



# Digital Bay Controller

## Instruction manual

### GEK-106310N



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## 1. GETTING STARTED

### 1.1 IMPORTANT PROCEDURES

1.1.1	CAUTIONS AND WARNINGS .....	1-1
1.1.2	INSPECTION CHECKLIST .....	1-4
1.1.3	SAFETY INSTRUCTIONS .....	1-6

### 1.2 OVERVIEW

1.2.1	INTRODUCTION TO 650 FAMILY OF RELAYS .....	1-7
1.2.2	HARDWARE ARCHITECTURE .....	1-7
1.2.3	SOFTWARE ARCHITECTURE .....	1-8
1.2.4	COMMUNICATIONS ARCHITECTURE .....	1-8

### 1.3 ENERVISTA 650 SETUP SOFTWARE

1.3.1	SYSTEM REQUIREMENTS .....	1-10
1.3.2	INSTALLATION .....	1-10
1.3.3	CONNECTING WITH THE UNIT .....	1-15
1.3.4	COMMUNICATIONS .....	1-16

## 2. PRODUCT DESCRIPTION

### 2.1 OVERVIEW

2.1.1	F650 OVERVIEW .....	2-1
-------	---------------------	-----

### 2.2 SUMMARY

2.2.1	ANSI DEVICE NUMBERS AND FUNCTIONS .....	2-2
-------	---	-----

### 2.3 ORDERING CODE

### 2.4 TECHNICAL SPECIFICATIONS

2.4.1	PROTECTION UNITS .....	2-6
2.4.2	CONTROL .....	2-16
2.4.3	MONITORING .....	2-17
2.4.4	USER –PROGRAMMABLE ELEMENTS .....	2-19
2.4.5	METERING .....	2-20
2.4.6	INPUTS .....	2-21
2.4.7	REAL TIME CLOCK .....	2-23
2.4.8	OUTPUTS .....	2-23
2.4.9	CONTROL POWER SUPPLY .....	2-24
2.4.10	COMMUNICATIONS .....	2-24
2.4.11	ENVIRONMENTAL CHARACTERISTICS .....	2-25
2.4.12	PACKAGING AND WEIGHT .....	2-26
2.4.13	TYPE TESTS .....	2-26
2.4.14	APPROVALS .....	2-26

### 2.5 EXTERNAL CONNECTIONS

## 3. HARDWARE

### 3.1 MODULE DESCRIPTION

### 3.2 MECHANICAL DESCRIPTION

3.2.1	MOUNTING .....	3-3
3.2.2	REAR DESCRIPTION .....	3-5

### 3.3 WIRING

3.3.1	EXTERNAL CONNECTIONS .....	3-9
3.3.2	DIGITAL INPUTS WITH TRIP CIRCUIT SUPERVISION .....	3-9
3.3.3	CABLE/FIBER ETHERNET BOARD .....	3-9

### 3.4 OPTIC FEATURES

### 3.5 TRANSCEIVER OPTICAL POWER BUDGET VERSUS LINK LENGTH

#### 4. HUMAN INTERFACES, SETTINGS & ACTUAL VALUES

##### 4.1 ENERVISTA 650 SETUP SOFTWARE INTERFACE

4.1.1	OVERVIEW .....	4-1
4.1.2	MAIN SCREEN .....	4-2
4.1.3	STARTING COMMUNICATION .....	4-3
4.1.4	FILE MANAGEMENT .....	4-7
4.1.5	ENERVISTA 650 SETUP MENUS STRUCTURE .....	4-12
4.1.6	FILE MENU OVERVIEW .....	4-13
4.1.7	SETTINGS MENU OVERVIEW .....	4-17
4.1.8	ACTUAL VALUES MENU OVERVIEW .....	4-26
4.1.9	OPERATIONS MENU OVERVIEW .....	4-31
4.1.10	COMMUNICATION MENU OVERVIEW .....	4-31
4.1.11	SECURITY MENU OVERVIEW .....	4-32
4.1.12	VIEW MENU OVERVIEW .....	4-32
4.1.13	HELP MENU OVERVIEW .....	4-32

##### 4.2 HUMAN MACHINE INTERFACE (HMI)

4.2.1	DISPLAY .....	4-33
4.2.2	FRONT LED INDICATORS .....	4-34
4.2.3	PUSHBUTTONS .....	4-34
4.2.4	FRONT PORT AND COVER SEALING SYSTEM .....	4-35
4.2.5	TEXT MENUS .....	4-36
4.2.6	GRAPHIC DISPLAY .....	4-55

##### 4.3 WEB SERVER

4.3.1	HOME .....	4-64
4.3.2	SNAPSHOT EVENTS .....	4-65
4.3.3	CONTROL EVENTS .....	4-66
4.3.4	ALARMS .....	4-67
4.3.5	OSCILLOGRAPHY .....	4-68
4.3.6	FAULT REPORT .....	4-69
4.3.7	DATA LOGGER .....	4-70
4.3.8	METERING .....	4-71

#### 5. SETTINGS

##### 5.1 OVERVIEW

5.1.1	SETTING MAIN MENU .....	5-1
-------	-------------------------	-----

##### 5.2 PRODUCT SETUP

5.2.1	COMMUNICATION SETTINGS .....	5-3
5.2.2	MODBUS USER MAP .....	5-6
5.2.3	FAULT REPORT .....	5-6
5.2.4	OSCILLOGRAPHY .....	5-9
5.2.5	DATA LOGGER .....	5-12
5.2.6	DEMAND .....	5-14

##### 5.3 SYSTEM SETUP

5.3.1	GENERAL SETTINGS .....	5-20
5.3.2	FLEX CURVES .....	5-20
5.3.3	BREAKER .....	5-22
5.3.4	SWITCHGEAR .....	5-24

##### 5.4 PROTECTION ELEMENTS

5.4.1	CHANGE OF SETTING TABLES IN F650 ELEMENTS .....	5-25
5.4.2	INVERSE TIME CURVES CHARACTERISTICS .....	5-29
5.4.3	PHASE CURRENT .....	5-39
5.4.4	NEUTRAL CURRENT .....	5-50
5.4.5	GROUND CURRENT .....	5-56
5.4.6	SENSITIVE GROUND CURRENT .....	5-59
5.4.7	NEGATIVE SEQUENCE CURRENT .....	5-64
5.4.8	VOLTAGE ELEMENTS .....	5-65
5.4.9	POWER .....	5-70

##### 5.5 CONTROL ELEMENTS

5.5.1	SETTING GROUP .....	5-77
5.5.2	UNDERFREQUENCY ELEMENT (81U) .....	5-78
5.5.3	OVERFREQUENCY ELEMENT (81O) .....	5-78
5.5.4	SYNCHRONISM CHECK ELEMENT - SYNCHROCHECK (25) .....	5-79

## TABLE OF CONTENTS

5.5.5	AUTORECLOSE (79).....	5-87
5.5.6	BREAKER FAILURE ELEMENT (50BF).....	5-94
5.5.7	VT FUSE FAILURE ELEMENT (VTFF) .....	5-97
5.5.8	BROKEN CONDUCTOR.....	5-98
5.5.9	LOCKED ROTOR .....	5-99
<b>5.6 INPUTS/OUTPUTS</b>		
5.6.1	INPUT/OUTPUT PLACEMENT.....	5-101
5.6.2	CONTROL SETTINGS FOR INPUTS/OUTPUTS.....	5-102
5.6.3	INPUTS.....	5-104
5.6.4	OUTPUTS .....	5-106
5.6.5	CIRCUIT SUPERVISION AND CONTACT SEAL-IN CIRCUITS .....	5-108
5.6.6	ANALOG BOARDS SPECIFIC SETTINGS .....	5-118
5.6.7	VIRTUAL INPUTS.....	5-119
5.6.8	VIRTUAL OUTPUTS.....	5-119
<b>5.7 TESTINGS</b>		
5.7.1	FORCE IO –INPUT TESTING .....	5-120
5.7.2	FORCE IO –OUTPUT TESTING .....	5-120
<b>5.8 RELAY CONFIGURATION</b>		
5.8.1	OUTPUTS .....	5-121
5.8.2	LEDS.....	5-122
5.8.3	OPERATIONS.....	5-123
5.8.4	PROTECTION ELEMENTS .....	5-127
5.8.5	OSCILLOGRAPHY .....	5-128
5.8.6	CONTROL EVENTS .....	5-129
5.8.7	SWITCHGEAR .....	5-131
5.8.8	HMI (HUMAN-MACHINE INTERFACE).....	5-132
<b>5.9 LOGIC CONFIGURATION (PLC EDITOR)</b>		
5.9.1	INTRODUCTION.....	5-135
5.9.2	THEORY OF OPERATION .....	5-136
5.9.3	MAIN MENU.....	5-139
5.9.4	CONFIGURATION GENERATION .....	5-140
5.9.5	GENERATION OF LIBRARIES .....	5-141
5.9.6	EXAMPLE OF APPLICATION .....	5-143

## 6. ACTUAL VALUES

### 6.1 FRONT PANEL

6.1.1	LEDS.....	6-1
-------	-----------	-----

### 6.2 STATUS

6.2.1	OPERATION BITS.....	6-2
6.2.2	BREAKER .....	6-2
6.2.3	PROTECTION.....	6-2
6.2.4	CONTROL ELEMENTS .....	6-8
6.2.5	PROTECTION SUMMARY .....	6-13
6.2.6	SNAPSHOT EVENTS SUMMARY.....	6-14
6.2.7	MODBUS USER MAP.....	6-15
6.2.8	SWITCHGEAR STATUS.....	6-16
6.2.9	CALIBRATION .....	6-17
6.2.10	FLEX CURVES .....	6-18
6.2.11	SYSTEM INFO.....	6-18
6.2.12	RECORD STATUS .....	6-18

### 6.3 METERING

6.3.1	PRIMARY VALUES.....	6-22
6.3.2	SECONDARY VALUES .....	6-25
6.3.3	PHASOR DIAGRAM .....	6-27
6.3.4	FREQUENCY.....	6-27
6.3.5	INPUTS / OUTPUTS.....	6-28

### 6.4 RECORDS

6.4.1	EVENT RECORDER.....	6-34
6.4.2	WAVEFORM CAPTURE .....	6-36
6.4.3	FAULT REPORT.....	6-37
6.4.4	DATA LOGGER .....	6-39

## TABLE OF CONTENTS

<b>7. IEC 61850 PROTOCOL</b>	<b>7.1 IEC61850 GENERIC SUBSTATION STATE EVENT (GSSE)</b>
	7.1.1 REMOTE DEVICES.....7-1
	7.1.2 REMOTE INPUTS .....7-3
	7.1.3 REMOTE OUTPUTS .....7-4
	<b>7.2 IEC 61850 PROFILE FOR F650</b>
	7.2.1 INTRODUCTION .....7-6
	7.2.2 ACSI CONFORMANCE STATEMENT .....7-6
	7.2.3 LOGICAL NODES .....7-11
	7.2.4 COMMON DATA CLASS.....7-29
	7.2.5 DATASETS.....7-44
	7.2.6 MAPPINGS BETWEEN TOC CURVES IN IEC 61850 AND F650 RELAY IMPLEMENTATION. 7-46
	7.2.7 UNIDADES Y ESCALAS DE LOS DATOS ANALÓGICOS .....7-47
<b>8. SECURITY</b>	<b>8.1 ADDING USERS</b>
	8.1.1 USER RIGHTS .....8-1
	<b>8.2 CHANGING PASSWORDS</b>
	<b>8.3 ENABLING SECURITY</b>
	<b>8.4 LOGGING INTO ENERVISTA 650 SETUP</b>
<b>9. BOOTCODE AND FIRMWARE UPGRADE</b>	<b>9.1 INTRODUCTION</b>
	9.1.1 COMMUNICATION PARAMETERS.....9-2
	<b>9.2 BOOT CODE UPGRADE</b>
	<b>9.3 FIRMWARE VERSION UPGRADE</b>
	9.3.1 FIRMWARE UPGRADE .....9-9
	<b>9.4 STEP LIST SUMMARY FOR VERSIONS 1.70 AND LATER</b>
	9.4.1 BOOT CODE UPGRADE (*).....9-12
	9.4.2 FIRMWARE UPGRADE (*).....9-12
<b>10. COMMISSIONING</b>	<b>10.1 VISUAL INSPECTION</b>
	<b>10.2 GENERAL CONSIDERATIONS ON THE POWER SUPPLY NETWORK</b>
	<b>10.3 ISOLATION TESTS</b>
	<b>10.4 INDICATORS</b>
	<b>10.5 POWER SUPPLY TESTING</b>
	<b>10.6 COMMUNICATIONS</b>
	<b>10.7 VERIFICATION OF MEASURE</b>
	10.7.1 VOLTAGES .....10-7
	10.7.2 PHASE CURRENTS.....10-7
	10.7.3 ACTIVE, REACTIVE POWER, AND COSJ METERING .....10-8
	10.7.4 FREQUENCY .....10-8
	<b>10.8 INPUTS AND OUTPUTS</b>
	10.8.1 DIGITAL INPUTS.....10-9
	10.8.2 CONTACT OUTPUTS.....10-10
	10.8.3 CIRCUIT CONTINUITY SUPERVISION INPUTS .....10-10
	10.8.4 LATCHING CIRCUITS.....10-10

<b>10.9 CONNECTIONS FOR TESTING PROTECTION ELEMENTS</b>	
<b>10.10 INSTANTANEOUS OVERCURRENT (50PH, 50PL, 50N, 50G Y 50SG)</b>	
<b>10.11 INVERSE TIME OVERCURRENT (51PH, 51PL, 51N, 51G Y 46)</b>	
<b>10.12 DIRECTIONAL ELEMENTS (67P, 67N, 67G, 67SG)</b>	
10.12.1 67P ELEMENT .....	10-14
10.12.2 67N ELEMENT .....	10-14
10.12.3 67G ELEMENT .....	10-15
10.12.4 67SG ELEMENT .....	10-16
<b>10.13 UNDERVOLTAGE ELEMENTS (27P, 27X)</b>	
10.13.1 27P ELEMENT .....	10-17
10.13.2 27X ELEMENT .....	10-17
<b>10.14 OVERVOLTAGE ELEMENTS (59P, 59X, 59NH, 59NL, 47)</b>	
10.14.1 59P ELEMENT .....	10-18
10.14.2 59X ELEMENT .....	10-18
10.14.3 59NH AND 59NL ELEMENTS .....	10-19
10.14.4 47 ELEMENT - NEG SEQ OV .....	10-20
<b>10.15 FREQUENCY ELEMENTS (81O/81U)</b>	
<b>10.16 RECLOSER (79)</b>	
10.16.1 RECLOSING CYCLE .....	10-22
10.16.2 RECLOSER STATUSES .....	10-23
10.16.3 EXTERNAL RECLOSE INITIATION .....	10-23
<b>10.17 THERMAL IMAGE ELEMENT (49)</b>	

## 11. APPLICATION EXAMPLES

### 11.1 EXAMPLE1: COMMUNICATION & PROTECTION SETTINGS PROCEDURE

11.1.1 DESCRIPTION OF THE EXERCISE .....	11-1
11.1.2 PROCEDURE TO COMMUNICATE WITH THE RELAY .....	11-1
11.1.3 PROCEDURE TO SET THE PROTECTION FUNCTION .....	11-3
11.1.4 TEST .....	11-4

### 11.2 EXAMPLE 2: TOC PROTECTION + RECLOSING SETTINGS PROCEDURE

11.2.1 DESCRIPTION OF THE EXERCISE .....	11-5
11.2.2 PROCEDURE TO COMMUNICATE THE RELAY .....	11-5
11.2.3 PROCEDURE TO SET THE PROTECTION FUNCTION .....	11-5
11.2.4 PROCEDURE TO SET THE RECLOSER .....	11-6
11.2.5 PROCEDURE TO SET THE SYNCHRO CHECK .....	11-6

### 11.3 EXAMPLE Nº 3 – PROCEDURE TO SET AN OPERATION

11.3.1 DESCRIPTION OF THE EXERCISE .....	11-8
11.3.2 PROCEDURE .....	11-8
11.3.3 TEST .....	11-10

## 12. FREQUENTLY ASKED QUESTIONS

<b>12.1 COMMUNICATIONS</b>
<b>12.2 PROTECTION</b>
<b>12.3 CONTROL AND HMI</b>
<b>12.4 RELAY CONFIGURATION</b>

## 13. TROUBLESHOOTING GUIDE

## A. LOGIC OPERANDS

## B. MODBUS PROTOCOL

### B.1 ACCESS TO F650 DATA

#### B.2 MODBUS F650

B.2.1	FUNCTIONS USED .....	B-2
B.2.2	PHYSICAL LAYER .....	B-3
B.2.3	DATA LINK LAYER .....	B-4
B.2.4	GENERIC READING .....	B-5
B.2.5	GENERIC WRITING .....	B-6
B.2.6	FUNCTION CODES .....	B-7
B.2.7	EXCEPTIONS AND ERROR RESPONDS .....	B-8

#### B.3 DATA TYPE

#### B.4 MODBUS APPENDIX

B.4.1	DATA MANAGEMENT .....	B-10
B.4.2	WRITING SETTINGS .....	B-11
B.4.3	SNAP-SHOT EVENTS .....	B-12
B.4.4	OPERATIONS .....	B-15

#### B.5 OUTPUT WRITING

B.5.1	CONTROL EVENTS .....	B-17
B.5.2	EVENT STRUCTURE .....	B-18

#### B.6 EVENTS STATUS REQUEST (ALARMS)

B.6.1	CONTROL EVENTS RETRIEVAL FROM THE COMMAND LINE .....	B-21
B.6.2	SERIAL COMMUNICATION .....	B-22
B.6.3	ETHERNET COMMUNICATION .....	B-23
B.6.4	ACKNOWLEDGEMENT OF EVENTS (ALARMS) .....	B-24
B.6.5	VIRTUAL INPUTS WRITING .....	B-25
B.6.6	USER MAP .....	B-26
B.6.7	RETRIEVING OSCILOGRAPHY .....	B-27
B.6.8	TIME SYNCHRONIZATION .....	B-28
B.6.9	ENQUEUEING MESSAGES .....	B-29
B.6.10	TRACES AND TROUBLESHOOTING .....	B-30
B.6.11	MODBUS CHECK FUNCTION .....	B-31

#### B.7 MEMORY MAP

## C. DNP 3.0 PROTOCOL FOR F650

### C.1 DNP 3.0 PROTOCOL SETTINGS

### C.2 DNP 3.0 DEVICE PROFILE DOCUMENT

### C.3 IMPLEMENTATION TABLE

### C.4 BINARY INPUT POINTS

### C.5 DNP CONFIGURATION EXAMPLES

C.5.1	CONFIGURING DNP USER MAP .....	C-11
C.5.2	EXAMPLE OF CUSTOM BINARY INPUT POINTS MAP .....	C-13
C.5.3	MULTIPLE DNP 3.0 MASTERS COMMUNICATION WITH F650 .....	C-15

### C.6 BINARY OUTPUT AND CONTROL RELAY OUTPUT

### C.7 BINARY COUNTERS

### C.8 ANALOG INPUTS

TABLE OF CONTENTS

D. IEC 60870-5-104 PROTOCOL	D.1 INTRODUCTION
	D.2 TECHNICAL DESCRIPTION
	D.3 BASIC APPLICATION FUNCTIONS
	D.4 IEC 104 SETTINGS
	D.5 IEC 60870-5-104 POINT LIST
E. FACTORY DEFAULT LOGIC	E.1 FACTORY DEFAULT SETTINGS
	E.1.1 FACTORY DEFAULT SETTINGS.....E-1
F. FACTORY DEFAULT CONFIGURATION	F.1 FACTORY DEFAULT SETTINGS
	F.2 FACTORY DEFAULT CONFIGURATION
G. MISCELLANEOUS	G.1 F650 FIRMWARE REVISION HISTORY
	G.2 GE MULTILIN WARRANTY





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

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

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



Figure 1-1: FRONT VIEW OF F650 UNITS

#### a) COMMUNICATION BOARDS WITHDRAWAL / INSERTION

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

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

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

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

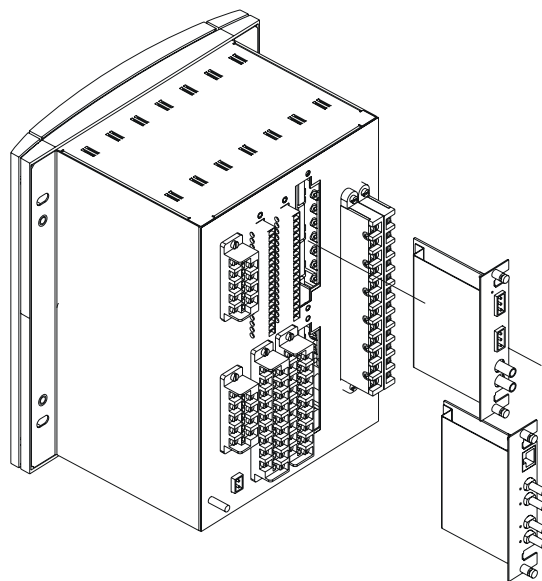


Figure 1–2: MODULE WITHDRAWAL/INSERTION

Before performing any of these actions, **control power must be removed from the relay and all the relay rear terminals must be potential free**. A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components.

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

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

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

## b) MAGNETIC MODULE TERMINALS

1

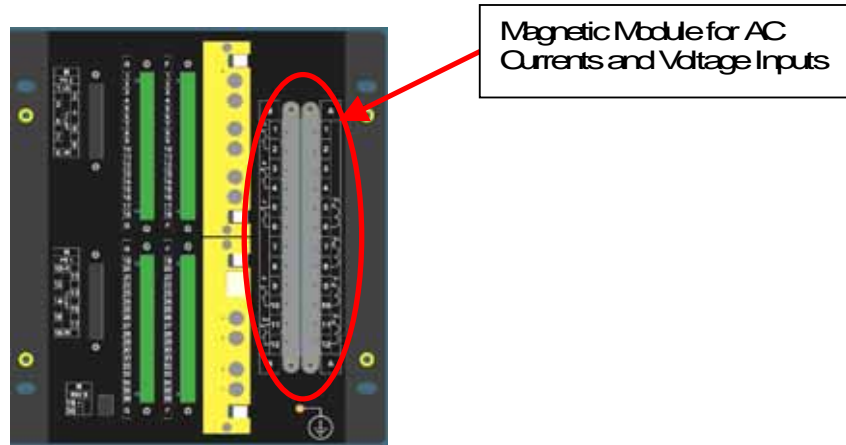
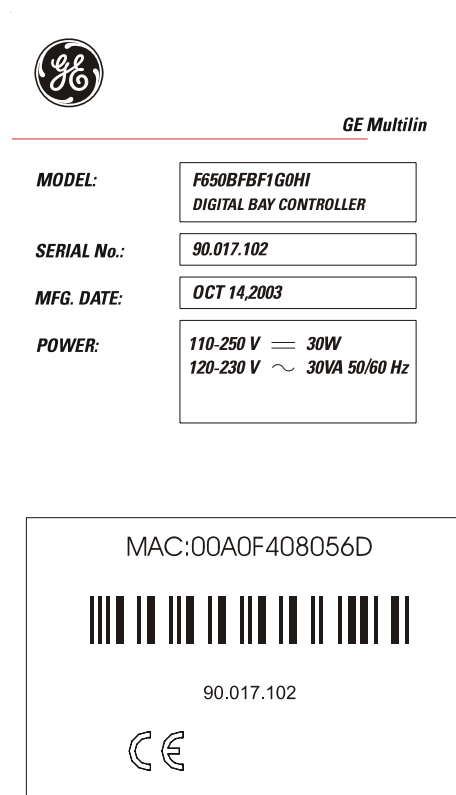


Figure 1–3: REAR VIEW OF F650 UNIT

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

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

Refer to the label on the side of the relay verifies that the model number is the correct model ordered.



**Figure 1-4: IDENTIFICATION LABEL (A4455P6)**

- Please ensure that you receive the following items with your relay:

- Mounting screws for rear terminals and for fixing the relay to a cabinet
- CD containing EnerVista F650 Setup software
- Wiring diagram
- Certificate of Compliance

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

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

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

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

## 1.1.3 SAFETY INSTRUCTIONS

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

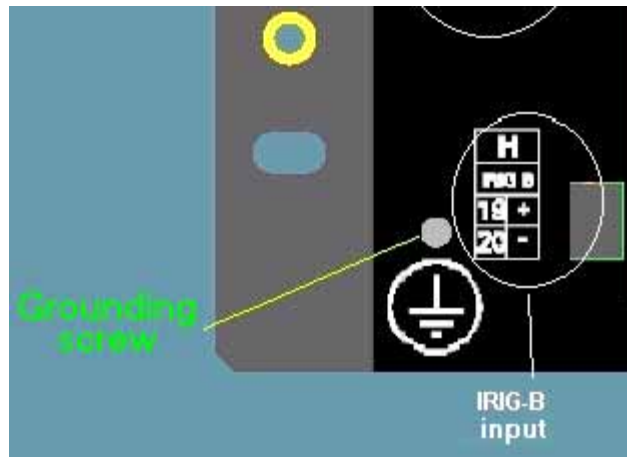


Figure 1–5: LOCATION OF GROUNDING SCREW

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

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

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

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

## 1.2.1 INTRODUCTION TO 650 FAMILY OF RELAYS

1

This platform of relays has been designed to meet the goals that are appearing nowadays in the environment of new substations.

Historically, protection, control and metering functions have been performed by electromechanical elements at the beginning, then static devices, and finally by digital equipment able to integrate all these functions in a single device, called IED (Intelligent Electronic Device).

These IEDs not only must be able to perform all functions related to system protection and control, but also, using high speed communications, they must share information among them and send this information to control dispatch centers, thus reducing the quantity of auxiliary elements and wiring up to 70%.

The F650 relay belongs to this new generation of devices, and can be easily incorporated in substation automation schemes.

## 1.2.2 HARDWARE ARCHITECTURE

F650 units incorporate a series of interconnected modules to perform protection and control functions. Firstly, it includes a group of AC transformers for retrieving current and voltage. These magnitudes, once digitized, are sent to a digital signal processor (DSP), which performs metering functions and communicates with the main processor via a wide band bus. This architecture liberates the main processor from performing real time metering, allowing a high sampling rate, of up to 64 samples per cycle, without interfering with global performance.

F650 relays are digital devices that include a CPU that can control multiple types of input and output signals.

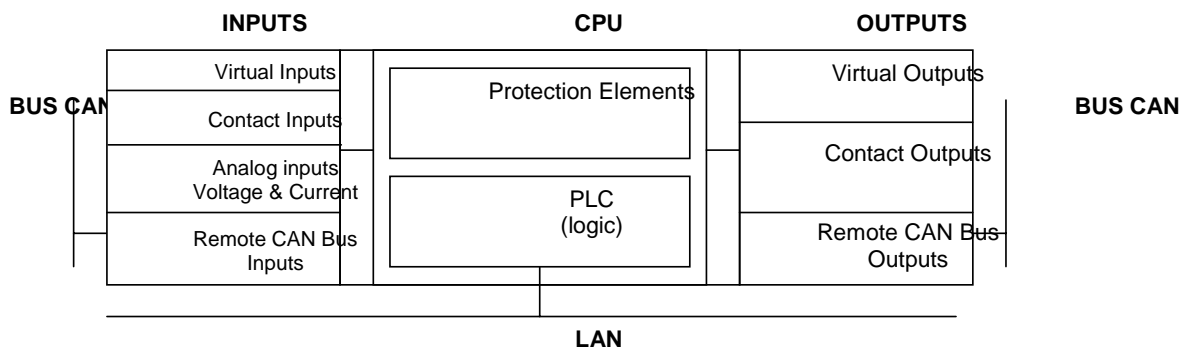


Figure 1-6: F650 CONCEPT BLOCK DIAGRAM

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

**Analog Inputs** are signals coming from the inputs of current and voltage transformers, used for monitoring the power system signals.

**Remote CAN Bus Inputs/Outputs:** are signals associated to physical input/output contacts from independent modules connected to the 650 unit via a fiber optic CAN Bus.

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

**Protection Elements:** Relay protection elements, for example: Overcurrent, overvoltage, etc.



## 1.2.3 SOFTWARE ARCHITECTURE

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

## 1.2.4 COMMUNICATIONS ARCHITECTURE

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

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

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

One of the modules provides asynchronous serial communications, using different physical media (RS485, plastic or glass fiber optic) depending on the selected model. The module incorporates two identical ports, COM1 and COM2. COM2 port is multiplexed with the front port. Additionally, this module may incorporate a glass fiber optic port for CAN BUS communications, used for the connection to the Remote CAN BUS I/O module. This feature allows increasing up to 100% the I/O capability, when the maximum number of I/Os available inside the relay (up to 32 inputs and 16 outputs) is not enough for a specific application.

Available options are:

**Table 1–1: 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
Z	Two Glass F.O. ports and a CAN port for remote CAN Bus Inputs/Outputs

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

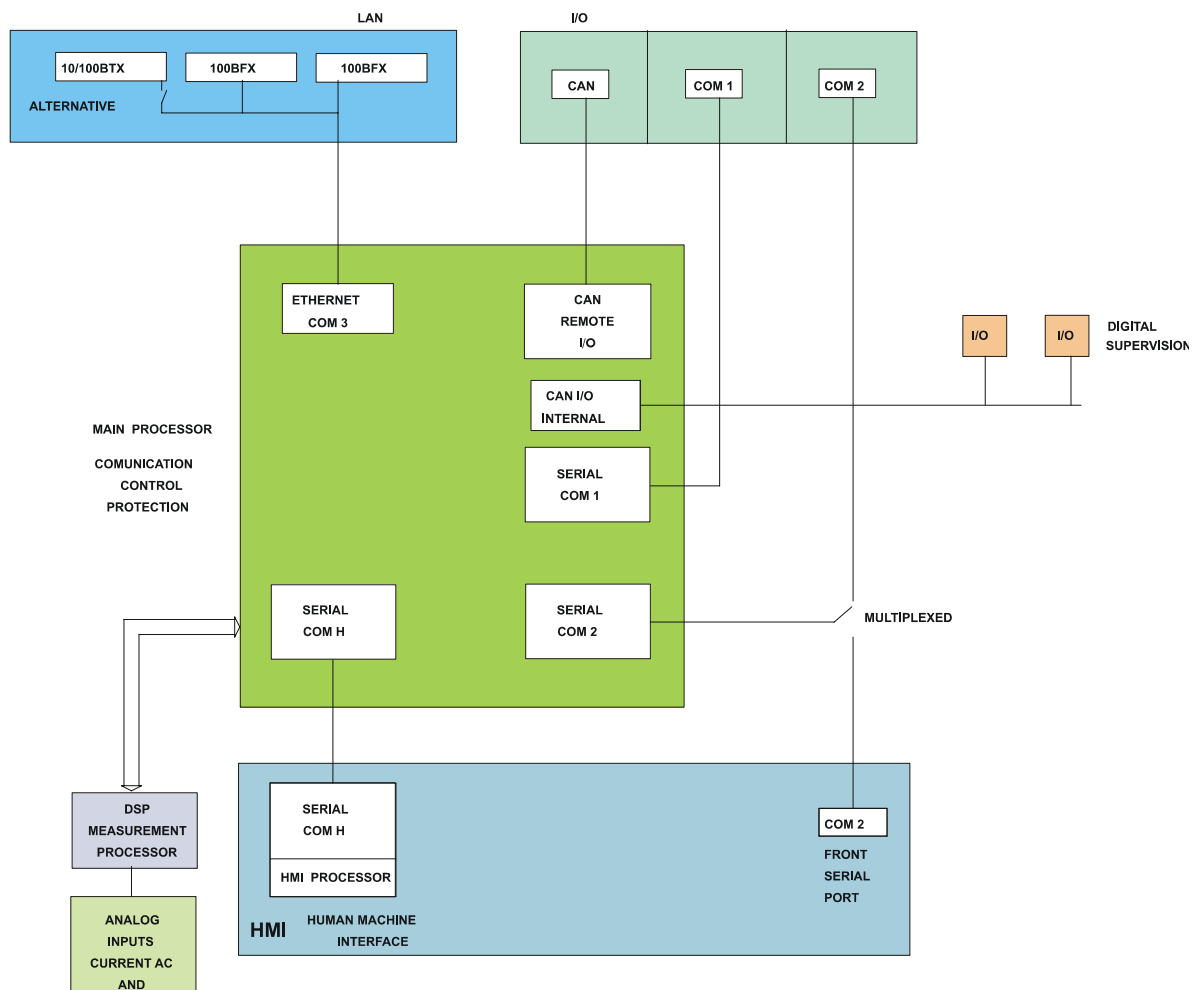
Available Options are:

**Table 1-2: REAR ETHERNET COMMUNICATIONS BOARD 2**

Board Code	Functionality
B	One 10/100BaseTX port (self-negotiable speed)
C	One 10/100BaseTX port and one 100BaseFX port.
D	One 10/100BaseTX port and two 100BaseFX ports

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

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



**Figure 1-7: COMMUNICATIONS ARCHITECTURE (B6816F1)**

### 1.3.1 SYSTEM REQUIREMENTS

The EnerVista F650 Setup software interface is the preferred method to edit settings and view actual values because the PC monitor can display more information in a simple comprehensible format.

The following minimum requirements must be met for the EnerVista F650 Setup software to properly operate on a PC:

- Pentium® class or higher processor (Pentium® II 300 MHz or higher recommended)
- Windows® NT 4.0 (Service Pack 3 or higher), Windows® 2000, Windows® XP
- Internet Explorer® 5.0 or higher
- 64 MB of RAM (128 MB recommended)
- 40 MB of available space on system drive and 40 MB of available space on installation drive
- RS232C serial and Ethernet port for communications to the relay

### 1.3.2 INSTALLATION

After ensuring the minimum requirements for using EnerVista F650 Setup are met (see previous section), use the following procedure to install the EnerVista F650 Setup from the GE EnerVista CD.

1. Insert the GE EnerVista CD into your CD-ROM drive.
2. Click the **Install Now** button and follow the installation instructions to install the no-charge EnerVista software.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click the **IED Setup** section of the **Launch Pad** window.



Figure 1–8: LAUNCHPAD WINDOW

5. In the EnerVista Launch Pad window, click the **Add Product** button and select the “F650 Bay Controller” relay from the Install Software window as shown below. Select the “Web” option to ensure the most recent software release, or select “CD” if you do not have a web connection, then click the **Add Now** button to list software items for the F650.



Figure 1-9: ADD PRODUCT WINDOW

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

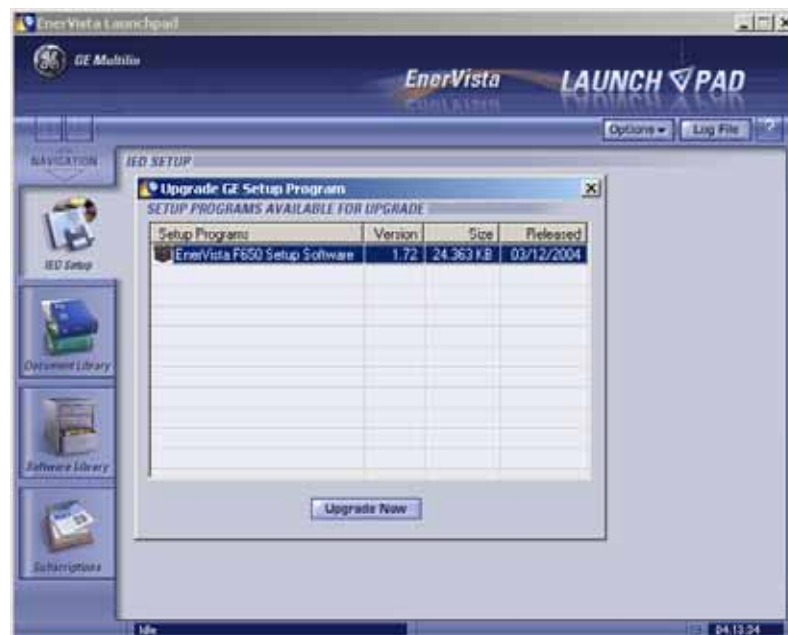


Figure 1-10: WEB UPGRADE WINDOW

7. EnerVista Launchpad will obtain the installation program from the Web or CD. Once the download is complete, double-click the installation program to install the EnerVista F650 Setup software.
8. Select the complete path, including the new directory name, where the EnerVista F650 Setup will be installed.

9. Click on **Next** to begin the installation. The files will be installed in the directory indicated and the installation program will automatically create icons and add EnerVista F650 Setup to the Windows start menu.
10. Follow the on-screen instructions to install the EnerVista F650 Setup software. When the **Welcome** window appears, click on **Next** to continue with the installation procedure.



Figure 1-11: ENERVISTA F650 SETUP INSTALLATION

11. When the **Choose Destination Location** window appears, and if the software is not to be located in the default directory, click **Change...** and type in the complete path name including the new directory name and click **Next** to continue with the installation procedure.

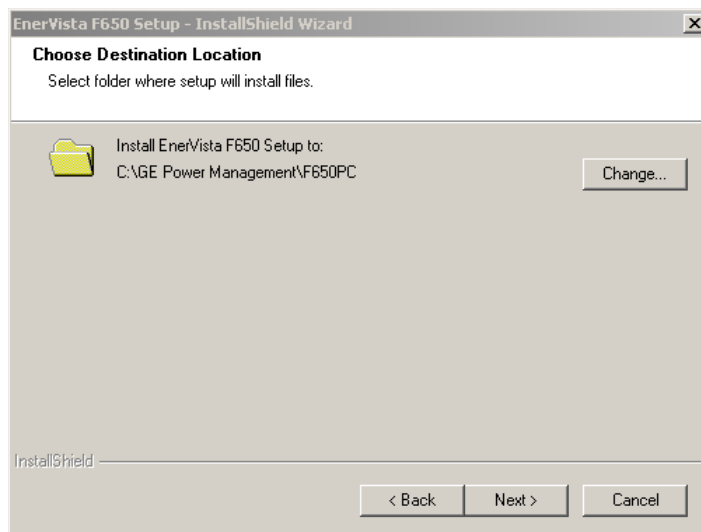


Figure 1-12: ENERVISTA F650 SETUP INSTALLATION CONT.

12. The default program group where the application will be added to is shown in the **Selected Program Folder** window. Click Next to begin the installation process, and all the necessary program files will be copied into the chosen directory.

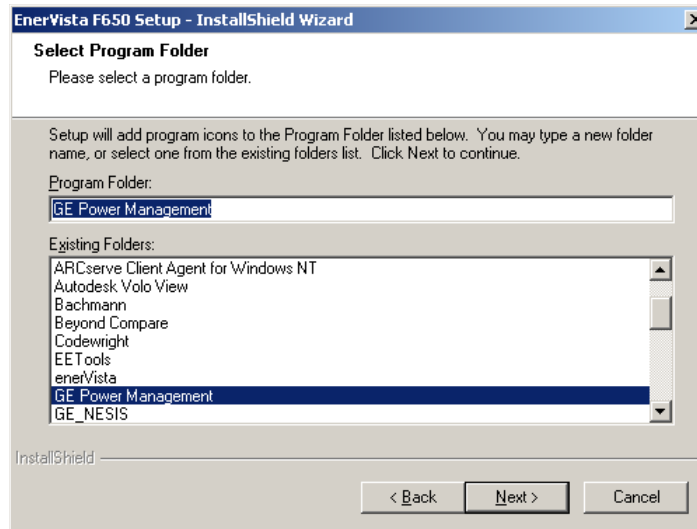


Figure 1–13: SELECT PROGRAM FOLDER

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

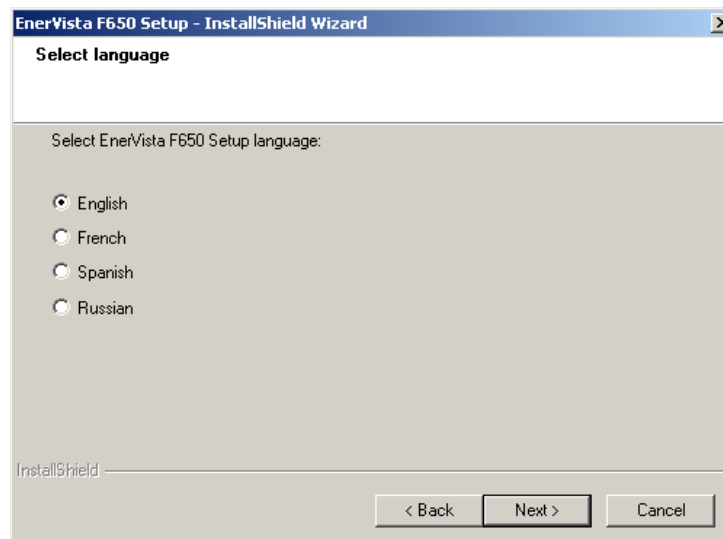


Figure 1–14: LANGUAGE WINDOW

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



Figure 1–15: ENERVISTA LAUNCHPAD

### 1.3.3 CONNECTING WITH THE UNIT

This section is intended as a quick start guide to using the EnerVista F650 Setup software. Please refer to section 4.1 in this manual for more information about the EnerVista F650 Setup software interface.

#### a) CONFIGURING AN ETHERNET CONNECTION

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

1. Install and start the latest version of the EnerVista F650 Setup software (available from the GE EnerVista CD or online from <http://www.GEindustrial.com/multilin> (see previous section for installation instructions).
2. Go to “**Communication>Computer**” and enter the following data referred to communications:
3. Select Control Type as MODBUS TCP/IP from the drop-down list. This option will display a number of interface parameters that must be entered for proper Ethernet communications.
4. Enter the relay IP address (from “**Setpoint>Product Setup >Communication Settings>Network>IP ADDRESS**”) in the IP Address field in MODBUS TCP/IP SETUP.
5. Enter the relay ModBus address (from “**Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Address COM1/COM2 setting**”) in the Unit Identifier (Slave Address) field.
6. Enter the ModBus port address (from “**Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Port Number**” setting) in the ModBus Port field.
7. The Device has now been configured for Ethernet communications. Proceed to press the ON button to begin communicating.

**b) CONFIGURING AN RS232 CONNECTION**

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

1. Install and start the latest version of the EnerVista F650 Setup software (available from the GE EnerVista CD or online from <http://www.GEindustrial.com/multilin> (see previous section for installation instructions).
2. Go to “**Communication>Computer**” and enter the following data referred to communications:
3. Select Control Type as No Control Type from the drop-down list. This option will display a number of interface parameters that must be entered for proper serial communications.
4. Enter the relay Slave Address (“**Setpoint>Product Setup >Communication Settings>ModBus Protocol**” menu) in the Slave Address field.
5. Enter the physical communications parameters (Baudrate and parity settings) from “**Setpoint>Product Setup >Communication Settings>Serial Ports**” menu, in their respective fields.
6. The Device has now been configured for RS232 communications. Proceed to press the ON button to begin communicating.

**1.3.4 COMMUNICATIONS**

To communicate with the relay via the faceplate RS232 port, a standard “straight through” serial cable is used. The DB9 male end is connected to the relay and the DB9 or DB25 female end is connected to the PC COM1 or COM2 port as described in the figure below.

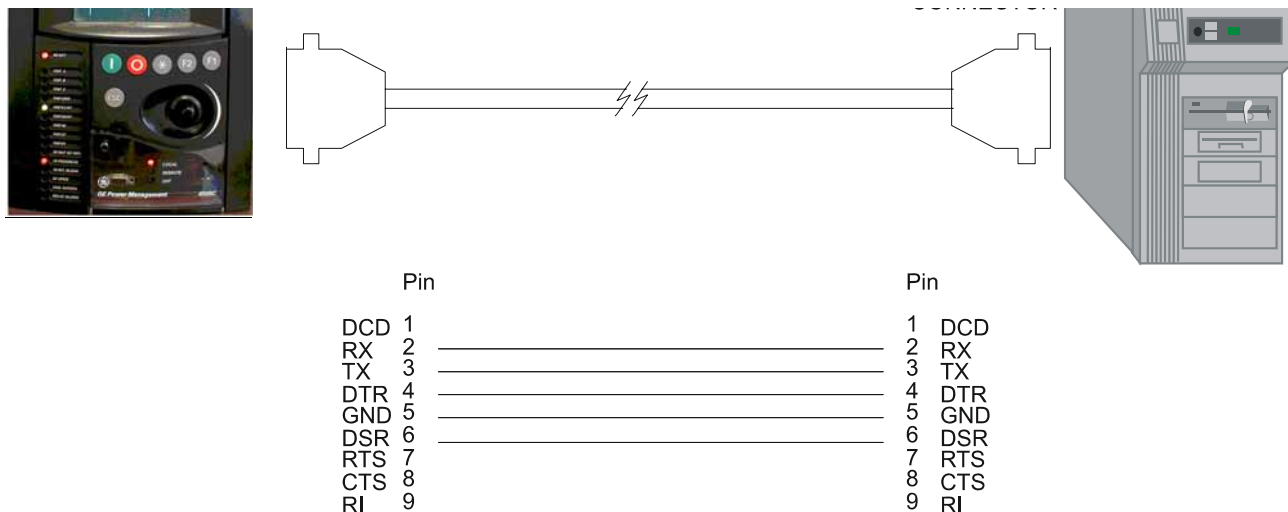
Direct connection to the Ethernet port will be carried out using a crossover cable. If this connection is performed through a hub or switch, we will use direct Ethernet cable.

To communicate with the relay rear RS485 port from a computer RS232 port, an RS232/RS485 converter box is needed. We recommend using the F485 converter, manufactured by GE. This converter box is connected to the computer using a straight through serial cable. A shielded twisted pair (20, 22 or 24 AWG according to the American standards; 0.25, 0.34 or 0.5 mm<sup>2</sup> according to the European standards) cable is used to connect the converter box to the relay rear communications terminals. In order to minimize communication errors that could be caused by external noise, it is recommended to use a shielded twist pair. In order to avoid loops where external currents could flow, the cable shield must be grounded only at one end.

The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in a RC network (i.e. 120 ohm, 1 nF). This circuit is shown on Figure 1–17:: RS485 CONNECTION FOR F650 UNITS, associated to text Zt(\*).



1



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

To minimize errors from noise, the use of shielded twisted pair wire is recommended. For a correct operation, polarity must be respected, although if it is not so, there is no danger to damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result confusing sometimes, as the RS485 standard refers only to terminals named “A” and “B”, although many devices use terminals named “+” and “-”.

As a general rule, terminals “A” should be connected to terminals “-”, and terminals “B” to “+”. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. Each relay should also be daisy chained to the next one in the link. A maximum of 32 relays can be connected in this manner without exceeding driver capability. For larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel to more than 32. Do not use other connection configuration different than the recommended.

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

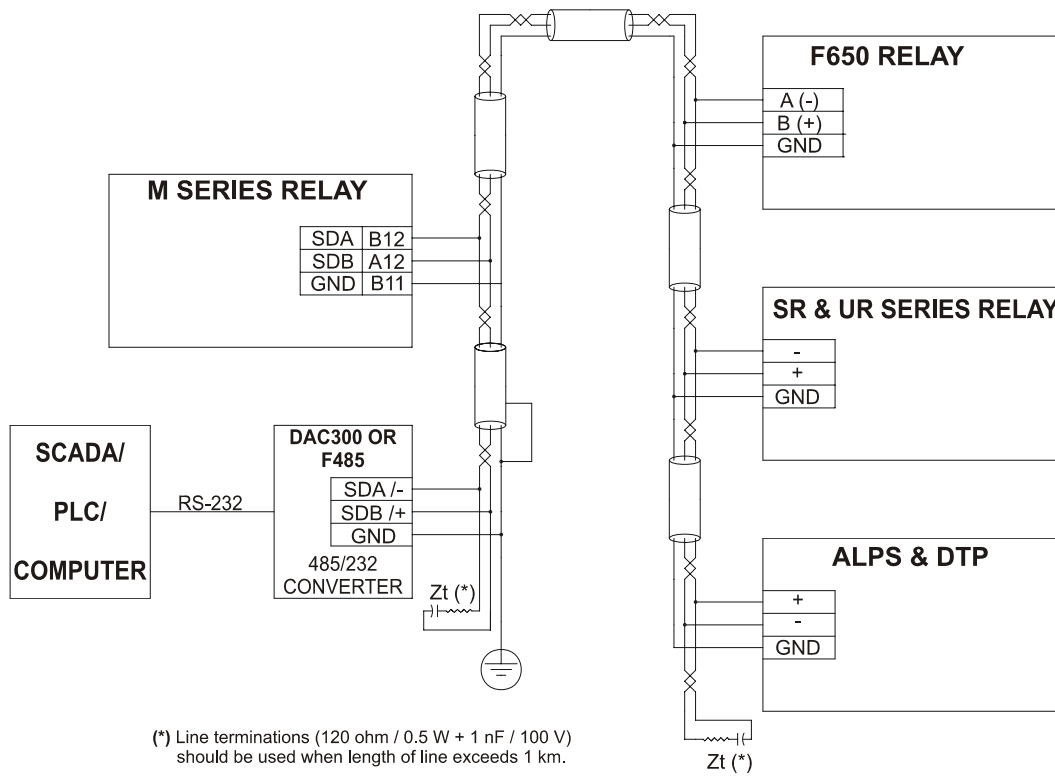


Figure 1–17: RS485 CONNECTION FOR F650 UNITS



## 2.1.1 F650 OVERVIEW

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

- Directional overcurrent protection for phases, neutral, ground and sensitive ground
- Under and overvoltage protection
- Under and overfrequency protection
- Autorecloser
- Synchronism
- Metering
- Oscillography registers, fault reports, data logger
- Bay control (open/close commands, etc.)
- Bay mimic.
- Communications (RS232/RS485/fibre optic/Ethernet)
- Fully programmable front buttons, 15 LED's and input/output contacts

2

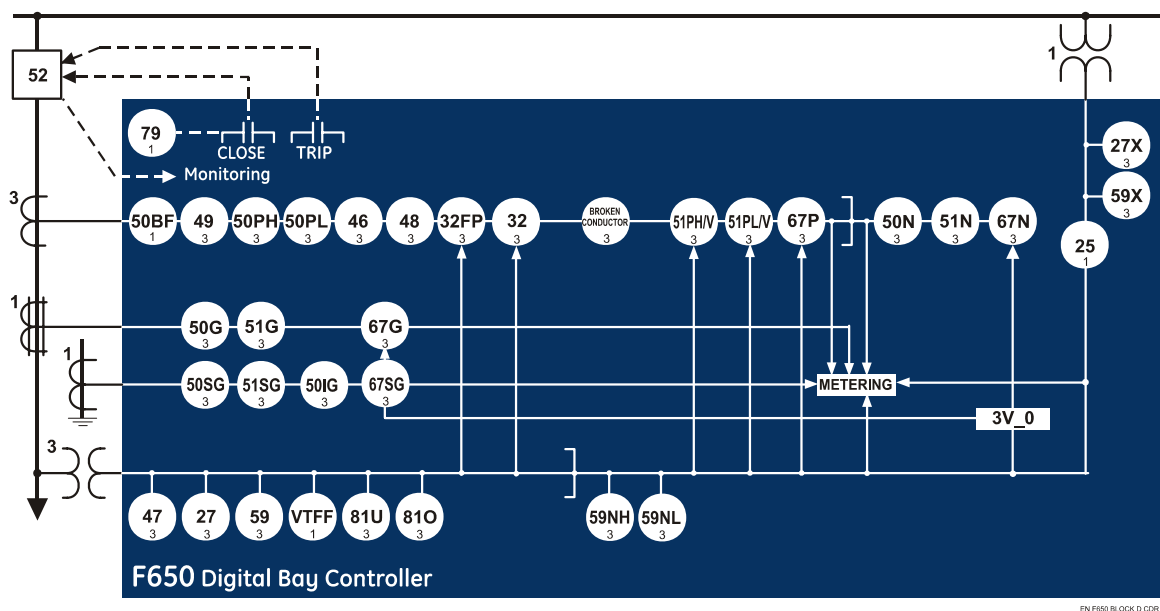


Figure 2–1: FUNCTIONAL BLOCK DIAGRAM

## 2.2.1 ANSI DEVICE NUMBERS AND FUNCTIONS

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

Table 2-1: OTHER DEVICE FUNCTIONS

INPUTS/OUTPUTS	METERING	COMMUNICATIONS
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)	Metering Current for phases, ground and sensitive ground inputs	Front RS232 port, Two rear RS485/fibre optic ports, 10/100 TX and 100 FX Mbps Ethernet port
Digital Programmable Contact Inputs (up to 32)	Voltages phase to phase and phase to ground	ModBus Communications RTU and over TCP/IP
Digital Programmable Contact Outputs (up to 16)	Real, Reactive and Apparent Power and Power Factor	DNP Multimaster (3.0 Level 2)
32 Latched Virtual Inputs	Three Phase Energy	IEC 870-5-104
32 Self-Reset Virtual Inputs	Frequency	ModBus User Map
Virtual Outputs (up to 512)	Sequence components of currents and voltages	
Tripping and closing circuit supervision		

USER INTERFACE	RECORDS	OTHERS
Alphanumerical display (4x20)	Data Logger	Breaking Arcing Current (I <sub>2t</sub> )
Graphic display (16 x 40)	Demand	Breaker Control
User Programmable LEDs (15)	Event Recorder (up to 128 configurable events)	IRIG-B synchronization
User Programmable Keys (up to 5)	Fault Locator and Fault report (up to 10 records)	Logic Equations (PLC Editor)
Easy menu management thanks to shuttle key	Oscillography (up to 20 records)	Settings Groups (up to 3)
Configurable One-Line Diagram (Graphic model only)	Snapshot Events (up to 479)	Operations (up to 24)
Phasor Diagram (available in EnerVista F650 Setup)		Web Server Application

F650 units are supplied as ½ 19" rack, 6 units high devices, containing the following modules: power supply, CPU, I/O modules, communication modules. Each of these modules can be supplied in different versions that must be specified when ordering. The required information to completely define an F650 model is shown on TABLE 2-1.

**Table 2-2: ORDERING CODE**

F650	-	-	-	F	-	G	-	-	DESCRIPTION
	<b>B</b>								Basic display (4x20 characters)
	<b>M</b>								Graphic display (240x128 pixels)
									<b>REAR SERIAL COMMUNICATIONS BOARD 1</b>
		<b>F</b>							None
		<b>A</b>							Redundant RS485
		<b>P</b>							Redundant plastic fiber optic
		<b>G</b>							Redundant glass fiber optic
		<b>X</b>							Redundant RS485 + fiber remote CAN bus I/O
		<b>Y</b>							Redundant plastic fiber optic + fiber remote CAN bus I/O
		<b>Z</b>							Redundant glass fiber optic + fiber remote CAN bus I/O
		<b>C</b>							Cable remote CAN Bus I/O
		<b>M</b>							RS485 + cable remote CAN Bus I/O
									<b>REAR ETHERNET COMMUNICATIONS BOARD 2</b>
			<b>B</b>						10/100 Base TX
			<b>C</b>						10/100 Base TX + 100 Base FX
			<b>D</b>						10/100 Base TX + Redundant 100 Base FX
			<b>E</b>						Redundant 10/100 Base TX
									<b>I/O BOARD IN SLOT F</b>
					<b>1</b>				16 Digital Inputs + 8 Outputs
					<b>2</b>				8 Digital Inputs - 8 Outputs + 2 trip/close circuit supervision circuits
									<b>I/O BOARD IN SLOT G</b>
							<b>0</b>		None
							<b>1</b>		16 Inputs + 8 Outputs
									<b>AUXILIARY VOLTAGE</b>
								<b>LO</b>	24-48 Vdc (range 19.2 – 57.6)
								<b>HI</b>	110-250 Vdc (range 88 – 300)
									120-230 Vac (range 96 – 250)
								<b>LOR</b>	Redundant LO
								<b>HIR</b>	Redundant HI
									<b>LANGUAGE</b>
									English/English
								<b>F</b>	French/English
								<b>P</b>	Russian/English (*)
								<b>S</b>	Spanish/English

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

(\*) Note: Russian language available only for basic display models.

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

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

The required information to completely define a CIO Module is shown on TABLE 2-2.

**Table 2–3: ORDERING CODE FOR CIO MODULE**

CIO	H	-	J	-	-	DESCRIPTION
						<b>I/O BOARD IN SLOT H</b>
		<b>1</b>				16 inputs + 8 outputs
		<b>2</b>				8 inputs + 4 circuit supervision circuits + 6 outputs + 2 outputs with tripping current supervision (latching)
						<b>I/O BOARD IN SLOT J</b>
				<b>0</b>		None
				<b>1</b>		16 inputs + 8 outputs
				<b>2</b>		8 inputs + 4 circuit supervision circuits + 6 outputs + 2 outputs with tripping current supervision (latching)
						<b>AUXILIARY VOLTAGE</b>
					<b>LO</b>	24-48 Vdc (range 19.2 – 57.6)
					<b>HI</b>	110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)



**NOTE: TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE**

### 2.4.1 PROTECTION UNITS

2

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

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

#### a) PHASE TIME OVERCURRENT WITH VOLTAGE RESTRAINT (51PH/51PL)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse $I^2t$ Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)
Voltage restraint	Selectable by setting
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

#### b) GROUND TIME OVERCURRENT (51G)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.

Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse $I^2t$ Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup $\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

**c) NEUTRAL TIME OVERCURRENT (51N)**

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse $I^2t$ Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup $\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

**d) SENSITIVE GROUND TIME OVERCURRENT (51SG)**

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Reset level	98% of the pickup level
Level Accuracy	$\pm 1.5\%$ of the reading $\pm 1$ mA from 0.005 to 16 A

Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse $I^2t$ Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup $\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

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

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	$\pm 3\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

#### f) NEUTRAL INSTANTANEOUS OVERCURRENT (50N)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	$\pm 3\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**g) SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)**

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Reset level	97% of the pickup level
Level Accuracy	$\pm 1.5\%$ of the reading $\pm 1$ mA from 0.005 to 16 A
Overreach	$< 2\%$
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz
Timing accuracy	$\pm 3\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**h) ISOLATED GROUND INSTANTANEOUS OVERCURRENT (50IG)**

Current Input	Fundamental Phasor (without harmonics)
Voltage Input	Fundamental Phasor (without harmonics)
Current Pickup level	0.005 to 0.400 A in steps of 0.001 A
Voltage Pickup level	2 to 70 V in steps of 1 V
Reset level	97-98% of the pickup level
Level Accuracy	$\pm 1.5\%$ of the reading $\pm 1$ mA from 0.005 to 16 A
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Time to instantaneous	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	$\pm 3\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**i) NEGATIVE SEQUENCE (46)**

Current Input	Fundamental Phasor (without harmonics)
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse $I^2t$ Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at $> 1.03$ times the pickup $\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)

Saturation Level  
Snapshot Events

48 times the pickup level  
Selectable by setting

#### j) PHASE DIRECTIONAL (67P)

Directionality  
Polarizing

Forward and reverse selectable by setting  
Quadrature Voltage:  
ABC seq: Phase A (VBC), Phase B (VCA), Phase C (VAB)  
ACB seq: Phase A (VCB), Phase B (VAC), Phase C (VBA)  
0 to 300 Vac in steps of 1 V  
-90° to +90° in steps of 1°  
Permission or Block selectable by setting  
 $\pm 2^\circ$  for  $I > 0.1$  A and  $V > 5$  Vac  
<30ms, typically

Polarizing voltage threshold  
Characteristic angle  
Block Logic  
Angle accuracy  
Operate time

#### k) GROUND DIRECTIONAL (67G)

Directionality  
Polarizing  
Polarizing Voltage  
Polarizing Current  
Operating Current  
Polarizing Voltage threshold  
Polarizing Current threshold  
Characteristic angle  
Block Logic  
Angle accuracy  
Operate time

Forward and reverse selectable by setting  
Voltage, current, dual  
 $V_N$  (measured or calculated, selected by setting)  
 $I_{sg}$  (measured from 5<sup>th</sup> current transformer)  
 $I_g$  (measured from 4<sup>th</sup> current transformer)  
0 to 300 Vac in steps of 1 V  
0.005 A  
-90° to +90° in steps of 1°  
Permission or Block selectable by setting  
 $\pm 2^\circ$  for  $I > 0.1$  A and  $V > 5$  Vac  
<30ms, typically

#### l) NEUTRAL DIRECTIONAL (67N)

Directionality  
Polarizing  
Polarizing Voltage  
Polarizing Current  
Operating Current  
Polarizing Voltage threshold  
Polarizing Current threshold  
Characteristic angle  
Block Logic

Forward and reverse selectable by setting  
Voltage, current, dual  
 $V_N$  (measured or calculated, selected by setting)  
 $I_{sg}$  (measured from 5<sup>th</sup> current transformer)  
 $I_N$   
0 to 300 Vac in steps of 1 V  
0.005 A  
-90° to +90° in steps of 1°  
Permission or Block selectable by setting

Angle accuracy	$\pm 2^\circ$ for $I > 0.1$ A and $V > 5$ Vac
Operate time	$< 30$ ms, typically

**m) SENSITIVE GROUND DIRECTIONAL (67SG)**

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

**n) THERMAL MODEL (49)**

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Heating constant	Between 3 and 600 minutes
Cooling constant	1 to 6 times the heating constant
Snapshot Events	Selectable by setting

**o) PHASE OVERVOLTAGE (59P)**

Voltage Input	Fundamental Phasor (without harmonics) of phase-to-phase voltages
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level Accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Logic	Any/Two/All phases logic selectable by setting
Snapshot Events	Selectable by setting

**p) PHASE UNDERVOLTAGE (27P)**

Voltage Input	Fundamental Phasor of phase-to-ground or phase-to-phase voltages (selectable by setting)
Pickup level	3 to 300 in steps of 1 V
Reset level	103% of the pickup level
Level accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Minimum Voltage Threshold	0 to 300 in steps of 1 V
Logic	Any/Two/All phases logic selectable by setting
Supervised by Breaker	Selectable by setting
Snapshot Events	Selectable by setting

**q) NEUTRAL OVERVOLTAGE (59NH/59NL)**

Voltage Input	Fundamental Phasor of the neutral voltage
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**r) NEGATIVE SEQUENCE OVERVOLTAGE (47)**

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**s) AUXILIARY OVERVOLTAGE (59X)**

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level

Level accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**t) AUXILIARY UNDERVOLTAGE (27X)**

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 V in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	$\pm 1\%$ reading $\pm 0.1\%$ Full Scale from 10 to 275 V
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**u) UNDERFREQUENCY (81U)**

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

**v) OVERFREQUENCY (81O)**

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



**w) FORWARD POWER (32FP)**

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	0.00-10000.00 MW in steps of 0.01 MW
Reset level	97% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

**x) SENSITIVE DIRECTIONAL POWER (32)**

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	-10000.00 to 10000.00 MW (primary values) in steps of 0.01 MW
Characteristic Angle (two stages)	0.00 to 359.99 in steps of 0.01
Reset level	97% of the pickup level
Accuracy for primary magnitudes	±3% complete range
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

**y) BROKEN CONDUCTOR (I2/I1)**

Pickup level	20.0-100.0% (I2/I1 ratio) in steps of 0.1%
Reset level	97% of the pickup level
Trip delay	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Minimum Phase Current Threshold	0.05 A
Snapshot Events	Selectable by setting
Operation Threshold	0.000 to 1.000 A in steps of 0.001 A

Note: The I2/I1 current inhibition level for the different firmware versions is as follows

Firmware Version	Current Inhibition Level
1.50 or Lower	10 mA
1.60 or Higher	50 mA
1.80 or Higher	Selectable by setting from 0.000 to 1.000 in steps of 0.001 A

**z) LOCKED ROTOR (48)**

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Full Load Current	0.10 to 10.00 KA in steps of 0.01 KA
Pickup level	1.01 to 109.00 in steps of 0.01
Reset level	97% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**2.4.2 CONTROL****a) AUTORECLOSE (79)**

Schemes	Three-pole tripping schemes
Number of shots	Up to 4 reclose attempts before lockout
Dead time	Independent dead time setting before each shot adjustable between 0 and 900 s in steps of 0.01 s
Reclaim time	0.00 to 900.00 s in steps of 0.01 s
Condition permission	Selectable by setting
Hold time	0.00 to 900.00 s in steps of 0.01 s
Reset time	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting
Possibility to modify protection settings after each shot programmable through PLC (block signals available after each shot)	

**b) SYNCHROCHECK (25)**

Dead/live levels for line and bus	0.00 to 300.00 in steps of 0.01 V
Maximum voltage difference	2.00 to 300.00 V in steps of 0.01 V
Maximum angle difference	2.0° 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 600.00 s in steps of 0.01 s
Angle accuracy	2°
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

**c) FUSE FAILURE**

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

**2****d) BREAKER FAILURE (50BF)**

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level for supervision	0.05 to 160.00 A in steps of 0.01 A
Pickup level for high level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for low level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for internal arcing	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	$\pm 0.5\%$ of the reading $\pm 10$ mA from 0.05 to 10 A $\pm 1.5\%$ of the reading for higher values.
Timing accuracy	$\pm 3.5\%$ of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

**e) BREAKER SETTINGS**

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

**f) BREAKER MAINTENANCE**

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

**g) SWITCHGEAR**

Switchgear	1 to 16 (configurable in "relay configuration" screen).
Snapshot Events	Selectable by setting (for each switchgear in "system setup")

**a) 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 No of Oscillos * No of samples/cycle
Trigger position:	5% to 95% of total length
Trigger:	Programmable via PLC
Data:	5 current channels and 4 voltage channels Up to 16 digital channels programmable through PLC
Data Storage:	In non volatile memory (flash) without battery
Format:	International Standard COMTRADE ASCII - IEEE C37.111-1999.
Automatic Overwrite:	Selectable by setting. (Oscillography records can be concatenated)
Snapshot Events:	Selectable by setting

**b) FAULT LOCATOR**

Method:	Single-ended
Positive Sequence Module:	0.01 to 250.00 Ohm in steps of 0.01 Ohms
Positive Sequence Angle:	25 to 90° in steps of 1°
Zero Sequence Module:	0.01 to 750.00 Ohms in steps of 0.01 Ohm
Zero Sequence Angle:	25 a 90° in steps of 1°
Line Length:	0.0 to 2000.0 in steps of 0.1 (miles or km)
Accuracy:	5% (typical)
Display Fault on HMI:	Selectable by setting
Snapshot Events:	Selectable by setting
Maximum Records:	Up to 10 fault report records.
Data:	Fault date and time, pre-fault currents and voltages, fault currents and voltages, fault type, distance to the fault (fault location), line parameters, recloser and breaker status information.
Data Storage:	In non volatile memory (flash) without battery available through communications In volatile memory (ram) available through HMI (if selectable by setting)
Format:	Text in ASCII format

**c) SNAPSHOT EVENTS**

Capacity:	479 scrolling events
Time-tag	1 ms using an internal clock of 100 $\mu$ s
Timing Accuracy:	1 ms (using the IRIG-B synchronization input)
Triggers:	Any element pickup, dropout Digital input /output change of state By virtual inputs and control events
Data Storage	In non volatile memory (flash) without battery
The snapshot event recording procedure can be enabled or disabled by setting for each protection function	

**d) CONTROL EVENTS**

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

**e) DEMAND**

Channels:	9
Parameters:	Ia (kA RMS), Ib (kA RMS), Ic (kA RMS), Ig (kA RMS), Isg (kA RMS), I2 (kA), P (MW), Q (MVA) 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:	$\pm 1\%$
Trigger Input	Selectable by setting (operation mode selection for the Block Interval calculation method)
Snapshot Events:	Selectable by setting

**f) DATA LOGGER**

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

## 2.4.4 USER –PROGRAMMABLE ELEMENTS

**a) PLC LOGIC**

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

**b) FLEXCURVES**

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

**c) USER-PROGRAMMABLE LEDS**

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

**d) USER-DEFINABLE DISPLAYS**

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

**e) USER-PROGRAMMABLE FRONT KEYS**

Number of configurable Keys: 5  
 Operation: drive PLC operands

**2****2.4.5 METERING****a) CURRENT**

Accuracy:  $\pm 0.5\%$  of the reading  $\pm 10$  mA from 0.05 to 10 A (for phases and ground)  
 $\pm 1.5\%$  of the reading  $\pm 1$  mA from 0.005 to 5 A (for sensitive ground)  
 $\pm 1.5\%$  of the reading for higher values

**b) VOLTAGE**

Accuracy:  $\pm 1\%$  reading  $\pm 0.1\%$  Full Scale from 10 to 275 V

**c) REAL POWER (WATTS)**

Accuracy:  $\pm 1\%$  of the reading at  $-0.8 < \text{PF} < -1$  and  $0.8 < \text{PF} < 1$

**d) REACTIVE POWER (VARs)**

Accuracy:  $\pm 1\%$  of the reading at  $0.2 = \text{PF} = 0.2$

**e) APPARENT POWER (VA)**

Accuracy:  $\pm 1\%$  of the reading

**f) WATT-HOURS (POSITIVE AND NEGATIVE)**

Accuracy:  $\pm 1\%$  of the reading  
 Range:  $\pm 0$  to 2147 MWh  
 Parameters: 3-phase only  
 Update rate: 100 ms

**g) VAR-HOURS (POSITIVE AND NEGATIVE)**

Accuracy:  $\pm 1\%$  of the reading  
 Range:  $\pm 0$  to 2147 MVarh  
 Parameters: 3-phase only  
 Update rate: 100 ms

**h) POWER FACTOR**

Accuracy: 0.02  
 Parameters: 3-Phase and single phase

**i) FREQUENCY**

Accuracy:	$\pm 10$ mHz at 50 Hz
	$\pm 12$ mHz at 60 Hz

**j) ANGLE**

Accuracy:	2°
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**2.4.6 INPUTS****a) AC CURRENT INPUTS**

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

**b) AC VOLTAGE INPUTS**

VT Ratio	1.0 to 6000.0 in steps of 0.1
Rated Voltages	275 Vac
Metering range:	From 2 to 275 Vac
Relay Burden:	0.05 VA at 120 Vac (50 or 60 Hz)
Voltage Withstand:	Continuous at 260 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

**c) DIGITAL INPUTS**

Input Activation Voltage Threshold:	1 to 255 Vdc in steps of 1 V (selectable by setting)
Impedance:	> 100 kOhm
Maximum error:	$\pm 10\%$ setting $\pm 2.5$ V
Load for voltage supervision inputs:	2 mA + V/100 kOhm
Voltage threshold for voltage supervision inputs	< 10 V (fixed)
Debounce Time:	1 to 50 in steps of 1 ms
Recognition time:	< 1ms
Timing resolution:	1 ms

For Input Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B.

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)

**d) IRIG-B INPUT**

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

**2.4.7 REAL TIME CLOCK**

Accuracy:	Typical $\pm 20$ ppm
Backup energy:	More than 1 week

**2.4.8 OUTPUTS**

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

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

Output Logic Type	Positive / Negative
Output Type	Normal / Pulse / Latch (Selectable by setting for each output)
Pulse Output Time	0 to 60000 ms in steps of 1 ms (applicable only to signals set as pulse type)
Separate operate and reset signal can be configured by any digital signal programmable through PLC	

Contact Outputs (F31-F33, F34-F36) for board type 2 (supervision) in slot F:	The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 100 mA, the function is sealed independently of the status of the function that caused the trip.
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## 2.4.9 CONTROL POWER SUPPLY

## LOW RANGE (LO)

Nominal DC Voltage:	24 to 48 V
Min/Max DC Voltage	19.2 / 57.6 V
Note:	Low range is DC only

## HIGH RANGE (HI)

Nominal DC Voltage:	110 to 250 V
Min/Max DC Voltage	88 / 300 V
Nominal AC Voltage:	120 to 230 V
Min/Max AC Voltage	102 / 250 V

## ALL RANGES

Voltage Loss hold-up time	200 ms typical, worst case 100 ms without unit reset
Power consumption	Typical =25 VA, Maximum =45 VA

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

## 2.4.10 COMMUNICATIONS

## FRONT PORT:

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

## ASYNCHRONOUS REAR PORTS:

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

Protocols available:	ModBus® RTU / DNP 3.0
Typical distance:	1200 m
Isolation:	2 kV
<b>CAN PORT:</b>	
Rear port:	CAN port in models X, Y, Z for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Wave length:	1300 nm
Fiber type:	multimode 62.5/125 µm or 50/125 µm
Isolation:	2 kV
<b>ETHERNET PORT:</b>	
Rear port:	COM3
Type (depending on model):	
Model B:	10/100BaseTX self-negotiable
Model C:	10/100BaseTX + 100Base FX
Model D:	10/100BaseTX + Double 100BaseFX (Physical media redundancy)
10/100BaseTX	RJ45 connector
100BaseFX	ST connectors
Wave length:	1300 nm
Fiber type:	multimode 62.5/125 µm or 50/125 µm
Protocols available:	ModBus® TCP/IP
	DNP over TCP/IP and UDP/IP
	IEC 870-5-104
	Http, ftp, tftp (allow the use of a standard Internet browser)
Typical distance:	1.65 km
Response time to ModBus commands:	10 ms Typical
Isolation:	2 kV
In Models C and D, the 10/100BaseTX port is selected by an internal switch (see 3.3.3)	
Two witness LED's for transmission and reception are included	

#### 2.4.11 ENVIRONMENTAL CHARACTERISTICS

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

#### 2.4.12 PACKAGING AND WEIGHT

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

## 2.4.13 TYPE TESTS

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

Type test report available upon request.

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

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

## 2.4.14 APPROVALS

ISO9001 Registered system.

CE marking: Meets the CE standards relevant for protections.

F650 units can hold two different options for F module:

Option 1: Board with 16 inputs and 8 outputs.

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

Each model has a different wiring diagram, as follows:

2

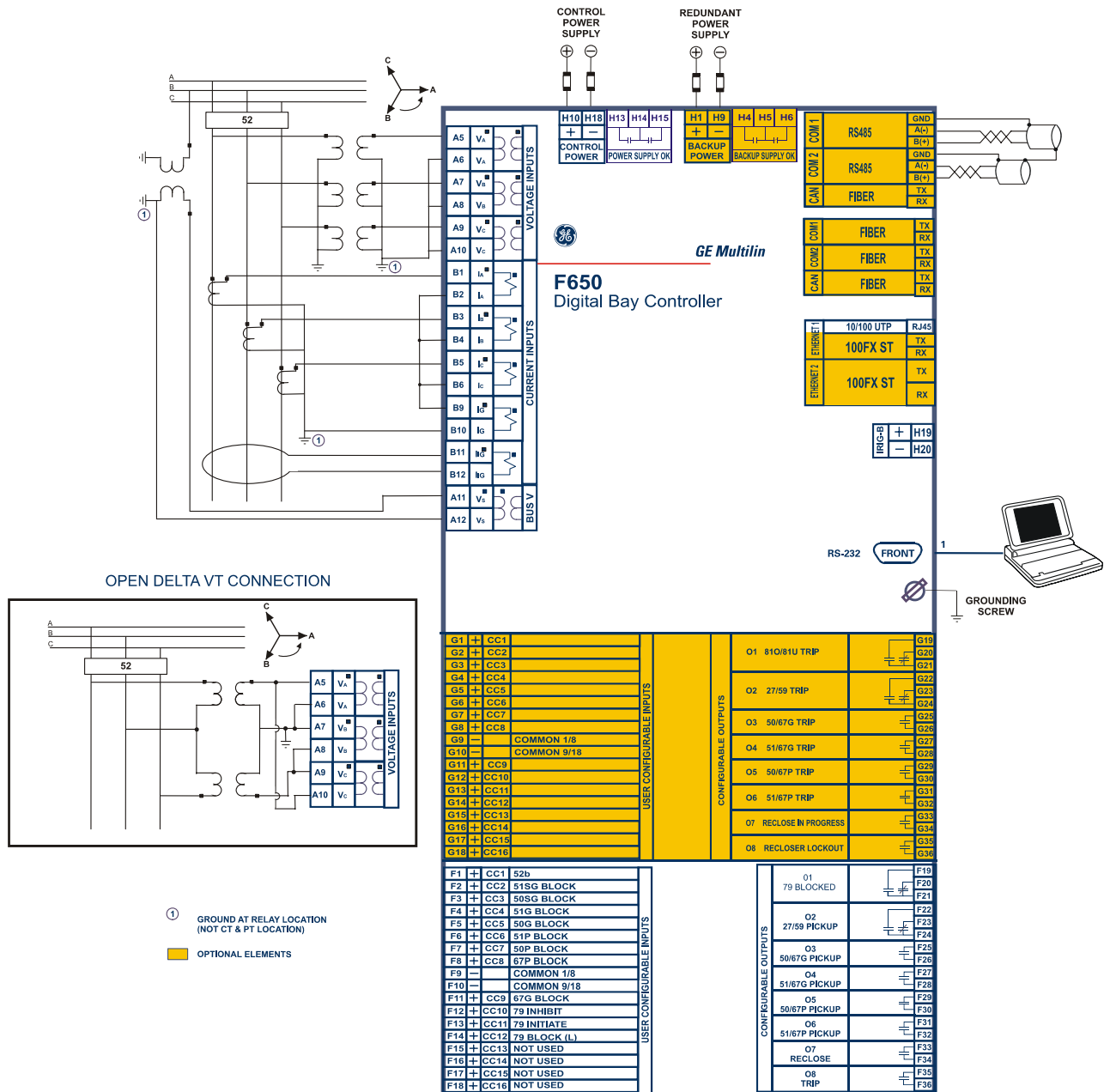


Figure 2-2: WIRING DIAGRAM FOR MODELS WITH OPTION 1 (189C4216H3)

The option 2 wiring diagram is shown below:

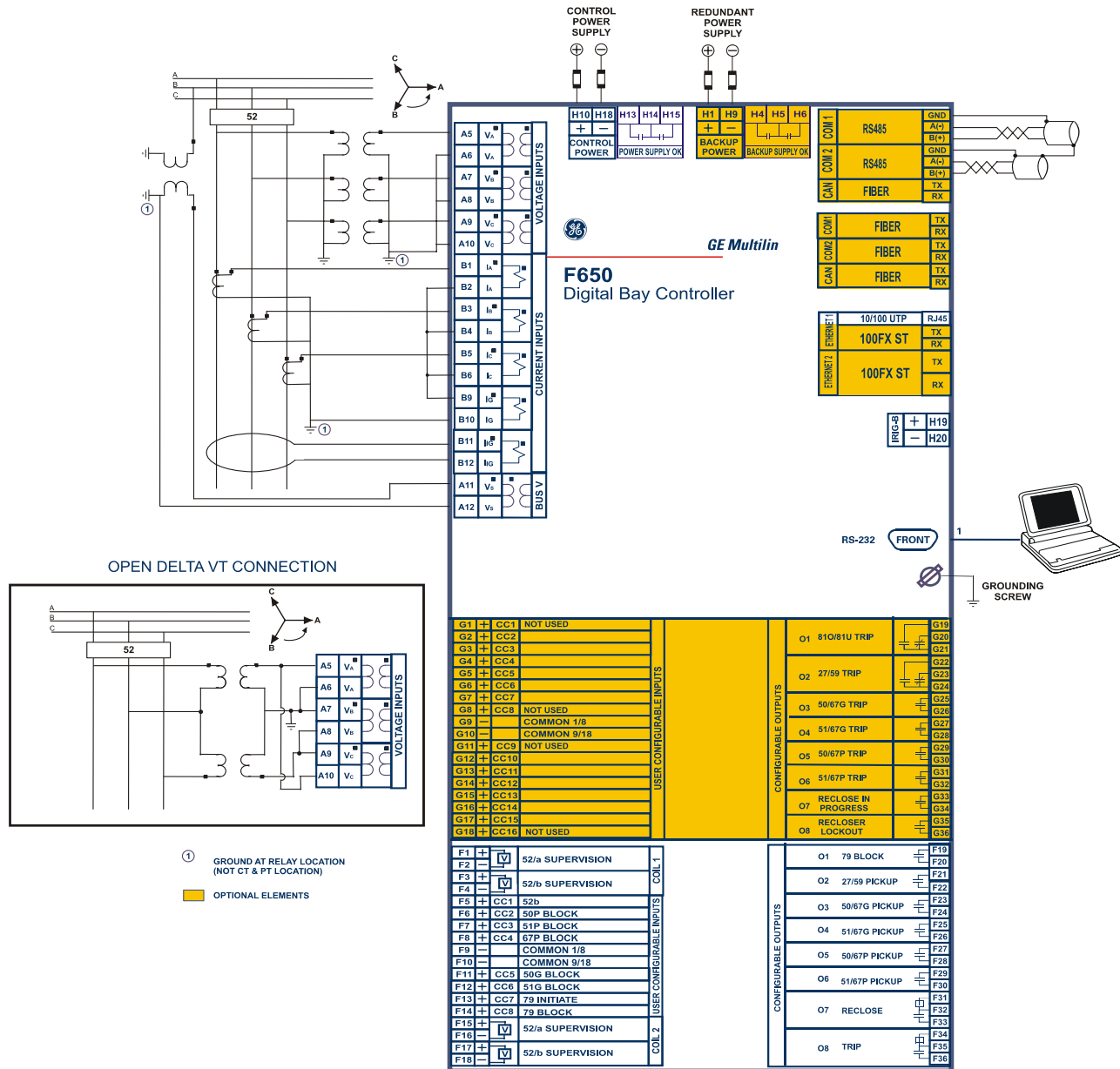


Figure 2-3: WIRING DIAGRAM FOR MODELS WITH OPTION 2 (189C4216H2)



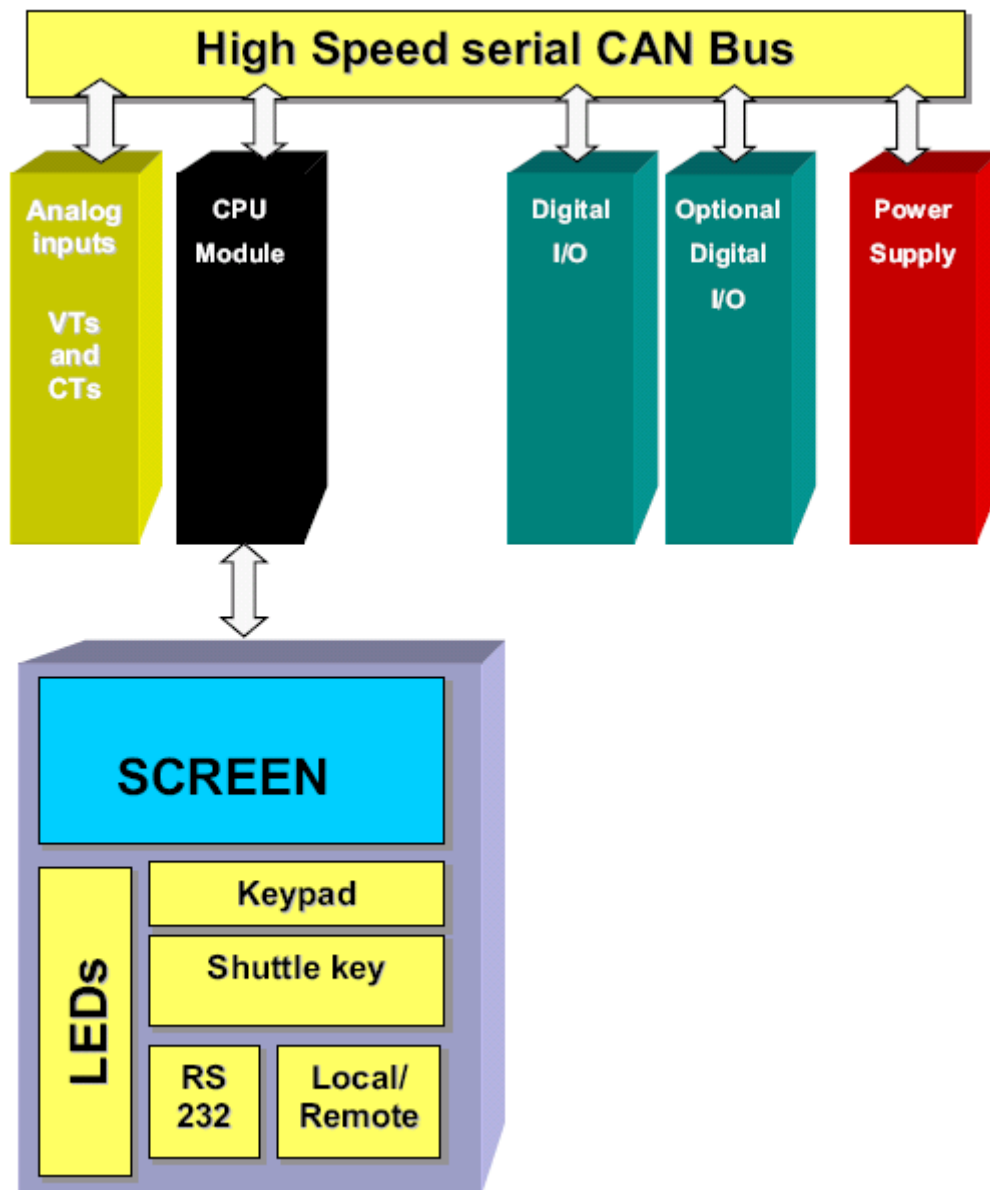


Figure 3–1: BLOCK DIAGRAM

**F650 units incorporate the following modules:**

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



- **Input/Output module** included in basic unit
- Optionally, a **second I/O module** can be added.

The F650 can incorporate a simple or redundant power supply.

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

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

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

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

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

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

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

Skilled personnel must carry out the insertion or extraction of communication boards, only after interrupting the relay auxiliary voltage, and making sure that all rear terminals are potential free.

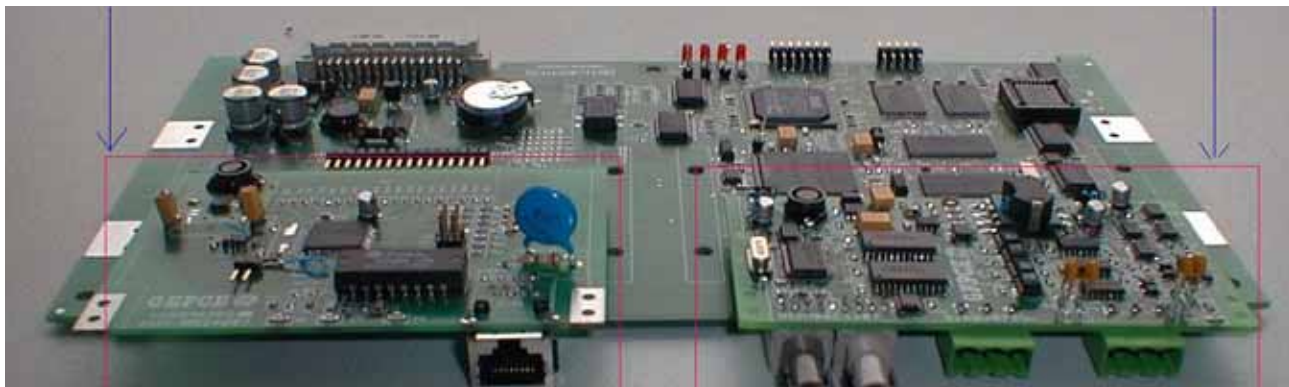


Figure 3–2: COMMUNICATIONS MODULE

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

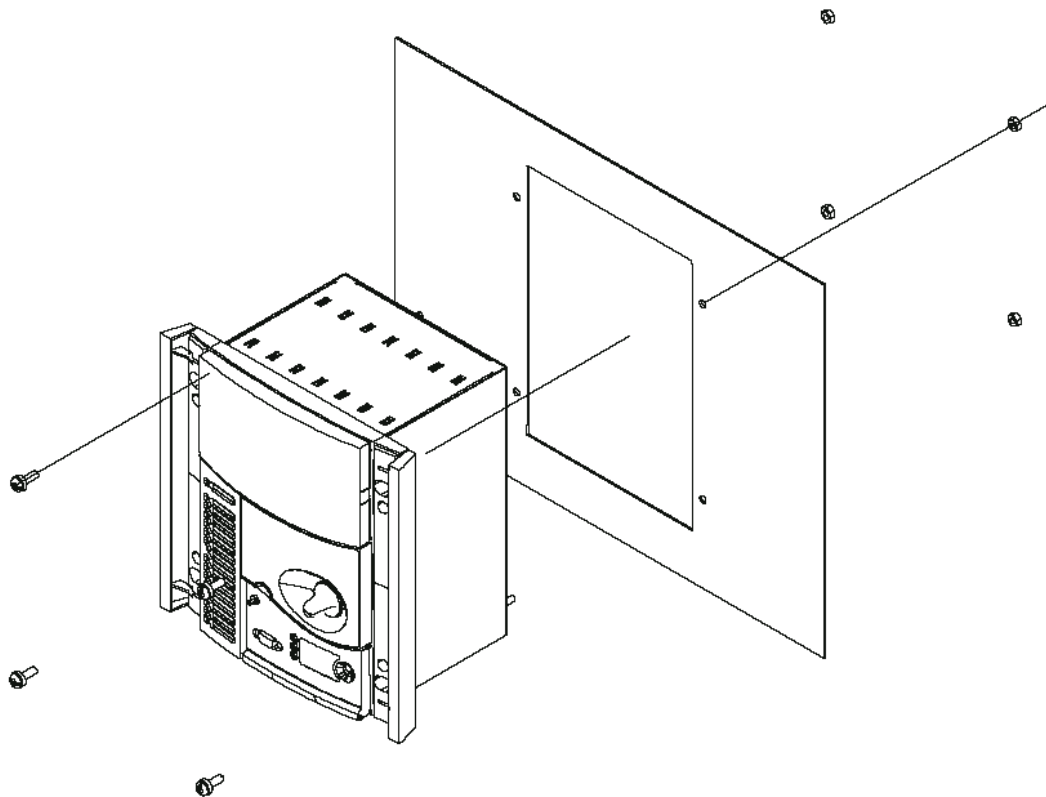
The metallic case of the unit is highly resistant to corrosion. It is made of stainless steel (AISI 304), coated with an epoxy layer, and the rest of the metallic pieces are covered with a high quality resistive coating that has successfully passed at least 96 hours in the salt spray chamber (S/N ASTM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

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

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

### 3.2.1 MOUNTING

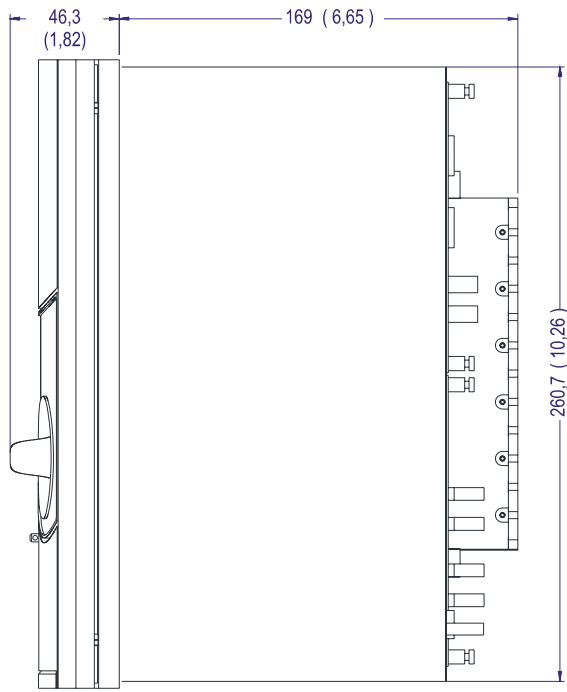
The unit is designed for semi-flush mounting. The relay is secured to the panel with the 4 M6 screws provided with the unit. The user has access to the front keypad, display and communication port. The wiring is at the rear of the unit. The drilling dimensions are shown on Figure 3-4:: DRILLING DIMENSIONS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



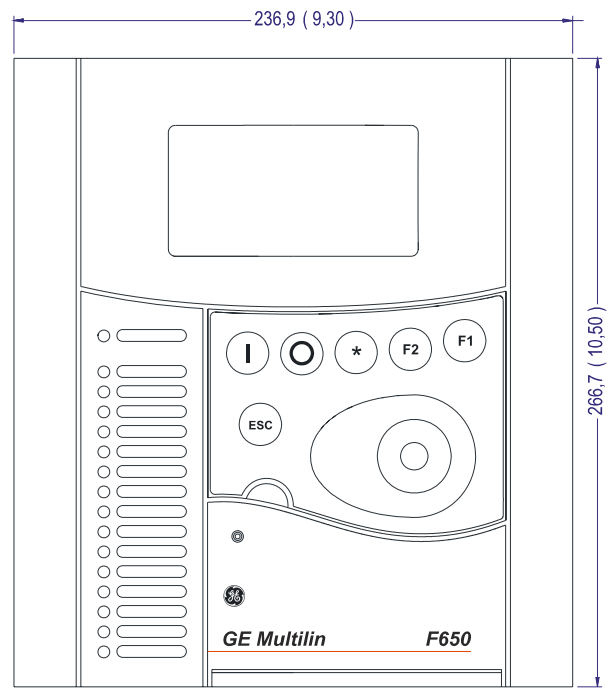
**Figure 3-3: PANEL MOUNTING**

The relay width allows the mounting of two units on a standard 19" panel, 6 units high.

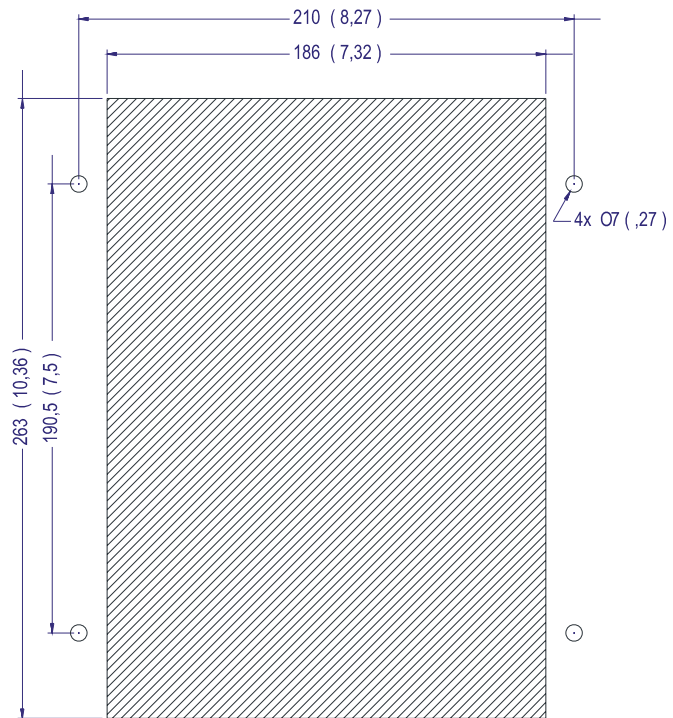
3



SIDE VIEW



FRONT VIEW



PANEL MOUNTING CUTOUT

NOTE: All dimensions are shown in mm ( inches ).

Figure 3-4: DRILLING DIMENSIONS DIAGRAM

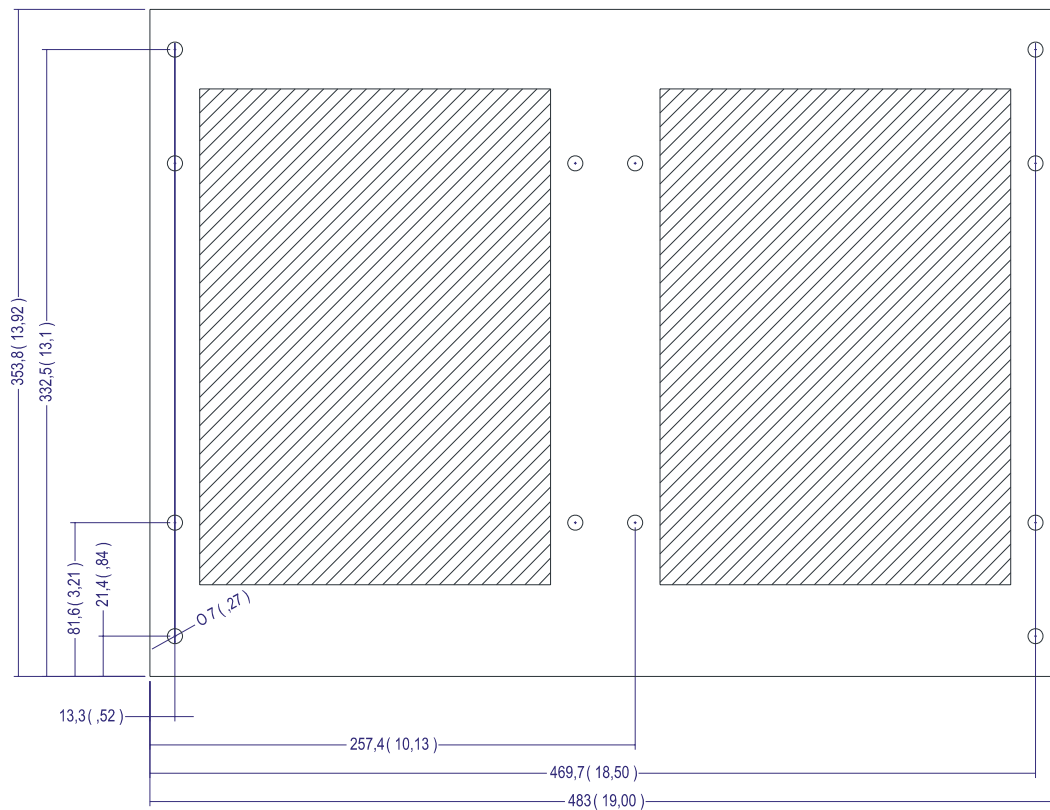


Figure 3-5: DIMENSIONS OF THE 19" RACKS 6U HIGH FOR TWO RELAYS

### 3.2.2 REAR DESCRIPTION

The relay is wired through the terminal blocks located at the rear of the unit. Terminal blocks vary depending on their functionality. The magnetic module, which receives the CT secondary currents and the metering voltages, incorporates a very robust terminal board (columns A and B). In this terminal board, current terminals are shorted two-by-two when the transformer module is extracted, so that the CT secondary never remains open. **For safety reasons it is not allowed to change or swift the magnetic module terminals.** The maximum recommended cable section for this terminal board, with the appropriate terminal, is 6 mm<sup>2</sup> (AWG 10).

The rest of the terminal blocks (columns F, G, and H), for power supply, inputs/outputs and IRIG-B, 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<sup>2</sup> (AWG 12).

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

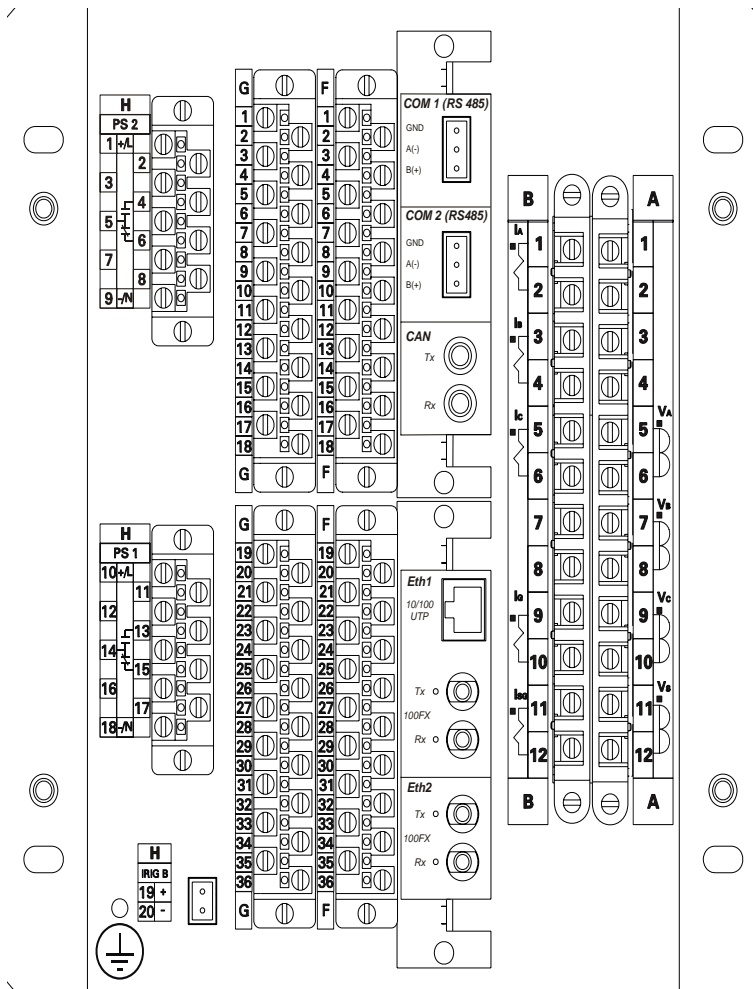



Figure 3-6: CONNECTORS LOCATION

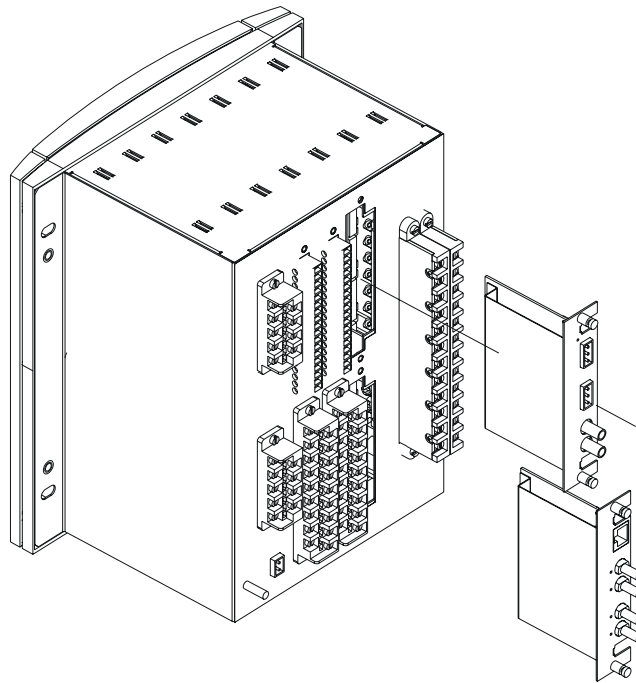


TYPE OF COMMUNICATION	CONNECTOR	
RS485	Plug-in, 3 poles.	
IRIG B	Plug-in, 2 poles.	
Plastic fiber optic	Versatile Link	
Ethernet 10/100 UTP (10/100BaseTX)	RJ45, Class 5.	
Glass fiber optic (100BaseFX)	ST	
Ethernet 100 FX (100BaseFX)	ST	
CAN Distributed I/O	ST	

**Figure 3–7: COMMUNICATIONS MEDIA SELECTOR GUIDE**

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

Skilled personnel must carry out the insertion or extraction of communication boards only after interrupting the relay auxiliary voltage.



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

The number of screws and fixtures has been minimized to guarantee an easy maintenance operation, and to protect the application from severe vibrations such as those experienced during long distance transportation.

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

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

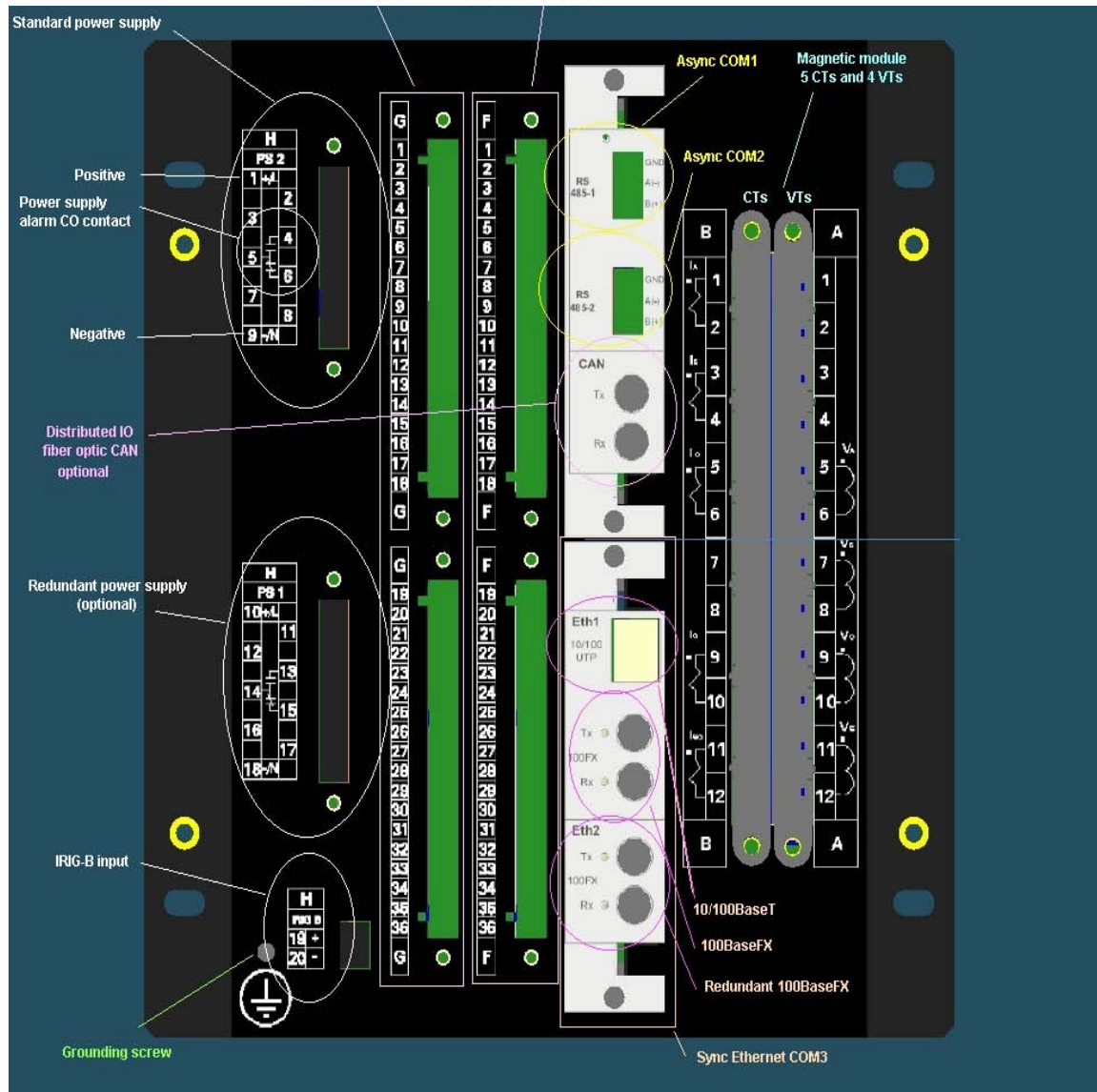


Figure 3-9: REAR TERMINALS LOCATION



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3.3.1 EXTERNAL CONNECTIONS

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F650 units can hold two different options for F module:

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

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

Each model has a different wiring diagram, both wiring diagrams can be seen in chapter 2 in this manual.

The wiring diagram for models with option 1 has the internal code **(189C4216H3)**

The wiring diagram for models with option 2 has the internal code **(189C4216H2)**.

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3.3.2 DIGITAL INPUTS WITH TRIP CIRCUIT SUPERVISION

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

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

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

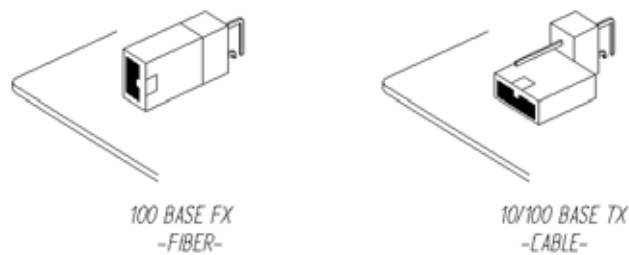
**In order to implement these schemes, it is not necessary to perform any setting in the unit. Internal functions are always operative. The detailed description of trip circuit supervision is included in chapter 5 in this manual.**

**3.3.3 CABLE/FIBER ETHERNET BOARD**

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

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

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



**Figure 3–10: FIBER/CABLE SELECTION**

**Wave length:** 1300nm

**Connector types:** ST package style

**Fiber type:** multimode 62.5/125  $\mu\text{m}$  or 50/125  $\mu\text{m}$

3

Transmitter characteristics						
Parameter		Min	Typ	Ma	Unit	Referenc
Output Optical Power BOL		-19		-14	dBm	Note 1
62.5/125 μm, NA = 0.275 Fiber		-20			avg.	
EOL						
Output Optical Power BOL		-		-14	dBm	Note 1
50/125 μm, NA = 0.275 Fiber		22.5			avg.	
EOL		23.5				
Output Optical Power at				-45	dBm	Note 2
Logic “0” State					avg.	
Receiver characteristics						
Parameter		Min	Typ	Ma	Unit	Referenc
Input Optical Power			-	-31	dBm	Note 3
Minimum at Window Edge			33.9		avg.	
Input Optical Power			-	-	dBm	Note 4
Minimum at Eye Center			35.2	31.8	avg.	
Input Optical Power Maximum		-14			dBm	Note 3
					avg.	

**Notes:**

- 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  $\mu\text{m}$  or 50/125  $\mu\text{m}$  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  $2.5\text{e-}10$ .

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.

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

OPB (dB)		Fiber optic Cable length (km)
62.5/125 $\mu\text{m}$	50/125 $\mu\text{m}$	
11.4	8	0
10.9	7.4	0.3
10.5	7.1	0.5
9.6	6.2	1.0
8.5	5.3	1.5
7.3	4.3	2.0
6	3.3	2.5

## 4.1.1 OVERVIEW

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

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

a) Setting files

EnerVista 650 Setup software provides two ways of working with setting files:

1. OFF LINE Mode: Creating or editing setting files not connected to the relay, to be stored later in the proper unit.
2. ON LINE Mode: Connecting to the relay. This on line mode allows settings modifications, reading metering values, internal status, oscillography records, event records, etc.

b) Configuration

The relay allows to fully program all the inputs, outputs, LEDs, control events, operations, block signals in protection elements, switchgear, one line diagram in HMI, and create internal logic.

For simple relay configurations a direct configuration can be used (Relay configuration screen), and for more complex configurations a PLC Editor tool is provided (Logic Configuration screen).

- c) Monitoring of all metering values, internal states, inputs and outputs provided by F650 device.
- d) Performing the previously configured operations
- e) Updating of operating system, firmware version and web server utility.
- f) One line diagrams configuration (bay mimics) for its use in models with graphical display only.
- g) Registering data info for control events, snapshot events, alarms, fault reports, oscillography files, data logger, etc.

## 4.1.2 MAIN SCREEN

EnerVista 650 Setup software provides the following areas:

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

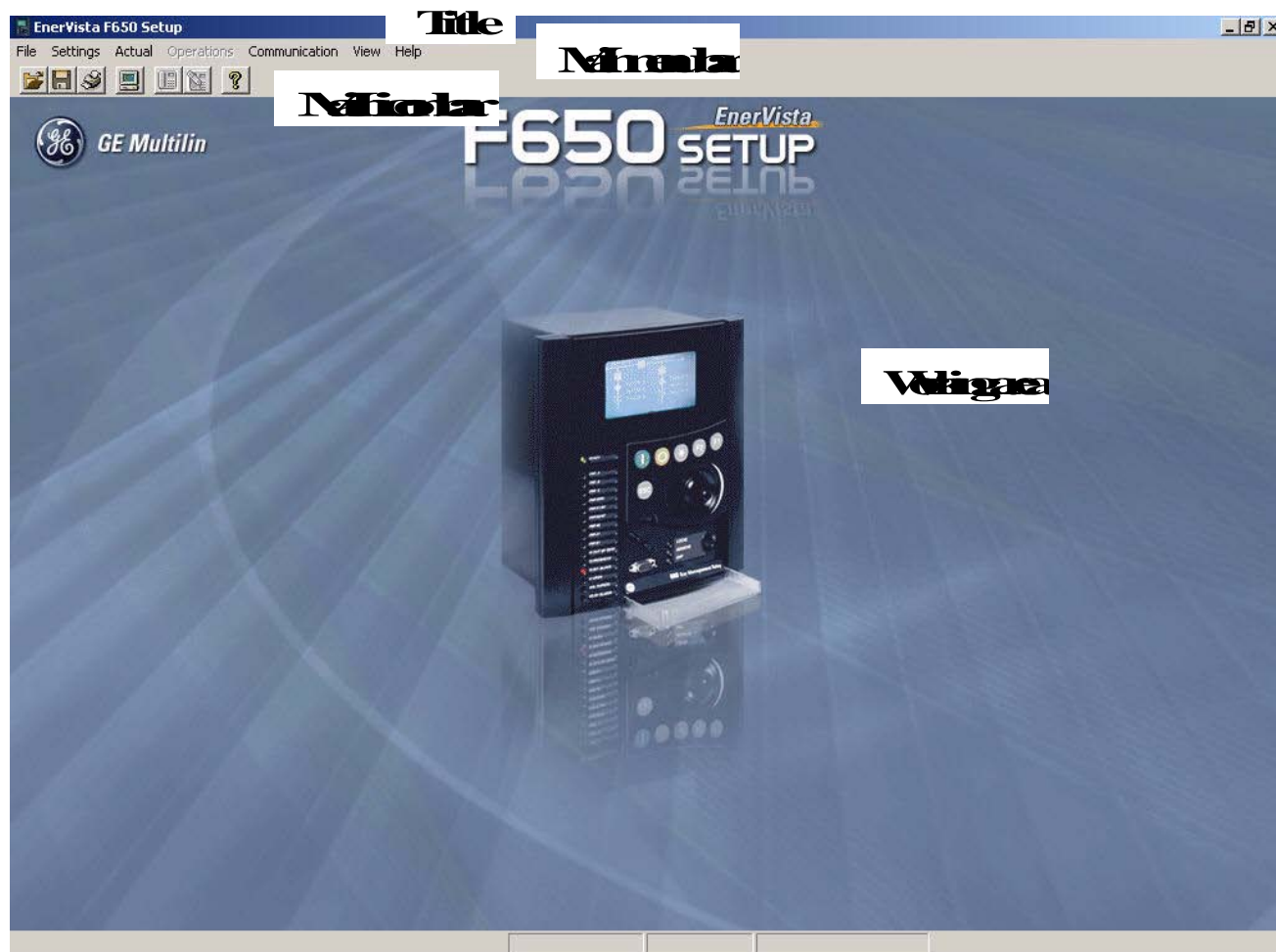


Figure 4–1: ENERVISTA 650 SETUP MAIN SCREEN

## 4.1.3 STARTING COMMUNICATION

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

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

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

Figure 4–2: COMMUNICATION PARAMETERS MENU

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

Computer settings: Main communication parameters for serial communication and control type selection.

ModBus/TCP Setup (if ModBus /TCP is selected as control type): Communication parameters for ModBus TCP communication.

Communication control: Device communication status (communicating or not communicating).

Communication optimization: allows optimizing the communication time outs and failure establishing.



**COMPUTER SETTINGS:**

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

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

**ModBus Slave Address:** ModBus addresses used for serial and Ethernet communication. These parameters can be accessed through the relay HMI and EnerVista 650 Setup software. In Relay HMI: go to **“Main screen>View or Change Settings menu >Product Setup>Communication> ModBus Protocol”**.

To move through the HMI, press intro (press in shuttle key) to enter in the internal menus and “esc” to exit.

In EnerVista 650 Setup go to **“Setpoint>Product Setup>Communication Settings>ModBus Protocol”**

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

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

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

Baud rate and parity are serial communication parameters located both in serial ports menu. In relay HMI: go to **“Main screen>View or Change Settings menu >Product Setup>Communication> Serial Ports”**. In EnerVista 650 Setup, go to **“Setpoint>Product Setup>Communication Settings>Serial Ports”**.

**Control Type:** The available control modes are:

- No Control Type, this option selects the serial communication mode, for use with serial communication ports (front port, RS485, or plastic or glass fiber optic).
- MODBUS/TCP, this option selects ModBus TCP/IP communication mode, for communication through the Ethernet port. In this case, the top right window will show the typical parameters to be programmed; IP address, port address and unit identifier in the MODBUS TCP SETUP section.

To access the relay IP address in relay HMI, go to **“Main screen>View or Change Settings menu >Product Setup>Communication> Ethernet>Ethernet 1 or 2”**. In EnerVista 650 Setup, go to **“Setpoint>Product Setup>Communication Settings>Network (Ethernet)>Ethernet 1 or 2”**.

For port address and unit identifier, in relay HMI go to **“Main screen>View or Change Settings menu >Product Setup>Communication>ModBus Protocol”**. In EnerVista 650 Setup, go to **“Setpoint>Product Setup>Communication Settings>ModBus Protocol”**.

- 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).

**COMMUNICATION CONTROL:**

The Communication Control subsection is located on the bottom left communication window and shows the communication status in the relay. There are two legends, “Status” in which the communication text status will be displayed and “Communication” which includes two buttons to start (ON) and stop (OFF) the communication with the relay.

Relay NOT communicating: In status, a message will be displayed with the communication status, e.g. 650 Setup is not talking to an F650. The ON button will be available to press and the OFF button will be disabled (in grey color). In this stage the relay is not communicating to the computer and the communication parameters can be modified to establish the communication lately by pressing in the ON communication button.

Relay communicating: In status, a message will be displayed with the communication status, e.g. 650 Setup is now talking to an F650. The ON button will be disabled (in grey color) and the OFF button will be available to press. In this stage the relay communicating to the computer and the communication parameters cannot be modified. In the example on Figure 4–2: COMMUNICATION PARAMETERS MENU , communication has not been established yet.

**COMMUNICATION OPTIMIZATION:**

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

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

- Modem: Allows configuring the unit for remote communications via modem, using telephonic line. It is only available if the relay is not communicating and if modem has been select on Communication>computer control type selection. Go to **“Communication>Modem”**
- Troubleshooting (Serial or Ethernet connection): Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established. Go to **“Communication>Troubleshooting”**. An example is provided in Figure 4–3:

4

COMMUNICATION / TROUBLESHOOTING						
MEMORY MAP INSPECTION (READ DATA)						
Group	Address	Type	# of elem	Selection	Values	Transmit Total
<input type="checkbox"/> 1	1	SP	1	HEX		0
<input checked="" type="checkbox"/> 2	B000	SP	13	CHAR	"F650MZDF2G1HI"	164
<input type="checkbox"/> 3	3	SP	3	INT		0
<input type="checkbox"/> 4	4	SP	4	UINT		0
<input type="checkbox"/> 5	5	AV	5	LONG		0

MEMORY MAP INSERTION (WRITE DATA)						
Group	Address	# of elem	Selection	Values		Transmit Total
<input type="checkbox"/> 1	1	1	WORD	a	SEND	0
<input type="checkbox"/> 2	2	2	WORD	b		0
<input type="checkbox"/> 3	3	3	WORD	c		0
<input type="checkbox"/> 4	4	4	WORD	d		0

CLEAR TRANSMIT TOTALS

**Figure 4–3: COMMUNICATION TROUBLESHOOTING SCREEN**

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

**IMPORTANT NOTE:**

**READ CAREFULLY THE FLASH MEMORY UPDATE PROCEDURE DESCRIBED IN SECTION AND CLOSE ALL THE RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND boot code UPDATING PROCESS**

Before updating firmware check that the firmware version that is going to be updated match the boot code version of the relay. Otherwise it is necessary to update the boot code before proceeding to update the firmware. Other combinations of firmware and boot code different from the listed below will not be operative

The boot code version is available in the logotype main screen in HMI; it is the number between brackets in the first line, e.g. F6501.70 (2.35). The boot code version is 2.35

Firmware version up to 1.5X must be used with Boot Code 2.30 (or 2.20 and 2.35)

Firmware version from 1.6X up to 1.7X must be used with Boot Code 2.35

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

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

**IMPORTANT NOTE:**

\*.650 files contain protection, control settings, relay configuration and compiled logic equations. This file can be retrieved from the relay, using the **“File>Get info from relay”** option in EnerVista 650 Setup (through serial or Ethernet communication). **“File>Send info to relay”** option stores this \*.650 file in the relay.

\*.pep, \*.aut and lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the **“Communication>Upload info files to relay”** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using **“Communication>Download info files to relay”** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the \*.pep, \*.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the **“Communication>Upload info files to relay”** option to store these logic configuration files into the relay.

It is important to distinguish between **“Send / Get info to relay”** and **“Upload / Download info files to/from relay”**. **“File>Send/Get info to relay”** sends/gets settings and configuration and compiled logic equation to/from the relay (\*.650 format), and the relay automatically starts working with the new settings once they are stored. **“Communications>Upload/Download info files to relay”**, stores/retrieves in the relay flash memory: settings, configuration and compiled logic equations (\*.650) besides the PLC files (\*.pep, \*.aut, \*.lib). This is only a physical storage (file backup).

## 4.1.4 FILE MANAGEMENT

File management with EnerVista 650 Setup software:

## 4.1.4.1 OFF LINE MODE WITHOUT CONNECTION TO THE RELAY

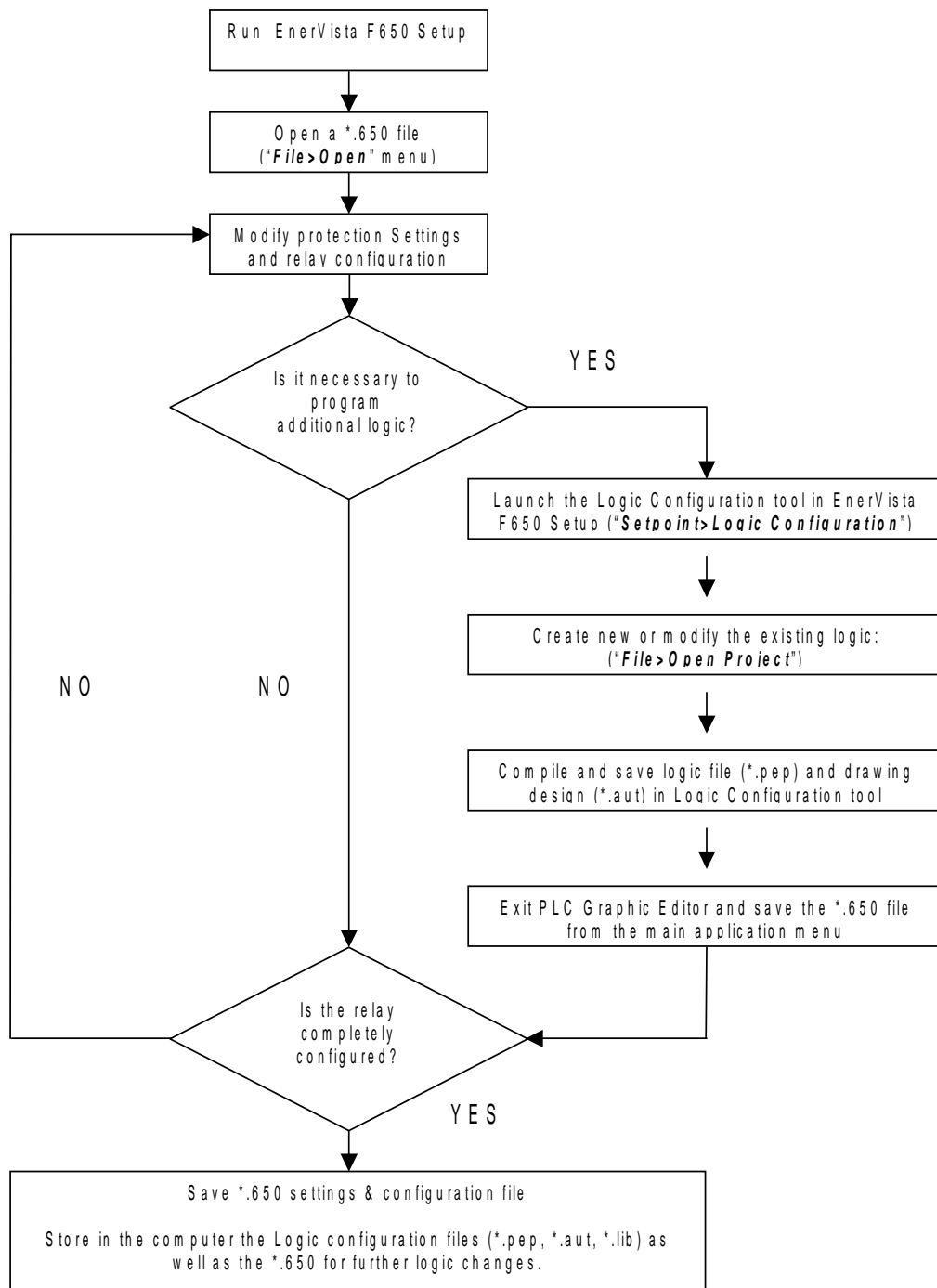


Figure 4–4: OFF-LINE MODE FILE MANAGEMENT

**NOTE 1:** Depending on the type of Inputs/Outputs incorporated in relay slots F and G, configuration options will be different. There are 2 template files available for working off-line with any F650 available model:

F650\_F1G0\_V200.650: Board 1 in slot F and without any board in slot G.

F650\_F1G1\_V200.650: Board 1 in slot F and board 1 in slot G.

F650\_F1G4\_V200.650: Board 1 in slot F and board 4 in slot G.

F650\_F1G5\_V200.650: Board 1 in slot F and board 5 in slot G.

F650\_F2G0\_V200.650: Board 2 in slot F and without any board in slot G.

F650\_F2G1\_V200.650: Board 2 in slot F and board 1 in slot G.

F650\_F2G4\_V200.650: Board 2 in slot F and board 4 in slot G.

F650\_F2G5\_V200.650: Board 2 in slot F and board 5 in slot G.

**Table 4–1: TYPES OF FILES GENERATED BY ENERVISTA 650 SETUP SOFTWARE OPERATION MODE OFF-LINE:**

FILE TYPE	SETTINGS & CONFIGURATION FILE *.650		LOGIC CONFIGURATION FILES (*.PEP, *.AUT, *.LIB)		
			*.PEP	*.AUT	*.LIB
Relevant sections inside the file	Protection Settings and Configuration Section	Compiled logic equations section	Header for Logic project	Graphical edition container. Logic equations 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)	Logic configuration graphic editor (PLC Editor)
Definition and contents	Relay configuration file containing all protection elements Settings, input/output and LEDs configuration, graphic display configuration, etc.	Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by F650 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.
File storage in the PC	EnerVista 650 Setup: <b>"File&gt;Save"</b>	EnerVista 650 Setup: <b>"File&gt;Save"</b> It is necessary to store the logic configuration files used to create the PLC project for further logic modifications.	PLC Editor: <b>"File&gt;Save Project"</b>	PLC Editor: <b>"File&gt;Save Project"</b>	PLC Editor: <b>"File&gt;Save Library"</b>
File Retrieval of previously stored files in PC	EnerVista 650 Setup: <b>"File&gt;Open"</b>	EnerVista 650 Setup: <b>"File&gt;Open"</b> It is necessary to have the logic configuration files used to create the PLC project	PLC Editor: <b>"File&gt;Open Project"</b>	PLC Editor: <b>"File&gt;Open Project"</b>	PLC Editor: <b>"File&gt;Library&gt;New Library"</b>
Basic information transfer mode to the relay	Connect with the relay ( <b>"Communications&gt;Computer"</b> ) Open the created file ( <b>"File&gt;Open"</b> ) Send to relay from the menu: <b>"File&gt;Send info to relay"</b> 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 ( <b>"Communications&gt;Computer"</b> ) Launch F650 PLC Editor ( <b>"Setpoint&gt;Logic Configuration"</b> ) Open the created PLC project ( <b>"File&gt;Open Project"</b> ) Compile the project ( <b>"Run&gt;Compile"</b> ) Now the logic (virtual outputs) can be sent directly to relay ( <b>"Run&gt;Send Equations to Relay"</b> ). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		

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

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

File storage inside the relay (RECOMMENDED)	" <b>Communication &gt; Upload info files to relay</b> " through Ethernet
Retrieval of files stored in the relay (RECOMMENDED)	" <b>Communication &gt; Download info files from relay</b> " through Ethernet

## 4.1.4.2 ON LINE MODE CONNECTED TO THE RELAY

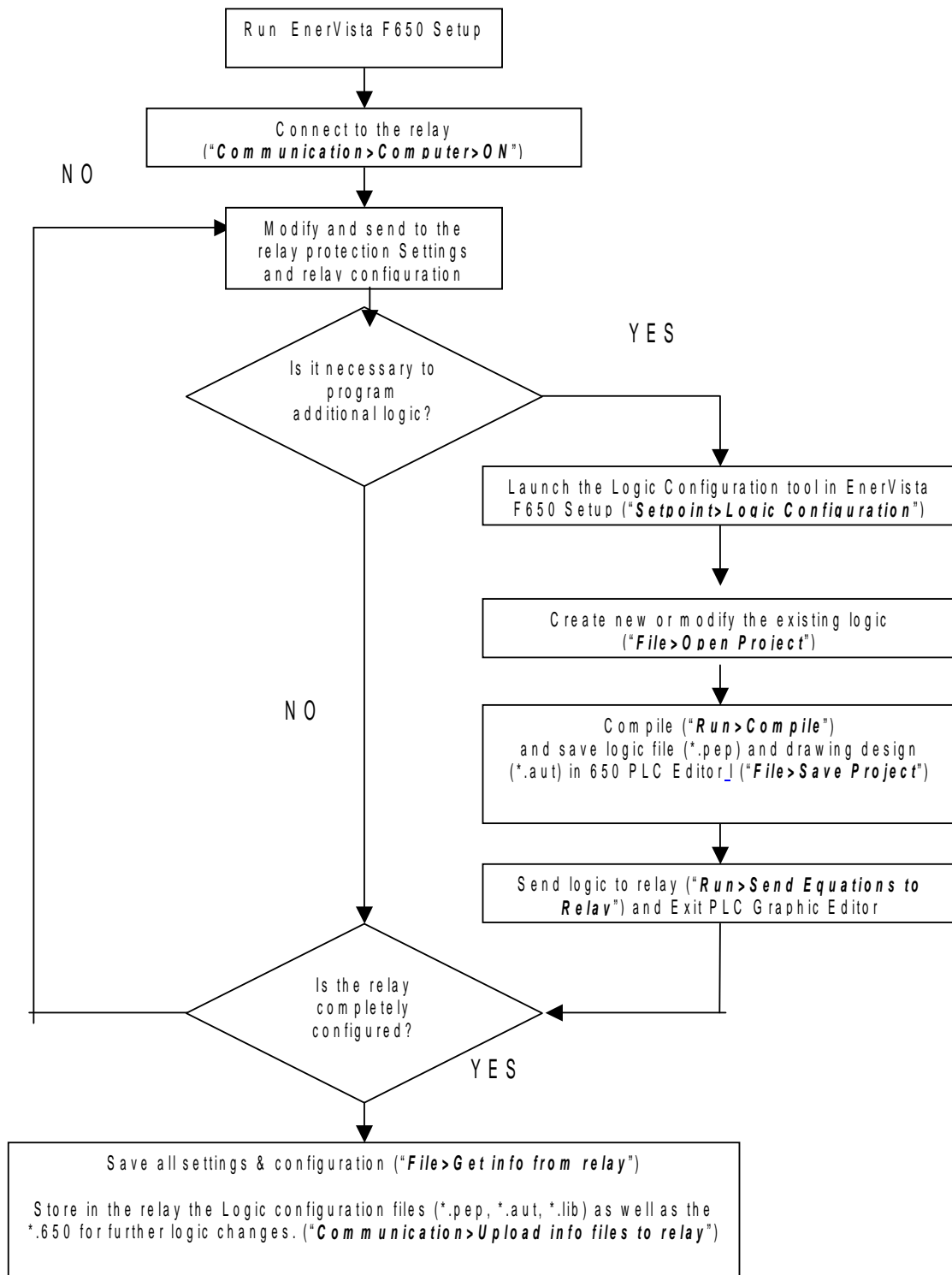


Figure 4-5: ON LINE MODE FILE MANAGEMENT



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

FILE TYPE	SETTINGS & CONFIGURATION FILE *.650		LOGIC CONFIGURATION FILES (*.PEP, *.AUT, *.LIB)		
			*.PEP	*.AUT	*.LIB
Relevant sections inside the file	Protection Settings and Configuration Section	Compiled logic equations section (relay configuration and logic configuration)	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) and relay configuration screen	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Definition and contents	Relay configuration file containing all protection elements, settings, input/output and LEDs configuration, graphic display configuration, etc.	Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by F650 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.
Basic information transfer mode to the relay	Connect with the relay (" <b>Communications&gt;Computer</b> ")		Connect with the relay (" <b>Communications&gt;Computer</b> ")		
	Send settings and configuration from file:		Launch 650 PLC Editor (" <b>Setpoint&gt;Logic Configuration</b> ")		
	Send protection and control settings to relay: " <b>File&gt;Send info to relay</b> ", select *.650 file, choose Protection and Control settings option in screen and press send	Send configuration and logic compiled equation to relay: " <b>File&gt;Send info to relay</b> ", select *.650 file, choose "Relay and Logic Configuration" option in screen and press send. When the message "Configuration stored" appear in the relay HMI the configuration has been stored.	Open the created PLC project (" <b>File&gt;Open Project</b> ")		
			Compile the project (" <b>Run&gt;Compile</b> ")		
	Modify settings and configuration directly in the relay:		Now the logic (virtual outputs) can be sent directly to relay (" <b>Run&gt;Send Equations to Relay</b> "). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		
	Go to " <b>Setpoint&gt;&gt;&gt;Product Setup&gt;&gt;&gt;System Setup&gt;&gt;&gt;Protection Elements&gt;&gt;&gt;Control Elements&gt;&gt;&gt;Inputs/Outputs</b> " in EnerVista 650 Setup and modify the selected settings and press store to send them to the relay.	Go to " <b>Settings&gt;Relay Configuration&gt;&gt;&gt;Outputs&gt;&gt;&gt;LEDs&gt;&gt;&gt;Operations&gt;&gt;&gt;Protection Elements&gt;&gt;&gt;Oscillography&gt;&gt;&gt;Operations&gt;&gt;&gt;Control Events&gt;&gt;&gt;Switchgear&gt;&gt;&gt;Inputs&gt;&gt;&gt;Virtual Inputs&gt;&gt;&gt;Operations&gt;&gt;&gt;MMI (HMI)</b> " in EnerVista 650 Setup, modify the selected values and press store to send them to the relay.			
File storage in PC	EnerVista 650 Setup: " <b>File&gt;Get info from relay</b> ". User definable texts retrieved are operations, events, and LEDs.	EnerVista 650 Setup: The relay provides this information in a basic format (compiled equations). It is necessary to have the logic configuration files used for creating the PLC project to view the logic in a graphical way (FDB) and be able to modify it (virtual outputs).	PLC Editor:		
			<b>"File&gt;Save Project"</b>		<b>"File&gt;Save Library"</b>
			The relay will not provide this information unless the *.pep file is stored in the relay	The relay will not provide this information unless the *.pep file is stored in the relay.	The relay will not provide this information unless the *.pep file is stored in the relay.
File storage inside the relay in a flash memory (RECOMMENDED):			To store the logic configuration files in the relay use the " <b>Communication&gt;Upload info files to relay</b> " option		
File Retrieval of relay hard disk stored files (RECOMMENDED):			<b>"Communication&gt;Download info files from relay"</b> through Ethernet		

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

#### 4.1.5 ENERVISTA 650 SETUP MENUS STRUCTURE

The EnerVista 650 Setup menus structure is shown in EnerVista 650 SETUP MENUS STRUCTURE.

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

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

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

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

4

**Table 4–3: ENERVISTA 650 SETUP MENUS STRUCTURE**

FILE	SETPOINT	ACTUAL	OPERATIONS (*)	COMMUNICATION	SECURITY	VIEW	HELP
Open (**)	Product Setup	Front Panel	NA	Computer	Login user	Traces	Instruction Manual
Save As (**)	System Setup	Status	NA	Modem (*)	Change Password	ModBus Memory Map	About EnerVista 650 Setup
Close (**)	Protection Elements	Metering	NA	Troubleshooting (*)	User Management	Languages (**)	
Config File Converter	Control Elements	Inputs/Outputs	NA	Calibration (*)			
Properties (**)	Inputs/Outputs	Records (*)	NA	Upgrade firmware version (*)			
Get info from relay (*)	Relay Configuration		NA	Upgrade operating system (*)			
Send info to relay (*)	Logic Configuration		NA	Upgrade F650 Web Server			
Print Setup (**)	Clock (*)		NA	Upload info files to relay			
Print Preview (**)			NA	Download info files from relay			
Print (**)			NA				
Print to file (**)			NA				
Exit			NA				

## 4.1.6 FILE MENU OVERVIEW

Table 4–4: GENERAL OVERVIEW OF FILE MENU:

FILE	
Open (**)	Open a settings and configuration file for off-line working.
Save As (**)	Save *.650 settings and configuration file.
Close (**)	Close the opened *.650 file in EnerVista 650 Setup.
Config File (*.650) Converter	Tool to convert the *.650 files from one version to another
Properties (**)	File properties for *.650.
Get info from relay (*)	Retrieve the *.650 settings and relay configuration compiled equations from the relay.
Send info to relay (*)	Send and write the *.650 settings and configuration to the relay.
Print Setup (**)	To configure printer settings.
Print Preview (**)	Preview of settings and configuration file printing format.
Print (**)	Launch the *.650 file to be printed.
Print to file (*.xls) (**)	*.650 printed to file in excel format.
Exit	Quit the application closing all the open windows.

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

#### 4.1.6.1 OPEN, SAVE AS AND CLOSE

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

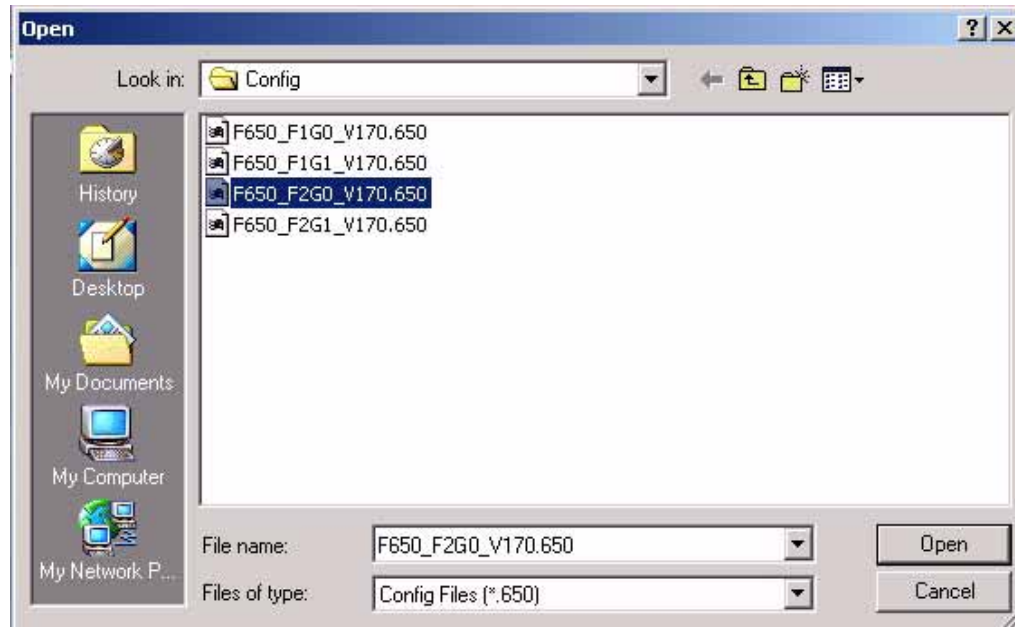


Figure 4–6: OPEN FILE MENU

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

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

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

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

#### 4.1.6.2 CONFIG FILE (\*.650) CONVERTER

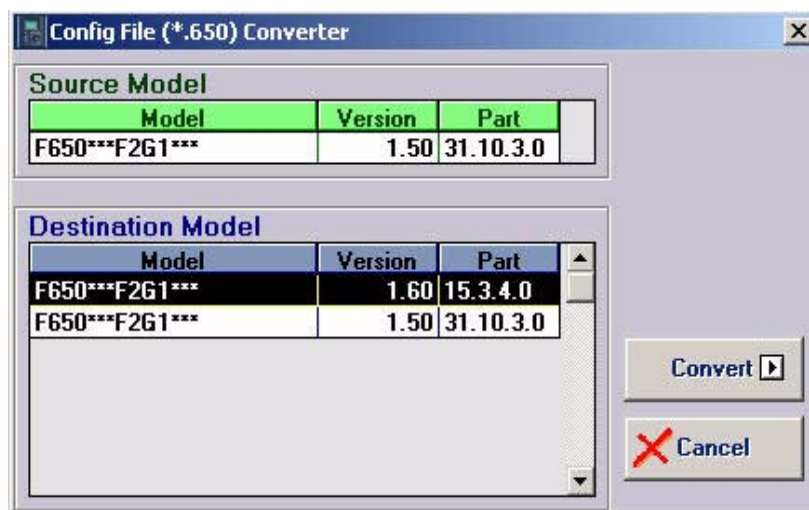


Figure 4–7: CONFIG FILE (\*.650) CONVERTER MENU

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

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

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

#### 4.1.6.3 PROPERTIES

When this option is selected, the program will show a screen including the relay model information, firmware version, etc. of the file being edited, as shown on Figure 4–8:



Figure 4–8: FILE PROPERTIES MENU

#### 4.1.6.4 PRINTING OPTIONS (PRINT SETUP/PRINT PREVIEW/PRINT/PRINT TO FILE)

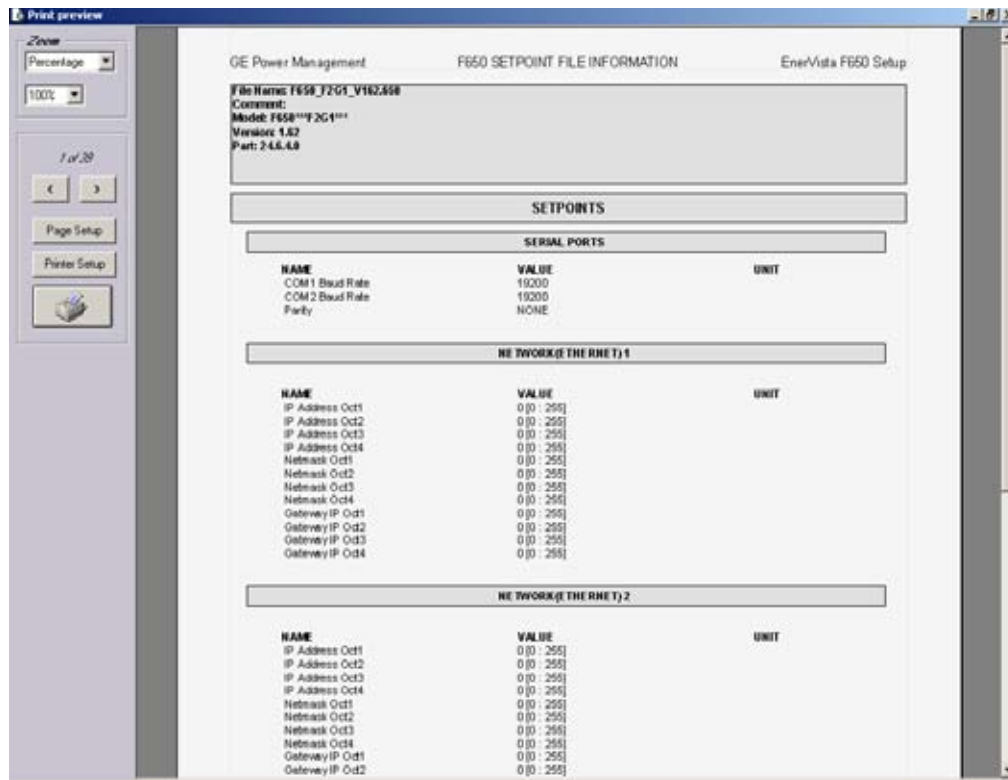
The printing options are active only in off-line mode, in "File edition", and not in on-line mode, connected with the relay.

**4.1.6.5 PRINT SETUP**

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

**4.1.6.6 PRINT PREVIEW**

Option to preview the whole settings and configuration file (\*.650) in paper format to be printed as shown in Figure 4–9:.



**Figure 4–9: PRINT PREVIEW OF SETTINGS FILE**

**4.1.6.7 PRINT**

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

**4.1.6.8 PRINT TO FILE (\*.XLS)**

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

## 4.1.7 SETTINGS MENU OVERVIEW

Table 4–5: GENERAL OVERVIEW OF SETPOINT MENU IN ENERVISTA 650 SETUP:

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

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

## 4.1.7.1 PRODUCT SETUP

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

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

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

### e) COMMUNICATION SETTINGS

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

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

COMMUNICATION SETTINGS	
Serial Ports	Baud rate and parity for COM1 and COM2 serial communication ports.
Network (Ethernet)	Ethernet communication parameters for COM3 (IP Address, Netmask, Gateway IP, etc.) 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.
IEC 870-5-104,	TCP Port, Common Addr of ASDU, Cyclic Meter Period and, Synchronization Event settings.
SNTP (*)	Synchronization over Ethernet settings

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

#### 4.1.7.2 SYSTEM SETUP

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

**Table 4–8: GENERAL OVERVIEW OF SYSTEM SETUP MENU:**

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

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



### 4.1.7.3 PROTECTION ELEMENTS

This option shows all the protection-grouped elements available in the relay as shown in Table 1–9:. Each of these groups includes the specific protection units of the same type. For example phase currents group includes TOC, IOC, directional units, etc. There are three groups available, so there are three protection units of each function that can work in grouped mode or ungrouped (altogether).

**Table 4–9: GENERAL OVERVIEW OF PROTECTION ELEMENTS MENU:**

PROTECTION ELEMENTS	
Phase Current	All overcurrent grouped functions for phase current.
Neutral Current	All overcurrent grouped functions for neutral current. (Calculated from phases, not measured)
Ground Current	All overcurrent grouped functions for ground current. (Measured from 4 <sup>th</sup> current input)
Sensitive Ground Current	All overcurrent grouped functions for sensitive ground current. (Measured from 5 <sup>th</sup> current input)
Negative Sequence Current	Negative sequence time overcurrent function
Voltage Elements	All under and overvoltage grouped functions for phases, neutral, auxiliary voltage and negative sequence.
Power	Forward and directional power grouped protection functions.

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

Table 4–10: DIFFERENT PROTECTION ELEMENTS INCLUDED

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

#### 4.1.7.4 CONTROL ELEMENTS

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

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

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

**4.1.7.5 INPUT/OUTPUTS**

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

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

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

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

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

**Table 4–13: GENERAL OVERVIEW OF “INPUTS/OUTPUTS>CONTACT I/O” SETTINGS MENU.**

CONTACT I/O	Board F	Board located in first slot, always connected, either type 1 or 2.
	Board G	Board located in second slot, depends on model definition. If model is type G0 there is no board in second slot.
	Board H	Board located in first slot of CIO Module (external inputs/outputs module)
	Board J	Board located in second slot of CIO Module (external inputs/outputs module)

#### 4.1.7.6 RELAY CONFIGURATION

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

**Table 4–14: GENERAL OVERVIEW OF RELAY CONFIGURATION MENU:**

RELAY CONFIG	
Outputs	Configuration of contact output operate and reset signals for all boards.
LEDs	15 LEDs fully configurable from any logical variable, contact or virtual input. First 5 LEDs are latched by hardware, the rest are self-reset but can be latched through PLC configuration. From the LED configuration screen, it is possible to print the vertical LED label for the relay
Operations	Configurable operations up to 24. Operation texts, interlocks, final states, frontal keys, time outs and masters.
Protection Elements	This tab allows assigning operands (logic signals) as inputs to different protection elements. To block, reset, initiate the different protection elements inputs.
Oscillography	Trigger and up to 16 digital channels to be included in oscillography records, are programmable from any logical variable, contact or virtual input. Text configuration is only for off-line mode. <b>NOTE:</b> 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 <b>Settings&gt;Product Setup&gt;Oscillography</b> menu.
Control Events	Up to 128 user programmable events from any logical variable, contact or virtual input. Possibility to display the event as an alarm on the alarms panel. Control events are also displayed in the snapshot events recording. 1 ms time tagging. A control event is a logic signal associated to an operand or combination of operands, that allows following the status of that signal.
Switchgear	Up to 16 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 16 programmable switchgear elements.
Remote outputs	Up to 32 DNA bits and 6?????? bits to be transmitted to remote devices over CAN using GSSE messages
Inputs	Text configuration for off-line mode file management for all the contact inputs available in device.
Virtual Inputs	Text configuration for off-line mode file management. 32 latched and 32 self reset virtual inputs.
MMI (HMI-Human Machine Interface)	Screen for one line diagram configuration. This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings. See an example in Figure 4–11:

The following figures show an example of the default factory configuration for F650.

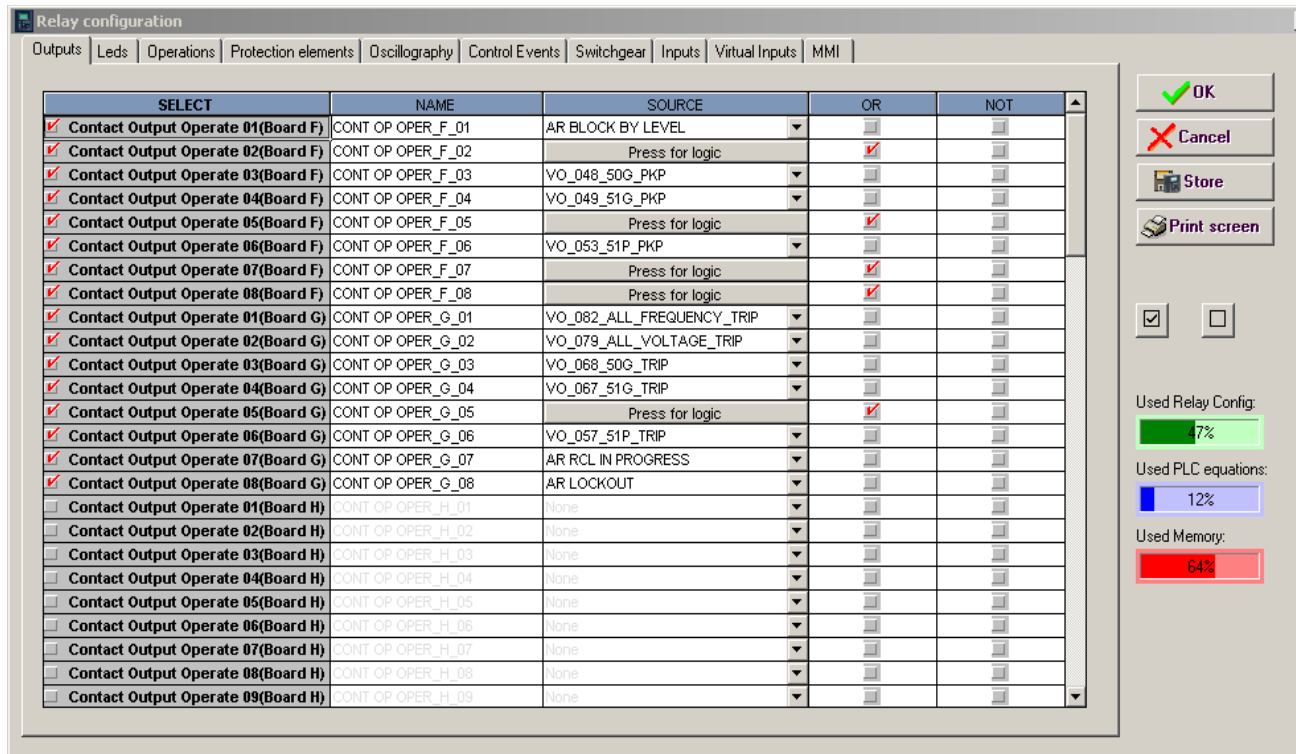


Figure 4-10: RELAY CONFIGURATION

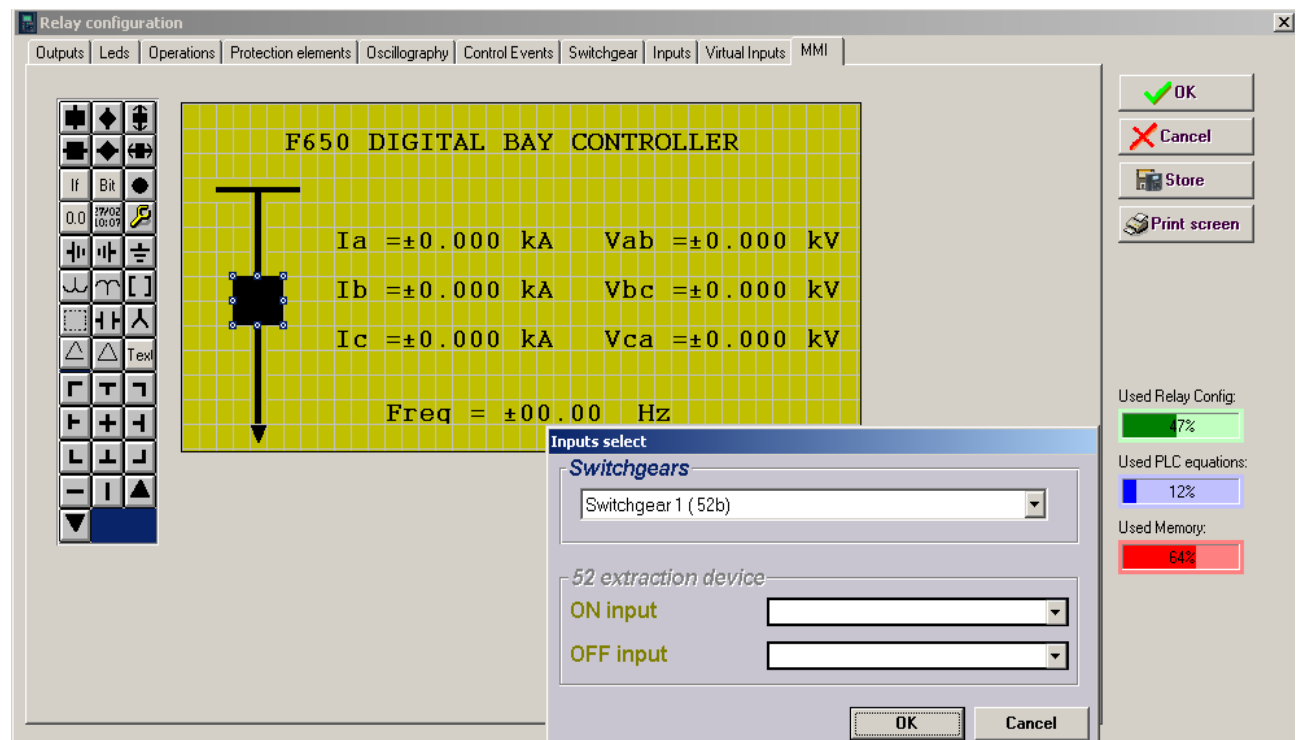


Figure 4-11: HMI CONFIGURATION

4.1.7.7 LOGIC CONFIGURATION

This logic configuration allows creating more complex configurations, using the graphical PLC, than using the tables from Relay Configuration. For file management detailed information go to section 4.1.4.

Table 4–15: GENERAL OVERVIEW OF LOGIC CONFIGURATION MENU:

LOGIC CONFIG	
*.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 F650 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.

#### 4.1.7.8 CLOCK

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

Figure 4-12: CLOCK

### 4.1.8 ACTUAL VALUES MENU OVERVIEW

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

Table 4-16: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:

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

#### 4.1.8.1 FRONT PANEL

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

#### 4.1.8.2 STATUS

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



Table 4–17: GENERAL OVERVIEW OF STATUS MENU:

STATUS	
Operation bits	Up to 24 elements. OPERATION BIT XX is (0) when the configured time out for the operation XX expires or when success conditions are met. And it is (1) if operation XX is executed and interlocks are fulfilled.
Breaker	Breaker status (open, closed or undefined). The rest of the status signals corresponding to the switchgear XX configured as breaker are in the <b>"Status&gt;Switchgear Status&gt;Switchgear XX"</b> 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 <b>"Settings&gt;Product Setup&gt;ModBus User Map"</b>
Switchgear Status	Up to 16 blocks of switchgear status signals for the 16 configurable devices. Status signals such as inputs for A and B contacts, status for A and B, open and close status, error 00 and error 11, open init and close init, fail to open and fail to close signals.
Calibration	Internal states for calibration. Factory calibration and calibration error signals.
Flex Curves	Flex curve status for A, B, C and D user curves. (0) if it is not configured, (1) if it is configured. To configure a flex curve go to <b>"Settings&gt;System Setup&gt;Flex Curves"</b> menu.
System Info	This screen can monitor the system parameters and the internal status of the Relay boot code. Not enabled by default, password required
Records Status	Information related to the different records stored in the Relay, such as: Fault reports, control events, oscillography, data logger, demand, energy, and breaker maintenance.
SNTP-IRIG-B	Information related to synchronization via IRIG_B or SNTP

Table 4–18: DIFFERENT CONTROL ACTUAL VALUES INCLUDED IN THE CONTROL ELEMENTS MENU

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

Table 4–19: DIFFERENT PROTECTION ACTUAL VALUES INCLUDED IN THE PROTECTION MENU

PROTECTION		
Protection Blocks		This screen shows all the protection element blocks available. Protection elements block signals can be configured at “ <b>Settings&gt;Relay Configuration &gt; Protection Elements</b> ”.
Phase Current		Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for phase current.
Neutral Current		Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for neutral current (calculated from phases).
Ground Current		Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for ground current (measured from 4 <sup>th</sup> current input).
Sensitive Ground Current		Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent, isolated and directional protection functions for ground current (measured from 4 <sup>th</sup> current input).
Negative Sequence Current		Protection status signals (pickups and operations) for negative sequence time overcurrent function.
Thermal Model		Protection status signals for thermal model. Reset, alarm and operation signals for phases and for unit, besides the thermal image values in percentage for all phases and units.
Voltage		Protection status signals (pickups and operations) for all voltage functions, undervoltage, overvoltage, neutral overvoltage, negative sequence overvoltage and auxiliary under and over voltage.
Power		Protection status signals (pickups and operations) for forward and directional power units.

Table 4–20: SHOWS THE ACTUAL VALUES RELATED TO RECORDING FUNCTIONS IN THE RECORDS STATUS MENU:

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

**Table 4–21: GENERAL OVERVIEW OF METERING MENU:**

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

### 4.1.8.4 INPUTS/OUTPUTS

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

**Table 4–22: GENERAL OVERVIEW OF INPUTS/OUTPUTS MENU:**

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

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

### 4.1.8.5 RECORDS

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

**Table 4–23: GENERAL OVERVIEW OF RECORDS MENU:**

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

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

## 4.1.9 OPERATIONS MENU OVERVIEW

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

**Table 4–24: GENERAL OVERVIEW OF OPERATIONS MENU:**

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

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

## 4.1.10 COMMUNICATION MENU OVERVIEW

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

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

**Table 4–25: GENERAL OVERVIEW OF COMMUNICATION MENU:**

COMMUNICATION	
Computer	Menu to start communication with the relay.
Modem (**)	Menu to set modem communication parameters (only available if control type is set to modem in computer menu).
Troubleshooting (*)	Menu that Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map.
Calibration (*)	Retrieval and store calibration settings from/to relay.
Upgrade firmware version (**)	Menu to update the relay firmware version through Ethernet
Upgrade boot code (**)	Menu to update the relay boot code (front RS323 and Ethernet connection)
Upgrade F650 web server	Menu to update the web server application (if available)
Upload info files to relay	Hard disk storage of settings and configuration files on the relay.
Download info files from relay	Retrieval of settings and configuration files that had been previously stored in the relay hard disk.

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

## 4.1.11 SECURITY MENU OVERVIEW

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

**Table 4–26: GENERAL OVERVIEW OF SECURITY MENU:**

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

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

## 4.1.12 VIEW MENU OVERVIEW

## 4

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

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

**Table 4–27: GENERAL OVERVIEW OF VIEW MENU:**

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

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

## 4.1.13 HELP MENU OVERVIEW

Complete instructions manual and data about EnerVista 650 Setup release.

**Table 4–28: GENERAL OVERVIEW OF HELP MENU:**

HELP		
Instructions Manual		Instructions manual in the language selected in "View>Languages" menu.
About EnerVista 650 Setup		Release version and date of EnerVista 650 Setup program.

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

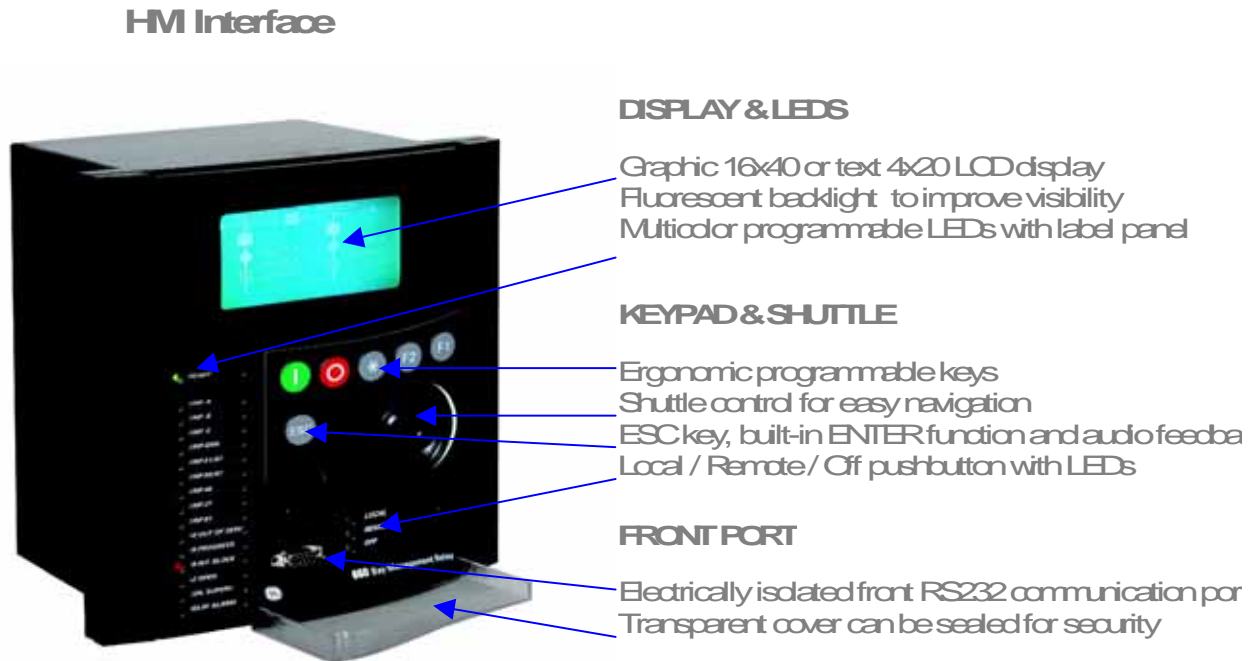


Figure 4-13: HMI INTERFACE

#### 4.2.1 DISPLAY

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

The boot code and firmware versions can be seen in the relay text main screen, this screen is the default screen in the text menu for all models: After the text "F650", appears the relay firmware version (2.00 in the example), and between brackets the boot program version (3.0 in the example), followed by "General Electric", the relay model and the default front RS232 port (COM2) communication parameters.

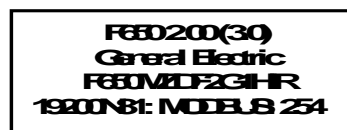


Figure 4-14: TEXT MAIN SCREEN

## 4.2.2 FRONT LED INDICATORS

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

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

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

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

## 4.2.3 PUSHBUTTONS

## 4

The front panel provides:

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

**RS232 port:** intended for connection to a portable PC.

## 4.2.3.1 KEYPAD AND SHUTTLE KEY












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

Figure 4–15: KEYPAD AND SHUTTLE KEY DESCRIPTION



**4.2.3.2 COMMAND PUSH BUTTON**

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

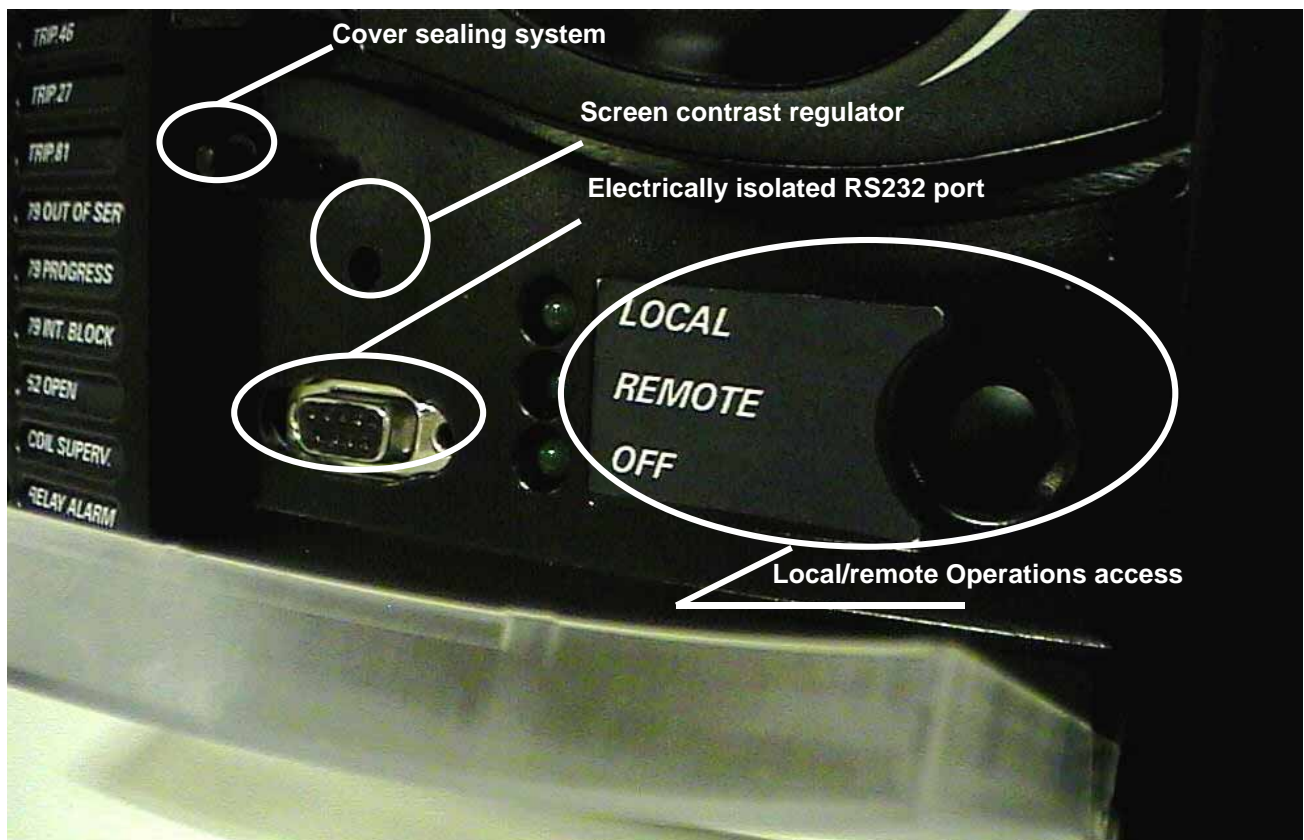
LOCAL operations (green)   
 REMOTE operations (green)   
 OFF (red)  

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

**4.2.4 FRONT PORT AND COVER SEALING SYSTEM**

Figure 4–16: shows the detail of the front RS232 communication port and local/remote button access cover sealing system. The sealing system is similar to the one used in energy meters, using wire and plumb seal.

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



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



## 4.2.5 TEXT MENUS

## 4.2.5.1 NAVIGATION IN TEXT MENU

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

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

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

Standby	Attopanel	Navigation
ENTER	PressShuttleKey	Enterthead
ESC	PressEscKey	Exittopainstled
LR	RotateShuttleKey	noexpandbwinfr
snalead		
L	RotateLeftShuttleKey	noexpinfesnaled
R	RotateRightShuttleKey	noexpwinfesnaled
?	Minustation	Minustation
>	Minustodisplay	Minustodisplay

Figure 4–17: shows an example of main menu navigation:

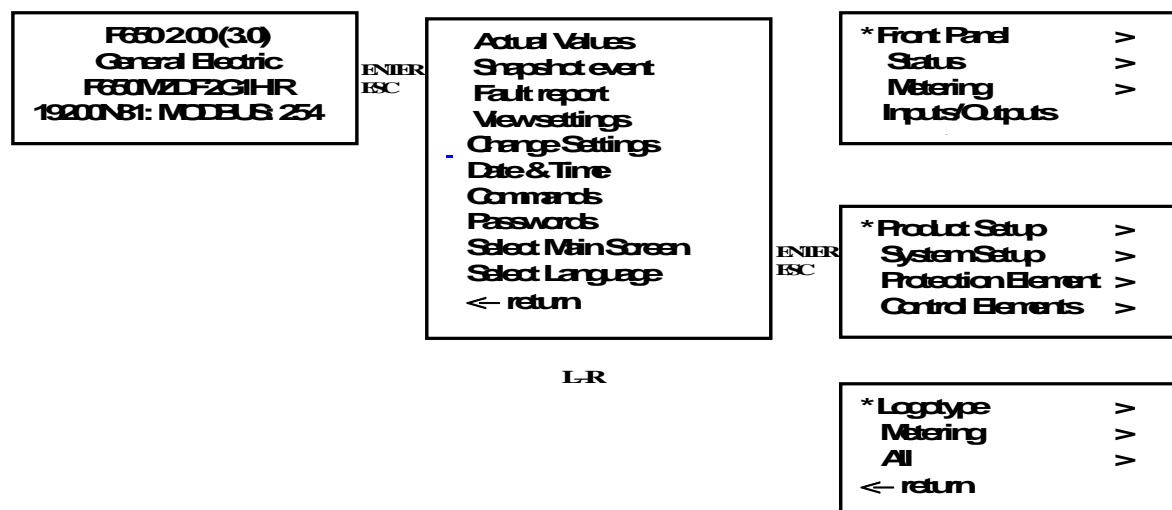


Figure 4–17: NAVIGATION IN MAIN TEXT MENU

**4.2.5.2 TEXT MENU HIERARCHY**

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

The main menu shows the following options:

**Table 4–29: GENERAL OVERVIEW OF MAIN TEXT MENU:**

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

**a) ACTUAL VALUES**

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

**Table 4–30: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:**

<b>Front Panel</b> >		
	LEDs	
<b>Status</b> >		
	Operation Bits	
	Breaker	
	Protection >	
		Protection Blocks
		Phase Current
		Neutral Current
		Ground Current
		Sens. Ground Current
		Neg. Seq. Current
		Thermal Model
		Voltage
		Power
	Control Elements >	
		Frequency
		Synchrocheck
		Autoreclose
		Breaker Failure
		VT Fuse Failure
		Broken Conductor
		Setting Groups
		Locked Rotor
	Switchgear Status >	
		Switchgear 1
		Switchgear ...
		Switchgear 16
	Calibration	
	Flex Curves	
	System Info	
	SNTP/IRIG_B	
	Records Status >	
		Fault Reports
		Control Events
		Oscillography
		Data logger
		Demand
		Energy
		Breaker Mainten.
<b>Metering</b> >		
	Primary Values >	
		Current
		Voltage
		Power
		Energy
		Demand
	Secondary Values >	
		Current

		Voltage
		Power
	Phasor Diagram	
	Frequency	
<b>Inputs/Outputs &gt;</b>		
	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 >	
		DNA
		User St
	Remote Inputs >	
		Remote Input
		Remote Devices
	Analog Inputs >	
		Board F/ Board G/ Board H/ Board J

To enter this menu press the shuttle key when the option Actual Values is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 4–30:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in Actual Values. Once the last sublevel is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 4–18:.

- First Line: Header of last level in actual values (Phase Current in the example)
- Second Line: Data identifier (in the example PH IOC1 HIGH A, is the pickup signal for the first instantaneous overcurrent function level high for phase A).
- Third line: Status of the displayed actual value.
- Fourth Line: Relative position in the menu (it is the first value of 114)



**Figure 4–18: ACTUAL VALUES SCREEN DATA**

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

### 4.2.5.3 *SNAPSHOT EVENTS*

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

Snapshot events are changes in the relay internal status.

One snapshot event is displayed in two text screens:

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

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

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

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

```

F650 2.00 (3.0)
General Electric
F650M ZDF2G1HIR
19200N81:MODBUS:254

```

ENTER  
ESC

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

```

Actual Values
? Snapshot event
Fault report
View settings

```

ENTER  
ESC

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

Press shuttle key to enter in the snapshot events menu

```

Breaker Closed ON >
St: ON (4/479)
Time: 16:35:02.027
Date: 10/Jun/2005

```

L-R

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

```

Isolated Gnd3 Block >
St: OFF (5/479)
Time: 16:35:01.995
Date: 10/Jun/2005

```

ENTER  
ESC

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

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

```

Ia 0.000    Vab 0.000
Ib 0.000    Vbc 0.000
Ic 0.000    Vca 0.000
Ig 0.000    Vo  0.000

```

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

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

Figure 4–19: SNAPSHOT EVENTS NAVIGATION IN HMI

#### 4.2.5.4 FAULT REPORT

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

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

1. Showing the fault warning messages in the text display when the fault is produced. This option has to be enabled by setting. To change from the HMI go to the menu “**Change Settings >Product Setup > Fault Report > Show Fault On HMI**” and enable it.
2. Only saving and allowing viewing the information from the last ten faults recorded in the relay.

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

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

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

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

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

The format of the displayed screens is as follows:

```

Actual Values
Snapshot event
* Fault report
View settings
  
```

ENTER  
ESC

Select the Fault report menu in text menu

```

Fault Report #1
NAF dist: 0.00
Time: 09:21:40.545
Date: 10/Jun/2005
  
```

L-R

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

```

Fault Report #2
NAF dist: 0.00
Time: 09:22:03.047
Date: 10/Jun/2005
  
```

ENTER  
ESC

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

```

Fault Report #2
Ia 0.00 Vab 0.00
Ib 0.00 Vbc 0.00
Ic 0.00 Vca 0.00
  
```

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

**Figure 4–20: FAULT REPORT NAVIGATION IN HMI**

Possible fault types are as follows:

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



#### 4.2.5.5 VIEW SETTINGS

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

**Table 4–31: GENERAL OVERVIEW OF “VIEW/CHANGE SETTINGS” MAIN MENU**

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
Product Setup >			
	Communication >		
		Serial Ports	
		Ethernet >	
			Ethernet 1
			Ethernet 2
		ModBus Protocol	
		DNP3 Slave >	
			DNP3 Slave 1
			DNP3 Slave 2
			DNP3 Slave 3
		IEC 870-5-104	
		SNTP	
	Fault Report		
	Oscillography		
	Demand		
System Setup >			
	General Settings		
	Breaker >		
		Breaker Settings	
		Breaker Maintenance	
Protection Element >			
	Phase Current >		
		Phase TOC High >	
			Phase TOC High 1
			Phase TOC High 2
			Phase TOC High 3
		Phase TOC Low >	
			Phase TOC Low 1
			Phase TOC Low 2
			Phase TOC Low 3
		Phase IOC High >	
			Phase IOC High 1
			Phase IOC High 2
			Phase IOC High 3
		Phase IOC Low >	
			Phase IOC Low 1
			Phase IOC Low 2
			Phase IOC Low 3
		Phase Directional >	
			Phase Directional 1
			Phase Directional 2
			Phase Directional 3
		Thermal Model >	
			Thermal Model 1

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

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			Phase UV 1
			Phase UV 2
			Phase UV 3
		Phase OV >	
			Phase OV 1
			Phase OV 2
			Phase OV 3
		Neutral OV High >	
			Neutral OV High 1
			Neutral OV High 2
			Neutral OV High 3
		Neutral OV Low >	
			Neutral OV Low 1
			Neutral OV Low 2
			Neutral OV Low 3
		Neg. Seq. OV >	
			Neg. Seq. OV 1
			Neg. Seq. OV 2
			Neg. Seq. OV 3
		Auxiliary OV >	
			Auxiliary OV 1
			Auxiliary OV 2
			Auxiliary OV 3
		Auxiliary UV >	
			Auxiliary UV 1
			Auxiliary UV 2
			Auxiliary UV 3
	Power >		
		Forward Power >	
			Forward Power 1
			Forward Power 2
			Forward Power 3
		Directional Power >	
			Directional Power 1
			Directional Power 2
			Directional Power 3
Control Elements >			
	Setting Group		
	Underfrequency >		
		Underfrequency 1	
		Underfrequency 2	
		Underfrequency 3	
	Overfrequency >		
		Overfrequency 1	
		Overfrequency 2	
		Overfrequency 3	
	Synchrocheck		
	Autoreclose		
	Breaker Failure		
	VT Fuse Failure		
	Broken Conductor >		
		Broken Conductor 1	

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
		Broken Conductor 2	
		Broken Conductor 3	
	Locked Rotor >		
		Locked Rotor 1	
		Locked Rotor 2	
		Locked Rotor 3	
Inputs/outputs >			
	Remote Comms.		

#### 4.2.5.6 CHANGE SETTINGS

To enter this menu press the shuttle key when the option “Change Settings” is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 4–31:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in “Change Settings”. Once the last sublevel is reached, move up and down to visualize the settings selected.

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

Figure 4–21: shows an example of change settings navigation:

```
Snapshot event
Fault report
View settings
' Change settings
```

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

```
Product Setup      >
' System Setup     >
Protection Elements >
Control Elements   >
```

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

```
' General Settings
Breaker           >
< - return
```

Press the shuttle key in the function to be modified

```
General Settings
Phase CT Ratio
6.0
[ 1.0:6000.0:0.1]
```

-> Group of settings

-> Setting to be modified

-> Value

-> Range and step

```
General Settings
Phase CT Ratio
< 6 > .0
[ 1.0:6000.0:0.1]
```

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

```
Press Intro
to save settings
```

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

Figure 4–21: CHANGE SETTINGS PROCEDURE IN HMI

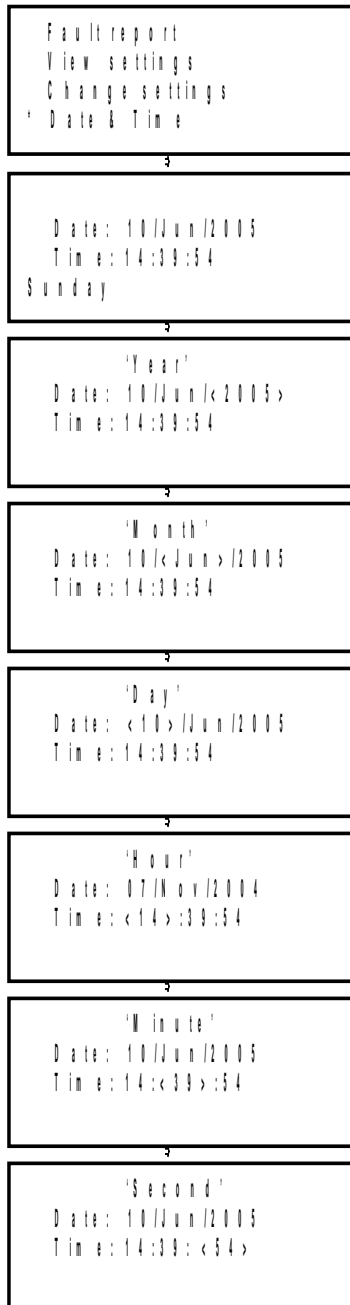
**4.2.5.7 DATE & TIME**

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

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

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



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

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

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

‘Year’

Date: Day/Month/(<Year>)

Time: Hour:Minutes:Seconds

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

‘Month’

Date: Day/(<Month>)/Year

Time: Hour:Minutes:Seconds

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

‘Day’

Date: (<Day>)/Month/Year

Time: Hour:Minutes:Seconds

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

‘Hour’

Date: Day/Month/Year

Time: (<Hour>):Minutes:Seconds

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

‘Minute’

Date: Day/Month/Year

Time: Hour:(<Minute>):Seconds

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

‘Second’

Date: Day/Month/Year

Time: Hour: Minute:(<Seconds>)

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

**Figure 4-22: CHANGE DATE AND TIME PROCEDURE IN HMI**

**4.2.5.8 COMMANDS**

Commands are configured using EnerVista 650 Setup, and they can be executed using the pushbuttons on the relay front. Using EnerVista 650 Setup software, the user can configure up to 24 commands with a descriptive text. When executing the operation from the relay front, the operation description text will be displayed.

Example of commands (operations) executions via HMI



ENTER  
ESC

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




L - R

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



ENTER  
ESC

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



ENTER  
ESC

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



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

**Figure 4–23: COMMANDS IN HMI**

#### 4.2.5.9 PASSWORDS

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

##### **Settings Password:**

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

##### **Commands Password:**

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

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

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

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

- "Login Pwd Settings"
- "Logout Pwd Settings"
- "Change Pwd Settings"
- "Login Pwd Commands"
- "Logout Pwd Commands"
- "Change Pwd Commands"
- "Forgot Password?"

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

- Login:** For entering the password, either for settings or commands, and enable access to settings or commands. Once entering the password the relay is no longer password protected, and access is enabled to settings modification or commands execution.
- Logout:** Once the necessary setting changes or operation commands have been executed, the user can log out, so that the relay is password protected again.
- Change:** This menu allows setting or modifying the desired password.
- Forgot Password:** This menu provides the encrypted password, so that it can be recovered if the user loses or forgets it.

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

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

#### a) PASSWORD RANGE

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

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



**b) ENTERING THE PASSWORD (LOGIN PWD)**

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

*Login Pwd Settings or Login Pwd Commands:*

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

**Setting passwd.**

**Login: < 1000 >**

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

**c) LOGGING OUT (LOGOUT PWD)**

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

*Logout Pwd Settings or Logout Pwd Commands:*

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

**d) CHANGING THE PASSWORD (CHANGE PWD COMMANDS)**

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

*Change Pwd Settings or Change Pwd Commands:*

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

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

**(Setting or Command) passwd.**

**Login: < 0000 >**

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

**(Setting o Command) passwd.**

**New passwd: < 1000 >**

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

**e) PASSWORD RECOVERY (FORGOT PASSWORD?)**

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

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

**Cod Settings: [35c0]**

**Cod Commands: [35c0]**

**<Push Intro>**

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

#### 4.2.5.10 SELECT MAIN SCREEN

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

##### Logotype

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

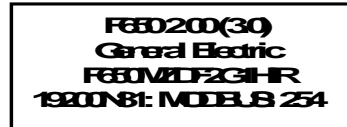


Figure 4-24: DEFAULT LOGOTYPE SCREEN

##### Metering

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

Ia 000	Vab 000
Ib 000	Vbc 000
Ic 000	Vca 000
Ig 000	V0 000

Figure 4-25: 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.

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. (see section **BUSCAR ORIGEN REFERENCIA 2.3.** ).

For example one relay in French language (e.g. F650MZDF2G1HIRF) 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

Commands  
 Password  
 Select Main Screen  
 \* Select Language

ENTER  
ESC

\* English  
 French  
 <- return

ENTER  
ESC

Language changed.  
 Please reboot  
 the relay.

Press the shuttle key to enter the select language menu.

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

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

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

**Figure 4–26: LANGUAGE SELECTION IN HMI**

## 4.2.6 GRAPHIC DISPLAY

## 4.2.6.1 ONE-LINE DIAGRAM

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

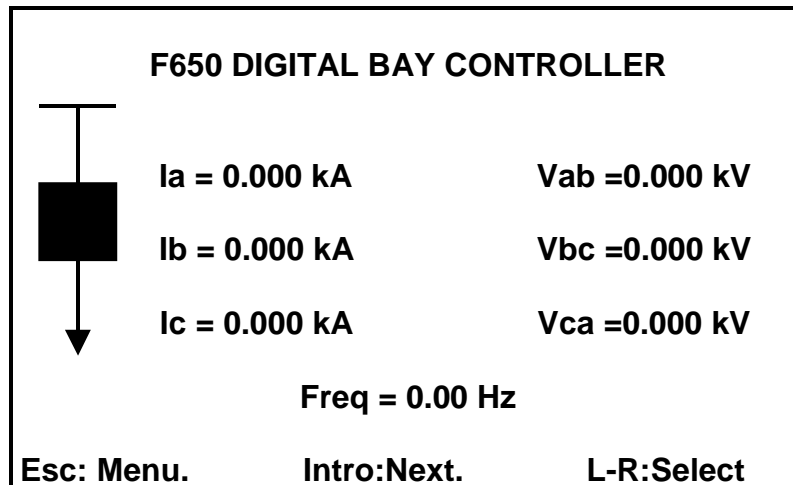


Figure 4-27: ONE-LINE DIAGRAM

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

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

The meaning of these options is as follows:

**Esc: Menu.**

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

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

**Intro: Next.**

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

**L-R: Select**

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

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

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

### 4.2.6.2 METERING SCREEN

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

Metering Screen.		Total metering 56
Phasor Ia Primary		0.000 KA
Phasor Ib Primary		0.000 KA
Phasor Ic Primary		0.000 KA
Phasor Ig Primary		0.000 KA
Phasor Isg Primary		0.000 KA
RMS Ia Primary		0.000 KA
RMS Ib Primary		0.000 KA
RMS Ic Primary		0.000 KA
RMS Ig Primary		0.000 KA
RMS Isg Primary		0.000 KA
I0 Primary		0.000 KA
Intro: Next.		ESC: Prev
		L-R: Scroll.

Figure 4–28: METERING SCREEN

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

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

#### Intro: Next.

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

#### Esc: Prev.

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

#### L-R: Scroll.

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

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

### 4.2.6.3 ALL EVENTS SCREEN

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

#### All Events (1/479)

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

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

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

Figure 4–29: ALL EVENTS SCREEN

The screen legend options are:

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

#### Esc: Prev.

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

#### Intro: Menu.

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

**next prev reload details At**

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

#### <NEXT>

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

#### <PREV>

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

#### <RELOAD>

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

## &lt;DETAILS&gt;

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: 10/Jun/2005	St: ON	
Time: 16:11:08.035	(1/479)	
Phasor Ia Primary	0.000	
Phasor Ib Primary	0.000	
Phasor Ic Primary	0.000	
Line Frequency	0.000	
Phasor Ig Primary	0.000	
Phasor Isg Primary	0.000	
I0 Primary	0.000	
I1 Primary	0.000	
Intro: Meters.	ESC: Prev.	L-R: Scroll.

Figure 4–30: SNAPSHOT EVENTS DETAIL SCREEN

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

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

**Intro: Meters.**

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

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

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

**ESC: Prev.**

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

**L-R: Scroll.**

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

**<AT>**

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

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

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

**Intro: Tag event.**

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

**4.2.6.4 NEW EVENTS SCREEN**

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

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

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



#### 4.2.6.5 ALARMS PANEL

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

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

Alarm Panel (1/3). #1 OPERATIONS IN LOCAL MODE		
7/11/04 16:54:16	OPERATIONS IN LO.	ON
7/11/04 16:54:16	GENERAL PICKUP	ON
7/11/04 16:54:16	GENERAL TRIP	ON
Esc: Prev. Intro: Menu		

Figure 4–31: ALARMS PANEL IN HMI

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

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

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

ESC: Prev.

Intro: Menu.

ESC: Prev.

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

Intro: Menu.

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

next          prev          ack          ack all

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

<NEXT>

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

<PREV>

The system returns to the previous New Events screen.

<ACK>

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

**<ACK ALL>**

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

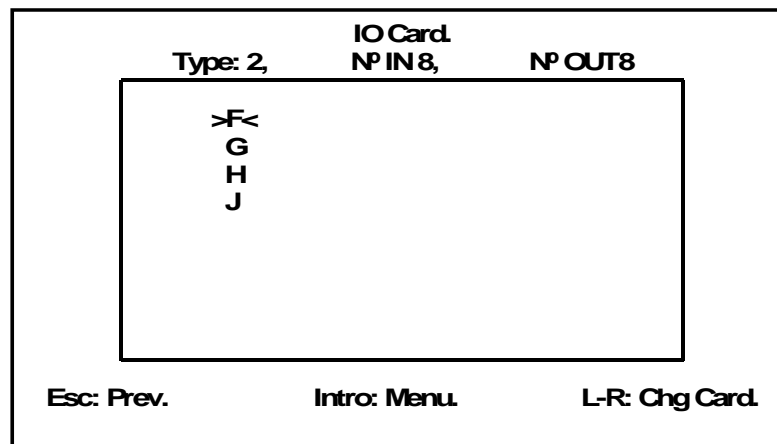
When an alarm has been acknowledged, a selection mark will appear to the right of its status. Inactive alarms will disappear from the screen once they are acknowledged.

**4.2.6.6 INPUT/OUTPUT MONITORING SCREEN**

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

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

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



**Figure 4–32: INPUTS/OUTPUTS GENERAL SCREEN**

The navigation legend on this screen is as follows:

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

**Esc: Prev.**

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

**Intro: Menu.**

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

This menu includes the following options.

**next          view          test input          test output**

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

IO Card F.		Type: 2,	# IN 8,	# OUT 8
Input		(ON OFF)		Output
0 CC1	8 Va COIL1			
1 CC2	9 Vb COIL1			
2 CC3	10 Va COIL2			
3 CC4	11 Vb COIL2			
4 CC5	12 Isense1			
5 CC6	13 Isense1			
6 CC7	14 SUP21			
7 CC8	15 SUP22			
				0 OUT1 ??
				1 OUT2 ??
				2 OUT3 ??
				3 OUT4 ??
				4 OUT5 ??
				5 OUT6 ??
				6 OUT7 ??
				7 OUT8 ??
next		>VIEW<		test input    test output

Figure 4-33: INPUT/OUTPUT VIEWING SCREEN

**<NEXT>**

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

**<VIEW>**

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

The first line of this screen shows the slot where the board is located, **F, G, H** or **J**, and the type of board, **2** if it includes supervision (8 inputs, 8 outputs, and 4 supervision circuits), or **1** if it is a mixed board (without supervision) with 16 digital inputs and 8 outputs. The view menu differentiates inputs and outputs; the active status (ON) is represented by the lighting of the corresponding input or output.

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

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

Returns to the general I/O screen

**Intro: Menu.**

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

**L-R: Chg Card**

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

**<TEST INPUT>**

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

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

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

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

**Esc: Exit Text.**

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

**Intro: Chg Input.**

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

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

**<TEST OUTPUT>**

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

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

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

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

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

**Intro: Chg Output.**

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

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

**L-R: Chg Card**

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

## 4.3.1 HOME

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

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

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

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



Figure 4–34: WEB SERVER MAIN SCREEN

## 4.3.2 SNAPSHOT EVENTS

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

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

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



Figure 4-35: 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 4-36: CONTROL EVENTS SCREEN

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

## 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.

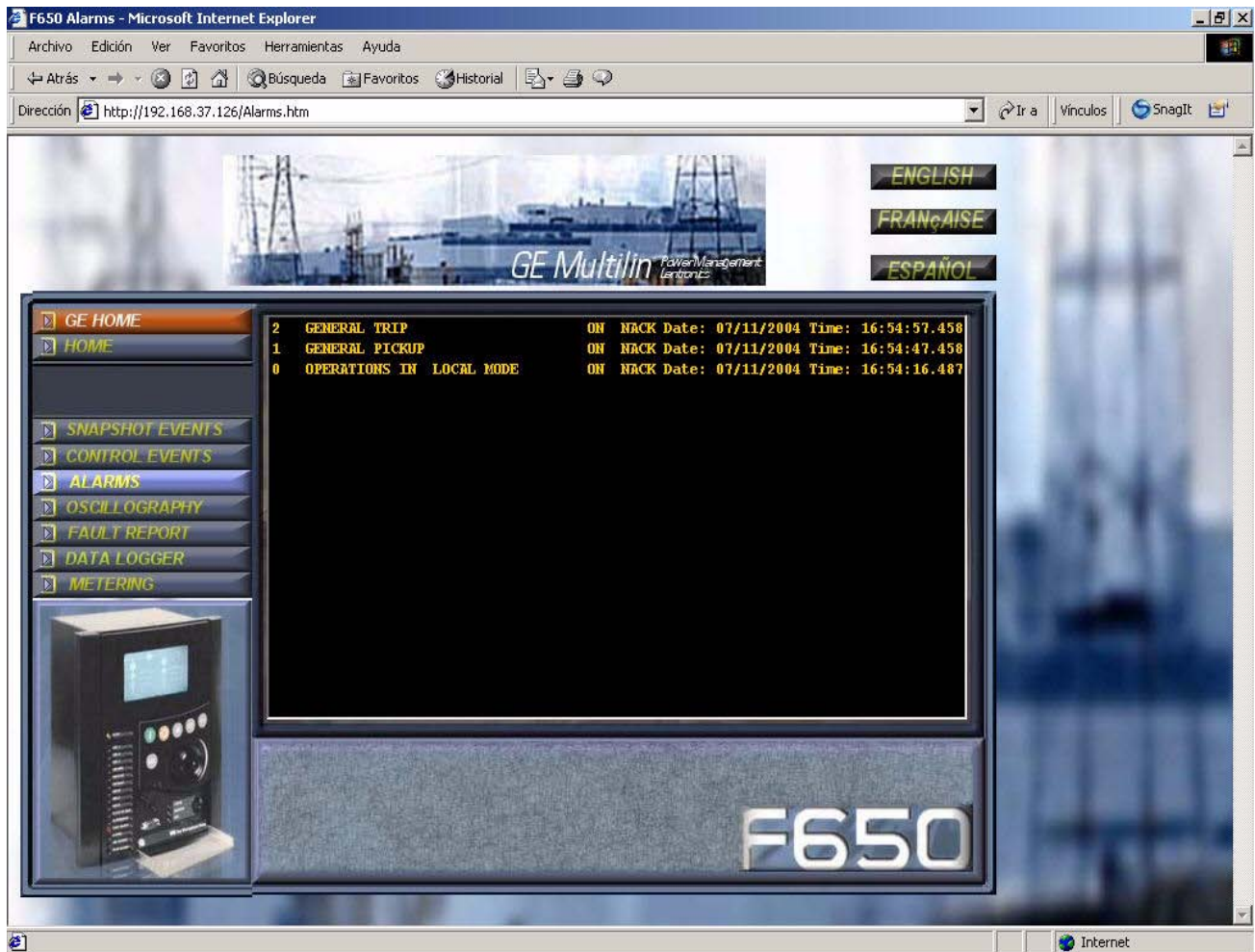


Figure 4–37: ALARMS SCREEN



## 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 4-38: OSCILLOGRAPHY SCREEN

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



Figure 4-39: GE-OSC LAUNCH SCREEN

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

## 4.3.6 FAULT REPORT

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

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

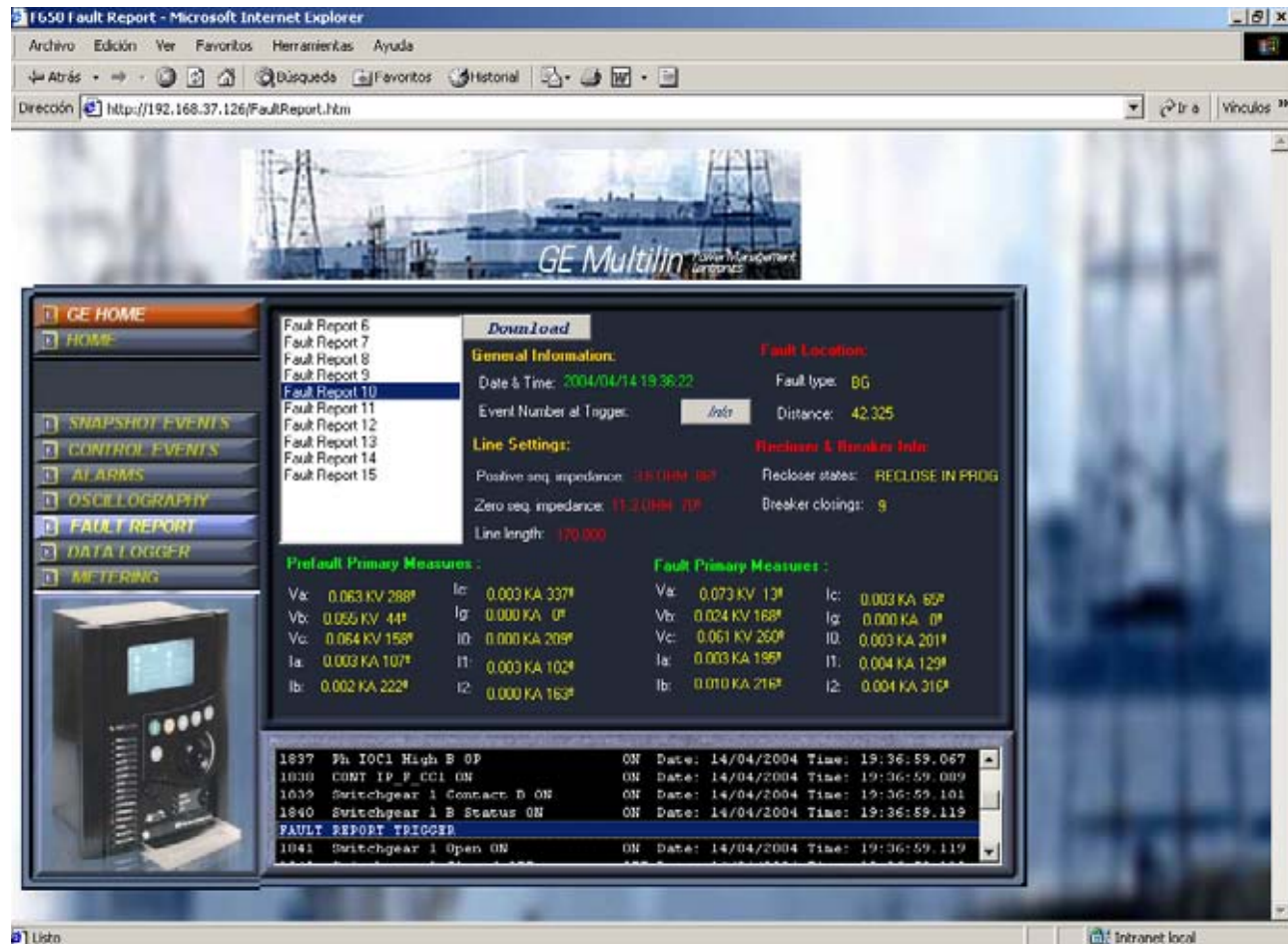


Figure 4-40: FAULT REPORT SCREEN

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

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

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

## 4.3.7 DATA LOGGER

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

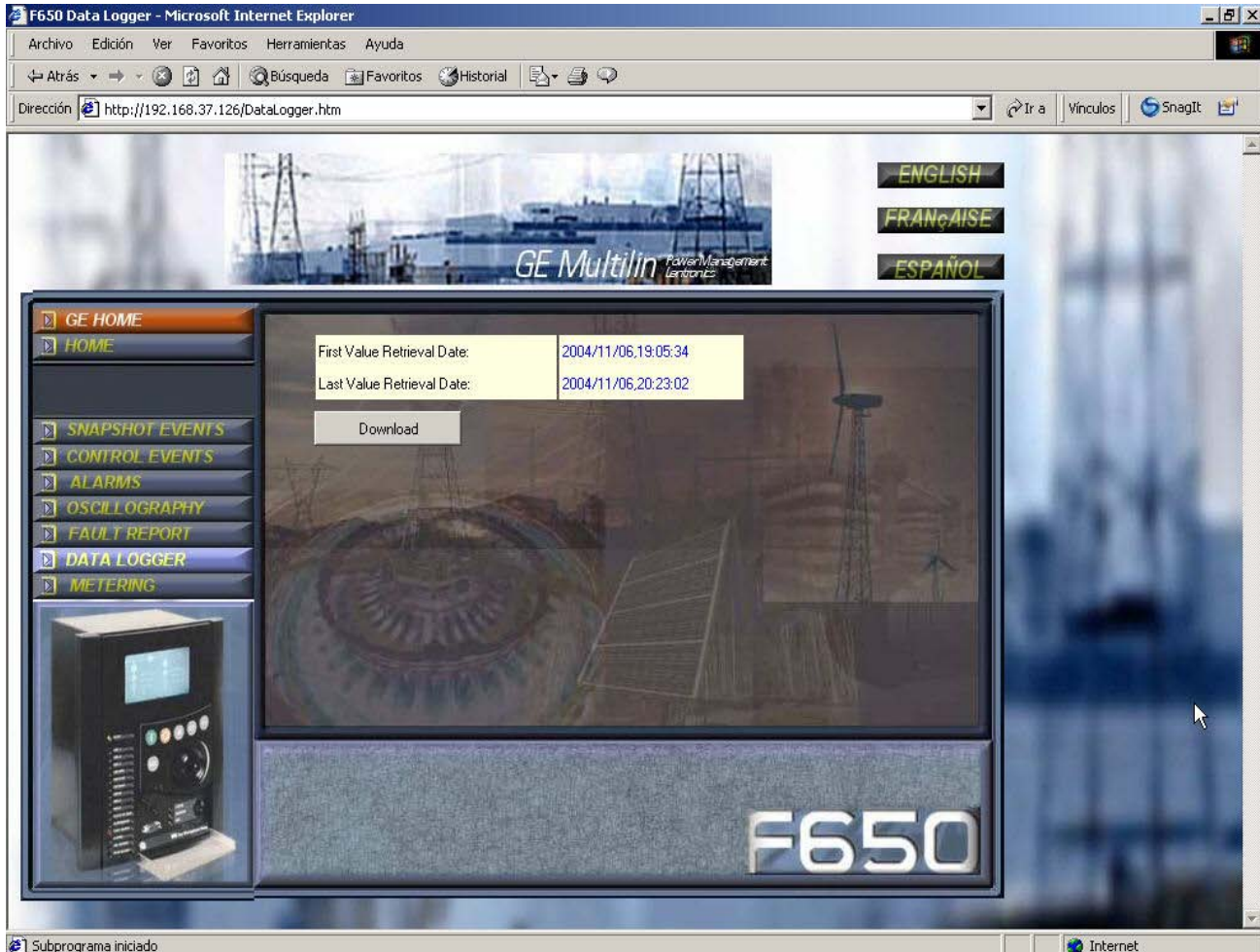


Figure 4-41: DATA LOGGER SCREEN



## 4.3.8 METERING

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



Figure 4-42: METERING SCREEN



## 5.1.1 SETPOINTS MAIN MENU

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

Product Setup		
	Communication setpoints	
		Serial Ports
		Network (Ethernet)
		ModBus Protocol
		DNP3 Slave
		IEC 870-5-104
	ModBus User Map	
	Fault Report	
	Oscillography	
	Data Logger	
	Demand	
System Setup		
	General setpoints	
	Flex Curves	
	Breaker	
		Breaker setpoints
		Breaker Maintenance
	Switchgear	
Protection Elements		
	Phase Current	
		Phase TOC High
		Phase TOC Low
		Phase IOC High
		Phase IOC Low
		Phase Directional
		Thermal Model
	Neutral Current	
	Ground Current	
		Ground TOC
		Ground IOC
		Ground Directional
	Sensitive Ground Current	
		Sensitive Ground TOC
		Sensitive Ground IOC
		Isolated Ground IOC
		Sensitive Ground Directional
	Negative Sequence Current	
		Negative Sequence TOC
	Voltage Elements	
		Phase UV
		Phase OV
		Neutral OV High
		Neutral OV Low
		Negative Sequence OV
		Auxiliary OV
		Auxiliary UV
	Power	
		Forward Power
		Directional Power
Control Elements		

	setpoint Group	
	Underfrequency	
	Overfrequency	
	Synchrocheck	
	Autoreclose	
	Breaker Failure	
	VT Fuse Failure	
	Broken Conductor	
Input/Outputs		
	Contact I/O	
		Board F
		Board G
		Board H
		Board J
	Virtual Inputs	
		Latched Virtual Inputs
		Self-Reset Virtual Inputs

## 5.2.1 COMMUNICATION SETPOINTS

## 5.2.1.1 SERIAL PORTS

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

Table 5–2: SERIAL PORTS SETPOINTS

PRODUCT SETUP > COMMUNICATION SETPOINTS > SERIAL PORTS			
Name	Default Value	Step	Range
COM1 Baud Rate	19200		[300 : 115200]
COM2 Baud Rate	19200		[300 : 115200]
Parity	NONE		[NONE:ODD:EVEN]

## 5.2.1.2 NETWORK (ETHERNET)

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

Table 5–3: NETWORK SETPOINTS

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

## 5.2.1.3 MODBUS PROTOCOL

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

Table 5–4: MODBUS PROTOCOL SETPOINTS

PRODUCT SETUP>COMMUNICATION SETPOINTS >MODBUS PROTOCOL			
Name	Default Value	Step	Range
ModBus Address COM1	254		[1 : 255]
ModBus Address COM2	254		[1 : 255]
ModBus Port Number	502		[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 detail information go to appendix C in this manual.

Table 5–5: DNP PROTOCOL SETPOINTS

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

Binary Input Block 6	CTL EVENTS 81-96		
Binary Input Block 7	CTL EVENTS 97-112		
Binary Input Block 8	CTL EVENTS 113-128		
Binary Input Block 9	SWITCHGEAR 1-8		
Binary Input Block 10	SWITCHGEAR 9-16		

#### 5.2.1.5 IEC 60870-5-104

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

**Table 5–6: IEC 60870-5-104 PROTOCOL SETPOINTS**

PRODUCT SETUP>COMMUNICATION SETPOINTS >IEC 870-5-104			
Name	Default Value	Step	Range
Function	DISABLED		[DISABLED – ENABLED]
TCP Port	2404		[0 : 65535]
Common Addr of ASDU	255		[0 : 65535]
Cyclic Meter Period	0		[0 : 3600]
Synchronization Event	0		[0 : 3600]

#### 5.2.2 MODBUS USER MAP

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

**Table 5–7: MODBUS USER MAP SETPOINTS**

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 FAULT REPORT

##### 5.2.3.1 OVERVIEW

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

The fault report provides fault date, fault type, fault location information, and the index of the last fault report produced (Fault Report Number) for the last fault produced.

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

- Fault date and time
- Pre-fault current and voltage in primary values

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

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

### 5.2.3.2 FAULT REPORT SETPOINTS

**Table 5–8: FAULT REPORT SETPOINTS**

SETPOINT > PRODUCT SETUP > FAULT REPORT				
setpoint Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

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

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

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

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

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

**Line Length:** The metering unit can be kilometers or miles.

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

**Snapshot Events:** This setpoint enables or disables the snapshot event generation for the fault report unit.

### 5.2.3.3 FAULT REPORT STATES

States associated to the fault report ("**Actual > Metering > Records Status > Fault Reports**"), are shown on Table 5–9:

**Table 5–9: FAULT REPORT STATES**

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

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

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

**FAULT DATE:** Date and time of the last fault produced.

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

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

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

#### 5.2.3.4 FAULT REPORT RETRIEVAL

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

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

Clicking on the “Download” button, the file is retrieved, and saved in folder “..\\EnerVista 650 Setup\\files\\osc”, using “FLTxxx.DAT”, where xxx is the corresponding record number. The fault report retrieval can be done using serial communication (ModBus RTU) or Ethernet (ftp, tftp).

Fault reports are stored in the relay non-volatile memory, so that they are accessible from the EnerVista 650 Setup software or the relay web server. The fault report is a text file named FLTxxx.txt where xxx is the record number, with a range of 001 to 999. Only files from the 10 last faults will be stored. If there are already ten files stored and a new fault occurs, this most recent file will overwrite the oldest file. Afterwards, the fault information is sent to the HMI shared memory, to enable the corresponding indicators to display the fault on the HMI display (if this option has been enabled by setpoint).

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

### 5.2.4 OSCILLOGRAPHY

#### 5.2.4.1 OVERVIEW

F650 units allocate 1-Mbyte of memory for storing oscillography records in RAM memory. These oscillography records are restored in a non-volatile memory (relay Flash memory).

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

The oscillography module is in charge of storing instantaneous values of the 9 analog signals and the 16 digital signals programmable 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 1IA channel.

Analog 2IB channel.

Analog 3IC channel.

Analog 4IG channel.

Analog 5ISG channel.

Analog 6 VA or VAB channel, depending on the selected configuration (Wye or Delta at “**setpoints>System Setup>General setpoints>Phase VT Connection**”).

Analog 7VB or VBC channel, depending on the selected configuration (Wye or Delta at “**setpoints>System Setup>General setpoints>Phase VT Connection**”).

Analog 8VC or VCA channel, depending on the selected configuration (Wye or Delta at “**setpoints>System Setup>General setpoints>Phase VT Connection**”).

Analog 9VN or VX channel, depending on the selected configuration (zero sequence measured, or busbar voltage at “**setpoints>System Setup>General setpoints>Auxiliary Voltage**”).

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

## 5

#### 5.2.4.2 OSCILLOGRAPHY SETPOINTS

These setpoints (“**Setpoint > Product Setup > Oscillography**”) are described in Table 5–10:

**Table 5–10: OSCILLOGRAPHY SETPOINTS**

SETPOINT > PRODUCT SETUP > OSCILLOGRAPHY				
setpoint 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 setpoint allows to create an oscillography record when the “**TRIGGER OSCILLO**” signal is activated.

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

**Samples/Cycle:** This setpoint defines the number of samples per cycle stored in each oscillography record. Please see example below.

**Maximum Number of Oscillos (Max. Number Osc.):** 1 to 20 oscillography records can be selected. The capacity of each record will depend on the capacity = 1Mbyte / Max. Number Osc. This capacity is divided in 9 measures \* 4 bytes/measure + 2 digital bytes = 38 bytes per stored sample. Please refer to example below.

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

**Snapshot Events:** This setpoint enables or disables the snapshot event generation for the oscillography unit.

#### EXAMPLE

For a Max. Number Osc. of 4, each record will store  $1\text{Mbyte} / 4 = 262144$  bytes.

For this example, the number of samples per oscillography record is  $262144 \text{ bytes} / 38 \text{ bytes} = 6898$  samples per stored oscillo.

If we set the relay to 64 samples per cycle, each record will store up to  $6898 / 64 = 107.78$  signal cycles. This value expressed in terms of time would be:

For 50 Hz:  $107.78 \text{ cycles} \times 20 \text{ ms/cycle} = 2.155$  seconds.

For 60 Hz:  $107.78 \text{ cycles} \times 16.67 \text{ ms/cycle} = 1.796$  seconds.

#### 5.2.4.3 OSCILLOGRAPHY STATES

States associated to the oscillography module ("**Actual >Metering>Records Status>Oscillography**"), are shown in Table 5–11:

**Table 5–11: 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 "**setpoints>Relay configuration>Oscillography**". Each of these states can be associated to any protection state or to any virtual output. Each oscillography record will reflect the changes experienced by this state during the record.

**OSCILLO TRIGGER:** The activation of this state will produce the oscillography record capture. Each record will contain a percentage of its capacity to store pre-fault information. This percentage can be selected in the Trigger Position setpoint, and the rest of the record capacity will store post-fault information.

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

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

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

#### 5.2.4.4 OSCILLOGRAPHY FILES RETRIEVAL

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

For obtaining oscillography records using EnerVista 650 Setup software, the user must access “**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 in the unit (Available Records in Device), programmable by setpoint. Clicking on the “View header” button, the system will show the header of the record selected at “Select Record”.

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

#### 5.2.5 DATA LOGGER

5

The F650 data logger can store information of up to 16 analog channels, among all channels available in the relay, with a sampling rate selectable by setpoint. The memory capacity of the data logger is fixed, 64 Kbytes, two bytes per analog measure. Selected channels will take all the available memory space. Therefore, the storage days will depend on the selected number of channels and sampling rate.

##### 5.2.5.1 DATA LOGGER SETPOINTS

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

**Table 5–12: DATA LOGGER SETPOINTS**

SETPOINT > PRODUCT SETUP > DATA LOGGER				
setpoint 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	See Note 1

**Function permission (Function):**Enabling this setpoint allows to start storing analog channel information programmed in this tool.

**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 setpoint change in the Data Logger will erase all the stored information.

### 5.2.5.2 DATA LOGGER ASSOCIATED STATES

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

**Table 5–13: DATA LOGGER STATES**

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

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

**NEWEST SAMPLE TIME:** Date/time state type with 6 characters. This is the time when the most recent sample was taken. This value advanced in the time period defined by the sample rate setpoint.

If no channel has been selected, these setpoints remain with a static value.

**DATA LOGGER CHANNELS:** This state shows the number of Channels Selected by setpoint.

**DATA LOGGER DAYS:** This state shows the number of days that can be stored in the associated data file. It depends on the Data Logger Rate setpoint, and on the number of channels selected.

### 5.2.5.3 DATA LOGGER FILES FORMAT AND RETRIEVAL

#### File Retrieval

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

For obtaining data logger files using 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 measures 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 folder “..\\EnerVista 650 Setup\\files\\osc”, using “DLGxxx.DAT”, “DLGxxx.CFG” names, where xxx is the corresponding record number. **Data logger files can be retrieved only by Ethernet.**

#### File Format

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



## 5.2.6 DEMAND

## 5.2.6.1 METERING VALUES AND SETPOINTS FOR THE DEMAND

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

Table 5–14: 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)	MVA <sub>r</sub>
Apparent power (VA)	MVA

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

Calculated demand values are as follows:

Table 5–15: 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 module setpoints are as follows:

Table 5–16: DEMAND SETPOINTS

SETPOINT > PRODUCT SETUP > DEMAND				
setpoint 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):** Enabling this setpoint allows to start 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 time, with a range of 5, 10, 15, 20, 30, 60 minutes. Measure integration is performed in the period adjusted in the Demand Interval setpoint.

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

**Snapshot Events:** This setpoint enables or disables the snapshot event generation for the demand unit.

### 5.2.6.2 DEMAND CALCULATION METHODS

#### a) CALCULATION METHOD 1: THERMAL EXPONENTIAL

This method simulates the action of a peak demand thermal analog recorder. The relay measures the magnitude for each phase (or three-phase, depending on the case) each second, and it assumes that the magnitude remains in that value until the next update. It calculates the equivalent thermal demand based on 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 / setpoint time d(t) reaches 90% of the signal entered in this time

If we assume that the input signal is monotonous increasing (each new value is higher than the previous value), with an initial value of  $D_0$ , different from zero, the previous equation becomes:

$$D = (V_S - D_0)$$

Being  $D_0$  the demand value in the moment when the input signal starts to increase.

If the input signal decreases, time t restarts at 0 and the equation to be applied (cooling) will be:

$$d(t) = D_0 - (D_0 - V_S)(1 - e^{-kt})$$

**b) CALCULATION METHOD 2: ROLLING DEMAND.**

This method calculates the linear average of the magnitude in the specified interval. The measure integration is made in the time period specified by the Demand Interval setpoint. The calculation is made every second. Operation of the rest of the system is performed every minute. The demand value is the average of the values obtained during the time period specified by the Demand Interval setpoint

**c) CALCULATION METHOD 3: BLOCK INTERVAL**

The Block Interval operation mode depends on the "Trigger Enabled" setpoint.

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

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

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

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

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

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

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

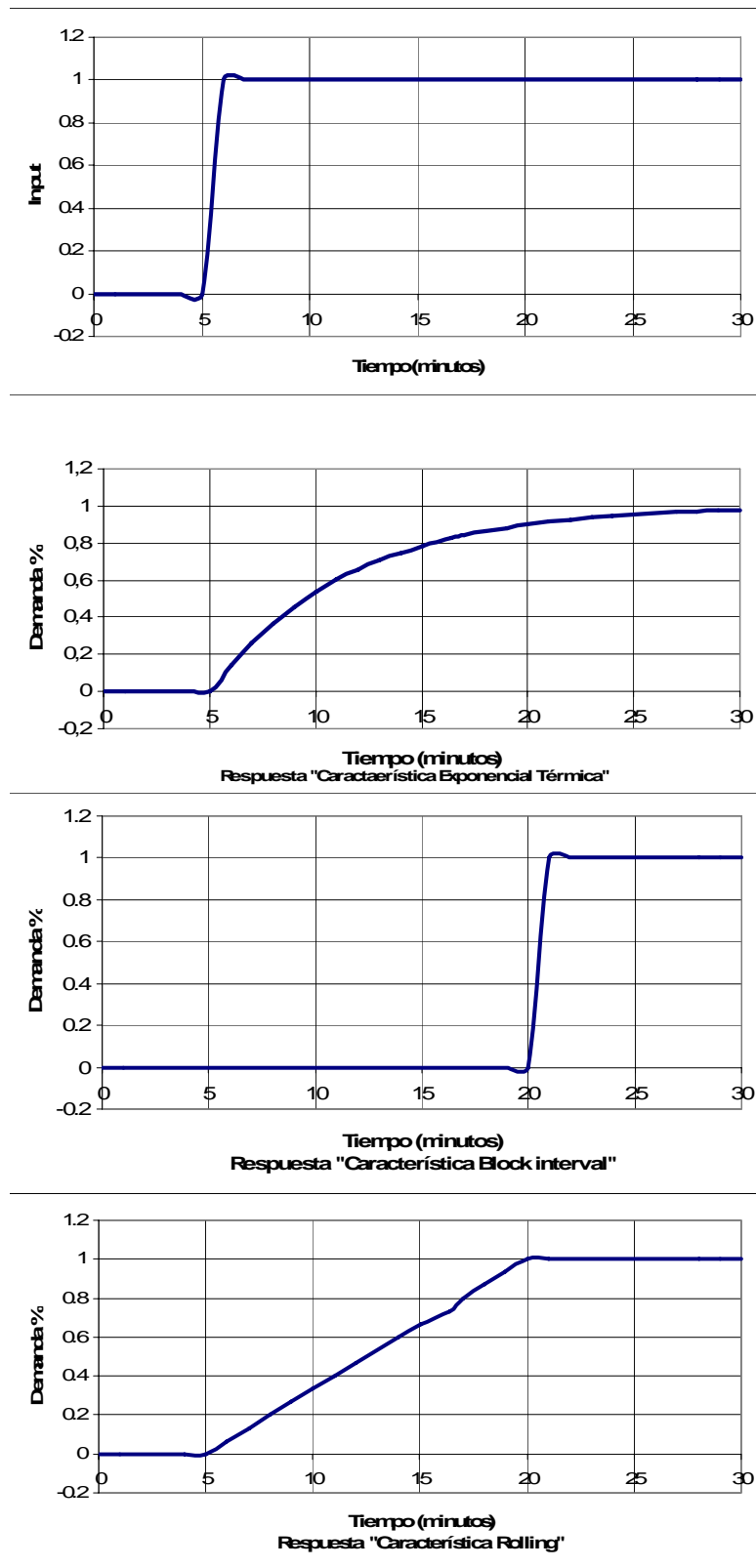


Figure 5-1: RESPONSE TO THE DIFFERENT DEMAND METHODS

### 5.2.6.3 DEMAND FUNCTION MEASURES AND STATES

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

**Table 5–17: DEMAND MEASURES**

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

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

- DEMAND IX Demand state; this is the demand value every minute or every integration period, depending on the selected setpoints.
- DEMAND IX MAX Demand maximeter; it stores the Maximum demand value until a demand reset is produced.
- DEMAND IX DATE Date of the Maximum demand value

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

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

DEMAND Y	Demand state; this is the demand value every minute or every integration period, depending on the selected setpoints
DEMAND Y MAX	Demand maximeter; it stores the Maximum demand value until a demand reset is produced.
DEMAND Y DATE	Date of the Maximum demand value.
Being <b>Y</b> the power considered in each case.	
W	Three-phase active power
VAR	Three-phase reactive power
VA	Three-phase apparent power

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

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

**Table 5–18: DEMAND ASSOCIATED VALUES**

DEMAND ASSOCIATED STATES
DEMAND TRIGGER INP
DEMAND RESET INP

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

**DEMAND TRIGGER INP** Bit type state, Programmable at “**setpoints>Relay Configuration>Protection Elements**” in EnerVista 650 Setup software. This signal is used by the Block Interval demand method. If this signal is associated to a digital input, the time to acknowledge this input is given by setpoints selected for the I/O boards set at **Setpoint > Inputs / outputs > Contact I/O > Board X**.

**DEMAND RESET INP** Bit type state, programmable at “**setpoints>Relay Configuration>Protection Elements**” in 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 1<sup>st</sup>, 2000).

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

### 5.3.1 GENERAL SETPOINTS

This section determines the unit configuration regarding its connection to the power system.

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

The corresponding setpoints are shown on the table below:

**Table 5–19: GENERAL SETPOINTS**

SETPOINT > SYSTEM SETUP > GENERAL SETPOINTS				
setpoint 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	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]

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 setpoint can be selected between VN and VX.

VN means that the  $V_0$  voltage value used by the neutral, ground, and sensitive ground directional elements, as well as 59NH and 59NL elements is going to be measured directly from the fourth voltage transformer of the F650 [A1-A12]. In this case, the synchronism element will be disabled, as the busbar voltage necessary for its operation would not be available.

If VX is selected in the Auxiliary Voltage setpoint, the measured voltage would be the busbar voltage used for the synchronism element, in this case the zero sequence voltage used by the neutral, ground and sensitive ground directional elements. 59N will be calculated from the phase voltages.

## 5.3.2 FLEX CURVES

The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in “**setpoints>System Setup>Flex Curves**” menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.

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

**Table 5–20: FLEX CURVE SETPOINTS**

SETPOINT > SYSTEM SETUP > FLEX CURVES FLEX CURVES A > FLEX CURVES B > FLEX CURVES C > FLEX CURVES D				
setpoint Description	Name	Default Value	Step	Range
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
...	...	...	...	...
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
...	...	...	...	...
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]

The definition of the curve points can be introduced directly in the Flex Curve setpoints menu or create them using the graphical tool provided by pressing “**Edit Curve**” in the Flex curves menu.

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

The user can also view a different curve model to the one the FlexCurve has been adapted to, and compare both models to adopt the most appropriate values in each case. If once the user curve has been configured the user wants to store the information, the “**Flex Curve > Exit with Data**” menu must be selected. If the results are not to be saved, the **Exit without Data** option must be selected. Once the configured curve point values have been stored, for these values to be definitely stored in the FlexCurve, the information must be saved in the FlexCurve general menu, by clicking on the “**Store**” option. This way the selected user curve is definitely stored, so that it can be used by any of the time overcurrent elements available in the relay.



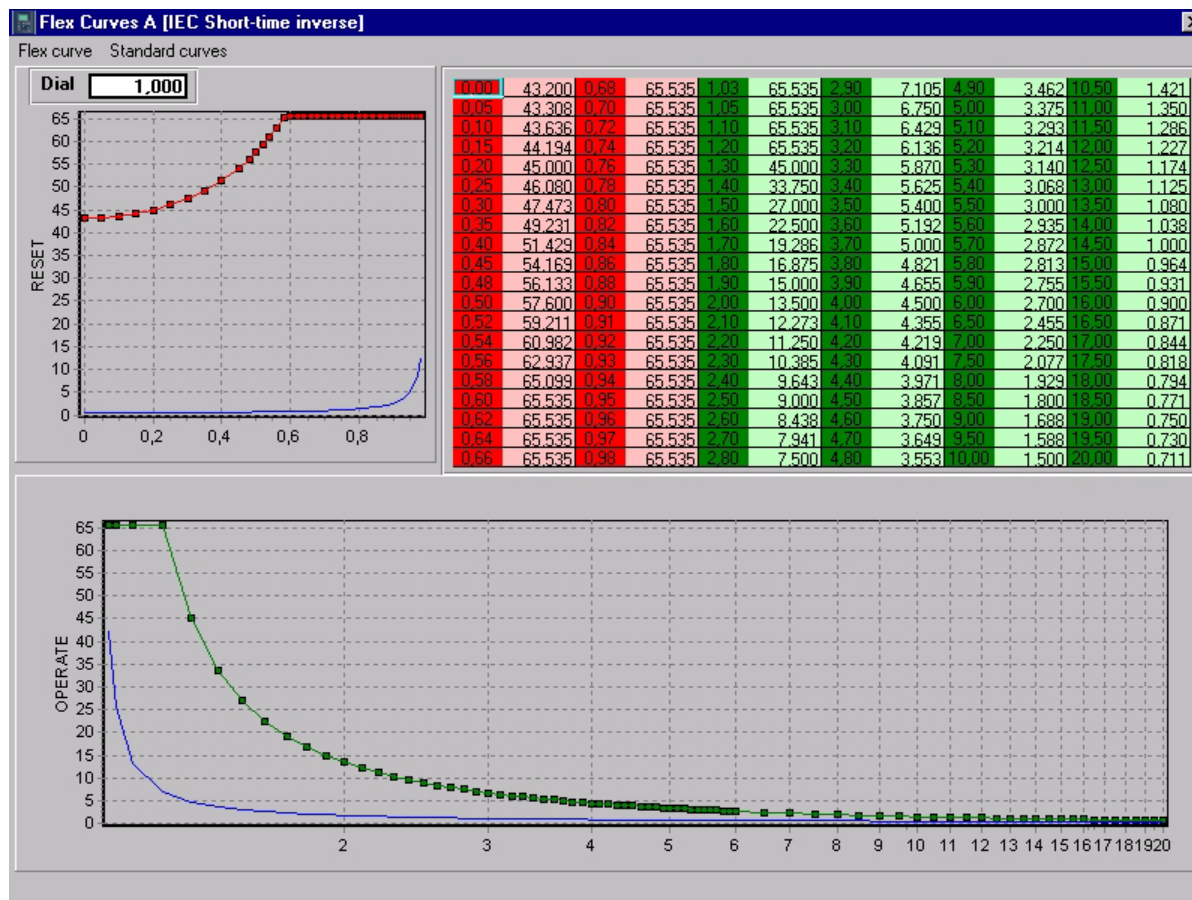


Figure 5–2: FLEXCURVES EDITION

## 5.3.3 BREAKER

There are two types of breaker setpoints:

**Breaker setpoints:** These setpoints correspond to the switchgear configured as breaker in the F650; this switchgear is used in the recloser functions, breaker failure and synchronism.

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

## 5.3.3.1 BREAKER SETPOINTS

**BREAKER setpointS** (*Setpoint > System Setup > Breaker > Breaker setpoints*)

**Table 5–21: BREAKER SETPOINTS**

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETPOINTS				
setpoint Description	Name	Default Value	Step	Range
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]

Breaker setpoints are as follows:

**Number of switchgear:** This is the Number of 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 setpoints must be previously configured at **Setpoint > Relay Configuration > Switchgear**. The relay allows to configure up to 16 switchgear elements, but the one configured as a breaker will be the reference for (KI)2t, openings and closings counters.

**Maximum KI2t:** This is the maximum set value for the square of current multiplied by the breaker opening time. There is a separate counter for each phase, but the value set as maximum is a single value for the three phases.

**KI2t Integration Time:** This is the integration time taken as base (fixed opening time) for the calculation of KI2t.

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

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

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

The interrupted current limit setpoint, fixes the Maximum breaker capacity (this value is set depending on the information provided by the breaker manufacturer); the relay incorporates a KI2t counter for each phase, where every time a trip or breaker opening occurs, the counter increases its value (in primary values). If the flowing current is lower than the rated current, the relay will take the rated current value for its calculations. When the cumulate counter for each phase reaches or exceeds the set value, the corresponding alarm signal will be activated.

The purpose of this function is to provide closer information of the current status of the breaker internal contacts, in order to ensure appropriate breaker maintenance, and to decrease the possible 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, accumulated I2t values and the number of operations are reset to zero.

### 5.3.3.2 BREAKER MAINTENANCE

To consider used breakers, the relay allows to set initial I2t values as well as an initial number of operations, in order to have into account previous breaker operations, as well as operations produced during testing. This breaker maintenance parameters can be set in the breaker maintenance menu.

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

**Table 5–22: BREAKER MAINTENANCE SETPOINTS**

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER MAINTENANCE				
setpoint Description	Name	Default Value	Step	Range
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]

In this group of setpoints, the start values of the breaker Counters can be reset.

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 historic, in case of second hand breakers, the system allows assigning an initial value to cumulated amperes, and to the number of opening and closing operations.

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

(KI)<sup>2</sup>t 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 unit incorporates a setpoint to select the integration time (KI2t Integ. Time) that allows either to assign a fix Opening time, or to leave the relay measure that time, from the opening command to the breaker opening.

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

**Table 5–23: BREAKER STATUS**

BREAKER STATUS	DESCRIPTION
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, as well as an indication of the set closing and opening failure time for such switchgear.
BREAKER CLOSED	Breaker closed
BREAKER UNDEFINED	Breaker undefined

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

**Table 5–24: BREAKER MAINTENANCE STATUS**

BREAKER MAINTENANCE	DESCRIPTION
KI2t PHASE A ALARM	This signal activates when the set value for phase A is exceeded.
KI2t PHASE B ALARM	This signal activates when the set value for phase B is exceeded.
KI2t 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 KI2t COUNTERS	KI2t Counters reset signal. This signal is configured at <b>Setpoint &gt; Relay Configuration &gt; Protection Elements</b> , and it is used for resetpoint the KI2t 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 <b>Setpoint &gt; Relay Configuration &gt; Protection Elements</b> , and it is used for resetpoint the breaker Opening and closing counters.
BREAKER OPENINGS	Number of Breaker openings
BREAKER CLOSINGS	Number of Breaker closings
KI2t PHASE A	Accumulated KI2t value for phase A ( KI2t Counter for Phase A)
KI2t PHASE B	Accumulated KI2t value for phase B ( KI2t Counter for Phase B)
KI2t PHASE C	Accumulated KI2t value for phase C ( KI2t Counter for Phase C)
BKR OPENING TIME	Maximum breaker Opening time. This signal is configured at <b>Setpoint &gt; Relay Configuration &gt; Switchgear</b> in the number of switchgear corresponding to the breaker selection
BKR CLOSING TIME	Maximum breaker Closing time. This signal is configured at <b>Setpoint &gt; Relay Configuration &gt; Switchgear</b> in the number of switchgear corresponding to the breaker selection

### 5.3.4 SWITCHGEAR

In firmware release 1.70 and higher ones there is the possibility to enable or disable the generation of internal signals for the different units (protection, control, inputs and outputs, switchgear) available in the device.

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

**Table 5–25: SWITCHGEAR SETPOINTS**

SETPOINT > SYSTEM SETUP > SWITCHGEAR				
setpoint Description	Name	Default Value	Step	Range
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]

## 5.4.1 CHANGE OF SETPOINT TABLES IN F650 UNITS

F650 relays incorporate the following **protection units**:

**CURRENT UNITS****Instantaneous overcurrent:**

- 3 x PHASE IOC HIGH (50PH)
- 3 x PHASE IOC LOW (50PL)
- 3 x NEUTRAL IOC (50N)
- 3 x GROUND IOC (50G)
- 3 x SENSITIVE GROUND IOC (50SG)
- 3 x ISOLATED GROUND IOC (50IG)

**Time delayed overcurrent:**

- 3 x PHASE TOC HIGH (51PH)
- 3 x PHASE TOC LOW (51PL)
- 3 x NEUTRAL TOC (51N)
- 3 x GROUND TOC (51G)
- 3 x SENSITIVE GROUND TOC (51SG)

**Negative sequence overcurrent:**

- 3 x NEGATIVE SEQUENCE TOC (46P)

**Thermal image:**

- 3 x THERMAL MODEL (49P)

**DIRECTIONAL UNITS**

- 3 x PHASE DIR (67P)
- 3 x NEUTRAL DIR (67N)
- 3 x GROUND DIR (67G)
- 3 x SENSITIVE GROUND DIR (67SG)

**VOLTAGE UNITS****Phase under/overvoltage**

- 3 x PHASE UV (27P)
- 3 x PHASE OV (59P)

**Zero sequence overvoltage**

- 3 x NEUTRAL OV HIGH (59NH)
- 3 x NEUTRAL OV LOW (59NL)

**Additional under/overvoltage (can be connected to the open delta for measured zero sequence, or to the busbar)**

3 x AUXILIARY OV (59X)

3 x AUXILIARY UV (27X)

**Negative sequence overvoltage:**

3 x NEGATIVE SEQUENCE OV (47P)

## POWER

3 x FORWARD POWER (32FP)

3 x DIRECTIONAL POWER (32)

Besides, F650 units incorporate also the following **control units**:

1 x setpoint GROUP

3 x OVERFREQUENCY (81O)

3 x UNDERFREQUENCY (81U)

1 x SYNCHROCHECK(25)

1 x AUTORECLOSE (79)

1 x BREAKER FAILURE (50BF)

1 x FUSE FAILURE (VTFF)

3 x BROKEN CONDUCTOR

1 x BREAKER setpointS

F650 units incorporate a flexible grouping capability for protection units. This means that protection units can be used in either one of the following modes:

### a) SINGLE SETPOINT GROUP

In this operation mode, all protection units can be activated and operate simultaneously. This provides the use of up to **87 independent protection units** that can be adapted to any application requiring a high number of protection units in a single relay.

In order to simplify the use of F650 units, this is the default mode.

### b) THREE SETPOINT GROUPS

In this mode, protection units are grouped in three independent tables with 29 protection units each, so that only one of them will be active at a given time. A logic signal, e.g. a digital input, will select which table is active at each time, providing adaptive protection to each network condition.

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

The distribution of protection units in tabled groups is described in Table 5–26:

Table 5–26: DISTRIBUTION OF PROTECTION ELEMENTS

TABLE 1	TABLE 2	TABLE 3
1x50PH	1x50PH	1x50PH
1x50PL	1x50PL	1x50PL
1x50N	1x50N	1x50N
1x50G	1x50G	1x50G
1x50SG	1x50SG	1x50SG
1x50IG	1x50IG	1x50IG
1x51PH	1x51PH	1x51PH
1x51PL	1x51PL	1x51PL
1x51N	1x51N	1x51N
1x51G	1x51G	1x51G
1x51SG	1x51SG	1x51SG
1x46P	1x46P	1x46P
1x49P	1x49P	1x49P
1x67P	1x67P	1x67P
1x67N	1x67N	1x67N
1x67G	1x67G	1x67G
1x67SG	1x67SG	1x67SG
1x27P	1x27P	1x27P
1x59P	1x59P	1x59P
1x47P	1x47P	1x47P
1x59NH	1x59NH	1x59NH
1x59NL	1x59NL	1x59NL
1x59X	1x59X	1x59X
1x27X	1x27X	1x27X
1x32FP	1x32FP	1x32FP
1x32	1x32	1x32
1x81U	1x81U	1x81U
1x81O	1x81O	1x81O
1 x Broken conductor	1 x Broken conductor	1 x Broken conductor

The setpoints used for setpoint table management are located in **Setpoint >Control Elements > setpoint Group**:

Table 5–27: SETPOINT GROUP SETPOINTS

SETPOINT > CONTROL ELEMENTS > SETPOINT GROUP				
setpoint Description	Name	Default Value	Step	Range
setpoint Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

setpoint Group setpoints are as follows:

**Function:** Possible values are: [DISABLED – ENABLED]

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

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

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

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

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

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

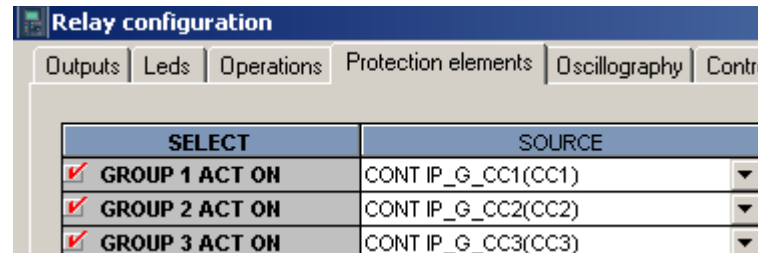


Figure 5–3: TABLE CHANGE SIGNALS CONFIGURATION EXAMPLE

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

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

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

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

Block signals are as follows:

- GROUP 1 BLOCKED
- GROUP 2 BLOCKED
- GROUP 3 BLOCKED

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



## 5.4.2 INVERSE TIME CURVES CHARACTERISTICS

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

- IEEE extremely/very/moderately inverse
- IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse
- IAC extremely/very/normally/moderately inverse
- ANSI extremely/very/normally/moderately inverse
- I<sup>2</sup>t
- Definite time
- Rectifier curve
- User Curve - FlexCurve A/B/C/D

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

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

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

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

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

## 5.4.2.1 IEEE CURVES

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

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

Where:

- t = Operation time in seconds
- Dial = multiplier setpoint
- I = Input current
- I<sub>tap</sub> = Current pickup value
- A, B, p = constants defined by the standard
- T<sub>RESET</sub> = reset time in seconds
- t<sub>r</sub> = characteristic constant.

Table 5–28: CONSTANTS FOR IEEE CURVES

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

Table 5–29: TABLE 5-29: TRIPPING TIME IN SECONDS FOR IEEE CURVES

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

### 5.4.2.2 IEC CURVES

This family of curves follows European standard IEC 255-4, and British standard BS142 for IEC Curves A, B and C, IEC Long-Time Inverse and IEC Short-Time Inverse. The formulas that define these curves are as follows:

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

Where:

t = Operation time in seconds

Dial = multiplying factor

I = Input current

I<sub>tap</sub> = Current pickup value

K, E = constants defined by the standard

T<sub>RESET</sub> = reset time in seconds (assuming 100% of power capacity and that the reset is activated)

t<sub>r</sub> = characteristic constant.

5

**Table 5–30: CONSTANTS FOR IEC CURVES**

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

Table 5–31: TRIPPING TIME IN SECONDS FOR IEC CURVES

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

## 5.4.2.3 IAC CURVES

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

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

Where:

t = Operation time in seconds

Dial = multiplier setpoint

I = Input current

I<sub>tap</sub> = Current pickup value

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

T<sub>RESET</sub> = reset time in seconds

t<sub>r</sub> = characteristic constant.

5

Table 5-32: CONSTANTS FOR IAC CURVES

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

Table 5–33: TRIPPING TIMES IN SECONDS FOR IAC CURVES

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

### 5.4.2.4 ANSI CURVES

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

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

$$T_{RESET} = TDM \times \left[ \frac{T_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1} \right]$$

where:

T = Operation time (in seconds).

Dial = Multiplying factor

I = Input current

$I_{pickup}$  = Current pickup setpoint

A, B, C, D, E = Constants

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

$T_r$  = Characteristic constant

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

**Table 5–34: CONSTANTS FOR ANSI CURVES**

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

Table 5–35: TRIPPING TIMES IN SECONDS FOR ANSI CURVES

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



**5.4.2.5 I<sup>2</sup>T CURVES**

The following formulas define this type of curves:

where:

t = Operation time in seconds

Dial = multiplier setpoint

I = Input current

I<sub>tap</sub> = Current pickup value

T<sub>RESET</sub> = reset time in seconds

**Table 5–36: TRIPPING TIME IN SECONDS FOR I<sup>2</sup>T CURVES**

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

**5.4.2.6 DEFINITE TIME CURVES**

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

**5.4.2.7 RECTIFIER CURVES**

Rectifier curves are generated from the following formulas:

$$T = TDM \left( \frac{45900}{\left( \frac{I}{I_{pickup}} \right)^{5.6} - 1} \right) \quad T_{reset} = TDM \left( \frac{45900}{\left( \frac{I}{I_{pickup}} \right)^2 - 1} \right)$$

where:

T = Operation time (in seconds).

TDM = Multiplying factor

I = Input current

I<sub>pickup</sub> = Pickup current

T<sub>reset</sub> = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

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

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

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

**Table 5–37: USER CURVE CHARACTERISTICS**

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

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

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

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

## 5.4.3 PHASE CURRENT

The F650 Phase current menu incorporates the following overcurrent elements:

- Phase time overcurrent (51PH/51PL)
- Phase instantaneous overcurrent (50PH/50PL)
- Phase directional overcurrent (67P)
- Thermal Model (49)

#### 5.4.3.1 PHASE TIME DELAYED OVERCURRENT UNITS – PHASE TOC (51PH/51PL)

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

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

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

The pickup current magnitude can be dynamically reduced depending on the existing voltage value, using the Voltage Restraint setpoint. The pickup current level is proportional to the phase-to-phase voltage measured according to a coefficient shown on Figure 5–4. This is accomplished via the multipliers (Mvr) corresponding to the phase-phase voltages of the voltage restraint characteristic curve; the pickup level is calculated as 'Mvr' times the 'Pickup' setpoint. In the figure,  $V_{pp}$  is the phase-to-phase voltage, and  $V_T$  Nominal is the rated voltage set under General setpoints (please refer to section

**1.3.1. BUSCAR REFERENCIA EN CAP. 1)**

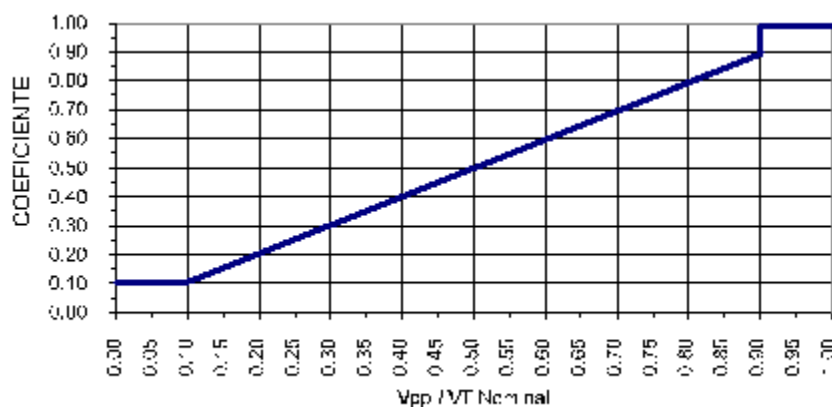


Figure 5–4: VOLTAGE RESTRAINT CHARACTERISTIC

Table 5–38: 51PH/51PL UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > > PHASE TOC HIGH > PHASE TOC HIGH 1> PHASE TOC HIGH 2 > PHASE TOC HIGH 3 > PHASE TOC LOW > PHASE TOC LOW 1 > PHASE TOC LOW 2 > PHASE TOC LOW 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

If the voltage restraint feature is disabled, the pickup level always remains at the value set in the Pickup Level setpoint.  
The snapshot event setpoint enables or disables the snapshot event generation for the phase time overcurrent units.

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

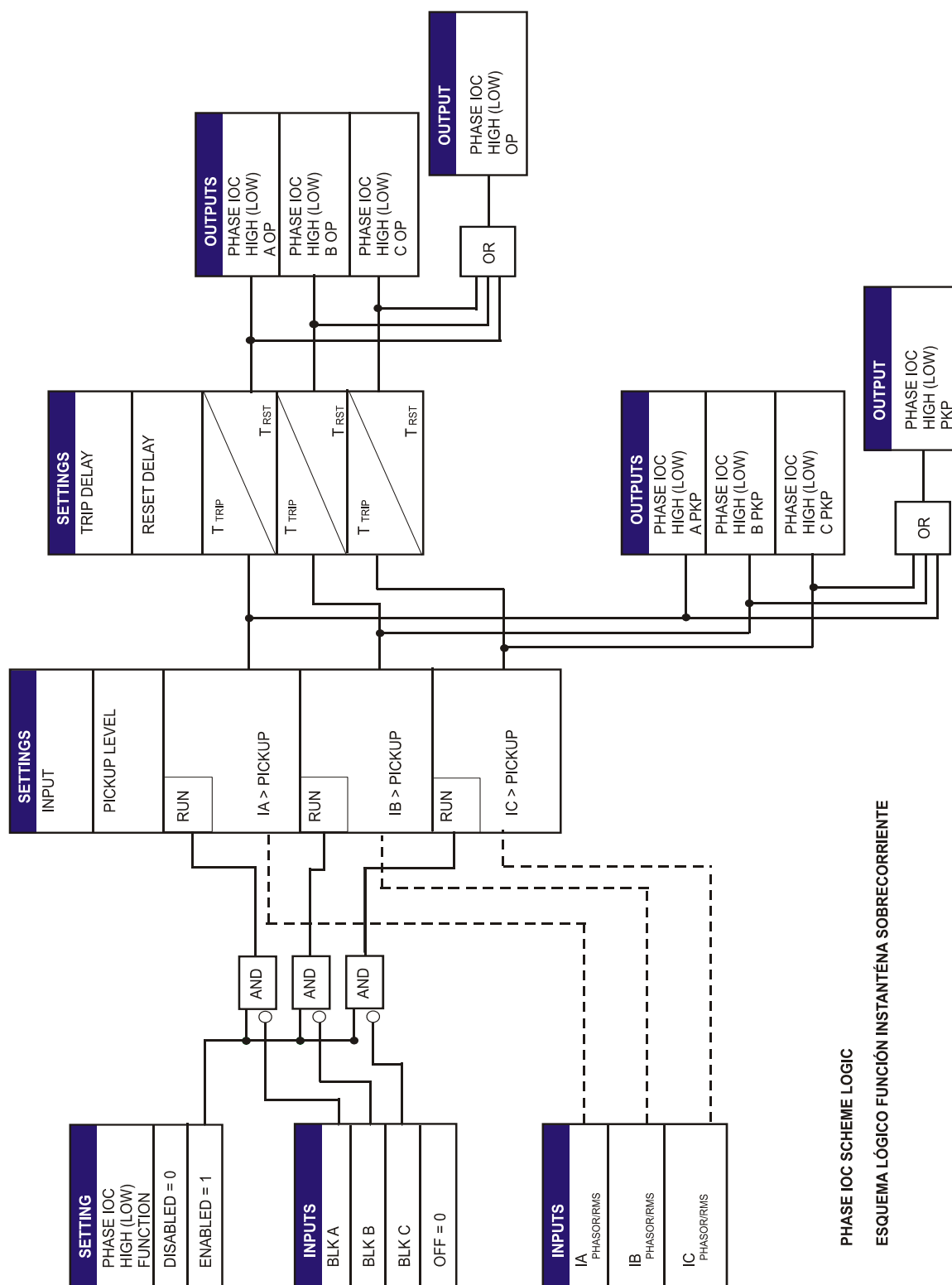


Figure 5–5: FIGURE 5-5. TOC UNIT LOGIC SCHEME (A6632F2)

### 5.4.3.2 PHASE INSTANTANEOUS OVERCURRENT UNIT- PHASE IOC (50PH/ 50PL)

The 50P phase instantaneous overcurrent unit has a setpoint range from 0.05 A to 160 A, which can be set as instantaneous or timed, with a timer selectable between 0.00 and 900 seconds. The phase current input quantities may be programmed as Fundamental phasor magnitude or total waveform RMS magnitude as required by the application. The unit incorporates a reset time selectable between 0 and 900 seconds.

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

**Table 5–39: 50PH/50PL UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > > PHASE IOC HIGH > PHASE IOC HIGH 1 > PHASE IOC HIGH 2 > PHASE IOC HIGH 3 > PHASE IOC LOW > PHASE IOC LOW 1 > PHASE IOC LOW 2 > PHASE IOC LOW 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for the phase instantaneous overcurrent units.

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

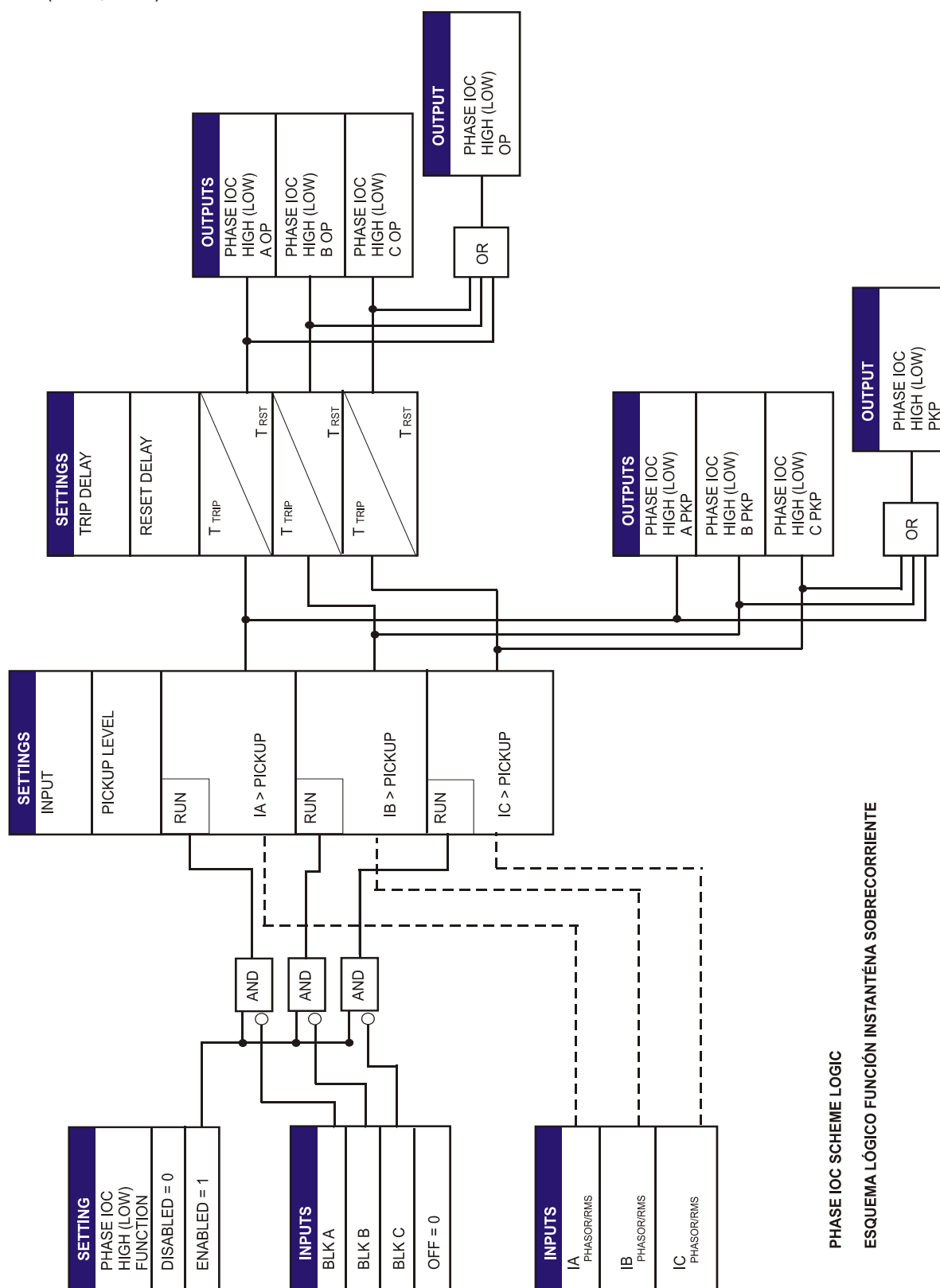


Figure 5–6: PHASE IOC UNITS LOGIC SCHEME (A6632F1)

### 5.4.3.3 PHASE DIRECTIONAL UNIT (67P)

The phase directional unit (67P) provides independent elements for each phase, and determines the direction of the current both in permanence and in fault condition.

Its main function is to apply a blocking signal to overcurrent units for preventing their operation when the current is flowing in certain direction. In order to determine the direction of current, the unit uses phase current values as operation magnitude, and phase-to-phase voltage values as polarization magnitude. This means that in order to polarize a phase, we use the phase-to-phase voltage of the other two phases, known as crossed polarization.

The following table describes the phase directional unit setpoints.

**Table 5–40: 67P UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > PHASE DIRECTIONAL > PHASE DIRECTIONAL 1 > PHASE DIRECTIONAL 2 > PHASE DIRECTIONAL 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	45°	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

<b>Function:</b>	This setpoint allows enabling or disabling the corresponding directional unit.
<b>MTA:</b>	The MTA setpoint corresponds to the Torque angle, which is the rotation applied to phase-to-phase crossed voltage.
<b>Direction:</b>	This setpoint allows selecting the area for the directional unit to operate, either forward or reverse.
<b>Block Logic:</b>	This setpoint allows selecting either permission or block, depending on the logic to be applied in the event of directional element block.
<b>Polarization Voltage Threshold:</b>	this is the minimum voltage considered for the direction calculation. Under this setpoint, the unit will be blocked.
<b>Snapshot Events:</b>	The snapshot event setpoint enables or disables the snapshot event generation for the phase directional units.

Phase directional element is an independent Protection unit that provides block and Operation signals for each phase. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at “**Actual > Status > Protection > Phase Current**”



Table 5–41: BLOCK AND OPERATION SIGNALS FOR THE PHASE DIRECTIONAL ELEMENT

BLOCK AND OPERATION FOR 67P
PHASE DIR1 BLOCK A
PHASE DIR1 A OP
PHASE DIR1 BLOCK B
PHASE DIR1 B OP
PHASE DIR1 BLOCK C
PHASE DIR1 C OP
PHASE DIR2 BLOCK A
PHASE DIR2 A OP
PHASE DIR2 BLOCK B
PHASE DIR2 B OP
PHASE DIR2 BLOCK C
PHASE DIR2 C OP
PHASE DIR3 BLOCK A
PHASE DIR3 A OP
PHASE DIR3 BLOCK B
PHASE DIR3 B OP
PHASE DIR3 BLOCK C
PHASE DIR3 C OP

## 5

Internal signals provided by the relay in the directional unit are of two types, block signals and operation signals. In the phase directional element, we can see how the obtained signals are separated for each phase (A, B, C), and by unit (1, 2, 3), and separated in block and operation signals.

Block signals indicate whether the directional unit is blocked, either by an external block signal or by polarization voltage loss. Operation signals indicate whether the directional unit provides operation permission or not.

Upon block of the directional unit, the user can select its behavior in a block situation, this means, whether operation of its supervised units is permitted, or on the other hand, if their operation is to be blocked under polarization voltage loss or external block of the directional unit. This selection is made through the “**Block Logic**” setpoint. If the **Block** option is selected, the supervised units operation will be disabled, and if the **Permission** option is selected, the supervised units will remain enabled.

In the example shown on OVERCURRENT UNITS BLOCK CONFIGURATION BY THE DIRECTIONAL UNIT, the **Block Logic** setpoint in the directional unit is set as **Block**, so in case of a directional unit block, operation signals will not produce an output. As shown on the figure, block signals are activated, as the directional unit is blocked and the permission signals are disabled to avoid operation of the associated protection units. If the **Block Logic** setpoint had set as **Permission**, operation signals would be activated to allow the operation of the associated overcurrent elements.

Signals used to block overcurrent units are configured at **Setpoint > Relay Configuration > Protection Elements**.

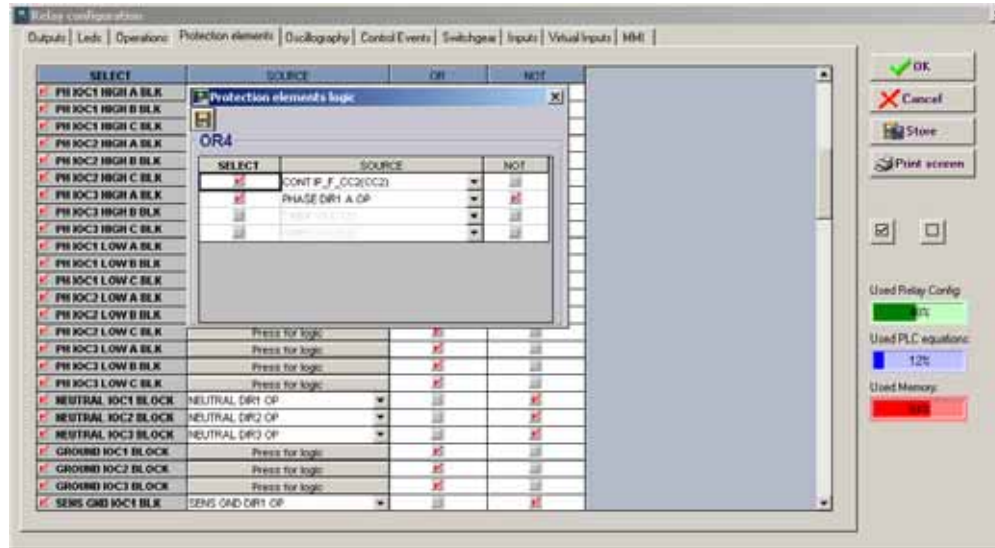


Figure 5-7: OVERCURRENT UNITS BLOCK CONFIGURATION BY THE DIRECTIONAL UNIT

The figure shows the block configuration for the Group 1 high range time overcurrent element. Block is configured independently for each phase and setpoint group, and the selected block signals can vary according to the user's requirements. The phase overcurrent unit will be blocked when the corresponding directional unit doesn't allow operation. PH IOC1 HIGH A BLK = NOT(PHASE DIR1 A OP). In this example, the overcurrent unit is also blocked by a digital input.

Directional units can also be blocked with signals coming from other relays, PLCs, or through signals configured in the relay PLC Editor (Logic configuration tool). The signal used in that case is PHASE DIR BLK INP. Figure 5-8: shows an example of the default block configuration of directional units by digital input. There is one block signal per input for each setpoint group.

Relay configuration			
Outputs Leds Operations Protection elements Oscillography Control Events Switchgear Inputs Virtual Input			
SELECT	SOURCE	OR	NOT
<input checked="" type="checkbox"/> PHASE DIR1 BLK INP	CONT IP_F_CC4(CC4)	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> PHASE DIR2 BLK INP	CONT IP_F_CC4(CC4)	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> PHASE DIR3 BLK INP	CONT IP_F_CC4(CC4)	<input type="checkbox"/>	<input type="checkbox"/>

Figure 5-8: DIRECTIONAL UNIT BLOCK CONFIGURATION BY INPUT

The main component of the phase directional element is the angle comparator with two inputs: the operation magnitude (phase current) and the polarization magnitude (phase-to-phase voltage rotated the angle set in MTA setpoint), which is the torque angle.

The Polarization type used in the directional unit is crossed, this means that in case of a fault in phase A, the Operation magnitude will be  $I_a$ , and the polarization magnitude will be  $V_{bc}$ , rotated the set torque angle. In case of a fault in phase B, the operation magnitude will be  $I_b$ , and the polarization magnitude will be  $V_{ca}$  rotated the set torque angle. Finally, in case of a fault in phase C, the operation magnitudes will be  $I_c$ , and  $V_{ab}$ .

Table 5-42: OPERATION AND POLARIZATION MAGNITUDES FOR DIRECTIONAL UNITS

PHASE	OPERATING SIGNAL	POLARIZING SIGNAL VPOL	
		ABC PHASE SEQUENCE	ACB PHASE SEQUENCE
A	$I_a$ angle	$V_{bc}$ angle x 1 MTA	$V_{cb}$ angle x 1 MTA
B	$I_b$ angle	$V_{ca}$ angle x 1 MTA	$V_{ac}$ angle x 1 MTA
C	$I_c$ angle	$V_{ab}$ angle x 1 MTA	$V_{ba}$ angle x 1 MTA

The polarization diagram is as follows:

Vpol: VBCx1|ECA

MAGNITUD DE OPERACION/OPERATION MAGNITUDE

MTA/ECA:(ANGULO CARACTERISTICO/ELEMENT CHARACTERISTIC ANGLE)

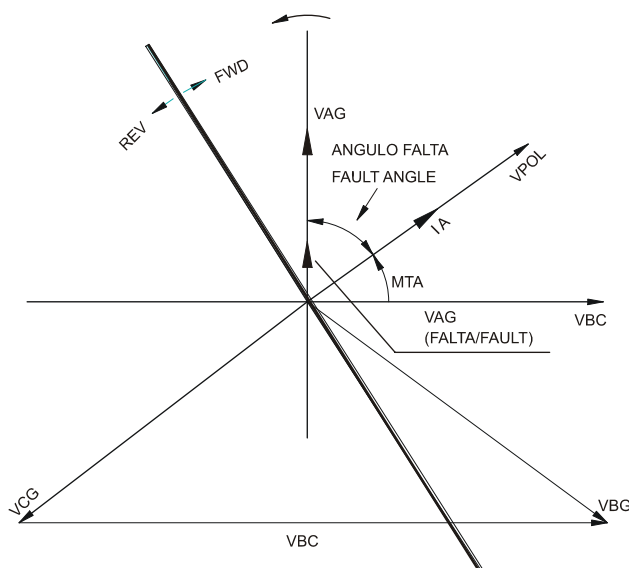


Figure 5-9: POLARIZATION DIAGRAM

The diagram shows a fault in phase A, therefore the Operation magnitude is  $I_A$ , the polarization magnitude is  $VBC$ , which has been rotated the torque angle set as **MTA**. Positive angles are considered as counter clockwise rotations, and negative angles clockwise rotations. Direction is considered to be forward when the fault current is inside an arc of  $\pm 90^\circ$  to both sides of the polarization voltage. In the directional unit setpoints there is a **Direction** setpoint that allows to select in which area the unit operation is allowed, either forward or reverse. Operation areas include a safety zone of  $5^\circ$  to each side of the cone. This safety cone is applied when the operation direction calculation is performed from initial block conditions. When we go from a non-trip area to a trip area, the safety cone is considered. In case we go from a trip area to a non-trip area, this cone will not be considered, and the whole area will be operative. This safety cone is located always in the operation area, both in forward and reverse cases.

**NOTE:** In situations where a current inversion is produced during a fault, the phase directional unit will require a period of time to establish the blocking signal. This time is approximately 20 ms. Certain instantaneous overcurrent units can be activated before receiving the blocking signal from the directional unit. In cases where these situations can be expected, we recommend to add a 50ms delay to IOC units.

The following figure shows the logic scheme for the phase directional unit.

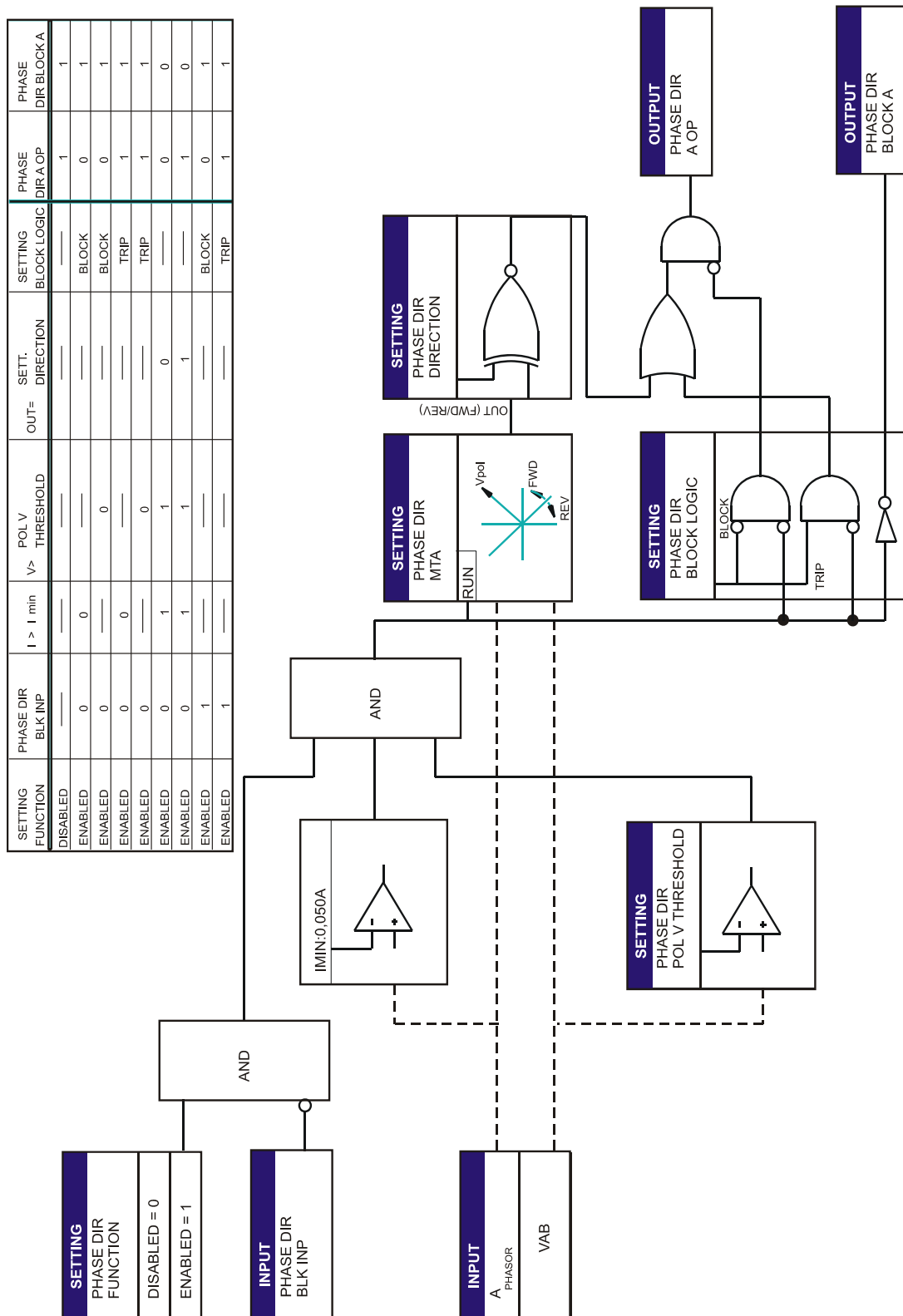


Figure 5-10: DIRECTIONAL UNIT LOGIC SCHEME (A6632F3)

PHASE DIR SCHEME LOGIC  
ESQUEMA LOGICO FUNCION DIRECCIONAL DE FASES

**5.4.3.4 THERMAL MODEL UNIT (49)**

Unit 49 is a protection element that measures the thermal heating generated as a result of the flowing current, and prevents this heating from causing damage to the protected equipment. In order to calculate the thermal image value, the following equation is used:

$$t = \tau * L n \frac{I^2}{I^2 - 1}$$

Where,

$\tau$  is the heating/cooling time constant.

$I$  is the ratio current/pickup

When a body is cooled, it does not always follow a time constant similar to the heating time constant; this is why the function has independent setpoints for heating and cooling constants.

**Table 5–43: 49 UNIT SETPOINTS**

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

The cooling constant is given in times the heating constant.

The snapshot event setpoint enables or disables the snapshot event generation for the thermal model units.

## 5.4.4 NEUTRAL CURRENT

The F650 Neutral Current menu incorporates the following overcurrent elements:

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

## 5.4.4.1 NEUTRAL TIME DELAYED OVERCURRENT UNIT (51N)

Unit 51N is a neutral time delayed overcurrent protection element. This unit uses as input quantity the **neutral current, calculated from the phase currents**. Trip can be timed by a curve selectable by setpoint. Reset can be instantaneous or linear.

Table 5–44: 51N UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL TOC NEUTRAL TOC 1> NEUTRAL TOC 2 > NEUTRAL TOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

## 5.4.4.2 NEUTRAL INSTANTANEOUS OVERCURRENT UNIT (50N)

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

Table 5–45: 50N UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL IOC NEUTRAL IOC 1> NEUTRAL IOC 2 > NEUTRAL IOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

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

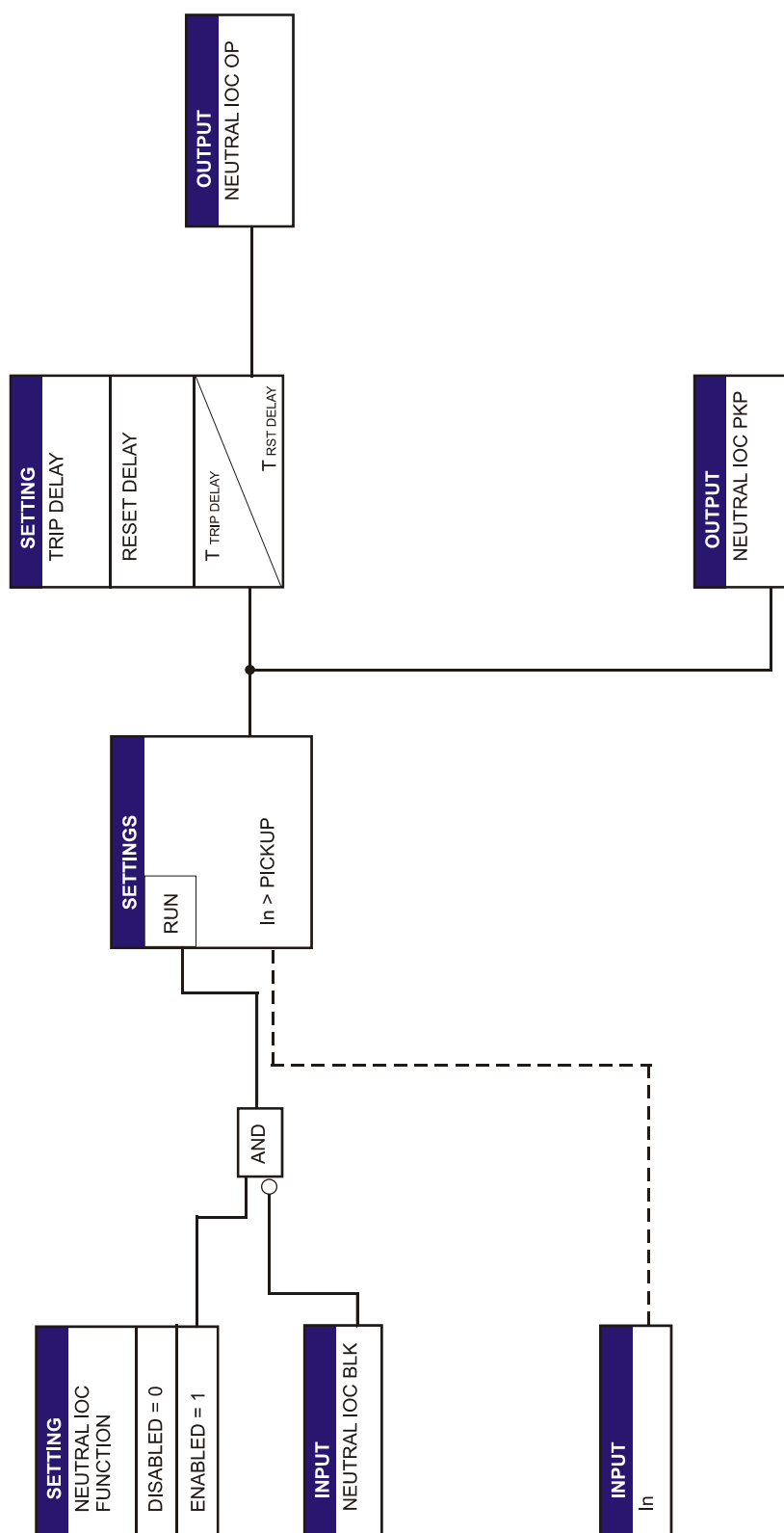


Figure 5-11: LOGIC SCHEME FOR NEUTRAL IOC UNIT

### 5.4.4.3 NEUTRAL DIRECTIONAL UNIT (67N)

The neutral directional unit is used for supervising the neutral (3I0) overcurrent units, **calculated from the phase currents as operation magnitude**, in order to discriminate the fault direction. This unit can be set to use either the neutral voltage (3V0), or the polarization current measured by the 5<sup>th</sup> current input (Ip), or both of them as polarization magnitude.

Table 5–46: 67N UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL DIRECTIONAL > NEUTRAL DIRECTIONAL 1> NEUTRAL DIRECTIONAL 2 > NEUTRAL DIRECTIONAL 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	V0	N/A	[ $V_0 - I_P - V_0 + I_P - V_0 * I_P$ ]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

setpoints for this unit are:

**Maximum Torque Angle (MTA):**

angle used to rotate the polarization voltage. Positive angles are counter clockwise rotations, and negative angles are counter clockwise rotations. The polarization magnitude, once rotated, defines the MTA line. Vn rotated this angle points the semi plane that corresponds to a Reverse fault. -Vn rotated this angle points the semi plane that corresponds to a Forward fault. A typical setpoint can be  $-45^\circ$ .

**Directional unit direction (Direction):**

This setpoint indicates the Direction for which the unit will allow a trip. Depending on this setpoint, the unit will be activated for faults in a direction, or on the opposite direction, allowing its use in tripping or blocking schemes. Possible options for this setpoint are FORWARD and REVERSE.

**Polarization type (Polarization):**

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

**V0** Voltage polarization

**Ip** Current polarization

**V0 + Ip** Voltage or current polarization, allows the unit to operate when any of the polarization magnitudes allow operation.

**V0 \* Ip** Voltage and current polarization, allows the unit to operate when both polarization magnitudes allow operation.

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

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

**Polarization Voltage Threshold**

this is the minimum voltage considered for the direction calculation. Under this setpoint, the unit will be blocked.

**Snapshot Events:**

The snapshot event setpoint enables or disables the snapshot event generation for this units.



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

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

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

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

#### a) VOLTAGE POLARIZATION OPERATION PRINCIPLES:

5

**Operation Magnitude:**  $I_n = 3 \cdot I_0$ , calculated from the phase currents.

**Polarization Magnitude:**  $-3V_0$ . Calculated from the phase voltages or measured at the input terminals (A11, A12). The relay measures  $3V_0$  and rotates  $180^\circ$  internally to obtain  $-3V_0$ .

Figure 2–12: shows the operation of the zero sequence polarization,  $3V_0$ , in case of an AG fault. In this case, the polarization magnitude  $3V_0$  can be calculated from the three phase voltage values, or measured through the fourth voltage input (Vx). In this last case, voltage transformer must be wye connected, and the **Auxiliary Voltage** setpoint in **General setpoints** must be configured as VX. The operation magnitude  $3I_0$ , is calculated from the phase currents.

When  $I_p$  Polarization is selected, the Polarization magnitude is  $I_p$ , the current value measured at the fifth current input (terminals B11-B12). This polarization current must usually come from a CT metering the current that flows from the ground to the neutral of the neutral fault current source, which will mainly be a transformer. The direction is considered to be **Forward** when the neutral current  $3I_0$  is inside a  $\pm 90^\circ$  arc at both sides of the polarization current. In any other case, the direction will be **Reverse**. If the polarization current is lower than 5 mA, the unit output takes the value of the **Block Logic** setpoint. VOLTAGE POLARIZATION

Figure 5–12: shows the Operation of the directional unit for a Phase A to Ground fault, where the Phase A current grows in magnitude and is delayed with respect to its voltage by an angle similar to the protected line, while  $V_a$  voltage decreases or can even disappear if the fault is close and the fault resistance is very low.

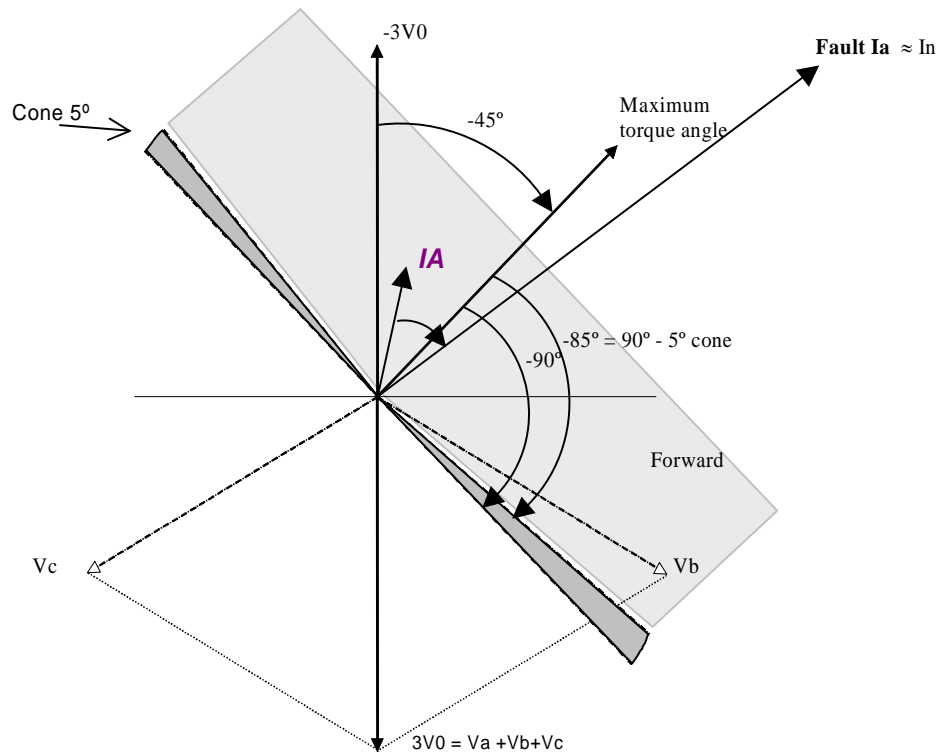


Figure 5–12: VOLTAGE POLARIZATION

The voltage polarization algorithm uses  $-V_n$ ,  $-(V_a + V_b + V_c) = -3 \cdot V_0$ , as a substitute for the faulted phase voltage. This magnitude can be rotated by the desired angle to fix the MTA line and to define the operative semi plane of the relay, following the rule that positive angles are in counter clockwise direction. A typical setpoint is  $-45^\circ$ , as shown on the figure. The operative semi plane is delimited to  $\pm 85^\circ$  of the MTA line. Every time the operation magnitude,  $I_n$ , is inside this semi plane, the unit will consider that the direction is forward. If the **Direction** setpoint is set as **Forward**, the operation signal of the neutral directional unit (NEUTRAL DIR OP) will be activated.

Minimum acceptable values, both for the polarization magnitude and the operation magnitude are as follows: minimum  $I_n$  current for the unit to operate is 50 mA. Minimum polarization voltage for the unit to operate is set in the **Polarization Voltage Threshold** setpoint. Minimum polarization current ( $I_p$ ) is 5 mA.

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

**b) CURRENT POLARIZATION OPERATION PRINCIPLES:**

Operation Magnitude:  $I_n = 3 \cdot I_o$ , calculated from the phase currents.

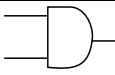


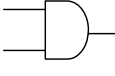
Polarization Magnitude:  $I_p$ , measured at input terminals B11-B12.

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

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

The following table shows the unit output signals management (block and permission) depending on the polarization type setpoint.

**Table 5–47: OUTPUT SIGNALS MANAGEMENT ACCORDING TO THE POLARIZATION TYPE SETPOINT**

POLARIZATION SETPOINT	NEUTRAL DIR BLOCK SIGNAL	NEUTRAL DIR OP SIGNAL
$V_o$	$V_o < \text{POL V THRESHOLD setpoint}$	Permission $V_o$
$I_p$	$I_p < 5 \text{ mA}$	Permission $I_p$
$V_o + I_p$	$V_o < \text{POL V THRESHOLD}$ $I_p < 5 \text{ Ma}$ 	Permission $V_o$ Permission $I_p$ 
$V_o * I_p$	$V_o < \text{POL V THRESHOLD}$ $I_p < 5 \text{ mA}$ 	Permission $V_o$ Permission $I_p$ 

5

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

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

NEUTRAL TOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL TOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL TOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

To block neutral instantaneous units:

NEUTRAL IOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL IOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL IOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

Table 5–48: QUANTITIES

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE ( $V_o$ )	FORWARD	$-V_o$	$I_o \times 1 \text{ MTA}$
	REVERSE	$-V_o$	$-I_o \times 1 \text{ MTA}$
CURRENT ( $I_p$ )	FORWARD	$I_{sg}$	$I_o$
	REVERSE	$I_{sg}$	$-I_o$
$V_o + I_p$	FORWARD	$-V_o$	$I_o$
		or	
		$I_{sg}$	$I_o$
	REVERSE	$-V_o$	$-I_o$
		or	
		$I_{sg}$	$-I_o$
$V_o * I_p$	FORWARD	$-V_o$	$I_o$
		and	
		$I_{sg}$	$I_o$
	REVERSE	$-V_o$	$-I_o$
		and	
		$I_{sg}$	$-I_o$

## 5.4.5 GROUND CURRENT

The F650 Ground Current menu incorporates the following overcurrent elements:

- Ground time overcurrent (51G)
- Ground instantaneous overcurrent (50G)
- Ground directional unit (67G)

## 5.4.5.1 GROUND TIME DELAYED OVERCURRENT UNIT (51G)

51G unit is a ground time delayed overcurrent protection element. The ground current input quantity is measured from the magnetic module ground input, terminals B9-B10, and it may be programmed as Fundamental phasor magnitude or total waveform RMS magnitude as required by the application. The unit trip can be time delayed using a selectable curve. And it incorporates a reset time selectable between instantaneous or linear.

Table 5–49: 51G UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND TOC GROUND TOC 1> GROUND TOC 2 > GROUND TOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

## 5.4.5.2 GROUND INSTANTANEOUS OVERCURRENT UNIT (50G)

50G unit is a ground instantaneous overcurrent protection element, with a setpoint range from 0.05 A to 160 A, which can also be time delayed, with a delay selectable between 0.00 and 900 seconds. The ground current input quantity is measured from the transformers module ground input, and it may be programmed as Fundamental phasor magnitude or total waveform RMS magnitude as required by the application. The unit incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The unit outputs are the general pickup and trip signals of the unit.

Table 5–50: 50G UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND IOC GROUND IOC 1> GROUND IOC 2 > GROUND IOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

### 5.4.5.3 GROUND DIRECTIONAL UNIT (67G)

67G unit is a directional protection element, used for monitoring the ground overcurrent units. The operation magnitude is the ground current measured directly from the corresponding input (B9-B10), while the polarization magnitude is the neutral voltage (3V0) calculated from the three phase voltages or measured from the dedicated voltage input (A11-A12).

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

*If the F650 is set to have synchronism check protection, then this input will be adjusted as busbar voltage and it will not be the 3V0 voltage (AUXILIARY VOLTAGE setpoint as VX)*

*If the F650 does not have a synchronism check unit, then this input can be set as 3V0 neutral voltage, and it can be used as polarization magnitude for the 67G unit (AUXILIARY VOLTAGE setpoint as VN).*

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

**Table 5–51: 67G UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND DIRECTIONAL > GROUND DIRECTIONAL 1> GROUND DIRECTIONAL 2 > GROUND DIRECTIONAL 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	VO	N/A	[ $V_0 - I_P - V_0 + I_P - V_0 * I_P$ ]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Operation of the Ground directional unit 67G is similar to the operation of the neutral directional unit 66N (please refer to section NEUTRAL DIRECTIONAL UNIT (67N)), with the exception that the operation magnitude here is the ground current  $I_g$  (67G), measured from the input terminals B9-B10 instead of the Neutral current,  $I_n$  (67N), calculated from the phase currents.

Polarization magnitudes can be, as in the case of 67N, Polarization voltage (3V0), either calculated from the phase voltages or measured from terminals A11-A12, or polarization current ( $I_p$ ), measured from the first input transformer terminals,  $I_{sg}$ , terminals B11-B12.





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

**Table 5–52: USED MAGNITUDES ACCORDING TO THE POLARIZATION SETPOINT**

POLARIZATION SETPOINT	OPERATION MAG.	POLARIZATION MAG.
V0	$I_g$	3V0
$I_p$	$I_g$	$I_{sg}$
$V_0 + I_p$	$I_g$	3V0 or $I_{sg}$
$V_0 * I_p$	$I_g$	3V0 and $I_{sg}$

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

**Table 5–53: OUTPUT SIGNALS MANAGEMENT ACCORDING TO THE POLARIZATION TYPE SETPOINT**

POLARIZATION SETPOINT	GROUND DIR BLOCK SIGNAL	GROUND DIR OP SIGNAL
V <sub>0</sub>	V <sub>0</sub> < Ajs. POL V THRESHOLD	Permission V <sub>0</sub>
I <sub>p</sub>	I <sub>p</sub> < 5 mA	Permission I <sub>p</sub>
V <sub>0</sub> + I <sub>p</sub>	V <sub>0</sub> < POL V THRESHOLD I <sub>p</sub> < 5 mA 	Permission V <sub>0</sub> Permission I <sub>p</sub> 
V <sub>0</sub> * I <sub>p</sub>	V <sub>0</sub> < POL V THRESHOLD I <sub>p</sub> < 5 mA 	Permission V <sub>0</sub> Permission I <sub>p</sub> 

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

For example, to block the ground time delayed units:

GROUND TOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND TOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND TOC3 BLOCK = NOT (GROUND DIR3 OP)

To block the Ground Instantaneous units:

GROUND IOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND IOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND IOC3 BLOCK = NOT (GROUND DIR3 OP)

## 5.4.6 SENSITIVE GROUND CURRENT

The F650 Sensitive ground Current menu incorporates the following overcurrent elements:

- Sensitive ground time overcurrent (51SG)
- Sensitive ground instantaneous overcurrent (50SG)
- Isolated ground overcurrent (50IG)
- Sensitive ground directional overcurrent (67SG)

## 5.4.6.1 SENSITIVE GROUND TIME DELAYED OVERCURRENT UNIT (51SG)

51SG unit is a sensitive ground time delayed overcurrent protection element with a setpoint range 0.005A to 16A. The sensitive ground current input quantity is measured from the transformers module sensitive ground input, terminals B11-B12, and it may be programmed as fundamental phasor magnitude or total waveform RMS magnitude as required by the application. The unit trip can be time delayed using a selectable curve. And it incorporates a reset time selectable between instantaneous or linear.

Table 5–54: 51SG UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND TOC SENSITIVE GROUND TOC 1> SENSITIVE GROUND TOC 2 > SENSITIVE GROUND TOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

## 5.4.6.2 SENSITIVE GROUND INSTANTANEOUS OVERCURRENT UNIT (50SG)

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

Table 5–55: 50SG UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND IOC SENSITIVE GROUND IOC 1> SENSITIVE GROUND IOC 2 > SENSITIVE GROUND IOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.



### 5.4.6.3 INSTANTANEOUS OVERCURRENT UNIT FOR UNGROUNDED SYSTEMS (50IG)

50IG unit is a protection element for distribution feeders connected to a busbar that is fed by a power transformer in a delta or wye connection. The operation of this unit is similar to that of sensitive ground overcurrent units; the difference is that in the case of 50IG, the 3I0 current is capacitive, and uses very reduced magnitudes (0.5-10 A primary values).

The operation characteristic is shown on figure Figure 5–13:, where Vh, VI, Ih and II are unit setpoints.

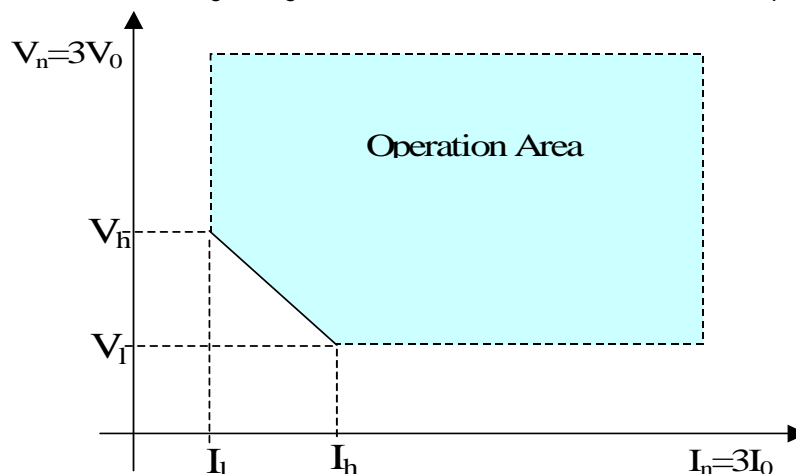


Figure 5–13: OPERATION CHARACTERISTIC FOR UNIT 50IG

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Table 5–56: 50IG UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > ISOLATED GROUND IOC ISOLATED GROUND IOC 1> ISOLATED GROUND IOC 2 > ISOLATED GROUND IOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
High Voltage	Vh Level	20	1 V	[2 : 70]
Low Current	II LEVEL	0.005	0.001 A	[0.005 : 0.400]
Low Voltage	VI LEVEL	2	1 V	[2 : 70]
High Current	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The relay setpoints for the 50IG elements are as follows:

- Function:** This setpoint determines whether the unit is operative and can generate pickup and trip events, which can be configured to close outputs, light up LEDs or trigger oscillography.
- Vh, VL, Ih, IL:** Vn and In values that define the points in the operative area.
- Operation time (Delay):** This is the selectable period between the unit pickup and trip, with a range from 0 to 900 seconds in steps of 0,01 seconds.
- Deviation time to Instantaneous (Time to inst):** Time after the trip during which the units become instantaneous. It must be set to zero if the functionality is not required.
- Snapshot Events:** The snapshot event setpoint enables or disables the snapshot event generation for this unit.

**OPERATION PRINCIPLES:**

Operation of the isolated Ground unit is based on the detection of a current that exceeds the setpoint, with neutral voltage supervision (3V0). This allows to set the unit in a very sensitive way, with a very low current level, ensuring that small angle or ratio errors in the current transformers will not produce the relay operation, as the neutral voltage verified is higher than the one set.

Values for h, IL, Vh and VL, which define the relay operation area, are configurable. H magnitudes must be higher than L magnitudes. The 50IG unit can be supervised by directional unit 67SG.

Using the relay input magnitudes In and Vn, if the point defined by (In, Vn) is inside the operation area and if the directional unit (if directional supervision is set) allows it, the unit picks up and the set delay time starts counting down. If a directional block appears during the countdown, the unit is reset. After the set time the unit trips. Once tripped, the relay cannot be blocked by the directional unit, and the trip remains while the fault exists.

After the trip, the deviation time to instantaneous starts to run, so that all pickups produced during this time will produce an Instantaneous trip. This means that, if after a trip the breaker is reclosed and the fault persists or reappears, the relay trip will be instantaneous. If the user doesn't want to use this function, then the **Deviation Time to Instantaneous (Time to inst)** setpoint must be set to zero seconds. Once the time has expired, the unit returns to its normal operation.

**5.4.6.4 SENSITIVE GROUND DIRECTIONAL UNIT (67SG)**

Function 67SG is a directional element used for supervising sensitive ground overcurrent functions. The operation magnitude is the ground current measured directly from the corresponding input (terminals B11-B12), while the polarization magnitude is the neutral voltage (3V0) either calculated from three phase voltages or measured from the dedicated voltage input (A11-A12)

In case of using the voltage measured at the dedicated voltage input terminals, the **Auxiliary Voltage** setpoint in **Setpoint > System Setup > General setpoints** must be VN.

*If the F650 is set to have synchronism check protection, then this input will be adjusted as busbar voltage and it will not be the 3V0 voltage (AUXILIARY VOLTAGE setpoint as VX)*

*If the F650 does not have a synchronism check unit, then this input can be set as 3V0 neutral voltage, and it can be used as polarization magnitude for the 67SG unit (AUXILIARY VOLTAGE setpoint as VN).*

The same way as the directional unit for phases, it has a polarization voltage loss logic that allows blocking or producing trip depending on the setpoint.

**Table 5–57: 67SG UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND DIRECTIONAL > SENSITIVE GROUND DIRECTIONAL 1> SENSITIVE GROUND DIRECTIONAL 2 > SENSITIVE GROUND DIRECTIONAL 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Available setpoints are:

**Function permission (Function):** This setpoint determines whether the sensitive Ground directional unit is enabled or Disabled.

**Maximum Torque Angle (MTA):** This angle is used to rotate the Polarization voltage. Positive angles mean counter clockwise rotation, and negative angles mean delay (counter clockwise). The polarization magnitude, once rotated, defines the MTA line. Vn rotated this angle points the semi plane that corresponds to a Reverse fault. (-Vn) rotated this angle points the semi plane that corresponds to a Forward fault.

**Operation Direction (Direction):** This setpoint indicates the Direction for which the unit will allow a trip. Depending on this setpoint, the unit will be activated for faults in a direction or in the opposite direction. Possible setpoint values are FORWARD or REVERSE.

**Polarization Voltage Threshold (Pol. V Threshold):** This is the minimum polarization voltage threshold, for a voltage value lower than this setpoint the directional unit will be blocked.

**Snapshot Events:** The snapshot event setpoint enables or disables the snapshot event generation for this unit.

Sensitive ground directional element is an independent Protection unit that provides block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at “**Actual > Status > Protection > Sensitive Ground Current**”

**67SG Block (SENS GND DIR1 BLOCK):** It indicates that the unit is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

**67SG Operation (SENS GND DIR1 OP):** It indicates that the directional unit is giving permission, that the angle relations between the operation magnitude and the polarization magnitude are met, according to the set conditions, or in case of having selected Permission in the Block Logic setpoint, it indicates that the unit allows operation under block conditions.

SENS GND DIRECTIONAL
SENS GND DIR1 BLOCK
SENS GND DIR1 OP
SENS GND DIR2 BLOCK
SENS GND DIR2 OP
SENS GND DIR3 BLOCK
SENS GND DIR3 OP

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

For example, to block sensitive Ground time overcurrent units, use the following signals:

SENS GND TOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND TOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND TOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block Ground instantaneous units:

SENS GND IOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND IOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND IOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block isolated Ground units:

ISOLATED GND1 BLK = NOT (SENS GND DIR1 OP)

ISOLATED GND2 BLK = NOT (SENS GND DIR2 OP)

ISOLATED GND3 BLK = NOT (SENS GND DIR3 OP)

## 5.4.7 NEGATIVE SEQUENCE CURRENT

The F650 Negative sequence menu incorporates the Negative sequence time overcurrent (46P) unit:

## 5.4.7.1 NEGATIVE SEQUENCE OVERCURRENT UNIT (46P)

46P unit is an overcurrent protection element that uses the fundamental phasor of the negative sequence current as input magnitude, calculated from the phase currents. This unit can be used for detecting load unbalance in the system, and for open phase conditions (fallen or broken conductor). The trip time can be selected as an inverse curve or instantaneous. The unit reset can also be selected as instantaneous or linear.

**Table 5–58: 46 UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE TOC > NEGATIVE SEQUENCE TOC 1 > NEGATIVE SEQUENCE TOC 2 > NEGATIVE SEQUENCE TOC 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

## 5.4.8 VOLTAGE ELEMENTS

The F650 incorporates the following voltage units:

- Phase undervoltage (27P)
- Phase overvoltage (59P)
- Neutral overvoltage (59NH/59NL)
- Negative sequence overvoltage (47)
- Auxiliary overvoltage (59X)
- Auxiliary undervoltage (27X)

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

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

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

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

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

$$T = \frac{D}{1 - \frac{V}{V_{pickup}}}$$

Where:

T = operation time

D = operation time setpoint (delay)

V = voltage applied to the relay

Vpickup = pickup setpoint (Pickup level)

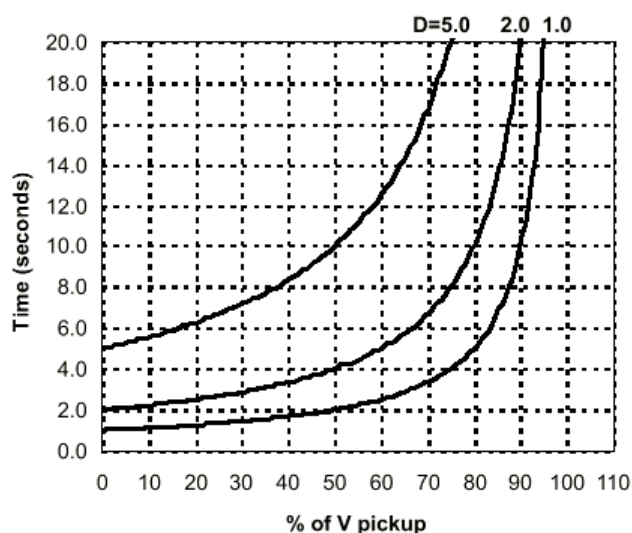


Figure 5-14: INVERSE TIME UNDERVOLTAGE CURVES

**5.4.8.1 PHASE UNDERVOLTAGE UNIT (27P)**

27P unit is a phase undervoltage protection element that uses as input magnitude the fundamental phasor of phase-to-phase or phase-to-ground voltage, selectable by setpoint. The unit time delay can be selected between definite time and inverse time. The unit reset is always instantaneous, that is, when the voltage exceeds the dropout value, the unit is reset.

There is an undervoltage setpoint that allows selection of a voltage level under which the unit will be inhibited. This way, we can distinguish between a fault condition and a Deadline condition where VTs are located in front of the breaker, and when it is open, the relay loses the voltage values. By setpoint this level to 0 we make this element operate every time the voltage value is lower than the setpoint. This unit generates independent pickup and trip signals per phase, and general pickup and trip signals for the unit. These last signals can be selected, by means of the operation logic setpoint, to be an OR (any phase signal) or an AND (all phase signals).

**Table 5–59: 27P UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE UV > PHASE UV 1> PHASE UV 2 > PHASE UV 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]
Minimum Voltage Threshold	Minimum Voltage	0	1 V	[0 : 300]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase undervoltage unit setpoints are:

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

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

**Pickup Level:** This is the voltage threshold under which the undervoltage unit will operate.

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

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

**Minimum voltage Threshold (Minimum Voltage):** Voltage setpoint under which the undervoltage element is inhibited, in order not to operate in deadline cases.

**Operation logic (Logic):** This setpoint allows the unit operation logic selection:

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

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

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

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

**Snapshot Events:** The snapshot event setpoint enables or disables the snapshot event generation for this unit.

### 5.4.8.2 PHASE OVERVOLTAGE UNIT (59P)

59P unit is a phase overvoltage protection element that uses as input magnitudes the phase-to-phase voltages, either measured directly from the voltage inputs in case the type of connection (**General Setpoint > Phase VT Connection**) is DELTA, or calculated from the phase-to-ground voltages in the case of a wye connection. The time delay can be set from instantaneous to 900 seconds. The unit reset can be delayed up to 900 seconds.

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

**Table 5–60: 59P UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE OV > PHASE OV 1 > PHASE OV 2 > PHASE OV 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase overvoltage unit setpoints are:

5

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

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

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

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

**Operation logic (Logic):** This setpoint allows the unit operation logic selection:

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

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

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

**Snapshot Events:** The snapshot event setpoint enables or disables the snapshot event generation for this unit.

### 5.4.8.3 NEUTRAL OVERVOLTAGE UNIT (HIGH LEVEL AND LOW LEVEL) (59NH/59NL)

59NH unit is a neutral overvoltage protection element that uses as input magnitude the system neutral voltage (3V0) calculated from the phase voltages, or the voltage value measured by the 4<sup>th</sup> voltage transformer. It is used for detecting unbalanced system voltage conditions, caused by a ground fault condition, or by the loss of one or two of the voltages. The unit time delay is selectable between 0 and 900 seconds. The unit incorporates a reset with a selectable delay between 0 and 900 seconds.

A setpoint makes the selection of the input voltage for this unit, either calculated from the phase voltages or measured from the 4th transformer of the F650. The setpoint to select the source of this voltage is configured in **Setpoint > System Setup > General Setpoint > Auxiliary Voltage** (Vn or Vx). By selecting Vn, the neutral voltage used in the phase overvoltage element will be measured at the fourth relay voltage transformer (A11-A12), and in this case the synchronism element of the relay will not be available. If Vx is selected as auxiliary voltage, this setpoint corresponds to the busbar voltage input used for the synchronism element, and the neutral voltage used in protection elements 59NH and 59NL will be calculated from the phase voltages.

Notice that the neutral overvoltage element will not be available if a **DELTA** Connection is set in the **Phase VT Connection** setpoint in General setpoints, and the fourth voltage transformer input is set to the busbar voltage for the synchronism element (Vx in **Auxiliary Voltage** setpoint). This is due to the fact that with this combination of setpoints is not possible to calculate the zero sequence component from the phase-to-phase voltage magnitudes.

**Table 5–61: 59NH/59NL UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > >NEUTRAL OV HIGH > NEUTRAL OV HIGH 1> NEUTRAL OV HIGH 2 > NEUTRAL OV HIGH 3 >NEUTRAL OV LOW > NEUTRAL OV LOW 1> NEUTRAL OV LOW 2 > NEUTRAL OV LOW 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

If the voltage input is calculated from the phase voltages, the equation for obtaining the input value will be as follows:

$$3 V_0 = V_A + V_B + V_C$$

If the voltage input is set as the voltage measured by the 4<sup>th</sup> voltage transformer, then the metered value will be applied directly to the algorithm. This voltage can be taken through a grounding resistance, a high impedance grounding, a busbar voltage etc.



**5.4.8.4 NEGATIVE SEQUENCE OVERVOLTAGE UNIT (47)**

47P unit is a negative sequence phase overvoltage protection element. It uses as input magnitude the negative sequence component calculated from the phase voltage values. This unit can be used to detect the loss of one or two phases, unbalance voltage conditions, etc.

**Table 5–62: 47 UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE OV > NEGATIVE SEQUENCE OV 1 > NEGATIVE SEQUENCE OV 2 > NEGATIVE SEQUENCE OV 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

**5.4.8.5 AUXILIARY OVERVOLTAGE UNIT (59X)**

This is an auxiliary one-phase overvoltage unit for general use that uses as input magnitude the voltage measured by the 4<sup>th</sup> VT. This voltage can be measured from the busbar, the neutral, etc. (this being the reason for its generic name and use). The time delay for unit 59X can be set from 0 to 900 seconds. The unit has a reset that can be programmed from 0 to 900 seconds.

**Table 5–63: 59X UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > AUXILIARY OV > AUXILIARY OV 1 > AUXILIARY OV 2 > AUXILIARY OV 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

**5.4.8.6 AUXILIARY UNDERVOLTAGE UNIT (27X)**

This is an auxiliary one-phase undervoltage unit for general use that uses as input magnitude the voltage measured by the 4<sup>th</sup> VT, terminals A11-A12. This voltage can be measured from the busbar, the neutral, etc. (this being the reason for its generic name and use).

**Table 5–64: 27X UNIT SETPOINTS**

Setpoint > Protection Elements > Auxiliary UV > Auxiliary UV 1 > Auxiliary UV 2 > Auxiliary UV 3				
setpoint Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

### 5.4.9.1 FORWARD POWER UNIT (32FP)

F650 units incorporate a forward power element with three units, as the rest of protection functions. The 32FP element produces a trip when exported power exceeds the setpoint value. Monitored power is active power, calculated by the three phase voltages and currents, and it is considered to be exported, positive active power, the one given in the direction of the line protected by the relay; in this situation, the angle between secondary voltage and current is lower than 90°, according to the relay wiring diagram.

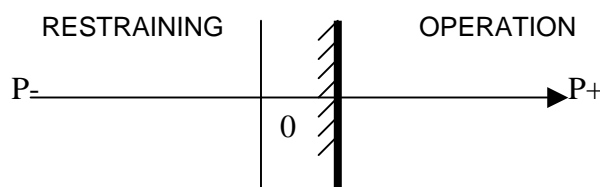


Figure 5-15: FORWARD POWER CHARACTERISTIC

Table 5-65: 2FP UNIT SETPOINTS

SETPOINT > PROTECTION ELEMENTS > POWER > FORWARD POWER FORWARD POWER 1 > FORWARD POWER 2 > FORWARD POWER 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

The F650 includes three 32FP elements. Each elements incorporates two stages, the first stage, less critical, is intended to produce an alarm, the second stage is used for trip. Both **levels are set in primary values**, for instance: if in general setpoints we set CT\_RATIO to a value of 100, and the same value for PT\_RATIO, the base power will be: 100 x 100 = 10.000 W

The block time allows blocking the element operation during a set time after the coupling breaker closure. For this purpose it is necessary to connect the breaker bay using a 52B type contact. The purpose of this setpoint is to avoid spurious trips caused by overloads after the breaker closure.

Power calculations depending on the VT connection:

- 1- **WYE** VT connection, or only one transformer in phase-to-ground connection:

$$P = V_a \times I_a \times \cos Y_a + V_b \times I_b \times \cos Y_b + V_c \times I_c \times \cos Y_c$$

- 2- **DELTA** VT connection, or only one voltage transformer in phase-to-ground connection:

$$P = \frac{V_{ab}}{\sqrt{3}} \times I_a \times \cos(Y_a - 30) + \frac{V_{bc}}{\sqrt{3}} \times I_b \times \cos(Y_b - 30) + \frac{V_{ca}}{\sqrt{3}} \times I_c \times \cos(Y_c - 30)$$

### 5.4.9.2 DIRECTIONAL POWER UNIT (32)

#### a) UNIT DESCRIPTION

The Directional Power element responds to three-phase active power measured from the feeder associated to the F650. This element can be selected to operate according to the power threshold adjusted in the corresponding setpoint. This element is ideal for reverse power applications (F32 REV) or forward power (F32 FWD), depending on the selected setpoint. The relay measures the three-phase power for wye or delta connections.

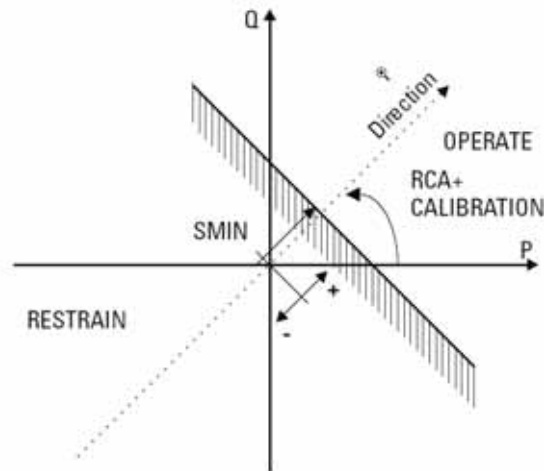
The element has an adjustable characteristic angle and minimum operating power as shown in the Directional Power Characteristic diagram. The element responds to the following condition:

$$P \cos(\varphi) + Q \sin(\varphi) > S_{MIN}$$

where: P and Q are active and reactive powers as measured per the F650 convention,  $\varphi$  is the angle set at the 32 setpoint (DIR POWER ANGLE) in degrees in steps of 0.01°, and S<sub>MIN</sub> is the minimum operating power

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

The Directional Power Characteristic is shown in the following diagram.



**Figure 5-16: POWER DIRECTIONAL CHARACTERISTIC**

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

Figure (a) below shows setpoints for reverse power application, while Figure (b) shows setpoints for low forward power application.

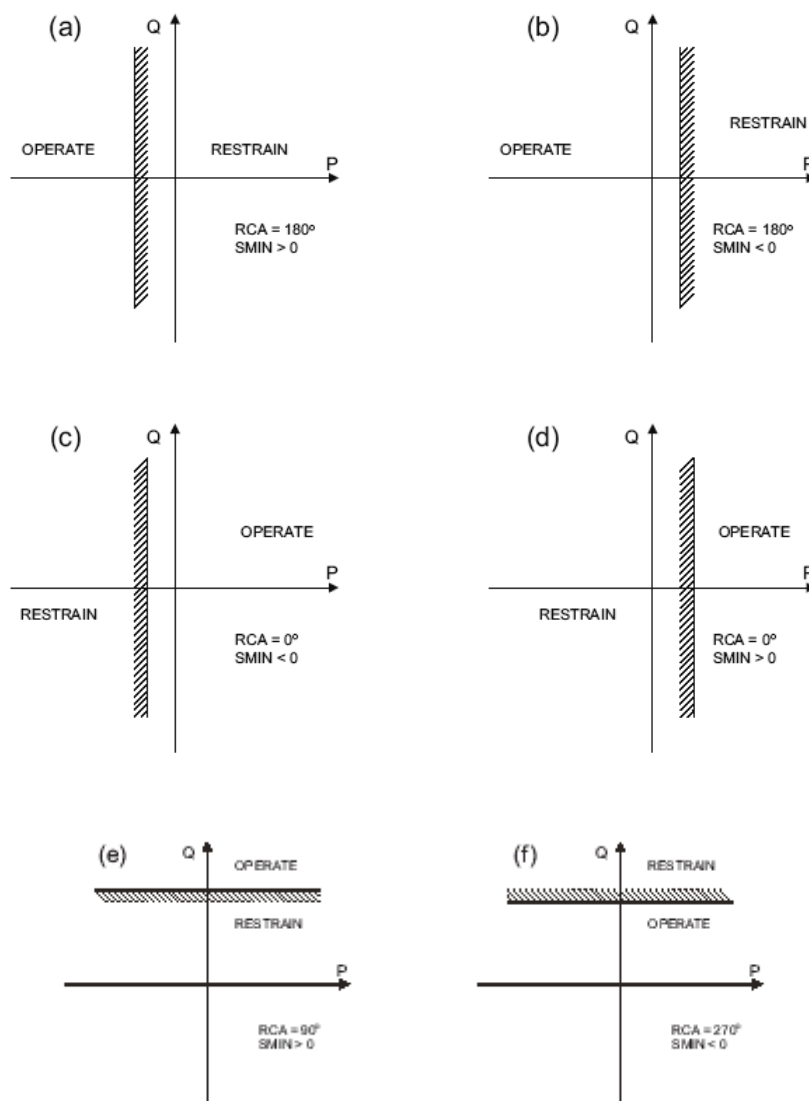


Figure 5-17: DIRECTIONAL POWER ELEMENT SAMPLE APPLICATIONS

The following table shows the SMIN and angle values that must be used for some typical applications:

Table 5-66: DIRECTIONAL POWER ELEMENT

SMIN (STAGE TAP)	ANGLE (RCA)	ELEMENT
>0	0°	Forward Active Power
<0	0°	Reverse Low Forward Active Power
>0	180°	Reverse Forward Active Power
<0	180°	Low Forward Active Power

By adding 90° to the angles shown on the table, the represented units would be similar but with **Reactive Power** instead of Active Power.

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

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

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

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

## b) SETPOINTS

**Table 5–67: 32 UNIT SETPOINTS**

SETPOINT > PROTECTION ELEMENTS > POWER > DIRECTIONAL POWER> DIRECTIONAL POWER 1> DIRECTIONAL POWER 2 > DIRECTIONAL POWER 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 1 (RCA1)	Dir Power Angle 1	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 2 (RCA2)	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

**Function:** Enables or disables the directional element.

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

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

The following figure illustrates the conventions established:

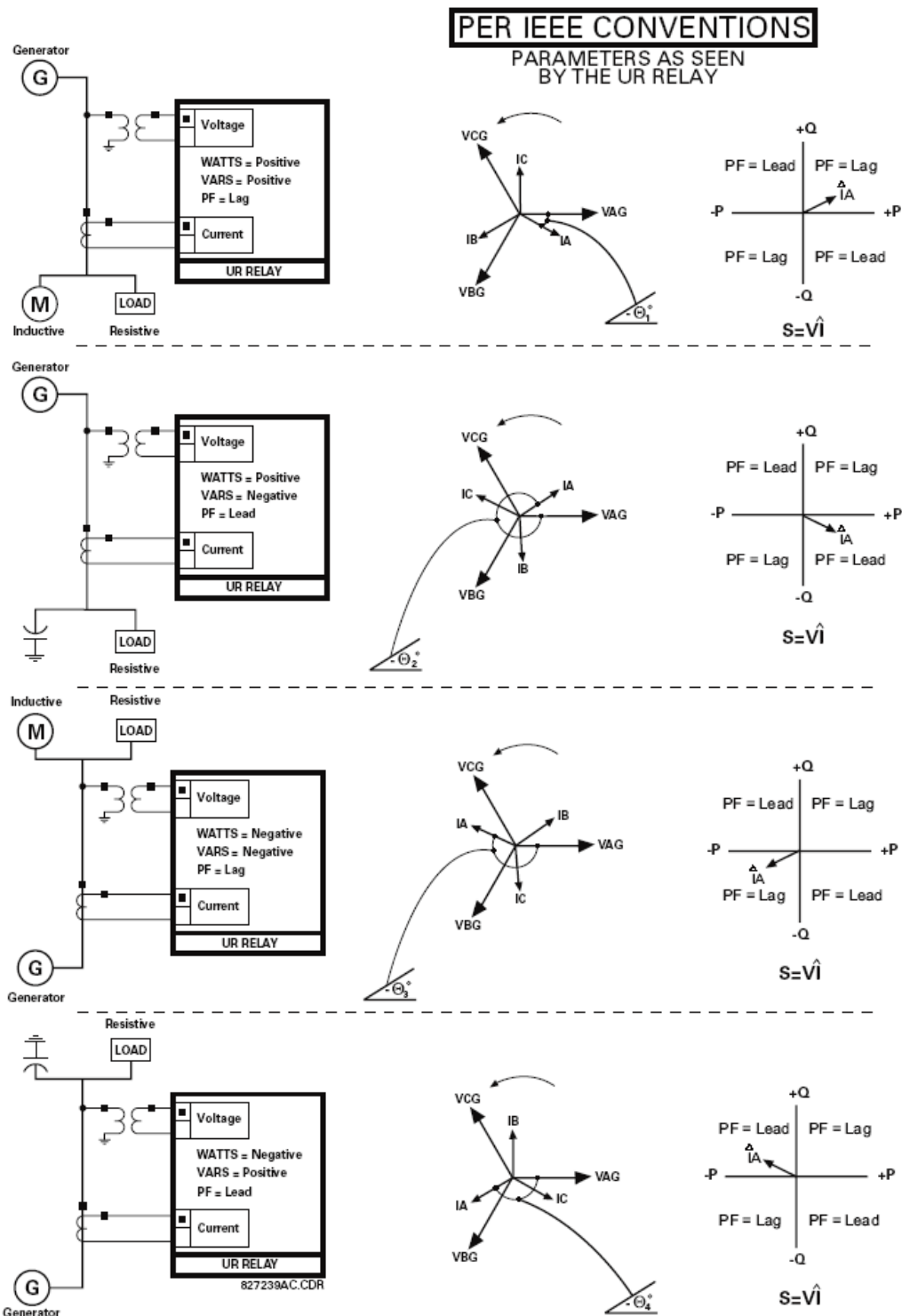


Figure 6-1: FLOW DIRECTION OF SIGNED VALUES FOR WATTS AND VARS

Figure 5-18: ANGLES

**Stage (1 - 2) Tap:** This setpoint specifies the minimum Operation three-phase power for the Stage 1 (2) element. The power value defined in this setpoint is the minimum distance between the source and the directional power characteristic. This value can be positive or negative. A positive value would define a characteristic slip through the positive power axis, while a negative value would move the characteristic through the negative axis. The value of this setpoint is defined in total MW (primary) – the CT and VT value is considered in the calculations.

**NOTE:**

Even if the unit defined in this setpoint is MW, this does not necessarily mean that the resulting value and the RCA setpoint are in MW. For example:

**RCA :** 30 ° **SMIN:** 100 MW.

If we assume that there is only active power. The unit operation would be produced for a value of:

$$P = 100 / \cos (30) = 115,7 \text{ MW.}$$

If there was only reactive power:

$$Q = 100/\sin (30) = 200,0 \text{ MVar.}$$

(In this case the real Operation units are Mvar, even if SMIN is expressed in MW.)

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

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



**c) STATUSES**

Statuses defined for this Function are as follows:

- DIR PWR1 (2, 3) BLOCK :** Writing status, operates by level. When this status is activated externally (via PLC), the directional power element is blocked. This status affects both units in the protection element (stage 1 and 2).  
 Activation of this status produces the event: **DIR PWR1 (2, 3) BLK ON.**  
 Deactivation produces the event : **DIR PWR1 (2, 3) BLK OFF.**
- DIR PWR1 (2, 3) STG1 (2) OP:** Reading status. This is activated when the unit that corresponds to stage 1/2 is activated. Events generated by this unit are:  
**DIR PWR1 (2, 3) STG1 (2) OP ON**  
**DIR PWR1 (2, 3) STG1 (2) OP OFF**
- DIR PWR1 (2, 3) STG1 (2) PKP:** Reading status. Activation of this status indicates that the power value has exceeded the threshold indicated by the Stage 1/2 unit. Events generated by this unit are:  
**DIR PWR1 (2, 3) STG1 (2) PKP ON**  
**DIR PWR1 (2, 3) STG1 (2) PKP OFF**
- DIR PWR1 (2, 3) STG PKP:** Reading status. This status is a logic OR between the DIR PWR STG1 PKP and DIR PWR STG2 PKP statuses. Activation of this status indicates that the power value has exceeded the threshold indicated by any of the Stage 1/2 units. Events generated by this unit are:  
**DIR PWR1 (2, 3) STG PKP ON**  
**DIR PWR1 (2, 3) STG PKP OFF**
- DIR PWR1 (2, 3) STG OP:** Reading status. This status is a logic OR between the DIR PWR STG1 OP and DIR PWR STG2 OP statuses. Activation of this status indicates that the power value has exceeded the threshold indicated by any of the Stage 1/2 units. Events generated by this unit are:  
**DIR PWR1 (2, 3) STG OP ON**  
**DIR PWR1 (2, 3) STG OP OFF**

The F650 incorporates the following control elements:

- setpoint Group
- Underfrequency
- Overfrequency
- Synchrocheck (25)
- Autoreclose (79)
- Breaker Failure (50BF)
- Broken Conductor (I2/I1)

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

### 5.5.1 SETPOINT GROUP

The setpoints used for setpoint table management are located in **Setpoint >Control Elements > setpoint Group**:

**Table 5–68: SETPOINT GROUP SETPOINTS**

SETPOINT > CONTROL ELEMENTS > SETPOINT GROUP				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
setpoint Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

For more detail information go to section 5.4.1

## 5.5.2 UNDERFREQUENCY UNIT (81U)

**Setpoint >Control Elements > Underfrequency**

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

**Table 5–69: 81U UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > UNDERFREQUENCY UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

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

## 5.5.3 OVERFREQUENCY UNIT (81O)

**Setpoint >Control Elements > Overfrequency**

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

**Table 5–70: 81O UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > OVERFREQUENCY OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

## 5.5.4 SYNCHRONISM CHECK UNIT - SYNCHROCHECK (25)

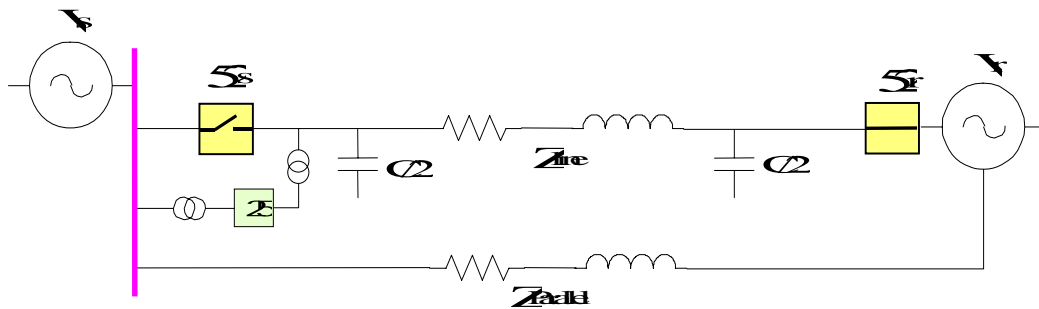
**Note:** The Switchgear element used in the F650 synchronism unit is the one configured in the **Number of Switchgear** setpoint inside **Breaker setpoints**, at "**Setpoint > System Setup > Breaker > Breaker setpoints**".

**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 unit 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 5–19:). The voltage comparison between both sides of a breaker is performed before closing the breaker, in order to minimize internal damage that could occur due to the voltage difference, both in magnitude and angle. This is extremely important in steam generating plants, where reclosing output lines with angle differences could lead to severe damage to the turbine axis.



**Figure 5–19:**

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

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

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

### 5.5.4.1 VOLTAGE INPUTS

In order to perform the synchronism check function, the F650 uses only one voltage from each end of the breaker. Voltage values to be compared must be on the same basis, either phase-to-phase or phase-to-ground voltage; they must be the same at both ends of the breaker; it is not possible to compare a phase-to-ground voltage at one end with a phase-to-phase voltage at the other end.

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

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

V1 is the line voltage, selectable from the relay voltage channels, using the “**Frequency Reference**” setpoint at **Setpoint > System Setup > General setpoints > Frequency Reference**. (Please refer to the voltage correspondence )

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** setpoint at **Setpoint > System Setup > General setpoints > Auxiliary Voltage**.

The voltage correspondence is detailed in the following table:

**Table 5–71: VOLTAGE CORRESPONDENCE UNIT 25**

	VOLTAGE CORRESPONDENCE		
<b>setpoints&gt;System Setup&gt;General setpoints&gt;Frequency Reference</b> Voltage selection for unit 25 of F650	V <sub>I</sub>	V <sub>II</sub>	V <sub>III</sub>
<b>setpoints&gt;System Setup&gt;General setpoints&gt;Phase VT Connection=WYE</b> Phase-to-ground voltage connection.(Wye connection)	V <sub>a-g</sub>	V <sub>b-g</sub>	V <sub>c-g</sub>
<b>setpoints&gt;System Setup&gt;General setpoints&gt;Phase VT Connection=DELTA</b> Phase-to-phase voltage connection.(Delta connection).	V <sub>a-b</sub>	V <sub>b-c</sub>	V <sub>c-a</sub>
setpoints>System Setup>General setpoints> Auxiliary Voltage=VX	V <sub>x</sub>		

**setpoints/System Setup/General setpoints/Auxiliary Voltage** setpoint must be set to V<sub>x</sub>, in order to monitor auxiliary voltage instead of V<sub>n</sub> (neutral voltage, coming from an open delta connection).

### 5.5.4.2 APPLICATION

Even if the application range of F650 is quite wide and the unit 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 F650 is not suitable for one and a half breaker configurations, or ring configurations where a transmission line or feeder has two breakers.

### 5.5.4.3 SETPOINTS

#### Setpoint > Control Elements > Synchrocheck

There is only one synchrocheck unit in the F650.

**Table 5–72: 25 UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > SYNCHROCHECK				
SETPOINT 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 : 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]

setpoints description for 25 unit:

**Function permission (Function):** This setpoint allows enabling and disabling the synchrocheck unit.

#### Voltage Level determination setpoints for busbar and line:

This setpoint 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 setpoints (live bus, live line):

F650 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 setpoints include a fourth time setpoint, 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 unit.

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

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

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

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

### Closing permission logic setpoints:

In case that the voltage at one or both ends of the breaker is null, the synchronism unit 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, F650 units 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 setpoint enables or disables the snapshot event generation for this unit.

## 5

#### 5.5.4.4 SYNCHROCHECK STATES

Internal signals provided by the F650 (*Actual > Status > Control Elements > Synchrocheck*) for the synchronism unit are as follows:

Table 5–73: SYNCHROCHECK INTERNAL STATES

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

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

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

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

**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.
<b>SLIP CONDITION: I</b>	Internal signal indicating frequency slip between the line voltage and bus voltage phasors.
<b>BUS FREQ &gt; LINE FREQ:</b>	Busbar Frequency higher than line frequency
<b>BUS FREQ &lt; LINE FREQ:</b>	Busbar Frequency lower than line frequency

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

**Actual> Metering > Primary Values > Voltage**

<b>VBB Primary (KV)</b>	Busbar voltage in primary values
<b>VL Primary (KV)</b>	Line voltage in primary values

**Actual> Metering > Secondary Values > Voltage**

<b>Line Voltage (V)</b>	Line voltage in secondary values
<b>Bus Voltage (V)</b>	Busbar voltage in secondary values

**Actual> Metering > Frequency**

<b>Line Frequency (Hz)</b>	Line frequency in Hz
<b>Bus Frequency (Hz)</b>	Bus frequency in Hz

**Note on the measure:** voltage and current angles are available for the user from firmware version 1.60.

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 setpoints (please refer to the voltage correspondence table (Table 5–71:), and the angle of the busbar voltage the one that corresponds to Vx Angle, when the Auxiliary Voltage setpoint as been selected as VX.

### 5.5.4.5 ALGORITHM

F650 units perform the synchronism check by basically establishing and comparing three parameters:

Module difference of voltage phasors  $\Delta V$  (V)

Phase angle of voltage phasors  $\Delta \varphi$  ( $^{\circ}$ )

Frequency slip between two phasors S (Hz)

**These parameters are continuously determined and managed once that Unit 25 has been enabled by setpoint, 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 unit will not issue a closing permission signal, even when closing conditions are met.

If voltage on one side of the breaker to be closed is null, the synchronism unit cannot establish the synchronism check, and therefore it will not issue synchronism permission. For these cases, usual in breaker maintenance situations, or in new installations where voltage might not be present, but the breaker operation needs to be verified, F650 units 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  $\Delta V$



Comparing the voltage values for line voltage ( $V_1$ ) and busbar voltage ( $V_2$ ) at both sides of the breaker, the relay can determine the synchronism situation of the unit (see Table 2–73:).

Being:

- $V_1$  line voltage
- $V_2$  bus voltage
- $V_L$  Minimum acceptable voltage by setpoint to establish synchronism conditions (dead line and bus levels).
- $V_H$  Appropriate voltage to establish synchronism conditions, configured by setpoint (live line and bus levels).

**Table 5–74: 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	$V_1 > \text{dead line level}$ $V_1 < \text{live line level}$	$V_2 > \text{dead bus level}$ $V_2 < \text{live bus level}$
(2) $(V_1 \& V_2) > V_H$	Permitted	Live Line – Live Bus	$V_1 > \text{live line level}$	$V_2 > \text{live bus level}$
(3) $(V_1 \& V_2) < V_L$	Not permitted	Dead Line – Dead Bus	$V_1 < \text{dead line level}$	$V_2 < \text{dead bus level}$
(4) $(V_1 < V_L) \& (V_L < V_2 < V_H)$	Not permitted	Not permitted	$V_1 < \text{dead line level}$	$V_2 > \text{dead bus level}$ $V_2 < \text{live bus level}$
(5) $(V_2 < V_L) \& (V_L < V_1 < V_H)$	Not permitted	Not permitted	$V_1 > \text{dead line level}$ $V_1 < \text{live line level}$	$V_2 < \text{dead bus level}$
(6) $(V_1 < V_L) \& (V_2 > V_H)$	Not permitted	Dead Line – Live Bus	$V_1 < \text{dead line level}$	$V_2 > \text{live bus level}$
(7) $(V_2 < V_L) \& (V_1 > V_H)$	Not permitted	Live Line – Dead Bus	$V_1 > \text{live line level}$	$V_2 < \text{dead bus level}$

Table 5–74: 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 unit will start evaluating the line and busbar voltage comparison with respect to the setpoint  $\Delta V_{\text{set}}$  established by setpoint (Max Volt Difference). In this case, if the voltage difference is lower than  $\Delta V_{\text{set}}$ , the synchronism check unit (25) will verify the angle difference  $\Delta\phi$  adjusted by setpoint (Max Angle Difference).

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

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

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

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

**Phase Angle Difference  $\Delta\phi$** 

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

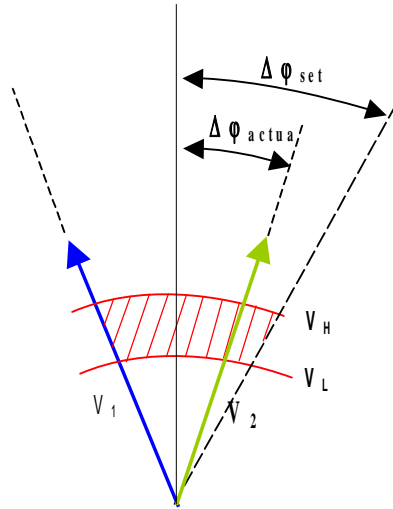


Figure 5-20: VOLTAGE ANGLE DIFFERENCE

**FREQUENCY SLIP  $\Delta f$** 

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

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

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

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

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

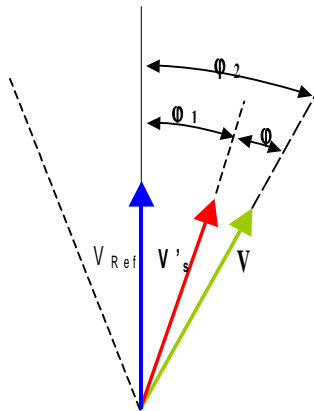


Figure 5-21: ANTICIPATIVE ALGORITHM

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)
$\varphi$	$360^\circ * TCB * \Delta f$ = Calculated angle for phasor $V'_s$
<b>TCB</b>	Breaker Closing time defined by setpoint
$\Delta f$	Frequency slip (mHz) between phasors
$\varphi_1$	Angle difference set as maximum angle difference ( $\Delta\varphi_{set}$ , Max Angle Difference)
$\varphi_2 =$	Angle difference between $V_{ref}$ and $V_s$ . The algorithm starts operating when $\varphi_2$ 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 ( $\varphi_2$ ) is entered, the relay will produce a closing permission output, if it is guaranteed that the projected phasor will be within the limit marked by the setpoint, as shown in the following figure.

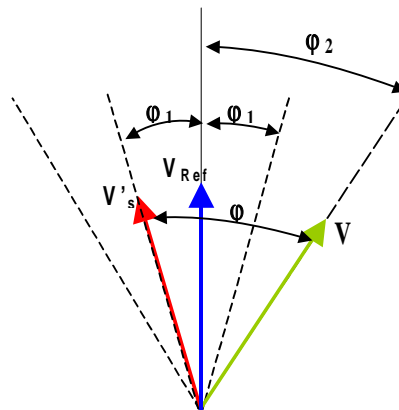


Figure 5-22: HIGH SLIP CLOSING PERMISSION SIGNAL

## 5.5.5 AUTORECLOSE (79)

## 5.5.5.1 INTRODUCTION

**Note:** The Switchgear element used in the F650 autoreclose unit is the one configured in the **Number of Switchgear** setpoint inside **Breaker setpoints**, at “**Setpoint > System Setup > Breaker > Breaker setpoints**”. Configuration of these Switchgear parameters is performed at **Setpoint > Relay Configuration > Switchgear** using EnerVista 650 Setup software.

The F650 autoreclose unit allows producing up to four breaker “shots” prior to locking out. Thanks to the great flexibility of F650 configurable logic, the conditions to produce the autoreclose initiation and the selection of which protection elements will be enabled after each shot can be programmed. This flexibility allows implementing protection schemes that used to require wiring and special functions in conventional equipments. One application is, for instance, to program instantaneous the first protection trip and the second one to be time delayed, in order to give time for output fuses to burning of a feeder branch. This can be as simply as disable the instantaneous units after the first shot using the programmable logic. (see example in section )

## 5.5.5.2 MAIN AUTORECLOSE SETPOINTS

**Setpoint > Control Elements > Autoreclose**

**Table 5–75: 79 UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > AUTORECLOSE				
SETPOINT 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 setpoints description:

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

**Max Number Shots:** This setpoint specifies the number of autoreclose shots allowed in the unit. 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 unit.

**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 setpoint enables the verification of the relay reclose conditions. If this setpoint is enabled, before the breaker closing command execution the system will verify the possible reclose conditions. If this setpoint is disabled, the closing command will be 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 setpoint indicates the waiting time for the reclose conditions to be present. This setpoint is only operative if the *Cond. Permission* setpoint 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 will reset and the autoreclose will get to READY.

### 5.5.5.3 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 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 5–76: 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** setpoint is enabled. Otherwise, these conditions wouldn't have any effect. In the default factory configuration, the conditions input is associated to the synchronism check element close permission.

#### 5.5.5.4 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 5–77: 79 INTERNAL STATUS**

AUTORECLOSE SINGLE STATUS	AUTORECLOSE ENUMERATED STATUS
AR CLOSE BREAKER	AR STATUS
AR OUT OF SERVICE	AR READY
AR READY	AR LOCKOUT
AR LOCKOUT	AR BLOCK
AR BLOCK	AR RCL IN PROGRESS
AR RCL IN PROGRESS	AR LOCKOUT MODE
AR LCK BY ANOMALY	AR LCK BY ANOMALY
AR LCK BY FAIL OPEN	AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE	AR LCK BY FAIL CLOSE
AR LCK BY USER	AR LCK BY USER
AR LCK BY CONDS	AR LCK BY CONDS
AR LCK BY TRIPS	AR LCK BY TRIPS
AR LCK BY SHOTS	AR LCK BY SHOTS
AR BLK AFTER 1 SHOT	AR BLOCK MODE
AR BLK AFTER 2 SHOT	AR BLOCK BY LEVEL
AR BLK AFTER 3 SHOT	AR BLOCK BY PULSE
AR BLK AFTER 4 SHOT	
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)

<b>AR BLOCK BY PULSE</b>	Autoreclose blocked by pulse. See AR block signals configuration (AR PULSE BLOCK)
<b>AR STATUS</b>	Autoreclose status (see )
<b>AR LOCKOUT MODE</b>	Autoreclose lockout mode (see )
<b>AR BLOCK MODE</b>	Autoreclose block mode (see )

### 5.5.5.5 GENERAL AUTORECLOSE STATUS DIAGRAM

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

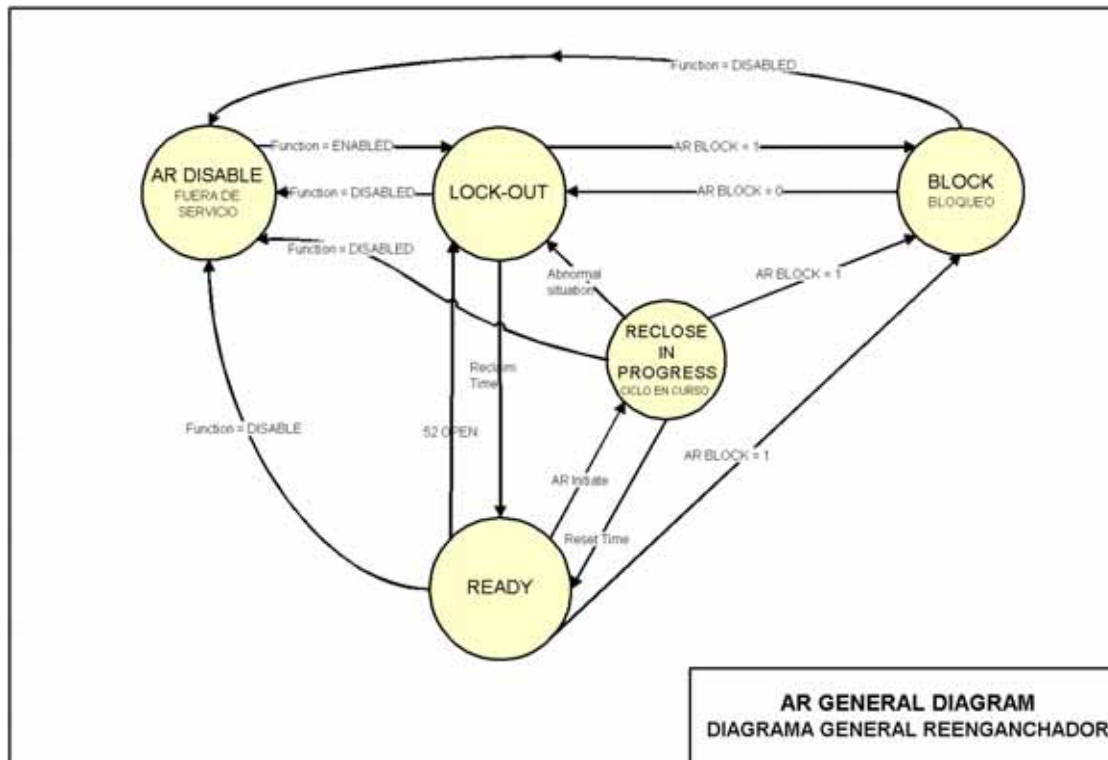


Figure 5–23: GENERAL AUTORECLOSE STATUS DIAGRAM

Description of the general autoreclose status:

#### OUT OF SERVICE / AR DISABLE

In this status, the autoreclose is disabled. From any state, if the *Function* setpoint is set as DISABLED, the autoreclose will move 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* setpoint expires, the autoreclose will go to the initial status of READY.

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

#### AR RECLOSE IN PROGRESS

From READY status, a reclose initiation will set the cycle counter to 1 and a reclosing sequence will be initiated which will produce breaker close commands, unless any abnormality is produced that will make 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** setpoint, the autoreclose will go to LOCKOUT by failure of opening status (AR LCK BY FAIL OPEN).



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

Once the Dead Time has expired, in case the **Conditions Permission** setpoint is disabled, a closing command would be produced. If the conditions permission setpoint is enabled, the system will wait 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 will go 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** setpoint is exceeded, the autoreclose will go to lockout by failure of closing (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 unit reset time there is no autoreclose initiation, the cycle counter will reset to its initial value (1), and the autoreclose will return to the standby status (READY). If during the **Reset Time** setpoint period, there is a new autoreclose initiation, the **Reclose In Progress** sequence will start again. If this reclose is produced after the last configured cycle in the **Maximum Number of Shots** setpoint, the autorecloser will go 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 will stay in LOCKOUT prior going to READY.

From the RECLOSE IN PROGRESS status, the recloser will go 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** setpoint.

#### 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 will be 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 5.5.5.3.

### 5.5.5.6 LOGIC FOR BLOCKING PROTECTION FUNCTIONS DURING THE RECLOSING CYCLE

The F650 autoreclose generates a series of internal signals that allow performing block logics for Protection units during the reclosing cycle. These signals are blocks after autoreclose shots (**BLK AFTER SHOT**). For example, if the user wants to block a protection unit 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 units at **Setpoint > Relay Configuration > Protection Elements**.

Figure 5–24: shows an example of the logic configuration for the block signal during the reclosing cycle.

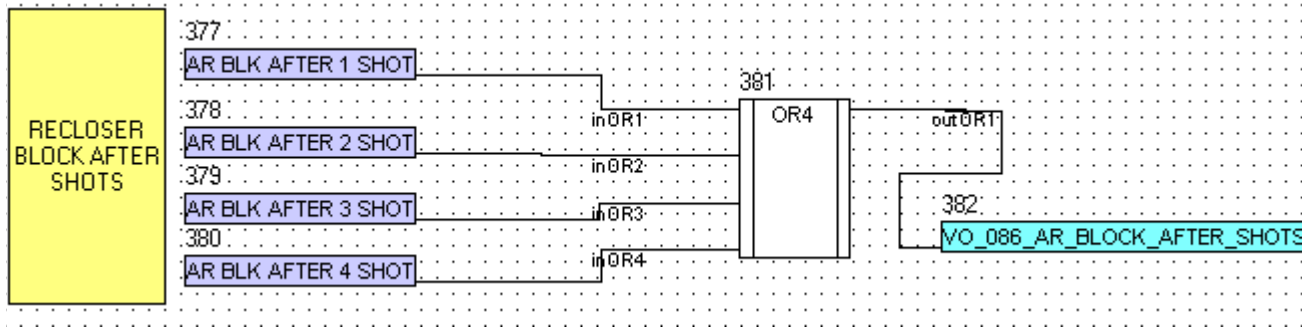


Figure 5–24: BLOCK SIGNAL DURING THE RECLOSING CYCLE

Figure 5–25: shows an example of the autoreclose initiation and protection unit block signals after the different shots. 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 unit, and finally the unit will remain blocked during the reclosing cycle. This means that only the first trip can be executed by the phase instantaneous overcurrent unit; after the first reclose shot, the unit will remain blocked until the end of the cycle.

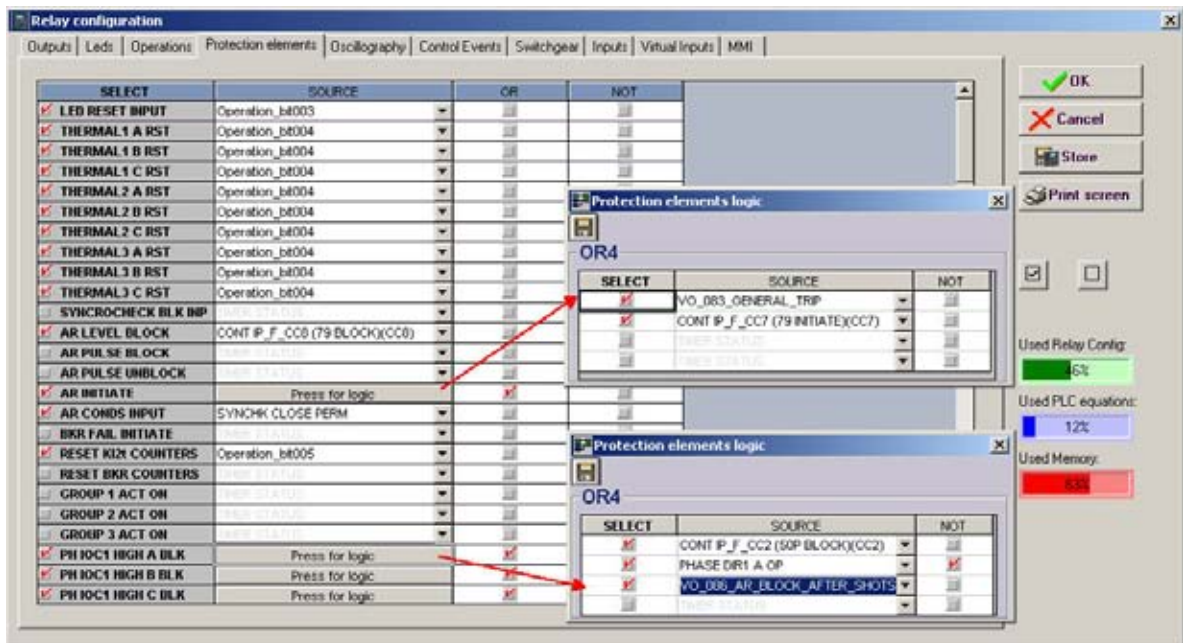


Figure 5–25: CONFIGURATION EXAMPLE OF THE RECLOSE INITIATION AND BLOCK SIGNALS

## 5.5.6 BREAKER FAILURE UNIT (50BF)

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

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

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

F650 units incorporate 2 levels of current and time, together with a trip without current unit, and an internal arc detection unit.

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

The following table describes the breaker failure unit setpoints: **Setpoint > Control Elements > Breaker Failure**

**Table 5–78: 50BF UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > BREAKER FAILURE				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Supervision (retrip) pickup level	Supervision Pickup	1.00	0.01 A	[0.05 : 160.00]
Hiset pickup level	Hiset Pickup	5.00	0.01 A	[0.05 : 160.00]
Lowset pickup level	Lowset Pickup	2.00	0.01 A	[0.05 : 160.00]
Internal arc pickup level	Internal Arc Pickup	0.10	0.01 A	[0.05 : 160.00]
Internal arc time delay	Internal Arc Delay	10.00	0.01 s	[0.00 : 900.00]
Retrip time delay	Supervision Delay	10.00	0.01 s	[0.00 : 900.00]
Hiset time delay	HiSet Delay	10.00	0.01 s	[0.00 : 900.00]
Lowset time delay	LowSet Delay	10.00	0.01 s	[0.00 : 900.00]
Second stage time delay	2nd Step Delay	10.00	0.01 s	[0.00 : 900.00]
WITHOUT current unit time delay	No Current Delay	10.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

setpoints description for breaker failure unit:

<b>Function permission (Function):</b>	This setpoint allows enabling and disabling the 50BF unit
<b>Supervision or retrip pickup level (Supervision Pickup):</b>	Supervision level pickup current threshold
<b>Hiset pickup level (Hiset Pickup):</b>	High-level pickup current threshold.
<b>Lowset pickup level (Lowset Pickup):</b>	Low level pickup current threshold.
<b>Internal arc pickup level (Internal Arc Pickup):</b>	Internal arc unit pickup current threshold.
<b>Internal arc time delay (Internal Arc Delay):</b>	Time delay applied to the internal arc unit
<b>Supervision or Retrip time delay (Supervision Delay):</b>	Time delay applied to the supervision or retrip unit.
<b>High-level time delay (Hiset Delay):</b>	Time delay applied to the high level unit.
<b>Low-level time delay (Lowset Delay):</b>	Time delay applied to the low level unit.
<b>2nd step time delay (2<sup>nd</sup> Step Delay):</b>	Time delay applied to the breaker failure second step.
<b>No current unit time delay (No Current Delay):</b>	Time delay applied to the trip without current unit.

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

**Table 5–79: BREAKER FAILURE STATUS**

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

<b>BKR FAIL INITIATE</b>	External signal for breaker failure initiation. (Configurable at <b>setpoints &gt; Relay Configuration &gt; Protection Elements</b> ).
<b>BKR FAIL NO CURRENT</b>	Signal for breaker failure without current
<b>BKR FAIL SUPERVISION</b>	Signal for supervision level breaker failure (retrip)
<b>BKR FAIL HISET</b>	Signal for high-level breaker failure
<b>BKR FAIL LOWSET</b>	Signal for low-level breaker failure
<b>INTERNAL ARC</b>	Signal for internal arc
<b>BKR FAIL 2nd STEP</b>	Signal for Second level breaker failure (high and low)

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

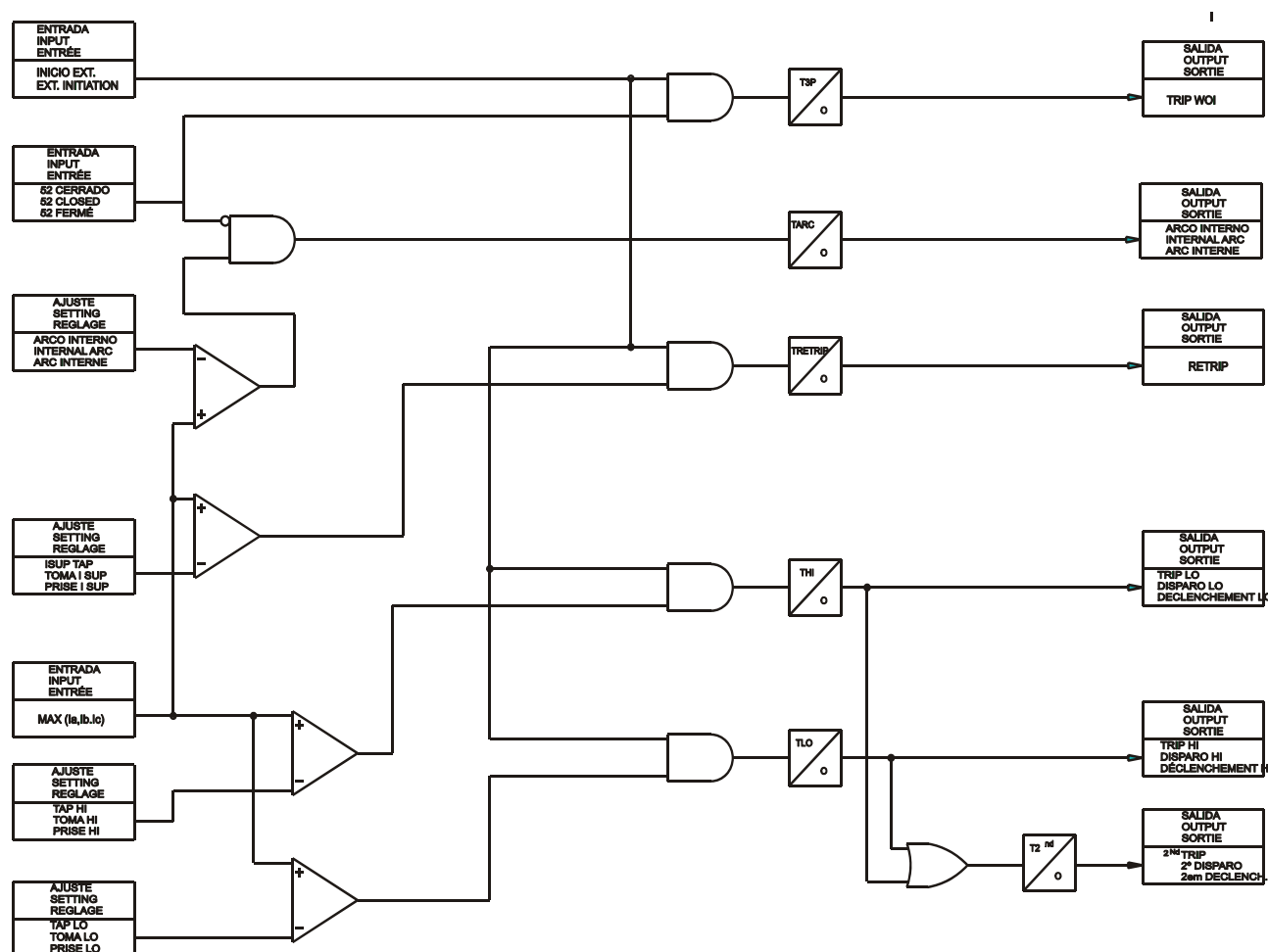


Figure 5-26: LOGIC SCHEME FOR 50BF

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

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

Operation of breaker failure units by level (supervision, hiset and loaset) is produced when the current level is higher than the set current for the pickup of each level during the time set in the corresponding delay setpoint.

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

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

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

## 5.5.7 VT FUSE FAILURE UNIT (VTFF)

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

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

**Setpoint > Control Elements > VT Fuse Failure**

**Table 5–80: VT FUSE FAILURE UNIT SETPOINTS**

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

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

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

#### 5.5.7.1 FUSE FAILURE ALGORITHM

To detect the different types of fuse failure that can occur, it is necessary to use different detection methods. A fuse failure indication with loss of one or two voltage phases provides a significant level of negative sequence voltage, while a failure caused by loss of the three phases is present with a noticeable positive sequence current level, being the positive sequence voltage level very low.

F650 units detect fuse failure under three possible situations:

- (1) Breaker closed and positive sequence voltage ( $V_1$ ) under an established value ( $V_1 < 0.5$  p.u.).
- (2) Positive sequence voltage lower than 0.5 p.u. ( $V_1 < 0.5$  p.u.) and positive sequence current higher than 0.075 p.u. ( $I_1 > 0.075$  p.u.).
- (3) Ratio between the negative and positive voltage components ( $V_2/V_1$ ) higher than 0.25.

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

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

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

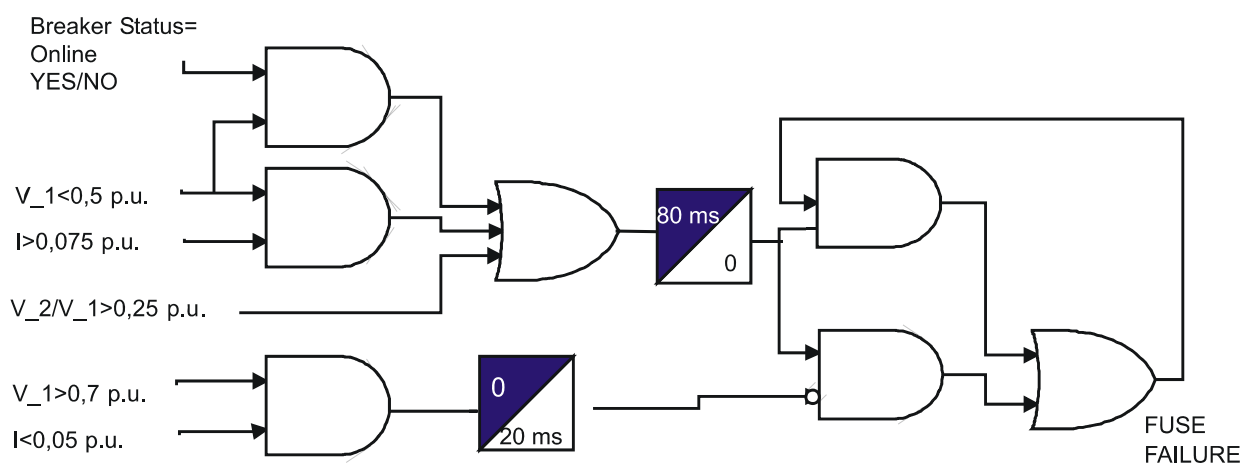


Figure 5-27: FUSE FAILURE UNIT BLOCK DIAGRAM

F650 units incorporate a broken or fallen conductor detection function. The relay uses the ratio between the negative sequence current,  $I_2$ , and the positive sequence current  $I_1$ . In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.

**Setpoint > Control Elements > Broken Conductor**

Table 5-81: BROKEN CONDUCTOR UNIT SETPOINTS

SETPOINT > CONTROL ELEMENTS > VT FUSE FAILURE				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Tap Level in percentage of $I_2/I_1$	Tap	20.0	0.1 %	[20.0 : 100.0]
Trip Time	Trip Delay	60.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Current Inhibition Level setpoint	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]

This way, when the function is enabled and the unbalance is produced over the set percentage, the unit will pick up. If unbalance conditions are maintained during a period longer than the set time delay, the unit will trip.

In order to avoid trips or pickups with very weak loads there is a **current level threshold to inhibit the operation of the unit** when the three phase currents are below that fixed level.

Note: The  $I_2/I_1$  current inhibition level for the different firmware versions is as follows:

FIRMWARE VERSION	CURRENT INHIBITION LEVEL
1.50 or Lower	10 mA
1.60 or Higher	50 mA
1.80 or Higher	Selectable by setpoint from 0.000 to 1.000 in steps of 0.001 A

The Operation Threshold level has been included to allow the user selecting the current inhibition level suitable for a particular application, in order to avoid operation of the unit when the relay is not connected to the line or in case the relay has previously operated correctly and has been disconnected from the line, as in this case the operation condition is met but the relay should not trip.

The operation threshold operation is as follows:

The Broken conductor element will be fully operational if at least one of the phase current levels is higher than the setpoint. This condition assumes that the relay is connected to the line.

If the unit is on trip or pickup condition, the element will be reset if the three phase currents are below the operation threshold level. This condition assumes that the relay is not connected to the line and therefore the relay should not trip.

Due to the response time of this function, if the set time delay is 0s, a trip could occur in situations where, for example, one of the currents is stopped before the rest, as these currents would produce a negative sequence current calculation. Therefore, to avoid this kind of undesired trips, it is strongly recommended to establish a minimum time delay setpoint, such as 100 ms, or higher depending on the expected normal unbalances in the network, to differentiate these situations from broken conductor situations.

### 5.5.9 LOCKED ROTOR

F650 units incorporate a locked rotor element with three units. Protection element 48 produces a trip when current (**primary values**) exceeds the setpoint value. This current setpoint value is the product of the Full load current setpoint by the pickup setpoint.

**Setpoint > Control Elements > Locked Rotor**

**Table 5–82: LOCKED ROTOR UNIT SETPOINTS**

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Full load current	Full Load Current	0.50	KA	[0.10 : 10.00]
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]
Trip time	Trip Delay	0.00	s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Locked rotor unit setpoints are:

**Function Permission (Function):** This setpoint indicates whether the locked rotor element is enabled or disabled.

**Input (Phasor(DFT)-RMS):** Selection between fundamental phasor magnitude (DFT) or total waveform RMS magnitude.

**Full Load Current (FLC):** This is the average maximum expected operating phase current for the motor.

**Pickup Level:** This is the current threshold over the full load current setpoint in which the unit will operate. The operating current for this unit is calculated as follows:

$$I_{tap} = FLC \times PKP\_Level$$

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

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



**Snapshot Events:**

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

The signals related to the locked rotor pickups and operations for the three locked rotor units can be viewed at **Actual > Status > Control Elements > Locked Rotor** and they are as follows:

**Table 5–83: LOCKED ROTOR STATUS**

LOCKED ROTOR STATUS
LOCKED ROTOR1 PKP
LOCKED ROTOR1 OP
LOCKED ROTOR2 PKP
LOCKED ROTOR2 OP
LOCKED ROTOR3 PKP
LOCKED ROTOR3 OP

The block signals for the locked rotor unit can be configured at: **Setpoint > Relay Configuration > Protection Elements**

**Table 5–84: LOCKED ROTOR BLOCKS**

LOCKED ROTOR BLOCKS
LOCKED ROTOR1 BLK
LOCKED ROTOR2 BLK
LOCKED ROTOR3 BLK

Note:

The unit works with primary values.

The unit will pickup if at least one of the three phase currents are above the adjusted level. The operation value will be the higher of the three.

Reset level at 97% of the pickup level.

This section includes the Coil Supervision and mixed I/O boards, or any other board located on relay terminals F and G, plus H and J connectors from the remote Bus Can I/O modules (CIO)

### 5.6.1 INPUT/OUTPUT PLACEMENT

TERMINAL	MIXED	SUPERVISION
	1	2
INPUTS		
1	CC 1	COIL 1
2	CC 2	5 2 / a
3	CC 3	COIL 1
4	CC 4	5 2 / b
5	CC 5	CC 1
6	CC 6	CC 2
7	CC 7	CC 3
8	CC 8	CC 4
9	COMMON 1 / 8	COMMON 1 / 4
10	COMMON 9 / 16	COMMON 5 / 8
11	CC 9	CC 5
12	CC 10	CC 6
13	CC 11	CC 7
14	CC 12	CC 8
15	CC 13	COIL 2
16	CC 14	5 2 / a
17	CC 15	COIL 2
18	CC 16	5 2 / b
OUTPUTS		
19		0 1
20		0 1
21		0 2
22		0 2
23		0 3
24		0 3
25		0 4
26		0 4
27		0 5
28		0 5
29		0 6
30		0 6
31		ISENS
32		0 7
33		ISENS
34		0 8
35		0 8
36		0 8

Figure 5–28: INPUT/OUTPUT LOCATION AND TYPE

## 5.6.2 CONTROL SETPOINTS FOR INPUTS/OUTPUTS

**Configuration of setpoints relative to inputs and outputs can only be accessed through 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.

setpoints relative to I/O boards are described in :

**Table 5–85: I/O BOARD SETPOINTS**

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O > BOARD F > BOARD G > BOARD H > BOARD J				
SETPOINT DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
I/O board type (available only for CIO modules)	I/O Board Type_H	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV]
Input activation voltage threshold Group A	Voltage Threshold A_X	80	1 V	[0 : 255]
Input activation voltage threshold Group B	Voltage Threshold B_X	80	1 V	[0 : 255]
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]
Input type	Input Type_X_CCY (CCY)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]
Input signal time delay	Delay Input Time_X_CCY (CCY)	0	1 ms	[0 : 60000]
Output logic type	Output Logic_X_OZ	POSITIVE	N/A	[POSITIVE, NEGATIVE]
Output type	Output Type_X_OZ	NORMAL	N/A	[NORMAL, PULSE, LATCH]
Output pulse length	Pulse Output Time_X_OZ	10000	1 ms	[0 : 60000]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setpoint enables or disables the snapshot event generation for this unit.

Being:

**X** F, G, H or J, the I/O board name, depending on the Relay model.

F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module).

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

**Table 5–86: I/O BOARD TYPE**

ASSOCIATED DIGIT	ENERVISTA 650 Setup BOARD setpointS	BOARD TYPE
0	NONE	None
1	16 INP+ 8OUT	Mixed
2	8 INP +8 OUT +SUPV	Supervision

**CCY** Is the name used for inputs in I/O boards

**Mixed**, 16 digital inputs: CC1....CC16

**Supervision**: 8 digital inputs: CC1,..., CC8

**OZ** 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)

## 5.6.3 INPUTS

## 5.6.3.1 INPUT SETPOINTS DESCRIPTION

**Input Activation Voltage Threshold:** The range of this value goes from 0 to 255 volts. There is a single setpoint 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.

**Debounce Time:** This is the debounce time set for inputs (1 to 50 ms). The debounce time is the time window for input filtering. If an input suffers a change of level that lasts less than this set time, the change will not be considered. There is a single setpoint for all inputs in the same group.

**Input Type:** Type of logic associated to the physical input. Possible setpoints are, positive and negative.

Positive and Negative setpoints correspond to signals that re activated or deactivated with the input level, considering the delay setpoint. Positive-edge, and Negative-edge setpoints correspond to signals that are activated with the change of the input signal; in this case, the Delay Input Time will not be considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. shows the types of signals associated to the different input configuration types.

**Delay Input Time:** This is the delay applied to the input signal; the default value is zero, meaning no delay; the setpoint range is 0 to 60000 milliseconds (1 minute). This setpoint is used in slow switchgear applications.

This is not a grouped setpoint; there is a different setpoint 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.

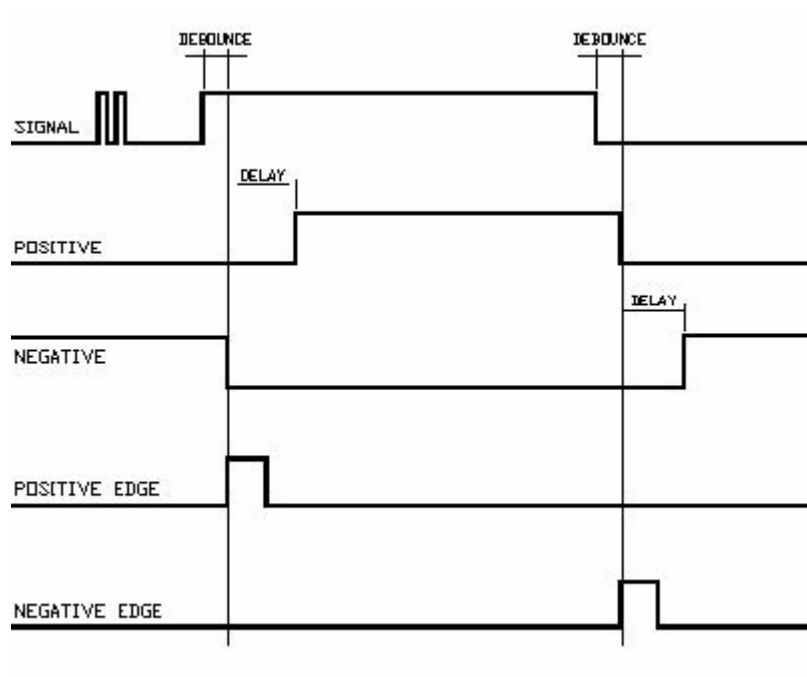


Figure 5–29: INPUT LOGIC TYPES

### 5.6.3.2 INPUT STATUS SIGNALS

**Actual > Inputs/Outputs > Contact inputs > Board X** (being X the corresponding board in each case). Depending on the I/O board, inputs are represented as follows:

**Table 5–87: CONTACT INPUTS STATUS**

INPUT STATUS (X: BOARD F, G, H, J)	MIXED BOARD (TYPE 1)	SUPERVISION BOARD (TYPE 2)
CONT IP_X_CC1	CC1	CC1
CONT IP_X_CC2	CC2	CC2
CONT IP_X_CC3	CC3	CC3
CONT IP_X_CC4	CC4	CC4
CONT IP_X_CC5	CC5	CC5
CONT IP_X_CC6	CC6	CC6
CONT IP_X_CC7	CC7	CC7
CONT IP_X_CC8	CC8	CC8
CONT IP_X_CC9	CC9	Va_COIL1
CONT IP_X_CC10	CC10	Vb_COIL1
CONT IP_X_CC11	CC11	Va_COIL2
CONT IP_X_CC12	CC12	Vb_COIL2
CONT IP_X_CC13	CC13	O7_SEAL
CONT IP_X_CC14	CC14	O8_SEAL
CONT IP_X_CC15	CC15	SUP_COIL1
CONT IP_X_CC16	CC16	SUP_COIL2

The operation logic for supervision signals (board type 2) is detailed in section . in this manual.

## 5.6.4 OUTPUTS

## 5.6.4.1 OUTPUT SETPOINTS 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 setpoint selected, the physical output will be in the same direction (positive) or opposite (negative) the output activation command.

**Output Type\_0X\_0Z:** Type of output adjusted. Possible values are **normal**, **pulse** or **latched**, the default value is **Normal**.

**Normal:** The contact output follows the activation command. Remains active while the operation signal is active.

**Pulse:** The contact output remains active the time the operation signal is active plus the pulse output time, according to the **Pulse Output Time** setpoint.

**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 5–30: shows the types of signals associated to the different output configuration types.

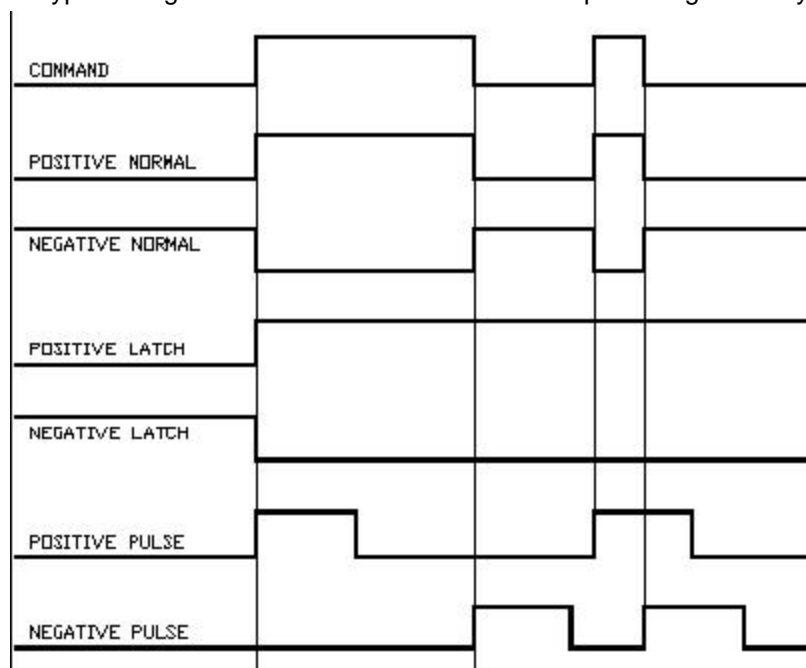


Figure 5–30: OUTPUT LOGIC TYPES.

### 5.6.4.2 OUTPUT STATUS SIGNALS

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in .

#### **Actual > Inputs/Outputs > Contact Output Status**

Real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in “**Setpoint > Inputs/Outputs > Contact I/O > Board X**”

#### **Actual > Inputs/Outputs > Contact Output Operates**

Activated or deactivated status of those variables used internally to operate a contact output.

#### **Actual > Inputs/Outputs > Contact Output Resets**

These are the logic signals associated to the contact output reset, which produce the reset of those signals previously configured as Latched. Configuration for the contact output reset signal is set at **Setpoint > Relay Configuration > Outputs > Contact Output Reset**.

#### **Actual > Inputs/Outputs > I/O Board Status**

These signals are associated to the different I/O boards. There are internal signals that provide information about the status of these boards, indicating whether there is any anomaly in the board, or whether the board is not available in the relay according to the relay model.

**Table 5–88: CONTACT OUTPUT SIGNALS**

CONTACT OUTPUT STATUS	CONTACT OUTPUT OPERATES	CONTACT OUTPUT RESETS	IO BOARD STATUS
CONT OP_X_01	CONT OP OPER_X_01	CONT OP RESET_X_01	BOARD F STATUS
CONT OP_X_02	CONT OP OPER_X_02	CONT OP RESET_X_02	BOARD G STATUS
CONT OP_X_03	CONT OP OPER_X_03	CONT OP RESET_X_03	BOARD H STATUS
CONT OP_X_04	CONT OP OPER_X_04	CONT OP RESET_X_04	BOARD J STATUS
CONT OP_X_05	CONT OP OPER_X_05	CONT OP RESET_X_05	
CONT OP_X_06	CONT OP OPER_X_06	CONT OP RESET_X_06	
CONT OP_X_07	CONT OP OPER_X_07	CONT OP RESET_X_07	
CONT OP_X_08	CONT OP OPER_X_08	CONT OP RESET_X_08	

Being X the corresponding board in each case



## 5.6.5 CIRCUIT SUPERVISION AND CONTACT SEAL-IN CIRCUITS

**Circuit Supervision:**

F650 units can include supervision boards (type 2), either in their internal slot F, or in an additional CIO module connected to the unit via a CAN Bus (slots H and J). This type of board includes 4 voltage detectors for implementing tripping or opening circuit supervision control logics.

**Contact Seal-in:**

The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 200 mA, the function is sealed independently of the status of the function that caused the trip.

This current seal-in function in tripping circuits is mainly used in applications where auxiliary contacts 52/a (in charge of cutting the current in the tripping circuit) are very slow. This may cause that, once the function that produced the trip is reset, the relay contact will open before the breaker auxiliary 52/a, even if the time delay of the first has expired.

By using this function, we prevent the relay contact from cutting the current (basically inductive and high) from the tripping circuit, which could cause damage to the unit, as these currents exceed the nominal breaking characteristics.

The circuit and the current threshold of the function are as follows:

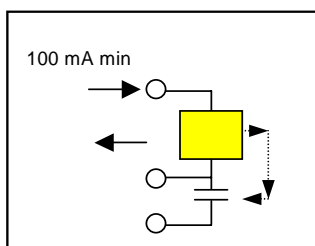


Figure 5–31: CURRENT SUPERVISION

## 5.6.5.1 DIGITAL INPUTS

**a) WITH TRIP CIRCUIT SUPERVISION**

Supervision board includes:

8 digital inputs in two groups of 4 inputs with one common, in terminals F9 to F10

8 auxiliary outputs: 6 normally open contacts in terminals F19 to F30 and two current sensing (latching) outputs (F31-F33 and F34-F36).

2 groups of inputs for trip circuit supervision with 4 voltage detectors. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

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

In order to implement these schemes, it is not necessary to perform any setpoint in the unit. Internal functions are always operative and provide the following logic operands:

**Table 5–89: SUPERVISION LOGIC OPERANDS**

ACTUAL > INPUTS/OUTPUTS > CONTACT INPUTS > BOARD X BEING X THE CORRESPONDING BOARD IN EACH CASE	
OPERAND	DESCRIPTION
CONT IP_X_CC9 (Va_COIL1)	Active when voltage is detected in terminals F1 - F2 (circuit 1)
CONT IP_X_CC10 (Vb_COIL1)	Active when voltage is detected in terminals F3 - F4 (circuit 1)
CONT IP_X_CC11 (Va_COIL2)	Active when voltage is detected in terminals F15 - F16 (circuit 2)
CONT IP_X_CC12 (Vb_COIL2)	Active when voltage is detected in terminals F17 - F18 (circuit 2)
CONT IP_X_CC13 (O7_SEAL)	Active if current is detected by sensor in output O7 (F31-F33)
CONT IP_X_CC14 (O8_SEAL)	Active if current is detected by sensor in output O8 (F34-F36)
CONT IP_X_CC15 (SUP_COIL1)	Active when continuity is detected in circuit 1
CONT IP_X_CC16 (SUP_COIL2)	Active when continuity is detected in circuit 2

A continuity failure is detected in a circuit when both voltage detectors (Va and Vb) detect lack of voltage during more than 500 ms. This function is not influenced by the breaker status.

These operands can be associated to internal signals (virtual outputs), LEDs or unit outputs, to issue alarm signals or to block elements, for example for blocking the Breaker close if an anomaly is detected in the trip circuit.

Available schemes are as follows:

1. Without supervision
2. With current supervision (with seal-in)
3. With simple voltage supervision
4. With double voltage supervision
5. With current and simple voltage supervision (with seal-in)
6. With current and double voltage supervision (with seal-in)
7. With current and double voltage supervision (with seal-in) and serial resistor in voltage monitors.

The following subsections describe the different types of connection to create each supervision scheme in an easy way. As the supervision circuits are identical, only the first group connection examples will be described, being also applicable to the second group.

In order to assure a high isolation level between groups, the digital inputs for supervision have been located in a symmetrical basis. That is to optimize the isolation between groups that can be connected to different batteries, and therefore requiring a greater distance between circuits.

**b) WITHOUT SUPERVISION**

This is a very frequent common case, and we must only wire the tripping circuit to terminals F35 and F36, leaving unused terminals F34, F15, F16, F17, F18.

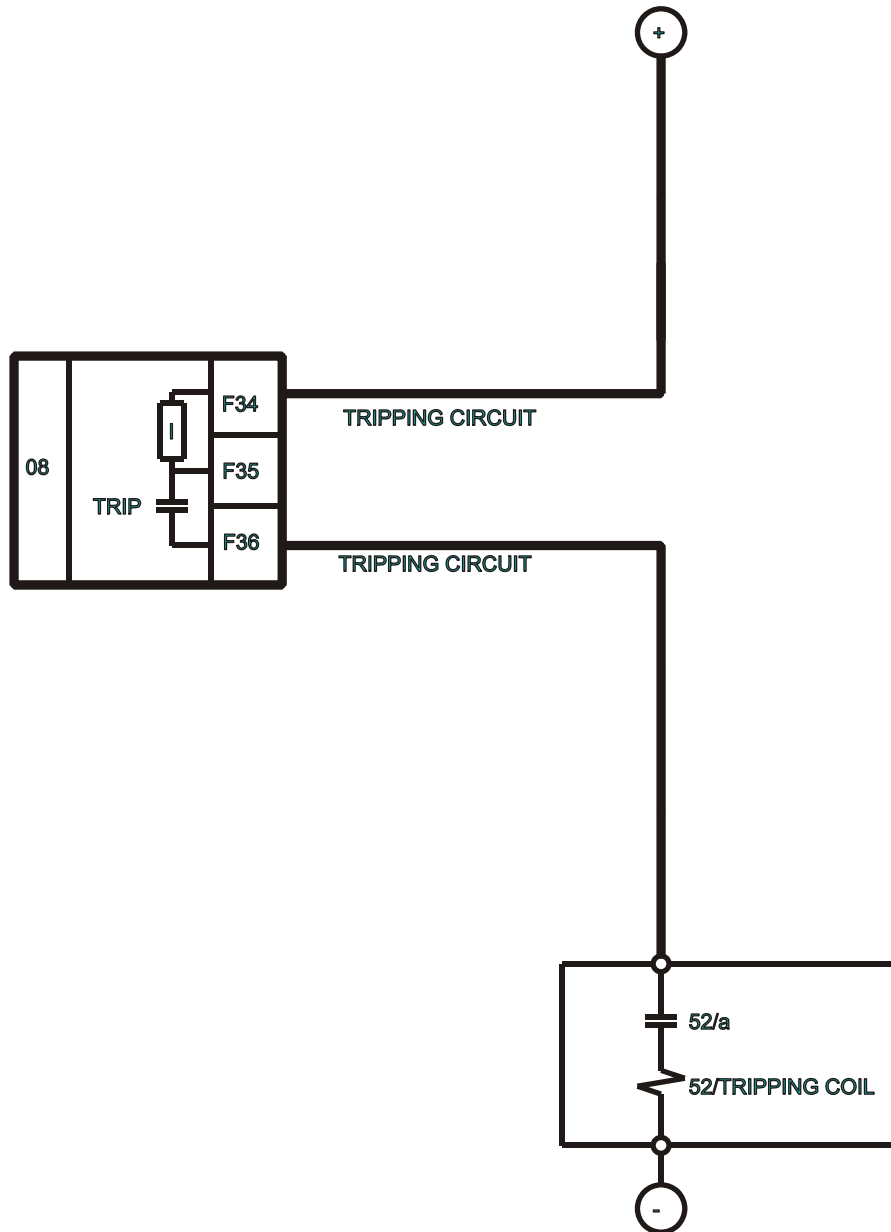
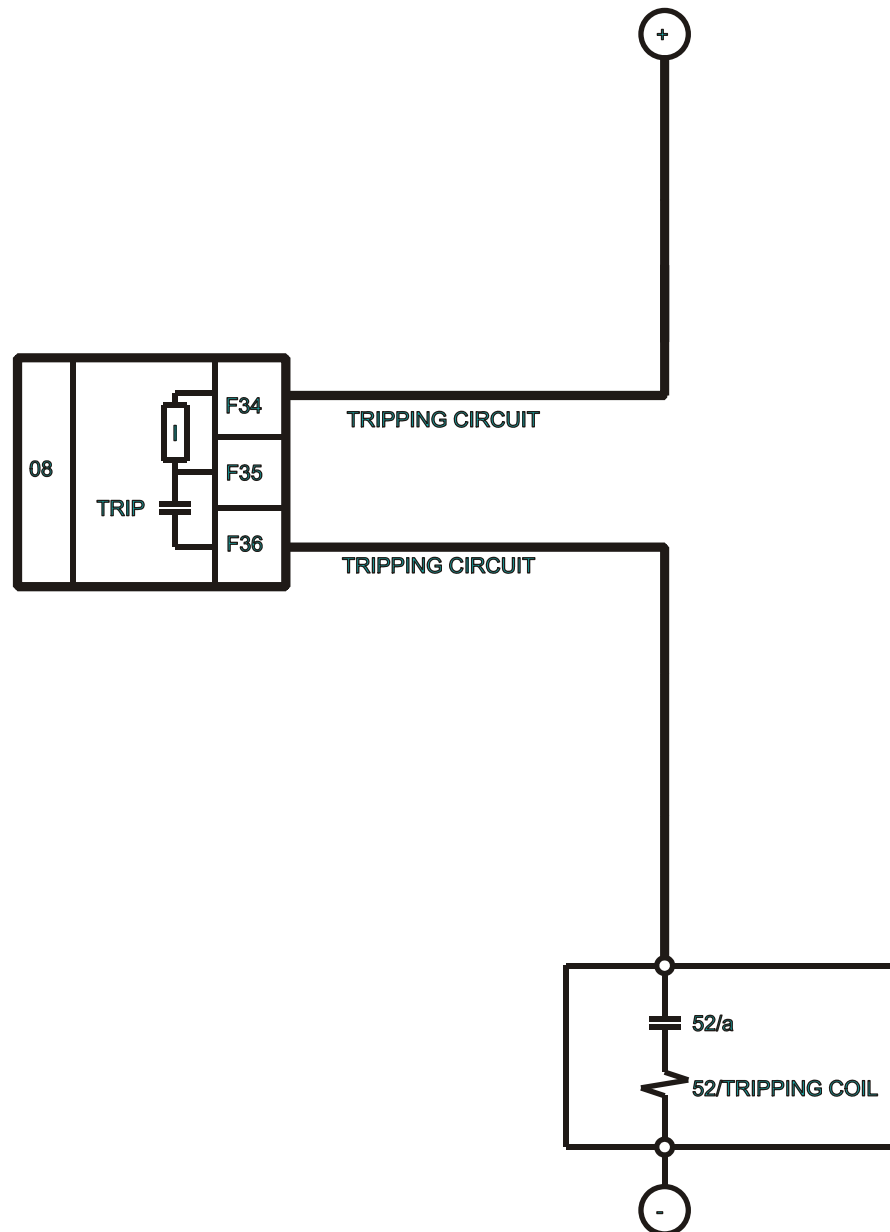


Figure 5–32: CIRCUIT WITHOUT TRIPPING CIRCUIT SUPERVISION (A6631F1)

**c) WITH CURRENT SUPERVISION (WITH SEAL-IN)**

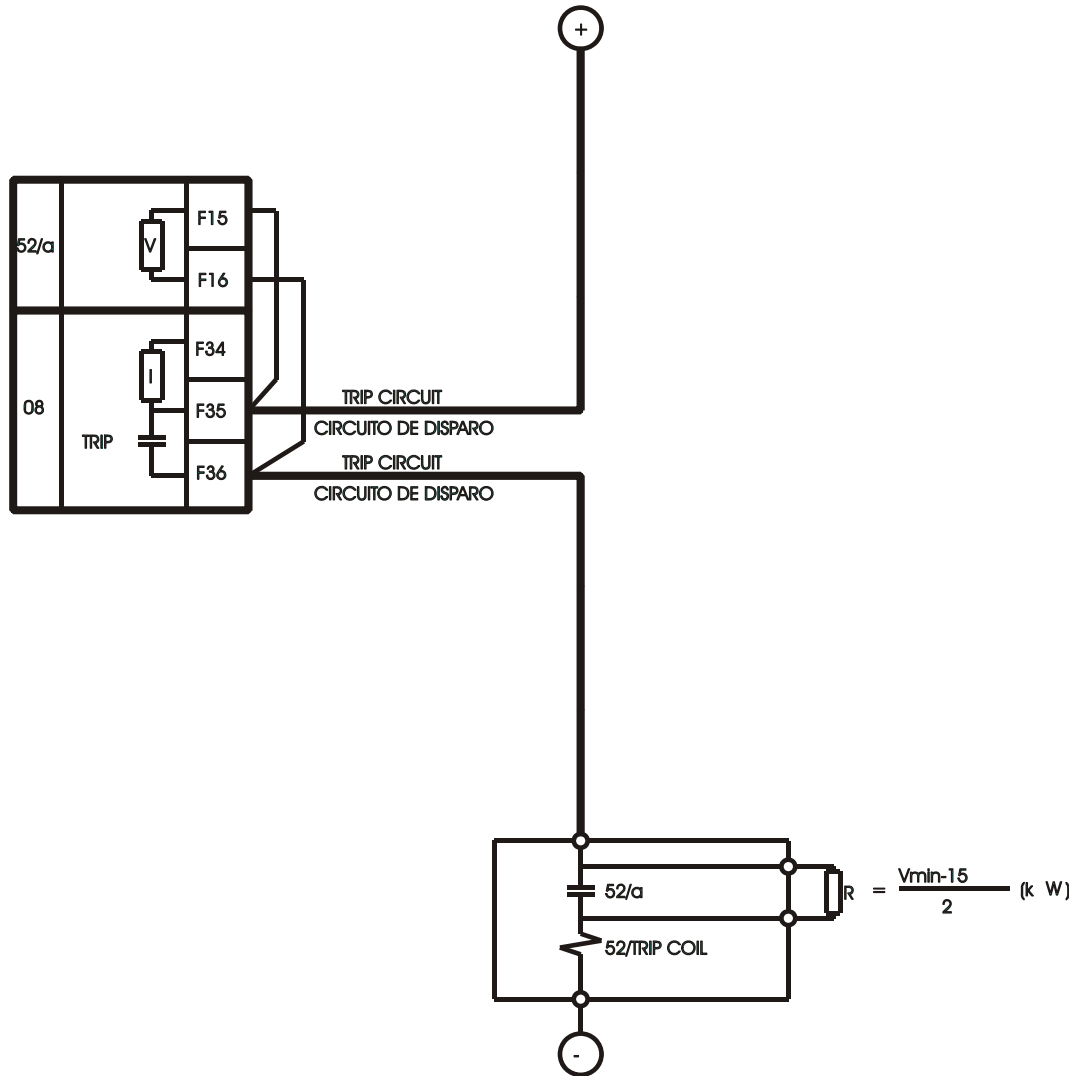
In this case, as shown in Figure 5–33:, the current supervision circuit consists of a circuit connected in series with the output contact, so that the external circuit is wired to terminals F34 and F36. This supervision circuit includes a low impedance reed relay that is activated when the current value exceeds 100 200 mA, and sends a signal to the main microprocessor. This will latch the output relay in such a way that this indication can be used to produce a latching of the output relay, so that it will remain closed while the circulating current is over 100 200 mA. To use the seal-in feature in the relay. For this purpose it is not necessary to configure any setpoint, it works only we must program the corresponding Circuit latching setpoint wiring the external circuit to terminals F34 and F36.

With this scheme, in the case of a failure to open from the breaker auxiliary contact, the F650 output relay will not be the one to open the tripping coil current, as in this case the contact may result damaged, as it is prepared for opening currents around 0.35 A at 125 Vdc. This latching or memory function is only guaranteed while the unit is powered.



**Figure 5–33: CURRENT SUPERVISION OF THE TRIPPING CONTACT (A6631F2)**

## d) WITH SIMPLE VOLTAGE SUPERVISION



SUPERVISION DEL CIRCUITO Y DE LA BOBINA DE DISPARO CON EL  
CONTACTO AUXILIAR 52/a. UTILIZACION DE UNA RESISTENCIA PARA  
MONITORIZAR CON INTERRUPTOR ABIERTO  
TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT  
52/a. USE OF A RESISTOR FOR MONITORING WITH OPEN BREAKER

Figure 5–34: SUPERVISION APPLICATION WITH AUXILIARY CONTACT 52A AND A RESISTOR (A6631F3)

Table 5–90: 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 5–91: SUPERVISION ALGORITHM WITH SIMPLE VOLTAGE SUPERVISION SCHEME

STATUS OF INVOLVED ELEMENTS			INPUT TO F650	DECISION
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	BREAKER STATUS	OPERAND CONT IP_X_CC11 (VA_COIL2) V 52/A (F15-F16)	OPERAND CONT IP_X_CC16 (SUP_COIL2)
Healthy	Open	52 closed	ON	ON
Healthy	Open	52 open	ON	ON
Healthy	Closed	52 closed	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Faulty	Open	52 closed	OFF	OFF (500 ms delay)
Faulty	Open	52 open	OFF	OFF (500 ms delay)
Faulty	Closed	52 closed	OFF	OFF (500 ms delay)
Faulty	Closed	52 open	OFF	OFF (500 ms delay)

In this table, ON means that the voltage detector V52/a is active, detecting voltage presence.

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 , when the relay is not tripped, trip contact F35-F36 remains open. If the breaker is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals F15 and F16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current will only circulate when there is continuity in the whole circuit, so the complete circuit is monitored, and not only the trip coil. This circuit includes auxiliary 52/a as well as the whole wiring between the battery and the relay tripping terminals, and between these and the breaker tripping circuit.

For the second case shown on the table, open breaker, its auxiliary contact 52/a remains open, and current cannot flow through it for detecting continuity. In order to correctly monitor the circuit, a resistor must be used, not included in the protection, connected in parallel. The value of resistance will be selected so that the V 52/a input circuit minimum detection current flows, but not as high as to activate the breaker-tripping coil. The figure shows the following equation:

Where:

$$R = \frac{V_{\min} - 15}{2}$$

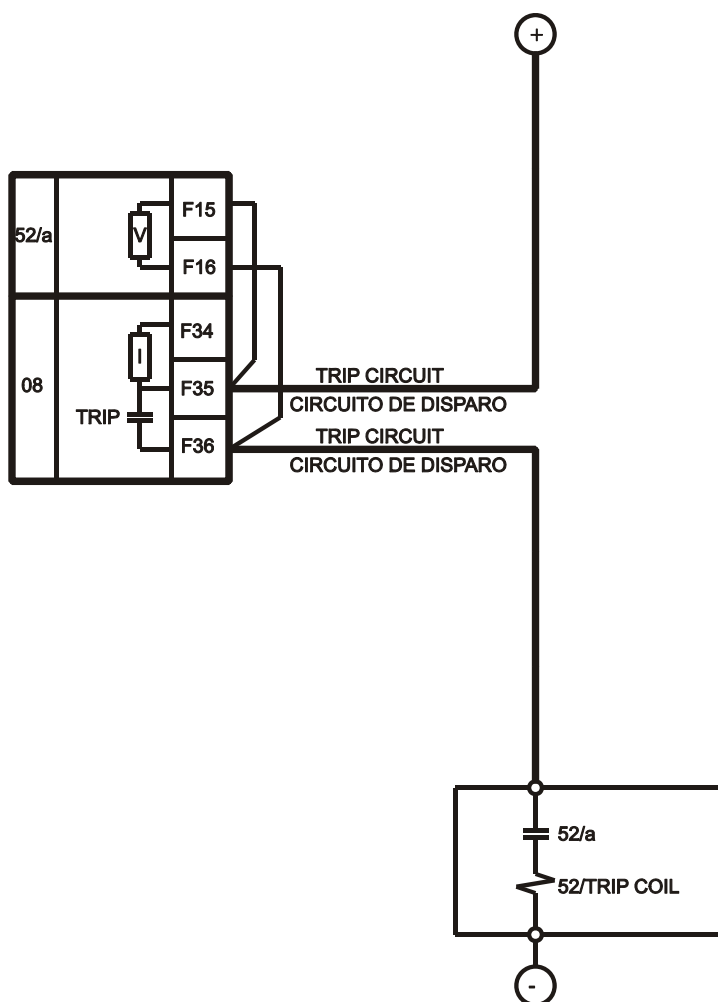
$V_{\min}$  Is the minimum voltage, in Volts, expected in the battery (e.g. 80% of  $V_n$ )  
 $R$  Resistance, in kilo ohms.  
 $2$  2 mA of approximate current flowing through input V 52/a

As shown in the second case in the table, with an open breaker, as current will flow through R if there is continuity in the WHOLE tripping circuit, voltage will be detected in input V 52/a.

This works correctly in steady state. However, if the breaker trips, while it is opening, the V 52/a input signal can be deactivated without this meaning that the circuit is not correct. This is due to the fact that the tripping relay, terminals F35-F36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is admitted that no signal will be detected during a period of 1 s to allow the breaker to open, and reopen the tripping relay F35-F36.

shows the possibility of monitoring the circuit only when the breaker is closed. In this case resistance R will not be used, but it must be observed in the unit logic, that the corresponding signal CONT IP\_F\_CC16 (SUP\_COIL2) will be activated showing a failure when the breaker is open, and therefore it will be required to supervise the continuity failure signaling by the breaker status information.

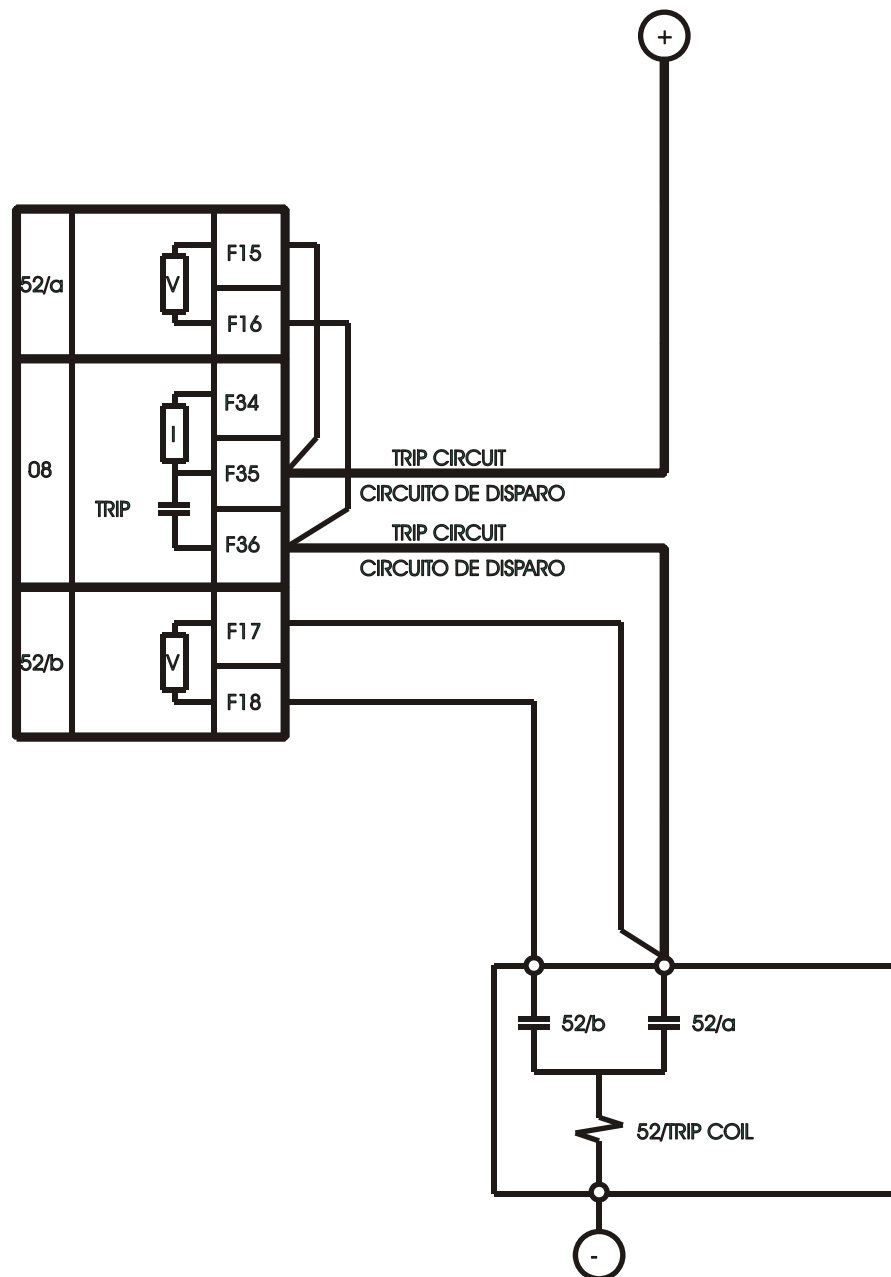


SUPERVISION DEL CIRCUITO Y DE LA BOBINA DE DISPARO CON EL CONTACTO AUXILIAR 52/a. SOLO PARA INTERRUPTOR CERRADO

TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/a. ONLY WITH CLOSED BREAKER

**Figure 5–35: TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACT 52/A. ONLY WITH CLOSED BREAKER (A6631F5)**

## e) WITH DOUBLE VOLTAGE SUPERVISION



SUPERVISION DEL CIRCUITO Y DE LA BOBINA DE DISPARO CON LOS CONTACTOS AUXILIARES 52/a Y 52/b. PARA MONITORIZACION CON INTERRUPTOR ABIERTO Y CERRADO.

TRIP CIRCUIT AND TRIP COIL SUPERVISION USING AUXILIARY CONTACTS 52/a AND 52/b. FOR MONITORING WITH OPEN AND CLOSED BREAKER.

Figure 5–36: SUPERVISION APPLICATION WITH AUXILIARY CONTACTS 52A AND 52B (A6631F4)



Table 5–92: SUPERVISION ALGORITHM WITH DOUBLE VOLTAGE SUPERVISION SCHEME

STATUS OF INVOLVED ELEMENTS			INPUTS TO F650		DECISION
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	BREAKER STATUS	OPERAND CONT IP_X_CC11 (VA_COIL2) V 52/A (F15-F16)	OPERAND CONT IP_X_CC12 (VB_COIL2) V 52/B (F17-F18)	OPERAND CONT IP_X_CC16 (SUP_COIL2)
Healthy	Open	52 closed	ON	OFF	ON
Healthy	Open	52 open	ON	ON	ON
Healthy	Closed	52 closed	OFF	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON	ON (if t < 500 ms) OFF (if t > 500 ms)
Defective	Open	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Open	52 open	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 open	OFF	OFF	OFF (500 ms delay)

There is a possibility to monitor the trip circuit continuity not only via its auxiliary contact 52/a, but also with auxiliary contact 52/b. This avoids the need to install a resistance in parallel with auxiliary 52/a. The correct connection is shown on Figure 5–36:

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs F15-F16 and F17-F18.

The advantage in this case is that circuit supervision with 52 open is more complete, as input V 52/b is used through contact 52/b, (that is closed when the breaker is open).

We must point out that in this scheme, the tripping contact, shown in the example as the F650 trip relay, can be the one in the relay (terminals F35 and F36), or be provided by another protection or by the parallel of several protections. This provides high flexibility in the use of this circuit.

The battery voltage can also be monitored, by using one of the standard digital inputs.

### f) WITH DOUBLE VOLTAGE SUPERVISION AND SERIAL RESISTOR IN VOLTAGE MONITORS.

Figure 2–37: shows the supervision scheme with an external resistor.

An external series resistor is used with the 52a voltage monitor to prevent CB tripping with a short-circuited voltage monitor. With CB open, 52/a is open and 52/b is closed. A shorted 52/a voltage monitor will not cause a trip because 52/b voltage monitor is limiting current to 2mA. With a shorted 52/b voltage monitor, no false trip will be performed because 52/a is in series limiting current to 2mA.

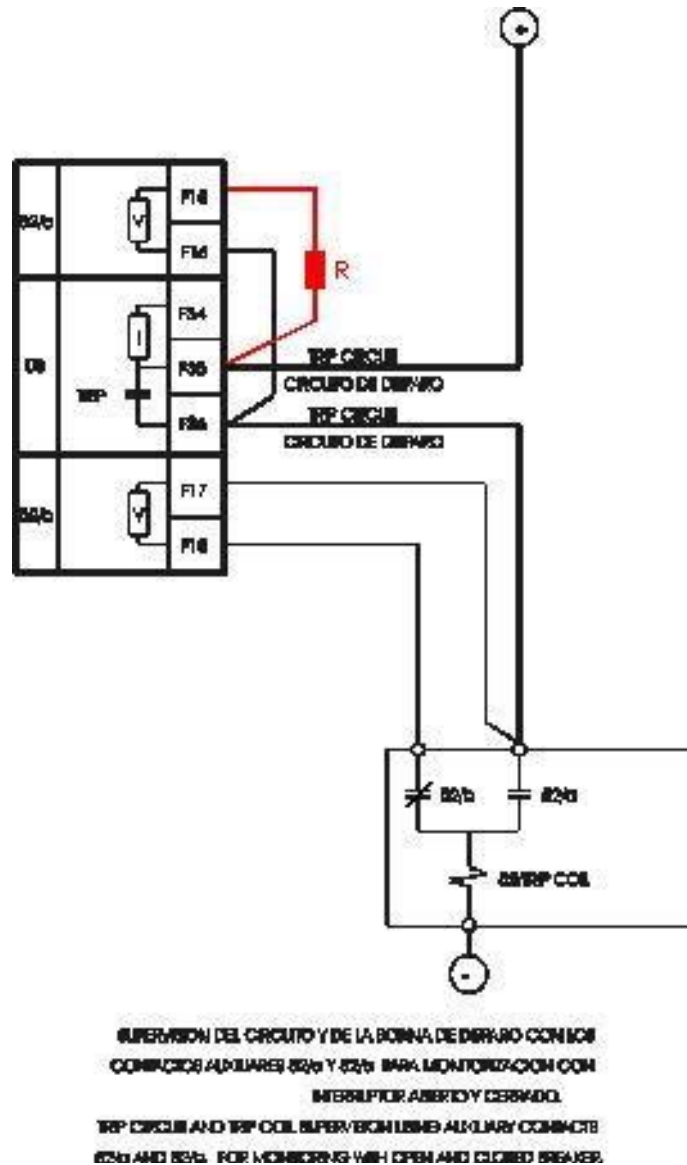


Figure 5–37: SUPERVISION APPLICATION WITH AUXILIARY CONTACTS 52A AND 52B AND SERIES RESISTOR IN F15-F16

## 5.6.6 VIRTUAL INPUTS

Virtual inputs are signals that can be written directly via communications. Their status can be established as ON (1) and OFF (0), through writing by communications using EnerVista 650 Setup.

The change of state of virtual inputs is made according to their type. Latched virtual inputs remain at the set value until it is changed by communications. Self-reset virtual inputs are activated by writing, and they remain active during one cycle. There are 32 virtual inputs of each type.

## 5.6.6.1 VIRTUAL INPUTS WRITING:

**Setpoint > Input/Outputs > Virtual Inputs** for activating / deactivating signals

To write a virtual input, select the virtual input to activate clicking on the virtual input checkbox, after that press on the store button and virtual input will be write in the relay (see Figure 5–38: ).

If it is a self-reset one it will remain active during one PLC cycle and after that the virtual input value will be cleared.

If it is a latched one, the value will remain active until it is cleared by the user, clicking again in the virtual input checkbox after that press on store to clear the value.

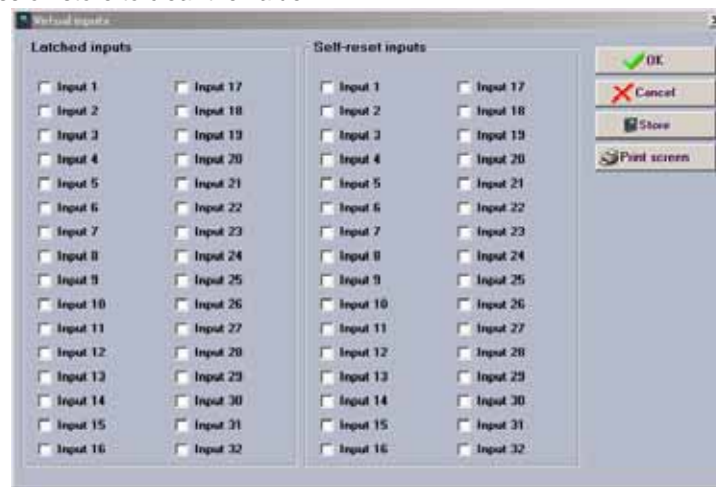


Figure 5–38: VIRTUAL INPUTS WRITING THROUGH ENERVISTA 650 SETUP

## 5.6.6.2 VIRTUAL INPUTS STATUS MONITORING:

**Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset**

Table 5–93: VIRTUAL INPUTS STATUS

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
...	...
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

Text assignment for virtual input is made at **Setpoint > Relay Configuration > Virtual Inputs**, but take into account that the text assigned for virtual inputs in the relay configuration screen are only for file management, they are not sent to the relay.

## 5.6.7 VIRTUAL OUTPUTS

There are 512 virtual outputs that may be assigned via Logic configuration. If not assigned, the output will be forced to .OFF. (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the logic equations. For more detail information see chapters 5.8 and 5.9 in this manual.

## 5.7.1 FORCE IO –INPUT TESTING

The input testing can only be performed in relay with graphical display, see the human interfaces section in this manual for more detail information.

## 5.7.2 FORCE IO –OUTPUT TESTING

Output testing can be performed via HMI in models with graphical display and via communications through EnerVista 650 Setup in all models.

**Setpoint > Inputs/Outputs > Force Outputs**

This menu allows activating each contact output in the relay, to facilitate maintenance testing. In the screen, the user can select the I/O board to be tested, and also select which output is to be forced (operated).

After selecting the desired output, clicking on the checkbox on the left, the user must press on the **Force Output** button to activate the selected output.

In order to refresh the real status of outputs, according to the information received by the relay processor, the **Refresh** button must be pressed.

The following figure shows the output-testing screen:

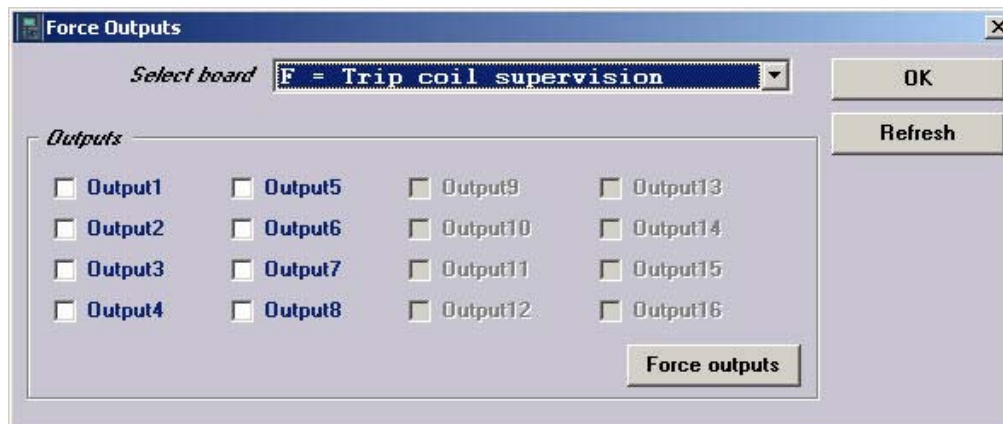


Figure 5–39: FORCE IO

**Setpoint > Relay Configuration**

This is the relay configuration section in which the relay can be configured (all input/output and LEDs configuration, protection elements signals, graphic display configuration, etc) using internal states or already compiled equation on PLC Editor (see section 5.9).

**5.8.1 OUTPUTS**

Configuration of contact output operates and reset signals for all boards available in the device:

To configure any output it is necessary to select the output to be configured, clicking on the checkbox in the select column and choose the logic operand in the source column. Different simple logics can be performed in 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 setpoint on that output
- **Name** setpoint for defining identification for the output.
- **Source** setpoint for defining a function, logic, remote input, digital input, etc. that will activate the contact.
- **OR** checkbox for configuring the output operation by activation of any of the indicated signals. The unit performs an OR of the signals, and its output produces operation.
- **NOT** checkbox for inverting or not the configured logic.



Figure 5-40: OUTPUTS CONFIGURATION

## 5.8.2 LEDS

F650 has 15 LEDs fully configurable from any logical variable, contact or virtual input. First 5<sup>th</sup> are latched by hardware, the rest are self-reset but can be latched through PLC configuration.

This window displays the entire relay LEDs with the following setpoint options for each of them:

- **Select** checkbox enables each LED. The LED must be enabled before modifying any other setpoint on that LED
- **Name** setpoint for defining identification for the LED
- **Source** setpoint defines which function; logic, remote input, digital input, etc. will activate the LED.
- **OR** checkbox for configuring the LED operation by activation of any of the indicated signals. The unit performs an OR of the signals, and its output produces operation.
- **NOT** checkbox for inverting or not the configured logic.

From the LED configuration screen, it is possible to print the vertical LED label for the relay. For this purpose, press on the printer icon. The label obtained will be similar to the default factory label, with black background and the LED texts in white. This label can replace the original one under the black plastic cover. The label is also provided in word format and can be modified by the user (e.g. different color marking)

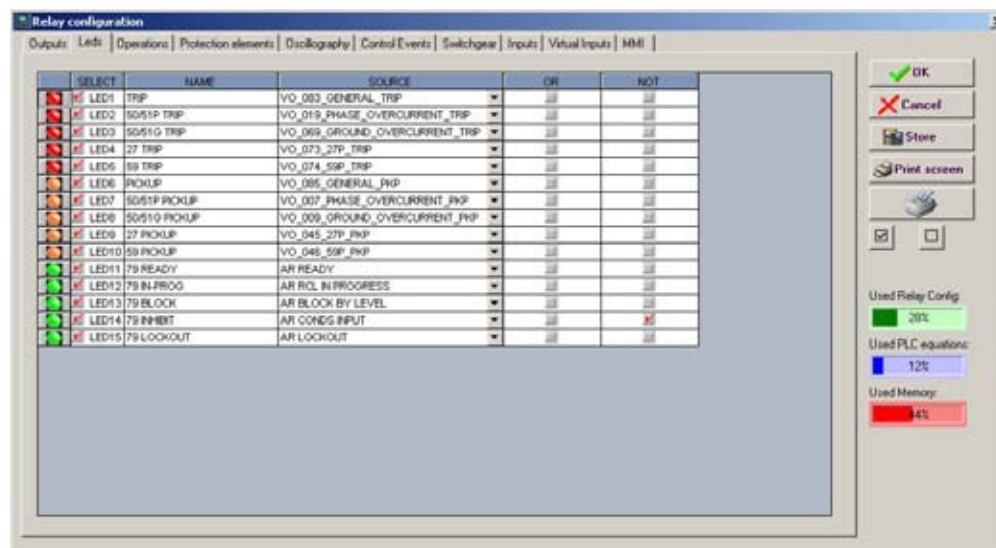


Figure 5-41: LED CONFIGURATION

## 5.8.3 OPERATIONS

This menu option shows the setpoints for the 24 control operations that can be programmed, as follows:

- **Select** checkbox enables the desired operation.
- **Command Text** setpoint defines the command name.
- **Interlocks Type** setpoint defines the desired interlock type (An interlock is a condition that must be fulfilled for an operation to be performed). The possible options are **Logic** or **None**. If the **LOGIC** option is selected, the program will enable a new window for creating the logic. If the **NONE** option is selected, then the following setpoint (**Interlockings**) will be irrelevant.
- **Interlocks** setpoint define the desired interlocks. This setpoint is enabled selecting the “**logic**” option in “**Interlock type**”. In the “**Interlock logic**” screen we can set the interlock logic, as shown on .

The setpoints 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 setpoints 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

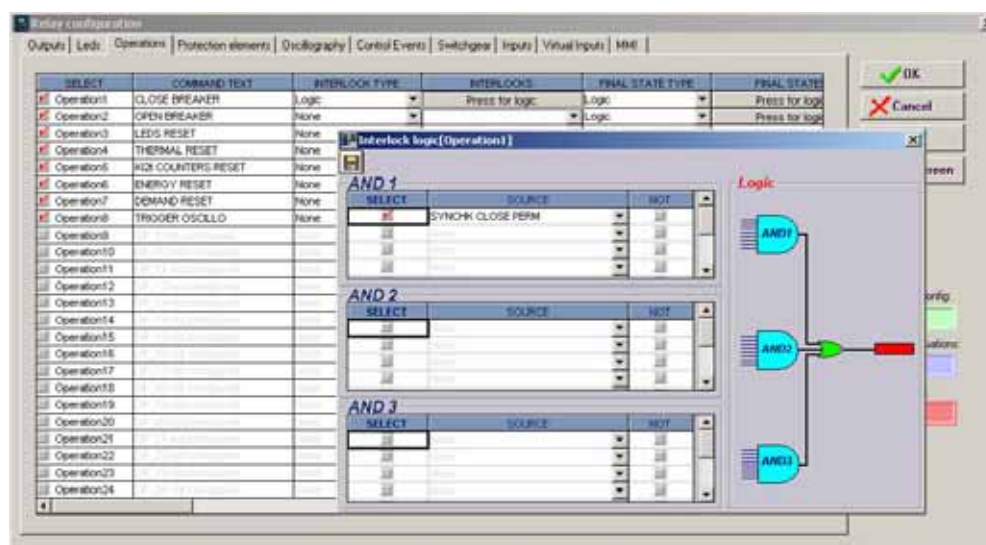


Figure 5-42: OPERATIONS AND INTERLOCKS

- **Final State Type** setpoint: 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** setpoint: defines the success condition of a programmed operation, if the previous setpoint (**Final State type**) was set as **LOGIC**.
- **Front Key** setpoint: defines the front pushbutton from which the operation can be executed.
- **Contact Input** setpoint: defines whether the operation can be executed by digital input. It defines the digital input to be used for this purpose.
- **Virtual Output** setpoint: defines whether the operation can be executed from a virtual output previously defined at the logic configuration tool (PLC logic).
- **Time Out** setpoint: 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)** setpoint: defines whether the operation can be executed by communications through rear port COM1.
- **COM2 (LOCAL)** setpoint: defines whether the operation can be executed by communications through rear port COM2. We must note that this local port is the same as the front port (DB-9 connector). We can establish simultaneous communication with the relay through ports COM1 and COM2. However, it is not possible to use rear COM2 and the front port simultaneously.
- **ETHER-MASTER** setpoint: 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 following diagram shows an example of the operations internal logic.

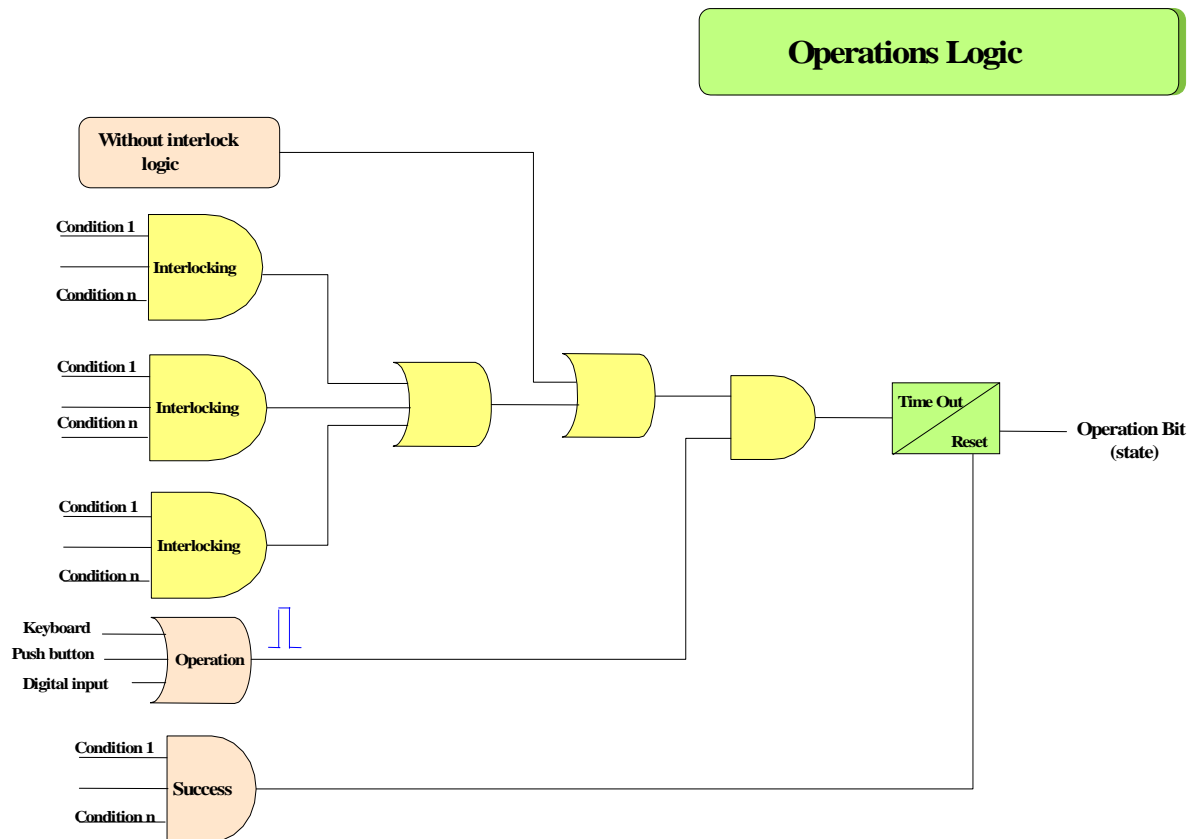


Figure 5–43: OPERATION LOGIC DIAGRAM



### 5.8.3.1 HOW TO PROGRAM AN OPERATION

Example of how to program an operation to close a breaker with an operating time of 90 ms (closing), incorporating 52/b contacts to indicate the change of position, using an interlock logic to enable the operation if there is 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 F650. In order to select an operation, press on the operation name under the **Select** column, and all the related parameters will be enabled. The chosen name for the operation is entered in "**Command Text**". To configure an interlock logic, select the **Logic** option in "**Interlocks Type**". Once this option has been selected, the interlock configuration screen will be enabled. To display this screen, click on "**Press for Logic**" for the desired operation on its **Interlocks** column. On this **Interlocks** screen, the two conditions that conform the Interlock that enables the operation have been selected. To save the interlock, press on the disk icon on the toolbar. A "**Logic Saved**" message will be displayed.

Once the Interlocks have been defined, the user must define the success conditions for the operation, define **Final State Type** as LOGIC, and a "PRESS FOR LOGIC" message will light up below **Final States**. When clicking on "PRESS FOR LOGIC", the success condition screen will be displayed, defining there as BREAKER CLOSED.

The front key to be used for executing the Operation can be selected on the Frontal Key column, in this example the **Key I** option is selected on "**Frontal Key**". As none of the other contact input or virtual output options are going to be used they will be set as **None**. The success condition time "**Time out**" is set to **500 ms**, and the operation is only enabled through the relay keypad, so only the **MMI** option is selected, thus disabling the rest of options (COM1, COM2, ETHERNET master are not selected).

All the selections previously related are summarized in the following table:

5

**Table 5-94: OPERATION SETPOINTS**

OPERATION	COMMAND TEXT	SETPOINTS	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 in the menu **Setpoint > Relay Configuration > Output**, selecting an output and choosing the internal signal OPERATION BIT 1, which corresponds to the bit that is activated when the related operation is executed.

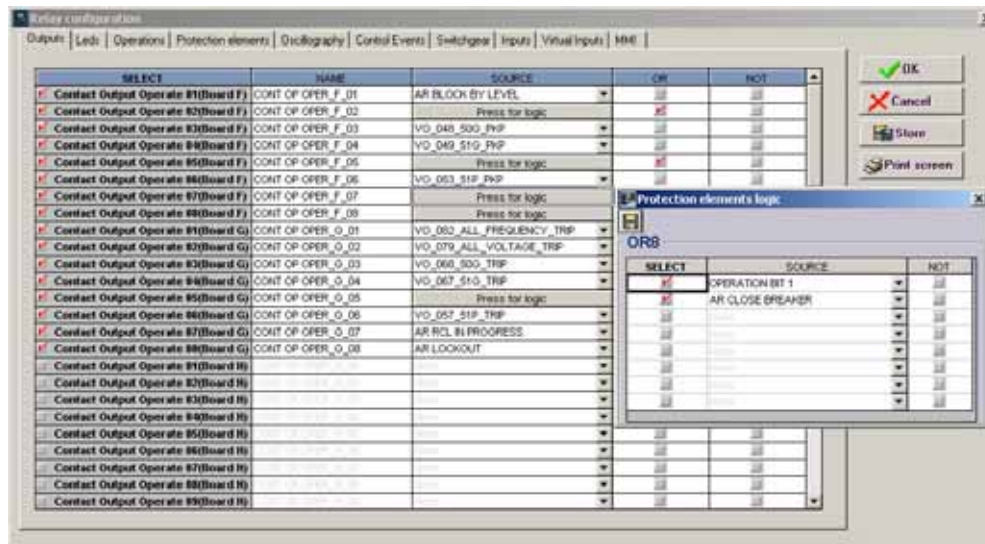


Figure 5–44: CONTACT OUTPUT CONFIGURATION

Note: Operations time out for confirmation

**Configurable screen in graphical HMI:** In the relay HMI the configurable objects wait one minute for confirmation after operation selection. The object will be blinking during one minute. After that time, the object will be deselected.

**Front Keys:** In operations performed by front keys, the time out for confirmation is 10 seconds.

## 5.8.4 PROTECTION ELEMENTS

This tab allows assigning operands (logic signals) as inputs to different protection elements. This way, the user assigns which operands can reset the Thermal Image, which operands can initiate the autoreclose, block the protection elements, etc. In this screen we can also configure a logic signal to perform the LED reset by communications.

The setpoints are as follows:

- **Select** checkbox enables/disables the selection.
- **Source** setpoint defines the operand that performs the function indicated in the SELECT column. **NOT** setpoint inverts the block signal.
- **NOT** setpoint for inverting the logic signal.
- **OR** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces the operation.

The following figure shows this screen:

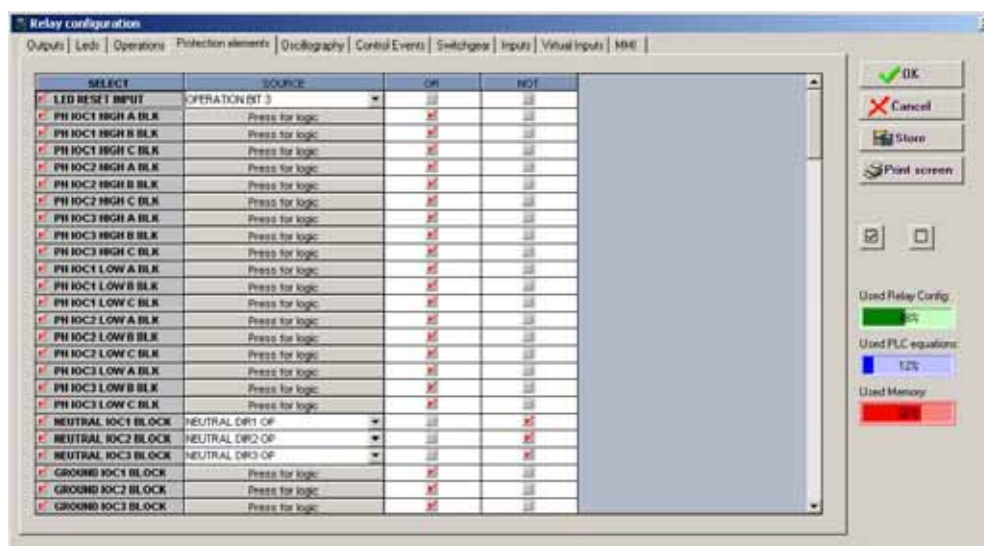


Figure 5-45: PROTECTION ELEMENTS

## 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 setpoints, the trigger selection can be any of the signals provided by the relay or a logic combination of these.

setpoints are described below:

- **Select** checkbox enables or disables a digital channel and the oscillography trigger.
- **Name** setpoint defines the name of the digital channel to be included in oscillography records.
- **Source** setpoint 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.

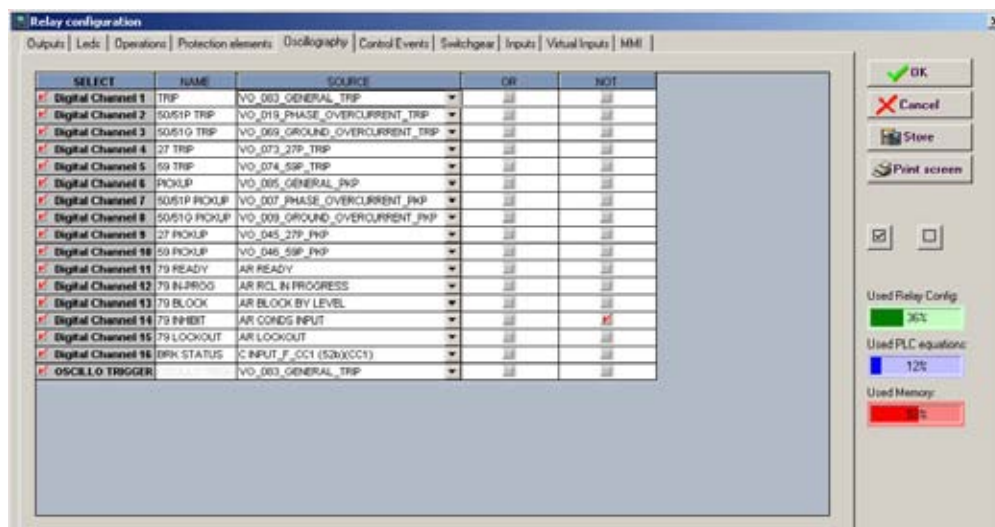


Figure 5-46: OSCILLOGRAPHY CONFIGURATION

**NOTE** This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/disabling, sampling rate, number of oscillography files, etc. must be set on the **Setpoint > Product Setup > Oscillography** menu.

## 5.8.6 CONTROL EVENTS

This menu is used for defining the **CONTROL EVENTS**, up to 128 user programmable events.

A control event is a logic signal associated to an operand or combination of operands which monitors the change of status of the logic operand. The relay shows which events are active each time, as well as their date and time of activation.

There are 128 user programmable events and 64 pre-established events for switchgear, which correspond to opening, closing, Error00 and Error11 of the 16 programmable switchgear elements. (Please refer to section for more detailed information).

As for the rest of previous setpoints, 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 setpoints are as follows:

- **Select** checkbox: enables or disables the generation of each event.
- **Name** setpoint: defines the text for each control event.
- **Source** setpoint defines the source that will trigger the event. The source is chosen from the list that shows all the operands available in the unit.
- **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.

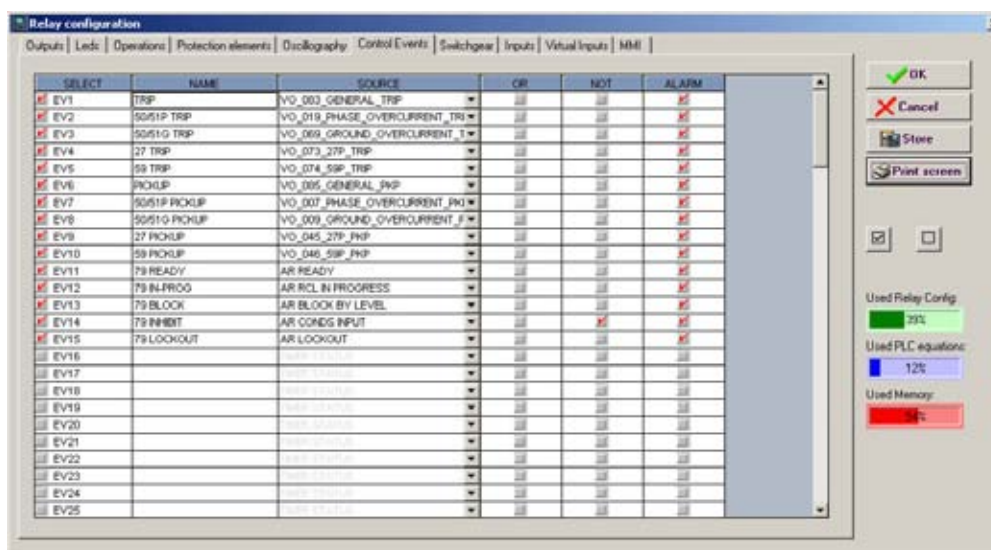


Figure 5-47: CONTROL EVENTS CONFIGURATION

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 F650:

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 5–95: ALARM MANAGEMENT**

ALARM STATUS	MASTER MANAGEMENT		
ACTIVE - NOT ACTIVE	ALL MASTERS		
ACKNOWLEDGED - NOT ACKNOWLEDGED	LOCAL	REMOTE	
	COM2 & HMI	COM1	ETHERNET

ACTIVE status is shown on the display (relay HMI), showing an ON label on the right of the alarm. The PC will show the alarm text in red color.

ACKNOWLEDGED: Operation acknowledgement can be performed from three independent channels: MMI-COM2 (local), COM1 (remote) and COM3 (Ethernet). Inactive alarms disappear from the HMI when being acknowledged.

HMI: Acknowledged status is shown on the HMI with a selection mark on the right of the ON label.

EnerVista 650 Setup: the acknowledged status is shown by a selection 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 setpoints are as follows:

- **Select** checkbox: enables or disables the control of a new switchgear element
- **Contacts** setpoint: 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** setpoint: 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** setpoint: defines the maximum closing time of an element. It is used for issuing a closing time failure signal if the element closing is not produced within this time.
- **Contact A** checkbox: allows selecting which operand or combination of operands activate the type A contact status. Usually it will be an input contact wired to type A contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is **52a** or **52a+52b**.
- **OR** checkbox: selects a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.
- **NOT** checkbox inverts the status of the signal selected in column **Contact A**.
- **Contact B** checkbox: allows selecting which operand or combination of operands activates the type B contact status. Usually it will be an input contact wired to type B contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is **52b** or **52a+52b**.
  - **OR** checkbox selects a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.
  - **NOT** checkbox inverts the status of the signal selected in column **Contact B**.
- **Open text** setpoint: allows associating a text to the control event associated to the element opening.
- **Close text** setpoint: allows associating a text to the control event associated to the element closing.
- **Error 00 text** setpoint: in case of using double contact for the switchgear element status (**52a+52b**), this setpoint allows to associate a text to the Error00 internal status, this means, when both contacts are inactive during a period longer than the associated to the opening or closing Operation, depending on which Operation is being performed.
- **Error 11 text** setpoint: in case of using double contact for the switchgear element status (**52a+52b**), this setpoint allows to associate a text to the Error11 internal status, this means, when both contacts are active during a period longer than the associated to the opening or closing Operation, depending on which Operation is being performed.
- **ALARM** setpoint: 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** setpoint: this setpoint 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** setpoint: this setpoint selects which operand or combination of operands indicate the initiation of a closing operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the opening init must be configured in the operations tab inside relay configuration.



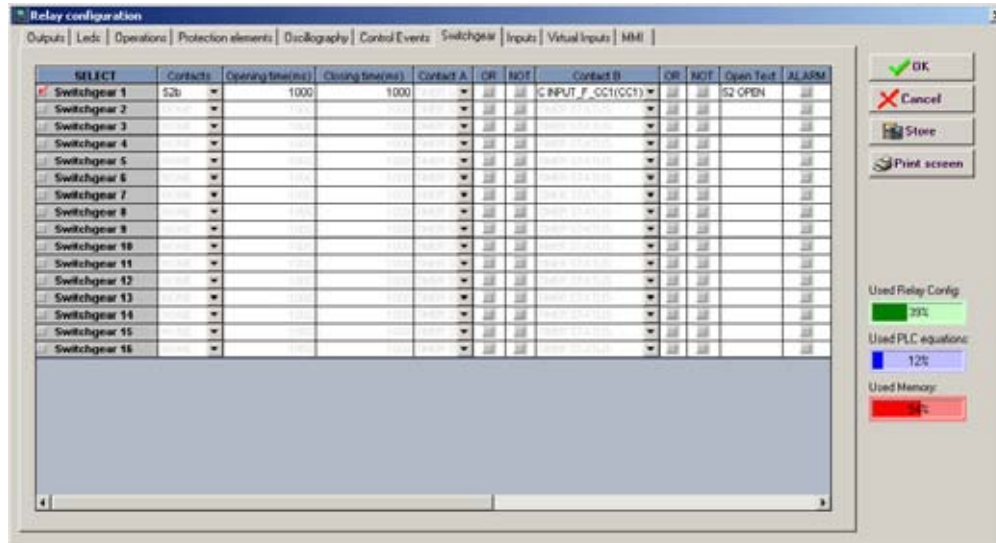


Figure 5-48: SWITCHGEAR CONFIGURATION

**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)

5

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.

For using the drawing toolbar elements, we must select the desired element with the mouse and then click on the yellow area. The selected element will be moved to the screen on the selected spot (see ).

The graphic display can be used to configured switchgear elements, operations, metering values, date and time, etc. The configured values will always be updated with the real status of the relay.

This functionality is only applicable to F650 units with graphical display (240x128pixels), and not for units with alphanumerical display (20x4 characters).

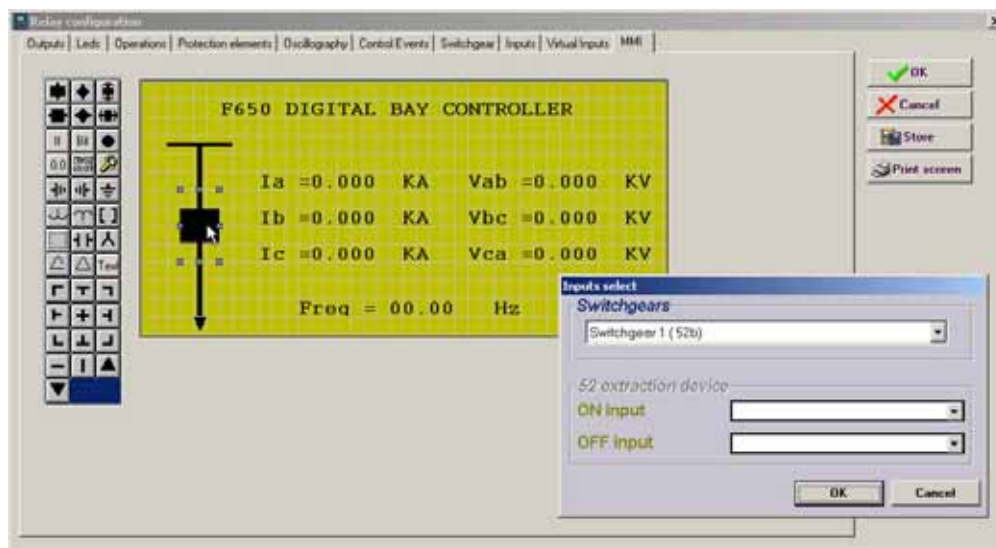


Figure 5-49: HMI CONFIGURATION



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 5–96: ACTIVE SYMBOLS CONFIGURABLE IN ONE-LINE DIAGRAM FOR GRAPHICAL HMI**
















ACTIVE SYMBOLS	
ICONS IN SCREEN	DESCRIPTION
<b>SWITCHGEAR SYMBOLS</b>	
	These symbols correspond to switchgear elements: breaker (square) and selector switch (rhombus), in vertical and horizontal positions. It is necessary to associate the figure to its corresponding switchgear number. The figure is shown filled if the element is closed, and blank if the element is open. The symbol on the right represents an unpluggable breaker. In this case it is necessary to indicate which operands show whether the element is plugged or unplugged. The figure shows also graphically these two statuses.
<b>MULTISTATE VARIABLE SYMBOL</b>	
	Displays on screen a dialog box 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.
<b>STATUS SYMBOLS</b>	
<b>(TEXT AND GRAPHIC MODES):</b>	
	BitRepresents 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
<b>ANALOG MAGNITUDE SYMBOL</b>	
	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
<b>DATE AND TIME SYMBOL</b>	
	Symbol used for displaying in the HMI the date and time provided by the device.
<b>OPERATIONS SYMBOL:</b>	
	This symbol indicates de possibility to configure and execute operations on the graphic display. This symbol can only be selected once the operations have already been configured in the “ <b>Operations</b> ” screen of the “ <b>Relay Configuration</b> ” menu. To select an Operation, click on the element and then on the display. The program will show a window to select the required operation among the displayed options, and the tab order. Once selected, a red border square will be shown. Place this square on the object to be operated. When the operated object is selected on the screen to execute this operation, the object on which it is located will blink. It is possible to place several operations on the same object, for example to open and close the breaker object.

Table 5–97: GRAPHIC AND TEXT EDITION SYMBOLS

GRAPHIC AND TEXT EDITION SYMBOLS	
ICONS IN SCREEN	DESCRIPTION
	Ground symbols in different positions.
	Transformers representation
	Symbols reserved for future uses
	Symbol for capacitor banks.
	Symbol for wye connection
	Symbol for open delta and delta connection
	Display of a fix text up to 40 ASCII characters
	Auxiliary drawing lines

**Setpoint > Logic Configuration**

The F650 logic allows setpoint the relay logic configuration using a sophisticated and complete program based on standard IEC 61131-3, with block diagrams, which is described in this section.

**5.9.1 INTRODUCTION**

The logic configuration (or PLC Editor) tool is a graphical design tool that allows the F650 built complex logic diagram in an easy way using different logic functions.

The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.

• **This standard defines five basic ways of programming:**

- Sequential Function Chart (SFC).
- Instruction List (IL).
- Structured Text (ST).
- Ladder Diagram (LD).
- Function Block Diagram (FBD).

Out of these five methods, FBD has been chosen because it allows for graphical configurations that are more comprehensive. This method provides the possibility of grouping several basic functions inside a single function (hereon called libraries), achieving higher modularity and clarity in the design.

**Please take note of the following remarks:**

The first equation entered in the PLC can never be a timer  
Analog elements (analog comparators, etc,) are not implemented.















## 5.9.2 THEORY OF OPERATION

## 5.9.2.1 DESCRIPTION

As already mentioned in the introduction, this tool uses FBD mode of IEC 61131-3 standard. For this purpose we have defined a series of basic operations with illustrations below.

The basic operations available in PLC Editor are located in the tool bar of the application and are as follows:

**Table 5–98: PLC EDITOR BASIC OPERATION IN F650**

PLC EDITOR BASIC OPERATION	
ICONS IN SCREEN	DESCRIPTION
	INPUT TO LOGIC: Selection of the digital input to the logic. (All available internal status can be used as logic inputs)
	OUTPUT FROM LOGIC: Virtual output built with internal logic. (Up to 512)
	LIBRARY: Possibility to build blocks of logic in a simple graphic object. OR and AND from 3 to 8 inputs are provided as libraries.
	AND of two digital inputs.
	OR of two digital inputs.
	NOT of a digital input.
	NAND of two digital inputs.
	XOR of two digital inputs.
	SR: Latch (set-reset): reset dominant.
	ONS: signal to pulse an logic input to a signal of one scan cycle length.
	TIMER: timer signal with set, reset and mask for timing.
	TEXT LABEL: text to customize the logic configuration file.
	Flip-Flop D : signal that maintains the actual value frozen during a PLC cycle
	MASK: Time mask to be used in timing operations.

Example of logic signals in F650 logic configuration:

Table 5–99: LOGIC SIGNALS IN F650

LOGIC SIGNALS EXAMPLES		
SIGNAL	DESCRIPTION	TIME DIAGRAM
SET	When the input signal is set to 1 the output signal remain fixed to 1 till a reset signal is received.	
RESET	When the input signal is reset to 1 the output signal remain fixed to 0.	
ONS	The input signal is pulsed. The width of the output pulse will be the same as that of the PLC cycle	
TIMER	With selectable time (MASK), one SET input and one RESET input	

### 5.9.2.2 LOGIC COMPILATION

The F650 configuration will be made using the basic operations related before and more complex operations can be developed inside libraries.

All the graphical configuration performed in the Logic configuration editor must be read and interpreted by the PLC as the F650 engine. The graphical equations must be translated into compiled equations to be understood by the relay. For this purpose the logic configuration editor provides a compilation option to compile the whole configuration, creating a series of equations that will form the logical configuration of the unit.

The next diagram shows the way compiled logic equations are built.

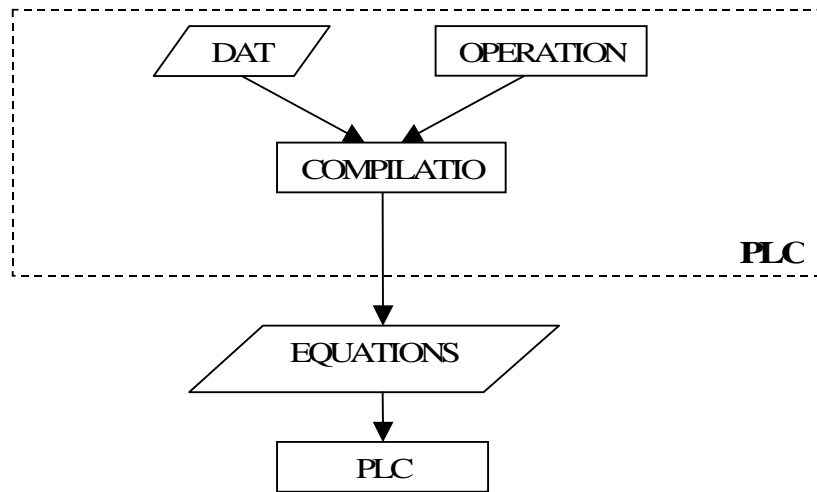


Figure 5-50: COMPILED LOGIC EQUATIONS

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:

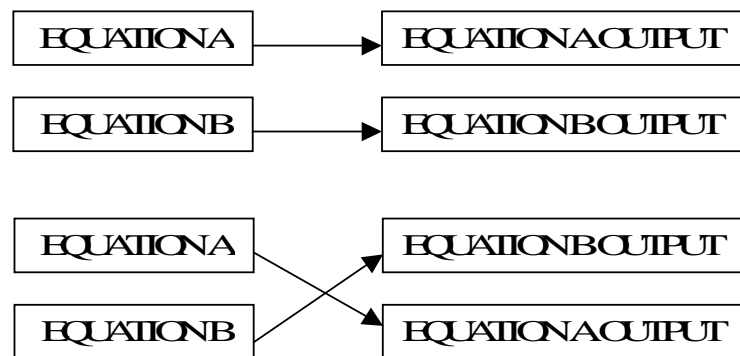


Figure 5-51: ORDER OF EQUATIONS

In this case, equation A is the first to be executed. However, in the second case, the first equation to be executed would be B, as its output is before the Equation A output.

## 5.9.3 MAIN MENU

The PLC Editor tool (*Setpoint > Logic Configuration* ) provides a main menu with different submenus (File, Project, Edit, Run, View, and Window) that allows the user to built customized logic for the F650 devices.

## 5.9.3.1 FILE MENU

The FILE menu includes the following options:

<b>New Project:</b>	allows to create a new project that will include the files of the logic configuration
<b>Open Project:</b>	opens an existing project.
<b>Close Project:</b>	closes the currently open project.
<b>Save Project and Save Project as:</b>	saves the open project.
<b>Save Automatic Function</b>	
<b>&amp; Save Automatic Function As:</b>	Saves the file of the active project.
<b>Library:</b>	Gives access to the libraries sub-menus, where new libraries can be created and existing ones can be modified and saved.
<b>Print:</b>	Prints the active configuration file.
<b>Preview:</b>	Preview of the document before printing.
<b>Exit:</b>	The system closes all open projects and exits the application.

## 5

## 5.9.3.2 PROJECT MENU

The Project menu includes the following options:

<b>Project Explorer:</b>	Displays a window where we see a tree structure with the files contained in the project.
<b>Insert library:</b>	Inserts a library in the active automatic function.

## 5.9.3.3 EDIT MENU

The Edit menu includes the following options:

<b>Undo:</b>	Undoes the last modification in the active function.
<b>Redo:</b>	Remakes the last modification.
<b>Cut:</b>	Cuts one or more logic operations.
<b>Copy:</b>	Copies one or more logic operations.
<b>Paste:</b>	Pastes one or more logic operations.
<b>Find:</b>	Looks for a logic operation in the project.
<b>Copy as Bitmap:</b>	Copies the active automatic function to the clipboard in picture format.
<b>View Clipboard:</b>	Launches the clipboard viewer application.

## 5.9.3.4 RUN MENU

The RUN menu includes the following options:

<b>Configuration:</b>	Not valid in the current application (for analog operations still not available)
<b>Compile:</b>	Compiles the configuration functions to generate the equations that will be interpreted by the F650 PLC.

**5.9.3.5 VIEW MENU**

The VIEW menu includes the following options:

<b>Log:</b>	Displays in one screen the status name and time stamp of the digital statuses configured in the PLC logic (still not available).
<b>Debug-Release window:</b>	Displays the values for the different project inputs, outputs, and variables (still not available).
<b>Equations:</b>	Displays the equations resulting from the compilation.
<b>Grid:</b>	Shows or hides the form grid where the configuration functions are developed. It also aligns the different objects to the grid.
<b>Zoom:</b>	Allows selecting the percentage of zoom in the application.
<b>Rectangle Zoom (Zoom rectangular):</b>	Allows zooming the Selected rectangle.

**5.9.4 CONFIGURATION GENERATION****5.9.4.1 CREATE A NEW PROJECT**

Clicking on the “File > New Project” menu option, a new PLC project is open, where the user can program the desired automatism. An automatism can be formed by one or more equations.

**5.9.4.2 CREATE EQUATION**

A single equation can be formed by one or more inputs, one or more operations, and one output.

The order of equations is determined by the relative position of their respective outputs, this order being downward.

To link the output of an equation with the input of another equation, an internal variable (virtual output) must be used.

The virtual output is used as an input to the second equation.

**5.9.4.3 ADD AN INPUT TO AN AUTOMATISM**

Using the mouse click on the button that represents the inputs in the toolbar at the top of the screen. A logic input can be any of the available digital internal status provided by the relay. Such as protection status, contact inputs, contact outputs, I/O status, other protection status, front keys, LEDs, operation bits, virtual inputs and virtual outputs.

**5.9.4.4 ADD AN OUTPUT TO AN AUTOMATISM**

Using the mouse click on the button that represents the outputs in the toolbar at the top of the screen. The logic outputs are always virtual outputs (up to 512 configurable signals).

**5.9.4.5 ADD A DIGITAL OPERATION**

Press on any of the digital operations in the toolbar at the top of the screen, and then click on the window background. Afterward a box with the selected digital operation will be displayed and the inputs and outputs must be connected to the logic box as explained before.

**5.9.4.6 LINK INPUTS, OUTPUTS AND OPERATIONS**

The user can link the different graphic objects clicking on an object output and dragging to the input of another graphic object. Graphic objects available in the PLC configuration are digital objects.

There is a series of restrictions when performing connections:

It is not possible to auto-link an object; the output of a certain object cannot be linked to its input;

There can only be one input per object input;

RESET and SET outputs must be internal variables or outputs.

We must take into account that as the timer is a digital operation that operates as an analog, there must only be a single internal variable or digital input in the timer input.



#### 5.9.4.7 ADD A LIBRARY

Click on the “LIB” button and select the corresponding file.

The user can built their own libraries and distribute them in their projects in an easy way.

The manufacturer provides default libraries such as ORs, ANDs of 3 up to 8 inputs, besides timers (pickup-dropout) and key examples.

### 5.9.5 GENERATION OF LIBRARIES

Libraries can contain a set of operations grouped in a single graphic object being formed by inputs, outputs and operations

Working with libraries follows the same procedure as working in the main project menu, the only difference is that the inputs and outputs to the library must be selected as external inputs and outputs. The rest of variables are internal variables used in the logic compilation.

The name assigned to the inputs and outputs of the library and to the library itself will be ones used to represent the library as an object in the main project.

Internal variables inside the libraries will be assigned randomly when compiling.

These libraries are saved in the LIB folder in order to be used in further projects

#### 5.9.5.1 LIBRARY EXAMPLE

Go to the main menu **File >Library > Open Library**

> New Library

Open a new library or modify an existing one, in this example a timer library is going to be displayed Timer(Pkp-Dpt).lib as shown on Figure 2–52:

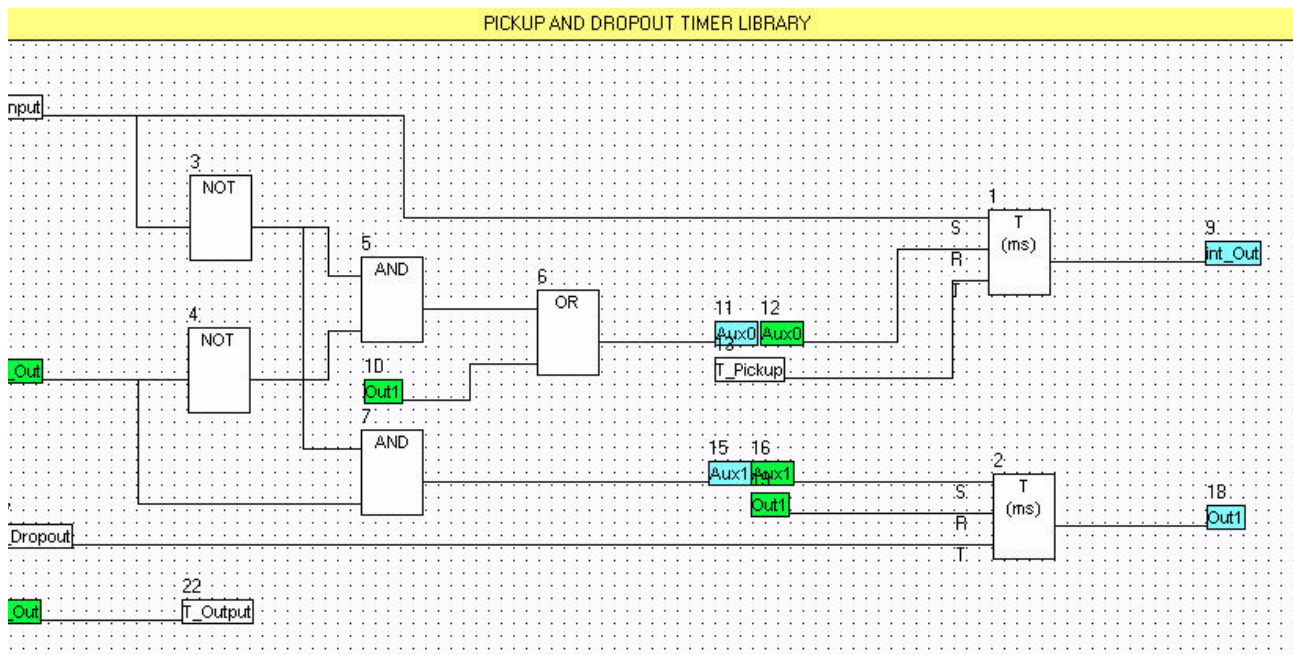


Figure 5-52: TIMER(PKP-DPT).LIB CONFIGURATION EXAMPLE

Green and blue signals are internal inputs and outputs used in the library and are not going to be accessible to the user when working in the main menu outside the library environment. The white boxes (T\_Input, T\_Pickup, T\_Dropout, T\_output) are inputs and outputs to the library that are going to be accessible to the user to connect the library in the main application to create virtual outputs to be sent to the relay.

Once the library is created and saved it can be selected in the main application menu in **Project > Insert Library**. The library will have the following object:

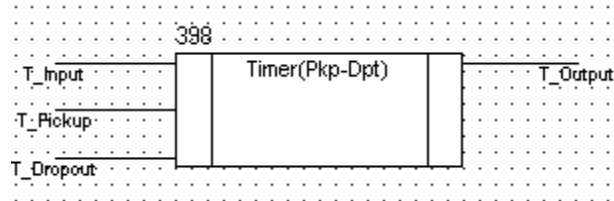


Figure 5–53: LIBRARY OBJECT

## 5.9.6 EXAMPLE OF APPLICATION

In this section a simple logic application is described step by step, a logic is such that keeping one digital input activated, several outputs will be activated and deactivated in a time window (outputs will remain activated for 200 ms and deactivated for 5 ms). See the following figure:

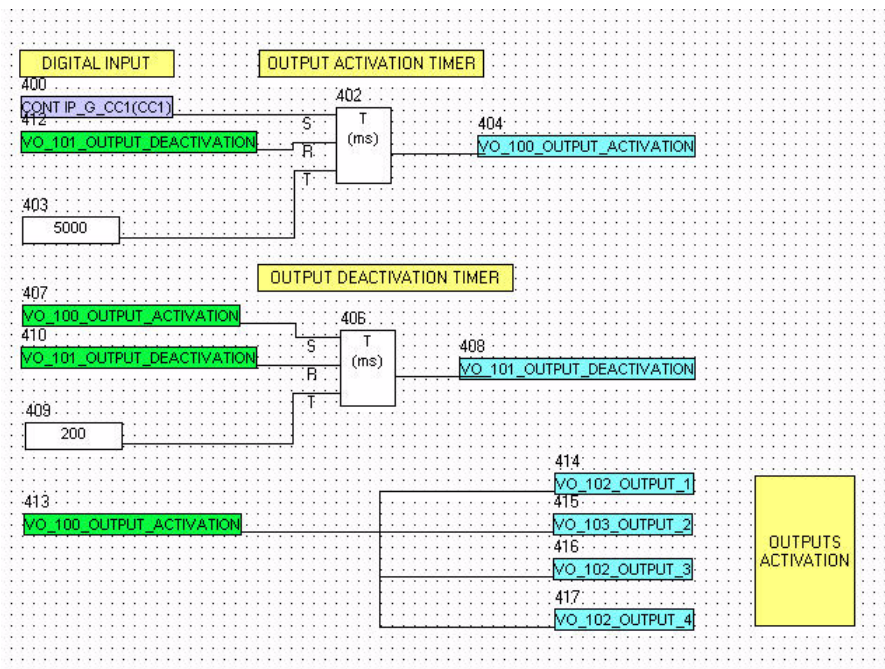


Figure 5-54: LOGIC EXAMPLE

Go to the main menu and select **File >New project**, create a new project and select an input in the icons toolbar on the top of the window. This input will be selected as a digital input among the several options for inputs that can be selected. This input is the SET input for the first timer to launch the output activation signal. Click on the icon related to the timer to insert the timer on the project. The timer has three inputs (S=set, R=reset and T=timing input)

The reset signal of the first timer is a virtual output called output\_deactivation that has been created as an output of another second timer. This signal is selected as an output

The timing signal for the first timer is a mask provided by the application, in which the time in milliseconds must be entered in order to configure the timer time delay.

After creating the first timer, the second one for output deactivation is made. The set signal will be the virtual output created as an output of the first timer (VO\_100\_OUTPUT\_ACTIVATION), the reset signal will be the output of the second timer (VO\_100\_OUTPUT\_DEACTIVATION), the time delay is set as 200 ms.

Once the timing logic (timer 1 + timer 2) has been created, the activation signal (VO\_100\_OUTPUT\_ACTIVATION) is linked to several virtual outputs. Therefore, virtual outputs (VO\_102\_OUTPUT\_1, VO\_103\_OUTPUT\_2, VO\_104\_OUTPUT\_3, VO\_105\_OUTPUT\_4) will be activated if the CONT IP\_G\_CC1(CC1) variable is set to 1. Once the VO\_100\_OUTPUT\_ACTIVATION is active, it will be deactivated after 200 ms, and will remain deactivated for 5 seconds. This process will be repeated while the digital input is active.

To finish the process the logic must be compiled (**Run >Compile**) and the equations sent to the relay (**Run >Send Equations to relay**) to start working with the new logic.

The menu bar in the main screen of EnerVista F650 Setup software shows the ACTUAL menu option. This option concentrates and displays all status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This menu is divided in several submenus that will be detailed in the following sections.

### 6.1.1 LEDS

Operation of the relay front LEDS is shown on the following figure (**Actual > Front Panel > LEDS**) by the lighting of the associated LED in the appropriate color. The Ready LED is green when the relay is in service. LEDS 1 to 5 light up in red when active, LEDS 6 to 10 light up in orange, and the last 5 LEDS light up in green.

The first five LEDS are latched by hardware and can only be reset by a LEDS RESET Command, either pressing the “esc” key on the Front of the Relay, or by Communications using the appropriate signal. The rest of LEDS are not latched, but can be latched by logic.

**Table 6–1: FRONT PANEL LEDS**

LEDS
READY LED
LED 1
LED 2
LED 3
LED 4
LED 5
LED 6
LED 7
LED 8
LED 9
LED 10
LED 11
LED 12
LED 13
LED 14
LED 15
LOCAL OPERATION MODE
OPERATIONS BLOCKED

## 6.2.1 OPERATION BITS

(**Actual > Status > Operation bits**)

OPERATION BIT 1..24 These 24 bits are the outputs of each possible Operation modules, programmed in menu **Setpoint > Relay Configuration > Operations**. The light up LED indicates their status 1 (activation)

**Table 6–2: OPERATION BITS**

OPERATION BITS
OPERATION BIT 1
OPERATION BIT 2
...
OPERATION BIT 24

## 6.2.2 BREAKER

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

**Table 6–3: BREAKER STATUS**

BREAKER STATUS
BREAKER OPEN
BREAKER CLOSED
BREAKER UNDEFINED

**BREAKER OPEN:** Open breaker status. In the switchgear selected as breaker, besides providing the usual switchgear contact status, the system provides also the open breaker, closed breaker, and undefined breaker states.

**BREAKER CLOSED:** Breaker closed.

**BREAKER UNDEFINED:** If there are two digital inputs configured for breaker contacts 52/a and 52/b, this status will be present when both inputs are at 0 or at 1. This status can be caused by a wiring failure, failure of auxiliary elements, etc.

## 6.2.3 PROTECTION

## 6.2.3.1 PROTECTION BLOCKS

(**Actual > Status > Protection > Protection Blocks**)

This screen shows the entire protection element blocks available. If the protection element is blocked, the green LED located on the right side of the text will light up and will remain lit as long as the element remains blocked.

Protection elements block signals are configured at **Setpoint > Relay Configuration > Protection Elements**.

**Table 6–4: PROTECTION ELEMENTS BLOCK**

IOC BLOCK SIGNALS	TOC BLOCK SIGNALS	DIRECTIONAL BLOCKS	VOLTAGE BLOCKS
PH IOC1 HIGH A / B / C BLK	PH TOC1 HIGH A / B / C BLK	PHASE DIR1 BLK INP	PHASE UV1 BLOCK
PH IOC2 HIGH A / B / C BLK	PH TOC2 HIGH A / B / C BLK	PHASE DIR2 BLK INP	PHASE UV2 BLOCK
PH IOC3 HIGH A / B / C BLK	PH TOC3 HIGH A / B / C BLK	PHASE DIR3 BLK INP	PHASE UV3 BLOCK
PH IOC1 LOW A / B / C BLK	PH TOC1 LOW A / B / C BLK	NEUTRAL DIR1 BLK INP	PHASE OV1 BLOCK
PH IOC2 LOW A / B / C BLK	PH TOC2 LOW A / B / C BLK	NEUTRAL DIR2 BLK INP	PHASE OV2 BLOCK
PH IOC3 LOW A / B / C BLK	PH TOC3 LOW A / B / C BLK	NEUTRAL DIR3 BLK INP	PHASE OV3 BLOCK
NEUTRAL IOC1 BLOCK	NEUTRAL TOC1 BLOCK	GROUND DIR1 BLK INP	NEUTRAL OV1 HIGH BLK

NEUTRAL IOC2 BLOCK	NEUTRAL TOC2 BLOCK	GROUND DIR2 BLK INP	NEUTRAL OV2 HIGH BLK
NEUTRAL IOC3 BLOCK	NEUTRAL TOC3 BLOCK	GROUND DIR3 BLK INP	NEUTRAL OV3 HIGH BLK
GROUND IOC1 BLOCK	GROUND TOC1 BLOCK	SENS GND DIR1 BLK IP	NEUTRAL OV1 LOW BLK
GROUND IOC2 BLOCK	GROUND TOC2 BLOCK	SENS GND DIR2 BLK IP	NEUTRAL OV2 LOW BLK
GROUND IOC3 BLOCK	GROUND TOC3 BLOCK	SENS GND DIR3 BLK IP	NEUTRAL OV3 LOW BLK
SENS GND IOC1 BLK	SENS GND TOC1 BLOCK	<b>POWER BLOCKS</b>	AUXILIARY UV1 BLOCK
SENS GND IOC2 BLK	SENS GND TOC2 BLOCK	FWD PWR1 BLOCK	AUXILIARY UV2 BLOCK
SENS GND IOC3 BLK	SENS GND TOC3 BLOCK	FWD PWR2 BLOCK	AUXILIARY UV3 BLOCK
<b>ISOLATED GROUND BLOCKS</b>	NEG SEQ TOC1 BLOCK	FWD PWR3 BLOCK	AUXILIARY OV1 BLOCK
ISOLATED GND1 BLK	NEG SEQ TOC2 BLOCK	DIR PWR1 BLOCK	AUXILIARY OV2 BLOCK
ISOLATED GND2 BLK	NEG SEQ TOC3 BLOCK	DIR PWR2 BLOCK	AUXILIARY OV3 BLOCK
ISOLATED GND3 BLK	<b>THERMAL MODEL BLOCKS</b>	DIR PWR3 BLOCK	NEG SEQ OV1 BLOCK
<b>SETTING GROUPS BLOCK IP</b>	THERMAL1 BLOCK	<b>FREQUENCY BLOCKS</b>	NEG SEQ OV2 BLOCK
SETT GROUPS BLOCK	THERMAL2 BLOCK	OVERFREQ1 BLOCK	NEG SEQ OV3 BLOCK
	THERMAL3 BLOCK	OVERFREQ2 BLOCK	<b>LOCKED ROTOR BLK</b>
	<b>BROKEN CONDUCTOR BLK</b>	OVERFREQ3 BLOCK	LOCKED ROTOR1 BLK
	BROKEN CONDUCT1 BLK	UNDERFREQ1 BLOCK	LOCKED ROTOR2 BLK
	BROKEN CONDUCT2 BLK	UNDERFREQ2 BLOCK	LOCKED ROTOR3 BLK
	BROKEN CONDUCT3 BLK	UNDERFREQ3 BLOCK	

### 6.2.3.2 PHASE CURRENT

This screen shows the pickup and trip for all phase instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the phase directional units. Any of these two events of any phase element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation. All the values are provided for phases and total as shown on the table below.

This screen is accessed in menu: **Actual> Status > Protection > Phase Current**, and includes the following signaling LEDs:

**Table 6–5: PHASE CURRENT ACTUAL VALUES**

PHASE IOC ACTUAL VALUES	PHASE IOC ACTUAL VALUES	PHASE DIRECTIONAL ACTUAL VALUES
PH IOC1 HIGH A / B / C PKP	PH TOC1 HIGH A / B / C PKP	PHASE DIR1 BLOCK A
PH IOC1 HIGH A / B / C OP	PH TOC1 HIGH A / B / C OP	PHASE DIR1 A OP
PH IOC1 HIGH PKP	PH TOC1 HIGH PKP	PHASE DIR1 BLOCK B
PH IOC1 HIGH OP	PH TOC1 HIGH OP	PHASE DIR1 B OP
PH IOC2 HIGH A / B / C PKP	PH TOC2 HIGH A / B / C PKP	PHASE DIR1 BLOCK C
PH IOC2 HIGH A / B / C OP	PH TOC2 HIGH A / B / C OP	PHASE DIR1 C OP
PH IOC2 HIGH PKP	PH TOC2 HIGH PKP	PHASE DIR2 BLOCK A
PH IOC2 HIGH OP	PH TOC2 HIGH OP	PHASE DIR2 A OP
PH IOC3 HIGH A / B / C PKP	PH TOC3 HIGH A / B / C PKP	PHASE DIR2 BLOCK B
PH IOC3 HIGH A / B / C OP	PH TOC3 HIGH A / B / C OP	PHASE DIR2 B OP
PH IOC3 HIGH PKP	PH TOC3 HIGH PKP	PHASE DIR2 BLOCK C
PH IOC3 HIGH OP	PH TOC3 HIGH OP	PHASE DIR2 C OP
PH IOC1 LOW A / B / C PKP	PH TOC1 LOW A / B / C PKP	PHASE DIR3 BLOCK A
PH IOC1 LOW A / B / C OP	PH TOC1 LOW A / B / C OP	PHASE DIR3 A OP
PH IOC1 LOW PKP	PH TOC1 LOW PKP	PHASE DIR3 BLOCK B
PH IOC1 LOW OP	PH TOC1 LOW OP	PHASE DIR3 B OP
PH IOC2 LOW A / B / C PKP	PH TOC2 LOW A / B / C PKP	PHASE DIR3 BLOCK C
PH IOC2 LOW A / B / C OP	PH TOC2 LOW A / B / C OP	PHASE DIR3 C OP
PH IOC2 LOW PKP	PH TOC2 LOW PKP	
PH IOC2 LOW OP	PH TOC2 LOW OP	
PH IOC3 LOW A / B / C PKP	PH TOC3 LOW A / B / C PKP	
PH IOC3 LOW A / B / C OP	PH TOC3 LOW A / B / C OP	
PH IOC3 LOW PKP	PH TOC3 LOW PKP	
PH IOC3 LOW OP	PH TOC3 LOW OP	

### 6.2.3.3 NEUTRAL CURRENT

This screen shows the pickup and trip for all neutral instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the neutral directional units. Any of these two events of any neutral element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Neutral Current**, and includes the following signaling LEDs:

**Table 6–6: NEUTRAL CURRENT ACTUAL VALUES**

NEUTRAL IOC ACTUAL VALUES	NEUTRAL TOC ACTUAL VALUES	NEUTRAL DIRECTIONAL ACTUAL VALUES
NEUTRAL IOC1 PKP	NEUTRAL TOC1 PKP	NEUTRAL DIR1 BLOCK
NEUTRAL IOC1 OP	NEUTRAL TOC1 OP	NEUTRAL DIR1 OP
NEUTRAL IOC2 PKP	NEUTRAL TOC2 PKP	NEUTRAL DIR2 BLOCK
NEUTRAL IOC2 OP	NEUTRAL TOC2 OP	NEUTRAL DIR2 OP
NEUTRAL IOC3 PKP	NEUTRAL TOC3 PKP	NEUTRAL DIR3 BLOCK
NEUTRAL IOC3 OP	NEUTRAL TOC3 OP	NEUTRAL DIR3 OP

### 6.2.3.4 GROUND CURRENT

This screen shows the pickup and trip for all ground instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the ground directional units. Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Ground Current**, and includes the following signaling LEDs:

**Table 6–7: GROUND CURRENT ACTUAL VALUES**

GROUND IOC ACTUAL VALUES	GROUND TOC ACTUAL VALUES	GROUND DIRECTIONAL ACTUAL VALUES
GROUND IOC1 PKP	GROUND TOC1 PKP	GROUND DIR1 BLOCK
GROUND IOC1 OP	GROUND TOC1 OP	GROUND DIR1 OP
GROUND IOC2 PKP	GROUND TOC2 PKP	GROUND DIR2 BLOCK
GROUND IOC2 OP	GROUND TOC2 OP	GROUND DIR2 OP
GROUND IOC3 PKP	GROUND TOC3 PKP	GROUND DIR3 BLOCK
GROUND IOC3 OP	GROUND TOC3 OP	GROUND DIR3 OP

### 6.2.3.5 SENSITIVE GROUND CURRENT

This screen shows the pickup and trip for all sensitive ground instantaneous, time overcurrent and isolated ground elements in the F650 and block and operation signals provided by the sensitive ground directional units. Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Sensitive Ground Current**, and includes the following signaling LEDs:

**Table 6–8: SENSITIVE GROUND CURRENT ACTUAL VALUES**

SENSITIVE GROUND IOC ACTUAL VALUES	SENSITIVE GROUND TOC ACTUAL VALUES	ISOLATED GROUND ACTUAL VALUES	SENSITIVE GROUND DIRECTIONAL ACTUAL VALUES
SENS GND IOC1 PKP	SENS GND TOC1 PKP	ISOLATED GND1 PKP	SENS GND DIR1 BLOCK
SENS GND IOC1 OP	SENS GND TOC1 OP	ISOLATED GND1 OP	SENS GND DIR1 OP
SENS GND IOC2 PKP	SENS GND TOC2 PKP	ISOLATED GND2 PKP	SENS GND DIR2 BLOCK
SENS GND IOC2 OP	SENS GND TOC2 OP	ISOLATED GND2 OP	SENS GND DIR2 OP
SENS GND IOC3 PKP	SENS GND TOC3 PKP	ISOLATED GND3 PKP	SENS GND DIR3 BLOCK
SENS GND IOC3 OP	SENS GND TOC3 OP	ISOLATED GND3 OP	SENS GND DIR3 OP



### 6.2.3.6 NEGATIVE SEQUENCE CURRENT

This screen shows the pickup and trip for negative sequence elements in the F650. Any of these two events of any ground element will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual> Status > Protection >Negative Sequence Current**, and includes the following signaling LEDs:

**Table 6–9: NEGATIVE SEQUENCE CURRENT ACTUAL VALUES**

NEGATIVE SEQUENCE ACTUAL VALUES
NEG SEQ TOC1 PKP
NEG SEQ TOC1 OP
NEG SEQ TOC2 PKP
NEG SEQ TOC2 OP
NEG SEQ TOC3 PKP
NEG SEQ TOC3 OP

### 6.2.3.7 THERMAL MODEL

F650 units incorporate up to 3 thermal image elements. For each of them, this screen shows by means of green LEDs, the activation of the reset, alarm, operation and thermal image signals for each phase (A, B, C) and each unit (1, 2, 3). Any of the reset, alarm and operation signals will light up the corresponding LED in this screen, and it will remain lit as the associated function remains in reset, pickup or operation. This function also provides the thermal image value for all the phases and functions in percentage. All the values are provided individually for phases and for the three thermal elements.

This screen is accessed in menu: **Actual> Status > Protection >Thermal image**, and includes the following signaling LEDs:

**Table 6–10: THERMAL IMAGE ACTUAL VALUES**

THERMAL IMAGE RESET SIGNALS	THERMAL IMAGE ALARM SIGNALS	THERMAL IMAGE OPERATION SIGNALS	THERMAL IMAGE VALUE IN %
	THERMAL1 ALARM	THERMAL1 OP	
THERMAL1 A RST	THERMAL1 A ALRM	THERMAL1 A OP	THERMAL1 IMAGE A
THERMAL1 B RST	THERMAL1 B ALRM	THERMAL1 B OP	THERMAL1 IMAGE B
THERMAL1 C RST	THERMAL1 C ALRM	THERMAL1 C OP	THERMAL1 IMAGE C
	THERMAL2 ALARM	THERMAL2 OP	
THERMAL2 A RST	THERMAL2 A ALRM	THERMAL2 A OP	THERMAL2 IMAGE A
THERMAL2 B RST	THERMAL2 B ALRM	THERMAL2 B OP	THERMAL2 IMAGE B
THERMAL2 C RST	THERMAL2 C ALRM	THERMAL2 C OP	THERMAL2 IMAGE C
	THERMAL3 ALARM	THERMAL3 OP	
THERMAL3 A RST	THERMAL3 A ALRM	THERMAL3 A OP	THERMAL3 IMAGE A
THERMAL3 B RST	THERMAL3 B ALRM	THERMAL3 B OP	THERMAL3 IMAGE B
THERMAL3 C RST	THERMAL3 C ALRM	THERMAL3 C OP	THERMAL3 IMAGE C



### 6.2.3.8 VOLTAGE

This screen shows the activation of all voltage elements available in the F650. It can be accessed from the menu: **Actual > Status > Protection > Voltage**, and it includes the following signaling LEDs.

The values shown are:

Pickup and operation signals for phase to ground and phase-to-phase undervoltage elements and the three-phase signal for pickup and operation for the undervoltage element.

Pickup and operation for negative sequence overvoltage element.

Pickup and operation signals for phase-to-phase overvoltage elements and the three-phase signal for pickup and operation for the overvoltage element.

Pickup and operation for neutral overvoltage elements (High and low).

Pickup and operation for auxiliary undervoltage and overvoltage elements.

**Table 6–11: VOLTAGE ACTUAL VALUES**

UNDervOLTAGE ACTUAL VALUES		OVERVOLTAGE ACTUAL VALUES	NEUTRAL OV (HIGH AND LOW) ACTUAL VALUES
PHASE UV1 A PKP	PHASE UV2 PKP	PHASE OV1 AB PKP	NEUTRAL OV1 HIGH PKP
PHASE UV1 A OP	PHASE UV2 OP	PHASE OV1 AB OP	NEUTRAL OV1 HIGH OP
PHASE UV1 B PKP	PHASE UV3 A PKP	PHASE OV1 BC PKP	NEUTRAL OV2 HIGH PKP
PHASE UV1 B OP	PHASE UV3 A OP	PHASE OV1 BC OP	NEUTRAL OV2 HIGH OP
PHASE UV1 C PKP	PHASE UV3 B PKP	PHASE OV1 CA PKP	NEUTRAL OV3 HIGH PKP
PHASE UV1 C OP	PHASE UV3 B OP	PHASE OV1 CA OP	NEUTRAL OV3 HIGH OP
PHASE UV1 AB PKP	PHASE UV3 C PKP	PHASE OV1 PKP	NEUTRAL OV1 LOW PKP
PHASE UV1 AB OP	PHASE UV3 C OP	PHASE OV1 OP	NEUTRAL OV1 LOW OP
PHASE UV1 BC PKP	PHASE UV3 AB PKP	PHASE OV2 AB PKP	NEUTRAL OV2 LOW PKP
PHASE UV1 BC OP	PHASE UV3 AB OP	PHASE OV2 AB OP	NEUTRAL OV2 LOW OP
PHASE UV1 CA PKP	PHASE UV3 BC PKP	PHASE OV2 BC PKP	NEUTRAL OV3 LOW PKP
PHASE UV1 CA OP	PHASE UV3 BC OP	PHASE OV2 BC OP	NEUTRAL OV3 LOW OP
PHASE UV1 PKP	PHASE UV3 CA PKP	PHASE OV2 CA PKP	<b>AUXILIARY OV</b>
PHASE UV1 OP	PHASE UV3 CA OP	PHASE OV2 CA OP	AUXILIARY OV1 PKP
PHASE UV2 A PKP	PHASE UV3 PKP	PHASE OV2 PKP	AUXILIARY OV1 OP
PHASE UV2 A OP	PHASE UV3 OP	PHASE OV2 OP	AUXILIARY OV2 PKP
PHASE UV2 B PKP		PHASE OV3 AB PKP	AUXILIARY OV2 OP
PHASE UV2 B OP		PHASE OV3 AB OP	AUXILIARY OV3 PKP
PHASE UV2 C PKP		PHASE OV3 BC PKP	AUXILIARY OV3 OP
PHASE UV2 C OP		PHASE OV3 BC OP	<b>AUXILIARY UV</b>
PHASE UV2 AB PKP		PHASE OV3 CA PKP	AUXILIARY UV1 PKP
PHASE UV2 AB OP		PHASE OV3 CA OP	AUXILIARY UV1 OP
PHASE UV2 BC PKP		PHASE OV3 PKP	AUXILIARY UV2 PKP
PHASE UV2 BC OP		PHASE OV3 OP	AUXILIARY UV2 OP
PHASE UV2 CA PKP			AUXILIARY UV3 PKP
PHASE UV2 CA OP			AUXILIARY UV3 OP

### 6.2.3.9 POWER

Forward Power and directional power elements

There are three identical forward power and three directional power detection elements, each of them with two power-setting levels.

Represented statuses are basically Pickup and Trip (Operation) for each step in each function.

This functions may have several applications, for example, small generating plants connected to the power system, to limit the supplied power and not to exceed its rated capacity.

If programmed conditions for any of the three elements are met, the corresponding LEDs will light up.

This screen shows the activation of all power elements available in the F650. It can be accessed from the menu: **Actual>Status > Protection >Power**, and it includes the following signaling LEDs.

**Table 6–12: POWER ACTUAL VALUES**

FORWARD POWER ACTUAL VALUES	DIRECTIONAL POWER ACTUAL VALUES
FWD PWR1 STG1 PKP	DIR PWR1 STG1 PKP
FWD PWR1 STG1 OP	DIR PWR1 STG1 OP
FWD PWR1 STG2 PKP	DIR PWR1 STG2 PKP
FWD PWR1 STG2 OP	DIR PWR1 STG2 OP
	DIR PWR1 STG PKP
	DIR PWR1 STG OP
FWD PWR2 STG1 PKP	DIR PWR2 STG1 PKP
FWD PWR2 STG1 OP	DIR PWR2 STG1 OP
FWD PWR2 STG2 PKP	DIR PWR2 STG2 PKP
FWD PWR2 STG2 OP	DIR PWR2 STG2 OP
	DIR PWR2 STG PKP
	DIR PWR2 STG OP
FWD PWR3 STG1 PKP	DIR PWR3 STG1 PKP
FWD PWR3 STG1 OP	DIR PWR3 STG1 OP
FWD PWR3 STG2 PKP	DIR PWR3 STG2 PKP
FWD PWR3 STG2 OP	DIR PWR3 STG2 OP
	DIR PWR3 STG PKP
	DIR PWR3 STG OP

## 6.2.4 CONTROL ELEMENTS

## 6.2.4.1 FREQUENCY

F650 units incorporate three overfrequency and three underfrequency units. For each of them there are two magnitudes pickup and trip (operation).

Frequency elements are often used in generating plants, as well as in the connection of substations to the main system. Frequency monitoring is the base for synchronous machines protection application, with a couple of setting levels, as well as for the development of automatic shedding functions and underfrequency reset.

This screen shows the activation of all frequency elements available in the F650. It can be accessed from the menu: **Actual > Status > Control Elements > Frequency**, and it includes the following signaling LEDs.

Table 6–13: FREQUENCY ACTUAL VALUES

OVERFREQUENCY ACTUAL VALUES	UNDERFREQUENCY ACTUAL VALUES
OVERFREQ1 PKP	UNDERFREQ1 PKP
OVERFREQ1 OP	UNDERFREQ1 OP
OVERFREQ2 PKP	UNDERFREQ2 PKP
OVERFREQ2 OP	UNDERFREQ2 OP
OVERFREQ3 PKP	UNDERFREQ3 PKP
OVERFREQ3 OP	UNDERFREQ3 OP

## 6.2.4.2 SYNCHROCHECK

This screen can be accessed at **Actual > Status > Control Elements > Synchrocheck**, and it includes the following signaling LEDs for the synchronism check function:

Table 6–14: SYNCHROCHECK ACTUAL VALUES

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

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

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

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

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

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

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

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

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

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

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

### 6.2.4.3 AUTORECLOSE

This screen can be accessed at **Actual > Status > Control Elements > Autoreclose**, and it includes the following signaling LEDs for the Autoreclose function:

**Table 6–15: 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

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 block 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 1 <sup>st</sup> shot.
AR BLK AFTER 2 SHOT:	Signal sent by the autoreclose after the 2 <sup>nd</sup> shot.
AR BLK AFTER 3 SHOT:	Signal sent by the autoreclose after the 3 <sup>rd</sup> shot.
AR BLK AFTER 4 SHOT:	Signal sent by the autoreclose after the 4 <sup>th</sup> 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

#### 6.2.4.4 BREAKER FAILURE

This screen can be accessed at **Actual> Status > Control Elements > Breaker Failure**, and it includes the following signaling LEDs for the breaker failure function:

**Table 6–16: BREAKER FAILURE ACTUAL VALUES**

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

<b>BKR FAIL INITIATE</b>	External signal for breaker failure initiation. (configurable at <b>Settings&gt; Relay Configuration &gt; Protection Elements</b> ).
<b>BKR FAIL NO CURRENT</b>	Signal for breaker failure without current
<b>BKR FAIL SUPERVISION</b>	Signal for supervision level breaker failure (retrip)
<b>BKR FAIL HISET</b>	Signal for high-level breaker failure
<b>BKR FAIL LOWSET</b>	Signal for low-level breaker failure
<b>INTERNAL ARC</b>	Signal for internal arc
<b>BKR FAIL 2nd STEP</b>	Signal for Second level breaker failure (high and low)

#### 6.2.4.5 VT FUSE FAILURE

This screen can be accessed at **Actual> Status > Control Elements > VT Fuse Failure**, and it includes only one LEDs for the VT fuse failure function, indicating the activation of the unit.

**Table 6–17: VT FUSE FAILURE ACTUAL VALUES**

VT FUSE FAILURE ACTUAL VALUES
VT FUSE FAILURE

#### 6.2.4.6 BROKEN CONDUCTOR

F650 units incorporate three Broken Conductor elements for special applications that may require different timing steps or levels for alarm or trip purposes.

The green LED will light up when the pickup or trip (operation) of each of the three available functions is activated. The three of them are identical and can be configured separately.

These functions compare the negative and positive sequence current levels per phase. If this magnitude exceeds a programmable threshold and is maintained for a programmable time delay, a tripping output will be issued. If a pickup or operation is produced, the corresponding LED in this screen will light up.

This screen can be accessed at **Actual> Status > Control Elements > Broken Conductor**, and it includes the following signaling LEDs for the breaker failure function:

**Table 6–18: TABLE 6-18 BROKEN CONDUCTOR ACTUAL VALUES**

BROKEN CONDUCTOR ACTUAL VALUES
BROKEN CONDUCT1 PKP
BROKEN CONDUCT1 OP
BROKEN CONDUCT2 PKP
BROKEN CONDUCT2 OP
BROKEN CONDUCT3 PKP
BROKEN CONDUCT3 OP

#### 6.2.4.7 SETTING GROUPS

This screen can be accessed at **Actual> Status > Control Elements > Setting Groups**, and it includes activation and block signals for the relay setting groups change in the following signaling LEDs:

**Table 6–19: SETTING GROUP ACTUAL VALUES**

SETTING GROUPS ACTUAL VALUES
GROUP 1 ACT ON
GROUP 2 ACT ON
GROUP 3 ACT ON
GROUP 1 BLOCKED
GROUP 2 BLOCKED
GROUP 3 BLOCKED

#### 6.2.4.8 LOCKED ROTOR

F650 units incorporate three locked rotor units. For each of them there are two magnitudes pickup and trip (operation).

This screen shows the activation of all locked rotor elements available in the F650. It can be accessed from the menu: **Actual> Status > Control Elements > Locked Rotor**, and it includes the following signaling LEDs.

**Table 6–20: LOCKED ROTOR ACTUAL VALUES**

LOCKED ROTOR ACTUAL VALUES
LOCKED ROTOR1 PKP
LOCKED ROTOR1 OP
LOCKED ROTOR2 PKP
LOCKED ROTOR2 OP
LOCKED ROTOR3 PKP
LOCKED ROTOR3 OP

## 6.2.5 PROTECTION SUMMARY

**Actual > Status > Protection Summary**. This screen shows a complete listing of all protection and control elements in the relay, showing their status (enabled or not) through the corresponding LED. **Table 6–21:**

Phase IOC1 High
Phase IOC2 High
Phase IOC3 High
Phase IOC1 Low
Phase IOC2 Low
Phase IOC3 Low
Neutral IOC1
Neutral IOC2
Neutral IOC3
Ground IOC1
Ground IOC2
Ground IOC3
Sensitive Ground IOC1
Sensitive Ground IOC2
Sensitive Ground IOC3
Phase TOC1 High
Phase TOC2 High
Phase TOC3 High
Neutral TOC1
Neutral TOC2
Neutral TOC3
Ground TOC1
Ground TOC2
Ground TOC3
Sensitive Ground TOC1
Sensitive Ground TOC2
Sensitive Ground TOC3
Phase UV1
Phase UV2
Phase UV3
Negative Sequence OV1
Negative Sequence OV2
Negative Sequence OV3
Thermal Image1
Thermal Image2
Thermal Image3
Phase Directional1
Phase Directional2
Phase Directional3
Neutral Directional1
Neutral Directional2
Neutral Directional3
Ground Directional1
Ground Directional2
Ground Directional3
Breaker Failure
Fuse Failure

Synchrocheck
Recloser
Neutral OV1 High
Neutral OV2 High
Neutral OV3 High
Neutral OV1 Low
Neutral OV2 Low
Neutral OV3 Low
Auxiliary UV1
Auxiliary UV2
Auxiliary UV3
Phase OV1
Phase OV2
Phase OV3
Auxiliary OV1
Auxiliary OV2
Auxiliary OV3
Negative Sequence TOC1
Negative Sequence TOC2
Negative Sequence TOC3
Overfrequency1
Overfrequency2
Overfrequency3
Underfrequency1
Underfrequency2
Underfrequency3
Oscillography
Fault Report
Broken Conductor1
Broken Conductor2
Broken Conductor3
Isolated Ground IOC1
Isolated Ground IOC2
Isolated Ground IOC3
Sensitive Ground Directional1
Sensitive Ground Directional2
Sensitive Ground Directional3
Forward power1
Forward power2
Forward power3
Demand
Phase TOC1 Low
Phase TOC2 Low
Phase TOC3 Low
Data Logger
Directional Power1
Directional Power2
Directional Power3
Locked Rotor1
Locked Rotor2
Locked Rotor3



## 6.2.6 SNAPSHOT EVENTS SUMMARY

**Actual > Status > Snapshot Event Summary**

The F650 provides via setting the possibility to enable or disable the snapshot event generation in the different functions available in the device.

This screen shows a complete listing of the snapshot event generation for all the protection, control and inputs/outputs elements in the relay, showing their status (enabled or not) through the corresponding LED.

**Table 6–22: SNAPSHOT EVENT SUMMARY**

SNAPSHOT EVENTS SUMMARY
Board F Event
Board G Event
General Settings Event
Phase IOC1 High Event
Phase IOC2 High Event
Phase IOC3 High Event
Phase IOC1 Low Event
Phase IOC2 Low Event
Phase IOC3 Low Event
Neutral IOC1 Event
Neutral IOC2 Event
Neutral IOC3 Event
Ground IOC1 Event
Ground IOC2 Event
Ground IOC3 Event
Sensitive Ground IOC1 Event
Sensitive Ground IOC2 Event
Sensitive Ground IOC3 Event
Phase TOC1 High Event
Phase TOC2 High Event
Phase TOC3 High Event
Neutral TOC1 Event
Neutral TOC2 Event
Neutral TOC3 Event
Ground TOC1 Event
Ground TOC2 Event
Ground TOC3 Event
Sensitive Ground TOC1 Event
Sensitive Ground TOC2 Event
Sensitive Ground TOC3 Event
Phase UV1 Event
Phase UV2 Event
Phase UV3 Event
Negative Sequence OV1 Event
Negative Sequence OV2 Event
Negative Sequence OV3 Event
Thermal Model1 Event
Thermal Model2 Event

Thermal Model3 Event
Phase Directional1 Event
Phase Directional2 Event
Phase Directional3 Event
Neutral Directional1 Event
Neutral Directional2 Event
Neutral Directional3 Event
Ground Directional1 Event
Ground Directional2 Event
Ground Directional3 Event
Breaker Failure Event
VT Fuse Failure Event
Synchrocheck Event
Autoreclose Event
Neutral OV1 High Event
Neutral OV2 High Event
Neutral OV3 High Event
Neutral OV1 Low Event
Neutral OV2 Low Event
Neutral OV3 Low Event
Auxiliary UV1 Event
Auxiliary UV2 Event
Auxiliary UV3 Event
Phase OV1 Event
Phase OV2 Event
Phase OV3 Event
Auxiliary OV1 Event
Auxiliary OV2 Event
Auxiliary OV3 Event
Negative Sequence TOC1 Event
Negative Sequence TOC2 Event
Negative Sequence TOC3 Event
Overfrequency1 Event
Overfrequency2 Event
Overfrequency3 Event
Underfrequency1 Event
Underfrequency2 Event
Underfrequency3 Event
Oscillography Event
Fault Report Event
Setting Group Event
Broken Conductor1 Event
Broken Conductor2 Event
Broken Conductor3 Event
Isolated Ground IOC1 Event
Isolated Ground IOC2 Event
Isolated Ground IOC3 Event
Sensitive Ground Directional1 Event
Sensitive Ground Directional2 Event

Sensitive Ground Directional3 Event
Forward Power1 Event
Forward Power2 Event
Forward Power3 Event
Demand Event
Board H Event
Board J Event
Phase TOC1 Low Event
Phase TOC2 Low Event
Phase TOC3 Low Event
Switchgear1 Event
Switchgear2 Event
Switchgear3 Event
Switchgear4 Event
Switchgear5 Event
Switchgear6 Event
Switchgear7 Event
Switchgear8 Event
Switchgear9 Event
Switchgear10 Event
Switchgear11 Event
Switchgear12 Event
Switchgear13 Event
Switchgear14 Event
Switchgear15 Event
Switchgear16 Event
Breaker Settings Event
Directional Power1 Event
Directional Power2 Event
Directional Power3 Event
Locked Rotor1 Event
Locked Rotor2 Event
Locked Rotor3 Event

### 6.2.7 MODBUS USER MAP

The ModBus User Map consists of a selection of the most important 256 records in the complete ModBus Map regarding the application. By selecting these records and defining the user map appropriately, it is possible to read all the information included by a single ModBus reading operation, optimizing the refresh time.

This screen can be accessed at **Actual> Status > ModBus User Map**, and it includes all the readings for the previously configured records in the ModBus memory map.

**Table 6–23: MODBUS USER MAP ACTUAL VALUES**

MODBUS USER MAP
Address 00
Address 01
...
Address 255

## 6.2.8 SWITCHGEAR STATUS

**Actual > Status > Switchgear Status**

For a better understanding of the represented statuses in this screen, figure 6.1 shows the available “Switchgear” modules to be programmed in the F650. 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).g

Each Switchgear module can be programmed at: **Setpoint > Relay Configuration > Switchgear**, and its statuses are as follows:

**Table 6–24: SWITCHGEAR STATUS**

SWITCHGEAR 1 STATUS		SWITCHGEAR X STATUS		SWITCHGEAR 16 STATUS
SWITCH 1 A INPUT	...	SWITCH X A INPUT	...	SWITCH 16 A INPUT
SWITCH 1 B INPUT	...	SWITCH X B INPUT	...	SWITCH 16 B INPUT
SWITCH 1 A STATUS	...	SWITCH X A STATUS	...	SWITCH 16 A STATUS
SWITCH 1 B STATUS	...	SWITCH X B STATUS	...	SWITCH 16 B STATUS
SWITCH 1 OPEN	...	SWITCH X OPEN	...	SWITCH 16 OPEN
SWITCH 1 CLOSED	...	SWITCH X CLOSED	...	SWITCH 16 CLOSED
SWITCH 1 00_ERROR	...	SWITCH X 00_ERROR	...	SWITCH 16 00_ERROR
SWITCH 1 11_ERROR	...	SWITCH X 11_ERROR	...	SWITCH 16 11_ERROR
SWITCH 1 OPEN INIT	...	SWITCH X OPEN INIT	...	SWITCH 16 OPEN INIT
SWITCH 1 CLOSE INIT	...	SWITCH X CLOSE INIT	...	SWITCH 16 CLOSE INIT
SWGR 1 FAIL TO OPEN	...	SWGR X FAIL TO OPEN	...	SWGR 16 FAIL TO OPEN
SWGR 1 FAIL TO CLOSE	...	SWGR X FAIL TO CLOSE	...	SWGR 16 FAIL TO CLOSE

SWITCH X A INPUT	The LED will light up when the input associated to that switchgear Contact A is activated.
SWITCH X B INPUT	The LED will light up when the input associated to that switchgear Contact B is activated.
SWITCH X A STATUS	Status associated to Switchgear contact A. It is activated once the time required for the Switchgear module to acknowledge contact A has expired.
SWITCH X B STATUS	Status associated to Switchgear contact B. It is activated once the time required for the Switchgear module to acknowledge contact B has expired..
SWITCH X OPEN	Lights up when the associated switchgear is open
SWITCH X CLOSED	Lights up when the associated switchgear is closed
SWITCH X 00_ERROR	Output that represents the Switchgear status 00, considered as abnormal.
SWITCH X 11_ERROR	Output that represents the Switchgear status 11, considered as abnormal.
SWITCH X OPEN INIT	Programmable input that indicates the initiation of the Opening Operation for the considered switchgear.
SWITCH X CLOSE INIT	Programmable input that indicates the initiation of the closing Operation for the considered switchgear.
SWGR X FAIL TO OPEN	Output that represents a failure to open, from the associated external device (opening time exceeded)
SWGR X FAIL TO CLOSE	Output that represents a failure to close from the associated external device (closing time exceeded)

See attached figure

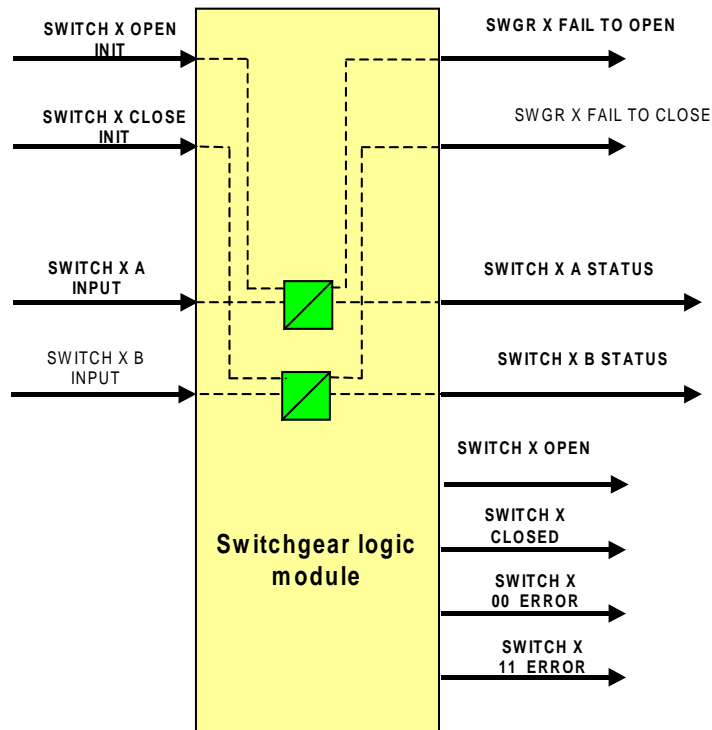


Figure 6–1: SWITCHGEAR CONTACTS

### 6.2.9 CALIBRATION

This screen can be accessed at **Actual > Status > Calibration**, and it includes the internal calibration status for the relay.

Table 6–25: CALIBRATION STATUS

CALIBRATION
FACTORY CALIBRATION
CALIBRATION ERROR

**FACTORY CALIBRATION:** this value will be active when the relay calibration settings are the default values (no calibration).

**CALIBRATION ERROR:** Error shown when there is a problem in the calibration settings (wrong values).

## 6.2.10 FLEX CURVES

This screen can be accessed at **Actual> Status > Flex Curves**, and it includes the internal flex curves status.

If the LED associated to the FlexCurve status is lit up, this indicates that the user curve has been configured with new values (not default values).

**Table 6–26: FLEX CURVES STATUS**

FLEX CURVES STATUS
FLEXCURVE A STATUS
FLEXCURVE B STATUS
FLEXCURVE C STATUS
FLEXCURVE D STATUS

## 6.2.11 SYSTEM INFO

This screen can monitor the system parameters and the internal status of the Relay operative system. It is only available with password provided by the manufacturer.

## 6.2.12 RECORD STATUS

This screen shows part of the information related to the different records stored in the Relay, such as:

## 6.2.12.1 FAULT REPORTS

**Actual> Status > Records Status > Fault Reports**

**Table 6–27: FAULT REPORT STATUS**

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

**FAULT REPORT TRIGG:** This signal indicates whether the signal that initiates the calculation of the distance to the fault has been activated.

**CLEAR FAULT REPORTS:** This signal indicates the reset of fault reports.

**FAULT DATE:** Date and time of the last fault produced in the relay. In format (Day/Month/year Hour:minutes:seconds.milliseconds)

**FAULT TYPE:** Type of the last fault produced in the Relay (phase to ground, phase to phase, three-phase, etc).

**FAULT LOCATION:** Location of the last fault produced in the relay.

**FAULT REPORT NUMBER:** Number of fault reports available in the relay (ten is the maximum number of records supported by the relay).

### 6.2.12.2 CONTROL EVENTS

#### **Actual> Status > Records Status > Control Events**

In this screen **Actual> Status > Records Status > Control Events**, the status of the signals configured to launch the control events can be seen, activated or not.

The F650 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 6–28: CONTROL EVENTS STATUS**

CONTROL EVENTS
CONTROL EVENT 1
CONTROL EVENT 2
...
CONTROL EVENT 128

### 6.2.12.3 OSCILLOGRAPHY

#### **Actual> Status > Records Status > Oscillography**

The following figure shows the status of the different digital channels that can be programmed to be included in oscillography records. When the signal associated to a specific channel is active, its LED will light up on this screen.

This screen shows as well the oscillography trigger status, active or inactive, by lighting up that channel.

**Table 6–29: OSCILLOGRAPHY STATUS**

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

The last three values shown are as follows:

**NUMBER OF TRIGGERS:** This is the number of the last oscillography record obtained in the relay. This value has a range of 0 to 999.

**CYCLES PER RECORD:** This is the number of cycles contained in the oscillography record; this value depends on the settings adjusted on the oscillography menu at **Setpoint > Product Setup > Oscillography**.

**AVAILABLE RECORDS:** This is the number of available oscillography records in the relay.

Values for these last 3 fields are reset every time the oscillography settings are modified.

**6.2.12.4 DATA LOGGER****Actual> Status > Records Status > Data Logger****Table 6–30: DATA LOGGER STATUS**

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

**OLDEST SAMPLE TIME:** Date and time of the oldest value stored in the data logger.

**NEWEST SAMPLE TIME:** Date and time of the most recent value stored in the data logger

**DATA LOGGER CHANNELS:** Number of channels configured in the data logger

**DATA LOGGER DAYS:** Time in days during which, samples are stored without overwriting them.

**6.2.12.5 DEMAND****Actual> Status > Records Status > Demand****Table 6–31: 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**

**6.2.12.6 ENERGY**

**Freeze/Unfreeze/reset Energy:** These signals correspond to the relay energy counters statuses of freeze, unfreeze and reset.

**Actual> Status > Records Status > Energy****Table 6–32: ENERGY STATUS**

ENERGY
FREEZE ENERGY CNT
UNFREEZE ENERGY CNT
RESET ENERGY CNT

**FREEZE ENERGY CNT:** Signal used to freeze the energy counters for measurement purposes.

**UNFREEZE ENERGY CNT:** Signal used to unfreeze the energy counters.

**RESET ENERGY CNT:** Signal to reset the energy measurements and set the values to zero.

These signals can be configured at **Setpoint > Relay Configuration > Protection Elements**

**6.2.12.7 BREAKER MAINTENANCE****Actual > Status > Records Status > Breaker Maintenance**

This screen shows the breaker status related to breaker maintenance. Other statuses are provided in the different switchgear or breaker status signals.

**Table 6–33: 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 ALRM	
BREAKER OPENINGS	
BREAKER CLOSINGS	
KI2t PHASE A	
KI2t PHASE B	
KI2t PHASE C	
BKR OPENING TIME	
BKR CLOSING TIME	

The breaker maintenance inputs are signals that can be configured at **Setpoint > Relay Configuration > Protection Elements**:

RESET KI2t COUNTERS	Signal to reset and set to zero all the KI2t counters (for all phases)
RESET BKR COUNTERS	Signal to reset and set to zero all the breaker counters (number of openings and closings and alarms)
KI2t PHASE A ALARM	Alarm signal for maximum breaking capacity in phase A exceeded
KI2t PHASE B ALARM	Alarm signal for maximum breaking capacity in phase B exceeded
KI2t PHASE C ALARM	Alarm signal for maximum breaking capacity in phase C exceeded
BKR OPENINGS ALARM	Alarm related to the maximum number of breaker openings
BKR OPEN 1 HOUR ALRM	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 <sup>2</sup> t phase A counter (total accumulative breaking level – phase A)
KI2t PHASE B	ki <sup>2</sup> t phase B counter (total accumulative breaking level – phase B)
KI2t PHASE C	ki <sup>2</sup> t phase C counter (total accumulative breaking level – phase C)
BKR OPENING TIME	Time to set a failure in opening the breaker.
BKR CLOSING TIME	Time to set a failure in closing the breaker.

Breaker opening and closing time signals are configured at **Setpoint > Relay Configuration > Switchgear** for the related switchgear device.



Values shown in each section are as follows:

### 6.3.1 PRIMARY VALUES

#### 6.3.1.1 CURRENT

*Actual > Metering > Primary Values > Current*

**Table 6–34: CURRENT PRIMARY VALUES**

DESCRIPTION	UNITS
CT Ratio	N/A
CT Ratio Ig	N/A
CT Ratio Isg	N/A
Ia Angle	Deg
Ib Angle	Deg
Ic Angle	Deg
In Angle	Deg
Ig Angle	Deg
Isg Angle	Deg
Phasor Ia Primary	KA
Phasor Ib Primary	KA
Phasor Ic Primary	KA
Phasor Ig Primary	KA
Phasor Isg Primary	KA
Phasor In Primary	KA
RMS Ia Primary	KA
RMS Ib Primary	KA
RMS Ic Primary	KA
RMS Ig Primary	KA
RMS Isg Primary	KA
I0 Primary	KA
I1 Primary	KA
I2 Primary	KA

## 6.3.1.2 VOLTAGE

*Actual > Metering > Primary Values > Voltage*

Table 6–35: VOLTAGE PRIMARY VALUES

DESCRIPTION	UNITS
PT Ratio	N/A
Va Angle	Deg
Vb Angle	Deg
Vc Angle	Deg
Vn Angle	Deg
Vx Angle	Deg
Vab Angle	Deg
Vbc Angle	Deg
Vca Angle	Deg
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*

Table 6–36: POWER PRIMARY VALUES

DESCRIPTION	UNITS
Phase A Real Pwr	MW
Phase A Reactive Pwr	MVAr
Phase A Apparent Pwr	MVA
Phase B Real Pwr	MW
Phase B Reactive Pwr	MVAr
Phase B Apparent Pwr	MVA
Phase C Real Pwr	MW
Phase C Reactive Pwr	MVAr
Phase C Apparent Pwr	MVA
3 Phase Real Pwr	MW
3 Phase Reactive Pwr	MVAr
3 Phase Apparent Pwr	MVA
Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

**NOTE:** If voltage inputs are configured in Delta connection and the auxiliary voltage input is set as Vx, measurement of single phase power value cannot be duly calculated, and therefore, its value will be zero. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

**6.3.1.4 ENERGY****Actual> Metering > Primary Values > Energy**

Energy is only given in three phase primary values

**Table 6–37: ENERGY PRIMARY VALUES**

DESCRIPTION	UNITS
Positive MWatthour	MWh
Negative MWatthour	MWh
Positive MVarhour	MVArh
Negative MVarhour	MVArh
Pos Mwatthour Cnt	MWh
Neg Mwatthour Cnt	MWh
Pos MVarhour Cnt	MVArh
Neg MVarhour Cnt	MVArh

When the energy counters reach the value  $(2^{31})/1000$  (approximately. 2147 MVArh and MWh) all the values are set to zero and starts counting again.

**6.3.1.5 DEMAND****Actual> Metering > Primary Values > Demand**

Demand is only given in primary values

**Table 6–38: DEMAND PRIMARY VALUES**

DESCRIPTION	UNITS
DEMAND IA	KA
DEMAND IA MAX	KA
DEMAND IA DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IB	KA
DEMAND IB MAX	KA
DEMAND IB DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IC	KA
DEMAND IC MAX	KA
DEMAND IC DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IG	KA
DEMAND IG MAX	KA
DEMAND IG DATE	dd/mm/yy hh:mm:ss:ms
DEMAND ISG	KA
DEMAND ISG MAX	KA
DEMAND ISG DATE	dd/mm/yy hh:mm:ss:ms
DEMAND I2	KA
DEMAND I2 MAX	KA
DEMAND I2 DATE	dd/mm/yy hh:mm:ss:ms
DEMAND W	MW
DEMAND W MAX	MW
DEMAND W DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VAR PWR	MVAr
DEMAND VAR MAX	MVAr
DEMAND VAR DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VA PWR	MVA
DEMAND VA MAX	MVA
DEMAND VA DATE	dd/mm/yy hh:mm:ss:ms

## 6.3.2 SECONDARY VALUES

## 6.3.2.1 CURRENT

*Actual > Metering > Secondary Values > Current*

Table 6–39: CURRENT SECONDARY VALUES

DESCRIPTION	UNITS
Phasor Ia	A
RMS Ia	A
Phasor Ib	A
RMS Ib	A
Phasor Ic	A
RMS Ic	A
Phasor In	A
Phasor Ig	A
RMS Ig	A
Phasor Isg	A
RMS Isg	A
Zero seq I0	A
Positive Seq I1	A
Negative Seq I2	A

## 6.3.2.2 VOLTAGE

*Actual > Metering > Secondary Values > Voltage*

Table 6–40: VOLTAGE SECONDARY VALUES

DESCRIPTION	UNITS
Phasor Vab	V
Phasor Vbc	V
Phasor Vca	V
Phasor Van	V
Phasor Vbn	V
Phasor Vcn	V
Phasor Vn	V
Positive Seq V1	V
Negative Seq V2	V
Zero Seq V0	V
Phasor Vx	V
Nominal Voltage	V
Line Voltage	V
Bus Voltage	V

## 6.3.2.3 POWER

**Actual > Metering > Secondary Values > Power**

**Table 6–41: POWER SECONDARY VALUES**

DESCRIPTION	UNITS
Phase A Apparent Pwr	VA
Phase B Apparent Pwr	VA
Phase C Apparent Pwr	VA
Phase A Real Pwr	W
Phase B Real Pwr	W
Phase C Real Pwr	W
Phase A Reactive Pwr	VARs
Phase B Reactive Pwr	VARs
Phase C Reactive Pwr	VARs
3 Phase Apparent Pwr	VA
3 Phase Real Pwr	W
3 Phase Reactive Pwr	VARs
Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

**NOTE:** If voltage inputs are configured in Delta connection and the auxiliary voltage input is set as  $V_x$ , measurement of single phase power value cannot be duly calculated, and therefore, its value will be 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 clockwise, all the angles are positive values, so for a system  $V_a$  (0,0°),  $V_b$  (0,-120°),  $V_c$  (0,120°) the relay will provided the following angles  $V_a$  (0,0°),  $V_b$  (0,120°),  $V_c$  (0,240°).

The following figure shows the phasor diagram provided by EnerVista F650 Setup:

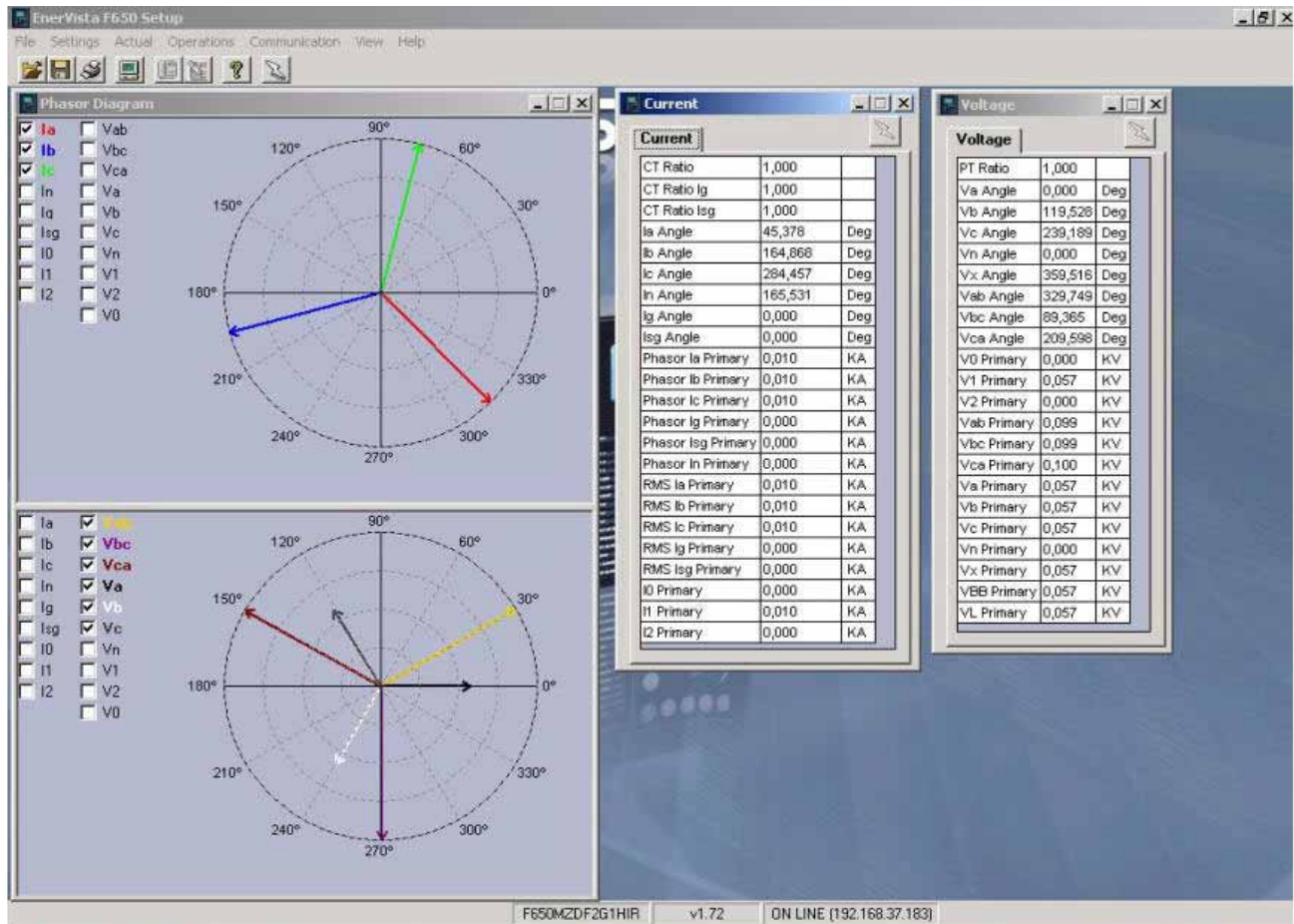


Figure 6–2: PHASOR DIAGRAM

## 6.3.4 FREQUENCY

**Actual> Metering > Frequency**

Table 6–42: FREQUENCY VALUES

DESCRIPTION	UNITS
Line Frequency	Hz
Bus Frequency	Hz

## 6.3.5 INPUTS / OUTPUTS

Digital inputs and outputs are located in the same board. Depending on the relay model, the number of inputs and outputs will vary as:

If the relay model is F650\*\*\*F1\*\*\* the unit will incorporate 1 board (**F**) with 16 inputs and 8 outputs.

If the relay model is F650\*\*\*F2\*\*\* the unit will incorporate 1 board (**F**) with:

8 inputs + 4 tripping coil supervision circuits and

6 outputs + 2 outputs with tripping current supervision circuits

If the relay model is F650\*\*\*F\*G1\*\* the unit will incorporate a second board (**G**) with 16 inputs and 8 outputs

## 6.3.5.1 CONTACT INPUTS

**Actual > Inputs/Outputs > Contact inputs > Board X** (being X the corresponding board in each case).

On the inputs screen, the LED associated to the activated input will light up in green, if an input is not activated, the LED will not light up. The "**Board X Status**" LED indicates the status of the board; it will be lit up if the board is correct and the communication or the Relay model is appropriate.

**Table 6–43: CONTACT INPUTS ACTIVATION SIGNALS**

CONTACT INPUTS TYPE 1	CONTACT INPUTS TYPE 2
CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)
CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)
CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)
CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)
CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)
CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)
CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)
CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)
CONT IP_X_CC9 (Va_COIL1)	CONT IP_X_CC9 (CC9)
CONT IP_X_CC10 (Vb_COIL1)	CONT IP_X_CC10 (CC10)
CONT IP_X_CC11 (Va_COIL2)	CONT IP_X_CC11 (CC11)
CONT IP_X_CC12 (Vb_COIL2)	CONT IP_X_CC12 (CC12)
CONT IP_X_CC13 (O7_SEAL)	CONT IP_X_CC13 (CC13)
CONT IP_X_CC14 (O8_SEAL)	CONT IP_X_CC14 (CC14)
CONT IP_X_CC15 (SUP_COIL1)	CONT IP_X_CC15 (CC15)
CONT IP_X_CC16 (SUP_COIL2)	CONT IP_X_CC16 (CC16)
BOARD X STATUS	BOARD X STATUS

### 6.3.5.2 CONTACT OUTPUT STATUS

**Actual > Inputs/Outputs > Contact Output Status > Board X** (being X the corresponding board in each case).

The corresponding Outputs screen will display the activation of a contact output by lighting up in green the associated LED. Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in .

This screen shows the real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in “**Setpoint > Inputs/Outputs > Contact I/O > Board X**”

**Table 6–44: CONTACT OUTPUT STATUS**

CONTACT OUTPUT STATUS
CONT OP_X_01
CONT OP_X_02
CONT OP_X_03
CONT OP_X_04
CONT OP_X_05
CONT OP_X_06
CONT OP_X_07
CONT OP_X_08
BOARD X STATUS

**NOTE:** Both in the outputs menu as in the rest of menus available in “**Actual**”, the user can view several screens at the same time to facilitate analysis.

### 6.3.5.3 CONTACT OUTPUT OPERATES

**Actual > Inputs/Outputs > Contact Output Operates > Board X** (being X the corresponding board in each case).

**Table 6–45: CONTACT OUTPUTS OPERATES**

CONTACT OUTPUT OPERATES
CONT OP OPER_X_01
CONT OP OPER_X_02
CONT OP OPER_X_03
CONT OP OPER_X_04
CONT OP OPER_X_05
CONT OP OPER_X_06
CONT OP OPER_X_07
CONT OP OPER_X_08
BOARD X STATUS

These screens are available for all boards incorporated in the relay model, which can be F, G, H, and/or J.

This screen shows the activated or deactivated status of those variables used internally to operate a contact output.

Signals shown on this screen are configured in the Outputs screen inside the **Setpoint > Relay Configuration** menu, either directly by selecting the signals provided by the relay, or selecting a signal provided by the logic configured at **Setpoint > Logic Configuration**.

These logic signals (Contact Output Operates), when being transformed by the outputs logic configured at **Setpoint > Inputs/Outputs > Contact I/O > Board X** become **Contact Output** signals. This output logic can be POSITIVE, NEGATIVE, pulse, latched, etc.



Operation example of output contacts:

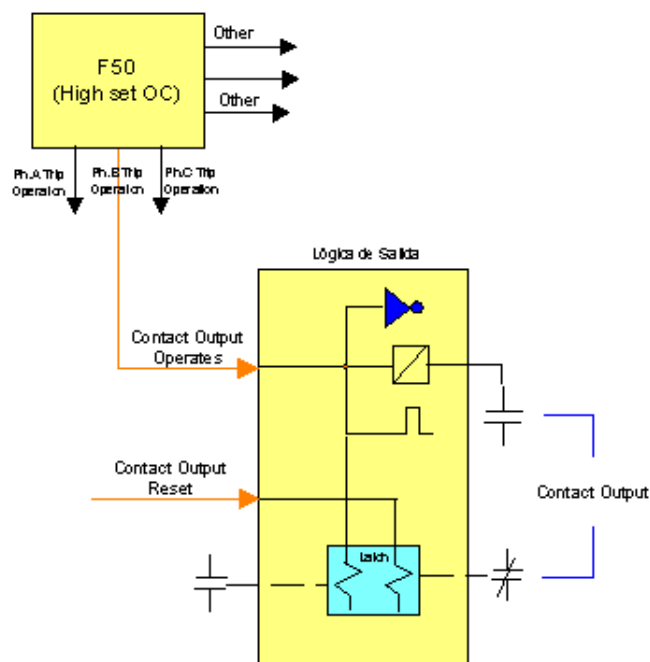


Figure 6–3: OUTPUT CONTACTS OPERATION

## 6

### 6.3.5.4 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 will light up. Otherwise, it will remain unlit.

Table 6–46: CONTACT OUTPUT RESETS

CONTACT OUTPUT RESETS
CONT OP RESET_X_01
CONT OP RESET_X_02
CONT OP RESET_X_03
CONT OP RESET_X_04
CONT OP RESET_X_05
CONT OP RESET_X_06
CONT OP RESET_X_07
CONT OP RESET_X_08
BOARD X STATUS

The last LED in this screen, labeled as “Board Status”, indicates the general board status.

This output reset Command will only be effective if the “***latch***” option has been selected for the “***Output Type***” setting on the I/O board, thus when the contact output has been configured to emulate function 86 (latching relay).

Configuration for the contact output reset signal is set at **Setpoint > Relay Configuration > Outputs > Contact Output Reset**.

### 6.3.5.5 I/O BOARD STATUS

#### **Actual > Inputs/Outputs > I/O Board Status**

This screen is used for verifying the status of I/O boards. If all the I/O boards, one (F) or both (F and G) depending on the relay model, are correctly inserted in their tracks and are in good state and communicating through the internal CAN Bus, the green LED will remain lit.

I/O boards accessible through the external CAN Bus are labeled as H and J. In order to start working with the external I/O boards is necessary to select the appropriated I/O board type for each slot (H or J for the CIO module) at **Setpoint > Inputs/Outputs > Contact I/O > Board H and J**. Otherwise the relay will not start communicating through external can to the related board.

If one of the boards has been extracted, or the relay model does not match the installed hardware, the corresponding LED will remain unlit.

**Table 6–47: I/O BOARD STATUS**

I/O BOARD STATUS
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS

For all I/O board screens described above, the last LED provides this same information individually.

### 6.3.5.6 VIRTUAL INPUTS

#### **Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset**

“Virtual Inputs” are signals transmitted by communications. The EnerVista F650 Setup provides a tool to set virtual inputs through ModBus at **Setpoint > Inputs /Outputs /Virtual inputs** that is only available in on line mode (communicating to the relay). There are two available groups of 32 signals each: Latched inputs and Self-reset inputs, and all of them can be used internally to perform operations, new logics in the PLC, etc.

In this actual values screen the status of the assigned virtual inputs can as shown on :

**Table 6–48: VIRTUAL INPUTS STATUS**

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
...	...
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

### 6.3.5.7 VIRTUAL OUTPUTS

#### **Actual > Inputs/Outputs > Virtual Outputs**

This screen provides the status of the 512 configurable virtual outputs (internal variables) used in the logic scheme. The virtual outputs are set from 000 to 511.

The configuration of the logic associated to the virtual output is in the **Setpoint > Logic Configuration** tool provided by EnerVista F650 Setup program.

**Table 6–49: VIRTUAL OUTPUTS STATUS**

VIRTUAL OUTPUT STATUS
VIRTUAL OUTPUT 000
VIRTUAL OUTPUT 001
...
VIRTUAL OUTPUT 511

## 6.4.1 EVENT RECORDER

## 6.4.1.1 ALL SNAPSHOT EVENTS

**Actual > Records > Event Recorder > All Snapshot Events**

By selecting this option, the F650 provides a general list of all snapshot events stored in the relay up to the request moment:

Select	Event	Date/Time	Cause
<input checked="" type="checkbox"/>	796	14-Oct-2003 12:00:12.749	Led 15 ON
<input checked="" type="checkbox"/>	795	14-Oct-2003 12:00:12.749	Led 14 ON
<input checked="" type="checkbox"/>	794	14-Oct-2003 12:00:12.749	Led 13 ON
<input checked="" type="checkbox"/>	793	14-Oct-2003 12:00:12.749	Led 12 ON
<input checked="" type="checkbox"/>	792	14-Oct-2003 12:00:12.749	Led 11 ON
<input checked="" type="checkbox"/>	791	14-Oct-2003 12:00:12.749	Led 10 ON
<input checked="" type="checkbox"/>	790	14-Oct-2003 12:00:12.749	Led 9 ON
<input checked="" type="checkbox"/>	789	14-Oct-2003 12:00:12.749	Led 8 ON
<input checked="" type="checkbox"/>	788	14-Oct-2003 12:00:12.749	Led 7 ON
<input checked="" type="checkbox"/>	787	14-Oct-2003 12:00:12.749	Led 6 ON
<input checked="" type="checkbox"/>	786	14-Oct-2003 12:00:12.749	Led 5 ON
<input checked="" type="checkbox"/>	785	14-Oct-2003 12:00:12.749	Led 4 ON
<input checked="" type="checkbox"/>	784	14-Oct-2003 12:00:12.749	Led 3 ON
<input checked="" type="checkbox"/>	783	14-Oct-2003 12:00:12.749	Led 2 ON
<input checked="" type="checkbox"/>	782	14-Oct-2003 12:00:12.749	Led 1 ON
<input checked="" type="checkbox"/>	781	14-Oct-2003 12:00:12.749	Led 15 OFF
<input checked="" type="checkbox"/>	780	14-Oct-2003 12:00:12.749	Led 14 OFF

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 ).

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.

Parameter	Actual value
Event Num	5197
Date/Time	01-Jan-2004 22:20:14.911
Cause	Fault Locator Trigger ON
Phasor Ia	3.001
Phasor Ib	7.349
Phasor Ic	3.190
Line Frequency	60.165
Phasor Ig	0.722
Phasor Isg	0.723
Zero seq I0	3.091
Positive seq I1	2.801
Negative seq I2	3.415
Phasor Vm	69.492
Phasor Vbn	31.403
Phasor Vcn	60.851
Positive Seq V1	51.657
Negative Seq V2	13.946
Zero Seq V0	18.494
3 Phase Power Factor	-0.618

Figure 6–5: SNAPSHOT EVENT DETAILS

### 6.4.1.2 NEW SNAPSHOT EVENTS

#### **Actual > Records > Event Recorder > New Snapshot Events**

This screen shows new Snapshot events, updated since the last time that this menu was accessed; there are three possible ways to access new events; in local mode (COM2-HMI), remote mode (COM1) and via Ethernet (COM3).

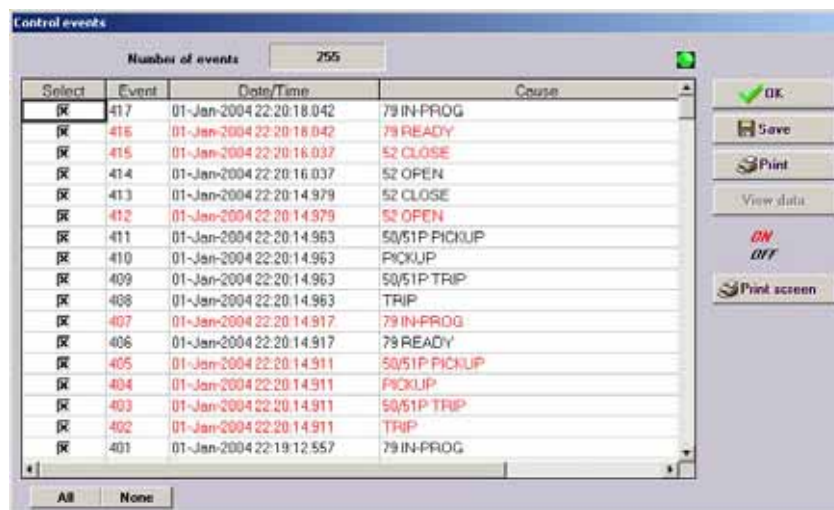
It is the same type of screen as shown on all snapshot event retrieval.

### 6.4.1.3 CONTROL EVENTS

#### **Actual > Records > Event Recorder > Control Events**

This screen is identical to the previous ones. The difference is that this screen will display only control events, i.e., those events configured in section **Setpoint > Relay Configuration > Events**. There are a total of 128 configurable events and 64 non-configurable switchgear events.

In this screen, red or black color for a specific event indicates whether it is activated (to 1) or in standby (to 0)



Select	Event	Date/Time	Cause
OK	417	01-Jan-2004 22:20:18.042	79 IN-PROG
OK	415	01-Jan-2004 22:20:18.042	79 READY
OK	415	01-Jan-2004 22:20:16.037	52 CLOSE
OK	414	01-Jan-2004 22:20:16.037	52 OPEN
OK	413	01-Jan-2004 22:20:14.979	52 CLOSE
OK	412	01-Jan-2004 22:20:14.979	52 OPEN
OK	411	01-Jan-2004 22:20:14.963	50/51P PICKUP
OK	410	01-Jan-2004 22:20:14.963	PICKUP
OK	409	01-Jan-2004 22:20:14.963	50/51P TRIP
OK	408	01-Jan-2004 22:20:14.963	TRIP
OK	407	01-Jan-2004 22:20:14.917	79 IN-PROG
OK	406	01-Jan-2004 22:20:14.917	79 READY
OK	405	01-Jan-2004 22:20:14.911	50/51P PICKUP
OK	404	01-Jan-2004 22:20:14.911	PICKUP
OK	403	01-Jan-2004 22:20:14.911	50/51P TRIP
OK	402	01-Jan-2004 22:20:14.911	TRIP
OK	401	01-Jan-2004 22:19:12.557	79 IN-PROG

Figure 6-6: CONTROL EVENTS

### 6.4.1.4 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.



Ack	Alarm	Date/Time
OK	TRIP	04-Jan-2004 16:58:50.162
OK	50/51P TRIP	04-Jan-2004 16:58:50.162
OK	PICKUP	04-Jan-2004 16:58:50.162
OK	50/51P PICKUP	04-Jan-2004 16:58:50.162
OK	79 READY	04-Jan-2004 16:58:53.242
OK	79 IN-PROG	04-Jan-2004 16:58:53.242

Figure 6-7: ALARM PANEL

## 6.4.2 WAVEFORM CAPTURE

The **Actual > Records > Waveform Capture** screen displays a list of all oscillography records available in the relay. The F650 stores oscillography records from 1 to 999; this is the index of the obtained oscillography record. This screen allows selecting the records to be saved among all records available. Download of these records will be done through the selected connection in the “**Communication > Computer**” menu, either serial mode or Ethernet.

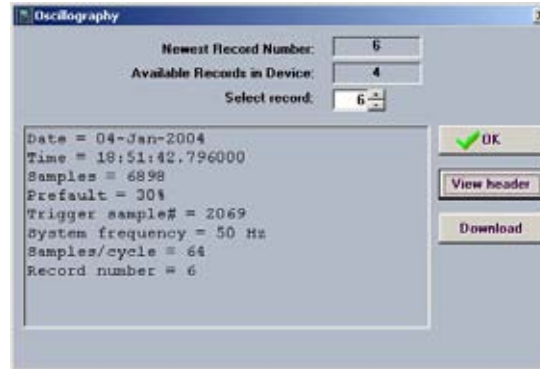


Figure 6–8: OSCILLOGRAPHY RECORD RETRIEVAL VIA ENERVISTA F650 SETUP

The screen will show all the available records in the Relay, and by clicking on each of them, the system will display the heading information for that record, allowing downloading the information to a disk. Once the file to be downloaded has been selected, the oscillography record can be opened using GE-OSC software.

GE-OSC is GE proprietary software that is not distributed together with EnerVista F650 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 F650 relays (as in the figure), the user must simply select it and click the **Open Selected Template** key. The program will then be prepared to view oscillography and digital records using the options in available menus (Waveforms and Digital Flags). Otherwise, it will be required to select the **Create New Template** option, where the program will help create a new template. Nevertheless, there is a specific instruction manual for GE-OSC software use.



Figure 6–9: GE-OSC OSCILLOGRAPHY ANALYSIS SOFTWARE

It must be taken into account that any settings change in the oscillography will produce the removal of all the information stored up to that moment.

## 6.4.3 FAULT REPORT

When selecting the **Actual > Records > Fault Report** menu, EnerVista F650 Setup will show the following screen, indicating the fault reports available in the relay.

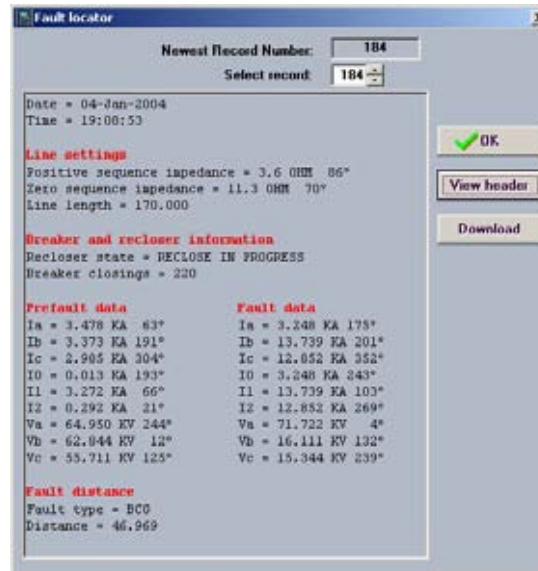


Figure 6–10: FAULT REPORT RETRIEVAL VIA ENERVISTA F650 SETUP

When selecting one of the records, a new screen will detail the following information:

- Date
- Time
- Pre-fault current and voltage in primary values
- Fault current and voltage in primary values
- Fault type
- Distance to the fault

The operation of this screen is similar to that of the previous oscillography screen, being in this case the number of fault reports a fixed number (10), instead of variable and setting-selected like as in the previous case.

Once a fault report is selected, its heading description will be displayed, showing pre-fault information, fault information and the distance to the fault. This file can be downloaded to the computer in a CSV format file.

Fault report file retrieval can be performed via serial or Ethernet communications. It must be taken into account that any settings change in the fault report will produce the removal of all the information stored up to that moment.

## 6.4.4 DATA LOGGER

The access menu is **Actual > Records > Data Logger**. Once open, this menu will show a screen containing the information monitored by the relay according to the settings adjusted at "**Setpoint > Product Setup > Data Logger**", where the user can select which analog channels will be recorded, as well as the sampling rate.

It must be taken into account that any settings change in the data logger will produce the removal of all the information stored up to that moment.

The data logger screen diagram shows the time during which the displayed values have been obtained.

The upper part of the window shows the time when the oldest sample was taken, as well as the time when the most recent value was taken.

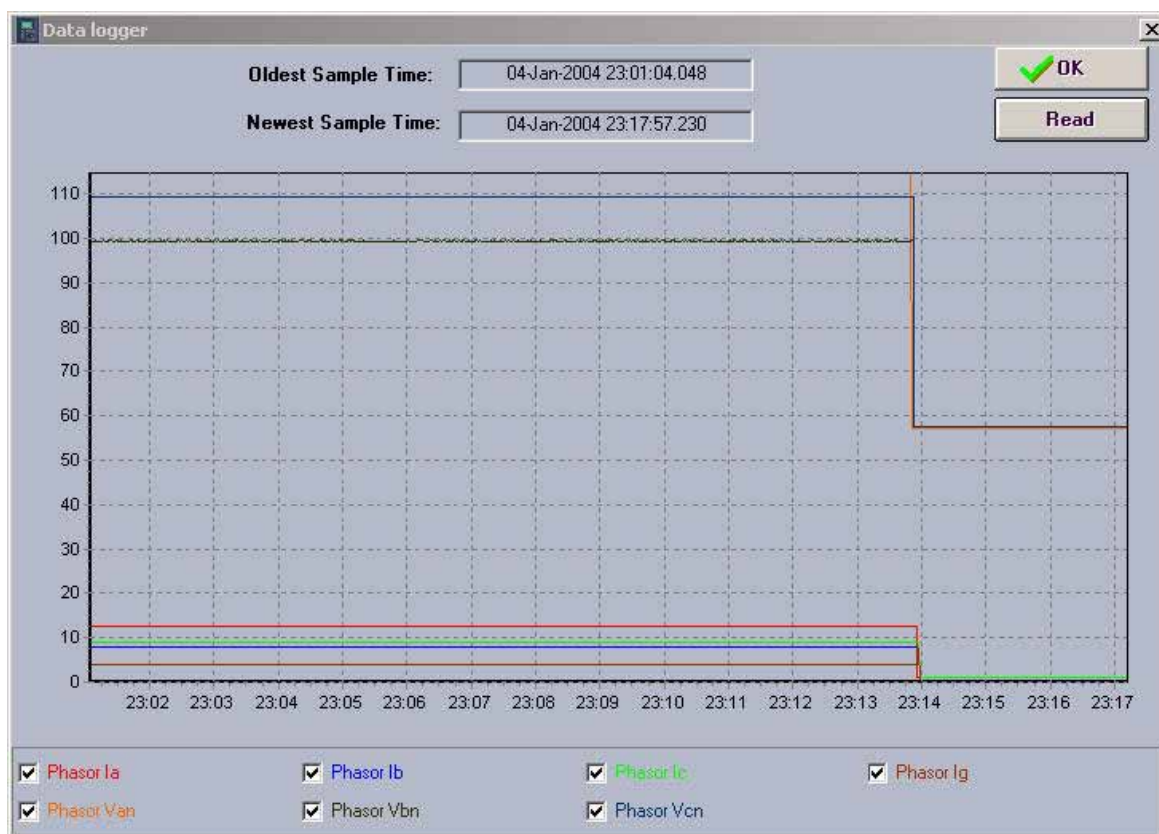


Figure 6–11: DATA LOGGER

This screen offers the possibility of storing the data logger record obtained for a further analysis, in COMTRADE format. Data Logger file retrieval can be performed only via Ethernet communications.



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

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

- **must be logged in with Administrator Permission**
- and [Enable Security](#) checkbox must be enabled

### 7.1.1 USER RIGHTS

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

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

**Table 7-1: USER RIGHTS AND FUNCTIONS**

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program will ask you to confirm the delete and if the Administrator chooses "yes", then the user whose "Delete Entry" box was checked will be permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user will become an EnerVista F650 Setup Administrator, therefore receiving all of the Administrative rights.
Actual Values	When this box is checked, the user will have the ability to <u>view</u> <b>Actual Values</b> and all records excluding event recorder.
Settings	When this box is checked, the user will have access to <u>view and modify</u> <b>Settings (Protection, control, inputs/ outputs and calibration)</b> .
Commands	When this box is checked, the user will be able to use <b>Commands</b> .
Event Recorder	When this box is checked, the user will have access to use <b>Event Recorder</b> .
Force IO	When this box is checked, the user will be able to use <b>Force IO</b> application.
Logic Configuration	When this box is checked, the user will have the ability to <u>view and modify</u> <b>Relay Configuration and Logic Configuration</b> .
Upgrade	When this box is checked, the user will have the ability to <b>upgrade firmware, bootware</b> and to <b>upload and download info files to/from relay</b> .



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

A screenshot of a 'Change Password' dialog box. It has a title bar with the text 'Change Password'. Inside, there are three text input fields: 'Enter Old Password', 'Enter New Password', and 'Re-enter New Password'. Below these is a text area with the instruction: 'Enter a personal question that only you know the answer to. This will be used if you ever forget your current password and would like to know what it is.' Below the text area is another text input field. At the bottom, there are two buttons: 'Change' and 'Cancel'.

**Figure 7–1: CHANGE SECURITY**

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

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

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

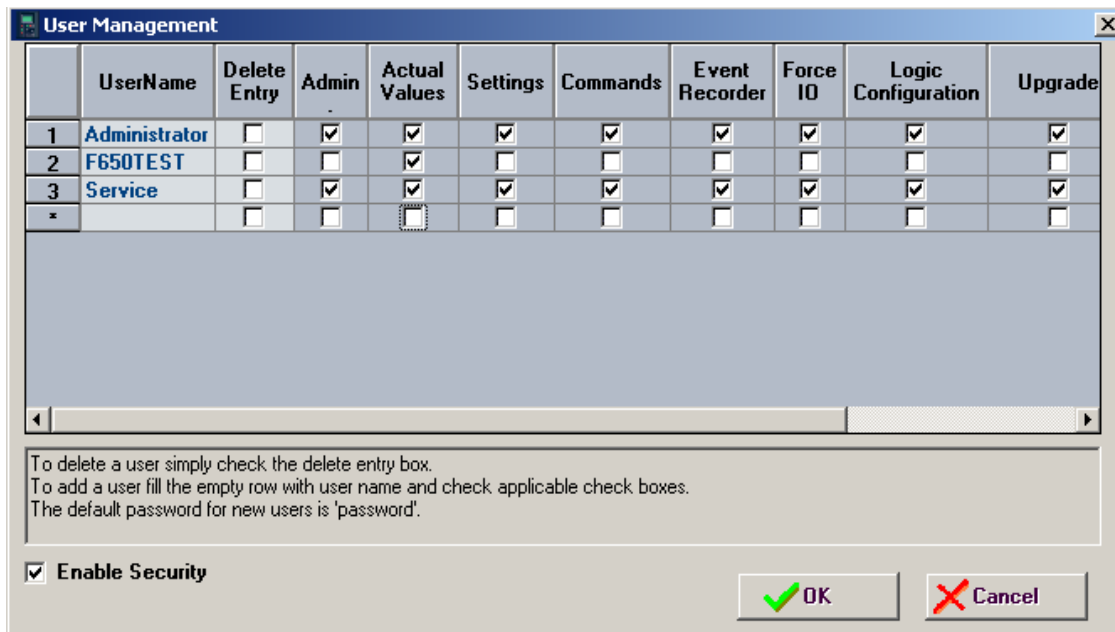


Figure 7-2: SECURITY ENABLING

Security Control is enabled by checking the **ENABLE SECURITY** check box. The first time the enable security option is selected is necessary to close and open EnerVista F650 Setup to start working under security management.

Users have to log on in order to use EnerVista F650 Setup program after Security Control has been enabled. After the start up of EnerVista F650 Setup, a dialog will pop up asking for user name and password.

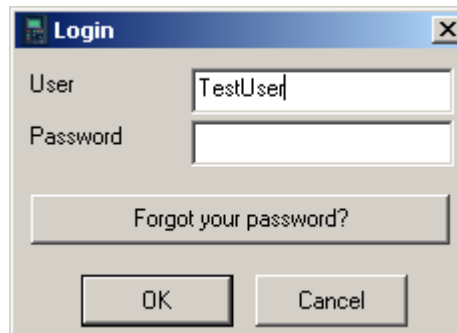


Figure 7-3: LOGIN USER

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

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

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



Figure 7-4: FORGOT YOUR PASSWORD?

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

This section describes the necessary steps to update the F650 operative system and firmware.

**WARNING**

BEFORE PERFORMING THE UPDATE PROCEDURE CHECK THAT BOOT AND FIRMWARE VERSION MATCH  
FIRMWARE VERSION 1.80 WORKS WITH BOOT VERSION 2.35

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



**Figure 8-1: MAIN SCREEN**

**BOOT CODE RELEASE NOTES**

Firmware version 1.60 and higher works with 2.35 boot version. It is mandatory to maintain version compatibility between firmware and boot code in the update procedure, otherwise the relay will not start after the updating procedure (if the versions are wrongly matched).

FIRMWARE AND BOOT VERSIONS COMPATIBILITY	
FIRMWARE VERSION	BOOT VERSION
1.8X	2.35
1.7X	2.35
1.6X	2.35
1.5X	2.30
1.4X	2.30
1.3X	2.30
1.2X	2.20
1.13	2.20
1.11	2.00
1.00	2.00

**NOTE**

The end of this section includes a STEP LIST SUMMARY that will allow the user to control the updating process. It is necessary to read the whole document before accomplishing the F650 UPDATE PROCEDURE related in these pages.

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

Backward compatibility of PLC projects, settings and configuration files is not assured for versions older than 1.13.

## NOTE

## RELAYS WITH FIBER OPTIC ETHERNET

The update of the boot program (BOOTCODE) will be performed, obligatorily, by crossed copper cable connected to the PC. It is not necessary to change the internal switch from fiber to RJ45, because the upgrade it is made at 10Mb/s and for that reason there is not conflict between copper/fiber optic.

This does not apply to the firmware upgrade, which can be done either via Ethernet Fiber connection, or through the RJ45 cable connection.

## 8.1.1 COMMUNICATION PARAMETERS

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

**Type of Ethernet connection:**

If the relay is connected through a hub or to a switch, a direct 10/100 Base TX Ethernet cable should be used, or with its fiber optic if the relay is of 100FX Ethernet. Otherwise, a direct connection from the PC to the relay (back-to-back) requires a crossover 10/100 Base T cable.

It is highly recommended to use a crossover cable to do the update process and do a direct connection from the PC to the relay instead of being connected through a hub or switch.

Relay IP address:

It is necessary to assign a valid IP address to the relay in the Ethernet parameters via HMI in the "Product Setup > Communication > Ethernet > Ethernet 1" menu or via EnerVista F650 Setup in "Setpoint > Product Setup>Communication Settings > Network (Ethernet) 1" as shown in Table 8–1: .

**Table 8–1: ETHERNET PARAMETERS**

PRODUCT SETUP>COMMUNICATION SETTINGS >NETWORK (ETHERNET) 1			
Name	Value	Units	Range
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	240		[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]

In the case of relay that has updated previously its Bootcode (Sections 2), the IP address already has been assigned in the previous process (see **figure 8-14**).

In both cases, it is necessary to check that there is no other equipment connected with the same IP address in the same net, to avoid collision.

In case of a back-to-back connection from a PC to the relay (through a crossover Ethernet cable), the IP address of the relay needs to be compatible with the TCP/IP configuration of the computer.

For example, if the relay settings are:

IP address: 192.168.37.240,

Netmask: 255.255.255.0 and

Gateway: 192.168.37.10.

The computer settings have to follow the model:

IP address: 192.168.37.XXX

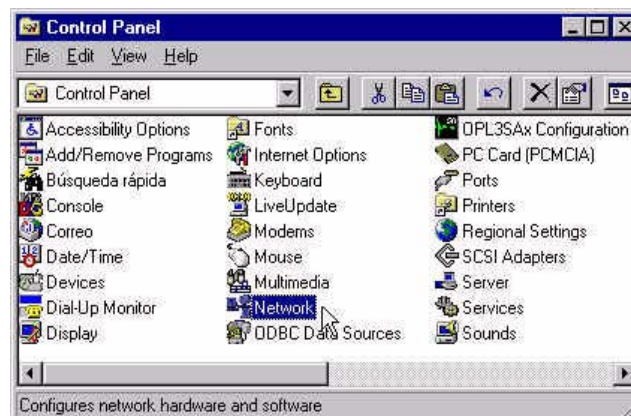
Netmask: 255.255.255.0 and

Gateway: 192.168.37.10 (if desired).

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

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

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



**Figure 8-2: NETWORK IN CONTROL PANEL**

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

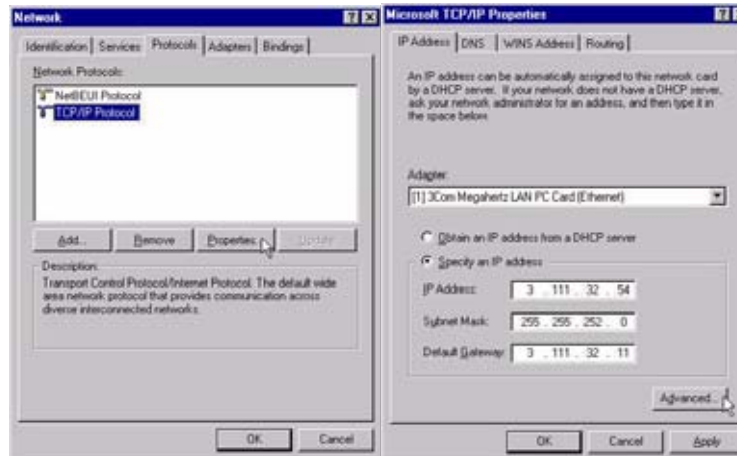


Figure 8-3: TCP/IP PROPERTIES

In **IP address** tab, select **Advanced...** () and add a new address in the PC that corresponds to the same LAN that the relay has (in the example below 192.168.37.54).

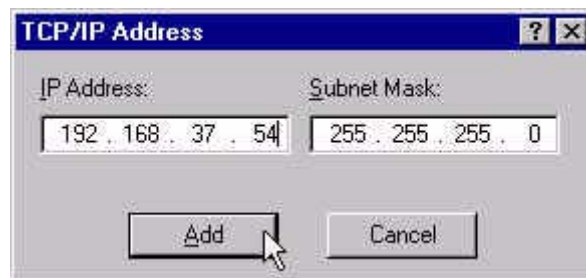


Figure 8-4: IP ADDRESS FOR COMPUTER

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

Operating system update is performed using EnerVista F650 Setup. For this purpose, it is required that there is no communication between the program and the relay, and that no configuration file is open.

In this case, menu option **Upgrade Operating System** will be enabled under the EnerVista F650 Setup **Communication** menu.

During the operative system updating process, all the data stored in the relay will be lost, so it is required to save all calibration, settings, oscillography, etc. from the relay before the upgrade. It is extremely important to save the relay settings and calibration before continuing with the process. In this step of the updating process if the user do not want to continue, click on the NO option and no change will be perform to the relay.

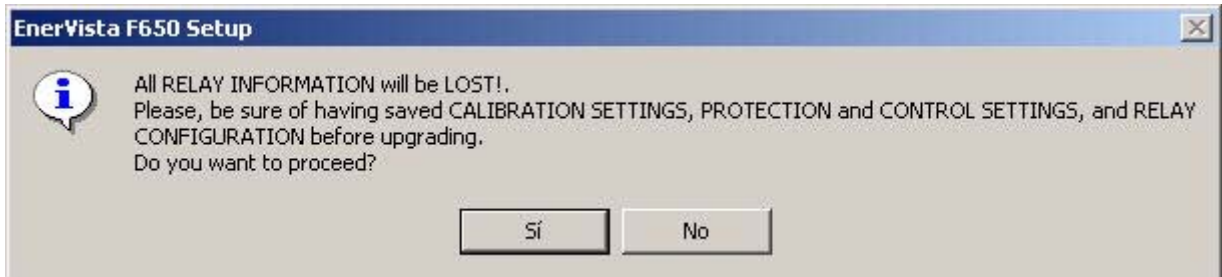


Figure 8–5: LOST DATA WARNING MESSAGE

For upgrading the operative system, it is required to connect an RS232 cable to the front of the relay, and an Ethernet cable to the rear port (COM3). The serial communication parameters will be the ones selected in the **Communications > Computer** menu, where the COMX port (the port to be used in the upgrade) must be selected. As regards Ethernet communication, if the upgrade is to be performed through a hub or switch, it is required to connect the relay to the hub or switch through a direct 10/100 base T cable.

If the connection is made directly from the PC to the relay it is necessary to use a 10/100 Base T crossover cable. This last connection will be obligatory for relays with Fiber Optic Ethernet, although it will not be necessary to change the internal switch. During the upgrade, the system will show the following message indicating the procedure to be followed.

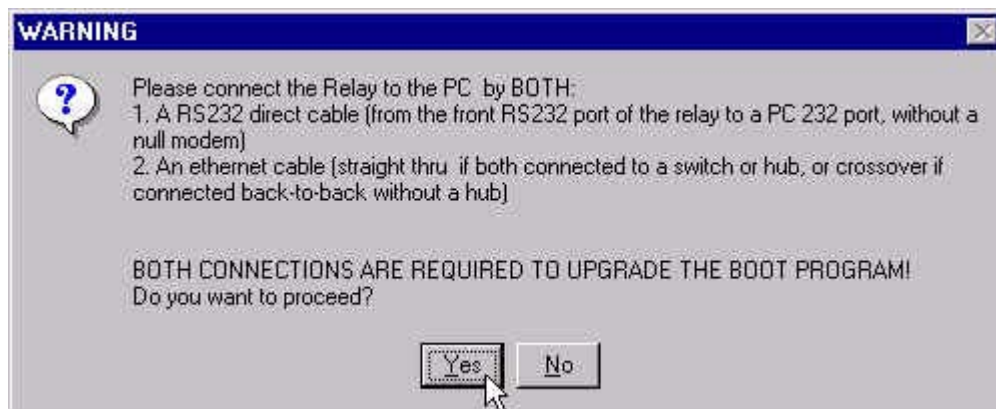


Figure 8–6: SERIAL AND ETHERNET CONNECTIONS FOR BOOT UPDATE

NOTE

To obtain more information about the Relay network configuration, please refer to section “Communication Parameters”



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

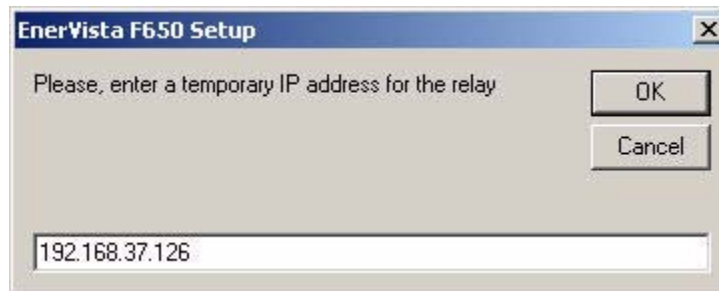


Figure 8-7: TEMPORARY IP ADDRESS SELECTION FOR BOOT UPDATE

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



Figure 8-8: BOOT FILE SELECTION

## 8

Once the appropriate boot program file has been selected, the program will proceed to load and update the relay's boot memory.

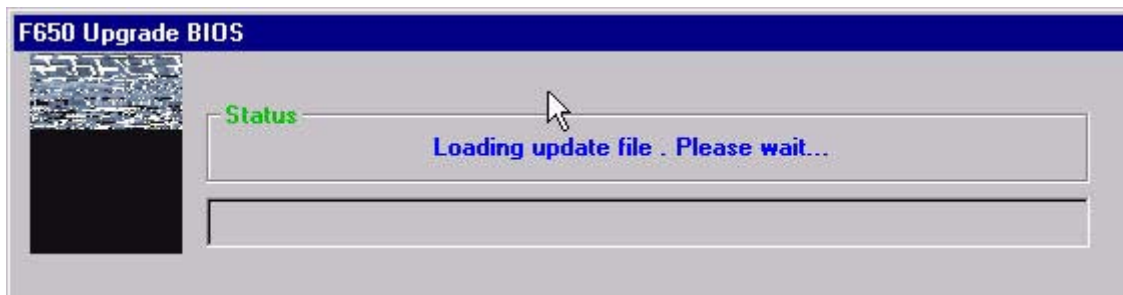


Figure 8-9: LOADING BOOT FILE

After the boot memory loading, the program shows a message requiring turning off and back on the relay while the progress bar is in course.

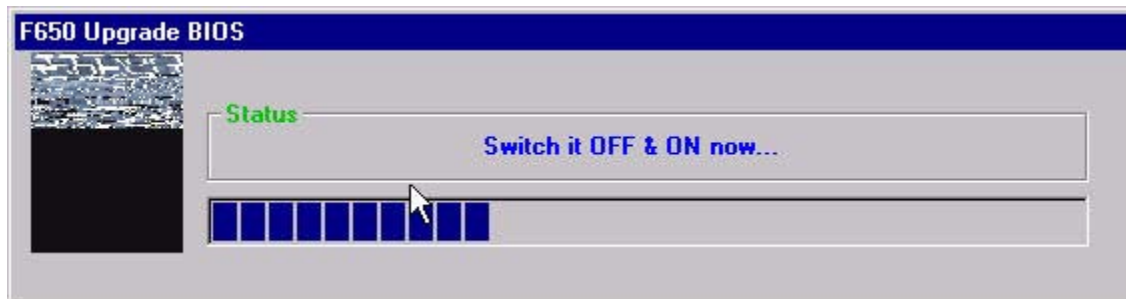


Figure 8–10: SWITCH THE RELAY OFF AND ON TO START THE BOOT PROCEDURE

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

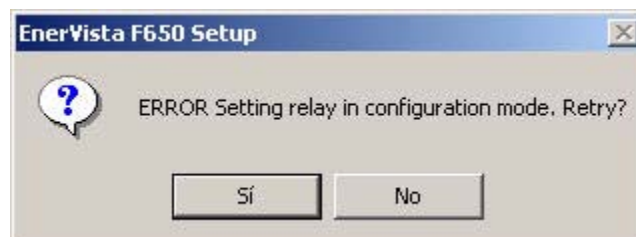


Figure 8–11: ERROR MESSAGE FOR COMMUNICATIONS PROBLEMS

If the serial communication between EnerVista F650 Setup and the relay has been successful the program shows a message to select to update the current version to the new one.



Figure 8–12: UPDATE CURRENT VERSION?

At this moment, selecting “**YES**” in the “**Update current version?**” option will start, beginning with the relay flash memory deletion, so at this point all the information stored in the relay will be lost.

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

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

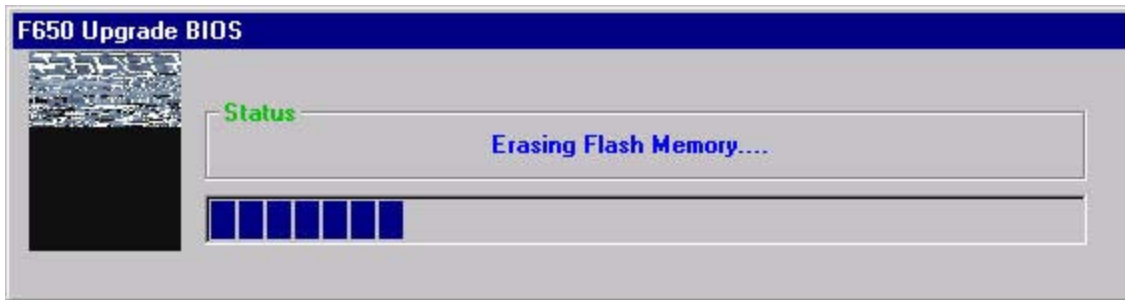


Figure 8–13: ERASING FLASH MEMORY

Once the memory has been erased and the files updated in the relay, the parameters for the Ethernet communications parameters must be assigned (Figure 8–14:). The requested values are the IP address and the gateway

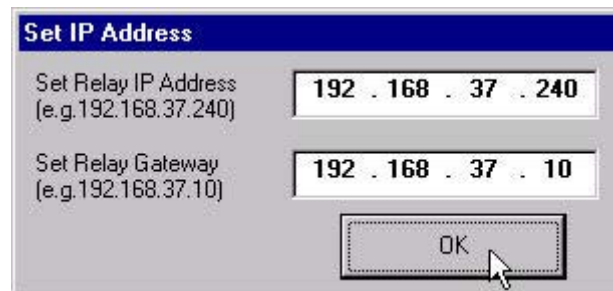


Figure 8–14: ETHERNET PARAMETERS

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

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

After assigning the Ethernet parameters, the update of the boot memory program has been completed successfully .



Figure 8–15: BOOT PROGRAM UPDATED

After boot memory update, the equipment firmware must also be updated (Section 8.3).

The F650 equipment includes a mechanism that allows the update of the internal program called firmware, to new versions that are periodically published in the GE Multilin web.

**The relay settings and configuration will be lost, so it is advisable to save them to a file. For firmware revisions lower than 1.50, it is required to save calibration settings in a file before updating the F650 to a new firmware version.** In case of versions higher than 1.50, the calibration retrieval process is automatic and it is not necessary to save them to a file (nevertheless is always advisable to do it). Take into account that if the operative system (bootcode) has been previously updated, all the data (including calibration settings) would be lost.

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

The firmware updating process should be done through the EnerVista F650 Setup software, after connecting the relay by Ethernet port (COM3).

### 8.3.1 FIRMWARE UPDATE

Once the communication with the relay through Ethernet connection has been verified<sup>1</sup>, enter the EnerVista F650 Setup program, select **Communication** and the **Upgrade Firmware Version** option.

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

After accepting to proceed, a window will open up for the update parameter for the F650 firmware update process. In firmware version previous to 1.70 the EnerVista F650 Setup program asked for the IP address of the relay to be updated and its serial number. In versions 1.70 and higher it is also necessary to enter the ordering code for the relay. See figure below:

This change is due to the multilingual implementation in F650 devices. See ordering code section in product description chapter in this manual ([section 2.3.](#) )



Figure 8–16: FIRMWARE SELECTION WINDOW

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

Go to EnerVista F650 Setup main menu "**Communication > Calibration > Get Calibration Settings**"

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

Once the upgrade parameters have been entered, relay IP address, serial number and ordering code, press the “**Upgrade Firmware**” button. When communication has been established, the program will show a message requesting to turn off and back on the relay to continue with the upgrade process.

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

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

Once the Update.txt file is selected, the “Upgrade Firmware” button will be enabled. Press this button to initiate the relay firmware upgrade process. A voltage range selection window will appear, this voltage range is connected to the serial number of the relay. The EnerVista F650 Setup program automatically pre-selects the appropriate voltage range for the unit. If the voltage range is not selected correctly the error in voltage measurements will be 20 %.

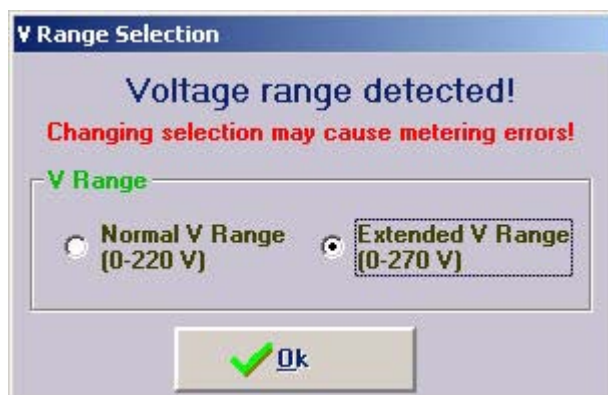


Figure 8-17: VOLTAGE RANGE SELECTION

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

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

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

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

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

Go to EnerVista F650 Setup main menu:

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

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

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

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

#### 8.4.1 BOOT MEMORY UPDATE (\*)

1. INSTALL THE PROPER VERSION OF THE ENERVISTA F650 SETUP PROGRAM.
2. CONNECT AN RS-232 CABLE IN THE FRONT PORT OF THE RELAY AND ETHERNET ONE AT THE REAR ETHERNET PORT (CROSSOVER CABLE FOR BACK-TO-BACK CONNECTION AND DIRECT ETHERNET CABLE FOR HUB OR SWITCH).
3. GET CALIBRATION SETTINGS (AND SAVE IT TO A FILE).
4. SAVE ALL THE DATA FROM THE RELAY (SETTINGS, OSCILLOGRAPHY, EVENTS).
5. FROM THE ENERVISTA F650 SETUP PROGRAM SELECT COMMUNICATION/UPGRADE OPERATING SYSTEM.
6. FOLLOW THE INDICATIONS OF THE PROGRAM AND SELECT THE BOOT PROGRAM BIN FILE.
7. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
8. CONTINUE WITH THE PROCESS AND SET THE IP ADDRESS AND GATEWAY WHEN REQUIRED.

#### 8.4.2 FIRMWARE UPDATE (\*)

1. SET THE APPROPRIATE IP ADDRESS IN THE RELAY.
2. SET THE APPROPRIATE IP ADDRESS IN THE PC.
3. FROM THE ENERVISTA F650 SETUP PROGRAM SELECT "COMMUNICATION/UPGRADE SOFTWARE VERSION".
4. ENTER THE IP ADDRESS, SERIAL NUMBER AND ORDERING CODE OF THE RELAY TO UPDATE.
5. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
6. LOCATE THE UPDATE.TXT FILE ACCORDING TO THE MODEL OF THE RELAY.
7. PRESS UPGRADE FIRMWARE AND INITIATE THE UPGRADE PROCESS.
8. TO COMPLETE THE PROCEDURE, SWITCH OFF AND BACK ON THE RELAY WHEN REQUIRED BY THE PROGRAM.
9. SET CALIBRATION SETTINGS (FROM THE PC TO THE RELAY) (for versions lower than 1.50).
10. THE SETTINGS AND CONFIGURATION ARE NOW SET TO FACTORY DEFAULT.
11. SEND THE NEW SETTINGS AND CONFIGURATION FILES TO THE RELAY IF NECESSARY.

(\*) The boot code upgrade must be performed using a crossed copper cable (RJ45) connected to the PC. It is not necessary to modify the internal fiber/cable switch, as the upgrade is carried out at 10 Mb/s, and thus there is not cable/fiber conflict.

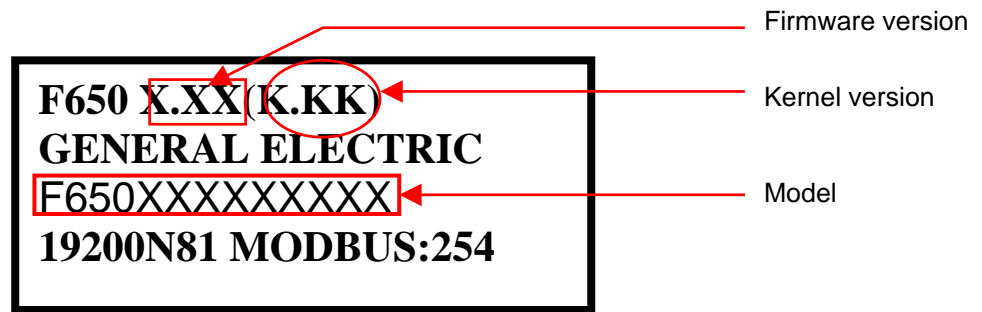
*This fact does not apply to the firmware upgrade, which can be performed either with the Ethernet fiber connection, or with the cable connection.*



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

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

Display information:





All devices running on AC current are affected by frequency. As a non-sinoidal wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, it can be deducted 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 sinoidal waveform. The pureness of a sinoidal wave (lack of harmonics) cannot be expressed specifically for a specific relay. However, any relay incorporating sintonized circuits, R-L and R-C circuits, will be affected by non-sinoidal waveforms, as in the case of F650.

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

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

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

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

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

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

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

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

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

**WARNING:** No communication circuit shall be tested for isolation.

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

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

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

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

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

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

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

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

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

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

**Front:**RS232

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

A computer with EnerVista F650 Setup software and an appropriate connector must be used.

Set the relay as follows

GENERAL SETTINGS			
NAME	VALUE	UNITS	RANGE
PHASE CT RATIO	1.0	0.1	1.0-6000.0
GROUND CT RATIO	1.0	0.1	1.0-6000.0
STV GROUND CT RATIO	1.0	0.1	1.0-6000.0
PHASE VT RATIO	1.0	0.1	1.0-6000.0
PHASE VT CONNECTION	WYE	N/A	WYE – DELTA
NOMINAL VOLTAGE	100 V	0.1	1-250 V
NOMINAL FREQUENCY	50 Hz	1 Hz	50-60 Hz
PHASE ROTATION	ABC	N/A	ABC – ACB
FREQUENCY REFERENCE	VI	N/A	VI-VII-VIII
AUXILIARY VOLTAGE	VX	N/A	VX – VN

**NOTE:**

**ALL ANGLES INDICATED ARE DELAY ANGLES**

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

### 9.7.1 VOLTAGES

Apply the following current and frequency values to the relay:

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

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

### 9.7.2 PHASE CURRENTS

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
Ia (A)	45°	0	15	10	5	1	0.1
Ib (A)	165°	0	15	10	5	1	0.1
Ic (A)	285°	0	15	10	5	1	0.1
IG(A)	0°	0	15	10	5	1	0.1
ISG(A)	0°	0	5	1	0.1	0.01	0.005

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

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

9.7.3 ACTIVE, REACTIVE POWER, AND COS $\phi$  METERING

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

POWER PER PHASE	THREE-PHASE POWER
$P = V \cdot I \cdot \cos\phi$	$P = P_a + P_b + P_c$
$Q = V \cdot I \cdot \sin\phi$	$Q = Q_a + Q_b + Q_c$

Apply the following current and voltage values:

APPLIED VOLTAGE AND CURRENT VALUES PER PHASE			
PHASE A	PHASE B	PHASE C	V-I ANGLES
$V_I = 50 \text{ V}, 0^\circ$	$V_{II} = 50 \text{ V}, 120^\circ$	$V_{III} = 50 \text{ V}, 240^\circ$	$\phi = 45^\circ$
$I_a = 10 \angle 45^\circ$	$I_b = 10 \angle 165^\circ$	$I_c = 10 \angle 285^\circ$	$\cos\phi = 0.707$

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

THEORETICAL POWER VALUES			
PHASE A	PHASE B	PHASE C	THREE-PHASE
$P_a = 353.55 \text{ MW}$	$P_b = 353.55 \text{ MW}$	$P_c = 353.55 \text{ MW}$	$P = 1060.66 \text{ MW}$
$Q_a = 353.55 \text{ MVar}$	$Q_b = 353.55 \text{ MVar}$	$Q_c = 353.55 \text{ MVar}$	$Q = 1060.66 \text{ MVar}$

Maximum admissible error is +/-1% of the test value for P and Q, and 0.02 for cos $\phi$ .

## 9.7.4 FREQUENCY

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

Apply 50 Vac at 50 Hz on channel VII. Maximum admissible error: +/- 10 mHz.

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

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

Apply 50 Vac at 50 Hz on channel Vx. Maximum admissible error: +/- 10 mHz.

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

Results:

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

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

### 9.8.1 DIGITAL INPUTS

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

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

Default board settings for the input test can be modified in EnerVista F650 Setup software in:

**Settings>Inputs/Outputs>Contact I/O>Board X**

**X, will be substituted by the corresponding board:**

F for board in first slot

G for board in second slot

H for board in first slot of CIO module

J for board in second slot of CIO module

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

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

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

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

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

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

If the relay incorporates more input modules, this test must also be applied to them.



## 9.8.2 CONTACT OUTPUTS

The correct activation of every output will be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated. Go to EnerVista F650 Setup Software (**Settings>Inputs/Outputs>Force Outputs**).

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

## 9.8.3 CIRCUIT CONTINUITY SUPERVISION INPUTS

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

**Coil 1:**

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

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

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

**Coil 2:**

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

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

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

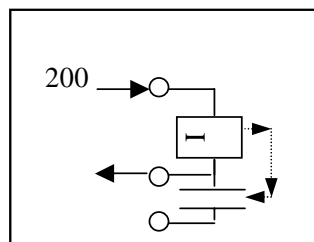
## 9.8.4 LATCHING CIRCUITS

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

Make circulate a current of 200 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 than the contact is released.



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The factory default configuration of the relay makes the overcurrent elements be supervised by directional units. This way, if the directional element is enabled and detects the fault in the block direction, then the overcurrent unit will not operate. If the directional element is not enabled or if it is enabled and it detects a fault in a trip direction, then the overcurrent unit will operate if the set current level is exceeded.

### 9.12.1 67P ELEMENT

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

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

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

Apply the following tests:

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

### 9.12.2 67N ELEMENT

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

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

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

Apply the following tests:

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

### 9.12.3 67G ELEMENT

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

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

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

Apply the following tests:

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

## 9.12.4 67SG ELEMENT

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

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

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

Apply the following tests:

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

## 9.13.1 27P ELEMENT

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

Set the relay as follows:

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

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

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

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

## 9.13.2 27X ELEMENT

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

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

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

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



## 9.14.1 59P ELEMENT

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

Set the relay as follows:

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

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

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

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

## 9.14.2 59X ELEMENT

Set the relay as follows:

GENERAL SETTINGS	
Auxiliary Voltage	VX

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

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

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

ELEMENT	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					THEORETICAL	ADMISSIBLE
59X	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1 ]
				132	2	[1.9 – 2.1]

## 9.14.3 59NH AND 59NL ELEMENTS

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VN

NEUTRAL OV HIGH/LOW (59NH/59NL)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00

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

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

ELEMENTS	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					THEORETICAL	ADMISSIBLE
59NH/59NL	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1 ]
				132	2	[1.9 – 2.1]

This element can also be tested by applying only phase voltages. For this purpose, it is necessary to set Auxiliary Voltage = VX. In this condition, Vn voltage is calculated as a sum of the phase voltages.

## 9.14.4 47 ELEMENT - NEG SEQ OV

Set the relay as follows:

NEG SEQ OV (47)	
Function	ENABLED
Pickup Level	50 V
Trip Delay	2.00
Reset Delay	0.00

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

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

CHANNEL	APPLIED VOLTAGE (V)	ANGLE	TRIPPING TIME (S)	
			THEORETICAL	ADMISSIBLE
VI	65	0°	NO TRIP	NA
VII	65	120°		
VIII	65	240°		
VI	55	0°	2	[1.9–2.1 ]
VII	55	240°		
VIII	55	120°		
VI	45	0°	NO TRIP	NA
VII	45	240°		
VIII	45	120°		

NOTE: All angles mentioned on the tables are delay angles, where a balanced ABC system would be composed by:

CHANNEL	APPLIED VOLTAGE (V)	ANGLE
VI	65	0°
VII	65	120°
VIII	65	240°

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

Set the relay as follows:

GENERAL SETTINGS	
Nominal Frequency	50 Hz

ELEMENT SETTINGS		
FREQUENCY (81)	81U	81O
Function	ENABLED	ENABLED
Pickup Level	47.50 Hz	52.50 Hz
Trip Delay	2.00 sec	2.00 sec
Reset Delay	0.00 sec	0.00 sec
Minimum Voltage	30 V	30 V

Apply voltage as indicated on the table, modifying frequency from the maximum threshold (48 Hz) to the minimum (46 Hz) for 81U, and from the minimum (52 Hz) to the maximum (54 Hz) for 81O, in steps of 10 mHz.

Verify that the relay trips at the set frequency in the corresponding element with an error of 3%  $\pm$  50 mHz.

Apply a voltage that is lower than the “Minimum Voltage” setting, with a frequency under (81U) or over (81O) the setting, and verify that the relay does not trip.

ELEMENTS	PHASE	PICKUP LEVEL (HZ)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	FREQUENCY THRESHOLDS	TRIPPING TIME (S)	
						THEORETICAL	ADMISSIBLE
81U	VII	47.5	2	80	48 Hz	No trip	NA
					46 Hz	2	[1.9 –2.2]
				25	46 Hz	No trip	NA
81 O	VII	52.5	2	80	52 Hz	No trip	NA
					54 Hz	2	[1.9 –2.2]
				25	54 Hz	No trip	NA

Set protection element 79 as follows:

RECLOSER	
Function	ENABLED
Max Number Shots	4
Dead Time 1	2.10 sec
Dead Time 2	4.10 sec
Dead Time 3	6.10 sec
Dead Time 4	8.10 sec
Reclaim Time	3.00 sec
Cond. Permission	ENABLED
Hold Time	7.00 sec
Reset Time	5.00 sec

Set the relay to trip by 50PH

50PH SETTINGS	
Function	ENABLED
Input	RMS
Pickup Level	3 A
Trip Delay	0.00 s
Reset Delay	0.00 s

### 9.16.1 RECLOSING CYCLE

Connect a latching relay simulating the breaker managed by the F650 unit.

Once the relay is set, close the breaker and wait for 5 seconds.

After this time, the recloser is ready to initiate the reclosing cycle.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 2.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 4.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 6.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 8.1 seconds.

Command a 50PH trip and verify that the breaker opens and the recloser passes to Lockout.

Verify the correct operation of programmed outputs

Tripping times must be within the following values:

Reclosing Cycle		
N° shot	Theoretical 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]

---

9.16.2 RECLOSER STATUSES

---

**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.

---

9.16.3 EXTERNAL RECLOSE INITIATION

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Close the breaker and wait for 5 seconds.

Activate the reclose initiation input and open the breaker, verify that the relay executes the first shot

Disable all protection elements except for Thermal Model (49).

Set the pickup level to 2 A.

Set the time constant  $\tau_1$  to 3 minutes and  $\tau_2$  to one time  $\tau_1$ .

Apply currents of 2, 5, and 10 times the tap and ensure that the operation times are within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	48.5 - 53.6
5	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

After each measure, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Repeat the test selecting a time constant  $\tau_1$  of 60 minutes. Verify that the operation time is within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	960 - 1072
5	10.0	5	141 - 156
	20.0	10	35.4 - 39

After each measure, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

## 10.1.1 DESCRIPTION OF THE EXERCISE

The requirements for this setting exercise are:

- Communicate the relay via serial cable or Ethernet 10/100 Base T cable using F650 PC program.
- Set some Phase Time Overcurrent protection function to operate at 5A , Inverse curve IEC, Dial 0.1
- Set some Output contact on board F to be operated and sealed by the operation of the phase TOC.
- Set some LED to show the operation of the phase TOC
- Set some Operation to reset the output contact after dropout of the phase TOC since the front F1 pushbutton.
- Set some Oscillography channel to record the pickup of phase TOC and output contact closing action.

To test the operation of this Phase Time Overcurrent protection

## 10.1.2 PROCEDURE TO COMMUNICATE WITH THE RELAY

This procedure describes the connection between any Laptop and some F650 relay using the **EnerVista 650 SETUP** program

For any one of these connections check first the communication parameters as follows:

**Serial Communication** (RS232 front port of the relay)

With the ESC key check on the main front screen the serial communication parameters (Baud rate, parity, data bits, stop bit and ID number).

Connect the serial cable PC-F650

Open the EnerVista 650 SETUP program in the PC and under **Communication** ↓ **Computer** menu check that the serial communication parameters displayed are the same read in the front of the relay. Check also that:

- Control Type is set to No Control Type
- Startup Mode is set to Communicate with relay
- Click **ON** key.

**Ethernet LAN** (10/100 Base T rear port of the relay)

In the Laptop choose **My PC-Control Panel-Network-Protocols-Protocol TCP/IP-Advance** and set in **IP Address** screen the following:

IP Address 192.168.37.126

Netmask 255.255.255.0

In the front of F650 relay and pressing the ESC key display the **Main Settings** screen.

Move clockwise the rotating knob to choose **Change Settings** and press down the rotating knob.

Choose **Comm Settings** and press down the rotating knob.

Choose **Network 0** and press down the rotating knob. It will be displayed **IP Address OCT 1** and set it according to the following table:

SEQUENCE		
ACTION	SETTING	ACTION
----	IP Address OCT 1	Set to 192 with rotating knob and press it down
Move rotating knob clockwise	IP Address OCT 2	Set to 168 with rotating knob and press it down



Move rotating knob clockwise	IP Address OCT 3	Set to 37 with rotating knob and press it down
Move rotating knob clockwise	IP Address OCT 4	Set to 125 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 1	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 2	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 3	Set to 255 with rotating knob and press it down
Move rotating knob clockwise	Netmask OCT 4	Set to 0 with rotating knob and press it down
Move rotating knob clockwise	Netway IP OCT 1	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 2	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 3	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 4	Leave default setting without any change
Move rotating knob clockwise	Press INTRO	Press down the rotating knob to validate settings

Press ESC key once.

Move rotating knob counterclockwise to **General Settings** and press it down. **General Settings 0** will be displayed now. Press rotating knob down again.

Set ModBus Port Number to 502 and press rotating knob down.

Move counterclockwise the rotating knob to find ModBus Address COM1 and press it down.

Set ModBus Address COM1 to 254 with the rotating knob and then press it down.

Move clockwise the rotating knob to find **Press Intro to End** and press it down to validate the setting.

Connect a crossover 10/100 MB Ethernet cable from PC to the relay.

Open the EnerVista 650 SETUP program in the PC and under **Communication** ↓ **Computer** menu and set:

IP Address            192.168.37.125  
Port                    502  
Unit Identifier        254  
Control Type to      ModBus/TCP  
Startup Mode to      Communicate with relay

Click **ON** key.

The program will start connection with the relay showing the progress screen.

## 10.1.3 PROCEDURE TO SET THE PROTECTION FUNCTION

Once the relay has been connected set protection functions and outputs according to the following steps:

Open EnerVista 650 SETUP program and under:

**SETPOINT ↓ SYSTEM SETUP ⇒ ↓ GENERAL SETTINGS**

NAME	VALUE
Phase CT Ratio	1.0 (default)
Ground CT Ratio	1.0 (default)
Stv Ground CT Ratio	1.0 (default)
Phase VT Ratio	1.0 (default)
Phase VT Connection	Wye
Nominal Voltage	100.0 (default)
Nominal Frequency	50
Phase Rotation	ABC
Frequency Reference	VI (default)
Auxiliary Voltage	VX (default)

Under

**SETPOINT ↓ PROTECTION ELEMENTS ⇒ ↓ PHASE CURRENT ⇒ ↓ PHASE TOC HIGH ⇒ PHASE TOC HIGH 1**

NAME	VALUE
Function	Enabled
Input	Phasor DFT
Pickup Level	5.0 A
Curve	IEC Curve A
TD Multiplier	0.1
Reset	Instantaneous
Voltage Restraint	Disabled

Under

**SETPOINT ↓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F**

NAME	VALUE
Output Logic_00_00	Positive
Output Type_00_00	Latch

Under

**SETPOINT ↓ RELAY CONFIGURATION ⇒ OUTPUTS**

SELECT	NAME	SOURCE	OR
Contact Output Operate 00 (Board F)	C Output Oper_00_00	<b>PRESS FOR LOGIC</b>	£
		Phase TOC A Op Phase TOC B Op Phase TOC C Op	
Contact Output Reset 00 (Board F)	C Output Reset_00_00	Operation bit 000	

Under

**SETPOINT ↓ RELAY CONFIGURATION ⇒ LEDS**

SELECT	NAME	SOURCE
--------	------	--------

£ Led 5	C Output Op 00	C Output_00_00
---------	----------------	----------------

Under

### SETPOINT ↓ RELAY CONFIGURATION ⇒ OPERATIONS

Select £ Operation 0

Command TextReset C Output 00

Interlock Type None

Interlocks---

Final State TypeNone

Final States---

Frontal KeyF1

Contact InputNone

Virtual OutputNone

Time Out500 (default)

MMI---

Com1---

Com 2---

ETH-Master 1---

ETH Master 2---

ETH Master 3---

ETH Mastef 4---

Under

### SETPOINT ↓ RELAY CONFIGURATION ⇒ OSCILLOGRAPHY

SELECT	NAME	SOURCE
£ Digital Channel 1	C Output Op_00_00	C Output Oper_00_00
£ Digital Channel 2	C Output_00_00	C Output_00_00

#### 10.1.4 TEST

Apply 7.5 A in phase A (terminals B1-B2) until contact 00 on Board F operates (terminals F19-F21 should be and remain closed), and LED 5 should be lit. Check that operating time is in the order of 1.7 seconds.

Remove current from terminals B1-B2

Press pushbutton F1 and check that contact 00 on Board F has been open.

Check that LED 5 in the front of the relay has been turned off.

Repeat the process for phase B (terminals B3-B4) and for phase C (terminals B5-B6)

Under **Actual** ↓ **Waveform Capture** menu retrieve the last oscillography recording stored, open it using GE\_OSC program and check that the two digital signals as well as the current signal were kept.

## 10.2.1 DESCRIPTION OF THE EXERCISE

The purpose of this exercise is to introduce the F650 User about the way to set a protection scheme including:

Trip operation of a phase time overcurrent protection.

Two reclosing shots with successful fault clearing.

Synchronism check action to verify two ends voltage conditions previous to perform each reclosing action.

## 10.2.2 PROCEDURE TO COMMUNICATE THE RELAY

This procedure is described in Example N° 1. Therefore check the actual PC communication status to assure a fast and reliable communication with F650 relay.

## 10.2.3 PROCEDURE TO SET THE PROTECTION FUNCTION

This procedure is fully described in paragraph 13.3 (see Example N° 1). Therefore it is not necessary to explain it here again except about the small modifications required for the actual exercise, as well the additional settings not used until now (i.e. recloser and synchrocheck).

Therefore, by having the F650 set like in the previous exercise (paragraph 13), the new settings and changes to be done in the relay to work in a protection-reclosing scheme are:

Under

**SETPOINT ↓ PROTECTION ⇒ ELEMENTS BREAKER ⇒ ↓ BREAKER SETTINGS**

NAME	VALUE
Number of Switchgear	1

Under

**SETPOINT ↓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F**

NAME	VALUE
Output Logic_00_00	Positive
Voltage Threshold B_00	80V
Debounce Time B_00	10 ms
Input Type_00_00 (CC1)	Positive
Delay Input Time_00_00 (CC1)	0 ms
Output Type_00_00	Normal
Pulse Output Time_00_00	500 ms

Under

**SETPOINT ↓ RELAY CONFIGURATION ⇒ PROTECTION ELEMENTS**

SELECT	SOURCE	OR
AR Initiate	<b>PRESS FOR LOGIC</b>	£
	Phase TOC A Op Phase TOC B Op Phase TOC C Op	
AR Conds Input	Synch Close Perm	

## 10.2.4 PROCEDURE TO SET THE RECLOSER

Under

**SETPOINT** ↓ **PROTECTION ELEMENTS** ⇒ ↓ **OTHER FUNCTIONS** ⇒ ↓ **RECLOSER**

NAME	VALUE
Function	Enabled
Max. Number of shots	2
Dead Time 1	2.0s
Dead Time 2	4.0s
Dead Time 3	---
Dead Time 4	---
Reclaim Time	0.05s
Condition Permission	Enabled
Hold Time	0.1s
Reset Time	1.9s

## 10.2.5 PROCEDURE TO SET THE SYNCHRO CHECK

Under

**SETPOINT** ↓ **PROTECTION ELEMENTS** ⇒ ↓ **OTHER FUNCTIONS** ⇒ ↓ **SYNCHROCHECK**

The synchrocheck function and its permission to close is a condition in the present exercise to allow the recloser to give the different programmed shots. Should not this condition be required these settings are non relevant, but if does like in the present case the synchrocheck function must be set as follows

NAME	VALUE
Function	Enabled
Dead Bus Level	10V
Live Bus Level	50V
Dead Line Level	10V
Live Line Level	50V
Max. Volt Difference	10
Max. Angle Difference	10°
Max. Freq. Difference	20mHz
Breaker Closing Time	0.07s
DL-DB Function	Disabled
LL-DB Function	Disabled
DL-LB Function	Disabled

## Additional Comments on Scheme

The programmed operation of a TOC protection with reclosing and synchrocheck features for the F650 relay is shown in . Some conclusions follows:

The recloser cycle ends at lockout status since a permanent fault remains after two unsuccessful reclosing trials.

The holding time for reclosing conditions can be very low since the processor internal time to check them is instantaneously if they are present at this moment. Depending in the application reclosing conditions might come later especially when commands are sent from dispatching center. If does then this timing must be set properly.

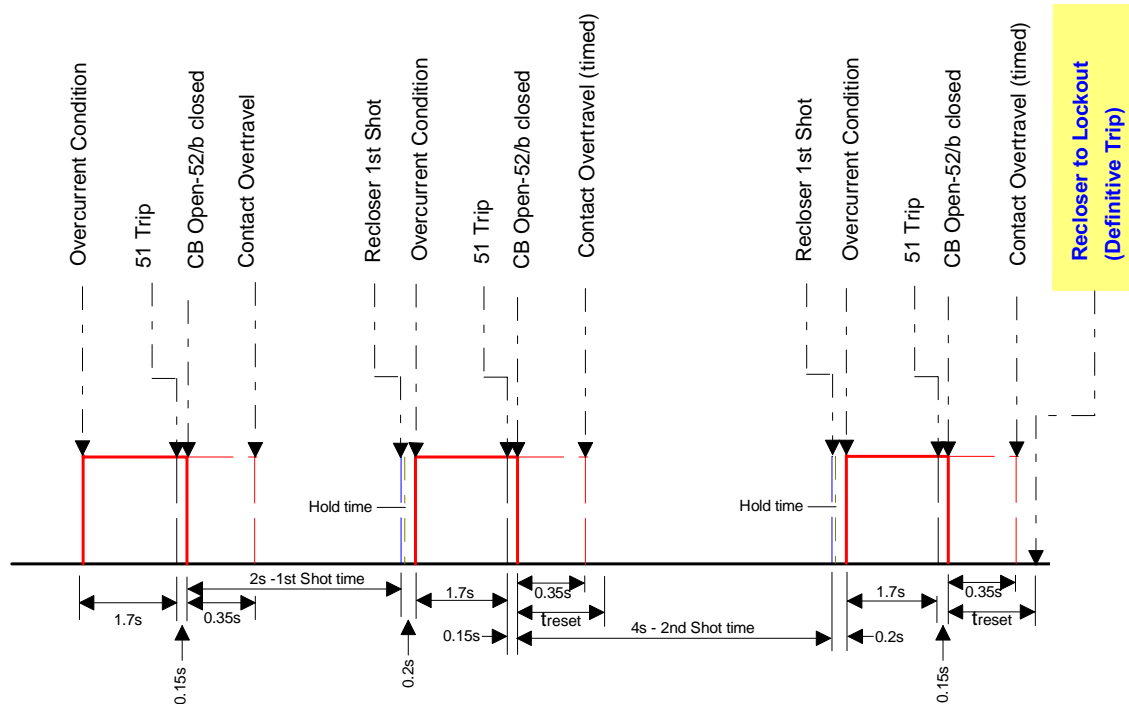
The F650 trip contact over-travel is the time the contact remains closed for some definite time to assure the tripping action of the breaker, specially in CB's with large tripping times (bulk or other CB's). This time delay has been set in group SETPOINT ↓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F

To test the reclosing scheme one current and two voltages signals equipment with phase and frequency shifting capability must be used. The current source must be switched OFF and ON in the time ranges described in the scheme

### Example N° 2

#### F650 Tripping and Reclosing Scheme

2 Shots followed by Permanent Fault



**Figure 10–1:**

## 10.3.1 DESCRIPTION OF THE EXERCISE

This simple operation describes how to program and set an operation command on the F650 relay. In the present case the operation is:

To configure some F650 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 F650 output contact using a front key pushbutton.

To reset the output contact and LED using another front key pushbutton.

## 10.3.2 PROCEDURE

Set the following values:

Under

**SETPOINT** ⇓ **CONTROL ELEMENTS** ⇒ **INPUTS/OUTPUTS** ⇒ **BOARD F**

NAME	VALUE
Output Logic_00_00	Positive
Output Type_00_00	Latch
Pulse Output Time	10000ms *

\* This setting is non-relevant since it applies only when “**pulse**” type is chosen

Under

**SETPOINT** ⇓ **RELAY CONFIGURATION** ⇒ **OUTPUTS**

SELECT	NAME	SOURCE
£ Contact Output Operate 00 (Board F)	C_Output Oper_00_00	Operation_bit000
£ Contact Output Reset 00 (Board F)	C_Output Reset_00_00	Operation_bit001

Under

**SETPOINT** ⇓ **RELAY CONFIGURATION** ⇒ **LEDS**

SELECT	NAME	SOURCE
£ Led 14	Close Contact_00_00	C_Output_00_00

Under

**SETPOINT ↓ RELAY CONFIGURATION ⇒ OPERATIONS**

Select	£ Operation 0
Command Text	Close C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F2
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Mastef 4	---

In the same window (next rows)

Select	£ Operation 1
Command Text	Reset C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F1
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Mastef 4	---



In the main front screen press **F2** key.

A message showing “Press Intro to Confirm Key →**F2**←” will be displayed.

Press down the **rotary knob**.

Check that contact\_00\_00 (board F) has been closed.

Check that the front LED 14<sup>th</sup> is lit.

In the main front screen press **F1** key.

A message showing “Press Intro to Confirm Key →**F1**←” will be displayed.

Press down the **rotary knob**.

Check that contact\_00\_00 (board F) has been opened.

Check that the front LED 14th has been switched off

**Q1 Does the F650 support DNP and ModBus over the Ethernet port?**

A1 F650 units support both protocols over both the asynchronous serial ports and the Ethernet LAN synchronous port using TCP/IP and UDP/IP layers over the Ethernet.

**Q2 Does this equipment support dual IP access?**

A1 Yes, it supports two independent IP addresses in aliasing mode. Those address go in the communications settings Network0 and Network1.

**Q3 Is the protocol IEC 870-103 supported by the F650?**

A3 At this moment it is not supported.

**Q4 Can the F650 be used as a DNP master station?**

A4 Not at this moment. It works as a slave IED station for all protocols.

**Q5 How many communication ports are included in the F650?**

A5 The equipment has 2 different boards, one for asynchronous serial ports and another for a high-speed synchronous Ethernet port. The first board has 2 comm ports, COM1 and COM2. COM2 is multiplexed with the front serial RS232 port, whereas the COM1 port is completely independent from COM2.

The synchronous LAN port is COM3.

**Q6 Are there one or two Ethernet ports?**

A6 The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

**Q7 How many different communication Ethernet sessions can be opened through the LAN port?**

A7 ModBus TCP/IP:4 sockets

DNP TCP/IP:3 sessions (from version 1.72 on)

**Q8 Does it support peer-to-peer horizontal communications? Is this going to interface with UR relays?**

A8 It is not included in the present release.

**Q9 May I use the cooper 10/100 BaseTX connection included in the basic model with all protocols?**

A9 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.

**Q10 Remote I/O CAN bus. Does it support DeviceNet protocol?**

A10 No it does not support DeviceNet.

**Q11: Which functions are available in the relay web server?**

A11 Currently, it includes several functions for viewing measures and retrieving information.

**Q12: What is the web site user password and name?**

A12: The password is: 7169 and user name is: GE

**Q13: May I use URPC to program the relay?**

A13: Only oscillography records may be viewed with URPC once downloaded to a file using the ENERVISTA F650 SETUP software.

**Q14: May I connect URs and F650s to the same Ethernet?**

A14: Yes, either in cable as in fiber, or even mix them.

**Q15: How do I connect with fiber 10-BASE-FL UR relays with 100-BASE-FX F650 relays?**

A15: Take into account that an UR is never connected directly to a F650 (neither two UR nor two F650 with each other) but they are always connected through a hub or switch. The hub or switch where the URs are connected must be 10-BASE-FL and the hub or switch for the F650 must be 100-BASE-FX.

**Q16: How do I connect with cable 10-BASE-T UR relays with 10/100-BASE-TX F650 relays?**

A16: The answer to this question is as described before but also in this case there is an advantage added, because the hub 10-BASE-TX port is able to understand a 10-BASE-T port. This means that a hub 10-BASE-T port may be connected to an UR or a F650, and a hub 10/100-BASE-TX port may be connected either to an UR or F650.

**Q17: What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the F650, although both are 100-BASE-FX?**

A17: Just buy fiber cables with the appropriate male connectors. For the UR and F650 side we need the same connectors, ST type, for the hub side, the correspondent ones. And in what concerns to the fiber type, it is used the same for 10 as for 100, it is the 50/125 or 62.5/125 multimode, this last one allows longer distances.

**Q18: What is the difference between a hub and a switch?**

A18: 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.

**Q19: Why do we have 10/100 compatibility for cable but not for fiber?**

A19: The cable has some advantages that the fiber does not have, and it is that the signal attenuation in short and medium distances, is worthless and this is truth for low and high frequency signals. By the contrary, the light in one fiber optic is highly attenuated, being much worse in case of high frequencies than in the low ones. The 10-BASE-FL fiber transmission is performed in a wavelength of 850nm, what allows a less expensive electronic than the 1300 nm used in 100-BASE-FX fiber transmission. Using, in both cases, the same glass multimode fiber type, the attenuation to 1300 nm is lower than the 850 nm ones, this way the greater attenuation of the 100 Mbits is compensated. There is another fiber standard, the 100-BASE-SX, which uses 850 nm to 100 Mbits, being compatible with the 10-BASE-FL one, although it sacrifices the maximum distance to 300 m. Nowadays, this standard has not had success among Ethernet equipment manufacturers and suppliers.

**Q1 Does the F650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?**

A1 Yes, the F650 includes an IRIG-B input for all models, including the basic ones.

It uses DC level format B. Formats used are B0000, B0002 and B0003.

Actual accuracy is 1 millisecond. Internal sampling rate allows true 1 ms accuracy time tagging.

The input burden is very low. The maximum number of units that may be connected to a generator depends on its output driving capability. Up to 60 units have been successfully connected with equipments commonly used in the market.

**Q2 Does the equipment work with dry inputs in both AC and DC?**

A2 The equipment works only with DC inputs.

Inputs should be driven with externally generated DC current. No special 48 Vdc or other outputs are included in the equipment to drive these inputs; therefore, contacts connected to the equipment should be connected to a DC source.

**Q3 Is this equipment valid for Petersen coil grounded systems and ungrounded systems?**

A3 The 5<sup>th</sup> current input is a very sensitive unit that measures from 5 mA up to 1.5 A, that is used for these systems. The present release includes 67SG (sensitive ground) as well as 67IG (isolated ground for ungrounded systems). Petersen Coil 67PC unit will be included in future releases that will only need firmware update.

**Q4 Is oscillography programmable?**

A4 Yes, the sampling rate is programmable (4, 8, 16, 32 or 64 samples per input). The depth will depend on the sampling rate.

**Q5 Do I have to select a different model for 1 or 5 A?**

A5 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.

**Q6 In my installation, several digital inputs become active when I energize the transformer. How can I reduce sensitivity?**

A6 By selecting debounce time and/or voltage threshold, the relay may adapt its sensitivity to different applications. Please select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

**Q1 What is the difference between Get/Send info from/to relay and Upload/Download info files to/from relay?**

A1 Get/Send are used for settings and configuration storage that although both are in a unique file, are sent separately in two times. Upload/Download are used for project or PLC files group storage. These files are the setting\_configuration file source. To operate, the F650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

**Q2 Could I program interlocks?**

A2 Yes, via ENERVISTA F650 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 during more than 3 seconds and then press the knob during a short pulse.

**Q10 Why do appear strange texts on the display when switching on the relay?**

A10 You will have pressed any button and the HMI has entered in a test mode.  
The display messages are updated after a few minutes, once the relay has completed the starting sequence.

- Q1 Does the "Service" contact on the Power Supply board cover all possible failures or do I have to create an output on the I/O board that includes all the internal errors I can access in the logic?**
- A1** The power supply ready contact only monitor hardware failures in the power supply, to monitor the internal error of the unit it is necessary to configure a virtual output to and the assign it to the device desired (contact output, LED, etc.).
- Q2 I set an output contact as "Latched". If I do not set a "reset" condition, will it reset from the "ESC" key?**
- A2** No, you have to configure the contact output reset signal (in **Settings>Relay Configuration>Outputs**). The ESC key only reset the LED indicators.



F650 units have been designed and verified using the most advanced and reliable equipment. Mounting and testing automation ensure a high consistency of the final product. Before sending a unit back to the factory, we strongly recommend you follow the recommendations below. Even if it will not always solve the problem, at least they will help define it better for a quicker repair.

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

CATEGORY	SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Protection	The relay does not trip	<ul style="list-style-type: none"> <li>-Function not permitted</li> <li>- Function blocked</li> <li>- Output not assigned</li> </ul>	<ul style="list-style-type: none"> <li>- Set the function permission to ENABLED</li> <li>- Check Protection units block screen</li> <li>- Program the output to the desired function using ENERVISTA F650 SETUP logic configuration</li> </ul>
General	When feeding the unit, no indicator is lit up	<ul style="list-style-type: none"> <li>-Insufficient power supply</li> <li>- Wrong versions</li> <li>-Fused fuse</li> <li>- Loose fuse</li> <li>-Incorrect wiring</li> </ul>	<ul style="list-style-type: none"> <li>-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range</li> <li>- Check relay and ENERVISTA F650 SETUP versions are the same</li> <li>-Remove power supply, dismount the power supply module and replace the fuse</li> <li>- Same as above with same fuse</li> <li>-Make sure that terminals labeled + and – are connected to the 9-pin connector corresponding to the power source</li> </ul>
Communication	The relay does not communicate via the front RS232 port	<ul style="list-style-type: none"> <li>-Incorrect cable</li> <li>-Damaged cable</li> <li>-Relay or PC not grounded</li> <li>-Incorrect baudrate, port, address, etc.</li> </ul>	<ul style="list-style-type: none"> <li>-Make sure you are using a straight cable</li> <li>-Replace the cable</li> <li>-Ensure ground connection</li> <li>-Test other ports, other baudrates, etc. Make sure that the communication parameters in the computer match the ones in the relay.</li> </ul>
General	After Updating the firmware the relay does not start up and always shows the message "Os Loading..."	Check that the bootware version match with the firmware version	<p>If there is an incompatibility between boot and firmware version, update to the corresponding boot and after that update the firmware version</p> <p>If the boot and firmware versions are correct, perform the firmware update procedure again.</p>
Communications	<p>Cannot see properly the web server in F650 with Windows XP.</p> <p>Some windows are in grey with a red cross mark.</p>	Disabled Java options in Advanced Internet Explorer properties or high level of security	<p>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.</p> <p>In case Microsoft VM is not installed in the computer, the user must install it using the Microsoft VM installation program <b>msjavx86.exe</b></p> <p>For internet explorer 6.0 or higher it is not included by default.</p> <p>2.- Try to set a lower level of security in internet explorer options.</p> <p>3.-Delete temporary internet files in "General" screen in internet explorer options.</p>



Communication	Enervista 650 Setup does not retrieve osc, fault reports and Data Logger files	Bad communication in TFTP using Windows 2000	Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again to retrieve files from relay
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OPERANDS - F650 - MODEL F2 - G1		
INTERNAL SYSTEM STATUS		
Autocheck internal states	TIMER STATUS	Real time clock autocheck
	E2PROM STATUS	E2prom status : (0) Not configured or problems during writing process ; (1) Configured and OK
	GRAPHIC STATUS	Graphic display status
	ALARM TEXT ARRAY	Text display status
	DSP COMM ERROR	DSP communication error
	MAGNETIC MODULE ERROR	Magnetic module error
	CALIBRATION ERROR	Calibration error
Other internal states	USER MAP STATUS	User map status: (0) Not configured ; (1) Configured
	FACTORY CALIBRATION	Calibration status (0) Not calibrated ; (1) Relay calibrated
	FLEXCURVE A STATUS	User curve A: (0) Not configured (1) Configured
	FLEXCURVE B STATUS	User curve B: (0) Not configured (1) Configured
	FLEXCURVE C STATUS	User curve C: (0) Not configured (1) Configured
	FLEXCURVE D STATUS	User curve D: (0) Not configured (1) Configured
	Green Zone	Memory internal status
	Yellow Zone	Memory internal status
	Orange Zone	Memory internal status
	Red Zone	Memory internal status
	UpTime	System Time
Configurable Logic Outputs (512 elements)	VIRTUAL OUTPUT 000	Configurable logic output 000
	VIRTUAL OUTPUT 001	Configurable logic output 001
	...	...
	VIRTUAL OUTPUT 511	Configurable logic output 511
Operation Bits (24 elements)	OPERATION BIT 1	Operation bit 001: (0) the configured time expires or when success conditions are met;(1) operation 1 is executed and interlocks are fulfilled.
	OPERATION BIT 2	Operation bit 002: (0) the configured time expires or when success conditions are met;(1) operation 2 is executed and interlocks are fulfilled.
	...	...
	OPERATION BIT 24	Operation bit 024: (0) the configured time expires or when success conditions are met;(1) operation 24 is executed and interlocks are fulfilled.
Bits de Eventos de Control (128 elementos)	CONTROL EVENT 1	Control Event 1 Activation Bit
	CONTROL EVENT 2	Control Event 2 Activation Bit
	...	...
	CONTROL EVENT 128	Control Event 128 Activation Bot
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

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Digital Inputs Board F (1 to 8)	CONT IP_F_CC1	Input 1 (CC1) Board F
	CONT IP_F_CC2	Input 2 (CC2) Board F
	...	...
	CONT IP_F_CC8	Input 8 (CC8) Board F
Supervision inputs Board F (9 to 16)	CONT IP_F_CC9 (Va_COIL1)	Contact Input 09 (Va_COIL1) for slot F. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_F_CC10 (Vb_COIL1)	Contact Input 10 (Vb_COIL1) for slot F. Input voltage (Vb) detected, Circuit 1. Complete circuit supervised
	CONT IP_F_CC11 (Va_COIL2)	Contact Input 11 (Va_COIL2) for slot F. Input voltage (Va) detected, Circuit 2. Complete circuit supervised
	CONT IP_F_CC12 (Vb_COIL2)	Contact Input 12 (Vb_COIL2) for slot F. Input voltage (Vb) detected, Circuit 2. Complete circuit supervised
	CONT IP_F_CC13 (O7_SEAL)	Contact Input 13 (O7_SEAL) for slot F. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_F_CC14 (O8_SEAL)	Contact Input 14 (O8_SEAL) for slot F. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_F_CC15 (SUP_COIL1)	Contact Input 15 SUP_COIL1) for slot F. Output for circuit 1 supervision element
Output activation signals Board F (8 elements)	CONT IP_F_CC16 (SUP_COIL2)	Contact Input 16 SUP_COIL2) for slot F. Output for circuit2 supervision element
	CONT OP OPER_F_01	Logic signal for Output 1 activation. Board F
	CONT OP OPER_F_02	Logic signal for Output 2 activation. Board F
	...	...
Output Reset Signals Board F (8 elements)	CONT OP OPER_F_8	Logic signal for Output 8 activation. Board F
	CONT OP RESET_F_01	board F, 01 latched output reset
	CONT OP RESET_F_02	board F, 02 latched output reset
	...	...
Contact Output Status Board F (8 elements)	CONT OP RESET_F_08	board F, 08 latched output reset
	CONT OP_F_01	Contact output 1 Board F operation
	CONT OP_F_02	Contact output 2 Board F operation
	...	...
Board F Status	CONT OP_F_08	Contact output 8 Board F operation
	BOARD F STATUS	Board F status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board

Input Status Board G (16 elements)	CONT IP_G_CC1	Input 1 (CC1) Board G
	CONT IP_G_CC2	Input 2 (CC2) Board G
	...	...
	CONT IP_G_CC16	Input 16 (CC16) Board G
Output activation signals Board G (8 elements)	CONT OP OPER_G_01	Logic signal for Output 1 activation. Board G
	CONT OP OPER_G_02	Logic signal for Output 2 activation. Board G
	...	...
	CONT OP OPER_G_8	Logic signal for Output 8 activation. Board G
Output Reset Signals Board G (8 elements)	CONT OP RESET_G_01	board G, 01 latched output reset
	CONT OP RESET_G_02	board G, 02 latched output reset
	...	...
	CONT OP RESET_G_08	board G, 08 latched output reset
Contact Output Status Board G (8 elements)	CONT OP_G_01	Contact output 1 Board G operation
	CONT OP_G_02	Contact output 2 Board G operation
	...	...
	CONT OP_G_08	Contact output 8 Board G operation
Board G Status	BOARD G STATUS	Board G status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board
Input Status Board H (16 elements) - CIO MODULE	CONT IP_H_CC1	Input 1 (CC1) Board H
	CONT IP_H_CC2	Input 2 (CC2) Board H
	...	...
	CONT IP_H_CC16	Input 16 (CC16) Board H
Output activation signals Board H (8 elements) - CIO MODULE	CONT OP OPER_H_01	Logic signal for Output 1 activation. Board H
	CONT OP OPER_H_02	Logic signal for Output 2 activation. Board H
	...	...
	CONT OP OPER_H_8	Logic signal for Output 8 activation. Board H
Output Reset Signals Board H (8 elements) - CIO MODULE	CONT OP RESET_H_01	board H, 01 latched output reset
	CONT OP RESET_H_02	board H, 02 latched output reset
	...	...
	CONT OP RESET_H_08	board H, 08 latched output reset
Contact Output Status Board H (8 elements) - CIO MODULE	CONT OP_H_01	Contact output 1 Board H operation
	CONT OP_H_02	Contact output 2 Board H operation
	...	...
	CONT OP_H_08	Contact output 8 Board H operation
Board H Status - CIO MODULE	BOARD H STATUS	Board H status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board
Input Status Board J (16 elements) - CIO MODULE	CONT IP_J_CC1	Input 1 (CC1) Board J
	CONT IP_J_CC2	Input 2 (CC2) Board J
	...	...
	CONT IP_J_CC16	Input 16 (CC16) Board J
Output activation signals Board J (8 elements) - CIO MODULE	CONT OP OPER_J_01	Logic signal for Output 1 activation. Board J
	CONT OP OPER_J_02	Logic signal for Output 2 activation. Board J
	...	...
	CONT OP OPER_J_8	Logic signal for Output 8 activation. Board J
Output Reset Signals Board J (8 elements) - CIO MODULE	CONT OP RESET_J_01	board J, 01 latched output reset
	CONT OP RESET_J_02	board J, 02 latched output reset
	...	...
	CONT OP RESET_J_08	board J, 08 latched output reset

Contact Output Status Board J (8 elements) - CIO MODULE	CONT OP_J_01	Contact output 1 Board J operation
	CONT OP_J_02	Contact output 2 Board J operation
	...	...
	CONT OP_J_08	Contact output 8 Board J operation
Board J Status - CIO MODULE	BOARD J STATUS	Board J 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
Switchgear outputs (16 elements)	SWITCH 16 B INPUT	Contact input type B to switchgear Function 16
	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
	...	...
Switchgear states (16 elements)	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
	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)

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Switchgear Open-Close Initializing States	SWITCH 1 OPEN INIT	Switchgear 1 opening initiation
	SWITCH 1 CLOSE INIT	Switchgear 1 closing initiation
	SWITCH 2 OPEN INIT	Switchgear 2 opening initiation
	SWITCH 2 CLOSE INIT	Switchgear 2 closing initiation
	...	...
	SWITCH 16 OPEN INIT	Switchgear 16 opening initiation
	SWITCH 16 CLOSE INIT	Switchgear 16 closing initiation
Switchgear Fail States	SWGR 1 FAIL TO OPEN	Failure to open Switchgear 1
	SWGR 2 FAIL TO OPEN	Failure to open Switchgear 2
	...	...
	SWGR 16 FAIL TO OPEN	Failure to open Switchgear 16
	SWGR 1 FAIL TO CLOSE	Failure to close Switchgear 1
	SWGR 2 FAIL TO CLOSE	Failure to close Switchgear 2
	...	...
	SWGR 16 FAIL TO CLOSE	Failure to close Switchgear 16

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LEDS HMI (16 elements)	READY LED	Ready LED: (0-Red) Relay out of service, protection OUT OF ORDER (1-Green) Relay in service; protection READY
	LED 1	Programmable LED 1 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 2	Programmable LED 2 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 3	Programmable LED 3 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 4	Programmable LED 4 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 5	Programmable LED 5 status: Red colour. Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 6	Programmable LED 6 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 7	Programmable LED 7 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 8	Programmable LED 8 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 9	Programmable LED 9 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 10	Programmable LED 10 status: Orange colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 11	Programmable LED 11 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 12	Programmable LED 12 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 13	Programmable LED 13 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 14	Programmable LED 14 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 15	Programmable LED 15 status: Green colour. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
LEDs reset input (programmable)	LED RESET INPUT	Programmable input for remote LED reset
Programmable Keypad Status (HMI)	I Key	I key operation (Programmable signal via PLC)
	O Key	O key operation (Programmable signal via PLC)
	* Key	* key operation (Programmable signal via PLC)
	F1 Key	F1 key operation (Programmable signal via PLC)
	F2 Key	F2 key operation (Programmable signal via PLC)

LOCAL/REMOTE Operation status LEDs	LOCAL OPERATION MODE	Local/remote status for operations 1 = Local, 0 = Remote. Selectable only through the front pushbutton (Hardware)
	OPERATIONS BLOCKED	Operations OFF status (1) Command execution block (operations blocked both in local and remote mode)
Oscillography States	OSC DIG CHANNEL 1	Oscillography Digital channel 1 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 2	Oscillography Digital channel 2 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 3	Oscillography Digital channel 3 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 4	Oscillography Digital channel 4 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 5	Oscillography Digital channel 5 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 6	Oscillography Digital channel 6 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 7	Oscillography Digital channel 7 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 8	Oscillography Digital channel 8 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 9	Oscillography Digital channel 9 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 10	Oscillography Digital channel 10: (1) Active ; (0) Not Active
	OSC DIG CHANNEL 11	Oscillography Digital channel 11 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 12	Oscillography Digital channel 12 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 13	Oscillography Digital channel 13 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 14	Oscillography Digital channel 14 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 15	Oscillography Digital channel 15 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 16	Oscillography Digital channel 16 : (1) Active ; (0) Not Active
	OSCILLO TRIGGER	Oscillo trigger activation (1) Active ; (0) Not active



Fault Report (Fault locator)	FAULT REPORT TRIGG	Fault report trigger (1) Active ; (0) Not active
	CLEAR FAULT REPORTS	Fault report removal from HMI and ModBus (volatile memory)
Energy Counters	FREEZE ENERGY CNT	Energy counter freeze
	UNFREEZE ENERGY CNT	Energy counter unfreeze
	RESET ENERGY CNT	Energy counter reset
Demand Inputs	DEMAND TRIGGER INP	Demand trigger (for Block interval algorithm)
	DEMAND RESET INP	Demand reset
Setting Groups	GROUP 1 ACT ON	Group 1 activation, and deactivation of groups 2 and 3
	GROUP 2 ACT ON	Group 2 activation, and deactivation of groups 1 and 3.
	GROUP 3 ACT ON	Group 3 activation, and deactivation of groups 1 and 2
	SETT GROUPS BLOCK	Group change input blocked
	GROUP 1 BLOCKED	Settings Group 1 blocked
	GROUP 2 BLOCKED	Settings Group 2 blocked
	GROUP 3 BLOCKED	Settings Group 3 blocked

Phase IOC High	PH IOC1 HIGH A BLK	Phase instantaneous overcurrent element block Group 1 phase A
	PH IOC1 HIGH B BLK	Phase instantaneous overcurrent element block Group 1 phase B
	PH IOC1 HIGH C BLK	Phase instantaneous overcurrent element block Group 1 phase C
	PH IOC1 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase A
	PH IOC1 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase A
	PH IOC1 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase B
	PH IOC1 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase B
	PH IOC1 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase C
	PH IOC1 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase C
	PH IOC1 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 1 any phase
	PH IOC1 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 any phase
	PH IOC2 HIGH A BLK	Phase instantaneous overcurrent element block Group 2 phase A
	PH IOC2 HIGH B BLK	Phase instantaneous overcurrent element block Group 2 phase B
	PH IOC2 HIGH C BLK	Phase instantaneous overcurrent element block Group 2 phase C
	PH IOC2 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase A
	PH IOC2 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase A
	PH IOC2 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase B
	PH IOC2 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase B
	PH IOC2 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase C
	PH IOC2 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase C
	PH IOC2 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 2 any phase
	PH IOC2 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 any phase
	PH IOC3 HIGH A BLK	Phase instantaneous overcurrent element block Group 3 phase A
	PH IOC3 HIGH B BLK	Phase instantaneous overcurrent element block Group 3 phase B
	PH IOC3 HIGH C BLK	Phase instantaneous overcurrent element block Group 3 phase C
	PH IOC3 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase A
	PH IOC3 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase A

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Phase IOC Low	PH IOC1 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 1 phase A
	PH IOC1 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 1 phase B
	PH IOC1 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 1 phase C
	PH IOC1 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase A
	PH IOC1 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase A
	PH IOC1 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase B
	PH IOC1 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase B
	PH IOC1 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase C
	PH IOC1 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase C
	PH IOC1 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 1 any phase
	PH IOC1 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 any phase
	PH IOC2 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 2 phase A
	PH IOC2 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 2 phase B
	PH IOC2 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 2 phase C
	PH IOC2 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase A
	PH IOC2 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase A
	PH IOC2 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase B
	PH IOC2 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase B
	PH IOC2 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase C
	PH IOC2 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase C
	PH IOC2 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 2 any phase
	PH IOC2 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 any phase
	PH IOC3 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 3 phase A
	PH IOC3 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 3 phase B
	PH IOC3 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 3 phase C

Neutral IOC	NEUTRAL IOC1 BLOCK	Neutral instantaneous overcurrent element block Group 1
	NEUTRAL IOC1 PKP	Neutral instantaneous overcurrent element pickup Group 1
	NEUTRAL IOC1 OP	Neutral instantaneous overcurrent element operation (trip) Group 1
	NEUTRAL IOC2 BLOCK	Neutral instantaneous overcurrent element block Group 2
	NEUTRAL IOC2 PKP	Neutral instantaneous overcurrent element pickup Group 2
	NEUTRAL IOC2 OP	Neutral instantaneous overcurrent element operation (trip) Group 2
	NEUTRAL IOC3 BLOCK	Neutral instantaneous overcurrent element block Group 3
	NEUTRAL IOC3 PKP	Neutral instantaneous overcurrent element pickup Group 3
	NEUTRAL IOC3 OP	Neutral instantaneous overcurrent element operation (trip) Group 3

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Ground IOC	GROUND IOC1 BLOCK	Ground instantaneous overcurrent element block Group 1
	GROUND IOC1 PKP	Ground instantaneous overcurrent element pickup Group 1
	GROUND IOC1 OP	Ground instantaneous overcurrent element operation (trip) Group 1
	GROUND IOC2 BLOCK	Ground instantaneous overcurrent element block Group 2
	GROUND IOC2 PKP	Ground instantaneous overcurrent element pickup Group 2
	GROUND IOC2 OP	Ground instantaneous overcurrent element operation (trip) Group 2
	GROUND IOC3 BLOCK	Ground instantaneous overcurrent element block Group 3
	GROUND IOC3 PKP	Ground instantaneous overcurrent element pickup Group 3
	GROUND IOC3 OP	Ground instantaneous overcurrent element operation (trip) Group 3
Sensitive Ground IOC	SENS GND IOC1 BLK	Sensitive ground instantaneous overcurrent element block Group 1
	SENS GND IOC1 PKP	Sensitive ground instantaneous overcurrent element pickup Group 1
	SENS GND IOC1 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 1
	SENS GND IOC2 BLK	Sensitive ground instantaneous overcurrent element block Group 2
	SENS GND IOC2 PKP	Sensitive ground instantaneous overcurrent element pickup Group 2
	SENS GND IOC2 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 2
	SENS GND IOC3 BLK	Sensitive ground instantaneous overcurrent element block Group 3
	SENS GND IOC3 PKP	Sensitive ground instantaneous overcurrent element pickup Group 3
	SENS GND IOC3 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 3
Isolated Ground	ISOLATED GND1 BLK	Isolated ground instantaneous overcurrent element block Group 1
	ISOLATED GND1 PKP	Isolated ground instantaneous overcurrent element pickup Group 1
	ISOLATED GND1 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 1
	ISOLATED GND2 BLK	Isolated ground instantaneous overcurrent element block Group 2
	ISOLATED GND2 PKP	Isolated ground instantaneous overcurrent element pickup Group 2
	ISOLATED GND2 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 2
	ISOLATED GND3 BLK	Isolated ground instantaneous overcurrent element block Group 3
	ISOLATED GND3 PKP	Isolated ground instantaneous overcurrent element pickup Group 3
	ISOLATED GND3 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 3

Phase TOC High	PH TOC1 HIGH A BLK	Phase timed overcurrent element block Group 1 phase A
	PH TOC1 HIGH B BLK	Phase timed overcurrent element block Group 1 phase B
	PH TOC1 HIGH C BLK	Phase timed overcurrent element block Group 1 phase C
	PH TOC1 HIGH A PKP	Phase timed overcurrent element pickup Group 1 phase A
	PH TOC1 HIGH A OP	Phase timed overcurrent element operation (trip) Group 1 phase A
	PH TOC1 HIGH B PKP	Phase timed overcurrent element pickup Group 1 phase B
	PH TOC1 HIGH B OP	Phase timed overcurrent element operation (trip) Group 1 phase B
	PH TOC1 HIGH C PKP	Phase timed overcurrent element pickup Group 1 phase C
	PH TOC1 HIGH C OP	Phase timed overcurrent element operation (trip) Group 1 phase C
	PH TOC1 HIGH PKP	Phase timed overcurrent element pickup Group 1 any phase
	PH TOC1 HIGH OP	Phase timed overcurrent element operation (trip) Group 1 any phase
	PH TOC2 HIGH A BLK	Phase timed overcurrent element block Group 2 phase A
	PH TOC2 HIGH B BLK	Phase timed overcurrent element block Group 2 phase B
	PH TOC2 HIGH C BLK	Phase timed overcurrent element block Group 2 phase C
	PH TOC2 HIGH A PKP	Phase timed overcurrent element pickup Group 2 phase A
	PH TOC2 HIGH A OP	Phase timed overcurrent element operation (trip) Group 2 phase A
	PH TOC2 HIGH B PKP	Phase timed overcurrent element pickup Group 2 phase B
	PH TOC2 HIGH B OP	Phase timed overcurrent element operation (trip) Group 2 phase B
	PH TOC2 HIGH C PKP	Phase timed overcurrent element pickup Group 2 phase C
	PH TOC2 HIGH C OP	Phase timed overcurrent element operation (trip) Group 2 phase C
	PH TOC2 HIGH PKP	Phase timed overcurrent element pickup Group 2 any phase
	PH TOC2 HIGH OP	Phase timed overcurrent element operation (trip) Group 2 any phase
	PH TOC3 HIGH A BLK	Phase timed overcurrent element block Group 3 phase A
	PH TOC3 HIGH B BLK	Phase timed overcurrent element block Group 3 phase B
	PH TOC3 HIGH C BLK	Phase timed overcurrent element block Group 3 phase C
	PH TOC3 HIGH A PKP	Phase timed overcurrent element pickup Group 3 phase A
	PH TOC3 HIGH A OP	Phase timed overcurrent element operation (trip) Group 3 phase A
	PH TOC3 HIGH B PKP	Phase timed overcurrent element pickup Group 3 phase B
	PH TOC3 HIGH B OP	Phase timed overcurrent element operation (trip) Group 3 phase B
	PH TOC3 HIGH C PKP	Phase timed overcurrent element pickup Group 3 phase C
	PH TOC3 HIGH C OP	Phase timed overcurrent element operation (trip) Group 3 phase C
	PH TOC3 HIGH PKP	Phase timed overcurrent element pickup Group 3 any phase
	PH TOC3 HIGH OP	Phase timed overcurrent element operation (trip) Group 3 any phase

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Phase TOC Low

PH TOC1 LOW A BLK	Phase timed overcurrent element block Low level Group 1 phase A
PH TOC1 LOW B BLK	Phase timed overcurrent element block Low level Group 1 phase B
PH TOC1 LOW C BLK	Phase timed overcurrent element block Low level Group 1 phase C
PH TOC1 LOW A PKP	Phase timed overcurrent element pickup low level Group 1 phase A
PH TOC1 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 1 phase A
PH TOC1 LOW B PKP	Phase timed overcurrent element pickup low level Group 1 phase B
PH TOC1 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 1 phase B
PH TOC1 LOW C PKP	Phase timed overcurrent element pickup low level Group 1 phase C
PH TOC1 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 1 phase C
PH TOC1 LOW PKP	Phase timed overcurrent element pickup low level Group 1 any phase
PH TOC1 LOW OP	Phase timed overcurrent element operation (trip) low level Group 1 any phase
PH TOC2 LOW A BLK	Phase timed overcurrent element block Low level Group 2 phase A
PH TOC2 LOW B BLK	Phase timed overcurrent element block Low level Group 2 phase B
PH TOC2 LOW C BLK	Phase timed overcurrent element block Low level Group 2 phase C
PH TOC2 LOW A PKP	Phase timed overcurrent element pickup low level Group 2 phase A
PH TOC2 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 2 phase A
PH TOC2 LOW B PKP	Phase timed overcurrent element pickup low level Group 2 phase B
PH TOC2 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 2 phase B
PH TOC2 LOW C PKP	Phase timed overcurrent element pickup low level Group 2 phase C
PH TOC2 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 2 phase C
PH TOC2 LOW PKP	Phase timed overcurrent element pickup low level Group 2 any phase
PH TOC2 LOW OP	Phase timed overcurrent element operation (trip) low level Group 2 any phase
PH TOC3 LOW A BLK	Phase timed overcurrent element block Low level Group 3 phase A
PH TOC3 LOW B BLK	Phase timed overcurrent element block Low level Group 3 phase B
PH TOC3 LOW C BLK	Phase timed overcurrent element block Low level Group 3 phase C
PH TOC3 LOW A PKP	Phase timed overcurrent element pickup low level Group 3 phase A
PH TOC3 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 3 phase A
PH TOC3 LOW B PKP	Phase timed overcurrent element pickup low level Group 3 phase B
PH TOC3 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 3 phase B
PH TOC3 LOW C PKP	Phase timed overcurrent element pickup low level Group 3 phase C

Neutral TOC	NEUTRAL TOC1 BLOCK	Neutral timed overcurrent element block Group 1
	NEUTRAL TOC1 PKP	Neutral timed overcurrent element pickup Group 1
	NEUTRAL TOC1 OP	Neutral timed overcurrent element operation (trip) Group 1
	NEUTRAL TOC2 BLOCK	Neutral timed overcurrent element block Group 2
	NEUTRAL TOC2 PKP	Neutral timed overcurrent element pickup Group 2
	NEUTRAL TOC2 OP	Neutral timed overcurrent element operation (trip) Group 2
	NEUTRAL TOC3 BLOCK	Neutral timed overcurrent element block Group 3
	NEUTRAL TOC3 PKP	Neutral timed overcurrent element pickup Group 3
	NEUTRAL TOC3 OP	Neutral timed overcurrent element operation (trip) Group 3
Ground TOC	GROUND TOC1 BLOCK	Ground timed overcurrent element block Group 1
	GROUND TOC1 PKP	Ground timed overcurrent element pickup Group 1
	GROUND TOC1 OP	Ground timed overcurrent element operation (trip) Group 1
	GROUND TOC2 BLOCK	Ground timed overcurrent element block Group 2
	GROUND TOC2 PKP	Ground timed overcurrent element pickup Group 2
	GROUND TOC2 OP	Ground timed overcurrent element operation (trip) Group 2
	GROUND TOC3 BLOCK	Ground timed overcurrent element block Group 3
	GROUND TOC3 PKP	Ground timed overcurrent element pickup Group 3
	GROUND TOC3 OP	Ground timed overcurrent element operation (trip) Group 3
Sensitive Ground TOC	SENS GND TOC1 BLOCK	Sensitive ground timed overcurrent element block Group 1
	SENS GND TOC1 PKP	Sensitive ground timed overcurrent element pickup Group 1
	SENS GND TOC1 OP	Sensitive ground timed overcurrent element operation (trip) Group 1
	SENS GND TOC2 BLOCK	Sensitive ground timed overcurrent element block Group 2
	SENS GND TOC2 PKP	Sensitive ground timed overcurrent element pickup Group 2
	SENS GND TOC2 OP	Sensitive ground timed overcurrent element operation (trip) Group 2
	SENS GND TOC3 BLOCK	Sensitive ground timed overcurrent element block Group 3
	SENS GND TOC3 PKP	Sensitive ground timed overcurrent element pickup Group 3
	SENS GND TOC3 OP	Sensitive ground timed overcurrent element operation (trip) Group 3



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Negative Sequence TOC	NEG SEQ TOC1 BLOCK	Negative sequence timed overcurrent element block Group 1
	NEG SEQ TOC1 PKP	Negative sequence timed overcurrent element pickup Group 1
	NEG SEQ TOC1 OP	Negative sequence timed overcurrent element operation Group 1
	NEG SEQ TOC2 BLOCK	Negative sequence timed overcurrent element block Group 2
	NEG SEQ TOC2 PKP	Negative sequence timed overcurrent element pickup Group 2
	NEG SEQ TOC2 OP	Negative sequence timed overcurrent element operation Group 2
	NEG SEQ TOC3 BLOCK	Negative sequence timed overcurrent element block Group 3
	NEG SEQ TOC3 PKP	Negative sequence timed overcurrent element pickup Group 3
	NEG SEQ TOC3 OP	Negative sequence timed overcurrent element operation Group 3

Thermal Image	THERMAL1 BLOCK	Thermal image block Group 1
	THERMAL1 A RST	Thermal image phase A Group 1 element reset
	THERMAL1 B RST	Thermal image phase B Group 1 element reset
	THERMAL1 C RST	Thermal image phase C Group 1 element reset
	THERMAL1 ALARM	Thermal image element alarm any phase Group 1
	THERMAL1 OP	Thermal image element operation any phase Group 1
	THERMAL1 A ALRM	Thermal image element alarm phase A Group 1
	THERMAL1 A OP	Thermal image element operation phase A Group 1
	THERMAL1 B ALRM	Thermal image element alarm phase B Group 1
	THERMAL1 B OP	Thermal image element operation phase B Group 1
	THERMAL1 C ALRM	Thermal image element alarm phase C Group 1
	THERMAL1 C OP	Thermal image element operation phase C Group 1
	THERMAL2 BLOCK	Thermal image block Group 2
	THERMAL2 A RST	Thermal image phase A Group 2 element reset
	THERMAL2 B RST	Thermal image phase B Group 2 element reset
	THERMAL2 C RST	Thermal image phase C Group 2 element reset
	THERMAL2 ALARM	Thermal image element alarm any phase Group 2
	THERMAL2 OP	Thermal image element operation any phase Group 2
	THERMAL2 A ALRM	Thermal image element alarm phase A Group 2
	THERMAL2 A OP	Thermal image element operation phase A Group 2
	THERMAL2 B ALRM	Thermal image element alarm phase B Group 2
	THERMAL2 B OP	Thermal image element operation phase B Group 2
	THERMAL2 C ALRM	Thermal image element alarm phase C Group 2
	THERMAL2 C OP	Thermal image element operation phase C Group 2
	THERMAL3 BLOCK	Thermal image block Group 3
	THERMAL3 A RST	Thermal image phase A Group 3 element reset
	THERMAL3 B RST	Thermal image phase B Group 3 element reset
	THERMAL3 C RST	Thermal image phase C Group 3 element reset
	THERMAL3 ALARM	Thermal image element alarm any phase Group 3
	THERMAL3 OP	Thermal image element operation any phase Group 3
	THERMAL3 A ALRM	Thermal image element alarm phase A Group 3
	THERMAL3 A OP	Thermal image element operation phase A Group 3
	THERMAL3 B ALRM	Thermal image element alarm phase B Group 3
	THERMAL3 B OP	Thermal image element operation phase B Group 3
	THERMAL3 C ALRM	Thermal image element alarm phase C Group 3
	THERMAL3 C OP	Thermal image element operation phase C Group 3

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Phase Directional	PHASE DIR1 BLK INP	Phase directional block Group 1
	PHASE DIR1 BLOCK A	Phase directional element block Group 1 Phase A
	PHASE DIR1 A OP	Phase directional element operation Group 1 Phase A
	PHASE DIR1 BLOCK B	Phase directional element block Group 1 Phase B
	PHASE DIR1 B OP	Phase directional element operation Group 1 Phase B
	PHASE DIR1 BLOCK C	Phase directional element block Group 1 Phase C
	PHASE DIR1 C OP	Phase directional element operation Group 1 Phase C
	PHASE DIR2 BLK INP	Phase directional block Group 2
	PHASE DIR2 BLOCK A	Phase directional element block Group 2 Phase A
	PHASE DIR2 A OP	Phase directional element operation Group 2 Phase A
	PHASE DIR2 BLOCK B	Phase directional element block Group 2 Phase B
	PHASE DIR2 B OP	Phase directional element operation Group 2 Phase B
	PHASE DIR2 BLOCK C	Phase directional element block Group 2 Phase C
	PHASE DIR2 C OP	Phase directional element operation Group 2 Phase C
	PHASE DIR3 BLK INP	Phase directional block Group 3
	PHASE DIR3 BLOCK A	Phase directional element block Group 3 Phase A
	PHASE DIR3 A OP	Phase directional element operation Group 3 Phase A
	PHASE DIR3 BLOCK B	Phase directional element block Group 3 Phase B
	PHASE DIR3 B OP	Phase directional element operation Group 3 Phase B
	PHASE DIR3 BLOCK C	Phase directional element block Group 3 Phase C
	PHASE DIR3 C OP	Phase directional element operation Group 3 Phase C
Neutral Directional	NEUTRAL DIR1 BLK INP	Neutral directional element block Group 1
	NEUTRAL DIR1 BLOCK	Neutral directional element block Group 1
	NEUTRAL DIR1 OP	Neutral directional element operation Group 1
	NEUTRAL DIR2 BLK INP	Neutral directional element block Group 2
	NEUTRAL DIR2 BLOCK	Neutral directional element block Group 2
	NEUTRAL DIR2 OP	Neutral directional element operation Group 2
	NEUTRAL DIR3 BLK INP	Neutral directional element block Group 3
	NEUTRAL DIR3 BLOCK	Neutral directional element block Group 3
Ground Directional	GROUND DIR1 BLK INP	Ground directional element block Group 1
	GROUND DIR1 BLOCK	Ground directional element block Group 1
	GROUND DIR1 OP	Ground directional element operation Group 1
	GROUND DIR2 BLK INP	Ground directional element block Group 2
	GROUND DIR2 BLOCK	Ground directional element block Group 2
	GROUND DIR2 OP	Ground directional element operation Group 2
	GROUND DIR3 BLK INP	Ground directional element block Group 3
	GROUND DIR3 BLOCK	Ground directional element block Group 3
	GROUND DIR3 OP	Ground directional element operation Group 3

Sensitive Ground Directional	SENS GND DIR1 BLK IP	Sensitive ground directional element block input Group 1
	SENS GND DIR1 BLOCK	Sensitive Ground directional element block Group 1
	SENS GND DIR1 OP	Sensitive Ground directional element operation Group 1
	SENS GND DIR2 BLK IP	Sensitive ground directional element block input Group 2
	SENS GND DIR2 BLOCK	Sensitive Ground directional element block Group 2
	SENS GND DIR2 OP	Sensitive Ground directional element operation Group 2
	SENS GND DIR3 BLK IP	Sensitive ground directional element block input Group 3
	SENS GND DIR3 BLOCK	Sensitive Ground directional element block Group 3
	SENS GND DIR3 OP	Sensitive Ground directional element operation Group 3
Fuse failure	VT FUSE FAILURE	Fuse failure operation

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Phase UV

PHASE UV1 BLOCK	Phase undervoltage element block Group 1
PHASE UV1 A PKP	Undervoltage element pickup AG Group 1
PHASE UV1 A OP	Undervoltage element operation AG Group 1
PHASE UV1 B PKP	Undervoltage element pickup BG Group 1
PHASE UV1 B OP	Undervoltage element operation BG Group 1
PHASE UV1 C PKP	Undervoltage element pickup CG Group 1
PHASE UV1 C OP	Undervoltage element operation CG Group 1
PHASE UV1 AB PKP	Undervoltage element pickup AB Group 1
PHASE UV1 AB OP	Undervoltage element operation AB Group 1
PHASE UV1 BC PKP	Undervoltage element pickup BC Group 1
PHASE UV1 BC OP	Undervoltage element operation BC Group 1
PHASE UV1 CA PKP	Undervoltage element pickup CA Group 1
PHASE UV1 CA OP	Undervoltage element operation CA Group 1
PHASE UV1 PKP	Pickup of any of the above mentioned elements
PHASE UV1 OP	Operation of any of the above mentioned elements
PHASE UV2 BLOCK	Phase undervoltage element block Group 2
PHASE UV2 A PKP	Undervoltage element pickup AG Group 2
PHASE UV2 A OP	Undervoltage element operation AG Group 2
PHASE UV2 B PKP	Undervoltage element pickup BG Group 2
PHASE UV2 B OP	Undervoltage element operation BG Group 2
PHASE UV2 C PKP	Undervoltage element pickup CG Group 2
PHASE UV2 C OP	Undervoltage element operation CG Group 2
PHASE UV2 AB PKP	Undervoltage element pickup AB Group 2
PHASE UV2 AB OP	Undervoltage element operation AB Group 2
PHASE UV2 BC PKP	Undervoltage element pickup BC Group 2
PHASE UV2 BC OP	Undervoltage element operation BC Group 2
PHASE UV2 CA PKP	Undervoltage element pickup CA Group 2
PHASE UV2 CA OP	Undervoltage element operation CA Group 2
PHASE UV2 PKP	Pickup of any of the above mentioned elements
PHASE UV2 OP	Operation of any of the above mentioned elements
PHASE UV3 BLOCK	Phase undervoltage element block Group 3
PHASE UV3 A PKP	Undervoltage element pickup AG Group 3
PHASE UV3 A OP	Undervoltage element operation AG Group 3
PHASE UV3 B PKP	Undervoltage element pickup BG Group 3
PHASE UV3 B OP	Undervoltage element operation BG Group 3
PHASE UV3 C PKP	Undervoltage element pickup CG Group 3
PHASE UV3 C OP	Undervoltage element operation CG Group 3
PHASE UV3 AB PKP	Undervoltage element pickup AB Group 3
PHASE UV3 AB OP	Undervoltage element operation AB Group 3
PHASE UV3 BC PKP	Undervoltage element pickup BC Group 3
PHASE UV3 BC OP	Undervoltage element operation BC Group 3
PHASE UV3 CA PKP	Undervoltage element pickup CA Group 3
PHASE UV3 CA OP	Undervoltage element operation CA Group 3
PHASE UV3 PKP	Pickup of any of the above mentioned elements
PHASE UV3 OP	Operation of any of the above mentioned elements

Phase OV	PHASE OV1 BLOCK	Phase overvoltage element block Group 1
	PHASE OV1 AB PKP	Overvoltage element pickup AB Group 1
	PHASE OV1 AB OP	Overvoltage element operation AB Group 1
	PHASE OV1 BC PKP	Overvoltage element pickup BC Group 1
	PHASE OV1 BC OP	Overvoltage element operation BC Group 1
	PHASE OV1 CA PKP	Overvoltage element pickup CA Group 1
	PHASE OV1 CA OP	Overvoltage element operation CA Group 1
	PHASE OV1 PKP	Pickup of any of the above mentioned elements
	PHASE OV1 OP	Operation of any of the above mentioned elements
	PHASE OV2 BLOCK	Phase overvoltage element block Group 2
	PHASE OV2 AB PKP	Overvoltage element pickup AB Group 2
	PHASE OV2 AB OP	Overvoltage element operation AB Group 2
	PHASE OV2 BC PKP	Overvoltage element pickup BC Group 2
	PHASE OV2 BC OP	Overvoltage element operation BC Group 2
	PHASE OV2 CA PKP	Overvoltage element pickup CA Group 2
	PHASE OV2 CA OP	Overvoltage element operation CA Group 2
	PHASE OV2 PKP	Pickup of any of the above mentioned elements
	PHASE OV2 OP	Operation of any of the above mentioned elements
	PHASE OV3 BLOCK	Phase overvoltage element block Group 3
	PHASE OV3 AB PKP	Overvoltage element pickup AB Group 3
	PHASE OV3 AB OP	Overvoltage element operation AB Group 3
	PHASE OV3 BC PKP	Overvoltage element pickup BC Group 3
	PHASE OV3 BC OP	Overvoltage element operation BC Group 3
	PHASE OV3 CA PKP	Overvoltage element pickup CA Group 3
	PHASE OV3 CA OP	Overvoltage element operation CA Group 3
	PHASE OV3 PKP	Pickup of any of the above mentioned elements
	PHASE OV3 OP	Operation of any of the above mentioned elements
Neutral OV High	NEUTRAL OV1 HIGH BLK	Neutral overvoltage element block high level Group 1
	NEUTRAL OV1 HIGH PKP	Neutral overvoltage element pickup high level Group 1
	NEUTRAL OV1 HIGH OP	Neutral overvoltage element operation high level Group 1
	NEUTRAL OV2 HIGH BLK	Neutral overvoltage element block high level Group 2
	NEUTRAL OV2 HIGH PKP	Neutral overvoltage element pickup high level Group 2
	NEUTRAL OV2 HIGH OP	Neutral overvoltage element operation high level Group 2
	NEUTRAL OV3 HIGH BLK	Neutral overvoltage element block high level Group 3
	NEUTRAL OV3 HIGH PKP	Neutral overvoltage element pickup high level Group 3
	NEUTRAL OV3 HIGH OP	Neutral overvoltage element operation high level Group 3

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Neutral OV Low	NEUTRAL OV1 LOW BLK	Neutral overvoltage element block low level Group 1
	NEUTRAL OV1 LOW PKP	Neutral overvoltage element pickup low level Group 1
	NEUTRAL OV1 LOW OP	Neutral overvoltage element operation low level Group 1
	NEUTRAL OV2 LOW BLK	Neutral overvoltage element block low level Group 2
	NEUTRAL OV2 LOW PKP	Neutral overvoltage element pickup low level Group 2
	NEUTRAL OV2 LOW OP	Neutral overvoltage element operation low level Group 2
	NEUTRAL OV3 LOW BLK	Neutral overvoltage element block low level Group 3
	NEUTRAL OV3 LOW PKP	Neutral overvoltage element pickup low level Group 3
	NEUTRAL OV3 LOW OP	Neutral overvoltage element operation low level Group 3
Auxiliary UV	AUXILIARY UV1 BLOCK	Auxiliary undervoltage element block Group 1
	AUXILIARY UV1 PKP	Auxiliary undervoltage element pickup Group 1
	AUXILIARY UV1 OP	Auxiliary undervoltage element operation Group 1
	AUXILIARY UV2 BLOCK	Auxiliary undervoltage element block Group 2
	AUXILIARY UV2 PKP	Auxiliary undervoltage element pickup Group 2
	AUXILIARY UV2 OP	Auxiliary undervoltage element operation Group 2
	AUXILIARY UV3 BLOCK	Auxiliary undervoltage element block Group 3
	AUXILIARY UV3 PKP	Auxiliary undervoltage element pickup Group 3
	AUXILIARY UV3 OP	Auxiliary undervoltage element operation Group 3
Auxiliary OV	AUXILIARY OV1 BLOCK	Auxiliary overvoltage element block Group 1
	AUXILIARY OV1 PKP	Auxiliary Overvoltage element pickup Group 1
	AUXILIARY OV1 OP	Auxiliary overvoltage element operation Group 1
	AUXILIARY OV2 BLOCK	Auxiliary overvoltage element block Group 2
	AUXILIARY OV2 PKP	Auxiliary Overvoltage element pickup Group 2
	AUXILIARY OV2 OP	Auxiliary overvoltage element operation Group 2
	AUXILIARY OV3 BLOCK	Auxiliary overvoltage element block Group 3
	AUXILIARY OV3 PKP	Auxiliary Overvoltage element pickup Group 3
	AUXILIARY OV3 OP	Auxiliary overvoltage element operation Group 3
Negative Sequence OV	NEG SEQ OV1 BLOCK	Negative sequence overvoltage element block Group 1
	NEG SEQ OV1 PKP	Negative sequence overvoltage element pickup Group 1
	NEG SEQ OV1 OP	Negative sequence overvoltage element operation Group 1
	NEG SEQ OV2 BLOCK	Negative sequence overvoltage element block Group 2
	NEG SEQ OV2 PKP	Negative sequence overvoltage element pickup Group 2
	NEG SEQ OV2 OP	Negative sequence overvoltage element operation Group 2
	NEG SEQ OV3 BLOCK	Negative sequence overvoltage element block Group 3
	NEG SEQ OV3 PKP	Negative sequence overvoltage element pickup Group 3
	NEG SEQ OV3 OP	Negative sequence overvoltage element operation Group 3

Sobrefrecuencia - Overfrequency	OVERFREQ1 BLOCK	Overfrequency element block Group 1
	OVERFREQ1 PKP	Overfrequency element pickup Group 1
	OVERFREQ1 OP	Overfrequency element operation Group 1
	OVERFREQ2 BLOCK	Overfrequency element block Group 2
	OVERFREQ2 PKP	Overfrequency element pickup Group 2
	OVERFREQ2 OP	Overfrequency element operation Group 2
	OVERFREQ3 BLOCK	Overfrequency element block Group 3
	OVERFREQ3 PKP	Overfrequency element pickup Group 3
	OVERFREQ3 OP	Overfrequency element operation Group 3
Subfrecuencia - Underfrequency	UNDERFREQ1 BLOCK	Underfrequency element block Group 1
	UNDERFREQ1 PKP	Underfrequency element pickup Group 1
	UNDERFREQ1 OP	Underfrequency element operation Group 1
	UNDERFREQ2 BLOCK	Underfrequency element block Group 2
	UNDERFREQ2 PKP	Underfrequency element pickup Group 2
	UNDERFREQ2 OP	Underfrequency element operation Group 2
	UNDERFREQ3 BLOCK	Underfrequency element block Group 3
	UNDERFREQ3 PKP	Underfrequency element pickup Group 3
	UNDERFREQ3 OP	Underfrequency element operation Group 3
Broken Conductor	BROKEN CONDUCT1 BLK	Broken conductor block Group 1
	BROKEN CONDUCT1 PKP	Broken conductor element Pickup Group 1
	BROKEN CONDUCT1 OP	Broken conductor element operation Group 1
	BROKEN CONDUCT2 BLK	Broken conductor block Group 2
	BROKEN CONDUCT2 PKP	Broken conductor element Pickup Group 2
	BROKEN CONDUCT2 OP	Broken conductor element operation Group 2
	BROKEN CONDUCT3 BLK	Broken conductor block Group 3
	BROKEN CONDUCT3 PKP	Broken conductor element Pickup Group 3
	BROKEN CONDUCT3 OP	Broken conductor element operation Group 3
Forward Power(32FP)	FWD PWR1 BLOCK	Forward power element block Group 1
	FWD PWR1 STG1 PKP	Forward Power element pickup level 1 Group 1
	FWD PWR1 STG1 OP	Forward Power element operation level 1 Group 1
	FWD PWR1 STG2 PKP	Forward Power element pickup level 2 Group 1
	FWD PWR1 STG2 OP	Forward Power element operation level 2 Group 1
	FWD PWR2 BLOCK	Forward power element block Group 2
	FWD PWR2 STG1 PKP	Forward Power element pickup level 1 Group 2
	FWD PWR2 STG1 OP	Forward Power element operation level 1 Group 2
	FWD PWR2 STG2 PKP	Forward Power element pickup level 2 Group 2
	FWD PWR2 STG2 OP	Forward Power element operation level 2 Group 2
	FWD PWR3 BLOCK	Forward power element block Group 3
	FWD PWR3 STG1 PKP	Forward Power element pickup level 1 Group 3
	FWD PWR3 STG1 OP	Forward Power element operation level 1 Group 3
	FWD PWR3 STG2 PKP	Forward Power element pickup level 2 Group 3
	FWD PWR3 STG2 OP	Forward Power element operation level 2 Group 3



A

Breaker States	KI2t PHASE A ALARM	K.I <sup>2</sup> t phase A Alarm
	KI2t PHASE B ALARM	K.I <sup>2</sup> t phase B Alarm
	KI2t PHASE C ALARM	K.I <sup>2</sup> t phase C Alarm
	BKR OPENINGS ALARM	Maximum Breaker openings alarm
	BKR OPEN 1 HOUR ALRM	Maximum Breaker openings in one hour alarm
	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
	RESET KI2t COUNTERS	KI <sup>2</sup> t Breaker ageing counter reset
	RESET BKR COUNTERS	Breaker openings and closings counters reset
Breaker Failure	BKR FAIL INITIATE	Breaker failure initiation
	BKR FAIL NO CURRENT	Breaker failure without current
	BKR FAIL SUPERVISION	Breaker failure 1st level (supervision – retrip)
	BKR FAIL HISET	Breaker failure 2nd level (high level)
	BKR FAIL LOWSET	Breaker failure 3rd level (low level)
	INTERNAL ARC	Internal arc
	BKR FAIL 2nd STEP	Breaker failure second step
Synchrocheck	SYNCROCHECK BLK INP	Synchronism element block
	SYNCROCHECK 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)
	SYNCROCHECK COND OP	Active if when it is set, any of the three following conditions is met:
	DL-DB OPERATION	Dead line – dead bus condition
	DL-LB OPERATION	Dead line – live bus condition
	LL-DB OPERATION	Live line – dead bus condition
	SLIP CONDITION	Slip conditions are met
	BUS FREQ > LINE FREQ	Bus Frequency higher than line frequency
	BUS FREQ < LINE FREQ	Bus Frequency lower than line frequency

Autorecloser	AR LEVEL BLOCK	Recloser element block by level
	AR PULSE BLOCK	Recloser element block by pulse
	AR PULSE UNBLOCK	Recloser element unblock by pulse
	AR INITIATE	Reclose initiate
	AR CONDS INPUT	Reclose permission condition in input to Function 1 = there are conditions
	AR CLOSE BREAKER	Closing permission for the recloser
	AR OUT OF SERVICE	Recloser out of service
	AR READY	Recloser READY
	AR LOCKOUT	Recloser in LOCKOUT
	AR BLOCK	Recloser BLOCKed
	AR RCL IN PROGRESS	Recloser – Cycle in progress
	AR LCK BY ANOMALY	Recloser – LOCKOUT by anomaly (reclosing command during cycle in progress)
	AR LCK BY FAIL OPEN	Recloser – LOCKOUT by failure to open
	AR LCK BY FAIL CLOSE	Recloser – LOCKOUT by failure to close
	AR LCK BY USER	Recloser – LOCKOUT by external operation (e.g.: manual opening with cycle in progress)
	AR LCK BY CONDS	Recloser – LOCKOUT by lack of reclosing conditions
	AR LCK BY TRIPS	Recloser – LOCKOUT by number of trips
	AR LCK BY SHOTS	Recloser – LOCKOUT by number of shots
	AR BLK AFTER 1 SHOT	Recloser – Block after first shot
	AR BLK AFTER 2 SHOT	Recloser – Block after second shot
	AR BLK AFTER 3 SHOT	Recloser – Block after third shot
	AR BLK AFTER 4 SHOT	Recloser – Block after fourth shot
	AR BLOCK BY LEVEL	Recloser – Block by level
	AR BLOCK BY PULSE	Recloser – Block by command (pulse)
Default Channel (not used)	Default Channel	Channel not used

A

Directional Power	DIR PWR1 BLOCK	Directional power element block Group 1
	DIR PWR1 STG1 PKP	Directional Power element pickup level 1 Group 1
	DIR PWR1 STG1 OP	Directional Power element operation level 1 Group 1
	DIR PWR1 STG2 PKP	Directional Power element pickup level 2 Group 1
	DIR PWR1 STG2 OP	Directional Power element operation level 2 Group 1
	DIR PWR1 STG PKP	Directional power element pickup Group 1
	DIR PWR1 STG OP	Directional Power element operation Group 1
	DIR PWR2 BLOCK	Directional power element block Group 2
	DIR PWR2 STG1 PKP	Directional Power element pickup level 1 Group 2
	DIR PWR2 STG1 OP	Directional Power element operation level 1 Group 2
	DIR PWR2 STG2 PKP	Directional Power element pickup level 2 Group 2
	DIR PWR2 STG2 OP	Directional Power element operation level 2 Group 2
	DIR PWR2 STG PKP	Directional power element pickup Group 2
	DIR PWR2 STG OP	Directional Power element operation Group 2
	DIR PWR3 BLOCK	Directional power element block Group 3
	DIR PWR3 STG1 PKP	Directional Power element pickup level 1 Group 3
	DIR PWR3 STG1 OP	Directional Power element operation level 1 Group 3
	DIR PWR3 STG2 PKP	Directional Power element pickup level 2 Group 3
	DIR PWR3 STG2 OP	Directional Power element operation level 2 Group 3
	DIR PWR3 STG PKP	Directional power element pickup Group 3
	DIR PWR3 STG OP	Directional Power element operation Group 3
Locked Rotor	LOCKED ROTOR1 BLK	Locked rotor element block Group 1
	LOCKED ROTOR1 PKP	Locked rotor element pickup Group 1
	LOCKED ROTOR1 OP	Locked rotor element operation Group 1
	LOCKED ROTOR2 BLK	Locked rotor element block Group 2
	LOCKED ROTOR2 PKP	Locked rotor element pickup Group 2
	LOCKED ROTOR2 OP	Locked rotor element operation Group 2
	LOCKED ROTOR3 BLK	Locked rotor element block Group 3
	LOCKED ROTOR3 PKP	Locked rotor element pickup Group 3
	LOCKED ROTOR3 OP	Locked rotor element operation Group 3

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B.1.1 ACCESS TO F650 DATA

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This document describes the procedure to read and write data in the F650 relay using ModBus/RTU protocol.

To prevent an existing integration from being affected by versions, a generic database has been created, **compatible between versions**, with all possible items that a F650 may have, independently from its type or configuration. This database describes completely each of these items. This descriptions includes the data type, length, memory position, object version, etc. Moreover, the database will group the different objects by subgroups, such as status and settings groups.

Each object has a **unique** memory position for the whole family. Only after reading the objects of a particular relay, it will be possible to elaborate its map. This map will only be valid for that particular relay and memory version. From one version to another the memory positions of existing objects remain fixed, and new objects are assigned new addresses, which again remain the same for following versions.

It is possible to get the Memory Map using **EnerVista 650 Setup software**, menu:

View, ModBus Memory map

### B.1.2.1 FUNCTIONS USED

The protocol used is standard ModBus/RTU, so any program or PLC will be able to easily communicate with F650 units. F650 always works as slave, which means that it never starts the communications. It is always the master who initiates communication.

Only one ModBus/RTU functions subgroup are implemented:

- **Reading function 3 (or 4).**
- **Writing function 16.**

### B.1.2.2 PHYSICAL LAYER

## B

ModBus/RTU protocol is independent from the hardware. This way, the physical layer may be in different hardware configurations: RS232, RS485, fiber optic or Ethernet.

F650 units incorporate a front RS232 port, two rear RS485 or fiber optic ports, and a 10/100Base T port, and in some configurations two 100BaseFX ports. The data flow in any of the configurations is "half-duplex".

Each data byte is transmitted in an asynchronous way and it is formed by: 1 start bit, 8 data bits, 1 stop bit and 1 parity bit if programmed. Thus you have a 10 or 11-bit data, depending on whether it has parity or not.

The port baud rate and the parity are independent and programmable for each communication port. Any port may be programmed to baud rates of: 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200. Parity may be pair, impair or without parity.

The master must know the client address with which it is going to communicate. No unit will operate after a master request if the message address is not its own, except if the address is 0, which is the broadcast address. In this case the relay will operate, but won't send any reply.

**B.1.2.3 DATA LINK LAYER**

Communication is performed in strings, data groups sent in an asynchronous way. The master transmits a string to the slave and then the slave responds with another string (except for the case of broadcast communication). A timeout or a silence time in the communication marks the end of a string. The length of this time varies depending on the baud rate, because it is equal to 3 characters.

The following table shows the generic string format, valid for transmission and reception. However, each function will have its own particularities, as described later in this manual.

<b>MODBUS FORMAT</b>		
CLIENT ADDRESS [A]	1 byte	Each device in a communications bus must have a unique address to prevent two units from responding at the same time to the same request. All relay ports will use this address, which can be programmed to a value between 1 and 254. When the master transmits a string with the slave address 0, this indicates that it is a Broadcast. Every slave in the communication bus will perform the requested action, but none of them will respond to the master. Broadcast is only accepted for writing because it is nonsense to perform a reading request in Broadcast, as no unit will respond to it.
FUNCTION CODE [B]	1 byte	This is one of the function codes supported by the equipment. In this case, the only supported function codes will be 3 and 4 for reading and 16 for writing. When the slave has to respond with an exception to any of these strings, it will place to 1 the most important bit of the correspondent function. For example, an exception to function 3 will be indicated with an 83 as function code, and an exception to function 16 or 0x10 in hexadecimal, will be indicated with a 0x90.
DATA [C]	N bytes	This section includes a variable number of bytes, depending on the function code. It may include: addresses, data length, settings, commands or exception codes sent by the client.
CRC [D]	2 bytes	Two-byte control code. ModBus/RTU includes a 16-bit CRC in each string for error detection. If the slave detects a string with errors, based on an incorrect CRC, it will neither perform any action, nor respond to the master. The CRC order is LSB-MSB.
TIME OUT	Required time to transmit 3,5 Bytes	A string is finished when nothing is received during a period of 3,5 bytes: 15 ms at 2400 bps 2 ms at 19200 bps 300 µs at 115200 bps etc.

**B.1.2.4 GENERIC READING**

MASTER

SERVER

**Request**

+[A]+ +[B]+ +[C]-----+ +[D]--+

01 03 0B 37 00 03 XX XX

Data addr. Regs.

**OK Response**

+[A]+ +[B]+ +[C]-----+ +[D]--+

01 03 06 02 2B 00 00 00 64 XX XX

Bytes .....Data .....

**Error Response**

+[A]+ +[B]+ +[C]+ +[D]--+

01 83 07 XX XX

**B**

**B.1.2.5 GENERIC WRITING**

MASTER

SERVER

**Request**

+[A]++[B]++[C]-----+[D]--+  
 01 10 00 87 00 02 04 00 0A 01 02 XX XX  
 Data addr. Regs. Bytes .....Data.....

**OK Response**

+[A]++[B]++[C]-----+[D]--+  
 01 10 00 87 00 02 XX XX  
 Data addr. Regs.

**Error Response**

+[A]++[B]++[C]++[D]--+  
 01 90 07 XX XX

**B**



**B.1.2.6 FUNCTION CODES**

CODE		MODBUS NAME	F650 DEFINITION	COMMENT
HEX	DEC			
03	3	Read Holding Registers	Reading of any value	Any of these two functions allow the master to read 1 or more consecutive relay addresses. Registers are always 16-bit long with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
04	4	Read Input Registers	Reading of any value	
10	16	Preset Multiple Registers	Writing	This function allows writing 1 or more registers representing one or more settings. Registers are 2-byte long values, transmitted with the most important byte first. The maximum number of registers to be written in a single package is 125.

**B.1.2.7 EXCEPTIONS AND ERROR RESPONDS**

The following table shows error codes defined in ModBus protocol:

01	ILLEGAL FUNCTION	The slave does not support any function with the received function code in this message.
02	ILLEGAL DATA ADDRESS	Master is trying to perform an operation in an incorrect address.
03	ILLEGAL DATA VALUE	Slave has detected that the value sent by the master is not valid.
04	ILLEGAL RESPONSE LENGTH	Indicates that a response to the master's request would exceed the maximum specified size for that function code.
05	ACKNOWLEDGE	Generic acknowledgement.
06	SLAVE DEVICE BUSY	Slave is busy and cannot perform the requested operation.
07	NEGATIVE ACKNOWLEDGE	Negative acknowledgement.

## B.1.3 DATA TYPE

TYPE	LENGTH	DESCRIPTION
F1	1	Boolean data type. As it is a bit, for evaluating it we need a memory address and a bit. For example: Value <i>0x1A41-0001101001000001b</i> 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. It has to be scaled, by multiplying by 1000 the value to be sent, or dividing between 1000 the received value. For example, if a value of 34509 is received, the converted value will be 34,509, and for writing value 334, we must send 334.000. This prevents the loss of accuracy involved in using float values. Example: 12312d=0x00003018. Real Value = 12312/1000=12,312
F3	2	4-byte Floating Example: 1240.5560x449B11CB
F4	1	Integer with 2 bytes sign. Example: 1230x007B
F5	2	Integer without 4 bytes sign. Example: 123120x00003018
F6	4	8 bytes Float Example: 123.3240x405ED4BC6A7EF9DB
F7	1	Characters without sign. As it needs to be sent in a register, i.e. in two bytes, the character will go below. Example: 'β'x00E1
F8	1	Characters with sign As it needs to be sent in a register, i.e. in two bytes, the character will go below. Example: 'A'x0041
F9	16	String. Chain of characters with a fixed length (32 bytes). The end of the string is marked with a "\0". Example: "ABC"0x41x42x43x00....
F10	1	This is a 16-bit integer without sign. Each value that can be taken by this integer will have a correspondence in the database Auxiliary Table. In this table we can find the corresponding chain, which must be shown for each value. In the memory, only an integer value will be received. Example: 0, 1Correspond to CLOSE, OPEN
F11	3	Milliseconds passed since 1/1/2000 at 00:00:00.000.

## B.1.4 MODBUS APPENDIX

**B.1.4.1 DATA MANAGEMENT**

The different sizes of data to be managed in ModBus and their functionality make it necessary to manage them in different ways. Depending on the functionality and importance of certain data, the use of ModBus is optimized in time for real time processes, as in the case of events.

Although configuration settings, such as GRAPHIC, PLC equations, TEXTS and ALARM and LEDS configuration, etc. can be read and written using ModBus protocol, formats are not shown because these are considered important design information subject to optimization, expansion and in short to changes. For their management, the user can use EnerVista 650 Setup program to manage and format them in a friendly way

**B.1.4.2 WRITING SETTINGS**

The writing process of settings GROUP is formed by two phases: writing of any zone and confirmation. The target is to guarantee the protections functionality and offer versatility for possible legacy programs.

The process of changing protection functionality will almost always involve the change of several settings at the same time, requiring a "time point" for new settings operation. The combination of numbers, enums, etc, which cooperate in fulfill a determined function is called GROUP

The memory map of a setting GROUP includes: the stored settings at the beginning of its settings zone and a temporary hole for new settings and confirmation.

When settings are changed, we must write in the selected settings zone, in any order or quantity of written zone, and finally, to give a reference point we must write a register in the last position of the group, (this is called CONFIRMATION by some protocols).

For safety reasons, there is certain limitation when CONFIRMING settings GROUPS; the time period from the last settings writing to CONFIRMATION, cannot exceed 15 seconds.

**B.1.4.3 SNAP-SHOT EVENTS**

Nowadays, event retrieval is completely compatible with UR family. In the F650, the NEW EVENTS concept has been extended, providing additional functionality. These are the events created after the last request.

Firmware version 1.60 adds a new way of reading snapshot events in binary format. Before this version, the relay sent information in ASCII format. The snapshot event retrieval is similar to the ASCII.

**a) SNAPSHOT EVENT READING IN ASCII FORMAT**

The events capture process is based on the opening and reading of a pseudo-file. This process is made in two steps:

**1º.- A writing message in the '0xfe00' address**, where desired opening file name is written:

- "EVE.TXT": to obtain all
- "NEW\_EVE.TXT": to obtain events created from the last request of this same file
- "EVE0234.TXT ": to obtain events starting, for example, from 234 rating

**2º.- The second and following ones are messages of reading on 0xff00 address**, where 244-byte strings are read from the open file. As this process is a request process, if there was a response string with error, the last string can be requested again, by a reading message on 0xff02 address.

The first reading message shows the events format, information is transmitted in the rest of messages. In the same string, the first four bytes indicate the file reading position and the following two bytes form a short with the quantity of useful bytes sent (if it is lower than 244, this indicates that it is the last message).

In the second step, many BUSY responds may be produced, because internally the ASCII format file is being created.

**b) SNAPSHOT EVENTS READING IN BINARY FORMAT:**

Write a message in address 0xfe00 to open the file.

“**EVE.BIN**”: to read all Snapshot events.

“**NEW\_EVE.BIN**”: to read new events since the last reading of this file.

“**EVE0234.BIN**”: to read events starting by number 234.

The second and successive messages are read in address 0xff00 in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data sent, and 244 data bytes). If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

Each Snapshot event includes:

1<sup>o</sup> byte: event format code.

N bytes: Event information structured depending on the code

At this moment there is only one format type with code 0. Its structure is as follows:

- -UINT16: event handle.
- -8 bytes: event date and time.
- -29 bytes: event cause. (string finished in null).
- -UINT32: Phasor Ia (scaled to 1000).
- -UINT32: Phasor Ib (scaled to 1000).
- -UINT32: Phasor Ic (scaled to 1000).
- -UINT32: Line Frequency (scaled to 1000).
- -UINT32: Phasor Ig (scaled to 1000).
- -UINT32: Phasor Isg (scaled to 1000).
- -UINT32: Zero seq I0 (scaled to 1000).
- -UINT32: Positive seq I1 (scaled to 1000).
- -UINT32: Negative seq I2 (scaled to 1000).
- -UINT32: Phasor Van (scaled to 1000).
- -UINT32: Phasor Vbn (scaled to 1000).
- -UINT32: Phasor Vcn (scaled to 1000).
- -UINT32: Positive Seq V1 (scaled to 1000).
- -UINT32: Negative Seq V2 (scaled to 1000).
- -UINT32: Zero Seq V0 (scaled to 1000).
- -UINT32: 3 Phase Power Factor (scaled to 1000).

Example:

**1<sup>st</sup> 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]

**2<sup>nd</sup> step:**

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] -----> **RELAY**

Probably the relay will respond with “SLAVE DEVICE BUSY”:

PC <----- 0xFE 0x83 0x06 0xF1 0x02]

The request is repeated:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] -----> RELAY

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 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 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.1.4.4 OPERATIONS**

For executing an Operation, it is necessary to write the bit corresponding to that Operation. For this purpose, there are two memory records whose bits represent operations. These records are 0xAFFE and 0xAFFF.

Each operation has assigned one bit in the register:

**Operation 1: bit 0 '0xaffe'**

**Operation 2: bit 1 '0xaffe'**

...

**Operation 16: bit 15 '0xaffe'**

**Operation 17: bit 0 '0xaaff'**

...

**Operation 24: bit 7 '0xaaff'**

The register format is 'MOTOROLA'; this means that the first byte arriving is the one with more weight.

Remember that depending on where it communicates the correspondent channel will be activated, which takes part for PLC operations if the operation is successful or not. The operations channels are:

**0 - MMI**

**1 - OPER REMOTE**

**2 - COM 1- COMUNICACION**

**3 - COM 2- COMUNICACION**

**4 - RED 1- COMUNICACION**

**5 - RED 2- COMUNICACION**

**6 - RED 3- COMUNICACION**

**7 - RED 4- COMUNICACIÓN**

Example, operation 1 is going to be perform:

[0xFE 0x10 0xAF 0xFE 0x00 0x01 0x02 0x00 0x01 0x68 0xB0] -----> **RELAY**

**PC** <----- [0xFE 0x10 0xAF 0xFE 0x00 0x01 0x55 0x22] ( **ACK (acknowledge) the operation**)

## B.1.5 OUTPUT WRITING

Relay contacts writing in the I/O boards are thought to make easy wiring checks. Proceeding as with a file access, with opening, writing and lockout.

If it is a writing to a mixed board (includes 16 inputs and 8 outputs):

**1º.- OPEN FILE OF OUTPUTS:** writing msg to 0xFE20 of 3 registers with the name: **OUTPUT**

**2º. - DESIRED OUTPUTS WRITING** writing message to 0xFF20 of 5 REGISTERS, the first one is the board number (0 or 1) and the restraint ones are the bytes of bits (bits are grouped byte to byte).

**3º.- CLOSE FILE OF OUTPUTS:** writing msg to 0xFE 28 of 3 registers with the name: **OUTPUT**

Example, activate the two lower relays to board '0':

**1<sup>st</sup> Opening**

[0xFE 0x10 0xFE 0x20 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0xA8 0x42] -----> RELAY

O U T P U T

PC <-----[0xFE 0x10 0xFE 0x20 0x00 0x03 0xA4 0x25]

**2<sup>nd</sup> Writing**

[0xFE 0x10 0xFF 0x20 0x00 0x05 0x0A 0x00 0x00 0x03 0x00 0x00 0x00 0x00 0x00 0x00 0x00]

0x0000 0x03

0xAE 0x8D] -----> RELAY

PC <----- [0xFE 0x10 0xFF 0x20 0x00 0x05 0x25 0xDB]

**3<sup>th</sup> Lockout:**

[0xFE 0x10 0xFE 0x28 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0x29 0xA8] -----> RELAY

PC <----- [0xFE 0x10 0xFE 0x28 0x00 0x03 0x25 0xE7]



**B.1.5.1 CONTROL EVENTS**

This section explains events set aside for control, not to be confused with the “snap shot events” , which are used for debugging tasks.

The event is the value change from 0 to 1 or from 1 to 0 of one bit. Associated to a time label, which shows when that change was performed.

In the F650, any status or combination of status may generate an event. For this, the F650 have **192 bits** capable of generate control events.

The first **128** may be configured through a table from EnerVista 650 Setup menu: **Setpoint, Relay configuration**, or for complex configurations by PLC Editor.

The other **64 bits** comes from the 16 possible switchgears, which generate 4 bits of status each one:

- Open(52B ON, 52A OFF)
- Close(52A ON, 52B OFF)
- Error 00(52A&52B OFF)
- Error 11(52A&52B ON)

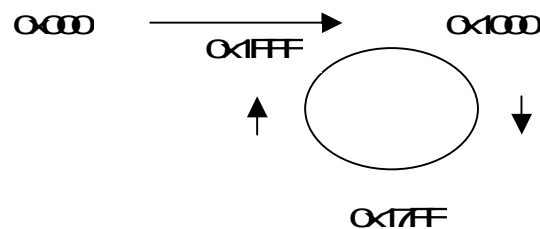
**B**

Internally the events buffer is a circular FIFO of 255 events. The addresses for managing this FIFO are:

- **0x03FF:** Number of the following event  
(To know whether there are new events)
- **0xFCFF:** Access from the oldest event
- **0xFD00 to 0xFDFF:** Access to any of the events (circular queue)

In the **0x03FF** address it is stored the event number of the following new event that it is going to be generated. For instance, if the number 7677 is stored, it means that the last event stored is the number 7676. This value, at the beginning is 0 and it is increased as soon as events from 0 to  $2^{12} + 1$  carry bit are generated.

Carry bit allows knowing whether the F650 has been started, as when it starts, either for lack of power supply or for a configuration change, the carry bit is set to 0. When events are generated, the event number will be increased up to a maximum value of 0x1FFF; in the next event the number will be 0x1000, that is, the bit of carriage will get always to 1, until a new F650 start up. The next figure shows it:



### B.1.5.2 EVENT STRUCTURE

Each event has 14 bytes, being its format:

- Short (2 bytes): event number (0 -  $2^{12}$  + carry bit)
- Short (2 bytes): events bit number (from 0 to 191).
- Short (2 bytes): the 0 bit indicates the event value (0 or 1) and the 15 bit whether it is event (to distinguish not valid values, in case of everything was set to 0)
- Double unsigned (8 bytes): milliseconds from 1 January 2000

The 0xFCFF-address usefulness is for when it is desired to read all the available events in the F650, something that will be done following a master start up.

**WARNING!** Unlike a standard ModBus address, these addresses consist of 14 bytes each one, instead of the 2 used in ModBus. This way, each event, which has a structure of 14 bytes, will be contained in one address, as shown on the table below:

[illegible]

Imagine that the events buffer contains the following information:

Event Number	7424	7425	.....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFE

105 registers: 15 events \* 7 registers.

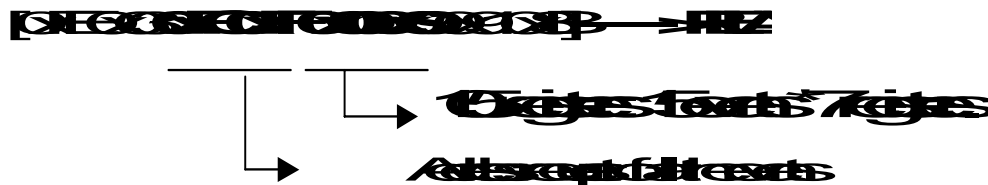
(NOTE: the 0x03FF address will have the event number 7677 because the 7676 is the last one).

## a) EVENTS COLLECTION PROCESS

## ALL EVENTS

There are two possibilities:

**First possibility:** start in 0xFCFF address and read events 15 by 15. The frame sent to the relay is the following one:



With this frame the buffer pointer will be set over the 7421 event, which in the example is the oldest one in the buffer, so it will send back all events until number 7435.

Now, to read the following 15, from 7436 to 7450, it is necessary to calculate the initiation address and send another frame:

Hex(7436)= 0x1D0C  
 0x1D0C AND 0x00FF= 0x0C  
 0xFD00+0x0C= 0xFD0C: **initiation address**


[0xFE 0x03 **0xFD 0x0C** 0x00 0x69 0x60 0x44] -----> **RELAY**

So, it will be asked until the relay responds 0 in one of the events, or reading address 0x03FF and checking the event number from the last event read.

**Second possibility:** read directly the memory from the 0xFD00 to 0xFDFE address and then arrange by event number. From that moment, only the new ones must be requested.

### NEW EVENTS

In the 0x03FF address there is the number of the following event that is going to be written, therefore, it is possible to know how many events must be read from the last time that the relay was asked. If the relay indicated that the new event to be generated is the 7677.



Event Number	7424	7425	.....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFE

(NOTE: the 0x03FF address will have the event number 7677, because the last one is 7676).

Supposing that we all events until number 7674 have already been read, now a frame must be sent to read the corresponding 28 bytes to events 7675 and 7676, given that there are only two new events from the last time that they were requested.

Hex(7675)=0x1DFB  
 0x1DFB AND 0xFF=0xFB  
 0xFD00+0xFB=0xFDFB: **reading address (\*)**

[0xFE 0x03 **0xFD 0xFB 0x00 0x0E** 0x90 0x5C] -----> **RELAY**

**B.1.6 EVENTS STATUS REQUEST (ALARMS)**

The necessary data to retrieve events that have been configured as alarms are located in the following addresses:

- 0xf000:** 24 registers, the first 12 indicate the status active/inactive and the last 12 indicate the status of acknowledged/not acknowledged.
- 0xf018:** 12 event alarm status (active - not active, acknowledged – not acknowledged) registers.
- 0xf024:** date and hour of the event bits starts (groups of 16 dates and hour must be asked for).

To obtain an instantaneous snapshot of all the events and alarms status, the procedure is:

- - Read the head of events FIFO (0x03FF).
- - Read the zones mentioned before.
- - Finally, read the head again to confirm that it has not changed. If it had changed, restart the procedure.

**NOTE:** The message must request the address and the quantity of bytes indicated in each zone. If other quantity is needed it will not respond with the requested data.

**B.1.6.1 CONTROL EVENTS RETRIEVAL FROM THE COMMAND LINE**

Starting EnerVista 650 Setup from the command line offers the possibility of transferring control events to a file. For this purpose, we need to indicate the event number from which event controls are to be retrieved, and the file where they are to be stored.

Communication can be established via serial communication by specifying the port and access baudrate, or via Ethernet through the IP address and communication port. The relay number from which events are to be retrieved must also be indicated.

For executing this Operation, 6 parameters must be written, for both cases, serial communication or Ethernet.

**B.1.6.2 SERIAL COMMUNICATION**

F650pc –e event number " File name" –com port: baudrate relay number

E.g.: EnerVista 650 Setup –e 6 "C:\GE Power Management\EnerVista 650 Setup\files\Events\eventos.txt" –com 1:19200 254

**B.1.6.3 ETHERNET COMMUNICATION**

F650pc –e event number " File name" –ip "IP address": port relay number

E.g.: EnerVista 650 Setup –e 6 "C:\GE Power Management\EnerVista 650 Setup\files\Events \eventos.txt" –ip 192.168.37.240:502 254

The created file format will look as follows:

```
#Event Number, Event Id,Event Text,Event Data Time,Event Value(0,1)#
6,1,Local,09-Sep-2003 17:42:40.782,1
7,1,Local,09-Sep-2003 17:42:43.236,0
8,2,Remote,09-Sep-2003 17:42:43.236,1
```

**B.1.6.4 ACKNOWLEDGEMENT OF EVENTS (ALARMS)**

For acknowledging the alarms we must simply write message to the 0xf324 address with 12 data registers. Each bit means an event, if we want to acknowledge an alarm, its corresponding bit must be set to '1' (in order within the 192 bits).

**NOTE:** it must be borne in mind the independence of the acknowledgement condition, for its reading and its change, depending on the communication channel

There are 6 channels:

- LOCAL:** by MMI or COM-2 (front and rear accessible).
- REMOTE:** by COM-1
- NET 1:** nowadays by any net communication
- NET 2:** (it does not exist in version 1.4x and lower)
- NET 3:** (it does not exist in version 1.4x and lower)
- NET 4:** (it does not exist in version 1.4x and lower)

**B.1.6.5 VIRTUAL INPUTS WRITING**

For forcing Virtual Inputs, a message with 4 indivisible records must be written at address, so that each bit corresponds to a Virtual Input. Values will not be correct if the first 4 records are not written in the same message. The first 32 are LATCHED (internally stored with RAM with battery), and the last 32 are SELF-RST (activated to 1 and deactivated in the next pass by the PLC).

For reading the status of Virtual Inputs, it is necessary to start with address 0x0083(bit 0x004) up to 0x0087 (bit 0x0200).

**B.1.6.6 USER MAP**

F650 units incorporate a powerful feature called ModBus User Map, that allows to read 256 non-consecutive data records (settings and statuses). It is often required for a master computer to interrogate continuously several connected slave relays. If those values are dispersed along the memory map, reading them may require several transmissions, and this may cause a communications overload. The User Map can be programmed to get several memory addresses together in a block of consecutive addresses of the User Map, so that they can be accessible with a single reading operation.

The user Map has two sections:

A record index area (addresses 0x3384 to 0x3483), containing 256 statuses and/or setting record addresses.

A record area (addresses 0xF330 to 0xF42F), containing the values for addresses indicated in the index area.

Data records that are separated in the rest of the memory map can be remapped to an address of an adjacent record in the User Map area. For programming the map this way, addresses for the required records must be written in the index area. This avoids the need for several reading operations, thus improving data transmission yield.

For instance, if Contact Outputs from Board F (address 0x008B) and Board G (address 0x00B0) values are required, these addresses must be mapped as follows:

In address 0x3384, write 0x008B.

In address 0x3385 XXX write 0x00B0.

The reading of records 0xF330 and 0xF331, applying the corresponding bit masks, will provide the required information about the two boards Contact Outputs.

**NOTE:** Only single data can be set in the map, data that are in the memory map and can be read. This feature is not valid for events, waveform records, etc. that are not located in a map address.

**B.1.6.7 RETRIEVING OSCILOGRAPHY**

In case of not using the quickest download method by FTP, ModBus can be used for downloading oscillography, in the same way that events (snap-shots). First of all, open file with writing message in 0xfe40, where desired file to open is indicated, it could be:

```
OSC01.DAT    (COMTRADE data file in binary)
OSC02.CFG    (COMTRADE configuration file)
OSC01.HDR    (COMTRADE header file)
OSC02.DAT
OSC02.HDR
...
```

For reading the oscillography in several strings, several reading requests must be sent to 0xff40 address. For reading the previous message a reading petition must be sent to 0xff42 address. The maximum number of bytes to be read in each part is 244.

**B.1.6.8 TIME SYNCHRONIZATION**

Time synchronization consists of setting of relay date and time.

It may be supposed that is similar to a usual settings group writing but it has particularities:

- It is a data type very particular because it is made up of other simples.
- Once the data is changed, varies with time, it is a changing setting that can be read.
- It shares the time change with the IRIGB (this has more priority) and with a possible modification from MMI or another protocols.
- In case of the relay gets disconnected from its auxiliary power supply, during some days, the time will remain in a chip, feed by a capacitor (it does not need maintenance).
- And last, there are synchronism between the real time chip and the microprocessor time.

Time synchronization is made by a reading message over 0xfff0 address, either with the address of a single relay, if a writing confirmation is desired, or in broadcast, to synchronize several relays simultaneously.

Date/time format is unsigned double (8 bytes) in MOTOROLA format, which indicates the passed milliseconds from 1<sup>st</sup> of January 2000.

**Reading example:**

[0xFE 0x03 0xFF 0xF0 0x00 0x04 0x60 0x21] -----> **RELAY**

**PC** <----- [0xFE 0x03 0x08 0x00 0x00 0x00 0x17 0x05 0xFA 0xD5 0xBA 0x2D 0x1D]

**Synchronism example:**

[0xFE 0x10 0xFF 0xF0 0x00 0x04 0x08 0x00 0x00 0x00 0x17 0x9B 0x53 0x3F 0x60 0xA4 0x2B] -----> **RELAY**

**PC** <----- [0xFE 0x10 0xFF 0xF0 0x00 0x04 0xE5 0xE2]

### B.1.6.9 ENQUEUEING MESSAGES

In ModBus protocol, as in other protocols, exists an internal procedure in message reception and transmission.

When a relay gets a string, determined by a silence of 3 or 4 characters, it is queued in a FIFO queue, for a later processing in its own protocol. When the protocol is free of execution, it searches in the queue for strings to respond of the FIFO. If there is such string, it processes it and then it is responded.

Several criteria have been adopted for real time operation:

- Each reading or writing is respond as soon as possible.
- This implies that when settings are changed and respond, a writing request recognition is indicated and then, the modification of internal settings is performed, (PERFORMING IT IN THE SHORTER TIME WITHOUT PROTECTION), and finally, settings are stored in a non-volatile memory device.

**NOTE:** As the relay is internally a modular system, it is possible that the response of some process is slower than what is expected by the external program, considering the message as missed and sending again another request. If so, there will be 2 queued messages and therefore, 2 messages will be responded. For this reason, response message 'ACK' must be verified with its request, and special attention must be paid to setting confirmation writings, especially with reference to time-out. EnerVista 650 Setup software is recommended to do the configuration modifications, as this software takes into account all these details.

### B.1.6.10 TRACES AND TROUBLESHOOTING

The tracer is a debugging tool to view the strings in any writing or reading process in ModBus. This tracer is activated in the menu from F650: **View, Traces**.

With this option enabled, request and response strings will be shown. If, for instance, request and response strings view is desired, between F650 and the relay, in general settings reading we will do what follows:

- 1º. - Activate traces, from *View, Traces menu*
- 2º. - Open the general settings menu

The screen will display that group settings, on the left side bottom the relay reading request will appear

```
<0001><06/18/03 12:14:15>[0xFE 0x03 0x21 0x8A 0x00 0x16 0xFB 0xDD]
```

And on the right the settings response will appear:

```
0001><06/18/03 12:14:15>[0xFE 0x03 0x2C 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F  
0x80 0x00 0x00 0x00 0x00 0x42 0xC8 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 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 F650 menu: **Communication, Troubleshooting**, any reading to any address can be requested, the PC will form the string together with check-sum register.

**B.1.6.11 MODBUS CHECK FUNCTION**

Next it is described the code to realize the message string check in ModBus, in a MOTOROLA micro. With this routine time is optimized to obtain the check register.

```
USHORT fn_035c_cr16(UCHAR *p, UNSIGNED us)
{
    const UCHAR hi[] = {
        0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
        0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
        0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
        0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
        0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
        0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,
        0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
        0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
        0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
        0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
        0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
        0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
        0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
        0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
        0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
        0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
        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,
        0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
        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,
```



## B

```

0X11,0Xd1,0Xd0,0X10,0Xf0,0X30,0X31,0Xf1,0X33,0Xf3,
0Xf2,0X32,0X36,0Xf6,0Xf7,0X37,0Xf5,0X35,0X34,0Xf4,
0X3c,0Xfc,0Xfd,0X3d,0Xff,0X3f,0X3e,0Xfe,0Xfa,0X3a,
0X3b,0Xfb,0X39,0Xf9,0Xf8,0X38,0X28,0Xe8,0Xe9,0X29,
0Xeb,0X2b,0X2a,0Xea,0Xee,0X2e,0X2f,0Xef,0X2d,0Xed,
0Xec,0X2c,0Xe4,0X24,0X25,0Xe5,0X27,0Xe7,0Xe6,0X26,
0X22,0Xe2,0Xe3,0X23,0Xe1,0X21,0X20,0Xe0,0Xa0,0X60,
0X61,0Xa1,0X63,0Xa3,0Xa2,0X62,0X66,0Xa6,0Xa7,0X67,
0Xa5,0X65,0X64,0Xa4,0X6c,0Xac,0Xad,0X6d,0Xaf,0X6f,
0X6e,0Xae,0Xaa,0X6a,0X6b,0Xab,0X69,0Xa9,0Xa8,0X68,
0X78,0Xb8,0Xb9,0X79,0Xbb,0X7b,0X7a,0Xba,0Xbe,0X7e,
0X7f,0Xbf,0X7d,0Xbd,0Xbc,0X7c,0Xb4,0X74,0X75,0Xb5,
0X77,0Xb7,0Xb6,0X76,0X72,0Xb2,0Xb3,0X73,0Xb1,0X71,
0X70,0Xb0,0X50,0X90,0X91,0X51,0X93,0X53,0X52,0X92,
0X96,0X56,0X57,0X97,0X55,0X95,0X94,0X54,0X9c,0X5c,
0X5d,0X9d,0X5f,0X9f,0X9e,0X5e,0X5a,0X9a,0X9b,0X5b,
0X99,0X59,0X58,0X98,0X88,0X48,0X49,0X89,0X4b,0X8b,
0X8a,0X4a,0X4e,0X8e,0X8f,0X4f,0X8d,0X4d,0X4c,0X8c,
0X44,0X84,0X85,0X45,0X87,0X47,0X46,0X86,0X82,0X42,
0X43,0X83,0X41,0X81,0X80,0X40 };

```

```

    UCHAR chi;

```

```

    UCHAR clo;

```

```

    USHORT ui;

```

```

chi = 0xff;
clo = 0xff;
while(us--)
{
    ui = chi ^ *p++;
    chi = clo ^ hi[ui];
    clo = lo[ui];
}

ui = chi;
ui = ui << 8;
ui = ui | clo;    // motorola format

return(ui);
}

```

```

typedef struct    //reading string
{  UCHAR    dire;
   UCHAR    fn;    //3 o 4
   USHORT   mem;
   USHORT   off;
   USHORT   check;
} PET_READ;
static PET_READ vpet_read;  ←----- this is the message (of reading)

```

**And now it is proceed to perform the reading message check:**

```

USHORT xx;
xx = vpet_read.check;
if(fn_035c_cr16( (UCHAR *)&vpet_read, sizeof(PET_READ)-2) == xx)
{   OK }
else
{ko  }

```

If it is INTEL everything works but bytes are interchanged.

## B.1.7 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
0x0087	0x2000	CONT IP_F_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x0089	0x0800	CONT IP_F_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta F (16 elementos) - Board F: Contact Output Operate -logical status-							
0x0089	0x1000	CONT OP OPER_F_01	F001		R	1	
0x0089	0x2000	CONT OP OPER_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008A	0x0800	CONT OP OPER_F_16	F001		R	1	
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_12	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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Estado Tarjeta G - Board G Status							
0x00B1	0x2000	BOARD G STATUS	F001		R	1	
LEDS HMI (16 elementos) - HMI Leds							
0x00D1	0x4000	READY LED	F001		R	1	
0x00D1	0x8000	LED 1	F001		R	1	
0x00D1	0x0001	LED 2	F001		R	1	
0x00D1	0x0002	LED 3	F001		R	1	
0x00D1	0x0004	LED 4	F001		R	1	
0x00D1	0x0008	LED 5	F001		R	1	
0x00D1	0x0010	LED 6	F001		R	1	
0x00D1	0x0020	LED 7	F001		R	1	
0x00D1	0x0040	LED 8	F001		R	1	
0x00D1	0x0080	LED 9	F001		R	1	
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	
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobrecorriente instantanea de fases nivel alto - Phase IOC High							
0x00F2	0x0080	PH IOC1 HIGH A BLK	F001		R	1	
0x00F3	0x0100	PH IOC1 HIGH B BLK	F001		R	1	
0x00F3	0x0200	PH IOC1 HIGH C BLK	F001		R	1	
0x00F3	0x0400	PH IOC1 HIGH A PKP	F001		R	1	
0x00F3	0x0800	PH IOC1 HIGH A OP	F001		R	1	
0x00F3	0x1000	PH IOC1 HIGH B PKP	F001		R	1	
0x00F3	0x2000	PH IOC1 HIGH B OP	F001		R	1	
0x00F3	0x4000	PH IOC1 HIGH C PKP	F001		R	1	
0x00F3	0x8000	PH IOC1 HIGH C OP	F001		R	1	
0x00F3	0x0001	PH IOC1 HIGH PKP	F001		R	1	
0x00F3	0x0002	PH IOC1 HIGH OP	F001		R	1	
0x00F8	0x0004	PH IOC2 HIGH A BLK	F001		R	1	
0x00F8	0x0008	PH IOC2 HIGH B BLK	F001		R	1	
0x00F8	0x0010	PH IOC2 HIGH C BLK	F001		R	1	
0x00F8	0x0020	PH IOC2 HIGH A PKP	F001		R	1	
0x00F8	0x0040	PH IOC2 HIGH A OP	F001		R	1	
0x00F8	0x0080	PH IOC2 HIGH B PKP	F001		R	1	
0x00F9	0x0100	PH IOC2 HIGH B OP	F001		R	1	
0x00F9	0x0200	PH IOC2 HIGH C PKP	F001		R	1	
0x00F9	0x0400	PH IOC2 HIGH C OP	F001		R	1	
0x00F9	0x0800	PH IOC2 HIGH PKP	F001		R	1	
0x00F9	0x1000	PH IOC2 HIGH OP	F001		R	1	
0x00FE	0x2000	PH IOC3 HIGH A BLK	F001		R	1	
0x00FE	0x4000	PH IOC3 HIGH B BLK	F001		R	1	
0x00FE	0x8000	PH IOC3 HIGH C BLK	F001		R	1	
0x00FE	0x0001	PH IOC3 HIGH A PKP	F001		R	1	
0x00FE	0x0002	PH IOC3 HIGH A OP	F001		R	1	
0x00FE	0x0004	PH IOC3 HIGH B PKP	F001		R	1	
0x00FE	0x0008	PH IOC3 HIGH B OP	F001		R	1	
0x00FE	0x0010	PH IOC3 HIGH C PKP	F001		R	1	
0x00FE	0x0020	PH IOC3 HIGH C OP	F001		R	1	
0x00FE	0x0040	PH IOC3 HIGH PKP	F001		R	1	
0x00FE	0x0080	PH IOC3 HIGH OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobrecorriente instantánea de fases nivel bajo - Phase IOC Low							
0x0104	0x0100	PH IOC1 LOW A BLK	F001		R	1	
0x0104	0x0200	PH IOC1 LOW B BLK	F001		R	1	
0x0104	0x0400	PH IOC1 LOW C BLK	F001		R	1	
0x0104	0x0800	PH IOC1 LOW A PKP	F001		R	1	
0x0104	0x1000	PH IOC1 LOW A OP	F001		R	1	
0x0104	0x2000	PH IOC1 LOW B PKP	F001		R	1	
0x0104	0x4000	PH IOC1 LOW B OP	F001		R	1	
0x0104	0x8000	PH IOC1 LOW C PKP	F001		R	1	
0x0104	0x0001	PH IOC1 LOW C OP	F001		R	1	
0x0104	0x0002	PH IOC1 LOW PKP	F001		R	1	
0x0104	0x0004	PH IOC1 LOW OP	F001		R	1	
0x0109	0x0008	PH IOC2 LOW A BLK	F001		R	1	
0x0109	0x0010	PH IOC2 LOW B BLK	F001		R	1	
0x0109	0x0020	PH IOC2 LOW C BLK	F001		R	1	
0x0109	0x0040	PH IOC2 LOW A PKP	F001		R	1	
0x0109	0x0080	PH IOC2 LOW A OP	F001		R	1	
0x010A	0x0100	PH IOC2 LOW B PKP	F001		R	1	
0x010A	0x0200	PH IOC2 LOW B OP	F001		R	1	
0x010A	0x0400	PH IOC2 LOW C PKP	F001		R	1	
0x010A	0x0800	PH IOC2 LOW C OP	F001		R	1	
0x010A	0x1000	PH IOC2 LOW PKP	F001		R	1	
0x010A	0x2000	PH IOC2 LOW OP	F001		R	1	
0x010F	0x4000	PH IOC3 LOW A BLK	F001		R	1	
0x010F	0x8000	PH IOC3 LOW B BLK	F001		R	1	
0x010F	0x0001	PH IOC3 LOW C BLK	F001		R	1	
0x010F	0x0002	PH IOC3 LOW A PKP	F001		R	1	
0x010F	0x0004	PH IOC3 LOW A OP	F001		R	1	
0x010F	0x0008	PH IOC3 LOW B PKP	F001		R	1	
0x010F	0x0010	PH IOC3 LOW B OP	F001		R	1	
0x010F	0x0020	PH IOC3 LOW C PKP	F001		R	1	
0x010F	0x0040	PH IOC3 LOW C OP	F001		R	1	
0x010F	0x0080	PH IOC3 LOW PKP	F001		R	1	
0x0110	0x0100	PH IOC3 LOW OP	F001		R	1	
Sobreintensidad instantánea de Neutro - Neutral IOC							
0x0115	0x0200	NEUTRAL IOC1 BLOCK	F001		R	1	
0x0115	0x0400	NEUTRAL IOC1 PKP	F001		R	1	
0x0115	0x0800	NEUTRAL IOC1 OP	F001		R	1	
0x011A	0x1000	NEUTRAL IOC2 BLOCK	F001		R	1	
0x011A	0x2000	NEUTRAL IOC2 PKP	F001		R	1	
0x011A	0x4000	NEUTRAL IOC2 OP	F001		R	1	
0x011F	0x8000	NEUTRAL IOC3 BLOCK	F001		R	1	
0x011F	0x0001	NEUTRAL IOC3 PKP	F001		R	1	
0x011F	0x0002	NEUTRAL IOC3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobreintensidad instantánea de Tierra - Ground IOC							
0x0124	0x0004	GROUND IOC1 BLOCK	F001		R	1	
0x0124	0x0008	GROUND IOC1 PKP	F001		R	1	
0x0124	0x0010	GROUND IOC1 OP	F001		R	1	
0x0129	0x0020	GROUND IOC2 BLOCK	F001		R	1	
0x0129	0x0040	GROUND IOC2 PKP	F001		R	1	
0x0129	0x0080	GROUND IOC2 OP	F001		R	1	
0x012F	0x0100	GROUND IOC3 BLOCK	F001		R	1	
0x012F	0x0200	GROUND IOC3 PKP	F001		R	1	
0x012F	0x0400	GROUND IOC3 OP	F001		R	1	
Sobreintensidad instantánea de Tierra Sensible - Sensitive Ground IOC							
0x0134	0x0800	SENS GND IOC1 BLK	F001		R	1	
0x0134	0x1000	SENS GND IOC1 PKP	F001		R	1	
0x0134	0x2000	SENS GND IOC1 OP	F001		R	1	
0x0139	0x4000	SENS GND IOC2 BLK	F001		R	1	
0x0139	0x8000	SENS GND IOC2 PKP	F001		R	1	
0x0139	0x0001	SENS GND IOC2 OP	F001		R	1	
0x013E	0x0002	SENS GND IOC3 BLK	F001		R	1	
0x013E	0x0004	SENS GND IOC3 PKP	F001		R	1	
0x013E	0x0008	SENS GND IOC3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobreintensidad Temporizada de Fases Nivel Alto - Phase TOC High							
0x0143	0x0010	PH TOC1 HIGH A BLK	F001		R	1	
0x0143	0x0020	PH TOC1 HIGH B BLK	F001		R	1	
0x0143	0x0040	PH TOC1 HIGH C BLK	F001		R	1	
0x0143	0x0080	PH TOC1 HIGH A PKP	F001		R	1	
0x0144	0x0100	PH TOC1 HIGH A OP	F001		R	1	
0x0144	0x0200	PH TOC1 HIGH B PKP	F001		R	1	
0x0144	0x0400	PH TOC1 HIGH B OP	F001		R	1	
0x0144	0x0800	PH TOC1 HIGH C PKP	F001		R	1	
0x0144	0x1000	PH TOC1 HIGH C OP	F001		R	1	
0x0144	0x2000	PH TOC1 HIGH PKP	F001		R	1	
0x0144	0x4000	PH TOC1 HIGH OP	F001		R	1	
0x0149	0x8000	PH TOC2 HIGH A BLK	F001		R	1	
0x0149	0x0001	PH TOC2 HIGH B BLK	F001		R	1	
0x0149	0x0002	PH TOC2 HIGH C BLK	F001		R	1	
0x0149	0x0004	PH TOC2 HIGH A PKP	F001		R	1	
0x0149	0x0008	PH TOC2 HIGH A OP	F001		R	1	
0x0149	0x0010	PH TOC2 HIGH B PKP	F001		R	1	
0x0149	0x0020	PH TOC2 HIGH B OP	F001		R	1	
0x0149	0x0040	PH TOC2 HIGH C PKP	F001		R	1	
0x0149	0x0080	PH TOC2 HIGH C OP	F001		R	1	
0x014A	0x0100	PH TOC2 HIGH PKP	F001		R	1	
0x014A	0x0200	PH TOC2 HIGH OP	F001		R	1	
0x014F	0x0400	PH TOC3 HIGH A BLK	F001		R	1	
0x014F	0x0800	PH TOC3 HIGH B BLK	F001		R	1	
0x014F	0x1000	PH TOC3 HIGH C BLK	F001		R	1	
0x014F	0x2000	PH TOC3 HIGH A PKP	F001		R	1	
0x014F	0x4000	PH TOC3 HIGH A OP	F001		R	1	
0x014F	0x8000	PH TOC3 HIGH B PKP	F001		R	1	
0x014F	0x0001	PH TOC3 HIGH B OP	F001		R	1	
0x014F	0x0002	PH TOC3 HIGH C PKP	F001		R	1	
0x014F	0x0004	PH TOC3 HIGH C OP	F001		R	1	
0x014F	0x0008	PH TOC3 HIGH PKP	F001		R	1	
0x014F	0x0010	PH TOC3 HIGH OP	F001		R	1	
Sobreintensidad Temporizada de Neutro - Neutral TOC							
0x0154	0x0020	NEUTRAL TOC1 BLOCK	F001		R	1	
0x0154	0x0040	NEUTRAL TOC1 PKP	F001		R	1	
0x0154	0x0080	NEUTRAL TOC1 OP	F001		R	1	
0x015A	0x0100	NEUTRAL TOC2 BLOCK	F001		R	1	
0x015A	0x0200	NEUTRAL TOC2 PKP	F001		R	1	
0x015A	0x0400	NEUTRAL TOC2 OP	F001		R	1	
0x015F	0x0800	NEUTRAL TOC3 BLOCK	F001		R	1	
0x015F	0x1000	NEUTRAL TOC3 PKP	F001		R	1	
0x015F	0x2000	NEUTRAL TOC3 OP	F001		R	1	



ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobreintensidad Temporizada de Tierra - Ground TOC							
0x0164	0x4000	GROUND TOC1 BLOCK	F001		R	1	
0x0164	0x8000	GROUND TOC1 PKP	F001		R	1	
0x0164	0x0001	GROUND TOC1 OP	F001		R	1	
0x0169	0x0002	GROUND TOC2 BLOCK	F001		R	1	
0x0169	0x0004	GROUND TOC2 PKP	F001		R	1	
0x0169	0x0008	GROUND TOC2 OP	F001		R	1	
0x016E	0x0010	GROUND TOC3 BLOCK	F001		R	1	
0x016E	0x0020	GROUND TOC3 PKP	F001		R	1	
0x016E	0x0040	GROUND TOC3 OP	F001		R	1	
Sobreintensidad Temporizada Tierra Sensible - Sensitive Ground TOC							
0x0173	0x0080	SENS GND TOC1 BLOCK	F001		R	1	
0x0174	0x0100	SENS GND TOC1 PKP	F001		R	1	
0x0174	0x0200	SENS GND TOC1 OP	F001		R	1	
0x0179	0x0400	SENS GND TOC2 BLOCK	F001		R	1	
0x0179	0x0800	SENS GND TOC2 PKP	F001		R	1	
0x0179	0x1000	SENS GND TOC2 OP	F001		R	1	
0x017E	0x2000	SENS GND TOC3 BLOCK	F001		R	1	
0x017E	0x4000	SENS GND TOC3 PKP	F001		R	1	
0x017E	0x8000	SENS GND TOC3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Subtensión de fases - Phase UV							
0x0183	0x0001	PHASE UV1 BLOCK	F001		R	1	
0x0183	0x0002	PHASE UV1 A PKP	F001		R	1	
0x0183	0x0004	PHASE UV1 A OP	F001		R	1	
0x0183	0x0008	PHASE UV1 B PKP	F001		R	1	
0x0183	0x0010	PHASE UV1 B OP	F001		R	1	
0x0183	0x0020	PHASE UV1 C PKP	F001		R	1	
0x0183	0x0040	PHASE UV1 C OP	F001		R	1	
0x0183	0x0080	PHASE UV1 AB PKP	F001		R	1	
0x0184	0x0100	PHASE UV1 AB OP	F001		R	1	
0x0184	0x0200	PHASE UV1 BC PKP	F001		R	1	
0x0184	0x0400	PHASE UV1 BC OP	F001		R	1	
0x0184	0x0800	PHASE UV1 CA PKP	F001		R	1	
0x0184	0x1000	PHASE UV1 CA OP	F001		R	1	
0x0184	0x2000	PHASE UV1 PKP	F001		R	1	
0x0184	0x4000	PHASE UV1 OP	F001		R	1	
0x0189	0x8000	PHASE UV2 BLOCK	F001		R	1	
0x0189	0x0001	PHASE UV2 A PKP	F001		R	1	
0x0189	0x0002	PHASE UV2 A OP	F001		R	1	
0x0189	0x0004	PHASE UV2 B PKP	F001		R	1	
0x0189	0x0008	PHASE UV2 B OP	F001		R	1	
0x0189	0x0010	PHASE UV2 C PKP	F001		R	1	
0x0189	0x0020	PHASE UV2 C OP	F001		R	1	
0x0189	0x0040	PHASE UV2 AB PKP	F001		R	1	
0x0189	0x0080	PHASE UV2 AB OP	F001		R	1	
0x018A	0x0100	PHASE UV2 BC PKP	F001		R	1	
0x018A	0x0200	PHASE UV2 BC OP	F001		R	1	
0x018A	0x0400	PHASE UV2 CA PKP	F001		R	1	
0x018A	0x0800	PHASE UV2 CA OP	F001		R	1	
0x018A	0x1000	PHASE UV2 PKP	F001		R	1	
0x018A	0x2000	PHASE UV2 OP	F001		R	1	
0x018F	0x4000	PHASE UV3 BLOCK	F001		R	1	
0x018F	0x8000	PHASE UV3 A PKP	F001		R	1	
0x018F	0x0001	PHASE UV3 A OP	F001		R	1	
0x018F	0x0002	PHASE UV3 B PKP	F001		R	1	
0x018F	0x0004	PHASE UV3 B OP	F001		R	1	
0x018F	0x0008	PHASE UV3 C PKP	F001		R	1	
0x018F	0x0010	PHASE UV3 C OP	F001		R	1	
0x018F	0x0020	PHASE UV3 AB PKP	F001		R	1	
0x018F	0x0040	PHASE UV3 AB OP	F001		R	1	
0x018F	0x0080	PHASE UV3 BC PKP	F001		R	1	
0x0190	0x0100	PHASE UV3 BC OP	F001		R	1	
0x0190	0x0200	PHASE UV3 CA PKP	F001		R	1	
0x0190	0x0400	PHASE UV3 CA OP	F001		R	1	
0x0190	0x0800	PHASE UV3 PKP	F001		R	1	
0x0190	0x1000	PHASE UV3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobretensión de Secuencia Negativa - Negative Sequence OV							
0x0195	0x2000	NEG SEQ OV1 BLOCK	F001		R	1	
0x0195	0x4000	NEG SEQ OV1 PKP	F001		R	1	
0x0195	0x8000	NEG SEQ OV1 OP	F001		R	1	
0x019A	0x0001	NEG SEQ OV2 BLOCK	F001		R	1	
0x019A	0x0002	NEG SEQ OV2 PKP	F001		R	1	
0x019A	0x0004	NEG SEQ OV2 OP	F001		R	1	
0x019F	0x0008	NEG SEQ OV3 BLOCK	F001		R	1	
0x019F	0x0010	NEG SEQ OV3 PKP	F001		R	1	
0x019F	0x0020	NEG SEQ OV3 OP	F001		R	1	
Imagen Térmica - Thermal Image							
0x01A4	0x0040	THERMAL1 BLOCK	F001		R	1	
0x01A4	0x0080	THERMAL1 A RST	F001		R	1	
0x01A5	0x0100	THERMAL1 B RST	F001		R	1	
0x01A5	0x0200	THERMAL1 C RST	F001		R	1	
0x01A5	0x0400	THERMAL1 ALARM	F001		R	1	
0x01A5	0x0800	THERMAL1 OP	F001		R	1	
0x01A5	0x1000	THERMAL1 A ALRM	F001		R	1	
0x01A5	0x2000	THERMAL1 A OP	F001		R	1	
0x01A5	0x4000	THERMAL1 B ALRM	F001		R	1	
0x01A5	0x8000	THERMAL1 B OP	F001		R	1	
0x01A5	0x0001	THERMAL1 C ALRM	F001		R	1	
0x01A5	0x0002	THERMAL1 C OP	F001		R	1	
0x01AA	0x0004	THERMAL2 BLOCK	F001		R	1	
0x01AA	0x0008	THERMAL2 A RST	F001		R	1	
0x01AA	0x0010	THERMAL2 B RST	F001		R	1	
0x01AA	0x0020	THERMAL2 C RST	F001		R	1	
0x01AA	0x0040	THERMAL2 ALARM	F001		R	1	
0x01AA	0x0080	THERMAL2 OP	F001		R	1	
0x01AB	0x0100	THERMAL2 A ALRM	F001		R	1	
0x01AB	0x0200	THERMAL2 A OP	F001		R	1	
0x01AB	0x0400	THERMAL2 B ALRM	F001		R	1	
0x01AB	0x0800	THERMAL2 B OP	F001		R	1	
0x01AB	0x1000	THERMAL2 C ALRM	F001		R	1	
0x01AB	0x2000	THERMAL2 C OP	F001		R	1	
0x01B0	0x4000	THERMAL3 BLOCK	F001		R	1	
0x01B0	0x8000	THERMAL3 A RST	F001		R	1	
0x01B0	0x0001	THERMAL3 B RST	F001		R	1	
0x01B0	0x0002	THERMAL3 C RST	F001		R	1	
0x01B0	0x0004	THERMAL3 ALARM	F001		R	1	
0x01B0	0x0008	THERMAL3 OP	F001		R	1	
0x01B0	0x0010	THERMAL3 A ALRM	F001		R	1	
0x01B0	0x0020	THERMAL3 A OP	F001		R	1	
0x01B0	0x0040	THERMAL3 B ALRM	F001		R	1	
0x01B0	0x0080	THERMAL3 B OP	F001		R	1	
0x01B1	0x0100	THERMAL3 C ALRM	F001		R	1	
0x01B1	0x0200	THERMAL3 C OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Unidad Direccional de Fases - Phase Directional							
0x01B6	0x0400	PHASE DIR1 BLK INP	F001		R	1	
0x01B6	0x0800	PHASE DIR1 BLOCK A	F001		R	1	
0x01B6	0x1000	PHASE DIR1 A OP	F001		R	1	
0x01B6	0x2000	PHASE DIR1 BLOCK B	F001		R	1	
0x01B6	0x4000	PHASE DIR1 B OP	F001		R	1	
0x01B6	0x8000	PHASE DIR1 BLOCK C	F001		R	1	
0x01B6	0x0001	PHASE DIR1 C OP	F001		R	1	
0x01BB	0x0002	PHASE DIR2 BLK INP	F001		R	1	
0x01BB	0x0004	PHASE DIR2 BLOCK A	F001		R	1	
0x01BB	0x0008	PHASE DIR2 A OP	F001		R	1	
0x01BB	0x0010	PHASE DIR2 BLOCK B	F001		R	1	
0x01BB	0x0020	PHASE DIR2 B OP	F001		R	1	
0x01BB	0x0040	PHASE DIR2 BLOCK C	F001		R	1	
0x01BB	0x0080	PHASE DIR2 C OP	F001		R	1	
0x01C1	0x0100	PHASE DIR3 BLK INP	F001		R	1	
0x01C1	0x0200	PHASE DIR3 BLOCK A	F001		R	1	
0x01C1	0x0400	PHASE DIR3 A OP	F001		R	1	
0x01C1	0x0800	PHASE DIR3 BLOCK B	F001		R	1	
0x01C1	0x1000	PHASE DIR3 B OP	F001		R	1	
0x01C1	0x2000	PHASE DIR3 BLOCK C	F001		R	1	
0x01C1	0x4000	PHASE DIR3 C OP	F001		R	1	
Unidad Direccional de Neutro - Neutral Directional							
0x01C6	0x8000	NEUTRAL DIR1 BLK INP	F001		R	1	
0x01C6	0x0001	NEUTRAL DIR1 BLOCK	F001		R	1	
0x01C6	0x0002	NEUTRAL DIR1 OP	F001		R	1	
0x01CB	0x0004	NEUTRAL DIR2 BLK INP	F001		R	1	
0x01CB	0x0008	NEUTRAL DIR2 BLOCK	F001		R	1	
0x01CB	0x0010	NEUTRAL DIR2 OP	F001		R	1	
0x01D0	0x0020	NEUTRAL DIR3 BLK INP	F001		R	1	
0x01D0	0x0040	NEUTRAL DIR3 BLOCK	F001		R	1	
0x01D0	0x0080	NEUTRAL DIR3 OP	F001		R	1	
Unidad Direccional de Tierra - Ground Directional							
0x01D6	0x0100	GROUND DIR1 BLK INP	F001		R	1	
0x01D6	0x0200	GROUND DIR1 BLOCK	F001		R	1	
0x01D6	0x0400	GROUND DIR1 OP	F001		R	1	
0x01DB	0x0800	GROUND DIR2 BLK INP	F001		R	1	
0x01DB	0x1000	GROUND DIR2 BLOCK	F001		R	1	
0x01DB	0x2000	GROUND DIR2 OP	F001		R	1	
0x01E0	0x4000	GROUND DIR3 BLK INP	F001		R	1	
0x01E0	0x8000	GROUND DIR3 BLOCK	F001		R	1	
0x01E0	0x0001	GROUND DIR3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Fallo de Interruptor - Breaker Failure							
0x01E5	0x0002	BKR FAIL INITIATE	F001		R	1	
0x01E5	0x0004	BKR FAIL NO CURRENT	F001		R	1	
0x01E5	0x0008	BKR FAIL SUPERVISION	F001		R	1	
0x01E5	0x0010	BKR FAIL HISET	F001		R	1	
0x01E5	0x0020	BKR FAIL LOWSET	F001		R	1	
0x01E5	0x0040	INTERNAL ARC	F001		R	1	
0x01E5	0x0080	BKR FAIL 2nd STEP	F001		R	1	
Fallo de Fusible - Fuse failure							
0x01EB	0x0100	VT FUSE FAILURE	F001		R	1	
Unidad de Sincronismo - Synchrocheck							
0x01F0	0x0200	SYNCHROCHECK BLK INP	F001		R	1	
0x01F0	0x0400	SYNCHROCHECK OP	F001		R	1	
0x01F0	0x0800	SYNCHK CLOSE PERM	F001		R	1	
0x01F0	0x1000	SYNCHROCHECK COND OP	F001		R	1	
0x01F0	0x2000	DL-DB OPERATION	F001		R	1	
0x01F0	0x4000	DL-LB OPERATION	F001		R	1	
0x01F0	0x8000	LL-DB OPERATION	F001		R	1	
0x01F0	0x0001	SLIP CONDITION	F001		R	1	
0x01F0	0x0002	BUS FREQ > LINE FREQ	F001		R	1	
0x01F0	0x0004	BUS FREQ < LINE FREQ	F001		R	1	
Reenganchador (bit) - Autorecloser							
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobretensión de Neutro Nivel Alto - Neutral OV High							
0x01FC	0x1000	NEUTRAL OV1 HIGH BLK	F001		R	1	
0x01FC	0x2000	NEUTRAL OV1 HIGH PKP	F001		R	1	
0x01FC	0x4000	NEUTRAL OV1 HIGH OP	F001		R	1	
0x0201	0x8000	NEUTRAL OV2 HIGH BLK	F001		R	1	
0x0201	0x0001	NEUTRAL OV2 HIGH PKP	F001		R	1	
0x0201	0x0002	NEUTRAL OV2 HIGH OP	F001		R	1	
0x0206	0x0004	NEUTRAL OV3 HIGH BLK	F001		R	1	
0x0206	0x0008	NEUTRAL OV3 HIGH PKP	F001		R	1	
0x0206	0x0010	NEUTRAL OV3 HIGH OP	F001		R	1	
Sobretensión de Neutro Nivel Bajo - Neutral OV Low							
0x020B	0x0020	NEUTRAL OV1 LOW BLK	F001		R	1	
0x020B	0x0040	NEUTRAL OV1 LOW PKP	F001		R	1	
0x020B	0x0080	NEUTRAL OV1 LOW OP	F001		R	1	
0x0211	0x0100	NEUTRAL OV2 LOW BLK	F001		R	1	
0x0211	0x0200	NEUTRAL OV2 LOW PKP	F001		R	1	
0x0211	0x0400	NEUTRAL OV2 LOW OP	F001		R	1	
0x0216	0x0800	NEUTRAL OV3 LOW BLK	F001		R	1	
0x0216	0x1000	NEUTRAL OV3 LOW PKP	F001		R	1	
0x0216	0x2000	NEUTRAL OV3 LOW OP	F001		R	1	
Subtensión Auxiliar - Auxiliary UV							
0x021B	0x4000	AUXILIARY UV1 BLOCK	F001		R	1	
0x021B	0x8000	AUXILIARY UV1 PKP	F001		R	1	
0x021B	0x0001	AUXILIARY UV1 OP	F001		R	1	
0x0220	0x0002	AUXILIARY UV2 BLOCK	F001		R	1	
0x0220	0x0004	AUXILIARY UV2 PKP	F001		R	1	
0x0220	0x0008	AUXILIARY UV2 OP	F001		R	1	
0x0225	0x0010	AUXILIARY UV3 BLOCK	F001		R	1	
0x0225	0x0020	AUXILIARY UV3 PKP	F001		R	1	
0x0225	0x0040	AUXILIARY UV3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobretensión de Fases - Phase OV							
0x022A	0x0080	PHASE OV1 BLOCK	F001		R	1	
0x022B	0x0100	PHASE OV1 AB PKP	F001		R	1	
0x022B	0x0200	PHASE OV1 AB OP	F001		R	1	
0x022B	0x0400	PHASE OV1 BC PKP	F001		R	1	
0x022B	0x0800	PHASE OV1 BC OP	F001		R	1	
0x022B	0x1000	PHASE OV1 CA PKP	F001		R	1	
0x022B	0x2000	PHASE OV1 CA OP	F001		R	1	
0x022B	0x4000	PHASE OV1 PKP	F001		R	1	
0x022B	0x8000	PHASE OV1 OP	F001		R	1	
0x0230	0x0001	PHASE OV2 BLOCK	F001		R	1	
0x0230	0x0002	PHASE OV2 AB PKP	F001		R	1	
0x0230	0x0004	PHASE OV2 AB OP	F001		R	1	
0x0230	0x0008	PHASE OV2 BC PKP	F001		R	1	
0x0230	0x0010	PHASE OV2 BC OP	F001		R	1	
0x0230	0x0020	PHASE OV2 CA PKP	F001		R	1	
0x0230	0x0040	PHASE OV2 CA OP	F001		R	1	
0x0230	0x0080	PHASE OV2 PKP	F001		R	1	
0x0231	0x0100	PHASE OV2 OP	F001		R	1	
0x0236	0x0200	PHASE OV3 BLOCK	F001		R	1	
0x0236	0x0400	PHASE OV3 AB PKP	F001		R	1	
0x0236	0x0800	PHASE OV3 AB OP	F001		R	1	
0x0236	0x1000	PHASE OV3 BC PKP	F001		R	1	
0x0236	0x2000	PHASE OV3 BC OP	F001		R	1	
0x0236	0x4000	PHASE OV3 CA PKP	F001		R	1	
0x0236	0x8000	PHASE OV3 CA OP	F001		R	1	
0x0236	0x0001	PHASE OV3 PKP	F001		R	1	
0x0236	0x0002	PHASE OV3 OP	F001		R	1	
Sobretensión Auxiliar - Auxiliary OV							
0x023B	0x0004	AUXILIARY OV1 BLOCK	F001		R	1	
0x023B	0x0008	AUXILIARY OV1 PKP	F001		R	1	
0x023B	0x0010	AUXILIARY OV1 OP	F001		R	1	
0x0240	0x0020	AUXILIARY OV2 BLOCK	F001		R	1	
0x0240	0x0040	AUXILIARY OV2 PKP	F001		R	1	
0x0240	0x0080	AUXILIARY OV2 OP	F001		R	1	
0x0246	0x0100	AUXILIARY OV3 BLOCK	F001		R	1	
0x0246	0x0200	AUXILIARY OV3 PKP	F001		R	1	
0x0246	0x0400	AUXILIARY OV3 OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobreintensidad Temporizada de Secuencia Negativa - Negative Sequence TOC							
0x024B	0x0800	NEG SEQ TOC1 BLOCK	F001		R	1	
0x024B	0x1000	NEG SEQ TOC1 PKP	F001		R	1	
0x024B	0x2000	NEG SEQ TOC1 OP	F001		R	1	
0x0250	0x4000	NEG SEQ TOC2 BLOCK	F001		R	1	
0x0250	0x8000	NEG SEQ TOC2 PKP	F001		R	1	
0x0250	0x0001	NEG SEQ TOC2 OP	F001		R	1	
0x0255	0x0002	NEG SEQ TOC3 BLOCK	F001		R	1	
0x0255	0x0004	NEG SEQ TOC3 PKP	F001		R	1	
0x0255	0x0008	NEG SEQ TOC3 OP	F001		R	1	
Sobrefrecuencia - Overfrequency							
0x025A	0x0010	OVERFREQ1 BLOCK	F001		R	1	
0x025A	0x0020	OVERFREQ1 PKP	F001		R	1	
0x025A	0x0040	OVERFREQ1 OP	F001		R	1	
0x025F	0x0080	OVERFREQ2 BLOCK	F001		R	1	
0x0260	0x0100	OVERFREQ2 PKP	F001		R	1	
0x0260	0x0200	OVERFREQ2 OP	F001		R	1	
0x0265	0x0400	OVERFREQ3 BLOCK	F001		R	1	
0x0265	0x0800	OVERFREQ3 PKP	F001		R	1	
0x0265	0x1000	OVERFREQ3 OP	F001		R	1	
Subfrecuencia - Underfrequency							
0x026A	0x2000	UNDERFREQ1 BLOCK	F001		R	1	
0x026A	0x4000	UNDERFREQ1 PKP	F001		R	1	
0x026A	0x8000	UNDERFREQ1 OP	F001		R	1	
0x026F	0x0001	UNDERFREQ2 BLOCK	F001		R	1	
0x026F	0x0002	UNDERFREQ2 PKP	F001		R	1	
0x026F	0x0004	UNDERFREQ2 OP	F001		R	1	
0x0274	0x0008	UNDERFREQ3 BLOCK	F001		R	1	
0x0274	0x0010	UNDERFREQ3 PKP	F001		R	1	
0x0274	0x0020	UNDERFREQ3 OP	F001		R	1	
Calibración - Calibration							
0x0279	0x0040	FACTORY CALIBRATION	F001		R	1	
0x0279	0x0080	CALIBRATION ERROR	F001		R	1	



ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
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	
Localizador de Falta - Fault Report							
0x0280	0x0200	FAULT REPORT TRIGG	F001		R	1	
0x0280	0x0400	CLEAR FAULT REPORTS	F001		R	1	
Agrupamiento de Funciones - Group States							
0x028F	0x0400	GROUP 1 ACT ON	F001		R	1	
0x028F	0x0800	GROUP 2 ACT ON	F001		R	1	
0x028F	0x1000	GROUP 3 ACT ON	F001		R	1	
0x028F	0x2000	SETT GROUPS BLOCK	F001		R	1	
0x028F	0x4000	GROUP 1 BLOCKED	F001		R	1	
0x028F	0x8000	GROUP 2 BLOCKED	F001		R	1	
0x028F	0x0001	GROUP 3 BLOCKED	F001		R	1	
Canal por defecto - Default Channel (not used)							
0x0294	0x0002	Default Channel	F001		R	1	
Unidad de Conductor Roto - Broken Conductor							
0x0294	0x0004	BROKEN CONDUCT1 BLK	F001		R	1	
0x0294	0x0008	BROKEN CONDUCT1 PKP	F001		R	1	
0x0294	0x0010	BROKEN CONDUCT1 OP	F001		R	1	
0x0299	0x0020	BROKEN CONDUCT2 BLK	F001		R	1	
0x0299	0x0040	BROKEN CONDUCT2 PKP	F001		R	1	
0x0299	0x0080	BROKEN CONDUCT2 OP	F001		R	1	
0x029F	0x0100	BROKEN CONDUCT3 BLK	F001		R	1	
0x029F	0x0200	BROKEN CONDUCT3 PKP	F001		R	1	
0x029F	0x0400	BROKEN CONDUCT3 OP	F001		R	1	
Energía - Energy							
0x02A4	0x0800	FREEZE ENERGY CNT	F001		R	1	
0x02A4	0x1000	UNFREEZE ENERGY CNT	F001		R	1	
0x02A4	0x2000	RESET ENERGY CNT	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Unidad de Tierra Aislada - Isolated Ground							
0x02B8	0x4000	ISOLATED GND1 BLK	F001		R	1	
0x02B8	0x8000	ISOLATED GND1 PKP	F001		R	1	
0x02B8	0x0001	ISOLATED GND1 OP	F001		R	1	
0x02C7	0x0002	ISOLATED GND2 BLK	F001		R	1	
0x02C7	0x0004	ISOLATED GND2 PKP	F001		R	1	
0x02C7	0x0008	ISOLATED GND2 OP	F001		R	1	
0x02D6	0x0010	ISOLATED GND3 BLK	F001		R	1	
0x02D6	0x0020	ISOLATED GND3 PKP	F001		R	1	
0x02D6	0x0040	ISOLATED GND3 OP	F001		R	1	
Unidad Direccional de Tierra Sensible - Sensitive Ground Directional							
0x02E5	0x0080	SENS GND DIR1 BLK IP	F001		R	1	
0x02E6	0x0100	SENS GND DIR1 BLOCK	F001		R	1	
0x02E6	0x0200	SENS GND DIR1 OP	F001		R	1	
0x02EB	0x0400	SENS GND DIR2 BLK IP	F001		R	1	
0x02EB	0x0800	SENS GND DIR2 BLOCK	F001		R	1	
0x02EB	0x1000	SENS GND DIR2 OP	F001		R	1	
0x02F0	0x2000	SENS GND DIR3 BLK IP	F001		R	1	
0x02F0	0x4000	SENS GND DIR3 BLOCK	F001		R	1	
0x02F0	0x8000	SENS GND DIR3 OP	F001		R	1	
Unidad de Potencia Máxima Directa - Forward Power(32FP)							
0x02F5	0x0001	FWD PWR1 BLOCK	F001		R	1	
0x02F5	0x0002	FWD PWR1 STG1 PKP	F001		R	1	
0x02F5	0x0004	FWD PWR1 STG1 OP	F001		R	1	
0x02F5	0x0008	FWD PWR1 STG2 PKP	F001		R	1	
0x02F5	0x0010	FWD PWR1 STG2 OP	F001		R	1	
0x02FA	0x0020	FWD PWR2 BLOCK	F001		R	1	
0x02FA	0x0040	FWD PWR2 STG1 PKP	F001		R	1	
0x02FA	0x0080	FWD PWR2 STG1 OP	F001		R	1	
0x02FB	0x0100	FWD PWR2 STG2 PKP	F001		R	1	
0x02FB	0x0200	FWD PWR2 STG2 OP	F001		R	1	
0x0300	0x0400	FWD PWR3 BLOCK	F001		R	1	
0x0300	0x0800	FWD PWR3 STG1 PKP	F001		R	1	
0x0300	0x1000	FWD PWR3 STG1 OP	F001		R	1	
0x0300	0x2000	FWD PWR3 STG2 PKP	F001		R	1	
0x0300	0x4000	FWD PWR3 STG2 OP	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 Status							
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Estado Señales Activación salidas Tarjeta H (16 elementos) - Board H: Contact Output Operate -logical status-							
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 status-							
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 Status							
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 status-							
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 status-							
0x0342	0x0004	CONT OP_J_01	F001		R	1	
0x0342	0x0008	CONT OP_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0343	0x0002	CONT OP_J_16	F001		R	1	
Estado Tarjeta J - Board J Status							
0x0343	0x0004	BOARD J STATUS	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Sobrecorriente Temporizada de Fases Nivel Bajo - Phase TOC Low							
0x0363	0x0008	PH TOC1 LOW A BLK	F001		R	1	
0x0363	0x0010	PH TOC1 LOW B BLK	F001		R	1	
0x0363	0x0020	PH TOC1 LOW C BLK	F001		R	1	
0x0363	0x0040	PH TOC1 LOW A PKP	F001		R	1	
0x0363	0x0080	PH TOC1 LOW A OP	F001		R	1	
0x0364	0x0100	PH TOC1 LOW B PKP	F001		R	1	
0x0364	0x0200	PH TOC1 LOW B OP	F001		R	1	
0x0364	0x0400	PH TOC1 LOW C PKP	F001		R	1	
0x0364	0x0800	PH TOC1 LOW C OP	F001		R	1	
0x0364	0x1000	PH TOC1 LOW PKP	F001		R	1	
0x0364	0x2000	PH TOC1 LOW OP	F001		R	1	
0x0369	0x4000	PH TOC2 LOW A BLK	F001		R	1	
0x0369	0x8000	PH TOC2 LOW B BLK	F001		R	1	
0x0369	0x0001	PH TOC2 LOW C BLK	F001		R	1	
0x0369	0x0002	PH TOC2 LOW A PKP	F001		R	1	
0x0369	0x0004	PH TOC2 LOW A OP	F001		R	1	
0x0369	0x0008	PH TOC2 LOW B PKP	F001		R	1	
0x0369	0x0010	PH TOC2 LOW B OP	F001		R	1	
0x0369	0x0020	PH TOC2 LOW C PKP	F001		R	1	
0x0369	0x0040	PH TOC2 LOW C OP	F001		R	1	
0x0369	0x0080	PH TOC2 LOW PKP	F001		R	1	
0x036A	0x0100	PH TOC2 LOW OP	F001		R	1	
0x036F	0x0200	PH TOC3 LOW A BLK	F001		R	1	
0x036F	0x0400	PH TOC3 LOW B BLK	F001		R	1	
0x036F	0x0800	PH TOC3 LOW C BLK	F001		R	1	
0x036F	0x1000	PH TOC3 LOW A PKP	F001		R	1	
0x036F	0x2000	PH TOC3 LOW A OP	F001		R	1	
0x036F	0x4000	PH TOC3 LOW B PKP	F001		R	1	
0x036F	0x8000	PH TOC3 LOW B OP	F001		R	1	
0x036F	0x0001	PH TOC3 LOW C PKP	F001		R	1	
0x036F	0x0002	PH TOC3 LOW C OP	F001		R	1	
0x036F	0x0004	PH TOC3 LOW PKP	F001		R	1	
0x036F	0x0008	PH TOC3 LOW OP	F001		R	1	
Contactos Configuración Aparamenta (16 elementos) - Switchgear Contact Configuration States							
0x0374	0x0010	SWITCH 1 A INPUT	F001		R	1	
0x0374	0x0020	SWITCH 1 B INPUT	F001		R	1	
0x0374	0x0040	SWITCH 2 A INPUT	F001		R	1	
0x0374	0x0080	SWITCH 2 B INPUT	F001		R	1	
...	...	...	...	...	...	...	...
0x0376	0x0004	SWITCH 16 A INPUT	F001		R	1	
0x0376	0x0008	SWITCH 16 B INPUT	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Estados Interruptor - Breaker States							
0x0390	0x0010	KI2t PHASE A ALARM	F001		R	1	
0x0390	0x0020	KI2t PHASE B ALARM	F001		R	1	
0x0390	0x0040	KI2t PHASE C ALARM	F001		R	1	
0x0390	0x0080	BKR OPENINGS ALARM	F001		R	1	
0x0391	0x0100	BKR OPEN 1 HOUR ALRM	F001		R	1	
0x0391	0x0200	BREAKER OPEN	F001		R	1	
0x0391	0x0400	BREAKER CLOSED	F001		R	1	
0x0391	0x0800	BREAKER UNDEFINED	F001		R	1	
0x0391	0x1000	RESET KI2t COUNTERS	F001		R	1	
0x0391	0x2000	RESET BKR COUNTERS	F001		R	1	
Estado Mapa Usuario - User Map State							
0x039B	0x4000	USER MAP STATUS	F001		R	1	
Estado Curvas Usuario - Flex Curves States							
0x039B	0x8000	FLEXCURVE A STATUS	F001		R	1	
0x03A0	0x0001	FLEXCURVE B STATUS	F001		R	1	
0x03A5	0x0002	FLEXCURVE C STATUS	F001		R	1	
0x03AA	0x0004	FLEXCURVE D STATUS	F001		R	1	
Estados Internos Sistema - Internal System States							
0x03B1	0x0008	Green Zone	F001		R	1	
0x03B1	0x0010	Yellow Zone	F001		R	1	
0x03B1	0x0020	Orange Zone	F001		R	1	
0x03B1	0x0040	Red Zone	F001		R	1	
unidad direccional de potencia Grupo - Directional Power(32)							
0x03B2	0x8000	DIR PWR1 BLOCK	F001		R	1	
0x03B2	0x0001	DIR PWR1 STG1 PKP	F001		R	1	
0x03B2	0x0002	DIR PWR1 STG1 OP	F001		R	1	
0x03B2	0x0004	DIR PWR1 STG2 PKP	F001		R	1	
0x03B2	0x0008	DIR PWR1 STG2 OP	F001		R	1	
0x03B2	0x0010	DIR PWR1 STG PKP	F001		R	1	
0x03B2	0x0020	DIR PWR1 STG OP	F001		R	1	
0x03B7	0x0040	DIR PWR2 BLOCK	F001		R	1	
0x03B7	0x0080	DIR PWR2 STG1 PKP	F001		R	1	
0x03B8	0x0100	DIR PWR2 STG1 OP	F001		R	1	
0x03B8	0x0200	DIR PWR2 STG2 PKP	F001		R	1	
0x03B8	0x0400	DIR PWR2 STG2 OP	F001		R	1	
0x03B8	0x0800	DIR PWR2 STG PKP	F001		R	1	
0x03B8	0x1000	DIR PWR2 STG OP	F001		R	1	
0x03BD	0x2000	DIR PWR3 BLOCK	F001		R	1	
0x03BD	0x4000	DIR PWR3 STG1 PKP	F001		R	1	
0x03BD	0x8000	DIR PWR3 STG1 OP	F001		R	1	
0x03BD	0x0001	DIR PWR3 STG2 PKP	F001		R	1	
0x03BD	0x0002	DIR PWR3 STG2 OP	F001		R	1	
0x03BD	0x0004	DIR PWR3 STG PKP	F001		R	1	
0x03BD	0x0008	DIR PWR3 STG OP	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Unidad de Rotor Bloqueado - Locked Rotor (48)							
0x03C2	0x0010	LOCKED ROTOR1 BLK	F001		R	1	
0x03C2	0x0020	LOCKED ROTOR1 PKP	F001		R	1	
0x03C2	0x0040	LOCKED ROTOR1 OP	F001		R	1	
0x03C3	0x0080	LOCKED ROTOR2 BLK	F001		R	1	
0x03C4	0x0100	LOCKED ROTOR2 PKP	F001		R	1	
0x03C4	0x0200	LOCKED ROTOR2 OP	F001		R	1	
0x03C5	0x0400	LOCKED ROTOR3 BLK	F001		R	1	
0x03C5	0x0800	LOCKED ROTOR3 PKP	F001		R	1	
0x03C5	0x1000	LOCKED ROTOR3 OP	F001		R	1	
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	
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Medidas en Valores Secundarios - Analog measures in Secondary Values (cont.)							
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	
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	



ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Medidas en Valores Secundarios - Analog measures in Secondary Values (cont.)							
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	
0x0CB4		CT Ratio	F002	1000	R	2	
0x0CB6		CT Ratio Ig	F002	1000	R	2	
0x0CB8		CT Ratio Isg	F002	1000	R	2	
0x0CBA		PT Ratio	F002	1000	R	2	
Angulos - Angles							
0x0CBC		Ia Angle	F002	1000	R	2	
0x0CBE		Ib Angle	F002	1000	R	2	
0x0CC0		Ic Angle	F002	1000	R	2	
0x0CC2		In Angle	F002	1000	R	2	
0x0CC4		Ig Angle	F002	1000	R	2	
0x0CC6		Isg Angle	F002	1000	R	2	
0x0CC8		Va Angle	F002	1000	R	2	
0x0CCA		Vb Angle	F002	1000	R	2	
0x0CCC		Vc Angle	F002	1000	R	2	
0x0CCE		Vn Angle	F002	1000	R	2	
0x0CD0		Vx Angle	F002	1000	R	2	
0x0CD2		Vab Angle	F002	1000	R	2	
0x0CD4		Vbc Angle	F002	1000	R	2	
0x0CD6		Vca Angle	F002	1000	R	2	
Valores Imagen Térmica - Thermal Image Values							
0x0DD9		THERMAL1 IMAGE A	F003	1	R	2	
0x0DDB		THERMAL1 IMAGE B	F003	1	R	2	
0x0DDD		THERMAL1 IMAGE C	F003	1	R	2	
0x0DE4		THERMAL2 IMAGE A	F003	1	R	2	
0x0DE6		THERMAL2 IMAGE B	F003	1	R	2	
0x0DE8		THERMAL2 IMAGE C	F003	1	R	2	
0x0DEF		THERMAL3 IMAGE A	F003	1	R	2	
0x0DF1		THERMAL3 IMAGE B	F003	1	R	2	
0x0DF3		THERMAL3 IMAGE C	F003	1	R	2	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
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	
Localizador de Falta - Fault Report							
0x0EBB		FAULT DATE	F011		R	3	
0x0EBE		FAULT TYPE	F012		R	1	0=GROUND
							1=PHASE
							2=3 PH
							3=AG
							4=ABG
							5=AB
							6=BG
							7=BCG
							8=BC
							9=CG
							10=CAG
							11=CA
							12=NAF
0x0EBF		FAULT LOCATION	F003	1	R	2	
0x0EC1		FAULT REPORT NUMBER	F005	1	R	2	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Medidas en Valores Primarios - Analog measures in Primary Values							
0x0EE2		Phasor Ia Primary	F002	1000	R	2	
0x0EE4		Phasor Ib Primary	F002	1000	R	2	
0x0EE6		Phasor Ic Primary	F002	1000	R	2	
0x0EE8		Phasor Ig Primary	F002	1000	R	2	
0x0EEA		Phasor Isg Primary	F002	1000	R	2	
0x0EEC		Phasor In Primary	F002	1000	R	2	
0x0EEE		RMS Ia Primary	F002	1000	R	2	
0x0EF0		RMS Ib Primary	F002	1000	R	2	
0x0EF2		RMS Ic Primary	F002	1000	R	2	
0x0EF4		RMS Ig Primary	F002	1000	R	2	
0x0EF6		RMS Isg Primary	F002	1000	R	2	
0x0EF8		I0 Primary	F002	1000	R	2	
0x0EFA		I1 Primary	F002	1000	R	2	
0x0EFC		I2 Primary	F002	1000	R	2	
0x0EFE		V0 Primary	F002	1000	R	2	
0x0F00		V1 Primary	F002	1000	R	2	
0x0F02		V2 Primary	F002	1000	R	2	
0x0F04		Vab Primary	F002	1000	R	2	
0x0F06		Vbc Primary	F002	1000	R	2	
0x0F08		Vca Primary	F002	1000	R	2	
0x0F0A		Va Primary	F002	1000	R	2	
0x0F0C		Vb Primary	F002	1000	R	2	
0x0F0E		Vc Primary	F002	1000	R	2	
0x0F10		Vn Primary	F002	1000	R	2	
0x0F12		Vx Primary	F002	1000	R	2	
0x0F14		VBB Primary	F002	1000	R	2	
0x0F16		VL Primary	F002	1000	R	2	
0x0F18		Phase A Real Pwr	F002	1000	R	2	
0x0F1A		Phase A Reactive Pwr	F002	1000	R	2	
0x0F1C		Phase A Apparent Pwr	F002	1000	R	2	
0x0F1E		Phase B Real Pwr	F002	1000	R	2	
0x0F20		Phase B Reactive Pwr	F002	1000	R	2	
0x0F22		Phase B Apparent Pwr	F002	1000	R	2	
0x0F24		Phase C Real Pwr	F002	1000	R	2	
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Medidas en Valores Primarios - Analog measures in Primary Values (cont.)							
0x0F3E		Negative MWatthour	F002	1000	R	2	
0x0F40		Positive MVarhour	F002	1000	R	2	
0x0F42		Negative MVarhour	F002	1000	R	2	
0x0F44		Pos MWatthour Cnt	F002	1000	R	2	
0x0F46		Neg MWatthour Cnt	F002	1000	R	2	
0x0F48		Pos MVarhour Cnt	F002	1000	R	2	
0x0F4A		Neg MVarhour Cnt	F002	1000	R	2	
Medidas Demanda - Demand measures							
0x0FAB		DEMAND IA	F002	1000	R	2	
0x0FAD		DEMAND IA MAX	F002	1000	R	2	
0x0FAF		DEMAND IA DATE	F011		R	3	
0x0FB2		DEMAND IB	F002	1000	R	2	
0x0FB4		DEMAND IB MAX	F002	1000	R	2	
0x0FB6		DEMAND IB DATE	F011		R	3	
0x0FB9		DEMAND IC	F002	1000	R	2	
0x0FBB		DEMAND IC MAX	F002	1000	R	2	
0x0FBD		DEMAND IC DATE	F011		R	3	
0x0FC0		DEMAND IG	F002	1000	R	2	
0x0FC2		DEMAND IG MAX	F002	1000	R	2	
0x0FC4		DEMAND IG DATE	F011		R	3	
0x0FC7		DEMAND ISG	F002	1000	R	2	
0x0FC9		DEMAND ISG MAX	F002	1000	R	2	
0x0FCB		DEMAND ISG DATE	F011		R	3	
0x0FCE		DEMAND I2	F002	1000	R	2	
0x0FD0		DEMAND I2 MAX	F002	1000	R	2	
0x0FD2		DEMAND I2 DATE	F011		R	3	
0x0FD5		DEMAND W	F002	1000	R	2	
0x0FD7		DEMAND W MAX	F002	1000	R	2	
0x0FD9		DEMAND W DATE	F011		R	3	
0x0FDC		DEMAND VAR PWR	F002	1000	R	2	
0x0FDE		DEMAND VAR MAX	F002	1000	R	2	
0x0FE0		DEMAND VAR DATE	F011		R	3	
0x0FE3		DEMAND VA PWR	F002	1000	R	2	
0x0FE5		DEMAND VA MAX	F002	1000	R	2	
0x0FE7		DEMAND VA DATE	F011		R	3	
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	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Registrador de Datos - Data Logger							
0x1153		OLDEST SAMPLE TIME	F011		R	3	
0x1156		NEWEST SAMPLE TIME	F011		R	3	
0x1159		DATA LOGGER CHANNELS	F004	1	R	1	
0x115A		DATA LOGGER DAYS	F003	1	R	2	
Estados Internos Sistema - Internal System States							
0x1160		Kswapd Time	F005	1	R	2	
0x1162		mtd2 Time	F005	1	R	2	
0x1164		mtd3 Time	F005	1	R	2	
0x1166		CPU Rtai	F005	1	R	2	
0x1168		CPU Linux	F005	1	R	2	
0x116A		Total RAM	F005	1024	R	2	
0x116C		Used DRAM	F005	1024	R	2	
0x116E		Free RAM	F005	1024	R	2	
0x1170		Shared RAM	F005	1024	R	2	
0x1172		Buffer RAM	F005	1024	R	2	
0x1174		Cached RAM	F005	1024	R	2	
0x1176		Green Counter	F005	1	R	2	
0x1178		Yellow Counter	F005	1	R	2	
0x117A		Orange Counter	F005	1	R	2	
0x117C		Red Counter	F005	1	R	2	
0x117E		UpTime	F005	1	R	2	
Funciones Protección habilitadas - Protection Summary							
0x2204	0x0001	Phase IOC1 High	F001		R	1	
0x2220	0x0001	Phase IOC2 High	F001		R	1	
0x223C	0x0001	Phase IOC3 High	F001		R	1	
0x2258	0x0001	Phase IOC1 Low	F001		R	1	
0x2274	0x0001	Phase IOC2 Low	F001		R	1	
0x2290	0x0001	Phase IOC3 Low	F001		R	1	
0x22AC	0x0001	Neutral IOC1	F001		R	1	
0x22C7	0x0001	Neutral IOC2	F001		R	1	
0x22E2	0x0001	Neutral IOC3	F001		R	1	
0x22FD	0x0001	Ground IOC1	F001		R	1	
0x2319	0x0001	Ground IOC2	F001		R	1	
0x2335	0x0001	Ground IOC3	F001		R	1	
0x2351	0x0001	Sensitive Ground IOC1	F001		R	1	
0x236D	0x0001	Sensitive Ground IOC2	F001		R	1	
0x2389	0x0001	Sensitive Ground IOC3	F001		R	1	
0x23A5	0x0001	Phase TOC1 High	F001		R	1	
0x23C2	0x0001	Phase TOC2 High	F001		R	1	
0x23DF	0x0001	Phase TOC3 High	F001		R	1	
0x23FC	0x0001	Neutral TOC1	F001		R	1	
0x2417	0x0001	Neutral TOC2	F001		R	1	
0x2432	0x0001	Neutral TOC3	F001		R	1	
0x244D	0x0001	Ground TOC1	F001		R	1	
0x2469	0x0001	Ground TOC2	F001		R	1	
0x2485	0x0001	Ground TOC3	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Funciones Protección habilitadas - Protection Summary (cont.)							
0x24A1	0x0001	Sensitive Ground TOC1	F001		R	1	
0x24BD	0x0001	Sensitive Ground TOC2	F001		R	1	
0x24D9	0x0001	Sensitive Ground TOC3	F001		R	1	
0x24F5	0x0001	Phase UV1	F001		R	1	
0x2514	0x0001	Phase UV2	F001		R	1	
0x2533	0x0001	Phase UV3	F001		R	1	
0x2552	0x0001	Negative Sequence OV1	F001		R	1	
0x256D	0x0001	Negative Sequence OV2	F001		R	1	
0x2588	0x0001	Negative Sequence OV3	F001		R	1	
0x25A3	0x0001	Thermal Model1	F001		R	1	
0x25C0	0x0001	Thermal Model2	F001		R	1	
0x25DD	0x0001	Thermal Model3	F001		R	1	
0x25FA	0x0001	Phase Directional1	F001		R	1	
0x2615	0x0001	Phase Directional2	F001		R	1	
0x2630	0x0001	Phase Directional3	F001		R	1	
0x264B	0x0001	Neutral Directional1	F001		R	1	
0x2667	0x0001	Neutral Directional2	F001		R	1	
0x2683	0x0001	Neutral Directional3	F001		R	1	
0x269F	0x0001	Ground Directional1	F001		R	1	
0x26BB	0x0001	Ground Directional2	F001		R	1	
0x26D7	0x0001	Ground Directional3	F001		R	1	
0x26F3	0x0001	Breaker Failure	F001		R	1	
0x271C	0x0001	Fuse Failure	F001		R	1	
0x2731	0x0001	Synchrocheck	F001		R	1	
0x2763	0x0001	Recloser	F001		R	1	
0x278C	0x0001	Neutral OV1 High	F001		R	1	
0x27A7	0x0001	Neutral OV2 High	F001		R	1	
0x27C2	0x0001	Neutral OV3 High	F001		R	1	
0x27DD	0x0001	Neutral OV1 Low	F001		R	1	
0x27F8	0x0001	Neutral OV2 Low	F001		R	1	
0x2813	0x0001	Neutral OV3 Low	F001		R	1	
0x282E	0x0001	Auxiliary UV1	F001		R	1	
0x2848	0x0001	Auxiliary UV2	F001		R	1	
0x2862	0x0001	Auxiliary UV3	F001		R	1	
0x287C	0x0001	Phase OV1	F001		R	1	
0x2898	0x0001	Phase OV2	F001		R	1	
0x28B4	0x0001	Phase OV3	F001		R	1	
0x28D0	0x0001	Auxiliary OV1	F001		R	1	
0x28EB	0x0001	Auxiliary OV2	F001		R	1	
0x2906	0x0001	Auxiliary OV3	F001		R	1	
0x2921	0x0001	I2 TOC1	F001		R	1	
0x293C	0x0001	I2 TOC2	F001		R	1	
0x2957	0x0001	I2 TOC3	F001		R	1	
0x2972	0x0001	Overfrequency1	F001		R	1	
0x298F	0x0001	Overfrequency2	F001		R	1	
0x29AC	0x0001	Overfrequency3	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Funciones Protección habilitadas - Protection Summary (cont.)							
0x24A1	0x0001	Sensitive Ground TOC1	F001		R	1	
0x29C9	0x0001	Underfrequency1	F001		R	1	
0x29E6	0x0001	Underfrequency2	F001		R	1	
0x2A03	0x0001	Underfrequency3	F001		R	1	
0x2A7C	0x0001	Oscillography	F001		R	1	
0x2A93	0x0001	Fault Report	F001		R	1	
0x2C08	0x0001	Broken Conductor1	F001		R	1	
0x2C21	0x0001	Broken Conductor2	F001		R	1	
0x2C3A	0x0001	Broken Conductor3	F001		R	1	
0x2DF6	0x0001	Isolated Ground IOC1	F001		R	1	
0x2E17	0x0001	Isolated Ground IOC2	F001		R	1	
0x2E38	0x0001	Isolated Ground IOC3	F001		R	1	
0x2E59	0x0001	Sensitive Ground Directional1	F001		R	1	
0x2E74	0x0001	Sensitive Ground Directional2	F001		R	1	
0x2E8F	0x0001	Sensitive Ground Directional3	F001		R	1	
0x2EAA	0x0001	Forward power1	F001		R	1	
0x2EC9	0x0001	Forward power2	F001		R	1	
0x2EE8	0x0001	Forward power3	F001		R	1	
0x2F07	0x0001	Demand	F001		R	1	
0x2F20	0x0001	IEC104 Protocol	F001		R	1	
0x32A5	0x0001	Phase TOC1 Low	F001		R	1	
0x32C2	0x0001	Phase TOC2 Low	F001		R	1	
0x32DF	0x0001	Phase TOC3 Low	F001		R	1	
0x38D4	0x0001	Data Logger	F001		R	1	
0x38FA	0x0001	Directional Power1	F001		R	1	
0x391D	0x0001	Directional Power2	F001		R	1	
0x3940	0x0001	Directional Power3	F001		R	1	
0x3963	0x0001	Locked Rotor1	F001		R	1	
0x3978	0x0001	Locked Rotor2	F001		R	1	
0x398D	0x0001	Locked Rotor3	F001		R	1	
Funciones con Eventos habilitados - Snapshot Events Summary							
0x1EE5	0x0001	Board F Event	F001		R	1	
0x208A	0x0001	Board G Event	F001		R	1	
0x2199	0x0001	General Settings Event	F001		R	1	
0x220C	0x0001	Phase IOC1 High Event	F001		R	1	
0x2228	0x0001	Phase IOC2 High Event	F001		R	1	
0x2244	0x0001	Phase IOC3 High Event	F001		R	1	
0x2260	0x0001	Phase IOC1 Low Event	F001		R	1	
0x227C	0x0001	Phase IOC2 Low Event	F001		R	1	
0x2298	0x0001	Phase IOC3 Low Event	F001		R	1	
0x22B3	0x0001	Neutral IOC1 Event	F001		R	1	
0x22CE	0x0001	Neutral IOC2 Event	F001		R	1	
0x22E9	0x0001	Neutral IOC3 Event	F001		R	1	
0x2305	0x0001	Ground IOC1 Event	F001		R	1	
0x2321	0x0001	Ground IOC2 Event	F001		R	1	
0x233D	0x0001	Ground IOC3 Event	F001		R	1	

ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Funciones con Eventos habilitados - Snapshot Events Summary (cont.)							
0x2359	0x0001	Sensitive Ground IOC1 Event	F001		R	1	
0x2375	0x0001	Sensitive Ground IOC2 Event	F001		R	1	
0x2391	0x0001	Sensitive Ground IOC3 Event	F001		R	1	
0x23AE	0x0001	Phase TOC1 High Event	F001		R	1	
0x23CB	0x0001	Phase TOC2 High Event	F001		R	1	
0x23E8	0x0001	Phase TOC3 High Event	F001		R	1	
0x2403	0x0001	Neutral TOC1 Event	F001		R	1	
0x241E	0x0001	Neutral TOC2 Event	F001		R	1	
0x2439	0x0001	Neutral TOC3 Event	F001		R	1	
0x2455	0x0001	Ground TOC1 Event	F001		R	1	
0x2471	0x0001	Ground TOC2 Event	F001		R	1	
0x248D	0x0001	Ground TOC3 Event	F001		R	1	
0x24A9	0x0001	Sensitive Ground TOC1 Event	F001		R	1	
0x24C5	0x0001	Sensitive Ground TOC2 Event	F001		R	1	
0x24E1	0x0001	Sensitive Ground TOC3 Event	F001		R	1	
0x2500	0x0001	Phase UV1 Event	F001		R	1	
0x251F	0x0001	Phase UV2 Event	F001		R	1	
0x253E	0x0001	Phase UV3 Event	F001		R	1	
0x2559	0x0001	Negative Sequence OV1 Event	F001		R	1	
0x2574	0x0001	Negative Sequence OV2 Event	F001		R	1	
0x258F	0x0001	Negative Sequence OV3 Event	F001		R	1	
0x25AC	0x0001	Thermal Model1 Event	F001		R	1	
0x25C9	0x0001	Thermal Model2 Event	F001		R	1	
0x25E6	0x0001	Thermal Model3 Event	F001		R	1	
0x2601	0x0001	Phase Directional1 Event	F001		R	1	
0x261C	0x0001	Phase Directional2 Event	F001		R	1	
0x2637	0x0001	Phase Directional3 Event	F001		R	1	
0x2653	0x0001	Neutral Directional1 Event	F001		R	1	
0x266F	0x0001	Neutral Directional2 Event	F001		R	1	
0x268B	0x0001	Neutral Directional3 Event	F001		R	1	
0x26A7	0x0001	Ground Directional1 Event	F001		R	1	
0x26C3	0x0001	Ground Directional2 Event	F001		R	1	
0x26DF	0x0001	Ground Directional3 Event	F001		R	1	
0x2708	0x0001	Breaker Failure Event	F001		R	1	
0x271D	0x0001	Fuse Failure Event	F001		R	1	
0x2745	0x0001	Synchrocheck Event	F001		R	1	
0x2774	0x0001	Recloser Event	F001		R	1	
0x2793	0x0001	Neutral OV1 High Event	F001		R	1	
0x27AE	0x0001	Neutral OV2 High Event	F001		R	1	
0x27C9	0x0001	Neutral OV3 High Event	F001		R	1	
0x27E4	0x0001	Neutral OV1 Low Event	F001		R	1	
0x27FF	0x0001	Neutral OV2 Low Event	F001		R	1	
0x281A	0x0001	Neutral OV3 Low Event	F001		R	1	
0x2834	0x0001	Auxiliary UV1 Event	F001		R	1	
0x284E	0x0001	Auxiliary UV2 Event	F001		R	1	
0x2868	0x0001	Auxiliary UV3 Event	F001		R	1	



ADDRESS	Bit	Name	Format	Step	Mode	Length	Miscellaneous
Funciones con Eventos habilitados - Snapshot Events Summary (cont.)							
0x2884	0x0001	Phase OV1 Event	F001		R	1	
0x28A0	0x0001	Phase OV2 Event	F001		R	1	
0x28BC	0x0001	Phase OV3 Event	F001		R	1	
0x28D7	0x0001	Auxiliary OV1 Event	F001		R	1	
0x28F2	0x0001	Auxiliary OV2 Event	F001		R	1	
0x290D	0x0001	Auxiliary OV3 Event	F001		R	1	
0x2928	0x0001	Negative Sequence TOC1 Event	F001		R	1	
0x2943	0x0001	Negative Sequence TOC2 Event	F001		R	1	
0x295E	0x0001	Negative Sequence TOC3 Event	F001		R	1	
0x297B	0x0001	Overfrequency1 Event	F001		R	1	
0x2998	0x0001	Overfrequency2 Event	F001		R	1	
0x29B5	0x0001	Overfrequency3 Event	F001		R	1	
0x29D2	0x0001	Underfrequency1 Event	F001		R	1	
0x29EF	0x0001	Underfrequency2 Event	F001		R	1	
0x2A0C	0x0001	Underfrequency3 Event	F001		R	1	
0x2A81	0x0001	Oscillography Event	F001		R	1	
0x2A9F	0x0001	Fault Report Event	F001		R	1	
0x2C0D	0x0001	Broken Conductor1 Event	F001		R	1	
0x2C26	0x0001	Broken Conductor2 Event	F001		R	1	
0x2C3F	0x0001	Broken Conductor3 Event	F001		R	1	
0x2E03	0x0001	Isolated Ground IOC1 Event	F001		R	1	
0x2E24	0x0001	Isolated Ground IOC2 Event	F001		R	1	
0x2E45	0x0001	Isolated Ground IOC3 Event	F001		R	1	
0x2E60	0x0001	Sensitive Ground Directional1 Event	F001		R	1	
0x2E7B	0x0001	Sensitive Ground Directional2 Event	F001		R	1	
0x2E96	0x0001	Sensitive Ground Directional3 Event	F001		R	1	
0x2EB5	0x0001	Forward Power1 Event	F001		R	1	
0x2ED4	0x0001	Forward Power2 Event	F001		R	1	
0x2EF3	0x0001	Forward Power3 Event	F001		R	1	
0x2F0C	0x0001	Demand Event	F001		R	1	
0x32AE	0x0001	Phase TOC1 Low Event	F001		R	1	
0x32CB	0x0001	Phase TOC2 Low Event	F001		R	1	
0x32E8	0x0001	Phase TOC3 Low Event	F001		R	1	
0x3909	0x0001	Directional Power1 Event	F001		R	1	
0x392C	0x0001	Directional Power2 Event	F001		R	1	
0x394F	0x0001	Directional Power3 Event	F001		R	1	
0x396D	0x0001	Locked Rotor1 Event	F001		R	1	
0x3982	0x0001	Locked Rotor2 Event	F001		R	1	
0x3997	0x0001	Locked Rotor3 Event	F001		R	1	
Mapa de Usuario - User Map							
0xF330		Address 00	F004	1	R	1	
0xF331		Address 01	F004	1	R	1	
...	...	...	...	...	...	...	...
0xF42F		Address 255	F004	1	R	1	

## C.1.1 DNP 3.0 PROTOCOL SETTINGS

F650 units enable the user to program certain parameters related to DNP3 protocol. These parameters are called DNP3 protocol settings and can be modified from the front panel or from the Level 2 software. The F650 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 F650 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**.

In the current 1.72 firmware version of the F650 relay only the first logical DNP3 slave can be configured DNP3 over serial link (COM1 or COM2). Therefore setting the DNP3 Physical Port to COM1 or COM2 for the second or the third logical slave devices will have no effect. The second and the third logical DNP3 slave devices can only communicate using DNP3 over TCP/IP.

Time synchronization through DNP protocol is available from all three DNP masters that can communicate with F650. However the date & time will be taken from only one master at the same moment. It is recommended to use only one master to do time sync through DNP.

SETTING NO	SETTING NAME	DEFAULT VALUE	RANGE
1	Physical Port	NONE	NONE, COM1, COM2, NETWORK
2	Address	255	0 to 65534, step 1
3	IP Addr Client1 Oct1	0	0 to 255 step 1
4	IP Addr Client1 Oct2	0	0 to 255 step 1
5	IP Addr Client1 Oct3	0	0 to 255 step 1
6	IP Addr Client1 Oct4	0	0 to 255 step 1
7	IP Addr Client2 Oct1	0	0 to 255 step 1
8	IP Addr Client2 Oct2	0	0 to 255 step 1
9	IP Addr Client2 Oct3	0	0 to 255 step 1
10	IP Addr Client2 Oct4	0	0 to 255 step 1
11	IP Addr Client3 Oct1	0	0 to 255 step 1
12	IP Addr Client3 Oct2	0	0 to 255 step 1
13	IP Addr Client3 Oct3	0	0 to 255 step 1
14	IP Addr Client3 Oct4	0	0 to 255 step 1
15	IP Addr Client4 Oct1	0	0 to 255 step 1
16	IP Addr Client4 Oct2	0	0 to 255 step 1
17	IP Addr Client4 Oct3	0	0 to 255 step 1
18	IP Addr Client4 Oct4	0	0 to 255 step 1
19	IP Addr Client5 Oct1	0	0 to 255 step 1
20	IP Addr Client5 Oct2	0	0 to 255 step 1
21	IP Addr Client5 Oct3	0	0 to 255 step 1
22	IP Addr Client5 Oct4	0	0 to 255 step 1
23	TCP/UDP Port	20000	1 to 65535, step 1
24	Unsol Resp Function	DISABLED	DISABLED, ENABLED
25	Unsol Resp TimeOut	5 s	0 to 60 sec, step 1
26	Unsol Resp Max Ret	10	1 to 255, step 1
27	Unsol Resp Dest Adr	200	0 to 65519, step 1
28	Current Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
29	Voltage Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
30	Power Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
31	Energy Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
32	Other Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
33	Current Deadband	30000	0 to 65535, step 1
34	Voltage Deadband	30000	0 to 65535, step 1

SETTING NO	SETTING NAME	DEFAULT VALUE	RANGE
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

1. **Physical Port:** The F650 supports the Distributed Network Protocol (DNP) version 3.0. The F650 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 F650.. 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 F650 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 F650 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 F650 waits for a DNP master to confirm an unsolicited response.
26. **Unsol Resp Max Ret:** This setting determines the number of times the F650 will retransmit an unsolicited response without receiving a confirmation from the master. Once this limit has been exceeded, the unsolicited response will continue to be sent at larger interval. This interval is called unsolicited offline interval and is fixed at 10 minutes.
27. **Unsol Resp Dest Adr:** This setting is DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the F650 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 F650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **Voltage Scale Factor** is set to a value of 1000, all DNP Analog Input points that are voltages will be returned with the values 1000 times smaller (e.g. a value 72000 V on the F650 will be returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in DNP masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times larger).
- 33-37. **Deadband:** These settings are the values used by the F650 to determine when to trigger unsolicited responses containing Analog Input data. These settings group the F650 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 F650 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 F650, the default deadbands will be in effect.

38. **Msg Fragment Size:** This setting determines the size, in bytes, at which message fragmentation occurs. Large fragment sizes allow for more efficient throughput; smaller fragment sizes cause more application layer confirmations to be necessary which can provide for more robust data transfer over noisy communication channels
- 39-48. **Binary Input Block x:** These settings allow customization and change of the size of DNP Binary Inputs point list. The default Binary Inputs point list contains 160 points representing binary states that are configured using “**Setpoint->Relay Configuration**” menu from the F650PC 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 F650 relay. If not all of the 160 points are required in the DNP master, a custom Binary Inputs point list can be created by selecting up to 10 blocks of 16 points. Each block represents 16 Binary Input points. Block 1 represents Binary Input points 0-15, block 2 represents Binary Input points 16- 31, block 3 represents Binary Input points 32-47, etc. The minimum number of Binary Input points that can be selected is 16 (1 block). If all of the **Binary Input Block x** settings are set to “NOT USED”, the default list of 160 points will be in effect. The F650 will form the Binary Inputs points list from the **Binary Input Block x** settings up to the first occurrence of a setting value “NOT USED”. Permitted values for these settings are: NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48, CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16.

## C.1.2 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.

## a) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 2 OF 3)

(Also see the IMPLEMENTATION TABLE in the following section)	
Vendor Name: <b>General Electric Multilin</b>	
Device Name: <b>F650 Relay</b>	
<b>Highest DNP Level Supported:</b> For Requests: <b>Level 2</b> For Responses: <b>Level 2</b>	<b>Device Function:</b> <input type="checkbox"/> Master <input checked="" type="checkbox"/> <b>Slave</b>
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): <b>Binary Inputs (Object 1)</b> <b>Binary Inputs Changes (Object 2)</b> <b>Binary Outputs (Object 10)</b> <b>Analog Inputs (Object 30)</b> <b>Analog Input Changes (Object 32)</b> <b>Analog Deadbands (Object 34)</b>	
<b>Maximum Data Link String Size (octets):</b> Transmitted: 292 Received: 292	<b>Maximum Application Fragment Size (octets):</b> Transmitted: Configurable up to 2048 Received: 2048
<b>Maximum Data Link Re-tries:</b> <input type="checkbox"/> None <input checked="" type="checkbox"/> <b>Fixed at 2</b> <input type="checkbox"/> Configurable	<b>Maximum Application Layer Re-tries:</b> <input checked="" type="checkbox"/> <b>None</b> <input type="checkbox"/> Configurable
<b>Requires Data Link Layer Confirmation:</b> <input checked="" type="checkbox"/> <b>Never</b> <input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Configurable	

## b) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 2 OF 3)

**Requires Application Layer Confirmation:**

- ☐ Never  
☐ Always  
☒ **When reporting Event Data**  
☒ **When sending multi-fragment responses**  
☐ Sometimes  
☐ Configurable

**Timeouts while waiting for:**

Data Link Confirm:	<input type="checkbox"/> None	<input checked="" type="checkbox"/> <b>Fixed at 3 s</b>	<input type="checkbox"/> Variable	<input type="checkbox"/> Configurable
Complete Appl. Fragment:	<input checked="" type="checkbox"/> <b>None</b>	<input type="checkbox"/> Fixed at	<input type="checkbox"/> Variable	<input type="checkbox"/> Configurable
Application Confirm:	<input type="checkbox"/> None	<input checked="" type="checkbox"/> <b>Fixed at 4 s</b>	<input type="checkbox"/> Variable	<input type="checkbox"/> Configurable
Complete Appl. Response	<input checked="" type="checkbox"/> <b>NoOne</b>	<input type="checkbox"/> Fixed at	<input type="checkbox"/> Variable	<input type="checkbox"/> Configurable

**Others:**

Transmission Delay:	<b>No intentional delay</b>
Need Time Delay:	<b>10 min.</b>
Select/Operate Arm Timeout:	<b>10 s</b>
Binary Input change scanning period:	<b>1 ms</b>
Packed binary change process period:	<b>1 s</b>
Analog Input change scanning period:	<b>500 ms</b>
Unsolicited response notification delay:	<b>500 ms</b>
Unsolicited response retry delay:	<b>Configurable 0 to 60 s</b>
Unsolicited offline interval:	<b>10 min.</b>

**Sends/Executes Control Operations:**

WRITE Binary Outputs	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
SELECT/OPERATE	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> <b>Always</b>	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
DIRECT OPERATE	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> <b>Always</b>	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
DIRECT OPERATE – NO ACK	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> <b>Always</b>	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Count > 1	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Pulse On	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> <b>Always</b>	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Pulse Off	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Latch On	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Latch Off	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Queue	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
Clear Queue	<input checked="" type="checkbox"/> <b>Never</b>	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable

## c) DNP V3.00 DEVICE PROFILE DOCUMENT (SHEET 3 OF 3)

Reports Binary Input Change Events when no specific variation requested: <input type="checkbox"/> Never <input checked="" type="checkbox"/> <b>Only time-tagged</b> <input type="checkbox"/> Only non-time-tagged <input type="checkbox"/> Configurable	Reports time-tagged Binary Input Change Events when no specific variation requested: <input type="checkbox"/> Never <input checked="" type="checkbox"/> <b>Binary Input Change With Time</b> <input type="checkbox"/> Binary Input Change With Relative Time <input type="checkbox"/> Configurable (attach explanation)
Sends Unsolicited Responses: <input type="checkbox"/> Never <input checked="" type="checkbox"/> <b>Configurable</b> <input type="checkbox"/> Only certain objects <input type="checkbox"/> Sometimes (attach explanation) <input checked="" type="checkbox"/> <b>ENABLE/DISABLE unsolicited Function codes supported</b>	Sends Static Data in Unsolicited Responses: <input checked="" type="checkbox"/> <b>Never</b> <input type="checkbox"/> When Device Restarts <input type="checkbox"/> When Status Flag Change No other options permitted
Default CounterObject/Variation: <input checked="" type="checkbox"/> <b>No Counters Reported</b> <input type="checkbox"/> Configurable (attach explanation) <input type="checkbox"/> Default Object: <input type="checkbox"/> Default Variation:	Counters Roll Over at: <input checked="" type="checkbox"/> <b>No Counters Reported</b> <input type="checkbox"/> Configurable (attach explanation) <input type="checkbox"/> 16 Bits <input type="checkbox"/> 32 Bits <input type="checkbox"/> Other Value: _____ <input type="checkbox"/> Point-by-point list attached
Sends Multi-Fragment Responses: <input checked="" type="checkbox"/> <b>Yes</b> <input type="checkbox"/> No	

## C.1.3 IMPLEMENTATION TABLE

The following table shows objects, variations, function codes and qualifiers supported by F650 units, both in requests and responses for DNP3 protocol. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07 or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Text in ***bold and italic*** indicates functionality higher than DNP3 implementation level 2.

## a) IMPLEMENTATION TABLE (SHEET 1 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) <b>22 (assign class)</b>	06 (no range, or all) <b>00,01 (start-stop)</b> <b>07,08 (limited qty)</b> <b>17,28 (index)</b>		
1	1	Binary Input	1 (read) <b>22 (assign class)</b>	<b>00,01 (start-stop)</b> <b>06 (no range, or all)</b> <b>07,08 (limited qty)</b> <b>17,28 (index)</b>	129 (response)	00, 01 (start-stop) <b>17,28 (index)</b> See Note 2
1	2	Binary Input with Status (default – see Note 1)	1 (read) <b>22 (assign class)</b>	<b>00,01 (start-stop)</b> <b>06 (no range, or all)</b> <b>07,08 (limited qty)</b> <b>17,28 (index)</b>	129 (response)	00, 01 (start-stop) <b>17,28 (index)</b> 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) <b>00,01 (start-stop)</b> <b>07,08 (limited qty)</b> <b>17,28 (index)</b>		
10	2	Binary Output Status See Note 1	<b>1 read</b>	<b>00,01 (start-stop)</b> <b>06 (no range, or all)</b> <b>07,08 (limited qty)</b> <b>17,28 (index)</b>	129 (response)	00, 01 (start-stop) <b>17,28 (index)</b> See Note 2
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir.op, noack)	<b>00,01 (start-stop)</b> <b>07,08 (limited qty)</b> 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter - All Variations	1 (select) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz.cl. noack)	06 (no range, or all)		

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.



## b) IMPLEMENTATION TABLE (SHEET 2 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
21	0	Frozen Counter - All Variations	1 (read)	06 (no range, or all)		
22	0	Counter Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
30	0	Analog Input - All Variations	1 (read) 22 (assign class)	06 (no range, or all) 00,01 (start-stop) 07,08 (limited qty) 17,28 (index)		
30	1	32-Bit Analog Input See Note 1	1 (read) 22 (assign class)	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	2	16-Bit Analog Input	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	3	32-Bit Analog Input without Flag	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	4	16-Bit Analog Input without Flag	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
32	0	Analog Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
32	1	32-Bit Analog Change Event without Time See Note 1	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)		
34	0	Analog Input Reporting Deadband	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
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)		

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.

## c) IMPLEMENTATION TABLE (SHEET 3 OUT OF 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
34	2	32-Bit Analog Input Reporting Deadband See Note 1	2 (write)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)		
50	0	Time and Date - All Variations	1 (read)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00,01 (start-stop) 17,28 (index) See Note 2
50	1	Time and Date See Note 1	1 (read) 2 (write)	00,01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited qty) 17,28 (index)	129 (response)	00,01 (start-stop) 17,28 (index) See Note 2
52	2	Time Delay Fine	1 (read) 2 (write)		129 (response)	07 (limited qty) quantity=1
60	0	Class 0, 1, 2, and 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all)		
60	1	Class 0 Data		06 (no range, or all)		
60	2	Class 1 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
60	3	Class 2 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
60	4	Class 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
		No Object (function code only) See Note 3	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.

## C.1.4 BINARY INPUT POINTS

The F650 relay has a configurable Map of DNP Binary Input points. This map can be formed by up to 10 blocks of 16 binary states that are configured using “*Setpoint->Relay Configuration*” menu from the F650PC 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 F650 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 1 Contact A, DNP Binary Input point 1 = Switchgear 1 Contact B, DNP Binary Input point 2 = Switchgear 2 Contact A, etc.

To each *Control Event* or *Switchgear Contact*, the user can assign any of the binary states of the F650 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 will have a zero value in the response.

Using the PLC-Editor, through the F650PC program, selecting menu: *Setpoint->Logic Configuration*, it will be possible to implement complex logic, more than simple OR and NOT previous functions. To perform this, in the menu: *Setpoint->Relay Configuration->Control Events* assign a Virtual Output to selected point, after that, implement wished logic with the PLC-Editor.

**BINARY INPUT POINTS**

Static (Steady-State) Object Number: 1

Change Event Object Number: 2

Request Function Codes supported: **1 (read), 22 (assign class)**

Static Variation Reported when variation 0 requested: **2 (Binary Input Change with status)**

Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**

Default Class for all points: 1

**DEFAULT BINARY INPUT POINTS MAP**

POINT INDEX	NAME/DESCRIPTION
0-127	Control Events 1-128
128	Switchgear 1 Contact A
129	Switchgear 1 Contact B
130	Switchgear 2 Contact A
131	Switchgear 2 Contact B
132	Switchgear 3 Contact A
133	Switchgear 3 Contact B
134	Switchgear 4 Contact A
135	Switchgear 4 Contact B
136	Switchgear 5 Contact A
137	Switchgear 5 Contact B
138	Switchgear 6 Contact A
139	Switchgear 6 Contact B
140	Switchgear 7 Contact A
141	Switchgear 7 Contact B
142	Switchgear 8 Contact A

143	Switchgear 8 Contact B
144	Switchgear 9 Contact A
145	Switchgear 9 Contact B
146	Switchgear 10 Contact A
147	Switchgear 10 Contact B
148	Switchgear 11 Contact A
149	Switchgear 11 Contact B
150	Switchgear 12 Contact A
151	Switchgear 12 Contact B
152	Switchgear 13 Contact A
153	Switchgear 13 Contact B
154	Switchgear 14 Contact A
155	Switchgear 14 Contact B
156	Switchgear 15 Contact A
157	Switchgear 15 Contact B
158	Switchgear 16 Contact A
159	Switchgear 16 Contact B

## C.1.5 DNP CONFIGURATION EXAMPLES

## C.1.5.1 CONFIGURING DNP USER MAP

Imagine that a user wants to configure DNP Binary Inputs Map with 8 Contact Inputs, 8 Protection states, 8 Contact Outputs and 2 Switchgears. This configuration can be done in two steps. In first step the user selects “Setpoint->Relay Configuration” from the F650PC program and then configures *Control Events* bits and *Switchgear* bits. It is shown in figures 9.1 and 9.2. In the second step the user selects “Setpoint->System Setup->Communication settings->DNP” in order to change DNP Binary Input Block settings. The user set values of the first three Binary Input blocks, Binary Input Block1 = CTL EVENTS 1-16, Binary Input Block2 = CTL EVENTS 17-32, Binary Input Block3 = SWITCHGEAR 1-8. It is shown in Configuration of Control Events bits

Relay configuration						
Outputs   Leds   Operations   Protection elements   Oscillography   Control Events   Switchgear   Inputs   Virtual Inputs   MMI						
SELECT	NAME	SOURCE	OR	NOT	ALARM	
<input checked="" type="checkbox"/> EV1	CONTROL EVENT 1	CONT IP_F_CC1(CC1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV2	CONTROL EVENT 2	CONT IP_F_CC2(CC2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV3	CONTROL EVENT 3	CONT IP_F_CC3(CC3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV4	CONTROL EVENT 4	CONT IP_F_CC4(CC4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV5	CONTROL EVENT 5	CONT IP_F_CC5(CC5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV6	CONTROL EVENT 6	CONT IP_F_CC6(CC6)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV7	CONTROL EVENT 7	CONT IP_F_CC7(CC7)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV8	CONTROL EVENT 8	CONT IP_F_CC8(CC8)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV9	CONTROL EVENT 9	PH IOC1 HIGH A PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV10	CONTROL EVENT 10	PH IOC1 HIGH B PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV11	CONTROL EVENT 11	PH IOC1 HIGH C PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV12	CONTROL EVENT 12	PH IOC1 LOW A PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV13	CONTROL EVENT 13	PH IOC1 LOW B PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV14	CONTROL EVENT 14	PH IOC1 LOW C PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV15	CONTROL EVENT 15	GROUND IOC1 PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV16	CONTROL EVENT 16	NEUTRAL IOC1 PKP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV17	CONTROL EVENT 17	CONT OP_F_01	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV18	CONTROL EVENT 18	CONT OP_F_02	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV19	CONTROL EVENT 19	CONT OP_F_03	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV20	CONTROL EVENT 20	CONT OP_F_04	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV21	CONTROL EVENT 21	CONT OP_F_05	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV22	CONTROL EVENT 22	CONT OP_F_06	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV23	CONTROL EVENT 23	CONT OP_F_07	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/> EV24	CONTROL EVENT 24	CONT OP_F_08	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/> EV25		None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/> EV26		None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure C-1: CONFIGURATION OF CONTROL EVENTS BITS

Relay configuration							
Outputs   Leds   Operations   Protection elements   Oscillography   Control Events   Switchgear   Inputs   Virtual Inputs   MMI							
SELECT	Contacts	Opening time(ms)	Closing time(ms)	Contact A	OR	NOT	Contact B
<input checked="" type="checkbox"/> Switchgear 1	52a + 52b	1000	1000	CONT IP_F_CC13(CC13)	<input type="checkbox"/>	<input type="checkbox"/>	CONT IP_F_CC14(CC14)
<input checked="" type="checkbox"/> Switchgear 2	52a + 52b	1000	1000	CONT IP_F_CC15(CC15)	<input type="checkbox"/>	<input type="checkbox"/>	CONT IP_F_CC16(CC16)
<input type="checkbox"/> Switchgear 3	NONE	1000	1000	None	<input type="checkbox"/>	<input type="checkbox"/>	None
<input type="checkbox"/> Switchgear 4	NONE	1000	1000	None	<input type="checkbox"/>	<input type="checkbox"/>	None
<input type="checkbox"/> Switchgear 5	NONE	1000	1000	None	<input type="checkbox"/>	<input type="checkbox"/>	None
<input type="checkbox"/> Switchgear 6	NONE	1000	1000	None	<input type="checkbox"/>	<input type="checkbox"/>	None

Figure C-2: CONFIGURATION OF SWITCHGEAR

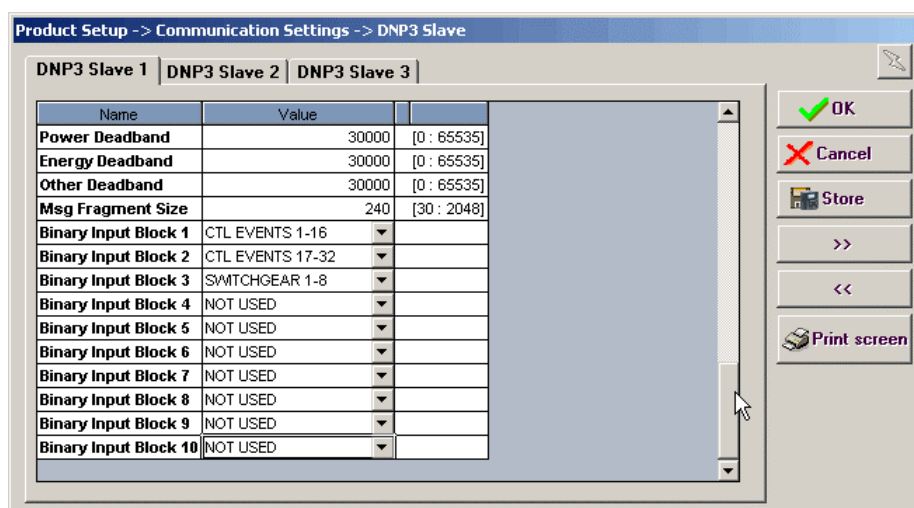


Figure C-3: CONFIGURATION OF DNP BINARY INPUT BLOCKS

In the example presented in this chapter the F650 relay has 48 Binary Input points, as shown in the table below.

## C

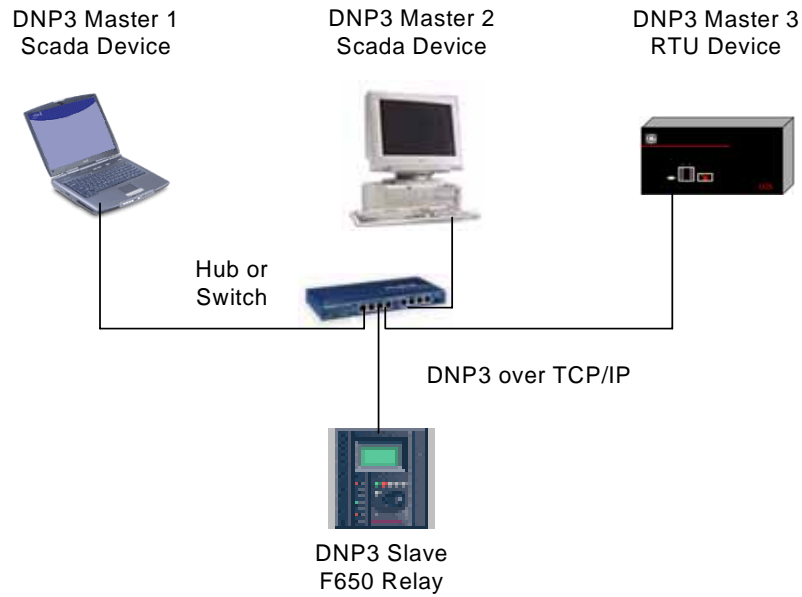
## C.1.5.2 EXAMPLE OF CUSTOM BINARY INPUT POINTS MAP

POINT INDEX	NAME/DESCRIPTION
0	CONT_IP_F_CC1(CC1)
1	CONT_IP_F_CC2(CC2)
2	CONT_IP_F_CC3(CC3)
3	CONT_IP_F_CC4(CC4)
4	CONT_IP_F_CC5(CC5)
5	CONT_IP_F_CC6(CC6)
6	CONT_IP_F_CC7(CC7)
7	CONT_IP_F_CC8(CC8)
8	PH IOC1 HIGH A PKP
9	PH IOC1 HIGH B PKP
10	PH IOC1 HIGH C PKP
11	PH IOC1 LOW A PKP
12	PH IOC1 LOW B PKP
13	PH IOC1 LOW C PKP
14	GROUND IOC1 PKP
15	NEUTRAL IOC1 PKP
16	CONT OP_F_01
17	CONT OP_F_02
18	CONT OP_F_03
19	CONT OP_F_04
20	CONT OP_F_05
21	CONT OP_F_06
22	CONT OP_F_07
23	CONT OP_F_08

24	Not Configured
25	Not Configured
26	Not Configured
27	Not Configured
28	Not Configured
29	Not Configured
30	Not Configured
31	Not Configured
32	CONT_IP_F_CC13 (CC13)
33	CONT_IP_F_CC14(CC14)
34	CONT_IP_F_CC15(CC15)
35	CONT_IP_F_CC16(CC16)
36	Not Configured
37	Not Configured
38	Not Configured
39	Not Configured
40	Not Configured
41	Not Configured
42	Not Configured
43	Not Configured
44	Not Configured
45	Not Configured
46	Not Configured
47	Not Configured

**C.1.5.3 MULTIPLE DNP 3.0 MASTERS COMMUNICATION WITH F650**

Typical architecture of multi-master communication using DNP 3.0.



**Figure C-4: MULTIPLE DNP3.0 MASTERS COMMUNICATING WITH F650**



DNP 3.0 Slave – F650	DNP 3.0 Master 1	DNP 3.0 Master 2	DNP 3.0 Master 3
<b>Ethernet Config</b> IP Addr: 192.168.37.20 Netmask: 255.255.255.0	<b>Ethernet Config</b> IP Addr: 192.168.37.1 Netmask: 255.255.255.0	<b>Ethernet Config</b> IP Addr: 192.168.37.2 Netmask: 255.255.255.0	<b>Ethernet Config</b> IP Addr: 192.168.37.3 Netmask: 255.255.255.0
<b>DNP 3.0 slave 1</b> Physical Port: Network Address: 255 IP Addr Cli1: 192.168.37.1 TCP/UDP Port : 20000 Unsol Dest Addr: 200	<b>DNP3 over TCP/IP</b> DNP Addr: 200 DNP Dest Addr: 255 IP Dest: 192.168.37.20 TCP Dest Port: 20000	<b>DNP3 over TCP/IP</b> DNP Addr: 201 DNP Dest Addr: 256 IP Dest : 192.168.37.20 TCP Dest Port: 20001	<b>DNP3 over TCP/IP</b> DNP Addr: 202 DNP Dest Addr: 257 IP Dest: 192.168.37.20 TCP Dest Port: 20002
<b>DNP 3.0 slave 2</b> Physical Port: Network Address: 256 IP Addr Cli1: 192.168.37.2 TCP/UDP Port : 20001 Unsol Dest Addr: 201			
<b>DNP 3.0 slave 3</b> 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 F650**

## C.1.6 BINARY OUTPUT AND CONTROL RELAY OUTPUT

Supported Control Relay Output Block fields: Pulse On.

The F650 relay provides 24 DNP Binary/Control Output points. These outputs are mapped to the first 24 commands configured in the F650. Executing a command is equal to activate the PLC equation that was attached to this command. Thus all of the 24 DNP Binary/Control Output points are pulsed points. It means that only Pulse On flag will be accepted in DNP control operations on those points. All commands have configurable names. Changing the command's name can be done using the F650PC 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

OPERATION\_00

OPERATION\_00

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
12	OPERATION13
13	OPERATION14
14	OPERATION15
15	OPERATION16
16	OPERATION17
17	OPERATION18
18	OPERATION19
19	OPERATION20
20	OPERATION21
21	OPERATION22
22	OPERATION23
23	OPERATION24



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**C.1.7 BINARY COUNTERS**

Currently there are no Binary Counters in the F650 relay. Nevertheless F650 accepts requests of DNP objects 20 (Binary Counters), 21 (Frozen Counters) and 22 (Counter Change Events). Function codes “Immediate Freeze”, “Freeze and Clear” etc. are accepted and F650 will respond with no objects and the IIN2-1 (Object Unknown) flag set. This behavior is in conformance with DNP Level 2 Implementation (Document 28528: Level 2 DNP 3.00 Implementation).

## C.1.8 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	Apparent Power:	MVA
Voltage:	kV	Energy:	MWh, Mvarh
Real Power:	MW	Frequency:	Hz
Reactive Power:	Mvar	Angle:	degrees

## a) ANALOG INPUT POINTS

POINT INDEX	NAME/DESCRIPTION
0	Phasor Ia Primary
1	Phasor Ib Primary
2	Phasor Ic Primary
3	Phasor Ig Primary
4	Phasor Isg Primary
5	Phasor In Primary
6	RMS Ia Primary
7	RMS Ib Primary
8	RMS Ic Primary
9	RMS Ig Primary
10	RMS Isg Primary
11	I0 Primary
12	I1 Primary
13	I2 Primary
14	V0 Primary
15	V1 Primary
16	V2 Primary
17	Vab Primary
18	Vbc Primary
19	Vca Primary
20	Vn Primary
21	Va Primary
22	Vb Primary
23	Vc Primary
24	VL Primary
25	VBB Primary
26	Phase A Reactive Pwr

POINT INDEX	NAME/DESCRIPTION
27	Phase A Apparent Pwr
28	Phase A Real Pwr
29	Phase B Reactive Pwr
30	Phase B Apparent Pwr
31	Phase B Real Pwr
32	Phase C Reactive Pwr
33	Phase C Apparent Pwr
34	Phase C Real Pwr
35	3 Phase Reactive Pwr
36	3 Phase Apparent Pwr
37	3 Phase Real Pwr
38	Phase A Power Factor
39	Phase B Power Factor
40	Phase C Power Factor
41	3 Phase Power Factor
42	Line Frequency Primary
43	Bus Frequency Primary
44	Vx Primary
45	Positive MVarhour
46	Negative MVarhour
47	Positive MWatthour
48	Negative MWatthour
49	Pos MVarhour Cnt
50	Neg MVarhour Cnt
51	Pos MWatthour Cnt
52	Neg MWatthour Cnt

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**D.1.1 INTRODUCTION**

The F650 is an IEC server. Answers to clients request or can send spontaneous Transmission. F650 implementation of 60870-5-104 provides analog meterings and states.

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**D.1.2 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 consist on 3 parts. (2 of them are not always present):

Link data + [ASDU header+ [ASDU data]]

The data between brackets can be omitted

In IEC104 communication is made by TCP/IP protocols. Actually, it is a TCP communication. The default port is the 2404. The F650 is listening as a server. Only one client is attended at time.

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D.1.3 BASIC APPLICATION FUNCTIONS

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**Cyclic data transmission**

- 2 ASDU for measured values
- 2 ASDU for single point information (64 states in each ASDU).
- 1 ASDU for Double point information (16 states for Switchgear).

**Spontaneous Transmission:**

- 2 ASDU for measured values (timing is set in Cyclic Meter Period, 0 means no spontaneous transmission).
- 1 ASDU for single point information in the time the event is produced (128 points in user map).
- 1 ASDU for Double point information in the time the event is produced (16 Switchgear information).

**Clock synchronization:****Command transmission:****Acquisition of transmission delay:**

## D.1.4 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		[0 : 3600]
Synchronization Event	0		[0 : 3600]

Function:	Enable or disable the protocol operation.
TCP Port:	Listening TCP port in the relay. Default value is 2404.
Common Addr of ASDU:	Address in the ASDU header. Default value is 255.
Cyclic Meter Period:	Number of seconds for instantaneous meterings. 0 means no spontaneous meterings.
Synchronization event:	Not implemented.

The F650 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 **Settings>Relay Configuration->Control Events**. The User Map contains 128 Binary Inputs. To each point of the User Map, the user can assign any of the binary states of the F650 relay, also is possible to combine those states using OR and NOT functions. These states are: contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. The User Map always has a size of 128 Binary Inputs. Points in the User Map that are not configured will have a zero value in the answer.

It is possible to implement more complex logic than simple OR and NOT using the **PLC Editor** tool in **EnerVista 650 Setup** in the menu **Settings>Logic Configuration**. These complex signals (Virtual Outputs) can be assigned to the binary points in the Control Events configuration for the IEC 104 user map.

## a) SELECTION OF STANDARD ASDUS:

**Process information in monitor direction**

&lt;1&gt; Single-point information M\_SP\_NA\_1

&lt;2&gt; Double-point information M\_DP\_NA\_1

&lt;3&gt; Measured value, short floating point value M\_ME\_NC\_1

**Process information in control direction**

&lt;46&gt; Single command C\_SC\_NA\_1

**System information in control direction**

&lt;106&gt; Reset process command C\_RP\_NA\_1

The F650 relay has a custom Binary Inputs points list, called **User Map**; it is common for any protocol. In the case of IEC 104 Protocol, those points are GROUP1 and GROUP2.

GROUP 1 STATUS	
POINT	DESCRIPTION
M_SP_NA_1 Points	
1000-1063	CONTROL EVENTS

GROUP 2 STATUS	
POINT	DESCRIPTION
M_SP_NA_1 Points	
1064-1127	CONTROL EVENTS

GROUP 3 STATUS	
POINT	DESCRIPTION
M_DP_NA_1 Points	
1500-1515	SWITCHGEAR EVENTS



GROUP 5 METERING	
POINT	DESCRIPTION
M_ME_NC_1 Points	
2000	Phasor Ia Primary
2001	Phasor Ib Primary
2002	Phasor Ic Primary
2003	Phasor Ig Primary
2004	Phasor Isg Primary
2005	Phasor In Primary
2006	RMS Ia Primary
2007	RMS Ib Primary
2008	RMS Ic Primary
2009	RMS Ig Primary
2010	RMS Isg Primary
2011	I0 Primary
2012	I1 Primary
2013	I2 Primary
2014	V0 Primary
2015	V1 Primary
2016	V2 Primary
2017	Vab Primary
2018	Vbc Primary
2019	Vca Primary
2020	Vn Primary
2021	Va Primary
2022	Vb Primary
2023	Vc Primary
2024	VL Primary
2025	VBB Primary
2026	Phase A Reactive Pwr

GROUP 6 METERING	
POINT	DESCRIPTION
M_ME_NC_1 Points	
2027	Phase A Apparent Pwr
2028	Phase A Real Pwr
2029	Phase B Reactive Pwr
2030	Phase B Apparent Pwr
2031	Phase B Real Pwr
2032	Phase C Reactive Pwr
2033	Phase C Apparent Pwr
2034	Phase C Real Pwr
2035	3 Phase Reactive Pwr
2036	3 Phase Apparent Pwr
2037	3 Phase Real Pwr
2038	Phase A Power Factor
2039	Phase B Power Factor
2040	Phase C Power Factor
2041	3 Phase Power Factor
2042	Line Frequency Primary
2043	Bus Frequency Primary
2044	Vx Primary
2045	Positive MVarhour
2046	Negative MVarhour
2047	Positive MWatthour
2048	Negative MWatthour

D

#### b) OPERATIONS IN IEC 60870-5-104 FOR F650

There are 24 available operation in F650 device, they must be configured using EnerVista 650 Setup in the menu “**Setting > Relay Configuration > Operations**”.

ASDU address must start with 3000, the addresses for operation are from 3000 to 3011. The operations go from 0 to 23. Subtracting 3000 we obtain a number between 0 and 11, this number is multiplied by two, and plus 1 if the operation is ON.

The date in the answer is the same as the received in the command.

The following ASDUS are answered to:

<45> Single command C\_SC\_NA\_1

<46> Double command C\_DC\_NA\_1

<58> Single command with time tag CP56Time2a C\_SC\_TA\_1

<59> Double command with time tag CP56Time2a C\_DC\_TA\_1

**Table D-1: OPERATIONS:**

OPERATIONS	
POINT	DESCRIPTION
C_SC_NA_1	
3000 – 3011	Command OFF
3000 – 3011	Command ON

**Table D-2: CLOCK SYNCHRONIZATION:**

CLOCK SYNCHRONIZATION	
POINT	DESCRIPTION
C_SC_NA_1	
0	Set Date

The date in the answer is the same as the received in the command.  
The relay date is synchronized after performing this command.

**Table D-3: RESET OF PROCESS**

RESET OF PROCESS	
POINT	DESCRIPTION
C_RP_NA_1	
0	Reset of Process

QRP\_RESET\_GRAL: General reset of process.

**Table D-4: ACQUISITION OF TRANSMISSION DELAY:**

DELAY ADQUISITION	
POINT	DESCRIPTION
C_CS_NA_1	
0	Delay Acquisition

The date in the answer is the same as the received in the command.

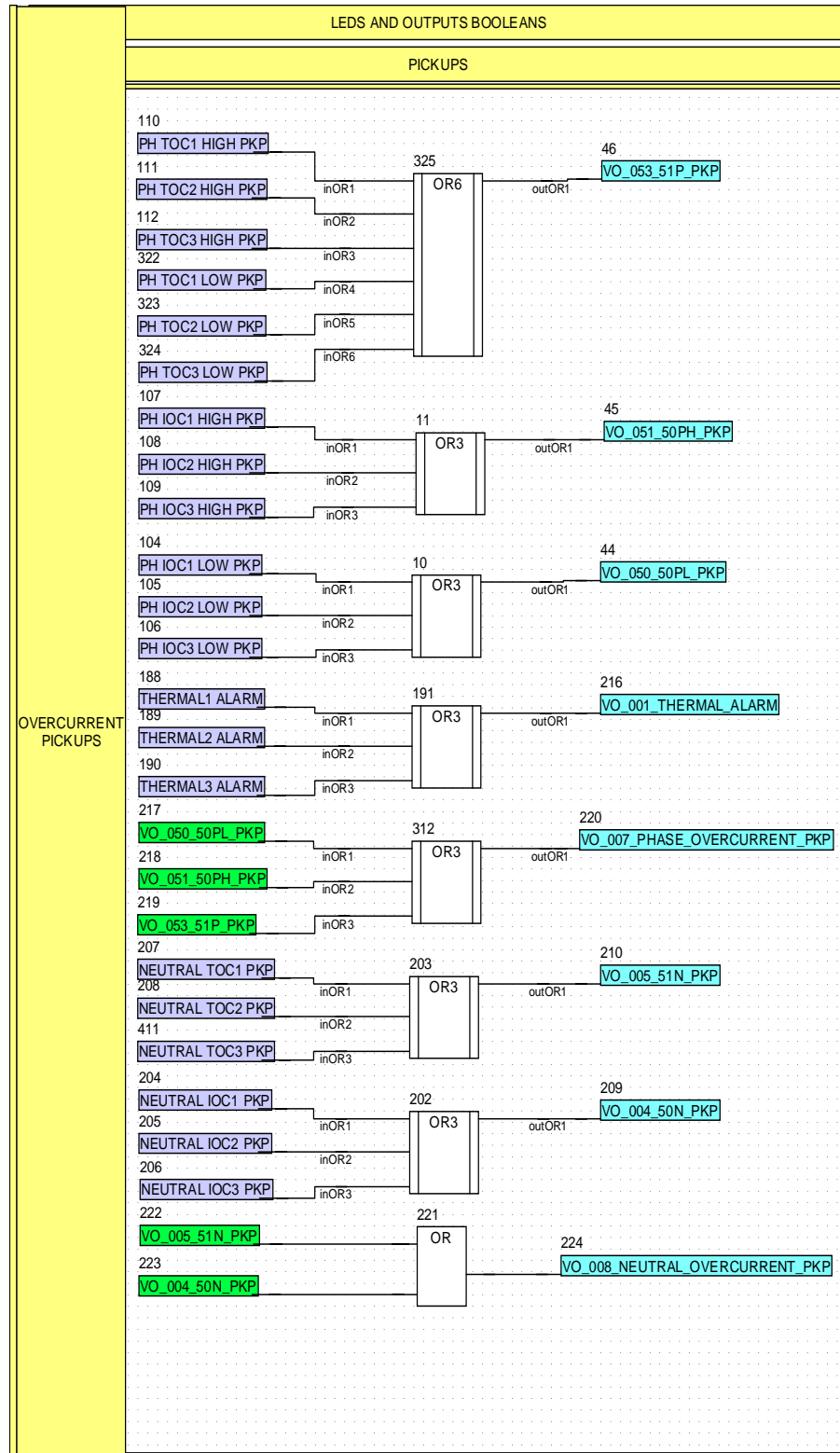


## E.1.1 FACTORY DEFAULT SETTINGS

GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

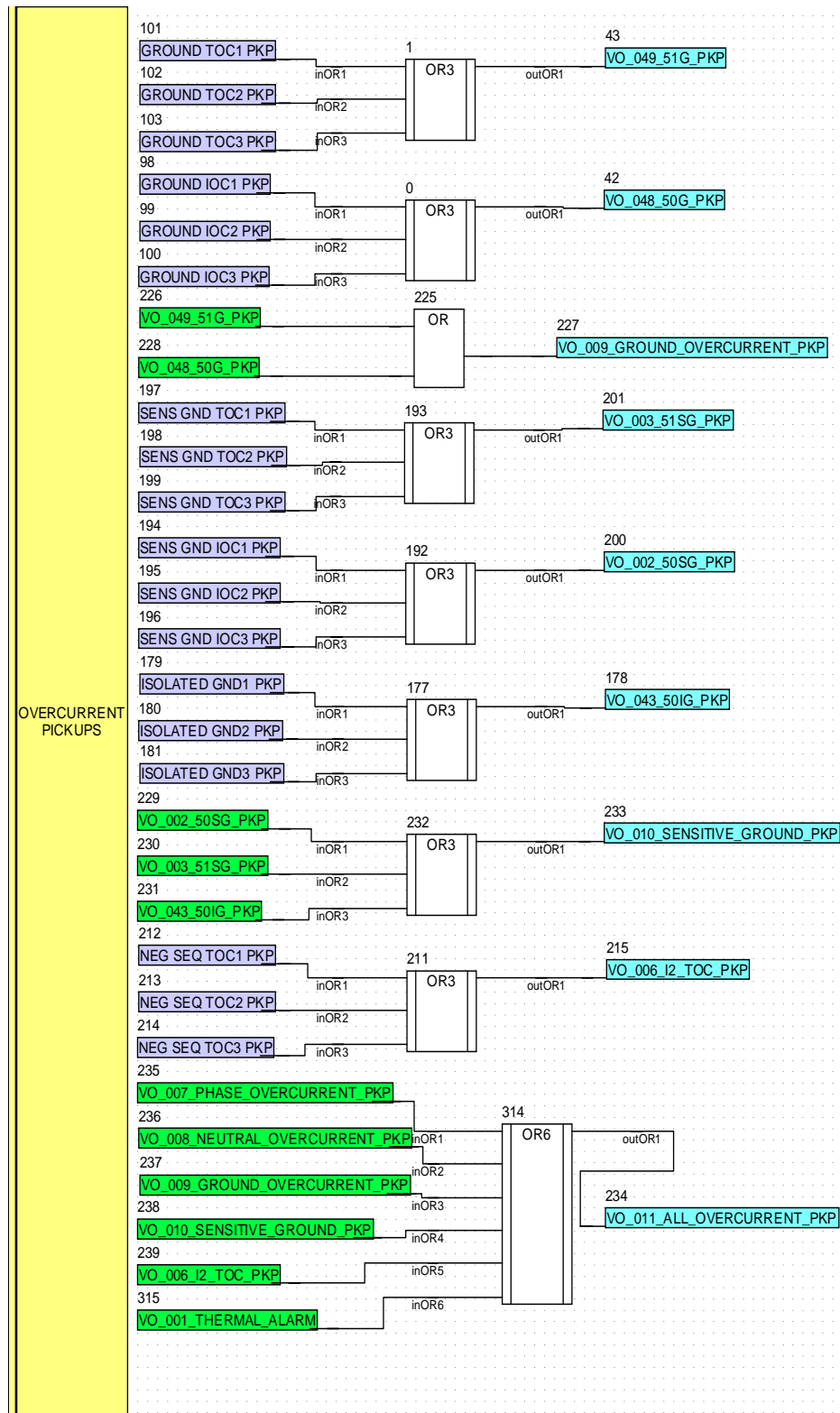
EnerVista F650 Setup



GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

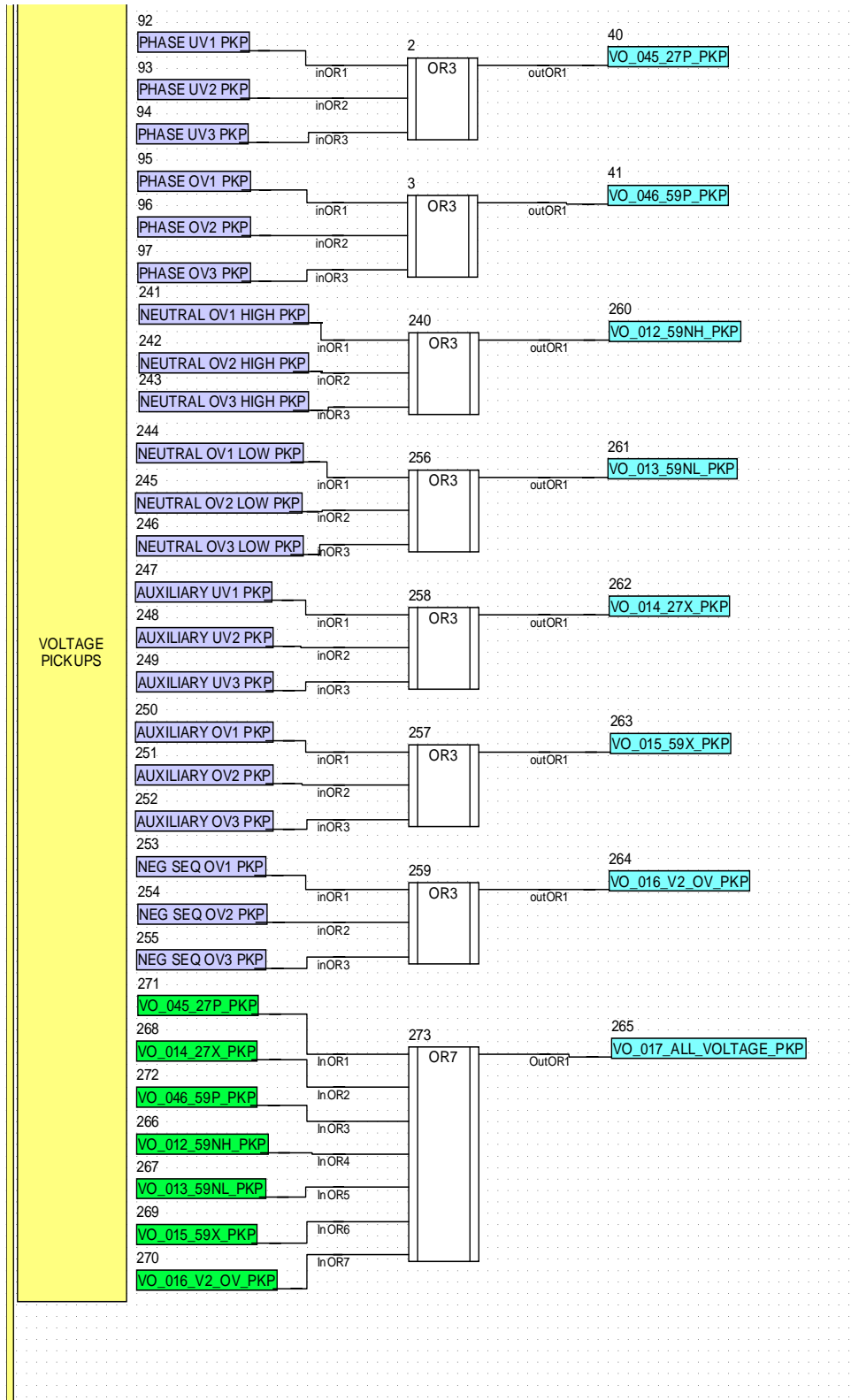
EnerVista F650 Setup



GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

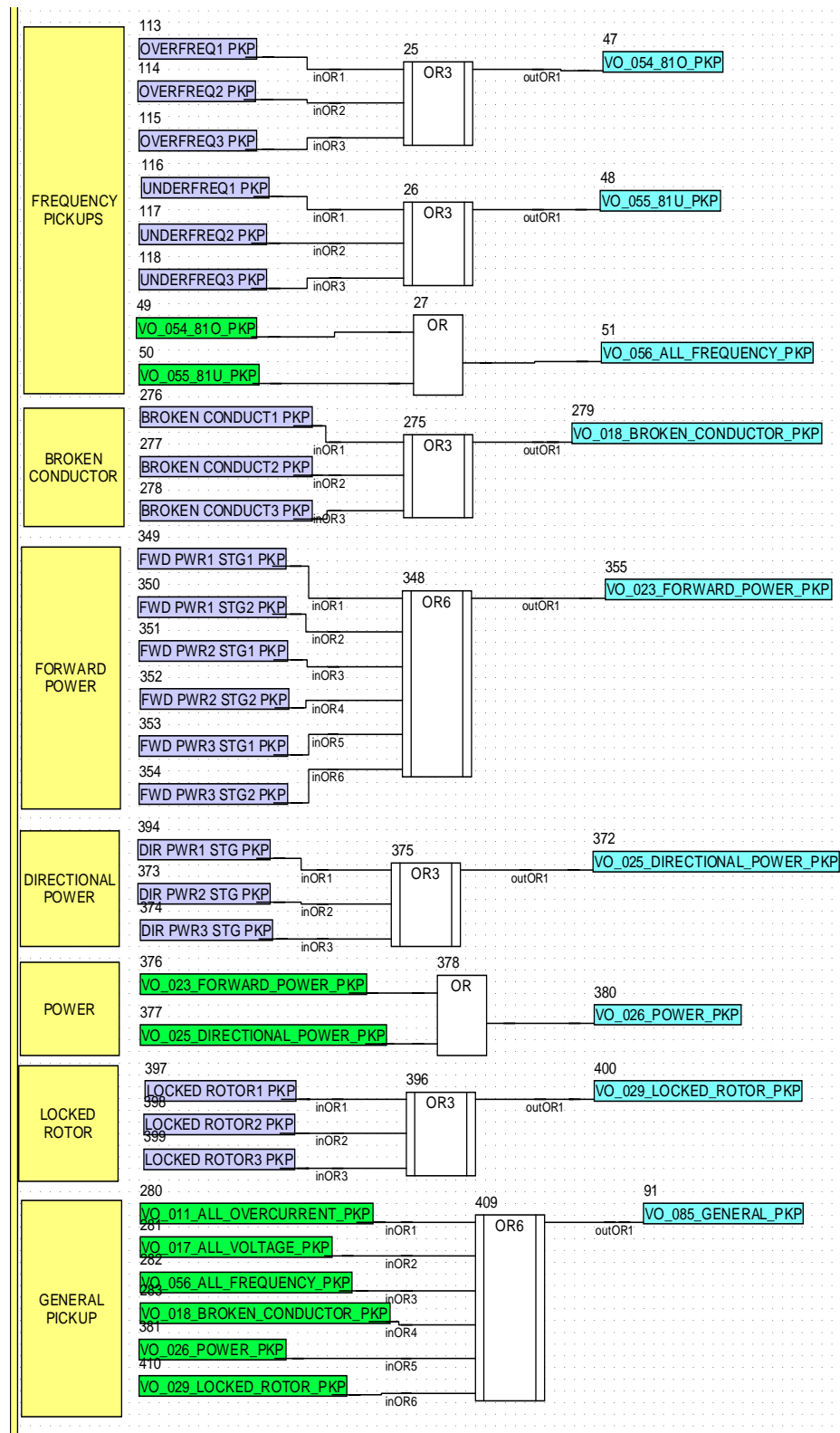
EnerVista F650 Setup



GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

EnerVista F650 Setup

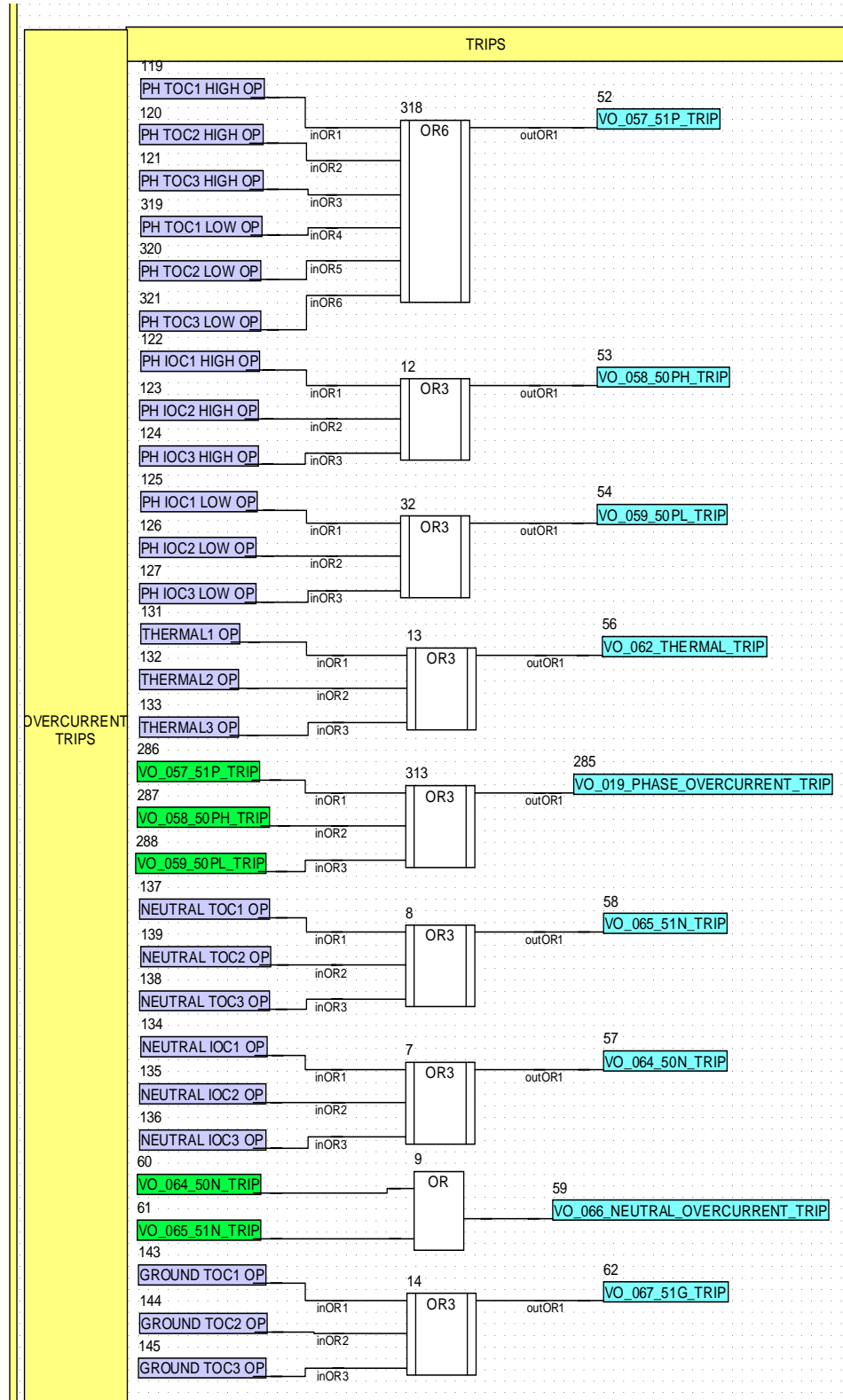


E

GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

EnerVista F650 Setup

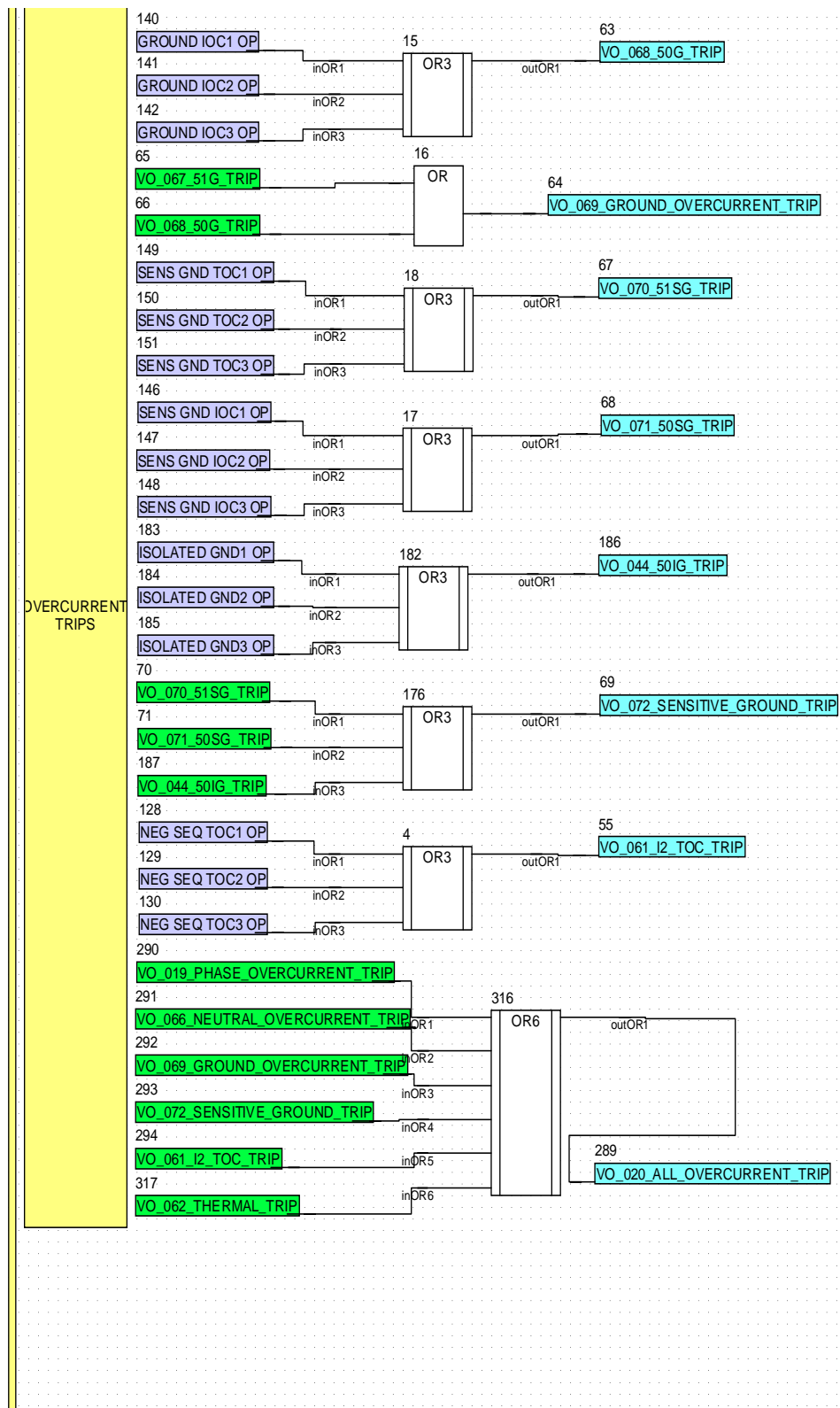




GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

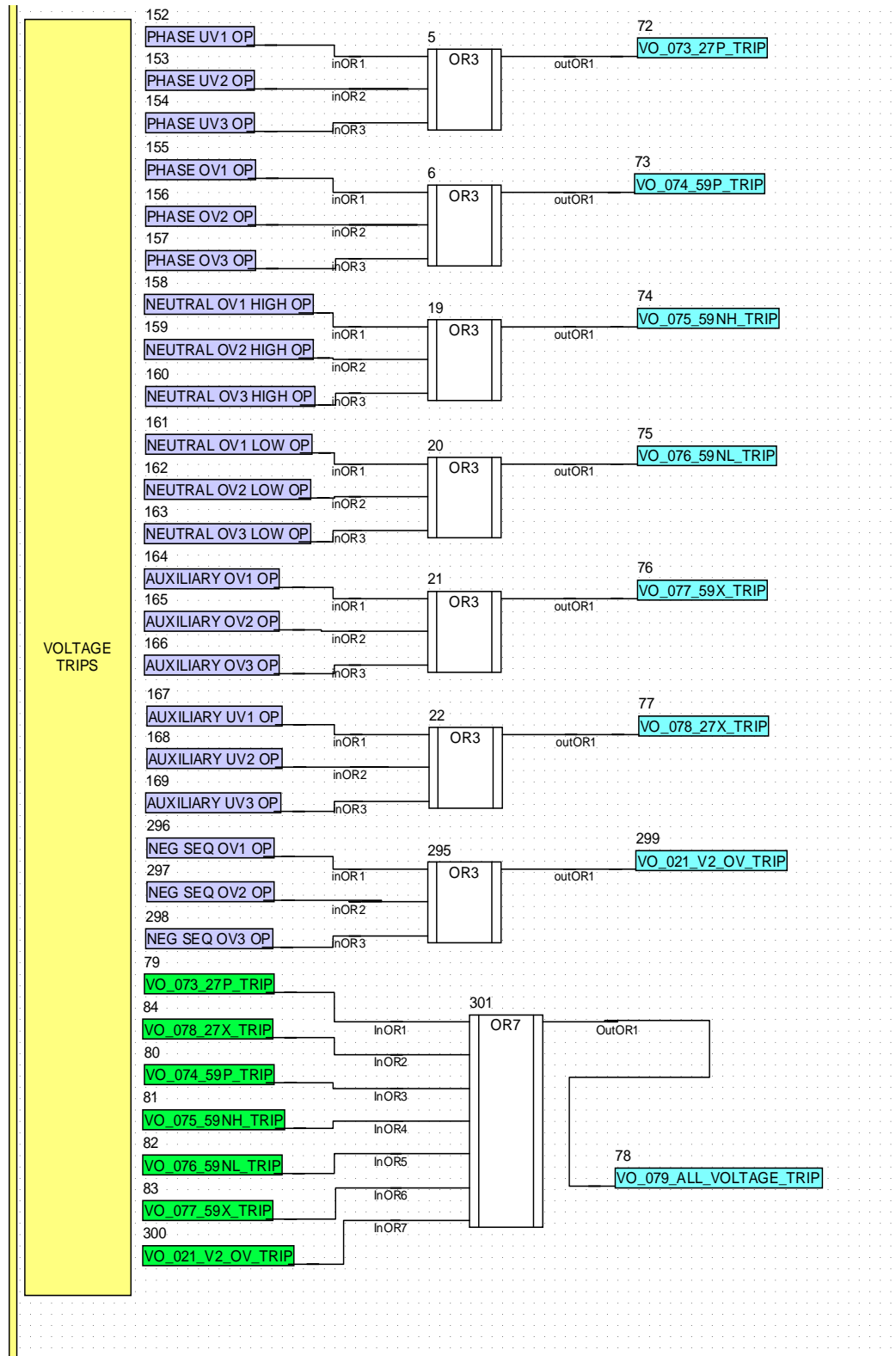
EnerVista F650 Setup



GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

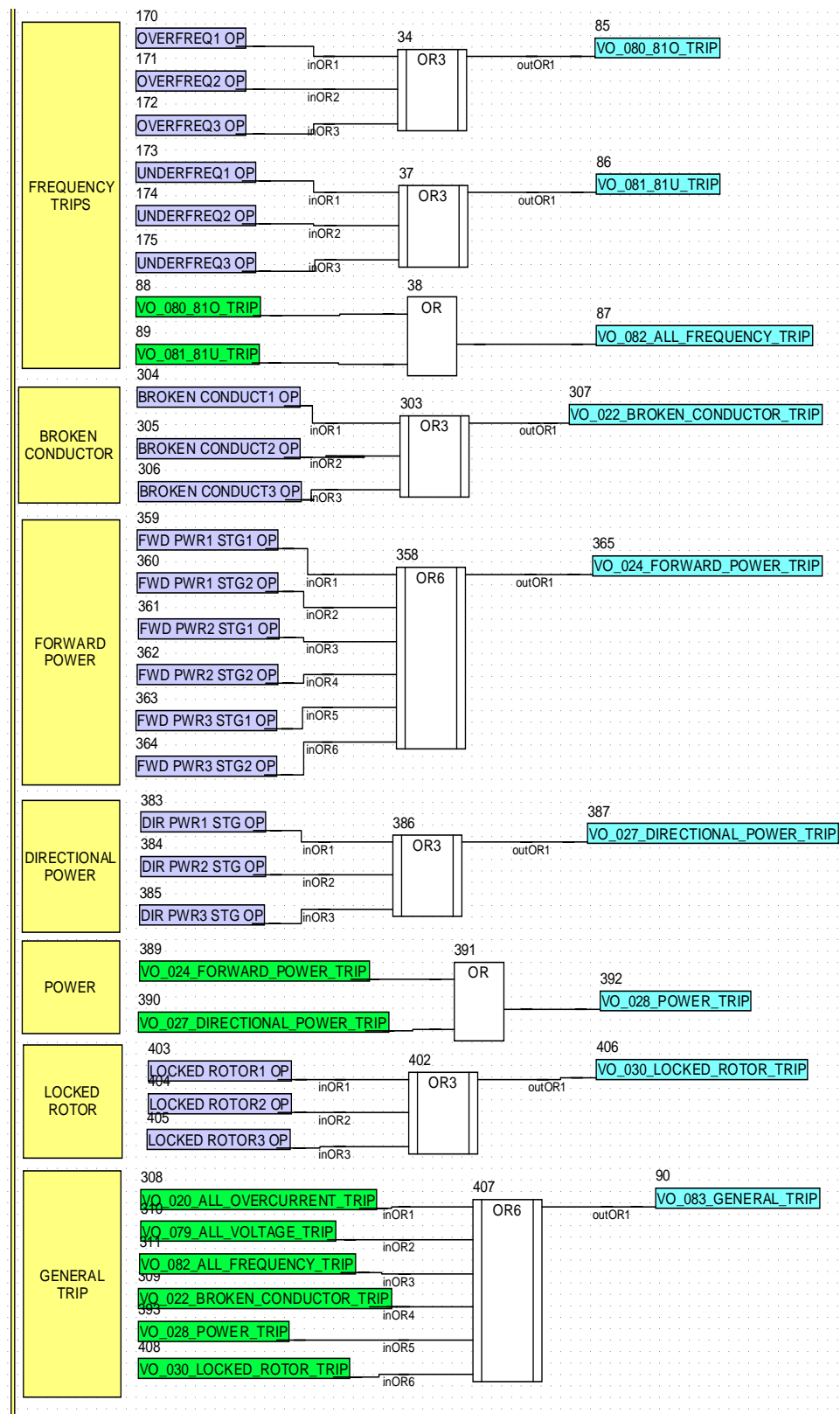
EnerVista F650 Setup



GE Power Management

F650\_F2G1\_1\_V180.aut (MAIN)

EnerVista F650 Setup



E

## F.1.1 FACTORY DEFAULT SETTINGS

PRODUCT SETUP>COMMUNICATION SETTINGS >SERIAL PORTS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Baud rate for COM 1	COM1 Baud Rate	19200	N/A	[300 : 115200]	
Baud rate for COM 2	COM2 Baud Rate	19200	N/A	[300 : 115200]	
Parity for serial COM ports	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]	

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 retransmission of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE (CONT.)					
DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	

DNP NOTES	
Note 1: Scale Factor	Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times
Note 2: Binary Input Block Selection:	[NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48, CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16]

PRODUCT SETUP>COMMUNICATION SETTINGS >IEC 870-5-104					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Enable or disable the protocol operation	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Listening TCP port in the relay	TCP Port	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU	255	N/A	[0 : 65535]	
Number of seconds for instantaneous meterings	Cyclic Meter Period	0	1 s	[0 : 3600]	
Not implemented	Synchronization Event	0	N/A	[0 : 3600]	

IEC 870-5-104 NOTES	
Note 1: Cyclic Meter Period	0 value means no spontaneous meterings

SETPOINT > PRODUCT SETUP > FAULT REPORT					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]	
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]	
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]	
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]	
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]	
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

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		

SETPOINT > PRODUCT SETUP > DEMAND					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	



**SETPOINT > SYSTEM SETUP > GENERAL SETTINGS**

SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]	
Rated Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	
Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	

**SETPOINT > SYSTEM SETUP > FLEX CURVES****FLEX CURVES A > FLEX CURVES B> FLEX CURVES C > FLEX CURVES D**

SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
...	...	...	0.001 s	[0.000 : 65.535]	
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
...	...	...	0.001 s	[0.000 : 65.535]	
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETTINGS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]	
Maximum value of KI2t	Maximum KI2t	9999.99	0.01 (KA) <sup>2</sup> 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) <sup>2</sup> s	[0.00 : 9999.99]	
KI2t Counter Phase B	KI2t BKR Ph B Cnt	0.00	0.01 (KA) <sup>2</sup> s	[0.00 : 9999.99]	
KI2t Counter Phase C	KI2t BKR Ph C Cnt	0.00	0.01 (KA) <sup>2</sup> s	[0.00 : 9999.99]	
Openings counter	BKR Openings Cnt	0	1	[0 : 9999]	
Closings counter	BKR Closings Cnt	0	1	[0 : 9999]	

SETPOINT > SYSTEM SETUP > SWITCHGEAR					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE TOC HIGH > PHASE TOC HIGH 1> PHASE TOC HIGH 2 > PHASE TOC HIGH 3					
> PHASE TOC LOW > PHASE TOC LOW 1 > PHASE TOC LOW 2 > PHASE TOC LOW 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE IOC HIGH > PHASE IOC HIGH 1> PHASE IOC HIGH 2 > PHASE IOC HIGH 3					
> PHASE IOC LOW > PHASE IOC LOW 1 > PHASE IOC LOW 2 > PHASE IOC LOW 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[Phasor – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > PHASE DIRECTIONAL >					
PHASE DIRECTIONAL 1> PHASE DIRECTIONAL 2 > PHASE DIRECTIONAL 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > THERMAL MODEL >					
THERMAL MODEL 1> THERMAL MODEL 2 > THERMAL MODEL 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]	
Cooling constant	Cool Time Constant	2.00	0.01 times Heat Time Ct.	[1.00 : 6.00]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Alarm level	Alarm Level	80.0	0.10%	[1.0 : 110.0]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL TOC					
NEUTRAL TOC 1> NEUTRAL TOC 2 > NEUTRAL TOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL IOC					
NEUTRAL IOC 1> NEUTRAL IOC 2 > NEUTRAL IOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL DIRECTIONAL >					
NEUTRAL DIRECTIONAL 1> NEUTRAL DIRECTIONAL 2 > NEUTRAL DIRECTIONAL 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	$[V_0 - I_P - V_0 + I_P - V_0 * I_P]$	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND TOC					
GROUND TOC 1> GROUND TOC 2 > GROUND TOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND IOC					
GROUND IOC 1> GROUND IOC 2 > GROUND IOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND DIRECTIONAL >					
GROUND DIRECTIONAL 1> GROUND DIRECTIONAL 2 > GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	$[V_0 - I_P - V_0 + I_P - V_0 * I_P]$	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND TOC					
SENSITIVE GROUND TOC 1> SENSITIVE GROUND TOC 2 > SENSITIVE GROUND TOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND IOC					
SENSITIVE GROUND IOC 1> SENSITIVE GROUND IOC 2 > SENSITIVE GROUND IOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > ISOLATED GROUND IOC					
ISOLATED GROUND IOC 1> ISOLATED GROUND IOC 2 > ISOLATED GROUND IOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
High Voltage level	Vh Level	20	1 V	[2 : 70]	
Low Current level	II LEVEL	0.005	0.001 A	[0.005 : 0.400]	
Low Voltage level	VI LEVEL	2	1 V	[2 : 70]	
High Current level	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]	
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]	
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND DIRECTIONAL >					
SENSITIVE GROUND DIRECTIONAL 1> SENSITIVE GROUND DIRECTIONAL 2 > SENSITIVE GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE TOC >					
NEGATIVE SEQUENCE TOC 1> NEGATIVE SEQUENCE TOC 2 > NEGATIVE SEQUENCE TOC 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE UV >					
PHASE UV 1> PHASE UV 2 > PHASE UV 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Minimum Voltage Threshold	Minimum Voltage	5	1 V	[0 : 300]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE OV >					
PHASE OV 1> PHASE OV 2 > PHASE OV 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS >					
>NEUTRAL OV HIGH > NEUTRAL OV HIGH 1> NEUTRAL OV HIGH 2 > NEUTRAL OV HIGH 3					
>NEUTRAL OV LOW > NEUTRAL OV LOW 1> NEUTRAL OV LOW 2 > NEUTRAL OV LOW 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE OV >					
NEGATIVE SEQUENCE OV 1> NEGATIVE SEQUENCE OV 2 > NEGATIVE SEQUENCE OV 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > AUXILIARY UV >					
AUXILIARY UV 1> AUXILIARY UV 2 > AUXILIARY UV 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > FORWARD POWER					
FORWARD POWER 1> FORWARD POWER 2 > FORWARD POWER 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > DIRECTIONAL POWER>					
DIRECTIONAL POWER 1> DIRECTIONAL POWER 2 > DIRECTIONAL POWER 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 1	Dir Power Angle 1	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 2	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	



SETPOINT > CONTROL ELEMENTS > SETTING GROUP					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > UNDERFREQUENCY					
UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > OVERFREQUENCY					
OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > SYNCHROCHECK					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > AUTORECLOSE					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

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

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR					
BROKEN CONDUCTOR 1 > BROKEN CONDUCTOR 2 > BROKEN CONDUCTOR 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Tap Level in percentage of I2/I1	Tap	20	0.10%	[20.0 : 100.0]	
Trip Time	Trip Delay	60	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Current Inhibition Level setting	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]	

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR					
LOCKED ROTOR 1 > LOCKED ROTOR 2 > LOCKED ROTOR 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Full load current	Full Load Current	0.5	KA	[0.10 : 10.00]	
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]	
Trip time	Trip Delay	0	s	[0.00 : 900.00]	
Reset time	Reset Delay	0	s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O >					
BOARD F > BOARD G > BOARD H > BOARD J					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
I/O board type (available only for CIO modules)	I/O Board Type_H	NONE	N/A	[NONE,	
				16 INP + 8OUT,	
				8 INP + 8OUT + SUPV]	
Input activation voltage threshold Group A	Voltage Threshold A_X	80	1 V	[0 : 255]	
Input activation voltage threshold Group B	Voltage Threshold B_X	80	1 V	[0 : 255]	
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]	
Input type	Input Type_X_CCY (CCY)	POSITIVE	N/A	[POSITIVE-EDGE,	
				NEGATIVE-EDGE,	
				POSITIVE,	
				NEGATIVE]	
Input signal time delay	Delay Input Time_X_CCY (CCY)	0	1 ms	[0 : 60000]	
Output logic type	Output Logic_X_0Z	POSITIVE	N/A	[POSITIVE,	
				NEGATIVE]	
Output type	Output Type_X_0Z	NORMAL	N/A	[NORMAL,	
				PULSE,	
				LATCH]	
Output pulse length	Pulse Output Time_X_0Z	10000	1 ms	[0 : 60000]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

**NOTE 2: DESCRIPTION OF X, Y AND Z IN INPUT/OUTPUT BOARDS**

<b>X</b>	F, G, H or J, the I/O board name, depending on the Relay model.		
	F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module).		
For the I/O board selection in the relay model:	I/O BOARD TYPE		
	ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
	0	NONE	None
	1	16 INP+ 8OUT	Mixed
	2	8 INP +8 OUT +SUPV	Supervision
<b>CCY</b>	Is the name used for inputs in I/O boards		
	<b>Mixed</b> , 16 digital inputs: CC1....CC16		
	<b>Supervision</b> : 8 digital inputs: CC1,..., CC8		
<b>OZ</b>	Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,..., 08)		

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN F650	
IEEE extremely/very/moderately inverse	
IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse	
IAC extremely/very/normally/moderately inverse	
ANSI extremely/very/normally/moderately inverse	
I <sup>2</sup> t	
Definite time	
Rectifier curve	
User Curve - FlexCurve™ A/B/C/D	

## F.1.2 FACTORY DEFAULT CONFIGURATION

**NOTE:****SOURCE COLUMN:**

This columns allow selecting the simple or complex (OR signal or Virtual output) operand that activates the selected elements on relay configuration

If more than one operands are selected, the relay performs an OR gate with them to activate the selected element.

**SIGNAL LOGIC COLUMN:**

Refers to each individual signal selected on its left. NOT legend means that the referred signal is inverted

**SOURCE LOGIC COLUMN:**

Refers to the whole SOURCE signal selected on its left. NOT legend means that SOURCE signal is inverted

If more than one operand were selected, the OR gate output is inverted

**SETPOINT>RELAY CONFIGURATION>OUTPUTS**

OUTPUT ID	OUTPUT NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
CONT OP OPER_F_01	79 BLOCKED	AR BLOCK BY LEVEL		
CONT OP OPER_F_02	27/59 PKP	VO_046_59P_PKP VO_045_27P_PKP		
CONT OP OPER_F_03	50/67G PKP	VO_048_50G_PKP		
CONT OP OPER_F_04	51/67G PKP	VO_049_51G_PKP		
CONT OP OPER_F_05	50/67P PKP	VO_051_50PH_PKP VO_050_50PL_PKP		
CONT OP OPER_F_06	51/67P PKP	VO_053_51P_PKP		
CONT OP OPER_F_07	RECLOSE	OPERATION BIT 1 AR CLOSE BREAKER		
CONT OP OPER_F_08	TRIP	OPERATION BIT 2 VO_083_GENERAL_TRIP		
CONT OP OPER_G_01	81U/81O TRIP	VO_082_ALL_FREQUENCY_TRIP		
CONT OP OPER_G_02	27/59 TRIP	VO_079_ALL_OVERVOLTAGE_TRIP		
CONT OP OPER_G_03	50/67G TRIP	VO_068_50G_TRIP		
CONT OP OPER_G_04	51/67G TRIP	VO_067_51G_TRIP		
CONT OP OPER_G_05	50/67P TRIP	VO_059_50PL_TRIP VO_058_50PH_TRIP		
CONT OP OPER_G_06	51/67P TRIP	VO_057_51P_TRIP		
CONT OP OPER_G_07	RCLS IN PROG	AR RCL IN PROGRESS		
CONT OP OPER_G_08	RCLS LOCKOUT	AR LOCKOUT		
CONT OP RESET_F_01	Not Configured			
CONT OP RESET_F_02	Not Configured			
CONT OP RESET_F_03	Not Configured			
CONT OP RESET_F_04	Not Configured			
CONT OP RESET_F_05	Not Configured			
CONT OP RESET_F_06	Not Configured			
CONT OP RESET_F_07	Not Configured			
CONT OP RESET_F_08	Not Configured			
CONT OP RESET_G_01	Not Configured			
CONT OP RESET_G_02	Not Configured			
CONT OP RESET_G_03	Not Configured			
CONT OP RESET_G_04	Not Configured			

CONT OP RESET_G_05	Not Configured			
CONT OP RESET_G_06	Not Configured			
CONT OP RESET_G_07	Not Configured			
CONT OP RESET_G_08	Not Configured			

## SETPOINT&gt;RELAY CONFIGURATION&gt;LEDS

LED ID	LED NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LED01	TRIP	VO_083_GENERAL_TRIP		
LED02	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
LED03	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
LED04	27 TRIP	VO_073_27P_TRIP		
LED05	59 TRIP	VO_074_59P_TRIP		
LED06	PICKUP	VO_085_GENERAL_PKP		
LED07	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
LED08	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
LED09	27 PICKUP	VO_045_27P_PKP		
LED10	59 PICKUP	VO_046_59P_PKP		
LED11	79 READY	AR READY		
LED12	79 IN-PROG	AR RCL IN PROGRESS		
LED13	79 BLOCK	AR BLOCK BY LEVEL		
LED14	79 INHIBIT	AR CONDS INPUT		NOT
LED15	79 LOCKOUT	AR LOCKOUT		

## SETPOINT&gt;RELAY CONFIGURATION&gt;PROTECTION ELEMENTS

PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LED RESET INPUT	OPERATION BIT 3		
PH IOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 1		

PH IOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 2		

PH IOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 2		
NEUTRAL IOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL IOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL IOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND IOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 3		
SENS GND IOC1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 4		
PH TOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 5		



PH TOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 5		
NEUTRAL TOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL TOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL TOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND TOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 7		
SENS GND TOC1 BLOCK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC2 BLOCK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC3 BLOCK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 8		
PHASE UV1 BLOCK	GROUP 1 BLOCKED		
PHASE UV2 BLOCK	GROUP 2 BLOCKED		
PHASE UV3 BLOCK	GROUP 3 BLOCKED		

NEG SEQ OV1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ OV2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ OV3 BLOCK	GROUP 3 BLOCKED		
THERMAL1 BLOCK	GROUP 1 BLOCKED		
THERMAL2 BLOCK	GROUP 2 BLOCKED		
THERMAL3 BLOCK	GROUP 3 BLOCKED		
PHASE DIR1 BLK INP	GROUP 1 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
PHASE DIR2 BLK INP	LATCHED VIRT IP 9		
	GROUP 2 BLOCKED		
PHASE DIR3 BLK INP	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
NEUTRAL DIR1 BLK INP	GROUP 3 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
NEUTRAL DIR2 BLK INP	LATCHED VIRT IP 9		
	GROUP 1 BLOCKED		
NEUTRAL DIR3 BLK INP	GROUP 2 BLOCKED		
	GROUP 3 BLOCKED		
GROUND DIR1 BLK INP	GROUP 1 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR2 BLK INP	GROUP 2 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR3 BLK INP	GROUP 3 BLOCKED		
	LATCHED VIRT IP 10		
NEUTRAL OV1 HIGH BLK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV2 HIGH BLK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV3 HIGH BLK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV1 LOW BLK	GROUP 1 BLOCKED		
NEUTRAL OV2 LOW BLK	GROUP 2 BLOCKED		
NEUTRAL OV3 LOW BLK	GROUP 3 BLOCKED		
AUXILIARY UV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY UV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY UV3 BLOCK	GROUP 3 BLOCKED		
PHASE OV1 BLOCK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV2 BLOCK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV3 BLOCK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 11		
AUXILIARY OV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY OV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY OV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ TOC1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ TOC2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ TOC3 BLOCK	GROUP 3 BLOCKED		
OVERFREQ1 BLOCK	GROUP 1 BLOCKED		
OVERFREQ2 BLOCK	GROUP 2 BLOCKED		

OVERFREQ3 BLOCK	GROUP 3 BLOCKED		
UNDERFREQ1 BLOCK	GROUP 1 BLOCKED		
UNDERFREQ2 BLOCK	GROUP 2 BLOCKED		
UNDERFREQ3 BLOCK	GROUP 3 BLOCKED		
SETT GROUPS BLOCK	Not Configured		
BROKEN CONDUCT1 BLK	GROUP 1 BLOCKED		
BROKEN CONDUCT2 BLK	GROUP 2 BLOCKED		
BROKEN CONDUCT3 BLK	GROUP 3 BLOCKED		
ISOLATED GND1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
ISOLATED GND2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
ISOLATED GND3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
SENS GND DIR1 BLK IP	GROUP 1 BLOCKED		
SENS GND DIR2 BLK IP	GROUP 2 BLOCKED		
SENS GND DIR3 BLK IP	GROUP 3 BLOCKED		
FWD PWR1 BLOCK	GROUP 1 BLOCKED		
FWD PWR2 BLOCK	GROUP 2 BLOCKED		
FWD PWR3 BLOCK	GROUP 3 BLOCKED		
PH TOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 6		

PH TOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 6		
DIR PWR1 BLOCK	GROUP 1 BLOCKED		
DIR PWR2 BLOCK	GROUP 2 BLOCKED		
DIR PWR3 BLOCK	GROUP 3 BLOCKED		
LOCKED ROTOR1 BLK	GROUP 1 BLOCKED		
LOCKED ROTOR2 BLK	GROUP 2 BLOCKED		
LOCKED ROTOR3 BLK	GROUP 3 BLOCKED		
THERMAL1 A RST	OPERATION BIT 4		
THERMAL1 B RST	OPERATION BIT 4		
THERMAL1 C RST	OPERATION BIT 4		
THERMAL2 A RST	OPERATION BIT 4		
THERMAL2 B RST	OPERATION BIT 4		
THERMAL2 C RST	OPERATION BIT 4		
THERMAL3 A RST	OPERATION BIT 4		
THERMAL3 B RST	OPERATION BIT 4		
THERMAL3 C RST	OPERATION BIT 4		
SYNCROCHECK BLK INP	Not Configured		
AR LEVEL BLOCK	CONT IP_F_CC8 (79 BLOCK)(CC8)		
	LATCHED VIRT IP 14		
AR PULSE BLOCK	Not Configured		
AR PULSE UNBLOCK	Not Configured		
AR INITIATE	VO_083_GENERAL_TRIP		
	CONT IP_F_CC7 (79 INITIATE)(CC7)		
	LATCHED VIRT IP 13		
AR CONDS INPUT	SYNCHK CLOSE PERM	NOT	NOT
	LATCHED VIRT IP 15		
BKR FAIL INITIATE	Not Configured		
RESET KI2t COUNTERS	OPERATION BIT 5		
RESET BKR COUNTERS	OPERATION BIT 5		
GROUP 1 ACT ON	Not Configured		
GROUP 2 ACT ON	Not Configured		
GROUP 3 ACT ON	Not Configured		
FAULT REPORT TRIGG	VO_083_GENERAL_TRIP		
CLEAR FAULT REPORTS	Not Configured		
DEMAND TRIGGER INP	Not Configured		
DEMAND RESET INP	OPERATION BIT 7		
FREEZE ENERGY CNT	Not Configured		
UNFREEZE ENERGY CNT	Not Configured		
RESET ENERGY CNT	OPERATION BIT 6		

## SETPOINT&gt;RELAY CONFIGURATION&gt;OSCILLOGRAPHY

DIGITAL CHANNELS	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
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DIG_CHANNEL#1	TRIP	VO_083_GENERAL_TRIP		
DIG_CHANNEL#2	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
DIG_CHANNEL#3	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
DIG_CHANNEL#4	27 TRIP	VO_073_27P_TRIP		
DIG_CHANNEL#5	59 TRIP	VO_074_59P_TRIP		
DIG_CHANNEL#6	PICKUP	VO_085_GENERAL_PKP		
DIG_CHANNEL#7	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
DIG_CHANNEL#8	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
DIG_CHANNEL#9	27 PICKUP	VO_045_27P_PKP		
DIG_CHANNEL#10	59 PICKUP	VO_046_59P_PKP		
DIG_CHANNEL#11	79 READY	AR READY		
DIG_CHANNEL#12	79 IN-PROG	AR RCL IN PROGRESS		
DIG_CHANNEL#13	79 BLOCK	AR BLOCK BY LEVEL		
DIG_CHANNEL#14	79 INHIBIT	AR CONDS INPUT	NOT	
DIG_CHANNEL#15	79 LOCKOUT	AR LOCKOUT		
DIG_CHANNEL#16	Not Configured			
OSCILLO TRIGGER	OSCILLO TRIGGER	OPERATION BIT 8 VO_083_GENERAL_TRIP		

## SETPOINT&gt;RELAY CONFIGURATION&gt;OPERATIONS

OPERATION	OPERATION TEXT	SETTINGS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK(LOGIC)	SYNCHK CLOSE PERM
		FINAL STATES AND(LOGIC)	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation2	OPEN BREAKER	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	BREAKER OPEN
		FRONT KEY	O Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation3	LEDS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation4	THERMAL RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL

Operation5	BRK COUNTERS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation6	ENERGY RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation7	DEMAND RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation8	TRIGGER OSCILLO	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
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
Operation10	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
Operation11	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

Operation12	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
Operation13	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
Operation14	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
Operation15	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
Operation16	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
Operation17	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
Operation18	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

Operation19	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
Operation20	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
Operation21	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
Operation22	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
Operation23	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>CONTROL EVENTS				
EVENT	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
EV1	Not Configured			
EV2	Not Configured			
EV3	Not Configured			
EV4	Not Configured			



EV5	Not Configured			
EV6	Not Configured			
EV7	Not Configured			
EV8	Not Configured			
EV9	Not Configured			
EV10	Not Configured			
EV11	Not Configured			
EV12	Not Configured			
EV13	Not Configured			
EV14	Not Configured			
EV15	Not Configured			
EV16	Not Configured			
EV17	Not Configured			
EV18	Not Configured			
EV19	Not Configured			
EV20	Not Configured			
EV21	Not Configured			
EV22	Not Configured			
EV23	Not Configured			
EV24	Not Configured			
EV25	Not Configured			
EV26	Not Configured			
EV27	Not Configured			
EV28	Not Configured			
EV29	Not Configured			
EV30	Not Configured			
EV31	Not Configured			
EV32	Not Configured			
EV33	Not Configured			
EV34	Not Configured			
EV35	Not Configured			
EV36	Not Configured			
EV37	Not Configured			
EV38	Not Configured			
EV39	Not Configured			
EV40	Not Configured			
EV41	Not Configured			
EV42	Not Configured			
EV43	Not Configured			
EV44	Not Configured			
EV45	Not Configured			
EV46	Not Configured			
EV47	Not Configured			
EV48	Not Configured			
EV49	Not Configured			
EV50	Not Configured			
EV51	Not Configured			
EV52	Not Configured			
EV53	Not Configured			
EV54	Not Configured			

EV55	Not Configured			
EV56	Not Configured			
EV57	Not Configured			
EV58	Not Configured			
EV59	Not Configured			
EV60	Not Configured			
EV61	Not Configured			
EV62	Not Configured			
EV63	Not Configured			
EV64	Not Configured			
EV65	Not Configured			
EV66	Not Configured			
EV67	Not Configured			
EV68	Not Configured			
EV69	Not Configured			
EV70	Not Configured			
EV71	Not Configured			
EV72	Not Configured			
EV73	Not Configured			
EV74	Not Configured			
EV75	Not Configured			
EV76	Not Configured			
EV77	Not Configured			
EV78	Not Configured			
EV79	Not Configured			
EV80	Not Configured			
EV81	Not Configured			
EV82	Not Configured			
EV83	Not Configured			
EV84	Not Configured			
EV85	Not Configured			
EV86	Not Configured			
EV87	Not Configured			
EV88	Not Configured			
EV89	Not Configured			
EV90	Not Configured			
EV91	Not Configured			
EV92	Not Configured			
EV93	Not Configured			
EV94	Not Configured			
EV95	Not Configured			
EV96	Not Configured			
EV97	Not Configured			
EV98	Not Configured			
EV99	Not Configured			
EV100	Not Configured			
EV101	Not Configured			
EV102	Not Configured			
EV103	Not Configured			
EV104	Not Configured			

EV105	Not Configured			
EV106	Not Configured			
EV107	Not Configured			
EV108	Not Configured			
EV109	Not Configured			
EV110	Not Configured			
EV111	Not Configured			
EV112	Not Configured			
EV113	Not Configured			
EV114	Not Configured			
EV115	Not Configured			
EV116	Not Configured			
EV117	Not Configured			
EV118	Not Configured			
EV119	Not Configured			
EV120	Not Configured			
EV121	Not Configured			
EV122	Not Configured			
EV123	Not Configured			
EV124	Not Configured			
EV125	Not Configured			
EV126	Not Configured			
EV127	Not Configured			
EV128	Not Configured			

## SETPOINT&gt;RELAY CONFIGURATION&gt;SWITCHGEAR

SWITCHGEAR	SETTING	VALUE/SOURCE	SIGNAL LOGIC	SOURCE LOGIC
SWITCHGEAR 1	CONTACTS	52b		
	OPENING TIME	1000		
	CLOSING TIME	1000		
	CONTACT A SOURCE	N/A		
	CONTACT B SOURCE	CONT IP_F_CC1 (52b)(CC1)		
	OPEN TEXT	52 OPEN		
	ALARM	NO		
	CLOSED TEXT	52 CLOSE		
	ALARM	NO		
	ERROR 00 TEXT	52 ERROR		
	ALARM	N/A		
	ERROR 11 TEXT	52 UNDEFINED		
	ALARM	N/A		
	OPENING INIT	OPERATION BIT 2		
	CLOSING INIT	OPERATION BIT 1		

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 3	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 4	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 5	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 6	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 7	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 8	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 9	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 10	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 11	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 12	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 13	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 14	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 15	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		





## G.1.1 F650 FIRMWARE REVISION HISTORY

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.00	2.00	First version of the product (Basic Model F1G0) Full protection scheme	F650BABF1G0HI	June 28 <sup>th</sup> 2002
1.11	2.00	New model F2G0 (inputs and outputs board type 2)	F650BABF2G0HI	October 14 <sup>th</sup> 2002
1.13	2.20	Snapshot Events included (New and All) Oscillography up to 4 records. Maximum 70 cycles at 64 samples per cycle, trip programmable via PLC. Broken Conductor protection function included. Boot program updated through F650PC program	ALL	December 20 <sup>th</sup> 2002
1.14	2.20	DNP 3.0 Level 2 protocol included, over TCP/IP and UDP/IP IRIG_B synchronization	ALL	January 22 <sup>nd</sup> 2003
1.20	2.25	Programmable Graphical display Calibration included to improve measurement accuracy	ALL	January 28 <sup>th</sup> 2003
1.30	2.25	Sensitive ground directional unit Isolated Ground directional unit (in 5 <sup>th</sup> current transformer) Energy measurements	ALL	March 31 <sup>st</sup> 2003
1.31	2.25	Enhancements in 60 Hz measurements Extended Settings Range in Negative Sequence Overcurrent function (46)	ALL	April 9 <sup>th</sup> 2003
1.33	2.30	Forward Power function (32FP) Demand	ALL	May 9 <sup>th</sup> 2003
1.44	2.30	51PL function included (besides existing 51PH) Control Events Alarms ModBus over TCP/IP	ALL	July 24 <sup>th</sup> 2003
1.48	2.30	Changes in 67 units in reverse mode ModBus TCP/IP enhancement	ALL	September 5 <sup>th</sup> 2003
1.50	2.30	<b>PROTECTION</b> The following operation curves have been added to F650 functionality: IEC Long-Time Inverse IEC Short-Time Inverse ANSI Extremely Inverse ANSI Very Inverse ANSI Normally Inverse ANSI Moderately Inverse Rectifier Curve User Curve A/B/C/D - Flex Curve™ Note: User Curves allow the user to program any non-standard curve type by selecting, point by point, the Operation time. <b>HARDWARE</b> Voltage Range: Voltage Metering Range expanded from (2 to 200 Volts) to (2 to 275V) CIO Module: For those applications requiring a high number of inputs and outputs, F650 units can be connected to a CIO module (Remote CAN Bus I/O module) for using up to 2 additional boards. <b>COMMUNICATIONS</b> ModBus Protocol: ModBus User Map Virtual Inputs (control over internal logic variables, which can be used in the configurable logic). DNP 3.0 Protocol New Metering scale factors Switchgear bits mapped to binary points Possibility of restricting the binary points map by setting <b>USER INTERFACE</b> HMI Configurable Main Screen: The main screen offers the possibility to select the initial logo, a simplified Metering screen showing primary values, or both. Snapshot Events: Possibility of viewing snapshot events from the relay display in models without graphical display.	ALL	October 31 <sup>st</sup> 2003

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.61	2.35	<b>COMMUNICATIONS</b> Configuration: LED Reset by communications using the configurable logic <b>METERING</b> Monitoring of phasor measurements in module and argument REGISTER Snapshot Events: Possibility of reading the Snapshot events in Binary and ASCII format via ModBus Oscillography: The oscillography function has been improved to offer the possibility of creating up to a maximum of 20 oscillography records, with possibility to create concatenated oscillographies. Oscillography records can be obtained via communications using serial messaging (ModBus) or Ethernet (TCP/IP or TFTP). Fault Report: This version incorporates the tool to visualize and store the information from the last ten faults produced. This report can be shown on the relay display. The fault report will be available on the relay display and via communications, either on ModBus (serial) or TCP/IP. Data Logger: It allows registering 16 channels among all the available analog measures in the relay. The information provided by the data logger can be obtained via TCP/IP. <b>USER INTERFACE</b> Fault Report screen on HMI: Fault report information on display, selectable by setting <b>WEB SERVER</b> Web server tool has been upgraded to provide visualization of: Snapshot Events Control Events Alarms Oscillography Fault report Data Logger Metering	ALL	April 30 <sup>th</sup> 2004
1.62	2.35	Internal file management enhancement. IP Address maintenance after firmware upgrading. Latched Virtual Inputs maintenance after powering off and on the relay.	ALL	June 24 <sup>th</sup> 2004
1.70	2.35	Multilingual relay (French and English available)	F650BABF1G0HIF F650MFDF2G1LOF F650MFCF1G1LOF	August 5 <sup>th</sup> 2004
1.72	2.35	<b>COMMUNICATIONS</b> Multimaster DNP (3 masters) <b>METERING</b> Measurement enhancement <b>PROTECTION</b> Sensitive Directional Power unit is included (32) <b>REGISTER</b> Snapshot Events: Possibility to be enabled and disabled by setting. In previous versions snapshot event generation was enabled by default and fixed for all elements. Using the "config file converter" tool the snapshot event settings will be included but to their default value (disabled), user must set the snapshot event generation to the desired value. Notice that having snapshot event to disabled no internal signals will be recorded in the snapshot event buffer. <b>USER INTERFACE</b> HMI Enhanced HMI meeting EnerVista F650 Setup structure. Multilingual Option available: The relay can be ordered in languages different from English, the relay always has English as default Languages Available now: French/English (F in ordering code request) English/English (former ordering code) <b>ENERVISTA F650 SETUP</b> Multilingual unit (French and English available). <b>WEB SERVER</b> Multilingual visualization of snapshot events, control events, oscillography, fault recorder, data logger, metering.	ALL	November 26 <sup>th</sup> 2004

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.80	2.35	<b>USER INTERFACE</b> <b>HMI:</b> New languages available: Russian and Spanish. Russian/English (P in ordering code, basic display only) Spanish/English (S in ordering code) <b>ENERVISTA F650 SETUP</b> New languages available: Russian and Spanish. Passwords included in EnerVista F650 Setup (different from the HMI ones). <b>WEB SERVER</b> Multilingual visualization of snapshot events, control events, oscillography, fault recorder, data logger, metering. New languages available: Russian and Spanish. Visualization Enhancement. <b>COMMUNICATIONS</b> Modbus TCP communications enhancement. External CAN interruptions management enhancement. <b>METERING</b> Decimal point included in PT and CT ratios. Power Factor measurement enhancement. <b>PROTECTION</b> Function 48 included. I2/I1 setting to select the minimum inhibition current level of the unit. TOC operation level at 1.03 times the pickup (1.05 in previous releases). Neutral units measures management enhancement. Startup Enhancement. <b>REGISTER</b> Time Stamp for switchgear control events enhancement.	ALL	March 1 <sup>st</sup> 2005
1.82	4.00	File system management enhancement in boot code 4.00 Measurements enhancement in 1.82 firmware version Versions 1.8X can not be upgraded to 2.XX firmware version without hardware change.	ALL	October 17th 2005
2.20	4.00	<b>USER INTERFACE</b> <b>ENERVISTA F650 SETUP.</b> - Data Logger visualization changes. - File name available in "Config file converter" tool. <b>COMMUNICATIONS.</b> - DNP Scale factor correction. - IIRGB synchronization: - Date and time synchronization available. - 980 ms delay correction. <b>INPUTS/OUTPUTS.</b> - Inputs Activation/Deactivation correction. - Voltage threshold setting range from 20 to 230 Vdc. - Debounce time settings: - Timestamp before debounce time - Setting range from 1 to 50 ms. <b>METERING.</b> - Power calculations using ARON method. - New measurements provided when using Delta connection and VN as auxiliary voltage input: - Neutral voltage available. - Phase to ground voltages available. - Single phase power measurements available. <b>PROTECTION.</b> - Neutral, ground and sensitive ground directional units available with delta connection and VN as auxiliary voltage input. - Minor changes in Forward Power elements. <b>REGISTER.</b> - Ground current available in Fault report. - Corrected 150 ms delay in Snapshot events measurements.	All models, excepting Options 4 and 5 for I/O boards. Option 6 for IEC 61850 protocol	November 25th 2005

## G.1.2 GE MULTILIN WARRANTY

**GE MULTILIN RELAY WARRANTY**

GE Power Management, S.A. (GE Multilin) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Multilin will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service center or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay, which has been subject to misuse, negligence, accident, incorrect installation, or use not in accordance with instructions nor any unit that has been altered outside a GE Multilin authorized factory outlet.

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.