GE Consumer & Industrial

Multilin

F650

Digital Bay Controller

User manual

GEK-113000T

Firmware version: 3.7X

EnerVista F650 Setup version: 3.7X

ISO9001 REGISTERED

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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.

BEFORE ATTEMPTING TO INSTALL OR USE THE RELAY, IT IS IMPERATIVE THAT ALL WARNINGS AND CAUTIONS IN THIS MANUAL ARE REVIEWED TO HELP PREVENT PERSONAL INJURY, EQUIPMENT DAMAGE, AND/OR DOWNTIME.

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.

Figure 1–1: FRONT VIEW OF F650 UNITS

1.1.1.1 COMMUNICATION BOARDS WITHDRAWAL / INSERTION

WARNING: MODULE WITHDRAWAL AND INSERTION SHALL ONLY BE PERFORMED BY DULY QUALIFIED SERVICE PERSONNEL. FOR PERSONAL SECURITY PURPOSES, BEFORE ACCOMPLISHING ANY WITHDRAWAL OR INSERTION OPERATION, THE RELAY MUST BE POWERED OFF AND ALL THE REAR TERMINALS MUST BE POTENTIAL FREE. THE RELAY MUST BE GROUNDED USING THE REAR GROUNDING SCREW.

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

Figure 1–2: shows the location of communication modules on the rear part of the relay. Qualified personnel must carry out the insertion or extraction of the communication boards only after interrupting the **relay** auxiliary voltage and ensuring that all the rear terminals are potential free.

Communication boards are installed on the rear of the unit, the upper port being reserved for the asynchronous communications board and CAN, and the lower port for the ETHERNET board in any of its configurations.

Before performing any of these actions, **control power must be removed from the relay and all the rear terminals must be potential free.** 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.

WITHDRAWAL: Loosen the small screws that keep the faceplate in place and extract the module.

INSERTION: Insert the module and press it firmly in the case, until it is completely fixed. After this, bolt the faceplate screws and replace the control power. Check that the relay is fully operative.

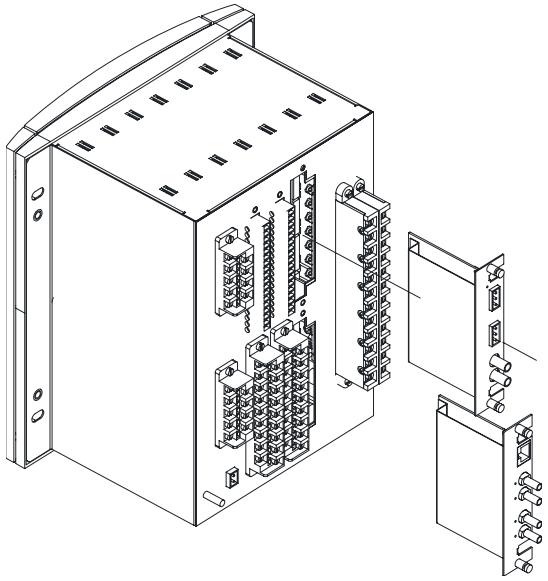

Figure 1–2: MODULE WITHDRAWAL/INSERTION

***GE Multilin* will not be responsible for any damage of the relay, connected equipment or personnel whenever these safety rules are not followed.**

1.1.1.2 MAGNETIC MODULE TERMINALS

The transformer module for the VTs and CTs is already connected to a female connector screwed to the case. The current inputs incorporate shorting bars, so that the module can be extracted without the need to short-circuit the currents externally. It is very important, for safety reasons not to change or switch the terminals for CTs and VTs.

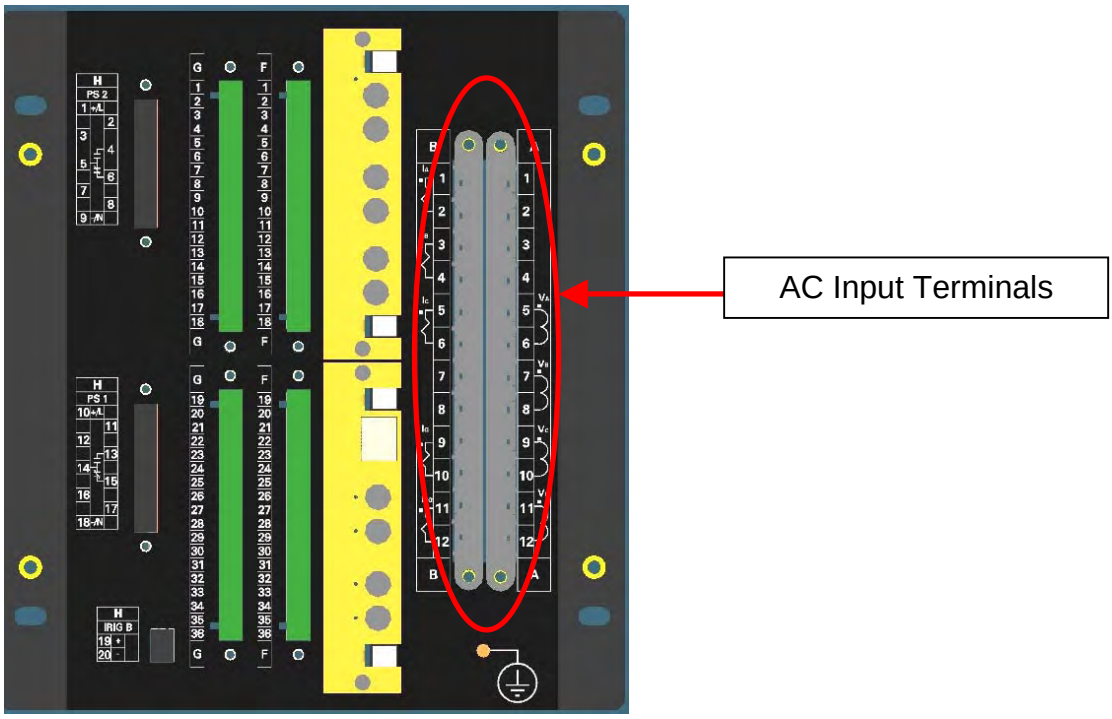

Figure 1–3: REAR VIEW OF F650 UNIT

***GE Multilin* will not be responsible for any damage of the relay, connected equipment or personnel whenever these safety rules are not followed.**

1

Unwrap the relay and inspect the relay for physical damage.

Verify that the model on the label on the side of the relay matches the model ordered.

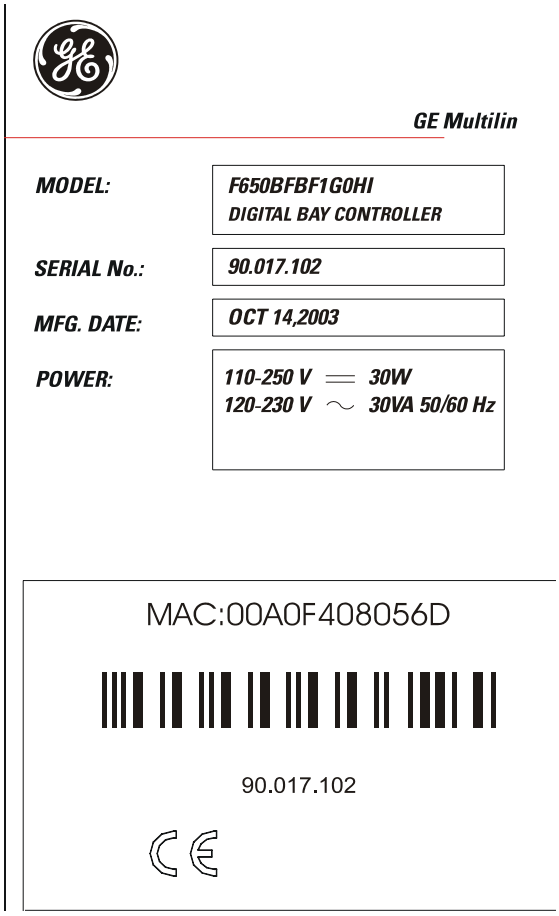

Figure 1–4: IDENTIFICATION LABEL (A4455P6)

Please ensure that you received the following items with your relay:

- Mounting screws for fixing the relay to a cabinet
- CD containing EnerVista 650 Setup software
- Wiring diagram
- Certificate of Compliance

For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin Home Page www.geindustrial.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 is not intended to cover all the details of the 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.

The F650 ground screw shown in Figure 1–5: must be correctly grounded.

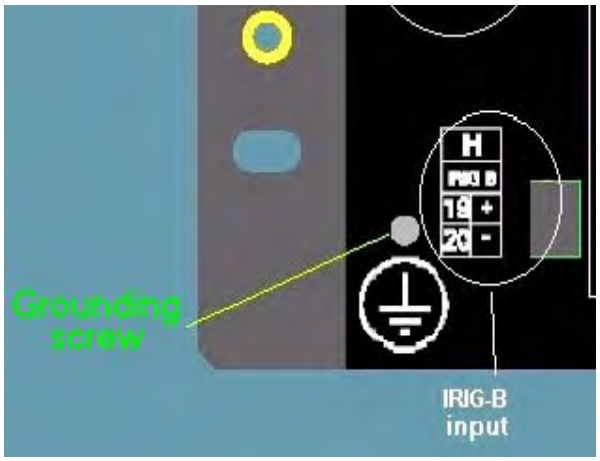

Figure 1–5: LOCATION OF GROUNDING SCREW

Before communicating with a F650 unit through the front serial port, please ensure that the computer is grounded.

In case of using a laptop, it is recommended not to have it connected to its power supply. In many cases it might not be correctly grounded either due to the power supply or to the connector cables used.

This is required not only for personal protection, but also to avoid a potential voltage difference between the relay's serial port and the computer's port, which could produce permanent damage to the computer or the relay.

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

1.2.1 INTRODUCTION TO 650 FAMILY OF RELAYS

Historically, substation protection, control and metering functions were performed with electromechanical equipment. This first generation of equipment was gradually replaced by analog electronic equipment (called static devices), most of which emulated the single-function approach of their electromechanical precursors. Both of these technologies required expensive cabling and auxiliary equipment to produce functioning systems.

Recently, digital electronic equipment has begun to provide protection, control and metering functions. Initially, this equipment was either single function or had very limited multi-function capability, and did not significantly reduce the cabling and auxiliary equipment required. However, recent digital relays have become quite multi-functional, reducing cabling and auxiliaries significantly. These devices also transfer data to central control facilities and Human Machine Interfaces using electronic communications. The functions performed by these products have become so broad that many users prefer the term IED (Intelligent Electronic Device).

It is obvious to station designers that the amount of cabling and auxiliary equipment installed in stations can be even further reduced, to 20% to 70% of the levels common in 1990, to achieve large cost reductions. This requires placing even more functions within the IEDs.

Users of power equipment are also interested in reducing cost by improving power quality and personnel productivity, and as always, in increasing system reliability and efficiency. These objectives are realized through software which is used to perform functions at both the station and supervisory levels. The use of these systems is growing rapidly.

High speed communications are required to meet the data transfer rates required by modern automatic control and monitoring systems. In the near future, very high speed communications will be required to perform protection signalling. This has been established by the IEC 61850 standard.

IEDs with capabilities outlined above will also provided significantly more power system data than is presently available, enhance operations and maintenance, and permit the use of adaptive system configuration for protection and control systems. This new generation of equipment must also be easily incorporated into automation systems, at both the station and enterprise levels.

1.2.2 HARDWARE ARCHITECTURE

650 family of relays has been designed to meet the goals described above that are appearing nowadays in the environment of new substations.

The 650 is a digital-based device containing a central processing unit (CPU) that handles multiple types of input and output signals. The 650 family can communicate over a local area network (LAN) with an operator interface, a programming device, or another 650 or UR device.

The **CPU module** contains firmware that provides protection elements in the form of logic algorithms, as well as programming logic gates, timers, and latches for control features. It incorporates two internal processors, one for generic use and a second one dedicated for communications.

Input Elements accept a variety of analog or digital signals from the field. The 650 isolates and converts these signals into logic signals used by the relay.

Output Elements convert and isolate the logic signals generated by the relay into digital signals that can be used to control field devices.

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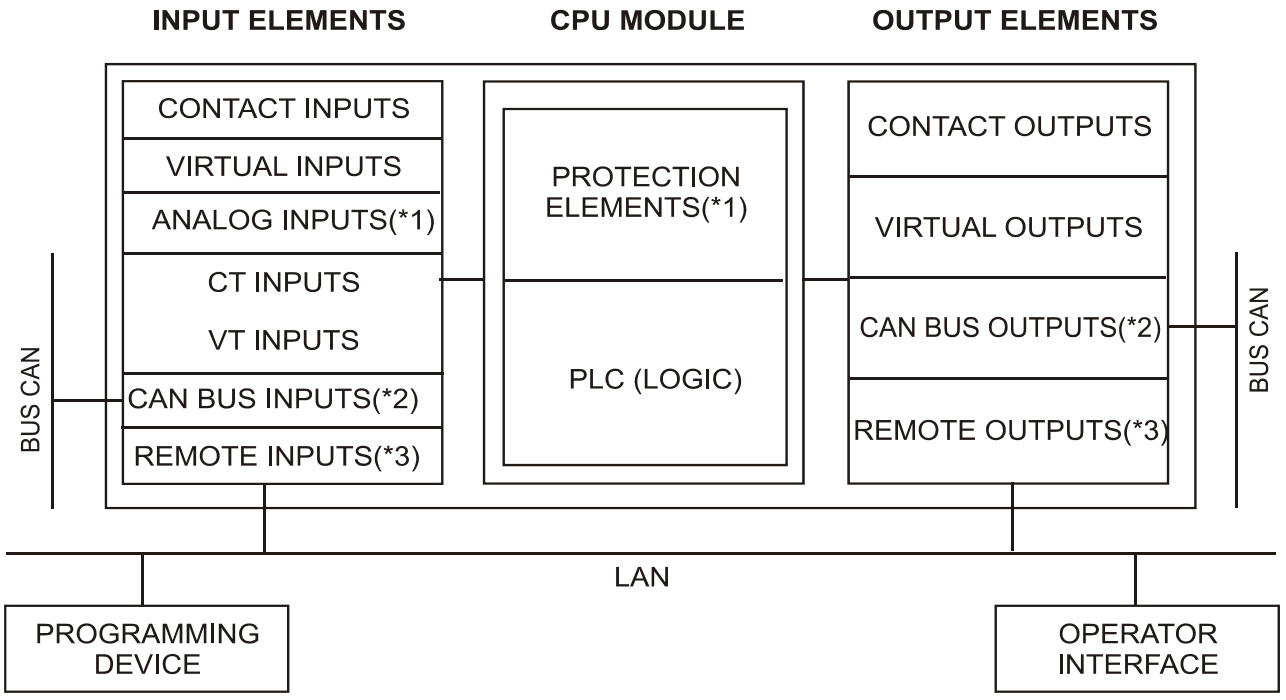


(*1) Analog CT and VT Inputs and Protection Elements are not available in C650 models
(*2) Can Bus Inputs/Outputs are not available in W650 models
(*3) Remote Inputs and Outputs are not available in G650 and C650 models

Figure 1–6: 650 CONCEPT BLOCK DIAGRAM

Contact Inputs/Outputs are signals associated to the physical input/output contacts in the relay

CT and VT inputs are signals coming from the inputs of current and voltage transformers, used for monitoring the power system signals. Not available for C650 models.

CAN Bus Inputs/Outputs: are signals associated to physical input/output contacts from independent modules connected to the 650 unit via a CAN Bus. Not available for W650 models.

PLC: Programmable Logic Controller. Control module that enables the unit configuration (assignment of inputs/outputs) and the implementation of logic circuits.

Protection Elements: Relay protection elements, for example: Overcurrent, overvoltage, etc. Not available for C650 models.

Remote inputs and outputs provide a means of sharing digital point state information between remote devices using IEC 61850 GSSE and GOOSE messages. Not available for G650 and C650 models.

Analog Inputs are signals associated with transducers.

1.2.3 SOFTWARE ARCHITECTURE

The firmware (software embedded in the relay) has been designed using object oriented programming techniques (OOP). These techniques are based on the use of objects and classes, and provide the software architecture with the same characteristics as the hardware architecture, i.e., modularity, scalability and flexibility.

1.2.4 COMMUNICATIONS ARCHITECTURE

The main processor performs protection, control, and communication functions, incorporating two internal processors, one for generic use and a second one dedicated for communications.

A dedicated serial port is used for communication between the main processor and the human-machine interface. The serial connection provides great immunity against electromagnetic disturbances, thus increasing system safety.

All F650 units incorporate an RS232 serial port on the front of the relay. There is also a possibility to incorporate up to two additional communication modules on the rear.

One of the modules provides asynchronous serial communications, using different physical media (RS485, plastic or glass fiber optic) depending on the selected model. The module incorporates two identical ports, COM1 and COM2. The COM2 port is multiplexed with the front port. Additionally, this module may incorporate a port for CAN BUS communications, used for the connection to the Remote CAN BUS I/O module. This feature allows increasing up to 100% the I/O capability, when the maximum number of I/Os available inside the relay is not enough for a specific application.

Available options are:

Table 1–1: REAR SERIAL COMMUNICATIONS BOARD 1

BOARD CODE	FUNCTIONALITY
F	Without additional communication ports
A	Two RS485 ports
P	Two Plastic F.O. ports
G	Two Glass F.O. ports
X	Two RS485 ports and a CAN port for remote CAN Bus Inputs/Outputs
Y	Two Plastic F.O. ports and a CAN port for remote CAN Bus Inputs/Outputs (fiber)
Z	Two Glass F.O. ports and a CAN port for remote CAN Bus Inputs/Outputs (fiber)
C	CAN port for remote CAN Bus I/O (cable)
M	RS485 + RS485 port and a CAN port for remote CAN bus I/O (cable)

The other module provides Ethernet communications (COM3 port), using 10/100BaseTX (self-negotiable speed) or 100BaseFX connectors, depending on the selected model. The most complete models include a double redundant 100BaseFX fiber optic port. Redundancy is provided at the physical level; the unit incorporates internally duplicated and independent controllers for extended system reliability and accessibility.

Available Options are:

Table 1–2: REAR ETHERNET COMMUNICATIONS BOARD 2

BOARD CODE	FUNCTIONALITY
B	One 10/100BaseTX port (self-negotiable speed)
C	One 10/100BaseTX port and one 100BaseFX port.
D	One 10/100BaseTX port and redundant 100BaseFX ports
E	Redundant 10/100BaseTX ports

For options C and D it is required to select the active physical media, by means of an internal selector inside the module. The factory configuration for this selection is the 10/100BaseTX port.

Finally, internal communication with input and output modules is performed via an internal CAN bus, independent from the one used for remote CAN BUS I/Os. This fact provides increased communication speed, as well as the possibility of acknowledgement of modules, abnormalities, etc. As this is a serial port supporting a communications protocol, it provides extraordinary immunity against external or internal disturbances.

1

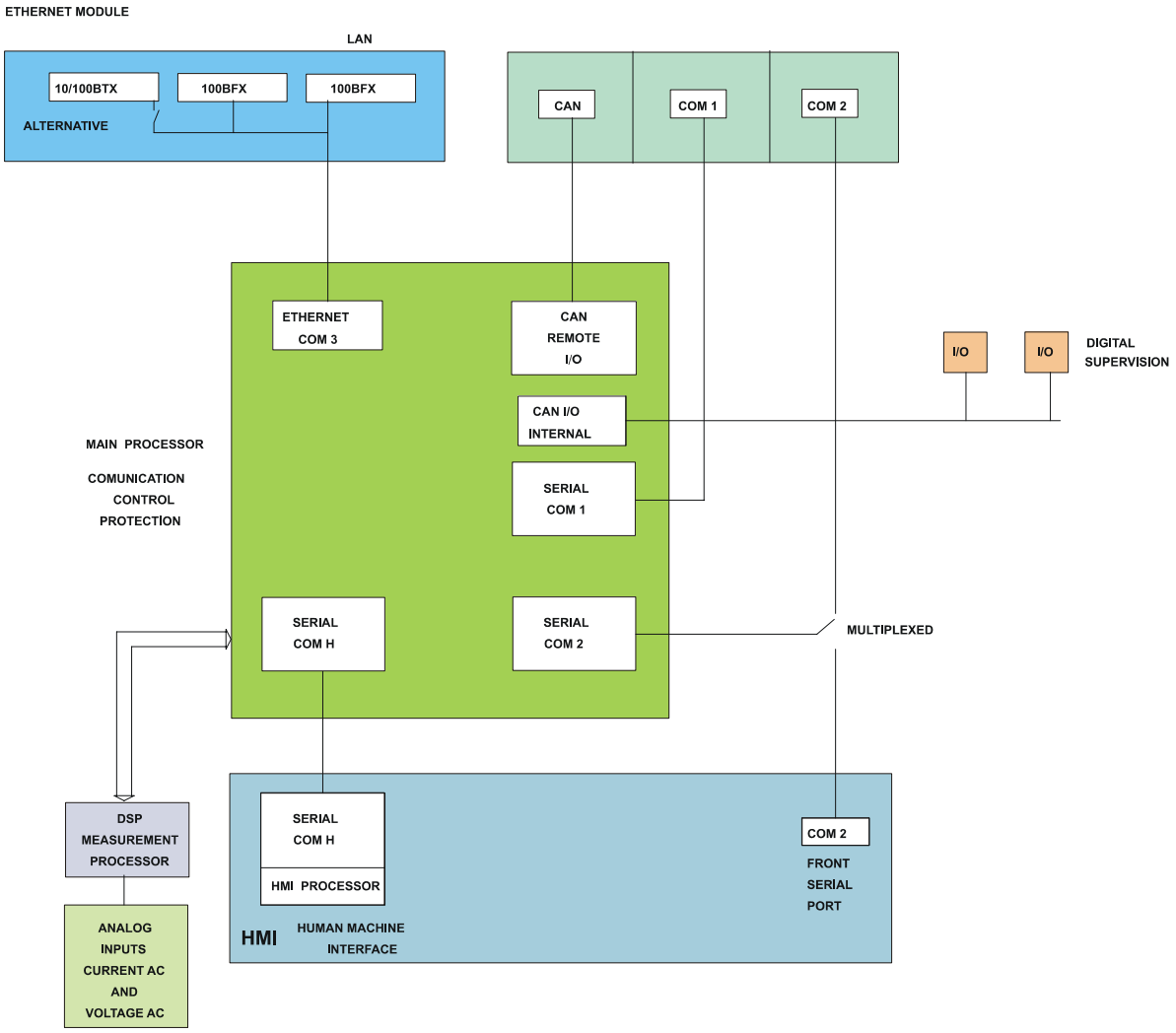


Figure 1–7: COMMUNICATIONS ARCHITECTURE (B6816F1)

1.3.1 SYSTEM REQUIREMENTS

The EnerVista 650 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 650 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/or Ethernet port for communications to the relay

1.3.2 INSTALLATION

After ensuring the minimum requirements for using EnerVista 650 Setup are met (see previous section), use the following procedure to install the EnerVista 650 Setup from the 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 1–8: LAUNCHPAD WINDOW

1

5. In the EnerVista Launch Pad window, click the **Add Product** button and select the "F650 Bay Controller" 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 F650.

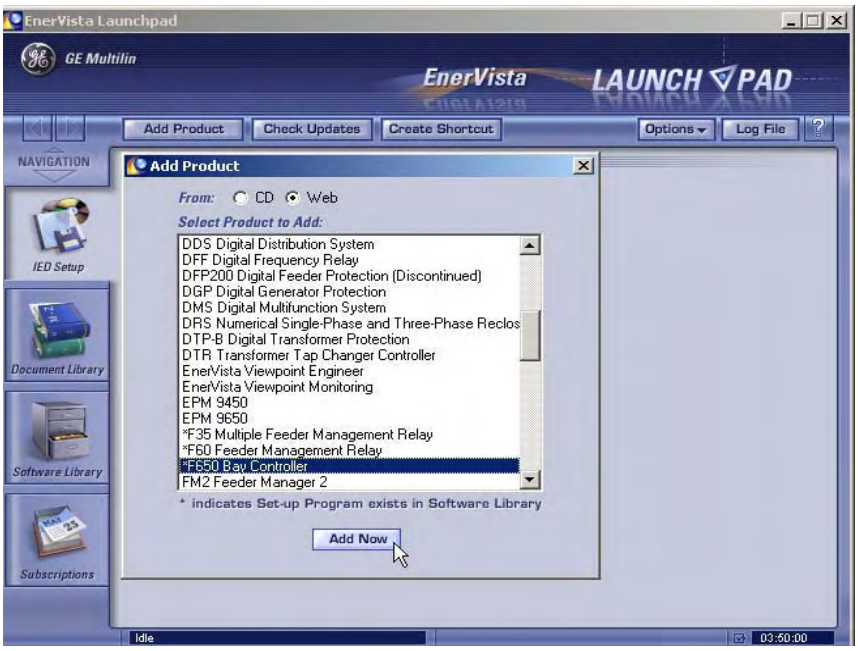


Figure 1–9: ADD PRODUCT WINDOW

6. If "Web" option is selected, choose the F650 software program and release notes (if desired) from the list and click the **Download Now** button to obtain the installation program.

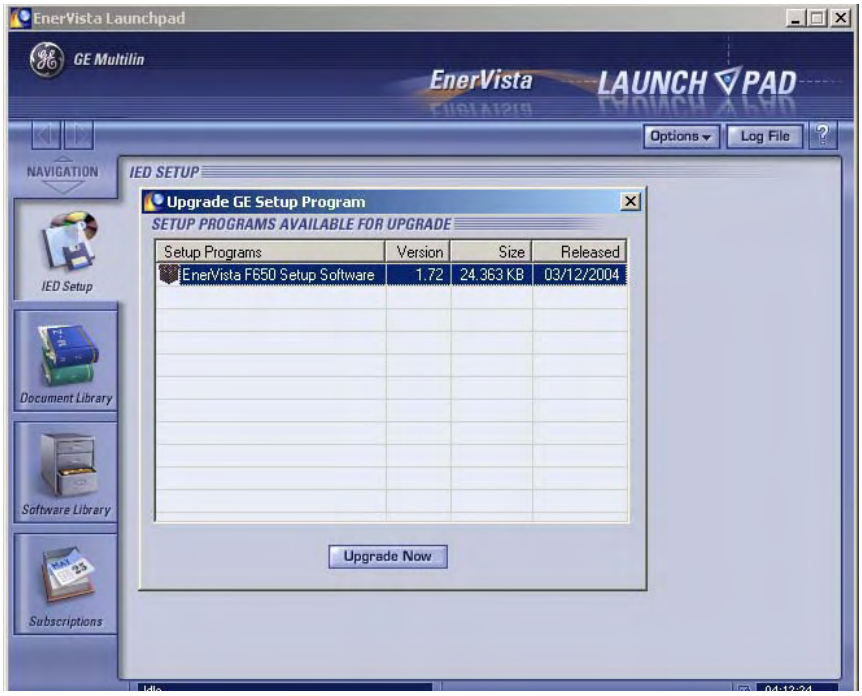


Figure 1–10: WEB UPGRADE WINDOW

7. EnerVista Launchpad will obtain the installation program from the Web or CD. Once the download is complete, double-click the installation program to install the EnerVista 650 Setup software.
8. Select the complete path, including the new directory name, where the EnerVista 650 Setup will be installed.
9. 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 650 Setup to the Windows start menu.
10. Follow the on-screen instructions to install the EnerVista 650 Setup software. When the **Welcome** window appears, click on **Next** to continue with the installation procedure.

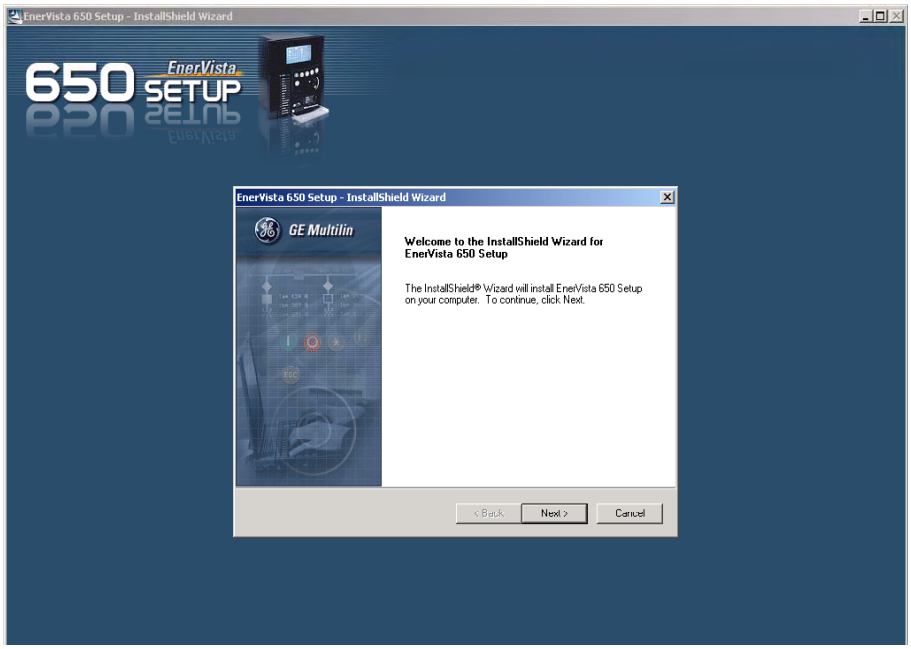


Figure 1–11: ENERVISTA 650 SETUP INSTALLATION

11. 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.

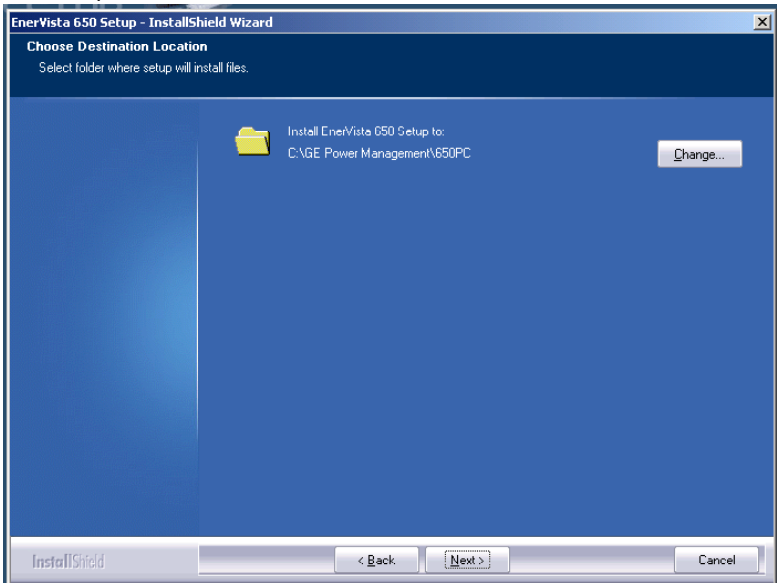


Figure 1–12: ENERVISTA 650 SETUP INSTALLATION CONT.

12. 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.

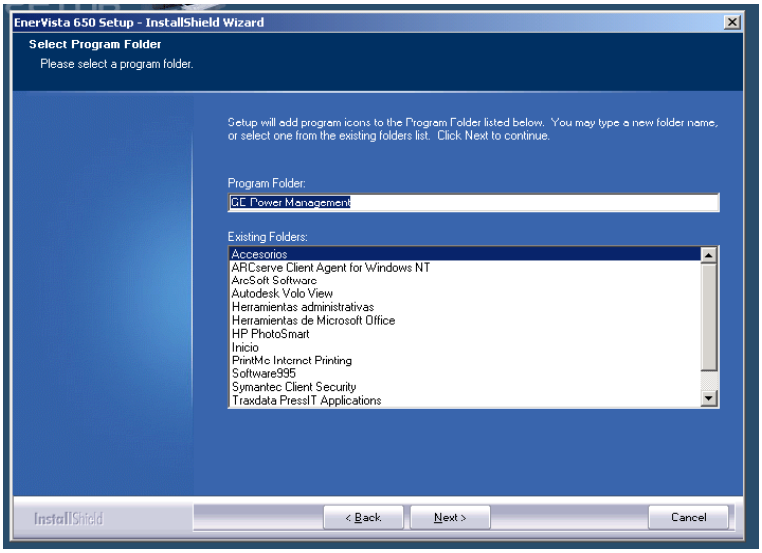


Figure 1–13: SELECT PROGRAM FOLDER

13. To finish with the installation process, select the desired language for startup.

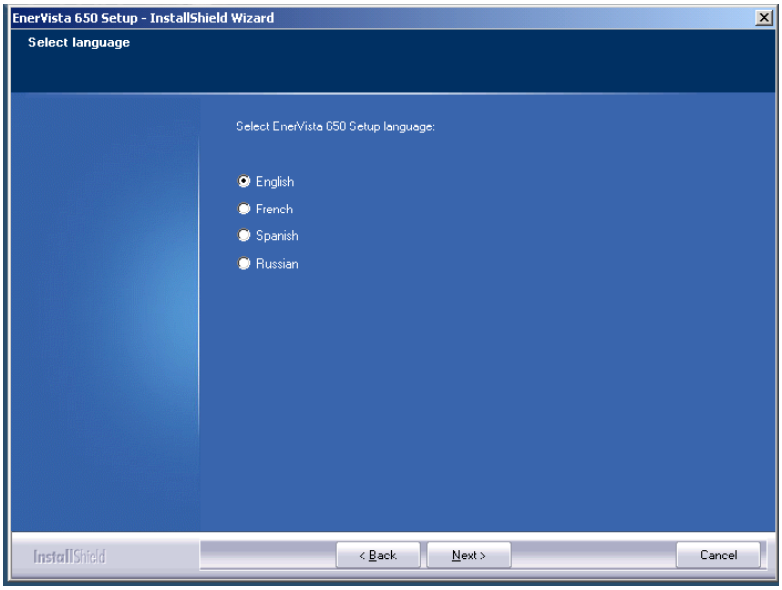


Figure 1–14: LANGUAGE WINDOW

14. Click **Finish** to end the installation. The F650 device will be added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

Figure 1–15: ENERVISTA LAUNCHPAD

1.3.3 CONNECTING ENERVISTA 650 SETUP WITH F650

This section is intended as a quick start guide to using the EnerVista 650 Setup software. Please refer to section 4.1 in this manual for more information about the EnerVista 650 Setup software interface.

a) CONFIGURING AN ETHERNET CONNECTION

Before starting, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista CD or online from http://www.GEindustrial.com/multilin (see previous section for installation instructions).
2. Go to "***Communication>Computer***" and enter the following data referring to communications:
3. Select Control Type as MODBUS TCP/IP from the drop-down list. This option will display a number of interface parameters that must be entered for proper Ethernet communications.
4. Enter the relay IP address (from "***Setpoint>Product Setup >Communication Settings>Network>IP ADDRESS***") in the IP Address field in MODBUS TCP/IP SETUP.
5. Enter the relay ModBus address (from "***Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Address COM1/COM2 setting***") in the Unit Identifier (Slave Address) field.
6. Enter the ModBus port address (from "***Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Port Number***" setting) in the ModBus Port field.
7. The Device has now been configured for Ethernet communications. Proceed to press the ON button to begin communicating.

b) CONFIGURING AN RS232 CONNECTION

Before starting, verify that the RS232 serial cable is properly connected to the RS232 port on the front panel of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista CD or online from http://www.GEindustrial.com/multilin (see previous section for installation instructions).
2. Go to "***Communication>Computer***" and enter the following data referred to communications:
3. Select Control Type as No Control Type from the drop-down list. This option will display a number of interface parameters that must be entered for proper serial communications.
4. Enter the relay Slave Address ("***Setpoint>Product Setup >Communication Settings>ModBus Protocol***" menu) in the Slave Address field. The default value is 254.
5. Enter the physical communications parameters (Baudrate and parity settings) from the ***"Setpoint>Product Setup >Communication Settings>Serial Ports***" menu, in their respective fields. Default values are 19200 for baudrate and none for parity.
6. The Device has now been configured for RS232 communications. Proceed to press the ON button to begin communicating.

1.4.1 MOUNTING & WIRING

Please refer to Chapter 3. Hardware for detailed mounting and wiring instructions.

1.4.2 650 COMMUNICATIONS

The Enervista 650 Setup software communicates to the relay via the faceplate RS232 port or the rear RS485/Ethernet ports. To communicate via the faceplate RS232 port, a standard “straight-through” serial cable is used. The DB-9 male end is connected to the relay and the DB-9 or DB-25 female end is connected to the PC COM1 or COM2 port as described in Figure 1–16:.

To communicate through the F650 rear RS485 port from a PC RS232 port, the GE Multilin RS232/RS485 converter box is required. This device (catalog number F485) connects to the computer using a “straight-through” serial cable. A shielded twisted-pair (20, 22 or 24 AWG according to American standards; 0.25, 0.34 or 0.5 mm2 according to European standards) connects the F485 converter to the F650 rear communication port.

In order to minimize communication errors that could be caused by external noise, it is recommended to use a shielded twist pair. In order to avoid loops where external currents could flow, the cable shield must be grounded only at one end.

The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in an RC network (i.e. 120 ohm, 1 nF). This circuit is shown on Figure 1–17: RS485 CONNECTION FOR 650 UNITS, associated to text Zt(*).

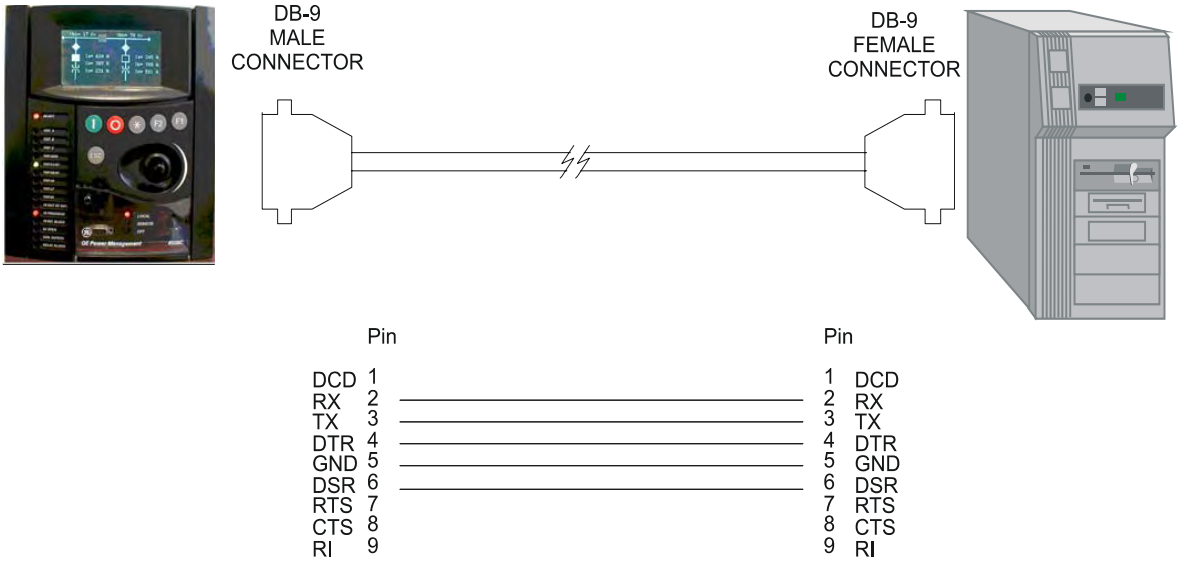


Figure 1–16: RELAY- PC CONNECTION FOR RS232 FRONT PORT

To minimize errors from noise, the use of shielded twisted pair wire is recommended. For correct operation, polarity must be respected, although a different polarity will not damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result confusing sometimes, as the RS485 standard refers only to terminals named “A” and “B”, although many devices use terminals named “+” and “-“.

As a general rule, terminals “A” should be connected to terminals “-“, and terminals “B” to “+”. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. 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 to the recommended.

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

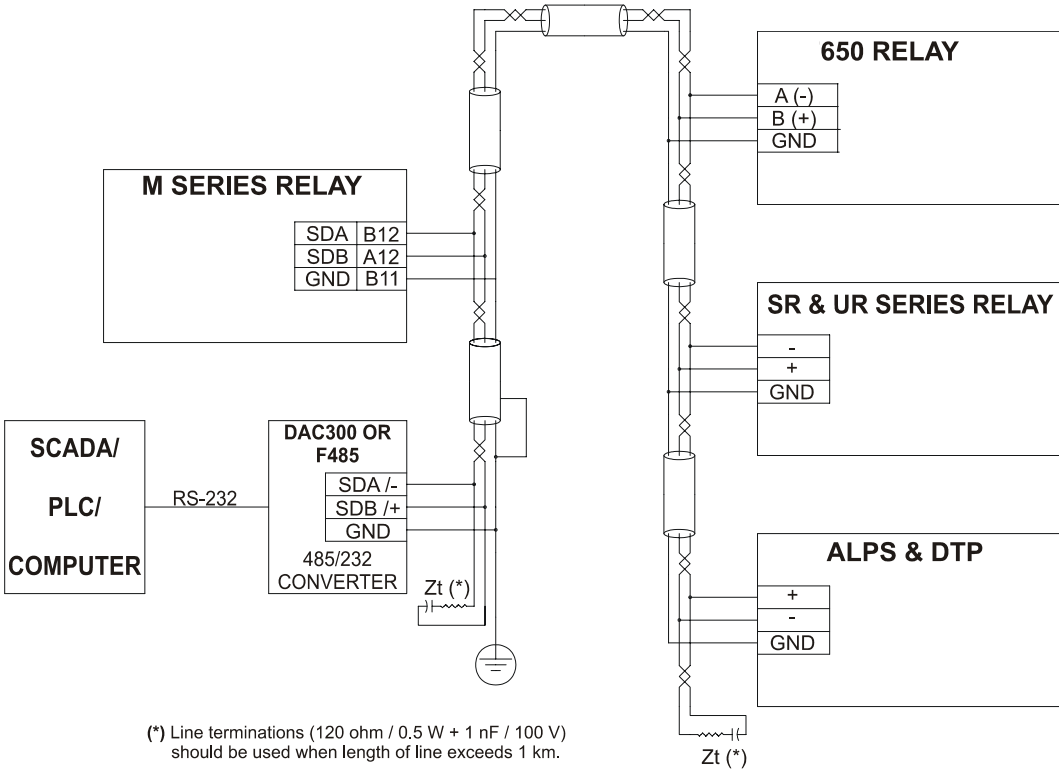


Figure 1–17: RS485 CONNECTION FOR 650 UNITS

To communicate through the F650 rear Ethernet port from a PC a crossover cable is required. If the connection is performed through a hub or a switch, a direct Ethernet cable is required.

1.4.3 FACEPLATE DISPLAY

All messages are displayed on a 20x4 character LCD display. An optional graphic display is also available. Messages are displayed in different languages according to selected model.

1.4.4 MAINTENANCE

F650 requires a minimum amount of maintenance when it is commissioned into service. F650 is a microprocessor based relay and its characteristics do not change over time. As such no further functional tests are required. However, it is recommended that maintenance on the F650 be scheduled with other system maintenance. The maintenance may involve the following:

In-service maintenance:

1. Visual verification of the analog values integrity such as voltage and current (in comparison to other devices on the corresponding system).
2. Visual verification of active alarms, relay display messages and LED indications.
3. Visual inspection for any damage, corrosion, dust or loose wires.

4. Event recorder file download with further event analysis.

Out-of-service maintenance:

1. Check wiring connections for firmness.
2. Analog values (current, voltages, analog inputs) injection test and metering accuracy verification. Calibrated test equipment is required.
3. Protection elements setpoints verification (analog values injection or visual verification of setting file entries against relay settings schedule).
4. Contact inputs and outputs verification. This test can be conducted by direct change of state forcing or as part of the system functional testing.
5. Visual inspection for any damage, corrosion or dust.
6. Event recorder file download with further events analysis.

Unscheduled maintenance such as during a disturbance causing system interruption:

1. View the event recorder and oscillography or fault report for correct operation of inputs, outputs and elements.

If it is concluded that the relay or one of its modules is of concern, contact GE Multilin or one of its representative for prompt service.

2.1.1 F650 OVERVIEW

F650 is a protection, control, monitoring, metering and registering unit, suitable for many different applications, such as main protection for distribution feeders and transmission lines, as well as backup protection for transformers, busbars, capacitor banks, etc.

Overvoltage and undervoltage protection, overfrequency and underfrequency protection, breaker failure protection, directional current supervision fault diagnostics and programmable logic functions are provided.

This relay also provides phase, neutral, ground and sensitive ground, instantaneous and time overcurrent protection. The time overcurrent function provides multiple curve shapes or FlexCurves™ for optimum co-ordination. Automatic reclosing, synchrocheck, and line fault locator features are also provided.

Voltage, current, power, and energy metering is built into the relay as a standard feature. Current parameters are available as total waveform RMS magnitude, or as fundamental frequency only RMS magnitude and angle (phasor).

Diagnostic features include a sequence of records. The internal clock used for time-tagging can be synchronized with an IRIG-B signal or via the SNTP protocol over the Ethernet port. This precise time stamping allows the sequence of events to be determined throughout the system. Oscillography data capture may be set to record the measured parameters before and after the event for viewing on a personal computer (PC). These tools significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

A faceplate RS232 port may be used to connect to a PC for the programming of settings and the monitoring of actual values.

A variety of communications modules are available. Two rear RS485 ports allow independent access by operating and engineering staff. All serial ports use the Modbus® RTU protocol. Optional communications modules include a 10BaseF Ethernet interface which can be used to provide fast, reliable communications in noisy environments.

Another option provides two 10BaseF fiber optic ports for redundancy. The Ethernet port supports IEC 61850, Modbus®/TCP, DNP 3.0 and TFTP protocols, and allows access to the relay via any standard web browser. The IEC 60870-5-104 protocol is supported on the Ethernet port.

The F650 IEDs use flash memory technology which allows field upgrading as new features are added:

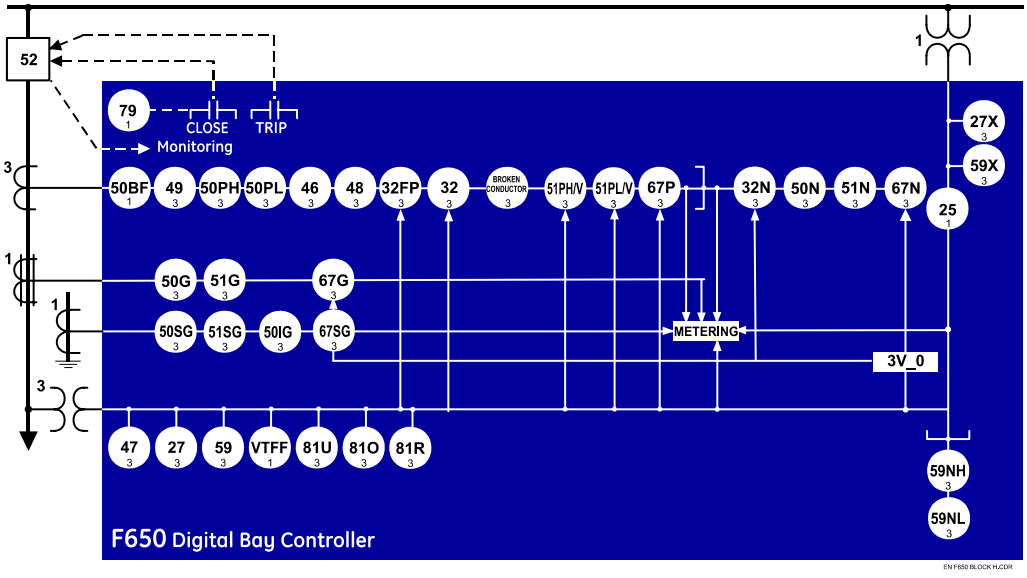


Figure 2–1: FUNCTIONAL BLOCK DIAGRAM

DEVICE NUMBER	FUNCTION
25	Synchronism Check
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Directional Power
32FP	Forward Power
32N	Wattmetric Zero-Sequence Directional
46	Negative Sequence Time Overcurrent
47	Negative Sequence Overvoltage
48	Locked Rotor
49	Protection against Overload by thermal model
50BF	Breaker Failure
50G	Ground Instantaneous Overcurrent (measured from 4th current transformer)
50N	Neutral Instantaneous Overcurrent (calculated from the phase currents)
50P	Phase Instantaneous Overcurrent (two elements, High and Low)
50SG	Ground Instantaneous Overcurrent for sensitive ground systems (measured from 5th current transformer)
50ISG	Isolated Ground Instantaneous Overcurrent (measured from 5th current transformer)
51G	Ground Time Overcurrent (measured from 4th current transformer)
51N	Neutral Time Overcurrent (calculated from the phase currents)
51P	Phase Time Overcurrent with Voltage Restraint (two elements, High and Low)
51SG	Ground Time Overcurrent for sensitive ground systems (measured from 5th current transformer)
59N	Neutral Overvoltage (two elements, High and Low)
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
67P	Phase Directional
67N	Neutral directional
67G	Ground Directional
67SG	Sensitive Ground Directional
79	Autoreclose (Four shot recloser)
810	Overfrequency
81U	Underfrequency
81R	Frequency Rate of Change
I2/I1	Broken Conductor
VTFF	VT Fuse Failure
	Load Encroachment

INPUTS/OUTPUTS
9 Analog Inputs: 5 current inputs (3 for phases, 1 for ground, 1 for sensitive ground), 4 voltage inputs (3 for phases, 1 for busbar or auxiliary voltage)
Digital Programmable Contact Inputs (up to 64)
Digital Programmable Contact Outputs (up to 16)
32 Latched Virtual Inputs 32 Self-Reset Virtual Inputs
Virtual Outputs (up to 512)
Tripping and closing circuit supervision
Remote Inputs/Outputs (GSSE and GOOSE messages)
Analog Inputs (dCmA)

METERING
Metering Current for phases, ground and sensitive ground inputs
Voltages phase to phase and phase to ground
Real, Reactive and Apparent Power and Power Factor
Three Phase Energy
Frequency
Sequence components of currents and voltages
Pulse Counters
Analog Comparators

COMMUNICATIONS
Front RS232 port, Two rear RS485/ fibre optic ports, 10/100 TX and 100 FX Mbps Ethernet port
ModBus Communications RTU and over TCP/IP
DNP Multimaster (3.0 Level 2)
IEC 870-5-104
ModBus User Map
IEC 61850

USER INTERFACE
Alphanumerical display (4x20)
Graphic display (16 x 40)
User Programmable LEDs (15)
User Programmable Keys (up to 5)
Easy menu management thanks to shuttle key
Configurable One-Line Diagram (Graphic model only)
Phasor Diagram (available in EnerVista 650 Setup)

RECORDS
Data Logger
Demand
Event Recorder (up to 128 configurable events)
Fault Locator and Fault report (up to 10 records)
Oscillography (up to 20 records)
Snapshot Events (up to 479)

OTHERS
Breaking Arcing Current (I^2t)
Breaker Control
IRIG-B synchronization/SNTP
Logic Equations (PLC Editor)
Settings Groups (up to 3)
Operations (up to 24)
Web Server Application

F650 units are supplied as ½ 19” rack, 6 units high, containing the following modules: power supply, CPU, I/O modules, communication modules. The required information to completely define an F650 model is shown on Table 2–1:

Table 2–1: ORDERING CODE

F650	-	-	-	F	-	G	-	-	-	-	-	DESCRIPTION
	B											Basic Display (See note 2)
	M											Graphic Display with Standard Symbols (See note 2)
	N											Graphic Display with IEC symbols (See note 2)
												REAR SERIAL COMMUNICATIONS BOARD 1
		F										None
		A										Redundant RS485
		P										Redundant plastic fiber optic
		G										Redundant glass fiber optic
		X										Redundant RS485 + fiber remote CAN bus I/O
		Y										Redundant plastic fiber optic + fiber remote CAN bus I/O
		Z										Redundant glass fiber optic + fiber remote CAN bus I/O
		C										Cable Remote CAN Bus I/O
		M										RS485 + cable Remote CAN Bus I/O
												REAR ETHERNET COMMUNICATIONS BOARD 2
			B									10/100 Base TX
			C									10/100 Base TX + 100 Base FX
			D									10/100 Base TX + Redundant 100 Base FX
			E									Redundant 10/100 Base TX
												I/O BOARD IN SLOT F
					1							16 Digital Inputs + 8 Outputs
					2							8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits
					4							32 Digital Inputs
					5							16 Digital Inputs + 8 Analog Inputs
												I/O BOARD IN SLOT G
							0					None
							1					16 Digital Inputs + 8 Outputs
							4					32 Digital Inputs (see Note 1)
							5					16 Digital Inputs + 8 Analog Inputs (See Note 1)
												AUXILIARY VOLTAGE
								LO				24-48 Vdc (range 19.2 – 57.6)
								HI				110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
								LOR				Redundant LO
								HIR				Redundant HI
												LANGUAGE
									-			English/English
									C			Chinese/English (See Note 2)
									F			French/English
									P			Russian/English (See Note 2)
									S			Spanish/English
												COMMUNICATION PROTOCOL
										-		Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104
										5		Procome, Modbus® RTU,TCP/IP
										6		IEC 61850, Modbus® RTU and TCP/IP,DNP 3.0 Level 2, IEC 60870-5-104
												ENVIRONMENTAL PROTECTION
											-	Without Harsh (Chemical) Environment Conformal Coating
											H	Harsh (Chemical) Environment Conformal Coating

SPECIAL MODELS: MOD001: 6A output contacts instead of 16A.

Notes:

(1) The digit selected for option G must be equal or higher than the digit selected for option F for models including boards 4 and 5.
F1G5 is a valid selection and F5G1 is and invalid selection.

(2) **Display options with language selection:**

Graphic display: available for English, French, Spanish and Chinese languages. For chinese only IEC symbols option is available (N in ordering code).

Basic display: available for all languages

For those applications requiring a high number of inputs and outputs, F650 units can be connected to a CIO module (Remote CAN Bus I/O module) for using up to 2 additional boards.

F650 units allow monitoring and configuring these I/O boards as if they were internal boards, located on slots F and G. In this case, slots are labeled as H y J.

The required information to completely define a CIO Module is shown on Table 2–2:.

Table 2–2: ORDERING CODE FOR CIO MODULE

CIO	H	-	J	-	-		DESCRIPTION
							I/O BOARD IN SLOT H
		1					16 Digital inputs + 8 outputs
		2					8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits
		4					32 Digital Inputs
		5					16 Digital Inputs + 8 Analog Inputs
							I/O BOARD IN SLOT J
				0			None
				1			16 Digital inputs + 8 outputs
				4			32 Digital Inputs (See Note 1)
				5			16 Digital Inputs + 8 Analog Inputs (See Note 1)
							AUXILIARY VOLTAGE
					LO		24-48 Vdc (range 19.2 – 57.6)
					HI		110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
							ENVIRONMENTAL PROTECTION
						H	Harsh (Chemical) Environment Conformal Coating

(1) The digit selected for option J must be equal or higher than the digit selected for option H for models including boards 4 and 5.
CIOH1J5**: is a valid selection CIOH5J1**: is an invalid selection

NOTE: TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.4.1 PROTECTION ELEMENTS

Phase and ground units use as operation magnitude the current value received by the unit in current inputs, while the neutral unit uses the calculated current value from the three phase currents.

The isolated ground unit will be used only for those applications where the neutral is completely isolated, and it uses the fifth CT of the unit. This CT has a sensitivity that is 10 times higher than the universal model (connected to 1A or 5A transformers). Therefore, it does not admit such a high permanent overload.

2.4.1.1 PHASE TIME OVERCURRENT (51PH/51PL)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Voltage restraint	Selectable by setting
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

2.4.1.2 GROUND TIME OVERCURRENT (51G)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

2.4.1.3 NEUTRAL TIME OVERCURRENT (51N)

Current Input	Fundamental Phasor (without harmonics)
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

2.4.1.4 SENSITIVE GROUND TIME OVERCURRENT (51SG)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±1.5% of the reading ± 1 mA from 0.005 to 16 A
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

2.4.1.5 PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50PH/50PL/50G)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	<50 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	at 0 ms time delay (no intentional delay): 50ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.6 NEUTRAL INSTANTANEOUS OVERCURRENT (50N)

Current Input	Fundamental Phasor (without harmonics)
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	<50 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	at 0 ms time delay (no intentional delay): 50ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.7 SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±1.5% of the reading ± 1 mA from 0.005 to 16 A
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	<50 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	at 0 ms time delay (no intentional delay): 50ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.8 ISOLATED GROUND INSTANTANEOUS OVERCURRENT (50IG)

Current Input	Fundamental Phasor (without harmonics)
Voltage Input	Fundamental Phasor (without harmonics)
Current Pickup level	0.005 to 0.400 A in steps of 0.001 A
Voltage Pickup level	2 to 70 V in steps of 1 V
Dropout level	97 to 98% of the pickup level
Level Accuracy	±1.5% of the reading ± 1 mA from 0.005 to 16 A
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Time to instantaneous	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	<50 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	at 0 ms time delay (no intentional delay): 50ms at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.9 NEGATIVE SEQUENCE CURRENT (46)

Current Input	Fundamental Phasor (without harmonics)
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

2.4.1.10 PHASE DIRECTIONAL (67P)

Directionality	Forward and reverse selectable by setting
Polarizing	Quadrature Voltage: ABC seq: Phase A (VBC), Phase B (VCA), Phase C (VAB) ACB seq: Phase A (VCB), Phase B (VAC), Phase C (VBA)
Polarizing voltage threshold	0 to 300 Vac in steps of 1 V
Current Sensitivity Threshold	50 mA
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

2.4.1.11 GROUND DIRECTIONAL (67G)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage, current, dual
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Polarizing Current	Isg (measured from 5th current transformer)
Operating Current	Ig (measured from 4th current transformer)
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Polarizing Current threshold	0.005 A
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

2.4.1.12 NEUTRAL DIRECTIONAL (67N)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage, current, dual
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Polarizing Current	Isg (measured from 5th current transformer)
Operating Current	I_N
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Polarizing Current threshold	0.005 A
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

2.4.1.13 SENSITIVE GROUND DIRECTIONAL (67SG)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Operating Current	Isg (measured from 5th current transformer)
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

2.4.1.14 THERMAL MODEL (49)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	Values at nominal frequency: ±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Heating constant	3.0 to 600.0 minutes in steps of 0.1 minute
Cooling constant	1.00 to 6.00 times the heating constant in steps of 0.01
Snapshot Events	Selectable by setting

2.4.1.15 PHASE OVERVOLTAGE (59P)

Voltage Input	Fundamental Phasor (without harmonics) of phase-to-phase voltages
Pickup level	3 to 300 in steps of 1 V
Dropout level	97% to 98% of the pickup level
Level Accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V at nominal frequency
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Logic	Any/Two/All phases logic selectable by setting
Snapshot Events	Selectable by setting

2.4.1.16 PHASE UNDERVOLTAGE (27P)

Voltage Input	Fundamental Phasor of phase-to-ground or phase-to-phase voltages (selectable by setting)
Pickup level	3 to 300 in steps of 1 V
Dropout level	102% to 103% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V at nominal frequency
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Minimum Voltage Threshold	0 to 300 in steps of 1 V
Logic	Any/Two/All phases logic selectable by setting
Supervised by Breaker	Selectable by setting
Snapshot Events	Selectable by setting

2.4.1.17 NEUTRAL OVERVOLTAGE (59NH/59NL)

Voltage Input	Fundamental Phasor of the neutral voltage
Pickup level	3 to 300 in steps of 1 V
Dropout level	97% to 98% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V at nominal frequency
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.18 NEGATIVE SEQUENCE OVERVOLTAGE (47)

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 in steps of 1 V
Dropout level	97% to 98% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.19 AUXILIARY OVERVOLTAGE (59X)

Voltage Input	Fundamental Phasor of the auxiliary voltage
Pickup level	3 to 300 in steps of 1 V
Dropout level	97% to 98% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V at nominal frequency
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.20 AUXILIARY UNDERVOLTAGE (27X)

Voltage Input	Fundamental Phasor of the auxiliary voltage
Pickup level	3 to 300 V in steps of 1 V
Dropout level	97% to 98% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V at nominal frequency
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.21 UNDERFREQUENCY (81U)

Pickup level	20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout level	Pickup + 0.03 Hz
Level accuracy	±0.01 Hz of the reading
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Minimum voltage threshold	30 to 300V in steps of 1 V
Timing accuracy	±3.5% of operate time or 100 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.22 OVERFREQUENCY (81O)

Pickup level	20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout level	Pickup - 0.03 Hz
Level accuracy	±0.01 Hz of the reading
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Minimum voltage threshold	30 to 300V in steps of 1 V
Timing accuracy	±3.5% of operate time or 100 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.23 FORWARD POWER (32FP)

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	0.00-10000.00 MW in steps of 0.01 MW
Dropout level	97% to 98% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

2.4.1.24 DIRECTIONAL POWER (32)

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	-10000.00 to 10000.00 MW (primary values) in steps of 0.01 MW
Characteristic Angle (two stages)	0.00 to 359.99 in steps of 0.01
Accuracy for primary magnitudes	±3% complete range
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting
Operate time:	< 45 ms at 50 Hz, typically

2.4.1.25 WATTMETRIC ZERO-SEQUENCE DIRECTIONAL (32N)

Measured Power	Zero sequence
Number of elements	6 (3 High level, 3 Low level)
Voltage Pickup Level (VN)	2.00 to 70.00 Volts in steps of 0.01 Voltage calculated from phases if Auxiliary voltage is set to Vx Voltage Measured directly from the fourth voltage transformer if Auxiliary voltage is set to VN.
Level Accuracy for Voltage	±1% reading ±0.1% Full Scale from 10 to 275 V
Current Selection	IN (calculated from phases) IG (measured directly from the fourth current transformer)
OC Pickup Level	0.005 to 0.400 Amps in steps of 0.001
Level Accuracy for current	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
OC Pickup Delay	0.00 to 600.00 seconds in steps of 0.01
Power Pickup Level	0.01 to 4.50 Watts in steps of 0.01
Characteristic Angle (MTA)	0 to 360º in steps of 1
Power Pickup Delay	0.00 to 600.00 seconds in steps of 0.01
Level Accuracy for Power	±1% of the reading at -0.8 = PF = -1 and 0.8 <PF=1
Curve Shapes	Inverse Curve Definite time FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.02 to 2.00 s in steps of 0.01 s
Tripping time accuracy	±3.5% of operate time or 50 ms whichever is greater
Snapshot Events	Selectable by setting
Operate time	< 45 ms at 50 Hz, typically

2.4.2 CONTROL

2.4.2.1 AUTORECLOSE (79)

Schemes	Three-pole tripping schemes
Number of shots	Up to 4 reclose attempts before lockout
Dead time	Independent dead time setting before each shot adjustable between 0 and 900 s in steps of 0.01 s
Reclaim time	0.00 to 900.00 s in steps of 0.01 s
Condition permission	Selectable by setting
Hold time	0.00 to 900.00 s in steps of 0.01 s
Reset time	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

Possibility to modify protection settings after each shot programmable through PLC (block signals available after each shot)

2.4.2.2 SYNCHROCHECK (25)

Dead/live levels for line and bus	0.00 to 300.00 in steps of 0.01 V
Maximum voltage difference	2.00 to 300.00 V in steps of 0.01 V
Maximum angle difference	2.0º to 80.0º in steps of 0.1º
Maximum frequency slip	10 to 5000 mHz in steps of 10 mHz
Synchronism time	0.01 to 600.00 s in steps of 0.01 s
Angle accuracy	3º
Dead Source function	None (DL-DB) Dead Line - Dead Bus (LL-DB) Live Line-Dead Bus (DL-LB) Dead Line – Live Bus
Snapshot Events	Selectable by setting

2.4.2.3 FUSE FAILURE

Algorithm based on positive sequence of voltage and current

Activation by V_2/V_1 ratio

2.4.2.4 BREAKER FAILURE (50BF)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level for supervision	0.05 to 160.00 A in steps of 0.01 A
Pickup level for high level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for low level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for internal arcing	0.05 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2.5 BROKEN CONDUCTOR (I2/I1)

Pickup level	20.0-100.0% (I2/I1 ratio) in steps of 0.1%
Dropout level	97% to 98% of the pickup level
Trip delay	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting
Operation Threshold	0.000 to 1.000 A in steps of 0.001 A
I2/I1 current inhibition level	Selectable by setting from 0.000 to 1.000 in steps of 0.001 A

2.4.2.6 LOCKED ROTOR (48)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Full Load Current	0.10 to 10.00 kA in steps of 0.01 kA
Pickup level	1.01 to 109.00 in steps of 0.01 x FLC
Dropout level	97% to 98% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	±3% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2.7 PULSE COUNTERS

Number of Pulse counters available	Up to 8
Multiplier factor	0.000 to 65000.000 in steps of 0.001
Overload factor	0 to 1000000 in steps of 1
Board Origin	All available input/outputs boards in the device. See ordering code [F, G, H, J]
Input origin	up to 32 [depending on the board type selection]

2.4.2.8 ANALOG COMPARATORS

Analog Input	Any analog value available in the device
Analog Maximum Threshold value	-100000.000 to 100000.000 in steps of 0.001
Analog Minimum Threshold value	-100000.000 to 100000.000 in steps of 0.001
Analog Delay	0.00 to 900.00 in steps of 0.01
Analog Hysteresis	0.0 to 50.00 in steps of 0.1
Analog Direction (for activation inside or outside the deadband)	IN or OUT

2.4.2.9 FREQUENCY RATE OF CHANGE

df/dt trend	increasing, decreasing, bi-directional
df/dt pickup level	0.10 to 10.00 Hz/s in steps of 0.01
df/dt level accuracy	80 mHz/s or 3.5%, whichever is greater
Overvoltage supv.	0.00 to 110.00 % in steps of 0.01
95% settling time for df/dt	< 24 cycles
Operate time:	
at 2 x pickup	12 cycles
at 3 x pickup	8 cycles
at 5 x pickup	6 cycles
Frequency Rate min.	20.00 to 80.00 Hz in steps of 0.01
Frequency Rate max.	20.00 to 80.00 Hz in steps of 0.01
Frequency Rate delay	0.00 to 60.00 s in steps of 0.01
Snapshot Events	Selectable by setting

2.4.2.10 LOAD ENCROACHMENT

Responds to:	Positive-sequence quantities
Minimum voltage:	0.00 to 300.00 V in steps of 0.01
Reach (sec. Ω):	0.02 to 250.00 Ω in steps of 0.01
Impedance accuracy:	±3%
Angle:	5 to 50º in steps of 1
Angle accuracy:	±3º
Pickup delay:	0.000 to 65.535 s in steps of 0.001
Reset delay:	0.000 to 65.535 s in steps of 0.001
Time accuracy:	±3.5% or ±60 ms, whichever is greater
Operate time:	<60 ms at 50 Hz typically
Snapshot Events	Selectable by setting

2.4.2.11 BREAKER SETTINGS

Number of Switchgear	1 to 16 (selection of switchgear for breaker control)
Maximum KI^2t	0.00 to 9999.99 in steps of 0.01 $(kA)^2$ s
KI^2t integration Time	0.03 to 0.25 s in steps of 0.01 s
Maximum openings	0 to 9999 in steps of 1
Maximum Openings in one hour	1 to 60 in steps of 1
Snapshot Events	Selectable by setting

2.4.2.12 BREAKER MAINTENANCE

KI^2t Breaker Counters for Phases A, B, C	0.00 to 9999.99 in steps of 0.01 $(kA)^2$ s
Breaker Openings Counter	0 to 9999 in steps of 1
Breaker Closings Counter	0 to 9999 in steps of 1

2.4.2.13 SWITCHGEAR

Switchgear	1 to16 (configurable in “relay configuration” screen).
Snapshot Events	Selectable by setting (for each switchgear in “system setup”)

2.4.3 MONITORING

2.4.3.1 OSCILLOGRAPHY

Maximum Records:	Up to 20 Oscillography records.
Sampling rate:	Programmable to 4, 8, 16, 32 or 64 samples per power cycle
Capacity per record:	$\frac{27592 \text{ samples}}{\text{No of Oscillos} * \text{No of samples/cycle}}$
Trigger position:	5% to 95% of total length
Trigger:	Programmable via PLC
Data:	5 current channels and 4 voltage channels Up to 16 digital channels programmable through PLC
Data Storage:	In non volatile memory (flash) without battery
Format:	International Standard COMTRADE ASCII - IEEE C37.111-1999.
Automatic Overwrite:	Selectable by setting. (Oscillography records can be concatenated)
Snapshot Events:	Selectable by setting

2.4.3.2 FAULT LOCATOR

Method:	Single-ended
Positive Sequence Module:	0.01 to 250.00 Ohm in steps of 0.01 Ohms
Positive Sequence Angle:	25 to 90º in steps of 1º
Zero Sequence Module:	0.01 to 750.00 Ohms in steps of 0.01 Ohm
Zero Sequence Angle:	25 to 90º in steps of 1º
Line Length:	0.0 to 2000.0 in steps of 0.1 (miles or km)
Accuracy:	5% (typical)
Show Fault on HMI:	Selectable by setting
Snapshot Events:	Selectable by setting
Maximum Records:	Up to 10 fault report records.
Data:	Fault date and time, pre-fault currents and voltages, fault currents and voltages, fault type, distance to the fault (fault location), line parameters, recloser and breaker status information.

Data Storage:	In non volatile memory (flash) without battery available through communications In volatile memory (ram) available through HMI (if selectable by setting)
Format:	Text in ASCII format

2.4.3.3 SNAPSHOT EVENTS

Capacity:	479 scrolling events
Time-tag	1 ms using an internal clock of 100 μs
Timing Accuracy:	1 ms (using the IRIG-B synchronization input)
Triggers:	Any element pickup, dropout or operation Digital input /output change of state By virtual inputs and control events
Data Storage	In non volatile memory (flash) without battery

The snapshot event recording procedure can be enabled or disabled by setting for each protection function

2.4.3.4 CONTROL EVENTS

Capacity:	128 events programmable through PLC
Time-tag:	1 ms using an internal clock of 100 μs
Timing Accuracy:	1 ms (using the IRIG-B synchronization input)
Triggers:	By any digital signal programmable through PLC
Alarm	Possibility to display the event as an alarm on the alarms panel. Information available always through Communications for all models and also in HMI for models with graphical display (M in ordering code).
Data Storage:	In non volatile memory (flash) without battery

Control events are also displayed in the snapshot events recording

2.4.3.5 DEMAND

Channels:	9
Parameters:	Ia (kA RMS), Ib (kA RMS), Ic (kA RMS), Ig (kA RMS), Isg (kA RMS), I2 (kA), P (MW), Q (MVAr) and S (MVA)
Current and Power Method	Thermal Exponential, Block Interval, Rolling Demand
Measurements:	Each channel shows the present and maximum measured value, with date and time for the maximum recorded value.
Samples:	5, 10, 15, 20, 30, 60 minutes.
Accuracy:	±1%
Trigger Input	Selectable by setting (operation mode selection for the Block Interval calculation method)
Snapshot Events:	Selectable by setting

2.4.3.6 DATA LOGGER

Number of Channels:	1 to 16
Parameters	Any available analog actual value
Samples	1 sec., 1, 5, 10, 15, 20, 30, 60 min.
Storage Capacity	Fixed, 32768 measures

2.4.4 USER-PROGRAMMABLE ELEMENTS

2.4.4.1 PLC LOGIC

Programming language:	The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.
Lines of code:	512
Supported operations:	NOT, XOR, OR (2 to 8 inputs), AND (2 to 8 inputs), NOR (2 to 8 inputs), NAND (2 to 8 inputs), Latch (Reset Dominant), Edge Detectors, Timers. 2 inputs default gates, from 3 to 8 inputs provided in library format.
Libraries:	Logical gates fully programmable by user. To create user-programmable logic to be distributed as a single object.
Inputs:	Any logical variable, contact or virtual input
Number of timers:	8 maximum in each logic scheme (provided in library format)

2.4.4.2 FLEXCURVES

Number:	4 (A through D)
Reset points:	40 (0 through 1 of pickup)
Operate points:	80 (1 through 20 of pickup)
Time delay:	0 to 65535 ms in steps of 1
Saturation Level	20 times the pickup level

2.4.4.3 USER-PROGRAMMABLE LEDS

Number:	15 configurable LEDs plus a ready non configurable LED
Programmability:	from any logical variable, contact, or virtual input
Reset mode:	Self-reset or Latched. The first 5 LED's are latched by hardware (red color ones), usually configured for trip signals. The following 10 ones (yellow and green) are self-reset but can be latched through PLC configuration.
Reset Signal:	The LED's can be reset by hardware, pressing the front "esc" key during more than 3 seconds or using the LED reset signal through PLC configuration.

2.4.4.4 USER-DEFINABLE DISPLAYS

Number of configurable displays:	1 (one line diagram fully configurable). In graphical displays only
Number of fixed displays:	6, Metering (in primary values), Snapshot events (all and new), Alarms, Inputs and outputs screen with test functionality for inputs and outputs. In graphical displays only
Number of selectable displays:	Logotype, metering or both in scrolling mode, can be selectable as default screen in text display for all models (basic and mimic). The metering screen contains current and voltages for phases and ground in primary values.

2.4.4.5 USER-PROGRAMMABLE FRONT KEYS

Number of configurable Keys:	5
Operation:	drive PLC operands

2.4.5 METERING

2.4.5.1 CURRENT

Accuracy: (at nominal frequency)	±0.5% of the reading ± 10 mA from 0.05 to 10 A (for phases and ground) ±1.5% of the reading ± 1 mA from 0.005 to 5 A (for sensitive ground) ±1.5% of the reading for higher values

2.4.5.2 VOLTAGE

Accuracy:	±1% reading ±0.1% Full Scale from 10 to 275 V

2.4.5.3 REAL POWER (WATTS)

Accuracy:	±1% of the reading at -0.8 ≤ PF ≤ -1.0 and 0.8 <PF≤1.0

2.4.5.4 REACTIVE POWER (VARS)

Accuracy:	±1% of the reading at-0.2 ≤ PF ≤ 0.2

2.4.5.5 APPARENT POWER (VA)

Accuracy:	±1% of the reading

2.4.5.6 WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±1.0% of the reading
Range:	±0 to 2147 MWh
Parameters:	3-phase only
Update rate:	100 ms

2.4.5.7 WAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±1.0% of the reading
Range:	±0 to 2147 MVArh
Parameters:	3-phase only
Update rate:	100 ms

2.4.5.8 POWER FACTOR

Accuracy:	0.02
Parameters:	3-Phase and single phase

2.4.5.9 FREQUENCY

Metering range from 30 Hz to 80 Hz

Accuracy:	For firmware version 3.00 and former ones:
	±10 mHz at 50 Hz
	±12 mHz at 60 Hz
	For firmware version 3.20 and later ones:
	±30 mHz at 50 Hz
	±36 mHz at 60 Hz

2.4.5.10 ANGLE

Accuracy:	±3º

2.4.6 INPUTS

2.4.6.1 AC CURRENT INPUTS

CT Ratio:	1.0 to 6000.0 in steps of 0.1
Rated currents:	Appropriate for 1 or 5 A. F650 has universal range for CT (valid for 1 or 5 A to only one terminal).
Relay Burden:	< 0.04 Ohm
Current Withstand	Continuous at 20 A
	1 second at 500 A for phases and ground 1 second at 50 A for sensitive ground

2.4.6.2 AC VOLTAGE INPUTS

VT Ratio	1.0 to 6000.0 in steps of 0.1
Rated Voltages	275 Vac
Metering range:	From 2 to 275 Vac
Relay Burden:	0.05 VA at 120 Vac (50 or 60 Hz)
Voltage Withstand:	Continuous at 275 V to neutral
	1 min/hr at 420 to neutral

VAC inputs do not need varistors, as the impulse test is applied to 100% of the transformers

2.4.6.3 CONTACT INPUTS

Input Activation Voltage Threshold:	20 to 230 Vdc in steps of 1 V (selectable by setting)
Impedance:	> 100 kOhm
Maximum error:	±10% setting or ± 5 V
Load for voltage supervision inputs:	2 mA + V/100 kOhm
Voltage threshold for voltage supervision inputs:	< 10 V (fixed)
Debounce Time:	1 to 50 in steps of 1 ms
Recognition time:	< 1ms
Timing resolution:	1 ms

For Input Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (inputs sharing the same common).

Input Type and Delay Input Time are not grouped; there is a different setting for each input.

Input Type	Positive-Edge / Negative-Edge / Positive/ Negative
Delay Input Time	0 to 60000 ms in steps of 1 ms (Input signal time delay)

2.4.6.4 REMOTE INPUTS (IEC61850 GSSE/GOOSE)

Number of input points:	32, configured from 64 incoming bit pairs
Number of remote devices:	16
Default states on loss of comms:	On, Off, Latest/on, Latest/off

2.4.6.5 ANALOG INPUTS

Input impedance	116Ω
Current Input (mADC):	0 to -1; 0 to +1; -1 to +1; 0 to 5; 0 to 10; 0 to 20; 4 to 20 (programmable)
Conversion Range:	-1 to +20mA
Accuracy:	±0.2% of full scale
Type:	Passive

2.4.6.6 IRIG-B INPUT

Amplitude modulation:	DC SHIFT = Demodulated input (no carrier)
Input Voltage:	TTL
Input Burden:	1.5 mA
Input Impedance:	3.3 kOhm
Minimum Input Voltage:	2.4 V
Maximum Input Voltage:	± 24 V
Formats:	B000 (*) B001, B002 and B003 (*) (*) Signal combinations recognized in accordance with IRIG Standard 200-95
Isolation:	2 kV

2.4.7 REAL TIME CLOCK

Accuracy:	Typical ±20 ppm
Backup energy:	More than 1 week

2.4.8 OUTPUTS

Carry continuous:	16 A
Make and Carry for 1 sec.	60 A
Break at L/R of 40 ms:	0.3 A DC max. at 125 Vdc 0.25 A DC max. at 250 Vdc
Operate Time:	< 8 ms
Contact material:	Silver Alloy

Output Logic Type, Output Type and Pulse Output Time are selectable by setting for each output

Output Logic Type	Positive / Negative
Output Type	Normal / Pulse / Latch (Selectable by setting for each output)
Pulse Output Time	0 to 60000 ms in steps of 1 ms (applicable only to signals set as pulse type)

Separate operate and reset signal can be configured by any digital signal programmable through PLC

Contact Outputs (F31-F33, F34-F36) for board type 2 (supervision) in slot F:

The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 500 mA, the function is sealed independently of the status of the function that caused the trip.

2.4.8.1 REMOTE OUTPUTS (IEC61850 GSSE/GOOSE)

Standard output points	32
User output points	32

2.4.9 CONTROL POWER SUPPLY

LOW RANGE (LO)	
Nominal DC Voltage:	24 to 48 V
Min/Max DC Voltage	19.2 / 57.6 V
Note:	Low range is DC only
HIGH RANGE (HI)	
Nominal DC Voltage:	110 to 250 V
Min/Max DC Voltage	88 / 300 V
Nominal AC Voltage:	120 to 230 V
Min/Max AC Voltage	102 / 250 V
ALL RANGES	
Voltage Loss hold-up time	200 ms typical, worst case 100 ms without unit reset
Power consumption	Typical =25 VA, Maximum =45 VA

Display backlight auto power-off mode after 15 minutes without touching any key, in order to ensure long life and minimum consumption.

2.4.10 COMMUNICATIONS

FRONT PORT:

Front port:	COM2
Type	RS232
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 y 115200 bauds
Default Baud Rate	19200
Protocols available:	ModBus® RTU / DNP 3.0
Typical distance:	1200 m
Isolation:	2 kV

ASYNCHRONOUS REAR PORTS:

None or two rear ports (depending on model):	COM1, COM2 (rear COM2 multiplexed with front port)
Type (depending on model):	
Model F	None
Model A	Redundant RS485
Model X	Redundant RS485 + fiber CAN for inputs/outputs module
Model P	Redundant 1mm-plastic F.O.
Model Y	Redundant 1mm-plastic F.O. + fiber CAN for inputs/outputs module
Model G	Redundant multimode glass F.O.
Model Z	Redundant multimode glass F.O. + fiber CAN for inputs/outputs module
Model C	Cable CAN port for I/O module
Model M	Cable CAN port for I/O module (cable) + RS485 (ModBus RTU)
Optic Features for ST connectors devices:	Wave length: 1300nm Fiber type: multimode 62.5/125 μm or 50/125 μm
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 y 115200 bauds
Default Baud Rate	19200

Protocols available:	ModBus® RTU / DNP 3.0
Typical distance:	1200 m
Isolation:	2 kV
CAN PORT:	
Rear port:	CAN port in models X, Y, Z for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Fiber Wave length:	1300 nm
Fiber type:	multimode 62.5/125 μm or 50/125 μm
Maximum recommended length	500m
Isolation:	2 kV
ETHERNET PORT:	
Rear port:	COM3
Type (depending on model):	
Model B:	10/100BaseTX self-negotiable
Model C:	10/100BaseTX + 100Base FX
Model D:	10/100BaseTX + redundant 100BaseFX (Physical media redundancy)
Model E:	Redundant 10/100BaseTX self-negotiable ports
10/100BaseTX	RJ45 connector
100BaseFX	ST connectors
Wave length:	1300 nm
Fiber type:	multimode 62.5/125 μm or 50/125 μm
Protocols available:	ModBus® TCP/IP
	DNP over TCP/IP and UDP/IP
	IEC 61850
	Http, ftp, tftp (allow the use of a standard Internet browser)
Typical distance:	1.65 km
Response time to ModBus commands:	10 ms Typical
Isolation:	2 kV

In Models C and D, the 10/100BaseTX port is selected by an internal switch (see 3.3.3)

Two witness LED's for transmission and reception are included

Wave length: 1300nm

Connector types: ST package style

Fiber type: multimode 62.5/125 μm or 50/125 μm

TRANSMITTER CHARACTERISTICS						
Parameter		Min.	Typ.	Max.	Unit	Reference
Output Optical Power 62.5/125 μm, NA = 0.275 Fiber	BOL EOL	-19 -20		-14	dBm avg.	Note 1
Output Optical Power 50/125 μm, NA = 0.275 Fiber	BOL EOL	-22.5 -23.5		-14	dBm avg.	Note 1
Output Optical Power at Logic "0" State				-45	dBm avg.	Note 2

RECEIVER CHARACTERISTICS					
Parameter	Min.	Typ.	Max.	Unit	Reference
Input Optical Power Minimum at Window Edge		-33.9	-31	dBm avg.	Note 3
Input Optical Power Minimum at Eye Center		-35.2	-31.8	dBm avg.	Note 4
Input Optical Power Maximum	-14			dBm avg.	Note 3

Notes:

1. These optical power values are measured with the following conditions:

   The Beginning of Live (BOL) to the End of Life (EOL) optical power degradation is typically 1.5 dB per industry convention for long wavelength LEDs. The actual degradation observed in Agilent's 1300nm LED products is <1 dB, as specified in this data sheet.

   Over the specified operating voltage and temperature ranges.

   With HALT Line State, (12.5 MHz square-wave), input signal.

   At the end of one meter of noted optical fiber with cladding modes removed.

   The average power value can be converted to a peak power value by adding 3 dB. Higher output optical power transmitters are available on special request.

2. The transmitter provides compliance with the need for Transmit_Disable commands from the FDDI SMT layer by providing an Output Optical Power level of <-45 dBm average in response to a logic "0" input. This specification applies to either 62.5/125 μm or 50/125 μm fiber cables.

3. This specification is intended to indicate the performance of the receiver section of the transceiver when Input Optical Power signal characteristics are present per the following definitions. The Input Optical Power dynamic range from the minimum level (with a window time-width) to the maximum level is the range over which the receiver is guaranteed to provide output data with a Bit Error Ratio (BER) better than or equal to 2.5e-10.

   At the Beginning of Life (BOL).

   Over the specified operating temperature and voltage ranges.

4. All conditions for Note 3 apply except that the measurement is made at the center of the symbol with no window time-width.

2.4.12 ENVIRONMENTAL CHARACTERISTICS

Operating temperature:	- 10°C to + 60°C
Storage temperature:	- 40°C to + 80°C
Humidity (non condensing):	95%
Altitude	Up to 2000 m
Installation category	II

2.4.13 PACKAGING AND WEIGHT

Net weight:	5 kg
Packaged:	6 kg
Package dimensions:	30x40x40 cm (DxWxH)

2.4.14 TYPE TESTS

CATEGORY	STANDARD	CLASS	TEST
EMC	IEC 61000-4-1 IEC 60255-22-1	III	Oscillatory waves immunity
	IEC 61000-4-2 IEC 60255-22-2	IV	Electrostatic discharge immunity test
	IEC 61000-4-3 IEC 60255-22-3	III	Radiated electromagnetic field disturbance test
	IEC 61000-4-4 IEC 60255-22-4	IV	Electrical fast transient
	IEC 61000-4-5 IEC 60255-22-5	IV	Surge immunity test
	IEC 61000-4-6 IEC 60255-22-6	III	Conducted electromagnetic field disturbance test
	IEC 61000-4-8 EN 61000-4-8	IV	Power frequency magnetic field immunity
	ENV50204	III	Radiated electromagnetic field disturbance test – 1890 MHz.
EMC Emisivity	IEC 60255-25 EN 61000-6-4	A	Conducted and radiated emissions
Product	IEC 60255-5	2 kV	Insulation resistance – dielectric test
	IEC 60255-5	6kV .5J	Impulse test
	IEC 60255-11	100 ms	Power supply Voltage dips/interruptions/variations:
Mechanical	IEC 60255-21-1	I	Vibration test (sinusoidal)
	IEC 60255-21-2 IEC 60255-21-3	I II	Shock and bump Seismic

Type test report available upon request.

F650 has been designed to comply with the highest existing requirements. More specifically, UNIPEDE recommendations for high voltage substations are followed, even if for most applications such high classes are not required.

The relay complies with ANSI C37.90 standards, and has been designed to comply with international standards.

2.4.15 APPROVALS

ISO9001 Registered system.

CE marking: Meets the CE standards relevant for protections.

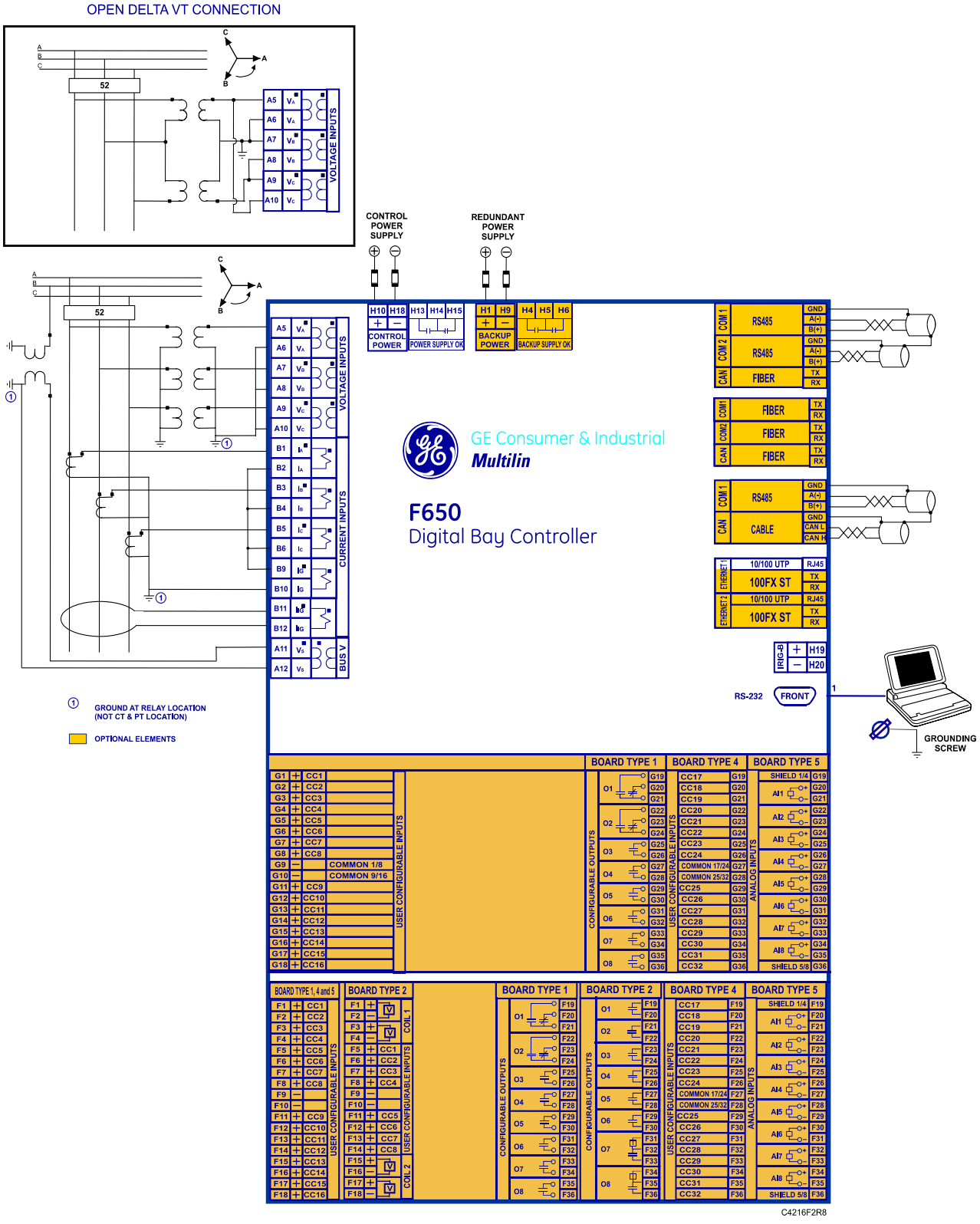


Figure 2–2: F650 WIRING DIAGRAM (189C4216H2)

INPUTS / OUTPUTS CONFIGURATION FOR BOARDS F1 AND F2

SLOT F CONFIGURATION (BOARD TYPE 1)

INPUTS F1

F1	+	CC1	52b	USER CONFIGURABLE INPUTS
F2	+	CC2	50P BLOCK	
F3	+	CC3	51P BLOCK	
F4	+	CC4	67P BLOCK	
F5	+	CC5	50G BLOCK	
F6	+	CC6	51G BLOCK	
F7	+	CC7	79 INITIATE	
F8	+	CC8	79 BLOCK	
F9	-	COMMON 1/8	COMMON 1/8	
F10	-	COMMON 9/16	COMMON 9/16	
F11	+	CC9	NOT USED	
F12	+	CC10	NOT USED	
F13	+	CC11	NOT USED	
F14	+	CC12	NOT USED	
F15	+	CC13	NOT USED	
F16	+	CC14	NOT USED	
F17	+	CC15	NOT USED	
F18	+	CC16	NOT USED	

OUTPUTS F1

USER CONFIGURABLE OUTPUTS	O1	F19 F20 F21	79 BLOCK
	O2	F22 F23 F24	27/59 PICKUP
	O3	F25 F26	50/67G PICKUP
	O4	F27 F28	51/67G PICKUP
	O5	F29 F30	50/67P PICKUP
	O6	F31 F32	51/67P PICKUP
	O7	F33 F34	RECLOSE
	O8	F35 F36	TRIP

SLOT F CONFIGURATION (BOARD TYPE 2)

INPUTS F2

F1	+	COIL 1 52/a	52/a SUPERVISION	COIL 1
F2	-			
F3	+	COIL 1 52/b	52/b SUPERVISION	
F4	-			
F5	+	CC1	52b	USER CONFIGURABLE INPUTS
F6	+	CC2	50P BLOCK	
F7	+	CC3	51P BLOCK	
F8	+	CC4	67P BLOCK	
F9	-	COMMON 1/4	COMMON 1/4	
F10	-	COMMON 5/8	COMMON 5/8	
F11	+	CC5	50G BLOCK	
F12	+	CC6	51G BLOCK	
F13	+	CC7	79 INITIATE	
F14	+	CC8	79 BLOCK	
F15	+	COIL 2 52/a	52/a SUPERVISION	COIL 2
F16	-			
F17	+	COIL 2 52/b	52/b SUPERVISION	
F18	-			

OUTPUTS F2

USER CONFIGURABLE OUTPUTS	O1	F19 F20	79 BLOCK
	O2	F21 F22	27/59 PICKUP
	O3	F23 F24	50/67G PICKUP
	O4	F25 F26	51/67G PICKUP
	O5	F27 F28	50/67P PICKUP
	O6	F29 F30	51/67P PICKUP
	I SENS O7	F31 F32 F33	RECLOSE
	I SENS O8	F34 F35 F36	TRIP

Figure 2–3: INPUT/OUTPUT CONFIGURATIONS FOR BOARDS F1 AND F2 (189C4216H1)

3.1.1 INTRODUCTION

The EnerVista 650 Setup software provides a graphical user interface (GUI) as one of two human interfaces to a 650 device. The alternate human interface is implemented via the device's faceplate keypad and display (see Human Machine Interface section in this chapter).

The EnerVista 650 Setup software provides a single facility to configure, monitor, maintain, and trouble-shoot the operation of relay functions, connected over local or wide area communication networks. It can be used while disconnected (i.e. offline) or connected (i.e. on-line) to a 650 device. In off-line mode, settings files can be created for eventual downloading to the device. In on-line mode, you can communicate with the device in real-time.

The EnerVista 650 Setup software, provided with every F650 relay, can be run from any computer supporting Microsoft Windows® 95, 98, NT, 2000, ME, and XP. This chapter provides a summary of the basic EnerVista 650 Setup software interface features. The EnerVista 650 Setup Help File provides details for getting started and using the EnerVista 650 Setup software interface.

3.1.2 ENERVISTA 650 SETUP SOFTWARE OVERVIEW

This software package uses ModBus protocol, and it is designed to communicate with a single relay at a time. GE offers different communication software packages, such as GE-POWER, which can be used to communicate simultaneously with several relays.

EnerVista 650 Setup software provides an easy way to configure, monitor and manage all F650 features.

3.1.2.1 ENGAGING A DEVICE

The EnerVista 650 Setup software may be used in on-line mode (relay connected) to directly communicate with a 650 device.

3.1.2.2 USING SETTINGS FILES

The EnerVista 650 Setup software interface supports three ways of handling changes to relay settings:

1. In off-line mode (relay disconnected) to create or edit relay settings files for later download to communicating relays.
2. While connected to a communicating relay to directly modify any relay settings via relay data view windows, and then save the settings to the relay.
3. You can create/edit settings files and then write them to the relay while the interface is connected to the relay.

Settings files are organized on the basis of file names assigned by the user. A settings file contains data pertaining to the following types of relay settings:

- Product Setup
- System Setup
- Protection Elements
- Control Elements
- Inputs/Outputs
- Relay Configuration
- Logic Configuration

3.1.2.3 VIEWING ACTUAL VALUES

You can view real-time relay data such as input/output status and measured parameters.

3.1.2.4 VIEWING TRIGGERED EVENTS

While the interface is in either on-line or off-line mode, you can view and analyze data generated by triggered specified parameters, via one of the following:

- **Event Recorder facility:** The event recorder captures contextual data associated with the last 479 events, listed in chronological order from most recent to oldest.
- **Oscillography facility:** The oscillography waveform traces and digital states are used to provide a visual display of power system and relay operation data captured during specific triggered events.

3.1.2.5 FIRMWARE UPGRADES

The firmware of a F650 device can be upgraded, locally or remotely, via the EnerVista 650 Setup software. The corresponding instructions are provided by the EnerVista 650 Setup Help file under the topic “Upgrading Firmware”.

Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, minimum/maximum values, data type, and item size) may change slightly from version to version of firmware.

The addresses are rearranged when new features are added or existing features are enhanced or modified.

3.1.2.6 ONE LINE DIAGRAMS

You can configure an one line diagram (bay mimic) to be used in relays with graphical display.

3.1.3 MAIN SCREEN

The EnerVista 650 Setup software main window supports the following primary display components:

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

Figure 3–1: ENERVISTA 650 SETUP MAIN SCREEN

To start communicating with the relay go to "***Communication>Computer>Computer settings***" section in the main EnerVista 650 Setup menu.

Safety instructions must be followed before connecting the computer to the relay. Safety instructions are detailed in section 1.1.3. Connect the relay ground terminal and the communicating computer to a good grounding. Otherwise, communication may not be viable, or even, in worst cases, the relay and/or the computer could result damaged by overvoltages.

For on-line working, previously ensure that all relay communication parameters, such as baudrate, slave ModBus address, etc., match the computer settings.

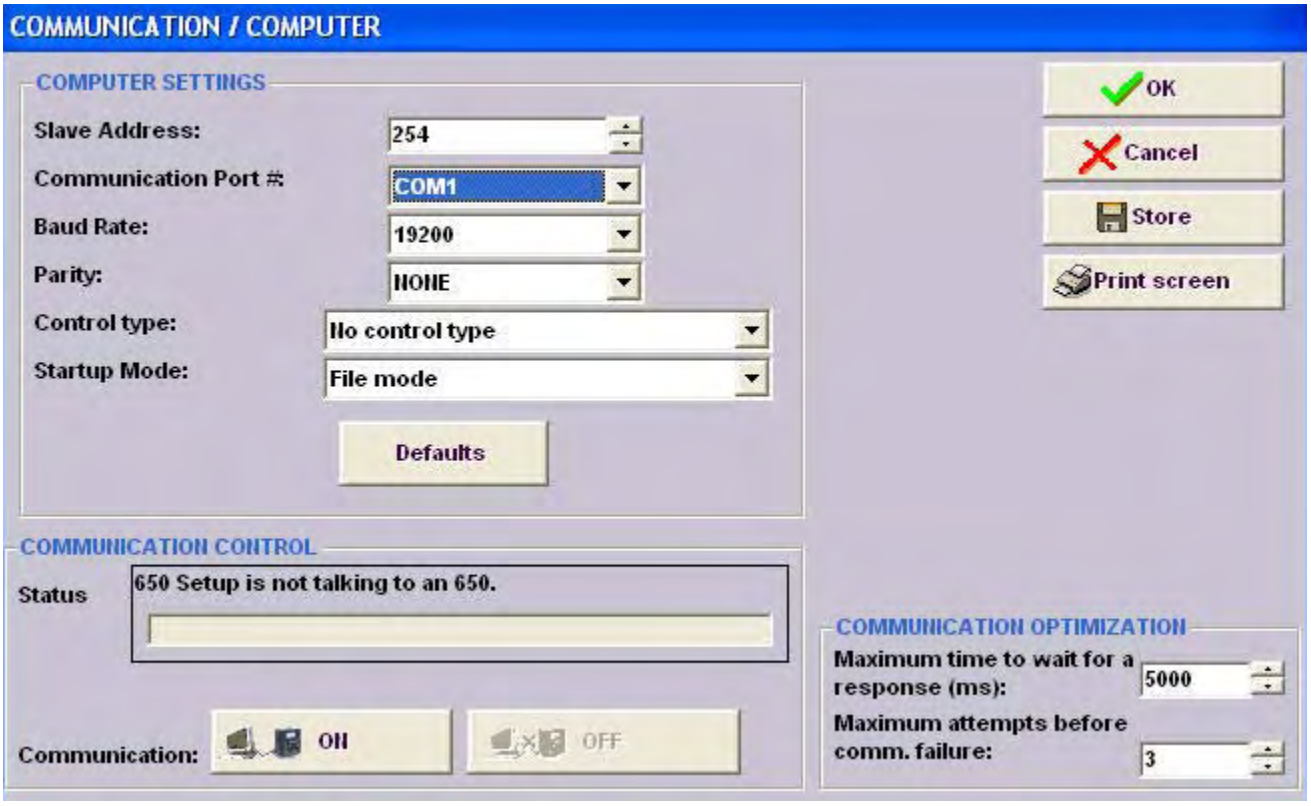


Figure 3–2: COMMUNICATION PARAMETERS MENU

The ***"Communication > computer"*** screen is divided in several subsections:

- Computer settings: Main communication parameters for serial communication and control type selection.
- ModBus/TCP Setup (if ModBus /TCP is selected as control type): Communication parameters for ModBus TCP communication.
- Communication control: Device communication status (communicating or not communicating).
- Communication optimization: allows optimizing the communication time outs and failure establishing.

3.1.4.1 COMPUTER SETTINGS:

Shows the communication parameters necessary in order to establish communication with the unit. Such as slave address, communication port, baud rate, parity, control type and startup mode.

Baud rate, parity, data bits, stop bits and ModBus slave address for com2 (RS232 front port and second serial port in the rear communication board) are displayed in the default text logotype main screen.

ModBus Slave Address: ModBus addresses used for serial and Ethernet communication.

Communication ports: port used in the computer for serial communication.

Baud Rate: Baud rate for serial communication (from 1200 up to 115200 bauds in EnerVista 650 Setup, from 300 to 115200 in relay).

Parity: parity for serial communication. None, odd or even can be selected.

Control Type: The available control modes are:

- No Control Type, this option selects the serial communication mode, for use with serial communication ports (front port, RS485, or plastic or glass fiber optic).
- MODBUS/TCP, this option selects ModBus TCP/IP communication mode, for communication through the Ethernet port. In this case, the top right window will show the typical parameters to be programmed; IP address, port address and unit identifier in the MODBUS TCP SETUP section.
- MODEM, this option displays the parameter to set in case of using a modem for the communication, such as Phone number, Time out (sec.), init. command, type of dialing (tones or pulses).

3.1.4.2 COMMUNICATION CONTROL:

Located at the bottom of the screen, it shows the status of the communication with the relay. With relay not communicating, a message “650 Setup is not talking to an 650” will be shown and ON button will be enable. Pressing this button, 650 Setup start communicating with the relay.

With relay communicating a message “650 Setup is now talking to an 650” will be shown and OFF will be enable. Pressing this button, communications between relay and PC will be closed.

3.1.4.3 COMMUNICATION OPTIMIZATION:

The parameters shown on the bottom right window (Communication optimization) can improve communication, although it is recommended to leave the default values indicated by the EnerVista 650 Setup. These parameters are the maximum time to wait for a response in the relay (in ms) and the maximum attempts to perform before assuming communications failure.

File management with EnerVista 650 Setup software:

3.1.5.1 OFF LINE MODE

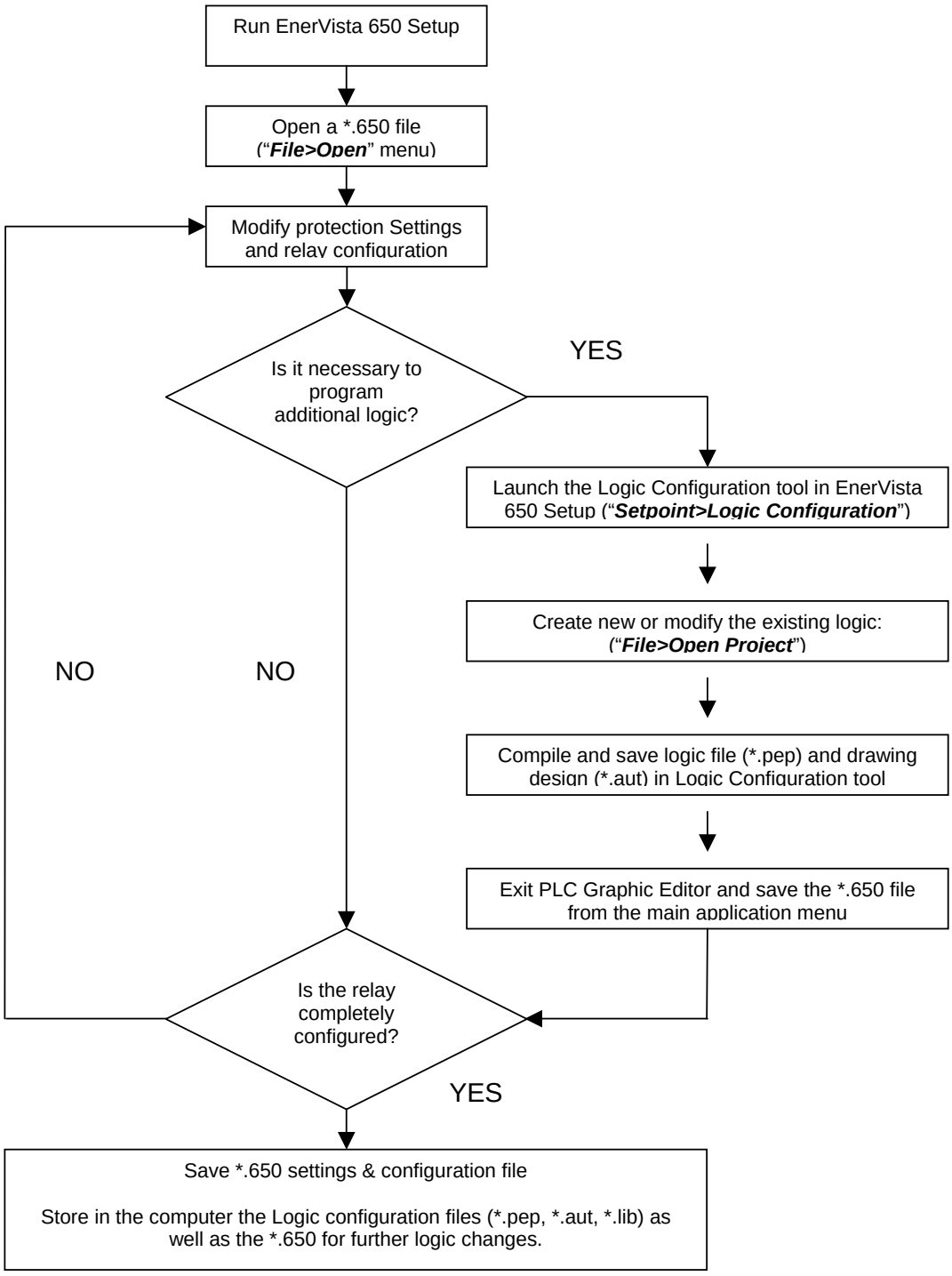


Figure 3–3: OFF-LINE MODE FILE MANAGEMENT

Table 3–1: TYPES OF FILES GENERATED BY ENERVISTA 650 SETUP SOFTWARE OPERATION MODE OFF-LINE:

	SETTINGS & CONFIGURATION FILE *.650	LOGIC CONFIGURATION FILES (*.PEP, *AUT, *.LIB)		
		*.PEP	*.AUT	*.LIB
Description	Protection Settings and Configuration Section	Header for Logic project	Graphical edition container. Logic equations (Virtual Outputs) in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Contents	Relay configuration file containing all protection elements Settings, input/output and LEDs configuration, graphic display configuration, etc. Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
How to save	EnerVista 650 Setup: **"*File>Save **"**	PLC Editor: **"*File>Save Project"**	PLC Editor: **"*File>Save Project"**	PLC Editor: **"*File>Save Library"**
How to open	EnerVista 650 Setup: **"*File>Open **"**	PLC Editor: "***File>Open Project"**	PLC Editor: "***File>Open Project"**	PLC Editor: "***File>Library>New Library"**
How to transfer to relay	Connect with the relay ("***Communications>Computer"**) Open the created file (**"*File>Open **"**) Send to relay from the menu: **"*File>Send info to relay"** Note that texts used in the configuration of inputs, outputs, etc. are not sent to the relay. The only texts sent to relay are operations, events, and LEDs.	Connect with the relay ("***Communications>Computer**") Launch Logic equations Editor ("***Setpoint>Logic Configuration**") Open the created PLC project ("***File>Open Project**") Compile the project ("***Run>Compile**") Now the logic (virtual outputs) can be sent directly to relay ("***Run>Send Equations to Relay**"). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		

In case of using element libraries (either existing ("***File Library>Open Library***") or created by the user ("***File Library>New Library***"), the program will create and manage the corresponding files (*.lib) in a folder named FDB (Functional Block Diagram). These files are used for the PLC project compilation. It is necessary to store them with the other logic configuration files that built the PLC project (*.pep, *.aut, *.lib).

Besides sending basic information to the relay (Settings + configuration) in *.650 format, it is recommended to store *.650, *.pep, *.aut and *.lib files inside the relay ("***Communication>Upload info files to relay***"), to ensure that logic configuration files will be available in the future for further logic modifications; either if these files are not used by the relay, they are required for connecting to a relay and analyzing its configuration. The program manages the logic configuration files globally, so that when the user selects to save file *.pep in the relay, the associated *.aut and *.lib files are also stored.

File storage inside the relay (RECOMMENDED)	"***Communication > Upload info files to relay***" through Ethernet
Retrieval of files stored in the relay (RECOMMENDED)	"***Communication > Download info files from relay***" through Ethernet

3.1.5.2 ON LINE MODE

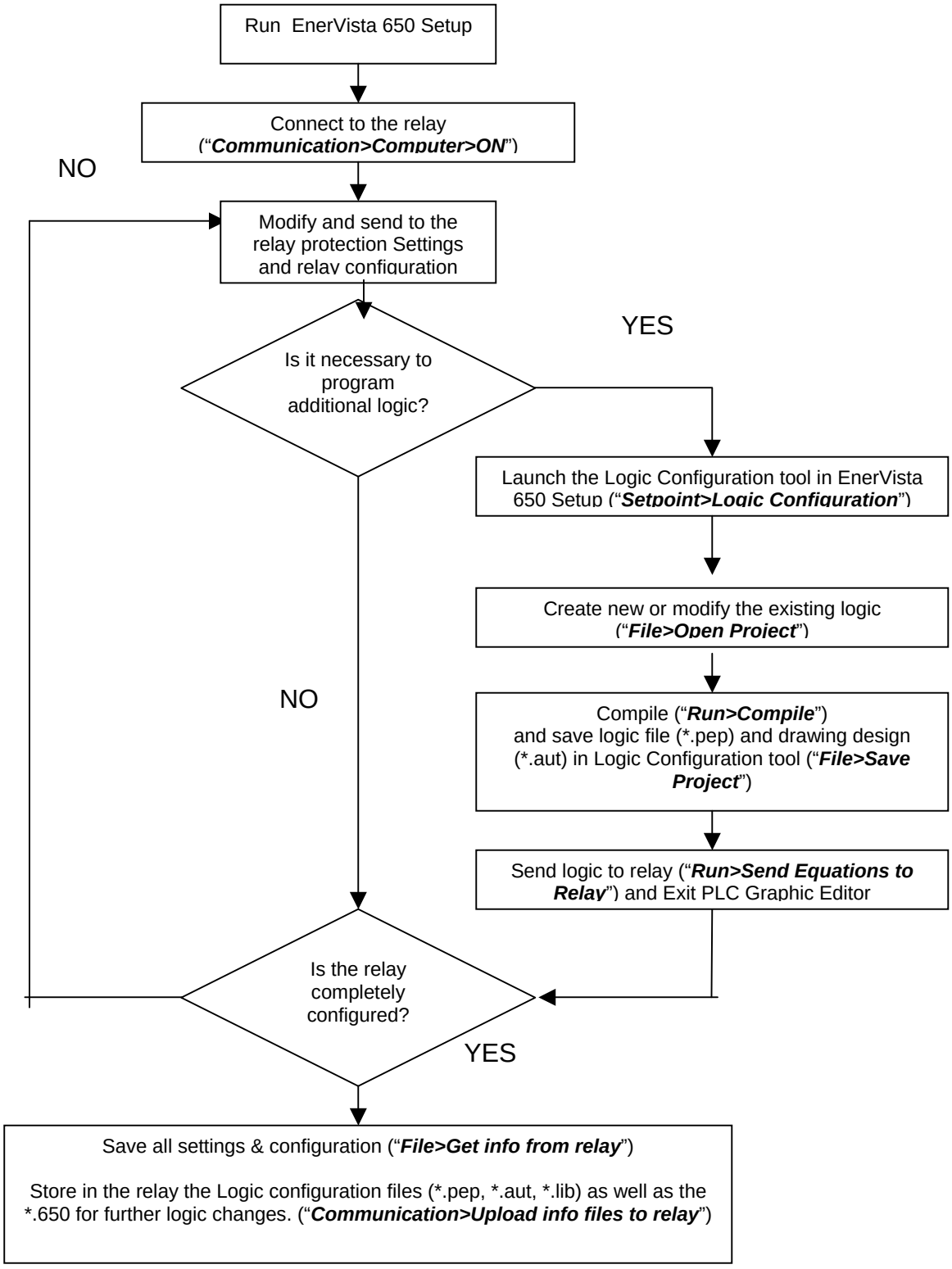


Figure 3–4: ON LINE MODE FILE MANAGEMENT

Table 3–2: TYPES OF FILES CREATED BY ENERVISTA 650 SETUP– ONLINE OPERATION MODE

<table>
<tr><th></th><th>SETTINGS & CONFIGURATION FILE *.650</th><th colspan="3">LOGIC CONFIGURATION FILES (*.PEP, *.AUT, *.LIB)</th></tr>
<tr><th></th><th></th><th>*.PEP</th><th>*.AUT</th><th>*.LIB</th></tr>
<tr><td>Description</td><td>Protection Settings and Configuration Section</td><td>Header for Logic project</td><td>Graphical edition container. Logic equations (Virtual Outputs) in FDB format.</td><td>User programmable logic objects</td></tr>
<tr><td>Created by</td><td>EnerVista 650 Setup</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td></tr>
<tr><td>Contents</td><td>Relay configuration file containing all protection elements, settings, input/output and LEDs configuration, graphic display configuration, etc.
Equations corresponding to the logic created and compiled in the PLC Editor</td><td>PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.</td><td>PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).</td><td>Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.</td></tr>
<tr><td rowspan="5">How to transfer to relay</td><td>Connect with the relay (“Communications>Computer”)</td><td colspan="3">Connect with the relay (“Communications>Computer”)</td></tr>
<tr><td rowspan="4">Send settings and configuration from file</td><td colspan="3">Launch 650 Logic equations editor (“Setpoint>Logic Configuration”)</td></tr>
<tr><td colspan="3">Open the created PLC project (“File>Open Project”)</td></tr>
<tr><td colspan="3">Compile the project (“Run>Compile”)</td></tr>
<tr><td colspan="3">Now the logic (virtual outputs) can be sent directly to relay (“Run>Send Equations to Relay”). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.</td></tr>
<tr><td>Modify settings and configuration directly in the relay:</td></tr>
<tr><td rowspan="4">How to save</td><td rowspan="4">EnerVista 650 Setup:
“File>Get info from relay”. User definable texts retrieved are operations, events, and LEDs.</td><td colspan="3">PLC Editor:</td></tr>
<tr><td colspan="2">“File>Save Project”</td><td>“File>Save Library”</td></tr>
<tr><td>The relay will not provide this information unless the *.pep file is stored in the relay</td><td>The relay will not provide this information unless the *.pep file is stored in the relay.</td><td>The relay will not provide this information unless the *.pep file is stored in the relay.</td></tr>
<tr><td colspan="3">To store the logic configuration files in the relay use the “Communication>Upload info files to relay” option</td></tr>
<tr><td colspan="2">How to store in the relay</td><td colspan="3">“Communication>Upload info files to relay” through Ethernet</td></tr>
<tr><td colspan="2">How to retrieve from the relay</td><td colspan="3">“Communication/Download info files from relay” through Ethernet</td></tr>
</table>

REMINDER:
Logic programming support files (*.pep, *.aut, *.lib) CANNOT be retrieved directly from the relay.
It is necessary * Either to have stored these files in the PC * Or to have uploaded previously the files into the relay (“***Communication>Upload info files to relay***”)

The EnerVista 650 Setup menus structure is shown in Table 3–3:.

Unless specified, options are available in both On-line and Off-line mode.

Options enabled only in On-line mode are marked as (*)

Options enabled only in Off-line mode are marked as (**)

The "***View > Language***" submenu allows the user to change the default language for the EnerVista 650 Setup program and it is only enabled when the relay is not communicating and no file has been opened.

Table 3–3: ENERVISTA 650 SETUP MENUS STRUCTURE

FILE	SETPOINT	ACTUAL	OPERATIONS (*)	COMMUNICATION	SECURITY	VIEW	HELP
New (**)	Product Setup	Front Panel	NA	Computer	Login user	Traces	Instruction Manual
Open (**)	System Setup	Status	NA	Modem (*)	Change Password	ModBus Memory Map	GE Multilin on the web
Save (**)	Protection Elements	Metering	NA	Troubleshooting (*)	User Management	Languages (**)	About EnerVista 650 Setup
Save As (**)	Control Elements	Inputs/Outputs	NA	Calibration (*)			
Close (**)	Inputs/Outputs	Records (*)	NA	Upgrade firmware version (*)			
Config File Converter	Relay Configuration		NA	Upgrade operating system (*)			
Properties (**)	Logic Configuration		NA	Upgrade 650 Web Server			
Get info from relay (*)	Clock (*)		NA	Upload info files to relay			
Send info to relay (*)			NA	Download info files from relay			
Print Setup (**)			NA				
Print Preview (**)			NA				
Print (**)			NA				
Print to file (**)							
Exit							

Table 3–4: GENERAL OVERVIEW OF FILE MENU:

FILE	
New (**)	Create a new settings and configuration file, with the default relay settings and no configuration
Open (**)	Open a settings and configuration file for off-line working.
Save (**)	Save *.650 settings and configuration file
Save As (**)	Save as *.650 settings and configuration file.
Close (**)	Close the opened *.650 file in EnerVista 650 Setup.
Config File (*.650) Converter	Tool to convert the *.650 files from one version to another
Properties (**)	File properties for *.650.
Get info from relay (*)	Retrieve the *.650 settings and relay configuration compiled equations from the relay.
Send info to relay (*)	Send and write the *.650 settings and configuration to the relay.
Print Setup (**)	To configure printer settings.
Print Preview (**)	Preview of settings and configuration file printing format.
Print (**)	Launch the *.650 file to be printed.
Print to file (*.xls) (**)	*.650 printed to file in excel format.
Exit	Quit the application closing all the open windows.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.7.1 NEW, OPEN, SAVE, SAVE AS AND CLOSE

In these options, the program opens a dialog box (with default path to ***Files>Config*** program folder) where the setting and configuration files can be selected for their “off-line” edition. For enabling access to this menu, there must be no communication between the PC program and the relay.

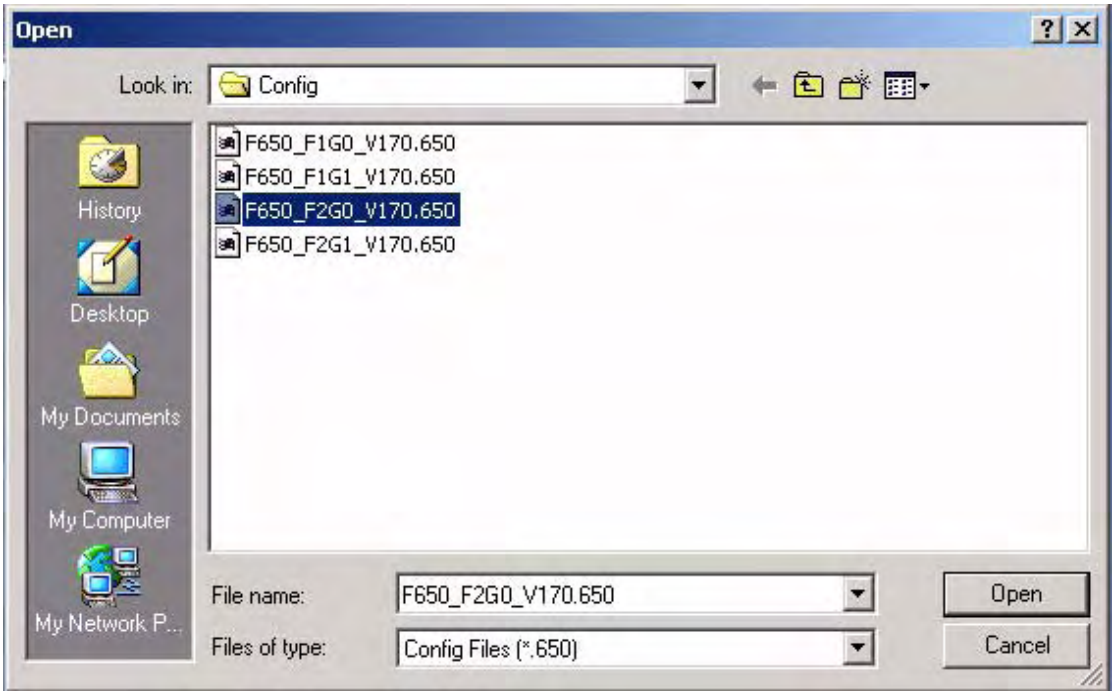


Figure 3–5: OPEN FILE MENU

Once the *.650 file with the appropriated relay model (FXGX) is selected, the program will enable the off-line options to fully program the unit. The enabled menus in the EnerVista 650 Setup program are: File, Setpoint, Actual, Communication, View and Help.

The off-line mode displays the File, Setpoint, Actual, Communication, Security, View and Help submenus to program the unit.

The Actual values submenus are for structure purposes only Values are not refreshed while the relay is not communicating.

The “Save as” and ”Close” submenus are used to save the *.650 file into the computer and to close the current file. To work in off line mode for settings and configuration edition it is not necessary to use the ”Close” option, a new *.650 can be opened without closing the previous one. The ”Close” option is used to clear all data in EnerVista 650 Setup program, enabling “Language”, ”Upgrade firmware version” and “Upgrade Operating system” options.

3.1.7.2 CONFIG FILE (*650) CONVERTER

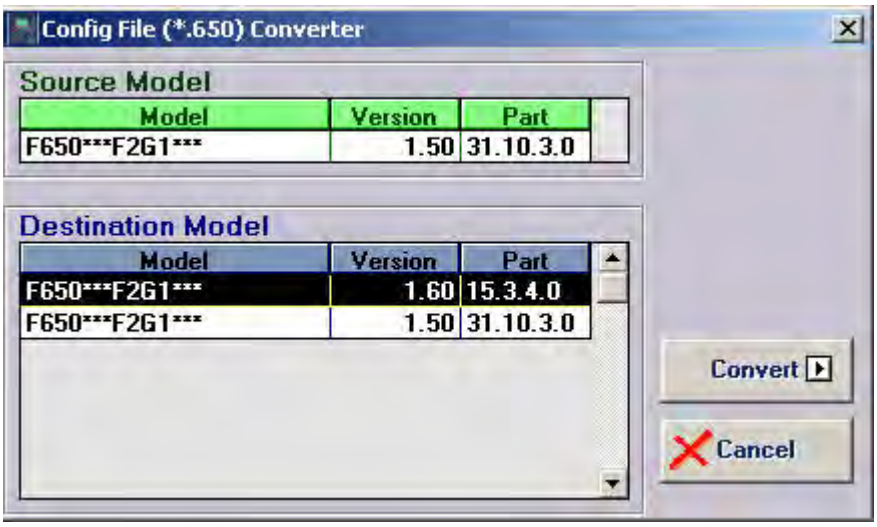


Figure 3–6: CONFIG FILE (*650) CONVERTER MENU

This tool provides automatic conversion of configuration files from a firmware version to a previous or later version.

Open the source *.650 file and select the version and model to be converted to.

It is possible to change the model type (FXGX) using the conversion tool. It must be taken into account that part of the logic can be readjusted to fit the new input and output boards selection. Notice also that the external wiring of inputs and outputs board are different for type 1, 2, 4 and 5.

3.1.7.3 PROPERTIES

When this option is selected, the program will show a screen including the relay model information, firmware version, etc. of the file being edited, as shown on Figure 3–7:

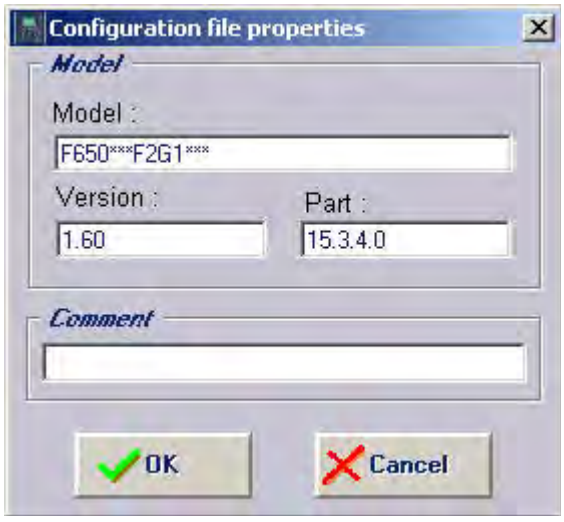


Figure 3–7: FILE PROPERTIES MENU

3.1.7.4 PRINTING OPTIONS (PRINT SETUP/PRINT PREVIEW/PRINT/PRINT TO FILE)

The printing options are active only in off-line mode, in “File edition”, and not in on-line mode, connected with the relay.

a) PRINT SETUP

Option to configure the printing options and settings for the printing device.

b) PRINT PREVIEW

Option to preview the whole settings and configuration file (*.650) in paper format to be printed as shown in Figure 3–8:

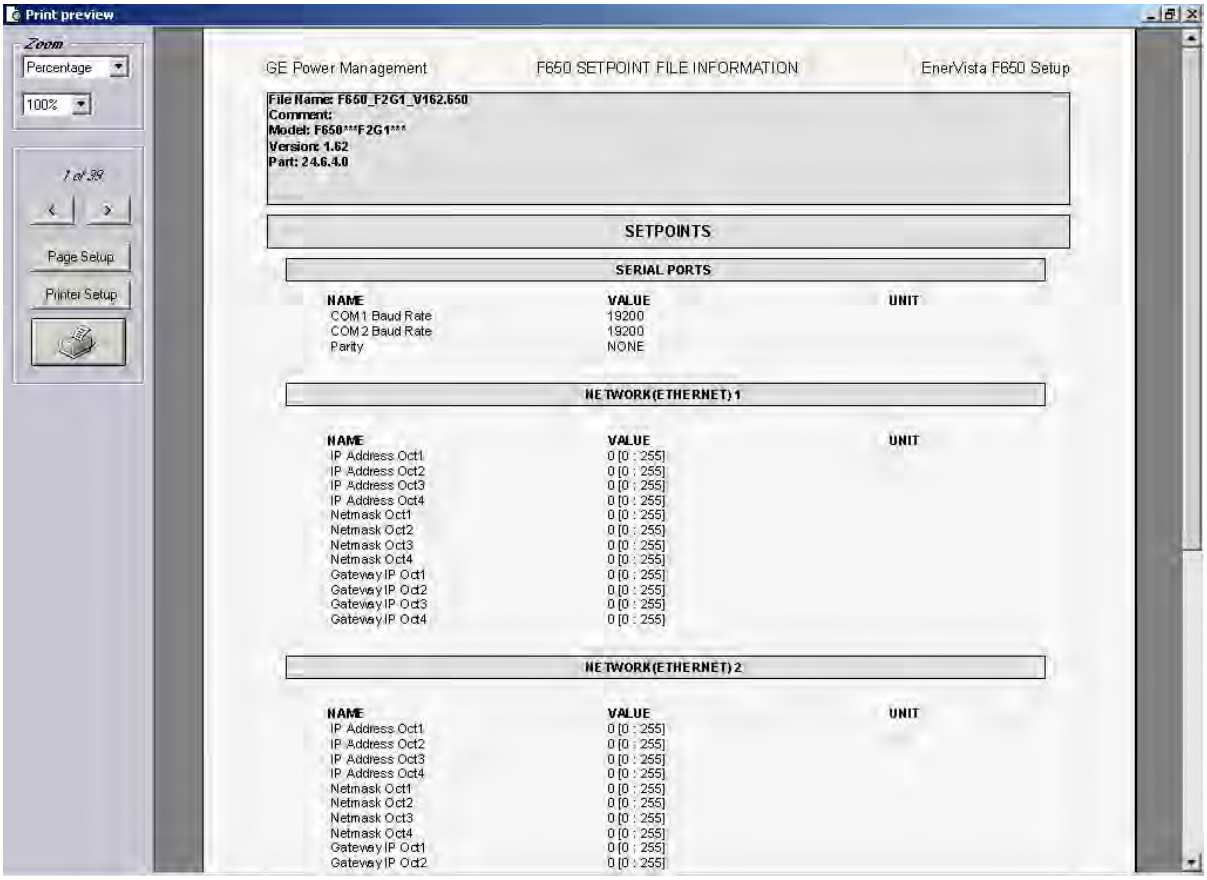


Figure 3–8: PRINT PREVIEW OF SETTINGS FILE

c) PRINT

In this option, the program will print the relay configuration using the PC default (active) printer on port COMx or LPT. This option is active only in off-line mode, in file edition, and not in on-line mode, connected with the relay.

d) PRINT TO FILE (*XLS)

Possibility to export the configuration file to an Excel file using the “Print to file (*.xls)” option.

Table 3–5: GENERAL OVERVIEW OF SETPOINT MENU IN ENERVISTA 650 SETUP:

SETPOINT	
Product Setup	Communications settings for all protocols and physical mediums. ModBus user map definition, fault report, oscillography, data logger and demand settings.
System Setup	General Settings, Flex Curves Definition, Breaker settings and maintenance, and switchgear snapshot events management.
Protection Elements	Phase, Neutral, Ground, Sensitive Ground and Negative Sequence Current Settings. Voltage Elements settings and Power Settings management.
Control Elements	Setting groups, under and overfrequency settings, synchrocheck, autoreclose, breaker failure, VT fuse failure, broken conductor and locked rotor settings management.
Inputs/Outputs	Contact I/O settings for all boards available in device, Remote Comms.
Relay Configuration	Configuration of Outputs, LEDs, Operations, Protection Elements, Oscillography, Control Events, Switchgear, Inputs, Virtual Inputs, Operations and HMI. Whole relay configuration with internal relay signals or user-definable ones as logic (virtual outputs).
Logic Configuration	Logic configuration graphic editor (PLC Editor). It is a PLC Project file editor that contains all the internal drawings used to make the logic (virtual outputs) based on IEC 61131-3 standard. Functional block diagram (FDB).
61850 Configuration	61850 Configuration tool. Only available for IEC61850 models (6) when communicating through Ethernet with EnerVista 650 Setup.
Procome Configuration	Procome Configuration tool. Only available for Procome models (5) when communicating through Ethernet with EnerVista 650 Setup
Clock (*)	Relay synchronization to computer clock or to user-definable date and time. On-line mode only.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.8.1 PRODUCT SETUP

Table 3–6: GENERAL OVERVIEW OF PRODUCT SETUP MENU:

PRODUCT SETUP	
Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave, IEC 870-5-104, SNTP settings and procome (if available on model selection).
ModBus User Map	ModBus user map definition. The ModBus user map is formed by 256 records, selectable from the complete relay ModBus map.
Fault Report	Fault report settings. Possibility to show fault reports on HMI screen.
Oscillography	Oscillography settings (trigger position, samples per cycle, etc.). The trigger and digital channels (up to 16) must be configured in "***Setpoint>Relay configuration***".
Data Logger	Data logger configuration
Demand	Demand settings. The demand trigger and demand reset signals must be configured in "***Setpoint>Relay configuration***"

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

a) COMMUNICATION SETTINGS

This section details the settings related to communication parameters for the different protocols available in the F650.

Table 3–7: GENERAL OVERVIEW OF COMMUNICATION SETTINGS MENU:

COMMUNICATION SETTINGS	
Serial Ports	Baud rate and parity for COM1 and COM2 serial communication ports.
Network (Ethernet)	Ethernet communication parameters for COM3 (IP Address, Netmask, Gateway IP) NOTE: The ModBus Slave address used by Ethernet ports is the one set for COM2.EnerVista 650 Setup software allows programming two different Ethernet addresses, but the first IP has always to be set as the second IP Address is an Alias.
ModBus Protocol	ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP
DNP3 Slave	Physical port, Slave Address for DNP, IP Addresses for Masters, TCP/UDP Port, Unsolicited Response parameters, Analog scale factors and deadbands, message fragment size, Binary input block.Available for standard and IEC61850 models.
IEC 870-5-104	TCP Port, Common Addr of ASDU, Cyclic Meter Period and, Synchronization Event settings.Available for standard and IEC61850 models.
SNTP (*)	Synchronization over Ethernet settings
PROCOME	Comm port and slave number for procome protocol. Only available for procome models (5).

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.8.2 SYSTEM SETUP

This section shows the settings related to the system setup definition such as shown in the following table.

Table 3–8: GENERAL OVERVIEW OF SYSTEM SETUP MENU:

SYSTEM SETUP	
General Settings	This screen describes and enables the settings of the power system where the relay will operate. Some of these settings will be used only for metering values presentation purposes; however, some of them apply directly to the sampling and analog-digital conversion process (rated frequency setting). Therefore, these settings need to be adjusted so that they fit the system settings.
Flex Curves	Flex Curves – Programmable user curves: The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in "***Setpoint>System Setup>Flex Curves>Edit Curve***" menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.
Breaker settings	Breaker settings, maintenance and switchgear selection of the device configured as breaker in the F650. The selected switchgear will be used in recloser, breaker failure and synchronism functions. The settings are Number of Switchgear, Maximum KI^2t, KI^2t Integ. Time, Maximum Openings, Max.Openings 1 hour and Snapshot Events.
Breaker maintenance	These settings correspond to the initialization of $(KI)^2t$ counters, and the counting of number of openings and closings of the switchgear configured as breaker. These Counters allow the breaker Maintenance. They are used to cumulate the breaker ageing produced by a trip or a breaker opening. In order to incorporate the breaker historic, in case of existing breakers, the system allows assigning an initial value to accumulated amperes, and to the number of opening and closing operations.
Switchgear	Configuration of snapshot events for each switchgear (enable or disable)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.8.3 PROTECTION ELEMENTS

This option shows all the protection-grouped elements available in the relay as shown in Table 3–9:. Each of these groups includes the specific protection units of the same type. For example phase currents group includes TOC, IOC, directional units, etc. There are three groups available, so there are three protection units of each function that can work in grouped mode or ungrouped (altogether).

Table 3–9: GENERAL OVERVIEW OF PROTECTION ELEMENTS MENU:

PROTECTION ELEMENTS	
Phase Current	All overcurrent grouped functions for phase current.
Neutral Current	All overcurrent grouped functions for neutral current. (Calculated from phases, not measured)
Ground Current	All overcurrent grouped functions for ground current. (Measured from 4th current input)
Sensitive Ground Current	All overcurrent grouped functions for sensitive ground current. (Measured from 5th current input)
Negative Sequence Current	All Negative sequence overcurrent grouped functions.
Voltage Elements	All voltage grouped functions for phases, neutral, ground and auxiliary voltage
Power	Forward power, directional power and wattmetric ground fault (High and Low) grouped protection functions.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

Table 3–10: PROTECTION ELEMENTS INCLUDED

PHASE CURRENT		
	Phase TOC High	Phase time overcurrent, high level (51PH)
	Phase TOC Low	Phase time overcurrent, low level (51PL)
	Phase IOC High	Phase instantaneous overcurrent, high level (50PH)
	Phase IOC Low	Phase instantaneous overcurrent, low level (50PL)
	Phase Directional	Phase directional unit (67P). Quadrature Voltage for polarization
	Thermal Model	Thermal model or Thermal image unit for phases (49)
NEUTRAL CURRENT		
	Neutral TOC	Neutral time overcurrent (51N)
	Neutral IOC	Neutral instantaneous overcurrent (50N)
	Neutral Directional	Neutral directional unit (67N). Voltage, current and dual polarization.
GROUND CURRENT		
	Ground TOC	Ground time overcurrent (51G)
	Ground IOC	Ground instantaneous overcurrent (50G)
	Ground Directional	Ground directional unit (67G). Voltage, current and dual polarization.
SENSITIVE GROUND CURRENT		
	Sensitive Ground TOC	Sensitive ground time overcurrent (51SG).
	Sensitive Ground IOC	Sensitive ground instantaneous overcurrent (50SG).
	Isolated Ground IOC	Isolated ground overcurrent (50IG)
	Sensitive Ground Directional	Sensitive ground directional unit (67SG)
NEGATIVE SEQUENCE CURRENT		
	Negative Sequence TOC	Negative sequence time overcurrent (46P)
VOLTAGE ELEMENTS		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)
	Neutral OV High	Neutral overvoltage, high level (59NH)
	Neutral OV Low	Neutral overvoltage, low level (59NL)
	Negative Sequence OV	Negative sequence overvoltage (47)
	Auxiliary OV	Auxiliary overvoltage (59X)
	Auxiliary UV	Auxiliary undervoltage (27X)
POWER		
	Forward Power	Forward power (32FP), in primary values.
	Directional Power	Directional power (32), in primary values.
	Watt Gnd Flt High	Wattmetric ground fault high (32N High), in secondary values
	Watt Gnd Flt Low	Wattmetric ground fault low (32N Low), in secondary values

3.1.8.4 CONTROL ELEMENTS

This option shows all the control elements available in the relay as shown in Table 3–11:. Some of the elements are grouped ones such as underfrequency, overfrequency and broken conductor.

Table 3–11: GENERAL OVERVIEW OF CONTROL ELEMENTS MENU:

CONTROL ELEMENTS	
	Setting Group: F650 units incorporate a flexible grouping capability for protection units. This means that protection units can be used in either single setting group (default mode-all units can operate simultaneously) or three setting groups (in this mode, protection units are grouped in three independent tables, with only one of them active at a given time). Protection element grouping involves only Protection elements together with broken conductor detection and over and under frequency, which are usually considered as control elements. The rest of control elements such as recloser, fuse failure, breaker failure, synchronism, and breaker settings are not involved in the tabled groups concept.
	Underfrequency: Underfrequency unit (81U). Grouped element
	Overfrequency: Overfrequency unit (81O). Grouped element
	Synchrocheck: Synchronism check unit (25). Not grouped, a single unit provided
	Autoreclose: Recloser (79). Not grouped, a single unit provided
	Breaker Failure: Breaker failure (50BF). Not grouped, a single unit provided.
	VT Fuse Failure: Fuse Failure (VTFF). Not grouped, a single unit provided.
	Broken Conductor: Broken or fallen conductor detection function (I2/I1). Grouped element. Ratio between the negative sequence current, I2, and the positive sequence current I1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.
	Locked Rotor: Locked rotor detection function (48). Grouped element.
	Pulse Counters: Pulse counters function. 8 counters provided.
	Analog Comparators: Analog comparator function. 20 analog comparators provided.
	Frequency rate of change: Frequency rate of change function (81R).Grouped element.
	Load Encroachment: Load Encroachment function. Grouped element.

3.1.8.5 INPUT/OUTPUTS

Section that contains the settings for all input and output boards and the Force Outputs and Virtual inputs activation tools.

Table 3–12: GENERAL OVERVIEW OF "INPUTS/OUTPUTS" SETTINGS MENU.

INPUTS/ OUTPUTS	
	Contact I/O: Inputs and outputs settings for all boards in F650. The I/O settings configuration can only be performed through EnerVista 650 Setup, not HMI available.
	Force Outputs (*): This menu allows activating each contact output in the relay, to facilitate maintenance testing. On line mode only.
	Virtual Inputs (*): This menu allows operating virtual inputs. These variables are used as inputs to logic schemes configured in the relay. Virtual inputs can be operated in a latched mode (32 latched virtual inputs) or in Self-reset mode (32 self reset virtual inputs).
	Remote Comms.: This menu allows configuring remote inputs coming from other devices through GSSE messages. Available for IEC61850 (6) models only.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

This section shows the settings related to inputs and outputs for the different boards available in F650 (F, G, H, J).

Table 3–13: GENERAL OVERVIEW OF "INPUTS/OUTPUTS>CONTACT I/O" SETTINGS MENU.

CONTACT I/O	
Board F	Board located in first slot, always connected.
Board G	Board located in second slot, depends on model definition. If model is type G0 there is no board in second slot.
Board H	Board located in first slot of CIO Module (external inputs/outputs module)
Board J	Board located in second slot of CIO Module (external inputs/outputs module)

3.1.8.6 RELAY CONFIGURATION

This is the relay configuration section in which the relay can be configured using internal states or already compiled equation on PLC Editor.

Table 3–14: GENERAL OVERVIEW OF RELAY CONFIGURATION MENU:

RELAY CONFIG	
Outputs	Configuration of contact output operate and reset signals for all boards.
LEDs	15 LEDs fully configurable from any logical variable, contact or virtual input. First 5 LEDs are latched by hardware, the rest are self-reset but can be latched through PLC configuration. From the LED configuration screen, it is possible to print the vertical LED label for the relay.
Operations	Configurable operations up to 24. Operation texts, interlocks, final states, frontal keys, time outs and masters.
Protection Elements	This tab allows assigning operands (logic signals) as inputs to different protection elements. To block, reset, initiate the different protection elements inputs.
Oscillography	Trigger and up to 16 digital channels to be included in oscillography records, are programmable from any logical variable, contact or virtual input. Text configuration is only for off-line mode. **NOTE:** This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/ disabling, sampling rate, number of oscillography files, etc. must be set on the ***Setpoint>Product Setup>Oscillography*** menu.
Control Events	Up to 128 user programmable events from any logical variable, contact or virtual input. Possibility to display the event as an alarm on the alarms panel. Control events are also displayed in the snapshot events recording. 1 ms time tagging. A control event is a logic signal associated to an operand or combination of operands, that allows following the status of that signal.
Switchgear	Up to 16 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 16 programmable switchgear elements.
Remote outputs	Up to 32 DNA bits and 64 user St bits to be transmitted to remote devices over CAN using GSSE messages
Inputs	Text configuration for off-line mode file management for all the contact inputs available in device.
Virtual Inputs	Text configuration for off-line mode file management. 32 latched and 32 self reset virtual inputs.
MMI (HMI-Human Machine Interface)	Screen for one line diagram configuration. This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings. See an example in

The following figures show an example of the default factory configuration for F650. The F650 has no default factory configuration, but a possible example could be the following:

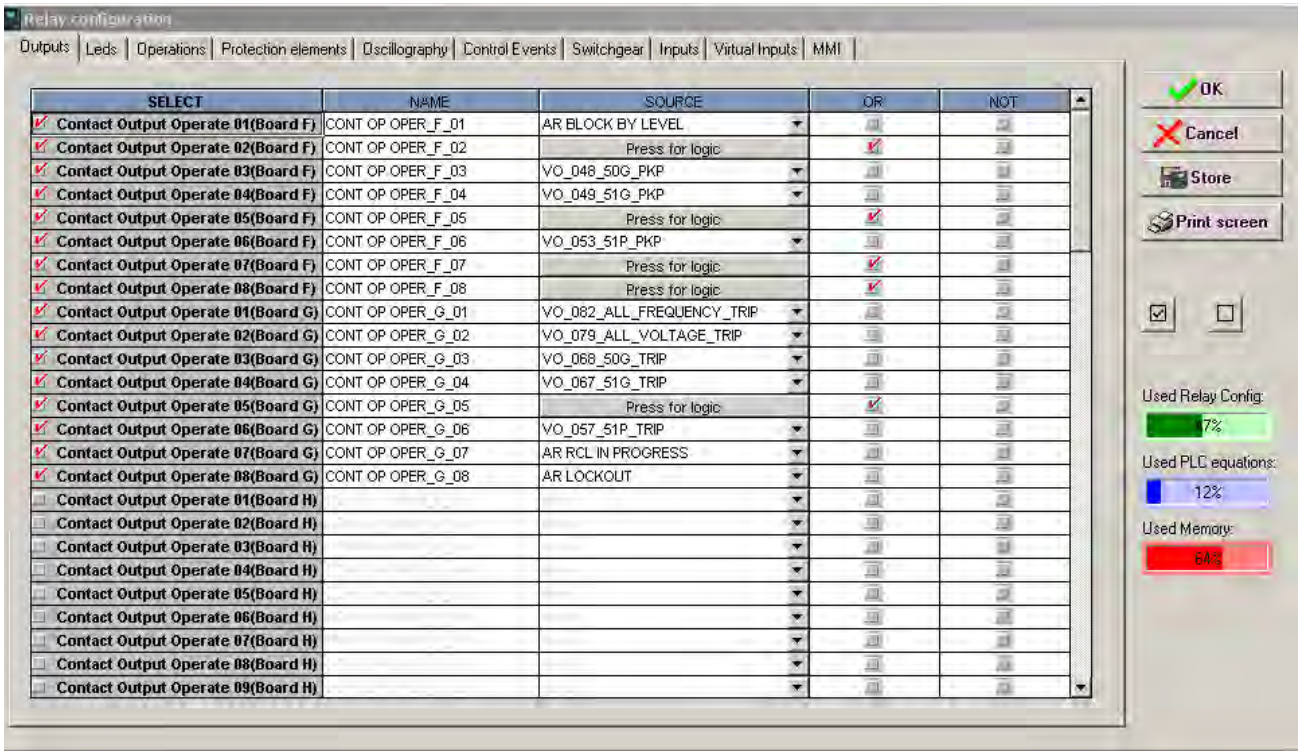


Figure 3–9: RELAY CONFIGURATION

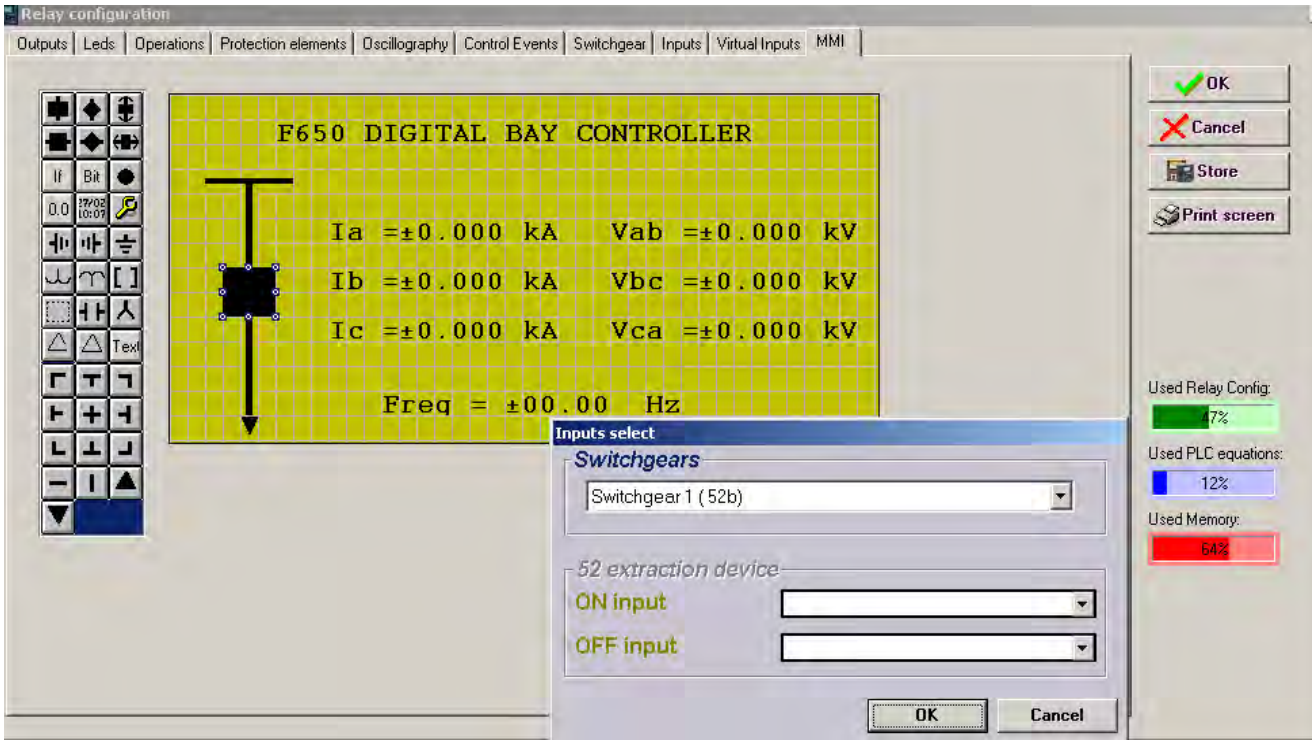


Figure 3–10: HMI CONFIGURATION

3.1.8.7 LOGIC CONFIGURATION

This logic configuration allows creating more complex configurations, using the graphical PLC, than using the tables from Relay Configuration. For file management detailed information go to section 3.1.5.

File description:

.pep: Header for Logic project: PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (.lib), graphic file name (*.aut), etc.

*.aut: PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).

*.lib: User programmable logic objects: Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.

3.1.8.8 CLOCK

This menu allows to update the date and time of the relay, either synchronizing them with the PC clock, or entering the information manually.

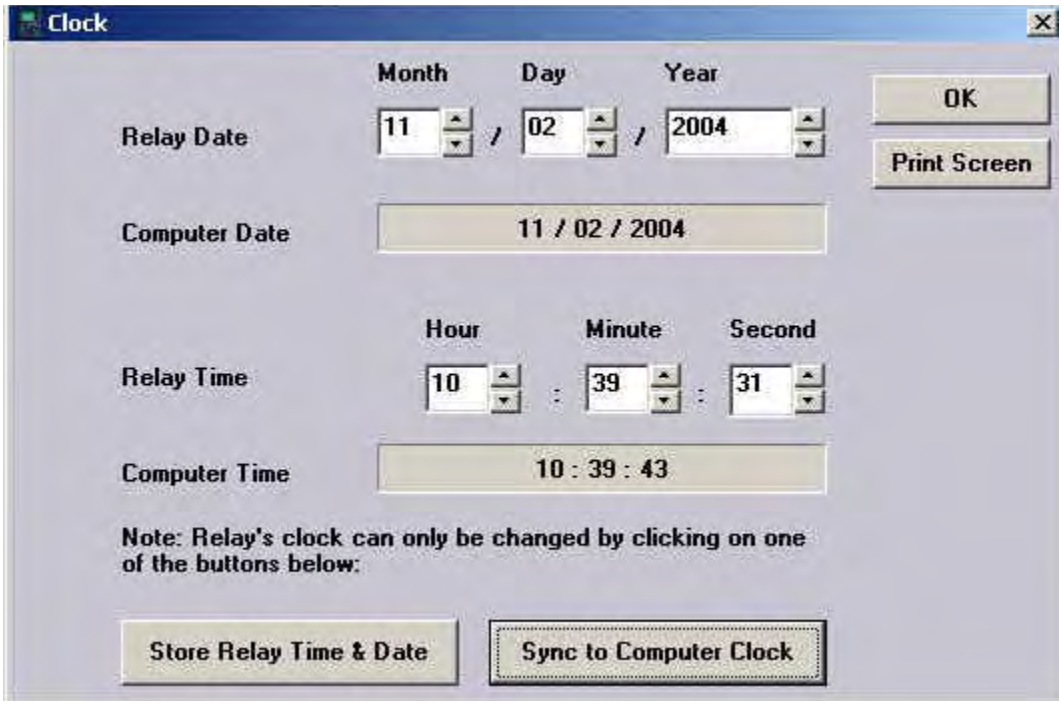


Figure 3–11: CLOCK

3.1.9 ACTUAL VALUES MENU OVERVIEW

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This section shows only the structure of menus in EnerVista 650 Setup.

Table 3–15: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:

ACTUAL	
Front Panel	The relay front LEDs status is shown on this menu.
Status	Protection and control status signals for all available protection functions in device.
Metering	All metering values available in device. Primary and secondary values, frequency and phasor diagram provided.
Inputs/Outputs	All input and output status provided. For contact inputs and contact outputs as well as virtual input and virtual output signals.
Records	Only enabled in on line mode, retrieval of all the available records in device. Snapshot events, control events, oscillography and fault reports.

3.1.9.1 FRONT PANEL

The front panel menu shows only the LEDs submenu where all the front LEDs can be monitored.

3.1.9.2 STATUS

The following menu includes all the available protection status in the device.

Table 3–16: GENERAL OVERVIEW OF STATUS MENU:

STATUS	
Operation bits	Up to 24 elements. OPERATION BIT XX is (0) when the configured time out for the operation XX expires or when success conditions are met. And it is (1) if operation XX is executed and interlocks are fulfilled.
Breaker	Breaker status (open, closed or undefined). The rest of the status signals corresponding to the switchgear XX configured as breaker are in the "***Status>Switchgear Status>Switchgear XX***" menu.
Protection	Status of all the protection units in the device.
Control Elements	Status of all the control units available in the device.
Protection Summary	This screen shows a complete list of all protection and control elements in the relay, showing their status (enabled or not).
Snapshots events summary	Summary of the snapshot events status (enabled or disabled) for protection, control, inputs and outputs boards and switchgear.
ModBus User Map	Up to 256 elements. Value in SIGNED INT 16 BIT format of the reading for the selected address configured in "***Setpoint>Product Setup>ModBus User Map***"
Switchgear Status	Up to 16 blocks of switchgear status signals for the 16 configurable devices. Status signals such as inputs for A and B contacts, status for A and B, open and close status, error 00 and error 11, open init and close init, fail to open and fail to close signals.
Calibration	Internal states for calibration. Factory calibration and calibration error signals.
Flex Curves	Flex curve status for A, B, C and D user curves. (0) if it is not configured, (1) if it is configured. To configure a flex curve go to "***Setpoint>System Setup>Flex Curves***" menu.
System Info	This screen can monitor the system parameters and the internal status of the Relay operative system. Not enabled by default, password required
Records Status	Information related to the different records stored in the Relay, such as: Fault reports, control events, oscillography, data logger, demand, energy, and breaker maintenance.
SNTP-IRIG-B	Information related to synchronization via IRIG_B or SNTP

Table 3–17: ACTUAL VALUES INCLUDED IN THE PROTECTION MENU

PROTECTION	
Protection Blocks	This screen shows all the protection element blocks available. Protection elements block signals can be configured at "***Setpoint>Relay Configuration > Protection Elements***".
Phase Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for phase current.
Neutral Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for neutral current (calculated from phases).
Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for ground current (measured from 4th current input).
Sensitive Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent, isolated and directional protection functions for ground current (measured from 5th current input).
Negative Sequence Current	Protection status signals (pickups and operations) for negative sequence time overcurrent function.
Thermal Model	Protection status signals for thermal model. Reset, alarm and operation signals for phases and for unit, besides the thermal image values in percentage for all phases and units.
Voltage	Protection status signals (pickups and operations) for all voltage functions, undervoltage, overvoltage, neutral overvoltage, negative sequence overvoltage and auxiliary under and over voltage.
Power	Protection status signals (pickups and operations) for forward, directional and wattmetric ground fault (high and low) power units, and power factor status. Power values for 32N High and Low functions (in watts).

Table 3–18: DIFFERENT CONTROL ACTUAL VALUES INCLUDED IN THE CONTROL ELEMENTS MENU

CONTROL ELEMENTS	
Frequency	Status signals (pickups and operations) for under, overfrequency and frequency rate of change units.
Synchrocheck	Status signals for synchrocheck function (25).
Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc.), block signals after each shot.
Breaker Failure	Status signals for breaker failure function (50BF).
VT Fuse Failure	Fuse failure detection signal.
Broken Conductor	Status signals (pickups and operations) for broken conductor (I2/I1).
Setting Groups	Status signals (activations and blocks) for the relay setting group change. By default the "setting group" setting is disabled and all the grouped elements can be enabled at the same time.
Locked Rotor	Status signals (pickups and operations) for locked rotor units.
Pulse Counters	Status signals for pulse counters units.
Analog Comparator	Status signals for analog comparator units.
Load Encroachment	Status signals (pickups and operations) for load encroachment units.

Table 3–19: ACTUAL VALUES RELATED TO RECORDING FUNCTIONS IN THE RECORDS STATUS MENU:

RECORD STATUS	
Fault Reports	This menu shows the fault report status signals, as fault report trigger, fault date, fault type and location, besides the fault report number.
Control Events	Status of the control events (if the signal configured to launch the control event is active or not).
Oscillography	Status of signals related to oscillography recording, such as status or digital channels, oscillography trigger, number of records available, etc.
Data Logger	Data logger information about oldest and newest sample time stamp, and number of channels and days configured in data logger settings.
Demand	Demand trigger and reset inputs status.
Energy	Freeze, unfreeze and reset input signals for energy counters.
Breaker Maintenance	All signals related to breaker maintenance, such as number of openings, closings, $(KI)^2t$ counters, alarm signal for $(KI)^2t$, etc.

3.1.9.3 METERING

The Metering menu includes all the measurements available in the device. Primary and secondary values, and also the data related to the recording functions in the relay.

Table 3–20: GENERAL OVERVIEW OF METERING MENU:

METERING	
Primary Values	Primary values measurements for currents, voltages, power, energy and demand
Secondary Values	Secondary values measurements for currents, voltages and power.
Phasor Diagram	Current, voltage and sequence components.
Frequency	Line and Bus frequencies.

3.1.9.4 INPUTS/OUTPUTS

The Inputs/Outputs menu includes all the inputs and outputs signals available in the device. Contact and virtual type.

Table 3–21: GENERAL OVERVIEW OF INPUTS/OUTPUTS MENU:

INPUTS/ OUTPUTS	
Contact Inputs	Status of digital inputs in the Relay for each board according to the relay model.
Contact Output Status	Status of digital outputs in the Relay for each board according to the relay model.
Contact Outputs Operates	Status (activated or not) of the variables used to operate a contact output. To configure these signals go to “Setpoint>Relay Configuration>Outputs” menu.
Contact Outputs Resets	Status (activated or not) of the variables used to reset a contact output. To configure these signals go to “*Setpoint>Relay Configuration>Outputs*” menu. This output reset Command will only be effective if the “***latch***” option has been Selected for the “***Output Type***” setting on the I/O board, thus when the contact output has been configured to emulate function 86 (latching relay).
IO Board Status	Status of I/O boards. This status provides if the hardware it is OK (boards matching relay model, correctly inserted in their tracks, in good state and communicating through the internal CAN Bus).
Virtual Inputs	Status of Virtual inputs latched (32) and self-reset (32).
Virtual Outputs	Status of virtual outputs (configured in PLC Editor). Up to 512.
Remote Outputs	States of remote outputs for IEC61850 models.
Remote Inputs	Status of remote device and remote inputs for IEC61850 models.
Analog Inputs (*)	Measurements coming from analog inputs (DCMA)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.9.5 RECORDS

The Records menu is only available in on line mode and includes the possibility to retrieve all the records available in the device. By serial or Ethernet.

Table 3–22: GENERAL OVERVIEW OF RECORDS MENU:

RECORDS (*)	
Event recorder (*)	Retrieval and visualization of snapshot event (all and new), control events and alarm panel. By serial or Ethernet (ModBus RTU or TCP/IP)
Waveform capture (*)	Retrieval of oscillography files, by serial or Ethernet.
Fault Report (*)	Retrieval and visualization of fault report files, by serial or Ethernet.
Data logger (*)	Retrieval and visualization of data logger files. Only by Ethernet.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.10 OPERATIONS MENU OVERVIEW

Option only available in on line mode, showing all the operations previously configured in the relay with their corresponding texts.

Table 3–23: GENERAL OVERVIEW OF OPERATIONS MENU:

OPERATIONS	
Operation 1 (*)	Entry to first operation (with its corresponding text)
...	...
Operation 24 (*)	Entry to 24th operation (with its corresponding text)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.11 COMMUNICATION MENU OVERVIEW

The communication menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operative system, web server and other file storing capabilities (upload and download info files to/from relay).

For more detail information go to section 3.1.4 for communication menus description and to section 5 for flash memory update procedures.

Table 3–24: GENERAL OVERVIEW OF COMMUNICATION MENU:

COMMUNICATION	
Computer	Menu to start communication with the relay.
Modem (**)	Menu to set modem communication parameters (only available if control type is set to modem in computer menu).
Troubleshooting (*)	Menu that Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map.
Calibration (*)	Retrieval and store calibration settings from/to relay.
Upgrade firmware version (**)	Menu to update the relay firmware version through Ethernet
Upgrade operating system (**)	Menu to update the relay boot code (front RS232 and Ethernet connection)
Upgrade 650 web server	Menu to update the web server application (if available)
Upload info files to relay	Hard disk storage of settings and configuration files on the relay.Option only performed through Ethernet, not available in C650 models.
Download info files from relay	Retrieval of settings and configuration files that had been previously stored in the relay hard disk.Option only performed through Ethernet, not available in C650 models.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

The rest of options available in the Communication menu in EnerVista 650 Setup are:

- Modem: Allows configuring the unit for remote communications via modem, using telephonic line. It is only available if the relay is not communicating and if modem has been select on Communication>computer control type selection. Go to ***"Communication>Modem"***
- Troubleshooting (Serial or Ethernet connection): Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established. Go to ***"Communication>Troubleshooting"***. An example is provided in Figure 3–12:

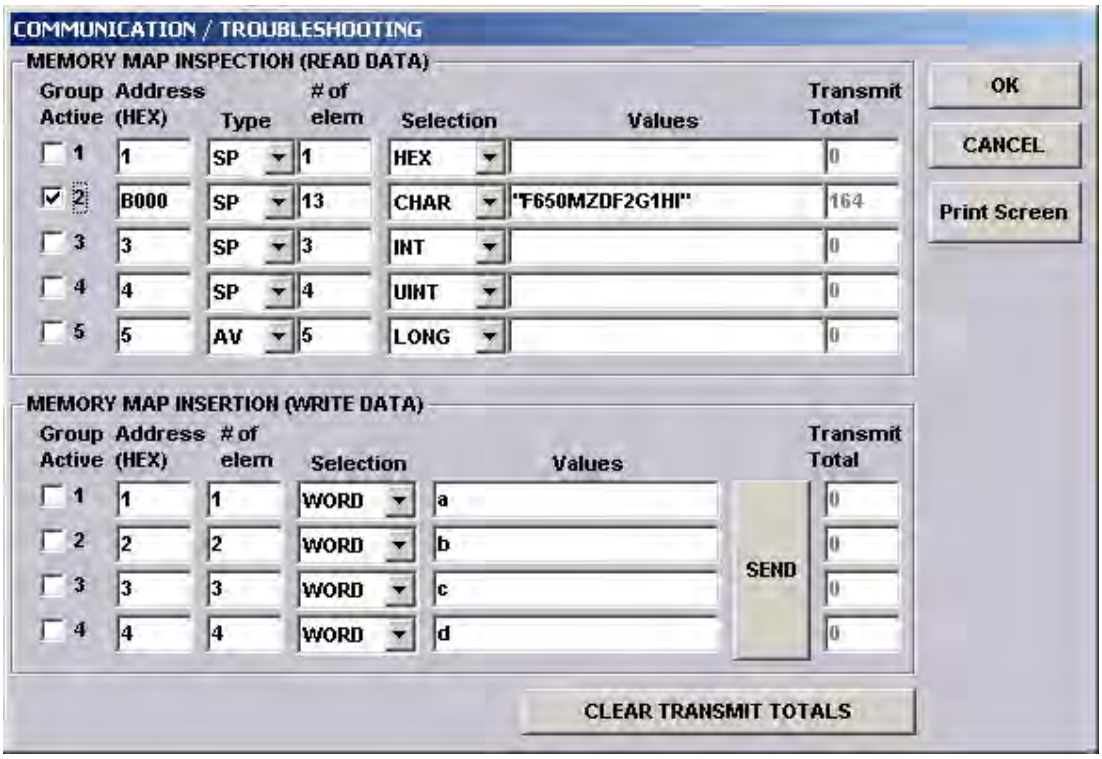


Figure 3–12: COMMUNICATION TROUBLESHOOTING SCREEN

- Calibration (Serial or Ethernet connection): Allows retrieving the unit calibration settings and storing them in a file (with extension *.cal). For reading or storing the calibration settings in the relay go to ***"Communications>Calibration>Get or Set calibration settings"*** and select the intended calibration file. The calibration retrieval process is necessary to be performed before updating the unit operative system, when the operating system is updated all the data in the relay is deleted, including the factory calibration settings. When only the firmware is updated (for versions higher than 1.50), the calibration settings are automatically saved in the relay.
- Upgrade firmware version (Ethernet connection): Go to ***"Communications>Upgrade firmware version"***, this menu allows the user to update the firmware version of the relay through Ethernet communication. Firmware is related to the relay internal program, designed by GE Multilin, which performs the protection and control functions, and which is run by the relay main microprocessor.
- Upgrade operating system (Serial and Ethernet connection): Go to ***"Communications>Upgrade operating system"***. This option allows the user to update the relay operative system. The operative system or OS is the program that supports the firmware and provides auxiliary services for access to electronic devices included in the relay.

IMPORTANT NOTE:

READ CAREFULLY THE FLASH MEMORY UPDATE PROCEDURE DESCRIBED IN SECTION 5 AND CLOSE ALL THE RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND OPERATIVE SYSTEM UPDATING PROCESS
Before updating firmware check that the firmware version that is going to be updated match the operative system version of the relay. Otherwise it is necessary to update the operative system before proceeding to update the firmware. Other combinations of firmware and operative system different from the listed in section 5 will not be operative
The operative system version is available in the logotype main screen in HMI; it is the number between brackets in the first line, e.g. F650 1.70 (2.35). The operative system version is 2.35

Thanks to the use of a double flash memory, one with the Bootcode startup program and the operative system, and a second one with the application program (firmware), a high reliability is guaranteed when updating the unit firmware, as even if the case of a communication breakdown during the firmware upgrade process, we can retry the process for an unlimited number of times.

- Upgrade 650 web server (Ethernet connection): Go to ***"Communications> Upgrade 650 web server"***. The relay web server application can be updated to further versions (if available) using this menu without modifying the relay operative system.Upload info files to relay (Ethernet connection): Go to ***"Communications>Upload info files to relay"***. This functionality is used to store setting files (*.650) inside the relay, as well as auxiliary files used by the programmable logic graphical editor (*.pep, *.aut, *.lib).
- Download info files from relay (Ethernet connection): Go to ***"Communications>Download info files from relay"***. This functionality is used for retrieving the files (*.650 and *.pep, *.aut, *.lib) that have been previously stored in the relay flash memory.

Important Note:

*.650 files contain protection, control settings, relay configuration and compiled logic equations. This file can be retrieved from the relay, using the ***"File>Get info from relay"*** option in EnerVista 650 Setup (through serial or Ethernet communication). ***"File>Send info to relay"*** option stores this *.650 file in the relay.
*.pep, *.aut and *.lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the ***"Communication>Upload info files to relay"*** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using ***"Communication>Download info files to relay"*** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the ***"Communication>Upload info files to relay"*** option to store these logic configuration files into the relay.
It is important to distinguish between "***Send / Get info to relay***" and ***"Upload / Download info files to/from relay"***. ***"File>Send/Get info to relay"*** **sends/gets** settings and configuration and compiled logic equation to/from the relay (*.650 format), and the relay automatically starts working with the new settings once they are stored. "***Communications>Upload/Download info files to relay"***, **stores/retrieves** in the relay hard disk: settings, configuration and compiled logic equations (*.650) besides the PLC files (*.pep, *.aut, *.lib). This is only a physical storage (file backup).

3.1.12 SECURITY MENU OVERVIEW

The security menu includes all the menus related to security control in EnerVista 650 Setup. EnerVista 650 Setup security users and passwords are not related to passwords in HMI. Each security level has its own access for HMI management and EnerVista 650 Setup management.

Table 3–25: GENERAL OVERVIEW OF SECURITY MENU:

SECURITY	
Login User (*)	Log on menu for EnerVista 650 Setup. Enabled after security control has been enabled in user management menu.
Change Password (*)	Menu to change passwords and establish password recovering questions.
User Management (*)	User management dialog box.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.13 VIEW MENU OVERVIEW

The view menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operative system, web server and other file storing capabilities (upload and download info files to/from relay).

The ModBus memory map is detailed in the complete instruction manual (English only) and can be obtained from EnerVista 650 Setup program.

Table 3–26: GENERAL OVERVIEW OF VIEW MENU:

VIEW	
Traces (*)	To inspect ModBus communication traces between the EnerVista 650 Setup and the relay.
ModBus Memory map	Complete ModBus memory map description.
Languages (**)	Option to change the EnerVista 650 Setup default language. Only available if the relay is not communicating and no file (*650) is open.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.14 HELP MENU OVERVIEW

Complete instructions manual and data about EnerVista 650 Setup release.

Table 3–27: GENERAL OVERVIEW OF HELP MENU:

HELP	
Instructions Manual	Instructions manual in the language selected in “View>Languages” menu.
GE Mulitlin on the Web	GE Multilin web page link.
About EnerVista 650 Setup	Release version and date of EnerVista 650 Setup program.

The HMI interface consists of several functional panels. The faceplate can be unscrewed to allow easy access to the removable modules. There is also a removable dust cover that fits over the display and other cover that protects the front RS232 Communications port and the commands buttons that can be sealed. The following figure shows the HMI in F650

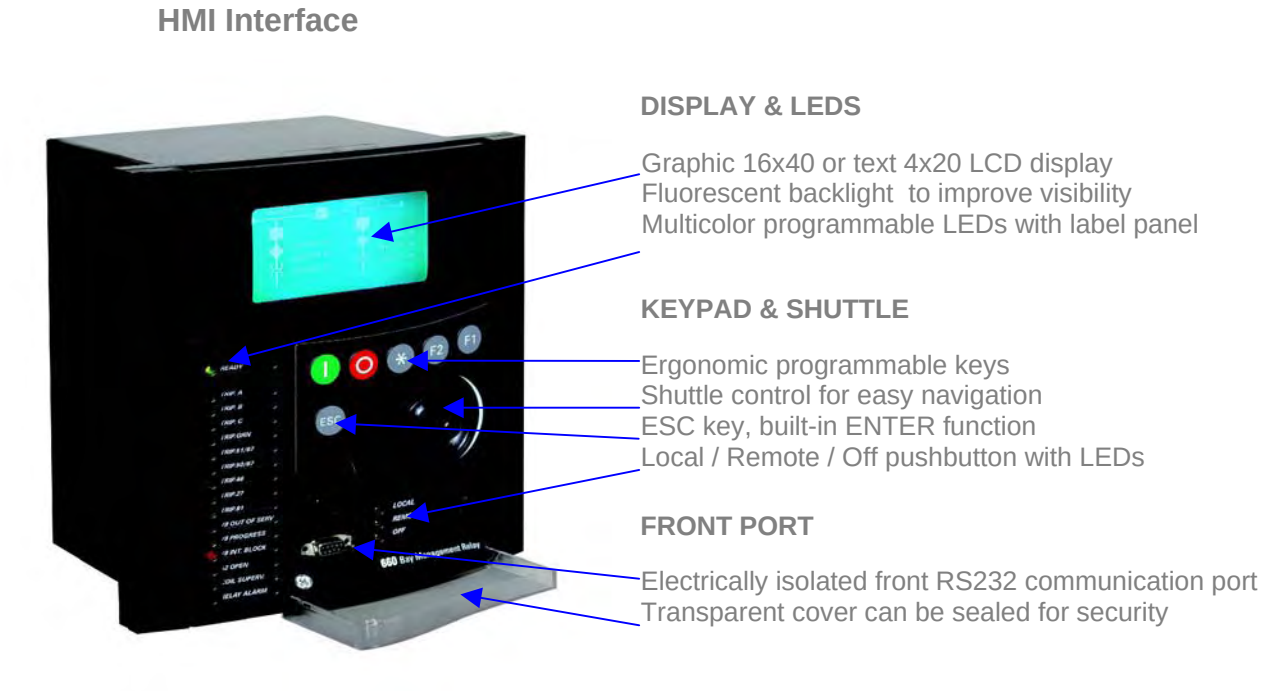


Figure 3–13: HMI INTERFACE

3.2.1 DISPLAY

F650 units are available with two different options for the front display. The first option is an alphanumerical display of 4 lines with 20 characters each, and the second option is a graphical display of 16 lines with 40 characters each (128x240 pixels), being B the ordering code option for the text display model (basic), and M the code for the mimic display (graphical).

The boot code and firmware versions can be seen in the relay text main screen, this screen is the default screen in the text menu for all models: After the text “F650”, appears the relay firmware version (3.44in the example), and between brackets the boot program version (4.10 in the example), followed by “General Electric”, the relay model and the default front RS232 port (COM2) communication parameters.

F650 3.70 (4.10)
General Electric
F650MZDF2G1HIR
19200N81: MODBUS: 254

Figure 3–14: TEXT MAIN SCREEN

3.2.2 FRONT LED INDICATORS

The relay provides 16 LED indicators, 15 user programmable plus one non-configurable LED (READY) that shows if the relay is in service.

Programmable LEDs are divided into groups of 5 LEDs, each of the groups having a different color. The first group of LED indicators is latched by hardware (red color ones), usually configured for trip signals. The second group (yellow color) and third group (green color) of LED indicators are self-reset type and will be reset once the condition has been cleared, but can be latched using logic through PLC configuration.

The ESC key is used to reset any latched led indicator, once the condition has been cleared. Keep the ESC button pressed for more than 3 seconds; all LEDs will light up, verifying their correct operation. When releasing the ESC key, all indicators programmed with memory, such as tripping LEDs, will be reset.

The latched conditions can also be reset via communications using the LED reset input (to configure this signal go to "***Setpoint>Relay Configuration>Protection elements>LED RESET INPUT***"). By default this LED reset input signal is set to LEDS RESET operation.

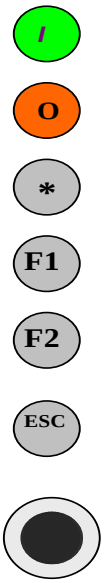
3.2.3 PUSHBUTTONS

The front panel provides:

Push buttons: keypad (5 user programmable plus ESC non configurable), shuttle key or shuttle key for easy navigation, command pushbutton to select operations mode.

RS232 port: intended for connection to a portable PC.

3.2.3.1 KEYPAD AND SHUTTLE KEY

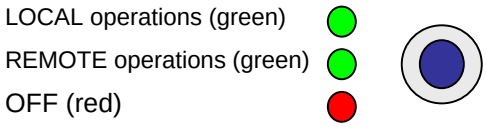


This button can be used for closing the user programmable switchgear. It is fully programmable by the user.
This button can be used for closing the user programmable switchgear. It is fully programmable by the user.
User programmable.
User programmable.
User programmable.
(ESC) Escape key. When pressed during more than 3 seconds, it will test all LEDs and reset the trip LEDs.
Rotary knob or Shuttle Key (it can be both rotated and pressed): Used for selecting menus, submenus, settings and for confirmation. Press or rotate the shuttle key to enter the text main menu from the text standby screen.

Figure 3–15: KEYPAD AND SHUTTLE KEY DESCRIPTION

3.2.3.2 COMMAND PUSH BUTTON

The unit incorporates a command pushbutton located at the bottom right side of the faceplate, with three options: local, remote, and off. The first option (LOCAL) allows executing operations in local mode (HMI, front RS232 port, and rear COM2 port). The second option (REMOTE) allows operation execution only through remote communications (COM1 and COM3 - Ethernet). The third option (OFF) blocks the execution of operations. Each position is identified with an LED indicator, as follows:



Press the command button to switch from local to remote operations mode and vice versa. OFF status (operation inhibited for maintenance and safety) can be reach pressing the commands pushbutton during several seconds (local-remote-off sequence).

The local-remote-off sequence can be also available through communications (see chapter 5.8), with a configurable signal that can be set in the "***Setpoint>Relay Configuration>Protection Elements***" screen.

3.2.4 FRONT PORT AND COVER SEALING SYSTEM

Figure 3–16: shows the detail of the front RS232 communication port and local/remote button access cover sealing system. The sealing system is similar to the one used in energy meters, using wire and plumb seal.

High quality plastic have been used in the design to withstand extreme environmental conditions, both mechanical and electrical, sun radiation, humidity, etc. in order to guarantee a long life for the unit.

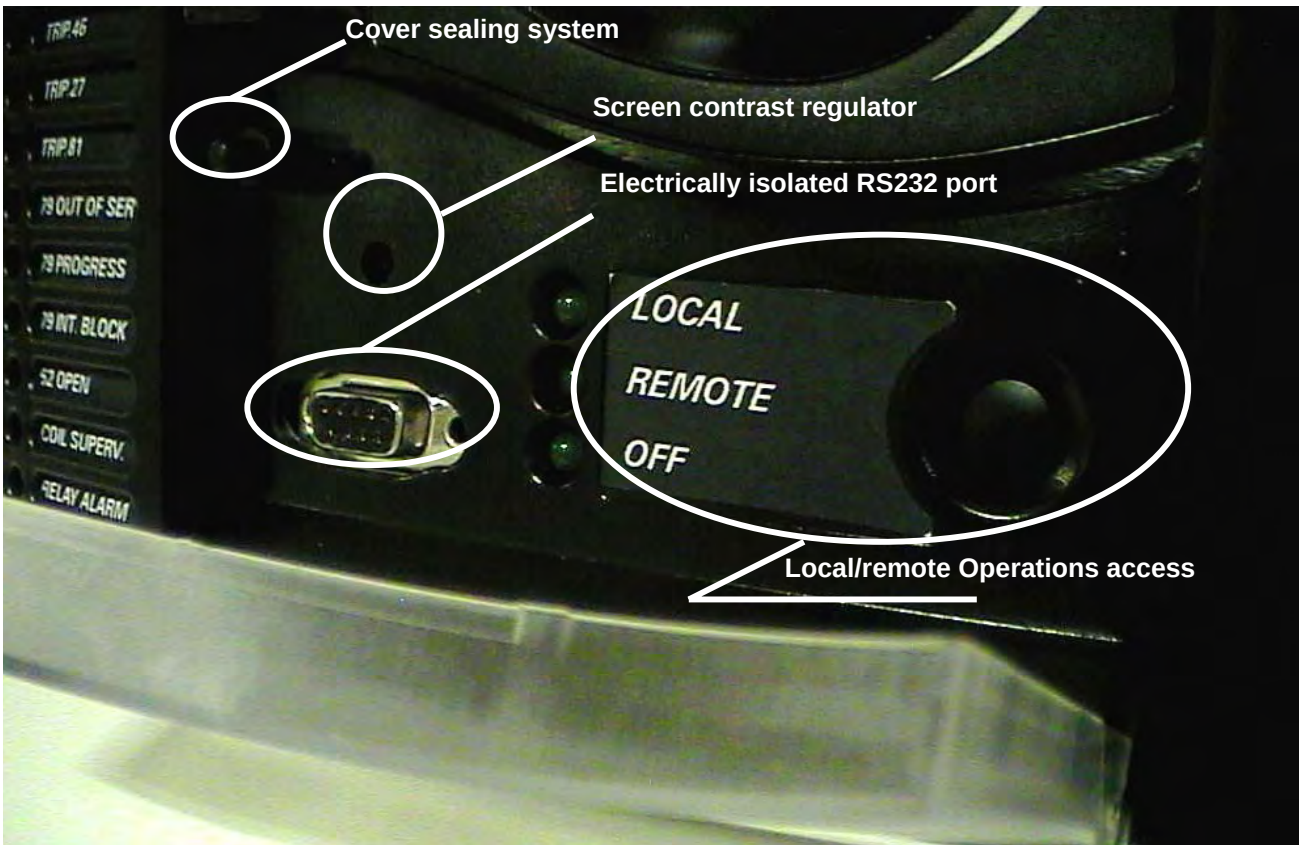


Figure 3–16: DETAIL OF FRONT PORT AND COVER SEALING SYSTEM

3.2.5.1 NAVIGATION IN TEXT MENU

Text menu is available for all models, this is the main menu for visualizing actual values, metering, changing settings, etc. through the HMI. In models with graphical display (M in ordering code) besides this text main menu there are several screens providing more performance for control purposes.

Press (or rotate left or right) the shuttle key to enter the main menu, starting from the standby screen (default main screen). The default main screen can be accessed pressing ESC key till it appears. In all the navigation press the shuttle key to select the desired header display (top-level menu). Each press of the shuttle key advances through the main heading pages as illustrated below. To return to previous menus press the ESC key. To move inside the top-level menu without changing to other low levels, rotate the shuttle key left to move up and right to move down.

When rotating the shuttle key the selected menu is marked by a single scroll bar character. The mark (**>**) in the right part of any menu means that contains more than one level.

Symbol	Action Performed	Navigation in menu
ENTER	Press Shuttle Key	Enter next level
ESCAPE	Press Esc Key	Exit to previous level
L-R	Rotate Shuttle Key	Move up and down in the same level
L	Rotate left Shuttle Key	Move up in the same level
R	Rotate right Shuttle Key	Move down in the same level
■	Menu selection	Menu selection
>	More menus to display	More menus to display

Figure 3–17: Shows an example of main menu navigation:

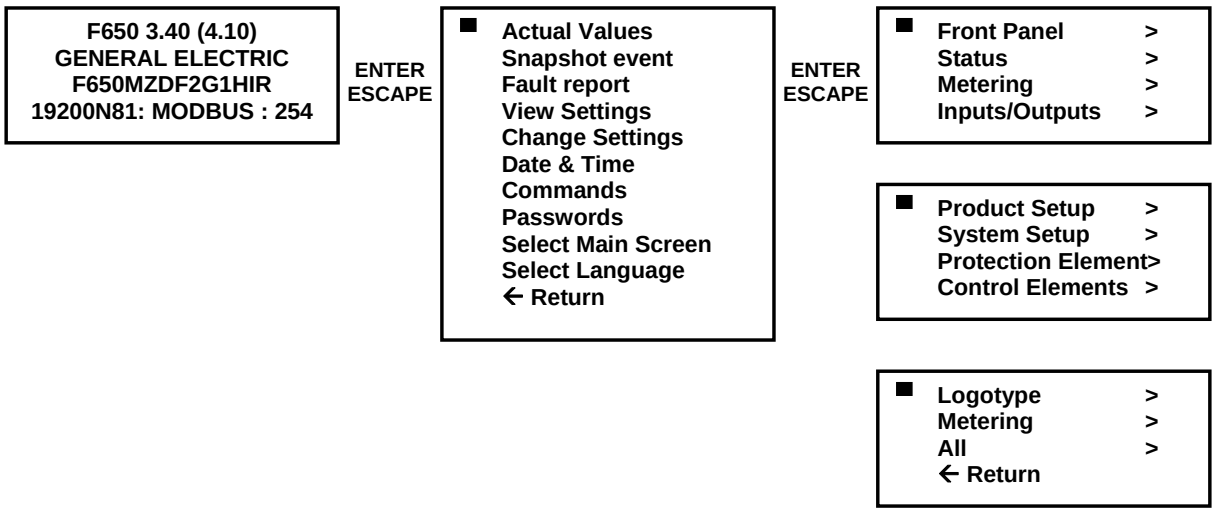


Figure 3–17: NAVIGATION IN MAIN TEXT MENU

3.2.5.2 TEXT MENU HIERARCHY

The structure of HMI text menu is similar to the EnerVista 650 Setup in the actual values and settings (view and change) menus.

The main menu shows the following options:

Table 3–28: GENERAL OVERVIEW OF MAIN TEXT MENU:

NAME	DESCRIPTION	NAVIGATION IN MENU
Actual Values	Actual values of all the signals available in device. Status of protection and control elements, measurements, inputs and outputs, etc.	Press shuttle key to enter next level. Press ESC to return to default main screen.
Snapshot events	Visualization of all snapshot events in text mode (two screens for each snapshot event). In graphical displays there can be seen in a dedicated screen.	Press shuttle key to visualize snapshot events in text menu. Press ESC to return to default main screen.
Fault Report	Fault reports information available in HMI (two screens for each fault report)	Press shuttle key to enter next level. Move L-R to see all the available fault reports in device. Press shuttle key to enter particular information for fault report selected.
View Settings	Visualization of all protection and control settings available in device.	Press shuttle key to enter next level. Move L-R to select submenu. Press ESC to return to previous level.
Change Settings	Menu that allows changing all protection and control settings available in device. Inputs and outputs settings, relay configuration and logic configuration are not available in HMI, only via EnerVista 650 Setup software.	Press shuttle key to enter next level. Move L-R to select submenu. Press esc to return to previous level.
Date & Time	Date and time visualization and modification by user.	First mode is visualization. Press again shuttle key to start modification in date and time. Press ESC to return to previous level.
Commands	Operations execution in local mode.	Move L-R to pre select operation. Press shuttle key to select and confirm. Press ESC to return to previous level.
Password	Password menu for settings and commands	Move L-R to select submenu. Press shuttle key to enter next level. Press ESC to return to previous level.
Select Main Screen	Selection of default main screen in text menu.	Move L-R to select the default main screen type. Press shuttle key to confirm.
Select Language	Language selection. Between default language (see ordering code) and English.	Move L-R to select the default language. Press shuttle key to confirm selection. Switch the relay off and on.
< - return	Return to previous level	Press shuttle key to return to previous level.

3.2.5.3 ACTUAL VALUES

The Actual Values menu option in HMI concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc.

Table 3–29: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:

Front Panel >		
	LEDs	
Status >		
	Operation Bits	
	Breaker	
	Protection >	
		Protection Blocks
		Phase Current
		Neutral Current
		Ground Current
		Sens. Ground Current
		Neg. Seq. Current
		Thermal Model
		Voltage
		Power
	Control Elements >	
		Frequency
		Synchrocheck
		Autoreclose
		Breaker Failure (enhanced models only)
		VT Fuse Failure
		Broken Conductor
		Setting Groups
		Locked Rotor
		Pulse Counters
		Analog Comparators
		Load Encroachment
	Switchgear Status >	
		Switchgear 1
		Switchgear...
		Switchgear 16
	Calibration	
	Flex Curves	
	System Info	
	Records Status >	
		Fault Reports
		Control Events
		Oscillography
		Data logger
		Demand
		Energy
		Breaker Maintenan.
	SNTP-IRIG_B	

Metering >		
	Primary Values >	
		Current
		Voltage
		Power
		Energy
		Demand
	Secondary Values >	
		Current
		Voltage
		Power
	Frequency	
Inputs/Outputs >		
	Contact Inputs >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output St. >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output Op. >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output Rs. >	
		Board F/ Board G/ Board H/ Board J
	IO Board Status	
	Virtual Inputs >	
		Virtual Inp.Latched
		Virtual Inp.SR
	Virtual Outputs	
	Remote Outputs (for IEC61850 models only) >	
		DNA
		User St
		GOOSE Dig Outputs
	Remote Inputs for IEC61850 models only)>	
		Remote Input
		Remote Devices
		GOOSE Dig Inputs
		GOOSE Analog Inputs
	Analog Inputs >	
		Board F/ Board G/ Board H/ Board J

To enter this menu press the shuttle key when the option Actual Values is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 3–29:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in Actual Values. Once the last sublevel is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 3–18:.

First Line: Header of last level in actual values (Phase Current in the example)

Second Line: Data identifier (in the example PH IOC1 HIGH A, is the pickup signal for the first instantaneous overcurrent function level high for phase A).

Third line: Status of the displayed actual value.

Fourth Line: Relative position in the menu (it is the first value of 114)

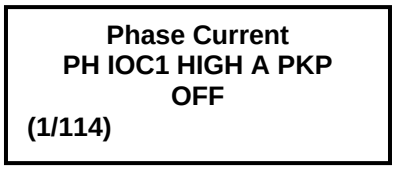


Figure 3–18: ACTUAL VALUES SCREEN DATA

In the Actual Values menus are different types of data, each type of data will display its particular status type (on and off, 0 or 1, ok or fail, analog values, etc.)

3.2.5.4 SNAPSHOT EVENTS

To enter this menu press the shuttle key when the option Snapshot events is selected in main menu (). In this menu all the snapshot events stored can be displayed.

Snapshot events are changes in the relay internal status.

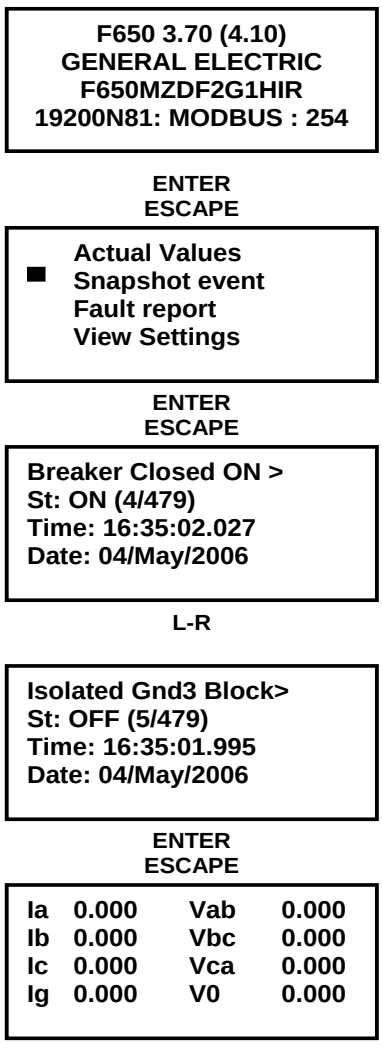
One snapshot event is displayed in two text screens:

The first screen display the status, date and time of the snapshot event: the snapshot event identifier, its status, event number and the date and time of the occurrence. If the snapshot event identifier does not fit the first line, the whole text will be shown using as well the second line alternating with the status and event number.

The second screen displays currents and voltages in primary values for that particular snapshot event. Ia, Ib, Ic and Ig for currents and Vab, Vbc, Vca and V0 for voltages. To access the metering screen in snapshot events menu, press shuttle key from the snapshot event first screen. To exit from the metering screen press ESC.

To select different snapshot events to be displayed, rotate the shuttle key to select the snapshot event and then press the shuttle key to enter the metering screen. Press esc to exit the metering screen and return to snapshot events menu.

Figure 3–19: shows an example of snapshot events navigation:



Press shuttle key from the default main screen and enter in the main text menu.

Move the shuttle key until a single scroll bar character (☐) appears in the left part of Snapshot event header.

Press shuttle key to enter in the snapshot events menu)

Select the snapshot event to display using the shuttle key (left and right to move up and down inside the recorded snapshot events).

Once selected the snapshot event, identifier, status, date and time will be displayed.

In the second line St: is showing the status and the relative snapshot index from the whole recorded number. Third and fourth lines are used to display the time and date of the snapshot event.

Pressing the shuttle key the metering screen for the snapshot event will be displayed.

To exit from this screen press the ESC key and return to the snapshot events menu.

Figure 3–19: SNAPSHOT EVENTS NAVIGATION IN HMI

3.2.5.5 FAULT REPORT

To enter this menu press the shuttle key when the option Fault report is selected in main menu (). This menu displays information about the last ten faults recorded in the relay.

The Relay HMI allows two types of visualization for the fault reports stored in the Relay:

1. Showing the fault warning messages in the text display when the fault is produced. This option has to be enabled by setting. To change from the HMI go to the menu "***Change Settings >Product Setup > Fault Report > Show Fault On HMI***" and enable it.

2.Only saving and allowing viewing the information from the last ten faults recorded in the relay.

In the first option, when a fault occurs a warning message is displayed, including information about the fault in two screens, one with general fault information, and a second one with the measured values in the moment of the fault.

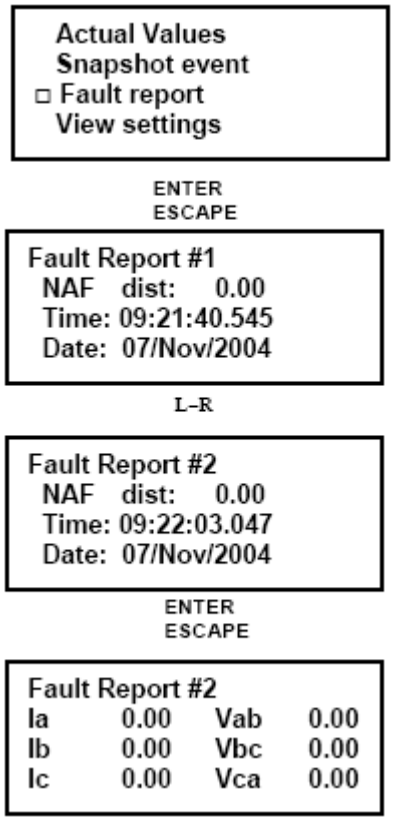
The fault-warning message must be acknowledged by the user; this means that the user must press the shuttle key for this screen to disappear, The HMI will not allow to perform any other operation until the screen is acknowledged. In the event of several consecutive faults, the HMI will always show the most recent fault, and the user will need to acknowledge all of them, up to a maximum of ten faults.

In the second option, viewing the fault reports in the menu available in the HMI, the Fault Report menu in the main text screen must be accessed by pressing the shuttle key. The display will show the information about the last ten faults produced, and both the general information and the metering screens can be viewed for each fault. Displayed information starts in the most recent fault, and the user can switch to another fault by rotating the shuttle key.

Displayed information is stored in the relay volatile memory, so if the relay is turned off this information will be lost, as well as if a "Clear Fault Report" command is executed. However, fault reports stored in the relay non-volatile memory will remain after the Fault reset, and they can be obtained from the relay using EnerVista 650 Setup software, at the "Actual>Records>Fault report" menu.

If there is no fault report available through the display, the relay will show a "***Fault report not available***" message.

The format of the displayed screens is as follows:



Select the Fault report menu in text menu

If there is more than one fault record rotate the shuttle key and select the desired record to be displayed.

First screen with general fault information: Fault report #number, fault type, distance and date and time.

Second screen with metering data for that fault record. All this data is a summary from the fault report file that can be retrieved via EnerVista 650 Setup software.

Figure 3–20: FAULT REPORT NAVIGATION IN HMI

Possible fault types are as follows:

GROUND	Ground faults
	AG phase A to ground ABG phase AB to ground BG phase BG to ground BCG phase BCG to ground CG phase CG to ground CAG phase CAG to ground
PHASE	Phase to phase faults
	AB phase A to phase B BC phase B to phase C CA phase C to phase A
3PHASE	Three-phase faults (shown on the display as 3PH)
NAF	**Fault type not calculated**

3.2.5.6 VIEW SETTINGS

To enter this menu press the shuttle key when the option “View Settings” is selected in main menu (☐). A secondary level will be displayed with different sublevels as shown on Table 3–30:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed (☐), press the shuttle key again to enter in next level and press esc key to return to previous level if desired. This navigation will be performed the same for all the menus in “View Settings”. Once the last sublevel is reached, move up and down to visualize the settings selected.

Table 3–30: GENERAL OVERVIEW OF “VIEW/CHANGE SETTINGS” MAIN MENU

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
Product Setup >			
	Communication >		
		Serial Ports	
		Ethernet >	
			Ethernet 1
			Ethernet 2
		ModBus Protocol	
		DNP3 Slave (Available for standard and IEC61850 models)>	
			DNP3 Slave 1
			DNP3 Slave 2
			DNP3 Slave 3
		IEC 870-5-104(Available for standard and IEC61850 models)>	
		SNTP	
		PROCOME (Available for procome models only).	
	Fault Report		
	Oscillography		
	Demand		
System Setup >			
	General Settings		
	Breaker >		
		Breaker Settings	
		Breaker Maintenance	
Protection Element >			
	Phase Current >		
		Phase TOC High >	
			Phase TOC High 1
			Phase TOC High 2
			Phase TOC High 3
		Phase TOC Low >	
			Phase TOC Low 1
			Phase TOC Low 2
			Phase TOC Low 3
		Phase IOC High >	
			Phase IOC High 1
			Phase IOC High 2
			Phase IOC High 3
		Phase IOC Low >	
			Phase IOC Low 1
			Phase IOC Low 2
			Phase IOC Low 3
		Phase Directional >	

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			Phase Directional 1
			Phase Directional 2
			Phase Directional 3
		Thermal Model >	
			Thermal Model 1
			Thermal Model 2
			Thermal Model 3
	Neutral Current >		
		Neutral TOC >	
			Neutral TOC 1
			Neutral TOC 2
			Neutral TOC 3
		Neutral IOC >	
			Neutral IOC 1
			Neutral IOC 2
			Neutral IOC 3
		Neutral Dir >	
			Neutral Dir 1
			Neutral Dir 2
			Neutral Dir 3
	Ground Current >		
		Ground TOC >	
			Ground TOC 1
			Ground TOC 2
			Ground TOC 3
		Ground IOC >	
			Ground IOC 1
			Ground IOC 2
			Ground IOC 3
		Ground Dir >	
			Ground Dir 1
			Ground Dir 2
			Ground Dir 3
	Sens. Ground Curr >		
		Sens. Ground TOC. >	
			Sens. Ground TOC 1
			Sens. Ground TOC 2
			Sens. Ground TOC 3
		Sens. Ground IOC >	
			Sens. Ground IOC 1
			Sens. Ground IOC 2
			Sens. Ground IOC 3
		Isolated Gnd IOC >	
			Isolated Gnd IOC 1
			Isolated Gnd IOC 2
			Isolated Gnd IOC 3
		Sens. Ground Dir. >	
			Sens. Ground Dir. 1
			Sens. Ground Dir. 2
			Sens. Ground Dir. 3
	Neg. Seq. Current >		
		Neg. Seq. TOC >	

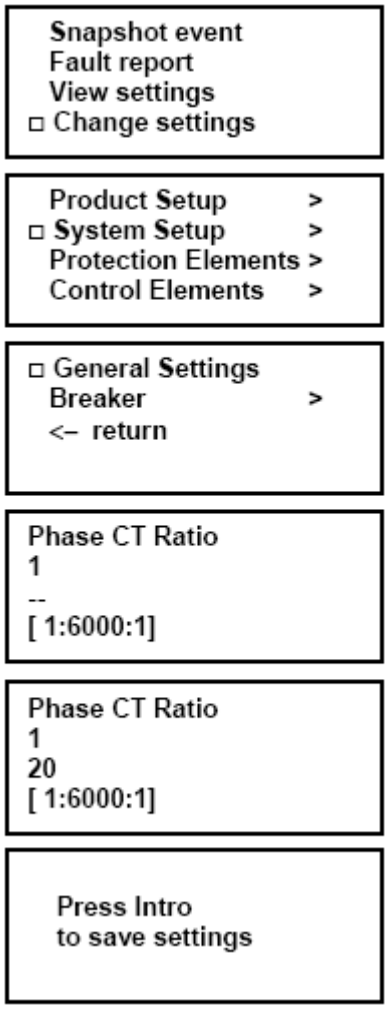
MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			Neg. Seq. TOC 1
			Neg. Seq. TOC 2
			Neg. Seq. TOC 3
	Voltage Elements >		
		Phase UV >	
			Phase UV 1
			Phase UV 2
			Phase UV 3
		Phase OV >	
			Phase OV 1
			Phase OV 2
			Phase OV 3
		Neutral OV High >	
			Neutral OV High 1
			Neutral OV High 2
			Neutral OV High 3
		Neutral OV Low >	
			Neutral OV Low 1
			Neutral OV Low 2
			Neutral OV Low 3
		Neg. Seq. OV >	
			Neg. Seq. OV 1
			Neg. Seq. OV 2
			Neg. Seq. OV 3
		Auxiliary OV >	
			Auxiliary OV 1
			Auxiliary OV 2
			Auxiliary OV 3
		Auxiliary UV >	
			Auxiliary UV 1
			Auxiliary UV 2
			Auxiliary UV 3
	Power>		
		Forward Power >	
			Forward Power 1
			Forward Power 2
			Forward Power 3
		Directional Power >	
			Directional Power 1
			Directional Power 2
			Directional Power 3
		Watt Gnd Flt High >	
			Watt Gnd Flt High 1
			Watt Gnd Flt High 2
			Watt Gnd Flt High 3
		Watt Gnd Flt Low >	
			Watt Gnd Flt Low 1
			Watt Gnd Flt Low 2
			Watt Gnd Flt Low 3
Control Elements >			

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
	Setting Group		
	Underfrequency >		
		Underfrequency 1	
		Underfrequency 2	
		Underfrequency 3	
	Overfrequency >		
		Overfrequency 1	
		Overfrequency 2	
		Overfrequency 3	
	Synchrocheck		
	Autoreclose		
	Breaker Failure		
	VT Fuse Failure.		
	Broken Conductor >		
		Broken Conductor 1	
		Broken Conductor 2	
		Broken Conductor 3	
	Locked Rotor >		
		Locked Rotor 1	
		Locked Rotor 2	
		Locked Rotor 3	
	Fq Rate of Change		
		Fq Rate of Change 1	
		Fq Rate of Change 2	
		Fq Rate of Change 3	
	Load Encroachment		
		Load Encroachment 1	
		Load Encroachment 2	
		Load Encroachment 3	

3.2.5.7 CHANGE SETTINGS

To enter this menu press the shuttle key when the option “Change Settings” is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 3–30:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in “Change Settings”. Once the last sublevel is reached, move up and down to visualize the settings selected.

To change a particular setting, press the shuttle key on the setting to be modified. After selecting the setting, the value for that setting will appear between brackets. Choose the new value moving up and down the shuttle key. After selecting the appropriate value press again the shuttle key to fix that value. To save the new settings, go to the end of the menu rotating the shuttle key right, and select the menu “Press Enter to save settings”. When pressing the shuttle key inside this menu the new settings will be saved.



Select the menu Change settings and press the shuttle key to enter in the next sublevel.

If there is more than one sublevel, select the next sublevel by rotating and pressing the shuttle key till the last level is reached.

Press the shuttle key in the function to be modified

-> Group of settings

-> Setting to be modified

-> Value

-> Range and step

Pressing the shuttle key, value appears between brackets and can be modified rotating the shuttle key. Pressing again the shuttle key, the new value will be accepted.

Once all settings inside the group have been modified, go to the last screen rotating the shuttle key and press Enter. At this moment of time, the new settings will be active in the relay.

Figure 3–21: CHANGE SETTINGS PROCEDURE IN HMI

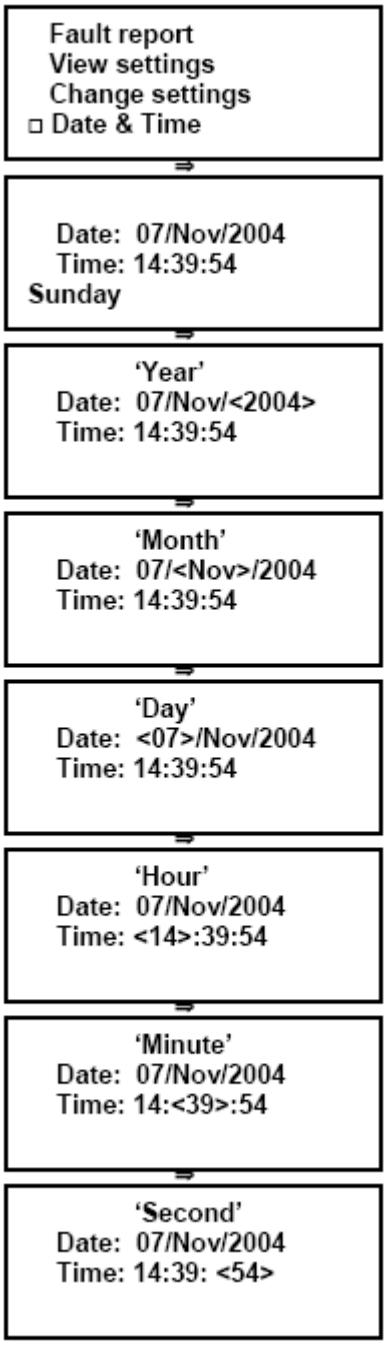
3.2.5.8 DATE & TIME

The “Date & Time” menu will show the relay date and time information in the following format:

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

To modify date and time, press the shuttle key. The relay will show the year between brackets at the top of the screen. By rotating the shuttle key, reach the desired value for the year, and press the shuttle key to select and store that value. After the year, the relay will show the month. Proceed as in the case of the year. The date & time modification sequence is as follows:



Rotate the shuttle key to select the “Date and Time” menu and press to enter in it

The date and time data will appear in the format related above.

Pressing the shuttle key the year can be modified rotating the shuttle key, after selecting the desired value, press again the shuttle key to store the value.

‘Year’

Date: Day/Month/**<Year>**

Time: Hour:Minutes:Seconds

After storing the value for Year, Month will appear between brackets and can be modified

‘Month’

Date: Day/<**Month>**/Year

Time: Hour:Minutes:Seconds

After storing the value for Month, Day will appear between brackets and can be modified

‘Day’

Date: <**Day**>/Month/Year

Time: Hour:Minutes:Seconds

After storing the value for Day, Hour will appear between brackets and can be modified

‘Hour’

Date: Day/Month/Year

Time: <**Hour**>:Minutes:Seconds

After storing the value for Hour, Minutes will appear between brackets and can be modified

‘Minute’

Date: Day/Month/Year

Time: Hour:<**Minute**>:Seconds

After storing the value for Minutes, Seconds will appear between brackets and can be modified

‘Second’

Date: Day/Month/Year

Time: Hour: Minute:<**Seconds**>

Once this sequence is completed, these values will remain stored in the relay, and the display will show again the date at the bottom of the text screen.

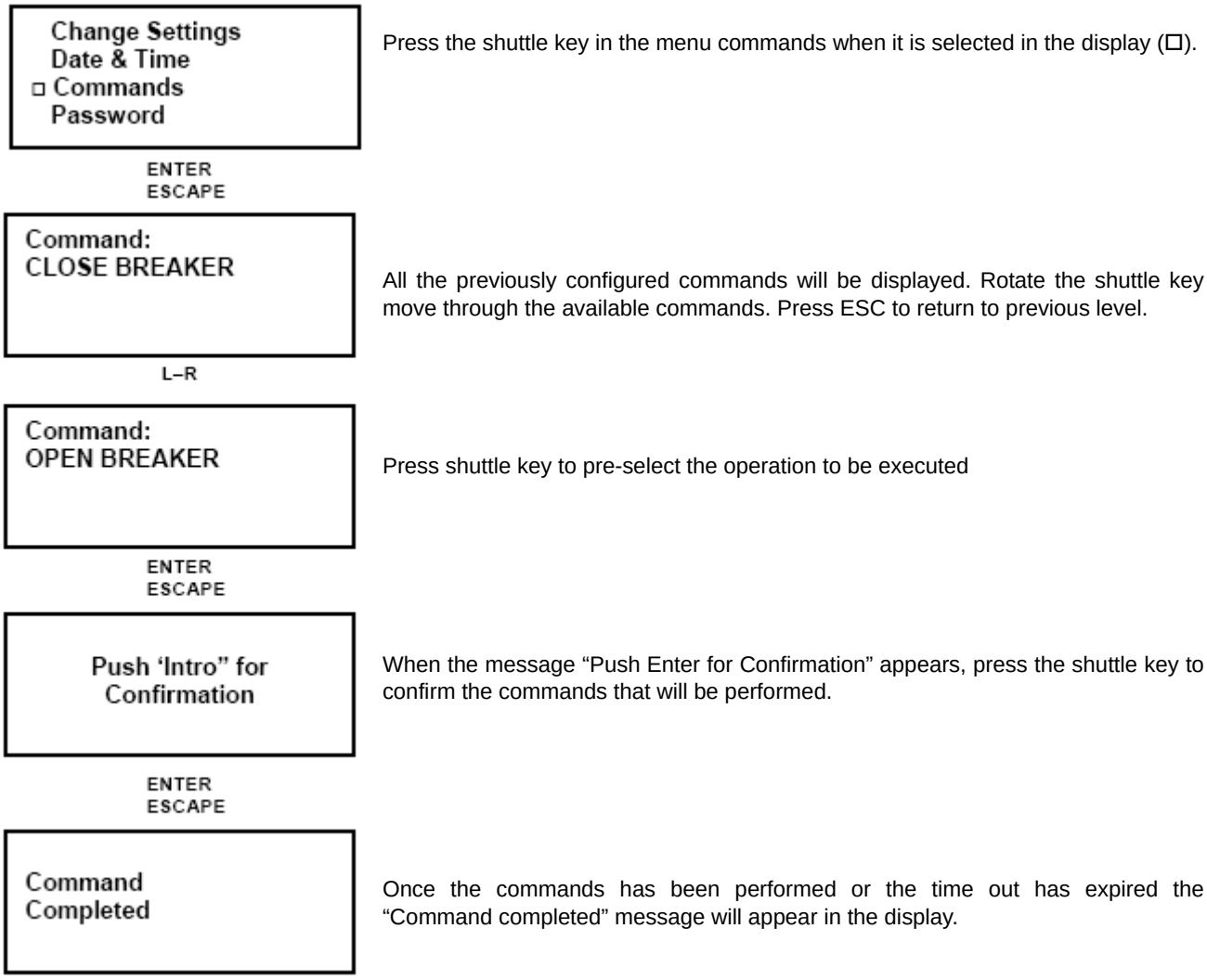
Figure 3–22: CHANGE DATE AND TIME PROCEDURE IN HMI

3.2.5.9 COMMANDS

Commands are configured using EnerVista 650 Setup, and they can be executed using the pushbuttons on the relay front.

Using EnerVista 650 Setup software, the user can configure up to 24 commands with a descriptive text. When executing the operation from the relay front, the operation description text will be displayed.

Example of commands (operations) executions via HMI



Press the shuttle key in the menu commands when it is selected in the display (□).

All the previously configured commands will be displayed. Rotate the shuttle key move through the available commands. Press ESC to return to previous level.

Press shuttle key to pre-select the operation to be executed

When the message "Push Enter for Confirmation" appears, press the shuttle key to confirm the commands that will be performed.

Once the commands has been performed or the time out has expired the "Command completed" message will appear in the display.

Figure 3–23: COMMANDS IN HMI

3.2.5.10 PASSWORDS

F650 units incorporate independent passwords for protection and control, in order to prevent unauthorized keypad and display access to the relay.

Settings Password:

This password allows restricting access to settings changes in the relay protection elements.

Commands Password:

This password is required for executing operation commands through the keypad and display.

If the Commands Password is activated, when the user tries to execute an operation, the relay will request this password, and in case of using the single-line diagram for graphical display models, all objects will not be operational until this password is entered, either logging in ***Login Pwd Commands***, or entering the password in the ***Commands*** menu.

Relay settings view, measures, and other monitored information are not password-protected, and they can be accessed by all users.

Access to the password menu is located at the ***Password*** option in the relay text menu. This menu includes the following options:

"Login Pwd Settings"

"Logout Pwd Settings"

"Change Pwd Settings"

"Login Pwd Commands"

"Logout Pwd Commands"

"Change Pwd Commands"

"Forgot Password?"

Among the available options in this menu, there are three types of functionality:

Login: For entering the password, either for settings or commands, and enable access to settings or commands. Once entering the password the relay is no longer password protected, and access is enabled to settings modification or commands execution.

Logout: Once the necessary setting changes or operation commands have been executed, the user can log out, so that the relay is password protected again.

Change: This menu allows setting or modifying the desired password.

Forgot Password: This menu provides the encrypted password, so that it can be recovered if the user loses or forgets it.

Passwords are restricted for Settings change and Commands execution. To password-protect the relay, it is first necessary to set the desired password, using the corresponding “Change Pwd...” menu. The default password is **0000**. This password provides access to the whole relay functionality.

Once a new password has been set, the user must log in to access the protected functionality; otherwise, the relay will request the password when trying to change settings or execute commands. Once the password is entered the relay is unprotected (as if the user had logged in), and the user must log out to protect again the relay.

a) PASSWORD RANGE

The valid range for F650 passwords is a number from 0000 to 9999.

The default password is 0000, which provides access to the whole relay functionality. This is the default option for enabling relay use without using passwords.

b) ENTERING THE PASSWORD (LOGIN PWD)

This operation is the same for both the settings and commands passwords. The only difference will be the access menu. For entering the password, the user must access the ***Login*** menus inside the ***Password*** menu.

Login Pwd Settings or *Login Pwd Commands:*

The relay requests the password with the following message on the screen:

Setting passwd.

Login: < 1000 >

For entering the desired password, the user must rotate the shuttle key to the left (decrease) or to the right (increase), and establish the desired number. Once entered, the selected password between brackets has been entered, the relay will show the message **"Processing passwd. Wait..."**. If the password is correct, the relay will allow access to the settings change or command execution. It is not necessary to enter the password every time a change is to be performed. The relay will request the password 15 minutes after the last keypad action has taken place. This period of time is the same that takes the relay to turn off the display backlighting.

c) LOGGING OUT (LOGOUT PWD)

To disable access to settings and commands, the user must logout.

Logout Pwd Settings or *Logout Pwd Commands:*

For safety reasons, if the user does not log out, the relay will do it automatically 15 minutes after the last keypad action.

d) CHANGING THE PASSWORD (CHANGE PWD COMMANDS)

To set a password in the relay, both for settings and commands, the corresponding menu must be accessed inside the ***Password*** menu:

Change Pwd Settings or *Change Pwd Commands:*

To modify the password, the user must first introduce the existing password; if the relay has the default factory password, this would be 0000.

For modifying the password, the relay requests the existing password with the following message:

(Setting or Command) passwd.

Login: < 0000 >

Once the entered password has been acknowledged, the new password must be entered:

(Setting o Command) passwd.

New passwd: < 1000 >

Once the new password has been entered, the relay returns to the general Passwords menu.

e) PASSWORD RECOVERY (FORGOT PASSWORD?)

If the relay passwords need to be recovered, the ***"Forgot Password?"*** menu must be accessed. This menu is the last option inside the text ***Passwords*** menu.

This menu will show two passwords, which correspond to the encrypted protection settings, and commands passwords, as shown in the following example:

Cod Settings: [35c0]

Cod Commands: [35c0]

<Push Enter>

In order to obtain the decoded password from the encrypted codes provided by the relay, it is necessary to contact GE Multilin and provide these encrypted codes.

3.2.5.11 SELECT MAIN SCREEN

The relay display offers the possibility to select the default main screen. For this purpose, the user must access the "***Select Main Screen***" menu through the HMI. This menu includes the following options:

Logotype

This option selects as main screen the relay logotype including the firmware and boot code versions, the relay model and the communication parameters for local port COM2.

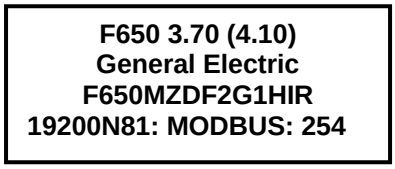


Figure 3–24: DEFAULT LOGOTYPE SCREEN

Metering

This option shows a Metering screen including the phase and ground currents as well as phase-to-phase voltage, and zero sequence voltage values, all of them in primary values.

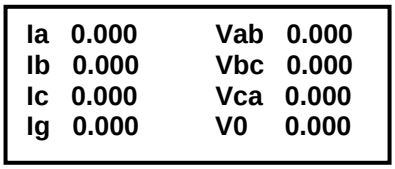


Figure 3–25: DEFAULT METERING SCREEN

All

This option alternates in time the two previous options.

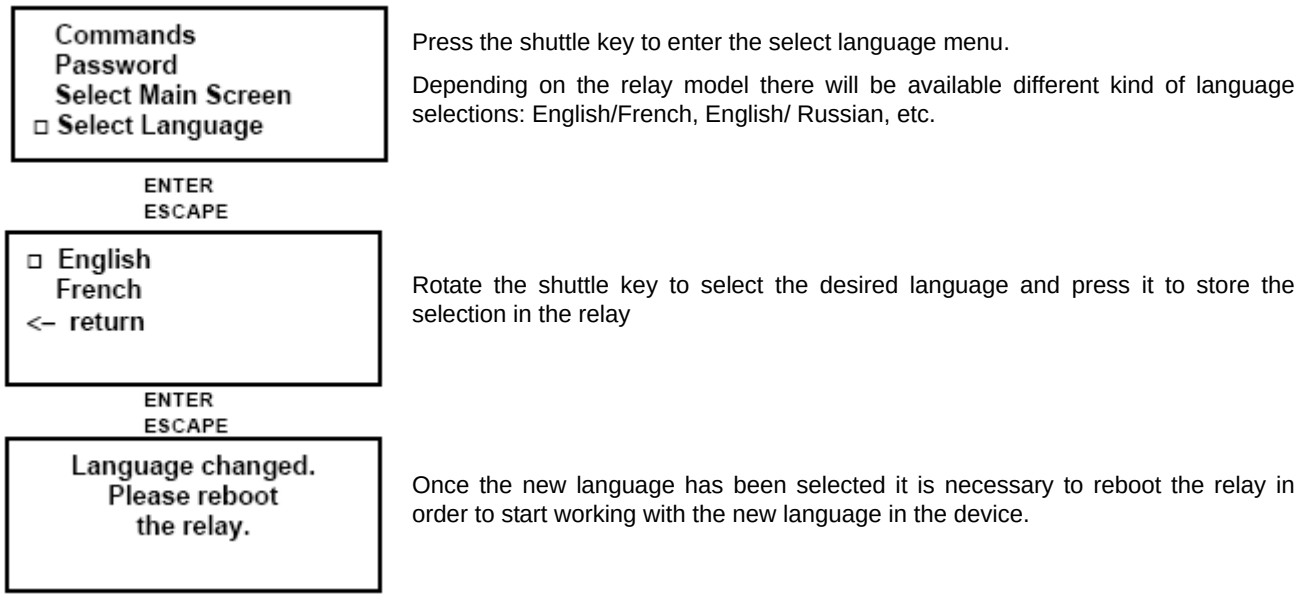
3.2.5.12 SELECT LANGUAGE

Option only available for versions 1.70 or higher.

The relay display offers the possibility to select the default language for the relay. For this purpose, the user must access the "***Select language***" menu located at the end of the main menu through the HMI. This menu allows the user to set the default language of the relay between English (always available) and second language selected in the relay model.

For example one relay in French language (e.g. F650MZDF2G1HIR**F**) can be displayed in French or in English only by changing the language setting in HMI. It is necessary to switch off and on the relay to start working with the new language configuration in the relay. In EnerVista 650 Setup it is possible to select the language for the software (View>Languages).

Example of language selection in HMI



Press the shuttle key to enter the select language menu.

Depending on the relay model there will be available different kind of language selections: English/French, English/ Russian, etc.

Rotate the shuttle key to select the desired language and press it to store the selection in the relay

Once the new language has been selected it is necessary to reboot the relay in order to start working with the new language in the device.

Figure 3–26: LANGUAGE SELECTION IN HMI

3.2.6.1 ONE-LINE DIAGRAM

In models with graphic display (F650M) default main screen is the single-line diagram. This single-line diagram can be configured using EnerVista 650 Setup software by choosing the ***HMI*** menu inside ***Relay Configuration*** (***Setpoint>Relay Configuration>HMI***).

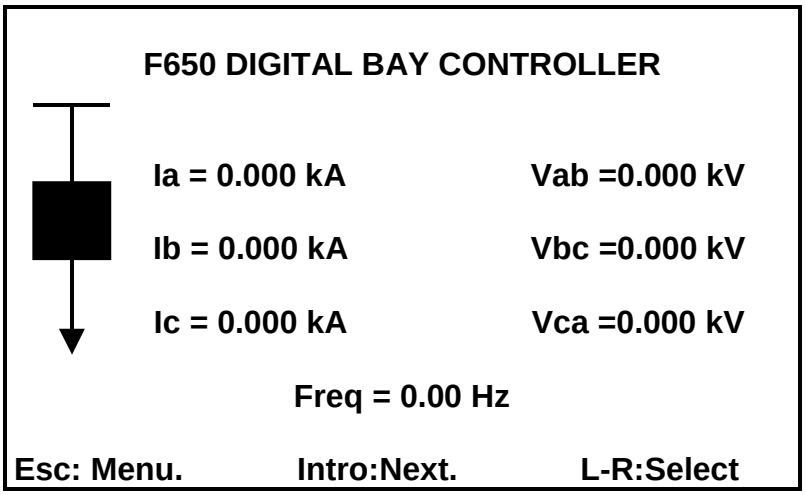


Figure 3–27: ONE-LINE DIAGRAM

The bottom of the display shows a legend that indicates the possible selections that can be made from this screen.

Esc: Menu. **Intro: Next.** **L-R: Select.**

The meaning of these options is as follows:

Esc: Menu.

Pressing the ESC key, the user will access the relay main menu, similar to the one displayed by the text-display model (F650B).

Pressing again the ESC key; the menu selection screen (Actual Values, Snapshot events, etc.) will be displayed. This main menu screen is identical to the one described for the text display. Its functionality is described in section 3.2.5 in this manual.

Intro: Next.

Pressing the shuttle key, the user access the next graphical screen, which in this case corresponds to the primary metering values screen.

L-R: Select

Once the different switchgear elements to be operated have been configured using EnerVista 650 Setup, the user will be able to operate them from the graphic display.

If a single-line diagram has been previously configured in the EnerVista 650 Setup, in the HMI option inside the ***Relay Configuration*** menu, the different switchgear elements configured for the display will be operative from the graphic display. By rotating the shuttle key to the left and right, the cursor moves among the elements and blinks on each of them. When an element is selected by pressing the shuttle key, the relay will indicate the command to be executed, and the user will need to confirm it by pressing again the shuttle key.

The following sections describe only the operation of screens that are specific for the graphic display models.

3.2.6.2 METERING SCREEN

The Metering screen displays relay analog measures in their primary values. Available metering values are as follows:

Metering Screen.	Total metering 53
Phasor Ia Primary	0.000 KA
Phasor Ib Primary	0.000 KA
Phasor Ic Primary	0.000 KA
Phasor Ig Primary	0.000 KA
Phasor Isg Primary	0.000 KA
RMS Ia Primary	0.000 KA
RMS Ib Primary	0.000 KA
RMS Ic Primary	0.000 KA
RMS Ig Primary	0.000 KA
RMS Isg Primary	0.000 KA
I0 Primary	0.000 KA
Intro: Next. ESC: Prev	L-R:Scroll.

Figure 3–28: METERING SCREEN

As in the rest of graphical display screens, the bottom part shows a legend that indicates the possible options for the user. In this case, the options are:

Intro: Next. **Esc: Prev.** **L-R: Scroll.**

Intro: Next.

Pressing the shuttle key the user accesses the next screen, in this case the ALL EVENTS screen.

Esc: Prev.

Pressing the ESC key the user returns to the previous screen (One-line diagram)

L-R: Scroll.

Rotating the shuttle key to the left (L) or right (R) the user can access all the Metering values in the screen. Rotating the shuttle key left will move up in the screen, and rotating right will move down.

METERING SCREEN ANALOG MEASURES IN PRIMARY VALUES			
Phasor Ia Primary	V0 Primary	Phase A Real Pwr	Line Frequency Primary
Phasor Ib Primary	V1 Primary	Phase B Reactive Pwr	Bus Frequency Primary
Phasor Ic Primary	V2 Primary	Phase B Apparent Pwr	Vx Primary
Phasor Ig Primary	Vab Primary	Phase B Real Pwr	Pos MVarhour Freeze
Phasor Isg Primary	Vbc Primary	Phase C Reactive Pwr	NegMVarhour Freeze
Phasor In Primary	Vca Primary	Phase C Apparent Pwr	PosMWatthour Freeze
RMS Ia Primary	Vn Primary	Phase C Real Pwr	Neg MWatthour Freeze
RMS Ib Primary	Va Primary	3 Phase Reactive Pwr	Positive MVarhour
RMS Ic Primary	Vb Primary	3 Phase Apparent Pwr	Negative MVarhour
RMS Ig Primary	Vc Primary	3 Phase Real Pwr	Positive MWatthour
RMS Isg Primary	VL Primary	Phase A Power Factor	Negative MWatthour
I0 Primary	VBB Primary	Phase B Power Factor	
I1 Primary	Phase A Reactive Pwr	Phase C Power Factor	
I2 Primary	Phase A Apparent Pwr	3 Phase Power Factor	

3.2.6.3 ALL EVENTS SCREEN

This screen shows all events that have been produced in the relay. The top of the screen shows its name (All Events), and the relative and total number of events contained in the screen.

All Events (1/479)

This legend means that there are a total of 479 events stored in the relay, and that the cursor is located on event number 1. The information shown on this screen for each event is as follows:

"**Hour:Minute:Second:Millisecond" "Event text" "Event status (ON/OFF)"**

All Events (1/479). - [Ready LED ON] -		
16:11:08.035	Ready LED ON	ON
16:11:08.017	Breaker Closed ON	ON
16:11:08.005	Isolated Gnd3 Block OFF	OFF
16:11:08.005	Isolated Gnd2 Block OFF	OFF
16:11:08.005	Isolated Gnd1 Block OFF	OFF
16:11:08.005	Sens Gnd TOC3 Block OFF	OFF
16:11:08.005	Sens Gnd TOC2 Block OFF	OFF
16:11:08.005	Sens Gnd TOC1 Block OFF	OFF
16:11:08.005	Ground TOC3 Block OFF	OFF
16:11:08.005	Ground TOC2 Block OFF	OFF
16:11:08.005	Ground TOC1 Block OFF	OFF
Esc: Prev.	Intro: Menu.	L-R: Scroll.

Figure 3–29: ALL EVENTS SCREEN

The screen legend options are:

Esc: Prev. **Intro: Menu.** **L-R: Scroll.**

Esc: Prev.

Pressing the ESC key, the user returns to the previous screen (Metering screen)

Intro: Menu.

Pressing the shuttle key, the user accesses the Events menu that offers the following options at the bottom of the screen:

next prev reload details At

To access the different options in the snapshot events graphic menu the user must move the cursor from left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the user must press again the shuttle key.

<NEXT>

The user accesses the next available graphic screen (Events – New)

<PREV>

This option returns to the general events graphic menu (All Events)

<RELOAD>

This option updates all events stored in the relay and returns to the general events screen.

<DETAILS>

The Details screen provides access to metering values, and date and time related with the event.

The top of the screen displays a legend with the event text, followed by the date and time, the event status (ON or OFF), and the event index number related to the complete list of events in the relay, for example (1/479). The rest of information provided by the Details screen corresponds to the relay measures in the moment of the event. Metering values provided in the events are secondary, and voltage values correspond to phase-to-ground voltage.

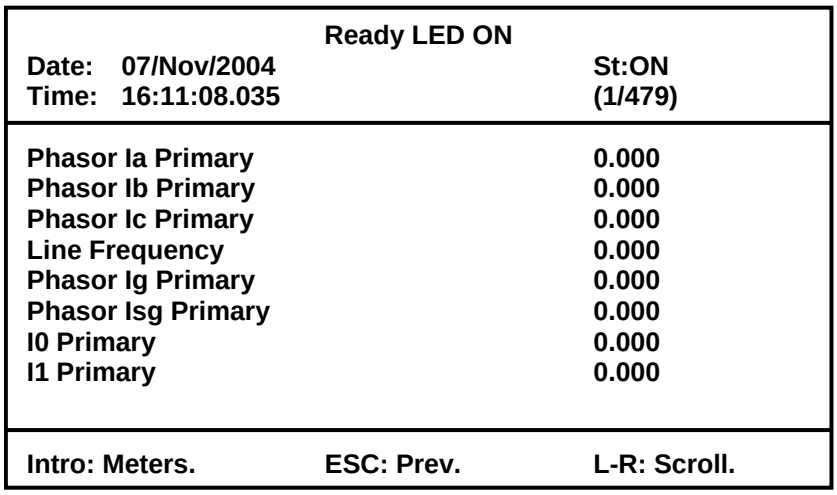


Figure 3–30: SNAPSHOT EVENTS DETAIL SCREEN

To navigate this screen the user must follow the legend at the bottom of the screen:

Intro: Meters. **ESC: Prev.** **L-R: Scroll.**

Intro: Meters.

To access the metering values in the moment of the event, the user must press the shuttle key. A new metering screen will be displayed, containing the primary metering values in the snapshot event, such as:

Phasor Ia Primary	I2 Primary
Phasor Ib Primary	Vab Primary
Phasor Ic Primary	Vbc Primary
Line Frequency Primary	Vca Primary
Phasor Ig Primary	V1 Primary
Phasor Isg Primary	V2 Primary
I0 Primary	V0 Primary
I1 Primary	3 Phase Power Factor

Once inside the Metering screen, a new legend will be shown for each event (Intro or ESC: Prev. L-R: Scroll); this legend indicates that by pressing ESC or the shuttle key, the system will return to the Event Detail screen, and rotating the shuttle key the user will access all the metering values contained in the metering screen of the considered event.

ESC: Prev.

If the user presses the ESC key from the event detail screen, the system will return to the all events screen.

L-R: Scroll.

Rotating the shuttle key left (L) or right (R) moves among all the events contained in the all events screen, allowing a preview of the details for each of them.

<AT>

When this option is selected, the system marks the event where the cursor is located. A relative time stamp is performed, in such a way that the selected event, marked with an asterisk (*) between the time and the event name is set with a relative time of 00:00:00:000 on the top line of the event screen, together with its relative index, and the rest of events in the screen will show a date/time that relates to the marked event. This operation mode allows a quick inspection of the relative time passed between several events, which is very useful for analyzing events in the field. The corresponding legend to this relative event-marking screen is as follows:

Esc: Out At. **Intro: Tag event.**

Esc: Out At.

The relative event marking is eliminated and the system returns to the general events screen.

Intro: Tag event.

If the user places the cursor on a different event by rotating the shuttle key left or right, pressing the shuttle key will change the relative mark to that new event.

3.2.6.4 NEW EVENTS SCREEN

This screen shows the new events that have been produced in the relay since the last time the New Events screen was read. The top of the screen shows a "**New Events**" legend, and the relative and total number of events contained.

Navigation through the different menus in this New Events screen is similar to the one described in the previous section for All Events. The main difference is that in the case of new events it is necessary to select the ***RELOAD*** submenu to update the screen with new events that have been produced, while in the All Events screen, this refreshment is automatic.

After the new events have been read, if the user selects again the ***Reload*** menu, the system will show a ***<No new events available.>*** message, indicating that there are no more new events available since the last reading.

3.2.6.5 ALARMS PANEL

Alarms panel can be viewed in all F650 models using communication software EnerVista 650 Setup, however, only models with graphic display allow access to the alarms panel from the HMI.

First line shows the relative and total number of alarms existing in that screen. The relative number refers to the alarm on which the cursor is located, and the total number refers to the total amount of alarms available. The second line on this screen shows an index that indicates the number of the configured control event that corresponds to the displayed alarm, followed by the alarm text configured in the ***Control Events*** menu inside the ***Relay Configuration*** option ("***Setpoint>Relay Configuration>Control Events***").

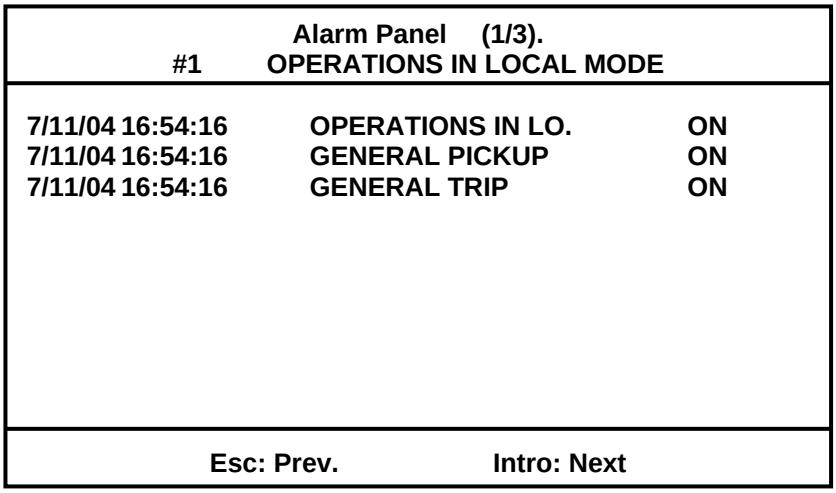


Figure 3–31: ALARMS PANEL IN HMI

The rest of the screen shows the different alarms produced in the relay with the date and time when the corresponding event was produced, followed by the alarm identification text, and its status, active (ON) or inactive (OFF).

In the previous example, the produced alarm is the change to local of the execution of operations (OPERATIONS IN LOCAL MODE), the date and time when this event has been produced, and its status (ON):

The bottom of the screen shows the legend that indicates how to navigate through the different options available in the screen.

ESC: Prev. Intro: Next.

ESC: Prev.

Pressing the ESC key, the system returns to the previous New Events screen.

Intro: Next.

Pressing the shuttle key, the user accessed the available alarms menu, which includes the following options.

next prev ack ack all

To access the different options provided by the alarms graphic menu, the user must move the shuttle key left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the shuttle key must be pressed.

<NEXT>

This option provides access to the next available graphic screen (I/O boards)

<PREV>

The system returns to the previous New Events screen.

<ACK>

This option acknowledges the alarm on which the cursor is located.

<ACK ALL>

This option acknowledges all alarms. Alarm acknowledgement through the graphic HMI is considered as through communication port COM2, as it is considered to be Local in both cases.

When an alarm has been acknowledged, a selection mark will appear to the right of its status. Inactive alarms will disappear from the screen once they are acknowledged.

3.2.6.6 INPUT/OUTPUT MONITORING SCREEN

This is the last screen available in the graphic display. This screen allows viewing the status of the relay inputs and outputs, as well as emulate inputs (for verification of the logic, or related functions), and contact outputs (to verify wiring).

The format of this screen is shown on the figure below.

The first line shows the name of the screen “I/O Cards”, followed by the type and description of the board where the cursor is located, which will appear between selection marks **> <** and blinking.

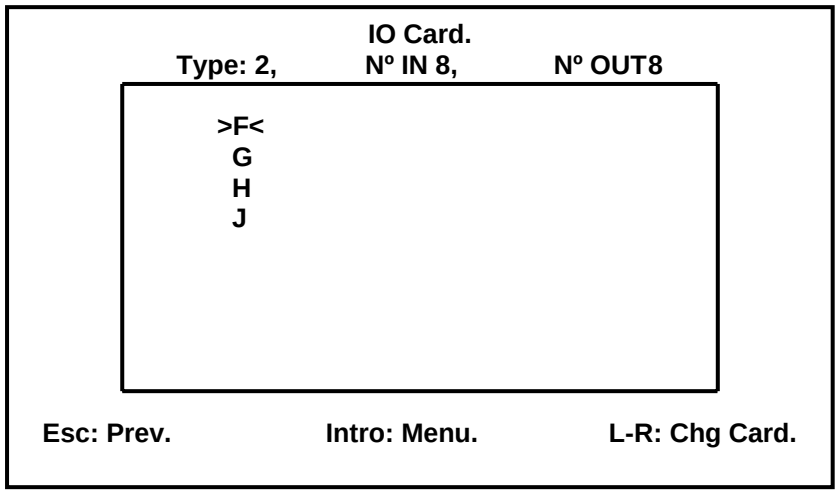


Figure 3–32: INPUTS/OUTPUTS GENERAL SCREEN

The navigation legend on this screen is as follows:

Esc: Prev. Intro: Menu. L-R: Chg Card

Esc: Prev.

This option returns to the previous screen (Alarms Panel).

Intro: Menu.

This option provides access to the selected I/O board menu:

This menu includes the following options.

next view test input test output

As in previous screens, to access the different options provided by the inputs/outputs graphic menu, the user must move the shuttle key left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the shuttle key must be pressed.

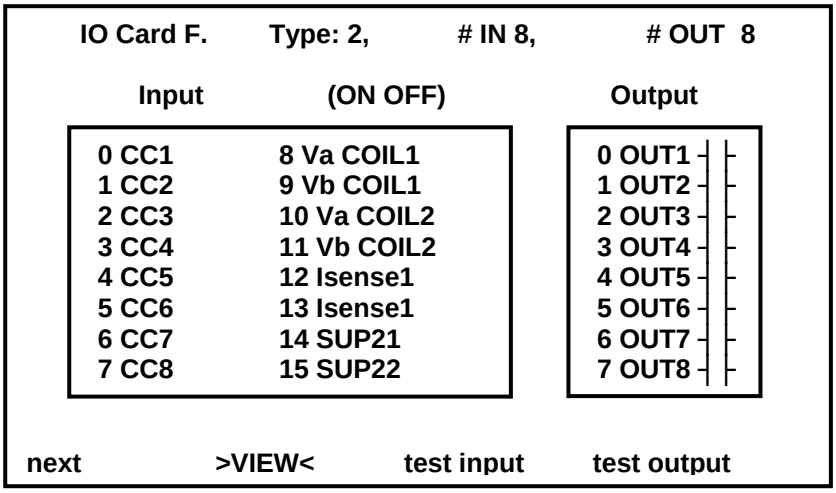


Figure 3–33: INPUT/OUTPUT VIEWING SCREEN

<NEXT>

This option brings the system back to the one-line diagram.

<VIEW>

This option shows the real status of all inputs and outputs in the selected board. Depending on the type of board, with or without supervision, the screen will vary to get adapted to the characteristics of each board.

The first line of this screen shows the slot where the board is located, **F**, **G**, **H** or **J**, and the type of board. The view menu differentiates inputs and outputs; the active status (ON) is represented by the lighting of the corresponding input or output.

The legend at the bottom of the screen indicates how to navigate:

Esc: Prev. **Intro: Menu.** **L-R: Chg Card**

Esc: Prev.

Returns to the general I/O screen

Intro: Menu.

Provides access to the I/O menu (next, view, test input, test output).

L-R: Chg Card

Moving the shuttle key to the left or right provides access to the status of inputs/outputs for the different boards available in the relay.

<TEST INPUT>

This option allows testing the input activation (in emulation mode). The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay inputs.

This screen shows the ***Input*** name lit up, showing that this is an Input emulation mode.

The first relay input will appear blinking and between brackets; the user can select a different input by rotating the shuttle key. When the shuttle key is pressed, the selected input will be activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Intro: Chg Input.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Intro: Chg Input.

Pressing the shuttle key on the blinking input, this input will be activated in emulation mode.

Note: input emulation can only be executed through the TEST INPUT tool on the graphic display.

<TEST OUTPUT>

This option allows testing the output activation in emulation mode. The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay contact outputs to test the wiring.

This screen shows the ***Output*** name lit up, showing that this is an output emulation mode.

The first relay output will appear blinking and between brackets; the user can select a different output by rotating the shuttle key. When the shuttle key is pressed, the selected output will be activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Intro: Chg Output.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Intro: Chg Output.

Pressing the shuttle key on the blinking output, this output will be activated in emulation mode.

Note: Output emulation can be executed through the TEST OUTPUT tool on the graphic display, and also through communications using EnerVista 650 Setup software for all F650 models.

L-R: Chg Card

Rotating the shuttle key allows to change the selected I/O board in the main I/O screen.

3.3.1 HOME

The web server in the F650 can be accessed running the Windows explorer, and keying http://xxx.xxx.xx.xxx, being xxx.xxx.xxx.xxx the relay IP address, which must be configured in ***Setpoint > Product Setup > Communication Settings > Ethernet***.

The main screen of the F650 web server shows the different monitoring possibilities for snapshot events, events, alarms, oscillography, fault reports, data logger and metering values provided by the relay through the web.

In order to access the different functions provided by the web server, the user must simply click on the list name on the left side of the screen.

The web server (for version 1.70 and higher ones) allows the user to visualize the different web server screen languages: English, French, Spanish and Russian by pressing the language button on the top right corner of the main window. Take into account that this selection only changes the language in the web server screen, all the relay texts, such as snapshot events, control events, etc. will be the in the language selected in the relay (see section 3.2.5.12 in this manual).

Figure 3–34: WEB SERVER MAIN SCREEN

The Snapshot events screen shows all Snapshot events produced in the relay. This screen is refreshed automatically every minute.

The information provided in this screen includes: first, the relative event index, the lowest index corresponding to the most recent event; next, the event text that shows the reason for the event, its status, active (ON) or inactive (OFF), and finally the date and time when the event was produced.

The bottom of the screen shows a Metering screen; clicking on one of the events, the associated metering values will be shown on that screen.

Figure 3–35: SNAPSHOT EVENTS SCREEN

The control events screen provides access to all events that have been configured in the Control Events screen inside the ***Relay Configuration*** menu of EnerVista 650 Setup.

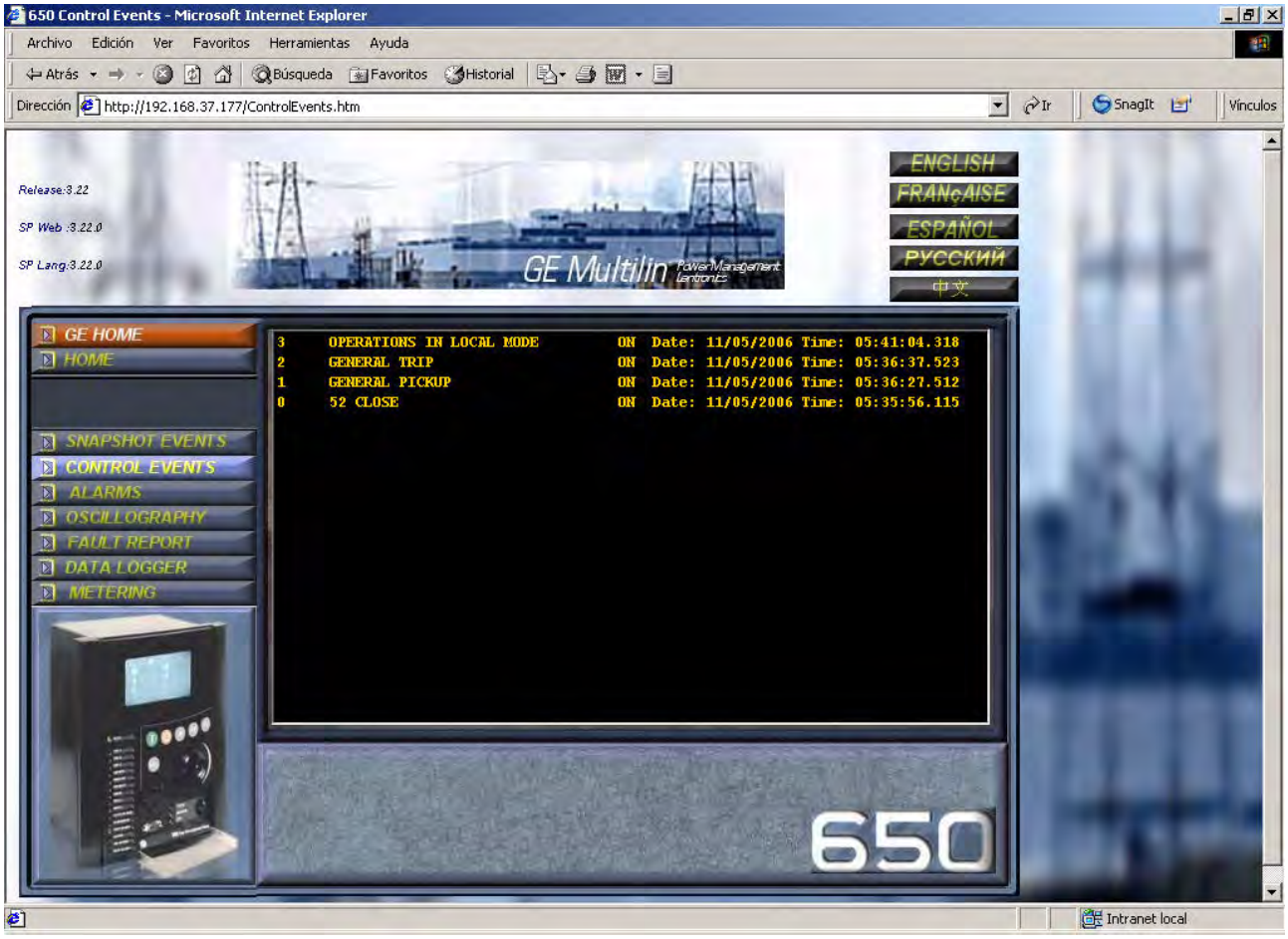


Figure 3–36: CONTROL EVENTS SCREEN

Unlike the case of Snapshot events, in this screen the highest index corresponds to the most recent event. The information provided is the control event index, the text that has been associated to such event when configured, its status, active (ON) or inactive (OFF), and its date and time.

3.3.4 ALARMS

The alarms screen provides access to alarms configured in the relay. As in the case of snapshot events and control events, this screen allows only to view the alarms, but not to acknowledge them.

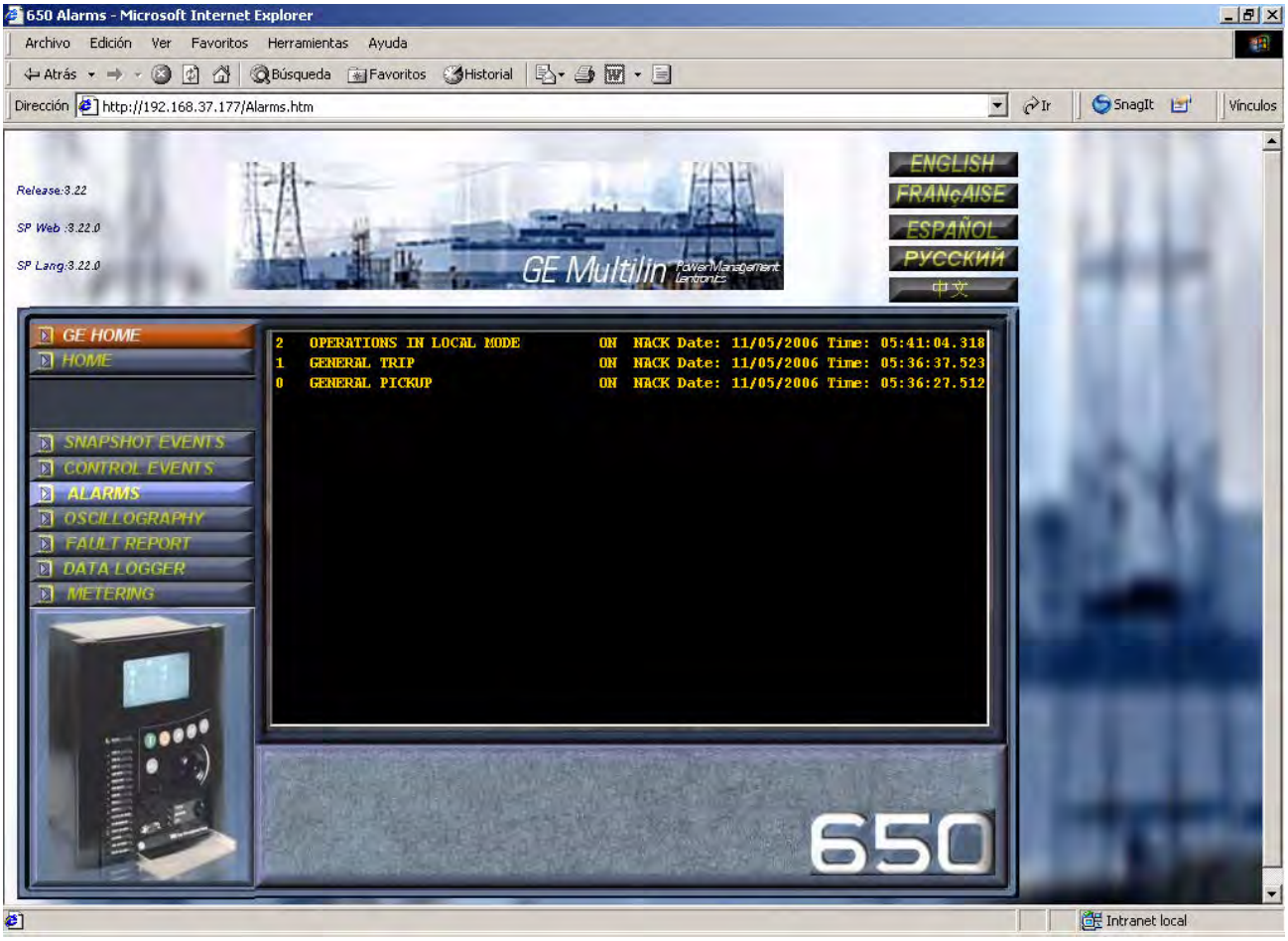


Figure 3–37: ALARMS SCREEN

The oscillography screen allows obtaining from the relay available oscillography records in that moment.

This screen includes two windows. The first window shows oscillography records available in the relay, identified by an index, being the highest index the most recent record (oscillography record No 6 in the example below).

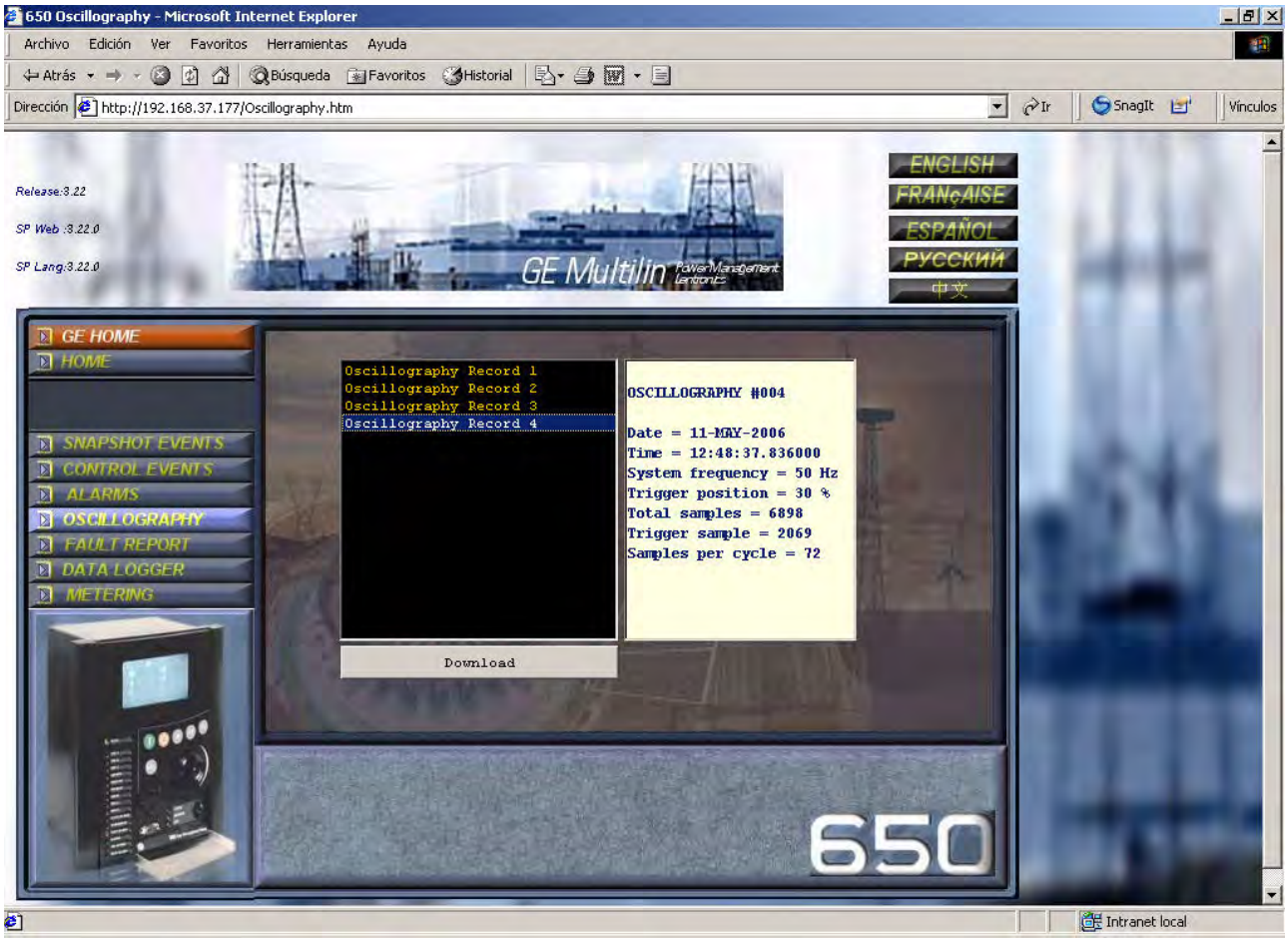


Figure 3–38: OSCILLOGRAPHY SCREEN

If the user clicks on the oscillo record he wants to retrieve, the window on the right will show a description of the record header, indicating its date, time, and the most relevant parameters of the record. Once a record is selected, it is required to press the ***Download*** button. The system will then open a window to allow saving the files in Comtrade format in the PC hard drive. Once the records have been saved, the system will ask if the user wants to open GE-OSC tool (Comtrade record viewer) to view the downloaded files.

Figure 3–39: GE-OSC LAUNCH SCREEN

Clicking on the *Home* option, the system will return to the web server main screen.

3.3.6 FAULT REPORT

The fault report screen provides access to the last 10 fault reports obtained by the relay. These records are stored according to an index that marks their position among all records produced in the relay, with a range from 1 to 999, returning to 1 in case of exceeding the limit of 999. As in the case of oscillography records, the highest index corresponds to the most recent record.

In the fault report, oscillography and data logger screens, the system will request acceptance of a safety-warning message.

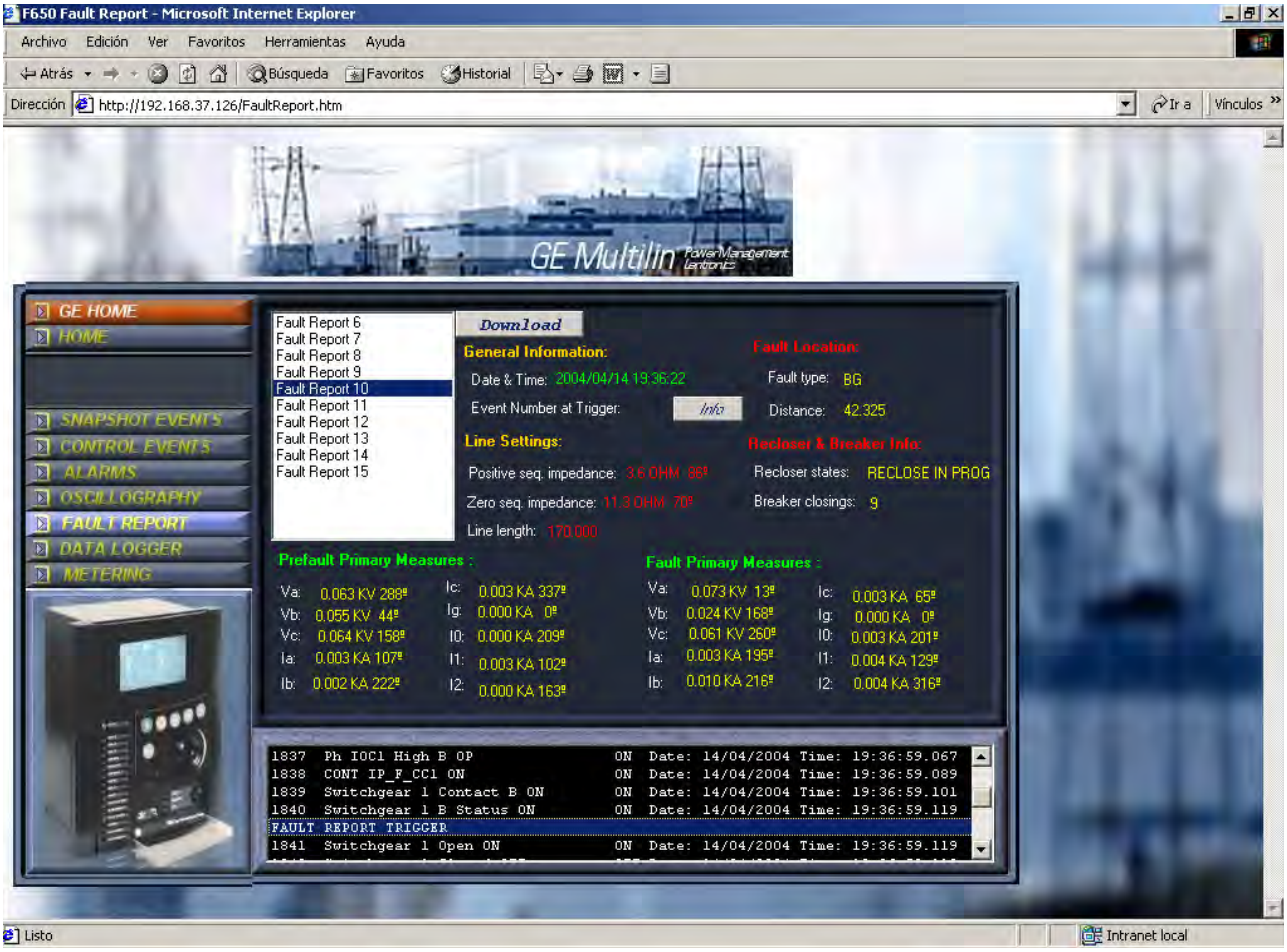


Figure 3–40: FAULT REPORT SCREEN

The information provided in this screen includes the date and time when the fault was registered, fault calculations such as distance to the fault, type of fault, date and time, and the line parameters, as well as the recloser and breaker status during the fault.

This screen shows also prefault and fault voltage and current primary values. At the top of the screen, associated to the trigger event number there is a button labeled as **INFO**. This button displays at the bottom of the screen the events produced before and after the fault report trigger, so that the user has very useful information about the moment when the fault was produced.

To obtain a text file with all the fault report information, press the ***Download*** option and save the file in the computer.

3.3.7 DATA LOGGER

The data logger screen allows viewing the data logger first and last value retrieval date and allows downloading the data record files in Comtrade format, by pressing the ***Download*** option. Stored files can be viewed later using any Comtrade format viewer.

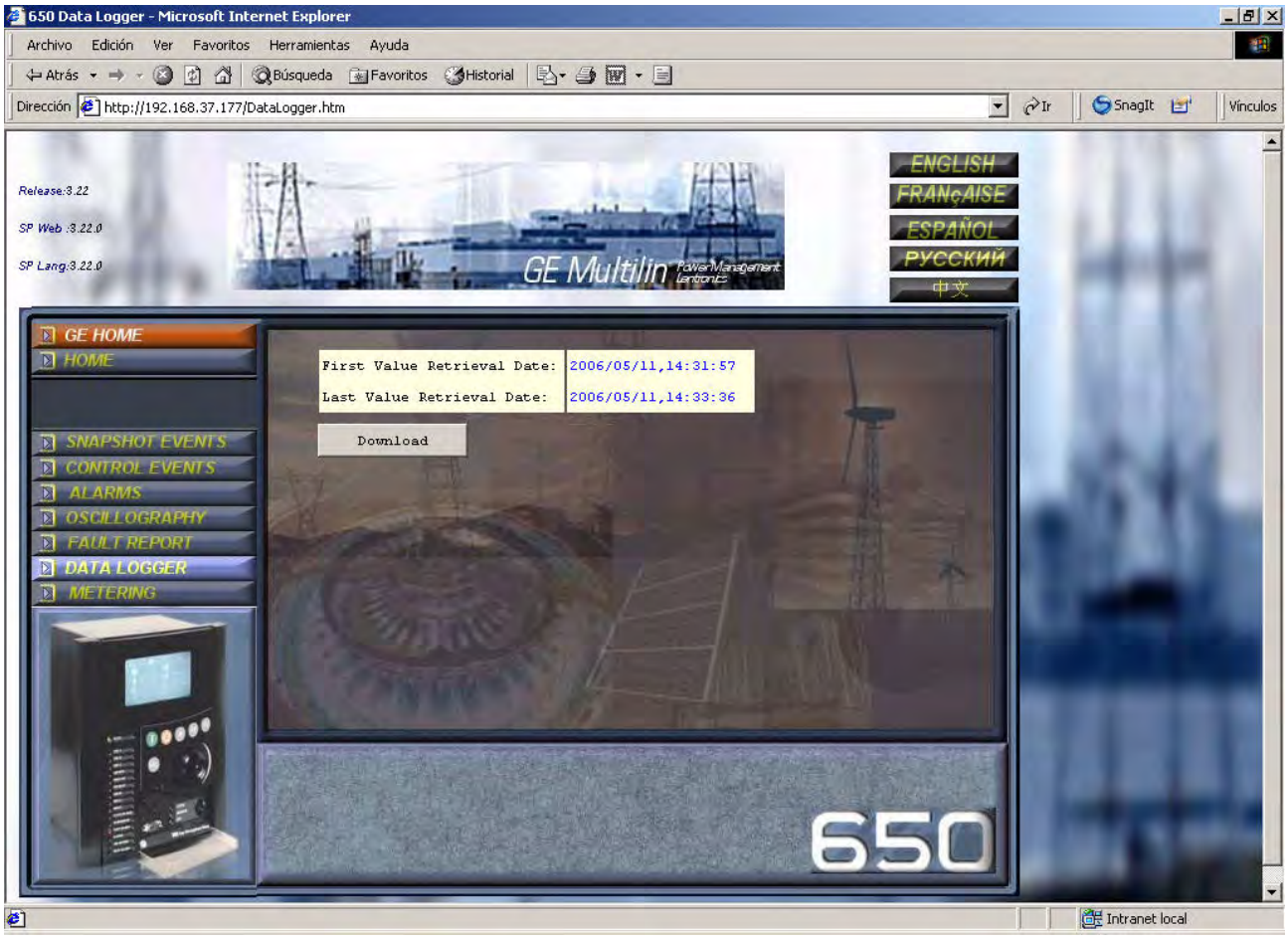


Figure 3–41: DATA LOGGER SCREEN

This screen includes the 53 primary metering values provided by the relay display.

Figure 3–42: METERING SCREEN

New users can only be added by users that have **Administrator Access (or Admin Rights)** . The **Enable Security** check box located in the **Security**->**User Management** window must be enabled.

Remember: (**In order to add new users and assign user rights**)

- **must be logged in with Administrator Permission**
- **and Enable Security checkbox must be enabled**

4.1.1 USER RIGHTS

NOTE: Only Administrators have access to the User Management dialog box.

Following is a list of all of the User Rights Options available to be granted to users, and their functions.

Table 4–1: USER RIGHTS AND FUNCTIONS

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program will ask you to confirm the delete and if the Administrator chooses "yes", then the user whose "Delete Entry" box was checked will be permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user will become an EnerVista 650 Setup Administrator, therefore receiving all of the Administrative rights.
Actual Values	When this box is checked, the user will have the ability to *view* **Actual Values** and all records excluding event recorder.
Settings	When this box is checked, the user will have access to *view and modify* **Settings (Protection, control, inputs/ outputs and calibration)**.
Commands	When this box is checked, the user will be able to use **Commands**.
Event Recorder	When this box is checked, the user will have access to use **Event Recorder**.
Force IO	When this box is checked, the user will be able to use **Force IO** application.
Logic Configuration	When this box is checked, the user will have the ability to *view and modify* **Relay Configuration and Logic Configuration**.
Upgrade	When this box is checked, the user will have the ability to **upgrade firmware, bootware** and to **upload** and **download info files to/from relay.**

By default, Administrator and Service users are created with "password" as default password.

Users will be prompted to change their password after the first successful log in or through clicking **Security** from the toolbar, and choose **Change Password**.

Figure 4–1: CHANGE SECURITY

When the operator enters a new password for the first time, he/she should also enter a personal question that only they could answer. There is a limit of 50 characters available to enter the personal question. One example, as in the above diagram, would be "What is my mother's maiden name?". This question will be posed to the user if the user forgets their password and would like to know what their password was.

EnerVista 650 Setup Security Control is disabled by default. Users don't have to log in through user name and password after installation and are granted access as Administrator.

Security Control can be enabled through **Security** from the tool bar when logged on as an Administrator. Click on **User Management** and a dialog box will show up.

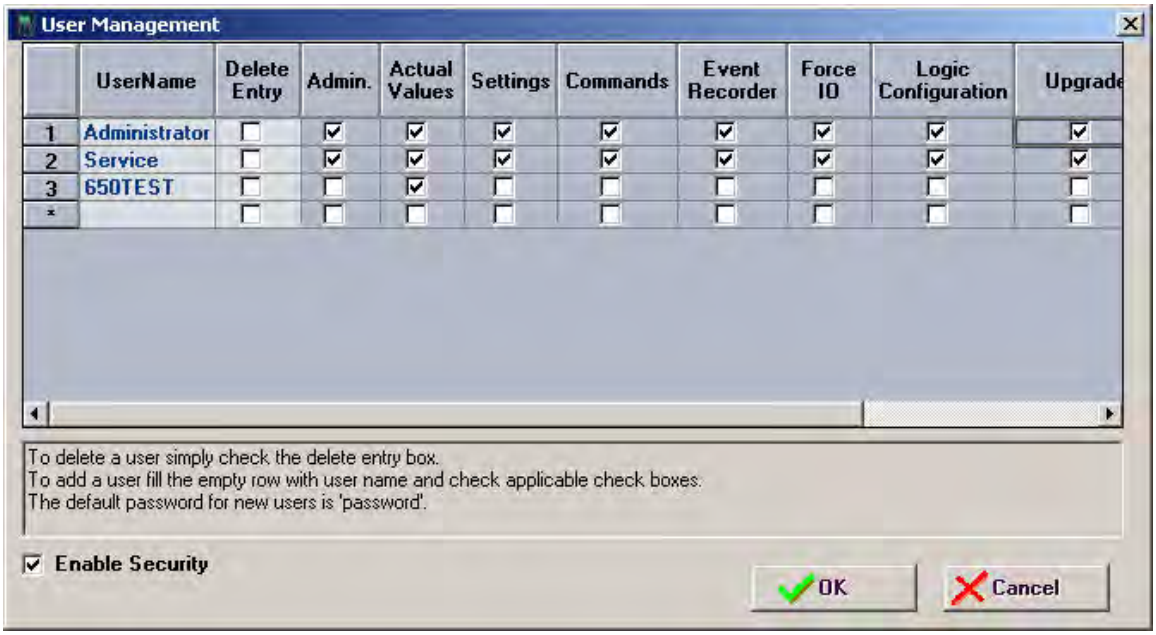


Figure 4–2: SECURITY ENABLING

Security Control is enabled by checking the **ENABLE SECURITY** check box. The first time the enable security option is selected is necessary to close and open EnerVista 650 Setup to start working under security management.

Users have to log on in order to use EnerVista 650 Setup program after Security Control has been enabled. After the start up of EnerVista 650 Setup, a dialog will pop up asking for user name and password.

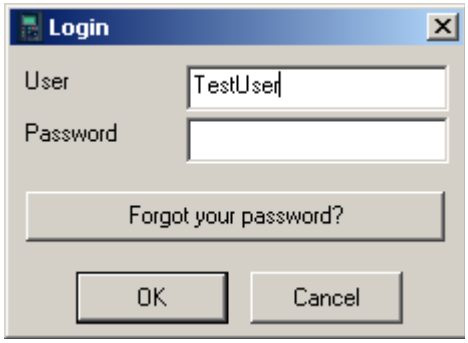


Figure 4–3: LOGIN USER

The user name field will display the last log in user name as default, in this example, TestUser. For the first log in session of any user name, the default password will be "password". User will be prompt to change the password to something else after the first successfully log in.

Log on can also be done by clicking **Security** from the toolbar and choose **Login New User**. User will be prompted with the same log in dialog box for a different user name and password combination.

In case a user has forgotten about the log in password, the **Forgot Password** function can be used to retrieve the password.

Figure 4–4: FORGOT YOUR PASSWORD?

A question, which is pre-set by the user, will be asked. The password will be retrieved for entering the right answer.

This section explains how to upgrade the F650 boot code and firmware.

WARNING
BEFORE PERFORMING THE UPGRADE PROCEDURE CHECK THAT BOOT AND FIRMWARE VERSION MATCH

The boot code and firmware versions can be seen in the relay main screen: The relay firmware version appears after the text "F650" (1.20 in the example) with the boot program version (2.20 in the example) followed by “GENERAL ELECTRIC”, the relay model and the default front RS232 port communication parameters.

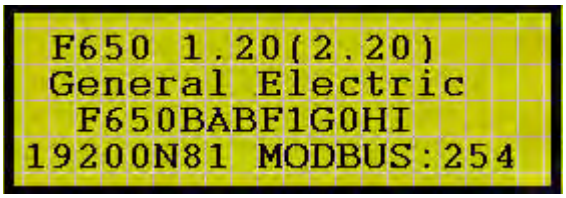


Figure 5–1: MAIN SCREEN

BOOT CODE RELEASE NOTES

It is mandatory to maintain version compatibility between firmware and boot code in the upgrade procedure, otherwise the relay will not start after upgrading.

FIRMWARE AND BOOT VERSIONS COMPATIBILITY	
FIRMWARE VERSION	**BOOT VERSION**
3.70	4.00-4.10
3.60	4.00-4.10
3.44	4.00-4.10
3.40	4.00-4.10
3.20	4.00-4.10
3.00	4.00-4.10
2.20	4.00-4.10
1.82	4.00-4.10
2.0	3.00
1.8X	2.35
1.7X	2.35
1.6X	2.35
1.5X	2.30
1.4X	2.30
1.3X	2.30
1.2X	2.20
1.13	2.20
1.11	2.00
1.00	2.00

NOTE
A STEP LIST SUMMARY that will allow the user to control the upgrading process is included at the end of this section. It is necessary to read chapter 5 before accomplishing the F650 UPGRADE PROCEDURE.
Be aware that boot program and firmware upgrades will erase all the data contained in the relay, thus it is advisable to save all the data, oscillography, events, settings and configuration files previously.
Backward compatibility of PLC projects, settings and configuration files is not assured for versions older than 1.13.

NOTE
RELAYS WITH FIBER OPTIC ETHERNET
The upgrade of the boot program (BOOTCODE) must be performed by crossed Ethernet copper cable connected to the PC. It is not necessary to change the internal switch from fiber to RJ45, because the upgrade is made at 10Mb/s.
This does not apply to the firmware upgrade, which can be done either via Ethernet Fiber connection, or through the RJ45 cable connection.

5.1.1 COMMUNICATION PARAMETERS

Before proceeding with the upgrade process, the following points should be taken into account:

Type of Ethernet connection:

Upgrade requires Ethernet communications.

It is highly recommended to use a direct connection between the PC and the relay using a crossed-over RJ45 Ethernet cable, instead of using an indirect connection through a hub or switch.

Relay IP address:

It is necessary to assign a valid IP address to the relay in the Ethernet parameters via HMI in the “Product Setup > Communication > Ethernet > Ethernet 1” menu or via EnerVista 650 Setup in “Setpoint > Product Setup>Communication Settings > Network (Ethernet) 1” as shown in Table 5–1:

Table 5–1: ETHERNET PARAMETERS

PRODUCT SETUP>COMMUNICATION SETTINGS >NETWORK (ETHERNET) 1			
NAME	**VALUE**	**UNITS**	**RANGE**
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	177		[0 : 255]
Netmask Oct1	255		[0 : 255]
Netmask Oct2	255		[0 : 255]
Netmask Oct3	255		[0 : 255]
Netmask Oct4	0		[0 : 255]
Gateway IP Oct1	192		[0 : 255]
Gateway IP Oct2	168		[0 : 255]
Gateway IP Oct3	37		[0 : 255]

Gateway IP Oct4	10		[0 : 255]

If the relay is connected to an Ethernet network, check that the IP address is unique in order to avoid collisions.

In the case of relay that has upgraded previously its Bootcode (Sections 2), the IP address already has been assigned in the previous process (see Figure 5–14:).

For example, if the relay settings are:

IP address: 192.168.37.177,

Netmask: 255.255.255.0 and

Gateway: 192.168.37.10.

The computer settings have to follow the pattern:

IP address: 192.168.37.XXX

Netmask: 255.255.255.0 and

Gateway: 192.168.37.10 (if desired).

XXX is a number between 0 and 255 that is not assigned to any other device to avoid collisions.

If there are not TCP/IP settings according to this pattern in the computer, it should be added (in order to communicate with the relay) following these steps:

Go to the **Control Panel** of the computer and select the **Network** option (the name of this option may depend on the PC boot code).

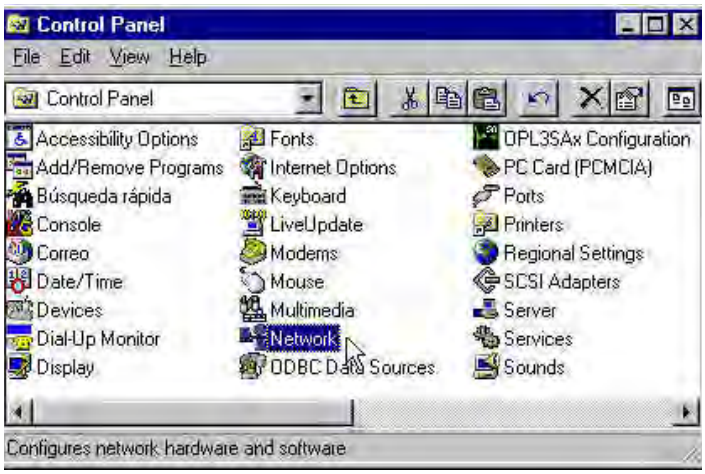


Figure 5–2: NETWORK IN CONTROL PANEL

In **Network,** enter in **Protocols**, select **TCP/IP protocol** and click on **Properties**.

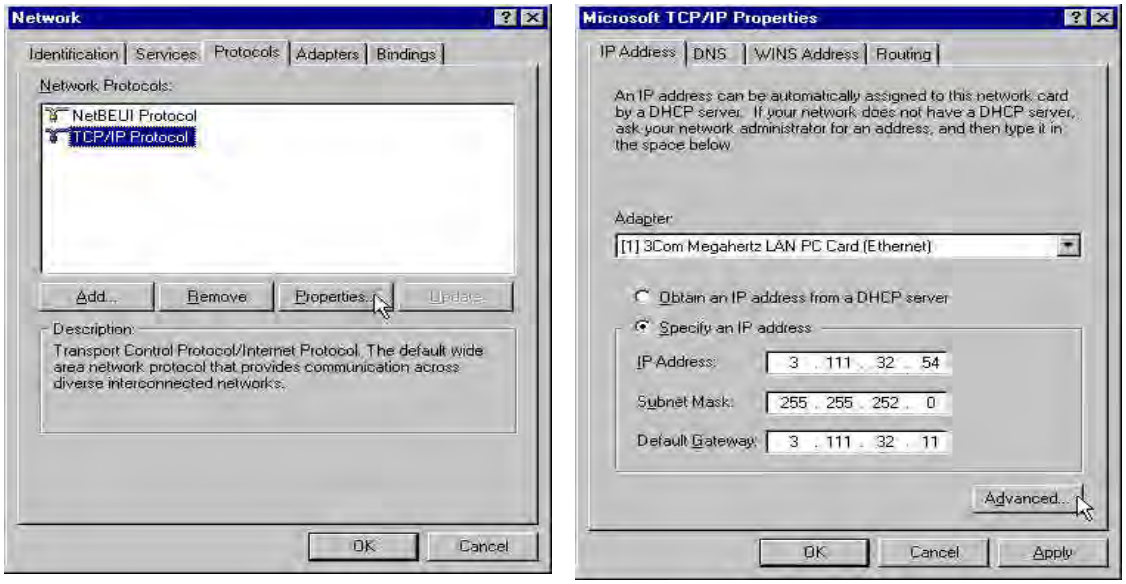


Figure 5–3: TCP/IP PROPERTIES

5

In the **IP address** tab, select **Advanced...** (see Figure 5–3:) and add a new address in the PC that corresponds to the same LAN pattern that the relay has (in the example bellow 192.168.37.54).

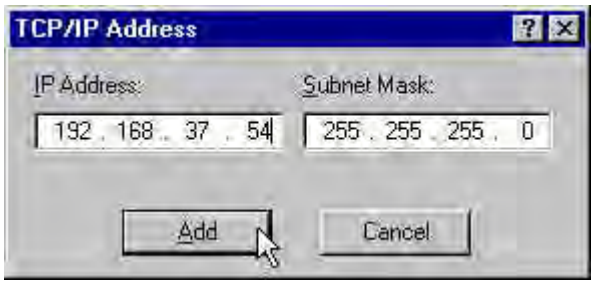


Figure 5–4: IP ADDRESS FOR COMPUTER

Windows allows Multihosting, so it permits having as many IP addresses as desired. It is necessary to turn off and on the computer to activate the new address that has been assigned to the PC.

Boot code upgrade is performed using EnerVista 650 Setup. It is required that there is no active communication between the program and the relay, and that no configuration file is open.

In this case, menu option ***Upgrade Boot code*** will be enabled under the EnerVista 650 Setup ***Communication*** menu.

During the boot code upgrading process, all the data stored in the relay will be lost, so it is required to save all calibration, settings, oscillography, etc. from the relay before the upgrade. It is extremely important to save the relay settings and calibration before continuing with the process.

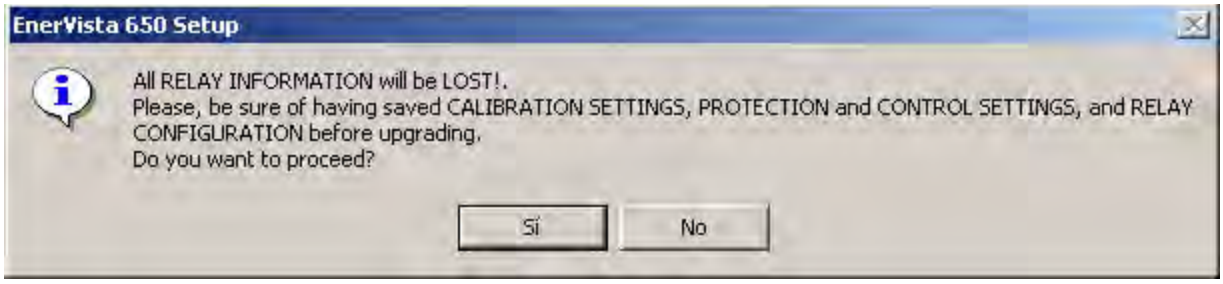


Figure 5–5: LOST DATA WARNING MESSAGE

To upgrade the boot code, it is required to connect an RS232 cable to the front of the relay, and an Ethernet cable to the rear port (COM3).

The serial communication parameters will be the ones selected in the ***Communications > Computer*** menu, where the COMX port (the port to be used in the upgrade) must be selected.

If the connection is made directly from the PC to the relay it is necessary to use a 10/100 Base T crossover cable. During the upgrade, the system will show the following message indicating the procedure to be followed.

Figure 5–6: SERIAL AND ETHERNET CONNECTIONS FOR BOOT CODE UPGRADE

After accepting to proceed, a window will open up for selecting a temporary IP Address. It is advisable to set the IP Address that is going to be used lately in the relay for Ethernet connection.

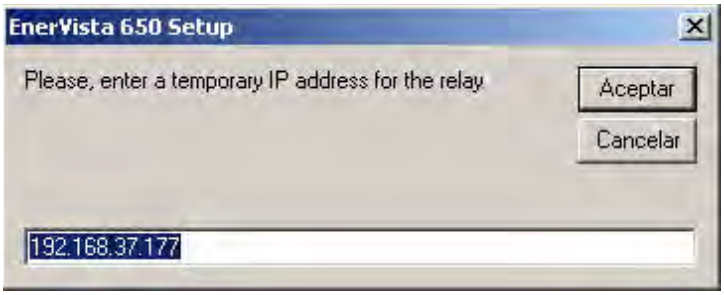


Figure 5–7: TEMPORARY IP ADDRESS SELECTION FOR BOOT UPGRADE

After entering the temporary IP address, a window will open up for selecting the appropriate file from the Multilin web site or Product CD.

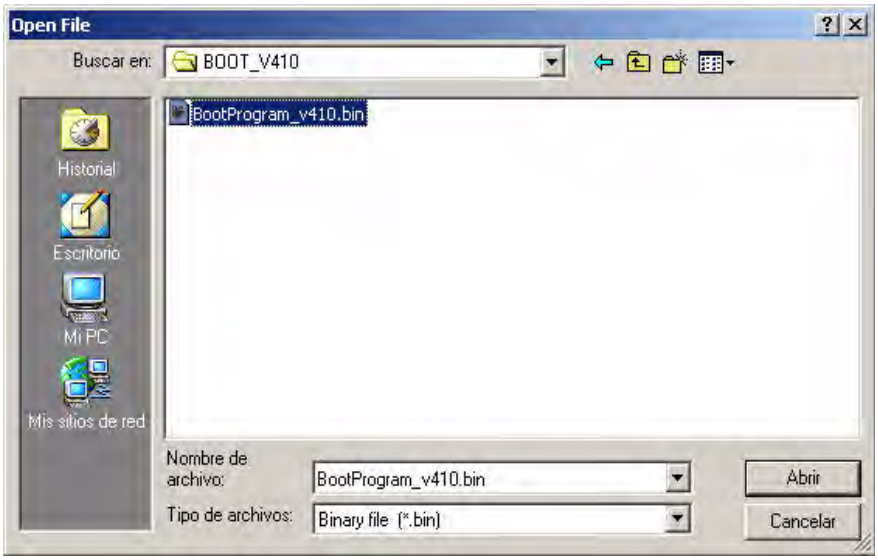


Figure 5–8: BOOT FILE SELECTION

Once the appropriate boot program file has been selected, the program will proceed to load the selected file.

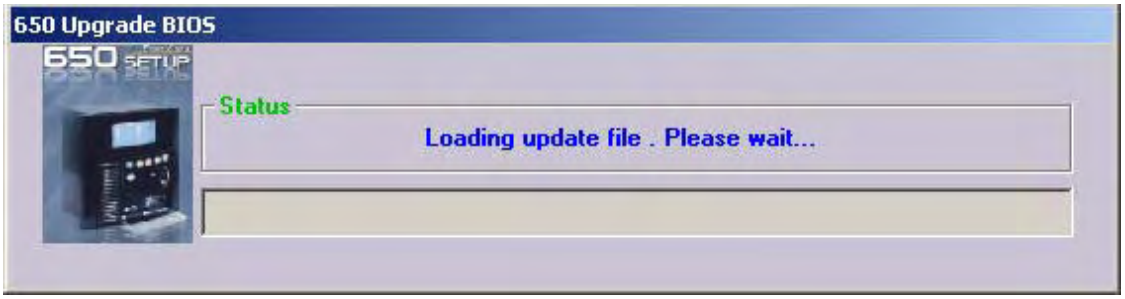


Figure 5–9: LOADING BOOT FILE

Then the program shows a message requiring switch off and on the relay while the progress bar is in course, to start the upgrading process.

Figure 5–10: SWITCH THE RELAY OFF AND ON TO START THE BOOT PROCEDURE

It is important to switch the Relay off and on again during the time shown by the progress bar; in case this time expires, the program will offer the option to continue with the process or to postpone, verify the correct RS232 connections and try again later. Notice that the serial port used in the boot upgrade procedure is the one selected in the "***Communication>computer***" menu.

Figure 5–11: ERROR MESSAGE FOR COMMUNICATIONS PROBLEMS

After switching the relay off and on, if the serial communication between EnerVista 650 Setup and the relay is correct the program shows a message to select to upgrade the current version to the new one.

Figure 5–12: UPGRADE CURRENT VERSION?

At this moment, selecting **"YES"** ("Sí" in the figure) the process will start, beginning with the relay flash memory deletion, so at this point all the information stored in the relay will be lost.

Until now, no important change has been made to the relay, the boot memory upgrading process has simply been prepared.

The process of flash memory erasing and boot code downloading can take some minutes, during which a progress bar is displayed.

Figure 5–13: ERASING FLASH MEMORY

Once the memory has been erased and the files upgraded in the relay, the parameters for the Ethernet communications must be set (Figure 5–14:). The requested values are the IP address and the gateway

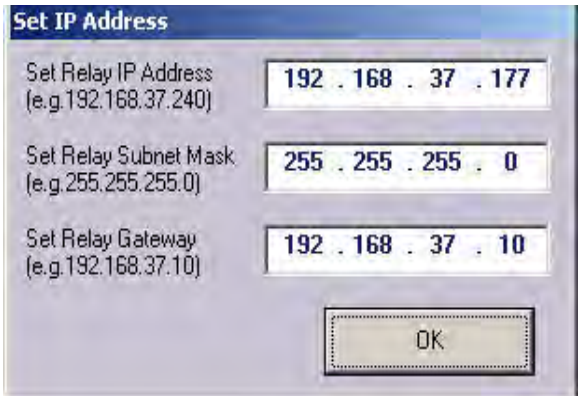


Figure 5–14: ETHERNET PARAMETERS

These values should match the LAN structure in which the relay will be connected.

The gateway must be the one used in the LAN structure connecting the relay. The relay IP address should have the first three octets corresponding with the Gateway and the last octet must be a free IP address reserved to the relay to avoid possible collisions with other devices.

After assigning the Ethernet parameters, the upgrade of the boot code has been completed successfully (Figure 5–15:).

Figure 5–15: BOOT PROGRAM UPGRADED

After boot code upgrade, the equipment firmware must also be upgraded (Section 5.3).

The relay settings and configuration will be lost, so it is advisable to save them to a file. For firmware revisions lower than 1.50, it is required to save calibration settings in a file before upgrading the F650 to a new firmware version. Take into account that if the boot code has been previously upgraded, all the data (including calibration settings) was lost.

In case of error during the firmware upgrading process, the user could repeat the whole process as many times as necessary, this is possible thanks to an independent boot memory (bootcode).

The firmware upgrading process should be done using the EnerVista 650 Setup software, after connecting the relay by Ethernet port (COM3).

5.3.1 FIRMWARE UPGRADE

Once the communication with the relay through Ethernet connection has been verified[1], enter the EnerVista 650 Setup program, select **Communication** and the **Upgrade Firmware Version** option.

At this point, proceeding with the upgrade will erase all the data stored in the equipment, including the calibration settings in firmware version previous to 1.50. Therefore, it is necessary to save all settings to a file before following with the process.

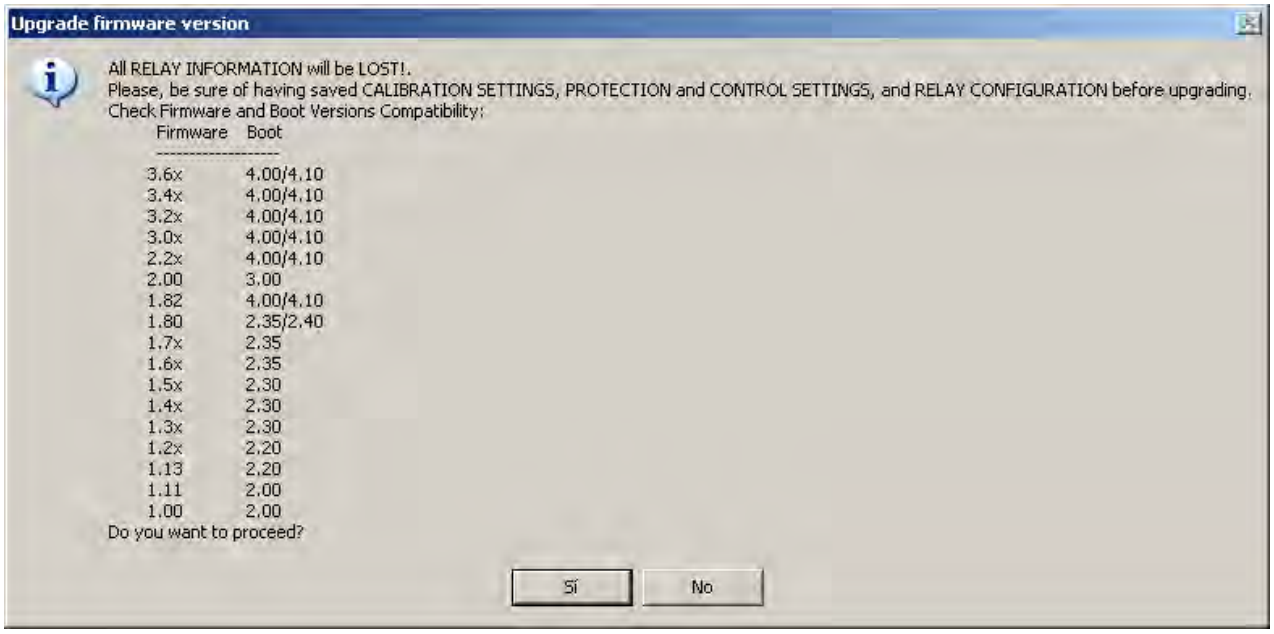


Figure 5–16: FIRMWARE-BOOT VERSION COMPATIBILITY

After accepting to proceed, a window will open up for the upgrade parameter. In firmware version previous to 1.70 the EnerVista 650 Setup program asks for the IP address of the relay to be upgraded and its serial number. In versions 1.70 and higher it is also necessary to enter the ordering code for the relay. See figure below:

1. Calibration settings should be stored in a file before upgrading the firmware.

Go to EnerVista 650 Setup main menu "***Communication > Calibration > Get Calibration Settings***"

Store the file in the PC using the relay serial number, for instance, as the name of the file.

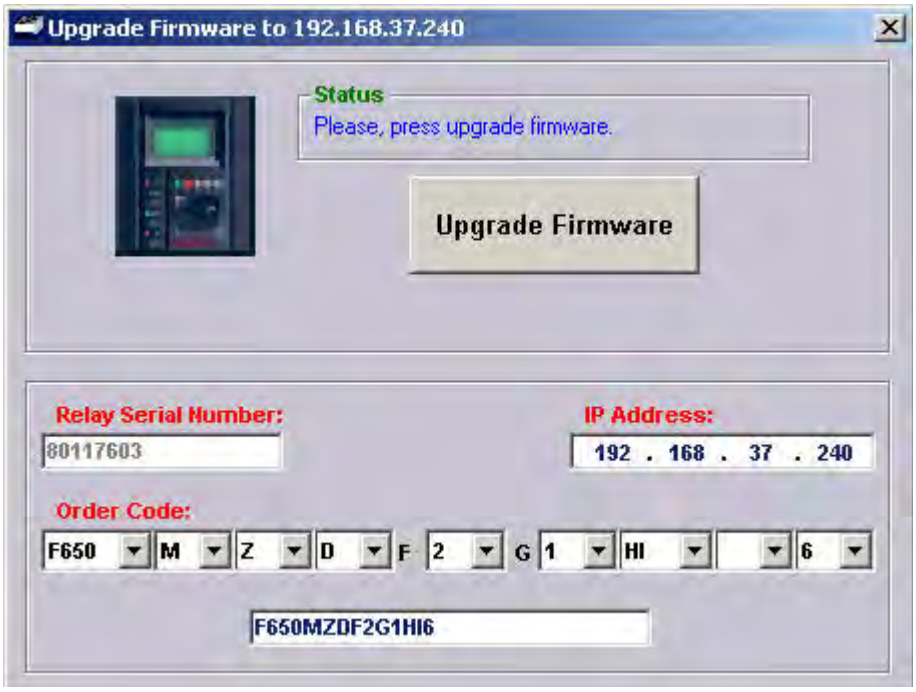


Figure 5–17: FIRMWARE SELECTION WINDOW

5

When upgrading models with Enhanced protection and control functionality (see ordering code selection), the program will request a password in order to continue with the process.

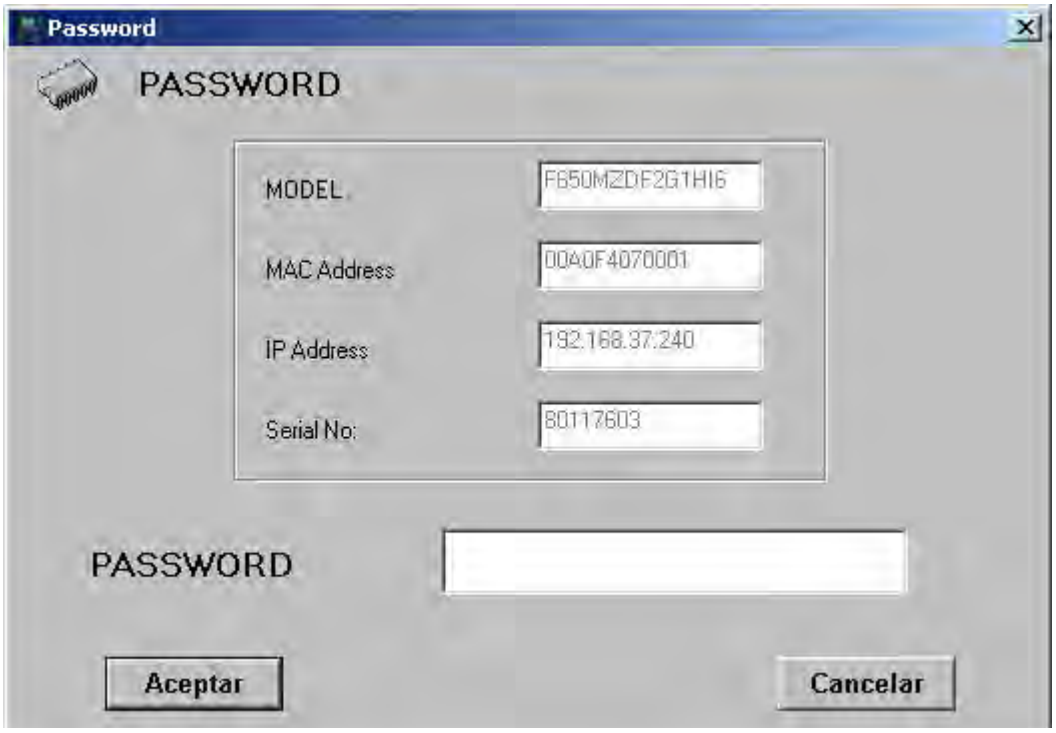


Figure 5–18: PASSWORD FOR ENHANCED MODEL UPGRADE

This password can be obtained placing an order with GE Multilin. The following parameters must be clearly indicated in the order:

- Unit serial number
- Current model option (before memory upgrade)
- Desired model option (after memory upgrade)
- Unit MAC address (available in the identification label)

Once the upgrade parameters have been entered, press the **"Upgrade Firmware"** button. When communication has been established, the program will show a message requesting to turn off and back on the relay to continue with the upgrade process.

Once the relay has been turned off and on, a new screen allows selecting the folder that contains the firmware upgrade files ("upgrade.txt" file must be located in this folder). This Upgrade.txt file is located in the folder where the desired firmware upgrade files are. This firmware upgrade files can be found in the Multilin web site.

If the files are downloaded from the web, they are compressed in a zip file. It should be decompressed in a temporary directory from which the upgrade.txt file will be selected.

Once the Upgrade.txt file is selected, the "**Upgrade Firmware**" button will be enabled. Press this button to initiate the process. A voltage range selection window will appear, this voltage range is connected to the serial number of the relay. The EnerVista 650 Setup program automatically pre-selects the appropriate voltage range for the unit based on the serial number. Users can select a different range, but if the voltage range is not selected correctly there will be an error in the voltage measurements (around 20%) due to an incorrect assignment of the calibration values.

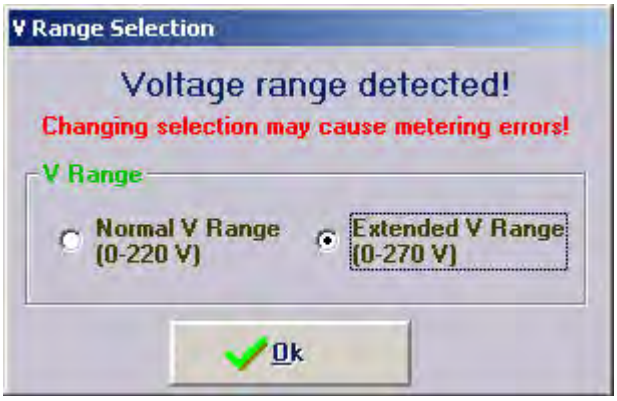


Figure 5–19: VOLTAGE RANGE SELECTION

During the process, the program displays the files that are being upgraded. When the files transfer is finished, a message appears informing that it is necessary to wait sometime before resetting the unit, in order to start working with the new firmware version in the relay. When the whole process has finished a message will be displayed asking to switch the F650 on and off.

At this point, the firmware upgrade procedure is finished and the relay is ready to be powered down and back up to check that the firmware has been upgraded properly.

When upgrading the firmware the entire settings and relay configuration are reset to factory default value.

Once the equipment has been properly checked, the F650 is ready to be used.

Remember that calibration settings and configuration must be loaded to the relay. To recover the relay calibration:

Go to EnerVista 650 Setup main menu:

Communication > Calibration > Set calibration Settings to store in the relay the calibration settings if necessary.

File > Config file (*.650) Converter to convert the setting and configuration file *.650 for the relay (if is was in a previous version format) to the new version (see section 3.1.7.2 in human interfaces in this manual)

File > Send info to relay to send the new settings and configuration file to the unit.

Notice that boot program and firmware upgrade will erase all the data contained in the relay, thus it is advisable to save all the data, oscillography, events, settings and configuration files previously.

5.4.1 BOOT CODE UPGRADE (*)

1. INSTALL THE PROPER VERSION OF THE ENERVISTA 650 SETUP PROGRAM.
2. CONNECT ONE RS-232CABLE IN THE FRONT PORT OF THE RELAY AND ONE ETHERNET CABLE AT THE REAR ETHERNET PORT (CROSSOVER CABLE FOR BACK-TO-BACK CONNECTION AND STRAIGHT-THROUGH ETHERNET CABLE FOR HUB OR SWITCH) .
3. GET CALIBRATION SETTINGS (AND SAVE IT TO A FILE).
4. SAVE ALL THE DATA FROM THE RELAY (SETTINGS, OSCILLOGRAPHY, EVENTS).
5. FROM THE ENERVISTA 650 SETUP PROGRAM SELECT "***Communication > Upgrade Boot Code***".
6. FOLLOW THE INDICATIONS OF THE PROGRAM AND SELECT THE BOOT PROGRAM BIN FILE.
7. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
8. CONTINUE WITH THE PROCESS AND SET THE IP ADDRESS AND GATEWAY WHEN REQUIRED.

5.4.2 FIRMWARE UPGRADE (*)

1. INSTALL THE PROPER VERSION OF THE ENERVISTA 650 SETUP PROGRAM.
2. CONNECT ONE ETHERNET CABLE AT THE REAR ETHERNET PORT (CROSSOVER CABLE FOR BACK-TO-BACK CONNECTION AND STRAIGHT-THROUGH ETHERNET CABLE FOR HUB OR SWITCH).
3. SET THE APPROPRIATE IP ADDRESS IN THE RELAY.
4. SET THE APPROPRIATE IP ADDRESS IN THE PC.
5. FROM THE ENERVISTA 650 SETUP PROGRAM SELECT "***Communications > Upgrade Firmware Version***".
6. ENTER THE IP ADDRESS, SERIAL NUMBER AND ORDERING CODE OF THE RELAY TO UPGRADE.
7. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
8. LOCATE THE UPGRADE.TXT FILE ACCORDING TO THE MODEL OF THE RELAY.
9. PRESS UPGRADE FIRMWARE AND INITIATE THE UPGRADE PROCESS.
10. TO COMPLETE THE PROCEDURE, SWITCH OFF AND BACK ON THE RELAY WHEN REQUIRED BY THE PROGRAM.
11. SET CALIBRATION SETTINGS (FROM THE PC TO THE RELAY) (for versions lower than 1.50).
12. THE SETTINGS AND CONFIGURATION ARE NOW SET TO FACTORY DEFAULT.
13. SEND THE NEW SETTINGS AND CONFIGURATION FILES TO THE RELAY IF NECESSARY.

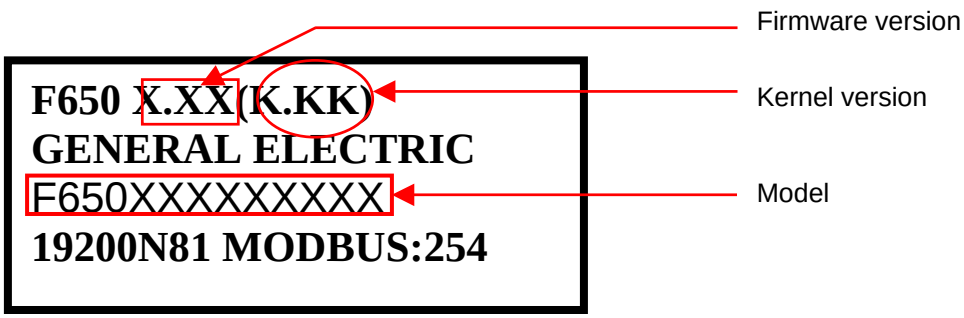
(*) The boot code upgrade must be performed using a crossed copper cable (RJ45) connected to the PC. It is not necessary to modify the internal fiber/cable switch, as the upgrade is carried out at 10 Mb/s, and thus there is not cable/fiber conflict.This fact does not apply to the firmware upgrade, which can be performed either with the Ethernet fiber connection, or with the cable connection.

Note: Please see chapter 8 TROUBLESHOOTING GUIDE if there is any problem during the upgrading process.

Verify that the relay has not suffered any damage during transportation, and that all screws are correctly fixed, and all relay terminal boards are in good condition.

Verify that the information shown on the relay front plate corresponds to the data shown on the display, and to the requested relay model.

Display information:



All devices running on AC current are affected by frequency. As a non-sine wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, we can infer that devices running on AC current are influenced by the applied waveform.

For a correct testing of relays running on AC current, it is fundamental to use a current and/or voltage senoidal waveform. The pureness of a senoidal wave (lack of harmonics) cannot be expressed specifically for a specific relay. However, any relay incorporating sintonized circuits, R-L and R-C circuits, will be affected by non-senoidal waveforms, as in the case of F650.

These relays respond to the voltage waveform in a different way to the majority of AC current voltmeters. If the power supply network used for the testing contains wide harmonics, the voltmeter and relay responses will be different.

Relays have been calibrated in factory using a Network of 50 or 60 Hz with a minimum harmonic content. When the relay is tested, a power supply network with no harmonics in its waveform must be used.

The ammeters and chronometers used for testing the pickup current and relay operation time must be calibrated and their accuracy must be better than the relay's. The power supply used in the tests must remain stable, mainly in the levels near the operation thresholds.

It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments used. Functional tests performed with unsuitable power supply network and instruments are useful to check that the relay operates properly and therefore its operating characteristics are verified in an approximate manner. However, if the relay would be calibrated in these conditions, its operational characteristics would be outside the tolerance range values.

The following sections detail the list of tests for verifying the complete relay functionality.

During all tests, the screw located on the rear of the relay must be grounded.

For verifying isolation, independent groups will be created, and voltage will be applied as follows:

2200 RMS volts will be applied **progressively** among all terminals in a group, short-circuited between them and the case, during one second.

2200 RMS volts will be applied **progressively** between groups, during one second.

WARNING: No communication circuit shall be tested for isolation.

Groups to be created will depend on the type of modules included in F650, selectable according to the model.

The following table shows the different groups depending on the module type:

SOURCE 1:	**G1**: H10, H18
	G2: H13, H14, H15
SOURCE 2:	**G1**: H1, H9
	G2: H4, H5, H6
MAGNETIC MODULE.	**G1**: A5..A12
	G2: B1..B12
I/O F1 (MIXED)	**G1** (Inp. 1): F1..9
	G2 (Inp. 2): F10..18
	G3 (Out.): F19..36
I/O F2 (SUPERVISION)	**G1** (Spv 1): F1..4
	G2 (Inp. 1): F5..9
	G3 (Inp. 2): F10..14
	G4 (Spv 2): F15..18
	G5 (Out.): F19..30
	G6 (Out.): F31.36
I/O G1 (MIXED)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18
	G3 (Out.): G19..36
I/O G4 (32DI)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18
	G3 (Inp. 3): G19..28
	G4 (Inp. 3): G29..36
I/O G4 (ANALOG)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18

Feed the relay and verify that when commanding a LED reset operation, all LED indicators light up and they are turned off when pressing the **ESC** key for more than 3 seconds.

Feed the relay with the minimum and maximum voltage. For each voltage value, verify that the alarm relay is activated when there is voltage, and it is deactivated when there is no feed. If the power supply source incorporates AC feed, this test will be performed also for VAC.

If the relay incorporates a redundant power supply, these tests shall be performed on both power supplies.

Voltage values to be applied will be the ones indicated below according to the relay model:

SUPPLY	V MIN.	V MAX.
HI/HIR 110-250 Vdc 120-230 Vac	 88 Vdc 96 Vac	 300 Vdc 250 Vac
LO/LOR 24-48 Vdc	 20 Vdc	 57.6 Vdc

NOTE: Codes HIR and LOR correspond to a redundant power supply

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

Front:RS232

Rear:2 x RS485, 2 x Fiber Optic - Serial, 2 x Fiber Optic - Ethernet, 1 x RJ45 - Ethernet .

A computer with EnerVista 650 Setup software and an appropriate connector must be used.

Set the relay as follows

GENERAL SETTINGS			
NAME	**VALUE**	**UNITS**	**RANGE**
PHASE CT RATIO	1.0	0.1	1.0-6000.0
GROUND CT RATIO	1.0	0.1	1.0-6000.0
STV GROUND CT RATIO	1.0	0.1	1.0-6000.0
PHASE VT RATIO	1.0	0.1	1.0-6000.0
PHASE VT CONNECTION	WYE	N/A	WYE – DELTA
NOMINAL VOLTAGE	100 V	0.1	1-2250 V
NOMINAL FREQUENCY	50 Hz	1 Hz	50-60 Hz
PHASE ROTATION	ABC	N/A	ABC – ACB
FREQUENCY REFERENCE	VI	N/A	VI-VII-VIII
AUXILIARY VOLTAGE	VX	N/A	VX – VN

NOTE:

ALL ANGLES INDICATED ARE LAGGING ANGLES

ALL VALUES OBTAINED IN THIS TEST MUST BE THE ONES CORRESPONDING TO THE PHASOR ONES

6.7.1 VOLTAGES

Apply the following voltage and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
VI	0º	0	5	50	100	150	275
VII	120º	0	5	50	100	150	275
VIII	240º	0	5	50	100	150	275
VX	0º	0	5	50	100	150	275

Verify that the relay measures the values with an error of ±1 % of the applied value plus 0,1% of full scale (275V).

6.7.2 PHASE CURRENTS

Apply the following current and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
Ia (A)	45º	0	15	10	5	1	0.1
Ib (A)	165º	0	15	10	5	1	0.1
Ic (A)	285º	0	15	10	5	1	0.1
IG (A)	0º	0	15	10	5	1	0.1
ISG (A)	0º	0	5	1	0.1	0.01	0.005

Verify that the relay measures the values with an error lower than ±0.5% of the test value or ± 10 mA, whichever is greater, for phases and ground.

Verify that the relay measures the values with an error lower than ±1.5% of the test value or ± 1 mA, whichever is greater, for sensitive ground (SG).

6.7.3 ACTIVE, REACTIVE POWER, AND COSϑ METERING

Equations to be applied for powers in a wye connection are as follows:

POWER PER PHASE	THREE-PHASE POWER
P=V*I*Cosφ	P=Pa+Pb+Pc
Q=V*I*Senφ	Q=Qa+Qb+Qc

Apply the following current and voltage values:

APPLIED VOLTAGE AND CURRENT VALUES PER PHASE			
PHASE A	**PHASE B**	**PHASE C**	**V-I ANGLES**
VI = 50 V, 0º	VII = 50 V , 120º	VIII = 50V, 240º	φ=45º
Ia = 10∠45º	Ib= 10∠165º	Ic = 10∠285º	**Cosφ= 0.707**

With the indicated voltage and current values, verify that the power measure corresponds to expected values indicated in the following table:

EXPECTED POWER VALUES			
PHASE A	**PHASE B**	**PHASE C**	**THREE-PHASE**
Pa = 353.55 MW	Pb = 353.55 MW	Pc = 353.55 MW	P = 1060.66 MW
Qa = 353.55 MVAr	Qb = 353.55 MVAr	Qc = 353.55 MVAr	Q = 1060.66 MVAr

Maximum admissible error is ± 1% of the test value for P and Q, and 0.02 for cosφ.

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6.7.4 FREQUENCY

Frequency measure on channel VII (terminals A7-A8):

Apply 50 Vac at 50 Hz on channel VII. Maximum admissible error:± 10 mHz.

Apply 50 Vac at 60 Hz on channel VII. Maximum admissible error: ± 12 mHz.

Frequency measure on channel Vx (terminals A11-A12):

Apply 50 Vac at 50 Hz on channel Vx. Maximum admissible error:± 10 mHz.

Apply 50 Vac at 60 Hz on channel Vx. Maximum admissible error: ± 12 mHz.

Results:

CHANNEL	VOLTAGE (V)	SET FREQUENCY (HZ)	MEASURED FREQUENCY (HZ)
VII	50	50 Hz	
		60 Hz	
VX	50	50 Hz	
		60 Hz	

During all tests, the screw on the rear of the relay must be grounded.

6.8.1 DIGITAL INPUTS

During this test, the user will determine the activation/deactivation points for every input in the relay for the set voltage value of 30 Volts.

Verify that the error does not exceed ± 10% (+10% on activation, -10% on deactivation).

Default board settings for the input test can be modified in EnerVista 650 Setup software in:

Setpoint>Inputs/Outputs>Contact I/O>Board X

X, will be substituted by the corresponding board:

F for board in first slot

G for board in second slot

H for board in first slot of CIO module

J for board in second slot of CIO module

Test settings for mixed board (type 1:16 inputs and 8 outputs):

I/O BOARD TYPE 1 (MIXED)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC16 (CC16)	POSITIVE

The inputs test is completed by groups of 8 inputs, as this type of board has 2 groups of 8 inputs with the same common. For the first 8 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 8 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC16) must also be set to POSITIVE.

Test settings for mixed board (type 2: 8 digital inputs, 4 blocks for supervision and 8 outputs):

I/O BOARD TYPE 2 (SUPERVISION)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC8 (CC8)	POSITIVE

The inputs test is completed by groups of 4 inputs, as this type of board has 2 groups of 4 inputs with the same common. For the first 4 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 4 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC8) must also be set to POSITIVE.

If the relay incorporates more input modules, these tests must also be applied to them.

6.8.2 CONTACT OUTPUTS

The correct activation of every output will be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated. Go to EnerVista 650 Setup Software (***Setpoint>Inputs/Outputs>Force Outputs***).

For switched contacts, the change of state of both contacts shall be verified.

6.8.3 CIRCUIT CONTINUITY SUPERVISION INPUTS

Supervision inputs will be tested as normal inputs, revising the voltage level that will be 19 Volts.

Coil 1:

Apply 19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

Coil 2:

Apply 19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

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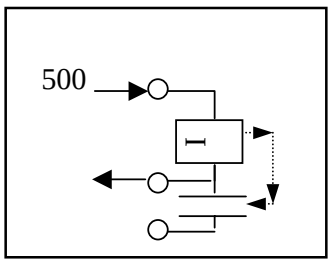
6.8.4 LATCHING CIRCUITS

Send a closing command to the latched contact (F31-F33).

Make circulate a current of 500 mA through the contact in series with the sensing terminal.

Send an opening command and verify that the contact does not open.

Interrupt current and check that the contact is released.



Repeat the test for the other latched contact (F34-F36).

Connect current sources to the relay according to the wiring diagram. Current and voltage input terminals are as follows:

PHASE	CONNECTIONS
Current	
IA	B1-B2
IB	B3-B4
IC	B5-B6
IG	B9-B10
ISG	B11-B12
Voltage	
VI	A5-A6
VII	A7-A8
VIII	A9-A10
VX	A11-A12

Set the relay to trip for the protection element being tested. Configure any of the outputs to be enabled only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Gradually increase the current value and verify that the relay operates between 1 and 1.1 times the set pickup current. The relay must trip by instantaneous in a time frame of 10 to 55 ms. All the relay trip contacts must operate, as well as the contact set as 50.

Remove current and apply it again suddenly to a value of 4 times the pickup current. The relay should trip instantaneously in a time frame of 10 to 45 ms.

Test one point for each phase and group of the protection element.

50 ELEMENTS TEST PARAMETERS		
Element Settings (50PH, 50PL, 50G y 50SG)		
Setting	Value	Units
Function	Enabled	
Input	RMS	NA
Pickup Level	3	A
Delay time	0	Seconds
Test Execution		
Configure one output for 50 Trip		
Apply times I pickup	Element Trip	Tripping times (ms)
0.9 x Pickup	NO	NA
1.1 x Pickup	YES	10-55
4 x Pickup	YES	10-45
Elements	Phase	Group
50PH and 50PL	IA	0
	IB	0
	IC	0
50G	IG	0
50SG (*)	ISG	0

Note (*): Only available for Enhanced models

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Apply 1.5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

Apply 5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

PROTECTION ELEMENT SETTINGS (51PH, 51PL, 51N, 51G AND 46)						
SETTING			VALUE		UNIT	
FUNCTION			ENABLED			
INPUT			PHASOR (DFT)			
PICKUP LEVEL			1		A	
CURVE			MODIFY FOR EACH TEST			
TD MULTIPLIER			MODIFY FOR EACH TEST			
VOLTAGE RESTRAINT			DISABLED			
ELEMENT	PHASE	CURVE TYPE	DIAL	TIMES IPICKUP	TRIPPING TIMES (SEC)	
					EXPECTED	ADMISSIBLE
51PH	IA	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]
51PL	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]
51N	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
51G	IG	Definite Time	2	0.9	NA	
				5	2.000	[1.900 – 2.100]
46	I2	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]

In order to test directional units in the relay, instantaneous trips will be commanded.

Two points will be tested, per phase, test element.

In order to test the directional units, configure (in the "***Setpoint > Relay Configuration > Protection Elements***" screen of the EnerVista 650 Setup program), some overcurrent element to be supervised by a directional unit. This way, if the directional element is enabled and detects the fault in the block direction, then the overcurrent unit will not operate. If the directional element is not enabled or if it is enabled and it detects a fault in a trip direction, then the overcurrent unit will operate if the set current level is exceeded.

6.12.1 67P ELEMENT

Activate only protection elements 50PH and 67P and set the relay as follows:

67P SETTINGS		50PH SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Block Logic	PERMISSION	Trip Delay	0.30
Pol V Threshold	30 V	Reset Delay	0.00

Configure one of the outputs to be activated only by unit 50PH.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50PH/67P	IA	2 A	0º	VIII	60 V	0º	NO
					60 V	180º	YES
	IB	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IC	2 A	0º	VII	60 V	0º	NO
					60 V	180º	YES

6.12.2 67N ELEMENT

Activate only protection elements 50N and 67N and set the relay as follows:

67N SETTINGS		50N SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50N/67N	IA	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IB	0 A	0º	VII	0 V	0º	
	IC	0 A	0º	VIII	0 V	0º	

Activate only protection elements 50G and 67G and set the relay as follows:

67G SETTINGS		50G SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50G/67G	IG	2 A	0º	VI	60V	0º	NO
					60V	180º	YES
				VII		0º	
				VIII		0º	

6.12.4 67SG ELEMENT

Activate only protection elements 50SG and 67SG and set the relay as follows:

67SG SETTINGS		50SG SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50SG.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50SG/67SG	ISG	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
				VII	0 V	0º	
				VIII	0 V	0º	

6.13.1 27P ELEMENT

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHASE UV (27P)	
Function	ENABLED
Mode	PHASE-GROUND
Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec
Minimum Voltage	30 V
Logic	ANY PHASE
Supervised by 52	DISABLED

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	PHASE	CURVE	PICKUP LEVEL	DELAY	APPLIED VOLTAGE	TRIPPING TIMES (S)	
						EXPECTED	ADMISSIBLE
27P	VI	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

6.13.2 27X ELEMENT

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VX

AUXILIARY UV (27X)	
Function	ENABLED
Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	INPUT	CURVE	PICKUP LEVEL	DELAY	APPLIED VOLTAGE	TRIPPING TIME (S)	
						EXPECTED	ADMISSIBLE
27X	VX	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

6.14.1 59P ELEMENT

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHSE OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00
Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	PHASE	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					EXPECTED	ADMISSIBLE
59P	VII	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

6.14.2 59X ELEMENT

Set the relay as follows:

GENERAL SETTINGS	
Auxiliary Voltage	VX

AUXILIARY OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00
Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					EXPECTED	ADMISSIBLE
59X	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VN

NEUTRAL OV HIGH/LOW (59NH/59NL)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENTS	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					EXPECTED	ADMISSIBLE
59NH/59NL	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

This element can also be tested by applying only phase voltages. For this purpose, it is necessary to set Auxiliary Voltage = VX. In this condition, Vn voltage is calculated as a sum of the phase voltages.

Set the relay as follows:

NEG SEQ OV (47)	
Function	ENABLED
Pickup Level	50 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

CHANNEL	APPLIED VOLTAGE (V)	ANGLE	TRIPPING TIME (S)	
			EXPECTED	ADMISSIBLE
VI	65	0º	NO TRIP	NA
VII	65	120º		
VIII	65	240º		
VI	55	0º	2	[1.9–2.1]
VII	55	240º		
VIII	55	120º		
VI	45	0º	NO TRIP	NA
VII	45	240º		
VIII	45	120º		

NOTE: All angles mentioned on the tables are delay angles, where a balanced ABC system would be composed by:

CHANNEL	APPLIED VOLTAGE (V)	ANGLE
VI	65	0º
VII	65	120º
VIII	65	240º

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

GENERAL SETTINGS	
Nominal Frequency	50 Hz

ELEMENT SETTINGS		
FREQUENCY (81)	**81U**	**81O**
Function	ENABLED	ENABLED
Pickup Level	47.50 Hz	52.50 Hz
Trip Delay	2.00 sec	2.00 sec
Reset Delay	0.00 sec	0.00 sec
Minimum Voltage	30 V	30 V

Apply voltage as indicated on the table, modifying frequency from the maximum threshold (48 Hz) to the minimum (46 Hz) for 81U, and from the minimum (52 Hz) to the maximum (54 Hz) for 81O, in steps of 10 mHz.

Verify that the relay trips at the set frequency in the corresponding element with an error of 3% ó ±50 mHz.

Apply a voltage that is lower than the “Minimum Voltage” setting, with a frequency under (81U) or over (81O) the setting, and verify that the relay does not trip.

ELEMENTS	PHASE	PICKUP LEVEL (HZ)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	FREQUENCY THRESHOLDS	TRIPPING TIME (S)	
						EXPECTED	ADMISSIBLE
81U	VII	47.5	2	80	48 Hz	No trip	NA
					46 Hz	2	[1.9 –2.2]
				25	46 Hz	No trip	NA
81 O	VII	52.5	2	80	52 Hz	No trip	NA
					54 Hz	2	[1.9 –2.2]
				25	54 Hz	No trip	NA

Set protection element 79 as follows:

RECLOSER	
Function	ENABLED
Max Number Shots	4
Dead Time 1	2.10 sec
Dead Time 2	4.10 sec
Dead Time 3	6.10 sec
Dead Time 4	8.10 sec
Reclaim Time	3.00 sec
Cond. Permission	ENABLED
Hold Time	7.00 sec
Reset Time	5.00 sec

Set the relay to trip by 50PH, and configure the signals necessary to test the 79 element:

Configure one output as AR RECLOSE

Configure the AR INITIATE signal with the 50PH trip

Configure the AR LEVEL BLOCK signal with a digital input

Configure the AR CONDS INPUT with the digital signal desired

50PH SETTINGS	
Function	ENABLED
Input	RMS
Pickup Level	3 A
Trip Delay	0.00 s
Reset Delay	0.00 s

6.16.1 RECLOSING CYCLE

Connect a latching relay simulating the breaker managed by the F650 unit.

Once the relay is set, close the breaker and wait for 5 seconds.

After this time, the recloser is ready to initiate the reclosing cycle.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 2.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 4.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 6.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 8.1 seconds.

Command a 50PH trip and verify that the breaker opens and the recloser passes to Lockout.

Verify the correct operation of programmed outputs

Tripping times must be within the following values:

RECLOSING CYCLE		
Nº shot	**Expected time**	**Admissible time**
1	2.1 sec	[1.8 – 2.3]
2	4.1 sec	[3.8 – 4.3]
3	6.1 sec	[5.8 – 6.3]
4	8.1 sec	[7.8 – 8.3]

6.16.2 RECLOSER STATUS

BLOCK

Activate the block input and verify that the recloser is in BLOCK status.

Close the breaker and wait for 5 seconds.

Command a trip and verify that the breaker opens but there is no reclose.

INHIBITION BY RECLOSING CONDITIONS

Close the breaker and wait for 5 seconds.

Command a trip, verify that the breaker opens and wait for the first shot.

Activate the inhibition input and command a new trip.

Verify that the breaker opens, wait for 8 seconds and verify that the relay does not reclose.

6.16.3 EXTERNAL RECLOSE INITIATION

Close the breaker and wait for 5 seconds.

Activate the reclose initiation input and open the breaker, verify that the relay executes the first shot

Disable all protection elements except for Thermal Model (49).

Set the pickup level to 2 A.

Set the time constant τ1 to 3 minutes and τ2 to one time τ1.

Apply currents of 2, 5, and 10 times the tap and ensure that the operation times are within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	48.5 - 53.6
5	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

After each measuring, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Repeat the test selecting a time constant τ1 of 60 minutes. Verify that the operation time is within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	960 - 1072
5	10.0	5	141 - 156
	20.0	10	35.4 - 39

After each measuring, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Q1. Does the F650 support DNP and ModBus over the Ethernet port?

A1. F650 units support both protocols over both the asynchronous serial ports and the Ethernet LAN synchronous port using TCP/IP and UDP/IP layers over the Ethernet.

Q2. Does this equipment support dual IP access?

A2. Yes, it supports two independent IP addresses in aliasing mode. Those address go in the communications settings Network0 and Network1.

Q3. Is the protocol IEC 870-103 supported by the F650?

A3. At this moment it is not supported.

Q4. Can the F650 be used as a DNP master station?

A4. Not at this moment. It works as a slave IED station for all protocols.

Q5. How many communication ports are included in the F650?

A5. The equipment has 2 different boards, one for asynchronous serial ports and another for a high-speed synchronous Ethernet port. The first board has 2 comm ports, COM1 and COM2. COM2 is multiplexed with the front serial RS232 port, whereas the COM1 port is completely independent from COM2.

The synchronous LAN port is COM3.

Q6. Are there one or two Ethernet ports?

A6. The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

Q7. How many different communication Ethernet sessions can be opened through the LAN port?

A7. ModBus TCP/IP:4 sockets

DNP TCP/IP:3 sessions (from version 1.72 on)

Q8. May I use the cooper 10/100 BaseTX connection included in the basic model with all protocols?

A8. Yes, it may be used with all protocols. In noisy substation environments and/or long distances, it is recommended to use fiber optic options due to much better EMC performance and immunity. For fiber optic models, it is necessary to adjust an internal jumper to use the copper port.

Q9. Remote I/O CAN bus. Does it support DeviceNet protocol?

A9. No it does not support DeviceNet.

Q10. Which functions are available in the relay web server?

A10. Currently, it includes several functions for viewing measures and retrieving information.

Q11. Q11 May I use URPC to program the relay?

A11. Only oscillography records may be viewed with URPC once downloaded to a file using the ENERVISTA 650 Setup software.

Q12. May I connect URs and F650s to the same Ethernet?

A12. Yes, either in cable as in fiber, or even mix them.

Q13. How do I connect with fiber 10-BASE-FL UR relays with 100-BASE-FX F650 relays?

A13. Take into account that an UR is never connected directly to a F650 (neither two UR nor two F650 with each other) but they are always connected through a hub or switch. The hub or switch where the URs are connected must be 10-BASE-FL and the hub or switch for the F650 must be 100-BASE-FX.

Q14. How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX F650 relays?

A14. The answer to this question is as described before but also in this case there is an advantage added, because the hub 10-BASE-TX port is able to understand a 10-BASE-T port. This means that a hub 10-BASE-T port may be connected to an UR or a F650, and a hub 10/100-BASE-TX port may be connected either to an UR or F650.

Q15. What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the F650, although both are 100-BASE-FX?

A15. Just buy fiber cables with the appropriate male connectors. For the UR and F650 side we need the same connectors, ST type, for the hub side, the correspondent ones. And in what concerns to the fiber type, it is used the same for 10 as for 100, it is the 50/125 or 62.5/125 multimode, this last one allows longer distances.

Q16. What is the difference between a hub and a switch?

A16. In a repeater type hub (shared hub), one unit talks and the rest listen. If all the units are talking at the same time there may be collisions in the messages, what may produce certain communication delays.

The switch (switched hub) has very powerful processors and a lot of memory and it is much more expensive than the hub. It directs messages to the proper destination avoiding collisions and allowing a much more efficient communication.

Q17. Why do we have 10/100 compatibility for cable but not for fiber?

A17. The cable has some advantages that the fiber does not have, and it is that the signal attenuation in short and medium distances, is worthless and this is truth for low and high frequency signals. By the contrary, the light in one fiber optic is highly attenuated, being much worse in case of high frequencies than in the low ones. The 10-BASE-FL fiber transmission is performed in a wavelength of 850nm, what allows a less expensive electronic than the 1300 nm used in 100-BASE-FX fiber transmission. Using, in both cases, the same glass multimode fiber type, the attenuation to 1300 nm is lower than the 850 nm ones, this way the greater attenuation of the 100 Mbits is compensated. There is another fiber standard, the 100-BASE-SX, which uses 850 nm to 100 Mbits, being compatible with the 10-BASE-FL one, although it sacrifices the maximum distance to 300 m. Nowadays, this standard has not had success among Ethernet equipment manufacturers and suppliers.

Q1. Does the F650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1. Yes, the F650 includes an IRIG-B input for all models, including the basic ones.

It uses DC level format B. Formats used are B0000, B0002 and B0003.

Actual accuracy is 1 millisecond. Internal sampling rate allows true 1 ms accuracy time tagging.

The input burden is very low. The maximum number of units that may be connected to a generator depends on its output driving capability. Up to 60 units have been successfully connected with equipments commonly used in the market.

Q2. Does the equipment work with dry inputs in both AC and DC?

A2. The equipment works only with DC inputs.

Inputs should be driven with externally generated DC current. No special 48 Vdc or other outputs are included in the equipment to drive these inputs; therefore, contacts connected to the equipment should be connected to a DC source.

Q3. Is it oscillography programmable?

A3. Yes, the sampling rate is programmable (4, 8, 16, 32 or 64 samples per input). The depth will depend on the sampling rate.

Q4. Do I have to select a different model for 1 or 5 A?

A4. No. The same model is able to work with either /1 A or /5 A rated secondary currents. There are high accuracy sensing transformers that allow the use of any current input through the same terminals to reduce the spares and simplify wiring.

Q5. In my installation, several digital inputs become active when I energize the transformer. How can I reduce sensitivity?

A5. By selecting debounce time and/or voltage threshold, the relay may adapt its sensitivity to different applications. Please select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

Q1. What is the difference between Get/Send info from/to relay and Upload/Download info files to/from relay?

A1. Get/Send are used for settings and configuration storage that although both are in a unique file, are sent separately in two times. Upload/Download are used for project or PLC files group storage. These files are the setting_configuration file source. To operate, the F650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

Q2. Could I program interlocks?

A2. Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q3. Can we rotate the display 90 degrees to show feeders vertically?

A3. No. The product has been designed to view it in horizontal mode (landscape) due to the following reasons:

It is easier to read the LCD display because it has been designed for horizontal positions.

Compatibility between text display (4x20 characters) and LCD display (16x40 characters or 128x240 pixels).

Refresh speed is better in horizontal than vertical format.

Q4. Do I need a laptop or handheld to program the unit?

A4. No, all main operations can easily be performed with just the incorporated HMI. Handheld or laptops may be required to download large quantities of information (such as oscillograms, etc.) but they are not mandatory for a conventional user that just needs to change settings, view measurements, states, etc.

Q5. Is there password security for protection and control?

A5. Yes, there are two passwords. An independent password for protection changes and control operations is available since version 1.44

Q6. Is it possible to have a remote HMI installed in the front of the panel with the rest of the relay in the rear side?

A6. Not in the present version.

Q7. Is it possible to program a default screen for the HMI?

A7. In graphic display versions the user may program a custom screen with the single-line diagram, measurements, etc. In text display models, there is a choice of logo, measurements, or scrolling both screens.

Q8. May I force inputs and outputs to ease commissioning and testing?

A8. Yes.

Q9. How can I disable the rotary knob buzzer?

A9. Press ESC key more than 3 seconds and then press the knob during a short pulse.

Q10. Why do appear strange texts on the display when switching on the relay?

A10. You will have pressed any button and the HMI has entered in a test mode.

The display messages are updated after a few minutes, once the relay has completed the starting sequence.

Q1. Does the "Service" contact on the Power Supply board cover all possible failures or do I have to create an output on the I/O board that includes all the internal errors I can access in the logic?

A1. The power supply ready contact only monitor hardware failures in the power supply, to monitor the internal error of the unit it is necessary to configure a virtual output to and the assign it to the device desired (contact output, LED, etc.).

Q2. I set an output contact as "Latched". If I do not set a "reset" condition, will it reset from the "ESC" key?

A2. No, you have to configure the contact output reset signal (in ***Setpoint>Relay Configuration>Outputs***).

The ESC key only reset the LED indicators.

F650 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	-Function not permitted	-Set the function permission to ENABLED
		- Function blocked	-Check Protection units block screen
		- Output not assigned	-Program the output to the desired function using ENERVISTA 650 Setup logic configuration
General	When feeding the unit, no indicator is lit up	-Insufficient power supply	-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range
		- Wrong versions	-Check relay and ENERVISTA 650 Setup versions are the same
		-Fuse failure	-Remove power supply, dismount the power supply module and replace the fuse
		- Loose fuse	-Same as above with same fuse
		-Incorrect wiring	-Make sure that terminals labeled + and – are connected to the 9-pin connector corresponding to the power source
Communication	The relay does not communicate via the front RS232 port	-Incorrect cable	-Make sure you are using a straight cable
		-Damaged cable	-Replace the cable
		-Relay or PC not grounded	-Ensure ground connection
		-Incorrect baudrate, port, address, etc.	-Test other ports, other baudrates, etc. Make sure that the communication parameters in the computer match the ones in the relay.
General	After Updating the firmware the relay does not start up and always shows the message “Os Loading…”.	Check that the bootware version match with the firmware version	-If there is an incompatibility between boot and firmware version, update to the corresponding boot and after that update the firmware version
			-If the boot and firmware versions are correct, perform the firmware update procedure again.

CATEGORY	SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Communications	Cannot see properly the web server in F650 with Windows XP. Some windows are in grey with a red cross mark.	Disabled Java options in Advanced Internet Explorer properties or high level of security	1.- Go to Advanced in Internet options for Internet explorer and select the three selections in Microsoft VM (Java Virtual Machine) and deselect any other virtual machine not Microsoft, for example SUN. In case Microsoft VM is not installed in the computer, the user must install it using the Microsoft VM installation program **msjavx86.exe** For internet explorer 6.0 or higher it is not included by default. 2.- Try to set a lower level of security in internet explorer options. 3.-Delete temporary internet files in “General” screen in internet explorer options.
Communication	Enervista 650 Setup does not retrieve osc, fault reports and Data Logger files	Bad communication in TFTP using Windows 2000	Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again to retrieve files from relay
Firmware and bootware upgrade			
Bootware	The relay gets stuck during the upgrading process after switching off and on the relay, giving the following error message: “ERROR Setting relay in configuration mode. Retry?	- The relay does not communicate via the front RS232 port	To perform the bootware upgrading process it is necessary to connect the unit thought the front RS232 port. check: • Serial cable correct(straightthrouhg) and undamaged. • Settings selection in Enervista 650 Setup Communication>Computer Settings”: o Com port selected must be the one that is being used to perform this procedure o Parity set to NONE o Baudrate set to 19200 o Control type: No control type o Modbus slave number: any **Note: if the bootware upgrading procedure got stuck at this point the relay will not be upgraded. After switching it off and on will continue working with the former firmware and bootware versions**.

CATEGORY	SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Bootware	The relay gets stuck at "Sending file imagen_kernel..."	-The Ethernet connection does not work properly.	Serial communications work properly and the flash memory has been erased but ethernet communication does not work properly, check: • RJ45 cable used (crossover cable for back-to-back connection and straightthrough Ethernet cable for hub or switch) • IP address, netmask, gateway are correct and corresponding to the ones used in the computer used to perform the procedure. See chapter 5.2.1 COMMUNICATION SETTINGS • Ethernet board parameters selection, check that: o 802.1p QOS is Enabled o Flow control is Auto o Speed & Duplex is Auto (or 10 Mb Full) • If all the above points are correct but the problem persists: o Force the Speed & Duplex to 10 Mb Full o Disable and enable the Ethernet connection while the files are being sent (during the "sending file..." message **Note: if the bootware upgrading procedure got stuck at this point, the relay flash memory has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI will show the message "Os Loading..." and the relay will not start up**.
Firmware	The procedure can not start due to ethernet problems	-The Ethernet connection does not work properly.	• Check the same as in the point above for bootware. Note: if the firmware upgrading procedure got stuck at this point the relay will not be upgraded. After switching it off and on will continue working with the former firmware and bootware versions.
Firmware	Program messages "file" do not exist in local drive	- File path is too long - File has no file attributes	• Check the path length, copy the files in a shorter path and start again the upgrade procedure. • Check the unzip process to see if the file properties are properly set to "File". • **Note: if the firmware upgrading procedure got stuck after having been started, the former firmware has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI will show the message "Os Loading..." and the relay will not start up.**
Firmware	It is not possible to to upgrade models without IEC 61850 to models with IEC 61850 automatically	- IEC 61850 upgrade from standard models is password protected.	• If the customer wants to upgrade from a standard model to a 6 one, ask the factory for a Upgrade package, depending on the former hardware the unit has, if hardware 00 they will need hardware and firmware change (passwored protected), if hardware 01 or above they will need only firmware change (passwored protected).

Firmware	During the upgrading procces for models with IEC 61850 sometimes it ask for password and sometimes not.	- Communication problems during the upgrade procecure. -The procedure has been not performed in a continuous way.	• EnerVista 650 Setup program do not ask for a password if the relay model is IEC61850 and the procedure is completed. • If during the process there is any problem and has to be started again, this second time the program will ask to confirm the IEC password. • If the EnerVista 650 Setup program is closed and started again during the bootware and firmware upgrade process, the program will ask to confirm the IEC password.
Firmware	Password for IEC61850 incorrect	- Model change - Incorrect mac or serial number	• The password is tied to the model, MAC Address and serial number, any change in any of the following will need a password change. • If the model has been modified to add or replace any boards or communication protocol, the IEC 61850 passwords will need to be updated (contact the factory).
EnerVista 650 Setup	InstallShield Setup Initialization Error 6001	A previous installation of any product using InstallShield for installation may have corrupted some of the InstallShield files used in the EnerVista 650 Setup installation	Delete (or rename) the 0701 folder located in "C:\Program Files\Common Files\InstallShield\Professional\RunTime\" and retry installation

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS		
AUTOCHECK INTERNAL STATES (CRITICAL)		
DSP Internal States (Critical to metering and protection)	DSP COMM ERROR	DSP Communication Error: (0) Rignt communications between DSP and main processor; (1) Communication Error between DSP and main processor
	MAGNETIC MODULE ERROR	Magnetic Module Error: (0) Right Communication between DSP and magnetic module processor; (1) Communication Error between DSP and magnetic module processor
	CALIBRATION ERROR	Calibration Error: (0) Right calibration values stored; (1) The calibration values stored are out of the calibration limits.
Flash Internal States (Critical to Relay configuration and stored data)	E2PROM STATUS	E2prom status :(0) Not configured or problems during writing process ; (1) Configured and OK
IO Board States (Critical to operation and protection)	BOARD F STATUS	Board F status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD G STATUS	Board G status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD H STATUS	Board H status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD J STATUS	Board J status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
IEC61850 INTERNAL STATES (NON CRITICAL)		
IEC61850 Internal States	ICD STATUS	UNKNOWN: when the relay has not the IEC61850 protocol in the relay model the ICD status is unknow to the unit
		ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 will not be operative (the IEC 61850 client, reports and gooses will not work). It is advisable to include the ICD ERROR in the main error signal configured by the customers in their applications.
		MODIFIED: The settings have been changed in the icd but they are still not wrtten in the icd file in the relay
		IN PROGRESS: The icd setting are being written to the file in the relay
		OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
		OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting will prevail over the relay settings.
OTHER INTERNAL STATES (NON CRITICAL)		

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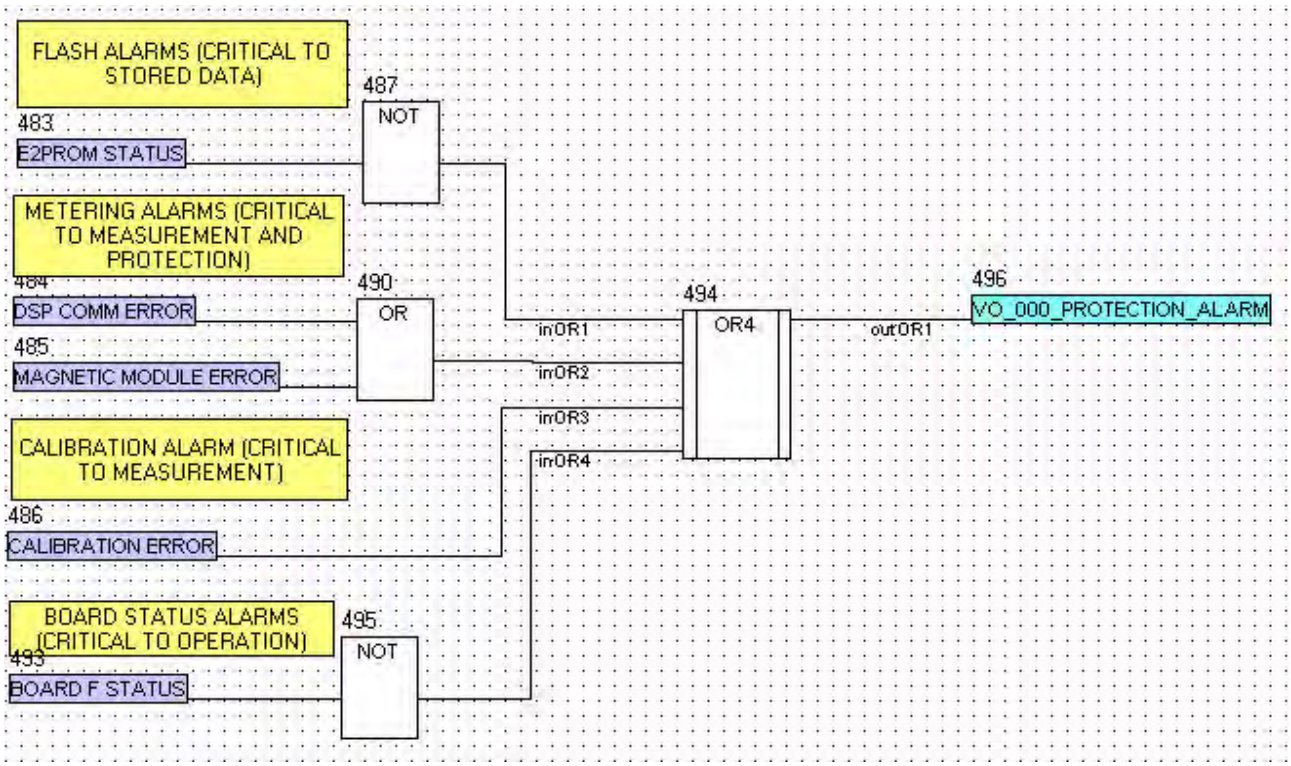
Other internal states	USER MAP STATUS	User map status: (0) Not configured ; (1) Configured
	FACTORY CALIBRATION	Calibration status (0) Not calibrated ; (1) Relay calibrated
	FLEXCURVE A STATUS	User curve A: (0) Not configured (1) Configured
	FLEXCURVE B STATUS	User curve B: (0) Not configured (1) Configured
	FLEXCURVE C STATUS	User curve C: (0) Not configured (1) Configured
	FLEXCURVE D STATUS	User curve D: (0) Not configured (1) Configured
	Green Zone	Memory internal status
	Yellow Zone	Memory internal status
	Orange Zone	Memory internal status
	Red Zone	Memory internal status
	UpTime	System Time
Autocheck Internal States (Not available)	TIMER STATUS	Real time clock autocheck (not available)
	GRAPHIC STATUS	Graphic display status (not available)
	ALARM TEXT ARRAY	Text display status (not available)

Note: It is advisable to use the critical alarms to raise an event or to light a warning led for maintenance purposes. See the example below, the Board X Status depends on the relay model.



Configurable Logic Outputs (512 elements)	VIRTUAL OUTPUT 000	Configurable logic output 000
	VIRTUAL OUTPUT 001	Configurable logic output 001
	...	...
	VIRTUAL OUTPUT 511	Configurable logic output 511
Operation Bits (24 elements)	OPERATION BIT 1	Operation bit 001: (0) the configured time expires or when success conditions are met;(1) operation 1 is executed and interlocks are fulfilled.
	OPERATION BIT 2	Operation bit 002: (0) the configured time expires or when success conditions are met;(1) operation 2 is executed and interlocks are fulfilled.
	...	...
	OPERATION BIT 24	Operation bit 024: (0) the configured time expires or when success conditions are met;(1) operation 24 is executed and interlocks are fulfilled.

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Control Event Bits (128 elements)	CONTROL EVENT 1	Control Event 1 Activation Bit
	CONTROL EVENT 2	Control Event 2 Activation Bit
	...	...
	CONTROL EVENT 128	Control Event 128 Activation Bit
Latched Virtual Inputs (32 elements)	LATCHED VIRT IP 1	Latched virtual input 1
	LATCHED VIRT IP 2	Latched virtual input 2
	...	...
	LATCHED VIRT IP 32	Latched virtual input 32
Self Reset Virtual Inputs (32 elements)	SELF-RST VIRT IP 1	Self reset virtual input 1
	SELF-RST VIRT IP 2	Self reset virtual input 2
	...	...
	SELF-RST VIRT IP 32	Self reset virtual input 32
Contact Inputs Type 1Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 2 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC8	Input 8 (CC8) in Board X
	CONT IP_X_CC9 (Va_COIL1)	Contact Input 09 (Va_COIL1) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC10 (Vb_COIL1)	Contact Input 10 (Vb_COIL1) for slot X. Input voltage (Vb) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC11 (Va_COIL2)	Contact Input 11 (Va_COIL2) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC12 (Vb_COIL2)	Contact Input 12 (Vb_COIL2) for slot X. Input voltage (Vb) detected, Circuit 2. Complete circuit supervised
	CONT IP_X_CC13 (O7_SEAL)	Contact Input 13 (07_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC14 (O8_SEAL)	Contact Input 14 (08_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC15 (SUP_COIL1)	Contact Input 15 (SUP_COIL1) for slot X. Output for circuit 1 supervision element
	CONT IP_X_CC16 (SUP_COIL2)	Contact Input 16 (SUP_COIL2) for slot X. Output for circuit 2 supervision element

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Contact Inputs Type 4 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC32	Input 32 (CC32) in Board X
Contact Inputs Type 5 Board (Digital Values)	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 5 Board (Analog Values)	ANALOG_INP_X_01	Analog Input 01 in Board X
	ANALOG_INP_X_02	Analog Input 02 in Board X
	ANALOG_INP_X_03	Analog Input 03 in Board X
	...	...
	ANALOG_INP_X_08	Analog Input 08 in Board X
Contact Outputs Type 1 & 2 Board Activation signals	CONT OP OPER_X_01	Logic signal for Output 1 activation. Board X
	CONT OP OPER_X_02	Logic signal for Output 2 activation. Board X
	...	...
	CONT OP OPER_X_08	Logic signal for Output 8 activation. Board X
Contact Outputs Type 1 & 2 Board Reset signals	CONT RESET_X_01	board X, 01 latched output reset
	CONT RESET_X_02	board X, 02 latched output reset
	...	...
	CONT RESET_X_08	board X, 08 latched output reset
Contact Outputs Type 1 & 2 Board Status	CONT OP_X_01	Contact output 1 Board X operation
	CONT OP_X_02	Contact output 2 Board X operation
	...	...
	CONT OP_X_8	Contact output 8 Board X operation
Board Status	BOARD X STATUS	Board X status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board
Switchgear status (16 elements)	SWITCH 1 A INPUT	Contact input type A to switchgear Function 1
	SWITCH 1 B INPUT	Contact input type B to switchgear Function 1
	SWITCH 2 A INPUT	Contact input type A to switchgear Function 2
	SWITCH 2 B INPUT	Contact input type B to switchgear Function 2
	...	...
	SWITCH 16 A INPUT	Contact input type A to switchgear Function 16
	SWITCH 16 B INPUT	Contact input type B to switchgear Function 16

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Switchgear outputs (16 elements)	SWITCH 1 A STATUS	Contact logic output type A from switchgear Function 1
	SWITCH 1 B STATUS	Contact logic output type B from switchgear Function 1
	SWITCH 2 A STATUS	Contact logic output type A from switchgear Function 2
	SWITCH 2 B STATUS	Contact logic output type B from switchgear Function 2
	...	...
	SWITCH 16 A STATUS	Contact logic output type A from switchgear Function 16
	SWITCH 16 B STATUS	Contact logic output type B from switchgear Function 16
Switchgear states (16 elements)	SWITCH 1 OPEN	switchgear 1 open
	SWITCH 1 CLOSED	switchgear 1 closed
	SWITCH 1 00_ERROR	Error 00 switchgear 1 (contact A = 0, contact B = 0)
	SWITCH 1 11_ERROR	Error 11 switchgear 1 (contact A = 1, contact B = 1)
	SWITCH 2 OPEN	Switchgear 2 open
	SWITCH 2 CLOSED	Switchgear 2 closed
	SWITCH 2 00_ERROR	Error 00 switchgear 2 (contact A = 0, contact B = 0)
	SWITCH 2 11_ERROR	Error 11 switchgear 2 (contact A = 1, contact B = 1)
	...	...
	SWITCH 16 OPEN	Switchgear 16 open
	SWITCH 16 CLOSED	Switchgear 16 closed
	SWITCH 16 00_ERROR	Error 00 switchgear 16 (contact A = 0, contact B = 0)
	SWITCH 16 11_ERROR	Error 11 switchgear 16 (contact A = 1, contact B = 1)
Switchgear Open-Close Initializing States	SWITCH 1 OPEN INIT	Switchgear 1 opening initiation
	SWITCH 1 CLOSE INIT	Switchgear 1 closing initiation
	SWITCH 2 OPEN INIT	Switchgear 2 opening initiation
	SWITCH 2 CLOSE INIT	Switchgear 2 closing initiation
	...	...
	SWITCH 16 OPEN INIT	Switchgear 16 opening initiation
	SWITCH 16 CLOSE INIT	Switchgear 16 closing initiation
Switchgear Fail States	SWGR 1 FAIL TO OPEN	Failure to open Switchgear 1
	SWGR 2 FAIL TO OPEN	Failure to open Switchgear 2
	...	...
	SWGR 16 FAIL TO OPEN	Failure to open Switchgear 16
	SWGR 1 FAIL TO CLOSE	Failure to close Switchgear 1
	SWGR 2 FAIL TO CLOSE	Failure to close Switchgear 2
	...	...
	SWGR 16 FAIL TO CLOSE	Failure to close Switchgear 16

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
LEDS HMI (16 Elements)	READY LED	Ready LED: (0-Red) Relay out of service, protection OUT OF ORDER (1-Green) Relay in service; protection READY
	LED 1	Programmable LED 1 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 2	Programmable LED 2 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 3	Programmable LED 3 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 4	Programmable LED 4 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 5	Programmable LED 5 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 6	Programmable LED 6 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 7	Programmable LED 7 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 8	Programmable LED 8 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 9	Programmable LED 9 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 10	Programmable LED 10 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 11	Programmable LED 11 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 12	Programmable LED 12 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 13	Programmable LED 13 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 14	Programmable LED 14 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 15	Programmable LED 15 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
LEDs reset input (programmable)	LED RESET INPUT	Programmable input for remote LED reset

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Programmable Keypad Status (HMI)	I Key	I key operation (Programmable signal via PLC)
	O Key	O key operation (Programmable signal via PLC)
	* Key	* key operation (Programmable signal via PLC)
	F1 Key	F1 key operation (Programmable signal via PLC)
	F2 Key	F2 key operation (Programmable signal via PLC)
LOCAL/REMOTE Operation status LEDs	LOCAL OPERATION MODE	Local/remote status for operations 1 = Local, 0 = Remote. Selectable through the front pushbutton (Hardware) and also through communications (software).
	OPERATIONS BLOCKED	Operations OFF status (1) Command execution block (operations blocked both in local and remote mode).Selectable through the front pushbutton (Hardware) and also through communications (software).
LOCAL/REMOTE/OFF Selection	CHANGE LOCAL-REMOTE	Changing local-remote status by communications
	CHANGE OP BLOCKED	Operations Block-Unblock signal
HMI Tab Order Selection (Swithgear selection status in HMI)	HMI Tab Order 01	HMI element 1 selection. 0 = Not selected, 1 =Selected. The selection is performed through the SEL front key. When the element 1 has it selection enabled, it can be commanded through the O and I front keys.
	HMI Tab Order 02	HMI element 2 selection. 0 = Not selected, 1 =Selected. The selection is performed through the SEL front key. When the element 2 has it selection enabled, it can be commanded through the O and I front keys.
	...	...
	HMI Tab Order 16	HMI element 16 selection. 0 = Not selected, 1 =Selected. The selection is performed through the SEL front key. When the element 16 has it selection enabled, it can be commanded through the O and I front keys.
HMI Backlight	HMI BACKLIGHT ON	"Switching on backlignt" signal (the display is switched on by communications
	HMI BACKLIGHT OFF	"Switching off backlignt" signal (the display is switched off by communications

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Oscillography States	OSC DIG CHANNEL 1	Oscillography Digital channel 1 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 2	Oscillography Digital channel 2 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 3	Oscillography Digital channel 3 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 4	Oscillography Digital channel 4 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 5	Oscillography Digital channel 5 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 6	Oscillography Digital channel 6 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 7	Oscillography Digital channel 7 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 8	Oscillography Digital channel 8 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 9	Oscillography Digital channel 9 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 10	Oscillography Digital channel 10: (1) Active ; (0) Not Active
	OSC DIG CHANNEL 11	Oscillography Digital channel 11 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 12	Oscillography Digital channel 12 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 13	Oscillography Digital channel 13 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 14	Oscillography Digital channel 14 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 15	Oscillography Digital channel 15 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 16	Oscillography Digital channel 16 : (1) Active ; (0) Not Active
	OSCILLO TRIGGER	Oscillo trigger activation (1) Active ; (0) Not active
Fault Report (Fault locator)	FAULT REPORT TRIGG	Fault report trigger (1) Active ; (0) Not active
	CLEAR FAULT REPORTS	Fault report removal from HMI and ModBus (volatile memory)
Energy Counters	FREEZE ENERGY CNT	Energy counter freeze
	UNFREEZE ENERGY CNT	Energy counter unfreeze
	RESET ENERGY CNT	Energy counter reset
Demand Inputs	DEMAND TRIGGER INP	Demand trigger (for Block interval algorithm)
	DEMAND RESET INP	Demand reset

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Setting Groups	GROUP 1 ACT ON	Group 1 activation, and deactivation of groups 2 & 3
	GROUP 2 ACT ON	Group 2 activation, and deactivation of groups 1 & 3
	GROUP 3 ACT ON	Group 3 activation, and deactivation of groups 1 & 2
	SETT GROUPS BLOCK	Group change input blocked
	GROUP 1 BLOCKED	Settings Group 1 blocked
	GROUP 2 BLOCKED	Settings Group 2 blocked
	GROUP 3 BLOCKED	Settings Group 3 blocked

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase IOC High	PH IOC1 HIGH A BLK	Phase instantaneous overcurrent element block Group 1 phase A
	PH IOC1 HIGH B BLK	Phase instantaneous overcurrent element block Group 1 phase B
	PH IOC1 HIGH C BLK	Phase instantaneous overcurrent element block Group 1 phase C
	PH IOC1 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase A
	PH IOC1 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase A
	PH IOC1 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase B
	PH IOC1 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase B
	PH IOC1 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase C
	PH IOC1 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase C
	PH IOC1 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 1 any phase
	PH IOC1 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 any phase
	PH IOC2 HIGH A BLK	Phase instantaneous overcurrent element block Group 2 phase A
	PH IOC2 HIGH B BLK	Phase instantaneous overcurrent element block Group 2 phase B
	PH IOC2 HIGH C BLK	Phase instantaneous overcurrent element block Group 2 phase C
	PH IOC2 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase A
	PH IOC2 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase A
	PH IOC2 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase B
	PH IOC2 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase B
	PH IOC2 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase C
	PH IOC2 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase C
	PH IOC2 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 2 any phase
	PH IOC2 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 any phase
	PH IOC3 HIGH A BLK	Phase instantaneous overcurrent element block Group 3 phase A
	PH IOC3 HIGH B BLK	Phase instantaneous overcurrent element block Group 3 phase B

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase IOC High	PH IOC3 HIGH C BLK	Phase instantaneous overcurrent element block Group 3 phase C
	PH IOC3 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase A
	PH IOC3 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase A
	PH IOC3 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase B
	PH IOC3 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase B
	PH IOC3 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase C
	PH IOC3 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase C
	PH IOC3 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 3 any phase
	PH IOC3 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 any phase

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase IOC Low	PH IOC1 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 1 phase A
	PH IOC1 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 1 phase B
	PH IOC1 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 1 phase C
	PH IOC1 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase A
	PH IOC1 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase A
	PH IOC1 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase B
	PH IOC1 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase B
	PH IOC1 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase C
	PH IOC1 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase C
	PH IOC1 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 1 any phase
	PH IOC1 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 any phase
	PH IOC2 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 2 phase A
	PH IOC2 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 2 phase B
	PH IOC2 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 2 phase C
	PH IOC2 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase A
	PH IOC2 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase A
	PH IOC2 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase B
	PH IOC2 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase B
	PH IOC2 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase C
	PH IOC2 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase C
	PH IOC2 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 2 any phase
	PH IOC2 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 any phase
	PH IOC3 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 3 phase A

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase IOC Low	PH IOC3 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 3 phase B
	PH IOC3 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 3 phase C
	PH IOC3 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase A
	PH IOC3 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase A
	PH IOC3 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase B
	PH IOC3 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase B
	PH IOC3 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase C
	PH IOC3 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase C
	PH IOC3 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 3 any phase
	PH IOC3 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 any phase
Neutral IOC	NEUTRAL IOC1 BLOCK	Neutral instantaneous overcurrent element block Group 1
	NEUTRAL IOC1 PKP	Neutral instantaneous overcurrent element pickup Group 1
	NEUTRAL IOC1 OP	Neutral instantaneous overcurrent element operation (trip) Group 1
	NEUTRAL IOC2 BLOCK	Neutral instantaneous overcurrent element block Group 2
	NEUTRAL IOC2 PKP	Neutral instantaneous overcurrent element pickup Group 2
	NEUTRAL IOC2 OP	Neutral instantaneous overcurrent element operation (trip) Group 2
	NEUTRAL IOC3 BLOCK	Neutral instantaneous overcurrent element block Group 3
	NEUTRAL IOC3 PKP	Neutral instantaneous overcurrent element pickup Group 3
	NEUTRAL IOC3 OP	Neutral instantaneous overcurrent element operation (trip) Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Ground IOC	GROUND IOC1 BLOCK	Ground instantaneous overcurrent element block Group 1
	GROUND IOC1 PKP	Ground instantaneous overcurrent element pickup Group 1
	GROUND IOC1 OP	Ground instantaneous overcurrent element operation (trip) Group 1
	GROUND IOC2 BLOCK	Ground instantaneous overcurrent element block Group 2
	GROUND IOC2 PKP	Ground instantaneous overcurrent element pickup Group 2
	GROUND IOC2 OP	Ground instantaneous overcurrent element operation (trip) Group 2
	GROUND IOC3 BLOCK	Ground instantaneous overcurrent element block Group 3
	GROUND IOC3 PKP	Ground instantaneous overcurrent element pickup Group 3
	GROUND IOC3 OP	Ground instantaneous overcurrent element operation (trip) Group 3
Sensitive Ground IOC	SENS GND IOC1 BLK	Sensitive ground instantaneous overcurrent element block Group 1
	SENS GND IOC1 PKP	Sensitive ground instantaneous overcurrent element pickup Group 1
	SENS GND IOC1 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 1
	SENS GND IOC2 BLK	Sensitive ground instantaneous overcurrent element block Group 2
	SENS GND IOC2 PKP	Sensitive ground instantaneous overcurrent element pickup Group 2
	SENS GND IOC2 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 2
	SENS GND IOC3 BLK	Sensitive ground instantaneous overcurrent element block Group 3
	SENS GND IOC3 PKP	Sensitive ground instantaneous overcurrent element pickup Group 3
	SENS GND IOC3 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 3

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Isolated Ground	ISOLATED GND1 BLK	Isolated ground instantaneous overcurrent element block Group 1
	ISOLATED GND1 PKP	Isolated ground instantaneous overcurrent element pickup Group 1
	ISOLATED GND1 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 1
	ISOLATED GND2 BLK	Isolated ground instantaneous overcurrent element block Group 2
	ISOLATED GND2 PKP	Isolated ground instantaneous overcurrent element pickup Group 2
	ISOLATED GND2 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 2
	ISOLATED GND3 BLK	Isolated ground instantaneous overcurrent element block Group 3
	ISOLATED GND3 PKP	Isolated ground instantaneous overcurrent element pickup Group 3
	ISOLATED GND3 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase TOC High	PH TOC1 HIGH A BLK	Phase timed overcurrent element block Group 1 phase A
	PH TOC1 HIGH B BLK	Phase timed overcurrent element block Group 1 phase B
	PH TOC1 HIGH C BLK	Phase timed overcurrent element block Group 1 phase C
	PH TOC1 HIGH A PKP	Phase timed overcurrent element pickup Group 1 phase A
	PH TOC1 HIGH A OP	Phase timed overcurrent element operation (trip) Group 1 phase A
	PH TOC1 HIGH B PKP	Phase timed overcurrent element pickup Group 1 phase B
	PH TOC1 HIGH B OP	Phase timed overcurrent element operation (trip) Group 1 phase B
	PH TOC1 HIGH C PKP	Phase timed overcurrent element pickup Group 1 phase C
	PH TOC1 HIGH C OP	Phase timed overcurrent element operation (trip) Group 1 phase C
	PH TOC1 HIGH PKP	Phase timed overcurrent element pickup Group 1 any phase
	PH TOC1 HIGH OP	Phase timed overcurrent element operation (trip) Group 1 any phase
	PH TOC2 HIGH A BLK	Phase timed overcurrent element block Group 2 phase A
	PH TOC2 HIGH B BLK	Phase timed overcurrent element block Group 2 phase B
	PH TOC2 HIGH C BLK	Phase timed overcurrent element block Group 2 phase C
	PH TOC2 HIGH A PKP	Phase timed overcurrent element pickup Group 2 phase A
	PH TOC2 HIGH A OP	Phase timed overcurrent element operation (trip) Group 2 phase A
	PH TOC2 HIGH B PKP	Phase timed overcurrent element pickup Group 2 phase B
	PH TOC2 HIGH B OP	Phase timed overcurrent element operation (trip) Group 2 phase B
	PH TOC2 HIGH C PKP	Phase timed overcurrent element pickup Group 2 phase C
	PH TOC2 HIGH C OP	Phase timed overcurrent element operation (trip) Group 2 phase C
	PH TOC2 HIGH PKP	Phase timed overcurrent element pickup Group 2 any phase
	PH TOC2 HIGH OP	Phase timed overcurrent element operation (trip) Group 2 any phase
	PH TOC3 HIGH A BLK	Phase timed overcurrent element block Group 3 phase A
	PH TOC3 HIGH B BLK	Phase timed overcurrent element block Group 3 phase B
	PH TOC3 HIGH C BLK	Phase timed overcurrent element block Group 3 phase C

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase TOC High	PH TOC3 HIGH A PKP	Phase timed overcurrent element pickup Group 3 phase A
	PH TOC3 HIGH A OP	Phase timed overcurrent element operation (trip) Group 3 phase A
	PH TOC3 HIGH B PKP	Phase timed overcurrent element pickup Group 3 phase B
	PH TOC3 HIGH B OP	Phase timed overcurrent element operation (trip) Group 3 phase B
	PH TOC3 HIGH C PKP	Phase timed overcurrent element pickup Group 3 phase C
	PH TOC3 HIGH C OP	Phase timed overcurrent element operation (trip) Group 3 phase C
	PH TOC3 HIGH PKP	Phase timed overcurrent element pickup Group 3 any phase
	PH TOC3 HIGH OP	Phase timed overcurrent element operation (trip) Group 3 any phase
Phase TOC Low	PH TOC1 LOW A BLK	Phase timed overcurrent element block Low level Group 1 phase A
	PH TOC1 LOW B BLK	Phase timed overcurrent element block Low level Group 1 phase B
	PH TOC1 LOW C BLK	Phase timed overcurrent element block Low level Group 1 phase C
	PH TOC1 LOW A PKP	Phase timed overcurrent element pickup low level Group 1 phase A
	PH TOC1 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 1 phase A
	PH TOC1 LOW B PKP	Phase timed overcurrent element pickup low level Group 1 phase B
	PH TOC1 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 1 phase B
	PH TOC1 LOW C PKP	Phase timed overcurrent element pickup low level Group 1 phase C
	PH TOC1 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 1 phase C
	PH TOC1 LOW PKP	Phase timed overcurrent element pickup low level Group 1 any phase
	PH TOC1 LOW OP	Phase timed overcurrent element operation (trip) low level Group 1 any phase
	PH TOC2 LOW A BLK	Phase timed overcurrent element block Low level Group 2 phase A
	PH TOC2 LOW B BLK	Phase timed overcurrent element block Low level Group 2 phase B
	PH TOC2 LOW C BLK	Phase timed overcurrent element block Low level Group 2 phase C
	PH TOC2 LOW A PKP	Phase timed overcurrent element pickup low level Group 2 phase A
	PH TOC2 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 2 phase A
	PH TOC2 LOW B PKP	Phase timed overcurrent element pickup low level Group 2 phase B

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase TOC Low	PH TOC2 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 2 phase B
	PH TOC2 LOW C PKP	Phase timed overcurrent element pickup low level Group 2 phase C
	PH TOC2 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 2 phase C
	PH TOC2 LOW PKP	Phase timed overcurrent element pickup low level Group 2 any phase
	PH TOC2 LOW OP	Phase timed overcurrent element operation (trip) low level Group 2 any phase
	PH TOC3 LOW A BLK	Phase timed overcurrent element block Low level Group 3 phase A
	PH TOC3 LOW B BLK	Phase timed overcurrent element block Low level Group 3 phase B
	PH TOC3 LOW C BLK	Phase timed overcurrent element block Low level Group 3 phase C
	PH TOC3 LOW A PKP	Phase timed overcurrent element pickup low level Group 3 phase A
	PH TOC3 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 3 phase A
	PH TOC3 LOW B PKP	Phase timed overcurrent element pickup low level Group 3 phase B
	PH TOC3 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 3 phase B
	PH TOC3 LOW C PKP	Phase timed overcurrent element pickup low level Group 3 phase C
	PH TOC3 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 3 phase C
	PH TOC3 LOW PKP	Phase timed overcurrent element pickup low level Group 3 any phase
	PH TOC3 LOW OP	Phase timed overcurrent element operation (trip) low level Group 3 any phase
Neutral TOC	NEUTRAL TOC1 BLOCK	Neutral timed overcurrent element block Group 1
	NEUTRAL TOC1 PKP	Neutral timed overcurrent element pickup Group 1
	NEUTRAL TOC1 OP	Neutral timed overcurrent element operation (trip) Group 1
	NEUTRAL TOC2 BLOCK	Neutral timed overcurrent element block Group 2
	NEUTRAL TOC2 PKP	Neutral timed overcurrent element pickup Group 2
	NEUTRAL TOC2 OP	Neutral timed overcurrent element operation (trip) Group 2
	NEUTRAL TOC3 BLOCK	Neutral timed overcurrent element block Group 3
	NEUTRAL TOC3 PKP	Neutral timed overcurrent element pickup Group 3
	NEUTRAL TOC3 OP	Neutral timed overcurrent element operation (trip) Group 3

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Ground TOC	GROUND TOC1 BLOCK	Ground timed overcurrent element block Group 1
	GROUND TOC1 PKP	Ground timed overcurrent element pickup Group 1
	GROUND TOC1 OP	Ground timed overcurrent element operation (trip) Group 1
	GROUND TOC2 BLOCK	Ground timed overcurrent element block Group 2
	GROUND TOC2 PKP	Ground timed overcurrent element pickup Group 2
	GROUND TOC2 OP	Ground timed overcurrent element operation (trip) Group 2
	GROUND TOC3 BLOCK	Ground timed overcurrent element block Group 3
	GROUND TOC3 PKP	Ground timed overcurrent element pickup Group 3
	GROUND TOC3 OP	Ground timed overcurrent element operation (trip) Group 3
Sensitive Ground TOC	SENS GND TOC1 BLOCK	Sensitive ground timed overcurrent element block Group 1
	SENS GND TOC1 PKP	Sensitive ground timed overcurrent element pickup Group 1
	SENS GND TOC1 OP	Sensitive ground timed overcurrent element operation (trip) Group 1
	SENS GND TOC2 BLOCK	Sensitive ground timed overcurrent element block Group 2
	SENS GND TOC2 PKP	Sensitive ground timed overcurrent element pickup Group 2
	SENS GND TOC2 OP	Sensitive ground timed overcurrent element operation (trip) Group 2
	SENS GND TOC3 BLOCK	Sensitive ground timed overcurrent element block Group 3
	SENS GND TOC3 PKP	Sensitive ground timed overcurrent element pickup Group 3
	SENS GND TOC3 OP	Sensitive ground timed overcurrent element operation (trip) Group 3
Negative Sequence TOC	NEG SEQ TOC1 BLOCK	Negative sequence timed overcurrent element block Group 1
	NEG SEQ TOC1 PKP	Negative sequence timed overcurrent element pickup Group 1
	NEG SEQ TOC1 OP	Negative sequence timed overcurrent element operation Group 1
	NEG SEQ TOC2 BLOCK	Negative sequence timed overcurrent element block Group 2
	NEG SEQ TOC2 PKP	Negative sequence timed overcurrent element pickup Group 2
	NEG SEQ TOC2 OP	Negative sequence timed overcurrent element operation Group 2
	NEG SEQ TOC3 BLOCK	Negative sequence timed overcurrent element block Group 3
	NEG SEQ TOC3 PKP	Negative sequence timed overcurrent element pickup Group 3
	NEG SEQ TOC3 OP	Negative sequence timed overcurrent element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Thermal Image	THERMAL1 BLOCK	Thermal image block Group 1
	THERMAL1 A RST	Thermal image phase A Group 1 element reset
	THERMAL1 B RST	Thermal image phase B Group 1 element reset
	THERMAL1 C RST	Thermal image phase C Group 1 element reset
	THERMAL1 ALARM	Thermal image element alarm any phase Group 1
	THERMAL1 OP	Thermal image element operation any phase Group 1
	THERMAL1 A ALRM	Thermal image element alarm phase A Group 1
	THERMAL1 A OP	Thermal image element operation phase A Group 1
	THERMAL1 B ALRM	Thermal image element alarm phase B Group 1
	THERMAL1 B OP	Thermal image element operation phase B Group 1
	THERMAL1 C ALRM	Thermal image element alarm phase C Group 1
	THERMAL1 C OP	Thermal image element operation phase C Group 1
	THERMAL2 BLOCK	Thermal image block Group 2
	THERMAL2 A RST	Thermal image phase A Group 2 element reset
	THERMAL2 B RST	Thermal image phase B Group 2 element reset
	THERMAL2 C RST	Thermal image phase C Group 2 element reset
	THERMAL2 ALARM	Thermal image element alarm any phase Group 2
	THERMAL2 OP	Thermal image element operation any phase Group 2
	THERMAL2 A ALRM	Thermal image element alarm phase A Group 2
	THERMAL2 A OP	Thermal image element operation phase A Group 2
	THERMAL2 B ALRM	Thermal image element alarm phase B Group 2
	THERMAL2 B OP	Thermal image element operation phase B Group 2
	THERMAL2 C ALRM	Thermal image element alarm phase C Group 2
	THERMAL2 C OP	Thermal image element operation phase C Group 2
	THERMAL3 BLOCK	Thermal image block Group 3
	THERMAL3 A RST	Thermal image phase A Group 3 element reset
	THERMAL3 B RST	Thermal image phase B Group 3 element reset
	THERMAL3 C RST	Thermal image phase C Group 3 element reset
	THERMAL3 ALARM	Thermal image element alarm any phase Group 3
	THERMAL3 OP	Thermal image element operation any phase Group 3
	THERMAL3 A ALRM	Thermal image element alarm phase A Group 3
	THERMAL3 A OP	Thermal image element operation phase A Group 3
	THERMAL3 B ALRM	Thermal image element alarm phase B Group 3
	THERMAL3 B OP	Thermal image element operation phase B Group 3
	THERMAL3 C ALRM	Thermal image element alarm phase C Group 3
	THERMAL3 C OP	Thermal image element operation phase C Group 3

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase Directional	PHASE DIR1 BLK INP	Phase directional block Group 1
	PHASE DIR1 BLOCK A	Phase directional element block Group 1 Phase A
	PHASE DIR1 A OP	Phase directional element operation Group 1 Phase A
	PHASE DIR1 BLOCK B	Phase directional element block Group 1 Phase B
	PHASE DIR1 B OP	Phase directional element operation Group 1 Phase B
	PHASE DIR1 BLOCK C	Phase directional element block Group 1 Phase C
	PHASE DIR1 C OP	Phase directional element operation Group 1 Phase C
	PHASE DIR2 BLK INP	Phase directional block Group 2
	PHASE DIR2 BLOCK A	Phase directional element block Group 2 Phase A
	PHASE DIR2 A OP	Phase directional element operation Group 2 Phase A
	PHASE DIR2 BLOCK B	Phase directional element block Group 2 Phase B
	PHASE DIR2 B OP	Phase directional element operation Group 2 Phase B
	PHASE DIR2 BLOCK C	Phase directional element block Group 2 Phase C
	PHASE DIR2 C OP	Phase directional element operation Group 2 Phase C
	PHASE DIR3 BLK INP	Phase directional block Group 3
	PHASE DIR3 BLOCK A	Phase directional element block Group 3 Phase A
	PHASE DIR3 A OP	Phase directional element operation Group 3 Phase A
	PHASE DIR3 BLOCK B	Phase directional element block Group 3 Phase B
	PHASE DIR3 B OP	Phase directional element operation Group 3 Phase B
	PHASE DIR3 BLOCK C	Phase directional element block Group 3 Phase C
	PHASE DIR3 C OP	Phase directional element operation Group 3 Phase C
Neutral Directional	NEUTRAL DIR1 BLK INP	Neutral directional element block input signal Group 1
	NEUTRAL DIR1 BLOCK	Neutral directional element blocked Group 1
	NEUTRAL DIR1 OP	Neutral directional element operation Group 1
	NEUTRAL DIR2 BLK INP	Neutral directional element block input signal Group 2
	NEUTRAL DIR2 BLOCK	Neutral directional element blocked Group 2
	NEUTRAL DIR2 OP	Neutral directional element operation Group 2
	NEUTRAL DIR3 BLK INP	Neutral directional element block input signal Group 3
	NEUTRAL DIR3 BLOCK	Neutral directional element blocked Group 3
	NEUTRAL DIR3 OP	Neutral directional element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Ground Directional	GROUND DIR1 BLK INP	Ground directional element block input signal Group 1
	GROUND DIR1 BLOCK	Ground directional element blocked Group 1
	GROUND DIR1 OP	Ground directional element operation Group 1
	GROUND DIR2 BLK INP	Ground directional element block input signal Group 2
	GROUND DIR2 BLOCK	Ground directional element blocked Group 2
	GROUND DIR2 OP	Ground directional element operation Group 2
	GROUND DIR3 BLK INP	Ground directional element block input signal Group 3
	GROUND DIR3 BLOCK	Ground directional element blocked Group 3
	GROUND DIR3 OP	Ground directional element operation Group 3
Sensitive Ground Directional	SENS GND DIR1 BLK IP	Sensitive ground directional element block input Group 1
	SENS GND DIR1 BLOCK	Sensitive Ground directional element block Group 1
	SENS GND DIR1 OP	Sensitive Ground directional element operation Group 1
	SENS GND DIR2 BLK IP	Sensitive ground directional element block input Group 2
	SENS GND DIR2 BLOCK	Sensitive Ground directional element block Group 2
	SENS GND DIR2 OP	Sensitive Ground directional element operation Group 2
	SENS GND DIR3 BLK IP	Sensitive ground directional element block input Group 3
	SENS GND DIR3 BLOCK	Sensitive Ground directional element block Group 3
	SENS GND DIR3 OP	Sensitive Ground directional element operation Group 3
Fuse failure	VT FUSE FAILURE	Fuse failure operation
Phase UV	PHASE UV1 BLOCK	Phase undervoltage element block Group 1
	PHASE UV1 A PKP	Undervoltage element pickup AG Group 1
	PHASE UV1 A OP	Undervoltage element operation AG Group 1
	PHASE UV1 B PKP	Undervoltage element pickup BG Group 1
	PHASE UV1 B OP	Undervoltage element operation BG Group 1
	PHASE UV1 C PKP	Undervoltage element pickup CG Group 1
	PHASE UV1 C OP	Undervoltage element operation CG Group 1
	PHASE UV1 AB PKP	Undervoltage element pickup AB Group 1
	PHASE UV1 AB OP	Undervoltage element operation AB Group 1
	PHASE UV1 BC PKP	Undervoltage element pickup BC Group 1
	PHASE UV1 BC OP	Undervoltage element operation BC Group 1
	PHASE UV1 CA PKP	Undervoltage element pickup CA Group 1

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase UV	PHASE UV1 CA OP	Undervoltage element operation CA Group 1
	PHASE UV1 PKP	Pickup of any of the above mentioned elements
	PHASE UV1 OP	Operation of any of the above mentioned elements
	PHASE UV2 BLOCK	Phase undervoltage element block Group 2
	PHASE UV2 A PKP	Undervoltage element pickup AG Group 2
	PHASE UV2 A OP	Undervoltage element operation AG Group 2
	PHASE UV2 B PKP	Undervoltage element pickup BG Group 2
	PHASE UV2 B OP	Undervoltage element operation BG Group 2
	PHASE UV2 C PKP	Undervoltage element pickup CG Group 2
	PHASE UV2 C OP	Undervoltage element operation CG Group 2
	PHASE UV2 AB PKP	Undervoltage element pickup AB Group 2
	PHASE UV2 AB OP	Undervoltage element operation AB Group 2
	PHASE UV2 BC PKP	Undervoltage element pickup BC Group 2
	PHASE UV2 BC OP	Undervoltage element operation BC Group 2
	PHASE UV2 CA PKP	Undervoltage element pickup CA Group 2
	PHASE UV2 CA OP	Undervoltage element operation CA Group 2
	PHASE UV2 PKP	Pickup of any of the above mentioned elements
	PHASE UV2 OP	Operation of any of the above mentioned elements
	PHASE UV3 BLOCK	Phase undervoltage element block Group 3
	PHASE UV3 A PKP	Undervoltage element pickup AG Group 3
	PHASE UV3 A OP	Undervoltage element operation AG Group 3
	PHASE UV3 B PKP	Undervoltage element pickup BG Group 3
	PHASE UV3 B OP	Undervoltage element operation BG Group 3
	PHASE UV3 C PKP	Undervoltage element pickup CG Group 3
	PHASE UV3 C OP	Undervoltage element operation CG Group 3
	PHASE UV3 AB PKP	Undervoltage element pickup AB Group 3
	PHASE UV3 AB OP	Undervoltage element operation AB Group 3
	PHASE UV3 BC PKP	Undervoltage element pickup BC Group 3
	PHASE UV3 BC OP	Undervoltage element operation BC Group 3
	PHASE UV3 CA PKP	Undervoltage element pickup CA Group 3
	PHASE UV3 CA OP	Undervoltage element operation CA Group 3
	PHASE UV3 PKP	Pickup of any of the above mentioned elements
	PHASE UV3 OP	Operation of any of the above mentioned elements

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Phase OV	PHASE OV1 BLOCK	Phase overvoltage element block Group 1
	PHASE OV1 AB PKP	Overvoltage element pickup AB Group 1
	PHASE OV1 AB OP	Overvoltage element operation AB Group 1
	PHASE OV1 BC PKP	Overvoltage element pickup BC Group 1
	PHASE OV1 BC OP	Overvoltage element operation BC Group 1
	PHASE OV1 CA PKP	Overvoltage element pickup CA Group 1
	PHASE OV1 CA OP	Overvoltage element operation CA Group 1
	PHASE OV1 PKP	Pickup of any of the above mentioned elements
	PHASE OV1 OP	Operation of any of the above mentioned elements
	PHASE OV2 BLOCK	Phase overvoltage element block Group 2
	PHASE OV2 AB PKP	Overvoltage element pickup AB Group 2
	PHASE OV2 AB OP	Overvoltage element operation AB Group 2
	PHASE OV2 BC PKP	Overvoltage element pickup BC Group 2
	PHASE OV2 BC OP	Overvoltage element operation BC Group 2
	PHASE OV2 CA PKP	Overvoltage element pickup CA Group 2
	PHASE OV2 CA OP	Overvoltage element operation CA Group 2
	PHASE OV2 PKP	Pickup of any of the above mentioned elements
	PHASE OV2 OP	Operation of any of the above mentioned elements
	PHASE OV3 BLOCK	Phase overvoltage element block Group 3
	PHASE OV3 AB PKP	Overvoltage element pickup AB Group 3
	PHASE OV3 AB OP	Overvoltage element operation AB Group 3
	PHASE OV3 BC PKP	Overvoltage element pickup BC Group 3
	PHASE OV3 BC OP	Overvoltage element operation BC Group 3
	PHASE OV3 CA PKP	Overvoltage element pickup CA Group 3
	PHASE OV3 CA OP	Overvoltage element operation CA Group 3
	PHASE OV3 PKP	Pickup of any of the above mentioned elements
	PHASE OV3 OP	Operation of any of the above mentioned elements

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Neutral OV High	NEUTRAL OV1 HIGH BLK	Neutral overvoltage element block high level Group 1
	NEUTRAL OV1 HIGH PKP	Neutral overvoltage element pickup high level Group 1
	NEUTRAL OV1 HIGH OP	Neutral overvoltage element operation high level Group 1
	NEUTRAL OV2 HIGH BLK	Neutral overvoltage element block high level Group 2
	NEUTRAL OV2 HIGH PKP	Neutral overvoltage element pickup high level Group 2
	NEUTRAL OV2 HIGH OP	Neutral overvoltage element operation high level Group 2
	NEUTRAL OV3 HIGH BLK	Neutral overvoltage element block high level Group 3
	NEUTRAL OV3 HIGH PKP	Neutral overvoltage element pickup high level Group 3
	NEUTRAL OV3 HIGH OP	Neutral overvoltage element operation high level Group 3
Neutral OV Low	NEUTRAL OV1 LOW BLK	Neutral overvoltage element block low level Group 1
	NEUTRAL OV1 LOW PKP	Neutral overvoltage element pickup low level Group 1
	NEUTRAL OV1 LOW OP	Neutral overvoltage element operation low level Group 1
	NEUTRAL OV2 LOW BLK	Neutral overvoltage element block low level Group 2
	NEUTRAL OV2 LOW PKP	Neutral overvoltage element pickup low level Group 2
	NEUTRAL OV2 LOW OP	Neutral overvoltage element operation low level Group 2
	NEUTRAL OV3 LOW BLK	Neutral overvoltage element block low level Group 3
	NEUTRAL OV3 LOW PKP	Neutral overvoltage element pickup low level Group 3
	NEUTRAL OV3 LOW OP	Neutral overvoltage element operation low level Group 3
Auxiliary UV	AUXILIARY UV1 BLOCK	Auxiliary undervoltage element block Group 1
	AUXILIARY UV1 PKP	Auxiliary undervoltage element pickup Group 1
	AUXILIARY UV1 OP	Auxiliary undervoltage element operation Group 1
	AUXILIARY UV2 BLOCK	Auxiliary undervoltage element block Group 2
	AUXILIARY UV2 PKP	Auxiliary undervoltage element pickup Group 2
	AUXILIARY UV2 OP	Auxiliary undervoltage element operation Group 2
	AUXILIARY UV3 BLOCK	Auxiliary undervoltage element block Group 3
	AUXILIARY UV3 PKP	Auxiliary undervoltage element pickup Group 3
	AUXILIARY UV3 OP	Auxiliary undervoltage element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Auxiliary OV	AUXILIARY OV1 BLOCK	Auxiliary overvoltage element block Group 1
	AUXILIARY OV1 PKP	Auxiliary Overvoltage element pickup Group 1
	AUXILIARY OV1 OP	Auxiliary overvoltage element operation Group 1
	AUXILIARY OV2 BLOCK	Auxiliary overvoltage element block Group 2
	AUXILIARY OV2 PKP	Auxiliary Overvoltage element pickup Group 2
	AUXILIARY OV2 OP	Auxiliary overvoltage element operation Group 2
	AUXILIARY OV3 BLOCK	Auxiliary overvoltage element block Group 3
	AUXILIARY OV3 PKP	Auxiliary Overvoltage element pickup Group 3
	AUXILIARY OV3 OP	Auxiliary overvoltage element operation Group 3
Negative Sequence OV	NEG SEQ OV1 BLOCK	Negative sequence overvoltage element block Group 1
	NEG SEQ OV1 PKP	Negative sequence overvoltage element pickup Group 1
	NEG SEQ OV1 OP	Negative sequence overvoltage element operation Group 1
	NEG SEQ OV2 BLOCK	Negative sequence overvoltage element block Group 2
	NEG SEQ OV2 PKP	Negative sequence overvoltage element pickup Group 2
	NEG SEQ OV2 OP	Negative sequence overvoltage element operation Group 2
	NEG SEQ OV3 BLOCK	Negative sequence overvoltage element block Group 3
	NEG SEQ OV3 PKP	Negative sequence overvoltage element pickup Group 3
	NEG SEQ OV3 OP	Negative sequence overvoltage element operation Group 3
Overfrequency	OVERFREQ1 BLOCK	Overfrequency element block Group 1
	OVERFREQ1 PKP	Overfrequency element pickup Group 1
	OVERFREQ1 OP	Overfrequency element operation Group 1
	OVERFREQ2 BLOCK	Overfrequency element block Group 2
	OVERFREQ2 PKP	Overfrequency element pickup Group 2
	OVERFREQ2 OP	Overfrequency element operation Group 2
	OVERFREQ3 BLOCK	Overfrequency element block Group 3
	OVERFREQ3 PKP	Overfrequency element pickup Group 3
	OVERFREQ3 OP	Overfrequency element operation Group 3

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Underfrequency	UNDERFREQ1 BLOCK	Underfrequency element block Group 1
	UNDERFREQ1 PKP	Underfrequency element pickup Group 1
	UNDERFREQ1 OP	Underfrequency element operation Group 1
	UNDERFREQ2 BLOCK	Underfrequency element block Group 2
	UNDERFREQ2 PKP	Underfrequency element pickup Group 2
	UNDERFREQ2 OP	Underfrequency element operation Group 2
	UNDERFREQ3 BLOCK	Underfrequency element block Group 3
	UNDERFREQ3 PKP	Underfrequency element pickup Group 3
	UNDERFREQ3 OP	Underfrequency element operation Group 3
Frequency rate of change	FREQ RATE1 BLOCK	Frequency rate of change element block Group 1
	FREQ RATE1 PKP	Frequency rate of change element pickup Group 1
	FREQ RATE1 OP	Frequency rate of change element operation Group 1
	FREQ RATE2 BLOCK	Frequency rate of change element block Group 2
	FREQ RATE2 PKP	Frequency rate of change element pickup Group 2
	FREQ RATE2 OP	Frequency rate of change element operation Group 2
	FREQ RATE3 BLOCK	Frequency rate of change element block Group 3
	FREQ RATE3 PKP	Frequency rate of change element pickup Group 3
	FREQ RATE3 OP	Frequency rate of change element operation Group 3
Broken Conductor	BROKEN CONDUCT1 BLK	Broken conductor block Group 1
	BROKEN CONDUCT1 PKP	Broken conductor element Pickup Group 1
	BROKEN CONDUCT1 OP	Broken conductor element operation Group 1
	BROKEN CONDUCT2 BLK	Broken conductor block Group 2
	BROKEN CONDUCT2 PKP	Broken conductor element Pickup Group 2
	BROKEN CONDUCT2 OP	Broken conductor element operation Group 2
	BROKEN CONDUCT3 BLK	Broken conductor block Group 3
	BROKEN CONDUCT3 PKP	Broken conductor element Pickup Group 3
	BROKEN CONDUCT3 OP	Broken conductor element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Forward Power (32FP)	FWD PWR1 BLOCK	Forward power element block Group 1
	FWD PWR1 STG1 PKP	Forward Power element pickup level 1 Group 1
	FWD PWR1 STG1 OP	Forward Power element operation level 1 Group 1
	FWD PWR1 STG2 PKP	Forward Power element pickup level 2 Group 1
	FWD PWR1 STG2 OP	Forward Power element operation level 2 Group 1
	FWD PWR2 BLOCK	Forward power element block Group 2
	FWD PWR2 STG1 PKP	Forward Power element pickup level 1 Group 2
	FWD PWR2 STG1 OP	Forward Power element operation level 1 Group 2
	FWD PWR2 STG2 PKP	Forward Power element pickup level 2 Group 2
	FWD PWR2 STG2 OP	Forward Power element operation level 2 Group 2
	FWD PWR3 BLOCK	Forward power element block Group 3
	FWD PWR3 STG1 PKP	Forward Power element pickup level 1 Group 3
	FWD PWR3 STG1 OP	Forward Power element operation level 1 Group 3
	FWD PWR3 STG2 PKP	Forward Power element pickup level 2 Group 3
	FWD PWR3 STG2 OP	Forward Power element operation level 2 Group 3
Breaker Maintenance	KI2t PHASE A ALARM	$K \cdot I^2t$ phase A Alarm
	KI2t PHASE B ALARM	$K \cdot I^2t$ phase B Alarm
	KI2t PHASE C ALARM	$K \cdot I^2t$ phase C Alarm
	BKR OPENINGS ALARM	Maximum Breaker openings alarm
	BKR OPEN 1 HOUR ALRM	Maximum Breaker openings in one hour alarm
	RESET KI2t COUNTERS	KI^2t Breaker ageing counter reset
	RESET BKR COUNTERS	Breaker openings and closings counters reset
Breaker Status	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
Breaker Failure	BKR FAIL INITIATE	Breaker failure initiation
	BKR FAIL NO CURRENT	Breaker failure without current
	BKR FAIL SUPERVISION	Breaker failure 1st level (supervision – retrip)
	BKR FAIL HISET	Breaker failure 2nd level (high level)
	BKR FAIL LOWSET	Breaker failure 3rd level (low level)
	INTERNAL ARC	Internal arc
	BKR FAIL 2nd STEP	Breaker failure second step

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Synchrocheck	Synchrocheck BLK INP	Synchronism element block
	Synchrocheck OP	Synchronsim condition (Dv, Dj and Df are within the set range)
	SYNCHK CLOSE PERM	Closing permission for the synchronism element: (SYNCHK OP) OR (SYNCHK CON OP)
	Synchrocheck COND OP	Active if when it is set, any of the three following conditions is met:
	DL-DB OPERATION	Dead line – dead bus condition
	DL-LB OPERATION	Dead line – live bus condition
	LL-DB OPERATION	Live line – dead bus condition
	SLIP CONDITION	Slip conditions are met
	BUS FREQ > LINE FREQ	Bus Frequency higher than line frequency
	BUS FREQ < LINE FREQ	Bus Frequency lower than line frequency
Autorecloser	AR LEVEL BLOCK	Recloser element block by level
	AR PULSE BLOCK	Recloser element block by pulse
	AR PULSE UNBLOCK	Recloser element unblock by pulse
	AR INITIATE	Reclose initiate
	AR CONDS INPUT	Reclose permission condition in input to Function 1 = there are conditions
	AR CLOSE BREAKER	Closing permission for the recloser
	AR OUT OF SERVICE	Recloser out of service
	AR READY	Recloser READY
	AR LOCKOUT	Recloser in LOCKOUT
	AR BLOCK	Recloser BLOCKed
	AR RCL IN PROGRESS	Recloser – Cycle in progress
	AR LCK BY ANOMALY	Recloser – LOCKOUT by anomaly (reclosing command during cycle in progress)
	AR LCK BY FAIL OPEN	Recloser – LOCKOUT by failure to open
	AR LCK BY FAIL CLOSE	Recloser – LOCKOUT by failure to close
	AR LCK BY USER	Recloser – LOCKOUT by external operation (e.g.: manual opening with cycle in progress)
	AR LCK BY CONDS	Recloser – LOCKOUT by lack of reclosing conditions
	AR LCK BY TRIPS	Recloser – LOCKOUT by number of trips
	AR LCK BY SHOTS	Recloser – LOCKOUT by number of shots
	AR BLK AFTER 1 SHOT	Recloser – Block after first shot
	AR BLK AFTER 2 SHOT	Recloser – Block after second shot
	AR BLK AFTER 3 SHOT	Recloser – Block after third shot
	AR BLK AFTER 4 SHOT	Recloser – Block after fourth shot

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Autorecloser	AR BLOCK BY LEVEL	Recloser – Block by level
	AR BLOCK BY PULSE	Recloser – Block by command (pulse)
Default Channel (not used)	Default Channel	Channel not used
Directional Power	DIR PWR1 BLOCK	Directional power element block Group 1
	DIR PWR1 STG1 PKP	Directional Power element pickup level 1 Group 1
	DIR PWR1 STG1 OP	Directional Power element operation level 1 Group 1
	DIR PWR1 STG2 PKP	Directional Power element pickup level 2 Group 1
	DIR PWR1 STG2 OP	Directional Power element operation level 2 Group 1
	DIR PWR1 STG PKP	Directional power element pickup Group 1
	DIR PWR1 STG OP	Directional Power element operation Group 1
	DIR PWR2 BLOCK	Directional power element block Group 2
	DIR PWR2 STG1 PKP	Directional Power element pickup level 1 Group 2
	DIR PWR2 STG1 OP	Directional Power element operation level 1 Group 2
	DIR PWR2 STG2 PKP	Directional Power element pickup level 2 Group 2
	DIR PWR2 STG2 OP	Directional Power element operation level 2 Group 2
	DIR PWR2 STG PKP	Directional power element pickup Group 2
	DIR PWR2 STG OP	Directional Power element operation Group 2
	DIR PWR3 BLOCK	Directional power element block Group 3
	DIR PWR3 STG1 PKP	Directional Power element pickup level 1 Group 3
	DIR PWR3 STG1 OP	Directional Power element operation level 1 Group 3
	DIR PWR3 STG2 PKP	Directional Power element pickup level 2 Group 3
	DIR PWR3 STG2 OP	Directional Power element operation level 2 Group 3
	DIR PWR3 STG PKP	Directional power element pickup Group 3
	DIR PWR3 STG OP	Directional Power element operation Group 3
Locked Rotor	LOCKED ROTOR1 BLK	Locked rotor element block Group 1
	LOCKED ROTOR1 PKP	Locked rotor element pickup Group 1
	LOCKED ROTOR1 OP	Locked rotor element operation Group 1
	LOCKED ROTOR2 BLK	Locked rotor element block Group 2
	LOCKED ROTOR2 PKP	Locked rotor element pickup Group 2
	LOCKED ROTOR2 OP	Locked rotor element operation Group 2
	LOCKED ROTOR3 BLK	Locked rotor element block Group 3
	LOCKED ROTOR3 PKP	Locked rotor element pickup Group 3
	LOCKED ROTOR3 OP	Locked rotor element operation Group 3

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OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Pulse Counters	PulseCntr Value 1	Pulse counter element value Group 1
	PulseCntr Value 2	Pulse counter element value Group 2
	...	...
	PulseCntr Value 8	Pulse counter element value Group 8
	PulseCntr Freeze 1	Pulse counter element freeze value Group 1
	PulseCntr Freeze 2	Pulse counter element freeze value Group 2
	...	...
	PulseCntr Freeze 8	Pulse counter element freeze value Group 8
Analog comparators	Analog Level 01	Analog comparator element level Group 1
	Analog Level 02	Analog comparator element level Group 2
	...	...
	Analog Level 20	Analog comparator element level Group 20
Load Encroachment	LOAD ENCR1 BLK	Load Encroachment element block Group 1
	LOAD ENCR1 PKP	Load Encroachment element pickup Group 1
	LOAD ENCR1 OP	Load Encroachment element operation Group 1
	LOAD ENCR2 BLK	Load Encroachment element block Group 2
	LOAD ENCR2 PKP	Load Encroachment element pickup Group 2
	LOAD ENCR2 OP	Load Encroachment element operation Group 2
	LOAD ENCR3 BLK	Load Encroachment element block Group 3
	LOAD ENCR3 PKP	Load Encroachment element pickup Group 3
	LOAD ENCR3 OP	Load Encroachment element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
wattmetric Ground Fault High (Logic Operands)	32N1 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 1
	32N1 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 1
	32N1 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 1
	32N1 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 1
	32N2 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 2
	32N2 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 2
	32N2 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 2
	32N2 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 2
	32N3 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 3
	32N3 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 3
	32N3 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 3
	32N3 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 3
wattmetric Ground Fault High (Power Measurements)	32N1 HIGH POWER	wattmetric Ground Fault Element High Level Group 1 Power Value (watts)
	32N2 HIGH POWER	wattmetric Ground Fault Element High Level Group 2 Power Value (watts)
	32N3 HIGH POWER	wattmetric Ground Fault Element High Level Group 3 Power Value (watts)

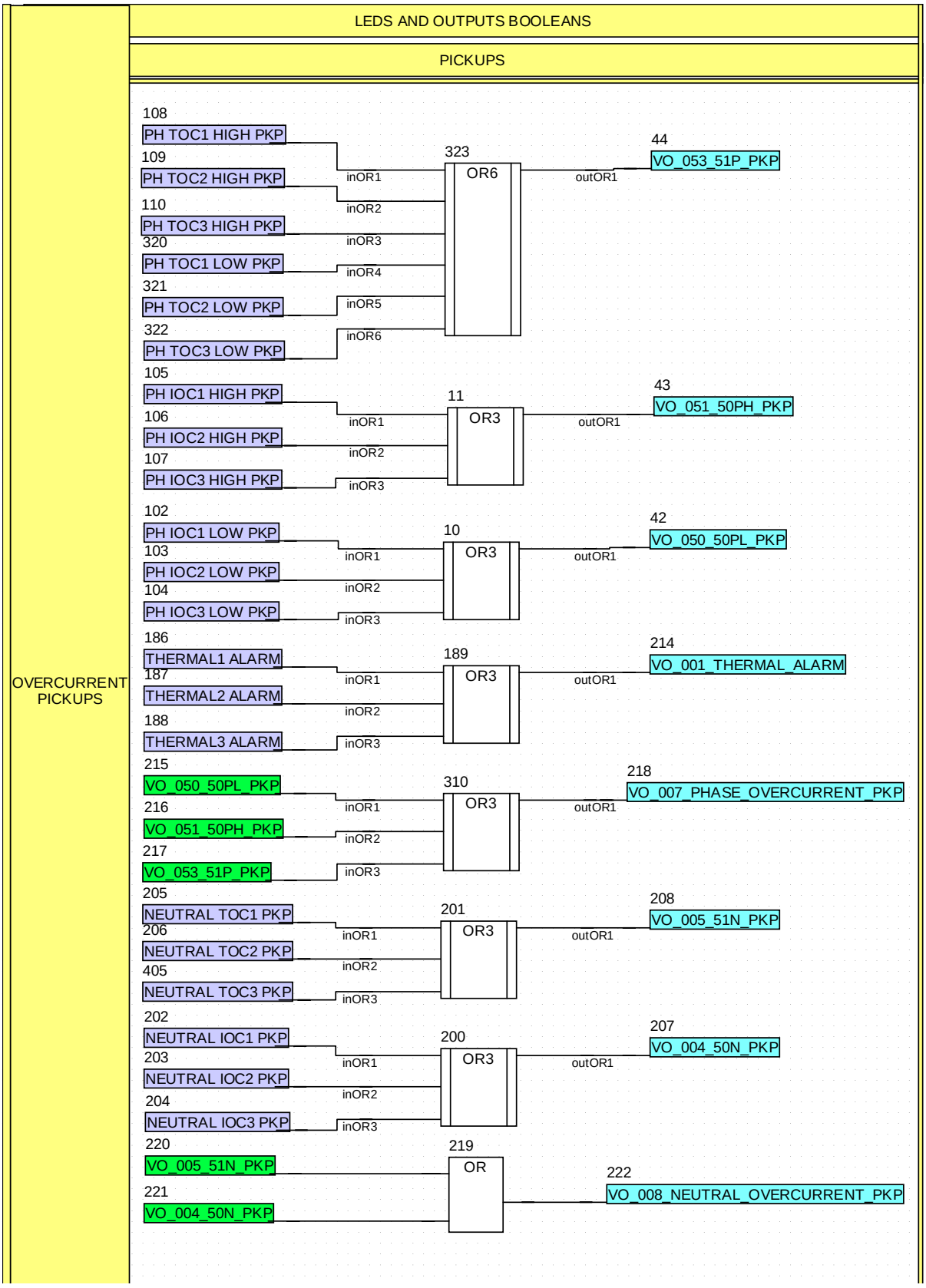
A

OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
wattmetric Ground Fault Low (Logic Operands)	32N1 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 1
	32N1 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 1
	32N1 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 1
	32N1 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 1
	32N2 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 2
	32N2 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 2
	32N2 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 2
	32N2 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 2
	32N3 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 3
	32N3 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 3
	32N3 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 3
	32N3 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 3
wattmetric Ground Fault Low (Power Measurements)	32N1 LOW POWER	wattmetric Ground Fault Element Low Level Group 1 Power Value (watts)
	32N2 LOW POWER	wattmetric Ground Fault Element Low Level Group 2 Power Value (watts)
	32N3 LOW POWER	wattmetric Ground Fault Element Low Level Group 3 Power Value (watts)

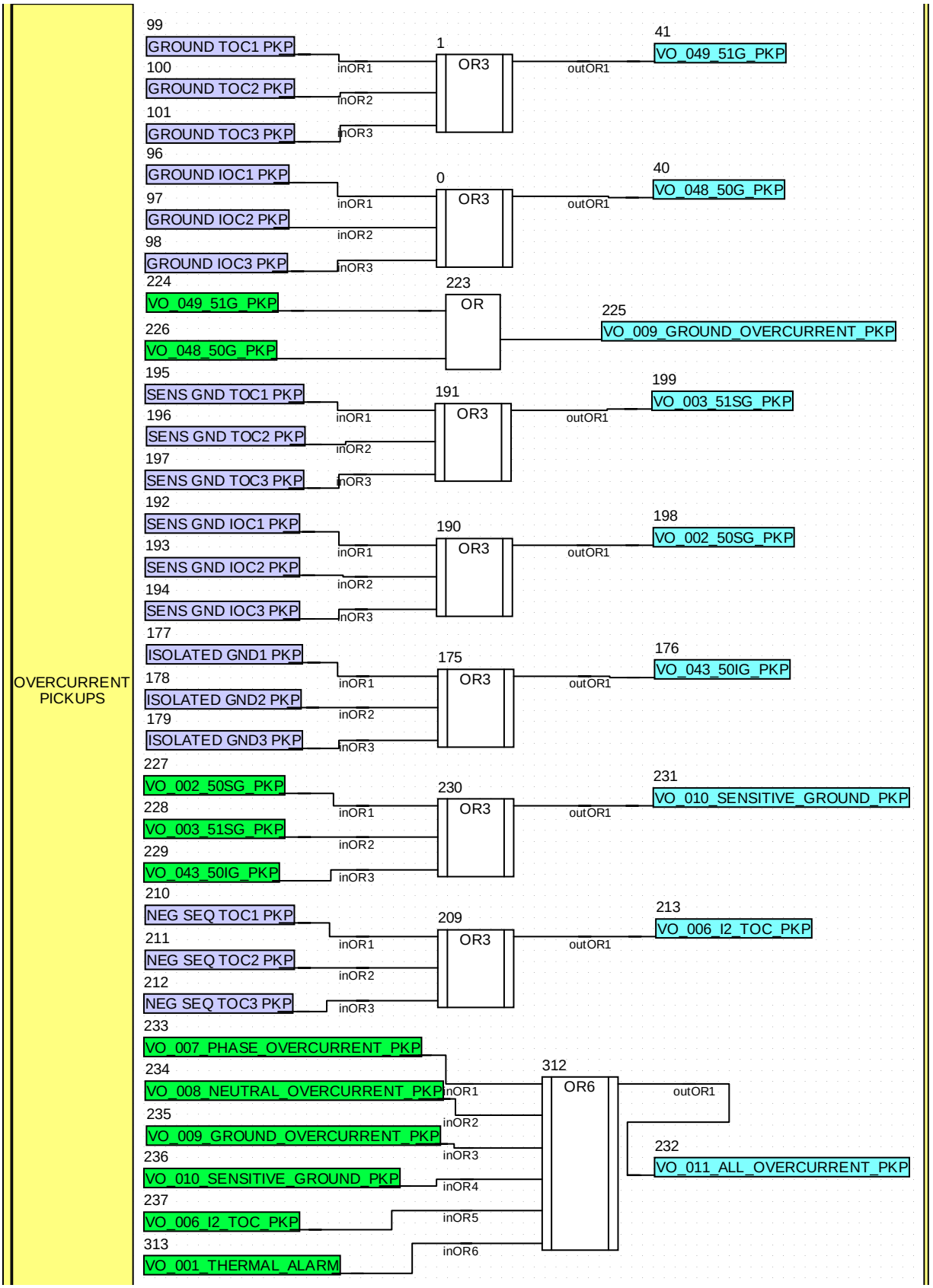
OPERANDS - F650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Remote Outputs	DNA 1	1 output on. Remote Output DNA 1 Operation (GSSE/ GOOSE)
	DNA 2	1 output on. Remote Output DNA 2 Operation (GSSE/ GOOSE)
	...	...
	DNA 32	1 output on. Remote Output DNA 32 Operation (GSSE/ GOOSE)
	User St 1	1 output on. Remote Output UserSt 1 Operation (GSSE/ GOOSE)
	User St 2	1 output on. Remote Output UserSt 2 Operation (GSSE/ GOOSE)
	...	...
	User St 64	1 output on. Remote Output UserSt 64 Operation (GSSE/GOOSE)
	Rem GOOSE Dig Out 1	1 output on. Remote Output GOOSE 1 Operation (GOOSE)
	Rem GOOSE Dig Out 2	1 output on. Remote Output GOOSE 2 Operation (GOOSE)
	...	...
	Rem GOOSE Dig Out 32	1 output on. Remote Output GOOSE 32 Operation (GOOSE)
Remote Inputs	Remote Input 1	Flag is set, logic =1
	Remote Input 2	Flag is set, logic =1
	...	...
	Remote Input 32	Flag is set, logic =1
Remote Devices	Remote Device 1	Flag is set, logic =1
	Remote Device 2	Flag is set, logic =1
	...	...
	Remote Device 16	Flag is set, logic =1
GOOSE DIG INPUTS	Rem GOOSE Dig Input 1	Flag is set, logic = 1
	Rem GOOSE Dig Input 2	Flag is set, logic =1
	...	...
	Rem GOOSE Dig Input 32	Flag is set, logic =1
GOOSE Analog Inputs (FLOAT AND INTEGER)	Rem Ana Inp FLOAT 1	Analog Input 1 (Float type)
	Rem Ana Inp FLOAT 2	Analog Input 2 (Float type)
	...	...
	Rem Ana Inp FLOAT 8	Analog Input 8 (Float type)
	Rem Ana Inp INT 1	Analog Input 1 (Integer type)
	Rem Ana Inp INT 2	Analog Input 2 (Integer type)
	...	...
	Rem Ana Inp INT 8	Analog Input 8 (Integer type)

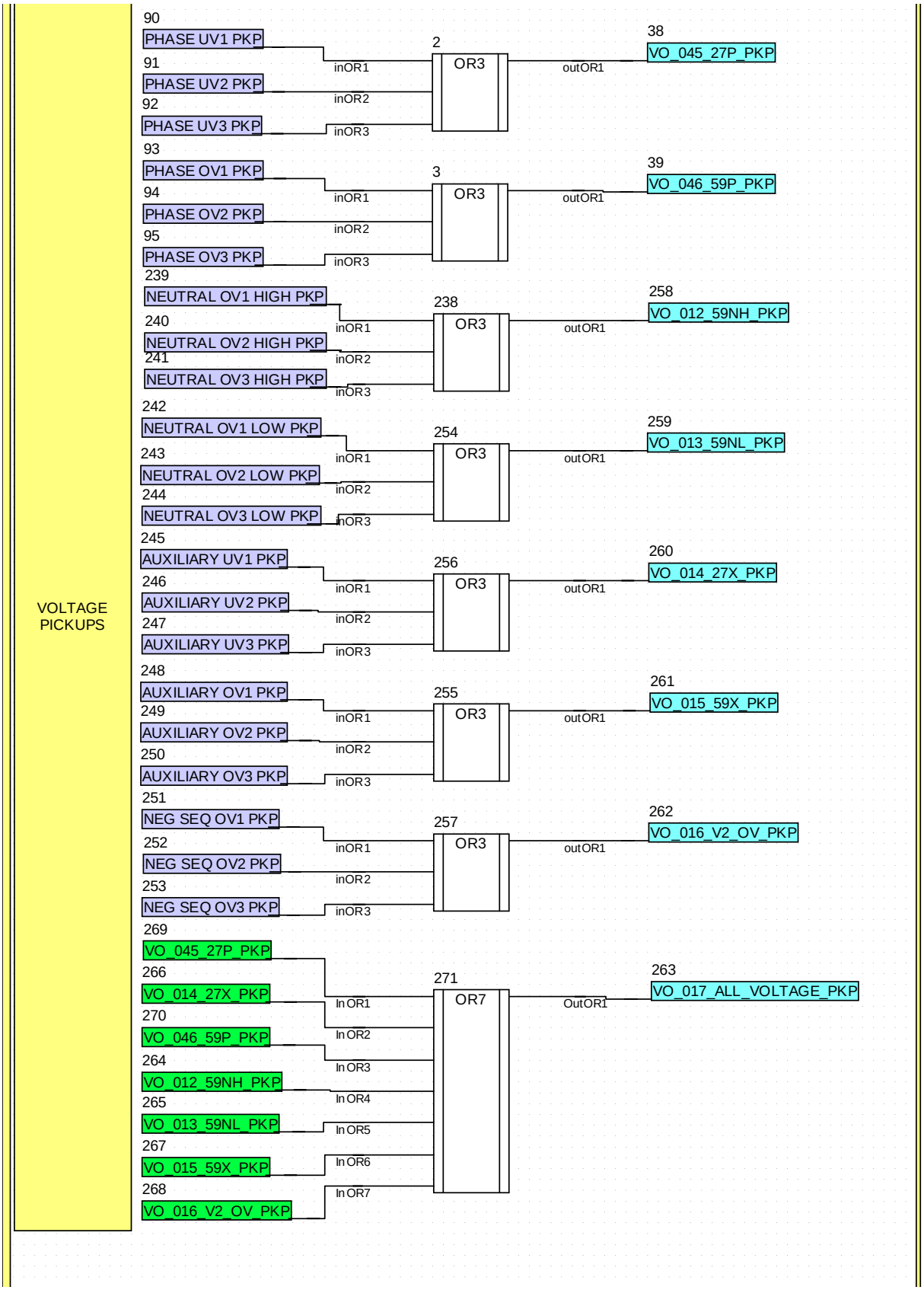
A

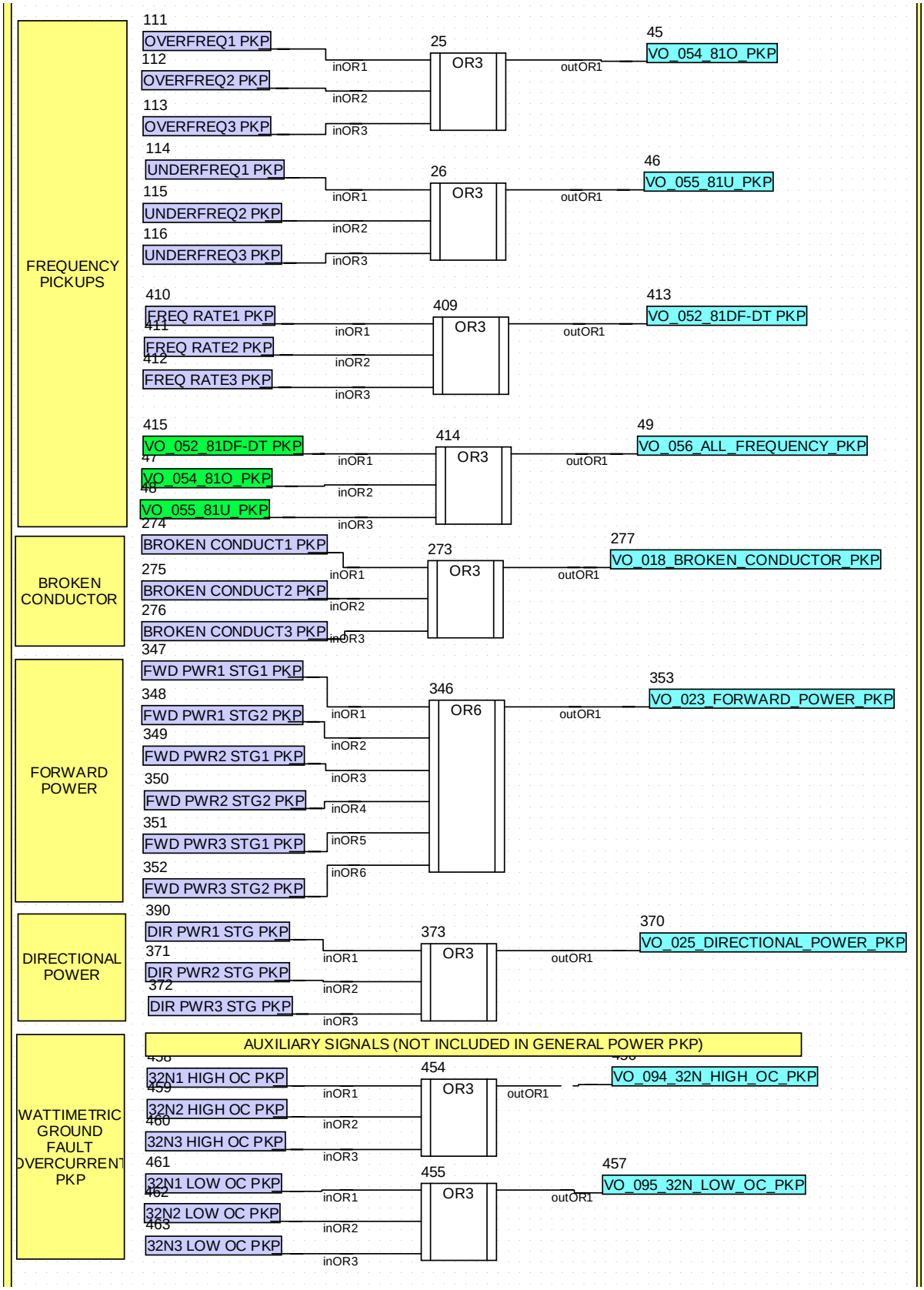
B

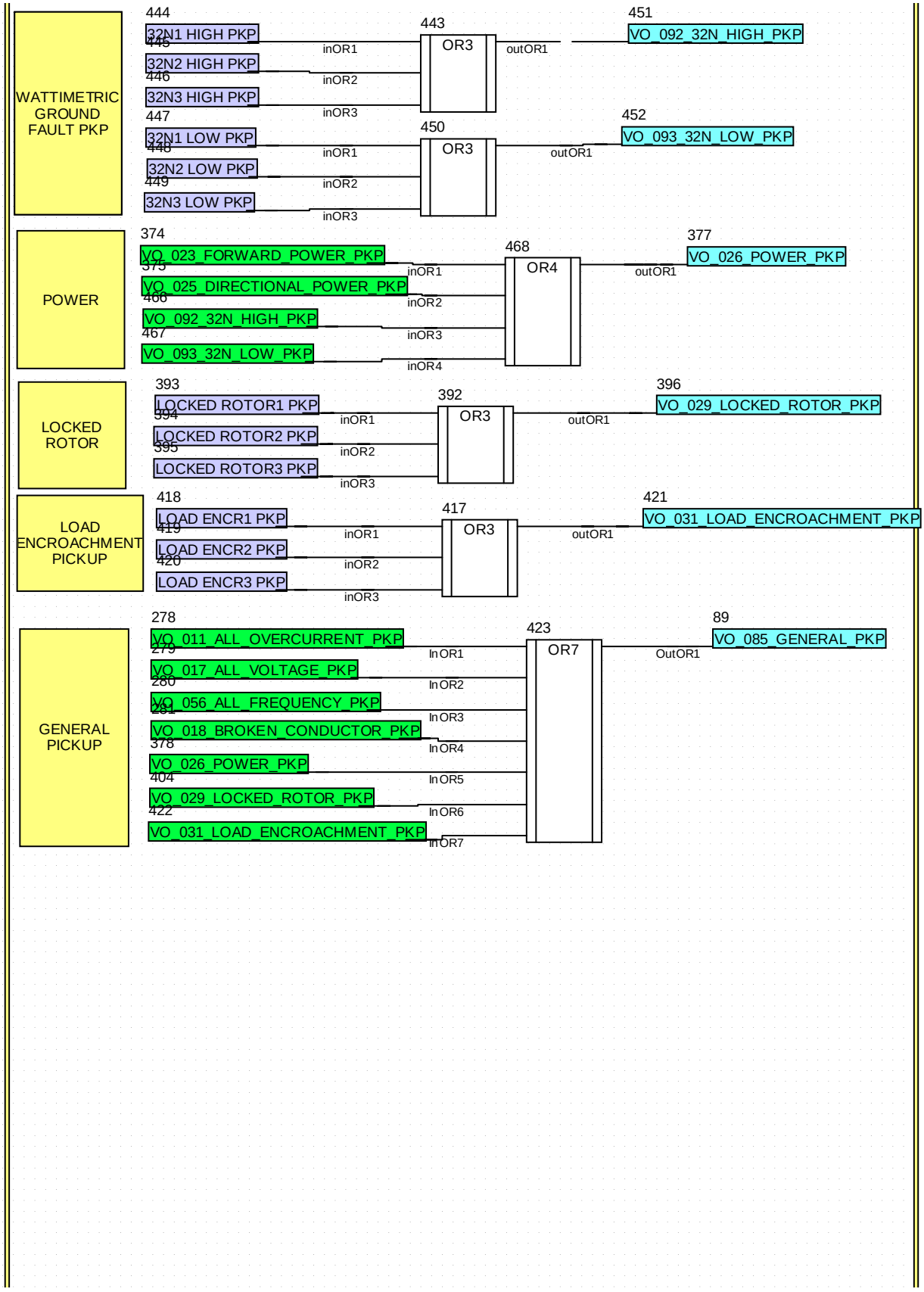

LEDS AND OUTPUTS BOOLEANS
PICKUPS
OVERCURRENT PICKUPS
108
PH TOC1 HIGH PKP
109
PH TOC2 HIGH PKP
110
PH TOC3 HIGH PKP
320
PH TOC1 LOW PKP
321
PH TOC2 LOW PKP
322
PH TOC3 LOW PKP
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
323
OR6
outOR1
44
VO_053_51P_PKP
105
PH IOC1 HIGH PKP
106
PH IOC2 HIGH PKP
107
PH IOC3 HIGH PKP
11
OR3
43
VO_051_50PH_PKP
102
PH IOC1 LOW PKP
103
PH IOC2 LOW PKP
104
PH IOC3 LOW PKP
10
42
VO_050_50PL_PKP
186
THERMAL1 ALARM
187
THERMAL2 ALARM
188
THERMAL3 ALARM
189
214
VO_001_THERMAL_ALARM
215
VO_050_50PL_PKP
216
VO_051_50PH_PKP
217
VO_053_51P_PKP
310
218
VO_007_PHASE_OVERCURRENT_PKP
205
NEUTRAL TOC1 PKP
206
NEUTRAL TOC2 PKP
405
NEUTRAL TOC3 PKP
201
208
VO_005_51N_PKP
202
NEUTRAL IOC1 PKP
203
NEUTRAL IOC2 PKP
204
NEUTRAL IOC3 PKP
200
207
VO_004_50N_PKP
220
VO_005_51N_PKP
221
VO_004_50N_PKP
219
OR
222
VO_008_NEUTRAL_OVERCURRENT_PKP

B

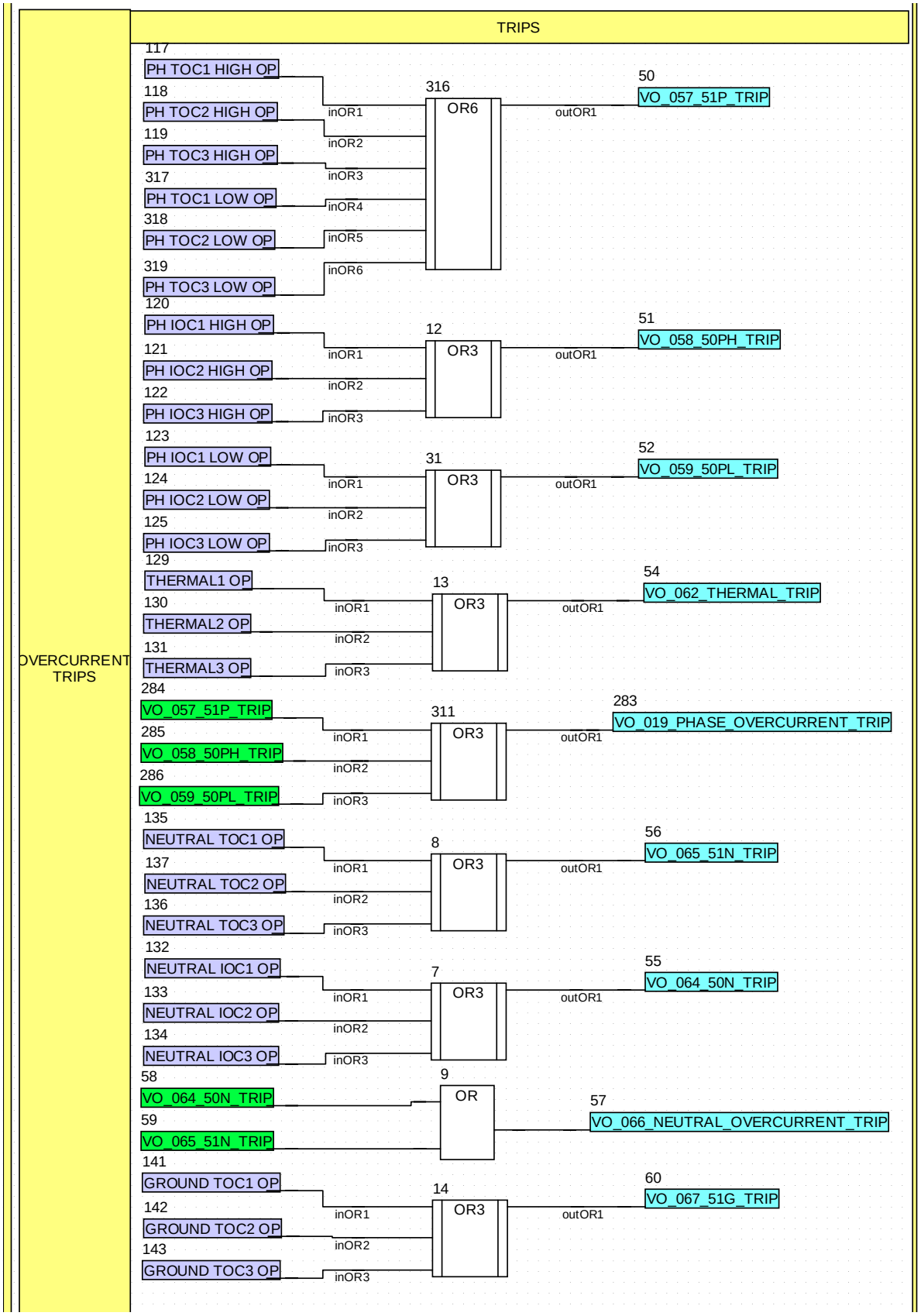

OVERCURRENT PICKUPS
99
GROUND TOC1 PKP
100
GROUND TOC2 PKP
101
GROUND TOC3 PKP
inOR1
inOR2
inOR3
1
OR3
outOR1
41
VO_049_51G_PKP
96
GROUND IOC1 PKP
97
GROUND IOC2 PKP
98
GROUND IOC3 PKP
0
OR3
40
VO_048_50G_PKP
224
VO_049_51G_PKP
226
VO_048_50G_PKP
223
OR
225
VO_009_GROUND_OVERCURRENT_PKP
195
SENS GND TOC1 PKP
196
SENS GND TOC2 PKP
197
SENS GND TOC3 PKP
191
OR3
199
VO_003_51SG_PKP
192
SENS GND IOC1 PKP
193
SENS GND IOC2 PKP
194
SENS GND IOC3 PKP
190
OR3
198
VO_002_50SG_PKP
177
ISOLATED GND1 PKP
178
ISOLATED GND2 PKP
179
ISOLATED GND3 PKP
175
OR3
176
VO_043_50IG_PKP
227
VO_002_50SG_PKP
228
VO_003_51SG_PKP
229
VO_043_50IG_PKP
230
OR3
231
VO_010_SENSITIVE_GROUND_PKP
210
NEG SEQ TOC1 PKP
211
NEG SEQ TOC2 PKP
212
NEG SEQ TOC3 PKP
209
OR3
213
VO_006_I2_TOC_PKP
233
VO_007_PHASE_OVERCURRENT_PKP
234
VO_008_NEUTRAL_OVERCURRENT_PKP
235
VO_009_GROUND_OVERCURRENT_PKP
236
VO_010_SENSITIVE_GROUND_PKP
237
VO_006_I2_TOC_PKP
313
VO_001_THERMAL_ALARM
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
312
OR6
outOR1
232
VO_011_ALL_OVERCURRENT_PKP

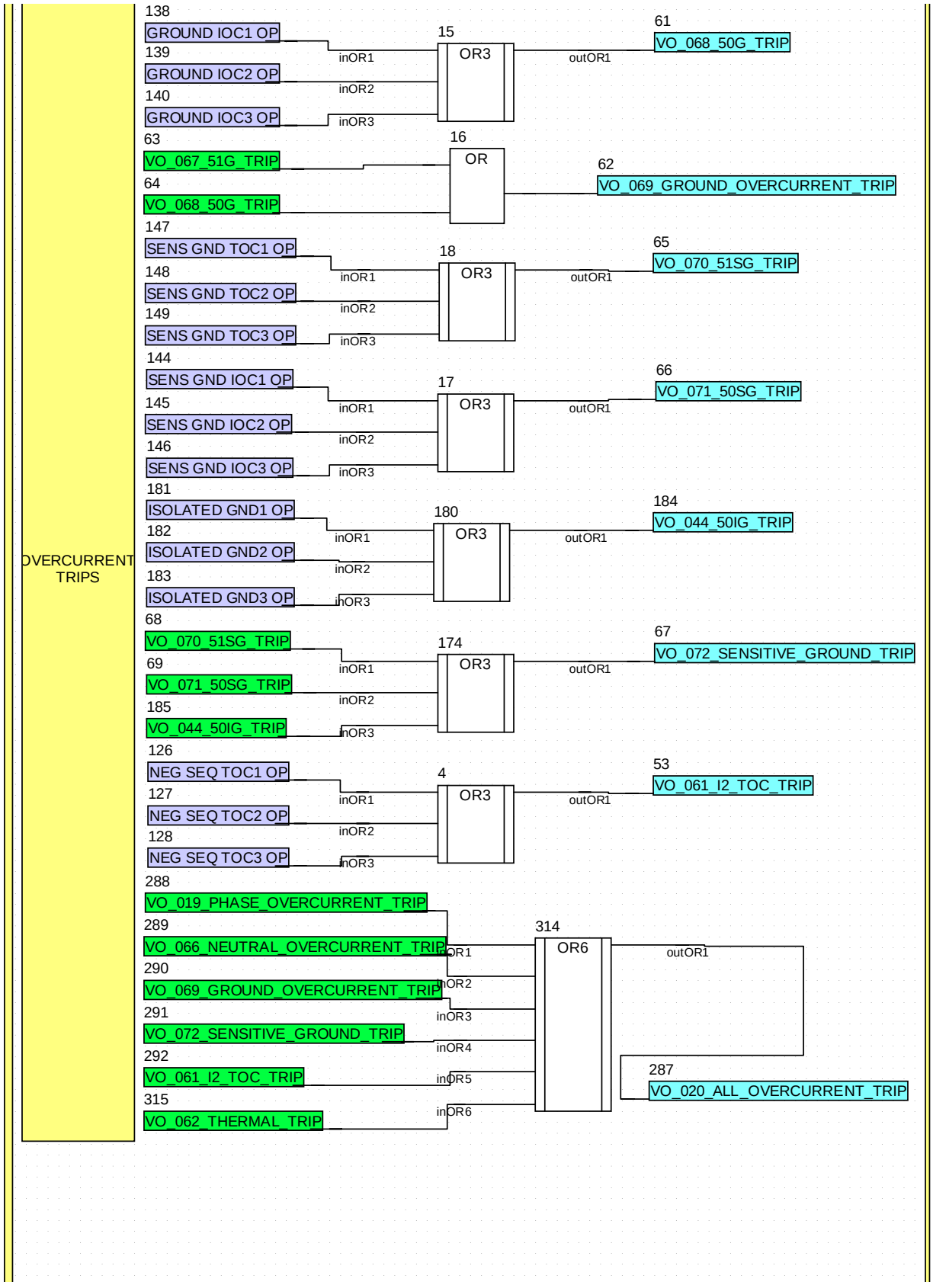

VOLTAGE PICKUPS
90
PHASE UV1 PKP
91
PHASE UV2 PKP
92
PHASE UV3 PKP
inOR1
inOR2
inOR3
2
OR3
outOR1
38
VO_045_27P_PKP
93
PHASE OV1 PKP
94
PHASE OV2 PKP
95
PHASE OV3 PKP
3
39
VO_046_59P_PKP
239
NEUTRAL OV1 HIGH PKP
240
NEUTRAL OV2 HIGH PKP
241
NEUTRAL OV3 HIGH PKP
238
258
VO_012_59NH_PKP
242
NEUTRAL OV1 LOW PKP
243
NEUTRAL OV2 LOW PKP
244
NEUTRAL OV3 LOW PKP
254
259
VO_013_59NL_PKP
245
AUXILIARY UV1 PKP
246
AUXILIARY UV2 PKP
247
AUXILIARY UV3 PKP
256
260
VO_014_27X_PKP
248
AUXILIARY OV1 PKP
249
AUXILIARY OV2 PKP
250
AUXILIARY OV3 PKP
255
261
VO_015_59X_PKP
251
NEG SEQ OV1 PKP
252
NEG SEQ OV2 PKP
253
NEG SEQ OV3 PKP
257
262
VO_016_V2_OV_PKP
269
VO_045_27P_PKP
266
VO_014_27X_PKP
270
VO_046_59P_PKP
264
VO_012_59NH_PKP
265
VO_013_59NL_PKP
267
VO_015_59X_PKP
268
VO_016_V2_OV_PKP
InOR1
InOR2
InOR3
InOR4
InOR5
InOR6
InOR7
271
OR7
OutOR1
263
VO_017_ALL_VOLTAGE_PKP


FREQUENCY PICKUPS
111
OVERFREQ1 PKP
112
OVERFREQ2 PKP
113
OVERFREQ3 PKP
inOR1
inOR2
inOR3
25
OR3
outOR1
45
VO_054_81O_PKP
114
UNDERFREQ1 PKP
115
UNDERFREQ2 PKP
116
UNDERFREQ3 PKP
26
46
VO_055_81U_PKP
410
FREQ RATE1 PKP
411
FREQ RATE2 PKP
412
FREQ RATE3 PKP
409
413
VO_052_81DF-DT PKP
415
VO_052_81DF-DT PKP
47
VO_054_81O_PKP
48
VO_055_81U_PKP
414
49
VO_056_ALL_FREQUENCY_PKP
BROKEN CONDUCTOR
274
BROKEN CONDUCT1 PKP
275
BROKEN CONDUCT2 PKP
276
BROKEN CONDUCT3 PKP
273
277
VO_018_BROKEN_CONDUCTOR_PKP
FORWARD POWER
347
FWD PWR1 STG1 PKP
348
FWD PWR1 STG2 PKP
349
FWD PWR2 STG1 PKP
350
FWD PWR2 STG2 PKP
351
FWD PWR3 STG1 PKP
352
FWD PWR3 STG2 PKP
inOR4
inOR5
inOR6
OR6
346
353
VO_023_FORWARD_POWER_PKP
DIRECTIONAL POWER
390
DIR PWR1 STG PKP
371
DIR PWR2 STG PKP
372
DIR PWR3 STG PKP
373
370
VO_025_DIRECTIONAL_POWER_PKP
WATTIMETRIC GROUND FAULT OVERCURRENT PKP
AUXILIARY SIGNALS (NOT INCLUDED IN GENERAL POWER PKP)
458
32N1 HIGH OC PKP
459
32N2 HIGH OC PKP
460
32N3 HIGH OC PKP
454
VO_094_32N_HIGH_OC_PKP
461
32N1 LOW OC PKP
462
32N2 LOW OC PKP
463
32N3 LOW OC PKP
455
457
VO_095_32N_LOW_OC_PKP

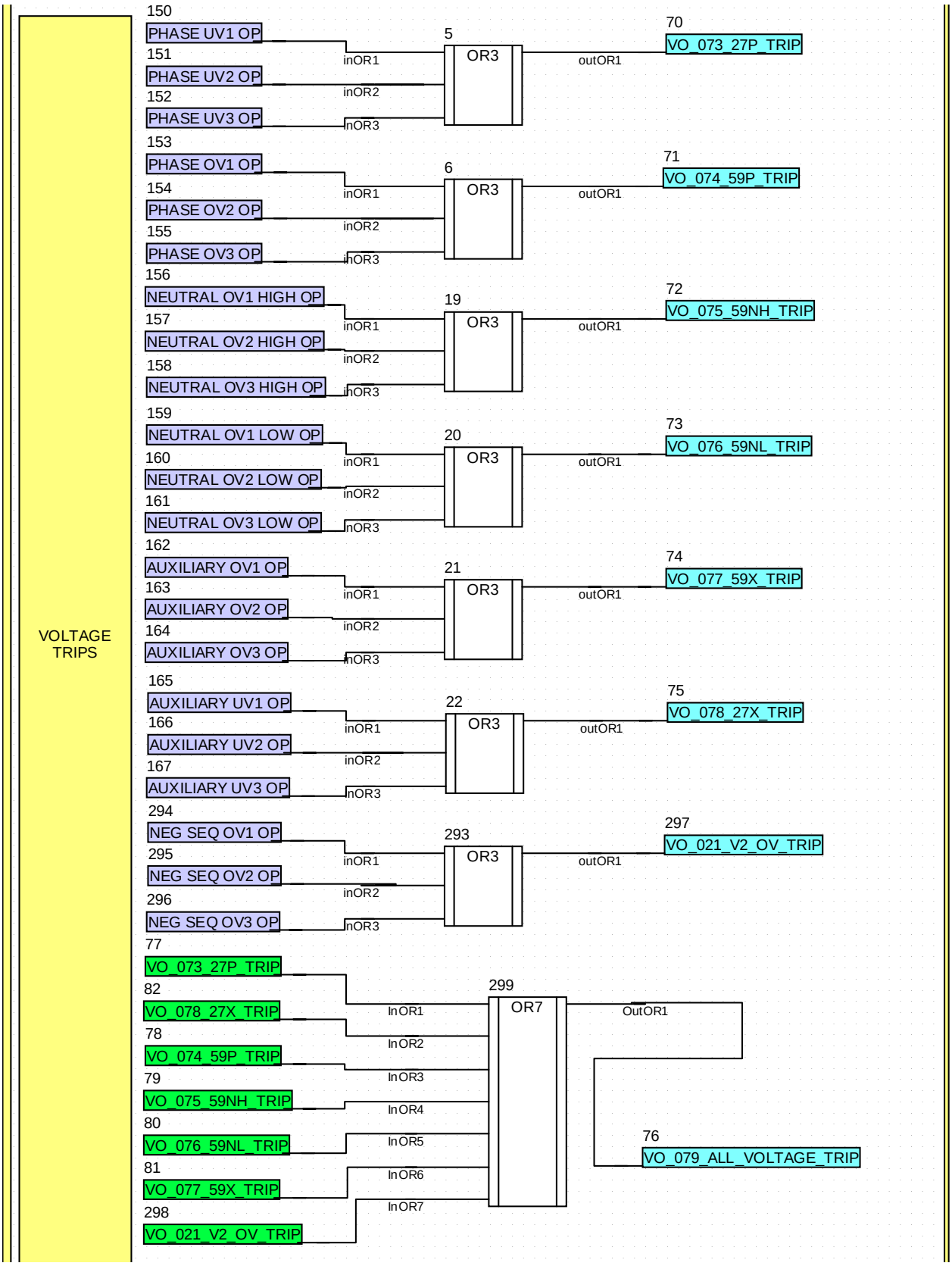

WATTIMETRIC GROUND FAULT PKP
444
32N1 HIGH PKP
445
32N2 HIGH PKP
446
32N3 HIGH PKP
inOR1
inOR2
inOR3
443
OR3
outOR1
451
VO_092_32N_HIGH_PKP
447
32N1 LOW PKP
448
32N2 LOW PKP
449
32N3 LOW PKP
450
OR3
452
VO_093_32N_LOW_PKP
POWER
374
VO_023_FORWARD_POWER_PKP
375
VO_025_DIRECTIONAL_POWER_PKP
466
VO_092_32N_HIGH_PKP
467
VO_093_32N_LOW_PKP
inOR4
468
OR4
377
VO_026_POWER_PKP
LOCKED ROTOR
393
LOCKED ROTOR1 PKP
394
LOCKED ROTOR2 PKP
395
LOCKED ROTOR3 PKP
392
OR3
396
VO_029_LOCKED_ROTOR_PKP
LOAD ENCROACHMENT PICKUP
418
LOAD ENCR1 PKP
419
LOAD ENCR2 PKP
420
LOAD ENCR3 PKP
417
OR3
421
VO_031_LOAD_ENCROACHMENT_PKP
GENERAL PICKUP
278
VO_011_ALL_OVERCURRENT_PKP
279
VO_017_ALL_VOLTAGE_PKP
280
VO_056_ALL_FREQUENCY_PKP
281
VO_018_BROKEN_CONDUCTOR_PKP
378
VO_026_POWER_PKP
404
VO_029_LOCKED_ROTOR_PKP
422
VO_031_LOAD_ENCROACHMENT_PKP
InOR1
InOR2
InOR3
InOR4
InOR5
InOR6
InOR7
423
OR7
OutOR1
89
VO_085_GENERAL_PKP

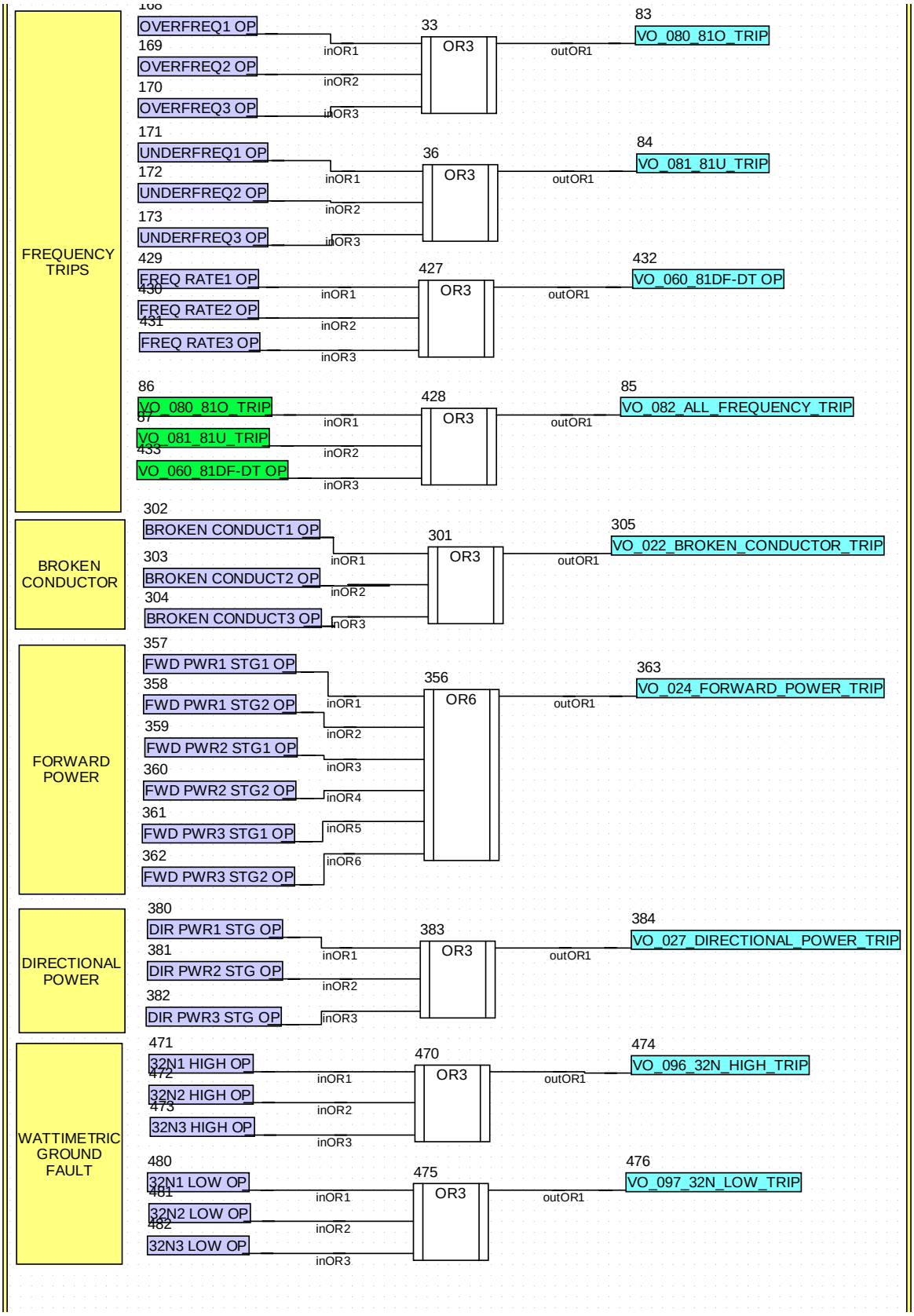
B


OVERCURRENT TRIPS
TRIPS
117
PH TOC1 HIGH OP
118
PH TOC2 HIGH OP
119
PH TOC3 HIGH OP
317
PH TOC1 LOW OP
318
PH TOC2 LOW OP
319
PH TOC3 LOW OP
316
OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
50
VO_057_51P_TRIP
120
PH IOC1 HIGH OP
121
PH IOC2 HIGH OP
122
PH IOC3 HIGH OP
12
OR3
51
VO_058_50PH_TRIP
123
PH IOC1 LOW OP
124
PH IOC2 LOW OP
125
PH IOC3 LOW OP
31
52
VO_059_50PL_TRIP
129
THERMAL1 OP
130
THERMAL2 OP
131
THERMAL3 OP
13
54
VO_062_THERMAL_TRIP
284
VO_057_51P_TRIP
285
VO_058_50PH_TRIP
286
VO_059_50PL_TRIP
311
283
VO_019_PHASE_OVERCURRENT_TRIP
135
NEUTRAL TOC1 OP
137
NEUTRAL TOC2 OP
136
NEUTRAL TOC3 OP
8
56
VO_065_51N_TRIP
132
NEUTRAL IOC1 OP
133
NEUTRAL IOC2 OP
134
NEUTRAL IOC3 OP
7
55
VO_064_50N_TRIP
58
VO_064_50N_TRIP
59
VO_065_51N_TRIP
9
OR
57
VO_066_NEUTRAL_OVERCURRENT_TRIP
141
GROUND TOC1 OP
142
GROUND TOC2 OP
143
GROUND TOC3 OP
14
60
VO_067_51G_TRIP

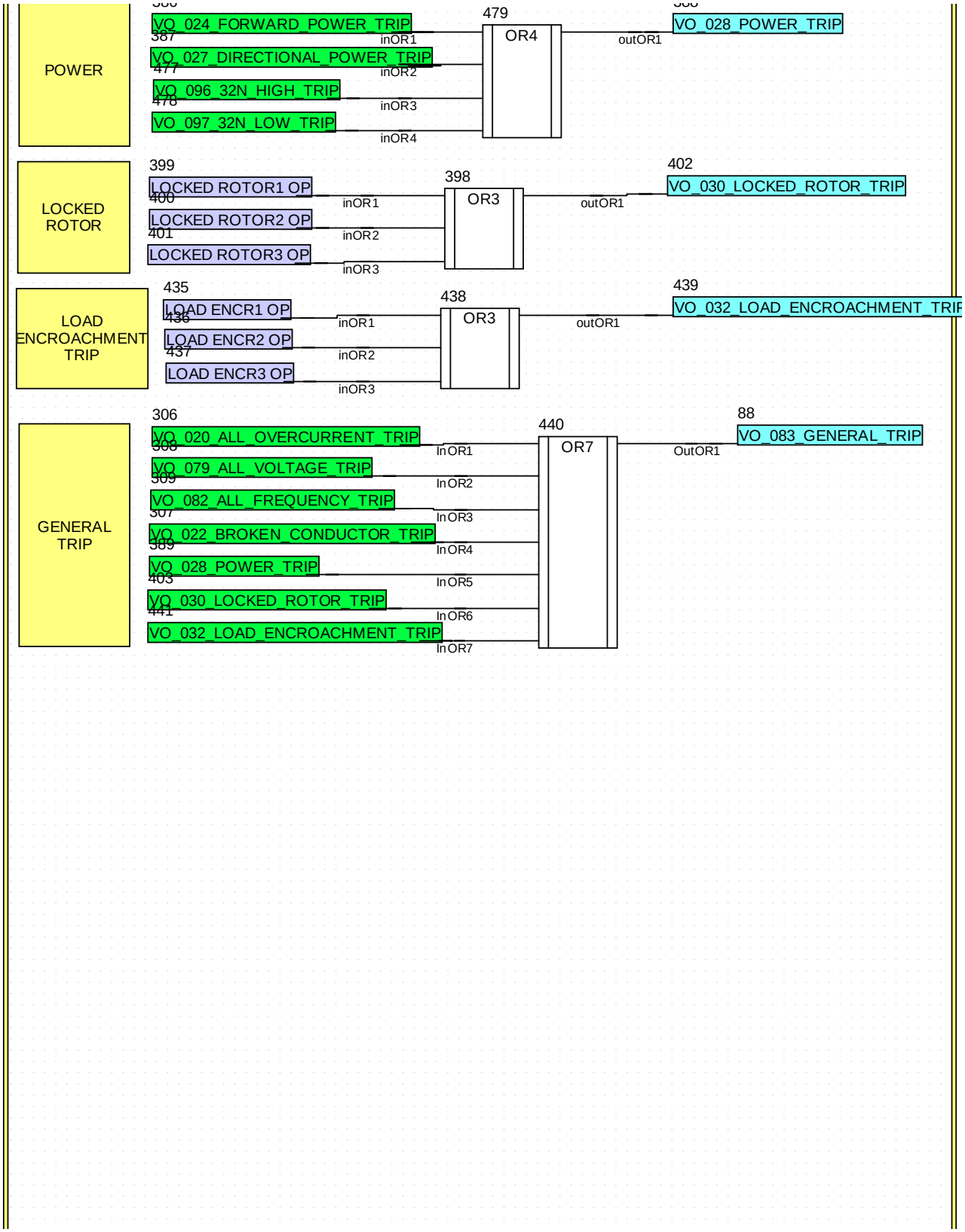

OVERCURRENT TRIPS
138
GROUND IOC1 OP
139
GROUND IOC2 OP
140
GROUND IOC3 OP
inOR1
inOR2
inOR3
15
OR3
outOR1
61
VO_068_50G_TRIP
63
VO_067_51G_TRIP
64
VO_068_50G_TRIP
16
OR
62
VO_069_GROUND_OVERCURRENT_TRIP
147
SENS GND TOC1 OP
148
SENS GND TOC2 OP
149
SENS GND TOC3 OP
18
65
VO_070_51SG_TRIP
144
SENS GND IOC1 OP
145
SENS GND IOC2 OP
146
SENS GND IOC3 OP
17
66
VO_071_50SG_TRIP
181
ISOLATED GND1 OP
182
ISOLATED GND2 OP
183
ISOLATED GND3 OP
180
184
VO_044_50IG_TRIP
68
VO_070_51SG_TRIP
69
VO_071_50SG_TRIP
185
VO_044_50IG_TRIP
174
67
VO_072_SENSITIVE_GROUND_TRIP
126
NEG SEQ TOC1 OP
127
NEG SEQ TOC2 OP
128
NEG SEQ TOC3 OP
4
53
VO_061_I2_TOC_TRIP
288
VO_019_PHASE_OVERCURRENT_TRIP
289
VO_066_NEUTRAL_OVERCURRENT_TRIP
290
VO_069_GROUND_OVERCURRENT_TRIP
291
VO_072_SENSITIVE_GROUND_TRIP
292
VO_061_I2_TOC_TRIP
315
VO_062_THERMAL_TRIP
inOR4
inOR5
inOR6
314
OR6
287
VO_020_ALL_OVERCURRENT_TRIP

B


VOLTAGE TRIPS
150
PHASE UV1 OP
151
PHASE UV2 OP
152
PHASE UV3 OP
inOR1
inOR2
inOR3
5
OR3
outOR1
70
VO_073_27P_TRIP
153
PHASE OV1 OP
154
PHASE OV2 OP
155
PHASE OV3 OP
6
71
VO_074_59P_TRIP
156
NEUTRAL OV1 HIGH OP
157
NEUTRAL OV2 HIGH OP
158
NEUTRAL OV3 HIGH OP
19
72
VO_075_59NH_TRIP
159
NEUTRAL OV1 LOW OP
160
NEUTRAL OV2 LOW OP
161
NEUTRAL OV3 LOW OP
20
73
VO_076_59NL_TRIP
162
AUXILIARY OV1 OP
163
AUXILIARY OV2 OP
164
AUXILIARY OV3 OP
21
74
VO_077_59X_TRIP
165
AUXILIARY UV1 OP
166
AUXILIARY UV2 OP
167
AUXILIARY UV3 OP
22
75
VO_078_27X_TRIP
294
NEG SEQ OV1 OP
295
NEG SEQ OV2 OP
296
NEG SEQ OV3 OP
293
297
VO_021_V2_OV_TRIP
77
VO_073_27P_TRIP
82
VO_078_27X_TRIP
78
VO_074_59P_TRIP
79
VO_075_59NH_TRIP
80
VO_076_59NL_TRIP
81
VO_077_59X_TRIP
298
VO_021_V2_OV_TRIP
InOR1
InOR2
InOR3
InOR4
InOR5
InOR6
InOR7
299
OR7
OutOR1
76
VO_079_ALL_VOLTAGE_TRIP


FREQUENCY TRIPS
168
OVERFREQ1 OP
169
OVERFREQ2 OP
170
OVERFREQ3 OP
inOR1
inOR2
inOR3
33
OR3
outOR1
83
VO_080_81O_TRIP
171
UNDERFREQ1 OP
172
UNDERFREQ2 OP
173
UNDERFREQ3 OP
36
84
VO_081_81U_TRIP
429
FREQ RATE1 OP
430
FREQ RATE2 OP
431
FREQ RATE3 OP
427
432
VO_060_81DF-DT OP
86
VO_080_81O_TRIP
87
VO_081_81U_TRIP
433
VO_060_81DF-DT OP
428
85
VO_082_ALL_FREQUENCY_TRIP
BROKEN CONDUCTOR
302
BROKEN CONDUCT1 OP
303
BROKEN CONDUCT2 OP
304
BROKEN CONDUCT3 OP
301
305
VO_022_BROKEN_CONDUCTOR_TRIP
FORWARD POWER
357
FWD PWR1 STG1 OP
358
FWD PWR1 STG2 OP
359
FWD PWR2 STG1 OP
360
FWD PWR2 STG2 OP
361
FWD PWR3 STG1 OP
362
FWD PWR3 STG2 OP
inOR4
inOR5
inOR6
356
OR6
363
VO_024_FORWARD_POWER_TRIP
DIRECTIONAL POWER
380
DIR PWR1 STG OP
381
DIR PWR2 STG OP
382
DIR PWR3 STG OP
383
384
VO_027_DIRECTIONAL_POWER_TRIP
WATTIMETRIC GROUND FAULT
471
32N1 HIGH OP
472
32N2 HIGH OP
473
32N3 HIGH OP
470
474
VO_096_32N_HIGH_TRIP
480
32N1 LOW OP
481
32N2 LOW OP
482
32N3 LOW OP
475
476
VO_097_32N_LOW_TRIP

B


POWER
VO_024_FORWARD_POWER_TRIP
387
inOR1
VO_027_DIRECTIONAL_POWER_TRIP
477
inOR2
VO_096_32N_HIGH_TRIP
478
inOR3
VO_097_32N_LOW_TRIP
inOR4
479
OR4
outOR1
VO_028_POWER_TRIP
LOCKED ROTOR
399
LOCKED ROTOR1 OP
inOR1
400
LOCKED ROTOR2 OP
inOR2
401
LOCKED ROTOR3 OP
inOR3
398
OR3
outOR1
402
VO_030_LOCKED_ROTOR_TRIP
LOAD ENCROACHMENT TRIP
435
LOAD ENCR1 OP
inOR1
436
LOAD ENCR2 OP
inOR2
437
LOAD ENCR3 OP
inOR3
438
OR3
outOR1
439
VO_032_LOAD_ENCROACHMENT_TRIP
GENERAL TRIP
306
VO_020_ALL_OVERCURRENT_TRIP
InOR1
308
VO_079_ALL_VOLTAGE_TRIP
InOR2
309
VO_082_ALL_FREQUENCY_TRIP
InOR3
307
VO_022_BROKEN_CONDUCTOR_TRIP
InOR4
389
VO_028_POWER_TRIP
InOR5
403
VO_030_LOCKED_ROTOR_TRIP
InOR6
441
VO_032_LOAD_ENCROACHMENT_TRIP
InOR7
440
OR7
OutOR1
88
VO_083_GENERAL_TRIP

PRODUCT SETUP>COMMUNICATION SETTINGS >SERIAL PORTS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Baud rate for COM1	COM1 Baud Rate	19200	N/A	[300 : 115200]	
Baud rate for COM2	COM2 Baud Rate	19200	N/A	[300 : 115200]	
Parity for COM1	COM1 Parity	NONE	N/A	[NONE:ODD:EVEN]	
Parity for COM2	COM2 Parity	NONE	N/A	[NONE:ODD:EVEN]	

PRODUCT SETUP>COMMUNICATION SETTINGS >NETWORK (ETHERNET)					
NETWORK (ETHERNET)1 > NETWORK (ETHERNET)2					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
1st octec of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octec of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octec of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octec of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octec of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octec of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octec of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octec of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
1st octec of Gateway	Gateway IP Oct1	0	N/A	[0 : 255]	
2nd octec of Gateway	Gateway IP Oct2	0	N/A	[0 : 255]	
3rd octec of Gateway	Gateway IP Oct3	0	N/A	[0 : 255]	
4th octec of Gateway	Gateway IP Oct4	0	N/A	[0 : 255]	

PRODUCT SETUP>COMMUNICATION SETTINGS >MODBUS PROTOCOL					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Slave address for COM1	Modbus Address COM1	254	N/A	[1 : 255]	
Slave address for COM2	Modbus Address COM2	254	N/A	[1 : 255]	
Modbus port number for Modbus TCP/IP	Modbus Port Number	502	N/A	[0 : 65535]	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE					
DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Communications port assigned to the DNP protocol	Physical Port	NONE	N/A	[COM1:COM2:NETWORK]	
DNP slave address	Address	255	N/A	[0 : 65534]	
1st Octect of IP address of DNP master 1	IP Addr Client1 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 1	IP Addr Client1 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 1	IP Addr Client1 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 1	IP Addr Client1 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 2	IP Addr Client2 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 2	IP Addr Client2 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 2	IP Addr Client2 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 2	IP Addr Client2 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 3	IP Addr Client3 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 3	IP Addr Client3 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 3	IP Addr Client3 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 3	IP Addr Client3 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client4 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client4 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client4 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client4 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client5 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client5 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client5 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client5 Oct4	0	N/A	[0 : 255]	
TCP/UDP port number for DNP over Ethernet	TCP/UDP Port	20000	N/A	[0 : 65535]	
Unsolicited responses permission	Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]	
Time out to confirm an unsolicited response	Unsol Resp TimeOut	5	1 s	[0 : 60]	
Number of retransmissions of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE (CONT.)					
DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	

DNP NOTES	
Note 1: Scale Factor	Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times
Note 2: Binary Input Block Selection:	[NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48,CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16]

PRODUCT SETUP>COMMUNICATION SETTINGS >IEC 870-5-104					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Enable or disable the protocol operation	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Listening TCP port in the relay	TCP Port	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU	255	N/A	[0 : 65535]	
Number of seconds for instantaneous metering	Cyclic Meter Period	0	1 s	[0 : 3600]	
Not implemented	Synchronization Event	0	N/A	[0 : 3600]	

IEC 870-5-104 NOTES	
Note 1: Cyclic Meter Period	0 value means no spontaneous metering

PRODUCT SETUP>COMMUNICATION SETTINGS > SNTP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Port used	UDP port	123	1	[1 : 65535]	
IP Address OCT 1	Server IP Oct 1	0	1	[1 : 255]	
IP Address OCT 2	Server IP Oct 2	0	1	[1 : 255]	
IP Address OCT 3	Server IP Oct 3	0	1	[1 : 255]	
IP Address OCT 4	Server IP Oct 4	0	1	[1 : 255]	

PRODUCT SETUP>COMMUNICATION SETTINGS >PROCOME					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Serial Remote Com Port selection	COMM Port	NONE		[NONE – COM1]	
Slave number for procome	Slave Number	0		[0 : 254]	

SETPOINT > PRODUCT SETUP > MODBUS USER MAP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Address 00 for Modbus user map	Address 00	0	N/A	[0000 : FFFF]	
Address 01 for Modbus user map	Address 01	0	N/A	[0000 : FFFF]	
	...	...		...	
Address 254 for Modbus user map	Address 254	0	N/A	[0000 : FFFF]	
Address 255 for Modbus user map	Address 255	0	N/A	[0000 : FFFF]	

SETPOINT > PRODUCT SETUP > FAULT REPORT					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]	
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]	
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]	
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]	
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]	
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PRODUCT SETUP > OSCILLOGRAPHY					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]	
Prefault	Trigger Position	30	1%	[5 : 95]	
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]	
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]	
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PRODUCT SETUP > DATA LOGGER					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min.]	
Data Logger analog channels X	Data Logger Chnl X	None	N/A	[1 to 16]	

SETPOINT > PRODUCT SETUP > DEMAND					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > GENERAL SETTINGS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]	
Rated Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	
Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > FLEX CURVES					
FLEX CURVES A > FLEX CURVES B> FLEX CURVES C > FLEX CURVES D					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETTINGS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]	
Maximum value of KI2t	Maximum KI2t	9999.99	0.01(KA)2 s	[0.00 : 9999.99]	
KI2t integration time	KI2t Integ. Time	0.03	0.01s	[0.03 : 0.25]	
Maximum number of openings	Maximum Openings	9999	1	[0 : 9999]	
Maximum Openings in one hour	Max.Openings 1 hour	40	1	[1 : 60]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER MAINTENANCE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
KI2t Counter Phase A	KI2t BKR Ph A Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase B	KI2t BKR Ph B Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase C	KI2t BKR Ph C Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
Openings counter	BKR Openings Cnt	0	1	[0 : 9999]	
Closings counter	BKR Closings Cnt	0	1	[0 : 9999]	

SETPOINT > SYSTEM SETUP > SWITCHGEAR					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE TOC HIGH > PHASE TOC HIGH 1> PHASE TOC HIGH 2 > PHASE TOC HIGH 3					
> PHASE TOC LOW > PHASE TOC LOW 1 > PHASE TOC LOW 2 > PHASE TOC LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE IOC HIGH > PHASE IOC HIGH 1> PHASE IOC HIGH 2 > PHASE IOC HIGH 3					
> PHASE IOC LOW > PHASE IOC LOW 1 > PHASE IOC LOW 2 > PHASE IOC LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > PHASE DIRECTIONAL >					
PHASE DIRECTIONAL 1> PHASE DIRECTIONAL 2 > PHASE DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > THERMAL MODEL >					
THERMAL MODEL 1> THERMAL MODEL 2 > THERMAL MODEL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]	
Cooling constant	Cool Time Constant	2.00	0.01 times Heat Time Ct.	[1.00 : 6.00]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Alarm level	Alarm Level	80.0	0.10%	[1.0 : 110.0]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL TOC					
NEUTRAL TOC 1> NEUTRAL TOC 2 > NEUTRAL TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL IOC					
NEUTRAL IOC 1> NEUTRAL IOC 2 > NEUTRAL IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL DIRECTIONAL >					
NEUTRAL DIRECTIONAL 1> NEUTRAL DIRECTIONAL 2 > NEUTRAL DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND TOC					
GROUND TOC 1> GROUND TOC 2 > GROUND TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND IOC					
GROUND IOC 1> GROUND IOC 2 > GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

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SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND DIRECTIONAL >					
GROUND DIRECTIONAL 1> GROUND DIRECTIONAL 2 > GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND TOC					
SENSITIVE GROUND TOC 1> SENSITIVE GROUND TOC 2 > SENSITIVE GROUND TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND IOC					
SENSITIVE GROUND IOC 1> SENSITIVE GROUND IOC 2 > SENSITIVE GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > ISOLATED GROUND IOC					
ISOLATED GROUND IOC 1> ISOLATED GROUND IOC 2 > ISOLATED GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
High Voltage level	Vh Level	20	1 V	[2 : 70]	
Low Current level	Il LEVEL	0.005	0.001 A	[0.005 : 0.400]	
Low Voltage level	Vl LEVEL	2	1 V	[2 : 70]	
High Current level	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]	
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]	
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND DIRECTIONAL >					
SENSITIVE GROUND DIRECTIONAL 1> SENSITIVE GROUND DIRECTIONAL 2 > SENSITIVE GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE TOC >					
NEGATIVE SEQUENCE TOC 1> NEGATIVE SEQUENCE TOC 2 > NEGATIVE SEQUENCE TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE UV >					
PHASE UV 1> PHASE UV 2 > PHASE UV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Minimum Voltage Threshold	Minimum Voltage	5	1 V	[0 : 300]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE OV >					
PHASE OV 1> PHASE OV 2 > PHASE OV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS >					
>NEUTRAL OV HIGH > NEUTRAL OV HIGH 1> NEUTRAL OV HIGH 2 > NEUTRAL OV HIGH 3					
>NEUTRAL OV LOW > NEUTRAL OV LOW 1> NEUTRAL OV LOW 2 > NEUTRAL OV LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS>NEGATIVE SEQUENCE OV >					
NEGATIVE SEQUENCE OV 1> NEGATIVE SEQUENCE OV 2 > NEGATIVE SEQUENCE OV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS >VOLTAGE ELEMENTS>AUXILIARY OV					
AUXILIARY OV 1> AUXILIARY OV 2 > AUXILIARY OV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip Time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]]	
Reset Time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS >VOLTAGE ELEMENTS>AUXILIARY UV					
AUXILIARY UV 1> AUXILIARY UV 2 > AUXILIARY UV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > FORWARD POWER					
FORWARD POWER 1> FORWARD POWER 2 > FORWARD POWER 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > DIRECTIONAL POWER> DIRECTIONAL POWER 1> DIRECTIONAL POWER 2 > DIRECTIONAL POWER 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 1	Dir Power Angle 1	0.00	0.01 Deg	[0.00 : 359.99]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 2	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > SETTING GROUP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > UNDERFREQUENCY UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > OVERFREQUENCY					
OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > SYNCHROCHECK					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > AUTORECLOSE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > BREAKER FAILURE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Supervision (retrip) pickup level	Supervision Pickup	1.00	0.01 A	[0.05 : 160.00]	
Hiset pickup level	Hiset Pickup	5.00	0.01 A	[0.05 : 160.00]	
Lowset pickup level	Lowset Pickup	2.00	0.01 A	[0.05 : 160.00]	
Internal arc pickup level	Internal Arc Pickup	0.10	0.01 A	[0.05 : 160.00]	
Internal arc time delay	Internal Arc Delay	10.00	0.01 s	[0.00 : 900.00]	
Retrip time delay	Supervision Delay	10.00	0.01 s	[0.00 : 900.00]	
Hiset time delay	HiSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Lowset time delay	LowSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Second stage time delay	2nd Step Delay	10.00	0.01 s	[0.00 : 900.00]	
WITHOUT current element time delay	No Current Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > VT FUSE FAILURE)					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > BROKEN CONDUCTOR					
BROKEN CONDUCTOR 1 >BROKEN CONDUCTOR 2 >BROKEN CONDUCTOR 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Tap Level in percentage of I2/I1	Tap	20	0.10%	[20.0 : 100.0]	
Trip Time	Trip Delay	60	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Current Inhibition Level setting	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]	

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR					
LOCKED ROTOR 1 >LOCKED ROTOR 2 >LOCKED ROTOR 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Full load current	Full Load Current	0.50	KA	[0.10 : 10.00]	
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]	
Trip time	Trip Delay	0.00	s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]	
Name of the pulse counter	CntPulses Name X	Pulse Counter 1	N/A	N/A	
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]	
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]	
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]	
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]	
Note: X is the pulse counter index, up to 8.					

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]	
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]	
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]	
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]	
Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	OUT	N/A	[IN-OUT]	
Note: X is the analog comparator index, up to 20					

SETPOINT > CONTROL ELEMENTS > FREQUENCY RATE OF CHANGE					
FREQUENCY RATE OF CHANGE 1 > FREQUENCY RATE OF CHANGE 2 > FREQUENCY RATE OF CHANGE 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Direction of the frequency change	Freq. Rate Trend	INCREASING	N/A	[INCREASING - DECREASING - BI-DIRECTIONAL]	
Operation Value in Hz/s	Freq. Rate Pickup	0.50	0.01 Hz/s	[0.10 : 10.00]	
Minimum required voltage in % nominal voltage	Freq. Rate OV Supv	40.00	0.01%	[0.00 : 110.00]	
Minimum Frequency Threshold	Freq. Rate Min	45.00	0.01 Hz	[20.00 : 80.00]	
Maximum Frequency Threshold	Freq. Rate Max	65.00	0.01 Hz	[20.00 : 80.00]	
Frequency rate Trip Delay	Freq. Rate Delay	0.00	0.01 s	[0.00 : 60.00]	
Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > LOAD ENCROACHMENT					
LOAD ENCROACHMENT 1 > LOAD ENCROACHMENT 2 > LOAD ENCROACHMENT 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Minimum positive-sequence voltage required	Min. Voltage	25.00	0.01 V	[0.00 : 300.00]	
Impedance reach of the element	Reach	1.00	0.01 Ohm	[0.02 : 250.00]	
Angle (Size of the blocking region)	Angle	5	1 Deg	[5 : 50]	
Trip Time	Pickup Delay	0.000	0.001 s	[0.000 : 65.535]	
Reset Time	Reset Delay	0.000	0.001 s	[0.000 : 65.535]	
Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS >POWER					
WATT GND FLT HIGH 1> WATT GND FLT HIGH 2 > WATT GND FLT HIGH 3 WATT GND FLT LOW 1> WATT GND FLT LOW 2 > WATT GND FLT LOW 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED-ENABLED]	
Supervision minimum voltage	Voltage Pickup Level	2	0.01 V	[2.00 : 70.00]	
Source of operating current.	Current selection	IN	N/A	[IN-IG]	
Pickup Level for Overcurrent	OC Pickup Level	0,005	0.001A	[0.005 : 0.400]	
Pickup Delay for Overcurrent	OC Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Pickup Level for operating Power	Power Pickup	0,01	0.01 W	[0.01 : 4.50]	
Max torque angle	MTA	0	1 Deg	[0 : 360]	
Pickup Delay for Operating Power	Power Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME - INVERSE TIME - USER CURVE A - USER CURVE B - USER CURVE C - USER CURVE D]	
Multiplier	Multiplier	1	0.01 s	[0.02 : 2.00]	
Snapshot event generation	Snapshot Event	DISABLED	N/A	[DISABLED-ENABLED]	

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O > BOARD F > BOARD G >BOARD H>BOARD J					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
I/O board type (available only for CIO modules)	I/O Board Type_**X**	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV 32 INP 16 INP + 8 ANA]	
Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group C	Voltage Threshold C_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group D	Voltage Threshold D_**X**	80	1 V	[10 : 230]	
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]	
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]	
Debounce time for Group C	Debounce Time C_**X**	15	1 ms	[1 : 50]	
Debounce time for Group D	Debounce Time D_**X**	15	1 ms	[1 : 50]	
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]	
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]	
Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]	
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]	
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]	
Analog Inputs Range	Range_**X**_0**Z**	NONE	N/A	[NONE, -1 to 0mA, 0 to 1 mA, -1 to 1 mA, 0 to 5 mA, 0 to 10 mA]	
Minimum Value	Min_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Maximum Value	Max_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

NOTE 2: DESCRIPTION OF X, Y AND Z IN INPUT/OUTPUT BOARDS			
X	F, G, H or J, the I/O board name, depending on the Relay model.		
	F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module)		
For the I/O board selection in the relay model:	I/O BOARD TYPE		
	ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
	0	NONE	None
	1	16 INP+ 8 OUT	Mixed
	2	8 INP +8 OUT +SUPV	Supervision
	4	32 INP	32 digital inputs
	5	16 INP + 8 ANA	16 digital inputs + 8 analog inputs
CC**Y**	Is the name used for inputs in I/O boards		
	Mixed, 16 digital inputs: CC1….CC16		
	Supervision: 8 digital inputs: CC1,..., CC8		
	32 INP: 32 digital inputs; CC1,...,CC32		
0**Z**	Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,…., 08)		

SETPOINT > INPUTS/OUTPUTS > REMOTE COMMS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]	
SETTING DESCRIPTION FOR GOOSE					
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]	
Device Identification	650 ID	F650	N/A		
Hold time signal send by the transmiting device	Hold Time	10000	1 ms	[1000 : 60000]	
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]	
Remote Device Description	Remote Device X	Remote Device X	N/A		
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
Note: X is the Remote Device index, up to 32					

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN F650
IEEE extremely/very/moderately inverse
IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse
IAC extremely/very/normally/moderately inverse
ANSI extremely/very/normally/moderately inverse
I2t
Definite time
Rectifier curve
User Curve - FlexCurve™ A/B/C/D

NOTE:

SOURCE COLUMN:

This columns allow selecting the simple or complex (OR signal or Virtual output) operand that actives the selected elements on relay configuration

If more than one operands are selected, the relay performs an OR gate with them to activate the selected element.

SIGNAL LOGIC COLUMN:

Refers to each individual signal selected on its left. NOT legend means that the refered signal is inverted

SOURCE LOGIC COLUMN:

Refers to the whole SOURCE signal selected on its left. NOT legend means that SOURCE signal is inverted

If more than one operand were selected, the OR gate output is inverted

SETPOINT>RELAY CONFIGURATION>OUTPUTS				
OUTPUT ID	**OUTPUT NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
CONT OP OPER_F_01	79 BLOCKED	AR BLOCK		
CONT OP OPER_F_02	27/59 PKP	VO_046_59P_PKP		
		VO_045_27P_PKP		
CONT OP OPER_F_03	50/67G PKP	VO_048_50G_PKP		
CONT OP OPER_F_04	51/67G PKP	VO_049_51G_PKP		
CONT OP OPER_F_05	50/67P PKP	VO_051_50PH_PKP		
		VO_050_50PL_PKP		
CONT OP OPER_F_06	51/67P PKP	VO_053_51P_PKP		
CONT OP OPER_F_07	RECLOSE	OPERATION BIT 1		
		AR CLOSE BREAKER		
CONT OP OPER_F_08	TRIP	OPERATION BIT 2		
		VO_083_GENERAL_TRIP		
CONT OP OPER_G_01	Not Configured			
CONT OP OPER_G_02	Not Configured			
CONT OP OPER_G_03	Not Configured			
CONT OP OPER_G_04	Not Configured			
CONT OP OPER_G_05	Not Configured			
CONT OP OPER_G_06	Not Configured			
CONT OP OPER_G_07	Not Configured			
CONT OP OPER_G_08	Not Configured			
CONT OP RESET_F_01	Not Configured			
CONT OP RESET_F_02	Not Configured			
CONT OP RESET_F_03	Not Configured			
CONT OP RESET_F_04	Not Configured			
CONT OP RESET_F_05	Not Configured			
CONT OP RESET_F_06	Not Configured			
CONT OP RESET_F_07	Not Configured			
CONT OP RESET_F_08	Not Configured			
CONT OP RESET_G_01	Not Configured			
CONT OP RESET_G_02	Not Configured			
CONT OP RESET_G_03	Not Configured			
CONT OP RESET_G_04	Not Configured			
CONT OP RESET_G_05	Not Configured			
CONT OP RESET_G_06	Not Configured			
CONT OP RESET_G_07	Not Configured			
CONT OP RESET_G_08	Not Configured			

SETPOINT>RELAY CONFIGURATION>LEDS				
LED ID	**LED NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
LED01	TRIP	VO_083_GENERAL_TRIP		
LED02	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
LED03	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
LED04	27 TRIP	VO_073_27P_TRIP		
LED05	59 TRIP	VO_074_59P_TRIP		
LED06	PICKUP	VO_085_GENERAL_PKP		
LED07	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
LED08	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
LED09	27 PICKUP	VO_045_27P_PKP		
LED10	59 PICKUP	VO_046_59P_PKP		
LED11	79 READY	AR READY		
LED12	79 IN-PROG	AR RCL IN PROGRESS		
LED13	79 BLOCK	AR BLOCK		
LED14	79 INHIBIT	AR CONDS INPUT		NOT
LED15	79 LOCKOUT	AR LOCKOUT		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
LED RESET INPUT	OPERATION BIT 3		
CHANGE LOCAL-REMOTE	Not Configured		
CHANGE OP BLOCKED	Not Configured		
HMI BACKLIGHT ON	Not Configured		
HMI BACKLIGHT OFF	Not Configured		
PH IOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 1		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
PH IOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 2		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
NEUTRAL IOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL IOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL IOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND IOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 3		
SENS GND IOC1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 4		
PH TOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 5		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
PH TOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 5		
NEUTRAL TOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL TOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL TOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND TOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 7		
SENS GND TOC1 BLOCK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC2 BLOCK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC3 BLOCK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 8		
PHASE UV1 BLOCK	GROUP 1 BLOCKED		
PHASE UV2 BLOCK	GROUP 2 BLOCKED		
PHASE UV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ OV1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ OV2 BLOCK	GROUP 2 BLOCKED		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
NEG SEQ OV3 BLOCK	GROUP 3 BLOCKED		
THERMAL1 BLOCK	GROUP 1 BLOCKED		
THERMAL2 BLOCK	GROUP 2 BLOCKED		
THERMAL3 BLOCK	GROUP 3 BLOCKED		
PHASE DIR1 BLK INP	GROUP 1 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
PHASE DIR2 BLK INP	GROUP 2 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
PHASE DIR3 BLK INP	GROUP 3 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
NEUTRAL DIR1 BLK INP	GROUP 1 BLOCKED		
NEUTRAL DIR2 BLK INP	GROUP 2 BLOCKED		
NEUTRAL DIR3 BLK INP	GROUP 3 BLOCKED		
GROUND DIR1 BLK INP	GROUP 1 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR2 BLK INP	GROUP 2 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR3 BLK INP	GROUP 3 BLOCKED		
	LATCHED VIRT IP 10		
NEUTRAL OV1 HIGH BLK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV2 HIGH BLK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV3 HIGH BLK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV1 LOW BLK	GROUP 1 BLOCKED		
NEUTRAL OV2 LOW BLK	GROUP 2 BLOCKED		
NEUTRAL OV3 LOW BLK	GROUP 3 BLOCKED		
AUXILIARY UV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY UV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY UV3 BLOCK	GROUP 3 BLOCKED		
PHASE OV1 BLOCK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV2 BLOCK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV3 BLOCK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 11		
AUXILIARY OV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY OV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY OV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ TOC1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ TOC2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ TOC3 BLOCK	GROUP 3 BLOCKED		
OVERFREQ1 BLOCK	GROUP 1 BLOCKED		
OVERFREQ2 BLOCK	GROUP 2 BLOCKED		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
OVERFREQ3 BLOCK	GROUP 3 BLOCKED		
UNDERFREQ1 BLOCK	GROUP 1 BLOCKED		
UNDERFREQ2 BLOCK	GROUP 2 BLOCKED		
UNDERFREQ3 BLOCK	GROUP 3 BLOCKED		
SETT GROUPS BLOCK	Not Configured		
BROKEN CONDUCT1 BLK	GROUP 1 BLOCKED		
BROKEN CONDUCT2 BLK	GROUP 2 BLOCKED		
BROKEN CONDUCT3 BLK	GROUP 3 BLOCKED		
ISOLATED GND1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
ISOLATED GND2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
ISOLATED GND3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
SENS GND DIR1 BLK IP	GROUP 1 BLOCKED		
SENS GND DIR2 BLK IP	GROUP 2 BLOCKED		
SENS GND DIR3 BLK IP	GROUP 3 BLOCKED		
FWD PWR1 BLOCK	GROUP 1 BLOCKED		
FWD PWR2 BLOCK	GROUP 2 BLOCKED		
FWD PWR3 BLOCK	GROUP 3 BLOCKED		
PH TOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 6		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
PH TOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 6		
DIR PWR1 BLOCK	GROUP 1 BLOCKED		
DIR PWR2 BLOCK	GROUP 2 BLOCKED		
DIR PWR3 BLOCK	GROUP 3 BLOCKED		
LOCKED ROTOR1 BLK	GROUP 1 BLOCKED		
LOCKED ROTOR2 BLK	GROUP 2 BLOCKED		
LOCKED ROTOR3 BLK	GROUP 3 BLOCKED		
FREQ RATE1 BLOCK	GROUP 1 BLOCKED		
FREQ RATE2 BLOCK	GROUP 2 BLOCKED		
FREQ RATE3 BLOCK	GROUP 3 BLOCKED		
LOAD ENCR1 BLOCK	GROUP 1 BLOCKED		
LOAD ENCR2 BLOCK	GROUP 2 BLOCKED		
LOAD ENCR3 BLOCK	GROUP 3 BLOCKED		
32N1 HIGH BLOCK	GROUP 1 BLOCKED		
32N2 HIGH BLOCK	GROUP 2 BLOCKED		
32N3 HIGH BLOCK	GROUP 3 BLOCKED		
32N1 LOW BLOCK	GROUP 1 BLOCKED		
32N2 LOW BLOCK	GROUP 2 BLOCKED		
32N3 LOW BLOCK	GROUP 3 BLOCKED		
THERMAL1 A RST	OPERATION BIT 4		
THERMAL1 B RST	OPERATION BIT 4		
THERMAL1 C RST	OPERATION BIT 4		
THERMAL2 A RST	OPERATION BIT 4		
THERMAL2 B RST	OPERATION BIT 4		
THERMAL2 C RST	OPERATION BIT 4		
THERMAL3 A RST	OPERATION BIT 4		
THERMAL3 B RST	OPERATION BIT 4		
THERMAL3 C RST	OPERATION BIT 4		
Synchrocheck BLK INP	Not Configured		
AR LEVEL BLOCK	CONT IP_F_CC8 (79 BLOCK)(CC8)		
	LATCHED VIRT IP 14		
AR PULSE BLOCK	Not Configured		
AR PULSE UNBLOCK	Not Configured		
AR INITIATE	VO_083_GENERAL_TRIP		
	CONT IP_F_CC7 (79 INITIATE)(CC7)		
	LATCHED VIRT IP 13		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
AR CONDS INPUT	SYNCHK CLOSE PERM	NOT	NOT
	LATCHED VIRT IP 15		
BKR FAIL INITIATE	Not Configured		
GROUP 1 ACT ON	Not Configured		
GROUP 2 ACT ON	Not Configured		
GROUP 3 ACT ON	Not Configured		
FAULT REPORT TRIGG	VO_083_GENERAL_TRIP		
CLEAR FAULT REPORTS	Not Configured		
DEMAND TRIGGER INP	Not Configured		
DEMAND RESET INP	OPERATION BIT 7		
FREEZE ENERGY CNT	Not Configured		
UNFREEZE ENERGY CNT	Not Configured		
RESET ENERGY CNT	OPERATION BIT 6		
RESET KI2t COUNTERS	OPERATION BIT 5		
RESET BKR COUNTERS	OPERATION BIT 5		

SETPOINT>RELAY CONFIGURATION>OSCILLOGRAPHY				
DIGITAL CHANNEL	**NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
DIG_CHANNEL#1	TRIP	VO_083_GENERAL_TRIP		
DIG_CHANNEL#2	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
DIG_CHANNEL#3	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
DIG_CHANNEL#4	27 TRIP	VO_073_27P_TRIP		
DIG_CHANNEL#5	59 TRIP	VO_074_59P_TRIP		
DIG_CHANNEL#6	PICKUP	VO_085_GENERAL_PKP		
DIG_CHANNEL#7	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
DIG_CHANNEL#8	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
DIG_CHANNEL#9	27 PICKUP	VO_045_27P_PKP		
DIG_CHANNEL#10	59 PICKUP	VO_046_59P_PKP		
DIG_CHANNEL#11	79 READY	AR READY		
DIG_CHANNEL#12	79 IN-PROG	AR RCL IN PROGRESS		
DIG_CHANNEL#13	79 BLOCK	AR BLOCK		
DIG_CHANNEL#14	79 INHIBIT	AR CONDS INPUT	NOT	
DIG_CHANNEL#15	79 LOCKOUT	AR LOCKOUT		
DIG_CHANNEL#16	Not Configured			
OSCILLO TRIGGER	OSCILLO TRIGGER	OPERATION BIT 8		
		VO_083_GENERAL_TRIP		

SETPOINT>RELAY CONFIGURATION>OPERATIONS			
OPERATION	**OPERATION TEXT**	**SETTINGS**	**VALUE/SOURCE**
Operation1	CLOSE BREAKER	INTERLOCK(LOGIC)	SYNCHK CLOSE PERM
		FINAL STATES AND LOGIC	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL

SETPOINT>RELAY CONFIGURATION>OPERATIONS			
OPERATION	**OPERATION TEXT**	**SETTINGS**	**VALUE/SOURCE**
Operation2	OPEN BREAKER	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	BREAKER OPEN
		FRONT KEY	O Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation3	LEDS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation4	THERMAL RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation5	BRK COUNTERS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation6	ENERGY RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation7	DEMAND RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation8	TRIGGER OSCILLO	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL

SETPOINT>RELAY CONFIGURATION>OPERATIONS			
OPERATION	**OPERATION TEXT**	**SETTINGS**	**VALUE/SOURCE**
Operation9	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
.....	.....	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation24	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured

SETPOINT>RELAY CONFIGURATION>EVENTS				
EVENT	**NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
EV1	Not Configured			
EV2	Not Configured			
...	...			
EV128	Not Configured			

SETPOINT>RELAY CONFIGURATION>SWITCHGEAR				
SWITCHGEAR	**SETTING**	**VALUE/SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
SWITCHGEAR 1	CONTACTS	52b		
	OPENING TIME	1000		
	CLOSING TIME	1000		
	CONTACT A SOURCE	N/A		
	CONTACT B SOURCE	CONT IP_F_CC1 (52b)(CC1)		
	OPEN TEXT	52 OPEN		
	ALARM	NO		
	CLOSED TEXT	52 CLOSE		
	ALARM	NO		
	ERROR 00 TEXT	52 ERROR		
	ALARM	N/A		
	ERROR 11 TEXT	52 UNDEFINED		
	ALARM	N/A		
	OPENING INIT	OPERATION BIT 2		
	CLOSING INIT	OPERATION BIT 1		

SETPOINT>RELAY CONFIGURATION>SWITCHGEAR				
SWITCHGEAR	**SETTING**	**VALUE/SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
SWITCHGEAR 2	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
...	...	...	...	...
SWITCHGEAR 16	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

GE MULTILIN RELAY WARRANTY

GE Power Management, S.A. (GE Multilin) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Multilin will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service center or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay, which has been subject to misuse, negligence, accident, incorrect installation, or use not in accordance with instructions nor any unit that has been altered outside a GE Multilin authorized factory outlet.

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.

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