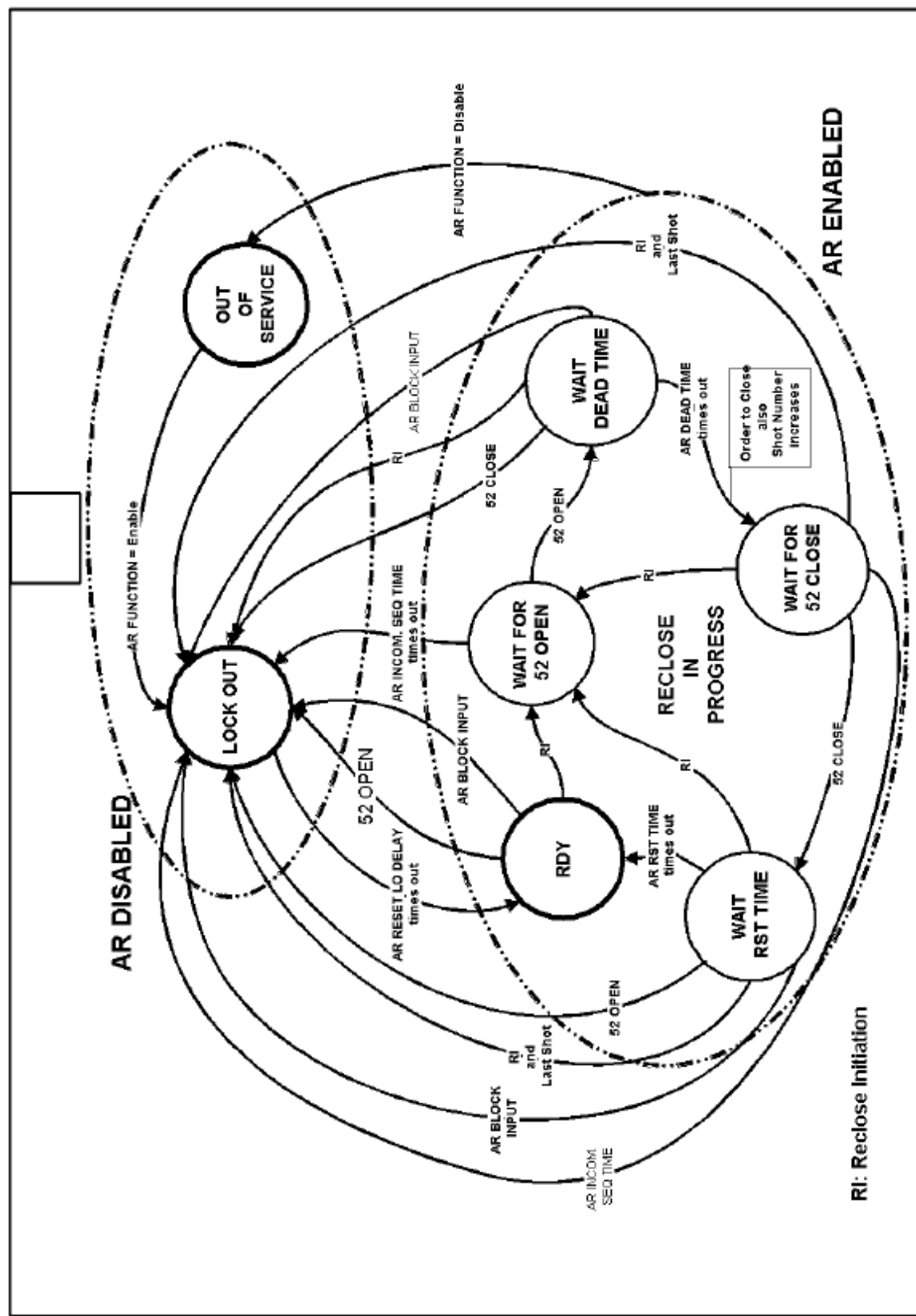
Figure 2–3: AUTORECLOSER DETAILED STATUS DIAGRAM
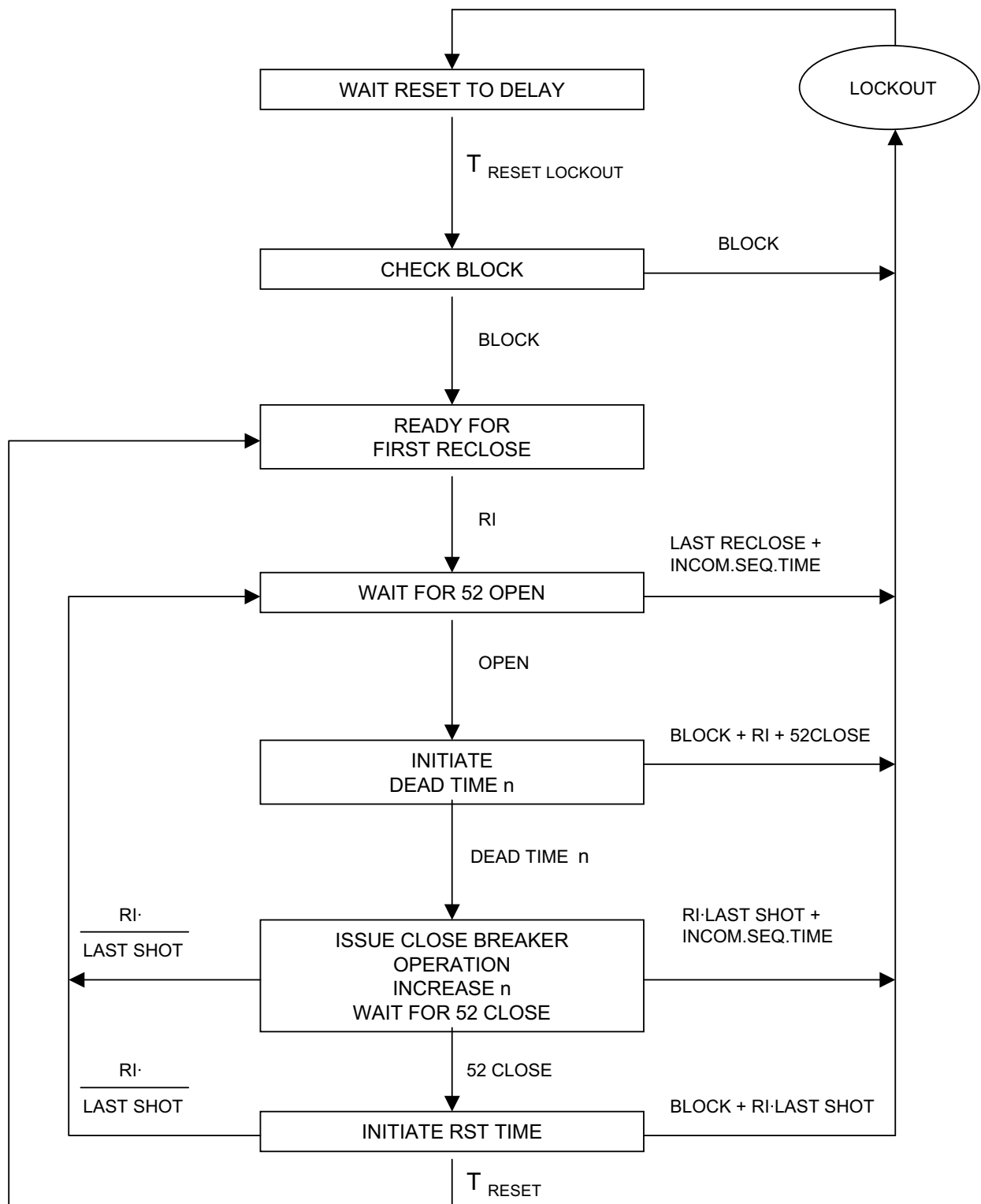
Figure 2–4: AUTORECLOSER DETAILED STATUS DIAGRAM (2)

2

RECLOSE ENABLED

The reclosure scheme is considered to be enabled when all of the following conditions are true:

*   The "AR FUNCTION" is set to ENABLED.

*   The scheme is not in the LOCKOUT state.

*   The "BLOCK" input is not asserted.

RECLOSE INITIATION

The autoreclose scheme is initiated by an enabled trip signal or physical input AR INITIATE. The scheme is initiated provided the circuit breaker is in the closed state before protection operation and RESET LOCKOUT DELAY timer times out.

RECLOSE IN PROGRESS (RIP)

RIP is set when a reclosing cycle begins following a reclose initiate signal. Once the cycle is successfully initiated, the RIP will seal-in and the scheme will continue through its sequence until one of the following conditions is satisfied:

*   The close signal is issued when the AR DEAD TIME timer times out.

*   The scheme goes to lockout.

While RIP is active, the scheme checks that the breaker is open and the shot number is below the limit, and the being measuring the AR DEAD TIME.

Each of the four possible shots has an independently settable dead time: AR DEAD TIME 1 ... AR DEAD TIME 4.

LOCKOUT

Scheme lockout blocks all phases of the reclosing cycle, preventing automatic reclosure, if any of the following occurs:

*   The maximum shot number was reached.

*   The incomplete sequence AR INCOM. SEQ TIME timer times out.

The recloser will be latched in the LOCKOUT state until the breaker has been closed and stay closed for the reset lockout time AR RESET LO DELAY.

CLOSE

After the dead time elapses, the scheme issues the close signal. The close signal is latched until the breaker closes of the scheme goes to LOCKOUT.

2

AR FUNCTION: the recloser may operate only if it is ENABLED. If DISABLED the recloser will be Out of Service.

AR MAX SHOTS: specifies the number of reclosures that can be attempted before recloser goes to LOCKOUT status, because the fault is permanent.

AR DEAD TIME 1 ... 4:   these are the intentional delays before first, second, third and fourth breaker automatic reclosures.

AR RESET LO DELAY: this setting establishes how long the breaker should stay closed after a manual close command, in order for the autorecloser to reset from LOCKOUT.

AR INCOM. SEQ TIME: this timer is used to set the maximum time interval allowed for a single reclose shot. It is started whenever a reclosure is initiated and is active when the scheme is in the RECLOSE IN PROGRESS state. If all conditions allowing a breaker closure are not satisfied when this time expires, the scheme goes to LOCKOUT.

AR RST TIME: a reset timer output resets the recloser following a successful reclosure sequence. The setting is based on the breaker "reclaim time" which is the minimum time required between successive reclose sequences.

Autoreclose initiation masks: used to select which events will initiate the autorecloser scheme.

After 1st, 2nd, 3rd, 4th trip masks: used to select which function will be enabled to trip.

2

This element avoids undesired operation of the overcurrent elements in case of high currents produced when energizing a line that has been open for a long period of time.

This element detects when the current values of the three phases are lower than 4% of the rated current (In). In this moment, a timer (T IN) is started.

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

When the timer has timed out, the tap settings of the instantaneous phase elements (50P1 and 50P2) are multiplied by a constant K50P, and the phase TOC (51P) tap settings are multiplied by a constant K51P. A status signal turns on indicating that the Cold Load Pickup is enabled, and the corresponding event is generated.

For exiting the CLP status, when the current values of the three phases are above 8% In, a T OUT timer is started.

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

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

The T IN and T OUT timer values, as well as the multiplying constants K50P and K51P, and the function permission are settings associated to the COLD LOAD PICKUP. These settings are included in the ADVANCED SETTINGS group. They will be described in detail in the SETTINGS section.
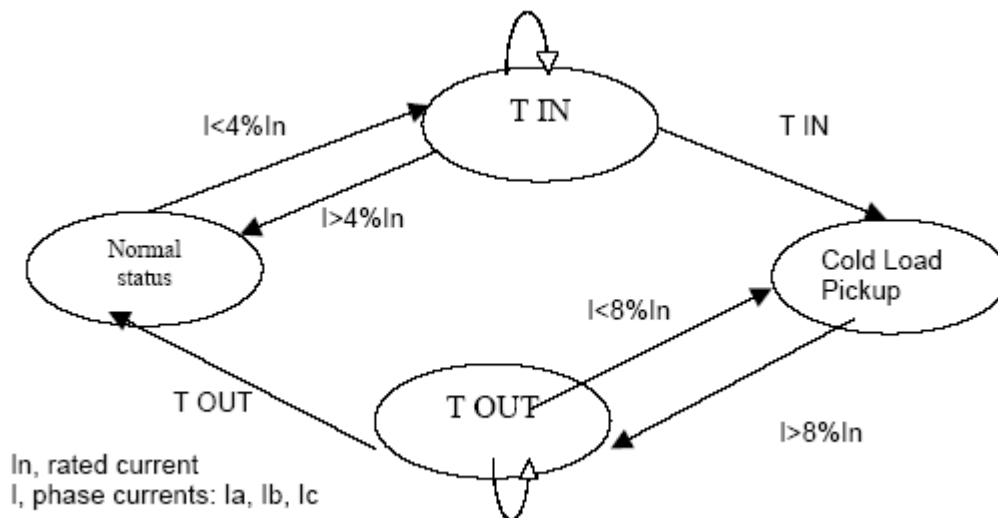
This element produces an alarm if the breaker does not open after a tripping command.

This element can be enabled independently from having an input that indicates the breaker status:

If a breaker status input is enabled:

After a trip, the following conditions are checked:

1. If the breaker is closed, the BREAKER FAILURE function is started.

2. If the breaker is open, the unit checks the current. If the highest current is over 8% of the rated current, the BREAKER FAILURE function is started.

After the BREAKER FAILURE pickup, a timer is started. When the timer countdown finishes, if the function is not disabled, the FAILURE TO OPEN status signal is activated, and the corresponding event is generated.

The Breaker Failure to Open signal is reset when the breaker is open and there is no current. once the breaker has been opened, it gets closed again.

If a breaker status input is not enabled:

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

The Breaker Failure to Open signal is reset when the current value, of at least one phase, rises above 8% of the rated current after all of the phase currents have fallen below 4% of it.

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

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

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

When the counter reaches or exceeds a limit value (setting), an I^2 ALARM signal will be produced in the unit status, and the corresponding event will be generated.

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

The I^2 counter, and the number of openings counter are stored in capacitor backed up RAM memory.

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

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

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

MIFII stores an historical record with the last 32 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 active or not in that moment.

In EnerVista MII SETUP there is an "**EVENTS**" menu, where the user can check how many events have been produced since the last time the Events were deleted. If the number of events produced is higher than 32 (maximum number of events stored), this means that only the last 32 will be stored.

This event record is stored in a capacitor backed up RAM memory. Events functionality in MIFII is performed via the EnerVista MII SETUP 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 SETPOINT – SETPOINT – ADVANCED SETTINGS – EVENT MASK section. The following table shows a list of all possible events.

MIFII relay with option C stores an historical record with the last 100 events. Each register contains the event description, date and time (4ms accuracy), the current values in phases and ground at that moment and a summary of the status signals tha can produce events and whether they were active or not in that moment.

Table 2–1: LIST OF EVENTS

DESCRIPTION	OPTION 1	OPTION 2
50P1 Pickup/Drop out		Yes
50P2 Pickup/Drop out		Yes
50G1 Pickup/Drop out		Yes
50G2 Pickup/Drop out		Yes
51P Pickup/Drop out		Yes
51G Pickup/Drop out		Yes
49 Alarm Pickup/Drop out		Yes
50P1 Trip		Yes
50P2 Trip		Yes
50G1 Trip		Yes
50G2 Trip		Yes
51P Trip		Yes
51G Trip		Yes
49 Trip		Yes
General trip		Yes
50P1 Trip enable/disable by digital input	Yes	Yes
50P2 Trip enable/disable by digital input	Yes	Yes
50G1 Trip enable/disable by digital input	Yes	Yes
50G2 Trip enable/disable by digital input	Yes	Yes
51P Trip enable/disable by digital input	Yes	Yes
51G Trip enable/disable by digital input	Yes	Yes
49 Trip enable/disable by digital input	Yes	Yes
General trip enable/disable by digital input	Yes	Yes
Protection status in service/out of service	Yes	Yes
Digital output 1 active/non active	Yes	Yes
Digital output 2 active/non active	Yes	Yes
Digital output 3 active/non active	Yes	Yes
Digital output 4 active/non active	Yes	Yes
Digital input 1 active/non active	Yes	Yes
Digital input 2 active/non active	Yes	Yes
Settings change disabled by digital input active/non active	Yes	Yes
Trip operation by digital input	Yes	Yes
Trip operation by command	Yes	Yes
Auxiliary digital output latch reset	Yes	Yes

Table 2–1: LIST OF EVENTS

DESCRIPTION	OPTION 1	OPTION 2
Close Breaker	Yes	Yes
52B open/closed	No	Yes
52A open/closed	No	Yes
52 open/closed	No	Yes
Group 2 selection by digital input	Yes	Yes
Oscillography triggered by digital input	Yes	Yes
Oscillography triggered by command	Yes	Yes
Breaker failure	No	Yes
I^2 Alarm	No	Yes
Settings change	Yes	Yes
EEPROM failure	Yes	Yes
User settings/Factory settings	Yes	Yes

OPTION 1: MIFII***E1**00; **OPTION 2:** MIFII***E2**00

MIFII stores an oscillography record, with a resolution of 8 samples per cycle with a length of 24 cycles (including 2 pre-fault cycles), with the following information:

- Instantaneous values of phase (Ia, Ib, Ic) and ground (I_g) currents. The 2 first cycles are pre-fault cycles.
- Digital information:
  - Pickups (protection functions[1])
  - Trip inhibition by digital input (protection functions[2])
  - Trips (protection functions[3])
  - Ready (protection in service)
  - Auxiliary digital outputs
  - Digital inputs
  - Breaker 52A, Breaker 52B, (status of the digital inputs)
  - Status 52 (status of the circuit breaker) (only OPTION 2 models)
  - Breaker opening failure (only OPTION 2 models)
  - I^2 alarm (only OPTION 2 models)
  - Cold load pickup (only OPTION 2 models)
  - Group 2 selection by digital input
  - EEPROM failure
  - Default settings/User settings

- Date and time
- Model
- Number of oscillo
- Value of the differential Ia, Ib, Ic and Ig currents at the moment of the oscillography trigger
- Active group at the moment of the oscillography trigger
- Element settings when retrieving the oscillography record.
- Oscillography and event mask
- File to emulate the relay model in PC program, with the relay settings and memory map

The number of oscillo is a circular counter that increases with each generated oscillography. 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.

MIFII functionality related to oscillography is performed from the ENERVISTA MII SETUP 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:

1. Pickup of one of the protection functions
2. Trip of one of the protection functions
3. Oscillography trigger by communications
4. 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 SETPOINT – SETPOINT – ADVANCED SETTINGS – OSCILOGRAPHY MASK section.

MIFII relay with option C stores 4 oscillography records, with a resolution of 16 samples per cycle with a total length of 150 cycles (including prefault cycles) each register. In General Settings there is a setting for prefault cycles. It is adjustable from 10 to 140 cycles.

2

2

Two independent Setting Groups are available in the permanent (non-volatile) memory of the MIFII relay. Only one of the two is active at a given time. Users can select which setting group is active using a setting, sending a command to the relay from the communications program, or by a digital input in OPTION 1 and OPTION 2 models.

Settings are divided in two different categories: Main Settings and Advanced Settings. This makes setting the relay extremely simple for those users who want to use just the Main functions of the MIFII relay. Users who require the full functionality of the relay can use the Advanced Settings.

2.13.1 MEASUREMENT

MIFII provides actual values for phase and ground currents Accuracy is 1% of injected current at rated current, and 3% of injected current $\pm 0.1\%$ full scale in the complete range.

2.13.2 SELF-TEST

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 released, indicating an out of service condition.

There are 6 LED Targets in the front of the relay. The first one is green ('READY' -relay in service-) and cannot be configured; the second one is red and fixed for trip, while the other 4 can be configured by the userin OPTION1 and OPTION2 models. The default configuration of the LEDs is shown in the following figure.

Figure 2–5: MIFII LEDS DEFAULT CONFIGURATION

It is possible to configure the color of the 4 configurable LEDs between red and green using the keypad of the front panel of the relay (for details, refer to Chapter 8).

The indication 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. If the LED is off with the above-mentioned conditions, this indicates a loss 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.
PHASE:	Indicates that the trip has been issued by one of the Phase Overcurrent Elements (51P, 50P1, 50P2).
GROUND:	Indicates that the trip has been issued by one of the Ground Overcurrent Elements (51G, 50G1, 50G2).
INST:	Indicates that the trip has been issued by one of the Instantaneous Elements, either phase or ground elements (50P1, 50P2, 50G1, 50G2).
PICKUP:	Indicates that at least one of the protective elements has picked up.

LEDs associated to tripping functions are latched and once they have been turned on, they remain on until the ESC/RESET button is pressed for more than 3 seconds (RESET) providing that the trip condition has disappeared. The LED associated to *function pickup* is self-reset type, and stays on while the pickup condition (current above setting) exists.

A five-button keypad allows access to MIFII relay information and settings changes. Measurement data (actual values), five last trip information (fault reports) and settings are shown on the 16x2 character LCD display.

The keypad includes the functionality to modify the contrast of the display (refer to Chapter 8 for details).

The event list, oscillography, I/O and logic configuration can be accessed only from the EnerVista MII SETUP program.

2.14.3 COMMUNICATION PORTS

The front RS232 and the rear RS485 port provide interface with the relay. All serial ports of the standard model use the Modbus® RTU protocol and may be connected to system computers with baud rates from 300 to 19200 bps. Up to 32 MIFII 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.

A special model with IEC60870-5-103 protocol (option C) is also available, which uses the rear port with 9600 and 19200 bps baud rates.

2.14.4 SOFTWARE

MIFII units are supplied together with EnerVista MII SETUP software, a Windows® based software that allows communication with the relay for data viewing and retrieval, as well as oscillography, I/O configuration and logical configuration (in models where these features are available).

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MIFII is supplied as 4U high and ¼ of a 19" rack wide. MIFII relays can be mounted in ¼ rack cases, one relay per case. The information required to completely specify the relay is provided in the following table:

Table 2–2: ORDERING CODE

MIFII	-	-	-	-	-	-	-	-	-	-	DESCRIPTION
											Application:
	P										3 Phase + Ground relay
	N										Single Phase relay
											Curves
		A									ANSI Curves
		I									IEC Curves
		U									IAC Curves
		C									EPTAR-C Curves(only for single phase models)
											Phases range:
			0								No CT(always for single phase models) Phase CT In = 1/5A (0.1-2.4 In)(Three phase models)
			1								Phase CT In = 1A (0.1-2.4 A)
			5								Phase CT In = 5A (0.5-12 A)
											Ground range:
				0							Ground CT In = 1/5 A (0.1-2.4 In)
				1							Ground CT In = 1A (0.1-2.4 A)
				5							Ground CT In = 5A (0.5-12 A)
				N							Sensitive ground In = 1 A (0.005-0.12 A)
				L							Very sensitive ground. In = 1 A (0.002-0.048 A)
											Language:
					E						English language
					F						French language
					T						Turkish language
											Options:
						0					Basic model (no options)
						1					Option 1[1]
						2					Option 2[2]
											Recloser option:
							0				Without recloser
							R				With recloser (not available in the basic model)
											Power Supply:
								LO			24-48 Vdc (Range: 19~58 Vdc)
								HI			110-250 Vdc (Range: 88~300 Vdc) 110-230 Vac (Range: 88~264 Vac)
											Protocol:
									0		Standard Model (Modbus RTU)
									C		Protocol IEC60870-5-103
											Conformal Coating:
										0	Without Harsh Environment Conformal Coating
										H	With Harsh Environment Conformal Coating

1.**OPTION 1**: Configurable I/O, event recording, oscillography

2.**OPTION 2**: Includes all OPTION 1 features, plus cold load pickup, breaker failure to open protection, breaker monitoring, breaker maintenance and configurable logic.

ACCESSORIES

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

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SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.16.1.1 PHASE / GROUND TIME OVERCURRENT (51P,51G)

Current:	Fundamental
Pickup Level:	0.1 - 2.4 times In (rated current) in steps of 0.01 x In (51P & 51G for 1/5 A ground models)
	0.005 - 0.12 A in steps of 0.001 x A (51G for sensitive ground models)
	0.002 - 0.048 A in steps of 0.001 x A (51G for very sensitive ground models)
Dropout Level:	97% (typical) of Pickup
Level Accuracy:	±1% at rated current
	±3% of injected current ±0.1% full scale in the whole range
Curve Shapes:	IEC (B.S.) A/B/C
	ANSI Inverse, Very Inverse, Extremely Inverse, user defined
	IAC Inverse, Very Inverse, Extremely Inverse, Inverse Short or Inverse Long
	Time delayed (0.00 to 600.00 sec. in steps of 0.01 sec).
Time Dial:	0.05 to 2 in steps of 0.01 for IEC curves
	0.5 to 20 in steps of 0.1 for ANSI curves
	0.5 to 10 in steps of 0.1 for IAC curves
Reset Type:	Instantaneous
Timing Accuracy:	± 5% + 50 ms of set time for 2< I < 20 times the Actual Pickup Level for IEC/ANSI/definite time curves. For I<2 times the Actual Pickup refer to APPENDIX F TIMING ACCURACY FOR 51 ELEMENT.
	± 6% of set time for 2 < I < 20 times the Actual Pickup for IAC curves
Type/measure time:	DFT of 1 cycle

2.16.1.2 PHASE / GROUND INSTANTANEOUS OVERCURRENT (50P1, 50P2, 50G1, 50G2)

Current:	Fundamental
Pickup Level:	0.1 - 30.0 times In (rated current) in steps of 0.1 x In (50P1/P2 & 50G1/G2 for 1/5 A ground models)
	0.005 - 1.5 A in steps of 0.001 x A (51G for sensitive ground models)
	0.002 - 0.6 A in steps of 0.001 x A (51G for very sensitive ground models)
Dropout Level:	97% (typical) of Pickup
Level Accuracy:	±1% at rated current
	±3% of injected current ±0.1% full scale in the whole range
Overreach:	< 2%
Time Delay:	0.00 to 600.00 sec. in steps of 0.01 s
Reset Type:	Instantaneous
Operate Time:	Between 20 and 30 ms for I > 2 x Actual Pickup
Timing Accuracy:	± 5% or 50ms(whichever is greater) of settled time for I > 2 times the Actual Pickup
Type/measure time:	DFT of 1 cycle

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2.16.1.3 THERMAL IMAGE ELEMENT (49)

Current:	Fundamental
Pickup Level:	0.10 - 2.40 In in steps of 0.01 x In
Dropout Level:	Between 97% typical of Pickup Level
Level Accuracy:	±1% at rated current
	±3% of injected current ±0.1% full scale in the whole range
Heating Constant τ1:	3 to 600 min in steps of 1 min.
Cooling Constant τ2:	1 to 6 times τ1 in steps of 1.
Thermal Image Alarm:	From 70% to 100% I_{pickup} in steps of 1%
Timing Accuracy:	5% for operate times greater than 2 sec.

2.16.2 METERING FUNCTIONS

2.16.2.1 FUNDAMENTAL CURRENT

Accuracy:	±1% at rated current
	±3% of injected current ±0.1% full scale in the whole range

2.16.3 INPUTS

2.16.3.1 AC CURRENT

Secondary Rated Current:	1 or 5 A depending on the selected model, or 50 mA for sensitive ground models
Frequency:	50 / 60 Hz ±3 Hz (The unit can be set to 50 or 60 Hz)
Relay CT Burden:	< 0.2 VA @ In = 5A secondary
	< 0.08 VA @ In = 1A secondary
	< 0.08 VA @ In = 1A sensitive ground, secondary
Current Withstand:	4 x In continuously.
	100 x In for 1 sec.

2.16.3.2 DIGITAL INPUTS

Voltage Level:	300 Vdc maximum for HI power supply
	75 Vdc maximum for LO power supply
Recognition Time:	< 4 ms

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2.16.4.1 LOW RANGE

Rated DC Voltage:	24 to 48 Vdc
Min./Max. DC Voltage:	19 / 58 Vdc

2.16.4.2 HIGH RANGE

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

2.16.5 OUTPUTS

2.16.5.1 OUTPUT RELAYS

Configuration:	6 Electro-Mechanical Form C
Contact Material:	Silver alloy suited for inductive loads
Maximum Operating Voltage:	400 Vac
Single Contact Carry Continuous:	10 A at 250 Vac.
	¾ HP, 124 Vac
	1-1/2 HP, 250 Vac
	10A, 250 Vac, 0.4 PF,
	B300 pilot duty
Make and Carry:	30 A
Breaking:	4000 VA

Max. Ratings for 100.000 operations:

VOLTAGE	MAKE&CARRY CONTINUOUS	MAKE&CARRY 0.2 SEC	BREAK	MAX LOAD
DC Resistive				
24 Vdc	10 A	48 A	10 A	384W
48 Vdc	10 A	48 A	2.6 A	125W
125 Vdc	10 A	48 A	0.6 A	75 W
250 Vdc	10 A	48 A	0.5 A	125 W
AC Resistive				
120 Vac	10 A	48 A	10 A	1920 VA
250 Vac	10 A	48 A	10 A	4000 VA
AC Inductive PF = 0.4				
250 Vac	10 A	30 A	10 A	1000 VA

2.16.6 COMMUNICATIONS

FRONT PORT	RS232	300, 600, 1200, 2400, 4800, 9600 or 19200 bps, Modbus® RTU
REAR PORT	RS485	300, 600, 1200, 2400, 4800, 9600 or 19200 bps, Modbus® RTU
		9600 or 19200 IEC60870-5-103

2.16.7 ENVIRONMENTAL

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

2.16.8 TYPE TESTS AND CERTIFICATIONS

The MIFII 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.PRODUCTION TESTS

STANDARD	DESCRIPTION	CLASS
ELECTROSTATIC COMPATIBILITY AND INSULATION		
IEC 60255-25 / EN 61000-6-4 (2001)	Conducted and Radiated Emission	
ENV 50204 (1995)	Radiated Electromagnetic Fields with Frequency Modulation	10 V/m, 900 MHz
IEC 60255-22-2 / EN 61000-6-2 (2001)	Electrostatic Discharge Immunity Test	Level 4 CM (8 kV). Level 3 AM (8 kV)
IEC 60255-22-3 / EN 61000-6-2 (2001) / ENV 50204 (1995)	Radiated RF Fields Immunity Test	Level 3 (10 V/m), 80-1000 MHz.

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IEC 60255-22-4	Electrical Fast Transient Immunity Test	Level 3 (±2 kV except for communications terminals RS-485 and RS-232 where the level was ±1 kV) with a perfomance criteria A.
IEC 60255-22-5 / EN 61000-6-2 (2001)	Surge Immunity Test	Level 3 (±2kV CM, ±1kV DM)
IEC 60255-21-6 / EN 61000-6-2 (2001)	Injected RF Signals Immunity Test	Level 3 (10 V/m), 0.15 – 80 MHz.
IIEC 60255-11 / EN 61000-6-2 (2001)	Voltage Dips and Interruptions Immunity Tests	Duration and Voltage described in the related report.
IEC 60255-22-1 (1988)	1 MHz Burst Disturbance Test	Level 3 (±2.5 kV in common mode and ± 1 kV in differential mode) in the I/O terminals specified in paragraph 4.2 of the corresponding report.
IEC 61000-4-8 (1993) / IEC 61000-4-8 (1993)	50 Hz Magnetic Fields Immunity Test	Level 5 (100 A/m for continuous applications and 1000 A/m for transient applications) with a performance criteria A.
IEC 60255-5 (1977)	Measurement of Insulation Resistance	In the paragraph relating to insulation resistance for all groups defined in paragraph 4 of the report.
IEC 60255-5 (1977)	Impulse Voltage Test	In the paragraph relating to impulse voltage test for ±5 kV applicatios in common mode and ± 1 kV in differential mode (class III) for all the groups defined in paragraph 4 of the correspond report.
IEC 60255-5 (1977)	Dielectric Test	In the paragraph relating to dielectric test for 2 kV, 50 Hz applications for all the groups defined in paragraph 4 of the correspond report.

STANDARD	DESCRIPTION	CLASS
CLIMATIC TESTS		
IEC 60068-2-1 (1990) + A1 (1992) + A2 (1994)	Test Ad	Cold
IEC 60068-2-2 (1974) + A1 (1993) + A2 (1994)	Test Bd	Dry Heat
MAKE AND CARRY		
ANSI C37-90:1990	Make and Carry	
VIBRATION, SHOCK AND BUMPS		
IEC 60255-21-1 (1998)	Sinusoidal vibration / Vibration endurance Test	Class I
IEC 60255-21-2 (1998)	Shock response / Shock strength / Bumps Test	Class I
VIBRATION		
EN 60255-21-3 (1996)	Seismic Test	

2.16.9 PRODUCTION TESTS

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

2.16.10 APPROVALS

Manufactured under an ISO9001 Registered system

Conforms to CE Marking

UL listed

2

WARNING

> The MIFII system incorporates electronic components that might be affected by electrostatic discharge currents flowing through certain component terminals. The main source of electrostatic discharges is human body, especially under low humidity conditions, with carpet floors or isolating shoes. If such conditions are present special care should be taken while manipulating MIFII modules. Operators, before even touching any components, must make sure that their bodies are not charged by either touching a grounded surface or by using an antistatic grounded wrist bracelet.

MIFII Units are made up of different modules, such as:

CPU, which includes the power supply, inputs and outputs.

Magnetic module with 4 current transformers(3 for phases and 1 for ground)

Front module with 16x2 LCD display. It also includes the front RS232 communication port.

Figure 3–1: MIFII FRONT VIEW

3.1.1 MECHANICAL DESCRIPTION

The metallic case of the unit is highly resistant to corrosion. It is made of stainless steel (AISI 304), coated with an epoxy layer, and the rest of the metallic pieces are covered with a high quality resistive coating that has successfully passed at least 96 hours in the salt spray chamber (S/N ASTM B-117).

The front of the relay is made of a shielded high quality thermoplastic, flame retardant (V0), highly resistive material, which guarantees the unit's immunity to all types of EMI/RFI/ESD interference. As well, an IP52 (IEC 529) protection degree against dust and water through the front and with the relay mounted in the panel.

The modular design of the relay simplifies repair or replacement of its components, without the need to manipulate the wiring. These types of operations must be performed exclusively by qualified personnel and only after removing auxiliary voltage from the unit.

The unit is designed for semi-flush mounting. The relay is secured to the panel with the 4 M6 screws provided with the unit. This allows the user access to the front keypad, display and communication port. The wiring is at the rear of the unit. The drilling dimensions are shown on the drilling dimension diagram.

FRONT   SIDE   CUTOUT
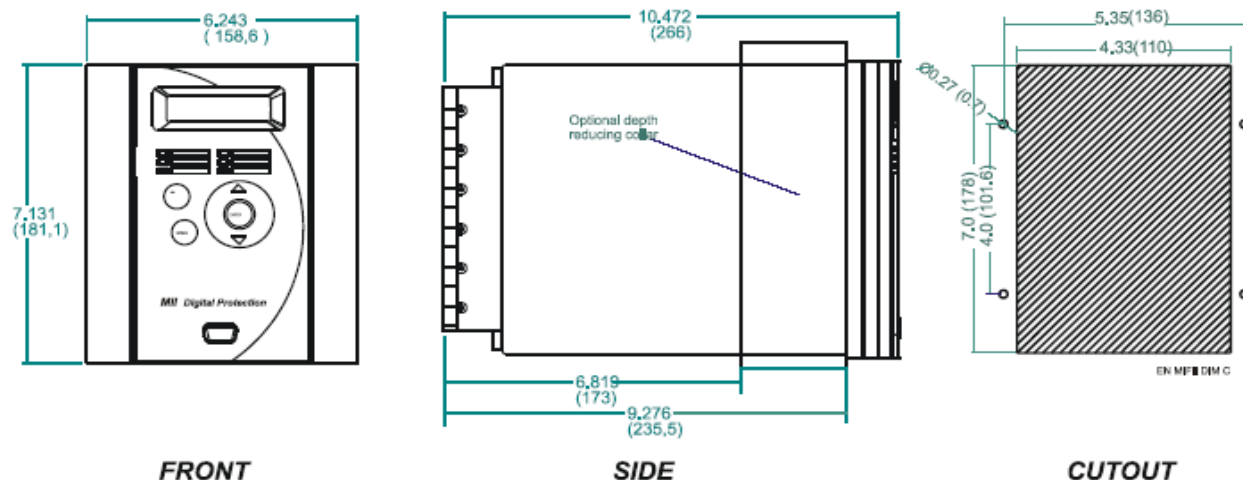
Note: Dimensions are shown in inches (mm).

Figure 3–2: MOUNTING AND DIMENSIONS DRAWING FOR MIFII MODELS WITH DEPTH REDUCING COLLAR

The relay is wired through the terminal blocks located at the rear of the unit. In this terminal board, current terminals are shorted two-by-two when the transformer module is extracted, so that the CT secondary never remains open.
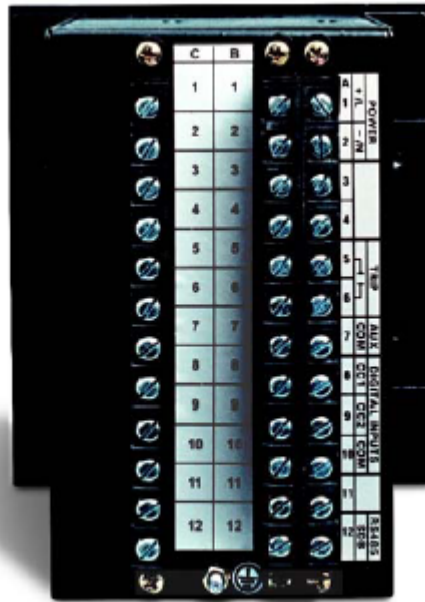
Figure 3–3: REAR VIEW

The magnetic module with the CTs is already connected to a female connector screwed to the case that incorporates shorting bars in the current inputs, so that it can be extracted without the need to short-circuit the current externally.

A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components.

In a similar way, when mounting and dismounting the front of the unit, be sure to correctly align the DIN connector of the rear bus with the DIN connectors of the module. A slow and careful insertion must be made until the module is correctly aligned, and then a more firm insertion can be applied, never forcing the module.

Recommended cable section: 12/16 AWG.

Copper conductor only.

Tightening torque: 1.2 Nm.
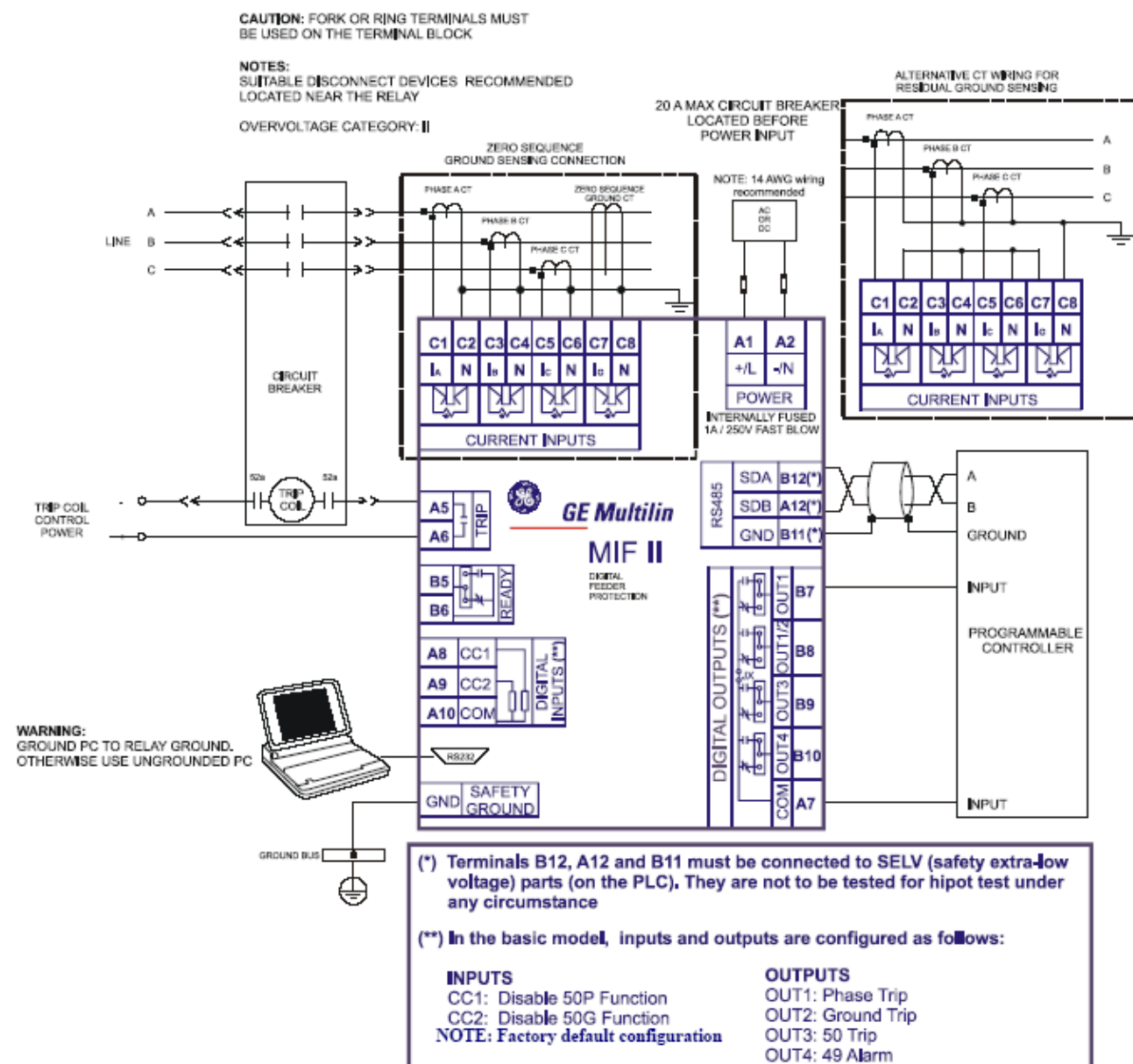
Figure 3–4a: TYPICAL WIRING DIAGRAM FOR MIFII RELAY WITHOUT RECLOSER
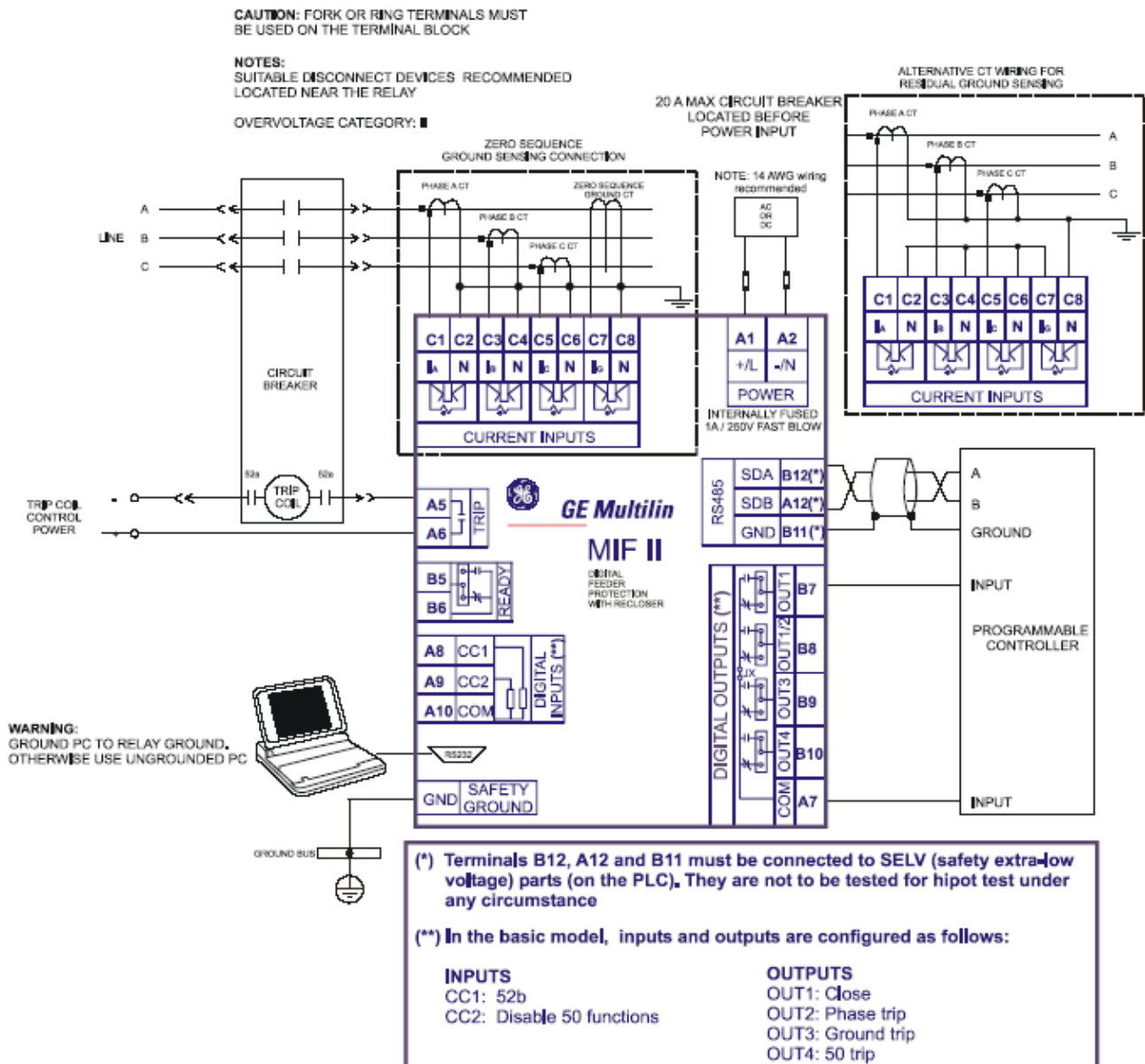
Figure 3–4b: TYPICAL WIRING DIAGRAM FOR MIFII RELAY WITH RECLOSER
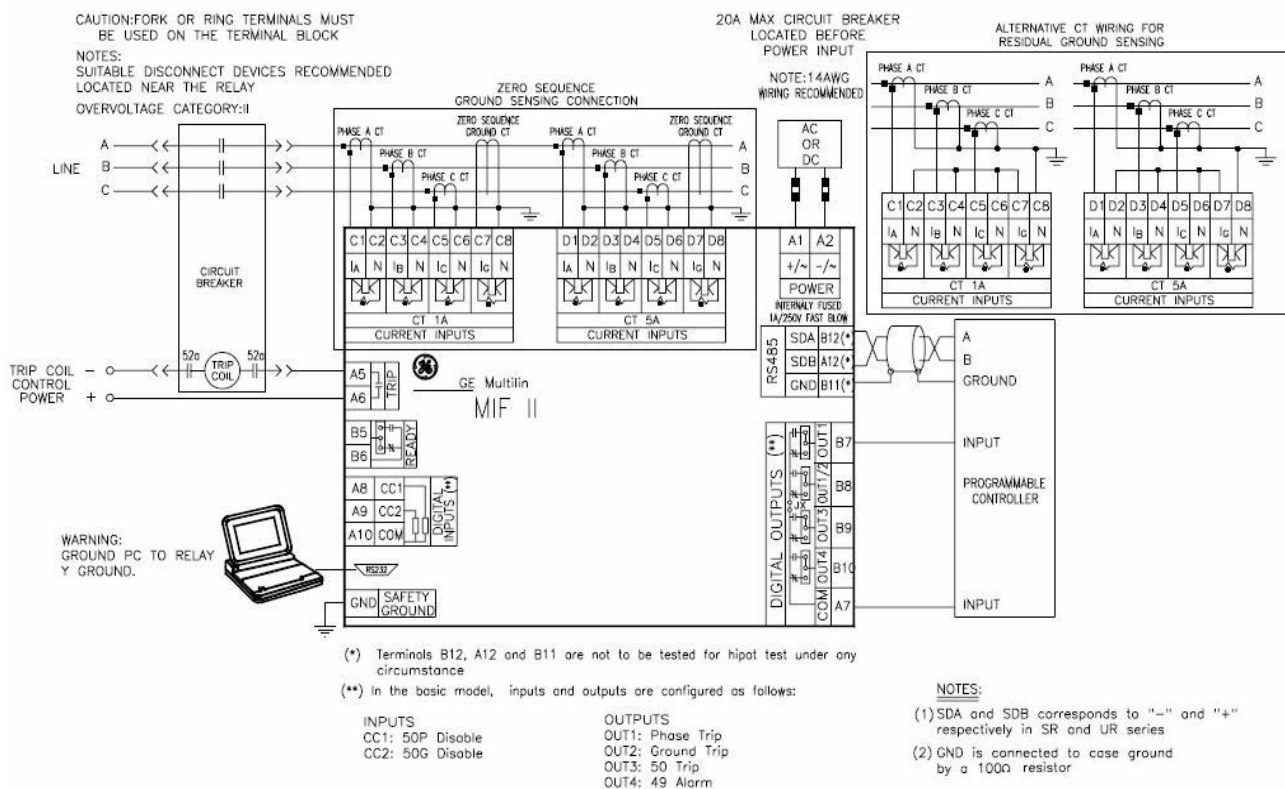
Figure 3–5a: TYPICAL WIRING DIAGRAM FOR MIFII RELAY CT 1/5 A WITHOUT RECLOSER
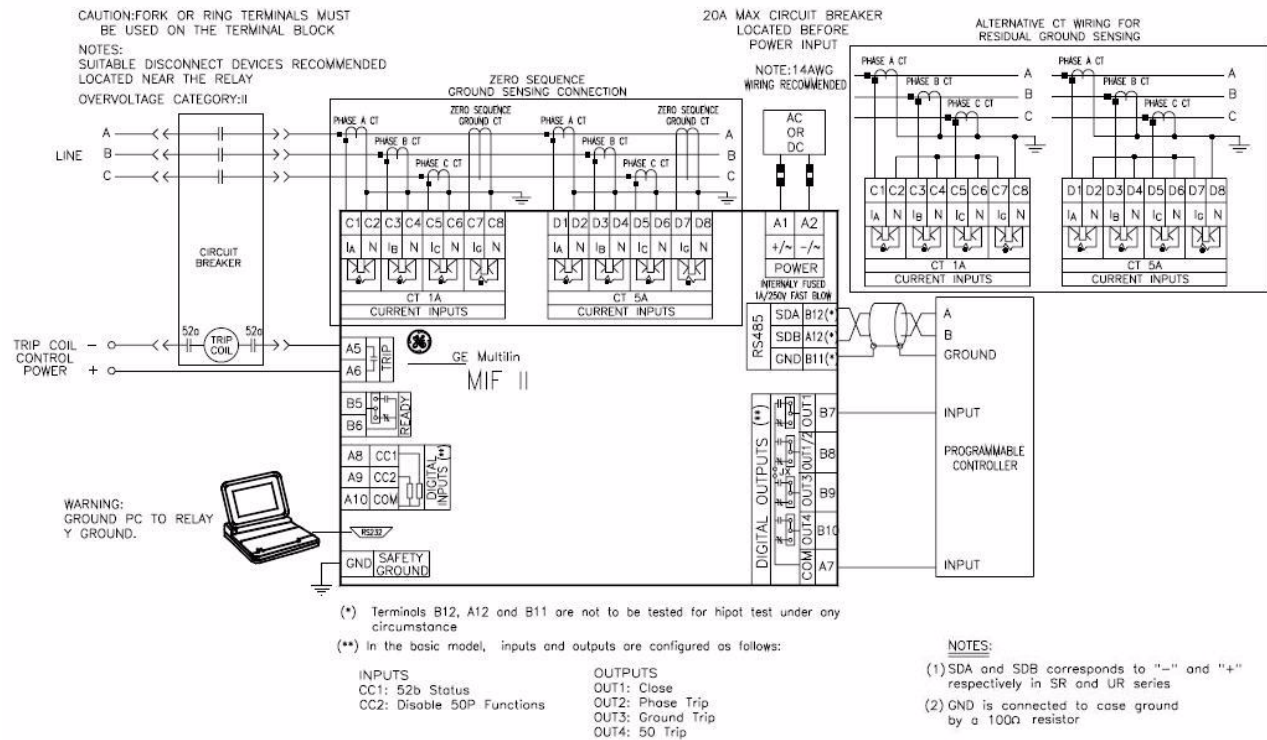
Figure 3–5b: TYPICAL WIRING DIAGRAM FOR MIFII RELAY CT 1/5 A WITH RECLOSER

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
LO	24/48 Vdc	19.2~57.6 Vdc
HI	110/250 Vdc 110/230 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.

3
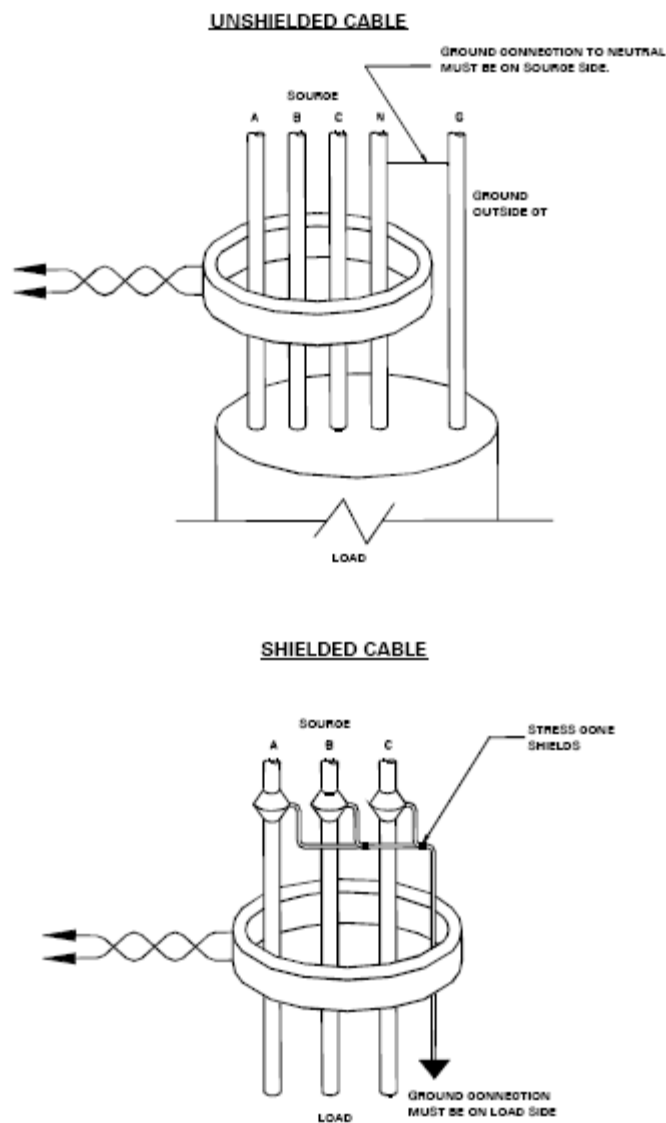
Figure 3–6: ZERO SEQUENCE CORE BALANCE CT INSTALLATION

3
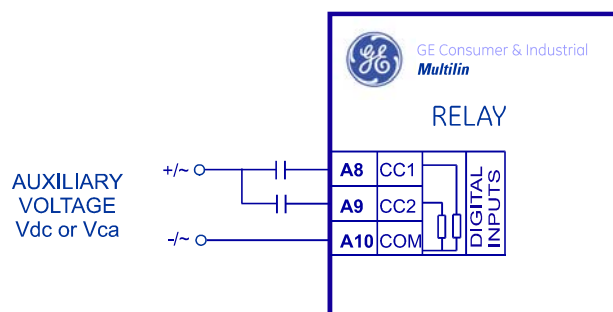
Figure 3–7: CONTACT INPUTS CONNECTIONS

Wet contacts must be connected to the inputs of the relay. 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 for HI models and 57.6 for LO models.

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

In case of using AC voltage, it must be ensured that there is no 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.
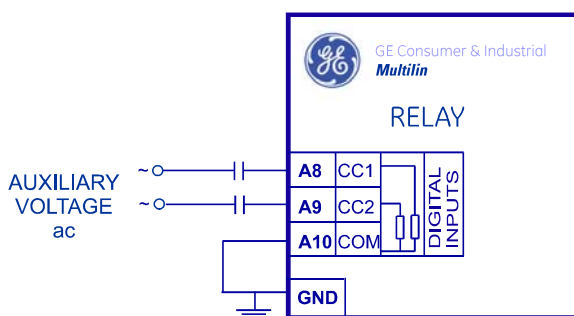
Figure 3–8: CONTACT INPUTS CONNECTIONS (AC ACTIVATION)

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

Next figure shows the PCB of a MIFII relay, and the location of the jumpers used to select the configuration of each output contact (NO or NC).

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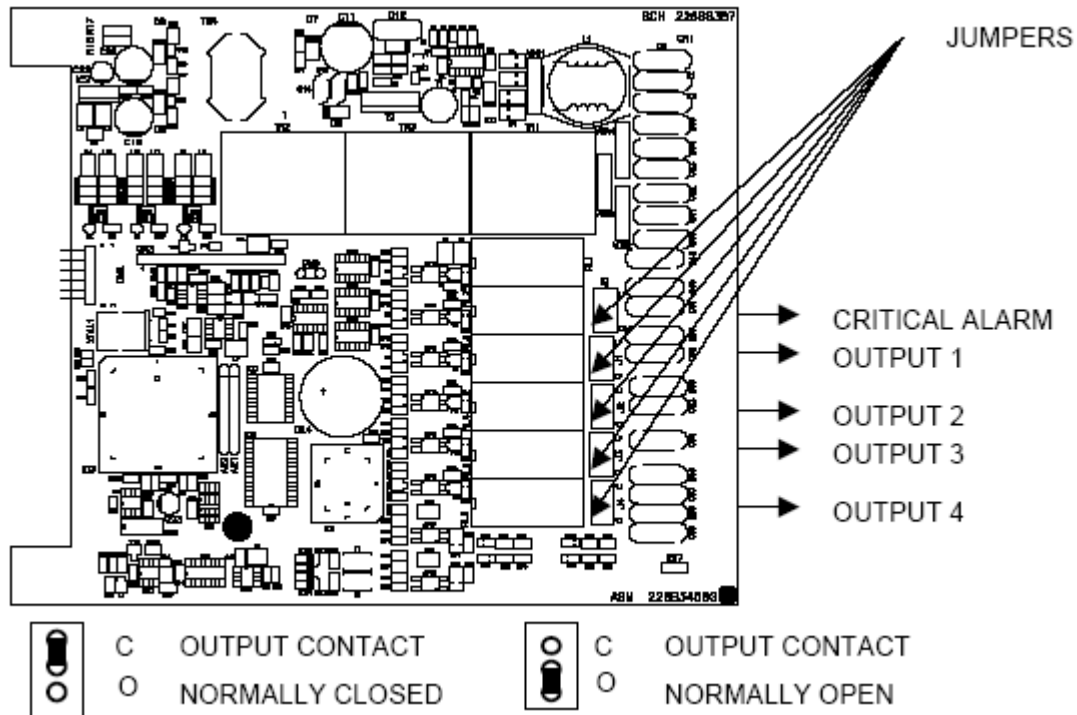
Figure 3–9: PCB SCHEME SHOWING THE JUMPERS TO CONFIGURE THE OUTPUT CONTACTS (NC / NO)

MII relays provide one trip contact, one alarm contact and four configurable contacts (option 1 and 2) sharing one common.

An internal jumper, called Jx jumper, has been provided to allow splitting the four configurable outputs into two isolated groups. In this case, the number of outputs is reduced to three.

Jx jumper is closed in the factory default configuration. (It is possible to order relays with Jx removed).

The figure shows the factory default configuration with Jx Jumper closed. It is located on the soldering part of the PCB containing the inputs and outputs.
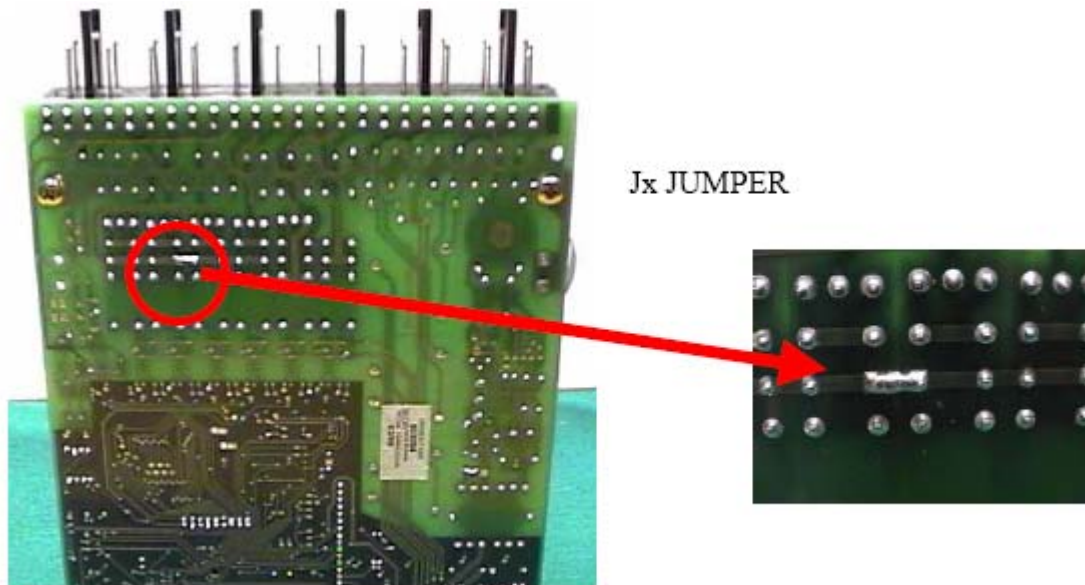
Figure 3–10: JX JUMPER

The Jx jumper is a tin-solder jumper easy to remove using a de-soldering tool.

The standard factory default output contact configuration consists of one group of four outputs, with the same common. The figure below shows the configuration:
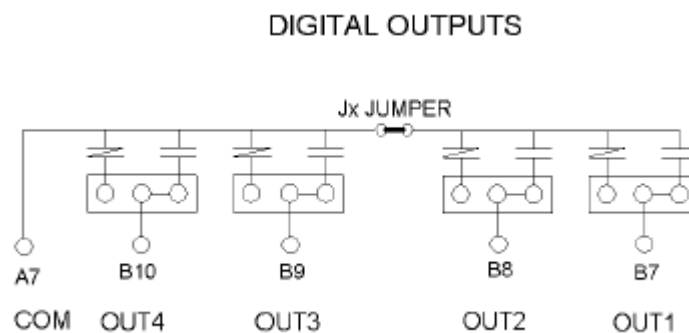
Each output has a different configuration, and it is able to operate independently to the others.

If Jx jumper is removed, the output contact configuration change as shown in the following figure:
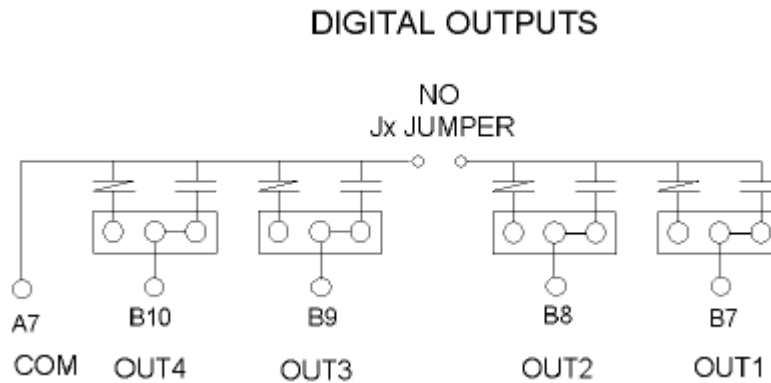
After removing the Jx Jumper, the outputs are divided in two groups: Independent and isolated.

Group1: Terminals B8-B7: Provide one output contact combining OUT1 and OUT2

Group 2: Terminals B9-A7: OUT3 Standard output contact

Terminals B10-A7: OUT4 Standard output contact

3.1.9.1 *OUTPUT CONFIGURATION AT TERMINALS B8-B7:*

To have a **closed** contact across terminals B7-B8, one of the two following procedures should be followed:

a) *JX REMOVED AND OUT1 AND OUT2 NORMALLY OPEN:*

OUT1 and OUT2 must operate together to operate like a single output.

The configuration of OUT1 and OUT2 must be the same so both outputs close simultaneously and operate successfully.
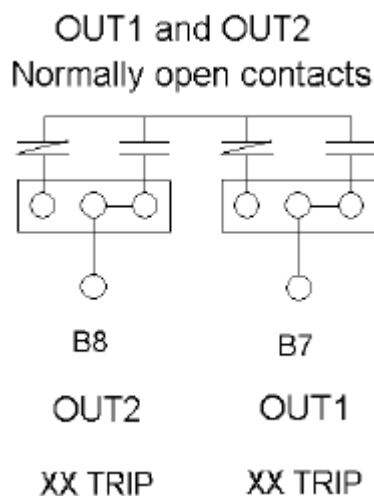
Figure 3–11: OUT1 AND OUT2 CONFIGURATION TO ACT AS A NORMALLY OPEN CONTACT

b) *JX REMOVED AND ONE OF THE TWO INTERNAL CONTACTS SET AS NORMALLY CLOSED:*

It is possible to change by hardware the contact configuration from normally open to normally closed (see the first point of
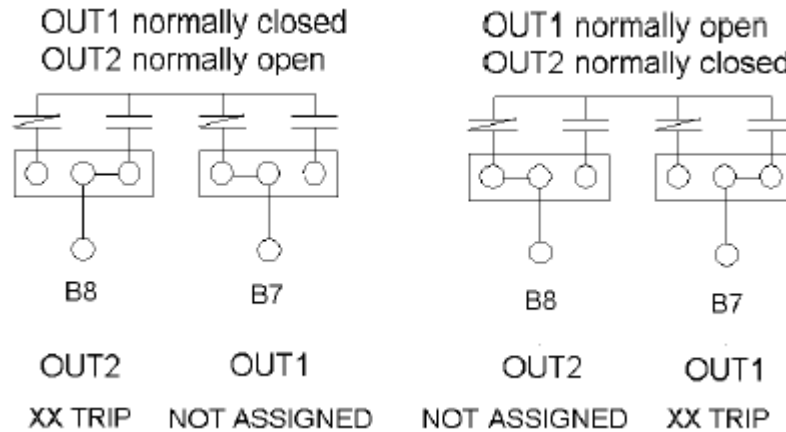
this document).

c) *OUT1 NORMALLY CLOSED AND OUT2 NORMALLY OPEN:*

The hardware configuration corresponds to OUT1 NC and OUT2 NO. To operate with this hardware configuration it is necessary to configure by software the OUT1 as NOT ASSIGNED, so it never change its state and remains closed, and OUT2 as required by the application (output configuration is only available in models option 1 and 2).

d) *OUT1 NORMALLY OPEN AND OUT2 NORMALLY CLOSED:*

The hardware configuration corresponds to OUT1 NO and OUT2 NC. To operate with this hardware configuration it is necessary to configure by software the OUT2 as NOT ASSIGNED, so it never change its state and remains closed, and OUT1 as required by the application (output configuration is only available in models option 1 and 2).

A 9-pin RS232C serial port is located on the front of the relay for programming with a portable (personal) computer. All that is required to use this interface is a personal computer running the EnerVista MII SETUP software. Next figure shows the communications cable configuration.

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

RELAY - PC CONNECTION WIRE FOR RS-232 FRONT PORT
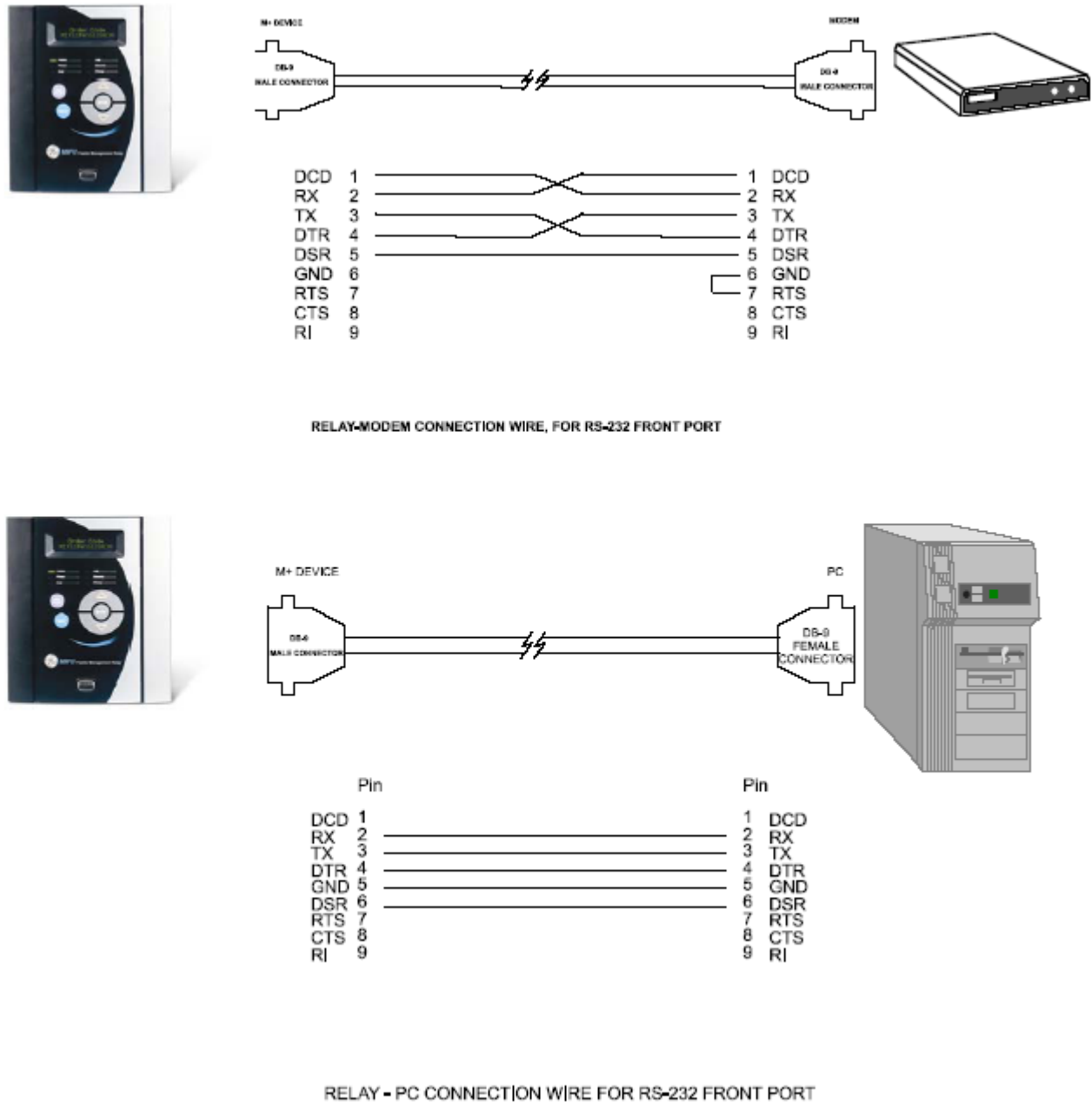
Figure 3–12: RS232 FRONT PORT CONNECTION

WARNING: IN ORDER TO PREVENT DAMAGE BOTH TO THE PC SERIAL COMMUNICATIONS PORT AND THE RELAY FRONT RS232 PORT, IT IS COMPULSORY TO CONNECT THE RELAY GROUND TO THE SAME GROUND AS THE PC. OTHERWISE, USE AN UNGROUNDED COMPUTER.

FOR THIS PURPOSE, PLEASE FOLLOW THE SAFETY INSTRUCTIONS IN CHAPTER 1

In addition to the front RS232 port, the relay provides the user with an additional RS485 communication port. RS485 data transmission and reception are accomplished over a single twisted pair that 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 minimize 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, 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. 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 the GE ALPS and DDS family of 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 configurations 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 provided internally. To ensure maximum reliability, all equipment should have similar transient protection devices installed.
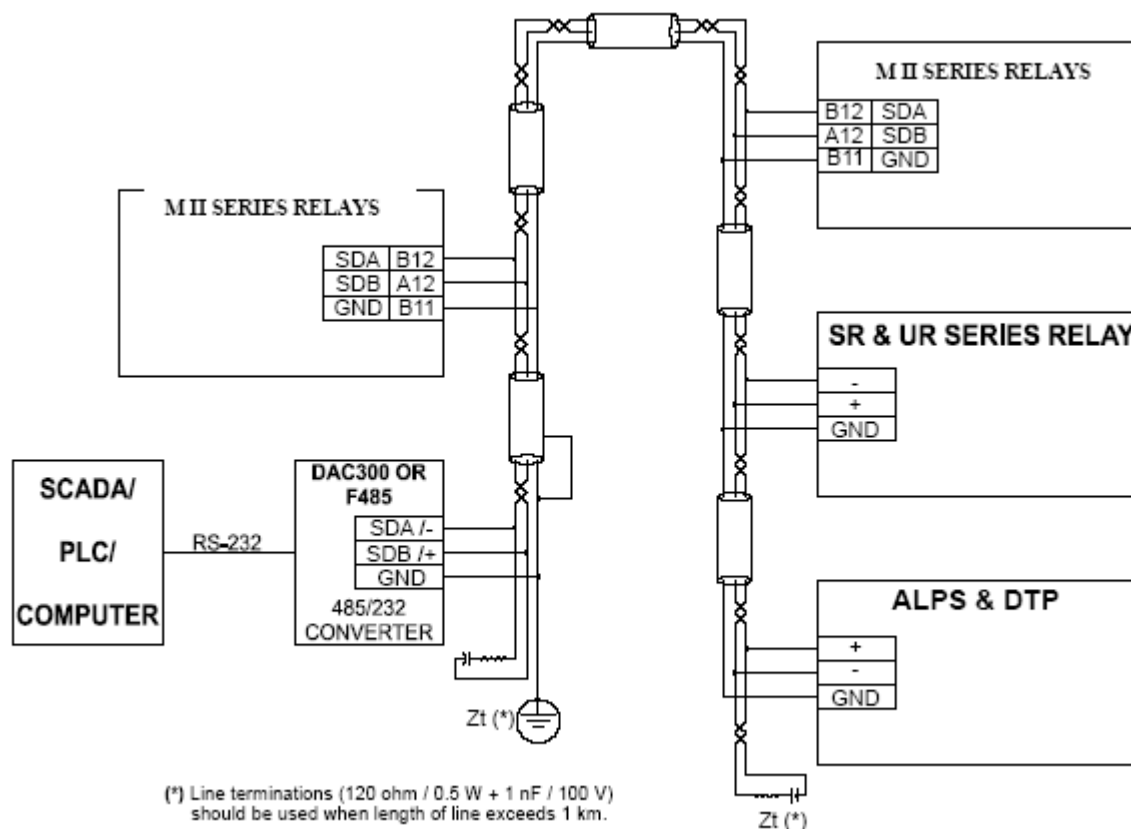
Figure 3–13: RS485 SERIAL CONNECTION (B6366H5)

IMPORTANT NOTE: MII FAMILY RELAYS CAN BE USED ONLY WITH ENERVISTA MII SETUP SOFTWARE.

The EnerVista MII SETUP software package uses only ModBus protocols, and is designed to communicate with a single relay at a time. GE Multilin offers different communication software packages, such as GE-POWER and ENERVISTA, which can be used to communicate simultaneously with several relays.

EnerVista MII SETUP software provides an easy way to configure, monitor and manage all MIFII features.

a)   Setting files

EnerVista MII SETUP software provides two ways of working with setting files:

1.In off-line mode, disconnected from the relay, creating or editing setting files for a future download to the relay.

2.Modifying directly the relay settings while connected to the relay.

b)   Configuration

The configuration of inputs, outputs and LEDs can be modified, and internal logics with the different relay elements can be created. For MIFII, it depends on the selected option (OPTION 0, 1 or 2)

c)   All metering values used by the unit can be monitored, as well as the internal states, inputs and outputs status.

d)   Performing the different available operations.

e)   Firmware updates.

f)   Viewing the different records stored in the relay, as events, oscillography, etc.

The simplified use of the EnerVista MII SETUP software is as follows:
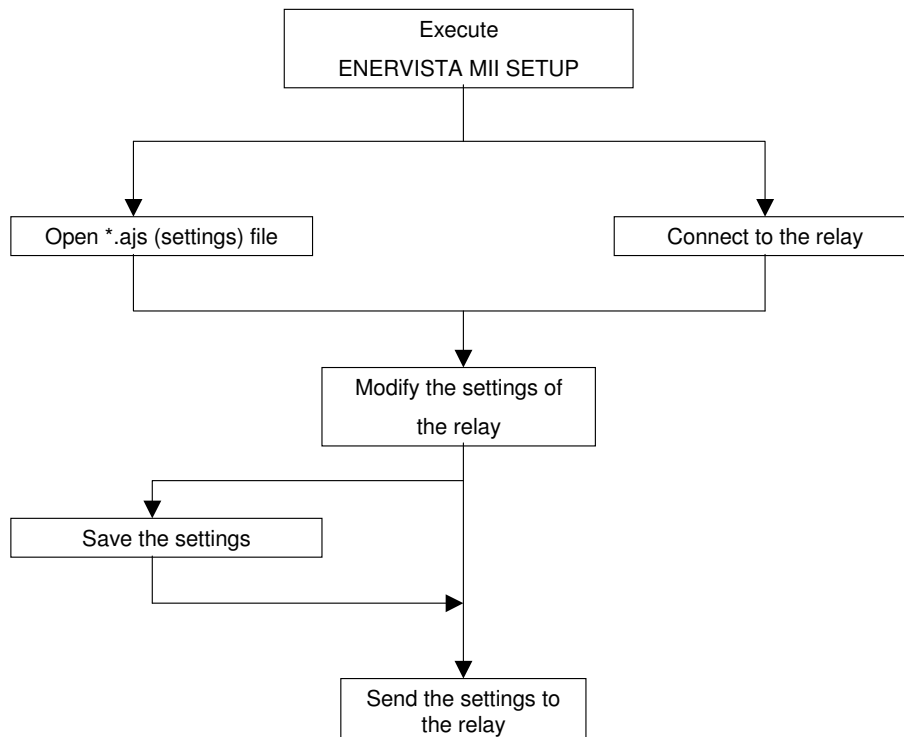
Before the physical connection to the relay, it is important that the user reviews the safety instructions detailed in section 1. This section explains the importance of connecting both relay ground terminal and computer to a good grounding. Otherwise, communication may not be possible, or the relay and/or the computer could be damaged.

To work online, the relay communication parameters (e.g. baud rate, relay address and password) must match the parameters in the computer.

The computer parameters can be modified, in the Communication – Computer menu. Refer to the appropriate section in this same chapter for more details.

4.1.3 MAIN SCREEN

The main screen of EnerVista MII SETUP software includes the following components:

- Title
- Main menu bar
- Main icon bar
- Working area
- Status bar

Figure 4–1: ENERVISTA MII SETUP MAIN SCREEN

From the **File – New** option, the user can create a new file that will contain all the protection unit settings, as well as the relay configuration (inputs, outputs, events, oscillography, etc.).

When the option is selected, the following screen will be shown. The user must select here a specific relay model matching exactly the relay model to which the settings and configuration will later be downloaded. The mentioned settings and configuration are related to the default factory settings of the relay

The Model Selection window will show only some basic models and those for which the MIIPC software has ever been connected. In case the relay has been connected to different firmware version of the same model, a version selection window will appear to choose the correct one.

.

MODEL SELECTION

| MIB10***E00000 |
| MIB20***E00000 |
| MIB30***E00000 |
| MIFIIPA11E00**00 |
| MIFIIPA51E10**00 |
| MIFIIPA51E20**00 |
| MIFIIPA55E00**00 |

OK   Cancel

Press F1 for HELP
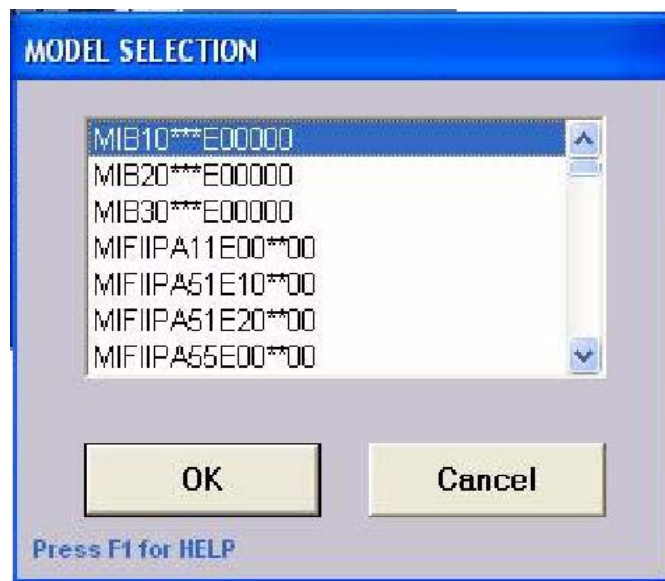
Figure 4–2: MODEL SELECTION

Once the relay model is selected, the software will load the relay structure and will enable the ***Setpoint***, ***Actual***, ***Communication***, ***View*** and ***Help*** menus for configuration.

Option that allows to open previously created setting files for their modification.

Once the relay model is selected, the program will enable ***Setpoint***, ***Actual***, ***Communication***, ***View*** and ***Help*** sub-menus.

The Settings File converter allows the user to convert former versions setting files to another one.

When the option is selected, a .ajs file chooser will be shown, to select the settings source file. After selecting it, a model selection window will appear for choosing the version of the new file. Please, note that the Relay I/O configuration an the Logic configuration won't be converted.

Figure 4–3: WARNING POP-UP

Finally, the settings will be charged on the Enervista MII Setup on offline mode, so it must be saved in order to get the new .ajs file.

4.2.4 PROPERTIES

From the **File – Properties** option, the program will show a screen including the relay model information, firmware version, etc., as shown on Figure 4–4:

Figure 4–4: MODEL/VERSION

The **File – Get info from relay** option enables the user to save the relay settings in a file on the hard disk of the computer. This file can later be opened offline to review and modify settings, and send them again to the relay after the modifications.

The **File – Send info to relay** option enables to send to the relay a settings file stored on the hard disk of the computer.

Please, note that only files matching the version of the relay's firmware will be acceptable for being sent to the relay. In other case, an error message will be shown, asking the user to convert the file using the Setting File Converter application included in this software.

The **File – Print Setup** option enables the user to configure the print setup for the settings file as shown in Figure 4–5:
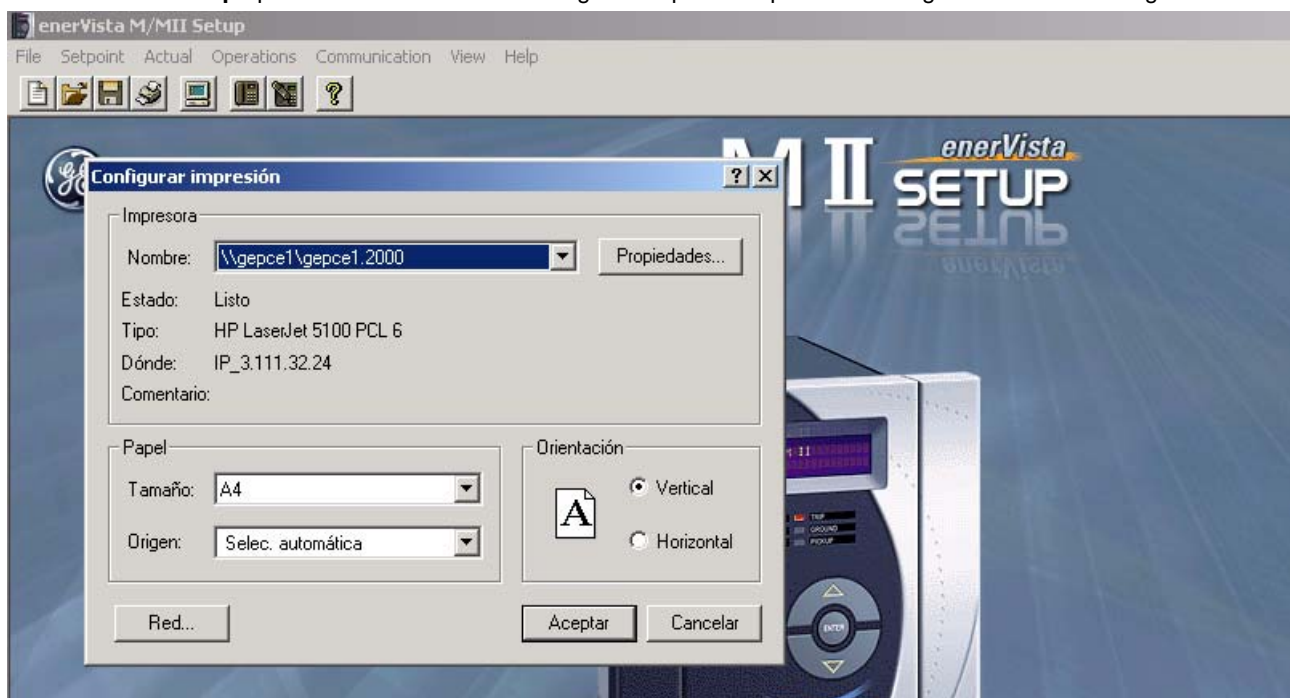
Figure 4–5: PRINTER SETUP

The **File – Print Preview** option displays a preview of the settings print-out. It is also provides a quick view of all the relay settings at a glance, without having to navigate through the different menu trees. From this screen it is also possible to configure the printer that will be used, or to directly print the document. Double clicking on the document with the left mouse button will enlarge the document view, and double clicking with the right button will reduce the size.

The available actions in this screen are shown in Figure 4–6:
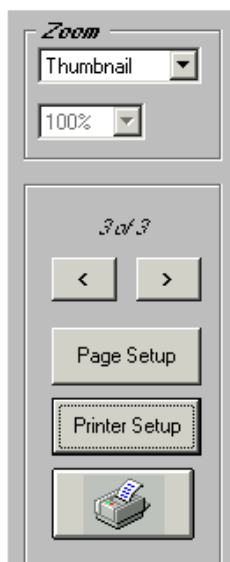
Figure 4–6: PRINT PREVIEW CONTROLS

4.2.9 PRINT

The **File – Print** option prints the relay settings using Windows default (active) printer.

4.2.10 CLOSE

The **File – Close** option exits the program. It does not prompt for confirmation or save the open file.

Clicking on the Setpoint menu entry gives access to Settings, Configuration, Logic Configuration and Clock.

The **Settings** sub-menu is the same for all MII family relays, and shows all relay settings divided in two groups: **Main Settings** and **Advanced Settings**. The first settings group has basic settings (main protection functions). The second settings group includes more advanced settings (double settings group, customized curves, etc.), needed only if more complex protection schemes are required

The purpose of this division is to simplify the use of the relay for those users only requiring the basic functionality of the relay.
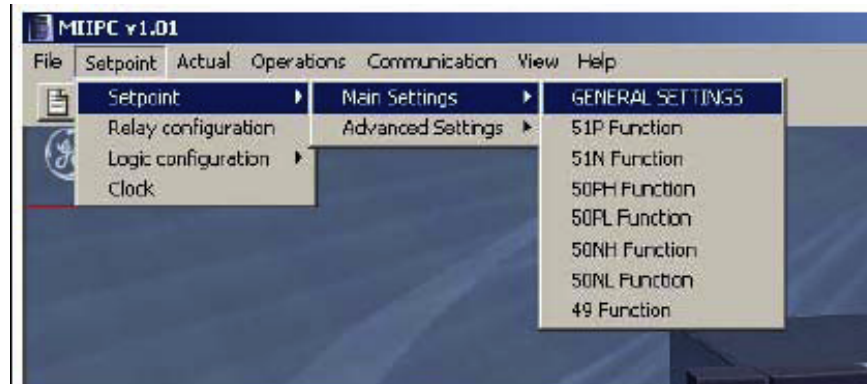
Figure 4–7: SETTINGS MENU

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 (the function selected in the example is the 51P function in a MIFII).

Edit the setting double-clicking on the value (for example, 51Penable).

Modify the value of the setting (see Figure 4–9: to Figure 4–11:).

Confirm/Accept the modified value.

Store the settings in the relay (if working in Emulation mode, this option stores them on a temporay file that must be saved with the File->Save option in order to preserve them) with the **Store** button. If the **OK** button is pressed without having pressed Store (a window asking confirmation will appear), the settings of this group will be discarded.
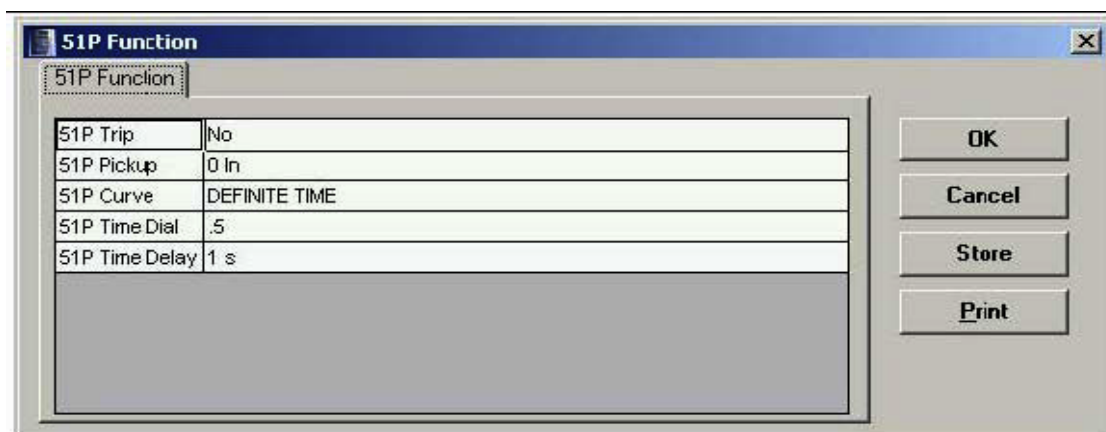
Figure 4–8: FUNCTION MENU

Primarily there are four different setting formats:

Boolean/Logic Settings   (only two choices). For Boolean settings, the two possible options are shown so as the user can select which one is the appropriate, clicking with the mouse on the option desired.

Numerical Settings   For Numerical settings, a number must be entered. The program shows the minimum and maximum value for each setting, and it will not accept any value out of the corresponding range.

Settings with a set of options For set of options settings, 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 4–9: LOGIC SETTING.   **Figure 4–10: NUMERIC SETTING.**   **Figure 4–11: SET OF OPTIONS.**

4.3.2 MAIN SETTINGS

4.3.2.1 GENERAL SETTINGS

General settings describe and activate the electric system settings where the relay is going to operate. Some of these settings will be used with measure values presentation purposes; however, some of them are directly applied during the sampling and analogical-numerical conversion process (nominal frequency setting). Therefore, these settings need to be altered so they fit with the system settings.

4.3.2.2 GROUP 1- GROUP 2 FUNCTION SETTINGS

The M family relays provide two independent setting groups. **Group 1** is available in the Main Settings group, while **Group 2** can be accessed in the Advanced Settings group. The setting groups can be selected by digital input, through a communications command or from the EnerVista MII SETUP, or simply selecting it with the relay keypad. The setting that shows the active group can be found in General Advanced Settings.

4.3.3 ADVANCED SETTINGS

4.3.3.1 ADVANCED GENERAL SETTINGS

Advanced General Settings enables configuration of the active setting group as well as the minimum time the trip contact will remain closed, to let the circuit breaker open the circuit so as the contact does not get burnt.

4.3.3.2 OTHER ADVANCED SETTINGS

Besides the Flex Curve values, the user may configure the mask of events that will generate an event report and the events that will generate an oscillography.

Setpoint – Relay Configuration shows a dialog box to configure digital inputs, contact outputs and front panel LEDs, as shown in Figure 4–12:

Figure 4–12: RELAY CONFIGURATION SETTINGS

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 greater flexibility when creating complex logics.

The meaning of the different columns is explained below:

- **INPUT/LED/OUTPUT**: Designates the respective element

- **I/O configuration**: the appearance and function of this column can be, depending on the state of the respective OR checkbox column:

    - **OR checkbox** is not checked: the element consists of a drop down list in which the user can select the function that will activate the output or LED, or that will be activated by the input

    - **OR checkbox** is checked: the element consists of a button that will activate a new window (see Figure 4–13:) where the user can choose a sum of several functions that will activate the output or LED, or be activated by the input. These functions are distributed in groups, and only functions in the same group can be chosen for the same OR gate.

- **OR**: activates the **OR button** for the I/O configuration column (see previous point). The window that appears when the OR button is pressed can be seen in Figure 4–13:
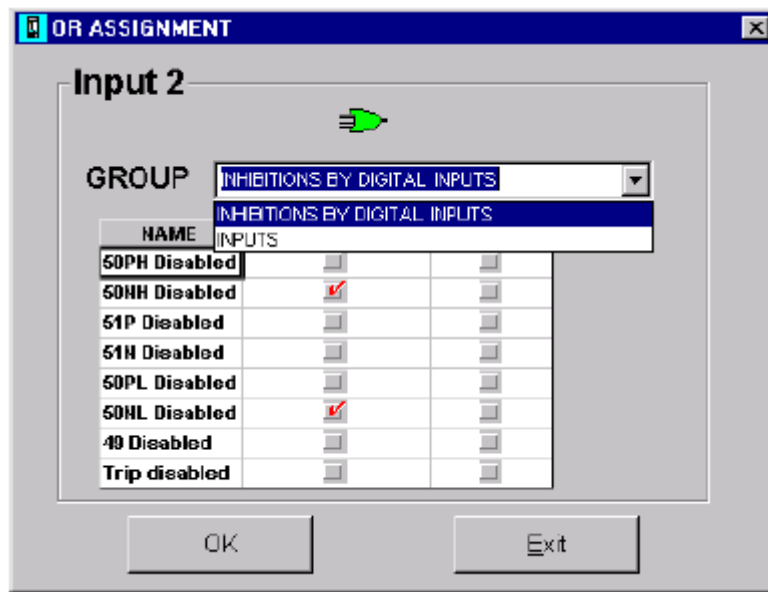
Figure 4–13: OR ASSIGNMENT

- **NOT**: when **NOT** checkbox is enabled, the logic is inverted. The element (input, output, LED) will actuate when the conditions are NOT fulfilled.

- **NAME**: the user can write an identifying label of up to 4 characters that will get stored to be displayed later on.

- **BLINK** (only for LEDs): the selection of **BLINK** checkbox makes the LED blink (alternatively switch ON and OFF) instead of being fixed when it is activated.

- **MEMORY** (only for outputs and LEDs): when **MEMORY** checkbox is enabled, the respective element will be latched. If the cause that generated the activation of the output or LED does no longer exist, the element will remain active until a RESET command is performed.

MII family relays can execute simple logic schemes that can be programmed from EnerVista MII SETUP. This logic schemes can be found at **Setpoint – Logic Configuration**.

When one of the logics is selected, a new window will appear where the user can assign up to 8 inputs to the logic circuit. Each of these inputs can be a single function or status, as well as a logical union of several statuses
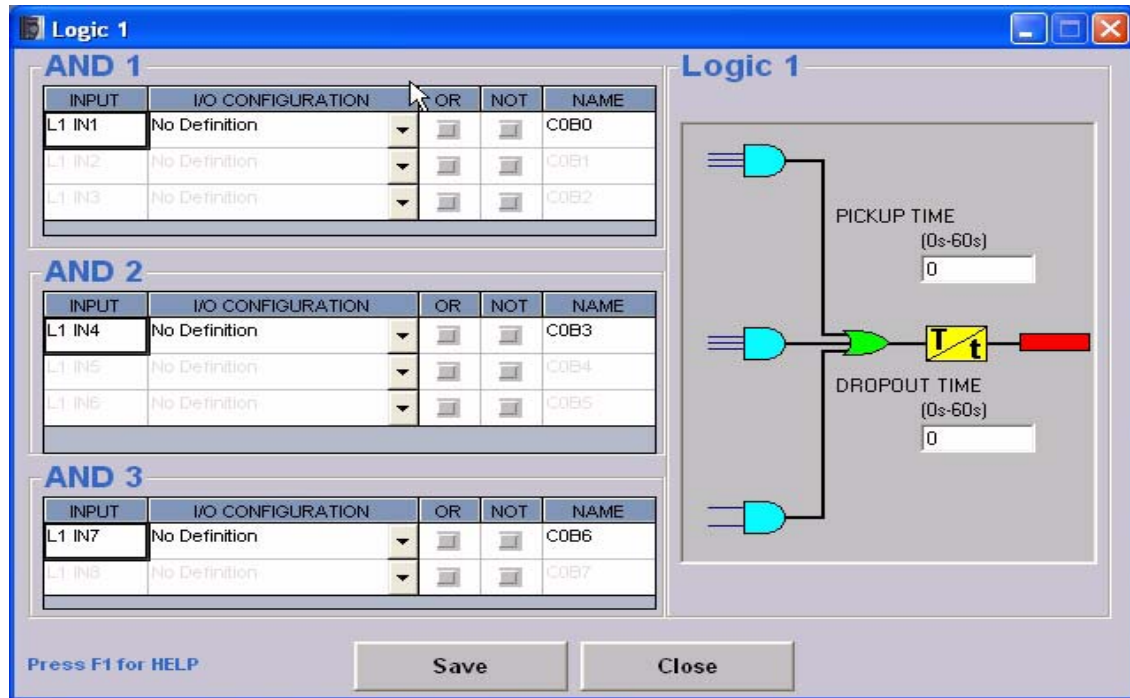
Figure 4–14: LOGIC CONFIGURATION

The way the logic works is illustrated in the diagram at the right of the logic window.

First, depending on the gate, up to 2 or 3 signals (internal flags coming from the status of the relay or from another logic, or external input signals) can be chosen as sources of each **AND gate**. The way they are programmed is similar to the way I/Os are (refer to relay configuration). The device will not take into account entries that are after an empty one. This means that every entry after the first empty one will be ignored. For example, if *L1 IN1* is programmed but *L1 IN2* is left empty, the relay will not take into account *L1 IN3* and will directly evaluate *L1 IN4*. In the same way, the relay will ignore *AND2* if *AND1* is not programmed, and will ignore *AND3* if *AND1* or *AND2* are not programmed.

Then the results from the AND gates are added by an **OR gate** that will produce the result of the logic.

It is possible to set the **pickup and dropout times for output from the OR gate.** Example: for picking time of 10s and a dropout time of 15s, if input of the OR gate changes to 1, this input has to remain for 10s before the result of the logic changes to 1. If result of the OR gate drops to 0, output will be 1 for 15s and after that time output will be 0.

See Chapter 7 for more details on logic configuration.

The **change date/time** option opens a window with two choices:

• Sending the PC date and time to the unit, this is, synchronizing the PC and the unit.

• Selecting a date and a time and sending it to the relay.
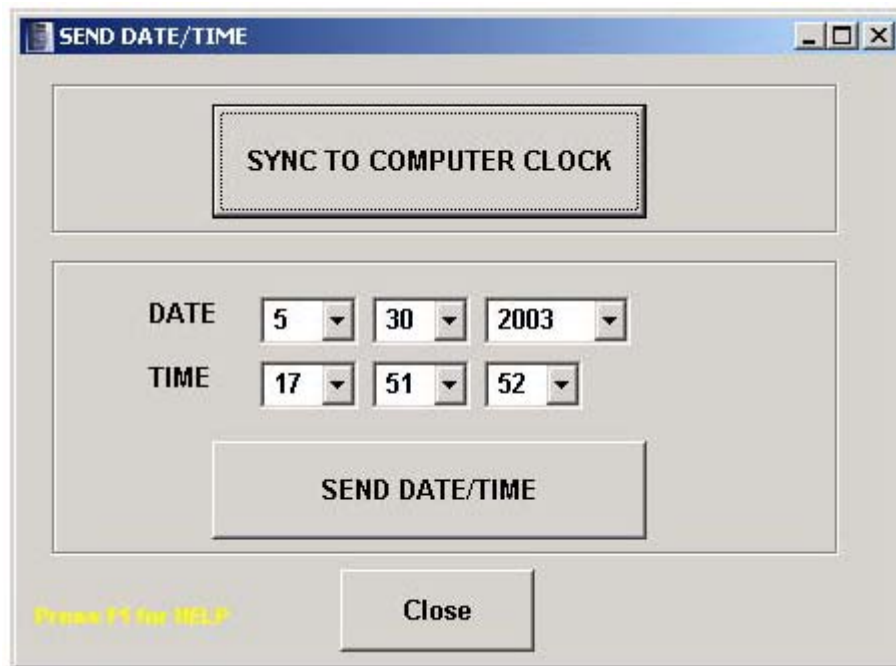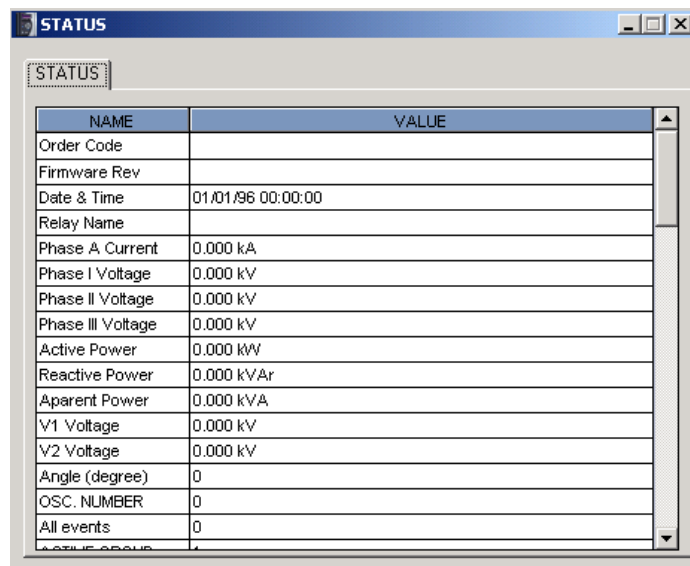
Figure 4–15: CHANGE DATE/TIME

Once the new date and time have been sent, the user can check in the status graph, or even in the relay itself, that the new date/time has been correctly entered.

Actual - Actual values menu displays the **Status Window** shown in Figure 4–16:. This window shows internal relay information, measures, function status as well as additional information. There is a vertical scroll bar to navigate up and down the table to reach the desired information:

- Relay model number and firmware version.

- Relay internal date and time.

- Values of currents, voltages and powers (phase and ground).

- Protection function status (pickup / trip for each function).

- Active settings group number.

- Contact inputs and outputs status, and LEDs status.

- Information from the self-test functions of the device.

Figure 4–16: STATUS WINDOW

Actual – Event Recorder option makes the last 24 relay events to be retrieved (up to 32 for MIFII) and displayed in the window appearing in Figure 4–17:. Each event record is labeled with date, time (with 1msec. 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 program also shows current and voltage values for all phases and ground, frequency and single line sequence voltage during the event.
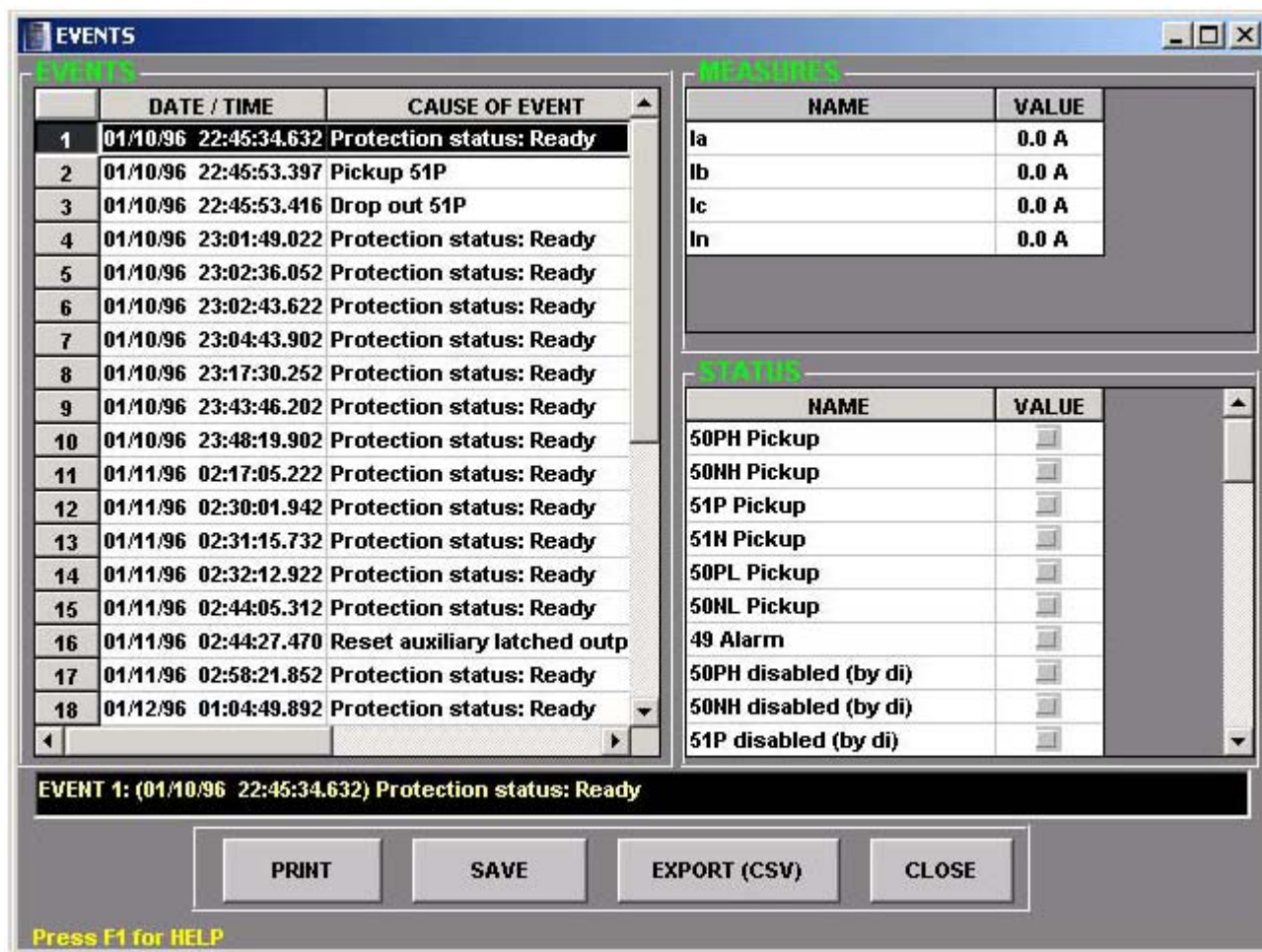
Figure 4–17: EVENTS WINDOW

The retrieved events can be reviewed in this window or also saved to disk (to be opened with EnerVista MII SETUP program) or exported to CSV (Comma Separated Values) format. This is a standard text table format that can be opened with most commercially available database or spreadsheet programs such as MS Access or Excel.

In the **Actual - WAVEFORM CAPTURE** option, the user can start the process to retrieve the Oscillography record stored in the relay. The program will request the path and filename where the file is to be stored, by means of the following form:
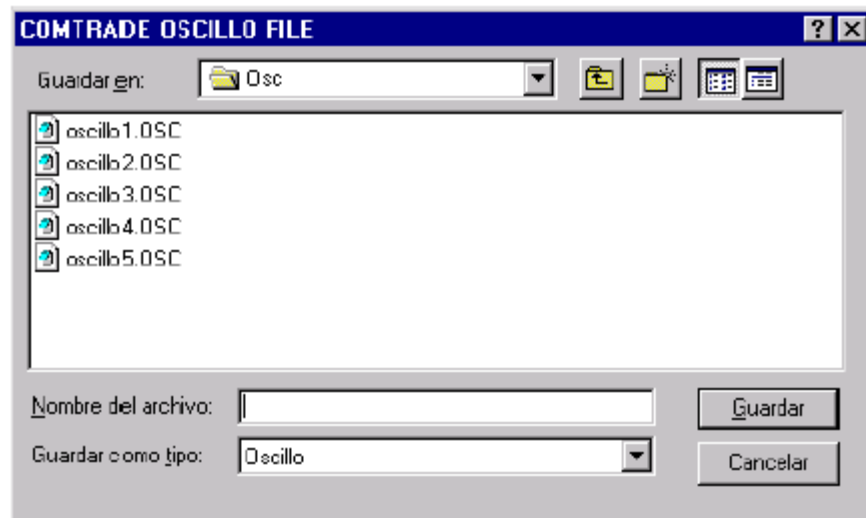
Figure 4–18: OSCILLOGRAPHY RECORD

This file can be viewed using GE_OSC software (the use of this software is described in manual GEK-105596).

From **Operations** menu the user can perform all possible operation commands.

Figure 4–19: OPERATIONS MENU

The **COMMUNICATION** menu provides configuration options to communicate with the relay, as well as to perform a ModBus communication troubleshooting, or to update the relay with a new firmware.

After making any change, pressing *Store* button saves the changes without exiting the window. Pressing *OK* saves and exits and pressing *Cancel* exits without saving changes.

4.6.1 COMPUTER

In **COMPUTER** dialog the user can configure the necessary adjustments to communicate with the relay from a PC.

Figure 4–20: COMMUNICATIONS DIALOG

4.6.1.1 COMPUTER SETTINGS

In **COMPUTER SETTINGS** box the user can configure computer communication settings, besides the connection (Control Type) and Startup Mode.

Control Type defines the connection type that is going to be used:

- **No control type** for serial connection (front RS232 or rear RS485),

- **ModBus/TCP** for Ethernet connection (by means of a serial/TCP converter). When this option is chosen, the serial configuration data disappears and a new box appears at the right to configure the IP address, the port number and the unit id.
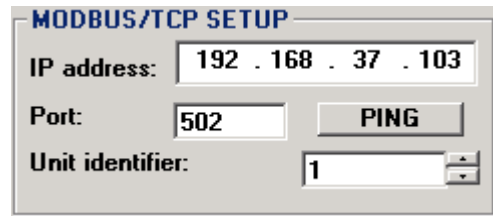
Figure 4–21: MODBUS/TCP SETUP

- **MODEM CONNECTION** for modem serial connection. The modem configuration options appear at the right when this option is chosen.

Defaults button returns the values to the factory default ones.

4.6.1.2 COMMUNICATION CONTROL

In **COMMUNICATIONS CONTROL** box the user can view the communication status (communicating to a relay or not), connect to a relay when the right parameters are entered in the Computer Settings box (**ON** button), or disconnect from the relay when desired (**OFF** button).

Once the connection is established, when the user accesses any Setpoint or Operations, or Actual – Event Recorder[i] menu entries for the first time, the program will ask the relay password. The following window will appear:
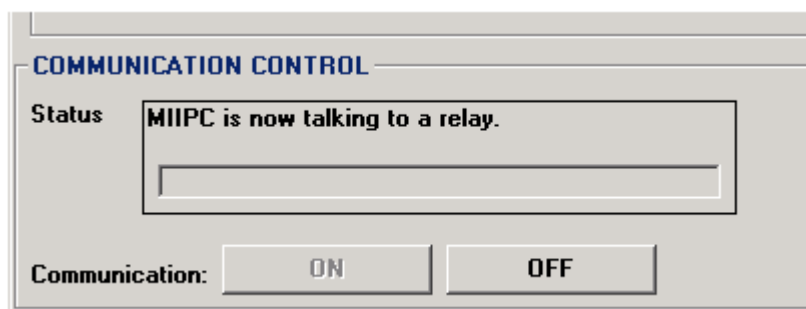
Figure 4–22: COMMUNICATION CONTROL – COMMUNICATING

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i. i.e., the first time a writing operation is performed against the relay during the current communication

4.6.1.3 *COMMUNICATION OPTIMIZATION*

COMMUNICATIONS OPTIMIZATION box allows the user to enter values to control device response to communication attempts. Changing these parameters can improve communication, although it is recommended not to make changes to the default values if it is not required.
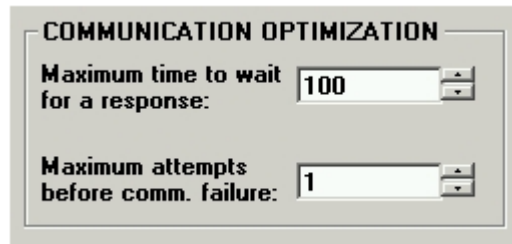
Figure 4–23: COMMUNICATION OPTIMIZATION

4.6.1.4 *PRINT SCREEN*

When the ***Print Screen*** button is pressed, a new window appears asking if the user wants to capture the entire screen or only the active window (the one with all the communication parameters). *Yes* means capturing the whole screen and *No* means capturing only the communications window.

Then a new window appears allowing to view the captured screen, to save the captured file in BMP or JPG format, or to print it (the print dialog window will appear so as the user can select which printer to use and enter the appropriate printer settings).
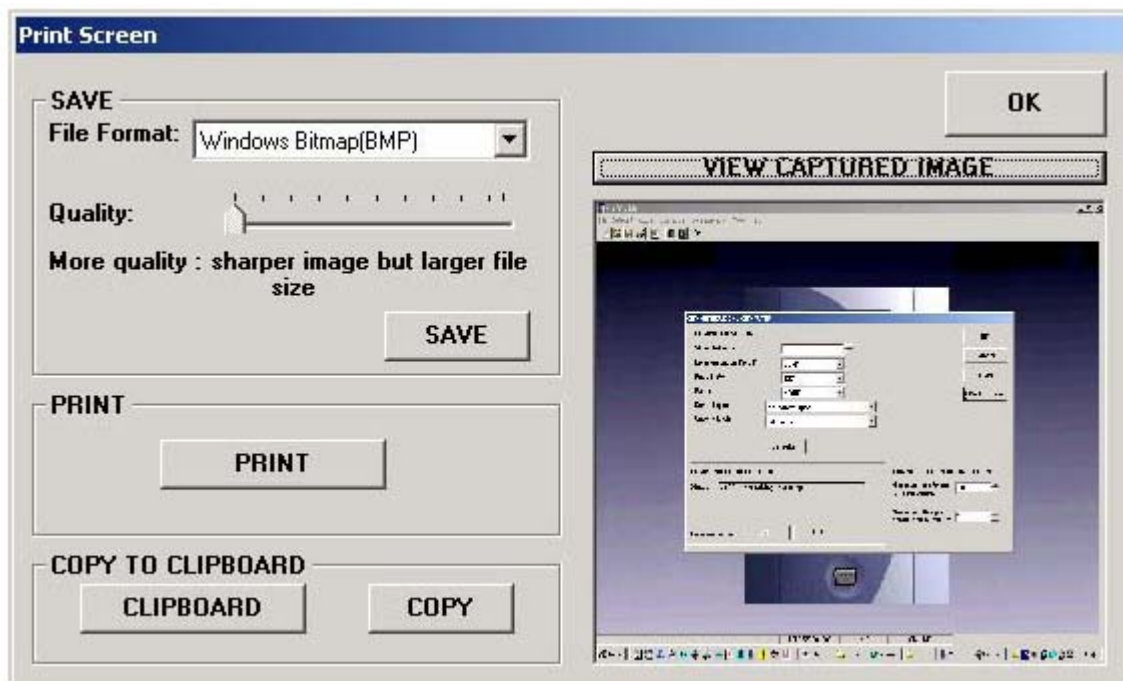
Figure 4–24: PRINT SCREEN

The **TROUBLESHOOTING** option is available only when the PC is communicating with a relay. It is intended to check the ModBus communication frames between the PC and the relay. In the upper part, the user can read any readable value from the relay (setpoints, actual values) by entering the desired hexadecimal address[i], the type of data to read (Setpoints, Actual Values), the number of registers (the length of each register is of 2 bytes) and the format of the data (integer, long, float...), checking the checkbox at the left to make the PC start polling that address or unchecking it to stop.

In the lower part, data can be sent to writable addresses of the relay. The working is similar to reading but, to send the data, the user must press the **SEND** button.

Figure 4–25: TROUBLESHOOTING

Refer to preceding section to learn about **Print Screen** button.

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i. To check how to read memory map addresses from the relay refer to the corresponding section further in this chapter

IMPORTANT WARNING: For upgrading the relay firmware to version 4.00 or later, it is mandatory that the ENERVISTA MII Setup version is 1.10 or higher. For firmware version 5.00 or later, the ENERVISTA MII Setup version must be 2.10 or later. Otherwise it may result in damage to the relay

The **UPGRADE FIRMWARE VERSION** option is active only when there is no active communication with the relay. If the PC is communicating with the relay, the user must switch communication off in **Communication > Computer** menu to activate this option.

When this option is selected, a window appears asking for the new firmware version file to be uploaded to the relay:
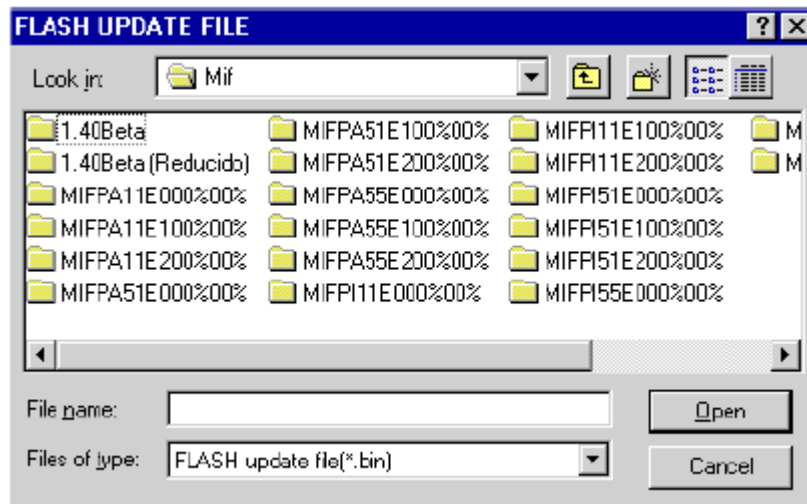
Figure 4–26: FLASH UPDATE FILE

After selecting the file that will be used to update the FLASH memory, the following screen will be displayed:
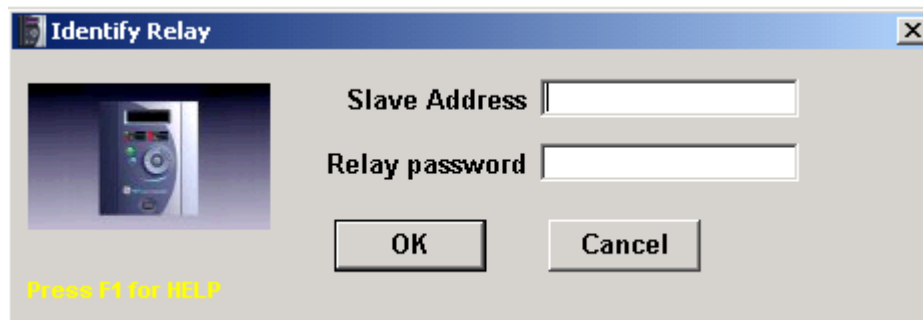
Figure 4–27: RELAY IDENTIFICATION

After introducing the Slave Address and Relay password (1 and 1 by default), the following screen will be displayed, showing details of the old model and the new model:
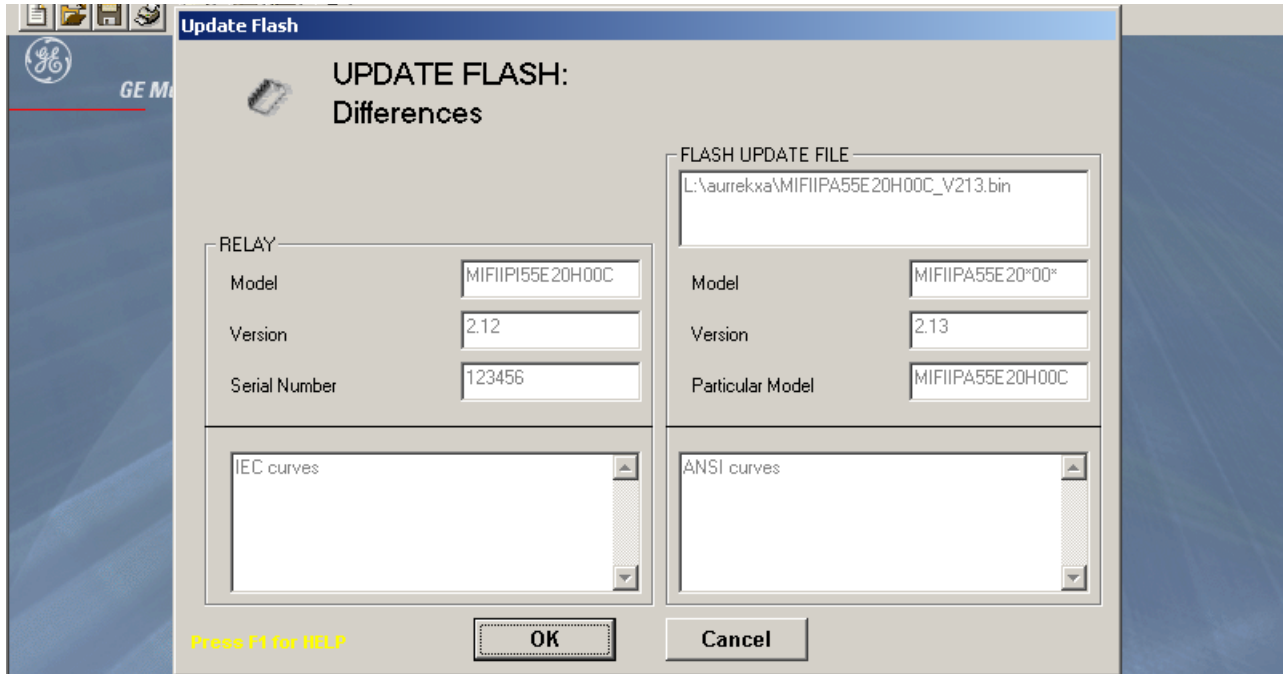
Figure 4–28: UPDATE FLASH DIFFERENCES

If the update is to a model option with higher functionality (see OPTION 1, OPTION 2 and OPTION R in the model list), the program will request a password. This password can be obtained placing an order with GE Multilin. The following three parameters must be clearly indicated in the order:

- Serial number of the unit.

- Current model option (before memory update).

- Desired model option (after memory update).

In a case where more than one unit needs to be updated, all the serial numbers must be detailed, and a different password will be assigned for each unit.
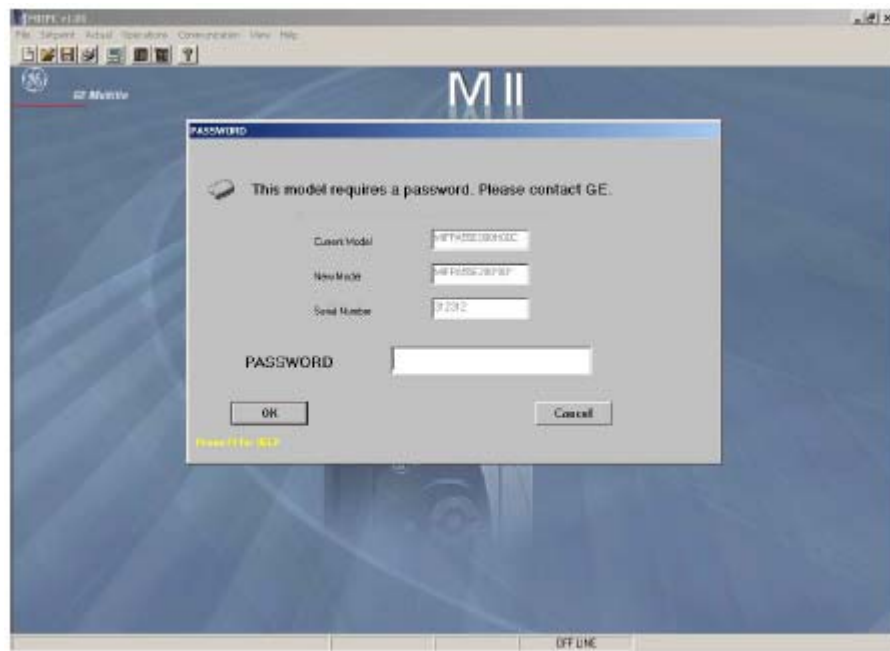
Figure 4–29: PASSWORD

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

After completing the previous screen, and during the loading process, the following screen will be displayed, showing the update process status:
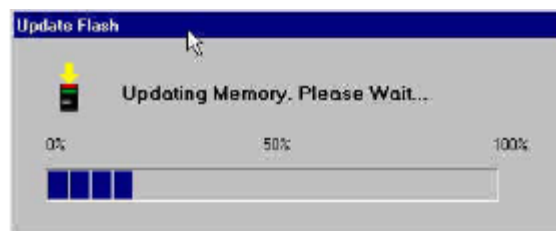
Figure 4–30: UPDATE PROCESS

During the update, the display and LEDs will blink until the total completion of the process. Then the following screen will appear:

Figure 4–31: UPDATE COMPLETED

It will take a few seconds for the relay to restart after the completion of the update process. Therefore, before unplugging the relay, please make sure that the relay main screen shows the analog inputs values.

<u>**IMPORTANT NOTICE:**</u>

The MODBUS® memory map may change for different firmware versions. As a result, the Flash memory update, when upgrading to a higher model (OPTION 1 or 2), may involve a MODBUS® memory map change. This may result a critical issue when the relay is integrated in a system, and the user should take into account the modifications that will have to be performed in the programs that access the MIFII relay memory maps.

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. If the user wants to keep the same settings after the memory update, a copy of the settings should be stored in a file before starting the update process.

4

TRACES option is only active when the PC is communicating with the relay. If the communication is not established, to activate this option the user must switch communication on in **Communication > Computer** menu.

When **TRACES** are active, the ModBus communication traces will be displayed in the lower part of the screen, as shown in Figure 4–32:
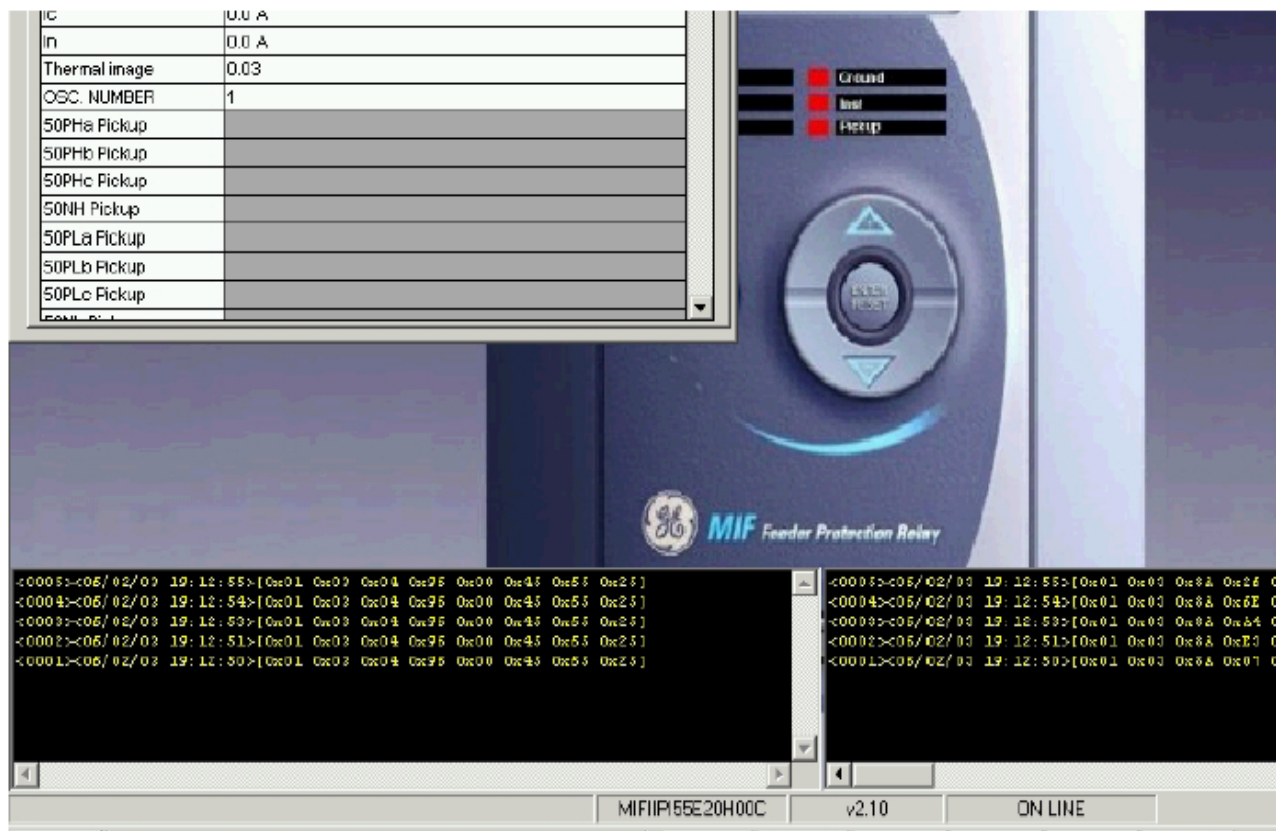
Figure 4–32: MODBUS TRACES

MODBUS MEMORY MAP option is only active when the PC is communicating with the relay. If the communication is not established, to activate this option the user must switch communication on in *Communication > Computer* menu.

With **MODBUS MEMORY MAP** option the user can extract the complete memory map from the relay and print or save it in CSV format (to be later opened with any database or spreadsheet program as MS Excel). It is recommended to use this feature as memory map changes with relay model and firmware version so this is the safest way of obtaining the appropriate memory map for every single relay.

MEMORY MAP

	MEM.	BIT	LENGTH	NAME	INTERNAL	FORMAT	TYPE	ID
1	0128		4	CT Ratio Phase	Phase CT Ratio	FLOAT32(INTEL)	RW	700
2	012C		4	CT Ratio Neutral	Neutral CT Ratio	FLOAT32(INTEL)	RW	701
3	0130		16	IDENTIFICATION	IDEN	BYTES ARRAY	RW	104
4	0140		4	TRIP MIN TIME	Trip Min Time	FLOAT32(INTEL)	RW	106
5	0144		4	FAIL TO OPEN TIMER	Delay	FLOAT32(INTEL)	RW	107
6	0148	0	2	ACTIVE TABLE	Settings Group	BIT	RW	105
7	014A	0	2	RELAY STATUS	Relay Operation	BIT	RW	126
8	014A	1	2	FREQUENCY	Frequency	BIT	RW	127
9	014C	0	2	51P Trip	Trip Enable 51P	BIT	RW	119
10	014C	1	2	51N Trip	Trip Enable 51N	BIT	RW	120
11	014C	2	2	50PH Trip	Trip Enable 50PH	BIT	RW	121
12	014C	3	2	50PL Trip	Trip Enable 50PL	BIT	RW	122
13	014C	4	2	50NH Trip	Trip Enable 50NH	BIT	RW	123
14	014C	5	2	50NL Trip	Trip Enable 50NL	BIT	RW	124
15	014C	6	2	49 Trip	Trip Enable 49	BIT	RW	125
16	014E		4	51P Pickup	Pickup 51P	FLOAT32(INTEL)	RW	128
17	0152		2	51P Curve	Curve 51P	ENUMERATION: ▼	RW	129
18	0154		4	51P Time Dial	TD Mult 51P	FLOAT32(INTEL)	RW	130
19	0158		4	51P Time Delay	Def Time 51P	FLOAT32(INTEL)	RW	131

Press F1 for HELP

PRINT   EXPORT (CSV)   Close

☐ Holding Registers
☐ Input Registers

Figure 4–33: MODBUS MEMORY MAP

LANGUAGES option is only active when there is no active communication with the relay. If the PC is communicating with the relay, to activate this option the user must switch communication off in *Communication – Computer* menu.
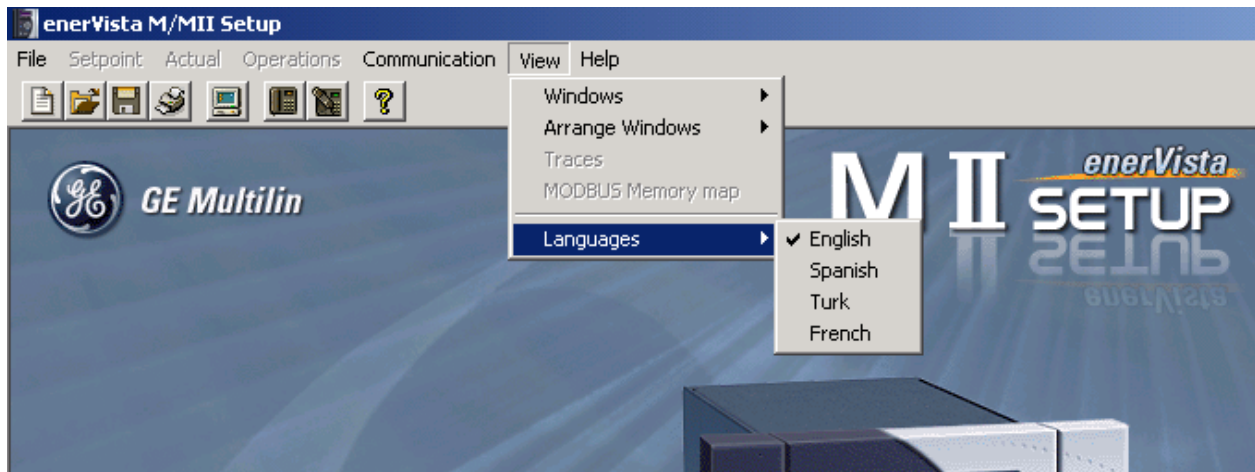
Figure 4–34: LANGUAGES

4

All the settings of the MIFII relay, together with the procedures 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. In the EnerVista MII SETUP program, the settings are grouped under the Setpoint menu, Setpoint sub-menu entry.

The MIFII relay provides two settings groups (group 2 is accessible in the ADVANCED SETTINGS group), stored in EEPROM memory (permanent memory). Using a setting or through a communications command*(or through a digital input in models with OPTION 1 or 2*), it is possible to select which group 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 EnerVista MII SETUP program. The use of the keypad to modify settings is described in Chapter 8. If the computer is used to handle the settings, the following steps must be considered:

Make sure your communication cable matches the scheme shown in Figure 3–12:

Connect the communications cable between the relay (or modem) and the computer serial port.

Run the EnerVista MII SETUP program. The procedure to install and use the EnerVista MII SETUP program is described in section 1.2.2 and in section 4.

Make sure that the communications parameters in the relay match the EnerVista MII SETUP configuration settings (*Communication - Computer* Menu). The communications parameters shown in the relay faceplate display, within the configuration menu are:

Comm Password

Comm Baud Rate

Slave Address

5

For instructions on how to check and modify EnerVista MII SETUP program communications parameters please refer to chapter 4.

Check that the relay number and password in the MIFII display match the numbers entered in the dialog window of the EnerVista MII SETUP, after clicking on Relay Connection.

CT ratio settings allow the user to view the current measures in primary values.

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
PRODUCT SETUP	**PRODUCT SETUP**	**PRODUCT SETUP**			
Relay Status	Relay Operation	Relay Operation	DISABLE	READY / DISABLE	NA
Frequency	Frequency	Frequency	60 Hz	50/60 Hz	NA
ModBus Format	---	ModBus Format	Intel	Intel/Motorola	NA
Phase CT ratio	Phase CT Ratio	Phase CT Ratio	1	1-4000	1
Ground CT ratio	Ground CT Ratio	Ground CT Ratio	1	1-4000	1
HMI Password	---	HMI Password	0	0-9999	1
Comm Password	---	Comm Password	1	1 – 255	1
Slave Address	---	Slave Address	1	1 – 255	1
Communication Baud rate	---	Comm Baud Rate	9.6	0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2	NA
Communication 2 Baud rate*	---	COM2 Baud rate	9.6	0.3,0.6,1.2,2.4,4.8,9.6,19.2	NA
Prefault cycles*	Prefault Cycles	Prefault Cycles	50	10-140	1

*Only available for option C models. For further information please see APPENDIX E

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	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Phase TOC Function	**PHASE TOC 51P**	**PHASE TOC 51P**			
51P Permission to Trip	Trip Enable 51P	Trip Enable 51P	No	Yes/No	NA
51P Pickup Value	Pickup 51P	Pickup 51P	0.5 In (Phase)	0.1-2.4 In (Ph)	0.01 In (Ph)
51P Curve Type	Curve 51P	Curve 51P	DEFINITE TIME	DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE SHORT, INVERSE LONG	NA
51P Time Dial	TD mult 51P	TD mult 51P	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
			0.5	0.5 – 10.0 (IAC curves)	0.01
51P Definite Time Delay	Def Time 51P	Def Time 51P	1.00 s.	0.00 – 600.00 s.	0.01 s.
Ground TOC Function	**GROUND TOC 51G**	**GROUND TOC 51G**			
51G Permission to Trip	Trip Enable 51G	Trip Enable 51G	No	Yes/No	NA
51G Pickup (for 1/5 A ground)	Pickup 51G	Pickup 51G	0.5 In (Ground)	0.10 – 2.40 In (Gnd)	0.01 In (Gnd)
51G Pickup (for sensitive ground)	Pickup 51G	Pickup 51G	0.005 A	0.005-0.12 A	0.001 A
51G Curve Type	Curve 51G	Curve 51G	DEFINITE TIME	DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE SHORT, INVERSE LONG	NA
51G Time Dial	TD Mult 51G	TD Mult 51G	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
			0.5	0.5 – 10.0 (IAC curves)	0.01
51G Definite Time Delay	Def Time 51G	Def Time 51G	1.00 s.	0 –600.00s.	0.01 s.

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5.2.3 PHASE / GROUND IOC SETTINGS (50P1 / 50P2 / 50G1/50G2)

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Phase IOC High Setting	**50P1 Function**	**Phase IOC 50P1**			
50P1 Permission to Trip	50P1 Trip	Trip Enable 50P1	No	Yes/No	NA
50P1 Tap / Pickup	50P1 Pickup	Pickup 50P1	1 In (Phase)	0.1 – 30.0 In (Ph)	0.1 In (Ph)
50P1 Time Delay	50P1 Time Delay	Delay 50P1	0 s.	0 – 600.00 s.	0.01 s.
Phase IOC Low Setting	**50P2 Function**	**Phase IOC 50P2**			
50P2 Permission to Trip	50P2 Trip	Trip Enable 50P2	No	Yes/No	NA
50P2 Tap / Pickup	50P2 Pickup	Pickup 50P2	1 In (Phase)	0.1 – 30.0 In (Ph)	0.1 In (Ph)
50P2 Time Delay	50P2 Time Delay	Delay 50P2	0 s.	0 – 600.00 s.	0.01 s.
Ground IOC High Set.	**50G1 Function**	**Ground IOC 50G1**			
50G1 Permission to Trip	50G1 Trip	Trip Enable 50G1	No	Yes/No	NA
50G1 Tap / Pickup (for 1/5 A ground)	50G1 Pickup	Pickup 50G1	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)
50G1 Tap / Pickup (for sensitive ground)	50G1 Pickup	Pickup 50G1	0.005 A	0.005-0.12 A	0.001 A
50G1 Time Delay	50G1 Time Delay	Delay 50G1	0 s.	0 – 600.00 s.	0.01 s.
Ground IOC Low Setting	**50G2 Function**	**Ground IOC 50G2**			
50G2 Permission to Trip	50G2 Trip	Trip Enable 50G2	No	Yes/No	NA
50G2 Tap / Pickup (for 1/5 A ground)	50G2 Pickup	Pickup 50G2	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)
50G2 Tap / Pickup (for sensitive ground)	50G2 Pickup	Pickup 50G2	0.005 A	0.005-0.12 A	0.001 A
50G2 Time Delay	50G2 Time Delay	Delay 50G2	0 s.	0 – 600.00 s.	0.01 s.

5.2.4 THERMAL IMAGE SETTINGS (49)

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Thermal Image (49)	49 Function	THERMAL MODEL 49			
Permission to Trip	49 Trip	Trip Enable 49	No	Yes/No	NA
49 Tap / Pickup	49 Pickup	Pickup 49	1 In (Phase)	0.10 – 2.4 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	49 Alarm Level	Alarm Level 49	80 %	70% – 100% ITH	1%
Heating Time Constant $\tau 1$	T1	Heat Time 49	6	3 – 600 min.	1 min
Cooling Time Constant $\tau 2$	T2	Cool Time 49	1	1 – 6 times $\tau 1$	1

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Autorecloser (79)	AUTORECLOSER 79	AUTORECLOSER 79			
Autorecloser Function	Autorecloser Function	AR Function	No	Yes / No	N/A
Number of shots	Number of shots	AR Max Shots	1	1 – 4	1
Delay before 1st reclosure	AR Dead Time Shot 1	AR Dead Time 1	1 s	0.1 – 600	0.01
Delay before 2nd reclosure	AR Dead Time Shot 2	AR Dead Time 2	2 s	0.1 – 600	0.01
Delay before 3rd reclosure	AR Dead Time Shot 3	AR Dead Time 3	3 s	0.1 – 600	0.01
Delay before 4th reclosure	AR Dead Time Shot 4	AR Dead Time 4	4 s	0.1 – 600	0.01
Time delay to reset from lockout status	AR Reset Lockout Time	AR Rst LO Delay	10 s	0.1 – 600	0.01
Time for incomplete sequence	AR Incomplete Sequence Time	AR Inc Seq Time	5 s	0.1 – 600	0.01
Recloser reset time after a successful reclosure	AR Reset Time	AR Reset Time	10 s	0.1 – 600	0.01
AUTORECLOSE INITIATION MASKS					
Permission for 50P1 to Init Autorecloser	AR 50P1 Permission Init	AR 50P1 Init	Yes	Yes / No	N/A
Permission for 50G1 to Init Autorecloser	AR 50G1 Permission Init	AR 50G1 Init	Yes	Yes / No	N/A
Permission for 50P2 to Init Autorecloser	AR 50P2 Permission Init	AR 50P2 Init	Yes	Yes / No	N/A
Permission for 50G2 to Init Autorecloser	AR 50G2 Permission Init	AR 50G2 Init	Yes	Yes / No	N/A
Permission for 51P to Init Autorecloser	AR 51P Permission Init	AR 51P Init	Yes	Yes / No	N/A
Permission for 51G to Init Autorecloser	AR 51G Permission Init	AR 51G Init	Yes	Yes / No	N/A
Permission for 49 to Init Autorecloser	AR 49 Permission Init	AR 49 Init	Yes	Yes / No	N/A
Permission for a DI to Init Autorecloser	AR External Permission Init	AR EXTERN Init	Yes	Yes / No	N/A
AFTER 1ST TRIP MASKS					
Permission for 50P1 function to trip after Shot 1	AR 50P1 Shot 1 Permission	AR 50P1 Shot 1	Yes	Yes / No	N/A
Permission for 50G1 function to trip after Shot 1	AR 50G1 Shot 1 Permission	AR 50G1 Shot 1	Yes	Yes / No	N/A
Permission for 50P2 function to trip after Shot 1	AR 50P2 Shot 1 Permission	AR 50P2 Shot 1	Yes	Yes / No	N/A
Permission for 50G2 function to trip after Shot 1	AR 50G2 Shot 1 Permission	AR 50G2 Shot 1	Yes	Yes / No	N/A
Permission for 51P function to trip after Shot 1	AR 51P Shot 1 Permission	AR 51P Shot 1	Yes	Yes / No	N/A
Permission for 51G function to trip after Shot 1	AR 51G Shot 1 Permission	AR 51G Shot 1	Yes	Yes / No	N/A
Permission for 49 function to trip after Shot 1	AR 49 Shot 1 Permission	AR 49 Shot 1	Yes	Yes / No	N/A

5

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
AFTER 2ND TRIP MASKS					
Permission for 50P1 function to trip after Shot 2	AR 50P1 Shot 2 Permission	AR 50P1 Shot 2	Yes	Yes / No	N/A
Permission for 50G1 function to trip after Shot 2	AR 50G1 Shot 2 Permission	AR 50G1 Shot 2	Yes	Yes / No	N/A
Permission for 50P2 function to trip after Shot 2	AR 50P2 Shot 2 Permission	AR 50P2 Shot 2	Yes	Yes / No	N/A
Permission for 50G2 function to trip after Shot 2	AR 50G2 Shot 2 Permission	AR 50G2 Shot 2	Yes	Yes / No	N/A
Permission for 51P function to trip after Shot 2	AR 51P Shot 2 Permission	AR 51P Shot 2	Yes	Yes / No	N/A
Permission for 51G function to trip after Shot 2	AR 51G Shot 2 Permission	AR 51G Shot 2	Yes	Yes / No	N/A
Permission for 49 function to trip after Shot 2	AR 49 Shot 2 Permission	AR 49 Shot 2	Yes	Yes / No	N/A
AFTER 3RD TRIP MASKS					
Permission for 50P1 function to trip after Shot 3	AR 50P1 Shot 3 Permission	AR 50P1 Shot 3	Yes	Yes / No	N/A
Permission for 50G1 function to trip after Shot 3	AR 50G1 Shot 3 Permission	AR 50G1 Shot 3	Yes	Yes / No	N/A
Permission for 50P2 function to trip after Shot 3	AR 50P2 Shot 3 Permission	AR 50P2 Shot 3	Yes	Yes / No	N/A
Permission for 50G2 function to trip after Shot 3	AR 50G2 Shot 3 Permission	AR 50G2 Shot 3	Yes	Yes / No	N/A
Permission for 51P function to trip after Shot 3	AR 51P Shot 3 Permission	AR 51P Shot 3	Yes	Yes / No	N/A
Permission for 51G function to trip after Shot 3	AR 51G Shot 3 Permission	AR 51G Shot 3	Yes	Yes / No	N/A
Permission for 49 function to trip after Shot 3	AR 49 Shot 3 Permission	AR 49 Shot 3	Yes	Yes / No	N/A
AFTER 4TH TRIP MASKS					
Permission for 50P1 function to trip after Shot 4	AR 50P1 Shot 4 Permission	AR 50P1 Shot 4	Yes	Yes / No	N/A
Permission for 50G1 function to trip after Shot 4	AR 50G1 Shot 4 Permission	AR 50G1 Shot 4	Yes	Yes / No	N/A
Permission for 50P2 function to trip after Shot 4	AR 50P2 Shot 4 Permission	AR 50P2 Shot 4	Yes	Yes / No	N/A
Permission for 50G2 function to trip after Shot 4	AR 50G2 Shot 4 Permission	AR 50G2 Shot 4	Yes	Yes / No	N/A
Permission for 51P function to trip after Shot 4	AR 51P Shot 4 Permission	AR 51P Shot 4	Yes	Yes / No	N/A
Permission for 51G function to trip after Shot 4	AR 51G Shot 4 Permission	AR 51G Shot 4	Yes	Yes / No	N/A
Permission for 49 function to trip after Shot 4	AR 49 Shot 4 Permission	AR 49 Shot 4	Yes	Yes / No	N/A

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Adv. General Setting	**Adv. General Settings**	**General Advanced**			
Identification	Identification	--------------------------	MIFII	Text	NA
Settings Group	Settings Group	Settings Group	1	1/2	NA
Trip Minimum Time	Trip Minimum Time	Trip Minimum Time	100 ms.	50-300 ms.	1 ms.

NOTE ABOUT THE TRIP MIN TIME SETTING:

This setting indicates the time during which the tripping contact will remain closed as a minimum in case of fault. If the fault persists for a longer time than the set value, the tripping contact will remain closed and will be opened immediately after the fault is cleared, while if the fault is shorter than the set time, the relay will maintain the contact closed for this set time.

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5.3.2 PHASE / GROUND TOC SETTINGS (51P/ 51G) (GROUP 2)

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Ph TOC Funct. group 2	**Phase TOC 51P (group 2)**	**PHASE TOC 51P**			
51P Permission to Trip	Trip Enable 51P	Trip Enable 51P	No	Yes/No	NA
51P Pickup Value	Pickup 51P	Pickup 51P	0.5 In (Phase)	0.1 – 2.4 In (Ph)	0.01 In (P)
51P Curve Type	Curve 51P	Curve 51P	DEFINITE TIME	DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51P Time Dial	TD mult 51P	TD mult 51P	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
			0.5	0.5 – 10.0 (IAC curves)	0.01
51P Definite Time Delay	Def Time 51P	Def Time 51P	1.00 s.	0.00 – 600.00 s.	1.00 s.
Gnd TOC Fun. group 2	**Ground TOC 51G (group 2)**	**GROUND TOC 51G**			
51G Permission to Trip	Trip Enable 51G	Trip Enable 51G	No	Yes/No	NA
51G Pickup Value (1/5 A ground)	Pickup 51G	Pickup 51G	0.5 In (Ground)	0.10 – 2.40 In (Gnd)	0.01 In (G)
51G Pickup Value (sensitive ground)	Pickup 51G	Pickup 51G	0.005 A	0.005-0.12 A	0.001 A
51G Curve Type	Curve 51G	Curve 51G	DEFINITE TIME	DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51G Time Dial	TD mult 51G	TD mult 51G	0.5	0.05 – 2.00 (IEC curves)	0.01
			5	0.5 – 20.0 (ANSI curves)	0.01
			0.5	0.5 – 10.0 (IAC curves)	0.01
51G Definite Time Delay	Def Time 51G	Def Time 51G	1.00	0.00 – 600.00 s	0.01 s

5.3.3 PHASE / GROUND IOC SETTINGS (50P1/ 50P2/ 50G1/ 50G2) (GROUP 2) (

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Ph IOC High Set group 2	**PHASE IOC 50P1 (group 2)**	**Phase IOC 50P1**			
50P1 Permission to Trip	Trip Enable 50P1	Trip Enable 50P1	No	Yes/No	NA
50P1 Pickup	Pickup 50P1	Pickup 50P1	1 In (Phase)	0.1 – 30 In (Ph)	0.1 In (Ph)
50P1 Time Delay	Delay 50P1	Delay 50P1	0 s.	0.00 –600.00s.	0.01 s.
Ph IOC Low Set group 2	**PHASE IOC 50P2 (group 2)**	**Phase IOC 50P2**			
50P2 Permission to Trip	Trip Enable 50P2	Trip Enable 50P2	No	Yes/No	NA
50P2 Pickup	Pickup 50P2	Pickup 50P2	1 In (Phase)	0.1 – 30 In (Ph)	0.1 In (Ph)
50P2 Time Delay	Delay 50P2	Delay 50P2	0 s.	0.00 –600.00s.	0.01 s.
Gnd IOC High Set group 2	**GROUND IOC 50G1 (group 2)**	**Ground IOC 50G1**			
50G1 Permission to Trip	Trip Enable 50 G1	Trip Enable 50 G1	No	Yes/No	NA
50 G1 Pickup (1/5 A ground)	Pickup 50G1	Pickup 50G1	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)
50 G1 Pickup Value (sensitive ground)	Pickup 50G1	Pickup 50G1	0.005 A	0.005-0.12 A	0.001 A
50 G1 Time Delay	Delay 50G1	Delay 50G1	0 s.	0.00 – 600.00 s.	0.01 s.
Gnd IOC Low Set group 2	**GROUND IOC 50G2 (group 2)**	**Ground IOC 50G2**			
50G2 Permission to Trip	Trip Enable 50G2	Trip Enable 50G2	No	Yes/No	NA
50G2 Pickup (1/5 A ground)	Pickup 50G2	Pickup 50G2	1 In (Ground)	0.1 – 30 In (Gnd)	0.1 In (G)
50G2 Pickup Value (sensitive ground)	Pickup 50G2	Pickup 50G2	0.005 A	0.005-0.12 A	0.001 A
50G2 Time Delay	Delay 50G2	Delay 50G2	0 s.	0.00 –600.00s.	0.01 s.

5.3.4 THERMAL IMAGE SETTINGS (49) (GROUP 2)

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Thermal Image group 2	**49 Function (group 2)**	**THERMAL MODEL 49**			
Permission to Trip	Trip Enable 49	Trip Enable 49	No	Yes/No	NA
49 Pickup	Pickup 49	Pickup 49	1 In (Phase)	0.10 – 2.40 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	Alarm Level 49	Alarm Level 49	80 %	70% – 100% ITH	
Heating Time Constant $\tau 1$	Heat Time 49	Heat Time 49	6	3 – 600 min.	1 min.
Cooling Time Constant $\tau 2$	Cool Time 49	Cool Time 49	1	1– 6 times $\tau 1$	1

USER CURVE

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Parameters	**User Curve**	**User Curve**			
A	A Parameter	A Parameter	0.0500	0.0000-125.0000	0.0001
B	B Parameter	B Parameter	0.0000	0.0000-3.0000	0.0001
P	P Parameter	P Parameter	0.0400	0.0000-3.0000	0.0001
Q	Q Parameter	Q Parameter	1.0000	0.0000-2.0000	0.0001
K	K Parameter	K Parameter	0.000	0.000-1.999	0.001

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5.3.5 EVENTS AND OSCILLOGRAPHY MASKS (ONLY ENERVISTA MII SETUP)

The event mask and oscillography mask groups are available only in models with OPTION 1 or 2. Event masks showing a 2 in the end of the row are available only in MIFII models with OPTION 2.

	ENERVISTA MII SETUP	DEFAULT	RANGE	STEP
Event masks	Event masks			
50P1 Pickup/Drop out	50P1 Pickup	YES	Y/N	NA
50P2 Pickup/Drop out	50P2 Pickup	YES	Y/N	NA
50G1 Pickup/Drop out	50G1 Pickup	YES	Y/N	NA
50G2 Pickup/Drop out	50G2 Pickup	YES	Y/N	NA
51P Pickup/Drop out	51P Pickup	YES	Y/N	NA
51G Pickup/Drop out	51G Pickup	YES	Y/N	NA
49 Alarm Pickup/Drop out	49 Alarm	YES	Y/N	NA
50P1 Trip	50P1 Trip	YES	Y/N	NA
50P2 Trip	50P2 Trip	YES	Y/N	NA
50G1 Trip	50G1 Trip	YES	Y/N	NA
50G2 Trip	50G2 Trip	YES	Y/N	NA
51P Trip	51P Trip	YES	Y/N	NA
51G Trip	51G Trip	YES	Y/N	NA
49 Trip	49 Trip	YES	Y/N	NA
General trip	General trip	YES	Y/N	NA
50P1 Trip enable/disable by digital input	50P1 disabled (by di)	YES	Y/N	NA
50P2 Trip enable/disable by digital input	50P2 disabled (by di)	YES	Y/N	NA
50G1 Trip enable/disable by digital input	50G1 disabled (by di)	YES	Y/N	NA
50G2 Trip enable/disable by digital input	50G2 disabled (by di)	YES	Y/N	NA
51P Trip enable/disable by digital input	51P disabled (by di)	YES	Y/N	NA
51G Trip enable/disable by digital input	51G disabled (by di)	YES	Y/N	NA
49 Trip enable/disable by digital input	49 disabled (by di)	YES	Y/N	NA
General Trip enable/disable by digital input	Trip disabled (by di)	YES	Y/N	NA
Protection status: in service/out of service	Protection status	YES	Y/N	NA
Digital output 1 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 disable	YES	Y/N	NA
Trip operation by digital input	Trip operation by input	YES	Y/N	NA
Trip operation by command	Trip operation by command	YES	Y/N	NA
Auxiliary digital output latch reset	Reset latch aux	YES	Y/N	NA
Close breaker operation	Close breaker operation	YES	Y/N	NA
52 B open/closed	Breaker 52 A	YES	Y/N	NA
52 A open/closed	Breaker 52 B	YES	Y/N	NA
52 open/closed	Breaker closed	YES	Y/N	NA
Group 2 selection by digital input	Active group change	YES	Y/N	NA
Oscillo trigger by digital input	Oscillo trigg by DI	YES	Y/N	NA
Oscillo trigger by command	Oscillo trigg by comm	YES	Y/N	NA
Breaker failure to open	BF to open	YES	Y/N	NA
I^2 Alarm	I^2 Alarm	YES	Y/N	NA
Settings change	Settings change	YES	Y/N	NA
EEPROM failure	EEPROM failure	YES	Y/N	NA
User settings/Factory settings	User settings	YES	Y/N	NA

OSCILLOGRAPHY MASK	ENERVISTA MII SETUP	DEFAULT	RANGE	STEP
Oscillography masks	**Oscillography mask**			
Oscillo by communications	Oscillo by communic.	NO	Y/N	NA
Oscillo by digital input	Oscillo by Digital Input	NO	Y/N	NA
Oscillo by trip	Oscillo by trip	NO	Y/N	NA
Oscillo by pickup	Oscillo by pickup	NO	Y/N	NA

This option is available only in MIFII models with OPTION 2.

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Counter		**I^2 MAX Value**			
I^2 limit	Maximum Counter	I^2 T MAX	999.000	0.000-999.000 kA2	0.001 kA2

This option is available only in MIFII models with OPTION 2

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Breaker failure to open	**Breaker failure to open**		**BF**		
Breaker failure to open enable	Breaker failure function	Function	NO	Y/N	NA
Fail to open timer	Fail to open timer	Delay	400	50-999 ms	1 ms

This option is available only in MIFII models with OPTION 2

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
Cold load pickup	**Cold load pickup**	**CLP**			
Cold load pickup enable	Cold load pickup function	Function	NO	Yes/No	NA
Pickup time	T IN	Outage Time	2.000	0.000-60.000 s	0.001 s
Drop out time	T OUT	On Load Time	2.000	0.000-60.000 s	0.001 s
Constant. 50P pickup	K 50P	Phase IOC Mult	1.00	1.00-5.00	0.01
Constant 51P pickup	K 51P	Phase TOC Mult	1.00	1.00-5.00	0.01

COMMENTS ON SETTINGS:

The factory default HMI password to change any setting is 1. See chapter 8 for details.

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

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 must be used (there are 195 different curves for each curve type, depending on the Time Dial Selected); if the curve type selected is DEFINITE TIME, then the Time Dial setting is ignored and the time delay used is the one specified in DEFINITE TIME setting.

MIFII includes an internal clock to time tag events. This clock can be either synchronized with the computer clock or set manually using the EnerVista MII SETUP software program (see Setpoints – Clock). It can also be set to a given Date and Time using the faceplate keypad (DATE & TIME menu entry).

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MIFII incorporates 2 digital inputs, which can be configured using the EnerVista MII SETUP software (***Setpoint > Relay Configuration***). The default input configuration is as follows:

	MODELS WITHOUT RECLOSER	MODELS WITH RECLOSER
Input 1	50P1 disabled & 50P2 disabled	52b breaker status
Input 2	50G1 disabled & 50G2 disabled.	50P1 disabled, 50P2 disabled, 50G1 disabled, 50G2 disabled.

All elements not defined as PULSE are LEVEL inputs.

In LEVEL inputs, while the voltage level is enough to activate the input, the input performs the function stated in its configuration.

PULSE inputs are different. In the configuration menu for each input there are several states already defined as Pulse inputs. When the input recognizes their activation, it performs the function stated in its configuration, independently from the time it remains activated. For the input to perform again the required function, it is required that the input voltage level is reset and reactivated.
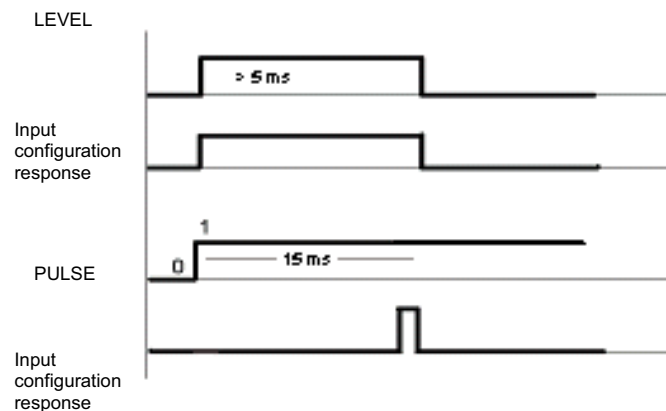
Figure 6–1: INPUT RESPONSE FOR LEVEL AND PULSE OPTIONS

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

Input elements are divided into two (three in models with recloser) tthree groups, besides the *No definition* one. Up to eight elements can be configured to be activated by the same input, providing that they are all in the same group. Elements belonging to different groups need to be assigned to different inputs.

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

INPUT CONFIGURATION WITH MORE THAN ONE FUNCTION (OR). EXAMPLE

As shown on the figure below, input 1 is assigned to an OR. Clicking on that OR checkbox, a second screen named "OR ASSIGNMENT" is displayed, where the user can select the group that contains the desired elements (in this example, "INHIBITIONS BY DIGITAL INPUT 1"). This group includes 8 elements, from which we can select the ones we want to operate in the input, and invert them by clicking on the NOT checkbox. In the example below, all functions have been assigned to the input, and all of them have been inverted. Finally, to validate the selected configuration, the user must click on the OK button both in the "OR ASSIGNMENT" and the "I/O CONFIGURATION" screens.
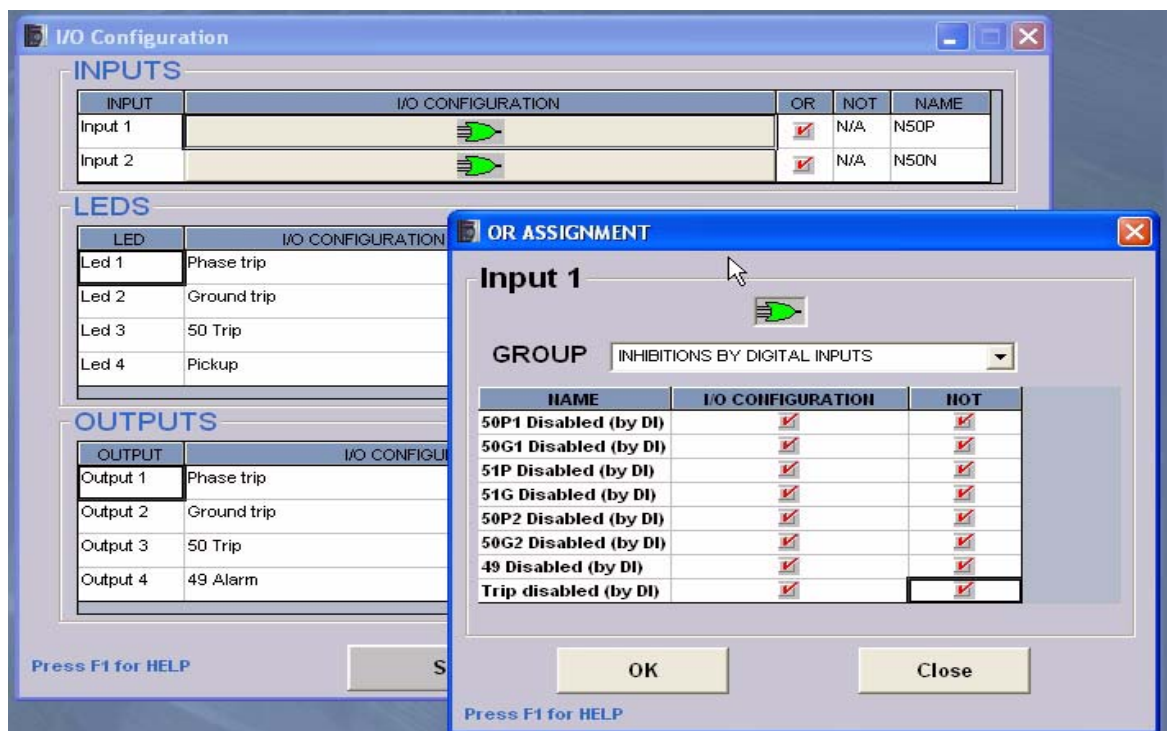
Figure 6–2: INPUT CONFIGURATION WITH MORE THAN ONE FUNCTION (OR)

SIMPLE ACTION INPUT CONFIGURATION (ONE ELEMENT ASSIGNMENT)

To assign breaker status input 52A to a digital input, select Breaker 52a from the I/O configuration selection list. The OR checkbox must not be selected.

The simplest way of programming an input is to assign it to a single element. For this purpose, the user must simply open the I/O configuration selection list of the desired input. Once opened, all possible configuration functions will be shown, and the user will then be able to select one of them.

To invert the selected function, the user must click on the NOT checkbox, to the right of the functions menu

.
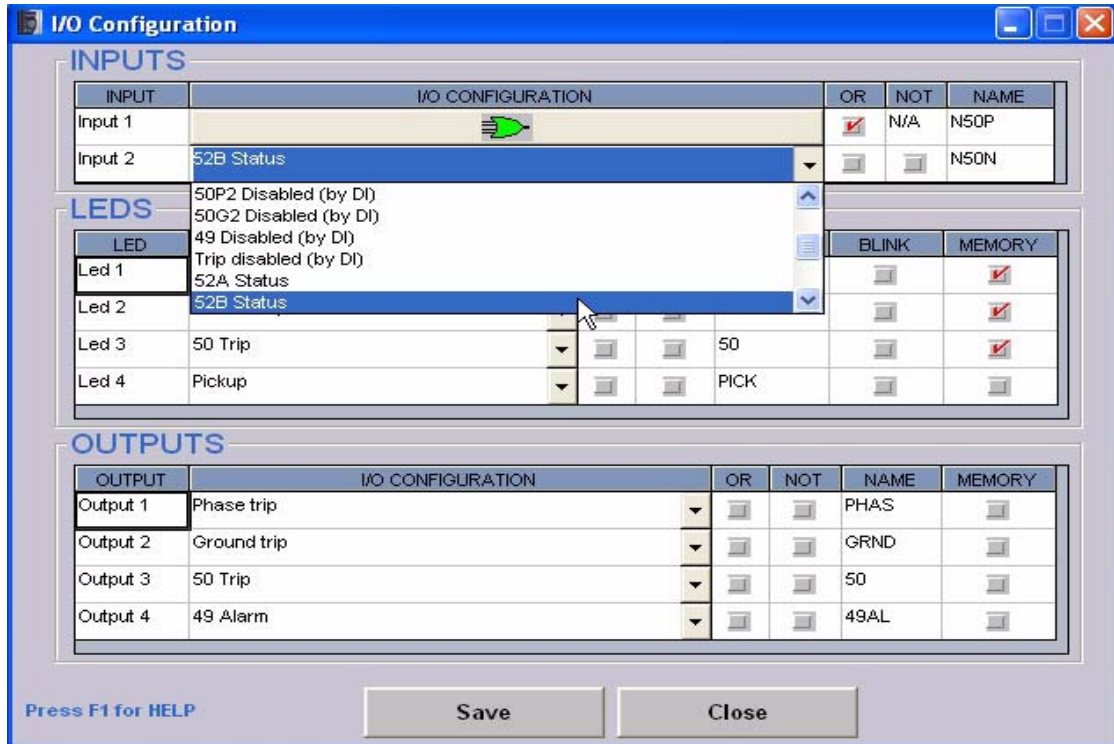
Figure 6–3: SIMPLE ACTION INPUT CONFIGURATION (ONE ELEMENT ASSIGNMENT)

In the example above, Input 2 has been programmed as 52a, inverted.

In case the user wants to program more than one function for each input, then an OR must be selected, as in the example regarding input configuration with more than one element (OR).

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

Table 6–1: INPUT ELEMENTS

	NO DEFINITION	**INPUT NOT ASSIGNED**
INHIBITIONS BY DIGITAL INPUT	50P1 disabled	50P1 trip disabled
	50G1 disabled	50G1 trip disabled
	51P disabled	51P trip disabled
	51G disabled	51G trip disabled
	50P2 disabled	50P2 trip disabled
	50G2 disabled	50G2 trip disabled
	49 disabled	49 trip disabled
	Trip disabled	Trip of all elements disabled
MISCELLANEOUS 2	AR External Initiation Input	AR External Initiation Input
	AR External Block Input	AR External Block Input
INPUTS	52 A status	Breaker closed indication
	52 B status	Breaker open indication
	Trip contact close (PULSE)	This element allows activating the trip output
	Group change	This setting has to be enabled for setting group 2. If disabled, the active setting group is the one defined in *ADVANCED GENERAL SETTINGS*
	Settings change disabled	Enabled means that settings and active group cannot be changed. It is only possible to switch to Group 2 through digital input Group change
	Reset (PULSE)	This element resets latched LEDs and outputs
	Oscillo trigger (PULSE)	Triggers oscillography element
	General input	Generic element that may be used in logic configuration.

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MIFII incorporates 6 outputs and 6 LED indicators. 4 of the outputs and LED indicators are user configurable, and can only be programmed using EnerVista MII SETUP software (SETPOINT – RELAY CONFIGURATION). The first two LEDs are fixed for READY (System ready) and TRIP. The fixed outputs are programmed for ALARM (System alarm) and TRIP.

The TRIP LED activates when the TRIP contact closes.

The READY LED turns on when all the following conditions are fulfilled:

- The relay status is READY

- At least one of the protection functions of the active table is enabled

- The trip of at least one of the enabled functions is also enabled.

The default configuration for outputs is as follows:

OUTPUT	CONFIGURATION		MEMORY
	MODELS WITHOUT RECLOSER	MODELS WITH RECLOSER	
1	Phase trip	Close breaker	No
2	Ground trip	Phase trip	No
3	50 trip	Ground trip	No
4	49 Alarm	50 trip	No

The default LED configuration is as follows:

LED	CONFIGURATION	MEMORY
1	Phase trip	Yes
2	Ground trip	Yes
3	50 Trip	Yes
4	Pickup	No

Outputs/LEDs can be configured to be activated by a single element or by a sum of several of them. These elements are divided into eight groups, besides the *No definition* element. Elements belonging to the same group can be assigned to the same output/LED. Elements of different groups need to be assigned to different outputs/LEDs[i].

In order to assign several elements to activate an output/LED, we first activate the **OR** button, next, click on the **I/O CONFIGURATION** frame and select the desired element group, then choose the desired elements. In order to invert an element, select the **NOT** button. Finally, click on the **OK** button.

The Output/LED logic can inverted selecting the general **NOT** button. Outputs can be latched, and LEDs can be set to be fixed or blinking.

Example:If we want to assign a phase differential trip to an output or LED, the output or LED must be programmed with 50P1 trip, 50P2 trip and 51P trip elements. To do this, check the OR box in the corresponding Output or LED line (for this case, Output1 and LED1). Then click on the OR button that appears in the I/O configuration column, select the desired group (*ELEMENT TRIPS*) and click the I/O configuration box for every element that will be blocked by the input.

If an output or LED has to activate when the relay is not in local mode, select *Local* from the I/O configuration dropdown list. The OR button must not be checked.

```
50P1 trip ─────────┐
                   │
50P2 trip ─────────┤ )─────── Output1/LED1 = Phase TRIP
                   │
51P trip  ─────────┘


Local ───────────────▷───────── Output/LED = NOT LOCAL


Local ───────────────▷───────── Output/LED
```
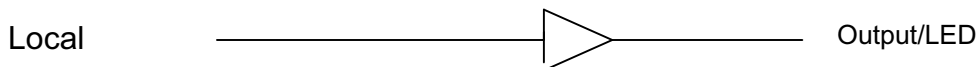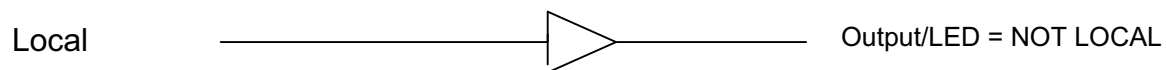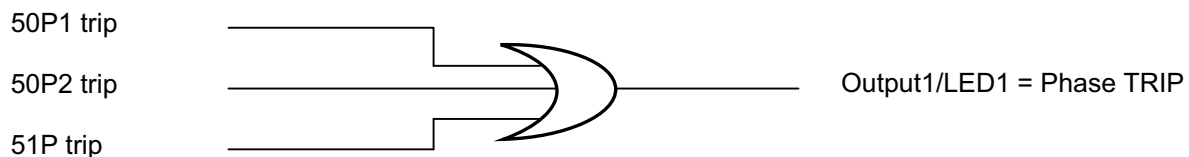
Elements from different groups cannot be included in an OR type logic.

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i. or select them in different logic diagrams (see logic configuration further on in this chapter and in *Chapter 4. COMMUNICATIONS*) and then choose the logic diagrams as the elements that will activate the output/LED

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

Table 6–2: OUTPUTS AND LEDS ELEMENTS

GROUP	NO DEFINITION	OUTPUT OR LED NOT ASSIGNED
CONFIGURATION	Logic 1	Output signal from logic 1
	Logic 2	Output signal from logic 2
	Logic 3	Output signal from logic 3
	Logic 4	Output signal from logic 4
MIXED 3	50 trip	Any trip of 50P1, 50G1, 50P2, 50G2 elements
	Phase trip	Any trip of 50P1, 50P2 elements
	Ground trip	Any trip of 50G1, 50G2 elements
	Phase A trip	Trip of any Phase A element
	Phase B trip	Trip of any Phase B element
	Phase C trip	Trip of any Phase C element
PHASE TRIPS 1	50-1a Trip	Trip of Phase A 50P1 element
	50-1b Trip	Trip of Phase B 50P1 element
	50-1c Trip	Trip of Phase C 50P1 element
	50-2a Trip	Trip of Phase A 50P2 element
	50-2b Trip	Trip of Phase B 50P2 element
	50-2c Trip	Trip of Phase C 50P2 element
PHASE TRIPS 2	51a Trip	Trip of Phase A 51P element
	51b Trip	Trip of Phase B 51P element
	51c Trip	Trip of Phase C 51P element
ELEMENT TRIPS	50P1 trip	50P1 element trip
	50G1 trip	50G1 element trip
	50P2 trip	50P2 element trip
	50G2 trip	50G2 element trip
	51P trip	51P element trip
	51G trip	51G element trip
	49 trip	49 element trip
	General trip	Any trip of the above mentioned elements
PHASE PICKUPS 1	50P1a Pickup	Pickup of Phase A 50P1 element
	50P1b Pickup	Pickup of Phase B 50P1 element
	50P1c Pickup	Pickup of Phase C 50P1 element
	50P2a Pickup	Pickup of Phase A 50P2 element
	50P2b Pickup	Pickup of Phase B 50P2 element
	50P2c Pickup	Pickup of Phase C 50P2 element
PHASE PICKUPS 2	51Pa Pickup	Pickup of Phase A 51P element
	51Pb Pickup	Pickup of Phase B 51P element
	51Pc Pickup	Pickup of Phase C 51P element
ELEMENT PICKUPS	50P1 pickup	50P1 element pickup
	50G1 pickup	50G1 element pickup
	50P2 pickup	50P2 element pickup
	50G2 pickup	50G2 element pickup
	51P pickup	51P element pickup
	51G pickup	51G element pickup
	49 Alarm	49 element pickup
	Pickup	Pickup of any of the above mentioned elements

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Table 6–2: OUTPUTS AND LEDS ELEMENTS

GROUP	NO DEFINITION	OUTPUT OR LED NOT ASSIGNED
PHASE VIRTUAL TRIPS 1	50-1a virtual trip	Virtual trip of Phase A 50P1 element
	50-1b virtual trip	Virtual trip of Phase B 50P1 element
	50-1c virtual trip	Virtual trip of Phase C 50P1 element
	50-2a virtual trip	Virtual trip of Phase A 50P2 element
	50-2b virtual trip	Virtual trip of Phase B 50P2 element
	50-2c virtual trip	Virtual trip of Phase C 50P2 element
PHASE VIRTUAL TRIPS 2	51 a virtual trip	Virtual trip of Phase A 51P element
	51 b virtual trip	Virtual trip of Phase B 51P element
	51 c virtual trip	Virtual trip of Phase C 51P element
ELEMENT VIRTUAL TRIPS	50P1 virtual trip	Trip condition for 50P1 element exists
	50G1 virtual trip	Trip condition for 50G1 element exists
	50P2 virtual trip	Trip condition for 50P2 element exists
	50G2 virtual trip	Trip condition for 50G2 element exists
	51P virtual trip	Trip condition for 51P element exists
	51G virtual trip	Trip condition for 51G element exists
	49 virtual trip	Trip condition for 49 element exists
	General virtual trip	Any virtual trip of the above mentioned elements
INPUTS/OUTPUTS	Input 1	Digital input 1
	Input 2	Digital input 2
MIXED 1	BKR fail status	Output of the breaker failure to open element, when it is enabled
	Breaker closed	Active when the breaker is closed, according to 52a or 52b[1]
	I^2 Alarm Status	Output of the I^2 counter element
	Cold load pickup	Output of the Cold load pickup element, when it is enabled
	EEPROM failure	Active when a failure is detected in EEPROM management
	User settings	This element is green when the default settings are active and red when the user's settings are active
LEDS	READY	Active when the relay is in service and at least one element has its trip enabled
MISCELLANEOUS 2	Autorecloser output	Autorecloser output
MIXED 2	ACTIVE GROUP	Group 2 active
	Local/Remote	It's Local when the HMI is inside the MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu

1. A 52a or 52b input must be configured. If there are two inputs configured as 52a and 52b, the relay will not take into account the input configured as 52a and will act according only to the status of the input configured as 52b.

Virtual trip signals are activated as soon as the protection unit trip conditions are present, independently from the enable setting. This signal can be used to activate LEDs or auxiliary outputs. If the user wants the protection unit to trip, then the trip enable setting must be activated. In this case, the relay will activate the trip contact.

MIFII incorporates 4 logic diagrams that can be configured independently using the EnerVista MII SETUP software (*Setpoint> Logic Configuration*).

The default logic configuration is the following:

LOGIC	I/O CONFIGURATION	PICKUP TIME	DROPOUT TIME
1	No Definition	0	0
2	No Definition	0	0
3	No Definition	0	0
4	No Definition	0	0

We can configure up to eight signals in the same Logic box with the following structure:
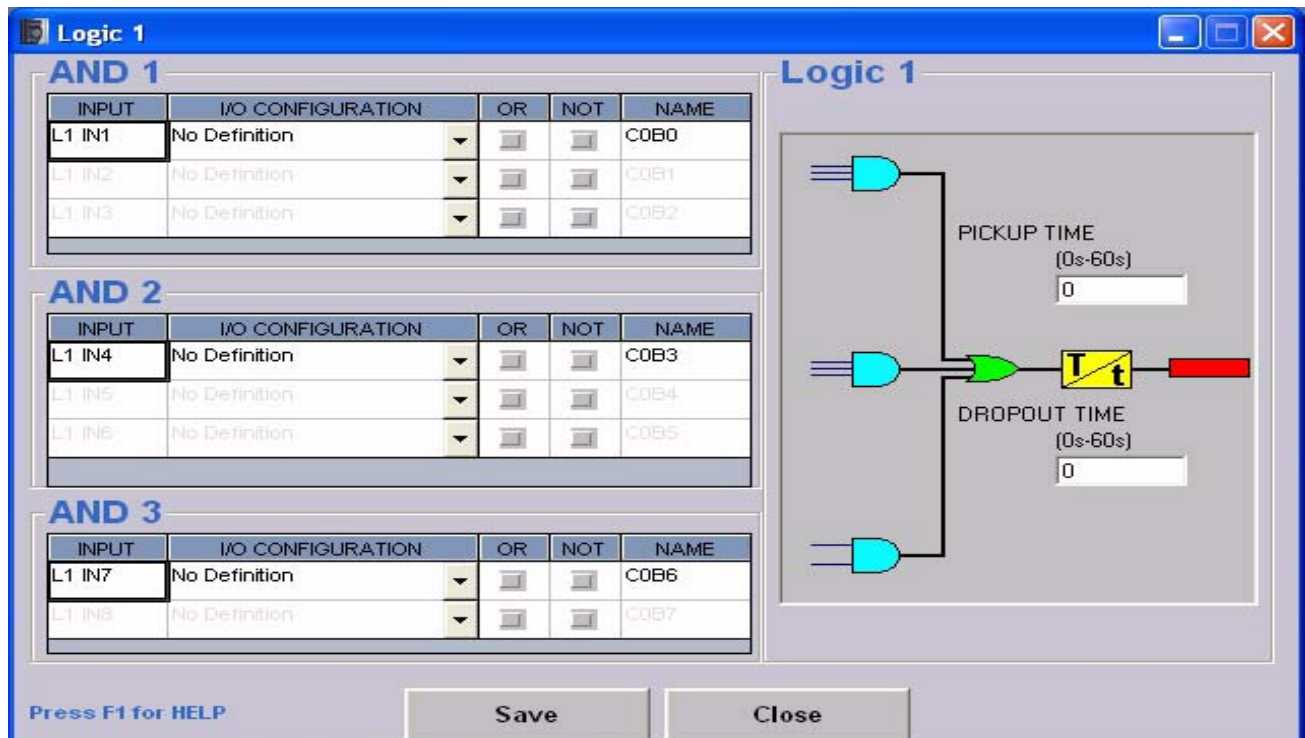
Each signal has the same configuration structure as the signals in outputs/LEDs.

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, they must be all in the same group. We must click on the OR button, next on I/O CONFIGURATION, and then select the desired group, etc.

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

IMPORTANT NOTE

Signals must be used in order, starting with L1 IN1. If we want to use more than one signal in the same AND gate, use L1 IN2 first and then L1 IN3. If we want to use another AND gate, use AND 2 first, and then AND3.

As shown on the example above, it is also possible to apply logic ORs to each AND logic input, as well as to invert the AND outputs. For this purpose, please refer to the "I/O Configuration" section in this manual.

Logics can be assigned both to LEDs or outputs, so that each user can create the desired configuration for a specific application

.
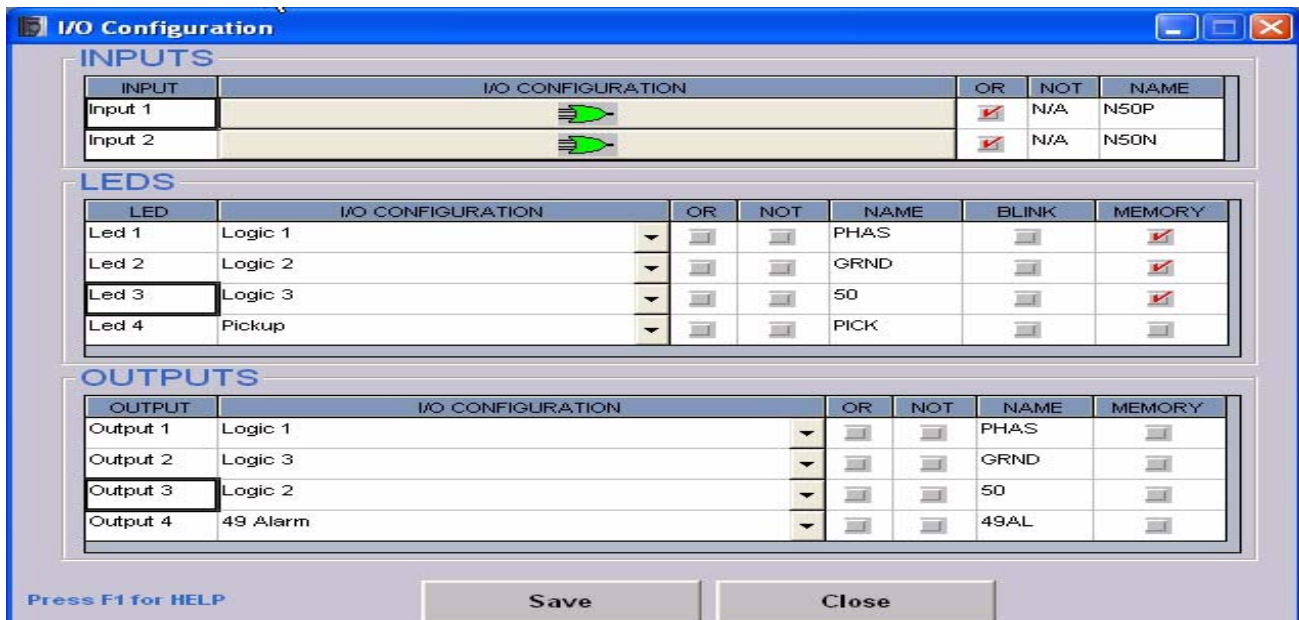
The "Application Notes" section in this manual describes several real application examples.

Time diagram for the logic configuration:
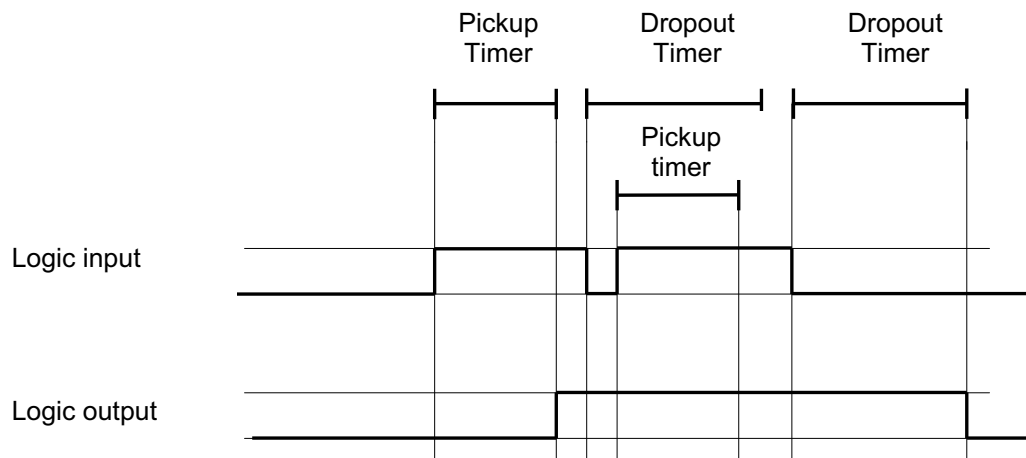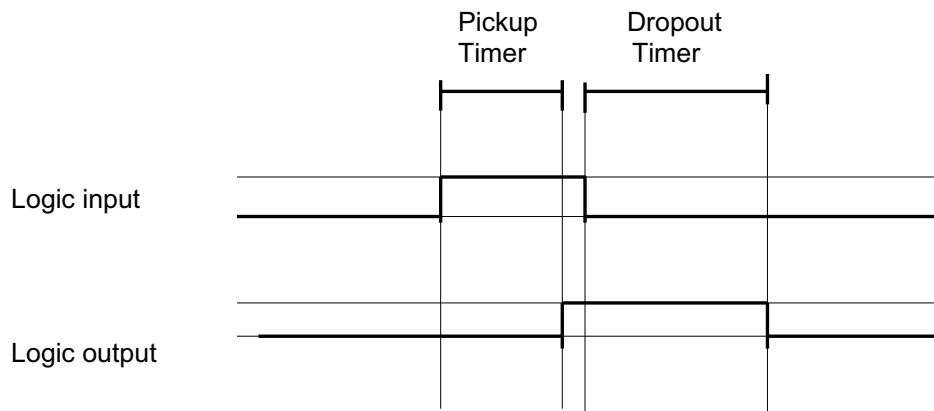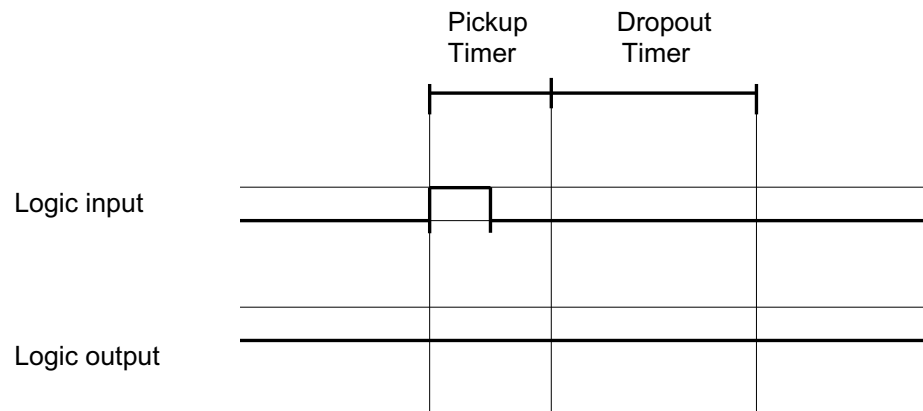
The list of elements that can be assigned in the configurable logic is divided into the following groups:

GROUP	NO DEFINITION	OUTPUT OR LED NOT ASSIGNED
CONFIGURATIONS	Logic 1	Output signal from logic 1
	Logic 2	Output signal from logic 2
	Logic 3	Output signal from logic 3
	Logic 4	Output signal from logic 4
MIXED 3	Phase trip	Any trip of 50P1, 50P2 elements
	Ground trip	Any trip of 50G1, 50G2 elements
	50 trip	Any trip of 50P1, 50G1, 50P2, 50G2 elements
	Phase A trip	Trip of any Phase A element
	Phase B trip	Trip of any Phase B element
	Phase C trip	Trip of any Phase C element
PHASE TRIPS 1	50-1a Trip	Trip of Phase A 50P1 element
	50-1b Trip	Trip of Phase B 50P1 element
	50-1c Trip	Trip of Phase C 50P1 element
	50-2a Trip	Trip of Phase A 50P2 element
	50-2b Trip	Trip of Phase B 50P2 element
	50-2c Trip	Trip of Phase C 50P2 element
PHASE TRIPS 2	51a Trip	Trip of Phase A 51P element
	51b Trip	Trip of Phase B 51P element
	51c Trip	Trip of Phase C 51P element
ELEMENT TRIPS	50P1 trip	50P1 element trip
	50G1 trip	50G1 element trip
	50P2 trip	50P2 element trip
	50G2 trip	50G2 element trip
	51P trip	51P element trip
	51G trip	51G element trip
	49 trip	49 element trip
	General trip	Any trip of the above mentioned elements
PHASE PICKUPS 1	50P1a Pickup	Pickup of Phase A 50P1 element
	50P1b Pickup	Pickup of Phase B 50P1 element
	50P1c Pickup	Pickup of Phase C 50P1 element
	50P2a Pickup	Pickup of Phase A 50P2 element
	50P2b Pickup	Pickup of Phase B 50P2 element
	50P2c Pickup	Pickup of Phase C 50P2 element
PHASE PICKUPS 2	51Pa Pickup	Pickup of Phase A 51P element
	51Pb Pickup	Pickup of Phase B 51P element
	51Pc Pickup	Pickup of Phase C 51P element
ELEMENT PICKUPS	50P1 pickup	50P1 element pickup
	50G1 pickup	50G1 element pickup
	50P2 pickup	50P2 element pickup
	50G2 pickup	50G2 element pickup
	51P pickup	51P element pickup
	51G pickup	51G element pickup
	49 Alarm	49 element pickup
	Pickup	Pickup of any of the above mentioned elements

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GROUP	NO DEFINITION	OUTPUT OR LED NOT ASSIGNED
PHASE VIRTUAL TRIPS 1	50-1a virtual trip	Virtual trip of Phase A 50P1 element
	50-1b virtual trip	Virtual trip of Phase B 50P1 element
	50-1c virtual trip	Virtual trip of Phase C 50P1 element
	50-2a virtual trip	Virtual trip of Phase A 50P2 element
	50-2b virtual trip	Virtual trip of Phase B 50P2 element
	50-2c virtual trip	Virtual trip of Phase C 50P2 element
PHASE VIRTUAL TRIPS 2	51 a virtual trip	Virtual trip of Phase A 51P element
	51 b virtual trip	Virtual trip of Phase B 51P element
	51 c virtual trip	Virtual trip of Phase C 51P element
ELEMENT VIRTUAL TRIPS	50P1 virtual trip	Trip condition for 50P1 element exists
	50G1 virtual trip	Trip condition for 50G1 element exists
	50P2 virtual trip	Trip condition for 50P2 element exists
	50G2 virtual trip	Trip condition for 50G2 element exists
	51P virtual trip	Trip condition for 51P element exists
	51G virtual trip	Trip condition for 51G element exists
	49 virtual trip	Trip condition for 49 element exists
	General virtual trip	Any virtual trip of the above mentioned elements
INHIBITIONS BY DIGITAL INPUTS	50P1 disabled (by di)	Element 50P1 disabled
	50G1 disabled (by di)	Element 50G1 disabled
	50P2 disabled (by di)	Element 51P disabled
	50G2 disabled (by di)	Element 51G disabled
	51P disabled (by di)	Element 50P2 disabled
	51G disabled (by di)	Element 50G2 disabled
	49 disabled (by di)	Element 49 disabled
	Trip disabled (by di)	Trip of all elements disabled
INPUTS/OUTPUTS	Output 1	Digital Output 1
	Output 2	Digital Output 2
	Output 3	Digital Output 3
	Output 4	Digital Output 4
	Input 1	Digital input 1
	Input 2	Digital input 2
INPUTS	General input	General input element
	Sett. change disable	Active means that settings or groups cannot be changed. It is only possible to switch to Group 2 by digital input Group change
	Breaker 52b	This element active means breaker closed
	Breaker 52a	This element active means breaker open
	Group change	Active means that active group is Group2 Not active means that active group is the group defined in General Settings group
MIXED 1	Breaker closed	Active when the breaker is closed, according to 52a or 52b[1]
	BF to open	Output of the breaker failure to open element, when it is enabled
	I^2 Alarm	Output of the I^2 counter element
	Cold load pickup	Output of the Cold load pickup element, when it is enabled
	E2PROM failure	Active when a failure is detected in EEPROM management
	User settings	This element is green when the default settings are active and red when the user's settings are active

GROUP	NO DEFINITION	OUTPUT OR LED NOT ASSIGNED
LEDS	READY	Active when the relay is in service and at least one element has its trip enabled
MIXED 2	SETTINGS GROUP	Group 2 active
	Local/Remote	It's Local when the HMI is inside the MAIN SETTINGS, ADVANCED SETTINGS or OPERATIONS menu

1.   A 52a or 52b input must be configured. If there are two inputs configured as 52a and 52b, the relay will not take into account the input configured as 52a and will act according only to the status of the input configured as 52b.

:

7

MIFII has five types of display messages: actual values, main settings, advanced settings, operations and date & time. Actual values are values that are measured by the relay, such as currents; digital values of the relay, and can be digital inputs, outputs status and others; or internal information as the firmware revision. Main settings and advanced settings comprise product setup, communications and protection elements adjustments. Operations are the available commands that can be performed in the relay.

These types of messages are located within a menu structure that groups the information into categories. This chapter describes the way to navigate this menu structure and shows the complete structure so that the user can reach certain screens quickly.

8

The MIFII faceplate keypad is made up of five keys, as shown in Figure 8–1:

Figure 8–1: KEYPAD

The **main screen** is the one that shows the three phase and neutral currents. If the relay is not showing the main screen, you can return to it from any other screen by pressing the **Escape** key as many times as necessary until exiting the menu structure.

From the main screen, the **Menu** key enters the menu structure. From that point on, the user can navigate through the menu structure using **Up** and **Down** arrows to move horizontally, **Enter** to enter submenus and **Escape** to exit to the upper level.

8

The faceplate display of the MIFII relay is a 16 column x 2-row characters alphanumeric LCD display. Messages in the display are shown in the English language.

Figure 8–2: DISPLAY

The **display contrast** can be modified simultaneously pressing **Escape + arrow**:

- **Escape + up arrow** increases the contrast
- **Escape + down arrow** decreases the contrast

If the keypad is not in use during 15 minutes, the display turns automatically off and returns to the main screen. Pressing ESC/RESET key, the display is automatically turned on and it shows the main screen with phase and groundcurrents.

Pressing any other key, corresponding screen in the menu structure is shown. As an example, pressing ENTER key the Thermal Capacity Used screen is shown, as pressing this key the display enters in One Key Operation menu.

The faceplate of the MIFII relay has six LEDs that show the relay status, as well as pickup and trip status. LEDs are grouped in two columns and three rows, as shown in the following figure:

Figure 8–3: LEDS

The two LEDs in the first row (**Ready** and **Trip**) are not configurable. For MIFII relays Option 1 or Option 2, relays the other four LEDs(by default Phase, Ground, Inst and Pickup) are configurable by the user, using EnerVista MII SETUP program. See Chapter 4 for more information on how to configure LEDs.The **color** of the four **LEDs** in rows 2 and 3 can be changed between red and green in any relay model. The way to do this is to press simultaneously **up** and **down arrow** keys for more than 2 seconds. Then a new menu appears:

8

COLOR LEDs MENU
LED1 GREEN

Press up or down arrow
to select, Enter to confirm

(⇑:RED —⇓:GREEN)
Enter

↓

COLOR LEDs MENU
LED2 RED

Press up or down arrow
to select, Enter to confirm

(⇑:RED —⇓:GREEN)
Enter

↓

COLOR LEDs MENU
LED3 GREEN

Press up or down arrow
to select, Enter to confirm

(⇑:RED —⇓:GREEN)
Enter

↓

COLOR LEDs MENU
LED4 RED

Press up or down arrow
to select, Enter to confirm

(⇑:RED —⇓:GREEN)
Enter

↓

Main Screen

Ia 0.0 Ib 0.0
Ic 0.0 Ig 0.0

8
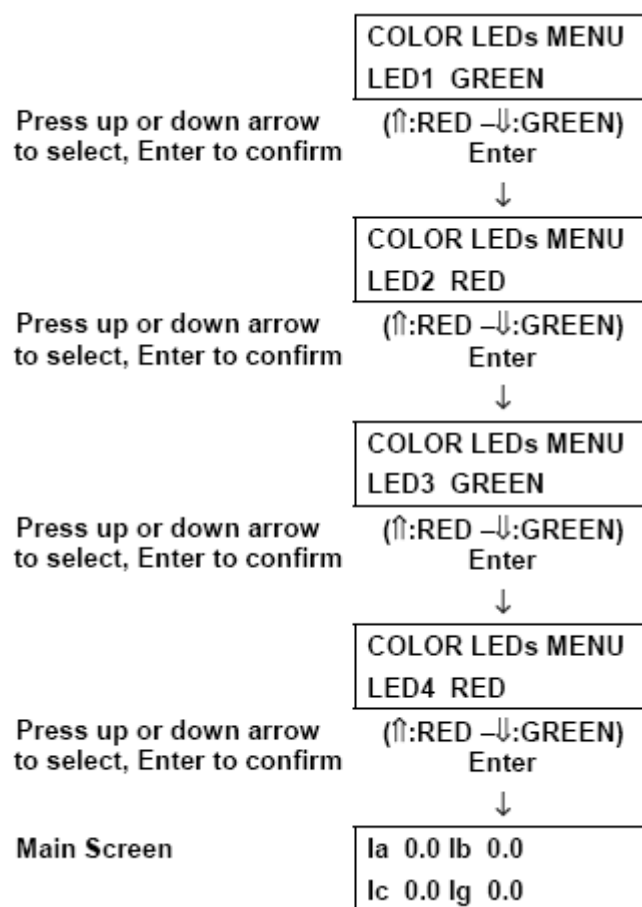
From the main screen, pressing Enter key the display shows a **one-key operation menu** that presents measures, thermal image value and up to **five latest trip element** data with the element that has tripped,and the secondary current value (not affected by CT ratio), with the day, month and time of the trip.

When a fault occurs, trip information is automatically shown in the display. Pressing ENTER key, main screen will be shown again. In order to perform a RESET operation, display must be in main screen showing phase and ground currents, in this situation, pressing ESC/RESET key for more than 3 seconds a RESET operation will be performed.

1. Day - month

Main screen	Ia 0.0 Ib 0.0 Ic 0.0 Ig 0.0

Enter

⇓

	TH Capacity Used .00

Enter

⇓

	Last Trip Unit

Enter

⇓

1st LTU	03-03[1] 11:23:02 1 51P A 2.19

Enter

⇓

2nd LTU	28-02 05:41:30 2 50P1 A 1.21

Enter

⇓

3rd LTU	01-01 00:00:00 3 ---- - ----

Enter

⇓

4th LTU	01-01 00:00:00 4 ---- - ----

Enter

⇓

5th LTU	01-01 00:00:00 5 ---- - ----
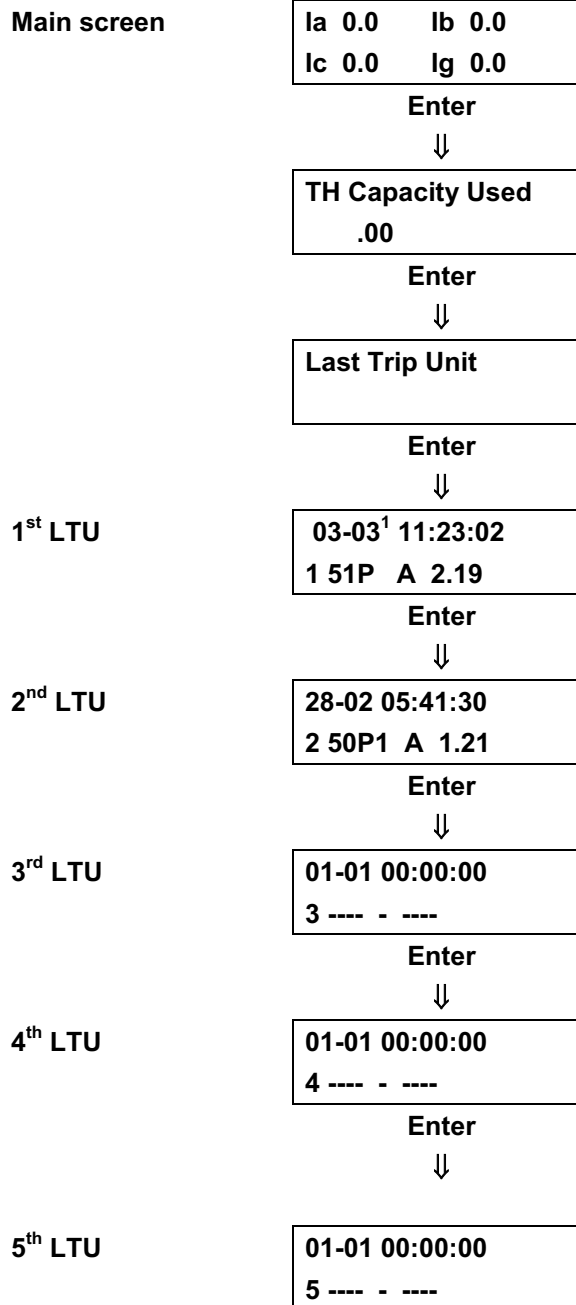
The MIFII relay allows settings protection by password. This password is called **HMI password** and it is disabled by default (value 0). If you change this value to other than 0, the HMI password will be enabled and required to change settings. **When the password is enabled, a value between 1 and 9999 is shown on the screen. This number is the password value shown in a coded format.**

When a setting is being changed, after pressing the Enter key to store the modified value the relay shows the following screen:

```
┌─────────────────────┐
│  ENTER PASSWORD     │
│                     │
│      4108           │
│                     │
└─────────────────────┘
```

Scroll up and down with the arrow keys until the screen shows the desired password; next, press enter for confirmation and the relay will accept and store the setting change. The setting password protection will then be disabled for **15 minutes** after the last setting change is made to the relay, or until a **reset operation** (the same as to reset LEDs, pressing Esc for more than 3 seconds from the main screen) is performed.

The password can be modified in the **Main Settings > Product Setup > HMI password** menu. The relay then asks for the current password. Once it has been entered, the relay asks for the new password. Here is an example of how to change from HMI password value 1 to 2:

If you don't know the programmed password please contact GE Multilin Technical Service and have the encoded password value shown in **Main Settings > Product Setup > HMI** handy.

MENU

ENTER MIFII
       ACTUAL VALUES
ESC

Order Code	MIFIIPI55E2RHIOO
Firmware Rev.	2.10
Date & Time	02-01-96
	08:42:24
Relay Name	MIFII
Serial Number	555555
Phase A Current	0.0
Phase B Current	0.0
Phase C Current	0.0
Ground Current	0.0
Th capacity used	0.0
Input 1	0
Input 2	0
Output 1	0
Output 2	0
Output 3	0
Output 4	0
Cold Load Status	0
52 A status	0
52 B Status	0
BRK Fail status	0
I^2 Alarm Status	0
I^2 Value	0
Breaker Trips	0

ENTER MIFII
       MAIN
ESC

ENTER MAIN
       SETTINGS
ESC

Relay Operation	READY - [DISABLE]
Frequency	[60]
Phase CT Ratio	[1] - 4000
Ground CT Ratio	[1] - 4000
HMI Password	[0] - 9999
Comm Password	[1] - 255
Slave Address	[1] - 255
Comm. Baud Rate	0.3, 0.6, 1.2, 2.4, 4.8, [9.6], 19.2

8

MENU

ENTER
MIFII
MAIN SETTINGS
ESC

ENTER
MAIN SETTINGS
PHASE TOC 51P
ESC

Trip enable 51P	- Yes - [No]
Pickup 51P	0.10 - 2.40 - [0.50]
Curve 51P:	[DEFINE TIME]-USER-MOD INVERSE-VERY INVERSE-EXTR INVERSE - INVERSE SHORT - INVERSE LONG
TD mult 51P	0.05 - 2.00 [0.50] (IEC)
	0.5 - 20.0 [5.00] (ANSI)
	0.5 - 10.0 [0.50] (IAC)
Def Time 51P	0.00 - 600.00 [5.00]

ENTER
MAIN SETTINGS
GROUND TOC 51G
ESC

Trip enable 51G	- yes - [No]
Pickup 51G	0,10 - 2,40 [0.50]
Curve 51G	[DEFINE TIME]-USER-MOD INVERSE-VERY INVERSE-EXTR INVERSE - INVERSE SHORT - INVERSE LONG
TD mult 51G	0.05 - 2.00 [0.50] (IEC)
	0.5 - 20.0 [5.00] (ANSI)
	0.5 - 10.0 [0.50] (IAC)
Def time 51G	0.00 - 600.00 [5.00] (ANSI)

ENTER
MAIN SETTINGS
PHASE IOC 50P1
ESC

Trip enable 50P1	- Yes - [No]
Pickup 50P1	0,10 - 30,0 [1.0]
Delay 50P1	[0,00] - 600.00

ENTER
MAIN SETTINGS
PHASE IOC 50P2
ESC

ENTER
MAIN SETTINGS
GROUND IOC 50G1
ESC

MENU

ENTER
MIFII
MAIN SETTINGS
ESC

ENTER
MAIN SETTINGS
GROUND IOC 50G2
ESC

ENTER
MAIN SETTINGS
THERMAL MODEL 49
ESC

Trip enable 49	Yes	[No]
Pickup 49	0.10 – 2.4	[1.00]
Alarm level 49	70 – 100	[80]
Heat time 49	3 – 600	[6]
Cool time 49	[1] – 6	

ENTER
MAIN SETTINGS
AUTORECLOSER 79
ESC

AR Function	Yes – [No]	
AR Max Shots	[1] – 4	
AR Dead Time	0.1 – 600s	[1]
AR Dead Time	0.1 – 600s	[2]
AR Dead Time	0.1 – 600s	[3]
AR Dead Time	0.1 – 600s	[4]
AR Rst Lo Delay	0.1 – 600s	[10]
AR Inc Seq Time	0.1 – 600	[5]
AR Reset Time	0.1 – 600	[10]
AR Block Input	Yes – [No]	
AR 50P1 Init	[Yes] – No	
AR 50G1 Init	[Yes] – No	
AR 50P2 Init	[Yes] – No	
AR 50G2 Init	[Yes] – No	
AR 50P Init	[Yes] – No	
AR 50G Init	[Yes] – No	
AR 49 Init	[Yes] – No	
AR EXTERNAL Init	[Yes] – No	

8

MENU

ENTER → MIFII
MAIN SETTINGS
ESC ←

ENTER → MAIN SETTINGS
AUTORECLOSER 79
ESC

AR 50P1 SHOT1	[Yes] – No
AR 50G1 SHOT1	[Yes] – No
AR 50P2 SHOT1	[Yes] – No
AR 50G2 SHOT1	[Yes] – No
AR 50P SHOT1	[Yes] – No
AR 50G SHOT1	[Yes] – No
AR 49 SHOT1	[Yes] – No
AR 50P1 SHOT2	[Yes] – No
AR 50G1 SHOT2	[Yes] – No
AR 50P2 SHOT2	[Yes] – No
AR 50G2 SHOT2	[Yes] – No
AR 50P SHOT2	[Yes] – No
AR 50G SHOT2	[Yes] – No
AR 49 SHOT2	[Yes] – No
AR 50P1 SHOT3	[Yes] – No
AR 50G1 SHOT3	[Yes] – No
AR 50P2 SHOT3	[Yes] – No
AR 50G2 SHOT3	[Yes] – No
AR 50P SHOT3	[Yes] – No
AR 50G SHOT3	[Yes] – No
AR 49 SHOT3	[Yes] – No
AR 50P1 SHOT4	[Yes] – No
AR 50G1 SHOT4	[Yes] – No
AR 50P2 SHOT4	[Yes] – No
AR 50G2 SHOT4	[Yes] – No
AR 50P SHOT4	[Yes] – No
AR 50G SHOT4	[Yes] – No
AR 49 SHOT4	[Yes] – No

8

MENU

ENTER →
ESC ←

MIFII
ADVANCED SETTINGS

ENTER →
← ESC

ADVANCED SETTINGS
GENERAL ADVANCED

⇕ → Settings group   [1] - 2
   → Trip min tiem   50 - 300 [100]

ENTER →
←
ESC

ADVANCED SETTINGS
PHASE TOC 51P

ESC
ENTER →
←

ADVANCED SETTINGS
GROUND TOC 51G

ESC
ENTER →
←

ADVANCED SETTINGS
PHASE IOC 50P1

ESC
ENTER →
←

ADVANCED SETTINGS
PHASE IOC 50P2

ENTER →
←

ADVANCED SETTINGS
GROUND IOC 50G1

ESC
ENTER →
←

ADVANCED SETTINGS
GROUND IOC 50G2

ESC
ENTER →
←

ADVANCED SETTINGS
THERMAL MODEL 49

ESC

ENTER →
←

ADVANCED SETTINGS
USER CURVE

ESC

⇕
→ A parameter   0.0000 - 125,0000 [0.0500]
→ B parameter   [0.0000] - 3.0000
→ P parameter   0.0000 - 3.0000 [0.0400]
→ Q parameter   0.0000 - 2.0000 [1.0000]
→ K parameter   [0.000] - 1.999
→

ENTER →
←

ADVANCED SETTINGS
I^2 SETTINGS

ESC

→ I^2 MAX value 0.000 - [999.000]

MENU

ENTER
ESC
MIFII
ADVANCED SETTINGS

ENTER
ESC
ADVANCED SETTINGS
COLD LOAD PICKUP

Element	[no] – yes
Outage time	0.000 – 60.00 [2.000]
On load time	0.000 – 60.00 [1.000]
Phase Ioc Mult	[1.00] – 5.00
Phase TOC Mult	[1.00] – 5.00

ENTER
ESC
ADVANCED SETTINGS
BREAKER FAILURE

| Element | [no] – yes |
| Delay | 50 – 999 [400] |

ENTER
ESC
MIFII
OPERATIONS

ENTER
ESC
OPERATIONS
LEDS RESET → LEDS RESET ENTER TO CONFIRM → PRESS PASSWORD → LEDS RESET IN PROCESS → LEDS RESET OPERATION OK

ENTER
ESC
OPERATIONS
RESET → RESET ENTER TO CONFIRM → RESET IN PROCESS → RESET OPERATION OK

ENTER
ESC
OPERATIONS
ACTIVATE TABLE 1 → ACTIVATE TABLE 1 ENTER TO CONFIRM → ACTIVATE TABLE 1 IN PROCESS → ACTIVATE TABLE 1 OPERATION OK

ENTER
ESC
OPERATIONS
ACTIVATE TABLE 2 → ACTIVATE TABLE 2 ENTER TO CONFIRM → ACTIVATE TABLE 2 IN PROCESS → ACTIVATE TABLE 2 OPERATION OK

ENTER
ESC
OPERATIONS
OPEN BREAKER → OPEN BREAKER ENTER TO CONFIRM → OPEN BREAKER IN PROCESS → OPEN BREAKER OPERATION OK

8

MENU

ENTER → MIFII OPERATIONS
ESC ←

↕

ENTER → OPERATIONS CLOSE BREAKER → CLOSE BREAKER ENTER TO CONFIRM → CLOSE BREAKER IN PROCESS → CLOSE BREAKER OPERATION OK
ESC ←

ESC
ENTER → OPERATIONS RESET BKR TRIPS → RESET BKR TRIPS ENTER TO CONFIRM → RESET BKR TRIPS IN PROCESS → RESET BKR TRIPS OPERATION OK
ESC ←

ENTER → OPERATIONS RESET I^2 → RESET I^2 ENTER TO CONFIRM → RESET I^2 IN PROCESS → RESET I^2 OPERATION OK
ESC ←

ENTER → MIFII CHANGE DATE & TIME
ESC ←

↕

→ YEAR
→ MONTH
→ DAY
→ HOUR
→ MINUTE
→ DATE & TIME
→

8

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

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 ensuring that the relay works roughly correctly and, therefore, for verifying its characteristics in an **approximate** manner.

Here follows a list of tests that can be used to check that the unit is fully operational. For a more limited test for the reception of units we recommend carrying out only the tests listed in sections 9.5, 9.8, 9.10, 9.11, 9.12, 9.13, 9.14, 9.15, 9.16, 9.17, 9.18 and 9.19. 9.4 to 9.19

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

NOTE:

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.

In case the Hi-Pot device used to test the relay trips due to excessive consumption, apply the test between each group and ground one at a time.

NOTE: Do not test insulation on terminals B12, A12 and B11 (RS485). These terminals must be grounded during the test.

> **DURING TESTS, GND TERMINAL MUST BE GROUNDED FOR SAFETY REASONS**

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

Necessary equipment:

- 1 AC current source .

- 1 DC voltage power supply.

- 1 timing device.

- 1 Multi-meter.

- Optionally, it is advisable to have a PC available, with the EnerVista MII SETUP software installed.

- Relay wiring diagram.

Connect the relay as shown in

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

 Energize the relay through terminals.

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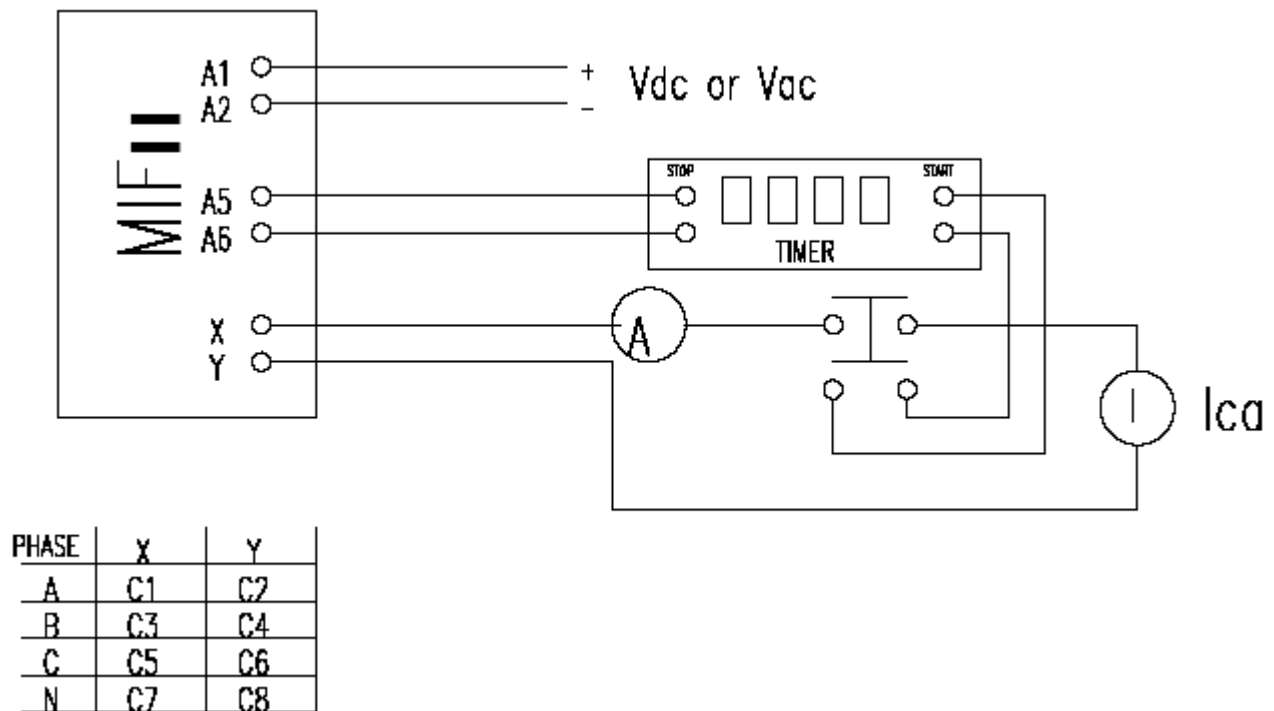
Figure 9–1: TEST CONNECTIONS FOR MIFII (RELAY

9

Check that pressing the "ESC/RESET" button for more than 3 seconds, all the front target LEDs light up and reset.

9

Connect the relay to a power supply at rated voltage

Enable the following elements: 51P, 51G, 50P1, 50P2 and 49, setting their pickups and times to the minimum possible value. All the auxiliary outputs corresponding to the elements enabled.Under these 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 "LO" (24 - 48 Vdc)	
Voltage (Vdc)	Maximum Consumption (mA)
18	900
48	300
58	250

Model "HI" (110 - 250 Vdc 120-230 Vac)	
Voltage (Vdc)	Maximum Consumption (mA)
88	130
110	105
250	55
Voltage (Vac)	Maximum Consumption (mA)
110	200
220	140

Shown values are only illustrative, as due to the nature of the internal power supply (switched power supply), the consumption currents are high frequency currents, and the meters used measure these values with a poor accuracy.

9

The communication test checks that the 2 communications ports (the front RS232 and the rear RS485) work properly. To perform this test is necessary to establish the connection between the PC and the relay (refer to figure 3-10). If the front port is used, a straight through cable is needed. If the rear RS485 port is used, an RS485/RS232 converter is needed. GE Multilin offers DAC300, F485 or RS232/485 converters.

The communications parameters that have to be set in the computer should match the relay default communication settings.

The factory default settings for the MIFII relay are:

COMMUNICATIONS			
NAME	VALUE	UNITS	RANGE
Slave Address	1		1 - 255
Communication Port	COM1		COM1 – COM*
Baud Rate	9.600	Bauds	300 – 19 200
Parity	NONE		NONE – ODD - EVEN
Control type	No control type		No control type, Modem connection, MODBUS/TCP
Start up mode	File Mode		Communicate with relay – File mode

Using the EnerVista MII SETUP 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

When the relay is shipped from the factory, it comes with a default set of settings, which act as the starting point for the following tests.

Since the MIFII relay has a large number of settings, a list of all the settings necessary for all tests will not be given here, but rather only the specific settings required for each test indicated.

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

Sequentially apply the rated voltage to input CC1 and CC2 (A8-A10 and A9-A10).

Check that when voltage is applied to one contact input, only this input gets active, and the other one remains inactive. Use the INFORMATION menu on the faceplate or a PC and the ACTUAL VALUES menu in the EnerVista MII SETUP program (*Actual> Actual Values*) to easily check which input gets active for each test.

Repeat this test at minimum and maximum permissible voltages.

9

Check that all the outputs are open.

Enable only 51P element , and set its pickup and time delay to the minimum values. Inject a current through phase A terminals equal to 2 x In (phase) to trip the relay. Check that the trip output (terminals A5-A6) and auxiliary output OUT1 (terminals A7-B7) are closed, and the **PICKUP, PHASE** and **TRIP**LEDs light up.

Enable only 51G element, and set its pickup and time delay to the minimum values. Inject a current through phase A terminals equal to 2 x In (phase) to trip the relay. Check that the trip output (terminals A5-A6) and auxiliary output OUT2 (terminals A7-B8) are closed, and the **PICK UP**, **TIME OC** and **TRIP** LEDs light up.

Enable only 50P element, and set its pickup to the minimum value. Inject a current through phase A terminals equal to 2 x In (phase) to trip the relay. Check that the trip output (terminals A5-A6) and auxiliary output OUT3 (terminals B9-A7) are closed, and the **PICK UP**, **PHASE, INST** and **TRIP** LEDs light up.

Enable only element 49, and set its pickup to the minimum value. Inject a current through phase A terminals equal to 2 x In (phase) making the relay trip. Check that the trip output (terminals A5-A6) and auxiliary output OUT4 (terminals B10-A7) are closed, and the **PICK UP, THERMAL** and **TRIP** LEDs light up.

Remove the Power Supply from the relay and check that the Alarm Output Contact (terminals B5-B6) is closed. Set the power supply back to the relay terminals and check that the Alarm Output Contact is open.

9

PHASE CURRENT

Set the relay to 50Hz 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 an accuracy better than 3%.

Set the relay at 60Hz and repeat the test.

GROUND CURRENT

Set the relay to 50Hz and apply the following current:

	1	2
In (Amps)	0.1 x In (ground)	4 x In (ground)

Check that the relay measures the current with accuracy better than 3%.

Set the relay at 60Hz and repeat the test.

9

Enable only 50P1 element.

Set time delay as needed. If the time delay is set to 0 sec., the relay operating time will be between 10 to 50 ms. Also, the customer has to test pickup.

With 0.9 times the pickup current the relay should not trip.

With 1.1 times the pickup current the relay should trip in between 10 to 50 ms.

With 4 times the pickup current the relay should trip in between 10 to 40 ms.

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

9

Enable only 50P2 element.

Set time delay as needed. If the time delay is set to 0 sec., the relay operating time will be between 10 to 50 ms. Also, the customer has to test pickup.

With 0.9 times the pickup current the relay should not trip.

With 1.1 times the pickup current the relay should trip in between 10 to 50 ms.

With 4 times the pickup current the relay should trip in between 10 to 40 ms.

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

9

Enable only 50G1 element.

Set time delay as needed. If the time delay is set to 0 sec., the relay operating time will be between 10 to 50 ms. Also, the customer has to test pickup.

With 0.9 times the pickup current the relay should not trip.

With 1.1 times the pickup current the relay should trip in between 10 to 50 ms.

With 4 times the pickup current the relay should trip in between 10 to 40 ms.

9

Enable only 50G2 element.

Set time delay as needed. If time delay is set to 0 sec., relay operating time will be between 10 to 50 ms. Also, the customer has to test pickup.

With 0.9 times the pickup current the relay should not trip.

With 1.1 times the pickup current the relay should trip in between 10 to 50 ms.

With 4 times the pickup current the relay should trip in between 10 to 40 ms.

9

Available curves IEC, ANSI or IAC (Inverse, Very Inverse, Extremely Inverse, Inverse Short, Inverse Long) 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 element. 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 element only, and set its current pickup value to the minimum possible.

9.15.1 IEC INVERSE CURVE

Set the relay as follows:

51P SETTINGS GROUP	
Curve	MOD 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 4.0 and 4.6 sec.

9.15.2 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 3.2 and 3.6 sec.

9.15.3 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 1.8 sec.

9

9.15.4 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 3.9 and 4.3 sec.

9.15.5 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 26.7 and 37.3 sec.

Apply 5 times the pickup current and the relay should trip between 2.4 and 2.8 sec.

9.15.6 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 17.2 and 23.6 sec.

Apply 5 times the pickup current and the relay should trip between 1.7 and 1.35 sec.

9.15.7 IAC INVERSE CURVE

Set the relay as follows:

51P 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 10.86 and 12.25 sec.

Apply 5 times the pickup current and the relay should trip between 3.69 and 4.16 sec.

9

9.15.8 IAC VERY INVERSE CURVE

Set the relay as follows:

51P 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 27.27 and 30.75 sec.

Apply 5 times the pickup current and the relay should trip between 2.50 and 2.82 sec.

9.15.9 IAC EXTREMELY INVERSE CURVE

Set the relay as follows:

51P SETTINGS GROUP	
Curve	EXTREMELY 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 31.94 and 36.02 sec.

Apply 5 times the pickup current and the relay should trip between 2.31 and 2.60 sec.

9.15.10 IAC INVERSE LONG CURVE

Set the relay as follows:

51P 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 122.17 and 137.77 sec.

Apply 5 times the pickup current and the relay should trip between 31.35 and 35.36 sec.

9.15.11 IAC INVERSE SHORT CURVE

Set the relay as follows:

51P SETTINGS GROUP	
Curve	EXTREMELY 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 1.38 and 1.56 sec.

Apply 5 times the pickup current and the relay should trip between 0.53 and 0.60 sec.

9

Set the relay as follows:

51P SETTINGS GROUP	
Curve	DEFINITE TIME
Definite Time Delay	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

Enable 51G element only and set its current pickup value to the minimum possible.

9.16.1 IEC INVERSE CURVE

Set the relay as follows:

51G SETTINGS GROUP	
Curve	MOD 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.

9.16.2 IEC VERY INVERSE CURVE

Set the relay as follows:

51G 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

9.16.3 IEC EXTREMELY INVERSE CURVE

Set the relay as follows:

51G 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

9.16.4 ANSI INVERSE CURVE

Set the relay as follows:

51G 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

9.16.5 ANSI VERY INVERSE CURVE

Set the relay as follows:

51G 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.

9.16.6 ANSI EXTREMELY INVERSE CURVE

Set the relay as follows:

51G 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

9.16.7 IAC INVERSE CURVE

Set the relay as follows:

51G 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 10.86 and 12.25 sec.

Apply 5 times the pickup current and the relay should trip between 3.69 and 4.16 sec.

9.16.8 IAC VERY INVERSE CURVE

Set the relay as follows:

51G 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 27.27 and 30.75 sec.

Apply 5 times the pickup current and the relay should trip between 2.50 and 2.82 sec.

9

9.16.9 IAC EXTREMELY INVERSE CURVE

Set the relay as follows:

51G SETTINGS GROUP	
Curve	EXTREMELY 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 31.94 and 36.02 sec.

Apply 5 times the pickup current and the relay should trip between 2.31 and 2.60 sec.

9.16.10 IAC INVERSE LONG CURVE

Set the relay as follows:

51G 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 122.17 and 137.77 sec.

Apply 5 times the pickup current and the relay should trip between 31.35 and 35.36 sec.

9.16.11 IAC INVERSE SHORT CURVE

Set the relay as follows:

51G SETTINGS GROUP	
Curve	EXTREMELY 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 1.38 and 1.56 sec.

Apply 5 times the pickup current and the relay should trip between 0.53 and 0.60 sec.

9.16.12 EPTAR C CURVE

Set the relay as follows:

51G SETTINGS GROUP	
Curve	EPTAR C
Time Dial	1

Apply 0.9 times the pickup current at phase C and the relay should not trip.

Apply 2 times the pickup current and the relay should trip between 43.3 and 47.8 sec.

Apply 5 times the pickup current and the relay should trip between 23.4 and 25.9 sec.

9

Set the relay as follows:

51G SETTINGS GROUP	
Curve	DEFINITE TIME
Definite Time Delay	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

Enable 49 element only.

Set the relay as follows:

49 SETTINGS GROUP	
Pickup	0.4 x In
Heating Time Constant T1	3 min.
Cooling Time Constant T2	1 times T1

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

- If relay has 5 Amps rated current:

RELAY RATED CURRENT (AMPS)	APPLIED CURRENT (AMPS)	TIMES IN SET IN THE RELAY	OPERATING TIME (SEC.)
5	4.0	2	48.5 – 53.6
	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

- If relay has 1 Amps rated current:

RELAY RATED CURRENT (AMPS)	APPLIED CURRENT (AMPS)	TIMES IN SET IN THE RELAY	OPERATING TIME (SEC)
1	0.8	2	48.5 - 53.6
	2.0	5	7.06 - 7.80
	4.0	10	1.77 - 1.95

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

- If relay has 5 Amps rated current:

RELAY RATED CURRENT (AMPS)	APPLIED CURRENT (AMPS)	TIMES IN SET IN THE RELAY	OPERATING TIME (SEC.)
5	4.0	2	960 - 1072
	10.0	5	141 - 156
	20.0	10	35.4 - 39

- If relay has 1 Amps rated current:

RELAY RATED CURRENT (AMPS)	APPLIED CURRENT (AMPS)	TIMES IN SET IN THE RELAY	OPERATING TIME (SEC.)
1	0.8	2	960 - 1072
	2.0	5	141 - 156
	4.0	10	35.4 - 39

9

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

Synchronize the relay date and time with the PC, using the EnerVista MII SETUP communications program (SETPOINT – CLOCK). Check using the keypad and display that the relay is actually in synchronism with the computer.

9

The following pages intend to be useful to register the user settings. They can be used as a guide or template or to record the relay settings.

9.19.1 MAIN SETTINGS

	ENERVISTA MII SETUP	HMI	USER SETTING	RANGE	STEP
PRODUCT SETUP	PRODUCT SETUP	PRODUCT SETUP			
Relay Status	Relay Operation	Relay Operation		READY / DISABLE	NA
Frequency	Frequency	Frequency		50/60 Hz	NA
Phase CT ratio	Phase CT Ratio	Phase CT Ratio		1-4000	1
Ground CT ratio	Ground CT Ratio	Ground CT Ratio		1-4000	1
HMI Password	---	HMI Password		0-9999	1
Comm Password	---	Comm Password		1 – 255	1
Slave Address	---	Slave Address		1 – 255	1
Communications Speed	---	Comm Baud Rate		0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2	NA
Phase TOC Function	PHASE TOC 51P	PHASE TOC 51P			
51P Permission to Trip	Trip Enable 51P	Trip Enable 51P		Yes/No	NA
51P Pickup Value	Pickup 51P	Pickup 51P		0.1-2.4 In (Ph)	0.01 In (Ph)
51P Curve Type	Curve 51P	Curve 51P		DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51P Time Dial	TD mult 51P	TD mult 51P		0.05 – 2.00 (IEC curves)	0.01
				0.5 – 20.0 (ANSI curves)	0.01
				0.5 – 10.0 (IAC curves)	0.01
51P Definite Time Delay	Def Time 51P	Def Time 51P		0.00 – 600.00 s.	0.01 s.
Ground TOC Function	GROUND TOC 51G	GROUND TOC 51G			
51G Permission to Trip	Trip Enable 51G	Trip Enable 51G		Yes/No	NA
51G Pickup (for 1/5 A ground)	Pickup 51G	Pickup 51G		0.10 – 2.40 In (Gnd)	0.01 In (Gnd)
51G Pickup (for sensitive ground)	Pickup 51G	Pickup 51G		0.005-0.12 A	0.001 A
51G Curve Type	Curve 51G	Curve 51G		DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51G Time Dial	TD Mult 51G	TD Mult 51G		0.05 – 2.00 (IEC curves)	0.01
				0.5 – 20.0 (ANSI curves)	0.01
				0.5 – 10.0 (IAC curves)	0.01
51G Definite Time Delay	Def Time 51G	Def Time 51G		0 –600.00s.	0.01 s.
Phase IOC High Setting	50P1 Function	Phase IOC 50P1			
50P1 Permission to Trip	50P1 Trip	Trip Enable 50P1		Yes/No	NA
50P1 Tap / Pickup	50P1 Pickup	Pickup 50P1		0.1 – 30.0 In (Ph)	0.1 In (Ph)
50P1 Time Delay	50P1 Time Delay	Delay 50P1		0 – 600.00 s.	0.01 s.
Phase IOC Low Setting	50P2 Function	Phase IOC 50P2			
50P2 Permission to Trip	50P2 Trip	Trip Enable 50P2		Yes/No	NA
50P2 Tap / Pickup	50P2 Pickup	Pickup 50P2		0.1 – 30.0 In (Ph)	0.1 In (Ph)
50P2 Time Delay	50P2 Time Delay	Delay 50P2		0 – 600.00 s.	0.01 s.
Ground IOC High Set.	50G1 Function	Ground IOC 50G1			
50G1 Permission to Trip	50G1 Trip	Trip Enable 50G1		Yes/No	NA
50G1 Tap / Pickup (for 1/5 A ground)	50G1 Pickup	Pickup 50G1		0.1 – 30 In (Gnd)	0.1 In (G)

9

	ENERVISTA MII SETUP	HMI	USER SETTING	RANGE	STEP
50G1 Tap / Pickup (for sensitive ground)	50G1 Pickup	Pickup 50G1		0.005-0.12 A	0.001 A
50G1 Time Delay	50G1 Time Delay	Delay 50G1		0 – 600.00 s.	0.01 s.
Ground IOC Low Setting	50G2 Function	Ground IOC 50G2			
50G2 Permission to Trip	50G2 Trip	Trip Enable 50G2		Yes/No	NA
50G2 Tap / Pickup (for 1/5 A ground)	50G2 Pickup	Pickup 50G2		0.1 – 30 In (Gnd)	0.1 In (G)
50G2 Tap / Pickup (for sensitive ground)	50G2 Pickup	Pickup 50G2		0.005-0.12 A	0.001 A
50G2 Time Delay	50G2 Time Delay	Delay 50G2		0 – 600.00 s.	0.01 s.
Thermal Image (49)	49 Function	THERMAL MODEL 49			
Permission to Trip	49 Trip	Trip Enable 49		Yes/No	NA
49 Tap / Pickup	49 Pickup	Pickup 49		0.10 – 2.4 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	49 Alarm Level	Alarm Level 49		70% – 100% ITH	1%
Heating Time Constant $\tau 1$	T1	Heat Time 49		3 – 600 min.	1 min
Cooling Time Constant $\tau 2$	T2	Cool Time 49		1 – 6 times $\tau 1$	1
Autorecloser (79)	AUTORECLOSER 79	AUTORECLOSER 79			
Autorecloser Function	Autorecloser Function	AR Function		Yes / No	N/A
Number of shots	Number of shots	AR Max Shots		1 – 4	1
Delay before 1st reclosure	AR Dead Time Shot 1	AR Dead Time 1		0.1 – 600	0.01
Delay before 2nd reclosure	AR Dead Time Shot 2	AR Dead Time 2		0.1 – 600	0.01
Delay before 3rd reclosure	AR Dead Time Shot 3	AR Dead Time 3		0.1 – 600	0.01
Delay before 4th reclosure	AR Dead Time Shot 4	AR Dead Time 4		0.1 – 600	0.01
Time delay to reset from lockout status	AR Reset Lockout Time	AR Rst LO Delay		0.1 – 600	0.01
Time for incomplete sequence	AR Incomplete Sequence Time	AR Inc Seq Time		0.1 – 600	0.01
Recloser reset time after a successful reclosure	AR Reset Time	AR Reset Time		0.1 – 600	0.01
Permission for 50P1 to Init Autorecloser	AR 50P1 Permission Init	AR 50P1 Init		Yes / No	N/A
Permission for 50G1 to Init Autorecloser	AR 50G1 Permission Init	AR 50G1 Init		Yes / No	N/A
Permission for 50P2 to Init Autorecloser	AR 50P2 Permission Init	AR 50P2 Init		Yes / No	N/A
Permission for 50G2 to Init Autorecloser	AR 50G2 Permission Init	AR 50G2 Init		Yes / No	N/A
Permission for 51P to Init Autorecloser	AR 51P Permission Init	AR 51P Init		Yes / No	N/A
Permission for 51G to Init Autorecloser	AR 51G Permission Init	AR 51G Init		Yes / No	N/A
Permission for 49 to Init Autorecloser	AR 49 Permission Init	AR 49 Init		Yes / No	N/A
Permission for a DI to Init Autorecloser	AR External Permission Init	AR EXTERN Init		Yes / No	N/A

9

	ENERVISTA MII SETUP	HMI	USER SETTING	RANGE	STEP
Permission for 50P1 function to trip after Shot 1	AR 50P1 Shot 1 Permission	AR 50P1 Shot 1		Yes / No	N/A
Permission for 50G1 function to trip after Shot 1	AR 50G1 Shot 1 Permission	AR 50G1 Shot 1		Yes / No	N/A
Permission for 50P2 function to trip after Shot 1	AR 50P2 Shot 1 Permission	AR 50P2 Shot 1		Yes / No	N/A
Permission for 50G2 function to trip after Shot 1	AR 50G2 Shot 1 Permission	AR 50G2 Shot 1		Yes / No	N/A
Permission for 51P function to trip after Shot 1	AR 51P Shot 1 Permission	AR 51P Shot 1		Yes / No	N/A
Permission for 51G function to trip after Shot 1	AR 51G Shot 1 Permission	AR 51G Shot 1		Yes / No	N/A
Permission for 49 function to trip after Shot 1	AR 49 Shot 1 Permission	AR 49 Shot 1		Yes / No	N/A
Permission for 50P1 function to trip after Shot 2	AR 50P1 Shot 2 Permission	AR 50P1 Shot 2		Yes / No	N/A
Permission for 50G1 function to trip after Shot 2	AR 50G1 Shot 2 Permission	AR 50G1 Shot 2		Yes / No	N/A
Permission for 50P2 function to trip after Shot 2	AR 50P2 Shot 2 Permission	AR 50P2 Shot 2		Yes / No	N/A
Permission for 50G2 function to trip after Shot 2	AR 50G2 Shot 2 Permission	AR 50G2 Shot 2		Yes / No	N/A
Permission for 51P function to trip after Shot 2	AR 51P Shot 2 Permission	AR 51P Shot 2		Yes / No	N/A
Permission for 51G function to trip after Shot 2	AR 51G Shot 2 Permission	AR 51G Shot 2		Yes / No	N/A
Permission for 49 function to trip after Shot 2	AR 49 Shot 2 Permission	AR 49 Shot 2		Yes / No	N/A
Permission for 50P1 function to trip after Shot 3	AR 50P1 Shot 3 Permission	AR 50P1 Shot 3		Yes / No	N/A
Permission for 50G1 function to trip after Shot 3	AR 50G1 Shot 3 Permission	AR 50G1 Shot 3		Yes / No	N/A
Permission for 50P2 function to trip after Shot 3	AR 50P2 Shot 3 Permission	AR 50P2 Shot 3		Yes / No	N/A
Permission for 50G2 function to trip after Shot 3	AR 50G2 Shot 3 Permission	AR 50G2 Shot 3		Yes / No	N/A
Permission for 51P function to trip after Shot 3	AR 51P Shot 3 Permission	AR 51P Shot 3		Yes / No	N/A
Permission for 51G function to trip after Shot 3	AR 51G Shot 3 Permission	AR 51G Shot 3		Yes / No	N/A
Permission for 49 function to trip after Shot 3	AR 49 Shot 3 Permission	AR 49 Shot 3		Yes / No	N/A
Permission for 50P1 function to trip after Shot 4	AR 50P1 Shot 4 Permission	AR 50P1 Shot 4		Yes / No	N/A
Permission for 50G1 function to trip after Shot 4	AR 50G1 Shot 4 Permission	AR 50G1 Shot 4		Yes / No	N/A
Permission for 50P2 function to trip after Shot 4	AR 50P2 Shot 4 Permission	AR 50P2 Shot 4		Yes / No	N/A
Permission for 50G2 function to trip after Shot 4	AR 50G2 Shot 4 Permission	AR 50G2 Shot 4		Yes / No	N/A
Permission for 51P function to trip after Shot 4	AR 51P Shot 4 Permission	AR 51P Shot 4		Yes / No	N/A
Permission for 51G function to trip after Shot 4	AR 51G Shot 4 Permission	AR 51G Shot 4		Yes / No	N/A
Permission for 49 function to trip after Shot 4	AR 49 Shot 4 Permission	AR 49 Shot 4		Yes / No	N/A

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	ENERVISTA MII SETUP	HMI	USER SETTING	RANGE	STEP
General Settings (Adv.)	ADV. GENERAL SETTINGS	GENERAL ADVANCED			
Identification	IDENTIFICATION	---		Text	NA
Active Group	Settings group	Settings Group		1 / 2	NA
Trip Contact - Minimum time closed.	Trip Min Time	Trip Min Time		50 – 300 ms.	1 ms.
Ph TOC Funct. group 2	Phase TOC 51P (group 2)	PHASE TOC 51P			
51P Permission to Trip	Trip Enable 51P	Trip Enable 51P		Yes/No	NA
51P Pickup Value	Pickup 51P	Pickup 51P		0.1 – 2.4 In (Ph)	0.01 In (P)
51P Curve Type	Curve 51P	Curve 51P		DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51P Time Dial	TD mult 51P	TD mult 51P		0.05 – 2.00 (IEC curves)	0.01
				0.5 – 20.0 (ANSI curves)	0.01
				0.5 – 10.0 (IAC curves)	0.01
51P Definite Time Delay	Def Time 51P	Def Time 51P		0.00 – 600.00 s.	1.00 s.
Gnd TOC Fun. group 2	Ground TOC 51G (group 2)	GROUND TOC 51G			
51G Permission to Trip	Trip Enable 51G	Trip Enable 51G		Yes/No	NA
51G Pickup Value (1/5 A ground)	Pickup 51G	Pickup 51G		0.10 – 2.40 In (Gnd)	0.01 In (G)
51G Pickup Value (sensitive ground)	Pickup 51G	Pickup 51G		0.005-0.12 A	0.001 A
51G Curve Type	Curve 51G	Curve 51G		DEFINITE TIME, USER, MOD INVERSE, VERY INVERSE, EXTR INVERSE, INVERSE LONG, INVERSE SHORT	NA
51G Time Dial	TD mult 51G	TD mult 51G		0.05 – 2.00 (IEC curves)	0.01
				0.5 – 20.0 (ANSI curves)	0.01
				0.5 – 10.0 (IAC curves)	0.01
51G Definite Time Delay	Def Time 51G	Def Time 51G		0.00 – 600.00 s	0.01 s
Ph IOC High Set group 2	PHASE IOC 50P1 (group 2)	Phase IOC 50P1			
50P1 Permission to Trip	Trip Enable 50P1	Trip Enable 50P1		Yes/No	NA
50P1 Pickup	Pickup 50P1	Pickup 50P1		0.1 – 30 In (Ph)	0.1 In (Ph)
50P1 Time Delay	Delay 50P1	Delay 50P1		0.00 –600.00s.	0.01 s.
Ph IOC Low Set group 2	PHASE IOC 50P2 (group 2)	Phase IOC 50P2			
50P2 Permission to Trip	Trip Enable 50P2	Trip Enable 50P2		Yes/No	NA
50P2 Pickup	Pickup 50P2	Pickup 50P2		0.1 – 30 In (Ph)	0.1 In (Ph)
50P2 Time Delay	Delay 50P2	Delay 50P2		0.00 –600.00s.	0.01 s.
Gnd IOC High Set group 2	GROUND IOC 50G1 (group 2)	Ground IOC 50G1			
50G1 Permission to Trip	Trip Enable 50 G1	Trip Enable 50 G1		Yes/No	NA

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	ENERVISTA MII SETUP	HMI	USER SETTING	RANGE	STEP
50 G1 Pickup (1/5 A ground)	Pickup 50G1	Pickup 50G1		0.1 – 30 In (Gnd)	0.1 In (G)
50 G1 Pickup Value (sensitive ground)	Pickup 50G1	Pickup 50G1		0.005-0.12 A	0.001 A
50 G1 Time Delay	Delay 50G1	Delay 50G1		0.00 – 600.00 s.	0.01 s.
Gnd IOC Low Set group 2	GROUND IOC 50G2 (group 2)	Ground IOC 50G2			
50G2 Permission to Trip	Trip Enable 50G2	Trip Enable 50G2		Yes/No	NA
50G2 Pickup (1/5 A ground)	Pickup 50G2	Pickup 50G2		0.1 – 30 In (Gnd)	0.1 In (G)
50G2 Pickup Value (sensitive ground)	Pickup 50G2	Pickup 50G2		0.005-0.12 A	0.001 A
50G2 Time Delay	Delay 50G2	Delay 50G2		0.00 –600.00s.	0.01 s.
Thermal Image group 2	49 Function (group 2)	THERMAL MODEL 49			
Permission to Trip	Trip Enable 49	Trip Enable 49		Yes/No	NA
49 Pickup	Pickup 49	Pickup 49		0.10 – 2.40 In (Ph)	0.01 In (Ph)
Overload Percent Alarm	Alarm Level 49	Alarm Level 49		70% – 100% ITH	
Heating Time Constant $\tau 1$	Heat Time 49	Heat Time 49		3 – 600 min.	1 min.
Cooling Time Constant $\tau 2$	Cool Time 49	Cool Time 49		1– 6 times $\tau 1$	1
Parameters	User Curve	User Curve			
A	A Parameter	A Parameter		0.0000-125.0000	0.0001
B	B Parameter	B Parameter		0.0000-3.0000	0.0001
P	P Parameter	P Parameter		0.0000-3.0000	0.0001
Q	Q Parameter	Q Parameter		0.0000-2.0000	0.0001
K	K Parameter	K Parameter		0.000-1.999	0.001
Counter		I^2 MAX Value			
I^2 limit	Maximum Counter	I^2 T MAX		0.000-999.000 kA2	0.001 kA2
Breaker failure to open	Breaker failure to open				
Breaker failure to open enable	Breaker failure function	Function		Y/N	NA
Fail to open timer	Fail to open timer	Delay		50-999 ms	1 ms
Cold load pickup	Cold load pickup	CLP			
Cold load pickup enable	Cold load pickup function	Function		Yes/No	NA
Pickup time	T IN	Outage Time		0.000-60.000 s	0.001 s
Drop out time	T OUT	On Load Time		0.000-60.000 s	0.001 s
Constant. 50P pickup	K 50P	Phase IOC Mult		1.00-5.00	0.01
Constant 51P pickup	K 51P	Phase TOC Mult		1.00-5.00	0.01

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9.19.2.1 EVENT MASKS

EVENT MASK	ENERVISTA MII SETUP	USER SETTING	RANGE	STEP
50P1 Pickup/Drop out	50P1 Pickup		Y/N	NA
50P2 Pickup/Drop out	50P2 Pickup		Y/N	NA
50G1 Pickup/Drop out	50G1 Pickup		Y/N	NA
50G2 Pickup/Drop out	50G2 Pickup		Y/N	NA
51P Pickup/Drop out	51P Pickup		Y/N	NA
51G Pickup/Drop out	51G Pickup		Y/N	NA
49 Alarm Pickup/Drop out	49 Alarm		Y/N	NA
50P1 Trip	50P1 Trip		Y/N	NA
50P2 Trip	50P2 Trip		Y/N	NA
50G1 Trip	50G1 Trip		Y/N	NA
50G2 Trip	50G2 Trip		Y/N	NA
51P Trip	51P Trip		Y/N	NA
51G Trip	51G Trip		Y/N	NA
49 Trip	49 Trip		Y/N	NA
General trip	General trip		Y/N	NA
50P1 Trip enable/disable by digital input	50P1 disabled (by di)		Y/N	NA
50P2 Trip enable/disable by digital input	50P2 disabled (by di)		Y/N	NA
50G1 Trip enable/disable by digital input	50G1 disabled (by di)		Y/N	NA
50G2 Trip enable/disable by digital input	50G2 disabled (by di)		Y/N	NA
51P Trip enable/disable by digital input	51P disabled (by di)		Y/N	NA
51G Trip enable/disable by digital input	51G disabled (by di)		Y/N	NA
49 Trip enable/disable by digital input	49 disabled (by di)		Y/N	NA
General Trip enable/disable by digital input	Trip disabled (by di)		Y/N	NA
Protection status: in service/out of service	Protection status		Y/N	NA
Digital output 1 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 disable		Y/N	NA
Trip operation by digital input	Trip operation by input		Y/N	NA
Trip operation by command	Trip operation by command		Y/N	NA
Auxiliary digital output latch reset	Reset latch aux		Y/N	NA
Close breaker operation	Close breaker operation		Y/N	NA
52 B open/closed	Breaker 52 A		Y/N	NA
52 A open/closed	Breaker 52 B		Y/N	NA
52 open/closed	Breaker closed		Y/N	NA
Group 2 selection by digital input	Active group change		Y/N	NA
Oscillo trigger by digital input	Oscillo trigg by DI		Y/N	NA
Oscillo trigger by command	Oscillo trigg by comm		Y/N	NA
Breaker failure to open	BF to open		Y/N	NA
I^2 Alarm	I^2 Alarm		Y/N	NA
Settings change	Settings change		Y/N	NA
EEPROM failure	EEPROM failure		Y/N	NA
User settings/Factory settings	User settings		Y/N	NA

I^2 counter, breaker failure to open and cold load pickup functions, available only in MIFII models with OPTION 2

9.19.2.2 OSCILLOGRAPHY MASKS

OSCILLOGRAPHY MASK	ENERVISTA MII SETUP	USER SETTING	RANGE
Oscillo by communications	Oscillo by comm.		Yes / No
Oscillo by digital input	Oscillo by digital input		Yes / No
Oscillo by trip	Oscillo by trip		Yes / No
Oscillo by pickup	Oscillo by pickup		Yes / No

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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 3 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 and mounting.

Given that the design of the MIFII 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

Threaded plug labelled as GND (refer to 1.3) should be correctly grounded, 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 capacitors that 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 case is connected to ground.

ATTENTION: Every time a PC is connected to the relay, the PC must be grounded to the same ground as the relay.

10

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 MIFII unit function properly is described in detail in the chapter entitled COMMISSIONING.

10

In case of detecting accumulated pollution, the unit can be cleaned with a clean cloth, either 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.

10

Q1   I have powered my MIFII unit to its rated voltage and the READY LED on the front remains turned off, although the screen is lit up and showing measures.

A1   If the READY LED is unlit, it means that the unit will not trip in case of a fault. Three conditions must be present for the unit to be in service:

> 1. No internal error must occur.

> 2. The STATUS setting in the Main Settings – General Settings group must be set to RDY (ready, in service).

> 3. At least one of the protection elements must be enabled.

All MIFII units are received from the factory with all protection elements disabled, in order to avoid undesired trips during commissioning, before the user has set the pickup values for each protection element. For this reason, the READY LED is off when a new unit is powered up

Make sure also that the enabled protection element belongs to the active settings group. If there is a protection element enabled in settings group 1 but no protection element enabled in settings group 2 and the active group is group 2, there will be no protection element active at the moment, and the READY LED will be off until either group 1 is active or any group 2 protection function is enabled.

Q2   I have tried to change a setting via HMI, but when I press the enter button to store the setting, the HMI shows the "ENTER PASSWORD" message. What I have to do?

A2   The settings configuration via HMI is secured by a password, so no unauthorized person can change any setting. The relay password by default is 1, so when the relay asks to "ENTER PASSWORD", you have to select with the up arrow-button the number 1 and then press the enter button.

Q3   What can I do if I forget the HMI password?

A3   Using the HMI it is possible to see an encrypted numerical value corresponding to the current HMI password. This value can be viewed in the MAIN SETTINGS – PRODUCT SETUP – HMI Password menu. Please contact GE Multilin Technical Support to decrypt this value and obtain the HMI password.

Q4   How can I change the HMI Password?

A4   In the MAIN SETTINGS – PRODUCT SETUP menu of the HMI, choose the HMI Password menu by pressing the enter button. Enter the current password, and then choose a new password number between 1 and 9999 and press enter. The new Password will be stored.

Q5   I have just received an MIFII unit, and I do not know which communication parameters I should set in the program.

A5   The default communication baud rate is **9600** baud, for the EnerVista MII SETUP program as well as for the relay. When starting the connection, the program will request the relay address and password; the value to be entered here is **1** in both cases.

Q6   I have followed the previous steps, but I cannot communicate with the relay using the front port.

A6   Check the following points:

> • Communications port in EnerVista MII SETUP (COM1, COM2, etc.)

> • Baud rate must be the same for EnerVista MII SETUP and the relay.

> • Relay address and password must be the same for EnerVista MII SETUP and the relay.

> • The communications wire must be direct; do not use null modems, as this type of modem crosses pins 2 and 3.

Check that the wire connections follow the table below[i]:

	CONNECTOR	PIN	PIN	PIN	PIN	PIN
MIFII	DB9	2	3	4	5	6
PC	DB9	2	3	4	5	6

Q7 How do I connect MIFII terminals SDA - SDB to an RS485/RS232 converter?

A7   The RS485 standard defines terminals "A" and "B" for communication, therefore, the connection will be MIFII SDA with converter's terminal A, and MIFII SDB with converter's terminal B. However it is usual to identify terminals as "+" and "-", taking for granted that terminal "A" will correspond to "-", and terminal "B" with "+". In this case, connections must be: MIFII terminal SDA with "-", and terminal SDB with "+".

Anyway, it is recommended to check the converter's documentation to confirm the manufacturer's criterion. For the concrete case of GE PM's F485 converter, connections are SDA with "-"and SDB with "+".

Q8 After the previous steps, I cannot communicate through the rear RS485 port.

A8   Check the following:

Communications port in EnerVista MII SETUP (COM1, COM2, etc.)

Baud rate is the same for EnerVista MII SETUP, the relay and the converter (if a setting is available)

Relay number and password is the same in the PC and the relay

Check the connections of SDA and SDB terminals in MIFII with the converter.

Selection of the converter's device type DTE/DCE.

Is the RS485 wire grounded in order to reduce noise?

Q9 How can I get the last version of firmware, PC software and instruction manual?

A9   **Urgent**: Via Internet on our website www.gedigitalenergy.com/multilin Make sure you subscribe to all MIFII data, in order to be informed about updates by e-mail.

Post: Sending a fax to GE Multilin (+34 94 485 88 45)

Q10 My MIFII unit has been powered off and I do not know if the stored information will be lost.

A10   MIFII relays have three different types of memory: FLASH, where the protection program is stored; this memory is maintained indefinitely without power supply; EEPROM, where the protection settings are stored; this memory is also maintained indefinitely; and RAM, where events and oscillography records are stored. The RAM memory is maintained for 48 hours without power supply, and after this time data will be lost. The unit date and time is also maintained for 48 hours without power supply.

Q11 Once the program events have been checked, I would like to analyze them more in detail. Can I export these data and work with them with a different application?

A11 EnerVista MII SETUP software allows saving events in a CSV format file. This format is used by different applications (e.g. Microsoft Excel‰), and consists of a series of data separated by comas. Once the information is saved in this format, they can be analyzed using all tools that accept this file format.

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i.   The rest of pins are not used.

Q12   My MIFII unit has tripped clearing a system fault, and I would like to analyze oscillography, should I use special software?

A12   EnerVista MII SETUP software allows saving oscillography in a COMTRADE format file (IEEE C37.111 / IEC 60255-24: Common format for transient data exchange for power systems). As the COMTRADE format chosen is ASCII, these files can be viewed in any application accepting ASCII format ("Microsoft Excel"), as well as specific applications for viewing oscillography records, as GE Multilin's GE OSC software.

Q13   My MIFII unit has the display off but the Ready LED is ON; does that mean the relay needs to be repaired?

A13   No, it doesn't. MII relays automatically turn off the display if in 15 minutes no key has been pressed. By pressing any key the display turns on again.

Q14   I want to pint/view all the relay settings in one window, how can I do it?

A14   In ENERVISTA MII Setup it is possible to see all the settings in a single window. After the communication with the relay, from the FILE menu of the program you can PRINT or PREVIEW the settings.

Q15   Do harmonics influence the MIFII measure?

A15   No, they don't. MIFII uses a complete cycle recursive DFT (Discrete Fourier Transformation) in order to obtain the resulting measure phasor. The Fourier transformation consists of decomposing a signal into a series of sinusoidal signals with frequencies that are multiples of the fundamental frequency. Once these signals have been obtained, harmonics are extracted to get the phasor value corresponding to the fundamental frequency; therefore, it acts as a digital harmonic filter and all the relay protection elements work only with the fundamental component of each signal.

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WARNING:

When communicating with the RS232 front port of the relay, ensure that the relay is properly grounded (ground must be at the same level of the PC). Otherwise, use ungrounded PC.

• **Read the instruction manual carefully before installing the device.**

• **Check the power supply rating before applying power to the relay.**

  Applying voltage greater than the maximum rating of the power supply (the actual rated voltage for an MIFII relay is indicated in the front panel) can result in permanent component damage to the relay's power supply.

• **Ensure that the source CT secondary matches the relay CT rated current.**

  MIFII can be ordered with either 1A or 5A phase and ground CTs. Verify that the relay rated current   (indicated in the front panel) matches the secondary rating of the connected CTs. Unmatched CTs may result in equipment damage or inadequate protection.

• **Check the correct polarity of the RS-485 connections.**

  Different manufacturers of Modbus® compatible devices including RS-485 ports can use different criteria for defining port polarities. In order to avoid misuse of the MIFII rear communication port, please verify connections in accordance with information provided in the MIFII instruction book.

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- **Do not connect to the RS232 front port of the relay until being ensured that the relay ground is at the same level of PC ground.**

- **Do not upgrade the relay firmware without first ensuring that relay Settings and Configuration have been downloaded and saved to a file.**

  Whenever a firmware download is performed into the flash memory, upon startup, the relay will automatically go back to factory default settings. A saved file will be a record of previously existing settings and relay configuration (I/O, LEDs and logic). In case the firmware download has not modified the Modbus® memory map of the relay, the previously saved file can be directly downloaded to the upgraded relay, if the memory map has been modified a new file has to be generated using EnerVista MII SETUP software.

- **Do not configure the two digital inputs in MIFII to the same logical value.**

  If done, MIFII will evaluate and monitor only the second digital input, resulting in the first input being useless. There are two exceptions to this rule; configuring both inputs to the same value is allowed whenever:

  1. The assigned value is "No definition". In this case the inputs are not defined and thus not evaluated by the MIFII relay.

  2. The assigned value is "General input". In this case, the activation of inputs does not activate any element in the MIFII protection logic, but the input values (active/non active) are evaluated and can be used with any purpose in the MIFII configurable logic.

- **Do not use both the 52/a and 52/b inputs to monitor the status of a circuit breaker.**

  MIFII monitors breaker status by means of a single contact that can be selected as either a 52/a or a 52/b contact, using both will result in wrong breaker status evaluation.

MIFII units have been designed and verified using the most advanced and reliable equipment. Mounting and testing automation ensure a high consistency of the final product. Before sending a unit back to the factory, we strongly recommend you follow the recommendations below.

Even if it will not always solve the problem, at least they will help define it better for a quicker repair.

If you need to send a unit back to the factory for repair, please use the appropriate RETURN MATERIAL AUTHORIZATION process, and follow the shipping instructions provided by our Service Department, especially in the case of international shipments. This will lead to a faster and efficient solution of your problem.

CATEGORY	SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
PROTECTION	The relay does not trip	- Element not enabled - Output not assigned - Inappropriate setting group	-Set the element permission to ENABLE -Program the output to the desired element using ENERVISTA MII SETUP-SETPOINT-RELAY CONFIGURATION - Make sure that desired group is active (group 1 or group 2) and/or that there is no settings group change input that could modify the active group
GENERAL	When feeding the unit, no indicator is light up	- Insufficient power supply - Fused fuse - Loose fuse - Incorrect wiring	- Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range. - Remove the power supply board and replace the fuse.
COMMUNICATIONS	The relay does not communicate via the front RS232 port	- Incorrect cable - Damaged cable - Relay or PC not grounded - Incorrect baud rate, port, address, etc.	- Make sure you are using a straight cable. - Replace the cable - Ensure ground connection - Make sure that the communication parameters in the computer match the ones in the relay.
	The relay does not communicate via the RS485 port	- Relay or PC not grounded - Incorrect polarity - Incorrect baud rate, address, etc.	- Ensure ground connection - Invert polarity - Test other baud rate, etc.

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A

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 goes out from service, the other one will work at 140% of rated load.

Under these circumstances, the relay on the transformer that remains 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.

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.

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

Being:

R =   Ohm Resistance (Ω)

I =   Current flowing through the element. (Amps)

m =   Mass of the element (kg)

C_e =   Specific Heat (Jul/kg/ºC)

θ=   Element Temperature over ambient temperature (ºC)

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

S =   Element Surface (m^2)

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

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

                                                                           [1]

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

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

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

                                                                           [2]

Where:

θ_0:   Initial temperature.

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

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

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

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

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

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

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

Introducing the following variable change:

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

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

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

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

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

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

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

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

It is necessary that I > 1.

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

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

Equation [10], represents the basic tripping algorithm for a thermal image relay, that for a given τ and I_∞, can be drawn, in general using a logarithm plane, using "v" as the parameter, as shown in Figure A–1: and Figure A–2:

A

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).

A

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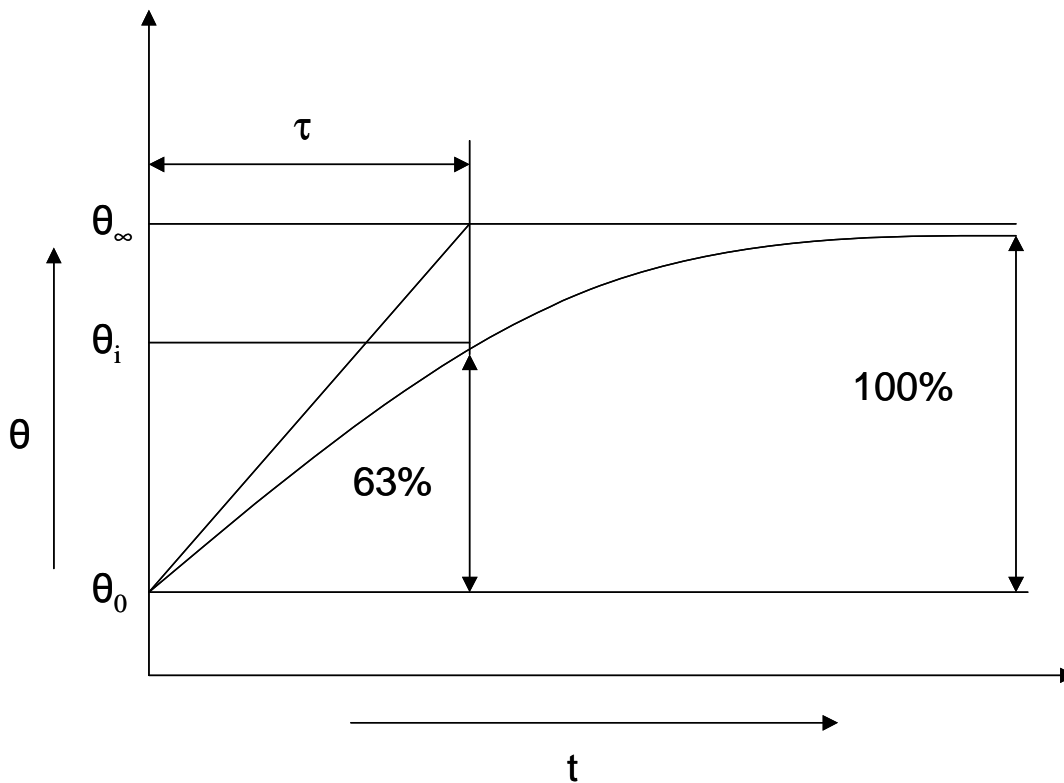
If θ_0 is the temperature origin, at a given time, the temperature can be written as:

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

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

The equation for the temperature given before was:

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

MIFII 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 in **MIFII** is designated as $\tau 1$.

By means of the keypad (or EnerVista MIIPC 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:

$$t = \tau_1 * \ln(I_{eq}'^2 / I_{eq}'^2 - 1)$$

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 established 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:

$$t = \tau_1 * \ln\left[\frac{I_{eq}^2 - I_e^2}{I_{eq}^2 - 1}\right]$$

Where:

I_e I_{me} / I_{tap}

I_{me} Current at which the protected element had stabilised.

I_{tap} Programmed tap current.

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

In the curves, the "Thermal Equivalent Current" is represented by the letter Ieq, and this is the value that the relay shows corresponding to the thermal image of the protected element. 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), MIFII 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 $\tau 1$.

A
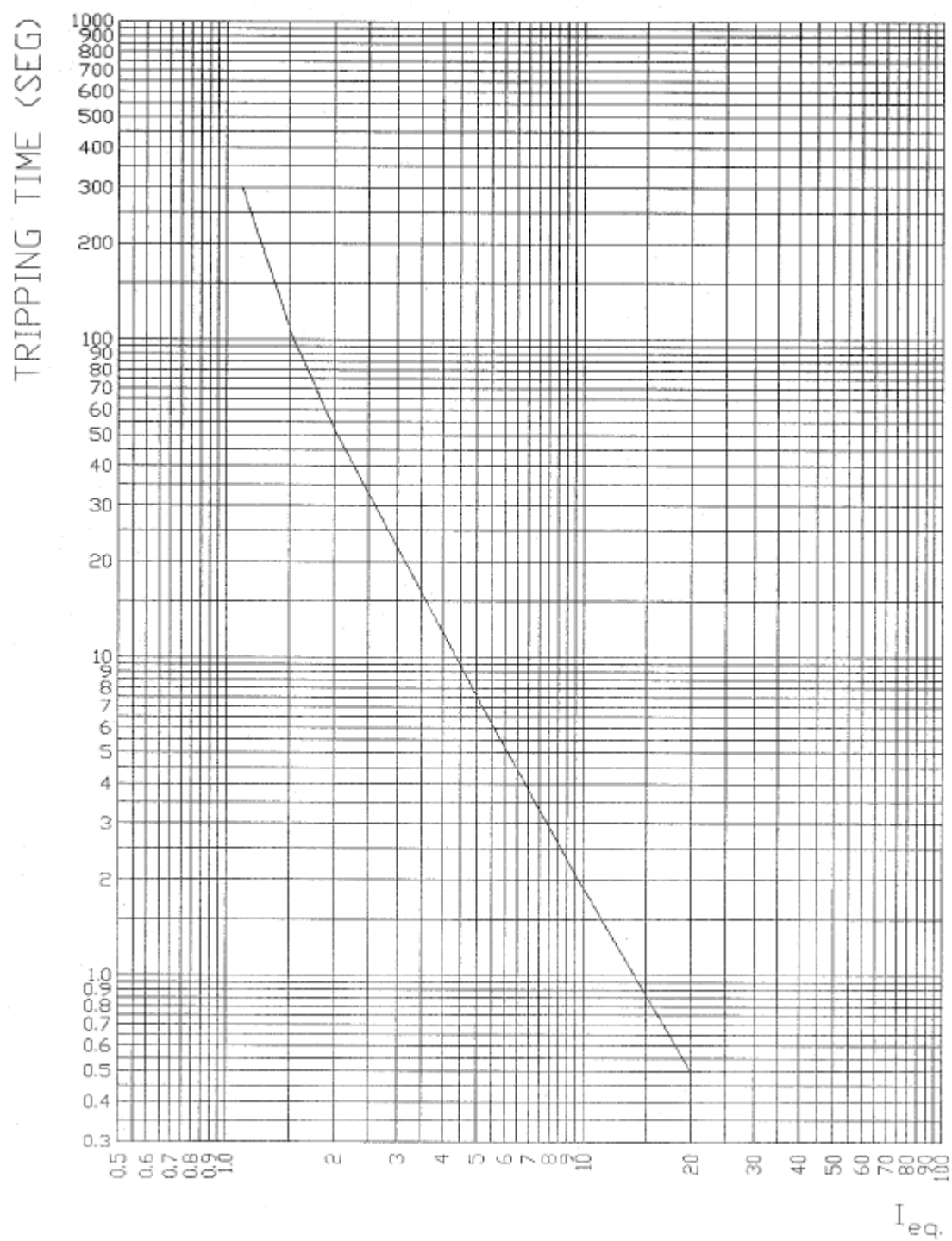
Figure A–1: THERMAL CURVE FOR $T1$ = 3 MINUTES.
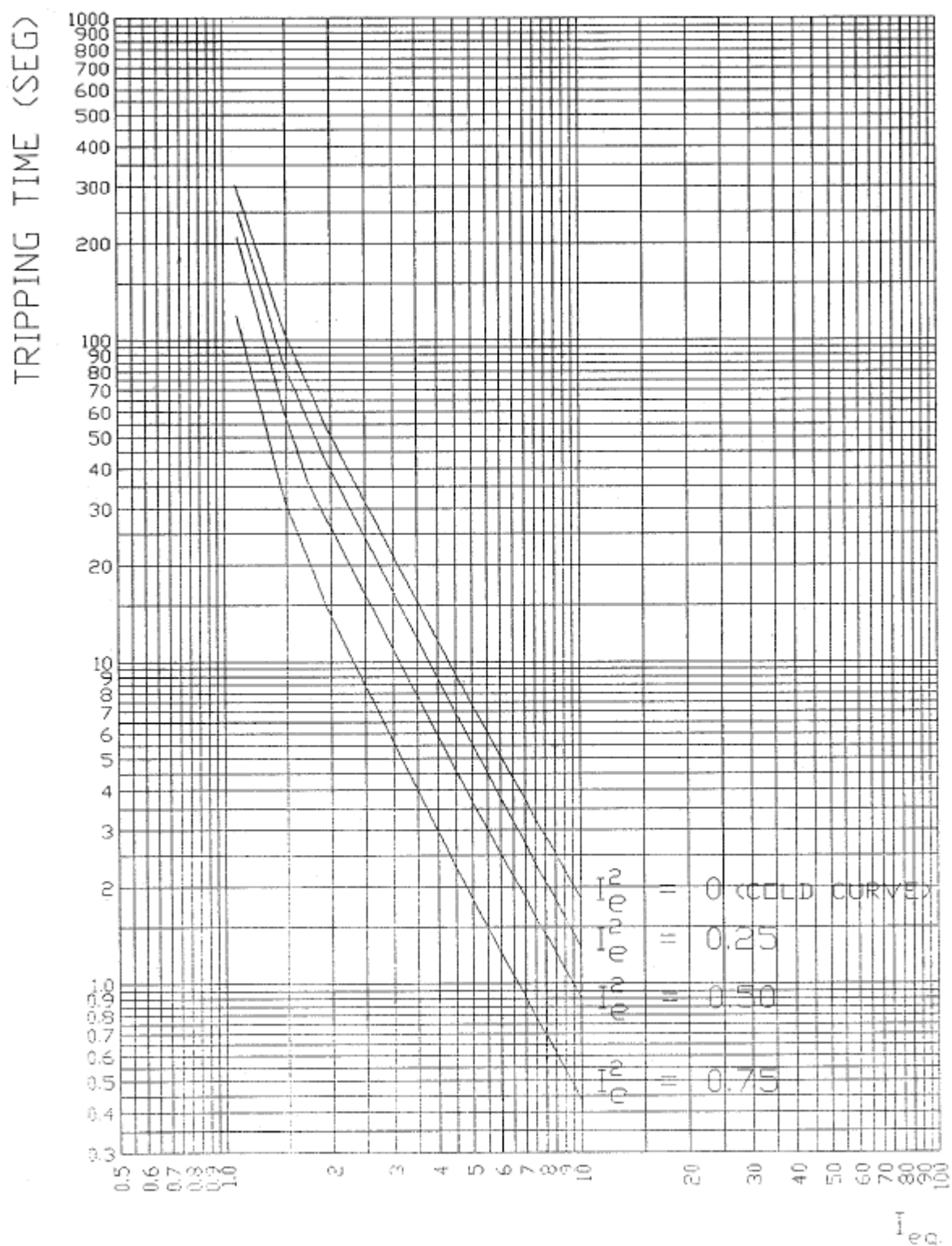
Figure A–2: THERMAL CURVES FOR T1 = 3 MIN.

A

For 1 < V <1.05 the unit will show a pickup signal and generate no trip.

For 1.05 ≤ V <20.00 trip time will be:

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

For V ≥ 20.00, trip time will be the same as for 20 times the setting:

$$T = \frac{A*D}{20^P - Q} + B*D + K$$

Where:

Table B–1: GE IEC/BS142 INVERSE TIME CURVE CONSTANTS

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

D = Time Dial

Trip times for IEC/BS142 curves are as follows:

Table B–2: TRIP TIMES (IN SECONDS) FOR IEC/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
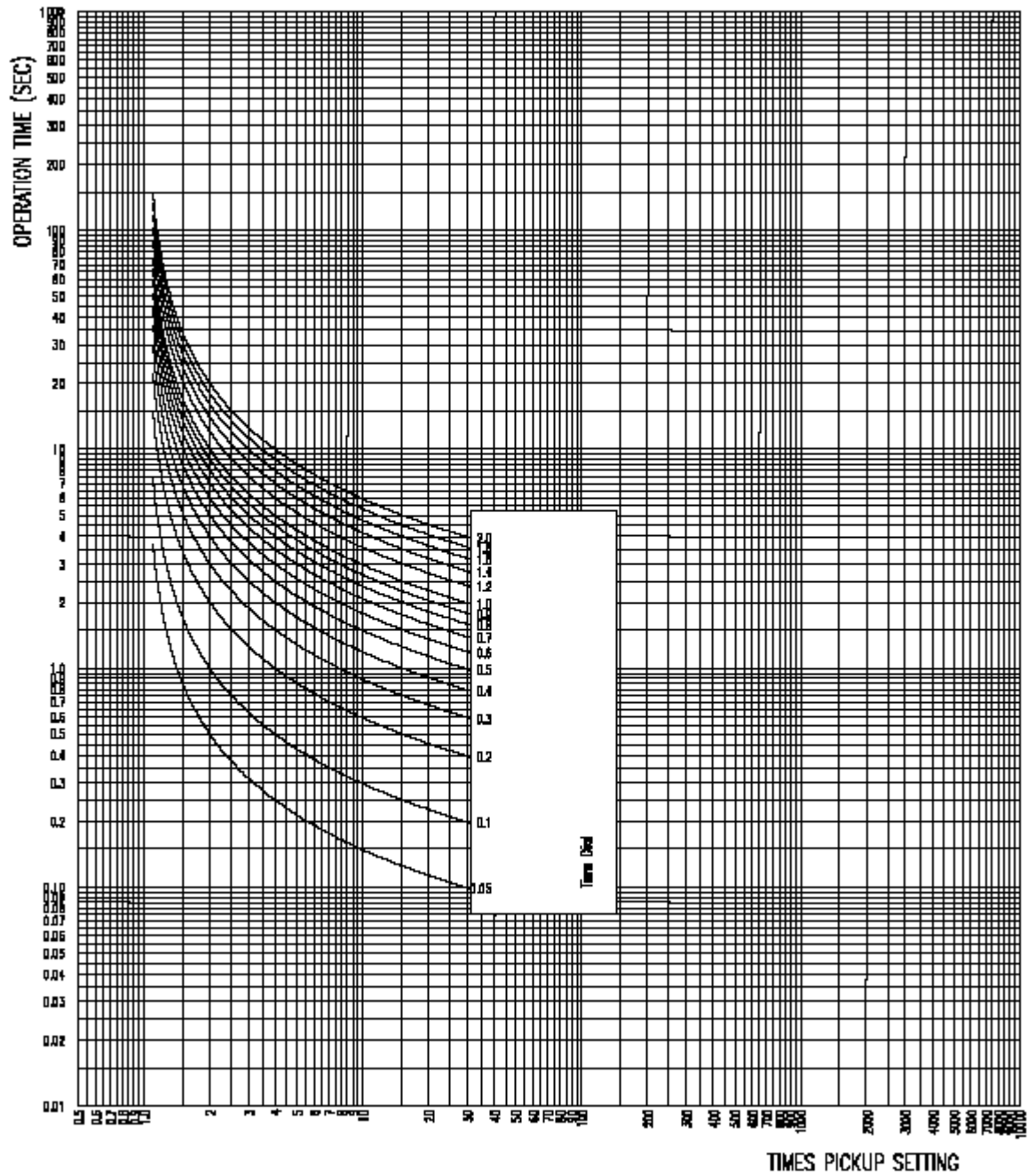
Figure B–1: IEC/BS142 INVERSE CURVES

B
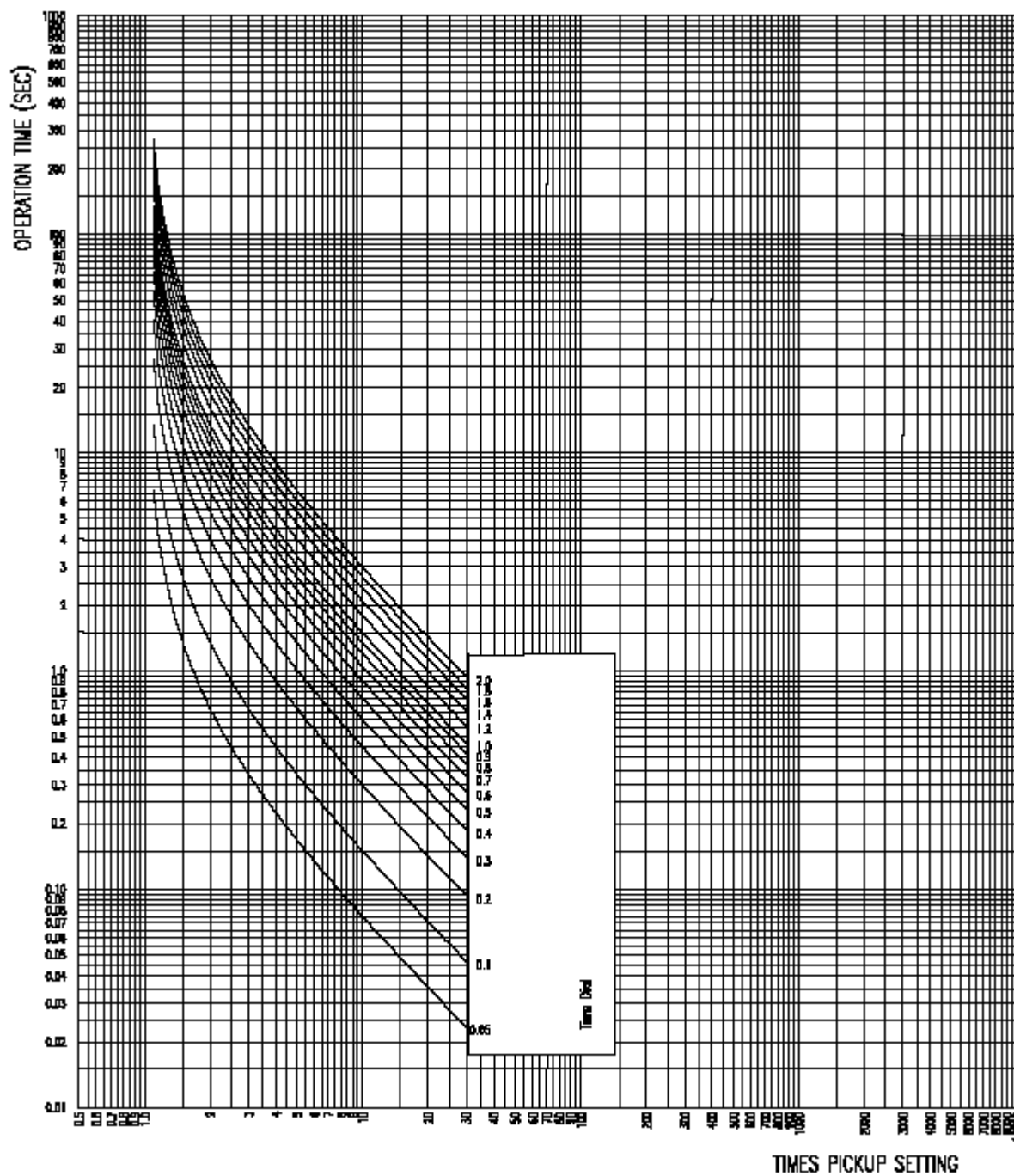
Figure B–2: IEC/BS142 VERY INVERSE CURVES
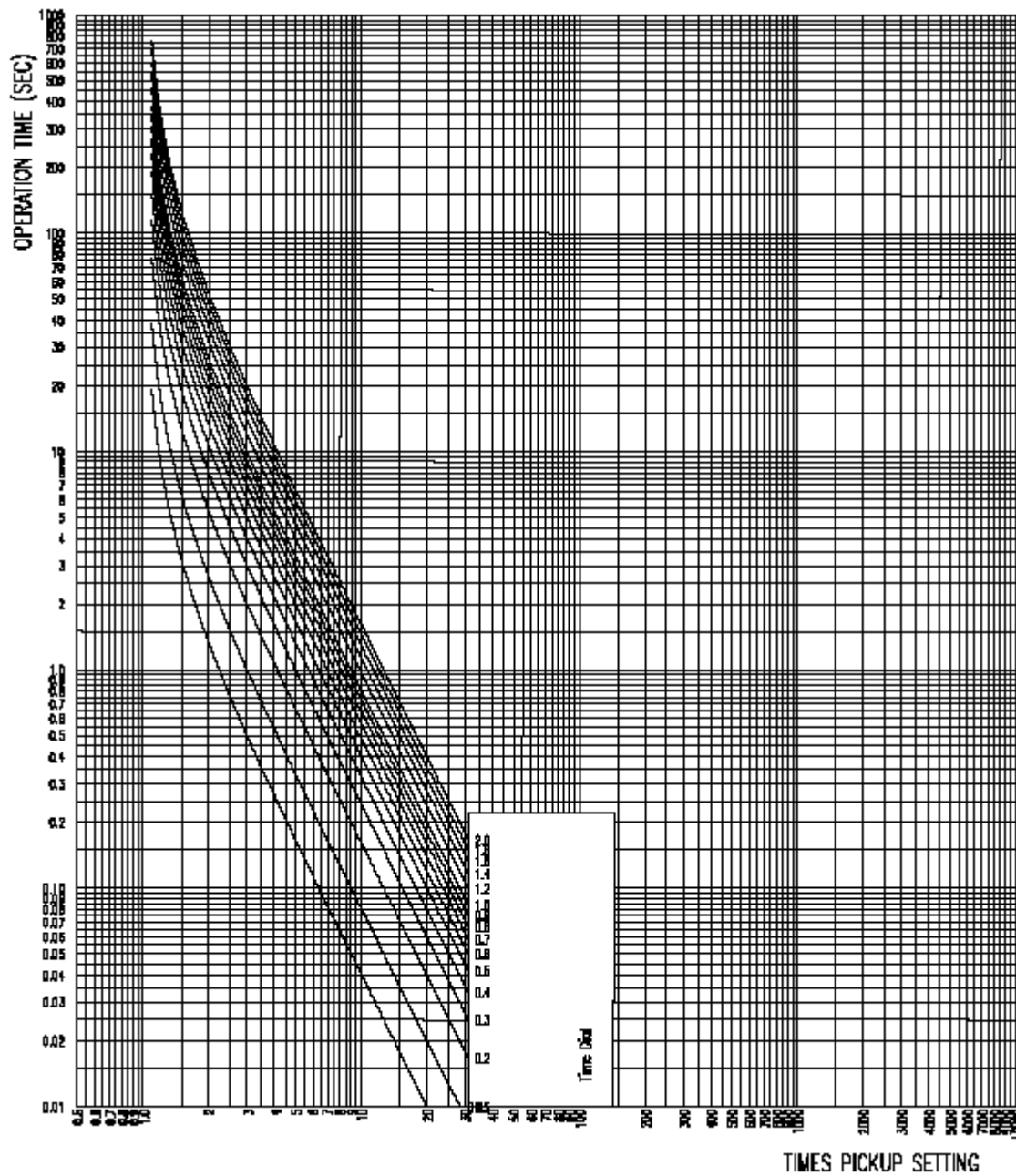
Figure B–3: IEC/BS142 EXTREMELY INVERSE CURVES

B

For 1 < V < 1.05 the unit will show a pickup signal and generate no trip.

For 1.05 ≤ V < 20.00, trip time will be

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

For V ≥ 20.00, trip time will be the same as for 20 times the setting

$$T = M * \left[A + \frac{B}{(20-C)} + \frac{D}{(20-C)^2} + \frac{E}{(20-C)^3} \right]$$

Where:

Table B–3: GE ANSI INVERSE TIME CURVE CONSTANTS

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

Table B–4: 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	0.66Q	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

B

B
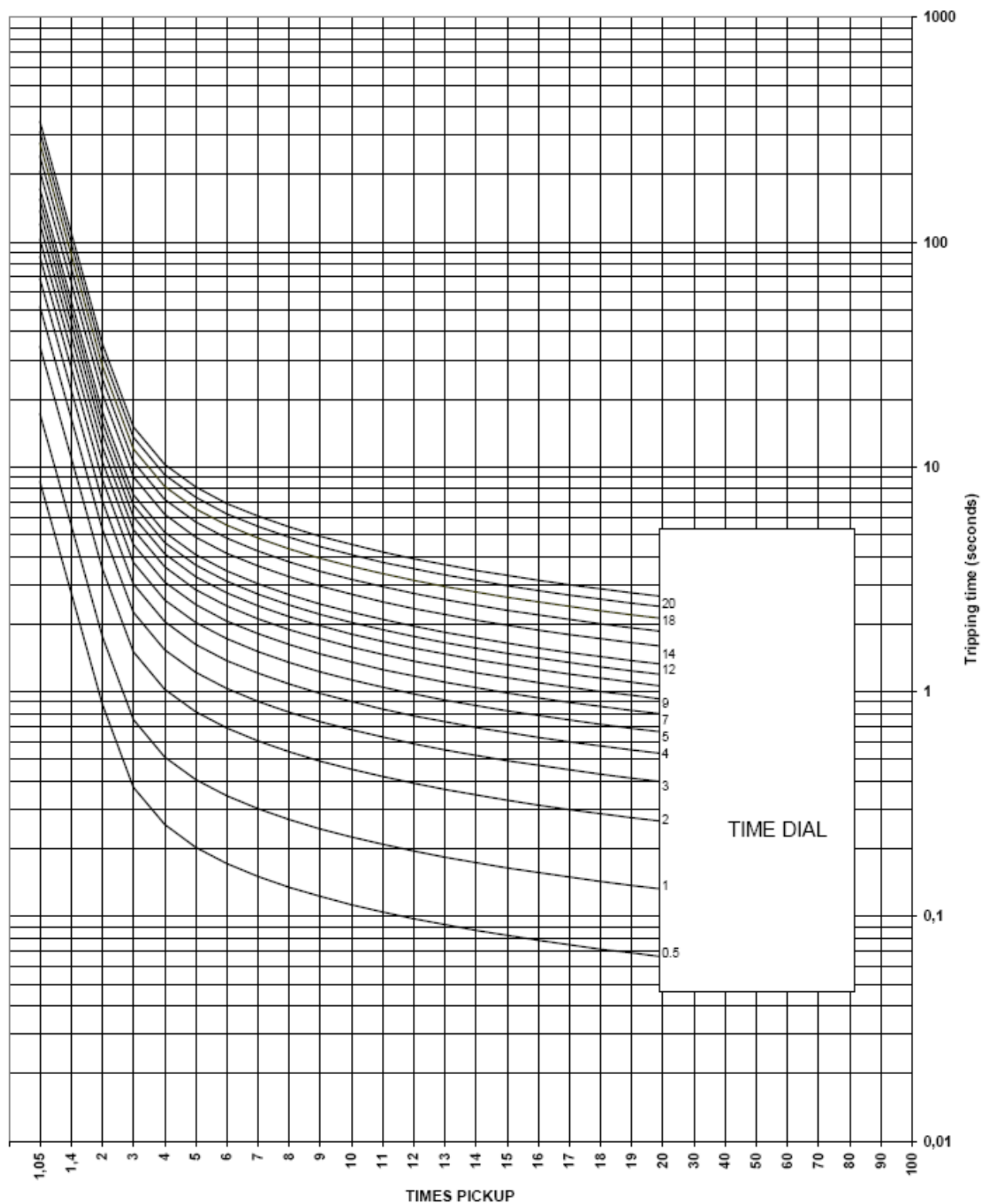
Figure B–4: ANSI INVERSE

B
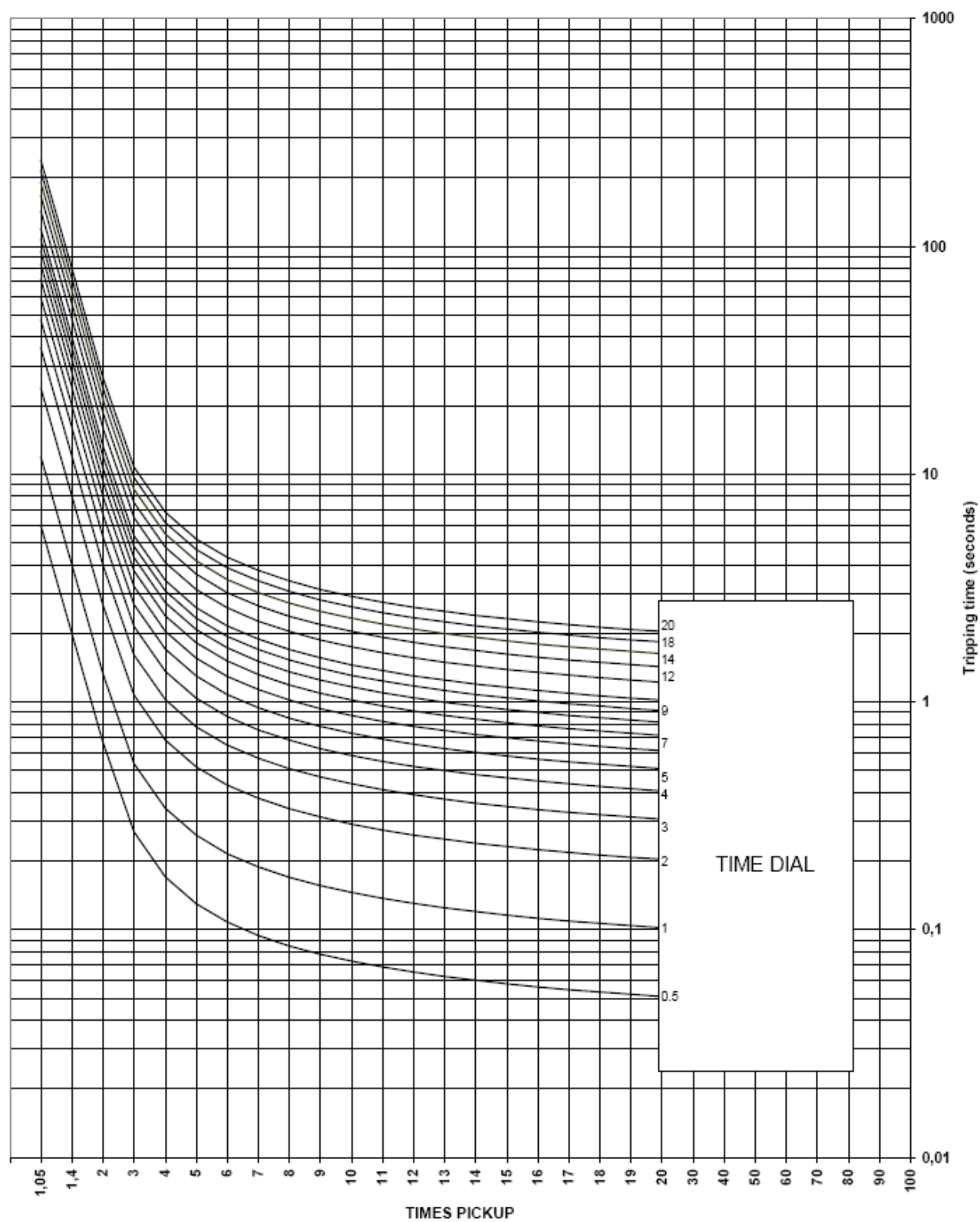
Figure B–5: ANSI VERY INVERSE

B
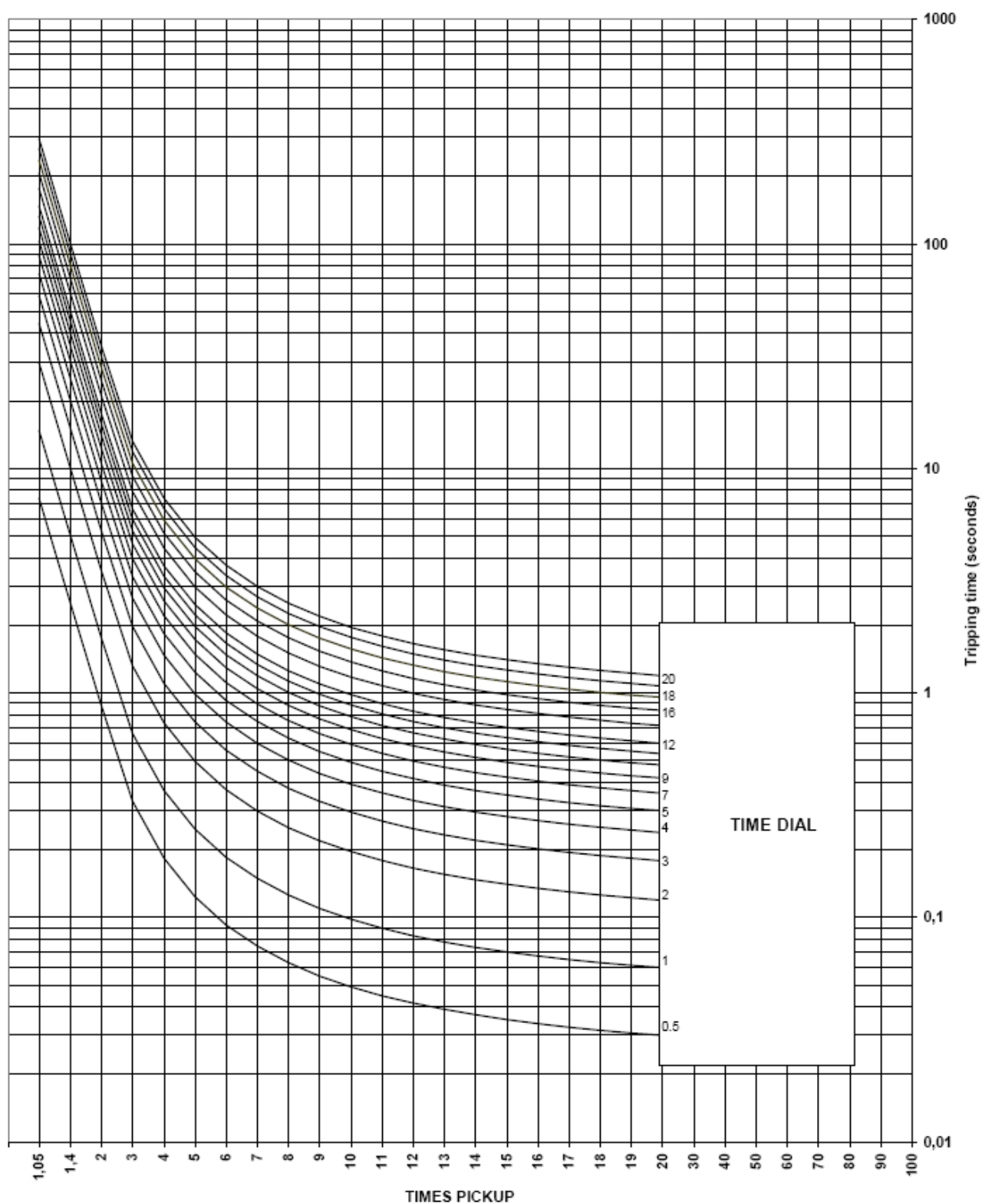
Figure B–6: ANSI EXTREMELY INVERSE

For 1<I/Ipickup<1.05 the unit will show a pickup signal and generate no trip

For 1.05<=I/Ipickup<30 trip time will be:

$$T = TDM * \left(A + \frac{B}{\left(\frac{I}{I_{pkp}}\right) - C} + \frac{D}{\left(\left(\frac{I}{I_{pkp}}\right) - C\right)^2} + \frac{E}{\left(\left(\frac{I}{I_{pkp}}\right) - C\right)^3} \right)$$

For I/Ipickup >= 30

$$T = TDM * \left(A + \frac{B}{30 - C} + \frac{D}{\left(30 - C\right)^2} + \frac{E}{\left(30 - C\right)^3} \right)$$

Where:

Table B–5: GE IAC INVERSE TIME CURVE CONSTANTS

IAC CURVE SHAPE	HMI	A	B	C	D	E
IAC Extremely Inverse	Extr Inverse	0.0040	0.6379	0.6200	1.7872	0.2461
IAC Very Inverse	Very Inverse	0.0900	0.7955	0.1000	-1.2885	7.9586
IAC Inverse	Mod Inverse	0.2078	0.8630	0.8000	-0.4180	0.1947
IAC Inverse Long	Inverse Long	0.3754	17.8307	0.32	-23.7187	23.8978
IAC Inverse Short	Inverse Short	0.0442	0.0482	0.34	0.0223	0.0697

TDM: Time Dial

Table B–6: IAC CURVE TRIP TIMES

MULTIPLIER (TDM)	CURRENT (I/I_PICKUP)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC EXTREMELY INVERSE										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC VERY INVERSE										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC INVERSE										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969
IAC INVERSE LONG										
0.5	6.498	3.813	2.484	1.974	1.668	1.455	1.297	1.174	1.076	0.995
1.0	12.997	7.625	4.968	3.949	3.336	2.910	2.593	2.348	2.151	1.991
2.0	25.993	15.250	9.936	7.898	6.671	5.820	5.187	4.695	4.303	3.981
4.0	51.987	30.501	19.871	15.795	13.342	11.639	10.373	9.391	8.605	7.963
6.0	77.980	45.751	29.807	23.693	20.014	17.459	15.560	14.086	12.908	11.944
8.0	103.974	61.001	39.743	31.590	26.685	23.279	20.746	18.782	17.211	15.925
10.0	129.967	76.252	49.678	39.488	33.356	29.098	25.933	23.477	21.514	19.906
IAC INVERSE SHORT										
0.5	0.073	0.048	0.035	0.030	0.028	0.027	0.026	0.026	0.025	0.025
1.0	0.147	0.097	0.069	0.060	0.056	0.054	0.052	0.051	0.050	0.050
2.0	0.294	0.193	0.138	0.121	0.113	0.108	0.104	0.102	0.100	0.099
4.0	0.588	0.386	0.277	0.242	0.225	0.215	0.209	0.204	0.201	0.198
6.0	0.882	0.579	0.415	0.363	0.338	0.323	0.313	0.306	0.301	0.297
8.0	1.176	0.773	0.553	0.484	0.450	0.430	0.417	0.408	0.401	0.396
10.0	1.470	0.966	0.692	0.605	0.563	0.538	0.522	0.510	0.502	0.495
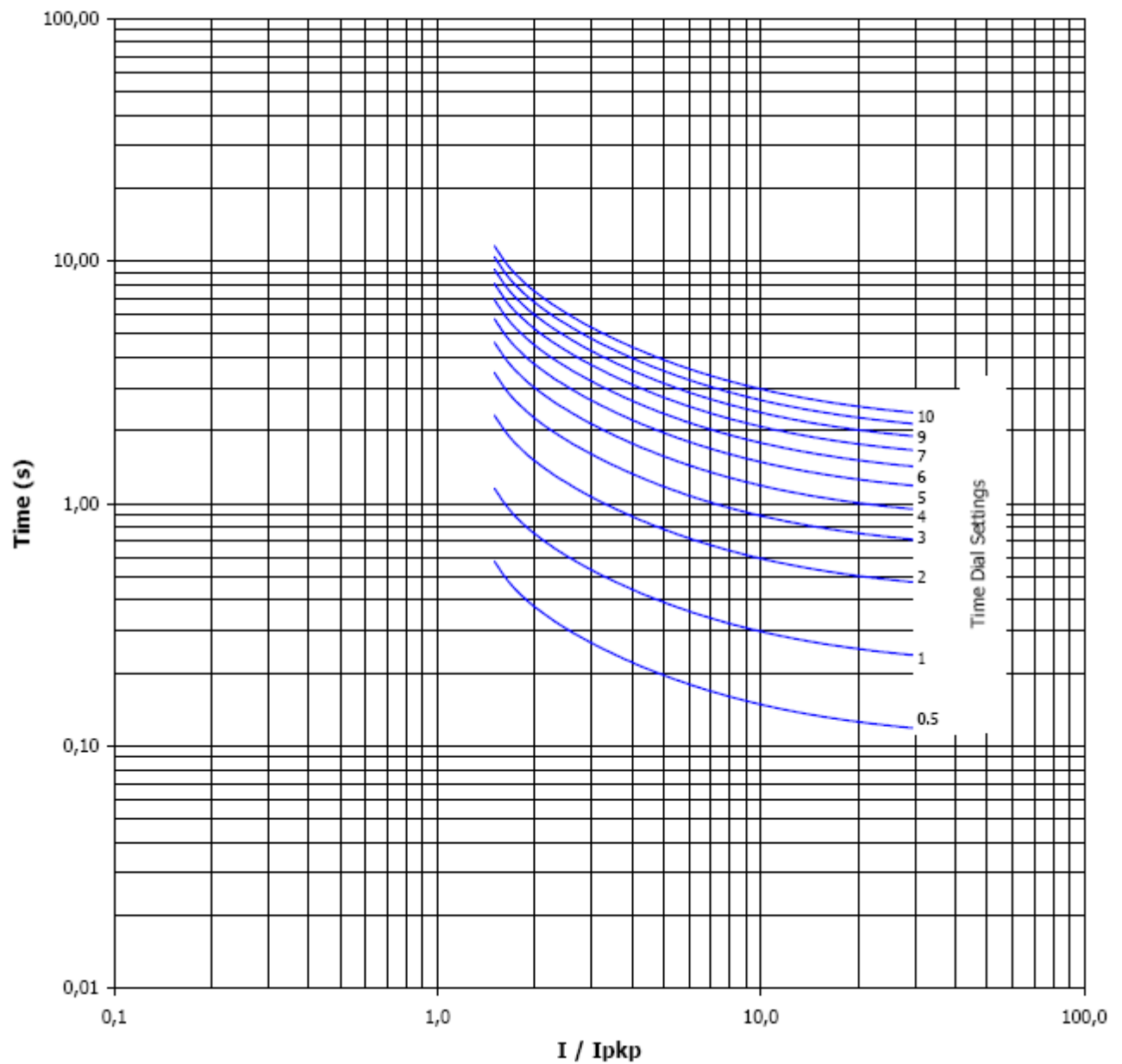
Figure B–7: IAC INVERSE GES-7001

B
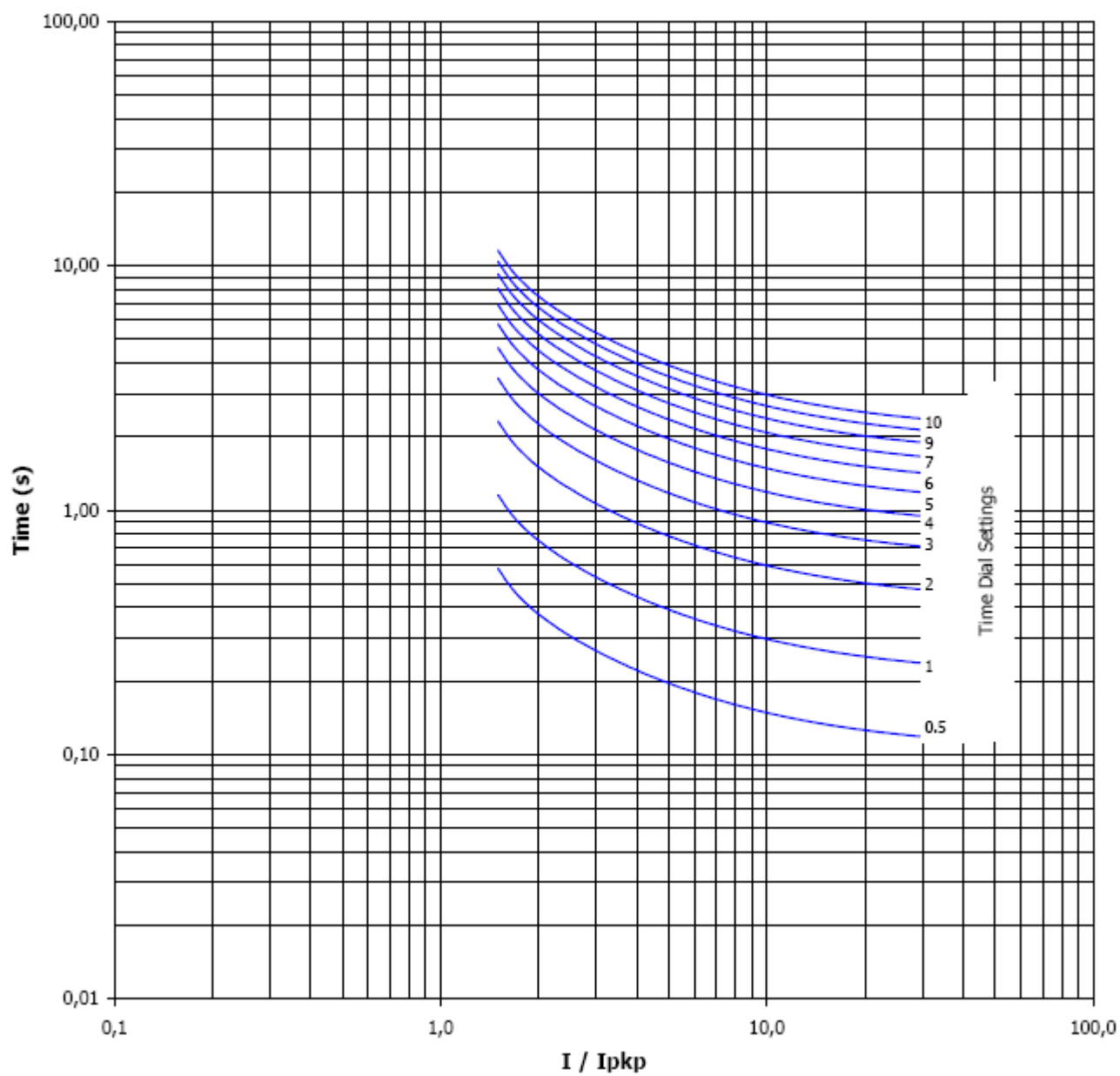
Figure B–8: IAC VERY INVERSE GES-7002
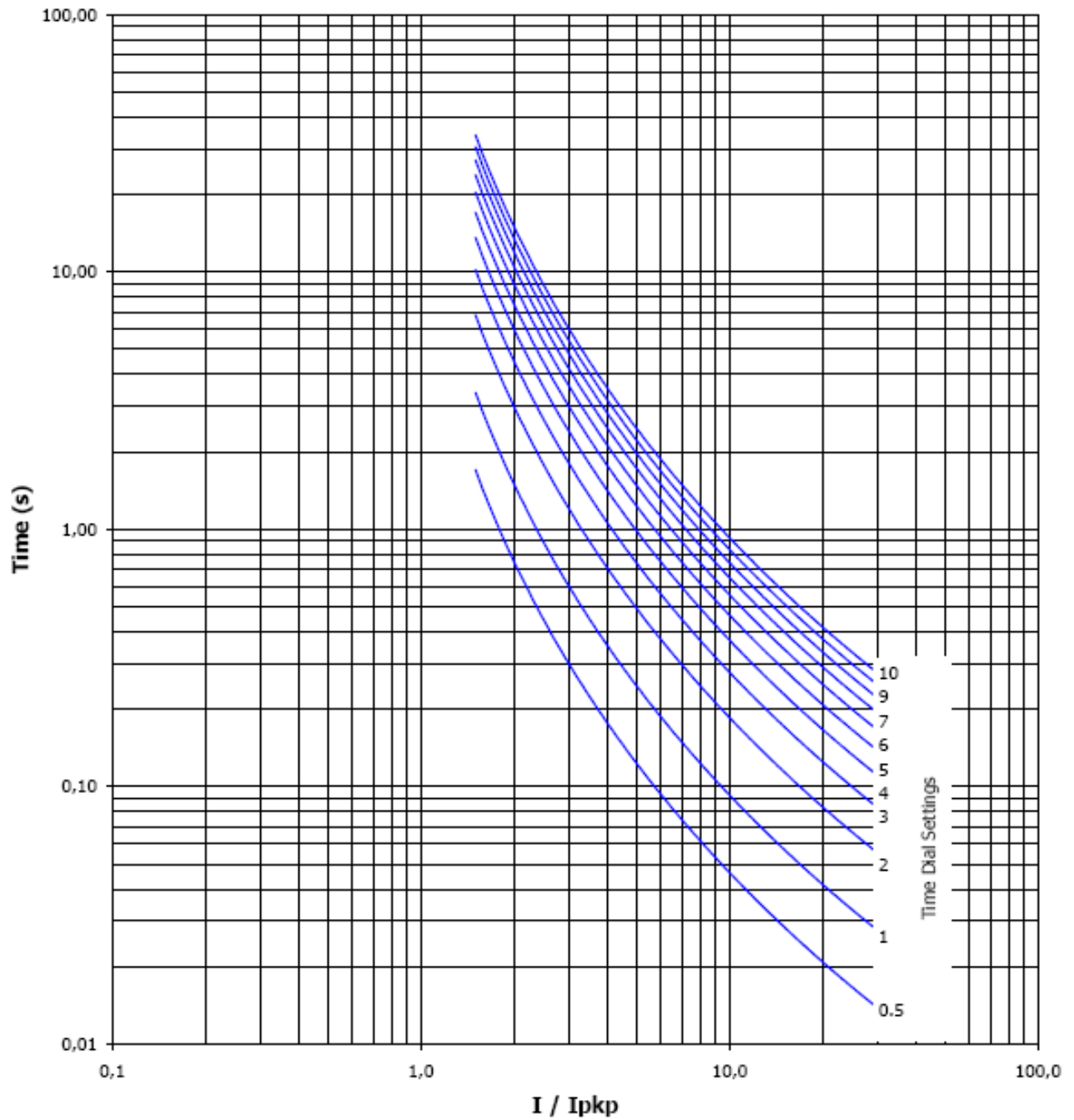
Figure B–9: IAC EXTREMELY INVERSE GES-7005
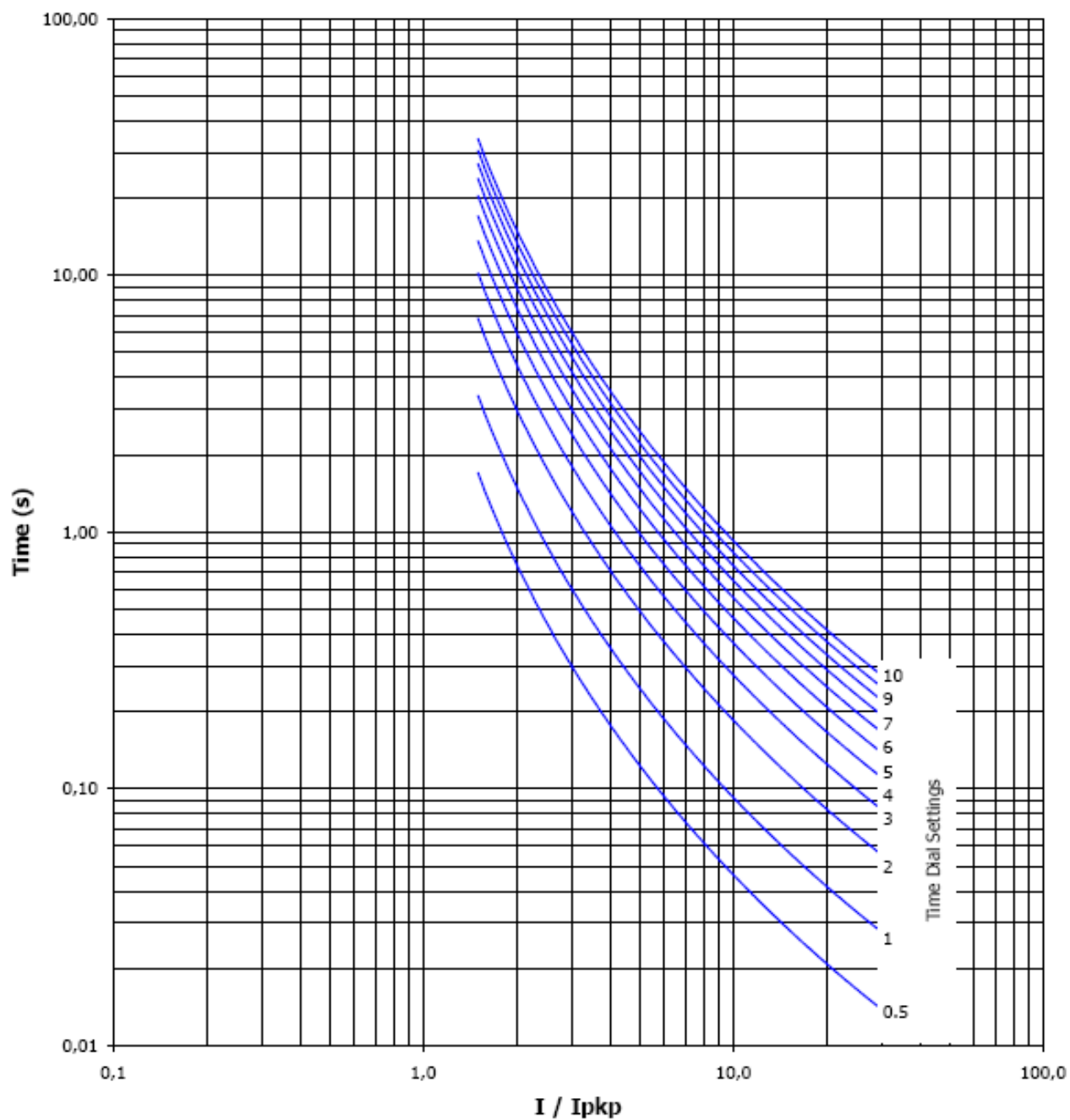
Figure B–10: IAC INVERSE LONG GES-7004
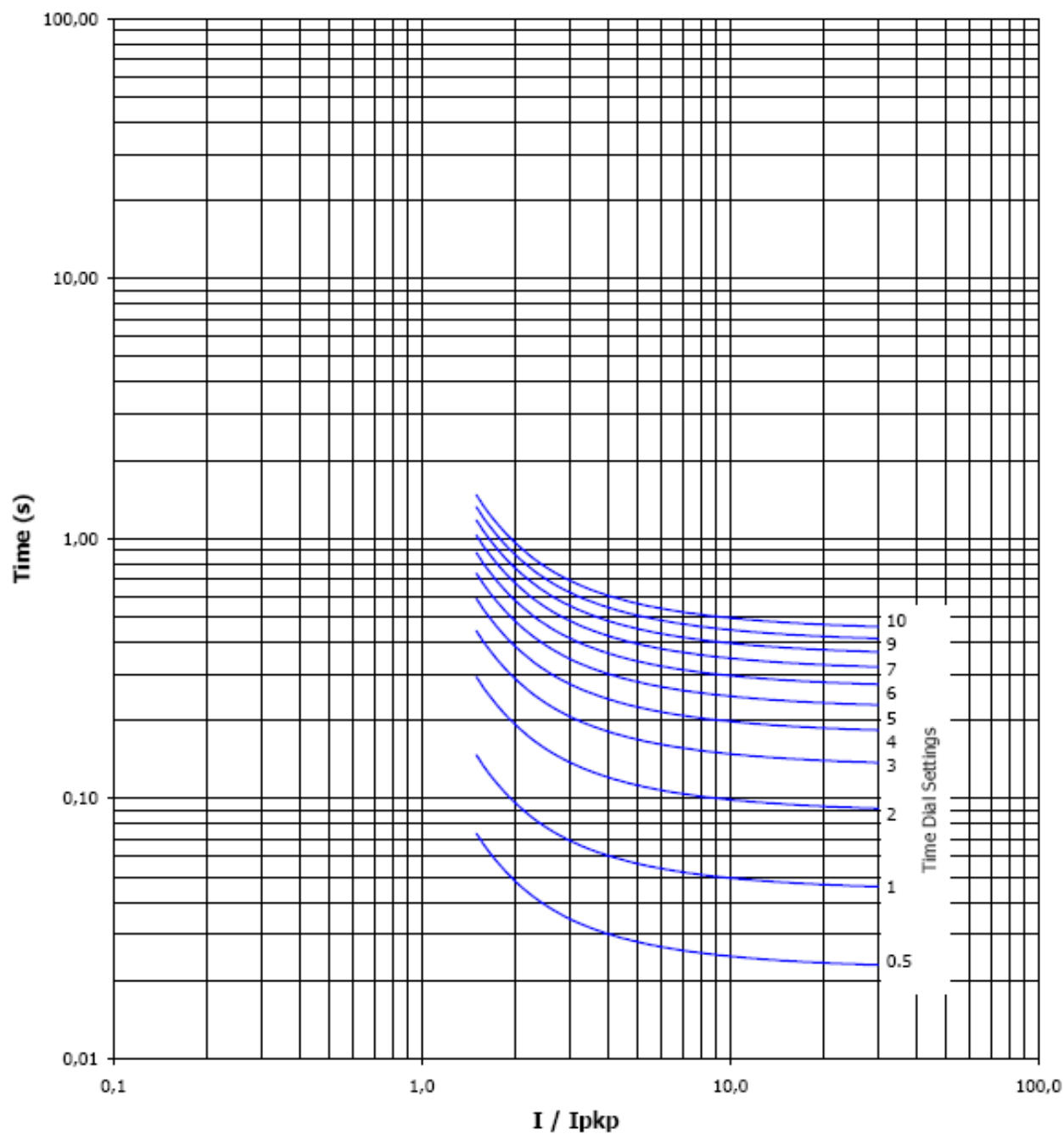
Figure B–11: IAC INVERSE LONG GES-7003

B

The **ModBus Format (**Intel/Motorola) setting**,** in General Settings, provides with different ways to access and/or modify the relay information

Differences between selecting the Intel or Motorola setting are explained in the following table:

	INTEL	MOTOROLA
ModBus Map Addressing	One byte at a time	One word at a time
Data presentation	High Byte – Low Byte	Low Byte – High Byte
Operations	Selection + Confirmation	Confirmation

C

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

Request:

FIELD	LENGTH
Relay address	1 Byte
Function	1 Byte (03h)
Beginning address	1 word (High Byte – Low Byte)
Number of registers	1 word (High Byte – Low Byte)
CRC	1 word

C

Reply:

FIELD	LENGTH
Relay address	1 Byte
Function	1 Byte
Nº of bytes	1 Byte (Number of registers * 2)
Value of the registers	n data bytes
CRC	1 word

Example:

Reading 75 registers (150 bytes) beginning from address 04FEH (word with 027F address)

IntelRequest:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	03H	04FEH	004BH	653DH

Intel Reply

ADDRESS	FUNCTION	BYTES	DATA0	...	DATA74	CRC
01H	03H	96H	500DH		0200H	84D5H

Motorola Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	03H	027FH	004BH	359DH

Motorola Reply:

ADDRESS	FUNCTION	BYTES	DATA0	...	DATA74	CRC
01H	03H	96H	0D50H		0002H	2783H

Commands with ModBus® Intel format setting are executed in two steps: **selection and confirmation**. First, send the command or operation selection command. When the relay response arrives, send the confirmation. It is necessary to send the relay password. The structure for both commands is the same; the only variation is the related code.

When Motorola is the selected ModBus format setting, commands only need the **confirmation** step.

The ModBus® function used is 16 (10h), PRESET MULTIPLE SETPOINTS. It consists of a writing of the operation code in address 0 (000H). The available commands list is as follows:

INTEL SELECTION

		INTEL		MOTOROLA
COMMAND		**SELECTION**	**CONFIRMATION**	**CONFIRMATION**
Setting change		01H	02H	02H
Thermal Image Reset		03H	04H	04H
Open breaker		07H	08H	08H
LEDs reset		09H	0AH	0AH
Change to group 1		0DH	0EH	0EH
Change to group 2		0FH	10H	10H
Oscillography trigger		17H	18H	18H
Set number of openings		2FH	30H	30H
Set I2		31H	32H	32H
Close breaker		39H	3AH	3AH
Time synchronization		0FEH	Not applicable	0FEH

Intel Request:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (000H) (High byte – low byte)
Number of registers	1 word (0001H) (High byte – low byte)
Number of bytes	1 byte (02H)
Value of the registers	Register1=> (INTEL) Command code (Low byte – High byte)
CRC	1 word

Intel Reply:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (000H) (High byte – low byte)
Nº of registers	1 word (0003H) (High byte – low byte)
CRC	1 word

Example:

We send the Group-related command. For instance, to activate Group 2, the selection command will be 15 (0F00H)

Intel Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES	DATA0	CRC
01H	10H	0000H	0001H	02H	0F00H	A3A0H

Intel Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0001H	01C9H

CONFIRMATION:

Intel Request:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (0000H) (High byte – low byte)
Number of registers	1 word (0001H) (High byte – low byte)
Number of bytes	1 byte (06H)
Value of the registers	Register1=>Command code (Low byte – High byte). Register2=>Relay password (Low byte – High byte). Register3=>Constant value
CRC	1 word

Intel Reply:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (0000H) (High byte – low byte)
Number of registers	1 word (0003H) (High byte – low byte)
CRC	1 word

Motorola Request:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (000H) (High byte – low byte)
Number of registers	1 word (0001H) (High byte – low byte)
Number of bytes	1 byte (02)
Value of the registers	Register1=>Command code (Low byte – High byte).
CRC	1 word

Motorola Reply:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (0000H) (High byte – low byte)
Number of registers	1 word (0001H) (High byte – low byte)
CRC	1 word

Example:

Request:

To activate Group 2, the selection command will be 0FH; therefore the operation to be performed is a writing of word 0F 00H at the address 00 00H.

The operation confirmation code for Group 2 activation is 16 (10h). In this case, it is necessary to send the relay password

Intel Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES	DATA0	DATA1	DATA2	CRC
01H	10H	0000H	0003H	06H	10 00H	01 00H	00 00H	E5ECH

Intel Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0003H	8008H

Motorola Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	BYTES	DATA0	CRC
01H	10H	0000H	0001H	02H	10 00H	AB90H

Motorola Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0001H	01C9H

C

To synchronize the date and time of a relay we use a command with the following characteristics:

1. The command is executed in broadcast mode (relay address = 00H)

2. Date and time are included in the message. The date and time format length is 6 bytes.

3. No answer is expected from the relay.

FIELD	LENGTH
Relay address	1 byte (00H – broadcast)
Function	1 byte (10H)
Beginning address	1 word (0000H) (High Byte – low byte)
Number of registers	1 word (0004H) (High Byte – low byte))
Number of bytes	1 byte (08H) (High Byte – low byte))
Value of the registers	Register 1=>Command code (Low byte –High byte). Register 2...4=>Date and time
CRC	1 word

Example:

To send the date and time of June 15th, 2005 at 00:015:09.000

Intel Synchronization:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES	DATA0	DATA1	DATA2	DATA3	CRC
00H	10H	0000H	0004H	08H	FE 00H	C8CAH	7476H	4500H	B950H

Motorola Synchronization:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES	DATA0	DATA1	DATA2	DATA3	CRC
00H	10H	0000H	0004H	08H	FE 00H	0045H	7674H	CAC8H	3919H

There are three steps to write a setting:

1. Execute a selection command using the corresponding code (See command execution)

2. Change the setting

3. Execute a confirmation command using the corresponding code (See command execution)

For Motorola format, only the last two steps are necessary

To modify a setting, use function 10H (PRESET MULTIPLE REGISTERS in MODBUS)

C

Request:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word (High Byte – low byte)
Number of registers	1 word (High Byte – low byte)
Number of bytes	1 byte
Value of the registers	Low byte- high byte
CRC	1 word

Reply:

FIELD	LENGTH
Relay address	1 byte
Function	1 byte (10H)
Beginning address	1 word
Number of registers	1 word
CRC	1 word

Example:

In this example we are going to modify the relay identification, which is a 16 characters text in the 0128H position for Intel or 94H for Motorola.

<u>SETTING CHANGE SELECTION (LIKE IN A COMMAND):</u>

I**ntel Request**:

ADDRESS	FUNCTION	BEGINNING	#REGS	BYTES	DATA0	CRC
01H	10H	0000H	0001H	02H	0100H	A7C0H

Intel Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0001H	01C9H

<u>SETTING CHANGE</u>

Intel Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES
01H	10H	0128H	0008H	10H

DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7	CRC
5052H	5545H	4241H	2020H	2020H	2020H	2020H	2020H	A0A2H

Data0 => 5152H (PR)Data4 => 2020H

Data1 => 5545H (UE)Data5 => 2020H

Data2 => 4241H (BA)Data6 => 2020H

Data3 => 2020HData7 => 2020H

Intel Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0128H	0008H	403BH

Motorola Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	#BYTES
01H	10H	0094H	0008H	10H

DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7	CRC
5052H	5545H	4241H	2020H	2020H	2020H	2020H	2020H	FA94H

Data0 => 5152H (PR)Data4 => 2020H

Data1 => 5545H (UE)Data5 => 2020H

Data2 => 4241H (BA)Data6 => 2020H

Data3 => 2020HData7 => 2020H

Motorola Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0094H	0008	8023H

SETTING CHANGE CONFIRMATION (LIKE IN A COMMAND)

Intel Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	BYTES	#DATA0	DATA1	DATA2	CRC
01H	10H	0000H	0003H	06H	0200H	0100H	0000H	E69EH

Intel Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0003H	8008H

Motorola Request:

ADDRESS	FUNCTION	BEGINNING	#REGS	BYTES	#DATA0	CRC
01H	10H	0000H	0001H	02H	0200H	A730H

Motorola Reply:

ADDRESS	FUNCTION	BEGINNING	#REGS	CRC
01H	10H	0000H	0001H	01CFH

When any of the previous commands produce an error in the slave the following frame is received:

ADDRESS	FUNCTION + 80 H	COD. ERROR	CRC
01H	90H	07H	0DC2H

We can receive the following values in the error code field:

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

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
0138	009C		Phase CT Ratio	Phase CT Ratio	4	FLOAT32
013C	009E		Ground CT Ratio	Ground CT Ratio	4	FLOAT32
0140	00A0		IDEN	IDEN	16	
0150	00A8		Trip Min Time	Trip Min Time	4	FLOAT32
0154	00AA		Delay	Delay	4	FLOAT32
0158	00AC	0	Settings Group	Settings Group	2	BIT
015A	00AD	0	Relay Operation	Relay Operation	2	BIT
015A	00AD	1	Frequency	Frequency	2	BIT
015C	00AE	0	Trip Enable 51P	Trip Enable 51P	2	BIT
015C	00AE	1	Trip Enable 51G	Trip Enable 51G	2	BIT
015C	00AE	2	Trip Enable 50P1	Trip Enable 50P1	2	BIT
015C	00AE	3	Trip Enable 50P2	Trip Enable 50P2	2	BIT
015C	00AE	4	Trip Enable 50G1	Trip Enable 50G1	2	BIT
015C	00AE	5	Trip Enable 50G2	Trip Enable 50G2	2	BIT
015C	00AE	6	Trip Enable 49	Trip Enable 49	2	BIT
015E	00AF		Pickup 51P	Pickup 51P	4	FLOAT32
0162	00B1		Curve 51P	Curve 51P	2	ENUMERATION
0164	00B2		TD Mult 51P	TD Mult 51P	4	FLOAT32
0168	00B4		Def Time 51P	Def Time 51P	4	FLOAT32
016C	00B6		Pickup 51G	Pickup 51G	4	FLOAT32
0170	00B8		Curve 51G	Curve 51G	2	ENUMERATION
0172	00B9		TD Mult 51G	TD Mult 51G	4	FLOAT32
0176	00BB		Def Time 51G	Def Time 51G	4	FLOAT32
017A	00BD		Pickup 50P1	Pickup 50P1	4	FLOAT32
017E	00BF		Delay 50P1	Delay 50P1	4	FLOAT32
0182	00C1		Pickup 50P2	Pickup 50P2	4	FLOAT32
0186	00C3		Delay 50P2	Delay 50P2	4	FLOAT32
018A	00C5		Pickup 50G1	Pickup 50G1	4	FLOAT32
018E	00C7		Delay 50G1	Delay 50G1	4	FLOAT32
0192	00C9		Pickup 50G2	Pickup 50G2	4	FLOAT32
0196	00CB		Delay 50G2	Delay 50G2	4	FLOAT32
019A	00CD		Pickup 49	Pickup 49	4	FLOAT32
019E	00CF		Alarm Level 49	Alarm Level 49	4	FLOAT32
01A2	00D1		Heat Time 49	Heat Time 49	4	FLOAT32
01A6	00D3		Cool Time 49	Cool Time 49	4	FLOAT32
01AA	00D5		AR Max Shots	AR Max Shots	4	FLOAT32
01AE	00D7		AR Dead Time 1	AR Dead Time 1	4	FLOAT32
01B2	00D9		AR Dead Time 2	AR Dead Time 2	4	FLOAT32
01B6	00DB		AR Dead Time 3	AR Dead Time 3	4	FLOAT32
01BA	00DD		AR Dead Time 4	AR Dead Time 4	4	FLOAT32
01BE	00DF		AR Rst LO Delay	AR Rst LO Delay	4	FLOAT32
01C2	00E1		AR Inc Seq Time	AR Inc Seq Time	4	FLOAT32
01C6	00E3		AR Reset Time	AR Reset Time	4	FLOAT32
01CA	00E5	0	Trip Enable 51P	Trip Enable 51P	2	BIT
01CA	00E5	1	Trip Enable 51G	Trip Enable 51G	2	BIT
01CA	00E5	2	Trip Enable 50P1	Trip Enable 50P1	2	BIT
01CA	00E5	3	Trip Enable 50P2	Trip Enable 50P2	2	BIT
01CA	00E5	4	Trip Enable 50G1	Trip Enable 50G1	2	BIT

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
01CA	00E5	5	Trip Enable 50G2	Trip Enable 50G2	2	BIT
01CA	00E5	6	Trip Enable 49	Trip Enable 49	2	BIT
01CC	00E6		Pickup 51P	Pickup 51P	4	FLOAT32
01D0	00E8		Curve 51P	Curve 51P	2	ENUMERATION
01D2	00E9		TD Mult 51P	TD Mult 51P	4	FLOAT32
01D6	00EB		Def Time 51P	Def Time 51P	4	FLOAT32
01DA	00ED		Pickup 51G	Pickup 51G	4	FLOAT32
01DE	00EF		Curve 51G	Curve 51G	2	ENUMERATION
01E0	00F0		TD Mult 51G		4	FLOAT32
01E4	00F2		Def Time 51G		4	FLOAT32
01E8	00F4		Pickup 50P1		4	FLOAT32
01EC	00F6		Delay 50P1	Delay 50P1	4	FLOAT32
01F0	00F8		Pickup 50P2	Pickup 50P2	4	FLOAT32
01F4	00FA		Delay 50P2	Delay 50P2	4	FLOAT32
01F8	00FC		Pickup 50G1	Pickup 50G1	4	FLOAT32
01FC	00FE		Delay 50G1	Delay 50G1	4	FLOAT32
0200	0100		Pickup 50G2	Pickup 50G2	4	FLOAT32
0204	0102		Delay 50G2	Delay 50G2	4	FLOAT32
0208	0104		Pickup 49	Pickup 49	4	FLOAT32
020C	0106		Alarm Level 49	Alarm Level 49	4	FLOAT32
0210	0108		Heat Time 49	Heat Time 49	4	FLOAT32
0214	010A		Cool Time 49	Cool Time 49	4	FLOAT32
0218	010C		A Parameter	A Parameter	4	FLOAT32
021C	010E		B Parameter	B Parameter	4	FLOAT32
0220	0110		P Parameter	P Parameter	4	FLOAT32
0224	0112		Q Parameter	Q Parameter	4	FLOAT32
0228	0114		K Parameter	K Parameter	4	FLOAT32
0234	011A		I^2 MAX Value	I^2 MAX Value	4	FLOAT32
0238	011C	0	O1	O1	2	BIT
0238	011C	1	O2	O2	2	BIT
0238	011C	2	O3	O3	2	BIT
0238	011C	3	O4	O4	2	BIT
023A	011D	0	sAPCOM	sAPCOM	2	BIT
023A	011D	1	sRLATC	sRLATC	2	BIT
023A	011D	4	sAR Close	sC INT	2	BIT
023A	011D	5	sAR Lockout	A50PH	2	BIT
023A	011D	6	sAR RIP	A 50NH	2	BIT
023A	011D	7	sAR Disable	A51P	2	BIT
023A	011D	10	sC INT	A51N	2	BIT
023A	011D	11	sOrd Reclose	A 50PL	2	BIT
023A	011D	14	sRecloser Block	A 50NL	2	BIT
023A	011D	15	sExtern Inpput	A 49	2	BIT
023C	011E	0	A50PH	IE50PH	2	BIT
023C	011E	1	A 50NH	IE50NH	2	BIT
023C	011E	2	A51P	I E51P	2	BIT
023C	011E	3	A51N	I E51N	2	BIT
023C	011E	4	A 50PL	IE50PL	2	BIT
023C	011E	5	A 50NL	IE50NL	2	BIT
023C	011E	6	A 49	I E49	2	BIT

C

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
023C	011E	8	IE50PH	D INH	2	BIT
023C	011E	9	IE50NH	D 50ph	2	BIT
023C	011E	10	I E51P	D 50nh	2	BIT
023C	011E	11	I E51N	D51p	2	BIT
023C	011E	12	IE50PL	D51n	2	BIT
023C	011E	13	IE50NL	D 50pl	2	BIT
023C	011E	14	I E49	D 50nl	2	BIT
023C	011E	15	D INH	D49	2	BIT
023E	011F	0	D 50ph	DISGEN	2	BIT
023E	011F	1	D 50nh	E PROT	2	BIT
023E	011F	2	D51p	aux1	2	BIT
023E	011F	3	D51n	aux2	2	BIT
023E	011F	4	D 50pl	aux3	2	BIT
023E	011F	5	D 50nl	aux4	2	BIT
023E	011F	6	D49	ENT 1	2	BIT
023E	011F	7	DISGEN	ENT 2	2	BIT
023E	011F	9	E PROT	ihca	2	BIT
023E	011F	10	aux1	ORD D	2	BIT
023E	011F	11	aux2	ED 52B	2	BIT
023E	011F	12	aux3	ED 52A	2	BIT
023E	011F	13	aux4	C TAB	2	BIT
023E	011F	14	ENT 1	Gosc	2	BIT
023E	011F	15	ENT 2	Fapr	2	BIT
0240	0120	1	ihca	est INTE	2	BIT
0240	0120	2	ORD D	STOC	2	BIT
0240	0120	4	ED 52B	A CNT	2	BIT
0240	0120	5	ED 52A	CLPs	2	BIT
0240	0120	6	C TAB	C AJUS	2	BIT
0240	0120	7	Gosc	SE2P	2	BIT
0240	0120	8	Fapr	Adef	2	BIT
0240	0120	9	est INTE	Function	2	BIT
0240	0120	10	STOC	Function	2	BIT
0240	0120	11	A CNT	AR Function	2	BIT
0240	0120	12	CLPs	AR 50P1 Init	2	BIT
0240	0120	13	C AJUS	AR 50G1 Init	2	BIT
0240	0120	14	SE2P	AR 51P Init	2	BIT
0240	0120	15	Adef	AR 51G Init	2	BIT
0242	0121	0	Function	AR 50P2 Init	2	BIT
0242	0121	1	Function	AR 50G2 Init	2	BIT
0242	0121	2	AR Function	AR 49 Init	2	BIT
0244	0122	0	AR 50P1 Init	AR EXTERN Init	2	BIT
0244	0122	1	AR 50G1 Init	AR 50P1 Shot 1	2	BIT
0244	0122	2	AR 51P Init	AR 50G1 Shot 1	2	BIT
0244	0122	3	AR 51G Init	AR 51P Shot 1	2	BIT
0244	0122	4	AR 50P2 Init	AR 51G Shot 1	2	BIT
0244	0122	5	AR 50G2 Init	AR 50P2 Shot 1	2	BIT
0244	0122	6	AR 49 Init	AR 50G2 Shot 1	2	BIT
0244	0122	7	AR EXTERN Init	AR 49 Shot 1	2	BIT
0246	0123	0	AR 50P1 Shot 1	AR 50P1 Shot 2	2	BIT

C

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
0246	0123	1	AR 50G1 Shot 1	AR 50G1 Shot 2	2	BIT
0246	0123	2	AR 51P Shot 1	AR 51P Shot 2	2	BIT
0246	0123	3	AR 51G Shot 1	AR 51G Shot 2	2	BIT
0246	0123	4	AR 50P2 Shot 1	AR 50P2 Shot 2	2	BIT
0246	0123	5	AR 50G2 Shot 1	AR 50G2 Shot 2	2	BIT
0246	0123	6	AR 49 Shot 1	AR 49 Shot 2	2	BIT
0248	0124	0	AR 50P1 Shot 2	AR 50P1 Shot 3	2	BIT
0248	0124	1	AR 50G1 Shot 2	AR 50G1 Shot 3	2	BIT
0248	0124	2	AR 51P Shot 2	AR 51P Shot 3	2	BIT
0248	0124	3	AR 51G Shot 2	AR 51G Shot 3	2	BIT
0248	0124	4	AR 50P2 Shot 2	AR 50P2 Shot 3	2	BIT
0248	0124	5	AR 50G2 Shot 2	AR 50G2 Shot 3	2	BIT
0248	0124	6	AR 49 Shot 2	AR 49 Shot 3	2	BIT
024A	0125	0	AR 50P1 Shot 3	AR 50P1 Shot 4	2	BIT
024A	0125	1	AR 50G1 Shot 3	AR 50G1 Shot 4	2	BIT
024A	0125	2	AR 51P Shot 3	AR 51P Shot 4	2	BIT
024A	0125	3	AR 51G Shot 3	AR 51G Shot 4	2	BIT
024A	0125	4	AR 50P2 Shot 3	AR 50P2 Shot 4	2	BIT
024A	0125	5	AR 50G2 Shot 3	AR 50G2 Shot 4	2	BIT
024A	0125	6	AR 49 Shot 3	AR 49 Shot 4	2	BIT
024C	0126	0	AR 50P1 Shot 4	Outage Time	2	BIT
024C	0126	1	AR 50G1 Shot 4	On Load Time	2	BIT
024C	0126	2	AR 51P Shot 4	Phase IOC Mult	2	BIT
024C	0126	3	AR 51G Shot 4	Phase TOC Mult	2	BIT
024C	0126	4	AR 50P2 Shot 4	Phase CT Ratio	2	BIT
024C	0126	5	AR 50G2 Shot 4	Ground CT Ratio	2	BIT
024C	0126	6	AR 49 Shot 4	IDEN	2	BIT
024E	0127		Outage Time	Trip Min Time	4	FLOAT32
0252	0129		On Load Time	Delay	4	FLOAT32
0256	012B		Phase IOC Mult	Settings Group	4	FLOAT32
025A	012D		Phase TOC Mult	Relay Operation	4	FLOAT32

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
04D0	0268		Date & Time	Date & Time	6	
04D6	026B		Firmware Rev	Firmware Rev	6	
04DC	026E		Order Code	Order Code	16	
04EC	0276		Relay Name	Relay Name	16	
0506	0283		Z2	Z2	4	
050A	0285		Z3	Z3	4	FLOAT32
0512	0289		f h	f h	6	
0522	0291	4	AR Close	AR Close	2	BIT
0522	0291	5	AR Lockout	AR Lockout	2	BIT
0522	0291	6	AR RIP	AR RIP	2	BIT
0522	0291	7	AR Disable	AR Disable	2	BIT
0524	0292	0	LD	LD	2	BIT
0524	0292	1	LR	LR	2	BIT
0524	0292	2	L1	L1	2	BIT
0524	0292	3	L2	L2	2	BIT
0524	0292	4	L3	L3	2	BIT
0524	0292	5	L4	L4	2	BIT
0524	0292	8	c1	c1	2	BIT
0524	0292	9	c2	c2	2	BIT
0524	0292	10	c3	c3	2	BIT
0524	0292	11	c4	c4	2	BIT
0526	0293	0	a 50HA	a 50HA	2	BIT
0526	0293	1	a 50HB	a 50HB	2	BIT
0526	0293	2	a 50HC	a 50HC	2	BIT
0526	0293	4	a 50LA	a 50LA	2	BIT
0526	0293	5	a 50LB	a 50LB	2	BIT
0526	0293	6	a 50LC	a 50LC	2	BIT
0526	0293	8	a 51 A	a 51 A	2	BIT
0526	0293	9	a 51 B	a 51 B	2	BIT
0526	0293	10	a 51 C	a 51 C	2	BIT
052C	0296	1	a 50NH	a 50NH	2	BIT
052C	0296	3	a 51N	a 51N	2	BIT
052C	0296	5	a 50NL	a 50NL	2	BIT
052C	0296	6	aa49	aa49	2	BIT
052C	0296	7	a GEN	a GEN	2	BIT
052E	0297	0	d 50PH	d 50PH	2	BIT
052E	0297	1	d 50NH	d 50NH	2	BIT
052E	0297	2	d 51P	d 51P	2	BIT
052E	0297	3	d 51N	d 51N	2	BIT
052E	0297	4	d 50PL	d 50PL	2	BIT
052E	0297	5	d 50NL	d 50NL	2	BIT
052E	0297	6	dd49	dd49	2	BIT
052E	0297	8	d	d	2	BIT
052E	0297	9	al	al	2	BIT
052E	0297	10	Output 1	Output 1	2	BIT
052E	0297	11	Output 2	Output 2	2	BIT
052E	0297	12	Output 3	Output 3	2	BIT
052E	0297	13	Output 4	Output 4	2	BIT

C

INTEL ADDRESS	MOTOROLA ADDRESS	BITS	NAME	DESCRIPTION	# OF BYTES	FORMAT
052E	0297	14	Input 1	Input 1	2	BIT
052E	0297	15	Input 2	Input 2	2	BIT
0530	0298	1	EDICAJ	EDICAJ	2	BIT
0530	0298	6	EDCTAB	EDCTAB	2	BIT
0530	0298	8	BKR Fail Status	BKR Fail Status	2	BIT
0530	0298	9	EST52	EST52	2	BIT
0530	0298	11	I^2 Alarm Status	I^2 Alarm Status	2	BIT
0530	0298	12	Cold Load Status	Cold Load Status	2	BIT
0530	0298	14	F1	F1	2	BIT
0530	0298	15	AU	AU	2	BIT
0532	0299	3	T AC	T AC	2	BIT
0532	0299	4	frec	frec	2	BIT
0532	0299	5	LOCREM	LOCREM	2	BIT
0536	029B	0	DIS 50HA	DIS 50HA	2	BIT
0536	029B	1	DIS 50HB	DIS 50HB	2	BIT
0536	029B	2	DIS 50HC	DIS 50HC	2	BIT
0536	029B	4	DIS 50LA	DIS 50LA	2	BIT
0536	029B	5	DIS 50LB	DIS 50LB	2	BIT
0536	029B	6	DIS 50LC	DIS 50LC	2	BIT
0536	029B	8	DIS 51A	DIS 51A	2	BIT
0536	029B	9	DIS 51B	DIS 51B	2	BIT
0536	029B	10	DIS 51C	DIS 51C	2	BIT
0538	029C	1	AR Enabled	AR Enabled	2	BIT
0538	029C	2	AR Shot Cnt0	AR Shot Cnt0	2	BIT
0538	029C	3	AR Shot Cnt1	AR Shot Cnt1	2	BIT
0538	029C	4	AR Shot Cnt2	AR Shot Cnt2	2	BIT
0538	029C	5	AR Shot Cnt3	AR Shot Cnt3	2	BIT
0538	029C	6	AR Shot Cnt4	AR Shot Cnt4	2	BIT
053A	029D		Phase A Current	Phase A Current	4	FLOAT32
053E	029F		Phase B Current	Phase B Current	4	FLOAT32
0542	02A1		Phase C Current	Phase C Current	4	FLOAT32
0546	02A3		Ground Current	Ground Current	4	FLOAT32
054A	02A5		TH Capacity Used	TH Capacity Used	4	FLOAT32
0552	02A9		I^2 Value	I^2 Value	4	FLOAT32
0556	02AB		Breaker Trips	Breaker Trips	4	FLOAT32
055A	02AD		OS	OS	2	UINT16
055E	02AF		St	St	2	UINT16
0592	02C9		SUCt	SUCt	1024	BUFFER
09C2|1442 1454	04E1|0A21 0A2A		OSC	OSC	2688|18 16	BUFFER

MII Family relays can be used to monitor Trip circuit integrity. The circuit is basically a Voltage Monitor connected to contact 52a. The circuit is continuously monitoring the voltage level. The circuit below is designed to monitor the complete trip circuit. It includes the tripping coil of the breaker and the trip circuit, the wiring between the relays, and the circuit breaker.

An alarm can be issued when the circuit is open. The figure below shows the typical wiring diagram that will provide trip circuit monitoring while the circuit breaker is closed.

D
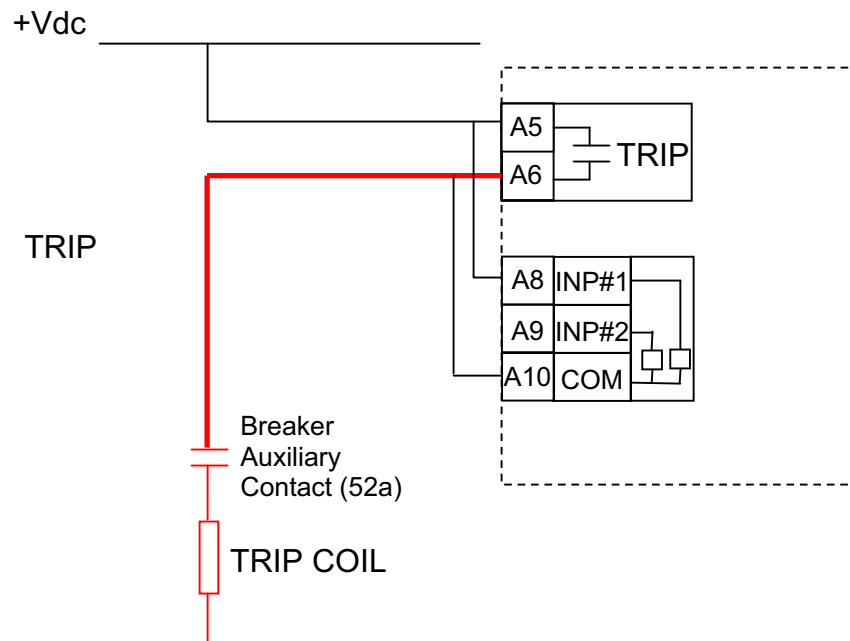
For monitoring the trip circuit while the breaker is open and when it is closed, a resistor must be added in parallel to the 52a contact, as shown below:
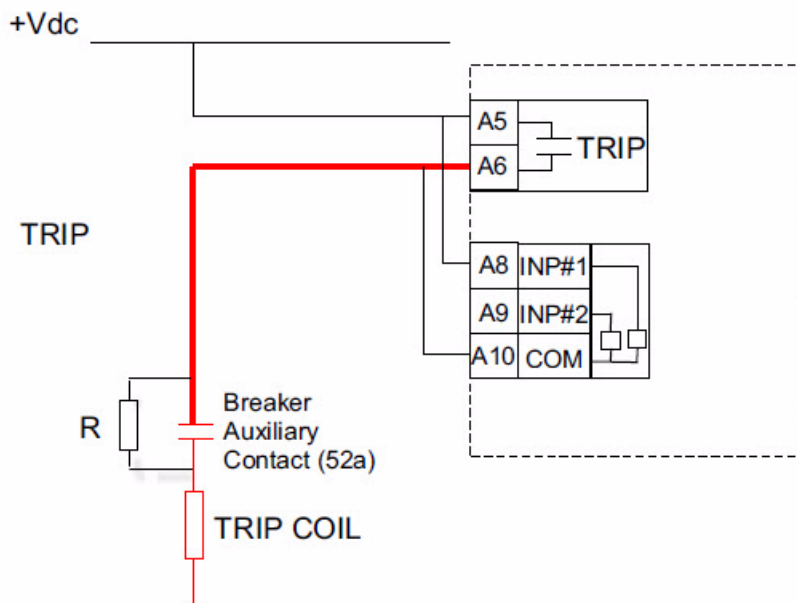
VALUE OF RESISTOR R		
Supply	Ohms	Watts
48 Vdc	10 K	2
125 Vdc	25 K	5
250 Vdc	50 K	5

Settings and configuration related to this function are described below:

1. Under I/O CONFIGURATION, Input#1 must be configured as 'General Input'. It will be used to monitor the permanent presence of voltage.

2. Under LOGIC CONFIGURATION, LOGIC#1, Invert Input#1 and set the timer to the time delay to produce the Trip Circuit Supervision Alarm, for example 15 seconds

3. Under I/O Configuration, configure LEDs and outputs as required. In this example, LED#1 and configurable output#1 are configured to operate when a Trip Circuit failure is detected. They are also configured to have memory, so they will remain active even if the Trip Circuit failure disappears.

D

This appendix describes the main features implemented in MIFII relays with protocol option C:

- IEC 60870-5-103 communication protocol added
- Two independent communication ports

The general settings of these models are described in the following table:

	ENERVISTA MII SETUP	HMI	DEFAULT	RANGE	STEP
PRODUCT SETUP	PRODUCT SETUP	PRODUCT SETUP			
Relay Status	Relay Operation	Relay Operation	DISABLE	READY / DISABLE	NA
Frequency	Frequency	Frequency	60 Hz	50/60 Hz	NA
ModBus Format	---	ModBus Format	Intel	Intel/Motorola	NA
Phase CT ratio	Phase CT Ratio	Phase CT Ratio	1	1-4000	1
Ground CT ratio	Ground CT Ratio	Ground CT Ratio	1	1-4000	1
HMI Password	---	HMI Password	1	1-9999	1
Comm Password	---	Comm Password	1	1 – 255	1
Slave Address	---	Slave Address	1	1 – 255	1
Communication Baud rate	---	Comm Baud Rate	9.6	0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2	NA
Communication 2 Baud rate	---	COM2 Baud rate	9.6	0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2	NA
Prefault cycles	Prefault Cycles	Prefault Cycles	50	10-140	1

E

In protocol option C models, front and rear communication ports are completely independent. This allows the user to access the relay information and configuration from both communication ports simultaneously.

The information related to measures and states is always available through both ports. However, if settings and switchgear menus are accessed by the frontal keyboard, the relay will be in local mode and no changes could be made using both ports. If we are not accessing the relay by the keyboard, the frontal port has the priority, this means that if we are trying to change something through the frontal port, the rear port will be blocked. If a setting or switchgear change by the rear port is required, we could not be doing it by the keyboard or the front port.

E

IEC 60870-5-103 applies to protection equipment with coded bit serial data transmission for exchanging information with control system. It defines a companion standard that enables interoperability between protection equipment and devices of a control system in a substation.

IEC 60870-5-103 presents specifications for the informative interface of protection equipment.

IEC 60870-5-103 presents two methods of information exchange: the first is based on explicitly specified APPLICATION SERVICE DATA UNITS (ASDUs) and application procedures for transmission of "standardized" messages and the second uses generic services for transmission of nearly all possible information. The "standardized" messages do not cover all possible protection functions, and furthermore a protection device may support only a subset of the messages specified in this standard

The IEC 60870-5 protocol is based on the three layer reference model "Enhanced Performance Architecture" (EPA).

This physical layer uses a fibre optic or a copper-wire based system that provides binary symmetric and memory less transmission.

The link layer consists of a number of link transmission procedures, using explicit LINK PROTOCOL CONTROL INFORMATION (LPCI), that are capable of carrying APPLICATION SERVICE DATA UNITS (ASDUs) as link user data. The link layer uses a selection of frame formats to provide the required integrity, efficiency, and convenience of transmission.

The application layer contains a number of application functions that involve the transmission of APPLICATION SERVICE DATA UNITS (ASDUs) between source and destination.

The application layer of this companion standards does not use explicit APPLICATION PROTOCOL CONTROL INFORMATION (APCI). This is implicit in the contents of the ASDU DATA UNIT IDENTIFIER and in the type of link service used.

E

A copper-wire based transmission system is used in MIFII between the protection equipment and the control system.

The data circuit terminating equipment (DCE) of the protection equipment may be realized as a copper-wire based transmission system. In the following sub-clauses is described.

E.3.1.1 ELECTRICAL INTERFACE - EIA RS-485 INTERFACE

As an alternative to the fibre optic transmission a copper-wire based transmission system is used between MIFII and the control system. This transmission system shall comply with the EIA RS-485 standard.

Due to the characteristic of the EIA RS-485 standard a maximum number of 32 units of load can be connected to one physical line. The location and the values of the termination resistances used are not specified, neither in the base standard nor in this companion standard. For compatibility purposes, the manufacturer shall state the units of load for each specific device.

The type of the cable used is not defined in the EIA RS-485 standard.

X	EIA RS-485
32	Number of loads for one protection equipment

E.3.1.2 OPTICAL INTERFACE - FIBRE OPTIC TRANSMISSION

If a fibre optic transmission system has been used, the compatible interface is a fibre optic connector at the protection equipment. Separate optical fibres are used in the monitor direction and in the control direction. The DCE may be mechanically and/or electrically integrated into the data terminal equipment (DTE).

	Glass fibre
	Plastic fibre
	F-SMA type connector
	BFOC/2,5 type connector

E.3.1.3 TRANSMISION CONTROL SPECIFICATIONS

The standard transmission speed are 9.6 kbits/s or 19.2 kbits/s (adjustable).

X	9600 bit/s
X	19200 bit/s

IEC 60870-5-2 offers a selection of link transmission procedures using a control field and an optional address field. Links between stations may be operated in either an unbalanced transmission mode. Appropriate function codes for the control field are specified for both modes of operation.

If the links from a control system to several protection equipments share a common physical channel, then these links shall be operated in an unbalanced mode to avoid the possibility that more than one protection equipment attempts to transmit on the channel at the same time. The sequence in which the various protection equipments are granted access to transmit on the channel is then determined by an application layer procedure in the control system.

The companion standard specifies whether an unbalanced or a balanced transmission mode is used, together with which link procedures (and corresponding link function codes) are to be used.

The companion standard specifies an unambiguous address (number) for each link. Each address may be unique within a specific system, or it may be unique within a group of links sharing a common channel. The latter needs a smaller address field but requires the control system to map addresses by channel number.

A companion standard shall specify one frame format chosen from those offered in IEC 60870-5-1. The format chosen shall provide the required data integrity together with the maximum efficiency available for an acceptable level of convenience of implementation.

E.3.2.1 UNBALANCED TRANSMISSION

The control system constitutes the master, the protection equipment the slave; i.e. the control system is always primary station, the protection equipment always secondary station. The RES bit is not used.

The following function codes are used:

PRM = 1   0, 3, 4, 9, 10, 11
PRM = 0   0, 1, 8, 9, 11

Address field A always consists of one octet only, for broadcast (send/no reply) the address is defined as 255.

E.3.2.2 ADDITIONAL SPECIFICATIONS TO IEC 60870-5-2

The following additional function code is defined in the reserved range:

PRM = 1   F-Code 7:= reset FCB   FCB and FCV = 0

This SEND function code is used to set the internal FCB bit to the value 0, i.e. the next successive primary message with FCV = 1 expected with the setting FCB = 1 by the protection equipment. No other reset function such as those associated with function code 0 (reset communication unit) are triggered.

The following codes are already specified in the standard. They are used here as follows:

PRM = 0   F-Code 14:= link service not functioning

Primary messages that cannot be passed on due to a malfunction are answered with an F-Code 14. The FCB bit is processed alternately.

PRM = 0   F-Code 15:= link service not functioning

Primary messages containing not implemented function codes are acknowledged with short messages and will not be processed. Non-plausible primary messages involving function codes 0-15 will be answered by means of function code 15 in a short message. The FCB bit will be processed alternately.

As long as the protection equipment is not able to process a further command, the DFC bit is set to "1" to prevent loss of information in the control direction. This state may only be maintained for a maximum of 15 s. During this time, no further command shall be transmitted by the control system. Such messages are answered by the protection equipment by means of a short message with function code 1 and are not processed. This leads to a loss of information. The exception to this is the broadcast command.

E

E.3.3.1 TRANSMISSION MODE FOR APPLICATION DATA (PACKING AND ORDER OF TRANSPORT OF DATA FIELD)

The way of presenting data elements usually follows the requirements of intended functional applications of the data contents. Thus numbers are usually presented as we are used to write and read them, namely from left to right with decreasing powers of their bases.

Sizes of Information elements that are not multiples of 8 bits allow condensed packing of sequences of information elements to achieve octet structures of the information field.

For information elements longer than on octet, the octet noted a the top is delivered first for transportation in mode 1 or is delivered last in mode 2. The choice of modes is specified in the application profile used.

E.3.3.2 COMMON ADDRESS OF ASDU

The fourth octet of the DATA UNIT IDENTIFIER of the ASDU defines the COMMON ADDRESS OF ASDU. This octet shall normally be identical to the station address used at the link level. Exceptions are only permitted where additional COMMON ADDRESSES OF ASDUs are required on the same physical link because of duplicated functions, for example two over current protection functions within a transformer differential protection.

COMMON ADDRESS OF ASDU   := UI8 [1…8] <0..255>

With   <0..254> :=station address

                                          <255> :=global address

System co-ordinated functions need only use the COMMON ADDRESS OF ASDU which is identical to the link layer address.

X	One common address of ASDU (identical with station address)
	More than one common address of ASDU

E.3.3.3 SELECTION OF STANDARD INFORMATION NUMBER IN MONITOR DIRECTION

The second number octet of the INFORMATION OBJECT IDENTIFIER defines the INFORMATION NUMBER within a given FUNCTION TYPE. The full range <0..255> is used independently in the control direction as well as in monitor direction.

INFORMATION NUMBER:=   UI8 [1…8] <0..255>

a) SYSTEM FUNCTIONS IN MONITOR DIRECTION.

	INF	SEMANTICS
X	<0>	End of general interrogation
X	<0>	Time Synchronization
X	<2>	Reset FCB
X	<3>	Reset CU
X	<4>	Start/restart
X	<5>	Power on

b) STATUS INDICATIONS IN MONITOR DIRECTION

	INF	SEMANTICS
X	<16>	Auto-recloser active

	INF	SEMANTICS
	<17>	Teleprotection active
X	<18>	Protection active
X	<19>	LED reset
	<20>	Monitor direction blocked
	<21>	Test mode
X	<22>	Local parameter setting
	<23>	Characteristic 1
	<24>	Characteristic 2
	<25>	Characteristic 3
	<26>	Characteristic 4
X	<27>	Auxiliary input 1
X	<28>	Auxiliary input 2
	<29>	Auxiliary input 3
	<30>	Auxiliary input 4

c) SUPERVISION INDICATIONS IN MONITOR DIRECTION

	INF	SEMANTICS
	<32>	Measurement supervision I
	<33>	Measurement supervision V
	<35>	Phase sequence supervision
	<36>	Trip circuit supervision
	<37>	50 back-up operation
	<38>	VT fuse failure
	<39>	Teleprotection disturbed
	<46>	Group warning
	<47>	Group alarm

d) EARTH FAULT INDICATIONS IN MONITOR DIRECTION

	INF	SEMANTICS
X	<48>	Earth fault L_1
X	<49>	Earth fault L_2
X	<50>	Earth fault L_3
	<51>	Earth fault forward, i.e. line
	<52>	Earth fault reverse, i.e. busbar

e) FAULT INDICATIONS IN MONITOR DIRECTION

	INF	SEMANTICS
X	<64>	Start/pick-up L_1
X	<65>	Start/pick-up L_2
X	<66>	Start/pick-up L_3
X	<67>	Start/pick-up N
X	<68>	General trip
X	<69>	Trip L_1
X	<70>	Trip L_2
X	<71>	Trip L_3
	<72>	Trip 50 (back-up operation)
	<73>	Fault location X in ohms
	<74>	Fault forward/line

	<75>	Fault reverse/busbar
	<76>	Teleprotection signal transmitted
	<77>	Teleprotection signal received
	<78>	Zone 1
	<79>	Zone 2
	<80>	Zone 3
	<81>	Zone 4
	<82>	Zone 5
	<83>	Zone 6
X	<84>	General start/pick-up
X	<85>	Breaker failure
	<86>	Trip measuring system L_1
	<87>	Trip measuring system L_2
	<88>	Trip measuring system L_3
	<89>	Trip measuring system E
X	<90>	Trip 51
X	<91>	Trip 50
X	<92>	Trip 51N
X	<93>	Trip 50N

f) AUTO-RECLOSURE IN MONITOR DIRECTION

	INF	SEMANTICS
X	<128>	CB 'on' by AR
X	<129>	CB 'on' by long-time AR
X	<130>	AR blocked
X	<140>	AR shot counts (Private) sent by ASDU 4 and COT = 1 (Spontaneous)

g) MEASUREMENTS IN MONITOR DIRECTION

	INF	SEMANTICS
	<144>	Measurement I
	<145>	Measurements I, V
	<146>	Measurements I, V, P, Q
X	<147>	Measurements I_N, V_{EN}
X	<148>	Measurements $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, f
X	<160>	I2t breaker arcing counts (Private) sent by ASDU 4 and COT = 2 (Cyclic)

h) GENERIC FUNCTIONS IN MONITOR DIRECTION

	INF	SEMANTICS
	<240>	Read headings for all defined groups
	<241>	Read values or attributes of all entries of one group
	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	End of general interrogation of generic data
	<249>	Write entry with confirmation

	<250>	Write entry with execution
	<251>	Write entry aborted

E.3.3.4 SELECTION OF STANDARD INFORMATION NUMBER IN CONTROL DIRECTION

The INFORMATION NUMBER <245> uses ASDU 10 with NGD = 0

a) SYSTEM FUNCTIONS IN CONTROL DIRECTION

	INF	**SEMANTICS**
X	<0>	Initiation of general interrogation
X	<0>	Time synchronization

b) GENERAL COMMANDS IN CONTROL DIRECTION

	INF	**SEMANTICS**
X	<16>	Auto-recloser on/off
	<17>	Teleprotection on/off
	<18>	Protection on/off
X	<19>	LED reset
	<23>	Activate characteristic 1
	<24>	Activate characteristic 2
	<25>	Activate characteristic 3
	<26>	Activate characteristic 4

c) GENERIC FUNCTIONS IN CONTROL DIRECTION

	INF	**SEMANTICS**
	<240>	Read headings of all defined groups
	<241>	Read values or attributes of all entries of one group
	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	General interrogation of generic data
	<248>	Write entry
	<249>	Write entry with confirmation
	<250>	Write entry with execution
	<251>	Write entry abort

E.3.3.5 FUNCTION TYPE

The first octet of the INFORMATION OBJECT IDENTIFIER defines the FUNCTION TYPE of the protection equipment used. In MIFII relay will always be:

<160> := overcurrent protection

E.3.3.6 BASIC APPLICATION FUNCTIONS

The clause defines an assortment of basic application functions that utilize standard communication services. The function are described by presenting diagrams that indicate the sequence of data units that are exchanged between controlling and controlled stations and by describing the tasks of this data units to accomplish the functions. The first two described basics application functions, namely station initialization and data acquisition by polling represent a base for the execution of further basic application functions. These two functions are performed by coordination of particular application and link services that are described on detail. Other basic application functions that may involve the utilization of polling procedures are then described without repeating details about this procedure.

	Test mode
	Blocking of monitor direction
	Disturbance data
	Generic services
	Private data

E.3.3.7 MISCELLANEOUS

Measurements are transmitted with ADSU 3 as well as with ADSU 9. As defined in 7.2.6.8, the maximum MVAL can be either 1,2 or 2,4 times the rated value. No different rating shall be used in ADSU 3 and ADSU 9, i.e. for each measurement there is only one choice.

Max. MVAL = times rated value

Measurement	1,2	2,4
Current L_1	X	
Current L_2	X	
Current L_3	X	
Voltage L_{1-E}		
Voltage L_{2-E}		
Voltage L_{3-E}		
Active Power P		
Reactive Power Q		
Frequency f		
Voltage $L_1 - L_2$		

E.3.3.8 INTEROPERABILITY, APPLICATION LAYER

a) SELECTION OF STANDARD ADSUS IN MONITORING DIRECTION

	ADSU	MEANING
X	<1>	Time-tagged message
X	<2>	Time-tagged message with relative time
X	<3>	Measurements I
	<4>	Time-tagged measurements with relative time
X	<5>	Identification
X	<6>	Time synchronization
X	<8>	General interrogation termination
X	<9>	Measurements II
	<10>	Generic data
	<11>	Generic identification
	<23>	List of recorded disturbances
	<26>	Ready for transmission of disturbance data
	<27>	Ready for transmission of a channel
	<28>	Ready for transmission of tags
	<29>	Transmission of tags
	<30>	Transmission of disturbance values
	<31>	End of transmission

b) SELECTION OF STANDARD ADSUS IN CONTROL DIRECTION

	ADSU	MEANING
X	<6>	Time synchronization
X	<7>	General interrogation
	<10>	Generic data
X	<20>	General command
	<21>	Generic command
	<24>	Order for disturbance data transmission
	<25>	Acknowledgement for disturbance data transmission

c) SUMMARY OF PRIVATE DATA IN MIFII

FUN	INF	DESCRIPTION	GI	ASDU	COT
<160>	<140>	Reading of AR shot counts (Autoreclosure indication)	-	<4>	<1>
<160>	<160>	Measurement of I2t breaker arcing counter (Measurement)	-	<4>	<2>

E

The aim of this appendix is to explain the behavior of GE MII Family relay regarding the *dependent time overcurrent protection*.

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Follow on an example will be defined to explain the timing accuracy for 51 element.

According to the manual, the general formula for the *IEC Very Inverse Curve* is as follows:

$$T = \frac{13.5 * D}{\left(\dfrac{I}{I_{pu}}\right)^1 - 1}$$

Since *IEC Standard* does not fix time error limits for current ratios below 2 (see F.4 of this appendix for more information), GE MII Family Relays fixes a maximum error of 5% maximum permitted in all range for **I / Ipu > 2**. Care must be taken to use (in the formula) the current measured by the relay.

```
        ┌─────────────────────┐
        │   Applied Current   │
        └─────────────────────┘
                   │                          5%max. Error for I/Ipu<2
                   ▼
        ┌─────────────────────┐              3%max. Error for I/Ipu>2
        │        MIFII        │
        │  Measured current   │
        └─────────────────────┘
                   │
                   ▼
        ┌─────────────────────┐
        │      Resultant      │
        │   Operation Time    │
        └─────────────────────┘
```
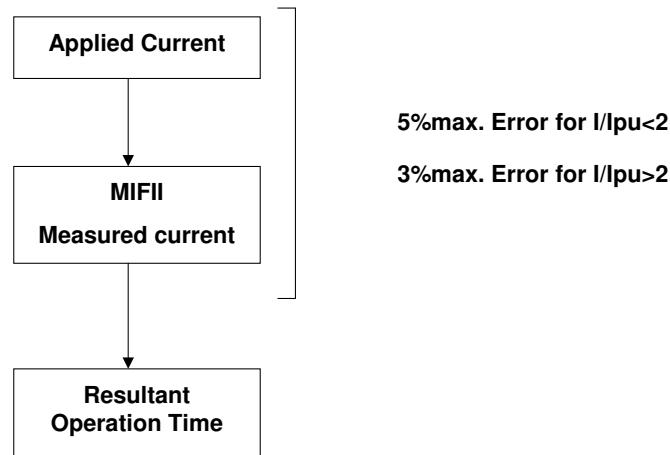
Figure F–1: MAXIMUM ERROR

The lower limit means 1.5 times the pickup multiplied by a coefficient for the error:

$$T = \frac{13.5 * 1}{(1.5 * 1.05)^1 - 1} = 23.4s$$

For the upper limit:

$$T = \frac{13.5 * 1}{(1.5 * 0.95)^1 - 1} = 31.8s$$

Using a real case, where the time dial is 0.45 for an injected current of 4 A and a pickup of 3.5 A, the limits are as follows:

$$T = \frac{13.5 * 0.45}{\left(\dfrac{4}{3.5} * 1.05\right)^1 - 1} = 30.375s \qquad T = \frac{13.5 * 0.45}{\left(\dfrac{4}{3.5} * 0.95\right)^1 - 1} = 70.875s$$

Please, take into account that the ±5% error is in the *Current Axis (X)*. Once the formula is used, the error in the *Time Axis (Y)* will be a function of the Current and the Curve, which, in this case, has a great slope:
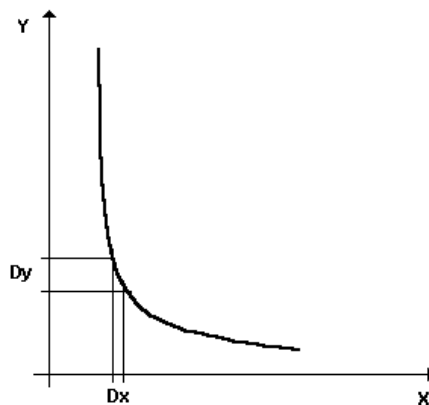
Using the values from the real case previously mentioned, we can prepare a table, where:

* **Theoretical Pickup** = Set Value * 1.05, in order to avoid undesired trips.

** **Adjusted Time:**

$$T = \frac{13.5 * 0.45}{\left(\dfrac{MeasuredCurrent}{3.5}\right)^1 - 1}$$

	PHASE A	PHASE B	PHASE C
Theoretical Pickup * (A)	3.675	3.675	3.675
Practical Pickup (A)	3.61	3.63	3.59
Estimated Current Error (%)	-1.77	-1.22	-2.31
Injected Current (A)	4	4	4
Measured Current (A)	3.93	3.95	3.91
Theoretical Time (s)	42.52	42.52	42.52
Adjusted Time ** (s)	49.45	47.25	51.86
Real Time (s)	50.1	50.2	50.2
Timing Error (s)	-0.65	-2.95	+1.66
Timing Error (%)	-1.29	-5.88	+3.31

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This table shows the relation between *current accuracy* (Estimated Current Accuracy) and *timing accuracy* (Timing Error). The current error is below 3%, as stated in the specifications, and the timing error will depend on it, according to the general formula.

Though the example is for a 3 phase relay, the same is applicable to single phase ones.

Standard Reference: **IEC 255-3 2nd Edition 1989-05**

There is a *General Section* (page 7) in which we have several definitions. The main concepts for us are: *the setting value of the characteristic quantity (* **Gs**) and the *threshold value of the characteristic quantity* (**Gt**).

According to this definition (and with *Current* as the *characteristic quantity*), **Gs** will be the setting value of the pickup and **Gt** the lowest value for the relay to trip.

The two criteria that may apply for the trip, according to the *IEC Standard*, are:

1)**Gs** $\leq$ **Gt** $\leq$ 1.3***Gs**

Therefore, there is a 30% tolerance.

In **GE MIFII Relays**, this is the followed criterion, with a 5% tolerance.

2)**Gt = Gs**

Not really recommended, in order to avoid undesired trips.

In relation to the timing accuracy for dependent time relays, *Section 4.3.2* (page 13), the reference limiting error is defined by an error (declared by the manufacturer), which may be multiplied by coefficients for different values within the effective range of the characteristic quantity.

For relays with decreasing time function, this *range* lies between **2** and **20 times Gs**.

This *reference limiting error* may be defined as:

a)A theoretical curve:

Gs < Gt < 1.3Gs
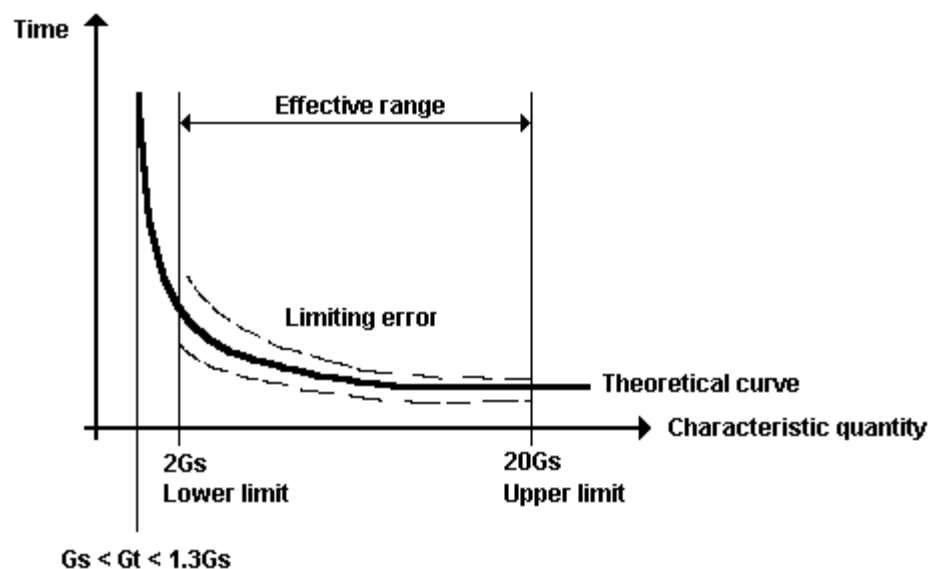
b)An assigned error, multiplied by stated factors within the effective range:

Value of characteristic quantity as multiple of setting value (G_S)	2	5	10	20
Limiting error as multiple of assigned error	2.5	1.5	1	1

c)In other cases, the manufacturer shall state the reference.

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The GE MIFII Relay works according to its specifications and to the IEC Standard as well.

In the real case used for this report, the specification would be the following range:

Lower time limit $\leq$ **Time to trip** $\leq$ *Upper time limit*

$$30.375 \leq 50.1 \leq 70.875$$

I*EC Standard* does not specify timing accuracy for pickup values lower than **2Gs**; therefore, the manufacturer's specified accuracy must be applied.

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