GE Consumer & Industrial
Multilin

G650

Generator Protection & Control System

Instruction manual

GEK-113285A

Firmware version: 3.74

EnerVista 650 Setup version: 3.76

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1.1.1 CAUTIONS AND WARNINGS

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 G650 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.

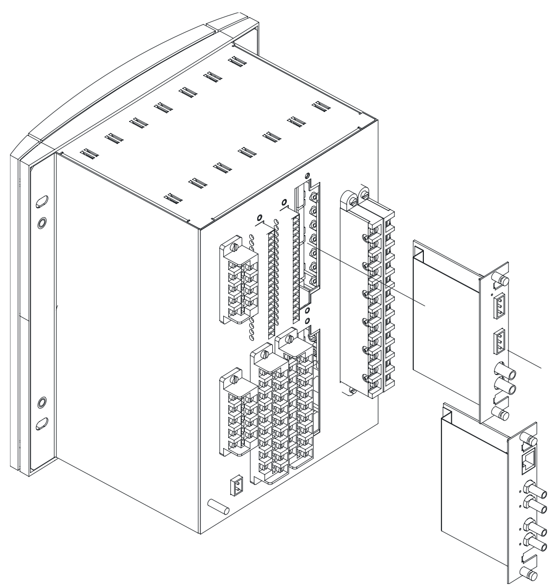

Figure 1–2: MODULE WITHDRAWAL/INSERTION

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.

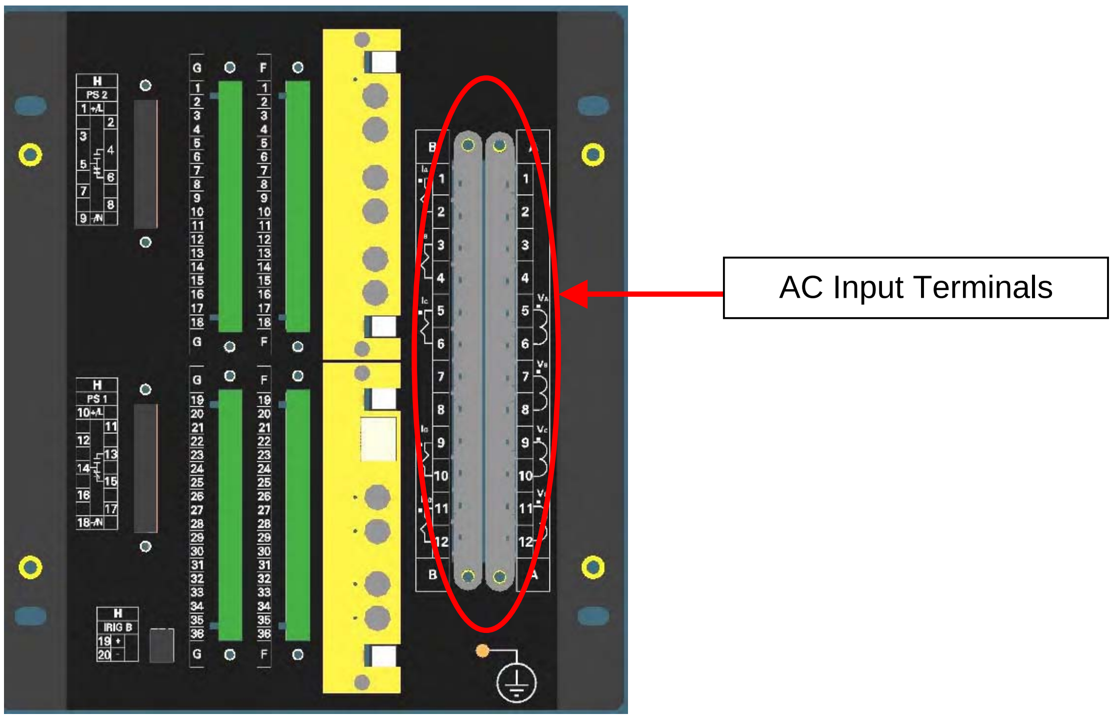

Figure 1–3: REAR VIEW OF G650 UNIT

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

1.1.2 INSPECTION CHECKLIST

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.

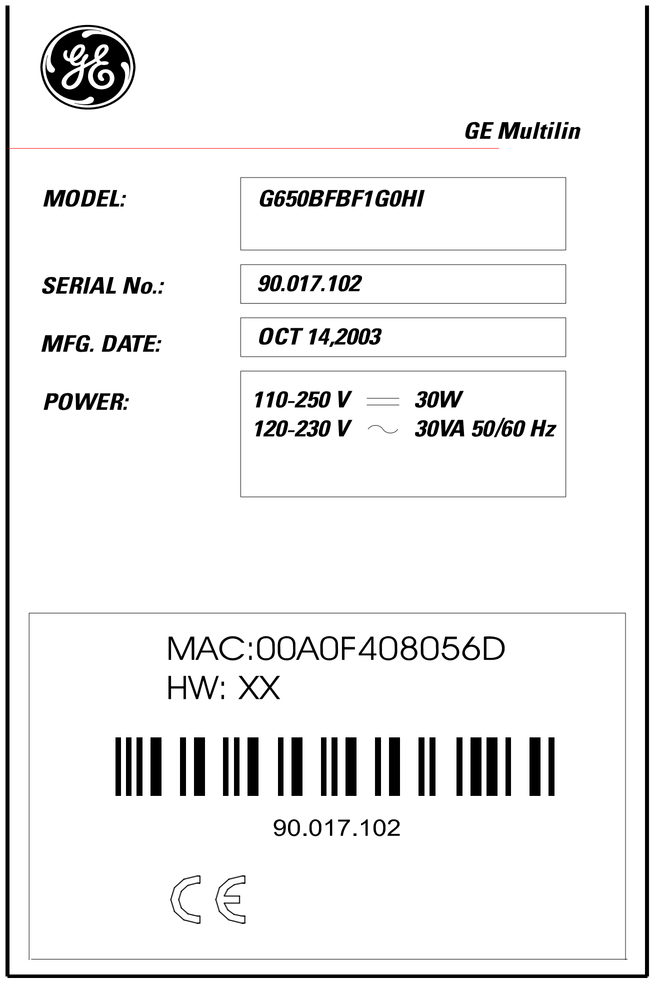

Figure 1–4: IDENTIFICATION LABEL (A4454P30)

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.

1.1.3 SAFETY INSTRUCTIONS

The G650 ground screw shown in Figure 1–5: must be correctly grounded.

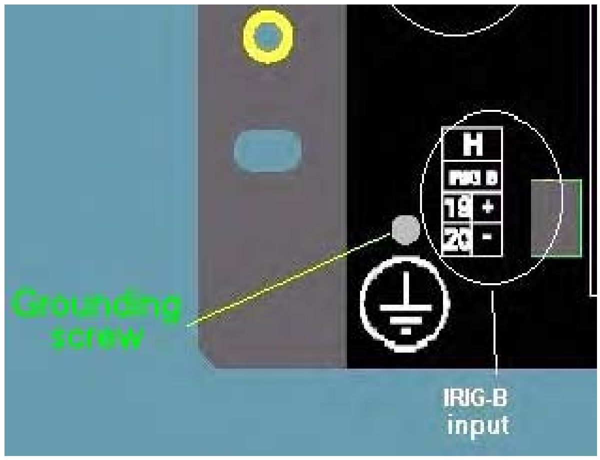


Figure 1–5: LOCATION OF GROUNDING SCREW

Before communicating with a G650 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.

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

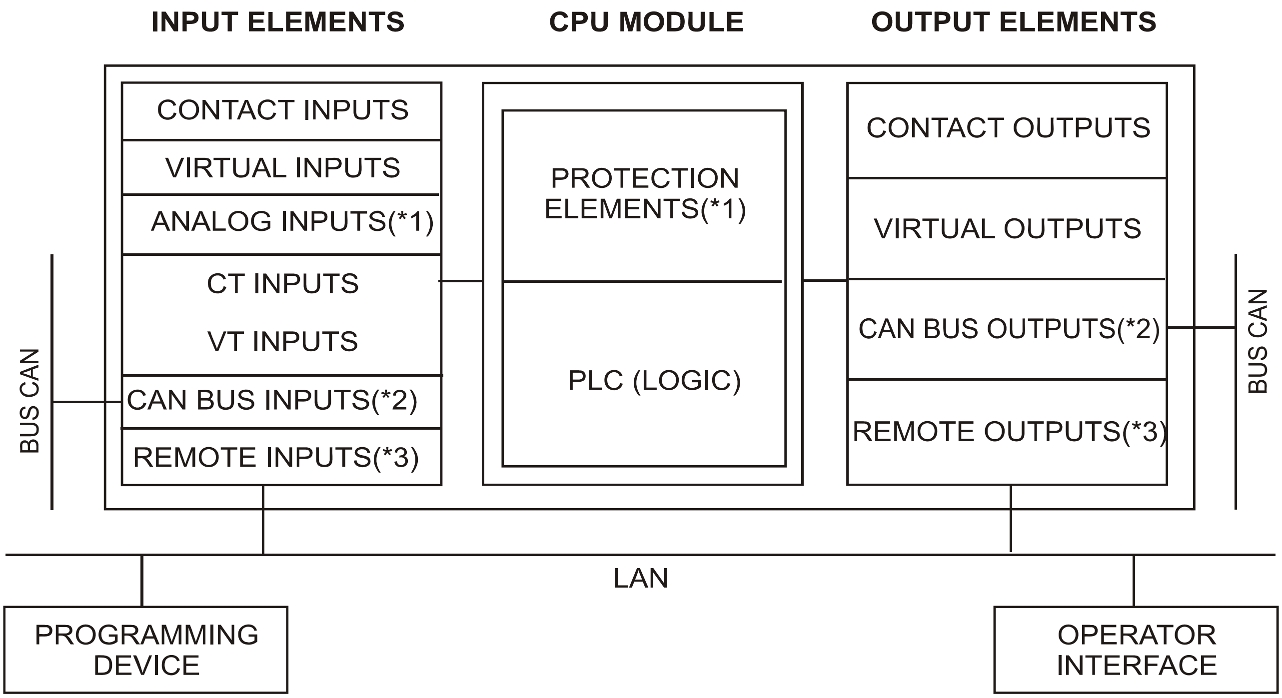
650 family of relays has been designed to meet the goals described above that are appearing nowadays in the environment of new substations.

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.



(*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.Remote I/O are not available for G650 models. 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 G650 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 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.

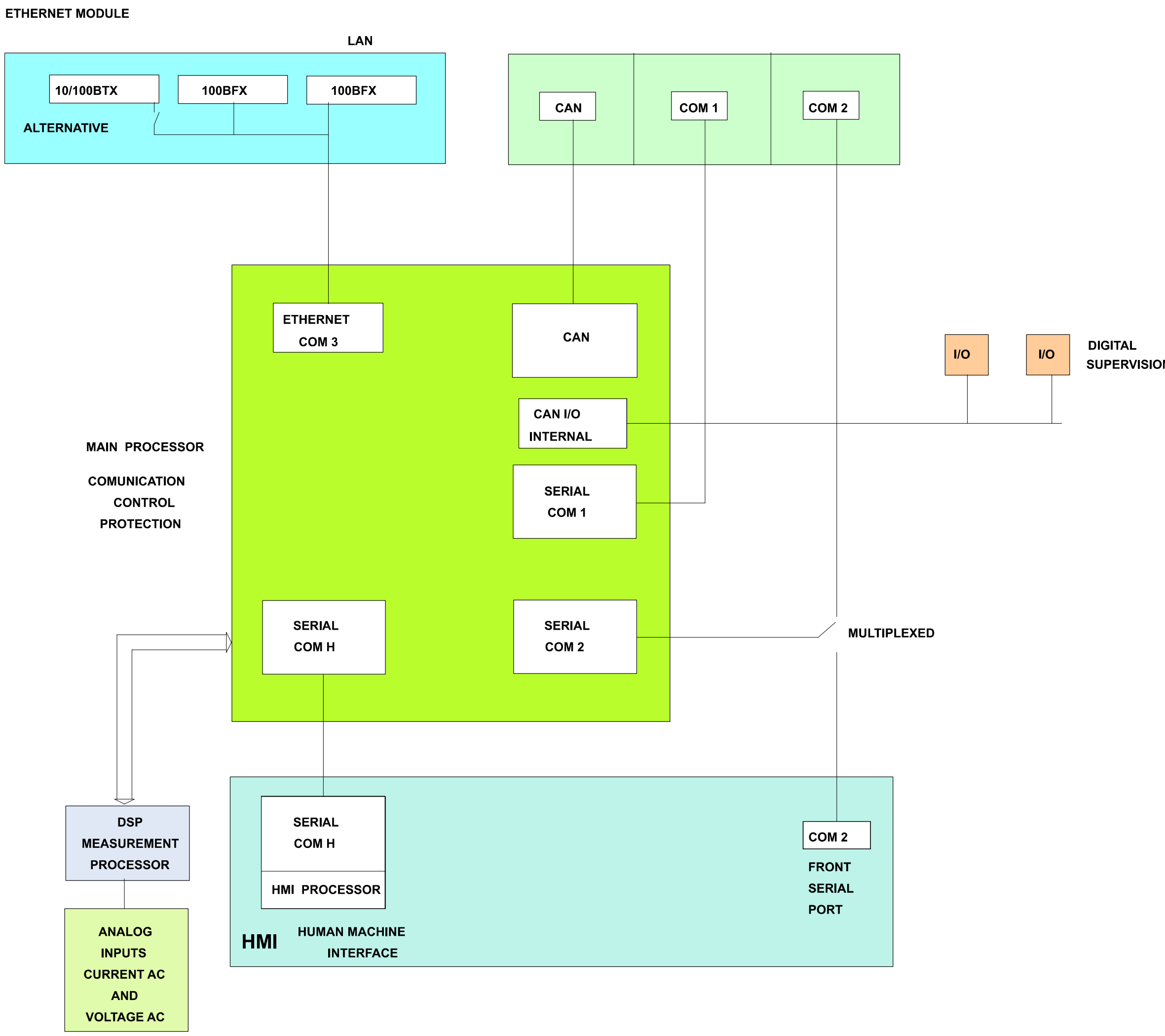


Figure 1–7: COMMUNICATIONS ARCHITECTURE (B6816F1)

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

5. In the EnerVista Launch Pad window, click the **Add Product** button and select the “G650 Generator Protection & Control System” 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 G650.

Figure 1–9: ADD PRODUCT WINDOW

6. If “Web” option is selected, choose the G650 software program and release notes (if desired) from the list and click the **Download Now** button to obtain the installation program.

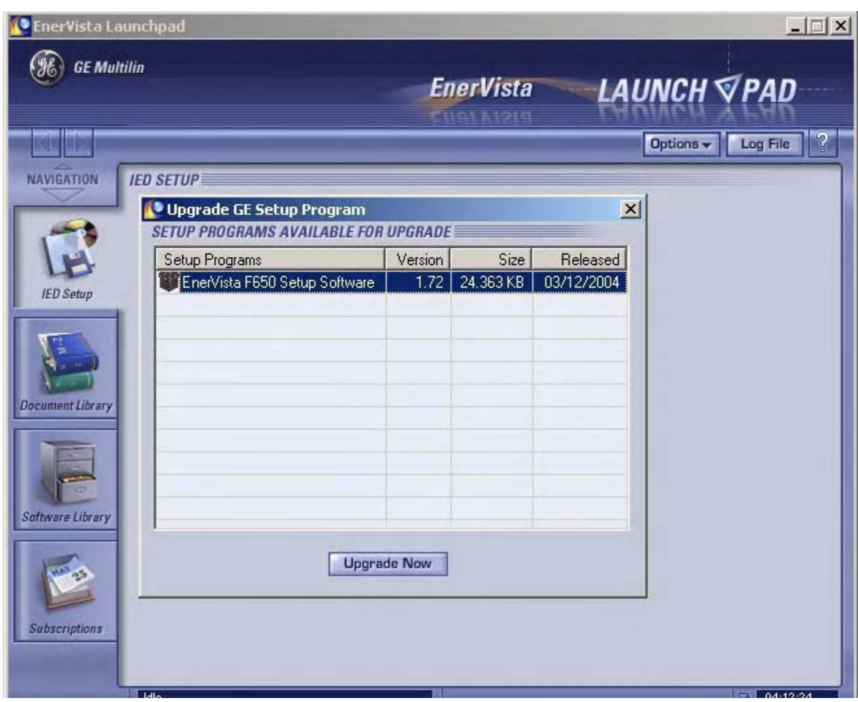


Figure 1–10: WEB UPGRADE WINDOW

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.

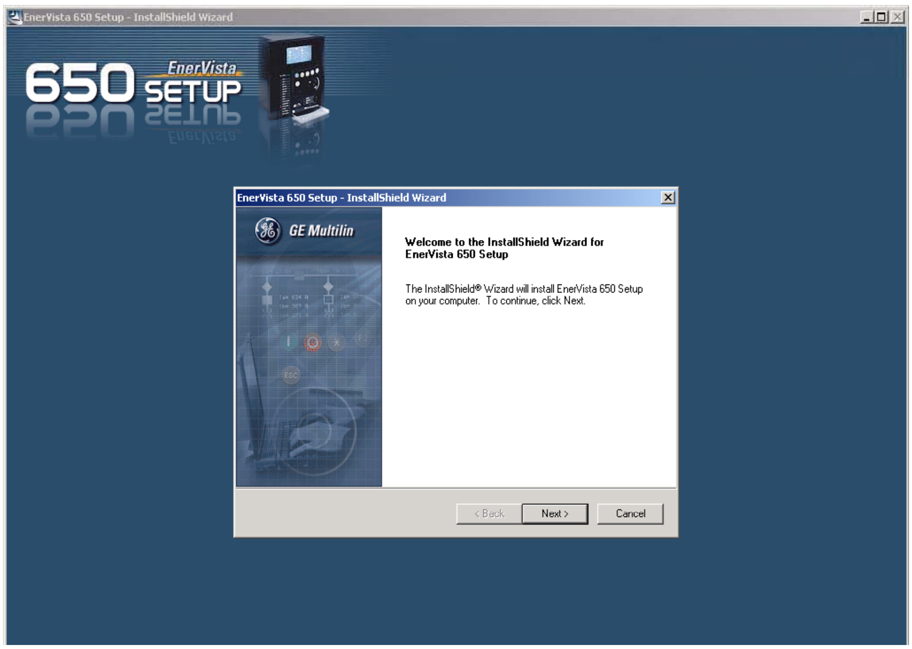


Figure 1–11: ENERVISTA 650 SETUP INSTALLATION

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.

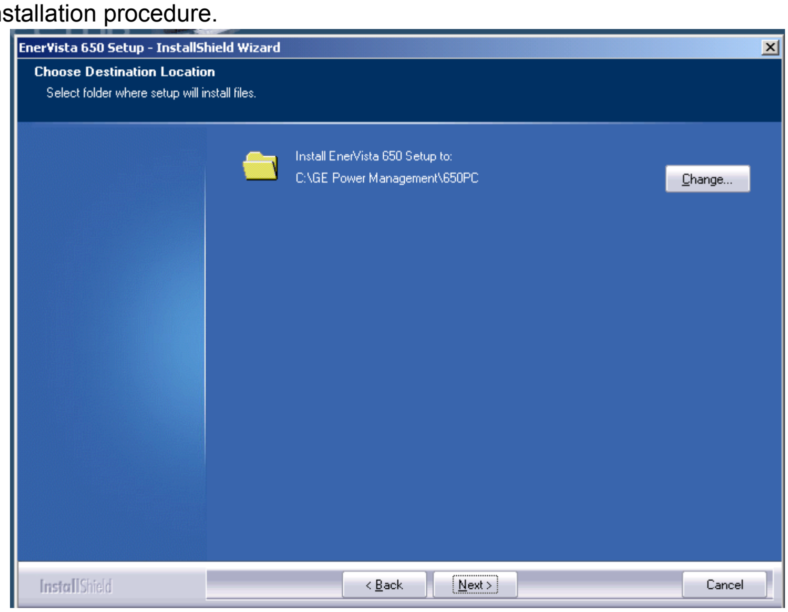


Figure 1–12: ENERVISTA 650 SETUP INSTALLATION CONT.

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.

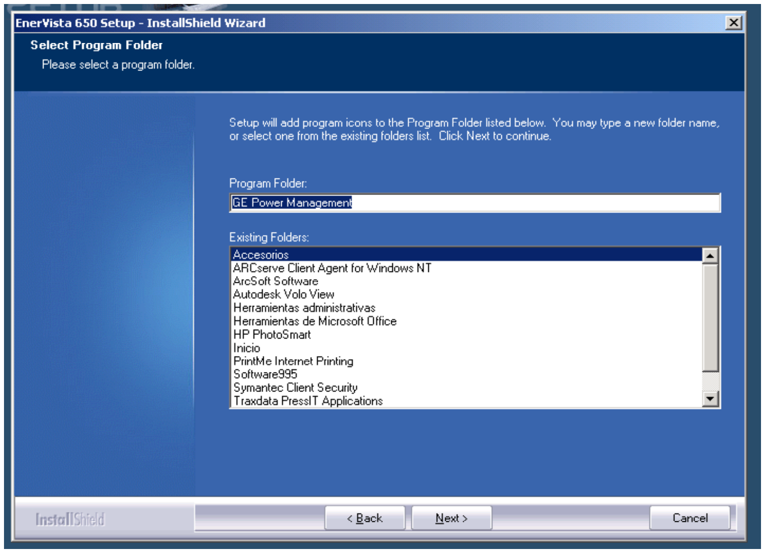


Figure 1–13: SELECT PROGRAM FOLDER

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

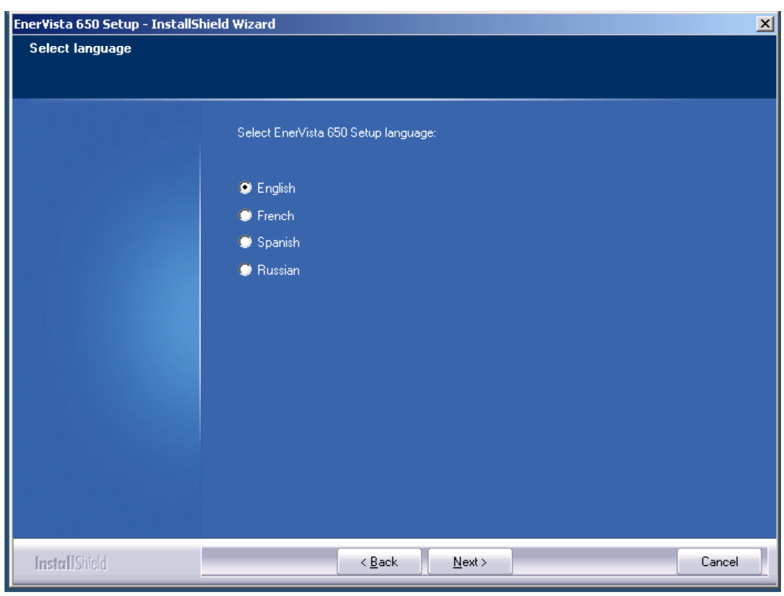


Figure 1–14: LANGUAGE WINDOW

14. Click **Finish** to end the installation. The G650 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 G650

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 G650 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 G650 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(*).

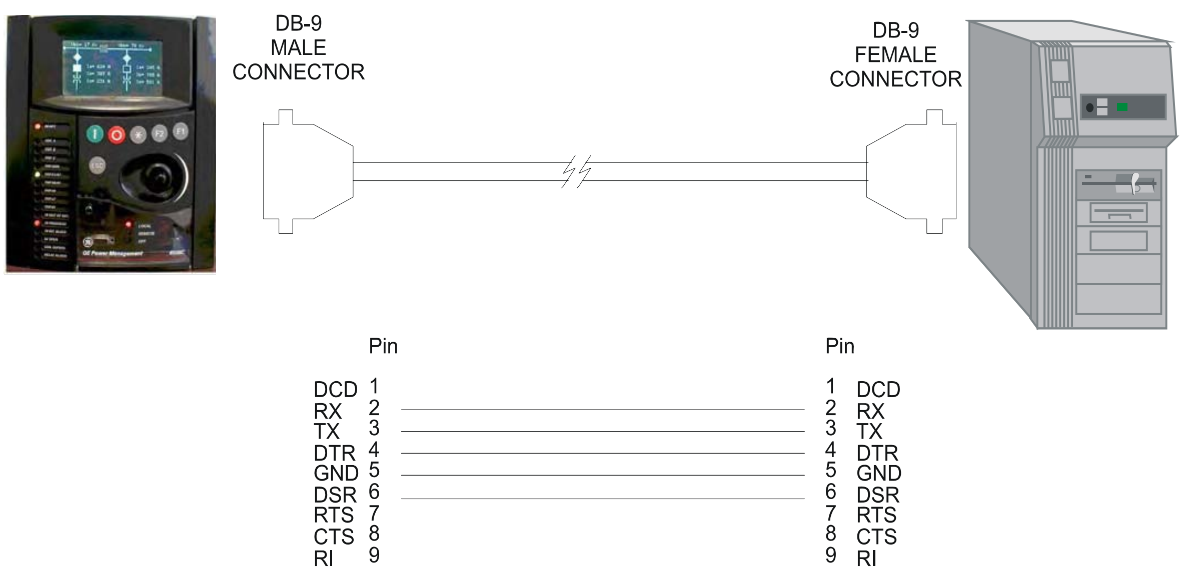


Figure 1–16: RELAY- PC CONNECTION FOR RS232 FRONT PORT

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.

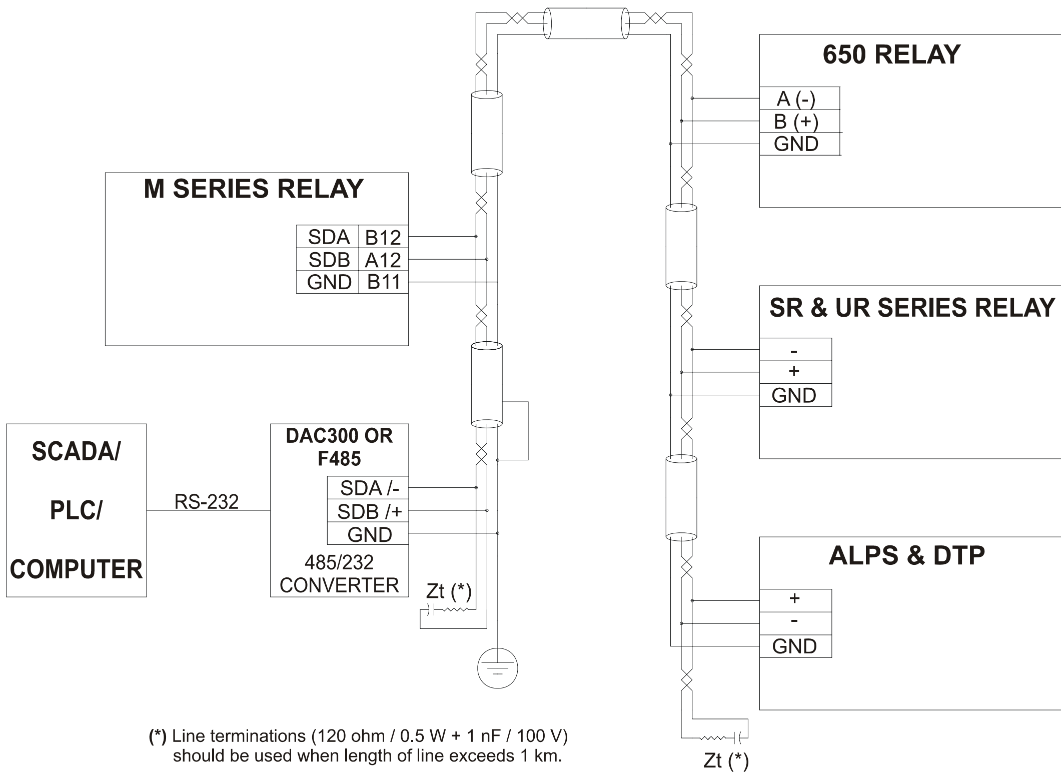


Figure 1–17: RS485 CONNECTION FOR 650 UNITS

To communicate through the G650 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

G650 requires a minimum amount of maintenance when it is commissioned into service. G650 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 G650 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.

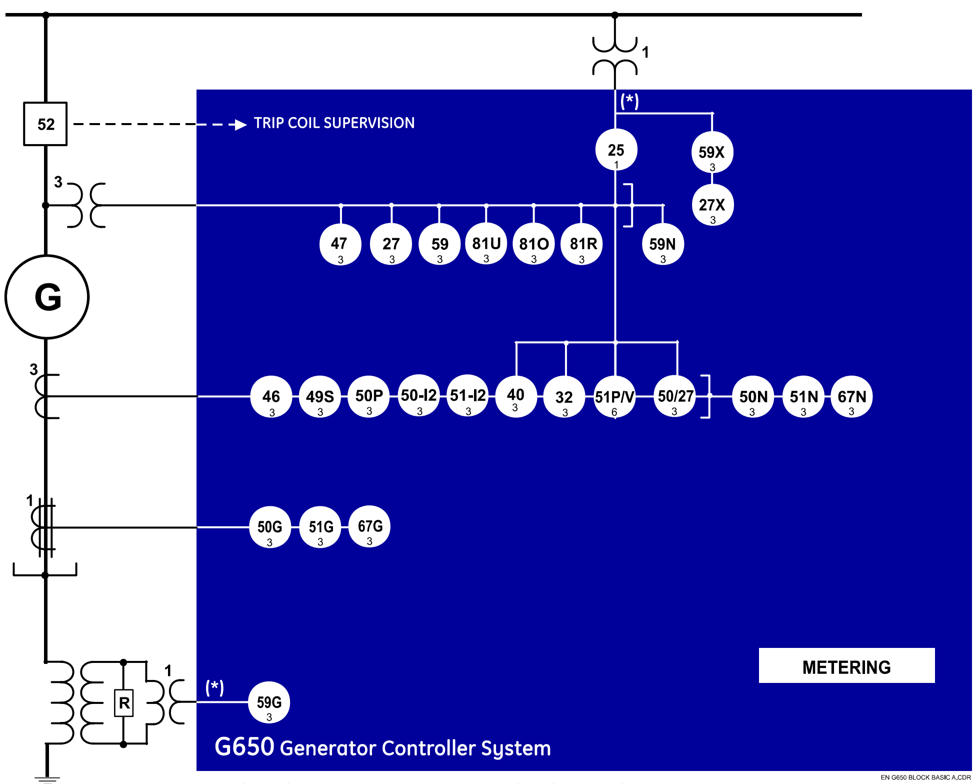
If it is concluded that the relay or one of its modules is of concern, contact GE Multilin or one of its representative for prompt service.

2.1.1 G650 OVERVIEW

The G650 is a machine generator protection and control device. It may be used to protect and control reciprocating machines, as well as to operate as a packaged generator sets mains failure detector. Generally speaking the G650 provides distributed generation management capabilities.

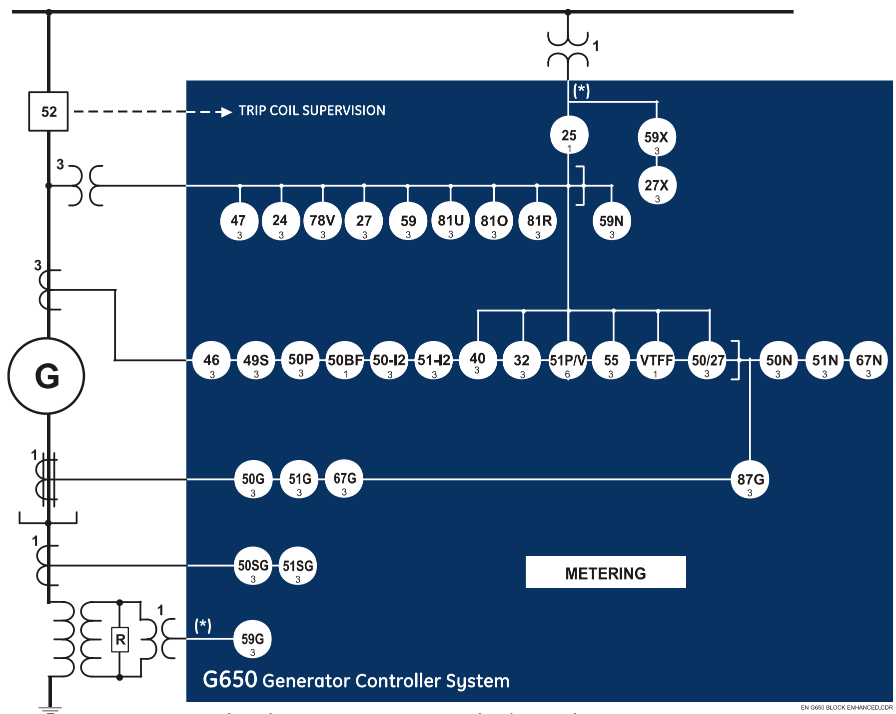
The main features of G650 devices include:

- Protection relay with control capabilities for protection of small and medium generators.
- Replacement for legacy devices in the long term based on improved and open protocols in communications as well as orientation to machine protection system rather than individual protection functions.
- Based on the 650 platform.
- Full graphic capabilities in large display with control functions and PLC programming.
- Protection elements repeated in three groups, used as independent groups or all elements at the same time.



(*) The relay incorporates one single-phase voltage input. Thus, protection elements 25 and 59G cannot be used simultaneously.

Figure 2–1: G650 BLOCK DIAGRAM FOR BASIC FUNCTIONALITY MODELS



(*) The relay incorporates one single-phase voltage input. Thus, protection elements 25 and 59G cannot be used simultaneously.

Figure 2–2: G650 BLOCK DIAGRAM FOR ENHANCED FUNCTIONALITY MODELS

2.2.1 ANSI DEVICE NUMBERS AND FUNCTIONS

DEVICE NUMBER	FUNCTION
24	Volt/Hertz ***(only enhanced model)***
25	Synchronism Check
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32DIR	Directional Power
40	Loss of Excitation
46	Generator Unbalance
47	Negative Sequence Overvoltage
49S	Generator thermal model
50/27	Inadvertent Generator Energization
50-2/51-2	Negative Sequence IOC/TOC
50BF	Breaker Failure (*only enhanced model*)
50G	Ground Instantaneous Overcurrent (measured from 4th current transformer)
50N	Neutral Instantaneous Overcurrent (calculated from the phase currents)
50P	Phase Instantaneous Overcurrent
51G	Ground Time Overcurrent (measured from 4th current transformer)
51N	Neutral Time Overcurrent (calculated from the phase currents)
51P/V	Voltage Restraint Overcurrent
50SG/51SG	Sensitive Ground Fault ***(only enhanced model)***
55	Power Factor Limiting (*Only enhanced model*)
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59G	Ground Overvoltage
67N	Neutral directional
67G	Ground Directional
78V	Phase shift / Loss of mains ***(only enhanced model)***
810	Overfrequency
81U	Underfrequency
81R	Frequency Rate of Change
87G	Restricted Ground Fault ***(only enhanced model)***
VTFF	VT Fuse Failure ***(only enhanced model)***

2.2.2 OTHER DEVICE FUNCTIONS

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
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

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)
Operations (up to 24)
Web Server Application

G650 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 G650 model is shown on Table 2–1:

Table 2–1: ORDERING CODE

G650	-	-	-	F	-	G	-	-	-	-	-	DESCRIPTION
	B											Basic Display (4x20 characters) and basic protection functionality (see Note 2)
	M											Graphic Display (240x128 pixels) with Standard Symbols and basic protection functionality (see Note 2)
	N											Graphic Display with IEC symbols (240x128 pixels) and basic protection functionality (see Note 2)
	E											Basic Display (4x20 characters) and enhanced protection functionality (see Note 2)
	C											Graphic Display (240x128 pixels) with Standard Symbols and enhanced protection functionality (see Note 2)
	D											Graphic Display with IEC symbols (240x128 pixels) and enhanced protection functionality (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
										5		Procome, Modbus® RTU,TCP/IP
												ENVIRONMENTAL PROTECTION
											-	Without Harsh (Chemical) Environment Conformal Coating
											H	Harsh (Chemical) Environment Conformal Coating

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) The Protection functionality description for basic and enhanced models is listed in section 2.2.1: ANSI DEVICE NUMBERS AND FUNCTIONS on page 2–3.

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

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 (50PH50G)

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 NEGATIVE SEQUENCE TIME OVERCURRENT (51-2)

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

2.4.1.9 NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT (50-2)

Current Input	Fundamental Phasor (without harmonics)
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 0.1 to 10 A ±1.5% of the reading for higher values
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	Operate at 1.00 times the pickup ±3% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2

2.4.1.10 GENERATOR UNBALANCE (46)

Gen. nominal current	0.00 to 10.00 A in steps of 0.01 A (rated full load current of the machine)
Stages	2 ((I2t with linear reset and definite time))
Pickup level	0.00 to 100.00% in steps of 0.01
Dropout level	97% to 98 % of the pickup level
Level Accuracy	Values at nominal frequency
	±0.5% of the reading ± 10 mA from 0.1 to 10 A
	±1.5% of the reading for higher values
Time dial (K-value)	0.00 to 100.00 in steps of 0.01
Pickup delay	0.0 to 1000.0 s in steps of 0.1
Reset delay	0.0 to 1000.0 s in steps of 0.1
Operate time	<50 ms at 50 Hz, typically
Timing accuracy	±3% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

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 00 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 00 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 GENERATOR THERMAL MODEL (49S)

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
K1 constant	0.0 to 8.0 in steps of 0.1 (Negative sequence influence)
Snapshot Events	Selectable by setting

2.4.1.14 RESTRICTED GROUND FAULT (87G)

Pickup level	0.02 to 20.00 in units of Phase CT Primary in steps of 0.01
Dropout level	97% to 98 % of the pickup level
Slope	0.00 to 100.00 % in steps of 0.01%
Trip delay	0.00 to 600.00 s in steps of 0.01 s
Operate time	<50 ms at 50 Hz, typically
Timing accuracy	±3% of operate time or 50 ms. (whichever is greater)
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 500 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 500 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 500 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 500 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 500 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)

Voltage Input	Fundamental Phasor of the neutral voltage (calculated from phases)
Pickup level	3 to 500 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 500 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 GROUND OVERVOLTAGE (59G)

Voltage Input	Fundamental Phasor of the ground voltage (measured from 4th voltage transformer)
Pickup level	3 to 500 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 500 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

2.4.1.19 AUXILIARY OVERVOLTAGE (59X)

Voltage Input	Fundamental Phasor of the auxiliary voltage
Pickup level	3 to 500 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 500V 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 500 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 500 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 VOLTS PER HERTZ (24)

Voltage Input	Fundamental Phasor of phases or auxiliary voltage input (selectable by setting)
Minimum Voltage	30.00 to 500.00 in steps of 0.01 V
Pickup level	0.80 to 4.00 in steps of 0.01 pu V/Hz
Dropout level	97% to 98 % of the pickup level
Level accuracy	±0.02 pu
Timing Curves	Definite Time, Inverse A, B and C
TD Multiplier	0.05 to 600.00 s in steps of 0.01
Reset delay	0.0 to 900.0 s. in steps of 0.1 s
Timing accuracy	±3.5% of operate time or 10 cycles (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.22 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 00V 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 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 00V in steps of 1 V
Timing accuracy	±3.5% of operate time or 100 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.1.24 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 POWER FACTOR LIMITING (55)

Lead Pickup level	0.05 to 0.99 in steps of 0.01
Lag Pickup level	0.05 to 0.99 in steps of 0.01
Dropout level	97% to 98 % of the pickup level
Level accuracy	±0.02
Stages	2 for Lead 2 for Lag
Trip delay	0.2 to 300.0 in steps of 0.1 s
Timing accuracy	±3.5% of operate time or 100 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2 CONTROL

2.4.2.1 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

2.4.2.2 FUSE FAILURE

Algorithm based on positive sequence of voltage and current
Activation by V_2/V_1 ratio

2.4.2.3 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

2.4.2.4 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]

2.4.2.5 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

2.4.2.6 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

2.4.2.7 INADVERTED GENERATOR ENERGIZATION (ACCIDENTAL ENERGIZATION) (50/27)

Operating condition	Overcurrent
Arming condition	Undervoltage and/or Machine Offline
Overcurrent	
Pickup level	0.00 to 160.00 A in steps of 0.01 A
Dropout level	97% to 98% of pickup level
Level Accuracy	Values at nominal frequency ±0.5% of the reading ± 10 mA from 0.1 to 10 A ±1.5% of the reading for higher values
Undervoltage	
Pickup level	0.00 to 500.00 V in steps of 0.01 V
Dropout level	102% to 103% of pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 500 V at nominal frequency
Operate time	<50 ms at 50 Hz, typically
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2.8 PHASE SHIFT-LOSS OF MAINS (78V)

Loss of Mains Mode	One Phase
Phase Shift Angle	2.00 to 22.00 in steps of 0.01 degrees
Minimum Voltage	30 to 500 in steps of 1 V
Level accuracy	± 3º
Timing accuracy	±3.5% of operate time or 60 ms (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2.9 LOSS OF EXCITATION (40)

Operating condition	Positive-sequence impedance
Characteristic	2 independent offset mho circles (Stages 1 and 2)
Center	0.10 to 300.00. Ω (sec.) in steps of 0.01
Radius	0.10 to 300.00. Ω (sec.) in steps of 0.01
Reach accuracy	±3%
Undervoltage supervision	Selectable by setting
UV superv. Level	0.0 to 500.0 v in steps of 0.1 V
Trip delay	0.00 to 65.54 s in steps of 0.01 s
Operate time	<50 ms at 50 Hz, typically
Timing accuracy	±3.5% of operate time or 50 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2.10 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

2.4.2.11 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

2.4.2.12 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:	250, 450, 900, 1800 or 3600 Hz
Full storage capacity:	1 Mb
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 plus one plc cycle using an internal clock of 100 μs. For Digital Inputs, the debounce time of these digital inputs must be added.
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 500 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:	±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. G650 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	500 Vac
Metering range:	From 2 to 500 Vac
Relay Burden:	0.05 VA at 120 Vac (50 or 60 Hz)
Voltage Withstand:	Continuous at 500 V to neutral
	1 min/hr at 800 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:	10 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 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

2.4.6.5 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.

2.4.9 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
	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

2.4.11 OPTIC FEATURES

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	I	Shock and bump
	IEC 60255-21-3	II	Seismic

Type test report available upon request.

G650 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.

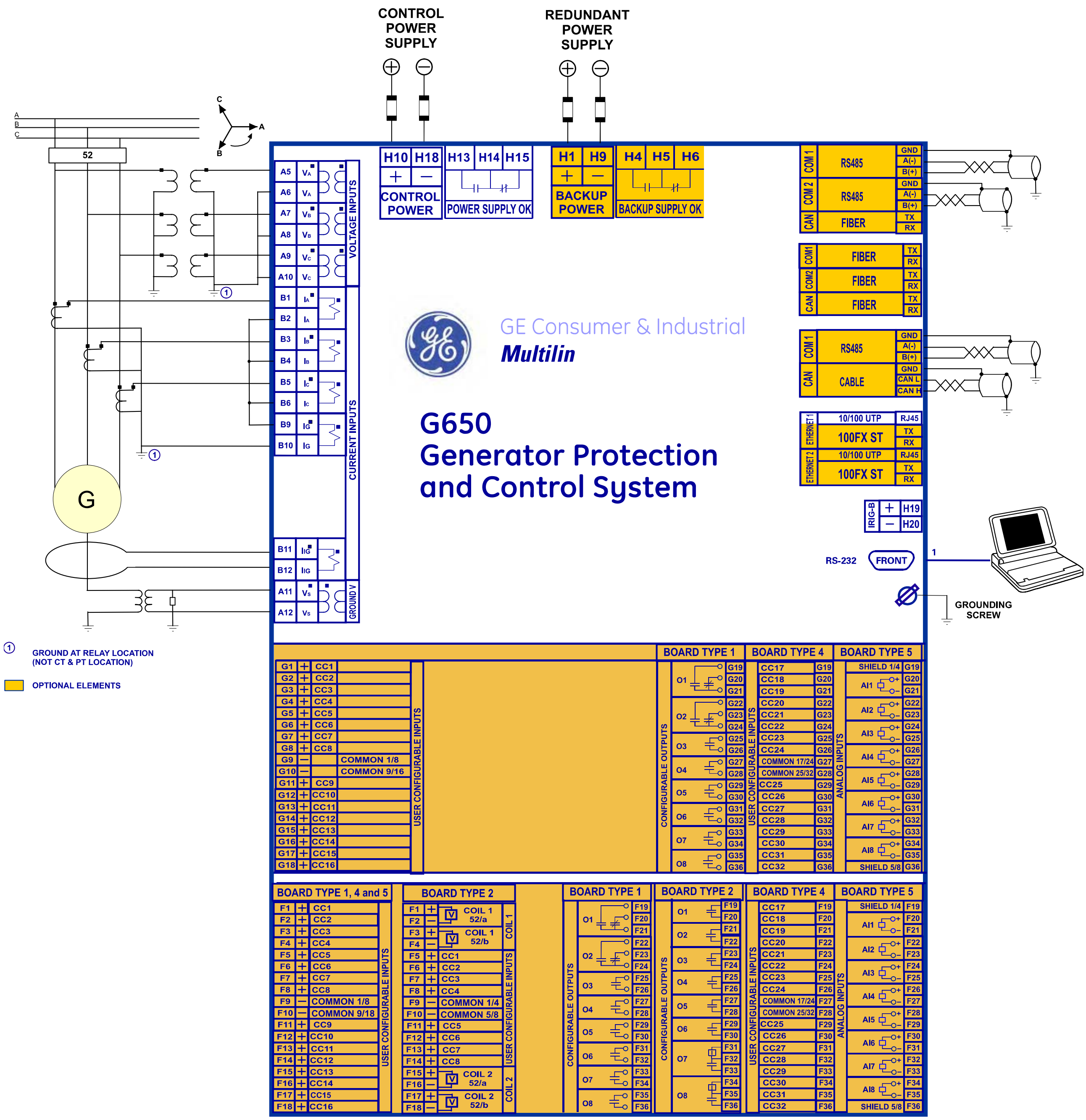


Figure 2–3: G650 WIRING DIAGRAM (189C4216H17R1)

SLOT F CONFIGURATION (BOARD TYPE 1)

INPUTS F1 (USER CONFIGURABLE INPUTS)

F1	+	CC1	52b
F2	+	CC2	50P BLOCK
F3	+	CC3	51P BLOCK
F4	+	CC4	50-2 BLOCK
F5	+	CC5	50G BLOCK
F6	+	CC6	51G BLOCK
F7	+	CC7	51-2 BLOCK
F8	+	CC8	67G 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	FREQ PICKUP
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	MANUAL CLOSE
O8	F35, F36	TRIP

SLOT F CONFIGURATION (BOARD TYPE 2)

INPUTS F2

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

OUTPUTS F2 (USER CONFIGURABLE OUTPUTS)

O1	F19, F20	FREQ PICKUP
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	MANUAL CLOSE
I SENS O8	F34, F35, F36	TRIP

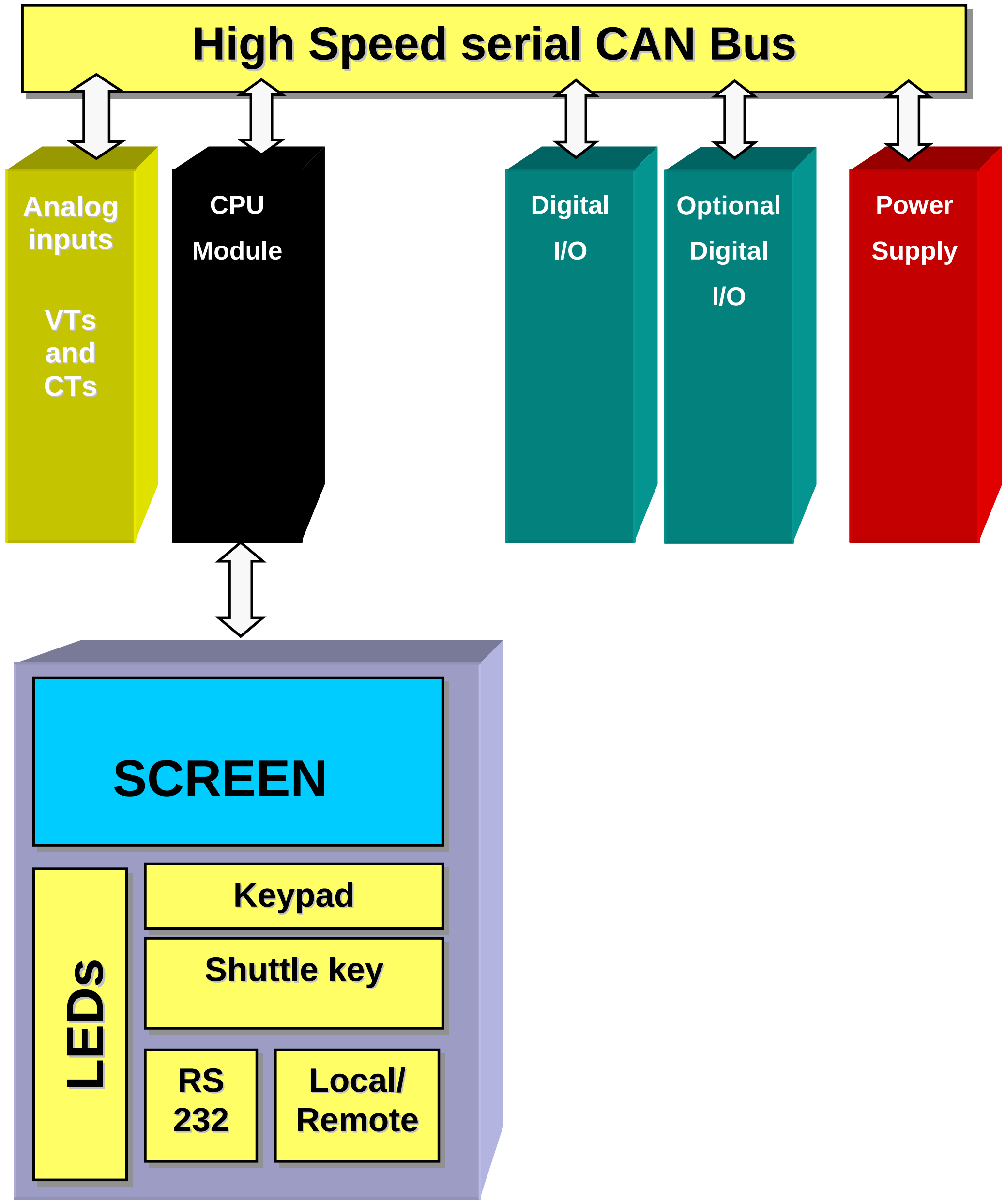


Figure 3–1: BLOCK DIAGRAM

G650 units incorporate the following modules:

- **Power supply**, which can be simple or redundant, depending on the selected model
- **Front module with alphanumerical (4 x 20) or optional graphical (16 x 40 characters) display.** It includes the bus on its rear, which communicates with the rest of modules via a high speed CAN bus.
- **Transformers module** with 5 current transformers and 4 voltage transformers
- **CPU** including a powerful DSP for measure processing as well as synchronous and asynchronous communication accessories.
- **Input/Output module** included in basic unit
- Optionally, a **second I/O module** can be added.

G650 can incorporate a simple or redundant power supply.

The power supply module is fixed to the base plate using 4 screws, and the main and backup modules are identical.

These modules work in parallel continuously, distributing the 50% of the load for each of them, thus ensuring greater reliability, and an instantaneous load transfer from the failed power supply to the other one, without loss of time or module reset.

A relay connected to the low voltage side of the power supply monitors this voltage. The three contact terminals, normally open, common, and normally closed, are available at the external connector terminals. This relay monitors only the power supply integrity and it is not controlled by the main microprocessor. This way, if we want a relay to monitor whether the unit is ready to protect (READY), we should program one of the auxiliary relays in the unit.

This is a “fly-back” type power supply, providing high efficiency, stability and reliability thanks to the maturity of this technology. There are two available ranges, Hi and Low, in order to optimize efficiency and general performance, including the capability to tolerate auxiliary voltage interruptions (dips).

Oversized components highly resistant to temperature are used. For example, all capacitors are specified to stand up to 105ºC, transformer components are specially designed to stand up to 180ºC, the used MOSFET transistor is of very low resistance, supports high voltage and is refrigerated by an oversized heat sink. This allows to support temperatures over the 60ºC shown in the Technical Characteristics section, and prolonged overloads such as the ones occurring at batteries in deep charge mode (much higher than +15% voltage shown in the Technical Characteristics section).

High capacitance capacitors are also used, providing high tolerance to prolonged dips, 100ms, even in the most unfavorable consumption conditions. This allows the relay to continue with normal operation without undesired resets, which would cause a long time of protection unavailability.

Figure 3–2: shows the location of communications modules over the CPU. These modules have been designed in accordance with the “plug and play” philosophy, so that units can be easily updated after their purchase, allowing for a simple and economical migration of the application.

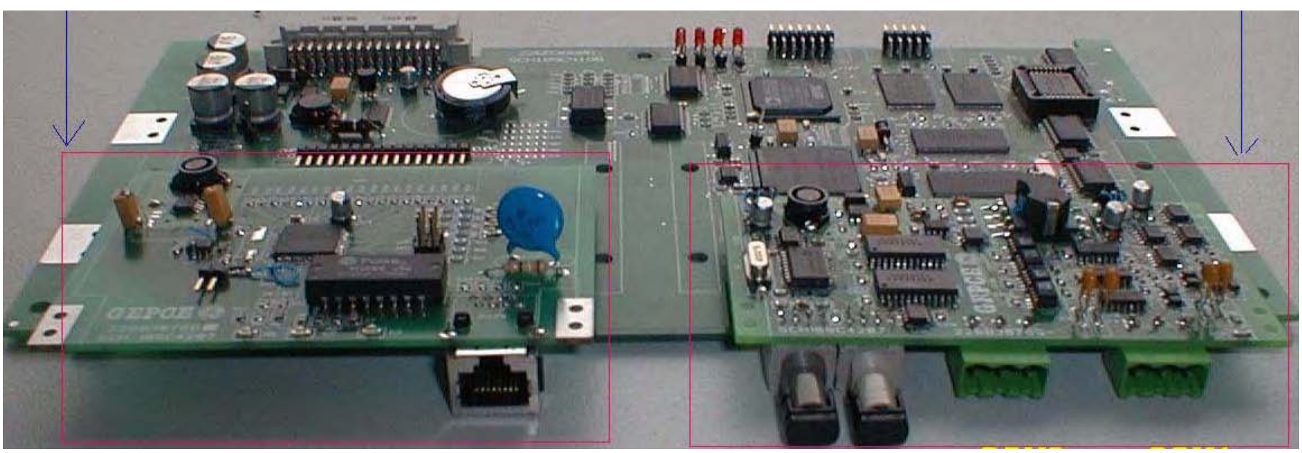


Figure 3–2: COMMUNICATIONS MODULE

The model number and electrical characteristics of the unit are indicated on the label located on the right side of the relay case.

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

The front of the relay is made of a thermoplastic, flame retardant (V0), highly resistive material, which guarantees the unit's immunity to all kinds of EMI/RFI/ESD interferences. As well, an IP51 (IEC 529) protection degree against dust and water through the front and with the relay mounted in the panel.

In order to guarantee safety and preventing access to the unit by unauthorized personnel, the front part of the relay has a sealable cover to protect the RS 232 front port and the operation mode key.

3.3.1 MOUNTING

The unit is designed for semi-flush mounting . The relay is secured to the panel with the 4 M6 screws provided with the unit. The user has access to the front keypad, display and communication port. The wiring is at the rear of the unit. The drilling dimensions are shown on Figure 3–4:

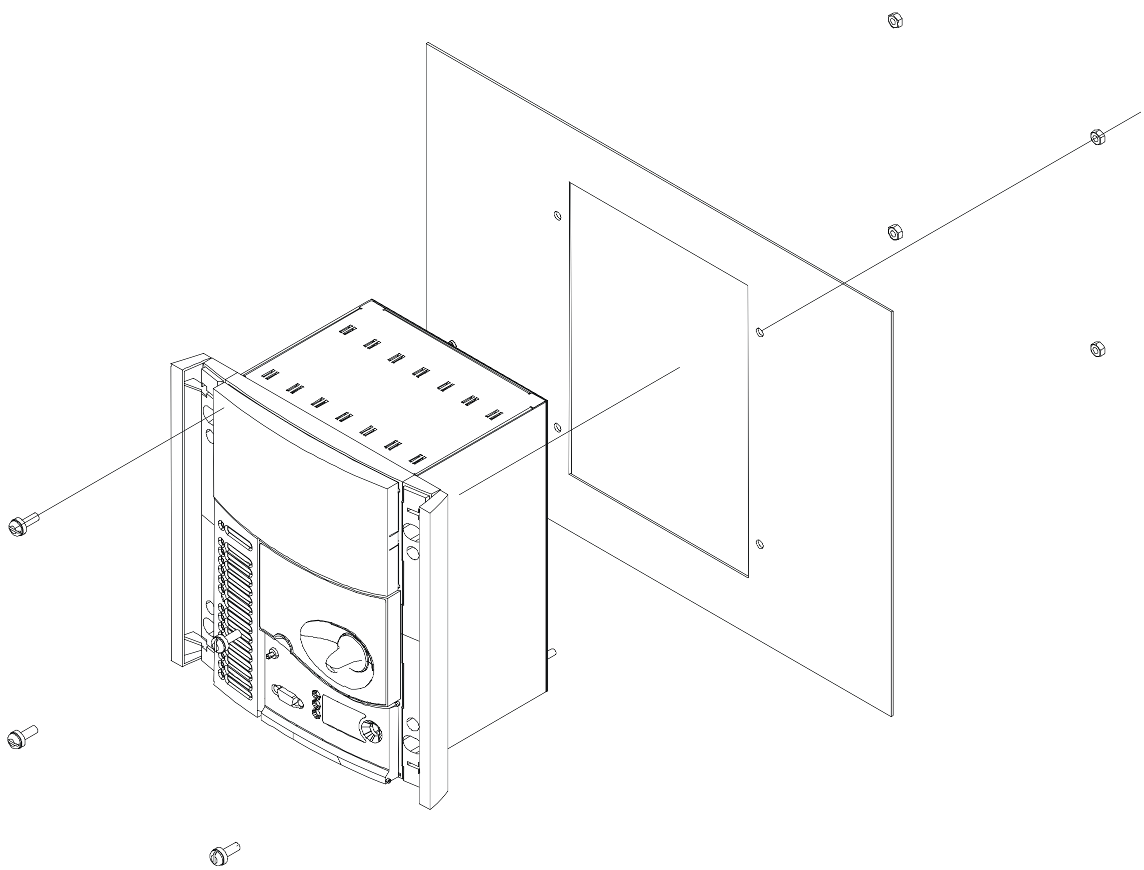


Figure 3–3: PANEL MOUNTING

The relay width allows the mounting of two units on a standard 19'' panel, 8 units high.

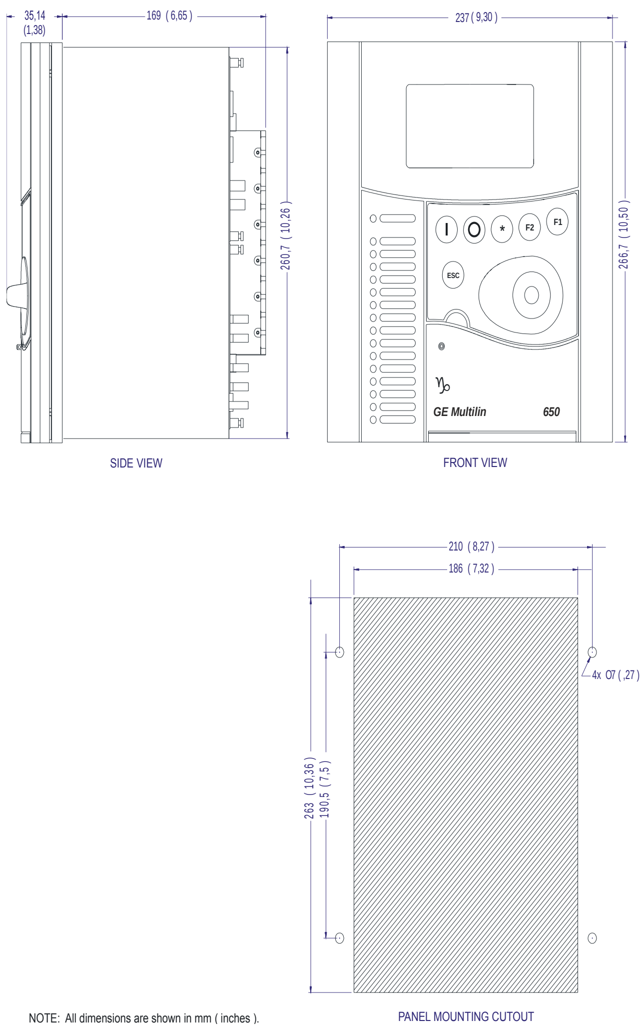


Figure 3–4: DRILLING DIMENSIONS DIAGRAM

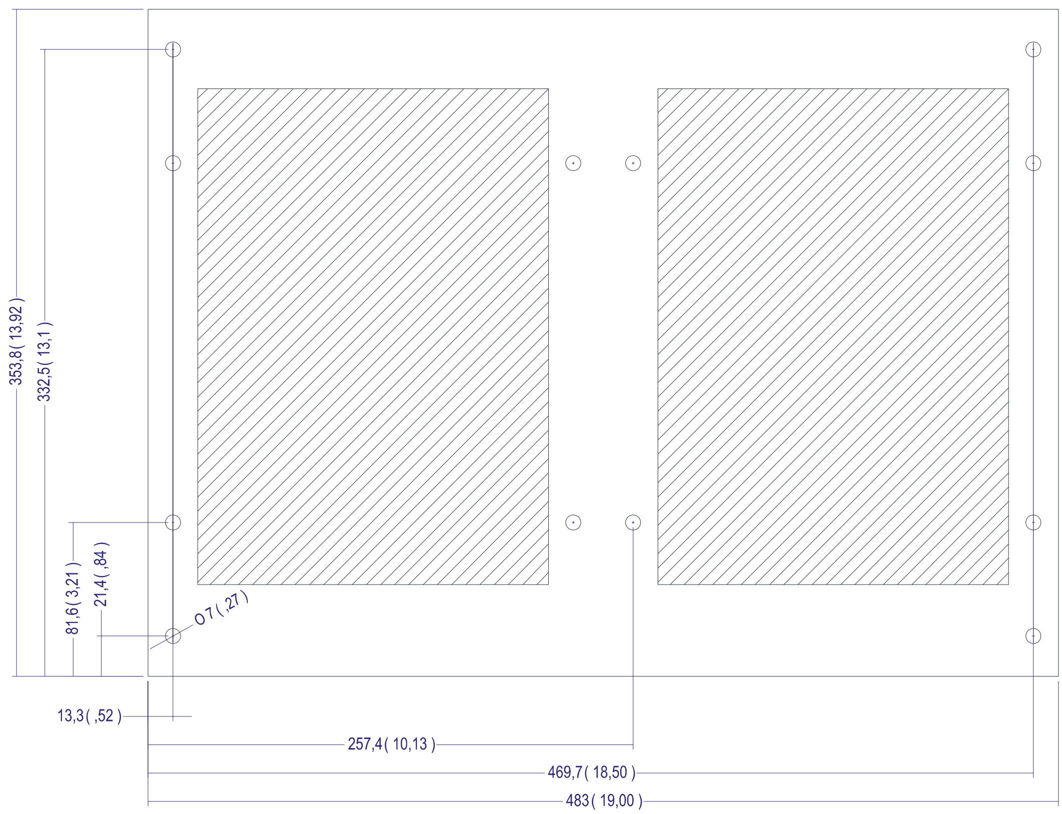


Figure 3–5: DIMENSIONS OF THE 19" RACKS 8U HIGH FOR TWO RELAYS

WARNING

Module withdrawal and insertion may only be performed when control power has been removed from the unit.

Proper electrostatic discharge protection (i.e. a static wrap) must be used when coming in contact with products while the relay is energized.

The relay is wired through the terminal blocks located at the rear of the unit.

The magnetic module, which receives the CT secondary currents and the metering voltages, incorporates a very robust terminal board (columns A and B). Current inputs provide automatic shorting of external CT circuits. The maximum recommended cable section for this terminal board, with the appropriate terminal, is 6 mm^2 (AWG 10).

The rest of the terminal blocks, F and G for I/O and H for power supply, incorporate high quality connectors with the capacity to withstand a rated current of 15 A at 300 V. These terminal blocks admit a cable section of up to 2.54 mm^2 (AWG 12).

The communication boards have a different type of connector depending on the selected media: RS485, glass or plastic fiber optic.

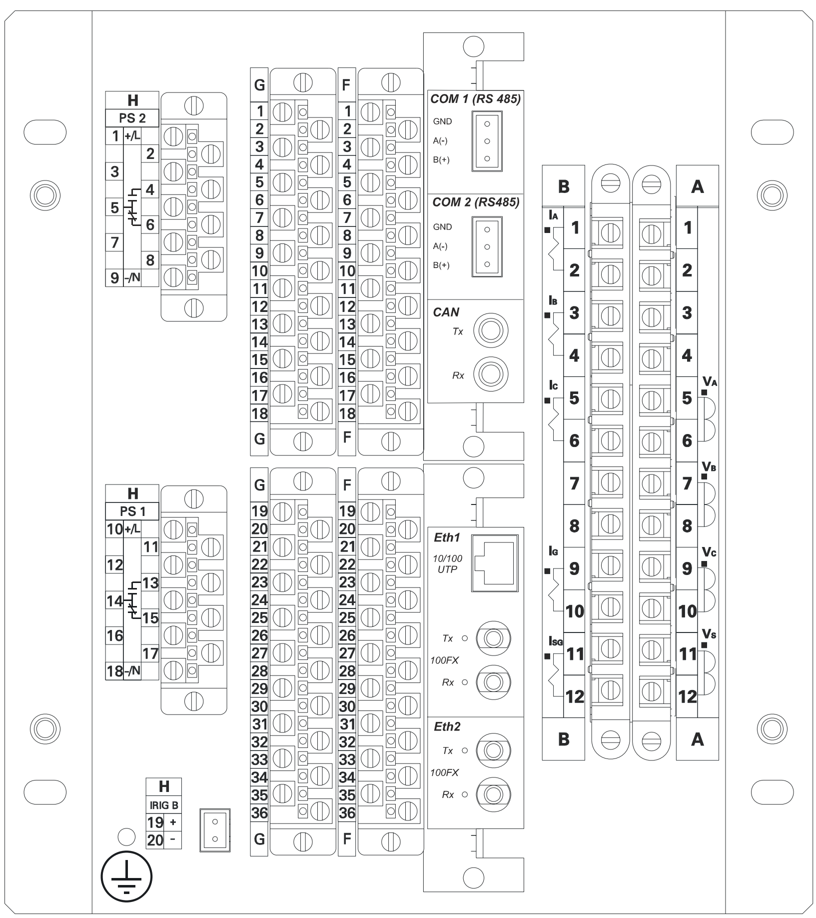


Figure 3–6: CONNECTORS LOCATION

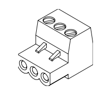
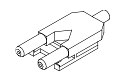
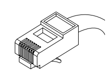
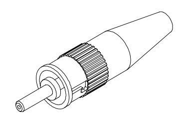
TYPE OF COMMUNICATION	CONNECTOR	
RS485 / CAN cable	Plug-in, 3 poles.	
IRIG B	Plug-in, 2 poles.	
Plastic fiber optic	Versatile Link	
Ethernet 10/100 UTP (10/100BaseTX)	RJ45, Class 5.	
Glass fiber optic (100BaseFX)	ST	
Ethernet 100 FX (100BaseFX)	ST	
CAN Fiber	ST	

Figure 3–7: COMMUNICATIONS MEDIA SELECTOR GUIDE

Communication boards are installed at the rear part 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.

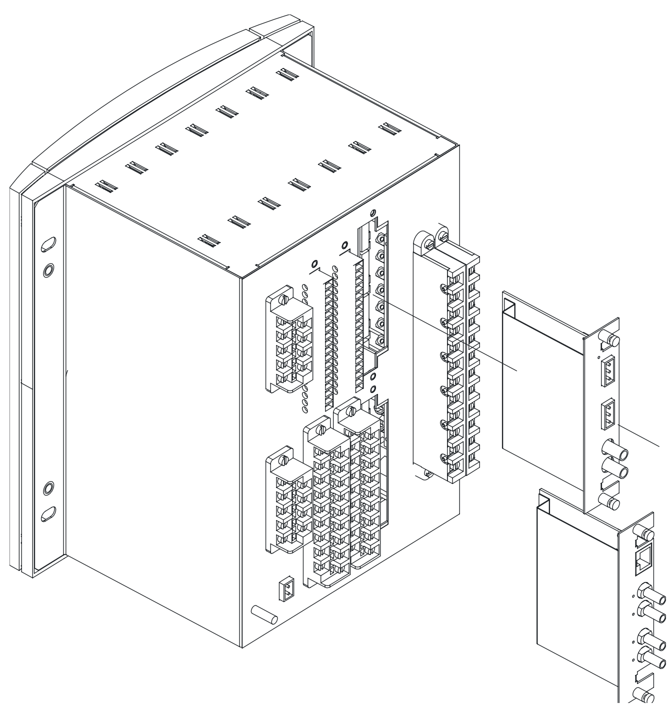


Figure 3–8: DETAIL OF INSERTION/EXTRACTION OF COMMUNICATION MODULES

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

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.

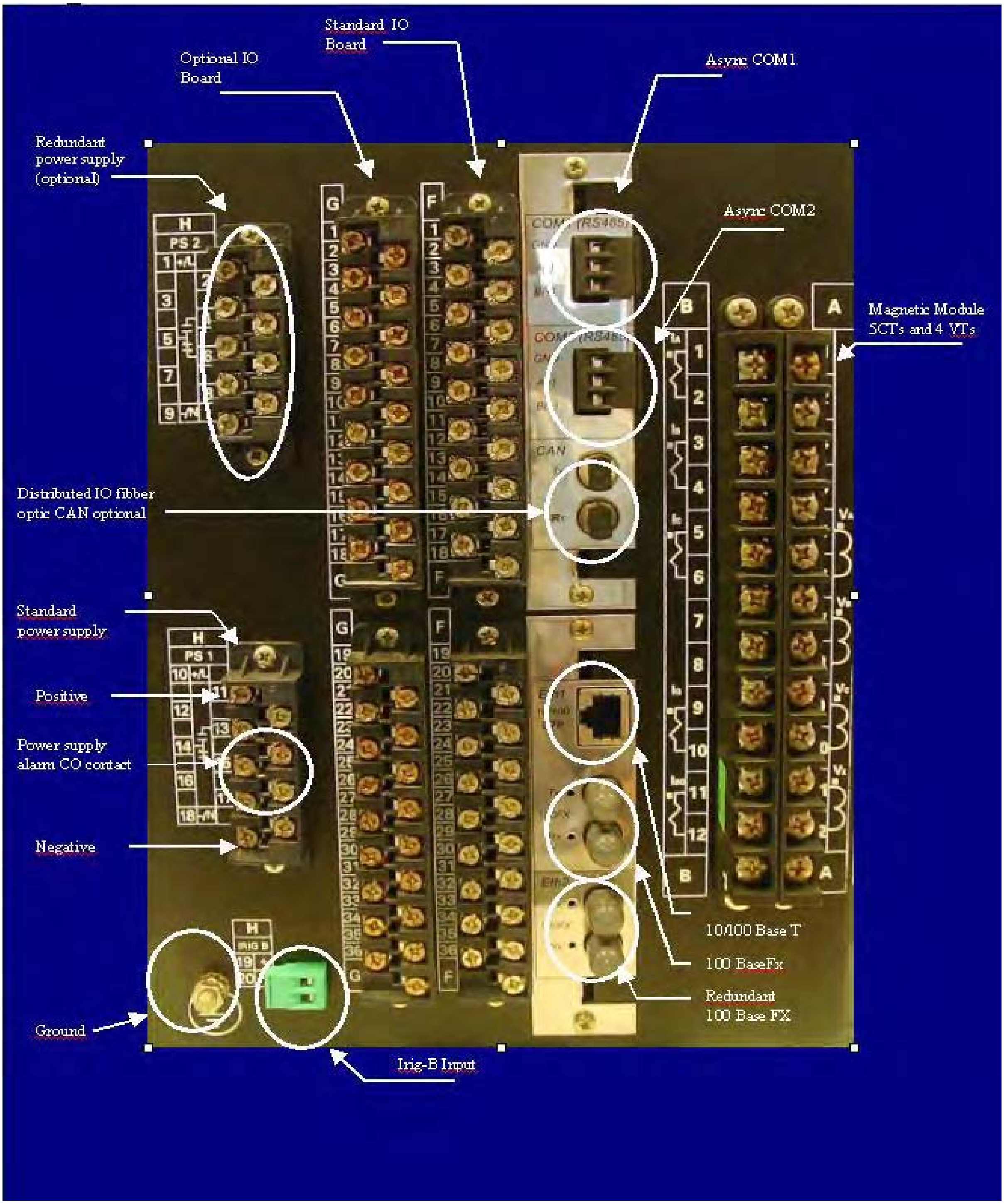


Figure 3–9: REAR TERMINALS LOCATION

3.4.1 EXTERNAL CONNECTIONS

G650 units can hold different options for F module:

Option 1: Board with 16 digital inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision inputs, 6 conventional outputs, and two current sensing outputs

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

For slot G there are four different options:

Option 0: No board

Option 1: Board with 16 digital inputs and 8 outputs.

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

The number selected for slot G must be equal or higher than the number selected for option F for models including boards 4 and 5.

3.4.2 DIGITAL INPUTS WITH TRIP CIRCUIT SUPERVISION

The Option 2 I/O board includes two groups of 4 inputs with one common, in terminals F9 to F10. It also includes 6 auxiliary outputs, in terminals F19 to F30 with normally open contacts and two current sensing (latching) outputs (F31-F33 and F34-F36).

Besides, there are 2 groups of inputs for trip circuit supervision. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the unit output contact.

In order to implement these schemes, it is not necessary to perform any setting in the unit. Internal functions are always operative. The detailed description of trip circuit supervision is included in chapter 5 in this manual.

3.4.3 CABLE/FIBER ETHERNET BOARD

The Ethernet board is the communication board 2 (COM3) shown in Figure 3–2:. It is located in the bottom at the rear part of the relay.

In Models C and D, the 10/100BaseTX port is selected by an internal switch. To select between fiber and cable it is necessary to extract the board, switch the jumper to the selected position, as indicated on Figure 3–10: FIBER/CABLE SELECTION and insert the board again. As with any other relay manipulation, the relay power supply must be removed and the operation must be performed only by skilled personnel.

The default port selected by switch is 10/100 TX in factory configuration. The switch selects between cable (10/100 TX) and the first fiber port (100 FX). In Ethernet board type D (double fiber port) the backup channel is always fiber.

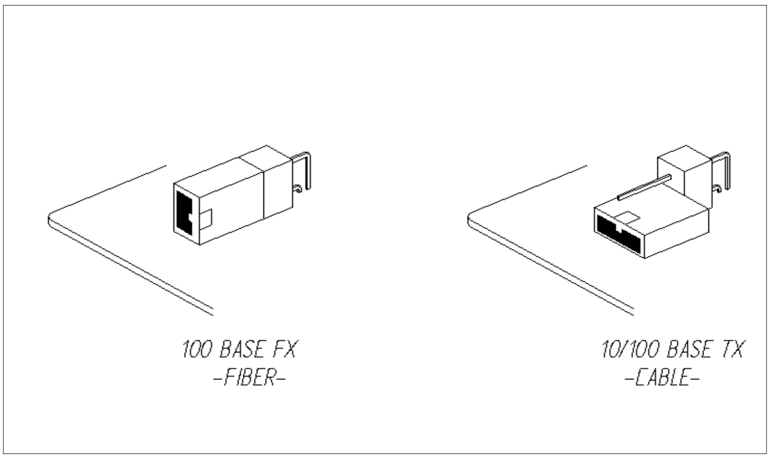


Figure 3–10: FIBER/CABLE SELECTION

Optical Power Budget (OPB) is the available optical power for a fiber optic link to accommodate fiber cable losses plus losses due to in-line connectors, splices, optical switches, and to provide margin for link aging and unplanned losses due to cable plant reconfiguration and repair.

OPB (DB)		**FIBER OPTIC CABLE LENGTH (KM)**
62.5/125 µm	**50/125 µm**	
11.4	8	0
10.9	7.4	0.3
10.5	7.1	0.5
9.6	6.2	1.0
8.5	5.3	1.5
7.3	4.3	2.0
6	3.3	2.5

4.1.1 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 G650 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.

4.1.2 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 G650 features.

4.1.2.1 ENGAGING A DEVICE

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

4.1.2.2 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

4.1.2.3 VIEWING ACTUAL VALUES

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

4.1.2.4 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.

4.1.2.5 FIRMWARE UPGRADES

4

The firmware of a G650 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.

4.1.2.6 ONE LINE DIAGRAMS

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

4.1.3 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 4–1: ENERVISTA 650 SETUP MAIN SCREEN

4.1.4 COMMUNICATION MENU

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.

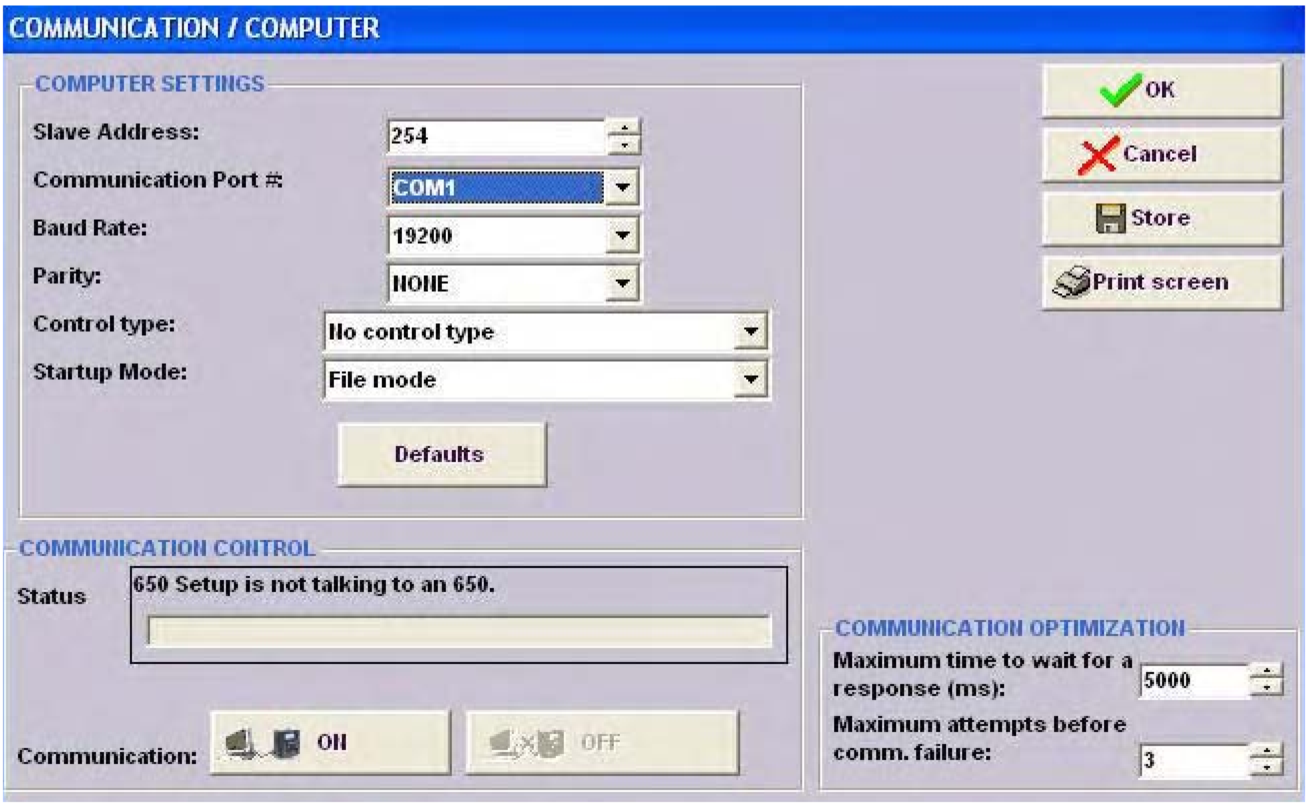


Figure 4–2: COMMUNICATION PARAMETERS MENU

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.

4.1.4.1 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).

4.1.4.2 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.

4.1.4.3 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.

4.1.5 FILE MANAGEMENT

File management with EnerVista 650 Setup software:

4.1.5.1 OFF LINE MODE

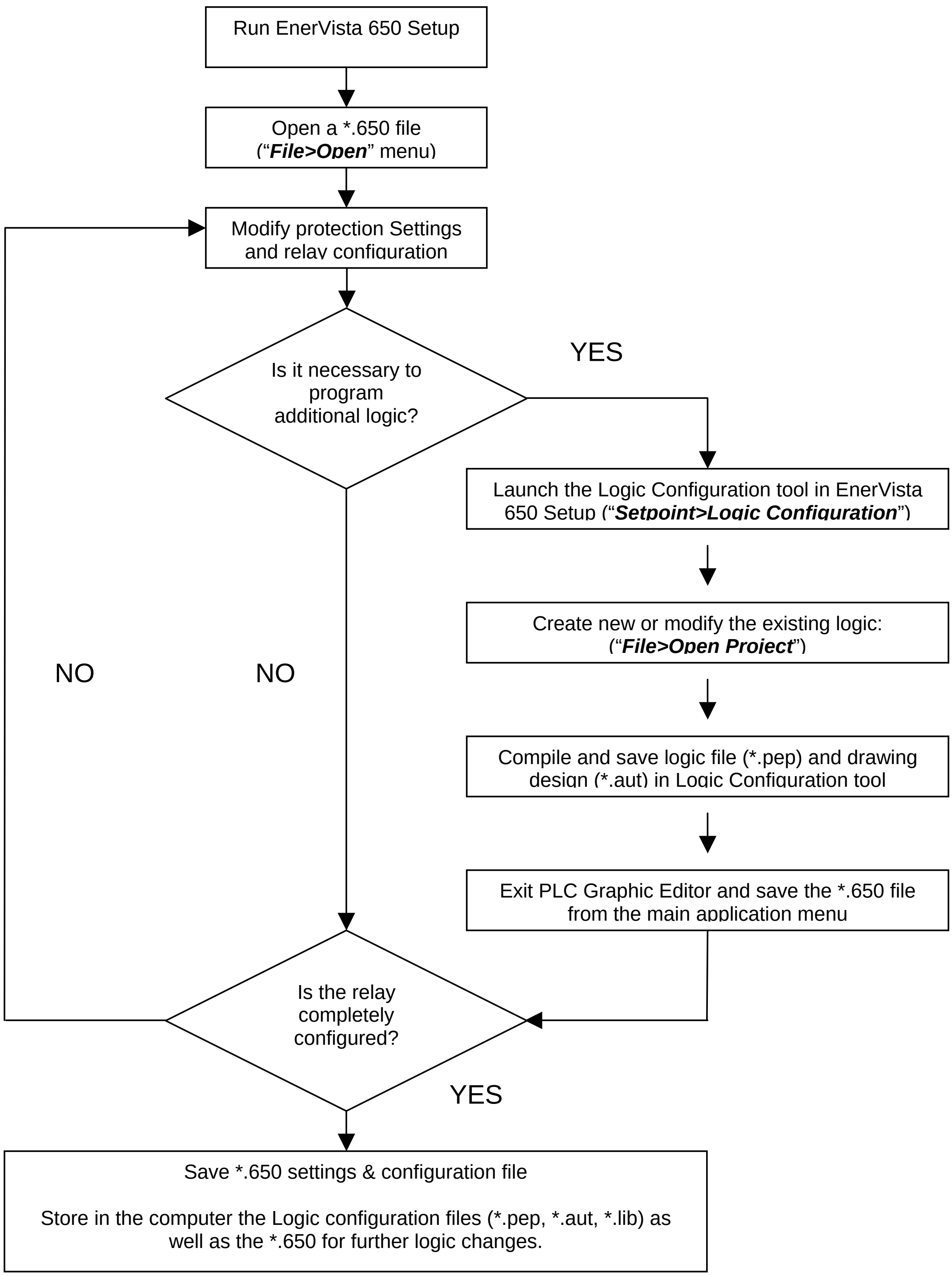


Figure 4–3: OFF-LINE MODE FILE MANAGEMENT

Table 4–1: 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

4.1.5.2 ON LINE MODE

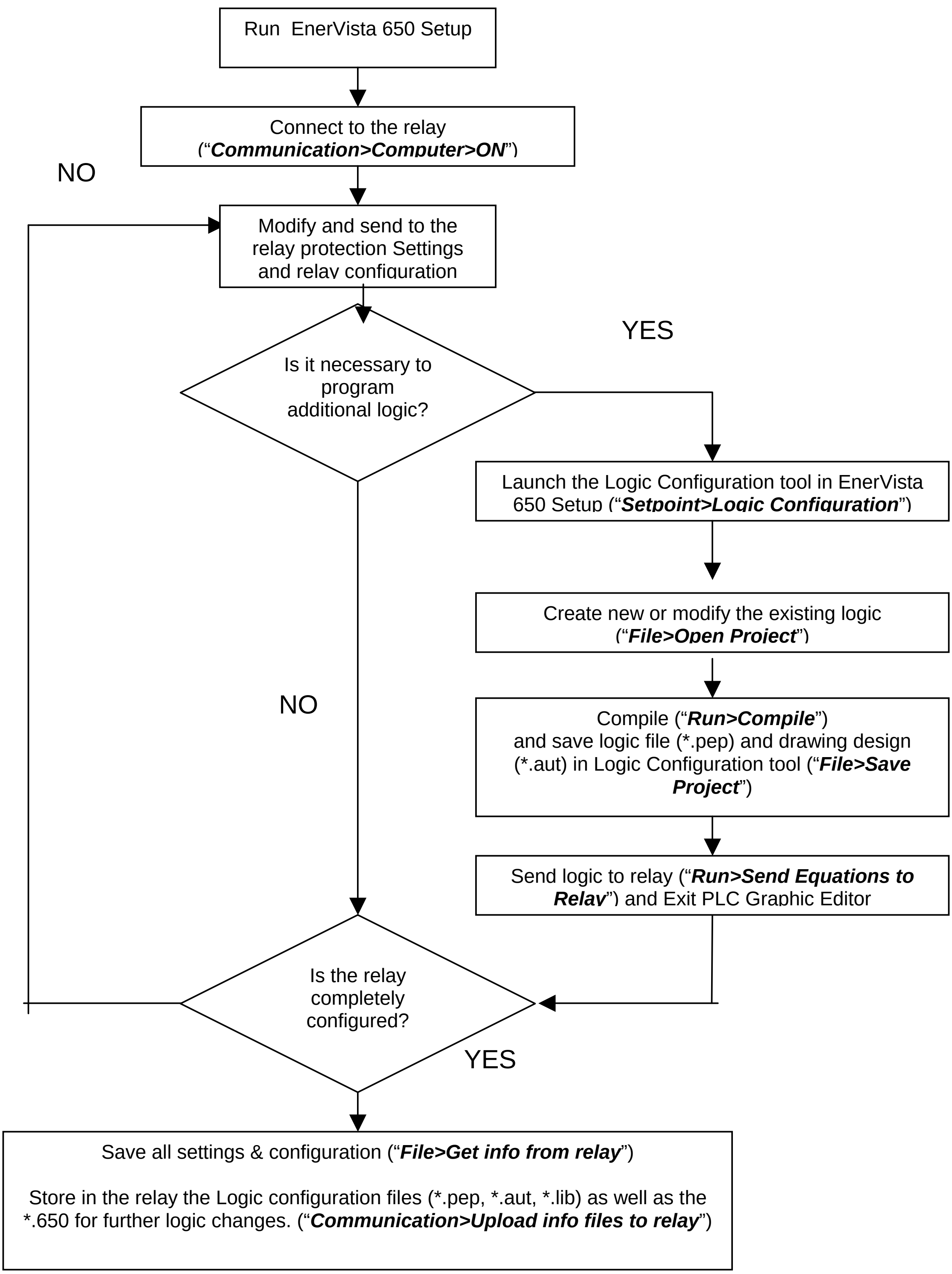


Figure 4–4: ON LINE MODE FILE MANAGEMENT

Table 4–2: TYPES OF FILES CREATED BY ENERVISTA 650 SETUP– ONLINE OPERATION MODE

	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 transfer to relay	Connect with the relay ("***Communications>Computer***")	Connect with the relay ("***Communications>Computer***")		
	Send settings and configuration from file	Launch 650 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.		
	Modify settings and configuration directly in the relay:			
How to save	EnerVista 650 Setup: "***File>Get info from relay***". User definable texts retrieved are operations, events, and LEDs.	PLC Editor:		
		"***File>Save Project***"		***"File>Save Library"***
		The relay will not provide this information unless the *.pep file is stored in the relay	The relay will not provide this information unless the *.pep file is stored in the relay.	The relay will not provide this information unless the *.pep file is stored in the relay.
		To store the logic configuration files in the relay use the "***Communication>Upload info files to relay***" option		
How to store in the relay		"***Communication>Upload info files to relay***" through Ethernet		
How to retrieve from the relay		"***Communication/Download info files from relay***" through Ethernet		

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***")

4.1.6 ENERVISTA 650 SETUP MENU STRUCTURE

The EnerVista 650 Setup menus structure is shown in Table 4–3:.

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 4–3: 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		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							

4.1.7 FILE MENU OVERVIEW

Table 4–4: 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 (**)

4.1.7.1 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.

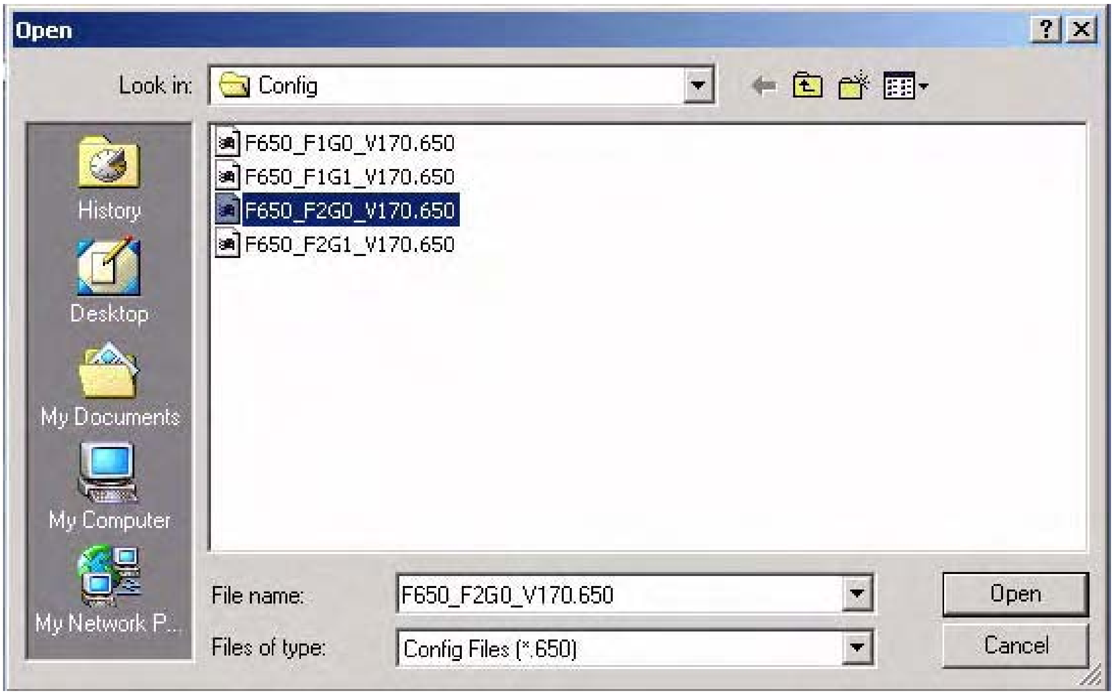


Figure 4–5: OPEN FILE MENU

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 ”Upgrade firmware version” and “Upgrade Operating system” options.

*4.1.7.2 CONFIG FILE (*650) CONVERTER*

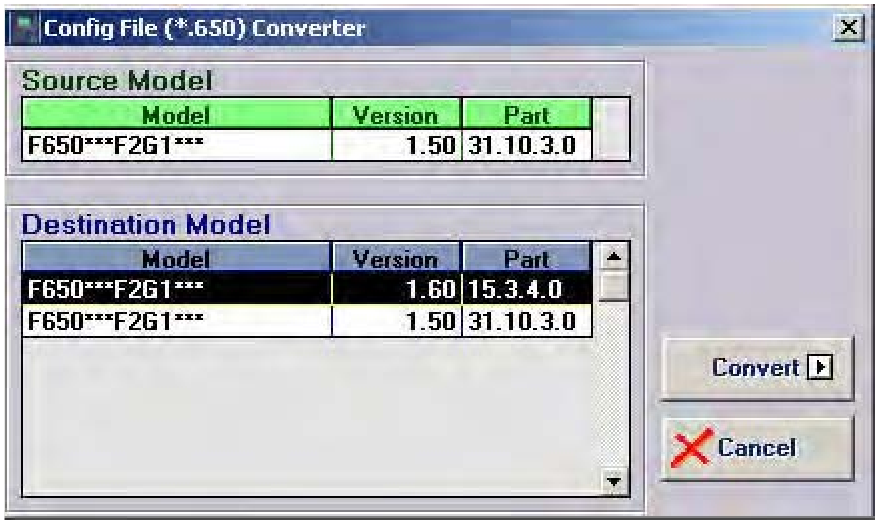


Figure 4–6: CONFIG FILE (*650) CONVERTER MENU

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.

4.1.7.3 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 4–7:

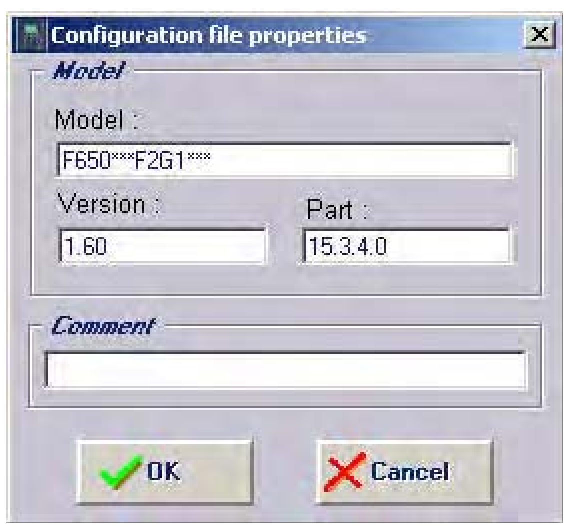


Figure 4–7: FILE PROPERTIES MENU

4.1.7.4 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 4–8:

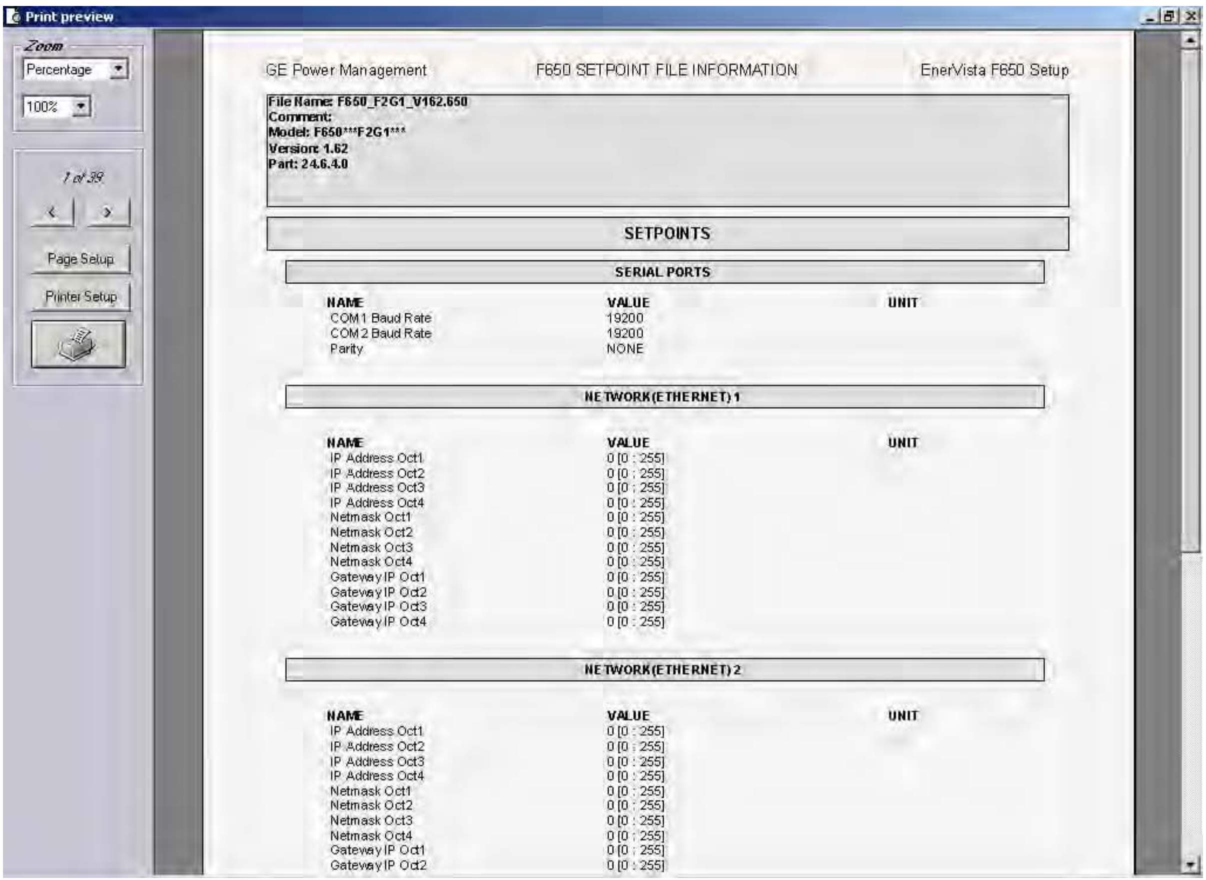


Figure 4–8: PRINT PREVIEW OF SETTINGS FILE

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.

4.1.8 SETPOINT MENU OVERVIEW

Table 4–5: 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, autoreclose, breaker failure VT fuse failure.
	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.
	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 (**)

4.1.8.1 PRODUCT SETUP

Table 4–6: GENERAL OVERVIEW OF PRODUCT SETUP MENU:

PRODUCT SETUP		
	Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave, IEC 870-5-104 and SNTP settings .
	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 G650.

Table 4–7: GENERAL OVERVIEW OF COMMUNICATION SETTINGS MENU:

COMMUNICATION SETTINGS

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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

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

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4.1.8.2 SYSTEM SETUP

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

Table 4–8: 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 G650. 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 (**)

4.1.8.3 PROTECTION ELEMENTS

This option shows all the protection-grouped elements available in the relay as shown in Table 4–9:. 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 4–9: 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	All power grouped protection functions.

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

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Table 4–10: 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)
	Generator Thermal Model	Thermal model or Thermal image unit for phases (49S)
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.
	Restricted Gnd Fault	Restricted Ground Fault (87G). Enhanced models only.
SENSITIVE GROUND CURRENT		
	Sensitive Ground TOC	Sensitive ground time overcurrent (51SG)Enhanced models only.
	Sensitive Ground IOC	Sensitive ground instantaneous overcurrent (50SG). Enhanced models only.
NEGATIVE SEQUENCE CURRENT		
	Negative Sequence TOC	Negative sequence time overcurrent (51-2)
	Negative Sequence IOC	Negative sequence instantaneous overcurrent (50-2)
	Generator Unbalance	Generator current unbalance (46)
VOLTAGE ELEMENTS		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)
	Neutral OV High	Neutral overvoltage, high level (59NH)
	Negative Sequence OV	Negative sequence overvoltage (47). Phase reversal
	Auxiliary OV	Auxiliary overvoltage (59X)
	Auxiliary UV	Auxiliary undervoltage (27X)
	Volts per Hertz	Volts per Hertz (24). Enhanced models only.
	Ground OV	Ground Overvoltage (59G)
POWER		
	Directional Power	Directional power (32), in primary values.
	Pwr Factor Limiting	Power Factor Limiting (55). Enhanced models only.

4.1.8.4 CONTROL ELEMENTS

This option shows all the control elements available in the relay as shown in Table 4–11:. Some of the elements are grouped ones such as underfrequency, overfrequency and broken conductor.

Table 4–11: GENERAL OVERVIEW OF CONTROL ELEMENTS MENU:

CONTROL ELEMENTS		
	Setting Group	G650 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 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
	Breaker Failure	Breaker failure (50BF). Not grouped, a single unit provided. Enhanced models only.
	VT Fuse Failure	Fuse Failure (VTFF). Not grouped, a single unit provided. Enhanced models only.
	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.
	Loss of Mains	Loss of Mains (78V). Grouped element. Enhanced models only.
	Loss of Excitation	Loss of Field (40). Grouped element
	Accidental Energization	Inadvertent generator energization (50/27). Grouped element

4.1.8.5 INPUT/OUTPUTS

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

Table 4–12: GENERAL OVERVIEW OF “INPUTS/OUTPUTS” SETTINGS MENU.

INPUTS/ OUTPUTS		
	Contact I/O	Inputs and outputs settings for all boards in G650. 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).

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 G650 (F, G, H, J).

Table 4–13: 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)

4.1.8.6 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.

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Table 4–14: 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.
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 G650:

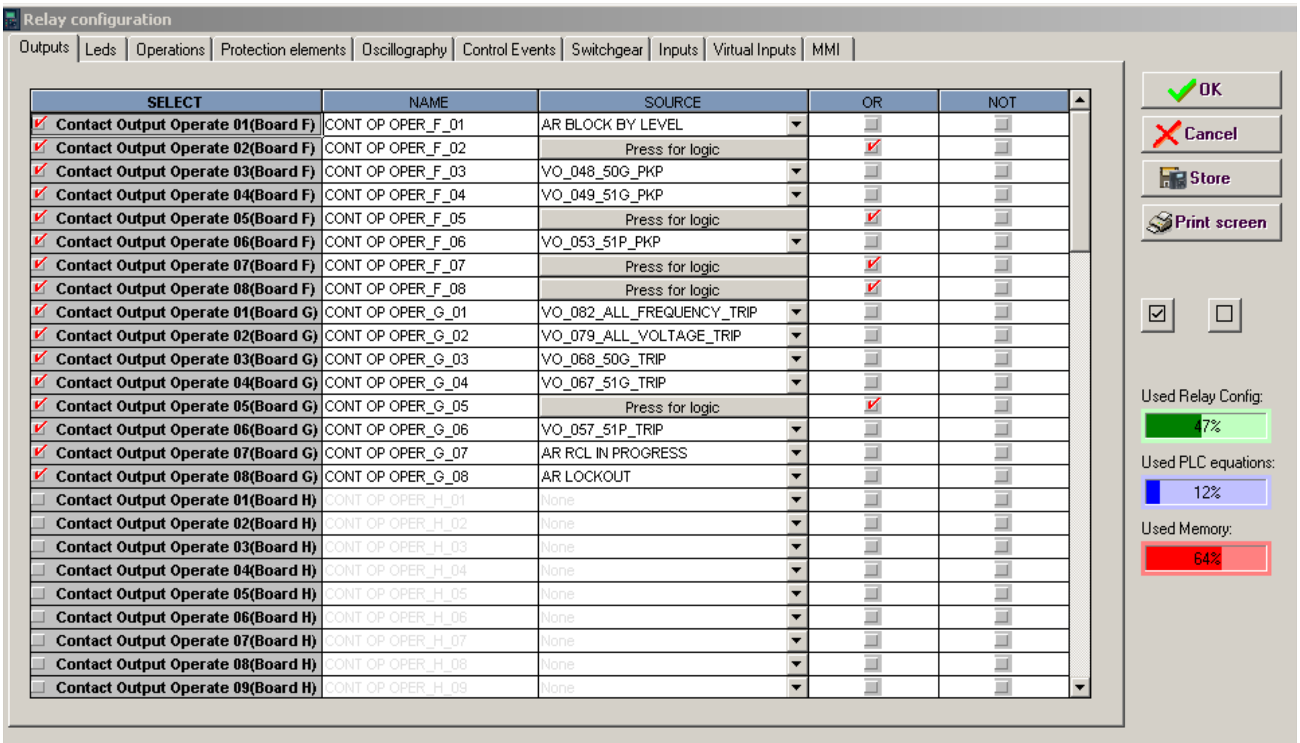

Figure 4–9: RELAY CONFIGURATION

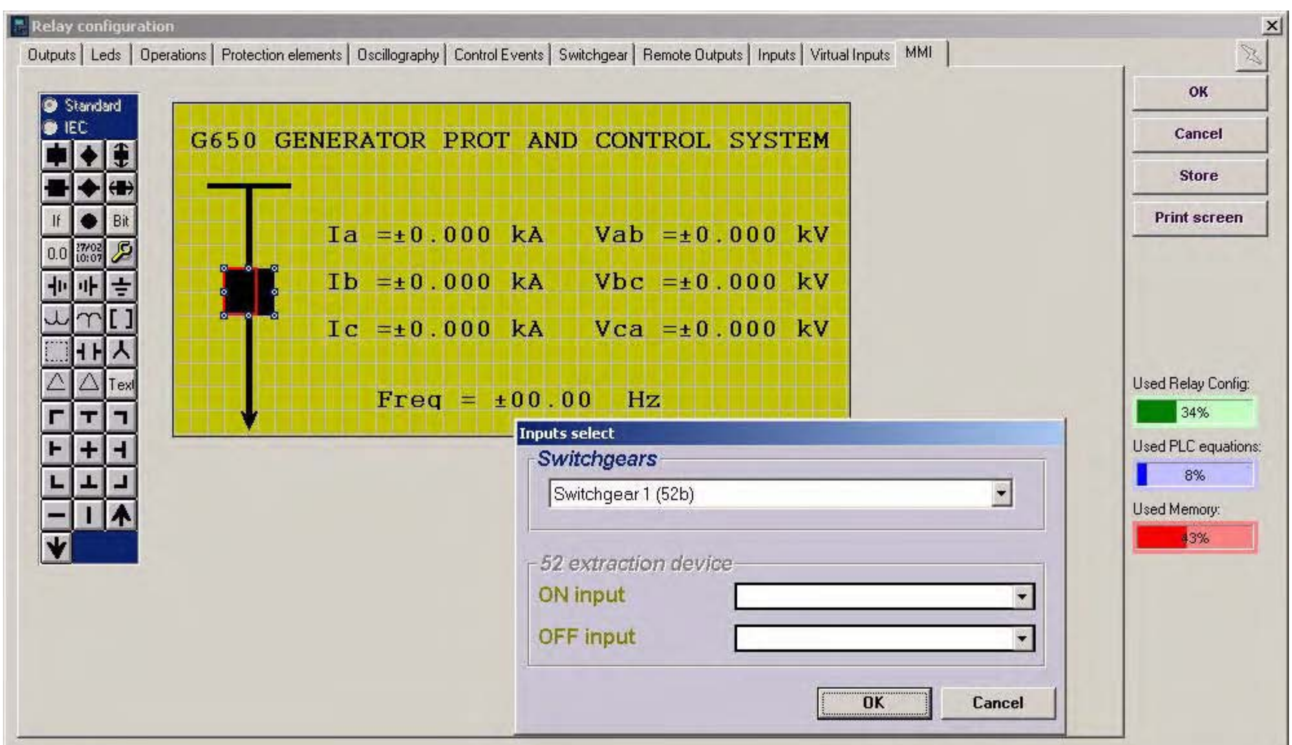

Figure 4–10: HMI CONFIGURATION

4.1.8.7 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 4.1.5.

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.

4.1.8.8 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.

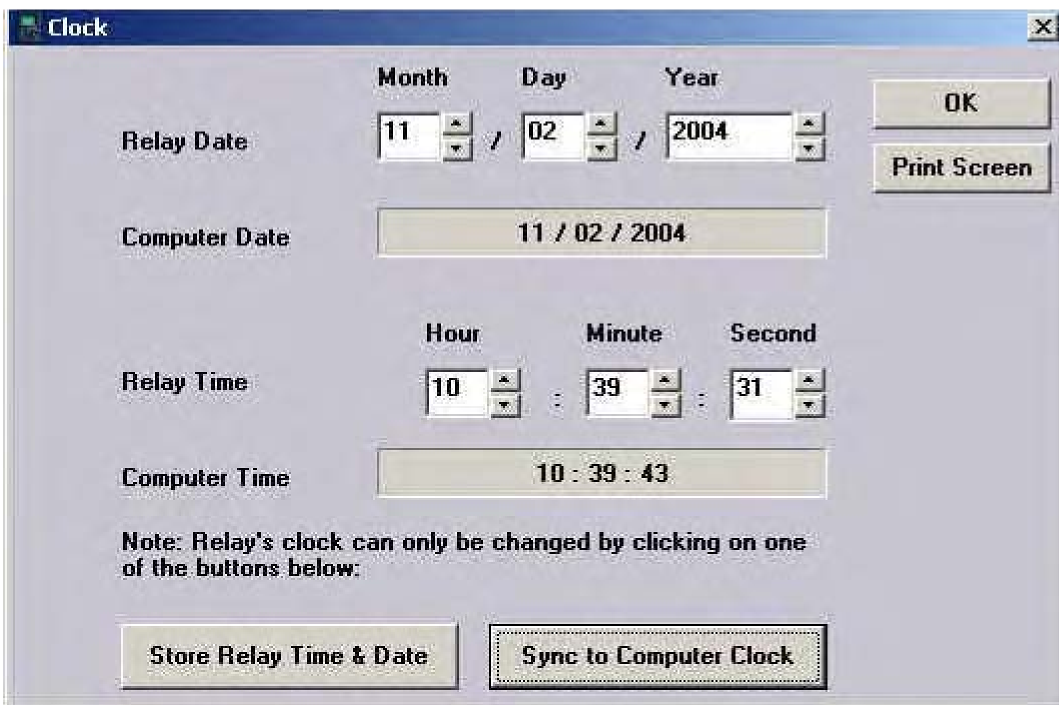

Figure 4–11: CLOCK

4.1.9 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 4–15: 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.

4.1.9.1 FRONT PANEL

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

4.1.9.2 STATUS

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

Table 4–16: 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 4–17: 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.
	Voltage	Protection status signals (pickups and operations) for all voltage functions, undervoltage, overvoltage, neutral overvoltage, negative sequence overvoltage and auxiliary under and over voltage, Volts/Hz and ground overvoltage.
	Power	Protection status signals (pickups and operations) for all power units .

Table 4–18: 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).
	Breaker Failure	Status signals for breaker failure function (50BF). Enhanced models only.
	VT Fuse Failure	Fuse failure detection signal. Enhanced models only.
	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.
	Pulse Counters	Status signals for pulse counters units.
	Analog Comparator	Status signals for analog comparator units.
	Loss of Mains	Status signals (operations) for loss of mains (78V). Enhanced models only.
	Loss of excitation	Status signals (pickups and operations) for loss of excitation (40).
	Accidental Energization	Status signals (off-line, armed and operation) for inadvertent generator energization (50/27).

Table 4–19: 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.

4.1.9.3 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 4–20: 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.

4.1.9.4 INPUTS/OUTPUTS

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

Table 4–21: 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.
	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 (**)

4.1.9.5 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 4–22: 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 (**)

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4.1.10 OPERATIONS MENU OVERVIEW

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

Table 4–23: 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 (**)

4.1.11 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 4.1.4 for communication menus description and to section 5 for flash memory update procedures.

Table 4–24: 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.

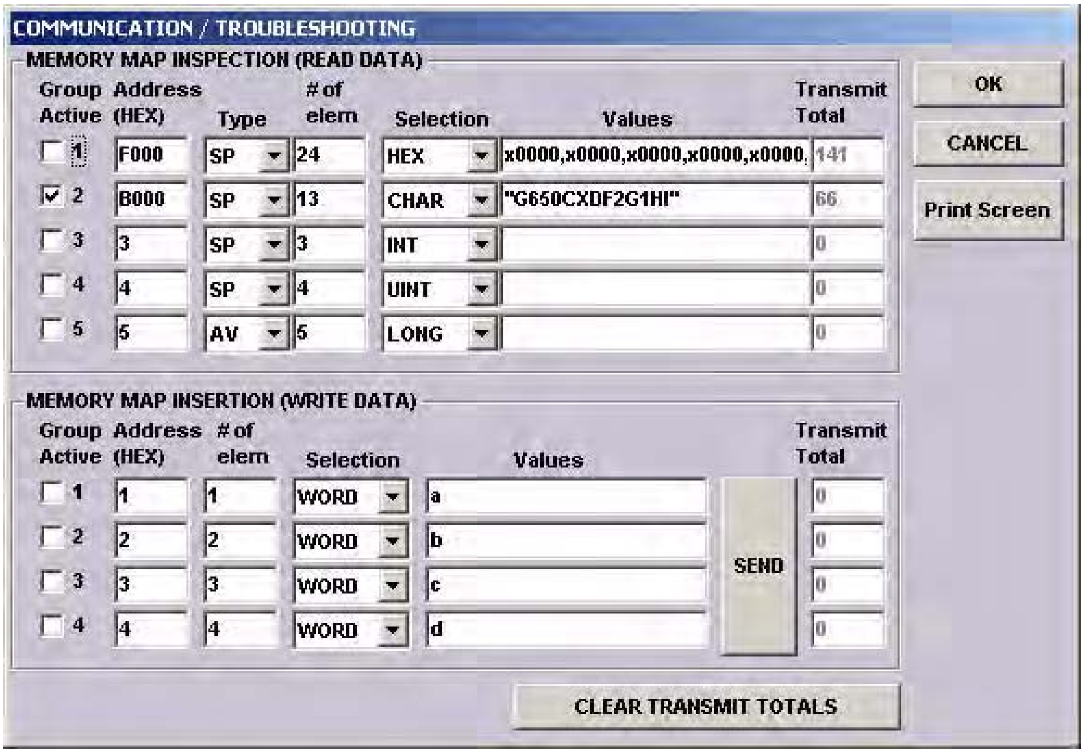
Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

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 4–12:

Figure 4–12: 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. G650 3.74 (4.10). The operative system version is 4.10

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).

4.1.12 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 4–25: 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 (**)

4.1.13 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 4–26: 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 (**)

4.1.14 HELP MENU OVERVIEW

Complete instructions manual and data about EnerVista 650 Setup release.

Table 4–27: 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 G650

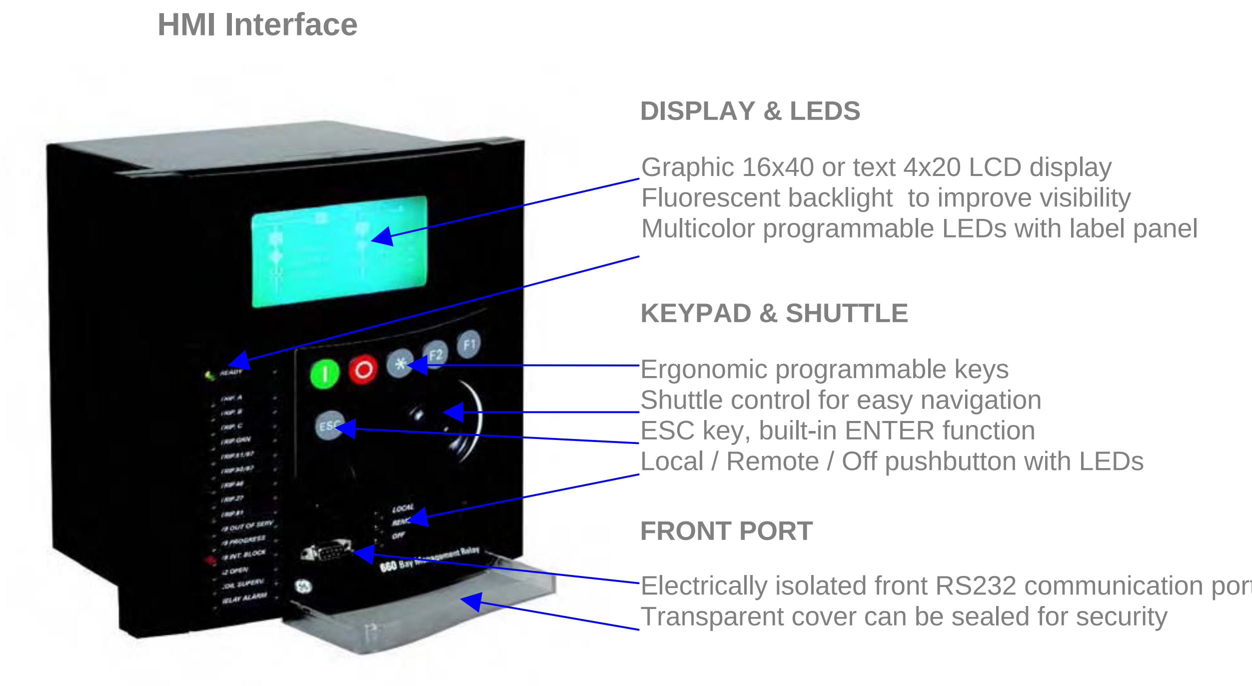


Figure 4–13: HMI INTERFACE

4.2.1 DISPLAY

G650 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 "G650", appears the relay firmware version (3.22in 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.

G650 3.74 (4.10)
General Electric
G650MCDF2G1HIR
19200N81: MODBUS: 254

Figure 4–14: TEXT MAIN SCREEN

4.2.2 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.

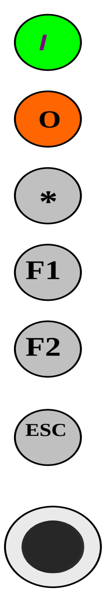
4.2.3 PUSHBUTTONS

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.

4.2.3.1 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 4–15: KEYPAD AND SHUTTLE KEY DESCRIPTION

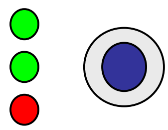
4.2.3.2 COMMAND PUSH BUTTON

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:

LOCAL operations (green)

REMOTE operations (green)

OFF (red)



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).

4.2.4 FRONT PORT AND COVER SEALING SYSTEM

Figure 4–16: 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.

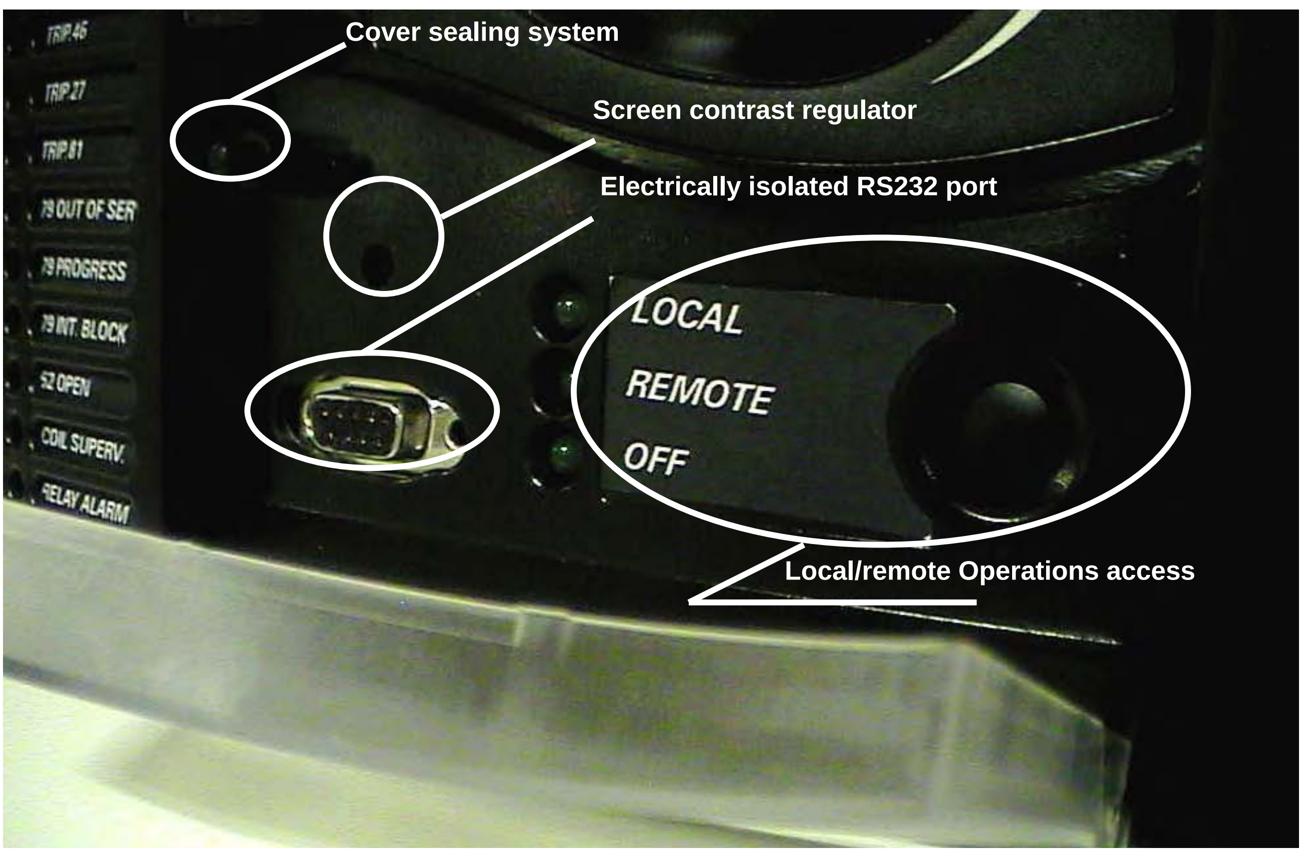


Figure 4–16: DETAIL OF FRONT PORT AND COVER SEALING SYSTEM

4.2.5.1 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 4–17: Shows an example of main menu navigation:

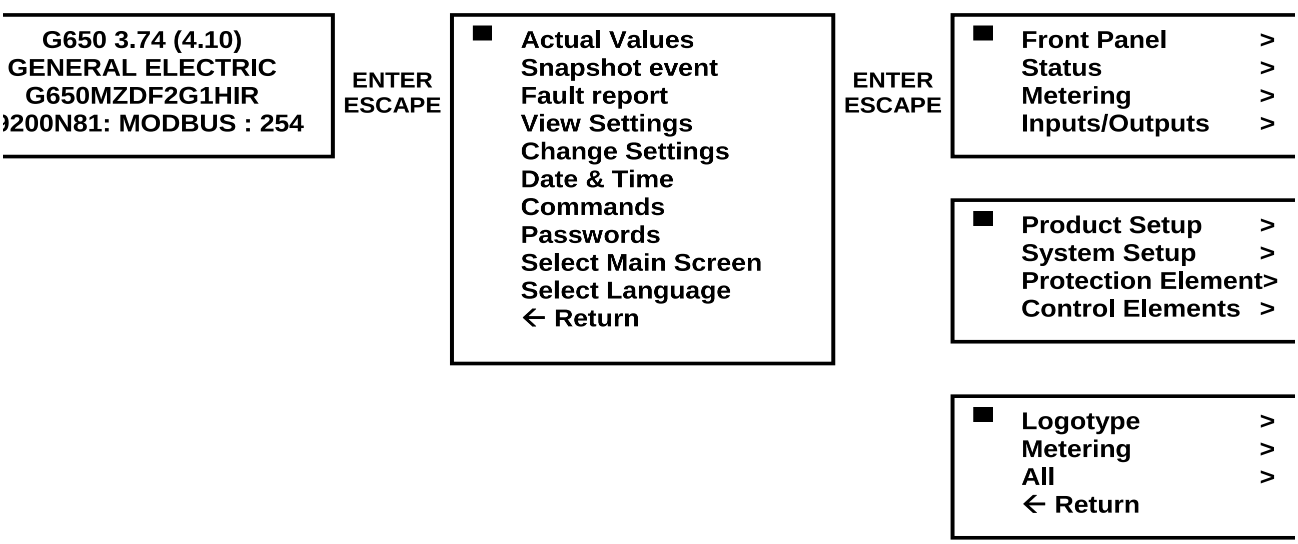


Figure 4–17: NAVIGATION IN MAIN TEXT MENU

4.2.5.2 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 4–28: 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.

4.2.5.3 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 4–29: 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
		Breaker Failure (enhanced models only)
		VT Fuse Failure (enhanced models only)
		Setting Groups
		Pulse Counters
		Analog Comparators
		Loss of Mains (enhanced models only)
		Loss of Excitation
		Accdnt Energ
	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	
	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 4–29:. 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 4–18:.

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)

Phase Current
PH IOC1 HIGH A PKP
OFF
(1/114)

Figure 4–18: 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.)

4.2.5.4 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 4–19: shows an example of snapshot events navigation:

```
G650 3.74 (4.10)
GENERAL ELECTRIC
G650MZDF2G1HIR
19200N81: MODBUS : 254
```

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

ENTER
ESCAPE

```
  Actual Values
■ Snapshot event
  Fault report
  View Settings
```

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)

ENTER
ESCAPE

```
Breaker Closed ON >
St: ON (4/479)
Time: 16:35:02.027
Date: 04/May/2006
```

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

L-R

```
Isolated Gnd3 Block>
St: OFF (5/479)
Time: 16:35:01.995
Date: 04/May/2006
```

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.

ENTER
ESCAPE

```
Ia  0.000   Vab   0.000
Ib  0.000   Vbc   0.000
Ic  0.000   Vca   0.000
Ig  0.000   V0    0.000
```

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 4–19: SNAPSHOT EVENTS NAVIGATION IN HMI

4.2.5.5 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.

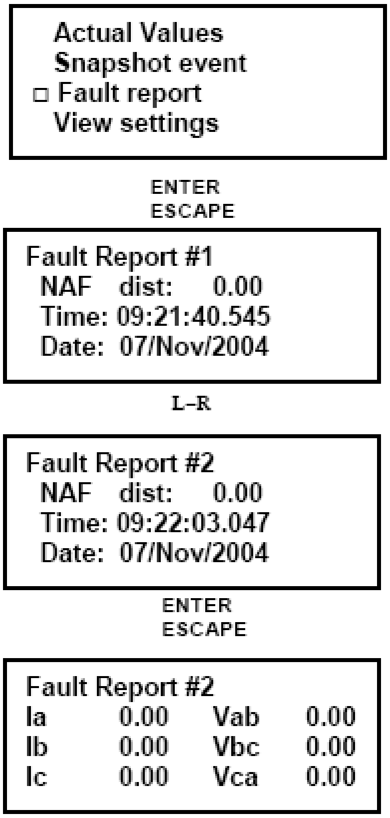
The fault-warning message must be acknowledged by the user; this means that the user must press the shuttle key for this screen to disappear, The HMI will not allow to perform any other operation until the screen is acknowledged. In the event of several consecutive faults, the HMI will always show the 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 4–20: 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**

4.2.5.6 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 4–30:. 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 4–30: 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 >	
			DNP3 Slave 1
			DNP3 Slave 2
			DNP3 Slave 3
		IEC 870-5-104>	
		SNTP	
	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
		Gen. Thermal Model >	
			Gen Thermal Model 1
			Gen Thermal Model 2
			Gen Thermal Model 3
	Neutral Current >		
		Neutral TOC >	
			Neutral TOC 1
			Neutral TOC 2
			Neutral TOC 3
		Neutral IOC >	

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			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
		Restd. Gnd Fault .(Enhanced models only) >	
			Restd. Gnd Fault 1
			Restd. Gnd Fault 2
			Restd. Gnd Fault 3
	Sens. Ground Curr >		
		Sens. Ground TOC. (Enhanced models only) >	
			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
	Neg. Seq. Current >		
		Neg. Seq. TOC >	
			Neg. Seq. TOC 1
			Neg. Seq. TOC 2
			Neg. Seq. TOC 3
		Neg. Seq. IOC >	
			Neg. Seq. IOC 1
			Neg. Seq. IOC 2
			Neg. Seq. IOC 3
		Gen. Unbalance >	
			Gen. Unbalance 1
			Gen. Unbalance 2
			Gen. Unbalance 3
	Voltage Elements >		
		Phase UV >	
			Phase UV 1
			Phase UV 2
			Phase UV 3

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
		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
		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
		Volts per Hertz . (Enhanced models only) >	
			Volts per Hertz 1
			Volts per Hertz 2
			Volts per Hertz 3
		Ground OV >	
			Ground OV 1
			Ground OV 2
			Ground OV 3
	Power>		
		Directional Power >	
			Directional Power 1
			Directional Power 2
			Directional Power 3
		PF Limiting. (Enhanced models only) >	
			PF Limiting 1
			PF Limiting 2
			PF Limiting 3
Control Elements >			
	Setting Group		
	Underfrequency >		
		Underfrequency 1	
		Underfrequency 2	
		Underfrequency 3	
	Overfrequency >		
		Overfrequency 1	
		Overfrequency 2	
		Overfrequency 3	
	Synchrocheck		

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
	Autoreclose		
	Breaker Failure		
	VT Fuse Failure. (Enhanced models only)		

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
	Freq. Rate of Change >		
		Freq. Rate of Change 1	
		Freq. Rate of Change 2	
		Freq. Rate of Change 3	
	Loss of Mains. (Enhanced models only) >		
		Loss of Mains 1	
		Loss of Mains 2	
		Loss of Mains 3	
	Loss of exc >		
		Loss of exc 1	
		Loss of exc 2	
		Loss of exc 3	
	Accdn Energ >		
		Accdn Energ 1	
		Accdn Energ 2	
		Accdn Energ 3	

4.2.5.7 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 4–30:. 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.

Snapshot event Fault report View settings □ Change settings	Select the menu Change settings and press the shuttle key to enter in the next sublevel.
Product Setup > □ System Setup > Protection Elements > Control Elements >	If there is more than one sublevel, select the next sublevel by rotating and pressing the shuttle key till the last level is reached.
□ General Settings Breaker > <– return	Press the shuttle key in the function to be modified
Phase CT Ratio 1 -- [1:6000:1]	-> Group of settings -> Setting to be modified -> Value -> Range and step
Phase CT Ratio 1 20 [1:6000:1]	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.
Press Intro to save settings	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 4–21: CHANGE SETTINGS PROCEDURE IN HMI

4.2.5.8 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:

Fault report
View settings
Change settings
□ Date & Time

⇒

Date: 07/Nov/2004
Time: 14:39:54
Sunday

⇒

‘Year’
Date: 07/Nov/<2004>
Time: 14:39:54

⇒

‘Month’
Date: 07/<Nov>/2004
Time: 14:39:54

⇒

‘Day’
Date: <07>/Nov/2004
Time: 14:39:54

⇒

‘Hour’
Date: 07/Nov/2004
Time: <14>:39:54

⇒

‘Minute’
Date: 07/Nov/2004
Time: 14:<39>:54

⇒

‘Second’
Date: 07/Nov/2004
Time: 14:39: <54>

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 4–22: CHANGE DATE AND TIME PROCEDURE IN HMI

4

4.2.5.9 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

Change Settings Date & Time □ Commands Password	Press the shuttle key in the menu commands when it is selected in the display (□).
ENTER ESCAPE	
Command: CLOSE BREAKER	All the previously configured commands will be displayed. Rotate the shuttle key move through the available commands. Press ESC to return to previous level.
L–R	
Command: OPEN BREAKER	Press shuttle key to pre-select the operation to be executed
ENTER ESCAPE	
Push 'Intro" for Confirmation	When the message "Push Enter for Confirmation" appears, press the shuttle key to confirm the commands that will be performed.
ENTER ESCAPE	
Command Completed	Once the commands has been performed or the time out has expired the "Command completed" message will appear in the display.

Figure 4–23: COMMANDS IN HMI

4.2.5.10 PASSWORDS

G650 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 G650 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.

4.2.5.11 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.

G650 3.74 (4.10)
General Electric
G650MCDF2G1HIR
19200N81: MODBUS: 254

Figure 4–24: 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.

Ia	**0.000**	**Vab**	**0.000**
Ib	**0.000**	**Vbc**	**0.000**
Ic	**0.000**	**Vca**	**0.000**
Ig	**0.000**	**V0**	**0.000**

Figure 4–25: DEFAULT METERING SCREEN

All

This option alternates in time the two previous options.

4.2.6.1 ONE-LINE DIAGRAM

In models with graphic display (G650M) 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***).

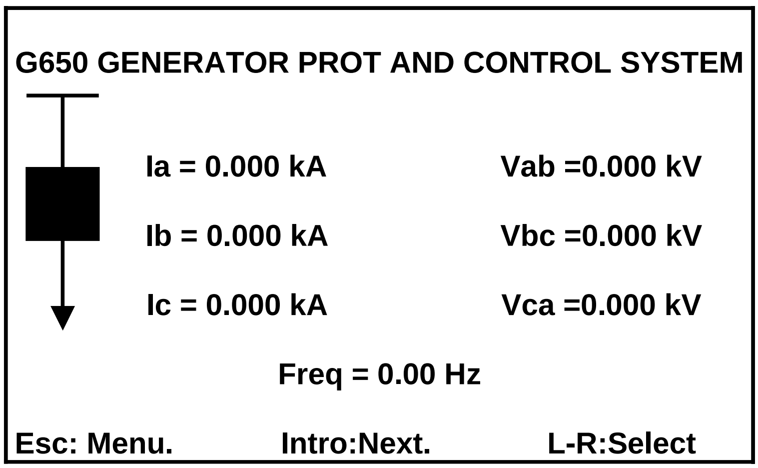


Figure 4–26: ONE-LINE DIAGRAM

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 (G650B).

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 4.2.5 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.

4.2.6.2 METERING SCREEN

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

Metering Screen.	Total metering 54
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 4–27: 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	Vg Primary
I1 Primary	Phase A Reactive Pwr	Phase C Power Factor	
I2 Primary	Phase A Apparent Pwr	3 Phase Power Factor	

4.2.6.3 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	**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 4–28: 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.

	Ready LED ON	
Date: 07/Nov/2004		**St:ON**
Time: 16:11:08.035		**(1/479)**
Phasor Ia Primary		**0.000**
Phasor Ib Primary		**0.000**
Phasor Ic Primary		**0.000**
Line Frequency		**0.000**
Phasor Ig Primary		**0.000**
Phasor Isg Primary		**0.000**
I0 Primary		**0.000**
I1 Primary		**0.000**
Intro: Meters.	**ESC: Prev.**	**L-R: Scroll.**

Figure 4–29: 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.

4.2.6.4 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.

4.2.6.5 ALARMS PANEL

Alarms panel can be viewed in all G650 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***").

Alarm Panel (1/3).
#1 OPERATIONS IN LOCAL MODE

7/11/04 16:54:16	**OPERATIONS IN LO.**	**ON**
7/11/04 16:54:16	**GENERAL PICKUP**	**ON**
7/11/04 16:54:16	**GENERAL TRIP**	**ON**

Esc: Prev. Intro: Next

Figure 4–30: 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.

4.2.6.6 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.

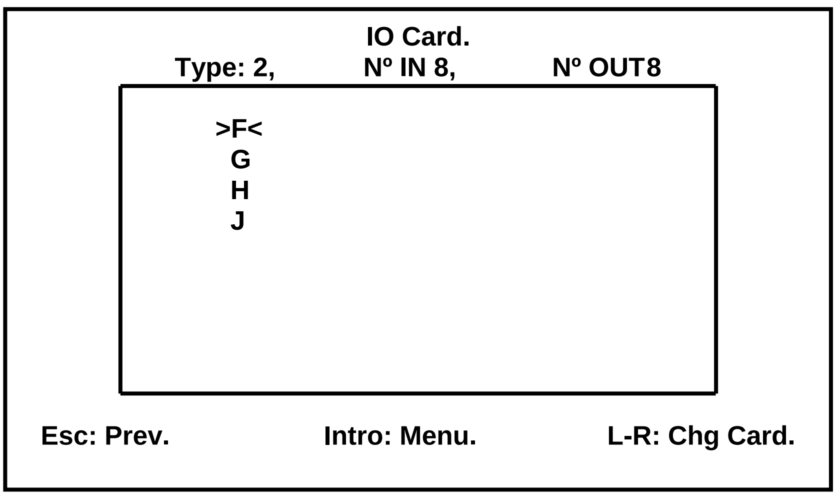


Figure 4–31: INPUTS/OUTPUTS GENERAL SCREEN

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.

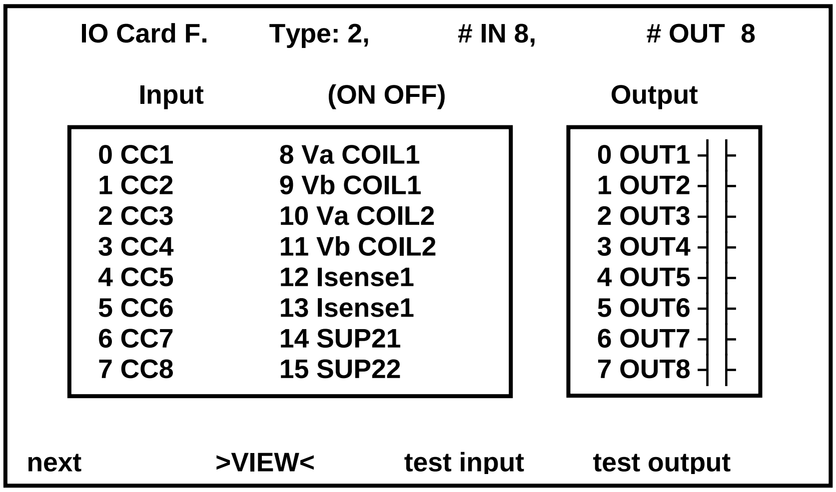


Figure 4–32: INPUT/OUTPUT VIEWING SCREEN

<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 G650 models.

L-R: Chg Card

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

4.3.1 HOME

The web server in the G650 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 G650 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.

Figure 4–33: WEB SERVER MAIN SCREEN

4.3.2 SNAPSHOT EVENTS

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 4–34: SNAPSHOT EVENTS SCREEN

4.3.3 CONTROL EVENTS

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.

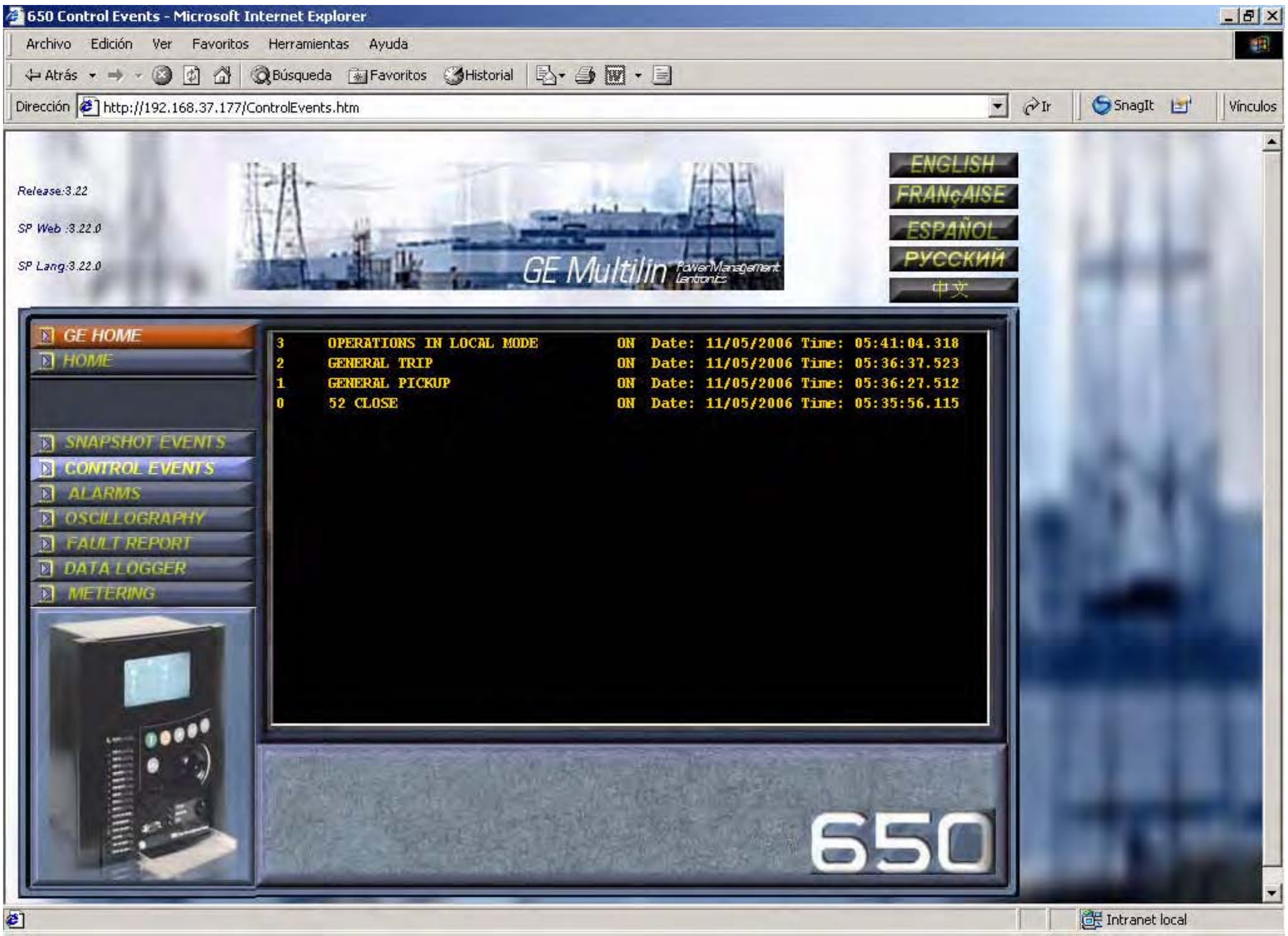


Figure 4–35: CONTROL EVENTS SCREEN

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.

4.3.4 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.

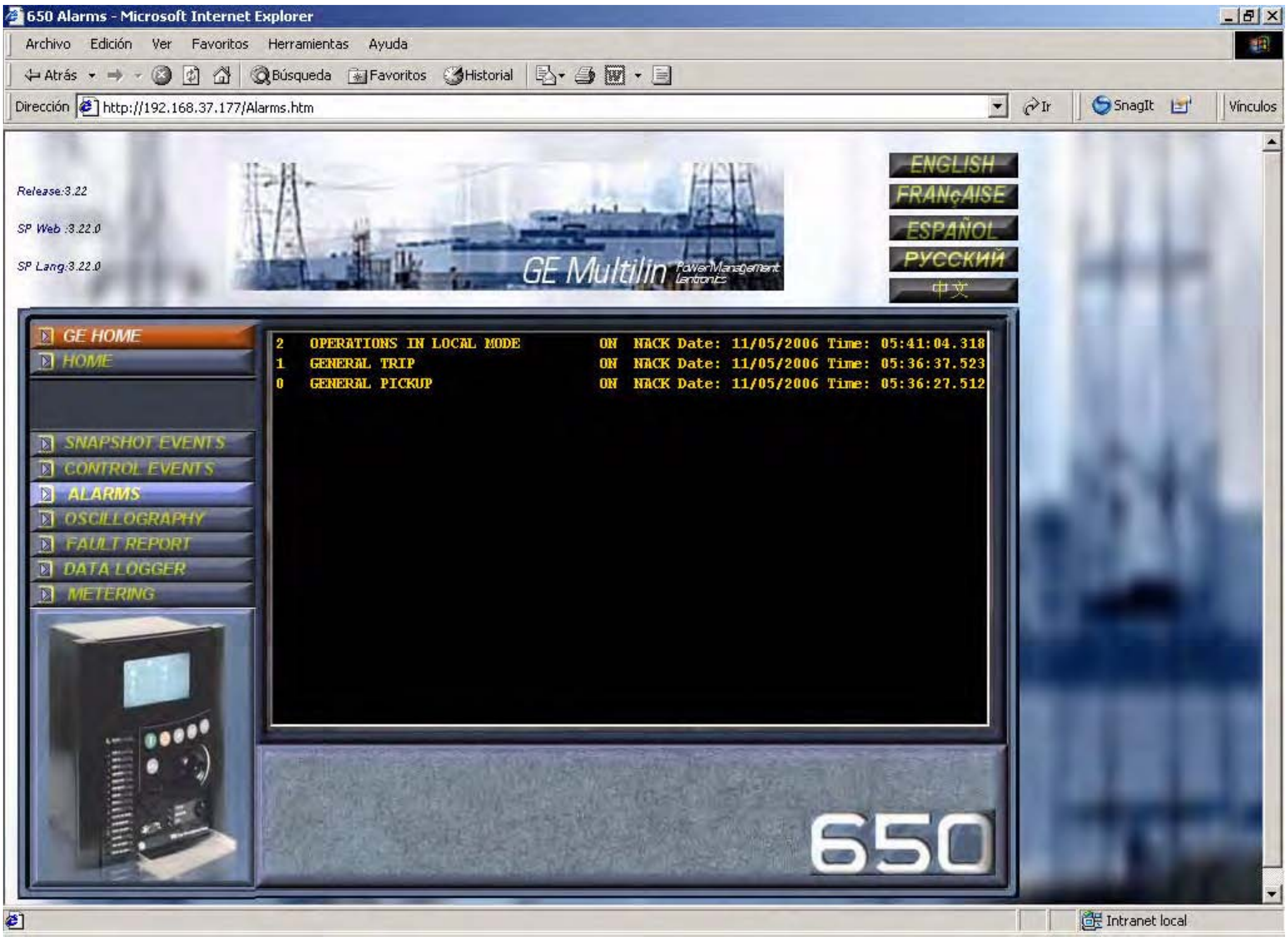


Figure 4–36: ALARMS SCREEN

4.3.5 OSCILLOGRAPHY

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).

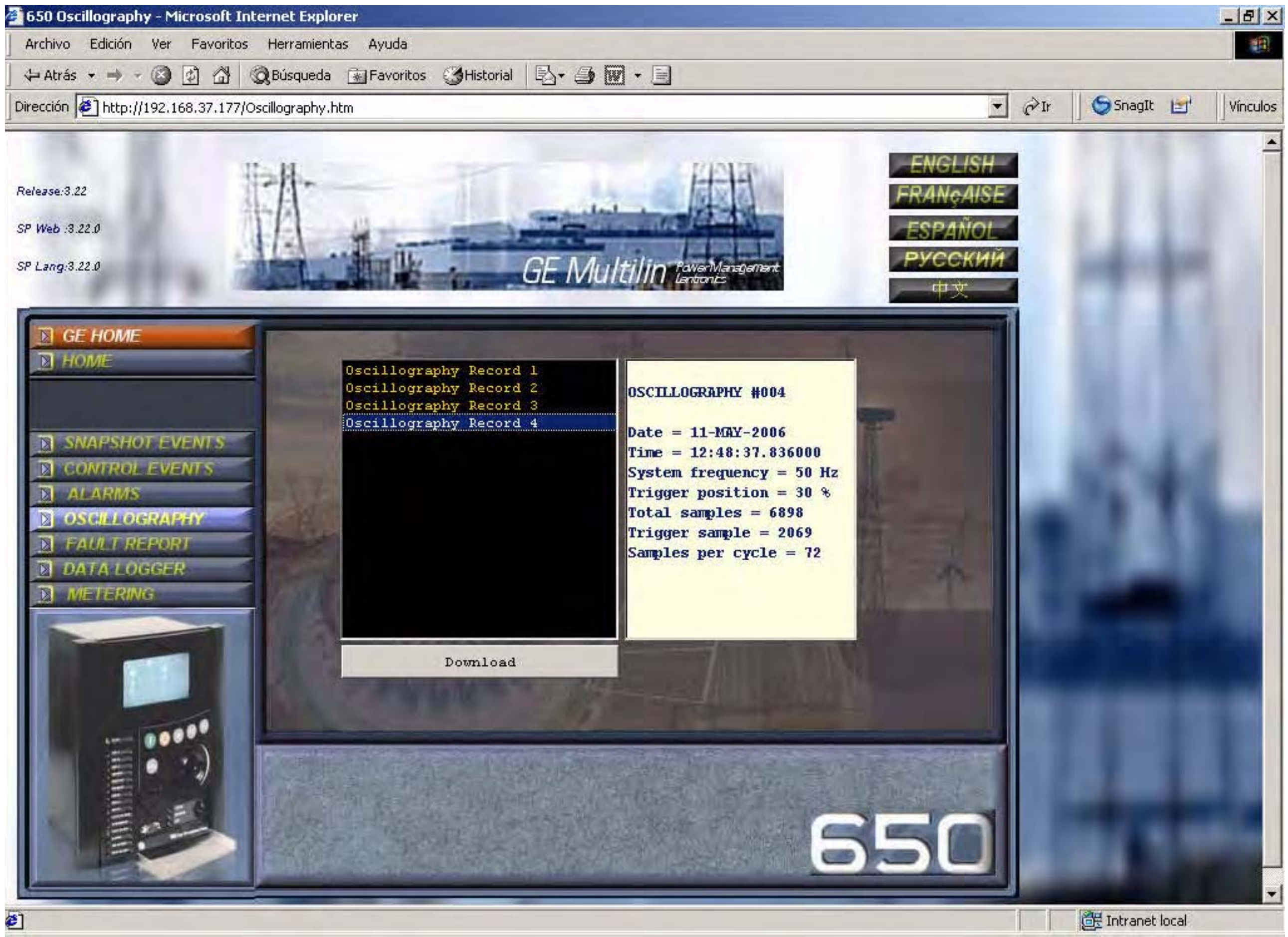


Figure 4–37: OSCILLOGRAPHY SCREEN

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.

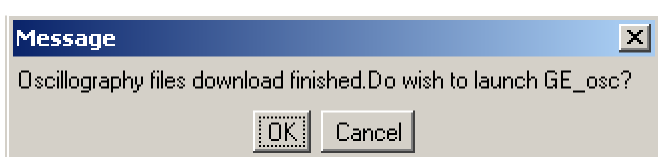


Figure 4–38: GE-OSC LAUNCH SCREEN

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

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4.3.6 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.

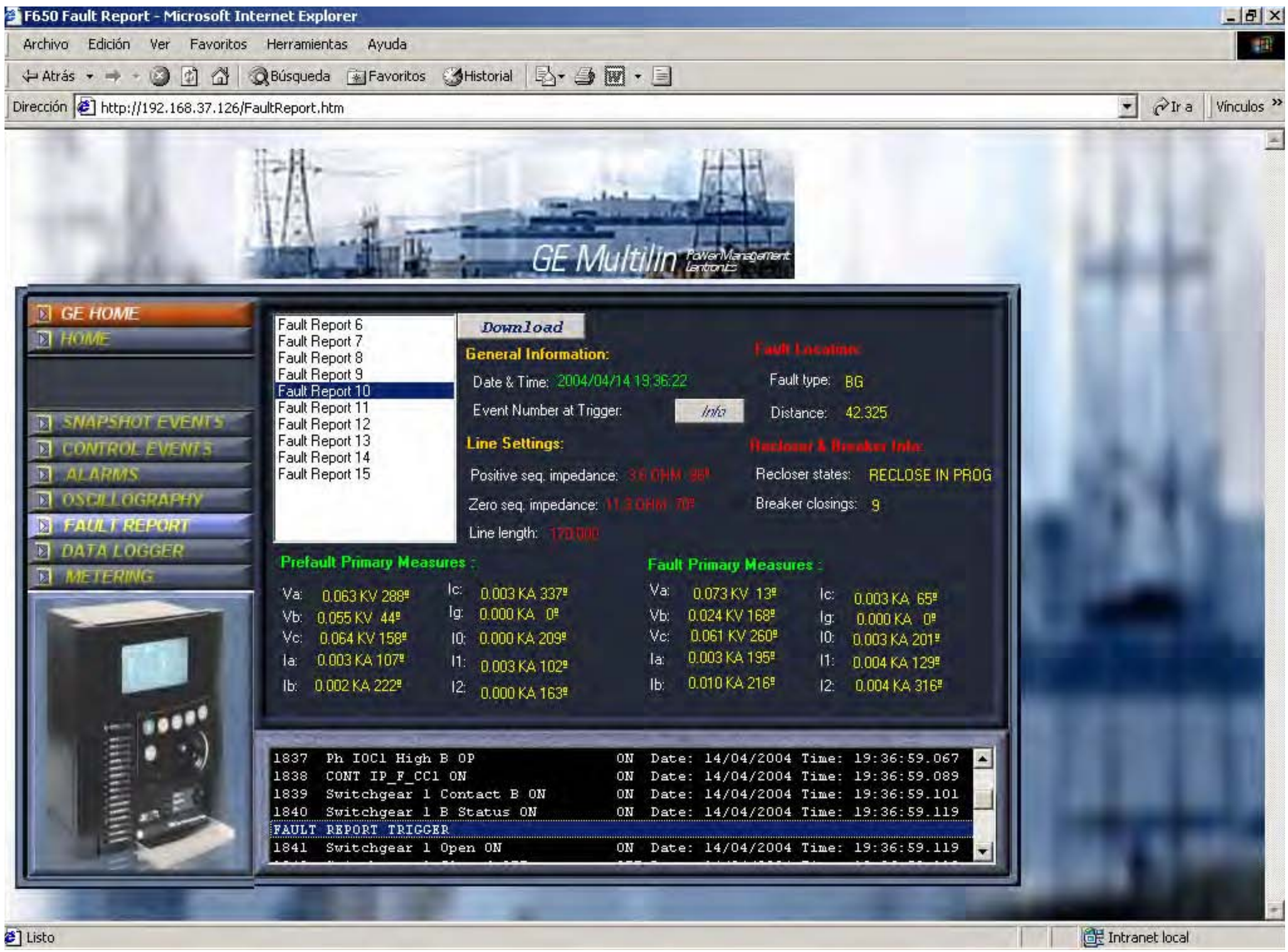

Figure 4–39: FAULT REPORT SCREEN

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.

4.3.7 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.

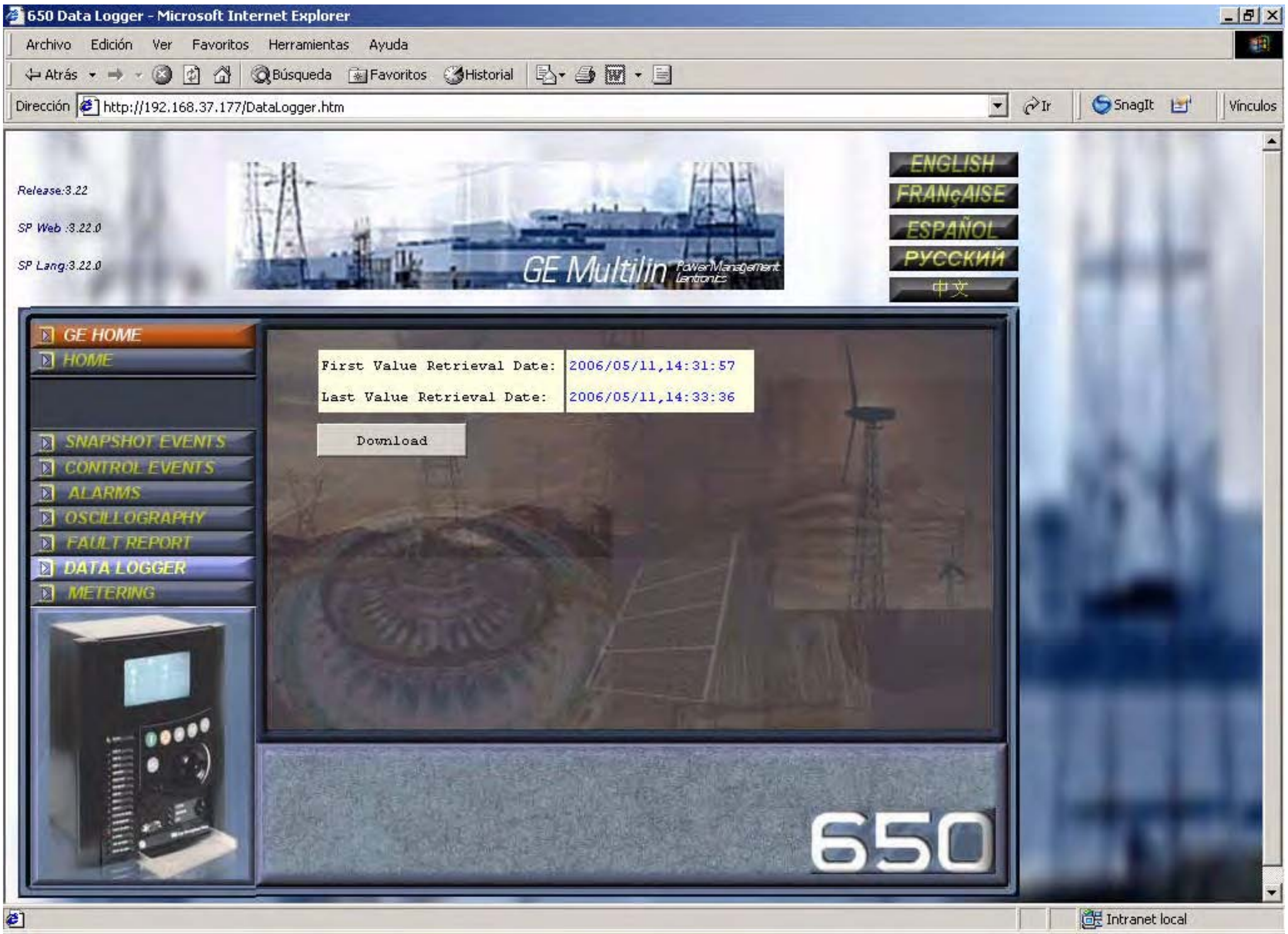

Figure 4–40: DATA LOGGER SCREEN

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4.3.8 METERING

This screen includes the 54 primary metering values provided by the relay display.

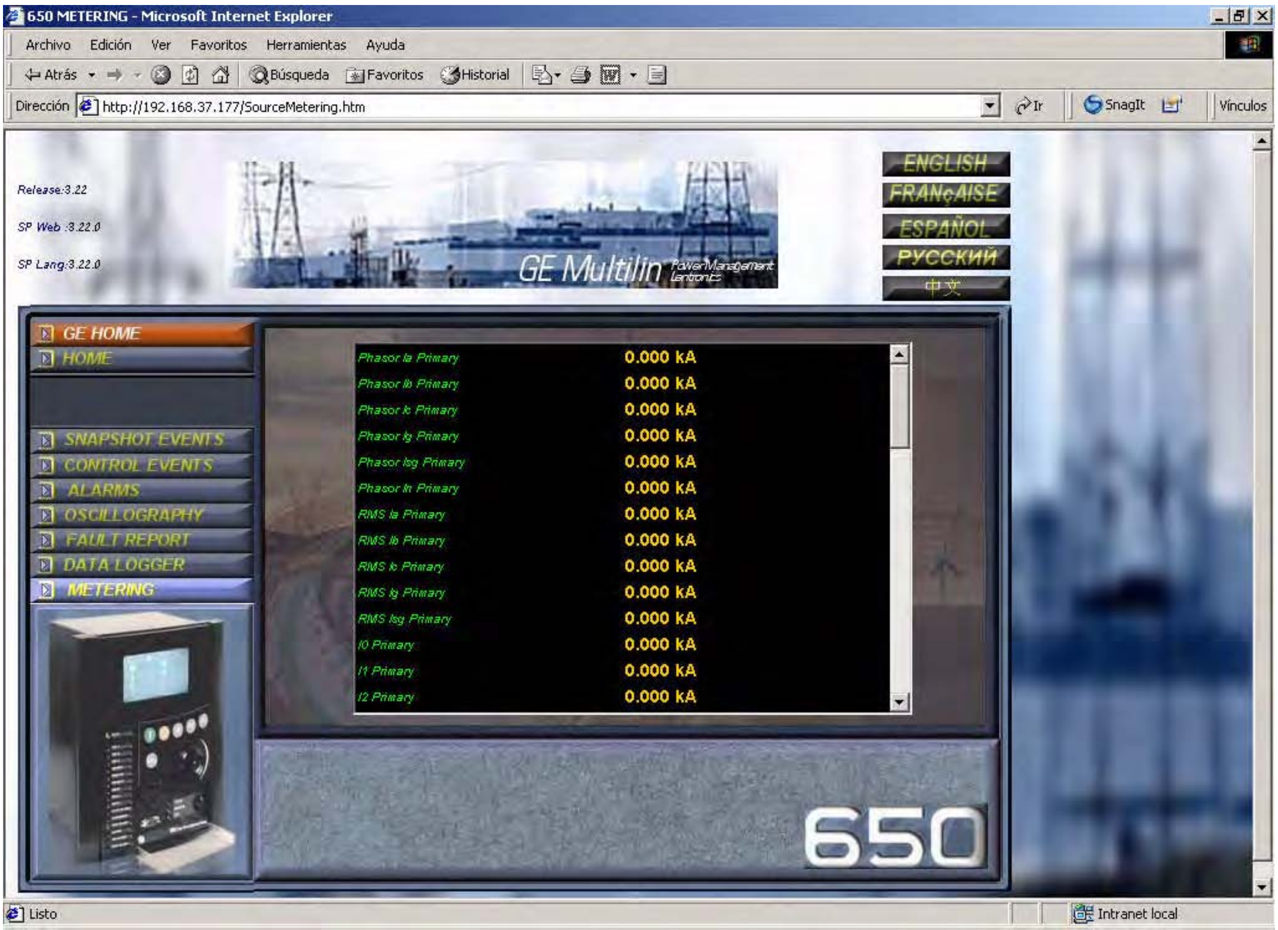

Figure 4–41: METERING SCREEN

5.1.1 SETTING MAIN MENU

Table 5–1: GENERAL OVERVIEW OF SETTING MAIN MENU IN ENERVISTA 650 SETUP:

Product Setup		
	Communication settings	
		Serial Ports
		Network (Ethernet)
		ModBus Protocol
		DNP3 Slave
		IEC 870-5-104
		SNTP
	ModBus User Map	
	Fault Report	
	Oscillography	
	Data Logger	
	Demand	
System Setup		
	General settings	
	Flex Curves	
	Breaker	
		Breaker Settings
		Breaker Maintenance
	Switchgear	
Protection Elements		
	Phase Current	
		Phase TOC High
		Phase TOC Low
		Phase IOC High
		Generator Thermal Model
	Neutral Current	
		Neutral TOC
		Neutral IOC
		Neutral Directional
	Ground Current	
		Ground TOC
		Ground IOC
		Ground Directional
		Restricted Gnd. Fault. (Enhanced models only)
	Sensitive Ground Current. (Enhanced models only)	
		Sensitive Ground TOC
		Sensitive Ground IOC
	Negative Sequence Current	
		Negative Sequence TOC
		Negative Sequence IOC
		Generator Unbalance

	Voltage Elements	
		Phase UV
		Phase OV
		Neutral OV High
		Negative Sequence OV
		Auxiliary OV
		Auxiliary UV
		Volts per Hertz. (Enhanced models only).
		Ground OV
	Power	
		Directional Power
		Pwr Factor Limiting. (Enhanced models only)
Control Elements		
	Setting Group	
	Underfrequency	
	Overfrequency	
	Synchrocheck	
	Breaker Failure. (Enhanced models only).	
	VT Fuse Failure. (Enhanced models only).	
	Pulse Counters	
	Analog Comparator	
	Frequency rate of change	
	Loss of Mains. (Enhanced models only).	
	Loss of Excitation	
	Accidental Energization	
Input/Outputs		
	Contact I/O	
		Board F
		Board G
		Board H
		Board J
	Force Outputs.	
	Virtual Inputs	
Relay configuration		
Logic configuration		
Clock		

5.2.1 COMMUNICATION SETTINGS

5.2.1.1 SERIAL PORTS

Baud rate and parity for COM1 and COM2 serial communication ports.

Table 5–2: SERIAL PORTS SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >SERIAL PORTS			
Name	Default Value	Step	Range
COM1 Baud Rate	19200	N/A	[300 : 115200]
COM2 Baud Rate	19200	N/A	[300: 115200]
COM1Parity	NONE	N/A	[NONE:ODD:EVEN]
COM2Parity	NONE	N/A	[NONE:ODD:EVEN]

5.2.1.2 NETWORK (ETHERNET)

Ethernet communication parameters for COM3. Two different Ethernet addresses can be used, but the first IP always has to be set as the second IP Address is an Alias. The ModBus Slave address used by Ethernet ports is the one set for COM2.

Table 5–3: NETWORK SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >NETWORK (ETHERNET) NETWORK (ETHERNET)1 > NETWORK (ETHERNET)2			
Name	Default Value	Step	Range
IP Address Oct1	0	N/A	[0: 255]
IP Address Oct2	0	N/A	[0: 255]
IP Address Oct3	0	N/A	[0: 255]
IP Address Oct4	0	N/A	[0: 255]
Netmask Oct1	0	N/A	[0: 255]
Netmask Oct2	0	N/A	[0: 255]
Netmask Oct3	0	N/A	[0: 255]
Netmask Oct4	0	N/A	[0: 255]
Gateway IP Oct1	0	N/A	[0: 255]
Gateway IP Oct2	0	N/A	[0: 255]
Gateway IP Oct3	0	N/A	[0: 255]
Gateway IP Oct4	0	N/A	[0: 255]

5.2.1.3 MODBUS PROTOCOL

ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP. For more detailed information go to appendix B in this manual.

Table 5–4: MODBUS PROTOCOL SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >MODBUS PROTOCOL			
Name	Default Value	Step	Range
ModBus Address COM1	254	1	[1 : 255]
ModBus Address COM2	254	1	[1 : 255]
ModBus Port Number	502	1	[0 : 65535]

5.2.1.4 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. For more detailed information go to appendix C in this manual.

Table 5–5: DNP PROTOCOL SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >DNP3 SLAVE DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3			
Name	Default Value	Step	Range
Physical Port	NONE	N/A	[COM1:COM2:NETWORK]
Address	255	1	[0 : 65534]
IP Addr Client1 Oct1	0	1	[0 : 255]
IP Addr Client1 Oct2	0	1	[0 : 255]
IP Addr Client1 Oct3	0	1	[0 : 255]
IP Addr Client1 Oct4	0	1	[0 : 255]
IP Addr Client2 Oct1	0	1	[0 : 255]
IP Addr Client2 Oct2	0	1	[0 : 255]
IP Addr Client2 Oct3	0	1	[0 : 255]
IP Addr Client2 Oct4	0	1	[0 : 255]
IP Addr Client3 Oct1	0	1	[0 : 255]
IP Addr Client3 Oct2	0	1	[0 : 255]
IP Addr Client3 Oct3	0	1	[0 : 255]
IP Addr Client3 Oct4	0	1	[0 : 255]
IP Addr Client4 Oct1	0	1	[0 : 255]
IP Addr Client4 Oct2	0	1	[0 : 255]
IP Addr Client4 Oct3	0	1	[0 : 255]
IP Addr Client4 Oct4	0	1	[0 : 255]
IP Addr Client5 Oct1	0	1	[0 : 255]
IP Addr Client5 Oct2	0	1	[0 : 255]
IP Addr Client5 Oct3	0	1	[0 : 255]
IP Addr Client5 Oct4	0	1	[0 : 255]
TCP/UDP Port	20000	1	[0 : 65535]
Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]
Unsol Resp TimeOut	5	1	[0 : 60]
Unsol Resp Max Ret	10	1	[0 : 255]
Unsol Resp Dest Adr	200	1	[0 : 65535]
Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Current Deadband	30000	1	[0 : 65535]
Voltage Deadband	30000	1	[0 : 65535]
Power Deadband	30000	1	[0 : 65535]
Energy Deadband	30000	1	[0 : 65535]
Other Deadband	30000	1	[0 : 65535]
Msg Fragment Size	240	1	[30 : 2048]
Binary Input Block 1	CTL EVENTS 1-16	N/A	
Binary Input Block 2	CTL EVENTS 17-32	N/A	
Binary Input Block 3	CTL EVENTS 33-48	N/A	
Binary Input Block 4	CTL EVENTS 49-64	N/A	
Binary Input Block 5	CTL EVENTS 65-80	N/A	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3			
Binary Input Block 6	CTL EVENTS 81-96	N/A	
Binary Input Block 7	CTL EVENTS 97-112	N/A	
Binary Input Block 8	CTL EVENTS 113-128	N/A	
Binary Input Block 9	SWITCHGEAR 1-8	N/A	
Binary Input Block 10	SWITCHGEAR 9-16	N/A	

5.2.1.5 IEC 60870-5-104

Communication settings for IEC 60870-5-104 protocol. For more detailed information go to appendix D in this manual.

Table 5–6: IEC 60870-5-104 PROTOCOL SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >IEC 870-5-104			
Name	Default Value	Step	Range
Function	DISABLED	N/A	[DISABLED-UNICAST–BROADCAST- ANYCAST]
TCP Port	2404	1	[1 : 65535]
Common Addr of ASDU	255	1	[0 : 65535]
Cyclic Meter Period	0	1	[0 : 3600]
Synchronization Event	0	1	[0 : 3600]

5.2.1.6 SNTP

Table 5–7: SNTP PROTOCOL SETTINGS

PRODUCT SETUP > COMMUNICATION SETTINGS >SNTP			
Name	Default Value	Step	Range
Function	DISABLED	N/A	[DISABLED – ENABLED]
UDP Port	123	1	[1 : 65535]
Server Ip Oct1	0	1	[0 : 255]
Server Ip Oct2	0	1	[0 : 255]
Server Ip Oct3	0	1	[0 : 255]
Server Ip Oct4	0	1	[0 : 255]

The G650 supports the Simple Network Time Protocol specified in RFC-2030. With SNTP, the G650 can obtain the clock time over an Ethernet network. The G650 acts as an SNTP client to receive time values from an SNTP/NTP server, usually a dedicated product using a GPS receiver to provide an accurate time. Three different modes of SNTP operation are supported. These modes are unicast, broadcast and anycast.

If SNTP functionality is enabled at the same time as an IRIG-B source is connected to the G650, the IRIG-B signal provides the time value to the G650 clock for as long as a valid signal is present. If the IRIG-B signal is removed, the time obtained from the SNTP server is used.

To use SNTP in unicast mode, **Server IP Oct1...4** must be set to the SNTP/NTP server IP address. Once this address is set and the **Function** setting is “UNICAST”, the G650 attempts to obtain time values from the SNTP/NTP server. Since many time values are obtained and averaged, it generally takes forty seconds until the G650 clock is synchronized with the SNTP/NTP server. It may take up to one minute for the G650 to signal an SNTP FAIL state if the server is off-line.

To use SNTP in broadcast mode, set the **Function** setting to “BROADCAST”. The G650 then listens to SNTP messages sent to the “all ones” broadcast address for the subnet. The G650 waits up to eighteen minutes (>1024 seconds) without receiving an SNTP broadcast message before signalling an SNTP FAIL state.

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To use SNTP in anycast mode, set the **Function** setting to “ANYCAST”. Anycast mode is designed for use with a set of cooperating servers whose addresses are not known beforehand by the client. The G650 sends a request to a multicast group address assigned by IANA for NTP protocol. This address is 224.0.1.1 and a group of SNTP/NTP servers listens to it. Upon receiving a request each server sends a unicast response to the SNTP/NTP client. The G650 relay binds to the first unicast message received from any server. Then it continues operating with SNTP/NTP server in unicast mode. Any further responses from other SNTP/NTP servers are ignored. In unicast mode of operation the chosen time server can go offline, in that case it takes about one minute for the G650 to signal an SNTP FAIL state and to switch again to anycast mode to try to find another time server. In anycast mode the G650 tries to send multicast messages up to five minutes before signalling an SNTP FAIL state.

The G650 relay does not support the multicast mode of SNTP functionality.

5.2.2 MODBUS USER MAP

The ModBus user map definition. 256 records, selectable from the complete relay ModBus map, from the ModBus user map. For more detailed information go to appendix B in this manual.

Table 5–8: MODBUS USER MAP SETTINGS

PRODUCT SETUP > MODBUS USER MAP			
Name	Default Value	Step	Range
Address 00	0000		[0000 : FFFF]
Address 01	0000		[0000 : FFFF]
...			...
Address 254	0000		[0000 : FFFF]
Address 255	0000		[0000 : FFFF]

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5.2.3 FAULT REPORT

5.2.3.1 OVERVIEW

The fault report module defines the type of fault (three-phase, phase-to-phase, phase-to-ground), and the distance to the fault. The fault activation signal (FAULT REPORT TRIGG) is programmed at "***Setpoint > Relay Configuration > Protection Elements***".

The fault report provides fault date, fault type and fault location information.

Information referred to the last ten faults is stored as fault report and available to the user through the EnerVista 650 Setup software or the web server application. Each fault report includes the following information:

- Fault date and time
- Pre-fault current and voltage in primary values
- Fault current and voltages in primary values
- Fault type
- Distance to the fault (fault location)
- Line parameters
- Recloser and breaker status information

As an option, the Relay offers the possibility to display a fault-warning message on the relay HMI (selectable by setting).

5.2.3.2 FAULT REPORT SETTINGS

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Table 5–9: FAULT REPORT SETTINGS

SETPOINT > PRODUCT SETUP > FAULT REPORT				
Setting Description	Name	Default Value	Step	Range
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]

Function permission (Function): Enabling this setting allows to create a fault report when the FAULT REPORT TRIGG is activated.

Positive sequence impedance module (Pos Seq Module): Value, in ohms, of the line positive sequence impedance module.

Positive sequence impedance Angle (Pos Seq Angle): Value, in degrees, of the line positive sequence angle.

Zero sequence impedance module (Zero Seq Module): Value, in ohms, of the line zero sequence impedance module.

Zero sequence impedance Angle (Zero Seq Angle): Value, in degrees, of the line zero sequence angle.

Line Length: The metering element can be kilometers or miles.

Show Fault On HMI: This setting enables or disables the option to display faults on the Relay HMI.

Snapshot Events: This setting enables or disables the snapshot event generation for the fault report element.

5.2.3.3 FAULT REPORT STATES

States associated to the fault report ("***Actual >Status>Records Status > Fault Reports***"), are shown on Table 5–10:

Table 5–10: FAULT REPORT STATES

FAULT REPORT STATES
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
FAULT DATE
FAULT TYPE
FAULT LOCATION
FAULT REPORT NUMBER

FAULT REPORT TRIGG: The activation of this state initiates the calculation of the fault location and the generation of the corresponding report.

CLEAR FAULT REPORTS: The activation of this state produces the removal of all faults stored in the relay. Additionally, all active faults on the HMI display will be acknowledged. This signal is programmed at "***Setpoint>Relay Configuration>Protection Elements***".

FAULT DATE: Date and time of the last fault.

FAULT TYPE: Type of the last fault produced (3PHASE, AG, BG, CG, AB, ABG, BC, BCG, CA, CAG, NAF). NAF indicates that the type of fault has not been calculated.

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FAULT LOCATION: Calculated distance to the last fault (the metering element will be the same used for setting the line length).

FAULT REPORT NUMBER: Number of the fault report file saved in the relay's non-volatile memory, associated to the last fault produced.

5.2.3.4 FAULT REPORT RETRIEVAL

Fault report files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

For obtaining fault reports using the EnerVista 650 Setup software, the user must access "***Actual>Records>Fault report***". The top of the window shows the number of the last fault report stored by the device (Fault Record Number). Clicking on the "View header" button, the system will show the header of the record selected at "Select Record".

Clicking on the "Download" button, the file is retrieved, and saved in a folder selected by the user. The file name is "FLTxxx.DAT", where xxx is the corresponding record number. The fault report retrieval can be done using serial communication (ModBus RTU) or Ethernet (tftp).

Fault reports are stored in the relay's non-volatile memory, so they are accessible from the EnerVista 650 Setup software or the relay's web server. The fault report is a text file named FLTxxx.txt where xxx is the record number, with a range of 001 to 999. Only files from the 10 last faults will be stored. If there are already ten files stored and a new fault occurs, the new fault will overwrite the oldest one. Enabling Show Fault on HMI option, this information will also be sent to HMI.

When a fault is produced and a warning message is displayed on the HMI, fault information alternates between two separate screens: one with general information, and a second one with the fault metering values. This screen needs to be acknowledged by the user by pressing the INTRO button to exit the fault report screen. If several consecutive faults are produced, the HMI will always display the most recent one. Each stored fault will need to be acknowledged up to a maximum of 10 faults. The HMI menu offers an option to view the last 10 faults produced, that menu displays both the general information screen and the metering screen for each fault.

5.2.4 OSCILLOGRAPHY

5.2.4.1 OVERVIEW

G650 elements allocate 1-Mbyte of memory for storing oscillography records. These oscillography records are stored in non-volatile memory.

Oscillography records are stored in COMTRADE ASCII - IEEE C37.111-1999 standard format.

The oscillography module is in charge of storing the instantaneous values of the 9 analog signals and the 16 programmable digital signals at ***Setpoint > Relay Configuration > Oscillography*** in fault conditions (OSCILLO TRIGGER signal activation).

All oscillography records store all analog signals (fixed) plus 16 digital signals (programmable). The order of storage in the case of analog signals is as follows:

Analog 1	IA channel.
Analog 2	IB channel.
Analog 3	IC channel.
Analog 4	IG channel.
Analog 5	ISG channel.
Analog 6	VA or VAB channel, depending on the selected configuration (Wye or Delta, at "***Setpoint>System Setup > General Settings > Serial VT Connection***").
Analog 7	VB or VBC channel, depending on the selected configuration (Wye or Delta, at "***Setpoint>System Setup > General settings > Phase VT Connection***").
Analog 8	VC or VCA channel, depending on the selected configuration (Wye or Delta, at "***Setpoint>System Setup > General settings>Phase VT Connection***").
Analog 9	VN or VX channel, depending on the selected configuration (zero sequence measured, or busbar voltage, at "***Setpoint>System Setup>General settings>Auxiliary Voltage***").

The 16 digital channels and the oscillography trigger signal are programmable using the EnerVista 650 Setup software at ***Setpoint > Relay configuration > Oscillography***. Each digital channel can be associated to a single status or to a logic status. In this last case, the logic must be configured using the PLC Editor tool, at ***Setpoint > Logic Configuration*** inside EnerVista 650 Setup, and its output must be associated to a virtual output. This virtual output is then associated to a digital channel. The oscillography trigger signal can be a single status or a configured logic. The relay's default configuration associates the oscillography trigger to Virtual Output 83, which corresponds to the logic associated to the general trip of protection elements.

5.2.4.2 OSCILLOGRAPHY SETTINGS

These settings (**“*Setpoint > Product Setup > Oscillography*”**) are described in Table 5–11:

Table 5–11: OSCILLOGRAPHY SETTINGS

SETPOINT > PRODUCT SETUP > OSCILLOGRAPHY				
Setting Description	Name	Default Value	Step	Range
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]
Prefault	Trigger Position	30	1%	[5 : 95]
Sampling rate	Sampling Rate	3600	Hz	[225-450-900-1800-3600]
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]

Function Permission (Function): Enabling this setting allows to create an oscillography record when the “**TRIGGER OSCILLO**” signal is activated.

Trigger Position: This setting defines the prefault data (in percentage) stored every time a new oscillo is produced.

Sampling Rate: This setting defines the sampling rate of the oscillography capture. Please see the example below.

Maximum Number of Oscillos (Max. Number Osc.):

1 to 20 oscillography records can be selected. The capacity of each record is = 1Mbyte / Max. Number Osc. This capacity is divided in 38 bytes (9 measurements * 4 bytes/ measurement + 2 digital bytes) per stored sample. Please refer to example below.

Automatic Overwrite: This setting allows chained oscillographies during the fault (TRIGGER OSCILLO signal activated). The maximum allowed value to be stored as a chained oscillography is 1 Mbyte. In this case, even if the trip continues during a time longer than the associated 1 Mbyte of memory, the relay will stop storing the oscillography in RAM memory until the complete record has been saved in non-volatile memory. The oscillography module will be reset once the data has been completely stored in Flash memory and the TRIGGER OSCILLO state is deactivated.

Snapshot Events: This setting enables or disables snapshot event generation for the oscillography element.

EXAMPLE

For a Max. Number Osc. of 4, each record will store 1Mbyte / 4 = 262144 bytes.

Therefore, the number of samples per oscillography record is 262144 bytes / 38 bytes = 6898 samples per stored oscillo.

If we set the relay to 3600 Hz as sampling rate , each record will store up to:

- 6898 / 72 = 95.78 signal cycles at 50 Hz as nominal frequency
- 6898 / 60 = 114.93 signal cycles at 60 Hz as nominal frequency

This value expressed in terms of time would be:

For 50 Hz: 95.78 cycles x 20 ms/cycle =1.915 seconds.

For 60 Hz: 114.93 cycles x 16.67 ms/cycle =1.915 seconds.

5.2.4.3 OSCILLOGRAPHY STATES

States associated to the oscillography module ("***Actual >Status>Records Status>Oscillography***"), are shown in Table 5–12:

Table 5–12: OSCILLOGRAPHY STATES

OSCILLOGRAPHY STATES
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12
OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD
AVAILABLE RECORDS

OSC DIGITAL CHANNEL XX: These states are configured at "***Setpoint>Relay configuration>Oscillography***". Each of these states can be associated to a protection state or to a virtual output. Each oscillography record will reflect the changes experienced by this state during the record.

OSCILLO TRIGGER: The activation of this state will produce the oscillography record capture. Each record uses a percentage of its capacity to store prefault information. This percentage is selected in the Trigger Position setting, and the rest of the record's capacity will store post-fault information.

NUMBER OF TRIGGERS: This is the number of the most recent oscillography record stored in the relay. The record is stored in COMTRADE format. The range is 0 to 999.

CYCLES PER RECORD: This state displays the number of cycles that will be stored in each oscillography record. Although the number of cycles can be a decimal number, the record will represent only the integer part.

AVAILABLE RECORDS: This shows the number of records stored in the relay, which can be retrieved by serial communication (ModBus RTU) or Ethernet (tftp). The range is 0 to 20.

5.2.4.4 OSCILLOGRAPHY FILES RETRIEVAL

Oscillography files can be retrieved using the EnerVista 650 Setup software, or the web server at “http:\\relay IP address”.

To obtain the oscillography records using the EnerVista 650 Setup software, go to “***Actual>Records>Waveform capture***”. The top of the window shows the number of the last oscillography record stored by the device (Newest Record Number), followed by the maximum number of oscillos available (Available Records in Device). Clicking on the “View header” button, the system will show the header of the record selected at “Select Record”.

Clicking on the “Download” button, the three files (*.DAT, *.HDR, *.CFG) that form the oscillography record in the COMTRADE standard will be retrieved, and they will be viewed automatically if the GE-OSC software is installed in the computer. Retrieved oscillographies can be viewed using any Comtrade viewer. The EnerVista 650 Setup software stores by default oscillography records in the folder “.\EnerVista 650 Setup\files\osc”, in the same directory where the program is installed. The file names are “OSCxxx.DAT”, “OSCxxx.CFG”, “OSCxxx.HDR”, where xxx is the corresponding record number. The oscillography retrieval can be done using serial communication (ModBus RTU) or Ethernet (tftp).

5.2.5 DATA LOGGER

The G650 data logger can store information of up to 16 analog channels, among all channels available in the relay, with a sampling rate selectable by setting. The memory of the data logger is fixed, 64 Kilobytes. Two bytes are needed per channel. The selected channels will take all the available memory space. Therefore, the storage days will depend on the selected number of channels and sampling rate.

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5.2.5.1 DATA LOGGER SETTINGS

Data logger settings can be found at “***Setpoint>Product Setup>Data Logger***”.

Table 5–13: DATA LOGGER SETTINGS

SETPOINT > PRODUCT SETUP > DATA LOGGER				
Setting Description	Name	Default Value	Step	Range
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]

Function permission (Function): This must be enabled to start storing information.

Data Logger Rate: the data logger can be configured in rates of 1 second, and 5, 10, 15, 20, 30 and 60 minutes

Data Logger Analog Channel X (Data Logger Chnl X): Analog Channels programmable in the data logger. The **X** value has a range from 0 to 16.

Any setting change in the Data Logger will erase all the stored information.

5.2.5.2 DATA LOGGER ASSOCIATED STATES

States associated to the data logger module ("***Actual >Status>Records Status>Data logger***) are shown on the table below:

Table 5–14: DATA LOGGER STATES

DATA LOGGER STATES
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: The Date/time of the oldest state with 6 characters. This is the time that corresponds to the oldest sample. This value will remain constant until the available memory capacity is exceeded. Afterwards, this value will change according to the sampling rate (Data Logger Rate).

NEWEST SAMPLE TIME: The Date/time of the newest state with 6 characters. This is the time when the most recent sample was taken. This value is updated according to the sample rate selected.

If no channel has been selected, these settings do not change.

DATA LOGGER CHANNELS: This state shows the number of channels selected.

DATA LOGGER DAYS: This state shows the number of days that can be stored. It depends on the Data Logger Rate setting, and on the number of channels selected.

5.2.5.3 DATA LOGGER FILES FORMAT AND RETRIEVAL

File Retrieval

Data logger files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

For obtaining the data logger files using the EnerVista 650 Setup software, the user must access "***Actual>Records>Data Logger***". The top of the window shows the date when the oldest sample was taken, and then the date when the newest sample was taken.

This screen shows the measurements stored for the different channels through the time.

Clicking on the "Download" button, all the information contained in the file can be read.

Clicking on the "Save" button, the data logger files (*.DAT, *.CFG) are retrieved in COMTRADE format, and saved by default in the folder "...\EnerVista 650 Setup\files\osc", using "DLGxxx.DAT", "DLGxxx.CFG" names, where xxx is the corresponding record number. **Data logger files can be retrieved only by Ethernet via tftp.**

File Format

Data logger information is made of two text files: configuration file (datalogger.cfg), and data file (datalogger.dat).

5.2.6 DEMAND

5.2.6.1 METERING VALUES AND SETTINGS

The demand calculation is made according to the following primary parameters:

Table 5–15: PRIMARY DEMAND VALUES

PRIMARY DEMAND VALUES	STEP
IA (RMS)	KA
IB (RMS)	KA
IC (RMS)	KA
IG (RMS)	KA
ISG (RMS)	KA
I2	KA
Three phase active power (W)	MW
Three phase reactive power (VAR)	MVAr
Apparent power (VA)	MVA

Different integration methods can be selected to calculate current and power values.

Calculated demand values are as follows:

Table 5–16: DEMAND CALCULATED VALUES

DEMAND CALCULATED VALUES		
DEMAND IA	DEMAND IG	DEMAND W
DEMAND IA MAX	DEMAND IG MAX	DEMAND W MAX
DEMAND IA DATE	DEMAND IG DATE	DEMAND W DATE
DEMAND IB	DEMAND ISG	DEMAND VAR PWR
DEMAND IB MAX	DEMAND ISG MAX	DEMAND VAR MAX
DEMAND IB DATE	DEMAND ISG DATE	DEMAND VAR DATE
DEMAND IC	DEMAND I2	DEMAND VA PWR
DEMAND IC MAX	DEMAND I2 MAX	DEMAND VA MAX
DEMAND IC DATE	DEMAND I2 DATE	DEMAND VA DATE

The relay measures current demanded on each phase, ground and sensitive ground, negative sequence and three-phase demand for real, reactive and apparent power. Current and Power methods can be chosen separately. Settings are provided to disable certain measuring techniques. These techniques are used by many utilities for statistical or control purposes.

Demand module settings are as follows:

Table 5–17: DEMAND SETTINGS

SETPOINT > PRODUCT SETUP > DEMAND				
Setting Description	Name	Default Value	Step	Range
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]

Function permission (Function): This setting enables the demand function.

Demand Method for Current values (CRNT Demand Method): Selection of the demand calculation method for current values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Method for Power values (POWER Demand Method): Selection of the demand calculation method for power values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Interval: Integration interval. Available intervals are 5, 10, 15, 20, 30, 60 minutes. Measurement integration is performed in the period adjusted in the Demand Interval setting.

Demand Trigger: Operation mode selection for the Block Interval calculation method. This operation mode depends on the “Trigger Enabled” setting. If trigger enabled is set as disabled, measurement integration is made in the Demand Interval period. If trigger enabled is enabled, measurement integration is made during the time interval between two consecutive pulses of the input assigned as DEMAND TRIGGER INP,. This input is set at ***Setpoint > Relay configuration > Protection Elements***

Snapshot Events: This setting enables or disables the snapshot event generation for the demand element.

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5.2.6.2 DEMAND CALCULATION METHODS

a) CALCULATION METHOD 1: THERMAL EXPONENTIAL

This method simulates the action of an analog peak recording thermal demand meter. The relay measures the magnitude for each phase (or three-phase, depending on the case) every second, and it assumes that the magnitude remains the same until the next update. It calculates the equivalent thermal demand using the following equation:

$$d(t) = D(1 - e^{-Kt})$$

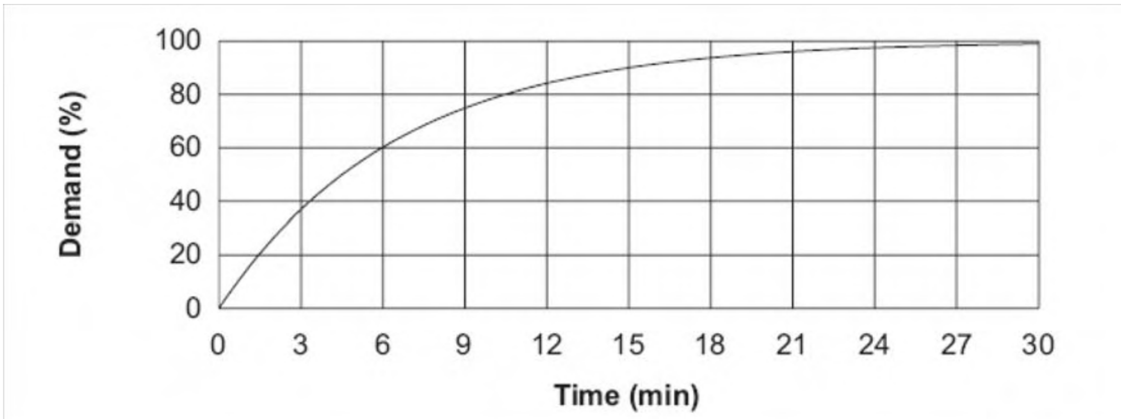
Where:

D Input signal (constant).

d(t) Demand value after applying the input value during time t (in minutes)

K 2.3 / thermal 90% response time

Illustrated bellow is the curve with a 90% characteristic time of 15 minutes. A setting establishes the time to reach 90% of a steady-state value, just as the response time of an analog instrument. A steady-state valve applied for twice the response time will indicate 99% of the value.



b) CALCULATION METHOD 2: ROLLING DEMAND.

This method calculates the linear average of the quantity over the set demand time interval. The calculation is made every second. The value is updated every minute and indicates the demand over the time interval just preceding the time of update.

c) CALCULATION METHOD 3: BLOCK INTERVAL

The Block Interval operation mode depends on the “Trigger Enabled” setting.

CALCULATION METHOD 3a: BLOCK INTERVAL – With trigger setting DISABLED.

This method consists on integrating the measurements during the time period specified in the DEMAND INTERVAL setting. The calculation will be made every second and the demand value will be the average of all values produced during the time interval. The time interval is chosen in the DEMAND INTERVAL setting. The interval demand value will be shown once this time has expired.

If, for example, the setting indicates 15 minutes for integration, the demand value update will be made every 15 minutes (although the calculation is made every second). This method calculates a linear average of the magnitude.

CALCULATION METHOD 3b: BLOCK INTERVAL – With trigger setting ENABLED.

The demand value is given by integration of the measurement during the time between two consecutive pulses in the input assigned. The input is assigned to DEMAND TRIGGER in Relay Configuration. The integration is made every second with each new measure.

In case the interval between two consecutive pulses exceeds 60 minutes, the relay will calculate the demand after 60 minutes from the last pulse, this measure will be updated in the status and a new demand count will start. This method calculates a linear average of the magnitude.

Figure 5–1: shows the behavior of the demand, depending on the Selected setting for demand calculation.

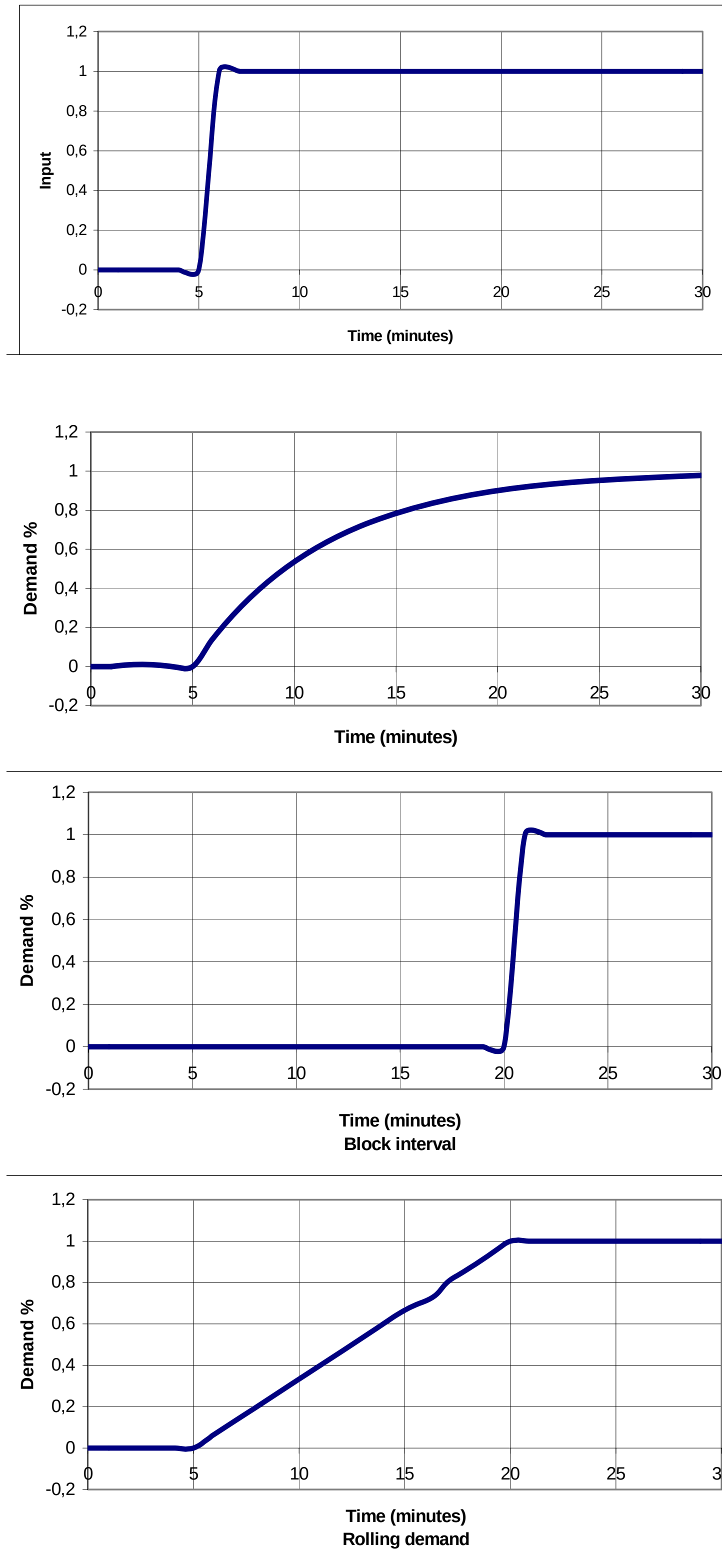


Figure 5–1: RESPONSE TO THE DIFFERENT DEMAND METHODS

5.2.6.3 DEMAND FUNCTION MEASURES AND STATES

Demand values are available at ***Actual > Metering > Primary Values > Demand***.

Table 5–18: DEMAND MEASURES

NAME	DEFAULT VALUE	STEP
DEMAND IA	0.000	KA
DEMAND IA MAX	0.000	KA
DEMAND IA DATE	01-Jan-2000 00:00:00.000	
DEMAND IB	0.000	KA
DEMAND IB MAX	0.000	KA
DEMAND IB DATE	01-Jan-2000 00:00:00.000	
DEMAND IC	0.000	KA
DEMAND IC MAX	0.000	KA
DEMAND IC DATE	01-Jan-2000 00:00:00.000	
DEMAND IG	0.000	KA
DEMAND IG MAX	0.000	KA
DEMAND IG DATE	01-Jan-2000 00:00:00.000	
DEMAND ISG	0.000	KA
DEMAND ISG MAX	0.000	KA
DEMAND ISG DATE	01-Jan-2000 00:00:00.000	
DEMAND I2	0.000	KA
DEMAND I2 MAX	0.000	KA
DEMAND I2 DATE	01-Jan-2000 00:00:00.000	
DEMAND W	0.000	MW
DEMAND W MAX	0.000	MW
DEMAND W DATE	01-Jan-2000 00:00:00.000	
DEMAND VAR PWR	0.000	MVAr
DEMAND VAR MAX	0.000	MVAr
DEMAND VAR DATE	01-Jan-2000 00:00:00.000	
DEMAND VA PWR	0.000	MVA
DEMAND VA MAX	0.000	MVA
DEMAND VA DATE	01-Jan-2000 00:00:00.000	

Demand measurements for **current values** are as follows:

DEMAND I**X** This is the demanded value every minute or every integration period, depending on the selected settings.

DEMAND I**X** MAX Demanded maximeter; it stores the Maximum demand value until a demand reset is issued.

DEMAND I**X** DATE Date of the Maximum demand value

Being **X** the phase considered in each case.

Demand measurements for **power values** are as follows:

DEMAND **Y** This is the demanded value every minute or every integration period, depending on the selected settings

DEMAND **Y** MAX Demanded maximeter; it stores the Maximum demand value until a demand reset is issued.

DEMAND **Y** DATE Date of the Maximum demand value.

Being **Y** the power considered in each case.

W	Three-phase active power
VAR	Three-phase reactive power
VA	Three-phase apparent power

The maximum demanded value is stored in non-volatile memory. It is not cleared when the relay is turned off. When the relay is turned on again, the maximum values are updated.

States associated to the demand ("***Actual>Status>Records Status>Demand***") are the following:

Table 5–19: DEMAND ASSOCIATED VALUES

DEMAND ASOCIATED STATES
DEMAND TRIGGER INP
DEMAND RESET INP

Besides the previously considered demand measures, two states are used for demand control:

DEMAND TRIGGER INP Bit type state, Programmable at "***Setpoint>Relay Configuration>Protection Elements"*** in the EnerVista 650 Setup software. This signal is used by the Block Interval demand method.

DEMAND RESET INP Bit type state, programmable at "***Setpoint>Relay Configuration>Protection Elements"*** in the EnerVista 650 Setup software. When this bit is activated, the demand measures are reset. All stored values are reset to zero (for demand dates, this value represents January 1st, 2000).

This section shows the settings related to the system setup definition.

5.3.1 GENERAL SETTINGS

This section determines the settings of the element configuration regarding its connection to the power system.

Access to these settings using the EnerVista 650 Setup software is at ***Setpoint > System Setup > General settings.***

The corresponding settings are shown on the table below:

Table 5–20: GENERAL SETTINGS

SETPOINT > SYSTEM SETUP > GENERAL SETTINGS				
setting Description	**Name**	**Default Value**	**Step**	**Range**
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 : 500.0]
Rated Frequency	Nominal Frequency	50 Hz	N/A	[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- VG]
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]
Frequency Tracking	Freq Tracking	DISABLED	N/A	[DISABLED – ENABLED]

The system rated voltage is used as reference by the voltage restraint in the phase timed overcurrent element.

The Frequency reference marks the voltage channel to which the system Frequency is measured.

The auxiliary voltage setting can be selected between VG , VNand VX.

VX means that all elements using neutral voltage will take the value calculated from phase voltages.

and the synchrocheck function will measure the busbar voltage from the fourth voltage input. 25, 27X and 59X units will be operative.

VN means that the neutral voltage is directly measured from the fourth voltage transformer. All elements using neutral voltage will take the value measured from the fouth voltage input. Measurements of single phase power value will be available in delta connection. 25, 27X and 59X, 59G units will not be operative.

VG means that the ground voltage is directly measured from the fourth voltage transformer.
This means that all elements using neutral voltage will take the value calculated from phase voltages.
Measurements of single phase power value will not be available in delta connection as they cannot be duly calculated. 25, 27X and 59X units will not be operative. 67N and 67G functions will work only will calculated values from phases, so if voltage inputs are configured in delta connection this unit will not be operative.

59G function will be operative.

5.3.2 FLEX 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”*** 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.

In the flex curves menu there are 120 points to define a user curve. 40 points for reset (from 0 to 0.98 times the pickup value) and 80 for operate (from 1.03 to 20 times the pickup).

Table 5–21: FLEX CURVE SETTINGS

SETPOINT > SYSTEM SETUP > FLEX CURVES FLEX CURVES A > FLEX CURVES B> FLEX CURVES C > FLEX CURVES D				
Setting Description	Name	Default Value	Step	Range
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]
…	…	…	…	…
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]
…	…	…	…	…
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]

The definition of the curve points can be introduced directly in the Flex Curve settings menu. Alternatively they can be created using the graphical tool provided by pressing **“Edit Curve”** in the Flex curves menu in EnerVista 650 Setup.

In the user curve edit screen (see Figure 5–2:), a base curve can be selected, from the Standard Curves menu. This curve will be used as a template to create the user curve. Once the standard curve is viewed, it is possible to make the user curve (operate, reset or both) reconcile the standard curve, using the ***Flex curve > set flex curve from the standard curve***, and then modifying any of the points by editing in the table the corresponding value.

The user can also view a different curve model to the one the FlexCurve has been adapted to, and compare both models to adopt the most appropriate values in each case. If once the user curve has been configured, the user wants to store the information, the “***Flex Curve > Exit with Data***” menu must be selected. If the results are not to be saved, the ***Exit without Data*** option must be selected. Now, calculated points must be saved in the Flex Curve using the “Store” option.

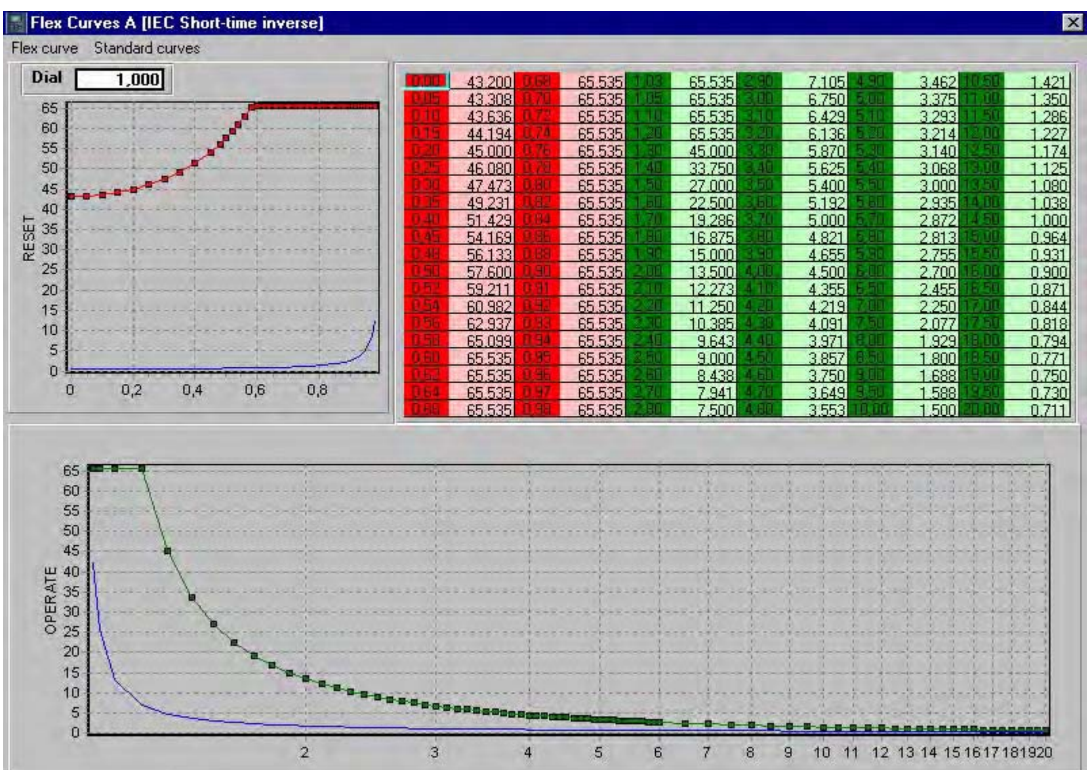


Figure 5–2: FLEXCURVES EDITION

5.3.3 BREAKER

There are two types of breaker settings:

Breaker settings: These settings correspond to the switchgear configured as a breaker in the G650; this switchgear is used in the recloser functions, breaker failure and synchronism.

Breaker Maintenance: These settings correspond to the initialization of the $(KI)^2t$ counters, and the counting of the number of openings and closings of the switchgear configured as a breaker.

5.3.3.1 BREAKER SETTINGS (SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETTINGS)

Table 5–22: BREAKER SETTINGS

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETTINGS				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]
Maximum value of $(KI)^2t$	Maximum $(KI)^2t$	9999.99	$0.01(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ integration time	$(KI)^2t$ 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]

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Breaker settings are as follows:

Number of switchgear: This is the Number of the Switchgear that is configured as a breaker. It is the reference for breaker failure (50BF) and synchronism (25) elements. The selected switchgear in the breaker settings must be previously configured at ***Setpoint > Relay Configuration > Switchgear***. The relay allows to configure up to 16 switchgear elements, but the one configured as a breaker will be the reference for $(KI)^2t$, openings and closings counters.

Maximum $(KI)^2t$: This is the maximum set value for the square of the current multiplied by the breaker opening time. There is a separate counter for each phase, but the value stored as the maximum is a single value for the three phases.

$(KI)^2t$ Integration Time: This is the integration time taken as the base (fixed opening time) for the calculation of $(KI)^2t$.

Maximum Openings: This is the maximum number of openings allowed in the relay, with a limit of 9999; once this value is exceeded, the relay will produce an alarm. When the limit 9999 is reached the maximum openings counter will start from zero.

Maximum Openings in 1 hour: This is the maximum number of openings allowed in the relay during one hour; once this value is exceeded, the corresponding alarm signal will be activated; this value is updated and reset after one hour.

Snapshot Events: This setting enables or disables the snapshot event generation for the breaker signals.

The interrupted current limit setting, fixes the Maximum breaker capacity (this value is set depending on the information provided by the breaker manufacturer); the relay incorporates a $(KI)^2t$ counter for each phase, when a breaker opening occurs, the counter increases its value (in primary values). If the flowing current is lower than the rated current, the relay will take the rated current value for its calculations. When the accumulated counter for each phase reaches or exceeds the set value, the corresponding alarm signal will be activated.

The purpose of this function is to provide closer information of the current status of the breaker's internal contacts. This is, in order to ensure appropriate breaker maintenance, and to decrease the risk of damage when the breaker has suffered severe operations during a long time. Once the breaker has been operated, and the preventive maintenance is in place, the accumulated I^2t values and the number of operations are reset to zero.

5.3.3.2 BREAKER MAINTENANCE

To consider used breakers, the relay allows to set initial I^2t values as well as an initial number of operations, in order to take into account previous breaker operations, as well as operations produced during testing. Breaker maintenance parameters can be set in the breaker maintenance menu.

BREAKER MAINTENANCE (***Setpoint > System Setup > Breaker > Breaker Maintenance***)

Table 5–23: BREAKER MAINTENANCE SETTINGS

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER MAINTENANCE				
setting Description	**Name**	**Default Value**	**Step**	**Range**
$(KI)^2t$ Counter Phase A	$(KI)^2t$ BKR Ph A Cnt	0.00	0.01 $(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ Counter Phase B	$(KI)^2t$ BKR Ph B Cnt	0.00	0.01 $(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ Counter Phase C	$(KI)^2t$ 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]

In this group of settings, the start values of the breaker Counters can be set.

These Counters allow the breaker Maintenance. They are used to accumulate the breaker aging produced by a trip or a breaker opening. In order to incorporate the breaker's history, in case of used breakers, the system allows assigning an initial value to accumulated amperes, and to the number of opening and closing operations.

To supervise breaker aging, $\Sigma(KI)^2t$ accumulated values are calculated and stored for each phase in each opening. If the rated current is not exceeded, as in the case of a manual opening command, without fault current, the relay uses the rated current instead of the measured value.

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$(KI)^2t$ value is accumulated and maintained in independent Counters for each phase. Counters can be accessed through the local HMI as well as through the EnerVista 650 Setup software. The element incorporates a setting to select the integration time ($(KI)^2t$ Integ. Time).

The signals associated to the opened or closed status of the breaker can be monitored at "***Actual > Status > Breaker***"

Table 5–24: BREAKER STATUS

BREAKER STATUS	DESCRIPTION
BREAKER OPEN	Breaker in open position.
BREAKER CLOSED	Breaker in close position
BREAKER UNDEFINED	Breaker undefined

The signals associated to breaker maintenance can be monitored at "***Actual > Status > Records Status > Breaker Maintenance***", and they are as follows:

Table 5–25: BREAKER MAINTENANCE STATUS

BREAKER MAINTENANCE	DESCRIPTION
$(KI)^2t$ PHASE A ALARM	This signal activates when the set value for phase A is exceeded.
$(KI)^2t$ PHASE B ALARM	This signal activates when the set value for phase B is exceeded.
$(KI)^2t$ PHASE C ALARM	This signal activates when the set value for phase C is exceeded.
BKR OPENINGS ALARM	Relay total Number of Openings alarm
BKR OPEN 1 HOUR ALRM	Relay total Number of Openings in one hour alarm
RESET $(KI)^2t$ COUNTERS	$(KI)^2t$ Counters reset signal. This signal is configured at ***Setpoint > Relay Configuration > Protection Elements***, and it is used for resetting the $(KI)^2t$ counter through the corresponding signal, command, digital input, etc.
RESET BKR COUNTERS	Reset signal for the Opening and Closing Counters. This signal is configured at ***Setpoint > Relay Configuration > Protection Elements***, and it is used for resetting the breaker Opening and closing counters.
BREAKER OPENINGS	Number of Breaker openings
BREAKER CLOSINGS	Number of Breaker closings

$(KI)^2t$ PHASE A	Accumulated $(KI)^2t$ value for phase A ($(KI)^2t$ Counter for Phase A)
$(KI)^2t$ PHASE B	Accumulated $(KI)^2t$ value for phase B ($(KI)^2t$ Counter for Phase B)
$(KI)^2t$ PHASE C	Accumulated $(KI)^2t$ value for phase C ($(KI)^2t$ Counter for Phase C)
BKR OPENING TIME	Maximum breaker Opening time. This signal is configured at ***Setpoint > Relay Configuration >Switchgear*** in the number of switchgear corresponding to the breaker selection
BKR CLOSING TIME	Maximum breaker Closing time. This signal is configured at ***Setpoint > Relay Configuration >Switchgear*** in the number of switchgear corresponding to the breaker selection

5.3.4 SWITCHGEAR

There is the possibility to enable or disable the generation of internal signals for the different elements (protection, control, inputs and outputs, switchgear) available in the device.

The configuration of snapshot events for each switchgear (enable or disable) can be selected at ***Setpoint* > System Setup > Switchgear**.

Table 5–26: SWITCHGEAR SETTINGS

SETPOINT > SYSTEM SETUP > SWITCHGEAR				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

5.4.1 CHANGE OF SETTING TABLES IN G650 ELEMENTS

G650 relays incorporate the following **protection elements**:

CURRENT ELEMENTS

Instantaneous overcurrent:

3 x PHASE IOC HIGH (50PH)

3 x NEUTRAL IOC (50N)

3 x GROUND IOC (50G)

3 x SENSITIVE GROUND IOC (50SG) (Enhanced models only)

Time delayed overcurrent:

3 x PHASE TOC HIGH (51PH)

3 x PHASE TOC LOW (51PL)

3 x NEUTRAL TOC (51N)

3 x GROUND TOC (51G)

3 x SENSITIVE GROUND TOC (51SG) (Enhanced models only)

3 x RESTRICTED GROUND FAULT (87G) (Enhanced models only)

Negative sequence overcurrent:

3 x NEGATIVE SEQUENCE TOC (51-2)

3 x NEGATIVE SEQUENCE IOC (50-2)

3 x GENERATOR UNBALANCE (46)

Thermal image:

3 x THERMAL MODEL (49S)

DIRECTIONAL ELEMENTS

3 x NEUTRAL DIR (67N)

3 x GROUND DIR (67G)

VOLTAGE ELEMENTS

Phase under/overvoltage

3 x PHASE UV (27P)

3 x PHASE OV (59P)

Zero sequence overvoltage

3 x NEUTRAL OV HIGH (59NH)

Additional Ground overvoltage (For Vg selection in Auxiliary Voltage)

3 x GROUND OV (59G)

Additional auxiliary under/overvoltage (for VX selection in auxiliary voltage)

3 x AUXILIARY OV (59X)

3 x AUXILIARY UV (27X)

Negative sequence overvoltage:

3 x NEGATIVE SEQUENCE OV (47)

Volts per Hertz:

3 x VOLTS PER HERTZ (24) (Enhanced models only)

POWER

3 x DIRECTIONAL POWER (32)

3 x PWR FACTOR LIMITING (55) (Enhanced models only)

The G650 elements incorporate also the following **control elements**:

1 x SETTINGS GROUP

3 x OVERFREQUENCY (81O)

3 x UNDERFREQUENCY (81U)

1 x SYNCHROCHECK(25)

1 x BREAKER FAILURE (50BF) (Enhanced models only)

1 x FUSE FAILURE (VTFF) (Enhanced models only)

8 x PULSE COUNTERS (No group concept)

20 x ANALOG COMPARATORS (No group concept)

3 x FREQUENCY RATE OF CHANGE (81 df/dt)

3 x LOSS OF MAINS (78V) (Enhanced models only)

3 x LOSS OF EXCITATION (40)

3 x ACCIDENTAL ENERGIZATION (50/27)

G650 elements incorporate a flexible grouping capability for protection ELEMENTS. This means that protection elements can be used in either one of the following modes:

a) SINGLE SETTING GROUPS

In this operation mode, all protection elements can be activated and operated simultaneously.

b) THREE SETTING GROUPS

In this mode, protection elements are grouped in three independent tables. Only one of them will be active at a given time. A logic signal, e.g. a digital input, will select which table is active at each time, providing adaptive protection to each network condition.

Protection element grouping involves only Protection elements together with broken conductor detection and active and directional power, which are usually considered as control elements. The rest of the control elements such as recloser, fuse failure, breaker failure, synchronism, and breaker settings are not involved in the tabled groups concept.

The distribution of protection elements in tabled groups is described in Table 5–27:

Table 5–27: DISTRIBUTION OF PROTECTION AND CONTROL ELEMENTS

DEVICE NUMBER FUNCTION	TABLE 1	TABLE 2	TABLE 3
24 Volt/Hertz ***(only enhanced model)***	1x24	1x24	1x24
25 Synchronism Check (No group concept)	NA	NA	NA
27P Phase Undervoltage	1x27P	1x27P	1x27P
27X Auxiliary Undervoltage	1x27X	1x27X	1x27X
32DIR Directional Power	1x32	1x32	1x32
40 Loss of Excitation	1x40	1x40	1x40
46 Generator Unbalance	1x46	1x46	1x46
47 Negative Sequence Overvoltage	1x47	1x47	1x47
49S Generator thermal model	1x49S	1x49S	1x49S
50/27 Inadvertent Generator Energization	1x50/27	1x50/27	1x50/27
50-2 Negative Sequence IOC/	1x50-2	1x50-2	1x50-2
50BF Breaker Failure***(only enhanced model)***	NA	NA	NA
50G Ground Instantaneous Overcurrent (measured from 4th current transformer)	1x50G	1x50G	1x50G
50N Neutral Instantaneous Overcurrent (calculated from the phase currents)	1x50N	1x50N	1x50N
50P Phase Instantaneous Overcurrent	1x50P	1x50P	1x50P
50SG Sensitive Ground IOC ***(only enhanced model)***	1x50SG	1x50SG	1x50SG
51-2 Negative Sequence TOC	1x51-2	1x51-2	1x51-2
51G Ground Time Overcurrent (measured from 4th current transformer)	1x51G	1x51G	1x51G
51N Neutral Time Overcurrent (calculated from the phase currents)	1x51N	1x51N	1x51N
51P/V Voltage Restraint Overcurrent High	1x51PH	1x51PH	1x51PH
51P/V Voltage Restraint Overcurrent Low	1x51PL	1x51PL	1x51PL
51SG Sensitive Ground TOC ***(only enhanced model)***	1x51SG	1x51SG	1x51SG
55 Power Factor Limiting***(only enhanced model)***	1x55	1x55	1x55
59G Ground Overvoltage	1x59G	1x59G	1x59G
59N Neutral Overvoltage	1x59N	1x59N	1x59N
59P Phase Overvoltage	1x59P	1x59P	1x59P
59X Auxiliary Overvoltage	1x59X	1x59X	1x59X
67G Ground Directional	1x67G	1x67G	1x67G
67N Neutral directional	1x67N	1x67N	1x67N
78V Loss of mains ***(only enhanced model)***	1x78V	1x78V	1x78V
81O Overfrequency	1x81O	1x81O	1x81O
81U Underfrequency	1x81U	1x81U	1x81U
81R Frequency Rate of Change	1x81R	1x81R	1x81R
87G Restricted Ground Fault ***(only enhanced model)***	1x87G	1x87G	1x87G
VTFF VT Fuse Failure ***(only enhanced model)*** (No group concept)	NA	NA	NA
Pulse Counters (No group concept)	NA	NA	NA
Analog Comparators (No group concept)	NA	NA	NA

The settings used for setting table management are located in **Setpoint >Control Elements > Setting Group**:

Table 5–28: SETTING GROUP SETTINGS

SETPOINT > CONTROL ELEMENTS > SETTING GROUP				
Setting Description	Name	Default Value	Step	Range
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]

Setting Group settings are as follows:

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Function: Possible values are: [DISABLED – ENABLED]

When this setting is disabled, the relay is working in single setting group mode, with all the available protection elements working at the same time. If this function is enabled, the setting groups will be enabled, and only the setting group indicated by the Active Group setting will be active.

Active group: Possible values are 1, 2 or 3.

The setting group selected by default is setting Group 1. This setting indicates which setting group is active (for this purpose, the previous setting must be set as ENABLED)

The Relay incorporates several signals associated to the Protection elements grouping in tables. First, signals that indicate the group activation:

GROUP 1 ACT ON	This signal produces the activation of setting group 1
GROUP 2 ACT ON	This signal produces the activation of setting group 2
GROUP 3 ACT ON	This signal produces the activation of setting group 3

These activation signals for the different setting groups are configured using EnerVista 650 Setup at ***Setpoint > Relay Configuration > Protection Elements*** as shown in the figure.

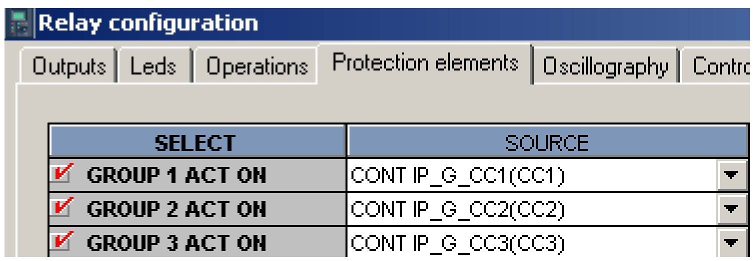

Figure 5–3: TABLE CHANGE SIGNALS CONFIGURATION EXAMPLE

The example above uses three digital inputs to perform the table selection, but it is possible to use any other logic signal in the relay.

In case of using digital inputs, the user can select the setting table activating these digital inputs (which could come from the PLC, or from a different relay, or from an auxiliary switch, for adaptive protection). This selection of the active group has priority over the setting. If several signals are active at the same time, the highest one will be taken as valid. For example, if selection signals for both groups 1 and 2 are active, the active table will be number 2.

The time used in the table change is one PLC logic scan cycle (5 ms typical), allowing a fast adaptation to system changes.

Another type of signals are block signals. These are internal relay signals that indicate which groups are active, and which are blocked. For example, if the setting group function is enabled and setting group 1 has been set as active, block signals from setting groups 2 and 3 will be active, and the block signal that corresponds to group 1 will be inactive because that group is enabled.

Block signals are as follows:

GROUP 1 BLOCKED

GROUP 2 BLOCKED

GROUP 3 BLOCKED

All signals corresponding to setting Groups, both the activation and the block signals, are located in the ***Actual > Status > Control Elements > setting Groups*** menu.

5.4.2 INVERSE TIME CURVES CHARACTERISTICS

Inverse time curves available in time overcurrent elements are as follows:

IEEE extremely/very/moderately inverse

IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse

IAC extremely/very/moderately inverse

ANSI extremely/very/normally/moderately inverse

I2t

Definite time curves

Rectifier time curves

User Curve - FlexCurve A/B/C/D

Recloser Curves

The saturation level for the user curve is 20 times the pickup value, for the rest of time overcurrent elements the saturation level is 48 times the pickup.

All these curves follow the standards defined for each of them, allowing an efficient coordination with other devices located downstream. A dial or curve setting allows selection of a tripping time X times the set time in the selected curve. Fixing this value to 0 would produce an instantaneous response for any selected curve.

Tripping time calculations are performed on the base of an internal variable called “energy”. This energy represents the system dissipation capability, that is, when 100% of energy is reached, this means that the tripping time associated to the curve for a certain current value has expired.

Therefore, once the current value has exceeded the pickup value, the relay starts increasing the energy variable value. If it reaches 100%, a trip is produced. When the current value falls below 97% of the pickup value, the element is reset. There are two reset types: Instantaneous and Timed (IEEE) or Linear.

The instantaneous mode provides that, when the current value falls below the reset level, energy is immediately reset to 0. This mode is used for coordinating with static devices, which behave in a similar way. In the Linear mode, energy is reduced at a speed associated to the reset times curve (showed in the curve tables), trying to simulate the behavior of electromechanical relays.

5.4.2.1 IEEE CURVES

This family of curves follows the standard IEEE C37.112-1996 for extremely inverse, very inverse, and inverse curves. The following formulas define this type of curve:

$$t = dial * \left[\frac{A}{\left(\frac{I}{Itap}\right)^{p} - 1} + B \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^{2} - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, p = constants defined by the standard

T_{RESET} = reset time in seconds

t_r = characteristic constant.

Table 5–29: CONSTANTS FOR IEEE CURVES

IEEE CURVE SHAPE	NAME	A	B	P	TR
IEEE Extremely Inverse	IEEE Ext Inv	28.2	0.1217	2.0000	29.1
IEEE Very Inverse	IEEE Very Inv	19.61	0.491	2.0000	21.6
IEEE Inverse	IEEE Mod Inv	0.0515	0.1140	0.0200	4.85

Table 5–30: TRIPPING TIME IN SECONDS FOR IEEE CURVES

DIAL	CURRENT (I/ITAP)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEEE Extremely Inverse										
0.5	11.341	4.761	1.823	1.001	0.648	0.464	0.355	0.285	0.237	0.203
1.0	22.682	9.522	3.647	2.002	1.297	0.927	0.709	0.569	0.474	0.407
2.0	45.363	19.043	7.293	4.003	2.593	1.855	1.418	1.139	0.948	0.813
4.0	90.727	38.087	14.587	8.007	5.187	3.710	2.837	2.277	1.897	1.626
6.0	136.090	57.130	21.880	12.010	7.780	5.564	4.255	3.416	2.845	2.439
8.0	181.454	76.174	29.174	16.014	10.374	7.419	5.674	4.555	3.794	3.252
10.0	226.817	95.217	36.467	20.017	12.967	9.274	7.092	5.693	4.742	4.065
IEEE Very Inverse										
0.5	8.090	3.514	1.471	0.899	0.654	0.526	0.450	0.401	0.368	0.345
1.0	16.179	7.028	2.942	1.798	1.308	1.051	0.900	0.802	0.736	0.689
2.0	32.358	14.055	5.885	3.597	2.616	2.103	1.799	1.605	1.472	1.378
4.0	64.716	28.111	11.769	7.193	5.232	4.205	3.598	3.209	2.945	2.756
6.0	97.074	42.166	17.654	10.790	7.849	6.308	5.397	4.814	4.417	4.134
8.0	129.432	56.221	23.538	14.387	10.465	8.410	7.196	6.418	5.889	5.513
10.0	161.790	70.277	29.423	17.983	13.081	10.513	8.995	8.023	7.361	6.891
IEEE Inverse										
0.5	3.220	1.902	1.216	0.973	0.844	0.763	0.706	0.663	0.630	0.603
1.0	6.439	3.803	2.432	1.946	1.688	1.526	1.412	1.327	1.260	1.207
2.0	12.878	7.606	4.864	3.892	3.377	3.051	2.823	2.653	2.521	2.414
4.0	25.756	15.213	9.729	7.783	6.753	6.102	5.647	5.307	5.041	4.827
6.0	38.634	22.819	14.593	11.675	10.130	9.153	8.470	7.960	7.562	7.241
8.0	51.512	30.426	19.458	15.567	13.507	12.204	11.294	10.614	10.083	9.654
10.0	64.390	38.032	24.322	19.458	16.883	15.255	14.117	13.267	12.604	12.068

5.4.2.2 IEC CURVES

This family of curves follows the European standard IEC 255-4, and the British standard BF142 for IEC Curves A, B and C, IEC Long-Time Inverse and IEC Short-Time Inverse. The formulas that define these curves are as follows:

$$t = dial * \left[\frac{K}{\left(\frac{I}{Itap}\right)^{E} - 1} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^{2} - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplying factor

I = Input current

Itap = Current pickup value

K, E = constants defined by the standard

T_{RESET} = reset time in seconds (assuming 100% of power capacity and that the reset is activated)

t_r = characteristic constant.

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Table 5–31: CONSTANTS FOR IEC CURVES

IEC CURVE SHAPE	NAME	K	E	tr
IEC Curve A	IEC Curve A	0.140	0.020	9.7
IEC Curve B	IEC Curve B	13.500	1.000	43.2
IEC Curve C	IEC Curve C	80.000	2.000	58.2
IEC Long-Time Inverse	IEC Long-Time Inv	120.000	1.000	120.0
IEC Short-Time Inverse	IEC Short-Time Inv	0.050	0.040	0.5

Table 5–32: TRIPPING TIME IN SECONDS FOR IEC CURVES

DIAL	CURRENT (I/ITAP)									
	1.5	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
IEC Curve A										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC Curve B										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200
1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC Curve C										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
IEC Long-Time Inverse										
0.05	12.000	6.000	3.000	2.000	1.500	1.200	1.000	0.857	0.750	0.667
0.10	24.000	12.000	6.000	4.000	3.000	2.400	2.000	1.714	1.500	1.333
0.20	48.000	24.000	12.000	8.000	6.000	4.800	4.000	3.429	3.000	2.667
0.40	96.000	48.000	24.000	16.000	12.000	9.600	8.000	6.857	6.000	5.333
0.60	144.000	72.000	36.000	24.000	18.000	14.400	12.000	10.286	9.000	8.000
0.80	192.000	96.000	48.000	32.000	24.000	19.200	16.000	13.714	12.000	10.667
1.00	240.000	120.000	60.000	40.000	30.000	24.000	20.000	17.143	15.000	13.333
IEC Short-Time Inverse										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518

5.4.2.3 IAC CURVES

This family of curves follows the time response of the General Electric IAC electromechanical relays. The following formulas define these curves:

$$t = dial * \left[A + \frac{B}{\left(\frac{I}{Itap} - C\right)} + \frac{D}{\left(\frac{I}{Itap} - C\right)^2} + \frac{E}{\left(\frac{I}{Itap} - C\right)^3} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^2 - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, C, D, E = predefined constants

T_{RESET} = reset time in seconds

t_r = characteristic constant.

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Table 5–33: CONSTANTS FOR IAC CURVES

IAC CURVE SHAPE	NAME	A	B	C	D	E	TR
IAC Extremely Inverse	IAC Ext Inv	0.0040	0.6379	0.6200	1.7872	0.2461	6.008
IAC Very Inverse	IAC Very Inv	0.0900	0.7955	0.1000	-1.2885	7.9586	4.678
IAC Inverse	IAC Mod Inv	0.2078	0.8630	0.8000	-0.4180	0.1947	0.990

Table 5–34: TRIPPING TIMES IN SECONDS FOR IAC CURVES

DIAL	CURRENT (I/ITAP)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC Extremely Inverse										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC Very Inverse										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC Inverse										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969

5.4.2.4 ANSI CURVES

This family of curves complies with the American Standard ANSI C37.90 for Extremely inverse, Very inverse, Normally inverse and Moderately inverse curves. The formulas that define these curves are as follows:

$$T = Dial\left[A + \frac{B}{\left(\frac{I}{Ipickup} - C\right)} + \frac{D}{\left(\frac{I}{Ipickup} - C\right)^2} + \frac{E}{\left(\frac{I}{Ipickup} - C\right)^3}\right] \qquad T_{reset} = TDM \times \left[\frac{T_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1}\right]$$

where:

T = Operation time (in seconds).

Dial = Multiplying factor

I = Input current

I_{pickup} = Current pickup setting

A, B, C, D, E = Constants

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

T_r = Characteristic constant

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The different constants that define the above-mentioned curves are:

Table 5–35: CONSTANTS FOR ANSI CURVES

ANSI CURVE SHAPE	A	B	C	D	E	TR
ANSI Extremely Inverse	0.0399	0.2294	0.5	3.0094	0.7222	5.67
ANSI Very Inverse	0.0615	0.7989	0.34	-0.284	4.0505	3.88
ANSI Normally Inverse	0.0274	2.2614	0.3	-4.1899	9.1272	5.95
ANSI Moderately Inverse	0.1735	0.6791	0.8	-0.08	0.1271	1.08

Table 5–36: TRIPPING TIMES IN SECONDS FOR ANSI CURVES

DIAL	CURRENT (I/ITAP)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
ANSI Extremely inverse										
0.50	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049
1.00	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098
2.00	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196
4.00	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393
6.00	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589
8.00	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786
10.00	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982
ANSI Very Inverse										
0.50	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073
1.00	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146
2.00	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291
4.00	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583
6.00	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874
8.00	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165
10.00	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457
ANSI Normally inverse										
0.50	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113
1.00	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226
2.00	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452
4.00	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904
6.00	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356
8.00	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808
10.00	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260
ANSI Moderately inverse										
0.50	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123
1.00	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247
2.00	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493
4.00	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986
6.00	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479
8.00	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972
10.00	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465

5.4.2.5 I2T CURVES

The following formulas define this type of curves:

$$t = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{2}} \right] \qquad T_{RESET} = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{-2}} \right]$$

where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

T_{RESET} = reset time in seconds

Table 5–37: TRIPPING TIME IN SECONDS FOR I2T CURVES

DIAL	CURRENT (I/ITAP)									
	1.5	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
0.01	0.444	0.250	0.111	0.063	0.040	0.028	0.020	0.016	0.012	0.010
0.10	4.444	2.500	1.111	0.625	0.400	0.278	0.204	0.156	0.123	0.100
1.00	44.444	25.000	11.111	6.250	4.000	2.778	2.041	1.563	1.235	1.000
10.00	444.444	250.000	111.111	62.500	40.000	27.778	20.408	15.625	12.346	10.000
100.00	4444.444	2500.000	1111.111	625.000	400.000	277.778	204.082	156.250	123.457	100.000
600.00	26666.667	15000.000	6666.667	3750.000	2400.000	1666.667	1224.490	937.500	740.741	600.000

5.4.2.6 DEFINITE TIME CURVES

The definite time makes the element trip when the current value is maintained beyond the pickup value during a longer time period than the set value. The Dial setting allows modifying this time frame from instantaneous to 900 seconds in steps of 10 ms.

5.4.2.7 RECTIFIER TIME CURVES

Rectifier curves are generated from the following formulas:

$$T = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{5,6} - 1} \right) \qquad T_{reset} = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{2} - 1} \right)$$

where:

T = Operation time (in seconds).

TDM = Multiplying factor

I = Input current

I_{pickup} = Pickup current

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

5.4.2.8 USER CURVES - FLEXCURVES A/B/C/D

The relay incorporates 4 user curves called User Curve A, B, C and D. The points for these curves are defined by the user. Each of the four curves has an operation characteristic (operate), defined by 80 points, and a reset characteristic, defined by 40 points. Each point is defined as a time value for each I/I_{pickup} value (number of times the pickup current) given on the table. The user can assign values between 0 and 65.535 seconds in steps of 1 ms.

The following table details the 120 points as well as the characteristic for each of them, and a blank cell where the user can write the time value when the operation (for $I > I_{pickup}$) or the reset (for $I < I_{pickup}$) is required,

Table 5–38: USER CURVE CHARACTERISTICS

RESET (XPKP)	TIME (S)	RESET (XPKP)	TIME (S)	OPERATE (XPKP)	TIME (S)	OPERATE (XPKP)	TIME (S)	OPERATE (XPKP)	TIME (S)	OPERATE (XPKP)	TIME (S)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

The two first columns (40 points) correspond to the RESET curve. The other 4 columns, with 80 points in total, correspond to the OPERATE curve. The reset characteristic values are between 0 and 0.98, and the operation values are between 1.03 and 20.

The final curve will be created by means of a linear interpolation from the points defined by the user. This is a separate process for the RESET and the OPERATE curve.

The definition of these points is performed in a separate module from the relay, using a configuration program included in the EnerVista 650 Setup, which incorporates a graphical environment for viewing the curve, thus making it easy for the user to create it. This module can be accessed from the “Edit Curve” option in the FlexCurve menu, at ***Setpoint > System Setup > Flex Curves***.

5.4.3 PHASE CURRENT

The G650 Phase current menu incorporates the following overcurrent elements:

Phase time overcurrent (51PH/51PL)

Phase instantaneous overcurrent (50PH)

Generator Thermal Model (49S)

5.4.3.1 PHASE TIME DELAYED OVERCURRENT ELEMENTS – PHASE HIGH/LOW (51PH/51PL)

The phase overcurrent element (51P) operates in a time period that depends on the applied current and on the set curve. The phase current input may be selected as fundamental phasor magnitude or total waveform RMS magnitude as required by the application. The element reset can be selected between Instantaneous and Linear (timed according to the corresponding equation).

If the element timing is set as Definite Time, then the TD Multiplier setting will be use to define both the Operation time and, in case of selecting Linear reset,. the Reset time of the element.

The element incorporates independent block inputs for each phase. When the element is blocked, the tripping time counter is reset to 0. This feature allows the use of this input to instantaneously reset the protection element timing. The PICKUP setting of the element can be dynamically reduced by a VOLTAGE RESTRAINT feature. Possible outputs for the protection element logic are the pickup and tripping signals independent for each phase, and the general element pickup and tripping signals.

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The pickup current magnitude can be dynamically reduced depending on the existing voltage value. This is done using the Voltage Restraint setting. The pickup current level is proportional to the phase-to-phase voltage measured according to a coefficient shown on Figure 5–4:.This is accomplished via the multipliers (Mvr) corresponding to the phase-phase voltages of the voltage restraint characteristic curve; the pickup level is calculated as ‘Mvr’ times the ‘Pickup’ setting. In the figure, Vpp is the phase-to-phase voltage, and VT Nominal is the rated voltage set under General settings (please refer to section 5.3.1)

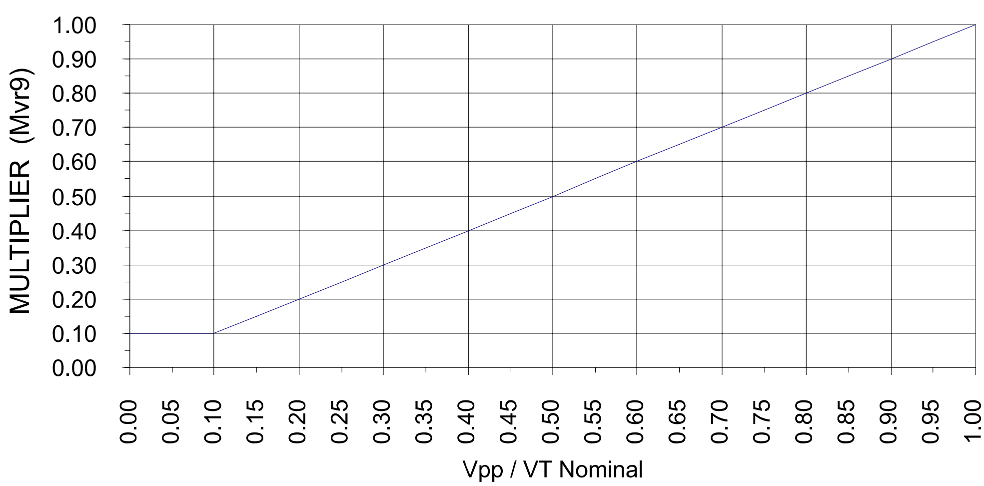

Figure 5–4: VOLTAGE RESTRAINT CHARACTERISTIC

Table 5–39: PHASE TIME OVERCURRENT SETTINGS

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**
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]

If the voltage restraint feature is disabled, the pickup level always remains at the value set in the Pickup Level setting.

The snapshot event setting enables or disables the snapshot event generation for the phase time overcurrent elements.

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The following diagram shows the logic scheme followed by high range and low range time overcurrent elements (51PH and 51PL) in the following figure.

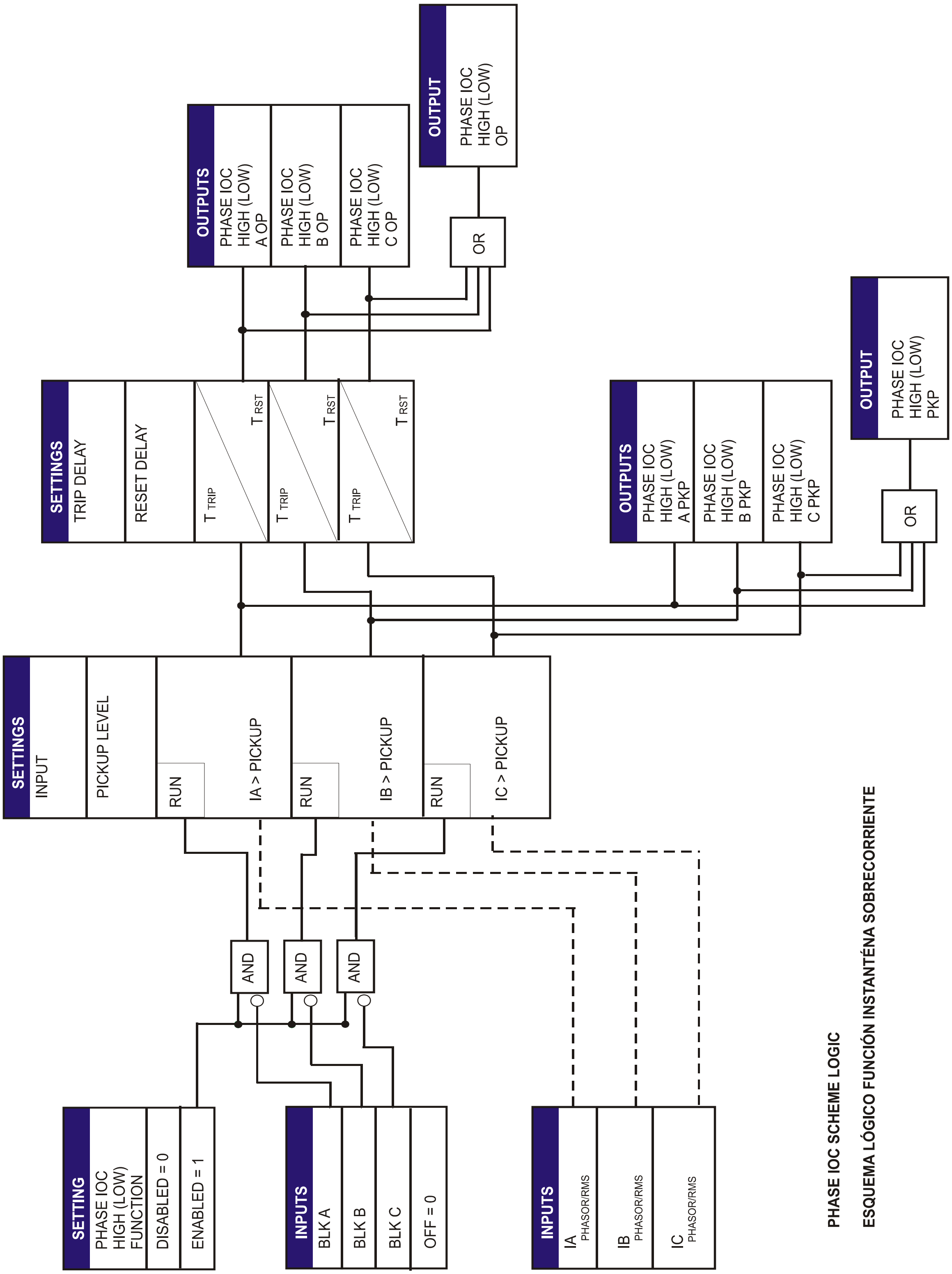

Figure 5–5: TOC ELEMENT LOGIC SCHEME (A6632F2)

5.4.3.2 PHASE INSTANTANEOUS OVERCURRENT ELEMENT- PHASE HIGH (50PH)

The Phase instantaneous overcurrent element has a setting range from 0.05 A to 160 A. It can be set as instantaneous or timed, with the timer selectable between 0.00 and 900 seconds. The input quantities may be chosen as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds.

This element also incorporates a block input for disabling the pickup and trip signals. The logic outputs for the element are the pickup and trip flags, independent for each phase, and general pickup and trip flags.

Table 5–40: PHASE INSTANTANEOUS OVERCURRENT ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > > PHASE IOC HIGH > PHASE IOC HIGH 1> PHASE IOC HIGH 2 > PHASE IOC HIGH 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

The snapshot event setting enables or disables the snapshot event generation for these elements.

The following figure shows the logic scheme diagram for high range and low range Instantaneous overcurrent elements (50PH).

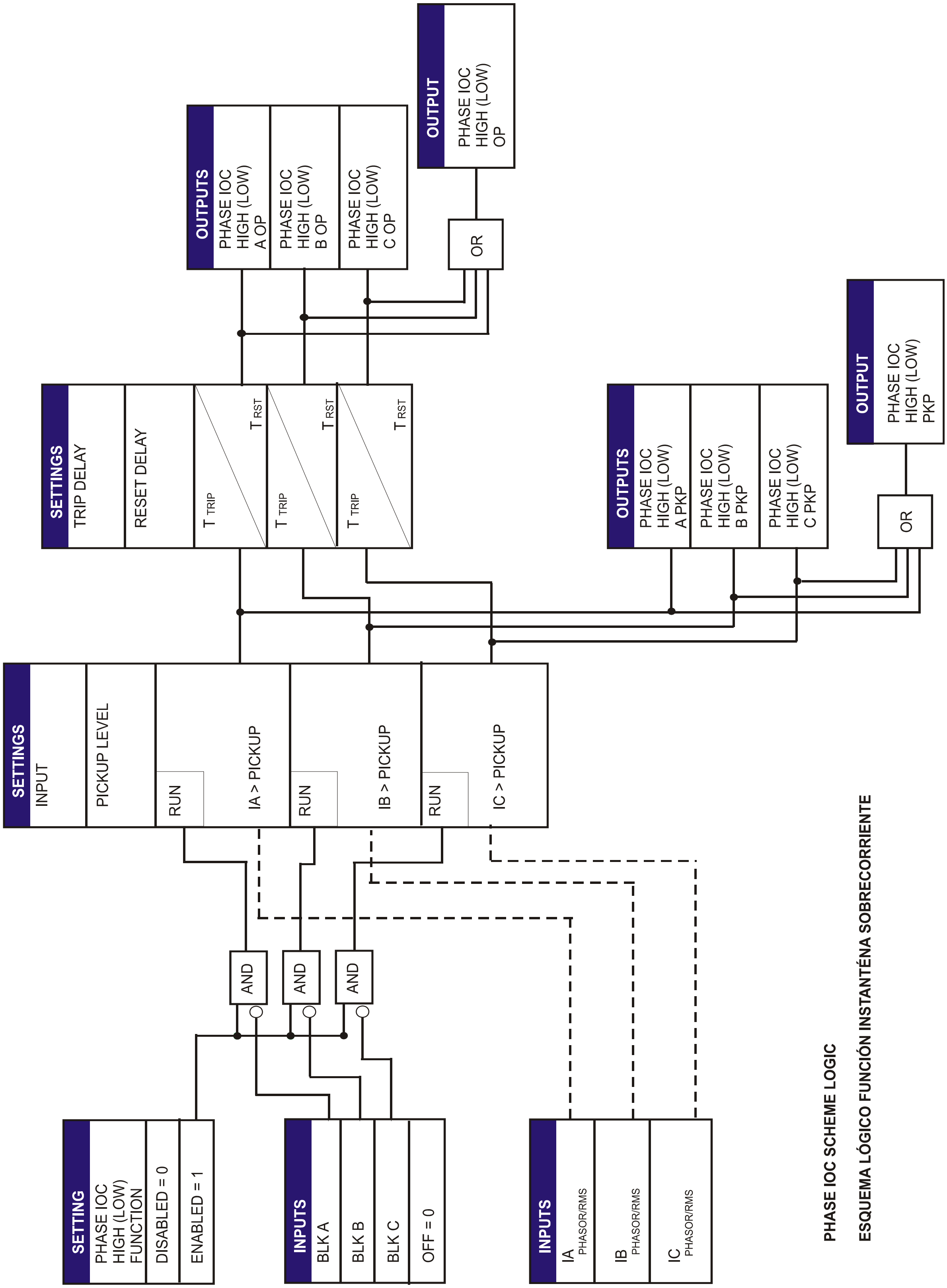

Figure 5–6: PHASE IOC ELEMENTS LOGIC SCHEME (A6632F1)

5.4.3.3 GENERATOR THERMAL MODEL ELEMENT (49S)

This unit provides protection against overheating due to overloading conditions. The operating time curve is set from the time curve family available, as a function of the time constant ô1 (settable between 3 and 600 minutes). The cooling time constant ô2 can be set between 1 and 6 times the heating time constant ô1.

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

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

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

The negative sequence is included in the above formula in order to protect the generator from the effects caused by the system light unbalanced currents, such as the ones produced by load unbalance. High negative sequence values, such as those produced by uncleared external faults (phase-to-phase or phase-to-ground), long lasting loss of a phase, etc. will be detected by function 46 in a faster way, as it works with a different algorithm. The phenomena that cause a supplementary overheating in the machine are described in section 2.5.

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

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

Where,

τ is the heating/cooling time constant.

Ieq is the ratio current/pickup

Table 5–41: THERMAL MODEL ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > THERMAL MODEL > GENERATOR THERMAL MODEL 1> GENERATOR THERMAL MODEL 2 > GENERATOR THERMAL MODEL 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Heating time constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]
Cooling time constant	Cool Time Constant	2.00	0.01 times Heat Time	[1.00 : 6.00]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Alarm level	Alarm Level	80.0	0.1 %	[1.0 : 110.0]
Negative sequence influence	K1 constant	1.0	0.1	[1.0 : 8.0]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The cooling constant is given in times the heating constant.

The snapshot event setting enables or disables the snapshot event generation for the thermal model elements.

5.4.4 NEUTRAL CURRENT

The Neutral Current menu incorporates the following overcurrent elements:

- Neutral time overcurrent (51N)
- Neutral instantaneous overcurrent (50N)
- Neutral directional element (67N)

5.4.4.1 NEUTRAL TIME DELAYED OVERCURRENT ELEMENT (51N)

Neutral TOC is a neutral time delayed overcurrent protection element. This element uses as the input quantity the **neutral current, calculated from the phase currents**. The trip can be timed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5–42: NEUTRAL TOC ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL TOC NEUTRAL TOC 1> NEUTRAL TOC 2 > NEUTRAL TOC 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

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The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.4.2 NEUTRAL INSTANTANEOUS OVERCURRENT ELEMENT (50N)

This function can be used as an instantaneous element or as a definite time element. The element responds to the neutral current, calculated from phase currents.

Table 5–43: NEUTRAL IOC ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL IOC NEUTRAL IOC 1> NEUTRAL IOC 2 > NEUTRAL IOC 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

The following figure shows the logic scheme for the neutral Instantaneous overcurrent element.

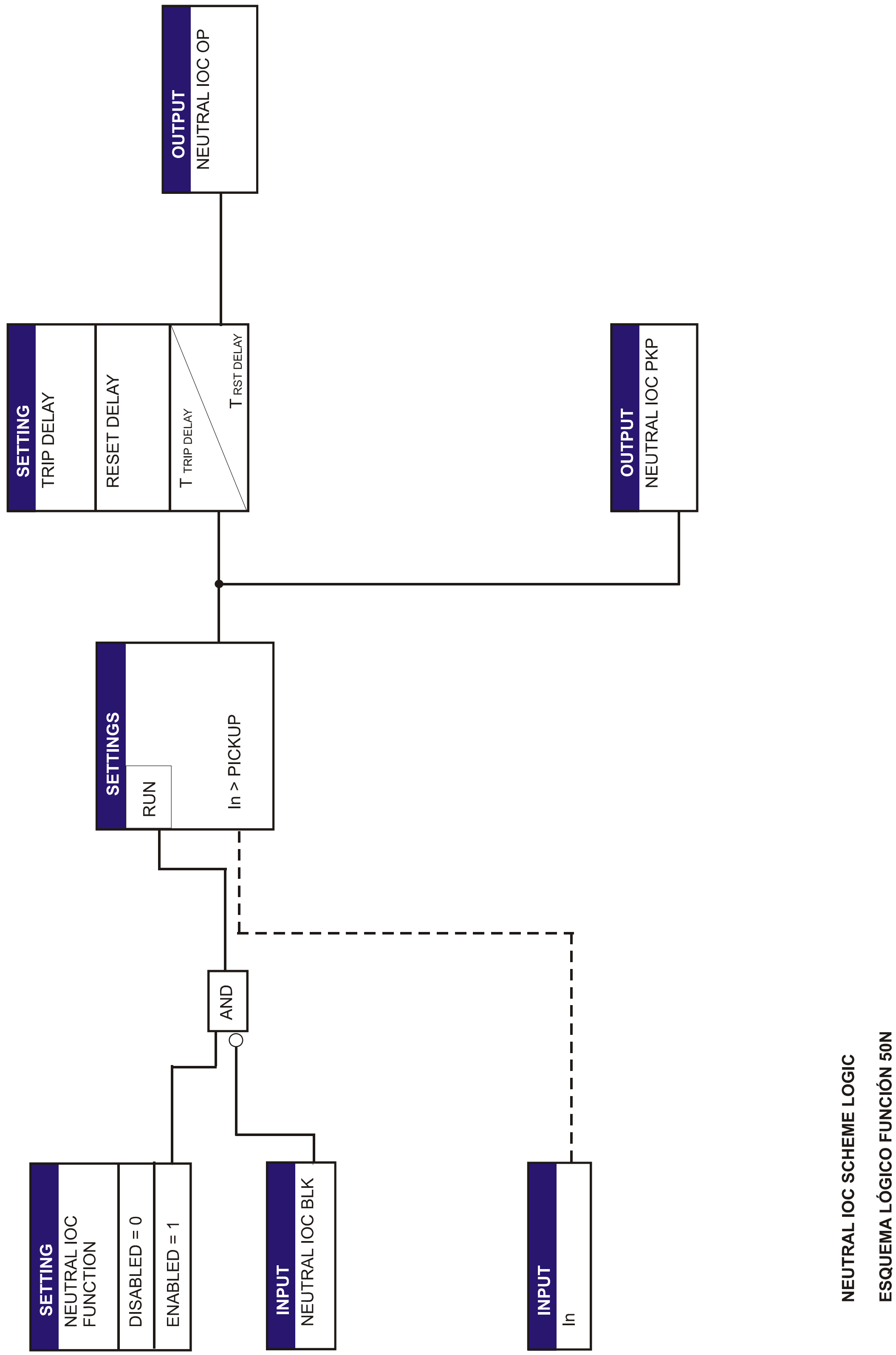

Figure 5–7: LOGIC SCHEME FOR NEUTRAL IOC ELEMENT

5.4.4.3 NEUTRAL DIRECTIONAL ELEMENT (67N)

The Neutral directional element is used for supervising the neutral (3I0) overcurrent elements. This element can be set to use either the neutral voltage, or the polarization current measured by the 5th current input (Ip), or both as polarization magnitude.

Table 5–44: 67N ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL DIRECTIONAL > NEUTRAL DIRECTIONAL 1> NEUTRAL DIRECTIONAL 2 > NEUTRAL DIRECTIONAL 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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	0	1 V	[0 : 00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings for this element are:

Maximum Torque Angle (MTA): Angle used to rotate the polarization voltage. Positive angles are counter clockwise rotations, and negative angles are clockwise rotations. The polarization magnitude, once rotated, defines the MTA line. Vn rotated by this angle points to the semi plane that corresponds to a Reverse fault. -Vn rotated this angle points to the semi plane that corresponds to a Forward fault. A typical setting can be –45º.

Directional element direction (Direction): This setting indicates the Direction for which the element will allow a trip. Depending on this setting, the element will be activated for faults in the forward direction, or ion the reverse direction, allowing its use in tripping or blocking schemes. Possible options for this setting are FORWARD and REVERSE.

Polarization type (Polarization): This setting indicates the type of Polarization to be used. The relay can use voltage polarization (V0), and/or current polarization (Ip). Possible setting values are:

V0 Voltage polarization

Ip Current polarization

V0 + Ip Voltage or current polarization. This allows the element to operate when any of the polarization magnitudes allow operation.

V0 * Ip Voltage and current polarization. This allows the element to operate when both polarization magnitudes allow operation.

If the selected polarization type is V0+Ip, then the relay will operate when any of the polarization magnitudes indicate the selected direction in the Direction setting.

If the selected polarization type is V0*Ip, then the relay will only operate when both polarization magnitudes indicate the selected direction in the Direction setting.

Polarization Voltage Threshold This is the minimum voltage considered for the direction calculation. Under this setting, the element will be blocked.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this elements.

The Neutral directional element is an independent Protection element that provides Block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at "***Actual > Status > Protection > Neutral Current***"

67N Block (NEUTRAL DIR BLOCK): It indicates that the element is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

67N Operation (NEUTRAL DIR OP): It indicates that the directional element is giving permission, that the angle relations between the operation magnitude and the polarization magnitude are met, according to the set conditions, or in case of having selected Permission in the Block Logic setting, it indicates that the element allows operation under block conditions.

Table 5–45: SIGNALS FOR THE NEUTRAL DIRECTIONAL ELEMENT

NEUTRAL DIRECTIONAL
NEUTRAL DIR1 BLOCK
NEUTRAL DIR1 OP
NEUTRAL DIR2 BLOCK
NEUTRAL DIR2 OP
NEUTRAL DIR3 BLOCK
NEUTRAL DIR3 OP

a) VOLTAGE POLARIZATION OPERATION PRINCIPLES:

Operation Magnitude: In = 3·Io, calculated from the phase currents.

Polarization Magnitude: $-3V_0$. Calculated from the phase voltages (if the Auxiliary Voltage setting in General settings main menu is set as VX or VG) or measured at the input terminals (A11, A12)if the Auxiliary Voltage setting in General settings main menu is set as VN.The relay measures $3V_0$ and rotates 180º internally to obtain $-3V_0$.

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shows the operation of the zero sequence polarization, $3V_0$, in case of an AG fault. In this case, the polarization magnitude $3V_0$ can be calculated from the three phase voltage values, or measured through the fourth voltage input (VN). The operation magnitude I_n, is calculated from the phase currents.

When Ip Polarization is selected, the Polarization magnitude is Ip, this current value measured at the fifth current input (terminals B11-B12). This polarization current must usually come from a CT measuring the current that flows from the ground to the neutral of the neutral fault current source, which will mainly be a transformer. The direction is considered to be ***Forward*** when the neutral current I_n is inside a ±90º arc at both sides of the polarization current. In any other case, the direction will be ***Reverse***. If the polarization current is lower than 5 mA, the element output takes the value of the ***Block Logic*** setting.VOLTAGE POLARIZATION

Figure 5–8: shows the Operation of the directional element for a Phase A to Ground fault, where the Phase A current grows in magnitude and is delayed with respect to its voltage by an angle similar to the protected line. Va voltage decreases or can even disappear if the fault is close and the fault resistance is very low.

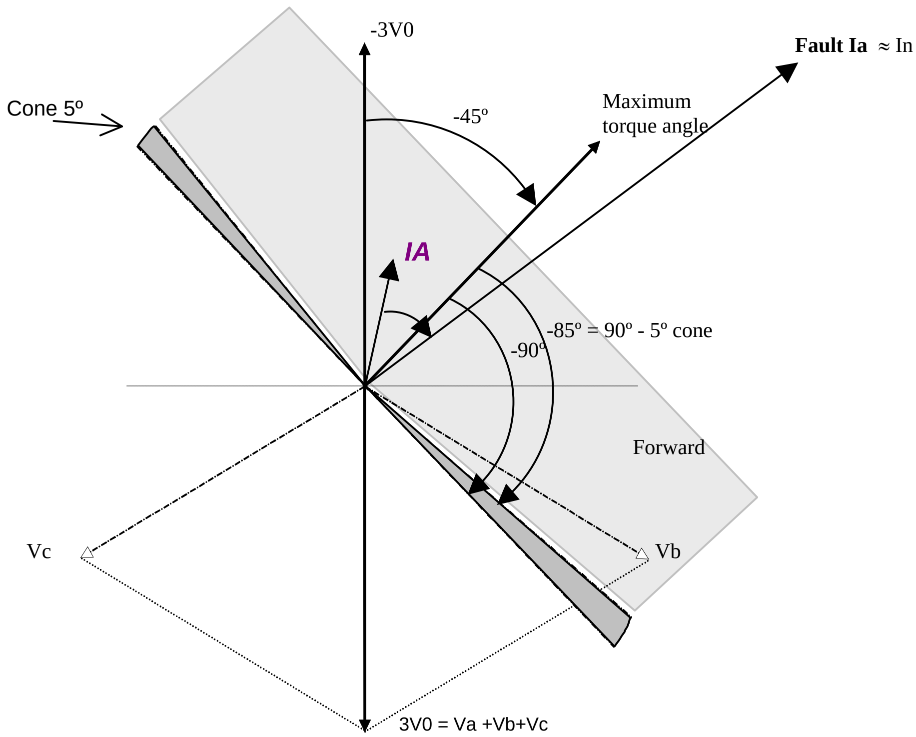


Figure 5–8: VOLTAGE POLARIZATION

The voltage polarization algorithm uses –Vn, -(Va+Vb+Vc) = -3·V_0, as a substitute for the faulted phase voltage. This magnitude can be rotated by the desired angle to fix the MTA line and to define the operative semi plane of the relay, following the rule that positive angles are in counter clockwise direction. A typical setting is –45º, as shown on the figure. The operative semi plane is delimited to ± 85º of the MTA line. Every time the operation magnitude, In, is inside this semi plane, the element will consider that the direction is forward. If the ***Direction*** setting is set as ***Forward***, the operation signal of the neutral directional element (NEUTRAL DIR OP) will be activated.

Minimum acceptable values, both for the polarization magnitude and the operation magnitude are as follows: minimum In current for the element to operate is 50 mA. Minimum polarization voltage for the element to operate is set in the ***Polarization Voltage Threshold*** setting. Minimum polarization current (Ip) is 5 mA.

The voltage polarized directional element needs a typical time of 1 cycle (20ms @ 50Hz) to polarize. This time must be considered when setting the overcurrent elements with the ***Block Logic*** setting as ***Permission***. This may cause, especially in testing processes, the relay to trip with counter direction faults when voltage and current are applied at the same time starting from zero. As there is no previous polarization voltage, the overcurrent element is ready to trip under any overcurrent (as set in the ***Block Logic*** setting), while the directional element will need a complete cycle to polarize and give the correct direction. If the current is high enough to pickup the overcurrent element and there is no set time delay, the element will trip before the directional element blocks the trip. In cases where this situation is foreseen, it is recommended to program the ***Block Logic*** setting as ***Block***, or else to add a small time delay to the overcurrent element to allow the directional element to polarize and block the trip.

b) CURRENT POLARIZATION OPERATION PRINCIPLES:

<u>Operation Magnitude</u>: In = calculated from phase currents.

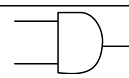
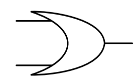
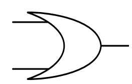
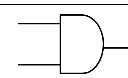
<u>Polarization Magnitude</u>: Ip, measured at input terminals B11-B12.

To perform a directional comparison by current, the polarization magnitude used is the current measured at the relay Ip input, terminals B11-B12, with input or “positive” in B11. This current is taken from the source (transformer or generator) neutral grounding.

Direction is considered to be forward when the phase shift between both magnitudes is lower than 85º. If the angle is higher than 85º, the fault is considered to be reverse.

The following table shows the element’s output signals management (block and permission) depending on the polarization type setting.

Table 5–46: OUTPUT SIGNALS MANAGEMENT ACCORDING TO THE POLARIZATION TYPE SETTING

POLARIZATION SETTING	NEUTRAL DIR BLOCK SIGNAL	NEUTRAL DIR OP SIGNAL
Vo	Vo < POL V THRESHOLD setting	Permission Vo
Ip	Ip < 5 mA	Permission Ip
Vo + Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 
Vo * Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 

Configuration of the required signals for blocking the neutral overcurrent elements from the signals provided by the neutral directional elements is performed at ***Setpoint > Relay Configuration > Protection Elements*** using the inverted operation signals to block the trip, as shown in the following example:

How to block neutral time overcurrent elements with neutral directional functions:

NEUTRAL TOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL TOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL TOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

To block neutral instantaneous elements:

NEUTRAL IOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL IOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL IOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

Table 5–47: QUANTITIES

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

5.4.5 GROUND CURRENT

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The Ground Current menu incorporates the following overcurrent elements:

Ground time overcurrent (51G)

Ground instantaneous overcurrent (50G)

Ground directional element (67G)

Restricted Ground Fault (87G). Enhanced models only.

5.4.5.1 GROUND TIME DELAYED OVERCURRENT ELEMENT (51G)

Ground TOC is a ground time delayed overcurrent protection element. The ground current is measured from the ground input, terminals B9-B10, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. It incorporates a reset time that is selectable between instantaneous or linear.

Table 5–48: 51G ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND TOC GROUND TOC 1> GROUND TOC 2 > GROUND TOC 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.2 GROUND INSTANTANEOUS OVERCURRENT ELEMENT (50G)

Ground IOC is a ground instantaneous overcurrent protection element, with a setting range from 0.05 A to 160 A, which can also be time delayed. The delay is selectable between 0.00 and 900 seconds. The ground current input quantity is measured from the ground input, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5–49: 50G ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND IOC GROUND IOC 1> GROUND IOC 2 > GROUND IOC 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.3 GROUND DIRECTIONAL ELEMENT (67G)

Ground directional is a directional protection element, used for monitoring the ground overcurrent elements. The operation magnitude is the ground current measured directly from the corresponding input (B9-B10), while the polarization magnitude is the neutral voltage (V_n). The neutral voltage is calculated from the three phase voltages (when VG or VX is selected as Auxiliary Voltage setting in the General Settings main menu) or measured from the dedicated voltage input (A11-A12)when VN is selected as Auxiliary Voltage setting in the General Settings main menu.

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In case of using the voltage measured from the dedicated voltage input terminals, the ***Auxiliary Voltage*** setting in ***General settings*** must be ***VN***.

As in the case of a phase directional element, this element incorporates a voltage loss logic that allows blocking or permitting the trip by means of a setting.

Table 5–50: 67G ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND DIRECTIONAL > GROUND DIRECTIONAL 1> GROUND DIRECTIONAL 2 > GROUND DIRECTIONAL 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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	0	1 V	[0 : 00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Operation of the Ground directional element 67G is similar to the operation of the neutral directional element 67N (refer to section 5.4.4.3), with the exception that the operation magnitude here is the ground current Ig (67G), measured from the input terminals B9-B10 instead of the Neutral current, In (67N), calculated from the phase currents.

Polarization magnitudes can be, as in the case of 67N, Polarization voltage (3Vo), either calculated from the phase voltages or measured from terminals A11-A12 when VN is selected as Auxiliary Voltage setting in the General Settings main menu, or polarization current (Ip), measured from the fifth input transformer terminals, Isg, terminals B11-B12.

The following table shows the used magnitudes in each of the Polarization possibilities:

Table 5–51: USED MAGNITUDES ACCORDING TO THE POLARIZATION SETTING

POLARIZATION SETTING	OPERATION MAG.	POLARIZATION MAG.
Vo	Ig	3V0
Ip	Ig	Isg
Vo + Ip	Ig	3V0 or Isg
Vo * Ip	Ig	3V0 and Isg

The following table shows the management of the element output signals (block and permission) depending on the ***Polarization Type*** setting.

Table 5–52: OUTPUT SIGNALS MANAGEMENT ACCORDING TO THE POLARIZATION TYPE SETTING

POLARIZATION SETTING	GROUND DIR BLOCK SIGNAL	GROUND DIR OP SIGNAL
Vo	V_0 < Ajs. POL V THRESHOLD	Permission V_0
Ip	I_P < 5 mA	Permission I_P
Vo + Ip	V_0 < POL V THRESHOLD I_P < 5 mA	Permission V_0 Permission I_P
Vo * Ip	V_0 < POL V THRESHOLD I_P < 5 mA	Permission V_0 Permission I_P

The configuration of the signals required for blocking the Ground overcurrent elements from the signals provided by the Ground directional element is made at ***Setpoint > Relay Configuration > Protection Elements*** using inverted operation signals to block the trip.

For example, to block the ground time delayed elements:

GROUND TOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND TOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND TOC3 BLOCK = NOT (GROUND DIR3 OP)

To block the Ground Instantaneous elements:

GROUND IOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND IOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND IOC3 BLOCK = NOT (GROUND DIR3 OP)

Table 5–53: QUANTITIES

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

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5.4.6 RESTRICTED GROUND FAULT (ONLY FOR ENHANCED MODELS)

G650 provides the possibility of having a RGF (Restricted Ground Fault) function, only available for Enhanced models (please see ordering code). This RGF function is based in the comparison of the neutral current calculated from phase currents with ground current measured from the fourth current input (B9-B10). The implementation is a low impedance current differential scheme. G650 calculates the vectorial difference of the residual and ground currents ($3I_0$-I_g) and divides this by the maximum line current (I_{max}) to produce a percent slope value.

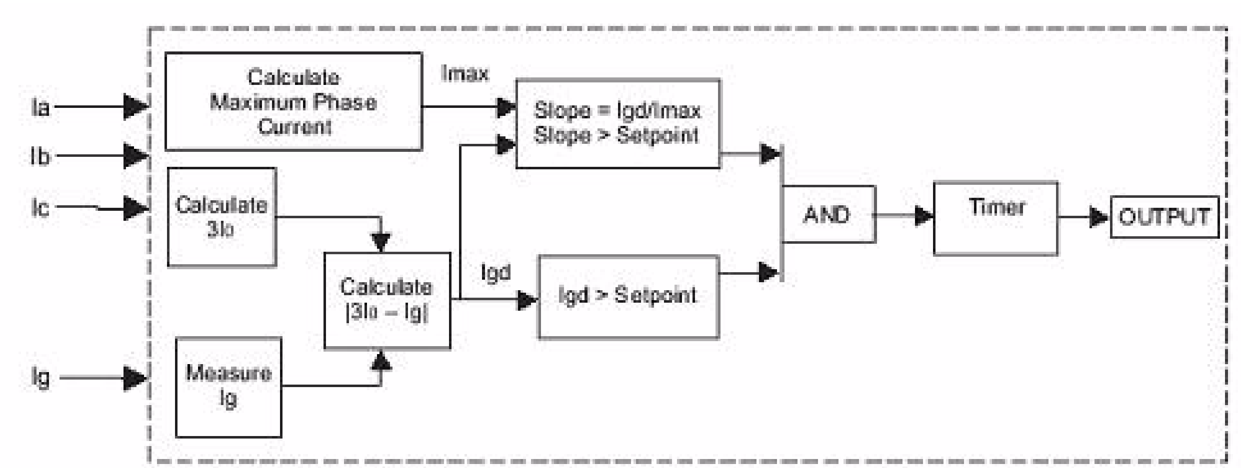


Figure 5–9: RESTRICTED GROUND FAULT IMPLEMENTATION

The RGF settings are shown on the table below:

Table 5–54: .RESTRICTED GROUND FAULT SETTINGS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > RESTRICTED GND FAULT > RESTRICTED GND FAULT 1> RESTRICTED GND FAULT 2 > RESTRICTED GND FAULT 3				
Setting Description	**Name**	**Default**	**Step**	**Range**
Restricted Ground Fault Function Permission	Function	Disabled	N/A	Disabled - Enabled
Restricted Ground Fault Pickup	Ground Fault Pickup	10.00	0.01 CT	0.02 - 20.00 CT
Restricted Ground Fault Slope	Ground Fault Slope	10.00	0.01%	0.00 - 100.00%
Restricted Ground Fault Delay	Ground Fault Delay	0.10 s	0.01	0.00 - 600.00 s
Snapshot Event Generation	Snapshot Events	Enabled	N/A	Disabled - Enabled

- **Restricted Ground Fault Function**: This setting allows enabling or disabling the restricted ground fault element.
- **Restricted Ground Fault Pickup**: This setting defines the minimum differential current required for operation in units of Phase CT Ratio.
- **Restricted Ground Fault Slope**: This setting defines the restraint during normal operation conditions to assure sensitivity to internal faults. Slope percentage of ground differential current to maximum line current.
- **Restricted Ground Fault Delay**: Time that the element must remain picked up before the element operates.

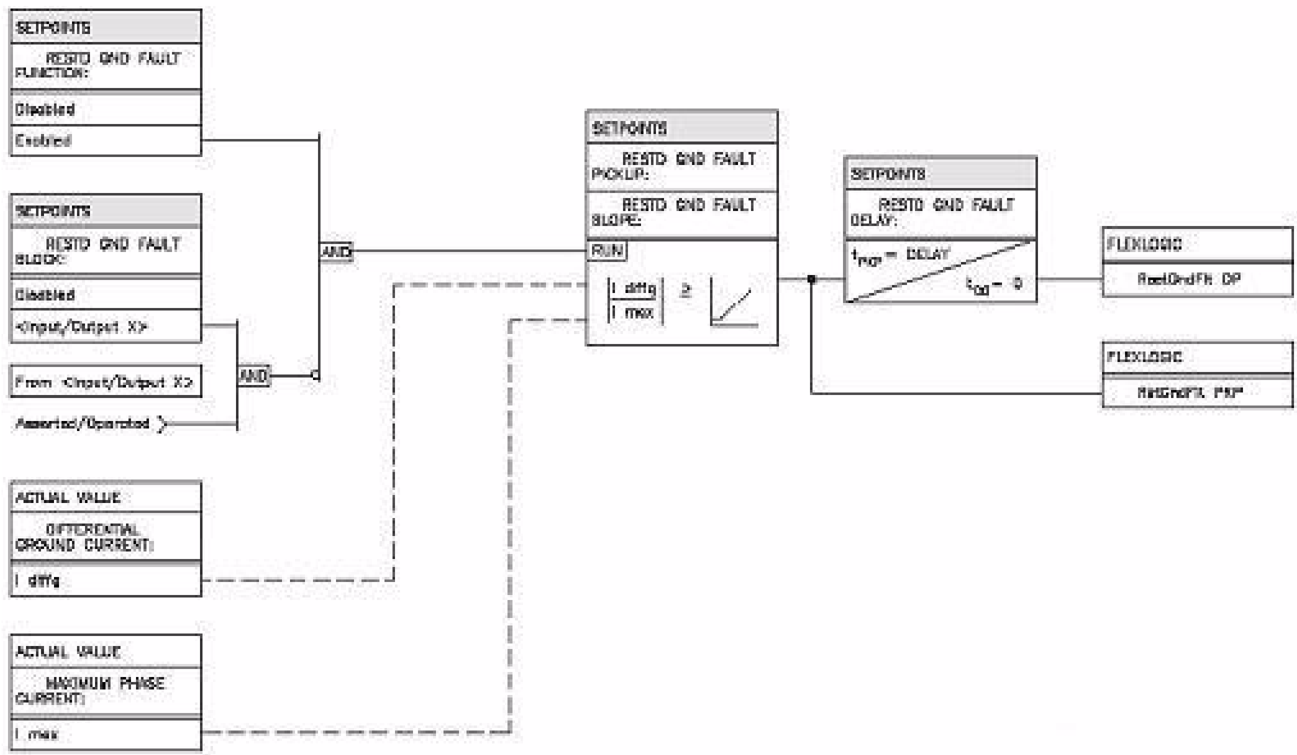


Figure 5–10: RESTRICTED GROUND FAULT ALGORITHM

The elements used in the 87G algorithm are listed in Table 5–55: and Table 5–56:

Table 5–55: RGF ALGORITHM ELEMENT INPUTS

Input	Comment
Idiffg	Differential Ground Current
Imax	Maximum phase current

Table 5–56: RGF ALGORITHM ELEMENT OUTPUTS

Output	Comment
RESTGNDFLT PKP	General Pickup Signal
RESTGNDFLT PKP	General Trip Signal

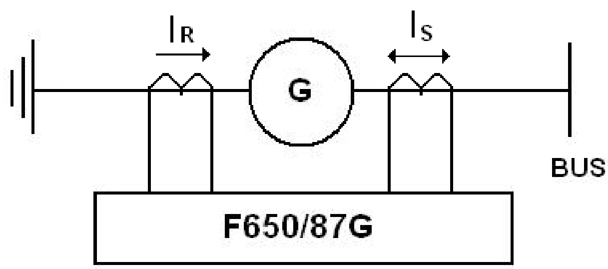
Table 5–57: RESTRICTED GROUND FAULT CONFIGURABLE SIGNALS

RESTRICTED GROUND FAULT BLOCK SIGNALS
RESTR GND FLT1 BLOCK
RESTR GND FLT2 BLOCK
RESTR GND FLT3 BLOCK

Table 5–58: RESTRICTED GROUND FAULT INTERNAL STATES

RESTRICTED GROUND FAULT INTERNAL STATES
RESTR GND FLT1 PKP
RESTR GND FLT1 OP
RESTR GND FLT2 PKP
RESTR GND FLT2 OP
RESTR GND FLT3 PKP
RESTR GND FLT3 OP

5.4.6.1 RESTRICTED GROUND FAULT SETTINGS EXAMPLE



SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > RESTRICTED GND FAULT > RESTRICTED GND FAULT 1> RESTRICTED GND FAULT 2 > RESTRICTED GND FAULT 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Restricted Ground Fault Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Restricted Ground Fault Pickup	Ground Fault Pickup	0.30	0.01 CT	[0.02 : 20.00]
Restricted Ground Fault Slope	Ground Fault Slope	0.00	0.01 %	[0.00 : 100.00]
Restricted Ground Fault Delay	Ground Fault Delay	0.10	0.01 s	[0.00 : 600.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

SETPOINT > SYSTEM SETUP > GENERAL SETTINGS				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Phase CT Ratio	Phase CT Ratio	80.0	0.1	[1.0 : 6000.0]
Ground CT ratio	Ground CT Ratio	40.0	0.1	[1.0 : 6000.0]

The example does not apply any slope, it is only intended to explain the pickup setting selection when the CT ratios are different for phases and ground.

- If the Phase CT Transformers are 400/5 this means a Phase CT Ratio of 80
- If the Ground CT Transformer is 200/5 this means a Ground CT Ratio of 40

Sensitivity is given in primary amperes with Phase CT Ratio reference, this is:

Sens =[Ground Fault Pickup] x [Phase CT Ratio]

If the Ground Fault Pickup setting is 0.3 A. This setting means that for phases the unit will trip when the Igd with phase current reference is higher that 24 A, and with ground current reference is higher than 12 A.

5.4.7 SENSITIVE GROUND CURRENT (ONLY FOR ENHANCED MODELS)

The G650 Sensitive ground Current menu incorporates the following overcurrent elements:

- Sensitive ground time overcurrent (51SG)
- Sensitive ground instantaneous overcurrent (50SG)

5.4.7.1 SENSITIVE GROUND TIME DELAYED OVERCURRENT ELEMENT (51SG)

Sensitive Ground TOC is a sensitive ground time delayed overcurrent protection element with a setting range 0.005A to 16A. The sensitive ground current input quantity is measured from the sensitive ground input, terminals B11-B12, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. And it incorporates a reset time selectable between instantaneous or linear.

Table 5–59: 51SG ELEMENT SETTINGS

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**
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]

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The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.7.2 SENSITIVE GROUND INSTANTANEOUS OVERCURRENT ELEMENT (50SG)

50SG is a sensitive ground instantaneous overcurrent protection element, with a setting range from 0.005 A to 16.00 A, which can also be time delayed, with a delay selectable between 0 and 900 seconds. The ground current input quantity is measured from the sensitive ground input, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5–60: 50SG ELEMENT SETTINGS

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**
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8 NEGATIVE SEQUENCE CURRENT

The Negative sequence menu incorporates the following elements:

- Negative sequence time overcurrent (51-2)
- Negative sequence instantaneous overcurrent (50-2)
- Generator unbalance (46)

5.4.8.1 NEGATIVE SEQUENCE OVERCURRENT ELEMENT (51-2)

Negative Sequence TOC is an overcurrent protection element that uses the fundamental phasor of the negative sequence current as input magnitude, calculated from the phase currents. This element can be used for detecting load unbalance in the system, and for open phase conditions (fallen or broken conductor). The trip can be time delayed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5–61: NEGATIVE SEQUENCE TOC ELEMENT SETTINGS

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**
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]

5

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.2 NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT ELEMENT (50-2)

Negative Sequence IOC is an overcurrent protection element that uses the fundamental phasor of the negative sequence current as input magnitude, calculated from the phase currents. This element can be used for detecting load unbalance in the system, and for open phase conditions (fallen or broken conductor). The trip time can be selected as instantaneous or timed, with the timer selectable between 0.00 and 900 seconds. The element incorporates a reset time selectable between 0 and 900 seconds.

Table 5–62: NEGATIVE SEQUENCE IOC ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE IOC > NEGATIVE SEQUENCE IOC 1> NEGATIVE SEQUENCE IOC 2 > NEGATIVE SEQUENCE IOC 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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 s	0.01 s	[0.00 : 900.00]
Reset time	Reset delay	0.00 s	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.3 GENERATOR UNBALANCE (46)

The generator unbalance element protects the machine from rotor damage due to excessive negative sequence current. Negative sequence current is used as operation element. The element has an inverse time stage (stage 1), typically used for tripping, and a definite time stage (stage 2) typically used for alarm purposes.

Stage 1 trip time is based on an inverse time curve, defined by the equation:

$$T = \frac{K}{\left(\frac{I2}{Inom * Ipkp}\right)^2}$$

where I_{nom} is the generator rated current and K is the negative-sequence ($I2^2T$) capability constant normally provided by the generator manufacturer.

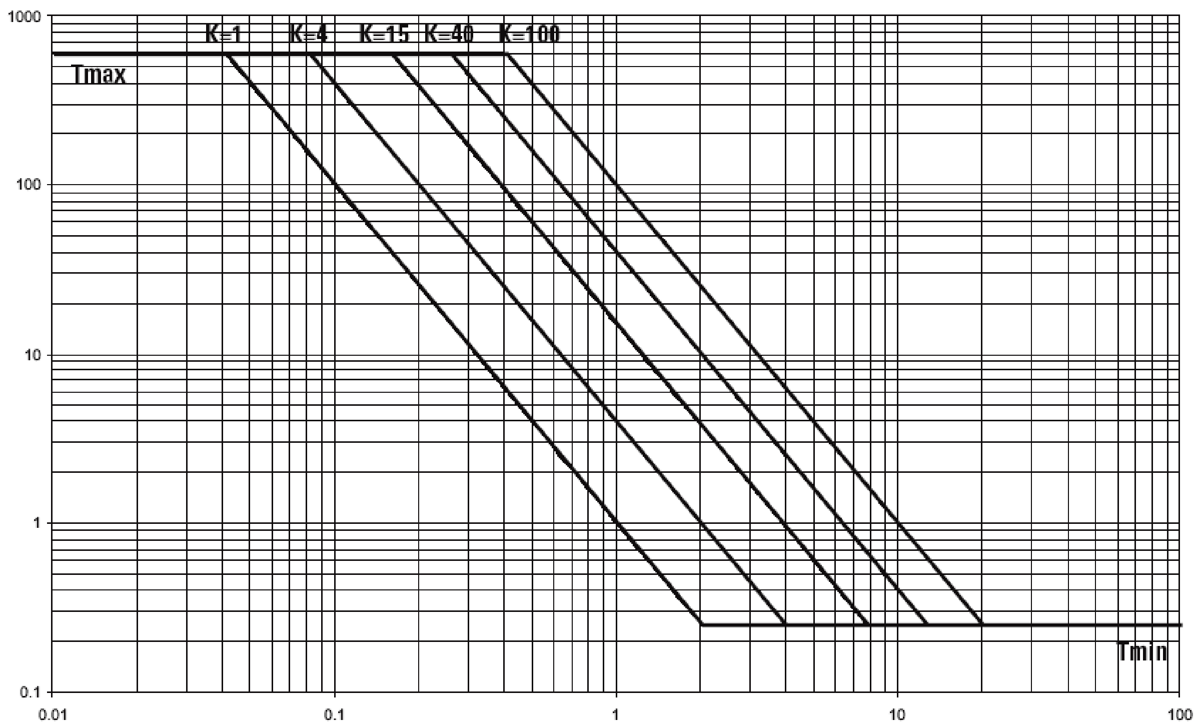

Table 5–63: GENERATOR UNBALANCE ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > GENERATOR UNBALANCE > GENERATOR UNBALANCE 1> GENERATOR UNBALANCE 2 > GENERATOR UNBALANCE 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function Permision	Function	DISABLED	N/A	[DISABLED – ENABLED]
Generator Rated Full Load Current	Gen Unbal Inom	5.00	0.01 A	[0.00 : 10.00]
Pickup level for stage 1 (as a percentage of Gen Unbal Inom)	Gen Unbal Stg1 Pkp	8.00	0.01 %	[0.00 : 100.00]
K (Negative sequence capability constant) for stage 1	Gen Unbal Stg1 K	1.00	0.01	[0.00 : 100.00]
Minimum Operating time for stage 1	Gen Unbal Stg1 Tmin	0.3	0.1 s	[0.0 : 1000.0]
Maximum Operating time for stage 1	Gen Unbal Stg1 Tmax	600.0	0.1 s	[0.0 : 1000.0]
K for Linear reset of the stage	Gen Unbal Stg1 K-Rst	240.0	0.1	[0.0 : 1000.0]
Pickup level for stage 2 (as a percentage of Gen Unbal Inom)	Gen Unbal Stg2 Pkp	3.00	0.01 %	[0.00 : 100.00]
Trip time for stage 2	Gen Unbal Stg2 Delay	5.0	0.1s	[0.0 : 1000.0]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

- **Gen Unbal Function**: This setting allows enabling or disabling the element.
- **Gen Unbal Inom**: This setting is the rated full load current of the machine.
- **Gen Unbal Stg1 Pkp**: This setting defines the pickup of the stage 1 element expressed as a percentage of the nominal current as specified by GEN UNBAL INOM setting. It is typically set at the maximum continuous negative sequence current rating of the machine.
- **Gen Unbal Stg1 K**: This setting is the negative sequence capability constant. This value is normally provided by the generator manufacturer.
- **Gen Unbal Stg1 Tmin**: This is the minimum operate time of the element.
- **Gen Unbal Stg1 Tmax**: This is the maximum operate time of the element. This setting can be applied to limit the maximum tripping time.
- **Gen Unbal Stg1 K-Rst**: This setting defines the linear reset rate of the stage. This feature provides a thermal memory of previous unbalance conditions.
- **Gen Unbal Stg2 Pkp**: This setting defines the pickup of the stage 2 element expressed as a percentage of the nominal current as specified by GEN UNBAL INOM setting.
- **Gen Unbal Stg2 Delay**: This is the minimum operate time of the stage 2 element.

Table 5–64: GENERATOR UNBALANCE INTERNAL SIGNALS

SIGNAL	COMMENT
GEN UNBAL (1, 2, 3) BLOCK	Input used to block the element (1, 2, 3) externally
GEN UNBAL (1, 2, 3) STG1 PKP	Output used to indicate I2/Inom ratio above stage 1 setting in units (1, 2, 3)
GEN UNBAL (1, 2, 3) STG1 OP	Output used to indicate stage 1 operation in units (1, 2, 3)
GEN UNBAL (1, 2, 3) STG2 PKP	Output used to indicate I2/Inom ratio above stage 2 setting in units (1, 2, 3)
GEN UNBAL (1, 2, 3) STG2 OP	Output used to indicate stage 2 operation in units (1, 2, 3)
GEN UNBAL1 PKP	This status is a logic OR between the GEN UNBAL(1, 2, 3) STG1 PKP and GEN UNBAL(1, 2, 3) STG2 PKP
GEN UNBAL1 OP	This status is a logic OR between the GEN UNBAL(1, 2, 3) STG1 OP and GEN UNBAL(1, 2, 3) STG2 OP

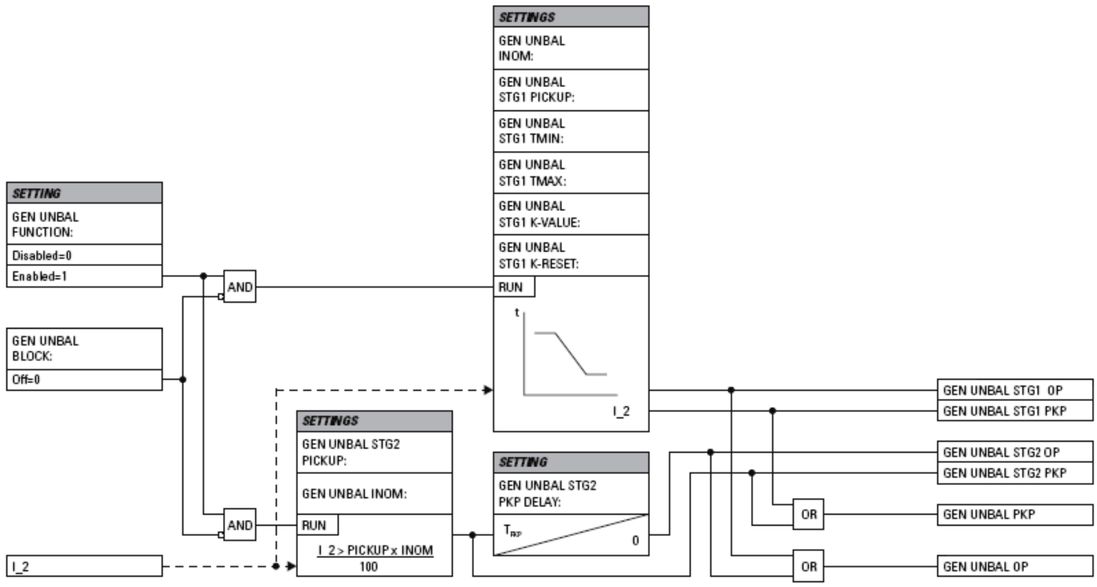

Figure 5–11: GENERATOR UNBALANCE ALGORITHM

5.4.9 VOLTAGE ELEMENTS

The G650 incorporates the following voltage elements:

- Phase undervoltage (27P)
- Phase overvoltage (59P)
- Neutral overvoltage (59NH)
- Negative sequence overvoltage (47)
- Auxiliary overvoltage (59X)
- Auxiliary undervoltage (27X)
- Volts per Hertz (24) ***(only available for enhanced models)***
- Ground Overvoltage (59G)

These protection elements can be used in multiple applications, such as:

Undervoltage protection: for induction motor load types, where a voltage dip can cause an increase of the consumed current. Element 27P (phase undervoltage) can be used to issue a trip or an alarm.

Transfer Schemes: in the event of an undervoltage condition, we can use the 27P element (phase undervoltage) to send a signal that will transfer load to another power source.

Undervoltage elements can be set to operate with definite time or with an inverse time curve. If the element is set as definite time, it will operate when voltage remains under the set value during the set period of time. This period can be set from 0s to 900.00 s in steps of 10ms.

These elements can also be set as inverse time curves. This family of curves is defined by the following formula:

$$T = \frac{D}{1 - \frac{V}{Vpickup}}$$

Where:

T = operation time

D = operation time setting (delay)

V = voltage applied to the relay

Vpickup = pickup setting (Pickup level)

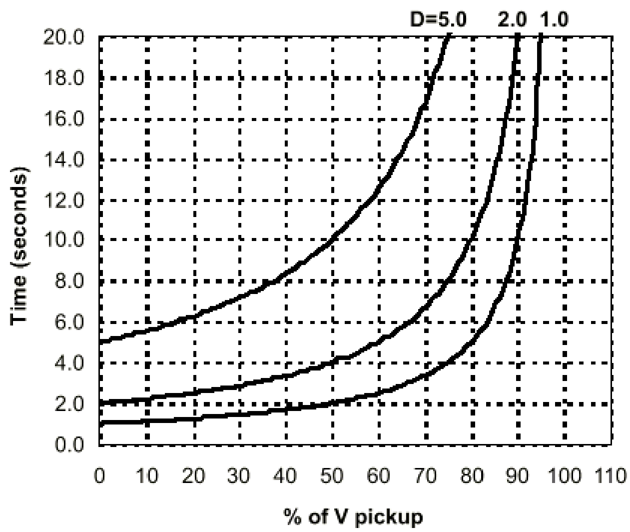

Figure 5–12: INVERSE TIME UNDERVOLTAGE CURVES

5.4.9.1 PHASE UNDERVOLTAGE ELEMENT (27P)

This element may be used to give a desired time-delayed operating characteristic versus the applied fundamental voltage (phase-to-ground or phase-to-phase for wye VT connection, or phase-to phase- for Delta VT connection) or as a Definite time element. The element resets instantaneously if the applied voltage exceeds the dropout voltage.

The delay setting selects the minimum operating time of the phase undervoltage. The minimum voltage setting selects the operating voltage below which the element is blocked (a setting of “0” will allow a dead source to be considered a fault condition.

This element generates independent pickup and trip signals per phase, and general pickup and trip signals for the element. These last signals can be selected, by means of the operation logic setting, to be an OR (any phase signal) or an AND (all phase signals).

Table 5–65: 27P ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE UV > PHASE UV 1> PHASE UV 2 > PHASE UV 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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 : 500]
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 : 500]
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]

Phase undervoltage element settings are:

Function Permission (Function): This setting indicates whether the phase undervoltage element is enabled or disabled.

Input mode (Mode): This setting allows selecting operation for phase-to-phase or phase-to-ground voltage, depending on the selected setting.

Pickup Level: This is the voltage threshold below which the undervoltage element will operate.

Curve Shape (Curve): Undervoltage elements can be set to operate with definite time or with an inverse time curve. Elements set as definite time operate when the voltage value remains under the pickup setting during the set time. If inverse time is selected, the element will operate according to the previously described inverse time curve.

Time Dial (Delay): Setting of the Protection element operation time.

Minimum voltage Threshold (Minimum Voltage): Voltage setting under which the undervoltage element is inhibited, in order not to operate in dead line cases.

Operation logic (Logic): This setting allows the element operation logic selection:

ANY PHASE The element will operate under an undervoltage condition in any of the three phases.

TWO PHASES The element will operate under an undervoltage condition in at least two phases.

ALL PHASES The element will operate under an undervoltage condition in the three phases.

Supervision by breaker status (Supervised by 52): This setting allows inhibiting the undervoltage element if the breaker is open breaker. In case this setting is enabled, the undervoltage element will be supervised by the breaker status. Otherwise, the element will operate independently of the breaker status.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.2 PHASE OVERVOLTAGE ELEMENT (59P)

The Phase overvoltage element may be used as an instantaneous element with no intentional time delay or as a Definite Time element. The input voltage is the phase-to-phase voltage, either measured directly from Delta-connected VTs or as calculated from phase-to-ground (wye) connected VTs. The time delay can be set from instantaneous to 900 seconds. The element reset can be delayed up to 900 seconds.

As in the case of the undervoltage element, this element generates independent pickup and trip signals for each phase. The general signal is selectable by setting to be an OR or an AND of the phase signals.

Table 5–66: 59P ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE OV > PHASE OV 1> PHASE OV 2 > PHASE OV 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

Phase overvoltage element settings are:

Function Permission (Function): This setting indicates whether the phase overvoltage element is enabled or disabled.

Pickup Level: This is the voltage threshold over which the overvoltage element will operate.

Trip time (Trip Delay): setting of the Protection element operation time.

Reset time (Reset Delay): Reset time of the Protection element.

Operation logic (Logic): This setting allows the element operation logic selection:

ANY PHASE The element will operate under an overvoltage condition in any of the three phases.

TWO PHASES The element will operate under an overvoltage condition in at least two phases.

ALL PHASES The element will operate under an overvoltage condition in the three phases.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.3 NEUTRAL OVERVOLTAGE ELEMENT (HIGH LEVEL) (59NH)

The Neutral Overvoltage element can be used to detect an asymmetrical system voltage condition due to a ground fault or to the loss of one or two phases of the source.

The element responds to the system neutral voltage (3V0), calculated from the phase voltages (if VX or VG is selected as as Auxiliary Voltage in General Settings) or measured by the 4th voltage transformer (if VN is selected as Auxiliary voltage in General Settings).

VT errors and normal voltage unbalance must be considered when setting this element.

The element time delay is selectable between 0 and 900 seconds and incorporates a reset with a selectable delay between 0 and 900 seconds.

Notice that the neutral overvoltage element will not be available if a ***DELTA*** Connection is set in the ***Phase VT Connection*** setting in General settings (the Auxiliary Voltage setting is set to VX or VG). This is because with this combination of settings it is not possible to calculate the zero sequence component from the phase-to-phase voltage magnitudes.

Table 5–67: 59NHELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > >NEUTRAL OV HIGH > NEUTRAL OV HIGH 1> NEUTRAL OV HIGH 2 > NEUTRAL OV HIGH 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.4 NEGATIVE SEQUENCE OVERVOLTAGE ELEMENT (47)

The Negative sequence phase overvoltage element uses as its input magnitude the negative sequence component calculated from the phase voltage values. This element can be used to detect the loss of one or two phases, unbalance voltage conditions, etc.

Table 5–68: 47 ELEMENT SETTINGS

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**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.5 AUXILIARY OVERVOLTAGE ELEMENT (59X)

This is an Auxiliary overvoltage element for general use that uses as its input magnitude the voltage measured by the 4th VT (when VX is selected as Auxiliary Voltage in General Settings). The time delay for element 59X can be set from 0 to 900 seconds. The element has a reset than can be programmed from 0 to 900 seconds.

Table 5–69: 59X ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > AUXILIARY OV > AUXILIARY OV 1> AUXILIARY OV 2 > AUXILIARY OV 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.6 AUXILIARY UNDERVOLTAGE ELEMENT (27X)

This is an Auxiliary undervoltage element for general use that uses as its input magnitude the voltage measured by the 4th VT, terminals A11-A12 (when VX is selected as Auxiliary Voltage in General Settings).

Table 5–70: 27X ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > AUXILIARY UV > AUXILIARY UV 1> AUXILIARY UV 2 > AUXILIARY UV 3				
setting Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9.7 VOLTS / HERTZ (24) (ENHANCED MODELS ONLY)

The Volt/Hertz elements can be used for generator protection. The element is active as soon as the magnitude and frequency of the voltage selected in the "V/Hz source" setting is measurable. This setting can be selected between PHASES or AUX VOLTAGE. The element uses for its calculations the voltage and frequency selected in "V/Hz Source" setting. When the setting selected is "PHASES" the function uses for its calculations the maximum of the three phase voltages available. When the setting selected is "AUX VOLTAGE" the voltage used is the one measured through the fourth voltage transformer (A11-A12).

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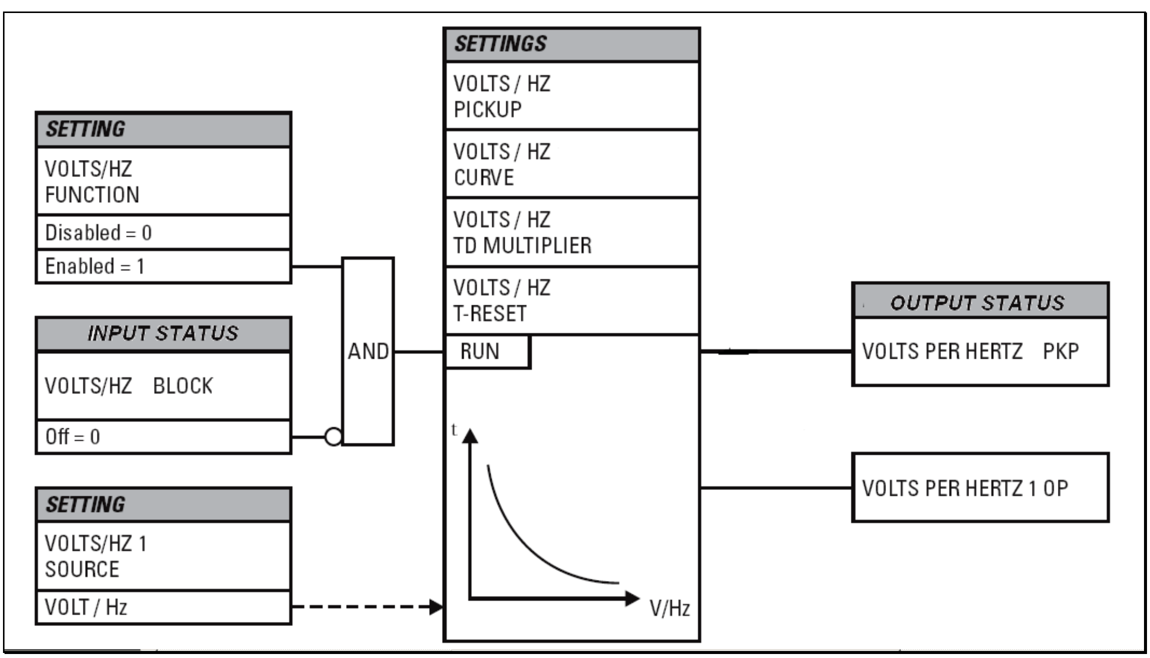

The element has a linear reset characteristic. The reset time can be programmed to match the cooling characteristics of the protected equipment. The element will fully reset from the trip threshold in Volts/Hz T-Reset seconds. The V/Hz element may be used as an instantaneous element with no intentional time delay or as a Definite or Inverse timed element.

The per unit value for this element is established as per voltage and nominal frequency power system settings as follows:

- **Nominal Voltage** setting is located in "Setpoint>System Setup>General Settings>Nominal Voltage"
- **Nominal Frequency** setting is located in "Setpoint>System Setup>General Settings>Nominal Frequency"

The 1 pu value for V/Hz operation is the Nominal Voltage setting divided by the Nominal Frequency setting adjusted in the General Settings menu.

The characteristics of the inverse curves are shown below:

- DEFINITE TIME: T (sec) = TD Multiplier.
- INVERSE CURVE A:

$$T = \frac{TDM}{\left[\left(\frac{V}{F}\right)\Big/ Pickup\right]^2 - 1} \quad when V/F > Pickup$$

where: T = operating time

TDM = Time Delay Multiplier (sec)

V = fundamental value of voltage (pu)

F=frequency of voltage signal (pu)

Pickup= volts-per-hertz pickup setpoint (pu)

- INVERSE CURVE B:

$$T = \frac{TDM}{\left[\left(\frac{V}{F}\right)\Big/ Pickup\right] - 1} \quad when V/F > Pickup$$

where: T = operating time

TDM = Time Delay Multiplier (sec)

V = fundamental value of voltage (pu)

F=frequency of voltage signal (pu)

Pickup= volts-per-hertz pickup setpoint (pu)

- INVERSE CURVE C:

$$T = \frac{TDM}{\left[\left(\frac{V}{F}\right)\Big/ Pickup\right]^{0.5} - 1} \quad when V/F > Pickup$$

where: T = operating time

TDM = Time Delay Multiplier (sec)

V = fundamental value of voltage (pu)

F=frequency of voltage signal (pu)

Pickup= volts-per-hertz pickup setpoint (pu)

5

Table 5–71: VOLTS PER HERTZ ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > VOLTS PER HERTZ > VOLTS PER HERTZ 1> VOLTS PER HERTZ 2 > VOLTS PER HERTZ 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
V/Hz Source for element calculations	V/Hz Source	PHASES	N/A	[PHASES – AUX VOLTAGE]
V/Hz Minimum operating Voltage	V/Hz Minimum Voltage	40.00	0.01 V	[30.00 : 500.00]
V/Hz Pickup Level	V/Hz Pickup Level	1.00	0.01 pu	[0.80 : 4.00]
V/Hz Curve	V/Hz Curve	DEFINITE TIME		[DEFINITE TIME-CURVE A-CURVE B – CURVE C]
V/Hz TD Multiplier	V/Hz TD Multiplier	1.00	0.01	[0.05 : 600.00]
V/Hz Reset Delay	V/Hz Reset Delay	1.0	0.1 s	[0.0 : 900.0]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

- **Function**: This setting allows enabling or disabling the Volts per Hertz element.
- **V/Hz Source**: This setting allows the user to select the voltage used to calculate the Volt/Hz ratio. If V/Hz source is configured as “PHASE”, the maximum phase among the three voltage channels at any given point in time is the input voltage signal for element operation (Va, Vb, Vc for WYE conection or Vab, Vbc, Vca for DELTA conection). If V/Hz source is configured as “AUX VOLTAGE”, the element will use the voltage measured through the fourth voltage transformer (A11-A12).
- **V/Hz Minimum Voltage:** Minimum operating voltage for this unit, if the voltage in any of the phases or in the auxiliary voltage input (depending on the V/Hz source setting) is below this value the function will be inhibited.
- **V/Hz Pickup Level**: This setting defines the Volts/Hz level to operate. The unit used for this setting is pu value defined as 1 pu = Nominal Voltage Setting/ System frequency Setting.
- **V/Hz Curve**: This setting allows the user to select between "Definite Time" or "Inverse Curve" types A, B or C.
- **V/Hz TD Multiplier**: In case of having selected "Definite Time", this setting defines the time in seconds. Instantaneous trips are obtained settings a zero value. Otherwise is the TD multiplier for the inverse curve selected in V/Hz curve setting.
- **V/Hz T-Reset Delay**: The element has a linear reset characteristic. The reset delay can be programmed to match the cooling characteristics of the protected equipment. The element will fully reset from the trip threshold in Volts/Hz T-Reset seconds.
- **Snapshot events**:The snapshot event setting enables or disables the snapshot event generation for this element.

Table 5–72: VOLTS PER HERTZ INTERNAL SIGNALS

Signal	Comment
Volts/Hz (1, 2,3) BLOCK	Input used to block the (1, 2, 3) element externally (configurable in Setpoint>Relay Configuration>Protection Elements)
Volts/Hz (1, 2,3) PKP	Output used to indicate a pickup of the (1, 2, 3) element
Volts/Hz (1, 2,3) OP	Output used to indicate an operation of the (1, 2, 3) element.

5.4.9.8 GROUND OVERVOLTAGE ELEMENT (59G)

G650 provides one ground overvoltage element. This function takes the measurement from the auxiliary voltage VTwhen VG is selected as Auxiliary Voltage in General Settings. The time delay for the 59G element can be set from 0 to 900 seconds, the element has a reset time setting that can be programmed from 0 to 900 seconds.

Table 5–73: 59G ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > GROUND OV > GROUND OV 1> GROUND OV 2 > GROUND OV 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 500]
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.10 POWER

5.4.10.1 DIRECTIONAL POWER ELEMENT (32)

a) ELEMENT DESCRIPTION

The Directional Power element responds to three-phase active power measured from the feeder associated to the G650. This element can be selected to operate according to the power threshold adjusted in the corresponding setting. This element is ideal for reverse power applications (F32 REV) or forward power (F32 FWD), depending on the selected setting. The relay measures the three-phase power for wye or delta connections.

The element has an adjustable characteristic angle and minimum operating power as shown in the Directional Power Characteristic diagram. The element responds to the following condition:

$P \cos(\varphi) + Q \sin(\varphi) > SMIN$

where: P and Q are active and reactive powers as measured per the G650 convention, φ is the angle set at the 32 setting (DIR POWER ANGLE) in degrees in steps of 0.01º, and SMIN is the minimum operating power.

The element has two independent (as to the pickup and delay settings) elements. Both elements can be used for alarm and trip, and they can be set separately to provide a mixed power protection.

The Directional Power Characteristic is shown in the following diagram.

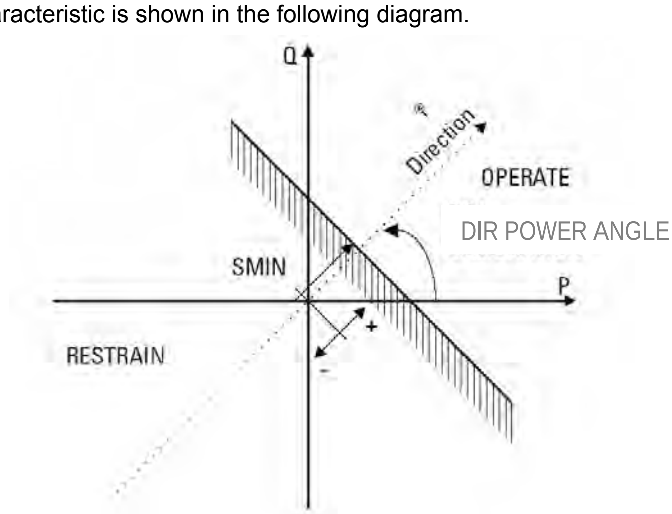

Figure 5–13: POWER DIRECTIONAL CHARACTERISTIC

By making the characteristic angle adjustable from 0º to 360º in steps of 0.01º, a variety of operating characteristics can be achieved as presented in the figures below. For example, for an angle of 0º, the element would operate as a 32 Forward Power element, while if setting an RCA angle of 180º, the element would operate as a 32 Reverse Power element. For angles of 90º and 270º, the case would be similar but with reactive power.

Figures (a, b, c, d, e, f) below shows settings for different power applications.

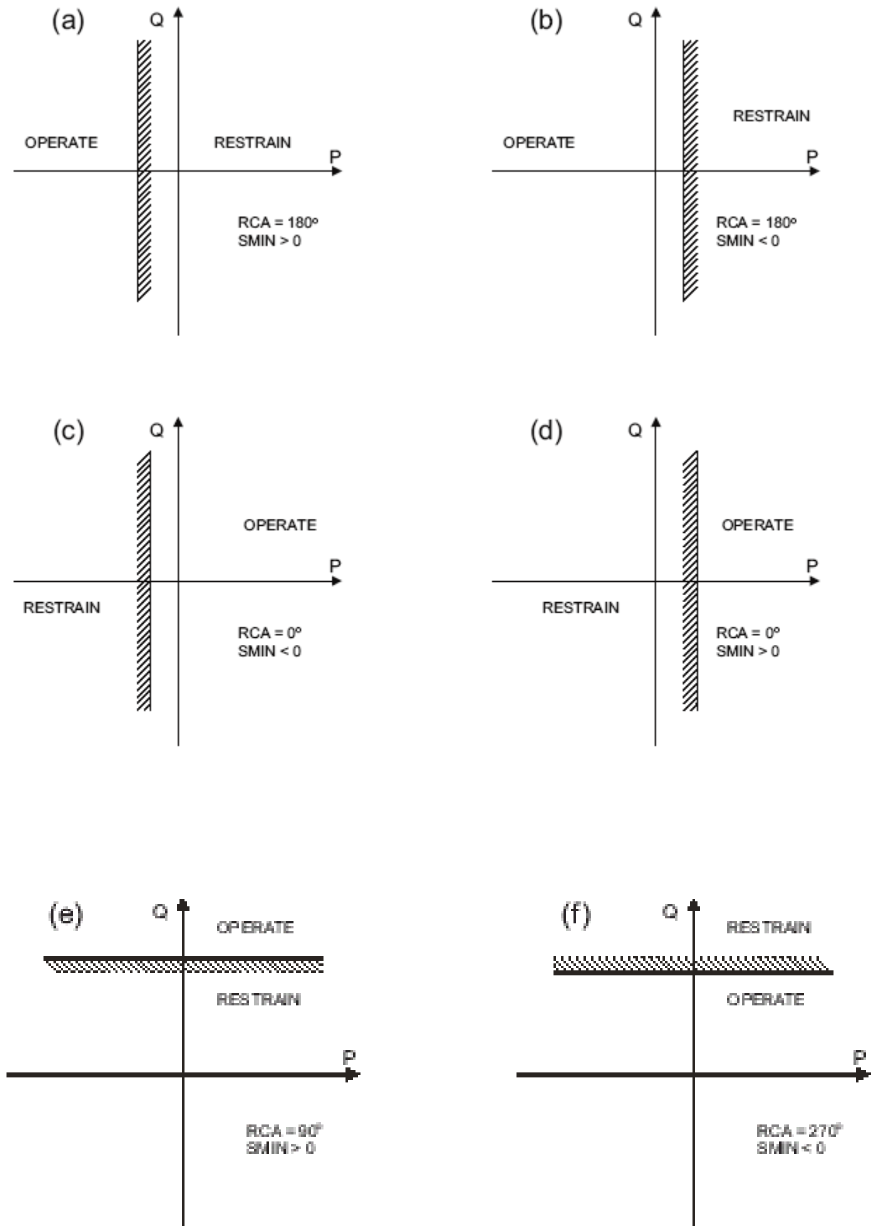

Figure 5–14: DIRECTIONAL POWER ELEMENT SAMPLE APPLICATIONS

By adding 90º to the angles shown on figures a, b, c and d, the represented elements would be similar but with ***Reactive Power*** instead of Active Power.

Any other angle would provide a mixed Protection Between Active and Reactive power.

A different angle selection for Stage 1 and Stage 2 could provide in a single element, a Reactive and Active power limitation. For example, using the following values:

Dir Power Angle 1(RCA)	0º
Stage 1 Tap	0
Dir Power Angle 2(RCA)	90º
Stage 2 Tap	0

We would obtain a mixed Protection Between figure (d) and figure (e).

b) SETTINGS

Table 5–74: 32 ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > POWER > DIRECTIONAL POWER> DIRECTIONAL POWER 1> DIRECTIONAL POWER 2 > DIRECTIONAL POWER 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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 (RCA1)	Dir Power Angle 1	0.00	1 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 (RCA2)	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]

The snapshot event setting enables or disables the snapshot event generation for this element.

Function: Enables or disables the directional element.

Blk Time After Close: In seconds. This settings allow to block the element 32 during the time specified in the setting after the breaker switches from OPEN to CLOSED.

Dir Power Angle (1-2) (RCA): This setting specifies the relay characteristic angle (RCA) for the directional power element. This setting provides ability to respond to the function in any direction defined (active forward power, active low forward power, etc.)

The following figure illustrates the conventions established:

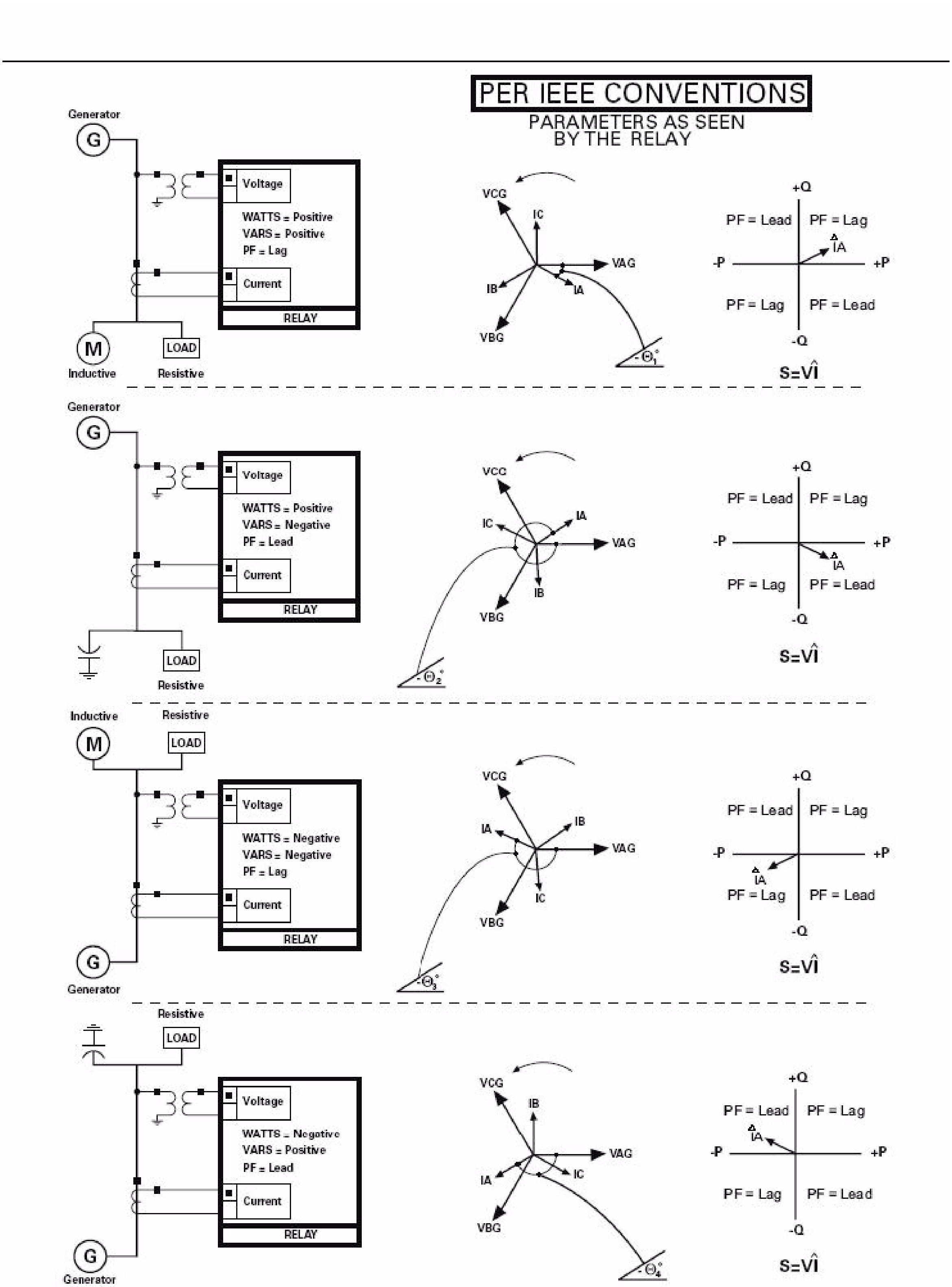

Figure 5–15: ANGLES

Stage (1 - 2) Tap: This setting specifies the minimum Operation three-phase power for the Stage 1 (2) element. The power value defined in this setting is the minimum distance between the source and the directional power characteristic. This value can be positive or negative. The value of this setting is defined in total MW (primary) – the CT and VT value is considered in the calculations.

> **NOTE**:
>
> Even if the element defined in this setting is MW, this does not necessarily mean that the resulting value and the RCA setting are in MW. For example:
>
> ***RCA**: 30 º* ***SMIN**: 100 MW.*
>
> If we assume that there is only active power. The element operation would be produced for a value of:
>
> P = 100 / cos (30) = 115,7 MW.
>
> If there was only reactive power:
>
> Q = 100/sin (30) = 200,0 MVar.
>
> (In this case the real Operation elements are Mvar, even if SMIN is expressed in MW.)

Stage 1 (2)Time: This setting specifies the delay for Stage 1 of the element. For reverse power or direct power applications, usually Stage 1 is used for alarm functions, while Stage 2 is used for tripping functions.

Snapshot Events: This setting enables or disables the generation of events. All states in this function are affected by this setting.

c) STATUSES

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Statuses defined for this Function are as follows:

DIR PWR1 (2, 3) BLOCK: Writing status, operates by level. When this status is activated externally (via PLC), the directional power element is blocked. This status affects both elements in the protection element (stage 1 and 2).

Activation of this status produces the event: **DIR PWR1 (2, 3) BLK ON.**

Deactivation produces the event : **DIR PWR1 (2, 3) BLK OFF.**

DIR PWR1 (2, 3) STG1 (2) OP: This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) OP ON

DIR PWR1 (2, 3) STG1 (2) OP OFF

DIR PWR1 (2, 3) STG1 (2) PKP: Activation of this status indicates that the power value has exceeded the threshold indicated by the Stage 1/2 element. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) PKP ON

DIR PWR1 (2, 3) STG1 (2) PKP OFF

DIR PWR1 (2, 3) STG PKP: This status is a logic OR between the DIR PWR STG1 PKP and DIR PWR STG2 PKP statuses. Activation of this status indicates that the power value has exceeded the threshold indicated by any of the Stage 1/2 elements. Events generated by this element are:

DIR PWR1 (2, 3) STG PKP ON

DIR PWR1 (2, 3) STG PKP OFF

DIR PWR1 (2, 3) STG OP: This status is a logic OR between the DIR PWR STG1 OP and DIR PWR STG2 OP statuses. This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG OP ON

DIR PWR1 (2, 3) STG OP OFF

5.4.10.2 POWER FACTOR LIMITING (55).(FOR ENHANCED MODELS ONLY)

This element allows the user to protect the machine against power factor values out of limits. The element has two stages which can be used as alarm or as trip.

Table 5–75: POWER FACTOR LIMITING ELEMENT SETTINGS

SETPOINT > PROTECTION ELEMENTS > POWER > PWR FACTOR LIMITING > PWR FACTOR LIMITING 1> PWR FACTOR LIMITING 2 > PWR FACTOR LIMITING 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level for PF Lead Stage1	PF Lead Stg1 Level	0.99	0.01	[0.05 : 0.99]
Pickup level for PF Lag Stage1	PF Lag Stg1 Level	0.80	0.01	[0.05 : 0.99]
Trip time for PF Stage1	PF Stg1 Trip Delay	1.0	0.1 s	[0.2 : 300.0]
Pickup level for PF Lead Stage2	PF Lead Stg2 Level	0.99	0.01	[0.05 : 0.99]
Pickup level for PF Lag Stage2	PF Lag Stg2 Level	0.75	0.01	[0.05 : 0.99]
Trip time for PF Stage2	PF Stg2 Trip Delay	1.0	0.1 s	[0.2 : 300.0]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

PF lag/Lead Stg level settings are cos φ values

- **Power Factor Function**: This setting allows enabling or disabling the Power Factor Limiting element.
- **PF Lead Stg # Level**: This setting defines the value of lead three-phase power factor to operate.
- **PF Lag Stg # Level**: This setting defines the value of lag three-phase power factor to operate.

5

Table 5–76: POWER FACTOR LIMITING INTERNAL SIGNALS

SIGNAL	COMMENT
POWER FACTOR 1 (2, 3) BLOCK	Input used to block the (1, 2, 3) element externally (configurable in "Setpoint>Relay Configuration>Protection Elements")
PF 1 (2, 3) LAG STG1 OP	Output used to indicate lagging power factor value above stage 1 setting
PF 1 (2, 3) LEAD STG1 OP	Output used to indicate leading power factor value above stage 1 setting
PF 1 (2, 3) LAG STG2 OP	Output used to indicate lagging power factor value above stage 2 setting
PF 1 (2, 3) LEAD STG2 OP	Output used to indicate leading power factor value above stage 2 setting
PF 1 (2, 3) LAG OP	Output used to indicate lagging power factor operation (stage 1 or stage 2)
PF 1 (2, 3) LEAD OP	Output used to indicate leading power factor operation (stage 1 or stage 2)

The G650 incorporates the following control elements:

Setting Group

Underfrequency

Overfrequency

Synchrocheck (25)

Breaker Failure (50BF) (enhanced models only)

VT Fuse Failure (enhanced models only)

Pulse Counters

Analog Comparators

Frequency Rate of Change (81 df/dt)

Phase Shift or Loss of Mains (78V) (enhanced models only)

Loss of Excitation (40)

Accidental Energization (50/27)

Note: for all control elements related to the breaker, it must be considered that all operations will be performed considering the status of the switchgear configured as breaker. In ***Setpoint > Relay Configuration > Switchgear*** up to 16 switchgear elements can be configured to operate and be monitored, but only one of them can be configured as a breaker, for monitoring, number of openings and closings counters, $(KI)^2t$.

5.5.1 SETTING GROUP

The settings used for setting table management are located in ***Setpoint > Control Elements > Setting Group***:

Table 5–77: SETTING GROUP SETTINGS

SETPOINT > CONTROL ELEMENTS > SETTING GROUP				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

The snapshot event setting enables or disables the snapshot event generation for this element.

For more detailed information go to section 5.4.1

5.5.2 UNDERFREQUENCY ELEMENT (81U)

Setpoint >Control Elements > Underfrequency

The steady-state frequency of a power system is a certain indicator of the existing balance between the generated power and the load. Whenever this balance is disrupted through the loss of an important generating unit, the effect will be a reduction in frequency. A reliable method to quickly restore the balance between load and generation is to automatically disconnect the selected loads, based on the actual system frequency. This technique called “load-shedding” maintains system integrity and minimizes widespread outages.

The 81U element is an underfrequency control element. The pickup setting can be selected from 20.00 to 65.00 Hz. The element reset time delayed is selectable between 0.00 and 900 seconds, and for the element to operate it is necessary that the voltage value is over the value set for minimum voltage threshold. This way undesired trips are prevented when the signal for metering the frequency is not available or has a very low value.

Table 5–78: 81U ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > UNDERFREQUENCY UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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 : 500]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

5

The snapshot event setting enables or disables the snapshot event generation for this element.

Frequency elements operate with the system frequency, this frequency is measured in the voltage channel set for the frequency reference, in the ***Frequency Reference*** setting inside ***Setpoint > System Setup >General Settings.***

5.5.3 OVERFREQUENCY ELEMENT (81O)

Setpoint >Control Elements > Overfrequency

81O is an overfrequency protection element. The pickup setting can be selected from 20.00 to 65.00 Hz, with a time delay selectable between 0 and 900 seconds. The element-reset delay is from 0.00 to 900.00 seconds.

Table 5–79: 81O ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > OVERFREQUENCY OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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 : 500]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.5.4 SYNCHRONISM CHECK ELEMENT - SYNCHROCHECK (25)

Note: The Switchgear element used in the G650 synchronism element is the one configured in the ***Number of Switchgear*** setting inside ***Breaker settings***, at "***Setpoint > System Setup > Breaker > Breaker Settings***".

WARNING

When testing this function do not forget that the relay must detect an open breaker to operate.

The synchronism element is used for monitoring the connection of two parts of the circuit by the close of a breaker. This element verifies that voltages (V1 and V2) at both sides of the breaker are within the magnitude, angle and frequency limits set by the user. V1 and V2 are the line and busbar voltage values measured by the relay.

Synchronism check (25) is defined as the comparison of the voltage difference of two circuits with different sources to be either linked through an impedance element (transmission line, feeder, etc.), or connected through parallel circuits of defined impedance (Figure 5–16:) The voltage comparison between both sides of a breaker is performed before closing the breaker, in order to minimize internal damage that could occur due to the voltage difference, both in magnitude and angle. This is extremely important in steam generating plants, where reclosing output lines with angle differences could lead to severe damage to the turbine axis.

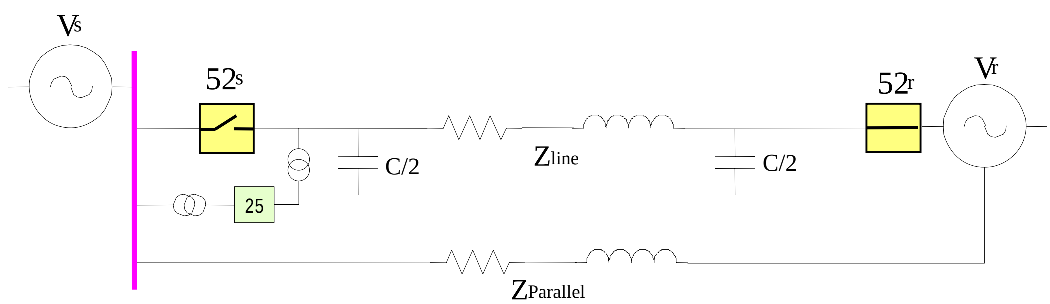

Figure 5–16: SYNCHRONISM CHECK ELEMENT

The difference in voltage level and phase angle in a given moment is the result of the existing load between remote sources connected through parallel circuits (load flux), as well as a consequence of the impedance of those elements connecting them (even if there is no load flux in parallel circuits, or because sources to be connected are completely independent and isolated from one another).

In interconnected systems, the angle difference between both ends of an open breaker is usually negligible, as its sources are remotely connected through other elements (equivalent or parallel circuits). However, in isolated circuits as in the case of an independent generator, the difference in angle, voltage levels and relative slip of voltage phasors can be very important. It may happen that the relative slip of voltage values is very low or null so that they will rarely be in phase. Luckily, due to the changing conditions of a power system (connection-disconnection of loads, sources, and new inductive-capacitive elements) the relative slip between phasors is not null and they can be synchronized.

In the first case, even if we must take into consideration the length of the line whose ends (sources) will be connected for determining the angle difference between them, this is not enough to fix the synchronism conditions before closing the breaker. Experience tells us that the window of angle difference between voltage phasors must be fixed to a value of 15º-20º.

5.5.4.1 VOLTAGE INPUTS

In order to perform the synchronism check function, the G650 uses only one voltage from each end of the breaker. Voltage values to be compared must be on the same basis, either phase-to-phase or phase-to-ground voltage; they must be the same at both ends of the breaker; it is not possible to compare a phase-to-ground voltage at one end with a phase-to-phase voltage at the other end.

Additionally, if on one end, three voltages have been connected, the necessary voltage on the other end for Function 25 will only be single-phase voltage. If there is only one voltage (either phase-to-phase or phase-to-ground) at both ends of the breaker, this must be from the same phase in both cases.

The selection of voltage values to be used by the synchronism element is made in the relay General settings:

V1 is the line voltage, selectable from the relay voltage channels, using the "***Frequency Reference***" setting at ***Setpoint > System Setup > General settings > Frequency Reference***. (Please refer to the voltage correspondence Table 5–80:)

V2 is the busbar voltage measured at the auxiliary voltage input (terminals A11-A12). To enable the busbar voltage metering in the relay, it is required to select VX in the ***Auxiliary Voltage*** setting at ***Setpoint > System Setup > General settings > Auxiliary Voltage***.

The voltage correspondence is detailed in the following table:

Table 5–80: VOLTAGE CORRESPONDENCE ELEMENT 25

	VOLTAGE CORRESPONDENCE		
Setpoint>System Setup>General settings>Frequency Reference Voltage selection for element 25 of G650	V_I	V_{II}	V_{III}
Setpoint>System Setup>General settings>Phase VT Connection=WYE Phase-to-ground voltage connection.(Wye connection**)**	V_{a-g}	V_{b-g}	V_{c-g}
Setpoint>*System Setup>General settings>Phase VT Connection=DELTA* Phase-to-phase voltage connection.(Delta connection).	V_{a-b}	V_{b-c}	V_{c-a}
Setpoint>System Setup>General settings> Auxiliary Voltage=Vx	V_x		

Setpoint > System Setup > General settings > Auxiliary Voltage setting must be set to Vx, in order to monitor auxiliary voltage instead of Vn (neutral voltage, coming from an open delta connection).

5.5.4.2 APPLICATION

Even if the application range of the G650 is quite wide and the element can be used in distribution lines at any voltage level, it must be taken into account that it is a **three-pole tripping** relay, designed for managing a **single breaker**. This is why G650 is not suitable for one and a half breaker configurations, or ring configurations where a transmission line or feeder has two breakers.

5.5.4.3 SETTINGS

Setpoint > Control Elements > Synchrocheck

There is only one synchrocheck element in the G650.

Table 5–81: 25 ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > SYNCHROCHECK				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 500.00]
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 500.00]
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 500.00]
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 500.00]
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 500.00]
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]

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Settings description for element 25:

Function permission (Function): This setting allows enabling and disabling the synchrocheck element.

Voltage Level determination settings for busbar and line:

This setting group allows determining the voltage levels considered as dead and live for line and busbar voltage.

Dead Bus voltage level (Dead Bus Level): Voltage level considered as dead bus

Live Bus voltage level (Live Bus Level): Voltage level considered as live bus

Dead Line voltage level (Dead Line Level): Voltage level considered as dead line

Live Line voltage level (Live Line Level): Voltage level considered as live line

Synchrocheck settings (live bus, live line):

G650 relays verify synchronism by establishing and comparing three basic parameters: the difference in module and angle of voltage phasors, and the frequency slip of a phasor related to the other one. synchrocheck settings include a fourth time setting, that allows using an anticipative algorithm to issue a closing signal.

Voltage Difference (Max Volt Difference): Maximum Difference in module between the line and busbar voltage to allow a closing in the synchrocheck element.

Angle Difference (Max Angle Difference): Maximum Difference in angle between the line and busbar voltage to allow a closing in the synchrocheck element.

Frequency Slip (Max Freq Difference): Maximum difference in frequency (slip) between both voltage values to be compared in the synchrocheck element.

Breaker Closing time (Time): Estimated breaker Closing time, used for establishing the Closing order in a moment that allows the busbar and line voltages to be in phase.

This time is considered if the relative slip is higher than 5 mHz; in this case, an anticipative algorithm is executed to calculate the closing signal with the necessary advance for the breaker effective Closing to be produced when voltages are in phase. In case the frequency slip is high (higher than 5 Hz) and it is not possible to obtain a closing in phase, the used algorithm ensures that the voltage difference in the moment of the closing is lower than the set voltage (Max Voltage Difference).

Note: Take into account that the value of related settings **"Frequency Slip (Max Freq Difference)" multiplied by "Breaker Closing time (Time)"** must no be higher than 1. If that value is higher, that means that is necessary more than one cycle to perform a close signal. In that case the relay will give the close signal only in the remain time. This function depend on the voltage difference, the angle difference, the frequency difference and the synchronism time to perform a close signal:

Angle = 360 x Time x Max Freq Difference < 360º and Time x Max Freq Difference < 1

Closing permission logic settings:

In case that the voltage at one or both ends of the breaker is null, the synchronism element cannot establish the necessary parameters to give closing conditions, and therefore it does not issue synchronism permission. For those situations where the user wants to enable the closing permission in a condition of loss of one or both voltages at both ends of the breaker, G650 elements incorporate closing permission logics for the cases of: dead line-dead bus, live line-dead bus and dead line-live bus.

Dead line- Dead Bus Function permission (DL-DB Function): Enabling this Function allows issuing a Closing permission signal in dead line and dead bus Condition (without voltage at both sides of the breaker).

Live line- Dead Bus Function permission (LL-DB Function): Enabling this Function allows to issue a Closing permission signal in live line and dead bus Condition (without voltage at the sides of the breaker that corresponds to the busbar voltage)

Dead line- Live Bus Function permission (DL-LB Function): Enabling this Function allows issuing a Closing permission signal in live line and dead bus Condition (without voltage at the sides of the breaker that corresponds to the line voltage).

Snapshot event: The snapshot event setting enables or disables the snapshot event generation for this element.

5.5.4.4 SYNCHROCHECK STATES

Internal signals provided by the G650 (***Actual> Status > Control Elements > Synchrocheck***) for the synchronism element are as follows:

Table 5–82: SYNCHROCHECK INTERNAL STATES

SYNCHROCHECK ACTUAL VALUES
SYNCROCHECK BLK INP
SYNCROCHECK OP
SYNCHK CLOSE PERM
SYNCROCHECK COND OP
DL-DB OPERATION
DL-LB OPERATION
LL-DB OPERATION
SLIP CONDITION
BUS FREQ > LINE FREQ
BUS FREQ < LINE FREQ
VOLTAGE DIFFERENCE
FREQUENCY DIFFERENCE

SYNCROCHECK BLK INP: Block signal for the synchrocheck element, configurable at ***Setpoint > Relay Configuration > Protection Elements***

SYNCROCHECK OP: Closing permission signal in live line-live bus conditions with open breaker.

SYNCHK CLOSE PERM: General Closing permission of the Synchronism element. It contemplates all possible situations, live line-live bus conditions, and the closing permission logics (dead line-dead bus, live line- dead bus, dead line-live bus). **Note**: in case the Function is disabled, the Closing permission signal will be activated in order not to interfere with possible logics where it is included. If the synchronism element is enabled, this signal will only be activated in the closing conditions established by setting.

SYNCROCHECK COND OP: Closing permission according to permission logics (DL-DB, LL-DB, DL-LB).

DL-DB OPERATION: Closing permission in dead line – dead bus condition.

DL-LB OPERATION: Closing permission in dead line – live bus condition.

LL-DB OPERATION: Closing permission in live line – dead bus condition.

SLIP CONDITION: Internal signal indicating frequency slip between the line voltage and bus voltage phasors.

BUS FREQ > LINE FREQ: Busbar Frequency higher than line frequency

BUS FREQ < LINE FREQ: Busbar Frequency lower than line frequency

VOLTAGE DIFFERENCE: Voltage difference in Volts between line and busbar

FREQ. DIFFERENCE: Frequency difference in Hz between line and busbar

Voltage and frequency values for the line and busbar can be obtained, both in primary and secondary values at:

Actual> Metering > Primary Values > Voltage

- **VBB Primary (KV)** Busbar voltage in primary values
- **VL Primary (KV)** Line voltage in primary values

Actual> Metering > Secondary Values > Voltage

- **Line Voltage (V)** Line voltage in secondary values
- **Bus Voltage (V)** Busbar voltage in secondary values

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Actual> Metering > Frequency

Line Frequency (Hz) Line frequency in Hz

Bus Frequency (Hz) Bus frequency in Hz

The voltage angles can be obtained in primary metering values *(Actual> Metering > Primary Values > Voltage)*, being the line voltage angle, the one that corresponds to the voltage set in the frequency reference in General settings (please refer to the voltage correspondence table (Table 5–80:), and the angle of the busbar voltage the one that corresponds to Vx Angle, when the Auxiliary Voltage setting as been selected as VX.

5.5.4.5 ALGORITHM

G650 elements perform the synchronism check by basically establishing and comparing three parameters:

Module difference of voltage phasors ΔV (V)

Phase angle of voltage phasors $\Delta\varphi$ (º)

Frequency slip between two phasors S (Hz)

These parameters are continuously determined and managed once that element 25 has been enabled by setting, and in open breaker conditions. It is necessary to consider that all calculations are made once the open breaker condition is detected; if the breaker is closed or undefined, the synchronism element will not issue a closing permission signal, even when closing conditions are met.

If voltage on one side of the breaker to be closed is null, the synchronism element cannot establish the synchronism check, and therefore it will not issue synchronism permission. For these cases, usual in breaker maintenance situations, or in new installations where voltage might not be present, but the breaker operation needs to be verified, G650 elements incorporate closing permission logics for situations of:

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Dead Line – Dead Bus (DL-DB)

Live Line – Dead Bus (LL-DB)

Dead Line – Live Bus (DL-LB)

In order to establish the closing permission signal, the first parameter used by the algorithm is the difference in magnitude between line and bus voltages, and afterwards, the angle difference and frequency slip are verified.

Voltage Difference ΔV

Comparing the voltage values for line voltage (V1) and busbar voltage (V2) at both sides of the breaker, the relay can determine the synchronism situation of the element (see Table 5–83:).

Being:

V_1 line voltage

V_2 bus voltage

V_L Minimum acceptable voltage by setting to establish synchronism conditions (dead line and bus levels).

V_H Appropriate voltage to establish synchronism conditions, configured by setting (live line and bus levels).

Table 5–83: SYNCHRONISM CONDITIONS

SYNCHRONISM SITUATION	SYNCHRONISM CHECK	CLOSING LOGIC	LINE VOLTAGE LEVELS	BUSBAR VOLTAGE LEVELS
(1) $V_L < (V_1 \& V_2) < V_H$	Not permitted	Not permitted	V1 > dead line level V1 < live line level	V2 > dead bus level V2 < live bus level
(2) $(V_1 \& V_2) > V_H$	Permitted	Live Line – Live Bus	V1 > live line level	V2 > live bus level
(3) $(V_1 \& V_2) < V_L$	Not permitted	Dead Line – Dead Bus	V1 < dead line level	V2 < dead bus level
(4) $(V_1 < V_L) \& (V_L < V_2 < V_H)$	Not permitted	Not permitted	V1 < dead line level	V2 > dead bus level V2 < live bus level
(5) $(V_2 < V_L) \& (V_L < V_1 < V_H)$	Not permitted	Not permitted	V1 > dead line level V1 < live line level	V2 < dead bus level
(6) $(V_1 < V_L) \& (V_2 > V_H)$	Not permitted	Dead Line – Live Bus	V1 < dead line level	V2 > live bus level
(7) $(V_2 < V_L) \& (V_1 > V_H)$	Not permitted	Live Line – Dead Bus	V1 > live line level	V2 < dead bus level

Table 5–83: shows the different synchrocheck and closing logic situations, that can be produced depending on the line and busbar voltage levels.

Live Line – Live Bus (Synchronism check): Only in case number (2), with live line and live bus, the element will start evaluating the line and busbar voltage comparison with respect to the setting $\Delta\mathbf{V}_{set}$ established by setting (Max Volt Difference). In this case, if the voltage difference is lower than $\Delta\mathbf{V}_{set}$, the synchronism check element (25) will verify the angle difference $\Delta\varphi$ adjusted by setting (Max Angle Difference).

Dead Line – Dead Bus (DL - DB): Case number (3) will not allow the synchronism function, but it will allow DL-DB operation logic, if this logic is enabled by setting (DL-DB Function).

Dead Line – Live Bus (DL - LB): Case number (6) will not allow the synchronism function, but it will allow DL-LB Operation logic, if this logic is enabled by setting (DL-LB Function)

Live Line – Dead Bus (LL - DB): Case number (7) will not allow the synchronism function, but it will allow LL-DB operation logic, if this logic is enabled by setting (LL-DB Function)

Case numbers (1), (4) and (5) are not considered neither for synchronism check purposes, nor for closing logic.

Phase Angle Difference $\Delta\varphi$

In the live line-live bus Condition, once the voltage difference has been successfully verified in magnitude, the system establishes the angle difference between both voltage phasors. If the angle difference is lower than the $\Delta\varphi_{set}$ (Max Angle Difference) setting, then the system will verify the frequency slip **S** (Max Freq Difference).

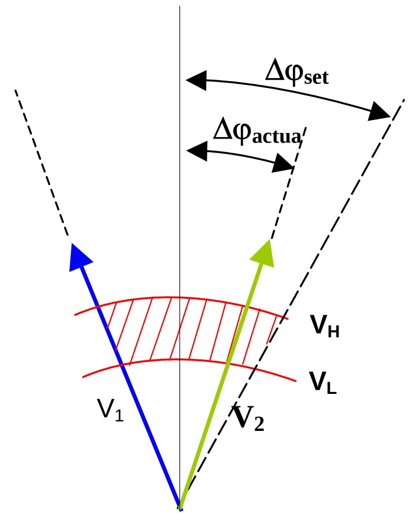

Figure 5–17: VOLTAGE ANGLE DIFFERENCE

Frequency slip Δf

The relative frequency slip between phasors is calculated if the angle difference is lower than the $\Delta\varphi_{set}$ (Max Freq Difference) setting. From the information obtained from the relay, the algorithm will know the slip (mHz) of both phasors, and it will take as reference (V_{Ref}) the lowest frequency phasor.

If the relative slip is higher than 5 mHz, the element performs an anticipative algorithm, determining the right moment to give the closing command to the breaker, so that the breaker closes when the line and busbar voltages are in phase. If the slip is higher than 5 Hz, as an in phase close is not possible, the algorithm ensures that the difference between voltages in the real closing moment is not higher than the set value (Max Volt Difference). If the relative slip, Δf, is equal or lower than 0.005 Hz, the algorithm gives permission to close as soon as the angle difference conditions are met, because at such a low speed, the hold time for getting an “in-phase” closing permission would be too long.

When the difference between voltage values equals “two times” the set angle as maximum angle difference ($\Delta\mathbf{V} = \Delta\mathbf{V}_{set}$), the anticipative algorithm starts running and uses the set breaker closing time to establish the initiation of permission, so that it is executed in the moment when both voltage phasors are completely in phase, thus minimizing the voltage difference in the breaker chamber to negligible values.

The main benefit is that after a considerable number of breaker operations, damage to internal connection elements, as well as to the chamber isolating element is drastically reduced, ensuring a longer life for the breaker, and reducing costly maintenance operations.

The Closing process using anticipative algorithm is described on the following figure:

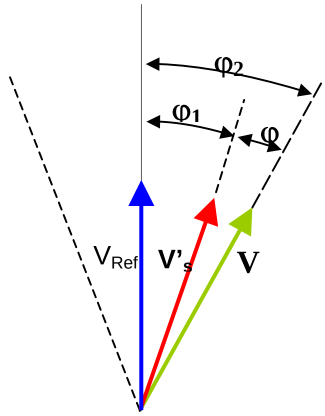

Figure 5–18: ANTICIPATIVE ALGORITHM

Where:

$\mathbf{V_{ref}}$	Referenced phasor (the one with lower frequency)
$\mathbf{V_s}$	Actual voltage phasor (the one with lower frequency)
$\mathbf{V'_s}$	Calculated voltage phasor, depending on the set breaker closing time (anticipative algorithm)
φ	360º *TCB *Δf = Calculated angle for phasor V'_s
TCB	Breaker Closing time defined by setting
Δf	Frequency slip (mHz) between phasors
φ_1	Angle difference set as maximum angle difference ($\Delta\varphi_{set}$, Max Angle Difference)
φ_2 =	Angle difference between V_{ref} and V_s. The algorithm starts operating when φ_2 equals two times the angle set as maximum angle difference.

Closing permission is given when $\mathbf{V'_s}$ is over $\mathbf{V_{ref}}$, which means that line and busbar voltages are in phase.

If the frequency slip is high, it is possible that as soon as the window defined by two times the maximum angle difference (φ_2) is entered, the relay will produce a closing permission output, if it is guaranteed that the projected phasor will be within the limit marked by the setting, as shown in the following figure.

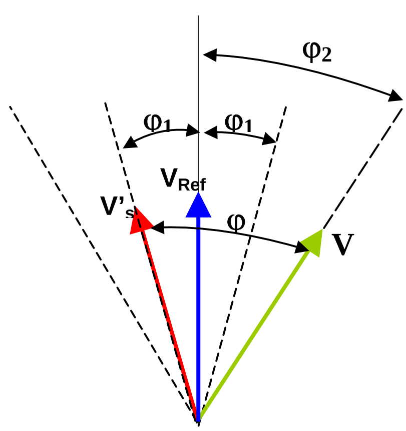

Figure 5–19: HIGH SLIP CLOSING PERMISSION SIGNAL

5.5.5 BREAKER FAILURE ELEMENT (50BF) (ENHANCED MODELS ONLY)

Note: The Switchgear element used in the **Breaker Failure** element is the one configured in the **Number of Switchgear** setting, inside **Breaker settings** at ***Setpoint > Protection Elements > Breaker > Breaker settings***

The breaker failure element is used to determine when a trip command sent to a breaker has not been executed within a selectable delay. Most commonly it is a failure to open from the tripped breaker. In the event of a breaker failure, the 50BF element must issue a signal that will trip the rest of breakers connected at that time to the same busbar, and that can provide fault current.

Comparing the current measured by the Relay with a setting level makes breaker failure detection. If after receiving a breaker initiate signal, the current level is maintained over the set level for a time period longer than the set time, this indicates that the breaker that has received the opening command has not been able to open and clear the fault. The relay would issue the corresponding breaker failure signal.

G650 elements incorporate 2 levels of current and time, together with a trip without current element, and an internal arc detection element.

The breaker failure Initiate signal is configured at ***Setpoint > Relay Configuration > Protection Elements***. In the BRK FAILURE INITIATE input, the user must select the desired signal for the breaker failure initiation.

The following table describes the breaker failure element settings: ***Setpoint > Control Elements > Breaker Failure***

Table 5–84: 50BF ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > BREAKER FAILURE				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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]

Settings description for breaker failure element:

Function permission (Function): This setting allows enabling and disabling the 50BF element

Supervision or retrip pickup level (Supervision Pickup): Supervision level pickup current threshold

Hiset pickup level (Hiset Pickup): High-level pickup current threshold.

Lowset pickup level (Loset Pickup): Low level pickup current threshold.

Internal arc pickup level (Internal Arc Pickup): Internal arc element pickup current threshold.

Internal arc time delay (Internal Arc Delay): Time delay applied to the internal arc element

Supervision or Retrip time delay (Supervision Delay): Time delay applied to the supervision or retrip element.

High-level time delay (Hiset Delay): Time delay applied to the high level element.

Low-level time delay (Lowset Delay): Time delay applied to the low level element.

2nd step time delay (2nd Step Delay): Time delay applied to the breaker failure second step.

No current element time delay (No Current Delay): Time delay applied to the trip without current element.

Signals relative to breaker failure provided by the relay can be viewed at ***Actual> Status > Control Elements > Breaker Failure***, and they are as follows:

Table 5–85: BREAKER FAILURE STATUS

BREAKER FAILURE STATUS
BKR FAIL INITIATE
BKR FAIL NO CURRENT
BKR FAIL SUPERVISION
BKR FAIL HISET
BKR FAIL LOWSET
INTERNAL ARC
BKR FAIL 2nd STEP

BKR FAIL INITIATE External signal for breaker failure initiation. (Configurable at ***settings> Relay Configuration > Protection Elements***).

BKR FAIL NO CURRENT Signal for breaker failure without current

BKR FAIL SUPERVISION Signal for supervision level breaker failure (retrip)

BKR FAIL HISET Signal for high-level breaker failure

BKR FAIL LOWSET Signal for low-level breaker failure

INTERNAL ARC Signal for internal arc

BKR FAIL 2nd STEP Signal for Second level breaker failure (high and low)

The following figure shows the logic scheme for the breaker failure element:

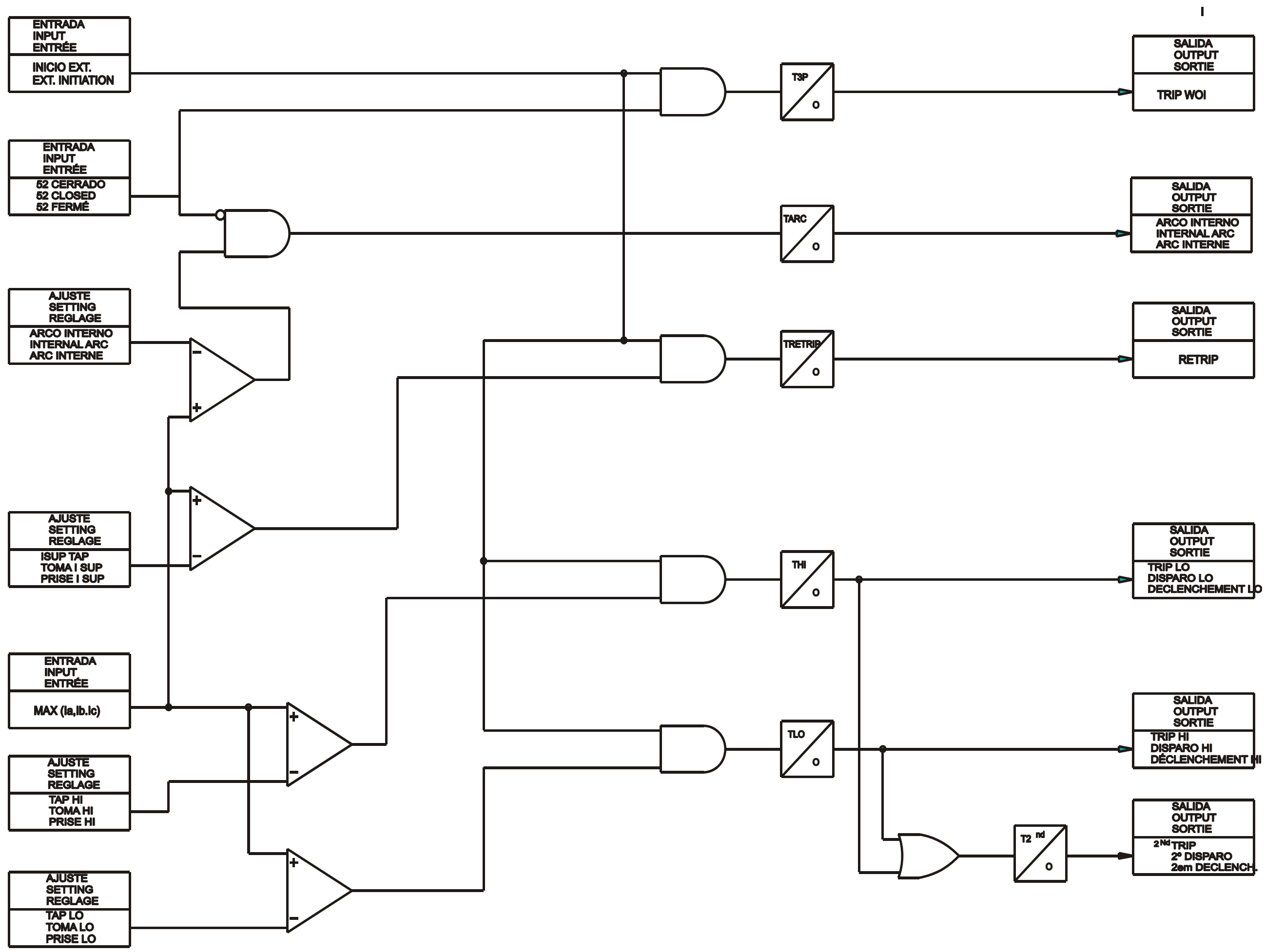

Figure 5–20: LOGIC SCHEME FOR 50BF

The breaker failure element has three levels. The first one is called “Retrip” or “Supervision”. This operation level can be used to give a signal to the breaker on which the initial opening has been executed. This is sometimes a usual practice; 50 milliseconds after the trip signal, a retrip signal is sent to the breaker.

Besides the supervision or retrip level, there are two additional levels, known as “Hiset” and “Lowset”. These two levels, together with their time delays, allow executing complex protection schemes. Additionally to these two supervision levels, there is a second time stage called “second step”.

Operation of breaker failure elements by level (supervision, hi set and lo set) is produced when the current level is higher than the set current for the pickup of each level during the time set in the corresponding delay setting.

High and low levels constitute a second step level; for the pickup of this second level, only the pickup of any of the two levels (hiset and loset) is required. For the element pickup to dropout it is required that the current is under the pickup levels of both hiset and loset settings. Once the second level time delay has expired, a “Second Step” trip signal will be issued.

50BF element incorporates also a no current tripping element, and an internal arc element. The no-current trip element is governed only by the status of the breaker auxiliary contact; once the external breaker failure initiation signal is received, if the breaker status does not change to open during the set time in the element (No Current Delay), the corresponding breaker failure signal is issued (BKR FAIL NO CURRENT),

The internal arc element inside the breaker failure element is independent from the external breaker failure signal; this element is used to detect arcing produced with an open breaker; if a higher current that the set level is detected during a period that is longer than the set delay for the element (Internal Arc Delay), and the breaker is open, the corresponding internal arc signal will be issued (INTERNAL ARC).

5.5.6 VT FUSE FAILURE ELEMENT (VTFF) (ENHANCED MODELS ONLY)

Note: The Switchgear element used in the **VT Fuse Failure** element is the one configured in the **Number of Switchgear** setting, inside **Breaker settings** at ***Setpoint > Protection Elements > Breaker > Breaker settings*.** This switchgear must have previously been configured at ***Setpoint > Relay Configuration > Switchgear***

The fuse failure detector is used to block protection elements that can operate incorrectly due to a partial or total voltage loss. This loss can be caused by the voltage transformers secondary circuit protection fuse failure.

Setpoint > Control Elements > VT Fuse Failure

Table 5–86: VT FUSE FAILURE ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > VT FUSE FAILURE				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The fuse failure element has only two settings, one to enable or disable the element and the other to enable or disable the snapshot event generation.

The fuse failure signal provided by the element (VT FUSE FAILURE) can be monitored at ***Actual> Status > Control Elements >VT Fuse Failure***

5.5.6.1 FUSE FAILURE ALGORITHM

To detect different types of fuses failures, it is necessary to use different detection methods. In example, a fuse failure indication with loss of one or two voltage phases provides a significant level of negative sequence voltage, instead of a loss of all voltage phases which will cause a very low positive sequence voltage, but any negative sequence voltage.

G650 elements detect fuse failure under three possible situations:

(1)Breaker closed and positive sequence voltage (V1) under an established value (V1<0.5 p.u.).

(2)Positive sequence voltage lower than 0.5 p.u (V1<0.5 p.u.) and positive sequence current higher than 0.075 p.u. (I1>0.075 p.u.).

(3)Ratio between the negative and positive voltage components (V2/V1) higher than 0.25 and the ratio between the negative and positive sequence components for current (I2/I1) lower than 0.20.

With the activation of any of the three previous signals during a period longer than 80 ms, the fuse failure signal (VT FUSE FAILURE) is activated. Once this signal is activated, it is latched until whatever caused it disappears; for this purpose the following condition must be met:

(4)Positive sequence voltage higher than 0.75 p.u and positive sequence current lower than 0.05 p.u.

The fuse failure signal can be used to issue an alarm and/or to block elements that may operate incorrectly due to a partial or total loss of voltage. Protection elements that are usually blocked by the fuse failure signal are voltage restraint overcurrent elements, and directional elements. To configure the block of these elements it is necessary to enter the ***Setpoint > Relay Configuration > Protection Elements***” menu and select as block input for protection elements, the fuse failure operation signal.

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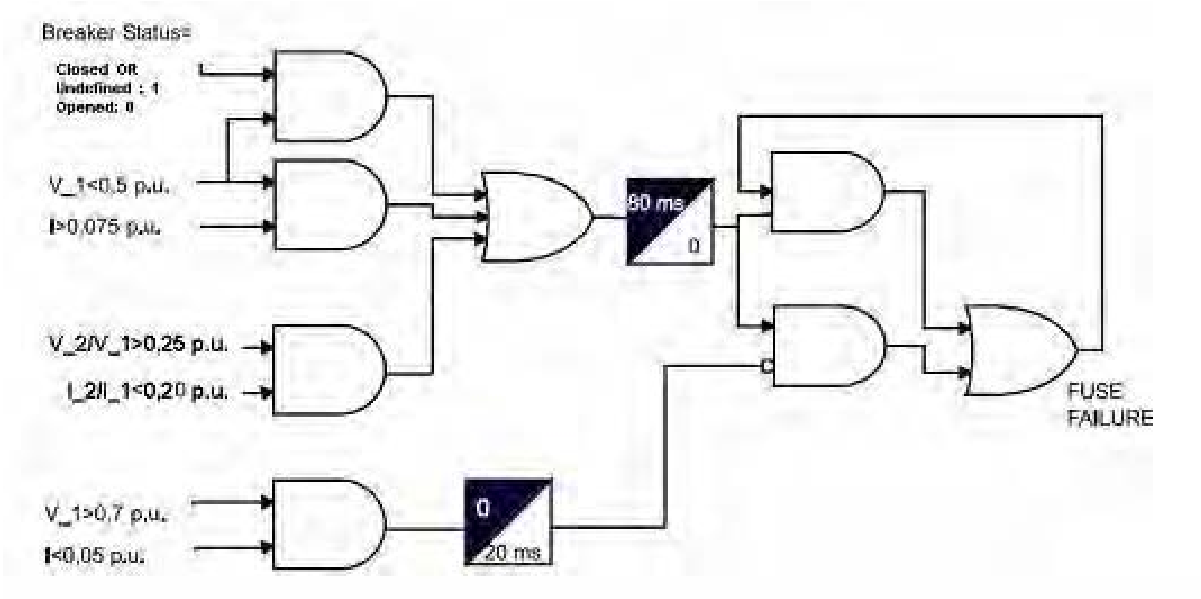

Figure 5–21: FUSE FAILURE ELEMENT BLOCK DIAGRAM

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5.5.7 PULSE COUNTERS

The G650 includes eight pulse counters, each pulse counter stores the activation number of the input set to that pulse counter. This value can be multiplied for a factor selectable by setting.

The inputs used in this pulse counter function can be selected from all the available in the G650 device. Take into account that the input/output settings are both set for the generic input as well as for the pulse counter input, e.g. Debounce time.

The settings for this function can be found at ***Setpoint > Control Elements > Pulse Counters***

Table 5–87: PULSE COUNTERS SETTINGS

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the pulse counter	CntPulses Name X	Pulse Counter X	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.				

Pulse Counters settings are:

CntPulses Enabled: Enable/disable each pulse counter.

CntPulses Name: Each pulse counter can have a configurable user name.

CntPulses Factor: This is the factor multiplier applied to the input activations number stored in the pulse counter, providing possibilities to adjust the obtained value to any scale. It the "CntPulses Factor X" is set to zero it will take no effect.

CntPulses Overflow: It is the maximum value set as result of the CntPulses Factor plus the number of inputs activation. This means that after reaching that value, the pulse counter value will start counting from zero.

CntPulses Board Origin: Board selection for the pulse counter input.

CntPulses Input Origin: Index of the input select in the board origin.

The signals related to the 8 pulse counters can be viewed at ***Actual> Status > Control Elements > Pulse Counters*** and they are as follows:

Table 5–88: PULSE COUNTERS STATUS

PULSE COUNTERS STATUS
CntPulses Value 1
CntPulses Value 2
CntPulses Value 3
CntPulses Value 4
CntPulses Value 5
CntPulses Value 6
CntPulses Value 7
CntPulses Value 8
CntPulses Freeze 1
CntPulses Freeze 2
CntPulses Freeze 3
CntPulses Freeze 4
CntPulses Freeze 5
CntPulses Freeze 6
CntPulses Freeze 7
CntPulses Freeze 8

The G650 includes eight different pulse counters in which the value shown is the result of the number of activation of the input configured for that counter multiplied plus the CntPulses Factor set for that pulse. For each pulse counter there are two magnitudes available, the actual value and the frozen value. The G650 includes eight different pulse counters in which the value shown is the result of the number of activation of the input configured for that counter multiplied plus the CntPulses Factor set for that pulse. For each pulse counter there are two magnitudes available, the actual value and the frozen value.

The freeze and unfreeze and reset operations are similar to the energy management, the signals used for that purpose are the same for both energy and pulse counters.

By default, all the values are unfreeze, updating the values in a continuous mode. After a freeze operation the freeze value stops updating and the actual value is being updated. If a freeze operation is set again, the actual value will be copied to the freeze one, which will remain frozen again.

To unfreeze all the values it is necessary to perform an unfreeze operation.

If a reset operation is set, all the values, actual and frozen ones will go to zero.

All the operations (freeze, unfreeze and reset) are performed over all the energy counters (both energy and pulse counters). It is not possible to set them to a particular counter.

5.5.8 ANALOG COMPARATORS

The G650 provides 20 different analog comparators in an analog comparator module located in the control elements part of the device. Each analog comparator gives indication when the analog variable selected is inside or outside some minimum and maximum threshold values.

The settings can be selected at ***Setpoint > Control Elements > Analog Comparators***

Table 5–89: ANALOG COMPARATORS SETTINGS

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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				

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The analog comparator settings includes two global settings such as

Analog Function: This setting allows enabling or disabling the analog comparators module. Each analog comparator can not be enabled/disabled individually.

Analog Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

Besides the main settings there are some settings for each analog comparator (up to 20) as follows:

Analog Input: Analog value selected by the user from the available analog variables in the device. This will be used to make the comparison inside a set band for that magnitude.

Analog Maximum: Maximum threshold value for the comparison band.

Analog Minimum: Minimum threshold value for the comparison band.

Analog Delay: Time value for the analog signal to be active inside the comparison band before setting the Analog Level signal to 1.

Analog Hysteresis: It establishes the deadband at each extreme. For the maximum value is the maximum minus the hysteresis value (in %) and for the minimum value is the minimum value plus the hysteresis value (in %).

Analog Direction: Analog direction for the activation signal to be set Inside or Outside the Deadband.

OUT:The "Analog Level X" will give an activation signal when the analog value is located outside the comparison band.

IN:The "Analog Level X" will give an activation signal when the analog value is located inside the comparison band.

The G650 provides 20 different analog comparators. Their status values can be viewed at ***Actual> Status > Control Elements > Analog Comparators:***

Table 5–90: ANALOG COMPARATOR STATUS

ANALOG COMPARATORS STATUS
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17
Analog Level 18
Analog Level 19
Analog Level 20

The analog level value is by default in a reset state, when the value meets the comparison (inside or outside the comparison band) the "Analog Level X" signal will be activated if the analog value remains active the time set in the analog delay setting. When the activation conditions are not met the "Analog Level X" value will go to the reset state.

An analog change must remain active at least 40 ms to be considered, plus the analog time setting. Besides the snapshot event data will have a 20 ms accuracy.

5.5.9 FREQUENCY RATE OF CHANGE

G650 uses a defined signal as frequency reference. This signal is analyzed by DSP and time between two consecutive zero-crossing is measured. Reference signal is set in ***Setpoint > System Setup > General Settings > Frequency Reference***.

The settings can be selected at ***Setpoint > Control Elements > Frequency rate of change***

Table 5–91: FREQUENCY RATE OF CHANGE SETTINGS

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
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]

Frequency rate of change settings are:

Rate of Change Function: This setting allows enabling or disabling the frequency rate of change element.

Freq rate trend: This setting allows to configure the element in order to answer to increasing, decreasing or both directions frequency changes.

Freq. Rate Pickup: This setting defines the value to operate the element. If Direction is set as "Increasing", element operates when df/dt > Pickup Level, if set as "Decreasing" when -df/dt > Pickup Level, if set as both when |df/dt| > Pickup Level.

Freq. Rate OV supv: This setting defines the minimum required voltage. Under this level, the frequency rate of change element is blocked. This is the percentage of the nominal voltage (adjust in general settings). Voltage used as reference is line voltage (see frequency reference setting in general settings).

Freq rate Min: This setting defines the minimum frequency required in this unit to be enabled. For any value under this level the element is disabled.

Freq rate Max: This setting defines the maximum frequency allowed in this unit to be enabled. For any value above this level the element is disabled.

Freq rate Delay: Time that the element must remain picked up before it operates.

Snapshot events: The snapshot event setting enables or disables the snapshot event generation for this element.

The frequency rate of change actual values can be viewed at ***Actual> Status > Control Elements > Frequency:***

Table 5–92: FREQUENCY RATE OF CHANGE STATUS

FREQUENCY RATE OF CHANGE STATUS
FREQ RATE1 PKP
FREQ RATE1 OP
FREQ RATE2 PKP
FREQ RATE2 OP
FREQ RATE3 PKP
FREQ RATE3 OP

The block signals for the frequency rate of change element can be viewed at: ***Actual> Status > Protection > Protection Blocks***:

Table 5–93: FREQUENCY RATE OF CHANGE BLOCKS

FREQUENCY RATE OF CHANGE BLOCKS
FREQ RATE1 BLOCK
FREQ RATE2 BLOCK
FREQ RATE3 BLOCK

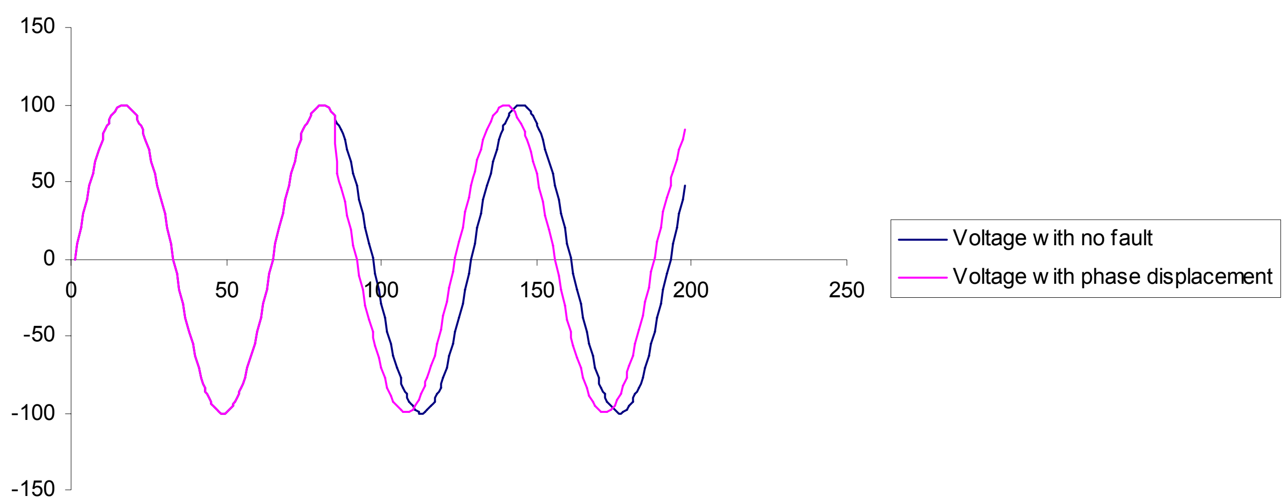
5.5.10 LOSS OF MAINS (78V) (FOR ENHANCED MODELS)

5.5.10.1 INTRODUCTION

The Phase Shift or Loss of main element (78V) measures the length of each cycle of the voltage signal. When a generator becomes disconnected, the sudden change in load causes a sudden change in cycle length. The single cycle becomes shifted with time.Therefore the 78V element can be used to detect disconnection from the grid.

A phase displacement is defined as a sudden change in the voltage, which can be generated by a big load increase or a sudden loss load. The loss of mains element detects a phase displacements comparing the period of the last cycle length with the period average of last N cycles. If the difference between these two values is above setting the element picks up and operates.

Figure 5–22: VOLTAGE PHASE DISPLACEMENT EXAMPLE



5.5.10.2 LOSS OF MAINS SETTINGS DESCRIPTION

The settings can be selected at ***Setpoint > Control Elements > Loss of Mains***

Table 5–94: LOSS OF MAINS ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > LOSS OF MAINS > LOSS OF MAINS 1> LOSS OF MAINS 2 > LOSS OF MAINS 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Any phase displacement mode to operate	Loss of Mains Mode	ONE PHASE	N/A	[ONE PHASE]
Minimum Phase shift angle value to operate	Phase Shift Angle	1.00	0.01 Deg	[2.00 : 22.00]
Minimum voltage threshold	Minimum Voltage	70	1 V	[30 : 500]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

- **Function**: This setting allows enabling or disabling the Loss of Mains element.
- **Loss of mains Mode**: ONE PHASE option: the loss of mains element gives indication when a phase displacement occurs in any phase..
- **Phase Shift Angle**: This setting defines the minimum detected angle difference to operate the element.
- **Minimum Voltage**: If measured voltage is below this setting, the unit will be blocked
- **Snapshot Events**: The snapshot event setting enables or disables the snapshot event generation for this element.

Table 5–95: LOSS OF MAINS INTERNAL SIGNALS

Signal	Comment
LOSS OF MAINS 1 (2, 3,) BLOCK	Input used to block externally the Loss of mains (1, 2, 3) element
LOSS OF MAINS 1 (2, 3,) A OP	Output used to indicate a loss of mains in phase A in the (1, 2, 3) elements
LOSS OF MAINS 1 (2, 3,) B OP	Output used to indicate a loss of mains in phase B in the (1, 2, 3) elements
LOSS OF MAINS 1 (2, 3,) C OP	Output used to indicate a loss of mains in phase C in the (1, 2, 3) elements
LOSS OF MAINS 1 (2, 3,) OP	Output used to indicate a loss of mains in the (1, 2, 3) elements

5.5.10.3 LOSS OF MAINS ALGORITHM IMPLEMENTATION

1. Calculation for the average of positive and negative semi-periods of the signal:

$$\overline{T}^{s} = \frac{1}{N}\sum_{i=1}^{i=N} T^{s}{}_{(n-i)}$$

$$\overline{T}^{b} = \frac{1}{N}\sum_{i=1}^{i=N} T^{b}{}_{(n-i)}$$

where N value is 10

2. If a) and b) are fulfilled we will be talking about a phase leap.

a)

$$|\overline{T_n}^{b} - \frac{1}{N}\sum_{i=1}^{i=N} T^{b}{}_{(n-i)}| > \varphi$$

$$|\overline{T_n}^{s} - \frac{1}{N}\sum_{i=1}^{i=N} T^{s}{}_{(n-i)}| > \varphi$$

b)

$$|\overline{T_{n+1}}^{b} - \frac{1}{N}\sum_{i=1}^{i=N} T^{b}{}_{(n-i)}| < \varphi$$

$$|\overline{T_{n+1}}^{s} - \frac{1}{N}\sum_{i=1}^{i=N} T^{s}{}_{(n-i)}| < \varphi$$

where φ value is value set in Loss of mains Angle.

First condition checks that something has occurred in the semi cycle and b) condition is used to differentiate between a phase displacement from a frequency change.

5.5.11 LOSS OF EXCITATION (40)

This function is used to detect loss of excitation on synchronous machines. It includes two mho characteristics looking into the machine, each with adjustable reach, center, and time delay.

Excitation can be lost due to inadvertent tripping of the field breaker, open or short circuit on the field winding, regulator failure, or loss of the source to the field winding. Loss of excitation can be damaging to the machine and/or detrimental to the operation of the system. When a synchronous generator loses excitation, it will tend to act as an induction generator: it will run above normal speed, operate at reduced power and receive its excitation (VARS) from the system. The impedance seen by a relay looking into a generator will depend on the machine characteristics, the load flow prior to the loss of excitation, and the type of excitation failure.

- The **stage 1** characteristic is typically set to detect severe cases of excitation failure. This is achieved with a mho element with a diameter equal to the base impedance of the machine and an offset equal to half the machine transient reactance (X'd).

$$Center1 = \frac{(Zb + X'd)}{2}$$

$$Radious1 = \frac{Zb}{2}$$

The stage 1 element should be time delayed to allow for blocking by the VT fuse failure element (60 ms).

- The **stage 2** characteristic is typically set to detect a loss of excitation for all load conditions. This is achieved with a mho element with a diameter equal to the synchronous reactance of the machine and an offset equal to half the machine transient reactance.

$$Center2 = \frac{(Xd + X'd)}{2}$$

$$Radious2 = \frac{Xd}{2}$$

Some stable power swing conditions may momentarily enter the stage 2 characteristic For security of the element under such conditions, it is recommended to delay stage 2 by a minimum of 0.5 seconds.

Figure 5–23: OPERATING CHARACTERISTIC

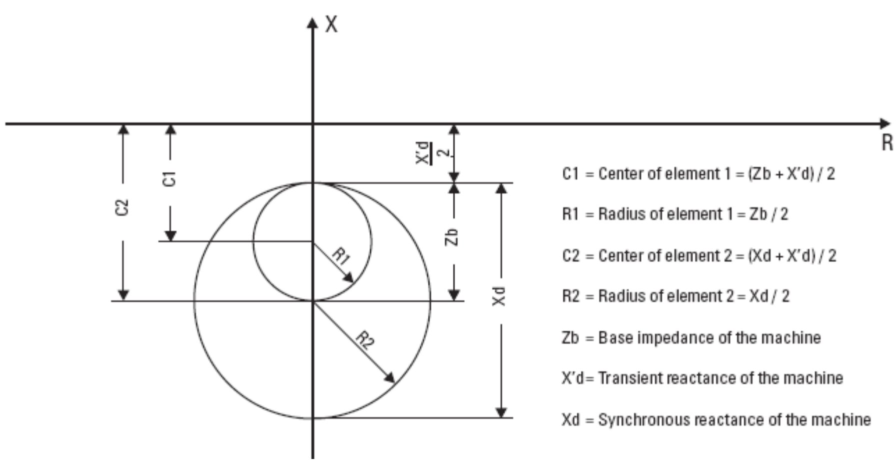


Table 5–96: LOSS OF EXCITATION ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > LOSS OF EXCITATION > LOSS OF EXCITATION 1> LOSS OF EXCITATION 2 > LOSS OF EXCITATION 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Center point in Ohms (sec) for Stage 1	Stage 1 Center	10.00	0.01 Ohm	[0.10 : 300.00]
Radius value in Ohms (sec) for Stage 1	Stage 1 Radius	8.00	0.01 Ohm	[0.10 : 300.00]
UV Supervision for stage 1	Stage 1 UV Supv	DISABLED	N/A	[DISABLED – ENABLED]
Trip time for Stage 1	Stage 1 Trip Delay	0.05	0.01 s	[0.00 : 65.54]
Center point in Ohms (sec) for Stage 2	Stage 2 Center	10.00	0.01 Ohm	[0.10 : 300.00]
Radius value in Ohms (sec) for Stage 2	Stage 2 Radius	8.00	0.01 Ohm	[0.10 : 300.00]
UV Supervision for stage 2	Stage 2 UV Supv	DISABLED	N/A	[DISABLED – ENABLED]
Trip time for Stage 2	Stage 2 Trip Delay	0.05	0.01 s	[0.00 : 65.54]
UV Supervision Level for both stages 1 and 2	UV Supv Level	40.0	0.1 V	[0.0 : 500.0]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Table 5–97: LOSS OF EXCITATION INTERNAL SIGNALS

SIGNAL	COMMENT
LOSS EXC 1 (2, 3) BLOCK	Input used to block the (1, 2, 3) element externally (configurable in "Setpoint>Relay Configuration>Protection Elements")
LOSS EXC 1 (2, 3) ST1 PKP	Output used to indicate a pickup of the stage 1 in the elements (1, 2, 3)
LOSS EXC 1 (2, 3) STG1 OP	Output used to indicate an operation of the stage 1 in the elements (1, 2, 3)
LOSS EXC 1 (2, 3) ST2 PKP	Output used to indicate a pickup of the stage 2 in the elements (1, 2, 3)
LOSS EXC 1 (2, 3) STG2 OP	Output used to indicate an operation of the stage 2 in the elements (1, 2, 3)
LOSS EXC 1 (2, 3) PKP	Output used to indicate a general pickup in the elements (1, 2, 3)
LOSS EXC 1 (2, 3) OP	Output used to indicate a general operation in the elements (1, 2, 3)

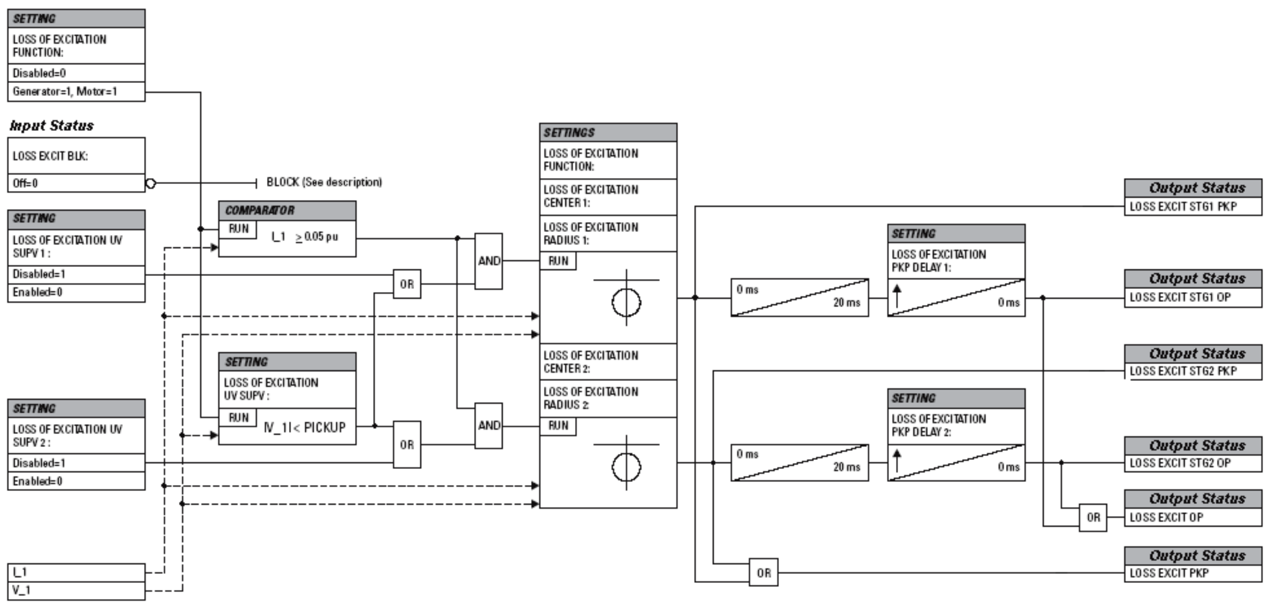


Figure 5–24: LOSS OF EXCITATION LOGIC SCHEME

5.5.12 ACCIDENTAL ENERGIZATION (50/27)

This element provides a protection against the generator energization while the generator is at standstill or reduced speed. This function is armed using either the AND or OR combination of the undervoltage and machine off-line conditions, selected with the ACCDNT ENGR ARMING MODE setting.

Once armed, the accidental energization feature operates upon detecting an overcurrent condition in any of the stator phases.

Table 5–98: ACCIDENTAL ENERGIZATION ELEMENT SETTINGS

SETPOINT > CONTROL ELEMENTS > ACCIDENTAL ENERGIZATION > ACCIDENTAL ENERGIZATION 1> ACCIDENTAL ENERGIZATION 2 > ACCIDENTAL ENERGIZATION 3				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Arming mode for Accidental Energization	Accdnt Enrg Mode	UV AND OFF-LINE	N/A	[UV AND OFF-LINE – UV OR OFF-LINE]
Overcurrent Level to operate	Overcurrent pickup	1.50	0.01 A	[0.00 : 160.00]
Arming undervoltage value	Ph Undervoltage pickup	40.00	0.01 V	[0.00 : 500.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

- **Function**: This setting allows enabling or disabling the accidental energization element.
- **Accdnt Enrg Mode**: This setting specifies whether the element gets armed by either of the undervoltage or machine off-line conditions ('UV or Off-line' value), or by both the conditions ('UV and Off-line' value). In both cases the element is armed after the conditions are maintained during 5 seconds.
- **Overcurrent pickup**: This setting defines the current level required to operate the armed Accidental energization.

- **Ph Undervoltage pickup**: This setting specifies the voltage level required to arm the accidental energization element. All of the line-to-line voltages must drop below the 'Ph Undervoltage pickup' level in order to detect the undervoltage condition.
- **Snapshot events:** The snapshot event setting enables or disables the snapshot event generation for this element.

Table 5–99: 50/27 ACCDNT ENRG ELEMENT INPUTS

INPUT	COMMENT
ACCDNT ENRG 1 (2, 3) BLOCK	Signal to block the accidental energization Element.(1, 2, 3)
ACCDNT ENRG 1 (2, 3) OFFLINE	This input indicates that the protected generator is off-line.for elements (1, 2, 3)

Table 5–100: 50/27 ACCDNT ENRG ELEMENT OUTPUTS

OUTPUT	COMMENT
ACCDNT ENRG 1 (2, 3) ARMED	This signal indicates that the element is ready for an accidental energization detection.for elements (1, 2, 3)
ACCDNT ENRG 1 (2, 3) OP	This output shows an accidental energization operation for elements (1, 2, 3)

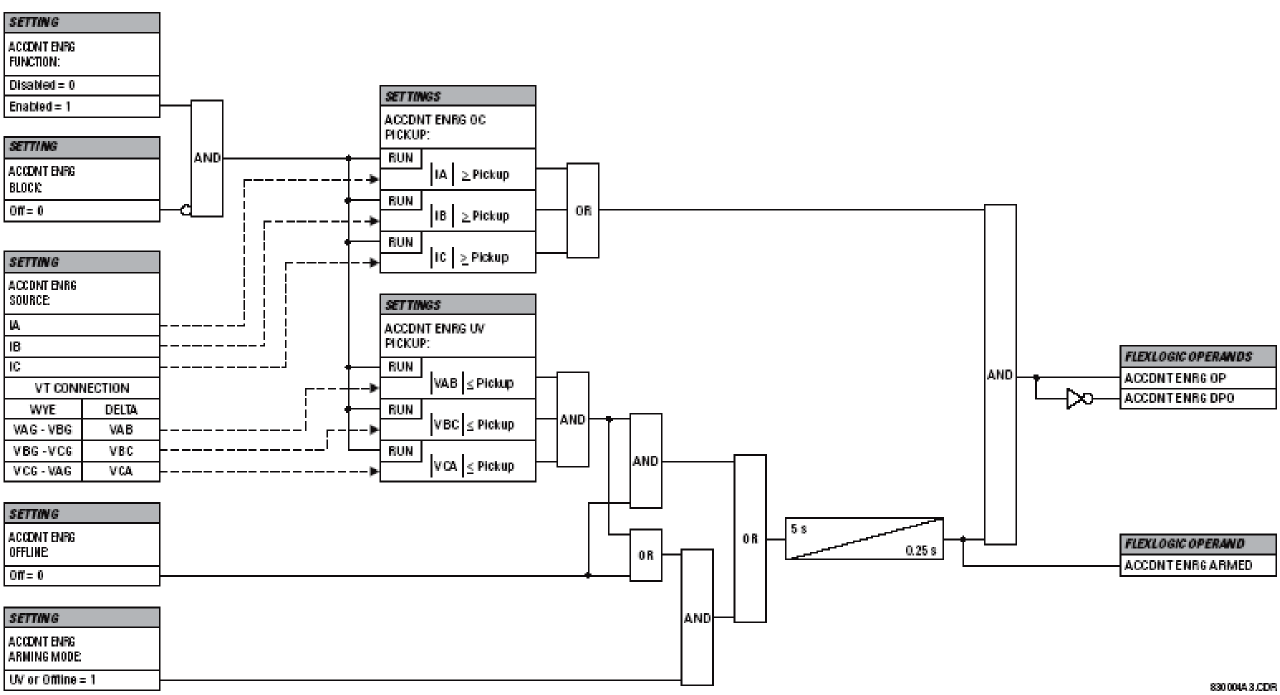


Figure 5–25: ACCIDENTAL ENERGIZATION LOGIC SCHEME

5.6.1 INPUT/OUTPUT PLACEMENT

	MIXED	SUPERVISION	INPUTS	ANALOG
TERMINALS	1	2	4	5
1	CC1	COIL 1	CC1	CC1
2	CC2	52/a	CC2	CC2
3	CC3	COIL 1	CC3	CC3
4	CC4	52/b	CC4	CC4
5	CC5	CC1	CC5	CC5
6	CC6	CC2	CC6	CC6
7	CC7	CC3	CC7	CC7
8	CC8	CC4	CC8	CC8
9	COMMON 1/8	COMMON 1/4	COMMON 1/8	COMMON 1/8
10	COMMON 9/16	COMMON 5/8	COMMON 9/16	COMMON 9/16
11	CC9	CC5	CC9	CC9
12	CC10	CC6	CC10	CC10
13	CC11	CC7	CC11	CC11
14	CC12	CC8	CC12	CC12
15	CC13	COIL 2	CC13	CC13
16	CC14	52/a	CC14	CC14
17	CC15	COIL 2	CC15	CC15
18	CC16	52/b	CC16	CC16
19		O1	CC17	SHIELD 1/4
20	O1		CC18	AI 1
21		O2	CC19	
22			CC20	AI 2
23	O2	O3	CC21	
24			CC22	AI 3
25	O3	O4	CC23	
26			CC24	AI 4
27	O4	O5	COMMON 17/24	
28			COMMON 25/32	AI 5
29	O5	O6	CC25	
30			CC26	AI 6
31	O6	I SENS	CC27	
32		O7	CC28	AI 7
33	O7		CC29	
34		I SENS	CC30	AI 8
35	O8	O8	CC31	
36			CC32	SHIELD 5/8

Figure 5–26: INPUT/OUTPUT LOCATION AND TYPE

5.6.2 CONTROL SETTINGS FOR INPUTS/OUTPUTS

Configuration of settings relative to inputs and outputs can only be accessed through the EnerVista 650 Setup software, and not via the HMI. For this purpose, the user must access ***Setpoint > Inputs/Outputs > Contact I/O > Board X***, being X the corresponding I/O board.

settings relative to I/O boards are described in Table 5–101:

Table 5–101: I/O BOARD SETTINGS

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O >				
BOARD F > BOARD G > BOARD H > BOARD J				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
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**_**CCY** (CCY)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]
Input signal time delay	Delay Input Time_**X**_**CCY** (CCY)	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]

The snapshot event setting enables or disables the snapshot event generation for this element. It is mandatory to enable this setting in order the input/output values to be refreshed in IEC61850 protocol.

Being:

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, associated digits to each board type are as follows:

Table 5–102: I/O BOARD TYPE

ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
0	NONE	None
1	16 INP+ 8OUT	Mixed
2	8 INP +8 OUT +SUPV	Supervision
4	32 INP	32 digital inputs
5	16 INP + 8 ANA	8 Analog Inputs + 16 digital inputs

CC**Y** Is the name used for inputs in I/O boards

0**Z** Is the name used for the different outputs in I/O boards

5.6.3.1 INPUT SETTINGS DESCRIPTION

Input Activation Voltage Threshold: The range of this value goes from 20 to 230 volts. There is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B., in 32DI board there are four groups of 8 inputs each.

Debounce Time: This is the debounce time set for inputs (1 to 50 ms). The debounce time is the time window for input filtering. If an input suffers a change of level that lasts less than this set time, the change will not be considered. There is a single setting for all inputs in the same group.

Input Type: Type of logic associated to the physical input. Possible settings are, positive and negative.

Positive and Negative settings correspond to signals that are activated or deactivated with the input level, considering the delay setting. Positive-edge, and Negative-edge settings correspond to signals that are activated with the change of the input signal; in this case, the Delay Input Time will not be considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. Figure 5–27: shows the types of signals associated to the different input configuration types.

Delay Input Time: This is the delay applied to the input signal; the default value is zero, meaning no delay; the setting range is 0 to 60000 milliseconds (1 minute). This setting is used in slow switchgear applications.

This is not a grouped setting; there is a different setting for each input. It is important to distinguish between this ***delay input time*** and the ***debounce time*** used for filtering undesired transients in the input signal. The Debounce time is always added to the delay input time.

5

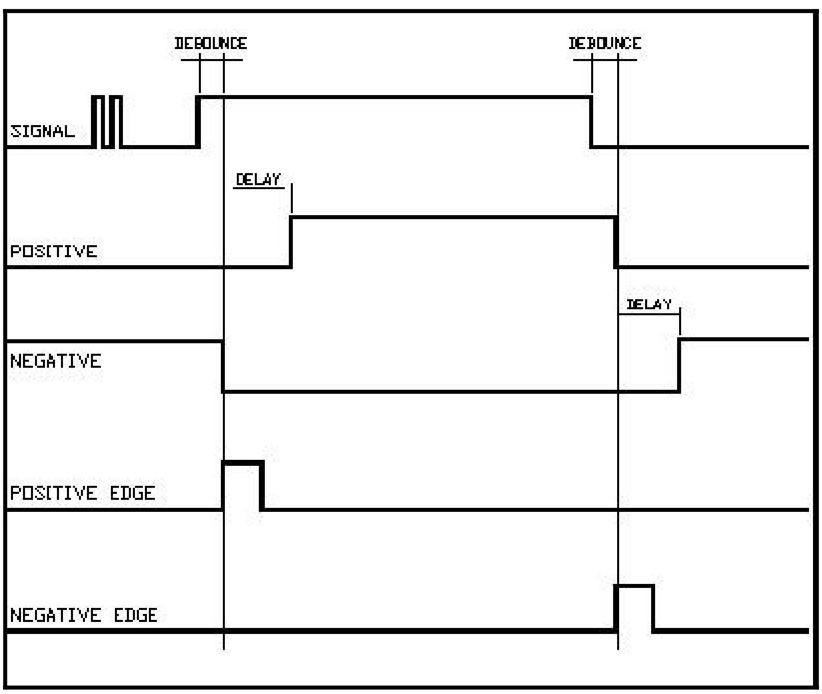


Figure 5–27: INPUT LOGIC TYPES

5.6.3.2 INPUT STATUS SIGNALS

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case). Depending on the I/O board, inputs are represented as follows:

Table 5–103: CONTACT INPUTS STATUS

INPUT STATUS (X: BOARD F, G, H, J)	MIXED AND ANALOG BOARD (TYPES 1 AND 5)	SUPERVISION BOARD (TYPE 2)	32 DI (TYPE 4)	
CONT IP_X_CC1	CC1	CC1	CC1	CC17
CONT IP_X_CC2	CC2	CC2	CC2	CC18
CONT IP_X_CC3	CC3	CC3	CC3	CC19
CONT IP_X_CC4	CC4	CC4	CC4	CC20
CONT IP_X_CC5	CC5	CC5	CC5	CC21
CONT IP_X_CC6	CC6	CC6	CC6	CC22
CONT IP_X_CC7	CC7	CC7	CC7	CC23
CONT IP_X_CC8	CC8	CC8	CC8	CC24
CONT IP_X_CC9	CC9	Va_COIL1	CC9	CC25
CONT IP_X_CC10	CC10	Vb_COIL1	CC10	CC26
CONT IP_X_CC11	CC11	Va_COIL2	CC11	CC27
CONT IP_X_CC12	CC12	Vb_COIL2	CC12	CC28
CONT IP_X_CC13	CC13	O7_SEAL	CC13	CC29
CONT IP_X_CC14	CC14	O8_SEAL	CC14	CC30
CONT IP_X_CC15	CC15	SUP_COIL1	CC15	CC31
CONT IP_X_CC16	CC16	SUP_COIL2	CC16	CC32

The operation logic for supervision signals (board type 2) is detailed in section 5.6.5 in this manual.

5.6.4.1 OUTPUT SETTINGS DESCRIPTION

Output Logic_0X _0Z: Type of logic applied to outputs. Possible values are ***positive*** and ***negative***. The default value is positive. Depending on the type of setting selected, the physical output will be in the same direction (positive) or opposite (negative) the output activation command.

Output Type_0X _0Z: Type of output adjusted. Possible values are ***normal***, ***pulse*** *or* ***latched***, the default value is ***Normal***.

Normal: The contact output follows the activation command. Remains active while the operation signal is active.

Pulse: The contact output remains active the time the operation signal is active plus the pulse output time, according to the ***Pulse Output Time*** setting.

Latched: The output remains active after the operation signal has been cleared. The reset signal for the latched outputs is configured at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***".

Pulse Output Time_0X _0Z: This is the length of the output pulse in case the output type is selected as ***pulse***; the default value is 10000 ms.

Figure 5–28:shows the types of signals associated to the different output configuration types.

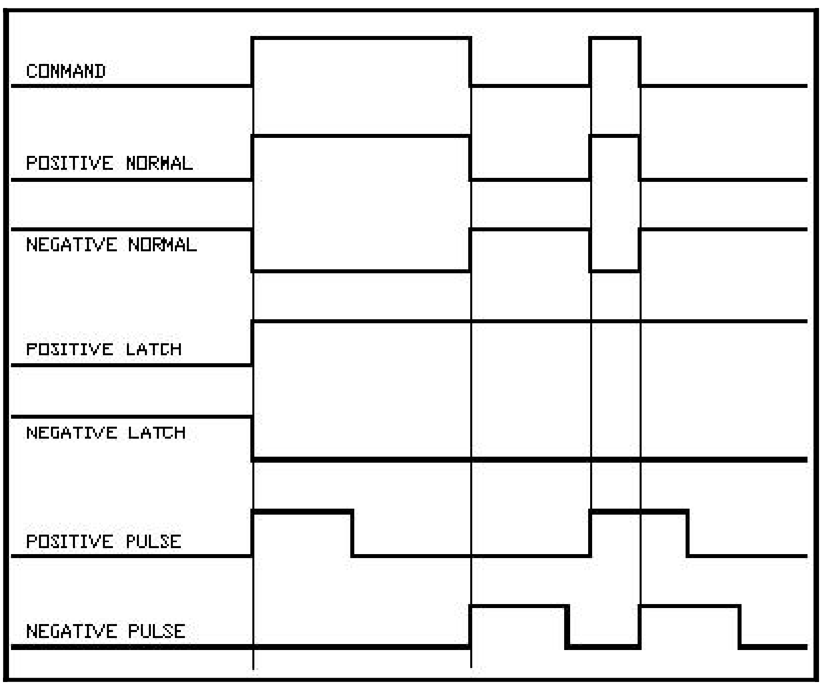


Figure 5–28: OUTPUT LOGIC TYPES.

5.6.4.2 OUTPUT STATUS SIGNALS

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in Table 5–104:

Actual > Inputs/Outputs >Contact Output Status

Real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in "***Setpoint > Inputs/Outputs >Contact I/O > Board X***"

Actual > Inputs/Outputs > Contact Output Operates

Activated or deactivated status of those variables used internally to operate a contact output.

Actual > Inputs/Outputs > Contact Output Resets

These are the logic signals associated to the contact output reset, which produce the reset of those signals previously configured as Latched. Configuration for the contact output reset signal is set at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***.

Actual > Inputs/Outputs >I/O Board Status

These signals are associated to the different I/O boards. There are internal signals that provide information about the status of these boards, indicating whether there is any anomaly in the board, or whether the board is not available in the relay according to the relay model.

Table 5–104: CONTACT OUTPUT SIGNALS

CONTACT OUTPUT STATUS	CONTACT OUTPUT OPERATES	CONTACT OUTPUT RESETS	IO BOARD STATUS
CONT OP_X_01	CONT OP OPER_X_01	CONT OP RESET_X_01	BOARD F STATUS
CONT OP_X_02	CONT OP OPER_X_02	CONT OP RESET_X_02	BOARD G STATUS
CONT OP_X_03	CONT OP OPER_X_03	CONT OP RESET_X_03	BOARD H STATUS
CONT OP_X_04	CONT OP OPER_X_04	CONT OP RESET_X_04	BOARD J STATUS
CONT OP_X_05	CONT OP OPER_X_05	CONT OP RESET_X_05	
CONT OP_X_06	CONT OP OPER_X_06	CONT OP RESET_X_06	
CONT OP_X_07	CONT OP OPER_X_07	CONT OP RESET_X_07	
CONT OP_X_08	CONT OP OPER_X_08	CONT OP RESET_X_08	

Being X the corresponding board in each case

5.6.5 CIRCUIT SUPERVISION AND CONTACT SEAL-IN CIRCUITS

Circuit Supervision:

G650 elements can include supervision boards (type 2), either in their internal slot F, or in an additional CIO module connected to the element via a CAN Bus (slots H and J). This type of board includes 4 voltage detectors for implementing tripping or opening circuit supervision control logics.

Contact Seal-in:

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.

This current seal-in function in tripping circuits is mainly used in applications where auxiliary contacts 52/a (in charge of cutting the current in the tripping circuit) are very slow. This may cause that, once the function that produced the trip is reset, the relay contact will open before the breaker auxiliary 52/a, even if the time delay of the first has expired.

By using this function, we prevent the relay contact from cutting the current (basically inductive and high) from the tripping circuit, which could cause damage to the element, as these currents exceed the nominal breaking characteristics.

The circuit and the current threshold of the function are as follows:

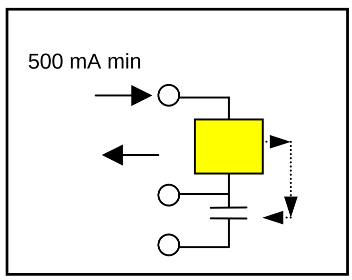


Figure 5–29: CURRENT SUPERVISION

5.6.5.1 DIGITAL INPUTS

a) WITH TRIP CIRCUIT SUPERVISION

The supervision board includes:

8 digital inputs in two groups of 4 inputs with one common, in terminals F9 to F10

8 auxiliary outputs: 6 normally open contacts in terminals F19 to F30 and two current sensing (latching) outputs (F31-F33 and F34-F36).

2 groups of inputs for trip circuit supervision with 4 voltage detectors. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the element output contact.

In order to implement these schemes, it is not necessary to set any setting in the element. Internal functions are always operative and provide the following logic operands:

Table 5–105: SUPERVISION LOGIC OPERANDS

ACTUAL > INPUTS/OUTPUTS > CONTACT INPUTS > BOARD X BEING X THE CORRESPONDING BOARD IN EACH CASE	
OPERAND	**DESCRIPTION**
CONT IP_X_CC9 (Va_COIL1)	Active when voltage is detected in terminals F1 - F2 (circuit 1)
CONT IP_X_CC10 (Vb_COIL1)	Active when voltage is detected in terminals F3 - F4 (circuit 1)
CONT IP_X_CC11 (Va_COIL2)	Active when voltage is detected in terminals F15 - F16 (circuit 2)
CONT IP_X_CC12 (Vb_COIL2)	Active when voltage is detected in terminals F17 - F18 (circuit 2)
CONT IP_X_CC13 (O7_SEAL)	Active if current is detected by sensor in output O7 (F31-F33)
CONT IP_X_CC14 (O8_SEAL)	Active if current is detected by sensor in output O8 (F34-F36)
CONT IP_X_CC15 (SUP_COIL1)	Active when continuity is detected in circuit 1
CONT IP_X_CC16 (SUP_COIL2)	Active when continuity is detected in circuit 2

A continuity failure is detected in a circuit when both voltage detectors (Va and Vb) detect lack of voltage during more than 500 ms. This function is not influenced by the breaker status.

These operands can be associated to internal signals (virtual outputs), LEDs or element outputs, to issue alarm signals or to block elements, for example for blocking the Breaker close if an anomaly is detected in the trip circuit.

Available schemes are as follows:

1. Without supervision
2. With current supervision (with seal-in)
3. With simple voltage supervision
4. With double voltage supervision
5. With current and simple voltage supervision (with seal-in)
6. With current and double voltage supervision (with seal-in)
7. With current and double voltage supervision (with seal-in) and serial resistor in voltage monitors.

The following subsections describe the different types of connection to create each supervision scheme in an easy way. As the supervision circuits are identical, only the first group connection examples will be described, being also applicable to the second group.

In order to assure a high isolation level between groups, the digital inputs for supervision have been located in a symmetrical basis. That is to optimize the isolation between groups that can be connected to different batteries, and therefore requiring a greater distance between circuits.

b) WITHOUT SUPERVISION

This is a very frequent common case, and we must only wire the tripping circuit to terminals F35 and F36, leaving unused terminals F34, F15, F16, F17, F18.

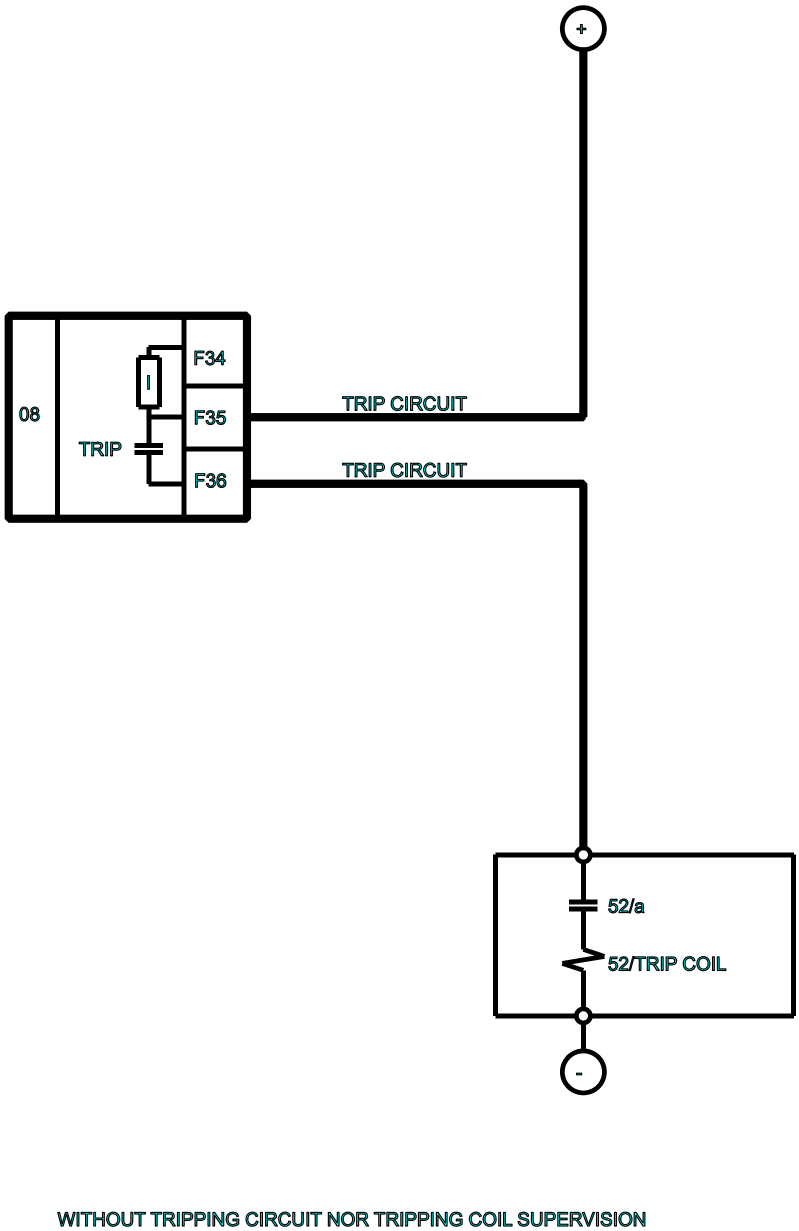


Figure 5–30: CIRCUIT WITHOUT TRIPPING CIRCUIT SUPERVISION (A6631F1)

c) WITH CURRENT SUPERVISION (WITH SEAL-IN)

In this case, as shown in Figure 5–31:, the current supervision circuit consists of a circuit connected in series with the output contact, so that the external circuit is wired to terminals F34 and F36. This supervision circuit includes a low impedance reed relay that is activated when the current value exceeds 200 mA, and sends a signal to the main microprocessor. This will latch the output relay in such a way that this indication can be used to produce a latching of the output relay, so that it will remain closed while the circulating current is over 200 mA. To use the seal-in feature in the relay it is not necessary to configure any setting. It works, we only must program the corresponding Circuit latching setting wiring the external circuit to terminals F34 and F36.

With this scheme, in the case of a failure to open from the breaker auxiliary contact, the G650 output relay will not be the one to open the tripping coil current, as in this case the contact may result damaged, as it is prepared for opening currents around 0.35 A at 125 Vdc. This latching or memory function is only guaranteed while the element is powered.

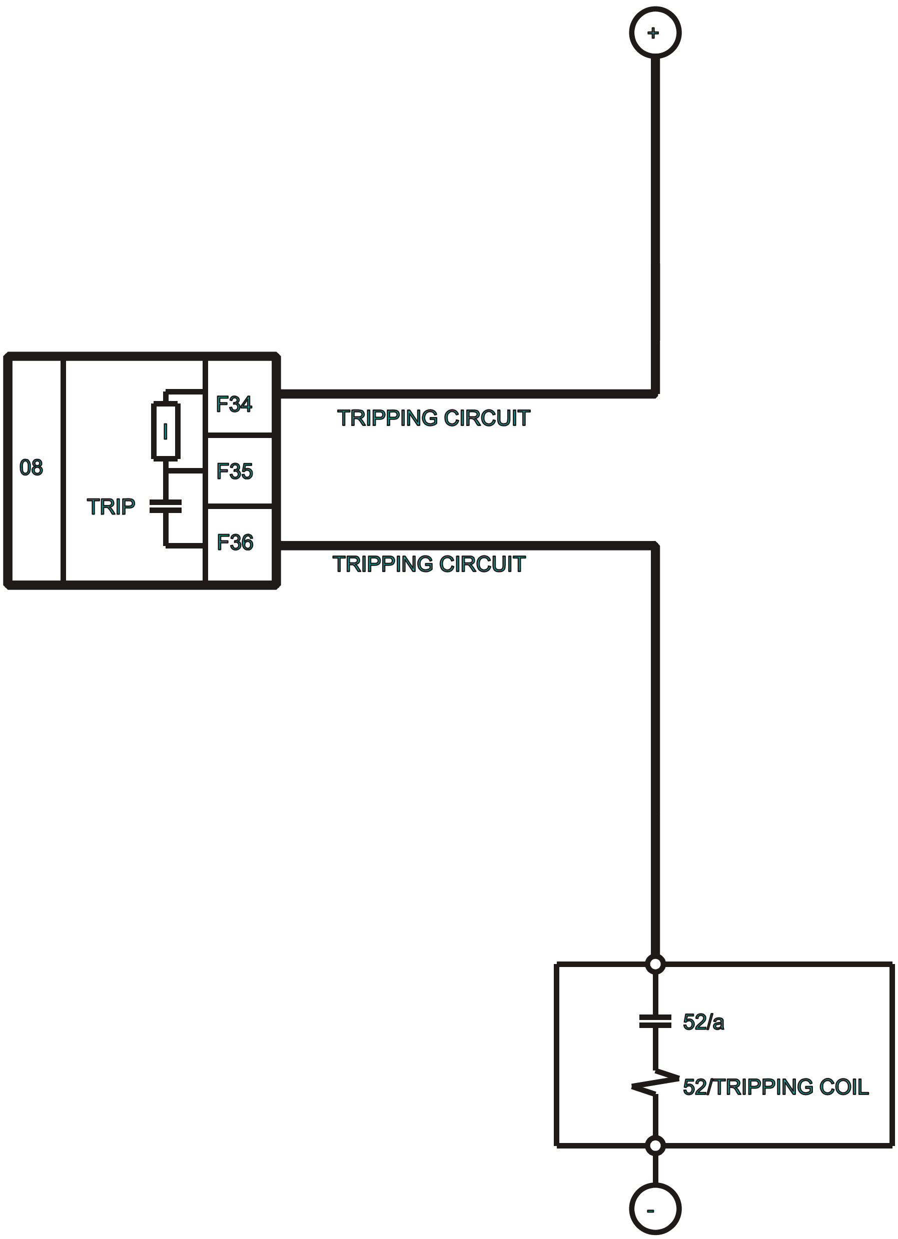


Figure 5–31: CURRENT SUPERVISION OF THE TRIPPING CONTACT (A6631F2)

d) WITH SIMPLE VOLTAGE SUPERVISION

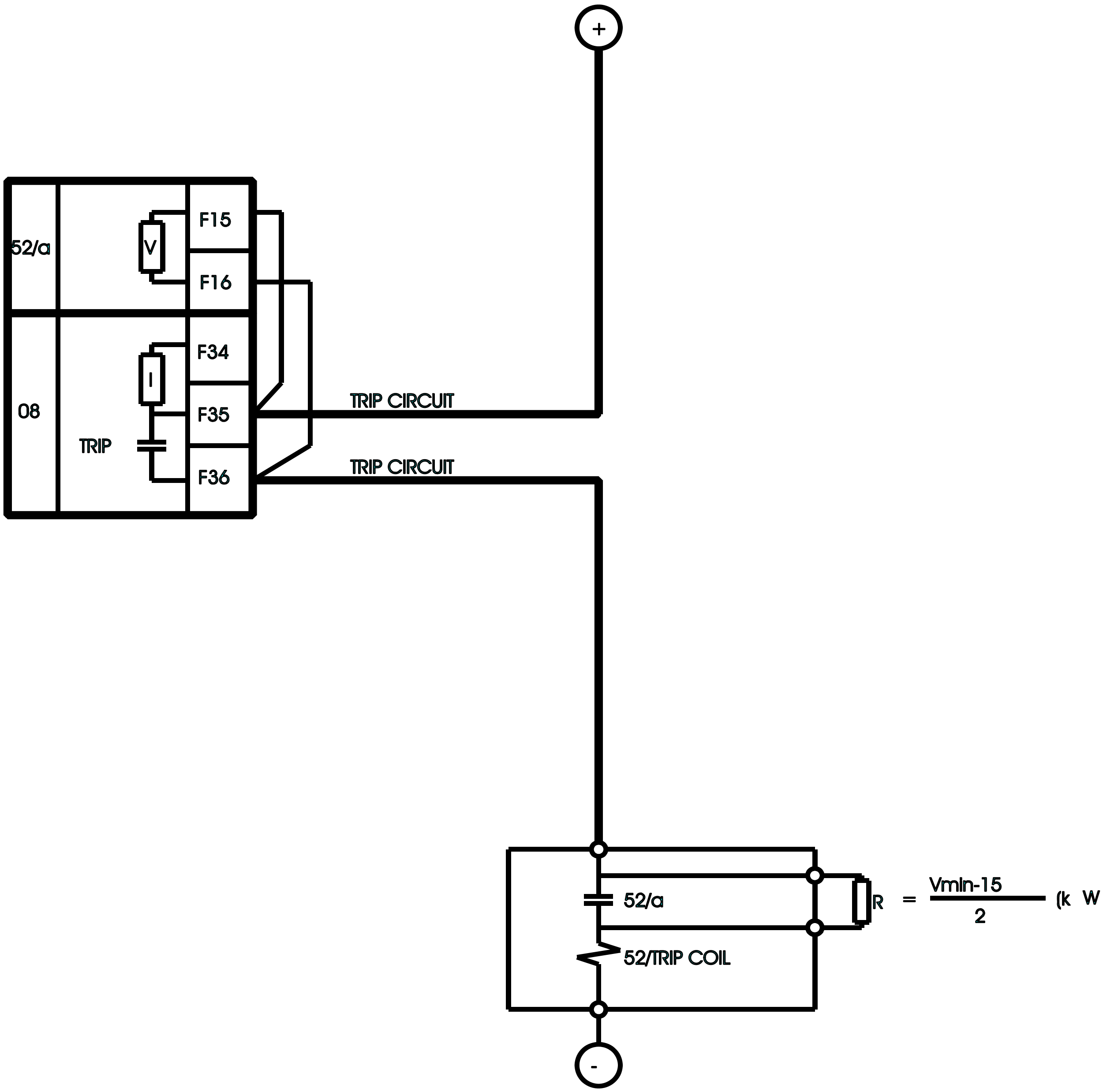


Figure 5–32: SUPERVISION APPLICATION WITH AUXILIARY CONTACT 52A AND A RESISTOR (A6631F3)

Table 5–106: SUPERVISION WITH 52/A

INTERNAL STATE	V 52/A	SUPERVISION
52 open	ON	OK
52 closed	ON	OK
TRIP	OFF	OK if t < 0.5 s
TRIP with 52 open	OFF	OK if t < 0.5 s

There is a possibility to monitor the trip circuit and trip coil continuity. This can be done by monitoring Vdc through the output contact when this is open.

Table 5–107: SUPERVISION ALGORITHM WITH SIMPLE VOLTAGE SUPERVISION SCHEME

STATUS OF INVOLVED ELEMENTS			INPUT TO G650	DECISION
CIRCUIT STATUS	**OUTPUT STATUS (F35-F36)**	**BREAKER STATUS**	**OPERAND CONT IP_X_CC11 (VA_COIL2) V 52/A (F15-F16)**	**OPERAND CONT IP_X_CC16 (SUP_COIL2)**
Healthy	Open	52 closed	ON	ON
Healthy	Open	52 open	ON	ON
Healthy	Closed	52 closed	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Faulty	Open	52 closed	OFF	OFF (500 ms delay)
Faulty	Open	52 open	OFF	OFF (500 ms delay)
Faulty	Closed	52 closed	OFF	OFF (500 ms delay)
Faulty	Closed	52 open	OFF	OFF (500 ms delay)

In this table, ON means that the voltage detector V52/a is active, detecting a voltage.

In the first case shown on the table, with closed breaker, voltage is detected by V 52/a sensor, and this means that there is continuity in the supervised circuit.

As shown on Figure 5–32:, when the relay is not tripped, trip contact F35-F36 remains open. If the breaker is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals F15 and F16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current will only circulate when there is continuity in the whole circuit, so the complete circuit is monitored, and not only the trip coil. This circuit includes auxiliary 52/a as well as the whole wiring between the battery and the relay tripping terminals, and between these and the breaker tripping circuit.

For the second case shown on the table, open breaker, its auxiliary contact 52/a remains open, and current cannot flow through it for detecting continuity. In order to correctly monitor the circuit, a resistor must be used, not included in the protection, connected in parallel. The value of resistance will be selected so that the V 52/a input circuit minimum detection current flows, but not as high as to activate the breaker-tripping coil. The figure shows the following equation:

Where:

$$R = \frac{V_{min} - 15}{2}$$

Vmin	Is the minimum voltage, in Volts, expected in the battery (e.g. 80% of Vn)
R	Resistance, in kilo ohms.
2	2 mA of approximate current flowing through input V 52/a

As shown in the second case in the table, with an open breaker, as current will flow through R if there is continuity in the WHOLE tripping circuit, voltage will be detected in input V 52/a.

This works correctly in steady state. However, if the breaker trips, while it is opening, the V 52/a input signal can be deactivated without this meaning that the circuit is not correct. This is due to the fact that the tripping relay, terminals F35-F36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is permitted that no signal will be detected during a period of 1s to allow the breaker to open, and reopen the tripping relay F35-F36.

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Figure 5–33: shows the possibility of monitoring the circuit only when the breaker is closed. In this case resistance R will not be used, but it must be observed in the element logic that the corresponding signal CONT IP_F_CC16 (SUP_COIL2) will be activated showing a failure when the breaker is open. Therefore it will be required to supervise the continuity failure signaling by the breaker status information.

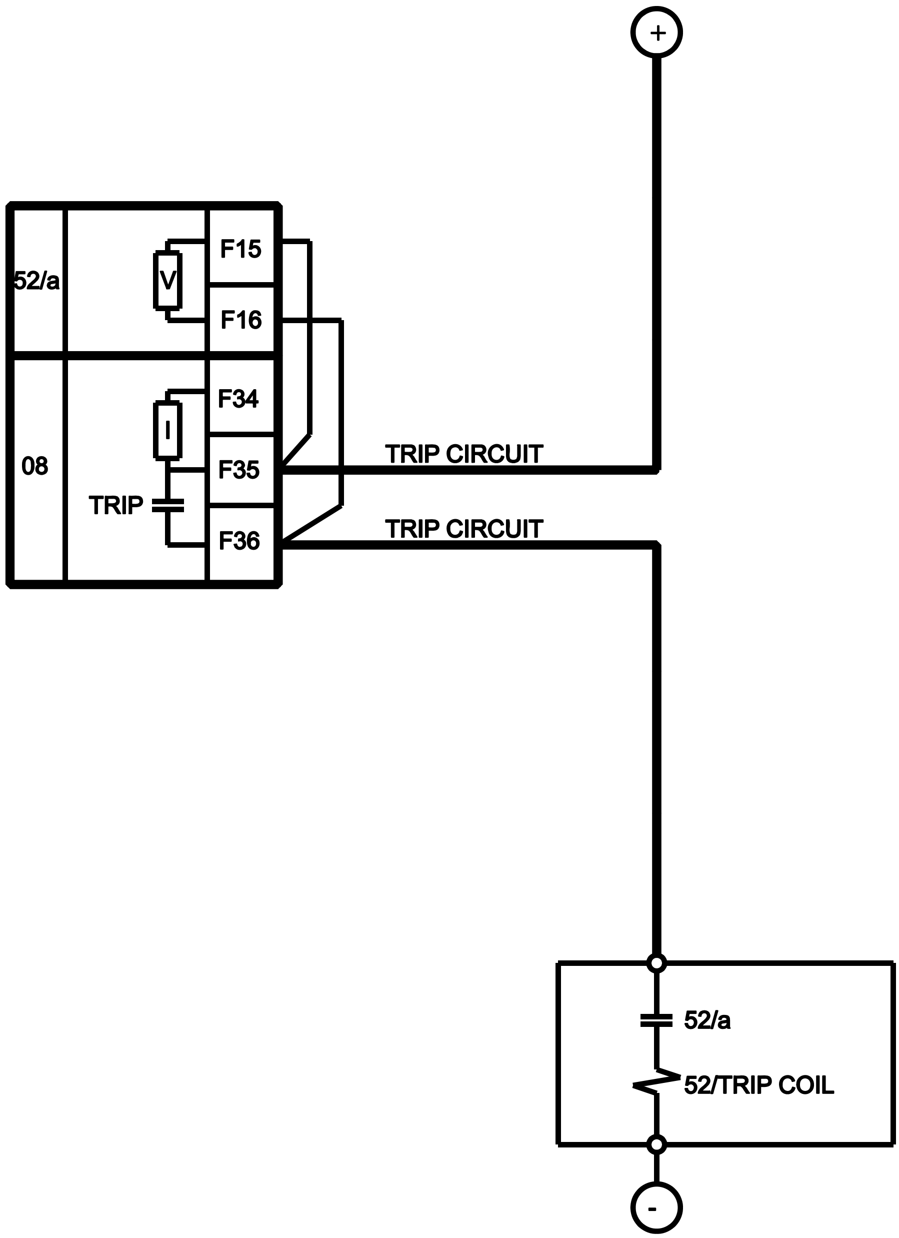


Figure 5–33: TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/A. ONLY WITH CLOSED BREAKER (A6631F5)

e) WITH DOUBLE VOLTAGE SUPERVISION

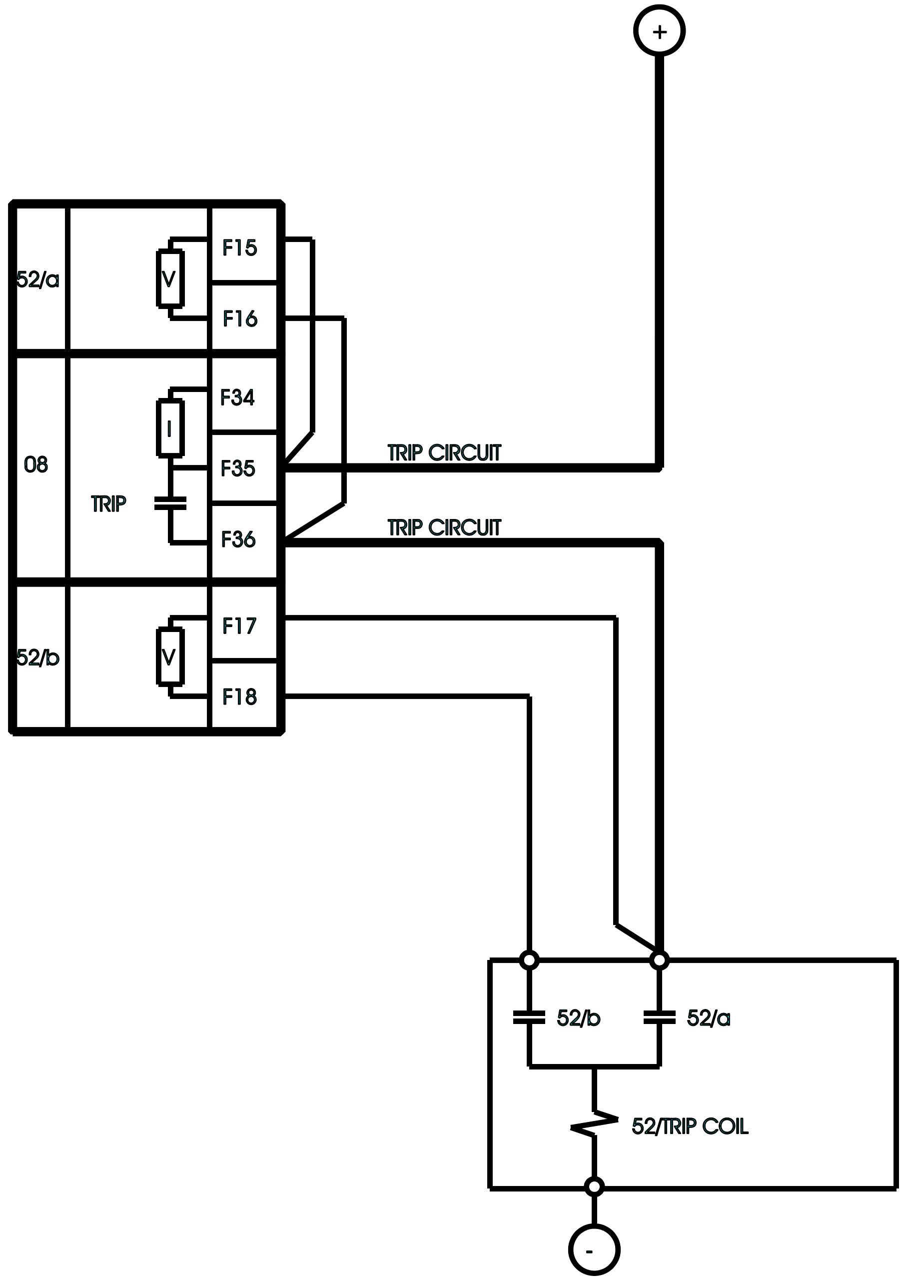


Figure 5–34: SUPERVISION APPLICATION WITH AUXILIARY CONTACTS 52A AND 52B (A6631F4)

Table 5–108: SUPERVISION ALGORITHM WITH DOUBLE VOLTAGE SUPERVISION SCHEME

STATUS OF INVOLVED ELEMENTS			INPUTS TO 650		DECISION
CIRCUIT STATUS	**OUTPUT STATUS (F35-F36)**	**BREAKER STATUS**	**OPERAND CONT IP_X_CC11 (VA_COIL2) V 52/A (F15-F16)**	**OPERAND CONT IP_X_CC12 (VB_COIL2) V 52/B (F17-F18)**	**OPERAND CONT IP_X_CC16 (SUP_COIL2)**
Healthy	Open	52 closed	ON	OFF	ON
Healthy	Open	52 open	ON	ON	ON
Healthy	Closed	52 closed	OFF	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON	ON (if t < 500 ms) OFF (if t > 500 ms)
Defective	Open	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Open	52 open	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 open	OFF	OFF	OFF (500 ms delay)

There is a possibility to monitor the trip circuit continuity not only via its auxiliary contact 52/a, but also with auxiliary contact 52/b. This avoids the need to install a resistance in parallel with auxiliary 52/a. The correct connection is shown on Figure 5–34:

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs F15-F16 and F17-F18.

The advantage in this case is that circuit supervision with 52 open is more complete, as input V 52/b is used through contact 52/b, (that is closed when the breaker is open).

We must point out that in this scheme, the tripping contact, shown in the example as the G650 trip relay, can be the one in the relay (terminals F35 and F36), or be provided by another protection or by the parallel of several protections. This provides high flexibility in the use of this circuit.

The battery voltage can also be monitored, by using one of the standard digital inputs.

f) WITH DOUBLE VOLTAGE SUPERVISION AND SERIAL RESISTOR IN VOLTAGE MONITORS.

Figure 5–35:shows the supervision scheme with an external resistor.

An external series resistor is used with the 52a voltage monitor to prevent CB tripping with a short-circuited voltage monitor. With CB open, 52/a is open and 52/b is closed. A shorted 52/a voltage monitor will not cause a trip because 52/b voltage monitor is current limited to 2mA. With a shorted 52/b voltage monitor, no false trip will be performed because 52/a is in series limiting current to 2mA.

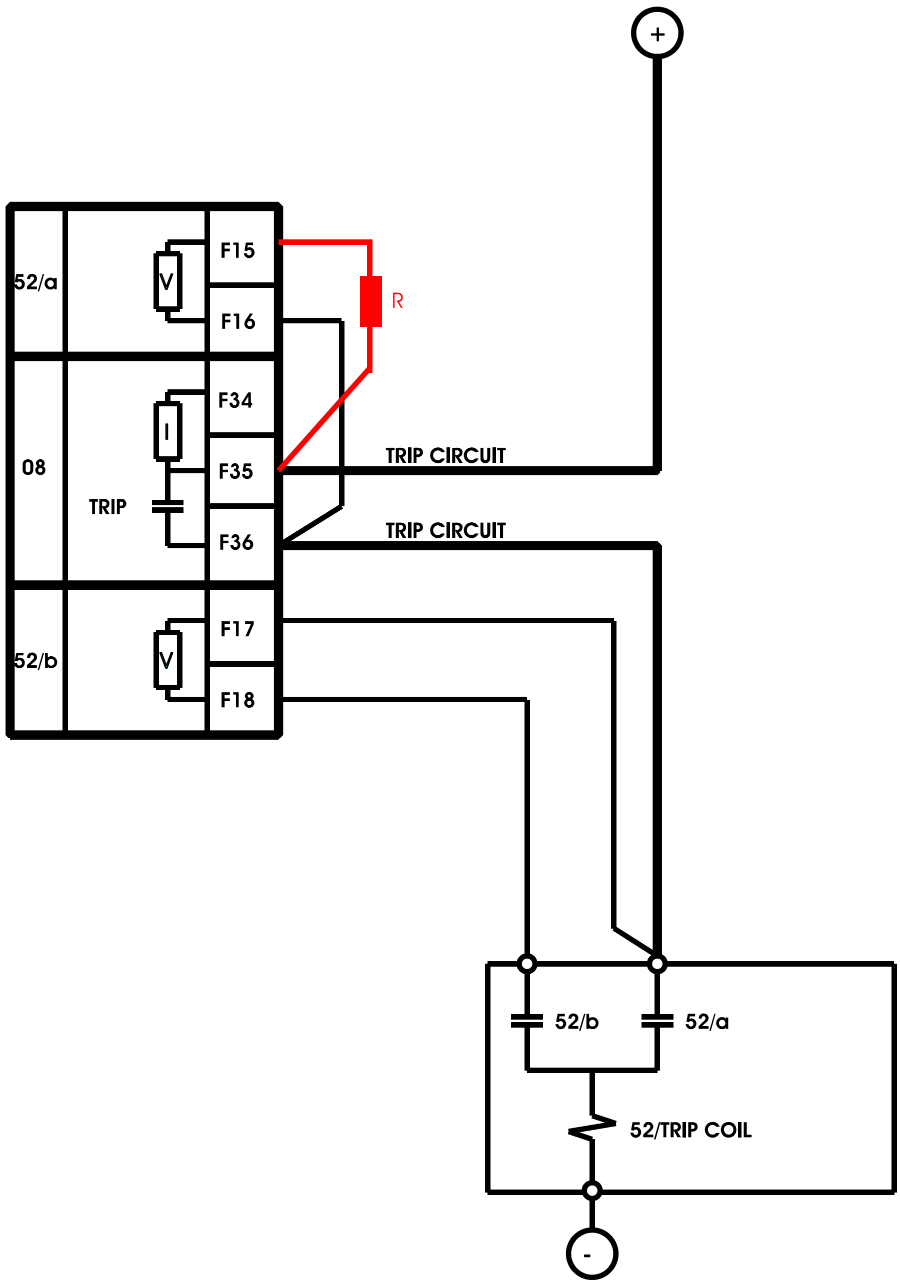


Figure 5–35: SUPERVISION APPLICATION WITH AUXILIARY CONTACTS 52A AND 52B AND SERIES RESISTOR IN F15-F16

5.6.6 ANALOG BOARDS SPECIFIC SETTINGS

Hardware and software is provided to receive signals from external transducers and convert these signals into a digital format for use as required. The relay will accept inputs in the range of –1 to +20 mA DC, suitable for use with the most common transducer output ranges; all inputs are assumed to be linear over the complete range.

The Input Range setting specifies the mA DC range of the transducer connected to the input channel.

- Range: -1 to 0, 0 to 1, -1 to 1, 0 to 5, 0 to 10, 0 to 20, 4 to 20.

The Min and Max Value settings are used to program the span of the transducer in primary units.

- Min Value: -9999.99 to 9999.99
- Max Value: -9999.99 to 9999.99

5.6.7 VIRTUAL INPUTS

Virtual inputs are signals that can be written directly via communications. Their status can be established as ON (1) and OFF (0), through writing by communications using EnerVista 650 Setup.

The change of state of virtual inputs is made according to their type. Latched virtual inputs remain at the set value until it is changed by communications. Self-reset virtual inputs are activated by writing, and they remain active during one cycle. There are 32 virtual inputs of each type.

5.6.7.1 VIRTUAL INPUTS WRITING:

Setpoint > Input/Outputs >Virtual Inputs for activating / deactivating signals

To write a virtual input, select the virtual input to activate clicking on the virtual input checkbox, then press on the store button and virtual input will be written to the relay (see Figure 5–36:).

If it is a self-reset one it will remain active during one PLC cycle and after that the virtual input value will be cleared.

If it is a latched one, the value will remain active until it is cleared by the user, clicking again in the virtual input checkbox and pressing on store to clear the value.

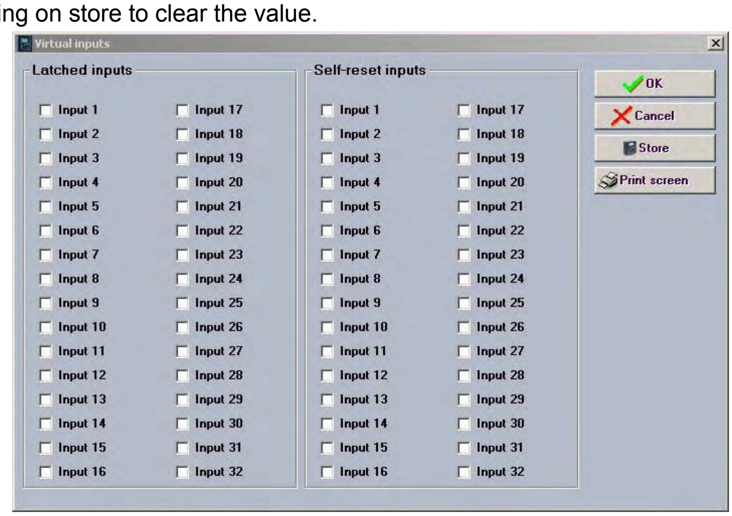


Figure 5–36: VIRTUAL INPUTS WRITING THROUGH ENERVISTA 650 SETUP

5.6.7.2 VIRTUAL INPUTS STATUS MONITORING:

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

Table 5–109: VIRTUAL INPUTS STATUS

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
…	…
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

Text assignment for virtual input is made at ***Setpoint > Relay Configuration > Virtual Inputs***. It should be taken into account that the text assigned for virtual inputs in the relay configuration screen are only for file management, they are not sent to the relay.

5.6.8 VIRTUAL OUTPUTS

There are 512 virtual outputs that may be assigned via Logic configuration. If not assigned, the output will be forced to OFF (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the logic equations. For more detailed information see chapters 5.8 and 5.9 in this manual.

5.7.1 FORCE IO–INPUT TESTING

The input testing can only be performed in relay with graphical display, see the human interfaces section in this manual for more detailed information.

5.7.2 FORCE IO–OUTPUT TESTING

Output testing can be performed via HMI in models with graphical display and via communications through EnerVista 650 Setup in all models.

Setpoint > Inputs/Outputs > Force Outputs

This menu allows activating each contact output in the relay, to facilitate maintenance testing. In the screen, the user can select the I/O board to be tested, and also select which output is to be forced (operated).

After selecting the desired output, clicking on the checkbox on the left, the user must press on the ***Force Output*** button to activate the selected output.

In order to refresh the real status of outputs, according to the information received by the relay processor, the ***Refresh*** button must be pressed.

The following figure shows the output-testing screen:

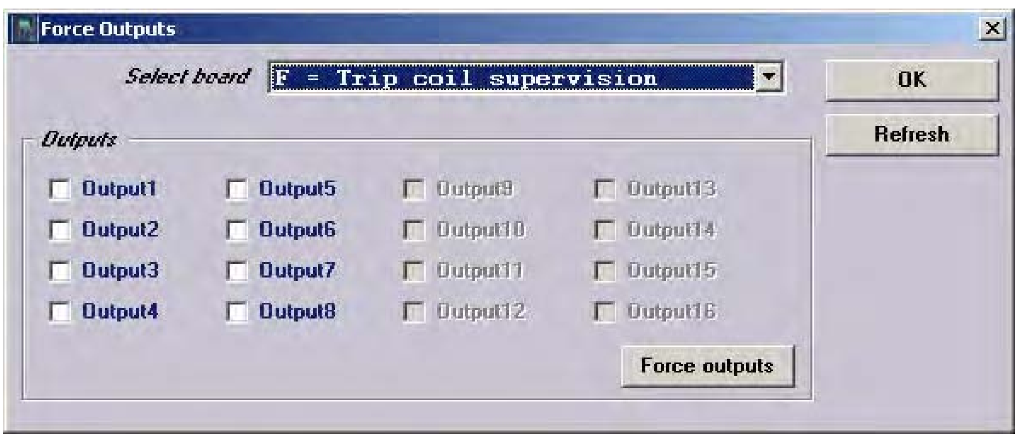


Figure 5–37: FORCE IO

Setpoint > Relay Configuration

This is the relay configuration section in which the relay can be configured (all input/output and LEDs configuration, protection elements signals, graphic display configuration, etc.) using internal states or already compiled equation on PLC Editor (see section 5.9).

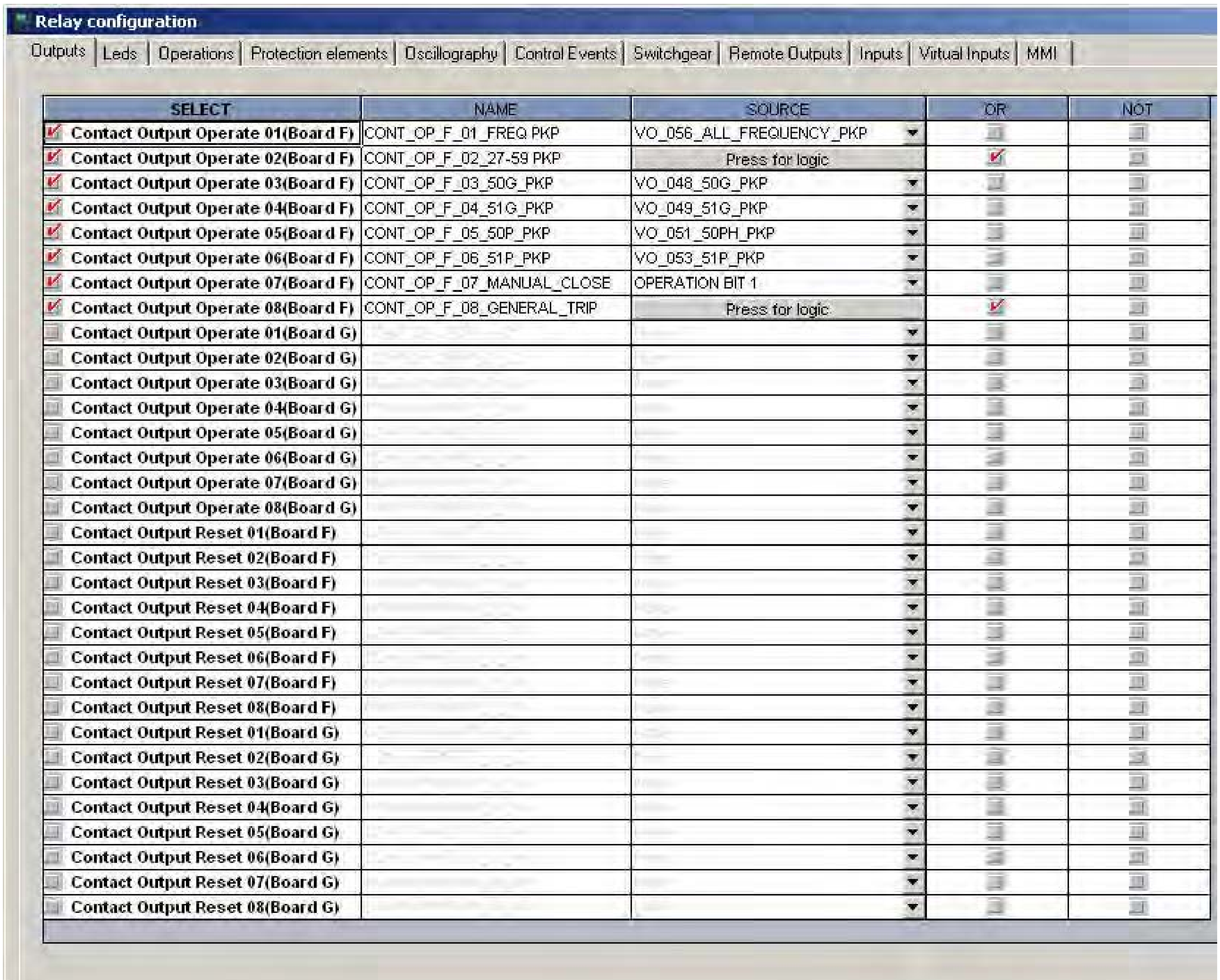
5.8.1 OUTPUTS

Configuration of contact output operates and reset signals for all boards available in the device:

To configure any output it is necessary to select the output to be configured, clicking on the checkbox in the select column and choose the logic operand in the source column. Simple logics can be performed on this screen, using the “or” and “not” columns, for more complex logics go to the logic configuration tool to create the virtual outputs and afterwards select it in the source column.

The different options available in this screen are the following:

- ***Select*** checkbox enables each output. The output must be enabled before modifying any other setting on that output
- ***Name*** setting for defining identification for the output.
- ***Source*** setting for defining a function, logic, remote input, digital input, etc. that will activate the contact.
- ***OR*** checkbox for configuring the output operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- ***NOT*** checkbox for inverting or not the configured logic.



SELECT	NAME	SOURCE	OR	NOT
Contact Output Operate 01(Board F)	CONT_OP_F_01_FREQ PKP	VO_056_ALL_FREQUENCY_PKP		
Contact Output Operate 02(Board F)	CONT_OP_F_02_27-59 PKP	Press for logic		
Contact Output Operate 03(Board F)	CONT_OP_F_03_50G_PKP	VO_048_50G_PKP		
Contact Output Operate 04(Board F)	CONT_OP_F_04_51G_PKP	VO_049_51G_PKP		
Contact Output Operate 05(Board F)	CONT_OP_F_05_50P_PKP	VO_051_50PH_PKP		
Contact Output Operate 06(Board F)	CONT_OP_F_06_51P_PKP	VO_053_51P_PKP		
Contact Output Operate 07(Board F)	CONT_OP_F_07_MANUAL_CLOSE	OPERATION BIT 1		
Contact Output Operate 08(Board F)	CONT_OP_F_08_GENERAL_TRIP	Press for logic		
Contact Output Operate 01(Board G)				
Contact Output Operate 02(Board G)				
Contact Output Operate 03(Board G)				
Contact Output Operate 04(Board G)				
Contact Output Operate 05(Board G)				
Contact Output Operate 06(Board G)				
Contact Output Operate 07(Board G)				
Contact Output Operate 08(Board G)				
Contact Output Reset 01(Board F)				
Contact Output Reset 02(Board F)				
Contact Output Reset 03(Board F)				
Contact Output Reset 04(Board F)				
Contact Output Reset 05(Board F)				
Contact Output Reset 06(Board F)				
Contact Output Reset 07(Board F)				
Contact Output Reset 08(Board F)				
Contact Output Reset 01(Board G)				
Contact Output Reset 02(Board G)				
Contact Output Reset 03(Board G)				
Contact Output Reset 04(Board G)				
Contact Output Reset 05(Board G)				
Contact Output Reset 06(Board G)				
Contact Output Reset 07(Board G)				
Contact Output Reset 08(Board G)				

Figure 5–38: OUTPUTS CONFIGURATION

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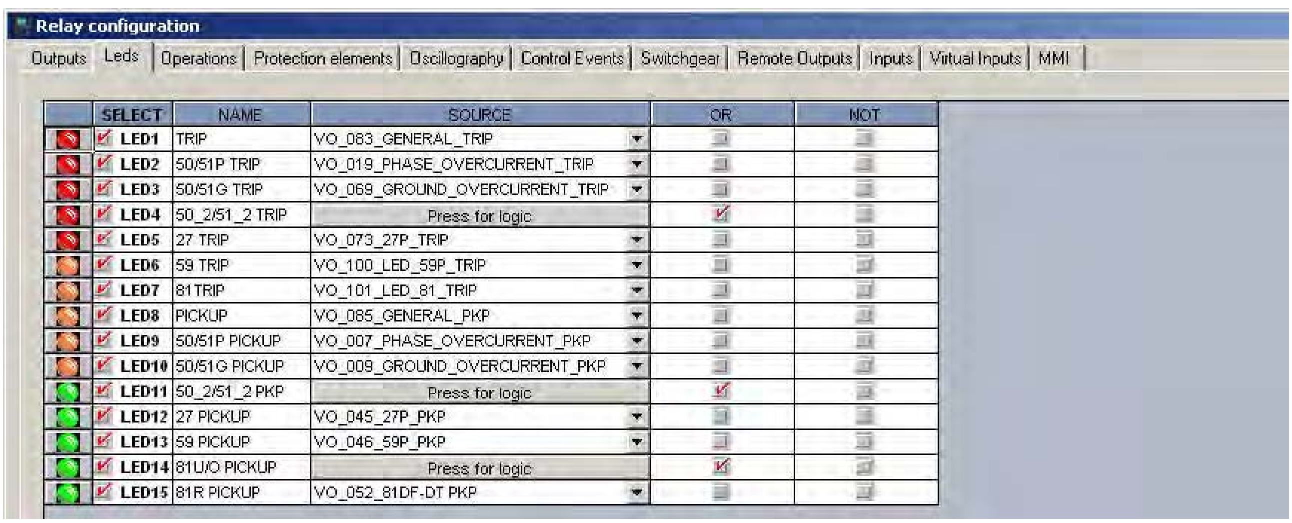
5.8.2 LEDS

G650 has 15 LEDs fully configurable from any logical variable, contact or virtual input. The first five are latched by hardware, the rest are self-reset but can be latched through PLC configuration.

This window displays the entire relay LEDs with the following setting options for each of them:

- ***Select*** checkbox enables each LED. The LED must be enabled before modifying any other setting on that LED
- ***Name*** setting for defining identification for the LED
- ***Source*** setting defines which function; logic, remote input, digital input, etc. will activate the LED.
- ***OR*** checkbox for configuring the LED operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- ***NOT*** checkbox for inverting or not the configured logic.

From the LED configuration screen, it is possible to print the vertical LED label for the relay. For this purpose, press on the printer icon. The label obtained will be similar to the default factory label, with black background and the LED texts in white. This label can replace the original one under the black plastic cover. The label is also provided in word format and can be modified by the user (e.g. different color marking)



SELECT	NAME	SOURCE	OR	NOT
LED1	TRIP	VO_083_GENERAL_TRIP		
LED2	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
LED3	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
LED4	50_2/51_2 TRIP	Press for logic	✓	
LED5	27 TRIP	VO_073_27P_TRIP		
LED6	59 TRIP	VO_100_LED_59P_TRIP		
LED7	81TRIP	VO_101_LED_81_TRIP		
LED8	PICKUP	VO_085_GENERAL_PKP		
LED9	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
LED10	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
LED11	50_2/51_2 PKP	Press for logic	✓	
LED12	27 PICKUP	VO_045_27P_PKP		
LED13	59 PICKUP	VO_046_59P_PKP		
LED14	81U/O PICKUP	Press for logic	✓	
LED15	81R PICKUP	VO_052_81DF-DT PKP		

Figure 5–39: LED CONFIGURATION

5.8.3 OPERATIONS

This menu option shows the settings for the 24 control operations that can be programmed, as follows:

- ***Select*** checkbox enables the desired operation.
- ***Command Text*** setting defines the command name.
- ***Interlocks Type*** setting defines the desired interlock type (An interlock is a condition that must be fulfilled for an operation to be performed). The possible options are ***Logic*** or ***None.*** If the **LOGIC** option is selected, the program will enable a new window for creating the logic. If the **NONE** option is selected, then the following setting (***Interlocks***) will be irrelevant.
- ***Interlocks*** setting define the desired interlocks. This setting is enabled selecting the "***logic***" option in "***Interlock type***". In the "***Interlock logic***" screen we can set the interlock logic, as shown on Figure 5–40:

  The settings on this screen allow creating a logic configuration with up to 3 AND gates and 1 OR gate for each of the 24 operations available in the relay. These settings are:

  Select – Enables/disables the selection for the interlock input

  Source – Selects a function, digital input, logic, etc. for defining each input of each AND gate.

  NOT – Logic inverter

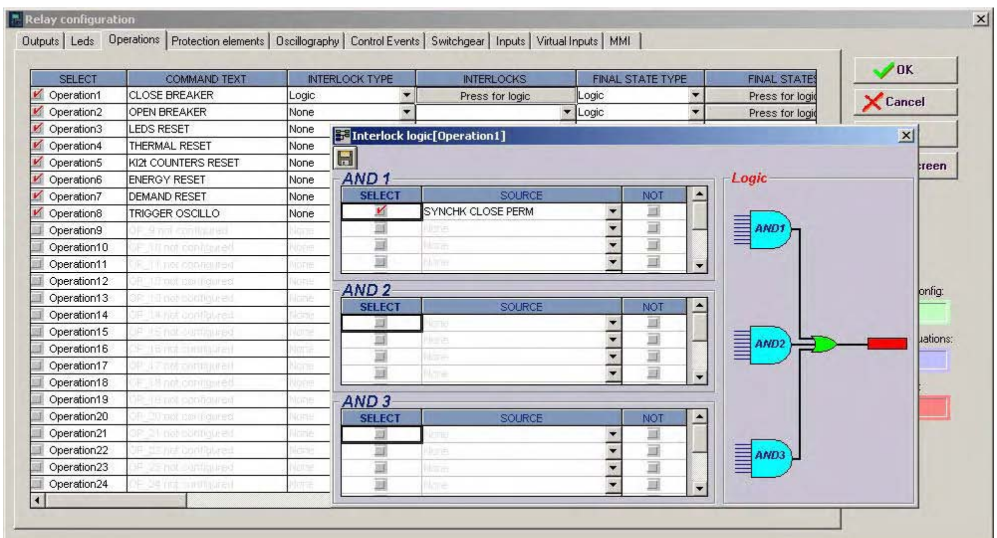


Figure 5–40: OPERATIONS AND INTERLOCKS

- ***Final State Type*** setting: defines whether the operation requires (in addition to the interlock logic) any other conditions to determine a "success condition". If so, we must select LOGIC. Otherwise, we must select NONE.
- ***Final State*** setting: defines the success condition of a programmed operation, if the previous setting (***Final State type***) was set as LOGIC.
- ***Front Key*** setting: defines the front pushbutton from which the operation can be executed.
- ***Contact Input*** setting: defines whether the operation can be executed by digital input. It defines the digital input to be used for this purpose.
- ***Virtual Output*** setting: defines whether the operation can be executed from a virtual output previously defined at the logic configuration tool (PLC logic).
- ***Time Out*** setting: defines the period during which the operation command will remain activated waiting for a success condition. If the success signal is received before this period expires, the command signal will be removed and the timer reset. If the success condition is not received within this period of time, the operation is considered to be finished.

- ***COM1 (REMOTE)*** setting: defines whether the operation can be executed by communications through the rear port COM1.
- ***COM2 (LOCAL)*** setting: defines whether the operation can be executed by communications through the rear port COM2. We must note that this local port is the same as the front port (DB-9 connector). We can establish simultaneous communication with the relay through ports COM1 and COM2. However, it is not possible to use rear COM2 and the front port simultaneously.
- ***ETHER-MASTER*** setting: defines whether the operation can be executed by communications through the ETHERNET.

It must be taken into account that besides the master selection in the operations screen inside relay configuration, there is a hardware selection (with the operation pushbutton in the front part of the relay) to switch between local (COM2 and HMI) and remote masters (COM1 and ETHERNET) for operations.The local-remote-off sequence can be also available through communications selecting the signal to switch in "***Setpoint>Relay Configuration>Protection Elements***".

The following diagram shows an example of the operations internal logic.

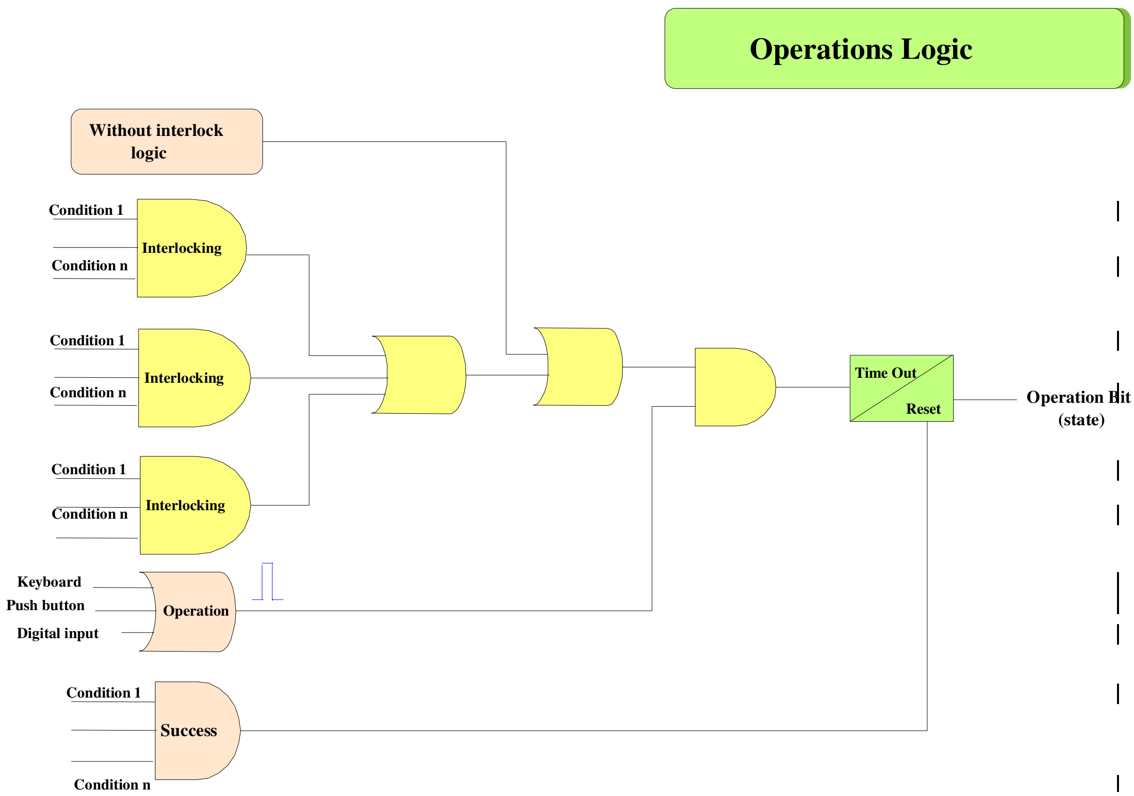


Figure 5–41: OPERATION LOGIC DIAGRAM

5.8.3.1 HOW TO PROGRAM AN OPERATION

Example of how to program an operation to close a breaker with an operating time of 90 ms (closing), incorporating 52/b contacts to indicate the change of position, using an interlock logic to enable the operation if there is no autoreclose in progress. The operation must be commanded from the relay faceplate using one of the available operation push buttons.

To configure the related operation, go to ***Setpoint > Relay Configuration*** and select ***Operations*** tab.

This screen shows all the fields required for the operations configuration in the G650. In order to select an operation, press on the operation name under the ***Select*** column, and all the related parameters will be enabled. The chosen name for the operation is entered in "***Command Text***". To configure an interlock logic, select the ***Logic*** option in "***Interlocks Type***". Once this option has been selected, the interlock configuration screen will be enabled. To display this screen, click on "***Press for Logic***" for the desired operation on its ***Interlocks*** column. On this ***Interlocks*** screen, the two conditions that conform the Interlock that enables the operation have been selected. To save the interlock, press on the disk icon on the toolbar. A "***Logic Saved***" message will be displayed.

Once the Interlocks have been defined, the user must define the success conditions for the operation, define ***Final State Type*** as LOGIC, and a "PRESS FOR LOGIC" message will light up below ***Final States***. When clicking on "PRESS FOR LOGIC", the success condition screen will be displayed, defining there as BREAKER CLOSED.

The front key to be used for executing the Operation can be selected on the Frontal Key column, in this example the **Key I** option is selected on "***Frontal Key***". As none of the other contact input or virtual output options are going to be used they will be set as **None**. The success condition time "***Time out***" is set to **500 ms**, and the operation is only enabled through the relay keypad, so only the **MMI** option is selected, thus disabling the rest of options (COM1, COM2, ETHERNET master are not selected).

All the selections previously related are summarized in the following table:

5

Table 5–110: OPERATION SETTINGS

OPERATION	COMMAND TEXT	SETTINGS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK (LOGIC)	
		FINAL STATES (LOGIC)	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	MMI

Finally, configure a contact output to be activated with the programmed Operation (Operation1).

This is done in the menu ***Setpoint > Relay Configuration > Output***, selecting an output and choosing the internal signal OPERATION BIT 1, which corresponds to the bit that is activated when the related operation is executed.

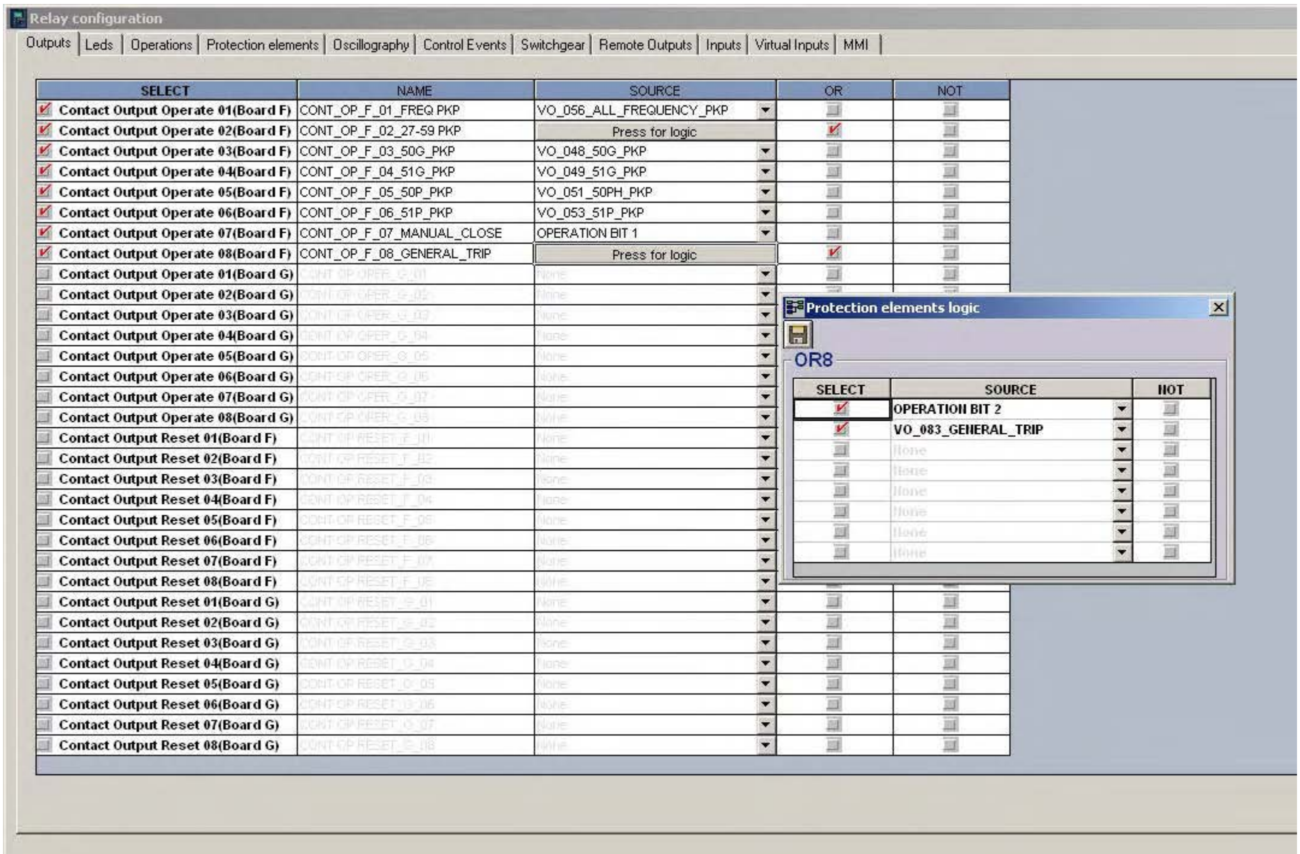


Figure 5–42: CONTACT OUTPUT CONFIGURATION

Note: Operations time out for confirmation

Configurable screen in graphical HMI: In the relay HMI the configurable objects wait one minute for confirmation after operation selection. The object will be blinking during one minute. After that time, the object will be deselected.

Front Keys: In operations performed by front keys, the time out for confirmation is 10 seconds.

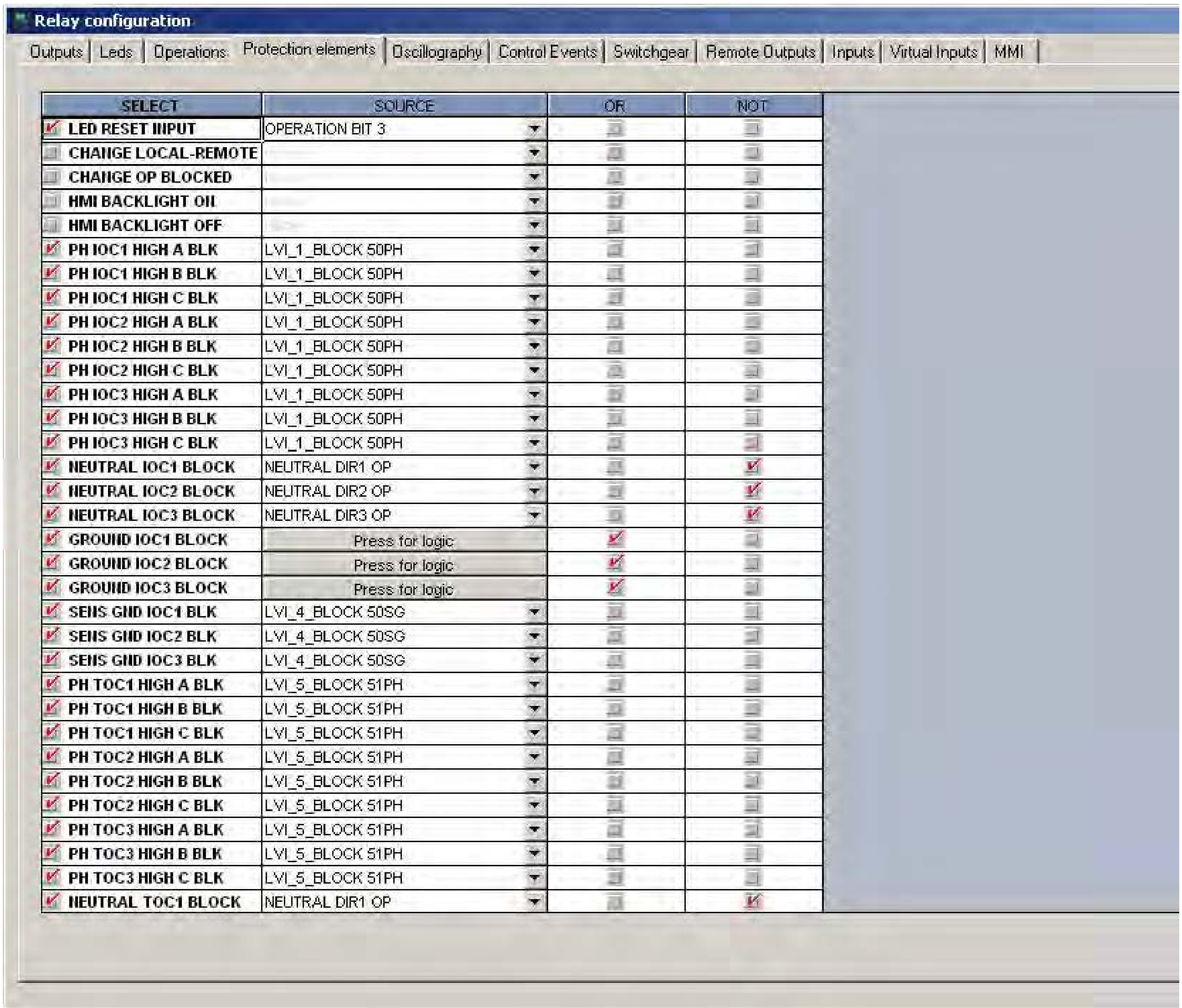
5.8.4 PROTECTION ELEMENTS

This tab allows assigning operands (logic signals) as inputs to different protection elements. This way, the user assigns etc. In this screen we can also configure a logic signal to perform the LED reset by communications.

The settings are as follows:

- ***Select*** checkbox enables/disables the selection.
- ***Source*** setting defines the operand that performs the function indicated in the SELECT column. ***NOT*** setting inverts the block signal.
- ***NOT*** setting for inverting the logic signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces the operation.

The following figure shows this screen:



SELECT	SOURCE	OR	NOT
✓ LED RESET INPUT	OPERATION BIT 3		
CHANGE LOCAL-REMOTE			
CHANGE OP BLOCKED			
HMI BACKLIGHT ON			
HMI BACKLIGHT OFF			
✓ PH IOC1 HIGH A BLK	LVI_1_BLOCK 50PH		
✓ PH IOC1 HIGH B BLK	LVI_1_BLOCK 50PH		
✓ PH IOC1 HIGH C BLK	LVI_1_BLOCK 50PH		
✓ PH IOC2 HIGH A BLK	LVI_1_BLOCK 50PH		
✓ PH IOC2 HIGH B BLK	LVI_1_BLOCK 50PH		
✓ PH IOC2 HIGH C BLK	LVI_1_BLOCK 50PH		
✓ PH IOC3 HIGH A BLK	LVI_1_BLOCK 50PH		
✓ PH IOC3 HIGH B BLK	LVI_1_BLOCK 50PH		
✓ PH IOC3 HIGH C BLK	LVI_1_BLOCK 50PH		
✓ NEUTRAL IOC1 BLOCK	NEUTRAL DIR1 OP		✓
✓ NEUTRAL IOC2 BLOCK	NEUTRAL DIR2 OP		✓
✓ NEUTRAL IOC3 BLOCK	NEUTRAL DIR3 OP		✓
✓ GROUND IOC1 BLOCK	Press for logic	✓	
✓ GROUND IOC2 BLOCK	Press for logic	✓	
✓ GROUND IOC3 BLOCK	Press for logic	✓	
✓ SENS GND IOC1 BLK	LVI_4_BLOCK 50SG		
✓ SENS GND IOC2 BLK	LVI_4_BLOCK 50SG		
✓ SENS GND IOC3 BLK	LVI_4_BLOCK 50SG		
✓ PH TOC1 HIGH A BLK	LVI_5_BLOCK 51PH		
✓ PH TOC1 HIGH B BLK	LVI_5_BLOCK 51PH		
✓ PH TOC1 HIGH C BLK	LVI_5_BLOCK 51PH		
✓ PH TOC2 HIGH A BLK	LVI_5_BLOCK 51PH		
✓ PH TOC2 HIGH B BLK	LVI_5_BLOCK 51PH		
✓ PH TOC2 HIGH C BLK	LVI_5_BLOCK 51PH		
✓ PH TOC3 HIGH A BLK	LVI_5_BLOCK 51PH		
✓ PH TOC3 HIGH B BLK	LVI_5_BLOCK 51PH		
✓ PH TOC3 HIGH C BLK	LVI_5_BLOCK 51PH		
✓ NEUTRAL TOC1 BLOCK	NEUTRAL DIR1 OP		✓

Figure 5–43: PROTECTION ELEMENTS

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5.8.5 OSCILLOGRAPHY

This menu is used for selecting the digital channels to be included in oscillography records, and the oscillo trigger signal. As for the above-described settings, the trigger selection can be any of the signals provided by the relay or a logic combination of these.

settings are described below:

- ***Select*** checkbox enables or disables a digital channel and the oscillography trigger.
- ***Name*** setting defines the name of the digital channel to be included in oscillography records.
- ***Source*** setting defines the source or signal to be recorded in that specific channel, which can be selected among all the operands available in the signals menu.
- ***NOT*** checkbox inverts the enabled digital channel signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.

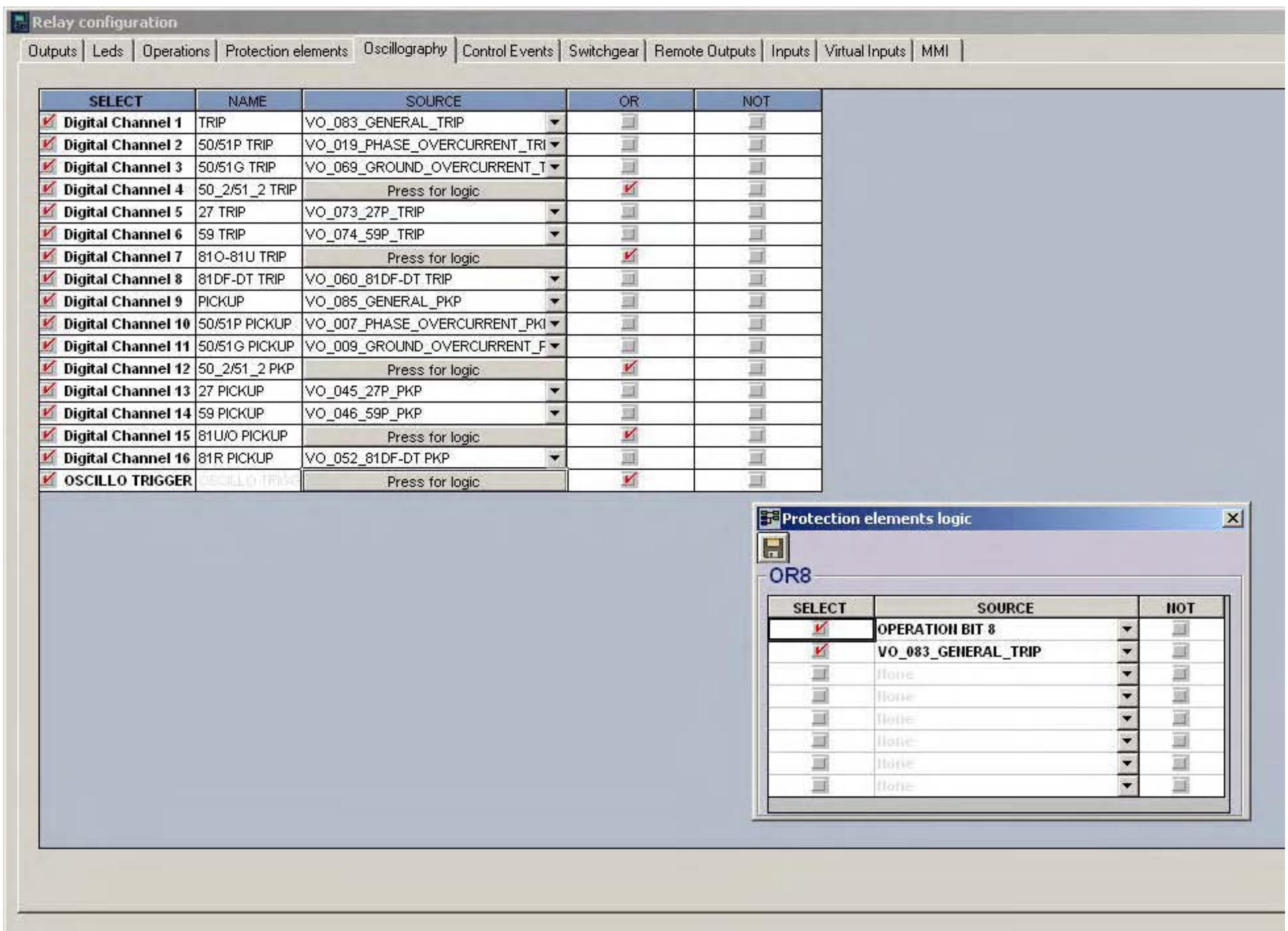

Figure 5–44: OSCILLOGRAPHY CONFIGURATION

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.

5.8.6 CONTROL EVENTS

This menu is used for defining the ***CONTROL EVENTS***, up to 128 user programmable events.

A control event is a logic signal associated to an operand or combination of operands which monitories the change of status of the logic operand. The relay shows which events are active each time, as well as their date and time of activation.

There are 128 user programmable events and 64 pre-established events for switchgear, which correspond to opening, closing, Error00 and Error11 of the 16 programmable switchgear elements. (Please refer to section 5.8.8 for more detailed information).

As for the rest of previous settings, the source selection can be made between:

- An operand, selecting it directly on this screen.
- An **OR** of several operands, selecting directly the **OR** column in this same menu.
- A logic combination of operands, by selecting a VIRTUAL OUTPUT as trigger source, and using the logic configuration available in the relay, graphical PLC, that allows to design logic circuits and to assign their outputs to internal variables, called VIRTUAL OUTPUT.

Available settings are as follows:

- ***Select*** checkbox: enables or disables the generation of each event.
- ***Name*** setting: defines the text for each control event.
- ***Source*** setting defines the source that will trigger the event. The source is chosen from the list that shows all the operands available in the element.
- ***NOT*** checkbox inverts the selected signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.
- ***Alarm*** checkbox: allows treating the event as an alarm and making the event activation to be reported on the alarm panel.

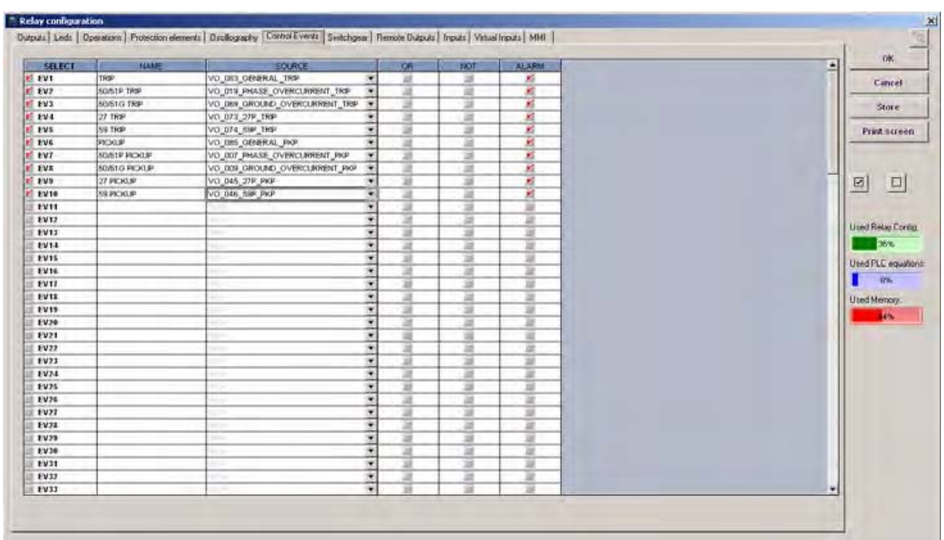

Figure 5–45: CONTROL EVENTS CONFIGURATION

The Alarm panel can be displayed in:

HMI screen for models with graphical display.

EnerVista 650 Setup: ***Actual>Event Recorder>Alarm Panel*** for all models.

Web Server application: ***http://xxx. xxx. xxx. xxx /Alarms.htm*** for all models.

If the event is not selected as an alarm, it can be viewed as an event at:

HMI screen for all models in snapshot event screen (with default text).

EnerVista 650 Setup: ***Actual>Event Recorder> Control Events*** for all models.

Web Server application: ***http://xxx.xxx.xxx.xxx/ControlEvents.htm*** for all models.

Alarm management in G650:

The relay can manage alarms in from three different masters, local, remote COM1, remote Ethernet. The alarms can be active or not active and can be acknowledged or not acknowledged. As shown in the following table:

Table 5–111: ALARM MANAGEMENT

ALARM STATUS	MASTER MANAGEMENT		
ACTIVE - NOT ACTIVE	ALL MASTERS		
ACKNOWLEDGED - NOT ACKNOWLEDGED	LOCAL	REMOTE	
	COM2 & HMI	COM1	ETHERNET

ACTIVE status is shown on the display (relay HMI), showing an ON label on the right of the alarm. The PC will show the alarm text in red color.

ACKNOWLEDGED: Operation acknowledgement can be performed from three independent channels: MMI-COM2 (local), COM1 (remote) and COM3 (Ethernet). Inactive alarms disappear from the HMI when being acknowledged.

HMI: Acknowledged status is shown on the HMI with a selection mark on the right of the ON label.

EnerVista 650 Setup: the acknowledged status is shown by a check mark to the left of the Operation name.

5.8.7 SWITCHGEAR

This menu is used for defining the SWITCHGEAR elements to be controlled by the relay. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. It is possible to define up to 16 switchgear elements. The settings are as follows:

- ***Select*** checkbox: enables or disables the control of a new switchgear element
- ***Contacts*** setting: allows selecting which type of contact is used for monitoring the status (open/closed) of the element. The selection can be: ***52a*** (contact type A, showing the same status as the represented element), ***52b*** (opposite status to the represented element), ***52a+52b*** (both types of contacts are used), ***NONE*** (no status monitoring).
- ***Opening Time*** setting: defines the maximum opening time of an element. It is used for issuing an opening time failure signal if the element opening is not produced within this time.
- ***Closing Time*** setting: defines the maximum closing time of an element. It is used for issuing a closing time failure signal if the element closing is not produced within this time.
- ***Contact A*** checkbox: allows selecting which operand or combination of operands activate the type A contact status. Usually it will be an input contact wired to type A contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52a*** or ***52a+52b***.
- ***OR*** checkbox: selects a group of operands instead of a single one. The relay performs and OR of the signals, and its output produces operation.
- ***NOT*** checkbox inverts the status of the signal selected in column ***Contact A***.
- ***Contact B*** checkbox: allows selecting which operand or combination of operands activates the type B contact status. Usually it will be an input contact wired to type B contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52b*** or ***52a+52b***.

  •***OR*** checkbox selects a group of operands instead of a single one. The relay performs OR of the signals, and its output produces operation.

  •***NOT*** checkbox inverts the status of the signal selected in column ***Contact B***.
- ***Open text*** setting: allows associating a text to the control event associated to the element opening.
- ***Close text*** setting: allows associating a text to the control event associated to the element closing.
- ***Error 00 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error00 internal status, this means, when both contacts are inactive during a period longer than the associated to the opening or closing Operation, depending on which Operation is being performed.
- ***Error 11 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error11 internal status, this means, when both contacts are active during a period longer than the associated to the opening or closing Operation, depending on which Operation is being performed.
- ***ALARM*** setting: enables the issue of an alarm in the event of a close, open, 00-type, 11-type error. If it is configured as an alarm.
- ***Opening init*** setting: this setting selects which operand or combination of operands indicate the initiation of an opening operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the opening init must be configured in the operations tab inside relay configuration.
- ***Closing init*** setting: this setting selects which operand or combination of operands indicate the initiation of a closing operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the opening init must be configured in the operations tab inside relay configuration.

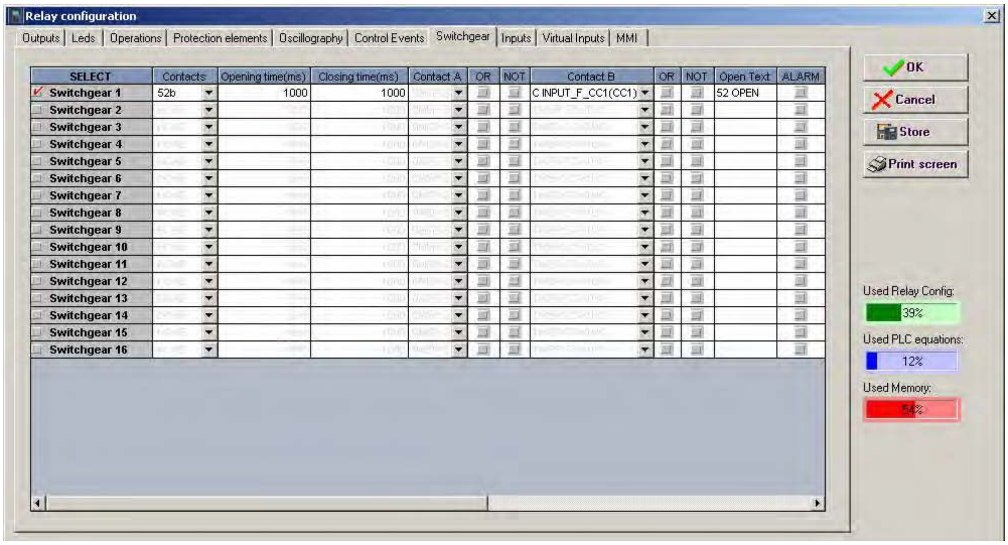

Figure 5–46: SWITCHGEAR CONFIGURATION

Note: when a switchgear device is only monitored (open init and closing init signals are not used), it is not possible to distinguish between the fail to open or fail to close time, the time used to give an error 00 or 11 signal is the maximum of the opening and closing time configured for that switchgear.

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5.8.8 HMI (HUMAN-MACHINE INTERFACE)

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.

To use the drawing toolbar elements, the desired element must be select with the mouse and then click on the yellow area. The selected element will be moved to the screen on the selected spot (see Figure 5–47:).

The graphic display can be used to configured switchgear elements, operations, metering values, date and time, etc. The configured values will always be updated with the real status of the relay.

This functionality is only applicable to G650 elements with graphical display(240x128pixels), and not for elements with alphanumerical display (20x4 characters). Depending on the relay model, the graphical display can show IEC 1082-1 symbols (N selection in ordering code).

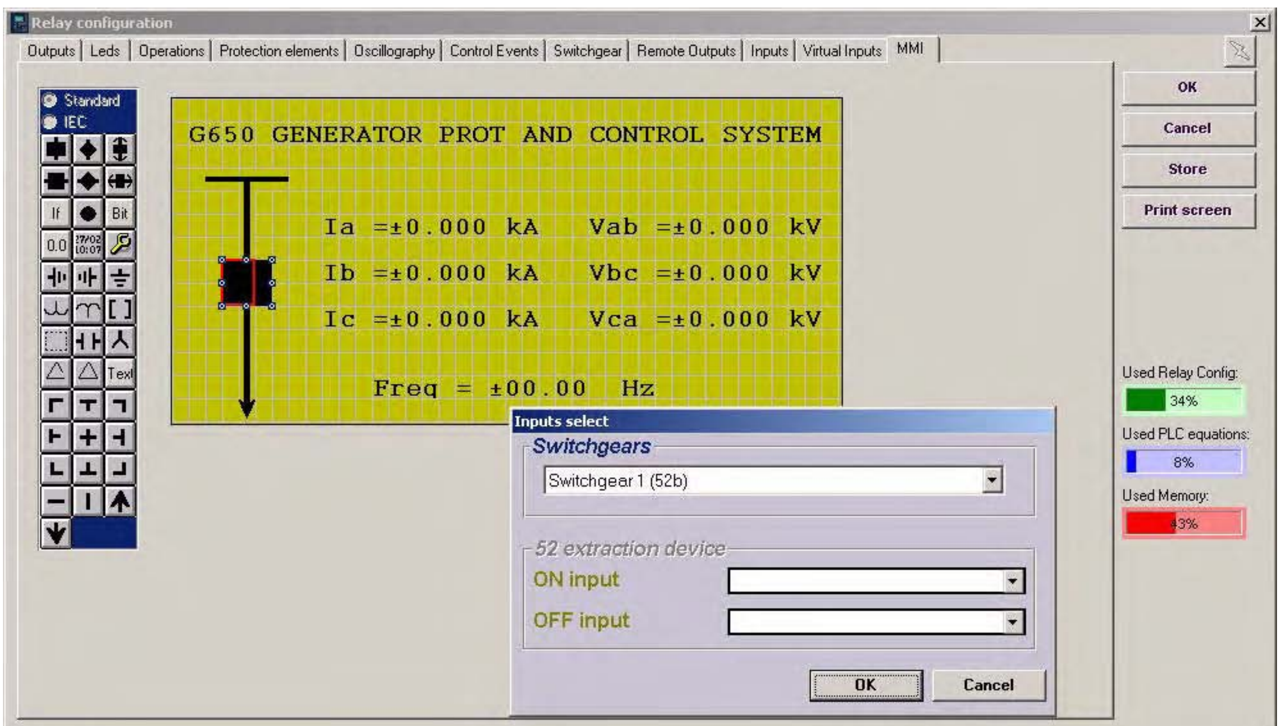
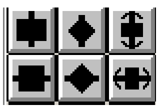
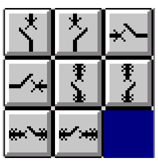
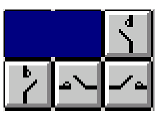
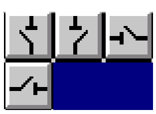
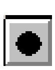


Figure 5–47: HMI CONFIGURATION

On the left side of the window all the available elements to be programmed on the HMI are displayed. Their meaning is detailed on the right.

Table 5–112: ACTIVE SYMBOLS CONFIGURABLE IN ONE-LINE DIAGRAM FOR GRAPHICAL HMI

ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
SWITCHGEAR SYMBOLS	STANDARD AND IEC 1082-1 SWITCHGEAR SYMBOLS
STANDARD SWITCHGEAR SYMBOLS	M and C selection for graphic display option in the ordering code
	These symbols correspond to switchgear elements: breaker (square) and selector switch (rhombus), in vertical and horizontal positions. It is necessary to associate the figure to its corresponding switchgear number. The figure is shown filled if the element is closed, and blank if the element is open. The symbol on the right represents an unpluggable breaker. In this case it is necessary to indicate which operands show whether the element is plugged or unplugged. The figure shows also graphically these two statuses.
IEC SWITCHGEAR SYMBOLS	N and C selection for graphic display option in the ordering code
	These symbols correspond to breakers and. breaker trucks in vertical and horizontal positions. The first fourth symbols are breakers in vertical and horizontal positions for left and right options. The last fourth symbols are breaker trucks or unpluggable breakers. When the device is connected two arrows can be seen, if the device is not connected only one arrow is displayed. When the device it is inserted the device can be seen and when it is not inserted only a blank space will be displayed
	These symbols correspond to contactors in vertical and horizontal positions
	These symbols correspond to selector switches in vertical and horizontal positions.
OTHER CONFIGURABLE SYMBOLS	Available for both M, N, C and D selection
STATUS SYMBOLS	(TEXT AND GRAPHIC MODES):
	Bit: Represents the state of an operand by means of a configurable text. It allows associating a test to the active status and a different text to the inactive status.
	Led(O) Performs the same function in a graphical mode. This way, it works as a virtual LED. When showing a black circle, it means that the selected operand is active, and if the circle is blank, the operand is inactive
ANALOG MAGNITUDE SYMBOL	
	Used for displaying analog magnitudes (current, voltage, power, etc.) in floating point numbers, such as a current value (123.5 A). Both the number of decimals and the integer characters can be selected, in order to facilitate the reading. Any of the analog magnitudes available in the relay can be configured.

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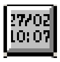
ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
DATE AND TIME SYMBOL	
	Symbol used for displaying in the HMI the date and time provided by the device.
OPERATIONS SYMBOL	
	This symbol indicates the possibility to configure and execute operations on the graphic display. This symbol can only be selected once the operations have already been configured in the “***Operations***” screen of the “***Relay Configuration***” menu. To select an Operation, click on the element and then on the display. The program will show a window to select the required operation among the displayed options, and the tab order. Once selected, a red border square will be shown. Place this square on the object to be operated. When the operated object is selected on the screen to execute this operation, the object on which it is located will blink. It is possible to place several operations on the same object, for example to open and close the breaker object.
	This symbol indicates the possibility to configure and execute operations with the frontal keys "I" and "O" on the graphic display over an object selected. To select the object, click on the element and then on the display. The program will show a window to select the required operations "I" and "O" among the displayed options, and the tab order. Once selected, a blue border square will be shown. Place this square on the object to be operated. When the object is selected on the screen to execute this operations, the object on which it is located will blink, then press key "I" or "O" to execute the operations configured.

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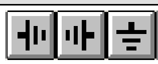
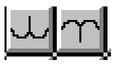
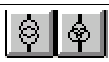
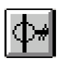
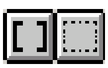
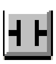
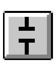
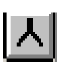
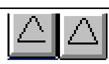
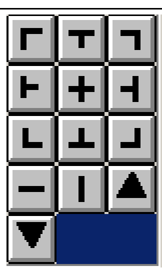
Table 5–113: GRAPHIC AND TEXT EDITION SYMBOLS

GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	**DESCRIPTION**	**AVAILABILITY**
	Ground symbols in different positions.	The first two are not available in the N model (IEC selection).
	Voltage Transformers representation	Only for standard model M.
	Two and three winding voltage transformers representation.	Only for N model (IEC selection)
	Current transformer representation	Only for N model (IEC selection).
	Symbols reserved for future uses	Both M and N selection
	Symbol for capacitor banks.	Both M and N selection
	Symbol for vertical capacitor banks.	Only for N model (IEC selection).
	Symbol for wye connection	Both M and N selection
	Symbol for open delta and delta connection	Both M and N selection
	Display of a fix text up to 40 ASCII characters	Both M and N selection
	Auxiliary drawing lines	Both M and N selection

Setpoint > Logic Configuration

The G650 logic allows setting the relay logic configuration using a sophisticated and complete program based on standard IEC 61131-3, with block diagrams, which is described in this section.

5.9.1 INTRODUCTION

The logic configuration (or PLC Editor) tool is a graphical design tool that allows the G650 built complex logic diagram in an easy way using different logic functions.

The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.

- **This standard defines five basic ways of programming:**
  - Sequential Function Chart (SFC).
  - Instruction List (IL).
  - Structured Text (ST).
  - Ladder Diagram (LD).
  - Function Block Diagram (FBD).

Out of these five methods, FBD has been chosen because it allows for graphical configurations that are more comprehensive. This method provides the possibility of grouping several basic functions inside a single function (hereon called libraries), achieving higher modularity and clarity in the design.

Please take note of the following remarks:
The first equation entered in the PLC can never be a timer
Analog elements (analog comparators, etc,) are not implemented.

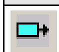
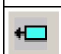
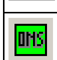
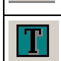
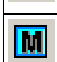
5.9.2 THEORY OF OPERATION

5.9.2.1 DESCRIPTION

As already mentioned in the introduction, this tool uses FBD mode of IEC 61131-3 standard. For this purpose we have defined a series of basic operations with illustrations below.

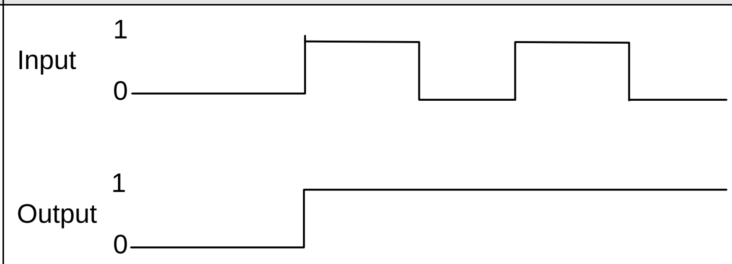
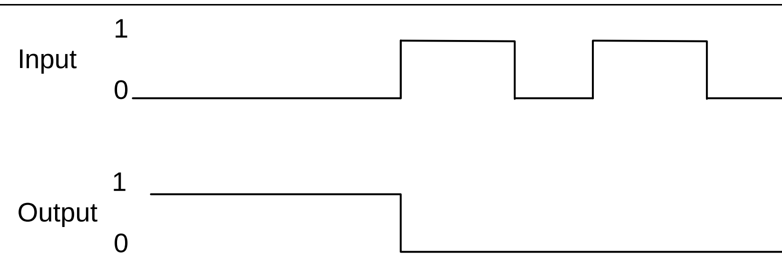
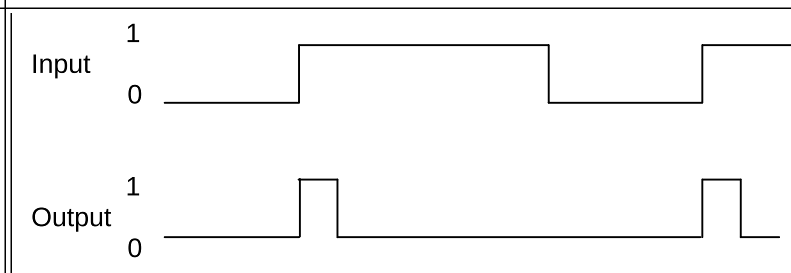
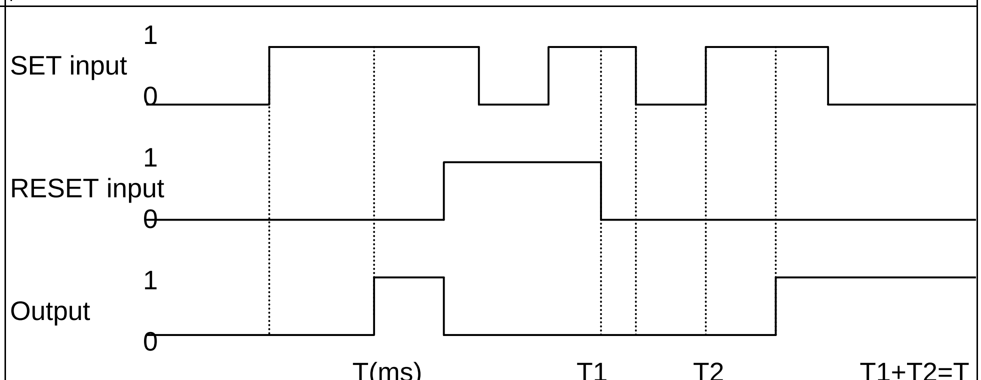
The basic operations available in PLC Editor are located in the tool bar of the application and are as follows:

Table 5–114: PLC EDITOR BASIC OPERATION IN G650

PLC EDITOR BASIC OPERATION	
ICONS IN SCREEN	**DESCRIPTION**
	INPUT TO LOGIC: Selection of the digital input to the logic. (All available internal status can be used as logic inputs)
	OUTPUT FROM LOGIC: Virtual output built with internal logic. (Up to 512)
	LIBRARY: Possibility to build blocks of logic in a simple graphic object. OR and AND from 3 to 8 inputs are provided as libraries.
	AND of two digital inputs.
	OR of two digital inputs.
	NOT of a digital input.
	NAND of two digital inputs.
	XOR of two digital inputs.
	SR: Latch (set-reset): reset dominant.
	ONS: signal to pulse an logic input to a signal of one scan cycle length.
	TIMER: timer signal with set, reset and mask for timing.
	TEXT LABEL: text to customize the logic configuration file.
	Flip-Flop D: signal that maintains the actual value frozen during a PLC cycle
	MASK: Time mask to be used in timing operations.

Example of logic signals in G650 logic configuration:

Table 5–115: LOGIC SIGNALS IN G650

LOGIC SIGNALS EXAMPLES		
SIGNAL	**DESCRIPTION**	**TIME DIAGRAM**
SET	When the input signal is set to 1 the output signal remain fixed to 1 till a reset signal is received.	
RESET	When the input signal is reset to 1 the output signal remain fixed to 0.	
ONS	The input signal is pulsed. The width of the output pulse will be the same as that of the PLC cycle	
TIMER	With selectable time (MASK), one SET input and one RESET input	

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5.9.2.2 LOGIC COMPILATION

The G650 configuration will be made using the basic operations related before and more complex operations can be developed inside libraries.

All the graphical configuration performed in the Logic configuration editor must be read and interpreted by the PLC as the G650 engine. The graphical equations must be translated into compiled equations to be understood by the relay. For this purpose the logic configuration editor provides a compilation option to compile the whole configuration, creating a series of equations that will form the logical configuration of the element.

The next diagram shows the way compiled logic equations are built.

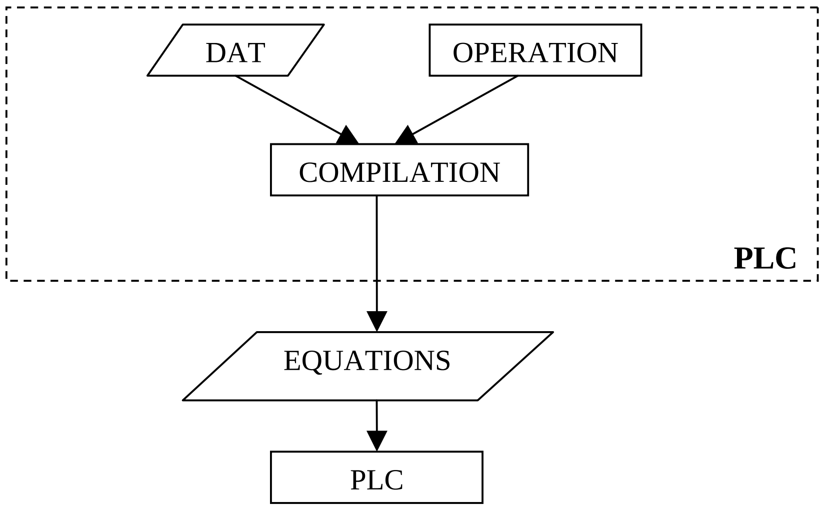

Figure 5–48: COMPILED LOGIC EQUATIONS

A single equation is composed of one or more inputs, one or more operations, and one output. The order of equations is determined by the relative position of their outputs.

In the following example is shown the order of compilation for equations determined by their relative position in the configuration file:

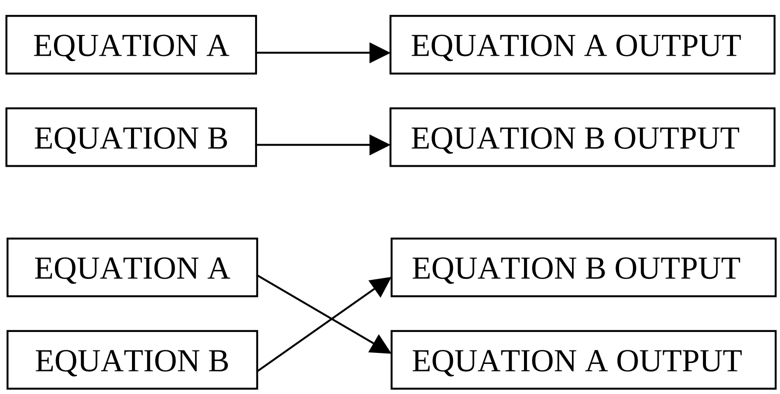

Figure 5–49: ORDER OF EQUATIONS

In this case, equation A is the first to be executed. However, in the second case, the first equation to be executed would be B, as its output is before the Equation A output.

5.9.3 MAIN MENU

The PLC Editor tool *(Setpoint > Logic Configuration)* provides a main menu with different submenus (File, Project, Edit, Run, View, and Window) that allows the user to built customized logic for the G650 devices.

5.9.3.1 FILE MENU

The FILE menu includes the following options:

New Project: allows to create a new project that will include the files of the logic configuration

Open Project: opens an existing project.

Close Project: closes the currently open project.

Save Project and Save Project as: saves the open project.

Save Automatic Function &

Save Automatic Function As: Saves the file of the active project.

Library: Gives access to the libraries sub-menus, where new libraries can be created and existing ones can be modified and saved.

Print: Prints the active configuration file.

Preview: Preview of the document before printing.

Exit: The system closes all open projects and exits the application.

5.9.3.2 PROJECT MENU

The Project menu includes the following options:

Project Explorer: Displays a window where we see a tree structure with the files contained in the project.

Insert library: Inserts a library in the active automatic function.

5.9.3.3 EDIT MENU

The Edit menu includes the following options:

Undo: Undoes the last modification in the active function.

Redo: Remakes the last modification.

Cut: Cuts one or more logic operations.

Copy: Copies one or more logic operations.

Paste: Pastes one or more logic operations.

Find: Looks for a logic operation in the project.

Copy as Bitmap: Copies the active automatic function to the clipboard in picture format.

View Clipboard: Launches the clipboard viewer application.

5.9.3.4 RUN MENU

The RUN menu includes the following options:

Configuration: Not valid in the current application (for analog operations still not available)

Compile: Compiles the configuration functions to generate the equations that will be interpreted by the 650 PLC.

Send Equations to Relay

5.9.3.5 VIEW MENU

The VIEW menu includes the following options:

Log: Displays in one screen the status name and time stamp of the digital statuses configured in the PLC logic (still not available).

Debug-Release window: Displays the values for the different project inputs, outputs, and variables (still not available).

Equations: Displays the equations resulting from the compilation.

Grid: Shows or hides the form grid where the configuration functions are developed. It also aligns the different objects to the grid.

Zoom: Allows selecting the percentage of zoom in the application.

Rectangle Zoom (Zoom rectangular): Allows zooming the Selected rectangle.

5.9.4 CONFIGURATION GENERATION

5.9.4.1 CREATE A NEW PROJECT

Clicking on the *"File > New Project"* menu option, a new PLC project is open, where the user can program the desired automatism. An automatism can be formed by one or more equations.

5.9.4.2 CREATE EQUATION

A single equation can be formed by one or more inputs, one or more operations, and one output.

The order of equations is determined by the relative position of their respective outputs, this order being downward.

To link the output of an equation with the input of another equation, an internal variable (virtual output) must be used.

The virtual output is used as an input to the second equation.

5.9.4.3 ADD AN INPUT TO AN AUTOMATISM

Using the mouse click on the button that represents the inputs in the toolbar at the top of the screen. A logic input can be any of the available digital internal status provided by the relay. Such as protection status, contact inputs, contact outputs, I/O status, other protection status, front keys, LEDs, operation bits, virtual inputs and virtual outputs.

5.9.4.4 ADD AN OUTPUT TO AN AUTOMATISM

Using the mouse click on the button that represents the outputs in the toolbar at the top of the screen. The logic outputs are always virtual outputs (up to 512 configurable signals).

5.9.4.5 ADD A DIGITAL OPERATION

Press on any of the digital operations in the toolbar at the top of the screen, and then click on the window background. Afterward a box with the selected digital operation will be displayed and the inputs and outputs much be connected to the logic box as explained before.

5.9.4.6 LINK INPUTS, OUTPUTS AND OPERATIONS

The user can link the different graphic objects clicking on an object output and dragging to the input of another graphic object. Graphic objects available in the PLC configuration are digital objects.

There is a series of restrictions when performing connections:

It is not possible to auto-link an object; the output of a certain object cannot be linked to its input;

There can only be one input per object input;

RESET and SET outputs must be internal variables or outputs.

We must take into account that as the timer is a digital operation that operates as an analog, there must only be a single internal variable or digital input in the timer input.

5.9.4.7 ADD A LIBRARY

Click on the “LIB” button and select the corresponding file.

Users can build their own libraries and distribute them in their projects in an easy way.

The manufacturer provides default libraries such as ORs, ANDs of 3 up to 8 inputs, besides timers (pickup-dropout) and key examples.

5.9.5 GENERATION OF LIBRARIES

Libraries can contain a set of operations grouped in a single graphic object being formed by inputs, outputs and operations

Working with libraries follows the same procedure as working in the main project menu, the only difference is that the inputs and outputs to the library must be selected as external inputs and outputs. The rest of variables are internal variables used in the logic compilation.

The name assigned to the inputs and outputs of the library and to the library itself will be ones used to represent the library as an object in the main project.

Internal variables inside the libraries will be assigned randomly when compiling.

These libraries are saved in the LIB folder in order to be used in further projects

5.9.5.1 LIBRARY EXAMPLE

Go to the main menu ***File >Library > Open Library***

> New Library

Open a new library or modify an existing one, in this example a timer library is going to be displayed Timer (Pkp-Dpt).lib as shown on Figure 5–50:

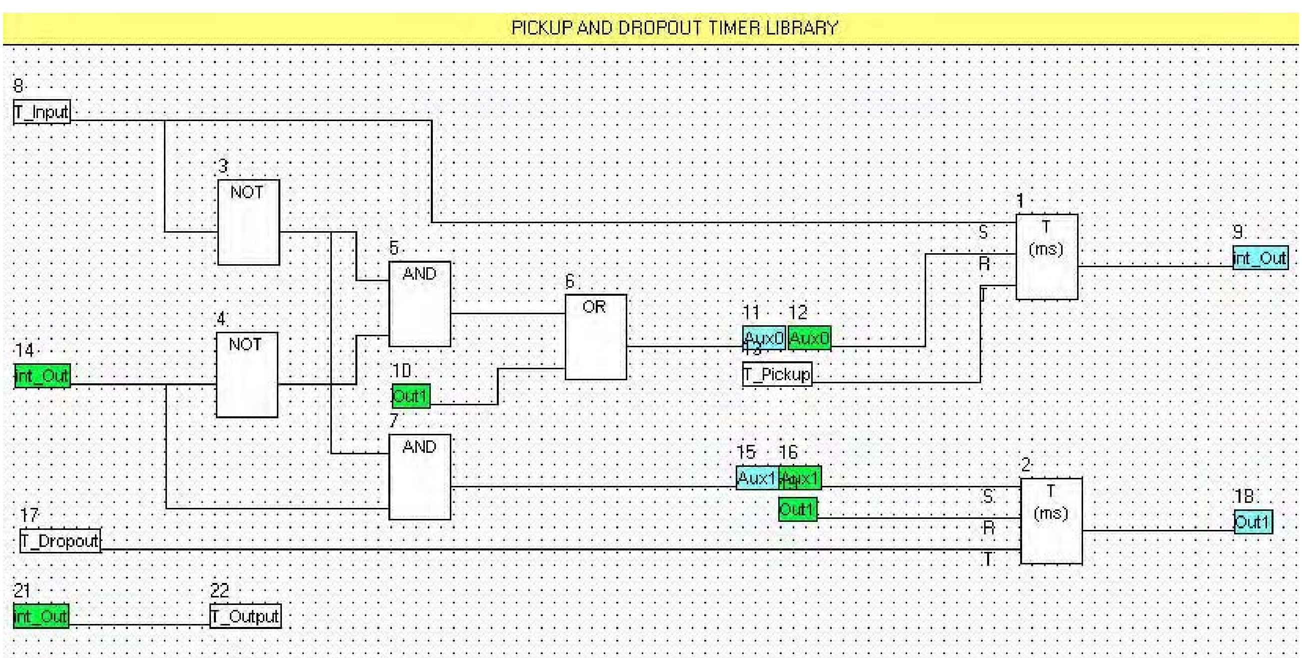

Figure 5–50: TIMER (PKP-DPT).LIB CONFIGURATION EXAMPLE

Green and blue signals are internal inputs and outputs used in the library and are not going to be accessible to the user when working in the main menu outside the library environment. The white boxes (T_Input, T_Pickup, T_Dropout, T_output) are inputs and outputs to the library that are going to be accessible to the user to connect the library in the main application to create virtual outputs to be sent to the relay.

Once the library is created and saved it can be selected in the main application menu in ***Project > Insert Library.*** The library will have the following object:

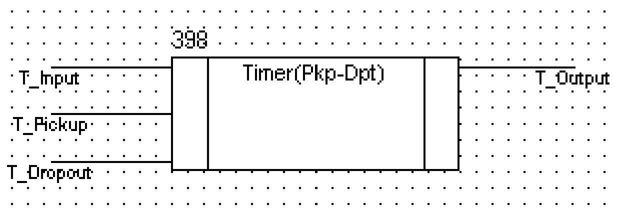

Figure 5–51: LIBRARY OBJECT

5.9.6 EXAMPLE OF APPLICATION

In this section a simple logic application is described step by step, a logic is such that keeping one digital input activated, several outputs will be activated and deactivated in a time window (outputs will remain activated for 200 ms and deactivated for 5 ms). See the following figure:

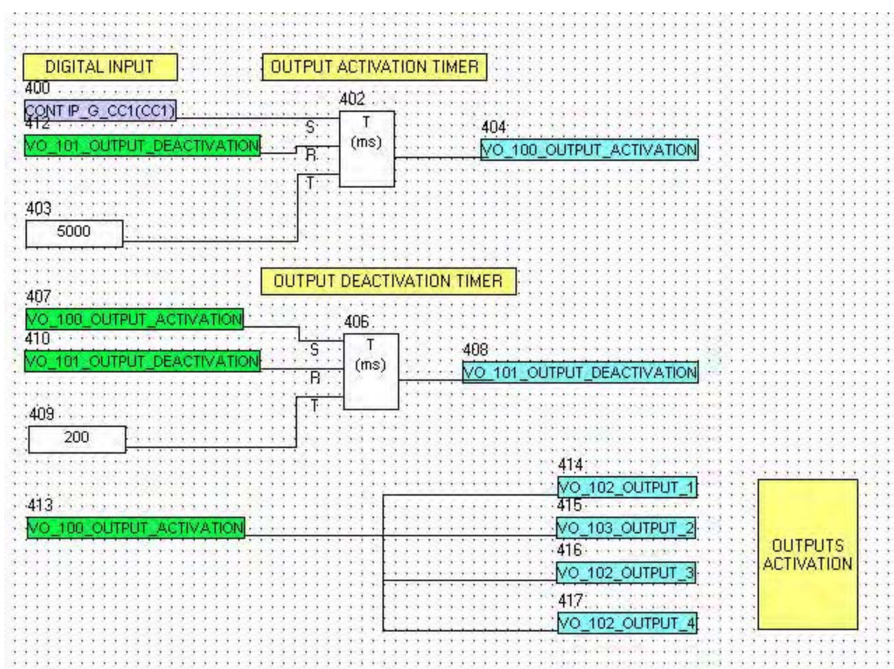

Figure 5–52: LOGIC EXAMPLE

Go to the main menu and select ***File >New project***, create a new project and select an input in the icons toolbar on the top of the window. This input will be selected as a digital input among the several options for inputs that can be selected. This input is the SET input for the first timer to launch the output activation signal. Click on the icon related to the timer to insert the timer on the project. The timer has three inputs (S=set, R=reset and T=timing input)

The reset signal of the first timer is a virtual output called output_deactivation that has been created as an output of another second timer. This signal is selected as an output

The timing signal for the first timer is a mask provided by the application, in which the time in milliseconds must be entered in order to configure the timer time delay.

After creating the first timer, the second one for output deactivation is made. The set signal will be the virtual output created as an output of the first timer (VO_100_OUTPUT_ACTIVATION), the reset signal will be the output of the second timer (VO_100_OUTPUT_DEACTIVATION), the time delay is set as 200 ms.

Once the timing logic (timer 1 + timer 2) has been created, the activation signal (VO_100_OUTPUT_ACTIVATION) is linked to several virtual outputs. Therefore, virtual outputs (VO_102_OUTPUT_1, VO_103_OUTPUT_2, VO_104_OUTPUT_3, VO_105_OUTPUT_4) will be activated if the CONT IP_G_CC1(CC1) variable is set to 1. Once the VO_100_OUTPUT_ACTIVATION is active, it will be deactivated after 200 ms, and will remain deactivated for 5 seconds. This process will be repeated while the digital input is active.

To finish the process the logic must be compiled (***Run >Compile***) and the equations sent to the relay (***Run >Send Equations to relay***) to start working with the new logic.

5

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This menu is divided in several submenus that will be detailed in the following sections.

6.1.1 LEDS

Operation of the relay front LEDs is shown on the following figure (***Actual > Front Panel > LEDs***) by the lighting of the associated LED in the appropriate color. The Ready LED is green when the relay is in service. LEDs 1 to 5 light up in red when active, LEDs 6 to 10 light up in orange, and the last 5 LEDs light up in green.

The first five LEDs are latched by hardware and can only be reset by a LEDs RESET Command, either pressing the “esc” key on the Front of the Relay, or by Communications using the appropriate signal. The rest of LEDs are not latched, but can be latched by logic.

Table 6–1: FRONT PANEL LEDS

LEDS
READY LED
LED 1
LED 2
LED 3
LED 4
LED 5
LED 6
LED 7
LED 8
LED 9
LED 10
LED 11
LED 12
LED 13
LED 14
LED 15
LOCAL OPERATION MODE
OPERATIONS BLOCKED

6.2.1 OPERATION BITS

(***Actual > Status > Operation bits***)

OPERATION BIT 1...24 These 24 bits are the outputs of each possible Operation modules, programmed in menu ***Setpoint > Relay Configuration > Operations***. The light up LED indicates their status 1 (activation)

Table 6–2: OPERATION BITS

OPERATION BITS
OPERATION BIT 1
OPERATION BIT 2
…
OPERATION BIT 24

6.2.2 BREAKER

The signals associated to the opened or closed status of the breaker can be monitored at "***Actual > Status > Breaker***"

Table 6–3: BREAKER STATUS

BREAKER STATUS
BREAKER OPEN
BREAKER CLOSED
BREAKER UNDEFINED

BREAKER OPEN: Open breaker status. In the switchgear selected as breaker, besides providing the usual switchgear contact status, the system provides also the open breaker, closed breaker, and undefined breaker states.

BREAKER CLOSED: Breaker closed.

BREAKER UNDEFINED: If there are two digital inputs configured for breaker contacts 52/a and 52/b, this status will be present when both inputs are at 0 or at 1. This status can be caused by a wiring failure, failure of auxiliary elements, etc.

6.2.3 PROTECTION

6.2.3.1 PROTECTION BLOCKS

(***Actual > Status > Protection > Protection Blocks***)

This screen shows the entire protection element blocks available. If the protection element is blocked, the green LED located on the right side of the text will light up and will remain lit as long as the element remains blocked.

Protection elements block signals are configured at ***Setpoint > Relay Configuration > Protection Elements***.

Table 6–4: PROTECTION ELEMENTS BLOCK

IOC BLOCK SIGNALS	TOC BLOCK SIGNALS	DIRECTIONAL BLOCKS	VOLTAGE BLOCKS
PH IOC1 HIGH A /B / C BLK	PH TOC1 HIGH A /B /C BLK	NEUTRAL DIR1 BLOCK	PHASE UV1 BLOCK
PH IOC2 HIGH A /B / C BLK	PH TOC2 HIGH A /B /C BLK	NEUTRAL DIR2 BLK INP	PHASE UV2 BLOCK
PH IOC3 HIGH A /B / C BLK	PH TOC3 HIGH A /B /C BLK	NEUTRAL DIR3 BLK INP	PHASE UV3 BLOCK
NEG SEQ1 IOC BLOCK	PH TOC1 LOW A /B /C BLK	GROUND DIR1 BLK INP	PHASE OV1 BLOCK
NEG SEQ2 IOC BLOCK	PH TOC2 LOW A /B /C BLK	GROUND DIR2 BLK INP	PHASE OV2 BLOCK
NEG SEQ3 IOC BLOCK	PH TOC3 LOW A /B /C BLK	GROUND DIR3 BLK INP	PHASE OV3 BLOCK
NEUTRAL IOC1 BLOCK	NEUTRAL TOC1 BLOCK	**FREQUENCY BLOCKS**	NEUTRAL OV1 HIGH BLK
NEUTRAL IOC2 BLOCK	NEUTRAL TOC2 BLOCK	OVERFREQ1 BLOCK	NEUTRAL OV2 HIGH BLK
NEUTRAL IOC3 BLOCK	NEUTRAL TOC3 BLOCK	OVERFREQ2 BLOCK	NEUTRAL OV3 HIGH BLK
GROUND IOC1 BLOCK	GROUND TOC1 BLOCK	OVERFREQ3 BLOCK	GND OV1 BLK
GROUND IOC2 BLOCK	GROUND TOC2 BLOCK	UNDERFREQ1 BLOCK	GND OV2 BLK
GROUND IOC3 BLOCK	GROUND TOC3 BLOCK	UNDERFREQ2 BLOCK	GND OV3 BLK
SENS GND IOC1 BLK(*)	SENS GND TOC1 BLOCK(*)	UNDERFREQ3 BLOCK	AUXILIARY UV1 BLOCK
SENS GND IOC2 BLK(*)	SENS GND TOC2 BLOCK(*)	FREQ RATE1 BLOCK	AUXILIARY UV2 BLOCK
SENS GND IOC3 BLK(*)	SENS GND TOC3 BLOCK(*)	FREQ RATE2 BLOCK	AUXILIARY UV3 BLOCK
POWER BLOCKS	THERMAL1 49S BLOCK	FREQ RATE3 BLOCK	AUXILIARY OV1 BLOCK
DIR PWR1 BLOCK	THERMAL2 49S BLOCK	**OTHER BLOCKS**	AUXILIARY OV2 BLOCK
DIR PWR2 BLOCK	THERMAL3 49S BLOCK	LOSS OF MAINS1 BLOCK(*)	AUXILIARY OV3 BLOCK
DIR PWR3 BLOCK	NEG SEQ TOC1 BLK	LOSS OF MAINS2 BLOCK(*)	NEG SEQ OV1 BLK
POWER FACTOR1 BLOCK(*)	NEG SEQ TOC2 BLK	LOSS OF MAINS3 BLOCK(*)	NEG SEQ OV2 BLK
POWER FACTOR2 BLOCK(*)	NEG SEQ TOC3 BLK	LOSS OF EXC1 BLOCK	NEG SEQ OV3 BLK
POWER FACTOR3 BLOCK(*)	**GENERATOR UNBALANCE**	LOSS OF EXC2 BLOCK	VOLTS/HZ1 BLK(*)
SETTING GROUPS BLOCK IP	GEN UNBAL1 BLOCK	LOSS OF EXC3 BLOCK	VOLTS/HZ2 BLK(*)
SETT GROUPS BLOCK	GEN UNBAL2 BLOCK	ACCDNT ENRG1 BLOCK	VOLTS/HZ3 BLK(*)
	GEN UNBAL3 BLOCK	ACCDNT ENRG2 BLOCK	
	RESTRICTED GND FAULT	ACCDNT ENRG3 BLOCK	
	RESTR GND FLT1 BLOCK(*)		
	RESTR GND FLT2 BLOCK(*)		
	RESTR GND FLT3 BLOCK(*)		

(*) Available only in enhanced models. Please see ordering code.

6.2.3.2 PHASE CURRENT

This screen shows the pickup and trip for all phase instantaneous and time overcurrent elements in the G650 and block and operation signals provided by the phase directional units. Any of these two events of any phase element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation. All the values are provided for phases and total as shown on the table below.

This screen is accessed in menu: ***Actual> Status > Protection > Phase Current***, and includes the following signaling LEDs:

Table 6–5: PHASE CURRENT ACTUAL VALUES

PHASE IOC ACTUAL VALUES	PHASE TOC ACTUAL VALUES
PH IOC1 HIGH A / B / C PKP	PH TOC1 HIGH A / B / C PKP
PH IOC1 HIGH A / B / C OP	PH TOC1 HIGH A / B / C OP
PH IOC1 HIGH PKP	PH TOC1 HIGH PKP
PH IOC1 HIGH OP	PH TOC1 HIGH OP
PH IOC2 HIGH A / B / C PKP	PH TOC2 HIGH A / B / C PKP
PH IOC2 HIGH A / B / C OP	PH TOC2 HIGH A / B / C OP
PH IOC2 HIGH PKP	PH TOC2 HIGH PKP
PH IOC2 HIGH OP	PH TOC2 HIGH OP
PH IOC3 HIGH A / B / C PKP	PH TOC3 HIGH A / B / C PKP
PH IOC3 HIGH A / B / C OP	PH TOC3 HIGH A / B / C OP
PH IOC3 HIGH PKP	PH TOC3 HIGH PKP
PH IOC3 HIGH OP	PH TOC3 HIGH OP
	PH TOC1 LOW A / B / C PKP
	PH TOC1 LOW A / B / C OP
	PH TOC1 LOW PKP
	PH TOC1 LOW OP
	PH TOC2 LOW A / B / C PKP
	PH TOC2 LOW A / B / C OP
	PH TOC2 LOW PKP
	PH TOC2 LOW OP
	PH TOC3 LOW A / B / C PKP
	PH TOC3 LOW A / B / C OP
	PH TOC3 LOW PKP
	PH TOC3 LOW OP

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6.2.3.3 NEUTRAL CURRENT

This screen shows the pickup and trip for all neutral instantaneous and time overcurrent elements in the G650 and block and operation signals provided by the neutral directional units. Any of these two events of any neutral element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: ***Actual > Status > Protection > Neutral Current***, and includes the following signaling LEDs:

Table 6–6: NEUTRAL CURRENT ACTUAL VALUES

NEUTRAL IOC ACTUAL VALUES	NEUTRAL TOC ACTUAL VALUES	NEUTRAL DIRECTIONAL ACTUAL VALUES
NEUTRAL IOC1 PKP	NEUTRAL TOC1 PKP	NEUTRAL DIR1 BLOCK
NEUTRAL IOC1 OP	NEUTRAL TOC1 OP	NEUTRAL DIR1 OP
NEUTRAL IOC2 PKP	NEUTRAL TOC2 PKP	NEUTRAL DIR2 BLOCK
NEUTRAL IOC2 OP	NEUTRAL TOC2 OP	NEUTRAL DIR2 OP
NEUTRAL IOC3 PKP	NEUTRAL TOC3 PKP	NEUTRAL DIR3 BLOCK
NEUTRAL IOC3 OP	NEUTRAL TOC3 OP	NEUTRAL DIR3 OP

6.2.3.4 GROUND CURRENT

This screen shows the pickup and trip for all ground instantaneous and time overcurrent elements in the G650 and block and operation signals provided by the ground directional units. Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: ***Actual > Status > Protection > Ground Current***, and includes the following signaling LEDs:

Table 6–7: GROUND CURRENT ACTUAL VALUES

GROUND IOC ACTUAL VALUES	GROUND TOC ACTUAL VALUES	GROUND DIRECTIONAL ACTUAL VALUES	RESTRICTED GROUND ACTUAL VALUES (*)
GROUND IOC1 PKP	GROUND TOC1 PKP	GROUND DIR1 BLOCK	RESTR GND FLT1 PKP
GROUND IOC1 OP	GROUND TOC1 OP	GROUND DIR1 OP	RESTR GND FLT1 OP
GROUND IOC2 PKP	GROUND TOC2 PKP	GROUND DIR2 BLOCK	RESTR GND FLT2 PKP
GROUND IOC2 OP	GROUND TOC2 OP	GROUND DIR2 OP	RESTR GND FLT2 OP
GROUND IOC3 PKP	GROUND TOC3 PKP	GROUND DIR3 BLOCK	RESTR GND FLT3 PKP
GROUND IOC3 OP	GROUND TOC3 OP	GROUND DIR3 OP	RESTR GND FLT3 OP

(*) Available only in enhanced models. Please see ordering code.

6.2.3.5 SENSITIVE GROUND CURRENT(ENHANCED MODELS ONLY)

This screen shows the pickup and trip for all sensitive ground instantaneous and time overcurrent elements in the G650 . Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: ***Actual > Status > Protection >Sensitive Ground Current***, and includes the following signaling LEDs:

Table 6–8: SENSITIVE GROUND CURRENT ACTUAL VALUES

SENSITIVE GROUND IOC ACTUAL VALUES (*)	SENSITIVE GROUND TOC ACTUAL VALUES (*)
SENS GND IOC1 PKP	SENS GND TOC1 PKP
SENS GND IOC1 OP	SENS GND TOC1 OP
SENS GND IOC2 PKP	SENS GND TOC2 PKP
SENS GND IOC2 OP	SENS GND TOC2 OP
SENS GND IOC3 PKP	SENS GND TOC3 PKP
SENS GND IOC3 OP	SENS GND TOC3 OP

(*) Available only in enhanced models. Please see ordering code.

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6.2.3.6 NEGATIVE SEQUENCE CURRENT

This screen shows the pickup and trip for negative sequence elements in the G650. Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: ***Actual> Status > Protection >Negative Sequence Current***, and includes the following signaling LEDs:

Table 6–9: NEGATIVE SEQUENCE CURRENT ACTUAL VALUES

NEGATIVE SEQUENCE TOC ACTUAL VALUES
NEG SEQ TOC1 PKP
NEG SEQ TOC1 OP
NEG SEQ TOC2 PKP
NEG SEQ TOC2 OP
NEG SEQ TOC3 PKP
NEG SEQ TOC3 OP
GENERATOR UNBALANCE ACTUAL VALUES
GEN UNBAL1 STG1 PKP
GEN UNBAL1 STG1 OP
GEN UNBAL1 STG2 PKP
GEN UNBAL1 STG2 OP
GEN UNBAL1 PKP
GEN UNBAL2 BLOCK
GEN UNBAL2 STG1 PKP
GEN UNBAL2 STG1 OP
GEN UNBAL2 STG2 PKP
GEN UNBAL2 STG2 OP
GEN UNBAL2 PKP
GEN UNBAL2 OP
GEN UNBAL3 STG1 PKP
GEN UNBAL3 STG1 OP
GEN UNBAL3 STG2 PKP
GEN UNBAL3 STG2 OP
GEN UNBAL3 PKP
GEN UNBAL3 OP
NEGATIVE SEQUENCE IOC ACTUAL VALUES
NEG SEQ1 IOC PKP
NEG. SEQ1 IOC OP
NEG. SEQ2 IOC PKP
NEG. SEQ2 IOC OP
NEG. SEQ3 IOC PKP
NEG. SEQ3 IOC OP

6.2.3.7 THERMAL MODEL

G650 units incorporate up to 3 thermal image elements. For each of them, this screen shows by means of green LEDs, the activation of the block, alarm, operation and thermal image signals for each unit (1, 2, 3). Any of the block, alarm and operation signals will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in reset, pickup or operation. This function also provides the thermal image value for all the phases and functions in percentage. All the values are provided individually for the three thermal elements.

This screen is accessed in menu: ***Actual> Status > Protection >Thermal image***, and includes the following signaling LEDs:

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Table 6–10: THERMAL MODEL ACTUAL VALUES

THERMAL IMAGE RESET SIGNALS	THERMAL IMAGE ALARM SIGNALS	THERMAL IMAGE OPERATION SIGNALS	THERMAL IMAGE VALUE IN %
THERMAL1 49S RST	THERMAL1 49S ALARM	THERMAL1 49S OP	THERMAL IMAGE1
THERMAL2 49S RST	THERMAL2 49S ALARM	THERMAL2 49S OP	THERMAL IMAGE2
THERMAL3 49S RST	THERMAL3 49S ALARM	THERMAL3 49S OP	THERMAL IMAGE3

6.2.3.8 VOLTAGE

This screen shows the activation of all voltage elements available in the G650. It can be accessed from the menu: ***Actual > Status > Protection > Voltage***, and it includes the following signaling LEDs.

The values shown are:

Pickup and operation signals for phase to ground and phase-to-phase undervoltage elements and the three-phase signal for pickup and operation for the undervoltage element.

Pickup and operation for negative sequence overvoltage element.

Pickup and operation signals for phase-to-phase overvoltage elements and the three-phase signal for pickup and operation for the overvoltage element.

Pickup and operation for neutral overvoltage element (High).

Pickup and operation for auxiliary undervoltage and overvoltage elements.

Pickup and operation for volts/Hz elements, see note (*).

Pickup and operation for ground overvoltage elements.

Table 6–11: VOLTAGE ACTUAL VALUES

UNDERVOLTAGE ACTUAL VALUES		OVERVOLTAGE ACTUAL VALUES	NEUTRAL OV HIGH ACTUAL VALUES
PHASE UV1 A PKP	PHASE UV2 AB PKP	PHASE OV1 AB PKP	NEUTRAL OV1 HIGH PKP
PHASE UV1 A OP	PHASE UV2 AB OP	PHASE OV1 AB OP	NEUTRAL OV1 HIGH OP
PHASE UV1 B PKP	PHASE UV2 BC PKP	PHASE OV1 BC PKP	NEUTRAL OV2 HIGH PKP
PHASE UV1 B OP	PHASE UV2 BC OP	PHASE OV1 BC OP	NEUTRAL OV2 HIGH OP
PHASE UV1 C PKP	PHASE UV2 CA PKP	PHASE OV1 CA PKP	NEUTRAL OV3 HIGH PKP
PHASE UV1 C OP	PHASE UV2 CA OP	PHASE OV1 CA OP	NEUTRAL OV3 HIGH OP
PHASE UV1 AB PKP	PHASE UV2 PKP	PHASE OV1 PKP	**AUXILIARY OV**
PHASE UV1 AB OP	PHASE UV2 OP	PHASE OV1 OP	AUXILIARY OV1 PKP
PHASE UV1 BC PKP	PHASE UV3 A PKP	PHASE OV2 AB PKP	AUXILIARY OV1 OP
PHASE UV1 BC OP	PHASE UV3 A OP	PHASE OV2 AB OP	AUXILIARY OV2 PKP
PHASE UV1 CA PKP	PHASE UV3 B PKP	PHASE OV2 BC PKP	AUXILIARY OV2 OP
PHASE UV1 CA OP	PHASE UV3 B OP	PHASE OV2 BC OP	AUXILIARY OV3 PKP
PHASE UV1 PKP	PHASE UV3 C PKP	PHASE OV2 CA PKP	AUXILIARY OV3 OP
PHASE UV1 OP	PHASE UV3 C OP	PHASE OV2 CA OP	**AUXILIARY UV**
PHASE UV2 A PKP	PHASE UV3 AB PKP	PHASE OV2 PKP	AUXILIARY UV1 PKP
PHASE UV2 A OP	PHASE UV3 AB OP	PHASE OV2 OP	AUXILIARY UV1 OP
PHASE UV2 B PKP	PHASE UV3 BC PKP	PHASE OV3 AB PKP	AUXILIARY UV2 PKP
PHASE UV2 B OP	PHASE UV3 BC OP	PHASE OV3 AB OP	AUXILIARY UV2 OP
PHASE UV2 C PKP	PHASE UV3 CA PKP	PHASE OV3 BC PKP	AUXILIARY UV3 PKP
PHASE UV2 C OP	PHASE UV3 CA OP	PHASE OV3 BC OP	AUXILIARY UV3 OP
	PHASE UV3 PKP	PHASE OV3 CA PKP	**VOLTS PER HERTZ (*)**
	PHASE UV3 OP	PHASE OV3 CA OP	VOLTS/HZ 1 BLOCK
		PHASE OV3 PKP	VOLTS/HZ 1 OP
		PHASE OV3 OP	VOLTS/HZ 2 BLOCK
		NEGATIVE SEQUENCE OV	VOLTS/HZ 2 OP
		NEG SEQ OV1 PKP	VOLTS/HZ 3 BLOCK
		NEG SEQ OV1 OP	VOLTS/HZ 3 OP
		NEG SEQ OV2 PKP	**GROUND OV**
		NEG SEQ OV2 OP	GROUND OV1 PKP
		NEG SEQ OV3 PKP	GROUND OV1 OP
		NEG SEQ OV3 OP	GROUND OV2 PKP
			GROUND OV2 OP
			GROUND OV3 PKP
			GROUND OV3 OP

Note (*): Only available for enhanced models (see ordering code)

6.2.3.9 POWER

Directional power and power factor elements

These functions may have several applications, for example, small generating plants connected to the power system, to limit the supplied power and not to exceed its rated capacity.

If programmed conditions for any of the three elements are met, the corresponding LEDs will light up.

This screen shows the activation of all power elements available in the G650. It can be accessed from the menu: ***Actual> Status > Protection >Power***, and it includes the following signaling LEDs.

Table 6–12: POWER ACTUAL VALUES

DIRECTIONAL POWER ACTUAL VALUES	POWER FACTOR ACTUAL VALUES(*)
DIR PWR1 STG1 PKP	PF1 LAG STG1 OP
DIR PWR1 STG1 OP	PF1 LEAD STG1 OP
DIR PWR1 STG2 PKP	PF1 LAG STG2 OP
DIR PWR1 STG2 OP	PF1 LEAD STG2 OP
DIR PWR1 STG PKP	PF1 LAG OP
DIR PWR1 STG OP	PF1 LEAD OP
DIR PWR2 STG1 PKP	PF2 LAG STG1 OP
DIR PWR2 STG1 OP	PF2 LEAD STG1 OP
DIR PWR2 STG2 PKP	PF2 LAG STG2 OP
DIR PWR2 STG2 OP	PF2 LEAD STG2 OP
DIR PWR2 STG PKP	PF2 LAG OP
DIR PWR2 STG OP	PF2 LEAD OP
DIR PWR3 STG1 PKP	PF3 LAG STG1 OP
DIR PWR3 STG1 OP	PF3 LEAD STG1 OP
DIR PWR3 STG2 PKP	PF3 LAG STG2 OP
DIR PWR3 STG2 OP	PF3 LEAD STG2 OP
DIR PWR3 STG PKP	PF3 LAG OP
DIR PWR3 STG OP	PF3 LEAD OP

Note (*): Only available for enhanced models (see ordering code)

6.2.4 CONTROL ELEMENTS

6.2.4.1 FREQUENCY

G650 units incorporate three overfrequency and three underfrequency units as well as three frequency rate of change units. For each of them there are two magnitudes pickup and trip (operation).

Frequency elements are often used in generating plants, as well as in the connection of substations to the main system. Frequency monitoring is the base for synchronous machines protection application, with a couple of setting levels, as well as for the development of automatic shedding functions and underfrequency reset.

This screen shows the activation of all frequency elements available in the G650. It can be accessed from the menu: ***Actual> Status > Control Elements >Frequency***, and it includes the following signaling LEDs.

Table 6–13: FREQUENCY ACTUAL VALUES

OVERFREQUENCY ACTUAL VALUES	UNDERFREQUENCY ACTUAL VALUES
OVERFREQ1 PKP	UNDERFREQ1 PKP
OVERFREQ1 OP	UNDERFREQ1 OP
OVERFREQ2 PKP	UNDERFREQ2 PKP
OVERFREQ2 OP	UNDERFREQ2 OP
OVERFREQ3 PKP	UNDERFREQ3 PKP
OVERFREQ3 OP	UNDERFREQ3 OP
FREQUENCY RATE OF CHANGE ACTUAL VALUES	
FREQ RATE1 PKP	
FREQ RATE1 OP	
FREQ RATE2 PKP	
FREQ RATE2 OP	
FREQ RATE3 PKP	
FREQ RATE3 OP	

6.2.4.2 SYNCHROCHECK

This screen can be accessed at ***Actual> Status > Control Elements > Synchrocheck***, and it includes the following signaling LEDs for the synchronism check function:

Table 6–14: SYNCHROCHECK ACTUAL VALUES

SYNCHROCHECK ACTUAL VALUES
Synchrocheck BLK INP
Synchrocheck OP
SYNCHK CLOSE PERM
Synchrocheck COND OP
DL-DB OPERATION
DL-LB OPERATION
LL-DB OPERATION
SLIP CONDITION
BUS FREQ > LINE FREQ
BUS FREQ < LINE FREQ
VOLTAGE DIFFERENCE
FREQUENCY DIFFERENCE

Synchrocheck BLK INP: Block signal for the synchrocheck unit, configurable at ***Setpoint > Relay Configuration > Protection Elements***

Synchrocheck OP: Closing permission signal in live line-live bus conditions with open breaker.

SYNCHK CLOSE PERM:	General Closing permission of the Synchronism unit. It contemplates all possible situations, live line-live bus conditions, and the closing permission logics (dead line-dead bus, live line- dead bus, dead line-live bus). **Note**: in case the Function is disabled, the Closing permission signal will be activated in order not to interfere with possible logics where it is included. If the synchronism unit is enabled, this signal will only be activated in the closing conditions established by setting.
Synchrocheck COND OP:	Closing permission according to permission logics (DL-DB, LL-DB, DL-LB). DL-DB OPERATION: Closing permission in dead line – dead bus condition. DL-LB OPERATION: Closing permission in dead line – live bus condition. LL-DB OPERATION: Closing permission in live line – dead bus condition.
SLIP CONDITION:	Internal signal indicating frequency slip between the line voltage and bus voltage phasors.
BUS FREQ > LINE FREQ:	Busbar Frequency higher than line frequency
BUS FREQ < LINE FREQ:	Busbar Frequency lower than line frequency
VOLTAGE DIFFERENCE:	Voltage difference between the line and the busbar in volts (secondary values), only available if the Synchrocheck element is enabled.
FREQ. DIFFERENCE:	Frequency difference between the line and the busbar in Hz, only available if the Synchrocheck element is enabled.

6.2.4.3 BREAKER FAILURE(ENHANCED MODELS ONLY)

This screen can be accessed at ***Actual> Status > Control Elements > Breaker Failure***, and it includes the following signaling LEDs for the breaker failure function:

Table 6–15: BREAKER FAILURE ACTUAL VALUES

BREAKER FAILURE ACTUAL VALUES
BKR FAIL INITIATE
BKR FAIL NO CURRENT
BKR FAIL SUPERVISION
BKR FAIL HISET
BKR FAIL LOWSET
INTERNAL ARC
BKR FAIL 2nd STEP

BKR FAIL INITIATE External signal for breaker failure initiation. (configurable at ***Settings> Relay Configuration > Protection Elements***).

BKR FAIL NO CURRENT Signal for breaker failure without current

BKR FAIL SUPERVISION Signal for supervision level breaker failure (retrip)

BKR FAIL HISET Signal for high-level breaker failure

BKR FAIL LOWSET Signal for low-level breaker failure

INTERNAL ARC Signal for internal arc

BKR FAIL 2nd STEP Signal for Second level breaker failure (high and low)

6.2.4.4 VT FUSE FAILURE(ENHANCED MODELS ONLY)

This screen can be accessed at ***Actual> Status > Control Elements >VT Fuse Failure***, and it includes only one LEDs for the VT fuse failure function, indicating the activation of the unit.

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Table 6–16: VT FUSE FAILURE ACTUAL VALUES

VT FUSE FAILURE ACTUAL VALUES
VT FUSE FAILURE

6.2.4.5 SETTING GROUPS

This screen can be accessed at ***Actual> Status > Control Elements > Setting Groups***, and it includes activation and block signals for the relay setting groups change in the following signaling LEDs:

Table 6–17: SETTING GROUP ACTUAL VALUES

SETTING GROUPS ACTUAL VALUES
GROUP 1 ACT ON
GROUP 2 ACT ON
GROUP 3 ACT ON
GROUP 1 BLOCKED
GROUP 2 BLOCKED
GROUP 3 BLOCKED

6.2.4.6 PULSE COUNTERS

G650 units incorporate eight pulse counters. For each of them there are two magnitudes: the actual value and the freeze value.

This screen shows the activation of all pulse counters available in the G650. It can be accessed from the menu:

Actual> Status > Control Elements > Pulse counters, and it includes the following values.

Table 6–18: PULSE COUNTERS ACTUAL VALUES

PULSE COUNTERS ACTUAL VALUES
CntPulses Value 1
CntPulses Value 2
CntPulses Value 3
CntPulses Value 4
CntPulses Value 5
CntPulses Value 6
CntPulses Value 7
CntPulses Value 8
CntPulses Freeze 1
CntPulses Freeze 2
CntPulses Freeze 3
CntPulses Freeze 4
CntPulses Freeze 5
CntPulses Freeze 6
CntPulses Freeze 7
CntPulses Freeze 8

6.2.4.7 ANALOG COMPARATORS

G650 units incorporate 20 analog comparators. This screen can be accessed from the menu:

Actual> Status > Control Elements >Analog Comparators and it includes the following signalling LEDs showing the ON/OFF status of the analog level.

Table 6–19: ANALOG COMPARATORS ACTUAL VALUES

ANALOG COMPARATORS ACTUAL VALUES
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17
Analog Level 18
Analog Level 19
Analog Level 20

6.2.4.8 LOSS OF MAINS(ENHANCED MODELS ONLY)

This screen can be accessed at ***Actual> Status > Control Elements > Loss of Mains***, and it includes pickup and operation signals for the loss of mains units in the following signaling LEDs:

Table 6–20: LOSS OF MAINS ACTUAL VALUES

LOSS OF MAINS ACTUAL VALUES
LOSS OF MAINS1 A OP
LOSS OF MAINS1 B OP
LOSS OF MAINS1 C OP
LOSS OF MAINS1 OP
LOSS OF MAINS2 A OP
LOSS OF MAINS2 B OP
LOSS OF MAINS2 C OP
LOSS OF MAINS2 OP
LOSS OF MAINS3 A OP
LOSS OF MAINS3 B OP
LOSS OF MAINS3 C OP
LOSS OF MAINS3 OP

6.2.4.9 LOSS OF EXCITATION

This screen can be accessed at ***Actual> Status > Control Elements > Loss of Excitation***, and it includes the following signaling LEDs for the Loss of Excitation function:

LOSS OF EXCITATION ACTUAL VALUES

LOSS OF EXCITATION ACTUAL VALUES
LOSS OF EXC1 ST1 PKP
LOSS OF EXC1 STG1 OP
LOSS OF EXC1 ST2 PKP
LOSS OF EXC1 STG2 OP
LOSS OF EXC1 PKP
LOSS OF EXC1 OP
LOSS OF EXC2 ST1 PKP
LOSS OF EXC2 STG1 OP
LOSS OF EXC2 ST2 PKP
LOSS OF EXC2 STG2 OP
LOSS OF EXC2 PKP
LOSS OF EXC2 OP
LOSS OF EXC3 STG1 PKP
LOSS OF EXC3 STG1 OP
LOSS OF EXC3 STG2 PKP
LOSS OF EXC3 STG2 OP
LOSS OF EXC3 PKP
LOSS OF EXC3 OP

- **LOSS EXC1 (2,3) STG1 PKP** Output used to indicate a pickup of the stage 1 for elements (1,2 ,3)
- **LOSS EXC1 (2,3) STG1 OP** Output used to indicate an operation of the stage 1 for elements (1,2 ,3)
- **LOSS EXC1 (2,3) STG2 PKP** Output used to indicate a pickup of the stage 2 for elements (1,2 ,3)
- **LOSS EXC1 (2,3) STG2 OP** Output used to indicate an operation of the stage 2 for elements (1,2 ,3)
- **LOSS EXC1 (2,3) PKP** Output used to indicate a general pickup for elements (1,2 ,3)
- **LOSS EXC1 (2,3) OP** Output used to indicate a general operation for elements (1,2 ,3)

6.2.4.10 ACCIDENTAL ENERGIZATION

This screen can be accessed at ***Actual> Status > Control Elements > Accidental Energization*** and it includes offline, armed and operation signals for the Accidental Energization elements in the following signaling LEDs:

Table 6–21: ACCIDENTAL ENERGIZATION ACTUAL VALUES

ACCIDENTAL ENERGIZATION ACTUAL VALUES
ACCDNT ENRG1 OFFLINE
ACCDNT ENRG1 ARMED
ACCDNT ENRG1 OP
ACCDNT ENRG2 OFFLINE
ACCDNT ENRG2 ARMED
ACCDNT ENRG2 OP
ACCDNT ENRG3 OFFLINE
ACCDNT ENRG3 ARMED
ACCDNT ENRG3 OP

- **ACCDNT ENRG1 (2, 3) OFFLINE** This input indicates that the protected generator is off-line for elements (1, 2, 3).
- **ACCDNT ENRG1 (2, 3) ARMED** This signal indicates that the element is ready for an accidental energization detection for elements (1, 2, 3).
- **ACCDNT ENRG1 (2, 3) OP** This output shows an accidental energization operation for elements (1, 2, 3).

6.2.5 PROTECTION SUMMARY

Actual > Status > Protection Summary . This screen shows a complete listing of all protection and control elements in the relay, showing their status (enabled or not) through the corresponding LED.

Table 6–22: PROTECTION SUMMARY

PROTECTION SUMMARY
Phase IOC1 High
Phase IOC2 High
Phase IOC3 High
Neutral IOC1
Neutral IOC2
Neutral IOC3
Ground IOC1
Ground IOC2
Ground IOC3
Sensitive Ground IOC1 (*)
Sensitive Ground IOC2 (*)
Sensitive Ground IOC3 (*)
Phase TOC1 High
Phase TOC2 High
Phase TOC3 High
Neutral TOC1
Neutral TOC2
Neutral TOC3
Ground TOC1
Ground TOC2
Ground TOC3
Sensitive Ground TOC1 (*)
Sensitive Ground TOC2 (*)
Sensitive Ground TOC3 (*)
Phase UV1
Phase UV2
Phase UV3
Negative Sequence OV1
Negative Sequence OV2
Negative Sequence OV3
Neutral Directional1
Neutral Directional2
Neutral Directional3
Ground Directional1
Ground Directional2
Ground Directional3
Breaker Failure(*)
Fuse Failure (*)
PROTECTION SUMMARY
Synchrocheck
Neutral OV1 High
Neutral OV2 High
Neutral OV3 High
Auxiliary UV1
Auxiliary UV2
Auxiliary UV3
Phase OV1

Phase OV2
Phase OV3
Auxiliary OV1
Auxiliary OV2
Auxiliary OV3
Negative Sequence TOC1
Negative Sequence TOC2
Negative Sequence TOC3
Overfrequency1
Overfrequency2
Overfrequency3
Underfrequency1
Underfrequency2
Underfrequency3
Oscillography
Fault Report
Demand
Phase TOC1 Low
Phase TOC2 Low
Phase TOC3 Low
Data Logger
Directional Power1
Directional Power2
Directional Power3

PROTECTION SUMMARY (CONT.)
Frequency rate1
Frequency rate2
Frequency rate3
Restricted Ground Fault1 (*)
Restricted Ground Fault2 (*)
Restricted Ground Fault3 (*)
Loss of Mains1 (*)
Loss of Mains2 (*)
Loss of Mains3 (*)
Generator Unbalance1
Generator Unbalance2
Generator Unbalance3
Volts per Hz1 (*)
Volts per Hz2 (*)
Volts per Hz3 (*)
Loss of Excitation1
Loss of Excitation2
Loss of Excitation3
Negative Sequence IOC1
Negative Sequence IOC2
Negative Sequence IOC3
Generator Thermal Model1
Generator Thermal Model2
Generator Thermal Model3
Power Factor Limiting1(*)
Power Factor Limiting2(*)
Power Factor Limiting3(*)
Accidental Energization1
Accidental Energization2
Accidental Energization3
Ground OV1
Ground OV2
Ground OV3

(*) Note: Available only for enhanced model (please see ordering code).

6.2.6 SNAPSHOT EVENTS SUMMARY

Actual > Status > Snapshot Event Summary

The G650 provides via setting the possibility to enable or disable the snapshot event generation in the different functions available in the device.

This screen shows a complete listing of the snapshot event generation for all the protection, control and inputs/outputs elements in the relay, showing their status (enabled or not) through the corresponding LED.

Table 6–23: SNAPSHOT EVENT SUMMARY

SNAPSHOT EVENTS SUMMARY
Board F Event
Board G Event
General Settings Event
Phase IOC1 High Event
Phase IOC2 High Event
Phase IOC3 High Event
Neutral IOC1 Event
Neutral IOC2 Event
Neutral IOC3 Event
Ground IOC1 Event
Ground IOC2 Event
Ground IOC3 Event
Sensitive Ground IOC1 Event (*)
Sensitive Ground IOC2 Event (*)
Sensitive Ground IOC3 Event (*)
Phase TOC1 High Event
Phase TOC2 High Event
Phase TOC3 High Event
Neutral TOC1 Event
Neutral TOC2 Event
Neutral TOC3 Event
Ground TOC1 Event
Ground TOC2 Event
Ground TOC3 Event
Sensitive Ground TOC1 Event (*)
Sensitive Ground TOC2 Event (*)
Sensitive Ground TOC3 Event (*)
Phase UV1 Event
Phase UV2 Event
Phase UV3 Event
Negative Sequence OV1 Event
Negative Sequence OV2 Event
Negative Sequence OV3 Event
SNAPSHOT EVENTS SUMMARY (CONT.)
Demand Event
Board H Event
Board J Event
Phase TOC1 Low Event
Phase TOC2 Low Event
Phase TOC3 Low Event

Switchgear1 Event
Switchgear2 Event
Switchgear3 Event
Switchgear4 Event
Switchgear5 Event
Switchgear6 Event
Switchgear7 Event
Switchgear8 Event
Switchgear9 Event
Switchgear10 Event
Switchgear11 Event
Switchgear12 Event
Switchgear13 Event
Switchgear14 Event
Switchgear15 Event
Switchgear16 Event
Breaker Settings Event
Directional Power1 Event
Directional Power2 Event
Directional Power3 Event
Analog Comparators Event
Frequency rate1 Event
Frequency rate2 Event
Frequency rate3 Event
Restricted Ground Fault1 Event (*)
Restricted Ground Fault2 Event (*)
Restricted Ground Fault3 Event (*)
Loss of Mains1 Event (*)
Loss of Mains2 Event (*)
Loss of Mains3 Event (*)
Generator Unbalance1 Event
Generator Unbalance2 Event
Generator Unbalance3 Event
Volts per Hertz1 Event (*)
Volts per Hertz2 Event (*)
Volts per Hertz3 Event (*)
Loss of Excitation1 Event
Loss of Excitation2 Event
Loss of Excitation3 Event
Negative Sequence IOC1 Event
Negative Sequence IOC2 Event
Negative Sequence IOC3 Event
Generator Thermal Model1 Event
Generator Thermal Model2 Event
Generator Thermal Model3 Event
Pwr Factor Limiting1 Event(*)
Pwr Factor Limiting2 Event(*)
Pwr Factor Limiting3 Event(*)
Accidental Energization1 Event
Accidental Energization2 Event
Accidental Energization3 Event
Ground OV1 Event

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Ground OV2 Event
Ground OV3 Event

(*) Note: Available for enhanced models only (please see ordering code).

6.2.7 MODBUS USER MAP

The ModBus User Map consists of a selection of the most important 256 records in the complete ModBus Map regarding the application. By selecting these records and defining the user map appropriately, it is possible to read all the information included by a single ModBus reading operation, optimizing the refresh time.

This screen can be accessed at ***Actual> Status> ModBus User Map***, and it includes all the readings for the previously configured records in the ModBus memory map.

Table 6–24: MODBUS USER MAP ACTUAL VALUES

MODBUS USER MAP
Address 00
Address 01
…
Address 255

6.2.8 SWITCHGEAR STATUS

Actual > Status > Switchgear Status

For a better understanding of the represented statuses in this screen, figure 6.1 shows the available “Switchgear” modules to be programmed in the G650. Each of them has a series of inputs/outputs that are the statuses represented on this screen. Separate signal for each switchgear device (for 1 to 16).

Each Switchgear module can be programmed at: ***Setpoint > Relay Configuration >Switchgear***, and its statuses are as follows:

Table 6–25: SWITCHGEAR STATUS

SWITCHGEAR 1 STATUS		SWITCHGEAR X STATUS		SWITCHGEAR 16 STATUS
SWITCH 1 A INPUT	…	SWITCH X A INPUT	…	SWITCH 16 A INPUT
SWITCH 1 B INPUT	…	SWITCH X B INPUT	…	SWITCH 16 B INPUT
SWITCH 1 A STATUS	…	SWITCH X A STATUS	…	SWITCH 16 A STATUS
SWITCH 1 B STATUS	…	SWITCH X B STATUS	…	SWITCH 16 B STATUS
SWITCH 1 OPEN	…	SWITCH X OPEN	…	SWITCH 16 OPEN
SWITCH 1 CLOSED	…	SWITCH X CLOSED	…	SWITCH 16 CLOSED
SWITCH 1 00_ERROR	…	SWITCH X 00_ERROR	…	SWITCH 16 00_ERROR
SWITCH 1 11_ERROR	…	SWITCH X 11_ERROR	…	SWITCH 16 11_ERROR
SWITCH 1 OPEN INIT	…	SWITCH X OPEN INIT	…	SWITCH 16 OPEN INIT
SWITCH 1 CLOSE INIT	…	SWITCH X CLOSE INIT	…	SWITCH 16 CLOSE INIT
SWGR 1 FAIL TO OPEN	…	SWGR X FAIL TO OPEN	…	SWGR 16 FAIL TO OPEN
SWGR 1 FAIL TO CLOSE	…	SWGR X FAIL TO CLOSE	…	SWGR 16 FAIL TO CLOSE

SWITCH **X** A INPUT — The LED will light up when the input associated to that switchgear Contact A is activated.

SWITCH **X** B INPUT — The LED will light up when the input associated to that switchgear Contact B is activated.

SWITCH **X** A STATUS — Status associated to Switchgear contact A. It is activated once the time required for the Switchgear module to acknowledge contact A has expired.

SWITCH **X** B STATUS — Status associated to Switchgear contact B. It is activated once the time required for the Switchgear module to acknowledge contact B has expired.

SWITCH **X** OPEN	Lights up when the associated switchgear is open
SWITCH **X** CLOSED	Lights up when the associated switchgear is closed
SWITCH **X** 00_ERROR	Output that represents the Switchgear status 00, considered as abnormal.
SWITCH **X** 11_ERROR	Output that represents the Switchgear status 11, considered as abnormal.
SWITCH **X** OPEN INIT	Programmable input that indicates the initiation of the Opening Operation for the considered switchgear.
SWITCH **X** CLOSE INIT	Programmable input that indicates the initiation of the closing Operation for the considered switchgear.
SWGR **X** FAIL TO OPEN	Output that represents a failure to open, from the associated external device (opening time exceeded)
SWGR **X** FAIL TO CLOSE	Output that represents a failure to close from the associated external device (closing time exceeded)

See attached figure

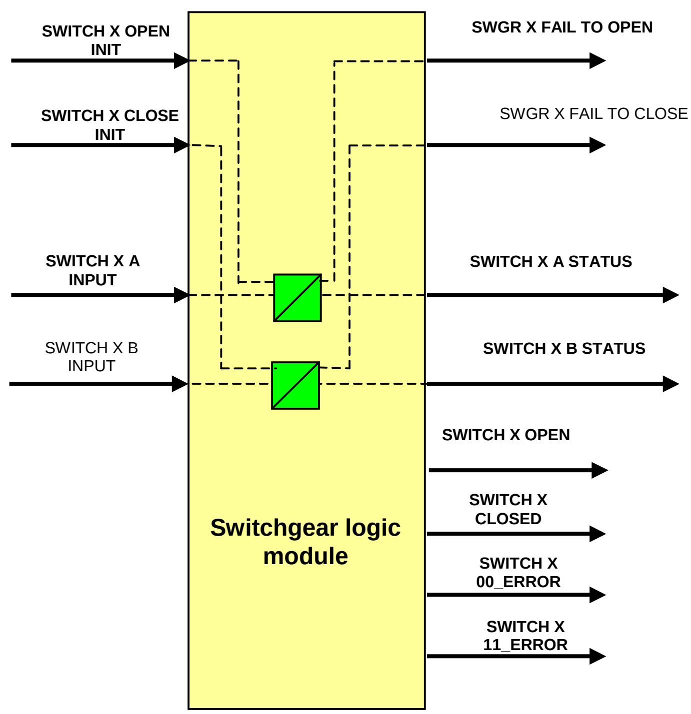

Figure 6–1: SWITCHGEAR CONTACTS

6.2.9 CALIBRATION

This screen can be accessed at ***Actual> Status > Calibration***, and it includes the internal calibration status for the relay.

Table 6–26: CALIBRATION STATUS

CALIBRATION
FACTORY CALIBRATION
CALIBRATION ERROR

FACTORY CALIBRATION: This value will be active when the relay calibration settings are the default values (no calibration).

CALIBRATION ERROR: Error shown when there is a problem in the calibration settings (wrong values).

6.2.10 FLEX CURVES

This screen can be accessed at ***Actual> Status > Flex Curves***, and it includes the internal flex curves status.

If the LED associated to the FlexCurve status is lit up, this indicates that the user curve has been configured with new values (not default values).

Table 6–27: FLEX CURVES STATUS

FLEX CURVES STATUS
FLEXCURVE A STATUS
FLEXCURVE B STATUS
FLEXCURVE C STATUS
FLEXCURVE D STATUS

6.2.11 SYSTEM INFO

This screen can be accessed at ***Actual> Status > System Info***. It can monitor the system parameters and the internal status of the Relay operative system.

6.2.12 RECORD STATUS

This screen shows part of the information related to the different records stored in the Relay, such as:

6.2.12.1 FAULT REPORTS

Actual> Status > Records Status > Fault Reports

Table 6–28: FAULT REPORT STATUS

FAULT REPORT STATUS
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
FAULT DATE
FAULT TYPE
FAULT LOCATION
FAULT REPORT NUMBER

FAULT REPORT TRIGG: This signal indicates whether the signal that initiates the calculation of the distance to the fault has been activated.

CLEAR FAULT REPORTS: This signal indicates the reset of fault reports.

FAULT DATE: Date and time of the last fault produced in the relay. In format (Day/Month/year Hour:minutes:seconds.milliseconds)

FAULT TYPE: Type of the last fault produced in the Relay (phase to ground, phase to phase, three-phase, etc).

FAULT LOCATION: Location of the last fault produced in the relay.

FAULT REPORT NUMBER: Number of fault reports available in the relay (ten is the maximum number of records supported by the relay).

6.2.12.2 CONTROL EVENTS

Actual> Status > Records Status > Control Events

In this screen ***Actual> Status > Records Status > Control Events***, the status of the signals configured to launch the control events can be seen, activated or not.

The G650 provides the possibility to configure 128 control events (at ***Settings>Relay Configuration > Control Events***). In the ***Actual > Records > Event Recorder > Control Events*** it is possible to see and retrieve the recorded control events to a file, seeing the text and date and time and status of the preconfigured control event.

Table 6–29: CONTROL EVENTS STATUS

CONTROL EVENTS
CONTROL EVENT 1
CONTROL EVENT 2
…
CONTROL EVENT 128

6.2.12.3 OSCILLOGRAPHY

Actual> Status > Records Status > Oscillography

The following figure shows the status of the different digital channels that can be programmed to be included in oscillography records. When the signal associated to a specific channel is active, its LED will light up on this screen.

This screen shows as well the oscillography trigger status, active or inactive, by lighting up that channel.

Table 6–30: OSCILLOGRAPHY STATUS

OSCILLOGRAPHY
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12
OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD
AVAILABLE RECORDS

The last three values shown are as follows:

NUMBER OF TRIGGERS: This is the number of the last oscillography record obtained in the relay. This value has a range of 0 to 999.

CYCLES PER RECORD: This is the number of cycles contained in the oscillography record; this value depends on the settings adjusted on the oscillography menu at ***Setpoint > Product Setup > Oscillography***.

AVAILABLE RECORDS: This is the number of available oscillography records in the relay.

Values for these last 3 fields are reset every time the oscillography settings are modified.

6.2.12.4 DATA LOGGER

Actual> Status > Records Status > Data Logger

Table 6–31: DATA LOGGER STATUS

DATA LOGGER
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: Date and time of the oldest value stored in the data logger.

NEWEST SAMPLE TIME: Date and time of the most recent value stored in the data logger

DATA LOGGER CHANNELS: Number of channels configured in the data logger

DATA LOGGER DAYS: Time in days during which, samples are stored without overwriting them.

6.2.12.5 DEMAND

Actual> Status > Records Status > Demand

Table 6–32: DEMAND STATUS

DEMAND
DEMAND TRIGGER INP
DEMAND RESET INP

DEMAND TRIGGER INP: Signal used for triggering the demand in the case of Rolling demand.

DEMAND RESET INP: Signal to reset the demand.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

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6.2.12.6 ENERGY

Freeze/Unfreeze/reset Energy: These signals correspond to the relay energy counters statuses of freeze, unfreeze and reset.

Actual> Status > Records Status > Energy

Table 6–33: ENERGY STATUS

ENERGY
FREEZE ENERGY CNT
UNFREEZE ENERGY CNT
RESET ENERGY CNT

FREEZE ENERGY CNT: Signal used to freeze the energy counters for measurement purposes.

UNFREEZE ENERGY CNT: Signal used to unfreeze the energy counters.

RESET ENERGY CNT: Signal to reset the energy measurements and set the values to zero.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

6.2.12.7 BREAKER MAINTENANCE

Actual> Status > Records Status > Breaker Maintenance

This screen shows the breaker status related to breaker maintenance. Other statuses are provided in the different switchgear or breaker status signals.

Table 6–34: BREAKER MAINTENANCE STATUS

BREAKER MAINTENANCE INPUTS
RESET KI2t COUNTERS
RESET BKR COUNTERS
BREAKER MAINTENANCE STATUS
KI2t PHASE A ALARM
KI2t PHASE B ALARM
KI2t PHASE C ALARM
BKR OPENINGS ALARM
BKR OPEN 1 HOUR ALARM
BREAKER OPENINGS
BREAKER CLOSINGS
KI2t PHASE A
KI2t PHASE B
KI2t PHASE C
BKR OPENING TIME
BKR CLOSING TIME

The breaker maintenance inputs are signals that can be configured at Setpoint > Relay Configuration > Protection Elements:

RESET KI2t COUNTERS	Signal to reset and set to zero all the KI2t counters (for all phases)
RESET BKR COUNTERS	Signal to reset and set to zero all the breaker counters (number of openings and closings and alarms)
KI2t PHASE A ALARM	Alarm signal for maximum breaking capacity in phase A exceeded
KI2t PHASE B ALARM	Alarm signal for maximum breaking capacity in phase B exceeded
KI2t PHASE C ALARM	Alarm signal for maximum breaking capacity in phase C exceeded
BKR OPENINGS ALARM	Alarm related to the maximum number of breaker openings
BKR OPEN 1 HOUR ALARM	Alarm related to the maximum number of breaker openings in one hour
BREAKER OPENINGS	Counter of the total number of openings performed by the breaker
BREAKER CLOSINGS	Counter of the total number of closings performed by the breaker
KI2t PHASE A	kI^2t phase A counter (total accumulative breaking level – phase A)
KI2t PHASE B	kI^2t phase B counter (total accumulative breaking level – phase B)
KI2t PHASE C	kI^2t phase C counter (total accumulative breaking level – phase C)
BKR OPENING TIME	Time to set a failure in opening the breaker.
BKR CLOSING TIME	Time to set a failure in closing the breaker.

Breaker opening and closing time signals are configured at ***Setpoint > Relay Configuration > Switchgear*** for the related switchgear device.

6.2.12.8 SNTP/IRIGB

Actual > Status > SNTP/IRIGB

This screen shows if the relay is synchronized by external devices using or SNTP protocol or IRIGB input port. In case of relays synchronized by both elements at the same time, IRIGB time will be used by the relay.

Table 6–35: SNTP-IRIG-B ACTUAL VALUES

SNTP-IRIGB ACTUAL VALUES
SNTP FAILURE
IRIGB FAILURE

Values shown in each section are as follows:

6.3.1 PRIMARY VALUES

6.3.1.1 CURRENT

Actual> Metering > Primary Values > Current

Table 6–36: CURRENT PRIMARY VALUES

DESCRIPTION	UNITS
CT Ratio	N/A
CT Ratio Ig	N/A
CT Ratio Isg	N/A
Ia Angle	Deg
Ib Angle	Deg
Ic Angle	Deg
In Angle	Deg
Ig Angle	Deg
Isg Angle	Deg
Phasor Ia Primary	KA
Phasor Ib Primary	KA
Phasor Ic Primary	KA
Phasor Ig Primary	KA
Phasor Isg Primary	KA
Phasor In Primary	KA
RMS Ia Primary	KA
RMS Ib Primary	KA
RMS Ic Primary	KA
RMS Ig Primary	KA
RMS Isg Primary	KA
I0 Primary	KA
I1 Primary	KA
I2 Primary	KA

6.3.1.2 VOLTAGE

Actual> Metering > Primary Values > Voltage

Table 6–37: VOLTAGE PRIMARY VALUES

DESCRIPTION	UNITS
PT Ratio	N/A
Va Angle	Deg
Vb Angle	Deg
Vc Angle	Deg
Vn Angle	Deg
Vx Angle	Deg
Vab Angle	Deg
Vbc Angle	Deg
Vca Angle	Deg
Vg Angle	Deg
V0 Primary	KV
V1 Primary	KV
V2 Primary	KV
Vab Primary	KV
Vbc Primary	KV
Vca Primary	KV
Va Primary	KV
Vb Primary	KV
Vc Primary	KV
Vn Primary	KV
Vx Primary	KV
VBB Primary	KV
VL Primary	KV
Vg Primary	KV

6.3.1.3 POWER

Actual> Metering > Primary Values > Power

Table 6–38: POWER PRIMARY VALUES

DESCRIPTION	UNITS
Phase A Real Pwr	MW
Phase A Reactive Pwr	MVAr
Phase A Apparent Pwr	MVA
Phase B Real Pwr	MW
Phase B Reactive Pwr	MVAr
Phase B Apparent Pwr	MVA
Phase C Real Pwr	MW
Phase C Reactive Pwr	MVAr
Phase C Apparent Pwr	MVA
3 Phase Real Pwr	MW
3 Phase Reactive Pwr	MVAr
3 Phase Apparent Pwr	MVA
Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

NOTE: If voltage inputs are configured in Delta connection and the Auxiliary Voltage input is set as VX or VN, measurements of single phase power value cannot be duly calculated, and therefore, its value will be zero. Measurement for single phase power value only will be provided when Wye connection is selected or when Delta connection and VN as Auxiliary Voltage is selected in General Settings main menu. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

6.3.1.4 ENERGY

Actual> Metering > Primary Values > Energy

Energy is only given in three phase primary values

Table 6–39: ENERGY PRIMARY VALUES

DESCRIPTION	UNITS
Positive MWatthour	MWh
Negative MWatthour	MWh
Positive MVarhour	MVArh
Negative MVarhour	MVArh
Pos Mwatthour Cnt	MWh
Neg Mwatthour Cnt	MWh
Pos MVarhour Cnt	MVArh
Neg MVarhour Cnt	MVArh

When the energy counters reach the value (2ˆ 31)/1000 (approximately 2147 MVArh and MWh) all the values are set to zero and starts counting again.

6.3.1.5 DEMAND

Actual> Metering > Primary Values > Demand

Demand is only given in primary values

Table 6–40: DEMAND PRIMARY VALUES

DESCRIPTION	UNITS
DEMAND IA	KA
DEMAND IA MAX	KA
DEMAND IA DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IB	KA
DEMAND IB MAX	KA
DEMAND IB DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IC	KA
DEMAND IC MAX	KA
DEMAND IC DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IG	KA
DEMAND IG MAX	KA
DEMAND IG DATE	dd/mm/yy hh:mm:ss:ms
DEMAND ISG	KA
DEMAND ISG MAX	KA
DEMAND ISG DATE	dd/mm/yy hh:mm:ss:ms
DEMAND I2	KA
DEMAND I2 MAX	KA
DEMAND I2 DATE	dd/mm/yy hh:mm:ss:ms
DEMAND W	MW
DEMAND W MAX	MW
DEMAND W DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VAR PWR	MVAr
DEMAND VAR MAX	MVAr
DEMAND VAR DATE	dd/mm/yy hh:mm:ss:ms

DEMAND VA PWR	MVA
DEMAND VA MAX	MVA
DEMAND VA DATE	dd/mm/yy hh:mm:ss:ms

6.3.2 SECONDARY VALUES

6.3.2.1 CURRENT

Actual> Metering > Secondary Values > Current

Table 6–41: CURRENT SECONDARY VALUES

DESCRIPTION	UNITS
Phasor Ia	A
RMS Ia	A
Phasor Ib	A
RMS Ib	A
Phasor Ic	A
RMS Ic	A
Phasor In	A
Phasor Ig	A
RMS Ig	A
Phasor Isg	A
RMS Isg	A
Zero seq I0	A
Positive Seq I1	A
Negative Seq I2	A

6.3.2.2 VOLTAGE

Actual> Metering > Secondary Values > Voltage

Table 6–42: VOLTAGE SECONDARY VALUES

DESCRIPTION	UNITS
Phasor Vab	V
Phasor Vbc	V
Phasor Vca	V
Phasor Van	V
Phasor Vbn	V
Phasor Vcn	V
Phasor Vn	V
Positive Seq V1	V
Negative Seq V2	V
Zero Seq V0	V
Phasor Vx	V
Nominal Voltage	V
Line Voltage	V
Bus Voltage	V
Phasor Vg	V

6.3.2.3 POWER

Actual> Metering > Secondary Values > Power

Table 6–43: POWER SECONDARY VALUES

DESCRIPTION	UNITS
Phase A Apparent Pwr	VA
Phase B Apparent Pwr	VA
Phase C Apparent Pwr	VA
Phase A Real Pwr	W
Phase B Real Pwr	W
Phase C Real Pwr	W
Phase A Reactive Pwr	VARS
Phase B Reactive Pwr	VARS
Phase C Reactive Pwr	VARS
3 Phase Apparent Pwr	VA
3 Phase Real Pwr	W
3 Phase Reactive Pwr	VARS
Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

NOTE: If voltage inputs are configured in Delta connection and the Auxiliary Voltage input is set as VX or VN, measurements of single phase power value cannot be duly calculated, and therefore, its value will be zero. Measurement for single phase power value only will be provided when Wye connection is selected or when Delta connection and VN as Auxiliary Voltage is selected in General Settings main menu. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

6.3.3 PHASOR DIAGRAM

Actual> Metering > Phasor Diagram

This window shows the phasors for voltage and current values, phase to phase, phase to ground and sequence values, provided by the unit. The angles provided by the unit are clockwise, all the angles are positive values, so for a system Va (0,0°), Vb (0,-120°), Vc (0,120°) the relay will provided the following angles Va (0,0°), Vb (0,120°), Vc (0,240°).

The following figure shows the phasor diagram provided by EnerVista 650 Setup:

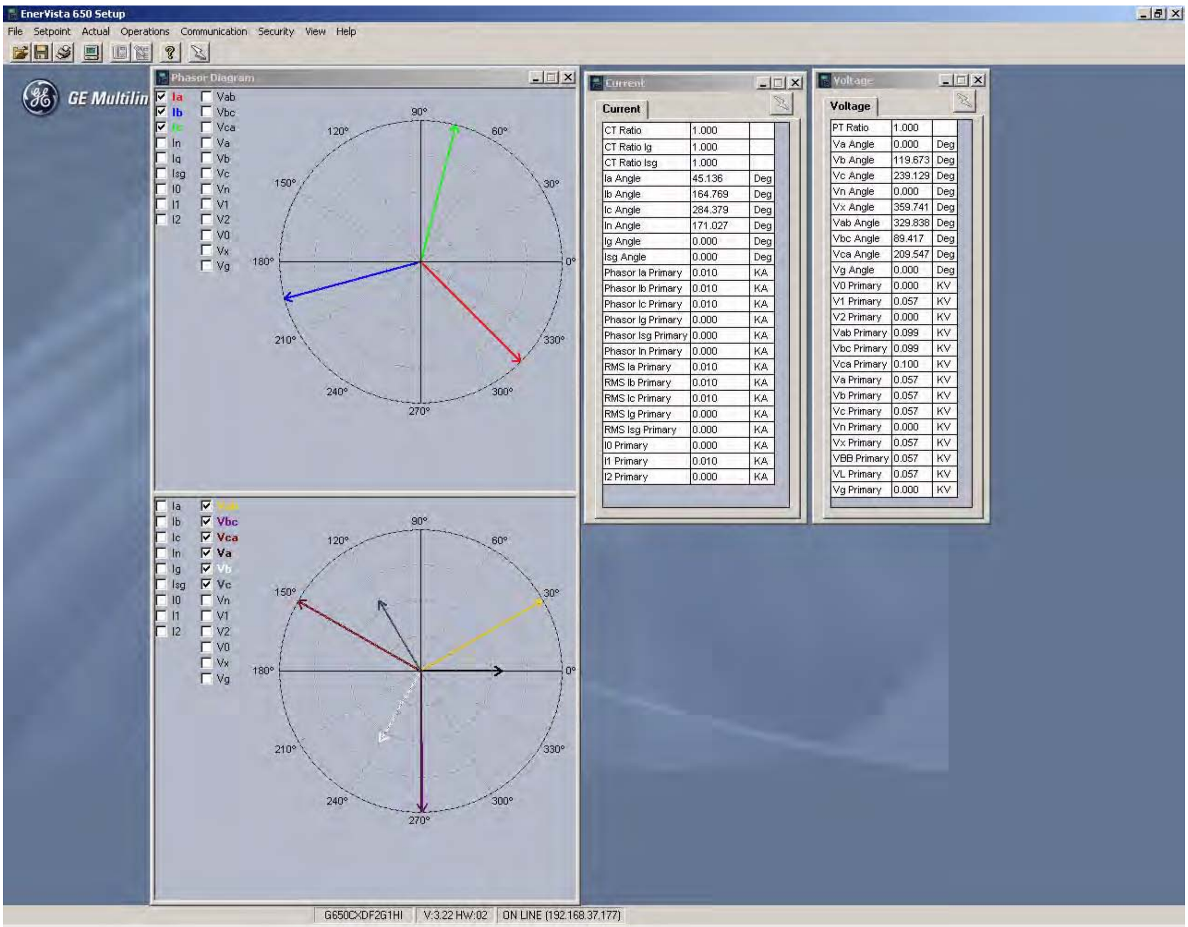

Figure 6–2: PHASOR DIAGRAM

6.3.4 FREQUENCY

Actual> Metering > Frequency

Table 6–44: FREQUENCY VALUES

DESCRIPTION	UNITS
Line Frequency	Hz
Bus Frequency	Hz
df/dt	Hz/s

Digital inputs and outputs are located in the same board. Depending on the relay model, the number of inputs and outputs will vary.

6.4.1 CONTACT INPUTS

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case).

On the inputs screen, the LED associated to the activated input will light up in green, if an input is not activated, the LED will not light up. The "***Board X Status***" LED indicates the status of the board; it will be lit up if the board is correct and the communication or the Relay model is appropriate.

Table 6–45: CONTACT INPUTS ACTIVATION SIGNALS

CONTACT INPUTS TYPE 1	CONTACT INPUTS TYPE 2	CONTACT INPUTS TYPE 4		CONTACT INPUTS TYPE 5
CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC17 (CC17)	CONT IP_X_CC1 (CC1)
CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC18 (CC18)	CONT IP_X_CC2 (CC2)
CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC19 (CC19)	CONT IP_X_CC3 (CC3)
CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC20 (CC20)	CONT IP_X_CC4 (CC4)
CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC21 (CC21)	CONT IP_X_CC5 (CC5)
CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC22 (CC22)	CONT IP_X_CC6 (CC6)
CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC23 (CC23)	CONT IP_X_CC7 (CC7)
CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC24 (CC24)	CONT IP_X_CC8 (CC8)
CONT IP_X_CC9 (Va_COIL1)	CONT IP_X_CC9 (CC9)	CONT IP_X_CC9 (CC9)	CONT IP_X_CC25 (CC25)	CONT IP_X_CC9 (CC9)
CONT IP_X_CC10 (Vb_COIL1)	CONT IP_X_CC10 (CC10)	CONT IP_X_CC10 (CC10)	CONT IP_X_CC26 (CC26)	CONT IP_X_CC10 (CC10)
CONT IP_X_CC11 (Va_COIL2)	CONT IP_X_CC11 (CC11)	CONT IP_X_CC11 (CC11)	CONT IP_X_CC27 (CC27)	CONT IP_X_CC11 (CC11)
CONT IP_X_CC12 (Vb_COIL2)	CONT IP_X_CC12 (CC12)	CONT IP_X_CC12 (CC12)	CONT IP_X_CC28 (CC28)	CONT IP_X_CC12 (CC12)
CONT IP_X_CC13 (O7_SEAL)	CONT IP_X_CC13 (CC13)	CONT IP_X_CC13 (CC13)	CONT IP_X_CC29 (CC29)	CONT IP_X_CC13 (CC13)
CONT IP_X_CC14 (O8_SEAL)	CONT IP_X_CC14 (CC14)	CONT IP_X_CC14 (CC14)	CONT IP_X_CC30 (CC30)	CONT IP_X_CC14 (CC14)
CONT IP_X_CC15 (SUP_COIL1)	CONT IP_X_CC15 (CC15)	CONT IP_X_CC15 (CC15)	CONT IP_X_CC31 (CC31)	CONT IP_X_CC15 (CC15)
CONT IP_X_CC16 (SUP_COIL2)	CONT IP_X_CC16 (CC16)	CONT IP_X_CC16 (CC16)	CONT IP_X_CC32 (CC32)	CONT IP_X_CC16 (CC16)
BOARD X STATUS	BOARD X STATUS		BOARD X STATUS	BOARD X STATUS

6.4.2 CONTACT OUTPUT STATUS

Actual **>** ***Inputs/Outputs*** **>** ***Contact Output Status*** **>** ***Board X*** (being X the corresponding board in each case).

The corresponding Outputs screen will display the activation of a contact output by lighting up in green the associated LED. Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in Table 6–46:

This screen shows the real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in "***Setpoint > Inputs/Outputs >Contact I/O > Board X***"

Table 6–46: CONTACT OUTPUT STATUS

CONTACT OUTPUT STATUS
CONT OP_X_01
CONT OP_X_02
CONT OP_X_03
CONT OP_X_04
CONT OP_X_05
CONT OP_X_06
CONT OP_X_07
CONT OP_X_08
BOARD X STATUS

NOTE: Both in the outputs menu as in the rest of menus available in "**Actual**", the user can view several screens at the same time to facilitate analysis.

6.4.3 CONTACT OUTPUT OPERATES

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Actual **>** ***Inputs/Outputs*** **>** ***Contact Output Operates*** **>** ***Board X*** (being X the corresponding board in each case).

Table 6–47: CONTACT OUTPUTS OPERATES

CONTACT OUTPUT OPERATES
CONT OP OPER_X_01
CONT OP OPER_X_02
CONT OP OPER_X_03
CONT OP OPER_X_04
CONT OP OPER_X_05
CONT OP OPER_X_06
CONT OP OPER_X_07
CONT OP OPER_X_08
BOARD X STATUS

These screens are available for all boards incorporated in the relay model, which can be F, G, H, and/or J.

This screen shows the activated or deactivated status of those variables used internally to operate a contact output.

Signals shown on this screen are configured in the Outputs screen inside the ***Setpoint > Relay Configuration*** menu, either directly by selecting the signals provided by the relay, or selecting a signal provided by the logic configured at ***Setpoint > Logic Configuration.***

These logic signals (Contact Output Operates), when being transformed by the outputs logic configured at ***Setpoint > Inputs/Outputs >Contact I/O > Board X*** become ***Contact Output*** signals. This output logic can be POSITIVE, NEGATIVE, pulse, latched, etc.

Operation example of output contacts:

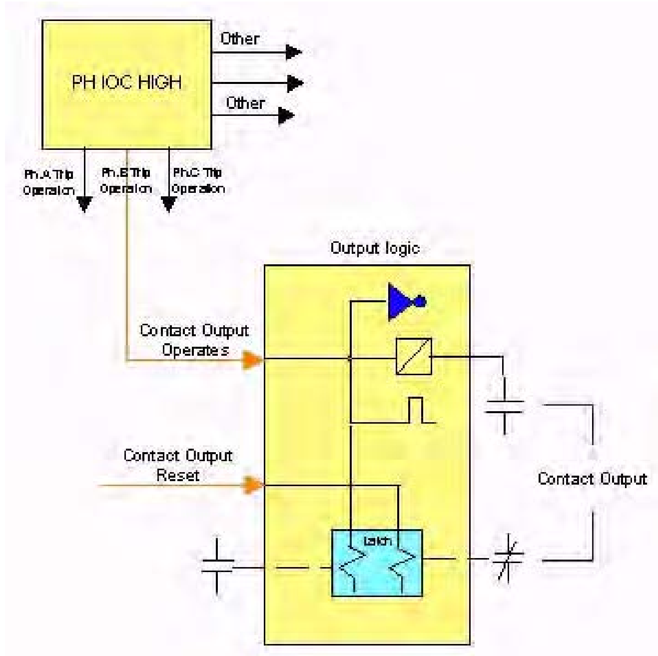

Figure 6–3: OUTPUT CONTACTS OPERATION

6.4.4 CONTACT OUTPUT RESETS

Actual > Inputs/Outputs > Contact Output Resets > Board X (being X the corresponding board in each case).

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in Table 6–48:

If the reset signal is active, the green LED will light up. Otherwise, it will remain unlit.

Table 6–48: CONTACT OUTPUT RESETS

CONTACT OUTPUT RESETS
CONT OP RESET_X_01
CONT OP RESET_X_02
CONT OP RESET_X_03
CONT OP RESET_X_04
CONT OP RESET_X_05
CONT OP RESET_X_06
CONT OP RESET_X_07
CONT OP RESET_X_08
BOARD X STATUS

The last LED in this screen, labeled as “Board Status”, indicates the general board status.

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).

Configuration for the contact output reset signal is set at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***.

6.4.5 I/O BOARD STATUS

Actual > Inputs/Outputs > I/O Board Status

This screen is used for verifying the status of I/O boards. If all the I/O boards, one (F) or both (F and G) depending on the relay model, are correctly inserted in their tracks and are in good state and communicating through the internal CAN Bus, the green LED will remain lit.

I/O boards accessible through the external CAN Bus are labeled as H and J. In order to start working with the external I/O boards is necessary to select the appropriated I/O board type for each slot (H or J for the CIO module) at ***Setpoint > Inputs/Outputs >Contact I/O > Board H and J***. Otherwise the relay will not start communicating through external can to the related board.

If one of the boards has been extracted, or the relay model does not match the installed hardware, the corresponding LED will remain unlit.

Table 6–49: I/O BOARD STATUS

I/O BOARD STATUS
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS

For all I/O board screens described above, the last LED provides this same information individually.

6.4.6 VIRTUAL INPUTS

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

“Virtual Inputs” are signals transmitted by communications. The EnerVista 650 Setup provides a tool to set virtual inputs through ModBus at **Setpoint > Inputs /Outputs /Virtual inputs** that is only available in on line mode (communicating to the relay). There are two available groups of 32 signals each: Latched inputs and Self-reset inputs, and all of them can be used internally to perform operations, new logics in the PLC, etc.

In this actual values screen the status of the assigned virtual inputs can as shown on Table 6–50:

Table 6–50: VIRTUAL INPUTS STATUS

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
…	…
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

6.4.7 VIRTUAL OUTPUTS

Actual > Inputs/Outputs > Virtual Outputs

This screen provides the status of the 512 configurable virtual outputs (internal variables) used in the logic scheme. The virtual outputs are set from 000 to 511.

The configuration of the logic associated to the virtual output is in the ***Setpoint > Logic Configuration*** tool provided by EnerVista 650 Setup program.

Table 6–51: VIRTUAL OUTPUTS STATUS

VIRTUAL OUTPUT STATUS
VIRTUAL OUTPUT 000
VIRTUAL OUTPUT 001
…
VIRTUAL OUTPUT 511

6.4.8 ANALOG INPUTS

Actual > Inputs/Outputs > Analog Intputs > Board X

This screen provides the values of the analog inputs.

ANALOG INPUTS VALUES
Analog_Inp_X_01
Analog_Inp_X_02
Analog_Inp_X_03
...
Analog_Inp_X_08

6.5.1 EVENT RECORDER

6.5.1.1 ALL SNAPSHOT EVENTS

Actual > Records > Event Recorder > All Snapshot Events

By selecting this option, the G650 provides a general list of all snapshot events stored in the relay up to the request moment:

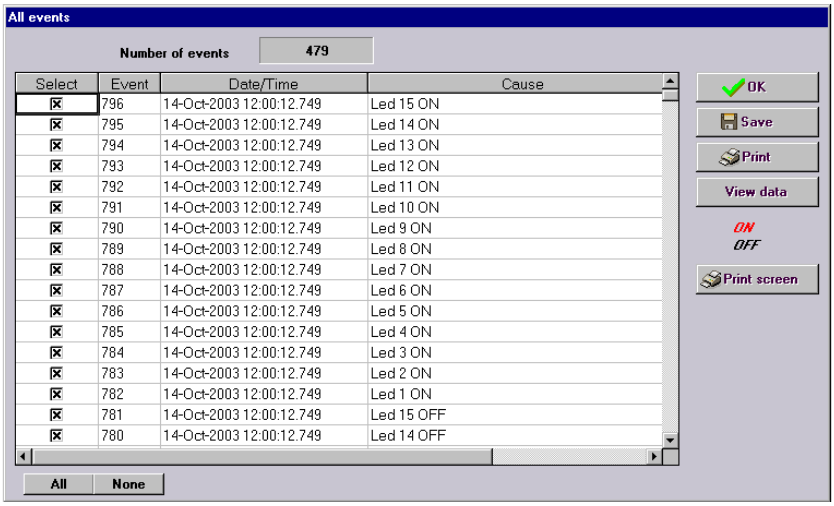

Figure 6–4: EVENT RECORDER – ALL SNAPSHOT EVENTS

The different options available on this screen are as follows:

Save: It allows saving the Snapshot events information obtained in the relay in a CSV format file.

Print: It allows printing the viewed data.

View data: It allows to view the information contained in the selected event, such as the event number, date and time, cause of the event, as well as the voltage and current values in the moment of the event (see Figure 6–5:).

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There is a “**Select**” option, which is used for selecting the events that are required to appear when the screen information is printed or saved.

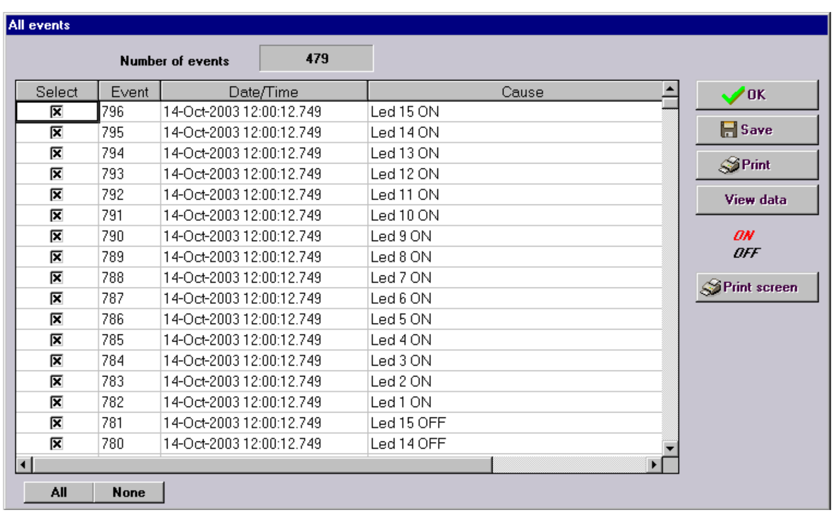

Figure 6–5: SNAPSHOT EVENT DETAILS

6.5.1.2 NEW SNAPSHOT EVENTS

Actual > Records > Event Recorder > New Snapshot Events

This screen shows new Snapshot events, updated since the last time that this menu was accessed; there are three possible ways to access new events; in local mode (COM2-HMI), remote mode (COM1) and via Ethernet (COM3).

It is the same type of screen as shown on all snapshot event retrieval.

6.5.1.3 CONTROL EVENTS

Actual > Records > Event Recorder > Control Events

This screen is identical to the previous ones. The difference is that this screen will display only control events, i.e., those events configured in section "***Setpoint > Relay Configuration > Events***". There are a total of 128 configurable events and 64 non-configurable switchgear events.

In this screen, red or black color for a specific event indicates whether it is activated (to 1) or in standby (to 0)

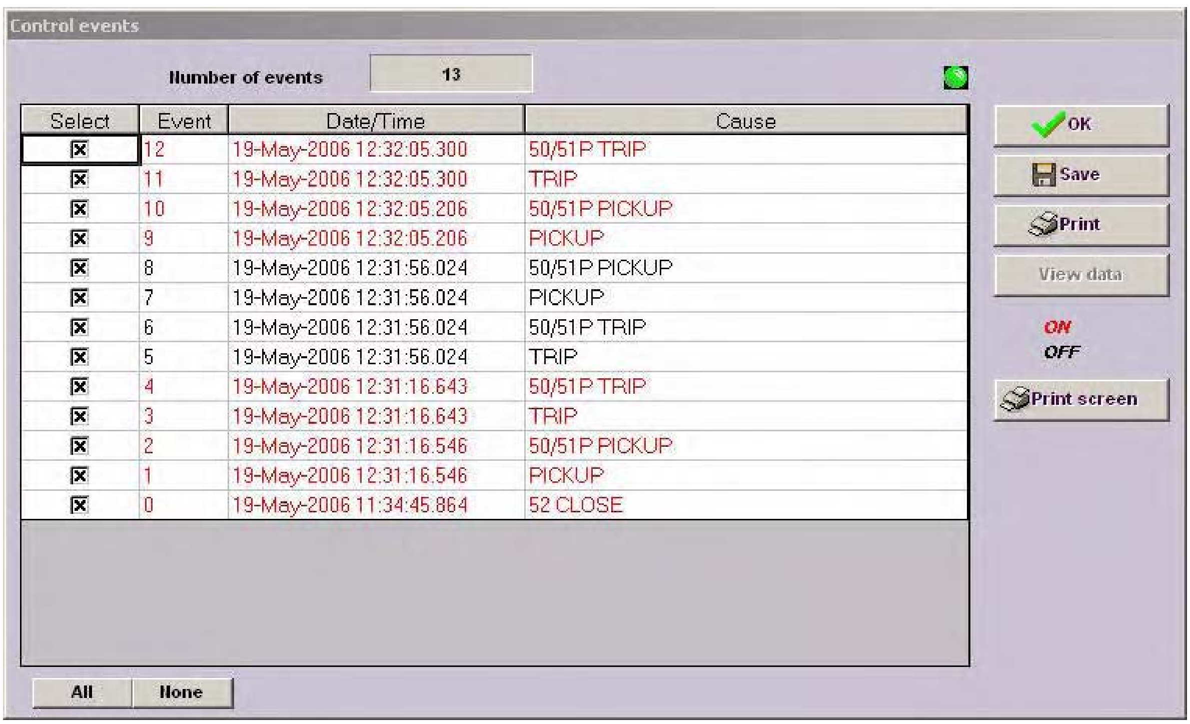

Figure 6–6: CONTROL EVENTS

6.5.1.4 ALARM PANEL

The alarm panel can be accessed at ***Actual > Records > Event Recorder > Alarm Panel***.

The following screen provides information about the issued alarms. The screen shows information about their status: active not acknowledged, active acknowledged and not active. The user can either acknowledge all alarms at the same time, or do it partially by selecting the alarms to be acknowledged.

Figure 6–7: ALARM PANEL

6.5.2 WAVEFORM CAPTURE

The ***Actual > Records > Waveform Capture*** screen displays a list of all oscillography records available in the relay. The G650 stores oscillography records from 1 to 999; this is the index of the obtained oscillography record. This screen allows selecting the records to be saved among all records available. Download of these records will be done through the selected connection in the "***Communication > Computer***" menu, either serial mode or Ethernet.

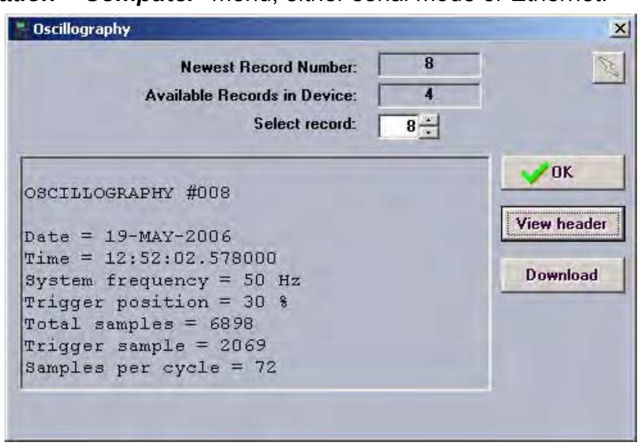

Figure 6–8: OSCILLOGRAPHY RECORD RETRIEVAL VIA ENERVISTA 650 SETUP

The screen will show all the available records in the Relay, and by clicking on each of them, the system will display the heading information for that record, allowing downloading the information to a disk. Once the file to be downloaded has been selected, the oscillography record can be opened using GE-OSC software.

GE-OSC is GE proprietary software that is not distributed together with EnerVista 650 Setup. This program is A COMTRADE viewer and analysis software for oscillography files.

If the user does not have the GE-OSC tool, the oscillography record can be stored and viewed using any other analysis tool capable of reproducing COMTRADE.1999 files.

When using GE-OSC software, this program requires the use of a template for each relay. If there is a stored template for G650 relays (as in the figure), the user must simply select it and click the **Open Selected Template** key. The program will then be prepared to view oscillography and digital records using the options in available menus (Waveforms and Digital Flags). Otherwise, it will be required to select the **Create New Template** option, where the program will help create a new template. Nevertheless, there is a specific instruction manual for GE-OSC software use.

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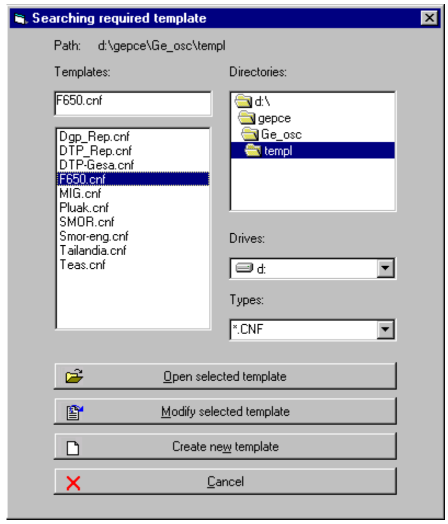

Figure 6–9: GE-OSC OSCILLOGRAPHY ANALYSIS SOFTWARE

It must be taken into account that any settings change in the oscillography will produce the removal of all the information stored up to that moment.

6.5.3 FAULT REPORT

When selecting the ***Actual > Records > Fault Report*** menu, EnerVista 650 Setup will show the following screen, indicating the fault reports available in the relay.

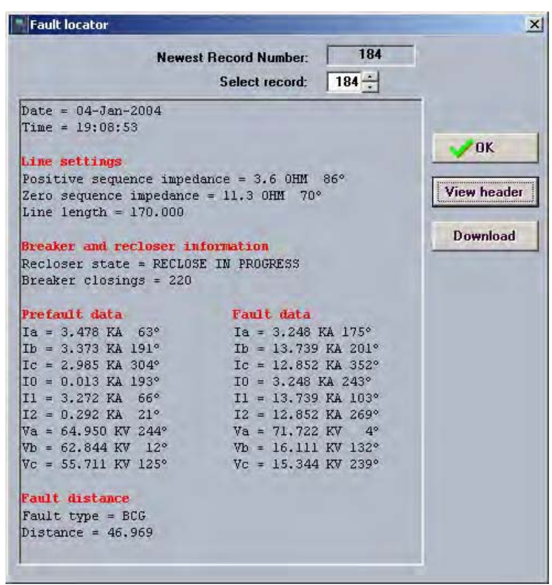

Figure 6–10: FAULT REPORT RETRIEVAL VIA ENERVISTA 650 SETUP

When selecting one of the records, a new screen will detail the following information:

- Date
- Time
- Pre-fault current and voltage in primary values

- Fault current and voltage in primary values
- Fault type
- Distance to the fault

The operation of this screen is similar to that of the previous oscillography screen, being in this case the number of fault reports a fixed number (10), instead of variable and setting-selected like as in the previous case.

Once a fault report is selected, its heading description will be displayed, showing pre-fault information, fault information and the distance to the fault. This file can be downloaded to the computer in a CSV format file.

Fault report file retrieval can be performed via serial or Ethernet communications. It must be taken into account that any settings change in the fault report will produce the removal of all the information stored up to that moment.

6.5.4 DATA LOGGER

The access menu is ***Actual > Records > Data Logger***. Once open, this menu will show a screen containing the information monitored by the relay according to the settings adjusted at "***Setpoint > Product Setup > Data Logger***", where the user can select which analog channels will be recorded, as well as the sampling rate.

It must be taken into account that any settings change in the data logger will produce the removal of all the information stored up to that moment.

The data logger screen diagram shows the time during which the displayed values have been obtained.

The upper part of the window shows the time when the oldest sample was taken, as well as the time when the most recent value was taken.

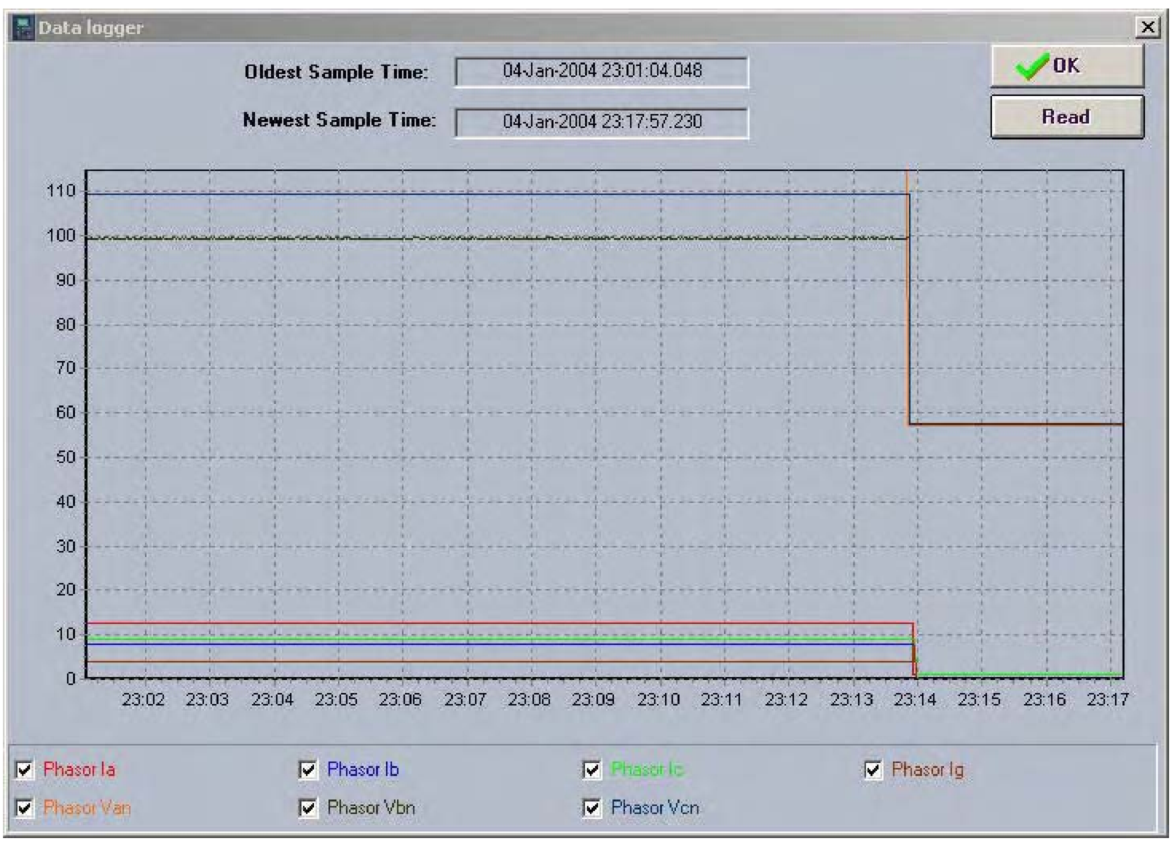

Figure 6–11: DATA LOGGER

This screen offers the possibility of storing the data logger record obtained for a further analysis, in COMTRADE format.

Data Logger file retrieval can be performed only via Ethernet communications.

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**

7.1.1 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 7–1: 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.

7

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 7–1: 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.

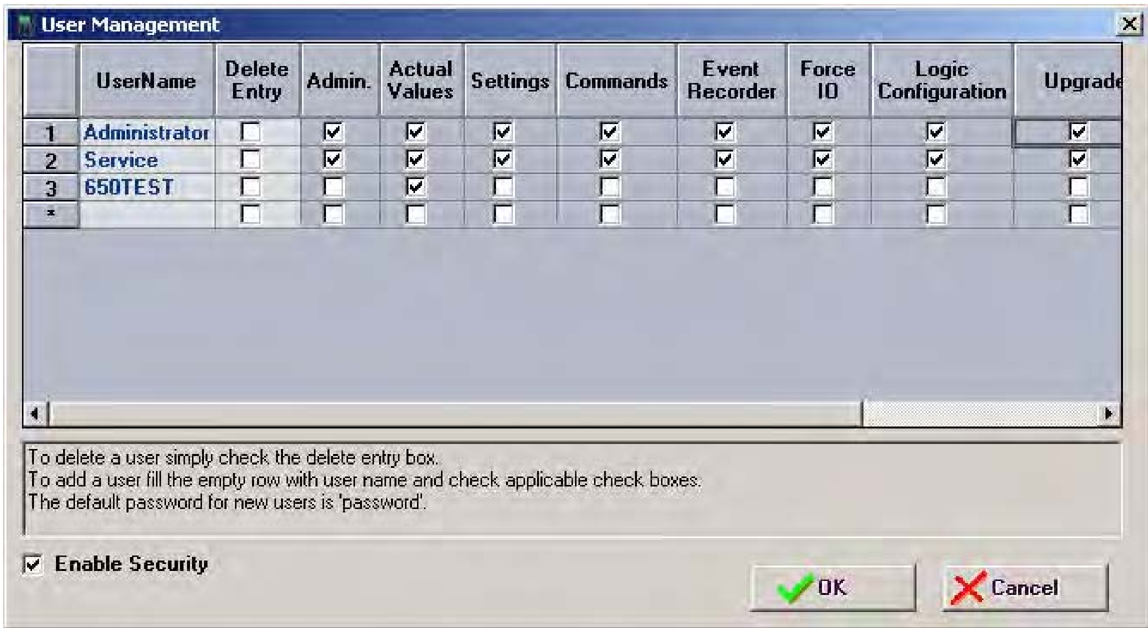

Figure 7–2: SECURITY ENABLING

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.

7

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.

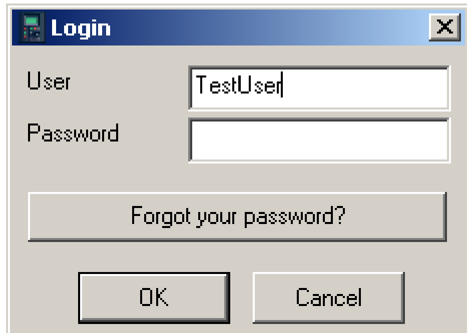

Figure 7–3: LOGIN USER

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 7–4: 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.

7

This section explains how to upgrade the G650 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 "G650" (3.74 in the example) with the boot program version (4.10 in the example) followed by "GENERAL ELECTRIC", the relay model and the default front RS232 port communication parameters.

G650 3.74 (4.10)
GENERAL ELECTRIC
G650BFBF1G0HI
19200N81 MODBUS:254

Figure 8–1: 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**
3.74	4.10
3.22	4.10

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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 8 before accomplishing the G650 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.

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.

8.1.1 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 8–1:

Table 8–1: 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 8–14:).

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).

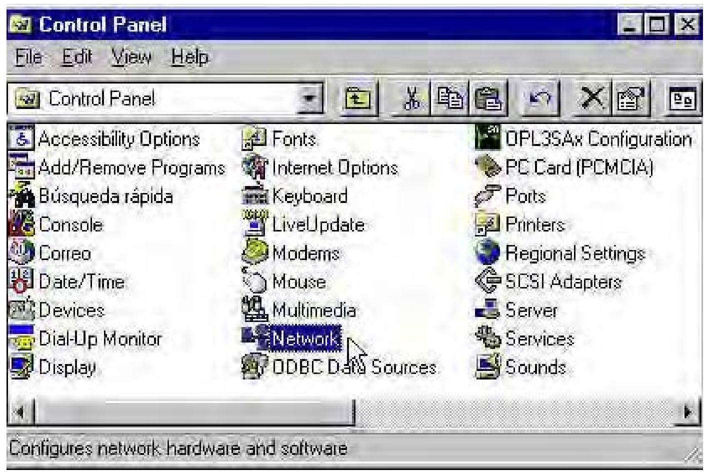

Figure 8–2: NETWORK IN CONTROL PANEL

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

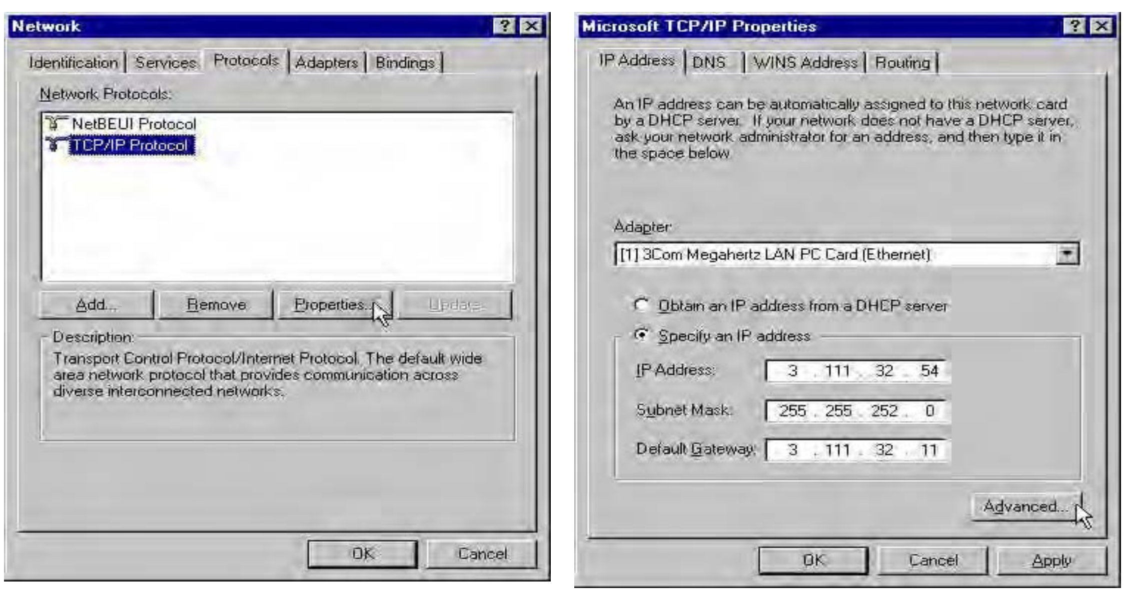

Figure 8–3: TCP/IP PROPERTIES

In the **IP address** tab, select **Advanced...** (see Figure 8–3:) 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).

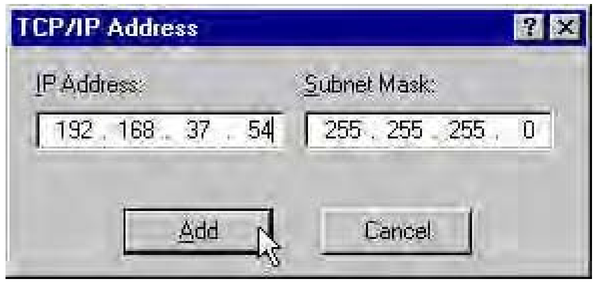

Figure 8–4: IP ADDRESS FOR COMPUTER

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.

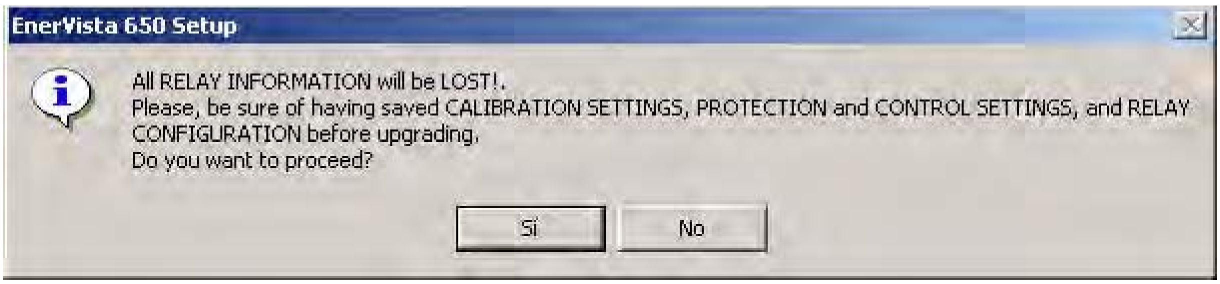

Figure 8–5: LOST DATA WARNING MESSAGE

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 8–6: 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.

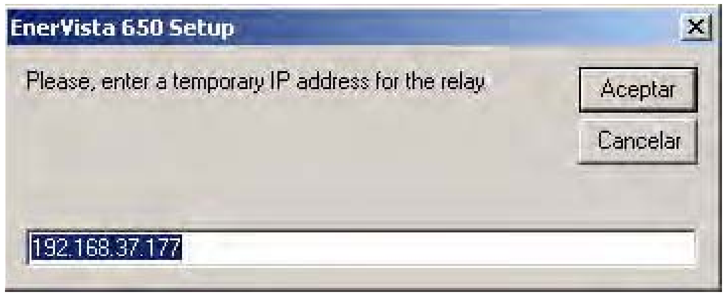

Figure 8–7: TEMPORARY IP ADDRESS SELECTION FOR BOOT UPGRADE

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

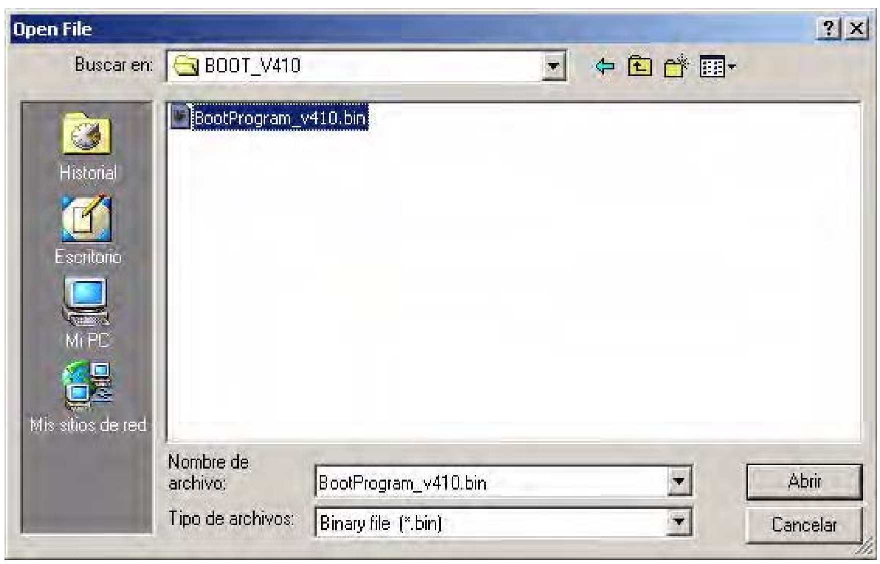

Figure 8–8: BOOT FILE SELECTION

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

Figure 8–9: 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 8–10: 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 8–11: 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 8–12: 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.

8

Figure 8–13: 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 8–14:). The requested values are the IP address and the gateway

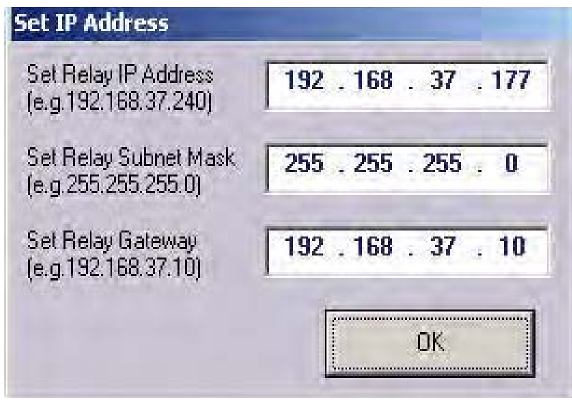

Figure 8–14: ETHERNET PARAMETERS

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 8–15:).

8

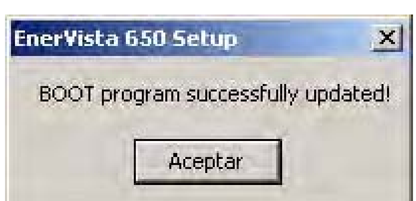

Figure 8–15: BOOT PROGRAM UPGRADED

After boot code upgrade, the equipment firmware must also be upgraded (Section 8.3).

The relay settings and configuration will be lost, so it is advisable to save them to a file. 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).

8.3.1 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.

Therefore, it is necessary to save all settings to a file before following with the process.

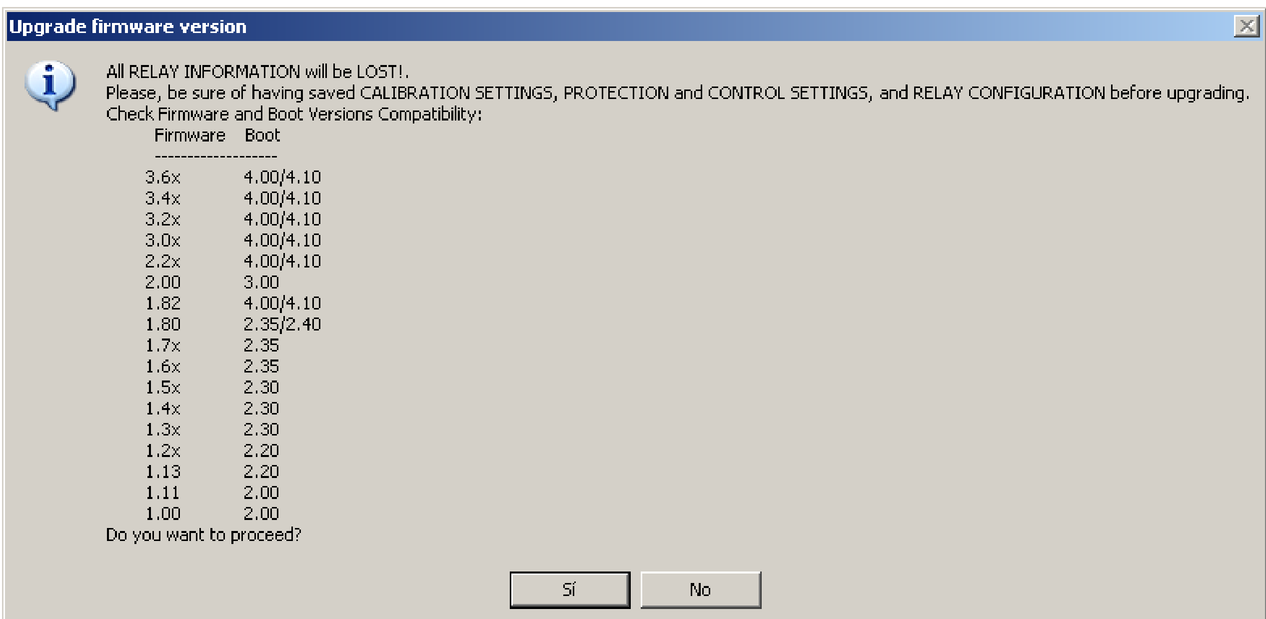

Figure 8–16: FIRMWARE-BOOT VERSION COMPATIBILITY

After accepting to proceed, a window will open up for the upgrade parameter.t 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 8–17: FIRMWARE SELECTION WINDOW

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.

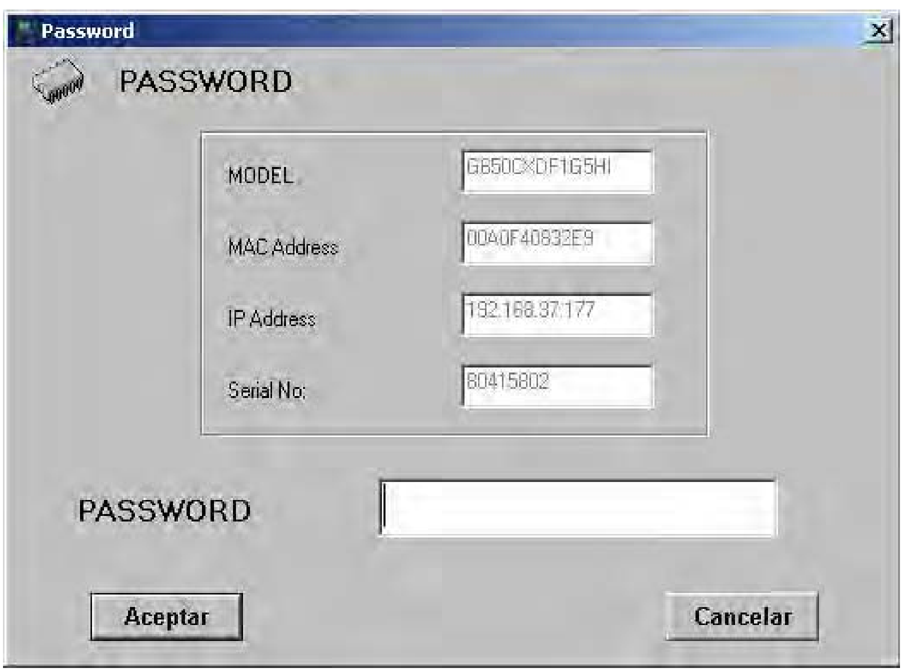

Figure 8–18: PASSWORD FOR ENHANCED MODEL UPGRADE

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

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- 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. 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 G650 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 G650 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.

For firmware versions 3.20 and higher ones, it is advisable to calibrate the offset in order to avoid measurement errors in RMS values. Go to **Communication > Calibration > Offset calibration** to recalibrate the offset in the relay if necessary (if RMS values do not show zero with zero inyection). To calibrate the offset the values for currents and voltages must be zero.

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.

8.3.2 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.

8.3.3 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).
12. THE SETTINGS AND CONFIGURATION ARE NOW SET TO FACTORY DEFAULT.
13. SEND THE NEW SETTINGS AND CONFIGURATION FILES TO THE RELAY IF NECESSARY.

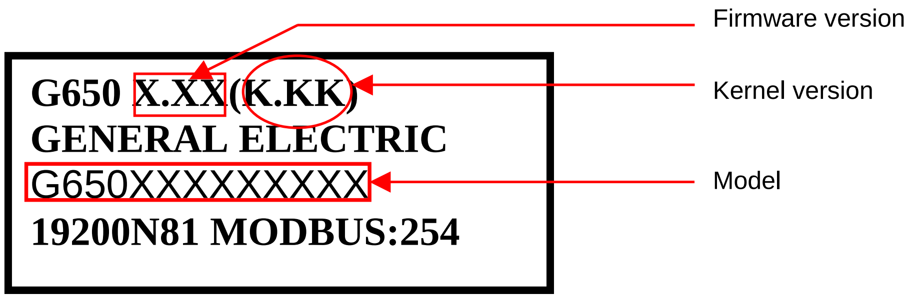
(*) The boot code upgrade must be performed using a crossed copper cable (RJ45) connected to the PC. It is not necessary to modify the internal fiber/cable switch, as the upgrade is carried out at 10 Mb/s, and thus there is not cable/fiber conflict.This fact does not apply to the firmware upgrade, which 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 G650.

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 G650, 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

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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	1-250 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 – VG
FREQ. TRACKING	ENABLED/ DISABLED	N/A	N/A

NOTE:

ALL ANGLES INDICATED ARE LAGGING ANGLES

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

9.7.1 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/VG	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).

9.7.2 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).

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9.7.3 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.

9.7.4 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.

9.8.1 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.

9.8.2 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.

9.8.3 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).

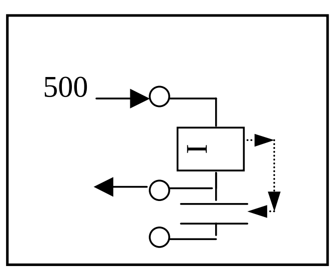
9.8.4 LATCHING CIRCUITS

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).

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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, 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	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)						
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]

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.

9.12.1 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	

9.12.2 67G ELEMENT

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	

9.13.1 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]

9.13.2 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

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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]

9.14.1 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]

9.14.2 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]

9.14.3 59NH ELEMENT

Set the relay as follows

NEUTRAL OV HIGH (59NH)	
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	VI	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

Vn voltage is calculated as a sum of the phase voltages.

9.14.4 47 ELEMENT - NEG SEQ OV

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

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10.1.1 DESCRIPTION OF THE EXERCISE

The requirements for this setting exercise are:

Communicate the relay via serial cable or Ethernet 10/100 Base T cable using EnerVista 650 Setup program.

Set some Phase Time Overcurrent protection function to operate at 5A, Inverse curve IEC, Dial 0.1

Set some Output contact on board F to be operated and sealed by the operation of the phase TOC.

Set some LED to show the operation of the phase TOC

Set some Operation to reset the output contact after dropout of the phase TOC since the front F1 pushbutton.

Set some Oscillography channel to record the pickup of phase TOC and output contact closing action.

To test the operation of this Phase Time Overcurrent protection

10.1.2 PROCEDURE TO COMMUNICATE WITH THE RELAY

This procedure describes the connection between any Laptop and some G650 relay using the **EnerVista 650 SETUP** program

For any one of these connections check first the communication parameters as follows:

Serial Communication (RS232 front port of the relay)

With the ESC key check on the main front screen the serial communication parameters (Baud rate, parity, data bits, stop bit and ID number).

Connect the serial cable PC-G650

Open the EnerVista 650 SETUP program in the PC and under **Communication ⇓ Computer** menu check that the serial communication parameters displayed are the same read in the front of the relay. Check also that:

Control Type is set to   No Control Type

Startup Mode is set to Communicate with relay

Click **ON** key.

Ethernet LAN (10/100 Base T rear port of the relay)

In the Laptop choose **My PC-Control Panel-Network-Protocols-Protocol TCP/IP-Advance** and set in **IP Address** screen the following:

IP Address   192.168.37.126

Netmask   255.255.255.0

In the front of G650 relay and pressing the ESC key display the **Main Settings** screen.

Move clockwise the rotating knob to choose **Change Settings** and press down the rotating knob.

Choose **Comm Settings** and press down the rotating knob.

Choose **Network 0** and press down the rotating knob. It will be displayed **IP Address OCT 1** and set it according to the following table:

SEQUENCE		
ACTION	**SETTING**	**ACTION**
----	IP Address OCT 1	Set to 192 with rotating knob and press it down
Move rotating knob clockwise	IP Address OCT 2	Set to 168 with rotating knob and press it down
Move rotating knob clockwise	IP Address OCT 3	Set to 37 with rotating knob and press it down
Move rotating knob clockwise	IP Address OCT 4	Set to 125 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 1	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 2	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 3	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 4	Set to 0 with rotating knob and press it down
Move rotating knob clockwise	Netway IP OCT 1	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 2	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 3	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 4	Leave default setting without any change
Move rotating knob clockwise	Press INTRO	Press down the rotating knob to validate settings

Press ESC key once.

Move rotating knob counterclockwise to **General Settings** and press it down. **General Settings 0** will be displayed now. Press rotating knob down again.

Set ModBus Port Number to 502 and press rotating knob down.

Move counterclockwise the rotating knob to find ModBus Address COM1 and press it down.

Set ModBus Address COM1 to 254 with the rotating knob and then press it down.

Move clockwise the rotating knob to find **Press Intro to End** and press it down to validate the setting.

Connect a crossover 10/100 MB Ethernet cable from PC to the relay.

Open the EnerVista 650 SETUP program in the PC and under **Communication** ⇓ **Computer** menu and set:

IP Address	192.168.37.125
Port	502
Unit Identifier	254
Control Type to	ModBus/TCP
Startup Mode to	Communicate with relay

Click **ON** key.

The program will start connection with the relay showing the progress screen.

10.1.3 PROCEDURE TO SET THE PROTECTION FUNCTION

Once the relay has been connected set protection functions and outputs according to the following steps:

Open EnerVista 650 SETUP program and under:

SETPOINT ⇓ SYSTEM SETUP ⇒ ⇓ GENERAL SETTINGS

NAME	VALUE
Phase CT Ratio	1.0 (default)
Ground CT Ratio	1.0 (default)
Stv Ground CT Ratio	1.0 (default)
Phase VT Ratio	1.0 (default)
Phase VT Connection	Wye
Nominal Voltage	100.0 (default)
Nominal Frequency	50
Phase Rotation	ABC
Frequency Reference	VI (default)
Auxiliary Voltage	VX (default)
Snapshot Events	Disabled (default)
Freq. Tracking	Disabled (default)

Under

SETPOINT ⇓ PROTECTION ELEMENTS ⇒ ⇓ PHASE CURRENT ⇒ ⇓ PHASE TOC HIGH ⇒ PHASE TOC HIGH 1

NAME	VALUE
Function	Enabled
Input	Phasor DFT
Pickup Level	5.0 A
Curve	IEC Curve A
TD Multiplier	0.1
Reset	Instantaneous
Voltage Restraint	Disabled

Under

SETPOINT ⇓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F

NAME	VALUE
Output Logic_00_00	Positive
Output Type_00_00	Latch

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OUTPUTS

SELECT	NAME	SOURCE	OR
Contact Output Operate 00 (Board F)	C Output Oper_00_00	**PRESS FOR LOGIC**	☑
		Phase TOC A Op Phase TOC B Op Phase TOC C Op	
Contact Output Reset 00 (Board F)	C Output Reset_00_00	Operation bit 000	

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ LEDS

SELECT	NAME	SOURCE
☑ Led 5	C Output Op 00	C Output_00_00

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OPERATIONS

Select	☑ Operation 0
Command Text	Reset C Output 00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F1
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Master 4	---

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OSCILLOGRAPHY

SELECT	NAME	SOURCE
☑ Digital Channel 1	C Output Op_00_00	C Output Oper_00_00
☑ Digital Channel 2	C Output_00_00	C Output_00_00

10.1.4 TEST

Apply 7.5 A in phase A (terminals B1-B2) until contact 00 on Board F operates (terminals F19-F21 should be and remain closed), and LED 5 should be lit. Check that operating time is in the order of 1.7 seconds.

Remove current from terminals B1-B2

Press pushbutton F1 and check that contact 00 on Board F has been open.

Check that LED 5 in the front of the relay has been turned off.

Repeat the process for phase B (terminals B3-B4) and for phase C (terminals B5-B6)

Under **Actual** ⇓ **Waveform Capture** menu retrieve the last oscillography recording stored, open it using GE_OSC program and check that the two digital signals as well as the current signal were kept.

2

10.2.1 DESCRIPTION OF THE EXERCISE

This simple operation describes how to program and set an operation command on the G650 relay. In the present case the operation is:

To configure some G650 output contact to be operated since the front of the relay.

To set some LED to show the operation of the output contact (while being closed).

To close a G650 output contact using a front key pushbutton.

To reset the output contact and LED using another front key pushbutton.

10.2.2 PROCEDURE

Set the following values:

Under

SETPOINT ⇓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F

NAME	VALUE
Output Logic_00_00	Positive
Output Type_00_00	Latch
Pulse Output Time	10000ms *****

***** This setting is non-relevant since it applies only when "**pulse**" type is chosen

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OUTPUTS

SELECT	NAME	SOURCE
☑ Contact Output Operate 00 (Board F)	C_Output Oper_00_00	Operation_bit000
☑ Contact Output Reset 00 (Board F)	C_Output Reset_00_00	Operation_bit001

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ LEDS

SELECT	NAME	SOURCE
☑ Led 14	Close Contact_00_00	C_Output_00_00

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OPERATIONS

Select	Operation 0
Command Text	Close C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F2
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Mastef 4	---

In the same window (next rows)

Select	Operation 1
Command Text	Reset C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F1
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Mastef 4	---

10.2.3 TEST

In the main front screen press **F2** key.

A message showing “Press Intro to Confirm Key →**F2**←” will be displayed.

Press down the **rotary knob**.

Check that contact_00_00 (board F) has been closed.

Check that the front LED 14th is lit.

In the main front screen press **F1** key.

A message showing “Press Intro to Confirm Key →**F1**←” will be displayed.

Press down the **rotary knob**.

Check that contact_00_00 (board F) has been opened.

Check that the front LED 14th has been switched off

Q1. Does the G650 support DNP and ModBus over the Ethernet port?

A1. G650 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 G650?

A3. At this moment it is not supported.

Q4. Can the G650 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 G650?

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

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 G650s 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 G650 relays?

A13. Take into account that an UR is never connected directly to a G650 (neither two UR nor two G650 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 G650 must be 100-BASE-FX.

Q14. How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX G650 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 G650, and a hub 10/100-BASE-TX port may be connected either to an UR or G650.

Q15. What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the G650, although both are 100-BASE-FX?

A15. Just buy fiber cables with the appropriate male connectors. For the UR and G650 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 G650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1. Yes, the G650 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 G650 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

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.

G650 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 - Function blocked - Output not assigned	-Set the function permission to ENABLED -Check Protection units block screen -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 - Wrong versions -Fuse failure - Loose fuse -Incorrect wiring	-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range -Check relay and ENERVISTA 650 Setup versions are the same -Remove power supply, dismount the power supply module and replace the fuse -Same as above with same fuse -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 -Damaged cable -Relay or PC not grounded -Incorrect baudrate, port, address, etc.	-Make sure you are using a straight cable -Replace the cable -Ensure ground connection -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 G650 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

OPERANDS - G650 - 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)		
OTHER INTERNAL STATES (NON CRITICAL)		
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)

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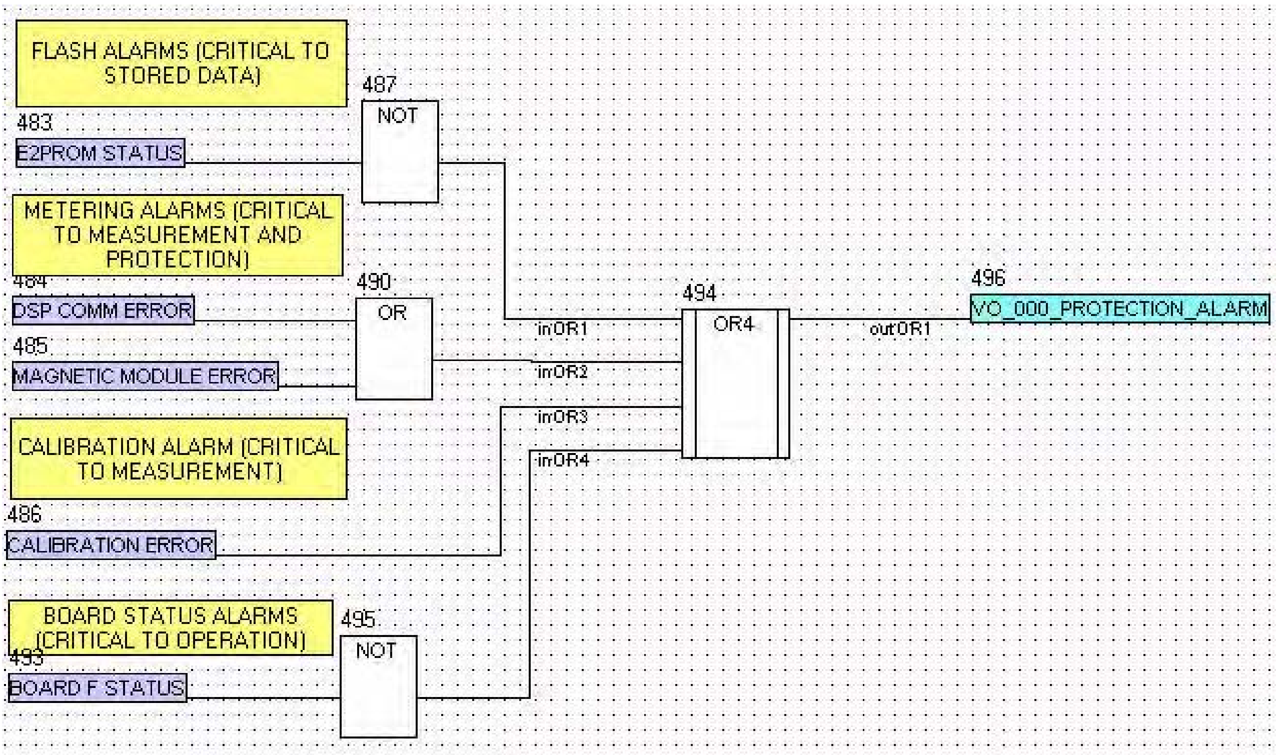
Note: It is advisable to use the critical alarms to raise an event or to light a warning led for maintenance purposes. See the example below, the Board X Status depends on the relay model.



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 - G650 - 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 - G650 - 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

OPERANDS - G650 - 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

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OPERANDS - G650 - 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 - G650 - 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 - G650 - 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 - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
	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
Setting Groups	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

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

OPERANDS - G650 - 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
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 - G650 - 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 (Enhanced Models only)	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 - G650 - 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

OPERANDS - G650 - 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

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OPERANDS - G650 - 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

OPERANDS - G650 - 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 (Enhanced Models only)	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

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OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Negative Sequence IOC	NEG. SEQ IOC1 BLOCK	Negative sequence instantaneous overcurrent element block Group 1
	NEG. SEQ IOC1 PKP	Negative sequence instantaneous overcurrent element pickup Group 1
	NEG. SEQ IOC1 OP	Negative sequence instantaneous overcurrent element operation Group 1
	NEG. SEQ IOC2 BLOCK	Negative sequence instantaneous overcurrent element block Group 2
	NEG. SEQ IOC2 PKP	Negative sequence instantaneous overcurrent element pickup Group 2
	NEG. SEQ IOC2 OP	Negative sequence instantaneous overcurrent element operation Group 2
	NEG. SEQ IOC3 BLOCK	Negative sequence instantaneous overcurrent element block Group 3
	NEG. SEQ IOC3 PKP	Negative sequence instantaneous overcurrent element pickup Group 3
	NEG. SEQ IOC3 OP	Negative sequence instantaneous overcurrent element operation Group 3
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
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

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OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Generator Unbalance	GEN UNBAL1 BLOCK	Generator Unbalance element block Group 1
	GEN UNBAL1 STG1 PKP	Generator Unbalance element pickup Stage 1 Group 1
	GEN UNBAL1 STG1 OP	Generator Unbalance element operation Stage 1 Group 1
	GEN UNBAL1 STG2 PKP	Generator Unbalance element pickup Stage 2 Group 1
	GEN UNBAL1 STG2 OP	Generator Unbalance element operation Stage 2 Group 1
	GEN UNBAL1 PKP	Generator Unbalance element general pickup Group 1
	GEN UNBAL1 OP	Generator Unbalance element general operation Group 1
	GEN UNBAL2 BLOCK	Generator Unbalance element block Group 2
	GEN UNBAL2 STG1 PKP	Generator Unbalance element pickup Stage 1 Group 2
	GEN UNBAL2 STG1 OP	Generator Unbalance element operation Stage 1 Group 2
	GEN UNBAL2 STG2 PKP	Generator Unbalance element pickup Stage 2 Group 2
	GEN UNBAL2 STG2 OP	Generator Unbalance element operation Stage 2 Group 2
	GEN UNBAL2 PKP	Generator Unbalance element general pickup Group 2
	GEN UNBAL2 OP	Generator Unbalance element general operation Group 2
	GEN UNBAL3 BLOCK	Generator Unbalance element block Group 3
	GEN UNBAL3 STG1 PKP	Generator Unbalance element pickup Stage 1 Group 3
	GEN UNBAL3 STG1 OP	Generator Unbalance element operation Stage 1 Group 3
	GEN UNBAL3 STG2 PKP	Generator Unbalance element pickup Stage 2 Group 3
	GEN UNBAL3 STG2 OP	Generator Unbalance element operation Stage 2 Group 3
	GEN UNBAL3 PKP	Generator Unbalance element general pickup Group 3
	GEN UNBAL3 OP	Generator Unbalance element general operation Group 3

OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Generator Thermal Model	THERMAL1 49S BLOCK	Generator Thermal Model element block Group 1
	THERMAL1 49S ALARM	Generator Thermal Model element alarm Group 1
	THERMAL1 49S OP	Generator Thermal Model element operation Group 1
	THERMAL1 49S RST	Generator Thermal Model element reset signal Group 1
	THERMAL2 49S BLOCK	Generator Thermal Model element block Group 2
	THERMAL2 49S ALARM	Generator Thermal Model element alarm Group 2
	THERMAL2 49S OP	Generator Thermal Model element operation Group 2
	THERMAL2 49S RST	Generator Thermal Model element reset signal Group 2
	THERMAL3 49S BLOCK	Generator Thermal Model element block Group 3
	THERMAL3 49S ALARM	Generator Thermal Model element alarm Group 3
	THERMAL3 49S OP	Generator Thermal Model element operation Group 3
	THERMAL3 49S RST	Generator Thermal Model element reset signal Group 3
Restricted Ground Fault (Enhanced models only)	RESTR GND FLT1 BLOCK	Restricted Ground Fault element block Group 1
	RESTR GND FLT1 PKP	Restricted Ground Fault element pickup Group 1
	RESTR GND FLT1 OP	Restricted Ground Fault element operation Group 1
	RESTR GND FLT2 BLOCK	Restricted Ground Fault element block Group 2
	RESTR GND FLT2 PKP	Restricted Ground Fault element pickup Group 2
	RESTR GND FLT2 OP	Restricted Ground Fault element operation Group 2
	RESTR GND FLT3 BLOCK	Restricted Ground Fault element block Group 3
	RESTR GND FLT3 PKP	Restricted Ground Fault element pickup Group 3
	RESTR GND FLT3 OP	Restricted Ground Fault element operation Group 3
VTFuse failure (Enhanced models only)	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

OPERANDS - G650 - 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 - G650 - 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

OPERANDS - G650 - 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
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
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

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OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
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
Volts per Hertz (Enhanced models only)	VOLTS/Hz1 BLOCK	Volts per Hertz element block Group 1
	VOLTS/Hz1 PKP	Volts per Hertz element pickup Group 1
	VOLTS/Hz1 OP	Volts per Hertz element operation Group 1
	VOLTS/Hz2 BLOCK	Volts per Hertz element block Group 2
	VOLTS/Hz2 PKP	Volts per Hertz element pickup Group 2
	VOLTS/Hz2 OP	Volts per Hertz element operation Group 2
	VOLTS/Hz3 BLOCK	Volts per Hertz element block Group 3
	VOLTS/Hz3 PKP	Volts per Hertz element pickup Group 3
	VOLTS/Hz3 OP	Volts per Hertz element operation Group 3
Ground Overvoltage	GND OV1 BLK	Ground Overvoltage element block Group 1
	GND OV1 PKP	Ground Overvoltage element pickup Group 1
	GND OV1 OP	Ground Overvoltage element operation Group 1
	GND OV2 BLK	Ground Overvoltage element block Group 2
	GND OV2 PKP	Ground Overvoltage element pickup Group 2
	GND OV2 OP	Ground Overvoltage element operation Group 2
	GND OV3 BLK	Ground Overvoltage element block Group 3
	GND OV3 PKP	Ground Overvoltage element pickup Group 3
	GND OV3 OP	Ground Overvoltage element operation Group 3

OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
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
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
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

OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Breaker Status	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
Breaker Failure(Enhanced models only)	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
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
Default Channel (not used)	Default Channel	Channel not used

OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
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

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OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Power Factor Limiting(Enhanced models only)	POWER FACTOR1 BLOCK	Power Factor element block Group 1
	PF1 LAG STG1 OP	Power Factor element lagging operation stage 1 Group 1
	PF1 LEAD STG1 OP	Power Factor element leading operation stage 1 Group 1
	PF1 LAG STG2 OP	Power Factor element lagging operation stage 2 Group 1
	PF1 LEAD STG2 OP	Power Factor element leading operation stage 2 Group 1
	PF1 LAG OP	Power Factor element lagging general operation (any stage) Group 1
	PF1 LEAD OP	Power Factor element leading general operation (any stage) Group 1
	POWER FACTOR2 BLOCK	Power Factor element block Group 2
	PF2 LAG STG1 OP	Power Factor element lagging operation stage 1 Group 2
	PF2 LEAD STG1 OP	Power Factor element leading operation stage 1 Group 2
	PF2 LAG STG2 OP	Power Factor element lagging operation stage 2 Group 2
	PF2 LEAD STG2 OP	Power Factor element leading operation stage 2 Group 2
	PF2 LAG OP	Power Factor element lagging general operation (any stage) Group 2
	PF2 LEAD OP	Power Factor element leading general operation (any stage) Group 2
	POWER FACTOR3 BLOCK	Power Factor element block Group 3
	PF3 LAG STG1 OP	Power Factor element lagging operation stage 1 Group 3
	PF3 LEAD STG1 OP	Power Factor element leading operation stage 1 Group 3
	PF3 LAG STG2 OP	Power Factor element lagging operation stage 2 Group 3
	PF3 LEAD STG2 OP	Power Factor element leading operation stage 2 Group 3
	PF3 LAG OP	Power Factor element lagging general operation (any stage) Group 3
	PF3 LEAD OP	Power Factor element leading general operation (any stage) Group 3

OPERANDS - G650 - 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
Loss of Mains (Enhanced models only)	LOSS OF MAINS1 BLOCK	Loss of mains element block Group 1
	LOSS OF MAINS1 A OP	Loss of mains element operation in phase A Group 1
	LOSS OF MAINS1 B OP	Loss of mains element operation in phase B Group 1
	LOSS OF MAINS1 C OP	Loss of mains element operation in phase C Group 1
	LOSS OF MAINS1 OP	Loss of mains element general operation Group 1
	LOSS OF MAINS2 BLOCK	Loss of mains element block Group 2
	LOSS OF MAINS2 A OP	Loss of mains element operation in phase A Group 2
	LOSS OF MAINS2 B OP	Loss of mains element operation in phase B Group 2
	LOSS OF MAINS2 C OP	Loss of mains element operation in phase C Group 2
	LOSS OF MAINS2 OP	Loss of mains element general operation Group 2
	LOSS OF MAINS3 BLOCK	Loss of mains element block Group 3
	LOSS OF MAINS3 A OP	Loss of mains element operation in phase A Group 3
	LOSS OF MAINS3 B OP	Loss of mains element operation in phase B Group 3
	LOSS OF MAINS3 C OP	Loss of mains element operation in phase C Group 3
	LOSS OF MAINS3 OP	Loss of mains element general operation Group 3

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OPERANDS - G650 - MODEL FX - GX		
INTERNAL SYSTEM STATUS (CONT.)		
Loss of Excitation	LOSS OF EXC1 BLOCK	Loss of Excitation element block Group 1
	LOSS OF EXC1 ST1 PKP	Loss of Excitation element pickup stage 1 Group 1
	LOSS OF EXC1 STG1 OP	Loss of Excitation element operation stage 1 Group 1
	LOSS OF EXC1 ST2 PKP	Loss of Excitation element pickup stage 2 Group 1
	LOSS OF EXC1 STG2 OP	Loss of Excitation element operation stage 2 Group 1
	LOSS OF EXC1 PKP	Loss of Excitation element general pickup (any stage) Group 1
	LOSS OF EXC1 OP	Loss of Excitation element general operation (any stage) Group 1
	LOSS OF EXC2 BLOCK	Loss of Excitation element block Group 2
	LOSS OF EXC2 ST1 PKP	Loss of Excitation element pickup stage 1 Group 2
	LOSS OF EXC2 STG1 OP	Loss of Excitation element operation stage 1 Group 2
	LOSS OF EXC2 ST2 PKP	Loss of Excitation element pickup stage 2 Group 2
	LOSS OF EXC2 STG2 OP	Loss of Excitation element operation stage 2 Group 2
	LOSS OF EXC2 PKP	Loss of Excitation element general pickup (any stage) Group 2
	LOSS OF EXC2 OP	Loss of Excitation element general operation (any stage) Group 2
	LOSS OF EXC3 BLOCK	Loss of Excitation element block Group 3
	LOSS OF EXC3 STG1 PKP	Loss of Excitation element pickup stage 1 Group 3
	LOSS OF EXC3 STG1 OP	Loss of Excitation element operation stage 1 Group 3
	LOSS OF EXC3 STG2 PKP	Loss of Excitation element pickup stage 2 Group 3
	LOSS OF EXC3 STG2 OP	Loss of Excitation element operation stage 2 Group 3
	LOSS OF EXC3 PKP	Loss of Excitation element general pickup (any stage) Group 3
	LOSS OF EXC3 OP	Loss of Excitation element general operation (any stage) Group 3
Accidental Energization	ACCDNT ENRG1 BLOCK	Accidental Energization element block Group 1
	ACCDNT ENRG1 OFFLINE	Accidental Energization element offline status Group 1
	ACCDNT ENRG1 ARMED	Accidental Energization element armed status Group 1
	ACCDNT ENRG1 OP	Accidental Energization element operation Group 1
	ACCDNT ENRG2 BLOCK	Accidental Energization element block Group 2
	ACCDNT ENRG2 OFFLINE	Accidental Energization element offline status Group 2
	ACCDNT ENRG2 ARMED	Accidental Energization element armed status Group 2
	ACCDNT ENRG2 OP	Accidental Energization element operation Group 2
	ACCDNT ENRG3 BLOCK	Accidental Energization element block Group 3
	ACCDNT ENRG3 OFFLINE	Accidental Energization element offline status Group 3
	ACCDNT ENRG3 ARMED	Accidental Energization element armed status Group 3
	ACCDNT ENRG3 OP	Accidental Energization element operation Group 3

This document describes the procedure to read and write data in the G650 relay using ModBus/RTU protocol.

To prevent an existing integration from being affected by versions, a generic database has been created, **compatible between versions**, with all possible items that a G650 may have, independently from its type or configuration. This database describes completely each of these items. This descriptions includes the data type, length, memory position, object version, etc. Moreover, the database will group the different objects by subgroups, such as status and settings groups.

Each object has a **unique** memory position for the whole family. Only after reading the objects of a particular relay, it will be possible to elaborate its map. This map will only be valid for that particular relay and memory version. From one version to another the memory positions of existing objects remain fixed, and new objects are assigned new addresses, which again remain the same for following versions.

It is possible to get the Memory Map using **EnerVista 650 Setup software**, menu:
View > ModBus Memory map

B.2.1 FUNCTIONS USED

The protocol used is standard ModBus/RTU, so any program or PLC will be able to easily communicate with G650 units.

G650 always works as slave, which means that it never starts the communications. It is always the master who initiates communication.

Only one ModBus/RTU functions subgroup are implemented:

- **Reading function 3 (or 4).**
- **Writing function 16.**

B.2.2 PHYSICAL LAYER

ModBus/RTU protocol is independent from the hardware. This way, the physical layer may be in different hardware configurations: RS232, RS485, fiber optic or Ethernet.

G650 units incorporate a front RS232 port, two rear RS485 or fiber optic ports, and a 10/100Base T port, and in some configurations two 100BaseFX ports. The data flow in any of the configurations is “half-duplex”.

Each data byte is transmitted in an asynchronous way and it is formed by: 1 start bit, 8 data bits, 1 stop bit and 1 parity bit if programmed. Thus you have a 10 or 11-bit data, depending on whether it has parity or not.

The port baud rate and the parity are independent and programmable for each communication port. Any port may be programmed to baud rates of: 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200. Parity may be pair, impair or without parity.

The master must know the client address with which it is going to communicate. No unit will operate after a master request if the message address is not its own, except it the address is 0, which is the broadcast address. In this case the relay will operate, but won’t send any reply.

B.2.3 DATA LINK LAYER

Communication is performed in strings, data groups sent in an asynchronous way. The master transmits a string to the slave and then the slave responds with another string (except for the case of broadcast communication). A timeout or a silence time in the communication marks the end of a string. The length of this time varies depending on the baud rate, because it is equal to 3 characters.

The following table shows the generic string format, valid for transmission and reception. However, each function will have its own particularities, as described later in this manual.

MODBUS FORMAT		
CLIENT ADDRESS [A]	1 byte	Each device in a communications bus must have a unique address to prevent two units from responding at the same time to the same request. All relay ports will use this address, which can be programmed to a value between 1 and 254. When the master transmits a string with the slave address 0, this indicates that it is a Broadcast. Every slave in the communication bus will perform the requested action, but none of them will respond to the master. Broadcast is only accepted for writing because it is nonsense to perform a reading request in Broadcast, as no unit will respond to it.
FUNCTION CODE [B]	1 byte	This is one of the function codes supported by the equipment. In this case, the only supported function codes will be 3 and 4 for reading and 16 for writing. When the slave has to respond with an exception to any of these strings, it will place to 1 the most important bit of the correspondent function. For example, an exception to function 3 will be indicated with an 83 as function code, and an exception to function 16 or 0x10 in hexadecimal, will be indicated with a 0x90.
DATA [C]	N bytes	This section includes a variable number of bytes, depending on the function code. It may include: addresses, data length, settings, commands or exception codes sent by the client.
CRC [D]	2 bytes	Two-byte control code. ModBus/RTU includes a 16-bit CRC in each string for error detection. If the slave detects a string with errors, based on an incorrect CRC, it will neither perform any action, nor respond to the master. The CRC order is LSB-MSB.
TIME OUT	Required time to transmit 3,5 Bytes	A string is finished when nothing is received during a period of 3,5 bytes: 15 ms at 2400 bps 2 ms at 19200 bps 300 µs at 115200 bps etc.

MASTER SERVER

Request

+[A]+ +[B]+ +[C]--------------+ +[D]--+

01 03 0B 37 00 03 XX XX

Data addr. Regs.

OK Response

+[A]+ +[B]+ +[C]------------------------+ +[D]--+

01 03 06 02 2B 00 00 00 64 XX XX

Bytes ....Data ....

Error Response

+[A]+ +[B]+ +[C]+ +[D]--+

01 83 07 XX XX

MASTER SERVER

Request

```
+[A]+ +[B]+ +[C]---------------------------------+ +[D]--+
 01    10    00 87   00 02   04   00  0A  01  02    XX XX
             Data addr.  Regs.   Bytes  .......Data.......
```

OK Response

```
+[A]+ +[B]+ +[C]-----------+ +[D]--+
 01    10    00 87   00 02    XX XX
             Data addr.  Regs.
```

Error Response

```
+[A]+ +[B]+ +[C]+ +[D]--+
 01    90    07    XX XX
```

B.2.6 FUNCTION CODES

CODE		MODBUS NAME	G650 DEFINITION	COMMENT
HEX	DEC			
03	3	Read Holding Registers	Reading of any value	Any of these two functions allow the master to read 1 or more consecutive relay addresses. Registers are always 16-bit long with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
04	4	Read Input Registers	Reading of any value	
10	16	Preset Multiple Registers	Writing	This function allows writing 1 or more registers representing one or more settings. Registers are 2-byte long values, transmitted with the most important byte first. The maximum number of registers to be written in a single package is 125.

B.2.7 EXCEPTIONS AND ERROR RESPONDS

The following table shows error codes defined in ModBus protocol:

01	ILLEGAL FUNCTION	The slave does not support any function with the received function code in this message.
02	ILLEGAL DATA ADDRESS	Master is trying to perform an operation in an incorrect address.
03	ILLEGAL DATA VALUE	Slave has detected that the value sent by the master is not valid.
04	ILLEGAL RESPONSE LENGTH	Indicates that a response to the master's request would exceed the maximum specified size for that function code.
05	ACKNOWLEDGE	Generic acknowledgement.
06	SLAVE DEVICE BUSY	Slave is busy and cannot perform the requested operation.
07	NEGATIVE ACKNOWLEDGE	Negative acknowledgement.

TYPE	LENGTH	DESCRIPTIÓN
F1	1	Boolean data type. As it is a bit, for evaluating it we need a memory address and a bit. For example: Value *0x1A41-0001101001000001b* Bit 15 0 Bit 14 0 Bit 13 0 Bit 12 1 Bit 11 1 Bit 10 0 Bit 09 1 Bit 08 0 Bit 07 0 Bit 06 1 Bit 05 0 Bit 04 0 Bit 03 0 Bit 02 0 Bit 01 0 Bit 00 1
F2	2	Integer with 4 bytes sign. It has to be scaled, by multiplying by 1000 the value to be sent, or dividing between 1000 the received value. For example, if a value of 34509 is received, the converted value will be 34,509, and for writing value 334, we must send 334.000. This prevents the loss of accuracy involved in using float values. Example: 12312d=0x00003018. Real Value = 12312/1000=12,312
F3	2	4-byte Floating Example: 1240.5560x449B11CB
F4	1	Integer with 2 bytes sign. Example: 1230x007B
F5	2	Integer without 4 bytes sign. Example: 123120x00003018
F6	4	8 bytes Float Example: 123.3240x405ED4BC6A7EF9DB
F7	1	Characters without sign. As it needs to be sent in a register, i.e. in two bytes, the character will go below. *Example: 'ß'x00E1*
F8	1	Characters with sign As it needs to be sent in a register, i.e. in two bytes, the character will go below. Example: 'A'x0041
F9	16	String. Chain of characters with a fixed length (32 bytes). The end of the string is marked with a "\0". Example: "ABC"0x41x42x43x00....
F10	1	This is a 16-bit integer without sign. Each value that can be taken by this integer will have a correspondence in the database Auxiliary Table. In this table we can find the corresponding chain, which must be shown for each value. In the memory, only an integer value will be received. Example: 0, 1Correspond to CLOSE, OPEN
F11	3	Milliseconds passed since 1/1/2000 at 00:00:00.000.

B.4.1 DATA MANAGEMENT

The different sizes of data to be managed in ModBus and their functionality make it necessary to manage them in different ways. Depending on the functionality and importance of certain data, the use of ModBus is optimized in time for real time processes, as in the case of events.

Although configuration settings, such as GRAPHIC, PLC equations, TEXTS and ALARM and LEDS configuration, etc. can be read and written using ModBus protocol, formats are not shown because these are considered important design information subject to optimization, expansion and in short to changes. For their management, the user can use EnerVista 650 Setup program to manage and format them in a friendly way

B.4.2 WRITING SETTINGS

The writing process of settings GROUP is formed by two phases: writing of any zone and confirmation. The target is to guarantee the protections functionality and offer versatility for possible legacy programs.

The process of changing protection functionality will almost always involve the change of several settings at the same time, requiring a “time point” for new settings operation. The combination of numbers, enums, etc, which cooperate in fulfill a determined function is called GROUP.

The memory map of a setting GROUP includes: the stored settings at the beginning of its settings zone and a temporary hole for new settings and confirmation.

When settings are changed, we must write in the selected settings zone, in any order or quantity of written zone, and finally, to give a reference point we must write a register in the last position of the group, (this is called CONFIRMATION by some protocols).

For safety reasons, there is certain limitation when CONFIRMING settings GROUPS; the time period from the last settings writing to CONFIRMATION, cannot exceed 15 seconds.

B.4.3 SNAPSHOT EVENTS

Nowadays, event retrieval is completely compatible with UR family. In the G650, the NEW EVENTS concept has been extended, providing additional functionality. These are the events created after the last request.

a) SNAPSHOT EVENT READING IN ASCII FORMAT

The events capture process is based on the opening and reading of a pseudo-file. This process is made in two steps:

1º.- A writing message in the ‘0xfe00’ address, where desired opening file name is written:

- **“EVE .TXT”:** to obtain all
- **“NEW_EVE.TXT":** to obtain events created from the last request of this same file
- **“EVE0234 .TXT “:** to obtain events starting, for example, from 234 rating

2º.- The second and following ones are messages of reading on 0xff00 address, where 244-byte strings are read from the open file. As this process is a request process, if there was a response string with error, the last string can be requested again, by a reading message on 0xff02 address.

The first reading message shows the events format, information is transmitted in the rest of messages. In the same string, the first four bytes indicate the file reading position and the following two bytes form a short with the quantity of useful bytes sent (if it is lower than 244, this indicates that it is the last message).

In the second step, many BUSY responds may be produced, because internally the ASCII format file is being created.

b) SNAPSHOT EVENTS READING IN BINARY FORMAT:

Write a message in address 0xfe00 to open the file.

"EVE.BIN": to read all Snapshot events.

"NEW_EVE.BIN": to read new events since the last reading of this file.

"EVE0234.BIN": to read events starting by number 234.

The second and successive messages are read in address 0xff00 in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data sent, and 244 data bytes). If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

Each Snapshot event includes:

1º byte: event format code.

N bytes: Event information structured depending on the code

At this moment there is only one format type with code 0. Its structure is as follows:

- -UINT16: event handle.
- -8 bytes: event date and time.
- -29 bytes: event cause. (string finished in null).
- -UINT32: Phasor Ia (scaled to 1000).
- -UINT32: Phasor Ib (scaled to 1000).
- -UINT32: Phasor Ic (scaled to 1000).
- -UINT32: Line Frequency (scaled to 1000).
- -UINT32: Phasor Ig (scaled to 1000).
- -UINT32: Phasor Isg (scaled to 1000).
- -UINT32: Zero seq I0 (scaled to 1000).
- -UINT32: Positive seq I1 (scaled to 1000).
- -UINT32: Negative seq I2 (scaled to 1000).
- -UINT32: Phasor Van (scaled to 1000).
- -UINT32: Phasor Vbn (scaled to 1000).
- -UINT32: Phasor Vcn (scaled to 1000).
- -UINT32: Positive Seq V1 (scaled to 1000).
- -UINT32: Negative Seq V2 (scaled to 1000).
- -UINT32: Zero Seq V0 (scaled to 1000).
- -UINT32: 3 Phase Power Factor (scaled to 1000).

Example:

1st step:

[0xFE 0x10 0xFE 0x00 0x00 0x06 0x0C 0x4E 0x45 0x57 0x5F 0x45 0x56 0x45 0x2E 0x54 0x58 0x54 0x00 0x16 0xB0] **--------> RELAY**

PC <--------- [0xFE 0x10 0xFE 0x00 0x00 0x06 0x65 0xEC]

2nd step:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

Probably the relay will respond with "SLAVE DEVICE BUSY":

PC <--------- 0xFE 0x83 0x06 0xF1 0x02]

The request is repeated:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

B

Now the relay sends the events format:

[A] Position within file (Unsigned 32 bits)

[B] Block size (Unsigned 16 bits)

PC ←--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0x00 0x00 0xF4 0x46 0x4F 0x52 0x4D 0x41

.............[A].............. .....[B]...... F O R M A

0x54 0x2C 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30

T , E V E N T _ F 6 5 0 _ V 0

0x30 0x2C 0x45 0x76 0x65 0x6E 0x74 0x20 0x4E 0x75 0x6D 0x2C 0x44 0x61 0x74

0 , E v e n t N u m , D a t

0x65 0x2F 0x54 0x69 0x6D 0x65 0x3C 0x48 0x65 0x78 0x3E 0x2C 0x43 0x61 0x75

e / T i m e . . . etc . . .

0x73 0x65 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x61 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x62 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x63 0x2C 0x4C 0x69 0x6E 0x65 0x20 0x46 0x72 0x65 0x71 0x75 0x65 0x6E 0x63 0x79 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x67 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x73 0x67 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x73 0x65 0x71 0x20 0x49 0x30 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x32 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x61 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x62 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x63 0x6E 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x32 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x53 0x65 0x71 0x20 0x56 0x30 0x2C 0x33 0x20 0x50 0x68 0x4C 0xF3]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0xF4 0x00 0xF4 0x61 0x73 0x65 0x20 0x50 0x6F

0x77 0x65 0x72 0x20 0x46 0x61 0x63 0x74 0x6F 0x72 0x0D 0x0A

CR LF (here the format ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35

E V E N T _ F 6 5 0 _ V 0 0 , 5 6 5

0 x37 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66

7 , 0 0 0 0 0 0 1 6 f 3 9 8 f

0x34 0x33 0x39 0x2C 0x4C 0x6F 0x63 0x61 0x6C 0x20 0x6D 0x6F 0x64 0x65 0x2C

4 3 9 , l o c a l m o d e ,

0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30

....

0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66 0x34 0x33 0x39 0x2C 0x28 0x31 0x29 0x56 0x69 0x72 0x74 0x75 0x61 0x6C 0x20 0x4F 0x75 0x74 0x38 0x39 0x36 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x34 0x24]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <---------[0xFE 0x03 0xFA 0x00 0x00 0x01 0xE8 0x00 0x47 0x30 0x0047 **=> last string**

0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x00 0x00 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x33 0x30 0x39 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x65 0x62 0x61 0x33 0x33 0x62 0x62 0x38 0x2C 0x43 0x6F 0x6E 0x74 0x61 0x63 0x74 0x20 0x4F 0x75 0x74 0x70 0x75 0x74 0x5F 0x30 0x30 0x5F 0x30 0x30 0x20 0x4F 0x4E 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0xDB 0xB4]

B.4.4 OPERATIONS

For executing an Operation, it is necessary to write the bit corresponding to that Operation. For this purpose, there are two memory records whose bits represent operations. These records are 0xAFFE and 0xAFFF.

Each operation has assigned one bit in the register:

Operation 1: bit 0 '0xaffe'

Operation 2: bit 1'0xaffe'

...

Operation 16: bit 15'0xaffe'

Operation 17: bit 0'0xafff'

...

Operation 24: bit 7'0xafff'

The register format is 'MOTOROLA'; this means that the first byte arriving is the one with more weight.

Remember that depending on where it communicates the correspondent channel will be activated, which takes part for PLC operations if the operation is successful or not. The operations channels are:

0 - MMI

1 - OPER REMOTE

2 - COM 1- COMMUNICATION

3 - COM 2- COMMUNICATION

4 - RED 1- COMMUNICATION

5 - RED 2- COMMUNICATION

6 - RED 3- COMMUNICATION

7 - RED 4- COMMUNICATION

Example, operation 1 is going to be perform:

[0xFE 0x10 0xAF 0xFE 0x00 0x01 0x02 0x00 0x01 0x68 0xB0] **---------> RELAY**

PC <--------- [0xFE 0x10 0xAF 0xFE 0x00 0x01 0x55 0x22] **(ACK (acknowledge) the operation)**

Relay contacts writing in the I/O boards are thought to make easy wiring checks. Proceeding as with a file access, with opening, writing and lockout.

If it is a writing to a mixed board (includes 16 inputs and 8 outputs):

1º.- OPEN FILE OF OUTPUTS: writing msg to 0xFE20 of 3 registers with the name: **OUTPUT**

2º.- DESIRED OUTPUTS WRITING writing message to 0xFF20 of 5 REGISTERS, the first one is the board number (0 or 1) and the restraint ones are the bytes of bits (bits are grouped byte to byte).

3º.- CLOSE FILE OF OUTPUTS: writing msg to 0xFE 28 of 3 registers with the name: **OUTPUT**

Example, activate the two lower relays to board '0':

1st Opening

[0xFE 0x10 0xFE 0x20 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0xA8 0x42] **---------> RELAY**

O U T P U T

PC <---------[0xFE 0x10 0xFE 0x20 0x00 0x03 0xA4 0x25]

2nd Writing

[0xFE 0x10 0xFF 0x20 0x00 0x05 0x0A 0x00 0x00 0x03 0x00 0x00 0x00 0x00 0x00 0x00 0x00

0x0000 0x03

0xAE 0x8D] **---------> RELAY**

PC <--------- [0xFE 0x10 0xFF 0x20 0x00 0x05 0x25 0xDB]

3th Lockout:

[0xFE 0x10 0xFE 0x28 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0x29 0xA8] ---------> RELAY

PC <--------- [0xFE 0x10 0xFE 0x28 0x00 0x03 0x25 0xE7]

B.5.1 CONTROL EVENTS

This section explains events set aside for control, not to be confused with the “snap shot events", which are used for debugging tasks.

The event is the value change from 0 to 1 or from 1 to 0 of one bit. Associated to a time label, which shows when that change was performed.

B

In the G650, any status or combination of status may generate an event. For this, the G650 have **192 bits** capable of generate control events.

The first **128** may be configured through a table from EnerVista 650 Setup menu: ***Setpoint, Relay configuration*,** or for complex configurations by PLC Editor.

The other **64 bits** comes from the 16 possible switchgears, which generate 4 bits of status each one:

- Open(52B ON, 52A OFF)

- Close(52A ON, 52B OFF)

- Error 00(52A&52B OFF)

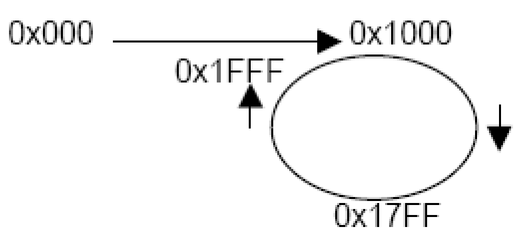
- Error 11(52A&52B ON)

Internally the events buffer is a circular FIFO of 255 events. The addresses for managing this FIFO are:

- 0x03FF:	Number of the following event
	(To know whether there are new events)
- 0xFCFF:	Access from the oldest event
- 0xFD00 to 0xFDFF:	Access to any of the events (circular queue)

In the **0x03FF** address it is stored the event number of the following new event that it is going to be generated. For instance, if the number 7677 is stored, it means that the last event stored is the number 7676. This value, at the beginning is 0 and it is increased as soon as events from 0 to 2^12 + 1 carry bit are generated.

Carry bit allows knowing whether the G650 has been started, as when it starts, either for lack of power supply or for a configuration change, the carry bit is set to 0. When events are generated, the event number will be increased up to a maximum value of 0x1FFF; in the next event the number will be 0x1000, that is, the bit of carriage will get always to 1, until a new G650 start up. The next figure shows it:



B.5.2 EVENT STRUCTURE

Each event has 14 bytes, being its format:

- Short (2 bytes): event number (0 - 2^12 + carry bit)
- Short (2 bytes): events bit number (from 0 to 191).
- Short (2 bytes): the 0 bit indicates the event value (0 or 1) and the 15 bit whether it is event (to distinguish not valid values, in case of everything was set to 0)
- Double unsigned (8 bytes): milliseconds from 1 January 2000

The 0xFCFF-address usefulness is for when it is desired to read all the available events in the G650, something that will be done following a master start up.

WARNING! Unlike a standard ModBus address, these addresses consist of 14 bytes each one, instead of the 2 used in ModBus. This way, each event, which has a structure of 14 bytes, will be contained in one address, as shown on the table below:

0xFD00	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
....														
0xFDFF	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte

Imagine that the events buffer contains the following information:

Circular queue

Event Number	7424	7425	....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

105 registers: 15 events * 7 registers.

(NOTE: the 0x03FF address will have the event number 7677 because the 7676 is the last one).

a) EVENTS COLLECTION PROCESS

<u>ALL EVENTS</u>

There are two possibilities:

First possibility: start in 0xFCFF address and read events 15 by 15. The frame sent to the relay is the following one:

[0xFE 0x03 0xFC 0xFF 0x00 0x69 0x91 0x8B] ---------> RELAY

105 registers: 15 events * 7 registers.

Address request of all the events

With this frame the buffer pointer will be set over the 7421 event, which in the example is the oldest one in the buffer, so it will send back all events until number 7435.

Now, to read the following 15, from 7436 to 7450, it is necessary to calculate the initiation address and send another frame:

Hex(7436)=	0x1D0C
0x1D0C AND 0x00FF=	0xOC
0xFD00+0x0C=	0xFD0C: **initiation address**

[0xFE 0x03 **0xFD 0x0C** 0x00 0x69 0x60 0x44] **---------> RELAY**

So, it will be asked until the relay responds 0 in one of the events, or reading address 0x03FF and checking the event number from the last event read.

Second possibility: read directly the memory from the 0xFD00 to 0xFDFF address and then arrange by event number. From that moment, only the new ones must be requested.

NEW EVENTS

In the 0x03FF address there is the number of the following event that is going to be written, therefore, it is possible to know how many events must be read from the last time that the relay was asked. If the relay indicated that the new event to be generated is the 7677.

Circular queue

Event Number	7424	7425	....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

(NOTE: the 0x03FF address will have the event number 7677, because the last one is 7676).

Supposing that we all events until number 7674 have already been read, now a frame must be sent to read the corresponding 28 bytes to events 7675 and 7676, given that there are only two new events from the last time that they were requested.

Hex(7675)=0x1DFB

0x1DFB AND 0xFF=0xFB

0xFD00+0xFB=0xFDFB: **reading address (*)**

[0xFE 0x03 **0xFD 0xFB 0x00 0x0E** 0x90 0x5C] **---------> RELAY**

The necessary data to retrieve events that have been configured as alarms are located in the following addresses:

0xf000: 24 registers, the first 12 indicate the status active/inactive and the last 12 indicate the status of acknowledged/not acknowledged.

0xf018: 12 event alarm status (active - not active, acknowledged – not acknowledged) registers.

0xf024: date and hour of the event bits starts (groups of 16 dates and hour must be asked for).

To obtain an instantaneous snapshot of all the events and alarms status, the procedure is:

- - Read the head of events FIFO (0x03FF).
- - Read the zones mentioned before.
- - Finally, read the head again to confirm that it has not changed. If it had changed, restart the procedure.

NOTE: The message must request the address and the quantity of bytes indicated in each zone. If other quantity is needed it will not respond with the requested data.

B.6.1 CONTROL EVENTS RETRIEVAL FROM THE COMMAND LINE

Starting EnerVista 650 Setup form the command line offers the possibility of transferring control events to a file. For this purpose, we need to indicate the event number from which event controls are to be retrieved, and the file where they are to be stored.

Communication can be established via serial communication by specifying the port and access baudrate, or via Ethernet through the IP address and communication port. The relay number from which events are to be retrieved must also be indicated.

For executing this Operation, 6 parameters must be written, for both cases, serial communication or Ethernet.

B.6.2 SERIAL COMUNICATION

EnerVista 650 Setup –e event number " File name" –com port: baudrate relay number

E.g.: EnerVista 650 Setup –e 6 “C:\GE Power Management\EnerVista 650 Setup\files\Events\eventos.txt” –com 1:19200 254

B.6.3 ETHERNET COMMUNICATION

EnerVista 650 Setup –e event number " File name" –ip “IP address”: port relay number

E.g.: EnerVista 650 Setup –e 6 “C:\GE Power Management\EnerVista 650 Setup\files\Events \eventos.txt” –ip 192.168.37.240:502 254

The created file format will look as follows:

#Event Number, Event Id,Event Text,Event Data Time,Event Value(0,1)#

6,1,Local,09-Sep-2003 17:42:40.782,1

7,1,Local,09-Sep-2003 17:42:43.236,0

8,2,Remote,09-Sep-2003 17:42:43.236,1

B.6.4 ACKNOWLEDGEMENT OF EVENTS (ALARMS)

For acknowledging the alarms we must simply write message to the 0xf324 address with 12 data registers. Each bit means an event, if we want to acknowledge an alarm, its corresponding bit must be set to ‘1’ (in order within the 192 bits).

NOTE: it must be borne in mind the independence of the acknowledgement condition, for its reading and its change, depending on the communication channel

B

There are 6 channels:

LOCAL: by MMI or COM-2 (front and rear accessible).

REMOTE: by COM-1

NET 1: nowadays by any net communication

NET 2: (it does not exist in version 1.4x and lower)

NET 3: (it does not exist in version 1.4x and lower)

NET 4: (it does not exist in version 1.4x and lower)

B.6.5 VIRTUAL INPUTS WRITING

For forcing Virtual Inputs, a message with 4 indivisible records must be written at address, so that each bit corresponds to a Virtual Input. Values will not be correct if the first 4 records are not written in the same message. The first 32 are LATCHED (internally stored with RAM with battery), and the last 32 are SELF-RST (activated to 1 and deactivated in the next pass by the PLC).

For reading the status of Virtual Inputs, it is necessary to start with address 0x0083(bit 0x004) up to 0x0087 (bit 0x0200).

B.6.6 USER MAP

G650 units incorporate a powerful feature called ModBus User Map, that allows to read 256 non-consecutive data records (settings and statuses). It is often required for a master computer to interrogate continuously several connected slave relays. If those values are dispersed along the memory map, reading them may require several transmissions, and this may cause a communications overload. The User Map can be programmed to get several memory addresses together in a block of consecutive addresses of the User Map, so that they can be accessible with a single reading operation.

The user Map has two sections:

A record index area (addresses 0x3384 to 0x3483), containing 256 statuses and/or setting record addresses.

A record area (addresses 0xF330 to 0xF42F), containing the values for addresses indicated in the index area.

Data records that are separated in the rest of the memory map can be remapped to an address of an adjacent record in the User Map area. For programming the map this way, addresses for the required records must be written in the index area. This avoids the need for several reading operations, thus improving data transmission yield.

For instance, if Contact Outputs from Board F (address 0x008B) and Board G (address 0x00B0) values are required, these addresses must be mapped as follows:

In address 0x3384, write 0x008B.

In address 0x3385

XXX write 0x00B0.

The reading of records 0xF330 and 0xF331, applying the corresponding bit masks, will provide the required information about the two boards Contact Outputs.

NOTE: Only single data can be set in the map, data that are in the memory map and can be read. This feature is not valid for events, waveform records, etc. that are not located in a map address.

B.6.7 RETRIEVING OSCILOGRAPHY

In case of not using the quickest download method by FTP, ModBus can be used for downloading oscillography, in the same way that events (snap-shots). First of all, open file with writing message in 0xfe40, where desired file to open is indicated, it could be:

OSC01.DAT (COMTRADE data file in binary)

OSC02.CFG (COMTRADE configuration file)

OSC01.HDR (COMTRADE header file)

OSC02.DAT

OSC02.HDR

...

For reading the oscillography in several strings, several reading requests must be sent to 0xff40 address . For reading the previous message a reading petition must be sent to 0xff42 address. The maximum number of bytes to be read in each part is 244.

B.6.8 TIME SYNCHRONIZATION

Time synchronization consists of setting of relay date and time.

It may be supposed that is similar to a usual settings group writing but it has particularities:

- It is a data type very particular because it is made up of other simples.
- Once the data is changed, varies with time, it is a changing setting that can be read.
- It shares the time change with the IRIGB (this has more priority) and with a possible modification from MMI or another protocols.
- In case of the relay gets disconnected from its auxiliary power supply, during some days, the time will remain in a chip, feed by a capacitor (it does not need maintenance).
- And last, there are synchronism between the real time chip and the microprocessor time.

Time synchronization is made by a reading message over 0xfff0 address, either with the address of a single relay, if a writing confirmation is desired, or in broadcast, to synchronize several relays simultaneously.

Date/time format is unsigned double (8 bytes) in MOTOROLA format, which indicates the passed milliseconds from 1st of January 2000.

Reading example:

[0xFE 0x03 0xFF 0xF0 0x00 0x04 0x60 0x21] **---------> RELAY**

PC <---------- [0xFE 0x03 0x08 0x00 0x00 0x00 0x17 0x05 0xFA 0xD5 0xBA 0x2D 0x1D]

Synchronism example:

[0xFE 0x10 0xFF 0xF0 0x00 0x04 0x08 0x00 0x00 0x00 0x17 0x9B 0x53 0x3F 0x60 0xA4 0x2B] **---------> RELAY**

PC <---------- [0xFE 0x10 0xFF 0xF0 0x00 0x04 0xE5 0xE2]

B

B.6.9 ENQUEUEING MESSAGES

In ModBus protocol, as in other protocols, exists an internal procedure in message reception and transmission.

When a relay gets a string, determined by a silence of 3 or 4 characters, it is queued in a FIFO queue, for a later processing in its own protocol. When the protocol is free of execution, it searches in the queue for strings to respond of the FIFO. If there is such string, it processes it and then it is responded.

Several criteria have been adopted for real time operation:

- Each reading or writing is respond as soon as possible.

- This implies that when settings are changed and respond, a writing request recognition is indicated and then, the modification of internal settings is performed, (PERFORMING IT IN THE SHORTER TIME WITHOUT PROTECTION), and finally, settings are stored in a non-volatile memory device.

NOTE: As the relay is internally a modular system, it is possible that the response of some process is slower than what is expected by the external program, considering the message as missed and sending again another request. If so, there will be 2 queued messages and therefore, 2 messages will be responded. For this reason, response message 'ACK' must be verified with its request, and special attention must be paid to setting confirmation writings, especially with reference to time-out. EnerVista 650 Setup software is recommended to do the configuration modifications, as this software takes into account all these details.

B.6.10 TRACES AND TROUBLESHOOTING

The tracer is a debugging tool to view the strings in any writing or reading process in ModBus. This tracer is activated in the menu from EnerVista 650 Setup: ***View, Traces.***

With this option enabled, request and response strings will be shown. If, for instance, request and response strings view is desired, between G650 and the relay, in general settings reading we will do what follows:

1º. - Activate traces, from *View, Traces menu*

2º. - Open the general settings menu

The screen will display that group settings, on the left side bottom the relay reading request will appear

<0001><06/18/03 12:14:15>[0xFE 0x03 0x21 0x8A 0x00 0x16 0xFB 0xDD]

And on the right the settings response will appear:

0001><06/18/03 12:14:15>[0xFE 0x03 0x2C 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x00 0x00 0x42 0xC8 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x01 0x00 0xFE 0x00 0xFE 0x00 0x06 0x00 0x06 0x00 0x00 0x01 0xF6 0xAC 0xB5]

This way, any request or mechanism to obtain information from the relay, can be viewed string by string.

There is another tool for tracing the relay memory: in EnerVista 650 Setup menu: ***Communication, Troubleshooting***, any reading to any address can be requested, the PC will form the string together with check-sum register.

B.6.11 MODBUS CHECK FUNCTION

Next it is described the code to realize the message string check in ModBus, in a MOTOROLA micro. With this routine time is optimized to obtain the check register.

```
USHORT fn_035c_cr16(UCHAR *p, UNSIGNED us)
{
const UCHAR hi[] = {
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40};

const UCHAR lo[] = {
0X0,0Xc0,0Xc1,0X1,0Xc3,0X3,0X2,0Xc2,0Xc6,0X6,
0X7,0Xc7,0X5,0Xc5,0Xc4,0X4,0Xcc,0Xc,0Xd,0Xcd,
0Xf,0Xcf,0Xce,0Xe,0Xa,0Xca,0Xcb,0Xb,0Xc9,0X9,
0X8,0Xc8,0Xd8,0X18,0X19,0Xd9,0X1b,0Xdb,0Xda,0X1a,
0X1e,0Xde,0Xdf,0X1f,0Xdd,0X1d,0X1c,0Xdc,0X14,0Xd4,
```

```
0Xd5,0X15,0Xd7,0X17,0X16,0Xd6,0Xd2,0X12,0X13,0Xd3,
0X11,0Xd1,0Xd0,0X10,0Xf0,0X30,0X31,0Xf1,0X33,0Xf3,
0Xf2,0X32,0X36,0Xf6,0Xf7,0X37,0Xf5,0X35,0X34,0Xf4,
0X3c,0Xfc,0Xfd,0X3d,0Xff,0X3f,0X3e,0Xfe,0Xfa,0X3a,
0X3b,0Xfb,0X39,0Xf9,0Xf8,0X38,0X28,0Xe8,0Xe9,0X29,
0Xeb,0X2b,0X2a,0Xea,0Xee,0X2e,0X2f,0Xef,0X2d,0Xed,
0Xec,0X2c,0Xe4,0X24,0X25,0Xe5,0X27,0Xe7,0Xe6,0X26,
0X22,0Xe2,0Xe3,0X23,0Xe1,0X21,0X20,0Xe0,0Xa0,0X60,
0X61,0Xa1,0X63,0Xa3,0Xa2,0X62,0X66,0Xa6,0Xa7,0X67,
0Xa5,0X65,0X64,0Xa4,0X6c,0Xac,0Xad,0X6d,0Xaf,0X6f,
0X6e,0Xae,0Xaa,0X6a,0X6b,0Xab,0X69,0Xa9,0Xa8,0X68,
0X78,0Xb8,0Xb9,0X79,0Xbb,0X7b,0X7a,0Xba,0Xbe,0X7e,
0X7f,0Xbf,0X7d,0Xbd,0Xbc,0X7c,0Xb4,0X74,0X75,0Xb5,
0X77,0Xb7,0Xb6,0X76,0X72,0Xb2,0Xb3,0X73,0Xb1,0X71,
0X70,0Xb0,0X50,0X90,0X91,0X51,0X93,0X53,0X52,0X92,
0X96,0X56,0X57,0X97,0X55,0X95,0X94,0X54,0X9c,0X5c,
0X5d,0X9d,0X5f,0X9f,0X9e,0X5e,0X5a,0X9a,0X9b,0X5b,
0X99,0X59,0X58,0X98,0X88,0X48,0X49,0X89,0X4b,0X8b,
0X8a,0X4a,0X4e,0X8e,0X8f,0X4f,0X8d,0X4d,0X4c,0X8c,
0X44,0X84,0X85,0X45,0X87,0X47,0X46,0X86,0X82,0X42,
0X43,0X83,0X41,0X81,0X80,0X40 };

    UCHAR chi;
    UCHAR clo;
    USHORT ui;



chi = 0xff;
    clo = 0xff;
    while(us--)
    {   ui = chi ^ *p++;
    chi = clo ^ hi[ui];
    clo = lo[ui];
    }
    ui = chi;
    ui = ui << 8;
    ui = ui | clo;      // motorola format

    return(ui);
}
```

```
typedef struct          //reading string
{   UCHAR       dire;
    UCHAR       fn;         //3 o 4
    USHORT      mem;
    USHORT      off;
    USHORT      check;
}   PET_READ;
static PET_READ    vpet_read;     ←------ this is the message (of reading)
```

And now it is proceed to perform the reading message check:

```
USHORT xx;
xx = vpet_read.check;
if(fn_035c_cr16( (UCHAR *)&vpet_read, sizeof(PET_READ)-2) == xx)
 {      OK }
else
{ko    }
```

If it is INTEL everything works but bytes are interchanged.

B

Modbus memory map example for Enhanced models

The Memory map can be obtained from EnerVista 650 Setup software, menu:

View > ModBus Memory map

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estado CPU - CPU Status							
0x0003	0x0100	TIMER STATUS	F001		R	1	
0x0003	0x0200	E2PROM STATUS	F001		R	1	
Salidas Virtuales (512 elementos) - Virtual Outputs							
0x0005	0x0400	VIRTUAL OUTPUT 000	F001		R	1	
0x0005	0x0800	VIRTUAL OUTPUT 001	F001		R	1	
...	...	...	...	...	...	...	...
0x0025	0x0200	VIRTUAL OUTPUT 511	F001		R	1	
Maniobras (24 elementos) - Operations							
0x0025	0x0400	OPERATION BIT 1	F001		R	1	
0x0025	0x0800	OPERATION BIT 2	F001		R	1	
...	...	...	...	...	...	...	..
0x0026	0x0002	OPERATION BIT 24	F001		R	1	
Eventos de control (128 elementos) - Control Events							
0x003D	0x0400	CONTROL EVENT 1	F001		R	1	
0x003D	0x0800	CONTROL EVENT 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0045	0x0200	CONTROL EVENT 128	F001		R	1	
Entradas Virtuales con sellado (32 elementos) - Virtual Input Latched							
0x0083	0x0400	LATCHED VIRT IP 1	F001		R	1	
0x0083	0x0800	LATCHED VIRT IP 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0085	0x0200	LATCHED VIRT IP 32	F001		R	1	
Entradas Virtuales Autoresetables (32 elementos) - Virtual Input Self Reset							
0x0085	0x0400	SELF-RST VIRT IP 1	F001		R	1	
0x0085	0x0800	SELF-RST VIRT IP 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0087	0x0200	SELF-RST VIRT IP 32	F001		R	1	
Estado Pantalla - Display Status (does not apply to C650 models)							
0x0087	0x0400	GRAPHIC STATUS	F001		R	1	
0x0087	0x0800	ALARM TEXT ARRAY	F001		R	1	
Estado Entradas Tarjeta F (32 elementos) - Board F: Contact Input Status							
0x0087	0x1000	CONT IP_F_CC1	F001		R	1	
0x0087	0x2000	CONT IP_F_CC2	F001		R	1	
...	...	...	...	....	...	...	...
0x0089	0x0800	CONT IP_F_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta F (16 elementos) - Board F: Contact Output Operate -logical status-							
0x0089	0x1000	CONT OP OPER_F_01	F001		R	1	
0x0089	0x2000	CONT OP OPER_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008A	0x0800	CONT OP OPER_F_16	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estado Señales Reposición de Salidas Tarjeta F (16 elementos) - Board F: Contact Output Resets							
0x008A	0x1000	CONT OP RESET_F_1	F001		R	1	
0x008A	0x2000	CONT OP RESET_F_2	F001		R	1	
...	...	...	...	...	...	...	...
0x008B	0x0800	CONT OP RESET_F_16	F001		R	1	
Estado Salidas Tarjeta F (16 elementos) - Board F: Contact Outputs -physical status-							
0x008B	0x1000	CONT OP_F_01	F001		R	1	
0x008B	0x2000	CONT OP_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008C	0x0800	CONT OP_F_16	F001		R	1	
Estado Tarjeta F - Board F Status							
0x008C	0x1000	BOARD F STATUS	F001		R	1	
Estado Entradas Tarjeta G (32 elementos) - Board G: Contact Input Status							
0x00AC	0x2000	CONT IP_G_CC1	F001		R	1	
0x00AC	0x4000	CONT IP_G_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x00AE	0x1000	CONT IP_G_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta G (16 elementos) - Board G: Contact Output Operate -logical status-							
0x00AE	0x2000	CONT OP OPER_G_01	F001		R	1	
0x00AE	0x4000	CONT OP OPER_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00AF	0x1000	CONT OP OPER_G_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta G (16 elementos) - Board G: Contact Output Resets							
0x00AF	0x2000	CONT OP RESET_G_01	F001		R	1	
0x00AF	0x4000	CONT OP RESET_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00B0	0x1000	CONT OP RESET_G_16	F001		R	1	
Estado Salidas Tarjeta G (16 elementos) - Board G: Contact Outputs -physical status-							
0x00B0	0x2000	CONT OP_G_01	F001		R	1	
0x00B0	0x4000	CONT OP_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00B1	0x1000	CONT OP_G_16	F001		R	1	
Estado Tarjeta G - Board G Status							
0x00B1	0x2000	BOARD G STATUS	F001		R	1	
LEDS HMI (16 elementos) - HMI Leds							
0x00D1	0x4000	READY LED	F001		R	1	
0x00D1	0x8000	LED 1	F001		R	1	
0x00D1	0x0001	LED 2	F001		R	1	
0x00D1	0x0002	LED 3	F001		R	1	
0x00D1	0x0004	LED 4	F001		R	1	
0x00D1	0x0008	LED 5	F001		R	1	
0x00D1	0x0010	LED 6	F001		R	1	
0x00D1	0x0020	LED 7	F001		R	1	
0x00D1	0x0040	LED 8	F001		R	1	
0x00D1	0x0080	LED 9	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
LEDS HMI (16 elementos) - HMI Leds (cont.)							
0x00D2	0x0100	LED 10	F001		R	1	
0x00D2	0x0200	LED 11	F001		R	1	
0x00D2	0x0400	LED 12	F001		R	1	
0x00D2	0x0800	LED 13	F001		R	1	
0x00D2	0x1000	LED 14	F001		R	1	
0x00D2	0x2000	LED 15	F001		R	1	
Teclas HMI - HMI Keys							
0x00D2	0x4000	I Key	F001		R	1	
0x00D2	0x8000	O Key	F001		R	1	
0x00D2	0x0001	* Key	F001		R	1	
Señales estado LOCAL/REMOTO para maniobras - LOCAL/REMOTE Operation status signals							
0x00D2	0x0002	F1 Key	F001		R	1	
0x00D2	0x0004	F2 Key	F001		R	1	
0x00D2	0x0008	LOCAL OPERATION MODE	F001		R	1	
0x00D2	0x0010	OPERATIONS BLOCKED	F001		R	1	
Estados Internos - Internal States							
0x00D2	0x0020	DSP COMM ERROR	F001		R	1	
0x00D2	0x0040	MAGNETIC MODULE ERROR	F001		R	1	
Entrada Reset Leds (configurable) -Led reset Input							
0x00D2	0x0080	LED RESET INPUT	F001		R	1	
Entradas Cambio Estado Local-Remoto-OFF (configurable) - Local-Remote-Off Input selection							
0x00D3	0x0100	CHANGE LOCAL-REMOTE	F001		R	1	
0x00D3	0x0200	CHANGE OP BLOCKED	F001		R	1	
Entradas Cambio Estado iluminación pantalla (configurable) - Backlight status selection							
0x00D3	0x1000	HMI BACKLIGHT ON	F001		R	1	
0x00D3	0x2000	HMI BACKLIGHT OFF	F001		R	1	
Estados Selección Aparamenta en Display -Swithgear Selection Status in HMI							
0x00D3	0x4000	HMI Tab Order 01	F001		R	1	
0x00D3	0x8000	HMI Tab Order 02	F001		R	1	
0x00D3	0x0001	HMI Tab Order 03	F001		R	1	
0x00D3	0x0002	HMI Tab Order 04	F001		R	1	
0x00D3	0x0004	HMI Tab Order 05	F001		R	1	
0x00D3	0x0008	HMI Tab Order 06	F001		R	1	
0x00D3	0x0010	HMI Tab Order 07	F001		R	1	
0x00D3	0x0020	HMI Tab Order 08	F001		R	1	
0x00D3	0x0040	HMI Tab Order 09	F001		R	1	
0x00D3	0x0080	HMI Tab Order 10	F001		R	1	
0x00D4	0x0100	HMI Tab Order 11	F001		R	1	
0x00D4	0x0200	HMI Tab Order 12	F001		R	1	
0x00D4	0x0400	HMI Tab Order 13	F001		R	1	
0x00D4	0x0800	HMI Tab Order 14	F001		R	1	
0x00D4	0x1000	HMI Tab Order 15	F001		R	1	
0x00D4	0x2000	HMI Tab Order 16	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobrecorriente instantanea de fases nivel alto - Phase IOC High States							
0x00F2	0x0080	PH IOC1 HIGH A BLK	F001		R	1	
0x00F3	0x0100	PH IOC1 HIGH B BLK	F001		R	1	
0x00F3	0x0200	PH IOC1 HIGH C BLK	F001		R	1	
0x00F3	0x0400	PH IOC1 HIGH A PKP	F001		R	1	
0x00F3	0x0800	PH IOC1 HIGH A OP	F001		R	1	
0x00F3	0x1000	PH IOC1 HIGH B PKP	F001		R	1	
0x00F3	0x2000	PH IOC1 HIGH B OP	F001		R	1	
0x00F3	0x4000	PH IOC1 HIGH C PKP	F001		R	1	
0x00F3	0x8000	PH IOC1 HIGH C OP	F001		R	1	
0x00F3	0x0001	PH IOC1 HIGH PKP	F001		R	1	
0x00F3	0x0002	PH IOC1 HIGH OP	F001		R	1	
0x00F8	0x0004	PH IOC2 HIGH A BLK	F001		R	1	
0x00F8	0x0008	PH IOC2 HIGH B BLK	F001		R	1	
0x00F8	0x0010	PH IOC2 HIGH C BLK	F001		R	1	
0x00F8	0x0020	PH IOC2 HIGH A PKP	F001		R	1	
0x00F8	0x0040	PH IOC2 HIGH A OP	F001		R	1	
0x00F8	0x0080	PH IOC2 HIGH B PKP	F001		R	1	
0x00F9	0x0100	PH IOC2 HIGH B OP	F001		R	1	
0x00F9	0x0200	PH IOC2 HIGH C PKP	F001		R	1	
0x00F9	0x0400	PH IOC2 HIGH C OP	F001		R	1	
0x00F9	0x0800	PH IOC2 HIGH PKP	F001		R	1	
0x00F9	0x1000	PH IOC2 HIGH OP	F001		R	1	
0x00FE	0x2000	PH IOC3 HIGH A BLK	F001		R	1	
0x00FE	0x4000	PH IOC3 HIGH B BLK	F001		R	1	
0x00FE	0x8000	PH IOC3 HIGH C BLK	F001		R	1	
0x00FE	0x0001	PH IOC3 HIGH A PKP	F001		R	1	
0x00FE	0x0002	PH IOC3 HIGH A OP	F001		R	1	
0x00FE	0x0004	PH IOC3 HIGH B PKP	F001		R	1	
0x00FE	0x0008	PH IOC3 HIGH B OP	F001		R	1	
0x00FE	0x0010	PH IOC3 HIGH C PKP	F001		R	1	
0x00FE	0x0020	PH IOC3 HIGH C OP	F001		R	1	
0x00FE	0x0040	PH IOC3 HIGH PKP	F001		R	1	
0x00FE	0x0080	PH IOC3 HIGH OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobreintensidad instantánea de Neutro - Neutral IOC States							
0x0115	0x0200	NEUTRAL IOC1 BLOCK	F001		R	1	
0x0115	0x0400	NEUTRAL IOC1 PKP	F001		R	1	
0x0115	0x0800	NEUTRAL IOC1 OP	F001		R	1	
0x011A	0x1000	NEUTRAL IOC2 BLOCK	F001		R	1	
0x011A	0x2000	NEUTRAL IOC2 PKP	F001		R	1	
0x011A	0x4000	NEUTRAL IOC2 OP	F001		R	1	
0x011F	0x8000	NEUTRAL IOC3 BLOCK	F001		R	1	
0x011F	0x0001	NEUTRAL IOC3 PKP	F001		R	1	
0x011F	0x0002	NEUTRAL IOC3 OP	F001		R	1	
Estados Sobreintensidad instantánea de Tierra - Ground IOC States							
0x0124	0x0004	GROUND IOC1 BLOCK	F001		R	1	
0x0124	0x0008	GROUND IOC1 PKP	F001		R	1	
0x0124	0x0010	GROUND IOC1 OP	F001		R	1	
0x0129	0x0020	GROUND IOC2 BLOCK	F001		R	1	
0x0129	0x0040	GROUND IOC2 PKP	F001		R	1	
0x0129	0x0080	GROUND IOC2 OP	F001		R	1	
0x012F	0x0100	GROUND IOC3 BLOCK	F001		R	1	
0x012F	0x0200	GROUND IOC3 PKP	F001		R	1	
0x012F	0x0400	GROUND IOC3 OP	F001		R	1	
Estados Sobreintensidad instantánea de Tierra Sensible - Sensitive Ground IOC States (Enhanced Model only)							
0x0134	0x0800	SENS GND IOC1 BLK	F001		R	1	
0x0134	0x1000	SENS GND IOC1 PKP	F001		R	1	
0x0134	0x2000	SENS GND IOC1 OP	F001		R	1	
0x0139	0x4000	SENS GND IOC2 BLK	F001		R	1	
0x0139	0x8000	SENS GND IOC2 PKP	F001		R	1	
0x0139	0x0001	SENS GND IOC2 OP	F001		R	1	
0x013E	0x0002	SENS GND IOC3 BLK	F001		R	1	
0x013E	0x0004	SENS GND IOC3 PKP	F001		R	1	
0x013E	0x0008	SENS GND IOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada de Fases Nivel Alto - Phase TOC High States							
0x0143	0x0010	PH TOC1 HIGH A BLK	F001		R	1	
0x0143	0x0020	PH TOC1 HIGH B BLK	F001		R	1	
0x0143	0x0040	PH TOC1 HIGH C BLK	F001		R	1	
0x0143	0x0080	PH TOC1 HIGH A PKP	F001		R	1	
0x0144	0x0100	PH TOC1 HIGH A OP	F001		R	1	
0x0144	0x0200	PH TOC1 HIGH B PKP	F001		R	1	
0x0144	0x0400	PH TOC1 HIGH B OP	F001		R	1	
0x0144	0x0800	PH TOC1 HIGH C PKP	F001		R	1	
0x0144	0x1000	PH TOC1 HIGH C OP	F001		R	1	
0x0144	0x2000	PH TOC1 HIGH PKP	F001		R	1	
0x0144	0x4000	PH TOC1 HIGH OP	F001		R	1	
0x0149	0x8000	PH TOC2 HIGH A BLK	F001		R	1	
0x0149	0x0001	PH TOC2 HIGH B BLK	F001		R	1	
0x0149	0x0002	PH TOC2 HIGH C BLK	F001		R	1	
0x0149	0x0004	PH TOC2 HIGH A PKP	F001		R	1	
0x0149	0x0008	PH TOC2 HIGH A OP	F001		R	1	
0x0149	0x0010	PH TOC2 HIGH B PKP	F001		R	1	
0x0149	0x0020	PH TOC2 HIGH B OP	F001		R	1	
0x0149	0x0040	PH TOC2 HIGH C PKP	F001		R	1	
0x0149	0x0080	PH TOC2 HIGH C OP	F001		R	1	
0x014A	0x0100	PH TOC2 HIGH PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobreintensidad Temporizada de Fases Nivel Alto - Phase TOC High States(cont.)							
0x014A	0x0200	PH TOC2 HIGH OP	F001		R	1	
0x014F	0x0400	PH TOC3 HIGH A BLK	F001		R	1	
0x014F	0x0800	PH TOC3 HIGH B BLK	F001		R	1	
0x014F	0x1000	PH TOC3 HIGH C BLK	F001		R	1	
0x014F	0x2000	PH TOC3 HIGH A PKP	F001		R	1	
0x014F	0x4000	PH TOC3 HIGH A OP	F001		R	1	
0x014F	0x8000	PH TOC3 HIGH B PKP	F001		R	1	
0x014F	0x0001	PH TOC3 HIGH B OP	F001		R	1	
0x014F	0x0002	PH TOC3 HIGH C PKP	F001		R	1	
0x014F	0x0004	PH TOC3 HIGH C OP	F001		R	1	
0x014F	0x0008	PH TOC3 HIGH PKP	F001		R	1	
0x014F	0x0010	PH TOC3 HIGH OP	F001		R	1	
Estados Sobreintensidad Temporizada de Neutro - Neutral TOC States							
0x0154	0x0020	NEUTRAL TOC1 BLOCK	F001		R	1	
0x0154	0x0040	NEUTRAL TOC1 PKP	F001		R	1	
0x0154	0x0080	NEUTRAL TOC1 OP	F001		R	1	
0x015A	0x0100	NEUTRAL TOC2 BLOCK	F001		R	1	
0x015A	0x0200	NEUTRAL TOC2 PKP	F001		R	1	
0x015A	0x0400	NEUTRAL TOC2 OP	F001		R	1	
0x015F	0x0800	NEUTRAL TOC3 BLOCK	F001		R	1	
0x015F	0x1000	NEUTRAL TOC3 PKP	F001		R	1	
0x015F	0x2000	NEUTRAL TOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada de Tierra - Ground TOC States							
0x0164	0x4000	GROUND TOC1 BLOCK	F001		R	1	
0x0164	0x8000	GROUND TOC1 PKP	F001		R	1	
0x0164	0x0001	GROUND TOC1 OP	F001		R	1	
0x0169	0x0002	GROUND TOC2 BLOCK	F001		R	1	
0x0169	0x0004	GROUND TOC2 PKP	F001		R	1	
0x0169	0x0008	GROUND TOC2 OP	F001		R	1	
0x016E	0x0010	GROUND TOC3 BLOCK	F001		R	1	
0x016E	0x0020	GROUND TOC3 PKP	F001		R	1	
0x016E	0x0040	GROUND TOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada Tierra Sensible - Sentive Ground TOC States (Enhanced Model only)							
0x0173	0x0080	SENS GND TOC1 BLOCK	F001		R	1	
0x0174	0x0100	SENS GND TOC1 PKP	F001		R	1	
0x0174	0x0200	SENS GND TOC1 OP	F001		R	1	
0x0179	0x0400	SENS GND TOC2 BLOCK	F001		R	1	
0x0179	0x0800	SENS GND TOC2 PKP	F001		R	1	
0x0179	0x1000	SENS GND TOC2 OP	F001		R	1	
0x017E	0x2000	SENS GND TOC3 BLOCK	F001		R	1	
0x017E	0x4000	SENS GND TOC3 PKP	F001		R	1	
0x017E	0x8000	SENS GND TOC3 OP	F001		R	1	
Estados Subtensión de fases - Phase UV States							
0x0183	0x0001	PHASE UV1 BLOCK	F001		R	1	
0x0183	0x0002	PHASE UV1 A PKP	F001		R	1	
0x0183	0x0004	PHASE UV1 A OP	F001		R	1	
0x0183	0x0008	PHASE UV1 B PKP	F001		R	1	
0x0183	0x0010	PHASE UV1 B OP	F001		R	1	
0x0183	0x0020	PHASE UV1 C PKP	F001		R	1	
0x0183	0x0040	PHASE UV1 C OP	F001		R	1	
0x0183	0x0080	PHASE UV1 AB PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Subtensión de fases - Phase UV States(cont.)							
0x0184	0x0100	PHASE UV1 AB OP	F001		R	1	
0x0184	0x0200	PHASE UV1 BC PKP	F001		R	1	
0x0184	0x0400	PHASE UV1 BC OP	F001		R	1	
0x0184	0x0800	PHASE UV1 CA PKP	F001		R	1	
0x0184	0x1000	PHASE UV1 CA OP	F001		R	1	
0x0184	0x2000	PHASE UV1 PKP	F001		R	1	
0x0184	0x4000	PHASE UV1 OP	F001		R	1	
0x0189	0x8000	PHASE UV2 BLOCK	F001		R	1	
0x0189	0x0001	PHASE UV2 A PKP	F001		R	1	
0x0189	0x0002	PHASE UV2 A OP	F001		R	1	
0x0189	0x0004	PHASE UV2 B PKP	F001		R	1	
0x0189	0x0008	PHASE UV2 B OP	F001		R	1	
0x0189	0x0010	PHASE UV2 C PKP	F001		R	1	
0x0189	0x0020	PHASE UV2 C OP	F001		R	1	
0x0189	0x0040	PHASE UV2 AB PKP	F001		R	1	
0x0189	0x0080	PHASE UV2 AB OP	F001		R	1	
0x018A	0x0100	PHASE UV2 BC PKP	F001		R	1	
0x018A	0x0200	PHASE UV2 BC OP	F001		R	1	
0x018A	0x0400	PHASE UV2 CA PKP	F001		R	1	
0x018A	0x0800	PHASE UV2 CA OP	F001		R	1	
0x018A	0x1000	PHASE UV2 PKP	F001		R	1	
0x018A	0x2000	PHASE UV2 OP	F001		R	1	
0x018F	0x4000	PHASE UV3 BLOCK	F001		R	1	
0x018F	0x8000	PHASE UV3 A PKP	F001		R	1	
0x018F	0x0001	PHASE UV3 A OP	F001		R	1	
0x018F	0x0002	PHASE UV3 B PKP	F001		R	1	
0x018F	0x0004	PHASE UV3 B OP	F001		R	1	
0x018F	0x0008	PHASE UV3 C PKP	F001		R	1	
0x018F	0x0010	PHASE UV3 C OP	F001		R	1	
0x018F	0x0020	PHASE UV3 AB PKP	F001		R	1	
0x018F	0x0040	PHASE UV3 AB OP	F001		R	1	
0x018F	0x0080	PHASE UV3 BC PKP	F001		R	1	
0x0190	0x0100	PHASE UV3 BC OP	F001		R	1	
0x0190	0x0200	PHASE UV3 CA PKP	F001		R	1	
0x0190	0x0400	PHASE UV3 CA OP	F001		R	1	
0x0190	0x0800	PHASE UV3 PKP	F001		R	1	
0x0190	0x1000	PHASE UV3 OP	F001		R	1	
Estados Sobretensión de Secuencia Negativa - Negative Sequence OV States							
0x0195	0x2000	NEG SEQ OV1 BLOCK	F001		R	1	
0x0195	0x4000	NEG SEQ OV1 PKP	F001		R	1	
0x0195	0x8000	NEG SEQ OV1 OP	F001		R	1	
0x019A	0x0001	NEG SEQ OV2 BLOCK	F001		R	1	
0x019A	0x0002	NEG SEQ OV2 PKP	F001		R	1	
0x019A	0x0004	NEG SEQ OV2 OP	F001		R	1	
0x019F	0x0008	NEG SEQ OV3 BLOCK	F001		R	1	
0x019F	0x0010	NEG SEQ OV3 PKP	F001		R	1	
0x019F	0x0020	NEG SEQ OV3 OP	F001		R	1	
Estados Unidad Direccional de Neutro - Neutral Directional States							
0x01C6	0x8000	NEUTRAL DIR1 BLK INP	F001		R	1	
0x01C6	0x0001	NEUTRAL DIR1 BLOCK	F001		R	1	
0x01C6	0x0002	NEUTRAL DIR1 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01CB	0x0004	NEUTRAL DIR2 BLK INP	F001		R	1	
0x01CB	0x0008	NEUTRAL DIR2 BLOCK	F001		R	1	
0x01CB	0x0010	NEUTRAL DIR2 OP	F001		R	1	
0x01D0	0x0020	NEUTRAL DIR3 BLK INP	F001		R	1	
0x01D0	0x0040	NEUTRAL DIR3 BLOCK	F001		R	1	
0x01D0	0x0080	NEUTRAL DIR3 OP	F001		R	1	
Estados Unidad Direccional de Tierra - Ground Directional States							
0x01D6	0x0100	GROUND DIR1 BLK INP	F001		R	1	
0x01D6	0x0200	GROUND DIR1 BLOCK	F001		R	1	
0x01D6	0x0400	GROUND DIR1 OP	F001		R	1	
0x01DB	0x0800	GROUND DIR2 BLK INP	F001		R	1	
0x01DB	0x1000	GROUND DIR2 BLOCK	F001		R	1	
0x01DB	0x2000	GROUND DIR2 OP	F001		R	1	
0x01E0	0x4000	GROUND DIR3 BLK INP	F001		R	1	
0x01E0	0x8000	GROUND DIR3 BLOCK	F001		R	1	
0x01E0	0x0001	GROUND DIR3 OP	F001		R	1	
Estados Fallo de Interruptor - Breaker Failure States(Enhanced models only)							
0x01E5	0x0002	BKR FAIL INITIATE	F001		R	1	
0x01E5	0x0004	BKR FAIL NO CURRENT	F001		R	1	
0x01E5	0x0008	BKR FAIL SUPERVISION	F001		R	1	
0x01E5	0x0010	BKR FAIL HISET	F001		R	1	
0x01E5	0x0020	BKR FAIL LOWSET	F001		R	1	
0x01E5	0x0040	INTERNAL ARC	F001		R	1	
0x01E5	0x0080	BKR FAIL 2nd STEP	F001		R	1	
Estados Fallo de Fusible - Fuse failure States							
0x01EB	0x0100	VT FUSE FAILURE	F001		R	1	
Estados Unidad de Sincronismo - Synchrocheck States							
0x01F0	0x0200	Synchrocheck BLK INP	F001		R	1	
0x01F0	0x0400	Synchrocheck OP	F001		R	1	
0x01F0	0x0800	SYNCHK CLOSE PERM	F001		R	1	
0x01F0	0x1000	Synchrocheck COND OP	F001		R	1	
0x01F0	0x2000	DL-DB OPERATION	F001		R	1	
0x01F0	0x4000	DL-LB OPERATION	F001		R	1	
0x01F0	0x8000	LL-DB OPERATION	F001		R	1	
0x01F0	0x0001	SLIP CONDITION	F001		R	1	
0x01F0	0x0002	BUS FREQ > LINE FREQ	F001		R	1	
0x01F0	0x0004	BUS FREQ < LINE FREQ	F001		R	1	
Estados Sobretensión de Neutro Nivel Alto - Neutral OV High States							
0x01FC	0x1000	NEUTRAL OV1 HIGH BLK	F001		R	1	
0x01FC	0x2000	NEUTRAL OV1 HIGH PKP	F001		R	1	
0x01FC	0x4000	NEUTRAL OV1 HIGH OP	F001		R	1	
0x0201	0x8000	NEUTRAL OV2 HIGH BLK	F001		R	1	
0x0201	0x0001	NEUTRAL OV2 HIGH PKP	F001		R	1	
0x0201	0x0002	NEUTRAL OV2 HIGH OP	F001		R	1	
0x0206	0x0004	NEUTRAL OV3 HIGH BLK	F001		R	1	
0x0206	0x0008	NEUTRAL OV3 HIGH PKP	F001		R	1	
0x0206	0x0010	NEUTRAL OV3 HIGH OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Subtensión Auxiliar - Auxiliary UV States							
0x021B	0x4000	AUXILIARY UV1 BLOCK	F001		R	1	
0x021B	0x8000	AUXILIARY UV1 PKP	F001		R	1	
0x021B	0x0001	AUXILIARY UV1 OP	F001		R	1	
0x0220	0x0002	AUXILIARY UV2 BLOCK	F001		R	1	
0x0220	0x0004	AUXILIARY UV2 PKP	F001		R	1	
0x0220	0x0008	AUXILIARY UV2 OP	F001		R	1	
0x0225	0x0010	AUXILIARY UV3 BLOCK	F001		R	1	
0x0225	0x0020	AUXILIARY UV3 PKP	F001		R	1	
0x0225	0x0040	AUXILIARY UV3 OP	F001		R	1	
Estados Sobretensión de Fases - Phase OV States							
0x022A	0x0080	PHASE OV1 BLOCK	F001		R	1	
0x022B	0x0100	PHASE OV1 AB PKP	F001		R	1	
0x022B	0x0200	PHASE OV1 AB OP	F001		R	1	
0x022B	0x0400	PHASE OV1 BC PKP	F001		R	1	
0x022B	0x0800	PHASE OV1 BC OP	F001		R	1	
0x022B	0x1000	PHASE OV1 CA PKP	F001		R	1	
0x022B	0x2000	PHASE OV1 CA OP	F001		R	1	
0x022B	0x4000	PHASE OV1 PKP	F001		R	1	
0x022B	0x8000	PHASE OV1 OP	F001		R	1	
0x0230	0x0001	PHASE OV2 BLOCK	F001		R	1	
0x0230	0x0002	PHASE OV2 AB PKP	F001		R	1	
0x0230	0x0004	PHASE OV2 AB OP	F001		R	1	
0x0230	0x0008	PHASE OV2 BC PKP	F001		R	1	
0x0230	0x0010	PHASE OV2 BC OP	F001		R	1	
0x0230	0x0020	PHASE OV2 CA PKP	F001		R	1	
0x0230	0x0040	PHASE OV2 CA OP	F001		R	1	
0x0230	0x0080	PHASE OV2 PKP	F001		R	1	
0x0231	0x0100	PHASE OV2 OP	F001		R	1	
0x0236	0x0200	PHASE OV3 BLOCK	F001		R	1	
0x0236	0x0400	PHASE OV3 AB PKP	F001		R	1	
0x0236	0x0800	PHASE OV3 AB OP	F001		R	1	
0x0236	0x1000	PHASE OV3 BC PKP	F001		R	1	
0x0236	0x2000	PHASE OV3 BC OP	F001		R	1	
0x0236	0x4000	PHASE OV3 CA PKP	F001		R	1	
0x0236	0x8000	PHASE OV3 CA OP	F001		R	1	
0x0236	0x0001	PHASE OV3 PKP	F001		R	1	
0x0236	0x0002	PHASE OV3 OP	F001		R	1	
Estados Sobretensión Auxiliar - Auxiliary OV States							
0x023B	0x0004	AUXILIARY OV1 BLOCK	F001		R	1	
0x023B	0x0008	AUXILIARY OV1 PKP	F001		R	1	
0x023B	0x0010	AUXILIARY OV1 OP	F001		R	1	
0x0240	0x0020	AUXILIARY OV2 BLOCK	F001		R	1	
0x0240	0x0040	AUXILIARY OV2 PKP	F001		R	1	
0x0240	0x0080	AUXILIARY OV2 OP	F001		R	1	
0x0246	0x0100	AUXILIARY OV3 BLOCK	F001		R	1	
0x0246	0x0200	AUXILIARY OV3 PKP	F001		R	1	
0x0246	0x0400	AUXILIARY OV3 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobreintensidad Temporizada de Secuencia Negativa - Negative Sequence TOC States							
0x024B	0x0800	NEG SEQ TOC1 BLOCK	F001		R	1	
0x024B	0x1000	NEG SEQ TOC1 PKP	F001		R	1	
0x024B	0x2000	NEG SEQ TOC1 OP	F001		R	1	
0x0250	0x4000	NEG SEQ TOC2 BLOCK	F001		R	1	
0x0250	0x8000	NEG SEQ TOC2 PKP	F001		R	1	
0x0250	0x0001	NEG SEQ TOC2 OP	F001		R	1	
0x0255	0x0002	NEG SEQ TOC3 BLOCK	F001		R	1	
0x0255	0x0004	NEG SEQ TOC3 PKP	F001		R	1	
0x0255	0x0008	NEG SEQ TOC3 OP	F001		R	1	
Estados Sobrefrecuencia - Overfrequency States							
0x025A	0x0010	OVERFREQ1 BLOCK	F001		R	1	
0x025A	0x0020	OVERFREQ1 PKP	F001		R	1	
0x025A	0x0040	OVERFREQ1 OP	F001		R	1	
0x025F	0x0080	OVERFREQ2 BLOCK	F001		R	1	
0x0260	0x0100	OVERFREQ2 PKP	F001		R	1	
0x0260	0x0200	OVERFREQ2 OP	F001		R	1	
0x0265	0x0400	OVERFREQ3 BLOCK	F001		R	1	
0x0265	0x0800	OVERFREQ3 PKP	F001		R	1	
0x0265	0x1000	OVERFREQ3 OP	F001		R	1	
Estados Subfrecuencia - Underfrequency States							
0x026A	0x2000	UNDERFREQ1 BLOCK	F001		R	1	
0x026A	0x4000	UNDERFREQ1 PKP	F001		R	1	
0x026A	0x8000	UNDERFREQ1 OP	F001		R	1	
0x026F	0x0001	UNDERFREQ2 BLOCK	F001		R	1	
0x026F	0x0002	UNDERFREQ2 PKP	F001		R	1	
0x026F	0x0004	UNDERFREQ2 OP	F001		R	1	
0x0274	0x0008	UNDERFREQ3 BLOCK	F001		R	1	
0x0274	0x0010	UNDERFREQ3 PKP	F001		R	1	
0x0274	0x0020	UNDERFREQ3 OP	F001		R	1	
Estados Calibración - Calibration States							
0x0279	0x0040	FACTORY CALIBRATION	F001		R	1	
0x0279	0x0080	CALIBRATION ERROR	F001		R	1	
Estados Oscilografía - Oscillography States							
0x027A	0x0100	OSC DIG CHANNEL 1	F001		R	1	
0x027A	0x0200	OSC DIG CHANNEL 2	F001		R	1	
0x027A	0x0400	OSC DIG CHANNEL 3	F001		R	1	
0x027A	0x0800	OSC DIG CHANNEL 4	F001		R	1	
0x027A	0x1000	OSC DIG CHANNEL 5	F001		R	1	
0x027A	0x2000	OSC DIG CHANNEL 6	F001		R	1	
0x027A	0x4000	OSC DIG CHANNEL 7	F001		R	1	
0x027A	0x8000	OSC DIG CHANNEL 8	F001		R	1	
0x027A	0x0001	OSC DIG CHANNEL 9	F001		R	1	
0x027A	0x0002	OSC DIG CHANNEL 10	F001		R	1	
0x027A	0x0004	OSC DIG CHANNEL 11	F001		R	1	
0x027A	0x0008	OSC DIG CHANNEL 12	F001		R	1	
0x027A	0x0010	OSC DIG CHANNEL 13	F001		R	1	
0x027A	0x0020	OSC DIG CHANNEL 14	F001		R	1	
0x027A	0x0040	OSC DIG CHANNEL 15	F001		R	1	
0x027A	0x0080	OSC DIG CHANNEL 16	F001		R	1	
0x027B	0x0100	OSCILLO TRIGGER	F001		R	1	

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ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Localizador de Faltas - Fault Report States							
0x0280	0x0200	FAULT REPORT TRIGG	F001		R	1	
0x0280	0x0400	CLEAR FAULT REPORTS	F001		R	1	
Agrupamiento de Funciones - Group States							
0x028F	0x0400	GROUP 1 ACT ON	F001		R	1	
0x028F	0x0800	GROUP 2 ACT ON	F001		R	1	
0x028F	0x1000	GROUP 3 ACT ON	F001		R	1	
0x028F	0x2000	SETT GROUPS BLOCK	F001		R	1	
0x028F	0x4000	GROUP 1 BLOCKED	F001		R	1	
0x028F	0x8000	GROUP 2 BLOCKED	F001		R	1	
0x028F	0x0001	GROUP 3 BLOCKED	F001		R	1	
Canal por defecto - Default Channel (not used)							
0x0294	0x0002	Default Channel	F001		R	1	
Estados Energía - Energy States							
0x02A4	0x0800	FREEZE ENERGY CNT	F001		R	1	
0x02A4	0x1000	UNFREEZE ENERGY CNT	F001		R	1	
0x02A4	0x2000	RESET ENERGY CNT	F001		R	1	
Entradas Demanda - Demand Inputs							
0x0305	0x8000	DEMAND TRIGGER INP	F001		R	1	
0x0305	0x0001	DEMAND RESET INP	F001		R	1	
Estado Entradas Tarjeta H (32 elementos) - Board H: Contact Input States							
0x0319	0x0002	CONT IP_H_CC1	F001		R	1	
0x0319	0x0004	CONT IP_H_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x031B	0x0001	CONT IP_H_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta H (16 elementos) - Board H: Contact Output Operate -logical States-							
0x031B	0x0002	CONT OP OPER_H_01	F001		R	1	
0x031B	0x0004	CONT OP OPER_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031C	0x0001	CONT OP OPER_H_16	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estado Señales Reposición de Salidas Tarjeta H (16 elementos) - Board H: Contact Output Resets							
0x031C	0x0002	CONT OP RESET_H_01	F001		R	1	
0x031C	0x0004	CONT OP RESET_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031D	0x0001	CONT OP RESET_H_16	F001		R	1	
Estado Salidas Tarjeta H (16 elementos) - Board H: Contact Outputs -physical States-							
0x031D	0x0002	CONT OP_H_01	F001		R	1	
0x031D	0x0004	CONT OP_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031E	0x0001	CONT OP_H_16	F001		R	1	
Estado Tarjeta H - Board H Status							
0x031E	0x0002	BOARD H STATUS	F001		R	1	
Estado Entradas Tarjeta J (32 elementos) - Board J: Contact Input States							
0x033E	0x0004	CONT IP_J_CC1	F001		R	1	
0x033E	0x0008	CONT IP_J_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x0340	0x0002	CONT IP_J_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta J (16 elementos) - Board J: Contact Output Operate -logical States-							
0x0340	0x0004	CONT OP OPER_J_01	F001		R	1	
0x0340	0x0008	CONT OP OPER_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0341	0x0002	CONT OP OPER_J_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta J (16 elementos) - Board J: Contact Output Resets							
0x0341	0x0004	CONT OP RESET_J_01	F001		R	1	
0x0341	0x0008	CONT OP RESET_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0342	0x0002	CONT OP RESET_J_16	F001		R	1	
Estado Salidas Tarjeta J (16 elementos) - Board J: Contact Outputs -physical states-							
0x0342	0x0004	CONT OP_J_01	F001		R	1	
0x0342	0x0008	CONT OP_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0343	0x0002	CONT OP_J_16	F001		R	1	
Estado Tarjeta J - Board J Status							
0x0343	0x0004	BOARD J STATUS	F001		R	1	
Estados Sobrecorriente Temporizada de Fases Nivel Bajo - Phase TOC Low States							
0x0363	0x0008	PH TOC1 LOW A BLK	F001		R	1	
0x0363	0x0010	PH TOC1 LOW B BLK	F001		R	1	
0x0363	0x0020	PH TOC1 LOW C BLK	F001		R	1	
0x0363	0x0040	PH TOC1 LOW A PKP	F001		R	1	
0x0363	0x0080	PH TOC1 LOW A OP	F001		R	1	
0x0364	0x0100	PH TOC1 LOW B PKP	F001		R	1	
0x0364	0x0200	PH TOC1 LOW B OP	F001		R	1	
0x0364	0x0400	PH TOC1 LOW C PKP	F001		R	1	
0x0364	0x0800	PH TOC1 LOW C OP	F001		R	1	
0x0364	0x1000	PH TOC1 LOW PKP	F001		R	1	
0x0364	0x2000	PH TOC1 LOW OP	F001		R	1	
0x0369	0x4000	PH TOC2 LOW A BLK	F001		R	1	
0x0369	0x8000	PH TOC2 LOW B BLK	F001		R	1	
0x0369	0x0001	PH TOC2 LOW C BLK	F001		R	1	
0x0369	0x0002	PH TOC2 LOW A PKP	F001		R	1	
0x0369	0x0004	PH TOC2 LOW A OP	F001		R	1	
0x0369	0x0008	PH TOC2 LOW B PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobrecorriente Temporizada de Fases Nivel Bajo - Phase TOC Low States(cont.)							
0x0369	0x0010	PH TOC2 LOW B OP	F001		R	1	
0x0369	0x0020	PH TOC2 LOW C PKP	F001		R	1	
0x0369	0x0040	PH TOC2 LOW C OP	F001		R	1	
0x0369	0x0080	PH TOC2 LOW PKP	F001		R	1	
0x036A	0x0100	PH TOC2 LOW OP	F001		R	1	
0x036F	0x0200	PH TOC3 LOW A BLK	F001		R	1	
0x036F	0x0400	PH TOC3 LOW B BLK	F001		R	1	
0x036F	0x0800	PH TOC3 LOW C BLK	F001		R	1	
0x036F	0x1000	PH TOC3 LOW A PKP	F001		R	1	
0x036F	0x2000	PH TOC3 LOW A OP	F001		R	1	
0x036F	0x4000	PH TOC3 LOW B PKP	F001		R	1	
0x036F	0x8000	PH TOC3 LOW B OP	F001		R	1	
0x036F	0x0001	PH TOC3 LOW C PKP	F001		R	1	
0x036F	0x0002	PH TOC3 LOW C OP	F001		R	1	
0x036F	0x0004	PH TOC3 LOW PKP	F001		R	1	
0x036F	0x0008	PH TOC3 LOW OP	F001		R	1	
Estados Contactos Configuración Aparamenta (16 elementos) - Switchgear Contact Configuration States							
0x0374	0x0010	SWITCH 1 A INPUT	F001		R	1	
0x0374	0x0020	SWITCH 1 B INPUT	F001		R	1	
0x0374	0x0040	SWITCH 2 A INPUT	F001		R	1	
0x0374	0x0080	SWITCH 2 B INPUT	F001		R	1	
...	...	...	...	...	...	...	...
0x0376	0x0004	SWITCH 16 A INPUT	F001		R	1	
0x0376	0x0008	SWITCH 16 B INPUT	F001		R	1	
Estados Contactos Aparamenta (16 elementos) - Switchgear Contact States							
0x0376	0x0010	SWITCH 1 A STATUS	F001		R	1	
0x0376	0x0020	SWITCH 1 B STATUS	F001		R	1	
0x0376	0x0040	SWITCH 2 A STATUS	F001		R	1	
0x0376	0x0080	SWITCH 2 B STATUS	F001		R	1	
...	...	...	...	...	...	...	...
0x0378	0x0004	SWITCH 16 A STATUS	F001		R	1	
0x0378	0x0008	SWITCH 16 B STATUS	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Aparamenta (16 elementos) - Switchgear States							
0x0378	0x0010	SWITCH 1 OPEN	F001		R	1	
0x0378	0x0020	SWITCH 1 CLOSED	F001		R	1	
0x0378	0x0040	SWITCH 1 00_ERROR	F001		R	1	
0x0378	0x0080	SWITCH 1 11_ERROR	F001		R	1	
0x0379	0x0100	SWITCH 2 OPEN	F001		R	1	
0x0379	0x0200	SWITCH 2 CLOSED	F001		R	1	
0x0379	0x0400	SWITCH 2 00_ERROR	F001		R	1	
0x0379	0x0800	SWITCH 2 11_ERROR	F001		R	1	
...	...	...	...	...	...	...	...
0x037C	0x0001	SWITCH 16 OPEN	F001		R	1	
0x037C	0x0002	SWITCH 16 CLOSED	F001		R	1	
0x037C	0x0004	SWITCH 16 00_ERROR	F001		R	1	
0x037C	0x0008	SWITCH 16 11_ERROR	F001		R	1	
Estados Inicio Apertura y Cierre Aparamenta - Switchgear Open-Close Initializing States							
0x037C	0x0010	SWITCH 1 OPEN INIT	F001		R	1	
0x037C	0x0020	SWITCH 1 CLOSE INIT	F001		R	1	
0x037C	0x0040	SWITCH 2 OPEN INIT	F001		R	1	
0x037C	0x0080	SWITCH 2 CLOSE INIT	F001		R	1	
...	...	...	...	...	...	...	...
0x037E	0x0004	SWITCH 16 OPEN INIT	F001		R	1	
0x037E	0x0008	SWITCH 16 CLOSE INIT	F001		R	1	
Estados Fallo Apertura y Cierre Aparamenta - Switchgear Fail States							
0x037E	0x0010	SWGR 1 FAIL TO OPEN	F001		R	1	
0x037E	0x0020	SWGR 2 FAIL TO OPEN	F001		R	1	
...	...	...	...	...	...	...	...
0x037F	0x0008	SWGR 16 FAIL TO OPEN	F001		R	1	
0x037F	0x0010	SWGR 1 FAIL TO CLOSE	F001		R	1	
0x037F	0x0020	SWGR 2 FAIL TO CLOSE	F001		R	1	
...	...	...	...	...	...	...	...
0x0380	0x0008	SWGR 16 FAIL TO CLOSE	F001		R	1	
Estados Interruptor - Breaker States							
0x0390	0x0010	KI2t PHASE A ALARM	F001		R	1	
0x0390	0x0020	KI2t PHASE B ALARM	F001		R	1	
0x0390	0x0040	KI2t PHASE C ALARM	F001		R	1	
0x0390	0x0080	BKR OPENINGS ALARM	F001		R	1	
0x0391	0x0100	BKR OPEN 1 HOUR ALRM	F001		R	1	
0x0391	0x0200	BREAKER OPEN	F001		R	1	
0x0391	0x0400	BREAKER CLOSED	F001		R	1	
0x0391	0x0800	BREAKER UNDEFINED	F001		R	1	
0x0391	0x1000	RESET KI2t COUNTERS	F001		R	1	
0x0391	0x2000	RESET BKR COUNTERS	F001		R	1	
Estado Mapa Usuario - User Map State							
0x039B	0x4000	USER MAP STATUS	F001		R	1	
Estado Curvas Usuario - Flex Curves States							
0x039B	0x8000	FLEXCURVE A STATUS	F001		R	1	
0x03A0	0x0001	FLEXCURVE B STATUS	F001		R	1	
0x03A5	0x0002	FLEXCURVE C STATUS	F001		R	1	
0x03AA	0x0004	FLEXCURVE D STATUS	F001		R	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Internos Sistema - Internal System States							
0x03B1	0x0008	Green Zone	F001		R	1	
0x03B1	0x0010	Yellow Zone	F001		R	1	
0x03B1	0x0020	Orange Zone	F001		R	1	
0x03B1	0x0040	Red Zone	F001		R	1	
Estados Unidad direccional de potencia - Directional Power States							
0x03B2	0x8000	DIR PWR1 BLOCK	F001		R	1	
0x03B2	0x0001	DIR PWR1 STG1 PKP	F001		R	1	
0x03B2	0x0002	DIR PWR1 STG1 OP	F001		R	1	
0x03B2	0x0004	DIR PWR1 STG2 PKP	F001		R	1	
0x03B2	0x0008	DIR PWR1 STG2 OP	F001		R	1	
0x03B2	0x0010	DIR PWR1 STG PKP	F001		R	1	
0x03B2	0x0020	DIR PWR1 STG OP	F001		R	1	
0x03B7	0x0040	DIR PWR2 BLOCK	F001		R	1	
0x03B7	0x0080	DIR PWR2 STG1 PKP	F001		R	1	
0x03B8	0x0100	DIR PWR2 STG1 OP	F001		R	1	
0x03B8	0x0200	DIR PWR2 STG2 PKP	F001		R	1	
0x03B8	0x0400	DIR PWR2 STG2 OP	F001		R	1	
0x03B8	0x0800	DIR PWR2 STG PKP	F001		R	1	
0x03B8	0x1000	DIR PWR2 STG OP	F001		R	1	
0x03BD	0x2000	DIR PWR3 BLOCK	F001		R	1	
0x03BD	0x4000	DIR PWR3 STG1 PKP	F001		R	1	
0x03BD	0x8000	DIR PWR3 STG1 OP	F001		R	1	
0x03BD	0x0001	DIR PWR3 STG2 PKP	F001		R	1	
0x03BD	0x0002	DIR PWR3 STG2 OP	F001		R	1	
0x03BD	0x0004	DIR PWR3 STG PKP	F001		R	1	
0x03BD	0x0008	DIR PWR3 STG OP	F001		R	1	
Estados Sicronizacion Remota - SNTP/IRIG B Status(Do not apply to C650 models)							
0x03F2	0x0008	SNTP FAILURE	F001		R	1	
0x03F2	0x0010	IRIGB FAILURE	F001		R	1	
Comparadores analógicos-Analog Comparators							
0x03F8	0x0020	Analog Level 01	F001		R	1	
0x03F8	0x0040	Analog Level 02	F001		R	1	
0x03F8	0x0080	Analog Level 03	F001		R	1	
0x03F9	0x0100	Analog Level 04	F001		R	1	
0x03F9	0x0200	Analog Level 05	F001		R	1	
0x03F9	0x0400	Analog Level 06	F001		R	1	
0x03F9	0x0800	Analog Level 07	F001		R	1	
0x03F9	0x1000	Analog Level 08	F001		R	1	
0x03F9	0x2000	Analog Level 09	F001		R	1	
0x03F9	0x4000	Analog Level 10	F001		R	1	
0x03F9	0x8000	Analog Level 11	F001		R	1	
0x03F9	0x0001	Analog Level 12	F001		R	1	
0x03F9	0x0002	Analog Level 13	F001		R	1	
0x03F9	0x0004	Analog Level 14	F001		R	1	
0x03F9	0x0008	Analog Level 15	F001		R	1	
0x03F9	0x0010	Analog Level 16	F001		R	1	
0x03F9	0x0020	Analog Level 17	F001		R	1	
0x03F9	0x0040	Analog Level 18	F001		R	1	
0x03F9	0x0080	Analog Level 19	F001		R	1	
0x03FA	0x0100	Analog Level 20	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Derivada de Frecuencia - Frequency Rate of Change States							
0x03FC	0x0002	FREQ RATE1 BLOCK	F001		R	1	
0x03FC	0x0004	FREQ RATE1 PKP	F001		R	1	
0x03FC	0x0008	FREQ RATE1 OP	F001		R	1	
0x0401	0x0010	FREQ RATE2 BLOCK	F001		R	1	
0x0401	0x0020	FREQ RATE2 PKP	F001		R	1	
0x0401	0x0040	FREQ RATE2 OP	F001		R	1	
0x0406	0x0080	FREQ RATE3 BLOCK	F001		R	1	
0x0407	0x0100	FREQ RATE3 PKP	F001		R	1	
0x0407	0x0200	FREQ RATE3 OP	F001		R	1	
0x03FC	0x0002	FREQ RATE1 BLOCK	F001		R	1	
0x03FC	0x0004	FREQ RATE1 PKP	F001		R	1	
0x03FC	0x0008	FREQ RATE1 OP	F001		R	1	
0x0401	0x0010	FREQ RATE2 BLOCK	F001		R	1	
0x0401	0x0020	FREQ RATE2 PKP	F001		R	1	
0x0401	0x0040	FREQ RATE2 OP	F001		R	1	
0x0406	0x0080	FREQ RATE3 BLOCK	F001		R	1	
0x0407	0x0100	FREQ RATE3 PKP	F001		R	1	
0x0407	0x0200	FREQ RATE3 OP	F001		R	1	
Estados función Tierra Restringida - Restricted Ground Fault status(Enhanced Models only)							
0x042A	0x2000	RESTR GND FLT1 BLOCK	F001		R	1	
0x042A	0x4000	RESTR GND FLT1 PKP	F001		R	1	
0x042A	0x8000	RESTR GND FLT1 OP	F001		R	1	
0x042B	0x0001	RESTR GND FLT2 BLOCK	F001		R	1	
0x042B	0x0002	RESTR GND FLT2 PKP	F001		R	1	
0x042B	0x0004	RESTR GND FLT2 OP	F001		R	1	
0x042C	0x0008	RESTR GND FLT3 BLOCK	F001		R	1	
0x042C	0x0010	RESTR GND FLT3 PKP	F001		R	1	
0x042C	0x0020	RESTR GND FLT3 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados función Salto de vector - Loss of Mains status(Enhanced Models Only)							
0x042D	0x0040	LOSS OF MAINS1 BLOCK	F001		R	1	
0x042D	0x0080	LOSS OF MAINS1 A OP	F001		R	1	
0x042E	0x0100	LOSS OF MAINS1 B OP	F001		R	1	
0x042E	0x0200	LOSS OF MAINS1 C OP	F001		R	1	
0x042E	0x0400	LOSS OF MAINS1 OP	F001		R	1	
0x042F	0x0800	LOSS OF MAINS2 BLOCK	F001		R	1	
0x042F	0x1000	LOSS OF MAINS2 A OP	F001		R	1	
0x042F	0x2000	LOSS OF MAINS2 B OP	F001		R	1	
0x042F	0x4000	LOSS OF MAINS2 C OP	F001		R	1	
0x042F	0x8000	LOSS OF MAINS2 OP	F001		R	1	
0x0430	0x0001	LOSS OF MAINS3 BLOCK	F001		R	1	
0x0430	0x0002	LOSS OF MAINS3 A OP	F001		R	1	
0x0430	0x0004	LOSS OF MAINS3 B OP	F001		R	1	
0x0430	0x0008	LOSS OF MAINS3 C OP	F001		R	1	
0x0430	0x0010	LOSS OF MAINS3 OP	F001		R	1	
Estados Desequilibrio de Generador - Generator Unbalance status							
0x0431	0x0020	GEN UNBAL1 BLOCK	F001		R	1	
0x0431	0x0040	GEN UNBAL1 STG1 PKP	F001		R	1	
0x0431	0x0080	GEN UNBAL1 STG1 OP	F001		R	1	
0x0432	0x0100	GEN UNBAL1 STG2 PKP	F001		R	1	
0x0432	0x0200	GEN UNBAL1 STG2 OP	F001		R	1	
0x0432	0x0400	GEN UNBAL1 PKP	F001		R	1	
0x0432	0x0800	GEN UNBAL1 OP	F001		R	1	
0x0433	0x1000	GEN UNBAL2 BLOCK	F001		R	1	
0x0433	0x2000	GEN UNBAL2 STG1 PKP	F001		R	1	
0x0433	0x4000	GEN UNBAL2 STG1 OP	F001		R	1	
0x0433	0x8000	GEN UNBAL2 STG2 PKP	F001		R	1	
0x0433	0x0001	GEN UNBAL2 STG2 OP	F001		R	1	
0x0433	0x0002	GEN UNBAL2 PKP	F001		R	1	
0x0433	0x0004	GEN UNBAL2 OP	F001		R	1	
0x0434	0x0008	GEN UNBAL3 BLOCK	F001		R	1	
0x0434	0x0010	GEN UNBAL3 STG1 PKP	F001		R	1	
0x0434	0x0020	GEN UNBAL3 STG1 OP	F001		R	1	
0x0434	0x0040	GEN UNBAL3 STG2 PKP	F001		R	1	
0x0434	0x0080	GEN UNBAL3 STG2 OP	F001		R	1	
0x0435	0x0100	GEN UNBAL3 PKP	F001		R	1	
0x0435	0x0200	GEN UNBAL3 OP	F001		R	1	
Estados función Voltios/Hercios - Volts per Hertz status(Enhanced Models Only)							
0x0436	0x0400	VOLTS/Hz1 BLOCK	F001		R	1	
0x0436	0x0800	VOLTS/Hz1 PKP	F001		R	1	
0x0436	0x1000	VOLTS/Hz1 OP	F001		R	1	
0x0437	0x2000	VOLTS/Hz2 BLOCK	F001		R	1	
0x0437	0x4000	VOLTS/Hz2 PKP	F001		R	1	
0x0437	0x8000	VOLTS/Hz2 OP	F001		R	1	
0x0438	0x0001	VOLTS/Hz3 BLOCK	F001		R	1	
0x0438	0x0002	VOLTS/Hz3 PKP	F001		R	1	
0x0438	0x0004	VOLTS/Hz3 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Pérdida Excitación - Loss of Excitation status							
0x0439	0x0008	LOSS OF EXC1 BLOCK	F001		R	1	
0x0439	0x0010	LOSS OF EXC1 ST1 PKP	F001		R	1	
0x0439	0x0020	LOSS OF EXC1 STG1 OP	F001		R	1	
0x0439	0x0040	LOSS OF EXC1 ST2 PKP	F001		R	1	
0x0439	0x0080	LOSS OF EXC1 STG2 OP	F001		R	1	
0x043A	0x0100	LOSS OF EXC1 PKP	F001		R	1	
0x043A	0x0200	LOSS OF EXC1 OP	F001		R	1	
0x043B	0x0400	LOSS OF EXC2 BLOCK	F001		R	1	
0x043B	0x0800	LOSS OF EXC2 ST1 PKP	F001		R	1	
0x043B	0x1000	LOSS OF EXC2 STG1 OP	F001		R	1	
0x043B	0x2000	LOSS OF EXC2 ST2 PKP	F001		R	1	
0x043B	0x4000	LOSS OF EXC2 STG2 OP	F001		R	1	
0x043B	0x8000	LOSS OF EXC2 PKP	F001		R	1	
0x043B	0x0001	LOSS OF EXC2 OP	F001		R	1	
0x043C	0x0002	LOSS OF EXC3 BLOCK	F001		R	1	
0x043C	0x0004	LOSS OF EXC3 STG1 PKP	F001		R	1	
0x043C	0x0008	LOSS OF EXC3 STG1 OP	F001		R	1	
0x043C	0x0010	LOSS OF EXC3 STG2 PKP	F001		R	1	
0x043C	0x0020	LOSS OF EXC3 STG2 OP	F001		R	1	
0x043C	0x0040	LOSS OF EXC3 PKP	F001		R	1	
0x043C	0x0080	LOSS OF EXC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada Sequencia Negativa - Negative Sequence IOC status							
0x043E	0x0100	NEG. SEQ1 IOC BLOCK	F001		R	1	
0x043E	0x0200	NEG. SEQ1 IOC PKP	F001		R	1	
0x043E	0x0400	NEG. SEQ1 IOC OP	F001		R	1	
0x043F	0x0800	NEG. SEQ2 IOC BLOCK	F001		R	1	
0x043F	0x1000	NEG. SEQ2 IOC PKP	F001		R	1	
0x043F	0x2000	NEG. SEQ2 IOC OP	F001		R	1	
0x0440	0x4000	NEG. SEQ3 IOC BLOCK	F001		R	1	
0x0440	0x8000	NEG. SEQ3 IOC PKP	F001		R	1	
0x0440	0x0001	NEG. SEQ3 IOC OP	F001		R	1	
Estados Imagen Térmica Generador - Generator Thermal Model status							
0x0441	0x0002	THERMAL1 49S BLOCK	F001		R	1	
0x0441	0x0004	THERMAL1 49S ALARM	F001		R	1	
0x0441	0x0008	THERMAL1 49S OP	F001		R	1	
0x0441	0x0010	THERMAL1 49S RST	F001		R	1	
0x0442	0x0020	THERMAL2 49S BLOCK	F001		R	1	
0x0442	0x0040	THERMAL2 49S ALARM	F001		R	1	
0x0442	0x0080	THERMAL2 49S OP	F001		R	1	
0x0443	0x0100	THERMAL2 49S RST	F001		R	1	
0x0444	0x0200	THERMAL3 49S BLOCK	F001		R	1	
0x0444	0x0400	THERMAL3 49S ALARM	F001		R	1	
0x0444	0x0800	THERMAL3 49S OP	F001		R	1	
0x0444	0x1000	THERMAL3 49S RST	F001		R	1	
Estados Limitador Factor Potencia - Power Factor Limiting status(Enhanced Models Only)							
0x0445	0x2000	POWER FACTOR1 BLOCK	F001		R	1	
0x0445	0x4000	PF1 LAG STG1 OP	F001		R	1	
0x0445	0x8000	PF1 LEAD STG1 OP	F001		R	1	
0x0445	0x0001	PF1 LAG STG2 OP	F001		R	1	
0x0445	0x0002	PF1 LEAD STG2 OP	F001		R	1	
0x0445	0x0004	PF1 LAG OP	F001		R	1	
0x0445	0x0008	PF1 LEAD OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0446	0x0010	POWER FACTOR2 BLOCK	F001		R	1	
0x0446	0x0020	PF2 LAG STG1 OP	F001		R	1	
0x0446	0x0040	PF2 LEAD STG1 OP	F001		R	1	
0x0446	0x0080	PF2 LAG STG2 OP	F001		R	1	
0x0447	0x0100	PF2 LEAD STG2 OP	F001		R	1	
0x0447	0x0200	PF2 LAG OP	F001		R	1	
0x0447	0x0400	PF2 LEAD OP	F001		R	1	
0x0448	0x0800	POWER FACTOR3 BLOCK	F001		R	1	
0x0448	0x1000	PF3 LAG STG1 OP	F001		R	1	
0x0448	0x2000	PF3 LEAD STG1 OP	F001		R	1	
0x0448	0x4000	PF3 LAG STG2 OP	F001		R	1	
0x0448	0x8000	PF3 LEAD STG2 OP	F001		R	1	
0x0448	0x0001	PF3 LAG OP	F001		R	1	
0x0448	0x0002	PF3 LEAD OP	F001		R	1	
Estados Energización Accidental - Accidental Energization status							
0x0449	0x0004	ACCDNT ENRG1 BLOCK	F001		R	1	
0x0449	0x0008	ACCDNT ENRG1 OFFLINE	F001		R	1	
0x0449	0x0010	ACCDNT ENRG1 ARMED	F001		R	1	
0x0449	0x0020	ACCDNT ENRG1 OP	F001		R	1	
0x044A	0x0040	ACCDNT ENRG2 BLOCK	F001		R	1	
0x044A	0x0080	ACCDNT ENRG2 OFFLINE	F001		R	1	
0x044B	0x0100	ACCDNT ENRG2 ARMED	F001		R	1	
0x044B	0x0200	ACCDNT ENRG2 OP	F001		R	1	
0x044C	0x0400	ACCDNT ENRG3 BLOCK	F001		R	1	
0x044C	0x0800	ACCDNT ENRG3 OFFLINE	F001		R	1	
0x044C	0x1000	ACCDNT ENRG3 ARMED	F001		R	1	
0x044C	0x2000	ACCDNT ENRG3 OP	F001		R	1	
Estados Sobretención de Tierra - Ground OV status							
0x044D	0x4000	GND OV1 BLK	F001		R	1	
0x044D	0x8000	GND OV1 PKP	F001		R	1	
0x044D	0x0001	GND OV1 OP	F001		R	1	
0x044E	0x0002	GND OV2 BLK	F001		R	1	
0x044E	0x0004	GND OV2 PKP	F001		R	1	
0x044E	0x0008	GND OV2 OP	F001		R	1	
0x044F	0x0010	GND OV3 BLK	F001		R	1	
0x044F	0x0020	GND OV3 PKP	F001		R	1	
0x044F	0x0040	GND OV3 OP	F001		R	1	
Entradas Analógicas (Tarjetas F y G)- Analog Inputs (F and G boards)(Do not apply to C650 models)							
0x0B06		ANALOG_INP_F_01	F002	1000	R	2	
0x0B08		ANALOG_INP_F_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x0B14		ANALOG_INP_F_08	F002	1000	R	2	
0x0B86		ANALOG_INP_G_01	F002	1000	R	2	
0x0B88		ANALOG_INP_G_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x0B94		ANALOG_INP_G_08	F002	1000	R	2	
Medidas en Valores Secundarios - Analog measures in Secondary Values							
0x0C00		Phasor Ia	F002	1000	R	2	
0x0C02		RMS Ia	F002	1000	R	2	
0x0C04		Ia Real	F002	1000	R	2	
0x0C06		Ia Imag	F002	1000	R	2	
0x0C08		Phasor Ib	F002	1000	R	2	
0x0C0A		RMS Ib	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0C0C		Ib Real	F002	1000	R	2	
0x0C0E		Ib Imag	F002	1000	R	2	
0x0C10		Phasor Ic	F002	1000	R	2	
0x0C12		RMS Ic	F002	1000	R	2	
0x0C14		Ic Real	F002	1000	R	2	
Medidas en Valores Secundarios - Analog measures in Secondary Values(cont.)							
0x0C16		Ic Imag	F002	1000	R	2	
0x0C18		Phasor In	F002	1000	R	2	
0x0C1A		In Real	F002	1000	R	2	
0x0C1C		In Imag	F002	1000	R	2	
0x0C1E		Phasor Ig	F002	1000	R	2	
0x0C20		RMS Ig	F002	1000	R	2	
0x0C22		Ig Real	F002	1000	R	2	
0x0C24		Ig Imag	F002	1000	R	2	
0x0C26		Phasor Isg	F002	1000	R	2	
0x0C28		RMS Isg	F002	1000	R	2	
0x0C2A		Isg Real	F002	1000	R	2	
0x0C2C		Isg Imag	F002	1000	R	2	
0x0C2E		Zero seq I0	F002	1000	R	2	
0x0C30		I0 Real	F002	1000	R	2	
0x0C32		I0 Imag	F002	1000	R	2	
0x0C34		Positive Seq I1	F002	1000	R	2	
0x0C36		I1 Real	F002	1000	R	2	
0x0C38		I1 Imag	F002	1000	R	2	
0x0C3A		Negative Seq I2	F002	1000	R	2	
0x0C3C		I2 Real	F002	1000	R	2	
0x0C3E		I2 Imag	F002	1000	R	2	
0x0C40		Phasor Vab	F002	1000	R	2	
0x0C42		Vab Real	F002	1000	R	2	
0x0C44		Vab Imag	F002	1000	R	2	
0x0C46		Phasor Vbc	F002	1000	R	2	
0x0C48		Vbc Real	F002	1000	R	2	
0x0C4A		Vbc Imag	F002	1000	R	2	
0x0C4C		Phasor Vca	F002	1000	R	2	
0x0C4E		Vca Real	F002	1000	R	2	
0x0C50		Vca Imag	F002	1000	R	2	
0x0C52		Phasor Van	F002	1000	R	2	
0x0C54		Va Real	F002	1000	R	2	
0x0C56		Va Imag	F002	1000	R	2	
0x0C58		Phasor Vbn	F002	1000	R	2	
0x0C5A		Vb Real	F002	1000	R	2	
0x0C5C		Vb Imag	F002	1000	R	2	
0x0C5E		Phasor Vcn	F002	1000	R	2	
0x0C60		Vc Real	F002	1000	R	2	
0x0C62		Vc Imag	F002	1000	R	2	
0x0C64		Phasor Vn	F002	1000	R	2	
0x0C66		Vn Real	F002	1000	R	2	
0x0C68		Vn Imag	F002	1000	R	2	
0x0C6A		Positive Seq V1	F002	1000	R	2	
0x0C6C		V1 Real	F002	1000	R	2	
0x0C6E		V1 Imag	F002	1000	R	2	
0x0C70		Negative Seq V2	F002	1000	R	2	
0x0C72		V2 Real	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0C74		V2 Imag	F002	1000	R	2	
0x0C76		Zero Seq V0	F002	1000	R	2	
0x0C78		V0 Real	F002	1000	R	2	
0x0C7A		V0 Imag	F002	1000	R	2	
0x0C7C		Phasor Vx	F002	1000	R	2	
Medidas en Valores Secundarios - Analog measures in Secondary Values(cont.)							
0x0C7E		Vx Real	F002	1000	R	2	
0x0C80		Vx Imag	F002	1000	R	2	
0x0C82		Nominal Voltage	F002	1000	R	2	
0x0C84		VL Real	F002	1000	R	2	
0x0C86		VL Imag	F002	1000	R	2	
0x0C88		VBB Real	F002	1000	R	2	
0x0C8A		VBB Imag	F002	1000	R	2	
0x0C8C		Line Voltage	F002	1000	R	2	
0x0C8E		Bus Voltage	F002	1000	R	2	
0x0C90		Line Frequency	F002	1000	R	2	
0x0C92		Bus Frequency	F002	1000	R	2	
0x0C94		Phase A Apparent Pwr	F002	1000	R	2	
0x0C96		Phase B Apparent Pwr	F002	1000	R	2	
0x0C98		Phase C Apparent Pwr	F002	1000	R	2	
0x0C9A		Phase A Real Pwr	F002	1000	R	2	
0x0C9C		Phase B Real Pwr	F002	1000	R	2	
0x0C9E		Phase C Real Pwr	F002	1000	R	2	
0x0CA0		Phase A Reactive Pwr	F002	1000	R	2	
0x0CA2		Phase B Reactive Pwr	F002	1000	R	2	
0x0CA4		Phase C Reactive Pwr	F002	1000	R	2	
0x0CA6		3 Phase Apparent Pwr	F002	1000	R	2	
0x0CA8		3 Phase Real Pwr	F002	1000	R	2	
0x0CAA		3 Phase Reactive Pwr	F002	1000	R	2	
0x0CAC		Phase A Power Factor	F002	1000	R	2	
0x0CAE		Phase B Power Factor	F002	1000	R	2	
0x0CB0		Phase C Power Factor	F002	1000	R	2	
0x0CB2		3 Phase Power Factor	F002	1000	R	2	
Ratios corriente y tensión - Current and Voltage Ratios							
0x0CB4		CT Ratio	F002	1000	R	2	
0x0CB6		CT Ratio Ig	F002	1000	R	2	
0x0CB8		CT Ratio Isg	F002	1000	R	2	
0x0CBA		PT Ratio	F002	1000	R	2	
Angulos - Angles							
0x0CBC		Ia Angle	F002	1000	R	2	
0x0CBE		Ib Angle	F002	1000	R	2	
0x0CC0		Ic Angle	F002	1000	R	2	
0x0CC2		In Angle	F002	1000	R	2	
0x0CC4		Ig Angle	F002	1000	R	2	
0x0CC6		Isg Angle	F002	1000	R	2	
0x0CC8		Va Angle	F002	1000	R	2	
0x0CCA		Vb Angle	F002	1000	R	2	
0x0CCC		Vc Angle	F002	1000	R	2	
0x0CCE		Vn Angle	F002	1000	R	2	
0x0CD0		Vx Angle	F002	1000	R	2	
0x0CD2		Vab Angle	F002	1000	R	2	
0x0CD4		Vbc Angle	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0CD6		Vca Angle	F002	1000	R	2	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Frequency rate of change value							
0x0CD8		df/dt	F002	1000 0	R	2	
Medidas Valores Secundarios Tensión de Tierra VG) - Ground Voltage Analog Measures in secondary values							
0x0CDA		Phasor Vg	F002	1000	R	2	
0x0CDC		Vg Real	F002	1000	R	2	
0x0CDE		Vg Imag	F002	1000	R	2	
Ángulo Tensión de Tierra VG - Ground Voltage Angle							
0x0CE0		Vg Angle	F002	1000	R	2	
Versión del HMI - HMI Version							
0x0CE2		HMI Version	F004	1000	R	1	
0x0CE3		DISPLAY TYPE	F004	1000	R	1	
Diferencia de tensión para la función de sincronismo-Voltage Difference for synchrocheck unit							
0x0E31		VOLTAGE DIFFERENCE	F002	1000 0	R	2	
Diferencia de Frecuencia para la función de sincronismo-Frequency Difference for synchrocheck unit							
0x0E33		FREQ. DIFFERENCE	F002	1000 0	R	2	
Estados Oscilografía - Oscillography States							
0x0EB6		NUMBER OF TRIGGERS	F004	1	R	1	
0x0EB7		CYCLES PER RECORD	F004	1	R	1	
0x0EB8		AVAILABLE RECORDS	F004	1	R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Localizador de Faltas - Fault Report States							
0x0EBB		FAULT DATE	F011		R	3	
0x0EBE		FAULT TYPE	F012		R	1	0=GROUND
							1=PHASE
							2=3 PH
							3=AG
							4=ABG
							5=AB
							6=BG
							7=BCG
							8=BC
							9=CG
							10=CAG
							11=CA
							12=NAF
0x0EBF		FAULT LOCATION	F003	1	R	2	
0x0EC1		FAULT REPORT NUMBER	F005	1	R	2	
Medidas en Valores Primarios - Analog measures in Primary Values							
0x0EE2		Phasor Ia Primary	F002	1000	R	2	
0x0EE4		Phasor Ib Primary	F002	1000	R	2	
0x0EE6		Phasor Ic Primary	F002	1000	R	2	
0x0EE8		Phasor Ig Primary	F002	1000	R	2	
0x0EEA		Phasor Isg Primary	F002	1000	R	2	
0x0EEC		Phasor In Primary	F002	1000	R	2	
0x0EEE		RMS Ia Primary	F002	1000	R	2	
0x0EF0		RMS Ib Primary	F002	1000	R	2	
0x0EF2		RMS Ic Primary	F002	1000	R	2	
0x0EF4		RMS Ig Primary	F002	1000	R	2	
0x0EF6		RMS Isg Primary	F002	1000	R	2	
0x0EF8		I0 Primary	F002	1000	R	2	
0x0EFA		I1 Primary	F002	1000	R	2	
0x0EFC		I2 Primary	F002	1000	R	2	
0x0EFE		V0 Primary	F002	1000	R	2	
0x0F00		V1 Primary	F002	1000	R	2	
0x0F02		V2 Primary	F002	1000	R	2	
0x0F04		Vab Primary	F002	1000	R	2	
0x0F06		Vbc Primary	F002	1000	R	2	
0x0F08		Vca Primary	F002	1000	R	2	
0x0F0A		Va Primary	F002	1000	R	2	
0x0F0C		Vb Primary	F002	1000	R	2	
0x0F0E		Vc Primary	F002	1000	R	2	
0x0F10		Vn Primary	F002	1000	R	2	
0x0F12		Vx Primary	F002	1000	R	2	
0x0F14		VBB Primary	F002	1000	R	2	
0x0F16		VL Primary	F002	1000	R	2	
0x0F18		Phase A Real Pwr	F002	1000	R	2	
0x0F1A		Phase A Reactive Pwr	F002	1000	R	2	
0x0F1C		Phase A Apparent Pwr	F002	1000	R	2	
0x0F1E		Phase B Real Pwr	F002	1000	R	2	
0x0F20		Phase B Reactive Pwr	F002	1000	R	2	
0x0F22		Phase B Apparent Pwr	F002	1000	R	2	
0x0F24		Phase C Real Pwr	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Medidas en Valores Primarios - Analog measures in Primary Values(cont.)							
0x0F26		Phase C Reactive Pwr	F002	1000	R	2	
0x0F28		Phase C Apparent Pwr	F002	1000	R	2	
0x0F2A		3 Phase Real Pwr	F002	1000	R	2	
0x0F2C		3 Phase Reactive Pwr	F002	1000	R	2	
0x0F2E		3 Phase Apparent Pwr	F002	1000	R	2	
0x0F30		Phase A Power Factor	F002	1000	R	2	
0x0F32		Phase B Power Factor	F002	1000	R	2	
0x0F34		Phase C Power Factor	F002	1000	R	2	
0x0F36		3 Phase Power Factor	F002	1000	R	2	
0x0F38		Line Frequency	F002	1000	R	2	
0x0F3A		Bus Frequency	F002	1000	R	2	
0x0F3C		Positive MWatthour	F002	1000	R	2	
0x0F3E		Negative MWatthour	F002	1000	R	2	
0x0F40		Positive MVarhour	F002	1000	R	2	
0x0F42		Negative MVarhour	F002	1000	R	2	
0x0F44		Pos MWatthour Cnt	F002	1000	R	2	
0x0F46		Neg MWatthour Cnt	F002	1000	R	2	
0x0F48		Pos MVarhour Cnt	F002	1000	R	2	
0x0F4A		Neg MVarhour Cnt	F002	1000	R	2	
Medidas Valores Primarios Tensión de Tierra VG - Ground Voltage Analog Measures in primary values							
0x0F4C		Vg Primary	F002	1000	R	2	
Medidas Demanda - Demand measures							
0x0FAB		DEMAND IA	F002	1000	R	2	
0x0FAD		DEMAND IA MAX	F002	1000	R	2	
0x0FAF		DEMAND IA DATE	F011		R	3	
0x0FB2		DEMAND IB	F002	1000	R	2	
0x0FB4		DEMAND IB MAX	F002	1000	R	2	
0x0FB6		DEMAND IB DATE	F011		R	3	
0x0FB9		DEMAND IC	F002	1000	R	2	
0x0FBB		DEMAND IC MAX	F002	1000	R	2	
0x0FBD		DEMAND IC DATE	F011		R	3	
0x0FC0		DEMAND IG	F002	1000	R	2	
0x0FC2		DEMAND IG MAX	F002	1000	R	2	
0x0FC4		DEMAND IG DATE	F011		R	3	
0x0FC7		DEMAND ISG	F002	1000	R	2	
0x0FC9		DEMAND ISG MAX	F002	1000	R	2	
0x0FCB		DEMAND ISG DATE	F011		R	3	
0x0FCE		DEMAND I2	F002	1000	R	2	
0x0FD0		DEMAND I2 MAX	F002	1000	R	2	
0x0FD2		DEMAND I2 DATE	F011		R	3	
0x0FD5		DEMAND W	F002	1000	R	2	
0x0FD7		DEMAND W MAX	F002	1000	R	2	
0x0FD9		DEMAND W DATE	F011		R	3	
0x0FDC		DEMAND VAR PWR	F002	1000	R	2	
0x0FDE		DEMAND VAR MAX	F002	1000	R	2	
0x0FE0		DEMAND VAR DATE	F011		R	3	
0x0FE3		DEMAND VA PWR	F002	1000	R	2	
0x0FE5		DEMAND VA MAX	F002	1000	R	2	
0x0FE7		DEMAND VA DATE	F011		R	3	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Entradas Analógicas (Tarjetas J y H)- Analog Inputs (J and H boards)							
0x0FFE		ANALOG_INP_H_01	F002	1000	R	2	
0x1000		ANALOG_INP_H_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x100C		ANALOG_INP_H_08	F002	1000	R	2	
0x107E		ANALOG_INP_J_01	F002	1000	R	2	
0x1080		ANALOG_INP_J_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x108C		ANALOG_INP_J_08	F002	1000	R	2	
Contadores de Interruptor - Breaker Counters							
0x111D		BREAKER OPENINGS	F005	1	R	2	
0x111F		BREAKER CLOSINGS	F005	1	R	2	
0x1121		KI2t PHASE A	F003	1	R	2	
0x1123		KI2t PHASE B	F003	1	R	2	
0x1125		KI2t PHASE C	F003	1	R	2	
0x1127		BKR OPENING TIME	F003	1	R	2	
0x1129		BKR CLOSING TIME	F003	1	R	2	
Registrador de Datos - Data Logger							
0x1153		OLDEST SAMPLE TIME	F011		R	3	
0x1156		NEWEST SAMPLE TIME	F011		R	3	
0x1159		DATA LOGGER CHANNELS	F004	1	R	1	
0x115A		DATA LOGGER DAYS	F003	1	R	2	
Estados Internos Sistema - Internal System States							
0x1160		Kswapd Time	F005	1	R	2	
0x1162		mtd2 Time	F005	1	R	2	
0x1164		mtd3 Time	F005	1	R	2	
0x1166		CPU Rtai	F005	1	R	2	
0x1168		CPU Linux	F005	1	R	2	
0x116A		Total RAM	F005	1024	R	2	
0x116C		Used DRAM	F005	1024	R	2	
0x116E		Free RAM	F005	1024	R	2	
0x1170		Shared RAM	F005	1024	R	2	
0x1172		Buffer RAM	F005	1024	R	2	
0x1174		Cached RAM	F005	1024	R	2	
0x1176		Green Counter	F005	1	R	2	
0x1178		Yellow Counter	F005	1	R	2	
0x117A		Orange Counter	F005	1	R	2	
0x117C		Red Counter	F005	1	R	2	
0x117E		UpTime	F005	1	R	2	
0x120E		ICD STATUS	F012		R	1	0=UNKNOWN
							1=ICD ERROR
							2=MODIFIED
							3=IN PROGRESS
							4=OK WITHOUT DAIS
							5=OK

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Valor del Contador de Pulsos-Pulse Counter Value							
0x121B		PulseCntr Value 1	F002	1000 000	R	2	
0x121D		PulseCntr Value 2	F002	1000 000	R	2	
0x121F		PulseCntr Value 3	F002	1000 000	R	2	
0x1221		PulseCntr Value 4	F002	1000 000	R	2	
0x1223		PulseCntr Value 5	F002	1000 000	R	2	
0x1225		PulseCntr Value 6	F002	1000 000	R	2	
0x1227		PulseCntr Value 7	F002	1000 000	R	2	
0x1229		PulseCntr Value 8	F002	1000 000	R	2	
Valor del Contador de Pulsos Congelado-Freeze Pulse Counter Value							
0x122B		PulseCntr Freeze 1	F002	1000 000	R	2	
0x122D		PulseCntr Freeze 2	F002	1000 000	R	2	
0x122F		PulseCntr Freeze 3	F002	1000 000	R	2	
0x1231		PulseCntr Freeze 4	F002	1000 000	R	2	
0x1233		PulseCntr Freeze 5	F002	1000 000	R	2	
0x1235		PulseCntr Freeze 6	F002	1000 000	R	2	
0x1237		PulseCntr Freeze 7	F002	1000 000	R	2	
0x1239		PulseCntr Freeze 8	F002	1000 000	R	2	
Valores Imagen Térmica Generador- Generator Thermal Model Values							
0x1307		THERMAL IMAGE1	F003	1	R	2	
0x130E		THERMAL IMAGE2	F003	1	R	2	
0x1315		THERMAL IMAGE3	F003	1	R	2	
Funciones Protección habilitadas - Protection Summary							
0x2204	0x0001	Phase IOC1 High	F001		R	1	
0x2220	0x0001	Phase IOC2 High	F001		R	1	
0x223C	0x0001	Phase IOC3 High	F001		R	1	
0x22AC	0x0001	Neutral IOC1	F001		R	1	
0x22C7	0x0001	Neutral IOC2	F001		R	1	
0x22E2	0x0001	Neutral IOC3	F001		R	1	
0x22FD	0x0001	Ground IOC1	F001		R	1	
0x2319	0x0001	Ground IOC2	F001		R	1	
0x2335	0x0001	Ground IOC3	F001		R	1	
0x2351	0x0001	Sensitive Ground IOC1	F001		R	1	
0x236D	0x0001	Sensitive Ground IOC2	F001		R	1	
0x2389	0x0001	Sensitive Ground IOC3	F001		R	1	
0x23A5	0x0001	Phase TOC1 High	F001		R	1	
0x23C2	0x0001	Phase TOC2 High	F001		R	1	
0x23DF	0x0001	Phase TOC3 High	F001		R	1	
0x23FC	0x0001	Neutral TOC1	F001		R	1	
0x2417	0x0001	Neutral TOC2	F001		R	1	
0x2432	0x0001	Neutral TOC3	F001		R	1	
0x244D	0x0001	Ground TOC1	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2469	0x0001	Ground TOC2	F001		R	1	
0x2485	0x0001	Ground TOC3	F001		R	1	
0x24A1	0x0001	Sensitive Ground TOC1	F001		R	1	
0x24BD	0x0001	Sensitive Ground TOC2	F001		R	1	
0x24D9	0x0001	Sensitive Ground TOC3	F001		R	1	
0x24F5	0x0001	Phase UV1	F001		R	1	
0x2514	0x0001	Phase UV2	F001		R	1	
0x2533	0x0001	Phase UV3	F001		R	1	
0x2552	0x0001	Negative Sequence OV1	F001		R	1	
0x256D	0x0001	Negative Sequence OV2	F001		R	1	
0x2588	0x0001	Negative Sequence OV3	F001		R	1	
0x264B	0x0001	Neutral Directional1	F001		R	1	
0x2667	0x0001	Neutral Directional2	F001		R	1	
0x2683	0x0001	Neutral Directional3	F001		R	1	
0x269F	0x0001	Ground Directional1	F001		R	1	
0x26BB	0x0001	Ground Directional2	F001		R	1	
0x26D7	0x0001	Ground Directional3	F001		R	1	
Funciones Protección habilitadas - Protection Summary(cont)							
0x26F3	0x0001	Breaker Failure	F001		R	1	
0x271C	0x0001	Fuse Failure	F001		R	1	
0x2731	0x0001	Synchrocheck	F001		R	1	
0x278C	0x0001	Neutral OV1 High	F001		R	1	
0x27A7	0x0001	Neutral OV2 High	F001		R	1	
0x27C2	0x0001	Neutral OV3 High	F001		R	1	
0x282E	0x0001	Auxiliary UV1	F001		R	1	
0x2848	0x0001	Auxiliary UV2	F001		R	1	
0x2862	0x0001	Auxiliary UV3	F001		R	1	
0x287C	0x0001	Phase OV1	F001		R	1	
0x2898	0x0001	Phase OV2	F001		R	1	
0x28B4	0x0001	Phase OV3	F001		R	1	
0x28D0	0x0001	Auxiliary OV1	F001		R	1	
0x28EB	0x0001	Auxiliary OV2	F001		R	1	
0x2906	0x0001	Auxiliary OV3	F001		R	1	
0x2921	0x0001	Negative Sequence TOC1	F001		R	1	
0x293C	0x0001	Negative Sequence TOC2	F001		R	1	
0x2957	0x0001	Negative Sequence TOC3	F001		R	1	
0x2972	0x0001	Overfrequency1	F001		R	1	
0x298F	0x0001	Overfrequency2	F001		R	1	
0x29AC	0x0001	Overfrequency3	F001		R	1	
0x29C9	0x0001	Underfrequency1	F001		R	1	
0x29E6	0x0001	Underfrequency2	F001		R	1	
0x2A03	0x0001	Underfrequency3	F001		R	1	
0x2A7C	0x0001	Oscillography	F001		R	1	
0x2A93	0x0001	Fault Report	F001		R	1	
0x2F07	0x0001	Demand	F001		R	1	
0x2F20	0x0001	IEC104 Protocol	F001		R	1	
0x32A5	0x0001	Phase TOC1 Low	F001		R	1	
0x32C2	0x0001	Phase TOC2 Low	F001		R	1	
0x32DF	0x0001	Phase TOC3 Low	F001		R	1	
0x38D4	0x0001	Data Logger	F001		R	1	
0x38FA	0x0001	Directional Power1	F001		R	1	
0x391D	0x0001	Directional Power2	F001		R	1	
0x3940	0x0001	Directional Power3	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Funciones Protección habilitadas - Protection Summary(cont.)							
0x4130	0x0001	Frequency Rate1	F001		R	1	
0x4150	0x0001	Frequency Rate2	F001		R	1	
0x4170	0x0001	Frequency Rate3	F001		R	1	
0x4224	0x0001	Restricted Ground Fault1	F001		R	1	
0x4236	0x0001	Restricted Ground Fault2	F001		R	1	
0x4248	0x0001	Restricted Ground Fault3	F001		R	1	
0x425A	0x0001	Loss of Mains1	F001		R	1	
0x426B	0x0001	Loss of Mains2	F001		R	1	
0x427C	0x0001	Loss of Mains3	F001		R	1	
0x428D	0x0001	Generator Unbalance1	F001		R	1	
0x42A9	0x0001	Generator Unbalance2	F001		R	1	
0x42C5	0x0001	Generator Unbalance3	F001		R	1	
0x42E1	0x0001	Volts per Hz1	F001		R	1	
0x42F7	0x0001	Volts per Hz2	F001		R	1	
0x430D	0x0001	Volts per Hz3	F001		R	1	
0x4323	0x0001	Loss of Excitation1	F001		R	1	
0x433F	0x0001	Loss of Excitation2	F001		R	1	
0x435B	0x0001	Loss of Excitation3	F001		R	1	
0x4377	0x0001	Negative Sequence IOC1	F001		R	1	
0x4389	0x0001	Negative Sequence IOC2	F001		R	1	
0x439B	0x0001	Negative Sequence IOC3	F001		R	1	
0x43AD	0x0001	Generator Thermal Model1	F001		R	1	
0x43C3	0x0001	Generator Thermal Model2	F001		R	1	
0x43D9	0x0001	Generator Thermal Model3	F001		R	1	
0x43EF	0x0001	Power Factor Limiting1	F001		R	1	
0x4407	0x0001	Power Factor Limiting2	F001		R	1	
0x441F	0x0001	Power Factor Limiting3	F001		R	1	
0x4437	0x0001	Accidental Energization1	F001		R	1	
0x4448	0x0001	Accidental Energization2	F001		R	1	
0x4459	0x0001	Accidental Energization3	F001		R	1	
0x446A	0x0001	Ground Overvoltage1	F001		R	1	
0x447C	0x0001	Ground Overvoltage2	F001		R	1	
0x448E	0x0001	Ground Overvoltage3	F001		R	1	
Funciones con Eventos habilitados - Snapshot Events Summary							
0x1EE5	0x0001	Board F Event	F001		R	1	
0x208A	0x0001	Board G Event	F001		R	1	
0x2199	0x0001	General Settings Event	F001		R	1	
0x220C	0x0001	Phase IOC1 High Event	F001		R	1	
0x2228	0x0001	Phase IOC2 High Event	F001		R	1	
0x2244	0x0001	Phase IOC3 High Event	F001		R	1	
0x22B3	0x0001	Neutral IOC1 Event	F001		R	1	
0x22CE	0x0001	Neutral IOC2 Event	F001		R	1	
0x22E9	0x0001	Neutral IOC3 Event	F001		R	1	
0x2305	0x0001	Ground IOC1 Event	F001		R	1	
0x2321	0x0001	Ground IOC2 Event	F001		R	1	
0x233D	0x0001	Ground IOC3 Event	F001		R	1	
0x2359	0x0001	Sensitive Ground IOC1 Event	F001		R	1	
0x2375	0x0001	Sensitive Ground IOC2 Event	F001		R	1	
0x2391	0x0001	Sensitive Ground IOC3 Event	F001		R	1	
0x23AE	0x0001	Phase TOC1 High Event	F001		R	1	
0x23CB	0x0001	Phase TOC2 High Event	F001		R	1	
0x23E8	0x0001	Phase TOC3 High Event	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2403	0x0001	Neutral TOC1 Event	F001		R	1	
0x241E	0x0001	Neutral TOC2 Event	F001		R	1	
0x2439	0x0001	Neutral TOC3 Event	F001		R	1	
0x2455	0x0001	Ground TOC1 Event	F001		R	1	
0x2471	0x0001	Ground TOC2 Event	F001		R	1	
0x248D	0x0001	Ground TOC3 Event	F001		R	1	
0x24A9	0x0001	Sensitive Ground TOC1 Event	F001		R	1	
0x24C5	0x0001	Sensitive Ground TOC2 Event	F001		R	1	
0x24E1	0x0001	Sensitive Ground TOC3 Event	F001		R	1	
0x2500	0x0001	Phase UV1 Event	F001		R	1	
0x251F	0x0001	Phase UV2 Event	F001		R	1	
0x253E	0x0001	Phase UV3 Event	F001		R	1	
0x2559	0x0001	Negative Sequence OV1 Event	F001		R	1	
0x2574	0x0001	Negative Sequence OV2 Event	F001		R	1	
0x258F	0x0001	Negative Sequence OV3 Event	F001		R	1	
Funciones con Eventos habilitados - Snapshot Events Summary(cont.)							
0x2653	0x0001	Neutral Directional1 Event	F001		R	1	
0x266F	0x0001	Neutral Directional2 Event	F001		R	1	
0x268B	0x0001	Neutral Directional3 Event	F001		R	1	
0x26A7	0x0001	Ground Directional1 Event	F001		R	1	
0x26C3	0x0001	Ground Directional2 Event	F001		R	1	
0x26DF	0x0001	Ground Directional3 Event	F001		R	1	
0x2708	0x0001	Breaker Failure Event	F001		R	1	
0x271D	0x0001	VT Fuse Failure Event	F001		R	1	
0x2745	0x0001	Synchrocheck Event	F001		R	1	
0x2793	0x0001	Neutral OV1 High Event	F001		R	1	
0x27AE	0x0001	Neutral OV2 High Event	F001		R	1	
0x27C9	0x0001	Neutral OV3 High Event	F001		R	1	
0x2834	0x0001	Auxiliary UV1 Event	F001		R	1	
0x284E	0x0001	Auxiliary UV2 Event	F001		R	1	
0x2868	0x0001	Auxiliary UV3 Event	F001		R	1	
0x2884	0x0001	Phase OV1 Event	F001		R	1	
0x28A0	0x0001	Phase OV2 Event	F001		R	1	
0x28BC	0x0001	Phase OV3 Event	F001		R	1	
0x28D7	0x0001	Auxiliary OV1 Event	F001		R	1	
0x28F2	0x0001	Auxiliary OV2 Event	F001		R	1	
0x290D	0x0001	Auxiliary OV3 Event	F001		R	1	
0x2928	0x0001	Negative Sequence TOC1 Event	F001		R	1	
0x2943	0x0001	Negative Sequence TOC2 Event	F001		R	1	
0x295E	0x0001	Negative Sequence TOC3 Event	F001		R	1	
0x297B	0x0001	Overfrequency1 Event	F001		R	1	
0x2998	0x0001	Overfrequency2 Event	F001		R	1	
0x29B5	0x0001	Overfrequency3 Event	F001		R	1	
0x29D2	0x0001	Underfrequency1 Event	F001		R	1	
0x29EF	0x0001	Underfrequency2 Event	F001		R	1	
0x2A0C	0x0001	Underfrequency3 Event	F001		R	1	
0x2A81	0x0001	Oscillography Event	F001		R	1	
0x2A9F	0x0001	Fault Report Event	F001		R	1	
0x2AB4	0x0001	Setting Group Event	F001		R	1	
Funciones con Eventos habilitados - Snapshot Events Summary(cont.)							
0x2F0C	0x0001	Demand Event	F001		R	1	
0x3000	0x0001	Board H Event	F001		R	1	
0x31A5	0x0001	Board J Event	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x32AE	0x0001	Phase TOC1 Low Event	F001		R	1	
0x32CB	0x0001	Phase TOC2 Low Event	F001		R	1	
0x32E8	0x0001	Phase TOC3 Low Event	F001		R	1	
0x332C	0x0001	Switchgear1 Event	F001		R	1	
0x332D	0x0001	Switchgear2 Event	F001		R	1	
0x332E	0x0001	Switchgear3 Event	F001		R	1	
0x332F	0x0001	Switchgear4 Event	F001		R	1	
0x3330	0x0001	Switchgear5 Event	F001		R	1	
0x3331	0x0001	Switchgear6 Event	F001		R	1	
0x3332	0x0001	Switchgear7 Event	F001		R	1	
0x3333	0x0001	Switchgear8 Event	F001		R	1	
0x3334	0x0001	Switchgear9 Event	F001		R	1	
0x3335	0x0001	Switchgear10 Event	F001		R	1	
0x3336	0x0001	Switchgear11 Event	F001		R	1	
0x3337	0x0001	Switchgear12 Event	F001		R	1	
0x3338	0x0001	Switchgear13 Event	F001		R	1	
0x3339	0x0001	Switchgear14 Event	F001		R	1	
0x333A	0x0001	Switchgear15 Event	F001		R	1	
0x333B	0x0001	Switchgear16 Event	F001		R	1	
0x3354	0x0001	Breaker Settings Event	F001		R	1	
0x3909	0x0001	Directional Power1 Event	F001		R	1	
0x392C	0x0001	Directional Power2 Event	F001		R	1	
0x394F	0x0001	Directional Power3 Event	F001		R	1	
0x4054	0x0001	Analog Comparators Event	F001		R	1	
0x413C	0x0001	Frequency Rate1 Event	F001		R	1	
0x415C	0x0001	Frequency Rate2 Event	F001		R	1	
0x417C	0x0001	Frequency Rate3 Event	F001		R	1	
0x422B	0x0001	Restricted Ground Fault1 Event	F001		R	1	
0x423D	0x0001	Restricted Ground Fault2 Event	F001		R	1	
0x424F	0x0001	Restricted Ground Fault3 Event	F001		R	1	
0x4260	0x0001	Loss of Mains1 Event	F001		R	1	
0x4271	0x0001	Loss of Mains2 Event	F001		R	1	
0x4282	0x0001	Loss of Mains3 Event	F001		R	1	
0x429E	0x0001	Generator Unbalance1 Event	F001		R	1	
0x42BA	0x0001	Generator Unbalance2 Event	F001		R	1	
0x42D6	0x0001	Generator Unbalance3 Event	F001		R	1	
0x42EC	0x0001	Volts per Hz1 Event	F001		R	1	
0x4302	0x0001	Volts per Hz2 Event	F001		R	1	
0x4318	0x0001	Volts per Hz3 Event	F001		R	1	
0x4334	0x0001	Loss of Excitation1 Event	F001		R	1	
0x4350	0x0001	Loss of Excitation2 Event	F001		R	1	
0x436C	0x0001	Loss of Excitation3 Event	F001		R	1	
0x437E	0x0001	Negative Sequence IOC1 Event	F001		R	1	
0x4390	0x0001	Negative Sequence IOC2 Event	F001		R	1	
0x43A2	0x0001	Negative Sequence IOC3 Event	F001		R	1	
0x43B8	0x0001	Generator Thermal Model1 Event	F001		R	1	
0x43CE	0x0001	Generator Thermal Model2 Event	F001		R	1	
0x43E4	0x0001	Generator Thermal Model3 Event	F001		R	1	
0x43FC	0x0001	Power Factor Limiting1 Event	F001		R	1	
0x4414	0x0001	Power Factor Limiting2 Event	F001		R	1	
0x442C	0x0001	Power Factor Limiting3 Event	F001		R	1	
0x443D	0x0001	Accidental Energization1 Event	F001		R	1	
0x444E	0x0001	Accidental Energization2 Event	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x445F	0x0001	Accidental Energization3 Event	F001		R	1	
0x4471	0x0001	Ground Overvoltage1 Event	F001		R	1	
0x4483	0x0001	Ground Overvoltage2 Event	F001		R	1	
0x4495	0x0001	Ground Overvoltage3 Event	F001		R	1	
Mapa de Usuario - User Map							
0xF330		Address 00	F004	1	R	1	
0xF331		Address 01	F004	1	R	1	
...	...	...	...	...	...	...	...
0xF42F		Address 255	F004	1	R	1	
Textos Maniobras - Commands text							
0x1C00		OPERATION 00	F009	1	R/W	16	
0x1C10		OPERATION 01	F009	1	R/W	16	
...	...	...	...	...	...	...	...
0x1DF0		OPERATION 24	F009	1	R/W	16	
0x1E3F		Confirmation address			W	1	
Ajustes Tarjeta F - Board F Settings							
Ajustes de Tensión Tarjeta F - Board F Voltage Settings							
0x1E41		Voltage Threshold A_F	F004	1	R/W	1	[10 , 230] V
0x1E42		Voltage Threshold B_F	F004	1	R/W	1	[10 , 230] V
0x1EE6		Voltage Threshold C_F	F004	1	R/W	1	[10 , 230] V
0x1EE7		Voltage Threshold D_F	F004	1	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta F - Board F Debounce Time Settings							
0x1E43		Debounce Time A_F	F004	1	R/W	1	[1 , 50] ms
0x1E44		Debounce Time B_F	F004	1	R/W	1	[1 , 50] ms
0x1EE8		Debounce Time C_F	F004	1	R/W	1	[1 , 50] ms
0x1EE9		Debounce Time D_F	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta F (32 elementos) - Board F Input Type Setting (32 items)							
0x1E45		Input Type_F_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x1E46		Input Type_F_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x1E64		Input Type_F_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajuste Tiempo Retardo Entradas Tarjeta F (32 elementos) - Board F Delay Input Time Setting (32 items)							
0x1E65		Delay Input Time_F_CC1	F005	1	R/W	2	[0 , 60000] ms
0x1E67		Delay Input Time_F_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x1EA3		Delay Input Time_F_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajuste Lógica de Salidas Tarjeta F (16 elementos) - Board F Output Logic Settings (16 items)							
0x1EA5		Output Logic_F_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x1EA6		Output Logic_F_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x1EB4		Output Logic_F_16	F012	1	R/W	1	0=POSITIVE

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=NEGATIVE

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Tipo de Salidas Tarjeta F (16 elementos) - Board F Output Type Settings (16 items)							
0x1EB5		Output Type_F_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x1EB6		Output Type_F_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x1EC4		Output Type_F_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Tiempo Pulso de Salida Tarjeta F - Board F Pulse Output Time Settings (16 items)							
0x1EC5		Pulse Output Time_F_01	F005	1	R/W	2	[0 , 60000] ms
0x1EC7		Pulse Output Time_F_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x1EE3		Pulse Output Time_F_16	F005	1	R/W	2	[0 , 60000] ms
0x1EE5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica F (8 elementos) - Board F Analog Input Range Settings (8 items)							
0x1EEA		Range_F_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
0x1EEB		Range_F_02	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
...	...	...	...	...	...	...	...
0x1EF1		Range_F_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA

B

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Rango de Medida de Entrada Analógica F (8 elementos) - Board F Analog Input Measurement Range (8 items)							
0x1EF2		Min Value_F_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF4		Min Value_F_02	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF6		Min Value_F_03	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF8		Min Value_F_04	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFA		Min Value_F_05	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFC		Min Value_F_06	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFE		Min Value_F_07	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F00		Min Value_F_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F02		Max Value_F_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F04		Max Value_F_02	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F06		Max Value_F_03	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F08		Max Value_F_04	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0A		Max Value_F_05	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0C		Max Value_F_06	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0E		Max Value_F_07	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F10		Max Value_F_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1FE4		Confirmation address			W	1	
Ajustes Tarjeta G - Board G Settings							
Ajustes de Tensión Tarjeta G - Board G Voltage Settings							
0x1FE6		Voltage Threshold A_G	F004	1	R/W	1	[10 , 230] V
0x1FE7		Voltage Threshold B_G	F004	1	R/W	1	[10 , 230] V
0x208B		Voltage Threshold C_G	F004	1	R/W	1	[10 , 230] V
0x208C		Voltage Threshold D_G	F004	1	R/W	1	[10 , 230] V
Tiempo Antirrebotes Tarjeta G - Board G Debounce Time Settings							
0x1FE8		Debounce Time A_G	F004	1	R/W	1	[1 , 50] ms
0x1FE9		Debounce Time B_G	F004	1	R/W	1	[1 , 50] ms
0x208D		Debounce Time C_G	F004	1	R/W	1	[1 , 50] ms
0x208E		Debounce Time D_G	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta G (32 elementos) - Board G Input Type Settings (32 items)							
0x1FEA		Input Type_G_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x1FEB		Input Type_G_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x2009		Input Type_G_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta G (32 elementos) - Board G Delay Input Time Settings (32 items)							
0x200A		Delay Input Time_G_CC1	F005	1	R/W	2	[0 , 60000] ms
0x200C		Delay Input Time_G_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2048		Delay Input Time_G_CC32	F005	1	R/W	2	[0 , 60000] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Lógica de Salidas Tarjeta G (16 elementos) - Board G Output Logic Settings (16 items)							
0x204A		Output Logic_G_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x204B		Output Logic_G_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x2059		Output Logic_G_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta G (16 elementos) - Board G Output Type Settings (16 items)							
0x205A		Output Type_G_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x205B		Output Type_G_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x2069		Output Type_G_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta G - Board G Pulse Output Time Settings (16 items)							
0x206A		Pulse Output Time_G_01	F005	1	R/W	2	[0 , 60000] ms
0x206C		Pulse Output Time_G_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2088		Pulse Output Time_G_16	F005	1	R/W	2	[0 , 60000] ms
0x208A		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica G (8 elementos) - Board G Analog Input Range Settings (8 items)							
0x208F		Range_G_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x2096		Range_G_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Rango de Medida de Entrada Analógica G (8 elementos) - Board G Analog Input Measurement Range Settings (8 items)							
0x2097		Min Value_G_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x2099		Min Value_G_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x20A5		Min Value_G_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x20A7		Max Value_G_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x20A9		Max Value_G_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x20B5		Max Value_G_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x2189		Confirmation address			W	1	
Ajustes Tarjeta H (MODULO CIO) - Board H Settings (CIO MODULE)							
Ajustes Tipo Tarjeta H - Board H Board Type Settings							
0x2F5B		I/O Board Type_H	F012	1	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta H - Board H Voltage Settings							
0x2F5C		Voltage Threshold A_H	F004	1	R/W	1	[10 , 230] V
0x2F5D		Voltage Threshold B_H	F004	1	R/W	1	[10 , 230] V
0x3001		Voltage Threshold C_H	F004	1	R/W	1	[10 , 230] V
0x3002		Voltage Threshold D_H	F004	1	R/W	1	[10 , 230] V
Tiempo Antirrebotes Tarjeta H - Board H Debounce Time Settings							
0x2F5E		Debounce Time A_H	F004	1	R/W	1	[1 , 50] ms
0x2F5F		Debounce Time B_H	F004	1	R/W	1	[1 , 50] ms
0x3003		Debounce Time C_H	F004	1	R/W	1	[1 , 50] ms
0x3004		Debounce Time D_H	F004	1	R/W	1	[1 , 50] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Tipo de Entrada Tarjeta H (32 elementos) - Board H Input Type Settings (32 items)							
0x2F60		Input Type_H_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x2F61		Input Type_H_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x2F7F		Input Type_H_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajuste Tiempo Retardo Entradas Tarjeta H (32 elementos) - Board H Delay Input Time Settings (32 items)							
0x2F80		Delay Input Time_H_CC1	F005	1	R/W	2	[0 , 60000] ms
0x2F82		Delay Input Time_H_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2FBE		Delay Input Time_H_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajuste Lógica de Salidas Tarjeta H (16 elementos) - Board H Output Logic Settings (16 items)							
0x2FC0		Output Logic_H_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x2FC1		Output Logic_H_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x2FCF		Output Logic_H_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajuste Tipo de Salidas Tarjeta H (16 elementos) - Board H Output Type Settings (16 items)							
0x2FD0		Output Type_H_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x2FD1		Output Type_H_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x2FDF		Output Type_H_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajuste Tiempo Pulso de Salida Tarjeta H - Board H Pulse Output Time Settings (16 items)							
0x2FE0		Pulse Output Time_H_01	F005	1	R/W	2	[0 , 60000] ms
0x2FE2		Pulse Output Time_H_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2FFE		Pulse Output Time_H_16	F005	1	R/W	2	[0 , 60000] ms
0x3000		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Rango de Entrada Analogica H (8 elementos) - Board H Analog Input Range Settings (8 items)							
0x3005		Range_H_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x300C		Range_H_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
Ajuste Rango de Medida de Entrada Analógica H (8 elementos) - Board H: Analog Input Measurement Range (8 items)							
0x300D		Min Value_H_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x300F		Min Value_H_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x301B		Min Value_H_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x301D		Max Value_H_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x301F		Max Value_H_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x302B		Max Value_H_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x30FF		Confirmation address			W	1	
Ajustes Tarjeta J (MODULO CIO) - Board J Settings (CIO MODULE)							
Ajustes Tipo Tarjeta J - Board J Board Type Settings							
0x3100		I/O Board Type_J	F012	1	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta J - Board J Voltage Settings							
0x3101		Voltage Threshold A_J	F004	1	R/W	1	[10 , 230] V
0x3102		Voltage Threshold B_J	F004	1	R/W	1	[10 , 230] V
0x31A6		Voltage Threshold C_J	F004	1	R/W	1	[10 , 230] V
0x31A7		Voltage Threshold D_J	F004	1	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta J - Board J Debounce Time Settings							
0x3103		Debounce Time A_J	F004	1	R/W	1	[1 , 50] ms
0x3104		Debounce Time B_J	F004	1	R/W	1	[1 , 50] ms
0x31A8		Debounce Time C_J	F004	1	R/W	1	[1 , 50] ms
0x31A9		Debounce Time D_J	F004	1	R/W	1	[1 , 50] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Tipo de Entrada Tarjeta J (32 elementos) - Board J Input Type Settings (32 items)							
0x3105		Input Type_J_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x3106		Input Type_J_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x3124		Input Type_J_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta J (32 elementos) - Board J Delay Input Time Settings (32 items)							
0x3125		Delay Input Time_J_CC1	F005	1	R/W	2	[0 , 60000] ms
0x3127		Delay Input Time_J_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x3163		Delay Input Time_J_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajustes Lógica de Salidas Tarjeta J (16 elementos) - Board J Output Logic Settings (16 items)							
0x3165		Output Logic_J_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x3166		Output Logic_J_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x3174		Output Logic_J_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta J (16 elementos) - Board J Output Type Settings (16 items)							
0x3175		Output Type_J_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x3176		Output Type_J_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x3184		Output Type_J_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta J - Board J Pulse Output Time Settings (16 items)							
0x3185		Pulse Output Time_J_01	F005	1	R/W	2	[0 , 60000] ms
0x3187		Pulse Output Time_J_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x31A3		Pulse Output Time_J_16	F005	1	R/W	2	[0 , 60000] ms
0x31A5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED

B

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajuste Rango de Entrada Analogica J (8 elementos) - Board J Analog Input Range Settings (8 items)							
0x31AA		Range_J_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x31B1		Range_J_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
Ajustes Rango de Medida de Entrada Analógica J (8 elementos) - Board J Analog Input Measurement Range Settings (8 items)							
0x31B2		Min Value_J_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31B4		Min Value_J_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x31C0		Min Value_J_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31C2		Max Value_J_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31C4		Max Value_J_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x31D0		Max Value_J_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x32A4		Confirmation address			W	1	
Ajustes Generales - General Settings							
0x218A		Phase CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x218C		Ground CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x218E		Stv Ground CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x2190		Phase VT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x2192		Phase VT Connection	F012	1	R/W	1	0=WYE
							1=DELTA
0x2193		Nominal Voltage	F003	1	R/W	2	[1.0 , 500.0] V
0x2195		Nominal Frequency	F012	1	R/W	1	0=50 Hz
							1=60 Hz
0x2196		Phase Rotation	F012	1	R/W	1	0=ABC
							1=ACB
0x2197		Frequency Reference	F012	1	R/W	1	0=VI
							1=VII
							2=VIII
0x2198		Auxiliary Voltage	F012	1	R/W	1	0=VX
							1=VN
							2=VG
0x2199		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x219A		Freq. Tracking	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2203		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 1 - Phase IOC High 1 Settings							
0x2204		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2205		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2206		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2208		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x220A		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x220C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x221F		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 2 - Phase IOC High 2 Settings							
0x2220		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2221		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2222		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2224		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2226		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2228		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x223B		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 3 - Phase IOC High 3 Settings							
0x223C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x223D		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x223E		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2240		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2242		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2244		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2257		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Neutro Grupo 1 - Neutral IOC 1 Settings							
0x22AC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22AD		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22AF		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22B1		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22B3		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22C6		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Neutro Grupo 2 - Neutral IOC 2 Settings							
0x22C7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22C8		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22CA		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22CC		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22CE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22E1		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Neutro Grupo 3 - Neutral IOC 3 Settings							

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x22E2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22E3		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22E5		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22E7		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22E9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22FC		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Instantánea de Tierra Grupo 1 - Ground IOC 1 Settings							
0x22FD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22FE		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x22FF		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2301		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2303		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2305		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2318		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Grupo 2 - Ground IOC 2 Settings							
0x2319		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x231A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x231B		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x231D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x231F		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2321		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2334		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Grupo 3 - Ground IOC 3 Settings							
0x2335		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2336		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2337		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2339		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x233B		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x233D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2350		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 1 - Sensitive Ground IOC 1 Settings (Enhanced models only)							
0x2351		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2352		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2353		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x2355		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2357		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2359		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x236C		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 2 - Sensitive Ground IOC 2 Settings (Enhanced models only)							
0x236D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x236E		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x236F		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x2371		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2373		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2375		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2388		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 3 - Sensitive Ground IOC 3 Settings (Enhanced models only)							
0x2389		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x238A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x238B		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x238D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x238F		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2391		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23A4		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC High 1 Settings							
0x23A5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23A6		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23A7		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23A9		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23AA		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23AC		Reset	F012	1	R/W	1	0=INSTANTANEOUS

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC High 1 Settings(cont.)							
							1=LINEAR
0x23AD		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23C1		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC High 2 Settings							
0x23C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23C3		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23C4		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23C6		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23C7		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23C9		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x23CA		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23CB		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23DE		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC High 3 Settings							
0x23DF		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23E0		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23E1		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23E3		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23E4		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23E6		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x23E7		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23E8		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23FB		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Neutro Grupo 1 - Neutral TOC 1 Settings							
0x23FC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23FD		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23FF		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							21=User Curve D
0x2400		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2402		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2403		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2416		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Neutro Grupo 2 - Neutral TOC 2 Settings							
0x2417		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2418		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x241A		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x241B		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x241D		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x241E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2431		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Neutro Grupo 3 - Neutral TOC 3 Settings							
0x2432		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2433		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2435		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2436		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2438		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2439		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x244C		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Grupo 1 - Ground TOC 1 Settings							
0x244D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x244E		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x244F		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2451		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Tierra Grupo 1 - Ground TOC 1 Settings(cont.)							
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2452		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2454		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2455		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2468		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Grupo 2 - Ground TOC 2 Settings							
0x2469		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x246A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x246B		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x246D		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x246E		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2470		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2471		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2484		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Tierra Grupo 3 - Ground TOC 3 Settings							
0x2485		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2486		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2487		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2489		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x248A		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x248C		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x248D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24A0		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 1 - Sensitive Ground TOC 1 Settings (Enhanced models only)							
0x24A1		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24A2		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24A3		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24A5		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 1 - Sensitive Ground TOC 1 Settings (Enhanced models only)(cont.)							
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24A6		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24A8		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24A9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24BC		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 2 - Sensitive Ground TOC 2 Settings (Enhanced models only)							
0x24BD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24BE		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24BF		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24C1		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24C2		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24C4		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24C5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24D8		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 3 - Sensitive Ground TOC 3 Settings (Enhanced models only)							
0x24D9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24DA		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24DB		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24DD		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24DE		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24E0		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24E1		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24F4		Confirmation address			W	1	
Ajustes Subtensión de Fases Grupo 1 - Phase UV 1 Settings							
0x24F5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24F6		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x24F7		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x24F9		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x24FA		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x24FC		Minimum Voltage	F003	1	R/W	2	[0 , 500] V
0x24FE		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x24FF		Supervised by 52	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2500		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2513		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Subtensión de Fases Grupo 2 - Phase UV 2 Settings							
0x2514		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2515		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x2516		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2518		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2519		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x251B		Minimum Voltage	F003	1	R/W	2	[0 , 500] V
0x251D		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x251E		Supervised by 52	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x251F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2532		Confirmation address			W	1	
Ajustes Subtensión de Fases Grupo 3 - Phase UV 3 Settings							
0x2533		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2534		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x2535		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2537		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2538		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x253A		Minimum Voltage	F003	1	R/W	2	[0 , 500] V
0x253C		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x253D		Supervised by 52	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x253E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2551		Confirmation address			W	1	
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 1 - Negative Sequence OV 1 Settings							
0x2552		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2553		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2555		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2557		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2559		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x256C		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 2 - Negative Sequence OV 2 Settings							
0x256D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x256E		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2570		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2572		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2574		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2587		Confirmation address			W	1	
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 3 - Negative Sequence OV 3 Settings							
0x2588		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2589		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x258B		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x258D		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x258F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25A2		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 1 - Neutral Directional 1 Settings							
0x264B		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x264C		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x264E		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x264F		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x2650		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2651		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x2653		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2666		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 2 - Neutral Directional 2 Settings							
0x2667		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2668		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x266A		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x266B		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x266C		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x266D		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x266F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2682		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 3 - Neutral Directional 3 Settings							
0x2683		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2684		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2686		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2687		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x2688		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2689		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x268B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x269E		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Grupo 1 - Ground Directional 1 Settings							
0x269F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26A0		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26A2		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26A3		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26A4		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26A5		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x26A7		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26BA		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Unidad Direccional de Tierra Grupo 2 - Ground Directional 2 Settings							
0x26BB		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26BC		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26BE		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26BF		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26C0		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26C1		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x26C3		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26D6		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Grupo 3 - Ground Directional 3 Settings							
0x26D7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26D8		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26DA		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26DB		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26DC		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26DD		Pol V Threshold	F003	1	R/W	2	[0 , 500] V
0x26DF		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26F2		Confirmation address			W	1	
Ajustes Fallo Interruptor - Breaker Failure Settings(Enhanced models only)							
0x26F3		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26F4		Supervision Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26F6		Hiset Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26F8		Lowset Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26FA		Internal Arc Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26FC		Internal Arc Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x26FE		Supervision Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2700		HiSet Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2702		LowSet Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2704		2nd Step Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2706		No Current Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2708		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x271B		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Fallo Fusible - VT Fuse Failure Settings(Enhanced models only)							
0x271C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x271D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2730		Confirmation address			W	1	
Ajustes Sincronismo - Synchrocheck Settings							
0x2731		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2732		Dead Bus Level	F003	1	R/W	2	[0.00 , 500.00] V
0x2734		Live Bus Level	F003	1	R/W	2	[0.00 , 500.00] V
0x2736		Dead Line Level	F003	1	R/W	2	[0.00 , 500.00] V
0x2738		Live Line Level	F003	1	R/W	2	[0.00 , 500.00] V
0x273A		Max Volt Difference	F003	1	R/W	2	[2.00 , 500.00] V
0x273C		Max Angle Difference	F003	1	R/W	2	[2.0 , 80.0] Deg
0x273E		Max Freq Difference	F003	1	R/W	2	[10 , 5000] mHz
0x2740		Time	F003	1	R/W	2	[0.01 , 600.00] s
0x2742		DL-DB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2743		LL-DB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2744		DL-LB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2745		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2762		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Alto Grupo 1 - Neutral OV High 1 Settings							
0x278C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x278D		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x278F		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2791		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2793		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27A6		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobretensión de Neutro Nivel Alto Grupo 2 - Neutral OV High 2 Settings							
0x27A7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27A8		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x27AA		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27AC		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27C1		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Alto Grupo 3 - Neutral OV High 3 Settings							
0x27C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27C3		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x27C5		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27C7		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27C9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27DC		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Subtensión Auxiliar Grupo 1 - Auxiliary UV 1 Settings							
0x282E		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x282F		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2831		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2832		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2834		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2847		Confirmation address			W	1	
Ajustes Subtensión Auxiliar Grupo 2 - Auxiliary UV 2 Settings							
0x2848		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2849		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x284B		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x284C		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x284E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2861		Confirmation address			W	1	
Ajustes Subtensión Auxiliar Grupo 3 - Auxiliary UV 3 Settings							
0x2862		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2863		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2865		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2866		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2868		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x287B		Confirmation address			W	1	
Ajustes Sobretensión de Fases Grupo 1 - Phase OV 1 Settings							
0x287C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x287D		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x287F		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2881		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2883		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x2884		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2897		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobretensión de Fases Grupo 2 - Phase OV 2 Settings							
0x2898		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2899		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x289B		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x289D		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x289F		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x28A0		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28B3		Confirmation address			W	1	
Ajustes Sobretensión de Fases Grupo 3 - Phase OV 3 Settings							
0x28B4		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28B5		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x28B7		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28B9		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28BB		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x28BC		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28CF		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 1 - Auxiliary OV 1 Settings							
0x28D0		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28D1		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x28D3		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28D5		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28D7		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28EA		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 2 - Auxiliary OV 2 Settings							
0x28EB		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28EC		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x28EE		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28F0		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28F2		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2905		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 3 - Auxiliary OV 3 Settings							
0x2906		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2907		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x2909		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x290B		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x290D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2920		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 1 - Negative Sequence TOC 1 Settings							
0x2921		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2922		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2924		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2925		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2927		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2928		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x293B		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 2 - Negative Sequence TOC 2 Settings							
0x293C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x293D		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x293F		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 2 - Negative Sequence TOC 2 Settings(cont.)							
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2940		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2942		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2943		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2956		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 3 - Negative Sequence TOC 3 Settings							
0x2957		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2958		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x295A		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x295B		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x295D		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x295E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2971		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobrefrecuencia Grupo 1 - Overfrequency 1 Settings							
0x2972		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2973		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2975		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2977		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2979		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x297B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x298E		Confirmation address			W	1	
Ajustes Sobrefrecuencia Grupo 2 - Overfrequency 2 Settings							
0x298F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2990		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2992		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2994		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2996		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x2998		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29AB		Confirmation address			W	1	
Ajustes Sobrefrecuencia Grupo 3 - Overfrequency 3 Settings							
0x29AC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29AD		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29AF		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29B1		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29B3		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x29B5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29C8		Confirmation address			W	1	
Ajustes Subfrecuencia Grupo 1 - Underfrequency 1 Settings							
0x29C9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29CA		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29CC		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29CE		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29D0		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x29D2		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29E5		Confirmation address			W	1	
Ajustes Subfrecuencia Grupo 2 - Underfrequency 2 Settings							
0x29E6		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29E7		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29E9		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29EB		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29ED		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x29EF		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A02		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Subfrecuencia Grupo 3 - Underfrequency 3 Settings							
0x2A03		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A04		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2A06		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2A08		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2A0A		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x2A0C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A1F		Confirmation address			W	1	
Ajustes Oscilografía - Oscillography Settings							
0x2A7C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A7D		Trigger Position	F004	1	R/W	1	[5 , 95] %
0x2A7E		Sampling Rate	F012	1	R/W	1	0=225 Hz
							1=450 Hz
							2=900 Hz
							3=1800 Hz
							4=3600 Hz
0x2A7F		Max. Number Osc.	F004	1	R/W	1	[1 , 20]
0x2A80		Automatic Overwrite	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A81		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A92		Confirmation address			W	1	
Ajustes Localizador de Faltas - Fault Report Settings							
0x2A93		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A94		Pos Seq Module	F003	1	R/W	2	[0.01 , 250.00] Ohm
0x2A96		Pos Seq Angle	F003	1	R/W	2	[25 , 90] Deg
0x2A98		Zero Seq Module	F003	1	R/W	2	[0.01 , 750.00] Ohm
0x2A9A		Zero Seq Angle	F003	1	R/W	2	[25 , 90] Deg
0x2A9C		Line Length	F003	1	R/W	2	[0.0 , 2000.0]
0x2A9E		Show Fault On HMI	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A9F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AB1		Confirmation address			W	1	
Ajustes de Agrupamiento de Funciones - Setting Groups Settings							
0x2AB2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AB3		Active Group	F012	1	R/W	1	0=GROUP 1
							1=GROUP 2
							2=GROUP 3
0x2AB4		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AC7		Confirmation address			W	1	
Textos Canales Digitales - Osc digital channels text							
0x2AC8		Channel 1 Txt	F009	1	R/W	16	
0x2AD8		Channel 2 Txt	F009	1	R/W	16	
0x2AE8		Channel 3 Txt	F009	1	R/W	16	
0x2AF8		Channel 4 Txt	F009	1	R/W	16	
0x2B08		Channel 5 Txt	F009	1	R/W	16	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Textos Canales Digitales - Osc digital channels text(cont.)							
0x2B18		Channel 6 Txt	F009	1	R/W	16	
0x2B28		Channel 7 Txt	F009	1	R/W	16	
0x2B38		Channel 8 Txt	F009	1	R/W	16	
0x2B48		Channel 9 Txt	F009	1	R/W	16	
0x2B58		Channel 10 Txt	F009	1	R/W	16	
0x2B68		Channel 11 Txt	F009	1	R/W	16	
0x2B78		Channel 12 Txt	F009	1	R/W	16	
0x2B88		Channel 13 Txt	F009	1	R/W	16	
0x2B98		Channel 14 Txt	F009	1	R/W	16	
0x2BA8		Channel 15 Txt	F009	1	R/W	16	
0x2BB8		Channel 16 Txt	F009	1	R/W	16	
0x2C07		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Ethernet 1 - ETHERNET 1 Settings							
0x2C53		IP Address Oct1	F004	1	R/W	1	[0 , 255]
0x2C54		IP Address Oct2	F004	1	R/W	1	[0 , 255]
0x2C55		IP Address Oct3	F004	1	R/W	1	[0 , 255]
0x2C56		IP Address Oct4	F004	1	R/W	1	[0 , 255]
0x2C57		Netmask Oct1	F004	1	R/W	1	[0 , 255]
0x2C58		Netmask Oct2	F004	1	R/W	1	[0 , 255]
0x2C59		Netmask Oct3	F004	1	R/W	1	[0 , 255]
0x2C5A		Netmask Oct4	F004	1	R/W	1	[0 , 255]
0x2C5B		Gateway IP Oct1	F004	1	R/W	1	[0 , 255]
0x2C5C		Gateway IP Oct2	F004	1	R/W	1	[0 , 255]
0x2C5D		Gateway IP Oct3	F004	1	R/W	1	[0 , 255]
0x2C5E		Gateway IP Oct4	F004	1	R/W	1	[0 , 255]
0x2C86		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Ethernet 2 - ETHERNET 2 Settings							
0x2C87		IP Address Oct1	F004	1	R/W	1	[0 , 255]
0x2C88		IP Address Oct2	F004	1	R/W	1	[0 , 255]
0x2C89		IP Address Oct3	F004	1	R/W	1	[0 , 255]
0x2C8A		IP Address Oct4	F004	1	R/W	1	[0 , 255]
0x2C8B		Netmask Oct1	F004	1	R/W	1	[0 , 255]
0x2C8C		Netmask Oct2	F004	1	R/W	1	[0 , 255]
0x2C8D		Netmask Oct3	F004	1	R/W	1	[0 , 255]
0x2C8E		Netmask Oct4	F004	1	R/W	1	[0 , 255]
0x2C8F		Gateway IP Oct1	F004	1	R/W	1	[0 , 255]
0x2C90		Gateway IP Oct2	F004	1	R/W	1	[0 , 255]
0x2C91		Gateway IP Oct3	F004	1	R/W	1	[0 , 255]
0x2C92		Gateway IP Oct4	F004	1	R/W	1	[0 , 255]
0x2CBA		Confirmation address			W	1	
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings							
0x2CBB		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
0x2CBC		Address	F005	1	R/W	2	[0 , 65534]
0x2CBE		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2CBF		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC0		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC1		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2CC2		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2CC3		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC4		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC5		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2CC6		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2CC7		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC8		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC9		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2CCA		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2CCB		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2CCC		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2CCD		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2CCE		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]
0x2CCF		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2CD0		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2CD1		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2CD2		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2CD4		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2CD5		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2CD7		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2CD8		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2CDA		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings(cont.)							
							7=100
							8=1000
							9=10000
0x2CDB		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDC		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDD		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDE		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDF		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE1		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE3		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE5		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE7		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE9		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2CEB		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings(cont.)							
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CEC		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CED		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CEE		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CEF		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings(cont.)							
0x2CF0		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CF1		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CF2		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CF3		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2CF4		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings(cont.)							
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D1C		Confirmation address			W	1	
0x2D1D		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 Settings							
0x2D1E		Address	F005	1	R/W	2	[0 , 65534]
0x2D20		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2D21		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2D22		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]
0x2D23		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2D24		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2D25		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2D26		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2D27		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2D28		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2D29		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2D2A		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2D2B		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2D2C		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2D2D		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2D2E		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2D2F		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2D30		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]
0x2D31		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2D32		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2D33		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2D34		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2D36		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2D37		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2D39		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2D3A		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2D3C		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3D		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 Settings(cont.)							
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3E		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3F		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D40		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D41		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2D43		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2D45		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2D47		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2D49		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2D4B		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2D4D		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D4E		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D4F		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D50		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D51		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D52		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D53		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D54		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D55		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D56		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D7E		Confirmation address			W	1	
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3							
0x2D7F		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
0x2D80		Address	F005	1	R/W	2	[0 , 65534]
0x2D82		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2D83		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2D84		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]
0x2D85		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2D86		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2D87		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2D88		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2D89		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2D8A		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2D8B		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2D8C		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2D8D		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2D8E		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2D8F		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2D90		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2D91		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2D92		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]
0x2D93		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2D94		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2D95		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2D96		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2D98		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2D99		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2D9B		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2D9C		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2D9E		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D9F		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001

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ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3(cont.)							
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA0		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA1		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA2		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA3		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA5		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA7		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA9		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2DAB		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2DAD		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2DAF		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3(cont.)							
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB0		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB1		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB2		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB3		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB4		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3(cont.)							
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB5		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB6		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB7		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DB8		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3(cont.)							
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2DE0		Confirmation address			W	1	
Ajustes Demanda - Demand Settings							
0x2F07		Demand Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F08		CRNT Demand Method	F012	1	R/W	1	0=THERMAL EXPONENTIAL
							1=BLOCK INTERVAL
							2=ROLLING DEMAND
0x2F09		POWER Demand Method	F012	1	R/W	1	0=THERMAL EXPONENTIAL
							1=BLOCK INTERVAL
							2=ROLLING DEMAND
0x2F0A		Demand Interval	F012	1	R/W	1	0=5 Minutes
							1=10 Minutes
							2=15 Minutes
							3=20 Minutes
							4=30 Minutes
							5=60 Minutes
0x2F0B		Trigger Enabled	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F0C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F1F		Confirmation address			W	1	
Ajustes Protocolo IEC 870-5-104 Settings							
0x2F20		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F21		TCP Port	F005	1	R/W	2	[0 , 65535]
0x2F23		Common Addr of ASDU	F005	1	R/W	2	[0 , 65535]
0x2F25		Cyclic Meter Period	F005	1	R/W	2	[0 , 3600]
0x2F27		Synchronization Event	F005	1	R/W	2	[0 , 3600]
0x2F5A		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC Low 1 Settings							
0x32A5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32A6		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32A7		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32A9		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32AA		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32AC		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32AD		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32C1		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC Low 2 Settings							
0x32C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32C3		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32C4		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32C6		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC Low 2 Settings(cont.)							
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32C7		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32C9		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32CA		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32CB		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32DE		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC Low 3 Settings							
0x32DF		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32E0		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32E1		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32E3		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32E4		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32E6		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32E7		Voltage Restraint	F012	1	R/W	1	0=DISABLED

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC Low 3 Settings(cont.)							
							1=ENABLED
0x32E8		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32FB		Confirmation address			W	1	
Ajustes Aparamenta (16 elementos) - Switchgear Settings (16 items)							
0x32FC		CONTACTS TYPE_01	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
0x32FD		CONTACTS TYPE_02	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
...	...	...	...	...	...	...	...
0x330B		CONTACTS TYPE_16	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
0x330C		FAIL TO OPEN 01 t	F004	1	R/W	1	[0 , 30000] ms
0x330D		FAIL TO OPEN 02 t	F004	1	R/W	1	[0 , 30000] ms
...	...	...	...	...	...	...	...
0x331B		FAIL TO OPEN 16 t	F004	1	R/W	1	[0 , 30000] ms
0x331C		FAIL TO CLOSE 01 t	F004	1	R/W	1	[0 , 30000] ms
0x331D		FAIL TO CLOSE 02 t	F004	1	R/W	1	[0 , 30000] ms
...	...	...	...	...	...	...	...
0x332B		FAIL TO CLOSE 16 t	F004	1	R/W	1	[0 , 30000] ms
0x332C		Snapshot Events SWGR 1	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x332D		Snapshot Events SWGR 2	F012	1	R/W	1	0=DISABLED
							1=ENABLED
...	...	...	...	...	...	...	...
0x333B		Snapshot Events SWGR 16	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x334C		Confirmation address			W	1	
Ajustes Interruptor - Breaker Settings							
0x334D		Number of Switchgear	F004	1	R/W	1	[1 , 16]
0x334E		Maximum KI2t	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x3350		KI2t Integ. Time	F003	1	R/W	2	[0.03 , 0.25] s
0x3352		Maximum Openings	F004	1	R/W	1	[0 , 9999]
0x3353		Max.Openings 1 hour	F004	1	R/W	1	[1 , 60]
0x3354		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3367		Confirmation address			W	1	
Ajustes Contadores Interruptor - Breaker Maintenance Settings							
0x3368		KI2t BKR Ph A Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336A		KI2t BKR Ph B Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336C		KI2t BKR Ph C Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336E		BKR Openings Cnt	F004	1	R/W	1	[0 , 9999]
0x336F		BKR Closings Cnt	F004	1	R/W	1	[0 , 9999]
0x3383		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Mapa Usuario Modbus - Modbus User Map Settings							
0x3384		Address 00	F004	1	R/W	1	[0 , 65535]
0x3385		Address 01	F004	1	R/W	1	[0 , 65535]
...	...	...	...	...	...	...	...
0x3483		Address 255	F004	1	R/W	1	[0 , 65535]
0x3494		Confirmation address			W	1	
Ajustes Curva Usuario A - Flex Curves A Settings							
0x3495		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x3497		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x3499		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349B		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349D		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349F		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A1		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A3		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A5		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A7		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A9		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AB		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AD		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AF		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B1		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B3		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B5		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B7		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B9		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BB		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BD		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BF		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C1		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C3		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C5		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C7		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C9		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CB		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CD		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CF		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D1		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D3		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D5		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D7		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D9		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DB		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DD		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DF		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E1		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E3		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E5		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E7		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E9		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34EB		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34ED		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34EF		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario A - Flex Curves A Settings(cont.)							
0x34F1		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F3		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F5		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F7		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F9		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FB		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FD		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FF		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3501		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3503		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3505		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3507		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3509		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350B		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350D		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350F		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3511		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3513		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3515		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3517		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3519		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351B		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351D		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351F		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3521		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3523		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3525		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3527		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3529		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352B		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352D		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352F		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3531		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3533		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3535		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3537		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3539		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353B		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353D		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353F		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3541		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3543		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3545		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3547		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3549		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354B		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354D		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354F		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3551		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3553		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3555		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3557		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario A - Flex Curves A Settings(cont.)							
0x3559		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355B		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355D		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355F		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3561		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3563		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3565		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3567		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3569		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356B		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356D		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356F		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3571		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3573		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3575		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3577		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3579		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357B		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357D		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357F		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3581		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3583		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3598		Confirmation address			W	1	
Ajustes Curva Usuario B - Flex Curves B Settings							
0x3599		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359B		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359D		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359F		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A1		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A3		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A5		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A7		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A9		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AB		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AD		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AF		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B1		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B3		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B5		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B7		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B9		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BB		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BD		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BF		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C1		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C3		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C5		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C7		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C9		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35CB		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35CD		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario B - Flex Curves B Settings(cont.)							
0x35CF		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D1		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D3		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D5		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D7		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D9		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DB		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DD		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DF		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E1		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E3		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E5		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E7		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E9		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35EB		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35ED		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35EF		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F1		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F3		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F5		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F7		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F9		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FB		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FD		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FF		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3601		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3603		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3605		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3607		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3609		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360B		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360D		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360F		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3611		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3613		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3615		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3617		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3619		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361B		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361D		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361F		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3621		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3623		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3625		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3627		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3629		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362B		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362D		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362F		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3631		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3633		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3635		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario B - Flex Curves B Settings(cont.)							
0x3637		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3639		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363B		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363D		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363F		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3641		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3643		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3645		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3647		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3649		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364B		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364D		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364F		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3651		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3653		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3655		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3657		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3659		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365B		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365D		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365F		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3661		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3663		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3665		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3667		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3669		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x366B		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x366D		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x366F		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3671		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3673		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3675		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3677		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3679		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367B		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367D		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367F		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3681		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3683		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3685		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3687		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x369C		Confirmation address			W	1	
Ajustes Curva Usuario C - Flex Curves C							
0x369D		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x369F		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A1		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A3		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A5		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A7		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A9		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36AB		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario C - Flex Curves C(cont.)							
0x36AD		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36AF		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B1		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B3		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B5		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B7		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B9		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BB		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BD		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BF		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C1		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C3		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C5		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C7		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C9		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CB		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CD		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CF		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D1		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D3		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D5		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D7		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D9		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36DB		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36DD		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36DF		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E1		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E3		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E5		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E7		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E9		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36EB		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36ED		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36EF		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F1		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F3		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F5		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F7		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F9		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FB		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FD		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FF		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3701		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3703		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3705		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3707		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3709		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370B		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370D		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370F		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3711		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3713		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario C - Flex Curves C(cont.)							
0x3715		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3717		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3719		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371B		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371D		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371F		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3721		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3723		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3725		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3727		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3729		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372B		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372D		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372F		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3731		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3733		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3735		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3737		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3739		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x373B		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x373D		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x373F		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3741		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3743		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3745		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3747		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3749		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374B		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374D		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374F		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3751		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3753		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3755		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3757		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3759		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375B		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375D		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375F		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3761		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3763		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3765		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3767		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3769		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376B		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376D		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376F		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3771		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3773		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3775		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3777		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3779		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario C - Flex Curves C(cont.)							
0x377B		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x377D		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x377F		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3781		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3783		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3785		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3787		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3789		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x378B		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A0		Confirmation address			W	1	
Ajustes Curva Usuario D - Flex Curves D							
0x37A1		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A3		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A5		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A7		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A9		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AB		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AD		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AF		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B1		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B3		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B5		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B7		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B9		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BB		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BD		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BF		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C1		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C3		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C5		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C7		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C9		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CB		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CD		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CF		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D1		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D3		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D5		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D7		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D9		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DB		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DD		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DF		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E1		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E3		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E5		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E7		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E9		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37EB		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37ED		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37EF		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario D - Flex Curves D(cont.)							
0x37F1		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F3		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F5		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F7		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F9		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FB		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FD		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FF		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3801		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3803		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3805		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3807		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3809		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380B		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380D		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380F		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3811		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3813		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3815		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3817		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3819		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381B		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381D		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381F		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3821		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3823		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3825		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3827		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3829		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382B		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382D		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382F		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3831		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3833		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3835		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3837		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3839		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383B		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383D		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383F		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3841		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3843		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3845		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3847		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3849		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384B		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384D		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384F		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3851		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3853		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3855		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Curva Usuario D - Flex Curves D(cont.)							
0x3857		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3859		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385B		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385D		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385F		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3861		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3863		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3865		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3867		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3869		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386B		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386D		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386F		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3871		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3873		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3875		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3877		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3879		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387B		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387D		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387F		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3881		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3883		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3885		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3887		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3889		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388B		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388D		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388F		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x38A4		Confirmation address			W	1	
Ajustes Protocolo Modbus - MODBUS Settings							
0x38A5		Modbus Address COM1	F004	1	R/W	1	[1 , 255]
0x38A6		Modbus Address COM2	F004	1	R/W	1	[1 , 255]
0x38A7		Modbus Port Number	F005	1	R/W	2	[0 , 65535]
0x38BC		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Puertos Serie - SERIAL PORTS Settings							
0x38BD		COM1 Baud Rate	F012	1	R/W	1	0=300
							1=600
							2=1200
							3=2400
							4=4800
							5=9600
							6=19200
							7=38400
							8=57600
							9=115200
0x38BE		COM2 Baud Rate	F012	1	R/W	1	0=300
							1=600
							2=1200
							3=2400
							4=4800
							5=9600
							6=19200
							7=38400
							8=57600
							9=115200
0x38BF		COM1 Parity	F012	1000	R/W	1	0=NONE
							1=ODD
							2=EVEN
0x38C0		COM2 Parity	F012	1000	R/W	1	0=NONE
							1=ODD
							2=EVEN
0x38D3		Confirmation address			W	1	
Ajustes Registrador de Datos - Data Logger Settings							
0x38D4		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x38D5		Data Logger Rate	F012	1	R/W	1	0=1 s
							1=5 Minutes
							2=10 Minutes
							3=15 Minutes
							4=20 Minutes
							5=30 Minutes
							6=60 Minutes
0x38D6		Data Logger Chnl 1	F004	1	R/W	1	[0 , 32767]
0x38D7		Data Logger Chnl 2	F004	1	R/W	1	[0 , 32767]
0x38D8		Data Logger Chnl 3	F004	1	R/W	1	[0 , 32767]
0x38D9		Data Logger Chnl 4	F004	1	R/W	1	[0 , 32767]
0x38DA		Data Logger Chnl 5	F004	1	R/W	1	[0 , 32767]
0x38DB		Data Logger Chnl 6	F004	1	R/W	1	[0 , 32767]
0x38DC		Data Logger Chnl 7	F004	1	R/W	1	[0 , 32767]
0x38DD		Data Logger Chnl 8	F004	1	R/W	1	[0 , 32767]
Ajustes Registrador de Datos - Data Logger Settings							
0x38DE		Data Logger Chnl 9	F004	1	R/W	1	[0 , 32767]
0x38DF		Data Logger Chnl 10	F004	1	R/W	1	[0 , 32767]
0x38E0		Data Logger Chnl 11	F004	1	R/W	1	[0 , 32767]
0x38E1		Data Logger Chnl 12	F004	1	R/W	1	[0 , 32767]
0x38E2		Data Logger Chnl 13	F004	1	R/W	1	[0 , 32767]

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x38E3		Data Logger Chnl 14	F004	1	R/W	1	[0 , 32767]
0x38E4		Data Logger Chnl 15	F004	1	R/W	1	[0 , 32767]
0x38E5		Data Logger Chnl 16	F004	1	R/W	1	[0 , 32767]
0x38F9		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 1 - Directional Power 1 Settings							
0x38FA		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x38FB		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x38FD		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x38FF		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3901		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3903		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3905		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3907		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3909		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x391C		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 2 - Directional Power 2 Settings							
0x391D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x391E		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x3920		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3922		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3924		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3926		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3928		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x392A		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x392C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x393F		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 3 - Directional Power 3 Settings							
0x3940		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3941		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x3943		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3945		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3947		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3949		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x394B		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x394D		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x394F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3962		Confirmation address			W	1	
Ajustes Sincronizacion SNTP - SNTP synchronization Settings (Do not apply to C650 models)							
		SNTP					
0x3F5C		Function	F012	1	R/W	1	0=DISABLED
							1=UNICAST
							2=BROADCAST
							3=ANYCAST
0x3F5D		UDP Port	F005	1	R/W	2	[1 , 65535]
0x3F5F		Server IP Oct 1	F004	1	R/W	1	[0 , 255]
0x3F60		Server IP Oct 2	F004	1	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3F61		Server IP Oct 3	F004	1	R/W	1	[0 , 255]
0x3F62		Server IP Oct 4	F004	1	R/W	1	[0 , 255]
0x3F66		Confirmation address					

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Contador de Pulsos-Pulse Counters							
0x3F88		PulseCntr Enabled 1	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3F89		PulseCntr Name 1	F009	1,000	R/W	16	
0x3F99		PulseCntr Factor 1	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3F9B		PulseCntr Overflow 1	F005	1,000	R/W	2	[0 , 1000000]
0x3F9D		PulseCntr Board Origin 1	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3F9E		PulseCntr Input Origin 1	F004	1,000	R/W	1	[1 , 32]
0x3F9F		PulseCntr Enabled 2	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FA0		PulseCntr Name 2	F009	1,000	R/W	16	
0x3FB0		PulseCntr Factor 2	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FB2		PulseCntr Overflow 2	F005	1,000	R/W	2	[0 , 1000000]
0x3FB4		PulseCntr Board Origin 2	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FB5		PulseCntr Input Origin 2	F004	1,000	R/W	1	[1 , 32]
0x3FB6		PulseCntr Enabled 3	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FB7		PulseCntr Name 3	F009	1,000	R/W	16	
0x3FC7		PulseCntr Factor 3	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FC9		PulseCntr Overflow 3	F005	1,000	R/W	2	[0 , 1000000]
0x3FCB		PulseCntr Board Origin 3	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FCC		PulseCntr Input Origin 3	F004	1,000	R/W	1	[1 , 32]
0x3FCD		PulseCntr Enabled 4	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FCE		PulseCntr Name 4	F009	1,000	R/W	16	
0x3FDE		PulseCntr Factor 4	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FE0		PulseCntr Overflow 4	F005	1,000	R/W	2	[0 , 1000000]
0x3FE2		PulseCntr Board Origin 4	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FE3		PulseCntr Input Origin 4	F004	1,000	R/W	1	[1 , 32]
0x3FE4		PulseCntr Enabled 5	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Contador de Pulsos-Pulse Counters(cont.)							
0x3FE5		PulseCntr Name 5	F009	1,000	R/W	16	
0x3FF5		PulseCntr Factor 5	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FF7		PulseCntr Overflow 5	F005	1,000	R/W	2	[0 , 1000000]
0x3FF9		PulseCntr Board Origin 5	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FFA		PulseCntr Input Origin 5	F004	1,000	R/W	1	[1 , 32]
0x3FFB		PulseCntr Enabled 6	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FFC		PulseCntr Name 6	F009	1,000	R/W	16	
0x400C		PulseCntr Factor 6	F003	1,000	R/W	2	[0.000 , 65000.000]
0x400E		PulseCntr Overflow 6	F005	1,000	R/W	2	[0 , 1000000]
0x4010		PulseCntr Board Origin 6	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x4011		PulseCntr Input Origin 6	F004	1,000	R/W	1	[1 , 32]
0x4012		PulseCntr Enabled 7	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4013		PulseCntr Name 7	F009	1,000	R/W	16	
0x4023		PulseCntr Factor 7	F003	1,000	R/W	2	[0.000 , 65000.000]
0x4025		PulseCntr Overflow 7	F005	1,000	R/W	2	[0 , 1000000]
0x4027		PulseCntr Board Origin 7	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x4028		PulseCntr Input Origin 7	F004	1,000	R/W	1	[1 , 32]
0x4029		PulseCntr Enabled 8	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x402A		PulseCntr Name 8	F009	1,000	R/W	16	
0x403A		PulseCntr Factor 8	F003	1,000	R/W	2	[0.000 , 65000.000]
0x403C		PulseCntr Overflow 8	F005	1,000	R/W	2	[0 , 1000000]
0x403E		PulseCntr Board Origin 8	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x403F		PulseCntr Input Origin 8	F004	1,000	R/W	1	[1 , 32]
0x4052		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Comparadores Analógicos-Analog comparators							
0x4053		Analog Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4054		Analog Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4055		Analog Input 01	F004	1,000	R/W	1	
0x4056		Analog Maximum 01	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4058		Analog Minimum 01	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x405A		Analog Delay 01	F003	1,000	R/W	2	[0.00 , 900.00] s
0x405C		Analog Hysteresis 01	F003	1,000	R/W	2	[0.0 , 50.0]
0x405E		Analog Direction 01	F012	1,000	R/W	1	0=OUT
							1=IN
0x405F		Analog Input 02	F004	1,000	R/W	1	
0x4060		Analog Maximum 02	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4062		Analog Minimum 02	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4064		Analog Delay 02	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4066		Analog Hysteresis 02	F003	1,000	R/W	2	[0.0 , 50.0]
0x4068		Analog Direction 02	F012	1,000	R/W	1	0=OUT
							1=IN
0x4069		Analog Input 03	F004	1,000	R/W	1	
0x406A		Analog Maximum 03	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x406C		Analog Minimum 03	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x406E		Analog Delay 03	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4070		Analog Hysteresis 03	F003	1,000	R/W	2	[0.0 , 50.0]
0x4072		Analog Direction 03	F012	1,000	R/W	1	0=OUT
							1=IN
0x4073		Analog Input 04	F004	1,000	R/W	1	
0x4074		Analog Maximum 04	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4076		Analog Minimum 04	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4078		Analog Delay 04	F003	1,000	R/W	2	[0.00 , 900.00] s
0x407A		Analog Hysteresis 04	F003	1,000	R/W	2	[0.0 , 50.0]
0x407C		Analog Direction 04	F012	1,000	R/W	1	0=OUT
							1=IN
0x407D		Analog Input 05	F004	1,000	R/W	1	
0x407E		Analog Maximum 05	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4080		Analog Minimum 05	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4082		Analog Delay 05	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4084		Analog Hysteresis 05	F003	1,000	R/W	2	[0.0 , 50.0]
0x4086		Analog Direction 05	F012	1,000	R/W	1	0=OUT
							1=IN
0x4087		Analog Input 06	F004	1,000	R/W	1	
0x4088		Analog Maximum 06	F003	1,000	R/W	2	[-100000.000 , 100000.000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Comparadores Analógicos-Analog comparators(cont.)							
0x408A		Analog Minimum 06	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x408C		Analog Delay 06	F003	1,000	R/W	2	[0.00 , 900.00] s
0x408E		Analog Hysteresis 06	F003	1,000	R/W	2	[0.0 , 50.0]
0x4090		Analog Direction 06	F012	1,000	R/W	1	0=OUT
							1=IN
0x4091		Analog Input 07	F004	1,000	R/W	1	
0x4092		Analog Maximum 07	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4094		Analog Minimum 07	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4096		Analog Delay 07	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4098		Analog Hysteresis 07	F003	1,000	R/W	2	[0.0 , 50.0]
0x409A		Analog Direction 07	F012	1,000	R/W	1	0=OUT
							1=IN
0x409B		Analog Input 08	F004	1,000	R/W	1	
0x409C		Analog Maximum 08	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x409E		Analog Minimum 08	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40A0		Analog Delay 08	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40A2		Analog Hysteresis 08	F003	1,000	R/W	2	[0.0 , 50.0]
0x40A4		Analog Direction 08	F012	1,000	R/W	1	0=OUT
							1=IN
0x40A5		Analog Input 09	F004	1,000	R/W	1	
0x40A6		Analog Maximum 09	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40A8		Analog Minimum 09	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40AA		Analog Delay 09	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40AC		Analog Hysteresis 09	F003	1,000	R/W	2	[0.0 , 50.0]
0x40AE		Analog Direction 09	F012	1,000	R/W	1	0=OUT
							1=IN
0x40AF		Analog Input 10	F004	1,000	R/W	1	
0x40B0		Analog Maximum 10	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40B2		Analog Minimum 10	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40B4		Analog Delay 10	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40B6		Analog Hysteresis 10	F003	1,000	R/W	2	[0.0 , 50.0]
0x40B8		Analog Direction 10	F012	1,000	R/W	1	0=OUT
							1=IN
0x40B9		Analog Input 11	F004	1,000	R/W	1	
0x40BA		Analog Maximum 11	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40BC		Analog Minimum 11	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40BE		Analog Delay 11	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40C0		Analog Hysteresis 11	F003	1,000	R/W	2	[0.0 , 50.0]
0x40C2		Analog Direction 11	F012	1,000	R/W	1	0=OUT
							1=IN
0x40C3		Analog Input 12	F004	1,000	R/W	1	

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ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Comparadores Analógicos-Analog comparators(cont.)							
0x40C4		Analog Maximum 12	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40C6		Analog Minimum 12	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40C8		Analog Delay 12	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40CA		Analog Hysteresis 12	F003	1,000	R/W	2	[0.0 , 50.0]
0x40CC		Analog Direction 12	F012	1,000	R/W	1	0=OUT
							1=IN
0x40CD		Analog Input 13	F004	1,000	R/W	1	
0x40CE		Analog Maximum 13	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40D0		Analog Minimum 13	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40D2		Analog Delay 13	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40D4		Analog Hysteresis 13	F003	1,000	R/W	2	[0.0 , 50.0]
0x40D6		Analog Direction 13	F012	1,000	R/W	1	0=OUT
							1=IN
0x40D7		Analog Input 14	F004	1,000	R/W	1	
0x40D8		Analog Maximum 14	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40DA		Analog Minimum 14	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40DC		Analog Delay 14	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40DE		Analog Hysteresis 14	F003	1,000	R/W	2	[0.0 , 50.0]
0x40E0		Analog Direction 14	F012	1,000	R/W	1	0=OUT
							1=IN
0x40E1		Analog Input 15	F004	1,000	R/W	1	
0x40E2		Analog Maximum 15	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40E4		Analog Minimum 15	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40E6		Analog Delay 15	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40E8		Analog Hysteresis 15	F003	1,000	R/W	2	[0.0 , 50.0]
0x40EA		Analog Direction 15	F012	1,000	R/W	1	0=OUT
							1=IN
0x40EB		Analog Input 16	F004	1,000	R/W	1	
0x40EC		Analog Maximum 16	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40EE		Analog Minimum 16	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40F0		Analog Delay 16	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40F2		Analog Hysteresis 16	F003	1,000	R/W	2	[0.0 , 50.0]
0x40F4		Analog Direction 16	F012	1,000	R/W	1	0=OUT
							1=IN
0x40F5		Analog Input 17	F004	1,000	R/W	1	
0x40F6		Analog Maximum 17	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40F8		Analog Minimum 17	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40FA		Analog Delay 17	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40FC		Analog Hysteresis 17	F003	1,000	R/W	2	[0.0 , 50.0]
0x40FE		Analog Direction 17	F012	1,000	R/W	1	0=OUT
							1=IN

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Comparadores Analógicos-Analog comparators(cont.)							
0x40FF		Analog Input 18	F004	1,000	R/W	1	
0x4100		Analog Maximum 18	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4102		Analog Minimum 18	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4104		Analog Delay 18	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4106		Analog Hysteresis 18	F003	1,000	R/W	2	[0.0 , 50.0]
0x4108		Analog Direction 18	F012	1,000	R/W	1	0=OUT
							1=IN
0x4109		Analog Input 19	F004	1,000	R/W	1	
0x410A		Analog Maximum 19	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x410C		Analog Minimum 19	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x410E		Analog Delay 19	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4110		Analog Hysteresis 19	F003	1,000	R/W	2	[0.0 , 50.0]
0x4112		Analog Direction 19	F012	1,000	R/W	1	0=OUT
							1=IN
0x4113		Analog Input 20	F004	1,000	R/W	1	
0x4114		Analog Maximum 20	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4116		Analog Minimum 20	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4118		Analog Delay 20	F003	1,000	R/W	2	[0.00 , 900.00] s
0x411A		Analog Hysteresis 20	F003	1,000	R/W	2	[0.0 , 50.0]
0x411C		Analog Direction 20	F012	1,000	R/W	1	0=OUT
							1=IN
0x412F		Confirmation address			W	1	
Ajustes Derivada de Frecuencia 1-Frequency Rate of Change 1 Settings							
0x4130		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4131		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL
0x4132		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4134		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4136		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4138		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x413A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x413C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x414F		Confirmation address			W	1	
Ajustes Derivada de Frecuencia 2-Frequency Rate of Change 2 Settings							
0x4150		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4151		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4152		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4154		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4156		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4158		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x415A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x415C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x416F		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Derivada de Frecuencia 3-Frequency Rate of Change 3 Settings							
0x4170		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4171		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL
0x4172		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4174		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4176		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4178		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x417A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x417C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x418F		Confirmation address			W	1	
Ajustes Tierra Restringida Grupo 1 - Restricted Gnd Fault 1 Settings(Enhanced models only)							
0x4224		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4225		Ground Fault Pickup	F003	1	R/W	2	[0.02 , 20.00] CT
0x4227		Ground Fault Slope	F003	1	R/W	2	[0.00 , 100.00] %
0x4229		Ground Fault Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x422B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4235		Confirmation address			W	1	
Ajustes Tierra Restringida Grupo 2 - Restricted Gnd Fault 2 Settings(Enhanced models only)							
0x4236		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4237		Ground Fault Pickup	F003	1	R/W	2	[0.02 , 20.00] CT
0x4239		Ground Fault Slope	F003	1	R/W	2	[0.00 , 100.00] %
0x423B		Ground Fault Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x423D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4247		Confirmation address			W	1	
Ajustes Tierra Restringida Grupo 3 - Restricted Gnd Fault 3 Settings(Enhanced models only)							
0x4248		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4249		Ground Fault Pickup	F003	1	R/W	2	[0.02 , 20.00] CT
0x424B		Ground Fault Slope	F003	1	R/W	2	[0.00 , 100.00] %
0x424D		Ground Fault Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x424F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4259		Confirmation address			W	1	
Ajustes Salto Vector Grupo 1 - Loss of Mains 1 Settings(Enhanced models only)							
0x425A		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x425B		Loss of Mains Mode	F012	1	R/W	1	0=ONE PHASE
0x425C		Phase Shift Angle	F003	1	R/W	2	[2.00 , 22.00] Deg
0x425E		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x4260		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x426A		Confirmation address			W	1	
Ajustes Salto Vector Grupo 2 - Loss of Mains 2 Settings(Enhanced models only)							
0x426B		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x426C		Loss of Mains Mode	F012	1	R/W	1	0=ONE PHASE
0x426D		Phase Shift Angle	F003	1	R/W	2	[2.00 , 22.00] Deg
0x426F		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x4271		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x427B		Confirmation address			W	1	
Ajustes Salto Vector Grupo 3 - Loss of Mains 3 Settings(Enhanced models only)							
0x427C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x427D		Loss of mains mode	F012	1	R/W	1	0=ONE PHASE
0x427E		Phase shift angle	F003	1	R/W	2	[2.00 , 22.00] Deg
0x4280		Minimum Voltage	F003	1	R/W	2	[30 , 500] V
0x4282		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x428C		Confirmation address			W	1	
Ajustes Desequilibrio de Generador Grupo 1 - Generator Unbalance 1 Settings							
0x428D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x428E		Gen Unbal Inom	F003	1	R/W	2	[0.00 , 10.00] A
0x4290		Gen Unbal Stg1 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x4292		Gen Unbal Stg1 K	F003	1	R/W	2	[0.00 , 100.00]
0x4294		Gen Unbal Stg1 Tmin	F003	1	R/W	2	[0.0 , 1000.0] s
0x4296		Gen Unbal Stg1 Tmax	F003	1	R/W	2	[0.0 , 1000.0] s
0x4298		Gen Unbal Stg1 K-Rst	F003	1	R/W	2	[0.0 , 1000.0]
0x429A		Gen Unbal Stg2 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x429C		Gen Unbal Stg2 Delay	F003	1	R/W	2	[0.0 , 1000.0] s
0x429E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42A8		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Desequilibrio de Generador Grupo 2 - Generator Unbalance 2 Settings							
0x42A9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42AA		Gen Unbal Inom	F003	1	R/W	2	[0.00 , 10.00] A
0x42AC		Gen Unbal Stg1 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x42AE		Gen Unbal Stg1 K	F003	1	R/W	2	[0.00 , 100.00]
0x42B0		Gen Unbal Stg1 Tmin	F003	1	R/W	2	[0.0 , 1000.0] s
0x42B2		Gen Unbal Stg1 Tmax	F003	1	R/W	2	[0.0 , 1000.0] s
0x42B4		Gen Unbal Stg1 K-Rst	F003	1	R/W	2	[0.0 , 1000.0]
0x42B6		Gen Unbal Stg2 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x42B8		Gen Unbal Stg2 Delay	F003	1	R/W	2	[0.0 , 1000.0] s
0x42BA		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42C4		Confirmation address			W	1	
Ajustes Desequilibrio de Generador Grupo 3 - Generator Unbalance 3 Settings							
0x42C5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42C6		Gen Unbal Inom	F003	1	R/W	2	[0.00 , 10.00] A
0x42C8		Gen Unbal Stg1 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x42CA		Gen Unbal Stg1 K	F003	1	R/W	2	[0.00 , 100.00]
0x42CC		Gen Unbal Stg1 Tmin	F003	1	R/W	2	[0.0 , 1000.0] s
0x42CE		Gen Unbal Stg1 Tmax	F003	1	R/W	2	[0.0 , 1000.0] s
0x42D0		Gen Unbal Stg1 K-Rst	F003	1	R/W	2	[0.0 , 1000.0]
0x42D2		Gen Unbal Stg2 Pkp	F003	1	R/W	2	[0.00 , 100.00] %
0x42D4		Gen Unbal Stg2 Delay	F003	1	R/W	2	[0.0 , 1000.0] s
0x42D6		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42E0		Confirmation address			W	1	
Ajustes Voltios/ Hercios Grupo 1 - Volts per Hertz 1 Settings(Enhanced models only)							
0x42E1		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42E2		V/Hz Source	F012	1	R/W	1	0=PHASES
							1=AUX VOLTAGE
0x42E3		V/Hz Minimum Voltage	F003	1	R/W	2	[30.00 , 500.00] V
0x42E5		V/Hz Pickup Level	F003	1	R/W	2	[0.80 , 4.00] pu
0x42E7		V/Hz Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=CURVE A
							2=CURVE B
							3=CURVE C
0x42E8		V/Hz TD Multiplier	F003	1	R/W	2	[0.05 , 600.00]
0x42EA		V/Hz Reset Delay	F003	1	R/W	2	[0.0 , 900.0] s
0x42EC		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42F6		Confirmation address			W	1	
Ajustes Voltios/ Hercios Grupo 2 - Volts per Hertz 2 Settings(Enhanced models only)							
0x42F7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x42F8		V/Hz Source	F012	1	R/W	1	0=PHASES
							1=AUX VOLTAGE
0x42F9		V/Hz Minimum Voltage	F003	1	R/W	2	[30.00 , 500.00] V
0x42FB		V/Hz Pickup Level	F003	1	R/W	2	[0.80 , 4.00] pu
0x42FD		V/Hz Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=CURVE A

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=CURVE B
							3=CURVE C
0x42FE		V/Hz TD Multiplier	F003	1	R/W	2	[0.05 , 600.00]
0x4300		V/Hz Reset Delay	F003	1	R/W	2	[0.0 , 900.0] s
0x4302		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x430C		Confirmation address			W	1	
Ajustes Voltios/ Hercios Grupo 3 - Volts per Hertz 3 Settings(Enhanced models only)							
0x430D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x430E		V/Hz Source	F012	1	R/W	1	0=PHASES
							1=AUX VOLTAGE
0x430F		V/Hz Minimum Voltage	F003	1	R/W	2	[30.00 , 500.00] V
0x4311		V/Hz Pickup Level	F003	1	R/W	2	[0.80 , 4.00] pu
0x4313		V/Hz Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=CURVE A
							2=CURVE B
							3=CURVE C
0x4314		V/Hz TD Multiplier	F003	1	R/W	2	[0.05 , 600.00]
0x4316		V/Hz Reset Delay	F003	1	R/W	2	[0.0 , 900.0] s
0x4318		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4322		Confirmation address			W	1	
Ajustes Pérdida de Excitación Grupo 1 - Loss of Excitation 1 Settings							
0x4323		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4324		Stage 1 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4326		Stage 1 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4328		Stage 1 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4329		Stage 1 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s
0x432B		Stage 2 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x432D		Stage 2 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x432F		Stage 2 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4330		Stage 2 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s
0x4332		UV Supv Level	F003	1	R/W	2	[0.0 , 500.0] V
0x4334		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x433E		Confirmation address			W	1	
Ajustes Pérdida de Excitación Grupo 2 - Loss of Excitation 2 Settings							
0x433F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4340		Stage 1 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4342		Stage 1 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4344		Stage 1 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4345		Stage 1 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s
0x4347		Stage 2 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4349		Stage 2 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x434B		Stage 2 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x434C		Stage 2 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x434E		UV Supv Level	F003	1	R/W	2	[0.0 , 500.0] V
0x4350		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x435A		Confirmation address			W	1	
Ajustes Pérdida de Excitación Grupo 3 - Loss of Excitation 3 Settings							
0x435B		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x435C		Stage 1 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x435E		Stage 1 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4360		Stage 1 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4361		Stage 1 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s
0x4363		Stage 2 Center	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4365		Stage 2 Radius	F003	1	R/W	2	[0.10 , 300.00] Ohm
0x4367		Stage 2 UV Supv	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4368		Stage 2 Trip Delay	F003	1	R/W	2	[0.00 , 65.54] s
0x436A		UV Supv Level	F003	1	R/W	2	[0.0 , 500.0] V
0x436C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4376		Confirmation address			W	1	
Ajustes Sobrecorriente Instantánea de Secuencia Inversa Grupo 1 - Negative Sequence IOC 1 Settings							
0x4377		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4378		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x437A		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x437C		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x437E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4388		Confirmation address			W	1	
Ajustes Sobrecorriente Instantánea de Secuencia Inversa Grupo 2 - Negative Sequence IOC 2 Settings							
0x4389		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x438A		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x438C		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x438E		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4390		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x439A		Confirmation address			W	1	
Ajustes Sobrecorriente Instantánea de Secuencia Inversa Grupo 3 - Negative Sequence IOC 3 Settings							
0x439B		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x439C		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x439E		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x43A0		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x43A2		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43AC		Confirmation address			W	1	

B

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Imagen Térmica Generador Grupo 1 - Generator Thermal Model 1 Settings							
0x43AD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43AE		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x43B0		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x43B2		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x43B4		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x43B6		Constant K1	F003	1	R/W	2	[1.0 , 8.0]
0x43B8		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43C2		Confirmation address			W	1	
Ajustes Imagen Térmica Generador Grupo 2 - Generator Thermal Model 2 Settings							
0x43C3		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43C4		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x43C6		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x43C8		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x43CA		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x43CC		Constant K1	F003	1	R/W	2	[1.0 , 8.0]
0x43CE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43D8		Confirmation address			W	1	
Ajustes Imagen Térmica Generador Grupo 3 - Generator Thermal Model 3 Settings							
0x43D9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43DA		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x43DC		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x43DE		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x43E0		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x43E2		Constant K1	F003	1	R/W	2	[1.0 , 8.0]
0x43E4		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43EE		Confirmation address			W	1	
Ajustes Limitador Factor de Potencia Grupo 1 - Pwr Factor Limiting 1 Settings(Enhanced models only)							
0x43EF		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x43F0		PF Lead Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x43F2		PF Lag Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x43F4		PF Stg1 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x43F6		PF Lead Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]
0x43F8		PF Lag Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]
0x43FA		PF Stg2 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x43FC		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4406		Confirmation address			W	1	
Ajustes Limitador Factor de Potencia Grupo 2 - Pwr Factor Limiting 2 Settings(Enhanced models only)							
0x4407		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4408		PF Lead Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x440A		PF Lag Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x440C		PF Stg1 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x440E		PF Lead Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]
0x4410		PF Lag Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4412		PF Stg2 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x4414		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x441E		Confirmation address			W	1	
Ajustes Limitador Factor de Potencia Grupo 3 - Pwr Factor Limiting 3 Settings(Enhanced models only)							
0x441F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4420		PF Lead Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x4422		PF Lag Stg1 Level	F003	1	R/W	2	[0.05 , 0.99]
0x4424		PF Stg1 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x4426		PF Lead Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]
0x4428		PF Lag Stg2 Level	F003	1	R/W	2	[0.05 , 0.99]
0x442A		PF Stg2 Trip Delay	F003	1	R/W	2	[0.2 , 300.0] s
0x442C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4436		Confirmation address			W	1	
Ajustes Energización Accidental Grupo 1 - Accidental Energization 1 Settings							
0x4437		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4438		Accdnt Enrg Mode	F012	1	R/W	1	0=UV AND OFF-LINE
							1=UV OR OFF-LINE
0x4439		Overcurrent pickup	F003	1	R/W	2	[0.00 , 160.00] A
0x443B		Ph Undervoltage pickup	F003	1	R/W	2	[0.00 , 500.00] V
0x443D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4447		Confirmation address			W	1	
Ajustes Energización Accidental Grupo 2 - Accidental Energization 2 Settings							
0x4448		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4449		Accdnt Enrg Mode	F012	1	R/W	1	0=UV AND OFF-LINE
							1=UV OR OFF-LINE
0x444A		Overcurrent pickup	F003	1	R/W	2	[0.00 , 160.00] A
0x444C		Ph Undervoltage pickup	F003	1	R/W	2	[0.00 , 500.00] V
0x444E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4458		Confirmation address			W	1	
Ajustes Energización Accidental Grupo 3 - Accidental Energization 3 Settings							
0x4459		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x445A		Accdnt Enrg Mode	F012	1	R/W	1	0=UV AND OFF-LINE
							1=UV OR OFF-LINE
0x445B		Overcurrent pickup	F003	1	R/W	2	[0.00 , 160.00] A
0x445D		Ph Undervoltage pickup	F003	1	R/W	2	[0.00 , 500.00] V
0x445F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4469		Confirmation address			W	1	
Ajustes Sobretensión Tierra Grupo 1 - Ground OV 1 Settings							
0x446A		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x446B		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x446D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x446F		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4471		Snapshot Events	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x447B		Confirmation address			W	1	
Ajustes Sobretensión Tierra Grupo 2 - Ground OV 2 Settings							
0x447C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x447D		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x447F		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4481		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4483		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x448D		Confirmation address			W	1	
Ajustes Sobretensión Tierra Grupo 3 - Ground OV 3 Settings							
0x448E		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x448F		Pickup Level	F003	1	R/W	2	[3 , 500] V
0x4491		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4493		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x4495		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x449F		Confirmation address			W	1	
Datos Ecuaciones PLC - PLC Data							
0x6000		PLC equations	F009		R	15360	
Datos Display Gráfico - LCD Data							
0x9C00		LCD configuration			R	768	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Bits de Maniobra (24 bits) - Commands							
0xAFFE	0x0001	Operation 1	F001		W	1	
0xAFFE	0x0002	Operation 2	F001		W	1	
0xAFFE	0x0004	Operation 3	F001		W	1	
0xAFFE	0x0008	Operation 4	F001		W	1	
0xAFFE	0x0010	Operation 5	F001		W	1	
0xAFFE	0x0020	Operation 6	F001		W	1	
0xAFFE	0x0040	Operation 7	F001		W	1	
0xAFFE	0x0080	Operation 8	F001		W	1	
0xAFFE	0x0100	Operation 9	F001		W	1	
0xAFFE	0x0200	Operation 10	F001		W	1	
0xAFFE	0x0400	Operation 11	F001		W	1	
0xAFFE	0x0800	Operation 12	F001		W	1	
0xAFFE	0x1000	Operation 13	F001		W	1	
0xAFFE	0x2000	Operation 14	F001		W	1	
0xAFFE	0x4000	Operation 15	F001		W	1	
0xAFFE	0x8000	Operation 16	F001		W	1	
0xAFFF	0x0001	Operation 17	F001		W	1	
0xAFFF	0x0002	Operation 18	F001		W	1	
0xAFFF	0x0004	Operation 19	F001		W	1	
0xAFFF	0x0008	Operation 20	F001		W	1	
0xAFFF	0x0010	Operation 21	F001		W	1	
0xAFFF	0x0020	Operation 22	F001		W	1	
0xAFFF	0x0040	Operation 23	F001		W	1	
0xAFFF	0x0080	Operation 24	F001		W	1	
Identificación del Equipo - Relay Identification							
0xB000		Relay model	F009		R	8	
0xB008		Firmware version	F009		R	2	
0xB018		Year(0=2000,1=2001,...) and part of firmware compilation	F001		R	1	
0xB019		Day and month of firmware compilation	F001		R	1	
0xB020		Address of PLC equations	F005		R	2	
0xB022		Address of LCD configuration	F005		R	2	
Eventos de Control y Panel de Alarmas - Control Events & Alarm Panel							
0xF000		Status and acknowledge of the 192 control events	F001		R	24	Status = 24 first bytes
							1st byte: 1st eight control events (First event=bit less significant)
							2nd byte: 2nd eight control events (Ninth event=bit less significant)
							. . .
							Ack = 24 second bytes
							25th byte: 1st eight control events (First event=bit less significant)
							26th byte: 2nd eight control events (Ninth event=bit less significant)
							. . .

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Eventos de Control y Panel de Alarmas - Control Events & Alarm Panel (cont.)							
0xF018		Indicate which control events are configurated as alarm	F001		R	12	1st byte: 1st eight control events (First event=bit less significant)
							2nd byte: 2nd eight control events (Ninth event=bit less significant)
							. . .
0xF024		Date/Time of the 1-16 alarms	F011		R	64	
0xF064		Date/Time of the 17-32 alarms	F011		R	64	
0xF0A4		Date/Time of the 33-48 alarms	F011		R	64	
0xF0E4		Date/Time of the 49-64 alarms	F011		R	64	
0xF124		Date/Time of the 65-80 alarms	F011		R	64	
0xF164		Date/Time of the 81-96 alarms	F011		R	64	
0xF1A4		Date/Time of the 97-112 alarms	F011		R	64	
0xF1E4		Date/Time of the 113-128 alarms	F011		R	64	
0xF224		Date/Time of the 129-144 alarms	F011		R	64	
0xF264		Date/Time of the 145-160 alarms	F011		R	64	
0xF2A4		Date/Time of the 161-176 alarms	F011		R	64	
0xF2E4		Date/Time of the 177-192 alarms	F011		R	64	
0xF324		Alarm acknowledge	F001		W	12	1st byte: 1st eight alarms (First alarm=bit less significant)
							2nd byte: 2nd eight alarms (Ninth alarm=bit less significant)
							. . .
Entradas Virtuales - Virtual Inputs							
0xF430		64 Virtual Inputs (32 Latched + 32 Self Reset)	F001		R/W	4	2nd byte: 1st eight virtual inputs (First virtual input=bit less significant)
							1st byte: 2nd eight virtual inputs (Ninth virtual input=bit less significant)
							. . .
Nombre Fichero de Eventos - Events File Name							
0xFE00		Name of the events file to read	F009		W		EVE.TXT: all snapshot-events are sent in ASCII format
							NEW_EVE.TXT: the new snapshot-events are sent in ASCII format
							EVE.BIN: all snapshot-events are sent in BINARY format
							NEW_EVE.BIN: the new snapshot-events are sent in BINARY format
Forzado de Salidas por Comunicaciones - Forcing Outputs							
0xFE20		Opening force output file	F004		W	3	Write "OUTPUT"
0xFE28		Closing force output file	F004		W	3	Write "OUTPUT"
0xFF20		Forcing outputs	F004		W	5	First word = Board number;
Ficheros Oscilografía y Reporte de Faltas - Oscillography and Fault Report Files							
0xFE40		Name of the oscillography/fault report file to read	F009		W		OSCXXX.DAT, OSCXXX.CFG, OSCXXX.HDR,
							FLTXXX.TXT (where XXX=001 to 999)
Sucesos - Snapshot events							
0xFF00		Character position of current block within events file	F005		R	2	
0xFF02		Size of currently-available data block of events file	F004		R	1	
0xFF03		Block of data requested events file (122 items)	F004		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ficheros Oscilografía y Reporte de Faltas - Oscillography and Fault Report Files							
0xFF40		Character position of current block within osc file	F005		R	2	
0xFF42		Size of currently-available data block of osc file	F004		R	1	
0xFF43		Block of data requested osc file (122 items)	F004		R	1	
Sincronización Horaria - Synchronization							
0xFFF0		Synchronization (miliseconds from 01/01/2000)	F011		R/W	4	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
DESCRIPCIÓN FORMATO DE DATOS - FORMATS DESCRIPTION							
	F001	UNSIGNED INT 16 BIT (BITMASK)					
	F002	SIGNED INT 32 BIT					
	F003	FLOAT 32 BIT					
	F004	SIGNED INT 16 BIT					
	F005	SIGNED INT 32 BIT					
	F006	DOUBLE 64 BIT					
	F007	UNSIGNED INT 8 BIT					
	F008	SIGNED INT 8 BIT					
	F009	STRING					
	F011	UNSIGNED INT 64 BIT (MILISECONDS FROM 01/01/2000)					
	F012	UNSIGNED INT 16 BIT (ENUMERATED)					

G650 units enable the user to program certain parameters related to DNP3 protocol. These parameters are called DNP3 protocol settings and can be modified from the front panel or from the Level 2 software. The G650 relay supports communication with multiple masters (3) and maintains three separate groups of DNP3 settings. Each group of DNP3 settings is related to a single **logical DNP3 slave device**. The G650 relay is able to communicate simultaneously with up to three different DNP3 master stations. Each master communicates with a different **logical DNP3 slave**, these logical slaves appearing as separate physical DNP3 slaves. This is achieved by keeping separate set of settings, event queues and set of states for each logical device.

Notice that it is necessary to set different **DNP Address** and **TCP/UDP Port** for each **logical DNP3 slave device**.

Time synchronization through DNP protocol is available from all three DNP masters that can communicate with G650. However the date & time will be taken from only one master at the same moment. It is recommended to use only one master to do time sync through DNP.

SETTING NO	SETTING NAME	DEFAULT VALUE	RANGE
1	Physical Port	NONE	NONE, COM1, COM2, NETWORK
2	Address	255	0 to 65534, step 1
3	IP Addr Client1 Oct1	0	0 to 255 step 1
4	IP Addr Client1 Oct2	0	0 to 255 step 1
5	IP Addr Client1 Oct3	0	0 to 255 step 1
6	IP Addr Client1 Oct4	0	0 to 255 step 1
7	IP Addr Client2 Oct1	0	0 to 255 step 1
8	IP Addr Client2 Oct2	0	0 to 255 step 1
9	IP Addr Client2 Oct3	0	0 to 255 step 1
10	IP Addr Client2 Oct4	0	0 to 255 step 1
11	IP Addr Client3 Oct1	0	0 to 255 step 1
12	IP Addr Client3 Oct2	0	0 to 255 step 1
13	IP Addr Client3 Oct3	0	0 to 255 step 1
14	IP Addr Client3 Oct4	0	0 to 255 step 1
15	IP Addr Client4 Oct1	0	0 to 255 step 1
16	IP Addr Client4 Oct2	0	0 to 255 step 1
17	IP Addr Client4 Oct3	0	0 to 255 step 1
18	IP Addr Client4 Oct4	0	0 to 255 step 1
19	IP Addr Client5 Oct1	0	0 to 255 step 1
20	IP Addr Client5 Oct2	0	0 to 255 step 1
21	IP Addr Client5 Oct3	0	0 to 255 step 1
22	IP Addr Client5 Oct4	0	0 to 255 step 1
23	TCP/UDP Port	20000	1 to 65535, step 1
24	Unsol Resp Function	DISABLED	DISABLED, ENABLED
25	Unsol Resp TimeOut	5 s	0 to 60 sec, step 1
26	Unsol Resp Max Ret	10	1 to 255, step 1
27	Unsol Resp Dest Adr	200	0 to 65519, step 1
28	Current Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
29	Voltage Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
30	Power Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
31	Energy Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
32	Other Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
33	Current Deadband	30000	0 to 65535, step 1
34	Voltage Deadband	30000	0 to 65535, step 1
35	Power Deadband	30000	0 to 65535, step 1
36	Energy Deadband	30000	0 to 65535, step 1
37	Other Deadband	30000	0 to 65535, step 1
38	Msg Fragment Size	240	30 to 2048, step 1
39	Binary Input Block1	CTL EVENTS 1-16	See the explanation below

SETTING NO	SETTING NAME	DEFAULT VALUE	RANGE
40	Binary Input Block2	CTL EVENTS 17-32	See the explanation below
41	Binary Input Block3	CTL EVENTS 33-48	See the explanation below
42	Binary Input Block4	CTL EVENTS 49-64	See the explanation below
43	Binary Input Block5	CTL EVENTS 65-80	See the explanation below
44	Binary Input Block6	CTL EVENTS 81-96	See the explanation below
45	Binary Input Block7	CTL EVENTS 97-112	See the explanation below
46	Binary Input Block8	CTL EVENTS 113-128	See the explanation below
47	Binary Input Block9	SWITCHGEAR 1-8	See the explanation below
48	Binary Input Block10	SWITCHGEAR 9-16	See the explanation below

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1. **Physical Port**: The G650 supports the Distributed Network Protocol (DNP) version 3.0. The G650 can be used as a DNP slave device connected up to three DNP masters (usually RTUs or SCADA master stations). The Physical Port setting is used to select the communications port assigned to the DNP protocol for a specific logical DNP slave device of G650. When this setting is set to NETWORK, the DNP protocol can be used over either TCP/IP or UDP/IP.

2. **Address**: This setting is the DNP slave address. This number identifies de G650 on a DNP communications link. Each logical DNP slave should be assigned a unique address.

3-22. **IP Addr Client x Oct x:** this setting is one of four octets of an IP address. The G650 relay can respond to a maximum of 5 specific DNP masters (not in the same time). To set the IP address of DNP master it is necessary to set four octets (e.g. to set the IP address of the first DNP master to 192.168.48.125, you should set **IP Addr Client1 Oct1** = 192, **IP Addr Client1 Oct2** = 168, **IP Addr Client1 Oct3** = 48, **IP Addr Client1 Oct4** = 125).

23. **TCP/UDP Port**: TCP/UDP port number for the case of DNP3 communication being performed through the Ethernet.

24. **Unsol Resp Function**: ENABLED, if unsolicited responses are allowed, and DISABLED otherwise.

25. **Unsol Resp TimeOut**: sets the time the G650 waits for a DNP master to confirm an unsolicited response.

26. **Unsol Resp Max Ret**: This setting determines the number of times the G650 will retransmit an unsolicited response without receiving a confirmation from the master. Once this limit has been exceeded, the unsolicited response will continue to be sent at larger interval. This interval is called unsolicited offline interval and is fixed at 10 minutes.

27. **Unsol Resp Dest Adr**: This setting is DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the G650 from either the current DNP TCP connection or the most recent UDP message.

28-32. **Scale Factor**: These settings are numbers used to scale Analog Input point values. These settings group the G650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **Voltage Scale Factor** is set to a value of 1000, all DNP Analog Input points that are voltages will be returned with the values 1000 times smaller (e.g. a value 72000 V on the G650 will be returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in DNP masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times larger).

33-37. **Deadband**: These settings are the values used by the G650 to determine when to trigger unsolicited responses containing Analog Input data. These settings group the G650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger unsolicited responses from the G650 when any current values change by 15 A, the **Current Deadband** setting should be set to 15. Note that these settings are the default values of the deadbands. DNP object 34 points can be used to change deadband values, from the default, for each individual DNP Analog Input point. Whenever power is removed and re-applied to the G650, the default deadbands will be in effect.

38. **Msg Fragment Size**: This setting determines the size, in bytes, at which message fragmentation occurs. Large fragment sizes allow for more efficient throughput; smaller fragment sizes cause more application layer confirmations to be necessary which can provide for more robust data transfer over noisy communication channels

39-48. **Binary Input Block x**: These settings allow customization and change of the size of DNP Binary Inputs point list. The default Binary Inputs point list contains 160 points representing binary states that are configured using "***Setpoint->Relay Configuration***" menu from the EnerVista 650 Setup program. These 160 binary states are grouped in 10 blocks of 16 points each. There are 128 bits (8 blocks of 16) called *Control Events* and 32 bits (2 blocks of 16) corresponding to the states of 16 *switchgears* available in G650 relay. If not all of the 160 points are required in the DNP master, a custom Binary Inputs point list can be created by selecting up to 10 blocks of 16 points. Each block represents 16 Binary Input points. Block 1 represents Binary Input points 0-15, block 2 represents Binary Input points 16- 31, block 3 represents Binary Input points 32-47, etc. The minimum number of Binary Input points that can be selected is 16 (1 block). If all of the **Binary Input Block x** settings are set to "NOT USED", the default list of 160 points will be in effect. The G650 will form the Binary Inputs points list from the **Binary Input Block x** settings up to the first occurrence of a setting value "NOT USED". Permitted values for these settings are: 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.

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The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document.

a) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 1 OF 3)

(Also see the IMPLEMENTATION TABLE in the following section)	
Vendor Name: **General Electric Multilin**	
Device Name: **G650 Relay**	
Highest DNP Level Supported: For Requests: **Level 2** For Responses: **Level 2**	**Device Function:** ☐ Master ✓ **Slave**
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): **Binary Inputs (Object 1)** **Binary Inputs Changes (Object 2)** **Binary Outputs (Object 10)** **Analog Inputs (Object 30)** **Analog Input Changes (Object 32)** **Analog Deadbands (Object 34)**	
Maximum Data Link String Size (octets): Transmitted: 292 Received: 292	**Maximum Application Fragment Size (octets):** Transmitted: Configurable up to 2048 Received: 2048
Maximum Data Link Re-tries: ☐ None ✓ **Fixed at 2** ☐ Configurable	**Maximum Application Layer Re-tries:** ✓ **None** ☐ Configurable
Requires Data Link Layer Confirmation: ✓ **Never** ☐ Always ☐ Sometimes ☐ Configurable	

b) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 2 OF 3)

Requires Application Layer Confirmation:

☐ Never
☐ Always
✔ **When reporting Event Data**
✔ **When sending multi-fragment responses**
☐ Sometimes
☐ Configurable

Timeouts while waiting for:

Data Link Confirm:	☐ None	✔ **Fixed at 3 s**	☐ Variable	☐ Configurable
Complete Appl. Fragment:	✔ **None**	☐ Fixed at	☐ Variable	☐ Configurable
Application Confirm:	☐ None	✔ **Fixed at 4 s**	☐ Variable	☐ Configurable
Complete Appl. Response	✔ **No0ne**	☐ Fixed at	☐ Variable	☐ Configurable

Others:

Transmission Delay:	**No intentional delay**
Need Time Delay:	**10 min.**
Select/Operate Arm Timeout:	**10 s**
Binary Input change scanning period:	**1 ms**
Packed binary change process period:	**1 s**
Analog Input change scanning period:	**500 ms**
Unsolicited response notification delay:	**500 ms**
Unsolicited response retry delay:	**Configurable 0 to 60 s**
Unsolicited offline interval:	**10 min.**

Sends/Executes Control Operations:

WRITE Binary Outputs	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
Count > 1	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	✔ **Always**	☐ Sometimes	☐ Configurable
Pulse Off	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch On	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Queue	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	✔ **Never**	☐ Always	☐ Sometimes	☐ Configurable

c) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 3 OF 3)

Reports Binary Input Change Events when no specific variation requested: ☐ Never ✓ **Only time-tagged** ☐ Only non-time-tagged ☐ Configurable	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ✓ **Binary Input Change With Time** ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ✓ **Configurable** ☐ Only certain objects ☐ Sometimes (attach explanation) ✓ **ENABLE/DISABLE unsolicited Function codes supported**	Sends Static Data in Unsolicited Responses: ✓ **Never** ☐ When Device Restarts ☐ When Status Flag Change No other options permitted
Default CounterObject/Variation: ✓ **No Counters Reported** ☐ Configurable (attach explanation) ☐ Default Object: ☐ Default Variation:	Counters Roll Over at: ✓ **No Counters Reported** ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ☐ Other Value: ______ ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ✓ **Yes** ☐ No	

The following table shows objects, variations, function codes and qualifiers supported by G650 units, both in requests and responses for DNP3 protocol. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07 or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Text in ***bold and italic*** indicates functionality higher than DNP3 implementation level 2.

a) IMPLEMENTATION TABLE (SHEET 1 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) ***22 (assign class)***	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
1	1	Binary Input	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
1	2	Binary Input with Status (default – see Note 1)	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
2	0	Binary Input Change - All Variations See Note 1	1 (read)	06 (no range, or all) 07,08 (limited qty)		
2	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
2	2	Binary Input Change with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
10	0	Binary Output - All Variations	1 (read)	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
10	2	Binary Output Status See Note 1	***1 read***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir.op, noack)	***00,01 (start-stop)*** ***07,08 (limited qty)*** 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter - All Variations	1 (select) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz.cl. noack)	06 (no range, or all)		

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The G650 is not restarted, but the DNP process is restarted.

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b) IMPLEMENTATION TABLE (SHEET 2 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
21	0	Frozen Counter - All Variations	1 (read)	06 (no range, or all)		
22	0	Counter Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
30	0	Analog Input - All Variations	1 (read) ***22 (assign class)***	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
30	1	32-Bit Analog Input See Note 1	1 (read) ***22 (assign class)***	***000,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	2	16-Bit Analog Input	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	3	32-Bit Analog Input without Flag	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
30	4	16-Bit Analog Input without Flag	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
32	0	Analog Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	1	32-Bit Analog Change Event without Time See Note 1	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	129 (response) 130 (unsol.resp)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	129 (response) 130 (unsol.resp)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
32	4	16-Bit Analog Change Event with Time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
34	0	Analog Input Reporting Deadband	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***		
34	1	16-Bit Analog Input Reporting Deadband See Note 1	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** See Note 2

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The G650 is not restarted, but the DNP process is restarted.

c) IMPLEMENTATION TABLE (SHEET 3 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
34	2	32-Bit Analog Input Reporting Deadband See Note 1	***2 (write)***	***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
50	0	Time and Date - All Variations	***1 (read)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** ***See Note 2***
50	1	Time and Date See Note 1	***1 (read)*** ***2 (write)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07 (limited qty=1)*** ***08 (limited qty)*** ***17,28 (index)***	***129 (response)***	***00,01 (start-stop)*** ***17,28 (index)*** ***See Note 2***
52	2	Time Delay Fine	***1 (read)*** 2 (write)		***129 (response)***	07 (limited qty) quantity=1
60	0	Class 0, 1, 2, and 3 Data	***1 (read)*** ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all)		
60	1	Class 0 Data		06 (no range, or all)		
60	2	Class 1 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
60	3	Class 2 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
60	4	Class 3 Data	1 (read) ***20 (enable unsol)*** ***21 (disable unsol)*** ***22 (assign class)***	06 (no range, or all) 07,08 (limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
		No Object (function code only) See Note 3	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The G650 is not restarted, but the DNP process is restarted.

The G650 relay has a configurable Map of DNP Binary Input points. This map can be formed by up to 10 blocks of 16 binary states that are configured using "*Setpoint->Relay Configuration*" menu from the EnerVista 650 Setup program. The minimum number of DNP Binary Input points is 16 and the maximum number is 160. Within these 160 DNP points, 128 bits (8 blocks of 16) are mapped to *Control Events* (***"Setpoint->Relay Configuration->Control Events"***) and 32 bits (2 block of 16) are mapped to contacts A, B of 16 *Switchgears* (***"Setpoint->Relay Configuration->Switchgear"***). Each *Switchgear* in G650 is mapped into two DNP Binary Input points. Lets say the setting Binary Input Block1 has been set the value Switchgear 1-8, it means that DNP Binary Input point 0 = Switchgear 1Contact A, DNP Binary Input point 1 = Switchgear 1 Contact B, DNP Binary Input point 2 = Switchgear 2 Contact A, etc.

To each *Control Event* or *Switchgear Contact*, the user can assign any of the binary states of the G650 relay. These states are contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. DNP Points that correspond to *Control Events* o *Switchgear Contacts* that are not configured will have a zero value in the response.

Using the PLC-Editor, through the EnerVista 650 Setup program, selecting menu: ***"Setpoint->Logic Configuration"***, it will be possible to implement complex logic, more than simple OR and NOT previous functions. To perform this, in the menu: ***"Setpoint->Relay Configuration->Control Events"*** assign a Virtual Output to selected point, after that, implement wished logic with the PLC-Editor.

BINARY INPUT POINTS
Static (Steady-State) Object Number: **1**
Change Event Object Number: **2**
Request Function Codes supported: **1 (read), 22 (assign class)**
Static Variation Reported when variation 0 requested: **2 (Binary Input Change with status)**
Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**
Default Class for all points: **1**

DEFAULT BINARY INPUT POINTS MAP

POINT INDEX	NAME/DESCRIPTION
0-127	Control Events 1-128
128	Switchgear 1 Contact A
129	Switchgear 1 Contact B
130	Switchgear 2 Contact A
131	Switchgear 2 Contact B
132	Switchgear 3 Contact A
133	Switchgear 3 Contact B
134	Switchgear 4 Contact A
135	Switchgear 4 Contact B
136	Switchgear 5 Contact A
137	Switchgear 5 Contact B
138	Switchgear 6 Contact A
139	Switchgear 6 Contact B
140	Switchgear 7 Contact A
141	Switchgear 7 Contact B
142	Switchgear 8 Contact A
143	Switchgear 8 Contact B
144	Switchgear 9 Contact A
145	Switchgear 9 Contact B
146	Switchgear 10 Contact A
147	Switchgear 10 Contact B
148	Switchgear 11 Contact A
149	Switchgear 11 Contact B
150	Switchgear 12 Contact A
151	Switchgear 12 Contact B
152	Switchgear 13 Contact A
153	Switchgear 13 Contact B
154	Switchgear 14 Contact A
155	Switchgear 14 Contact B
156	Switchgear 15 Contact A
157	Switchgear 15 Contact B
158	Switchgear 16 Contact A
159	Switchgear 16 Contact B

C.5.1 CONFIGURING DNP USER MAP

Imagine that a user wants to configure DNP Binary Inputs Map with 8 Contact Inputs, 8 Protection states, 8 Contact Outputs and 2 Switchgears. This configuration can be done in two steps. In first step the user selects **“*Setpoint->Relay Configuration*”** from the EnerVista 650 Setup program and then configures *Control Events* bits and *Switchgear* bits. It is shown in figures 9.1 and 9.2. In the second step the user selects **“*Setpoint->System Setup->Communication settings->DNP*”** in order to change DNP Binary Input Block settings. The user set values of the first three Binary Input blocks, Binary Input Block1 = CTL EVENTS 1-16, Binary Input Block2 = CTL EVENTS 17-32, Binary Input Block3 = SWITCHGEAR 1-8. It is shown in Configuration of Control Events bits13-1

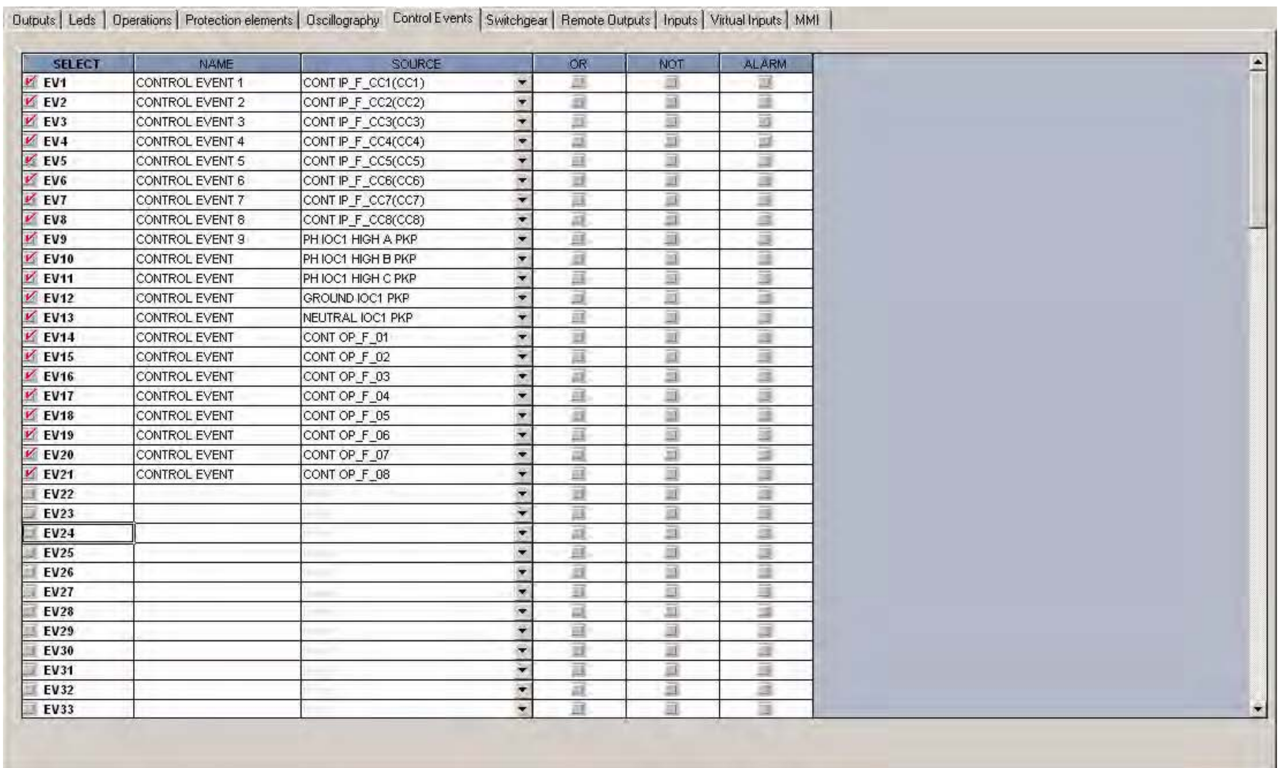


Figure C–1: CONFIGURATION OF CONTROL EVENTS BITS

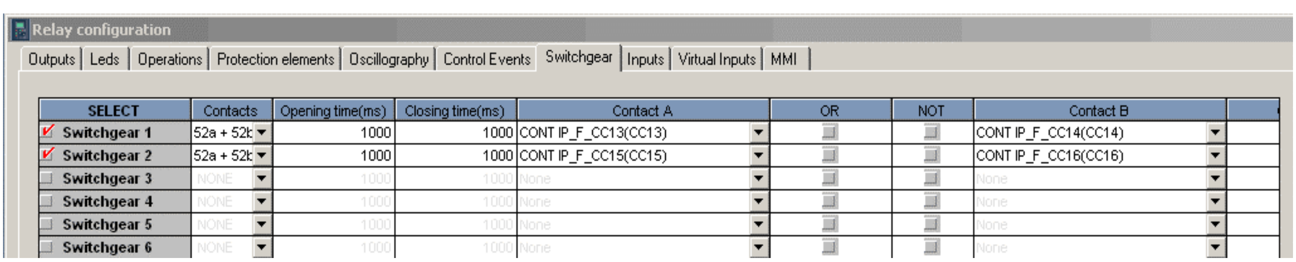


Figure C–2: CONFIGURATION OF SWITCHGEAR

C

C

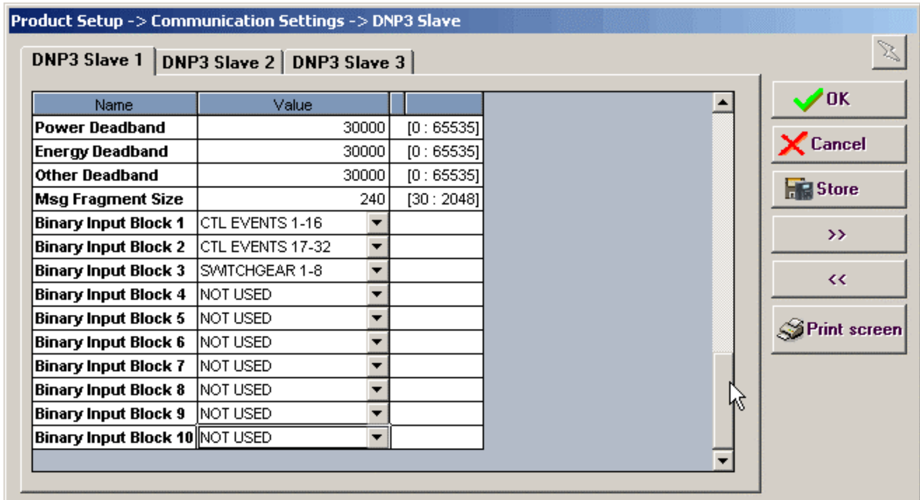


Figure C–3: CONFIGURATION OF DNP BINARY INPUT BLOCKS

In the example presented in this chapter the G650 relay has 48 Binary Input points, as shown in the table below.

C.5.2 EXAMPLE OF CUSTOM BINARY INPUT POINTS MAP

POINT INDEX	NAME/DESCRIPTION
0	CONT_IP_F_CC1(CC1)
1	CONT_IP_F_CC2(CC2)
2	CONT_IP_F_CC3(CC3)
3	CONT_IP_F_CC4(CC4)
4	CONT_IP_F_CC5(CC5)
5	CONT_IP_F_CC6(CC6)
6	CONT_IP_F_CC7(CC7)
7	CONT_IP_F_CC8(CC8)
8	PH IOC1 HIGH A PKP
9	PH IOC1 HIGH B PKP
10	PH IOC1 HIGH C PKP
11	Not Configured
12	Not Configured
13	Not Configured
14	GROUND IOC1 PKP
15	NEUTRAL IOC1 PKP
16	CONT OP_F_01
17	CONT OP_F_02
18	CONT OP_F_03
19	CONT OP_F_04
20	CONT OP_F_05
21	CONT OP_F_06
22	CONT OP_F_07
23	CONT OP_F_08

POINT INDEX	NAME/DESCRIPTION
24	Not Configured
25	Not Configured
26	Not Configured
27	Not Configured
28	Not Configured
29	Not Configured
30	Not Configured
31	Not Configured
32	CONT_IP_F_CC13 (CC13)
33	CONT_IP_F_CC14(CC14)
34	CONT_IP_F_CC15(CC15)
35	CONT_IP_F_CC16(CC16)
36	Not Configured
37	Not Configured
38	Not Configured
39	Not Configured
40	Not Configured

41	Not Configured
42	Not Configured
43	Not Configured
44	Not Configured
45	Not Configured
46	Not Configured
47	Not Configured

C.5.3 MULTIPLE DNP 3.0 MASTERS COMMUNICATION WITH G650

Typical architecture of multi-master communication using DNP 3.0.

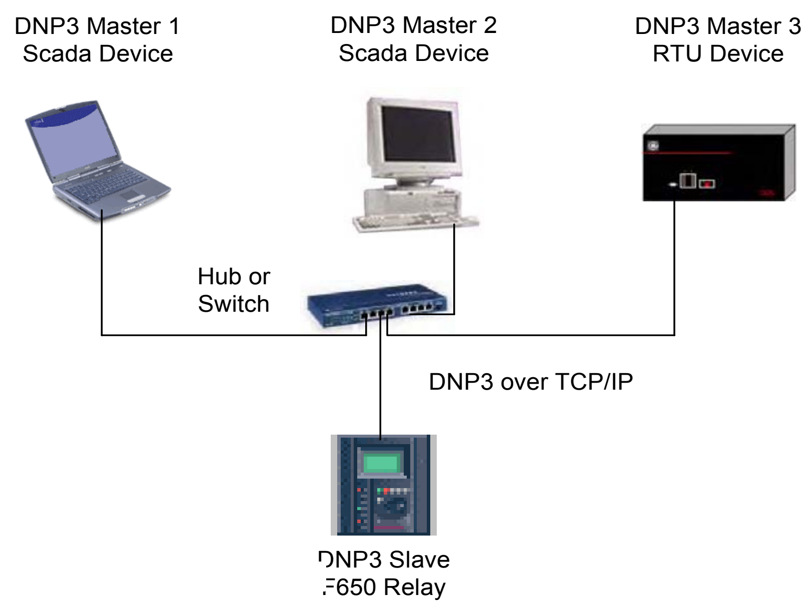


Figure C–1: MULTIPLE DNP3.0 MASTERS COMMUNICATING WITH G650

DNP 3.0 Slave – '650	DNP 3.0 Master 1	DNP 3.0 Master 2	DNP 3.0 Master 3
Ethernet Config IP Addr: 192.168.37.20 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.1 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.2 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.3 Netmask: 255.255.255.0
DNP 3.0 slave 1 Physical Port: Network Address: 255 IP Addr Cli1: 192.168.37.1 TCP/UDP Port : 20000 Unsol Dest Addr: 200	DNP3 over TCP/IP DNP Addr: 200 DNP Dest Addr: 255 IP Dest: 192.168.37.20 TCP Dest Port: 20000	DNP3 over TCP/IP DNP Addr: 201 DNP Dest Addr: 256 IP Dest : 192.168.37.20 TCP Dest Port: 20001	DNP3 over TCP/IP DNP Addr: 202 DNP Dest Addr: 257 IP Dest: 192.168.37.20 TCP Dest Port: 20002
DNP 3.0 slave 2 Physical Port: Network Address: 256 IP Addr Cli1: 192.168.37.2 TCP/UDP Port : 20001 Unsol Dest Addr: 201			
DNP 3.0 slave 3 Physical Port: Network Address: 257 IP Addr Cli1: 192.168.37.3 TCP/UDP Port : 20002 Unsol Dest Addr: 202			

Figure C–2: SETTINGS FOR DNP3.0 MULTI-MASTER COMMUNICATIONS WITH G650

C

Supported Control Relay Output Block fields: Pulse On.

The G650 relay provides 24 DNP Binary/Control Output points. These outputs are mapped to the first 24 commands configured in the G650. Executing a command is equal to activate the PLC equation that was attached to this command. Thus all of the 24 DNP Binary/Control Output points are pulsed points. It means that only Pulse On flag will be accepted in DNP control operations on those points. All commands have configurable names. Changing the command's name can be done using the EnerVista 650 Setup program.

BINARY OUTPUT STATUS POINTS

Object Number: **10**

Request Function Codes supported: **1 (read)**

Default Variation Reported when variation 0 requested: **2 (Binary Output Status)**

CONTROL RELAY OUTPUT BLOCKS

Object Number: **12**

Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no ack)**

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
0	OPERATION1
1	OPERATION2
2	OPERATION3
3	OPERATION4
4	OPERATION5
5	OPERATION6
6	OPERATION7
7	OPERATION8
8	OPERATION9
9	OPERATION10
10	OPERATION11
11	OPERATION12

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
12	OPERATION13
13	OPERATION14
14	OPERATION15
15	OPERATION16
16	OPERATION17
17	OPERATION18
18	OPERATION19
19	OPERATION20
20	OPERATION21
21	OPERATION22
22	OPERATION23
23	OPERATION24

Currently there are no Binary Counters in the G650 relay. Nevertheless G650 accepts requests of DNP objects 20 (Binary Counters), 21 (Frozen Counters) and 22 (Counter Change Events). Function codes “Immediate Freeze”, “Freeze and Clear” etc. are accepted and G650 will respond with no objects and the IIN2-1 (Object Unknown) flag set. This behaviour is in conformance with DNP Level 2 Implementation (Document 28528: Level 2 DNP 3.00 Implementation).

It is important to note that 16-bit and 32-bit variations of Analog Inputs are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation is 32767. This is a DNP requirement.

The deadbands for all Analog Input points are in the same units as the Analog Input quantity. For example, an Analog Input quantity measured in volts has a corresponding deadband in units of volts. This is in conformance with DNP Technical Bulletin 9809-001 Analog Input Reporting Deadband. The scale factors apply also to deadbands. For example if Current Scale Factor is set to 0.001, and it is desired that a specific Analog Input point (that is of type current) trigger an event when its value changes by 1 kA, then the deadband for this point should be set to 1000. Relay settings are available to set default deadband values according to data type. Deadbands for individual Analog Input Points can be set using DNP Object 34.

ANALOG INPUT POINTS

Static (Steady-State) Object Number: **30**

Change Event Object Number: **32**

Request Function Codes supported: **1 (read), 2 (write, deadbands only), 22 (assign class)**

Static Variation Reported when variation 0 requested: **1 (32-Bit Analog Input)**

Change Event Variation reported when variation 0 requested: 1 **(Analog Change event without Time)**

Change Event Scan Rate: defaults to **500ms.**

Default Class for all points: **1**

Units for Analog Input points are as follows:

Current:	kA	Apparent Power:	MVA
Voltage:	kV	Energy:	MWh, Mvarh
Real Power:	MW	Frequency:	Hz
Reactive Power:	Mvar	Angle:	degrees

a) ANALOG INPUT POINTS

POINT	DESCRIPTION	UNIT
0	Phasor Ia Primary	kA
1	Phasor Ib Primary	kA
2	Phasor Ic Primary	kA
3	Phasor Ig Primary	kA
4	Phasor Isg Primary	kA
5	Phasor In Primary	kA
6	RMS Ia Primary	kA
7	RMS Ib Primary	kA
8	RMS Ic Primary	kA
9	RMS Ig Primary	kA
10	RMS Isg Primary	kA
11	I0 Primary	kA
12	I1 Primary	kA
13	I2 Primary	kA
14	V0 Primary	kV
15	V1 Primary	kV
16	V2 Primary	kV
17	Vab Primary	kV
18	Vbc Primary	kV
19	Vca Primary	kV
20	Vn Primary	kV
21	Va Primary	kV
22	Vb Primary	kV
23	Vc Primary	kV
24	VL Primary	kV
25	VBB Primary	kV
26	Phase A Reactive Pwr	MVAr
27	Phase A Apparent Pwr	MVA
28	Phase A Real Pwr	MW
29	Phase B Reactive Pwr	MVAr
30	Phase B Apparent Pwr	MVA
31	Phase B Real Pwr	MW
32	Phase C Reactive Pwr	MVAr
33	Phase C Apparent Pwr	MVA
34	Phase C Real Pwr	MW
35	3 Phase Reactive Pwr	MVAr
36	3 Phase Apparent Pwr	MVA
37	3 Phase Real Pwr	MW
38	Phase A Power Factor	
39	Phase B Power Factor	
40	Phase C Power Factor	
41	3 Phase Power Factor	
42	Line Frequency Primary	Hz
43	Bus Frequency Primary	Hz
44	Vx Primary	kV
45	Pos MVarhour Freeze	MVArh
46	Neg MVarhour Freeze	MVArh
47	Pos MWatthour Freeze	MWh
48	Pos MWatthour Freeze	MWh
49	Positive MVarhour	MVArh

POINT	DESCRIPTION	UNIT
50	Negative MVarhour	MVArh
51	Positive MWatthour	MWh
52	Negative MWatthour	MWh
53	Vg Primary	kV
54	Fault 1 Prefault Phase A Current Magnitude	kA
55	Fault 1 Prefault Phase A Current Angle	degrees
56	Fault 1 Prefault Phase B Current Magnitude	kA
57	Fault 1 Prefault Phase B Current Angle	degrees
58	Fault 1 Prefault Phase C Current Magnitude	kA
59	Fault 1 Prefault Phase C Current Angle	degrees
60	Fault 1 Prefault Phase AB Voltage Magnitude	kV
61	Fault 1 Prefault Phase AB Voltage Angle	degrees
62	Fault 1 Prefault Phase BC Voltage Magnitude	kV
63	Fault 1 Prefault Phase BC Voltage Angle	degrees
64	Fault 1 Prefault Phase CA Voltage Magnitude	kV
65	Fault 1 Prefault Phase CA Voltage Angle	degrees
66	Fault 1 Postfault Phase A Current Magnitude	kA
67	Fault 1 Postfault Phase A Current Angle	degrees
68	Fault 1 Postfault Phase B Current Magnitude	kA
69	Fault 1 Postfault Phase B Current Angle	degrees
70	Fault 1 Postfault Phase C Current Magnitude	kA
71	Fault 1 Postfault Phase C Current Angle	degrees
72	Fault 1 Postfault Phase AB Voltage Magnitude	kV
73	Fault 1 Postfault Phase AB Voltage Angle	degrees
74	Fault 1 Postfault Phase BC Voltage Magnitude	kV
75	Fault 1 Postfault Phase BC Voltage Angle	degrees
76	Fault 1 Postfault Phase CA Voltage Magnitude	kV
77	Fault 1 Postfault Phase CA Voltage Angle	degrees
78	Fault 1 Type	Enum
79	Fault 1 Location	km

The "Fault Type" is represented by enumeration value. The table below shows values with DNP3 setting "Other Scale Factor = 1".

If this setting has another value then "Enum Value" will be scaled by the adjusted factor.

For example if "Other Scale Factor = 0.001", then the value corresponding to "TRIPH" fault type will be 2000.

ENUM VALUE	FAULT TYPE
0	GROUND
1	PHASE
2	TRIPH
3	AG
4	ABG
5	AB
6	BG
7	BCG
8	BC
9	CG
10	CAG
11	CA
12	NAF

NAF indicates that the type of fault has not been calculated.

C

The G650 is an IEC server. Answers to clients request or can send spontaneous Transmission. G650 implementation of 60870-5-104 provides analog meterings and states.

ASDU is the information unit used for data transmission. An ASDU may have data inside or not. The ASDU is encapsulated in another package of the link layer. ASDU address takes up 2 bytes.

Communication frames can be control or data frames. Control strings do not have ASDU inside.

A frame is consist on 3 parts. (2 of them are not always present):

Link data + [ASDU header+ [ASDU data]]

The data between brackets can be omitted

In IEC104 communication is made by TCP/IP protocols. Actually, it is a TCP communication. The default port is the 2404. The G650 is listening as a server. Only one client is attended at time.

Cyclic data transmission

2 ASDU for measured values

2 ASDU for single point information (64 states in each ASDU).

1 ASDU for Double point information (16 states for Switchgear).

Spontaneous Transmission:

2 ASDU for measured values (timing is set in Cyclic Meter Period, 0 means no spontaneous transmission).

1 ASDU for single point information in the time the event is produced (128 points in user map).

1 ASDU for Double point information in the time the event is produced (16 Switchgear information).

Clock synchronization

Command transmission

Acquisition of transmission delay

The Communication settings for IEC 60870-5-104 protocol are the following:

PRODUCT SETUP>COMMUNICATION SETTINGS >IEC 870-5-104			
NAME	**VALUE**	**UNITS**	**RANGE**
Function	DISABLED		
TCP Port	2404		[0 : 65535]
Common Addr of ASDU	255		[0 : 65535]
Cyclic Meter Period	0		[0 : 3600]
Synchronization Event	0		[0 : 3600]

Function: Enable or disable the protocol operation.

TCP Port: Listening TCP port in the relay. Default value is 2404.

Common Addr of ASDU: Address in the ASDU header. Default value is 255.

Cyclic Meter Period: Number of seconds for instantaneous meterings. 0 means no spontaneous meterings.

Synchronization event: Not implemented.

The G650 relay has a custom Binary Inputs points list, called User Map; it is common for any protocol. In the case of IEC 104 Protocol, those points are GROUP1 and GROUP2.

The IEC 104 User Map can be configured using the **EnerVista 650 Setup** software in ***Setpoint>Relay Configuration->Control Events***. The User Map contains 128 Binary Inputs. To each point of the User Map, the user can assign any of the binary states of the G650 relay, also is possible to combine those states using OR and NOT functions. These states are: contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. The User Map always has a size of 128 Binary Inputs. Points in the User Map that are not configured will have a zero value in the answer.

It is possible to implement more complex logic than simple OR and NOT using the **PLC Editor** tool in **EnerVista 650 Setup** in the menu ***Setpoint>Logic Configuration*****.** These complex signals (Virtual Outputs) can be assigned to the binary points in the Control Events configuration for the IEC 104 user map.

a) SELECTION OF STANDARD ASDUS:

Process information in monitor direction

<1> Single-point information M_SP_NA_1

<2> Double-point information M_DP_NA_1

<3> Measured value, short floating point value M_ME_NC_1

Process information in control direction

<46> Single command C_SC_NA_1

System information in control direction

<106> Reset process command C_RP_NA_1

The G650 relay has a custom Binary Inputs points list, called **User Map**; it is common for any protocol. In the case of IEC 104 Protocol, those points are GROUP1 and GROUP2.

GROUP 1 STATUS	
POINT	**DESCRIPTION**
M_ SP_NA_1 Points	
1000-1063	CONTROL EVENTS

GROUP 2 STATUS	
POINT	**DESCRIPTION**
M_ SP_NA_1 Points	
1064-1127	CONTROL EVENTS

GROUP 3 STATUS	
POINT	**DESCRIPTION**
M_ DP_NA_1 Points	
1500-1515	SWITCHGEAR EVENTS

D

GROUP 5 METERING	
POINT	DESCRIPTION
M_ ME_NC_1 Points	
2000	Phasor Ia Primary
2001	Phasor Ib Primary
2002	Phasor Ic Primary
2003	Phasor Ig Primary
2004	Phasor Isg Primary
2005	Phasor In Primary
2006	RMS Ia Primary
2007	RMS Ib Primary
2008	RMS Ic Primary
2009	RMS Ig Primary
2010	RMS Isg Primary
2011	I0 Primary
2012	I1 Primary
2013	I2 Primary
2014	V0 Primary
2015	V1 Primary
2016	V2 Primary
2017	Vab Primary
2018	Vbc Primary
2019	Vca Primary
2020	Vn Primary
2021	Va Primary
2022	Vb Primary
2023	Vc Primary
2024	VL Primary
2025	VBB Primary
2026	Phase A Reactive Pwr

GROUP 6 METERING	
POINT	DESCRIPTION
M_ ME_NC_1 Points	
2027	Phase A Apparent Pwr
2028	Phase A Real Pwr
2029	Phase B Reactive Pwr
2030	Phase B Apparent Pwr
2031	Phase B Real Pwr
2032	Phase C Reactive Pwr
2033	Phase C Apparent Pwr
2034	Phase C Real Pwr
2035	3 Phase Reactive Pwr
2036	3 Phase Apparent Pwr
2037	3 Phase Real Pwr
2038	Phase A Power Factor
2039	Phase B Power Factor
2040	Phase C Power Factor
2041	3 Phase Power Factor
2042	Line Frequency Primary
2043	Bus Frequency Primary
2044	Vx Primary
2045	Positive MVarhour Freeze
2046	Negative MVarhour Freeze
2047	Positive MWatthour Freeze
2048	Negative MWatthour Freeze
2049	Positive MVarhour
2050	Negative MVarhour
2051	Positive MWatthour
2052	Negative MWatthour
2053	VG Primary

b) OPERATIONS IN IEC 60870-5-104 FOR G650

There are 24 available operation in G650 device, they must be configured using EnerVista 650 Setup in the menu "***Setting > Relay Configuration > Operations***".

ASDU address must start with 3000, the addresses for operation are from 3000 to 3011. The operations go from 0 to 23. Subtracting 3000 we obtain a number between 0 and 11, this number is multiplied by two, and plus 1 if the operation is ON.

The date in the answer is the same as the received in the command.

The following ASDUS are answered to:

<45> Single command C_SC_NA_1

<46>Double command C_DC_NA_1

<58> Single command with time tag CP56Time2a C_SC_TA_1

<59>Double command with time tag CP56Time2a C_DC_TA_1

Table D–1: OPERATIONS:

OPERATIONS	
POINT	**DESCRIPTION**
C_SC_NA_1	
3000 – 3011	Command OFF
3000 – 3011	Command ON

Table D–2: CLOCK SYNCHRONIZATION:

CLOCK SYNCHRONIZATION	
POINT	**DESCRIPTION**
C_SC_NA_1	
0	Set Date

The date in the answer is the same as the received in the command.

The relay date is synchronized after performing this command.

Table D–3: RESET OF PROCESS

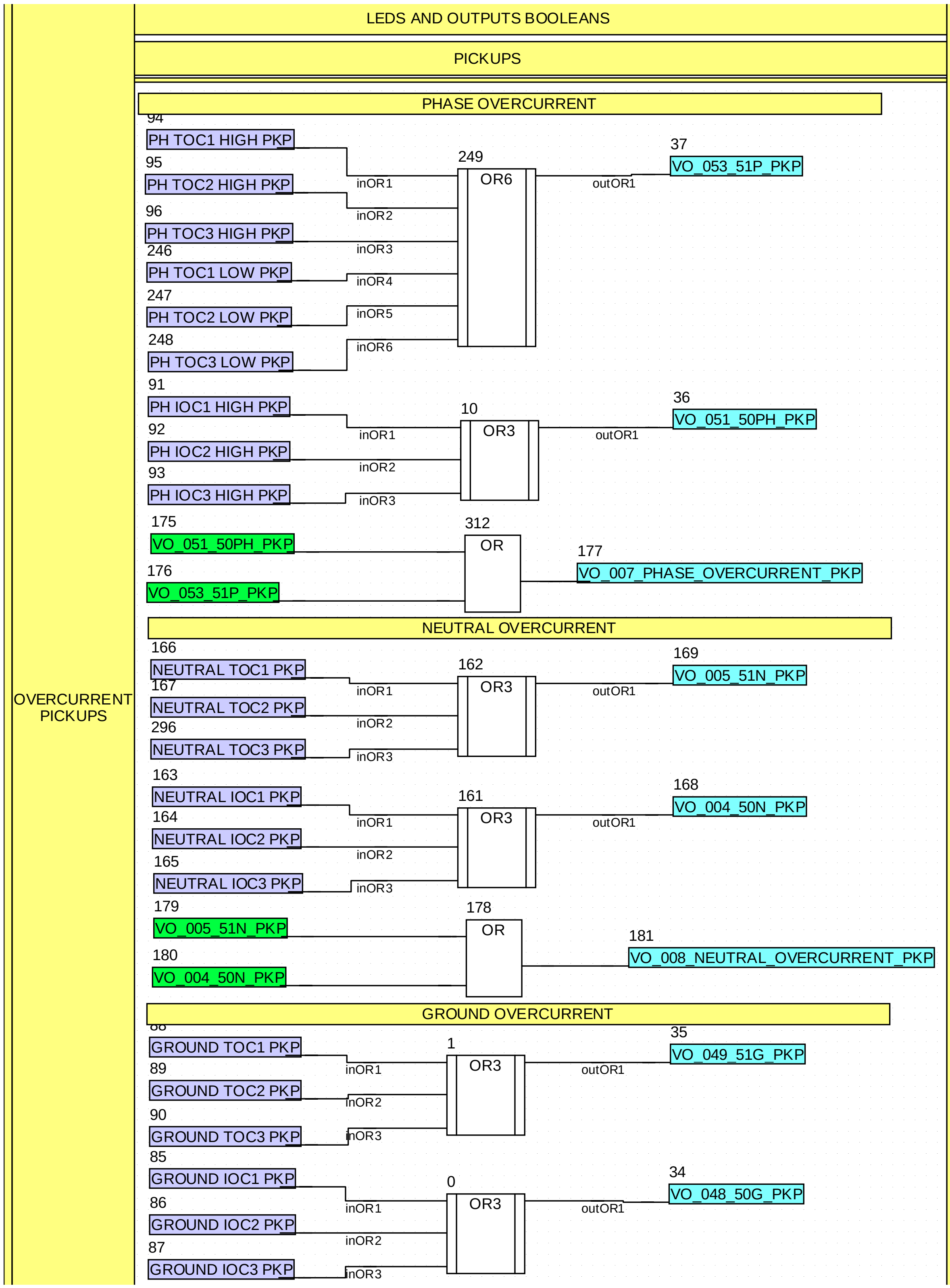
RESET OF PROCESS	
POINT	**DESCRIPTION**
C_RP_NA_1	
0	Reset of Process

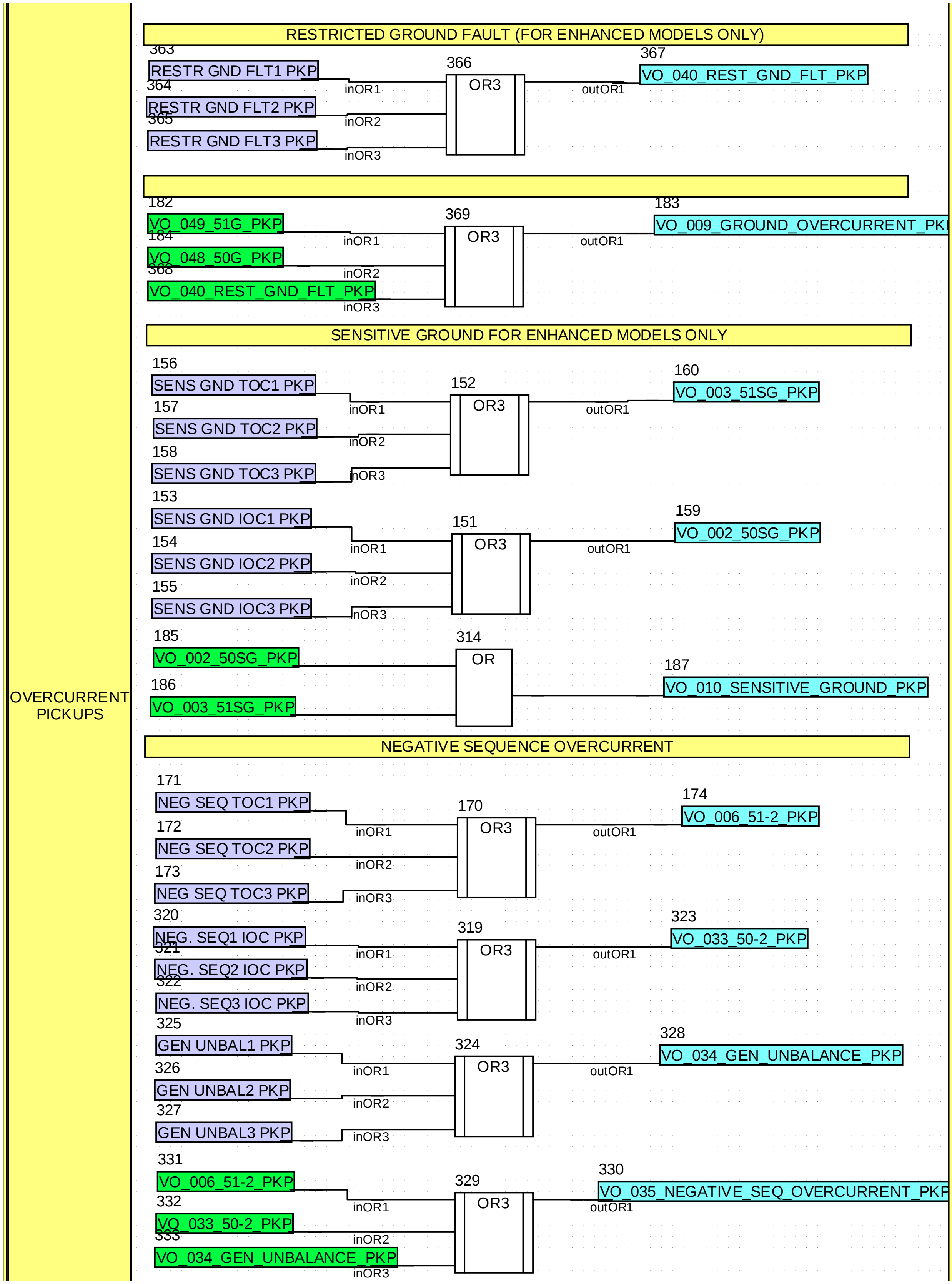
QRP_RESET_GRAL: General reset of process.

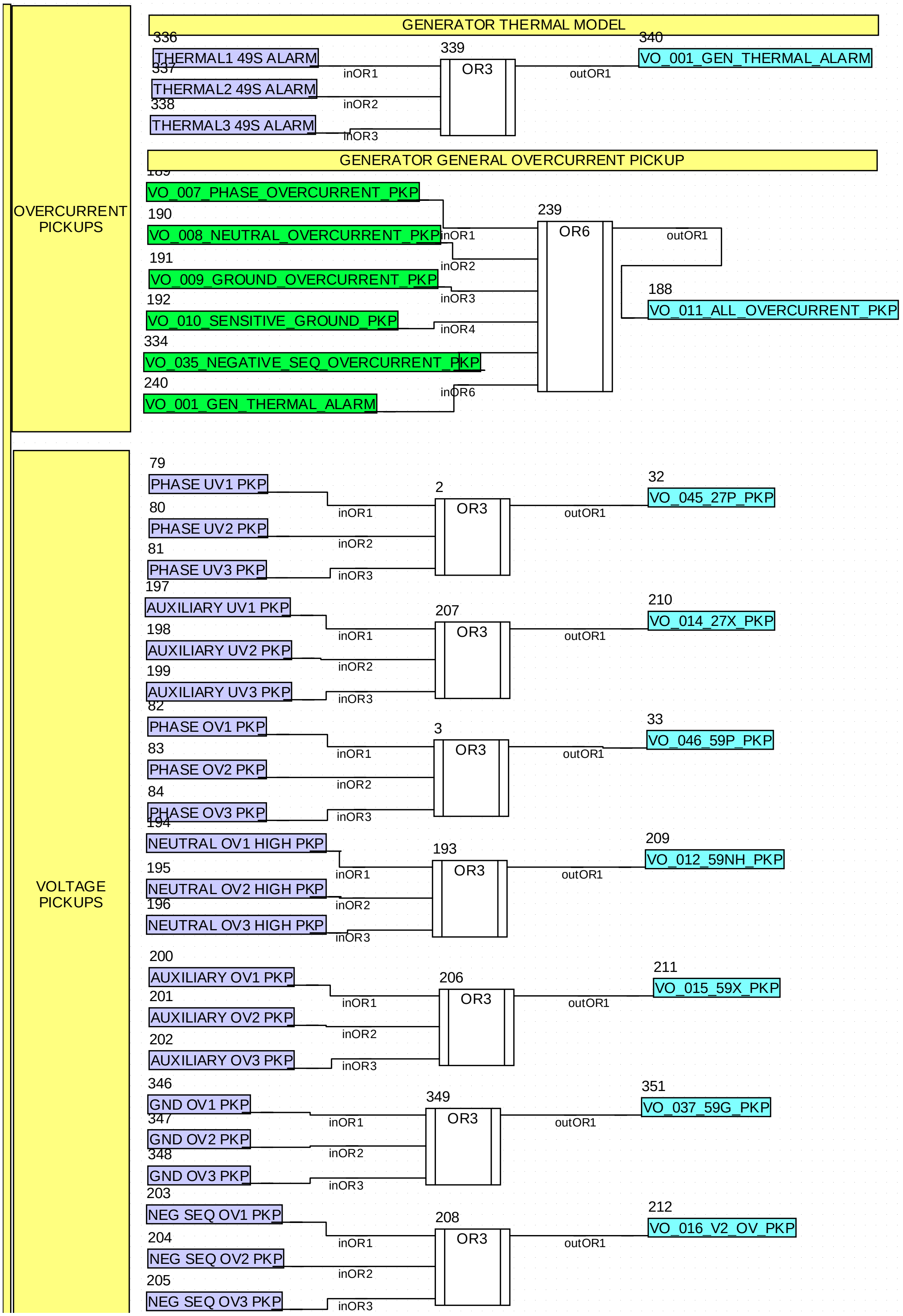
Table D–4: ACQUISITION OF TRANSMISSION DELAY:

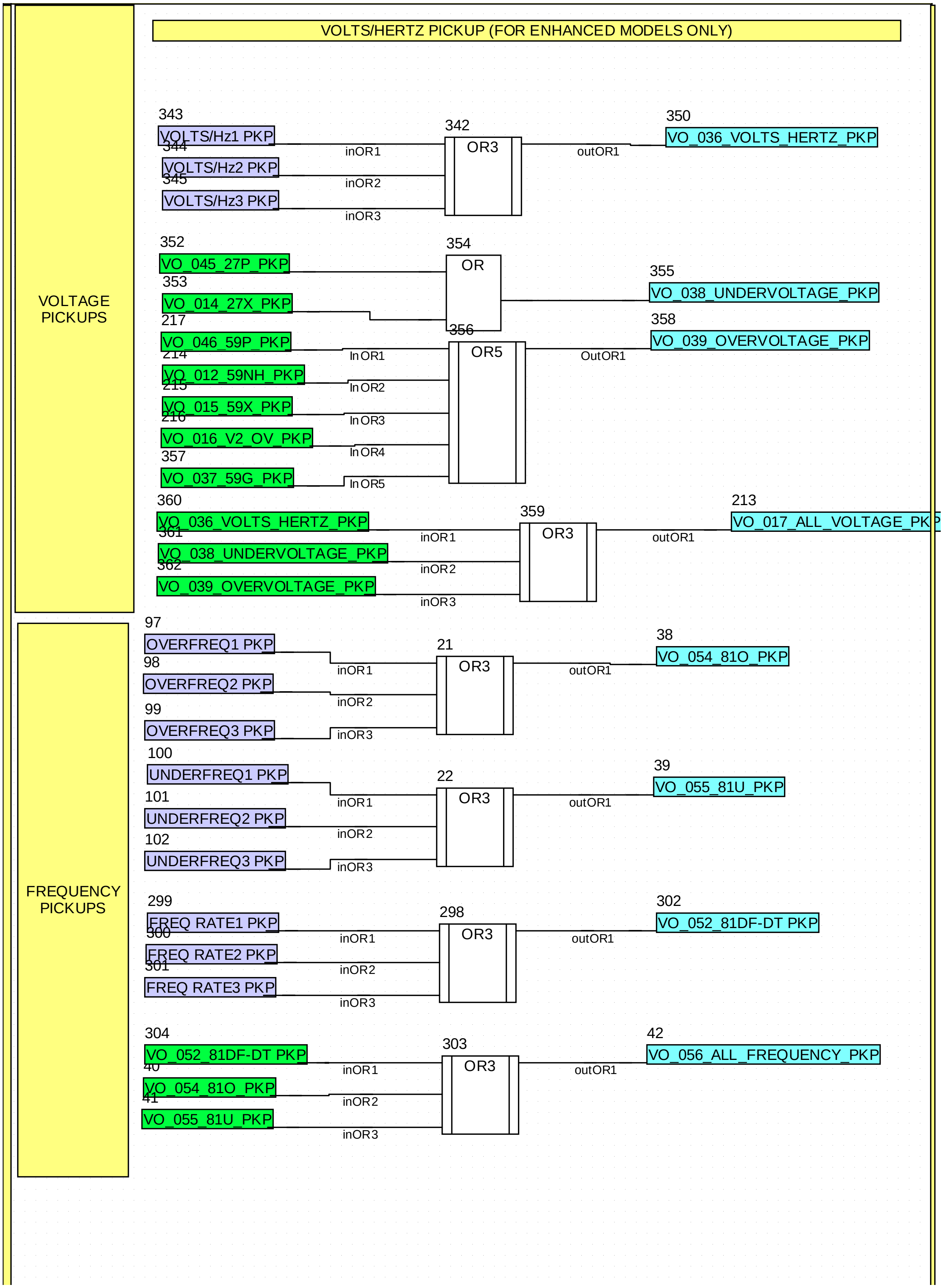
DELAY ADQUISITION	
POINT	**DESCRIPTION**
C_CS_NA_1	
0	Delay Acquisition

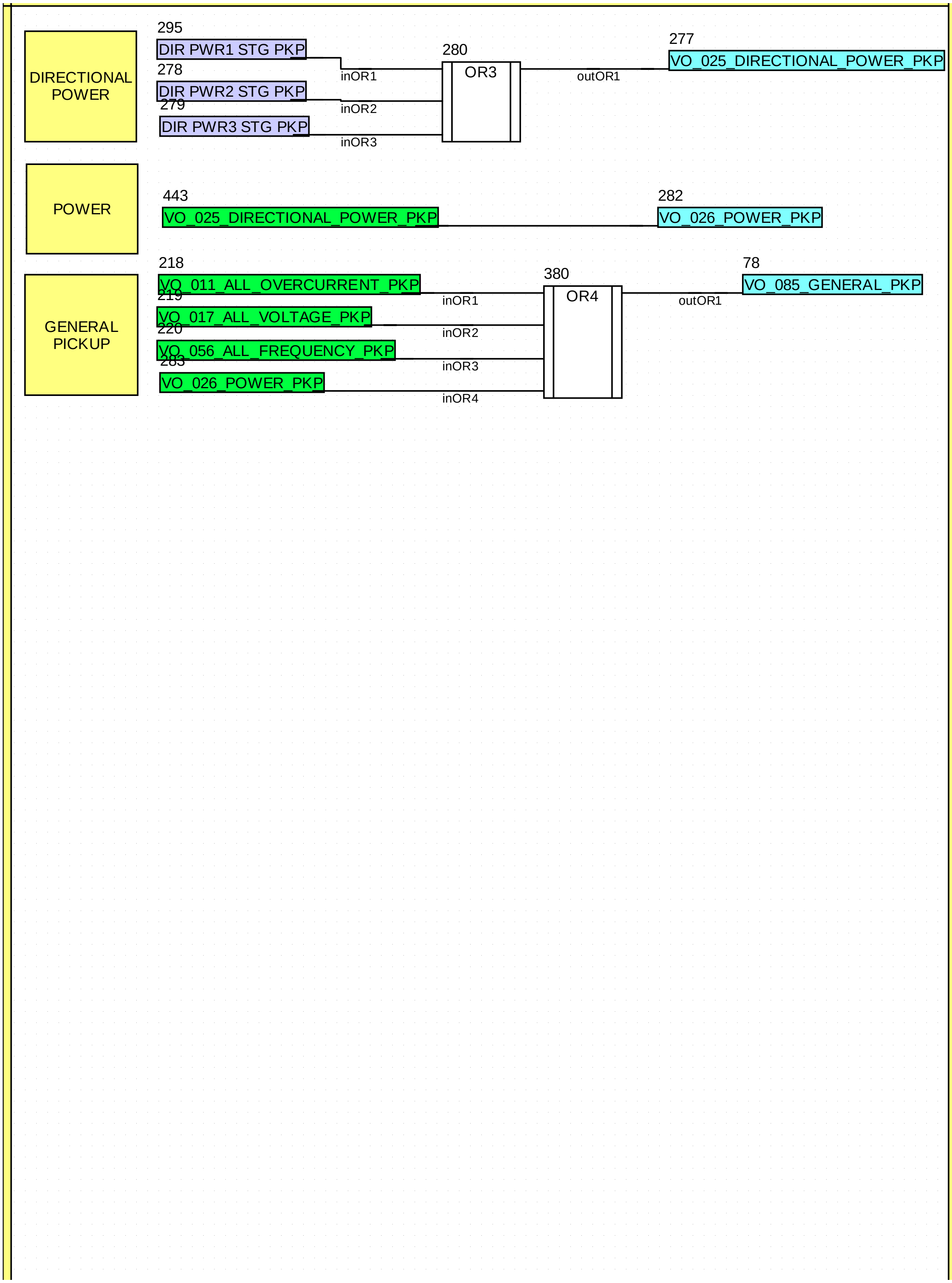
The date in the answer is the same as the received in the command.

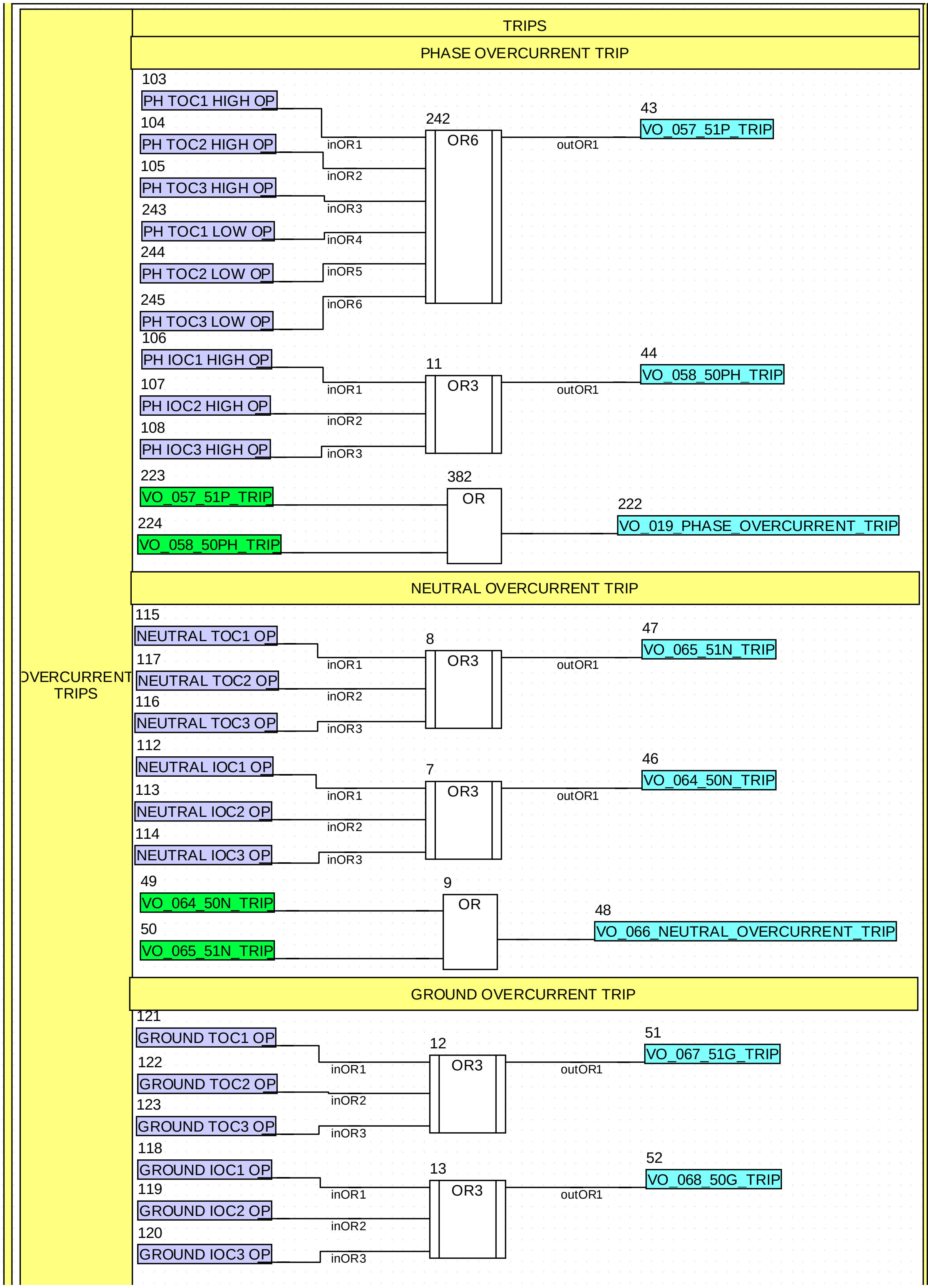

LEDS AND OUTPUTS BOOLEANS
PICKUPS
OVERCURRENT PICKUPS
PHASE OVERCURRENT
94
PH TOC1 HIGH PKP
95
PH TOC2 HIGH PKP
96
PH TOC3 HIGH PKP
246
PH TOC1 LOW PKP
247
PH TOC2 LOW PKP
248
PH TOC3 LOW PKP
249
OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
37
VO_053_51P_PKP
91
PH IOC1 HIGH PKP
92
PH IOC2 HIGH PKP
93
PH IOC3 HIGH PKP
10
OR3
inOR1
inOR2
inOR3
outOR1
36
VO_051_50PH_PKP
175
VO_051_50PH_PKP
176
VO_053_51P_PKP
312
OR
177
VO_007_PHASE_OVERCURRENT_PKP
NEUTRAL OVERCURRENT
166
NEUTRAL TOC1 PKP
167
NEUTRAL TOC2 PKP
296
NEUTRAL TOC3 PKP
162
OR3
inOR1
inOR2
inOR3
outOR1
169
VO_005_51N_PKP
163
NEUTRAL IOC1 PKP
164
NEUTRAL IOC2 PKP
165
NEUTRAL IOC3 PKP
161
OR3
inOR1
inOR2
inOR3
outOR1
168
VO_004_50N_PKP
179
VO_005_51N_PKP
180
VO_004_50N_PKP
178
OR
181
VO_008_NEUTRAL_OVERCURRENT_PKP
GROUND OVERCURRENT
GROUND TOC1 PKP
89
GROUND TOC2 PKP
90
GROUND TOC3 PKP
1
OR3
inOR1
inOR2
inOR3
outOR1
35
VO_049_51G_PKP
85
GROUND IOC1 PKP
86
GROUND IOC2 PKP
87
GROUND IOC3 PKP
0
OR3
inOR1
inOR2
inOR3
outOR1
34
VO_048_50G_PKP

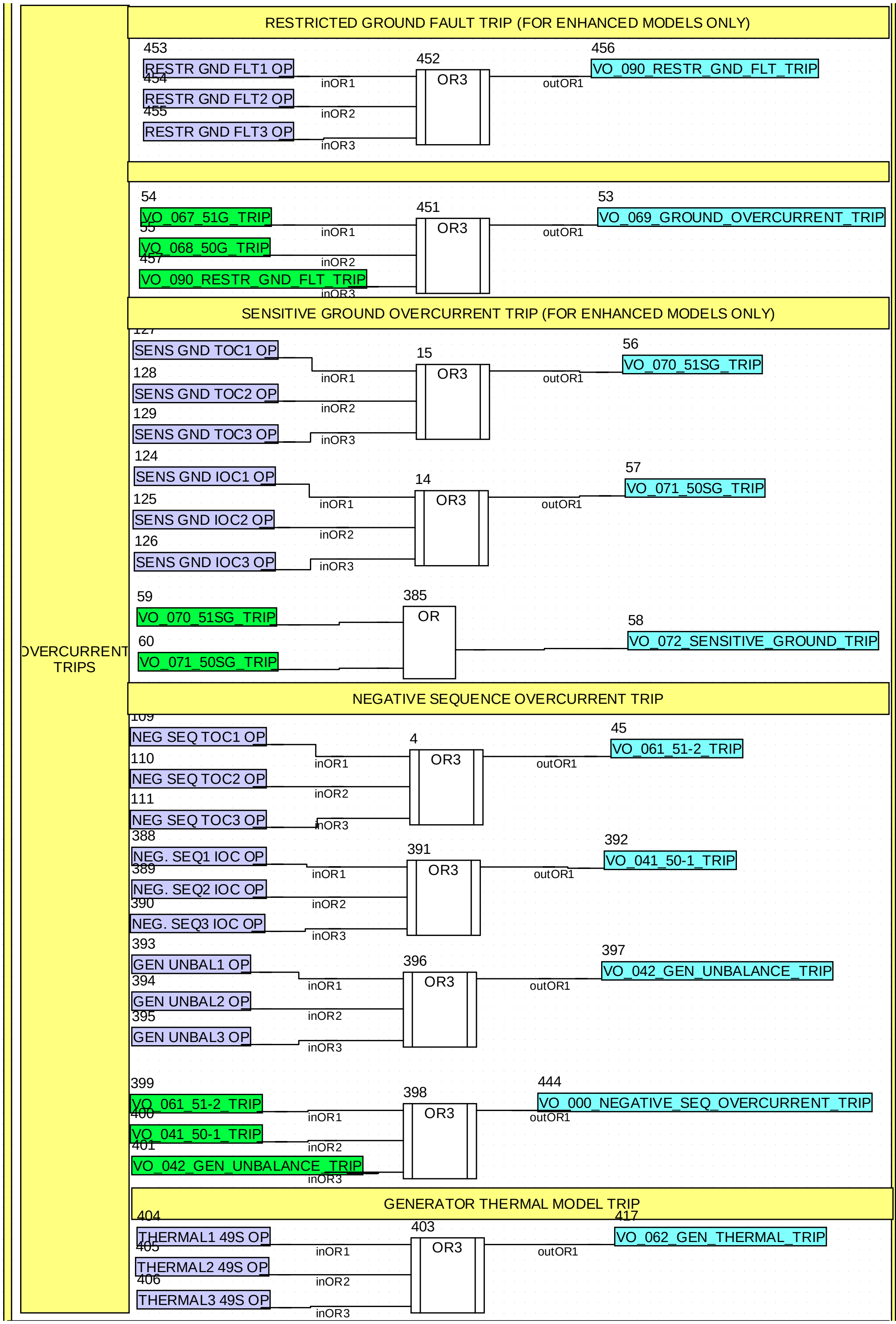

RESTRICTED GROUND FAULT (FOR ENHANCED MODELS ONLY)
363
RESTR GND FLT1 PKP
364
RESTR GND FLT2 PKP
365
RESTR GND FLT3 PKP
366
OR3
inOR1
inOR2
inOR3
outOR1
367
VO_040_REST_GND_FLT_PKP
182
VO_049_51G_PKP
184
VO_048_50G_PKP
368
VO_040_REST_GND_FLT_PKP
369
OR3
183
VO_009_GROUND_OVERCURRENT_PKP
SENSITIVE GROUND FOR ENHANCED MODELS ONLY
156
SENS GND TOC1 PKP
157
SENS GND TOC2 PKP
158
SENS GND TOC3 PKP
152
OR3
160
VO_003_51SG_PKP
153
SENS GND IOC1 PKP
154
SENS GND IOC2 PKP
155
SENS GND IOC3 PKP
151
OR3
159
VO_002_50SG_PKP
185
VO_002_50SG_PKP
186
VO_003_51SG_PKP
314
OR
187
VO_010_SENSITIVE_GROUND_PKP
OVERCURRENT PICKUPS
NEGATIVE SEQUENCE OVERCURRENT
171
NEG SEQ TOC1 PKP
172
NEG SEQ TOC2 PKP
173
NEG SEQ TOC3 PKP
170
OR3
174
VO_006_51-2_PKP
320
NEG. SEQ1 IOC PKP
321
NEG. SEQ2 IOC PKP
322
NEG. SEQ3 IOC PKP
319
OR3
323
VO_033_50-2_PKP
325
GEN UNBAL1 PKP
326
GEN UNBAL2 PKP
327
GEN UNBAL3 PKP
324
OR3
328
VO_034_GEN_UNBALANCE_PKP
331
VO_006_51-2_PKP
332
VO_033_50-2_PKP
333
VO_034_GEN_UNBALANCE_PKP
329
OR3
330
VO_035_NEGATIVE_SEQ_OVERCURRENT_PKP


OVERCURRENT PICKUPS
GENERATOR THERMAL MODEL
336
THERMAL1 49S ALARM
337
THERMAL2 49S ALARM
338
THERMAL3 49S ALARM
339
OR3
inOR1
inOR2
inOR3
outOR1
340
VO_001_GEN_THERMAL_ALARM
GENERATOR GENERAL OVERCURRENT PICKUP
189
VO_007_PHASE_OVERCURRENT_PKP
190
VO_008_NEUTRAL_OVERCURRENT_PKP
191
VO_009_GROUND_OVERCURRENT_PKP
192
VO_010_SENSITIVE_GROUND_PKP
334
VO_035_NEGATIVE_SEQ_OVERCURRENT_PKP
240
VO_001_GEN_THERMAL_ALARM
239
OR6
inOR1
inOR2
inOR3
inOR4
inOR6
outOR1
188
VO_011_ALL_OVERCURRENT_PKP
VOLTAGE PICKUPS
79
PHASE UV1 PKP
80
PHASE UV2 PKP
81
PHASE UV3 PKP
2
OR3
32
VO_045_27P_PKP
197
AUXILIARY UV1 PKP
198
AUXILIARY UV2 PKP
199
AUXILIARY UV3 PKP
207
OR3
210
VO_014_27X_PKP
82
PHASE OV1 PKP
83
PHASE OV2 PKP
84
PHASE OV3 PKP
3
OR3
33
VO_046_59P_PKP
194
NEUTRAL OV1 HIGH PKP
195
NEUTRAL OV2 HIGH PKP
196
NEUTRAL OV3 HIGH PKP
193
OR3
209
VO_012_59NH_PKP
200
AUXILIARY OV1 PKP
201
AUXILIARY OV2 PKP
202
AUXILIARY OV3 PKP
206
OR3
211
VO_015_59X_PKP
346
GND OV1 PKP
347
GND OV2 PKP
348
GND OV3 PKP
349
OR3
351
VO_037_59G_PKP
203
NEG SEQ OV1 PKP
204
NEG SEQ OV2 PKP
205
NEG SEQ OV3 PKP
208
OR3
212
VO_016_V2_OV_PKP

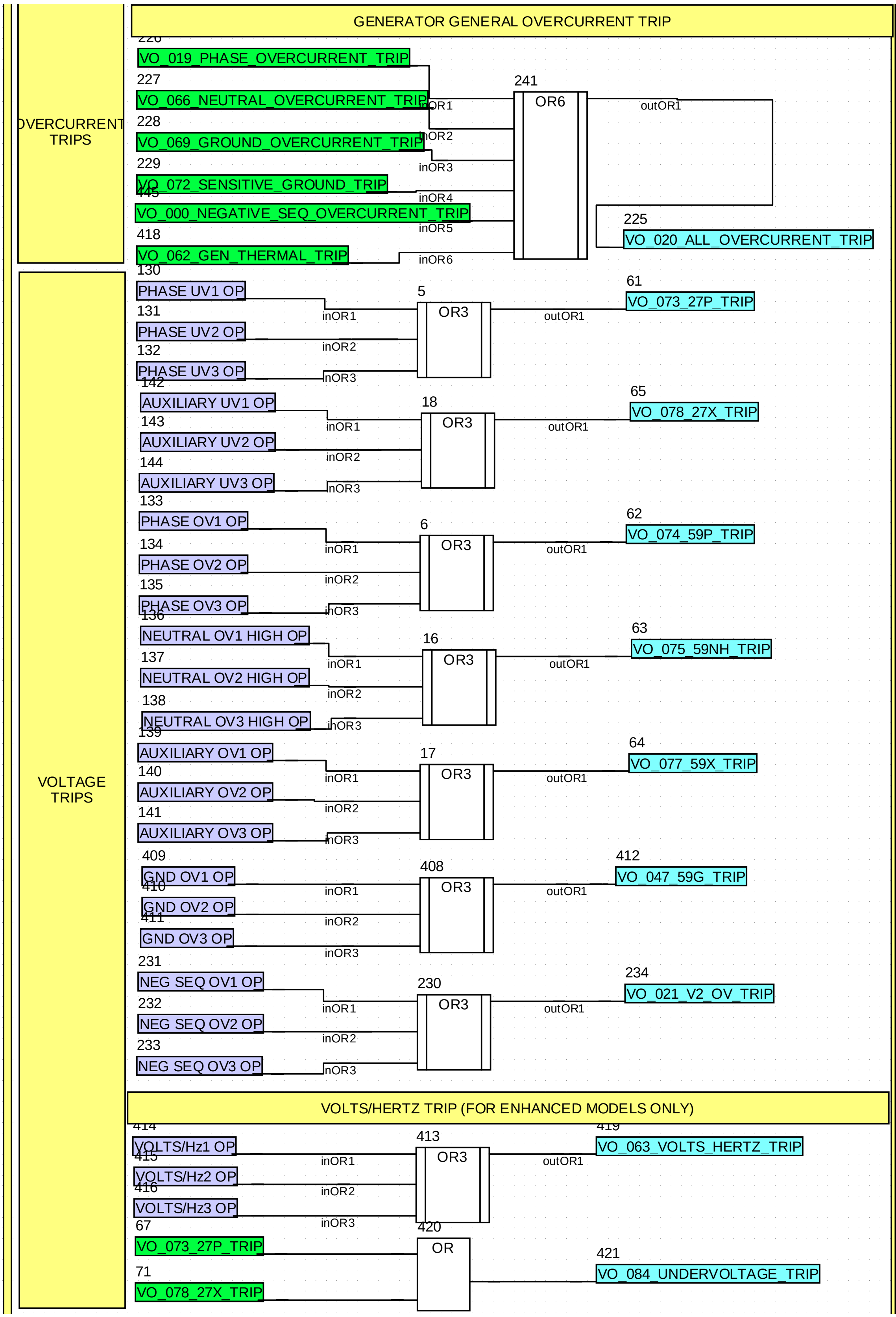

VOLTS/HERTZ PICKUP (FOR ENHANCED MODELS ONLY)
VOLTAGE PICKUPS
343
VOLTS/Hz1 PKP
344
VOLTS/Hz2 PKP
345
VOLTS/Hz3 PKP
342
OR3
inOR1
inOR2
inOR3
outOR1
350
VO_036_VOLTS_HERTZ_PKP
352
VO_045_27P_PKP
353
VO_014_27X_PKP
354
OR
355
VO_038_UNDERVOLTAGE_PKP
217
VO_046_59P_PKP
214
VO_012_59NH_PKP
215
VO_015_59X_PKP
216
VO_016_V2_OV_PKP
357
VO_037_59G_PKP
356
OR5
In OR1
In OR2
In OR3
In OR4
In OR5
OutOR1
358
VO_039_OVERVOLTAGE_PKP
360
VO_036_VOLTS_HERTZ_PKP
361
VO_038_UNDERVOLTAGE_PKP
362
VO_039_OVERVOLTAGE_PKP
359
OR3
213
VO_017_ALL_VOLTAGE_PKP
FREQUENCY PICKUPS
97
OVERFREQ1 PKP
98
OVERFREQ2 PKP
99
OVERFREQ3 PKP
21
OR3
38
VO_054_81O_PKP
100
UNDERFREQ1 PKP
101
UNDERFREQ2 PKP
102
UNDERFREQ3 PKP
22
OR3
39
VO_055_81U_PKP
299
FREQ RATE1 PKP
300
FREQ RATE2 PKP
301
FREQ RATE3 PKP
298
OR3
302
VO_052_81DF-DT PKP
304
VO_052_81DF-DT PKP
40
VO_054_81O_PKP
41
VO_055_81U_PKP
303
OR3
42
VO_056_ALL_FREQUENCY_PKP

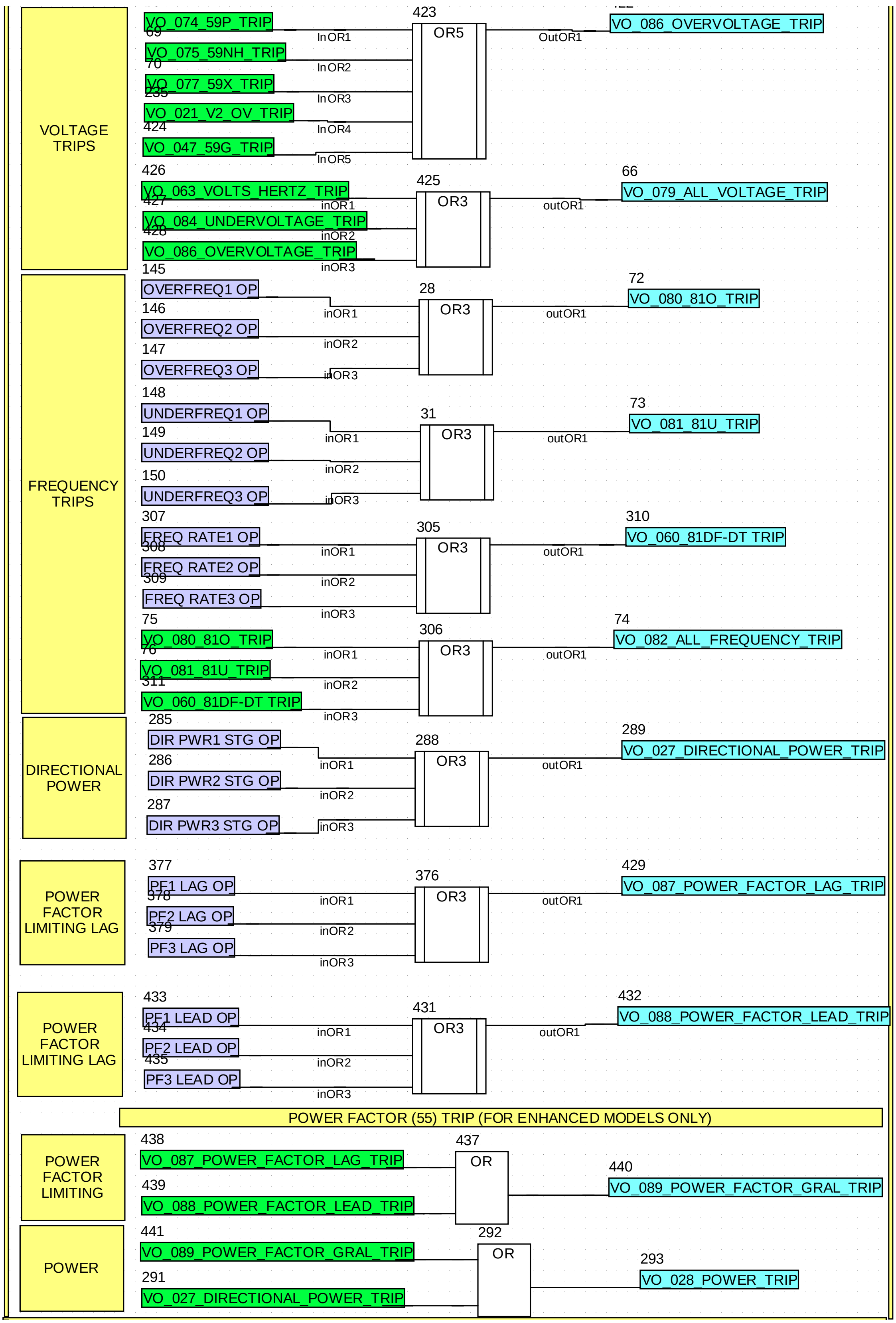

DIRECTIONAL POWER
295
DIR PWR1 STG PKP
278
DIR PWR2 STG PKP
279
DIR PWR3 STG PKP
inOR1
inOR2
inOR3
280
OR3
outOR1
277
VO_025_DIRECTIONAL_POWER_PKP
POWER
443
VO_025_DIRECTIONAL_POWER_PKP
282
VO_026_POWER_PKP
GENERAL PICKUP
218
VO_011_ALL_OVERCURRENT_PKP
219
VO_017_ALL_VOLTAGE_PKP
220
VO_056_ALL_FREQUENCY_PKP
283
VO_026_POWER_PKP
inOR1
inOR2
inOR3
inOR4
380
OR4
outOR1
78
VO_085_GENERAL_PKP


TRIPS
PHASE OVERCURRENT TRIP
103
PH TOC1 HIGH OP
104
PH TOC2 HIGH OP
105
PH TOC3 HIGH OP
243
PH TOC1 LOW OP
244
PH TOC2 LOW OP
245
PH TOC3 LOW OP
242
OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
43
VO_057_51P_TRIP
106
PH IOC1 HIGH OP
107
PH IOC2 HIGH OP
108
PH IOC3 HIGH OP
11
OR3
44
VO_058_50PH_TRIP
223
VO_057_51P_TRIP
224
VO_058_50PH_TRIP
382
OR
222
VO_019_PHASE_OVERCURRENT_TRIP
NEUTRAL OVERCURRENT TRIP
OVERCURRENT TRIPS
115
NEUTRAL TOC1 OP
117
NEUTRAL TOC2 OP
116
NEUTRAL TOC3 OP
8
OR3
47
VO_065_51N_TRIP
112
NEUTRAL IOC1 OP
113
NEUTRAL IOC2 OP
114
NEUTRAL IOC3 OP
7
OR3
46
VO_064_50N_TRIP
49
VO_064_50N_TRIP
50
VO_065_51N_TRIP
9
OR
48
VO_066_NEUTRAL_OVERCURRENT_TRIP
GROUND OVERCURRENT TRIP
121
GROUND TOC1 OP
122
GROUND TOC2 OP
123
GROUND TOC3 OP
12
OR3
51
VO_067_51G_TRIP
118
GROUND IOC1 OP
119
GROUND IOC2 OP
120
GROUND IOC3 OP
13
OR3
52
VO_068_50G_TRIP

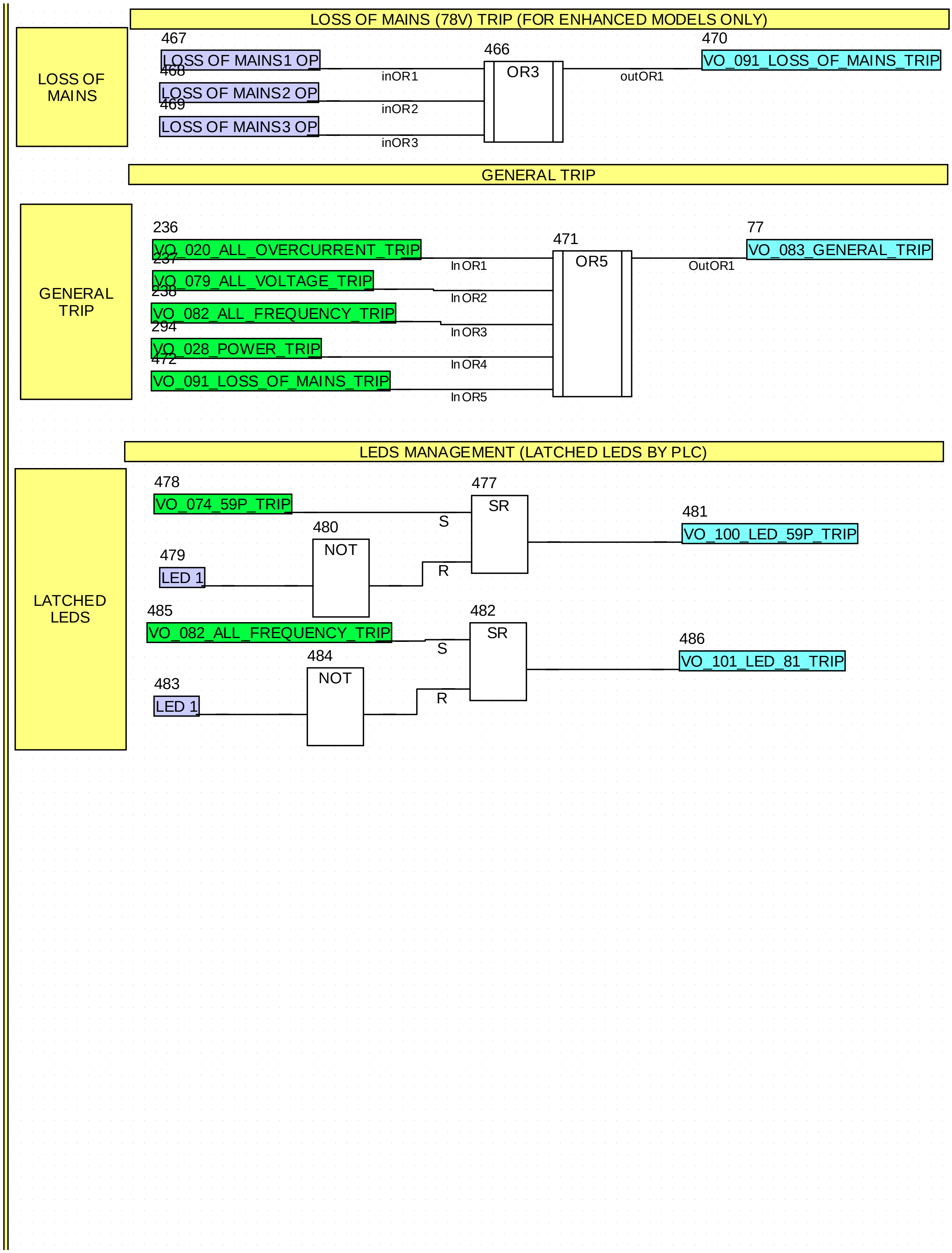

RESTRICTED GROUND FAULT TRIP (FOR ENHANCED MODELS ONLY)
453
RESTR GND FLT1 OP
454
RESTR GND FLT2 OP
455
RESTR GND FLT3 OP
452
OR3
inOR1
inOR2
inOR3
outOR1
456
VO_090_RESTR_GND_FLT_TRIP
54
VO_067_51G_TRIP
55
VO_068_50G_TRIP
457
VO_090_RESTR_GND_FLT_TRIP
451
OR3
53
VO_069_GROUND_OVERCURRENT_TRIP
SENSITIVE GROUND OVERCURRENT TRIP (FOR ENHANCED MODELS ONLY)
127
SENS GND TOC1 OP
128
SENS GND TOC2 OP
129
SENS GND TOC3 OP
15
OR3
56
VO_070_51SG_TRIP
124
SENS GND IOC1 OP
125
SENS GND IOC2 OP
126
SENS GND IOC3 OP
14
OR3
57
VO_071_50SG_TRIP
59
VO_070_51SG_TRIP
60
VO_071_50SG_TRIP
385
OR
58
VO_072_SENSITIVE_GROUND_TRIP
OVERCURRENT TRIPS
NEGATIVE SEQUENCE OVERCURRENT TRIP
109
NEG SEQ TOC1 OP
110
NEG SEQ TOC2 OP
111
NEG SEQ TOC3 OP
4
OR3
45
VO_061_51-2_TRIP
388
NEG. SEQ1 IOC OP
389
NEG. SEQ2 IOC OP
390
NEG. SEQ3 IOC OP
391
OR3
392
VO_041_50-1_TRIP
393
GEN UNBAL1 OP
394
GEN UNBAL2 OP
395
GEN UNBAL3 OP
396
OR3
397
VO_042_GEN_UNBALANCE_TRIP
399
VO_061_51-2_TRIP
400
VO_041_50-1_TRIP
401
VO_042_GEN_UNBALANCE_TRIP
398
OR3
444
VO_000_NEGATIVE_SEQ_OVERCURRENT_TRIP
GENERATOR THERMAL MODEL TRIP
404
THERMAL1 49S OP
405
THERMAL2 49S OP
406
THERMAL3 49S OP
403
OR3
417
VO_062_GEN_THERMAL_TRIP

E


GENERATOR GENERAL OVERCURRENT TRIP
OVERCURRENT TRIPS
VO_019_PHASE_OVERCURRENT_TRIP
VO_066_NEUTRAL_OVERCURRENT_TRIP
VO_069_GROUND_OVERCURRENT_TRIP
VO_072_SENSITIVE_GROUND_TRIP
VO_000_NEGATIVE_SEQ_OVERCURRENT_TRIP
VO_062_GEN_THERMAL_TRIP
OR6
VO_020_ALL_OVERCURRENT_TRIP
VOLTAGE TRIPS
PHASE UV1 OP
PHASE UV2 OP
PHASE UV3 OP
VO_073_27P_TRIP
AUXILIARY UV1 OP
AUXILIARY UV2 OP
AUXILIARY UV3 OP
VO_078_27X_TRIP
PHASE OV1 OP
PHASE OV2 OP
PHASE OV3 OP
VO_074_59P_TRIP
NEUTRAL OV1 HIGH OP
NEUTRAL OV2 HIGH OP
NEUTRAL OV3 HIGH OP
VO_075_59NH_TRIP
AUXILIARY OV1 OP
AUXILIARY OV2 OP
AUXILIARY OV3 OP
VO_077_59X_TRIP
GND OV1 OP
GND OV2 OP
GND OV3 OP
VO_047_59G_TRIP
NEG SEQ OV1 OP
NEG SEQ OV2 OP
NEG SEQ OV3 OP
VO_021_V2_OV_TRIP
VOLTS/HERTZ TRIP (FOR ENHANCED MODELS ONLY)
VOLTS/Hz1 OP
VOLTS/Hz2 OP
VOLTS/Hz3 OP
VO_063_VOLTS_HERTZ_TRIP
VO_073_27P_TRIP
VO_078_27X_TRIP
OR
VO_084_UNDERVOLTAGE_TRIP



VOLTAGE TRIPS
VO_074_59P_TRIP
VO_075_59NH_TRIP
VO_077_59X_TRIP
VO_021_V2_OV_TRIP
VO_047_59G_TRIP
423 OR5
VO_086_OVERVOLTAGE_TRIP
425 OR3
VO_063_VOLTS_HERTZ_TRIP
VO_084_UNDERVOLTAGE_TRIP
VO_086_OVERVOLTAGE_TRIP
66 VO_079_ALL_VOLTAGE_TRIP
FREQUENCY TRIPS
OVERFREQ1 OP
OVERFREQ2 OP
OVERFREQ3 OP
28 OR3
72 VO_080_81O_TRIP
UNDERFREQ1 OP
UNDERFREQ2 OP
UNDERFREQ3 OP
31 OR3
73 VO_081_81U_TRIP
FREQ RATE1 OP
FREQ RATE2 OP
FREQ RATE3 OP
305 OR3
310 VO_060_81DF-DT TRIP
VO_080_81O_TRIP
VO_081_81U_TRIP
VO_060_81DF-DT TRIP
306 OR3
74 VO_082_ALL_FREQUENCY_TRIP
DIRECTIONAL POWER
DIR PWR1 STG OP
DIR PWR2 STG OP
DIR PWR3 STG OP
288 OR3
289 VO_027_DIRECTIONAL_POWER_TRIP
POWER FACTOR LIMITING LAG
PF1 LAG OP
PF2 LAG OP
PF3 LAG OP
376 OR3
429 VO_087_POWER_FACTOR_LAG_TRIP
POWER FACTOR LIMITING LAG
PF1 LEAD OP
PF2 LEAD OP
PF3 LEAD OP
431 OR3
432 VO_088_POWER_FACTOR_LEAD_TRIP
POWER FACTOR (55) TRIP (FOR ENHANCED MODELS ONLY)
POWER FACTOR LIMITING
VO_087_POWER_FACTOR_LAG_TRIP
VO_088_POWER_FACTOR_LEAD_TRIP
437 OR
440 VO_089_POWER_FACTOR_GRAL_TRIP
POWER
VO_089_POWER_FACTOR_GRAL_TRIP
VO_027_DIRECTIONAL_POWER_TRIP
292 OR
293 VO_028_POWER_TRIP


LOSS OF MAINS (78V) TRIP (FOR ENHANCED MODELS ONLY)
LOSS OF MAINS
467
LOSS OF MAINS1 OP
468
LOSS OF MAINS2 OP
469
LOSS OF MAINS3 OP
inOR1
inOR2
inOR3
466
OR3
outOR1
470
VO_091_LOSS_OF_MAINS_TRIP
GENERAL TRIP
GENERAL TRIP
236
VO_020_ALL_OVERCURRENT_TRIP
237
VO_079_ALL_VOLTAGE_TRIP
238
VO_082_ALL_FREQUENCY_TRIP
294
VO_028_POWER_TRIP
472
VO_091_LOSS_OF_MAINS_TRIP
In OR1
In OR2
In OR3
In OR4
In OR5
471
OR5
OutOR1
77
VO_083_GENERAL_TRIP
LEDS MANAGEMENT (LATCHED LEDS BY PLC)
LATCHED LEDS
478
VO_074_59P_TRIP
479
LED 1
480
NOT
477
SR
S
R
481
VO_100_LED_59P_TRIP
485
VO_082_ALL_FREQUENCY_TRIP
483
LED 1
484
NOT
482
SR
S
R
486
VO_101_LED_81_TRIP

Factory Default Settings Example for Enhanced Models

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]	

F

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]

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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]	

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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]	
Sampling Rate	Sampling Rate	3600	N/A	[225-450-900-1800-3600]	
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]	

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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 : 500.0]	
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– VG]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Frequency Tracking	Freq. Tracking	DISABLED	N/A	[DISABLED – ENABLED]	

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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					
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 > PHASE CURRENT > GENERATOR THERMAL MODEL >					
GENERATOR THERMAL MODEL 1> GENERATOR THERMAL MODEL 2 > GENERATOR THERMAL MODEL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating time constant	Heat time constant	6.00 min	0.1 min	[3.0 : 600.0]	
Cooling time constant	Cool time constant	2.00	0.01 times Heat Time	[1.00 : 6.00]	
Pickup level value	Pickup level	1.00 A	0.01 A	[0.05 : 160.00]	
Alarm level value	Alarm level	80.0 %	0.1 %	[1.0 : 110.0]	
Negative sequence influence	K1 constant	1.0	0.1	[1.0 : 8.0]	
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 : 500]	
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]	

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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]	

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 : 500]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > RESTRICTED GROUND FAULT (ENHANCED MODELS ONLY) >					
RESTRICTED GND FAULT 1> RESTRICTED GND FAULT 2 > RESTRICTED GND FAULT 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Ground Fault Pickup	10.00	0.01 CT	0.02 – 20.00	
Function slope	Ground Fault Slope	10.00	0.01%	0.00 – 100.00	
Time delay	Ground Fault Delay	0.10	0.01 s	0.00 – 600.00	
Snapshot event generation	Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND TOC (ENHANCED MODELS ONLY)					
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]	

F

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND IOC (ENHANCED MODELS ONLY)					
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 > 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 > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE IOC >					
NEGATIVE SEQUENCE IOC 1> NEGATIVE SEQUENCE IOC 2 > NEGATIVE SEQUENCE IOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function name	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	30.00	0.01 A	0.05 – 160.00	
Trip delay time	Trip Delay	0.00	0.01 s	0.00 – 900.00	
Reset delay time	Reset Delay	0.00	0.01 s	0.00 – 900.00	
Snapshot event generation	Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > GENERATOR UNBALANCE > GENERATOR UNBALANCE 1> GENERATOR UNBALANCE 2 > GENERATOR UNBALANCE 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	
Function Permision	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Generator Rated Full Load Current	Gen Unbal Inom	5.00	0.01 A	[0.00 : 10.00]	
Pickup level for stage 1 (as a percentage of Gen Unbal Inom)	Gen Unbal Stg1 Pkp	8.00	0.01 %	[0.00 : 100.00]	
K (Negative sequence capability constant) for stage 1	Gen Unbal Stg1 K	1.00	0.01	[0.00 : 100.00]	
Minimum Operating time for stage 1	Gen Unbal Stg1 Tmin	0.3	0.1 s	[0.0 : 1000.0]	
Maximum Operating time for stage 1	Gen Unbal Stg1 Tmax	600.0	0.1 s	[0.0 : 1000.0]	
K for Linear reset of the stage	Gen Unbal Stg1 K-Rst	240.0	0.1	[0.0 : 1000.0]	
Pickup level for stage 2 (as a percentage of Gen Unbal Inom)	Gen Unbal Stg2 Pkp	3.00	0.01 %	[0.00 : 100.00]	
Trip time for stage 2	Gen Unbal Stg2 Delay	5.0	0.1s	[0.0 : 1000.0]	
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 : 500]	
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 : 500]	
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 : 500]	
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					
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 : 500]	
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 : 500]	
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 : 500]	
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 : 500]	
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 >VOLTAGE ELEMENTS>VOLTS/HERTZ (ENHANCED MODELS ONLY)					
VOLTS/HERTZ 1> VOLTS/HERTZ 2 > VOLTS/HERTZ 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
V/Hz Source for element calculations	V/Hz Source	PHASES	N/A	[PHASES – AUX VOLTAGE]	
V/Hz Minimum operating Voltage	V/Hz Minimum Voltage	40.00	0.01 V	[30.00 : 500.00]	
V/Hz Pickup Level	V/Hz Pickup Level	1.00	0.01 pu	[0.80 : 4.00]	
V/Hz Curve	V/Hz Curve	DEFINITE TIME		[DEFINITE TIME-CURVE A-CURVE B – CURVE C]	
V/Hz TD Multiplier	V/Hz TD Multiplier	1.00	0.01	[0.05 : 600.00]	
V/Hz Reset Delay	V/Hz Reset Delay	1.0	0.1 s	[0.0 : 900.0]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS >VOLTAGE ELEMENTS>GROUND OV					
GROUND OV 1> GROUND OV 2 > GROUND 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 – 500]	
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]	

F

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 > PROTECTION ELEMENTS > POWER > POWER FACTOR LIMITING(ENHANCED MODELS ONLY)> PWR FACTOR LIMITING 1> PWR FACTOR LIMITING 2 > PWR FACTOR LIMITING 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level for PF Lead Stage1	PF Lead Stg1 Level	0.99	0.01	[0.05 : 0.99]	
Pickup level for PF Lag Stage1	PF Lag Stg1 Level	0.80	0.01	[0.05 : 0.99]	
Trip time for PF Stage1	PF Stg1 Trip Delay	1.0	0.1 s	[0.2 : 300.0]	
Pickup level for PF Lead Stage2	PF Lead Stg2 Level	0.99	0.01	[0.05 : 0.99]	
Pickup level for PF Lag Stage2	PF Lag Stg2 Level	0.75	0.01	[0.05 : 0.99]	
Trip time for PF Stage2	PF Stg2 Trip Delay	1.0	0.1 s	[0.2 : 300.0]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

F

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	0	1 V	[30 : 00]	
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 : 500]	
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 : 500.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 500.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 500.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 500.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 500.00]	
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 > BREAKER FAILURE(ENHANCED MODELS ONLY)					
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(ENHANCED MODELS ONLY)					
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 > 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 > LOSS OF MAINS(ENHANCED MODELS ONLY					
LOSS OF MAINS 1 > LOSS OF MAINS 2 > LOSS OF MAINS 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Any phase or three phase displacement mode to operate	Loss of Mains Mode	ONE PHASE	N/A	[ONE PHASE]	
Minimum Phase shift angle value to operate	Phase Shift Angle	1.00	0.01 Deg	[2.00 : 22.00]	
Minimum voltage threshold	Minimum Voltage	70	1 V	[30 : 500]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > LOSS OF EXCITATION

F

LOSS OF EXCITATION 1 > LOSS OF EXCITATION 2 > LOSS OF EXCITATION 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Center point in Ohms (sec) for Stage 1	Stage 1 Center	10.00	0.01 Ohm	[0.10 : 300.00]	
Radius value in Ohms (sec) for Stage 1	Stage 1 Radius	8.00	0.01 Ohm	[0.10 : 300.00]	
UV Supervision for stage 1	Stage 1 UV Supv	DISABLED	N/A	[DISABLED – ENABLED]	
Trip time for Stage 1	Stage 1 Trip Delay	0.05	0.01 s	[0.00 : 65.54]	
Center point in Ohms (sec) for Stage 2	Stage 2 Center	10.00	0.01 Ohm	[0.10 : 300.00]	
Radius value in Ohms (sec) for Stage 2	Stage 2 Radius	8.00	0.01 Ohm	[0.10 : 300.00]	
UV Supervision for stage 2	Stage 2 UV Supv	DISABLED	N/A	[DISABLED – ENABLED]	
Trip time for Stage 2	Stage 2 Trip Delay	0.05	0.01 s	[0.00 : 65.54]	
UV Supervision Level for both stages 1 and 2	UV Supv Level	40.0	0.1 V	[0.0 : 500.0]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > ACCIDENTAL ENERGIZATION					
ACCIDENTAL ENERGIZATION 1 > ACCIDENTAL ENERGIZATION 2 > ACCIDENTAL ENERGIZATION 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Arming mode for Accidental Energization	Accdnt Enrg Mode	UV AND OFF-LINE	N/A	[UV AND OFF-LINE – UV OR OFF-LINE]	
Overcurrent Level to operate	Overcurrent pickup	1.50	0.01 A	[0.00 : 160.00]	
Arming undervoltage value	Ph Undervoltage pickup	40.00	0.01 V	[0.00 : 500.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

F

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]	

F

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)		

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN G650
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	CONT_OP_F_01_FREQ PKP	VO_056_ALL_FREQUENCY_PKP		
CONT OP OPER_F_02	CONT_OP_F_02_27-59 PKP	VO_046_59P_PKP		
		VO_045_27P_PKP		
CONT OP OPER_F_03	CONT_OP_F_03_50G_PKP	VO_048_50G_PKP		
CONT OP OPER_F_04	CONT_OP_F_04_51G_PKP	VO_049_51G_PKP		
CONT OP OPER_F_05	CONT_OP_F_05_50P_PKP	VO_051_50PH_PKP		
CONT OP OPER_F_06	CONT_OP_F_06_51P_PKP	VO_053_51P_PKP		
CONT OP OPER_F_07	CONT_OP_F_07_MANUAL_CLOSE	OPERATION BIT 1		
CONT OP OPER_F_08	CONT_OP_F_08_GENERAL_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			

SETPOINT>RELAY CONFIGURATION>OUTPUTS				
OUTPUT ID	**OUTPUT NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
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	50_2/51_2 TRIP	VO_061_51-2_TRIP		
		VO_041_50-1_TRIP		
LED05	27 TRIP	VO_073_27P_TRIP		
LED06	59 TRIP	VO_100_LED_59P_TRIP		
LED07	81TRIP	VO_101_LED_81_TRIP		
LED08	PICKUP	VO_085_GENERAL_PKP		
LED09	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
LED10	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
LED11	50_2/51_2 PKP	VO_006_51-2_PKP		
		VO_033_50-2_PKP		
LED12	27 PICKUP	VO_045_27P_PKP		
LED13	59 PICKUP	VO_046_59P_PKP		
LED14	81U/O PICKUP	VO_054_81O_PKP		
		VO_055_81U_PKP		
LED15	81R PICKUP	VO_052_81DF-DT PKP		

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		
	LVI_1_BLOCK 50PH		
PH IOC1 HIGH B BLK	GROUP 1 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC1 HIGH C BLK	GROUP 1 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC2 HIGH A BLK	GROUP 2 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC2 HIGH B BLK	GROUP 2 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC2 HIGH C BLK	GROUP 2 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC3 HIGH A BLK	GROUP 3 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC3 HIGH B BLK	GROUP 3 BLOCKED		
	LVI_1_BLOCK 50PH		
PH IOC3 HIGH C BLK	GROUP 3 BLOCKED		
	LVI_1_BLOCK 50PH		
NEUTRAL IOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	

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SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
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		
	LVI_3_BLOCK 50G		
	GROUND DIR1 OP	NOT	
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
GROUND IOC2 BLOCK	GROUP 2 BLOCKED		
	LVI_3_BLOCK 50G		
	GROUND DIR2 OP	NOT	
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
GROUND IOC3 BLOCK	GROUP 3 BLOCKED		
	LVI_3_BLOCK 50G		
	GROUND DIR3 OP	NOT	
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
SENS GND IOC1 BLK (*)	GROUP 1 BLOCKED		
	LVI_4_BLOCK 50SG		
SENS GND IOC2 BLK (*)	GROUP 2 BLOCKED		
	LVI_4_BLOCK 50SG		
SENS GND IOC3 BLK (*)	GROUP 3 BLOCKED		
	LVI_4_BLOCK 50SG		
PH TOC1 HIGH A BLK	GROUP 1 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC1 HIGH B BLK	GROUP 1 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC1 HIGH C BLK	GROUP 1 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC2 HIGH A BLK	GROUP 2 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC2 HIGH B BLK	GROUP 2 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC2 HIGH C BLK	GROUP 2 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC3 HIGH A BLK	GROUP 3 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC3 HIGH B BLK	GROUP 3 BLOCKED		
	LVI_5_BLOCK 51PH		
PH TOC3 HIGH C BLK	GROUP 3 BLOCKED		
	LVI_5_BLOCK 51PH		
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		
	LVI_7_BLOCK 51G		
	GROUND DIR1 OP	NOT	

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SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
GROUND TOC2 BLOCK	GROUP 2 BLOCKED		
	LVI_7_BLOCK 51G		
	GROUND DIR2 OP	NOT	
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
GROUND TOC3 BLOCK	GROUP 3 BLOCKED		
	LVI_7_BLOCK 51G		
	GROUND DIR3 OP	NOT	
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
SENS GND TOC1 BLOCK (*)	GROUP 1 BLOCKED		
	LVI_8_BLOCK 51SG		
SENS GND TOC2 BLOCK (*)	GROUP 2 BLOCKED		
	LVI_8_BLOCK 51SG		
SENS GND TOC3 BLOCK (*)	GROUP 3 BLOCKED		
	LVI_8_BLOCK 51SG		
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		
NEG SEQ OV3 BLOCK	GROUP 3 BLOCKED		
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		
	LVI_10_BLOCK 67G		
	CONT IP_F_CC8 (67G BLOCK)(CC8)		
GROUND DIR2 BLK INP	GROUP 2 BLOCKED		
	LVI_10_BLOCK 67G		
	CONT IP_F_CC8 (67G BLOCK)(CC8)		
GROUND DIR3 BLK INP	GROUP 3 BLOCKED		
	LVI_10_BLOCK 67G		
	CONT IP_F_CC8 (67G BLOCK)(CC8)		
NEUTRAL OV1 HIGH BLK	GROUP 1 BLOCKED		
	LVI_12_BLOCK 59NH		
NEUTRAL OV2 HIGH BLK	GROUP 2 BLOCKED		
	LVI_12_BLOCK 59NH		
NEUTRAL OV3 HIGH BLK	GROUP 3 BLOCKED		
	LVI_12_BLOCK 59NH		
AUXILIARY UV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY UV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY UV3 BLOCK	GROUP 3 BLOCKED		
PHASE OV1 BLOCK	GROUP 1 BLOCKED		
	LVI_11_BLOCK 59P		
PHASE OV2 BLOCK	GROUP 2 BLOCKED		

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SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
	LVI_11_BLOCK 59P		
PHASE OV3 BLOCK	GROUP 3 BLOCKED		
	LVI_11_BLOCK 59P		
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		
	CONT IP_F_CC7 (51-2 BLOCK)(CC7)		
NEG SEQ TOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC7 (51-2 BLOCK)(CC7)		
NEG SEQ TOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC7 (51-2 BLOCK)(CC7)		
OVERFREQ1 BLOCK	GROUP 1 BLOCKED		
OVERFREQ2 BLOCK	GROUP 2 BLOCKED		
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		
PH TOC1 LOW A BLK	GROUP 1 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC1 LOW B BLK	GROUP 1 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC1 LOW C BLK	GROUP 1 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC2 LOW A BLK	GROUP 2 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC2 LOW B BLK	GROUP 2 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC2 LOW C BLK	GROUP 2 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC3 LOW A BLK	GROUP 3 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC3 LOW B BLK	GROUP 3 BLOCKED		
	LVI_6_BLOCK 51PL		
PH TOC3 LOW C BLK	GROUP 3 BLOCKED		
	LVI_6_BLOCK 51PL		
DIR PWR1 BLOCK	GROUP 1 BLOCKED		
DIR PWR2 BLOCK	GROUP 2 BLOCKED		
DIR PWR3 BLOCK	GROUP 3 BLOCKED		
FREQ RATE1 BLOCK	GROUP 1 BLOCKED		
FREQ RATE2 BLOCK	GROUP 2 BLOCKED		
FREQ RATE3 BLOCK	GROUP 3 BLOCKED		
RESTR GND FLT1 BLOCK (*)	GROUP 1 BLOCKED		
RESTR GND FLT2 BLOCK (*)	GROUP 2 BLOCKED		
RESTR GND FLT3 BLOCK (*)	GROUP 3 BLOCKED		

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SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LOSS OF MAINS1 BLOCK (*)	GROUP 1 BLOCKED		
LOSS OF MAINS2 BLOCK (*)	GROUP 2 BLOCKED		
LOSS OF MAINS3 BLOCK (*)	GROUP 3 BLOCKED		
GEN UNBAL1 BLOCK	GROUP 1 BLOCKED		
GEN UNBAL2 BLOCK	GROUP 2 BLOCKED		
GEN UNBAL3 BLOCK	GROUP 3 BLOCKED		
VOLTS/Hz1 BLOCK (*)	GROUP 1 BLOCKED		
VOLTS/Hz2 BLOCK (*)	GROUP 2 BLOCKED		
VOLTS/Hz3 BLOCK (*)	GROUP 3 BLOCKED		
LOSS OF EXC1 BLOCK	GROUP 1 BLOCKED		
LOSS OF EXC2 BLOCK	GROUP 2 BLOCKED		
LOSS OF EXC3 BLOCK	GROUP 3 BLOCKED		
NEG. SEQ1 IOC BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC4 (50-2 BLOCK)(CC4)		
NEG. SEQ2 IOC BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC4 (50-2 BLOCK)(CC4)		
NEG. SEQ3 IOC BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC4 (50-2 BLOCK)(CC4)		
THERMAL1 49S BLOCK	GROUP 1 BLOCKED		
THERMAL2 49S BLOCK	GROUP 2 BLOCKED		
THERMAL3 49S BLOCK	GROUP 3 BLOCKED		
POWER FACTOR1 BLOCK(*)	GROUP 1 BLOCKED		
POWER FACTOR2 BLOCK(*)	GROUP 2 BLOCKED		
POWER FACTOR3 BLOCK(*)	GROUP 3 BLOCKED		
ACCDNT ENRG1 BLOCK	GROUP 1 BLOCKED		
ACCDNT ENRG2 BLOCK	GROUP 2 BLOCKED		
ACCDNT ENRG3 BLOCK	GROUP 3 BLOCKED		
GND OV1 BLK	GROUP 1 BLOCKED		
GND OV2 BLK	GROUP 2 BLOCKED		
GND OV3 BLK	GROUP 3 BLOCKED		
THERMAL1 49S RST	Not Configured		
THERMAL2 49S RST	Not Configured		
THERMAL3 49S RST	Not Configured		
SYNCROCHECK BLK INP	Not Configured		
BKR FAIL INITIATE	Not Configured		
GROUP 1 ACT ON	Not Configured		
GROUP 2 ACT ON	Not Configured		
GROUP 3 ACT ON	Not Configured		
ACCDNT ENRG1 OFFLINE	Not Configured		
ACCDNT ENRG2 OFFLINE	Not Configured		
ACCDNT ENRG3 OFFLINE	Not Configured		
FAULT REPORT TRIGG	Not Configured		
CLEAR FAULT REPORTS	Not Configured		
DEMAND TRIGGER INP	Not Configured		

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SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
DEMAND RESET INP	Not Configured		
FREEZE ENERGY CNT	Not Configured		
UNFREEZE ENERGY CNT	Not Configured		
RESET ENERGY CNT	Not Configured		
RESET KI2t COUNTERS	Not Configured		
RESET BKR COUNTERS	Not Configured		
Note (*): Only available for Enhanced models (see ordering code)			

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	50_2/51_2 TRIP	VO_061_51-2_TRIP		
		VO_041_50-1_TRIP		
DIG_CHANNEL#5	27 TRIP	VO_073_27P_TRIP		
DIG_CHANNEL#6	59 TRIP	VO_074_59P_TRIP		
DIG_CHANNEL#7	81O81U TRIP	VO_081_81U_TRIP		
		VO_080_81O_TRIP		
DIG_CHANNEL#8	81DFDT TRIP	VO_060_81DF-DT TRIP		
DIG_CHANNEL#9	PICKUP	VO_085_GENERAL_PKP		
DIG_CHANNEL#10	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
DIG_CHANNEL#11	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
DIG_CHANNEL#12	50_2/51_2 PKP	VO_033_50-2_PKP		
		VO_006_51-2_PKP		
DIG_CHANNEL#13	27 PICKUP	VO_045_27P_PKP		
DIG_CHANNEL#14	59 PICKUP	VO_046_59P_PKP		
DIG_CHANNEL#15	81U/O PICKUP	VO_055_81U_PKP		
		VO_054_81O_PKP		
DIG_CHANNEL#16	81R PICKUP	VO_052_81DF-DT PKP		
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.