GE
Grid Solutions

C650 Bay Controller
and Monitoring System

Instruction Manual

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imagination at work

GE Multilin C650 Bay Controller & Monitoring System instruction manual for revision 1601-0801-A2.

Part number: 1601-0801-A2 (March 2021)

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Grid Solutions

C650 Bay Controller & Monitoring System

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C650 Bay Controller & Monitoring System

Chapter 1: Getting Started

1.1 Important procedures

Use this chapter for initial setup of your new C650 Bay Controller & Monitoring System.

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 unit, it is imperative that all warnings and cautions in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.

The following safety and equipment symbols are used in this document.

DANGER **Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

WARNING **Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

CAUTION **Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

NOTICE Indicates practices not related to personal injury.

1.1.1.1 General cautions and warnings

The following general safety precautions and warnings apply.

WARNING **Ensure that all connections to the product are correct so as to avoid accidental risk of shock and/or fire, for example such as can arise from high voltage connected to low voltage terminals.**

Follow the requirements of this manual, including adequate wiring size and type, terminal torque settings, voltage, current magnitudes applied, and adequate isolation/clearance in external wiring from high to low voltage circuits.

Use the device only for its intended purpose and application.

Ensure that all ground paths are uncompromised for safety purposes during device operation and service.

Ensure that the control power applied to the device, the AC current, and voltage input match the ratings specified on the relay nameplate. Do not apply current or voltage in excess of the specified limits.

Only qualified personnel are to operate the device. Such personnel must be thoroughly familiar with all safety cautions and warnings in this manual and with applicable country, regional, utility, and plant safety regulations.

Hazardous voltages can exist in the power supply and at the device connection to current transformers, voltage transformers, control, and test circuit terminals. Make sure all sources of such voltages are isolated prior to attempting work on the device.

Hazardous voltages can exist when opening the secondary circuits of live current transformers. Make sure that current transformer secondary circuits are shorted out before making or removing any connection to the current transformer (CT) input terminals of the device.

For tests with secondary test equipment, ensure that no other sources of voltages or currents are connected to such equipment and that trip and close commands to the circuit breakers or other switching apparatus are isolated, unless this is required by the test procedure and is specified by appropriate utility/plant procedure.

When the device is used to control primary equipment, such as circuit breakers, isolators, and other switching apparatus, all control circuits from the device to the primary equipment must be isolated while personnel are working on or around this primary equipment to prevent any inadvertent command from this device.

Uses an external disconnect to isolate the mains voltage supply.

WARNING **LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered safe to the unaided eye. Do not view directly with optical instruments.**

NOTICE This product is rated to Class A emissions levels and is to be used in Utility, Substation Industrial environments. Not to be used near electronic devices rated for Class B levels.

Figure 1-1: Front view of C650 half-rack unit

Figure 1-2: Front view of C650 full-rack unit

1.1.1.2 Communication board 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 UNIT MUST BE POWERED OFF AND ALL THE REAR TERMINALS MUST BE POTENTIAL FREE. THE UNIT MUST BE GROUNDED USING THE REAR GROUNDING SCREW.**

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

Figure 1-1: Module withdrawal/insertion for half-rack unit 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 disconnecting the unit auxiliary voltage and ensuring that all the rear terminals are potential free.

Communication boards are installed on the rear of the unit, with upper port reserved for the asynchronous communications board and CAN bus, and the lower port for the ETHERNET board. (The Ethernet module can be withdrawn or inserted only in models with Rear Ethernet Communication Board 2: "B", "C", "D" or "E". For the remaining options, Ethernet communications are included in the main CPU).

Before performing any of these actions, control power must be removed from the unit and all the rear terminals must be potential free. A grounded anti-static 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 unit is fully operative.

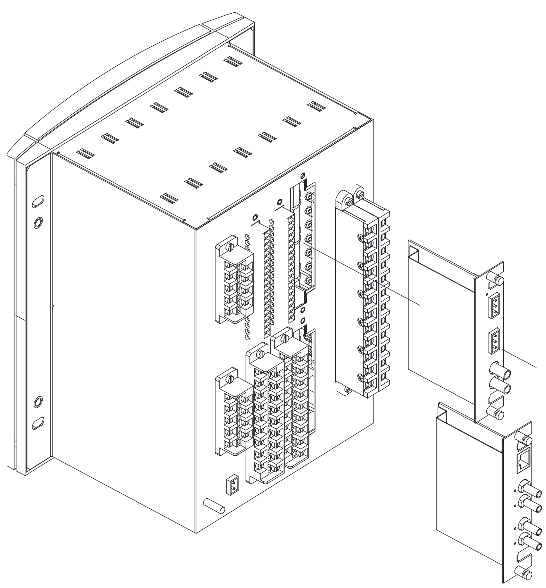

Figure 1-1: Module withdrawal/insertion for half-rack unit

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

1.1.1.3 Magnetic module terminals

Magnetic module terminals are only available in models with Enhanced functionality (Display option E, C, D). 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.

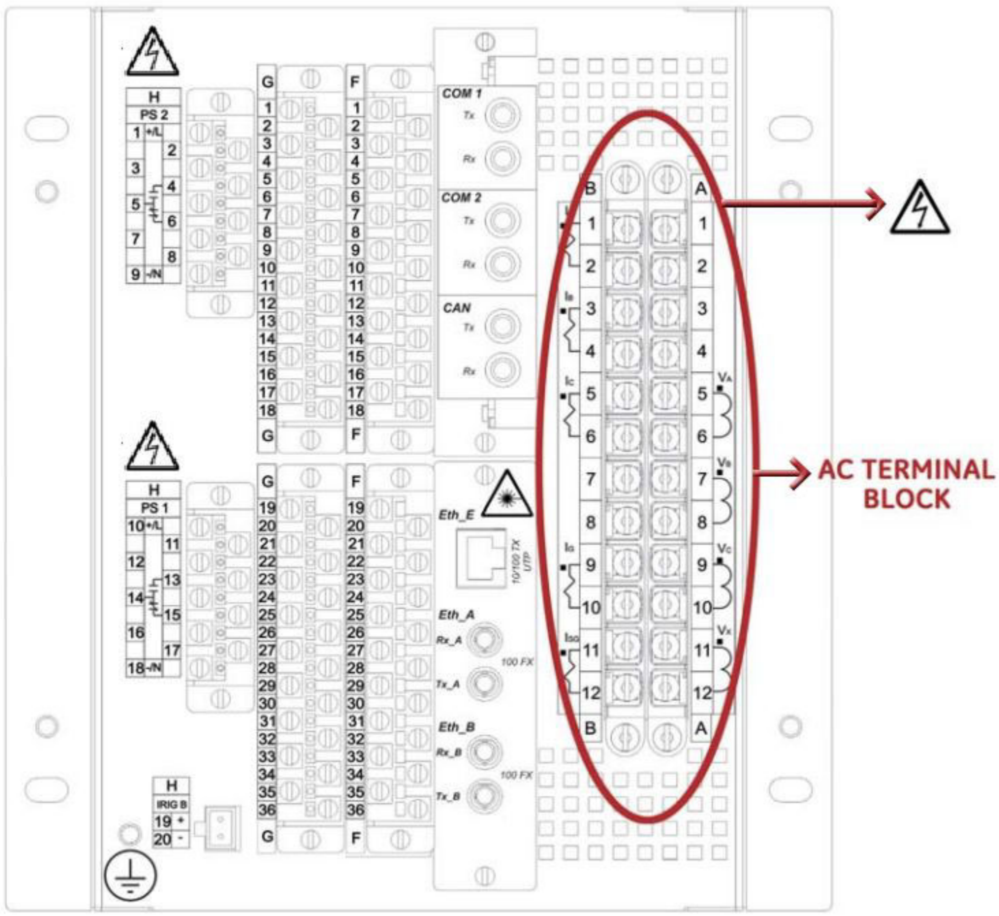

Figure 1-1: Rear view of C650 unit

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

1. Unwrap the unit and inspect the unit for physical damage.
2. View the nameplate and verify that the correct model has been ordered and delivered. The model number is at the top.

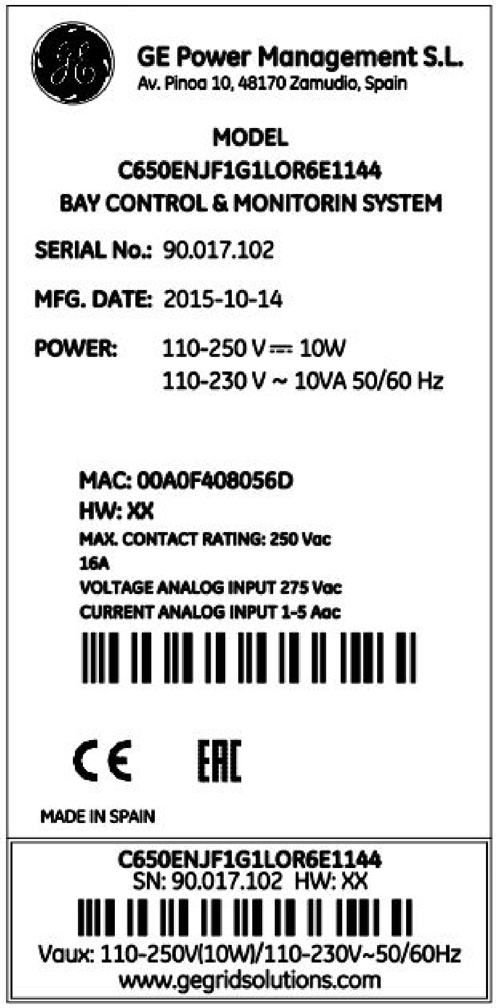

Figure 1-2: Identification label (A4454P45)

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

- Mounting screws for fixing the unit to a cabinet
- GE EnerVista™ DVD (includes the EnerVista 650 Setup software and manuals in PDF format)
- Wiring diagram.
- Certificate of Compliance

For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin Home Page: http://www.gegridsolutions.com/multilin/

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

EUROPE, MIDDLE EAST AND AFRICA:

GE Grid Solutions
Av. Pinoa, 10
48170 Zamudio, Vizcaya (SPAIN)
Tel.: (34) 94-485 88 54
Fax: (34) 94-485 88 38
E-mail: multilin.tech.euro@ge.com

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GE Grid Solutions
650 Markland Street
Markham, Ontario
Canada L6C 0M1
North America toll-free: +1 800 547 8629
Tel.: +1 905 927 7070
Fax: +1 905 927 5098
E-mail: multilin.tech@ge.com

CAUTION **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, Grid Solutions.

1.1.3 Safety instructions

The C650 ground screw shown in Figure 1-3: Location of grounding screw must be correctly grounded.

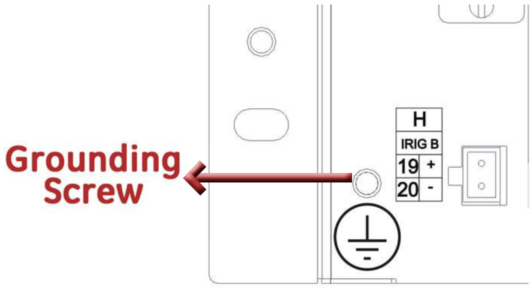


Figure 1-3: Location of grounding screw

Before communicating with the C650 through the front USB port, ensure that the computer's power supply is grounded. When using a laptop, it is recommended that the power supply be disconnected. In many cases the laptop may not be correctly grounded either due to the power supply or to the connector cables used.

GE Multilin will not be responsible for any damage to the unit or connected equipment when this basic safety rule is not followed.

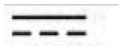
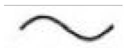
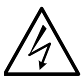
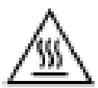
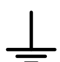
1.1.3.1 General safety instructions

⚠CAUTION

- **Failure to practice safe working procedures is likely to damage the equipment, cause severe injury and/or death.**
- **The use of appropriate safety gloves, safety glasses and protective clothing are recommended during equipment installation, maintenance and service of the equipment.**
- **All procedures must be strictly adhered to.**
- **Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.**
- **Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.**
- **If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in Impaired operation and injury.**
- **Beware of potential hazards, wear personal protective equipment and carefully inspect the work area for tools and objects that may have been left inside the equipment.**
- **Caution: Hazardous voltages can cause shock, burns or death.**
- **Test/Installation/Service personnel must be familiar with general device test practices, safety precautions and follow standard ESD precautions to avoid personal injury or equipment damage.**
- **Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.**
- **Failure to shut equipment power off prior to removing the power connections could expose you to dangerous voltages causing injury or death.**
- **All recommended equipment that should be grounded must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.**
- **Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.**
- **Keep all ground leads as short as possible.**
- **At all times, equipment ground terminal must be grounded during device operation.**
- **While the equipment manual may suggest several safety and reliability steps, safety precautions must be used in conjunction with the safety codes in force at your location.**
- **LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered safe to the unaided eye. Do not view directly with optical instruments.**
- **It is the responsibility of the user to check the equipment ratings and installation instructions prior to commissioning, service.**
- **Use a lift system with side rails/bucket to reduce a fall hazard as opposed to other means when installing or servicing.**
- **In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.**
- **Before working on CTs, they must be short circuited.**
- **Do not remove the voltage terminal blocks or disconnect the voltage input wires when the voltage phases are live. The voltage inputs must be de-energized prior to any servicing.**

1.1.3.2 Warning symbols

The following table explains the meaning of warning symbols that may appear on the device or in this manual.

	The relevant circuit is direct current. Le circuit principal est à courant continu.
	The relevant circuit is alternating current. Le circuit principal est à courant alternatif.
	**CAUTION**: Refer to the documentation for important operating and maintenance instructions. Failure to take or avoid a specified action can result in loss of data or physical damage. **AVERTISSEMENT**: Se réferer à la documentation pour l'entretien et l'utilisation. L'absence ou èviter de prender des mesures spècifiques peut entraîner des pertes de données ou même causer des dommages physiques.
	**WARNING**! Dangerous voltage constituting a risk of electric shock is present within the unit. Failure to take or avoid a specified action can result in physical harm to the user. **AVERTISSEMENT**! Tensions dangereuses comportant un risque de choc électrique sont presents dans l'equipement. L'absence ou èviter de prender des mesures spècifiques peut causer des dommages physiques à l'utilisateur.
	**CAUTION**: Class 1M Laser (IEC 60825-1 Safety of laser products) DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS. **AVERTISSEMENT**: Laser de classe 1M (IEC60825-1) ÉVITER DE REGARDER DIRECTEMENT LE DISPOSITIF QUI ÉMET LE LASER OPTIQUE.
	**CAUTION**: Hot surface. **AVERTISSEMENT**: Surface chaude.
	Earth (Ground) Terminal. Terminal de terre (masse).
	Protective Earth Terminal. Terminal de terre de protection.

Note: Read all instructions included in package before using your product. Additional safety information Product Safety Supplement document available at; http://www.gegridsolutions.com/ProductSafety/

1.2 Overview

1.2.1 Introduction to the 650 family of relays

The GE 650 family relay is a new generation of digital and multifunction equipment that is easily incorporated into automation systems, at both the station and enterprise levels.

1.2.2 Hardware architecture

1.2.2.1 C650 basic design

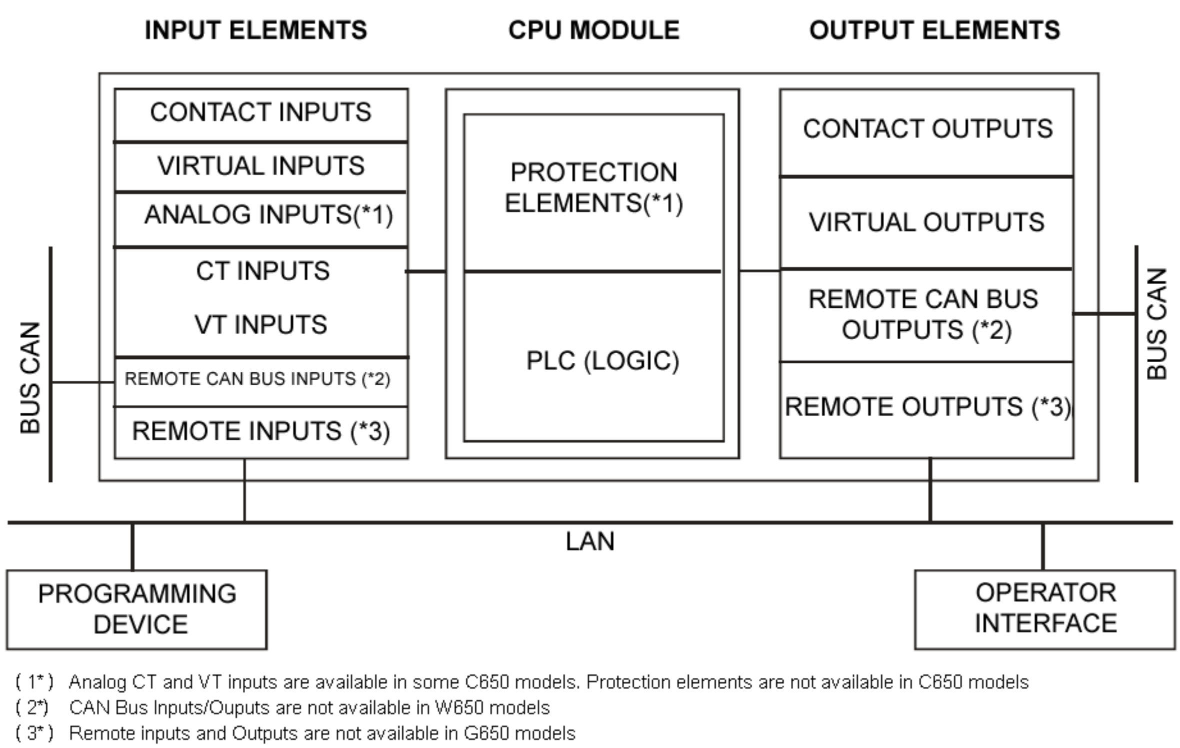
The 650 is a digital-based device containing a central processing unit (CPU) that handles multiple types of input and output signals. The 650 family can communicate over a local area network (LAN) with an operator interface, a programming device, or another 650 device.

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.

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 unit.

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

Figure 1-1: 650 concept block diagram



1.2.2.2 C650 signal type

Contact Inputs/Outputs: Digital signals.

CT and VT inputs: Signals coming from the inputs of current and voltage transformers, used for monitoring the power system signals.

Remote CAN Bus Inputs/Outputs: Signals associated with physical input/output contacts from a Remote Digital Input/ Output Module (CIO) connected to the 650 unit via the CAN Bus existing in options X, Y, Z, C and M for rear serial communication board 1.

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

Remote inputs and outputs: Provide a means of sharing digital point state information between remote devices using IEC 61850 GSSE and GOOSE messages.

Analog Inputs: Signals associated with transducers.

1.2.3 Communications architecture

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

All 650 units incorporate one USB serial port on the front of the relay. They can also incorporate up to two additional communication modules on the rear.

The rear serial communications board 1 provides asynchronous serial communications, using different physical media (Cable remote CAN bus I/O or RS485 + cable remote CAN bus I/O, 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 increases the I/O capability by up to 100% if 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 port (Modbus RTU)+ RS485 port and a CAN port for remote CAN Bus I/O (cable)

Rear serial communications board 2 provides Ethernet communications (COM3). For C650 models, this board is only used for bootware and firmware upgrades, and is not available during normal operation.

Available Options are:

Table 1-2: REAR ETHERNET COMMUNICATIONS BOARD 2

G	1588, 10/100 Base TX* + 100 Base TX
H	1588, 10/100 Base TX* + 100 Base FX
J	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
K	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
L	PRP, 1588, 10/100 Base TX + Redundant 100 Base TX
M	PRP, HSR, RSTP, 1588, 10/100 Base TX + Redundant 100 Base TX

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

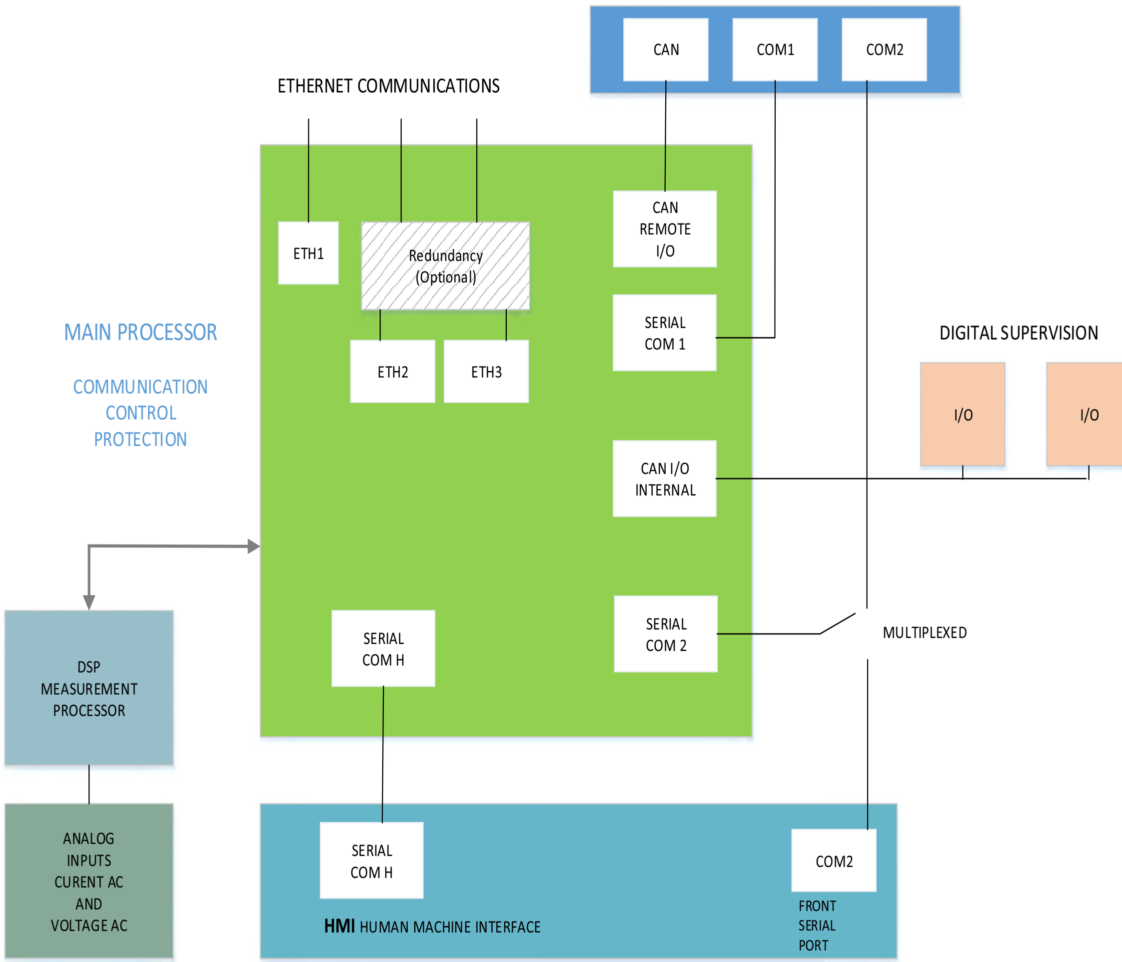


Figure 1-1: Communications architecture (B6816F2)

1.3 EnerVista 650 Setup software

1.3.1 System requirements

The relay front panel or the EnerVista 650 Setup software can be used to communicate with the relay. The software interface is the preferred method to edit settings and view actual values because the computer monitor can display more information.

The minimum system requirements for the EnerVista 650 Setup software are as follows:

- Pentium® 4 (Core Duo recommended).
- Windows® XP with Service Pack 2 (Service Pack 3 recommended), Windows 7, or Windows 8
- 1 GB of RAM (2 GB recommended).
- 500 MB free hard drive space (1 GB recommended).
- 1024 x 768 display (1280 x 800 recommended).
- USB serial and/or Ethernet port for communications with the relay.

1.3.2 Installation

After ensuring the minimum requirements for using EnerVista 650 Setup are met (see previous section), obtain the software from the GE EnerVista DVD, or download from: http://www.gegridsolutions.com/multilin/ as follows:

1. Insert the GE EnerVista DVD into the DVD drive of your computer.
2. Click **Install Now** and follow the installation instructions to install the complimentary EnerVista software.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click **IED Setup** in the **Launch Pad** window.

Figure 1-2: Launchpad window

5. Click **Add Product** and select the “C650 Bay Control and Monitoring 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 **Add Now** to list software items for the C650.

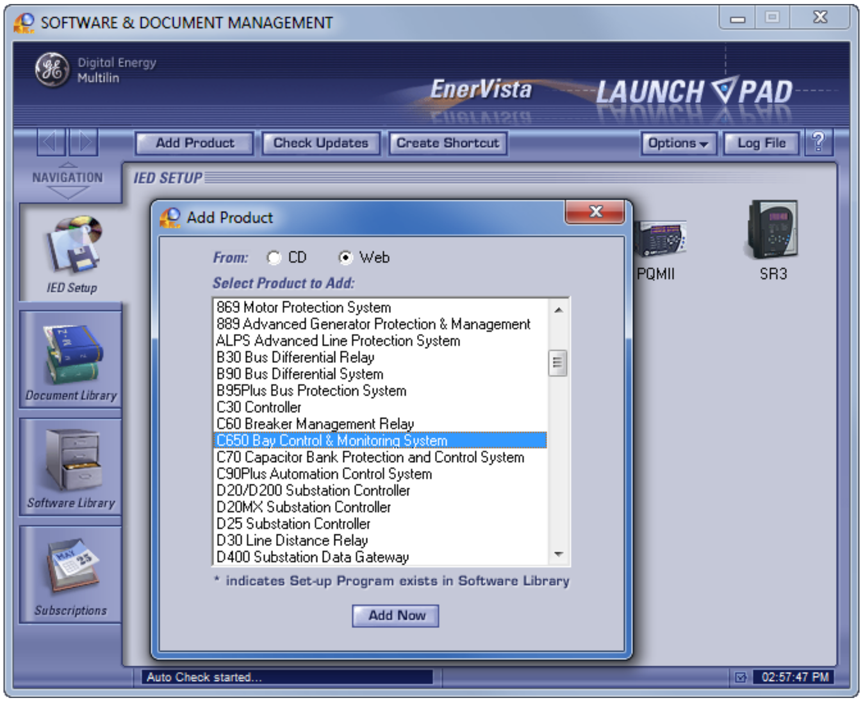


Figure 1-3: Add Product window

6. EnerVista Launchpad obtains 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.
7. Follow the on-screen instructions to install the EnerVista 650 Setup software. When the **Welcome** window appears, click **Next** to continue with the installation.

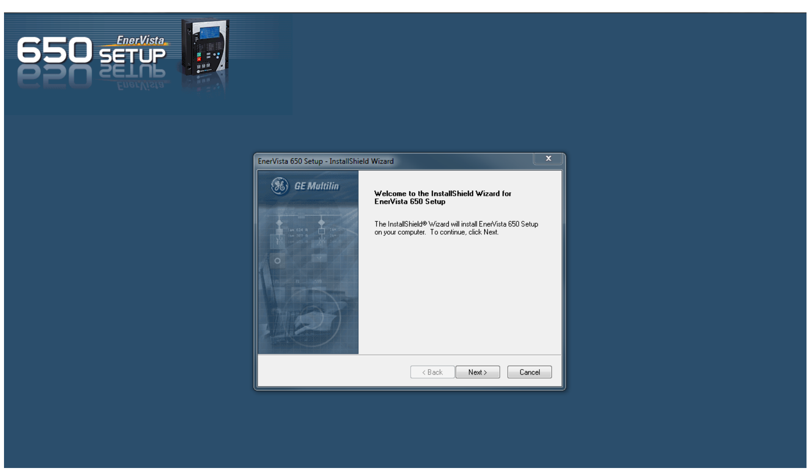


Figure 1-4: EnerVista 650 Setup installation

8. When the **Choose Destination Location** window is displayed, change the installation directory id needed by clicking **Change...** and typing in the complete path name including the new directory name. Click **Next** to continue with the installation.

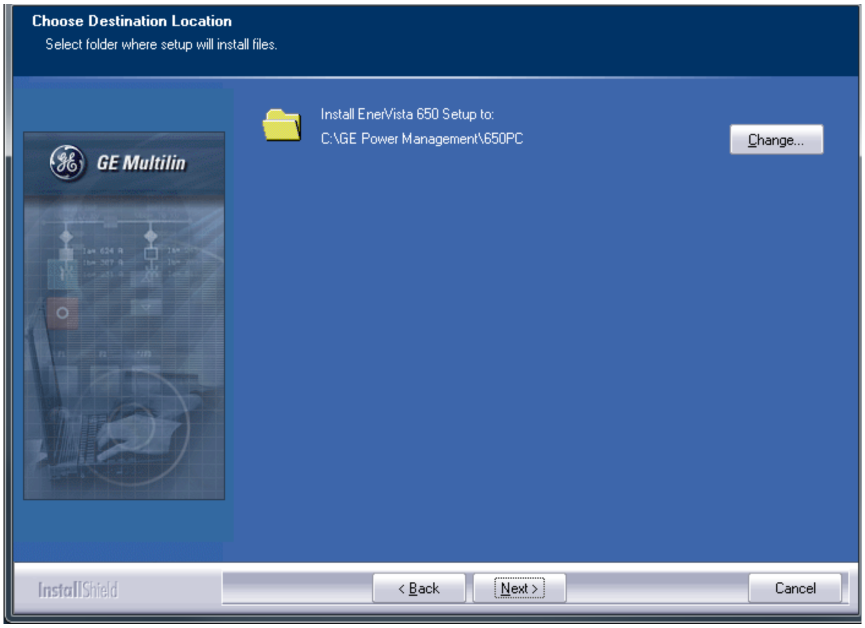


Figure 1-5: EnerVista 650 Setup installation cont.

9. The default program group containing the application is added to as shown in the **Selected Program Folder** window. Click **Next** to begin the installation process, and all the necessary program files are copied into the selected directory.

Figure 1-6: Select program folder

10. To complete the installation, select the desired language for startup.

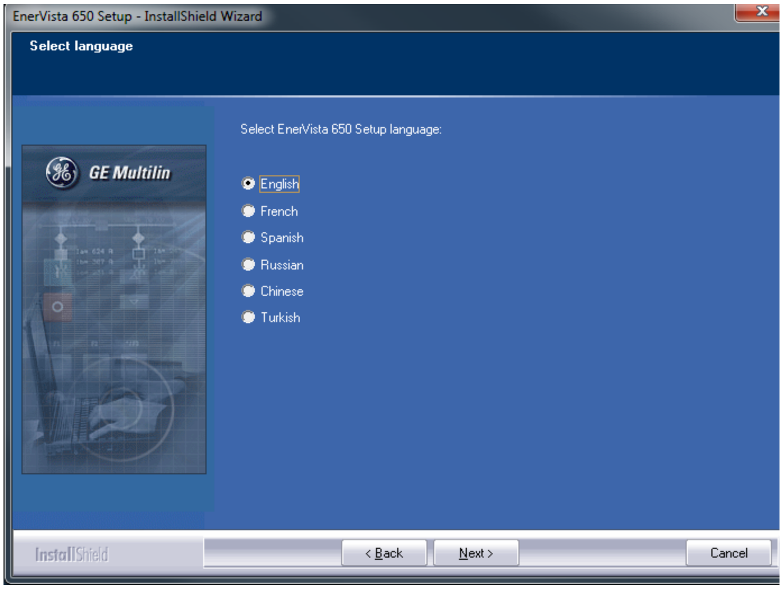


Figure 1-7: Language window

11. Click **Finish** to end the installation. The C650 device has been added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

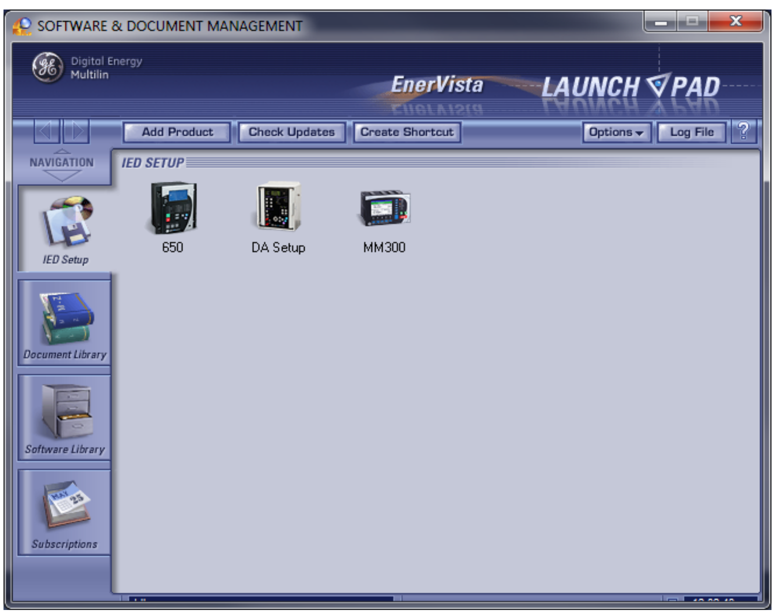


Figure 1-8: EnerVista Launchpad

1.3.3 USB-serial driver installation

1. Insert the GE EnerVista DVD into your CD-ROM drive.
2. Select the **Driver USB TUSB3410** folder and click **Win9x Setup.exe** for Windows 9X operating systems or click "WinXP Setup.exe" for Windows 2000 and XP operating systems

3. Follow the installation instructions to install the Win9X or WinXP USB-Serial Adapter drivers in your computer. Select the complete path, including the new directory name where the USB-Serial Adapter driver will be installed (for example: "C:\Program Files\Texas Instruments\USB-Serial Adapter\")

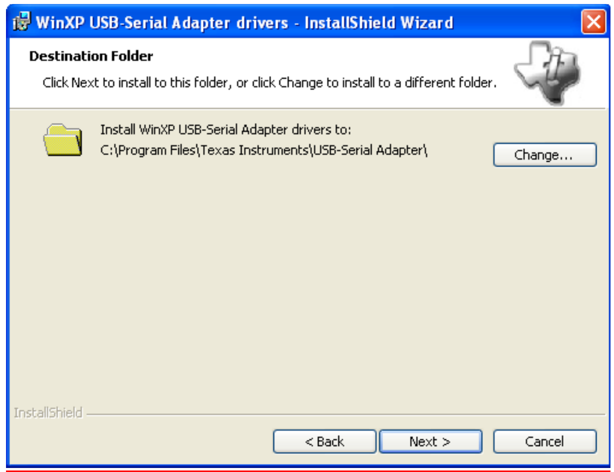


Figure 1-9: INSTALLATION PATH

4. When the installation is finished, the serial USB adapter driver is installed on the PC, ready to be enabled.
5. Use a USB type AB plug cable for the serial connection. Connect the USB type B plug connector on the USB port of the C650 unit (when it is switched on) and the USB type A plug connector on the USB port of your computer.
6. The computer plug and play option detects new hardware connected and asks to update the controller drivers. When the update window appears, select the third option **No, not this time**, to perform the driver update directly from the files previously installed on your computer.

Figure 1-10: FOUND NEW HARDWARE WIZARD

7. Select the second option **Install from a list or specific location (Advanced)**

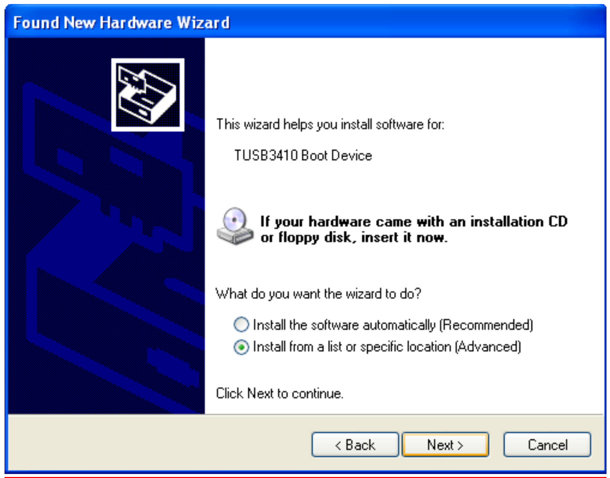
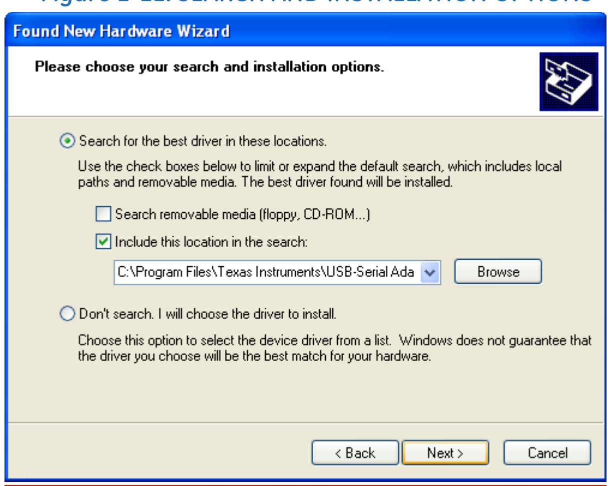


Figure 1-11: FOUND NEW HARDWARE WIZARD

8. Select with a check mark in the exact path "C:\Program Files\Texas Instruments\USB-Serial Adapter\" where the drivers were previously installed.

Figure 1-12: SEARCH AND INSTALLATION OPTIONS



9. Continue with the installation process. Click **Continue Anyway** if a windows message appears.

10. Click the **Finish** button to complete the installation for the TUSB3410 device.

Figure 1-13: FINISHING THE INSTALLATION OF THE DEVICE

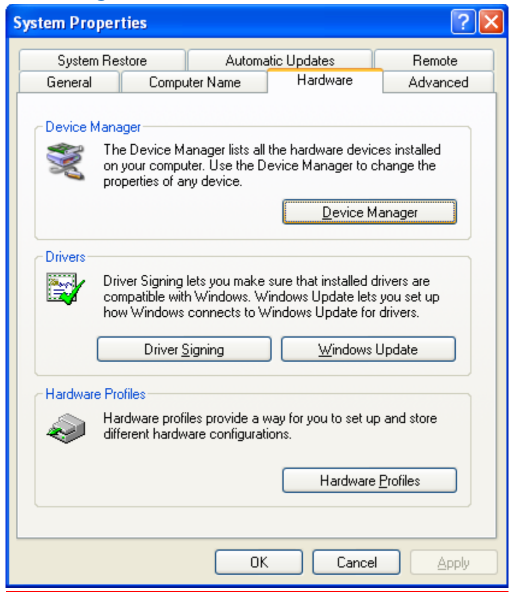
11. When finished with the "TUSB3410 device" installation, the computer starts installation of the "Texas Instrument UMP Serial Port". Follow the same procedure as in steps 6, 7, 8 and 9.
12. Click the **Finish** button to complete the installation for the **USB - Serial Port.**

Figure 1-14: FINISHING THE INSTALLATION OF THE USB

13. A message is shown stating, **Your new hardware is installed and ready to use**.
14. In case of any problems during the installation process, go to **Settings > Control Panel** and select **Control Panel >**

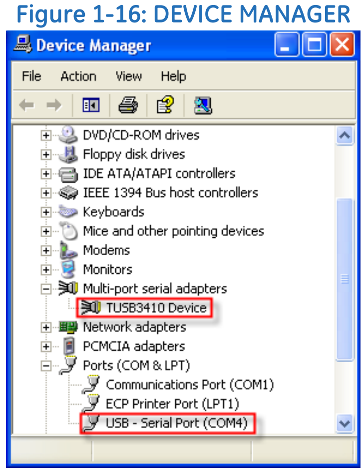
System > Hardware > Device Manager to see the list of all the hardware devices installed on your computer.

Figure 1-15: SYSTEM PROPERTIES



15. Check that the **Multiport serial adapters** option shows that **TUSB3410 Device** is correctly installed (no question mark should appear on it) and the **USB - Serial Port** has been correctly assigned to a COM port on your computer (it must have no question mark on it and a COM port number).

Figure 1-16: DEVICE MANAGER



16. In case of a yellow "**!**" mark on any of the previous options, **TUSB3410 Device** or **USB - Serial Port**, switch the computer off and then on again to force the drivers to reload. If the problem persists try to reinstall the drivers.

1.3.4 Connecting EnerVista 650 Setup to the C650

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

1.3.4.1 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 DVD or online from http://www.gegridsolutions.com/multilin (see previous section for installation instructions).
2. Go to **Communication > Computer**.
3. Select **Control Type** as **MODBUS TCP/IP** from the drop-down list. This option displays 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. Click **ON** to begin communicating.

1.3.4.2 Configuring a USB-serial connection

Before starting, verify that the RS232 USB cable is properly connected to the USB port or the USB port on the front panel of the unit.

1. Check that the USB - Serial Adapter drivers have been properly installed. See 1.3.3 USB-serial driver installation.
2. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista DVD or online from http://www.gegridsolutions.com/index.htm (see previous section for installation instructions).
3. Go to **Communication > Computer** and enter the following data referred to communications:
4. Under **Control Type** select **No Control Type** from the drop-down list.
5. Enter the communication Port corresponding to the USB – Serial port (COMX) previously installed.
6. Enter the relay Slave Address (**Setpoint > Product Setup > Communication Settings > ModBus Protocol**) in the Slave Address field. The default value is 254.
7. Enter the physical communications parameters (Baud rate and parity settings) from the **Setpoint > Product Setup > Communication Settings > Serial Ports** menu. Default values are 19200 for baud rate and none for parity.
8. The unit has now been configured for USB-serial communications. Click **ON** to begin communicating.

1.4 650 hardware

1.4.1 Mounting & wiring

Refer to Chapter 3. Hardware for detailed mounting and wiring instructions.

1.4.2 650 communications

The EnerVista 650 Setup software communicates with the relay via the faceplate USB Type B port or the rear RS485/ Ethernet ports. To communicate via the faceplate USB Type B Port, a standard USB type AB plug cable is used. The USB type B plug end is connected to the C650 unit and the USB type A plug en is connected to the PC USB type A port.

To communicate via the C650 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 mm^2 according to European standards) connects the F485 converter to the C650 rear communication port.

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

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 in Figure 1-1: RS485 connection for 650 units, associated with the text Zt(*).

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 in confusion, as the RS485 standard refers to terminals “A” and “B”, although many devices use terminals labeled “+” and “-“.

As a general rule, terminals labeled “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 relay in the system. 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. Do not use other connection configurations.

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 provided internally. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

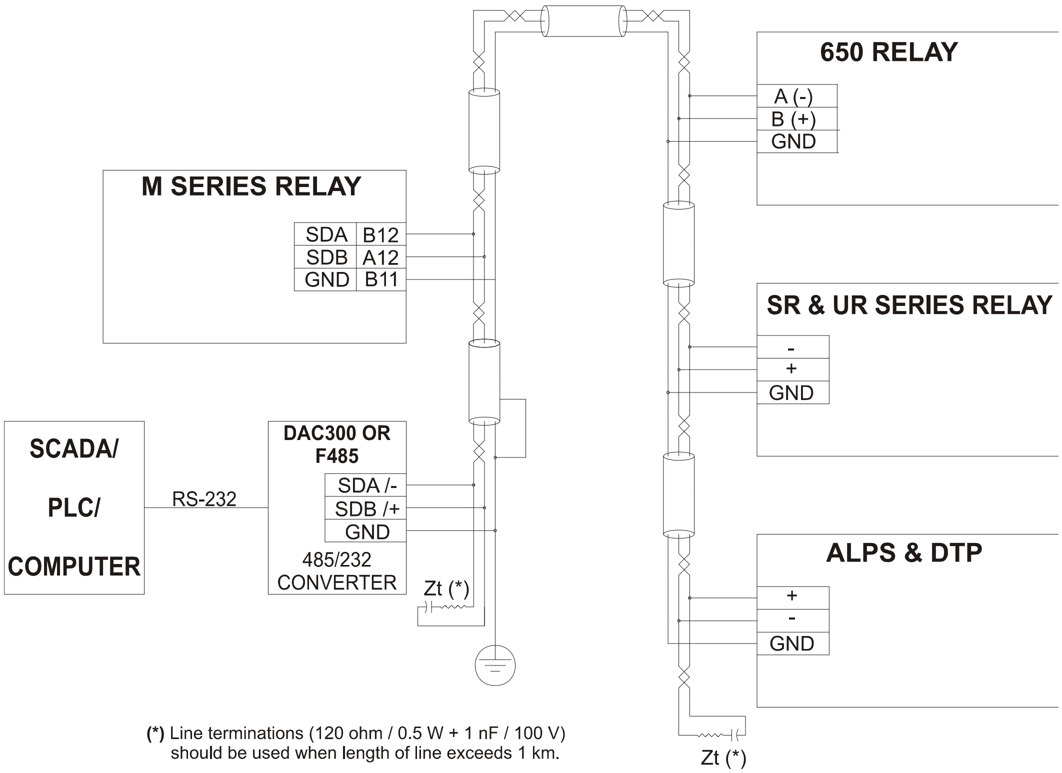


Figure 1-1: RS485 connection for 650 units

To communicate through the C650 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 depending on the model and configuration settings.

1.4.4 Maintenance

1.4.4.1 General maintenance

The C650 requires minimum maintenance once it is commissioned into service. C650 is a microprocessor based relay and its characteristics do not change over time; as such no further functional tests are required. While the C650 performs continual self-tests, it is recommended that maintenance be scheduled with other system maintenance. This maintenance can involve in-service, out-of-service, or unscheduled maintenance.

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.

1.4.4.2 In-service maintenance

1. Visual verification of the analog value integrity such as voltage and current (in comparison to other devices in the 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.

1.4.4.3 Out-of-service maintenance

1. Check wiring connections for firmness.
2. Analog value (current, voltages, analog inputs) injection test and metering accuracy verification. Calibrated test equipment is required.
3. Protection element setpoint verification (analog values injection or visual verification of setting file entries against relay settings).
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.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.4.4 Unscheduled maintenance

Unscheduled maintenance such as during a disturbance causing system interruption:

- View the event recorder and oscillography for correct operation of inputs, outputs and elements.

1.4.5 Storage

Store the unit indoors in a cool, dry place. If possible, store in the original packaging. Follow the storage temperature range outlined in the Specifications.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.6 Repairs

The firmware and software can be upgraded without return of the device to the factory.

For issues not solved by troubleshooting, the process to return the device to the factory for repair is as follows:

- Contact a GE Grid Solutions Technical Support Center. Contact information is found in the first chapter.
- Obtain a Return Materials Authorization (RMA) number from the Technical Support Center.
- Verify that the RMA and Commercial Invoice received have the correct information.
- Tightly pack the unit in a box with bubble wrap, foam material, or Styrofoam inserts or packaging peanuts to cushion the item(s). You may also use double boxing whereby you place the box in a larger box that contains at least 5 cm of cushioning material.
- Ship the unit by courier or freight forwarder, along with the Commercial Invoice and RMA, to the factory.
- Fax a copy of the shipping information to the GE Grid Solutions service department. Customers are responsible for shipping costs to the factory, regardless of whether the unit is under warranty.

Use the detailed return procedure outlined at

https://www.gegridsolutions.com/multilin/support/ret_proc.htm

The current warranty and return information are outlined at

https://www.gegridsolutions.com/multilin/warranty.htm

1.4.7 Disposal

The C650 is intended to be part of defective large-scale stationary industrial tools and large-scale fixed installations. This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

C650 Bay Controller & Monitoring System

Chapter 2: Product Description

2.1 C650 Overview

C650 is a, control, monitoring, metering and registering unit, suitable for many different applications, such as Bay Control and Monitoring Systems. Voltage, current, power, and energy metering is built into the relay as an optional feature (only included in C650 units with Enhanced functionality). Current parameters are available as total waveform RMS magnitude, or as fundamental frequency only RMS magnitude and angle (phasor).

Diagnostic features include a sequence of records. The internal clock used for time-tagging can be synchronized with an IRIG-B signal or via SNTP, DNP or Modbus protocol over the Ethernet port. From firmware version 7.00 and above, IEEE 1588 time protocol is also available. Precise time stamping allows the sequence of events to be determined throughout the system. Oscillography data capture may be set to record the measured parameters before and after the event for viewing on a personal computer (PC). These tools significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

The C650 unit provides one HMI with a configurable LED matrix of 16 LED indicators, 15 user programmable plus one non-configurable LED (READY) that shows if the relay is in service. The HMI also provides 3 dedicated keys for command (I/O) and element selection (SEL). The LED matrix can be configured with any of the four switchgear elements with the open, closed and selected status available for each of them. A faceplate USB - serial port (COM2) may be used to connect to a PC for programming settings, configuration and the monitoring of actual values. A faceplate RS232 or USB port may be used to connect to a PC for programming settings and monitoring actual values.

A variety of communications modules are available. Two rear RS485 ports allow independent access by operating and engineering personnel. All serial ports use the Modbus® RTU protocol. Optional communications modules include a 100BaseFX Ethernet interface which can be used to provide fast, reliable communications in noisy environments.

Another option provides two 100BaseFX fiber optic ports for redundancy. The Ethernet port supports IEC 61850, Modbus®/TCP, DNP 3.0 and TFTP protocols, and allows access to the relay via any standard web browser. The IEC 60870-5-104 protocol is supported on the Ethernet port. The Ethernet port also supports the Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR) of IEC 62439-3 (clause 4 (PRP) and clause 5 (HSR)) for firmware version 7.10 and up.

The C650 IEDs use flash memory technology which allows field upgrading as new features are added:

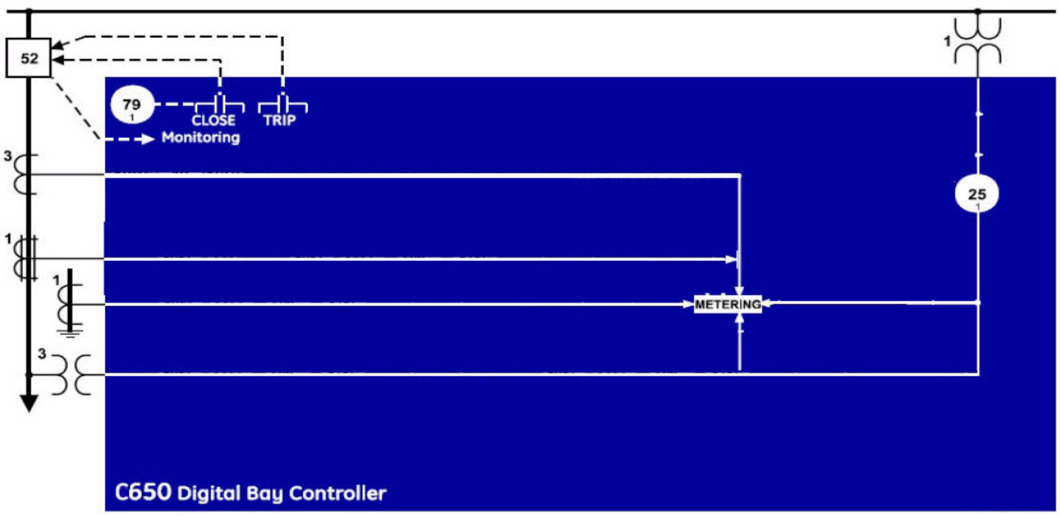


Figure 2-1: FUNCTIONAL BLOCK DIAGRAM

2.2 ANSI device numbers and functions

Main features available in the relay are gathered in tables below

DEVICE NUMBER	PROTECTION & CONTROL FUNCTIONS
25*	Synchronism Check
79*	Autoreclose (Four shot recloser)

(*) These functions are available only in C650 models with Enhanced functionality. See section *2.4 Order codes* for details.

2.3 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) (Optional)
Digital Programmable Contact Inputs (up to 64)
Digital Programmable Contact Outputs (up to 16)
32 Latched Virtual Inputs 32 Self-Reset Virtual Inputs
Virtual Outputs (up to 512)
Tripping and closing circuit supervision
Remote Inputs/Outputs (GSSE and GOOSE messages)
Analog Inputs (dCmA)

METERING (OPTIONAL)
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
*Digital Counters

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

*This functionality is available for firmware version 7.10 onwards.

USER INTERFACE
Alphanumerical display (4x20)
Graphic display (16 x 40)
User Programmable LEDs (15)
User Programmable Keys (up to 5)
Easy menu management
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 (up to 10 records)
Oscillography (up to 20 records)
Snapshot Events (up to 1023)**

OTHERS
Breaking Arcing Current (I^2t)
Breaker Control
IRIG-B synchronization/SNTP/ IEEE 1588
Logic Equations (PLC Editor)
Operations (up to 24)
Web Server Application

** Maximum number of events can vary depending on firmware version. See Snapshot events in section 2.5.2: Monitoring on page 2–9.

2.4 Order codes

C650 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 C650 model is shown in Table 2–1:

Table 2-1: Order codes

C650	-	-	-	F	-	G	-	-	-	-	-						DESCRIPTION
																	DISPLAY OPTIONS (See Note 8)
	B																Basic Display and Basic Control Functionality. (See note 1) (See Note 2)
	M																Graphic Display with Standard Symbolsand Basic Control Functionality. (See note 1. (See Note 2)
	N																Graphic Display with IEC symbols.and Basic Control Functionality.(See note 1) (See Note 2)
	E																Basic Display and Enhanced Control Functionality. (See note 1)
	C																Graphical Display with Standard Symbols and Enhanced Control Functionality. (See note 1)
	D																Graphical Display with IEC Symbols and Enhanced Control Functionality. (See note 1)
	E																Basic Display and Enhanced Control Functionality. (See Note 2)
	C																Graphical Display with Standard Symbols and Enhanced Control Functionality. (See Note 2)
	D																Graphical Display with IEC Symbols and Enhanced Control Functionality. (See Note 2)
																	FORM FACTOR 19" SERIAL COMMS
		N															RS485
																	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
			G														1588, 10/100 Base TX* + 100 Base TX (See Note 3)
			H														1588, 10/100 Base TX* + 100 Base FX (See Note 3)
			J														PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX (See Note 4)
			K														PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX (See Note 4)
			L														PRP, 1588, 10/100 Base TX*+ Redundant 100 Base TX (See Note 4)
			M														PRP, HSR, RSTP, 1588, 10/100 Base TX*+ Redundant 100 Base TX (See Note 4)
																	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 12)
							5										16 Digital Inputs + 8 Analog Inputs (See Note 12)
																	AUXILIARY VOLTAGE
								LO									24-48 Vdc (range 19.2 – 57.6)
								HI									110-250 Vdc (range 88 – 300). 120-230 Vac (range 96 – 250)
								LOR									Redundant LO
								HIR									Redundant HI
																	LANGUAGE
									-								English/English
									F								French/English
									S								Spanish/English
									T								Turkish/English
																	COMMUNICATION PROTOCOL
										-							Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104
										6							IEC 61850 (See Note 7), Modbus® RTU and TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104
																	ENVIRONMENTAL PROTECTION
											-						Without Harsh (Chemical) Environment Conformal Coating
											H						Harsh (Chemical) Environment Conformal Coating
																	I/O Board in slot H (only for FORM FACTOR 19")
													0				None
													1				16 Digital Inputs + 8 Outputs
													4				32 Digital Inputs (See Note 12)
													5				16 Digital Inputs + 8 Analog Inputs (See Note 12)
																	I/O Board in slot J (only for FORM FACTOR 19")
														0			None
														1			16 Inputs + 8 Outputs
														4			32 Digital Inputs (See Note 12)
														5			16 Digital Inputs + 8 Analog Inputs (See Note 12)
																	I/O Board in slot 2H (only for FORM FACTOR 19")
															0		None
															1		16 Digital Inputs + 8 Outputs
															4		32 Digital Inputs (See Note 12)
															5		16 Digital Inputs + 8 Analog Inputs (See Note 12)
																	I/O Board in slot 2J (only for FORM FACTOR 19")
																0	None
																1	16 Inputs + 8 Outputs
																4	32 Digital Inputs (See Note 12)
																5	16 Digital Inputs + 8 Analog Inputs (See Note 12)

Notes:

(*) For firmware version 7.00 or above, Port E is only intended for maintenance purposes.

(1) Control Functionality description for basic and enhanced models. See table below. Order code option F4 requires option G4 or G5. Order code option F5 requires option G5. F1G5 is a valid selection and F5G1 is an invalid selection. Similarly, order code options J, 2H, and 2J must be greater than or equal to the preceding order code option for options including boards 4 and 5.

ANSI code	Control Functionality	C650 Basic	C650 Enhanced
25	Synchrocheck		X
79	Recloser		X
	Metering		X

(2) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5 Control Functionality description for basic and enhanced models:**

ANSI Code	Protection & Control Functions	C650 Basic	C650 Enhanced
25	Synchronism Check		X
79	Recloser		X
	Metering		X

(3) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5. Advanced functionality Level I:**

G, H: IEEE1588 Precision Time Protocol (PTP), 61850 Edition 2.0. Digital counters. Max numbers of starts and Cold Load Pick-up functionality.

(4) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5. Advanced functionality Level II:**

J, L: Parallel Redundancy Port (PRP,) IEEE1588 Precision Time Protocol (PTP), 61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CILO, mapping of BlkOpn and BlkCls leafs of XSWI nodes, Max numbers of starts and Cold Load Pick-up functionality.

K, M: High-Availability Seamless Redundancy (HSR), Rapid Spanning Tree Protocol (RSTP), Parallel Redundancy Port (PRP,) IEEE1588 Precision Time Protocol (PTC), 61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CILO, mapping of BlkOpn and BlkCls leafs of XSWI nodes, Max numbers of starts and Cold Load Pick-up functionality.

(5) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5. For special models requested, relay order code shall be codified as a standard model (Table 2-1) following by Abbreviation + MX where X indicates the number of special model selected.**

(6) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5. For non-last released firmware version models requested, relay order code shall be codified as standard model (Table 2-1), following by Abbreviation +VXXXXXBYYYYY where XXXXX is the firmware version requested and YYYYY is the corresponding bootcode version.**

(7) For C650 with Communication Option "6", Rear Ethernet Communication Board 2, and firmware version 7.70 or higher, IEC 61850 Edition 1.0 is also available in relays with this option selected. Relay will work with IEC 61850 Edition 1.0 or Edition 2.0 depending on which ICD is sent to the device. See section 7.6.3.1.2 Open IEC61850 file from disk / open *CID file on page 7–120.

(8) **The number selected for option G must be equal or higher than the number selected for option F for models including boards 4 and 5. Display options with language selection:**

Graphic display: available for English, French and Spanish languages.

Basic display: available for all languages

2.4.1 CIO Modules

For applications requiring a high number of inputs and outputs, C650 half-rack units can be connected up to two CIO modules (Remote CAN Bus I/O module) to use up to 4 additional boards. Also C650 19" rack models are available, which hold a C650 unit and 2 CIO modules. The 19" RACK device can manage up to 6 I/O boards, however it cannot be externally connected to a CIO module.

C650 units monitor and configure these I/O boards as if they were internal boards, located on slots F and G. In this case, the slots are labeled H, J, 2H, and 2J.

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

Note1: The CIO 1 rear roulette must be set to 1 and the CIO 2 rear roulette must be set to 3. Both CIO units must be powered Off and ON after changing the roulette setting.

Note2: For C650 half-rack models, only one CIO can be linked by CAN fiber to the 650 unit. The second CIO must be linked by CAN cable to the additional CIO.

Table 2-2: Order code for CIO module

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

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

2.5 Technical specifications

NOTICE TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.5.1 Control

AUTORECLOSE (79)

Schemes: ....three-pole tripping schemes
Number of Shots: ....up to 4 reclose attempts before lockout
Dead Time: ....independent dead time setting before each shot
adjustable between 0.00 and 900.00 s in steps of 0.01 s.
Reclaim Time: ....0.00 and 900.00 s in steps of 0.01 s
Condition Permission: ....selectable by setting
Hold Time: ....0.00 and 900.00 s in steps of 0.01 s
Reset Time: ....0.00 and 900.00 s in steps of 0.01 s
Snapshot Events: ....selectable by setting

Protection settings can be modified after each shot through PLC programming (block signals are available after each shot).

SYNCHROCHECK (25)

Dead/live Level 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: ....2.0° to 80.0° in steps of 0.1°
Maximum Frequency Slip: ....10 to 5000 mHz in steps of 10 mHz
Synchronism Time: ....0.01 to 1.00 s in steps of 0.01 s
Angle Accuracy: ....3°
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

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 10000000 in steps of 1
Board Origin: ....all available input/output boards in the device. See order code (F, G, H, J)
Input Origin: ....up to 32 (depending on board type selection)

ANALOG COMPARATORS

Analog Input: ....any analog value 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 50.0 in steps of 0.1
Analog Direction (for activation inside or outside the
deadband: ....IN or OUT

BREAKER SETTINGS

Number of Switchgear: ....1 to 16 (selection of switchgear for breaker control)
Maximum KI^2t: ....0.00 to 9999.99 $(kA)^2s$ in steps of 0.01 $(kA)^2s$
KI^2t Integration Time: ....0.03 to 0.25 s in steps of 0.01
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

BREAKER MAINTENANCE

KI^2t Breaker Counters for Phases A, B, C: .... 0.00 to 9999.99 $(kA)^2s$ in steps of 0.01 $(kA)^2s$
Breaker Opening Counters: .... 0 to 9999 in steps of 1
Breaker Closing Counters: .... 0 to 9999 in steps of 1

SWITCHGEAR

Switchgear: .... 1 to 16 (configurable in **Relay Configuration**)
Snapshpt Events: .... selectable by setting (for each switchgear, in **System Setup**)

DIGITAL COUNTERS

Function: .... Disabled, Enabled
Name: .... any 12 alphanumeric characters
Preset: .... -2147483648, 0, +2147483647
Compare: .... -2147483648, 0, +2147483647

2.5.2 Monitoring

OSCILLOGRAPHY

Maximum Records: .... up to 20 oscillography records
Sampling Rate: .... programmable to 4, 8, 16, 32, or 64 samples per power cycle
Capacity per record: .... (27592 samples)/(number of oscillos x number of samples/cycle)
Trigger Position: .... 5% to 95% of total length
Trigger: .... programmable via PLC
Data: .... 5 current channels and 4 voltage channels
up to 16 digital channels programmable through PLC
Data Storage: .... non-volatile (flash) memory 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

SNAPSHOT EVENTS

Capacity*: .... 1023 scrolling events
Time-tag: .... 1 ms using an internal clock of 100 µs
Timing Accuracy: .... 1 ms (using IRIG-B synchronization)
Triggers: .... any element pickup, dropout, or operation
digital input/output change of state
virtual inputs and control events
Data Storage: .... non-volatile (flash) memory without battery

*Note: For firmware 7.20, up to 511 snapshot events are available. For firmware below 7.20, up to 479 snapshot events are available.

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 (with IRIG-B synchronization input)
Trigger: .... Any digital signal programmable through the PLC
Alarm: .... Control events can be displayed as an alarm on the alarms panel. Information is always available through **Communications** for all models and in the HMI for models with a graphical display (M in order code).
Data Storage: .... non-volatile (flash) memory without battery

Control events are also displayed in the snapshot events recording

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:..........±2%
Trigger Input: ....selectable by setting (operation mode selection for the block interval calculation method)
Snapshot Events: ....selectable by setting

DATA LOGGER
Number of Channels:..........1 to 16
Parameters:..........any available analog actual value
Samples: ....1 second, 1, 5, 10, 15, 20, 30, 60 minutes
Storage Capacity:..........fixed, 32768 measurements

2.5.3 User-programmable

PLC LOGIC
Programming language:..........The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.
Lines of code*: ....1000 total equations or 15360 bytes, whichever is greater (for versions >= 7.00)
640 lines of code or 15360 bytes, whichever is greater (for versions < 7.00)
(*) Note: Reserved Modbus memory space of PLC equations in text format is up to 15360 bytes. This space is shared with information configured in Enervista at **Setpoint > Relay Configuration**. According to this, the number of PLC equations can be limited by values configured on that section.
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.
Starting in version 7.20, analog operators are also available.
Libraries: ....Logical gates fully programmable by user. Used 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)

USER-PROGRAMMABLE LEDS
Number:..........15 configurable LEDs plus the Ready non-configurable LED
Programmability:..........any logical variable, contact, or virtual input
Reset Mode:..........self-reset or latched.
The first 5 LEDs (red) are latched by hardware, usually configured for trip signals.
The following 10 LEDs (yellow and green) are self-reset but can be latched through PLC configuration.
Reset Signal:..........The LEDs can be reset by hardware, pressing the front “esc” key for more than 3 seconds or using the LED reset signal through PLC configuration.

USER-DEFINABLE DISPLAYS
Number of Configurable Displays: ....1: one line diagram fully configurable. In graphical displays only
Number of Fixed Displays: ....6: Metering (selectable between Primary and Secondary 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:..........2: Logotype, Metering, or both in scrolling mode can be selected as the default screen in text display for all models (basic and mimic). The metering screen contains current and voltages for phases and ground in primary or secondary values.

USER-PROGRAMMABLE FRONT KEYS
Number of Configurable Keys:..........5

Operation: .... Drive PLC operands

2.5.4 Metering (optional)

CURRENT

Accuracy (at nominal frequency): .... ±0.5% of the reading ± 10 mA from 0.05 to 10.00 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

% of Load-to-trip Accuracy: .... ±0.5% of full-scale

VOLTAGE

Accuracy: .... ±1% of reading from 10 to 208 V

REAL POWER (WATTS)

Accuracy: .... ±2.0% of the reading at -0.8 ≤ PF ≤ -1.0 and 0.8 < PF ≤ 1.0

REACTIVE POWER (VARS)

Accuracy: .... ±2.0% of the reading at -0.2 ≤ PF ≤ 0.2

APPARENT POWER (VA)

Accuracy: .... ±2.0% of the reading

WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy: .... ±2.0% of the reading
Range: .... -2147483 to +2147483 MWh
Parameters: .... 3-phase only
Update Rate: .... 100 ms

WAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy: .... ±2.0% of the reading
Range: .... -2147483 to +2147483 MVArh
Parameters: .... 3-phase only
Update Rate: .... 100 ms

FREQUENCY

Accuracy: .... +/- 0.03Hz
From 30 to 80 Hz

Note: Voltage input must be above 10 V to start measuring frequency

ANGLE

Accuracy: .... ±3°

2.5.5 Inputs

AC CURRENT INPUTS (OPTIONAL)

CT Ratio: .... 1.0 to 6000.0 in steps of 0.1
Rated Currents: .... Appropriate for 1 or 5 A. C650 has universal range for CT (valid for 1 or 5 A to only one terminal).
Relay Burden: .... < 8 mVA at 1 A
< 200 mVA at 5 A
Input Impedance: .... < 8 mOhm
Current Withstand: .... Continuous at 20 A
1 s at 500 A for phases and ground
1 s at 50 A for sensitive ground

AC VOLTAGE INPUTS (OPTIONAL)

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

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

CONTACT INPUTS

Input Activation Threshold:....................10 to 230 Vdc in steps of 1 V (selectable by setting)
Impedance: ....> 100 kΩ
Maximum Error:....................±10% setting or ± 5 V
Load for Voltage Supervision Inputs (for board type 2 (supervision) in slot H (for CIO selection) or in Slot F: ....2 mA + V/100 kΩ
Voltage Threshold for Voltage Supervision Inputs (for board type 2 (supervision) in slot H (for CIO selection) or in Slot F:....................< 19 V (fixed) (Typical)
<10 (fixed) (Worst case scenario)
Debounce Time: ....1 to 50 ms in steps of 1 ms
Recognition Time:....................2 ms (typical)
Timing Resolution:....................1 ms

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

REMOTE INPUTS (IEC61850 GSSE/GOOSE)

Number of Input Devices:....................32, configured from 64 incoming bit pairs
Number f Remote Devices: ....16 (24 for relay version 7.10 and above)
Default States on Loss of Comms: ....On, Off, Latest/on, Latest/off

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 +20 mA
Accuracy:....................±0.2% of full scale
Type: ....passive

IRIG-B INPUT

Amplitude Modulation:....................DC SHIFT = demodulated input (no carrier)
Input Voltage:....................TTL
Input Burden:....................1.5 mA
Input Impedance: ....3.3 kΩ
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

2.5.6 Real time clock

Accuracy: typical ±20 ppm
Backup Energy: more than 1 week

Note: For relay versions before 7.10, when the relay date and time is changed using any documented methods (Modbus, IRIG-B, SNTP, Front Panel...) the relay acknowledges and updates the time instantly but it takes nearly 3 minutes for the new time to be permanently stored in the Real Time Clock's NVRAM.

2.5.7 Outputs

Single Contact Carry continuous: 16 A at 20°C
Make and Carry for 1 s: 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 sent as pulse type)
Separate operate and reset signals can be configured by any digital signal programmable through the PLC
Contact Outputs (H31-H33, H34-H36) for board type 2 (supervision) in slot H (for CIO selection): 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.

REMOTE OUTPUTS (IEC61850 GSSE/GOOSE)

Standard Output Points: 32
User Output Points: 32

2.5.8 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
Voltage Loss hold-up time:(*)	24 Vdc 30 ms 48 Vdc 100 ms

ALL RANGES

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

Note: (*) These figures have been calculated for models with the following characteristic:
- IEC Symbols Graphic display
- Rear Ethernet Communication Board 2: PRP, 1588, 10/100 Base TX+ Redundant 100 Base FX
- F and G I/O Board:
  - Slot F: 8 Digital Inputs + 8 Outputs + 2 Trip / Close circuit supervision circuits
  - Slot G: 16 Digital Inputs + 8 Outputs

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
Voltage Loss Hold-up Time (1/2 rack model):	200 ms typical 100 ms worst case
Voltage Loss Hold-up Time (full rack model):	50 ms worst case (without unit reset)

INTERNAL FUSE

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)

UL listed miniature Fuse

2.5.9 Communications

FRONT PORT:	
Front port:	**COM2**
Type:	USB type B Jack
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0
Typical Distance:	3 m
Isolation:	2 kV

USB FEATURES:

Fully compliant with USB 2.0 full speed Specifications

Supports 12-Mbps USB data rate (full speed)

Supports USB suspend, resume, and remote wakeup operations

Supports two power source modes:

Bus-powered mode

Self-powered mode

Can support a total of 3-input and 3-output (interrupt, bulk) endpoints

ASYNCHRONOUS REAR PORTS:	
None or one 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 Connector 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 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0/IEC103
Typical Distance:	1200 m for copper cable, 1000 m for glass fiber and 50 m for plastic fiber
Isolation:	2 kV
CAN PORT:	
Rear Port:	CAN port in models C and M for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Fiber Wavelength:	820 nm
Fiber Type:	Multimode 62.5/125 µm or 50/125 µm
Maximum Recommended Length:	300 m for cooper cable and glass fiber
Isolation:	2 kV
ETHERNET PORT:	
Rear port:	ETH_E/ ETH_A/ ETH_B
Type (depending on model):	
Model G:	1588, 10/100 Base TX* + 100 Base TX
Model H:	1588, 10/100 Base TX* + 100 Base FX
Model J:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model K:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model L:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base TX

Model M:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base TX

Note: (*) Ethernet port E (ETH_E) is intended only for maintenance purposes.

10/100BaseTX:	RJ45 connector
100BaseFX:	ST connectors
Wavelength:	1300 nm
Fiber Type:	multimode 62.5/125 µm or 50/125 µm
Protocols:	ModBus® TCP/IP
	DNP over TCP/IP and UDP/IP
	IEC 61850
	http, ftp, tftp (allow the use of a standard Internet browser)
Typical Distance:	1000 m for glass fiber and 150 m for RJ45 cable
Response Time to ModBus Commands:	10 ms typical
Isolation:	2 kV

Note: In Models C and D, the 10/100BaseTX port is selected by an internal switch.

(see section 3.4.3: Cable/fiber Ethernet board on page 3–12)

Note: Two witness LEDs for transmission and reception are included

SIMPLE NETWORK TIME PROTOCOL (SNTP)

Clock Synchronization error:	<10 ms (typical)

PRECISION TIME PROTOCOL (PTP)

PTP IEEE Std 1588 2008 (version 2)

Power Profile (PP) per IEEE Standard PC37.238TM2011

Slave-only ordinary clock

Peer delay measurement mechanism

PARALLEL REDUNDANCY PROTOCOL (PRP) (IEC 62439-3 CLAUSE 4, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

PARALLEL REDUNDANCY PROTOCOL (HSR) (IEC 62439-3 CLAUSE 5, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

RAPID SPANNING TREE PROTOCOL (RSTP) (IEC 62439-1, IEEE 801.2D)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

2.5.10 Optical

Wave length: 1300 nm

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.

CAUTION: LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered eye safe to the unaided eye. **Do not view directly with optical instruments.**

2.5.11 Environmental

Operating Temperature: - 10°C to + 60°C
Storage Temperature: - 40°C to + 85°C
Humidity (non-condensing): 95%
Altitude: up to 2000 m
Class of Equipment: I
Equipment Mobility: fixed
Overvoltage Category: III
Pollution Degree: 2

2.5.12 Packaging and weight

FOR 1/2 RACK UNIT

Net Weight: 5 kg
Packaged Weight: 6 kg
Package Dimensions: 30 x 40 x 40 cm (D x W x H)

FOR ONE RACK UNIT

Net Weight: 5 kg
Packaged Weight: 6 kg
Package Dimensions: 30 x 40 x 40 cm (D x W x H)

2.5.13 Type tests

CATEGORY	STANDARD	CLASS	TEST
SAFETY	Dielectric voltage withstand	IEC60255-27	2 KV / 2.3 KV
	Impulse voltage withstand	IEC60255-27	5 KV
	Insulation resistance	IEC60255-27	500 V (test level)
EMC	Electrostatic Discharge Immunity	IEC60255-26/IEC61000-4-2	Level 4
	Radiated RF Electromagnetic Field Immunity	IEC60255-26/IEC61000-4-3	Level 3
	Electrical Fast Transient Immunity	IEC60255-26/IEC61000-4-4	Zone A
	Surge Immunity	IEC60255-26/IEC61000-4-5	Zone A
	Conducted RF Immunity	IEC60255-26/IEC61000-4-6	Level 3
	Power magnetic Immunity	IEC60255-26/IEC61000-4-8	Level 5
	Power Frequency Immunity	IEC60255-26/IEC61000-4-16	Zone A
	Damped Oscillatory Wave Immunity	IEC60255-26/IEC61000-4-18	2.5 KV Common Mode 1 KV Diff. Mode
	Voltage Dips & Interruptions	IEC60255-26/IEC61000-4-11/ IEC61000-4-29	Levels based on IEC61000-4-11 & IEC61000-4-29
	Ripple on DC	IEC60255-26/IEC61000-4-17	15% Rated DC value
	Radiated & Conducted Emissions	IEC60255-26/CISPR11/ CISPR22	Class A
MECHANICAL	Sinusoidal Vibration	IEC60255-21-1	Class 1
	Shock & Bump	IEC60255-21-2	Class 1
	Seismic	IEC60255-21-3	Class 2
	Enclosure Protection	IEC60255-27/IEC60529	IP52
CLIMATIC	Cold test (storage)	IEC60068-2-1	-40˚C 16 hrs
	Cold test (operational)	IEC60068-2-1	-20˚C 16 hrs
	Dry heat test (storage)	IEC60068-2-2	85˚C 16 hrs
	Dry heat test (operational)	IEC60068-2-2	60˚C 16 hrs
	Change of Temperature	IEC60068-2-14	5 cycles (3+3) -20˚C/60˚C
	Damp Heat Humidity Cyclic	IEC60068-2-30	6 cycles (12+12) 55˚C @ 93% R.H.
	Damp Heat steady state	IEC60068-2-78	40˚C @ 93% R.H.

Type test reports available upon request.

C650 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.

2.5.14 Approvals

	APPLICABLE COUNCIL DIRECTIVE	ACCORDING TO
CE COMPLIANCE	Low voltage directive	IEC60255-27
	EMC Directive	IEC60255-26
NORTH AMERICA	UL	UL508
EAC	Machines and Equipment	TR CU 010/2011
ISO	Manufactured under a registered quality program	ISO9001

EAC

The EAC Technical Regulations (TR) for Machines and Equipment apply to the Customs Union (CU) of the Russian Federation, Belarus, and Kazakhstan

Item	Description
Country of origin	Spain
Date of manufacture	See label on the C650 unit
Declaration of Conformity and/or Certificate of Conformity	Available on request

2.6 External connections

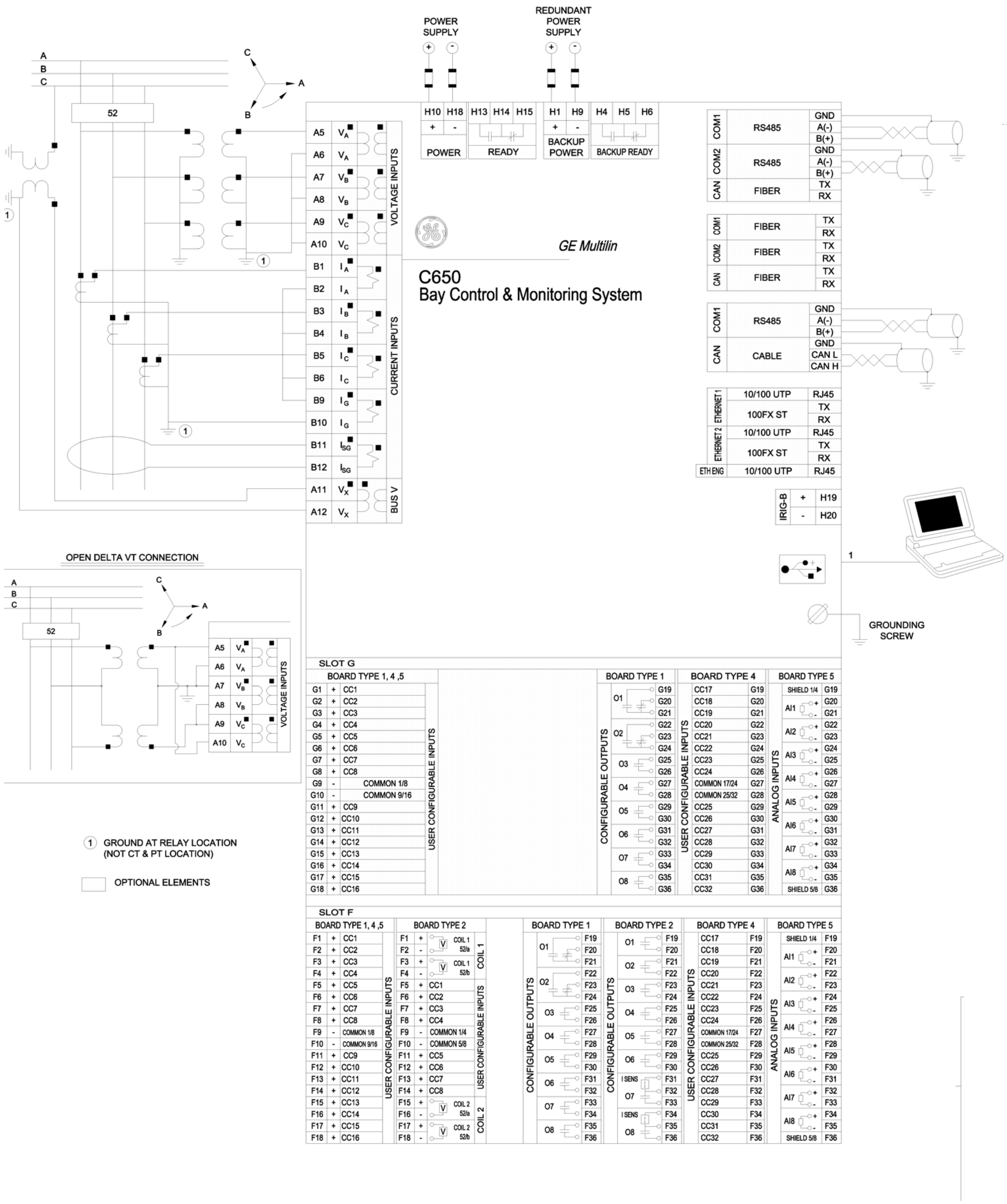


Figure 2-2: C650 wiring diagram for 1/2 rack (189C4216H22)

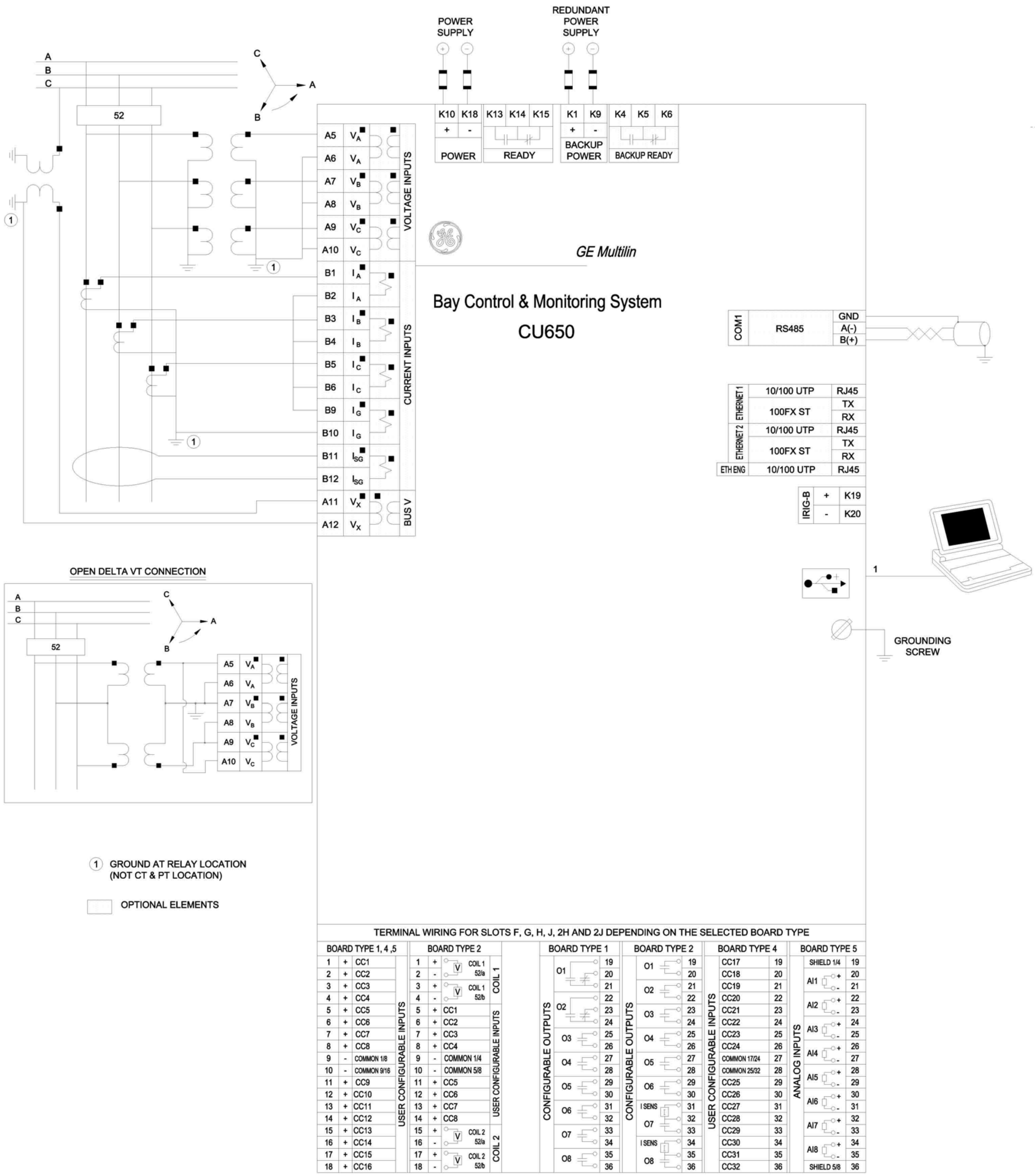


Figure 2-3: C650 wiring diagram for one rack (189C4216H25)

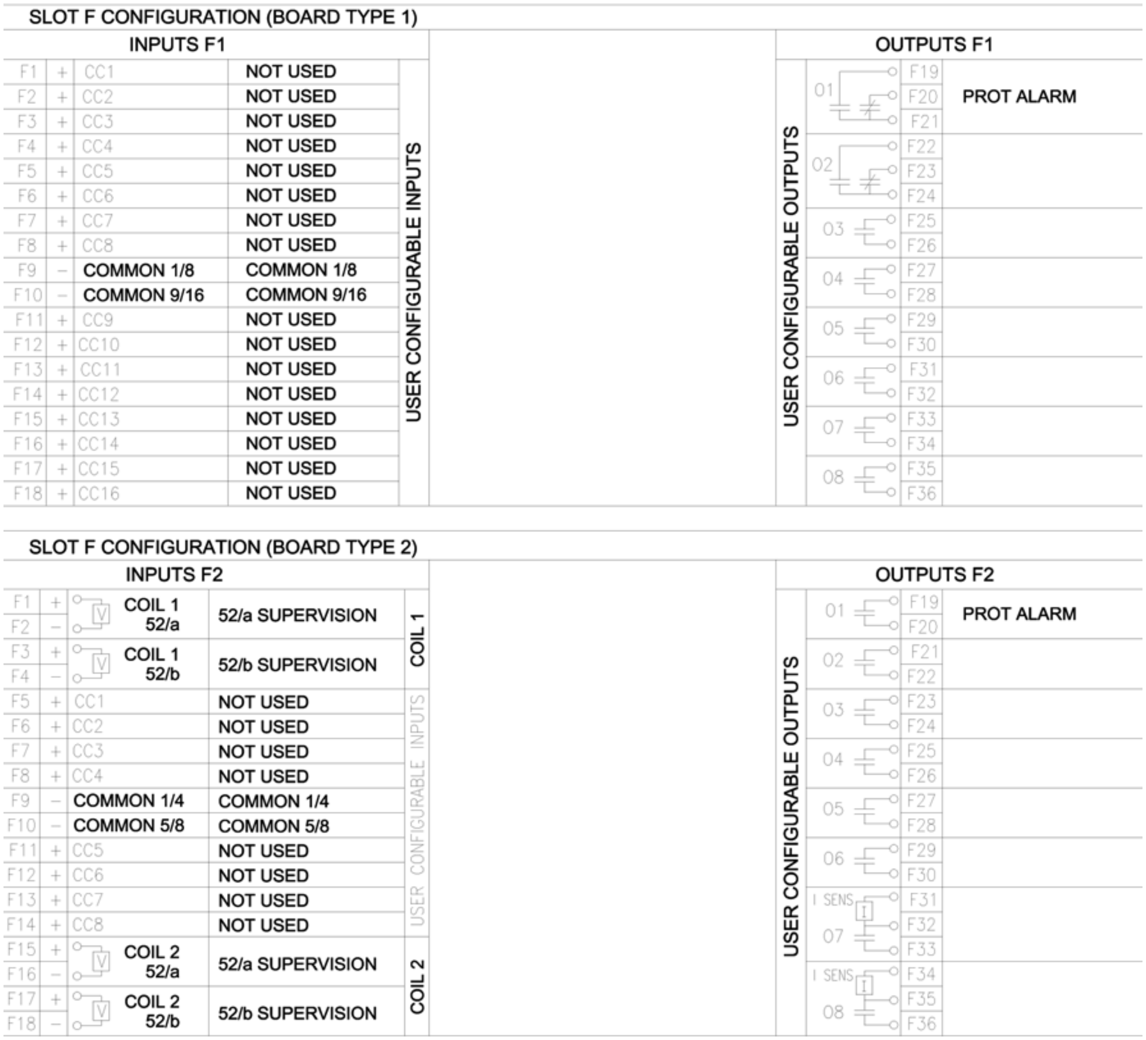


Figure 2-4: Input/output configurations for boards F1 and F2 (189C4216H23)

Note: For detailed information about different I/O boards types configuration. Go to section 5.5.1 Input/output placement on page 5–53.

C650 Bay Controller & Monitoring System

Chapter 3: Hardware

3.1 Module description

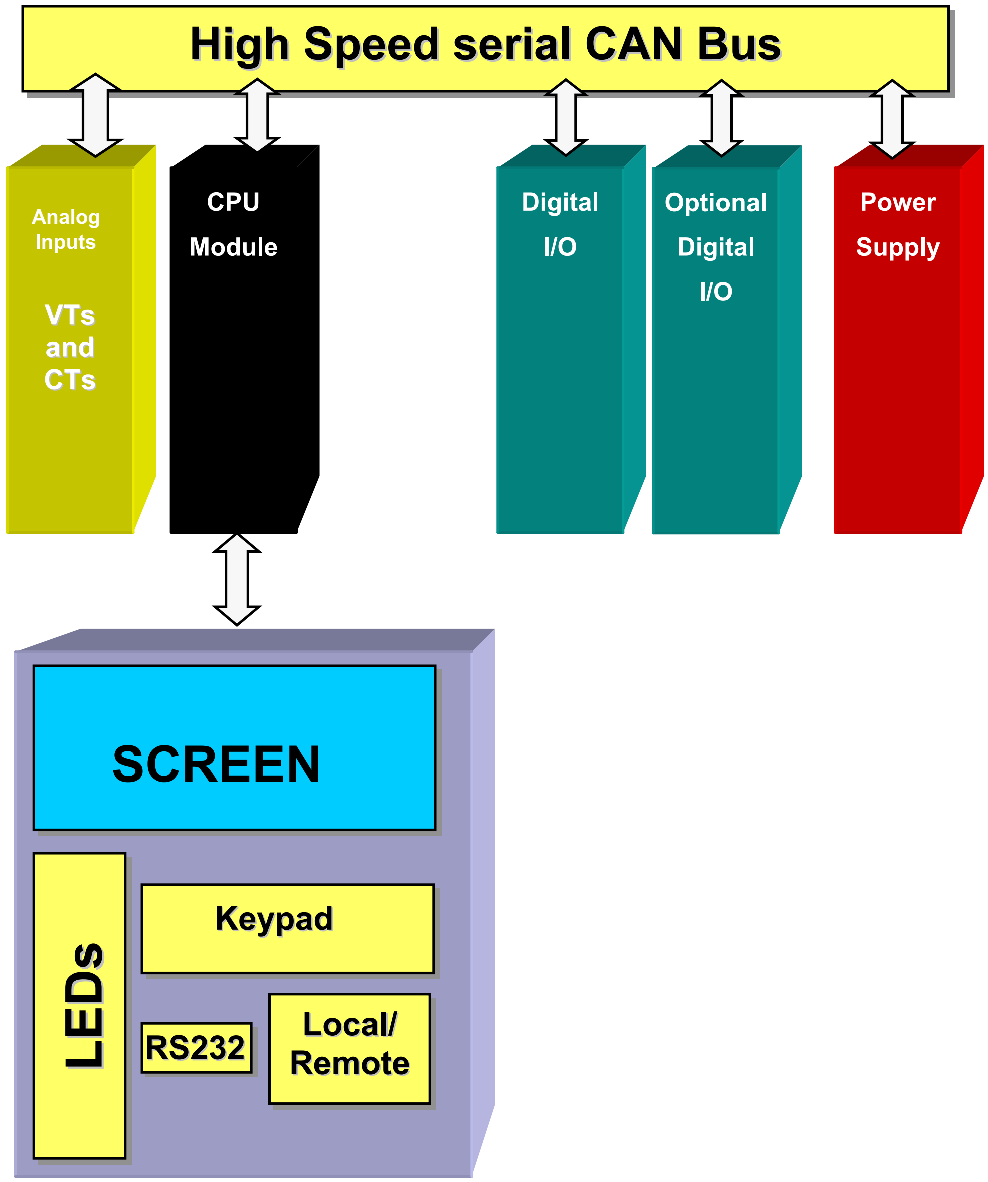


Figure 3-1: Block diagram

C650 units incorporate the following modules:

- **Power supply**, which can be simple or redundant, depending on the selected model
- **Front module** with 15 configurable LEDs, 3 dedicated front keys and one USB-serial com port **with alphanumerical (4 x 20) or optional graphical (16 x 40 characters) display.** It includes the USB-serial connector on one lateral for Modbus RTU communications. The HMI is connected to the main C650 module with an RJ45 straight through cable.
- Optionally, a **Transformer module** with 5 current transformers and 4 voltage transformers can be added.
- **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.

3.2 Power supply

C650 can incorporate a simple or redundant power supply. The main and backup modules are identical.

NOTICE Control power supplied to the relay must be connected to the matching power supply range of the relay. If the voltage is applied to the wrong terminals, damage can occur.

NOTICE The C650 relay contains electrolytic capacitors. These capacitors are well known to be subject to deterioration over time if voltage is not applied periodically. Deterioration can be avoided by powering the relays up once a year.

In the case of a redundant power supply the two modules work in parallel continuously, distributing 50% of the load on each, thus ensuring greater reliability and an instantaneous load transfer from a failed power supply to the backup, without loss of time or module reset.

A contact 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. The contact monitors the power supply integrity and it is not controlled by the main microprocessor. In order to monitor whether the unit is ready to protect (READY), an auxiliary output contacts in the unit should be programmed. This “fly-back” type power supply provides high efficiency, stability and reliability and is available in two 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 105°C, transformer components are specially designed to stand up to 180°C, the MOSFET transistor has very low resistance, supports high voltage and is refrigerated by an oversized heat sink. This allows temperatures over the 60°C shown in the Technical Characteristics section, and prolonged overloads such as those 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 operating normally without undesired resets leaving protection features offline.

⚠CAUTION **In the case of a blown fuse, replacement should be conducted by authorized/trained personnel only. Use replacement fuses with the same characteristics.**

Fuse Requirements:

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)

UL listed miniature fuse

Note: Contact technical support for further guidance.

3.3 Mechanical description

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 430), coated with an epoxy layer. 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, UL94), highly resistive material, which guarantees the unit's immunity to all kinds of EMI/RFI/ESD interferences. There is also an IP52 (IEC 529) protection rating against dust and water through the front and with the relay mounted in the panel.

3.3.1 Mounting

The unit is designed for semi-flush mounting of the main box. The unit is secured to the panel with the 4 M6 screws provided with the unit. The wiring is at the rear of the unit. Drilling dimensions are shown in Figure 3-3: Drilling dimensions for 1/2 rack relay (B2216H03) on page 3–5, and Figure 3-4: Drilling dimensions for full rack relay (B2216H2) on page 3–6.

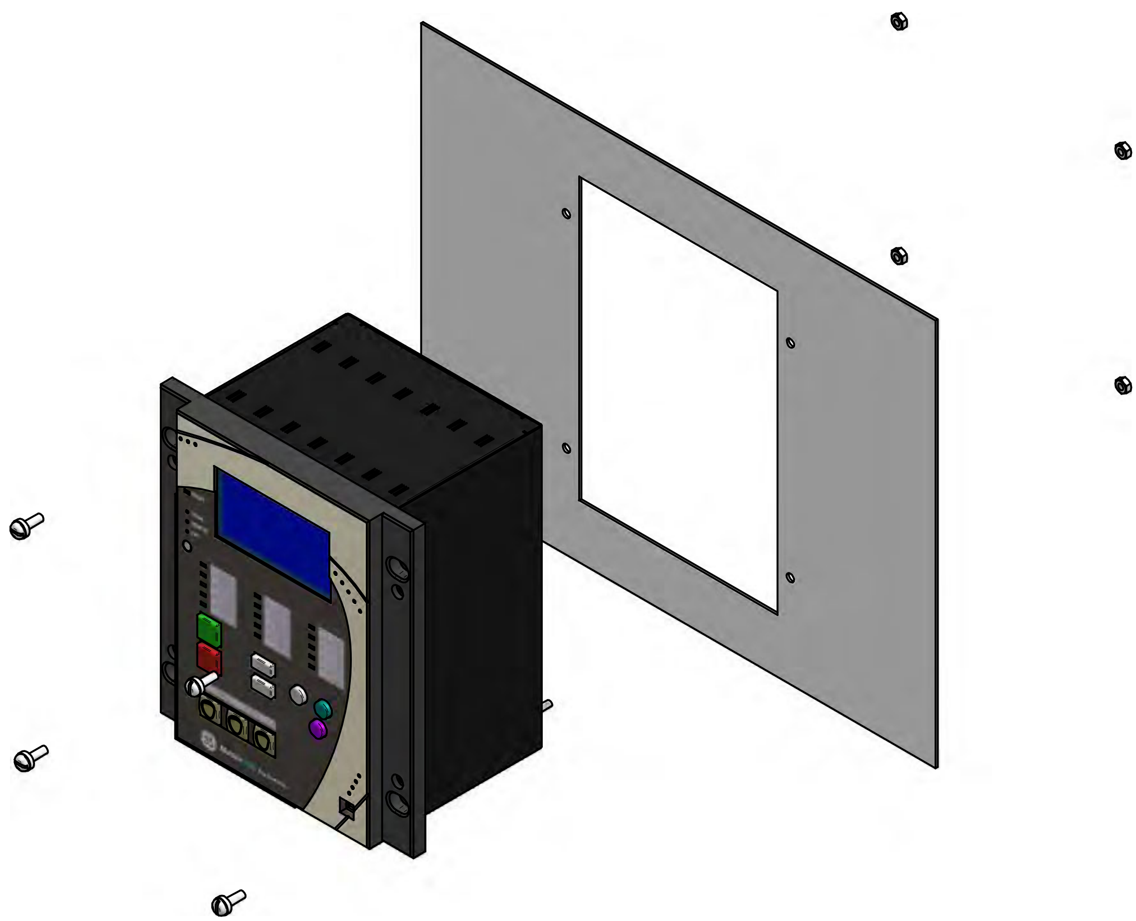


Figure 3-2: Panel mount

The relay width allows the mounting of one 19" unit or two 1/2 RACK units on a standard 19” panel, 8 units high.

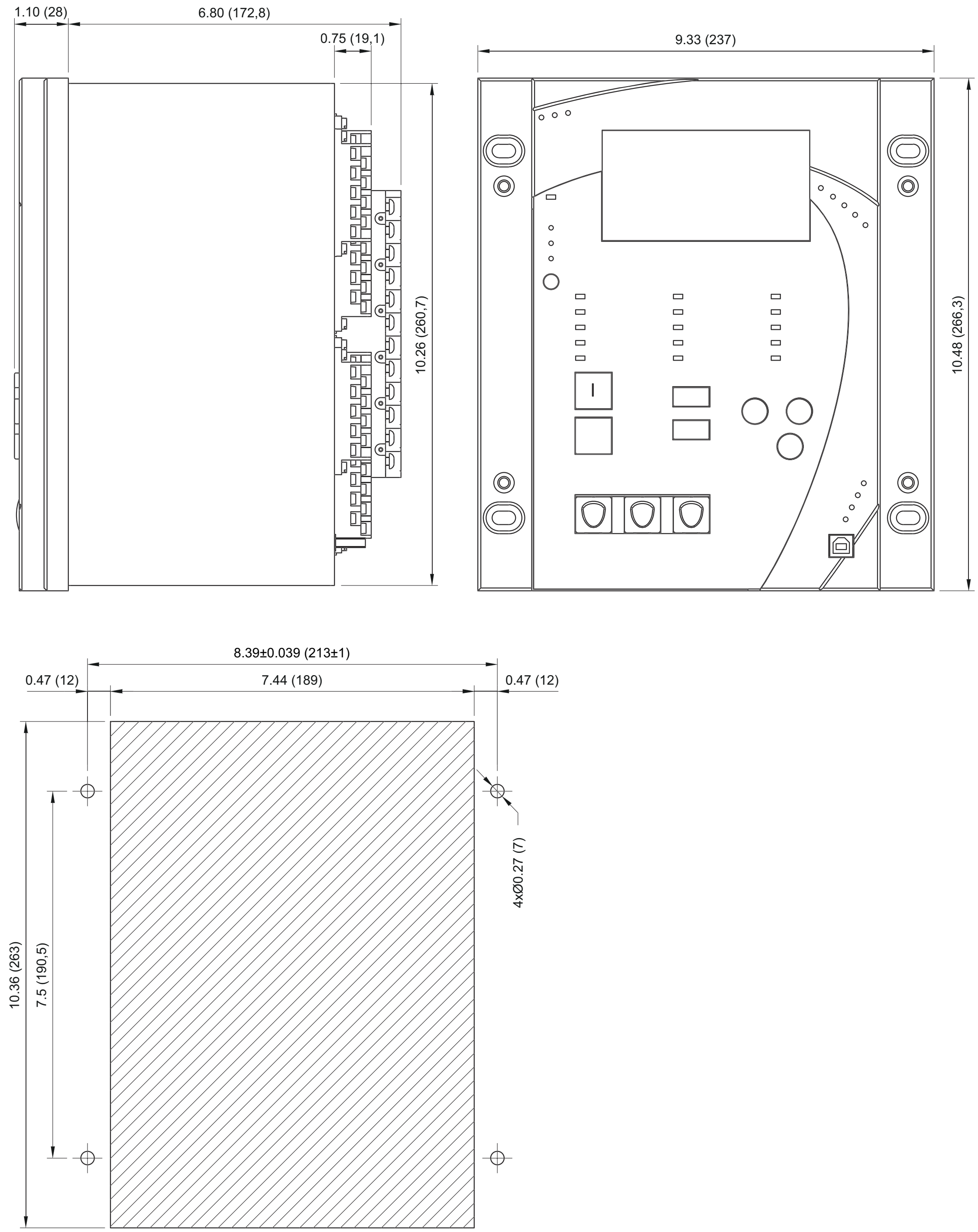


Figure 3-3: Drilling dimensions for 1/2 rack relay (B2216H03)

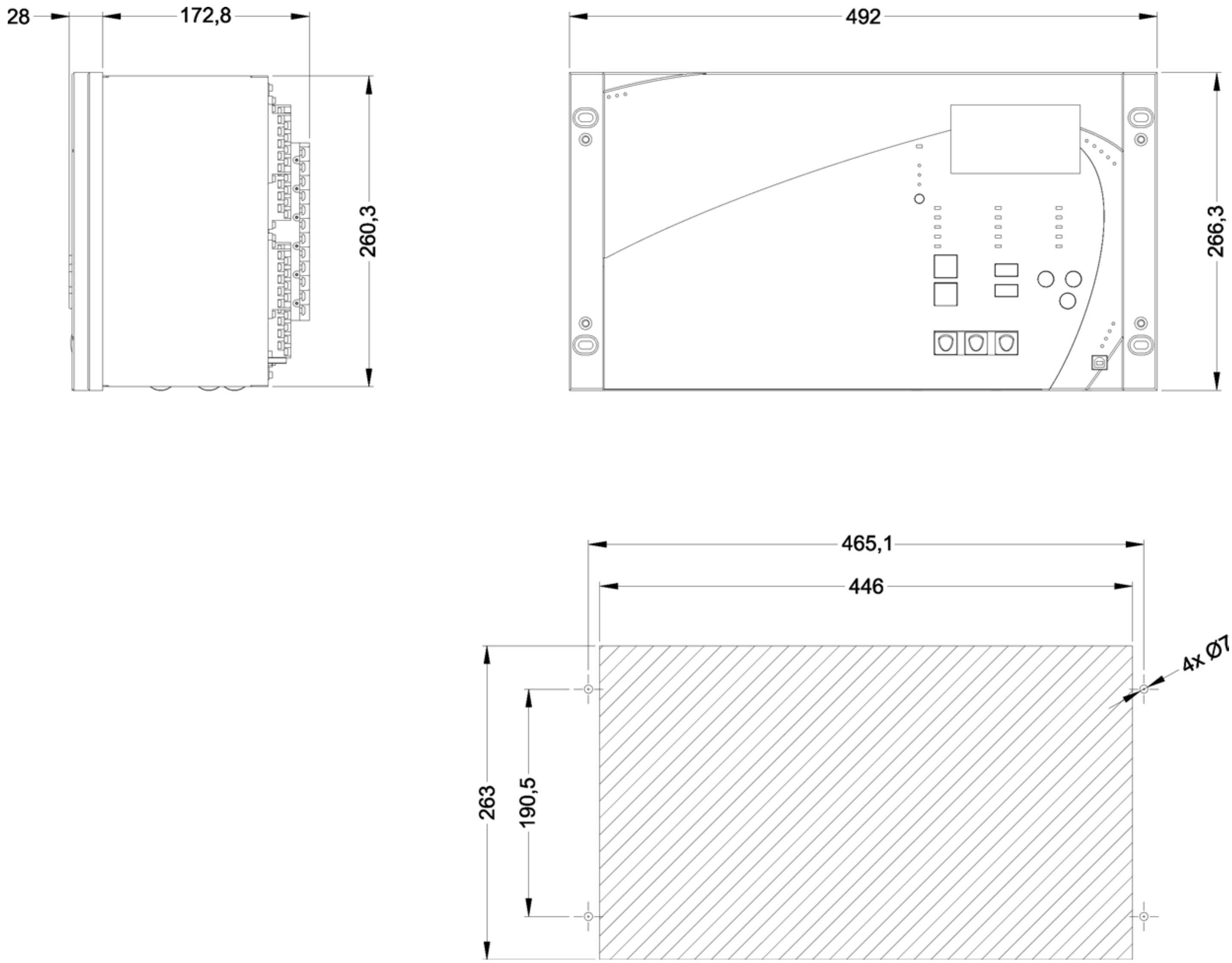


Figure 3-4: Drilling dimensions for full rack relay (B2216H2)

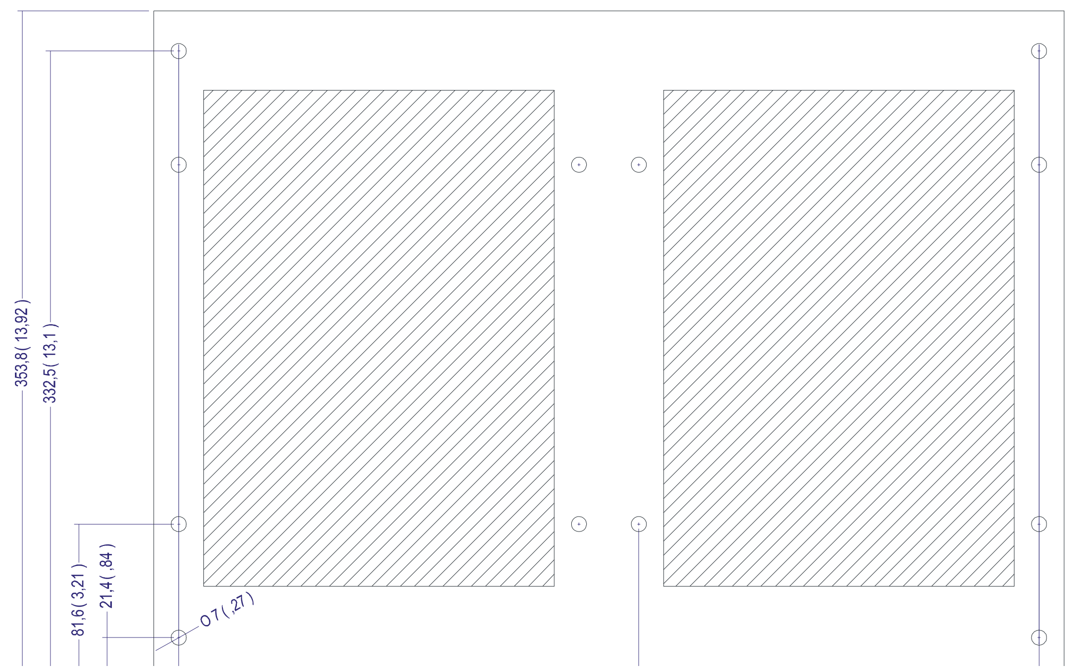


Figure 3-5: Drilling dimensions for two 1/2 rack relays on one 19" rack 8U high (B1351H88)

3.3.2 Rear description

⚠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 unit 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) The maximum tightening torque for the screws on terminal boards A and B is 1.2 Nm. 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 use of twisted pair wire and/or shielded is recommended for the CT secondary current Isg.

The rest of the terminal blocks, 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 relay should be connected directly to the ground bus, using the shortest practical path. A tinned copper, braided, shielding and bonding cable should be used. As a minimum, 96 strands of number 34 AWG should be used.

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

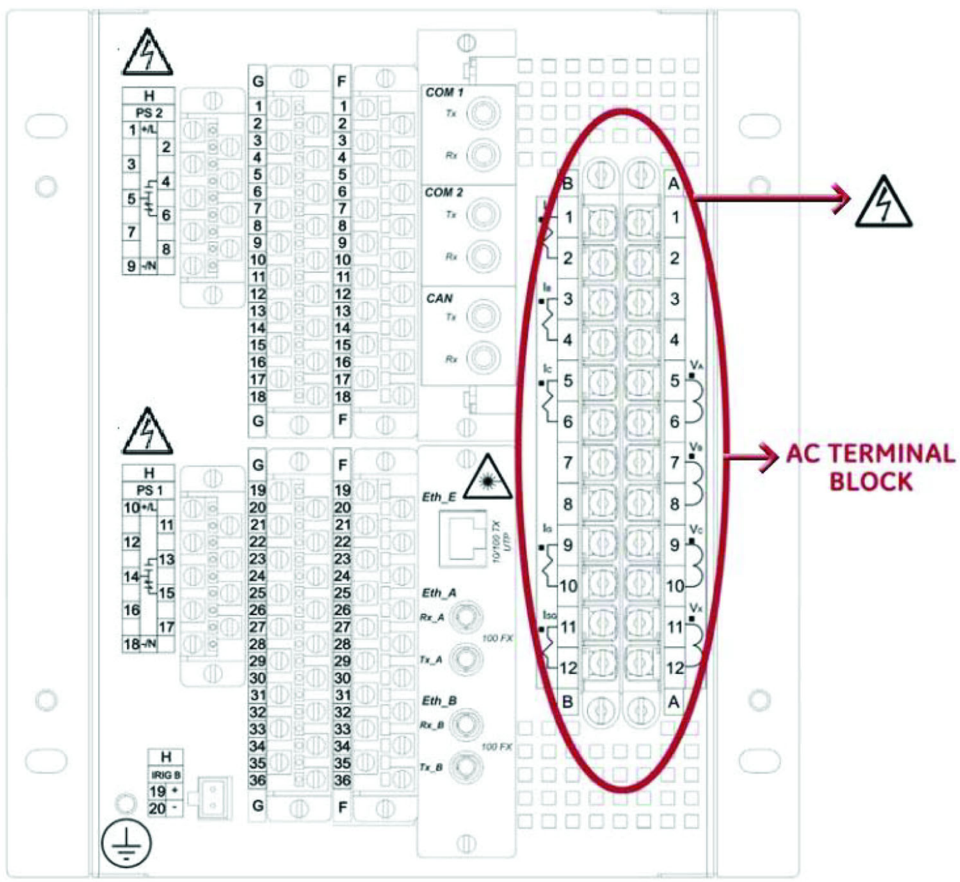


Figure 3-6: Connector locations

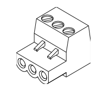
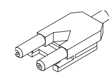
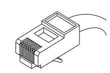
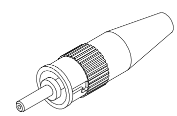
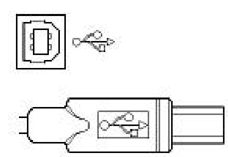
TYPE OF COMMUNICATION	CONNECTOR	
RS485 / CAN cable	Plug-in, 3 poles.	
IRIG B	Plug-in, 2 poles.	
Plastic fiber optic	Versatile Link	
Ethernet 10/100 UTP (10/100BaseTX)	RJ45, Class 5.	
Glass fiber optic (100BaseFX)	ST	
Ethernet 100 FX (100BaseFX)	ST	
CAN Fiber	ST	
USB serial	USB type B plug	

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.The USB port type B jack is located in the front HMI of the C650 unit.

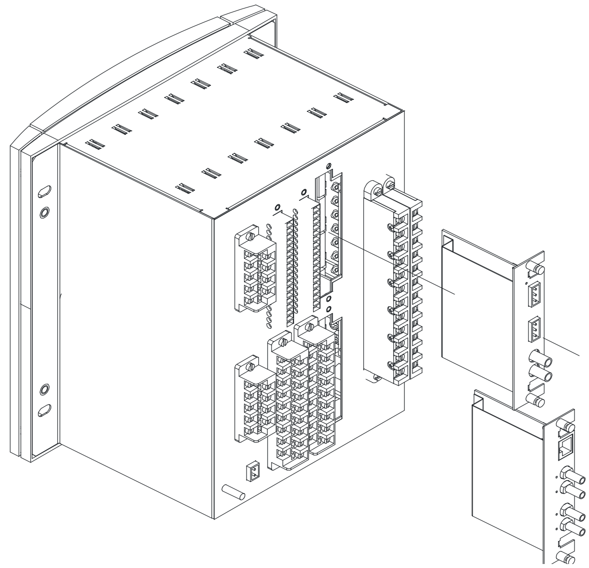


Figure 3-8: Detail of insertion/extraction of communication modules

Note: For version 7.00 and above, only the serial card can be removed

⚠WARNING **The transformer module housing 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 switch 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

⚠WARNING **Special care is required when disconnecting CT wire leads from the terminal block.**

A high voltage potential can occur if a wire is disconnected while a CT is energized.

CT isolation or de-energization is required prior to CT terminal wire removal.

3.4 Wiring

3.4.1 External connections

C650 units can have different options for the slot 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 the modules in slots G, H, J, 2H, and 2J, there are 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. F1G5 is a valid selection and F5G1 is an invalid selection.

Similarly, the number selected for slots J, 2H, and 2J must be greater than or equal to the preceding order code option 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.

NOTICE

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

3.4.3 Cable/fiber Ethernet board

The Ethernet board for versions prior to 7.10 is an independent module located in the bottom at the rear part of the relay.

In models C and D (options for versions prior to 7.10), the 10/100BaseTx port is selected by an internal switch. This switch must be configured as shown in the Figure 3-9: Fiber/cable selection in order to select between fiber or cable.

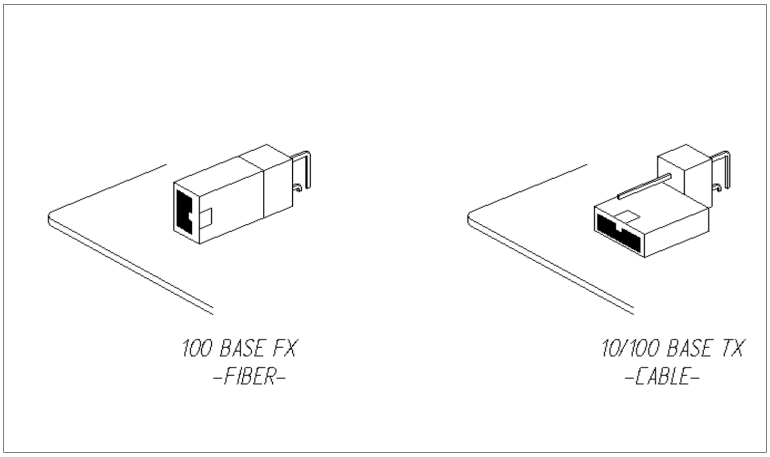


Figure 3-9: Fiber/cable selection

3.5 Transceiver optical power budget vs. link length

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, and optical switches. OPB also provides a 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

C650 Bay Controller & Monitoring System

Chapter 4: Interfaces, Settings & Actual Values

4.1 EnerVista 650 Setup software

4.1.1 Introduction

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

The EnerVista 650 Setup software interface provides access 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 (offline) or connected (online) with a 650 device. In offline mode, settings files can be created for eventual download to the device. In online mode, real-time communication with the device is supported.

The EnerVista 650 Setup software, provided with every C650 relay, can be run from a computer supporting Microsoft Windows XP(SP 2 or 3), Windows 7 or Windows 8. 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.

The EnerVista 650 Setup software package uses ModBus protocol, and 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 C650 features.

4.1.1.1 Using settings files

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

1. In offline mode (relay disconnected), create or edit relay settings files for later download to communicating relays.
2. In online mode (relay connected), modify any relay settings via relay data view windows, and then save the settings to the relay.
3. Combining online and offline modes, 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
- Quick Settings
- Relay Configuration
- Logic Configuration

4.1.1.2 Viewing actual values

You can view real-time relay data such as input/output status and measurements while connected to a relay.

4.1.1.3 Viewing triggered events

In online mode, you can view and analyze data generated by triggered specified parameters, via one of the following:

- **Event Recorder:** The event recorder captures contextual data associated with the last 479 events, listed in chronological order from most recent to oldest. For firmware version 7.20 or higher, 511 events are available.
- **Oscillography:** 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.

4.1.1.4 Firmware upgrades

The firmware of a C650 device can be upgraded, locally or remotely, via the EnerVista 650 Setup software. Instructions are provided in Chapter 9: Bootcode and firmware upgrade.

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.

4.1.1.5 One line diagrams

Users can configure a one line diagram (bay mimic) to be used in models with a graphical display.

4.1.2 Main screen

The EnerVista 650 Setup software main window includes the following components:

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

Figure 4-1: EnerVista 650 Setup main screen

4.1.3 Connect to the relay

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

NOTICE Safety instructions must be followed before connecting the computer to the relay. Safety instructions are detailed in section 1.1.3 Safety instructions. 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 can result damaged by overvoltages.

When working online, ensure that all relay communication parameters, such as baud rate, slave ModBus address, etc., match the computer settings before connected to the relay.

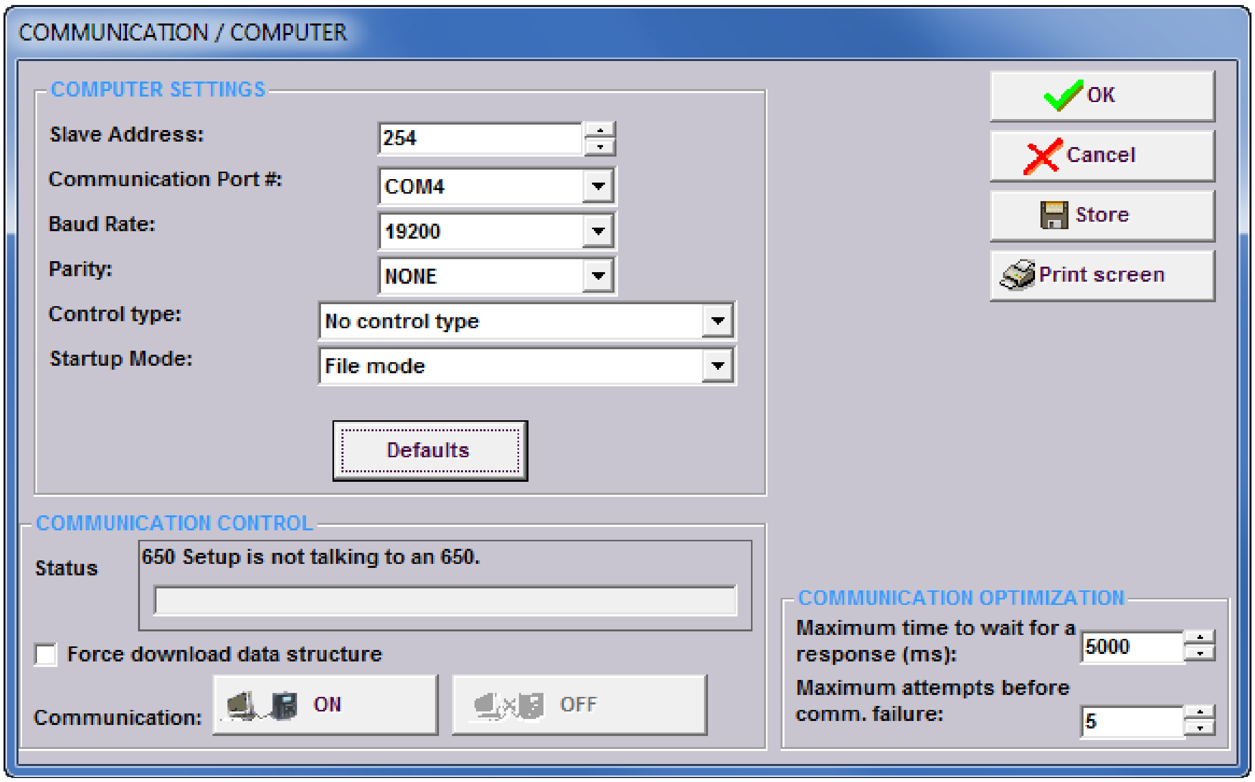


Figure 4-2: Communication parameters menu

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.

4.1.3.1 Computer Settings

This section shows the communication parameters needed 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 on the relay main screen.

ModBus Slave Address: ModBus address used for serial and Ethernet communication; default 254.

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

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

4.1.3.2 Communication Control

Located at the bottom of the screen, this section shows the status of communication with the relay. When the relay is not communicating, the message "*650 Setup is not talking to a 650*" is shown and the **ON** button is enabled. Click **ON** to start the EnerVista 650 Setup software communicating with the relay.

When the relay is communicating, the message "*650 Setup is now talking to an 650*" is shown and **OFF** is enabled. Click **OFF** to disconnect communications between the relay and PC.

4.1.3.3 Communication Optimization

Adjusting the parameters in the Communication optimization section can improve communication, although using the default values is recommended in most cases. These parameters are the maximum time to wait for a response in the relay (in ms) and the maximum number of connection attempts to perform before assuming communications failure.

4.1.4 File management menu

File management with EnerVista 650 Setup software:

4.1.4.1 File Management menu for firmware below v7.70

4.1.4.1.1 Offline mode

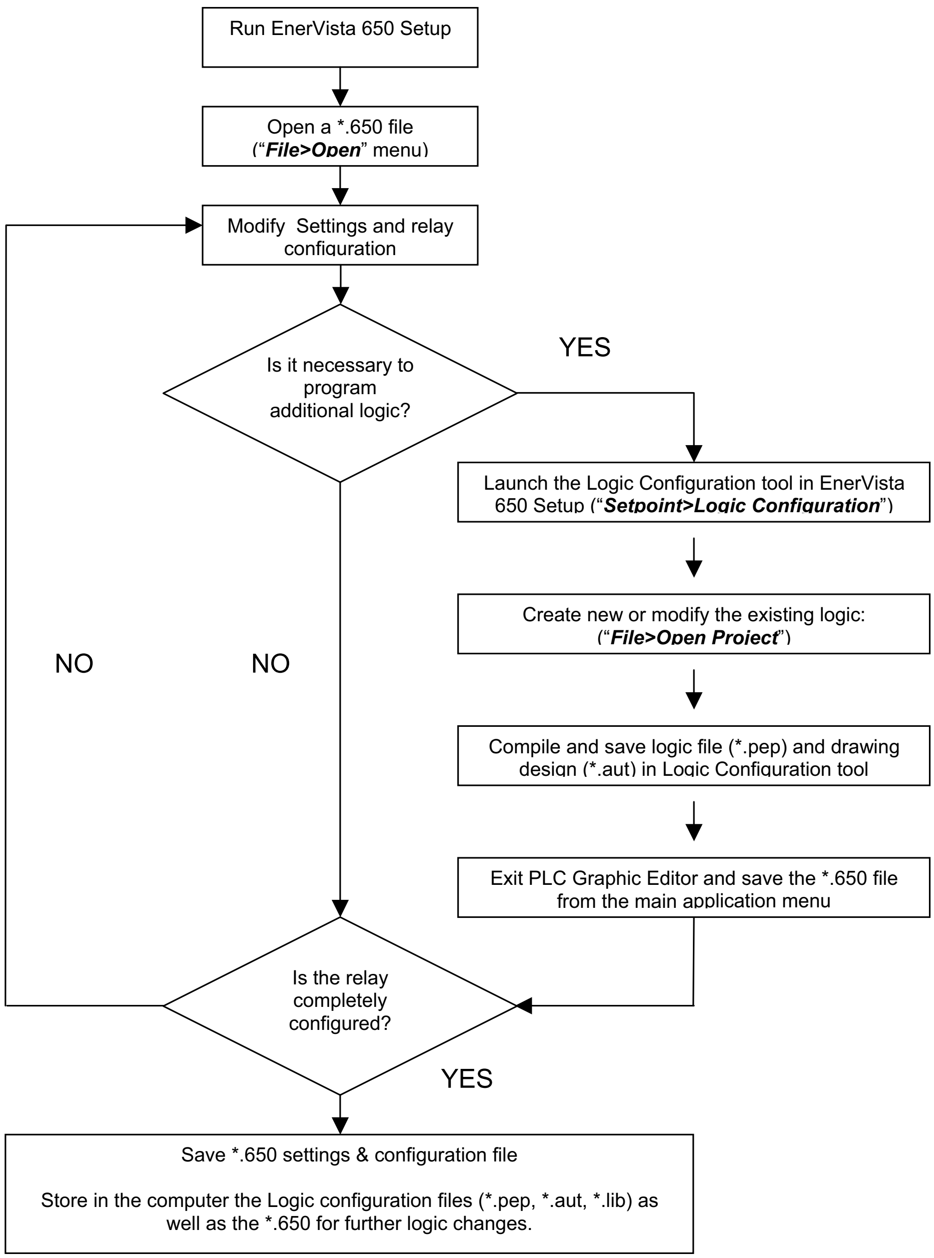


Figure 4-3: Offline mode file management[1]

1. "Relay and logic configuration" and "Protection and Control Settings" must be uploaded to the C650 relay or the device to operate properly

Table 4-1: Types of files generated by EnerVista 650 Setup software, offline:

	Settings & Configuration File *.650	**Logic Configuration Files (*.pep, *aut, *.lib)**		
		***.pep**	***.aut**	***.lib**
Description	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 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.		

When using element libraries (both pre-existing in **File Library > Open Library** or created by the user in **File Library > New Library**), the program creates and manages the corresponding files (*.lib) in a folder named FDB (Functional Block Diagram). These files are used for PLC project compilation. The element library files must be stored with the other logic configuration files that build the PLC project (*.pep, *.aut, *.lib).

Besides sending configuration information to the relay (Settings & configuration in *.650 format), storing the complete set of *.650, *.pep, *.aut and *.lib files inside the relay is recommended (**Communication > Upload info files to relay**). This ensures that logic configuration files are available in future for logic modifications. Even if these files are not used by the relay, they are required to connect to the relay and analyze its configuration. The EnerVista 650 Setup software program manages the logic configuration files globally, so that when the *.pep file is uploaded to 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

4.1.4.1.2 Online mode

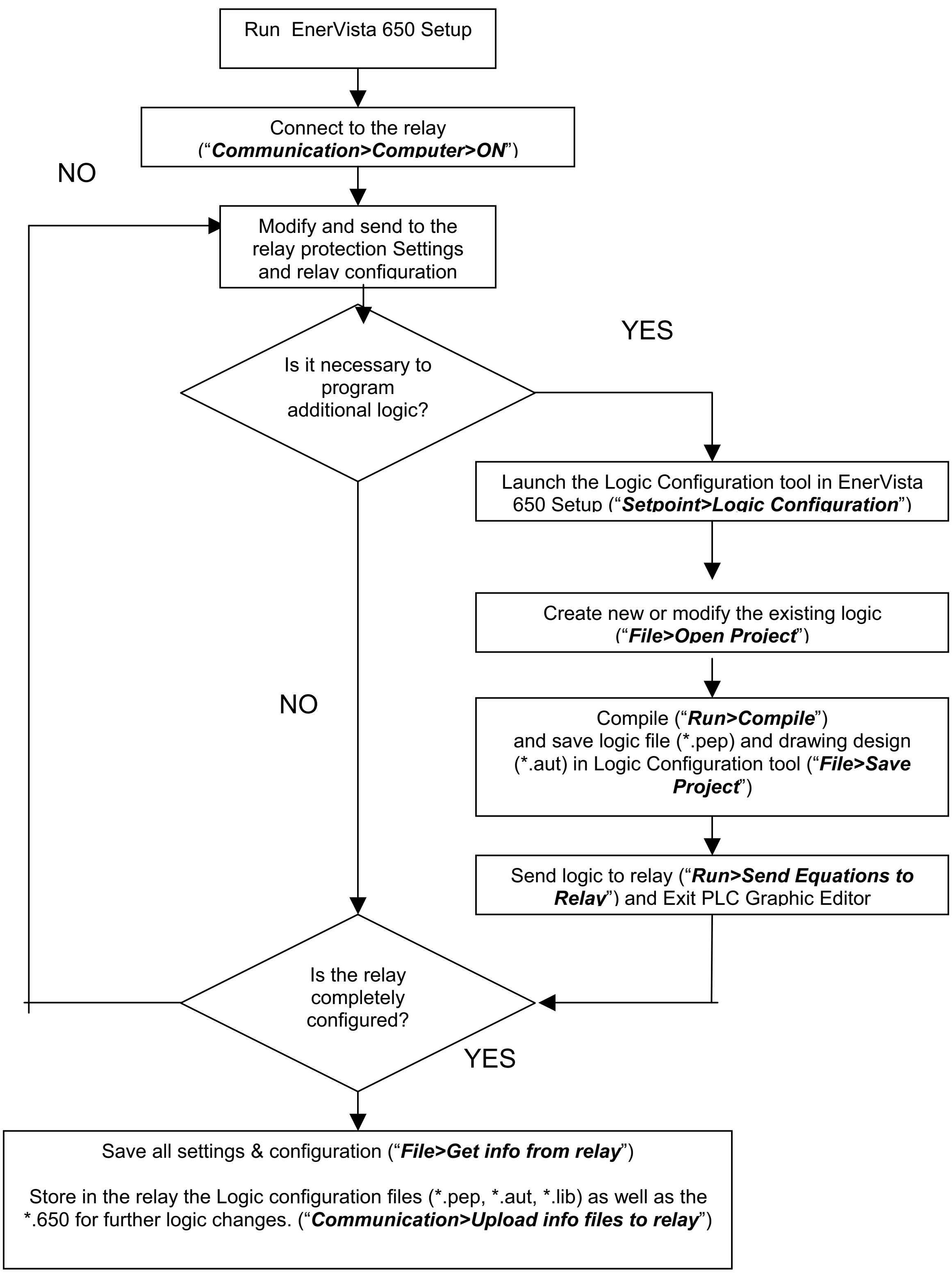


Figure 4-4: Online mode file management

Table 4-2: Types of files generated by EnerVista 650 Setup software, online

<table>
<tr><th rowspan="2"></th><th rowspan="2">Settings & Configuration File *.650</th><th colspan="3">Logic Configuration Files (*.pep, *.aut, *.lib)</th></tr>
<tr><th>*.pep</th><th>*.aut</th><th>*.lib</th></tr>
<tr><td>Description</td><td>Settings and Configuration Section</td><td>Header for Logic project</td><td>Graphical edition container. Logic equations (Virtual Outputs) in FDB format.</td><td>User programmable logic objects</td></tr>
<tr><td>Created by</td><td>EnerVista 650 Setup</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td></tr>
<tr><td>Contents</td><td>Relay configuration file containing all elements, settings, input/output and LEDs configuration, graphic display configuration, etc.
Equations corresponding to the logic created and compiled in the PLC Editor</td><td>PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.</td><td>PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).</td><td>Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.</td></tr>
<tr><td rowspan="6">How to transfer to relay</td><td>Connect with the relay (Communications > Computer)</td><td colspan="3">Connect with the relay (Communications > Computer)</td></tr>
<tr><td rowspan="4">Send settings and configuration from file</td><td colspan="3">Launch 650 Logic equations editor (Setpoint > Logic Configuration)</td></tr>
<tr><td colspan="3">Open the created PLC project (File > Open Project)</td></tr>
<tr><td colspan="3">Compile the project (Run > Compile)</td></tr>
<tr><td colspan="3" rowspan="2">Now the logic (virtual outputs) can be sent directly to relay (Run > Send Equations to Relay). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.</td></tr>
<tr><td>Modify settings and configuration directly in the relay:</td></tr>
<tr><td rowspan="4">How to save</td><td rowspan="4">EnerVista 650 Setup:
File > Get info from relay. User definable texts retrieved are operations, events, and LEDs.</td><td colspan="3">PLC Editor:</td></tr>
<tr><td colspan="2">File > Save Project</td><td>File > Save Library</td></tr>
<tr><td>The relay does not provide this information unless the *.pep file is stored in the relay</td><td>The relay does not provide this information unless the *.pep file is stored in the relay.</td><td>The relay does not provide this information unless the *.pep file is stored in the relay.</td></tr>
<tr><td colspan="3">To store the logic configuration files in the relay use the Communication > Upload info files to relay option</td></tr>
<tr><td>How to store in the relay</td><td>Communication > Upload info files to relay through Ethernet</td><td colspan="3">Communication > Upload info files to relay through Ethernet</td></tr>
<tr><td>How to retrieve from the relay</td><td>Communication > Download info files from relay through Ethernet</td><td colspan="3">Communication > Download info files from relay through Ethernet</td></tr>
</table>

REMINDER:
Logic programming support files (*.pep, *.aut, *.lib) CANNOT be retrieved directly from the relay.
It is necessary to do one of the following to store support files: * Store in the PC * Upload to the relay (**Communication > Upload info files to relay**), after which they can be retrieved from the relay

4.1.4.2 File Management menu for firmware v7.70 and above

Firmware versions 7.70 and above work with EnerVista 650 Setup software version 8.10 and above (see corresponding release notes).

EnerVista 650 Setup software 8.10 and above uses a new *.650 file format, combining previous settings and configuration files (*.650) along with Logic configuration files (*.pep, *.aut,*.lib) into a single *.650 file.

4.1.4.2.1 Offline mode (firmware v7.70 and above)

This mode will allow to create, open and/or modify only one file (*.650) instead of multiple files that are managed for firmware versions below 7.70 (setting and configuration file (*.650) and Logic configuration files (*.pep, *.aut,*.lib)).

Existing *.650 files for firmware below 7.70 must be converted to files supported by firmware version 7.70 or above using Enervista 650 Setup version 8.10 or above. During the update process, a PLC project file (*.aut,*.pep,*.lib) must be selected.

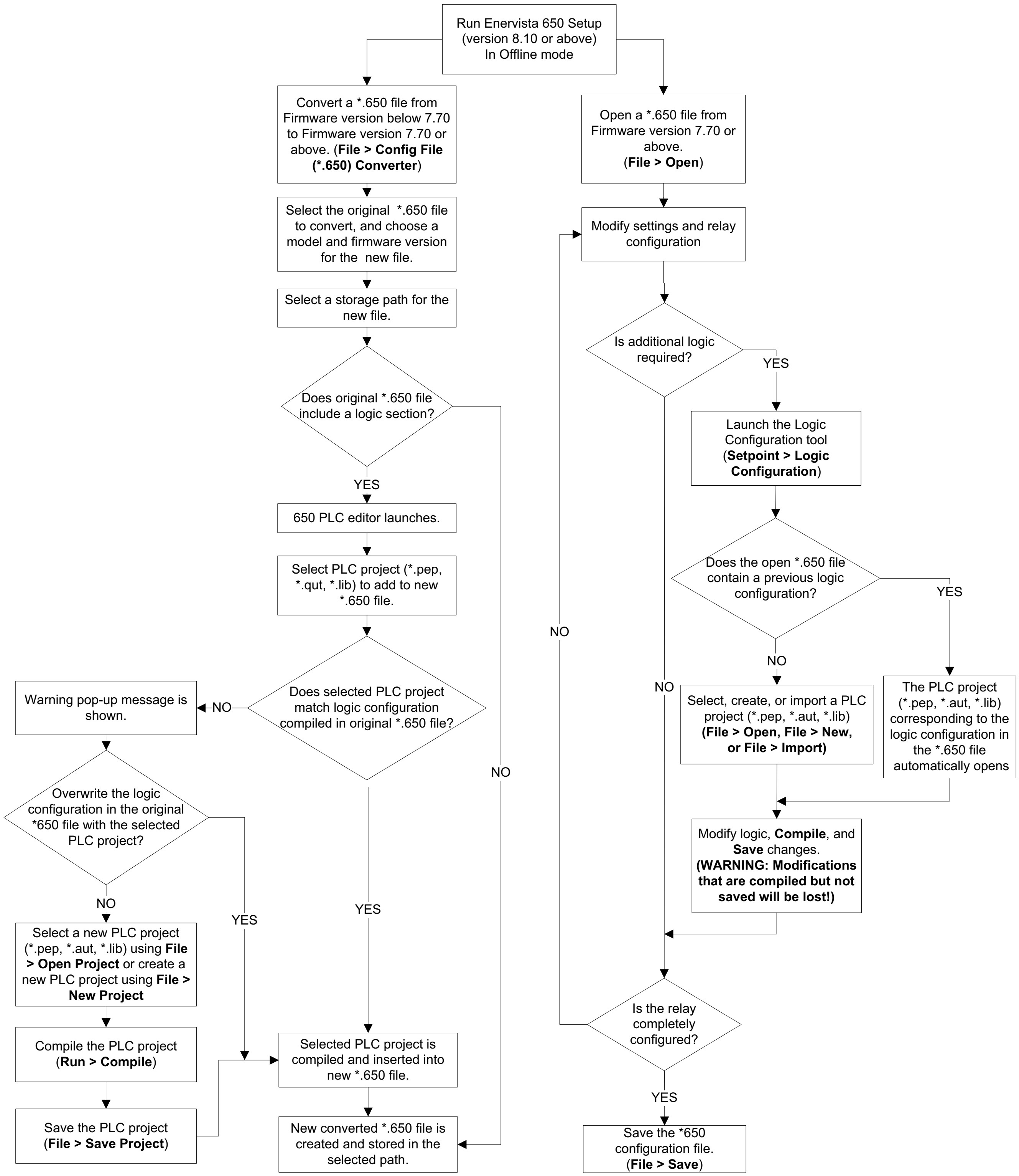


Figure 4-5: Offline mode file management (firmware v7.70 and above))

4.1.4.2.2 Online mode (firmware v7.70 and above)

This mode allows the modification of Logic Configuration that is running in the relay without having to store a backup of the PLC project (*.pep,*.aut,*.lib) on the local computer or by running **Communication > Upload info files to relay** as was done previously.

NOTE: Storing a local PC back-up of the following 650 relay configuration files before changing settings or logic is highly recommended:

- *.650 configuration file
- Logic programming support files (*.pep, *.aut, *.lib) inserted into *.650 (PLC Editor> File> Export)

WARNING

Do not try to communicate with the relay during the start-up process. Doing so may cause loss of the configuration file (*.650), leading to unexpected behavior.

Communication can be established safely once relay has fully started-up. The relay has completed its start-up process when Menus are accessible from the HMI.

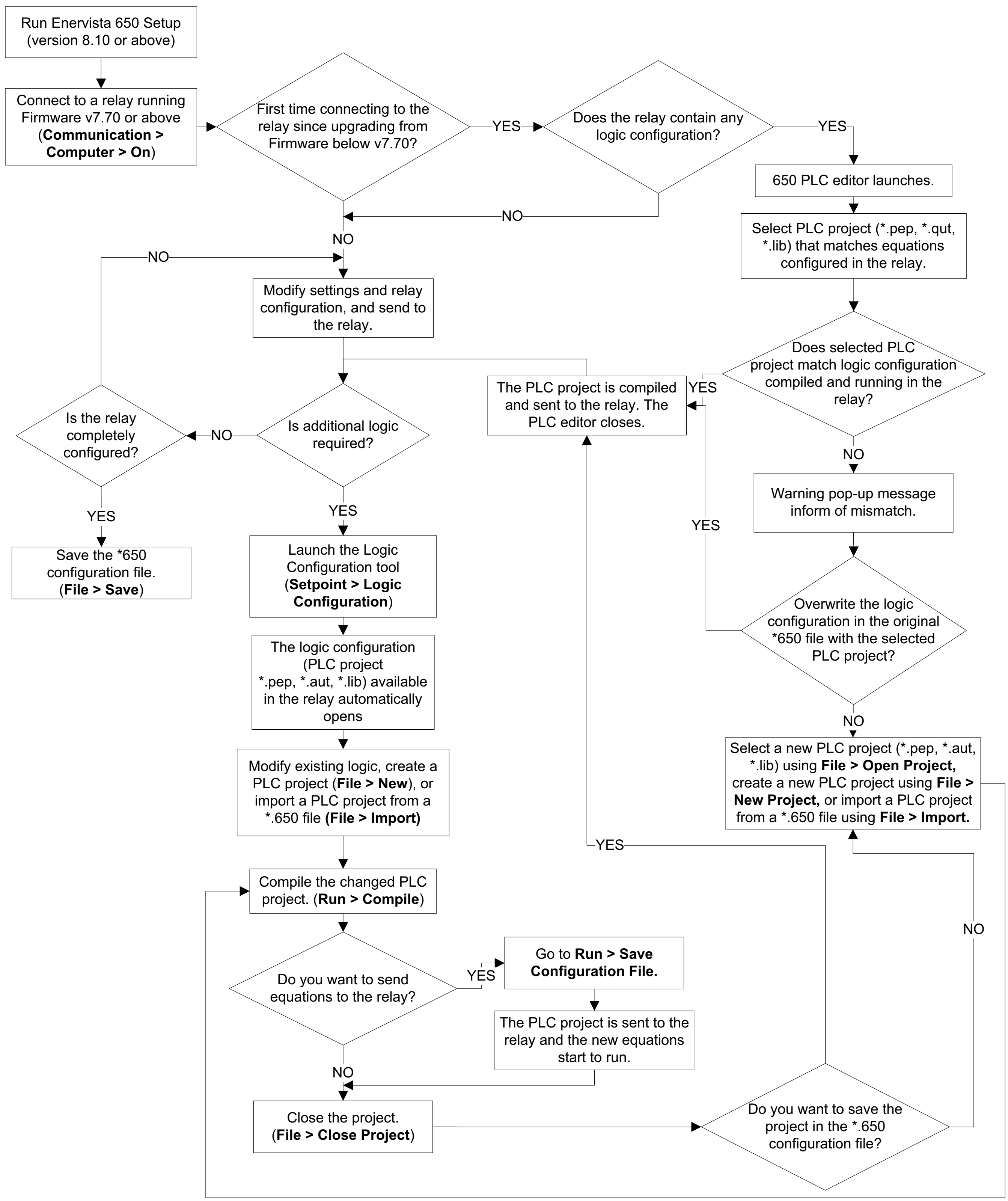


Figure 4-6: Online mode file management (firmware v7.70 and above)

4.1.5 EnerVista 650 Setup menu

The EnerVista 650 Setup menu structure is shown in Table 4-3: EnerVista 650 Setup menu structure.

Unless specified, options are available in both online and offline mode.

(*) indicates options enabled only in online mode. (**) indicates options enabled only in offline mode.

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

Table 4-3: EnerVista 650 Setup menu structure

File	Setpoint	Actual	Operations(*)	Communication	IEC 61850 CONFIGURATOR	Security	View	Help
New (**)	Product Setup	Front Panel	Fixed commands	Computer		Login user	Traces	Instruction Manual
Open (**)	System Setup	Status		Modem (*)		Change Password	ModBus Memory Map	GE Multilin on the web
Save (**)	Protection Elements	Metering		Troubleshooting (*)		User Management	Languages (**)	About EnerVista 650 Setup
Save As (**)	Control Elements	Inputs/ Outputs		Calibration (*)				
Close (**)	Inputs/Outputs Quick Settings	Records (*)		Upgrade Relay (*)				
Config File (* 650) Converter	Relay Configuration							
Compare to settings file	Logic Configuration							
Properties (**)	Clock (*)			Upgrade 650 Web Server				
Get info from relay (*)				Upload info files to relay				
Send info to relay (*)				Download info files from relay				
Print Setup (**)								
Print Preview (**)								
Print (**)								
Print to file								
PLC Checksum Calculation								
Settings Checksum Calculation								
Order Code								
Exit								

4.1.6 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 offline 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
Compare to settings file	Compare online unit or opened settings file to another settings file
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.
PLC Checksum Calculation	Calculate the CRC of PLC equations of the .650 file (When a .650 is uploaded to the relay, the calculate PLC CRC and the actual value of the PLC CRC read from the relay must match).
Settings Checksum Calculation	Calculate the CRC of settings of the .650 file (When a .650 is uploaded to the relay, the calculate Setting CRC and the actual value of the Setting CRC read from the relay must match).
Order code(*)	Option available for C650 with firmware version 7.00 or above. This allows a model to have special functionality (see model selection) with password requirements. For detailed information go to section 9.2.2.3 Order code upgrade process on page 9–26.
Exit	Quit the application closing all the open windows.

(*) indicates online only, (**) indicates offline only

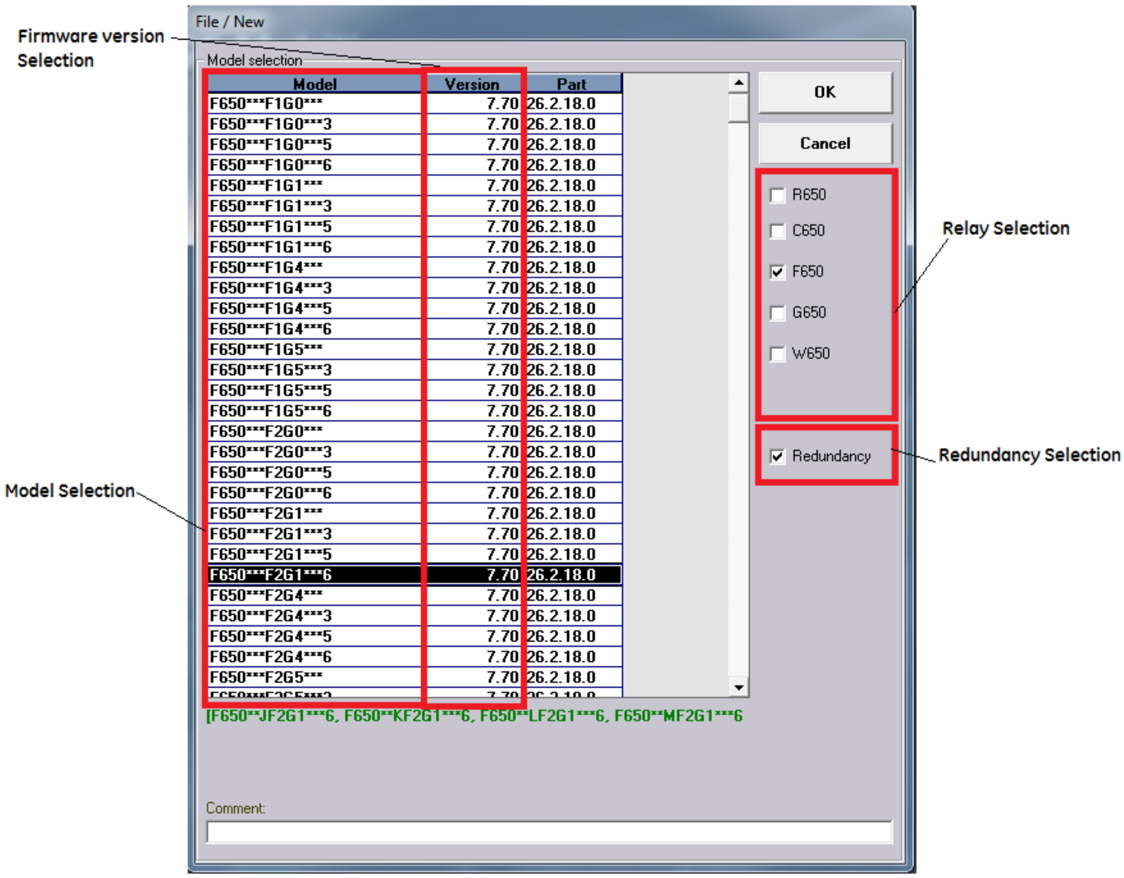
4.1.6.1 New

Use the **File > New** menu option to create a new default settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

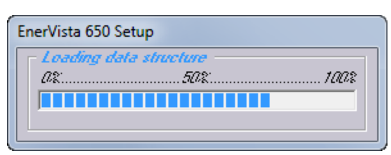
1. Select **File > New**.

   EnerVista 650 Setup opens a pop-up window with a list of all files available for different models/firmware versions.

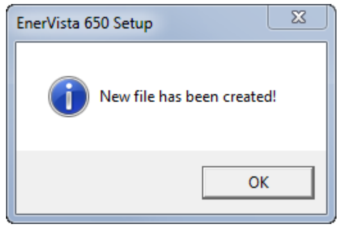


– Relay Selection: Select a 650 family relay (F650, R650, C650, W650 or G650).
– Redundancy Selection (firmware v7.00 and above only): Select to include files for F650/C650 relays with Rear Ethernet Communications 2 Board options J, K, L and M.
– Models and Firmware Selection: Click to select one of the different models and firmware versions available.

2. Once you have selected a file, click **OK** and wait until the file has finished loading.



3. A message indicates when the new *650 file has been created. Click **OK** to access the new file in offline mode.



4.1.6.2 Open

Use the **File > Open** menu option to open an existing settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

Open a *.650 configuration file for firmware versions below 7.70:

- Navigate to **File > Open** and select a file to open.

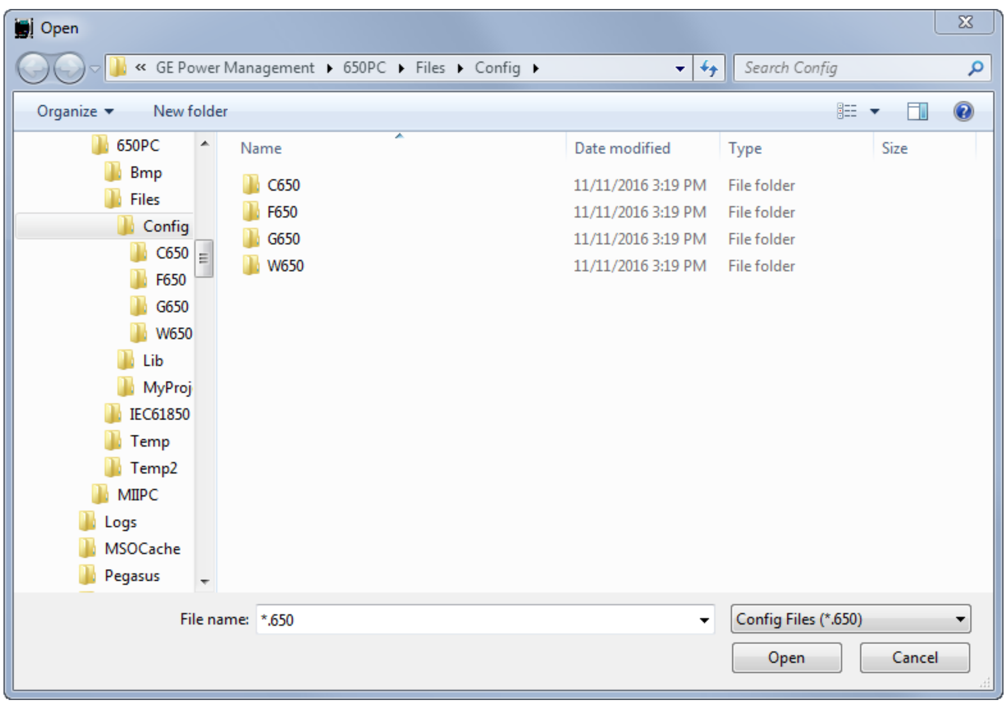


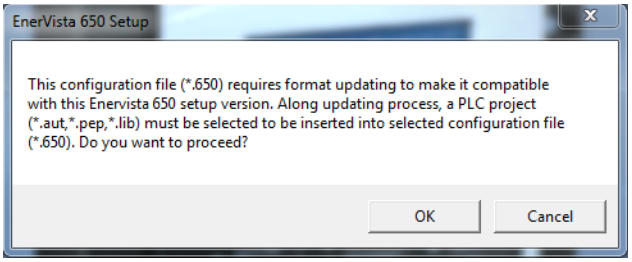
Figure 4-7: Open file menu

Open a *.650 configuration file for firmware versions 7.70 and above:

Enervista 650 Setup version 8.10 or above is required.

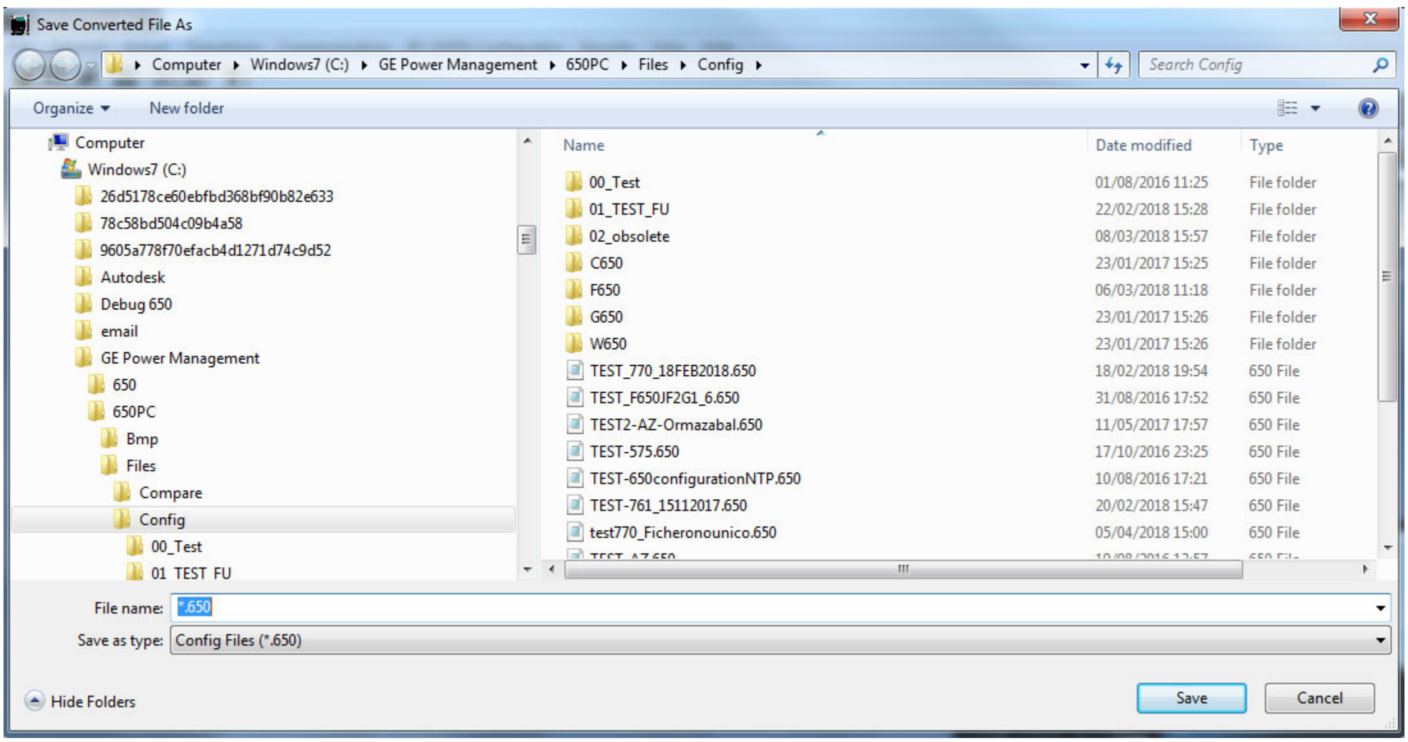
1. Navigate to **File > Open** and select a file to open.
   – If the file is a firmware v7.70 or higher file, or has already been converted, proceed to edit the settings and configuration.
   – If the file has logic configuration that has not yet been updated for firmware v 7.70 and higher, continue to follow these steps.

2. The following message is shown:

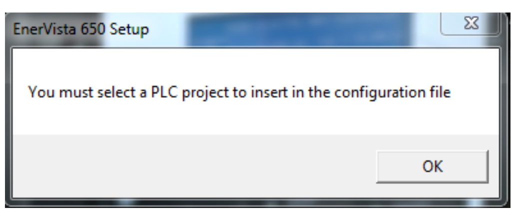


Click **OK** to continue with the update process.

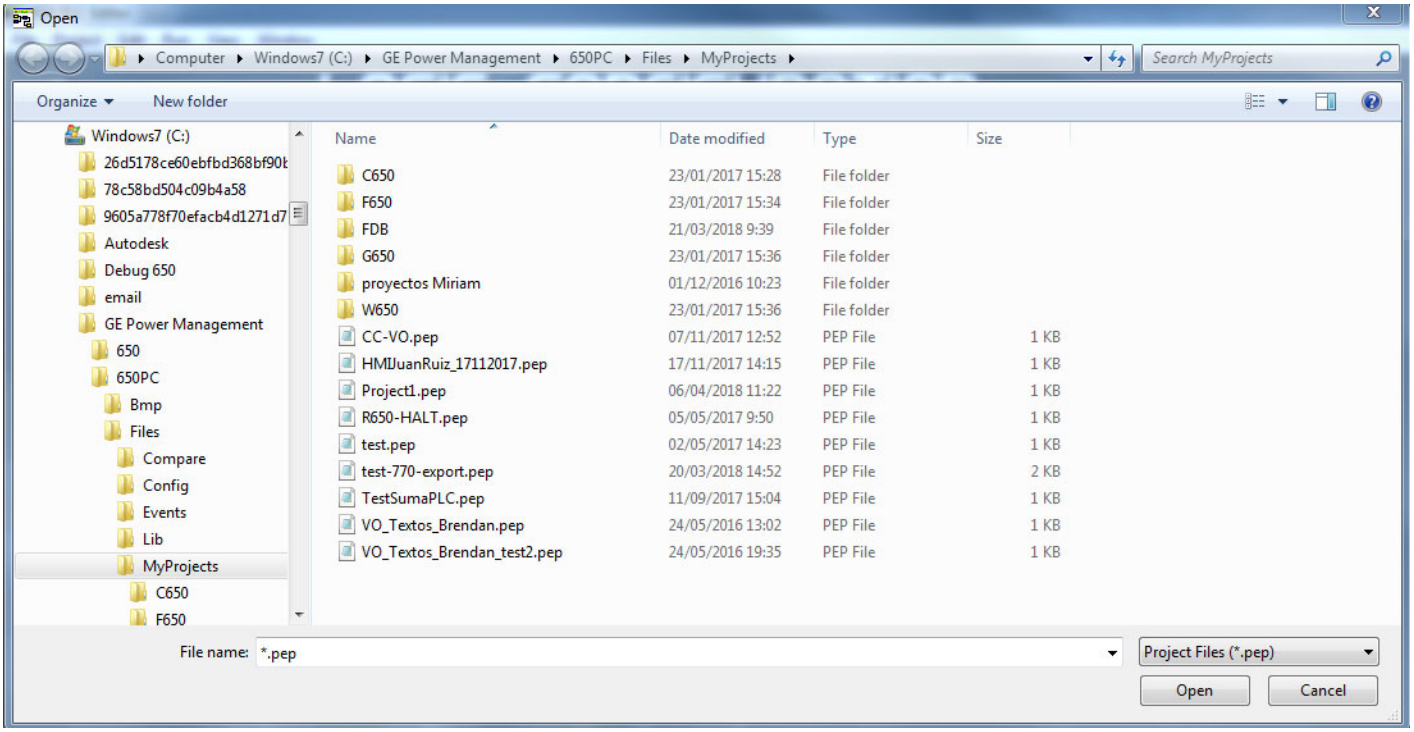
3. Select a name and path for the new, updated *650 file being created.



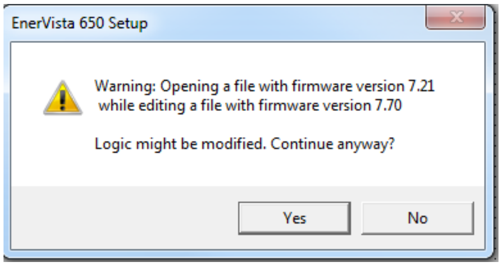
A message explains that the *.650 file needs a PLC project

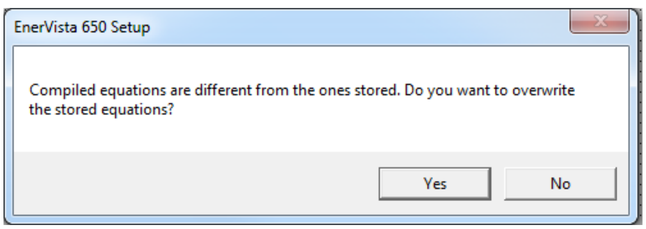


4. Select PLC files (*.pep, *.aut, *.lib) as prompted.

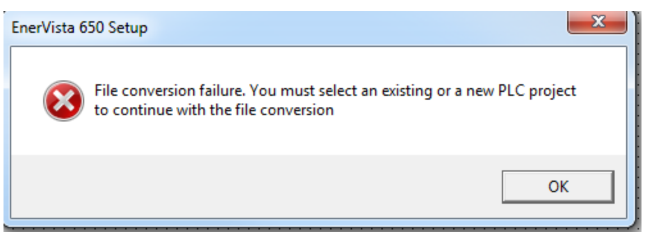


Depending on the *.650 file and selected PLC project files, one of the following messages may be displayed:

<table>
<tr><th>Message</th><th>Meaning</th></tr>
<tr><td>Warning: Opening a file with firmware version x.xx while editing a file with firmware version y.yy
Logic might be modified. Continue anyway?
</td><td>The version of the *.650 configuration file and version of the PLC project (*.pep, *.aut,*.lib) do not match.

Some PLC project variables may not be supported by the *.650 configuration file.</td></tr>
<tr><td>Compiled equations are different from the ones stored. Do you want to overwrite the stored equations?
</td><td>Logic equations compiled in the *.650 configuration file do not match equations in the selected PLC project (*.pep, *.aut,*.lib).

Select Yes, and logic configuration from the selected PLC project (*.pep, *.aut,*.lib) will be compiled and saved into *.650 configuration file.

Select No, and the original logic will remain in the *.650 configuration file.</td></tr>
<tr><td>File conversion failure. You must select an existing or a new PLC project to continue with file conversion.
</td><td>This message indicates that the conversion process is unsuccessful because a PLC project has not been selected.

A PLC project (*.pep, *.aut,*.lib) must be selected for insertion into the *.650 configuration file, and the conversion process restarts.</td></tr>
</table>

5. Upon successful file conversion, the newly converted *.650 file is saved.

4.1.6.3 Save/Save as

The **Save as** and **Close** file options are used to save the *.650 file into the computer and to close the current file. To work in offline mode for settings and configuration editing, a new *.650 file can be opened without closing the previous file.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

During settings and configuration edits, saving your file regularly is recommended. Unsaved changes will be lost when the file is closed.

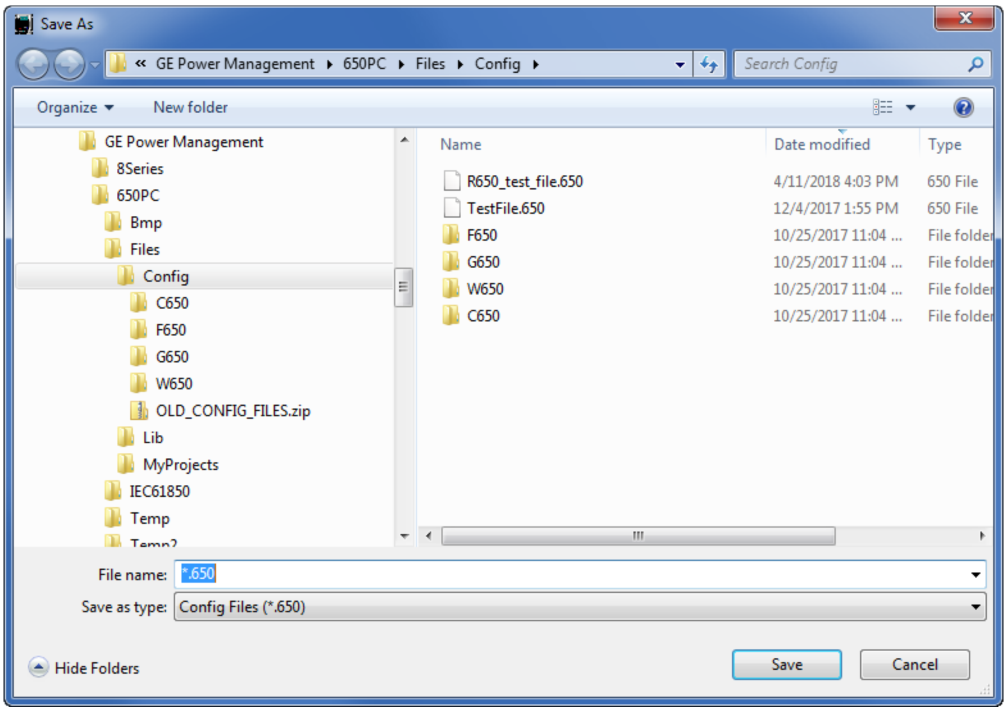


Figure 4-8: Save/Save as file menu

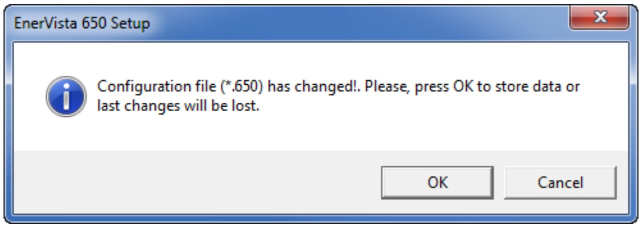
4.1.6.4 Close

In addition to closing the working file, the **File > Close** option is used to clear all data in the EnerVista 650 Setup program, enabling the Language, Upgrade firmware version, and Upgrade Operating system menu options.

Use the **File > Close** menu option to close a settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

If **File > Close** is selected during *.650 configuration process, without first saving the file (**File > Save**), the following warning message is shown:



Click **OK** to open the **File > Save/Save as** window, or **Cancel** to close without saving.

4.1.6.5 Configuration file converter

The configuration file converter tool provides automatic conversion of configuration files from and older firmware version to a newer version. In order to convert a configuration file, follow these steps:

1. Working in offline mode, go to **File > Config File (*.650) Converter**
2. Select the file to be converted.
3. After source file selection is complete, select conversion settings. Make the following selections:

Source Model:	Indicates source C650 model and original version of selected file.
Destination model:	Drop-down list of available C650 models and firmware versions. Select a destination model and firmware version. In the bottom part of this section, a brief description of all models affected is displayed in green after selecting one model in the list.
Source file path	Indicates the path where source model file is located.

Source Model

Destination Model

Source file path

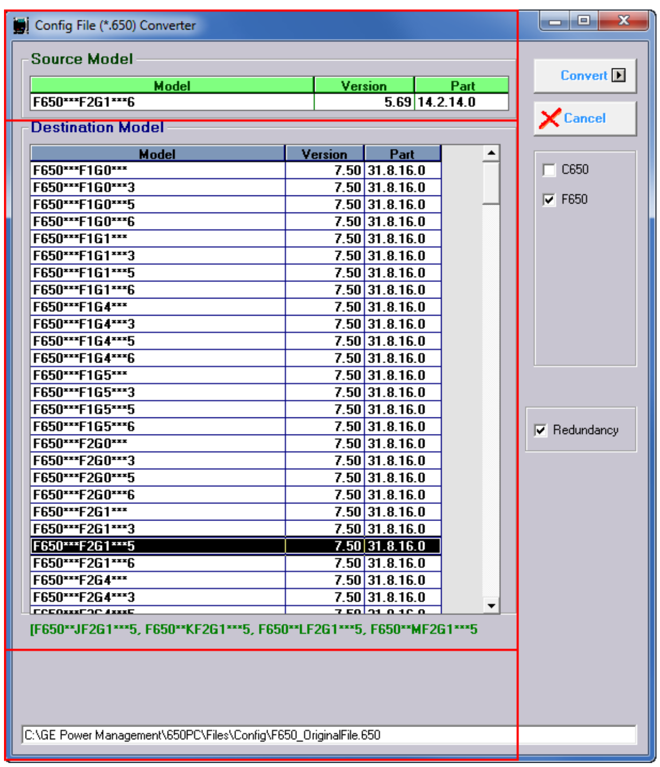


Figure 4-9: Config file (*650) converter menu

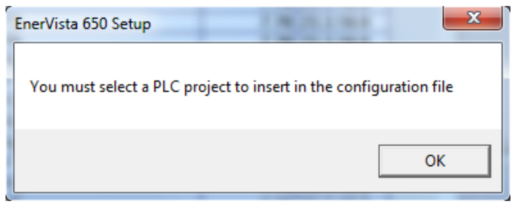
It is possible to change the model type (FXGX) using the conversion tool. It must be taken into account that part of the logic can be readjusted to fit the new input and output board selection. Notice also that the external wiring of input and output boards is different for type 1, 2, 4 and 5.

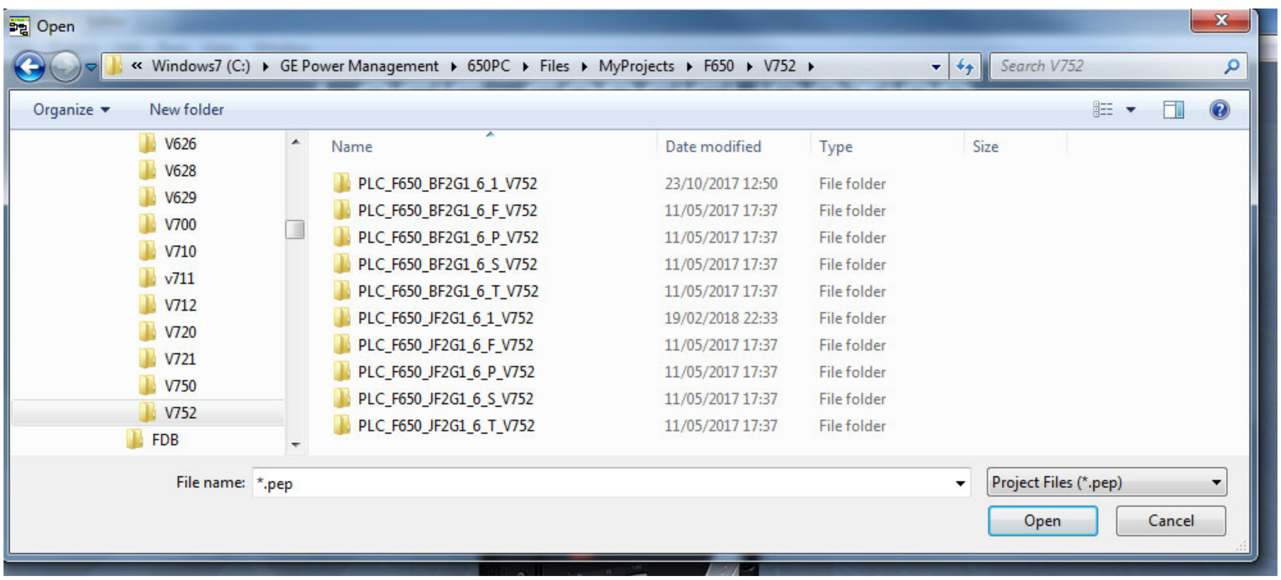
File conversion to firmware version 7.70 or above

The *.650 configuration files for firmware v7.70 and above include the logic configuration and don't require separate PLC project files (*.pep, *.aut, *.lib), some extra actions are required when converting configuration files from below firmware v7.70 to firmware v 7.70 or above.

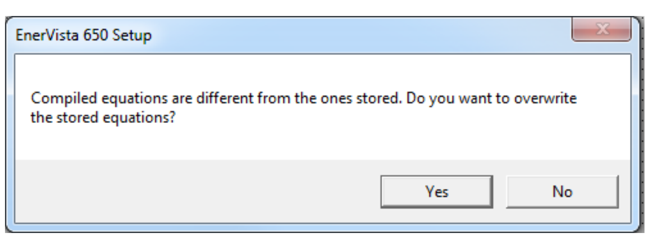
After selecting the *.650 source file and conversion settings:

- If the source (*.650) configuration file does not contain Logic configuration, file conversion is completed automatically.
- If the source (*.650) configuration file contains Logic configuration, a PLC project (*.pep, *.aut, *.lib) must be selected for insertion into the converted (*.650) configuration file.:



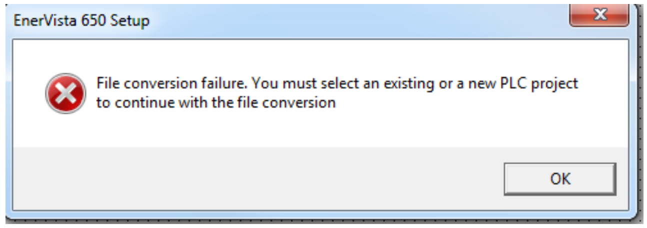


The selected PLC project file is checked against the (*.650) configuration file to ensure they match. If the files do not match, the following message pops-up:



Select **Yes**, and the equations available on selected PLC project (*.pep, *.aut, *.lib) will be compiled and stored into (*.650) configuration file. New equations will overwrite the equations existing in (*.650) configuration file

Select **No**, and the following message will display to indicate that file conversion process has failed.



To convert the *,650 file, a new PLC project (*.pep, *.aut, *.lib) must be selected for insertion into the converted (*.650) configuration file.

Note: If the PLC editor is closed before selecting, compiling and storing a PLC project, the file conversion process will not be successful.

4.1.6.6 Properties

When this option is selected, the program displays the relay model information, firmware version, etc. of the file being edited, as shown:

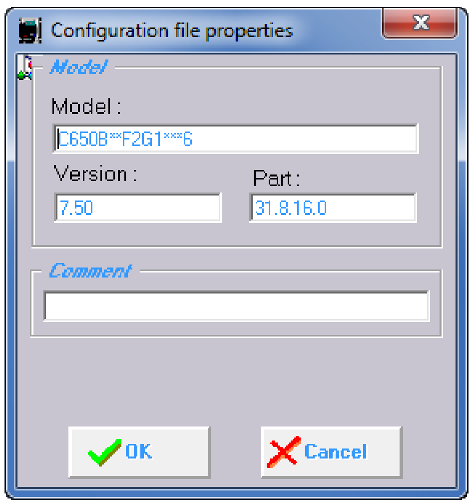


Figure 4-10: File properties menu

4.1.6.7 Print options

The printing options are active only in offline mode with a file open, and not in online mode, connected with the relay.

Print setup

Option to configure the printer options and settings**.**

Print preview

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

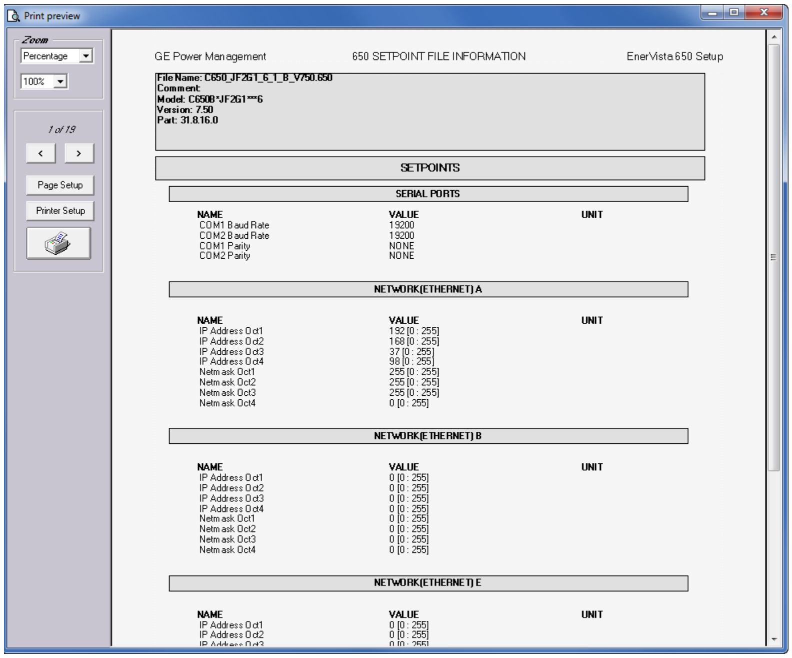


Figure 4-11: Print preview of settings file

Print

Option to print the relay configuration using the PC default (active) printer on port COMx or LPT. This option is active only in offline mode and in file edition (not in online mode while connected to the relay).

Print to file (*xls)

Option to export the configuration file to an Excel file.

4.1.6.8 Compare to settings file

This tool provides an automatic comparison of two different configuration files, or of an online unit to one settings file.

Open the source *.650 file and select the version and model to compare against. The results of the comparison are displayed as shown:

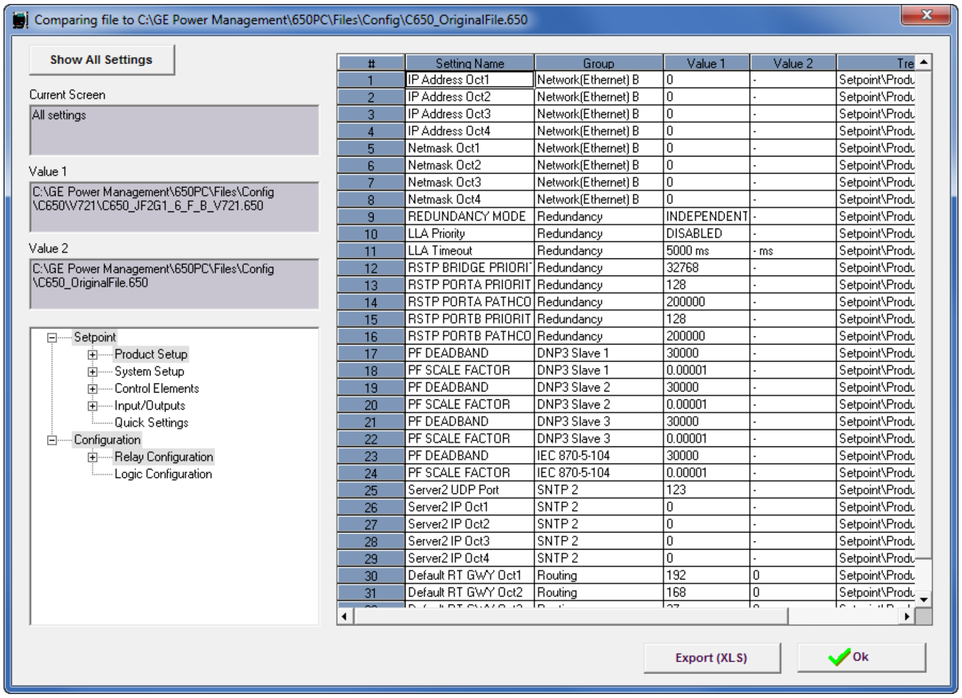


Figure 4-12: Compare to settings file

4.1.6.9 PLC checksum calculation

When working in offline mode, the PLC Checksum calculation option calculates the CRC of the PLC equations and Relay configuration section for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated PLC Checksum and the actual value of the PLC Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All equations compiled in the file and located in EnerVista 650 Setup **Setpoint > Logic configuration**
- Configuration available in the file and located in EnerVista 650 Setup **Setpoint > Relay configuration**, excluding:
  - HMI tab configuration
  - All configured text
  - Opening and closing time in the Switchgear section

4.1.6.10 Setting checksum calculation

When working in offline mode, the Settings Checksum calculation option calculates the CRC of different configured settings for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated Settings Checksum and the actual value of the Settings Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All settings in the relay configuration section (**Setpoint > Relay configuration**) excluding:
  - Those communication settings: **Setpoint > Product Setup > Communication settings > SerialPorts** or **Network (Ethernet)** or **Modbus Protocol** or **Routing**
  - Relay calibration factors
  - Opening and closing time in the Switchgear section

4.1.7 Setpoint menu

Setpoint		
	Product Setup	Communications settings for all protocols and physical mediums. ModBus user map definition, oscillography, data logger demand settings and Time Settings.
	System Setup	General Settings, Flex Curves Definition, Breaker settings, maintenance, switchgear snapshot events management and Miscellaneous Settings.
	Control Elements	Synchrocheck, autoreclose, Pulse Counters, Analog comparators, Digital Counters and PLC Timer Masks.
	Inputs/Outputs	Contact I/O settings for all boards available in device, Remote Comms Force Outputs and Virtual inputs.
	Quick Settings	Menu that encompass the most important settings to configure the device such as; Current and Voltage sensing or current protection element.
	Relay Configuration	Configuration of Outputs, LEDs, Operations, Protection Elements, Oscillography, Control Events, Control Elements, 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).
	Clock (*)	Relay synchronization to computer clock or to user-definable date and time. Online mode only.

(*) indicates online only, (**) indicates offline only

4.1.7.1 Product setup menu

Product Setup		
	Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave, IEC 870-5-104, SNTP settings and procome (if available on model selection), PTP1588 and Routing (for firmware version 7.00 and higher)
	ModBus User Map	ModBus user map definition. The ModBus user map is formed by 256 records, selectable from the complete relay ModBus map.
	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**
	Time Settings	Time settings.

(*) indicates online only, (**) indicates offline only

4.1.7.2 Communication settings menu

This section details the settings related to communication parameters for the different protocols available in the C650.

COMMUNICATIoN SETTINGS		
	Serial Ports	Baud rate and parity for COM1 and COM2 serial communication ports.
	Network (Ethernet)	Ethernet communication parameters for ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model) (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
PTP 1588	Precission Time Protocol 1588 settings. (Available on fw version 7.00 or higher)
Routing	A default route and a maximum number of 6 static routes may be configured. The default route is used as the last choice, if no other route towards a given destination is found.This option is only available for version 7.00 and higher.

(*) indicates online only, (**) indicates offline only

4.1.7.3 System setup menu

SYSTEM SETUP

General Settings	This screen describes and enables the settings of the power system where the relay operates. Some of these settings are 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 to fit the system settings.
Breaker	Breaker Configuration
Switchgear	Configuration of snapshot events for each switchgear (enable or disable)
Miscellaneous Settings	This screen contains settings related with relay working mode. Out of service setting, Local/ Remote mode and Active language mode are options listed below.

(*) indicates online only, (**) indicates offline only

4.1.7.4 Breaker menu

Breaker settings	Breaker settings, maintenance and switchgear selection of the device configured as breaker in the C650. The selected switchgear is used in recloser, breaker failure and synchronism functions. The settings are Number of Switchgear, Maximum KI2t, KI2t 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.

4.1.7.5 Control elements menu

This option shows all protection elements available in the relay as shown in the following two tables (exact menu depends on firmware version).

Table 4-4: Control elements menu, firmware version below 7.50

Control Elements		
	Synchrocheck	Synchronism check unit (25). Single element.
	Autoreclose	Recloser (79). Single element.
	Pulse Counters	Pulse counters function. 8 counters provided.
	Analog Comparators	Analog comparator function. 20 analog comparators provided.
	Digital Counters	Up to 8 Digital Counters
	PLC Timer Masks	Configuration of masks that can be assigned to PLC timers

Table 4-5: Control elements menu, firmware version 7.50 and above

Control Elements		
	Setting Group	C650 incorporate a flexible grouping capability for protection units can be used in either single setting group (default mode- All units that belong to Active group, configured in Setpoint > Control > Setting Group, can operate simultaneously) or up to six setting groups (in this mode, all protection elements, that are available when setting group function is disabled, will be available in each individual setting group (Up to maximum of 6). Only one of setting group will be active at a given time). Units grouped under Protection elements section will be the units affected by changing of setting group.
	Synchrocheck	Synchronism check unit (25). Single element.
	Autoreclose	Recloser (79). Single element.
	Pulse Counters	Pulse counters function. 8 counters provided.
	Analog Comparators	Analog comparator function. 20 analog comparators provided.
	Digital Counters	Up to 8 Digital Counters
	PLC Timer Masks	Configuration of masks that can be assigned to PLC timers

4.1.7.6 Inputs/Outputs menu

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

Inputs/Outputs		
	Contact I/O	Inputs and outputs settings for all boards in C650. The I/O settings configuration can only be performed through EnerVista 650 Setup, not available through the HMI.
	Force Outputs (*)	This menu allows activating each contact output in the relay, to facilitate maintenance testing. Online mode only.
	Virtual Inputs (*)	This menu allows operating virtual inputs. These variables are used as inputs to logic schemes configured in the relay. Virtual inputs can be operated in a latched mode (32 latched virtual inputs) or in Self-reset mode (32 self reset virtual inputs).
	Remote Comms.	This menu allows configuring remote inputs coming from other devices and allow enabling None, GSSE or GOOSE messages. Available for IEC61850 (6) models only.

(*) indicates online only, (**) indicates offline only

This section shows the settings related to inputs and outputs for the different boards available in C650 (F, G, H, J, 2H, 2J)

Contact I/O		
	Board F	Board located in first slot, always connected.
	Board G	Board located in second slot, depending 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) or in 1 rack models
Board J	Board located in second slot of CIO Module (external inputs/outputs module) or in 1 rack models
Board 2H	Board located in first slot of CIO Module (external inputs/outputs module) or in 1 rack models
Board 2J	Board located in second slot of CIO Module (external inputs/outputs module) or in 1 rack models

4.1.7.7 Relay configuration menu

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

.

Relay Configuration		
	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. For firmware version 7.20 and higher, all 15 LEDs can be latched by setting. 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	N/A
	Control Elements	This tab allows assigning operands (logic signals) as inputs to different control elements.
	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 offline 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. For C650, Oscillography is only available for models with enhanced functionality.
	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 with an operand or combination of operands, that allows following the status of that signal.
	Switchgear	Up to 16 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 16 programmable switchgear elements.
	Remote outputs	Up to 32 DNA bits and 64 user St bits to be transmitted to remote devices over CAN using GSSE messages
	Inputs	Text configuration for offline mode file management for all the contact inputs available in device.
	Virtual Inputs	Text configuration for offline mode file management. 32 latched and 32 self reset virtual inputs.
	MMI (HMI-Human Machine Interface)	Screen one line diagram configuration. This menu shows a canvas 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 on the next page.

The following figures show an example of the default factory configuration for C650:

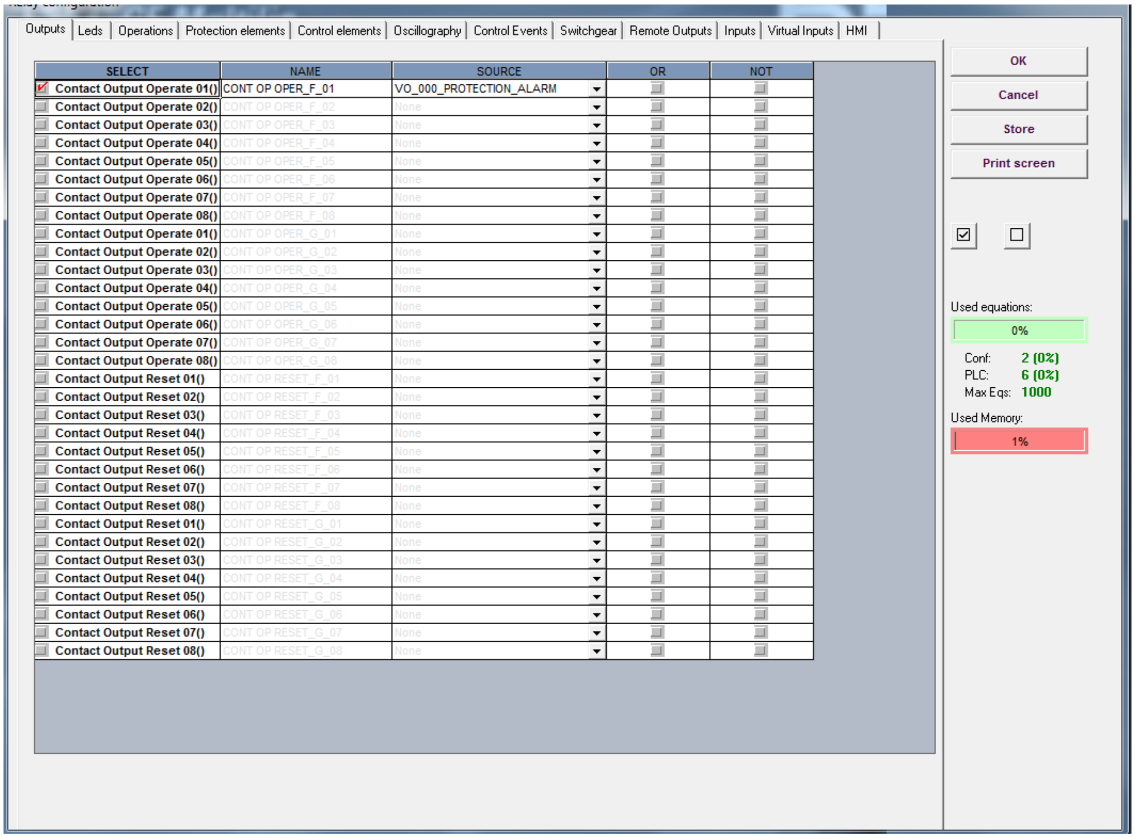


Figure 4-13: Relay configuration

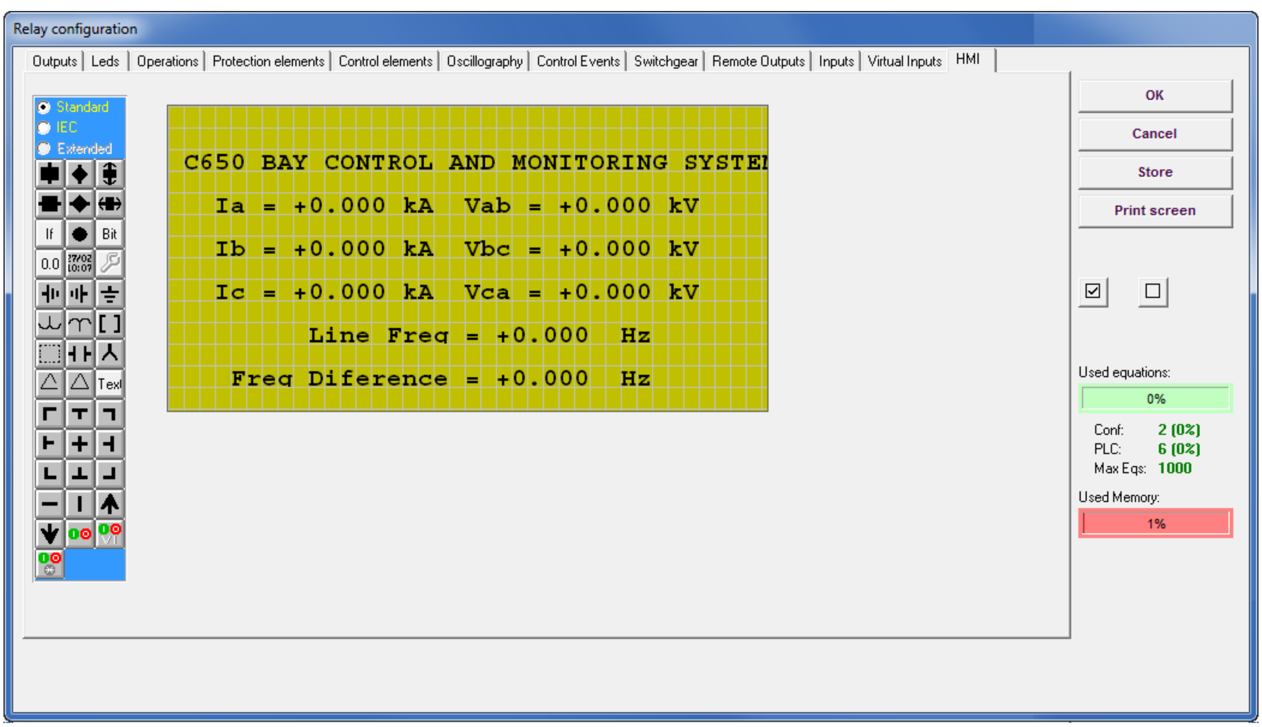


Figure 4-14: HMI configuration

4.1.7.8 Logic Configuration menu

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 4.1.4 File management menu.

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.

4.1.7.9 Clock menu

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

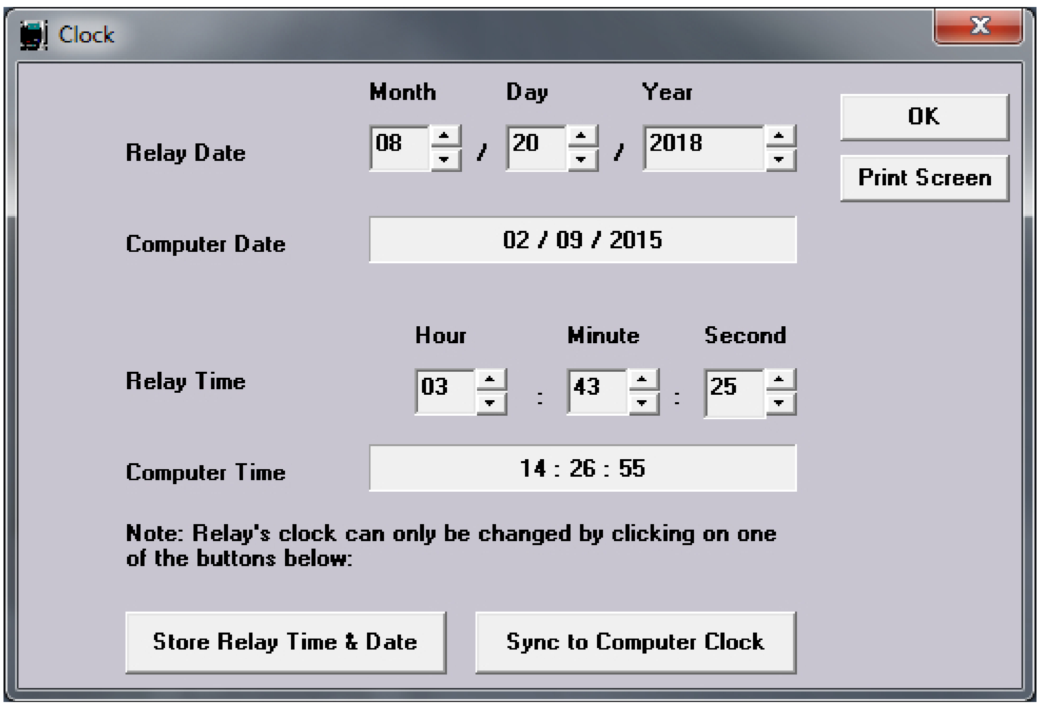


Figure 4-15: Clock

4.1.8 Actual values menu

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 operations, control elements, metering, counters information, oscillography, events, fault locator, etc. This section shows only the structure of menus in EnerVista 650 Setup.

Actual		
	Front Panel	The relay front LED 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 online mode, retrieval of all the available records in device. Snapshot events, control events, oscillography and fault reports.

4.1.8.1 Front panel

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

4.1.8.2 Status

The following menu includes all the available control and general status in the device. Location of different menus can vary depending firmware version.

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.
	System Info	This screen can monitor the system parameters and the internal status of the Relay operating system. Not enabled by default, password required
	Records Status	Information related to the different records stored in the Relay, such as: Control events, oscillography, data logger, demand, energy, and breaker maintenance.
	SNTP-IRIG_B & PTP 1588	Information related to synchronization via IRIG_B, SNTP or PTP1588.
	Versions	Information related to the different firmware versions and hardware revisions.
	Redundancy	Information related to the status of the frames sent through PRP and HSR. Also information related to the status of RSTP port.

Table 4-6: Control elements, actual values menu, firmware versions below 7.50

Control Elements		
	Synchrocheck	Status signals for synchrocheck function (25).
	Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc.), block signals after each shot.
	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.
	Digital Counters	Status signals for the Digital Counter units.

Table 4-7: Control elements, actual values menu, firmware version 7.50 and above

Control Elements		
	Synchrocheck	Status signals for synchrocheck function (25).
	Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc.), block signals after each shot.
	Setting Groups	Status signals (activations and blocks) for the relay setting group change. By default the **Setting Groups** 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.
	Digital Counters	Status signals for the Digital Counter units.

Table 4-8: Records status, actual values menu

Record Status		
	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.

4.1.8.3 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

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.

4.1.8.4 Inputs/Outputs menu

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

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 is only effective if **latch** is selected for **Output Type** setting on the I/O board, thus the contact output has been configured to emulate function 86 (latching relay).
	IO Board Status	Status of I/O boards. This status provides if the hardware it is OK (boards matching relay model, correctly inserted in their tracks, in good state and communicating through the internal CAN bus).
	Virtual Inputs	Status of Virtual inputs latched (32) and self-reset (32).
	Virtual Outputs	Status of virtual outputs (configured in PLC Editor). Up to 512.
	Remote Outputs	States of remote outputs for IEC61850 models.
	Remote Inputs	Status of remote device and remote inputs for IEC61850 models.
	Analog Inputs (*)	Measurements coming from analog inputs (DCMA)
	Virtual Output Latched	Status of Virtual Output Latched (configured in PLC Editor). Up to 16.
	Virtual output Analogue	Status of Virtual OutputAnalogues configured in PLC Editor). Up to 49 float values and 49 integer values can be used.

(*) indicates online only, (**) indicates offline only

4.1.8.5 Records menu

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

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 Ethernet.
	Data logger (*)	Retrieval and visualization of data logger files. Only by Ethernet.

(*) indicates online only, (**) indicates offline only

4.1.9 Operations menu

Option only available in online mode, showing all the operations previously configured in the relay with their corresponding texts, which must be different from the default text (Op_X not configured).

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

(*) indicates online only, (**) indicates offline only

4.1.10 Communications menu

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

For more detail information go to section 4.1.3 Connect to the relay for communication menus description and to section 5 for flash memory update procedures.

Communication		
	Computer	Menu to start communication with the relay.
	Modem (**)	Configure the unit for remote communications via modem, using a telephone line. This is only available if the relay is not communicating and if modem has been selected under **Communication > Computer** control type.
	Troubleshooting (*)	Read/write to ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established.
	Calibration (*)	Retrieve 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 must be performed before updating the operating system. When the firmware and bootcode are 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 relay (**)	Upgrade firmware version (Ethernet connection): Update the relay firmware 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 650 web server	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 operating system.
	Upload info files to relay	Upload info files to relay (Ethernet connection): 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	Download info files from relay (Ethernet connection): This functionality is used for retrieving the files (*.650 and *.pep, *.aut, *.lib) that have been previously stored in the relay flash memory.

(*) indicates online only, (**) indicates offline only

CAUTION

CAREFULLY READ THE FLASH MEMORY UPDATE PROCEDURE DESCRIBED IN SECTION "BOOT CODE AND FIRMWARE" AND CLOSE ALL RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND OPERATING SYSTEM UPDATES.

NOTICE

For firmware versions below 7.00, check that the firmware version that is going to be updated matches the operating system version of the relay before updating firmware. If not, update the operating system before proceeding to update the firmware. Other combinations of firmware and operating system different from the listed in section 5 will not be operative.

For previous version than 7.00 the operating system version is available in the logotype main screen in HMI; it is the number between brackets in the first line, e.g. C650 1.70 (2.35). The operating system version is 2.35

NOTICE

*.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.

*.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.

An example of **Communication > Troubleshooting follows**:

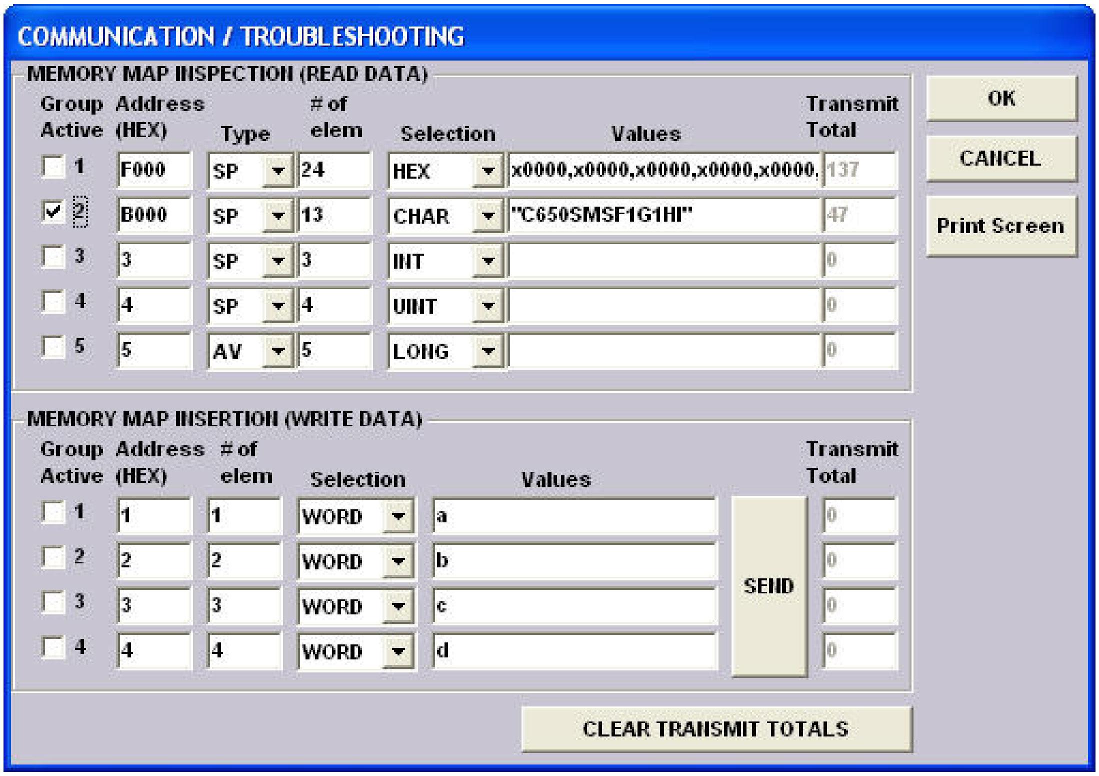


Figure 4-16: Communication troubleshooting example

4.1.11 Security menu

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.

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.

(*) indicates online only, (**) indicates offline only

4.1.12 View menu

The view menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operating 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.

View		
	Traces (*)	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.

(*) indicates online only, (**) indicates offline only

4.1.13 Help menu

Complete instructions manual and data about EnerVista 650 Setup release.

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

4.2 Human-machine interface (HMI)

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.

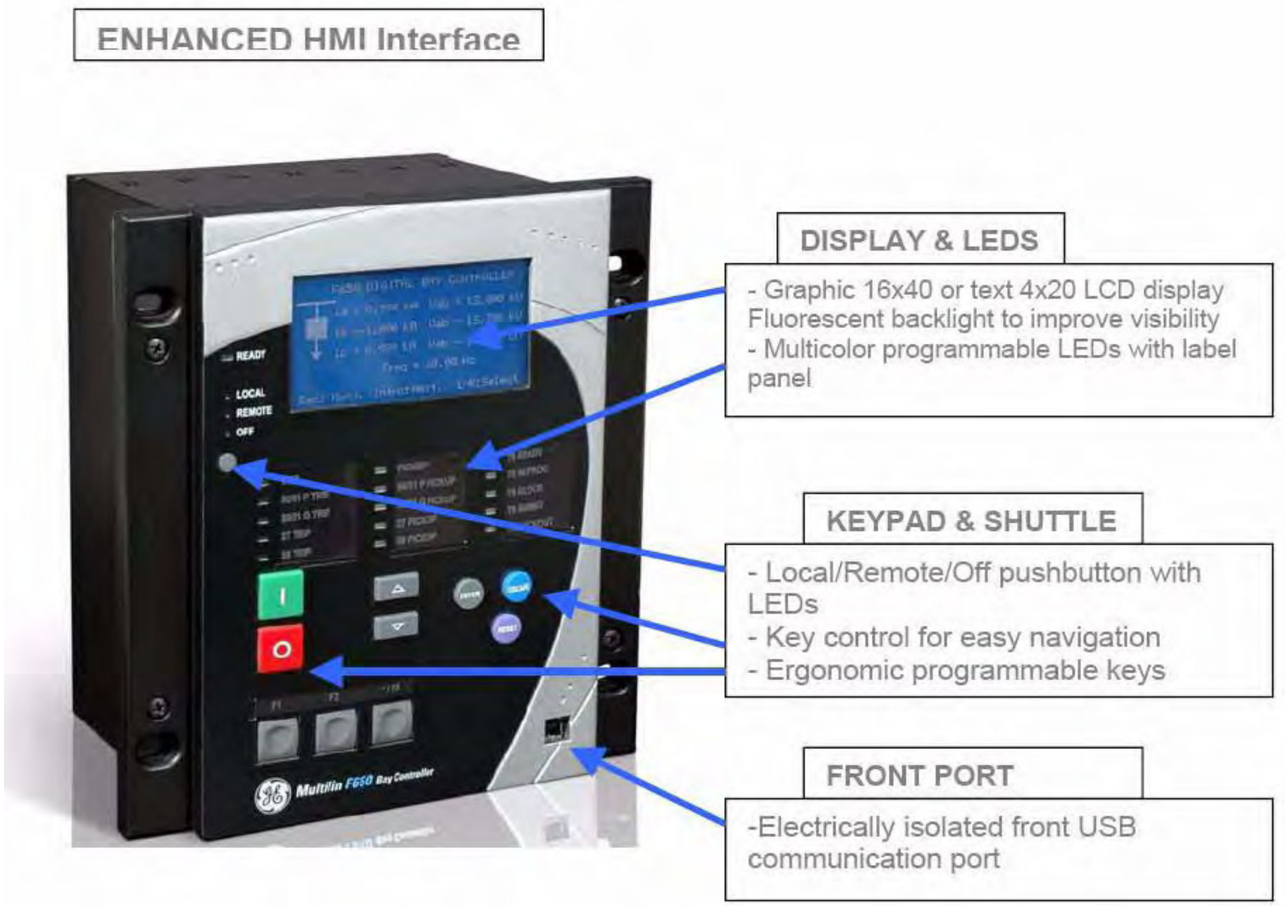


Figure 4-17: Enhanced HMI interface

4.2.1 Display

C650 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).

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 "C650", appears the relay firmware version (7.00 in the example), and between brackets the boot program version (7.00 in the example), followed by "General Electric", the relay model and the default front port (COM2) communication parameters.

C650 7.00 (7.00)
General Electric
C650MZKF2G1HI6E
19200N81: MODBUS: 254

Figure 4-18: Text main screen

4.2.2 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), usually configured for trip signals. The second group (yellow) and third group (green) of LED indicators are self-reset and will reset once the condition has been cleared. These LEDs can also be latched using logic through PLC configuration. For firmware version 7.20 and above, all 15 LEDs are latched through relay settings.

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 light up, verifying their correct operation. When releasing the ESC key, all indicators programmed with memory, such as tripping LEDs, are reset. For models with enhanced display, there is a reset LEDs button dedicated for this purpose.

The latched conditions can also be reset via communications using the LED reset input (to configure this signal go to **Setpoint > Relay Configuration > Control 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/ESCAPE non configurable), shuttle key or keypad for easy navigation, command pushbutton to select operations mode.

USB port: intended for connection to a portable PC.

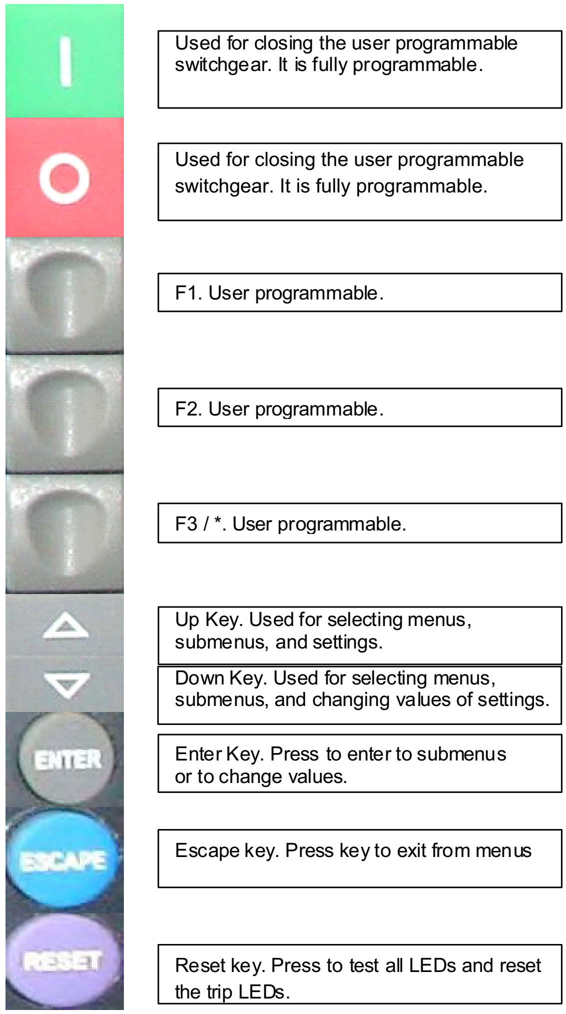
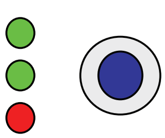


Figure 4-19: Enhanced keypad description

4.2.3.1 Command push button

The unit incorporates a command pushbutton located at the bottom right side of the HMI interface and at the top left for Enhanced interface, with three options: local, remote, and off. The first option (LOCAL) allows executing operations in local mode (HMI, front port, and rear COM2 port). The second option (REMOTE) allows operation execution only through remote communications (COM1 and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model)). 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).

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

4.2.4 Screen contrast

Regulation of screen contrast should be performed as described below depend on display model selected:

Enhanced HMI: Backlight level regulation can be performed by using enhanced keypad. Reset button must be pressed at the same time that the up or down key is pressed to increase or decrease the contrast.

4.2.5 Text menus

4.2.5.1 Navigation

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 besides this text main menu there are several screens providing more performance for control purposes.

Press (or rotate left or right) the enter/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 until it appears. In all the navigation press the enter/shuttle key to select the desired header display (top-level menu). Each press of the enter/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 (or use up/down keys).

When rotating the shuttle key (or up/down keys) 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
⇑/⇓	Up-down keys	Move up and down in the same level
▬	Menu selection	Menu selection
>	More menus to display	More menus to display

Figure 4-20: Text menu navigation Shows an example of main menu navigation:

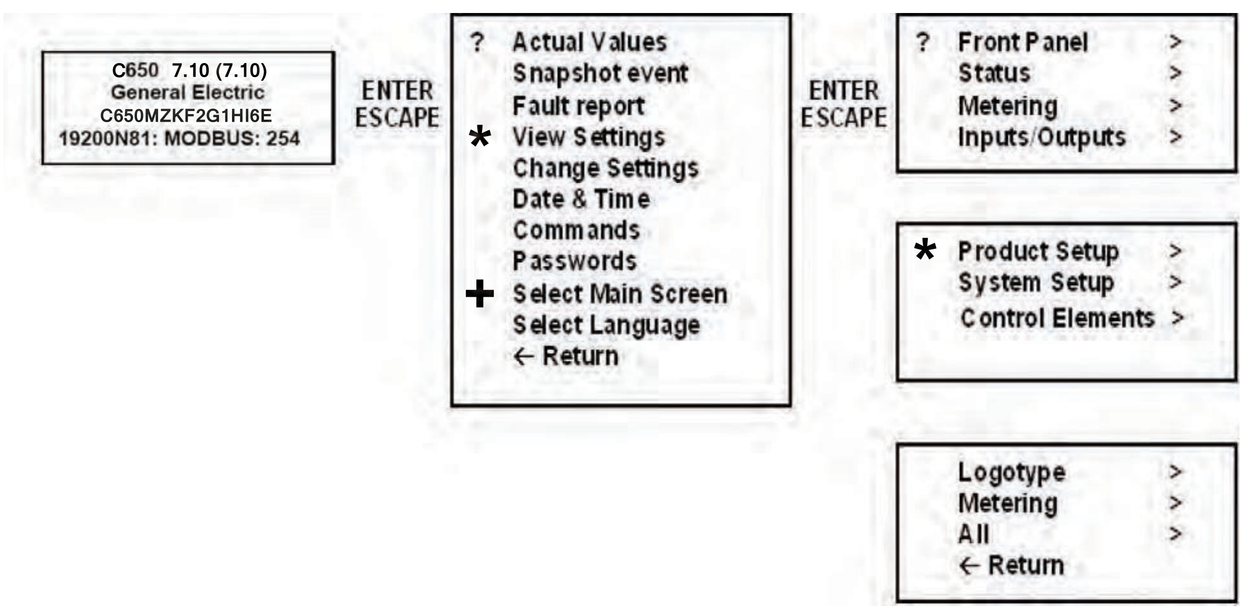


Figure 4-20: Text menu navigation

4.2.5.2 Text menu hierarchy

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

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 or enter 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 or enter key to visualize snapshot events in text menu. Press ESC to return to default main screen.
View Settings	Visualization of all protection and control settings available in device.	Press shuttle key or enter key to enter next level. Move Up/Down 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 or enter key to enter next level. Move Up/Down 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 or enter key to start modification in date and time. Press ESC to return to previous level.
Commands	Operations execution in local mode.	Move Up/Down to pre select operation. Press shuttle key or enter key to select and confirm. Press ESC to return to previous level.
Password	Password menu for settings and commands	Move Up/Down to select submenu. Press shuttle key or enter key to enter next level. Press ESC to return to previous level.
Select Main Screen	Selection of default main screen in text menu.	Move Up/Down to select the default main screen type. Press shuttle key or enter key to confirm.
Select Language	Language selection. Between default language (see order code) and English.	Move Up/Down to select the default language. Press shuttle key or enter key to confirm selection. Switch the relay off and on.
< - return	Return to previous level	Press shuttle key or enter 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.

Front Panel >		
	LEDs	
Status >		
	Operation Bits	
	Breaker	
	Control Elements >	Synchrocheck Autoreclose Analog Comparators Digital Counters
	Switchgear Status >	Switchgear 1 Switchgear... Switchgear 16
	Calibration	
	System Info	

	Records Status >	Control Events Oscillography Data logger Demand Energy Breaker Maintenance
	SNTP-IRIG_B-PTP	
	Versions	
	Redundancy	
Metering >		
	Primary Values >	Current Voltage Power Energy Demand
	Secondary Values >	Current Voltage Power
	Frequency	
Inputs/Outputs >		
	Contact Inputs >	Board F/ Board G/ Board H/ Board J
	Cont. Output St. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Op. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Rs. >	Board F/ Board G/ Board H/ Board J
	IO Board Status	
	Virtual Inputs >	Virtual Inp.Latched Virtual Inp.SR
	Virtual Outputs	
	Remote Outputs (for IEC61850 models only) >	DNA User St GOOSE Dig Outputs
	Remote Inputs for IEC61850 models only)>	Remote Input Remote Devices GOOSE Dig Inputs GOOSE Analog Inputs
	Analog Inputs >	Board F/ Board G/ Board H/ Board J/ Board 2J/ Board 2H
	Virtual out. Latched	
	Virtual out. Analogue	

To enter this menu press the shuttle key or enter key when the option Actual Values is selected in main menu. A secondary level is displayed with different sublevels as shown on 4.2.5.5 View settings menu. Pressing Up/down keys or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the enter/shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation is performed the same for all the menus in Actual Values. Once the last sub-level is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 4-21: Actual values screen data.

First Line: Header of last level in actual values (Switchgear 1 in the example)

Second Line: Data identifier (in the example SWITCH 1 A INPUT).

Third line: Status of the displayed actual value.

Fourth Line: Relative position in the menu (it is the first value of 12)

```
Switchgear 1
SWITCH 1 A INPUT
OFF
(1/12)
```

Figure 4-21: Actual values screen data

In the Actual Values menus are different types of data; each type of data displays 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 enter/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 is 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, press the up-down keys or rotate the shuttle key to select the snapshot event and then press the enter/shuttle key to enter the metering screen. Press esc to exit the metering screen and return to snapshot events menu.

Figure 4-22: Snapshot event navigation HMI shows an example of snapshot events navigation:

C650 7.10 (7.10) **General Electric** **C650MZKF2G1HI6E** **19200N81: MODBUS: 254**	Press enter/shuttle key from the default main screen and enter in the main text menu.
ENTER **ESCAPE**	
Actual Values ■ **Snapshot Events** **Fault report** **View Settings**	Move the shuttle key or press up-down keys until a single scroll bar character (o) appears in the left part of Snapshot event header. Press enter/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/2016**	Select the snapshot event to display using the up/down keys or shuttle key (left and right to move up and down inside the recorded snapshot events). Once selected the snapshot event, identifier, status, date and time are 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 enter/shuttle key the metering screen for the snapshot event is displayed. To exit from this screen press the ESC key and return to the snapshot events menu.

Figure 4-22: Snapshot event navigation HMI

4.2.5.5 View settings menu

To enter this menu press the enter/shuttle key when the option **View Settings** is selected in main menu (o). A secondary level is displayed with different sublevels. Pressing up-down keys or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed (o), press the enter/shuttle key again to enter in next level and press esc key to return to previous level if desired. This navigation is performed the same for all the menus in "View Settings". Once the last sublevel is reached, move up and down to see the available settings.

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
Product Setup >			
	Communication >		
		Serial Ports	
		Ethernet >	Ethernet A Ethernet B Ethernet E Redundancy
		ModBus Protocol	
		DNP3 Slave (Available for standard and IEC61850 models)>	DNP3 Slave 1..3
		IEC 870-5-104(Available for standard and IEC61850 models)>	
		SNTP	
		PROCOME (Available for procome models only).	
		PTP 1588	

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
		Routing	
	Oscillography		
	Demand		
	Time Settings		
System Setup >			
	General Settings		
	Breaker >	Breaker Settings Breaker Maintenance	
	Misc. settings		
Control elements > **(*) See note**			
	Synchrocheck		
	Autoreclose		
	Breaker Failure		
	PLC Timer Masks		

4.2.5.6 Change Settings

To enter this menu press the enter/shuttle key when **Change Settings** is selected in main menu. A secondary level is displayed with different sublevels. Press up-down key or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the enter/shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation is 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 enter/shuttle key on the setting to be modified. After selecting the setting, the value for that setting appears between brackets. Choose the new value moving up and down . After selecting the appropriate value press again the enter/shuttle key to fix that value. To save the new settings, go to the end of the menu pressing down key or rotating the shuttle key right, and select **Press Enter to save settings**. When pressing the shuttle key inside this menu the new settings is saved.

Snapshot Event **Fault report** **View settings** ☐ **Change settings**	Select the menu Change settings and press the enter/shuttle key to enter in the next sub-level.
Product Setup ☐ **System Setup** **Control Elements**	If there is more than one sub-level, select the next sub-level by pressing the up-down keys or rotating and pressing the enter/shuttle key until the last level is reached.
☐ **General Settings** **Breaker** **<- return**	Press the enter/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 enter/shuttle key, value appears between brackets and can be modified pressing the up-down keys or rotating the shuttle key. Pressing again the enter/shuttle key, the new value is accepted.
Press Intro **to save settings**	Once all settings inside the group have been modified, go to the last screen pressing the down key or rotating the shuttle key and press Enter. At this moment of time, the new settings is active in the relay.

Figure 4-23: Change settings in HMI

4.2.5.7 Date & time

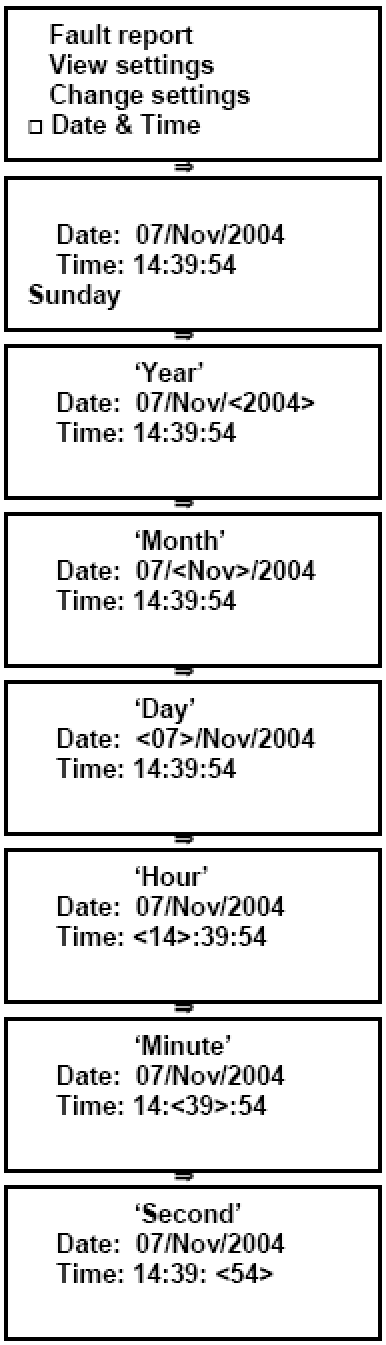
The "Date & Time" menu shows the relay date and time information in the following format:

DST: Daylight Saving Time information

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

To modify date and time, press the enter/shuttle key. The relay shows the year between brackets at the top of the screen. By pressing the up-down keys or rotating the shuttle key, reach the desired value for the year, and press the enter/shuttle key to select and store that value. After the year, the relay shows the month. Proceed as in the case of the year. The date & time modification sequence is as follows:



Press the up-down key or rotate the shuttle key to select the "Date and Time" menu and press to enter in it

The date and time data appear in the format described above.

Pressing the enter/shuttle key the year can be modified pressing up-down key or rotating the shuttle key, after selecting the desired value, press again the enter/shuttle key to store the value.

"Year"

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

Time:Hour:Minutes:Seconds

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

"Month"

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

Time:Hour:Minutes:Seconds

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

"Day"

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

Time:Hour:Minutes:Seconds

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

"Hour"

Date:Day/Month/Year

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

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

"Minute"

Date:Day/Month/Year

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

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

"Second"

Date:Day/Month/Year

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

Figure 4-24: Change date & time in HMI

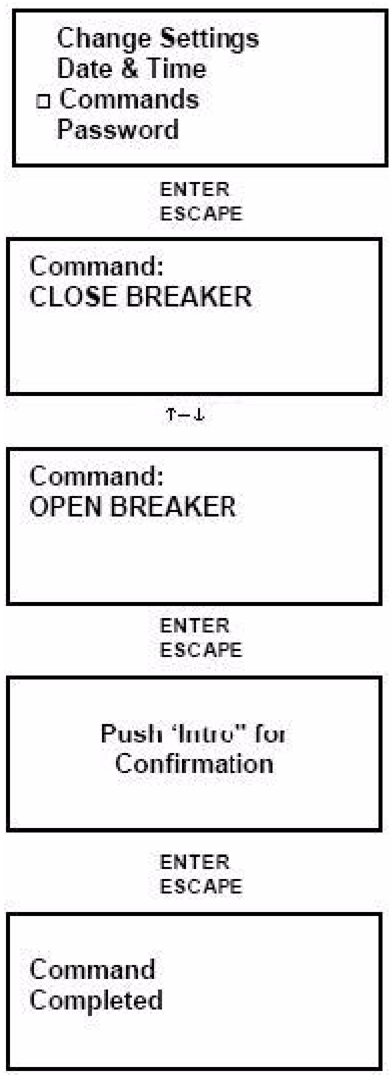
Once this sequence is completed, these values remain stored in the relay, and the display once again shows the date at the bottom of the text screen.

4.2.5.8 Commands

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

Use the EnerVista 650 Setup software to configure up to 24 commands with a descriptive text. When executing the operations from the relay front panel, the operation description is displayed.

Example of commands (operations) executions via HMI



Press the enter/shuttle key when **Commands** is selected in the display (o).

All the previously configured commands are displayed. Press up-down keys or rotate the shuttle key to move through the available commands. Press ESC to return to previous level.

Press the enter/shuttle key to pre-select the operation to execute.

When the message **Push Enter for Confirmation** appears, press the enter/shuttle key to confirm.

Once the command has been performed or the time out has expired the **Command completed** message is shown on the display.

Figure 4-25: Commands in HMI

4.2.5.9 Passwords

The C650 units incorporate independent passwords for protection and control, in order to prevent unauthorized keypad and display access to the relay.

Settings Password:

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

Commands Password:

This password restricts access to executing operation commands through the keypad and display.

If the Commands Password is activated, when the user tries to execute an operation, the relay requests this password. When using single-line diagrams for graphical display models, all objects are not operational until the password is entered, either by logging in to **Login Pwd Commands**, or by entering the password in the **Commands** menu.

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

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:	Setting or modifying the desired password.
Forgot Password:	Retrieves 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 requests 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 remains so for 15 minutes of inactivity or until the user logs out.

Password range

The valid range for C650 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.

Entering passwords (Login PWD)

This operation is the same for both the settings and commands passwords. The only difference is 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 press up-down key or 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 shows the message **"Processing passwd. Wait..."**. If the password is correct, the relay allows 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 requests the password again after 15 minutes of inactivity. This period of time is the same that takes the relay to turn off the display backlighting.

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, the relay automatically logs out the active user 15 minutes after the last keypad action.

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 change the password, the user must first log in with the existing password; if the relay has the default factory password, this would be 0000.

The relay requests the existing password with the following message:

(Setting or Command) passwd.

Login: < 0000 >

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

(Setting or Command) passwd.

New passwd: < 1000 >

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

Service Command for password recovery

In the event of losing all passwords, the Service Command allows the customer to reset both Settings and Commands HMI Passwords.

1. Customer must call the customer support service.
2. A secret key will be provided by customer support to facilitate the reset
3. At the moment, the HMI has no passwords for Settings and Commands. The customer can reintroduce new passwords.

4.2.5.10 Select main screen

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

Logotype

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

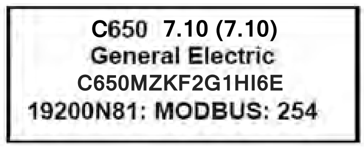


Figure 4-26: Default logotype screen

Metering

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

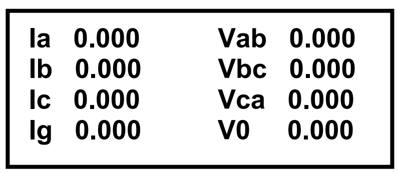


Figure 4-27: Default metering screen

All

This option alternates in time the two previous options.

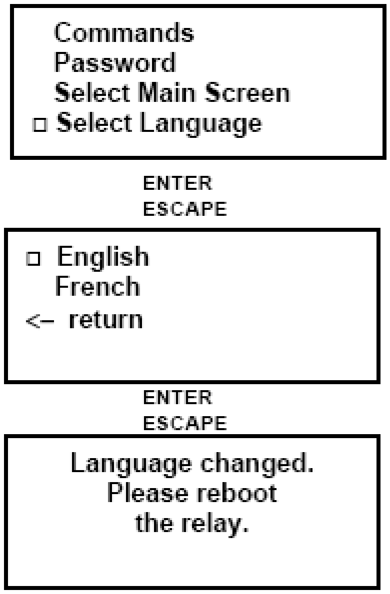
4.2.5.11 Select language

Option only available for versions 1.70 or higher than 5.20.

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

For example one relay in French language (e.g. FC650MZDF2G1HIR**F**) can be displayed in French or in English only by changing the language setting in HMI. It is necessary to switch off and on the relay to start working with the new language configuration in the relay. In EnerVista 650 Setup it is possible to select the language for the software (**View > Languages**).

Example of language selection in HMI



Press the enter/shuttle key to enter the select language menu.

Depending on the relay model there are different language selections available: English/French, English/ Russian, etc.

Press up-down keys or rotate the shuttle key to select the desired language and press enter to store the selection in the relay

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

Figure 4-28: Language selection in HMI

4.2.6 Graphic display

4.2.6.1 One-line diagram

In models with graphic display 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**).

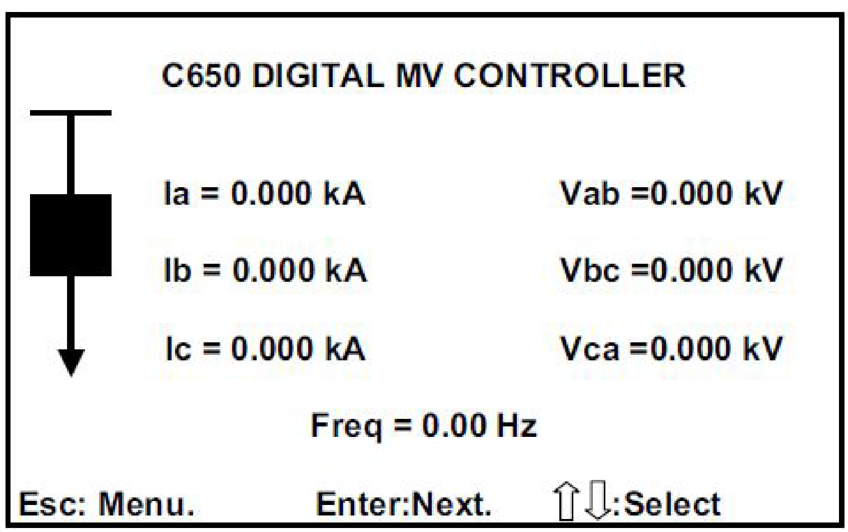


Figure 4-29: One-line diagram

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

Esc: Menu. **Enter: Next.** **⇧⇩ : Select.**

The meaning of these options is as follows:

Esc: Menu.

Press the ESC key to access the relay main menu, similar to the one displayed by the text-display model (C650B).

Press the ESC key again and the menu selection screen (Actual Values, Snapshot events, etc.) is displayed. This main menu screen is identical to the one described for the text display, with functionality described in section 4.2.5 Text menus.

Intro: Next.

Press the enter/shuttle key to access the next graphical screen, which in this case corresponds to the primary metering values screen.

⇧⇩ : Select

Once the different switchgear elements have been configured using EnerVista 650 Setup, they can be operated from the graphic display.

If a single-line diagram has been configured in the EnerVista 650 Setup software, in the HMI option inside the ***Relay Configuration*** menu, the different switchgear elements configured for the display are operative from the graphic display. By pressing the up-down key or 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 enter/shuttle key, the relay indicates the command to be executed, and the user needs to confirm by pressing the enter/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 53
Phasor Ia Primary	0.000 KA
Phasor Ib Primary	0.000 KA
Phasor Ic Primary	0.000 KA
Phasor Ig Primary	0.000 KA
Phasor Isg Primary	0.000 KA
RMS Ia Primary	0.000 KA
RMS Ib Primary	0.000 KA
RMS Ic Primary	0.000 KA
RMS Ig Primary	0.000 KA
RMS Isg Primary	0.000 KA
I0 Primary	0.000 KA
Enter: Next. ESC: Prev	⇧⇩:Scroll.

Figure 4-30: 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:

Enter: Next.Esc: Prev. ⇧⇩ : Scroll.

Intro: Next.

Pressing the enter 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)

⇧⇩ : Scroll.

Pressing the up-down key or rotating the shuttle key to the left (L) or right (R) the user can access all the Metering values in the screen.

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	% of Load-to-trip
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) or (1/511 for Firmware version 7.20 or higher)

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

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

```
All Events (1/479).
            - [ Ready LED ON ] -

16:11:08.035   Ready LED ON                ON
16:11:08.017   Breaker Closed ON           ON
16:11:08.005   Isolated Gnd3 Block OFF     OFF
16:11:08.005   Isolated Gnd2 Block OFF     OFF
16:11:08.005   Isolated Gnd1 Block OFF     OFF
16:11:08.005   Sens Gnd TOC3 Block OFF     OFF
16:11:08.005   Sens Gnd TOC2 Block OFF     OFF
16:11:08.005   Sens Gnd TOC1 Block OFF     OFF
16:11:08.005   Ground TOC3 Block OFF       OFF
16:11:08.005   Ground TOC2 Block OFF       OFF
16:11:08.005   Ground TOC1 Block OFF       OFF

Esc: Prev.         Enter: Menu.        ⇧⇩: Scroll.
```

Figure 4-31: All events screen

The screen legend options are:

Esc: Prev. Enter: Menu. ⇧⇩ : Scroll.

Esc: Prev.

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

Intro: Menu.

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

nextprevreloaddetailsAt

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

<NEXT>

The user accesses the next available graphic screen (Events ‚Äì 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
Enter: Meters.	ESC: Prev	⇧⇩: Scroll.

Figure 4-32: Snapshot events details screen

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

Enter: Meters. **ESC: Prev.** **⇧⇩ : Scroll.**

Enter: Meters.

To access the metering values in the moment of the event, the user must press the enter/shuttle key. A new metering screen is 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 is shown for each event (Intro or ESC: Prev. U-D (L-R: Scroll); press ESC or the shuttle key to return to the Event Details screen, and press the up-down key or rotate the shuttle key to access all the metering values contained in the metering screen of the selected event.

ESC: Prev.

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

⇧⇩: Scroll.

Pressing the up-down key or 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 shows 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.Enter: Tag event.

Esc: Out At.

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

Enter: Tag event.

If the user places the cursor on a different event by pressing the up-down key or rotating the shuttle key left or right, pressing the enter/shuttle key changes 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 shows 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 C650 models using communication software EnerVista 650 Setup, however, only models with graphic display allow access to the alarms panel from the HMI.

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

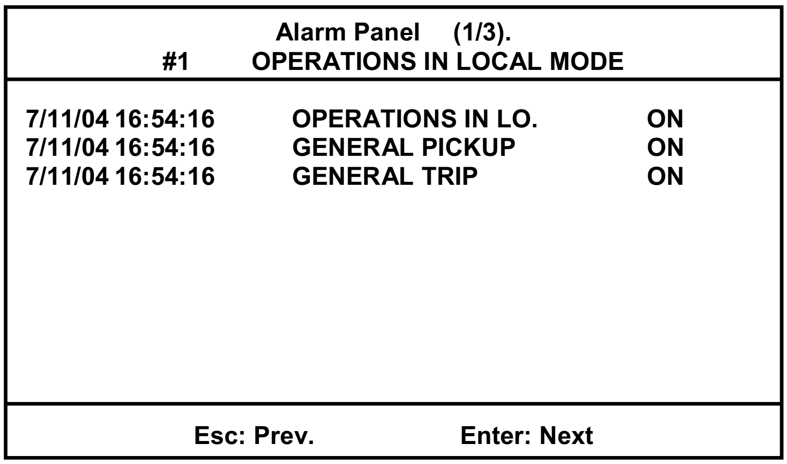


Figure 4-33: Alarms panel in HMI

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.Enter: Next.

ESC: Prev.

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

Enter: Next.

Pressing the enter/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 press the up-down key or move the shuttle key left to right. The selected option is displayed in upper case and between brackets. To access the selected option, the enter/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 acknowledgment 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 appears to the right of its status. Inactive alarms 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 appears between selection marks **> <** and blinking.

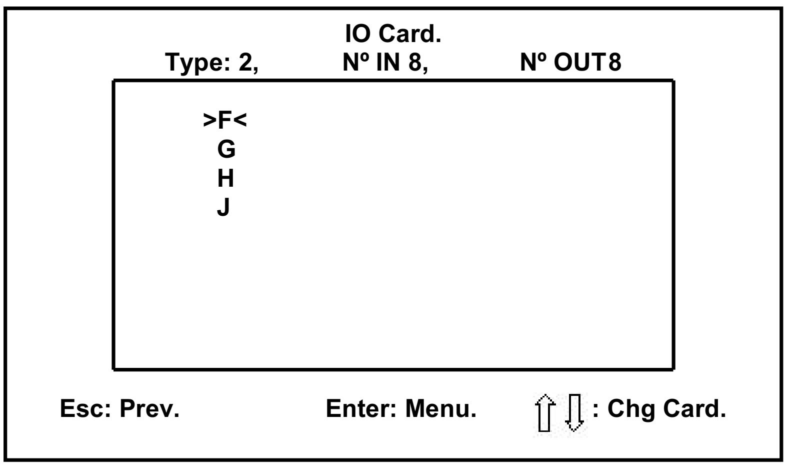


Figure 4-34: INPUTS/OUTPUTS GENERAL SCREEN

The navigation legend on this screen is as follows:

Esc: Prev. **Enter: Menu.** **: ⇧⇩ Chg Card**

Esc: Prev.

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

Enter: Menu.

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

This menu includes the following options.

nextviewtest inputtest output

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

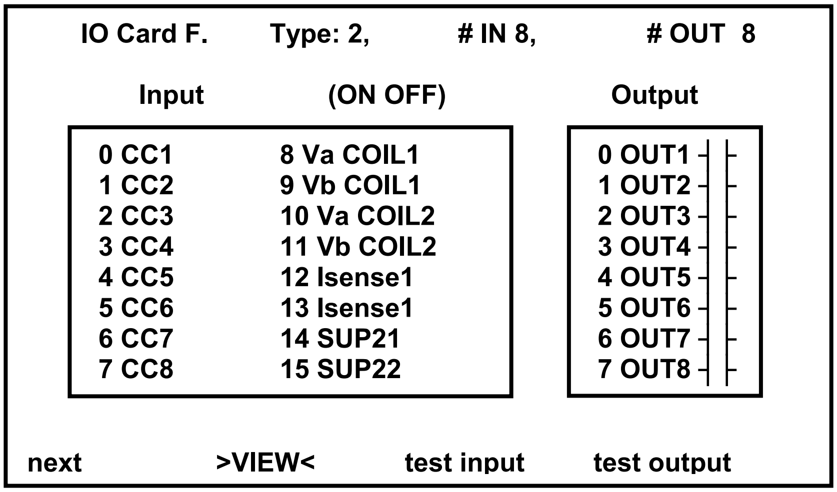


Figure 4-35: Input/output viewing screen

<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 varies depending on the board characteristics.

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. **Enter: Menu.** ⇧⇩ **: Chg Card**

Esc: Prev.

Returns to the general I/O screen

Enter: Menu.

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

⇧⇩ **: Chg Card**

Pressing the up-down key or 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 appears blinking and between brackets; the user can select a different input by pressing up-down key or rotating the enter/shuttle key. When the shuttle key is pressed, the selected input is activated. Navigation through this screen is indicated by the following legend:

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

Esc: Exit Text.

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

Enter: Chg Input.

Pressing the enter/shuttle key on the blinking input, this input is 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 appears blinking and between brackets; the user can select a different output by pressing the up-down key or rotating the shuttle key. When the enter/shuttle key is pressed, the selected output is activated. Navigation through this screen is indicated by the following legend:

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

Esc: Exit Text.

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

Enter: Chg Output.

Pressing the enter/shuttle key on the blinking output, this output is 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 C650 models.

⇧⇩ : Chg Card

Pressing the up-down key or rotating the shuttle key allows to change the selected I/O board in the main I/O screen.

4.3 Web server

4.3.1 Home

The web server in the C650 can be accessed running the Windows explorer, and typing http://xxx.xxx.xx.xxx, where xxx.xxx.xxx.xxx is the relay IP address, which must be configured in **Setpoint > Product Setup > Communication Settings > Ethernet**.

The main screen of the C650 web server shows the different monitoring possibilities for snapshot events, events, alarms, oscillography, 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 the list name on the left side of the screen.

The web server (for version 1.70 and higher ones) allows the user to visualize the different web server screen languages: English, French, Spanish, Russian and Chinese by pressing the language button on the top right corner of the main window. Take into account that this selection only changes the language in the web server screen, all the relay texts, such as snapshot events, control events, etc. are in the language selected in the relay (see section 4.2.5.11 Select language in this manual).

Figure 4-36: 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 are shown on that screen.

Figure 4-37: 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 4-38: 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 with the 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 4-39: 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 4-40: Oscillography screen

If the user clicks on the oscillography record he wants to retrieve, the window on the right shows 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 then opens a window to allow saving the files in Comtrade format on the PC hard drive. Once the records have been saved, the system asks if the user wants to open GE-OSC tool (Comtrade record viewer) to view the downloaded files.

Figure 4-41: GE-osc launch screen

4.3.6 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 4-42: Data logger screen

C650 Bay Controller & Monitoring System

Chapter 5: Setpoints

5.1 Overview

5.1.1 Setpoint main menu

Table 5-1: Setpoint main menu in EnerVista 650 Setup software:

Product Setup		
	Communication settings	
		Serial Ports
		Network (Ethernet)
		ModBus Protocol
		DNP3 Slave (Available for standard and IEC61850 models, not available for IEC 870-5-103 models)
		IEC 870-5-104 (Available for standard and IEC61850 models, not available for IEC 870-5-103 models)
		SNTP
		PTP 1588 (Available from V7.00)
		Routing (Available from V7.00)
	ModBus User Map	
	Oscillography	
	Data Logger	
	Demand	
	Time Settings	
System Setup		
	General settings	
	Flex Curves	
	Breaker	
		Breaker Settings
		Breaker Maintenance

	Switchgear	
	Miscellaneous Settings	
Control Elements		
	Setting Group	
	Underfrequency	
	Overfrequency	
	Synchrocheck	
	Autoreclose	
	Breaker Failure.	
	VT Fuse Failure.	
	Broken Conductor	
	Locked Rotor	
	Pulse Counters	
	Analog Comparator	
	Frequency rate of change	
	Load Encroachment	
	Digital Counters	
Input/Outputs		
	Contact I/O	
		Board F
		Board G
		Board 2H
		Board 2J
	Force Outputs.	
	Remote Comms (Available for IEC61850 models only).	
	Virtual Inputs	

5.2 Product setup

5.2.1 Communication settings

5.2.1.1 Serial ports

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

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)

For firmware versions 7.00 or higher; the Network settings are the Ethernet communication parameters for Port A, Port B and Port E. Depending on the order code, up to three different Ethernet addresses can be used, The ModBus Slave address used by Ethernet ports is the one set for COM2.

Table 5-2: Network settings for firmware version 7.00 and above

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET) NETWORK (ETHERNET)A > NETWORK (ETHERNET)B > NETWORK (ETHERNET) E > REDUNDANCY				
NAME	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
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]	

IP ADDRESS: This setting sets the ports IPv4 address in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

NETMASK: This setting sets the ports IPv4 subnet mask in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

Table 5-3: Redundancy settings

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET) > REDUNDANCY			
NAME	**DEFAULT VALUE**	**STEP**	**RANGE**
REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]
LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]
LLA Timeout	5000	N/A	[0 : 600000]
RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]
RSTP PORT A PRIORITY	128	N/A	[0 : 240]
RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]
RSTP PORT B PRIORITY	128	N/A	[0 : 240]
RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]

REDUNDANCY MODE: This setting is available only if the hardware has multiple ports. The setting determines if ports A and B operate in redundant or independent mode. Different options are listed below:

- **Independent**: In non-redundant mode, port A and B operate independently with their own MAC, IP address, mask and gateway.

  NOTE: *When using more than one Ethernet port, each port must be configured to belong to a different network, otherwise communications becomes unpredictable.*

  NOTE 2: *When non-redundant mode is selected, MAC address assigned to port A is the same as MAC address assigned to port E but increased in one unit and MAC address assigned to port B is the same as MAC address assigned to port A but increased in one unit.*

  E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DC)

- **LLA (Link Loss) operation**: The operation of ports A and B are as follows:

  Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

- **PRP (Parallel Redundancy Protocol):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to only be used if the two ports are connected to separate parallel LAN's. In this mode of operation both ports cannot be connected to the same LAN. The receiving devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, PRP uses conventional Ethernet hardware but both ports must know they are in PRP. Both ports of PRP devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

- **HSR (High-availability Seamless Redundancy):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to work in a ring topology. In this mode of operation port A is connected to other device's port B, and port B is connected to other device's port A provided that ring topology is respected. The receiving devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, HSR uses conventional Ethernet hardware but both ports must know they are in HSR. Both ports of HSR devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

- **RSTP (Rapid Spanning Tree Protocol):** ports A and B use the same MAC (physical device) address and can operate with different network topologies. The device operates only with one IP address through these 2 ports

- **DAISY CHAIN:** ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one. Note that it is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.

NOTE 3: When LLA/PRP/HSR or PRR mode is selected, MAC addresses assigned to port A and B are the same between them and a consecutive value of MAC address assigned to port E.

E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DB)

NOTE 4: When LLA/PRP/HSP/RSTP or DAISY CHAIN mode is selected, the IP configured at **Product Setup > Communication Settings > Network (Ethernet) > Network (Ethernet) A** is the one used by both ports (A and B) to communicate in these modes.

LLA PRIORITY: If this setting is set to enabled, the port A has the priority. If PORT A's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

LLA TIMEOUT: This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TIMEOUT value, the switch over to primary port is automatic.

RSTP BRIDGE PRIORITY: Specifies the switch (bridge) priority value. This value is used along with the switch MAC address to determine which switch in the network is the root device. Lower values mean higher priority. The value ranges from 0 to 65535, with a default of 32768.

RSTP PORTA PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTA PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

RSTP PORTB PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTB PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

For this setting change to take effect, a reboot is required.

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.

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. DNP protocol is available for standard and IEC61850 models.

Table 5-4: 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	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Product Setup > Communication Settings > DNP3 Slave **DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3**			
Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
PF Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
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]

PF Deadband	30000	1	[0 : 32767]
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	
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	
Default Analog Map	ENABLED	N/A	
Analog Input Point 0	End of list	N/A	
Analog Input Point 1	End of list	N/A	
Analog Input Point 2	End of list	N/A	
Analog Input Point 3	End of list	N/A	
Analog Input Point 4	End of list	N/A	
Analog Input Point 5	End of list	N/A	
Analog Input Point 6	End of list	N/A	
Analog Input Point 7	End of list	N/A	
Analog Input Point 8	End of list	N/A	
Analog Input Point 9	End of list	N/A	
Analog Input Point 10	End of list	N/A	
Analog Input Point 11	End of list	N/A	
Analog Input Point 12	End of list	N/A	
Analog Input Point 13	End of list	N/A	
Analog Input Point 14	End of list	N/A	
Analog Input Point 15	End of list	N/A	
Analog Input Point 16	End of list	N/A	
Analog Input Point 17	End of list	N/A	
Analog Input Point 18	End of list	N/A	
Analog Input Point 19	End of list	N/A	
Analog Input Point 20	End of list	N/A	
Analog Input Point 21	End of list	N/A	
Analog Input Point 22	End of list	N/A	
Analog Input Point 23	End of list	N/A	
Analog Input Point 24	End of list	N/A	
Analog Input Point 25	End of list	N/A	
Analog Input Point 26	End of list	N/A	
Analog Input Point 27	End of list	N/A	
Analog Input Point 28	End of list	N/A	
Analog Input Point 29	End of list	N/A	
Analog Input Point 30	End of list	N/A	
Analog Input Point 31	End of list	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. DNP protocol is available for standard and IEC61850 models.

Table 5-5: IEC 60870-5-104 protocol settings

Product Setup > Communication Settings >IEC 870-5-104			
Name	**Default Value**	**Step**	**Range**
Function	DISABLED	N/A	[DISABLED-ENABLED]
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]
IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]
Function 2	DISABLED	N/A	
TCP Port 2	2404	N/A	[0 : 65535]
Common Addr of ASDU 2	255	N/A	[0 : 65535]
IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]
IEC104 SCALE CURRENT	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]
IEC104 SCALE VOLTAGE	1		
IEC104 SCALE POWER	1		[0 : 65535]
IEC104 SCALE ENERGY	1		[0 : 65535]
IEC104 SCALE OTHER	1		[0 : 65535]
IEC104 DEADBAND CURRENT	30000		[0 : 65535]
IEC104 DEADBAND VOLTAGE	30000		[0 : 65535]
IEC104 DEADBAND POWER	30000		[0 : 65535]
IEC104 DEADBAND ENERGY	30000		[0 : 65535]
IEC104 DEADBAND OTHER	30000		[0 : 65535]
IEC104 IOA BINARIES	1000		[0 : 65535]
IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]
IEC104 IOA ANALOGS	2000		[0 : 65535]
IEC104 IOA COUNTERS	4000		[0 : 65535]
IEC104 IOA COMMANDS	3000		[0 : 65535]
IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]

5.2.1.6 SNTP

Product Setup > Communication Settings > SNTP > SNTP1/SNTP2			
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 C650 supports the Simple Network Time Protocol specified in RFC-2030. With SNTP, the C650 can obtain the clock time over an Ethernet network. The C650 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 C650, the IRIG-B signal provides the time value to the C650 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 C650 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 C650 clock is synchronized with the SNTP/NTP server. It may take up to one minute for the C650 to signal an SNTP FAIL state if the server is offline.

To use SNTP in broadcast mode, set the **Function** setting to "BROADCAST". The C650 then listens to SNTP messages sent to the "all ones" broadcast address for the subnet. The C650 waits up to eighteen minutes (>1024 seconds) without receiving an SNTP broadcast message before signalling an SNTP FAIL state.

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 C650 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 C650 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 C650 to signal an SNTP FAIL state and to switch again to anycast mode to try to find another time server. In anycast mode the C650 tries to send multicast messages up to five minutes before signalling an SNTP FAIL state.

The C650 relay does not support the multicast mode of SNTP functionality.

For firmware version 7.20 or above, C650 shall accept time synchronization from up to two different SNTP servers. In order to define number of SNTP servers to be used, different settings for each SNTP server must be configured in the C650. SNTP1 or/and SNTP2 tab settings shall be configured.

If only one SNTP server is used to synchronize the relay, SNTP1 tab settings shall be filled with its corresponding settings. If two SNTP servers are used, SNTP1 and SNTP2 tab shall be filled as follow:

"SNTP1 tab shall contain settings of main SNTP server.

"SNTP2 tab shall contain settings of back-up SNTP server.

If two SNTP servers are configured, C650 operation mode is described as follows:

Scenario	Expected Behavior
SNTP1 server= Available SNTP2 server= Available	C650 shall be synchronized by SNTP1 server. No alarm
SNTP1 server= Available SNTP2 server= Not Available	C650 shall continue to be synchronized by SNTP1 server No alarm
SNTP1 server= Not Available SNTP2 server= Available	If SNTP1 server fails, C650 shall get synchronization from SNTP2 server. When SNTP1 server recovers, C650 shall switch to be synchronized by SNTP1 server. No alarm
SNTP1 server= Not Available SNTP2 server= Not Available	"Not Synchronized" Alarm shall appear in local mimic

NOTE: SNTP settings take effect after rebooting the device.

5.2.1.7 PTP IEEE 1588 protocol settings

Product Setup > Communication Settings > PTP 1588		
Name	**Default Value**	**Step**
PTP FUNCTION	DISABLE	[DISABLE; ENABLE]
PORTA DELAY ADDER	0	ns [0 : 60000]
PORTA DELAY ASYM	0	ns [-1000 : 1000]
PORTB DELAY ADDER	0	ns [0 : 60000]
PORTB DELAY ASYM	0	ns [-1000 : 1000]
STRICT POWER PROFILE	DISABLED	DISABLED/ENABLED
PTP DOMAIN NUMBER	0	[0 : 255]
PTP VLAN PRIORITY	4	[0 : 7]
PTP VLAN ID	0	[0 : 4095]
PTP EPOCH	UTC SINCE 2000	UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900

C650 relay supports IEEE 1588 version 2.

The relay meets the time accuracy requirements of IEC 61850-5-Ed2 clause 11.1.3.3 time synchronization class T5 (± 1 μs) and of the IEEE Std. PC37.118.1 Draft 1.6 clause 4.3 (± 1 μs), given an error-free PP input and stable temperature

The relay resynchronizes to a grandmaster slewing at ±2 μs/s when the rate of change of frequency stabilizes. It may become unsynchronized when the ramp starts or stops.

The relay only supports Peer-To-Peer delay mechanism.

PTP FUNCTION

While this port setting is selected to disabled, PTP is disabled on this port. The relay does not generate or listen to PTP messages on this port.

PORT A, B PATH DELAY ADDER

The time delivered by PTP is advanced by the time value in this setting prior to the time being used to synchronize the relay's real time clock. This is to compensate to the extent practical for time delivery delays not compensated for in the network. In a fully compliant PP network, the peer delay and the processing delay mechanisms compensate for all the delays between the grandmaster and the relay. In such networks, this setting should be zero.

In networks containing one or more switches and/or clocks that do not implement both of these mechanisms, not all delays are compensated, so the time of message arrival at the relay is later than the time indicated in the message. This setting can be used to approximately compensate for this delay. However, as the relay is not aware of network switching that dynamically changes the amount of uncompensated delay, there is no setting that is always completely correct for uncompensated delay. A setting can be chosen to reduce the worst-case error to half of the range between minimum and maximum uncompensated delay, if these values are known.

PORT A, B PATH DELAY ASYMMETRY

Range: -1 000 ... +1 000 ns

Default: 0

This setting corresponds to "delayAsymmetry" in PTP, which is used by the peer delay mechanism to compensate for any difference in the propagation delay between the two directions of a link. Except in unusual cases, the two fibers are of essentially identical length and composition, so this setting should be set to zero.

In unusual cases where the length of the link is different in different directions, this setting should be set to the number of nanoseconds the Ethernet propagation delay to the relay is longer than the mean of path propagation delays to and from the relay. For instance, if it is known say from the physical length of the fibers and the propagation speed in the fibers that the delay from the relay to the Ethernet switch it is connected to is 9 000 ns and the that the delay from the switch to the relay is 11 000 ns, then the mean delay is 10 000 ns, and the path delay asymmetry is +1 000 ns.

STRICT POWER PROFILE

Power profile (IEEE Std C37.238™-2011) requires that the relay only select as a grandmaster power profile compliant clocks, that the delivered time have worst-case error of ±1 µs, and that the peer delay mechanism be implemented. With the strict power profile setting enabled, the relay only selects master clocks displaying the IEEE_C37_238 identification codes. It uses a port only when the peer delay mechanism is operational. With the strict power profile setting disabled, the relay uses clocks without the power profile identification when no power profile clocks are present, and uses ports even if the peer delay mechanism is non-operational.

This setting applies to all of the relay's PTP capable ports.

PTP DOMAIN NUMBER

This setting should be set to the domain number of the grandmaster-capable clock(s) to be synchronized to. A network may support multiple time distribution domains, each distinguished with a unique domain number. More commonly, there is a single domain using the default domain number zero.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN PRIORITY

This setting selects the value of the priority field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. In compliance with PP the default VLAN priority is 4, but it is recommended that in accordance with PTP it be set to 7.

Depending on the characteristics of the device to which the relay is directly linked, VLAN Priority may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN ID

This setting selects the value of the ID field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. It is provided in compliance with PP. As these messages have a destination address that indicates they are not to be bridged, their VLAN ID serves no function, and so may be left at its default value.

Depending on the characteristics of the device to which the relay is directly linked, VLAN ID may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP EPOCH

This setting sets the reference point from which time is measured.

NOTE: PTP settings take effect after rebooting the device.

5.2.1.8 Routing

A default route and a maximum number of 6 static routes may be configured. The default route is used as the last choice, if no other route towards a given destination is found.

Product Setup > Communication Settings > Routing		
Name	**Default Value**	**Step**
Default RT GWY Oct1	10	[0 : 255]
Default RT GWY Oct2	3	[0 : 255]
Default RT GWY Oct3	32	[0 : 255]
Default RT GWY Oct4	1	[0 : 255]
Static RT1 IP Oct1	0	[0 : 255]
Static RT1 IP Oct2	0	[0 : 255]
Static RT1 IP Oct3	0	[0 : 255]
Static RT1 IP Oct4	0	[0 : 255]
Static RT1 Mask Oct1	0	[0 : 255]
Static RT1 Mask Oct2	0	[0 : 255]
Static RT1 Mask Oct3	0	[0 : 255]
Static RT1 Mask Oct4	0	[0 : 255]
Static RT1 GWY Oct1	0	[0 : 255]
Static RT1 GWY Oct2	0	[0 : 255]
Static RT1 GWY Oct3	0	[0 : 255]
Static RT1 GWY Oct4	0	[0 : 255]
Static RT2 IP Oct1	0	[0 : 255]
Static RT2 IP Oct2	0	[0 : 255]
Static RT2 IP Oct3	0	[0 : 255]
Static RT2 IP Oct4	0	[0 : 255]
Static RT2 Mask Oct1	0	[0 : 255]
Static RT2 Mask Oct2	0	[0 : 255]
Static RT2 Mask Oct3	0	[0 : 255]
Static RT2 Mask Oct4	0	[0 : 255]
Static RT2 GWY Oct1	0	[0 : 255]
Static RT2 GWY Oct2	0	[0 : 255]
Static RT2 GWY Oct3	0	[0 : 255]
Static RT2 GWY Oct4	0	[0 : 255]
Static RT3 IP Oct1	0	[0 : 255]
Static RT3 IP Oct2	0	[0 : 255]
Static RT3 IP Oct3	0	[0 : 255]
Static RT3 IP Oct4	0	[0 : 255]
Static RT3 Mask Oct1	0	[0 : 255]
Static RT3 Mask Oct2	0	[0 : 255]
Static RT3 Mask Oct3	0	[0 : 255]
Static RT3 Mask Oct4	0	[0 : 255]
Static RT3 GWY Oct1	0	[0 : 255]
Static RT3 GWY Oct2	0	[0 : 255]
Static RT3 GWY Oct3	0	[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	**Default Value**	**Step**
Static RT3 GWY Oct4	0	[0 : 255]
Static RT4 IP Oct1	0	[0 : 255]
Static RT4 IP Oct2	0	[0 : 255]
Static RT4 IP Oct3	0	[0 : 255]
Static RT4 IP Oct4	0	[0 : 255]
Static RT4 Mask Oct1	0	[0 : 255]
Static RT4 Mask Oct2	0	[0 : 255]
Static RT4 Mask Oct3	0	[0 : 255]
Static RT4 Mask Oct4	0	[0 : 255]
Static RT4 GWY Oct1	0	[0 : 255]
Static RT4 GWY Oct2	0	[0 : 255]
Static RT4 GWY Oct3	0	[0 : 255]
Static RT4 GWY Oct4	0	[0 : 255]
Static RT5 IP Oct1	0	[0 : 255]
Static RT5 IP Oct2	0	[0 : 255]
Static RT5 IP Oct3	0	[0 : 255]
Static RT5 IP Oct4	0	[0 : 255]
Static RT5 Mask Oct1	0	[0 : 255]
Static RT5 Mask Oct2	0	[0 : 255]
Static RT5 Mask Oct3	0	[0 : 255]
Static RT5 Mask Oct4	0	[0 : 255]
Static RT5 GWY Oct1	0	[0 : 255]
Static RT5 GWY Oct2	0	[0 : 255]
Static RT5 GWY Oct3	0	[0 : 255]
Static RT5 GWY Oct4	0	[0 : 255]
Static RT6 IP Oct1	0	[0 : 255]
Static RT6 IP Oct2	0	[0 : 255]
Static RT6 IP Oct3	0	[0 : 255]
Static RT6 IP Oct4	0	[0 : 255]
Static RT6 Mask Oct1	0	[0 : 255]
Static RT6 Mask Oct2	0	[0 : 255]
Static RT6 Mask Oct3	0	[0 : 255]
Static RT6 Mask Oct4	0	[0 : 255]
Static RT6 GWY Oct1	0	[0 : 255]
Static RT6 GWY Oct2	0	[0 : 255]
Static RT6 GWY Oct3	0	[0 : 255]
Static RT6 GWY Oct4	0	[0 : 255]

The redundancy communications comes with the capability of setting a number of static routes and one default route, which is used instead of default gateway.

Default RT GWY:

This setting sets the gateway of the default route to be used by IP traffic sent from the relay, if no other route towards a given IP destination is found.

Note that this setting is only valid on port B if port REDUNDANCY is set to INDEPENDENT.

Static RTX IP: This setting sets the destination IPv4 route.

Static RTX MASK: This setting sets the IP mask associated with the route.

Static RTX GWY: This setting sets the gateway to reach the destination IP route.

Important Notes:

1. Host routes are not supported at present.
2. The route mask has IPv4 mask format. In binary this should be a set of contiguous bits of 1 from left to right, followed by one or more contiguous bits of 0.
3. The route destination and mask must match.
   - This can be verified by checking that RtDestination & RtMask == RtDestination
   - Example of good configuration: RtDestination= 10.1.1.0; Rt Mask= 255.255.255.0
   - Example of bad configuration: RtDestination = 10.1.1.1; Rt Mask= 255.255.255.0
4. The route destination must not be a connected network.
5. The route gateway must be on a connected network. This rule applies to the gateway address of the default route as well.

5.2.2 MODBUS user map settings

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.

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]

5.2.3 Oscillography settings

Oscillography records contain waveforms captured at the sampling rate as well as other relay data at the point of trigger. This trigger can be configured with a programmable logic operand.

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 with 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. 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 with the general trip of protection elements.

5.2.3.1 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]
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

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.

Samples/Cycle: This setting defines the number of samples per cycle stored in each oscillography record.

Maximum Number of Oscillos (Max. Number Osc.):
1 to 20 oscillography records can be selected.

Automatic Overwrite: This setting allows chained oscillographies during the fault (TRIGGER OSCILLO signal activated). The oscillography module is 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.

Oscillography files calculations

The overall maximum samples capacity is allocated for 27594 samples. The size of each oscillography file depends on the configured number of oscillographies and is evenly distributed based on the maximum samples value using these formulas:

Number of samples per oscillography = (27594 samples)/(Max. Number Osc. setpoint)

Number of cycles per oscillography = (Number of samples per oscillography)/(Samples / Cycle setpoint).

NOTICE After a change in oscillography settings all oscillography files stored on the flash memory are erased.

EXAMPLE

For a Max. Number Osc. of 4, each record stores 27594 / 4 = 6898 samples per stored oscillo.

If we set the Samples /Cycle setpoint to 64 samples per cycle, each record stores up to 6898 / 64 = 107.78 signal cycles. This value expressed in terms of time is:

For 50 Hz: 204.79 cycles x 20 ms/cycle = 4095.8 ms.

For 60 Hz: 204.79 cycles x 16.67 ms/cycle = 3413 ms.

5.2.3.2 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 with a protection state or to a virtual output. Each oscillography record reflects the changes experienced by this state during the record.

OSCILLO TRIGGER: The activation of this state produces 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 stores 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 are stored in each oscillography record. Although the number of cycles can be a decimal number, the record represents 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 (ftp, tftp). The range is 0 to 20.

5.2.3.3 Oscillography file 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). Click **View header** to show the header of the record selected at **Select Record**.

Click **Download** and the three files (*.DAT, *.HDR, *.CFG) that form the oscillography record in the COMTRADE standard are retrieved and viewed automatically if the GE-OSC software is installed in the computer. Retrieved oscillography records can be viewed using any Comtrade viewer. The EnerVista 650 Setup software stores oscillography records in the folder ".\EnerVista 650 Setup\files\osc" by default, 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.

For firmware versions above 7.00 and below 7.70, oscillography record retrieval Ethernet communications ports (tftp). For firmware versions 7.70 or above, oscillography record retrieval uses serial (ModBus RTU) or Ethernet (tftp) communication ports

5.2.4 Data logger

The C650 data logger can store information from up to 16 analog channels, among all channels available in the relay, with a selectable sampling rate. The memory of the data logger is fixed at 64 Kilobytes with two bytes needed per channel. The selected channels take all available memory space, therefore, the number of days of storage depends on the selected number of channels and sampling rate.

5.2.4.1 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 erases all stored information.

5.2.4.2 Data logger associated states

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

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 remains constant until the available memory capacity is exceeded. Afterwards, this value changes 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.

5.2.4.3 Data logger file 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.

For firmware versions below 7.70, datalogger record retrieval uses Ethernet communications ports (ftp, tftp). For firmware versions 7.70 or above, datalogger record retrieval uses serial (ModBus RTU) or Ethernet (ftp, tftp) communication ports

File Format

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

5.2.5 Demand settings

5.2.5.1 Metering values and settings

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

Table 5-6: 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

*Note: The step depends on the selected “Primary Meter Units” in System Setup > General Settings (A_V; KA_KV)

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

Calculated demand values are as follows:

Table 5-7: 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
DEMAND W MIN	DEMAND VAR MIN	DEMAND VA MIN

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 5-8: 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.

5.2.5.2 Demand calculation methods

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:

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

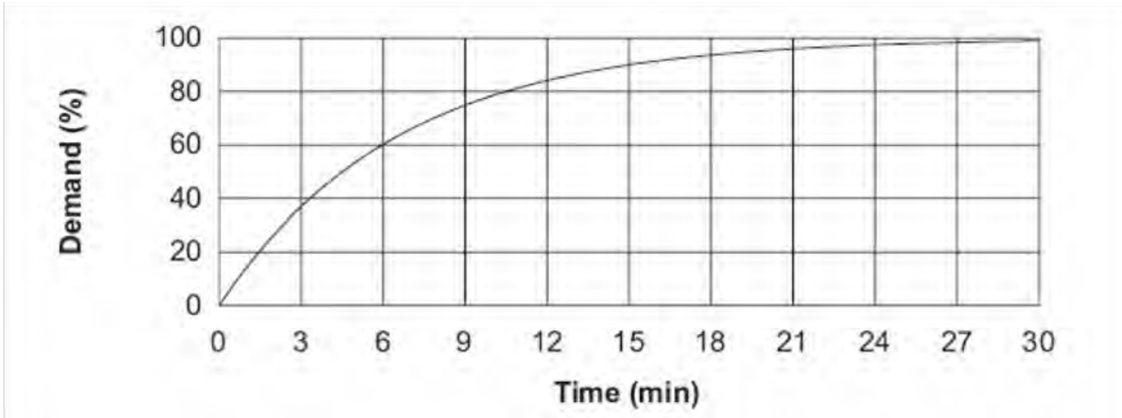
Where:

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 indicates 99% of the value.



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.

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 is made every second and the demand value is the average of all values produced during the time interval. The time interval is chosen in the DEMAND INTERVAL setting. The interval demand value is shown once this time has expired.

If, for example, the setting indicates 15 minutes for integration, the demand value update is 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 calculates the demand after 60 minutes from the last pulse, this measure is updated in the status and a new demand count starts. This method calculates a linear average of the magnitude.

Figure 5-1: Response to different demand methods shows the behavior of the demand, depending on the Selected setting for demand calculation.

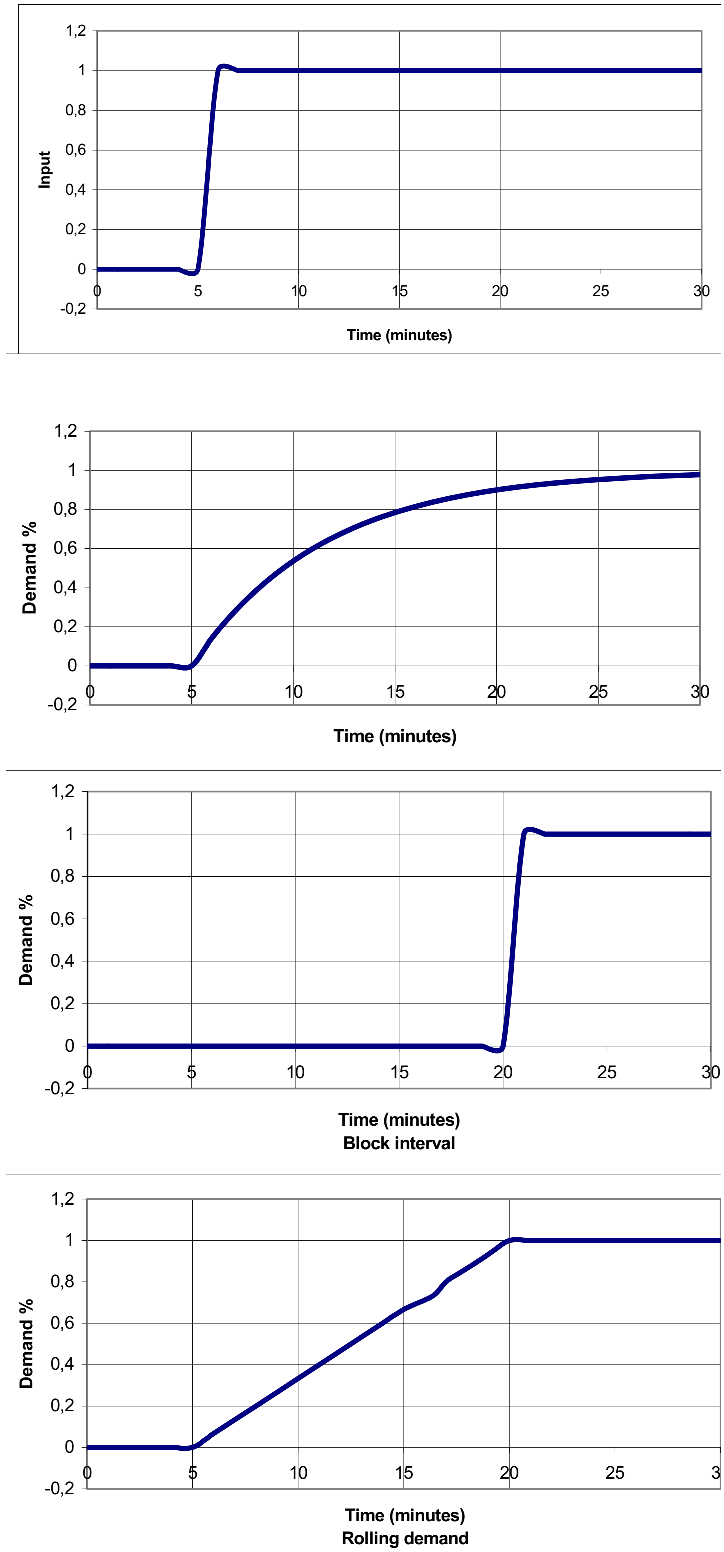


Figure 5-1: Response to different demand methods

5.2.5.3 Demand function measurements and states

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

Table 5-9: Demand measurements

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 MIN	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 MIN	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 MIN	0.000	MVA
DEMAND VA DATE	01-Jan-2000 00:00:00.000	

*Note: The step depends on the selected “Primary Meter Units” in System Setup > General Settings (A_V; KA_KV)

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** MIN	Demanded minimeter; it stores the Minimum 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 or minimum demanded values are stored in non-volatile memory. They are not cleared when the relay is turned off. When the relay is turned on again, the values are updated.

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

Table 5-10: 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.

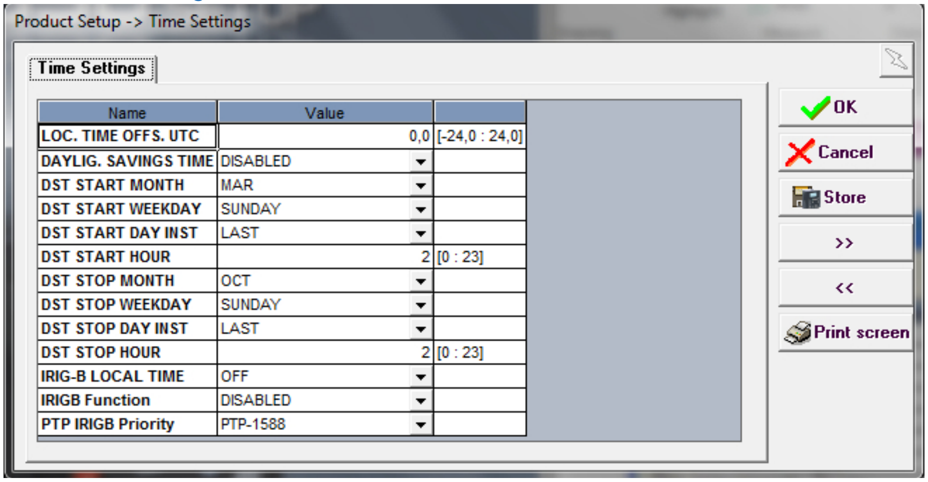
DEMAND RESET INP Bit type state, programmable at "***Setpoint > Relay Configuration > Protection Elements"*** in the EnerVista 650 Setup software. When this bit is activated, the demand measures are reset. All stored values are reset to zero (for demand dates, this value represents January 1st, 2000).

5.2.6 Time Settings

The date and time can be synchronized to a known time using the SNTP protocol, IRIG-B protocol (when it provides UTC Time) or IEEE1588 (Available starting from version V7.00) and the TIME SETTINGS allow setting the date and time provided by these protocols to the proper local time on the Real Time Clock.

When there is no SNTP protocol enabled, IRIG-B protocol is not set to UTC Time or IEEE1588 synchronization, the TIME SETTINGS are not used in the Real Time Clock but are still used to calculate the UTC Time (i.e., for the IEC61850 protocol), but its behavior is not assumed correct in several critical hour changes because of Daylight Savings Time getting effective. In these configuration cases, it is recommended to disable Daylight Savings Time.

Table 5-11: Time Settings



Name	Value	
LOC. TIME OFFS. UTC	0,0	[-24,0 : 24,0]
DAYLIG. SAVINGS TIME	DISABLED	
DST START MONTH	MAR	
DST START WEEKDAY	SUNDAY	
DST START DAY INST	LAST	
DST START HOUR	2	[0 : 23]
DST STOP MONTH	OCT	
DST STOP WEEKDAY	SUNDAY	
DST STOP DAY INST	LAST	
DST STOP HOUR	2	[0 : 23]
IRIG-B LOCAL TIME	OFF	
IRIGB Function	DISABLED	
PTP IRIGB Priority	PTP-1588	

The TIME SETTINGS settings are as follows:

LOC. TIME OFFS. UTC:

Is used to specify the local time zone offset from Universal Coordinated Time (Greenwich Mean Time) in hours.

DAYLIG. SAVINGS TIME:

Allow the unit clock to follow DST rules of the local time zone.

DST START MONTH:

Allow to set the start month of the DST from January to December

DST START WEEKDAY

Allow to set the start weekday of the DST from Monday to Sunday

DST START DAY INST:

Allow to set the start day instance from First, Second, Third, Fourth or Last

DST START HOUR

Allow to set the starting hour of the DST (in local time)

DST STOP MONTH

Allow to set the stop month of the DST from January to December

DST STOP WEEKDAY

Allow to set the stop weekday of the DST from Monday to Sunday

DST STOP DAY INST

Allow to set the stop day instance from First, Second, Third, Fourth or Last

DST STOP HOUR

Allow to set the stop hour of the DST (in local time)

IRIG-B LOCAL TIME:

Determines, in case of being enabled, if the IRIG-B protocol would carry the date in local time or else in UTC Time.

IRIG-B FUNCTION:

Setting for enable or disable the IRIG-B protocol

PTP IRIG-B PRIORITY:

If two or more time sources are setup the time source with the higher priority shown in the table below is used where 1 is considered to be the highest priority. Note that the time source priority of PTP and IRIG-B can be swapped. Setting changes become active after reboot.

The C650 is capable of receiving a time reference from several time sources in addition to its own internal clock for the purpose of time stamping events, transient recorders and other occurrences within the relay. The accuracy of the time stamp is based on the time reference that is used. The C650 supports an internal clock, SNTP, IRIG-B and 1588 as potential time references.

Regarding the PTP, C650 acts as an ordinary clock, with only Sync and Pdelay_Req messages.

Table 5-12: Synchronization priority table

Time source	Accuracy	Priority
PTP		1*
IRIG-B		2*
SNTP		3
Internal Clock		4

The priority of IRIG B and PTP can be swapped

Note:

Synchronization by IEC103, DNP, Modbus and IEC104 is not going to be issued if there is a sync source from IRIG-B, SNTP or PTP.

5.3 System setup

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.

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 : 250.0]
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]
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]
Primary Meter Units	Primary Meter Units	KA_KV	N/A	[KA_KV; A_V]
Device Name	Device Name		N/A	

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 VN and VX.

VN means that all elements using neutral voltage take the value directly from the fourth voltage input.

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

5.3.2 Miscellaneous settings

This section determines the relays status configuration regarding the service and local or remote modes.

Setpoint > System Setup > Miscellaneous Settings				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Relay Out of Service	Relay Out of Service	ENABLED	N/A	[DISABLED – ENABLED]
Local/Remote Blocked	Local/Remote Blocked	OFF	N/A	[ON -OFF]
Active Language	Active Language	0	N/A	[0;1]

5.3.2.1 Out of service setting

The unit **Relay Out of Service** setting is configured in **Setpoint > System Setup > Miscellaneous**. The unit also has an **Out of Service** status that is configured in **Relay configuration > Protection elements**. When active, these states stop all changes to PLC equations and functions, including changes in the input/output boards, so if there is a change in any input or output the unit will not show this change until has returned to ready mode. For example, if an output is closed and the unit goes to the **Out of Service** state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the **Out of Service** state, the output is then opened.

Functions affected by Out of service State

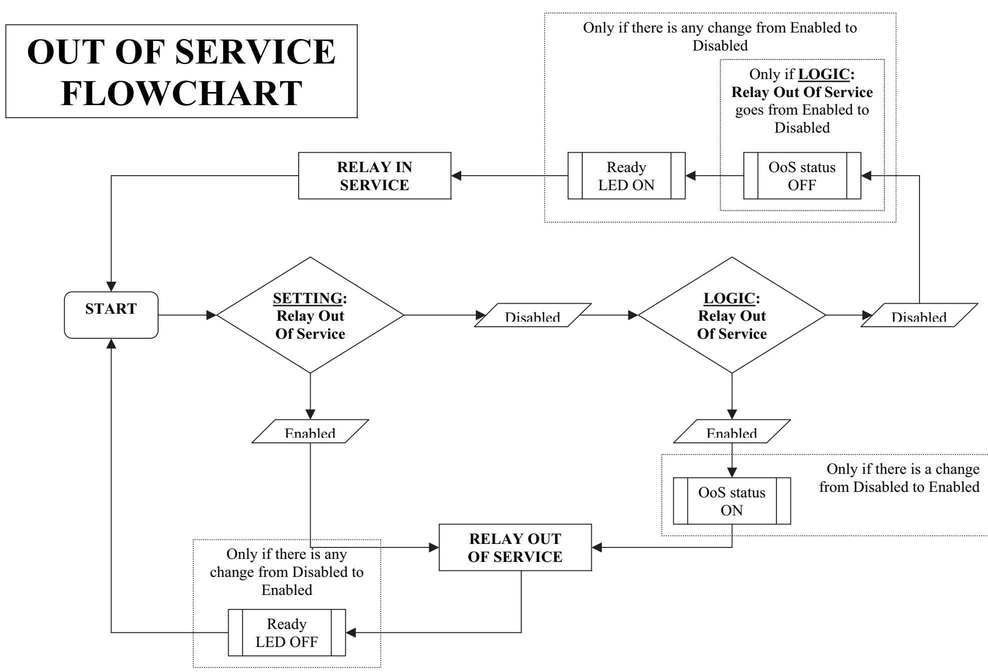
- IO Boards.

- Protection functions

- Setting Groups
- Recloser (79)
- Oscillography
- Synchrocheck (25)
- Fuse Failure (VTFF)
- Data Logger
- Comparator
- Switchgear
- Breaker

When the Out of Service status goes to ON, or the setting has been changed to Enabled, the ready LED changes to red. Be careful if the ready LED is linked to an output, because the output will not change its state. To set an output to the ready state, see the factory default Logic & Configuration. Take notice that VO_000 is set to the output instead of VO_099

The following figure shows the flow chart of these states



5.3.2.2 Local - remote block setting

In the enhanced HMI with USB port new setting has been released in order to be able to lock the Local/Remote front key. This setting is available via COMS or frontal HMI menu. The settings can be locked by password, so the operator wouldn't be able to change the local-remote without inserting the password.

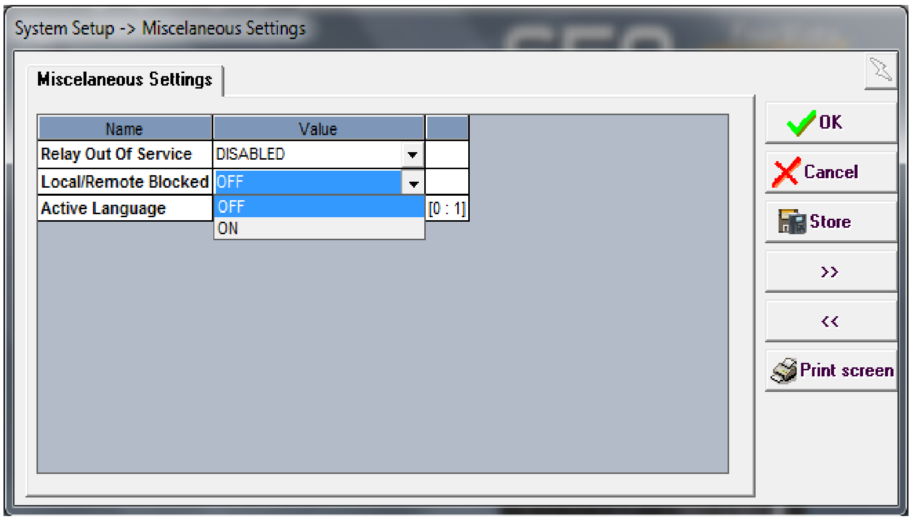
Definitions

The value is defined as:

- OFF: The operator is able to change the operations from local to remote or OFF.
- ON: The operator is not able to change the operations from local to remote or OFF.

Settings

The unit is set by the HMI and by 650PC software as it is shown in the following figure.



5.3.3 Breaker settings

There are two types of breaker settings:

Breaker settings: These settings correspond to the switchgear configured as a breaker in the C650; 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.

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]

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), recloser (79) 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 is 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 produces an alarm. When the limit 9999 is reached the maximum openings counter starts 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 reached, the corresponding alarm signal is 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 takes the rated current value for its calculations. When the accumulated counter for each phase reaches or exceeds the set value, the corresponding alarm signal is 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.

5.3.3.1 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.

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, $S(KI)^2t$ 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.

$(KI)^2t$ 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 with the opened or closed status of the breaker can be monitored at **Actual > Status > Breaker**

Table 5-13: Breaker status

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

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

Table 5-14: 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
BKR OPEN TIMING	Exact time in opening the breaker
BKR CLOSE TIMING	Exact time in closing the breaker

5.3.4 Switchgear settings

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.

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 Control elements

The C650 incorporates the following control elements:

Synchrocheck (25)

Autoreclose (79)

Pulse Counters

Digital Counters

Analog Comparators

PLC Timer mask

Note: for all control elements related to the breaker, it must be considered that all operations are 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, $(KI)^2t$.

5.4.1 Synchronism check element - synchrocheck (25)

Note: The Switchgear element used in the C650 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 5-2: Synchronism check element) The voltage comparison between both sides of a breaker is performed before closing the breaker, in order to minimize internal damage that can 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 can lead to severe damage to the turbine axis.

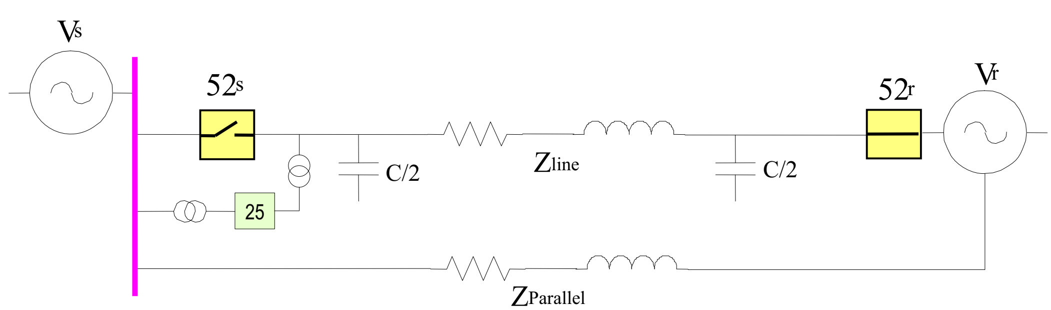


Figure 5-2: Synchronism check element

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 are rarely 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) are 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.

5.4.1.1 Voltage inputs

In order to perform the synchronism check function, the C650 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 is only 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***. (refer to the voltage correspondence Table 5-15: Voltage correspondence element 25)

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 5-15: Voltage correspondence element 25

	Voltage Correspondence		
Setpoint > System Setup > General Settings > Frequency Reference Voltage selection for element 25 of C650	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).

5.4.1.2 Application

Even if the application range of the C650 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 C650 is not suitable for one and a half breaker configurations, or ring configurations where a transmission line or feeder has two breakers.

5.4.1.3 Settings

There is only one synchrocheck element in the C650.

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 : 300.00]
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 1.00]
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]

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):

C650 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 20 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. The limit for the anticipative algorithm is two times the maximum angle difference. This means that if the product of the frequency slip multiplied by the breaker closing time covers an angle greater than two times the maximum angle, closing is not allowed. For further information see 5.5.4.5.

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, C650 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.

5.4.1.4 Synchrocheck states

Internal signals provided by the C650 (***Actual > Status > Control Elements > Synchrocheck***) for the synchronism element are as follows:

Table 5-16: 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 > Control 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 is activated in order not to interfere with possible logics where it is included. If the synchronism element is enabled, this signal is only 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

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 (refer to the voltage correspondence table (Table 5-15: Voltage correspondence element 25), and the angle of the busbar voltage the one that corresponds to Vx Angle, when the Auxiliary Voltage setting as been selected as Vx.

5.4.1.5 Algorithm

C650 elements perform the synchronism check by basically establishing and comparing three parameters:

Module difference of voltage phasors DV (V)

Phase angle of voltage phasors Dj (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 does 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 does 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, C650 elements incorporate closing permission logics for situations of:

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 DV

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 5-17: Synchronism conditions).

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 5-17: 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 5-17: Synchronism conditions 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 starts evaluating the line and busbar voltage comparison with respect to the setting **DV**$_{set}$ established by setting (Max Volt Difference). In this case, if the voltage difference is lower than **DV**$_{set}$, the synchronism check element (25) verifies the angle difference **Dj** adjusted by setting (Max Angle Difference).

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

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

Live Line – Dead Bus (LL - DB): Case number (7) does not allow the synchronism function, but it does 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 Dj

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 **Dj_{set}** (Max Angle Difference) setting, then the system verifies the frequency slip **S** (Max Freq Difference).

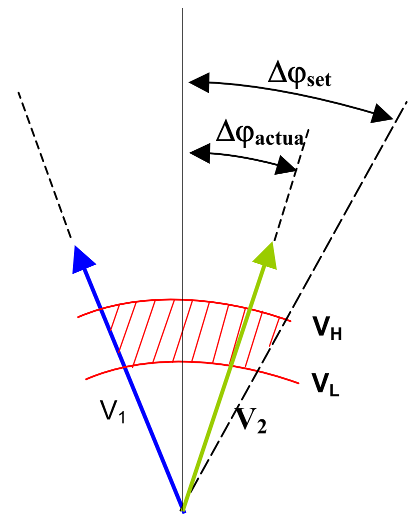


Figure 5-3: Voltage angle difference

In the live-live bus condition, once the voltage difference has been successfully verified in magnitude, the relative frequency slip between phasors is calculated. From the information obtained from the relay, the algorithm knows the slip (mHz) of both phasors and it takes as reference (VRef) the lowest frequency phasor. The behavior of the algorithm depends on the slip frequency and the breaker close time as follows:

1. If the relative slip, Δf, is equal or lower than 20 mHz, the algorithm gives permission to close as soon as the angle difference is slower than the Δ?set (Max Angle Difference), because at such a low speed, the hold time for getting an "in-phase" closing permission would be too long.
2. If the relative slip is higher than 20 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. When the difference between voltage values equals "two times" the set angle as maximum angle difference (ΔV = ΔVset), 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.
3. If the product of frequency slip and breaker closing time is higher than Max Angle difference and lower than two times this setting, 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).
4. If this product is beyond two times Max Angle difference, closing operation is not allowed.

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

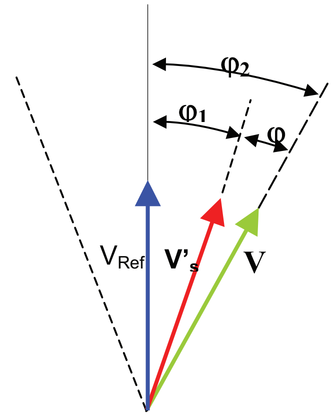


Figure 5-4: Anticipative algorithm

Where:

V_{ref}	Referenced phasor (the one with lower frequency)
V_s	Actual voltage phasor (the one with lower frequency)
V'_s	Calculated voltage phasor, depending on the set breaker closing time (anticipative algorithm)
j	360º *TCB *Df = Calculated angle for phasor V'_S
TCB	Breaker Closing time defined by setting
Df	Frequency slip (mHz) between phasors
j_1	Angle difference set as maximum angle difference (**Dj_{set}**, Max Angle Difference)
j_2 =	Angle difference between V_{ref} and V_S. The algorithm starts operating when **j_2** equals two times the angle set as maximum angle difference.

Closing permission is given when **V'_s** is over **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 (**j_2**) is entered, the relay produces a closing permission output, if it is guaranteed that the projected phasor is within the limit marked by the setting, as shown in the following figure. Besides, when the product of frequency slip and breaker close time goes beyond this window, closing is not allowed.

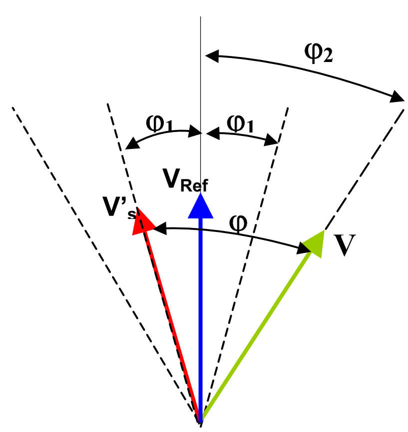


Figure 5-5: High slip closing permission signal

5.4.2 Autoreclose (79)

Note: The Switchgear element used in the C650 autoreclose element is the one configured in the ***Number of Switchgear*** setting inside ***Breaker settings***, at "***Setpoint > System Setup > Breaker > Breaker settings***". Configuration of these Switchgear parameters is performed at ***Setpoint > Relay Configuration > Switchgear*** using the EnerVista 650 Setup software.

The C650 autoreclose element produces up to four breaker "shots" prior to lockout. Thanks to the great flexibility of C650 configurable logic, the conditions to produce the autoreclose initiation and the selection of protection elements is enabled after each shot can be programmed. This flexibility allows implementing protection schemes that used to require wiring and special functions in conventional equipment. One application is, for instance, programming as instantaneous the first protection trip while the second one is time delayed, in order to give time for output fuses to burning of a feeder branch. This can be as simple as disabling the instantaneous elements after the first shot using programmable logic. (see example in section 5.4.2.5 Logic for blocking protection functions during reclose cycle)

5.4.2.1 Main autoreclose settings

Setpoint > Control Elements > Autoreclose				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Autoreclose settings description:

Function: This setting allows enabling or disabling the autoreclose operation. If this setting is adjusted as DISABLED, the recloser is out of service.

Max Number Shots: This setting specifies the number of autoreclose shots allowed in the element. If this number is exceeded, the autoreclose goes to LOCKOUT status, and the fault is considered to be permanent.

Dead Time 1 ... 4: These times correspond to the first, second, third and fourth breaker reclosings configured in the element.

Reclaim Time (also known as **safety time** or **reset lockout delay**): This is the time required to go from LOCKOUT to READY status once the breaker is closed.

Cond. Permission: This setting enables the verification of the relay reclose conditions. If this setting is enabled, before the breaker closing command execution the system verifies the possible reclose conditions. If this setting is disabled, the closing command is executed after the reclose time without verifying these conditions. The reclose conditions input is configured as AR CONDS INPUT at ***Setpoint > Relay Configuration > Protection Elements***

Hold Time: This setting indicates the waiting time for the reclose conditions to be present. This setting is only operative if the *Cond. Permission* setting is enabled.

Reset Time: This is the time that the autoreclose takes to return to READY status after a successful reclose. Once this time has expired, the shot counter resets and the autoreclose goes to READY.

5.4.2.2 Autoreclose inputs

For the correct operation of the autoreclose element, it is required to configure several input signals in the Relay. These signals can be configured using the EnerVista 650 Setup software, at **Setpoint > Relay Configuration > Protection Elements**. The **Protection Elements** screen allows to select simple signals provided directly by the relay (***states***), or to use more complex logics using **virtual outputs**, configured at **Setpoint > Logic Configuration** using the PLC Editor tool inside EnerVista 650 Setup.

Actual > Status > Control Elements > Autoreclose

Table 5-18: 79 configurable inputs

AUTORECLOSE INPUTS
AR LEVEL BLOCK
AR PULSE BLOCK
AR PULSE UNBLOCK
AR INITIATE
AR CONDS INPUT

AR LEVEL BLOCK: This signal is configured to block the autoreclose by level; when the block signal disappears, the recloser goes to Lockout status before returning to either the READY status, or the corresponding status in the reclosing cycle.

AR PULSE BLOCK: This signal is configured to block the autoreclose by pulse; a pulse moves the autoreclose to BLOCK status. The autoreclose block is active until an unblock signal is received.

AR PULSE UNBLOCK: This signal is configured as autoreclose unblock by pulse; this pulse is required to bring the recloser out of the block status. The autoreclose goes to Lockout after a block situation.

AR INITIATE: This signal indicates the autoreclose initiation. Usually, the factory default configuration sets this signal as a combination of the general trip signal (Virtual Output 83), and an external input configured as AR Initiate.

AR CONDS INPUT: This signal configures the conditions that are to be met before executing a breaker close command. These conditions are verified once the configured ***Dead Time*** has expired, and they are only considered if the ***Cond. Permission*** setting is enabled. Otherwise, these conditions wouldn't have any effect. In the default factory configuration, the conditions input is associated with the synchronism check element close permission.

5.4.2.3 Autoreclose internal status

Actual > Status > Control Elements > Autoreclose. These signals can be used as conditions for executing logics in the relay; they are also useful to know the autoreclose behavior.

Table 5-19: 79 Internal Status

AUTORECLOSE SINGLE STATUS
AR CLOSE BREAKER
AR OUT OF SERVICE
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER

AUTORECLOSE ENUMERATED STATUS
AR STATUS
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LOCKOUT MODE
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER

AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLK AFTER 1 SHOT
AR BLK AFTER 2 SHOT
AR BLK AFTER 3 SHOT
AR BLK AFTER 4 SHOT
AR BLOCK BY LEVEL
AR BLOCK BY PULSE

AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLOCK MODE
AR BLOCK BY LEVEL
AR BLOCK BY PULSE

Description of autoreclose internal status:

AR CLOSE BREAKER Breaker close command given by the autoreclose

AR OUT OF SERVICE Autoreclose out of service (Disabled)

AR READY Autoreclose in service

AR LOCKOUT Autoreclose in lockout status (finished cycled-definite trip)

AR BLOCK Autoreclose blocked (by input, logic, others, etc.).

AR RCL IN PROGRESS Cycle in course (autoreclose in progress).

AR LCK BY ANOMALY Autoreclose in “Lockout” by anomaly.

AR LCK BY FAIL OPEN Autoreclose in “Lockout” by failure to open

AR LCK BY FAIL CLOSE Autoreclose in “Lockout” by failure to close

AR LCK BY USER Autoreclose in “Lockout” by user Command; manual breaker close during the autoreclose cycle

AR LCK BY CONDS Autoreclose in lockout by non-compliance of the autoreclose conditions

AR LCK BY TRIPS Autoreclose in “Lockout” by maximum number of trips (Lockout status not available)

AR LCK BY SHOTS Autoreclose in “Lockout” at the end of cycle – Definite trip (due to Maximum Number of shots reached).

AR BLK AFTER 1 SHOT Block signal sent by the autoreclose after the first shot

AR BLK AFTER 2 SHOT Block signal sent by the autoreclose after the second shot

AR BLK AFTER 3 SHOT Block signal sent by the autoreclose after the third shot

AR BLK AFTER 4 SHOT Block signal sent by the autoreclose after the fourth shot

AR BLOCK BY LEVEL Autoreclose blocked by level. See AR block signals configuration (AR LEVEL BLOCK)

AR BLOCK BY PULSE Autoreclose blocked by pulse. See AR block signals configuration (AR PULSE BLOCK)

AR STATUS Autoreclose status (see Table 5-19: 79 Internal Status)

AR LOCKOUT MODE Autoreclose lockout mode (see Table 5-19: 79 Internal Status)

AR BLOCK MODE Autoreclose block mode (see Table 5-19: 79 Internal Status)

5.4.2.4 General autoreclose staus diagram

The following diagram describes the different autoreclose states, as well as the transitions between states.

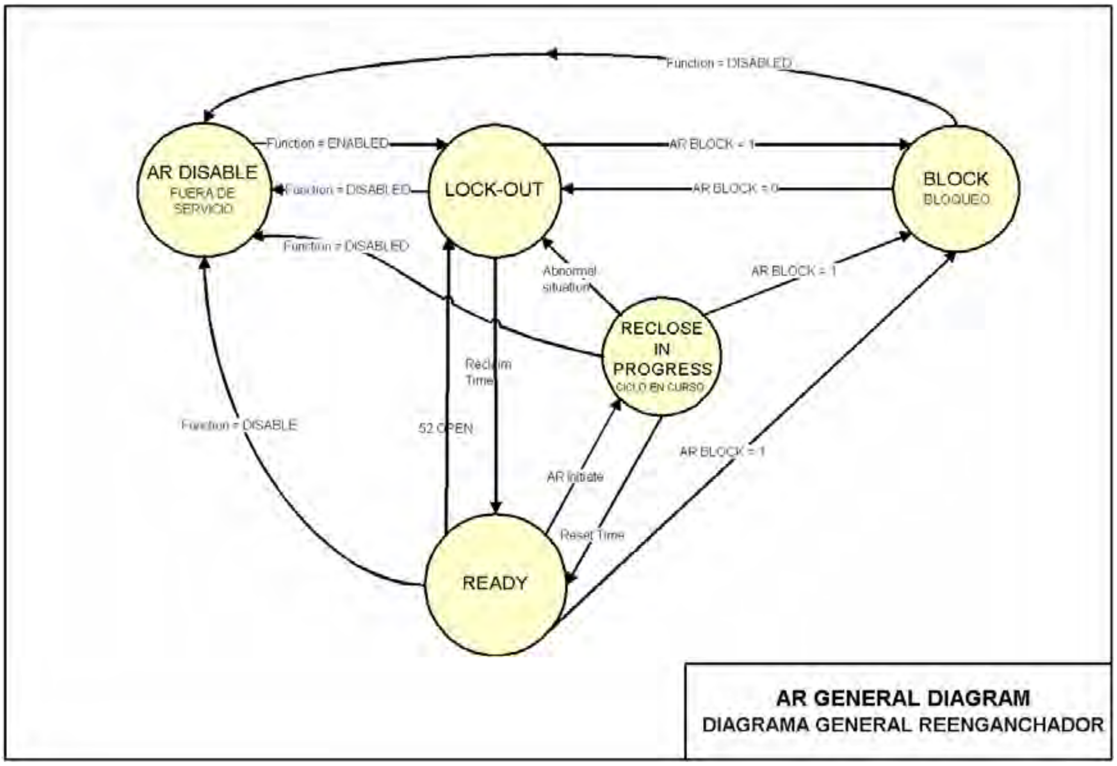


Figure 5-6: General autoreclose status diagram

Description of the general autoreclose status:

OUT OF SERVICE / AR DISABLE

In this status, the autoreclose is disabled. From any state, if the *Function* setting is set as DISABLED, the autoreclose moves to OUT OF SERVICE status, where it is not operative.

AR READY

This is the initiation and normality situation status: closed breaker. There are neither faults producing a autoreclose initiation nor Block signal.

If the autoreclose was in LOCKOUT, if the breaker is closed and the time set in *Reclaim Time* setting expires, the autoreclose goes to the initial status of READY.

From RECLOSE IN PROGRESS, the recloser moves to READY, if the *Reset Time* setting expires without any autoreclose initiation condition.

AR RECLOSE IN PROGRESS

From READY status, a reclose initiation sets the cycle counter to 1 and a reclosing sequence is initiated, which produces breaker close commands, unless any abnormality is produced that makes the autoreclose go to LOCKOUT status.

The reclosing sequence consists on the following steps:

Wait until the breaker is open, if the waiting exceeds the ***Fail to Open Time*** setting, the autoreclose goes to LOCKOUT by failure of opening status (AR LCK BY FAIL OPEN).

Once the breaker is open, it waits for the time set in the ***Dead Time N*** setting, *N* being the number of the cycles in progress. If during this waiting the breaker is closed or reclose initiation conditions are given, the recloser goes to LOCKOUT status by anomaly (AR LCK BY ANOMALY).

Once the Dead Time has expired, in case the ***Conditions Permission*** setting is disabled, a closing command would be produced. If the conditions permission setting is enabled, the system waits for the conditions fixed in the conditions input (AR CONDS INPUT) configured at ***Setpoint > Relay Configuration > Protection Elements***; if the waiting period for the reclosing conditions signal activation exceeds the ***Hold Time***, the autoreclose goes to Lockout status by conditions (AR LCK BY CONDS).

The autoreclose gives a Closing command and waits for the breaker to close. If the ***Fail to Close Time*** setting is exceeded, the autoreclose goes to lockout by failure to close (AR LCK BY FAIL CLOSE).

At this point, the diagram indicates that a reclosing cycle has been reached, and so the cycle counter is increased. In this time, the period set in ***Reset Time*** starts to count. If during the set element reset time there is no autoreclose initiation, the cycle counter resets to its initial value (1), and the autoreclose returns to the standby status (READY). If during the ***Reset Time*** setting period, there is a new autoreclose initiation, the ***Reclose In Progress*** sequence starts again. If this reclose is produced after the last configured cycle in the ***Maximum Number of Shots*** setting, the autorecloser goes to Lockout by maximum number of shots (AR LCK BY SHOTS).

AR LOCKOUT

This is a safety status, scheme lockout blocks all phases of the reclosing cycle, preventing automatic reclosure.

From the out of service (AR DISABLE) and BLOCK statuses, the autoreclose stays in LOCKOUT prior to going to READY.

From the RECLOSE IN PROGRESS status, the recloser goes to LOCKOUT status if any of the anomalies described above occur.

To go from the LOCKOUT status to READY it is necessary that the breaker is closed and stays closed for preset time in ***Reclaim Time*** setting.

AR BLOCK

The BLOCK status is similar to the LOCKOUT status, as it guarantees that if the autoreclose is in Block, no breaker close command is produced, but the difference between them is that this Block status is reached by an external action. The autoreclose block can be configured by pulse or level signals. This configuration must be selected at ***Setpoint > Relay Configuration > Protection Elements***

When the autoreclose block signal is deactivated, either by a level change in the set signal (in case of block by level) or by an Unblock pulse (in case of block by pulse), the block status is abandoned and the autoreclose returns to the Lockout status.

Configurable signals to block the autorecloser are described in section 5.4.2.2 Autoreclose inputs.

5.4.2.5 Logic for blocking protection functions during reclose cycle

The C650 autoreclose generates a series of internal signals that allow performing block logics for Protection elements during the reclosing cycle. These signals are blocks after autoreclose shots (***BLK AFTER SHOT***). For example, if the user wants to block a protection element during the complete reclosing cycle, it is necessary to configure a signal as an OR of the four blocking signals provided after each reclosing cycle in the logic configuration tool ***Setpoint > Logic Configuration***, and then use it to block the desired protection elements at ***Setpoint > Relay Configuration > Protection Elements***.

Figure 5-7: clock signal during reclose cycleshows an example of the logic configuration for the block signal during the reclosing cycle.

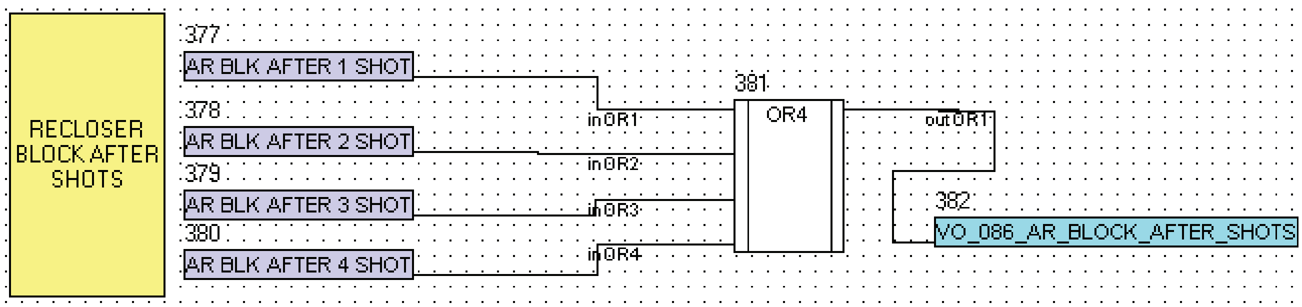


Figure 5-7: clock signal during reclose cycle

Figure 5-8: Reclose initiation and block signals configuration example shows an example of the autoreclose initiation and protection element block signals after the different trips. The autoreclose initiate signal is configured to the relay general trip that corresponds to virtual output 83 configured in the logic configuration tool, and a physical contact to generate an external autoreclose initiation.

In the example shown on the figure, the 50PH element block signal is configured as a combination of block by digital input, block by non-trip permission of the directional element, and finally the element remains blocked during the reclosing cycle. This means that only the first trip can be executed by the phase instantaneous overcurrent element; after the first reclose trip, the element remains blocked until the end of the cycle.

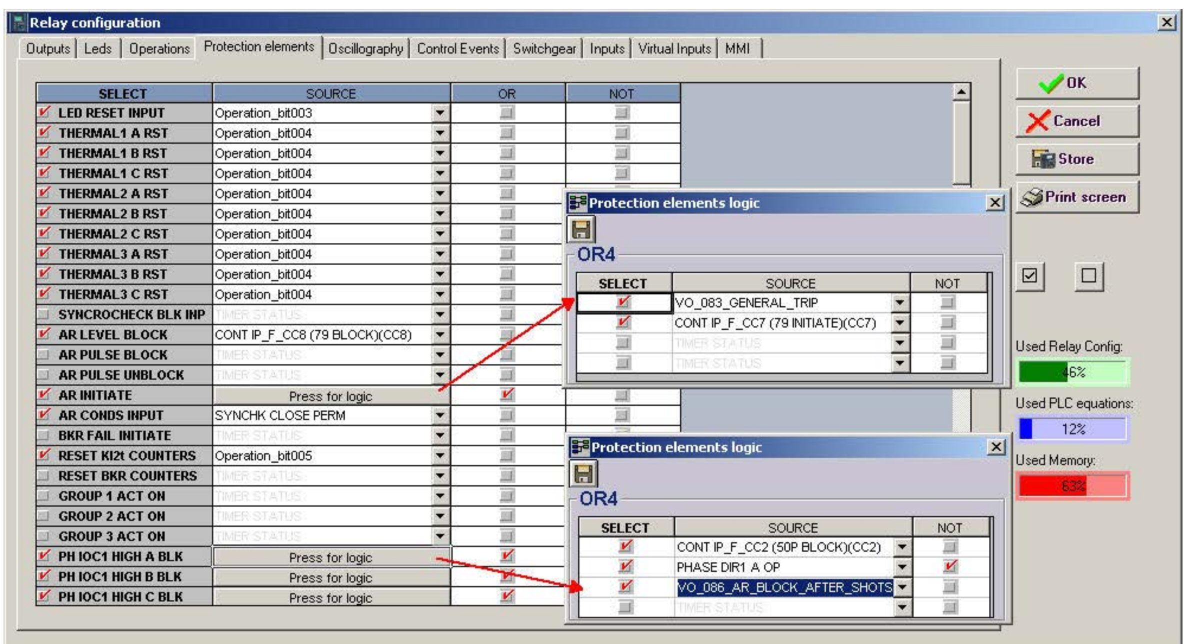


Figure 5-8: Reclose initiation and block signals configuration example

5.4.3 Pulse counters

The C650 includes eight pulse counters, each pulse counter stores the activation number 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 C650 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.

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 takes 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 starts 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 5-20: 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 C650 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 is copied to the freeze one, which remains 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 goes 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.

5.4.4 Analog comparators

The C650 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.

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				

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 is 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 when going out of operation band.

Direction IN: min value = min - hysteresis (in %)
max value = max + hysteresis (in %)

Direction OUT: min value = min + hysteresis (in %)
max value = max - hysteresis (in %)

Analog Direction: Analog direction for the activation signal to be set Inside or Outside the Deadband.

OUT: The "Analog Level X" gives an activation signal when the analog value is located outside the comparison band.

IN: The "Analog Level X" gives an activation signal when the analog value is located inside the comparison band.

The C650 provides 20 different analog comparators. Their status values can be viewed at ***Actual > Status > Control Elements > Analog Comparators:***

Table 5-21: 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 is 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 goes 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 has a 20 ms accuracy.

5.4.5 Digital counters

Digital Counters are functions to count discrete bit logic value changes, for example, it is able to count the number of pickups of a protection element, the number of breaker openings or the contact inputs state changes.

There are 8 identical digital counters and they count the number of state transitions from Logic 0 to Logic 1, of the logic states configured by the user, that trigger the increment or decrement commands of the digital counter value.

Settings

Setpoint > Control Elements > Digital Counters				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Digital counter enabling setting	DigCnt Function X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the digital counter	DigCnt Name X	Digital Counter X	N/A	N/A
Initial Digital counter value	DigCnt Preset X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Compare Digital counter value	DigCnt Compare X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Note: X is the pulse counter index, up to 8.				

For each of the 8 digital counters, there exist independent and identical groups of settings:

DigCnt X Function: This setting allow to Enables or disables the specified counter. If a counter's DigCnt X Function is set to Disabled, then the DIGCNT X HI, DIGCNT X EQ and DIGCNT X LO are set to OFF and the DIGCNT X VALUE, DIGCNT X FROZENVALUE and DIGCNT X FROZENDATE are set unaltered.

DigCnt X Name: Sets a name to identify the specified counter. Note that the name length is cut down to only 12 characters long.

DigCnt X Preset: Indicates the preset value that the specified counter can be set before counting operations begin or after a reset command is accomplished.

DigCnt X Compare: Indicates the comparison value that the specified counter current value is compared to and several logic bits (HI, EQ and LO) are updated accordingly.

Snapshot Events: This is a global setting that affects all of 8 digital counters. Enables or disables the snapshot events for this function. Note that all enabled digital counters are affected by this setting.

Relay configuration

To the correct operation of each counter, there are several PLC status variables in EnerVista 650 Setup at **Setpoint > Relay Configuration > Control Elements** section that should be configured properly. Each one of the 8 digital counters has its own PLC statuses and they are identical:

Setpoint > Relay Configuration > Control Elements	
Setting Description	**Name**
Digital counter block	DigCnt X Block
Digital counter UP	DigCnt X UP
Digital counter DOWN	DigCnt X DOWN
Digital counter SETPRESET	DigCnt X SetPreset
Digital counter RESET	DigCnt X Reset
Digital counter FREEZERESET	DigCnt X FreezeReset
Digital counter FREEZECOUNT	DigCnt X FreezeCount
Note: X is the pulse counter index, up to 8.	

DIGCNT X BLOCK: Blocks the functionality of the specified counter. If a counter's DIGCNT X BLOCK is set to 1, all the counter's values remain unaltered and no counter commands are processed. When the counter's DigCnt X Function is set to Enabled and the DIGCNT **X** BLOCK is set to 0, then the counter starts running and accepting counter commands.

DIGCNT X UP: Counter command. When this element changes from 0 to 1, the value of the specified counter is incremented by 1. If the current counter value is 2,147,483,647 and is incremented, the updated value is set to -2,147,483,648.

DIGCNT X DOWN: Counter command. When this element changes from 0 to 1, the value of the specified counter is decremented by 1. If the current counter value is -2,147,483,648 and is decremented, the updated value is set to 2,147,483,647.

DIGCNT X SETPRESET: Counter command. This element defines the behavior of the specified counter's Reset and the Freeze/Reset commands or when counter is set from Disabled to Enabled:

- If set to 0, all commands with a Reset involved or when counter is Enabled set the initial counter value to 0
- If set to 1, all commands with a Reset involved or when counter is Enabled set the initial counter value to the one specified in the setting DigCnt # Preset.

DIGCNT X RESET: Counter command. It sends a Reset command to the specified counter.

DIGCNT X FREEZERESET: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then a Reset command is sent to the specified counter.

DIGCNT X FREEZECOUNT: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then the specified counter value DIGCNT X VALUE is set to 0 or to the DigCnt X Preset setting value.

Periodically the counter current Value and Frozen Value and Date are saved to non-volatile memory to keep them safe from an unexpected energy loss.

Note: Digital Counters only appear in the Actual Values menu option in HMI, in the Control Elements level.

5.5 Inputs/outputs

5.5.1 Input/output placement

Boards type 1 (mixed) are used in C650 models in F and G slots.

All the other board types (including type 1) can be used in CIO modules. This section explains the different I/O board configurations available.

	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	O1	CC17	SHIELD 1/4
20			CC18	+ AI 1
21		O2	CC19	−
22	O2		CC20	+ AI 2
23		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 5-9: Input/output location and type

5.5.2 Control settings for input/output

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 5-22: I/O board settings

Table 5-22: 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**_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]

For versions previous to 7.00, 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, J, 2H, or 2J, the I/O board name, depending on the Relay model.

F and G are internal Relay boards and H, J, 2H and 2J are additional boards available in CIO modules (remote Bus CAN I/O module) or a C650 19" rack.

For the I/O board selection in the relay model, associated digits to each board type are as follows:

Table 5-23: 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 (C650 and CIO module)

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

5.5.3 Inputs

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 is not considered. There is a single setting for all inputs in the same group.

Input Type: Type of logic associated with 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 is not considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. Figure 5-10: INPUT LOGIC TYPES shows the types of signals associated with 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.

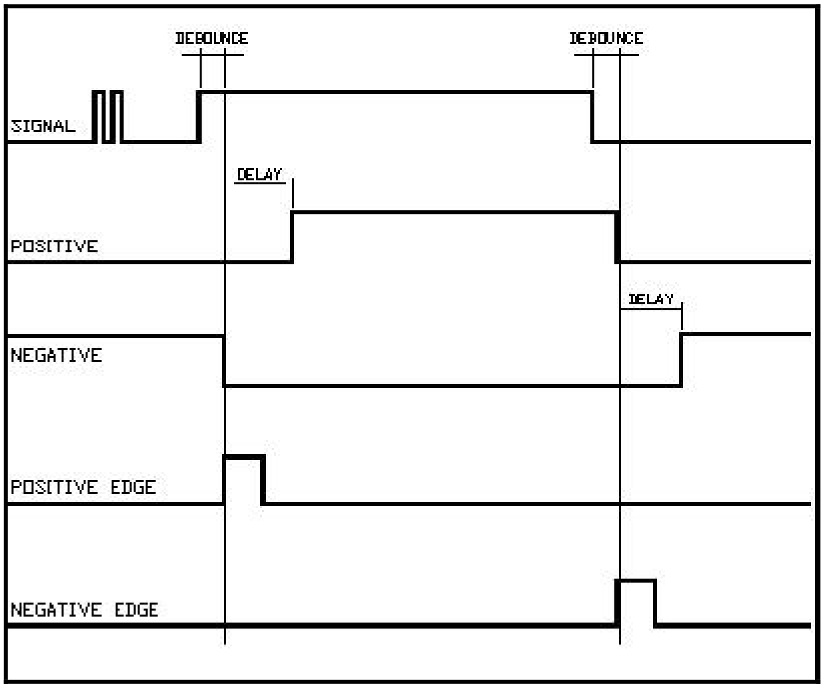


Figure 5-10: INPUT LOGIC TYPES

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 5-24: Contact inputs status

Input Status (X: board F, G, H, J, 2H, 2J)	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 5.5.5 Circuit supervision and contact seal-in circuits in this manual.

5.5.4 Outputs

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 is 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 is active for 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 5-11: Output logic typesshows the types of signals associated with the different output configuration types.

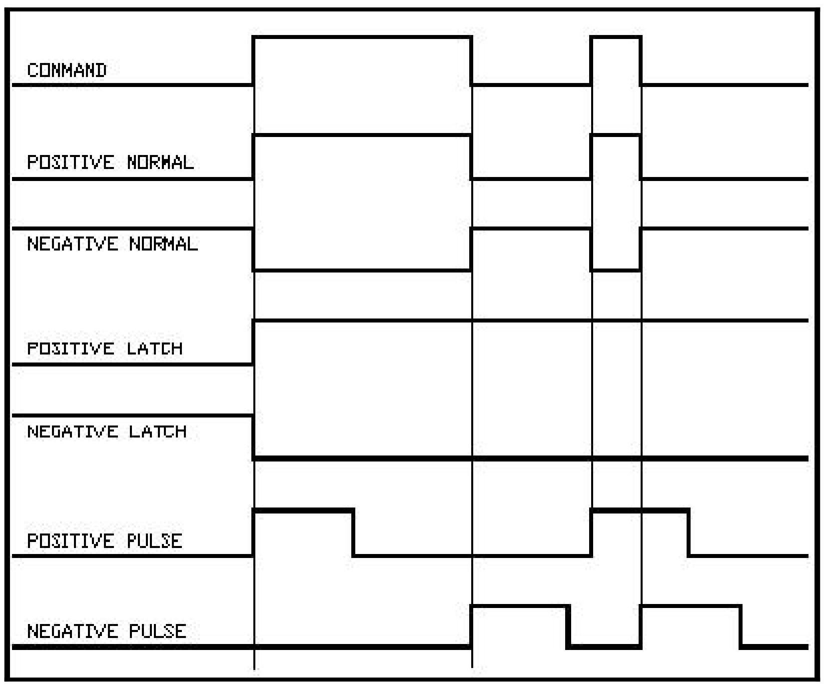


Figure 5-11: Output logic types

5.5.4.1 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 5-25: Contact output signals

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 with 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 with 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 5-25: 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

5.5.5 Circuit supervision and contact seal-in circuits

Circuit Supervision:

C650 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 logic.

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 opens 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 can 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:

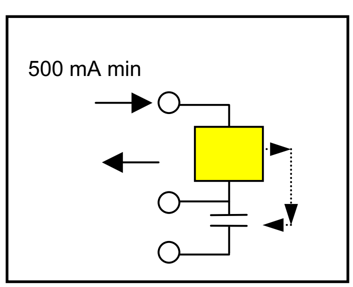


Figure 5-12: Current supervision

5.5.5.1 Digital inputs

5.5.5.2 With trip circuit supervision

The supervision board includes:

8 digital inputs in two groups of 4 inputs with one common, in terminals F/H9 to F/H10

8 auxiliary outputs: 6 normally open contacts in terminals F/H19 to F/H30 and two current sensing (latching) outputs (F/H31-F/H33 and F/H34-F/H36).

2 groups of inputs for trip circuit supervision with 4 voltage detectors. The first group includes two isolated digital inputs, terminals F/H1-F/H2 and F/H3-F/H4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F/H15-F/H16 and F/H17-F/H18.

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 5-26: 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 F/H1 - F/H2 (circuit 1)
CONT IP_X_CC10 (Vb_COIL1)	Active when voltage is detected in terminals F/H3 - F/H4 (circuit 1)
CONT IP_X_CC11 (Va_COIL2)	Active when voltage is detected in terminals F/H15 - F/H16 (circuit 2)
CONT IP_X_CC12 (Vb_COIL2)	Active when voltage is detected in terminals F/H17 - F/H18 (circuit 2)
CONT IP_X_CC13 (O7_SEAL)	Active if current is detected by sensor in output O7 (F/H31-F/H33)
CONT IP_X_CC14 (O8_SEAL)	Active if current is detected by sensor in output O8 (F/H34-F/H36)
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 with 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 are 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.

5.5.5.3 Without supervision

This is a very frequent common case, and we must only wire the tripping circuit to terminals F/H35 and F/H36, leaving unused terminals F/H34, F/H15, F/H16, F/H17, F/H18.

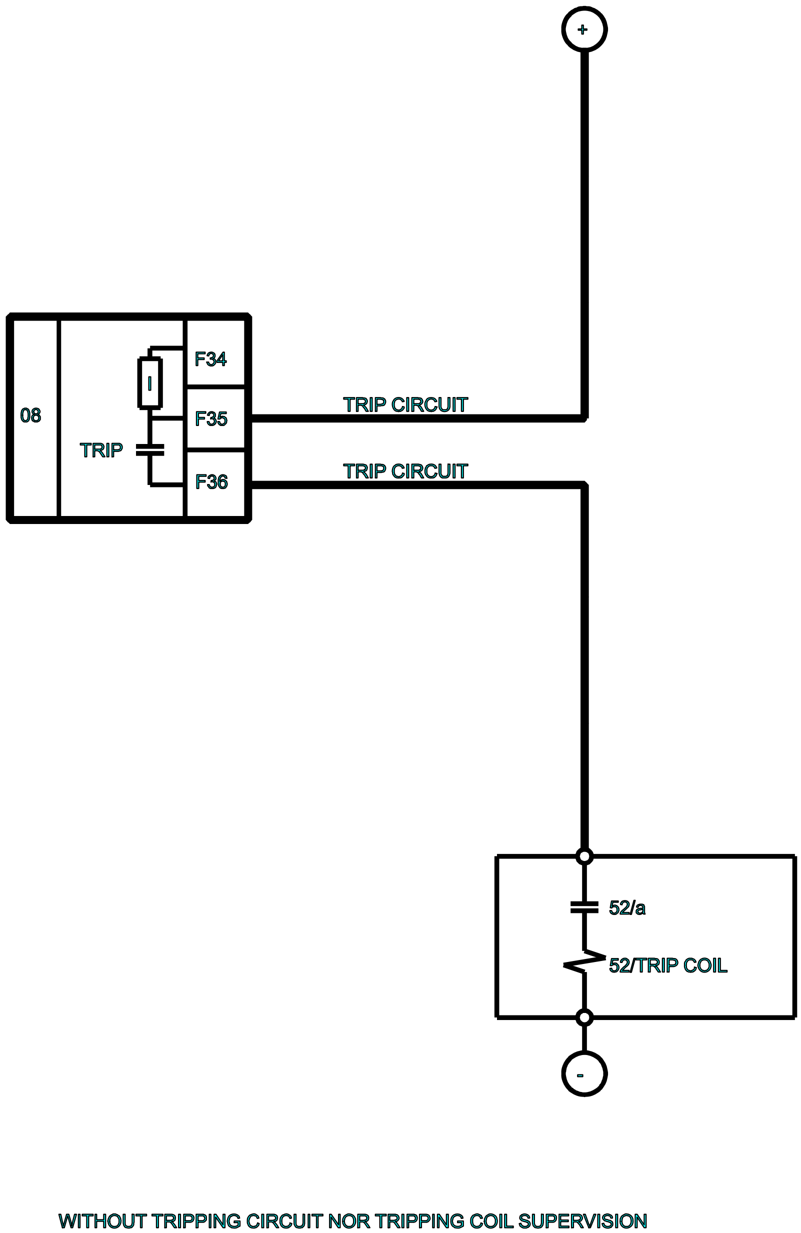


Figure 5-13: Circuit without tripping circuit supervision (A6631F1)

5.5.5.4 With current supervision (with SEAL-IN)

In this case, as shown in Figure 5-14: Current supervision of the tripping contact (A6631F2), the current supervision circuit consists of a circuit connected in series with the output contact, so that the external circuit is wired to terminals F/H34 and F/H36. 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 latches the output relay in such a way that this indication can be used to produce a latching of the output relay, so that it remains 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 F/H34 and F/H36.

With this scheme, in the case of a failure to open from the breaker auxiliary contact, the C650 output relay does not open the tripping coil current, as in this case the contact may be 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.

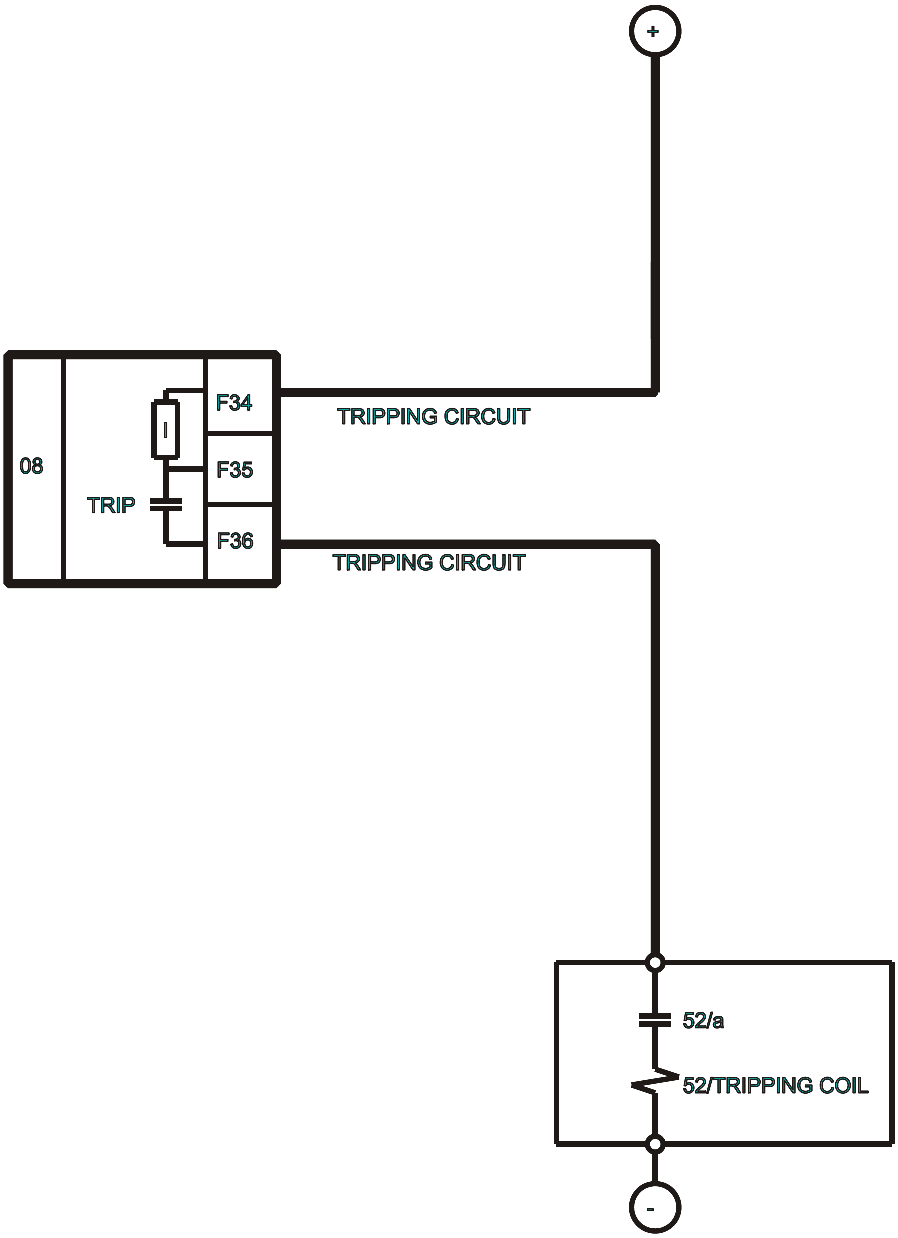


Figure 5-14: Current supervision of the tripping contact (A6631F2)

5.5.5.5 With simple voltage supervision

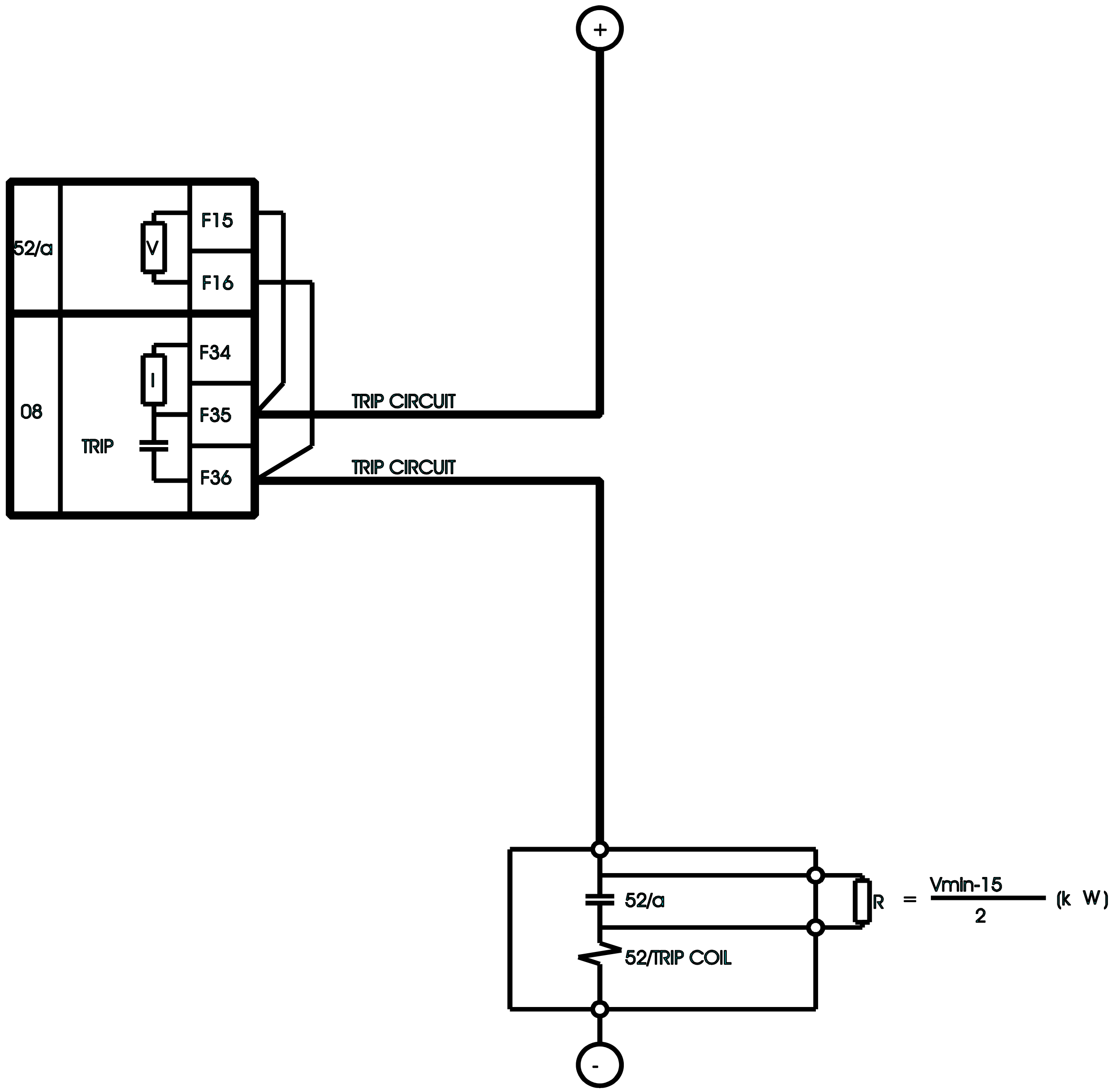


Figure 5-15: Supervision application with auxiliary contact 52a and a resistor (A6631F3)

Table 5-27: 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 5-28: Supervision algorithm with simple voltage supervision scheme

Status of Involved Elements			Input to C650	Decision
CIRCUIT STATUS	**OUTPUT STATUS (H35-H36)**	**BREAKER STATUS**	**OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (H15-H16)**	**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 5-15: Supervision application with auxiliary contact 52a and a resistor (A6631F3), when the relay is not tripped, trip contact H35-H36 remains open. If the breaker is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals H15 and H16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current only circulates 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 is 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 flows through R if there is continuity in the WHOLE tripping circuit, voltage is 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 H35-H36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is permitted that no signal is detected during a period of 1s to allow the breaker to open, and reopen the tripping relay H35-H36.

Figure 5-16: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed breaker only) (A6631F5) shows the possibility of monitoring the circuit only when the breaker is closed. In this case resistance R is not used, but it must be observed in the element logic that the corresponding signal CONT IP_H_CC16 (SUP_COIL2) is activated showing a failure when the breaker is open. Therefore it is required to supervise the continuity failure signaling by the breaker status information.

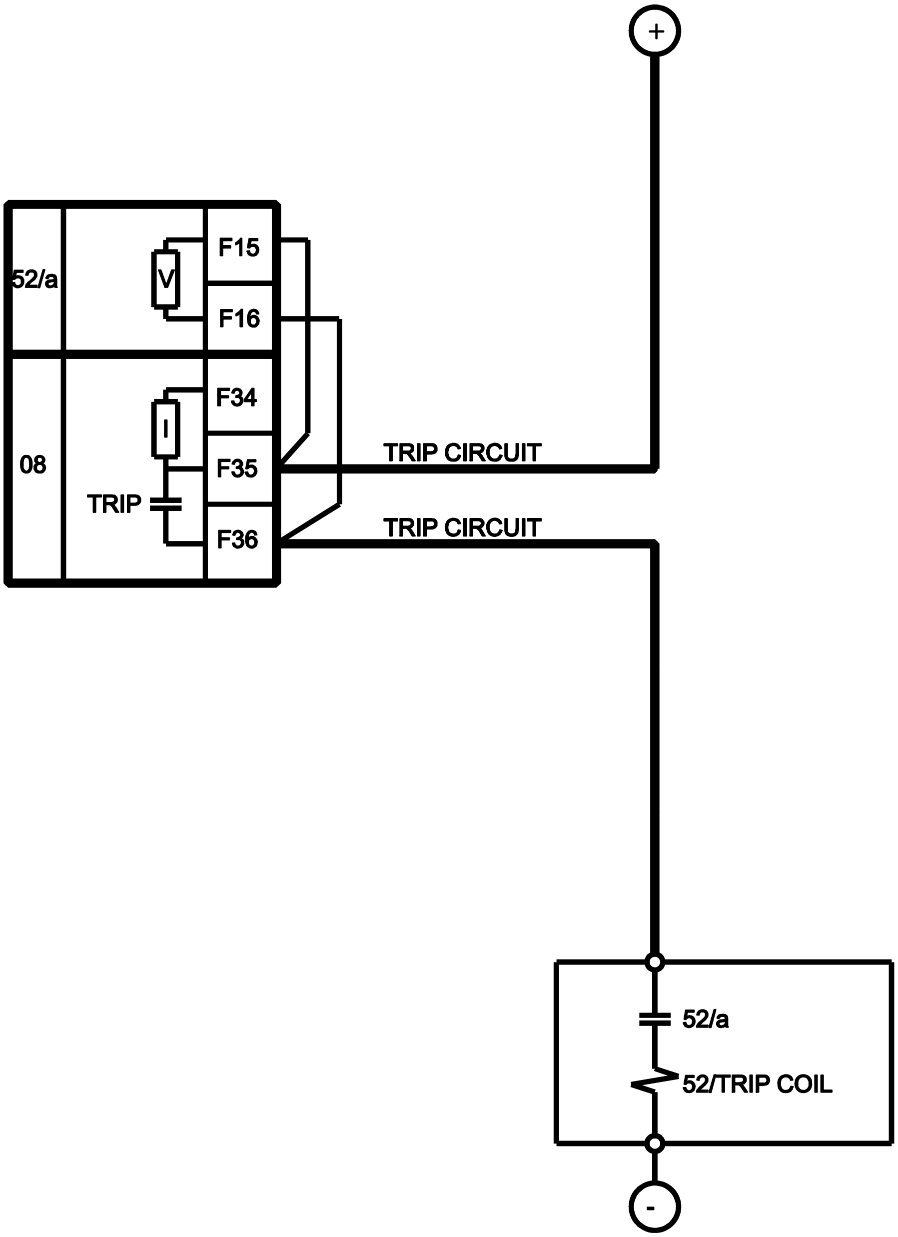


Figure 5-16: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed breaker only) (A6631F5)

5.5.5.6 With double voltage supervision

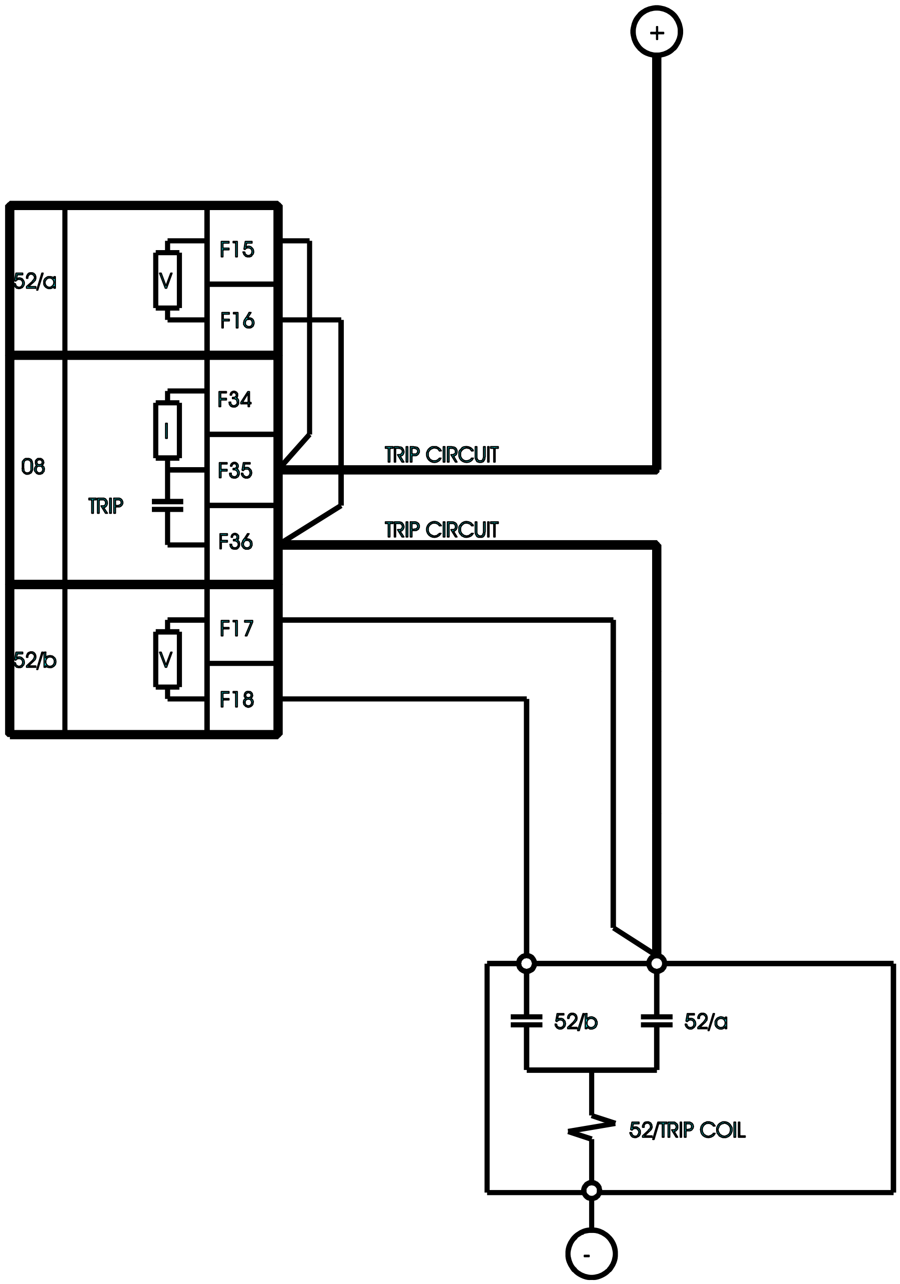


Figure 5-17: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

Table 5-29: Supervision algorithm with double voltage supervision scheme

Status of Involved Elements			Inputs to 650		Decision
CIRCUIT STATUS	**OUTPUT STATUS (F/H35-F/H36)**	**BREAKER STATUS**	**OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (F/H15-F/H16)**	**OPERAND CONT IP_X_CC12 (Vb_COIL2) V 52/b (F/H17-F/H18)**	**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 5-17: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs F/H15-F/H16 and F/H17-F/H18.

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 C650 trip relay, can be the one in the relay (terminals F/H35 and F/H36), 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.

5.5.5.7 With double voltage supervision and serial resistor in voltage monitors

Figure 5-18: Supervision application, auxiliary contacts 52a and 52b and series resistor in H15-H16shows 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 does not cause a trip because 52/b voltage monitor is current limited to 2mA. With a shorted 52/b voltage monitor, no false trip is performed because 52/a is in series limiting current to 2mA.

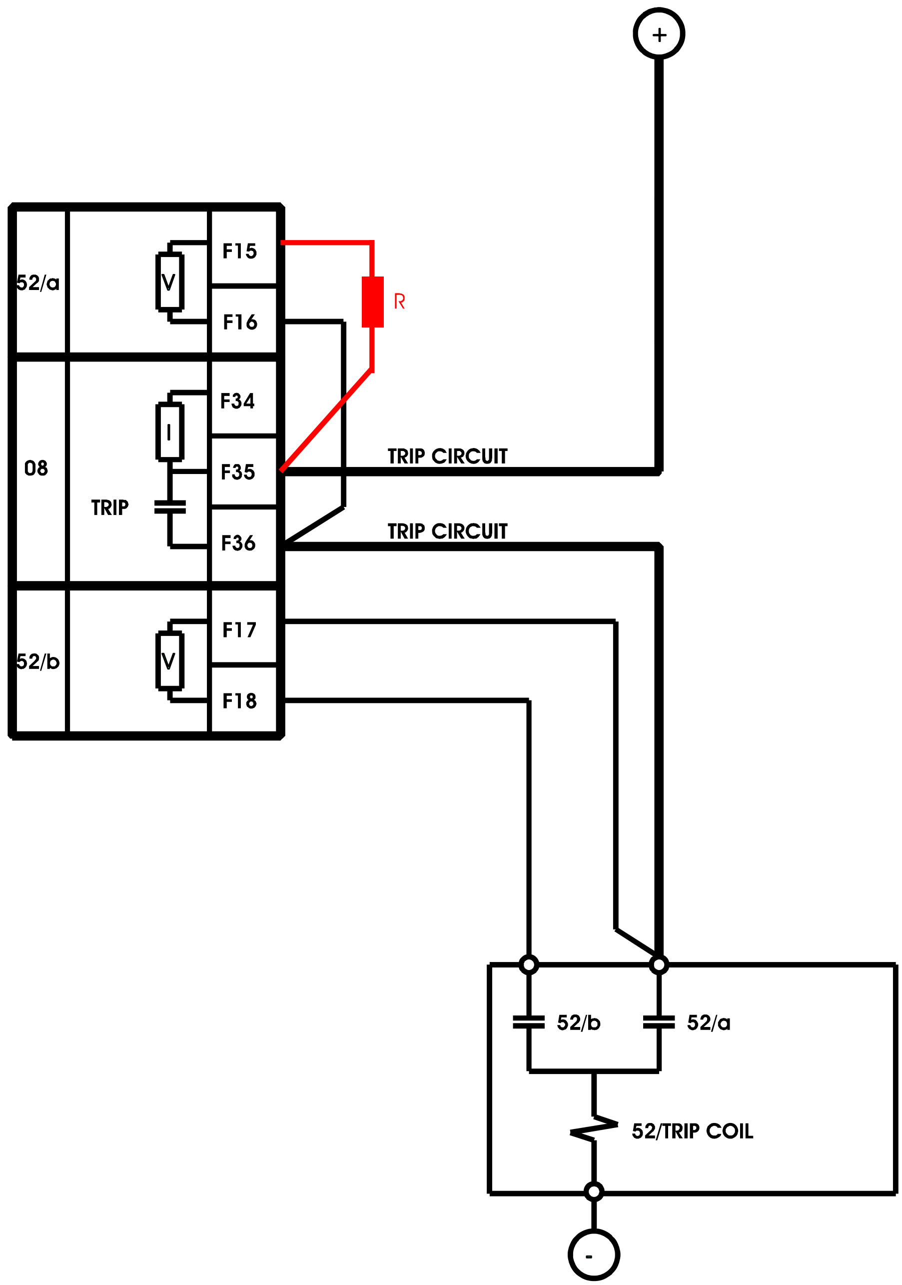


Figure 5-18: Supervision application, auxiliary contacts 52a and 52b and series resistor in H15-H16

5.5.6 Analog board 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 accepts 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

5.5.7 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.

5.5.7.1 Virtual inputs writing

Setpoint > Input/Outputs >Virtual Inputs for activating / deactivating signals

To write a virtual input, select the virtual input to activate by clicking on the virtual input checkbox, then click **Store** and the virtual input is written to the relay (see Figure 5-19: Virtual input writing through EnerVista 650 Setup).

For self-reset, the value remains active during one PLC cycle and after that the virtual input value is cleared.

For latched, the value remains active until it is cleared by the user, clicking again in the virtual input checkbox and clicking **Store** to clear the value.

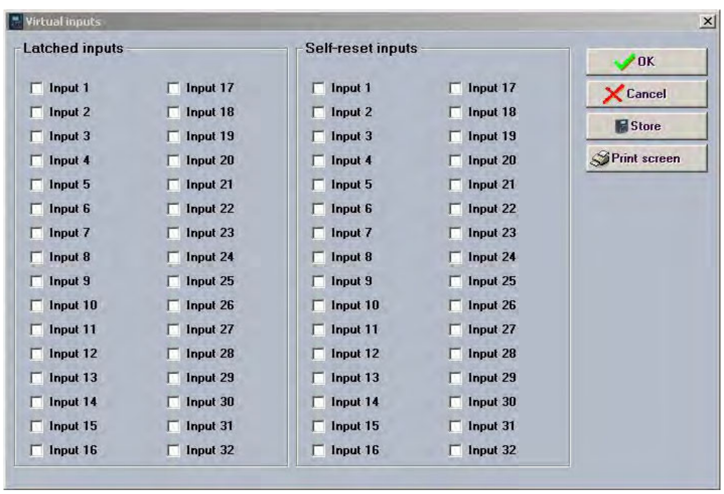


Figure 5-19: Virtual input writing through EnerVista 650 Setup

5.5.7.2 Virtual inputs status monitoring:

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

Table 5-30: Virtual input 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

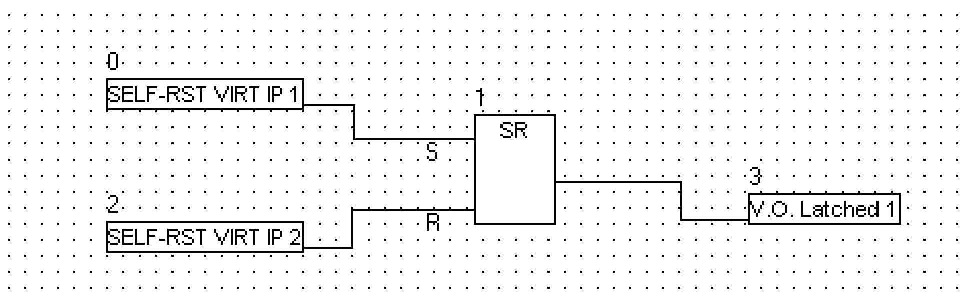
Text assignment for virtual input is made at ***Setpoint > Relay Configuration > Virtual Inputs***. It should be taken into account that the text assigned for virtual inputs in the relay configuration screen are only for file management, they are not sent to the relay.

5.5.8 Virtual outputs

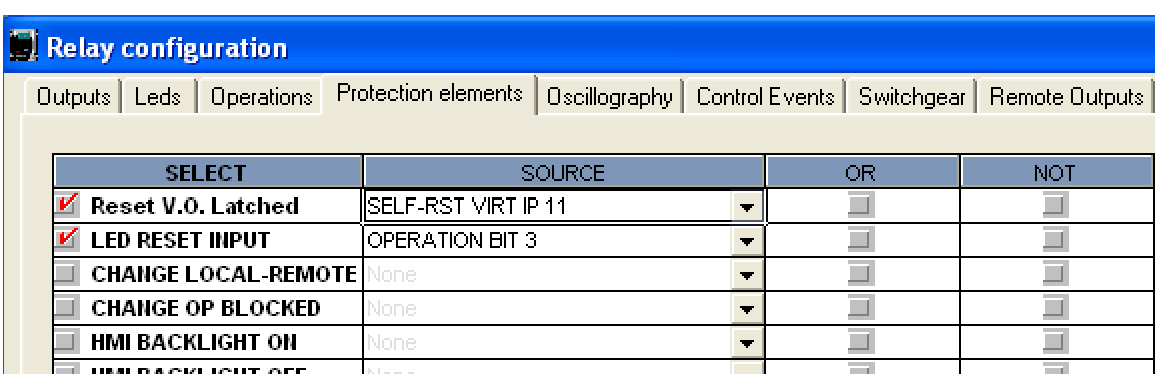
There are 512 virtual outputs that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the logic equations. For more detailed information see chapters 5.8 Relay configuration and 5.9 Logic configuration (PLC editor) in this manual.

5.5.9 Virtual outputs latched

There are 16 virtual outputs latched that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). Virtual outputs are resolved in each pass through the evaluation of the logic equations. These latched virtual outputs can only be assigned as an S/R output, they only are linked to a PLC's S/R output and their values remain after switching the unit off and then on.



These virtual output latched may be reset by a PLC setting as it is shown in the following figure



5.6 Remote comms

This settings allow configuring the remote comms settings for the IEC61850 protocol regarding GSSE. For more information see 7.3 IEC 61850 profile for C650.

SETPOINT > INPUTS/OUTPUTS > REMOTE COMMS				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]
SETTING DESCRIPTION FOR GSSE				
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]
Device Identification	650 ID	C650	N/A	
Hold time signal send by the transmitting device	Hold Time	10000	1 ms	[1000 : 60000]
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]
Remote Device Description	Remote Device X	Remote Device X	N/A	
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
SETTING DESCRIPTION FOR GOOSE				
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
Note: X is the Remote Device index, up to 32				

5.7 Testing

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 click **Force Output** to activate the selected output.

In order to refresh the real status of outputs, according to the information received by the relay processor, click **Refresh**.

The following figure shows the output-testing screen:

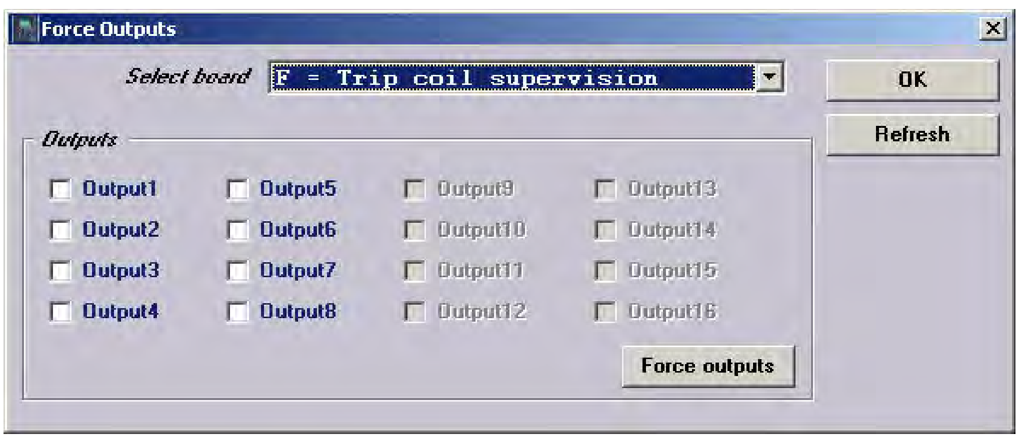


Figure 5-20: Force IO

5.8 Relay configuration

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 Logic configuration (PLC editor)).

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. Note: nor the Output name, nor the Input name, nor the Virtual Input name is recorded into the relay.
- ***Source*** setting for defining a function, logic, remote input, digital input, etc. that activates 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.

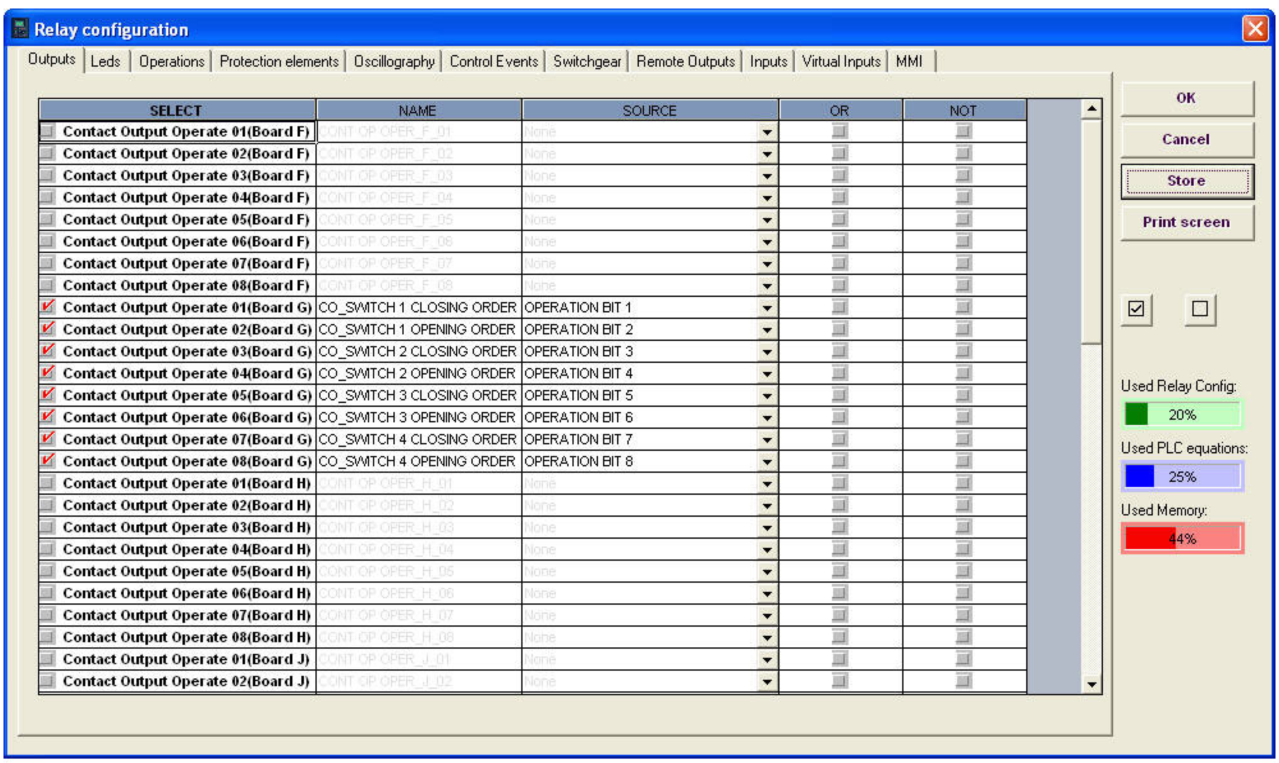


Figure 5-21: Output configuration

5.8.2 LEDs

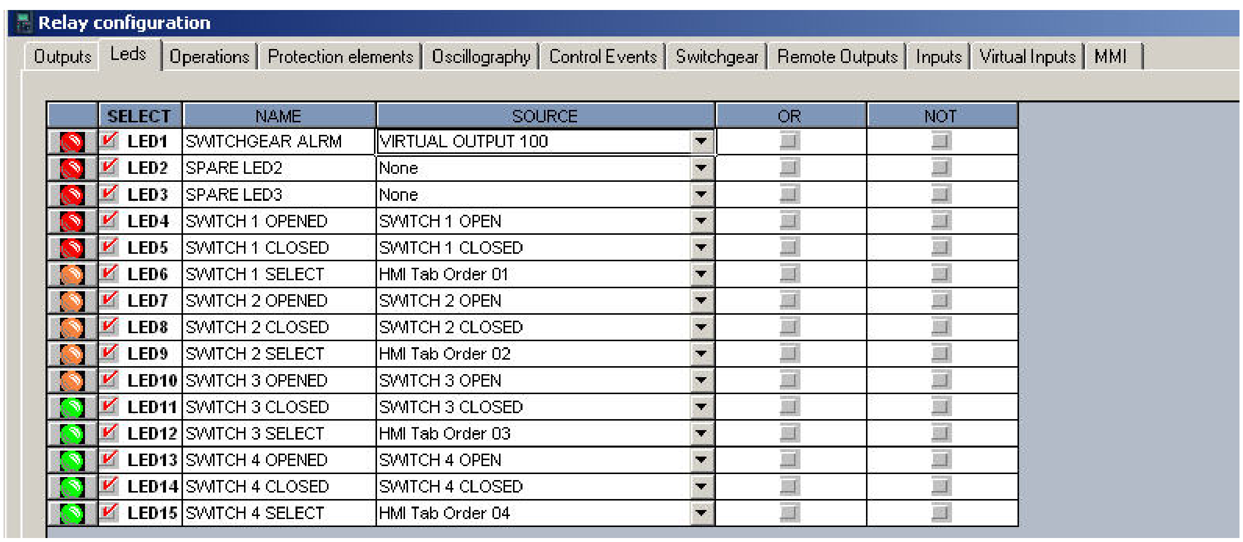
C650 has 15 LEDs fully configurable from any logical variable, contact or virtual input. For firmware version below 7.20, the first five are latched by hardware, the rest are self reset but can be latched through PLC Configuration. For firmware version 7.20 or higher, all these LEDs can be individually configured as latched or self-reset. This new setting is accessible from **Setpoint > Relay Configuration > LED**.

This window displays all relay LEDs with the following setting options for each one:

- **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. activates 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.

For firmware version 7.20 or higher, latched checkboxes are available for configuring the LEDs. If it is selected, LED shall work as latched, if it is deselected, LED shall work as self-reset.

From the LED configuration screen, it is possible to print the vertical LED label for the relay. For this purpose, click the printer icon. The label obtained is 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	SWITCHGEAR ALRM	VIRTUAL OUTPUT 100		
LED2	SPARE LED2	None		
LED3	SPARE LED3	None		
LED4	SWITCH 1 OPENED	SWITCH 1 OPEN		
LED5	SWITCH 1 CLOSED	SWITCH 1 CLOSED		
LED6	SWITCH 1 SELECT	HMI Tab Order 01		
LED7	SWITCH 2 OPENED	SWITCH 2 OPEN		
LED8	SWITCH 2 CLOSED	SWITCH 2 CLOSED		
LED9	SWITCH 2 SELECT	HMI Tab Order 02		
LED10	SWITCH 3 OPENED	SWITCH 3 OPEN		
LED11	SWITCH 3 CLOSED	SWITCH 3 CLOSED		
LED12	SWITCH 3 SELECT	HMI Tab Order 03		
LED13	SWITCH 4 OPENED	SWITCH 4 OPEN		
LED14	SWITCH 4 CLOSED	SWITCH 4 CLOSED		
LED15	SWITCH 4 SELECT	HMI Tab Order 04		

Figure 5-22: 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 enables a new window for creating the logic. If the **NONE** option is selected, then the following setting (***Interlocks***) is 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 5-23: Operations and interlocks

  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

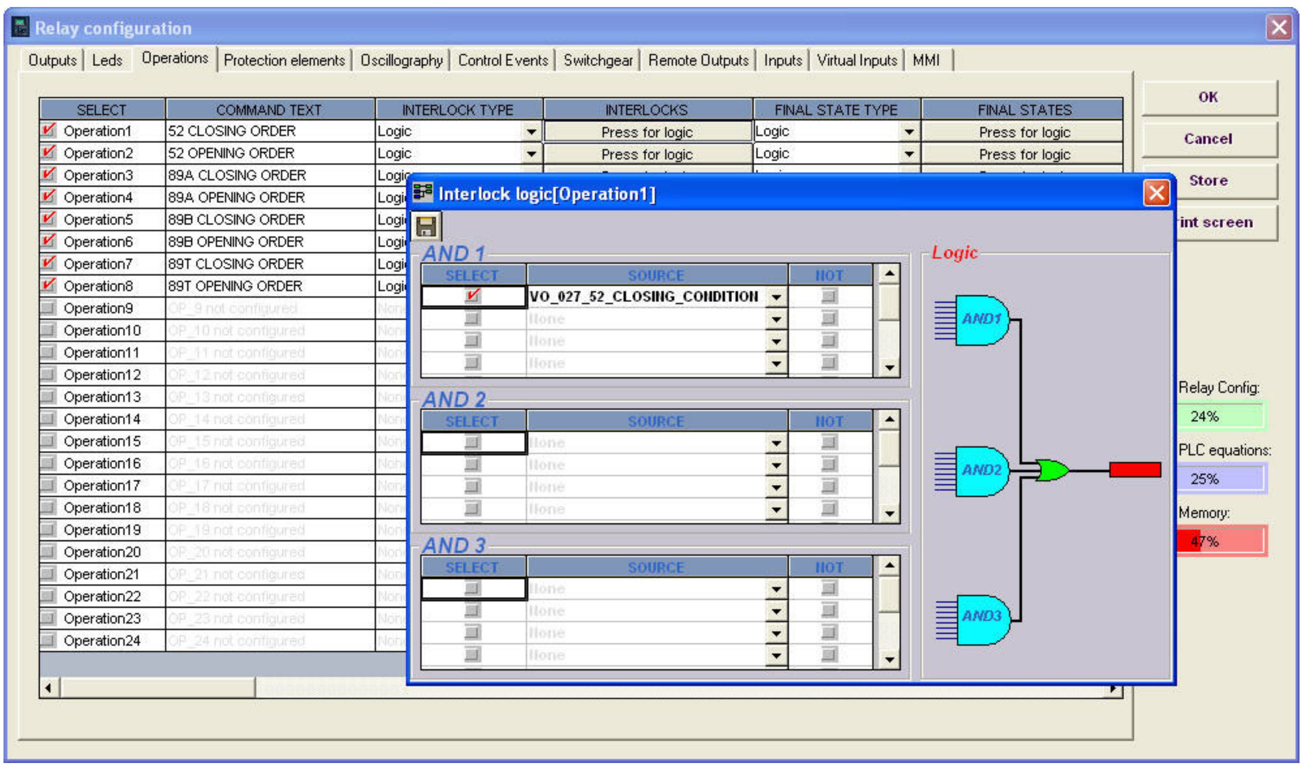


Figure 5-23: Operations and interlocks

- **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. 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.

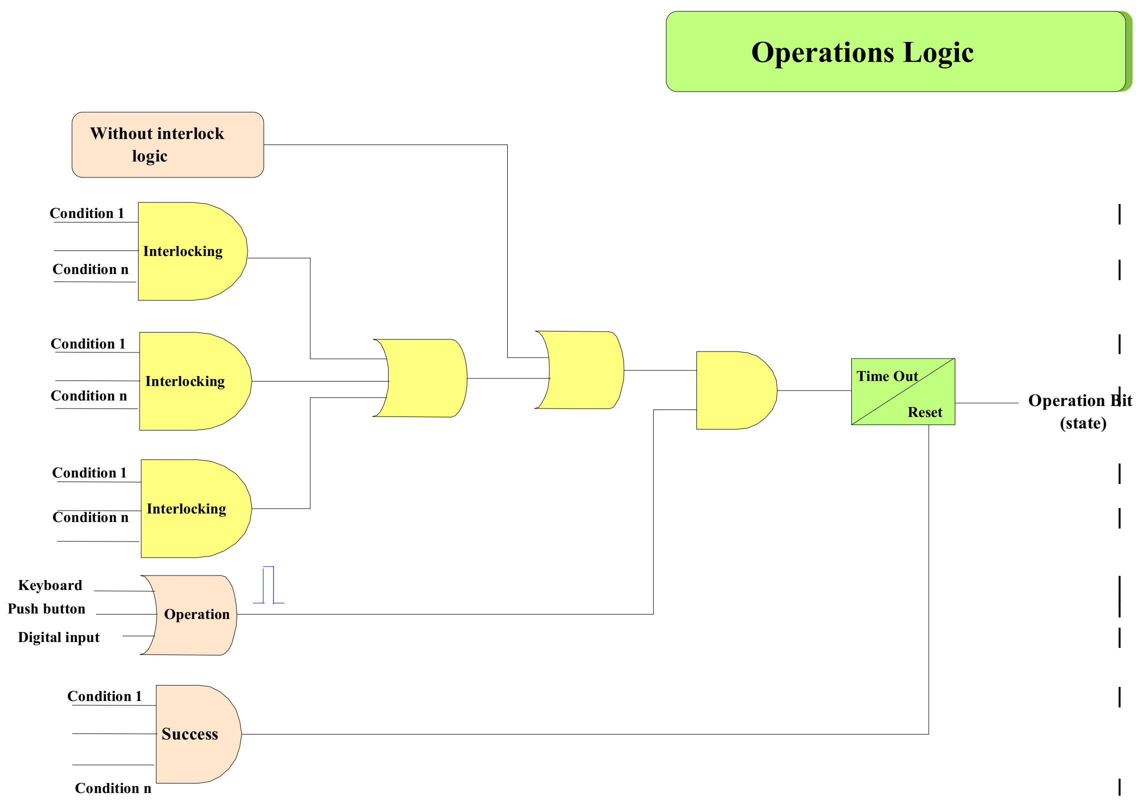


Figure 5-24: Operation logic diagram

5.8.3.1 Programming 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 synchronism condition, and 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 C650. In order to select an operation, click the operation name under the **Select** column, and all the related parameters are 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 is enabled. To display this screen, click **Press for Logic** for the desired operation on the **Interlocks** column. On this **Interlocks** screen, the two conditions that conform the Interlock that enables the operation have been selected. To save the interlock, click the disk icon on the toolbar. A **Logic Saved** displays.

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 lights up below **Final States**. When clicking PRESS FOR LOGIC, the success condition screen is 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 are set to **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:

Table 5-31: Operation settings

OPERATION	COMMAND TEXT	SETTINGS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK (LOGIC)	SYNCHK CLOSE PERM
		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 under **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.

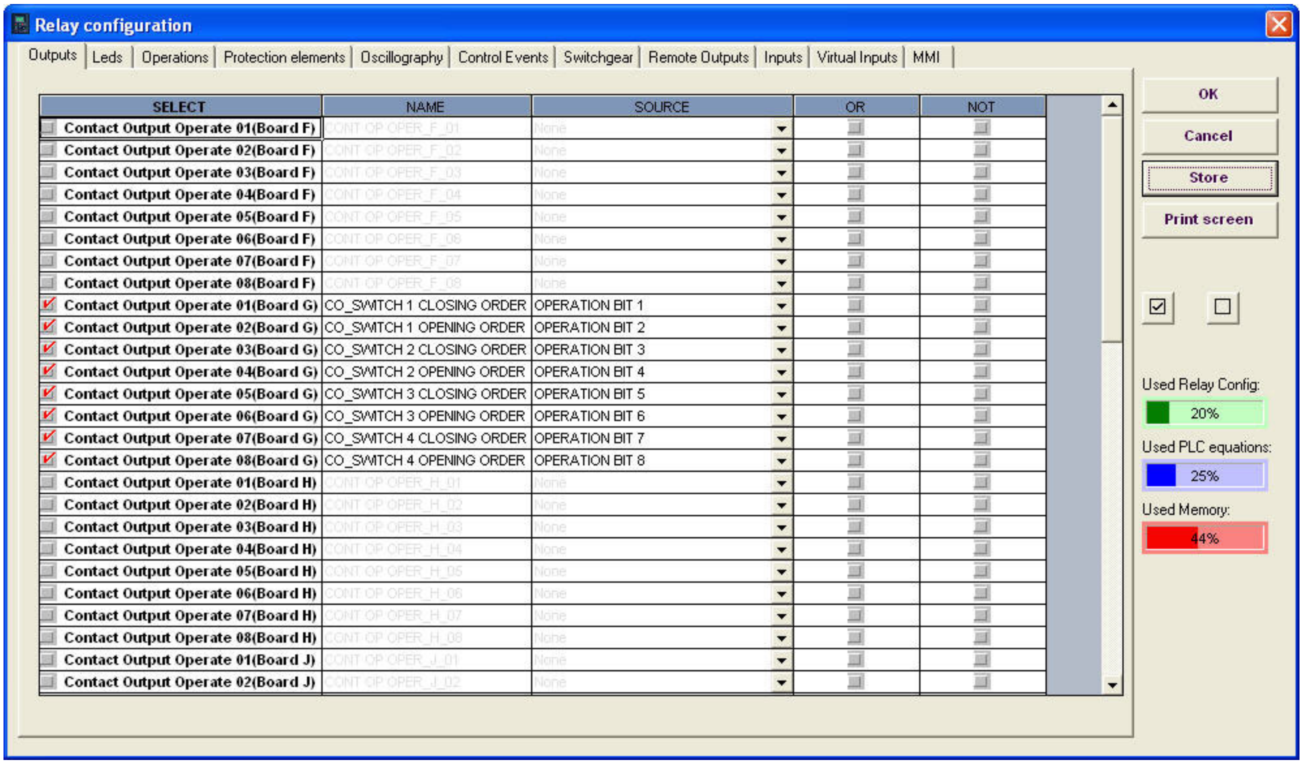


Figure 5-25: Contact output configuration

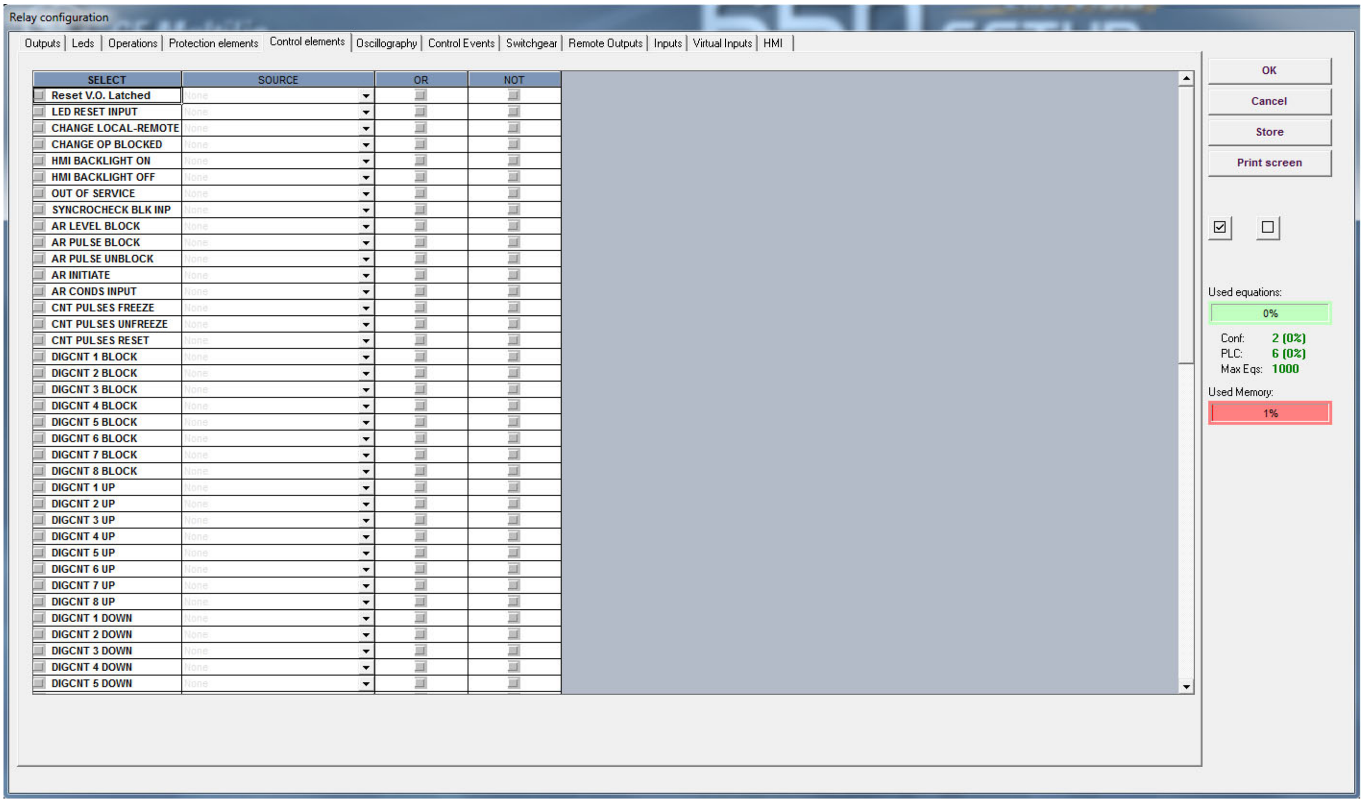
Note: Operations time out for confirmation

Configurable screen in graphical HMI: In the relay HMI the configurable objects wait one minute for confirmation after operation selection. The object is blinking for one minute. After that time, the object is deselected.

Front Keys: In operations performed by front keys, the time out for confirmation is 10 seconds.

5.8.4 Control elements tab

This tab allows assigning operands (logic signals) as inputs to different control elements. This way, the user assigns which operands configure digital counters, etc. In this screen we can also configure a logic signal to perform the LED reset by communications.



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.

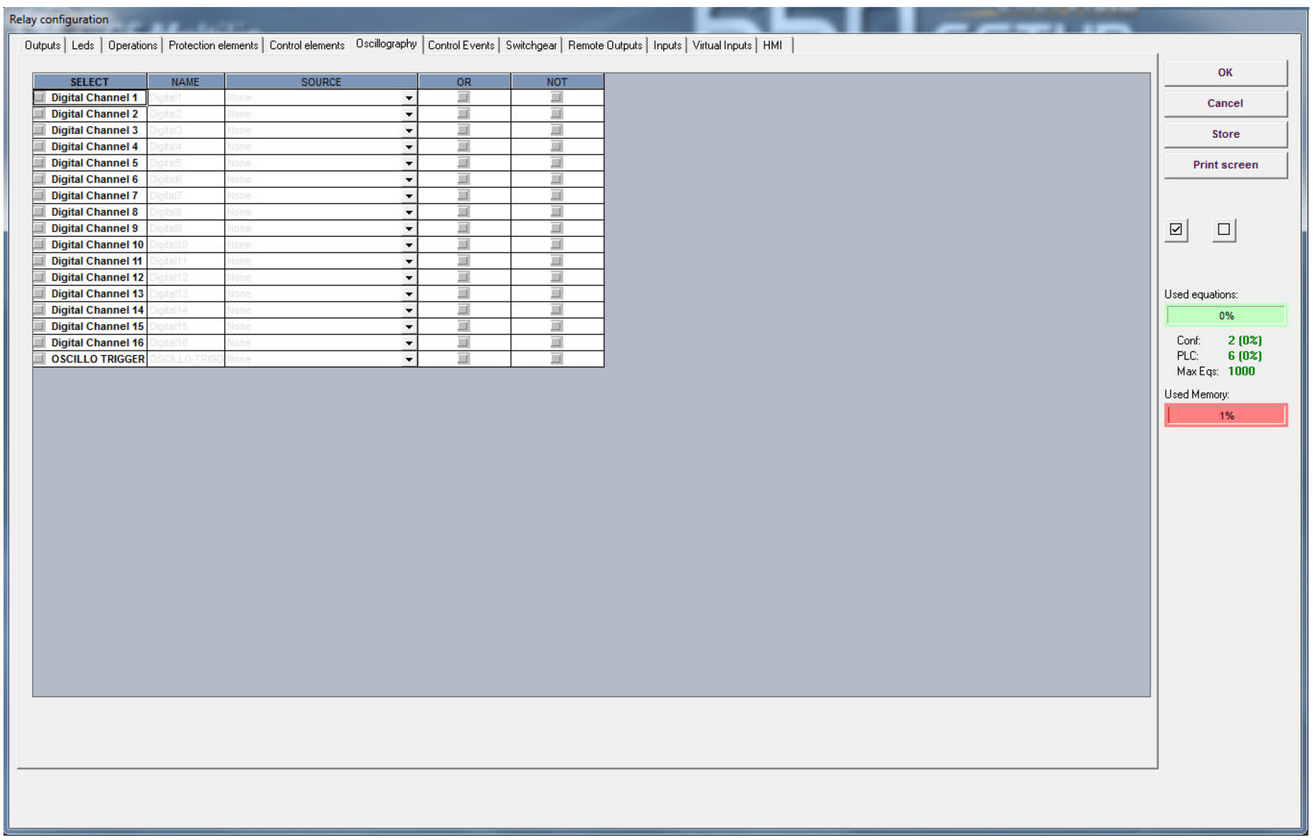


Figure 5-26: Oscillography configuration

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 with 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. (Refer to section 5.8.8 HMI (human-machine interface) 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 triggers 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.

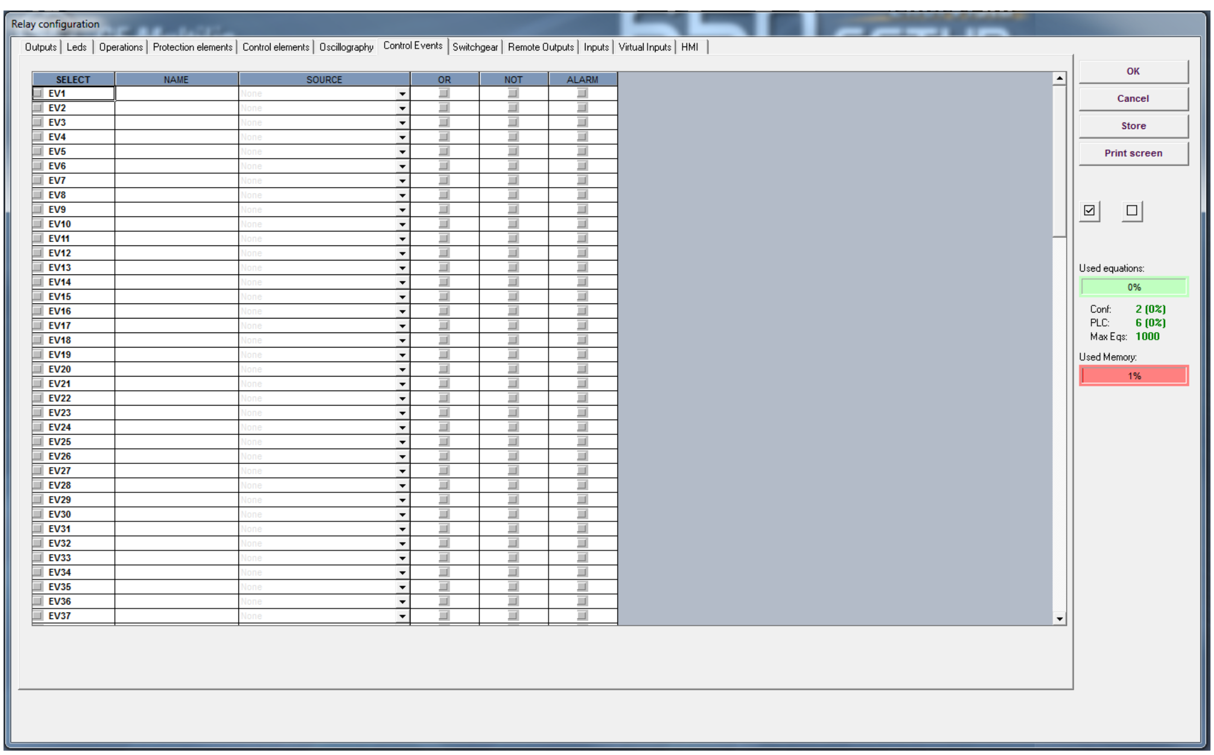


Figure 5-27: Control events configuration

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 C650:

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 5-32: 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 shows the alarm text in red.

ACKNOWLEDGED: Operation acknowledgment can be performed from three independent channels: MMI-COM2 (local), COM1 (remote) and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (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 is 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 is 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 with the element opening.
- ***Close text*** setting: allows associating a text to the control event associated with 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 with 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 with 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 closing init must be configured in the operations tab inside relay configuration.
- **Block Open** : allow selecting which operand or combination of operands activates the opening blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.
- **Block Close settings**: allow selecting which operand or combination of operands activates the closing blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.

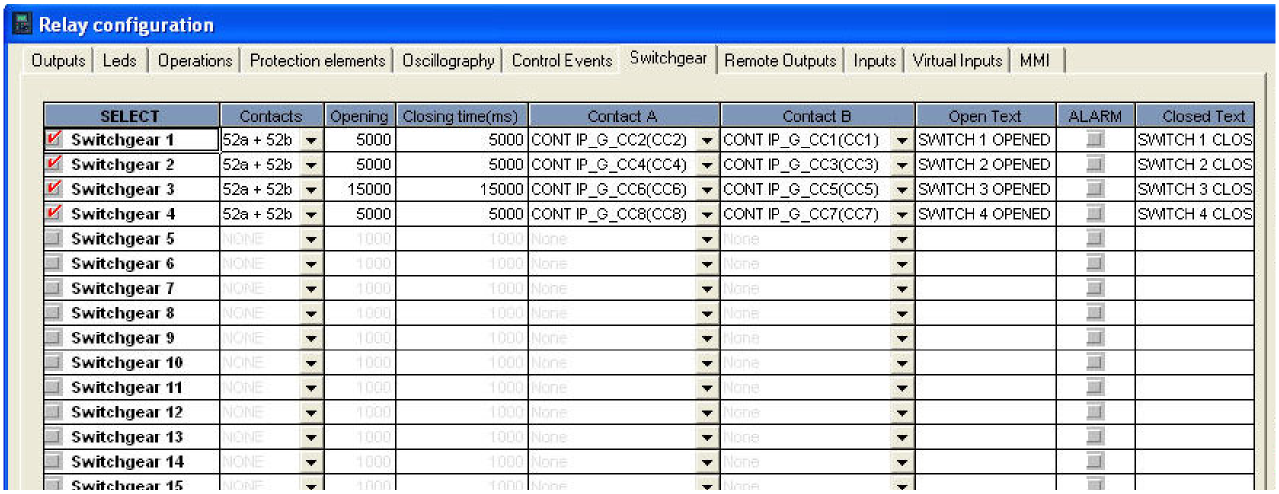


Figure 5-28: Switchgear configuration

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.

5.8.8 HMI (human-machine interface)

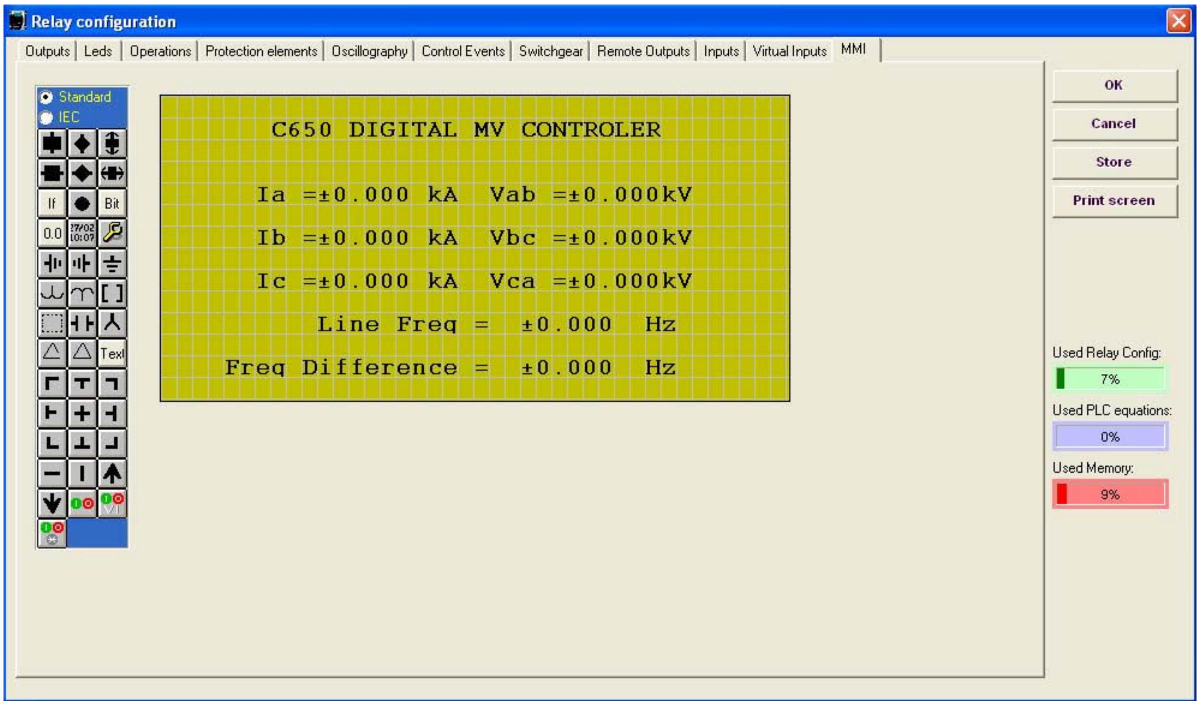
This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings.

To use the drawing toolbar elements, select the desired element and then click the yellow area. The selected element is moved to the screen on the selected spot (see Figure 5-29: HMI configuration).

The graphic display can be used to configured switchgear elements, operations, metering values, date and time, etc. The configured values is always updated with the real status of the relay.

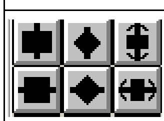
This functionality is only applicable to C650 elements with graphical display, and not for elements with alphanumerical display . Depending on the relay model, the graphical display can show IEC 1082-1 symbols (N option in order code).

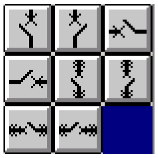
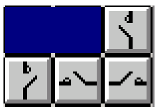
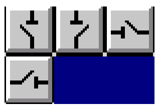
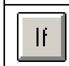
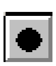
Figure 5-29: HMI configuration



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 5-33: Active configurable symbols in on-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 order code
	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 D selection for graphic display option in the order code

	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 is displayed
	Contactors in vertical and horizontal positions
	Selector switches in vertical and horizontal positions.
OTHER CONFIGURABLE SYMBOLS	Available for both M, N, C and D selection
MULTISTATE VARIABLE SYMBOL	
	Displays a dialog box on screen that is one variable status function (like a switch case) for the following internal states AR STATUS, AR LOCKOUT MODE, AR BLOCK MODE and FAULT TYPE. This type of data allows to visualize the different states of one particular value, for example, AR STATUS has several states such as (0) OUT OF SERVICE, (1) READY, (2) LOCKOUT, (3) BLOCK, (4) RECLOSE IN PROGRESS. Significant texts can be associated with those states.
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.

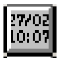
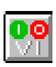
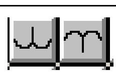
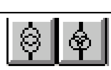
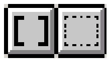
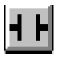
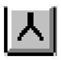
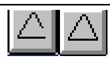
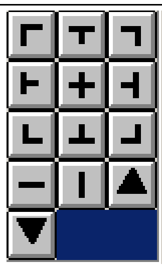
ACTIVE SYMBOLS	
ICONS IN SCREEN	**DESCRIPTION**
DATE AND TIME SYMBOL	
	Display the date and time provided by the device in the HMI.
OPERATIONS SYMBOL	
	Configure and execute operations on the graphic display. This symbol can only be selected once the operations have been configured in the **Operations** screen of the **Relay Configuration** menu. To select an Operation, click the element and then the display. A window opens to select the operation and the tab order. Once selected, a red border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this operation, the object on which it is located blinks. It is possible to place several operations on the same object, for example to open and close the breaker object.
	Configure and execute operations with the front keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I" and "O" and the tab order. Once selected, a blue border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I" or "O" to execute the configured operations.
	Configure and execute operations with the front keys "I", "O" and "*" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I", "O" and "*" and the tab order. Once selected, a green border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I", "O" or "*" to execute the configured operations. After executing this kind of operation, information about the result of the operation is displayed on the HMI..
	Configure and execute virtual inputs with the frontal keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required virtual operations "I" and "O" and the tab order. Once selected, a white border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this virtual inputs, the object on which it is located blinks. Press key "I" or "O" to set the configured virtual inputs.

Table 5-34: GRAPHIC AND TEXT EDITION SYMBOLS

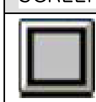
GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	**DESCRIPTION**	**AVAILABILITY**
	Ground symbols in different positions.	The first two are not available in the N model (IEC selection).
	Voltage Transformers representation	Only for standard model M.
	Two and three winding voltage transformers representation.	Only for N model (IEC selection)

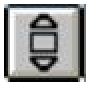
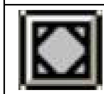
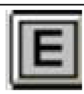
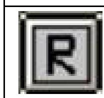
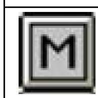
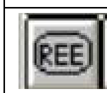
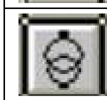
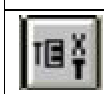
	Current transformer representation	Only for N model (IEC selection).
	Symbols reserved for future uses	Both M and N selection
	Symbol for capacitor banks.	Both M and N selection
	Symbol for vertical capacitor banks.	Only for N model (IEC selection).
	Symbol for wye connection	Both M and N selection
	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

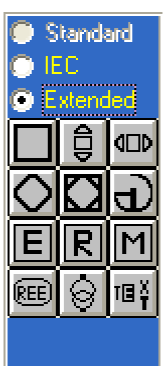
EXTENDED GRAPHIC SYMBOLS

For the extended graphic symbols, extraction device must be set to 52a+52b switchgear device.

Table 5-35: GRAPHIC AND TEXT EDITION SYMBOLS

EXTENDED GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	DESCRIPTION	AVAILABILITY
	Breaker	Only for N model (IEC selection)

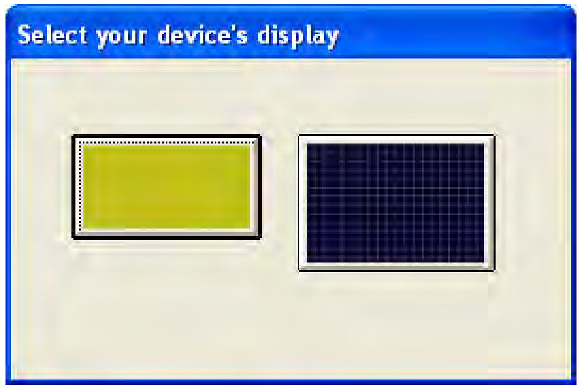
	Breaker+Extraction device (Vertical)	Only for N model (IEC selection)
	Breaker+Extraction device (Horizontal)	Only for N model (IEC selection)
	Isolator	Only for N model (IEC selection)
	Isolator Remote controlled	Only for N model (IEC selection)
	Neutral Reactance	Only for N model (IEC selection)
	"Encravado" Interlocked	Only for N model (IEC selection)
	Autorecloser In Service/ Out of Service	Only for N model (IEC selection)
	"M"/"A" Symbol for Manual/Automatic	Only for N model (IEC selection)
	"Regime Especial Exploração"	Only for N model (IEC selection)
	Voltage transformer	Only for N model (IEC selection)
	Different Text properties (Bold/Vertical/Reverse Video)	Only for N model (IEC selection)



5.8.9 Device display selection

5.8.9.1 Type of graphical display

On offline mode, when creating a new setting file (*.650), when entering on SETPOINT > RELAY CONFIGURATION > HMI, it is possible to choose the display type that is wanted to configure from two types of graphical displays depending on the order code. Green one for standard models and the black one for "N" model IEC selection.



5.9 Logic configuration (PLC editor)

Setpoint > Logic Configuration

The logic configuration (or PLC Editor) tool is a graphical design tool that allows the C650 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.

NOTICE The first equation entered in the PLC can never be a timer

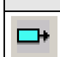
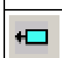
5.9.1 Theory of operation

5.9.1.1 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 the PLC Editor are located in the tool bar of the application and are as follows:

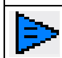
Table 5-36: PLC editor basic operation in C650

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.

For firmware 7.20 or above, analog operands are available. It is possible to use these operands with analog or digital values.

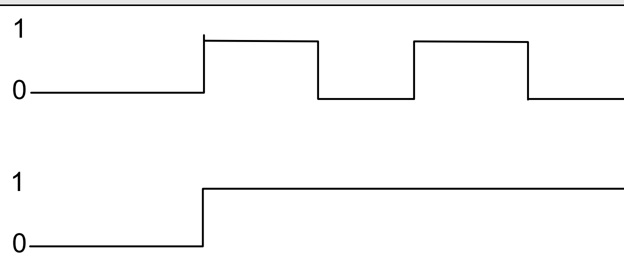
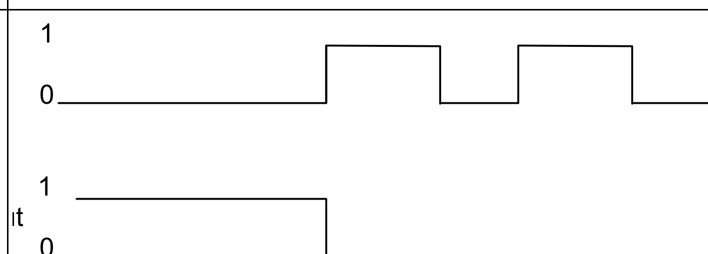
The basic operations available in PLC Editor are located in the tool bar of the application and are as follows:

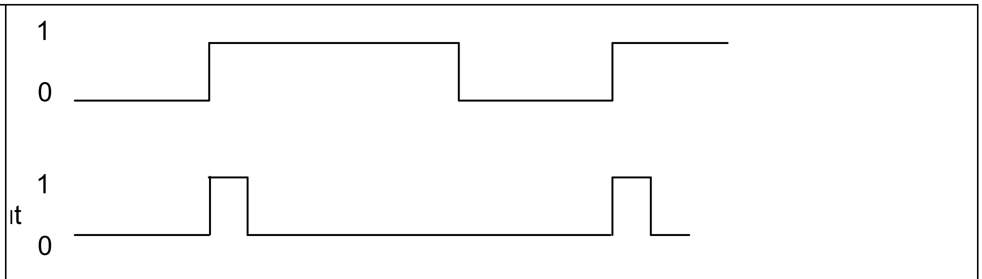
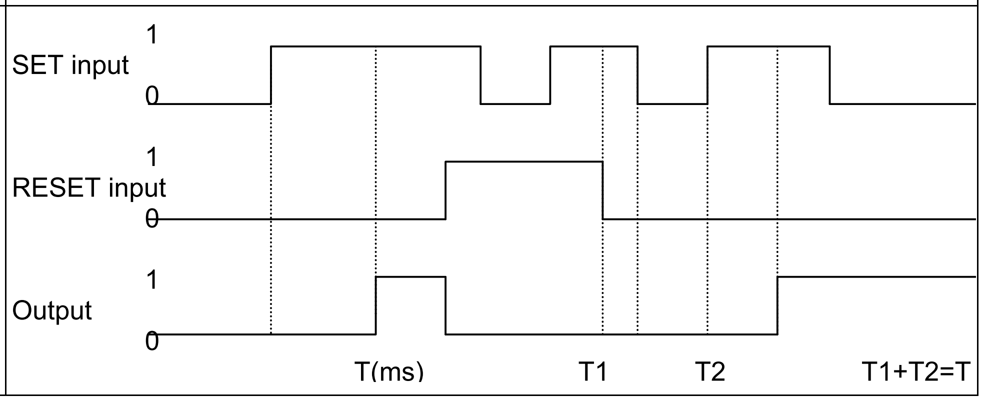
PLC EDITOR ANALOG OPERATION	
ICONS IN SCREEN	**DESCRIPTION**
	GREATER THAN COMPARATOR of two digital or analog inputs.
	EQUAL TO COMPARATOR of two digital or analog inputs
	MULTIPLIER of two digital or analog inputs
	DIVIDER of two digital or analog inputs
	ADDER of two digital or analog inputs
	SUBTRACTOR of two digital or analog inputs

**NOTE1: For firmware version 7.20 or above, two new inputs have been added; PLC_BOOL_ON and PLC_BOOL_OFF. These two inputs are set always to PLC_BOOL_ON =1 and PLC_BOOL_OFF =0 and their values are not accessible via protocol and cannot be modified.

Example of logic signals in C650 logic configuration:

Table 5-37: Logic signals in C650

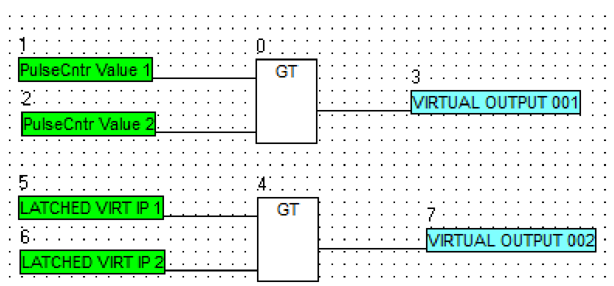
LOGIC SIGNALS EXAMPLES		
SIGNAL	**DESCRIPTION**	**TIME DIAGRAM**
SET	When the input signal is set to 1 the output signal remain fixed to 1 until a reset signal is received.	
RESET	When the input signal is reset to 1 the output signal remain fixed to 0.	

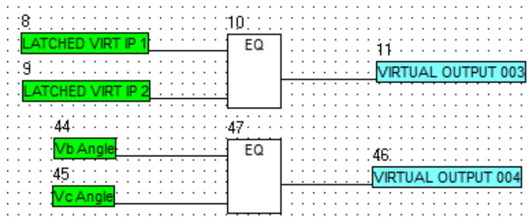
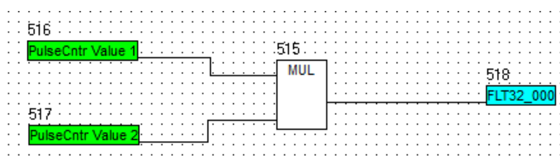
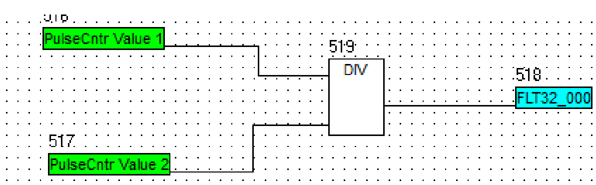
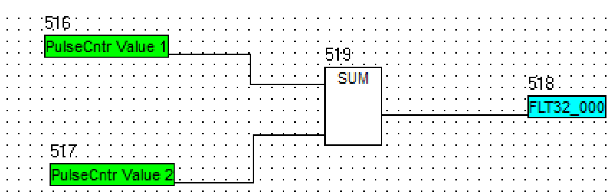
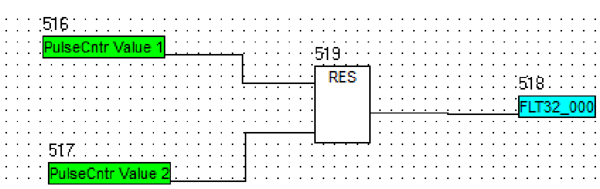
ONS	The input signal is pulsed. The width of the output pulse is the same as that of the PLC cycle	
TIMER	With selectable time (MASK), one SET input and one RESET input	

Example of analog operands in C650 logic configuration:

Table 5-38: Analog operands in C650

When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

ANALOG OPERANDS		
Operands	**Example**	**Description**
GREATER THAN		Analog Variables: 1. If Pulse Cntr value 1 > Pulse Cntr value 2 then Virtual output is set to 1 2. If Pulse Cntr value 1 = Pulse Cntr value 2 then Virtual output is set to 0 3. If Pulse Cntr value 1 < Pulse Cntr value 2 then Virtual output is set to 0 Digital Variables: 1. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 0 2. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 0 3. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 1 4 If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0

EQUAL TO		Analog Variables: 4. If Vb Angle > Vc Angle then Virtual output is set to 0 5. If Vb Angle = Vc Angle then Virtual output is set to 1 6. If Vb Angle < Vc Angle then Virtual output is set to 0 Digital Variables: 5. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 1 6. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 1 7. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 0 8. If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0
MULTIPLIER		Result of multiplication of both inputs is stored into variable assigned to Multiplier output
DIVISION		Result of division of both inputs is stored into variable assigned to Division output. If Input 2=0 Then result of division is stored as 0.
ADDITTION		Result of multiplication of both inputs is stored into variable assigned to addition output
SUBTRACTION		When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

5.9.1.2 Logic compilation

The C650 configuration is 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 C650 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 forms the logical configuration of the element.

The next diagram shows the way compiled logic equations are built.

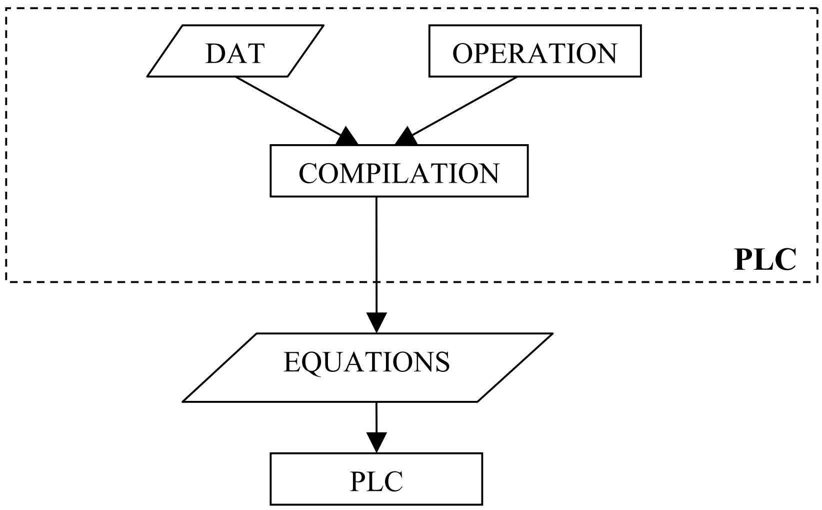


Figure 5-30: Compiled logic equations

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:

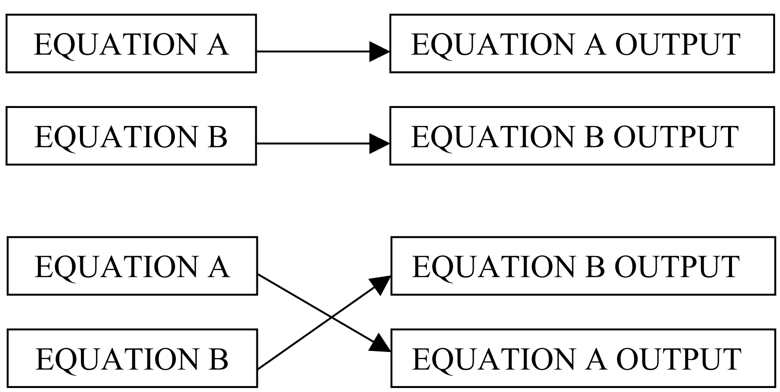


Figure 5-31: Order of equations

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.

5.9.2 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 C650 devices.

File menu

The FILE menu includes the following options:

New Project:	Create a new project that includes the logic configuration files.
Open Project:	Open an existing project.
Close Project:	Close the currently open project.
Get Project from Relay:	Retrieve a previously saved project from the relay.
Save Project and Save Project as:	Save the open project.
Save Automatic Function & Save Automatic Function As:	Save the file of the active project.
Library:	Give access to the library sub-menus, where new libraries can be created and existing libraries can be modified and saved.
Print:	Print the active configuration file.
Preview:	Preview of the document before printing.
Exit:	Close all open projects and exit the application.

Project menu

The Project menu includes the following options:

Project Explorer:	Display a tree structure showing all files contained in the project.
Insert library:	Insert a library in the active automatic function.

Edit menu

The Edit menu includes the following options:

Undo:	Undo the last modification in the active function.
Redo:	Repeat the last modification.
Cut:	Cut one or more logic operations.
Copy:	Copy one or more logic operations.
Paste:	Paste one or more logic operations.
Find:	Search for a logic operation in the project.
Copy as Bitmap:	Copy the active automatic function to the clipboard in picture format.
View Clipboard:	Launch the clipboard viewer application.

Run menu

The RUN menu includes the following options:

Configuration:	Not valid in the current application (for analog operations still not available).
Compile:	Compile the configuration functions to generate the equations that are interpreted by the 650 PLC.

Send Equations to Relay

View menu

The VIEW menu includes the following options:

Log:	Display the status name and time stamp of the digital statuses configured in the PLC logic (still not available).
Equations:	Display the equations resulting from the compilation.
Grid:	Show or hide the form grid where the configuration functions are developed. It also aligns the different objects to the grid.
Zoom:	Allow selection of the percentage of zoom in the application.
Rectangle Zoom (Zoom rectangular):	Allow zooming the selected rectangle.

5.9.3 Configuration generation

5.9.3.1 Create new project

Click **File > New Project** to open a new PLC project for programming the desired automation. An automation can be formed by one or more equations.

5.9.3.2 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.

5.9.3.3 Add input to automation

Click 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.

5.9.3.4 Add output to automation

Click the button that represents the outputs in the toolbar at the top of the screen. The logic outputs are virtual outputs (up to 512 configurable signals), virtual metering (up to float 32 signals, up to 50 int 32 signals) or virtual output latched (up to 16 signals).

5.9.3.5 Add digital operation

Click any of the digital operations in the toolbar at the top of the screen, and then click the window background. A box with the selected digital operation is displayed and the inputs and outputs must be connected to the logic box as explained before.

5.9.3.6 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.

5.9.3.7 Add library

Click **LIB** 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.

5.9.4 Library generation

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 are used to represent the library as an object in the main project.

Internal variables inside the libraries are assigned randomly when compiling.

These libraries are saved in the LIB folder in order to be used in further projects

5.9.4.1 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 5-32: Timer (PKP-DPT).LIB configuratin example

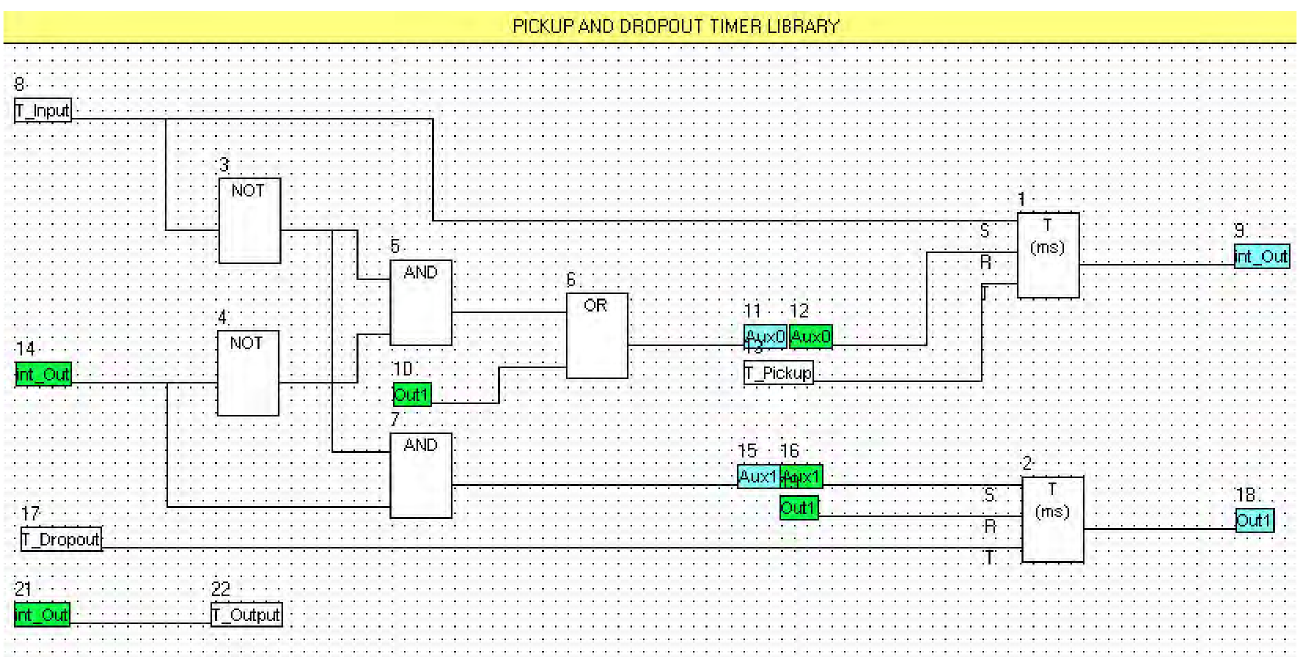


Figure 5-32: Timer (PKP-DPT).LIB configuratin example

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 has the following object:

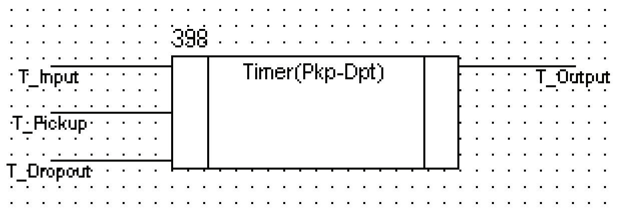


Figure 5-33: Library object

5.9.5 Application example

In this section a simple logic application is described step by step, a logic is such that keeping one digital input activated, several outputs are activated and deactivated in a time window (outputs remain activated for 200 ms and deactivated for 5 ms). See the following figure:

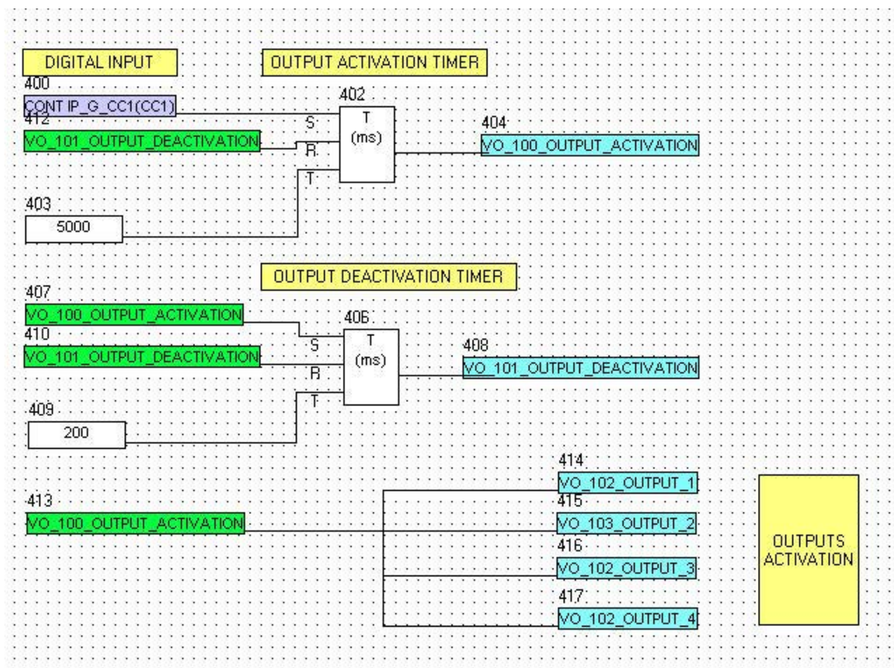


Figure 5-34: Logic example

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 is 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 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 is the virtual output created as an output of the first timer (VO_100_OUTPUT_ACTIVATION), the reset signal is 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) are activated if the CONT IP_G_CC1(CC1) variable is set to 1. Once the VO_100_OUTPUT_ACTIVATION is active, it is deactivated after 200 ms, and remains deactivated for 5 seconds. This process is 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.

5.10 IEC 61850 configuration

The 61850 Configuration option is only available if the C650 supports this protocol (6 in the order code for protocol selection) with firmware versions 3.44 or lower. For firmware versions 3.60 or higher ones, go to section 7.6 IEC 61850 Configurator.

This menu is located in **Setpoint > 61850 Configuration**

The user can configure some 61850 parameters in the C650.icd file, and then send this file to the relay. The parameters that can be configured are:

Domain name parameters:

· IED Name

· LD Name from the Domain Name

Ethernet parameters:

· IP Address

· Subnet Mask

· Gateway

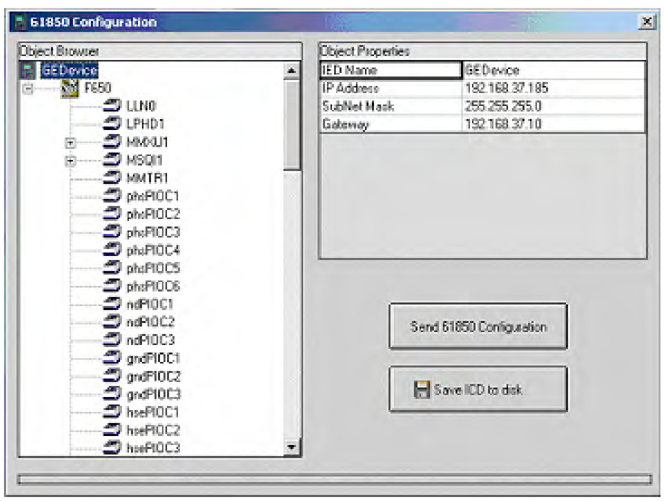


Figure 5-35: IED name and Ethernet parameter configuration

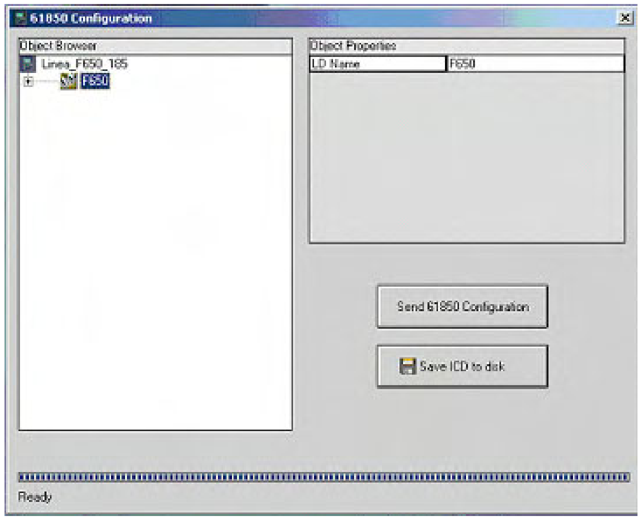


Figure 5-36: LD name configuration

MMXU parameters:

The MMXU deadband settings represent the deadband values used to determine when updating the MMXU.mag. and .cVal. values from the associated .instmag. and .instcVal. values.

The .mag. and .cVal. values are used for the IEC 61850 buffered and unbuffered reports. These settings correspond to the associated .db data items in the CF functional constraint of the MMXU logical node, as per the IEC 61850 standard. According to IEC 61850-7-3, the db values represent the percentage of difference between the maximum and the minimum in units of 0.00%. Thus, it is important to know the maximum value for each MMXU measured quantity, since this represents the 100.00% value for the deadband. The minimum value for all quantities is 0; the maximum values are as follows:

A value of 1000 represent the 1% of the scale.

The minimum and maximum main values (secondary) are:

-For Current 0 to 160 A

-For Voltage 0 to 300 V

-For frequency 0 to 70 Hz

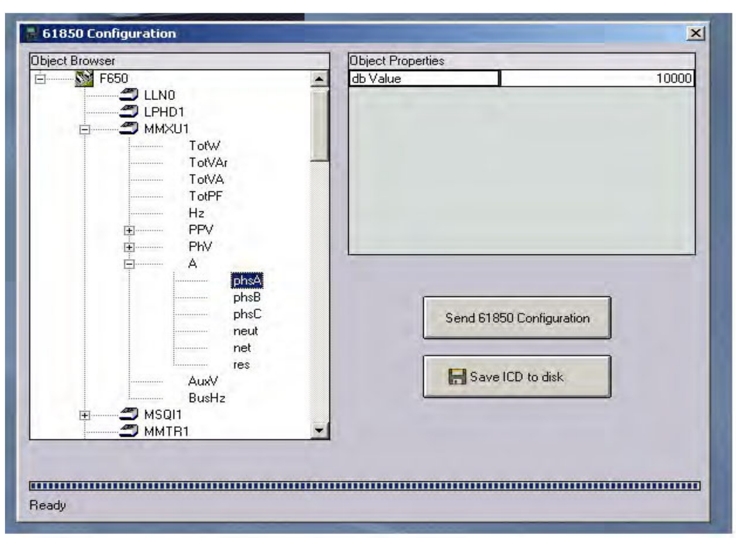


Figure 5-37: MMXU deadband setting configuration

C650 Bay Controller & Monitoring System

Chapter 6: Actual values

6.1 Front panel

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 sub menus that are 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 the 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
ST HMI BACKLIGHT

6.2 Status

6.2.1 Operation bits status

(***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)

OPERATION BITS
OPERATION BIT 1
OPERATION BIT 2
...
OPERATION BIT 24

6.2.2 Breaker status

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

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 is 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 Control element status

6.2.3.1 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 6-2: 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 is activated in order not to interfere with possible logics where it is included. If the synchronism unit is enabled, this signal only activates under 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.

6.2.3.2 Autoreclose

This screen can be accessed at ***Actual > Status > Control Elements > Autoreclose***, and it includes the following signaling LEDs for the Autoreclose function:

Table 6-3: Autoreclose actual values

AUTORECLOSE INPUTS
AR LEVEL BLOCK
AR PULSE BLOCK
AR PULSE UNBLOCK
AR INITIATE
AR CONDS INPUT
AUTORECLOSE INTERNAL STATUS
AR CLOSE BREAKER
AR OUT OF SERVICE
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER
AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLK AFTER 1 SHOT
AR BLK AFTER 2 SHOT
AR BLK AFTER 3 SHOT
AR BLK AFTER 4 SHOT
AR BLOCK BY LEVEL
AR BLOCK BY PULSE
AR STATUS
AR LOCKOUT MODE
AR BLOCK MODE
AUTORECST_61850

The AUTORECLOSE INPUTS are signal configurable by the user at ***Setpoint > Relay Configuration > Protection Elements*** to:

AR LEVEL BLOCK: programmable signal to block the autoreclose unit by level

AR PULSE BLOCK: programmable signal to block the autoreclose unit by pulse

AR PULSE UNBLOCK: programmable signal to unblock the autoreclose unit by pulse

AR INITIATE: programmable signal to initiate the autoreclose.

AR CONDS INPUT: programmable signal to set the conditions to be met before executing a breaker close.

The AUTORECLOSE INTERNAL STATUS are internal signals provided by the autoreclose unit:

AR CLOSE BREAKER: Breaker close command given by the autoreclose

AR OUT OF SERVICE: Autoreclose out of service (Disabled)

AR READY: Autoreclose in service

AR LOCKOUT: Autoreclose in lockout status (finished cycled-definite trip)

AR BLOCK:	Autoreclose blocked (by input, logic, others, etc).
AR RCL IN PROGRESS:	Cycle in course (autoreclose in progress).
AR LCK BY ANOMALY:	Autoreclose in "Lockout" by anomaly.
AR LCK BY FAIL OPEN:	Autoreclose in "Lockout" by a failure in opening the breaker.
AR LCK BY FAIL CLOSE:	Autoreclose in "Lockout" by a failure in closing the breaker.
AR LCK BY USER:	Autoreclose in "Lockout" by manual close.
AR LCK BY CONDS:	Autoreclose in "Lockout" by conditions. See input conditions configuration.
AR LCK BY TRIPS:	Autoreclose in "Lockout" by maximum number of trips.
AR LCK BY SHOTS:	Autoreclose in "Lockout" at the end of cycle – Definite trip.
AR BLK AFTER 1 SHOT:	Signal sent by the autoreclose after the 1st shot.
AR BLK AFTER 2 SHOT:	Signal sent by the autoreclose after the 2nd shot.
AR BLK AFTER 3 SHOT:	Signal sent by the autoreclose after the 3rd shot.
AR BLK AFTER 4 SHOT:	Signal sent by the autoreclose after the 4th shot.
AR BLOCK BY LEVEL:	Autoreclose blocked by level. See AR block signals configuration
AR BLOCK BY PULSE:	Autoreclose blocked by pulse. See AR block signals configuration
AR STATUS:	Autoreclose status (in service – out of service)
AR LOCKOUT MODE:	Relay "Lockout" status.
AR BLOCK MODE:	Relay "Block" status

AutoRecSt_61850: Autorecloser status sent in IEC 61850. This value represent whether or not the auto reclosing is ready, in progress or successful. It is an enumerate type whose values are defined in IEC 61850-7-4 Edition 2.0 standard and it is available

6.2.3.3 Pulse counters

C650 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 C650. It can be accessed from the menu:

Actual > Status > Control Elements > Pulse counters, and it includes the following values.

Table 6-4: Pulse counter 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
Cnt Pulses Freeze
Cnt Pulses Unfreeze
Cnt Pulses Reset

6.2.3.4 Analog comparators

C650 units incorporate 20 analog comparators. This screen can be accessed from the menu:

Actual > Status > Control Elements >Analog Comparators and it includes the following signaling LEDs showing the ON/OFF status of the analog level.

Table 6-5: 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

6.2.3.5 Digital counters

This screen can be accessed at **Actual > Status > Control Elements > Digital Counters**, and it includes 24 LEDs for the 8 Digital Counters status, indicating which status is activate (HI, LO or EQ).

Table 6-6: Digital counter actual values

DIGITAL COUNTERS ACTUAL VALUES
DIGCNT 1 HI
DIGCNT 2 HI
DIGCNT 3 HI
DIGCNT 4 HI
DIGCNT 5 HI

DIGCNT 6 HI
DIGCNT 7 HI
DIGCNT 8 HI
DIGCNT 1 EQ
DIGCNT 2 EQ
DIGCNT 3 EQ
DIGCNT 4 EQ
DIGCNT 5 EQ
DIGCNT 6 EQ
DIGCNT 7 EQ
DIGCNT 8 EQ
DIGCNT 1 LO
DIGCNT 2 LO
DIGCNT 3 LO
DIGCNT 4 LO
DIGCNT 5 LO
DIGCNT 6 LO
DIGCNT 7 LO
DIGCNT 8 LO
DIGCNT 1 VALUE
DIGCNT 2 VALUE
DIGCNT 3 VALUE
DIGCNT 4 VALUE
DIGCNT 5 VALUE
DIGCNT 6 VALUE
DIGCNT 7 VALUE
DIGCNT 8 VALUE
DIGCNT 1 FROZENVALUE
DIGCNT 2 FROZENVALUE
DIGCNT 3 FROZENVALUE
DIGCNT 4 FROZENVALUE
DIGCNT 5 FROZENVALUE
DIGCNT 6 FROZENVALUE
DIGCNT 7 FROZENVALUE
DIGCNT 8 FROZENVALUE
DIGCNT 1 FROZENDATE
DIGCNT 2 FROZENDATE
DIGCNT 3 FROZENDATE
DIGCNT 4 FROZENDATE
DIGCNT 5 FROZENDATE
DIGCNT 6 FROZENDATE
DIGCNT 7 FROZENDATE
DIGCNT 8 FROZENDATE

For each of the 8 digital counters, there exist independent and identical groups of actual values:

• DIGCNT # HI [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is greater than the setting DigCNt #Compare value.

• DIGCNT # EQ [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is equal than the setting DigCNt #Compare value.

• DIGCNT # LO [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is lower than the setting DigCNt #Compare value.

(These 3 previous states are mutually exclusive: only one can be ON at the same time. If the counter is Disabled, the 3 of them are OFF.)

• DIGCNT # VALUE [-2,147,483,648 : 2,147,483,647]: The specified counter current value.

• DIGCNT # FROZENVALUE [-2,147,483,648 : 2,147,483,647]: The specified counter last captured (frozen) value.

• DIGCNT # FROZENDATE [Valid date]: The specified counter last captured (frozen) date.

6.2.4 Protection & control status 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.

6.2.5 Snapshot event summary

Actual > Status > Snapshot Event Summary

The C650 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.

6.2.6 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 6-7: MODBUS user map actual values

MODBUS USER MAP
Address 00
Address 01
...
Address 255

6.2.7 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 C650. 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 6-8: 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 lights up when the input associated with switchgear Contact A is activated.

SWITCH **X** B INPUT — The LED lights up when the input associated with switchgear Contact B is activated.

SWITCH **X** A STATUS — Status associated with 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 with 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 the following figure:

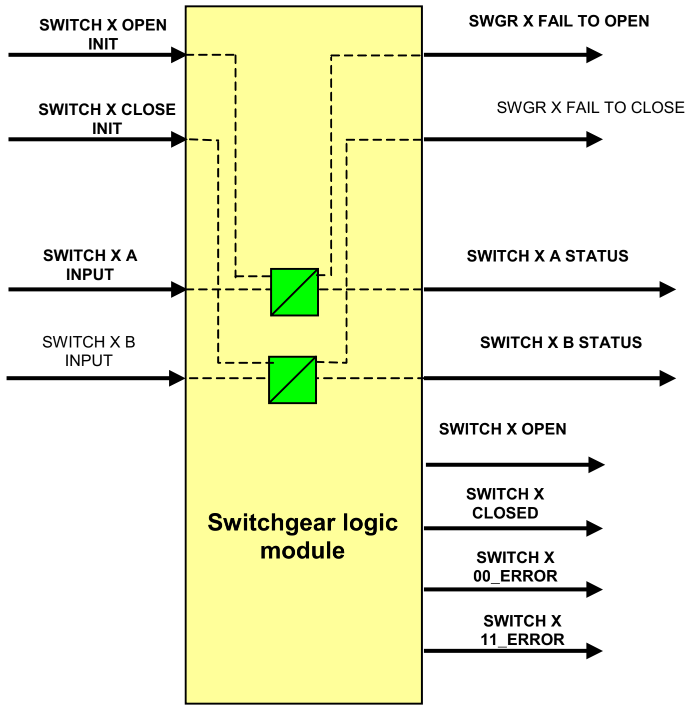


Figure 6-1: Switchgear contacts

6.2.8 Calibration status

This screen can be accessed at ***Actual*** **>** ***Status*** **>** ***Calibration***, and it includes the internal calibration status for the relay.

Table 6-9: Calibration status

CALIBRATION
FACTORY CALIBRATION
CALIBRATION ERROR
CALIBRATION DATE

FACTORY CALIBRATION: This value is 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).

CALIBRATION DATE: This value is showing date when relay was calibrated.

6.2.9 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 operating system.

Form firmware version prior to 7.00, System Info pop-up window shows general system information as described in the table below:

Table 6-10: System info for firmware versions below 7.00

SYSTEM INFO
E2PROM STATUS
DSP COMM ERROR
MAGNETIC MODULE ERROR
Green Zone
Yellow Zone
Orange Zone
Red Zone
Kswapd Time
mtd2 Time
mtd2 Time
CPU Rtai
CPU Linux
Total RAM
Used DRAM
Free RAM
Shared RAM
Buffer RAM
Chached RAM
Green Counter
Yellow Counter
Orange Counter
Red Counter
Up Time
DSP Counter
ICD Status
MAC Address
Serial Number
Manufacturer date

- **E2PROM status:** LED associated lights in green if E2PROM is configured and working properly
- **DSP comm error:** LED associated lights in green if communication error between DSP and main processor.
- **Magnetic module error:** LED associated lights in green if communication error between DSP and magnetic module.

- **Green/Yellow/Orange/Red Zones and Counters:** These 4 counters are referred to the total amount of free RAM available in the device. The usual state should be Green zone and the rest of indicators means that the device can have or stop some task just in case that they would need to prioritize the protection task.
- **Kswapd Time:** It should take value always to 0
- **Mtd2 Time:** Time accessing to this partition with Linux OS
- **Mtd3 Time:** Time accessing to this partition with Application
- **CPU Rtai:** Percentage corresponding to protection tasks execution
- **CPU Linux:** Percentage corresponding to rest of Linux tasks execution
- **Total RAM:** Total RAM in the device
- **Used DRAM:** Used RAM in the device
- **Free RAM:** Available RAM in the device
- **Chached RAM:** Memory reserved for the Linux OS
- **Up Time:** Second from the last power-up
- **DSP Counter:** It shows that DSP is running
- **ICD Status:** Information about status of ICD file stored in the C650. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **MAC address:** MAC address assigned to Ethernet ports, Eth_1 and Eth_2.
- **Serial number:** Serial number of the relay that is communicating with EnerVista 650 Setup.
- **Manufacturing date:** Date when the relay, connected to EnerVista 650 Setup, was assembled.

Table 6-11: System info for firmware versions 7.00 and above

SYSTEM INFO
E2PROM STATUS
DSP COMM ERROR
MAGNETIC MODULE ERROR
PLC ERROR
NET CONF ERROR
ORDER CODE ERROR
Total RAM
Used DRAM
Free RAM
Up Time
DSP Counter
CPU Usage
ICD Status
ICD Status NOTVAL
DSP Status
FLASH Usage
KINETICS Usage
CPU Max Usage
Temp Current Value
Temp Max Value

Temp Min Value
Scan Cycle Average
Scan Cycle Rate
PLC Checksum
Settings Checksum
MAC Address
Serial Number
Manufacturer date

- **E2PROM Status:** LED associated lights in green if E2PROM is configured and working properly
- **DSP COMM ERROR:** LED associated lights in green if communication error between DSP and main processor.
- **Magnetic module error:** LED associated lights in green if communication error between DSP and magnetic module.
- **Plc error:** PLC equations sent to the relay have an error or are incorrect.
- **Net conf error:** Network configuration is incorrect
- **Order code error:** Order code and hardware configuration do not match
- **Total RAM:** Total RAM in the device
- **Used DRAM:** Used RAM in the device
- **Free RAM:** Available RAM in the device
- **UpTime:** DSP heartbeat
- **DSP Counter:** Percentage of CPU in use
- **CPU Usage:** Percentage of CPU in use
- **ICD Status:** Information about status of ICD file stored in the C650. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **ICD Status NotVal:** Information about validation of new ICD after being sent into the relay. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **Dsp Status:** Internal status of the DSP
- **Flash Usage:** FLASH memory in use
- **KINETIS Status:** Kinetis working mode
- **CPU MAX Usage:** Maximum measured CPU usage
- **Temp Current Value:** Current temperature of CPU. This value is displayed in Celsius units.
- **Temp Max Value:** Maximum temperature reached by CPU during operating mode. This value is reset This value is taken into account from last reboot.
- **Temp Min Value:** Maximum temperature reached by CPU after last reboot.
- **Scan Cycle Average:** Mean time in nanoseconds that takes a Scan cycle to run
- **Scan Cycle Rate:** Every milliseconds a Scan cycle is run
- **PLC Checksum:** Value of CRC of PLC equations. This value is read from the relay.
- **Settings checksum:** Value of CRC of relay settings. This value is read from the relay.
- **MAC address:** MAC address assigned to Ethernet port, Eth_E.
- **Serial number:** Serial number of the relay that is communicating with EnerVista 650 Setup.
- **Manufacturing date:** Date when the relay, connected to EnerVista 650 Setup, was assembled.

6.2.10 Record status

This screen shows part of the information related to the different records stored in the Relay, such as:

6.2.10.1 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 C650 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 6-12: Control event status

CONTROL EVENTS
CONTROL EVENT 1
CONTROL EVENT 2
...
CONTROL EVENT 128

6.2.10.2 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 with a specific channel is active, its LED lights up on this screen.

This screen also shows the oscillography trigger status, active or inactive, by lighting up that channel.

Table 6-13: 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.

6.2.10.3 Data logger

Actual > Status > Records Status > Data Logger

Table 6-14: 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.

6.2.10.4 Demand

Actual > Status > Records Status > Demand

Table 6-15: 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***

6.2.10.5 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 6-16: 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***

6.2.10.6 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 6-17: 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
BKR OPEN TIMING
BKR CLOSE TIMING

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.
BKR OPEN TIMING	Exact time in opening the breaker
BKR CLOSE TIMING	Exact time in closing the breaker

Breaker opening and closing time signals are configured at ***Setpoint > Relay Configuration > Switchgear*** for the related switchgear device.

6.2.11 IEEE 1588 precision time protocol (PTP)

Actual > Status > IRIG-B PTP 1588

This screen shows the IRIG-B and PRP status. It includes the following signaling LEDs showing the FAILURE of the SNTP and IRIG-B and other statuses are provided.

SNTP - IRIGB - PTP1588 STATUS
SNTP FAILURE
IRIG-B FAILURE
RTC Sync Source
GrandMaster-ID LOW
GrandMaster-ID HIGH
PTP ACCURACY

The **RTC Sync Source** actual value is the time synchronizing source the relay is using at present. Possible sources are: Port A PTP Clock, Port B PTP Clock, IRIG B, SNTP and None.

Grandmaster ID is the grandmaster Identity code being received from the present PTP grandmaster if any. When the relay is not using any PTP grandmaster, this actual value is zero. The grandmaster Identity code is specified by PTP to be globally unique, so one can always know which clock is grandmaster in a system with multiple grandmaster-capable clocks.

PTP Accuracy is the estimated maximum time error at present in the Real Time Clock (RTC), considering the quality information embedded in the received time signal, how long the relay has had to lock to the time source, and in the case of time signal interruptions, the length of the interruption. The value 999,999,999 indicates that the magnitude of the estimated error is one second or more, or that the error cannot be estimated.

Note:

The C650 does not support the end-to-end delay mechanism, so it is not unexpected that changing the device to which the C650 is connected to this mode would cause the (NoPDelay) message. When PTP source clock is having "End to End clock delay" configured, and if C650 is receiving PTP packets from this clock C650 is getting synchronized and status is showing Synch'd (No Pdelay). Note that the relay does not allow manual overwriting of its RTC time if PTP is functional.

6.2.12 Versions

This screen can be accessed at **Actual > Status > Versions**. It shows the current versions and dates of the different applications.

VERSIONS
HMI Version
DISPLAY TYPE
Boot Version
Boot Date
Kinetis Boot Version
Kinetis Boot Date
Kinetis Loader Ver
Kinetis Loader Date
Kinetis App Version
Kinetis App Date
DSP Version
DSP Date
Firmware Date
FPGA Version
RM PRP HSR Version
RM RSTP Version
RM LLA Version

RM Bypass Version
CPU Revision

HMI Version: Relay display version

DISPLAY TYPE: Relay's display model (refers to order code, basic or graphic)

1. Basic display
2. Graphic display

Boot Version: Boot version

Boot Date: Boot versions release date

Kinetis Boot Version: Kinetis microprocessor boot version

Kinetis Boot Date: Kinetis boot release date

Kinetis Loader Ver: Kinetis bootloader version

Kinetis Loader Date: Kinetis bootloader release date

Kinetis App Version: Kinetis application version

Kinetis App Date: Kinetis application release date

DSP Version: Digital Signal Processor firmware version

DSP Date: Digital Signal Processor firmware release date

Firmware Date: Firmware application release date

FPGA Version: Current version of the bitstream running in CPU FPGA.

RM PRP HSR Version: Current version of the PRP_HSR bitstream running in the redundancy module FPGA.

RM RSTP Version: Current version of the RSTP-Daisy Chain bitstream running in the redundancy module FPGA.

RM LLA Version: Current version of the LLA bitstream running in the redundancy module FPGA.
RM Bypass Version: Current version of the Bypass bitstream running in the redundancy module FPGA.
CPU Revision: CPU hardware version:

- Redundant Fiber Optic: 0 or 4
- Redundant Cooper Cable: 1 or 5
- Single Fiber Optic: 2 or 6
- Single Cooper Cable: 3 or 7

6.2.13 Redundancy

Actual > Status > Redundancy: This screen shows the port A and B statuses related to PRP, HSR and RSTP protocols.

REDUNDANCY
PRP_HSR A tx
PRP_HSR B tx
PRP_HSR A err
PRP_HSR B err
RSTP PortA State
RSTP PortB State

- **PRP_HSR A TX**: This is the number of the transmitted messages over port A when PRP or HSR option is enabled.
- **PRP_HSR B TX**: This is the number of the transmitted messages over port B when PRP or HSR option is enabled.
- **PRP_HSR A ERR**: This value shows the number of messages received over port A with wrong LAN ID.
- **PRP_HSR B ERR**: This value shows the number of messages received over port B with wrong LAN ID.
- **RSTP PortA State**: This is the state of RSTP for port A (Discarding, Learning & Forwarding)
- **RSTP PortB State**: This is the state of RSTP for port B (Discarding, Learning & Forwarding)

6.3 Metering

6.3.1 Primary values

6.3.1.1 Current

Actual > Metering > Primary Values > Current

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
% Load to trip	N/A

6.3.1.2 Voltage

Actual> Metering > Primary Values > Voltage

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
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

6.3.1.3 Power

Actual > Metering > Primary Values > Power

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, measurements of single phase power value cannot be duly calculated, and therefore, its value is zero. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

NOTE 2: When currents and neither voltages are not available in the C650, default value for power factor will be indicated as zero.

6.3.1.4 Energy

Actual > Metering > Primary Values > Energy

Energy is only given in three phase 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 2147483 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

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 MIN	MW
DEMAND W DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VAR PWR	MVAr
DEMAND VAR MAX	MVAr
DEMAND VAR MIN	MVAr
DEMAND VAR DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VA PWR	MVA
DEMAND VA MAX	MVA

DEMAND VA MIN	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

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

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

6.3.2.3 Power

Actual > Metering > Secondary Values > Power

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, measurements of single phase power value cannot be duly calculated, and therefore, its value is zero. 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 counter clockwise, all the angles are positive values, so for a system Va (0,0°), Vb (0,-120°), Vc (0,120°) the relay provides the following angles Va (0,0°), Vb (0,240°), Vc (0,120°).

The following figure shows the phasor diagram provided by EnerVista 650 Setup:

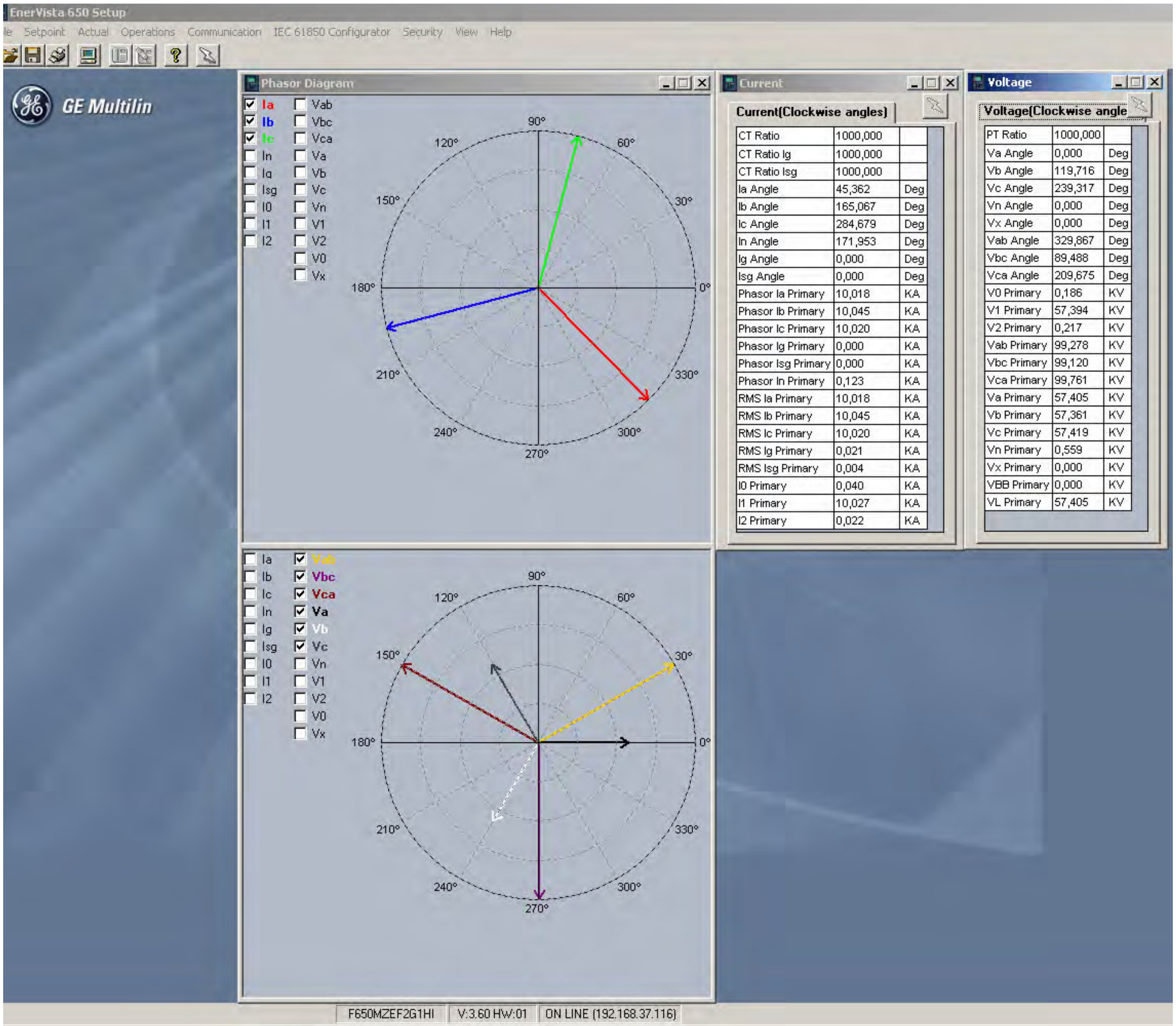


Figure 6-2: Phasor diagram

6.3.4 Frequency

Actual > Metering > Frequency

Description	Units
Line Frequency	Hz
Bus Frequency	Hz
df/dt	Hz/s

6.4 Inputs / outputs

Digital inputs and outputs are located in the same board. Depending on the relay model, the number of inputs and outputs varies.

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 with the activated input lights in green, if an input is not activated, the LED does not light up. The **Board X Status** LED indicates the status of the board; it is lit up if the board is correct and the communication or the Relay model is appropriate.

Table 6-18: Contact input 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 displays the activation of a contact output by lighting 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 the table below.

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**

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

Actual > Inputs/Outputs > Contact Output Operates > Board X (being X the corresponding board in each case).

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:

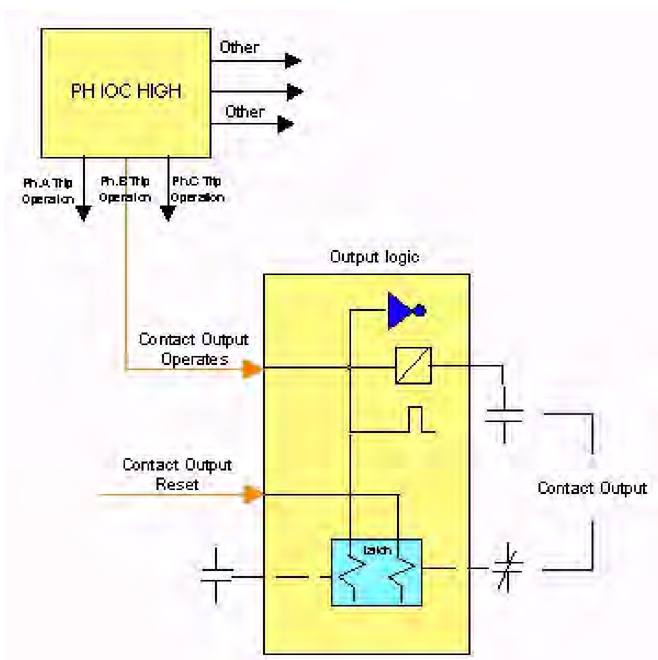


Figure 6-3: Output contact operation

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

If the reset signal is active, the green LED lights up. Otherwise, it remains unlit.

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 **Board Status**, indicates the general board status.

This output reset Command is only be effective if **latch** has been selected for **Output Type** on the I/O board, thus 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 remains 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 the external CAN bus 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 remains unlit.

I/O BOARD STATUS
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS
BOARD 2H STATUS
BOARD 2J 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 online 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 are shown as below:

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 with the virtual output is in the ***Setpoint > Logic Configuration*** tool provided by EnerVista 650 Setup program.

VIRTUAL OUTPUT STATUS
VIRTUAL OUTPUT 000
VIRTUAL OUTPUT 001
...
VIRTUAL OUTPUT 511

6.4.8 Remote outputs

Actual > Inputs/Outputs > Remote Outputs > DNA

This screen provides the status of the 32 DNA remote outputs.

Table 6-19: DNA STATUS

DNA STATUS
DNA 1
DNA 2
DNA 3
...
DNA 32

Actual > Inputs/Outputs > Remote Outputs > UserSt

This screen provides the status of the 64 UserSt remote outputs.

Table 6-20: USER ST STATUS

USERst STATUS
UserSt 1
UserSt 2
UserSt 3
...
UserSt 64

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Dig Outputs

This screen provides the status of the 32 Remote GOOSE Digital Outputs.

Table 6-21: Remote GOOSE digital output status

REMOTE GOOSE DIG OUTPUTS STATUS
Rem GOOSE Dig Out 1
Rem GOOSE Dig Out 2
Rem GOOSE Dig Out 3
...
Rem GOOSE Dig Out 32

6.4.9 Remote inputs

Actual > Inputs/Outputs > Remote Inputs > Remote Input

This screen provides the status of the 32 remote inputs.

REMOTE INPUTS STATUS
Remote Input 1
Remote Input 2
Remote Input 3
...
Remote Input 32

Actual > Inputs/Outputs > Remote Inputs > Remote Device

This screen provides the status of the 16 remote devices.

REMOTE DEVICE STATUS
Remote Device 1
Remote Device 2
Remote Device 3
...
Remote Device 16

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Inputs

This screen provides the status of the 32 Remote GOOSE Digital Inputs.

REMOTE GOOSE DIG INPUTS STATUS
Rem GOOSE Dig Inp 1
Rem GOOSE Dig Inp 2
Rem GOOSE Dig Inp 3
...
Rem GOOSE Dig Inp 32

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Analog Inputs

This screen provides the values of the 16 Remote GOOSE Analog Inputs. Eight of them are float type and the other eight are integer type.

REMOTE GOOSE ANALOG INPUTS STATUS
Rem Ana Inp FLOAT 1
Rem Ana Inp FLOAT 2
Rem Ana Inp FLOAT 3
...
Rem Ana Inp FLOAT 8
Rem Ana Inp INT 1
Rem Ana Inp INT 2
Rem Ana Inp INT 3
...
Rem Ana Inp INT 8

6.4.10 Analog inputs

Actual > Inputs/Outputs > Analog Inputs > 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

6.4.11 Virtual output latched

Actual > Inputs/Outputs > Virtual Output Latched

This screen provides the values of virtual output latched

VIRTUAL OUTPUT LATCHED
V.O. Latched 1
V.O. Latched 2
V.O. Latched 3
....
V.O. Latched 16

6.4.12 RIOs

Actual > Inputs/Outputs > RIOs

This screen provides the values of virtual output analogues, integer and float values

INTEGER VALUES	FLOAT VALUES
INT32_000	FLT32_000
INT32_001	FLT32_001
INT32_002	FLT32_002
....	...
INT32_049	FLT32_049

6.5 Records

6.5.1 Event recorder

6.5.1.1 All snapshot events

Actual > Records > Event Recorder > All Snapshot Events

By selecting this option, the C650 provides a general list of all snapshot events stored in the relay up to the request moment:

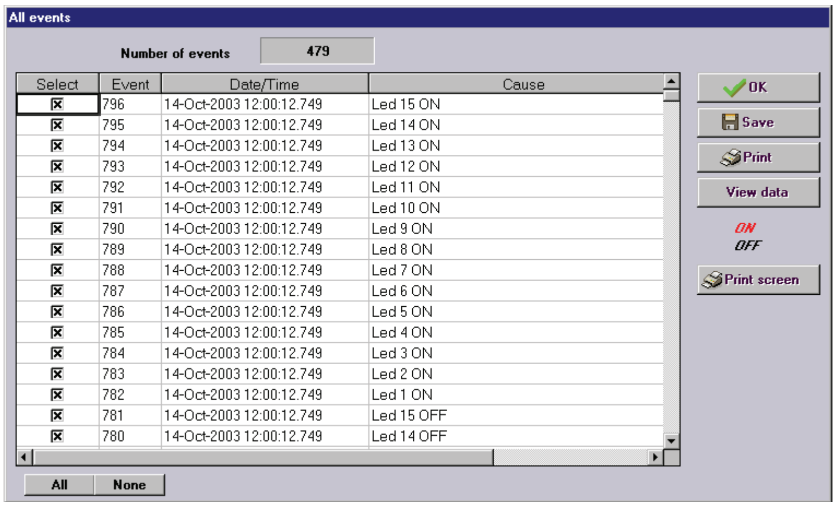


Figure 6-4: Event recorder - all snapshot events

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: Snapshot event details).

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.

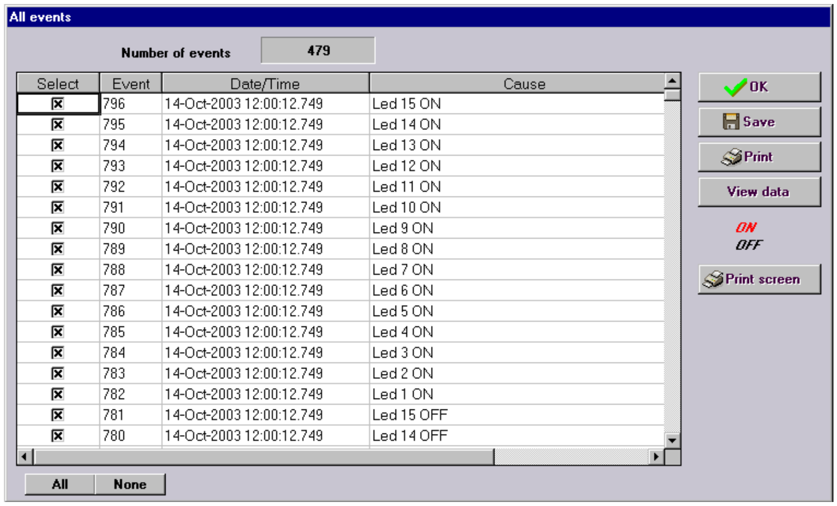


Figure 6-5: Snapshot event details

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 threetwo possible ways to access new events; in local mode (COM2-HMI), remote mode (COM1) and via Ethernet (ETH_1/ETH2 or ETH_E/ETH_A/ETH_B)

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 displays 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)

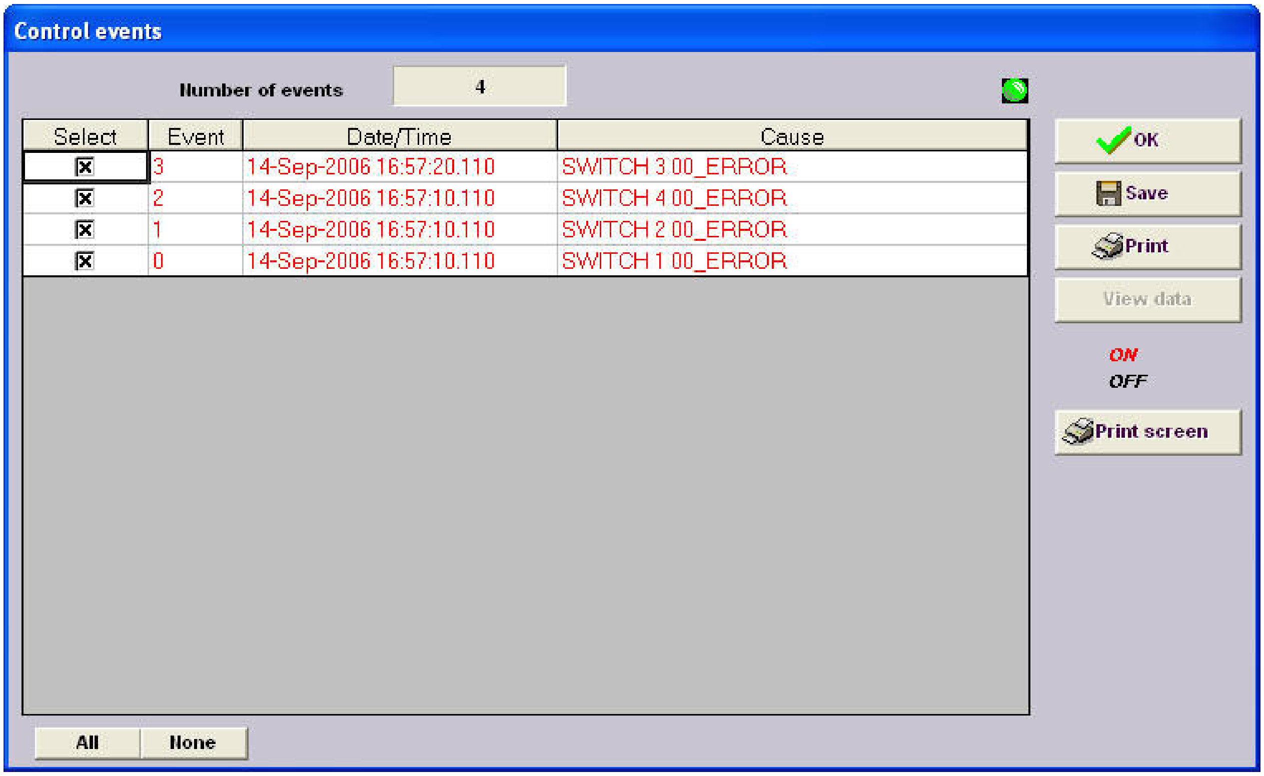


Figure 6-6: Control events

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.

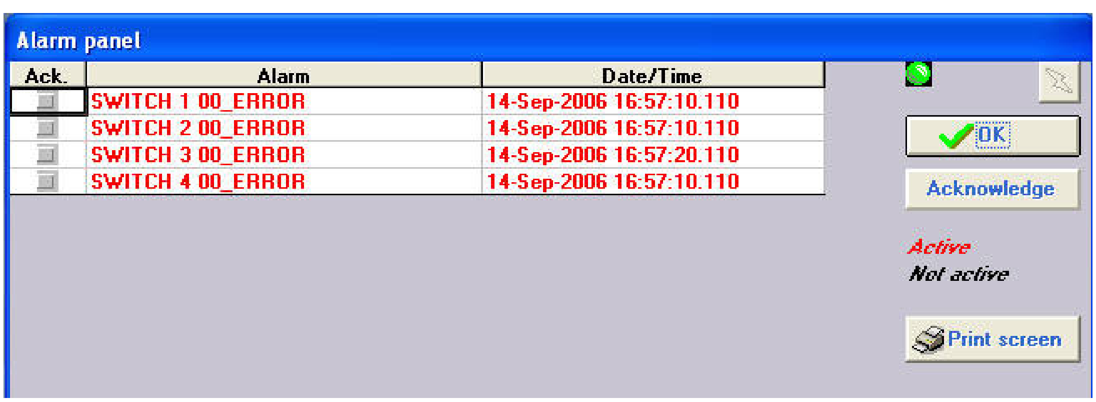


Figure 6-7: Alarm panel

6.5.2 Waveform capture

The ***Actual > Records > Waveform Capture*** screen displays a list of all oscillography records available in the relay. The C650 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 is done through the selected connection in the "***Communication > Computer***" menu, either serial mode or Ethernet.

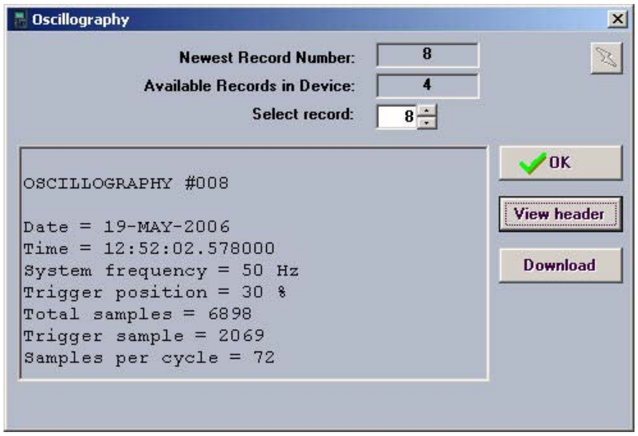


Figure 6-8: Oscillography record retrieval, EnerVista 650 Setup

The screen shows all the available records in the Relay, and by clicking on each of them, the system displays 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 C650 relays (as shown in the following figure), select the template and click **Open Selected Template**. The program then prepares to view oscillography and digital records using the options in available menus (Waveforms and Digital Flags). Otherwise, select the **Create New Template** option, and the program helps create a new template. See the GE-OSC software instruction manual for details.

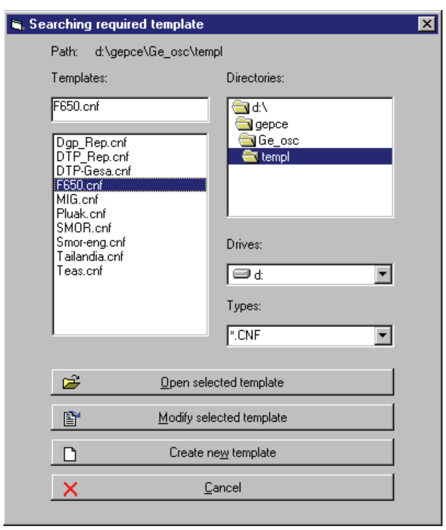


Figure 6-9: GE-OSC oscillography analysis software

Note that any settings change in the oscillography removes all the information stored up to that moment.

6.5.3 Data logger

The access menu is **Actual > Records > Data Logger**. Once open, this menu shows 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 are recorded, as well as the sampling rate.

Note that any settings change in the data logger removes all 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.

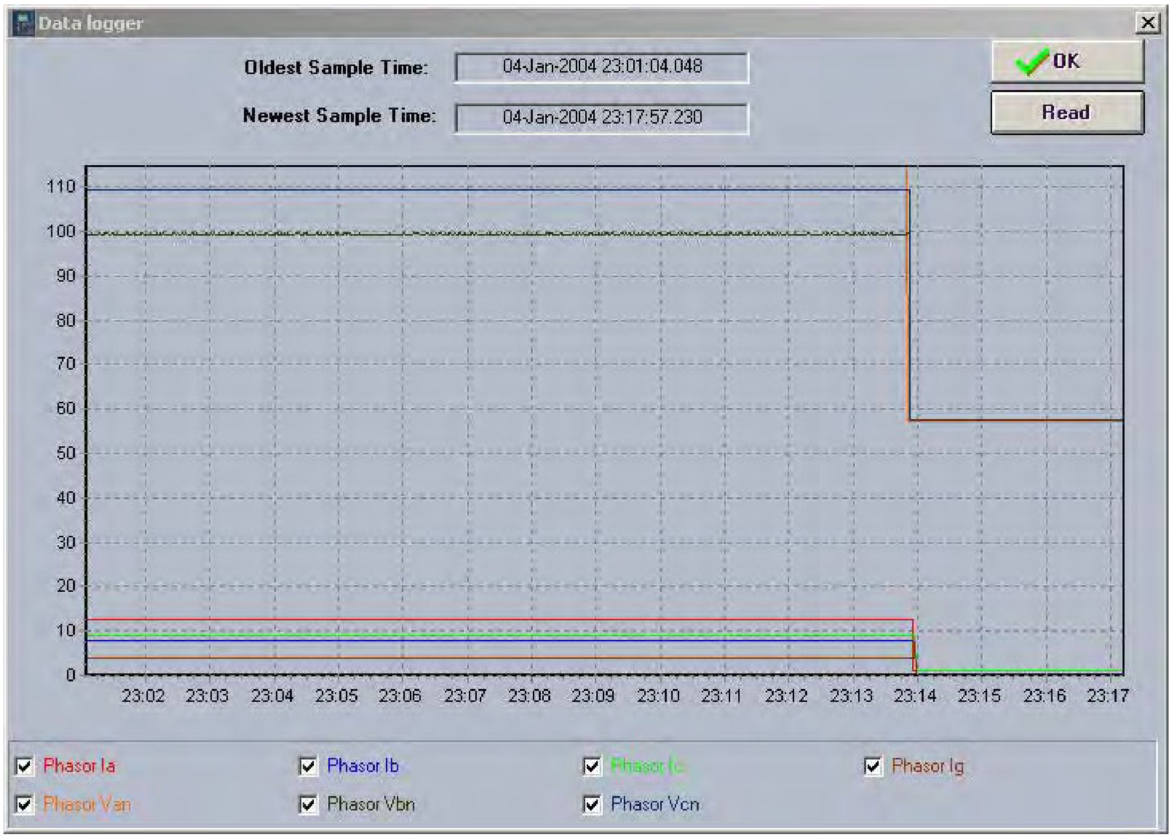


Figure 6-10: Data logger

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.

NOTE: Data logger information takes several minutes to be available.

C650 Bay Controller & Monitoring System

Chapter 7: IEC 61850 protocol

This chapter outlines the IEC 61850 communications protocol. The IEC 61850 protocol applies when ordered with the product. (Check the order code to determine whether IEC 61850 is included with your product).

7.1 IEC 61850 Overview

This section contains a description of IEC 61850, an International Electrotechnical Commission (IEC) series of documents entitled *Communication Networks and Systems for Power Utility Automation*. IEC 61850 is a series of international standards and technical reports applicable to power utility automation systems (PUAS). It includes semantics, abstract communication services, specific communication services, performance specifications, network engineering guidelines, configuration description methodologies, and engineering processes. The objective of the standard is to provide a framework to achieve interoperability among the intelligent electronic devices (IEDs) from different suppliers, and interoperability among software configuration tools from different suppliers. Interoperability in this case is the ability for IEDs to operate on the same network or communication path sharing information and commands, and for configuration tools to understand each other's configuration files. The standards can be obtained from the IEC (http://www.iec.ch).

650 models with an IEC 61850 option support both the IEC61850 GOOSE and IEC 61850 MMS Server service:

- 650 Family relays with firmware version below 7.00 firmware: As per IEC 61850 standard Edition 1
- 650 Family relays with firmware version from 7.00 to 7.50: As per IEC 61850 standard Edition 2
- F650- Feeder protection relay for firmware version 7.52 or above: As per IEC 61850 standard Edition 1 or 2 (depending on the CID file selected and sent to the relay)
- C650-Digital Bay Controller for firmware version 7.50 to below 7.70: As per IEC 61850 standard Edition 2
- C650-Digital Bay Controller for firmware version 7.70 onwards: As per IEC 61850 standard Edition 1 or 2 (depending on the CID selected and sent to the relay)
- R650 Recloser Controller: As per IEC 61850 standard Edition 2

The GOOSE messaging service provides the 650 relay unit the ability to Publish/Subscribe Digital Input Status and its Quality and Timestamp to and from other IEDs which support the GOOSE messaging service, while the server support allows remote a control center, RTU/Gateway, local HMI or other client role devices access to the relay for monitoring and control. The configuration of IEC61850 services is accomplished using the 650 IEC61850 configuration software, EnerVista 650 Setup software. A reboot is required before any changes made in the IEC61850 configuration take effect in the C650 relay.

These models support also Generic Substation State Events (GSSE).

7.2 IEC 61850 generic substation state event (GSSE)

7.2.1 Overview

IEC 61850 specifies two types of peer-to-peer data transfer services: Generic Substation State Events (GSSE) and Generic Object Oriented Substation Events (GOOSE). Both GSSE and GOOSE messages are designed to be short, reliable, and high priority.

GSSE services are compatible with UCA 2.0 GOOSE. IEC 61850 GOOSE services provide virtual LAN (VLAN) support, Ethernet priority tagging, and Ethertype Application ID configuration. The support for VLANs and priority tagging allows for the optimization of Ethernet network traffic. GOOSE messages can be given a higher priority than standard Ethernet traffic, and they can be separated onto specific VLANs. Because of the additional features of GOOSE services versus GSSE services, it is recommended that GOOSE be used wherever backwards compatibility with GSSE (or UCA 2.0 GOOSE) is not required.

Devices that transmit GSSE and/or GOOSE messages also function as servers. Each GSSE publisher contains a "GSSE control block" to configure and control the transmission. Each GOOSE publisher contains a "GOOSE control block" to configure and control the transmission. The transmission is also controlled via device settings. These settings can be seen in the ICD and/or SCD files, or in the device configuration software or files. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1. IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

GSSE messages contain a fixed set of digital points. IEC 61850 GOOSE messages can, in general, contain any configurable data items. When used by the remote input/output feature, IEC 61850 GOOSE messages contain the same data as GSSE messages. The GSSE message structure contains space for 128 bit pairs representing digital point state information. In addition to digital point states, GSSE/GOOSE messages identify the originator of the message and provide other information required by the communication specification. All devices listen to network messages and capture data only from messages that have originated from selected devices

7.2.2 Remote communication

The IEC 61850 specification includes features that are used to cope with the loss of communication between transmitting and receiving devices. Each transmitting device sends a GSSE/GOOSE message upon a successful power-up, when the state of any included point changes, or after a specified interval, four times the Hold Time setting value, if a change-of-state has not occurred.

Receiving devices are constantly monitoring the communications network for the messages they require, as recognized by the identification of the originating device carried in the message. If the receiving relay has not received another message from the originating device when the specified timeout period elapses, the remote device is declared to be non-communicating, so it uses the programmed default state for all points from that specific remote device.

If a message is received from a remote device before the interval of four times the Hold Time expires, all points for that device are updated to the states contained in the message. The status of a remote device can be displayed.

Remote inputs and outputs provide a means of exchanging digital state information between Ethernet-networked devices. The GSSE facility provides for 32 remote inputs and 64 remote outputs.

7.2.3 GSSE configuration

GSSE messages contain a number of double point status data items. These items are transmitted in two pre-defined data structures named DNA and UserSt. Each DNA and UserSt item is referred to as a 'bit pair'. GSSE messages are transmitted in response to state changes in any of the data points contained in the message. GSSE messages always contain the same number of DNA and UserSt bit pairs. Depending on the configuration, only some of these bit pairs may have values that are of interest to receiving devices.

The relay provides 32 "DNA" bit pairs that represent the state of two pre-defined events and 64 "UserSt" bit pairs, which are status bits representing user-definable events.

GSSE service can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comms**.

Remote Comms must be set to "GSSE" to enable GSSE configuration.

650 ID represents the IEC 61850 GSSE application ID name string sent as part of each GSSE message. This string identifies the GSSE message to the receiving device.

Hold time is used to calculate the interval, if a change-of-state has not occurred, that the device waits to send GSSE message.

Remote Device (1 to 32) is used to select specific remote devices by entering the exact identification (ID) assigned to these devices. A maximum of 32 devices can be configured for receiving GSSE messages.

Bit Pair (1 to 32) is used to assign the data from the GSSE message to remote inputs.

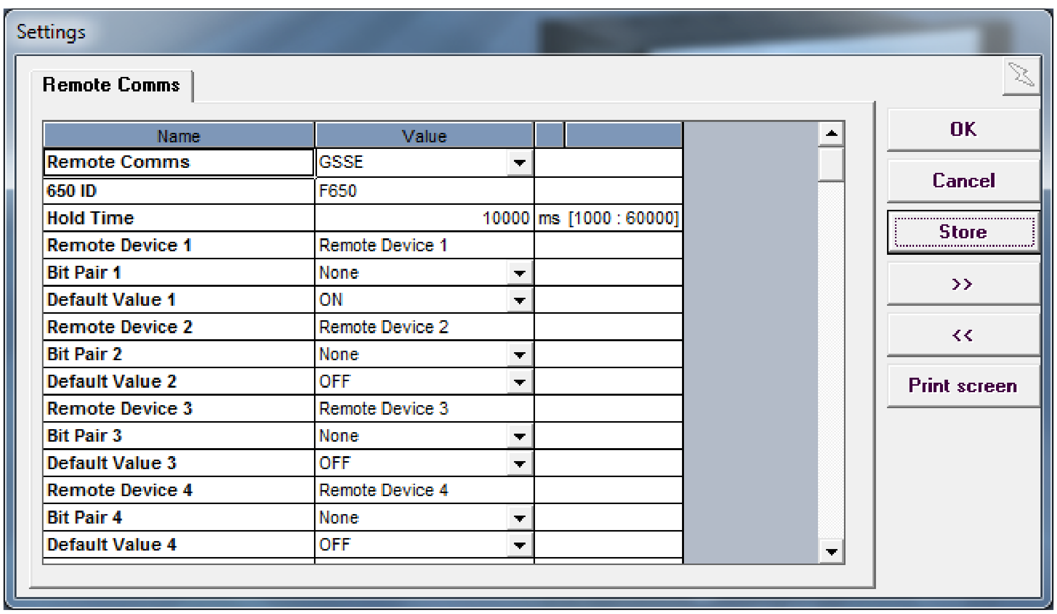


Figure 7-1: Remote communication

Default Value (1 to 32) selects the logic state for this point if the local relay has just completed startup or the remote device sending the point is declared to be non-communicating. The following choices are available:

- ON value defaults the input to Logic 1.
- OFF value defaults the input to Logic 0.
- Latest OFF freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 0. When communication resumes, the input becomes fully operational.
- Latest ON freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 1. When communication resumes, the input becomes fully operational.

Destination MAC Data (1 to 3): If a valid multicast Ethernet MAC address is entered, this address is used as the destination MAC address for GSSE messages. If a valid multicast Ethernet MAC address is not entered (for example, 00 00 00 00 00 00), the device uses the source Ethernet MAC address as the destination, with the multicast bit set.

GSSE RemDevice (1 to 24) MAC Data (1 to 3) is used to filter receiving messages.

GSSE PORT sets the network port through messaging will be done. Possible values are "Port A", "Port B" or "Both".

7.2.4 Remote inputs

Remote inputs, which create PLC operands at the receiving relay, are extracted from GSSE messages originating in remote devices. The relay provides 32 remote inputs, each of which can be selected from a list consisting of 96 selections: DNA-1 to DNA-32 and UserSt-1 to UserSt-64. The function of DNA and UserSt bits is in both cases the same so user can assign a Remote input either of them through the Bit Pair 1 to 32 field (see figure 1). They can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comms**.

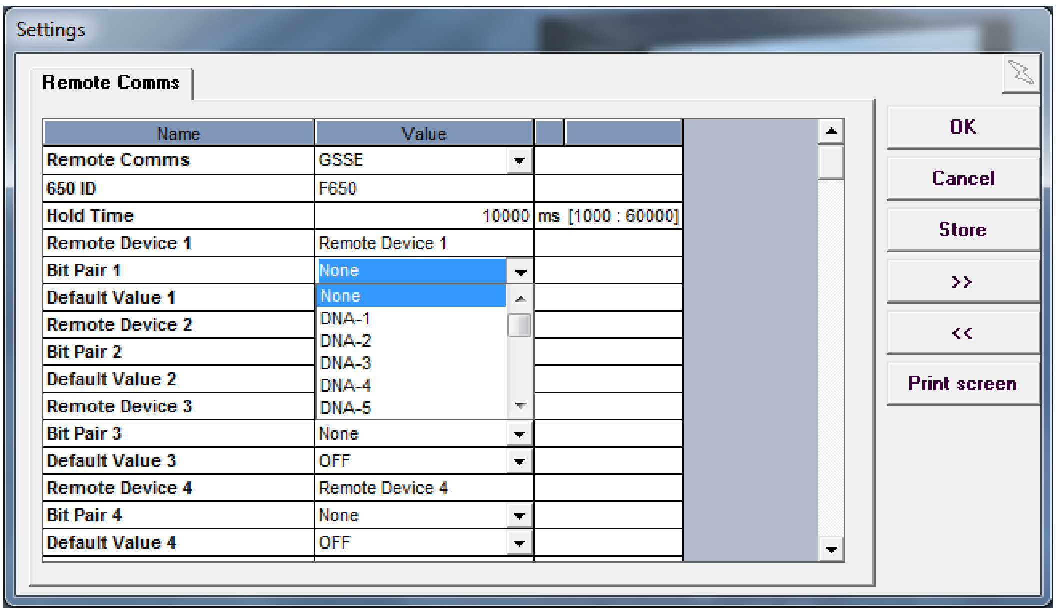


Figure 7-2: Remote communication (remote inputs)

7.2.5 Remote outputs

7.2.5.1 DNA bit pairs

Remote Outputs (1 to 32) are PLC operands inserted into GSSE messages that are transmitted to remote devices on a LAN. Each digital point in the message must be programmed to carry the state of a specific PLC operand, except reserved points DNA1 and DNA2. The complete operand setting represents a specific DNA function to be transmitted. These states are displayed in the C650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > DNA**.

Each DNA point can only be programmed in the EnerVista 650 Setup software in the menu **Setpoint > Relay Configuration > Remote Outputs**.

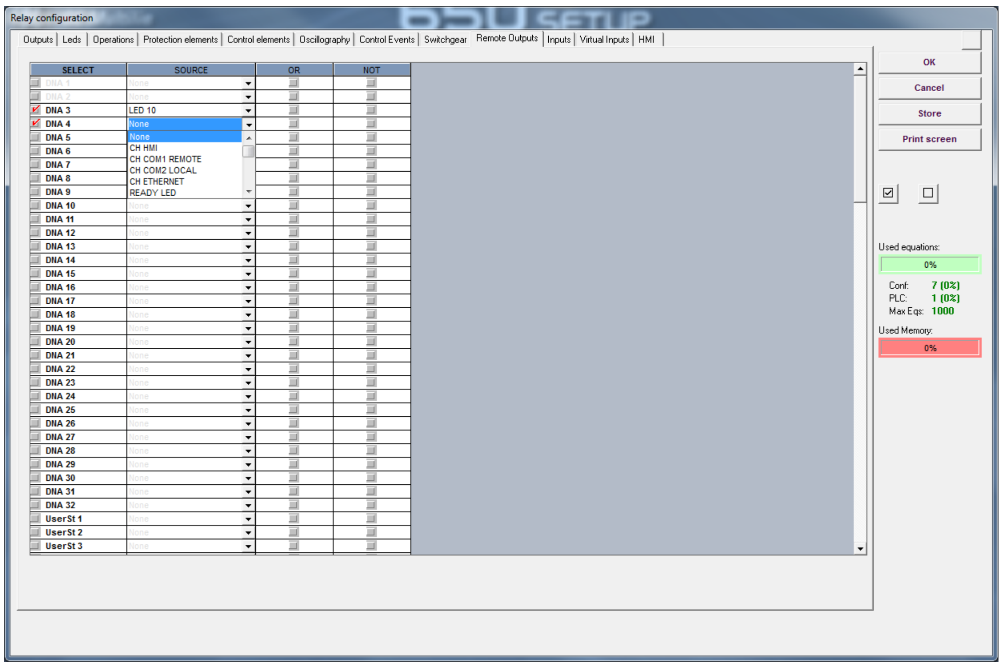


Figure 7-3: Remote outputs (DNA)

7.2.5.2 UserSt bit pairs

Remote Outputs 1 to 64 originates GSSE messages to be transmitted to remote devices. Each digital point in the message must be programmed to carry the state of a specific PLC operand. The UserSt (User Setpoint) setting is used to select the operand which represents a specific UserSt function to be transmitted. These states are displayed in the C650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > UserSt**.

Each User Set point can only be programmed and displayed in EnerVista 650 Setup in the menu **Setpoint > Relay Configuration > Remote Outputs**.

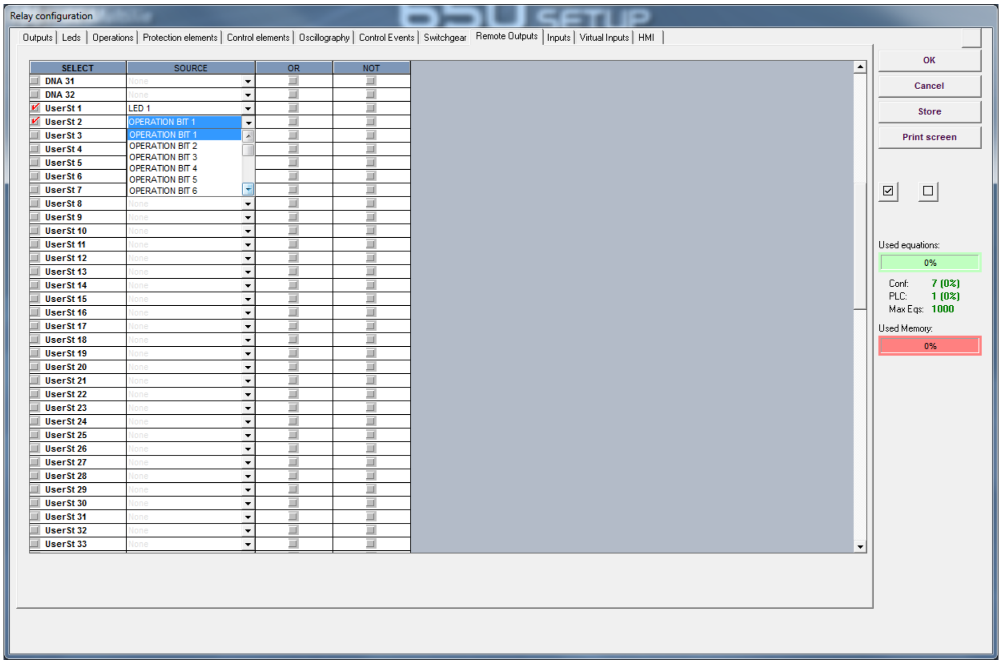


Figure 7-4: Remote outputs (UserSt)

7.3 IEC 61850 profile for C650

7.3.1 Overview

IEC 61850 is a series of standards describing client/server and peer-to-peer communications, substation design and configuration, testing, environmental and project standards.

The 10 parts of the standard IEC 61850 are as listed in the following tables:

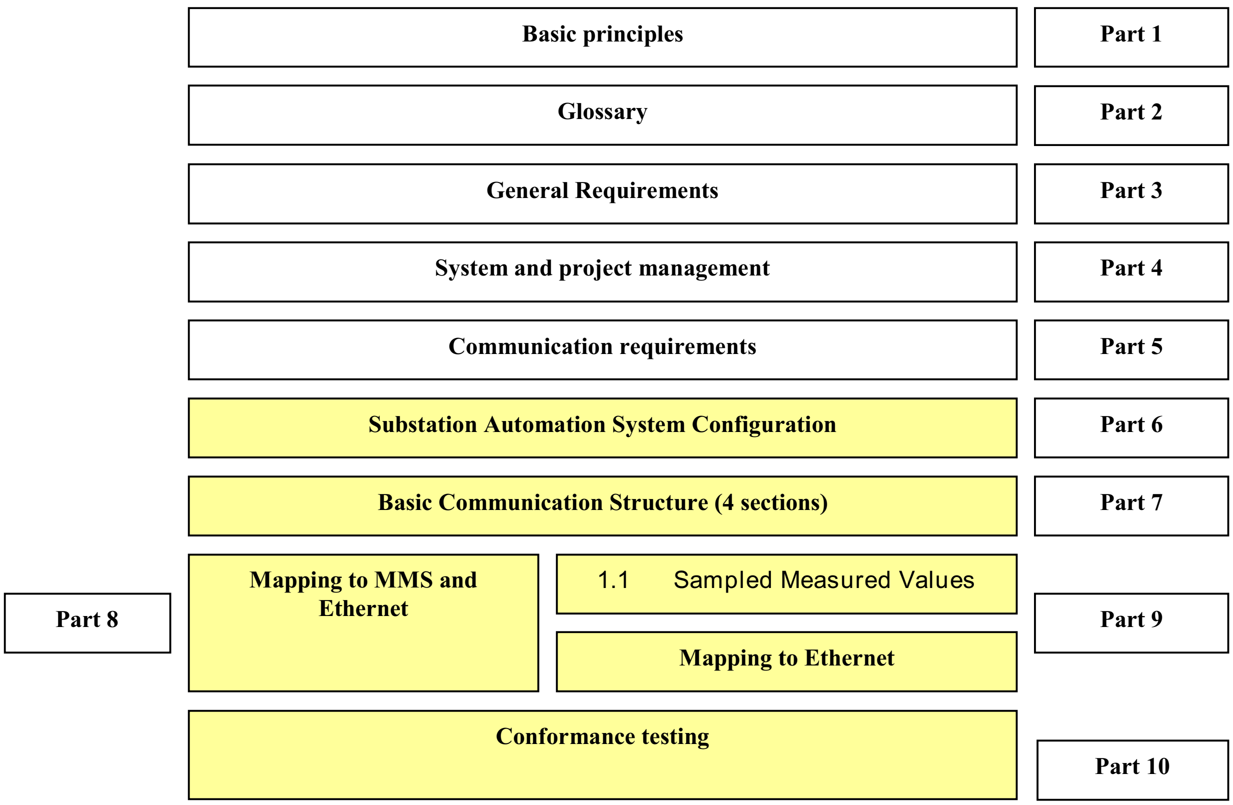
1.1.1 System Aspects Part 1: Introduction and Overview Part 2: Glossary Part 3: General Requirements Part 4: System and Project Management Part 5: Communication Requirements for Functions and Device Models
1.1.2 Configuration Part 6: Configuration Description Language For Communication In Electrical Substations Related To IEDs
1.1.3 Testing Part 10: Conformance Testing

The following parts define how the IED behaves:

1.1.4 Data Models Basic Communication Structure for Substations and Feeder Equipment Part 7-4: Compatible Logical Node Classes and Data Classes Part 7-3: Common Data Classes
1.1.5 Abstract Communications Basic Communication Structure for Substations and Feeder Equipment Part 7-2: Abstract Communication Services Interface (ACSI) Part 7-1: Principles and Models
1.1.6 Mapping to real Communication Networks (SCSM) Specific Communication Service Mapping (SCSM) Part 8-1: Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 Part 9-1: Sampled Values Over Serial Unidirectional Multidrop Point to Point Link Part 9-2: Sampled values over ISO/IEC 8802-3 Mapping on a IEEE 8802-3 based Process Bus

These documents can be obtained from the IEC (http://www.iec.ch). It is strongly recommended that all those involved with any IEC 61850 implementation obtain this document set.

7.3.1.1 Scope and outline of IEC 61850



Parts 3, 4, and 5 of the standard start by identifying the general and specific functional requirements for communications in a substation. These requirements are then used as forcing functions to aid in the identification of the services and data models needed, application protocol required, and the underlying transport, network, data link, and physical layers that meet the overall requirements.

The major architectural construct that 61850 adopts is that of "abstracting" the definition of the data items and the services, that is, creating data items/objects and services that are independent of any underlying protocols. The abstract definitions then allow "mapping" of the data objects and services to any other protocol that can meet the data and service requirements.

The definition of the abstract services is found in part 7.2 of the standard and the abstraction of the data objects (referred to as Logical Nodes) is found in part 7.4.

In as much as many of the data objects are made up of common pieces (such as Status, Control, Measurement, Substitution), the concept of "Common Data Classes" or "CDC" was developed which defined common building blocks for creating the larger data objects. The CDC elements are defined in part 7.3.

Given the data and services abstract definitions, the final step was one of "mapping" the abstract services into an actual protocol. Section 8.1 defines the mapping of the abstract data object and services onto the Manufacturing Messaging Specification - MMS2 and sections 9.1 and 9.2 define the mapping of the Sample Measured Values (unidirectional point-to-point and bi-directional multipoint accordingly) onto an Ethernet data frame. The 9.2 document defines what has become known as the Process Bus.

From a system perspective, there is a significant amount of configuration that is required in order to put all the pieces together and have them work. In order to facilitate this process and to eliminate much of the human error component, an XML based Substation Configuration Language (SCL) was defined in part 6. It allows the formal description of the relations between the substation automation system and the substation. At the application level, the substation topology itself and the relation of the substation structure to the SAS functions (logical nodes) configured on the IEDs can be described. Each device must provide an SCL file that describes the configuration of itself.

Finally, part 10 defines a testing methodology in order to determine "conformance" with the numerous protocol definitions and constraints defined in the standard.

7.3.2 Communication profiles

The C650 relay supports IEC61850 server services over TCP/IP. This profile requires the C650 to have an IP address to establish communications. It is possible to have up to five simultaneous connections.

7.3.3 TCP connection timing

A built-in TCP/IP connection timeout of 30 seconds is employed by the C650 to detect “dead” connections. If there is no data traffic on a TCP connection for greater than 30 seconds, the connection is aborted by the server. Therefore, when using IEC61850 reporting, clients should configure report control block items such that an integrity report is issued al least every 30 seconds. If other MMS data is being polled on the same connection al least once every 30 seconds, this timeout does not apply.

For firmware version 7.20 or higher, TCP connection timeout is configurable from 120 to 1800 seconds and its default value is 120 seconds

7.3.4 MMS protocol

IEC 61850 specifies the use of the Manufacturing Message Specification (MMS) at the upper (application) layer for transfer of real-time data. This protocol has been in existence for a number of years and provides a set of services suitable for the transfer of data within a substation LAN environment. Actual MMS protocol services are mapped to IEC 61850 abstract services in IEC 61850-8-1.

The exact structure and values of the supported IEC61850 logical nodes can be seen by connecting to a C650 relay with an MMS browser, such as “MMS Object Explorer and AXS4-MMS” DDE/OPC server from Sisco Inc.

7.3.5 Peer-to-peer communication

Peer-to-peer communication of a digital state information (remote inputs/outputs) is supported using the IEC61850 GOOSE/GSE services. This feature allows digital points to be exchanged between IEC 61850 conforming devices.

7.3.6 File services

MMS file services are supported to allow transfer of oscillography, event record, or other files from a C650 relay.

7.3.7 IEC 61850 conformance statements

This section describes conformity with IEC 61850.

7.3.7.1 Abbreviations and acronyms

- ASCI Abstract Communication Service Interface
- SCSM Specific Communication Service Mapping
- SCL Substation Configuration Language
- GSE Generic Substation Events
- GOOSE Generic Object Oriented Substation Events
- GSSE Generic Substation Status Events
- SVC Sampled Value Control
- LCB Log Control Block
- PICS Protocol Implementation Conformance Statement
- MICS Model Implementation Conformance Statement
- PIXIT Protocol Implementation extra Information for Testing
- TICS Technical Issues Conformance Statement

7.3.7.2 Definitions of the ISO/OSI reference model

Communications are based on the OSI Reference Model (OSI/IEC 7498-1) for a multi-layer communication function, to achieve stable data exchange.

The table below shows the ISO Application (A) and Transport (T) profiles.

- An ISO **A profile** is a set of specifications and declarations regarding the top three layers of the ISO/OSI reference model (i.e. the application, presentation, and session layers).
- The **T profile** is a set of specifications and declarations regarding the lower four layers (i.e. transport, network, data link, and physical layers).

Table 7-1: OSI reference model and profiles

Application layer	A Profile
Presentation layer	
Session layer	
Transport layer	T Profile
Network layer	
Data link layer	
Physical layer	

A and T profiles can be combined in various ways to form different types of services and information items that can be exchanged. The services specified in Part 7-2 of the IEC61850 standard are mapped onto four different combinations of the profiles. These four combinations are used for

- Client/server services,
- GOOSE/GSE management services,
- GSSE services,
- Time synchronization,
- Services for measured value sampling.

7.3.7.3 Conformance statements for C650 devices

For C650 relays whose order code contains Rear Ethernet Communication Board 2 "G", "H", "J", "K", "L" or "M" and Communication protocol "6", product protocol and model implementation conformance statements are described in the following sections:

IEC 61850 Edition 2:

- 7.3.7.3.1 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "H", "G", "K", "J","L", "M" and IEC 61850 Edition 2 on page 7–12 (PICS for 650 family of relays v1_2 firm7_20)
- 7.3.7.3.3 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–29 (MICS for 650 family of relays v1_40 firm7_20)
- 7.3.7.3.5 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–88 (TICS for 650 family of relays v1_00 firm7_20)
- 7.3.7.3.7 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–93 (PIXIT for 650 family of relays v1_6 firm7_00)

IEC 61850 Edition 1:

- 7.3.7.3.2 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–24 (PICS For C650 relay V1_00 firm7_70)
- 7.3.7.3.4 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–58 (MICS For C650 relay V1_00 firm7_70)
- 7.3.7.3.6 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–91 (TICS For C650 relay V1_00 firm7_70)
- 7.3.7.3.8 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–101 (PIXIT For C650 relay V1_00 firm7_70)

7.3.7.3.1 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "H", "G", "K", "J","L", "M" and IEC 61850 Edition 2

Reference documentation: **PICS for 650 family of relays v1_2 firm7_20**.

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 ACSI Conformance Statement

The following ACSI conformance statements shall be used to provide an overview and details about a device claiming conformance with ACSI to specify the communication features mapped to an SCSM:

- ACSI BASIC conformance statement.
- ACSI MODELS conformance statement.
- ACSI SERVICE conformance statement.

The statements specify the communication features mapped to IEC 61850-8-1 First Edition and/or Edition 2.

1.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- AA: Application Association.
- TP: Two-party (application association).
- MC: Multicast (application association).

1.2 ASCI basic conformance statement

The basic conformance statement is defined in Table 7-2: Basic conformance statement

Table 7-2: Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)		Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)			
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used		Y	
B22	**SCSM**: IEC 6185-9-1 used			Ed2:Deprecated
B23	**SCSM**: IEC 6185-9-2 used			
B24	**SCSM**: other			

Generic substation event model (GSE)				
B31	**Publisher** side		Y	
B32	**Subscriber** side	Y		
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			
– Y = supported N or empty = not supported				

1.3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table 7-3: ACSI models conformance statement.

Table 7-3: ACSI models conformance statement

		Client / Subscriber	Server / Publisher	Value / Comments
If Server or Client side (B11/12) supported				
M1	Logical device		Y	
M2	Logical node		Y	
M3	Data		Y	
M4	Data set		Y	
M5	Substitution		N	
M6	Setting group control		N	
	Reporting			
M7	Buffered report control		Y	
M7-1	sequence-number		Y	
M7-2	report-time-stamp		Y	
M7-3	reason-for-inclusion		Y	
M7-4	data-set-name		Y	
M7-5	data-reference		Y	
M7-6	buffer-overflow		Y	
M7-7	entryID		Y	
M7-8	BufTm		Y	
M7-9	IntgPd		Y	
M7-10	GI		Y	
M7-11	conf-revision		Y	
M8	Unbuffered report control		Y	
M8-1	sequence-number		Y	
M8-2	report-time-stamp		Y	
M8-3	reason-for-inclusion		Y	
M8-4	data-set-name		Y	
M8-5	data-reference		Y	
M8-6	BufTm		Y	
M8-7	IntgPd		Y	
M8-8	GI		Y	
M8-9	conf-revision		Y	
	Logging			
M9	Log control			
M9-1	IntgPd			
M10	Log			
M11	Control		Y	
M17	File Transfer		Y	

M18	Application association		Y	
M19	GOOSE Control Block		Y	
M20	Sampled Value Control Block			
If GSE (B31/32) is supported				
M12	GOOSE		Y	
M13	GSSE			Deprecated
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
For all IEDs				
M16	Time	Y	Y	
Y = service is supported N or empty = service is not supported				

1.4 ACSI service conformance statement

The ACSI service conformance statement is defined in Table 7-4: ACSI service conformance statement.

Table 7-4: ACSI service conformance statement

	Ed	ACSI Service	AA: TP/MC	Client Sub(C)	Server Pub(S)	Comments
Server						
S1	1,2	GetServerDirectory(LOGICAL-DEVICE)	TP		Y	
Application association						
S2	1,2	Associate	TP		Y	
S3	1,2	Abort	TP		Y	
S4	1,2	Release	TP		Y	
Logical device						
S5	1,2	GetLogicalDeviceDirectory	TP		Y	
Logical node						
S6	1,2	GetLogicalNodeDirectory	TP		Y	
S7	1,2	GetAllDataValues	TP		Y	
Data						
S8	1,2	GetDataValues	TP		Y	
S9	1,2	SetDataValues	TP		Y	
S10	1,2	GetDataDirectory	TP		Y	
S11	1,2	GetDataDefinition	TP		Y	
Data set						
S12	1,2	GetDataSetValues	TP		Y	
S13	1,2	SetDataSetValues	TP		N	
S14	1,2	CreateDataSet	TP		N	
S15	1,2	DeleteDataSet	TP		N	
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP		N	Ed1 only
Setting group control						
S18	1,2	SelectActiveSG	TP		Y	
S19	1,2	SelectEditSG	TP		Y	

S20	1,2	SetEditSGValues	TP		Y	
S21	1,2	ConfirmEditSGValues	TP		Y	
S22	1,2	GetEditSGValues	TP		Y	
S23	1,2	GetSGCBValues	TP		Y	

Reporting						
Buffered report control block (BRCB)						
S24	1,2	Report	TP		Y	
S24-1	1,2	data-change (dchg)			Y	
S24-2	1,2	quality-change (qchg)			Y	
S24-3	1,2	data-update (dupd)			N	
S25	1,2	GetBRCBValues	TP		Y	
S26	1,2	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)						
S27	1,2	Report	TP		Y	
S27-1	1,2	data-change (dchg)			Y	
S27-2	1,2	quality-change (qchg)			Y	
S27-3	1,2	data-update (dupd)			N	
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	

Logging						
Log control						
S30	1,2	GetLCBValues	TP		N	
S31	1,2	SetLCBValues	TP		N	
Log						
S32	1,2	QueryLogByTime	TP		N	
S33	1,2	QueryLogAfter	TP		N	
S34	1,2	GetLogStatusValues	TP		N	

Generic substation event model (GSE)						
GOOSE						
S35	1,2	SendGOOSEMessage	MC		Y	
GOOSE Control Block						
S36	1,2	GetGoReference	TP			
S37	1,2	GetGOOSEElementNumber	TP			
S38	1,2	GetGoCBValues	TP		Y	
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)						
S40	1,2	SendGSSEMessage	MC		N	Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)						
S41	1,2	GetGsReference	TP		N	Deprecated
S42	1,2	GetGSSEDataOffset	TP		N	Deprecated
S43	1,2	GetGsCBValues	TP		N	Deprecated
S44	1,2	SetGsCBValues	TP		N	Deprecated

Transmission of sampled value model (SVC)						
Multicast SV						
S45	1,2	SendMSVMessage	MC		N	Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP		N	
S47	1,2	SetMSVCBValues	TP		N	
Unicast SV						
S48	1,2	SendUSVMessage	TP		N	
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP		N	
S50	1,2	SetUSVCBValues	TP		N	

Control						
S51	1,2	Select	TP		Y	SBO Normal Security
S52	1,2	SelectWithValue	TP		Y	SBO Enhanced Security

S53	1,2	Cancel	TP		Y	
S54	1,2	Operate	TP		Y	
S55	1,2	CommandTermination	TP		Y	
S56	1,2	TimeActivatedOperate	TP		N	

File transfer						
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP		N	
S59	1,2	DeleteFile	TP		N	
S60	1,2	GetFileAttributeValues	TP		Y	
S61	1,2	GetServerDirectory (FILE)	TP		Y	

Time						
T1	1,2	Time resolution of internal clock	-		2ms	nearest negative power of 2 in seconds
T2	2	Time accuracy of internal clock	-			TL (ms) (low accuracy), T3 < 7) (only Ed2)
	1,2		-			T0 (ms) (<= 10 ms), 7 <= T3 < 9)
	1,2		-			T1 (µs) (<= 1 ms), 10 <= T3 < 13
	1,2		-			T2 (µs) (<= 100 µS), 13 <= T3 < 15
	1,2		-			T3 (µs) (<= 25 µS), 15 <= T3 < 18
	1,2		-			T4 (µs) (<= 4 µS), 18 <= T3 < 20
	1,2		-		Y	T5 (µs) (<= 1 µS), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1ms	nearest negative power of 2 in seconds

2 PICS ("Protocol Implementation Conformance Statement")

The tables in sections below appear in the same sequence as in standard IEC 61850-8-1, section 24.

The tables refer to part 7 of the standard and the corresponding information must be contained in the PICS.

2.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- X: Excluded. The implementation shall not implement this item.
- i: Out-of-scope. The implementation of the item is not within the scope of this standard.
- F/S: Functional Standard. Should be applied.
- Base: Shall be applied in any application claiming conformance to this standard.

2.2 Profile conformance

The following tables define the basic conformance statement.

2.2.1 PICS for A-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		realized	realized	
A1	Client/server A-profile	N	Y	
A2	GOOSE/GSE Management A-profile	Y	Y	Only GOOSE not GSE management
A3	GSSE A-profile	Y	Y	
A4	Time sync A-profile	Y	N	

2.2.2 PICS for T-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		Realized	Realized	
T1	TCP/IP T-profile	N	Y	
T2	OSI T-profile	N	N	
T3	GOOSE/GSE T-profile	Y	Y	Only GOOSE not GSE management
T4	GSSE T-profile	Y	Y	
T5	TimeSync T-profile	Y	N	

Refer to the services of Part 7 to see whether these profiles are supported. No distinction is made between A- and T-Profiles there because the definition only refers to the application.

2.3 MMS conformance

The following conformance statements are conditional upon the support of the client/server A-Profile (e.g. A1 see profile description in Clause 6) being declared.

Except where present, MMS conformance shall be in accordance with ISO/ISP 14226-2.

2.3.1 MMS Initiate conformance

2.3.1.1 MMS InitiateRequest general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateRequest				
localDetailCalling			Y	
proposedMaxServOutstandingCalling			Y	
ProposedMaxServOustandingCalled			Y	
InitRequestDetail			Y	
InitiateRequestDetail				
proposedVersionNumber			Y	
proposedParameterCBB			Y	
servicesSupportedCalling			Y	
additionalSupportedCalling			N	
additionalCbbSupportedCalling			N	
privilegeClassIdentityCalling			N	

2.3.1.2 MMS InitiateResponse general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateResponse				
localDetailCalled			Y	
negotiatedMaxServOutstandingCalling			Y	1
negotiatedMaxServOustandingCalled			Y	3
initResponseDetail			Y	
InitiateResponseDetail			Y	
negotiatedVersionNumber			Y	
negotiatedParameterCBB			Y	
servicesSupportedCalled			Y	
additionalSupportedCalled			N	
additionalCbbSupportedCalled			N	
privilegeClassIdentityCalled			N	

2.3.2 MMS services supported conformance statement

This table defines the service support requirement, and restrictions, for this standard. Relationship to ACSI services can be found in Table 1 of Part 8-1.

MMS service supported CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
status			Y	
getNameList			Y	
identify			Y	
rename			N	
read			Y	
write			Y	
getVariableAccessAttributes			Y	
defineNamedVariable			N	
defineScatteredAccess			N	
getScatteredAccessAttributes			N	
deleteVariableAccess			N	
defineNamedVariableList			N	
getNamedVariableListAttributes			Y	
deleteNamedVariableList			N	
defineNamedType			N	
getNamedTypeAttributes			N	
deleteNamedType			N	
Input			N	
Output			N	
takeControl			N	
relinquishControl			N	
defineSemaphore			N	
deleteSemaphore			N	
reportPoolSemaphoreStatus			N	
reportSemaphoreStatus			N	
initiateDownloadSequence			N	
downloadSegment			N	
terminateDownloadSequence			N	
initiateUploadSequence			N	
uploadSegment			N	
terminateUploadSequence			N	
requestDomainDownload			N	
requestDomainUpload			N	
loadDomainContent			N	
storeDomainContent			N	
deleteDomain			N	
getDomainAttributes			Y	
createProgramInvocation			N	
deleteProgramInvocation			N	
Start			N	
Stop			N	
Resume			N	
Reset			N	
Kill			N	
getProgramInvocationAttributes			N	

obtainFile			N	
defineEventCondition			N	
deleteEventCondition			N	
getEventConditionAttributes			N	
reportEventConditionStatus			N	
alterEventConditionMonitoring			N	
triggerEvent			N	
defineEventAction			N	
deleteEventAction			N	
alterEventEnrollment			N	
reportEventEnrollmentStatus			N	
getEventEnrollmentAttributes			N	
acknowledgeEventNotification			N	
getAlarmSummary			N	
getAlarmEnrollmentSummary			N	
readJournal			N	
writeJournal			N	
initializeJournal			N	
reportJournalStatus			N	
createJournal			N	
deleteJournal			N	
FileOpen			Y	
FileRead			Y	
FileClose			Y	
fileRename			N	
fileDelete			N	
fileDirectory			Y	
unsolicitedStatus			N	
informationReport			Y	
eventNotification			N	
attachToEventCondition			N	
attachToSemaphore			N	
Conclude			Y	
Cancel			Y	
getDataExchangeAttributes			N	
exchangeData			N	
defineAccessControlList			N	
getAccessControlListAttributes			N	
reportAccessControlledObjects			N	
deleteAccessControlList			N	
alterAccessControl			N	
reconfigureProgramInvocation			N	

2.3.3 MMS parameter Conformance Building Block (CBB)

MMS parameter CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
STR1			Y	
STR2			Y	
VNAM			Y	
VALT			Y	

VADR			N	
VSCA			N	
TPY			N	
VLIS			Y	
REAL			N	
CEI			N	
NEST			Y	7
ACO			N	
SEM			N	
CSR			N	
CSNC			N	
CSPLC			N	
CSPI			N	

2.3.4 GetNameList conformance statement

GetNameList	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
ObjectClass			Y	
ObjectScope			Y	
DomainName			Y	
ContinueAfter			Y	
Response+				
List Of Identifier			Y	
MoreFollows			Y	
Response–				
Error Type			Y	
NOTE Object class 'vmd' (formerly VMDSpecific in MMS V1.0) shall not appear. If a request contains this ObjectClass, an MMS Reject shall be issued.				

2.3.5 Variable access conformance statement

2.3.5.1 Supporting productions

2.3.5.1.1 AlternateAccessSelection conformance statement

AlternateAccessSelection	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
accessSelection			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	
alternateAccess			Y	
selectAccess			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	

2.3.5.1.2 VariableAccessSpecification conformance statement

VariableAccessSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	
variableListName			Y	

2.3.5.1.3 VariableSpecification conformance statement

VariableSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
name			Y	
address			N	
variableDescription			N	
scatteredAccessDescription			N	
invalidated			N	

2.3.5.2 Read conformance statement

Read	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
specificationWithResult			Y	
variableAccessSpecification			Y	
Response				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.3 Write conformance statement

Write	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfData			Y	
Response				
failure			Y	
success			Y	

2.3.5.4 InformationReport conformance statement

InformationReport	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.5 GetVariableAccessAttributes conformance statement

GetVariableAccessAttributes	Client-CR		Server-CR	
	Realized	**Value/range**	**Realized**	**Value/range**
Request				
name			Y	
address			N	
Response				
mmsDeletable			Y	
address			N	
typeSpecification			Y	

2.3.5.6 GetNamedVariableListAttributes conformance statement

GetNamedVariableListAttributes	Client-CR		Server-CR	
	Realized	**Value/range**	**Realized**	**Value/range**
Request				
ObjectName			Y	
Response				
mmsDeletable			Y	
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	

2.3.6 File management services

2.3.6.1 FileDirectory conformance statement

FileDirectory	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filespecification			Y	
continueAfter			Y	
Response+				
listOfDirectoryEntry			Y	
MoreFollows			Y	

2.3.6.2 FileOpen conformance statement

FileOpen	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filename			Y	
initialPosition			Y	
Response+				
frsmID			Y	
fileAttributes			Y	

2.3.6.3 FileRead conformance statement

FileRead	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+				
FileData			Y	
moreFollows			Y	

2.3.6.4 FileClose conformance statement

FileClose	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+			Y	

7.3.7.3.2 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **PICS For C650 relay V1_00 firm7_70**.

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 General

The following ACSI conformance statements are used to provide an overview and details about C650 bay controller, with firmware 7.70 and above:

- ACSI BASIC conformance statement.
- ACSI MODELS conformance statement.
- ACSI SERVICE conformance statement.

The statements specify the communication features mapped to IEC 61850-8-1 First Edition and/or Edition 2.

2 ASCI basic conformance statement

The basic conformance statement is defined in Table 7-5: Basic conformance statement

Table 7-5: Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)		Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)			
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used		Y	
B22	**SCSM**: IEC 6185-9-1 used			Ed2:Deprecated
B23	**SCSM**: IEC 6185-9-2 used			
B24	**SCSM**: other			
Generic substation event model (GSE)				
B31	**Publisher** side		Y	
B32	**Subscriber** side	Y		
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			
– Y = supported N or empty = not supported				

3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table 7-6: ACSI models conformance statement.

Table 7-6: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/Comments
If Server or Client side (B11/12) supported				
M1	Logical device		Y	
M2	Logical node		Y	
M3	Data		Y	
M4	Data set		Y	
M5	Substitution			
M6	Setting group control		Y	
	Reporting			
M7	Buffered report control		Y	
M7-1	sequence-number		Y	
M7-2	report-time-stamp		Y	
M7-3	reason-for-inclusion		Y	
M7-4	data-set-name		Y	
M7-5	data-reference		Y	
M7-6	buffer-overflow		Y	
M7-7	entryID		Y	
M7-8	BufTm		Y	
M7-9	IntgPd		Y	
M7-10	GI		Y	
M7-11	conf-revision		Y	
M8	Unbuffered report control		Y	
M8-1	sequence-number		Y	
M8-2	report-time-stamp		Y	
M8-3	reason-for-inclusion		Y	
M8-4	data-set-name		Y	
M8-5	data-reference		Y	
M8-6	BufTm		Y	
M8-7	IntgPd		Y	
M8-8	GI		Y	
M8-9	conf-revision		Y	
	Logging			
M9	Log control			
M9-1	IntgPd			
M10	Log			
M11	Control		Y	
M17	File Transfer		Y	
M18	Application association		Y	
M19	GOOSE Control Block		Y	
M20	Sampled Value Control Block			
If GSE (B31/32) is supported				
M12	GOOSE		Y	
M13	GSSE			Deprecated
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
For all IEDs				
M16	Time	Y	Y	

Y = service is supported N or empty = service is not supported

4 ACSI service conformance statement

The ACSI service conformance statement is defined in Table 7-7: ACSI service conformance statement.

Table 7-7: ACSI service conformance statement

	Ed	ACSI Service	AA: TP/MC	Client Sub(C)	Server Pub(S)	Comments
Server						
S1	1,2	GetServerDirectory(LOGICAL-DEVICE)	TP		Y	
Application association						
S2	1,2	Associate	TP		Y	
S3	1,2	Abort	TP		Y	
S4	1,2	Release	TP		Y	
Logical device						
S5	1,2	GetLogicalDeviceDirectory	TP		Y	
Logical node						
S6	1,2	GetLogicalNodeDirectory	TP		Y	
S7	1,2	GetAllDataValues	TP		Y	
Data						
S8	1,2	GetDataValues	TP		Y	
S9	1,2	SetDataValues	TP		Y	
S10	1,2	GetDataDirectory	TP		Y	
S11	1,2	GetDataDefinition	TP		Y	
Data set						
S12	1,2	GetDataSetValues	TP		Y	
S13	1,2	SetDataSetValues	TP		N	
S14	1,2	CreateDataSet	TP		N	
S15	1,2	DeleteDataSet	TP		N	
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP		N	Ed1 only
Setting group control						
S18	1,2	SelectActiveSG	TP		Y	
S19	1,2	SelectEditSG	TP		Y	
S20	1,2	SetEditSGValues	TP		Y	
S21	1,2	ConfirmEditSGValues	TP		Y	
S22	1,2	GetEditSGValues	TP		Y	
S23	1,2	GetSGCBValues	TP		Y	
Reporting						
Buffered report control block (BRCB)						
S24	1,2	Report	TP		Y	
S24-1	1,2	data-change (dchg)			Y	
S24-2	1,2	quality-change (qchg)			Y	
S24-3	1,2	data-update (dupd)			N	
S25	1,2	GetBRCBValues	TP		Y	
S26	1,2	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)						
S27	1,2	Report	TP		Y	

S27-1	1,2	data-change (dchg)			Y	
S27-2	1,2	quality-change (qchg)			Y	
S27-3	1,2	data-update (dupd)			N	
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	

Logging					
Log control					
S30	1,2	GetLCBValues	TP		N	
S31	1,2	SetLCBValues	TP		N	
Log					
S32	1,2	QueryLogByTime	TP		N	
S33	1,2	QueryLogAfter	TP		N	
S34	1,2	GetLogStatusValues	TP		N	

Generic substation event model (GSE)					
GOOSE					
S35	1,2	SendGOOSEMessage	MC		Y	
GOOSE Control Block					
S36	1,2	GetGoReference	TP			
S37	1,2	GetGOOSEElementNumber	TP			
S38	1,2	GetGoCBValues	TP		Y	
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)					
S40	1,2	SendGSSEMessage	MC		N	Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)					
S41	1,2	GetGsReference	TP		N	Deprecated
S42	1,2	GetGSSEDataOffset	TP		N	Deprecated
S43	1,2	GetGsCBValues	TP		N	Deprecated
S44	1,2	SetGsCBValues	TP		N	Deprecated

Transmission of sampled value model (SVC)					
Multicast SV					
S45	1,2	SendMSVMessage	MC		N	Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block					
S46	1,2	GetMSVCBValues	TP		N	
S47	1,2	SetMSVCBValues	TP		N	
Unicast SV					
S48	1,2	SendUSVMessage	TP		N	
Unicast Sampled Value Control Block					
S49	1,2	GetUSVCBValues	TP		N	
S50	1,2	SetUSVCBValues	TP		N	

Control					
S51	1,2	Select	TP		Y	SBO Normal Security
S52	1,2	SelectWithValue	TP		Y	SBO Enhanced Security
S53	1,2	Cancel	TP		Y	
S54	1,2	Operate	TP		Y	
S55	1,2	CommandTermination	TP		Y	
S56	1,2	TimeActivatedOperate	TP		N	

File transfer					
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP		N	
S59	1,2	DeleteFile	TP		N	
S60	1,2	GetFileAttributeValues	TP		Y	
S61	1,2	GetServerDirectory (FILE)	TP		Y	

Time					
T1	1,2	Time resolution of internal clock	-		2ms	nearest negative power of 2 in seconds

T2	2	Time accuracy of internal clock	-			TL (ms) (low accuracy), T3 < 7) (only Ed2)
	1,2		-			T0 (ms) (<= 10 ms), 7 <= T3 < 10)
	1,2		-			T1 (μs) (<= 1 ms), 10 <= T3 < 13
	1,2		-			T2 (μs) (<= 100 μS), 13 <= T3 < 15
	1,2		-			T3 (μs) (<= 25 μS), 15 <= T3 < 18
	1,2		-			T4 (μs) (<= 4 μS), 18 <= T3 < 20
	1,2		-		Y	T5 (μs) (<= 1 μS), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1ms	nearest negative power of 2 in seconds

7.3.7.3.3 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **MICS for 650 family of relays rev 1.05 firm 7_72**.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1 Logical Node List

IEC61850 profile has been updated for C650 firmware version 7.00. The Firmware version 7.00 and above supports IEC 61850 Edition 2. Several Logical Nodes have been added and they have been distributed according its functionality in two different Logical Devices, one for protection functions and the other for control and measure functions. LGOS (24 instances), PTRC, RBRF, RFLO and CILO (16 instances) have been included. Other Logical Nodes like XSWI and CSWI have increased their instances to 16 for each one. GGIO nodes and the Logical Nodes for protection functions have suffered some extensions.

For firmware 7.20 new logical nodes have been included in the data model such as RDRE, RBDR and PTTR. Other logical nodes like PTOF and PTUF have increased their instances to 6 for each one and suffered some extensions, and CSWI logical node has also extended its data model.

For firmware 7.72 new logical nodes have been included in the data model: LCCH, LTMS, SGCB, SCBR and vouGGIO.

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
LCCH (Physical communication channel supervision)
LGOS (GOOSE subscription)
LTMS (Time master supervision)
GoCB (GOOSE Control Block class definition)
SGCB (Setting Group Control Block class definition)
C: Logical Nodes for control
CILO (Interlocking)
CSWI (Switch controller)
R: Logical nodes for protection related functions
RREC (Autoreclosing)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMXU (Measurement)
MSQI (Sequence and imbalance)
MMTR (Metering)
X: Logical Nodes for switchgear
XCBR (Circuit breaker)
XSWI (Circuit switch)
S: Logical Nodes for supervision and monitoring
SCBR (Circuit breaker supervision)

2 Logical Nodes and Extensions

Notation:

M: Data is mandatory in the IEC-61850-7-4.

O: Data is optional in the IEC-61850-7-4 and is used in the device.

E: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1 LPHD (Physical device information)

LPHD class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	geDPL	Physical device name plate	M	
PhyHealth	geHealthENS	Physical device health	M	
Proxy	geSPS	Indicates if this LN is a proxy	M	

2.1.2.1 LLN0 (geLLNO) Logical node zero --> one instance in Protection LDevice

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	
OpTmh	geINS	Operation time	O	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.2.2 LLN0 (geLLN0_LocSta) Logical node zero --> one instance in Control LDevice

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	

OpTmh	geINS	Operation time	O	
LocSta	geSPC_2	Switching authority at station level	O	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.3 LCCH (geLCCG) --> Physical communication channel supervision: one instance in Control LDevice

LCCH class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LCCH		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
ChLiv	geSPS	Physical channel status	M	
RedChLiv	geSPS	Physical channel status of redundant channel	O	

2.1.4 LGOS (LGOS) --> GOOSE subscription information: 24 instances in Control LDevice

For firmware version 7.00 or higher, this LN Logical is used for monitoring GOOSE messages, diagnosing the subscription state of a GOOSE message and has 24 instances inside the device.

LGOS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LGOS		GOOSE Subscription		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Status Information				
St	geSPS	Status of the subscription	M	
LastStNum	geINS	Last status number received	O	
ConfRevNum	geINS	Expected conf. revision num.	O	
Settings				
GoCBRef	geORG	Ref. to the subscribed GOOSE control block	O	

2.1.5 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)
GoID	VISIBLE STRING65	GO	
DatSet	Object Reference	GO	
ConfRev	INT32U	GO	
NdsCom	BOOLEAN	GO	
DstAddress	PHYCOMADDR	GO	

2.1.6 LTMS (geLTMS) --> Time Synchronization: one instance in Control LDevice

LTMS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LTMS		Time master supervision		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
TmSrc	geVSS	Current time source	M	

2.1.7 SGCB (Setting Group control block class definition)

SGCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
NumOfSG	INT8U	SE/SG	Total number of settings group available in the LDevice. Fixed as 6
ActSG	INT8U	SE/SG	
EditSG	INT8U	SE/SG	
CnfEdit	BOOLEAN	SE/SG	
LactTm	TimeStamp	SE/SG	

2.2 Logical Nodes for control. LN Group: C

2.2.1 CSWI (Switch controller)

a) CSWI (geCSWI)

This logical node class is used for switchgear status and has 16 instances inside the device.

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
Loc	geSPS	Local operation	M	Local/Remote
Pos	geDPC_1	Switch position	M	Breaker open, close

2.2.2 CILO (Interlocking)

a) CILO (geCILO) --> 16 instance in Control LDevice

CILO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CILO		Switch controller		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
EnaOpn	geSPS	Enable Open	M	
EnaCls	geSPS	Enable Close	M	

2.3 Logical Nodes for protection related functions. LN Group: R

2.3.1 RREC (Autoreclosing)

a) geRREC

This logical node class is used for autorecloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC		Autoreclosing Element		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
OpCls	geGeneralACT	Direction	M	
AutoRecSt	geAutoRecStENS	Operate	M	
AutoRecLo	geINS_1	Block	O	
AutoRecBlk	geINS_1	Block Input	O	
RecCyc	INS	Actual reclose cycle	O	
Settings				
RRECEna	geSPG	Function	O	
MaxNumShot	geING_0	Max. Number Shots	O	
Rec1Tmms1	geING_8	Dead Time 1	O	
Rec1Tmms2	geING_8	Dead Time 2	O	
Rec1Tmms3	geING_8	Dead Time 3	O	
Rec1Tmms4	geING_8	Dead Time 4	O	
RclTmms	geING_8	Reclaim time		
CondEna	geSPG	Cond. Permission		
HoldTmms	geFloatASG_1	Hold Time		
RsTmms	geFloatASG_1	Reset Time		

2.4 Logical Nodes for generic references. LN Group: G

2.4.1 GGIO (Generic process I/O)

a) GGIO (geGGIO) --> 4 instances in Control LDevice

This logical node class is used is used to map digital and analogue inputs of 6 I/O boards F, G, H and J, 2H, 2J.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
BoardSt	geSPS_1	Board status	O	
Ind1	geSPS	Status contact input 1	O	
Ind2	geSPS	Status contact input 2	O	
..	..	..	..	
Ind32	geSPS	Status contact input 32	O	
Ind33	geSPS	Status contact output 1	O	
..	..		..	
Ind48	geSPS	Status contact output 16	O	
Measured and metered values				
AnIn1	geFloatMV	Analog input 1	O	
AnIn2	geFloatMV	Analog input 2	O	
..	..		..	
AnIn8	geFloatMV	Analog input 8	O	
Settings				
VThrldA	geIntASG_1	Voltage threshold A	O	
VThrldB	geIntASG_1	Voltage threshold B	O	
VThrldC	geIntASG_1	Voltage threshold C	O	
VThrldD	geIntASG_1	Voltage threshold D	O	
DbceTmmsA	geING_0	Debounce time A	O	
DbceTmmsB	geING_0	Debounce time B	O	
DbceTmmsC	geING_0	Debounce time C	O	
DbceTmmsD	geING_0	Debounce time D	O	
InTyp01	geING_0	Type input 1	O	
InTyp02	geING_0	Type input 2	O	
..	..	..	..	
InTyp32	geING_0	Type input 32	O	
DlInTmms01	geING_0	Delay time input 1	O	
DlInTmms02	geING_0	Delay time input 2	O	
..	..	..	..	
DlInTmms32	geING_0	Delay time input 32	O	
OutLogic01	geING_0	Logic output 1	O	
OutLogic02	geING_0	Logic output 2	O	
..	..	..	..	
OutLogic16	geING_0	Logic output 16	O	
OutTyp01	geING_0	Type output 1	O	
OutTyp02	geING_0	Type output 2	O	
..		..	..	
OutTyp16	geING_0	Type output 16	O	

PlsOutTmms01	geING_0	Pulse time output 1	O	
PlsOutTmms02	geING_0	Pulse time output 2	O	
..	..		..	
PlsOutTmms16	geING_0	Pulse time output 16	O	
Rng01	geING_0	Range analog input 1	O	
Rng02	geING_0	Range analog input 2	O	
..	..	..	..	
Rng08	geING_0	Range analog input 8	O	
OscTmmsA	geING_0	Oscillation time A	O	
OscTmmsB	geING_0	Oscillation time B	O	
OscTmmsC	geING_0	Oscillation time C	O	
OscTmmsD	geING_0	Oscillation time D	O	
NumChgs	geING_0	Number of transient changes	O	
SnpshtEvEna	geSPG	Snapshot Events enabled	O	

b) geVirtualGGIO: 1 virtual inputs logical node

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
DPCSO01	geSPC	Virtual Input 1	O	
DPCSO02	geSPC	Virtual Input 2	O	
..	..	..	..	
DPCSO64	geSPC	Virtual Input 64	O	

c) geEventsGGIO: 1 control events logical node

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Control Event 1	O	
Ind2	geSPS	Control Event 2	O	
....	....	....	....	
Ind192	geSPS	Control Event 32	O	

d) geRemoteInputsGGIO: 1 Remote Input logical node

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital input 1	O	
Ind2	geSPS	Remote digital input 2	O	
..	..	..	..	
Ind64	SgePS	Remote digital input 32	O	
AnIn1	geFloatMV	Remote float input 1	O	
AnIn2	geFloatMV	Remote float input 2	O	
..	..	..	..	
AnIn8	FgeloatMV	Remote float input 8	O	
AnIn9	geIntMV_1	Remote integer input 1	O	
AnIn10	geIntMV_1	Remote integer input 2	O	
..	..	..	..	
AnIn16	geIntMV_1	Remote integer input 8	O	
Settings				
OscTmms	geING_0	Oscillation time remote inputs	O	
NumChgs	geING_0	Number of transient changes	O	
InRef1	ORG_1	Remote digital input 1	O	
InRef64	ORG_1	Remote digital input 64	O	
InRef65	ORG_1	Remote analog input 1	O	
InRef80	ORG_1	Remote analog input 16	O	

e) geRemoteOutputsGGIO: 1 remote output logical node

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital output 1	O	
Ind2	geSPS	Remote digital output 2	O	
..	..	..	..	
Ind32	geSPS	Remote digital output 32	O	

f) DigitalCountersGGIO: 1 digital counter logical node

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Cnt1	geBCR_2	Digital counter 1	O	
..	..	..	..	
Cnt8	geBCR_2	Digital counter 8	O	
CntBlk1	geSPS_1	Digital counter 1 block	O	
..	..	..		
CntBlk8	geSPS_1	Digital counter 8 block	O	
CntHi1	geSPS_1	Digital counter 1 high	O	
..	..	..		
CntHi8	geSPS_1	Digital counter 8 high	O	
CntEq1	geSPS_1	Digital counter 1 equal	O	
..	..	..		
CntEq8	geSPS_1	Digital counter 8 equal	O	
CntLo1	geSPS_1	Digital counter 1 low	O	
..	..	..		
CntLo8	geSPS_1	Digital counter 8 low	O	
CntUp1	geSPS_1	Digital counter 1 up	O	
..	..	..		
CntUp8	geSPS_1	Digital counter 8 up	O	
CntDwn1	geSPS_1	Digital counter 1 down	O	
..	..	..		
CntDwn8	geSPS_1	Digital counter 8 down	O	
CntSetPre1	geSPS_1	Digital counter 1 set preset	O	
..	..	..		
CntSetPre8	geSPS_1	Digital counter 8 set preset	O	
CntRst1	geSPS_1	Digital counter 1 reset	O	
..	..	..		
CntRst8	geSPS_1	Digital counter 8 reset	O	
CntFrzRst1	geSPS_1	Digital counter 1 FreezeReset	O	
..	..	..		
CntFrzRst8	geSPS_1	Digital counter 8 FreezeReset	O	
CntFrzCnt1	geSPS_1	Digital counter 1 FreezeCount	O	
..	..	..		
CntFrzCnt8	geSPS_1	Digital counter 8 FreezeCount	O	

g) vouGGIO (gevouGGIO) --> virtual outputs: 1 instance in Control LDevice

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
AnOutInt1	geIntMV_2	Virtual output analog Int32 1	O	
...	...	...		
AnOutInt50	geIntMV_2	Virtual output analog Int32 50	O	
AnOutF1	geFloatMV_5	Virtual output analog Flt32 1	O	
...	...	...		
AnOutF50	geFloatMV_5	Virtual output analog Flt32 50	O	

2.5 Logical Nodes for metering and measurement. LN Group: M

2.5.1 MMXU (Measurement)

a) geMMXU: 1 logical node

MMXU class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured Values				
TotW	geFloatMV	Total active power (P)	O	
TotVAr	geFloatMV	Total reactive power (Q)	O	
TotVA	geFloatMV	Total apparent power (S)	O	
TotPF	geFloatMV	Average power factor (PF)	O	
Hz	geFloatMV	Line frequency	O	
PPV	geFloatDEL	Phase to phase voltages (VL1L2,...)	O	
PhV	geFloatPhsWYE	Phase to ground voltages (VL1ER,...)	O	
A	geFloatWYE	Phase currents (IL1,...)	O	
AuxV	geFloatCMV_1	Auxiliary phase voltage	O	
BusHz	geFloatMV_1	Auxiliary phase voltage	O	

2.5.2 MSQI (Sequence and imbalance)

a) geMSQI: 1 logical node

MSQI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O**	**Notes**
MSQI		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	

Measured Values				
SeqA	geFloatSEQ		O	
SeqV	geFloatSEQ		O	

2.5.3 MMTR (Metering)

a) geMMTR --> pulse counters (MMTR1) and energy calculation (MMTR2): 2 instances in Control LDevice

MMTR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O**	**Notes**
MMTR		Measurement		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured Values				
SupWh	geBCR	Pulse Counter 1/Real energy supply	O	
SupVArh	geBCR	Pulse Counter 2/Reactive energy supply	O	
DmdWh	geBCR	Pulse Counter 3/Real energy demand	O	
DmdVArh	geBCR	Pulse Counter 4/Reactive energy demand	O	
CntPsWh	geFloatMV_1	Positive Wat Counter	O	
CntNgWh	geFloatMV_1	Negative Wat Counter	O	
CntPsVArh	geFloatMV_1	Positive VAR Counter	O	
CntNgVArh	geFloatMV_1	Negative VAR Counter	O	

2.6 Logical Nodes for switchgear. LN Group: X

2.6.1 XCBR (Circuit Breaker)

geXCBR: 1 circuit breaker

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	BgeehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
OpCnt	geINS	Operation counter	M	Breaker openings
SumSwARs			O	
CBOpCap	geCBOpCapENS	Cicruit breaker operating capability	O	
Controls				
Pos	geDPC_1	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
Settings				
ThAlSwA	geFloatASG_1	Maximum KI2t	O	
SumSwATmms	geFloatASG_1	KI2t Integ. Time	O	
ExNumTr	geIntASG_1	Maximum Openings	O	
ExNumTr1hr	geIntASG_1	Max.Openings 1 hour	O	

2.6.2 XSWI (Circuit switch)

a) geXSWI: 16 switchgear

XSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local/Remote
EEHealth	geEEHealthENS	Ext. equipment health	O	
OpCnt	INS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC_2	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
SwTyp	geSwTypENS	Switch type	M	
SwOpCap	geSwOpCapENS	Switch operating capability		

2.7 Logical Nodes for supervision and monitoring. LN Group: S

2.7.1 SCBR (Circuit Breaker Supervision)

SCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
SCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
ColOpn	geSPS	Open command of trip coil	M	
AbrAlm	geSPS	Contact abrasion alarm	O	
OpTmOpnAlm	geSPS_1	Opening time exceed	O	
OpTmClsAlm	geSPS_1	Closing time exceed	O	
Measured Values				
AccAbr	geFloatMV_4	Cumulated abrasion	O	
OpTmOpn	geFloatMV_4	Operation time open	O	
OpTmCls	geFloatMV_4	Operation time close	O	

3. Common Data Class

3.1 Common Data Class for status information

3.1.1 Single Point Status (SPS)

SPS class (Single point status)
geSPS

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSPS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.2 Integer Status (INS)

INS class (Integer status)					
geINS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	INT32	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geINS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.3 Enumerated Status (ENS)

ENS class (Enumerated status)					
geAutoRecStENS (AutoRecSt)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geBehENS (Beh)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	On,blocked,test,test/blocked,Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geHealthENS (Health)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geEEHealthENS (EEHealth)					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
status					
stVal	INT32	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geCBOpCapENS (CBOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close-Open,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwOpCapENS (SwOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwTypENS (SwTyp)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Load Break,Disconnector,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

3.1.4 Protection activation information (ACT)

ACT class (Protection activation information)					
gePhsACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
gePhsACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**

DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
geNeutACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
geGeneralACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.5 Directional protection activation information (ACD)

ACD class (Directional protection activation information)					
gePhsACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
gePhsACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geNeutACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**

DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

3.1.6 Binary counter reading (BCR)

BCR class (Binary counter reading)					
geBCR					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	Dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
units	Unit	CF			O
pulsQty	Float32	CF			M
d	Vstring255	DC			O
geBCR_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
geBCR_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2 Common data class specifications for measurand information

3.2.1 Measured Value (MV)

MV class (Measured value)					
geFloatMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
geFloatMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O

rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	FloatAnalogueValue				
	FLOAT32				GC_1
	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geIntMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
d	Vstring255	DC			O
geIntMV_1					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	IntAnalogueValue				
i	INT32U				GC_1
hlim	IntAnalogueValue				
i	UINT32				GC_1
lLim	IntAnalogueValue				
i	INT32U				GC_1
llLim	IntAnalogueValue				
i	INT32U				GC_1
min	IntAnalogueValue				
i	INT32U				GC_1
max	IntAnalogueValue				
i	INT32U				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2.2 Complex Measured Value (CMV)

CMV class (Complex measured value)					
geFloatCMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O

rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
geFloatCMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE class					
geFloatPhsWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O
geFloatWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
net	CMV_0				GC_1
res	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL class (Phase to phase related measured values of a three phase system)					
geFloatDEL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsAB	CMV_0				GC_1
phsBC	CMV_0				GC_1
phsCA	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

3.2.5 Sequence (SEQ)

SEQ class (Sequence)					
geFloatSEQ					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
c1	CMV_0				GC_1
c2	CMV_0				GC_1
c3	CMV_0				GC_1
Measured attributes					
seqT	enumerated	MX		Pos-neg-zero | dir-quad-zero	O
configuration, description and extension					
d	Vstring255	DC			O

3.3 Common data class specifications for controllable status information

3.3.1 Controllable single point (SPC).

SPC class						
geSPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
configuration, description and extension						
ctlModel		ENUMERATED	CF		ctlModel	M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geSPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST

Q	Quality	ST			AC_ST
t	TimeStamp	ST			AC_ST
configuration, description and extension					
ctlModel	ENUMERATED	CF		ctlModel_1	M
d	Vstring255	DC			O

3.3.2 Controllable double point (DPC)

DPC class (Controllable double point)						
geDPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Cancel						
SBO						
SBOw						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M
sboTimeout		INT32U	CF			AC_CO_O
sboClass		ENUMERATED	CF			AC_CO_O
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_2						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M

q	BVstring13	ST	qchg		AC_ST
t	Utctime	ST			AC_ST
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.3.3 Controllable enumerated status (ENC).

ENC class (Controllable integer status)					
geModENC (type Mod)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.4 Common data class specifications for status settings

3.4.1 Single point setting (SPG)

SPG class					
geSPG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.4.2 Integer status setting (ING)

ING class					
geING_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O

dataNs	Vstring255	EX			O
geING_0_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_8_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O

3.4.3 Enumerated status setting (ENG)

ENG class					
geENG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SP		PolQty	AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
geENG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O

3.4.4 Object reference setting

ORG class					
geORG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					

setting					
setSrcRef	ObjectReference	SP		Object reference	M
configuration, description and extension					
d	Vstring255	DC			O

3.5 Common data class specifications for analogue settings

3.5.1 Analog setting (ASG)

ASG class					
geIntASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geIntASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SG			AC_SG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geFloatASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					

setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
geFloatASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SG			AC_SG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O

3.6 Common data class specifications for description information

3.6.1 Device name plate (DPL)

DPL class (Device name plate)					
geDPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
hwRev	Vstring255	DC			O
swRev	Vstring255	DC			O
serNum	Vstring255	DC			O
model	Vstring255	DC			O

3.6.2 Logical node name plate (LPL)

LPL class (Logical node name plate)					
geLPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
geLPL_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
ldNs	Vstring255	EX			O

7.3.7.3.4 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **MICS For C650 relay V1_00 firm7_70**.

This model implementation conformance statement is applicable for C650 Bay Controller, with firmware 7.70 or above.

This MICS document specifies the modeling extensions compared to IEC 61850 edition 1. For the exact details on the standardized model please compare the ICD substation configuration file: “<default_C650E_v770_Ed1.cid>”, version <1.0>.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1 Logical Node List

The following table contains the list of logical nodes implemented in the device:

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
GoCB (GOOSE Control Block Class definition)
R: Logical nodes for protection related functions
RBDR (Disturbance recorder channel binary)
RDRE (Disturbance recorder function)
RREC (Autoreclosing)*
RSYN (Synchrocheck)*
C: Logical Nodes for control
CILO (Interlocking)
CSWI (Switch controller)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMTR (Metering)
MMXU (Measurement)
MSQI (Sequence and imbalance)
X: Logical Nodes for switchgear
XCBR (Circuit breaker)
XSWI (Circuit switch)

* Only present in Enhanced models

2 Logical Nodes and Extensions

Notation:

- M: Data is mandatory in the IEC-61850-7-4.
- O: Data is optional in the IEC-61850-7-4 and is used in the device.
- E: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1 LPHD (Physical device information)

LPHD class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	geDPL	Physical device name plate	M	
PhyHealth	geHealthINS	Physical device health	M	
Proxy	geSPS	Indicates if this LN is a proxy	M	

2.1.2 LLN0 (Logical node zero)

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	
OpTmh	geINS	Operation time	O	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.3 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)
GoID	VISIBLE STRINGS	GO	
DatSet	Object Reference	GO	
ConfRev	INT32U	GO	
NdsCom	BOOLEAN	GO	
DstAddress	PHYCOMADDR	GO	

2.2 Logical Nodes for protection related functions. LN Group: R

2.2.1 RREC (Autoreclosing)*

2.2.1.1 geRREC

This logical node class is used for autorecloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC		Autoreclosing Element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Op	geGeneralACT		M	
OpCls	geGeneralACT	Direction	M	
AutoRecSt	geAutoRecStINS	Operate	M	
AutoRecLo	geINS_1	Block	O	
AutoRecBlk	geINS_1	Block Input	O	
Settings				
RRECEna	geSPG	Function	O	
MaxNumShot	geING_0	Max. Number Shots	O	
Rec1Tmms1	geING_8	Dead Time 1	O	
Rec1Tmms2	geING_8	Dead Time 2	O	
Rec1Tmms3	geING_8	Dead Time 3	O	
Rec1Tmms4	geING_8	Dead Time 4	O	
RclTmms	geING_8	Reclaim time		
CondEna	geSPG	Cond. Permission		
HoldTmms	geFloatASG_1	Hold Time		
RsTmms	geFloatASG_1	Reset Time		

*Only present in Enhanced models

2.2.2 RSYN (Synchronism-check)*

2.2.2.1 RSYN

This logical node class is used modeling the synchrocheck function and has 1 instance inside the device

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RSYN		Synchronism-check		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Blk	geSPS	Block signal	O	
SynOp	geSPS_1	Closing permission signal	O	
Rel	geSPS	Release	M	
SynCondOp	geSPS_1	Closing perm. according to logic	O	
DLDBOp	geSPS_1	Closing perm. in DLDB condition	O	
DLLBOp	geSPS_1	Closing perm. in DLLB condition	O	

LLDBOp	geSPS_1	Closing perm. in LLDB condition	O	
HzInd	geSPS	Frequency difference indicator	O	
BusHzHiLinHz	geSPS_1	Busbar frequency > line frequency	O	
BusHzLoLinHz	geSPS_1	Busbar frequency < line frequency	O	
Measured values				
DifVClc	geFloatMV	Calculated difference in voltage	O	
DifHzClc	geFloatMV	Calculated difference in frequency	O	
DifAngClc	geFloatMV	Calculated difference in angle	O	
Settings				
RSYNEna	geSPG	Function	O	
DeaBusVal	geFloatASG	Dead bus value	O	
LivBusVal	geFloatASG	Live bus value	O	
DeaLinVal	geFloatASG	Dead line value	O	
LivLinVal	geFloatASG	Live line value	O	
DifV	geFloatASG	Difference voltage	O	
DifAng	geFloatASG	Difference angle	O	
DifHz	geIntASG	Difference frequency	O	
TotTmms	geING_8	Total time of synch. process	O	
DLDBEna	geSPG	Dead line - dead bus permission	O	
LLDBEna	geSPG	Live line - dead bus permission	O	
DLLBEna	geSPG	Dead line - live bus permission	O	
EventEna	geSPG	Snapshot events enabled	O	

*Only present in Enhanced models

2.2.3 RDRE (Disturbance recorder function)

This logical node class is used modeling the disturbance recording function and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RDRE class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RDRE		Disturbance recorder		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
RcdMade	geSPS	Recording made	M	
FltNum	geINS	Fault number	M	
CycRcd	geINS_1	Cycles per record	O	
RcdNum	geINS_1	Available records	O	
Controls				
RcdTrg	geSPC_1	Trigger recorder	M	
Settings				
RDREEna	geSPG	Oscillography function enable	O	
TrgPos	geINS_0	Trigger position	O	
SmpCyc	geINS_10	Samples per cycle	O	
MaxNumRcd	geINS_8	Maximum number of records	O	
RcdMod	geINS_11	Recorder operation mode	O	
EventEna	geSPG	Snapshot events enabled	O	

2.2.4 RBDR (Disturbance recorder channel binary):

This logical node class is used for providing the circuit component and phase identification and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RBDR class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RBDR		Disturbance recorder channel binary		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
ChTrg	geSPS	Channel triggered	M	
FltNum	geINS	Fault Number	M	
DigCh01	geSPS_1	Oscillography digital channel 1	O	
...	...	...	...	
DigCh16	geSPS_1	Oscillography digital channel 16	O	

2.3 Logical Nodes for control. LN Group: C

2.3.1 CSWI (Switch controller)

2.3.1.1 geCSWI

In the CF650 there are up to 16 configurable switchgear.

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
Loc	geSPS	Local operation	M	Local/Remote
Pos	geDPC_3	Switch position	M	Switch open, close, undefined

2.3.2 CILO (Interlocking)

2.3.2.1 geCILO --> 16 switchgear

CILO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
CILO		Switch controller		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
EnaOpn	geSPS	Enable Open	M	
EnaCls	geSPS	Enable Close	M	

2.4 Logical Nodes for generic references. LN Group: G

2.4.1 GGIO (Generic process I/O)

2.4.1.1 geBoardGGIO --> 4 instances in Control LDevice

This logical node class is used is used to map digital and analogue inputs of I/O boards F, G, H, J, 2H and 2J.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
BoardSt	geSPS_1	Board status	O	
Ind1	geSPS	Status contact input 1	O	
Ind2	geSPS	Status contact input 2	O	
..	..	..	..	
Ind32	geSPS	Status contact input 32	O	
Ind33	geSPS	Status contact output 1	O	
..	..		..	
Ind48	geSPS	Status contact output 16	O	
Measured and metered values				
AnIn1	geFloatMV	Analog input 1	O	
AnIn2	geFloatMV	Analog input 2	O	
..	..		..	
AnIn8	geFloatMV	Analog input 8	O	
Settings				
VThrldA	geIntASG_1	Voltage threshold A	O	
VThrldB	geIntASG_1	Voltage threshold B	O	
VThrldC	geIntASG_1	Voltage threshold C	O	
VThrldD	geIntASG_1	Voltage threshold D	O	
DbceTmmsA	geING_0	Debounce time A	O	
DbceTmmsB	geING_0	Debounce time B	O	
DbceTmmsC	geING_0	Debounce time C	O	
DbceTmmsD	geING_0	Debounce time D	O	
InTyp01	geING_0	Type input 1	O	
InTyp02	geING_0	Type input 2	O	
..	..	..	..	
InTyp32	geING_0	Type input 32	O	
DlInTmms01	geING_0	Delay time input 1	O	
DlInTmms02	geING_0	Delay time input 2	O	
..	..	..	..	
DlInTmms32	geING_0	Delay time input 32	O	
OutLogic01	geING_0	Logic output 1	O	
OutLogic02	geING_0	Logic output 2	O	
..	..	..	..	
OutLogic16	geING_0	Logic output 16	O	
OutTyp01	geING_0	Type output 1	O	
OutTyp02	geING_0	Type output 2	O	
..		..	..	
OutTyp16	geING_0	Type output 16	O	

PlsOutms01	geING_0	Pulse time output 1	O	
PlsOutms02	geING_0	Pulse time output 2	O	
..	..		..	
PlsOutms16	geING_0	Pulse time output 16	O	
Rng01	geING_0	Range analog input 1	O	
Rng02	geING_0	Range analog input 2	O	
..	..	..	..	
Rng08	geING_0	Range analog input 8	O	
OscTmmsA	geING_0	Oscillation time A	O	
OscTmmsB	geING_0	Oscillation time B	O	
OscTmmsC	geING_0	Oscillation time C	O	
OscTmmsD	geING_0	Oscillation time D	O	
NumChgs	geING_0	Number of transient changes	O	
EventEna	geSPG	Snapshot Events enabled	O	

2.4.1.2 geVirtualGGIO

This logical node class is used is used to map the latched and self reset virtual Inputs.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
DPCSO01	geSPC	Virtual input 1	O	
DPCSO01	geSPC	Virtual input 2	O	
..	..	..	..	
DPCSO64	geSPC	Virtual input 32	O	

2.4.1.3 geEventsGGIO

This logical node class is used to map data from the list of any all internal digital states (PLC control events).

GGIO class				
Attribute Name	**Attribute Type**	Explanation	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Control Event 1	O	
Ind2	SPS	Control Event 2	O	
....	....	....	....	
Ind192	SPS	Control Event 32	O	

2.4.1.4 geRemoteInputsGGIO

This logical node class is used to map data from incoming GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital input 1	O	
Ind2	geSPS	Remote digital input 2	O	
..	..	..	..	
Ind64	geSPS	Remote digital input 32	O	
AnIn1	geFloatMV	Remote float input 1	O	
AnIn2	geFloatMV	Remote float input 2	O	
..	..	..	..	
AnIn8	geFloatMV	Remote float input 8	O	
AnIn9	geIntMV_1	Remote integer input 1	O	
AnIn10	geIntMV_1	Remote integer input 2	O	
..	..	..	..	
AnIn16	geIntMV_1	Remote integer input 8	O	
Settings				
OscTmms	geING_0	Oscillation time remote inputs	O	
NumChgs	geING_0	Number of transient changes	O	

2.4.1.5 geRemoteOutputsGGIO

This logical node class is used to map PLC digital states for outgoing GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital output 1	O	
Ind2	geSPS	Remote digital output 2	O	
..	..	..	..	
Ind32	SgePS	Remote digital output 32	O	

2.4.1.6 geDigitalCountersGGIO

This logical node is used for modeling the eight digital counters of F650 relay.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Cnt1	geBCR_2	Digital counter 1	O	
..	..	..	..	
Cnt8	geBCR_2	Digital counter 8	O	
CntBlk1	geSPS_1	Digital counter 1 block	O	
..	..	..		
CntBlk8	geSPS_1	Digital counter 8 block	O	
CntHi1	geSPS_1	Digital counter 1 high	O	
..	..	..		
CntHi8	geSPS_1	Digital counter 8 high	O	
CntEq1	geSPS_1	Digital counter 1 equal	O	
..	..	..		
CntEq8	geSPS_1	Digital counter 8 equal	O	
CntLo1	geSPS_1	Digital counter 1 low	O	
..	..	..		
CntLo8	geSPS_1	Digital counter 8 low	O	
CntUp1	geSPS_1	Digital counter 1 up	O	
..	..	..		
CntUp8	geSPS_1	Digital counter 8 up	O	
CntDwn1	geSPS_1	Digital counter 1 down	O	
..	..	..		
CntDwn8	geSPS_1	Digital counter 8 down	O	
CntSetPre1	geSPS_1	Digital counter 1 set preset	O	
..	..	..		
CntSetPre8	geSPS_1	Digital counter 8 set preset	O	
CntRst1	geSPS_1	Digital counter 1 reset	O	
..	..	..		
CntRst8	geSPS_1	Digital counter 8 reset	O	
CntFrzRst1	geSPS_1	Digital counter 1 FreezeReset	O	
..	..	..		
CntFrzRst8	geSPS_1	Digital counter 8 FreezeReset	O	
CntFrzCnt1	geSPS_1	Digital counter 1 FreezeCount	O	
..	..	..		
CntFrzCnt8	geSPS_1	Digital counter 8 FreezeCount	O	

2.5 Logical Nodes for metering and measurement. LN Group: M

2.5.1 MMXU (Measurement)*

2.5.1.1 geMMXU --> measurement analog values: 1 instance in Control LDevice

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
TotW	geFloatMV	Total active power (P)	O	
TotVAr	geFloatMV	Total reactive power (Q)	O	
TotVA	geFloatMV	Total apparent power (S)	O	
TotPF	geFloatMV	Average power factor (PF)	O	
Hz	geFloatMV	Line Frequency	O	
PPV	geFloatDEL	Phase to phase voltages (VL1L2,...)	O	
PhV	geFloatPhsWYE	Phase to ground voltages (VL1ER, ...)	O	
A	geFloatWYE	Phase currents (IL1, ...)	O	
AuxV	geFloatCMV_1	Auxiliary Phase Voltage	O	
BusHz	geFloatMV_1	Bus Frequency	O	
MaxDmdTotW	geFloatMV_1	Demand W Max	O	
MinDmdTotW	geFloatMV_1	Demand W Min	O	
MaxDmdTotVAr	geFloatMV_1	Demand VAr Max	O	
MinDmdTotVAr	geFloatMV_1	Demand VAr Min	O	
MaxDmdTotVA	geFloatMV_1	Demand VA Max	O	
MinDmdTotVA	geFloatMV_1	Demand VA Min	O	

* Only present in Enhanced models

2.5.2 MSQI (Sequence and imbalance)*

2.5.2.1 MSQI (geMSQI) --> sequence and imbalance analog values: 1 instance in Control LDevice

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MSQI		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SeqA	geFloatSEQ		O	
SeqV	geFloatSEQ		O	

* Only present in Enhanced models

2.6.3 MMTR (Metering)*

2.6.3.1 geMMTR

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SupWh	geBCR		O	
SupVArh	geBCR		O	
DmdWh	geBCR		O	
DmdVArh	geBCR		O	
CntPsWh	geFloatMV_1		O	
CntNgWh	geFloatMV_1		O	
CntPsVArh	geFloatMV_1		O	
CntNgVArh	geFloatMV_1		O	

* Only present in Enhanced models

2.6 Logical Nodes for switchgear. LN Group: X

2.6.1 XCBR (Circuit Breaker)

2.6.1.1 geXCBR --> 1 circuit breaker: 1 instance in Control LDevice

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Descriptions				
EEname	geDPL	External equipment name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
OpCnt	geINS	Operation counter	M	Breaker openings
SumSwARs			O	
CBOpCap	geCBOpCapENS	Circuit breaker operating capability	O	
Controls				
Pos	geDPC_1	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
Settings				
ThAlSwA	geFloatASG_1	Maximum KI2t	O	
SumSwATmms	geFloatASG_1	KI2t Integ. Time	O	
ExNumTr	geIntASG_1	Maximum Openings	O	
ExNumTr1hr	geIntASG_1	Max.Openings 1 hour	O	

2.6.2 XSWI (Circuit switch)

2.6.2.1 geXSWI

In the C650 there are up to 16 configurable switchgear.

XSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Descriptions				
EEName	DPL	External equipment name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
EEHealth	geEEHealthENS	Ext. equipment health	O	
OpCnt	geINS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC_3	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkCls	geSPC_1	Block closing	M	Virtual output
SwTyp	geSwTypENS	Switch type	M	
SwOpCap	geSwOpCapENS	Switch operating capability		

3. Common Data Class

3.1 Common Data Class for status information

3.1.1 Single Point Status (SPS)

SPS class (Single point status)					
gsSPS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSPS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.2 Integer Status (INS)

INS class (Integer status)					
geINS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	INT32	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geINS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.3 Enumerated Status (ENS)

ENS class (Enumerated status)					
geAutoRecStINS (AutoRecSt)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geBehINS (Beh)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	On,blocked,test,test/blocked,Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geHealthINS (Health)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M

configuration, description and extension					
d	Vstring255	DC			O
geCBOpCapINS (CBOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close-Open,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwOpCapINS (SwOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None,Open,Close,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geSwTypINS (SwTyp)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Load Break, Disconnector,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

3.1.4 Protection activation information (ACT)

ACT class (Protection activation information)					
gePhsACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
gePhsACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O

phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
geNeutACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
configuration, description and extension					
d	Vstring255	DC			O
geGeneralACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.5 Directional protection activation information (ACD)

ACD class (Directional protection activation information)					
gePhsACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
gePhsACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O
geNeutACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

dataNs	Vstring255	EX			AC_DLN_M
geGeneralACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

3.1.6 Binary counter reading (BCR)

BCR class (Binary counter reading)					
geBCR					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	Dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
units	Unit	CF			O
pulsQty	Float32	CF			M
d	Vstring255	DC			O
geBCR_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
geBCR_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1

frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2 Common data class specifications for measurand information

3.2.1 Measured Value (MV)

MV class (Measured value)					
geFloatMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
geFloatMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O

zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geIntMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
d	Vstring255	DC			O

geIntMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	IntAnalogueValue				
i	INT32U				GC_1
hlim	IntAnalogueValue				
i	UINT32				GC_1
lLim	IntAnalogueValue				
i	INT32U				GC_1
llLim	IntAnalogueValue				
i	INT32U				GC_1
min	IntAnalogueValue				
i	INT32U				GC_1
max	IntAnalogueValue				
i	INT32U				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2.2 Complex Measured Value (CMV)

CMV class (Complex measured value)					
geFloatCMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O

zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
geFloatCMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE class					
geFloatPhsWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O
geFloatWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
net	CMV_0				GC_1
res	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL class (Phase to phase related measured values of a three phase system)					
geFloatDEL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsAB	CMV_0				GC_1
phsBC	CMV_0				GC_1
phsCA	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

3.2.5 Sequence (SEQ)

SEQ class (Sequence)					
geFloatSEQ					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
c1	CMV_0				GC_1
c2	CMV_0				GC_1
c3	CMV_0				GC_1
Measured attributes					
seqT	enumerated	MX		Pos-neg-zero | dir-quad-zero	O
configuration, description and extension					
d	Vstring255	DC			O

3.3 Common data class specifications for controllable status information

3.3.1 Controllable single point (SPC).

SPC class						
geSPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
configuration, description and extension						
ctlModel		ENUMERATED	CF		ctlModel	M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
cdcNs		Vstring255	EX			
cdcName		Vstring255	EX			
geSPC_1						

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
control and status					
stVal	Boolean	ST		FALSE | TRUE	AC_ST
Q	Quality	ST			AC_ST
t	TimeStamp	ST			AC_ST
configuration, description and extension					
ctlModel	ENUMERATED	CF		ctlModel_1	M
d	Vstring255	DC			O

3.3.2 Controllable double point (DPC)

DPC class (Controllable double point)						
geDPC						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
cdcNs		Vstring255	EX			
cdcName		Vstring255	EX			
geDPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
control and status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Cancel						
SBO						
SBOw						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
configuration, description and extension						
ctlModel		ENUMERATED	CF			M

sboTimeout	INT32U	CF			AC_CO_O
sboClass	ENUMERATED	CF			AC_CO_O
operTimeout	INT32U	CF			AC_CO_O
d	Vstring255	DC			O
cdcNs	Vstring255	EX			
cdcName	Vstring255	EX			
geDPC_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
stVal	CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q	BVstring13	ST	qchg		AC_ST
t	Utctime	ST			AC_ST
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.3.3 Controllable enumerated status (ENC)

ENC class (Controllable integer status)					
geModINC (type Mod)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.4 Common data class specifications for status settings

3.4.1 Single point setting (SPG)

SPG class					
geSPG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.4.2 Integer status setting (ING)

ING class					
geING_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_0_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_8_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_9					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
geING_10					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					

setting					
setVal	Boolean	SG			AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			
geING_11					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Boolean	SP			
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			

3.4.3 Enumerated status setting (ENG)

ENG class					
geENG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SP		PolQty	AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
geENG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
configuration, description and extension					
d	Vstring255	DC			O

3.4.4 Object reference setting

ORG class					
geORG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setSrcRef	ObjectReference	SP		Object reference	M
configuration, description and extension					
d	Vstring255	DC			O

3.5 Common data class specifications for analogue settings

3.5.1 Analog setting (ASG)

ASG class					
geIntASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	M/O/C
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geIntASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	IntAnalogueValue	SG			AC_NSG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
setMag	IntAnalogueValue	SG			AC_SG_M
i	INT32				GC_1
configuration, description and extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geFloatASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
geFloatASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_1_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setMag	FloatAnalogueValue	SG			AC_NSG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_2					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
setting					
setMag	FloatAnalogueValue	SG			AC_SG_M
f	FLOAT32				GC_1
configuration, description and extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O

3.5.2 Setting curve (CURVE)

geCURVE_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setCharact	ENUMERATED	SG			O
d	Vstring255	DC			O
geCURVE_4					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
setting					
setCharact	ENUMERATED	SG			O
d	Vstring255	DC			O

3.6 Common data class specifications for description information

3.6.1 Device name plate (DPL)

DPL class (Device name plate)					
geDPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
hwRev	Vstring255	DC			O
swRev	Vstring255	DC			O
serNum	Vstring255	DC			O
model	Vstring255	DC			O

3.6.2 Logical node name plate (LPL)

LPL class (Logical node name plate)					
geLPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
geLPL_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
ldNs	Vstring255	EX			O

4. Enum Types

4.2 New Enum Types

4.2.1 setCharact_2

Value	Description	Remarks
0	Definite Time	
1	Inverse Time	

4.2.2 SamplesCycle

Value	Description	Remarks
0	64 samples/cycle	
1	32 samples/cycle	
2	16 samples/cycle	
3	8 samples/cycle	
4	4 samples/cycle	

7.3.7.3.5 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **TICS for 650 family of relays v1_00 firm7_20**.

This document describes the:

- Introduction
- TICS Template

1 Introduction

This document provides a template for the tissues conformance statement (TICS). According to the UCA QAP the TICS is required to perform a conformance test and is referenced on the final certificate.

In this TICS template only tissues with a "green" status are considered since they become mandatory and thus must be included in the UCA Device conformance test procedures.

"Green" Tissues listed in this document represent the current status of all Tissues for a date of the document creation. As for some of the remaining tissues, they are not yet included in the test procedures, either because they are just a recommendation or optional within the IEC 61850 documents, or because their respective proposals are not defined in such detail to be implemented or tested, or because they are simply not applicable, just editorial, with no change for implementation and testing.

The supported ("Sup") column indicates:

- Y: yes, the tissue is implemented in the device.
- N: no, the tissue is not implemented in the device.
- N.A.: not applicable, the tissue is not applicable for the device.

2 TICS Template

Tissue No.	Description	Supported? (Y / N / N/A)
IEC 61850 Part 6		
658	Tracking related features	N/A
663	FCDA element cannot be a "functionally constrained logical node"	Y
668	Autotransformer modeling	N/A
687	SGCB ResvTms	N/A
719	ConfDataSet - maxAttributes definition is confusing	Y
721	Log element name	N/A
768	bType VisString65 is missing	Y
770	Goose ID max. length is 129 characters	Y
779	object references	Y
788	SICS S56 from optional to mandatory	N/A
789	ConfLdName as services applies to both server and client	Y
804	valKind and IED versus System configuration	N/A
806	Max length of log name inconsistent between -6 and -7-2	N/A
807	Need a way to indicate if "Owner" present in RCB	N/A
822	Extension of IED capabilities	N/A
823	ValKind for structured data attributes	N/A
824	Short addresses on structured data attributes	N/A
825	Floating point value	N/A
845	SGCB ResvTms	N/A

Tissue No.	Description	Supported? (Y / N / N/A)
853	SBO and ProtNs	N/A
855	Recursive SubFunction	N/A
856	VoltageLevel frequency and phases	N/A
857	Function/SubFunction for ConductingEquipment	N/A
886	Missing 8-1 P-types	N/A
901	tServices as AP or as IED element	N/A
936	SupSubscription parameter usage is difficult	N/A
1168	doName and daName of ExtRef; doName may have one dot (DO.SDO)	N/A
1175	IPv6 address lowercase only	N/A
IEC 61850 Part 7-1		
828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
1151	simulated GOOSE disappears after 1st appearance when LPHD.Sim = TRUE	N/A
1196	Extensions to standardized LN classes made by third parties	N/A
IEC 61850 Part 7-2		
778	AddCause values - add value not-supported	Y
780	What are unsupported trigger option at a control block?	Y
783	TimOper Resp- ; add Authorization check	N/A
786	AddCause values 26 and 27 are switched	Y
820	Mandatory ACSI services (use for PICS template)	N/A
858	typo in enumeration ServiceType	N/A
861	dchg of ConfRev attribute	N/A
876	GenLogicalNodeClass and SGCB, GoCB, MsvCB, UsvCB	N/A
1038	Loss of Info Detection After Resynch	N/A
1050	GTS Phycomaddr definition in SCL	N/A
1062	Entrytime not used in CDC	N/A
1071	Length of DO name	Y
1091	The sentence "The initial value of EditSG shall be 0", has to be stated in part 7.2 not in 8.1	N/A
1127	Missing owner attribute in BTS and UTS	N/A
1163	Old report in URCB	N/A
1202	GI not optional	Y
IEC 61850 Part 7-3		
697	persistent command / PulseConfig	N/A
698	Wrong case is BAC.dB attribute	N/A
722	Units for 'h' and 'min' not in UnitKind enumeration.	N/A
919	Presence Condition for sVC	N/A
925	Presence of i or f attribute - Problem with writing	N/A
926	Presence Conditions within RangeConfig	Y
IEC 61850 Part 7-4		
671	mistake in definition of Mod & Beh	N/A
674	CDC of ZRRC.LocSta is wrong	N/A
675	SIML LN	N/A
676	Same data object name used with different CDC	N/A
677	MotStr is used with different CDC in PMMS and SOPM LN classes	N/A
679	Remove CycTrMod Enum	N/A
680	SI unit for MHYD.Cndct	N/A
681	Enum PIDAlg	N/A

Tissue No.	Description	Supported? (Y / N / N/A)
682	ANCR.ParColMod	N/A
683	Enum QVVR.IntrDetMth	N/A
685	Enum ParTraMod	N/A
686	New annex H - enums types in XML	N/A
694	Data object CmdBlk	N/A
696	LSVS.St (Status of subscription)	N/A
712	interpretation of quality operatorBlocked	N/A
713	DO Naming of time constants in FFIL	N/A
724	ANCR.Auto	N/A
725	Loc in LN A-group	N/A
734	LLN0.OpTmh vs. LPHD.OpTmh	N/A
735	ISAF.Alm and ISAF.AlmReset	N/A
736	PFSign	N/A
742	GAPC.Str, GAPC.Op and GAPC.StrVal	N/A
743	CCGR.PmpCtl and CCGR.FanCtl	N/A
744	LN STMP, EEHealth and EEName	N/A
772	LPHD.PwrUp/PwrDn shall be transient	N/A
773	Loc, LocKey and LocSta YPSH and YLTC	N/A
774	ITCI.LocKey	N/A
775	KVLV.ClsLim and OpnLim	N/A
776	LPHD.OutOv/InOv and LCCH.OutOv/InOv	N/A
800	Misspelling in CSYN	N/A
802	CCGR and Harmonized control authority	N/A
808	Presence condition of ZMOT.DExt and new DOs	N/A
831	Setting of ConfRevNum in LGOS	N/A
838	Testing in Beh=Blocked	N/A
844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	N/A
849	Presence conditions re-assessing in case of derived statistical calculation	N/A
877	QVUB -settings should be optional	N/A
909	Remove ANCR.ColOpR and ColOpL	N/A
920	Resettable Counter is NOT resettable	N/A
932	Rename AVCO.SptVol to AVCO.VolSpt	N/A
939	Change CDC for ANCR.FixCol	N/A
991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	N/A
1007	PTRC as fault indicator - Update of description required	Y
1044	TapChg in AVCO	N/A
1077	Rename DOnames within LTIM	N/A
IEC 61850 Part 8-1		
784	Tracking of control (CTS)	N/A
817	Fixed-length GOOSE float encoding	N/A
834	File dir name length 64	Y
951	Encoding of Owner attribute	N/A
1040	More associate error codes	N/A
1178	Select Response+ is non-null value	Y

Note: Tissues 675, 735, 772, 775, 776, 878 are not relevant for conformance testing

Compare the TISSUE database for more details: www.tissues.iec61850.com

7.3.7.3.6 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **TICS For C650 relay V1_00 firm7_70**

Mandatory IntOp Tissues

During the October 2006 meeting, IEC TC57 working group 10 decided that:

- green Tissues with the category "IntOp" are mandatory for IEC 61850 edition 1
- Tissues with the category "Ed.2" Tissues should not be implemented.

The table below gives an overview of the implemented IntOp Tissues.

Part	Tissue No.	Description	Implemented Y / N/A
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	N/A
	183	GetNameList error handling	N/A
	246	Control negative response (SBOns) with LastApplError	N/A
	545	Skip file directories with no files	N/A
7-4	252	AlmThm should have CDC SPS	Y
7-3	28	Definition of APC	N/A
	54	Point def xVal, not cVal	N/A
	55	Ineut = Ires ?	N/A
	63	mag in CDC CMV	N/A
	65	Deadband calculation of a Vector and trigger option	N/A
	219	operTm in ACT	N/A
	270	WYE and DEL rms values	N/A
	1199	BCR	N/A

7-2	30	control parameter T	N/A
	31	Typo	N/A
	32	Typo in syntax	N/A
	35	Typo Syntax Control time	Y
	36	Syntax parameter DSet-Ref missing	N/A
	37	Syntax GOOSE "T" type	N/A
	39	Add DstAddr to GoCB	N/A
	40	GOOSE Message "AppID" to "GoID"	N/A
	41	GsCB "AppID" to "GsID"	Y
	42	SV timestamp: "EntryTime" to "TimeStamp"	N/A
	43	Control "T" semantic	N/A
	44	AddCause - Object not sel	N/A
	45	Missing AddCauses	N/A
	46	Synchro check cancel	N/A
	47	"." in LD Name?	N/A
	49	BRCB TimeOfEntry (part of #453)	-
	50	LNName start with number?	N/A
	51	ARRAY [0..num] missing	N/A
	52	Ambiguity GOOSE SqNum	N/A
	53	Add DstAddr to GsCB, SV	N/A
	151	Name constraint for control blocks etc.	N/A
	166	DataRef attribute in Log	N/A
	185	Logging - Integrity periode	N/A
	189	SV Format	N/A
	190	BRCB: EntryId and TimeOfEntry (part of #453)	-
	191	BRCB: Integrity and buffering reports (part of #453)	-
	278	EntryId not valid for a server (part of #453)	-
	297	Sequence number	N/A
	298	Type of SqNum	N/A
	305	Reporting with BufTm = 0	N/A
	322	Write Configuration attribute of BRCBs	N/A
	329	Reporting and BufOvl	N/A
	333	Enabling of an incomplete GoCB	N/A
	335	Clearing of BufOvfl	N/A
	348	URCB class and report	N/A
	349	BRCB TimeOfEntry has two definitions	N/A
	453	Combination of all reporting and logging tissues	N/A
	1281	Trigger option GI is by default	N/A
Part 6	1	Syntax	N/A
	5	tExtensionAttributeNameEnum is restricted	Y
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	Y
	169	Ordering of enum differs from 7-3	N/A
	245	Attribute RptId in SCL	N/A
	529	Replace sev - Unknown by unknown	N/A

Note: Tissue 49, 190, 191, 275 and 278 are part of tissue #453, all other technical tissues in the table are mandatory if applicable.

Note: Editorial tissues are marked as "N/A".

7.3.7.3.7 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **PIXIT for 650 family of relays v1_6 firm7_00**.

This document describes the:

- PIXIT for Association Model
- PIXIT for Server model
- PIXIT for Dataset model
- PIXIT for Reporting model
- PIXIT for Generic substation events model
- PIXIT for Control model
- PIXIT for Time and time synchronization model
- PIXIT for File transfer model

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 650 family of relays.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Contents of this document: Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

1 PIXIT For Association Model

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	5
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1..20s	5 seconds but if no application message is detected within the As3 value, the device closes the connection.
As3	1,2	Lost connection detection time	120 seconds (Configurable)
As4	-	Authentication is not supported yet	
As5	1,2	What association parameters are necessary for successful association	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N
As6	1,2	If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 AP Title N/A AE Qualifier N/A
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 120000 Min MMS PDU size 32000
As8	1,2	What is the maximum start up time after a power supply interrupt	90 seconds

2 PIXIT for Server model

ID	Ed	Description	Value / Clarification
Sr1	1, 2	Which analogue value (MX) quality bits are supported (can be set by server)	**Validity:** Y Good, Y Invalid, N Reserved, Y Questionable N Overflow Y OutofRange Y BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** N Process NSubstituted N Test N OperatorBlocked
Sr2	1, 2	Which status value (ST) quality bits are supported (can be set by server)	**Validity:** Y Good Y Invalid N Reserved Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process Y Substituted Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request	Deprecated
Sr5	1	Which Mode values are supported [1]	Y OnY N [On-]Blocked N Test N Test/Blocked N Off

1. IEC 61850-6:2009 clause 9.5.6 states that if only a sub-range of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing.

3 PIXIT for Dataset model

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	576
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined datasets)	NOT SUPPORTED
Ds3	1	How many non-persistent data sets can be created by one or more clients	Not Supported

4 PIXIT for Substitution model

ID	Ed	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	Not Supported

5 PIXIT for Setting group control model

ID	Ed	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	Not Supported
Sg2	1, 2	What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 $16.2.4)	Not Supported
Sg3	1	Can multiple clients edit the same setting group	Not Supported
Sg4	1	What happens if the association is lost while editing a setting group	Not Supported
Sg5	1	Is EditSG value 0 allowed	Not Supported
Sg6	2	When ResvTms is not present how long is an edit setting group locked	Not Supported

6 PIXIT for Reporting model

ID	Ed	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	Y Integrity Y Data change Y Quality change N Data update Y General interrogation
Rp2	1	The supported optional fields are	Y Sequence-number Y Report-time-stamp Y Reason-for-inclusion Y Data-set-name Y Data-reference Y Buffer-overflow Y EntryID Y Conf-rev Y Segmentation
Rp3	1, 2	Can the server send segmented reports	Y
Rp4	1, 2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated
Rp7	1, 2	What is the buffer size for each BRCB or how many reports can be buffered	Buffer size = 50000 Bytes
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated
Rp9	1	May the reported data set contain: - structured data objects - data attributes	 Y Y (timestamp attributes are not supported)

Rp10	1, 2	What is the scan cycle for binary events Is this fixed, configurable	Event Driven Fixed
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration

7 PIXIT for Logging model

ID	Ed	Description	Value / Clarification
Lg1	1, 2	What is the default value of LogEna (Compare IEC 61850-8-1 $17.3.3.2.1, the default value should be FALSE)	NOT SUPPORTED
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1, 2	Are there are multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition (Compare IEC 61850-8-1 $17.3.3.3.2)	NOT SUPPORTED
Lg4	1	Pre-configured LCB attributes that cannot be changed online	NOT SUPPORTED

8 PIXIT for GOOSE publish model

ID	Ed	Description	Value / Clarification
Gp1	1, 2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set	N
Gp2	1	What is the behavior when the GOOSE publish configuration is incorrect	DUT keeps GoEna=F. Configuration tool does not allow wrong configuration to be uploaded into device. E.g.: empty dataset.
Gp3	1, 2	Published FCD supported common data classes are	SPS, INS, ENS, ACT, ACD, MV, CMV, SAV, WYE, DEL, SEQ, INC, ENC, SPC, DPC, INC, ENC. (Only the elements with FC=ST or MX are published).
Gp4	1, 2	What is the slow retransmission time Is it fixed or configurable	Configured by SCL or GoCB MaxTime
Gp5	1, 2	What is the fastest retransmission time Is it fixed or configurable	Fixed. MinTime = 5 ms
Gp6	-	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Y
Gp7	1, 2	What is the initial GOOSE sqNum after restart	sqNum = 1
Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y (timestamp attributes are not supported)
Gp9	2	How is the retransmission curve after a change.	sqNum = 0 New change sqNum = 1 -> 5ms later with TAL = 1000 sqNum = 2 -> 10ms later with TAL = 1000 sqNum = 3 -> 15ms later with TAL = 4000 sqNum = 4 -> 1000ms later with TAL = Update time* multipled by 4 sqNum = 5 -> Update time* later with TAL = Update time* multipled by 4 sqNum = 6-> Update time* later with TAL = Update time* multipled by 4 sqNum = 7 .... ***Update time** is configured in the ICT

9 PIXIT for GOOSE subscribe model

ID	Ed	Description	Value / Clarification
Gs1	1, 2	What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: the VLAN tag may be removed by a ethernet switch and shall not be checked the simulation flag shall always be checked (Ed2) the ndsCom shall always be checked (Ed2)	Y Ddestination MAC address Y APPID N gocbRef Y timeAllowedtoLive N datSet Y goID N t N stNum N sqNum Y simulation / test N confRev Y ndsCom Y numDatSetEntries
Gs2	1, 2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive after TAL
Gs3	1, 2	What is the behavior when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Message is ignored, but when the next correct message is received, it proceeds as normal.
Gs4	1, 2	What is the behavior when a subscribed GOOSE message is out-of-order	Message proceeds
Gs5	1, 2	What is the behavior when a subscribed GOOSE message is duplicated	Message is ignored
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y N
Gs8	1, 2	Subscribed FCD supported common data classes are	DUT can receive all kinds of data but only digitals can be mapped.
Gs9	1, 2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	N
Gs10	2	What is the behavior when a subscribed GOOSE message with TAL = 0 is received by the subscriber.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.
Gs11	2	What is the behavior when a subscribed GOOSE message hasn't the expected data structure.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

10 PIXIT for Control model

ID	Ed	Description	Value / Clarification
Ct1	-	What control models are supported (compare PICS)	Deprecated
Ct2	1, 2	Is the control model fixed, configurable and/or dynamic	Configurable & Dynamic
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated
Ct5	1, 2	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	N
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated

Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1, 2	What is the behavior of the DUT when the check conditions are set Is this behavior fixed, configurable, online changeable	N synchrocheck N interlock-check DUT ignores the check value and always perform the check
Ct9	1, 2	Which additional cause diagnosis are supported	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Step-limit Y Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected **Edition 1 specific values:** N Parameter-change-in-execution **Edition 2 specific values:** Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution
Ct10	1, 2	How to force a “test-not-ok” respond with SelectWithValue request	Device in local mode
Ct11	1, 2	How to force a “test-not-ok” respond with Select request	
Ct12	1, 2	How to force a “test-not-ok” respond with Operate request	DOns: Sending T=1 SBOns: Sending T=1 DOes:Sending T=1 SBOes: Sending T=1
Ct13	1, 2	Which origin categories are supported / accepted	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process
Ct14	1, 2	What happens if the orCat value is not supported or invalid	DOns: control is rejected (Oper-ObjectAccessDenied). SBOns: control is rejected (Oper-ObjectAccessDenied). DOes:control is rejected (Oper-ServiceError, ObjectAccessDenied). SBOes: control is rejected (SBOw-ServiceError, ObjectAccessDenied).

Ct15	1, 2	Does the IED accept a SelectWithValue / Operate with the same control value as the current status value Is this behavior configurable	N DOns N SBOns N DOes N SBOes N Configurable
Ct16	1, 2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	N DOns N SBOns N DOes: N SBOes
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	N SBOns N SBOes
Ct18	1, 2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step	SelectWithValue and Operate
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1, 2	Does the IED support local / remote operation	Y (Only for XCBR)
Ct21	1, 2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security	N SBOns N DOns:
Ct22	2	How to force a "parameter-change-in-execution"	N/A SBOns N/A SBOes

11 PIXIT for Time synchronization model

ID	Ed	Description	Value / Clarification
Tm1	1, 2	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized.
Tm2	1, 2	Describe the behavior when the time server(s) ceases to respond What is the time server lost detection time	On one time server: An event is generated On all time servers: An event is generated 60 seconds
Tm3	1, 2	How long does it take to take over the new time from time server	2 seconds
Tm4	1, 2	When is the time quality bit "ClockFailure" set	Never
Tm5	1, 2	When is the time quality bit "Clock not Synchronized" set	60 seconds after the time server(s) ceases to respond.
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Y
Tm8	1, 2	Which attributes of the SNTP response packet are validated	Y Leap indicator not equal to 3 Y Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N other (describe)
Tm9	1, 2	Do the COMTRADE files have local time or UTC time and is this configurable	Local N

12 PIXIT for File transfer model

		Description	Value / Clarification
	1, 2	What is structure of files and directories Where are the COMTRADE files stored Are comtrade files zipped and what files are included in each zip file	 /COMTRADE N
	1, 2	Directory names are separated from the file name by	"/"
	1, 2	The maximum file name size including path (recommended 64 chars)	255 chars
	1, 2	Are directory/file name case sensitive	Case sensitive
	1, 2	Maximum file size for SetFile	
	1, 2	Is the requested file path included in the MMS fileDirectory respond file name	Y
	1, 2	Is the wild char supported MMS fileDirectory request	No
	1, 2	Is it allowed that 2 clients get a file at the same time	Y same file Y different files
	1, 2	Which files can be deleted	

13 PIXIT for Service tracking model

ID	Ed	Description	Value / Clarification
Tr1	1, 2	Which ACSI services are tracked by LTRK.GenTrk	Not Applicable

7.3.7.3.8 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **PIXIT For C650 relay V1_00 firm7_70**.

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in:

C650 Bay Controller with firmware version 7.70 and above.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS documents or SCL file.

Each table specifies the PIXIT for applicable ACSI service model as structured in IEC 61850-10. The "Ed" column indicates if the entry is applicable for IEC 61850 Edition 1 and/or Edition 2.

1 PIXIT For Association Model

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	5
As2	1, 2	TCP_KEEPALIVE value. The recommended range is 1..20s	5 seconds but if no application message is detected within the As3 value, the device closes the connection.
As3	1, 2	Lost connection detection time	120 seconds (Configurable)
As4	-	Authentication is not supported yet	
As5	1, 2	What association parameters are necessary for successful association	Y Transport selector Y Session selector Y Presentation selector N AP Title N AE Qualifier
As6	1, 2	If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 AP Title N/A AE Qualifier N/A
As7	1, 2	What is the maximum and minimum MMS PDU size	Max MMS PDU size120000 Min MMS PDU size7000.
As8	1, 2	What is the maximum start up time after a power supply interrupt	90 seconds

2 PIXIT for Server model

ID	Ed	Description	Value / Clarification
Sr1	1, 2	Which analogue value (MX) quality bits are supported (can be set by server)	**Validity:** Y Good, Y Invalid N Reserved Y Questionable N Overflow Y OutofRange Y BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** N Process N Substituted N Test N OperatorBlocked
Sr2	1, 2	Which status value (ST) quality bits are supported (can be set by server)	**Validity:** Y Good Y Invalid N Reserved Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process Y Substituted Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request	Deprecated
Sr5	1	Which Mode values are supported [1]	Y On N [On-]Blocked N Test N Test/Blocked N Off

1. IEC 61850-6:2009 clause 9.5.6 states that if only a sub-range of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing.

3 PIXIT for Dataset model

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	576
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined datasets)	NOT SUPPORTED
Ds3	1	How many non-persistent data sets can be created by one or more clients	NOT SUPPORTED

4 PIXIT for Substitution model

ID	Ed	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	Not Supported

5 PIXIT for Setting group control model

ID	Ed	Description	Value / Clarification
Sg1		What is the number of supported setting groups for each logical device	6 groups for “PRO” logical device 3
Sg2		What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 $16.2.4)	The server saves to non-volatile storage 25 seconds after confirmation.
Sg3		Can multiple clients edit the same setting group	No
Sg4		What happens if the association is lost while editing a setting group	Lost Permission and EditSG = 0
Sg5		Is EditSG value 0 allowed	Yes
Sg6		When ResvTms is not present how long is an edit setting group locked	While EditSG > 0

6 PIXIT for Reporting model

ID	Ed	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	Y Integrity Y Data change Y Quality change N Data update Y General interrogation
Rp2	1	The supported optional fields are	Y Sequence-number Y Report-time-stamp Y Reason-for-inclusion Y Data-set-name Y Data-reference Y Buffer-overflow Y EntryID Y Conf-rev Y Segmentation
Rp3	1, 2	Can the server send segmented reports	Y
Rp4	1, 2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated
Rp7	1, 2	What is the buffer size for each BRCB or how many reports can be buffered	Buffer size = 50000 Bytes
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated
Rp9	1	May the reported data set contain: - structured data objects - data attributes	 Y Y (timestamp attributes are not supported)

Rp10	1, 2	What is the scan cycle for binary events Is this fixed, configurable	Event Driven Fixed
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration

7 PIXIT for Logging model

ID	Ed	Description	Value / Clarification
Lg1	1, 2	What is the default value of LogEna (Compare IEC 61850-8-1 $17.3.3.2.1, the default value should be FALSE)	NOT SUPPORTED
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1, 2	Are there are multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition (Compare IEC 61850-8-1 $17.3.3.3.2)	NOT SUPPORTED
Lg4	1	Pre-configured LCB attributes that cannot be changed online	NOT SUPPORTED

8 PIXIT for GOOSE publish model

ID	Ed	Description	Value / Clarification
Gp1	1, 2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set	N
Gp2	1	What is the behavior when the GOOSE publish configuration is incorrect	DUT keeps GoEna=F. Configuration tool does not allow wrong configuration to be uploaded into device. E.g.: empty dataset.
Gp3	1, 2	Published FCD supported common data classes are	SPS, INS, ENS, ACT, ACD, MV, CMV, SAV, WYE, DEL, SEQ, INC, ENC, SPC, DPC, INC, ENC. (Only the elements with FC=ST or MX are published).
Gp4	1, 2	What is the slow retransmission time Is it fixed or configurable	Configured by SCL or GoCB MaxTime
Gp5	1, 2	What is the fastest retransmission time Is it fixed or configurable	Fixed. MinTime = 5 ms
Gp6	-	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Y
Gp7	1, 2	What is the initial GOOSE sqNum after restart	sqNum = 1
Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y (timestamp attributes are not supported)
Gp9		How is the retransmission curve after a change.	sqNum = 0 New change sqNum = 1 -> 5ms later with TAL = 1000 sqNum = 2 -> 10ms later with TAL = 1000 sqNum = 3 -> 15ms later with TAL = 4000 sqNum = 4 -> 1000ms later with TAL = Update time* multipled by 4 sqNum = 5 -> Update time* later with TAL = Update time* multipled by 4 sqNum = 6-> Update time* later with TAL = Update time* multipled by 4 sqNum = 7 .... ***Update time** is configured in the ICT

9 PIXIT for GOOSE subscribe model

ID	Ed	Description	Value / Clarification
Gs1	1, 2	What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: the VLAN tag may be removed by a ethernet switch and shall not be checked the simulation flag shall always be checked (Ed2) the ndsCom shall always be checked (Ed2)	Y Destination MAC address Y APPID N gocbRef Y timeAllowedtoLive N datSet Y goID N t N stNum N sqNum Y simulation / test N confRev Y ndsCom Y numDatSetEntries
Gs2	1, 2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	message does not arrive after TAL
Gs3	1, 2	What is the behavior when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Message is ignored, but when the next correct message is received, it proceeds as normal.
Gs4	1, 2	What is the behavior when a subscribed GOOSE message is out-of-order	Message proceeds
Gs5	1, 2	What is the behavior when a subscribed GOOSE message is duplicated	Message is ignored
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y N
Gs8	1, 2	Subscribed FCD supported common data classes are	DUT can receive all kinds of data but only digitals can be mapped.
Gs9	1, 2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	N
Gs10	2	What is the behavior when a subscribed GOOSE message with TAL = 0 is received by the subscriber.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.
Gs11	2	What is the behavior when a subscribed GOOSE message hasn't the expected data structure.	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

10 PIXIT for Control model

ID	Ed	Description	Value / Clarification
Ct1	-	What control models are supported (compare PICS)	Deprecated
Ct2	1, 2	Is the control model fixed, configurable and/or dynamic	Configurable & Dynamic
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable)	N
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated

Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1, 2	What is the behavior of the DUT when the check conditions are set Is this behavior fixed, configurable, online changeable	N synchrocheck N interlock-check DUT ignores the check value and always perform the check
Ct9	1, 2	Which additional cause diagnosis are supported	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Step-limit N Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected **Edition 1 specific values:** N Parameter-change-in-execution **Edition 2 specific values:** Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution
Ct10	1, 2	How to force a “test-not-ok” respond with SelectWithValue request	Device in local mode
Ct11	1, 2	How to force a “test-not-ok” respond with Select request	
Ct12	1, 2	How to force a “test-not-ok” respond with Operate request	DOns: Sending T=1 SBOns: Sending T=1 DOes: Sending T=1 SBOes: Sending T=1
Ct13	1, 2	Which origin categories are supported / accepted	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process
Ct14	1, 2	What happens if the orCat value is not supported or invalid	DOns: control is rejected (Oper-ObjectAccessDenied). SBOns: control is rejected (Oper-ObjectAccessDenied). DOes: control is rejected (Oper-ServiceError, ObjectAccessDenied). SBOes: control is rejected (SBOw-ServiceError, ObjectAccessDenied).
Ct15	1, 2	Does the IED accept a SelectWithValue / Operate with the same control value as the current status value Is this behavior configurable	N DOns N SBOns N DOes N SBOes N Configurable

Ct16	1, 2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	N DOns N SBOns N DOes N SBOes
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	N SBOns N SBOes
Ct18	1, 2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step	SelectWithValue and Operate
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1, 2	Does the IED support local / remote operation	Y (Only for XCBR)
Ct21	1, 2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security	N DOns N SBOns
Ct22	2	How to force a "parameter-change-in-execution"	N/A SBOns N/A SBOes
Ct23	1, 2	How many SBOns / SBOes control objects be selected at the same time?	SBOns: n = "1" DOns: n = "1"
Ct24	1, 2	Does the DUT support any operate timeout >0	Y
Ct25	1, 2	When CDC=DPC is supported, is it possible to have DPC (Controllable Double Point) go to the intermediate state? (00)	N

11 PIXIT for Time synchronization model

ID	Ed	Description	Value / Clarification
Tm1	1, 2	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized.
Tm2	1, 2	Describe the behavior when the time server(s) ceases to respond What is the time server lost detection time	On one time server: An event is generated On all time servers: An event is generated 180 seconds
Tm3	1, 2	How long does it take to take over the new time from time server	2 seconds
Tm4	1, 2	When is the time quality bit "ClockFailure" set	Never
Tm5	1, 2	When is the time quality bit "Clock not Synchronized" set	60 seconds after the time server(s) ceases to respond.
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Y
Tm8	1, 2	Which attributes of the SNTP response packet are validated	Y Leap indicator not equal to 3 Y Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N Other (describe)
Tm9	1, 2	Do the COMTRADE files have local time or UTC time and is this configurable	Local N

12 PIXIT for File transfer model

ID	Ed	Description	Value / Clarification
Ft1	1	What is structure of files and directories Where are the COMTRADE files stored Are comtrade files zipped and what files are included in each zip file	 /COMTRADE N
Ft2	1, 2	Directory names are separated from the file name by	"/"
Ft3	1	The maximum file name size including path (recommended 64 chars)	255 chars
Ft4	1, 2	Are directory/file name case sensitive	Case sensitive
Ft5	1, 2	Maximum file size for SetFile	Not applicable
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	Y
Ft7	1	Is the wild char supported MMS fileDirectory request	No
Ft8	1, 2	Is it allowed that 2 clients get a file at the same time	Y same file Y different files
Ft9	1, 2	Which files can be deleted	Not applicable

13 PIXIT for Service tracking model

ID	Ed	Description	Value / Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk	Not Applicable

7.4 IEC 61850 FUNCTIONALITY

7.4.1 Client Connections

The 650 Family relay supports up to five IEC61850 concurrent client connections, i.e a maximum of 5 different IEC 61850 clients can connect to it.

The "UseLocSta" setting, which enables/disables usage of LLN0.LocSta, has been implemented in 61850 configurator, in order to verify the origin of the 61850 command. This setting has been added into the CID file, and is configurable using EnerVista IEC61850 version 8.14 or above. In order to access "UseLocSta", a .cid file must be opened in the IEC61850 Configurator menu and it can then be found using the path **GE_F650 > Server Configuration > UseLocSta**. If TRUE, it takes into consideration the LLN0.LocSta values during IEC61850 command execution and if FALSE, LLN0.LocSta values are ignored. If UseLocSta is not implemented, the operation over Logical Nodes XCBR/CSWI/XSWI/vinGGIO will not take LocSta status into consideration.

To activate the use of LocSta, set the value of "UseLocSta" to TRUE using EnerVista IEC61850 Configurator, save the CID file, download it to the relay and reboot it.

The data object "Loc" shows the control behavior of the logical node. In the datamodel of 650 relays, it appears in LLN0/XCBR/XSWI/CSWI Logical Nodes and it is internally mapped to the Local/Remote status of the device.

Note: The saving process is updated in ICD FILE STATUS in System Info and it is recommended that the relay is not rebooted until the process finishes (OK WITHOUT DAIS or OK), otherwise the last value of "LocSta" could be lost.

7.4.2 GOOSES

650 relays support transmission and reception of configurable IEC 61850 Generic Object Oriented Substation Event (GOOSE). To enable GOOSES communications, remote comms must be set to GOOSE in the EnerVista 650 Setup software at **Setpoint > Input/Output > Remote Comms**.

Configurable GOOSE is recommended for implementations that require GOOSE data transfer between 650 relays and devices from other manufacturers.

7.4.2.1 TRANSMISSION GOOSES

A maximum of four different transmission GOOSE applications are supported. Data Sets for transmissions GOOSES can have a maximum of 128 elements and can be leaf elements (Data Attributes), or complex structures (Data Objects).

7.4.2.2 RECEPTION GOOSES

650 relays can be subscribed up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital inputs and 16 Remote Goose Analog Inputs can be configured to be subscribed to.

The elements of Data Sets for reception GOOSEs can be of any types supported in IEC 61850 standard and can be both leaf elements (Data Attributes) and complex structures (Data Objects). However C650 relay can map to its internal variables incoming data of type Boolean, Float, Integer and any of the bits from Bitstring data type.

7.4.3 IEC 61850 Server

The IEC 61850 Server (i.e., 650 relay) reports data to the IEC 61850 Client, such as Local HMI, RTU and Gateway with the information of logical device, data sets, data control block, logical nodes and their data attributes.

7.4.3.1 LOGICAL DEVICES AND REPORTS

Supported buffered and un-buffered report, the report triggers are shown in the following Supported Triggers list.

Supported Triggers List:

- Data-Change

- Quality-Change
- Integrity
- General Interrogation

Supported buffered and un-buffered report option fields are shown in the following Field list.

Field List:

- Sequence number
- Report time stamp
- Reason-for-inclusion
- Dataset-name
- Data-reference
- Buffer-overflow (Buffered reports only)
- Entry id (Buffered reports only)
- Conf- revision

Report control block configuration settings are modified from IEC61850 configurator writing directly in a CID file. There is no Modbus register assigned to those. The datasets for reports are fully configurable with CDCs from any Logical Node. The Description field in the LN is fixed text and it cannot be updated from the Modbus settings

By default,

- if Unbuffered report is selected, 5 Unbuffered Report Control Blocks are created. This figure can be modified from 1 to 5.
- If Buffered report is selected, 1 Unbuffered Report Control Block is created. This figure can be modified from 1 to 5.

7.5 IEC 61850 Status

7.5.1 GOOSE Status

Different status information related with GOOSE transmission/reception process that can be checked through EnerVista 650 Setup:

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Digital Inputs**:

Rem GOOSE Dig Inp X - Provides status of Remote Goose Digital input X that relay is subscribed to. The green LED lights up if Remote GOOSE Digital Input was set to 1 last time it was received and it turns off if the last Remote GOOSE Digital Input was set to 0.

There is a maximum of 32 Remote GOOSE Digital Inputs that the relay can be subscribed to.

In **Actual > Inputs/Outputs > Remote Inputs > Remote Inputs**:

Remote Input X - Provides status of Remote input X that relay is subscribed to. The green LED lights up if Remote Input was set to 1 last time it was received and it turns off if the last Remote Input was set to 0

There is a maximum of 32 Remote Inputs that relay can be subscribed to. These remote inputs are digital signals.

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Analog Inputs:**

Rem GOOSE Ana Inp X- This is the last analog value received in the Remote GOOSE Analog Input configured.

The relay can be subscribed to up to maximum of 8 different float remote GOOSE analog values and 8 different integer remote GOOSE analog values.

In **Actual > Inputs/Outputs > Remote Inputs > Remote Devices:**

Remote Device X - Provides information about status of device that is transmitting GOOSES, that the relay is subscribed to. The green LED lights up if remote device is transmitting GOOSES and it turns off if GOOSE communication is lost with this remote device.

A maximum of 24 different Remote devices can be configured in CID

ALL REM DEV ONLINE - Provides status of Remote Devices that are transmitting GOOSES that the relay is subscribed to. If GOOSE communication with all configured Remote Devices is active, the green LED lights up. If GOOSE communication is lost with any of configured remote devices, it turns off.

In **Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Outputs:**

Rem GOOSE Dig Out X - Provides status of Remote Goose Digital outputs that are configured to be transmitted by the relay. The green LED lights up if Remote GOOSE Digital Output is set to 1 and it turns off if Remote GOOSE Digital Output is set to 0

7.5.2 IEC 61850 CID Status

Internal Status of CID and its validation can be checked in EnerVista in the following path:

Actual Values > Status > System Info

ICD Edition:

This field shows which IEC 61850 Edition if CID that relays is working with. For C650. See 7.1 IEC 61850 Overview on page 7–1.

ICD FILE STATUS:

This field provides status of CID that is running in the relay.

ICD FILE STATUS	UNKNOWN: When the relay has not the IEC61850 protocol in the relay model the ICD status is unknown to the unit.
	ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 is not operative (the IEC 61850 client, reports and gooses do not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
	MODIFIED: The settings have been changed in the icd but they are still not written in the icd file in the relay
	IN PROGRESS: The icd setting are being written to the file in the relay.
	OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
	OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting prevails over the relay settings
	DEFAULT: There is no CID file in notvalidated neither in validated and default CID has been loaded. After a reboot, default CID file is considered as a normal CID file.
	ERROR HEADER CID: there is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, relay shall not be able to communicate by using IEC 61850 until this discrepancy is solved. CID version and firmware version must match in order to get complete functional relay.
	ERROR SG CID is displayed if the relay has the Setting Group function disabled but the managed CID file has the Settings Groups available or the relay has the Setting Group function enabled but the managed CID file has the Settings Groups not available.

ICD STATUS NOTVAL:

This field provides information about the NotValidated folder, which is the folder where CIDs that are sent to the relay are stored prior to be validated and marked "Valid".

ICD STATUS NOTVAL	UNKNOWN: No 61850 protocol
	ERROR: The CID file in notvalidated is not valid
	NOTVALIDATED EMPTY: There is no CID file in notvalidated
	IN PROGRESS: The icd setting are being written to the file in the relay.
	PASSED TO VALIDATED: New valid CID file in notvalidated y and passed to validated
	ERROR HEADER CID: There is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, relay shall not be able to communicate by using IEC 61850 until this discrepancy is solved. CID version and firmware version must match in order to get complete functional relay.

NOTICE

1. WATCH OUT! If the ICD status is "MODIFIED" or "IN PROGRESS" it is not advisable to switch off the unit because the latest settings would not be stored in the unit.

2. In the case that ERROR SG CID is displayed in the ICD Status, ensure that the managed CID has Setting Group enabled if the Setting Groups function is enabled, or ensure that the managed CID has Setting Group disabled if the Setting Groups function is disabled.

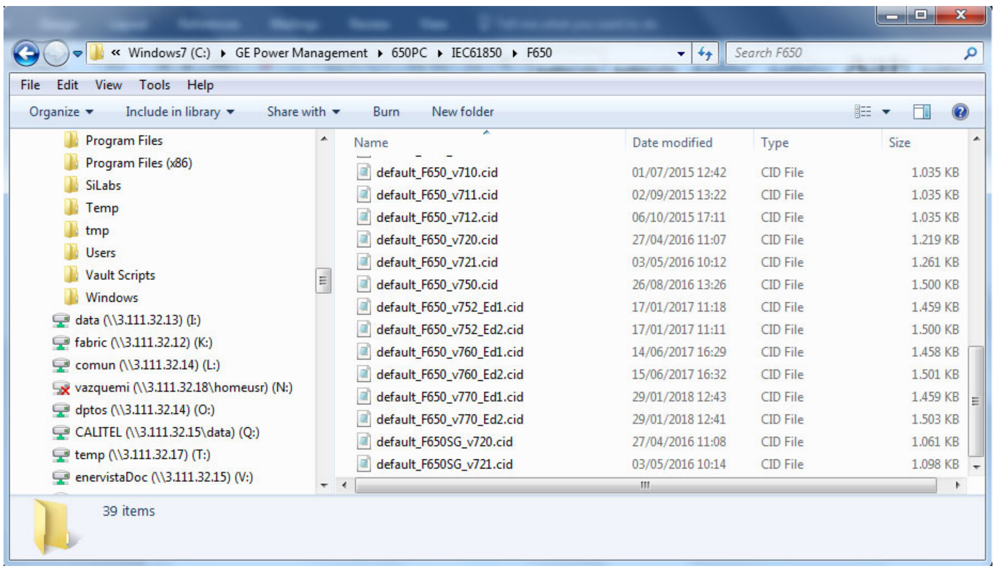
For firmware versions 7.20 and 7.21:

– default_F650SG_v7XX.cid: CID file with setting group option enabled

– default_F650_v7XX.cid: CID file with setting group option disabled

For firmware versions below 7.20 above 7.21:

– default_F650_v7XX.cid: CID file with setting group option disabled/enabled



3. Take into in account that if ERROR HEADER CID value is displayed in the ICD STATUS or ICD STATUS NOT VAL section in **Actual Values > Status > System info**, the relay cannot communicate using IEC 61850 until this discrepancy is resolved. CID version and firmware version must match for a fully functional relay.

7.6 IEC 61850 Configurator

7.6.1 Overview

The 650 family relays support the IEC 61850 protocol which is identified by order code option "6" or "7" (Communication protocol option). This configuration tool can be used with 650 family relays supporting IEC 61850 communication protocol and with firmware version 3.60 or above.

The "IEC 61850 Configurator" tool is located in the top-level menu in EnerVista 650 Setup and it can be used to browse and edit 650 relay's CID/IEC files:

- ICD/CID Settings
- Reports
- GOOSE Reception
- GOOSE Transmission

Figure 7-5: IEC61850 configurator menu location

Important Notes:

For firmware versions below 3.60, basic IEC 61850 configuration is located in **Setpoint > 61850 Configuration** (Domain name parameters, Ethernet parameters, MMXU parameters). With this tool some 61850 parameters can be configured in the *650.icd file, and then the .icd file can be uploaded to the relay.

7.6.2 Online/Offline operation modes

Two different working modes can be distinguished in the IEC 61850 Configurator: Offline mode and Online mode.

Offline Operation Mode: When user is not communicating with 650 Family relay, IEC 61850 Configurator tool can be used to work offline mode. In this case, if IEC 61850 Configurator menu is clicked at the menu toolbar in EnerVista, the following windows prompts to allow selection of the IED version to be configured.

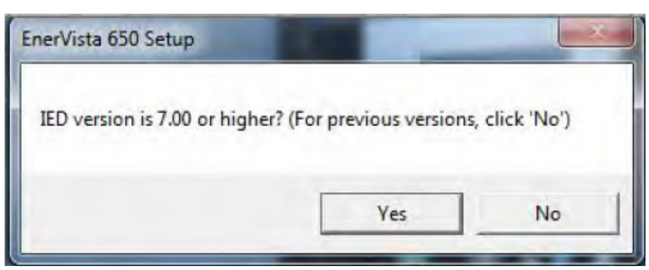


Figure 7-6: IED version verification

- Click **Yes** to browse and edit CID/ICD files for firmware versions above 7.XX
- Click **No** to browse and edit IEC files for firmware versions below 7.XX

Online Operation Mode: When communicating with an C650 using the EnerVista 650 Setup software, the IEC61850 Configurator tool allows access to the CID/IEC of the connected device, or to send a previously configured file.

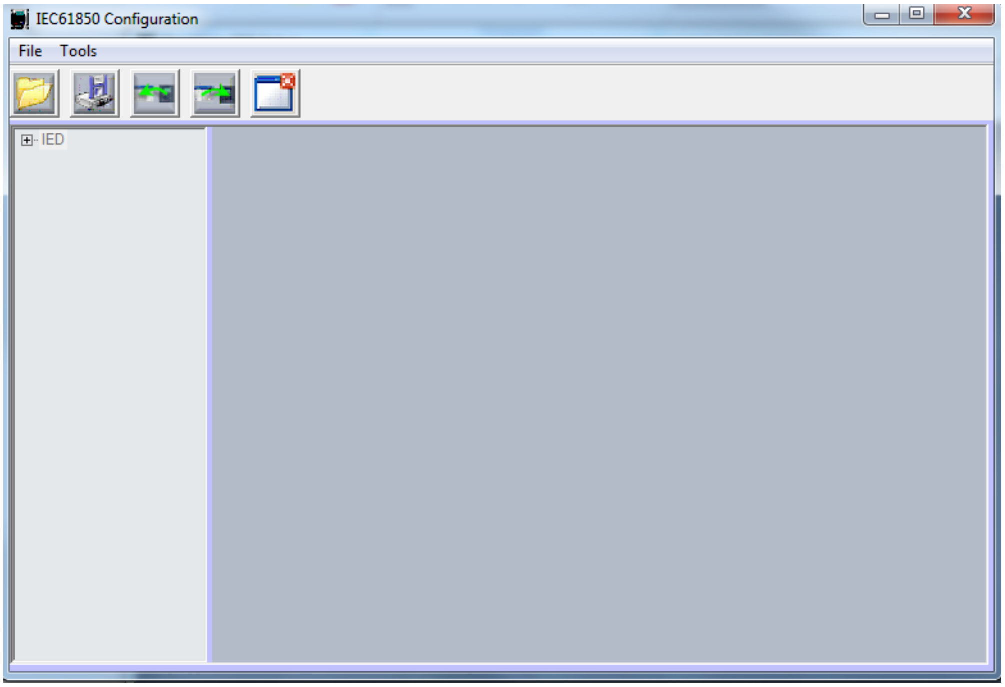


Figure 7-7: IEC 61850 Configurator main screen

7.6.3 IEC 61850 configurator details

The IEC61850 Configurator allows editing in all sections of the IEC61850 CID file. Other operations cannot be performed in the EnerVista 650 Setup software if the IEC 61850 Configurator is open. Close the IEC61850 session to perform other operations.

In the following sections, detailed information about CID configuration for firmware version 8.00 is described. These same steps apply to CID configuration for all 650 family firmware versions 7.00 and above.

7.6.3.1 IEC 61850 configurator interface.

Four different areas can be identified in IEC 61850 configurator interface, as shown in the figure that follows:

- "Menu toolbar
- Quick menu toolbar
- IEC 61850 IED Explorer window
- Configuration area

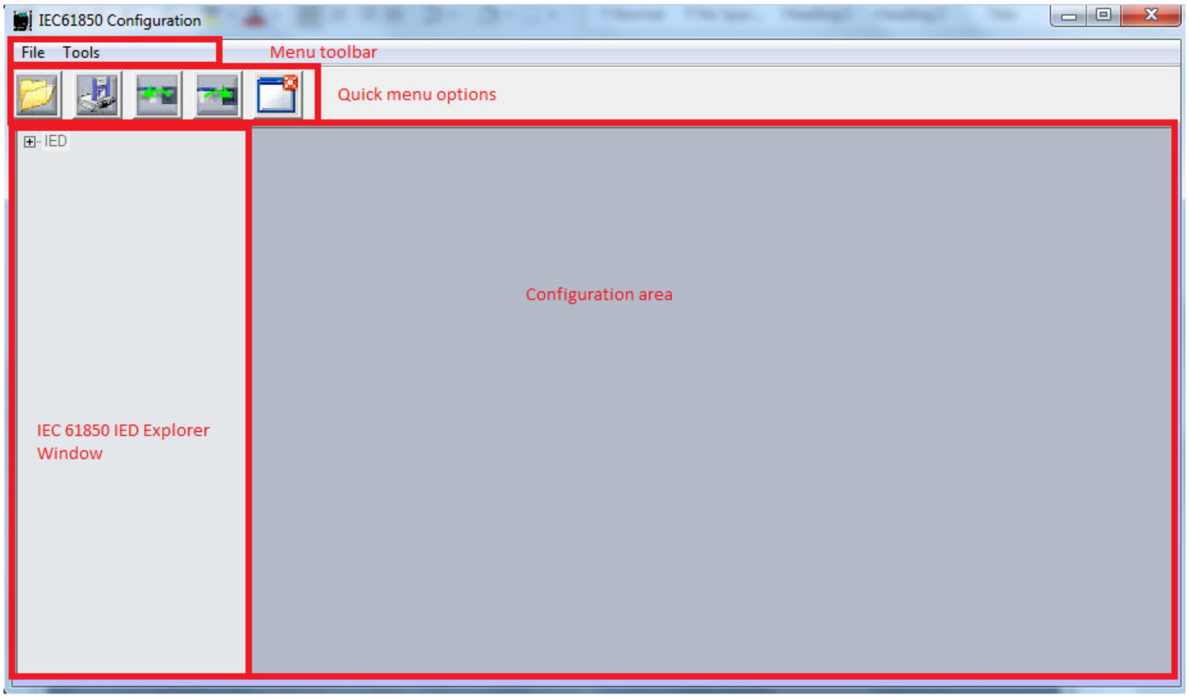


Figure 7-8: IEC 61850 Configurator interface

7.6.3.1.1 Menu toolbar

Two menus available in this area:

File Menu:

Open *.cid file

Save *cid file

Received *cid file from device

Send *cid file to the relay

See 7.6.3.1.2 Quick Menu Toolbar for detailed information

Tools Menu: (CID conversion tools)

A CID file converter menu option is available in the IEC 61850 Configurator menu: **Tools > ConvertCIDFiles**. The CID file converter enables CID file conversion, allowing for conversion of CID files in parallel with relay firmware updates. The main parts of the CID file that are maintained are the configurable fields at the Communication and IED levels, the public and private Settings, Datasets, Report Control Blocks, GOOSE Transmission Control Blocks and GOOSE Reception.

To convert a CID file, follow these steps:

1. In the IEC61850 Configurator, select **Tool > ConvertCIDFiles**.

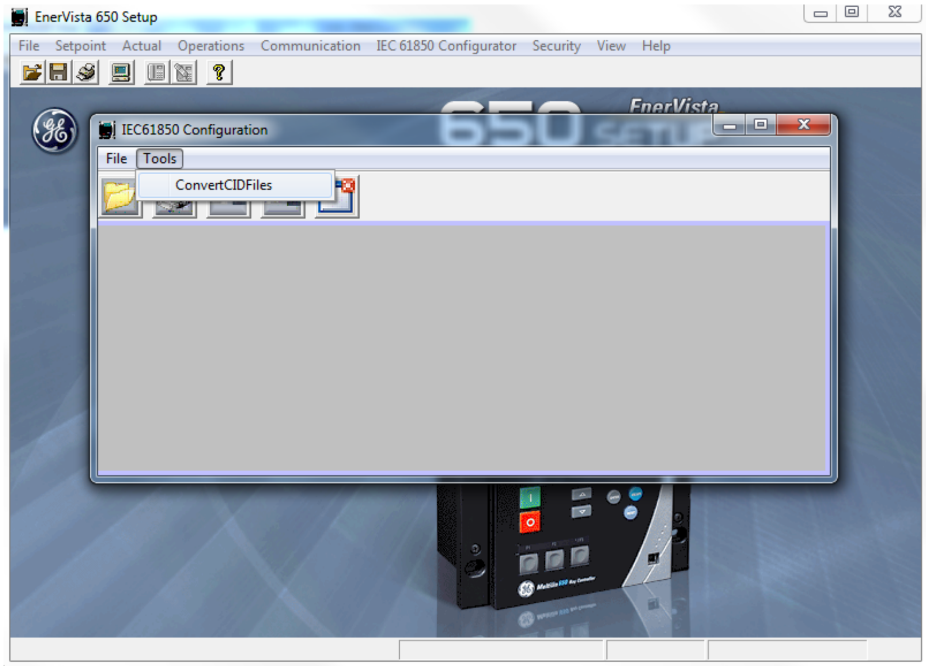


Figure 7-9: ConvertCIDFiles option

2. Select a CID file to convert in the **CID file (*.cid)** field.

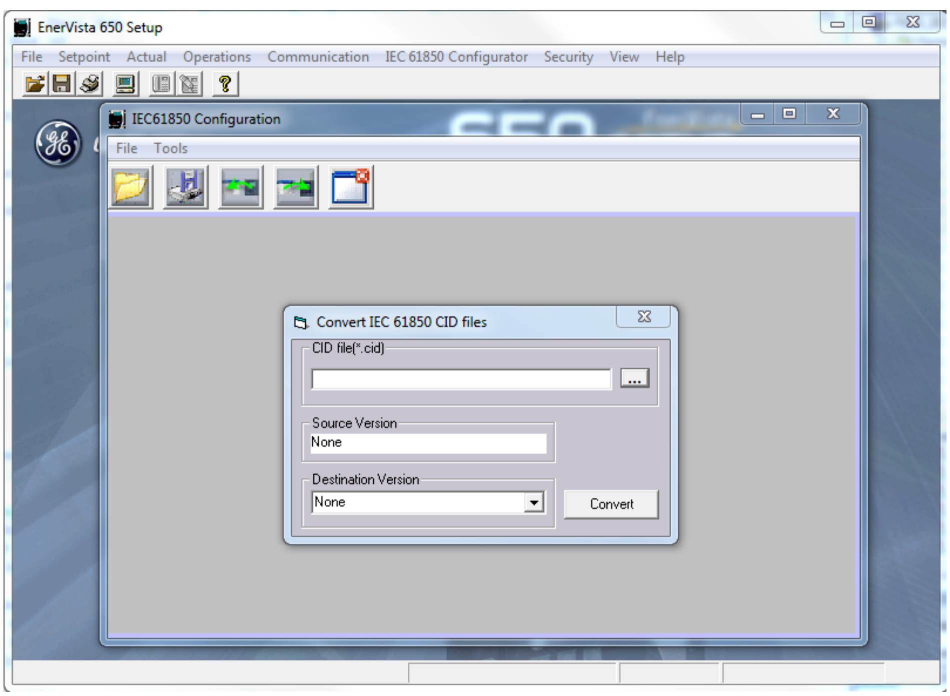
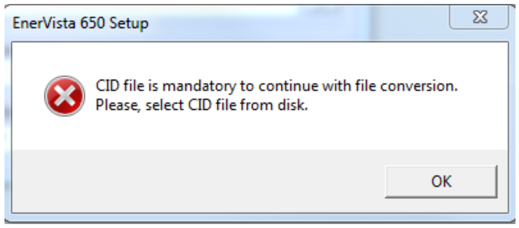


Figure 7-10: Main window in IEC61850 CID files conversion tool

3. If no **CID file** is selected, an error message is displayed.



4. The CID file Converter fills in the firmware version of the selected CID file under **Source Version**. Select the new firmware version for the CID file under **Destination Version**.

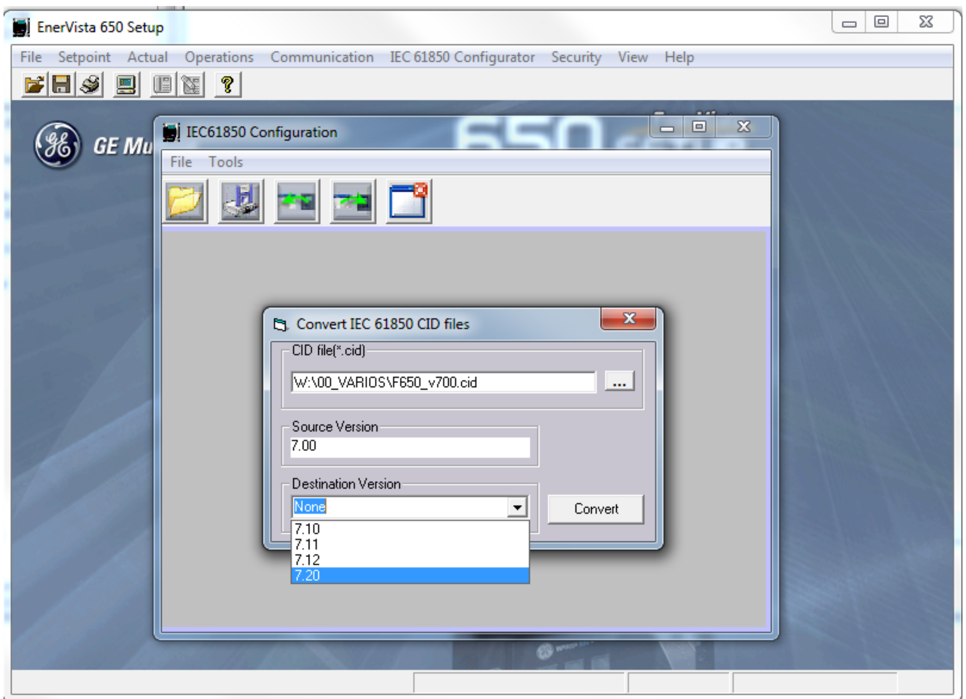
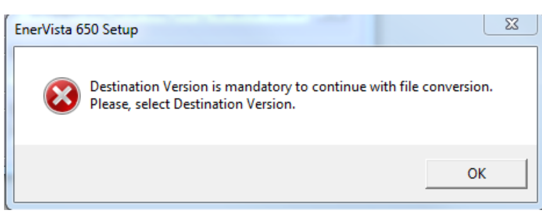


Figure 7-11: Selection of CID files versions

5. If no **Destination Version** is selected, an error message is displayed.



Note: For successful conversion, the default CID file templates installed with the EnerVista 650 Setup must be in the installed folder location with their original names, as shown.

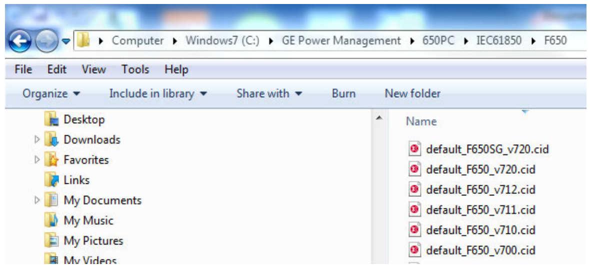


Figure 7-12: Requirements for CID conversion

6. Click **Convert** to start the conversion process. When the conversion is finished, a successful conversion message is displayed, followed by a message confirming the name and location of the converted file.

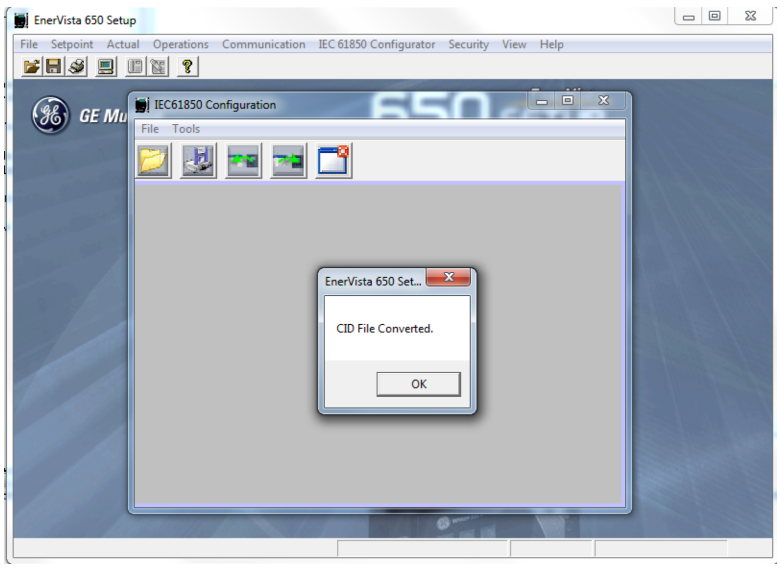


Figure 7-13: Successful CID conversion

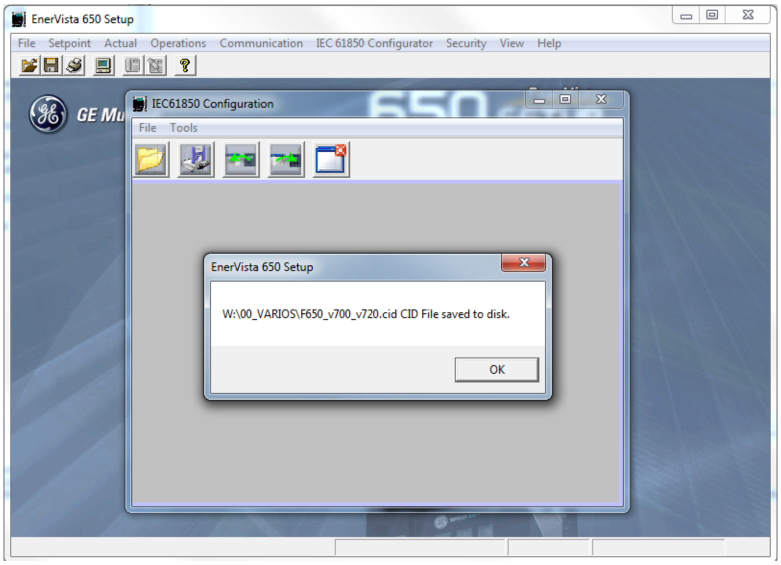


Figure 7-14: CID file created and saved to disk

7.6.3.1.2 Open IEC61850 file from disk / open *CID file

For firmware below 7.XX, the "Open IEC 61850 file from disk" menu allows the user to work in offline mode to configure IEC 61850 protocol in 650 devices. The tool works with files of *.iec extension which contain the icd file from the devices and proprietary files needed for the whole configuration.

In the EnerVista 650 Setup default files you will find the "F650_Vxxx.iec" corresponding to the firmware version related to the EnerVista installation.

For firmware version 7.XX or above, the "Open *CID file" menu allows the user to work in offline mode to configure IEC 61850 protocol in 650 devices. In that occasion, the tool shall work with *.cid file extension which contain the icd file from the device.

In the EnerVista 650 Setup default files, user will find the "default_F650_vXXX.cid" corresponding to the firmware version related to EnerVista installation.

For firmware version 7.XX or above, consider the following notes:

For firmware versions from 7.20 and below 7.50, two different *.cid files are available for each version:

- default_F650_vXXX.cid": Default IEC61850 CID file for F650 if Setting group option is disabled.
- default_F650SG_vXXX.cid": Default IEC61850 CID file for F650 if Setting group option is enabled.

For firmware version 7.52 or above, F650 will work with IEC 61850 Edition 1 or Edition 2 depending on which *.cid is configured and sent to the device. Consider your firmware version when choosing a default CID file from the files provided with 7.52 EnerVista 650 Setup. For a default installation, these files are located at:
C:\GE Power Management\650PC\IEC61850\F650

For firmware version 7.52 or above, two different *.cid files are available for each version:

- default_F650_vXXX_Ed1.cid”: Default IEC61850 CID Edition 1 file for F650
- default_F650_vXXX_Ed2.cid”: Default IEC61850 CID Edition 2 file for F650

To determine whether the relay is working with CID Edition 1 or Edition 2, download the active CID file from the relay:

1. Open the EnerVista Setup software, and click **IEC 61850 Configurator** on the menu bar.
2. Select **File > Receive CID file from device**, or click the download button.
3. Connect to the relay as prompted if you are not already connected.

Once the download completes, a message displays indicating a successful download. The CID file can then be viewed and edited in the IEC 61850 Configurator.

4. Check the title bar of the CID file to determine the IEC 61850 version, as shown in the figure below.

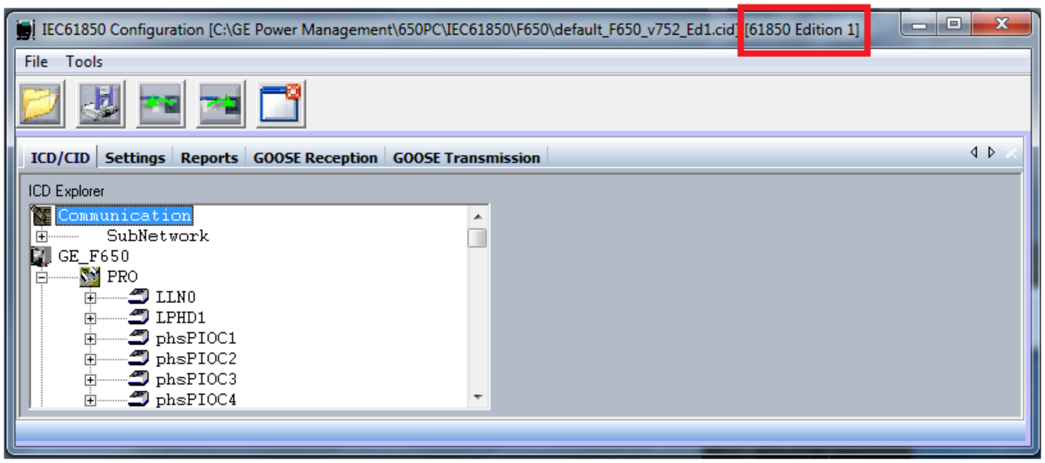


Figure 7-15: Information about the IEC 61850 Edition

For all scenarios, after opening the file all ICD data is displayed in the ICD/CID tab and the user can start configuring the IEC 61850 protocol in 650 devices.

7.6.3.1.3 IEC 61850 IED Explorer Window

After opening a CID file, the IED Explorer "tree" will be displayed in this area. Six different items are available in this menu:

- Access Point Addressing
- Server Configuration
- Settings
- DataSets
- Reports
- GOOSE

To Modify the Parameters

1. Select a parameter in the ICD Explorer window to open the Attributes window in the right part of the screen.
2. In the Configuration area, double click in the parameter column of the table and enter the new value for that setting. To confirm changes, double-click out of parameter field.

Access Point Addressing

Following settings can be configured in this section.

SETTING	PARAMETER
IP	0.0.0.0
IP-SUBNET	0.0.0.0
IP-GATEWAY	0.0.0.0
OSI-AP-Title	1,3,9999,1,1
OSI-AE-Qualifier	12
OSI-PSEL	00000001
OSI-SSEL	0001
OSI-TSEL	0001
GOOSE-Port	0
MMS-Port	102
MMS-Connection-Timeout	120 s

- IP, IP-SUBNET, IP-GATEWAY: The parameters are the configured ETH_A IP details configured in the device through EnerVista: **Setpoints > Product Setup > Communications > Network**
- OSI-AP-Title, OSI-AE-Qualifier, OSI-PSEL, OSI-SSEL, OSI-TSEL: The parameters must be configured according to the IEC 61850 standard
- GOOSE-port: Three different options are available in this drop-box depending which port wants to be selected for GOOSE transmission (ETHA-ETHB-Both) the user to change the GOOSE port number for GOOSE communication.
- MMS-Port: The range of the setting is 1 to 65535, in steps of 1. The setting allows the user to change the TCP port number for MMS connections.
- MMS- Connection-Timeout: The setting is useful for detecting "fail" IEC 61850 connections. The timer must be application specific for IEC 61850. If there is no data traffic on an established connection for more than this setting time, the connection is disconnected from the server

Server Configuration

SETTING	PARAMETER
IED NAME	TEMPLATE
UseDoiDai	false
Power Max and Min Automatic Calculation	true
PRO functional ldName	PRO
CON functional ldName	CON

- **IED NAME**: Up to 64 alphanumeric characters. The IED Name represents the MMS domain name (IEC 61850 logical device) where all IEC/MMS logical nodes are located. Valid characters for these values are upper and lowercase letters, numbers, and the underscore (_) character, and the first character in the string must be a letter. This conforms to the IEC 61850 standard. Default value is "GEDevice"
- **UseDoiDai**:
  - If this setting is set to false: the relay works only with the settings located in the relay's memory and the changes performed on the ICD in settings related with the protection and control functions are only stored on the ICD file but not updated in the relay.
  - If this setting is set to true, you are selecting the ICD file settings to prevail over the relay settings. This means that after changing settings in the ICD and powering the relay off and on the unit works with the settings included in the ICD.

  All setting changes performed through the HMI or EnerVista 650 Setup are automatically updated over the ICD file, likewise if there is any change in the ICD file these changes are updated in the relay settings. The relay starts working with the new ICD file after sending the file to the unit and powering the relay off and on.
- **Power Max and Min Automatic Calculation** *:
  - If set to True, Max and Min values used for Power reporting are automatically calculated based on the CT Ratio and VT Ratio setpoints.
  - If set to False, Max and Min values used for Power reporting are configurable in the Settings / Max and Min tab.

  *This setting is only available for Firmware version 7.70 and above.

- **PRO functional IdName**: ID name of logical device where all protection logical nodes are available. The logical device name is used to identify the IEC 61850 logical device that exists within the C650 and this name is composed of two parts: the IED NAME and the PRO/CON functional IdName. Default name for PRO functional IdName is PRO
- **CON functional IdName**: ID name of logical device where all control logical nodes are available. Default name for CON functional IdName is CON

Settings

Four different levels are available under setting section:

- Deadbands
- Commands
- Timeouts
- Oscillation
- Max and Min

DEADBANDS

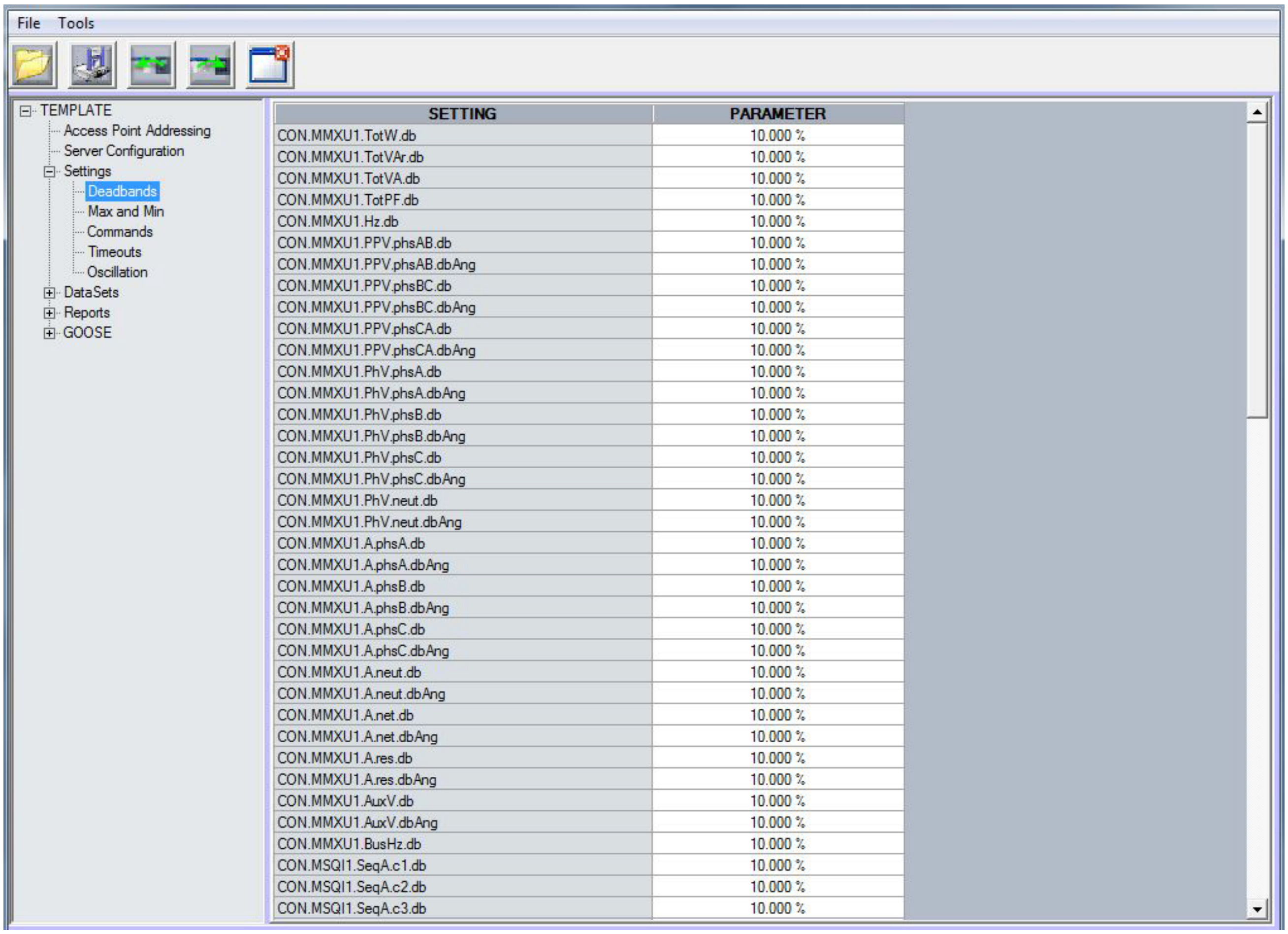


Figure 7-16: Configuration of deadbands for MMXU

Range: 1 to 100.000 %

The MMXU deadband settings represent the deadband values used to determine when to update the MMXU "mag" and "cVal" values from the associated "instmag" and "instcVal" values. The "mag" and "cVal" values are used for the IEC 61850 buffered and unbuffered reports. The settings correspond to the associated "db" data items in the CF functional constraint of the MMXU logical node, as per the IEC 61850 standard. According to IEC 61850-7-3, the db value "shall represent the percentage of difference between the maximum and minimum in units of 0.001%". Thus, it is important to know the maximum range for each MMXU measured quantity, since this represents the 100.00% value for the deadband and therefore A value of 1000 represents the 1% of the scale.

The equations to calculate minimum (min) and maximum (max) values that will be used to calculate deadbands in the MMXU nodes of C650 are as follows:

MMXU Node Value	**To Calculate Min/Max for F650/C650**
TotW , TotVar (MW, MVAr)	**For firmware below 7.70:** max = (Phase CT Ratio *160) * (Phase VT Ratio * 300)/1000000 min = -max **For firmware 7.70 or above:** If Power Max and Min Automatic Calculation setting is set to false: max = configurable value (Value is referred to primary values) min = configurable value (Value is referred to primary values) If Power Max and Min Automatic Calculation Setting is set to true: max value will be the same as for firmware below 7.70 min value will be the same as for firmware below 7.70 **Note**: When max/min values are configurable, setting these values below accuracy levels could result in unpredictable behavior.
TotVA (MVA)	**For firmware below 7.70:** max = (Phase CT Ratio *160) * (Phase VT Ratio * 300)/1000000 min = 0 **For firmware 7.70 or above:** If Power Max and Min Automatic Calculation setting is set to false: max = configurable value min = configurable positive value If Power Max and Min Automatic Calculation Setting is set to true: max value will be the same as for firmware below 7.70 min = 0 Note: When max/min values are configurable, setting these values below accuracy levels could result in unpredictable behavior.
Hz dbAng angle dB = (DB percentage* 360)	max = 70 min = 0
Hz Rte	max = 15 min = -15
PPV/PhV/Seq (measurement in kV)	max= VT Ratio /1000 * 300; min = 0
A$phsA, phsB, phsC, A$neut, A$res (kA) SeqA$c1, c2 ,c3	max=((Phase or Ground CT Ratio) /1000)*160; min = 0

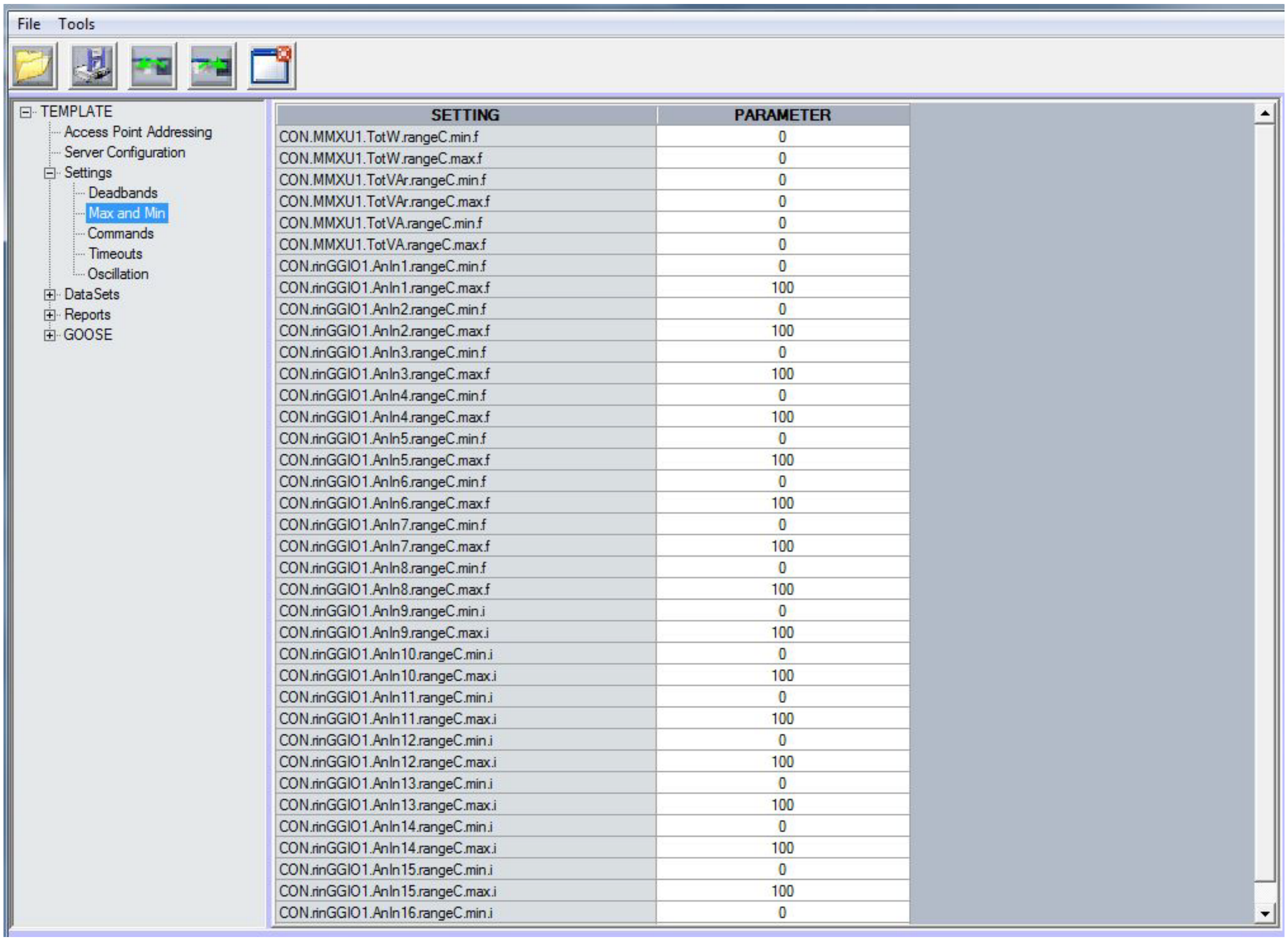
MMXU Node Value	To Calculate Min/Max for F650/C650
dbAng	angle dB = (DB percentage* 360) For firmware versions below 5.00: There is one common deadband used both for angles and magnitudes in the corresponding phasor measurement (current or voltage). Take this into account when using reports with data change, because in some cases the angle value can trigger reports quite often due to the difficulty in calculating a common deadband for both values (angle and magnitude). In these cases it is advisable to use the integrity report in firmware versions lower than 5.00. For firmware versions qbove 5.00: The 650 family of relays implements separate deadbands for magnitude and angle for phasors (voltages and currents). Thus, for example, the phase A current attribute in the 650 relay includes two deadbands, one for phase A current magnitude and the other for phase A current angle. The deadband for magnitude is the db parameter while the deadband for angle is the dbAng parameter In addition to the MMXU logical node, MSQI and Remote Input GGIO (default name rinGGIO1) also have attributes that are analogue values and contain db parameters to establish deadbands. For firmware version below 7.00, deadbands are available in ICD/CID tab.

Once maximum and minimum values are known, the maximum range can be calculated. This maximum range represents 100% of the deadband (100000). The deadband to be configured for expected variations will be calculated based on maximum range.

MAX AND MIN

Max and min values for analog inputs and power* reporting are configurable on this tab.

**Max and min values for Power reporting are only available when the Power Max and Min Automatic Calculation setting is set to false (See Server Configuration on page 7–122)*



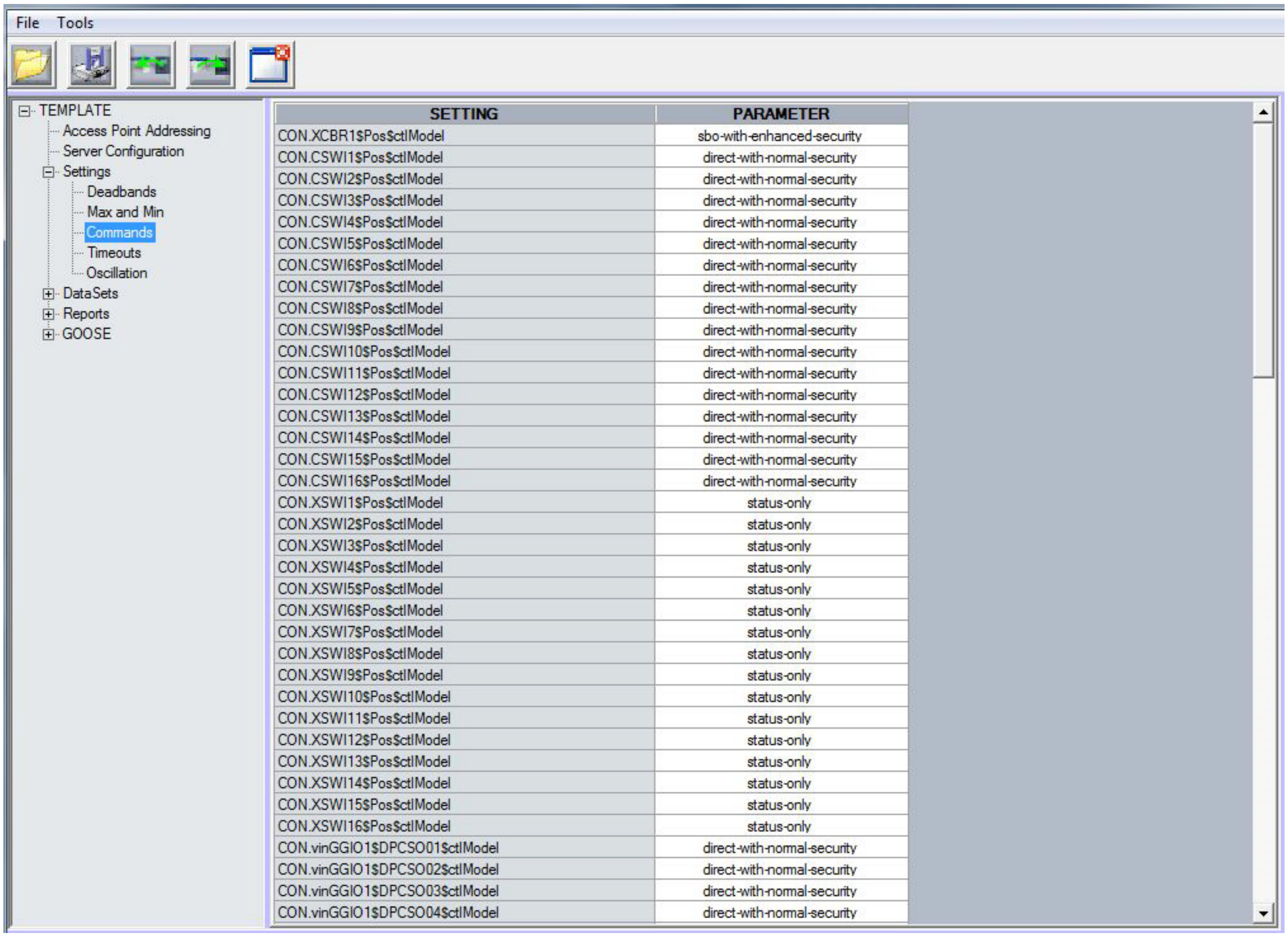
SETTING	PARAMETER
CON.MMXU1.TotW.rangeC.min.f	0
CON.MMXU1.TotW.rangeC.max.f	0
CON.MMXU1.TotVAr.rangeC.min.f	0
CON.MMXU1.TotVAr.rangeC.max.f	0
CON.MMXU1.TotVA.rangeC.min.f	0
CON.MMXU1.TotVA.rangeC.max.f	0
CON.rinGGIO1.AnIn1.rangeC.min.f	0
CON.rinGGIO1.AnIn1.rangeC.max.f	100
CON.rinGGIO1.AnIn2.rangeC.min.f	0
CON.rinGGIO1.AnIn2.rangeC.max.f	100
CON.rinGGIO1.AnIn3.rangeC.min.f	0
CON.rinGGIO1.AnIn3.rangeC.max.f	100
CON.rinGGIO1.AnIn4.rangeC.min.f	0
CON.rinGGIO1.AnIn4.rangeC.max.f	100
CON.rinGGIO1.AnIn5.rangeC.min.f	0
CON.rinGGIO1.AnIn5.rangeC.max.f	100
CON.rinGGIO1.AnIn6.rangeC.min.f	0
CON.rinGGIO1.AnIn6.rangeC.max.f	100
CON.rinGGIO1.AnIn7.rangeC.min.f	0
CON.rinGGIO1.AnIn7.rangeC.max.f	100
CON.rinGGIO1.AnIn8.rangeC.min.f	0
CON.rinGGIO1.AnIn8.rangeC.max.f	100
CON.rinGGIO1.AnIn9.rangeC.min.i	0
CON.rinGGIO1.AnIn9.rangeC.max.i	100
CON.rinGGIO1.AnIn10.rangeC.min.i	0
CON.rinGGIO1.AnIn10.rangeC.max.i	100
CON.rinGGIO1.AnIn11.rangeC.min.i	0
CON.rinGGIO1.AnIn11.rangeC.max.i	100
CON.rinGGIO1.AnIn12.rangeC.min.i	0
CON.rinGGIO1.AnIn12.rangeC.max.i	100
CON.rinGGIO1.AnIn13.rangeC.min.i	0
CON.rinGGIO1.AnIn13.rangeC.max.i	100
CON.rinGGIO1.AnIn14.rangeC.min.i	0
CON.rinGGIO1.AnIn14.rangeC.max.i	100
CON.rinGGIO1.AnIn15.rangeC.min.i	0
CON.rinGGIO1.AnIn15.rangeC.max.i	100
CON.rinGGIO1.AnIn16.rangeC.min.i	0

Figure 7-17: Max and Min

COMMANDS

In the C650 relay IEC 61850 controllable data exist in logical nodes vinGGIO, XCBR and CSWI:

- vinGGIO maps to Virtual Inputs of C650.
- XCBR represents the circuit breaker
- CSWI logical nodes represent switchgear of C650 relay.



SETTING	PARAMETER
CON.XCBR1PosctlModel	sbo-with-enhanced-security
CON.CSWI1PosctlModel	direct-with-normal-security
CON.CSWI2PosctlModel	direct-with-normal-security
CON.CSWI3PosctlModel	direct-with-normal-security
CON.CSWI4PosctlModel	direct-with-normal-security
CON.CSWI5PosctlModel	direct-with-normal-security
CON.CSWI6PosctlModel	direct-with-normal-security
CON.CSWI7PosctlModel	direct-with-normal-security
CON.CSWI8PosctlModel	direct-with-normal-security
CON.CSWI9PosctlModel	direct-with-normal-security
CON.CSWI10PosctlModel	direct-with-normal-security
CON.CSWI11PosctlModel	direct-with-normal-security
CON.CSWI12PosctlModel	direct-with-normal-security
CON.CSWI13PosctlModel	direct-with-normal-security
CON.CSWI14PosctlModel	direct-with-normal-security
CON.CSWI15PosctlModel	direct-with-normal-security
CON.CSWI16PosctlModel	direct-with-normal-security
CON.XSWI1PosctlModel	status-only
CON.XSWI2PosctlModel	status-only
CON.XSWI3PosctlModel	status-only
CON.XSWI4PosctlModel	status-only
CON.XSWI5PosctlModel	status-only
CON.XSWI6PosctlModel	status-only
CON.XSWI7PosctlModel	status-only
CON.XSWI8PosctlModel	status-only
CON.XSWI9PosctlModel	status-only
CON.XSWI10PosctlModel	status-only
CON.XSWI11PosctlModel	status-only
CON.XSWI12PosctlModel	status-only
CON.XSWI13PosctlModel	status-only
CON.XSWI14PosctlModel	status-only
CON.XSWI15PosctlModel	status-only
CON.XSWI16PosctlModel	status-only
CON.vinGGIO1$DPCSO01$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO02$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO03$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO04$ctlModel	direct-with-normal-security

Figure 7-18: Commands

vinGGIO

Controllable data in vinGGIO logical node are SPCSO1 - SPCSO64 and DPCSO1 - DPCSO16. Signals SPCSO1 - SPCSO32 map to 32 Virtual Inputs Latched in C650 relay and signals SPCSO33 - SPCSO64 map to Virtual Inputs Self-Reset. DPCSO1 - DPCSO16 are double control points and operate on pairs of Virtual Inputs Latched. Thus DPCSO1 - DPCSO16 map to 32 Virtual Inputs Latched and an operation of one attribute DPCSO always operate on two Virtual Inputs Latched, one Virtual Input of the pair is set to "1" and the other Virtual Input of the pair is set to "0". In vinGGIO logical node only control mode "direct control with normal security" can be used.

XCBR, CSWI, recPhXCSWI

Controllable data in these logical nodes are Pos (position) objects. These are operations used to change state of breaker, switch or recloser.

C650 relays supports all four IEC 61850 control modes (ctlModel), which are:

- Direct control with normal security (direct-with-normal-security)
- SBO control with normal security (sbo-with-normal-security)
- Direct control with enhanced security (direct-with-enhanced-security)
- SBO control with enhanced security (sbo-with-enhanced-security)

TIMEOUTS

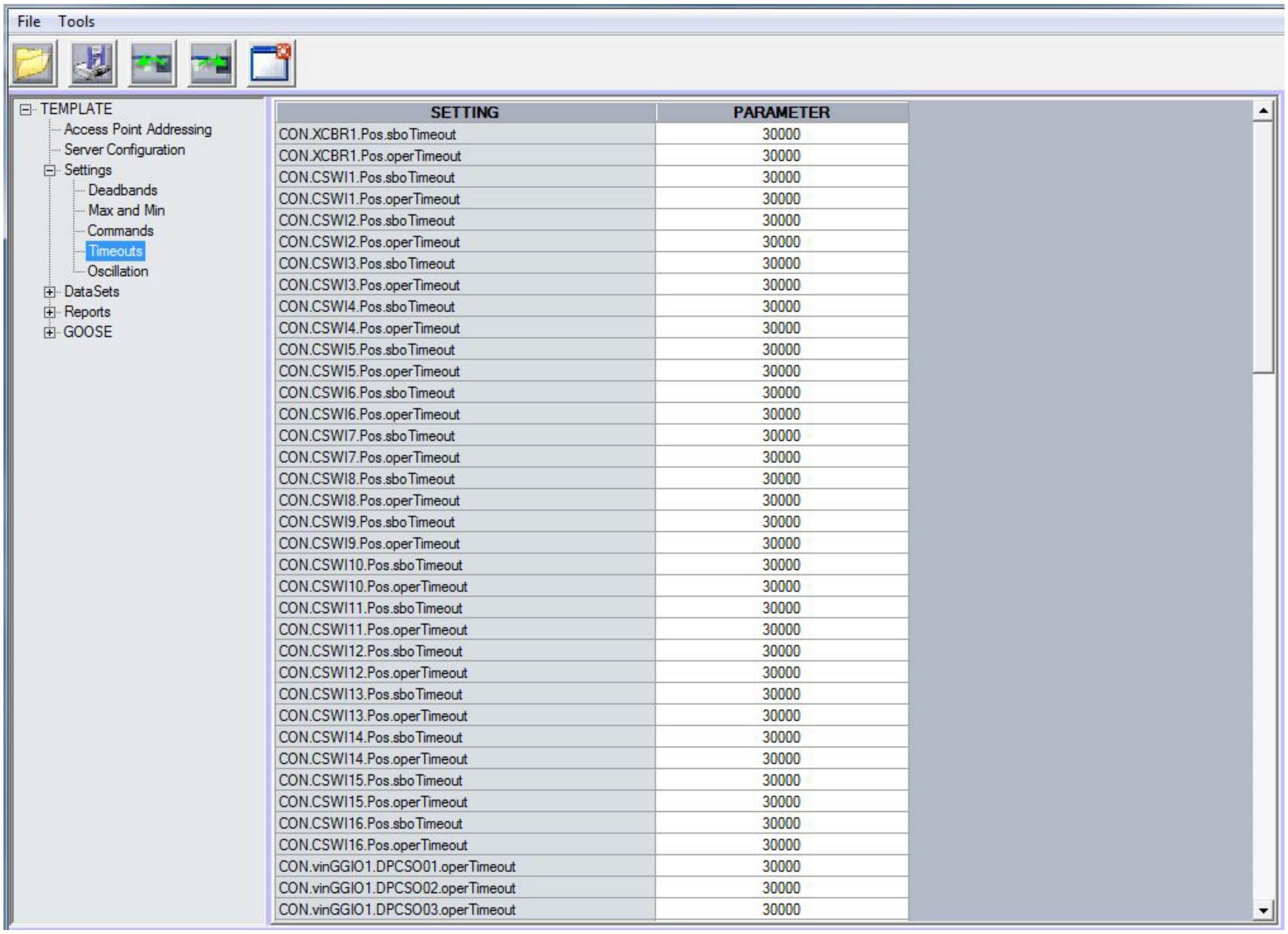


Figure 7-19: Timeouts

There is a configurable timeout for SBO control modes and for operation in logical nodes listed above. The value range for SBO timeout is 500 ms - 60 seconds.

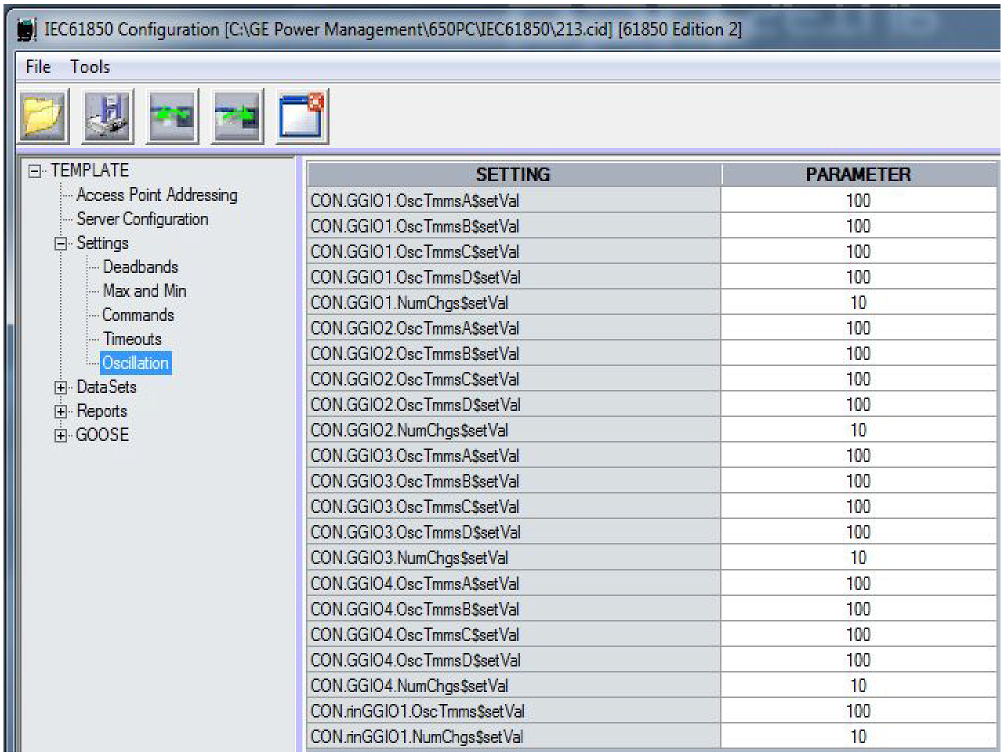
The sboClass attribute can only have value "operate-once", "operate-many" pattern is not supported in IEC 61850 SBO controls in 650 relay.

OSCILLATION

There are two settings used for the detection of the digital inputs of I/O boards and rinGGIO LN oscillation, OscTmms and NumChgs.

·OscTmms: time between two changes in the same direction (from 0 to 1 or from 1 to 0) to consider that a signal is oscillating. There are four settings for each GGIO (OscTmmsA, OscTmmsB, OscTmmsC and OscTmmsD), one for each group of inputs, and one in rinGGIO logical node.

·NumChgs: number of changes that have to be produced in an oscillatory signal to be consider as invalid and not to continue sending changes of the signal, sending the value of the signal when it was consider as oscillatory.



DataSet

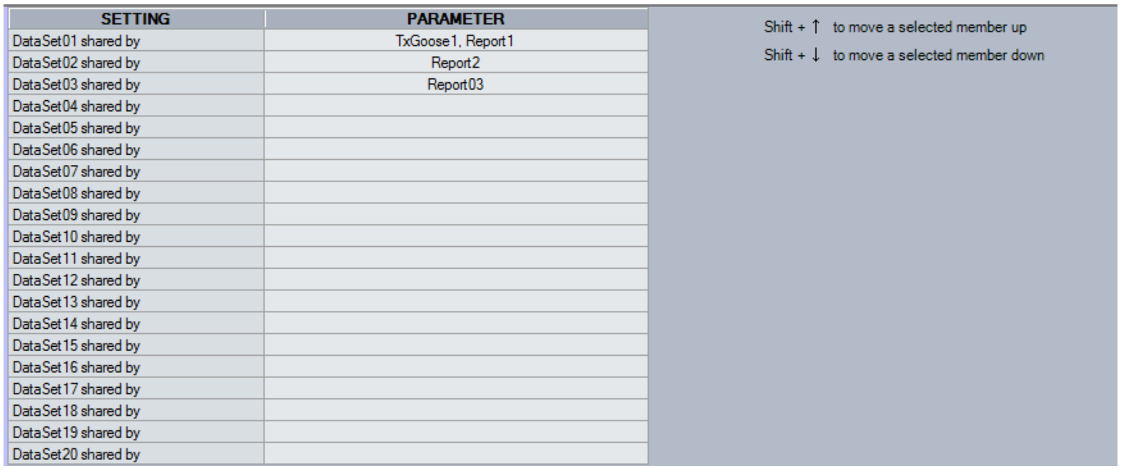
Two different sections will be differentiated under this section:

- Summary
- DataSetXX

SUMMARY

In this screen, user can find a list with information about where a configured DataSetXX has been used (Report and/or GOOSE).

If a DataSetXX is shared by more than one Report/GOOSE, all elements will be listed in DataSetXX Parameter field, separated by commas.



SETTING	PARAMETER
DataSet01 shared by	TxGoose1, Report1
DataSet02 shared by	Report2
DataSet03 shared by	Report03
DataSet04 shared by	
DataSet05 shared by	
DataSet06 shared by	
DataSet07 shared by	
DataSet08 shared by	
DataSet09 shared by	
DataSet10 shared by	
DataSet11 shared by	
DataSet12 shared by	
DataSet13 shared by	
DataSet14 shared by	
DataSet15 shared by	
DataSet16 shared by	
DataSet17 shared by	
DataSet18 shared by	
DataSet19 shared by	
DataSet20 shared by	

Figure 7-20: DataSetXX summary view

DataSetXX:

In this section, configure up to 20 different DataSets as follows:

DataSetXX name: It must be assigned initially. The first character of this attribute must be a letter (upper or lower case). The rest must be a number, a letter (upper or lower case or a "_". The number of characters allowed in 32

If this name is not configured, the following message will prompt when trying to drag any new element:

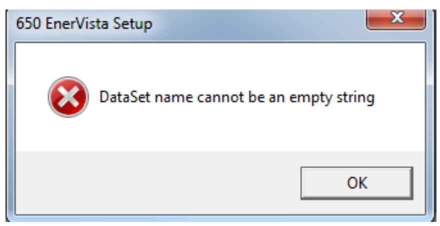


Figure 7-21: DataSet name not configured.

DataSetXX MemberX: After DataSet name is defined, members can be adding by dragging and dropping elements from the complete data model of the IED displayed below to the Data Set.

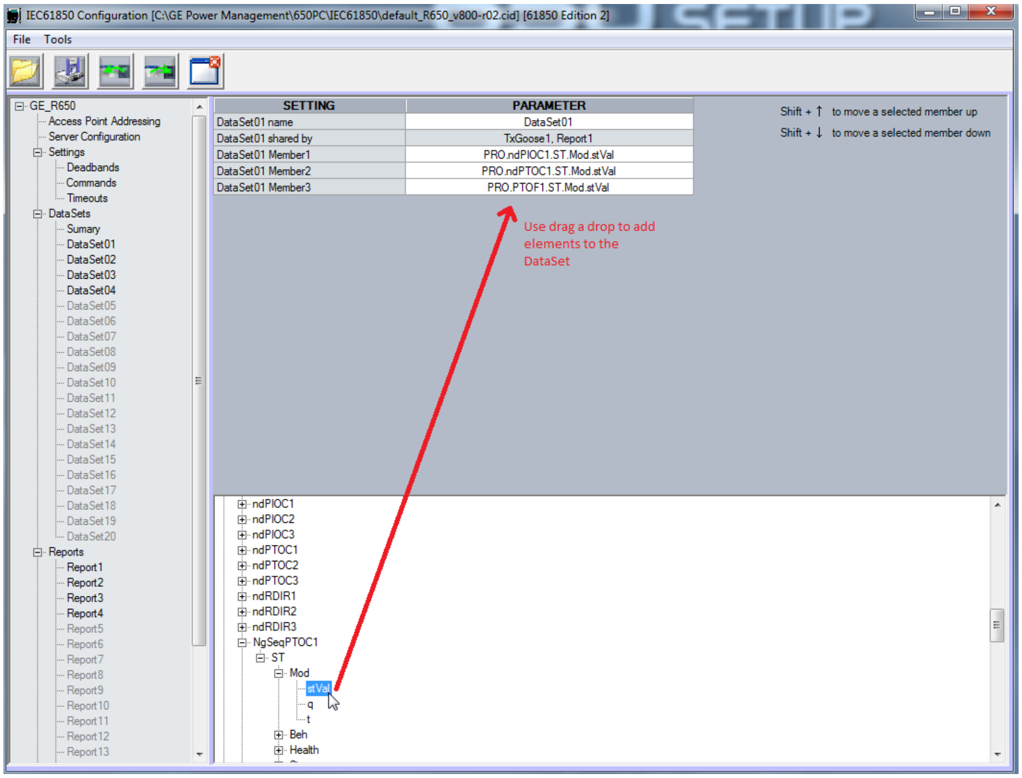


Figure 7-22: Adding attributes to a DataSet

There is a counter in the right-up corner of configuration area where users can visualize how many basic attributes have been added to a DataSetXX. This counter will increase automatically when basic attributes are dragged and dropped.

For example id CON.MMXU1.MX.A.net.cVal is dragged and dropped into DataSet, counter will be increased in two as there are two basic attributes in it (CON.MMXU1.MX.A.net.cVal.mag and CON.MMXU1.MX.A.net.cVal .ang)

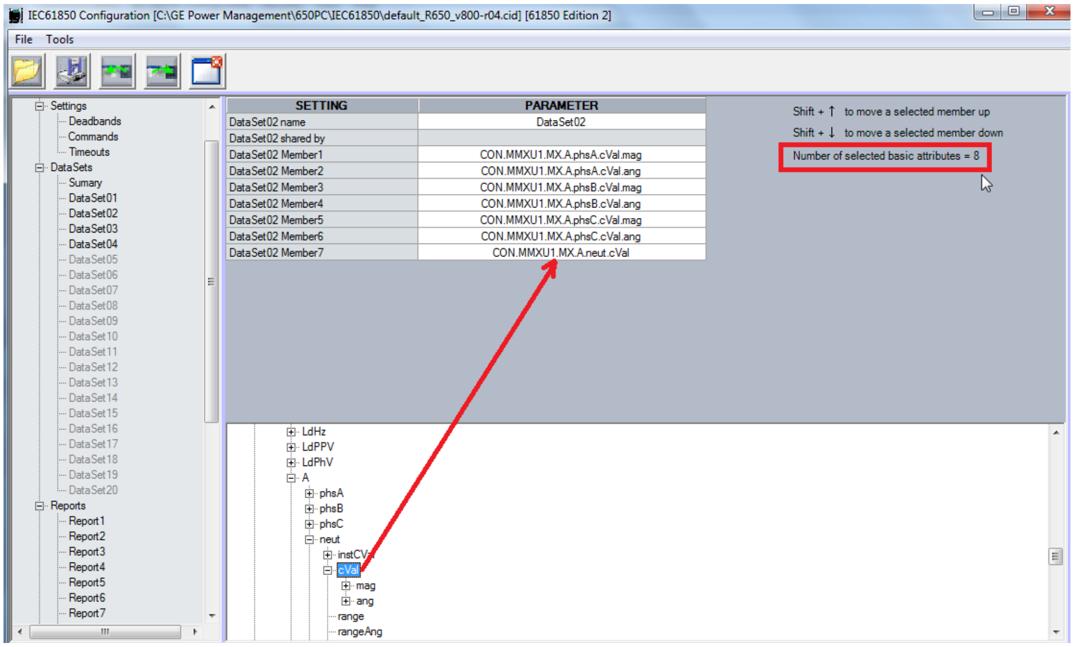


Figure 7-23: Basic attributes counter

To change the Order of the configured DataSet:

1. Select DataSet Member to be moved.
2. Click on Shift and up/down key.

To delete a Dataset Member:

1. Click on DataMember.
2. Press **SUPR** key.

To remove a DataSetXX:

1. Select DataSetXX in the IEC 61850 IED Explorer window.
2. Click right-button and select **Delete DataSet** as shown:

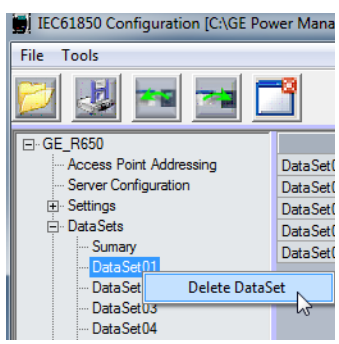


Figure 7-24: Delete DataSet

Reports

The 650 family relay supports both IEC 61850 buffered and unbuffered reporting. The device has configurable reports, which include user-defined Data Sets and Report Control Blocks.Reporting is based on Data Sets, which are collections of Data that can be included in Reports. The Report Control Block is a group of parameters which permit IEC 61850 customization of the reports being sent by the IEC 61850 server. For example, the IntgPd parameter of the Report Control Block contains the value in milliseconds of the interval between Integrity Reports sent by IEC 61850 servers.

A 650 family relay can have up to 20 different reports and up to 20 different Data Sets linked (only one DataSet can be linked to one Report). In the reports, each Dataset can be configured with a maximum of 576 Dataset Members.

All settings/datasets assigned to different reports can configured as described in this section. Up to 20 different reports can be configured.

SETTING	PARAMETER
Report1 Name	Report1
Report1 RptID	1
Report1 DatSet	DataSet01
Report1 ConfRev	1
Report1 OptFlds	Click to view or edit (223)
Report1 BufTm	0 ms
Report1 TrgOps	Click to view or edit (5)
Report1 IntgPd	60 ms
Report1 Buffered	True
Report1 Max Clients	1

ReportX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed in IEC61850 Configurator is 30 and IEC61850 MMS Library adds 2 more characters indicating the number of the instance of the RCB depending on the number of IEC61850 clients configured

ReportX RptID:

The attribute RptID is the client-specified report identifier of the RCB that has caused the generation of the report.

ReportX DatSet:

This dropbox lists only DataSets configured in DataSet section with less than 576 DataSet Members. Select the Dataset that is going to be assigned to Report X,

ReportX ConfRev:

It represents the configuration revision number of the control block

ReportX OptFlds:

Different options for report triggers are listed in this drop-box list. One or more options the report triggers are shown in the Supported Triggers list:

- Data-Change
- Quality-Change
- Integrity
- General Interrogation

ReportX BufTm:

This setting is only considered if ReportX Buffer setting is set to true. In case of an event that causes a report the server will wait for BufTm ms for other events. All data that is to be reported because of events in this time span is sent in a single report. If connection with client is lost, events will be logged during BufTm and they will be sent when client connects again.

ReportX IntgPd

Only working if general interrogation is configured in trigger options. The integrity period specifies an interval in ms for the periodic sending of integrity reports.

ReportX Buffered:

The standard distinguishes between two types of reporting: buffered reporting and unbuffered reporting. With buffered reporting reports are buffered by the server in case a connection to the client is interrupted. This way reports can be sent after the client has connected again. Buffered reporting is configured through buffered report control blocks (BRCB). Unbuffered reporting is configured through unbuffered report control blocks (URCB).

If it set to true, report will be configured as buffered report control block (BRCB). If set to false, report will be configured as unbuffered report control block (URCB)

ReportX Max Clients:

Number of clients that can be connected to a report control block. Up to 5 different clients can be configured

GOOSE

TxGOOSE

In this section, configure four different transmission GOOSE: TXGOOSEX.

SETTING	PARAMETER
TxGOOSE1 Name	TxGoose1
TxGOOSE1 Desc.	
TxGOOSE1 GoID	TxGOOSE1
TxGOOSE1 DataSet	DataSet01
TxGOOSE1 CONFREV	1
TxGOOSE1 Enabled	true
TxGOOSE1 DST MAC	01-0C-CD-01-00-01
TxGOOSE1 VLAN PRIORITY	4
TxGOOSE1 VLAN ID	000
TxGOOSE1 ETYPE APPID	0000
TxGOOSE1 MAX TIME	10000

Figure 7-25: Transmitted GOOSE settings

TxGOOSEX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed is 32.

TxGOOSEX Desc:

The maximum number of characters allowed is 32.

TxGOOSEX GoID:

The maximum number of characters allowed is 129

TxGOOSEX DataSet:

Select DataSet to be transmitted in this TxGOOSE. Only DataSets configured with 128 elements or less will be displayed in this drop-box.

TxGOOSEX CONFREV:

It can be used to indicate GOOSE configuration revision

TxGOOSEX Enabled:

To enable/disable transmission GOOSE

TxGOOSEX DST MAC:

The standard MAC address limit. 6 pairs of letters (from A to F, upper case or lower case) or numbers separated by colons.

Make sure to configure the MAC with the least significant bit in the most significant byte, set to 1. Example: 01: 0C: CD: 00: 00: 04

TxGOOSEX VLAN PRIORITY:

A number from 0 to 7 can be configured. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1.

TxGOOSEX VLAN ID:

The maximum number of characters allowed is 3. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFF).

TxGOOSEX ETYPE APPID:

All characters must be numerical. The maximum number of characters allowed is 4. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFFF).

IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. In the C650, the transmitted GOOSE Application ID number must match the configured receive Application ID number in the receiver. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

TxGOOSEX MAX TIME:

Time allowed to live. The maximum time packet remains alive after transmission. It must be configured in ms

Mapping TxGOOSES

For transmission GOOSE you can create Data Sets with drag-and-drop selecting the desired data attributes in the data model tree and dragging them to the DataSet panel. Data Sets can be directly formed by attributes of all Logical Nodes. For example they can contains status of protection functions as:

- PTOC1.ST.Op.phsA- "Time Overcurrent Function 1 Operate Phase A"
- PTUF2.ST.Str.general- "Underfrequency Function 2 Trip General"
- XCBR1.ST.Pos.stVal- "Circuit Breaker Position"
- etc.

There is also a dedicated logical node in C650 which can be used for mapping of internal signals to be transmitted via GOOSE. This logical node is rouGGIO1. It contains 32 digital indications with associated quality flags and timestamps. rouGGIO1 permits flexible mapping of any of relay's digital signals to outgoing GOOSE messages. This can be useful when transmission via GOOSE of internal signals that are not mapped to any IEC 61850 logical node in the C650 is required. An example of such signals are "Virtual Outputs" which are internal variables of C650 derived from PLC logic equations.

Mapping of signals to rouGGIO1 indications is performed in EnerVista 650 Setup software in menu **Setpoint > Relay Configuration > Remote Outputs**. rouGGIO1 indications are called **Rem GOOSE Dig Out 1**, **Rem GOOSE Dig Out 2**, etc. in this menu, and are listed after the DNA and UserSt bits.

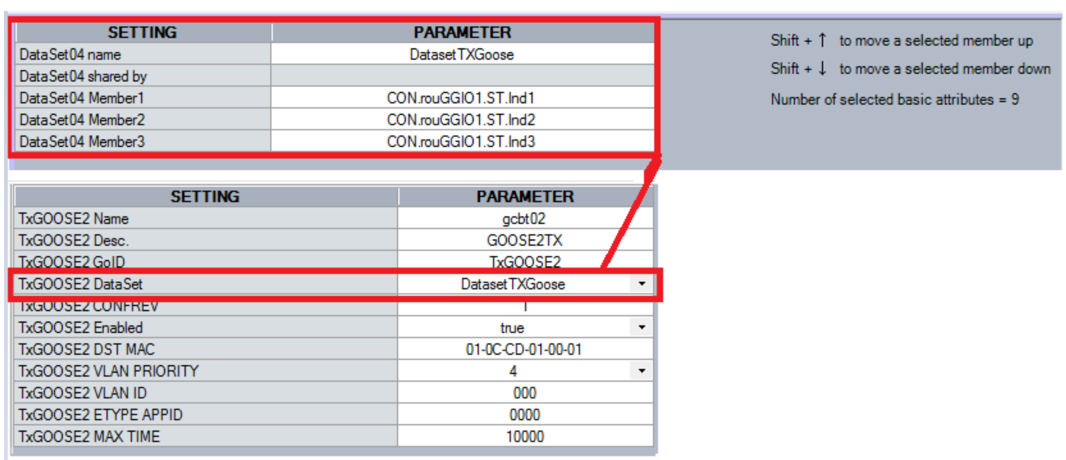


Figure 7-26: Example of rouGGIO mapping in Dataset

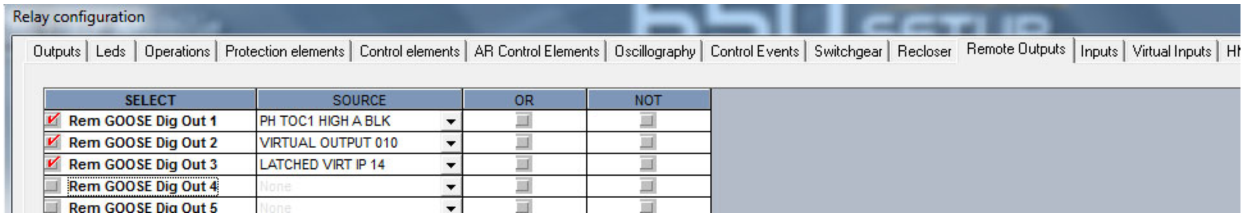


Figure 7-27: Example of rouGGIO mapping in Setpoint > Relay configuration

RxGOOSE

650 relays can subscribe to up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital Inputs, and 16 Remote Goose Analog Inputs can be configured as subscriptions.

Mapping RxGOOSES

In order to configure reception of configurable GOOSE in a 650 relay, it is necessary to have the ICD/CID file of the sending IED. This means that the first transmission GOOSE must be configured in the sender, and then the ICD/CID file must be imported using the **IEC 61850 Configurator** tool in the EnerVista 650 Setup software.

To import a CID file from a remote IED:

1. In the IED list panel, select LGOS X, right-click and select **Add IED** to add a new IED for GOOSE reception. Up to 24 different CIDs can be imported.

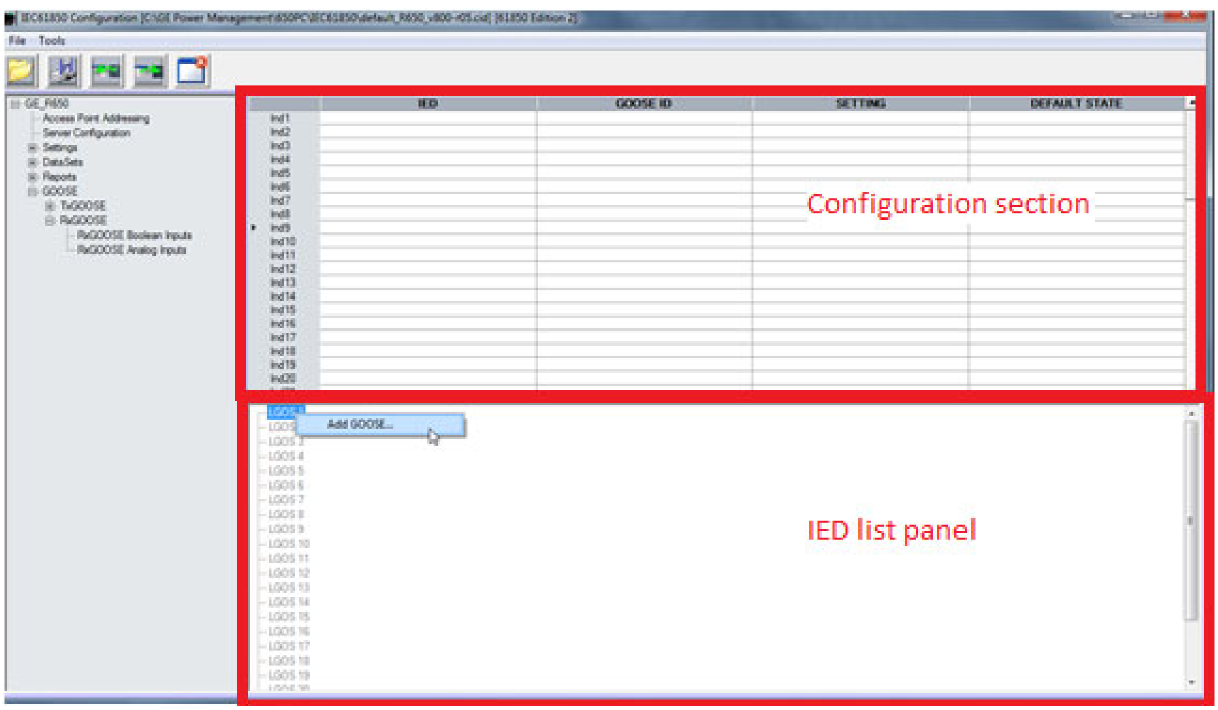


Figure 7-28: Import CID file

2. A pop-up window allows selection of the CID file to import, with transmission GOOSES previously configured.

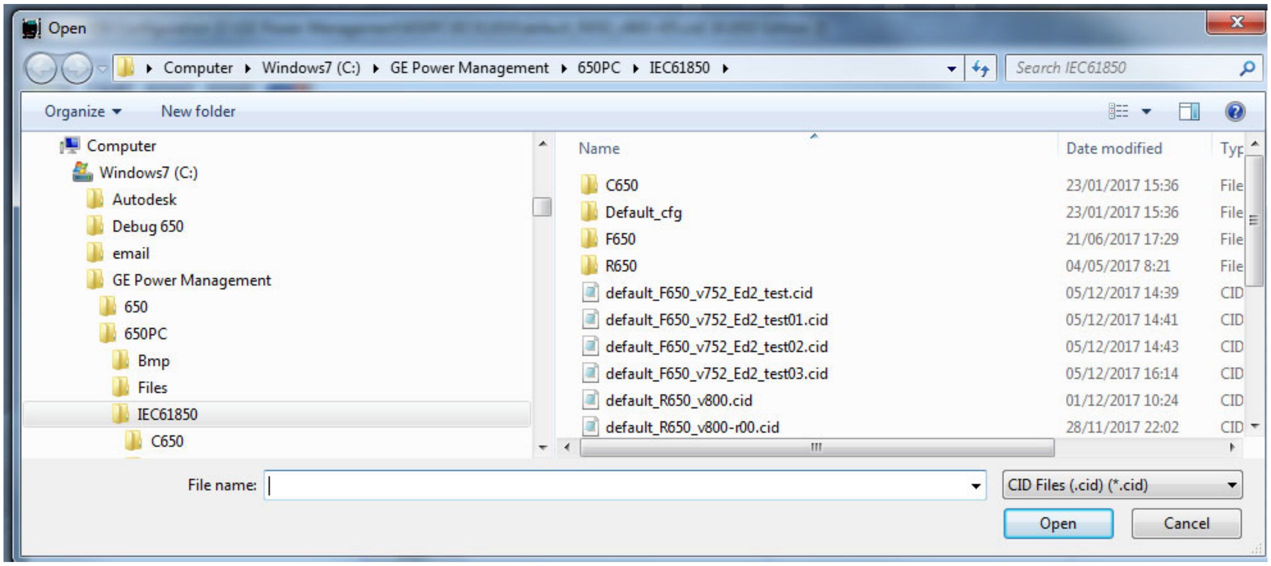


Figure 7-29: CID file selection

3. After selecting the CID file, all configured transmission GOOSES are imported and all GOOSE FCDAs are displayed as shown:

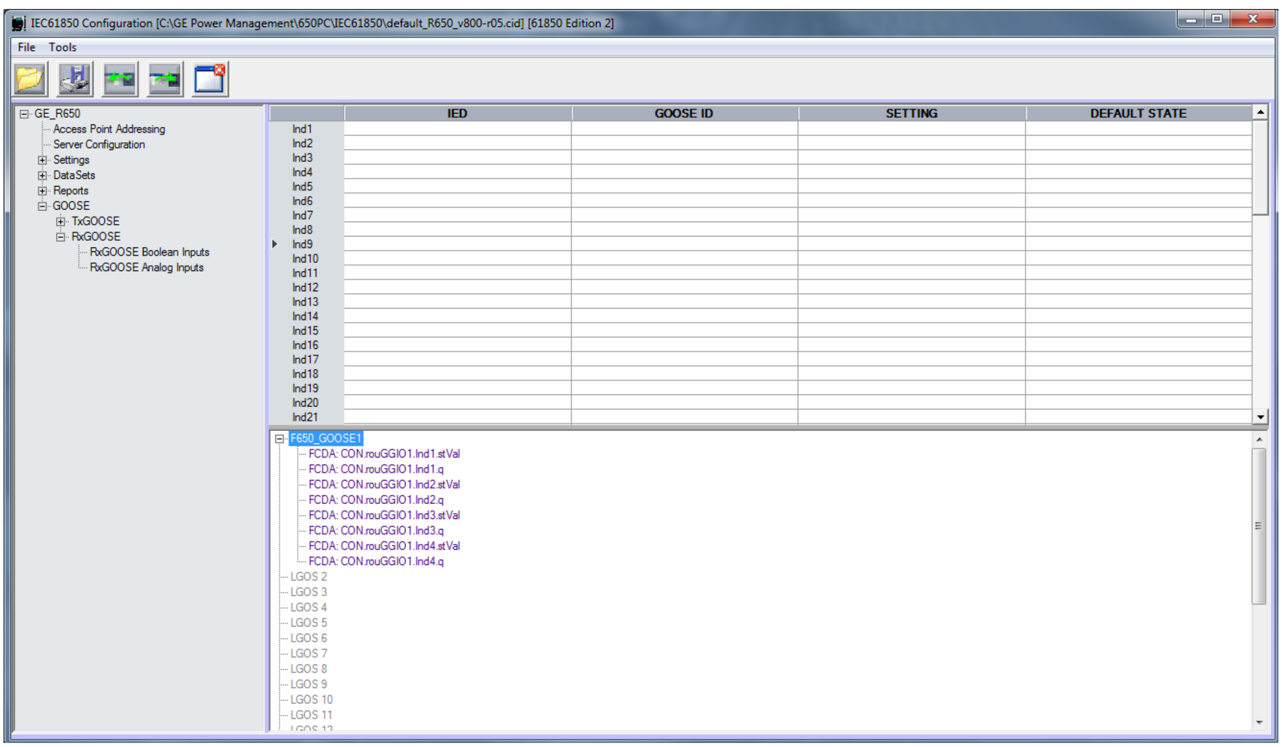


Figure 7-30: Imported CID file

4. If any imported transmission GOOSE needs to be deleted, updated, moved up/down or the header needs to be edited,

right-click on the imported GOOSE in the IED panel list

Figure 7-31: Transmission GOOSE menu

If a new CID is imported and it contains a GOOSE ID that it is already present in the IED panel list, the following message displays and no transmission GOOSES from the imported CID are added to IED panel list.

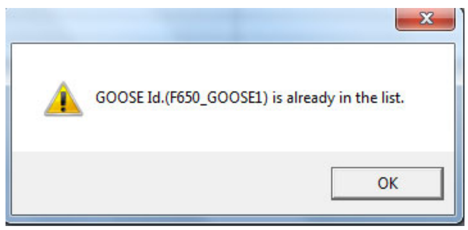


Figure 7-32: Warning message: Same GOOSE ID detected

Up to 32 Remote Inputs and 32 Goose Digital Inputs can be configured in a reception goose (RXGOOSE). The configuration section shows a list with 64 different rows. The first 32 values are shown on the Remote Goose Digital Inputs screen and the remaining 32 values are on the Remote Inputs screen.

To configure RxGOOSE Boolean Inputs follow these steps:

1. Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the

Configuration section.

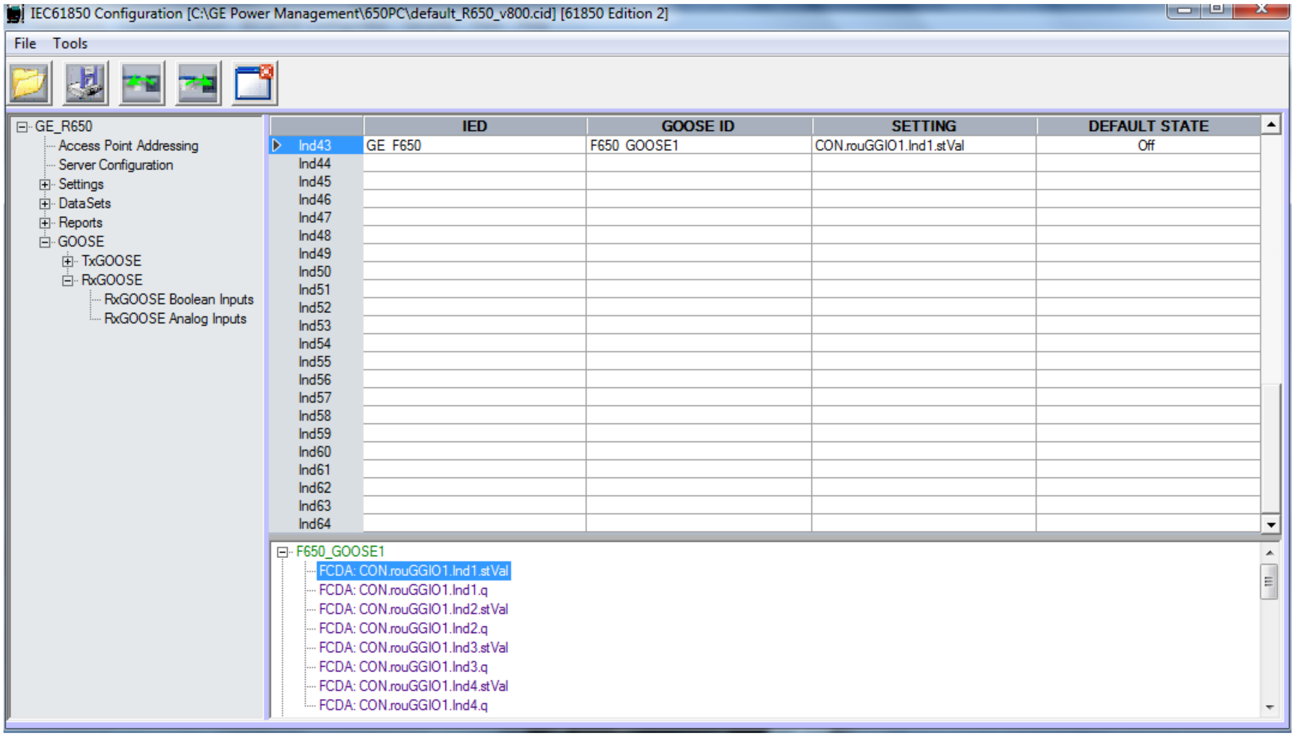


Figure 7-33: RXGOOSE Boolean Input

2. When a boolean signal is dragged and dropped into any IndX element, four columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of boolean signal from imported CID that has been dragged and dropped into the configuration area.
   - **DEFAULT STATE**: Value that signal shows when status has not been updated from the remote device.

Removing Boolean inputs:

- To remove a configured boolean signal, right-click on it and select **Remove Input**.

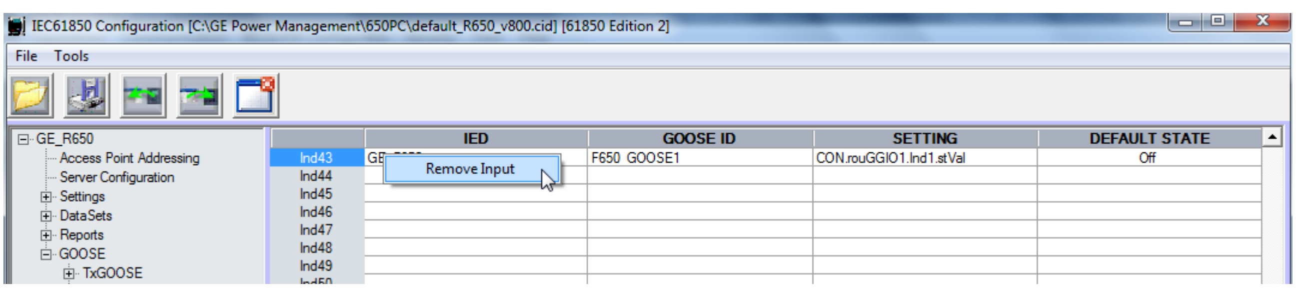


Figure 7-34: RXGOOSE Boolean input - Remove Input

To configure quality bits, follow these steps

1. Quality bits of Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the Configuration section. When a quality bit is dragged and dropped, a pop-up window opens to allow the selection of one of the thirteen quality bits available.

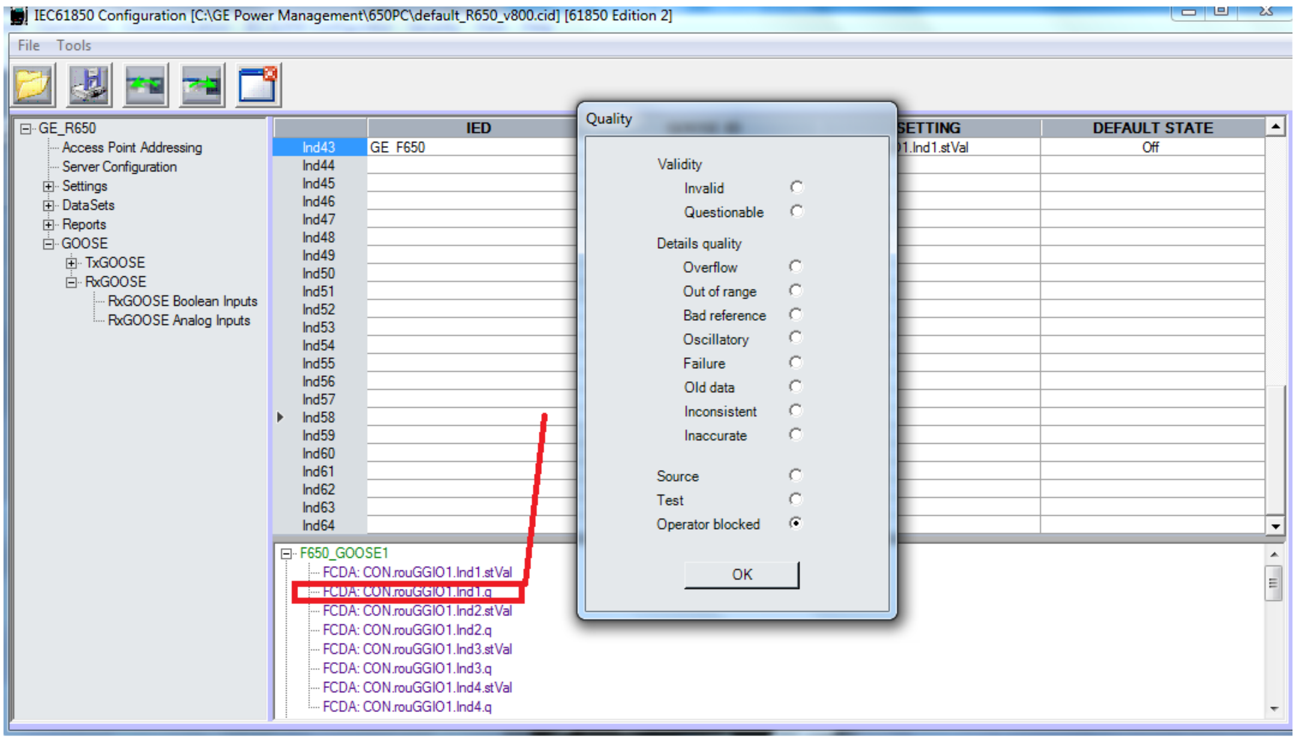
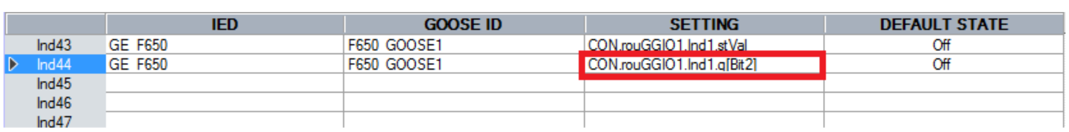


Figure 7-35: RXGOOSE Boolean input - Quality bit selection

2. Once a quality bit is selected, click **OK**, and the selected quality bit is shown in the Setting column of the Configuration area.

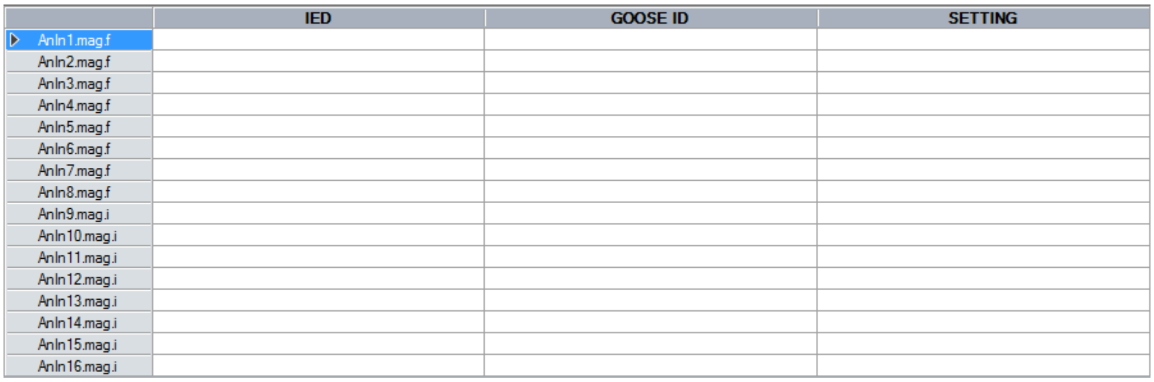


	IED	GOOSE ID	SETTING	DEFAULT STATE
Ind43	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.stVal	Off
Ind44	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.q[Bit2]	Off
Ind45				
Ind46				
Ind47				

Figure 7-36: RXGOOSE Boolean input - Selected quality bits shown

To configure RxGOOSE Analog Inputs, follow these steps:

Up to 8 float analog inputs (AnInX.mag.f) and 8 integer analog inputs (AnInX.mag.i) can configured in RXGOOSE Analog Inputs, as shown:



	IED	GOOSE ID	SETTING
AnIn1.mag.f			
AnIn2.mag.f			
AnIn3.mag.f			
AnIn4.mag.f			
AnIn5.mag.f			
AnIn6.mag.f			
AnIn7.mag.f			
AnIn8.mag.f			
AnIn9.mag.i			
AnIn10.mag.i			
AnIn11.mag.i			
AnIn12.mag.i			
AnIn13.mag.i			
AnIn14.mag.i			
AnIn15.mag.i			
AnIn16.mag.i			

Figure 7-37: RXGOOSE Analog Inputs

1. Add both float and Integer analog inputs by dragging and dropping values from the transmission GOOSES imported in the IED Panel list into AnInX.mag.X rows in the Configuration section.
2. When an analog signal is dragged and dropped into any element, three columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of Analog signal from imported CID that it has been dragged and dropped into configuration area.

   If the analog signal being dragged and dropped has been previously added from the IED panel list, the following warning message pops up:

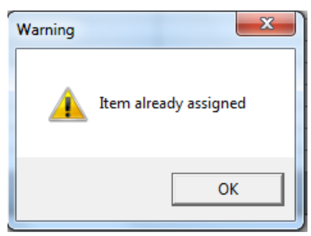
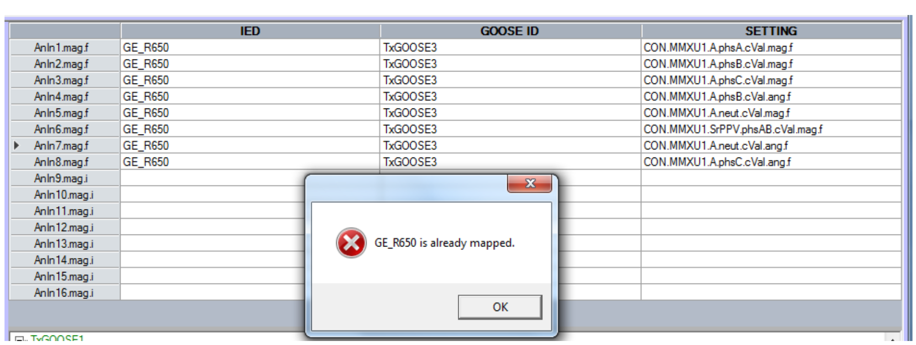


Figure 7-38: Warning message - Duplicate item

When all 8 Analog Inputs of one type (such as float) have been mapped, and an additional float analog value is dragged a dropped into the Configuration area, an error message is shown

:



	IED	GOOSE ID	SETTING
AnIn1.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.phsA.cVal.mag.f
AnIn2.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.phsB.cVal.mag.f
AnIn3.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.phsC.cVal.mag.f
AnIn4.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.phsB.cVal.ang.f
AnIn5.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.neut.cVal.mag.f
AnIn6.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.SrPPV.phsAB.cVal.mag.f
AnIn7.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.neut.cVal.ang.f
AnIn8.mag.f	GE_R650	TxGOOSE3	CON.MMXU1.A.phsC.cVal.ang.f
AnIn9.mag.i			
AnIn10.mag.i			
AnIn11.mag.i			
AnIn12.mag.i			
AnIn13.mag.i			
AnIn14.mag.i			
AnIn15.mag.i			
AnIn16.mag.i			

In order to replace an Analog Input, first remove the existing Analog Input.

Removing Analog inputs:

- To remove a configured analog signal, right-click it and select **Remove Input**.

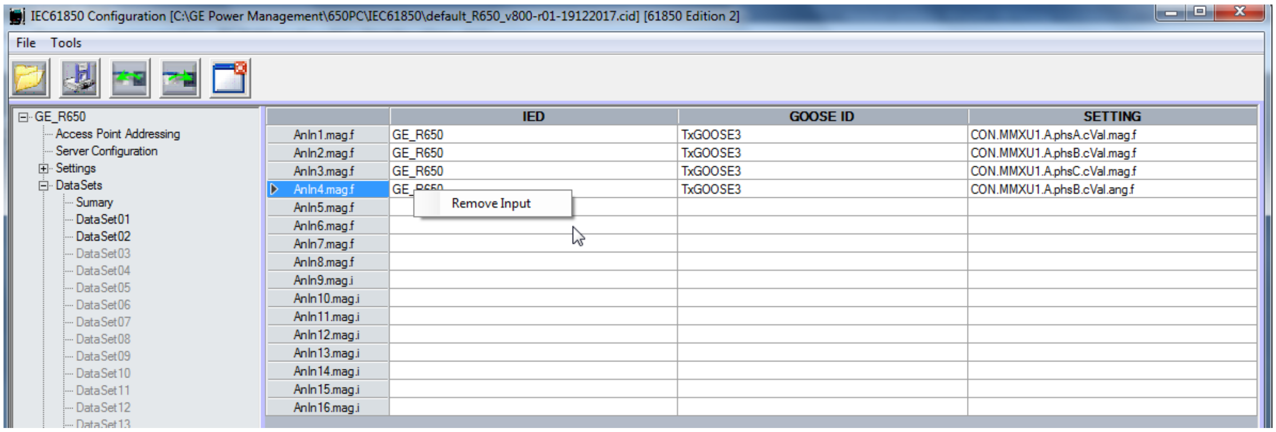


Figure 7-39: RXGOOSE Analog input- Removing inputs

7.6.3.2 Configuration of setting groups

The Logical Nodes affected by the implementation of the setting groups are:

- For firmware version below 7.50: LLN0, PIOC, PTOC, PTOF, PTOV, PTUV, PTUF and RDIR.
- For firmware version 7.50 or above: LLN0, PIOC, PTOC, PTOF, PTOV, PTUV, PTUF, RDIR, PTTR, PFRC, PDIS, PDOP, PRTR

The definition of the Logical Node LLN0 is shown in 7.2.7.3.3 or 7.2.7.3.4. The rest of the mentioned Logical Nodes are affected in the way that the setting data contained in those Logical Nodes have as many values as setting groups are defined:

- For firmware version below 7.50: 3 setting group for F650 relay
- For firmware version 7.50 or above: 6 setting group for F650 relay

Each setting data contained in those Logical Nodes has a type derived from one of the following common data classes defined in the standard IEC 61850-7-3: ING, SPG, ASG and CURVE. The setting data attributes of these common data classes have functional constraints SG (setting group) and SE (setting group editable) when the setting group function is enabled and SP (setpoint) when it is not.

When the setting group function is enabled the F650 relay has the following instances of the Logical Nodes mentioned before:

PIOC

- Phase instantaneous overcurrent: SGphHiPIOC1 and SGphLoPIOC1*/ phHiPIOC1 and phLoPIOC1
- Neutral instantaneous overcurrent: SGndPIOC1*/ ndPIOC1
- Ground instantaneous overcurrent: SGgndPIOC1*/ gndPIOC1
- Sensitive ground instantaneous overcurrent: SGhsePIOC1*/ hsePIOC1
- Isolated ground instantaneous overcurrent: IsoGndPIOC**
- Broken conductor: BknCndPIOC**

PTOC

- Phase time overcurrent: SGphHiPTOC1 and SGphLoPTOC1*/ phHiPTOC1 and phLoPTOC1
- Neutral time overcurrent: SGndPTOC1*/ ndPTOC1
- Ground time overcurrent: SGgndPTOC1*/ gndPTOC1
- Sensitive ground time overcurrent: SGhsePTOC1*/ hsePTOC1
- Sensitive ground time overcurrent: hsePTOC**
- Negative sequence time overcurrent: NgSeqPTOC**

PTOF

- Overfrequency: SGPTOF1*/ PTOF1

PTOV

- Phase overvoltage: SGphsPTOV1*/ phsPTOV1
- Auxiliary overvoltage: SGauxPTOV1*/ auxPTOV1
- Neutral overvoltage: SGneuHiPTOV1 and SGneuLoPTOV1*/ neuHiPTOV1 and neuLoPTOV1

PTUV

- Phase undervoltage: SGphsPTUV1*/ phsPTUV1
- Auxiliary undervoltage: SGauxPTUV1*/ auxPTUV1

PTUF

- Underfrequency: SGPTUF1*/ PTUF1

RDIR

- Phase directional element: SGphsRDIR1*/ phsRDIR1
- Neutral directional element: SGndRDIR1*/ ndRDIR1
- Ground directional element: SGgndRDIR1*/ gndRDIR1
- Sensitive ground directional element: SGhseRDIR1*/ hseRDIR1

PDOP

- Forward overpower: FwdPDOP **
- Directional overpower: DirPDOP**
- Wattmeter ground overpower: WattPDOP**

PFRC

- Frequency rate of change: PFRC**

PDIS

- Load encroachment: LodEncPDIS**

PRTR

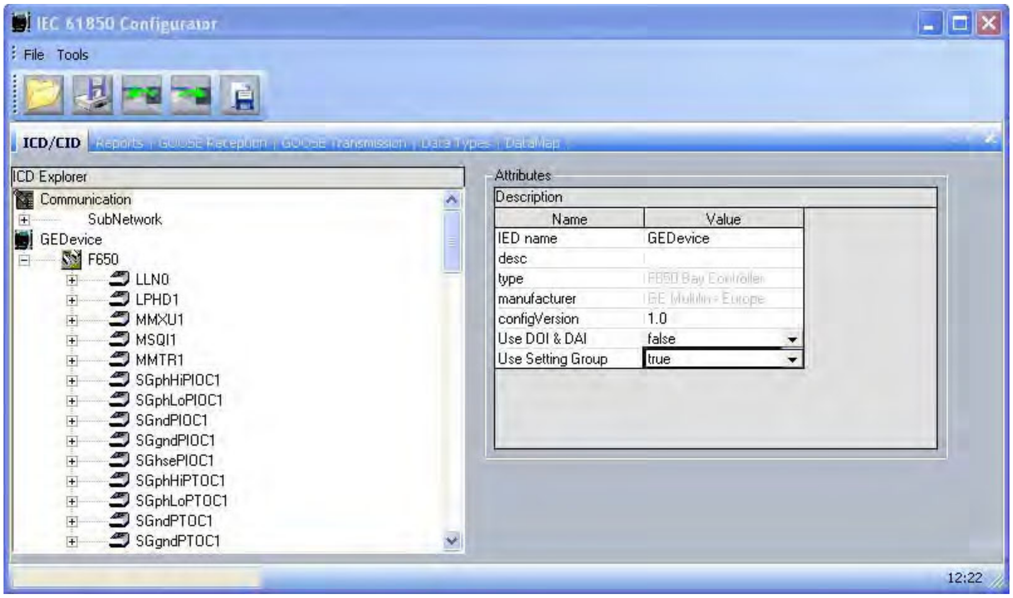
- Locked Rotor: LockedPRTR**

*These logical nodes model the corresponding protection function for setting groups in firmware version from 7.20 to below 7.50

**These functions have been included from firmware version 7.50.

If “Use Setting Group” is set to true for firmware version from 7.20 to below 7.50, the new instances of the Logical Nodes are accessible with the IEC 61850 Configurator as is shown in the following figure.

Firmware versions from 7.20 to below 7.50



Firmware versions 7.50 and above

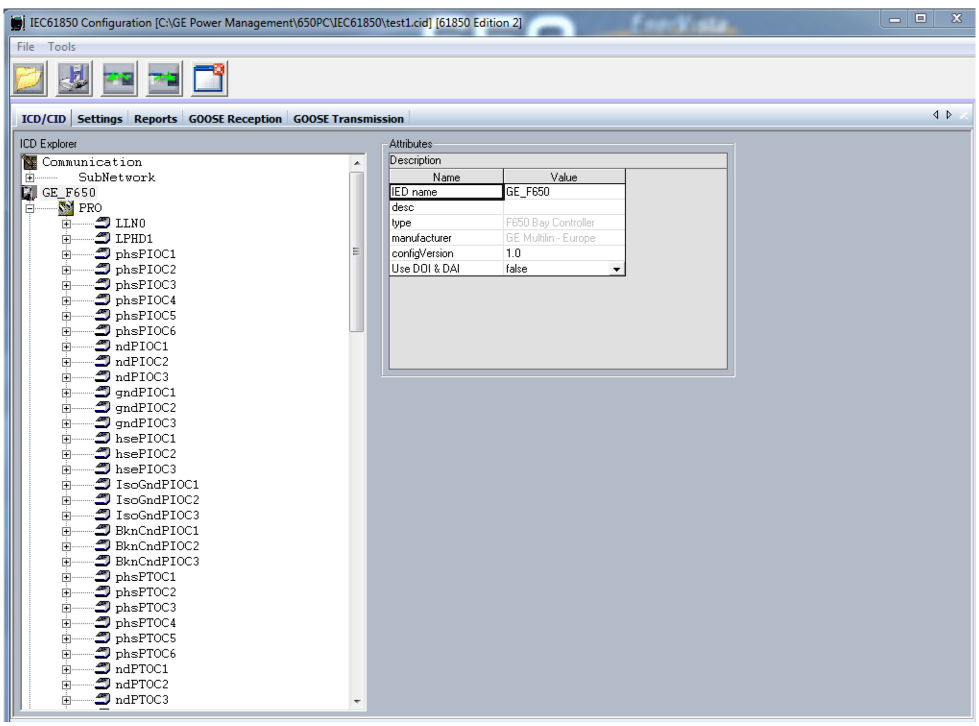


Figure 7-40: IEC 61850 Configurator

The setting grouping permission can be enabled or disabled using the relay HMI or using menu path **Setpoint > Control Elements > Setting Group** in the EnerVista 650 Setup program as shown in the figure.

For versions below 7.50 it can be enabled or disabled in the IEC61850 Configurator by setting **Use Setting Group** to true or false.

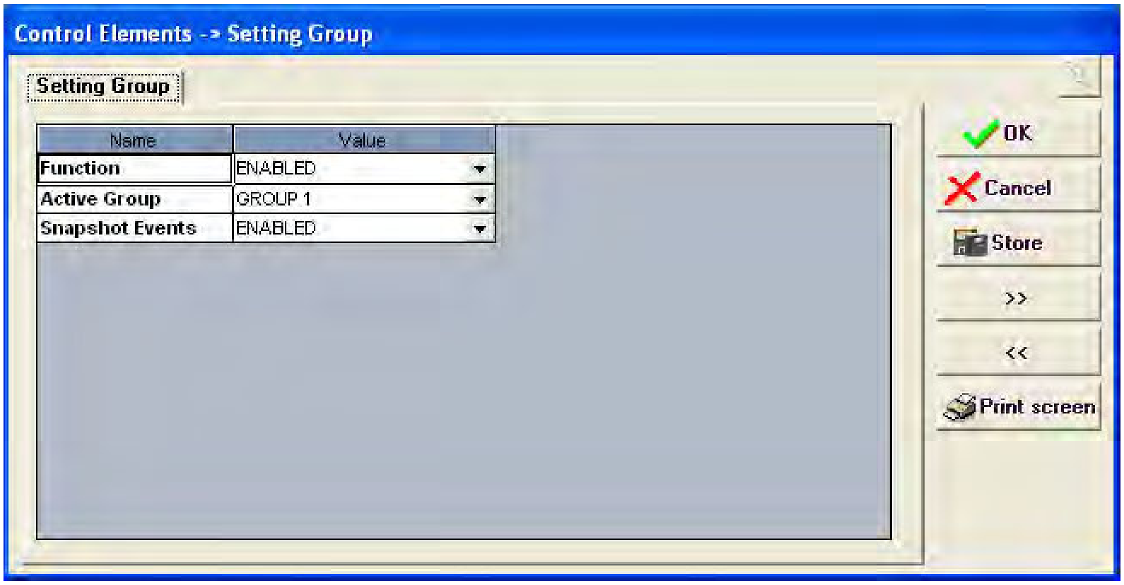


Figure 7-41: Control elements - setting group

The next figure is a capture of an MMS browser where SGCB class attributes are shown and configured, setting ActSG with the value 1 that corresponds with the first setting group in the F650 relay and EditSG with the value 2 that corresponds with the second setting group.

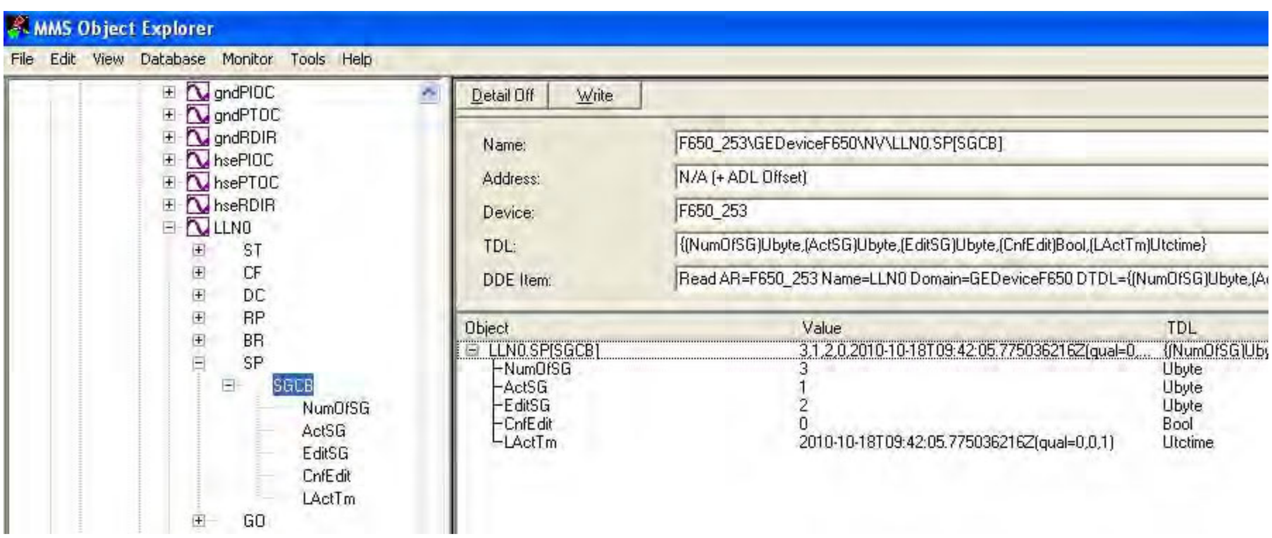
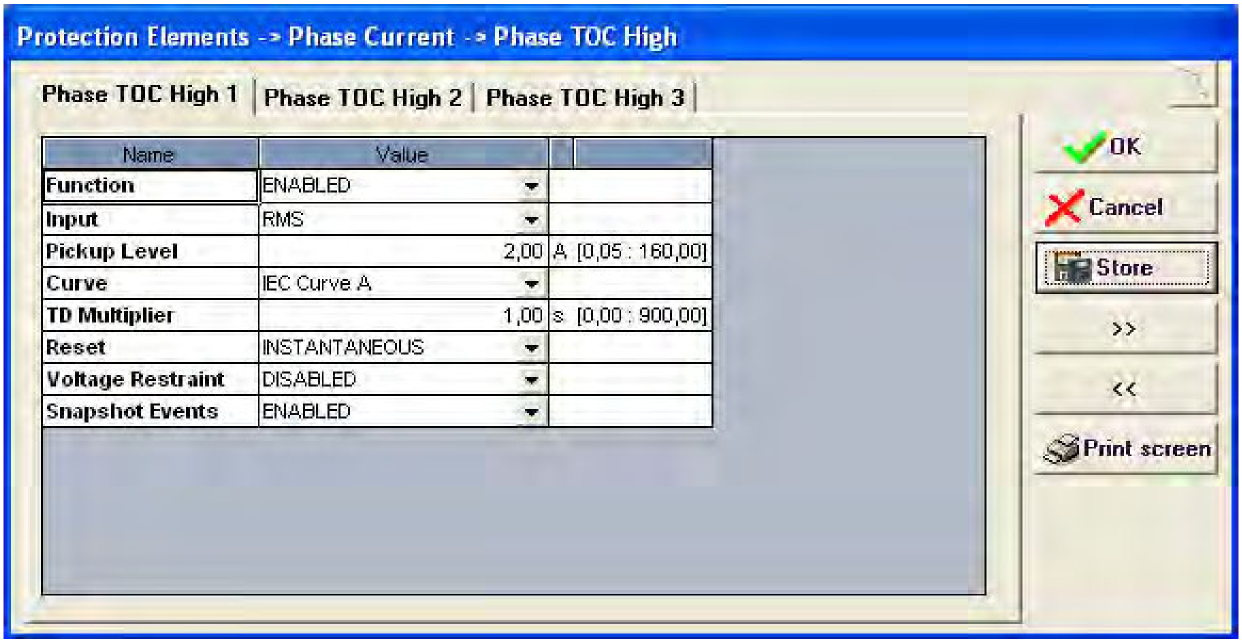
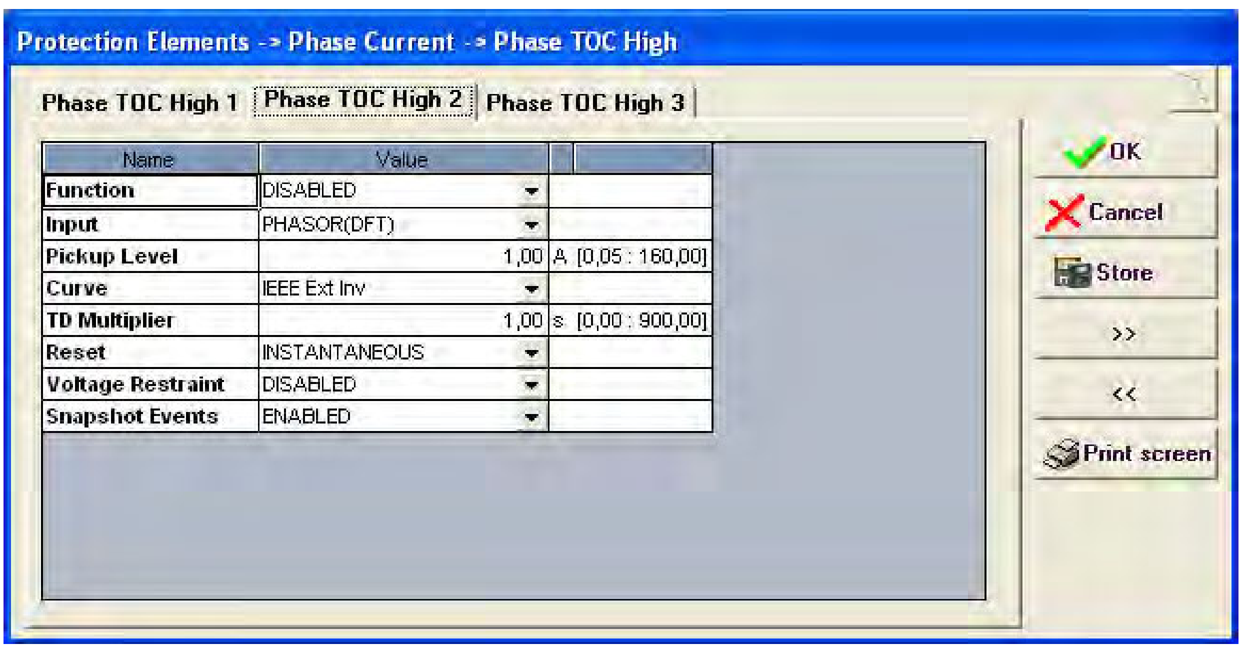


Figure 7-42: MMS object explorer

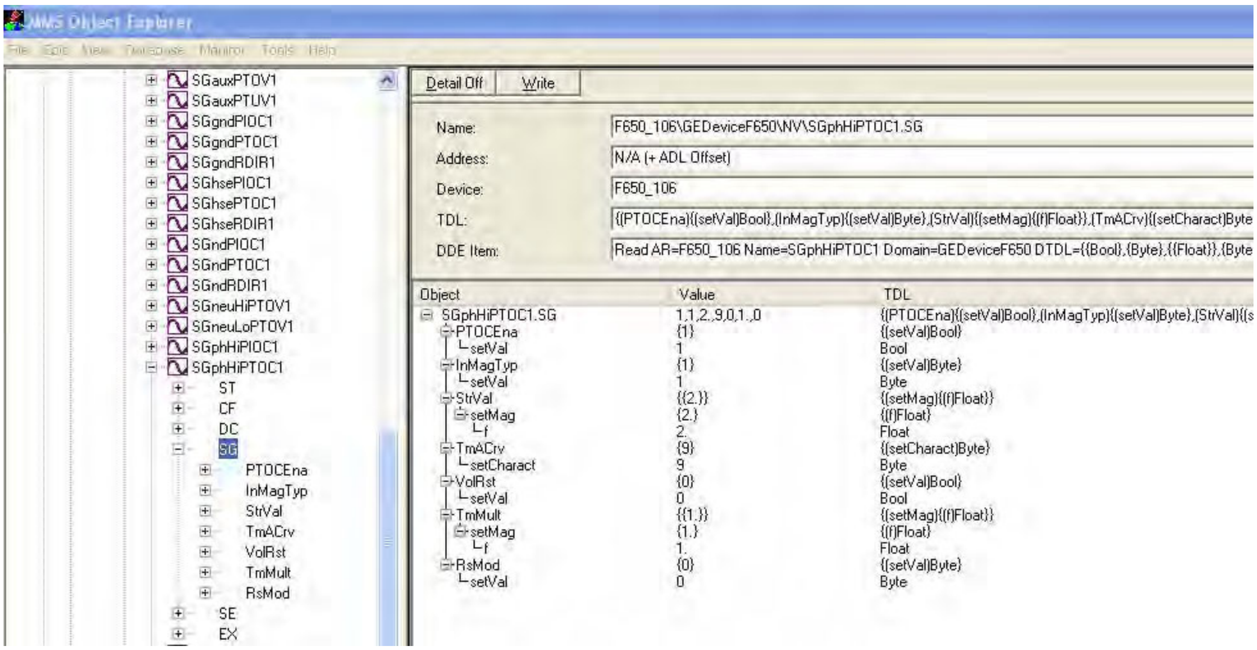
Firmware versions from 7.20 to below 7.50

The settings for the groups 1 and 2 of high level of Phase Time Overcurrent protection function are shown in the next figures.

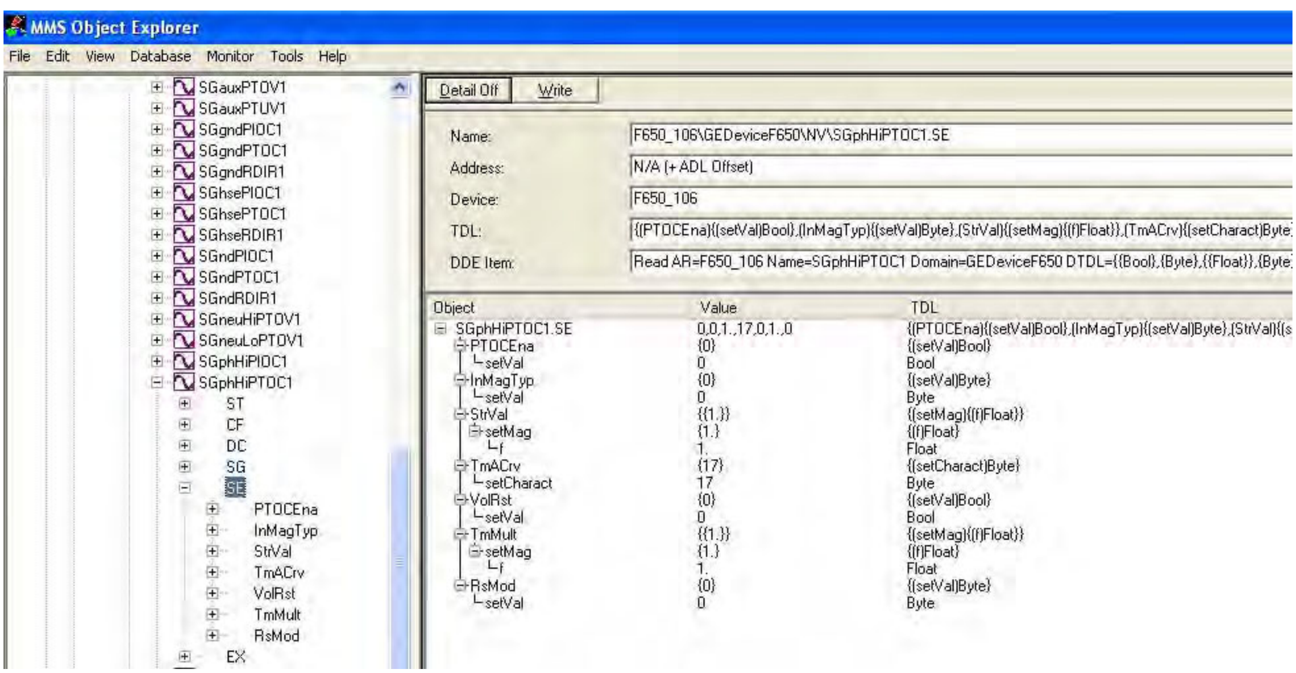




As it is shown in the figure, the values of the settings of the setting group indicated with the ActSg are the ones with the FC = SG in Logical Node SGphHiPTOC1, therefore the ones used by the high level of Phase Time Overcurrent protection function in the relay.

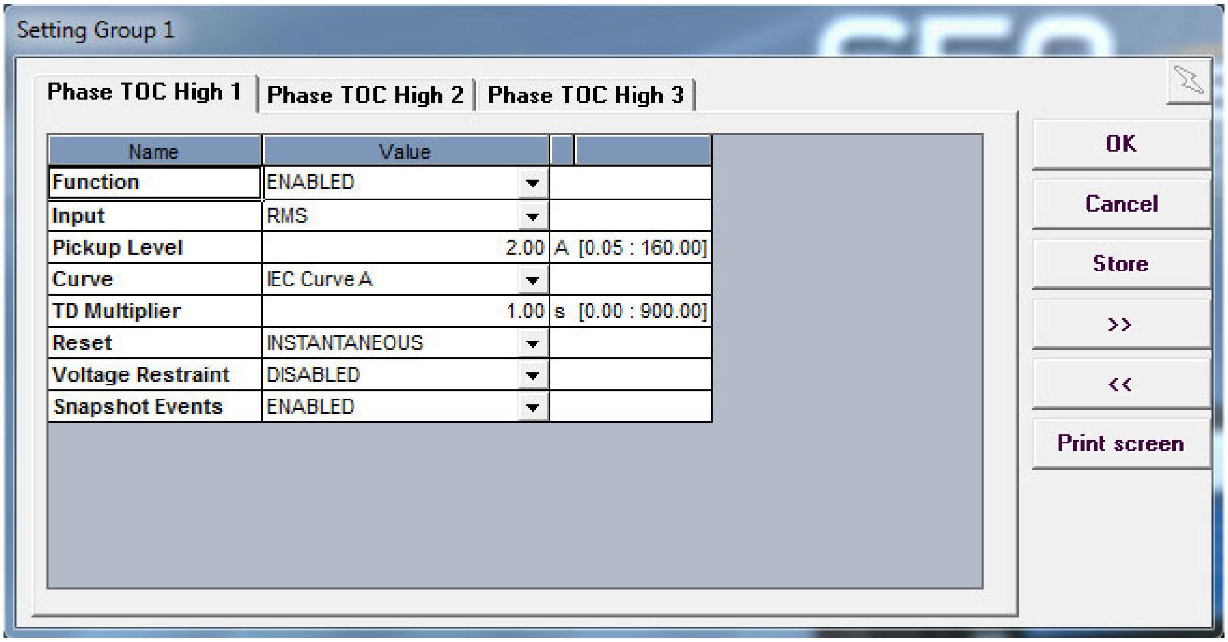


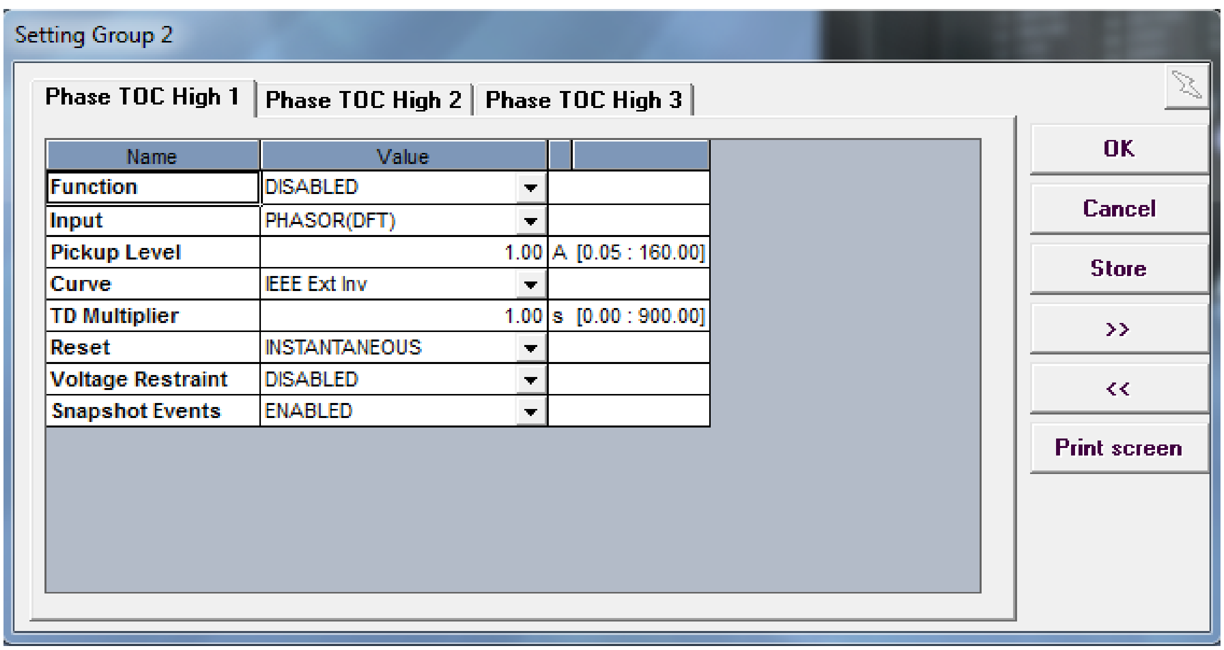
On the other hand, as it is shown in the figure, the values of the settings of the setting group indicated with the EditSg are the ones with the FC = SE in Logical Node SGphHiPTOC1.



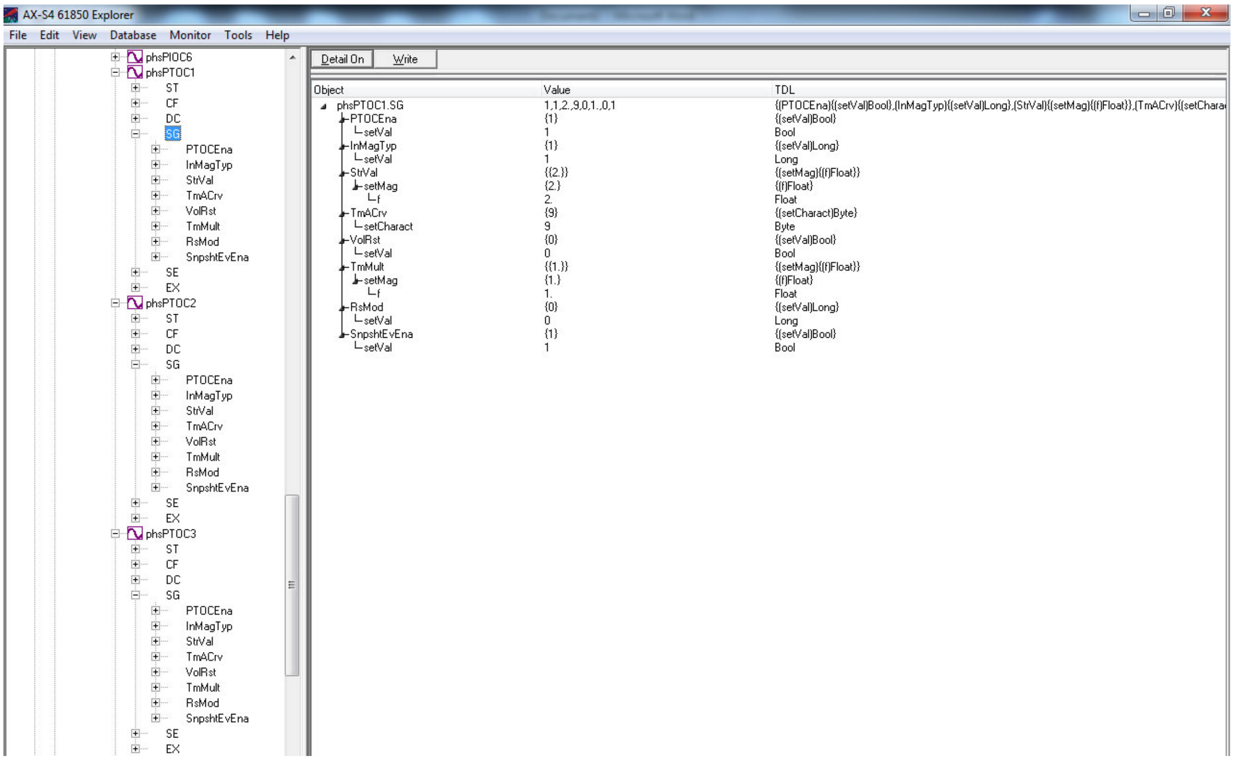
Firmware versions 7.50 and above

The settings for the high level Phase Time Overcurrent protection function (Phase TOC High 1, 2 and 3) on setting groups 1 (ActSG) and 2 (EditSG) are shown in the next figures.

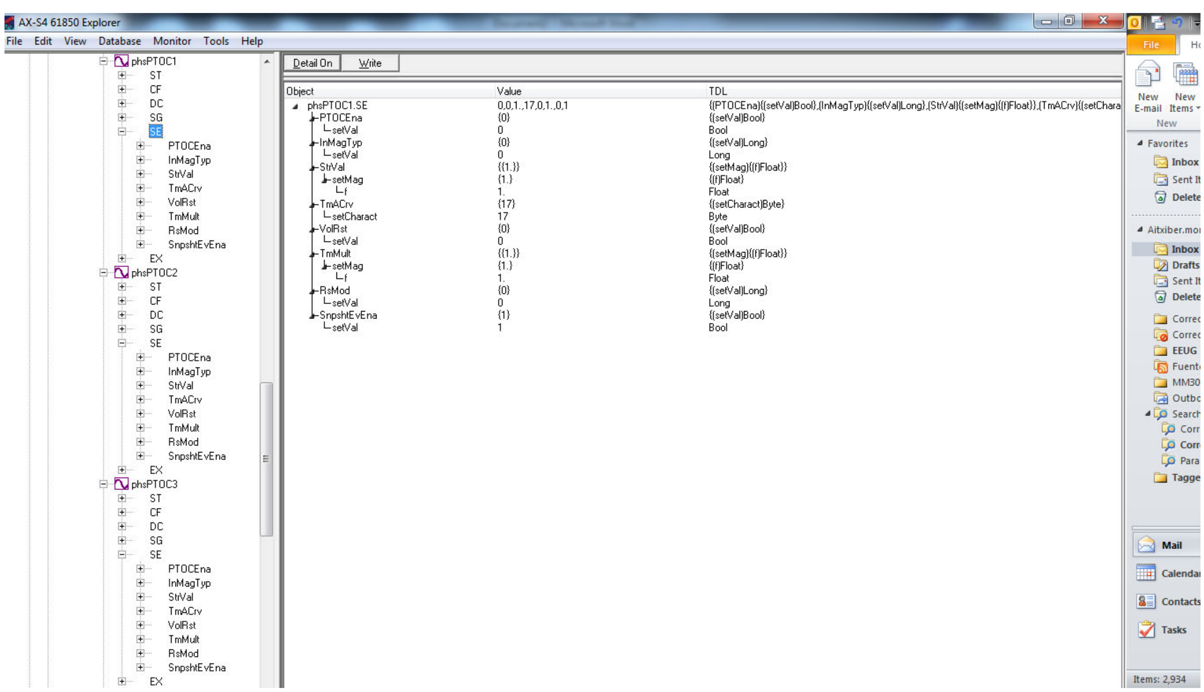




As it is shown in the figure, the values of the settings of the setting group indicated with the ActSg are the ones with the FC = SG in Logical Nodes phPTOC1, phPTOC2 and phPTOC3. Therefore the ones used by the high level of Phase Time Overcurrent protection function in the relay.



On the other hand, as it is shown in the figure, the values of the settings of the setting group indicated with the EditSg are the ones with the FC = SE in Logical Nodes phPTOC1, phPTOC2 and phPTOC3.



C650 Bay Controller & Monitoring System

Chapter 8: Security

8.1 Adding users

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**

8.1.1 User rights

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

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

Table 8-1: User rights and functions

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program asks to confirm the delete before the selected user is permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user becomes an EnerVista 650 Setup Administrator, receiving all Administrative rights.
Actual Values	When this box is checked, the user is able to *view* **Actual Values** and all records excluding event recorder.
Settings	When this box is checked, the user is able to *view and modify* **Settings (Protection, control, inputs/outputs and calibration)**.
Commands	When this box is checked, the user is able to use **Commands**.
Event Recorder	When this box is checked, the user is able to use **Event Recorder**.
Force IO	When this box is checked, the user is able to use **Force IO** application.
Logic Configuration	When this box is checked, the user is able to *view and modify* **Relay Configuration and Logic Configuration**.
Upgrade	When this box is checked, the user is able 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.

8.2 Changing passwords

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

Figure 8-1: Change security

When the operator enters a new password for the first time, he/she should also enter a personal question that only they can 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 is posed to the user if the user forgets their password and would like to know what their password was.

8.3 Enabling security

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 **User Management**:

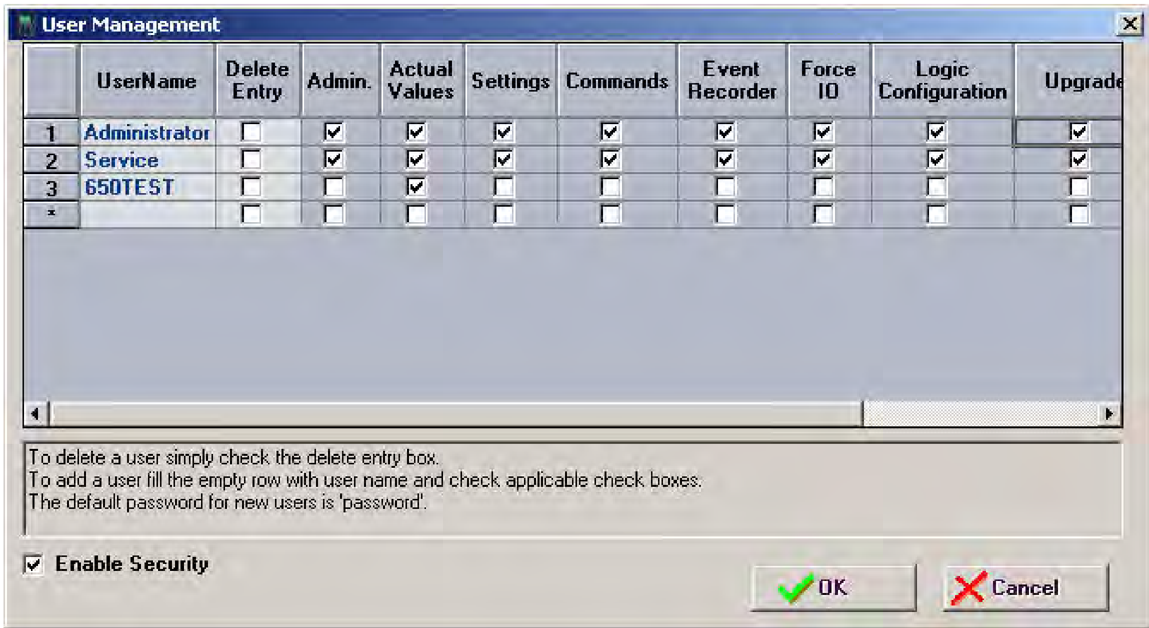


Figure 8-2: Enabling security

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

8.4 Logging into EnerVista 650 Setup

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 prompts for user name and password.

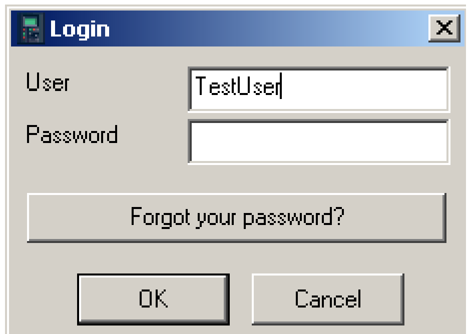


Figure 8-3: Login user

The user name field displays 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 is "password". The user is 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**. The user is prompted with the same log in dialog box for a different user name and password combination.

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

Figure 8-4: Forgot your password?

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

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C650 Bay Controller & Monitoring System

Chapter 9: Bootcode and firmware upgrade

9.1 Firmware upgrade versions below 7.00.

This section explains how to upgrade the C650 boot code and firmware for version below 7.00.

NOTICE **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 “C650“(5.70 in Figure 9-1: Main screen) with the boot program version (6.00 in Figure 9-1: Main screen) followed by “GENERAL ELECTRIC”, the relay model and the default front RS232/USB port communication parameters.

C650 7.00 (7.00)
General Electric
C650MZKF2G1HI6E
19200N81: MODBUS: 254

Figure 9-1: 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 does not start after upgrading.

FIRMWARE BOOTWARE AND 650 PC PROGRAM VERSIONS COMPATIBILITY		
FIRMWARE CODE	**BOOT CODE**	**ENERVISTA 650 PC**
5.72	6.00	7.20
5.70	6.00	7.20
5.68	6.00	7.20
5.64	5.60	7.20
5.40	5.44-5.40	7.20
5.00	5.44-5.40	7.20
4.00	5.44-5.40-5.00-4.10	7.20
3.71	5.44-5.40-5.00-4.10	7.20
3.70	5.44-5.40-5.00-4.10	7.20
2.20	5.40-5.00, 4.10, 4.00	7.20

NOTICE

A STEP LIST SUMMARY that allows the user to control the upgrading process is included at the end of this section. It is necessary to read paragraphs 1 to 4 of chapter 9 of manual GEK-106310 before accomplishing the C650 UPGRADE PROCEDURE.

Be aware that boot program and firmware upgrades erase all data contained in the relay, thus it is advisable to save all data, oscillography, events, settings and configuration files before proceeding.

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.

For upgrading firmware versions lower than 3.20 or upgrading bootware, be aware to calibrate the unit offset, after upgrading it, in **Communication > Calibration > Offset Calibration**. No analog currents nor analog voltages must be injected in the unit during this process.

9.1.1 Communication parameters

1. Ethernet Connection/Type - Both boot code and firmware upgrade processes require Ethernet communications. It is strongly recommended to use a direct connection between the PC and the relay using a Cross-Over RJ45 Ethernet cable, instead a direct connection through a hub or switch. Upgrading through Local Area Network (LAN) must be avoided.

   Serial RS232 Communication - Serial communication is necessary only to perform the bootware upgrade for versions previous to 7.00.

2. Relay IP Address - An IP address must be assigned to the relay in the Ethernet parameters via HMI at **Product Setup > Communication > Ethernet > Ethernet1** menu, or via EnerVista 650 Setup software at **Setpoint > Product Setup > Communication Settings > Network (Ethernet) 1** as shown in the table below:

Table 9-1: 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]

3. PC IP Address - In case the boot code has been previously updated to the relay (section 9.2), the IP address and other parameters already assigned in the process are:

   IP Address:192.168.37.177

   Netmask:255.255.255.0

   Gateway:192.168.37.10

Then the PC settings should be the same pattern as follows:

   IP Address:192.168.37.xxx

   Netmask:255.255.255.0

   Gateway:192.168.37.10 (if desired)

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

4. Other Network, Communications and Data Flow checks

- According to the model number of the relay, to enable the 10/100 BASE TX-CABLE option in the relay communication board, a specific jumper in this board must be changed. See detailed instructions in paragraph 3.4.3 of Instruction Manual GEK-106310AE.
- IP address, netmask, gateway are correct and match the parameters used in the computer to perform the procedure. See table 9.1 (on this chapter) of Manual GEK-106310AE **COMMUNICATION PARAMETERS.**

9.1.2 Bootware version upgrade

Boot code upgrade is performed using EnerVista 650 Setup, and the most recent version of EnerVista 650 setup software should be used. It is required that no active communication is currently established between the program and the relay, and that no configuration files are open.

During the boot code upgrading process, all the data stored in the relay is lost. Save all calibration, settings, oscillography, etc. from the relay before starting the upgrade.

9.1.2.1 Bootware upgrade

1. Windows XP, Windows 7 and Windows 8 Operating Systems must be used for installation and the reliable operation of EnerVista 650 Setup program and bootware/firmware relay upgrade.
2. 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 (ETH_1/ETH_2 or ETH_E/ETH_A/ETH_B).
3. If it is being used a USB-to-Serial RS232 Cable Converter, it must be a RS-232C standard compliant, powered by the User computer's USB bus and with DB9 male connector. To ensure the correct state of communication between the computer and the relay along the whole upgrading process, all other USB devices must be unplugged. Due to the extended variety of USB-to-Serial Cable Converters existing nowadays in the market, with different characteristics, even different charge imposed to the USB bus of the PC, it is strongly recommended to use the GE USB-to-Serial RS232 Cable Converter, part number GE0100-0001.
4. When using USB-to-Serial RS232 cable it is necessary first to determine the COM Port number the Laptop uses through the USB device. Depending in the actual C650 upgrade task under operation, the procedure is as follows:

   4.1 Firmware upgrade: It is not necessary to use a serial cable

   4.2 Bootware and firmware upgrade being the relay fully operative with the actual F/W version: The COM port number must be determined by using the 650 Setup program. With USB device disconnected from the Laptop and from the relay, start the 650 Setup program. At the top menu bar choose **Communication > Computer > Communication Port** menu and check the allowable serial ports displayed.Return to the main 650 Setup screen and connect the USB device to PC and select **Communication > Computer > Communication Port** to display the allowed serial ports. The new one port number shown is the USB port number to be used for the upgrade process.

   4.3 Bootware and firmware upgrade being the relay blocked at startup (no preliminary communication PC-Relay allowable): Repeat the process described above in 4.2 to determine the COM PORT number and continue with upgrade process.
5. Once the COM PORT number is determined, set it in **Communication > Computer** together with and the **Baud Rate** and **Parity** parameters. Click **Store**.
6. Start the EnerVista 650 Setup program and select **Communication > Upgrade Relay**.

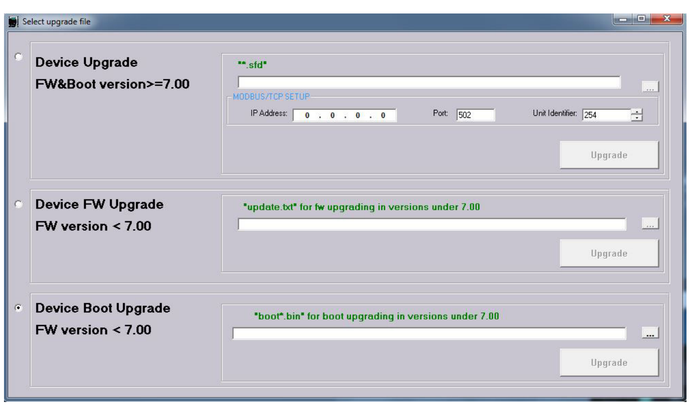


Figure 9-1: Upgrade device

7. Select **Device Boot Upgrade. FW version<7.00** and click the [...] button. The next new window requires the bootware file retrieved from http://www.gegridsolutions.com/index.htm and previously stored in the PC.

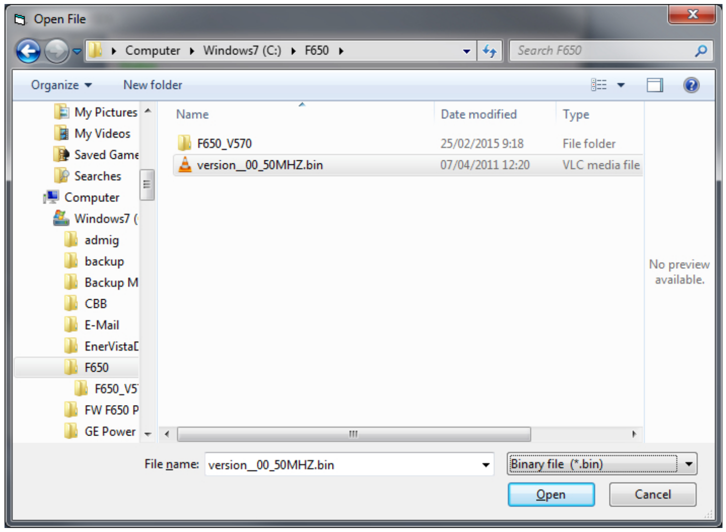


Figure 9-2: Boot code file selection

8. Choose the bootware file and click **Open** button:

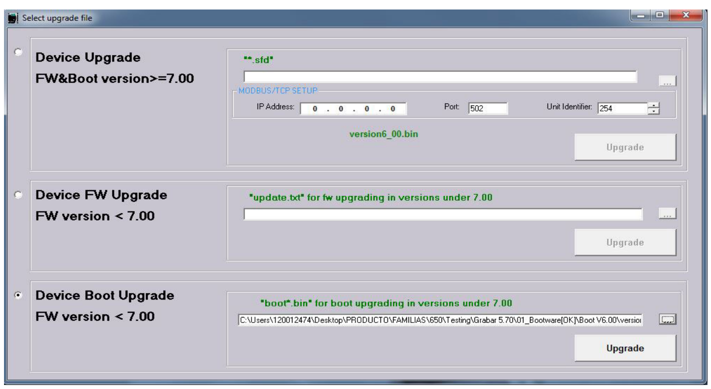
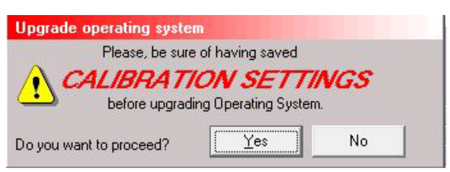


Figure 9-3: Upgrade selected BOOT file

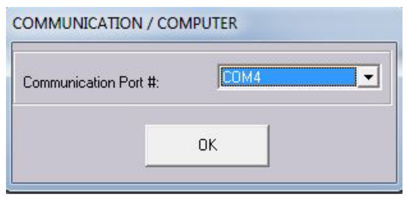
9. Click **Upgrade**. A warning messages is shown:



If calibration files were saved click **Yes,** otherwise click **No** to cancel the upgrade process and save first the calibration files according to section 4.1.11.

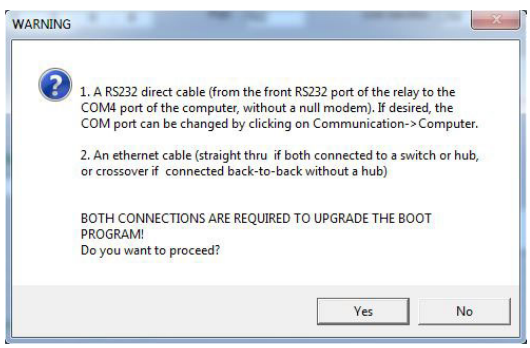
Figure 9-4: Warning message to save setting and configuration files

10. Parameters already set in step 5 are operative during serial communications. If they have not been previously set a pop up window prompts for the serial COM port to be used during upgrading.

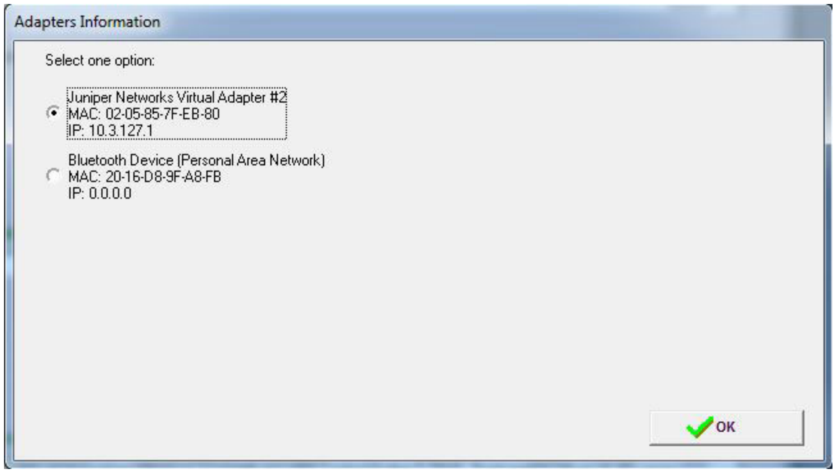


11. During the upgrade, the system shows the following message indicating the procedure to be followed.

    The serial and ethernet warning message is a generic message, the serial connection for C650 models is through a USB-serial cable. RS232 is used in other 650 devices.



If you click **Yes**, the next window allows you to choose the Network adapter for your Ethernet connection to the relay.



12. After selecting the Network adapter, a window to choose a temporary IP address is shown. It is advisable to set the same IP address that is going to be used later in the relay for Ethernet connection.

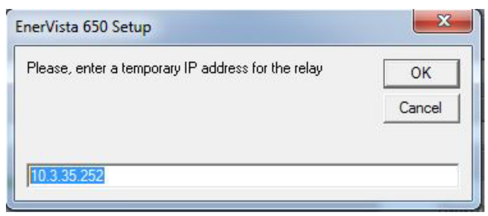


Figure 9-5: setting address

13. After entering the temporary IP Address, the next new window requires the bootware file retrieved from http://www.gegridsolutions.com/index.htm and previously stored someplace in the PC.

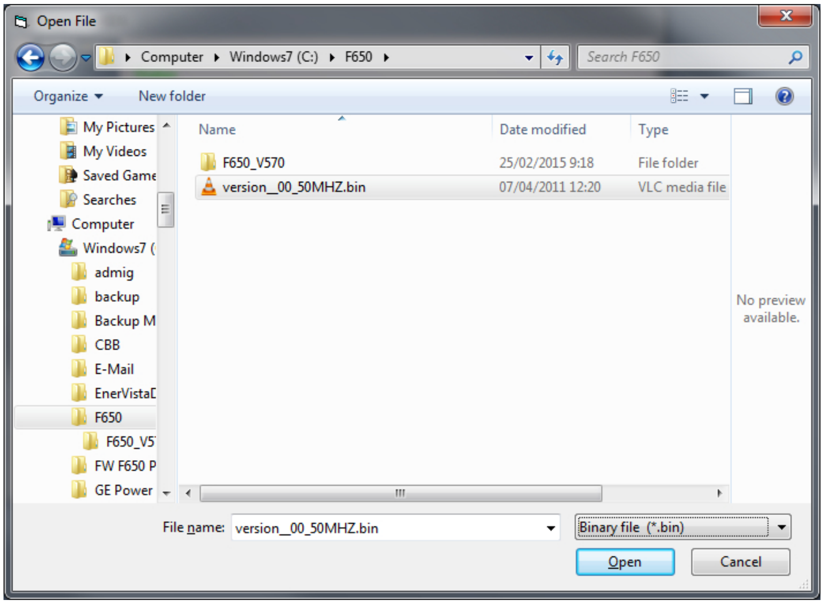


Figure 9-6: Boot code file selection

14. Choose the bootware file and click **Open** button.

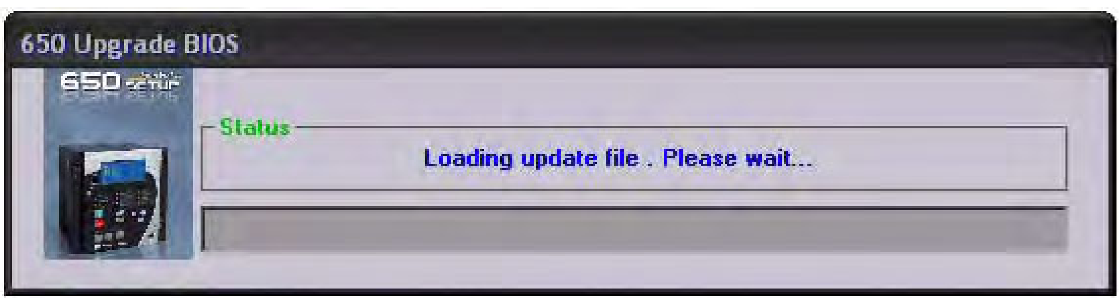


Figure 9-7: Loading boot code file

15. 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 9-8: Relay switch off-on message

16. 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 offers the option to continue with the process or to postpone, verify the correct RS232 connections and try again later. Notice that the serial COM PORT used in the boot upgrade procedure is the one selected in step 4 above.

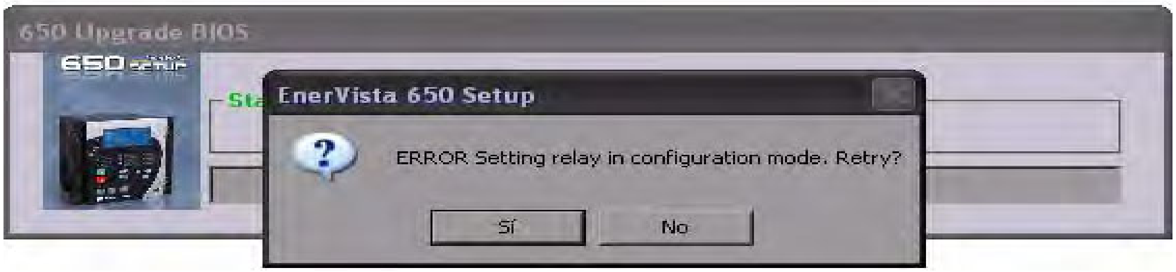


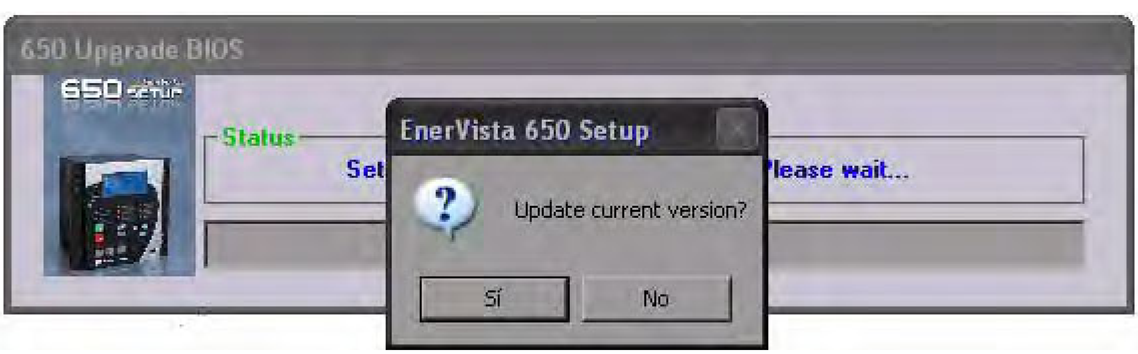
Figure 9-9: loading update file error message

If the relay gets stuck during the upgrading process after switching OFF and ON the relay, giving error message shown, it is due to no serial communication via the front RS232 port. Check the serial cable and serial settings connection. At this point the relay will not be upgraded.

After switching it OFF and ON it will continue working with the former firmware and bootware versions.

17. After switching the relay OFF and ON, if the serial communication between EnerVista 650 Setup and the relay is correct the program shows the following message:

Then it requires the confirmation to proceed to upgrade:



18. Click **Yes** to start the process, beginning with the relay flash memory deletion.

    At this point all the information stored in the relay is lost. Until now, no important change has been made to the relay, the boot memory upgrading process has just been prepared.

    This process can take several minutes, during which a progress bar is displayed.

19. If the process is successful, continue to step 20.

    If the process is unsuccessful and the relay gets stuck at **"Sending file imagen_kernel..."** (see figure below)

    This error may be due to no communication via the Ethernet port. At this point serial communications work properly, 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 shows the message **"OS Loading..."** and the relay does not start up.

    In this case refer to step 4 above

If all points from step 4 are correct but the problem persists:

Disable and **Enable** the Ethernet connection while the files are being sent (during the "Sending file..." message - previous figure). To do this, in Windows OS go to **Startup > Control Panel > Network Connection > Local Network,** right-click and select **Disable**. Now the Local Network status Icon is shown as **Disabled**. In the same screen, right-click **Local Network**, select **Enable**, and wait until **Enabled** status is shown.

20. Once the memory has been erased and the files upgraded in the relay, the parameters for the Ethernet communications must be set. The requested values are the IP address and the gateway.

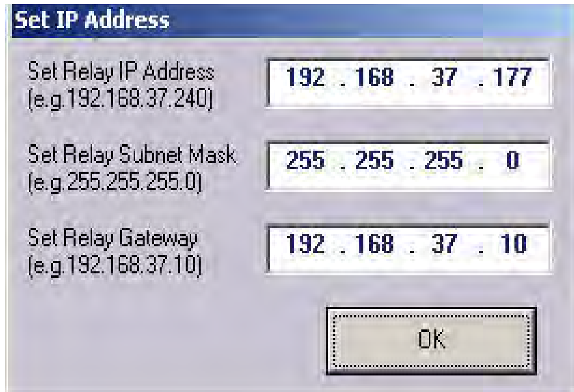


Figure 9-10: IP address setpoint window

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

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.

The gateway must be the one used in the LAN structure connecting the relay

21. After assigning the Ethernet parameters, the upgrade of the boot code is complete and successful.

22. A window is displayed with the message: **Setting Default IP address**, followed by:

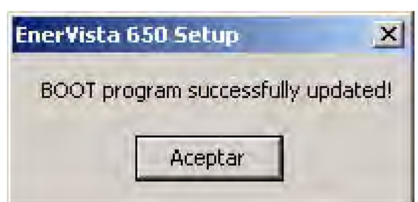


Figure 9-11: BOOTware upgrade successful process

After boot code upgrade, the equipment firmware must also be upgraded.

9.1.3 Firmware version upgrade

9.1.3.1 Introduction

1. Save relay settings and configuration to a file before proceeding, as they will be lost during upgrade.
2. Save calibration settings to a file for firmware revisions lower than 1.50, before upgrading the C650 to a new firmware version.
3. For firmware revision higher than 1.50 when only upgrading the firmware (no bootware upgrade), the calibration files are not modified and do not need to be saved.
4. Special care should be taken when the boot code has been previously upgraded: all data (including calibration settings) is lost.
5. In case of errors during the firmware upgrade process, repeat the entire process as many times as necessary. This is possible thanks to an independent boot memory (bootcode).
6. A pure firmware upgrade process should use the EnerVista 650 Setup software and Ethernet connection (Port ETH_1 or ETH2) via a **Cross-Over RJ45 Ethernet cable.**

Note: Downgrading firmware versions can cause errors in measurements.

9.1.3.2 Firmware upgrade

1. Once communication with the relay through the Ethernet connection has been verified, enter the EnerVista 650 Setup program and select **Communication > Upgrade Relay**.

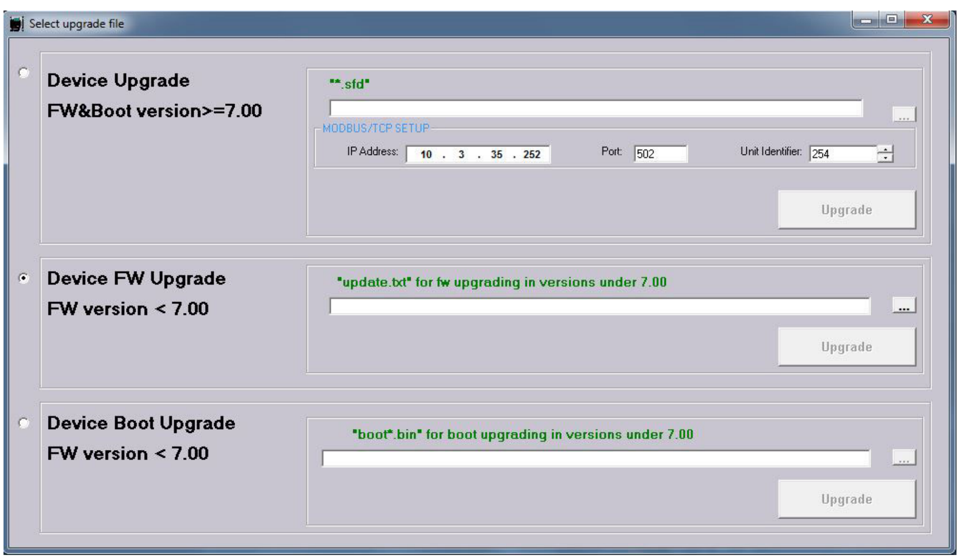


Figure 9-1: Upgrade device

2. Select **Device FW Upgrade FW version <7.00** and click [...]. to browse for the new firmware file.

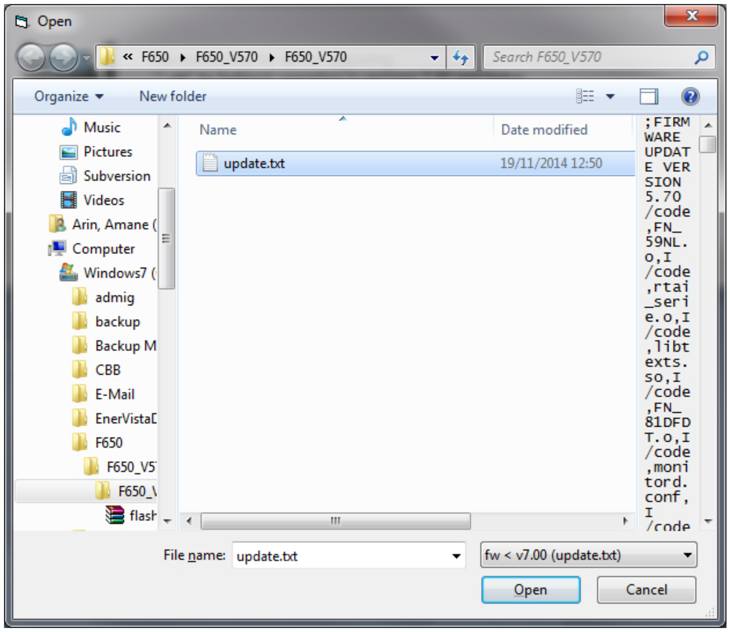


Figure 9-2: Select firmware file

3. Once the new firmware file has been selected, click **Upgrade** to continue.

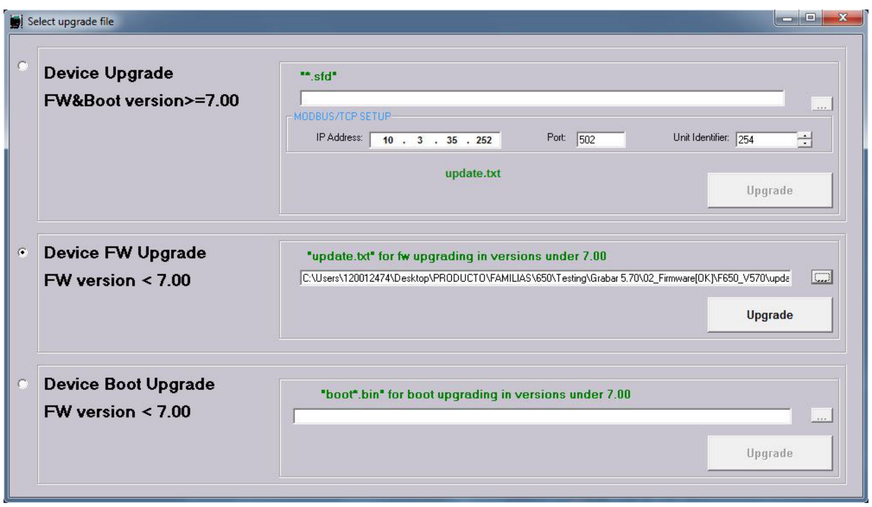


Figure 9-3: Upgrade firmware selected file

4. Fill in the device IP address, serial number, and order code as needed. (The order code is not required for firmware versions below 1.70).

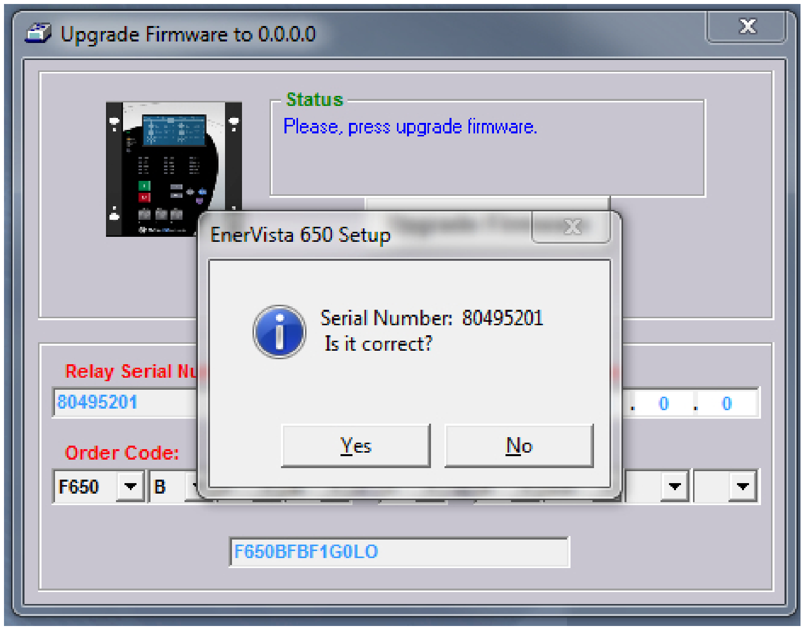
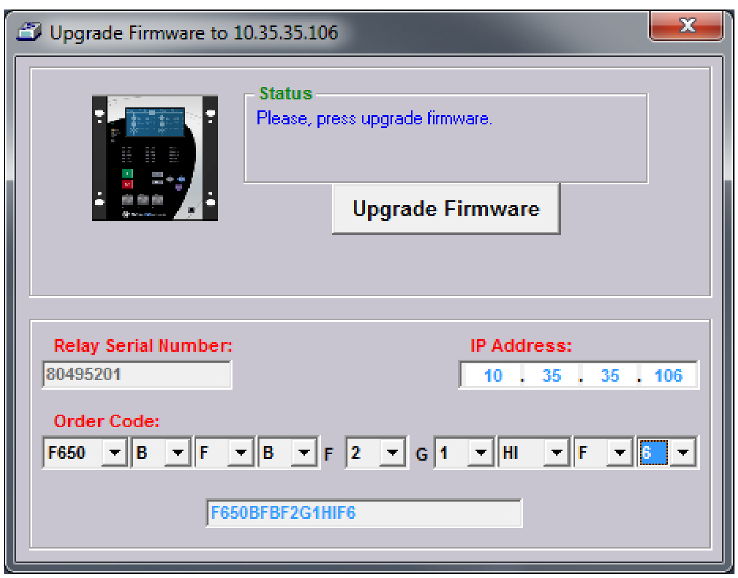


Figure 9-4: Relay serial number

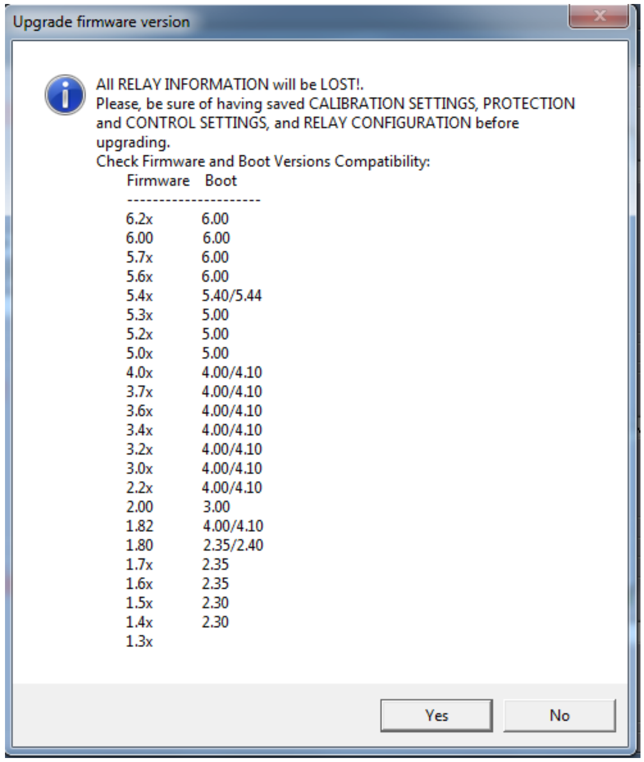
5. If the relay is not an enhanced model or one with control functionality, click **Upgrade Firmware** to continue the process (see the following figure).



At this point, proceeding with the upgrade erases all data stored in the equipment, including the calibration settings in firmware versions below 1.50. It is necessary to save all settings to a file now if you have not already done so.

The Firmware-boot version compatibility warning message is a generic message,

For C650 models the first firmware version is 3.42 with boot 4.10



Click **Yes** to continue. A message is displayed indicating that a local network reboot is necessary (see following figure). Proceed as follows:

- In the Windows Control Panel (**Start > Control Panel**), navigate to **Network Connection > Local Network**. Right-click and select **Disable**. Confirm that the Local Network status is now Disabled. Restart the local network in the same screen (right-click and select **Enable**). Wait until the local network status is Enabled before continuing.
- Click **Upgrade Firmware** to continue the process (as shown).

Figure 9-5: Advisory for local network reboot

6. When upgrading models with Enhanced protection or control functionality (see model selection), the upgrade program requires a password to continue (as shown).

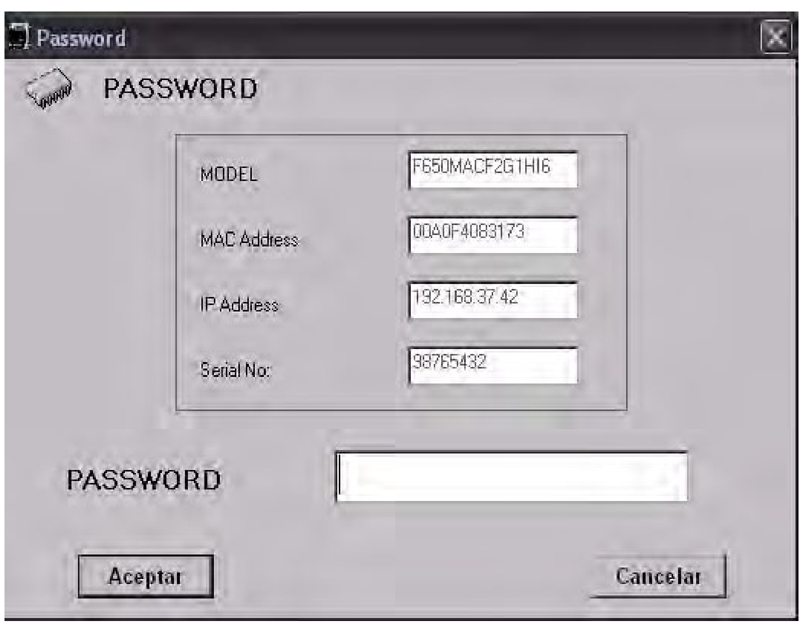


Figure 9-6: Relay upgrade password

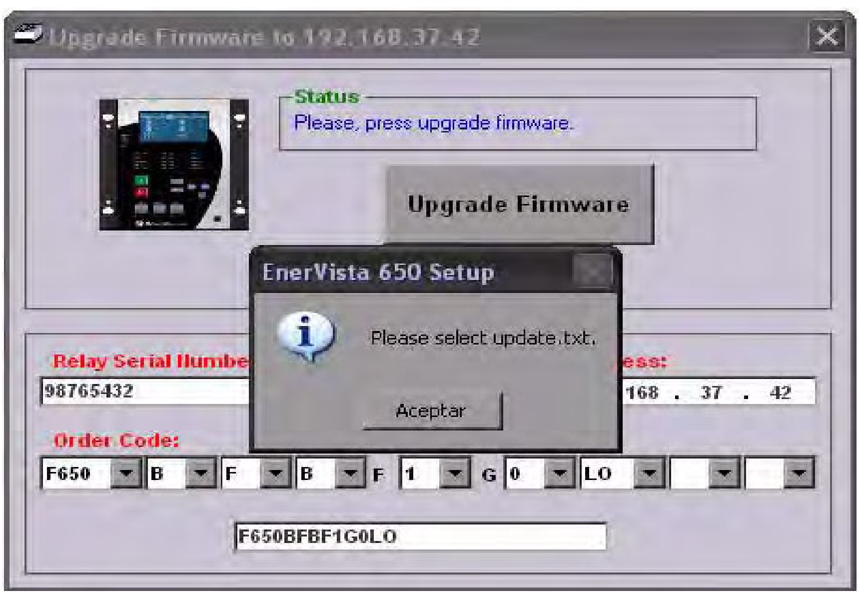
For a model with specialized functionality and a password requirement, contact GE Multilin.

The following parameters must be clearly indicated in the order:

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

7. Once the upgrade parameters have been entered, click **OK**. When communication has been established, the program shows a message requesting a reboot of the 650 (turn the relay off and then back on) to continue with the upgrade process.

8. Once the relay has been rebooted, you are prompted to select the new firmware upgrade file (update.txt).



The upgrade files, including update.txt, can be obtained online (http://www.gegridsolutions.com/index.htm) or from the Technical Service Dept. at any GE Multilin facility. Save the files in a directory in the root drive or the PC desktop. Extract any zipped files.

Browse to the "update.txt" file and click **Open**.

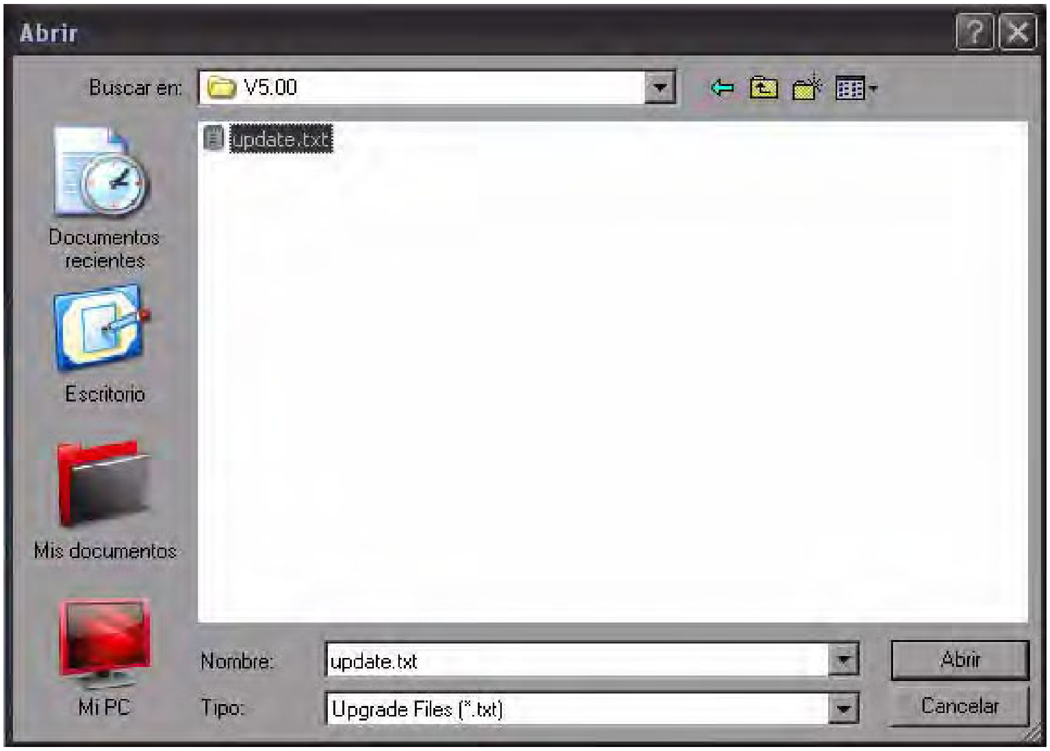


Figure 9-7: Firmware file selection

9. A voltage range selection window appears (see following figure). This voltage range is closely related to the serial number of the relay. For relays manufactured with firmware version 5.70 or higher (from May 2015 onwards), the EnerVista 650 Setup program automatically selects the appropriate voltage range for the unit based on the serial number, showing the selection with a step line square over the proper option. Click **OK**.

   In case an incorrect option is selected, metering errors may arise during normal operation (current and voltage values incorrectly displayed). In order to correct this behavior, the firmware upgrade process must be repeated and the correct option must be selected.

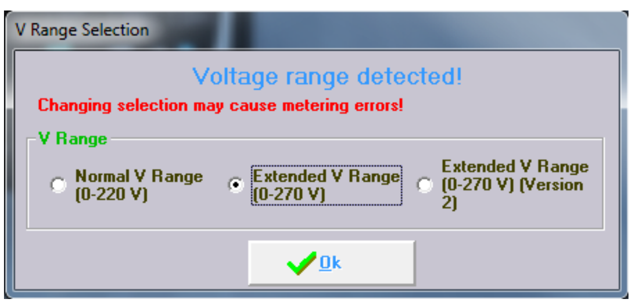


Figure 9-8: AC voltage range selection - extended V range (version 2)

10. Click **Yes**.
11. The Upgrade Firmware button is now enabled (figure below). Click to start the upgrade.

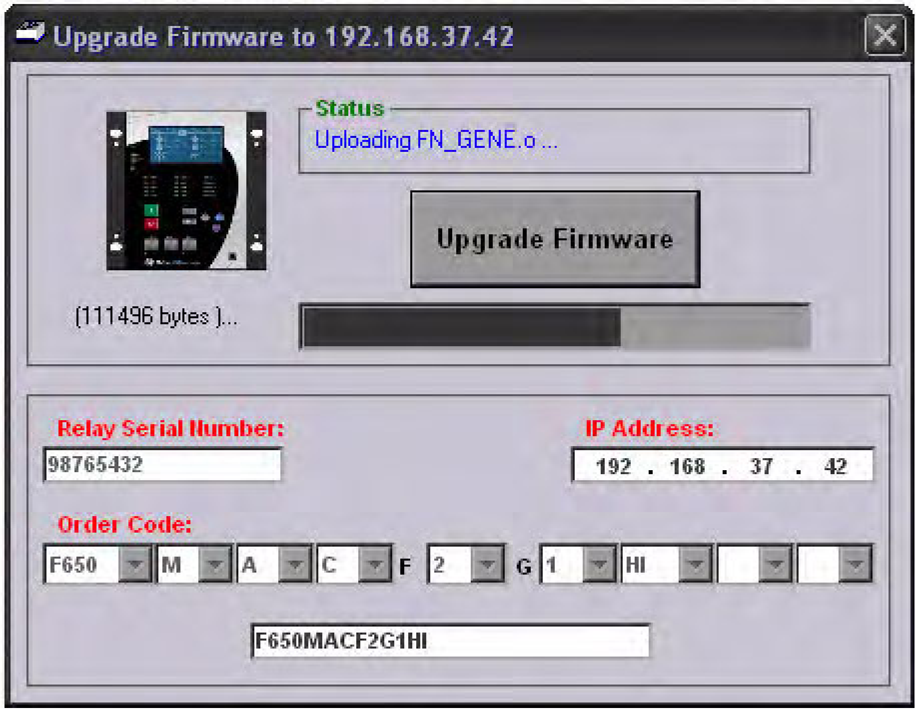


Figure 9-9: Initiate upgrade

During the upgrade process, the program displays the files that are being upgraded.

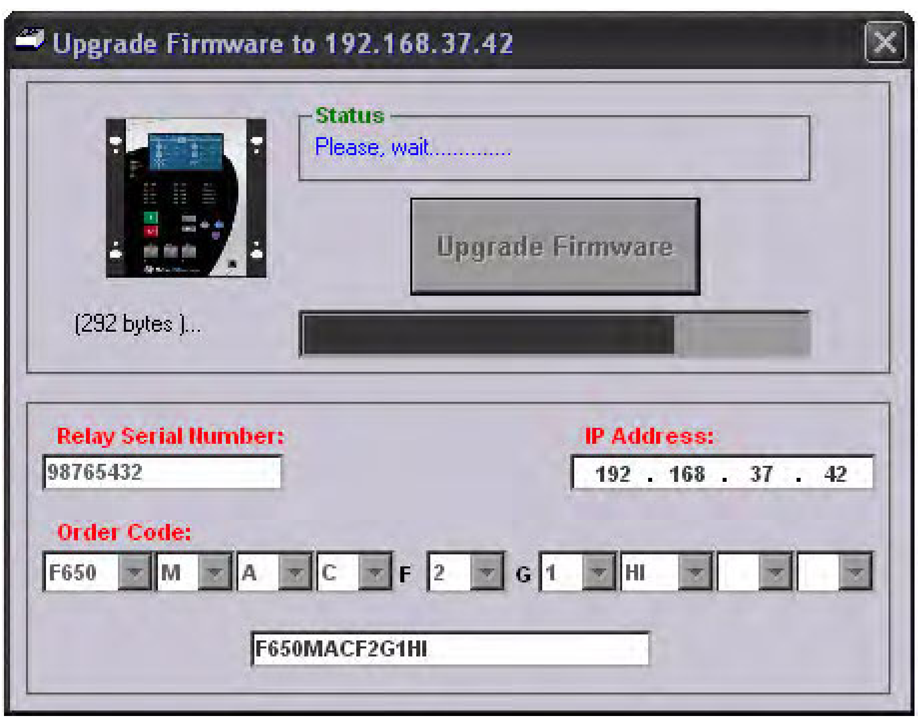


Figure 9-10: Firmware file selection

12. When the file transfer is finished, a message is displayed indicating that it is necessary to wait before resetting the unit, in order to start working with the new firmware version in the relay (figure below).

13. When the whole process has finished a message is displayed asking to switch the C650 on and off (figure below).

Figure 9-11: Firmware file selection

14. Click **OK (Aceptar)**. At this point, the firmware upgrade is finished and the relay can be powered OFF and ON to check that the firmware has been upgraded properly.

15. User settings and logic files downloading

When upgrading the firmware the entire settings and relay configuration are reset to factory default values. Then the User is committed to download the settings, configuration and logic files to the relay in order to get it fully operative.

Calibration settings and configuration must be reloaded to the relay the relay.

To recover and download the different files to the relay go to EnerVista 650 Setup and at the top menu bar choose:

- **Communication > Calibration > Set Calibration Files**: to restore calibration settings, if necessary.
- **File > Config File (*.650) Converter**: to convert the setting and configuration file *.650 for the relay (if it was in a previous version format).
- **File > Send Info to Relay:** to send the new settings and configuration file to the unit.

9.1.4 Summary of main steps

9.1.4.1 Boot code upgrade (*)

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect a USB-SERIAL cable to the front port relay and connect an Ethernet cable to the rear Ethernet port (crossover cable for back-to-back connection or straight-through Ethernet cable for hub or switch).
3. Save all calibration settings to a file.
4. Save all data from the relay (settings, oscillography, events).
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Follow the upgrade instructions, and select the boot program bin file.
7. Reboot the relay as required by the upgrade program.
8. Continue with the upgrade instructions, setting the IP address and gateway when prompted.

9.1.4.2 Firmware upgrade(*)

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect an Ethernet cable to the rear Ethernet port (a cross-over cable for back-to-back connection and straight-through cable for hub or switch).
3. Set the appropriate IP address in the relay.
4. Set the appropriate IP address in the PC.
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Enter the IP address, serial number, ad order code of the relay as prompted.
7. Reboot the relay as required by the upgrade program.
8. Locate the upgrade.txt file for the correct relay model.
9. Click Upgrade Firmware to initiate the upgrade process.
10. Reboot the relay as required by the upgrade program to complete the upgrade process.
11. Set calibration settings (from the PC to the relay) for versions lower than 1.50.
12. All settinga and configuration are now set to the factory default.
13. Send new settings and configuration files to the relay if needed.

(*) 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 no cable/fiber conflict.This does not apply to the firmware upgrade, which can be performed either with the Ethernet fiber connection, or with the cable connection.

Note: See chapter 13 C650 TROUBLESHOOTING GUIDE if there is any problem during the upgrade process.

9.2 Firmware upgrade version 7.00 or above

This section explains how to upgrade the C650 firmware code for version V7.00 or higher.

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.

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

Firmware	Bootware	EnerVista
7.12	7.12	Latest EnerVista version available
7.20	7.12	Latest EnerVista version available
7.21	7.12	Latest EnerVista version available
7.50	7.12	Latest EnerVista version available
7.52	7.12	Latest EnerVista version available
7.60	7.60	Latest EnerVista version available
7.70	7.70	Latest EnerVista version available
7.71	7.71	Latest EnerVista version available

9.2.1 Communication parameters

1. Ethernet Connection/Type - Firmware upgrade processes require Ethernet communications. It is strongly recommended to use a direct connection between the PC and the relay using a Cross-Over RJ45 Ethernet cable, instead a direct connection through a hub or switch.

2. Relay IP Address - The relay must be assigned a IP address in the Ethernet parameters, via HMI at **Product Setup > Communication > Ethernet > Ethernet E, A** or **B** menu or via the Enervista 650 Setup software at **Setpoint > Product Setup > Communication Settings > Network (Ethernet) E, A** or **B** as shown in the Table below.

Table 9-2: Ethernet parameters

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET)			
NAME	**EVALUE**	**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]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING			
NAME	**EVALUE**	**UNITS**	**RANGE**
Default RT GWY Oct1	192		[0 : 255]
Default RT GWY Oct2	168		[0 : 255]
Default RT GWY Oct3	37		[0 : 255]
Default RT GWY Oct4	10		[0 : 255]

3. Example of IP Address Configuration:

The IP address and other parameters already assigned in the process are:
IP Address:192.168.37.177
Netmask:255.255.255.0
Gateway:192.168.37.10

Note: To assure that the configuration is correctly setup it is possible to perform a ping command from the PC.

Then the PC settings should be the same pattern as follows:

IP Address:192.168.37.xxx

Netmask:255.255.255.0

Gateway:192.168.37.10 (if desired)

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

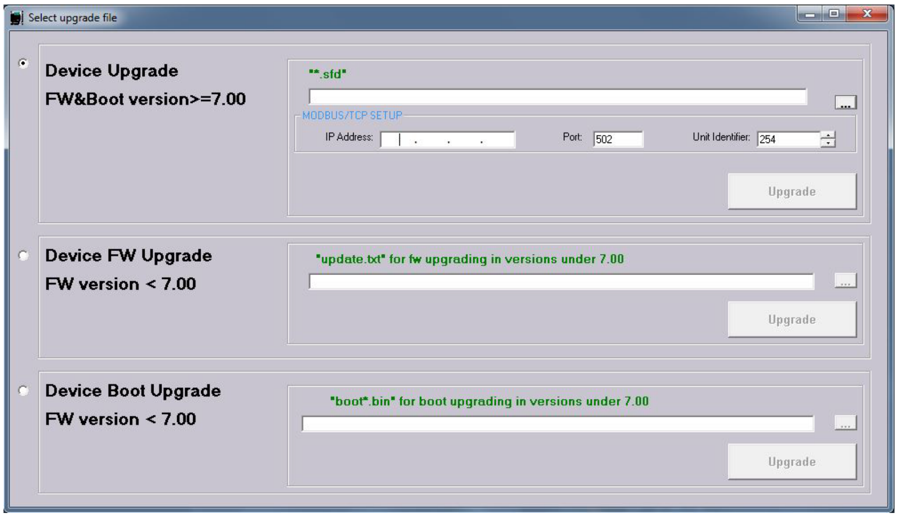
9.2.2 Firmware version upgrade

9.2.2.1 Introduction

1. The relay settings and configuration will be lost, so it is advisable to save them to a file.
2. In case of error during the firmware upgrading process, the user can repeat the whole process as many times as necessary.
3. Firmware upgrading process should be done using the EnerVista 650 Setup software and Ethernet connection (Port ETH_E, A or B) via **Cross-Over RJ45 Ethernet cable or Fiber Optic cable** (depending on order code option).
   Note that ETH_A and ETH_B ports cannot be used if PRP configuration is selected.

9.2.2.2 Firmware upgrade

1. Once the communication with the relay through Ethernet connection has been verified, enter the EnerVista 650 Setup program, select Communication and the **Upgrade Relay** option on the top menu bar.



2. Select **Device Upgrade FW&Boot>=7.00** and click [...] to browse for the file. The appropriate *.SFD file should be obtained from, http://www.gegridsolutions.com/index.htm or from The Technical Service Dept. at any GE Multilin facility. The file must be saved in the root drive or in the desktop of the PC. Choose the corresponding firmware file for upgrading the device.

3. Enter communication parameters for the relay being upgraded and click **Upgrade.**

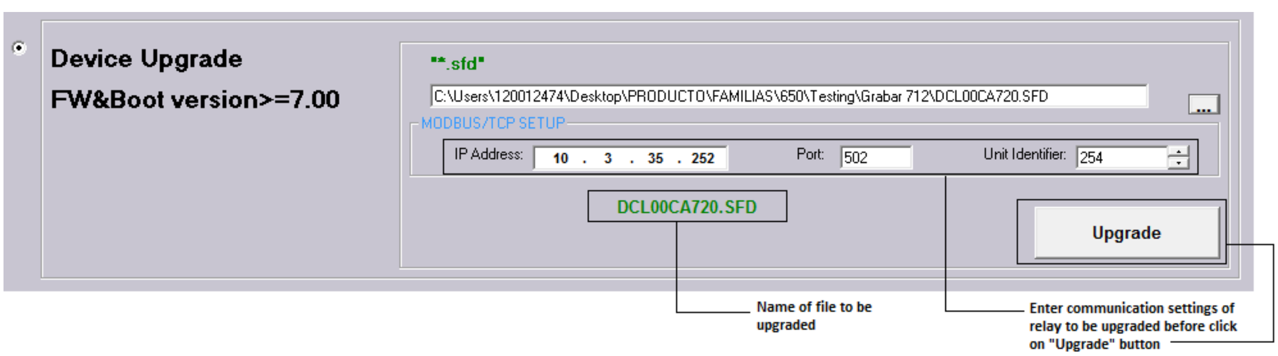
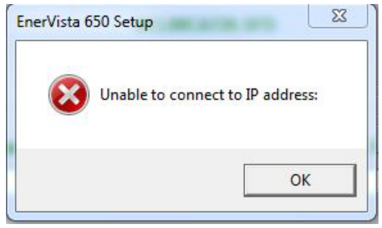
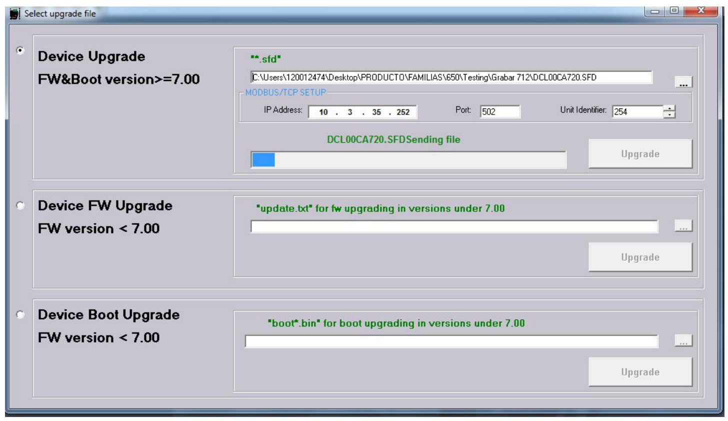


Figure 9-1: Relay communication parameters

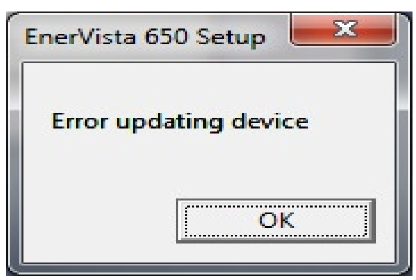
If the IP address is incorrect one, the following message is shown:



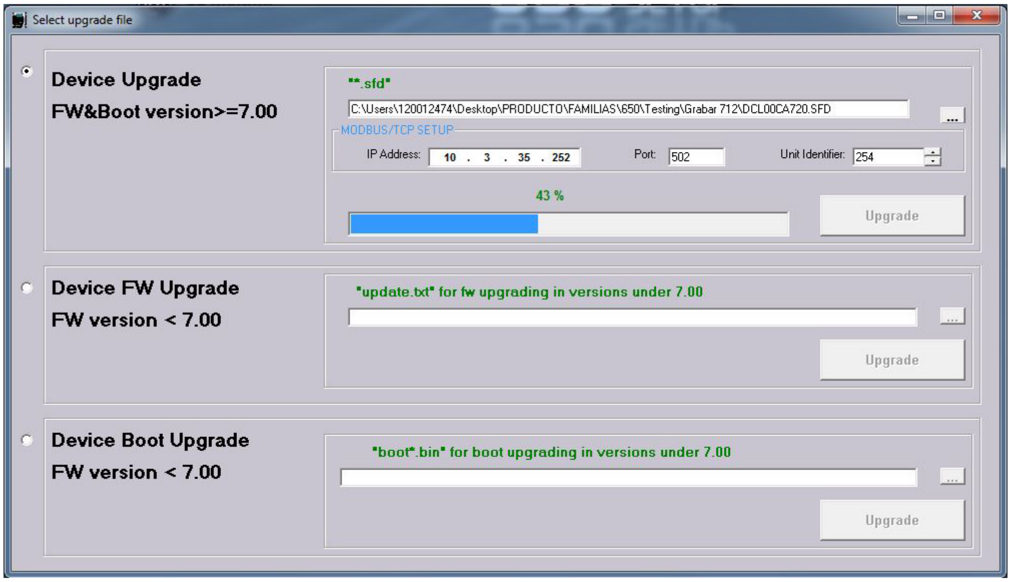
4. If the IP address is correctly set, then the message "*.SFD Sending file" is displayed. A sending file status bar shows the progress of the upgrade.



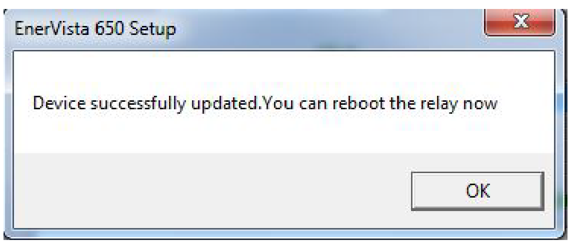
5. If the file is not sent successfully, the following message box is displayed.



6. After sending the file successfully, the upgrade process starts:



7. When the flashing upgrade process finishes, a message is displayed requesting a relay reboot.



8. User settings and logic files downloading

When upgrading the firmware the entire settings and relay configuration are reset to factory default values. Then the User is committed to download the settings, configuration and logic files to the relay in order to get it fully operative.

Calibration settings and configuration must be loaded to the relay once the upgrade process has finished.

To recover and download the different files to the relay use Enervista 650 Setup and at the top menu bar choose:

- **Communication > Calibration > Set Calibration Files**: to restore in the relay the calibration settings if necessary.
- **File > Config File (*.650) Converter**: to convert the setting and configuration file *.650 for the relay (if it was in a previous version format).
- **File > Send Info to Relay**: to send the new settings and configuration file to the unit.

9.2.2.3 Order code upgrade process

In the case of a relay model with specialized functionality (or a new order code requirement) with password requirement (see model selection), the program requests a password to continue.

1. To reach the window where the password is requested, the user must be communicating with the relay (ONLINE MODE). On the File menu the following submenu is available (for firmware versions above 7.00):

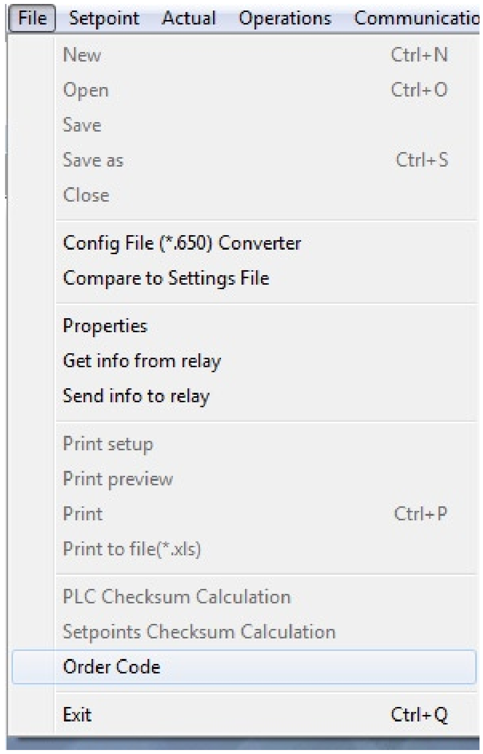


Figure 9-1: Order code submenu

2. Click Order Code on the menu and the following window is displayed:

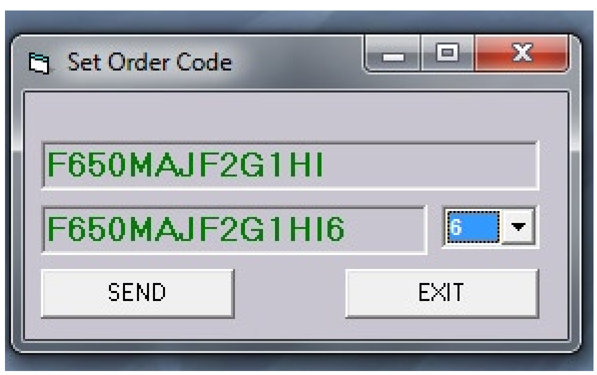


Figure 9-2: Set order code

3. This window only allows changing the last digit, which refers to supported communications protocols options. Click Send:

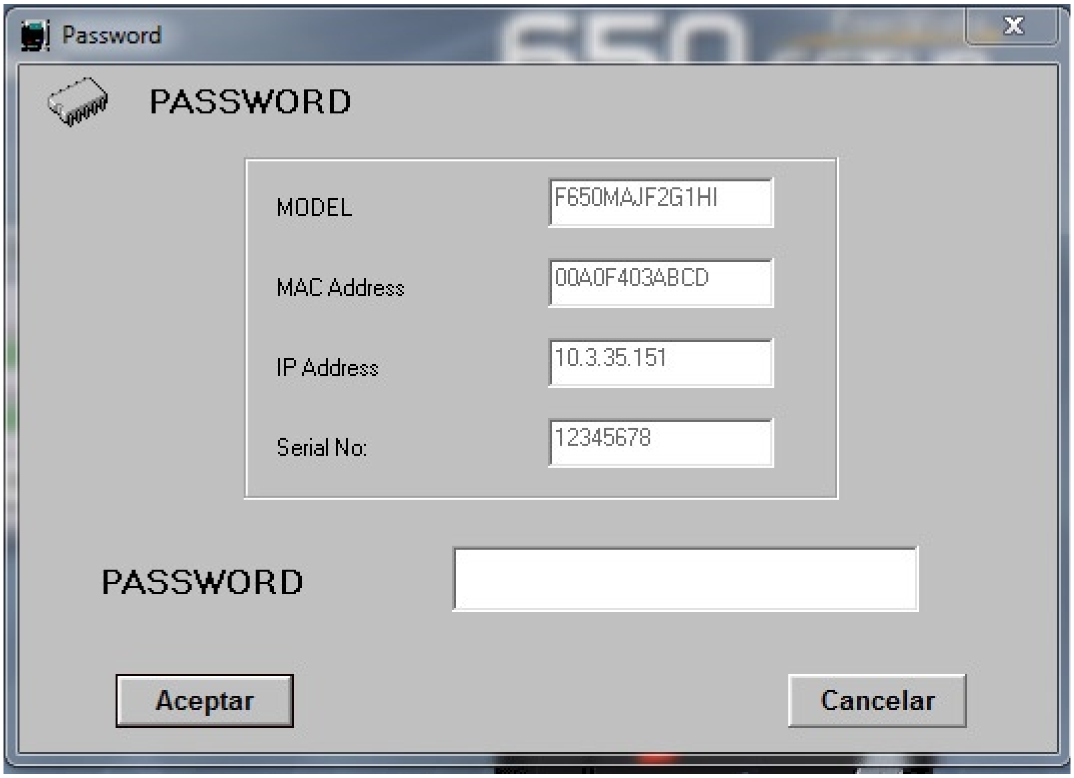


Figure 9-3: Password requirement (special models)

4. The users must contact GE Multilin and provide the following parameters in their order:
   - Unit serial number
   - Current model option (before memory upgrade)
   - Desired model option (after memory upgrade)
   - Unit MAC address (available in the identification label)

5. Once the password is obtained, enter it when prompted.Tthe following messages appear if the password is correct.:

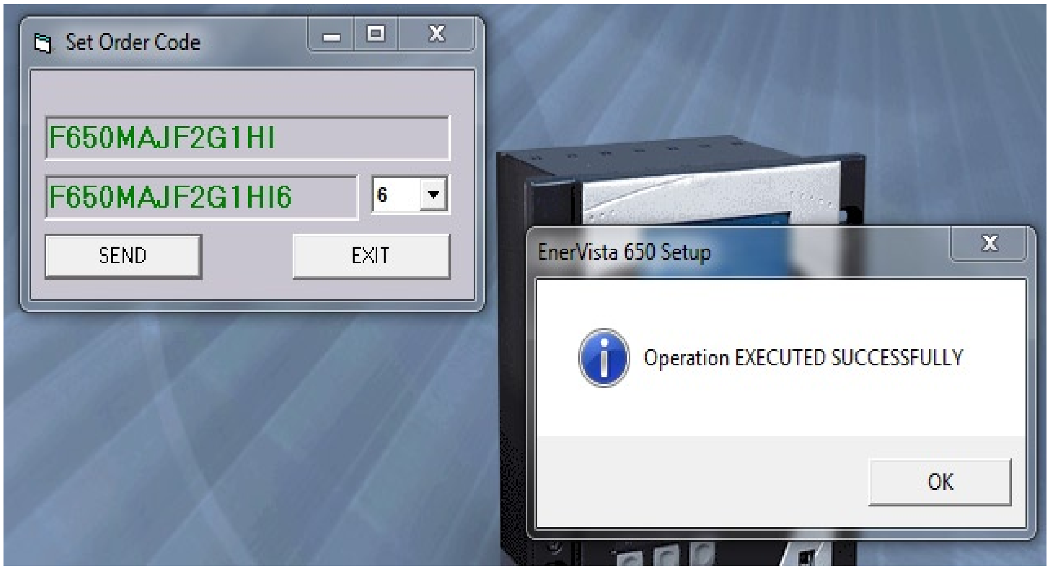


Figure 9-4: Executed successfully

6. After the successful operation, the SEND button is disabled. It is not allowed to make another change from here, so it can be seen what changes have been made. The new order code appears on the status bar.

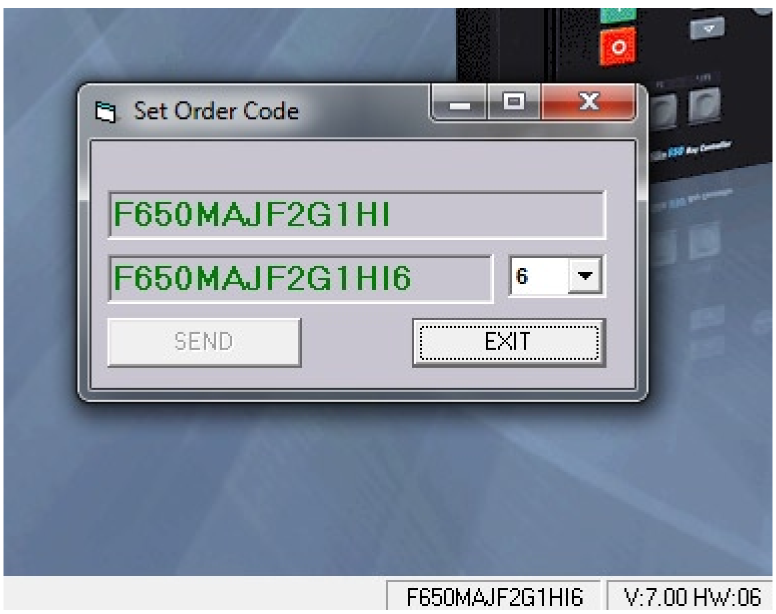


Figure 9-5: New order code

9.2.3 Summary of main firmware upgrade steps

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect an Ethernet cable to the rear Ethernet port (a cross-over cable for back-to-back connection and straight-through cable for hub or switch).
3. Set the appropriate IP address in the relay.
4. Set the appropriate IP address in the PC.
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Select the appropriate file (DCL000CAXXX.SDF) for the upgrade.
7. Enter the IP address, serial number, and unit identifier of the relay as prompted.
8. Click **Upgrade File** to initiate the upgrade process.
9. Reboot the relay as required by the upgrade program to complete the upgrade process.
10. All setting and configuration are now set to the factory default.
11. Send new settings and configuration files to the relay if needed.

NOTICE **See chapter 13 C650 trouble shooting guide, if there is any problem during the upgrading process.**

GE
Grid Solutions

C650 Bay Controller & Monitoring System

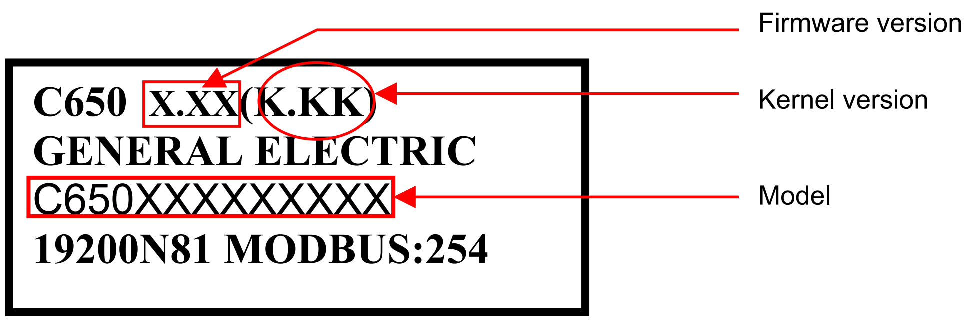
Chapter 10: Commissioning

10.1 Visual inspection

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:

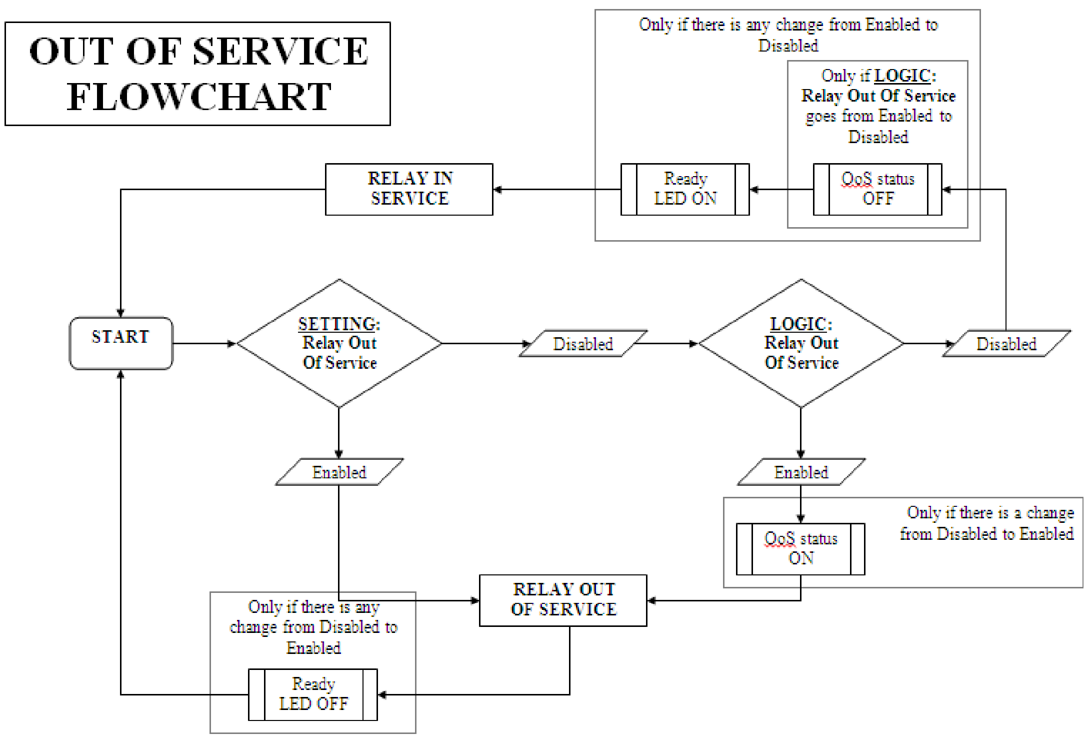


10.2 Out of service setting

The **Relay Out Of Service** setting is configured in **Setpoint > System Setup > Miscellaneous**. The unit also has an **Out of Service** status that is configured in **Relay configuration > Protection elements**. When active, these states stop all changes to PLC equations and functions, including changes to the input/output boards, so if there is a change in any input or output the unit will not show this change until it has returned to ready mode. For example if an output is closed and the unit goes to the **Out of Service** state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the **Out of Service** state, the output is then opened.

When the **Out of Service** status goes to ON, or the setting has been changed to Enabled, the ready LED also changes to red. Be careful if ready LED is linked to an output, because the output will not change its state. To set outputs to ready state see factory default Logic & Configuration in the detailed manual. Take notice that, in the default configuration, the general setting out of service is enabled, so it is necessary to change to disabled to start working with the unit

The following figure shows the flow chart of these states



10.3 General considerations, power supply network

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, is affected by non-senoidal waveforms, as in the case of C650.

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 are 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.

10.4 Isolation tests

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

For verifying isolation, independent groups are created, and voltage is 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 depend on the type of modules included in C650, 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 G5 (analog)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18

10.5 Indicators

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.

10.6 Power supply testing

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 is also performed for VAC.

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

Voltage values to be applied are 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	 19.2 Vdc	 57.6 Vdc

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

10.7 Communications

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

Front: USB-SERIAL

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

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

10.8 Verification of measurement

Set the relay as follows

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

NOTE:

ALL ANGLES INDICATED ARE LAGGING ANGLES

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

10.8.1 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	0°	0	5	50	100	150	200
VII	120°	0	5	50	100	150	200
VIII	240°	0	5	50	100	150	200
VX	0°	0	5	50	100	150	200

Verify that the relay measures the values with an error of ±1 % of the applied value from 10V to 208V.

10.8.2 Active, reactive power, and COSJ 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, 0°	VII = 50 V , 120°	VIII = 50V, 240°	φ=45°
Ia = 10∠45°	Ib= 10∠165°	Ic = 10∠285°	**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 W	Pb = 353.55 W	Pc = 353.55 W	P = 1060.66 W
Qa = 353.55 VAr	Qb = 353.55 VAr	Qc = 353.55 VAr	Q = 1060.66 VAr

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

10.8.3 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	

10.9 Inputs and outputs

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

10.9.1 Digital inputs

During this test, the user determines 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) or 5 volts, whichever is greater.

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, is 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.

10.9.2 Contact outputs

The correct activation of every output to 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.

10.9.3 Circuit continuity supervision inputs

This test applies to the board type 2 if located in the CIO module, or in C650 in 19" models.

Supervision inputs are tested as normal inputs, revising the voltage level that is 19 Volts.

Coil 1:

Apply 19 Vdc to both 52/a (terminals H1-H2) and 52/b (terminals H3-H4)"Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals H1-H2) and 52/b (terminals H3-H4)"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 H15-H16) and 52/b (terminals H17-H18)"Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals H15-H16) and 52/b (terminals H17-H18)"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).

10.9.4 Latching circuits

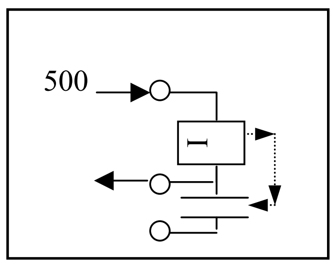
This test applies to the board type 2 if located in the CIO module, or in C650 in 19" models.

Send a closing command to the latched contact (H31-H33).

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 (FH34-FH36).

10.10 Connections for testing protection elements

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

10.11 Recloser (79)

Set protection element 79 as follows:

RECLOSER	
Function	**ENABLED**
Max Number Shots	4
Dead Time 1	2.10 sec
Dead Time 2	4.10 sec
Dead Time 3	6.10 sec
Dead Time 4	8.10 sec
Reclaim Time	3.00 sec
Cond. Permission	ENABLED
Hold Time	7.00 sec
Reset Time	5.00 sec

Set the relay to trip by 50PH, and configure the signals necessary to test the 79 element:

Configure one output as AR RECLOSE

Configure the AR INITIATE signal with the 50PH trip

Configure the AR LEVEL BLOCK signal with a digital input

Configure the AR CONDS INPUT with the digital signal desired

50PH Settings	
Function	**ENABLED**
Input	RMS
Pickup Level	3 A
Trip Delay	0.00 s
Reset Delay	0.00 s

10.11.1 Reclosing cycle

Connect a latching relay simulating the breaker managed by the C650 unit.

Once the relay is set, close the breaker and wait for 5 seconds.

After this time, the recloser is ready to initiate the reclosing cycle.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 2.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 4.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 6.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 8.1 seconds.

Command a 50PH trip and verify that the breaker opens and the recloser passes to Lockout.

Verify the correct operation of programmed outputs

Tripping times must be within the following values:

Reclosing Cycle		
N° shot	**Expected time**	**Admissible time**
1	2.1 sec	[1.8 – 2.3]
2	4.1 sec	[3.8 – 4.3]
3	6.1 sec	[5.8 – 6.3]
4	8.1 sec	[7.8 – 8.3]

10.11.2 Recloser status

BLOCK

Activate the block input and verify that the recloser is in BLOCK status.

Close the breaker and wait for 5 seconds.

Command a trip and verify that the breaker opens but there is no reclose.

INHIBITION BY RECLOSING CONDITIONS

Close the breaker and wait for 5 seconds.

Command a trip, verify that the breaker opens and wait for the first shot.

Activate the inhibition input and command a new trip.

Verify that the breaker opens, wait for 8 seconds and verify that the relay does not reclose.

10.11.3 External reclose initiation

Close the breaker and wait for 5 seconds.

Activate the reclose initiation input and open the breaker, verify that the relay executes the first shot

C650 Bay Controller & Monitoring System

Chapter 11: Application examples

11.1 Example: Set an operation

11.1.1 Description

This simple operation describes how to program and set an operation command on the C650 relay. In the present case the operation is:

To configure some C650 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 C650 output contact using a front key pushbutton.

To reset the output contact and LED using another front key pushbutton.

11.1.2 Procedure

Set the following values:

Under

SETPOINT ⇓ CONTROL ELEMENTS Þ 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	---

11.1.3 Test

In the main front screen press **F2** key.

A message showing “Press Enter to Confirm Key ®**F2**¬” is displayed.

Press **Enter**.

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 Enter to Confirm Key ®**F1**¬” is displayed.

Press **Enter**.

Check that contact_00_00 (board F) has been opened.

Check that the front LED 14th has been switched off

C650 Bay Controller & Monitoring System

Chapter 12: Frequently asked questions

12.1 Communications

Q1. Does the C650 support DNP and ModBus over the Ethernet port?

A1. C650 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 C650?

A3. Yes, IEC 870-103 is supported by the C650 in firmware version 5.00 and higher.

Q4. Can the C650 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 C650?

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 ETH_1/ETH2 or ETH_E/ ETH_A/ETH_B (Depending on model.

Q6. Are there one or two Ethernet ports?

A6. The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

Q7. How many different communication Ethernet sessions can be opened through the LAN port?

A7. ModBus TCP/IP:4 sockets. DNP TCP/IP:3 sessions (from version 1.72 onwards).

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 C650s 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 C650 relays?

A13. Take into account that an UR is never connected directly to a C650 (neither two UR nor two C650 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 C650 must be 100-BASE-FX.

Q14. How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX C650 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 C650, and a hub 10/100-BASE-TX port may be connected either to an UR or C650.

Q15. What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the C650, although both are 100-BASE-FX?

A15. Just buy fiber cables with the appropriate male connectors. For the UR and C650 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.

12.2 Protection

Q1. Does the C650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1. Yes, the C650 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 depends 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. Select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

12.3 Control & HMI

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 C650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

Q2. Can I program interlocks?

A2. Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q3. Can we rotate the display 90 degrees to show feeders vertically?

A3. No. The product has been designed to view it in horizontal mode (landscape) due to the following reasons:

It is easier to read the LCD display because it has been designed for horizontal positions.
Compatibility between text display (4x20 characters) and LCD display (16x40 characters or 128x240 pixels).
Refresh speed is better in horizontal than vertical format.

Q4. Do I need a laptop or handheld to program the unit?

A4. No, all main operations can easily be performed with just the incorporated HMI. Handheld or laptops may be required to download large quantities of information (such as oscillograms, etc.) but they are not mandatory for a conventional user that just needs to change settings, view measurements, states, etc.

Q5. Is there password security for protection and control?

A5. Yes, there are two passwords. An independent password for protection changes and control operations is available since version 1.44

Q6. Is it possible to have a remote HMI installed in the front of the panel with the rest of the relay in the rear side?

A6. Not in the present version.

Q7. Is it possible to program a default screen for the HMI?

A7. In graphic display versions the user may program a custom screen with the single-line diagram, measurements, etc. In text display models, there is a choice of logo, measurements, or scrolling both screens.

Q8. May I force inputs and outputs to ease commissioning and testing?

A8. Yes.

Q9. How can I disable the rotary knob buzzer?

A9. Press ESC key for more than 3 seconds and then press the knob during a short pulse.

Q10. How can I disable/enable beep sound HMI keypad in models with Enhanced HMI?

A10. To disable: Press ESC push-button more than 3 seconds and then press ENTER push-button while keeping ESC push button pressed.

To enable: Press ESC push-button more than 3 seconds. After this time, press the ENTER push-button and then Up/down key while keeping ESC push-button pressed.

Q11. Why do appear strange texts on the display when switching on the relay?

A11. You have pressed any button and the HMI has entered test mode.

The display messages are updated after a few minutes, once the relay has completed the starting sequence.

12.4 Relay configuration

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.

12.5 Common FAQs

Q1. Remote I/O CAN bus: Does it support DeviceNet protocol?

Q1. No it does not support DeviceNet

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. Can I program interlocks?

A3. Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q4. 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?

A4. 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.).

Q5. I set an output contact as "Latched". If I do not set a "reset" condition, will it reset ?

A5. No, you have to configure the contact output reset signal (in ***Setpoint > Relay Configuration > Outputs***).

C650 Bay Controller & Monitoring System

Chapter 13: C650 troubleshooting guide

13.1 Symptoms and recommended actions

C650 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 suggest you follow the recommendations below. These actions may solve the problem, and if not they will help define the problem for quicker repair.

To send a unit back to the factory for repair, 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 more efficient solution to your problem.

Category	Symptom	Possible cause	Recommended action
Control	The relay does not trip	-Function not permitted - Function blocked - Output not assigned - The unit is not set to ready	-Set the function permission to ENABLED -Check Control units block screen -Program the output to the desired function using EnerVista 650 Setup logic configuration - Verify that the general setting is set to disabled and the out of service state is not active
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 port	-Incorrect cable -Damaged cable -Relay or PC not grounded -Incorrect baud rate, port, address, etc.	-Make sure you are using a straight cable -Replace the cable -Ensure ground connection -Test other ports, other baud rates, 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 matches 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 the web server properly in C650 with Windows XP. Some windows are in grey with a red cross mark.	1.- Disabled Java options in Advanced Internet Explorer properties or high level of security 2.- No Java Virtual Machine installed.	1.1- 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 a 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.) 1.2.- Try to set a lower level of security in internet explorer options. 1.3.-Delete temporary internet files in "General" screen in internet explorer options. Communication EnerVista 650 Setup does not retrieve osc 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. 2.1- Install either Microsoft or Sun Java Virtual Machine
Communication	EnerVista 650 Setup does not retrieve osc 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 port	To perform the bootware upgrading process it is necessary to connect the unit thought the front RS232 port. check: • Serial cable correct (straight through) 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 Baud rate set to 19200 o Control type: No control type o Modbus slave number: any **Note: if the bootware upgrade procedure got stuck at this point the relay will not be upgraded. After reboot the relay 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 straight through Ethernet cable for hub or switch) • IP address and netmask, gateway are correct and correspond to the ones used in the computer performing 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 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 upgrade procedure is 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 shows the message "Os Loading..." and the relay does not start up**.
Firmware	The procedure cannot 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 upgrade procedure is stuck at this point the relay will not be upgraded. After switching it off and on it 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 restart the upgrade procedure. • Check the unzip process to see if the file properties are properly set to "File". **Note: if the firmware upgrade procedure is 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 shows the message "Os Loading..." and the relay does not start up.**

Category	**Symptom**	**Possible cause**	**Recommended action**
Firmware	It is not possible to upgrade models without IEC 61850 to models with IEC 61850 automatically	- IEC 61850 upgrade from standard models is password protected.	• To upgrade from a standard model to a 6 model, ask the factory for an upgrade package, depending on the hardware the existing unit has. If it is hardware 00 a hardware and firmware change is required (password protected), if it is hardware 01 or above only a firmware change is required (password protected).
Firmware	During the upgrading process for models with IEC 61850 sometimes it ask for password and sometimes not.	- Communication problems during the upgrade procedure. -The upgrade procedure has been not performed in a continuous way.	• EnerVista 650 Setup program does 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 it has to be restarted, 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, so a change in any of these requires a password change. • If the model has been modified to add or replace any boards or communication protocol, the IEC 61850 passwords needs to be updated (contact the factory).
EnerVista 650 Setup	InstallShield Setup Initialization Error 6001	A previous installation of any product using InstallShield for installation may have corrupted some of the InstallShield files used in the EnerVista 650 Setup installation	Delete (or rename) the 0701 folder located in "C:\Program Files\Common Files\InstallShield\Professional\RunTime\" and retry installation

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Appendix A: Logic Operands

A.1 Logic Operands

OPERANDS - C650 - 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) Right 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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
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.
	BOARD 2H STATUS	Board 2H status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD 2J STATUS	Board 2J status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
IEC61850 INTERNAL STATES (NON CRITICAL)		
IEC61850 Internal States	ICD STATUS	UNKNOWN: when the relay has not the IEC61850 protocol in the relay model the ICD status is unknown to the unit
		ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 will not be operative (the IEC 61850 client, reports and gooses will not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
		MODIFIED: The settings have been changed in the icd but they are still not written in the icd file in the relay
		IN PROGRESS: The icd setting are being written to the file in the relay
		OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
		OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting prevails over the relay settings.
OTHER INTERNAL STATES (NON CRITICAL)		
Other internal states	USER MAP STATUS	User map status: (0) Not configured ; (1) Configured
	FACTORY CALIBRATION	Calibration status (0) Relay calibrated; (1) Not 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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Autocheck Internal States (Not available)	TIMER STATUS	Real time clock autocheck (not available)
	GRAPHIC STATUS	Graphic display status (not available)
	ALARM TEXT ARRAY	Text display status (not available)

Note: It is advisable to use the critical alarms to raise an event or to light a warning LED for maintenance purposes. See the example below, the Board X Status depends on the relay model.

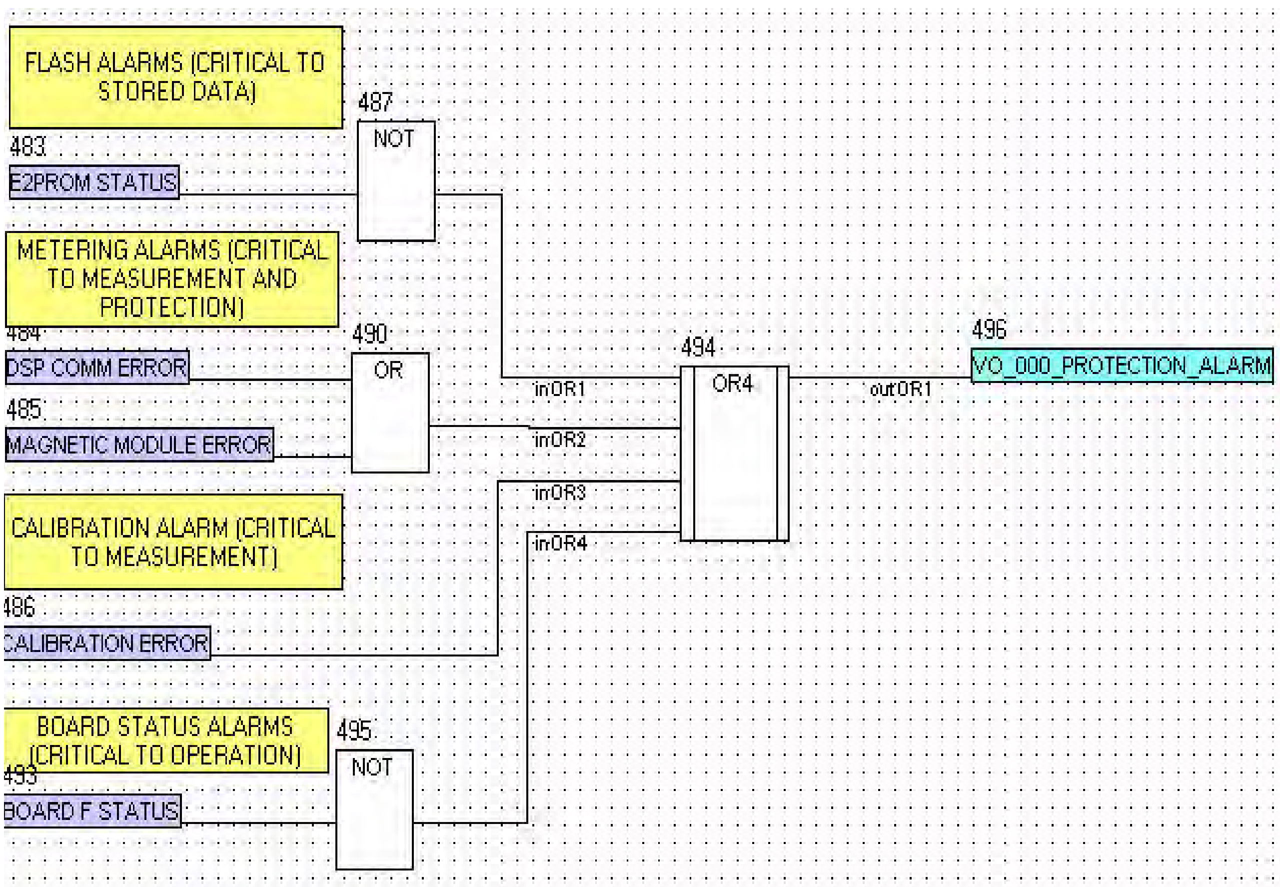


Figure A–1: Protection Alarm Signal

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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
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.
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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
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
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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
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
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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Switchgear Fail States	SWGR 1 FAIL TO OPEN	Failure to open Switchgear 1
	SWGR 2 FAIL TO OPEN	Failure to open Switchgear 2
	...	...
	SWGR 16 FAIL TO OPEN	Failure to open Switchgear 16
	SWGR 1 FAIL TO CLOSE	Failure to close Switchgear 1
	SWGR 2 FAIL TO CLOSE	Failure to close Switchgear 2
	...	...
	SWGR 16 FAIL TO CLOSE	Failure to close Switchgear 16

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
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 color.Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 2	Programmable LED 2 status: Red color. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 3	Programmable LED 3 status: Red color.Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 4	Programmable LED 4 status: Red color. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 5	Programmable LED 5 status: Red color. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 6	Programmable LED 6 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 7	Programmable LED 7 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 8	Programmable LED 8 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 9	Programmable LED 9 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 10	Programmable LED 10 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 11	Programmable LED 11 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 12	Programmable LED 12 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 13	Programmable LED 13 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 14	Programmable LED 14 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 15	Programmable LED 15 status: Green color. 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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Programmable Keypad Status (HMI)	I Key	I key operation (Programmable signal via PLC)
	O Key	O key operation (Programmable signal via PLC)
	*/F3 Key	*/F3 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/REMOTE 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 Backlight	HMI BACKLIGHT ON	"Switching on backlight" signal (the display is switched on by communications
	HMI BACKLIGHT OFF	"Switching off backlight" signal (the display is switched off by communications
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
Energy Counters	FREEZE ENERGY CNT	Energy counter freeze
	UNFREEZE ENERGY CNT	Energy counter unfreeze
	RESET ENERGY CNT	Energy counter reset

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Demand Inputs	DEMAND TRIGGER INP	Demand trigger (for Block interval algorithm)
	DEMAND RESET INP	Demand reset
	GROUP 1 ACT ON	Group 1 activation, and deactivation of groups 2 & 3
Breaker Maintenance	KI2t PHASE A ALARM	K·I^{2}t phase A Alarm
	KI2t PHASE B ALARM	K·I^{2}t phase B Alarm
	KI2t PHASE C ALARM	K·I^{2}t 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^{2}t Breaker ageing counter reset
	RESET BKR COUNTERS	Breaker openings and closings counters reset
Breaker Status	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
Synchrocheck	Synchrocheck BLK INP	Synchronism element block
	Synchrocheck OP	Synchronism 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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Autorecloser	AR LEVEL BLOCK	Recloser element block by level
	AR PULSE BLOCK	Recloser element block by pulse
	AR PULSE UNBLOCK	Recloser element unblock by pulse
	AR INITIATE	Reclose initiate
	AR CONDS INPUT	Reclose permission condition in input to Function 1 = there are conditions
	AR CLOSE BREAKER	Closing permission for the recloser
	AR OUT OF SERVICE	Recloser out of service
	AR READY	Recloser READY
	AR LOCKOUT	Recloser in LOCKOUT
	AR BLOCK	Recloser BLOCKED
	AR RCL IN PROGRESS	Recloser – Cycle in progress
	AR LCK BY ANOMALY	Recloser – LOCKOUT by anomaly (reclosing command during cycle in progress)
	AR LCK BY FAIL OPEN	Recloser – LOCKOUT by failure to open
	AR LCK BY FAIL CLOSE	Recloser – LOCKOUT by failure to close
	AR LCK BY USER	Recloser – LOCKOUT by external operation (e.g.: manual opening with cycle in progress)
	AR LCK BY CONDS	Recloser – LOCKOUT by lack of reclosing conditions
	AR LCK BY TRIPS	Recloser – LOCKOUT by number of trips
	AR LCK BY SHOTS	Recloser – LOCKOUT by number of shots
	AR BLK AFTER 1 SHOT	Recloser – Block after first shot
	AR BLK AFTER 2 SHOT	Recloser – Block after second shot
	AR BLK AFTER 3 SHOT	Recloser – Block after third shot
	AR BLK AFTER 4 SHOT	Recloser – Block after fourth shot
Autorecloser	AR BLOCK BY LEVEL	Recloser – Block by level
	AR BLOCK BY PULSE	Recloser – Block by command (pulse)
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

OPERANDS - C650 - MODEL FX - GX		
Internal System Status		
Remote Outputs	DNA 1	1 output on. Remote Output DNA 1 Operation (GSSE/ GOOSE)
	DNA 2	1 output on. Remote Output DNA 2 Operation (GSSE/ GOOSE)
	...	...
	DNA 32	1 output on. Remote Output DNA 32 Operation (GSSE/ GOOSE)
	User St 1	1 output on. Remote Output UserSt 1 Operation (GSSE/ GOOSE)
	User St 2	1 output on. Remote Output UserSt 2 Operation (GSSE/ GOOSE)
	...	**...**
	User St 64	1 output on. Remote Output UserSt 64 Operation (GSSE/ GOOSE)
	Rem GOOSE Dig Out 1	1 output on. Remote Output GOOSE 1 Operation (GOOSE)
	Rem GOOSE Dig Out 2	1 output on. Remote Output GOOSE 2 Operation (GOOSE)
	...	...
	Rem GOOSE Dig Out 32	1 output on. Remote Output GOOSE 32 Operation (GOOSE)
Remote Inputs	Remote Input 1	Flag is set, logic =1
	Remote Input 2	Flag is set, logic =1
	...	...
	Remote Input 32	Flag is set, logic =1
Remote Devices	Remote Device 1	Flag is set, logic =1
	Remote Device 2	Flag is set, logic =1
	...	...
	Remote Device 16	Flag is set, logic =1
GOOSE DIG INPUTS	Rem GOOSE Dig Input 1	Flag is set, logic = 1
	Rem GOOSE Dig Input 2	Flag is set, logic =1
	...	...
	Rem GOOSE Dig Input 32	Flag is set, logic =1
GOOSE Analog Inputs (FLOAT AND INTEGER)	Rem Ana Inp FLOAT 1	Analog Input 1 (Float type)
	Rem Ana Inp FLOAT 2	Analog Input 2 (Float type)
	...	...
	Rem Ana Inp FLOAT 8	Analog Input 8 (Float type)
	Rem Ana Inp INT 1	Analog Input 1 (Integer type)
	Rem Ana Inp INT 2	Analog Input 2 (Integer type)
	...	...
	Rem Ana Inp INT 8	Analog Input 8 (Integer type)

C650 Bay Controller & Monitoring System

Appendix B: MODBUS protocol

B.1 Introduction

This section describes the MODBUS memory map and how to read and write data from and to the C650 relay using MODBUS protocol. The MODBUS protocol is an industrial communications protocol based on a master/slave architecture (RTU-Serial) or a client/server architecture (TCP/IP). Refer to http://www.modbus.org/ for more information about this protocol.

A generic memory map has been created, **compatible between versions**, with all possible items that an C650 may have, independent of type or configuration to prevent an existing integration from being affected by version changes. This memory map describes each item including the data type, length, memory position, object version, etc. Moreover, the memory map groups the different objects into 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 model, it is possible to elaborate its own MODBUS memory map. This map is only 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.

View the Memory Map using **EnerVista 650 Setup software**, menu: View > MODBUS Memory map

B.2 MODBUS C650

B.2.1 Implemented MODBUS functionality

The implemented protocol is standard MODBUS, so any SCADA or PLC can easily communicate with C650 units.

The C650 unit always works as a slave/server, and thus never initiates communication; it is always the master/client (EnerVista 650 Software or PLC, i.e.) that initiates communication.

Only two MODBUS codes are implemented in all firmware versions:

- **Read function 3 (03h) and 4 (04h)**
- **Write function 16 (10h)**

Starting from firmware version 7.50 and above, two custom MODBUS functions have also been implemented:

- **Read function 66 (42h)**
- **Write function 67 (43h)**

The two new custom function codes allow the master/server to read/write settings of protection functions affected by the setting groups. If these MODBUS function codes are used, the master/server has access to read/write protection element settings that belong to any setting group. In contrast, if read function 3 or Write function 4 is used, only protection elements settings in the **active setting group** can be accessed/modified.

B.2.2 Physical layer

MODBUS protocol is independent of hardware. The physical layer may be in different hardware configurations: USB, RS485, fiber optic or Ethernet.

C650 units incorporate a front USB and can mount up to two rear RS485 or fiber optic ports, and a 1mixture of 10/100Base TX and 10/100Base FX ports, depending on the specific order code of each C650 unit. The data flow in any of these configurations is “half-duplex”.

B.2.2.1 Serial layer

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 even, odd, or none.

The master must know the slave address with which it is going to communicate. No unit operates after a master request if the message address is not its own, unless the address is 0, which is the broadcast address. In this case the relay operates, but won’t send a reply.

B.2.2.2 B.2.2.2 TCP/IP layer

The rear ethernet or fiber optic ports are used for this connection layer.

The settings for this type of connection are gathered from the Ethernet and MODBUS protocol setpoint menus, where the IP addresses and TCP port are configured, among other settings.

B.2.3 Data link layer

Communication is performed in strings, with data groups sent asynchronously. The master/client transmits a string to the slave/server and the slave/server responds with another string (except for the case of broadcast communication). For the MODBUS serial connection, a timeout or a pause in communication marks the end of a string. The length of this timeout is equal to 3 characters, thus it varies depending on the baud rate.

The following table shows the generic string format, valid for transmission and reception. However, each function has 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 use this address, which can be programmed to any 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 performs the requested action, but none of them responds to the master. Broadcast is only accepted for writing since no unit responds.
FUNCTION CODE [B]	1 byte	This is one of the function codes supported by the equipment. The generic function codes are 3 and 4 for reading and 16 for writing. Special read function 66 and write function 67 are available only for firmware version 7.50 or above. When the slave responds with an exception to any of these strings, it places to 1 the most important bit of the corresponding function. For example, an exception to function 3 is indicated with an 83 as function code, and an exception to function 16 or 0x10 in hexadecimal, is indicated with a 0x90.
SETTING GROUP SELECTED [B1]	1byte	This part of string format only applies to read function 66 and write function 67 (fw 7.50 or above).This byte indicates the setting group being read or written. Values should are as follow: 0 [Decimal]→ Setting Group 1 1 [Decimal]→ Setting Group 2 ... 5 [Decimal]→ Setting Group 6
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 neither performs an action, nor responds 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, with the actual time varying depending on baud rate: 15 ms at 2400 bps 2 ms at 19200 bps 300 μs at 115200 bps etc.

B.2.4 Generic reading

MASTER/CLIENT SLAVE/SERVER

Request

Reading function 3 or 4:

+[A]+ +[B]+ +[C]--------------+ +[D]--+

01 04 01 09 00 01 XX XX

Data addr. Regs.

Reading function 66:

+[A]+ +[B]+ +[B1]++[C]--------------+ +[D]--+

01 42 00 01 09 00 01 XX XX

SG Data addr. Regs.

OK Response

Reading function 3 or 4:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 04 02 00 08 XX XX

Bytes...Data .....

Reading function 66:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 42 02 00 08 XX XX

Bytes...Data ....

Error Response

R
e

Reading function 3 or 4:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 84 03 XX XX

Error code...........

Reading function 66:

+[A]+ +[B]+ +[C]-----------------------+ +[D]--+

01 C2 03 XX XX

B.2.5 Generic writing

MASTER/CLIENT SLAVE/SERVER

Request

Writing function 16:

+[A]+ +[B]+ +[C]-------------------------------+ +[D]--+

01 10 00 87 00 02 04 00 0A 01 02 XX XX

Data addr. Regs. Bytes ....Data.......

Writing function 67:

+[A]+ +[B]+ +[B1]++[C]--------------+ +[D]--+

01 43 00 09 C1 00 01 02 00 03 XX XX

SG Data addr. Regs. Bytes Data

OK Response

Writing function 16:

+[A]+ +[B]+ +[C]------------------------------+ +[D]--+

01 10 00 87 00 02 XX XX

Data Addr.......Regs .....

Writing function 67:

+[A]+ +[B]+ +[C]---------------------------------+ +[D]--+

01 43 09 C1 00 01 XX XX

Data Addr.......Regs .....

Error Response

Writing function 16:

+[A]+ +[B]+ +[C]------------------------+ +[D]--+

01 90 07 XX XX

Error code...........

Writing function 67:

+[A]+ +[B]+ +[C]------------------------+ -+ +[D]--+

01 C3 03 XX XX

B.2.6 Function codes

CODE		MODBUS NAME	C650 DEFINITION	COMMENT
HEX	DEC			
03	3	Read Holding Registers	Reading of any value	These functions allow the master to read one or more consecutive relay addresses. Registers are always 16-bits 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	
42	66	Setting Group Read	Reading of values affected by setting groups	This function allows the master to read any setting/actual value that belongs to any setting groups, active or not, in one or more consecutive relay addresses. Registers are always 16-bits 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.
10	16	Preset Multiple Registers	Writing	This function allows the master to write one 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 that can be written in a single package is 125, equivalent to 250 bytes.
43	67	Setting Group Write	Writing of values affected by setting	This function allows the master to write any setting that belongs to any setting group, active or not, in one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be written in a single package is 125, equivalent to 250 bytes.

B.2.7 Exception and error responses

The following table shows error codes defined in ModBus protocol:

01	ILLEGAL FUNCTION	Slave does not support the function code received.
02	ILLEGAL DATA ADDRESS	Master is using an incorrect address.
03	ILLEGAL DATA VALUE	Slave has detected an invalid value.
04	ILLEGAL RESPONSE LENGTH	Response to the master's request exceeds the maximum size for that function code.
05	ACKNOWLEDGE	Generic acknowledgment.
06	SLAVE DEVICE BUSY	Slave is busy and cannot perform the requested operation.
07	NEGATIVE ACKNOWLEDGE	Negative acknowledgment.

B.3 Data type

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 150 Bit 140 Bit 130 Bit 121 Bit 111 Bit 100 Bit 091 Bit 080 Bit 070 Bit 061 Bit 050 Bit 040 Bit 030 Bit 020 Bit 010 Bit 001
F2	2	Integer with 4 bytes sign. Must be scaled, by multiplying the sent value by 1000, or dividing the received value by 1000. For example, if a value of 34509 is received, the converted value is 34.509. To write the value 334, the value 334000 is sent. 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: 1240.556 = 0x449B11CB
F4	1	Integer with 2 bytes sign. Example: 123 = 0x007B
F5	2	Integer without 4 bytes sign. Example: 12312 = 0x00003018
F6	4	8 bytes Float Example: 123.324 = 0x405ED4BC6A7EF9DB
F7	1	Characters without sign. As it needs to be sent in a register, i.e. in two bytes, the character goes below. *Example: 'β = 0x00E1*
F8	1	Characters with sign As it needs to be sent in a register, i.e. in two bytes, the character goes below. Example: 'A' = 0x0041
F9	16	String. Chain of characters with a fixed length (32 bytes). The end of the string is marked with "\0". Example: "ABC" = 0x41x42x43x00....
F10	1	This is a 16-bit integer without sign. Each value that can be taken by this integer has a correspondence in the database Auxiliary Table. In this table we can find the corresponding chain, which must be shown for each value. In memory, only an integer value is received. Example: 0, 1Correspond to CLOSE, OPEN
F11	3	Milliseconds passed since January/1/2000 at 00:00:00.000.
F12	1	Unsigned int 16 bit (enumerated), example: In MODBUS address Ox0EBE is the FAULT TYPE 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

B.4 MODBUS data

B.4.1 Data management

The data managed in ModBus differs in size and functionality. 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 some configuration settings, such as GRAPHIC, PLC equations, TEXTS, and ALARM and LED configuration can be read and written using ModBus protocol, formats are not shown because they are subject to change. Use the EnerVista 650 Setup program to manage and format configuration settings.

B.4.2 Writing settings

The process for changing protection functionality usually involves the modification of a group of settings that belong to a particular protection function. This guarantees protection functionality and offers versatility for possible legacy programs.

Writing settings must be performed in two consecutive steps: Writing and Confirmation.

In order to perform this process, the MODBUS master must write the selected settings and then confirm the operation by writing a register in the last position of this group. For safety reasons, there is a set time window within which the confirm settings modification must be completed. The time window between the last settings being written to confirmation cannot exceed 15 seconds.

B.4.3 Snapshot events

In the C650, the NEW EVENTS concept has been extended, providing additional functionality. These are the events created after the last request.

Firmware version 1.60 added reading snapshot events in binary format. Before this version, the relay sent information only in ASCII format.

SNAPSHOT EVENT READING IN ASCII FORMAT

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .TXT": to read all events.

   "NEW_EVE.TXT": to read events created from the last request of this same file.

   "EVE0234 .TXT ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

   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).

   In the second step, many BUSY responses may be produced, because an ASCII file is being created internally.

SNAPSHOT EVENT READING IN BINARY FORMAT:

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .BIN": to read all events.

   "NEW_EVE.BIN": to read events created from the last request of this same file.

   "EVE0234 .BIN ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

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:

1st byte: Event format code.

N bytes: Event information structured depending on the code

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 end 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).

For C650 models, the analog data is set to zero. The structure remains the same as other 650 devices but with no data as the C650 units do not have a magnetic module option.

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**

The relay responds with “SLAVE DEVICE BUSY”:

PC <--------- 0xFE 0x83 0x06 0xF1 0x02]

The request is repeated:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

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

To execute an operation, write the bit corresponding to that operation. For this purpose, there are two memory records with bits representing operations. These records are 0xAFFE and 0xAFFF.

Each operation is 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 Big Endian; this means that the first byte arriving is the one with more weight. Operations commands are affected depending on the physical communication channel they use: serial port, ethernet ports, mmi, etc.

Refer to section 4.2.3.1 Command push button on page 4–42.

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 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)**

B.4.5 Force outputs of IO boards

To ease and test IO boards' outputs physical wiring, each IO boards' contact outputs can be forced to actuate with this MODBUS command. Proceed as with a file access (open, write, and close).

For example, to write to a mixed board (16 inputs and 8 outputs):

1 - OPEN OUTPUT FILE: write to 0xFE20, 3 registers with the name **OUTPUT**

2 - WRITE TO FILE: write to 0xFF20, 5 REGISTERS, the first one is the board slot (F=0, G=1, H=2, J=3 and so on) and the restraint ones are the bytes of bits (bits are grouped byte to byte).

3 - CLOSE OUTPUT FILE: write msg to 0xFE 28 of 3 registers with the name **OUTPUT**

Example, activate the two lower relays to board '0':

1 Open:

[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]

2 Write:

[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]

3 Close:

[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.4.6 Control events

This section explains control events, not to be confused with the snapshot events. A control event is the value change from 0 to 1 or from 1 to 0 of one bit, and is associated with a time label showing when the change occurred.

In the C650, any status or combination of status may generate an event. The C650 has **192 control events** available. The first **128 control events** are user-configurable through a table from the EnerVista 650 Setup menu: **Setpoint > Relay configuration**. The remaining **64 control events** are associated with the 16 possible switchgear, each one generating 4 status bits:

- 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:

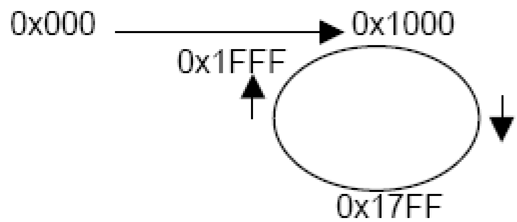
- 0x03FF: Number of the next event

- 0xFCFF: Access to the oldest event

- 0xFD00 to 0xFDFF: Access to any stored event (circular queue)

The address **0x03FF** stores the number of the next event. For example, if the number 7677 is stored, the last event stored is number 7676. This value is initially 0, and it is increases from 0 to 2^12 + 1 carry bit as events are generated.

The carry bit indicates whether the C650 has been started, since when the relay starts, whether due to lack of power supply or a configuration change, the carry bit is set to 0. When events are generated, the event number is increased up to a maximum value of 0x1FFF; in the next event the number is 0x1000, thus the carry bit is always 1, until the C650 is restarted. This is shown in the following figure:



B.4.6.1 Event structure

Each event has 14 bytes, with the following format:

- Short (2 bytes): event number (0 - 2^12 + carry bit)
- Short (2 bytes): event bit number (from 0 to 191).
- Short (2 bytes): the 0 bit indicates the event value (0 or 1) and the 15 bit indicates whether this is a valid event (all events are initially set to 0)
- Double unsigned (8 bytes): milliseconds from 1 January 2000

The 0xFCFF address is useful when reading all the available events in the C650, as is 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, is 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

For example, the events buffer could contain the following information:

Event Number	7424	7425	....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

105 registers: 15 events * 7 registers.

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

B.4.6.2 Event collection process

ALL EVENTS

When reading all events, there are two possible approaches:

First option: start from the oldest event, in address 0xFCFF, and read the events 15 by 15. The initial request frame sent to the relay is as follows:

Within this frame the buffer pointer is set to the oldest event, or number 7421 in the example. 15 events are returned, ending with number 7435.

In order to read the following 15 events, numbered from 7436 to 7450, calculate the initial address and send another request frame:

Hex(7436)=	0x1D0C
0x1D0C AND 0x00FF=	0xOC
0xFD00+0x0C=	0xFD0C: **initial address**

[0xFE 0x03 **0xFD 0x0C** 0x00 0x69 0x60 0x44] **---------> RELAY**

Either continue until the relay responds with a 0 event, or stop at the last recorded event by reading the number of the next upcoming event from address 0x03FF and comparing against the last event read.

Second option: read the circular event queue directly, from address 0xFD00 to 0xFDFF, and then rearrange the retrieved events by event number.

Once all events have been read, subsequent queries should only request new events.

NEW EVENTS

The 0x03FF address contains the number of the next event to be written. Based on this, the number of events recorded since the last query can be determined.For example, if the relay indicates that the next event to be generated is number 7677 and events up to number 7674 have already been read, there are two new events. A frame must be sent to read the two new events, 7675 and 7676, and the corresponding 28 bytes.

Event Number	7424	7425	....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

Hex(7675)=0x1DFB

0x1DFB AND 0xFF=0xFB

0xFD00+0xFB=0xFDFB: **reading address (*)**

[0xFE 0x03 **0xFD 0xFB 0x00 0x0E** 0x90 0x5C] **---------> RELAY**

B.4.6.3 Control events from the command line

Starting EnerVista 650 Setup from the command line allows the transfer of 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 baud rate, 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.

SERIAL COMUNICATION

EnerVista 650 Setup –e event number " File name" –com port: baud_rate relay_number

E.g.: EnerVista 650 Setup –e 6 "C:\GE Power Management\EnerVista 650 Setup\files\Events\eventos.txt" –com 1:19200 254

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 looks 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.4.6.4 Event status request (alarms)

To retrieve events that have been configured as alarms, see 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 events and alarms states, do the following:

1. Read the head of events FIFO (0x03FF).
2. Read the addresses above.
3. 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 another quantity is needed, it will not respond with the requested data.

B.4.6.5 Acknowledging 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

There are 6 channels:

LOCAL: by MMI or COM-2 (front and rear accessible port).

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.4.7 Write virtual inputs

For forcing Virtual Inputs, a message with 4 indivisible records must be written at address 0xF430, so that each bit corresponds to a Virtual Input. Values are not correct if the first 4 records are not written in the same message. The first 32 are LATCHED (internally stored in flash memory), 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.4.8 User map

C650 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 repeatedly several connected slave relays. If those values are dispersed along the memory map, reading them may require several petitions, 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, provides the required information about the two boards Contact Outputs.

NOTE: Only single data can be set in the map, i.e. 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.4.9 Retrieve oscillography

For firmware versions below 7.xx, in case of not using the quickest download method by TFTP, 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 can 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.

Note: For firmware versions 7.xx and above, this feature is not available.

B.4.10 Time synchronization

Time synchronization consists of setting the relay date and time.

This is similar to other settings group entries, with some unique characteristics:

- The data type is specific to time.
- Once the data is changed, varies with time, it is a changing setting that can be read.
- It shares the time change with IRIG-B (this has more priority) and with a possible modification from MMI or another protocols.
- When the relay is disconnected from its auxiliary power supply for extended periods (days) the time remains in a chip, fed 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 stored in 4 MODBUS registers (8 bytes, Big Endian format), which indicates elapsed milliseconds from the 1st of January 2000 at 00:00:00.000.

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.4.11 Queuing 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 answered as soon as possible.
- This implies that when settings are changed and answered, a writing request recognition is indicated and then, the modification of internal settings is performed, and finally, after confirmation is sent, 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 processes 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 message responses. 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.4.12 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 are shown. If, for instance, the request and response strings view is desired, between C650 and the relay, do the following:

1 - Activate traces, from **View > Traces**, and a new window opens at the bottom of the main window.

2 - Open the general settings menu: **Setpoint > System Setup > General Settings**

The screen displays the group settings, and on the left side bottom the relay read request is shown:

<0001><06/18/03 12:14:15>[0xFE 0x03 0x21 0x8A 0x00 0x16 0xFB 0xDD]

On the right the settings response is shown:

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 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 the EnerVista 650 Setup menu: **Communication > Troubleshooting**, any read of any address can be requested, and the PC forms the request string together with the check-sum register.

B.4.13 MODBUS CRC generation function

This section describes the C programming language implementation to calculate the CRC of the message string check in ModBus, in a Big-Endian format.

The implemented function in the C650 called here fn_035c_cr16 returns an unsigned 16 bit type (2 bytes) with the CRC of the message defined in the function parameters as:

p = pointer to the MODBUS message string to calculate the CRC

us = length in bytes of the MODBUS message (header + data) minus 2 bytes (the CRC of the message itself)

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;      // Big-Endian format

    return(ui);
}
```

If it is Little-Endian format the returned bytes must be interchanged: each unsigned 16 bit type's bytes need to be swapped.

B.5 Memory map

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	
Salidas virtuales analógicas- Virtual Output Analog							
0x07D0		INT32_000	F005	1.000	R	2	
0x07D2		INT32_001	F005	1.000	R	2	
0x07D4		INT32_002	F005	1.000	R	2	
0x07D6		INT32_003	F005	1.000	R	2	
0x07D8		INT32_004	F005	1.000	R	2	
0x07DA		INT32_005	F005	1.000	R	2	
0x07DC		INT32_006	F005	1.000	R	2	
0x07DE		INT32_007	F005	1.000	R	2	
0x07E0		INT32_008	F005	1.000	R	2	
0x07E2		INT32_009	F005	1.000	R	2	
0x07E4		INT32_010	F005	1.000	R	2	
0x07E6		INT32_011	F005	1.000	R	2	
0x07E8		INT32_012	F005	1.000	R	2	
0x07EA		INT32_013	F005	1.000	R	2	
0x07EC		INT32_014	F005	1.000	R	2	
0x07EE		INT32_015	F005	1.000	R	2	
0x07F0		INT32_016	F005	1.000	R	2	
0x07F2		INT32_017	F005	1.000	R	2	
0x07F4		INT32_018	F005	1.000	R	2	
0x07F6		INT32_019	F005	1.000	R	2	
0x07F8		INT32_020	F005	1.000	R	2	
0x07FA		INT32_021	F005	1.000	R	2	
0x07FC		INT32_022	F005	1.000	R	2	
0x07FE		INT32_023	F005	1.000	R	2	
0x0800		INT32_024	F005	1.000	R	2	
0x0802		INT32_025	F005	1.000	R	2	
0x0804		INT32_026	F005	1.000	R	2	
0x0806		INT32_027	F005	1.000	R	2	
0x0808		INT32_028	F005	1.000	R	2	
0x080A		INT32_029	F005	1.000	R	2	
0x080C		INT32_030	F005	1.000	R	2	
0x080E		INT32_031	F005	1.000	R	2	
0x0810		INT32_032	F005	1.000	R	2	
0x0812		INT32_033	F005	1.000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0814		INT32_034	F005	1.000	R	2	
0x0816		INT32_035	F005	1.000	R	2	
0x0818		INT32_036	F005	1.000	R	2	
0x081A		INT32_037	F005	1.000	R	2	
0x081C		INT32_038	F005	1.000	R	2	
0x081E		INT32_039	F005	1.000	R	2	
0x0820		INT32_040	F005	1.000	R	2	
0x0822		INT32_041	F005	1.000	R	2	
0x0824		INT32_042	F005	1.000	R	2	
0x0826		INT32_043	F005	1.000	R	2	
0x0828		INT32_044	F005	1.000	R	2	
0x082A		INT32_045	F005	1.000	R	2	
0x082C		INT32_046	F005	1.000	R	2	
0x082E		INT32_047	F005	1.000	R	2	
0x0830		INT32_048	F005	1.000	R	2	
0x0832		INT32_049	F005	1.000	R	2	
0x0834		FLT32_000	F003	1.000	R	2	
0x0836		FLT32_001	F003	1.000	R	2	
0x0838		FLT32_002	F003	1.000	R	2	
0x083A		FLT32_003	F003	1.000	R	2	
0x083C		FLT32_004	F003	1.000	R	2	
0x083E		FLT32_005	F003	1.000	R	2	
0x0840		FLT32_006	F003	1.000	R	2	
0x0842		FLT32_007	F003	1.000	R	2	
0x0844		FLT32_008	F003	1.000	R	2	
0x0846		FLT32_009	F003	1.000	R	2	
0x0848		FLT32_010	F003	1.000	R	2	
0x084A		FLT32_011	F003	1.000	R	2	
0x084C		FLT32_012	F003	1.000	R	2	
0x084E		FLT32_013	F003	1.000	R	2	
0x0850		FLT32_014	F003	1.000	R	2	
0x0852		FLT32_015	F003	1.000	R	2	
0x0854		FLT32_016	F003	1.000	R	2	
0x0856		FLT32_017	F003	1.000	R	2	
0x0858		FLT32_018	F003	1.000	R	2	
0x085A		FLT32_019	F003	1.000	R	2	
0x085C		FLT32_020	F003	1.000	R	2	
0x085E		FLT32_021	F003	1.000	R	2	
0x0860		FLT32_022	F003	1.000	R	2	
0x0862		FLT32_023	F003	1.000	R	2	
0x0864		FLT32_024	F003	1.000	R	2	
0x0866		FLT32_025	F003	1.000	R	2	
0x0868		FLT32_026	F003	1.000	R	2	
0x086A		FLT32_027	F003	1.000	R	2	
0x086C		FLT32_028	F003	1.000	R	2	
0x086E		FLT32_029	F003	1.000	R	2	
0x0870		FLT32_030	F003	1.000	R	2	
0x0872		FLT32_031	F003	1.000	R	2	
0x0874		FLT32_032	F003	1.000	R	2	
0x0876		FLT32_033	F003	1.000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0878		FLT32_034	F003	1.000	R	2	
0x087A		FLT32_035	F003	1.000	R	2	
0x087C		FLT32_036	F003	1.000	R	2	
0x087E		FLT32_037	F003	1.000	R	2	
0x0880		FLT32_038	F003	1.000	R	2	
0x0882		FLT32_039	F003	1.000	R	2	
0x0884		FLT32_040	F003	1.000	R	2	
0x0886		FLT32_041	F003	1.000	R	2	
0x0888		FLT32_042	F003	1.000	R	2	
0x088A		FLT32_043	F003	1.000	R	2	
0x088C		FLT32_044	F003	1.000	R	2	
0x088E		FLT32_045	F003	1.000	R	2	
0x0890		FLT32_046	F003	1.000	R	2	
0x0892		FLT32_047	F003	1.000	R	2	
0x0894		FLT32_048	F003	1.000	R	2	
0x0896		FLT32_049	F003	1.000	R	2	
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	
Salidas Virtuales Latcheadas (16 elementos) - Latched virtual outputs							
0x0045	0x0400	V.O. Latched 1	F001		R	1	
---	---	---	---	---	---	---	---
0x0045	0x1000	V.O. Latched 3	F001		R	1	
0x0046	0x0200	V.O. Latched 16	F001		R	1	
Reset Salidas Virtuales Latcheadas - Reset Latched virtual outputs							
0x0046	0x0400	Reset V.O. Latched	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 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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0089	0x2000	CONT OP OPER_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008A	0x0800	CONT OP OPER_F_16	F001		R	1	
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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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	
Estado PLC Fuera de Servicio - Out of Service PLC Status							
0x00D4	0x4000	OUT OF SERVICE	F001		R	1	
0x00D4	0x8000	PLC ERROR	F001		R	1	
0x00D4	0x0001	General Trip	F001		R	1	
0x00D4	0x0002	NET CONF ERROR	F001		R	1	
0x00D4	0x0004	ST HMI BACKLIGHT	F001		R	1	
0x00D4	0x0008	ORDERCODE ERROR	F001		R	1	
0x00D4	0x0010	LINK STATUS PORT E	F001		R	1	
0x00D4	0x0020	LINK STATUS PORT A	F001		R	1	
0x00D4	0x0040	LINK STATUS PORT B	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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01F0	0x0002	BUS FREQ > LINE FREQ	F001		R	1	
0x01F0	0x0004	BUS FREQ < LINE FREQ	F001		R	1	
Estados Reenganchador (bit) - Autorecloser States							
0x01F5	0x0008	AR LEVEL BLOCK	F001		R	1	
0x01F5	0x0010	AR PULSE BLOCK	F001		R	1	
0x01F5	0x0020	AR PULSE UNBLOCK	F001		R	1	
0x01F5	0x0080	AR INITIATE	F001		R	1	
0x01F6	0x0100	AR CONDS INPUT	F001		R	1	
0x01F6	0x0200	AR CLOSE BREAKER	F001		R	1	
0x01F6	0x0400	AR OUT OF SERVICE	F001		R	1	
0x01F6	0x0800	AR READY	F001		R	1	
0x01F6	0x1000	AR LOCKOUT	F001		R	1	
0x01F6	0x2000	AR BLOCK	F001		R	1	
0x01F6	0x4000	AR RCL IN PROGRESS	F001		R	1	
0x01F6	0x8000	AR LCK BY ANOMALY	F001		R	1	
0x01F6	0x0001	AR LCK BY FAIL OPEN	F001		R	1	
0x01F6	0x0002	AR LCK BY FAIL CLOSE	F001		R	1	
0x01F6	0x0004	AR LCK BY USER	F001		R	1	
0x01F6	0x0008	AR LCK BY CONDS	F001		R	1	
0x01F6	0x0010	AR LCK BY TRIPS	F001		R	1	
0x01F6	0x0020	AR LCK BY SHOTS	F001		R	1	
0x01F6	0x0040	AR BLK AFTER 1 SHOT	F001		R	1	
0x01F6	0x0080	AR BLK AFTER 2 SHOT	F001		R	1	
0x01F7	0x0100	AR BLK AFTER 3 SHOT	F001		R	1	
0x01F7	0x0200	AR BLK AFTER 4 SHOT	F001		R	1	
0x01F7	0x0400	AR BLOCK BY LEVEL	F001		R	1	
0x01F7	0x0800	AR BLOCK BY PULSE	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	
Canal por defecto - Default Channel (not used)							
0x0294	0x0002	Default Channel	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0343	0x0004	BOARD J STATUS	F001		R	1	
Estado Entradas Tarjeta 2H (32 elementos) - Board 2H: Contact Input States							
0x045A	0x8000	CONT IP_2H_CC1	F001		R	1	
0x045A	0x0001	CONT IP_2H_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x045C	0x4000	CONT IP_2H_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta 2H (16 elementos) - Board 2H: Contact Output Operate -logical States-							
0x045C	0x8000	CONT OP OPER_2H_01	F001		R	1	
0x045C	0x0001	CONT OP OPER_2H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x045D	0x4000	CONT OP OPER_2H_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta 2H (16 elementos) - Board 2H: Contact Output Resets							
0x045D	0x8000	CONT OP RESET_2H_01	F001		R	1	
0x045D	0x0001	CONT OP RESET_2H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x045E	0x4000	CONT OP RESET_2H_16	F001		R	1	
Estado Salidas Tarjeta 2H (16 elementos) - Board 2H: Contact Outputs -physical states-							
0x045E	0x8000	CONT OP_2H_01	F001		R	1	
0x045E	0x0001	CONT OP_2H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x045F	0x4000	CONT OP_2H_16	F001		R	1	
Estado Tarjeta J - Board 2H Status							
0x045F	0x8000	BOARD 2H STATUS	F001		R	1	
Estado Entradas Tarjeta 2J (32 elementos) - Board 2J: Contact Input States							
0x047F	0x0001	CONT IP_2J_CC1	F001		R	1	
0x047F	0x0002	CONT IP_2J_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x0481	0x8000	CONT IP_2J_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta 2J(16 elementos) - Board 2J: Contact Output Operate -logical States-							
0x0481	0x0001	CONT OP OPER_2J_01	F001		R	1	
0x0481	0x0002	CONT OP OPER_2J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0482	0x8000	CONT OP OPER_2J_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta 2J (16 elementos) - Board 2J: Contact Output Resets							
0x0482	0x0001	CONT OP RESET_2J_01	F001		R	1	
0x0482	0x0002	CONT OP RESET_2J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0483	0x8000	CONT OP RESET_2J_16	F001		R	1	
Estado Salidas Tarjeta 2J (16 elementos) - Board 2J: Contact Outputs -physical states-							
0x0483	0x0001	CONT OP_2J_01	F001		R	1	
0x0483	0x0002	CONT OP_2J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0484	0x8000	CONT OP_2J_16	F001		R	1	
Estado Tarjeta J - Board 2J Status							
0x0484	0x0001	BOARD 2J STATUS	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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
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	
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	
0x0380	0x0010	SWGR 1 BLOCK OPENING	F001		R	1	
0x0380	0x0020	SWGR 2 BLOCK OPENING	F001		R	1	
0x0380	0x0040	SWGR 3 BLOCK OPENING	F001		R	1	
0x0380	0x0080	SWGR 4 BLOCK OPENING	F001		R	1	
0x0381	0x0100	SWGR 5 BLOCK OPENING	F001		R	1	
0x0381	0x0200	SWGR 6 BLOCK OPENING	F001		R	1	
0x0381	0x0400	SWGR 7 BLOCK OPENING	F001		R	1	
0x0381	0x0800	SWGR 8 BLOCK OPENING	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0381	0x1000	SWGR 9 BLOCK OPENING	F001		R	1	
0x0381	0x2000	SWGR 10 BLOCK OPENING	F001		R	1	
0x0381	0x4000	SWGR 11 BLOCK OPENING	F001		R	1	
0x0381	0x8000	SWGR 12 BLOCK OPENING	F001		R	1	
0x0381	0x0001	SWGR 13 BLOCK OPENING	F001		R	1	
0x0381	0x0002	SWGR 14 BLOCK OPENING	F001		R	1	
0x0381	0x0004	SWGR 15 BLOCK OPENING	F001		R	1	
0x0381	0x0008	SWGR 16 BLOCK OPENING	F001		R	1	
0x0381	0x0010	SWGR 1 BLOCK CLOSING	F001		R	1	
0x0381	0x0020	SWGR 2 BLOCK CLOSING	F001		R	1	
0x0381	0x0040	SWGR 3 BLOCK CLOSING	F001		R	1	
0x0381	0x0080	SWGR 4 BLOCK CLOSING	F001		R	1	
0x0382	0x0100	SWGR 5 BLOCK CLOSING	F001		R	1	
0x0382	0x0200	SWGR 6 BLOCK CLOSING	F001		R	1	
0x0382	0x0400	SWGR 7 BLOCK CLOSING	F001		R	1	
0x0382	0x0800	SWGR 8 BLOCK CLOSING	F001		R	1	
0x0382	0x1000	SWGR 9 BLOCK CLOSING	F001		R	1	
0x0382	0x2000	SWGR 10 BLOCK CLOSING	F001		R	1	
0x0382	0x4000	SWGR 11 BLOCK CLOSING	F001		R	1	
0x0382	0x8000	SWGR 12 BLOCK CLOSING	F001		R	1	
0x0382	0x0001	SWGR 13 BLOCK CLOSING	F001		R	1	
0x0382	0x0002	SWGR 14 BLOCK CLOSING	F001		R	1	
0x0382	0x0004	SWGR 15 BLOCK CLOSING	F001		R	1	
0x0382	0x0008	SWGR 16 BLOCK CLOSING	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	
Estados Salidas Remotas DNA - DNA Remote Output Status							
0x03E5	0x0008	DNA 1	F001		R	1	
0x03E5	0x0010	DNA 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03E7	0x0004	DNA 32	F001		R	1	
Estados Salidas Remotas Usuario - UserSt Remote Output Status							
0x03E7	0x0008	UserSt 1	F001		R	1	
0x03E5	0x0010	UserSt 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03EB	0x0004	UserSt 64	F001		R	1	
Estados Entradas Remotas - Remote Inputs Status							
0x03EB	0x0008	Remote Input 1	F001		R	1	
0x03EB	0x0010	Remote Input 2	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
0x03ED	0x0004	Remote Input 32	F001		R	1	
Estados Dispositivos Remotos - Remote Devices Status							
0x03ED	0x0008	Remote Device 1	F001		R	1	
0x03ED	0x0010	Remote Device 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03EF	0x0400	Remote Device 24	F001		R	1	
Estados Sicronizacion Remota - SNTP/IRIG B Status							
0x03F2	0x0008	SNTP FAILURE	F001		R	1	
0x03F2	0x0010	IRIGB FAILURE	F001		R	1	
0x03F3	0x0001	CNT PULSES FREEZE	F001		R	1	
0x03F3	0x0002	CNT PULSES UNFREEZE	F001		R	1	
0x03F3	0x0004	CNT PULSES RESET	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	
Entradas digitales GOOSE-Rem GOOSE digital Inputs							
0x0421	0x2000	Rem GOOSE Dig Inp 1	F001		R	1	
0x0421	0x4000	Rem GOOSE Dig Inp 2	F001		R	1	
0x0421	0x8000	Rem GOOSE Dig Inp 3	F001		R	1	
0x0421	0x0001	Rem GOOSE Dig Inp 4	F001		R	1	
0x0421	0x0002	Rem GOOSE Dig Inp 5	F001		R	1	
0x0421	0x0004	Rem GOOSE Dig Inp 6	F001		R	1	
0x0421	0x0008	Rem GOOSE Dig Inp 7	F001		R	1	
0x0421	0x0010	Rem GOOSE Dig Inp 8	F001		R	1	
0x0421	0x0020	Rem GOOSE Dig Inp 9	F001		R	1	
0x0421	0x0040	Rem GOOSE Dig Inp 10	F001		R	1	
0x0421	0x0080	Rem GOOSE Dig Inp 11	F001		R	1	
0x0422	0x0100	Rem GOOSE Dig Inp 12	F001		R	1	
0x0422	0x0200	Rem GOOSE Dig Inp 13	F001		R	1	
0x0422	0x0400	Rem GOOSE Dig Inp 14	F001		R	1	
0x0422	0x0800	Rem GOOSE Dig Inp 15	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0422	0x1000	Rem GOOSE Dig Inp 16	F001		R	1	
0x0422	0x2000	Rem GOOSE Dig Inp 17	F001		R	1	
0x0422	0x4000	Rem GOOSE Dig Inp 18	F001		R	1	
0x0422	0x8000	Rem GOOSE Dig Inp 19	F001		R	1	
0x0422	0x0001	Rem GOOSE Dig Inp 20	F001		R	1	
0x0422	0x0002	Rem GOOSE Dig Inp 21	F001		R	1	
0x0422	0x0004	Rem GOOSE Dig Inp 22	F001		R	1	
0x0422	0x0008	Rem GOOSE Dig Inp 23	F001		R	1	
0x0422	0x0010	Rem GOOSE Dig Inp 24	F001		R	1	
0x0422	0x0020	Rem GOOSE Dig Inp 25	F001		R	1	
0x0422	0x0040	Rem GOOSE Dig Inp 26	F001		R	1	
0x0422	0x0080	Rem GOOSE Dig Inp 27	F001		R	1	
0x0423	0x0100	Rem GOOSE Dig Inp 28	F001		R	1	
0x0423	0x0200	Rem GOOSE Dig Inp 29	F001		R	1	
0x0423	0x0400	Rem GOOSE Dig Inp 30	F001		R	1	
0x0423	0x0800	Rem GOOSE Dig Inp 31	F001		R	1	
0x0423	0x1000	Rem GOOSE Dig Inp 32	F001		R	1	
Salidas digitales GOOSE-Remote GOOSE digital Outputs							
0x0423	0x2000	Rem GOOSE Dig Out 1	F001		R	1	
0x0423	0x4000	Rem GOOSE Dig Out 2	F001		R	1	
0x0423	0x8000	Rem GOOSE Dig Out 3	F001		R	1	
0x0423	0x0001	Rem GOOSE Dig Out 4	F001		R	1	
0x0423	0x0002	Rem GOOSE Dig Out 5	F001		R	1	
0x0423	0x0004	Rem GOOSE Dig Out 6	F001		R	1	
0x0423	0x0008	Rem GOOSE Dig Out 7	F001		R	1	
0x0423	0x0010	Rem GOOSE Dig Out 8	F001		R	1	
0x0423	0x0020	Rem GOOSE Dig Out 9	F001		R	1	
0x0423	0x0040	Rem GOOSE Dig Out 10	F001		R	1	
0x0423	0x0080	Rem GOOSE Dig Out 11	F001		R	1	
0x0424	0x0100	Rem GOOSE Dig Out 12	F001		R	1	
0x0424	0x0200	Rem GOOSE Dig Out 13	F001		R	1	
0x0424	0x0400	Rem GOOSE Dig Out 14	F001		R	1	
0x0424	0x0800	Rem GOOSE Dig Out 15	F001		R	1	
0x0424	0x1000	Rem GOOSE Dig Out 16	F001		R	1	
0x0424	0x2000	Rem GOOSE Dig Out 17	F001		R	1	
0x0424	0x4000	Rem GOOSE Dig Out 18	F001		R	1	
0x0424	0x8000	Rem GOOSE Dig Out 19	F001		R	1	
0x0424	0x0001	Rem GOOSE Dig Out 20	F001		R	1	
0x0424	0x0002	Rem GOOSE Dig Out 21	F001		R	1	
0x0424	0x0004	Rem GOOSE Dig Out 22	F001		R	1	
0x0424	0x0008	Rem GOOSE Dig Out 23	F001		R	1	
0x0424	0x0010	Rem GOOSE Dig Out 24	F001		R	1	
0x0424	0x0020	Rem GOOSE Dig Out 25	F001		R	1	
0x0424	0x0040	Rem GOOSE Dig Out 26	F001		R	1	
0x0424	0x0080	Rem GOOSE Dig Out 27	F001		R	1	
0x0425	0x0100	Rem GOOSE Dig Out 28	F001		R	1	
0x0425	0x0200	Rem GOOSE Dig Out 29	F001		R	1	
0x0425	0x0400	Rem GOOSE Dig Out 30	F001		R	1	
0x0425	0x0800	Rem GOOSE Dig Out 31	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0425	0x1000	Rem GOOSE Dig Out 32	F001		R	1	
Digital Counters actual values							
0x04A4	0x0002	DIGCNT 1 BLOCK	F001		R	1	
0x04A4	0x0004	DIGCNT 2 BLOCK	F001		R	1	
0x04A4	0x0008	DIGCNT 3 BLOCK	F001		R	1	
0x04A4	0x0010	DIGCNT 4 BLOCK	F001		R	1	
0x04A4	0x0020	DIGCNT 5 BLOCK	F001		R	1	
0x04A4	0x0040	DIGCNT 6 BLOCK	F001		R	1	
0x04A4	0x0080	DIGCNT 7 BLOCK	F001		R	1	
0x04A5	0x0100	DIGCNT 8 BLOCK	F001		R	1	
0x04A5	0x0200	DIGCNT 1 HI	F001		R	1	
0x04A5	0x0400	DIGCNT 2 HI	F001		R	1	
0x04A5	0x0800	DIGCNT 3 HI	F001		R	1	
0x04A5	0x1000	DIGCNT 4 HI	F001		R	1	
0x04A5	0x2000	DIGCNT 5 HI	F001		R	1	
0x04A5	0x4000	DIGCNT 6 HI	F001		R	1	
0x04A5	0x8000	DIGCNT 7 HI	F001		R	1	
0x04A5	0x0001	DIGCNT 8 HI	F001		R	1	
0x04A5	0x0002	DIGCNT 1 EQ	F001		R	1	
0x04A5	0x0004	DIGCNT 2 EQ	F001		R	1	
0x04A5	0x0008	DIGCNT 3 EQ	F001		R	1	
0x04A5	0x0010	DIGCNT 4 EQ	F001		R	1	
0x04A5	0x0020	DIGCNT 5 EQ	F001		R	1	
0x04A5	0x0040	DIGCNT 6 EQ	F001		R	1	
0x04A5	0x0080	DIGCNT 7 EQ	F001		R	1	
0x04A6	0x0100	DIGCNT 8 EQ	F001		R	1	
0x04A6	0x0200	DIGCNT 1 LO	F001		R	1	
0x04A6	0x0400	DIGCNT 2 LO	F001		R	1	
0x04A6	0x0800	DIGCNT 3 LO	F001		R	1	
0x04A6	0x1000	DIGCNT 4 LO	F001		R	1	
0x04A6	0x2000	DIGCNT 5 LO	F001		R	1	
0x04A6	0x4000	DIGCNT 6 LO	F001		R	1	
0x04A6	0x8000	DIGCNT 7 LO	F001		R	1	
0x04A6	0x0001	DIGCNT 8 LO	F001		R	1	
0x04A6	0x0002	DIGCNT 1 UP	F001		R	1	
0x04A6	0x0004	DIGCNT 2 UP	F001		R	1	
0x04A6	0x0008	DIGCNT 3 UP	F001		R	1	
0x04A6	0x0010	DIGCNT 4 UP	F001		R	1	
0x04A6	0x0020	DIGCNT 5 UP	F001		R	1	
0x04A6	0x0040	DIGCNT 6 UP	F001		R	1	
0x04A6	0x0080	DIGCNT 7 UP	F001		R	1	
0x04A7	0x0100	DIGCNT 8 UP	F001		R	1	
0x04A7	0x0200	DIGCNT 1 DOWN	F001		R	1	
0x04A7	0x0400	DIGCNT 2 DOWN	F001		R	1	
0x04A7	0x0800	DIGCNT 3 DOWN	F001		R	1	
0x04A7	0x1000	DIGCNT 4 DOWN	F001		R	1	
0x04A7	0x2000	DIGCNT 5 DOWN	F001		R	1	
0x04A7	0x4000	DIGCNT 6 DOWN	F001		R	1	
0x04A7	0x8000	DIGCNT 7 DOWN	F001		R	1	
0x04A7	0x0001	DIGCNT 8 DOWN	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x04A7	0x0002	DIGCNT 1 SETPRESET	F001		R	1	
0x04A7	0x0004	DIGCNT 2 SETPRESET	F001		R	1	
0x04A7	0x0008	DIGCNT 3 SETPRESET	F001		R	1	
0x04A7	0x0010	DIGCNT 4 SETPRESET	F001		R	1	
0x04A7	0x0020	DIGCNT 5 SETPRESET	F001		R	1	
0x04A7	0x0040	DIGCNT 6 SETPRESET	F001		R	1	
0x04A7	0x0080	DIGCNT 7 SETPRESET	F001		R	1	
0x04A8	0x0100	DIGCNT 8 SETPRESET	F001		R	1	
0x04A8	0x0200	DIGCNT 1 RESET	F001		R	1	
0x04A8	0x0400	DIGCNT 2 RESET	F001		R	1	
0x04A8	0x0800	DIGCNT 3 RESET	F001		R	1	
0x04A8	0x1000	DIGCNT 4 RESET	F001		R	1	
0x04A8	0x2000	DIGCNT 5 RESET	F001		R	1	
0x04A8	0x4000	DIGCNT 6 RESET	F001		R	1	
0x04A8	0x8000	DIGCNT 7 RESET	F001		R	1	
0x04A8	0x0001	DIGCNT 8 RESET	F001		R	1	
0x04A8	0x0002	DIGCNT 1 FREEZERESET	F001		R	1	
0x04A8	0x0004	DIGCNT 2 FREEZERESET	F001		R	1	
0x04A8	0x0008	DIGCNT 3 FREEZERESET	F001		R	1	
0x04A8	0x0010	DIGCNT 4 FREEZERESET	F001		R	1	
0x04A8	0x0020	DIGCNT 5 FREEZERESET	F001		R	1	
0x04A8	0x0040	DIGCNT 6 FREEZERESET	F001		R	1	
0x04A8	0x0080	DIGCNT 7 FREEZERESET	F001		R	1	
0x04A9	0x0100	DIGCNT 8 FREEZERESET	F001		R	1	
0x04A9	0x0200	DIGCNT 1 FREEZECOUNT	F001		R	1	
0x04A9	0x0400	DIGCNT 2 FREEZECOUNT	F001		R	1	
0x04A9	0x0800	DIGCNT 3 FREEZECOUNT	F001		R	1	
0x04A9	0x1000	DIGCNT 4 FREEZECOUNT	F001		R	1	
0x04A9	0x2000	DIGCNT 5 FREEZECOUNT	F001		R	1	
0x04A9	0x4000	DIGCNT 6 FREEZECOUNT	F001		R	1	
0x04A9	0x8000	DIGCNT 7 FREEZECOUNT	F001		R	1	
0x04A9	0x0001	DIGCNT 8 FREEZECOUNT	F001		R	1	
Entradas Analógicas (Tarjetas F y G)- Analog Inputs (F and G boards)							
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	
0x0C0C		Ib Real	F002	1000	R	2	
0x0C0E		Ib Imag	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0C10		Phasor Ic	F002	1000	R	2	
0x0C12		RMS Ic	F002	1000	R	2	
0x0C14		Ic Real	F002	1000	R	2	
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	
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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0CD4		Vbc Angle	F002	1000	R	2	
0x0CD6		Vca Angle	F002	1000	R	2	
Frequency rate of change value							
0x0CD8		df/dt	F002	1000 0	R	2	
Versión del HMI - HMI Version							
0x0CE2		HMI Version	F004	1000	R	1	
0x0CE3		DISPLAY TYPE	F004	1000	R	1	
Angle Difference for synchrocheck unit							
0x0E2F		ANGLE DIFFERENCE	F002	1,000, 000	R	2	
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 Reenganchador (Enumerado) - Autorecloser Status							
0x0E36		AR STATUS	F012		R	1	0=OUT OF SERVICE
							1=READY
							2=LOCKOUT
							3=BLOCK
							4=RECLOSE IN PROGRESS
0x0E37		AR LOCKOUT MODE	F012		R	1	0=NONE
							1=ANOMALY
							2=FAIL TO OPEN
							3=FAIL TO CLOSE
							4=MANUAL
							5=NO CONDITIONS
							6=MAX NUMBER OF TRIPS
							7=LAST SHOT
0x0E38		AR BLOCK MODE	F012		R	1	0=NONE
							1=LEVEL
							2=PULSE
							3=LEVEL+PULSE
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	
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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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	
0x0F4C		% of Load-To-Trip	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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
0x0FEA		DEMAND W MIN	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	
0x0FEC		DEMAND VAR MIN	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	
0x0FEE		DEMAND VA MIN	F002	1000	R	2	
0x0FE7		DEMAND VA DATE	F011		R	3	
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	
0x112B		BKR OPEN TIMING	F003	1	R	2	
0x112D		BKR CLOSE TIMING	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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
0x1180		DSP Counter	F005	1000	R	2	
0x1182		CPU Usage	F004	1000	R	1	
0x120E		ICD STATUS	F012		R	1	0=UNKNOWN
							1=ICD ERROR
							2=MODIFIED
							3=IN PROGRESS
							4=OK WITHOUT DAIS
							5=OK
							6=NotValidated Empty
							7=Passed to Validated
							8=Default
							9=ERROR HEADER CID
							10=ERROR SG CID
0x120F		ICD STATUS NOTVAL	F012		R	1	0=UNKNOWN
							1=ICD ERROR
							2=MODIFIED
							3=IN PROGRESS
							4=OK WITHOUT DAIS
							5=OK
							6=NotValidated Empty
							7=Passed to Validated
							8=Default
							9=ERROR HEADER CID
							10=ERROR SG CID

** For version previous to 7.00

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	
0x1263		GLOBAL STARTS CNT	F005	1000	R	2	
0x1265		BLOCK LOCKOUT TIME	F005	1000	R	2	
Entradas analógicas remotas tipo float- Float Remote Analog Input							
0x126D		Rem Ana Inp FLOAT 1	F003	1000	R	2	
0x126F		Rem Ana Inp FLOAT 2	F003	1000	R	2	
0x1271		Rem Ana Inp FLOAT 3	F003	1000	R	2	
0x1273		Rem Ana Inp FLOAT 4	F003	1000	R	2	
0x1275		Rem Ana Inp FLOAT 5	F003	1000	R	2	
0x1277		Rem Ana Inp FLOAT 6	F003	1000	R	2	
0x1279		Rem Ana Inp FLOAT 7	F003	1000	R	2	
0x127B		Rem Ana Inp FLOAT 8	F003	1000	R	2	
Entradas analogicas remotas tipo entero- Integer Remote Analog Input							
0x127D		Rem Ana Inp INT 1	F005	1000	R	2	
0x127F		Rem Ana Inp INT 2	F005	1000	R	2	
0x1281		Rem Ana Inp INT 3	F005	1000	R	2	
0x1283		Rem Ana Inp INT 4	F005	1000	R	2	
0x1285		Rem Ana Inp INT 5	F005	1000	R	2	
0x1287		Rem Ana Inp INT 6	F005	1000	R	2	
0x1289		Rem Ana Inp INT 7	F005	1000	R	2	
0x128B		Rem Ana Inp INT 8	F005	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Entradas Analógicas (Tarjetas 2J y 2H)- Analog Inputs (2J and 2H boards)							
0x137D		ANALOG_INP_2H_01	F002	1000	R	2	
0x137F		ANALOG_INP_2H_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x138B		ANALOG_INP_2H_08	F002	1000	R	2	
0x13FD		ANALOG_INP_2J_01	F002	1000	R	2	
0x13FF		ANALOG_INP_2J_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x140B		ANALOG_INP_2J_08	F002	1000	R	2	
Digital Counters Status							
0x147D		DIGCNT 1 VALUE	F005	1000	R	2	
0x147F		DIGCNT 2 VALUE	F005	1000	R	2	
0x1481		DIGCNT 3 VALUE	F005	1000	R	2	
0x1483		DIGCNT 4 VALUE	F005	1000	R	2	
0x1485		DIGCNT 5 VALUE	F005	1000	R	2	
0x1487		DIGCNT 6 VALUE	F005	1000	R	2	
0x1489		DIGCNT 7 VALUE	F005	1000	R	2	
0x148B		DIGCNT 8 VALUE	F005	1000	R	2	
0x148D		DIGCNT 1 FROZENVALUE	F005	1000	R	2	
0x148F		DIGCNT 2 FROZENVALUE	F005	1000	R	2	
0x1491		DIGCNT 3 FROZENVALUE	F005	1000	R	2	
0x1493		DIGCNT 4 FROZENVALUE	F005	1000	R	2	
0x1495		DIGCNT 5 FROZENVALUE	F005	1000	R	2	
0x1497		DIGCNT 6 FROZENVALUE	F005	1000	R	2	
0x1499		DIGCNT 7 FROZENVALUE	F005	1000	R	2	
0x149B		DIGCNT 8 FROZENVALUE	F005	1000	R	2	
0x149D		DIGCNT 1 FROZENDATE	F011		R	3	
0x14A0		DIGCNT 2 FROZENDATE	F011		R	3	
0x14A3		DIGCNT 3 FROZENDATE	F011		R	3	
0x14A6		DIGCNT 4 FROZENDATE	F011		R	3	
0x14A9		DIGCNT 5 FROZENDATE	F011		R	3	
0x14AC		DIGCNT 6 FROZENDATE	F011		R	3	
0x14AF		DIGCNT 7 FROZENDATE	F011		R	3	
0x14B2		DIGCNT 8 FROZENDATE	F011		R	3	
PTP 1588 Status							
0x14E5		RTC Sync Source	F012	1000	R	1	0=INTERNAL
							1=PTP-PORT
							2=SNTP
							3=IRIG-B
							4=SNTP2
0x14E6		GrandMaster-ID LOW	F009	1000	R	4	
0x14EA		GrandMaster-ID HIGH	F009	1000	R	4	
0x14EE		PTP ACCURACY	F005	1000	R	2	
0x14F0		PTP PORT A STATE	F012	1000	R	1	0=DISABLED
							1=NO SIGNAL
							2=CALIBRATING
							3=SYNCHD_NO_PDELAY
							4=SYNCHRONIZED
0x14F1		PTP PORT B STATE	F012	1000	R	1	0=DISABLED
							1=NO SIGNAL

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=CALIBRATING
							3=SYNCHD_NO_PDELAY
							4=SYNCHRONIZED
Application Versions (Part II)							
0x14F3		Boot Version	F004	1000	R	1	
0x14F4		Boot Date	F009		R	10	
0x14FE		Kinetis Boot Version	F004	1000	R	1	
0x14FF		Kinetis Boot Date	F009		R	10	
0x1509		Kinetis Loader Ver	F004	1000	R	1	
0x150A		Kinetis Loader Date	F009		R	10	
0x1514		Kinetis App Version	F004	1000	R	1	
0x1515		Kinetis App Date	F009		R	10	
0x151F		DSP Version	F004	1000	R	1	
0x1520		DSP Date	F009		R	16	
Internal System States (Part II)							
0x1530		DSP Status	F005	1000	R	2	
0x1532		Calibration Date	F011	1000	R	3	
Application Versions (Part III)							
0x1535		Firmware Date	F009		R	10	
0x153F		FPGA Version	F009	1000	R	4	
Internal System States (Part III)							
0x1543		FLASH Usage	F004	1000	R	1	
0x1544		KINETIS Status	F012		R	1	0=ERROR
							1=BOOT_MODE
							2=APP_MODE
0x1545		CPU MAX Usage	F004	1000	R	1	
Application Versions (Part IV)							
0x1546		RM PRP HSR Version	F009	1000	R	4	
0x154A		RM RSTP Version	F009	1000	R	4	
0x154E		RM LLA Version	F009	1000	R	4	
0x1552		RM Bypass Version	F009	1000	R	4	
Internal System States (Part IV)							
0x1556		Temp Current Value	F004	1000	R	1	
0x1557		Temp Max Value	F004	1000	R	1	
0x1558		Temp Min Value	F004	1000	R	1	
0x1559		Scan Cycle Average	F004	1000	R	1	
0x155A		Scan Cycle Rate	F004	1000	R	1	
0x155C		PLC Checksum	F005	1000	R	2	
0x155E		Settings Checksum	F005	1000	R	2	
Application Versions (Part V)							
0x1560		CPU Revision	F004	1000	R	1	
0x1561		ICD Edition	F004	1000	R	1	
Redundancy status							
0x157C		PRP_HSR A tx	F005	1000	R	2	
0x157E		PRP_HSR B tx	F005	1000	R	2	
0x1580		PRP_HSR A err	F005	1000	R	2	
0x1582		PRP_HSR B err	F005	1000	R	2	
0x1584		RSTP PortA State	F012		R	1	0=DISCARDING
							1=LEARNING
							2=FORWARDING

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x1585		RSTP PortB State	F012		R	1	0=DISCARDING
							1=LEARNING
							2=FORWARDING
Textos Maniobras - Commands text							
0x1C00		OPERATION 1	F009	1	R/W	16	
0x1C10		OPERATION 2	F009	1	R/W	16	
...	...	...	...	...	...	...	...
0x1DF0		OPERATION24	F009	1	R/W	16	
0x1E00		Confirmation address			W	1	
PLC Timer Masks							
0x1E01		TIMER MASK 01	F005	1	R/W	2	[0 , 86400000] ms
0x1E03		TIMER MASK 02	F005	1	R/W	2	[0 , 86400000] ms
0x1E05		TIMER MASK 03	F005	1	R/W	2	[0 , 86400000] ms
0x1E07		TIMER MASK 04	F005	1	R/W	2	[0 , 86400000] ms
0x1E09		TIMER MASK 05	F005	1	R/W	2	[0 , 86400000] ms
0x1E0B		TIMER MASK 06	F005	1	R/W	2	[0 , 86400000] ms
0x1E0D		TIMER MASK 07	F005	1	R/W	2	[0 , 86400000] ms
0x1E0F		TIMER MASK 08	F005	1	R/W	2	[0 , 86400000] ms
0x1E11		TIMER MASK 09	F005	1	R/W	2	[0 , 86400000] ms
0x1E13		TIMER MASK 10	F005	1	R/W	2	[0 , 86400000] ms
0x1E15		TIMER MASK 11	F005	1	R/W	2	[0 , 86400000] ms
0x1E17		TIMER MASK 12	F005	1	R/W	2	[0 , 86400000] ms
0x1E19		TIMER MASK 13	F005	1	R/W	2	[0 , 86400000] ms
0x1E1B		TIMER MASK 14	F005	1	R/W	2	[0 , 86400000] ms
0x1E1D		TIMER MASK 15	F005	1	R/W	2	[0 , 86400000] ms
0x1E1F		TIMER MASK 16	F005	1	R/W	2	[0 , 86400000] ms
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
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
							1=NEGATIVE
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
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]
0x1F12		Channelx1a_F_01	F003	1000	R/W	2	[0,950 , 1,050]
0x1F14		Channelx1a_F_02	F003	1000	R/W	2	[0,950 , 1,050]
0x1F16		Channelx1a_F_03	F003	1000	R/W	2	[0,950 , 1,050]
0x1F18		Channelx1a_F_04	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1A		Channelx1a_F_05	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1C		Channelx1a_F_06	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1E		Channelx1a_F_07	F003	1000	R/W	2	[0,950 , 1,050]
0x1F20		Channelx1a_F_08	F003	1000	R/W	2	[0,950 , 1,050]
0x1F22		Channelx1b_F_01	F004	1000	R/W	1	[-1000 , 1000]
0x1F23		Channelx1b_F_02	F004	1000	R/W	1	[-1000 , 1000]
0x1F24		Channelx1b_F_03	F004	1000	R/W	1	[-1000 , 1000]
0x1F25		Channelx1b_F_04	F004	1000	R/W	1	[-1000 , 1000]
0x1F26		Channelx1b_F_05	F004	1000	R/W	1	[-1000 , 1000]
0x1F27		Channelx1b_F_06	F004	1000	R/W	1	[-1000 , 1000]
0x1F28		Channelx1b_F_07	F004	1000	R/W	1	[-1000 , 1000]
0x1F29		Channelx1b_F_08	F004	1000	R/W	1	[-1000 , 1000]
0x1F2A		Channelx10a_F_01	F003	1000	R/W	2	[0,950 , 1,050]
0x1F2C		Channelx10a_F_02	F003	1000	R/W	2	[0,950 , 1,050]
0x1F2E		Channelx10a_F_03	F003	1000	R/W	2	[0,950 , 1,050]
0x1F30		Channelx10a_F_04	F003	1000	R/W	2	[0,950 , 1,050]
0x1F32		Channelx10a_F_05	F003	1000	R/W	2	[0,950 , 1,050]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x1F34		Channelx10a_F_06	F003	1000	R/W	2	[0,950 , 1,050]
0x1F36		Channelx10a_F_07	F003	1000	R/W	2	[0,950 , 1,050]
0x1F38		Channelx10a_F_08	F003	1000	R/W	2	[0,950 , 1,050]
0x1F3A		Channelx10b_F_01	F004	1000	R/W	1	[-1000 , 1000]
0x1F3B		Channelx10b_F_02	F004	1000	R/W	1	[-1000 , 1000]
0x1F3C		Channelx10b_F_03	F004	1000	R/W	1	[-1000 , 1000]
0x1F3D		Channelx10b_F_04	F004	1000	R/W	1	[-1000 , 1000]
0x1F3E		Channelx10b_F_05	F004	1000	R/W	1	[-1000 , 1000]
0x1F3F		Channelx10b_F_06	F004	1000	R/W	1	[-1000 , 1000]
0x1F40		Channelx10b_F_07	F004	1000	R/W	1	[-1000 , 1000]
0x1F41		Channelx10b_F_08	F004	1000	R/W	1	[-1000 , 1000]
0x1F42		Calibration Type_F	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
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
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
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]
0x20B7		Channelx1a_G_01	F003	1000	R/W	2	[0,950 , 1,050]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x20B9		Channelx1a_G_02	F003	1000	R/W	2	[0,950 , 1,050]
0x20BB		Channelx1a_G_03	F003	1000	R/W	2	[0,950 , 1,050]
0x20BD		Channelx1a_G_04	F003	1000	R/W	2	[0,950 , 1,050]
0x20BF		Channelx1a_G_05	F003	1000	R/W	2	[0,950 , 1,050]
0x20C1		Channelx1a_G_06	F003	1000	R/W	2	[0,950 , 1,050]
0x20C3		Channelx1a_G_07	F003	1000	R/W	2	[0,950 , 1,050]
0x20C5		Channelx1a_G_08	F003	1000	R/W	2	[0,950 , 1,050]
0x20C7		Channelx1b_G_01	F004	1000	R/W	1	[-1000 , 1000]
0x20C8		Channelx1b_G_02	F004	1000	R/W	1	[-1000 , 1000]
0x20C9		Channelx1b_G_03	F004	1000	R/W	1	[-1000 , 1000]
0x20CA		Channelx1b_G_04	F004	1000	R/W	1	[-1000 , 1000]
0x20CB		Channelx1b_G_05	F004	1000	R/W	1	[-1000 , 1000]
0x20CC		Channelx1b_G_06	F004	1000	R/W	1	[-1000 , 1000]
0x20CD		Channelx1b_G_07	F004	1000	R/W	1	[-1000 , 1000]
0x20CE		Channelx1b_G_08	F004	1000	R/W	1	[-1000 , 1000]
0x20CF		Channelx10a_G_01	F003	1000	R/W	2	[0,950 , 1,050]
0x20D1		Channelx10a_G_02	F003	1000	R/W	2	[0,950 , 1,050]
0x20D3		Channelx10a_G_03	F003	1000	R/W	2	[0,950 , 1,050]
0x20D5		Channelx10a_G_04	F003	1000	R/W	2	[0,950 , 1,050]
0x20D7		Channelx10a_G_05	F003	1000	R/W	2	[0,950 , 1,050]
0x20D9		Channelx10a_G_06	F003	1000	R/W	2	[0,950 , 1,050]
0x20DB		Channelx10a_G_07	F003	1000	R/W	2	[0,950 , 1,050]
0x20DD		Channelx10a_G_08	F003	1000	R/W	2	[0,950 , 1,050]
0x20DF		Channelx10b_G_01	F004	1000	R/W	1	[-1000 , 1000]
0x20E0		Channelx10b_G_02	F004	1000	R/W	1	[-1000 , 1000]
0x20E1		Channelx10b_G_03	F004	1000	R/W	1	[-1000 , 1000]
0x20E2		Channelx10b_G_04	F004	1000	R/W	1	[-1000 , 1000]
0x20E3		Channelx10b_G_05	F004	1000	R/W	1	[-1000 , 1000]
0x20E4		Channelx10b_G_06	F004	1000	R/W	1	[-1000 , 1000]
0x20E5		Channelx10b_G_07	F004	1000	R/W	1	[-1000 , 1000]
0x20E6		Channelx10b_G_08	F004	1000	R/W	1	[-1000 , 1000]
0x20E7		Calibration Type_G	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
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
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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]
0x302D		Channelx1a_H_01	F003	1000	R/W	2	[0,950 , 1,050]
0x302F		Channelx1a_H_02	F003	1000	R/W	2	[0,950 , 1,050]
0x3031		Channelx1a_H_03	F003	1000	R/W	2	[0,950 , 1,050]
0x3033		Channelx1a_H_04	F003	1000	R/W	2	[0,950 , 1,050]
0x3035		Channelx1a_H_05	F003	1000	R/W	2	[0,950 , 1,050]
0x3037		Channelx1a_H_06	F003	1000	R/W	2	[0,950 , 1,050]
0x3039		Channelx1a_H_07	F003	1000	R/W	2	[0,950 , 1,050]
0x303B		Channelx1a_H_08	F003	1000	R/W	2	[0,950 , 1,050]
0x303D		Channelx1b_H_01	F004	1000	R/W	1	[-1000 , 1000]
0x303E		Channelx1b_H_02	F004	1000	R/W	1	[-1000 , 1000]
0x303F		Channelx1b_H_03	F004	1000	R/W	1	[-1000 , 1000]
0x3040		Channelx1b_H_04	F004	1000	R/W	1	[-1000 , 1000]
0x3041		Channelx1b_H_05	F004	1000	R/W	1	[-1000 , 1000]
0x3042		Channelx1b_H_06	F004	1000	R/W	1	[-1000 , 1000]
0x3043		Channelx1b_H_07	F004	1000	R/W	1	[-1000 , 1000]
0x3044		Channelx1b_H_08	F004	1000	R/W	1	[-1000 , 1000]
0x3045		Channelx10a_H_01	F003	1000	R/W	2	[0,950 , 1,050]
0x3047		Channelx10a_H_02	F003	1000	R/W	2	[0,950 , 1,050]
0x3049		Channelx10a_H_03	F003	1000	R/W	2	[0,950 , 1,050]
0x304B		Channelx10a_H_04	F003	1000	R/W	2	[0,950 , 1,050]
0x304D		Channelx10a_H_05	F003	1000	R/W	2	[0,950 , 1,050]
0x304F		Channelx10a_H_06	F003	1000	R/W	2	[0,950 , 1,050]
0x3051		Channelx10a_H_07	F003	1000	R/W	2	[0,950 , 1,050]
0x3053		Channelx10a_H_08	F003	1000	R/W	2	[0,950 , 1,050]
0x3055		Channelx10b_H_01	F004	1000	R/W	1	[-1000 , 1000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3056		Channelx10b_H_02	F004	1000	R/W	1	[-1000 , 1000]
0x3057		Channelx10b_H_03	F004	1000	R/W	1	[-1000 , 1000]
0x3058		Channelx10b_H_04	F004	1000	R/W	1	[-1000 , 1000]
0x3059		Channelx10b_H_05	F004	1000	R/W	1	[-1000 , 1000]
0x305A		Channelx10b_H_06	F004	1000	R/W	1	[-1000 , 1000]
0x305B		Channelx10b_H_07	F004	1000	R/W	1	[-1000 , 1000]
0x305C		Channelx10b_H_08	F004	1000	R/W	1	[-1000 , 1000]
0x305D		Calibration Type_H	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
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
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
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]
...	...	...	...	...	...	...	...

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x31D0		Max Value_J_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31D2		Channelx1a_J_01	F003	1000	R/W	2	[0,950 , 1,050]
0x31D4		Channelx1a_J_02	F003	1000	R/W	2	[0,950 , 1,050]
0x31D6		Channelx1a_J_03	F003	1000	R/W	2	[0,950 , 1,050]
0x31D8		Channelx1a_J_04	F003	1000	R/W	2	[0,950 , 1,050]
0x31DA		Channelx1a_J_05	F003	1000	R/W	2	[0,950 , 1,050]
0x31DC		Channelx1a_J_06	F003	1000	R/W	2	[0,950 , 1,050]
0x31DE		Channelx1a_J_07	F003	1000	R/W	2	[0,950 , 1,050]
0x31E0		Channelx1a_J_08	F003	1000	R/W	2	[0,950 , 1,050]
0x31E2		Channelx1b_J_01	F004	1000	R/W	1	[-1000 , 1000]
0x31E3		Channelx1b_J_02	F004	1000	R/W	1	[-1000 , 1000]
0x31E4		Channelx1b_J_03	F004	1000	R/W	1	[-1000 , 1000]
0x31E5		Channelx1b_J_04	F004	1000	R/W	1	[-1000 , 1000]
0x31E6		Channelx1b_J_05	F004	1000	R/W	1	[-1000 , 1000]
0x31E7		Channelx1b_J_06	F004	1000	R/W	1	[-1000 , 1000]
0x31E8		Channelx1b_J_07	F004	1000	R/W	1	[-1000 , 1000]
0x31E9		Channelx1b_J_08	F004	1000	R/W	1	[-1000 , 1000]
0x31EA		Channelx10a_J_01	F003	1000	R/W	2	[0,950 , 1,050]
0x31EC		Channelx10a_J_02	F003	1000	R/W	2	[0,950 , 1,050]
0x31EE		Channelx10a_J_03	F003	1000	R/W	2	[0,950 , 1,050]
0x31F0		Channelx10a_J_04	F003	1000	R/W	2	[0,950 , 1,050]
0x31F2		Channelx10a_J_05	F003	1000	R/W	2	[0,950 , 1,050]
0x31F4		Channelx10a_J_06	F003	1000	R/W	2	[0,950 , 1,050]
0x31F6		Channelx10a_J_07	F003	1000	R/W	2	[0,950 , 1,050]
0x31F8		Channelx10a_J_08	F003	1000	R/W	2	[0,950 , 1,050]
0x31FA		Channelx10b_J_01	F004	1000	R/W	1	[-1000 , 1000]
0x31FB		Channelx10b_J_02	F004	1000	R/W	1	[-1000 , 1000]
0x31FC		Channelx10b_J_03	F004	1000	R/W	1	[-1000 , 1000]
0x31FD		Channelx10b_J_04	F004	1000	R/W	1	[-1000 , 1000]
0x31FE		Channelx10b_J_05	F004	1000	R/W	1	[-1000 , 1000]
0x31FF		Channelx10b_J_06	F004	1000	R/W	1	[-1000 , 1000]
0x3200		Channelx10b_J_07	F004	1000	R/W	1	[-1000 , 1000]
0x3201		Channelx10b_J_08	F004	1000	R/W	1	[-1000 , 1000]
0x3202		Calibration Type_J	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
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 , 250.0] 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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
0x2199		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x219B		Primary Meter Units	F012	1	R/W	1	0=KA_KV
							1=A_V
0x219C		Device Name	F009	1	R/W	8	
0x2203		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 , 300.00] V
0x2734		Live Bus Level	F003	1	R/W	2	[0.00 , 300.00] V
0x2736		Dead Line Level	F003	1	R/W	2	[0.00 , 300.00] V
0x2738		Live Line Level	F003	1	R/W	2	[0.00 , 300.00] V
0x273A		Max Volt Difference	F003	1	R/W	2	[2.00 , 300.00] 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 Reenganchador - Recloser Settings							
0x2763		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2764		Max Number Shots	F004	1	R/W	1	[1 , 4]
0x2765		Dead Time 1	F003	1	R/W	2	[0.00 , 900.00] s
0x2767		Dead Time 2	F003	1	R/W	2	[0.00 , 900.00] s
0x2769		Dead Time 3	F003	1	R/W	2	[0.00 , 900.00] s
0x276B		Dead Time 4	F003	1	R/W	2	[0.00 , 900.00] s
0x276D		Reclaim Time	F003	1	R/W	2	[0.00 , 900.00] s
0x276F		Cond. Permission	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2770		Hold Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2772		Reset Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2774		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x278B		Confirmation address			W	1	
Ajustes Oscilografía - Oscillography Settings							
0x2A7C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2A7D		Trigger Position	F004	1	R/W	1	[5 , 95] %
0x2A7E		Samples/Cycle	F012	1	R/W	1	0=64
							1=32
							2=16
							3=8
							4=4
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	
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	
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	
Ajustes Ethernet 1 (or "A")- ETHERNET 1 (or "A") 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	
Ajustes Ethernet 2 (or "B") - ETHERNET 2 (or "B") 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]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
							7=100
							8=1000
							9=10000
0x2CDB		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
Ajustes DNP3.0 Esclavo 1 - DNP 3.0 Slave 2 Settings							
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF5		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2CF6		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2CF7		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2CF8		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2CF9		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2CFA		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2CFB		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2CFC		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2CFD		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]
0x2CFE		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2CFF		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2D00		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2D01		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2D02		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2D03		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]
0x2D04		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2D05		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2D06		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2D07		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]
0x2D08		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2D09		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2D0A		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2D0B		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2D0C		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2D0D		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2D0E		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2D0F		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2D10		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2D11		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2D12		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2D13		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2D14		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2D15		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2D16		PF Deadband	F004	1000	R/W	1	[0 , 32767]
0x2D17		PF 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
0x2D1C		Confirmation address			W	1	

Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 Settings							
0x2D1D		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
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]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
							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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							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
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D57		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2D58		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2D59		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2D5A		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2D5B		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2D5C		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2D5D		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2D5E		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2D5F		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]
0x2D60		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2D61		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2D62		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2D63		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2D64		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]
0x2D65		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]
0x2D66		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2D67		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2D68		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2D69		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]
0x2D6A		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2D6B		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2D6C		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2D6D		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2D6E		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2D6F		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2D70		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2D71		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2D72		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2D73		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2D74		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2D75		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2D76		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2D77		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2D78		PF Deadband	F004	1000	R/W	1	[0 , 32767]
0x2D79		PF 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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							8=1000
							9=10000
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
							2=0.001
							3=0.01
							4=0.1

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB4		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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
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
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB9		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2DBA		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2DBB		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2DBC		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2DBD		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2DBE		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2DBF		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2DC0		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2DC1		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]
0x2DC2		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2DC3		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2DC4		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2DC5		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2DC6		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]
0x2DC7		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2DC8		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2DC9		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2DCA		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2DCB		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]
0x2DCC		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2DCD		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2DCE		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2DCF		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2DD0		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2DD1		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2DD2		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2DD3		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2DD4		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2DD5		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2DD6		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2DD7		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2DD8		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2DD9		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2DDA		PF Deadband	F004	1000	R/W	1	[0 , 32767]
0x2DDB		PF 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
0x2DE0		Confirmation address			W	1	
Miscellaneous Settings							
0x2DE2		Relay Out Of Service	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2DE3		Local/Remote Blocked	F012	1000	R/W	1	0=OFF
							1=ON
0x2DE4		Active Language	F004	1000	R/W	1	[0 , 1]
0x2DF5		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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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]
0x2F29		104 Net1 CLI1 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F2A		104 Net1 CLI1 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F2B		104 Net1 CLI1 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F2C		104 Net1 CLI1 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F2D		104 Net1 CLI2 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F2E		104 Net1 CLI2 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F2F		104 Net1 CLI2 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F30		104 Net1 CLI2 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F31		Function 2	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x2F32		TCP Port 2	F005	1,000	R/W	2	[0 , 65535]
0x2F34		Common Addr of ASDU 2	F005	1,000	R/W	2	[0 , 65535]
0x2F36		104 Net2 CLI1 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F37		104 Net2 CLI1 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F38		104 Net2 CLI1 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F39		104 Net2 CLI1 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F3A		104 Net2 CLI2 Octet1	F004	1,000	R/W	1	[0 , 255]
0x2F3B		104 Net2 CLI2 Octet2	F004	1,000	R/W	1	[0 , 255]
0x2F3C		104 Net2 CLI2 Octet3	F004	1,000	R/W	1	[0 , 255]
0x2F3D		104 Net2 CLI2 Octet4	F004	1,000	R/W	1	[0 , 255]
0x2F3E		Current Scale Factor	F012	1,000	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
0x2F3F		Voltage Scale Factor	F012	1,000	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							6=10
							7=100
							8=1000
							9=10000
0x2F40		Power Scale Factor	F012	1,000	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
0x2F41		Energy Scale Factor	F012	1,000	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
0x2F42		Other Scale Factor	F012	1,000	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
0x2F43		Current Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F45		Voltage Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F47		Power Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F49		Energy Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F4B		Other Deadband	F005	1,000	R/W	2	[0 , 65535]
0x2F4D		IOA Binaries	F013	1,000	R/W	1	[0 , 65535]
0x2F4E		IOA Double Points	F013	1,000	R/W	1	[0 , 65535]
0x2F4F		IOA Analogs	F013	1,000	R/W	1	[0 , 65535]
0x2F50		IOA Counters	F013	1,000	R/W	1	[0 , 65535]
0x2F51		IOA Commands	F013	1,000	R/W	1	[0 , 65535]
0x2F52		IOA Analog Param	F013	1,000	R/W	1	[0 , 65535]
0x2F53		PF Deadband	F004	1,000	R/W	1	[0 , 32767]
0x2F54		PF Scale Factor	F012	1,000	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2F5A		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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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 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	
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							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]
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]
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 Comunicaciones Remotas - Remote Communications Settings							
0x3A76		Remote Comms	F012	1	R/W	1	0=DISABLED
							1=GSSE
							2=GOOSE
0x3A77		C650 ID	F009	1	R/W	33	
0x3A98		Hold Time	F005	1	R/W	2	[1000 , 60000] ms
0x3A9A		Events Remote Out	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajustes Entradas Remotas (32 elementos) - Remote Inputs Settings (32 items) [Only Configurable for GSSE]							
0x3A9B		Remote Device 1	F009	1	R/W	33	
0x3ABC		Bit Pair 1	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32
							33=UserSt-1
							34=UserSt-2

							96=UserSt-64
0x3ABD		Default Value 1	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
0x3ABE		Remote Device 2	F009	1	R/W	33	
0x3ADF		Bit Pair 2	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32
							33=UserSt-1
							34=UserSt-2

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS

							96=UserSt-64
0x3AE0		Default Value 2	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
0x3ED8		Remote Device 32	F009	1	R/W	33	
0x3EF9		Bit Pair 32	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32
							33=UserSt-1
							34=UserSt-2

							96=UserSt-64
0x3EFA		Default Value 32	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
0x3EFB		Events Remote Inp	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3EFC		Destination MAC Data1	F004	1000	R/W	1	
0x3EFD		Destination MAC Data2	F004	1000	R/W	1	
0x3EFE		Destination MAC Data3	F004	1000	R/W	1	
0x3EFF		GSSE RemDevice01 MAC Data1	F004	1000	R/W	1	
0x3F00		GSSE RemDevice01 MAC Data2	F004	1000	R/W	1	
0x3F01		GSSE RemDevice01 MAC Data3	F004	1000	R/W	1	
0x3F02		GSSE RemDevice02 MAC Data1	F004	1000	R/W	1	
0x3F03		GSSE RemDevice02 MAC Data2	F004	1000	R/W	1	
0x3F04		GSSE RemDevice02 MAC Data3	F004	1000	R/W	1	
0x3F05		GSSE RemDevice03 MAC Data1	F004	1000	R/W	1	
0x3F06		GSSE RemDevice03 MAC Data2	F004	1000	R/W	1	
0x3F07		GSSE RemDevice03 MAC Data3	F004	1000	R/W	1	
0x3F08		GSSE RemDevice04 MAC Data1	F004	1000	R/W	1	
0x3F09		GSSE RemDevice04 MAC Data2	F004	1000	R/W	1	
0x3F0A		GSSE RemDevice04 MAC Data3	F004	1000	R/W	1	
0x3F0B		GSSE RemDevice05 MAC Data1	F004	1000	R/W	1	
0x3F0C		GSSE RemDevice05 MAC Data2	F004	1000	R/W	1	
0x3F0D		GSSE RemDevice05 MAC Data3	F004	1000	R/W	1	
0x3F0E		GSSE RemDevice06 MAC Data1	F004	1000	R/W	1	
0x3F0F		GSSE RemDevice06 MAC Data2	F004	1000	R/W	1	
0x3F10		GSSE RemDevice06 MAC Data3	F004	1000	R/W	1	
0x3F11		GSSE RemDevice07 MAC Data1	F004	1000	R/W	1	
0x3F12		GSSE RemDevice07 MAC Data2	F004	1000	R/W	1	
0x3F13		GSSE RemDevice07 MAC Data3	F004	1000	R/W	1	
0x3F14		GSSE RemDevice08 MAC Data1	F004	1000	R/W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3F15		GSSE RemDevice08 MAC Data2	F004	1000	R/W	1	
0x3F16		GSSE RemDevice08 MAC Data3	F004	1000	R/W	1	
0x3F17		GSSE RemDevice09 MAC Data1	F004	1000	R/W	1	
0x3F18		GSSE RemDevice09 MAC Data2	F004	1000	R/W	1	
0x3F19		GSSE RemDevice09 MAC Data3	F004	1000	R/W	1	
0x3F1A		GSSE RemDevice10 MAC Data1	F004	1000	R/W	1	
0x3F1B		GSSE RemDevice10 MAC Data2	F004	1000	R/W	1	
0x3F1C		GSSE RemDevice10 MAC Data3	F004	1000	R/W	1	
0x3F1D		GSSE RemDevice11 MAC Data1	F004	1000	R/W	1	
0x3F1E		GSSE RemDevice11 MAC Data2	F004	1000	R/W	1	
0x3F1F		GSSE RemDevice11 MAC Data3	F004	1000	R/W	1	
0x3F20		GSSE RemDevice12 MAC Data1	F004	1000	R/W	1	
0x3F21		GSSE RemDevice12 MAC Data2	F004	1000	R/W	1	
0x3F22		GSSE RemDevice12 MAC Data3	F004	1000	R/W	1	
0x3F23		GSSE RemDevice13 MAC Data1	F004	1000	R/W	1	
0x3F24		GSSE RemDevice13 MAC Data2	F004	1000	R/W	1	
0x3F25		GSSE RemDevice13 MAC Data3	F004	1000	R/W	1	
0x3F26		GSSE RemDevice14 MAC Data1	F004	1000	R/W	1	
0x3F27		GSSE RemDevice14 MAC Data2	F004	1000	R/W	1	
0x3F28		GSSE RemDevice14 MAC Data3	F004	1000	R/W	1	
0x3F29		GSSE RemDevice15 MAC Data1	F004	1000	R/W	1	
0x3F2A		GSSE RemDevice15 MAC Data2	F004	1000	R/W	1	
0x3F2B		GSSE RemDevice15 MAC Data3	F004	1000	R/W	1	
0x3F2C		GSSE RemDevice16 MAC Data1	F004	1000	R/W	1	
0x3F2D		GSSE RemDevice16 MAC Data2	F004	1000	R/W	1	
0x3F2E		GSSE RemDevice16 MAC Data3	F004	1000	R/W	1	
0x3F2F		GSSE RemDevice17 MAC Data1	F004	1000	R/W	1	
0x3F30		GSSE RemDevice17 MAC Data2	F004	1000	R/W	1	
0x3F31		GSSE RemDevice17 MAC Data3	F004	1000	R/W	1	
0x3F32		GSSE RemDevice18 MAC Data1	F004	1000	R/W	1	
0x3F33		GSSE RemDevice18 MAC Data2	F004	1000	R/W	1	
0x3F34		GSSE RemDevice18 MAC Data3	F004	1000	R/W	1	
0x3F35		GSSE RemDevice19 MAC Data1	F004	1000	R/W	1	
0x3F36		GSSE RemDevice19 MAC Data2	F004	1000	R/W	1	
0x3F37		GSSE RemDevice19 MAC Data3	F004	1000	R/W	1	
0x3F38		GSSE RemDevice20 MAC Data1	F004	1000	R/W	1	
0x3F39		GSSE RemDevice20 MAC Data2	F004	1000	R/W	1	
0x3F3A		GSSE RemDevice20 MAC Data3	F004	1000	R/W	1	
0x3F3B		GSSE RemDevice21 MAC Data1	F004	1000	R/W	1	
0x3F3C		GSSE RemDevice21 MAC Data2	F004	1000	R/W	1	
0x3F3D		GSSE RemDevice21 MAC Data3	F004	1000	R/W	1	
0x3F3E		GSSE RemDevice22 MAC Data1	F004	1000	R/W	1	
0x3F3F		GSSE RemDevice22 MAC Data2	F004	1000	R/W	1	
0x3F40		GSSE RemDevice22 MAC Data3	F004	1000	R/W	1	
0x3F41		GSSE RemDevice23 MAC Data1	F004	1000	R/W	1	
0x3F42		GSSE RemDevice23 MAC Data2	F004	1000	R/W	1	
0x3F43		GSSE RemDevice23 MAC Data3	F004	1000	R/W	1	
0x3F44		GSSE RemDevice24 MAC Data1	F004	1000	R/W	1	
0x3F45		GSSE RemDevice24 MAC Data2	F004	1000	R/W	1	
0x3F46		GSSE RemDevice24 MAC Data3	F004	1000	R/W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3F47		GSSE PORT	F012	1000	R/W	1	0=PORT A
							1=PORT B
							2=BOTH
0x3F5B		Confirmation address					
Ajustes Sincronizacion SNTP - SNTP synchronization Settings							
		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]
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					
0x3F67		Server2 UDP Port	F004	1	R/W	1	[0 , 255]
0x3F69		Server2 IP Oct 1	F004	1	R/W	1	[0 , 255]
0x3F6A		Server2 IP Oct 2	F004	1	R/W	1	[0 , 255]
0x3F6B		Server2 IP Oct 3	F004	1	R/W	1	[0 , 255]
0x3F6C		Server2 IP Oct 4	F004	1	R/W	1	[0 , 255]
0x3F87		Confirmation address			W	1	
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	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
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]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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]
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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	
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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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
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 de Fecha y Hora - Time Settings							
0x454F		LOC TIME OFFS. UTC	F003	1	R/W	2	[-24.0 , 24.0]
0x4551		DAYLIG. SAVINGS TIME	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4552		DST START MONTH	F012	1	R/W	1	0=JAN
							1=FEB
							2=MAR

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=APR
							4=MAY
							5=JUN
							6=JUL
							7=AUG
							8=SEP
							9=OCT
							10=NOV
							11=DEC
0x4553		DST START WEEKDAY	F012	1	R/W	1	0=Monday
							1=Tuesday
							2=Wednesday
							3=Thursday
							4=Friday
							5=Saturday
							6=Sunday
0x4554		DST START DAY INST	F012	1	R/W	1	0=First
							1=Second
							2=Third
							3=Fourth
							4=Last
0x4555		DST START HOUR	F004	1	R/W	1	[0 , 23]
0x4556		DST STOP MONTH	F012	1	R/W	1	0=JAN
							1=FEB
							2=MAR
							3=APR
							4=MAY
							5=JUN
							6=JUL
							7=AUG
							8=SEP
							9=OCT
							10=NOV
							11=DEC
0x4557		DST STOP WEEKDAY	F012	1	R/W	1	0=Monday
							1=Tuesday
							2=Wednesday
							3=Thursday
							4=Friday
							5=Saturday
							6=Sunday
0x4558		DST STOP DAY INST	F012	1	R/W	1	0=First
							1=Second
							2=Third
							3=Fourth
							4=Last
0x4559		DST STOP HOUR	F004	1	R/W	1	[0 , 23]
0x455A		IRIG-B LOCAL TIME	F012	1	R/W	1	0=OFF
							1=ON
0x455B		IRIGB Function	F012	1000	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x455C		PTP IRIGB Priority	F012	1000	R/W	1	0=PTP-1588
							1=IRIG-B
0x4564		Confirmation address			W	1	
Ajustes Tarjeta 2H (MODULO CIO) - Board 2H Settings (CIO MODULE)							
Ajustes Tipo Tarjeta 2H - Board 2H Board Type Settings							
0x4565		I/O Board Type_2H	F012	1,000	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							3=16OUT
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta 2H - Board 2H Voltage Settings							
0x4566		Voltage Threshold A_2H	F004	1,000	R/W	1	[10 , 230] V
0x4567		Voltage Threshold B_2H	F004	1,000	R/W	1	[10 , 230] V
0x460B		Voltage Threshold C_2H	F004	1,000	R/W	1	[10 , 230] V
0x460C		Voltage Threshold D_2H	F004	1,000	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta 2H - Board 2H Debounce Time Settings							
0x4568		Debounce Time A_2H	F004	1,000	R/W	1	[1 , 50] ms
0x4569		Debounce Time B_2H	F004	1,000	R/W	1	[1 , 50] ms
0x460D		Debounce Time C_2H	F004	1,000	R/W	1	[1 , 50] ms
0x460E		Debounce Time D_2H	F004	1,000	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta 2H (32 elementos) - Board 2H Input Type Settings (32 items)							
0x456A		Input Type_2H_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x456B		Input Type_2H_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x4589		Input Type_2H_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta 2H (32 elementos) - Board 2H Delay Input Time Settings (32 items)							
0x458A		Delay Input Time_2H_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x458C		Delay Input Time_2H_CC2	F005	1,000	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x45C8		Delay Input Time_2H_CC32	F005	1,000	R/W	2	[0 , 60000] ms
Ajustes Lógica de Salidas Tarjeta 2H (16 elementos) - Board 2H Output Logic Settings (16 items)							
0x45CA		Output Logic_2H_01	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
0x45CB		Output Logic_2H_02	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x45D9		Output Logic_2H_16	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta 2H (16 elementos) - Board 2H Output Type Settings (16 items)							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x45DA		Output Type_2H_01	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x45DB		Output Type_2H_02	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x45E9		Output Type_2H_16	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta J - Board J Pulse Output Time Settings (16 items)							
0x45EA		Pulse Output Time_2H_01	F005	1,000	R/W	2	[0 , 60000] ms
0x45EC		Pulse Output Time_2H_02	F005	1,000	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x4608		Pulse Output Time_2H_16	F005	1,000	R/W	2	[0 , 60000] ms
0x460A		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica J (8 elementos) - Board J Analog Input Range Settings (8 items)							
0x460F		Range_2H_01	F012	1,000	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
0x4610		Range_2H_02	F012	1,000	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
...	...	...	...	...	...	...	...
0x4616		Range_2H_08	F012	1,000	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
Ajustes Rango de Medida de Entrada Analógica J (8 elementos) - Board J Analog Input Measurement Range Settings (8 items)							
0x4617		Min Value_2H_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x4619		Min Value_2H_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
...	...	...	...	...	...	...	...
0x4625		Min Value_2H_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x4627		Max Value_2H_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x4629		Max Value_2H_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
0x4635		Max Value_2H_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x4637		Channelx1a_2H_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x4639		Channelx1a_2H_02	F003	1,000	R/W	2	[0,950 , 1,050]
...	...	...	...	...	...	...	...
0x4645		Channelx1a_2H_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x4647		Channelx1b_2H_01	F004	1,000	R/W	1	[-1000 , 1000]
0x4648		Channelx1b_2H_02	F004	1,000	R/W	1	[-1000 , 1000]
...	...	...	...	...	...	...	...
0x464E		Channelx1b_2H_08	F004	1,000	R/W	1	[-1000 , 1000]
0x464F		Channelx10a_2H_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x4651		Channelx10a_2H_02	F003	1,000	R/W	2	[0,950 , 1,050]
...	...	...	...	...	...	...	...
0x465D		Channelx10a_2H_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x465F		Channelx10b_2H_01	F004	1,000	R/W	1	[-1000 , 1000]
0x4660		Channelx10b_2H_02	F004	1,000	R/W	1	[-1000 , 1000]
...	...	...	...	...	...	...	...
0x4666		Channelx10b_2H_08	F004	1,000	R/W	1	[-1000 , 1000]
0x4667		Calibration Type_2H	F012	1,000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x46F9		Confirmation address			W	1	
Ajustes Tarjeta 2J (MODULO CIO) - Board 2J Settings (CIO MODULE)							
Ajustes Tipo Tarjeta 2J - Board 2J Board Type Settings							
0x46FA		I/O Board Type_2J	F012	1,000	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							3=16OUT
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta 2J - Board 2J Voltage Settings							
0x46FB		Voltage Threshold A_2J	F004	1,000	R/W	1	[10 , 230] V
0x46FC		Voltage Threshold B_2J	F004	1,000	R/W	1	[10 , 230] V
0x47A0		Voltage Threshold C_2J	F004	1,000	R/W	1	[10 , 230] V
0x47A1		Voltage Threshold D_2J	F004	1,000	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta 2J - Board 2J Debounce Time Settings							
0x46FD		Debounce Time A_2J	F004	1,000	R/W	1	[1 , 50] ms
0x46FE		Debounce Time B_2J	F004	1,000	R/W	1	[1 , 50] ms
0x47A2		Debounce Time C_2J	F004	1,000	R/W	1	[1 , 50] ms
0x47A3		Debounce Time D_2J	F004	1,000	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta 2J (32 elementos) - Board 2J Input Type Settings (32 items)							
0x46FF		Input Type_2J_CC1	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x4700		Input Type_2J_CC2	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
0x471E		Input Type_2J_CC32	F012	1,000	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta 2J (32 elementos) - Board 2J Delay Input Time Settings (32 items)							
0x471F		Delay Input Time_2J_CC1	F005	1,000	R/W	2	[0 , 60000] ms
0x4721		Delay Input Time_2J_CC2	F005	1,000	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x475D		Delay Input Time_2J_CC32	F005	1,000	R/W	2	[0 , 60000] ms
Ajustes Lógica de Salidas Tarjeta 2J (16 elementos) - Board 2J Output Logic Settings (16 items)							
0x475F		Output Logic_2J_01	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
0x4760		Output Logic_2J_02	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x476E		Output Logic_2J_16	F012	1,000	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta 2J (16 elementos) - Board 2J Output Type Settings (16 items)							
0x476F		Output Type_2J_01	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x4770		Output Type_2J_02	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x477E		Output Type_2J_16	F012	1,000	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta J - Board J Pulse Output Time Settings (16 items)							
0x477F		Pulse Output Time_2J_01	F005	1,000	R/W	2	[0 , 60000] ms
0x4781		Pulse Output Time_2J_02	F005	1,000	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x479D		Pulse Output Time_2J_16	F005	1,000	R/W	2	[0 , 60000] ms
0x479F		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica J (8 elementos) - Board J Analog Input Range Settings (8 items)							
0x47A4		Range_2J_01	F012	1,000	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
0x47A5		Range_2J_02	F012	1,000	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

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
...	...	...	...	...	...	...	...
0x47AB		Range_2J_08	F012	1,000	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
Ajustes Rango de Medida de Entrada Analógica J (8 elementos) - Board J Analog Input Measurement Range Settings (8 items)							
0x47AC		Min Value_2J_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x47AE		Min Value_2J_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
...	...	...	...	...	...	...	...
0x47BA		Min Value_2J_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x47BC		Max Value_2J_01	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x47BE		Max Value_2J_02	F003	1,000	R/W	2	[-9999,99 , 9999,99]
...	...	...	...	...	...	...	...
0x47CA		Max Value_2J_08	F003	1,000	R/W	2	[-9999,99 , 9999,99]
0x47CC		Channelx1a_2J_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x47CE		Channelx1a_2J_02	F003	1,000	R/W	2	[0,950 , 1,050]
...	...	...	...	...	...	...	...
0x47DA		Channelx1a_2J_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x47DC		Channelx1b_2J_01	F004	1,000	R/W	1	[-1000 , 1000]
0x47DD		Channelx1b_2J_02	F004	1,000	R/W	1	[-1000 , 1000]
...	...	...	...	...	...	...	...
0x47E3		Channelx1b_2J_08	F004	1,000	R/W	1	[-1000 , 1000]
0x47E4		Channelx10a_2J_01	F003	1,000	R/W	2	[0,950 , 1,050]
0x47E6		Channelx10a_2J_02	F003	1,000	R/W	2	[0,950 , 1,050]
...	...	...	...	...	...	...	...
0x47F2		Channelx10a_2J_08	F003	1,000	R/W	2	[0,950 , 1,050]
0x47F4		Channelx10b_2J_01	F004	1,000	R/W	1	[-1000 , 1000]
0x47F5		Channelx10b_2J_02	F004	1,000	R/W	1	[-1000 , 1000]
...	...	...	...	...	...	...	...
0x47FB		Channelx10b_2J_08	F004	1,000	R/W	1	[-1000 , 1000]
0x47FC		Calibration Type_2J	F012	1,000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x488E		Confirmation address			W	1	
Digital Counters							
0x48B8		DigCnt 1 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48B9		DigCnt 1 Name	F009	1000	R/W	16	
0x48C9		DigCnt 1 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48CB		DigCnt 1 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48CD		DigCnt 2 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x48CE		DigCnt 2 Name	F009	1000	R/W	16	
0x48DE		DigCnt 2 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48E0		DigCnt 2 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48E2		DigCnt 3 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48E3		DigCnt 3 Name	F009	1000	R/W	16	
0x48F3		DigCnt 3 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48F5		DigCnt 3 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48F7		DigCnt 4 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48F8		DigCnt 4 Name	F009	1000	R/W	16	
0x4908		DigCnt 4 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x490A		DigCnt 4 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x490C		DigCnt 5 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x490D		DigCnt 5 Name	F009	1000	R/W	16	
0x491D		DigCnt 5 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x491F		DigCnt 5 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4921		DigCnt 6 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4922		DigCnt 6 Name	F009	1000	R/W	16	
0x4932		DigCnt 6 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4934		DigCnt 6 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4936		DigCnt 7 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4937		DigCnt 7 Name	F009	1000	R/W	16	
0x4947		DigCnt 7 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4949		DigCnt 7 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x494B		DigCnt 8 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x494C		DigCnt 8 Name	F009	1000	R/W	16	
0x495C		DigCnt 8 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x495E		DigCnt 8 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4960		Snapshot Events	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x496A		Confirmation address			W	1	
PTP 1588							
0x4975		PTP FUNCTION	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4976		PORTA DELAY ADDER	F005	1000	R/W	2	[0 , 60000] ns
0x4978		PORTA DELAY ASYM	F004	1000	R/W	1	[-1000 , 1000] ns
0x497A		PORTB DELAY ADDER	F005	1000	R/W	2	[0 , 60000] ns
0x497C		PORTB DELAY ASYM	F004	1000	R/W	1	[-1000 , 1000] ns
0x497D		STRICT POWER PROFILE	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x497E		PTP DOMAIN NUMBER	F004	1000	R/W	1	[0 , 255]
0x497F		PTP VLAN PRIORITY	F004	1000	R/W	1	[0 , 7]
0x4980		PTP VLAN ID	F004	1000	R/W	1	[0 , 4095]
0x4981		PTP EPOCH	F012	1000	R/W	1	0=UTC_SINCE_2000
							1=UTC_SINCE_1900

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=UTC_SINCE_1970
0x4988		Confirmation address			W	1	
Routing							
0x4989		Default RT GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x498A		Default RT GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x498B		Default RT GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x498C		Default RT GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x498D		Static RT1 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x498E		Static RT1 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x498F		Static RT1 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x4990		Static RT1 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x4991		Static RT1 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x4992		Static RT1 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x4993		Static RT1 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x4994		Static RT1 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x4995		Static RT1 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x4996		Static RT1 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x4997		Static RT1 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x4998		Static RT1 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x4999		Static RT2 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x499A		Static RT2 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x499B		Static RT2 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x499C		Static RT2 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x499D		Static RT2 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x499E		Static RT2 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x499F		Static RT2 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49A0		Static RT2 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49A1		Static RT2 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49A2		Static RT2 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49A3		Static RT2 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49A4		Static RT2 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49A5		Static RT3 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49A6		Static RT3 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49A7		Static RT3 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49A8		Static RT3 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49A9		Static RT3 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49AA		Static RT3 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49AB		Static RT3 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49AC		Static RT3 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49AD		Static RT3 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49AE		Static RT3 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49AF		Static RT3 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49B0		Static RT3 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49B1		Static RT4 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49B2		Static RT4 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49B3		Static RT4 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49B4		Static RT4 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49B5		Static RT4 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49B6		Static RT4 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49B7		Static RT4 Mask Oct3	F004	1000	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x49B8		Static RT4 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49B9		Static RT4 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49BA		Static RT4 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49BB		Static RT4 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49BC		Static RT4 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49BD		Static RT5 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49BE		Static RT5 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49BF		Static RT5 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49C0		Static RT5 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49C1		Static RT5 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49C2		Static RT5 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49C3		Static RT5 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49C4		Static RT5 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49C5		Static RT5 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49C6		Static RT5 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49C7		Static RT5 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49C8		Static RT5 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49C9		Static RT6 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49CA		Static RT6 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49CB		Static RT6 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49CC		Static RT6 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49CD		Static RT6 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49CE		Static RT6 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49CF		Static RT6 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49D0		Static RT6 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49D1		Static RT6 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49D2		Static RT6 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49D3		Static RT6 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49D4		Static RT6 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49EC		Confirmation address			W	1	
Network(Ethernet) E Settings							
0x49ED		IP Address Oct1	F004	1000	R/W	1	[0 , 255]
0x49EE		IP Address Oct2	F004	1000	R/W	1	[0 , 255]
0x49EF		IP Address Oct3	F004	1000	R/W	1	[0 , 255]
0x49F0		IP Address Oct4	F004	1000	R/W	1	[0 , 255]
0x49F1		Netmask Oct1	F004	1000	R/W	1	[0 , 255]
0x49F2		Netmask Oct2	F004	1000	R/W	1	[0 , 255]
0x49F3		Netmask Oct3	F004	1000	R/W	1	[0 , 255]
0x49F4		Netmask Oct4	F004	1000	R/W	1	[0 , 255]
0x4A05		Confirmation address			W	1	
Redundancy settings							
0x4A06		REDUNDANCY MODE	F012	1000	R/W	1	0=INDEPENDENT
							1=LLA 2=PRP 3=HSR 4=RSTP 5=DAISY_CHAIN
0x4A07		LLA Priority	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4A08		LLA Timeout	F005	1000	R/W	2	[0 , 600000] ms
0x4A0A		RSTP BRIDGE PRIORITY	F005	1000	R/W	2	[0 , 61440]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4A0C		RSTP PORTA PRIORITY	F005	1000	R/W	2	[0 , 240]
0x4A0E		RSTP PORTA PATHCOST	F005	1000	R/W	2	[0 , 2000000]
0x4A10		RSTP PORTB PRIORITY	F005	1000	R/W	2	[0 , 240]
0x4A12		RSTP PORTB PATHCOST	F005	1000	R/W	2	[0 , 2000000]
0x4A1E		Confirmation address			W	1	
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
							. . .
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	
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	
Ficheros Oscilografía y Reporte de Faltas - Oscillography and Fault Report Files							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
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 (milliseconds from 01/01/2000)	F011		R/W	4	
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 (MILLISECONDS FROM 01/01/2000)					
	F012	UNSIGNED INT 16 BIT (ENUMERATED)					

C650 Bay Controller & Monitoring System

Appendix C: DNP 3.0 protocol for C650

C.1 DNP 3.0 protocol settings

C650 units enable the programming of 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 C650 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 C650 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 C650. However the date & time are 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

Setting No.	Setting Name	Default Value	Range
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
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
49	Default analog Map	Disabled	See the explanation below
50	Analog Input Point 0	End Of List	See the explanation below
51	Analog Input Point 1	End Of List	See the explanation below
52	Analog Input Point 2	End Of List	See the explanation below
53	Analog Input Point 3	End Of List	See the explanation below
54	Analog Input Point 4	End Of List	See the explanation below
55	Analog Input Point 5	End Of List	See the explanation below
56	Analog Input Point 6	End Of List	See the explanation below
57	Analog Input Point 7	End Of List	See the explanation below
58	Analog Input Point 8	End Of List	See the explanation below
59	Analog Input Point 9	End Of List	See the explanation below
60	Analog Input Point 10	End Of List	See the explanation below
61	Analog Input Point 11	End Of List	See the explanation below
62	Analog Input Point 12	End Of List	See the explanation below
63	Analog Input Point 13	End Of List	See the explanation below
64	Analog Input Point 14	End Of List	See the explanation below
65	Analog Input Point 15	End Of List	See the explanation below
66	Analog Input Point 16	End Of List	See the explanation below

Setting No.	Setting Name	Default Value	Range
67	Analog Input Point 17	End Of List	See the explanation below
68	Analog Input Point 18	End Of List	See the explanation below
69	Analog Input Point 19	End Of List	See the explanation below
70	Analog Input Point 20	End Of List	See the explanation below
71	Analog Input Point 21	End Of List	See the explanation below
72	Analog Input Point 22	End Of List	See the explanation below
73	Analog Input Point 23	End Of List	See the explanation below
74	Analog Input Point 24	End Of List	See the explanation below
75	Analog Input Point 25	End Of List	See the explanation below
76	Analog Input Point 26	End Of List	See the explanation below
77	Analog Input Point 27	End Of List	See the explanation below
78	Analog Input Point 28	End Of List	See the explanation below
79	Analog Input Point 29	End Of List	See the explanation below
80	Analog Input Point 30	End Of List	See the explanation below
81	Analog Input Point 31	End Of List	See the explanation below

1. **Physical Port**: The C650 supports the Distributed Network Protocol (DNP) version 3.0. The C650 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 C650. 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 C650 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 C650 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 C650 waits for a DNP master to confirm an unsolicited response.

26. **Unsol Resp Max Ret**: This setting determines the number of times the C650 retransmits an unsolicited response without receiving a confirmation from the master. Once this limit has been exceeded, the unsolicited response is sent at a larger interval. This interval is called the 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 C650 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 C650 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 are returned with the values 1000 times smaller (e.g. a value 72000 V on the C650 is 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 is 10 times larger).

33-37. **Deadband**: These settings are the values used by the C650 to determine when to trigger unsolicited responses containing Analog Input data. These settings group the C650 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 C650 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 C650, the default deadbands are 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*** in 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 C650 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 is in effect. The C650 forms 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,BOARD F 1-16,BOARD F 17-32, BOARD G 1-16, BOARD G 17-32,BOARD H 1-16, BOARD H 17-32, BOARD J 1-16,BOARD J 17-32.

49-81. **Default analog Map:** This setting allows selection between predefined Analog Input Points or choosing preferred Analog Input Points (from 50 to 81).

C.2 DNP 3.0 device profile document

The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document.

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 1 of 3)

<table>
<tr><td colspan="2">(Also see the IMPLEMENTATION TABLE in the following section)</td></tr>
<tr><td colspan="2">Vendor Name: General Electric Multilin</td></tr>
<tr><td colspan="2">Device Name: C650 Relay</td></tr>
<tr><td>Highest DNP Level Supported:
For Requests: Level 2
For Responses: Level 2</td><td>Device Function:
☐ Master
✔ Slave</td></tr>
<tr><td colspan="2">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)
Binary Counters (Object 20)
Frozen Counters (21)
Binary Counters Change (Object 22)
Frozen Counter Change (23)
Analog Inputs (Object 30)
Analog Input Changes (Object 32)
Analog Deadbands (Object 34)</td></tr>
<tr><td>Maximum Data Link String Size (octets):
Transmitted: 292
Received: 292</td><td>Maximum Application Fragment Size (octets):
Transmitted: Configurable up to 2048
Received: 2048</td></tr>
<tr><td>Maximum Data Link Re-tries:
☐ None
✔ Fixed at 2
☐ Configurable</td><td>Maximum Application Layer Re-tries:
✔ None
☐ Configurable</td></tr>
<tr><td colspan="2">Requires Data Link Layer Confirmation:
✔ Never
☐ Always
☐ Sometimes
☐ Configurable</td></tr>
</table>

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	✓ **None**	☐ 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

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 **Explanation of 'Sometimes':** It will be disabled for RS-485 applications, since there is no collision avoidance mechanism. For ethernet communication it will be available and it can be disabled or enabled with the proper function code.	***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: 20.** **Default Variation: 1** ✔ **Point-by-point list attached**	***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	

C.3 Implementation table

The following table shows objects, variations, function codes and qualifiers supported by C650 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, are responded to with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 are responded to 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.

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, are responded to 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 C650 is not restarted, but the DNP process is restarted.

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)		
23	0	Frozen Counter Change Event	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
30	5	Analog Short Float	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)***
32	5	Analogs (Short-float) without time	***1 (read)***	***06 (no range, or all)*** ***07,08 (limited qty)***	***129 (response)*** ***130 (unsol.resp)***	***17,28 (index)***
32	7	Analogs (Short-float) 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, are responded to 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 C650 is not restarted, but the DNP process is restarted.

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, are responded to 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 C650 is not restarted, but the DNP process is restarted.

C.4 Binary input points

The C650 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*** in 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 C650 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*, assign any of the binary states of the C650 relay. These states are contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. DNP Points that correspond to *Control Events* or *Switchgear Contacts* that are not configured have a zero value in the response.

Using the PLC-Editor, through the EnerVista 650 Setup program select ***Setpoint > Logic Configuration*** to implement complex logic, more than simple OR and NOT previous functions. To accomplish this, under ***Setpoint > Relay Configuration > Control Events,*** assign a Virtual Output to a selected point, and then 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	POINT INDEX	NAME/DESCRIPTION
0-127	Control Events 1-128	143	Switchgear 8 Contact B
128	Switchgear 1 Contact A	144	Switchgear 9 Contact A
129	Switchgear 1 Contact B	145	Switchgear 9 Contact B
130	Switchgear 2 Contact A	146	Switchgear 10 Contact A
131	Switchgear 2 Contact B	147	Switchgear 10 Contact B
132	Switchgear 3 Contact A	148	Switchgear 11 Contact A
133	Switchgear 3 Contact B	149	Switchgear 11 Contact B
134	Switchgear 4 Contact A	150	Switchgear 12 Contact A
135	Switchgear 4 Contact B	151	Switchgear 12 Contact B
136	Switchgear 5 Contact A	152	Switchgear 13 Contact A
137	Switchgear 5 Contact B	153	Switchgear 13 Contact B
138	Switchgear 6 Contact A	154	Switchgear 14 Contact A
139	Switchgear 6 Contact B	155	Switchgear 14 Contact B
140	Switchgear 7 Contact A	156	Switchgear 15 Contact A
141	Switchgear 7 Contact B	157	Switchgear 15 Contact B
142	Switchgear 8 Contact A	158	Switchgear 16 Contact A
		159	Switchgear 16 Contact B

C.5 DNP configuration examples

C.5.1 Configuring DNP user map

For example, consider configuring 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, select **Setpoint > Relay Configuration** from the EnerVista 650 Setup program and then configure the **Control Events** bits and **Switchgear** bits. This is shown in figures 9.1 and 9.2. In the second step, select **Setpoint > System Setup > Communication settings > DNP** in order to change the DNP Binary Input Block settings. Set the 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. This is shown in Figure C-1: Configuration of Control Events bits 13-1

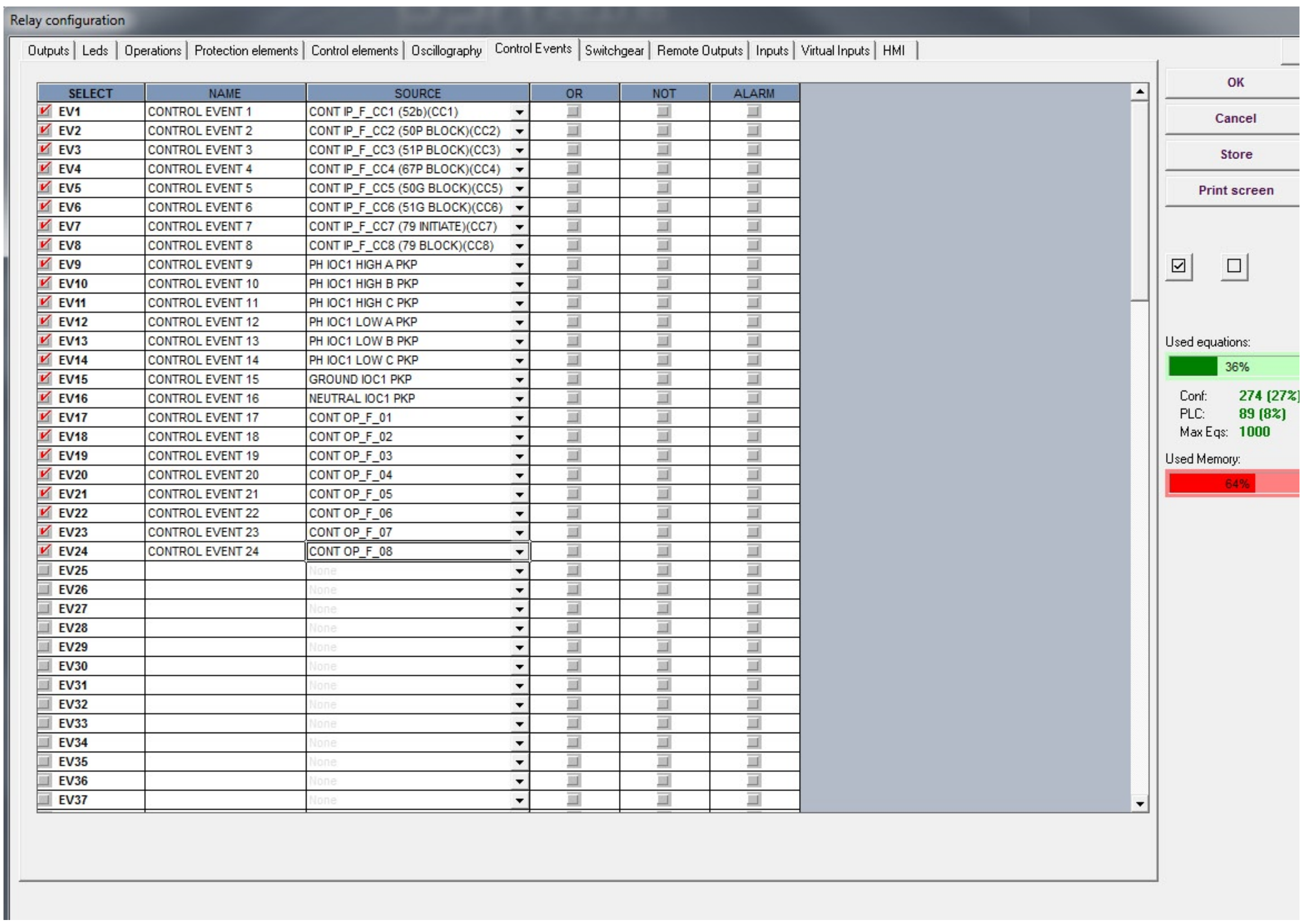


Figure C-1: Configuration of Control Events bits

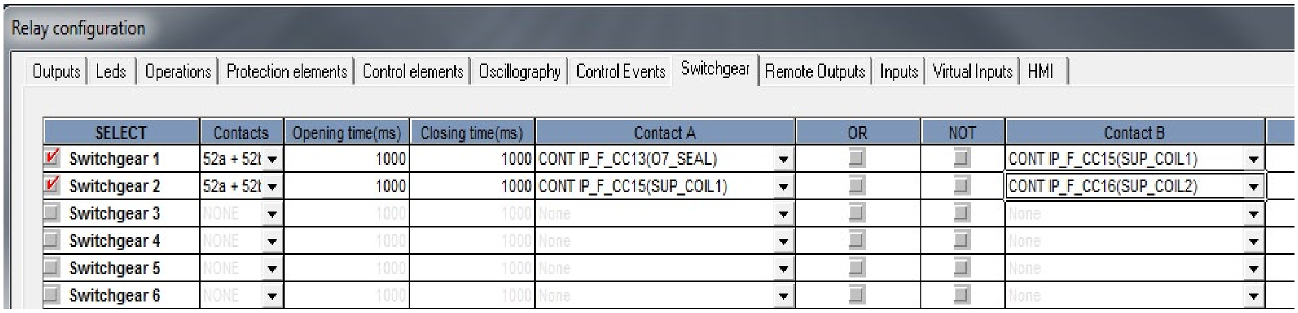


Figure C-2: CONFIGURATION OF SWITCHGEAR

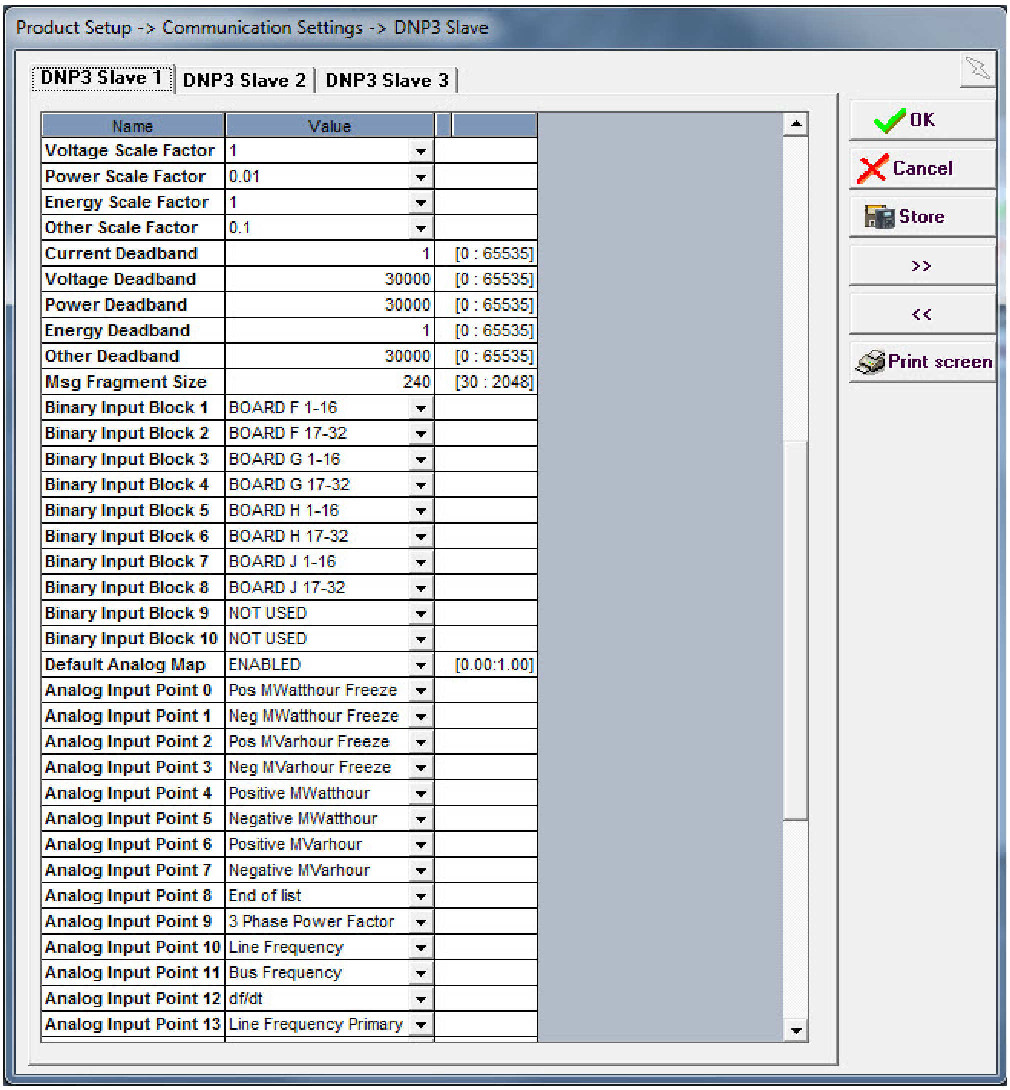


Figure C-3: CONFIGURATION OF DNP BINARY INPUT BLOCKS

In the example presented in this chapter the C650 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	POINT INDEX	NAME/DESCRIPTION
0	CONT_IP_F_CC1(CC1)	24	Not Configured
1	CONT_IP_F_CC2(CC2)	25	Not Configured
2	CONT_IP_F_CC3(CC3)	26	Not Configured
3	CONT_IP_F_CC4(CC4)	27	Not Configured
4	CONT_IP_F_CC5(CC5)	28	Not Configured
5	CONT_IP_F_CC6(CC6)	29	Not Configured
6	CONT_IP_F_CC7(CC7)	30	Not Configured
7	CONT_IP_F_CC8(CC8)	31	Not Configured
8	PH IOC1 HIGH A PKP	32	CONT_IP_F_CC13 (CC13)
9	PH IOC1 HIGH B PKP	33	CONT_IP_F_CC14(CC14)
10	PH IOC1 HIGH C PKP	34	CONT_IP_F_CC15(CC15)
11	PH IOC1 LOW A PKP	35	CONT_IP_F_CC16(CC16)
12	PH IOC1 LOW B PKP	36	Not Configured
13	PH IOC1 LOW C PKP	37	Not Configured
14	GROUND IOC1 PKP	38	Not Configured
15	NEUTRAL IOC1 PKP	39	Not Configured
16	CONT OP_F_01	40	Not Configured
17	CONT OP_F_02	41	Not Configured
18	CONT OP_F_03	42	Not Configured
19	CONT OP_F_04	43	Not Configured
20	CONT OP_F_05	44	Not Configured
21	CONT OP_F_06	45	Not Configured
22	CONT OP_F_07	46	Not Configured
23	CONT OP_F_08	47	Not Configured

C.5.3 Multiple DNP 3.0 masters communication with C650

Typical architecture of multi-master communication using DNP 3.0.

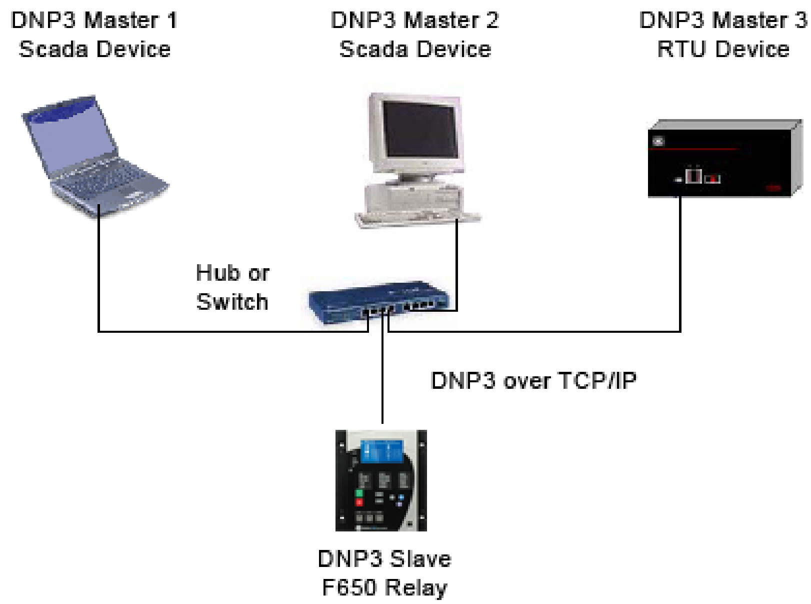


Figure C-4: Multiple DNP3.0 masters communicating with C650

DNP 3.0 Slave – F650	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-5: Settings for DNP3.0 multi-master communications with C650

C.6 Binary output and control relay output

Supported Control Relay Output Block fields: Pulse On.

The C650 relay provides 24 DNP Binary/Control Output points. These outputs are mapped to the first 24 commands configured in the C650. 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 is 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
12	OPERATION13
13	OPERATION14
14	OPERATION15
15	OPERATION16
16	OPERATION17
17	OPERATION18
18	OPERATION19
19	OPERATION20
20	OPERATION21
21	OPERATION22
22	OPERATION23
23	OPERATION24
24-55	VI latched 1-32
56	VI Self Reset 1-2
57	VI Self Reset 3-4
58	VI Self Reset 5-6

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	**NAME/DESCRIPTION**
59	VI Self Reset 7-8
60	VI Self Reset 9-10
61	VI Self Reset 11-12
62	VI Self Reset 13-14
63	VI Self Reset 15-16
64	VI Self Reset 17-18
65	VI Self Reset 19-20
66	VI Self Reset 21-22
67	VI Self Reset 23-24
68	VI Self Reset 25-26
69	VI Self Reset 27-28
70	VI Self Reset 29-30
71	VI Self Reset 31-32

C.7 Binary counters

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point. Digital Counter values are represented as 32-bit integers. The DNP 3.0 protocol defines counters to be unsigned integers. Care should be taken when interpreting negative counter values.

BINARY COUNTERS

Static (Steady-State) Object Number: **20**
Change Event Object Number: **22**
Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze no ack), 9 (freeze and clear), 10 (freeze and clear, no ack), 22 (assign class)**
Static Variation reported when variation 0 requested: **1 (32-Bit Binary Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Change Event without time)**
Default Class for all points: **3**

FROZEN COUNTERS

Static (Steady-State) Object Number: **21**
Change Event Object Number: **23**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event without time)**
Default Class for all points: **3**

BINARY AND FROZEN COUNTERS POINT INDEX NAME/DESCRIPTION:

0 Pulse Counter 1	16 Pos MWatthour
1 Pulse Counter 2	17 Neg MWatthour
2 Pulse Counter 3	18 Pos MVatthour
3 Pulse Counter 4	19 Neg MVatthour
4 Pulse Counter 5	
5 Pulse Counter 6	
6 Pulse Counter 7	
7 Pulse Counter 8	
8 Digital Counter 1	
9 Digital Counter 2	
10 Digital Counter 3	
11 Digital Counter 4	
12 Digital Counter 5	
13 Digital Counter 6	
14 Digital Counter 7	
15 Digital Counter 8	

C.8 Analog inputs

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/A	Apparent Power:	MVA/KVA
Voltage:	kV/V	Energy:	MWh, MVArh/ kWh, kVArh
Real Power:	MW/KV	Frequency:	Hz
Reactive Power:	MVAr/kVAr	Angle:	degrees

ANALOG INPUT POINTS

POINT	DESCRIPTION	UNIT
0	Phasor Ia Primary	kA / A
1	Phasor Ib Primary	kA / A
2	Phasor Ic Primary	kA / A
3	Phasor Ig Primary	kA / A
4	Phasor Isg Primary	kA / A
5	Phasor In Primary	kA / A
6	RMS Ia Primary	kA / A
7	RMS Ib Primary	kA / A
8	RMS Ic Primary	kA / A
9	RMS Ig Primary	kA / A
10	RMS Isg Primary	kA / A
11	I0 Primary	kA / A
12	I1 Primary	kA / A

POINT	DESCRIPTION	UNIT
13	I2 Primary	kA / A
14	V0 Primary	kV / V
15	V1 Primary	kV / V
16	V2 Primary	kV / V
17	Vab Primary	kV / V
18	Vbc Primary	kV / V
19	Vca Primary	kV / V
20	Vn Primary	kV / V
21	Va Primary	kV / V
22	Vb Primary	kV / V
23	Vc Primary	kV / V
24	VL Primary	kV / V
25	VBB Primary	kV / V
26	Phase A Reactive Pwr	MVAr / kVAr
27	Phase A Apparent Pwr	MVA / kVA
28	Phase A Real Pwr	MW / kW
29	Phase B Reactive Pwr	MVAr / kVAr
30	Phase B Apparent Pwr	MVA / kVA
31	Phase B Real Pwr	MW / kW
32	Phase C Reactive Pwr	MVAr / kVAr
33	Phase C Apparent Pwr	MVA / kVA
34	Phase C Real Pwr	MW / kW
35	3 Phase Reactive Pwr	MVAr / kVAr
36	3 Phase Apparent Pwr	MVA / kVA
37	3 Phase Real Pwr	MW / kW
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 / V
45	Pos MVarhour Freeze	MVArh / kVArh
46	Neg MVarhour Freeze	MVArh / kVArh
47	Pos MWatthour Freeze	MWh / kWh
48	Pos MWatthour Freeze	MWh / kWh
49	Positive MVarhour	MVArh / kVArh
50	Negative MVarhour	MVArh / kVArh
51	Positive MWatthour	MWh / kWh
52	Negative MWatthour	MWh / kWh
53	Fault 1 Prefault Phase A Current Magnitude	kA / A
54	Fault 1 Prefault Phase A Current Angle	degrees
55	Fault 1 Prefault Phase B Current Magnitude	kA / A
56	Fault 1 Prefault Phase B Current Angle	degrees
57	Fault 1 Prefault Phase C Current Magnitude	kA / A
58	Fault 1 Prefault Phase C Current Angle	degrees
59	Fault 1 Prefault Phase AB Voltage Magnitude	kV / V
60	Fault 1 Prefault Phase AB Voltage Angle	degrees
61	Fault 1 Prefault Phase BC Voltage Magnitude	kV / V
62	Fault 1 Prefault Phase BC Voltage Angle	degrees

POINT	DESCRIPTION	UNIT
63	Fault 1 Prefault Phase CA Voltage Magnitude	kV / V
64	Fault 1 Prefault Phase CA Voltage Angle	degrees
65	Fault 1 Postfault Phase A Current Magnitude	kA / A
66	Fault 1 Postfault Phase A Current Angle	degrees
67	Fault 1 Postfault Phase B Current Magnitude	kA / A
68	Fault 1 Postfault Phase B Current Angle	degrees
69	Fault 1 Postfault Phase C Current Magnitude	kA / A
70	Fault 1 Postfault Phase C Current Angle	degrees
71	Fault 1 Postfault Phase AB Voltage Magnitude	kV / V
72	Fault 1 Postfault Phase AB Voltage Angle	degrees
73	Fault 1 Postfault Phase BC Voltage Magnitude	kV / V
74	Fault 1 Postfault Phase BC Voltage Angle	degrees
75	Fault 1 Postfault Phase CA Voltage Magnitude	kV / V
76	Fault 1 Postfault Phase CA Voltage Angle	degrees
77	Fault 1 Type	Enum
78	Fault 1 Location	km
79	Fault 1 Prefault Ground Current Magnitude	kA / A
80	Fault 1 Prefault Ground Current Angle	degrees
81	Fault 1 Prefault Sensitive Ground Current Magnitude	kA / A
82	Fault 1 Prefault Sensitive Ground Current Angle	degrees
83	Fault 1 Postfault Ground Current Magnitude	kA / A
84	Fault 1 Postfault Ground Current Angle	degrees
85	Fault 1 Postfault Sensitive Ground Current Magnitude	kA / A
86	Fault 1 Postfault Sensitive Ground Current Angle	degrees
87	% of Load to Trip	%
88	Board F - Analog 1	
89	Board F - Analog 2	
90	Board F - Analog 3	
91	Board F - Analog 4	
92	Board F - Analog 5	
93	Board F - Analog 6	
94	Board F - Analog 7	
95	Board F - Analog 8	
96	Board G - Analog 1	
97	Board G - Analog 2	
98	Board G - Analog 3	
99	Board G - Analog 4	
100	Board G - Analog 5	
101	Board G - Analog 6	
102	Board G - Analog 7	
103	Board G - Analog 8	
104	Board H - Analog 1	
105	Board H - Analog 2	
106	Board H - Analog 3	
107	Board H - Analog 4	
108	Board H - Analog 5	
109	Board H - Analog 6	
110	Board H - Analog 7	
111	Board H - Analog 8	
112	Board J - Analog 1	

POINT	DESCRIPTION	UNIT
113	Board J - Analog 2	
114	Board J - Analog 3	
115	Board J - Analog 4	
116	Board J - Analog 5	
117	Board J - Analog 6	
118	Board J - Analog 7	
119	Board J - Analog 8	

The "Fault Type" is represented by enumeration value. The table below shows values with DNP3 setting "Other Scale Factor = 1".

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

If the DNP3 setting "Other Scale Factor" has a value different from "1" then "Enum Value" is scaled by the adjusted factor. For example if "Other Scale Factor = 0.001", then the value corresponding to "TRIPH" fault type is 2000.

NAF indicates that the type of fault has not been calculated.

C650 Bay Controller & Monitoring System

Appendix D: IEC 60870-5-104 protocol

D.1 Introduction

The C650 implements functionality of an IEC 60870-5-104 server. The devices responds to client requests or can send spontaneous transmissions. C650 implementation of 60870-5-104 provides analog metering and states.

The IEC 60870-5-104 communications protocol is supported on Ethernet ports A and B only.

D.2 Technical description

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 consisting of 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 C650 is listening as a server and supports up to two different IEC60870-5-104 masters simultaneously.

D.3 Basic application functions

Cyclic data transmission

Cyclic data transmission is used to send measured values to the IEC 60870-5-104 master.

Spontaneous Transmission:

Information objects may be transmitted without a specific request from the IEC 60870-5-104 master.

The data that can be sent spontaneously are:

- Measured values when a deadband overflow takes place.
- Single points in the time the event is produced.
- Double points in the time the event is produced.
- Integrated Totals

Clock synchronization

C650 supports clock synchronization from IEC 60870-5-104 master.

If IRIG-B, PTP-1588 or SNTP is being used for time synchronization, the IEC 60870-5-104 clock synchronization command does not set the C650 real time clock.

Command transmission

C650 is allowed to accept single commands and double commands.

D.4 IEC 104 settings

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	Seconds	[0:3600]
Synchronization Event	0	Minutes	[0:1400]
IEC104 NET1 CLI1 OCTET1	0		[0 : 255]
IEC104 NET1 CLI1 OCTET2	0		[0 : 255]
IEC104 NET1 CLI1 OCTET3	0		[0 : 255]
IEC104 NET1 CLI1 OCTET4	0		[0 : 255]
IEC104 NET1 CLI2 OCTET1	0		[0 : 255]
IEC104 NET1 CLI2 OCTET2	0		[0 : 255]
IEC104 NET1 CLI2 OCTET3	0		[0 : 255]
IEC104 NET1 CLI2 OCTET4	0		[0 : 255]
Function 2	DISABLED		
TCP Port 2	2404		[0:65535]
Common Addr of ASDU 2	255		[0:65535]
IEC104 NET2 CLI1 OCTET1	0		0 : 255]
IEC104 NET2 CLI1 OCTET2	0		0 : 255]
IEC104 NET2 CLI1 OCTET3	0		0 : 255]
IEC104 NET2 CLI1 OCTET4	0		0 : 255]
IEC104 NET2 CLI2 OCTET1	0		0 : 255]
IEC104 NET2 CLI2 OCTET2	0		0 : 255]
IEC104 NET2 CLI2 OCTET3	0		0 : 255]
IEC104 NET2 CLI2 OCTET4	0		0 : 255]
IEC104 SCALE CURRENT	1		
IEC104 SCALE VOLTAGE	1		
IEC104 SCALE POWER	1		
IEC104 SCALE ENERGY	1		
IEC104 SCALE OTHER	1		
IEC104 DEADBAND CURRENT	30000		[0:65535]
IEC104 DEADBAND VOLTAGE	30000		[0:65535]
IEC104 DEADBAND POWER	30000		[0:65535]
IEC104 DEADBAND ENERGY	30000		[0:65535]
IEC104 DEADBAND OTHER	30000		[0:65535]
IEC104 IOA BINARIES	1000		[0:65535]
IEC104 IOA DOUBLE POINTS	1500		[0:65535]
IEC104 IOA ANALOGS	2000		[0:65535]
IEC104 IOA COUNTERS	4000		[0:65535]
IEC104 IOA COMMANDS	3000		[0:65535]
IEC104 IOA ANALOG PARAMETERS	5000		[0:65535]

Function:	Enable or disable the protocol operation for the first IEC 60870-5-104 connection.
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 cyclical data sending, 0 means no spontaneous metering.
Synchronization event:	Period of time (in minutes) for which timestamps are considered valid after receiving a clock synchronization command.
IEC104 NET1 CLI1 OCTET1 to 4:	These four octets define the IP address of the first client that is accepted in the first connection. The C650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
EC104 NET1 CLI2 OCTET1 to 4:	These four octets define the IP address of the second client that is accepted in the first connection. The C650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
Function 2:	Enable or disable the protocol operation for the second connection.
TCP Port 2:	Listening TCP port in the relay. Default value is 2404.
Common Addr of ASDU2:	Address in the ASDU header. Default value is 255.
IEC104 NET2 CLI1 OCTET1 to 4:	These four octets define the IP address of the first client that is accepted in the second connection. The C650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
IEC104 NET2 CLI2 OCTET1 to 4:	These four octets define the IP address of the second client that is accepted in the second connection. The C650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.
IEC104 SCALE CURRENT, VOLTAGE, POWER, ENERGY, OTHER:	These settings are numbers used to scale Analog Input point values. These settings group the C650 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 **IEC104 SCALE VOLTAGE** is set to a value of 1000, all IEC104 Analog Input points that are voltages are returned with the values 1000 times smaller (e.g. a value 72000 V on the C650 is returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in IEC 60870-5-104 masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times larger).
IEC104 DEADBAND CURRENT, VOLTAGE, POWER, ENERGY, OTHER:	These settings are the values used by the C650 to determine when to trigger spontaneous responses containing Analog Input data. These settings group the C650 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 spontaneous responses from the C650 when any current values change by 15 A, the **IEC104 DEADBAND CURRENT** setting should be set to 15. Note that these settings are the default values of the deadbands. Parameter of measured value ASDU can be used to change deadband values, from the default, for each individual IEC104 Analog Input point. Whenever power is removed and re-applied to the C650, the default deadbands are in effect.

IEC104 IOA BINARIES:	Starting Information Object Address for Single Points.
IEC104 IOA DOUBLE POINTS:	Starting Information Object Address for Double Points.
IEC104 IOA ANALOGS:	Starting Information Object Address for Analog Inputs.
IEC104 IOA COUNTERS:	Starting Information Object Address for Counters.
IEC104 IOA COMMANDS:	Starting Information Object Address for Single or Double Commands.
IEC104 IOA ANALOG PARAMETERS:	Starting Information Object Address for Parameter of measured value. Each Measured value has a Parameter of measured value associated with its threshold.

The C650 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, assign any of the binary states of the C650 relay. It is also 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 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.

Groups of Data

The data is organized into groups in order to provide values when the controlling station requests them by a general or group interrogation.

Group 1, 2 & 4 are set by the 256 Single Points (M_SP_NA_1).

Group 3 is set by the 16 Double Points (M_DP_NA_1).

Group 5 and 6 are set by the120 Analog Inputs, short floating-point (M_ME_NC_1).

Group 7 is set by the 120 Parameter of measured value, short floating-point (P_ME_NC_1).

These 256 Single Points, 16 Double points and 120 Measured Values are also sent as a response to a General Interrogation.

The 20 Integrated Totals (M_IT_NA_1) has its own Counter Group and it is sent as a response to a General Request Counter.

Group 1 Status	
POINT	**DESCRIPTION**
M_SP_NA_1	
1000-1063	CONTROL EVENTS 1-64

Group 2 Status	
POINT	**DESCRIPTION**
M_SP_NA_1	
1064-1127	CONTROL EVENTS 65-128

Group 3 Status	
POINT	**DESCRIPTION**
M_DP_NA_1	
1500-1515	SWITCHGEAR EVENTS

Group 4 Status	
POINT	**DESCRIPTION**
M_SP_NA_1	
1128-1255	BOARD F 1-32, G 1-32, H 1-32, J 1-32

Group 5 Single Point	
POINT	**DESCRIPTION**
M_ME_NC_1	
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
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

Group 5 Single Point	
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	Pos Mvarhour Freeze
2046	Neg Mvarhour Freeze
2047	Pos MWatthour Freeze
2048	Neg MWatthour Freeze
2049	Positive MVarhour
2050	Negative MVarhour
2051	Positive MWatthour
2052	Negative MWatthour
2053	Fault 1 Prefault Phase A Current Magnitude
2054	Fault 1 Prefault Phase A Current Angle
2055	Fault 1 Prefault Phase B Current Magnitude
2056	Fault 1 Prefault Phase B Current Angle
2057	Fault 1 Prefault Phase C Current Magnitude
2058	Fault 1 Prefault Phase C Current Angle
2059	Fault 1 Prefault Phase AB Voltage Magnitude

Group 6 Metering	
POINT	**DESCRIPTION**
M_ME_NC_1	
2060	Fault 1 Prefault Phase AB Voltage Angle
2061	Fault 1 Prefault Phase BC Voltage Magnitude
2062	Fault 1 Prefault Phase BC Voltage Angle
2063	Fault 1 Prefault Phase CA Voltage Magnitude
2064	Fault 1 Prefault Phase CA Voltage Angle
2065	Fault 1 Postfault Phase A Current Magnitude
2066	Fault 1 Postfault Phase A Current Angle
2067	Fault 1 Postfault Phase B Current Magnitude
2068	Fault 1 Postfault Phase B Current Angle
2069	Fault 1 Postfault Phase C Current Magnitude
2070	Fault 1 Postfault Phase C Current Angle
2071	Fault 1 Postfault Phase AB Voltage Magnitude
2072	Fault 1 Postfault Phase AB Voltage Angle
2073	Fault 1 Postfault Phase BC Voltage Magnitude
2074	Fault 1 Postfault Phase BC Voltage Angle
2075	Fault 1 Postfault Phase CA Voltage Magnitude
2076	Fault 1 Postfault Phase CA Voltage Angle
2077	Fault 1 Type
2078	Fault 1 Location
2079	Fault 1 Prefault Ground Current Magnitude
2080	Fault 1 Prefault Ground Current Angle
2081	Fault 1 Prefault Sensitive Ground Current Magnitude

Group 6 Metering	
2082	Fault 1 Prefault Sensitive Ground Current Angle
2083	Fault 1 Postfault Ground Current Magnitude
2084	Fault 1 Postfault Ground Current Angle
2085	Fault 1 Postfault Sensitive Ground Current Magnitude
2086	Fault 1 Postfault Sensitive Ground Current Angle
2087	% of Load to Trip
2088	Board F – Analog 1
2089	Board F – Analog 2
2090	Board F – Analog 3
2091	Board F – Analog 4
2092	Board F – Analog 5
2093	Board F – Analog 6
2094	Board F – Analog 7
2095	Board F – Analog 8
2096	Board G – Analog 1
2097	Board G – Analog 2
2098	Board G – Analog 3
2099	Board G – Analog 4
2100	Board G – Analog 5
2101	Board G – Analog 6
2102	Board G – Analog 7
2103	Board G – Analog 8
2104	Board H – Analog 1
2105	Board H – Analog 2
2106	Board H – Analog 3
2107	Board H – Analog 4
2108	Board H – Analog 5
2109	Board H – Analog 6
2110	Board H – Analog 7
2111	Board H – Analog 8
2112	Board J – Analog 1
2113	Board J – Analog 2
2114	Board J – Analog 3
2115	Board J – Analog 4
2116	Board J – Analog 5
2117	Board J – Analog 6
2118	Board J – Analog 7
2119	Board J – Analog 8

Group 7 Deadband	
POINT	**DESCRIPTION**
P_ME_NC_1	
5000-5119	Analog Input Deadbands 2000-2119

Integrated Totals	
POINT	**DESCRIPTION**
M_IT_NA_1	
4000-4007	Pulse Counter 1-8
4008-4015	Digital Counters 1-8
4016-4019	Energy Counters

D.5 IEC 60870-5-104 point list

OPERATIONS IN IEC 60870-5-104 FOR C650

The two standard procedures for command transmission are accepted, Direct command or Select and Execute command. The following table determines how a command can be executed in C650.

Commands		
POINT	**DESCRIPTION**	**COMMAND MODE**
3000	Operation 1 (ON) + Operation 2(OFF)	Select and Execute Double Command
---	---	---
3005	Operation 11 (ON) + Operation 12(OFF)	Select and Execute Double Command
3006	Operation 13 (ON) + Operation 14(OFF)	Direct Double Command
---	---	---
3011	Operation 23 (ON) + Operation 24(OFF)	Direct Double Command
3012	Virtual Self Reset 1 (ON) + Virtual Self Reset 2(OFF)	Direct Double Command
---	---	---
3027	Virtual Self Reset 31 (ON) + Virtual Self Reset 32(OFF)	Direct Double Command
3028-3059	Virtual Latched 1-32	Direct Single Command

There are 24 available operation in C650 device; they must be configured using EnerVista 650 Setup in ***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.

D.6 IEC 60870-5-104 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of "structured" or "unstructured" fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

NOTE: In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows

	Function or ASDU is not used
X	Function or ASDU is used as standardized (default)
R	Function or ASDU is used in reverse mode
B	Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

System or device

System-specific parameter. Indicate definition of a system or a device by marking one of the following with "**X**":

	System definition
X	Controlling station definition (Master)
R	Controlled station definition (Slave)

Network configuration

Network-specific parameter. All configurations that are used are to be marked "**X**":

■	~~Point-to-point~~	■	~~Multipoint-partyline~~
■	~~Multiple point-to-point~~	■	~~Multipoint-star~~

Physical layer

Network-specific parameter, all interfaces and data rates that are used are to be marked "**X**".

Transmission speed (control direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
Standard	Recommended if >1 200 bit/s		
■ ~~100 bit/s~~	■ ~~2 400 bit/s~~	■ ~~2 400 bit/s~~	■ ~~56 000 bit/s~~
■ ~~200 bit/s~~	■ ~~4 800 bit/s~~	■ ~~4 800 bit/s~~	■ ~~64 000 bit/s~~
■ ~~300 bit/s~~	■ ~~9 600 bit/s~~	■ ~~9 600 bit/s~~	
■ ~~600 bit/s~~		■ ~~19 200 bit/s~~	
■ ~~1 200 bit/s~~		■ ~~38 400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
Standard	Recommended if >1 200 bit/s		
■ ~~100 bit/s~~	■ ~~2 400 bit/s~~	■ ~~2 400 bit/s~~	■ ~~56 000 bit/s~~
■ ~~200 bit/s~~	■ ~~4 800 bit/s~~	■ ~~4 800 bit/s~~	■ ~~64 000 bit/s~~
■ ~~300 bit/s~~	■ ~~9 600 bit/s~~	■ ~~9 600 bit/s~~	
■ ~~600 bit/s~~		■ ~~19 200 bit/s~~	
■ ~~1 200 bit/s~~		■ ~~38 400 bit/s~~	

Link layer

Network-specific parameter. All options that are used are to be marked "X". Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission

■ ~~Balanced transmission~~

■ ~~Unbalanced transmission~~

Frame length

■ ~~Balanced transmission~~

■ ~~Unbalanced transmission~~

Address field of the link

■ ~~not present (balanced transmission only)~~

■ ~~One octet~~

■ ~~Two octets~~

■ ~~Structured~~

■ ~~Unstructured~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

■ ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).~~

APPLICATION LAYER

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

System-specific parameter. All configurations that are used are to be marked "X".

■ ~~One octet~~

☒ Two octets

Information object address

System-specific parameter. All configurations that are used are to be marked "**X**".

■ ~~One octet~~

■ ~~Two octets~~

☒ Three octets

☒ Structured

☒ Unstructured

Cause of transmission

System-specific parameter. All configurations that are used are to be marked "**X**".

■ ~~One octet~~

☒ Two octets (with originator address). Originator address is set to zero if not used

Length of APDU

System-specific parameter. Specify the maximum length of the APDU per system.

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

■ Maximum length of APDU per system in control direction

■ Maximum length of APDU per system in monitor direction

SELECTION OF STANDARD ASDUS

Process information in monitor direction

Station-specific parameter. Mark each Type ID “X” if it is only used in the standard direction, "**R**" if only used in the reverse direction, and “B” if used in both directions.

X	<1>	:= Single-point information	M_SP_NA_1
■	~~<2>~~	~~:= Single-point information with time tag~~	~~M_SP_TA_1~~
X	<3>	:= Double-point information	M_DP_NA_1
■	~~<4>~~	~~:= Double-point information with time tag~~	~~M_DP_TA_1~~
☐	<5>	:= Step position information	M_ST_NA_1
■	~~<6>~~	~~:= Step position information with time tag~~	~~M_ST_TA_1~~
☐	<7>	:= Bitstring of 32 bit	M_BO_NA_1
■	~~<8>~~	~~:= Bitstring of 32 bit with time tag~~	~~M_BO_TA_1~~
☐	<9>	:= Measured value, normalized value	M_ME_NA_1
■	~~<10>~~	~~:= Measured value, normalized value with time tag~~	~~M_ME_TA_1~~
☐	<11>	:= Measured value, scaled value	M_ME_NB_1
■	~~<12>~~	~~:= Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
X	<13>	:= Measured value, short floating point value	M_ME_NC_1
■	~~<14>~~	~~:= Measured value, short floating point value with time tag~~	~~M_ME_TC_1~~
X	<15>	:= Integrated totals	M_IT_NA_1
■	~~<16>~~	~~:= Integrated totals with time tag~~	~~M_IT_TA_1~~
■	~~<17>~~	~~:= Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■	~~<18>~~	~~:= Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■	~~<19>~~	~~:= Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
☐	<20>	:= Packed single-point information with status change detection	M_SP_NA_1
☐	<21>	:= Measured value, normalized value without quality descriptor	M_ME_ND_1
X	<30>	:= Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31>	:= Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32>	:= Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33>	:= Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34>	:= Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐	<35>	:= Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36>	:= Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<37>	:= Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38>	:= Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39>	:= Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40>	:= Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

Station-specific parameter. Mark each Type ID “X” if it is only used in the standard direction, "**R**" if only used in the reverse direction, and “**B**” if used in both directions.

X	<45> :=	Single command	C_SC_NA_1
X	<46> :=	Double command	C_DC_NA_1
	<47> :=	Regulating step command	C_RC_NA_1
	<48> :=	Set point command, normalized value	C_SE_NA_1
	<49> :=	Set point command, scaled value	C_SE_NB_1
	<50> :=	Set point command, short floating point value	C_SE_NC_1
	<51> :=	Bitstring of 32 bit	C_BO_NA_1
X	<58> :=	Single command with time tag CP56Time2a	C_SC_TA_1
X	<59> :=	Double command with time tag CP56Time2a	C_DC_TA_1
	<60> :=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
	<61> :=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
	<62> :=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
	<63> :=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
	<64> :=	Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

Station-specific parameter. Mark with an “**X**” if it is only used in the standard direction, “**R**” if only used in the reverse direction, and “**B**” if used in both directions.

X	<70> :=	End of initialization	M_EI_NA_1

System information in control direction

Station-specific parameter. Mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	<100>:=	Interrogation command	C_IC_NA_1
X	<101>:=	Counter interrogation command	C_CI_NA_1
X	<102>:=	Read command	C_RD_NA_1
X	<103>:=	Clock synchronization command (option see 7.6)	C_CS_NA_1
	~~<104>:=~~	~~Test command~~	~~C_TS_NA_1~~
X	<105>:=	Reset process command	C_RP_NA_1
	~~<106>:=~~	~~Delay acquisition command~~	~~C_CD_NA_1~~
X	<107>:=	Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

Station-specific parameter. Mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

☐	<110>:=	Parameter of measured value, normalized value	P_ME_NA_1
☐	<111>:=	Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:=	Parameter of measured value, short floating point value	P_ME_NC_1
☐	<113>:=	Parameter activation	P_AC_NA_1

File transfer

Station-specific parameter. Mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

☐	<120>:=	File ready	F_FR_NA_1
☐	<121>:=	Section ready	F_SR_NA_1
☐	<122>:=	Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:=	Last section, last segment	F_LS_NA_1
☐	<124>:=	Ack file, ack section	F_AF_NA_1
☐	<125>:=	Segment	F_SG_NA_1
☐	<126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐	<127>:=	Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments

Station-specific parameters.

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"**X**" if only used in the standard direction;

"**R**" if only used in the reverse direction;

"**B**" if used in both directions.

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1					X									X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1					X									X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1																			

~~<6>~~	~~M_ST_TA_1~~																				
<7>	M_BO_NA_1																				
~~<8>~~	~~M_BO_TA_1~~																				
<9>	M_ME_NA_1																				
~~<10>~~	~~M_ME_TA_1~~																				
<11>	M_ME_NB_1																				
~~<12>~~	~~M_ME_TB_1~~																				
<13>	M_ME_NC_1	X				X									X						
~~<14>~~	~~M_ME_TC_1~~																				
<15>	M_IT_NA_1															X					
~~<16>~~	~~M_IT_TA_1~~																				
~~<17>~~	~~M_EP_TA_1~~																				
~~<18>~~	~~M_EP_TB_1~~																				
~~<19>~~	~~M_EP_TC_1~~																				
<20>	M_PS_NA_1																				
<21>	M_ME_ND_1																				
<30>	M_SP_TB_1			X																	
<31>	M_DP_TB_1																				
<32>	M_ST_TB_1																				
<33>	M_BO_TB_1																				
<34>	M_ME_TD_1																				
<35>	M_ME_TE_1																				
<36>	M_ME_TF_1			X																	
<37>	M_IT_TB_1			X																	
<38>	M_EP_TD_1																				
<39>	M_EP_TE_1																				
<40>	M_EP_TF_1																				
<45>	C_SC_NA_1						X	X	X	X	X										
<46>	C_DC_NA_1						X	X	X	X	X										
<47>	C_RC_NA_1																				
<48>	C_SE_NA_1																				
<49>	C_SE_NB_1																				
<50>	C_SE_NC_1																				
<51>	C_BO_NA_1																				
<58>	C_SC_TA_1						X	X	X	X	X										
<59>	C_DC_TA_1						X	X	X	X	X										
<60>	C_RC_TA_1																				
Type identification		**Cause of transmission**																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<61>	C_SE_TA_1																				
<62>	C_SE_TB_1																				
<63>	C_SE_TC_1																				
<64>	C_BO_TA_1																				
<70>	M_EI_NA_1*				X																
<100>	C_IC_NA_1						X	X	X	X	X										

<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														
<103>	C_CS_NA_1						X	X												
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X												
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1						X	X							X					
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			
* Blank or X only																				

BASIC APPLICATION FUNCTIONS

Station initialization

Station-specific parameter, mark "**X**" if function is used.

X	Remote initialization

Cyclic data transmission

Station-specific parameter. Mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Cyclic data transmission

Read procedure

Station-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Read procedure

Spontaneous transmission

Station-specific parameter. Mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and “B” if used in both directions.

X	Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

Station-specific parameter. Mark each information type "**X**" where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object.

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses, for which double transmission is enabled, are defined in a project-specific list.

- [ ] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- [ ] Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- [ ] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- [ ] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- [ ] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- [ ] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- [ ] Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

Station-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	global				
X	group 1	X	group 7	X	group 13
X	group 2	X	group 8	X	group 14
X	group 3	X	group 9	X	group 15
X	group 4	X	group 10	X	group 16
X	group 5	X	group 11		
X	group 6	X	group 12		

Information object addresses assigned to each group must be shown in a separate table.

Clock synchronization

Station-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Spontaneous transmission
	Day of week used
	RES1, GEN (time tag substituted/ not substituted) used

	SU-bit (summertime) used

optional, see 7.6

Command transmission

Object-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Direct command transmission
	Direct set point command transmission
X	Select and execute command
	Select and execute set point command
X	C_SE ACTTERM used

X	No additional definition
X	Short-pulse duration (duration determined by a system parameter in the outstation)
X	Long-pulse duration (duration determined by a system parameter in the outstation)
X	Persistent output

X	Supervision of maximum delay in command direction of commands and set point commands

10s	Maximum allowable delay of commands and set point commands

Transmission of integrated totals

Station- or object-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Mode A: Local freeze with spontaneous transmission
X	Mode B: Local freeze with counter interrogation
X	Mode C: Freeze and transmit by counter-interrogation commands
X	Mode D: Freeze by counter-interrogation command, frozen values reported

X	Counter read
X	Counter freeze without reset
X	Counter freeze with reset
X	Counter freeze with reset

X	General request counter

X	Request counter group 1
X	Request counter group 2
X	Request counter group 3
	Request counter group 4

Parameter loading

Object-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

X	Threshold value
	Smoothing factor
	Low limit for transmission of measured values
	Low limit for transmission of measured values

Parameter activation

Object-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

	Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

Station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

	Test procedure

File transfer

Station-specific parameter, mark "X" if function is used.

File transfer in monitor direction:

	Transparent file
	Transmission of disturbance data of protection equipment
	Transmission of sequences of events
	Transmission of sequences of recorded analogue values

File transfer in control direction:

	Transparent file

Background scan

Station-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

☐ Background scan

Acquisition of transmission delay

Station-specific parameter. Mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions.

☐ ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value
t0	30 s	Time-out of connection establishment	N/A
t1	15 s	Time-out of send or test APDUs	15 s
t2	10 s	Time-out for acknowledges in case of no data messages t2 < t1	10 s
t3	20 s	Time-out for sending test frames in case of a long idle state	20 s

Maximum range for timeouts t0 to t2: 1 s to 255 s, accuracy 1 s.
Recommended range for timeout t3: 1 s to 48 h, resolution 1 s.
Long timeouts for t3 may be needed in special cases where satellite links or dial-up connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs *k* and latest acknowledge APDUs (*w*)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	12 APDUs
w	8 APDUs	Latest acknowledge after receiving *w* I format APDUs	8 APDUs

Maximum range of values *k*: 1 to 32767 (215–1) APDUs, accuracy 1 APDU

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: *w* should not exceed two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

☐ Number N of redundancy group connections used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for a given projects has to be chosen by the user of this standard.

X	Ethernet 802.3
	Serial X.21 interface
	Other selection from RFC 2200:

List of valid documents from RFC 2200

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. etc.

C650 Bay Controller & Monitoring System

Appendix E: Redundancy protocol

E.1 PRP and HSR Ethernet protocols

Industrial real-time Ethernets typically demand much higher availability and uninterrupted operation than office Ethernet solutions can provide. Even a short loss of connectivity can result in loss of functionality, as for example in some automation, vehicular, power generation, and power distribution systems.

To recover from a network failure, different standard redundancy schemes are applied such as Parallel Redundancy Protocol (PRP), High-availability Seamless Redundancy (HSR) and others.

The basic concept of both protocols, PRP and HSR, is to send practically identical frames over different paths and discard one of the copies in reception, at best. If an error occurs or one of the paths is down, the frame traveling through that path does not reach the destination, but its copy does.

If the node to be attached to a redundant network has not the capability to do it (e.g. has only one port), it can be connected through a Redundancy Box (RedBox). This type of node allows single attached nodes connect transparently to a redundant network. An example can be seen in Figures 1.

PRP operates on two independent networks. Each frame is replicated on the sending node and transmitted over both networks. The receiving node processes the frame arriving first and discards the subsequent copy. The PRP layer is responsible for this replicate/discard function and hides the two networks from the upper layers. This scheme works without explicit reconfiguration and switchover and therefore does not show a period of unavailability.

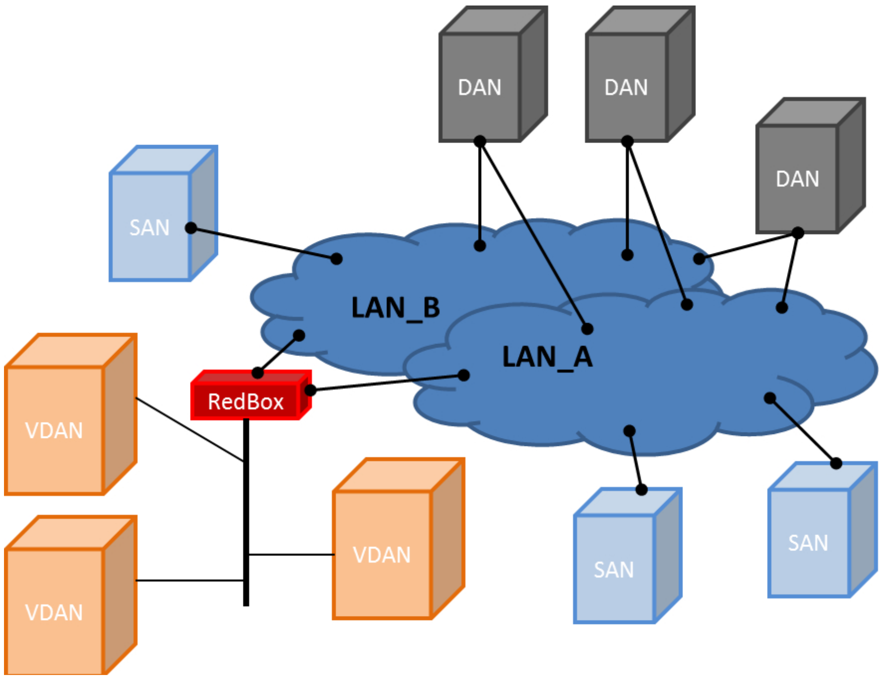


Figure E-1: Example of PRP with two LANs (LAN A and LAN B)

The two LANs, named LAN_A and LAN_B, are identical in protocol at the MAC level, but they can differ in performance and topology. Transmission delays can also be different. The LANs have no direct connection among them and they are assumed to be fail independent.

In some applications, only availability-critical nodes need a double attachment, while others do not. In order to meet the specific requirements, PRP defines different kinds of end nodes.

- The Dual Attached Node (DAN) is connected to both LANs.
- Uncritical nodes can be attached to only one LAN and are therefore called Single Attached Nodes (SAN). SANs that need to communicate with each other are on the same LAN.
- The Redundancy Box (RedBox) is used when a single interface node has to be attached to both networks. Such a node can communicate with all other nodes. Since a node behind a RedBox appears for other nodes like a DAN, it is called Virtual DANs (VDAN). The RedBox itself is a DAN and acts as a proxy on behalf of its VDANs. The RedBox has its own IP address for management purposes

Similarly to PRP, HSR is based in the duplication of every frame sent, but in a ring topology. Each copy of the frame is injected in a different direction of the ring. If any of the links between nodes is down, all nodes are still reachable. This topology forces every node in the net to be HSR aware because they have to forward every message until it reaches its destination. With that purpose, the redundancy information is located at the beginning of the frame allowing a faster forwarding, see next figure.

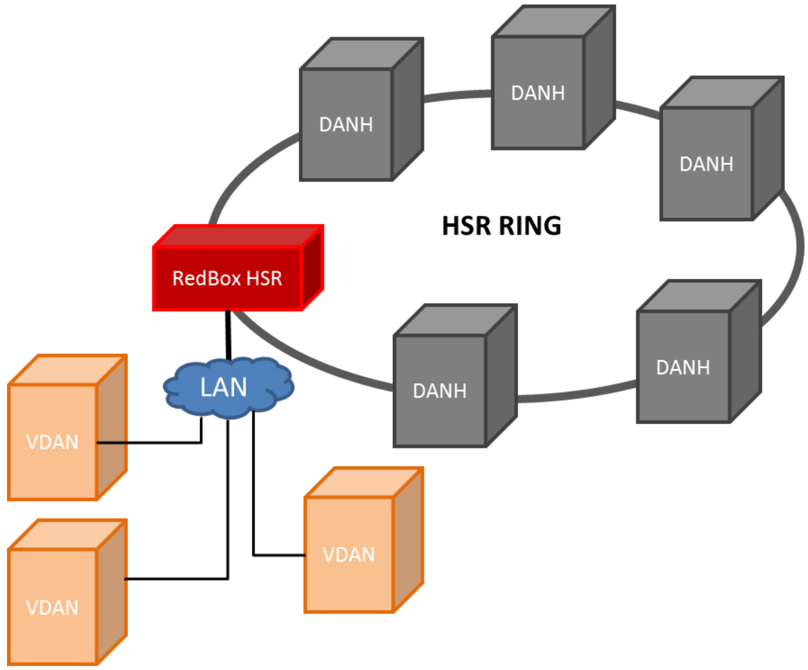


Figure E-2: Example of HSR with HSR ring

Definitions:

- PRP – Parallel Redundancy Protocol - redundancy protocol for high availability in substation automation networks based on IEC 62439-3 Clause 4 and applicable to networks based on Ethernet technology (ISO/IEC 8802-3).
- OSI - Open Systems Interconnection - model defined by the International Organization for Standardization (ISO) for standardizing the functions of a communication system in terms of abstraction layers. Similar communication functions are grouped into logical layers. A layer serves the layer above it and is served by the layer below it. There are 7 layers: physical, data link, network, transport, session, presentation, application.
- DANP – Doubly Attached Node running PRP – a node that has two ports which operate in parallel and are attached to the upper layers of the OSI communications stack through a Link Redundancy Entity module.
- DANH – Doubly Attached Node with HSR protocol.
- LRE - Link Redundancy Entity – module operating at the link layer of the OSI stack and responsible for handling duplicates and managing redundancy.
- SAN – Singly Attached Node – regular nodes with non-redundant network adapters
- RedBox – device attaching singly attached nodes (SANs) to a redundant network.

- RCT – Redundancy Check Trailer – PRP trailer added to frames and consisting of the following fields:
  - 16-bit sequence number (SeqNr);
  - 4-bit LAN identifier (LanId);
  - 12 bit frame size (LSDUsize)
  - 16-bit suffix (PRPsuffix).

E.1.1 PRP

PRP defines a redundancy protocol for high availability in substation automation networks. It is applicable to networks based on Ethernet technology (ISO/IEC 8802-3).

PRP is designed to provide seamless recovery in case of a single failure in the network, by using a combination of LAN duplication and frame duplication technique. Identical frames are sent on two completely independent networks that connect source and destination, see the following figure:

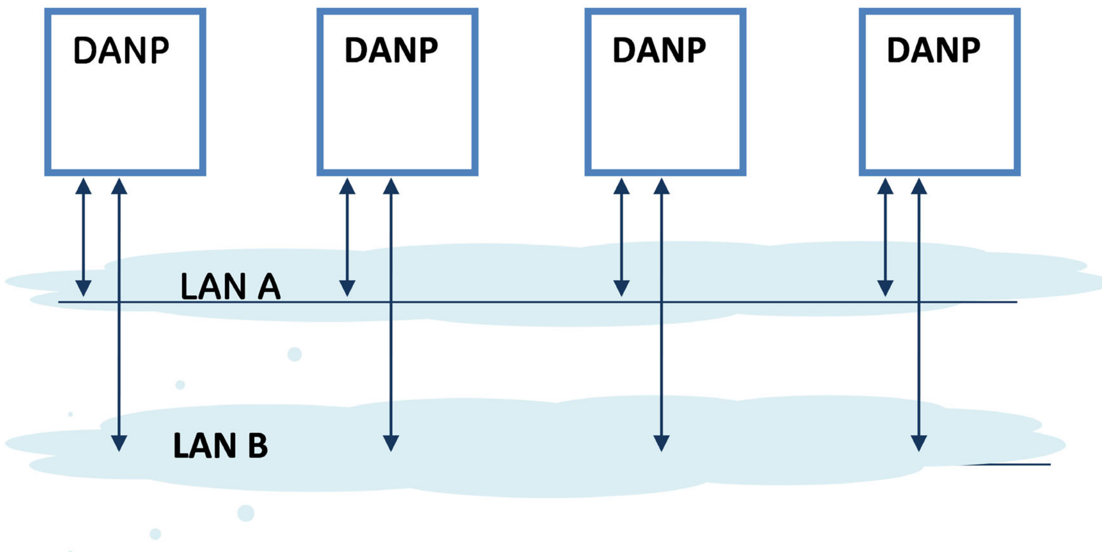


Figure E-3: Example of PRP Redundant Network

Under normal circumstances both frames reach their destination and one of them is sent up the OSI stack to the destination application, while the second one is discarded. If an error occurs in one of the networks and traffic is prevented from flowing on that path, connectivity is still be provided through the other network to ensure continuous communication. However, care must be taken when designing the two LANs, so that no single point of failure (such as a common power supply) is encountered, as such scenarios can bring down both LANs simultaneously.

PRP uses specialized nodes called doubly attached nodes (DANPs) for handling the duplicated frames. DANPs devices have an additional module at the link layer level, called the Link Redundancy Entity (LRE). LRE is responsible for duplicating frames and adding the specific PRP trailer when sending the frames out on the LAN, as well as making decisions on received frames as to which one is sent up the OSI stack to the application layer and which one is discarded. In essence LRE is responsible for making PRP transparent to the higher layers of the stack. There is a second type of specialized device used in PRP networks, called RedBox, with the role of connecting Single Attached Nodes (SANs) to a redundant network.

C650 relays implement only the DANP functionality. The RedBox functionality is not implemented.

The original standard IEC 62439-3 (2010) was amended to align PRP with the High availability Seamless Redundancy (HSR) protocol. To achieve this, the original PRP was modified at the cost of losing compatibility with the PRP 2010 version. The revised standard IEC 62439-3 (2012) is commonly referred to as PRP-1, while the original standard is PRP-0. The C650 relays support only PRP-1.

PRP can be enabled in configuration through a setting available on the network configuration menu (Product Setup? Communication Settings? Network (Ethernet), REDUNDANCY, which already has the capability of enabling Failover redundancy. When REDUNDANCY is set to PRP, the ports dedicated for PRP operate in redundant mode.

The rights associated with configuring PRP follow the security requirements for network configuration.

PRP management through SNMP MIB is not supported, as C650 doesn't currently support SNMP for configuration. Settings and actual values are only available through the front panel and through EnerVista.

The PRP solution to implement must ensure that performance requirements stated in IEC 61850-5 Clause 13 are still met. It is specified under Clause 13 (Message performance requirements) that messages of type 1A must meet the performance class P2/3, which is 3ms (See 3.7.1.1).

E.1.2 HSR

HSR defines a redundancy protocol for high availability in substation automation networks, based on PRP principles, provides the property of zero recovery time, typically used in ring topology but applicable to any topology.

In the C650 relay, HSR is implemented in devices with communication option number K (for Fiber; 100 Base Fx) and M (for cooper; Base 100 Tx). A frame is sent over both ports. A destination should receive, in the fault-free state, two identical frames within a certain time skew, forward the first frame to the application and discard the second frame when (and if) it comes. A sequence number is used to recognize such duplicates.

In contrast to PRP (IEC 62439-3- Clause 4), with which it shares the operating principle, HSR nodes are arranged into a ring, which allows the network to operate without dedicated switches, since every node is able to forward frames from port to port. HSR originally meant "High-availability Seamless Ring", but HSR is not limited to a simple ring topology.

Redundant connections to other HSR rings and to PRP networks are possible.

E.2 RSTP (IEEE 802.1D-2004) and daisy chain

E.2.1 RSTP description

The Rapid Spanning Tree Protocol (RTSP), like STP, was designed to avoid loops in an Ethernet network. Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w) is an evolution of the Spanning Tree Protocol (STP) (802.1d standard) and provides for faster spanning tree convergence after a topology change.

E.2.2 RSTP concepts

The IEEE 802.1d Spanning Tree Protocol (STP) was developed to allow the construction of robust networks that incorporate redundancy while pruning the active topology of the network to prevent loops. While STP is effective, it requires that frame transfer must halt after a link outage until all bridges in the network are sure to be aware of the new topology.

Using STP (IEEE 802.1d) recommended values, this period lasts 30 seconds. The Rapid Spanning Tree Protocol (IEEE 802.1w) is a further evolution of the 802.1d Spanning Tree Protocol. It replaces the settling period with an active handshake between switches (bridges) that guarantees topology information to be rapidly propagated through the network. RSTP converges in less than one second. RSTP also offers a number of other significant innovations. These include:

- Topology changes in STP must be passed to the root bridge before they can be propagated to the network. Topology changes in RSTP can be originated from and acted upon by any designated switch (bridge), leading to more rapid propagation of address information
- STP recognizes one state - blocking for ports that should not forward any data or information. RSTP explicitly recognizes two states or blocking roles - alternate and backup port including them in computations of when to learn and forward and when to block
- STP relays configuration messages received on the root port going out of its designated ports. If an STP switch (bridge) fails to receive a message from its neighbor it cannot be sure where along the path to the root a failure occurred. RSTP switches (bridges) generate their own configuration messages, even if they fail to receive one from the root bridge. This leads to quicker failure detection
- RSTP offers edge port recognition, allowing ports at the edge of the network to forward frames immediately after activation while at the same time protecting them against loops
- An improvement in RSTP allows configuration messages to age more quickly preventing them from “going around in circles” in the event of a loop RSTP has three states. They are discarding, learning and forwarding.

The discarding state is entered when the port is first taken into service. The port does not learn addresses in this state and does not participate in frame transfer. The port looks for STP traffic in order to determine its role in the network. When it is determined that the port plays an active part in the network, the state changes to learning. The learning state is entered when the port is preparing to play an active member of the network. The port learns addresses in this state but does not participate in frame transfer. In a network of RSTP switches (bridges) the time spent in this state is usually quite short. RSTP switches (bridges) operating in STP compatibility mode spend between 6 to 40 seconds in this state. After 'learning' the bridge places the port in the forwarding state. While in this state the port both learn addresses and participates in frame transfer while in this state. The result of these enhanced states is that the IEEE 802.1d version of spanning tree (STP) can take a fairly long time to resolve all the possible paths and to select the most efficient path through the network. The IEEE 802.1w Rapid reconfiguration of Spanning Tree significantly reduces the amount of time it takes to establish the network path. The result is reduced network downtime and improved network robustness. In addition to faster network reconfiguration, RSTP also implements greater ranges for port path costs to accommodate the higher connection speeds that are being implemented.
Proper implementations of RSTP (by switch vendors) is designed to be compatible with IEEE 802.1d STP. GE recommends that you employ RSTP or STP in your network.

E.2.3 Use in meshed networks

One great strength of RSTP is its support for all kinds of meshed topologies. The resulting flexibility regarding the installation is a clear advantage over the stringent restrictions that are imposed by ring protocols such as MRP and ring installations. However, this flexibility harbors one great disadvantage, namely the reconfiguration time, which for an interconnected network depends – among other things – on the complexity of the network topology and the location in the network at which the failure occurred. Since RSTP is a decentralized protocol, it may also provoke highly unpredictable race conditions in the establishment of new communications paths, particularly when choosing a new root bridge. This gives rise to network reconfiguration times that can be estimated only very roughly, and this does restrict the use of RSTP, particularly in meshed networks. In the case of meshed networks with very little complexity (such as ring networks with two or three additional loops or sub-rings), a detailed analysis can make it possible to determine upper limits, but these always need to be worked out individually. Unlike with the protocols MRP, HSR and PRP, it is not possible to make a general statement.

E.2.4 Daisy chain

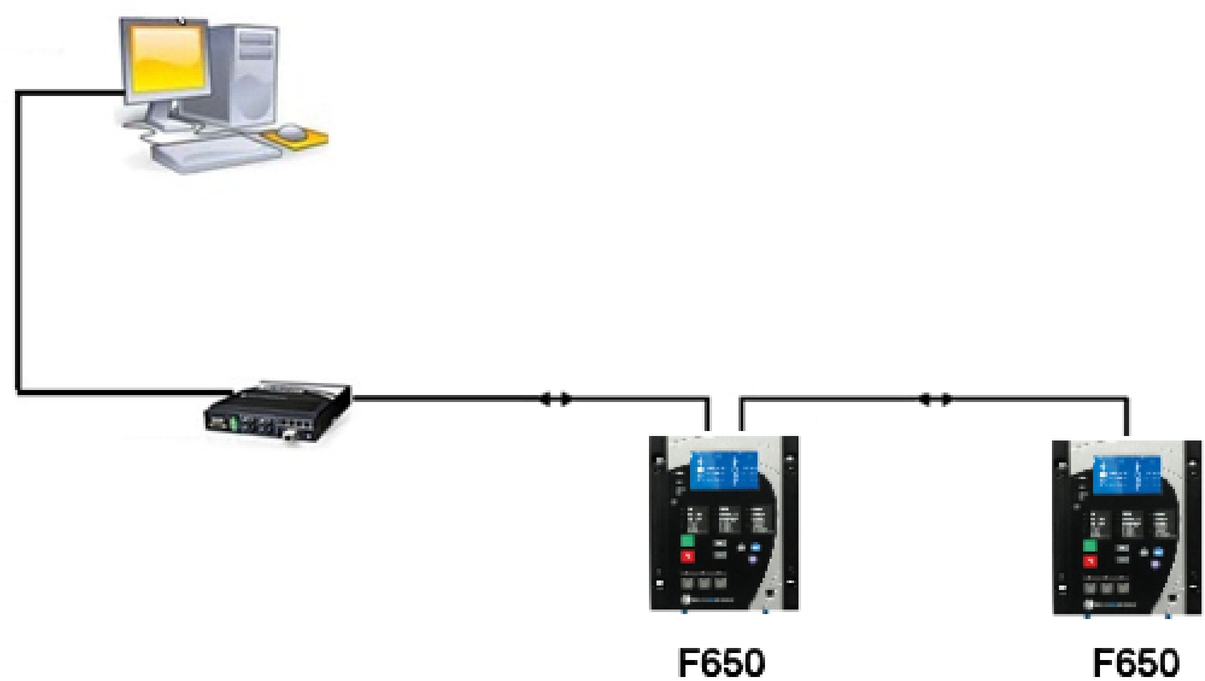
A daisy chain is an interconnection of devices where each device is connected in series to the next.

With an Ethernet daisy-chain redundancy selected, the C650 has two Ethernet ports and it is working as an Ethernet unmanaged switch. The two Ethernet ports are used for connecting each device to the ports of its two neighboring devices.

Each device in the daisy chain forwards the message until it reaches the destination.

Ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one.

Note: It is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.



E.3 Link loss alert (LLA)

E.3.1 LLA

(Link Loss Alert) operation: The operation of ports A and B are as follows:

Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

E.3.2 LLA priority

If this setting is set to enabled, the port A has the priority. If PORT A's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

E.3.3 LLA timeout

This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TOIMEOUT value, the switch over to primary port is automatic.

If the setting LLA PRIORITY is enabled:

- The primary port is port A while secondary (redundant) port is port B.
- The primary port is always used if available.
- If the link on primary port is lost switch over to secondary port occurs immediately.
- When the link on primary port is detected again, there is a monitoring timeout (LLA TIMEOUT) for the health of the network. After that period the communication switch over to primary port automatically.

If the setting LLA PRIORITY is disabled:

- There is no priority, therefore there is no primary port. The communication switch over from one Port to the other occurs when the link fails.
- In this case the LLA TIMEOUT setting does not act.

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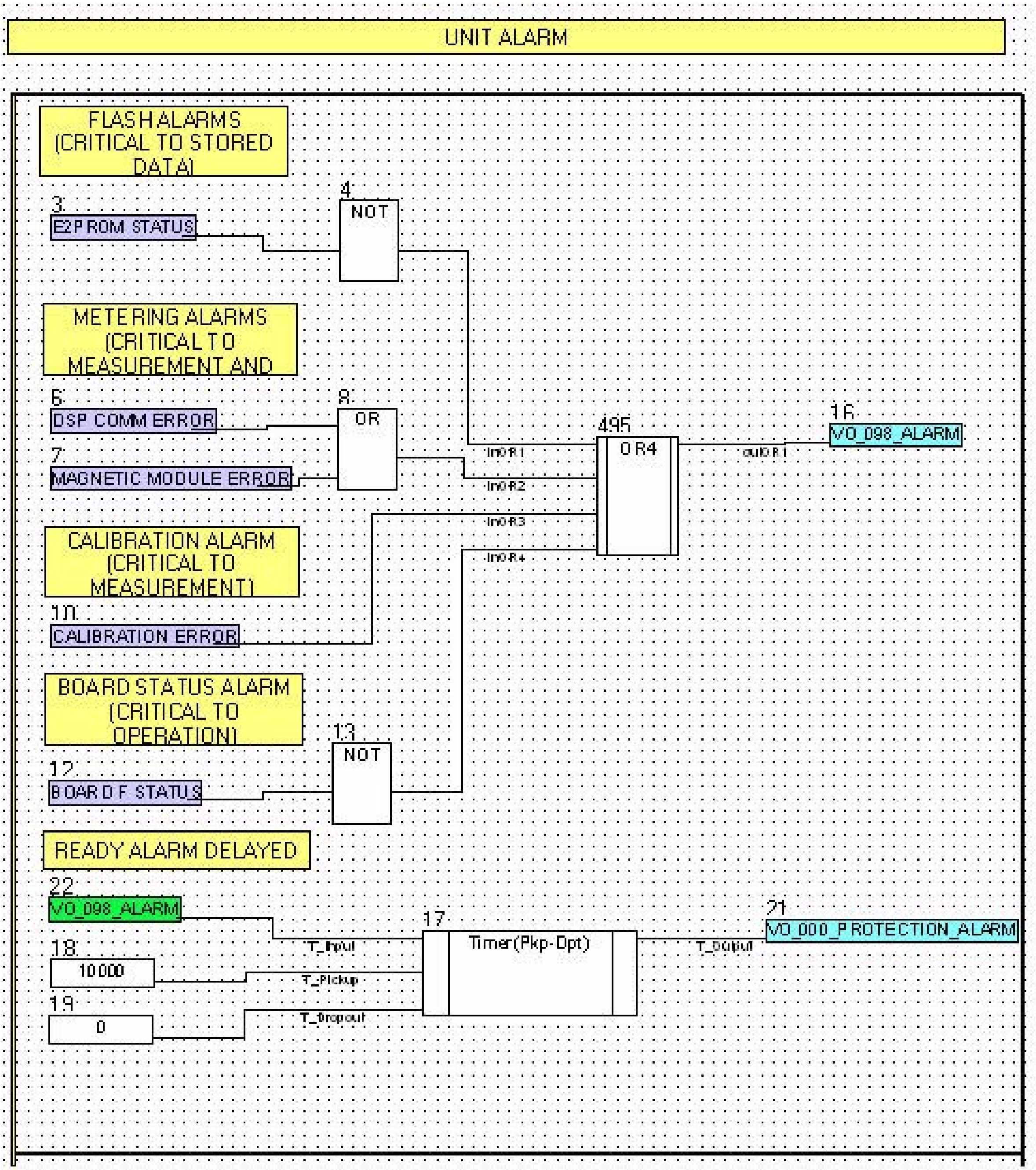
Appendix F: Factory default logic

F.1 Factory default logic



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Appendix G: Factory default configuration

G.1 Factory default settings

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 octet of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octet of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octet of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octet of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octet of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octet of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octet of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octet of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
1st octet of Gateway	Gateway IP Oct1	0	N/A	[0 : 255]	
2nd octet of Gateway	Gateway IP Oct2	0	N/A	[0 : 255]	
3rd octet of Gateway	Gateway IP Oct3	0	N/A	[0 : 255]	
4th octet of Gateway	Gateway IP Oct4	0	N/A	[0 : 255]	
**For firmware versions 7.10 or higher; the Network settings are the ethernet communication parameters are as follow					

Product Setup > Communication Settings > Network (Ethernet)					
Network (Ethernet)1 > Network (Ethernet)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
1st octet of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octet of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octet of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octet of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octet of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octet of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octet of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octet of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
**For firmware versions 7.10 or higher; on the Network settings are also located the settings for Redundancy.					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]	
Establish priority for Port A	LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]	
Switch over time from port B to port A	LLA Timeout	5000	N/A	[0 : 600000]	
Switch (bridge) priority value	RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]	
determine which ports are used for forwarding	RSTP PORT A PRIORITY	128	N/A	[0 : 240]	
assigned port cost value used for the switch	RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]	
Determine which ports are used for forwarding	RSTP PORT B PRIORITY	128	N/A	[0 : 240]	
Assigned port cost value used for the switch	RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]	

Product Setup > Communication Settings > Modbus Protocol					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Slave address for COM1	Modbus Address COM1	254	N/A	[1 : 255]	
Slave address for COM2	Modbus Address COM2	254	N/A	[1 : 255]	
Modbus port number for Modbus TCP/IP	Modbus Port Number	502	N/A	[0 : 65535]	

Product Setup > Communication Settings >DNP3 Slave					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Communications port assigned to the DNP protocol	Physical Port	NONE	N/A	[COM1:COM2:NETWORK]	
DNP slave address	Address	255	N/A	[0 : 65534]	
1st Octect of IP address of DNP master 1	IP Addr Client1 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 1	IP Addr Client1 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 1	IP Addr Client1 Oct3	0	N/A	[0 : 255]	

4th Octect of IP address of DNP master 1	IP Addr Client1 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 2	IP Addr Client2 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 2	IP Addr Client2 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 2	IP Addr Client2 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 2	IP Addr Client2 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 3	IP Addr Client3 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 3	IP Addr Client3 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 3	IP Addr Client3 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 3	IP Addr Client3 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client4 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client4 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client4 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client4 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client5 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client5 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client5 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client5 Oct4	0	N/A	[0 : 255]	
TCP/UDP port number for DNP over Ethernet	TCP/UDP Port	20000	N/A	[0 : 65535]	
Unsolicited responses permission	Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]	
Time out to confirm an unsolicited response	Unsol Resp TimeOut	5	1 s	[0 : 60]	
Number of retransmissions of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	

Product Setup > Communication Settings > DNP3 Slave (CONT.)					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	
Default Analog Map permission	Default Analog Map	ENABLED	N/A	[ENABLED; DISABLE]	
DNP Analog Input Points point list	Analog Input Point 0	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 1	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 2	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 3	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 4	End of list	N/A		

DNP Analog Input Points point list	Analog Input Point 5	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 6	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 7	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 8	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 9	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 10	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 11	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 12	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 13	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 14	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 15	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 16	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 17	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 18	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 19	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 20	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 21	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 22	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 23	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 24	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 25	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 26	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 27	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 28	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 29	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 30	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 31	End of list	N/A		

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**
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**

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]	
Synchronization Event	Synchronization Event	0	0 N/A	[0 : 3600]	
1st Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]	

Product Setup > Communication Settings > IEC 870-5-104 (CONT.)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
3nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]	
Enable or disable the protocol operation	Function 2	DISABLED	N/A		
Listening TCP port in the relay	TCP Port 2	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU 2	255	N/A	[0 : 65535]	
1st Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]	
IEC104 SCALE CURRENT	IEC104 SCALE CURRENT	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]	
IEC104 SCALE VOLTAGE	IEC104 SCALE VOLTAGE	1			
IEC104 SCALE POWER	IEC104 SCALE POWER	1			
IEC104 SCALE ENERGY	IEC104 SCALE ENERGY	1			
IEC104 SCALE OTHER	IEC104 SCALE OTHER	1			
IEC104 DEADBAND CURRENT	IEC104 DEADBAND CURRENT	30000		[0 : 65535]	
IEC104 DEADBAND VOLTAGE	IEC104 DEADBAND VOLTAGE	30000		[0 : 65535]	
IEC104 DEADBAND POWER	IEC104 DEADBAND POWER	30000		[0 : 65535]	

Product Setup > Communication Settings > IEC 870-5-104 (CONT.)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
IEC104 DEADBAND ENERGY	IEC104 DEADBAND ENERGY	30000		[0 : 65535]	
IEC104 DEADBAND OTHER	IEC104 DEADBAND OTHER	30000		[0 : 65535]	
IEC104 IOA BINARIES	IEC104 IOA BINARIES	1000		[0 : 65535]	
IEC104 IOA DOUBLE POINTS	IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]	
IEC104 IOA ANALOGS	IEC104 IOA ANALOGS	2000		[0 : 65535]	
IEC104 IOA COUNTERS	IEC104 IOA COUNTERS	4000		[0 : 65535]	
IEC104 IOA COMMANDS	IEC104 IOA COMMANDS	3000		[0 : 65535]	
IEC104 IOA ANALOG PARAMETERS	IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]	

IEC 870-5-104 Notes	
Note 1: Cyclic Meter Period	**0 value means no spontaneous metering**

Product Setup > Communication Settings > SNTP					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Port used	UDP port	123	1	[1 : 65535]	
IP Address OCT 1	Server IP Oct 1	0	1	[1 : 255]	
IP Address OCT 2	Server IP Oct 2	0	1	[1 : 255]	
IP Address OCT 3	Server IP Oct 3	0	1	[1 : 255]	
IP Address OCT 4	Server IP Oct 4	0	1	[1 : 255]	

Product Setup > Communication Settings > PTP 1588					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	PTP FUNCTION	DISABLE		[DISABLE; ENABLE]	
Port A, B Path Delay Adder	PORTA DELAY ADDER	0		ns [0 : 60000]	
Port A Path Delay Asymmetry	PORTA DELAY ASYM	0		ns [-1000 : 1000]	
Port B Path Delay Adder	PORTB DELAY ADDER	0		ns [0 : 60000]	
Port B Path Delay Asymmetry	PORTB DELAY ASYM	0		ns [-1000 : 1000]	
Strict Power Profile	STRICT POWER PROFILE	DISABLED		DISABLED/ENABLED	
PTP domain number	PTP DOMAIN NUMBER	0		[0 : 255]	
PTP VLAN Priority	PTP VLAN PRIORITY	4		[0 : 7]	
PTP VLAN Identification	PTP VLAN ID	0		[0 : 4095]	
Reference time defining the origin of a time scale is termed the epoch.	PTP EPOCH	UTC SINCE 2000		UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900	

Product Setup > Communication Settings > Routing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
1st octet of Gateway	Default RT GWY Oct1	0	1	[0 : 255]	
2nd octet of Gateway	Default RT GWY Oct2	0	1	[0 : 255]	
3nd octet of Gateway	Default RT GWY Oct3	0	1	[0 : 255]	
4th octet of Gateway	Default RT GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct4	0	1	[0 : 255]	

sets the IP mask associated with the route	Static RT3 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct4	0	1	[0 : 255]	

sets the destination IPv4 route	Static RT6 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct4	0	1	[0 : 255]	
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 > Oscillography					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]	
Prefault	Trigger Position	30	1%	[5 : 95]	
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]	
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]	
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Setpoint > Product Setup > Data Logger					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min.]	
Data Logger analog channels X	Data Logger Chnl X	None	N/A	[1 to 16]	
Setpoint > Product Setup > Demand					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	

Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Product Setup > Time Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Local time zone offset Universal Coordinated Time	LOC. TIME OFFS. UTC	0	1	[-24,0 : 24,0]	
To follow DST rules	DAYLIG. SAVINGS TIME	DISABLED	NA	[DISBLED; ENABLED]	
Set the start month of the DST	DST START MONTH	MAR	MONTH	January to December	
Set the start weekday of the DST	DST START WEEKDAY	SUNDAY	DAY	Monday to Sunday	
Set the start day instance	DST START DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the starting hour of the DST	DST START HOUR	2	1	[0 : 23]	
Set the Stop month of the DST	DST STOP MONTH	OCT	Month	January to December	
Set the stop weekday of the DST	DST STOP WEEKDAY	SUNDAY	Day	Monday to Sunday	
Set the stop day instance	DST STOP DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the stop hour of the DST	DST STOP HOUR	2	1	[0 : 23]	
IRIG-B local time	IRIG-B LOCAL TIME	OFF	NA	[ON; OFF]	
Function permission	IRIGB Function	DISABLED	NA	ENABLLED; DISABLED	
Establish the sync priority	PTP IRIGB Priority	PTP-1588	NA	PTP-1588; IRIG_B	

Setpoint > System Setup > General Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]	
Rated Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	
Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Primary meter units	Primary meter units	kA_kV	NA	A_V; kA_kV	
Device name	Device name	NA	NA	NA	

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 > System Setup > Miscellaneous					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Relay out of service status	Relay Out Of Service	ENABLED	N/A	[DISABLED – ENABLED]	
Set to local or remote	Local/Remote Blocked	OFF	N/A	ON; OFF	
Active language on the relay	Active Language	0	N/A	[0 : 1]	

Setpoint > Control Elements > Synchrocheck

Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Autoreclose					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Setpoint > Control Elements > Breaker Failure					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Supervision (retrip) pickup level	Supervision Pickup	1.00	0.01 A	[0.05 : 160.00]	
Hiset pickup level	Hiset Pickup	5.00	0.01 A	[0.05 : 160.00]	
Lowset pickup level	Lowset Pickup	2.00	0.01 A	[0.05 : 160.00]	
Internal arc pickup level	Internal Arc Pickup	0.10	0.01 A	[0.05 : 160.00]	
Internal arc time delay	Internal Arc Delay	10.00	0.01 s	[0.00 : 900.00]	
Retrip time delay	Supervision Delay	10.00	0.01 s	[0.00 : 900.00]	
Hiset time delay	HiSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Lowset time delay	LowSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Second stage time delay	2nd Step Delay	10.00	0.01 s	[0.00 : 900.00]	
WITHOUT current element time delay	No Current Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Pulse Counters					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]	
Name of the pulse counter	CntPulses Name X	Pulse Counter 1	N/A	N/A	
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]	
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]	
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]	
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]	
Note: X is the pulse counter index, up to 8.					

Setpoint > Control Elements > Analog Comparators					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]	
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]	
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]	
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]	
Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	OUT	N/A	[IN-OUT]	
Note: X is the analog comparator index, up to 20					

Setpoint > Control Elements > Digital Counters					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	DigCnt 1 Function	DISABLED	NA		
Digital Counter 1 name	DigCnt 1 Name		NA		
Digital counter 1 Preset	DigCnt 1 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 1 Compare	DigCnt 1 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 2 Function	DISABLED	NA		
Digital Counter 2 name	DigCnt 2 Name		NA		
Digital counter 2 Preset	DigCnt 2 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 2 Compare	DigCnt 2 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 3 Function	DISABLED	NA		
Digital Counter 3 name	DigCnt 3 Name		NA		
Digital counter 3 Preset	DigCnt 3 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 3 Compare	DigCnt 3 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 4 Function	DISABLED	NA		
Digital Counter 4 name	DigCnt 4 Name		NA		
Digital counter 4 Preset	DigCnt 4 Preset	0	1	[-2147483648 : 2147483647]	

Digital counter 4 Compare	DigCnt 4 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 5 Function	DISABLED	NA		
Digital Counter 5 name	DigCnt 5 Name		NA		
Digital counter 5 Preset	DigCnt 5 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 5 Compare	DigCnt 5 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 6 Function	DISABLED	NA		
Digital Counter 6 name	DigCnt 6 Name		NA		
Digital counter 6 Preset	DigCnt 6 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 6 Compare	DigCnt 6 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 7 Function	DISABLED	NA		
Digital Counter 7 name	DigCnt 7 Name		NA		
Digital counter 7 Preset	DigCnt 7 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 7 Compare	DigCnt 7 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 8 Function	DISABLED	NA		
Digital Counter 8 name	DigCnt 8 Name		NA		
Digital counter 8 Preset	DigCnt 8 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 8 Compare	DigCnt 8 Compare	0	1	[-2147483648 : 2147483647]	
Snapshot Event Generation	Snapshot Events	ENABLED	NA	[ENABLED; DISABLED]	

Setpoint > Inputs/Outputs > Contact I/O >					
Board F > Board G > Board H > Board J >Board 2h > Board 2j					
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]	

<table>
<tr><th colspan="4">Note 2: Description of X, Y and Z in input/output boards</th></tr>
<tr><td rowspan="2">X</td><td colspan="3">F, G, H, J, 2H, or 2J the I/O board name, depending on the Relay model.</td></tr>
<tr><td colspan="3">F and G are internal Relay boards, and H, J, 2H, and 2J are additional boards available in CIO modules (remote Bus CAN I/O module).</td></tr>
<tr><td rowspan="7">For the I/O board selection in the relay model:</td><td colspan="3">I/O BOARD TYPE</td></tr>
<tr><td>ASSOCIATED DIGIT</td><td>ENERVISTA 650 SETUP BOARD SETTINGS</td><td>BOARD TYPE</td></tr>
<tr><td>0</td><td>NONE</td><td>None</td></tr>
<tr><td>1</td><td>16 INP+ 8 OUT</td><td>Mixed</td></tr>
<tr><td>2</td><td>8 INP +8 OUT +SUPV</td><td>Supervision</td></tr>
<tr><td>4</td><td>32 INP</td><td>32 digital inputs</td></tr>
<tr><td>5</td><td>16 INP + 8 ANA</td><td>16 digital inputs + 8 analog inputs</td></tr>
<tr><td rowspan="4">CCY</td><td colspan="3">Is the name used for inputs in I/O boards</td></tr>
<tr><td colspan="3">Mixed, 16 digital inputs: CC1....CC16</td></tr>
<tr><td colspan="3">Supervision: 8 digital inputs: CC1,..., CC8</td></tr>
<tr><td colspan="3">32 INP: 32 digital inputs; CC1,...,CC32</td></tr>
<tr><td>0Z</td><td colspan="3">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)</td></tr>
</table>

Setpoint > Inputs/Outputs > Remote Comms					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]	
SETTING DESCRIPTION FOR GSSE					
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]	
Device Identification	650 ID	C650	N/A		
Hold time signal send by the transmitting device	Hold Time	10000	1 ms	[1000 : 60000]	
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]	
Remote Device Description	Remote Device X	Remote Device X	N/A		
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
SETTING DESCRIPTION FOR GOOSE					
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
Note: X is the Remote Device index, up to 32					

G.2 Factory default configuration

Note:

SOURCE COLUMN

This column allows the user to select the simple or complex (OR signal/virtual output) operand that activates the selected elements for configuration of the relay.

If more than one operand is selected, the relay performs an OR gate to activate the selected element.

SIGNAL LOGIC COLUMN

This refers to each individual signal selected on its left. NOT legend means that the signal is inverted.

SOURCE LOGIC COLUMN

This refers to the whole SOURCE signal selected on its left. NOT legend means that the signal is inverted. If more than one operand is 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 OPER_F_01	VO_000_PROTECTION_ALARM		
CONT OP OPER_F_02	Not Configured			
CONT OP OPER_F_03	Not Configured			
CONT OP OPER_F_04	Not Configured			
CONT OP OPER_F_05	Not Configured			
CONT OP OPER_F_06	Not Configured			
CONT OP OPER_F_07	Not Configured			
CONT OP OPER_F_08	Not Configured			
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			

SETPOINT > RELAY CONFIGURATION > OUTPUTS				
OUTPUT ID	OUTPUT NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
CONT OP RESET_G_04	Not Configured			
CONT OP RESET_G_05	Not Configured			
CONT OP RESET_G_06	Not Configured			
CONT OP RESET_G_07	Not Configured			
CONT OP RESET_G_08	Not Configured			

SETPOINT > RELAY CONFIGURATION > LEDS				
LED	SOURCE	SOURCE LOGIC	LOGIC	LED NAME
LED01	VO_000_PROTECTION_ALARM	PROT ALARM		
LED02	Not Configured			
LED03	Not Configured			
LED04	Not Configured			
LED05	Not Configured			
LED06	Not Configured			
LED07	Not Configured			
LED08	Not Configured			
LED09	Not Configured			
LED10	Not Configured			
LED11	Not Configured			
LED12	Not Configured			
LED13	Not Configured			
LED14	Not Configured			
LED15	Not Configured			

SETPOINT > RELAY CONFIGURATION > OSCILLOGRAPHY				
DIGITAL CHANNEL	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
DIG_CHANNEL#1	Not Configured	Not Configured		
DIG_CHANNEL#2	Not Configured	Not Configured		
DIG_CHANNEL#3	Not Configured	Not Configured		
DIG_CHANNEL#4	Not Configured	Not Configured		
DIG_CHANNEL#5	Not Configured	Not Configured		
DIG_CHANNEL#6	Not Configured	Not Configured		
DIG_CHANNEL#7	Not Configured	Not Configured		
DIG_CHANNEL#8	Not Configured	Not Configured		
DIG_CHANNEL#9	Not Configured	Not Configured		
DIG_CHANNEL#10	Not Configured	Not Configured		
DIG_CHANNEL#11	Not Configured	Not Configured		
DIG_CHANNEL#12	Not Configured	Not Configured		
DIG_CHANNEL#13	Not Configured	Not Configured		
DIG_CHANNEL#14	Not Configured	Not Configured		
DIG_CHANNEL#15	Not Configured	Not Configured		
DIG_CHANNEL#16	Not Configured	Not Configured		
OSCILLO TRIGGER	Not Configured	Not Configured		

SETPOINT > RELAY CONFIGURATION > OPERATIONS			
OPERATION	**OPERATION TEXT**	**SETTINGS**	**VALUE/SOURCE**
Operation1	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
Operation2	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
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

SETPOINT > RELAY CONFIGURATION > OPERATIONS			
OPERATION	**OPERATION TEXT**	**SETTINGS**	**VALUE/SOURCE**
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
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 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		

C650 Bay Controller & Monitoring System

Appendix H: Miscellaneous

H.1 Warranty

For products shipped as of 1 October 2013, GE warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at https://www.gegridsolutions.com/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies.

H.2 Revision History

MANUAL P/N	RELEASE DATE
113541A	2009
113541B	2011
113541C	July 2015
113541D	December 2018
1601-0801-A1	November 2020
1601-0801-A2	March 2021

H.2.1 Major Updates

For information on the updates included in this release of the C650 Bay Controller & Monitoring System, please refer to the latest release notes for Firmware version 7.7x, EnerVista F650 Setup version 8.1x online.