GE VERNOVA

OMNI

MU360

Technical Manual
Integrated Merging Unit - Extended

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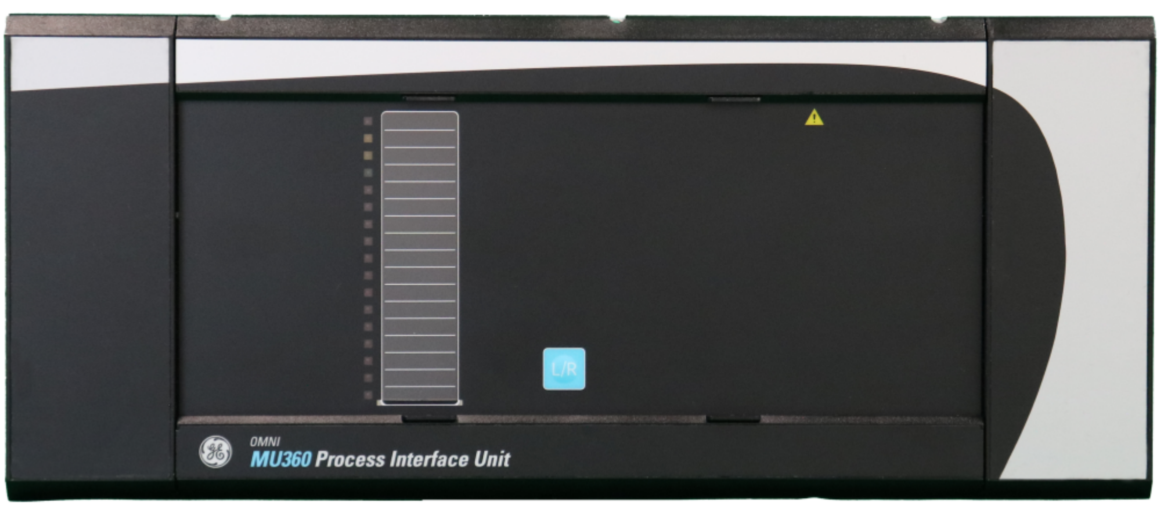

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The content of this document has been developed to provide guidance to properly install, configure and maintain this product for its intended applications. This guidance is not intended to cover every possible contingency that may arise during commissioning, operation, service, or maintenance activities. Should you encounter any circumstances not clearly addressed in this document, contact your local GE Vernova service site.

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Contents

CHAPTER 1

INTRODUCTION

1.1 CHAPTER OVERVIEW

This manual provides some general information about the technical manual and an introduction to the OMNI devices BC360 and MU360 units described in this technical document.

This chapter contains the following sections:

1.2 FOREWORD

This technical manual provides a functional and technical description of General Electric's MU360, as well as a comprehensive set of instructions for using the device. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product.

We have attempted to make this manual as accurate, comprehensive, and user-friendly as possible. However, we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors or have any suggestions for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product. We consider that this manual provides the necessary information, but if you consider that more details are needed, please contact us.

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1.2.1 TARGET AUDIENCE

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment. Also, system and protection engineers have a thorough knowledge of protection systems and associated equipment.

1.2.2 NOMENCLATURE

Due to the technical nature of this manual, many special terms, abbreviations, and acronyms are used throughout the manual. Some of these terms are well-known industry-specific terms while others may be special product specific terms used by General Electric. The first instance of any acronym or term used in a particular chapter is explained. In addition, a separate glossary is available at the end of this manual.

We would like to highlight the following changes of nomenclature however:

- The range of MU360 and BC360 substation and bay computers is being widened to encompass new applications such as the process bus Ethernet network. Please note that this is a phased evolution, and where the text in the manual refers to software labels, there may still be some references to the previous names until the software update is completed.
- The word 'relay' is no longer used to describe the device itself. Instead, the device is referred to as the 'IED' (Intelligent Electronic Device), the 'device', or the 'product'. The word 'relay' is used purely to describe the electromechanical components within the device, i.e., the output relays.
- The MU360 and BC360 units will now be referred to as "controllers" rather than "computers" to avoid any confusion with the PC-type computers used in other sub-systems.
- The British term 'Earth' is used in favour of the American term 'Ground'.

1.2.3 ABBREVIATIONS

AC (a.c.)	-	Alternating Current
A/D	-	Analog/Digital (Converter)
CD-ROM	-	Compact Disc
Read Only Memory CID	-	Configured IED Description
CR2032	-	Lithium Battery Model

CT	-	Current Transformer
DA	-	Data Attribute
DO	-	Data Object
DC (d.c.)	-	Direct Current
FPGA	-	Field Programmable Gate Array
GOOSE	-	Generic Object-Oriented Substation Events
GCB	-	GOOSE Control Block
IEC	-	International Electrotechnical Commission
IED	-	Intelligent Electronic Devices
IEEE	-	Institute of Electric and Electronic Engineers
I/O	-	Abbreviation of Input/Output
IMB	-	Imbalance
IP	-	Internet Protocol
IRIG-B	-	Time Synchronization Protocol Inter Range Instrumentation Group (Rate Designation B)
LAN	-	Local Area Network
LED	-	Light Emitting Diode
LD	-	Logical Device
LN	-	Logical Node
MAC	-	Media Access Control
MMS	-	Manufacturing Message Specification (ISO 9506)
MU	-	Merging Unit
NC	-	Normally Closed
NO	-	Normally Opened
RAM	-	Random Access Memory
RX	-	Receiver Data Connector
SCD	-	Substation Configuration Description
SCL	-	System Configuration Description Language
SSH	-	Secure Shell
SV	-	Sampled Values
Sync	-	Abbreviation of Synchronization
TCP	-	Transmission Control Protocol
TX	-	Transmitting Data Connector
PIU	-	Process Interface Unit
VLAN	-	Virtual Local Area Network
VT	-	Voltage Transformer

1.3 PLATFORM AND PRODUCTS

1.3.1 MU360

MU360 is the Process Interface Unit (PIU) with analog and binary interfaces for full switchyard modelling, control and digitalization over IEC 61850 standards and protocols such as Sampled Value (SV) and GOOSE.

The MU360 permits the full value of a completely digital substation, as the I/O interface to every bay IED, especially protective relays and bay control units. Limiting the field wiring to only the MU360 reduces project complexity by reducing cabling and physical connections. Bay IEDs can use data from redundant MU360 units, increasing system availability. Bay IEDs can be quickly replaced as no field wiring is involved. The MU360 has the additional benefit of improving CT performance and cost through a lower connected burden and a reduction in the number of CT cores required for an application.

1.3.2 BC360

Driven by the requirements around the world for advanced applications in SCADA, Digital Control Systems, Automation, Control and Monitoring, GE Vernova Grid Solutions has designed and developed a complete BC360 control unit product, specifically for the power process environment and electric utility industry. It allows the building of a customized solution for Control, Monitoring, Measurement and Automation of electrical processes.

The BC360 range is designed to address the needs of a wide variety of installations, from small to large and customer applications. Emphasis has been placed on strong compliance to standards, scalability, modularity and openness architecture. These facilitate the use in a range of applications from the most basic to the most demanding. They also ensure interoperability with existing components, and by providing building control units, PLC or IEDs, provide a comprehensive upgrade path, which allows BC360 capabilities to meet customer requirements.

The key features of this control unit result from it being based on an Ethernet client/server architecture, it is a modular control unit that offers a wide variety of applications such as Bay Controller, Remote Terminal Unit, Sequence of Event Recorder and Data Concentrator.

The BC360 substation controller is a sophisticated solution supporting multiple applications and functions for substation control, communication, monitoring, protection and automation.

The BC360 modular bay control unit is used to control and monitor switch bays. The information capacity of the BC360 is designed for controlling operated switchgear units equipped with electrical check-back signalling located in medium-voltage or high-voltage substations.

This simplifies handling of bay protection and control technology from planning to station commissioning.

Continuous self-monitoring reduces maintenance costs for protection and control systems.

Adjustment to the quantity of information required is made via the EnerVista Flex V2.

The BC360 can be connected to a higher control level, local control level or lower levels by way of a built-in communications interface.

1.4 BENEFITS OF USING MU360

- Compact form factor supports field installation options into circuit breakers cabinets, marshalling kiosks and metal-clad switchgear.
- 6 slots for I/O cards allows multiple applications. Apply as Merging Unit, Remote I/O device or PIU. Right size and point count for all type of application.
- Card slots for 2 CT/VT analog boards supports application on breaker-and-a-half lines, dual distribution feeders, and combination protection and metering installations.
- Optional metering accuracy CT/VT analog board for revenue metering and power quality application.
- 2 SV streams possible (one per CT/VT analog board). Each stream can be protection (80 s/c) or power quality (256 s/c) SV streams.
- Full integration into the digital substation through 2 Ethernet ports, support for Parallel Redundancy Protocol (PRP) high availability networks, and IEEE 1588 Precision Time Protocol.
- Full IEC 61850 Edition 2, including support for Test mode and Simulation. Multiple logical devices to integrate multiple circuit breakers and disconnectors in one MU360.

CHAPTER 2

SAFETY INFORMATION

2.1 CHAPTER OVERVIEW

This chapter provides information about the safe handling of the equipment. The equipment must be properly installed and handled to maintain it in a safe condition and to keep personnel safe at all times. You must be familiar with information contained in this chapter before unpacking, installing, commissioning, or servicing the equipment.

This chapter contains the following sections:

2.2 HEALTH AND SAFETY

Personnel associated with the equipment must be familiar with the contents of this Safety Information.

When electrical equipment is in operation, dangerous voltages are present in certain parts of the equipment. Improper use of the equipment and failure to observe warning notices will endanger personnel.

Only qualified personnel may work on or operate the equipment. Qualified personnel are individuals who are:

- Familiar with the installation, commissioning, and operation of the equipment and the system to which it is being connected.
- Familiar with accepted safety engineering practices and authorised to energise and de-energise equipment in the correct manner.
- Trained in the care and use of safety apparatus in accordance with safety engineering practices.
- Trained in emergency procedures (first aid).

It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified by this document. If this is not the case, then any safety protection provided by the equipment may be impaired.

The documentation provides instructions for installing, commissioning, and operating the equipment. However, it cannot cover all conceivable circumstances. In the event of questions or problems, do not take any action without proper authorisation. Please contact your local sales office and request the necessary information.

2.3 SYMBOLS

Throughout this manual you will come across the following symbols. You will also see these symbols on parts of the equipment.

Caution:
Refer to equipment documentation. Failure to do so could result in damage to the equipment.

Warning:
Risk of electric shock.

Warning:
Risk of damage to eyesight.

Earth terminal.

Note:
This symbol may also be used for a protective conductor (earth) terminal if that terminal is part of a terminal block or sub-assembly.

Protective conductor (earth) terminal.

Instructions on disposal requirements.

Note:
The term 'Earth' used in this manual is the direct equivalent of the North American term 'Ground'.

2.4 INSTALLATION, COMMISSIONING AND SERVICING

2.4.1 LIFTING HAZARDS

Many injuries are caused by:

- Lifting heavy objects
- Lifting things incorrectly
- Pushing or pulling heavy objects
- Using the same muscles repetitively

Plan carefully, identify any possible hazards and determine how best to move the product. Look at other ways of moving the load to avoid manual handling. Use the correct lifting techniques and Personal Protective Equipment (PPE) to reduce the risk of injury.

2.4.2 ELECTRICAL HAZARDS

Caution:
All personnel involved in installing, commissioning, or servicing this equipment must be familiar with the correct working procedures.

Caution:
Consult the equipment documentation before installing, commissioning, or servicing the equipment.

Caution:
Always use the equipment as specified. Failure to do so will jeopardise the protection provided by the equipment.

Warning:
Removal of equipment panels or covers may expose hazardous live parts. Do not touch until the electrical power is removed. Take care when there is unlocked access to the rear of the equipment.

Warning:
Isolate the equipment before working on the terminal strips.

Warning:
Use a suitable protective barrier for areas with restricted space, where there is a risk of electric shock due to exposed terminals.

Caution:
Disconnect power before disassembling. Disassembly of the equipment may expose sensitive electronic circuitry. Take suitable precautions against electrostatic voltage discharge (ESD) to avoid damage to the equipment.

Warning:
NEVER look into optical fibres or optical output connections. Always use optical power meters to determine operation or signal level.

Warning:
Testing may leave capacitors charged to dangerous voltage levels. Discharge capacitors by reducing test voltages to zero before disconnecting test leads.

Caution:
Operate the equipment within the specified electrical and environmental limits.

Caution:
Before cleaning the equipment, ensure that no connections are energised. Use a lint free cloth dampened with clean water.

Caution:
Check the integrity of the the PCT connection.

Note:
Contact fingers of test plugs are normally protected by petroleum jelly, which should not be removed.

2.5 WIRING

2.5.1 GENERAL WIRING

Only two wires can be screwed together on any one connector. The AC and DC signal and communication wires should use separate shielded cable.

Caution:
A high rupture capacity (HRC) fuse must be used for auxiliary supplies (for example Red Spot type NIT or TIA) with the following characteristics:
- Current rating: 16 Amps
- Minimum dc rating: 220 Vdc
- gG operating class in accordance with IEC 60269
The fuses must be connected in series with the positive auxiliary supply input connections (Pin 23) for BIU261DS inputs.

Wires should be connected with the power supply connectors unplugged. Each wired signal has to be tested before plugging and fixing the connectors. The connectors have to be fixed on the BC360 or MU360 case with the screws available at each extremity of the connector.

For connection of the protective (earth) conductor, Refer to the BC360 or MU360 user manuals.

2.5.2 PROTECTIVE EARTH WIRING

This equipment requires a protective conductor (earth) to ensure user safety according to the definition in the standard IEC 60255-27: 2013 Insulation Class 1.

2.5.2.1 FUSE REQUIREMENTS

Caution:
Reason devices contain an internal fuse for the power supply, which is only accessed by opening the product. This does not remove the requirement for external fusing or use of an MCB as previously mentioned. The ratings of the internal fuses are: MU360 unit: 5A, type T, 250V rating.

Note:
MU360 can work with 50% of BI and 50% of BO energized simultaneously at the maximum ambient temperature (-40 to 55°C). Before working on CT circuits, these shall be short-circuited.

2.5.3 EARTH CONNECTION

To ensure proper operation of the equipment under adverse conditions of electromagnetic compatibility, connect the protective earth terminal to the panel using a screened/shielded cable with insulated flexible wires of 4.0 mm^2 cross section.

2.5.4 USB PORT

The front panel includes a B-Type USB port intended for maintenance purposes only.

Warning:
The front serial USB port is intended for maintenance purposes only. It is isolated to ELV level and is not intended for user connection. ESD precautions should also be taken when accessing it.

2.6 STANDARD COMPLIANCE

Compliance with the European Commission Directive and UK Conformity, assessed on EMC and LVD, is demonstrated by self-certification against international standards.

2.6.1 EMC COMPLIANCE

Compliance with IEC 60255-26:2013 was used to establish conformity.

2.6.2 PRODUCTSAFETY: 2006/95/EC

Compliance with IEC 60255-27:2013 was used to establish conformity.

Protective Class

IEC 60255-27:2013 Protective Class 1. This equipment requires a protective conductor (earth) to ensure user safety.

Installation Category

When using the 48-250 Vdc power supply: IEC 60255-27:2013 Installation category III (Overvoltage Category III). Equipment in this category is qualification tested at 5kV peak, 1.2/50 µS, 500 Ohms, 0.5 J, between all supply circuits and earth and also between independent circuits.

Environment

IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-30, IEC 60068-2-14, IEC 60068-2-78, IEC 60255-21-1, IEC 60255-21-2, IEC 60255-21-3. The equipment shall always be installed in a specific cabinet or housing, which will enable it to meet the requirements of IEC 60529 with the classification of degree of protection IP54 or above.

Pollution degree 2 when mounted in its normal position of use.

2.6.3 R&TTE COMPLIANCE

Radio and Telecommunications Terminal Equipment (R&TTE) directive 99/5/EC. Conformity is demonstrated by compliance to both the EMC directive and the Low Voltage directive.

2.7 DECOMMISSIONING AND DISPOSAL

Caution:
Before decommissioning, completely isolate the equipment power supplies (both poles of any dc supply). The auxiliary supply input may have capacitors in parallel, which may still be charged. To avoid electric shock, discharge the capacitors using the external terminals before decommissioning.

Caution:
Avoid incineration or disposal to water courses. Dispose of the equipment in a safe, responsible and environmentally friendly manner, and if applicable, in accordance with country-specific regulations.

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Any application where a system failure would create a risk of harm to property or persons (including the risk of bodily injuries and death) should not be reliant solely upon one form of electronic system. Due to the risk of system failure, to avoid damage, injury or death, the user or application designer must take reasonable steps to protect against system failure, including - but not limited to - back-up or shut-down mechanisms, but not because the end-user system is customized and differs from GE Vernova Grid Solutions testing platforms. A user or application designer may use GE Vernova Grid Solutions products in combination with other products.

These actions cannot be evaluated or contemplated by GE Vernova Grid Solutions; thus, the user or application designer is ultimately responsible for verifying and validating the suitability of GE Vernova Grid Solutions products whenever they are incorporated in a system or application, even without limitation of the appropriate design, process and safety levels of such system or application.

2.11 MANUFACTURER

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CHAPTER 3

QUICK INSTALLATION GUIDE

3.1 CHAPTER OVERVIEW

This chapter describes the MU360 application and CORTEC definition interface. It gives the information about how to set the CORTEC when creating a MU360 in Enervista Flex v2.

This chapter contains the following sections:

3.2 APPLICATION/SOFTWARE

This section intends to demonstrate how to make a configuration regarding user´s demand for a fast interaction. Before going ahead take attention to some important tips described by Chapter 5 - Software Management, (Refer to Software Management). In the end, user would know how to select correct disposition of boards and functions.

3.2.1 CONFIGURATION

A configuration is an application demanded by user that IED will use in runtime. Having it well done depends on some questions should be answered, as follows:

1. Is it to publish Sample Values? Is it to intermediate protection orders, in the end based on chapter Chapter 4 - Functional Description (Refer to Built-in Automation), which functions should this MU360 attend?
2. Is iit to be synchronized in time? (Refer to Time Management)
3. Is it to have different users and roles (Refer to User Access Control)
4. Is it to subscribe any content from either other IED or internal function? (Refer to Input/Output Associations and GOOSE)
5. Is it to publish any content to another IED? (Refer to GOOSE)
6. Which CORTEC should be used?

Assuming missing point not answered is about CORTEC, this section will show how to undertake a configuration based on it, therefore it is going to present how a basic configuration should be done based on common use case.

3.2.1.1 PREPARING BASIC PROJECT

Any configuration should be hosted in a project, then to have it well covered one should be done following these steps:

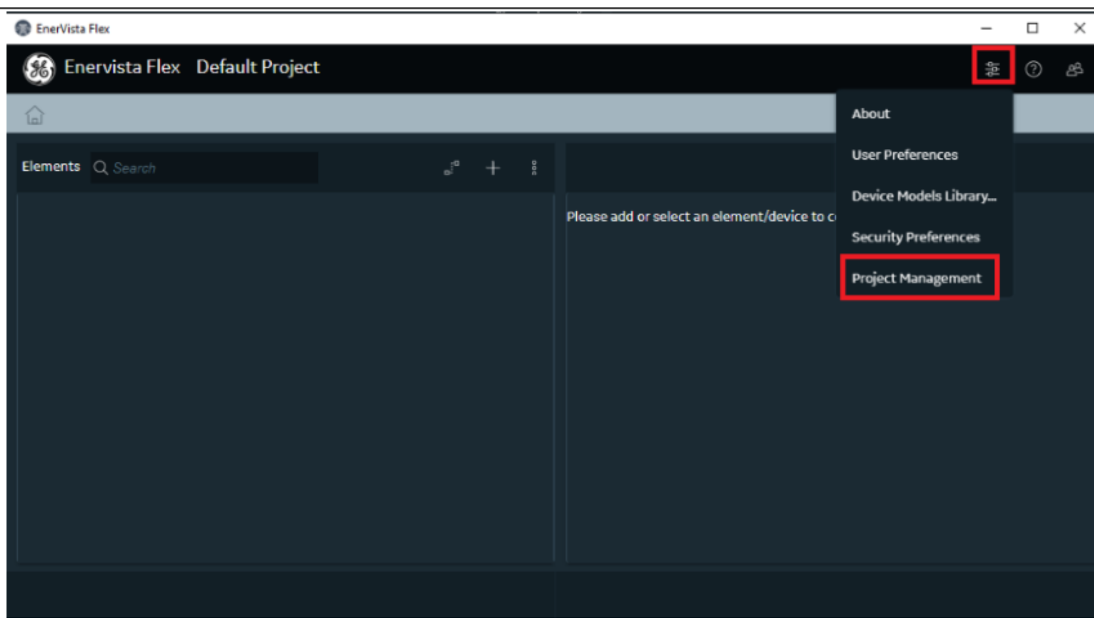


Figure 1: Step 1 - Access project management area

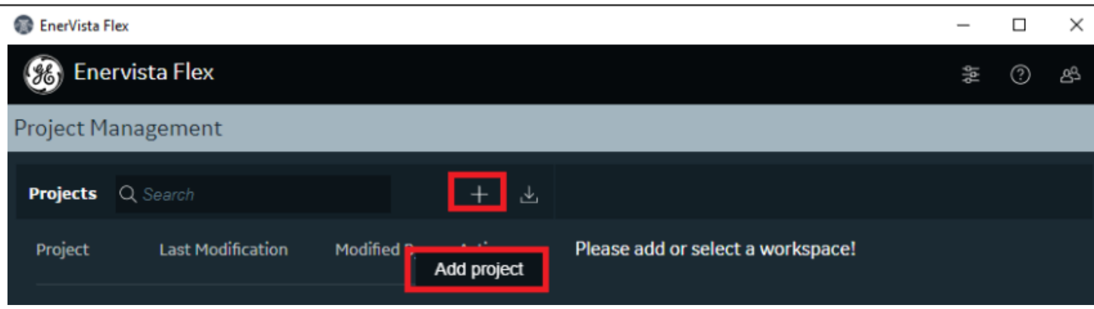


Figure 2: Step 2 - Add project

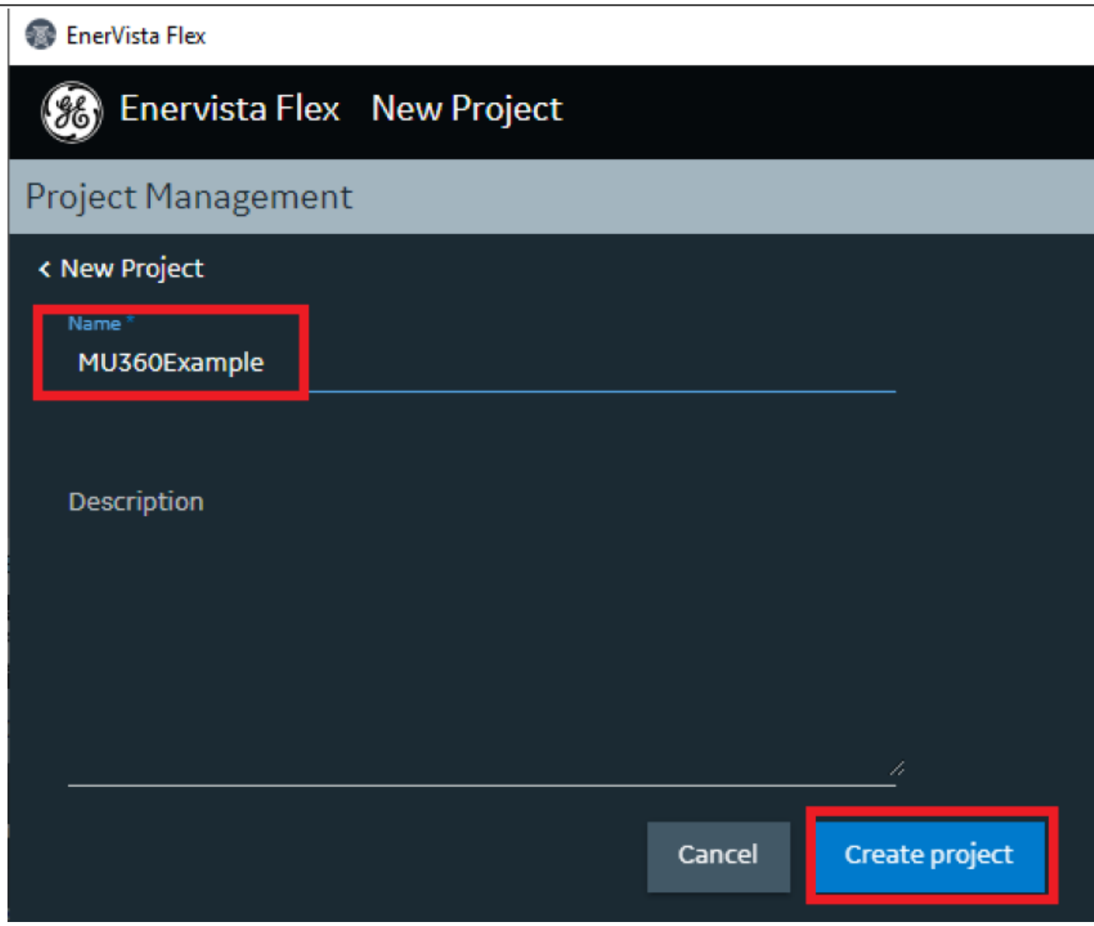


Figure 3: Step 3 - Give a name to the project

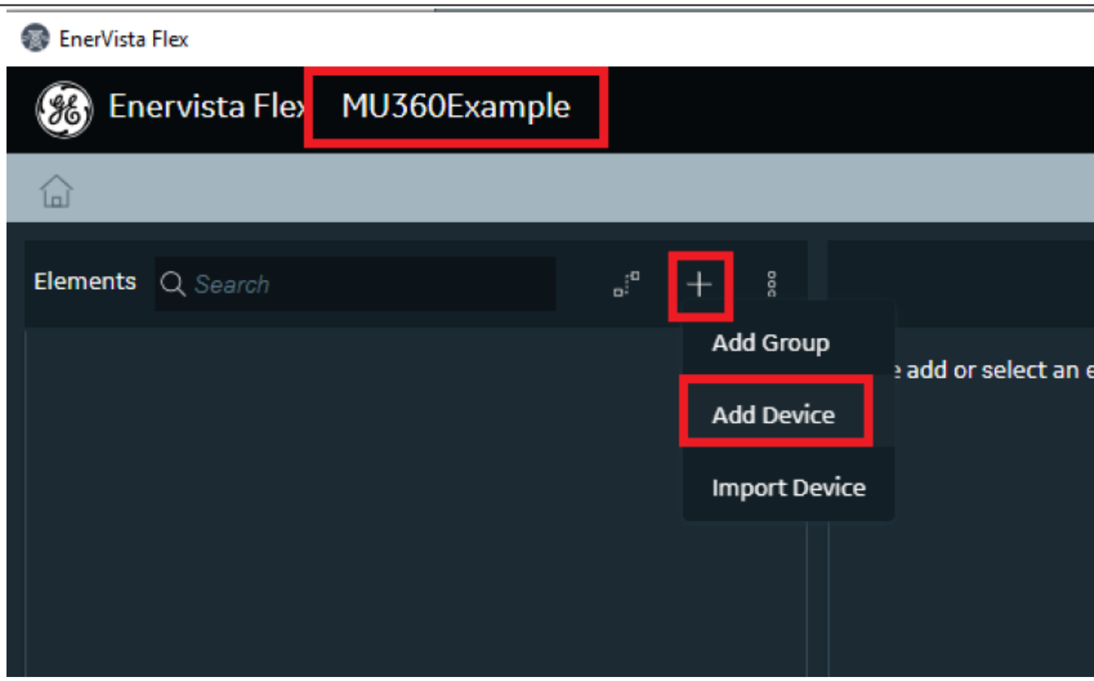


Figure 4: Step 4 - Add a device

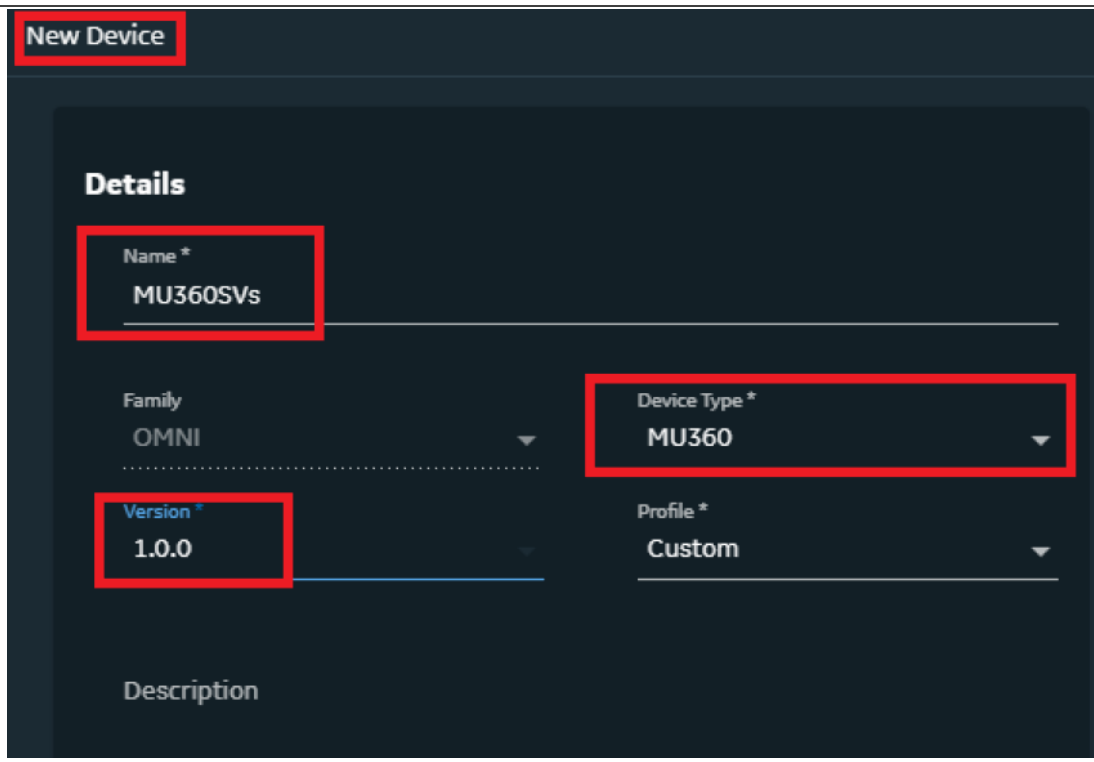


Figure 5: Step 5 - Give a context to the device

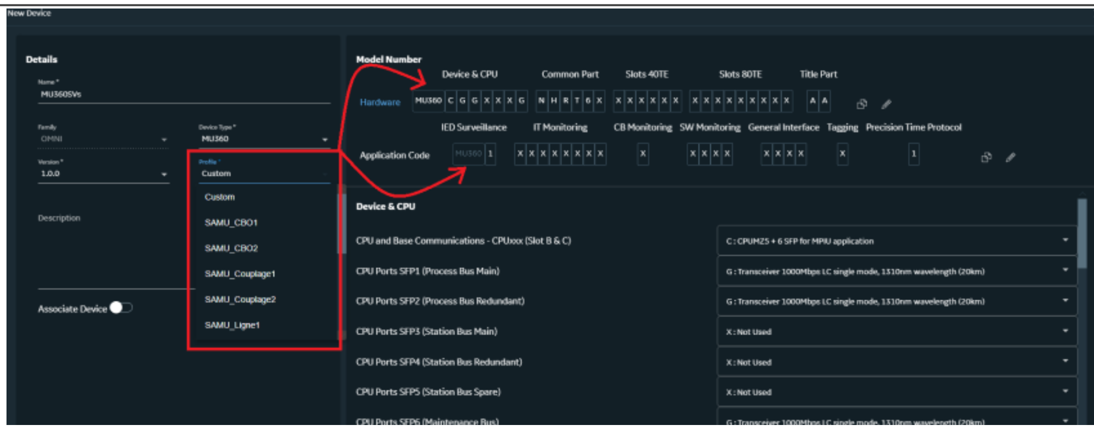


Figure 6: Step 6 - Select profile if all the CORTEC specifics are known. If not, keep it as custom.

> *Note:*
> *The user can try any Profile, if not good enough, custom can setup a CORTEC manually.*

> *Note:*
> *Any Profile is fixed, no way to change set of codes of Hardware/Application CORTEC. Check CORTEC section (Refer to Application Code and Hardware CORTEC) for more details.*

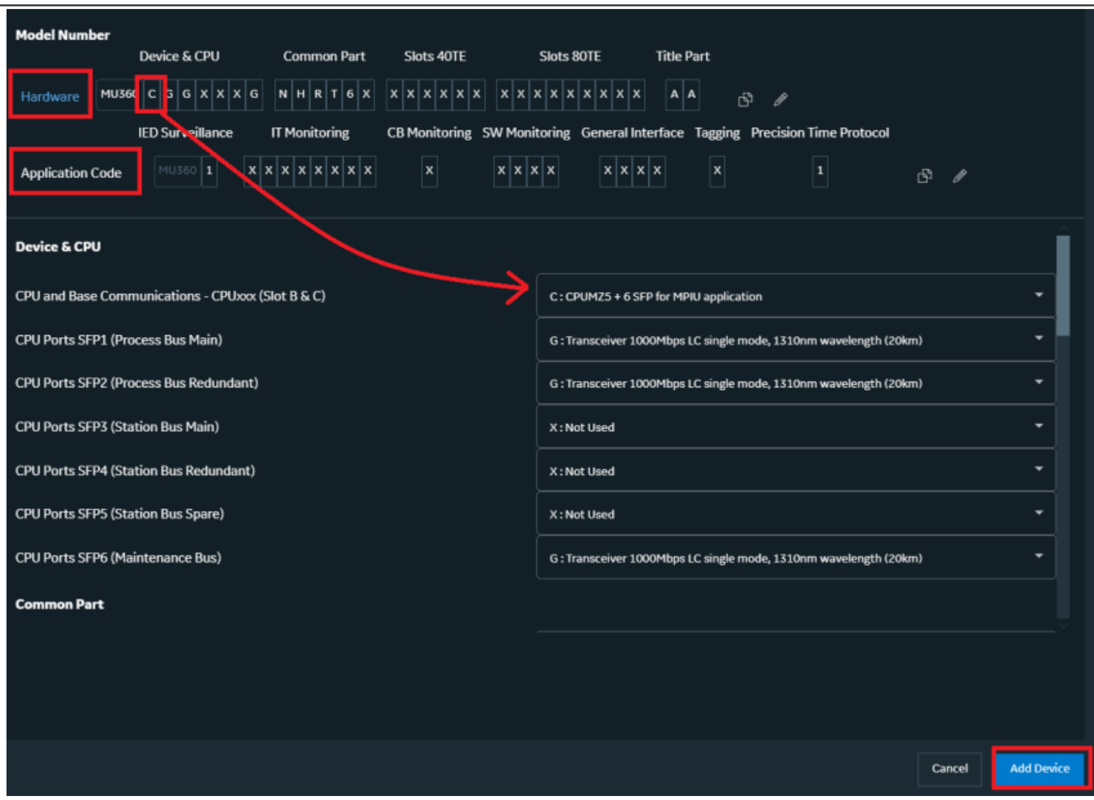


Figure 7: Step 7 - If custom profile, check/setup clicking on any CORTEC part. For application code, notice that functions ("Chapter 5 - Software Management", (Refer to Software Management) are associated with this area.

> *Note:*
> *Do not save it before checking if your set of codes is correct. After confirming click on “Add Device”. If there is no way to fix it, then the option is to create another device, following the same steps described above.*

3.2.2 APPLICATION CODE AND HARDWARE CORTEC

A CORTEC is a set of codes specifying number of main behaviors IED should attend. It is composed by two parts:

- Hardware: this part is fundamental to start an application since it describes all hardware disposition. Mandatory.
- Application Code: it depends on user's demand, which function should be used. Without any selection, only a simple configuration will be in place, only for demonstration, but not useful.

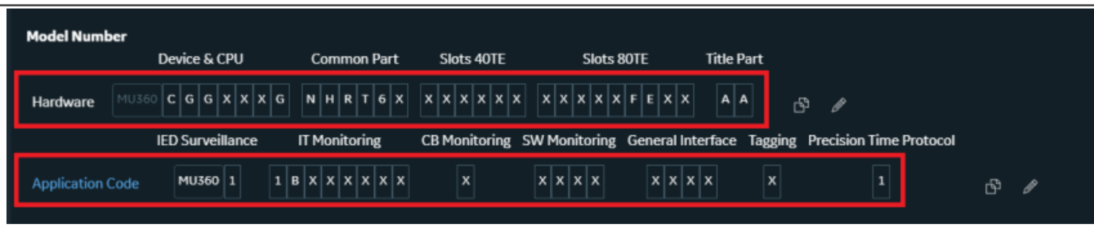


Figure 8: Model number

Most codes composing hardware CORTEC will indicate specificity to a physical board hosted at specific slot. As depicted below, slot N and O are the only port that can host TMU boards (Refer to CT/VT Protection Unit TMU310 and SCT/VT Measurement Unit TMU320), the other ones from D to M, can host either DIUs/DOUs or HBUs (Refer to Digital Inputs Unit DIU211 and Digital Outputs Unit DOU201 and High Break Unit HBU210)

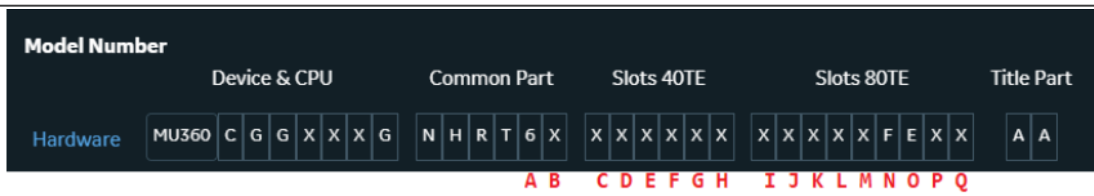


Figure 9: EnerVista Flex v2 hardware slots

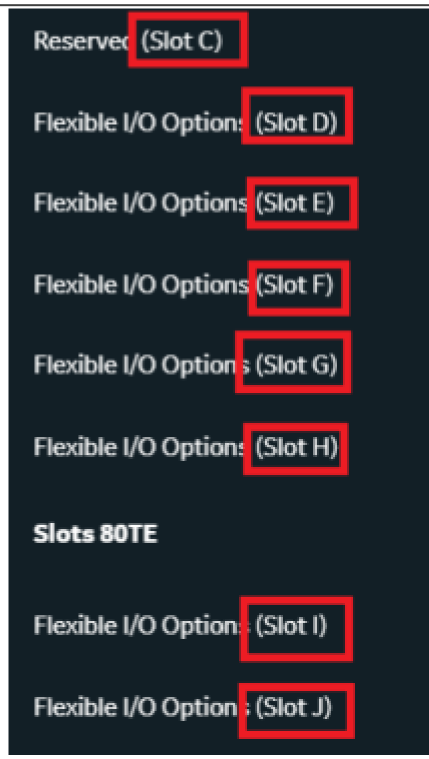


Figure 10: Hardware slots numbers

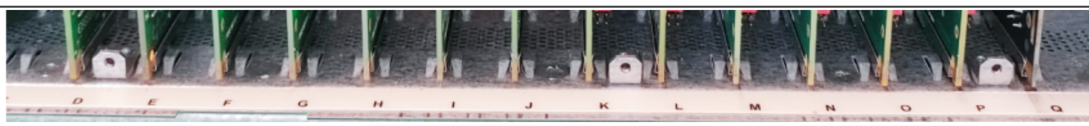


Figure 11: Hardware slots

Both parts (HARDWARE and Application code) are associated with each other, as the relationship when setting up IED treating a Voltage Transformer (TVTR) and Current Metering/Protection Transformer. First, it is necessary to have LDTM function enabled, clicking on specific Application code option, that depends on Hardware Slots hosting correct physical board (at slots N or O). Therefore, LDTM1 function is available when at least one TMU board is selected at slots N or O (options as Measurement and Protection). The LDTM2 function is available when the LDTM1 is already selected. Current Metering Transformer when the TMU320 board is selected (Measurement) and Current Protection Transformer when the TMU310 board is selected (Protection).

Extra functions should be included as depicted below, check details for each one in Chapter 4 - Functional Description.

Figure 12: Main MU360 functions

Summing up, user should know all functions MU360 should attend before configuring CORTEC, mainly for predicting which physical boards and functionalities are needed. Based on it, GE Vernova then will offer possible codes or those already fixed and presented by EnerVista Flex v2 (Profiles).

3.3 POWER SUPPLY

The BIU261S board includes the primary power supply, a watchdog relay, two input/output channels for MU360 redundancy, and two legacy isolated RS485 serial ports (Ports 1 and 2).

For quick installation, connect terminals 22 (Voltage input ground), 23 (Voltage input +), and 24 (Voltage input -) to an external DC power source, ensuring it meets the specifications in below table. Figure below shows the power supply connector pin-out.

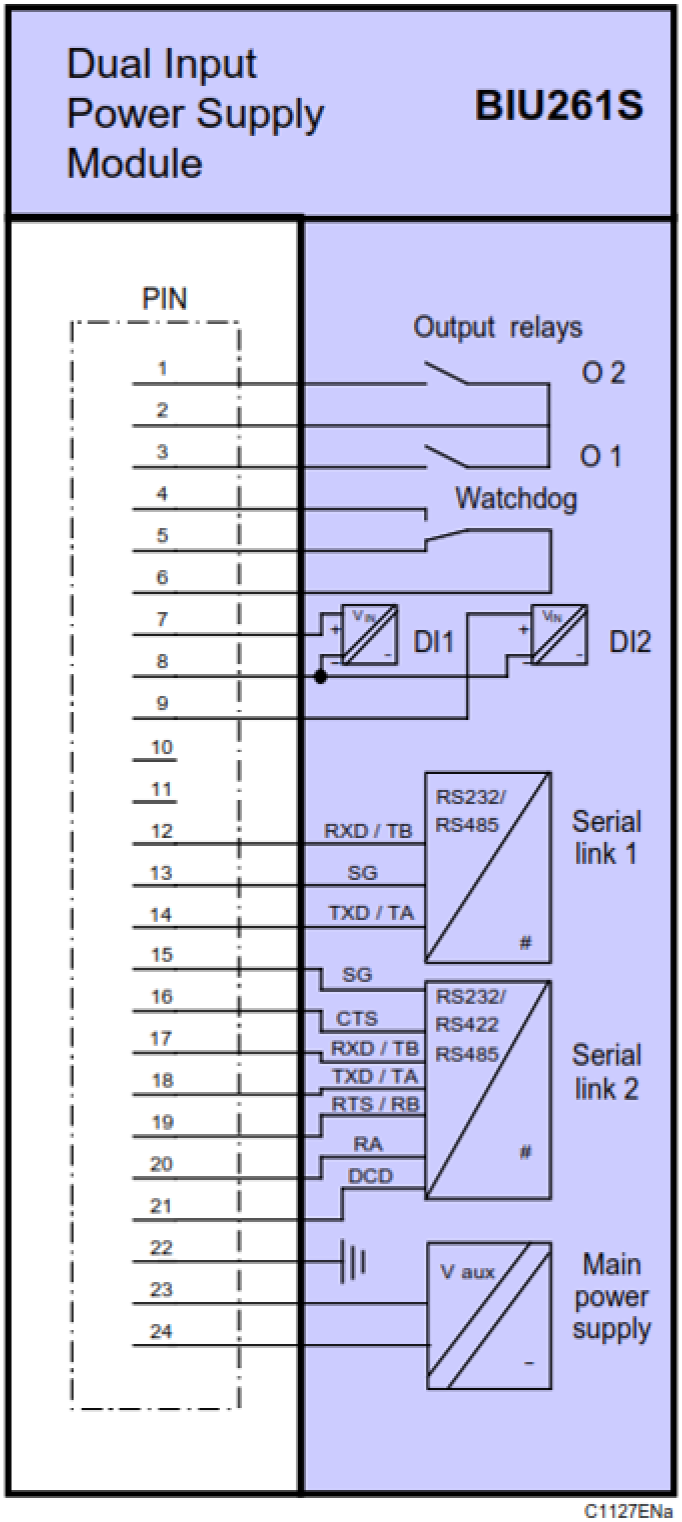


Figure 13: BIU261S Board - Block diagram

Power Supply Specifications NIU261S	
Operating nominal voltage	48 to 250 VDC
Frequency	DC only
Operating voltage range	40 to 300 VDC

Power Supply Specifications NIU261S	
Power consumption	38.7W @ 220Vdc 38.5W @ 110Vdc

For safety reasons MU360 must be earthed by protective conductor (earth) to the M4 threaded stud marked with the symbol shown below.

Warning:
To maintain the safety features of the equipment it is essential that the protective conductor (earth) is not disturbed when connecting or disconnecting functional earth conductors such as cable screens, to the PC stud.

Warning:
The protective conductor must be connected first, in such a way that it is unlikely to be loosened or removed during installation, commissioning or maintenance. It is recommended that this is achieved by use of an additional locking nut.

3.4 NETWORK CONNECTION

The MU360 has six physical communication interfaces, as shown in Figure 1. Each interface is compatible with 100BASE-LX (except the SFP6) or 1000BASE-LX, 1310nm wavelength optical Small Form-factor Pluggable (SFP) transceivers. More details see Chapter 6 - Communication.

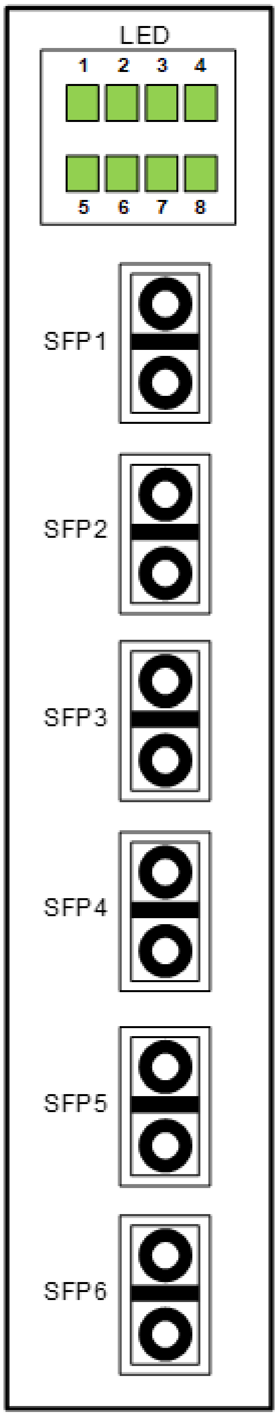


Figure 14: MU360 back view - communication interfaces

For a quick installation, a simple network setup is needed as shown below.

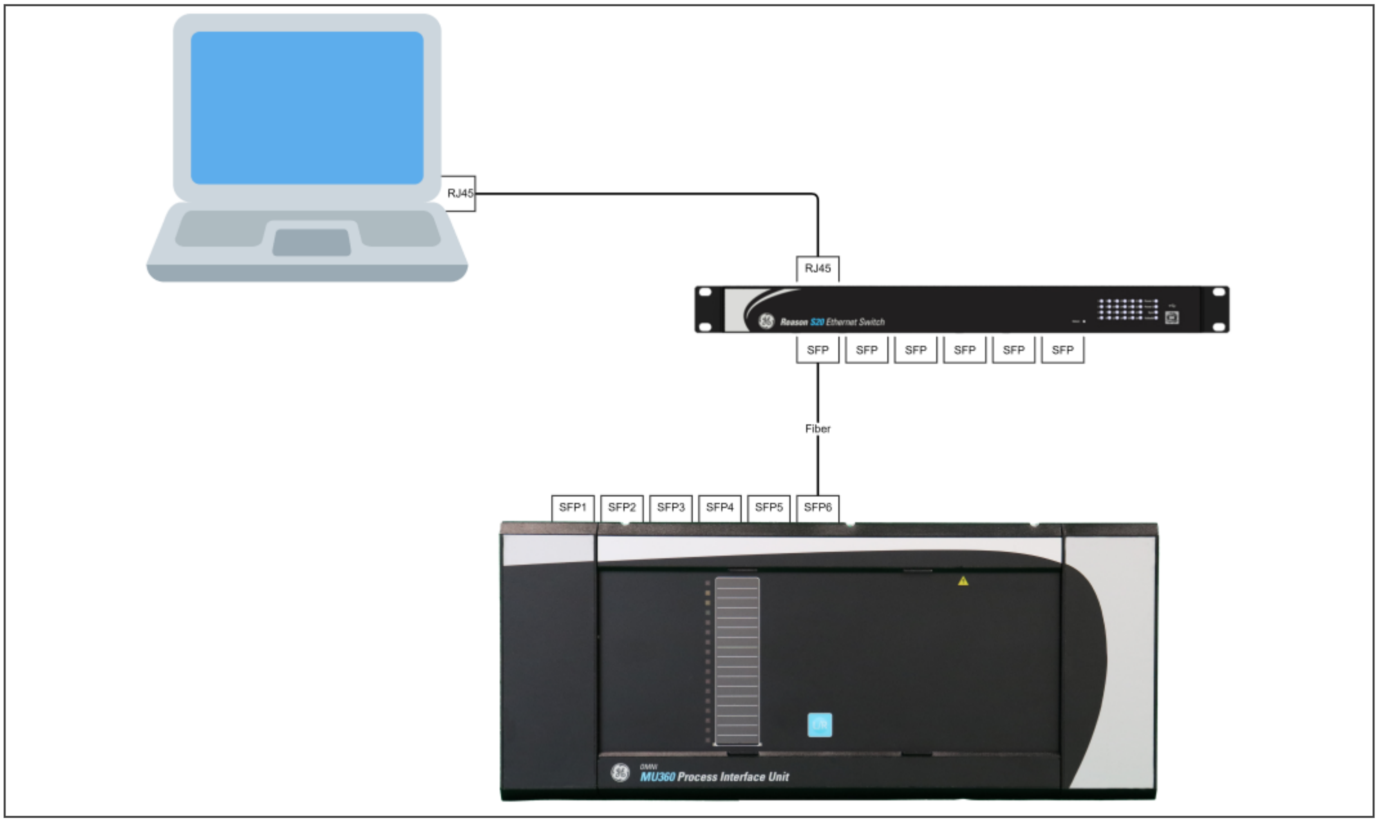


Figure 15: Simple network setup

When network is set-up, follow below steps to connect through Administration Bus (SFP6):

- Ensure that SFP6 of MU360 have an approved Small Form-factor Pluggable (SFP) transceivers and the switches that will be connect the MU360 too
- Connect optical fiber between SFP6 and switch
- Check if LED 7 (figure 1) is on or blinking, have communication
- Using a computer connected to switch, configure the computer in same network the MU360 (See below Table) and ping the device

Administration Bus Default Settings	
IP Address	192.168.1.199
Netmask	255.255.255.0
Broadcast	192.168.1.255

CHAPTER 4

FUNCTIONAL DESCRIPTION

4.1 CHAPTER OVERVIEW

This document is a chapter of the MU360 Technical Manual. This chapter contains the functional description of this device.

The hardware description can be found in the Hardware Description (HW) chapter of this manual.

All the connection diagrams are shown in the Connection (CO) chapter of this manual.

The capabilities, performance and environmental limits of this device can be found in the Technical Data chapter (TD) of this manual.

This chapter contains the following sections:

4.2 SUBSTATION APPLICATION

4.2.1 MU360 IMPLEMENTATION

The family of MU360 units discussed in this chapter can be integrated in the following configurations:

4.2.1.1 MU360 IMPLEMENTATION

Each MU360 includes an internal rack. The control unit's boards are mounted on this rack. "Rack" is the general technical name, but there can be different functional names.

The functional name depends on the MU360's location in a system. The functional names for the rack are:

- Main rack: In a standalone system, the first (and only) unit
- Main rack: In a redundant system, the default active unit
- Backup rack: In a redundant system, the default standby unit
- Redundant system: A system that includes an active unit and a standby unit

The family of MU360 units discussed in this chapter includes the following devices and configurations:

4.2.1.2 SINGLE BUSBAR SUBSTATION

The single busbar arrangement is the simplest substation topology. The substation design shown in figure below includes a bus section circuit-breaker. However, there are designs where this circuit breaker does not exist, meaning there is only a single busbar.

In the single busbar arrangement, there is only one protected zone, which is defined by the location of all feeder CTs. Dependability in clearing the busbar faults is ensured by remote backup protection. When a busbar fault occurs, the BusBar differential protection will trip all circuits connected to the busbar, shutting down the entire substation.

If for any reason the busbar differential protection does not operate, the remote Zone 2 distance protections will trip with time delay and the substation will be shut down. This action will also result in the disconnection of the line to this substation and all load connected to this line will lose power as well.

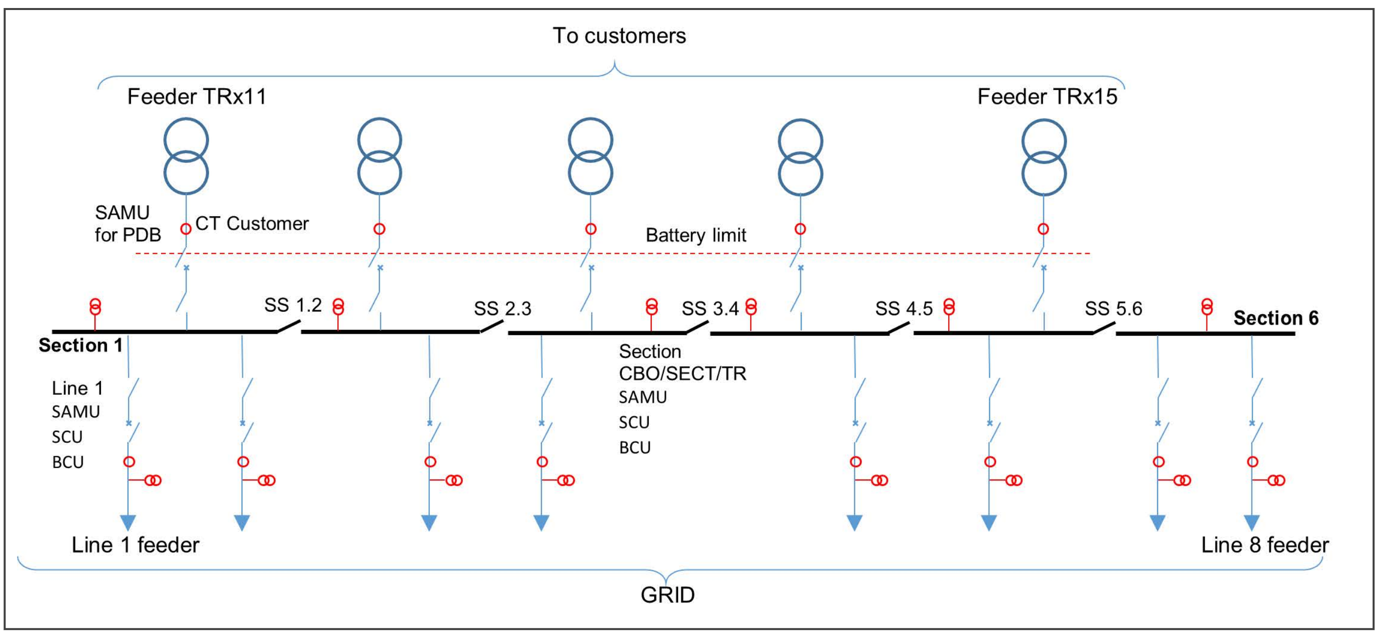


Figure 16: Single busbar arrangement

4.2.1.3 DOUBLE BUSBAR SINGLE BREAKER SUBSTATION

In substations with a double busbar single breaker with bus coupler arrangement, two busbar differential protection zones exist. When the bus coupler is open, busbar faults are fed directly by its connected feeders. During the process of clearing a bus fault, the busbar differential protection will open all corresponding circuit breakers and isolate only the affected zone.

The second zone (where fault does not exist) will remain stable, since its differential current will stay near zero. If for any reason the Busbar differential protection fails to operate, the fault will be cleared by remote backup protections, typically Zone 2 distance protections. The number of circuits disconnected will be the same as when the busbar differential protection operated properly, since the dependability is ensured by backup protections and the selectivity is ensured by the open state of the bus coupler.

The downside is that the fault clearance time is now dependent on the setting of the remote Zone 2. In addition, the tap loads connected to the supplying line will be disconnected as well. Even in case of an unwanted operation of the busbar differential protection that causes a trip of one protected zone, only the associated feeders will be disconnect from the power system.

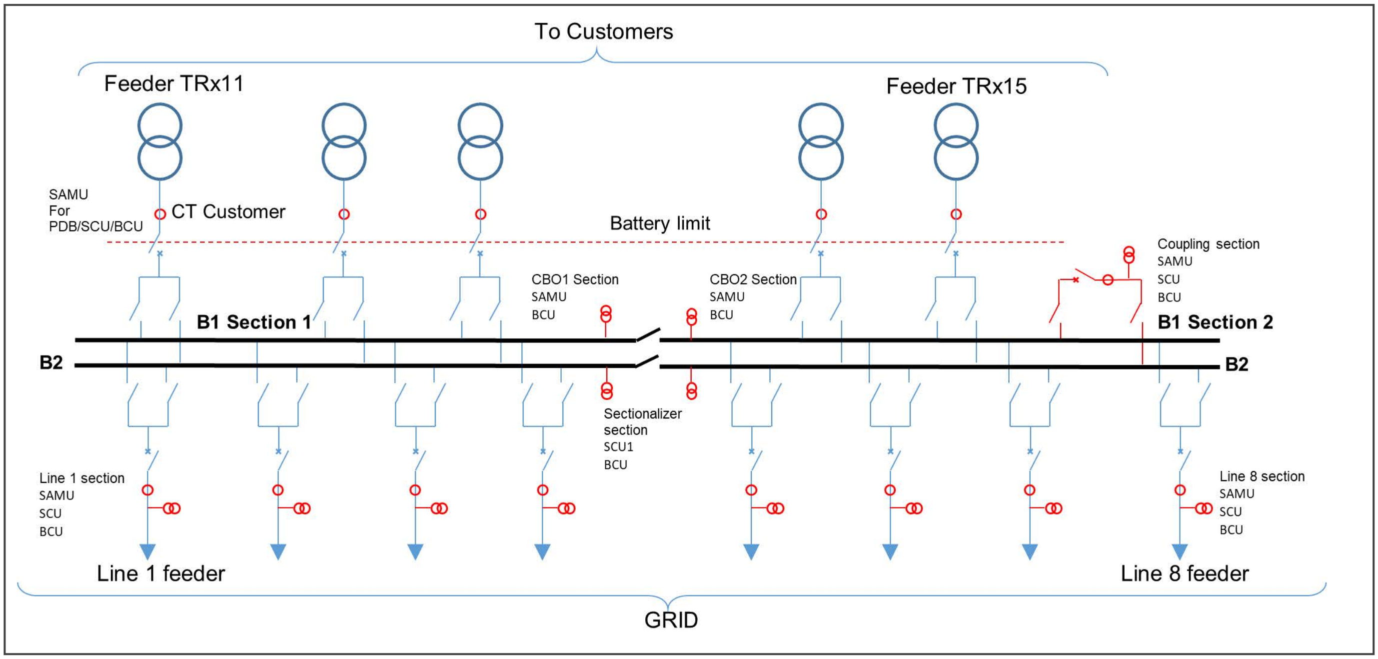


Figure 17: Double busbar single breaker arrangement with two sections

4.2.2 SUBSTATION NETWORK EXAMPLE

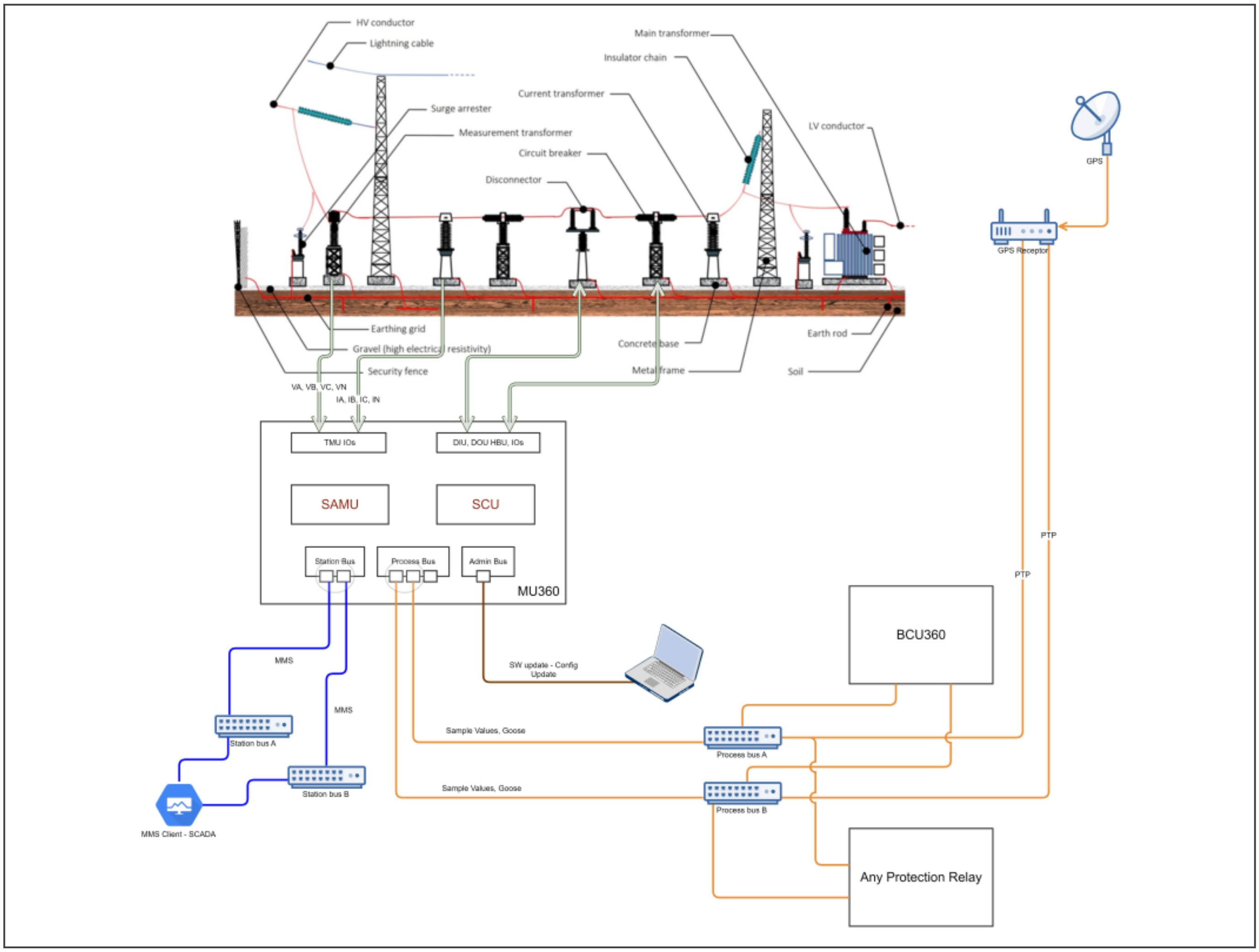


Figure 18: Substation network example

4.3 SOFTWARE FEATURES

The MU360 is a modular product at hardware, software and functional levels. All its functions are fully configurable in accordance with the customer's needs and requirements. The MU360 offers the following features:

- Direct Operator Interface (ICT)
- Embedded parameters to control all common plants or devices
- High communication abilities to IED and Ethernet
- Settable automation modules
- Events, alarms, measurement display, printing and archiving
- Enhanced inner management with database management, self-test controls and the capability to synchronise all the devices

The components of the software management include:

- Analogue Inputs: AI, received by subscribed SV coming from SAMU
- Communications with the Tele Control Bus (TBUS), Station Bus (SBUS)). Please refer to the Communication chapter of this manual.

The MU360 handles several functions such as:

- Built-in automation functions:
  - Voltage Check
  - Breaker Failure
- Protection function:
  - Overcurrent protection
  - Distance protection
- IEC 61850-9-2LE (Sampled Values) compliant
- IEC 61850-8-1 ed2.1 (GOOSE) support
- Report control blocks
- Protection and Measurement Sampled Values profile support
- Monitoring and control using MMS protocol
- Use of virtual LAN and priority tag (802.1Q)
- Transfer time of GOOSE signals within Type 1A, performance class P1 (less than 3ms)
- Support for network redundancy PRP (IEC 62439-3)
- In the event of communication loss, all main information is signalled via LEDs (Power, In Service, Alarm, Sync, LAN A and LAN B)
- Front-end IED configuration tools for standardised SCL file
- Synchronised via PTP version 2 IEEE 1588 protocol
- Excellent performance and stability
- Up to 16 analog inputs, 8 voltages and 8 currents
- High accuracy analog board with 4VT + 4CT
- Up to 96 conventional digital inputs and up to 32 digital GOOSE inputs
- Up to 48 binary outputs
- 2 simultaneous Sampled Values streams
- Binary inputs and outputs via GOOSE messages
- Installed in the substation courtyard within appropriate panel
- Operating temperature -40 °C (-40 °F) to +55 °C (+131°F)
- Fan-less and no rotating part design

- Fail-Safe relay (watchdog)
- Self-monitoring (internal voltages and temperature)
- Synchronisation holdover
- Circuit neutral calculation
- IEC 61850 Quality Bits
- Combined GOOSE inputs to operate a Binary Output
- IEC 61850 modelling for interface with Circuit Breakers and Switches
- Connection between digital signals and data model
- Interface for logic configuration of Binary Inputs and Binary Outputs
- Test mode
- Local time

4.4 MU360 MANAGEMENT

This chapter provides instructions for connecting, configuring, and updating the firmware of MU360. This section is designed for technicians, engineers, and system architects responsible for O&M of the devices and the final solution. It outlines the basic steps to achieve the desired device behavior, although detailed instructions for parametrization and advanced configurations can be found in the dedicated configurator manual.

4.4.1 CONNECTING THE DEVICE

The device can be managed using GE Vernova EnerVista Flex v2, connecting to it from the Administration network interface (SFP6) only. If the device was not already configured, it should be configured with the default administration IP: **192.168.1.199/24**.

- In Enervista, go to “Project Management” tab

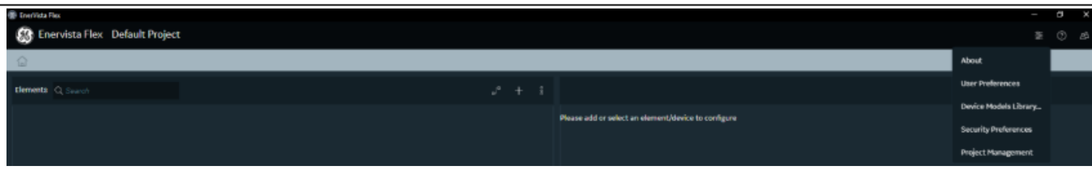


Figure 19: EnerVista Flex v2 project menu

- Create a new Project from the **+** icon

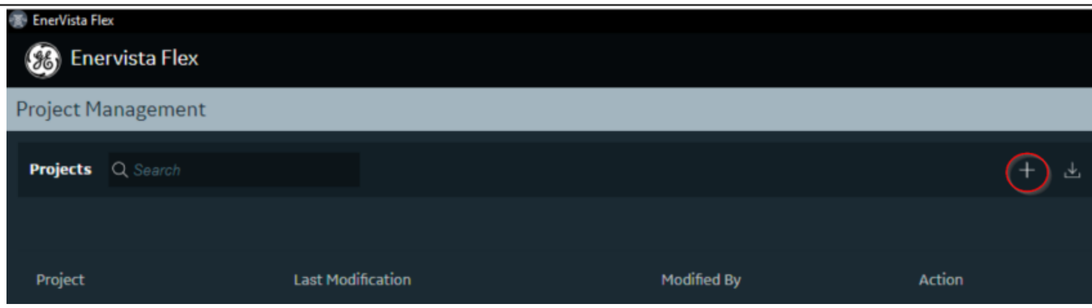


Figure 20: EnerVista project management menu

- Create a new project and a new Device

Figure 21: EnerVista Flex v2 new project

- Create a new MU360 device of your liking. Match the owned CORTEC and choose an adequate application code which will fit your needs.

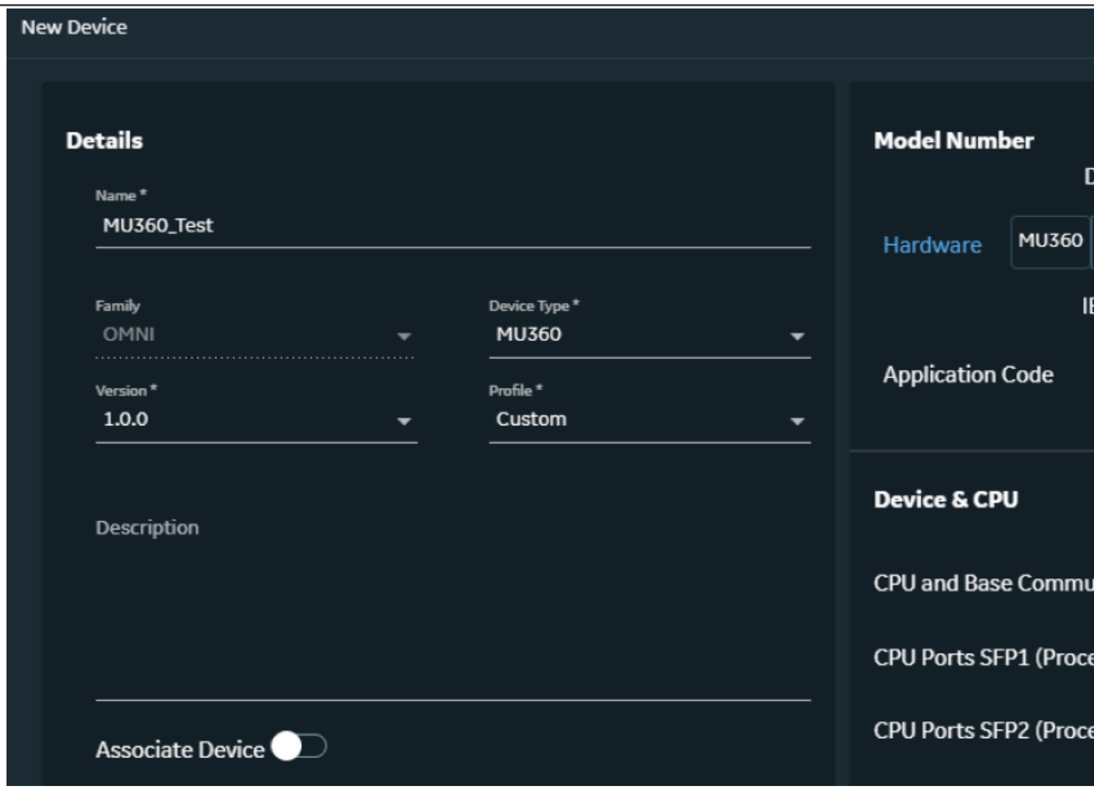


Figure 22: EnerVista Flex v2 new device

- Access the device menu by clicking on top of the device name

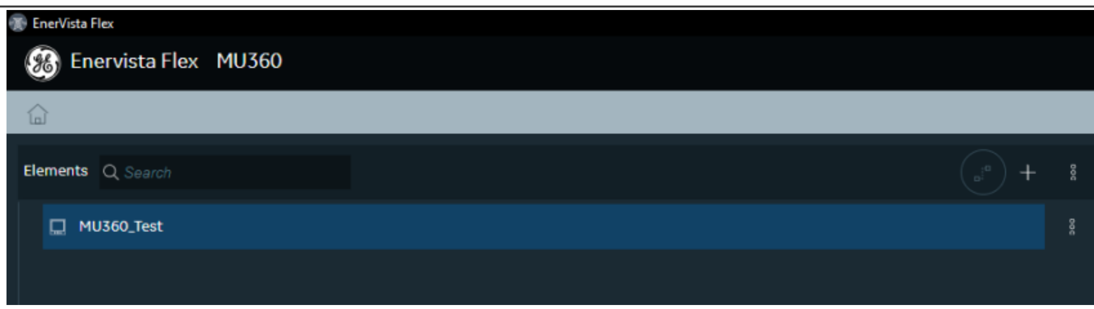


Figure 23: EnerVista Flex v2 device menu

- Click on “Connect” on the bottom left corner of the screen

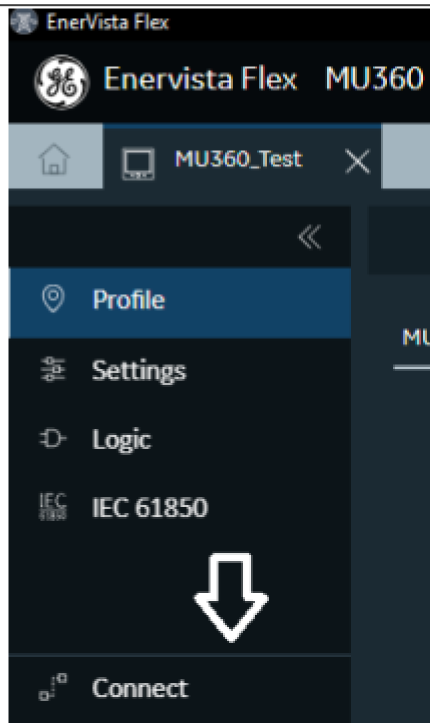


Figure 24: EnerVista Flex v2 device option tab

- Add the Connection information of your device

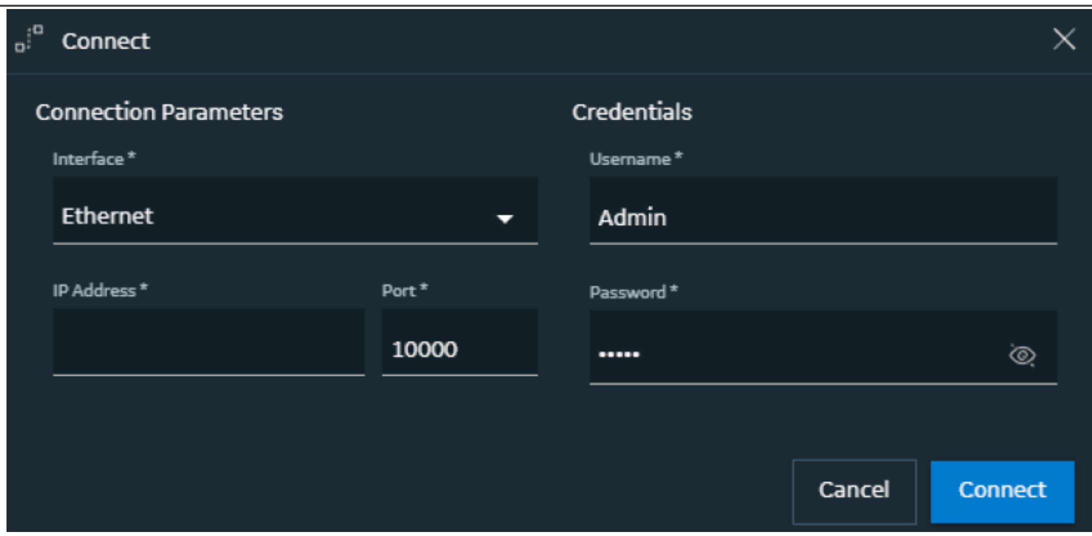


Figure 25: EnerVista Flex v2 connection pop-up

Upon connection, the user will be able to access device information and send commands.

4.4.2 CONFIGURATION UPDATE

To configure the device, go back to the device menu and click on "Send Full Configuration" then, if the device is reachable, the "File Transfer" pop-up will come out. Just click "OK" and it should handle the command.

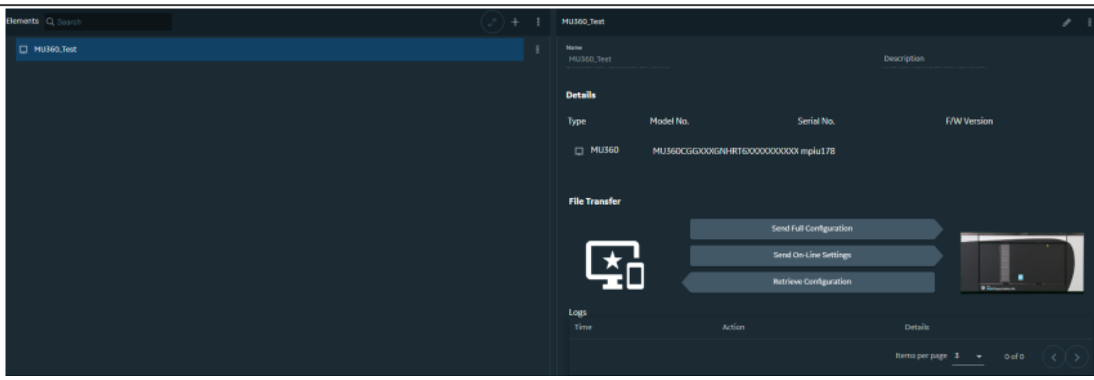


Figure 26: Device menu

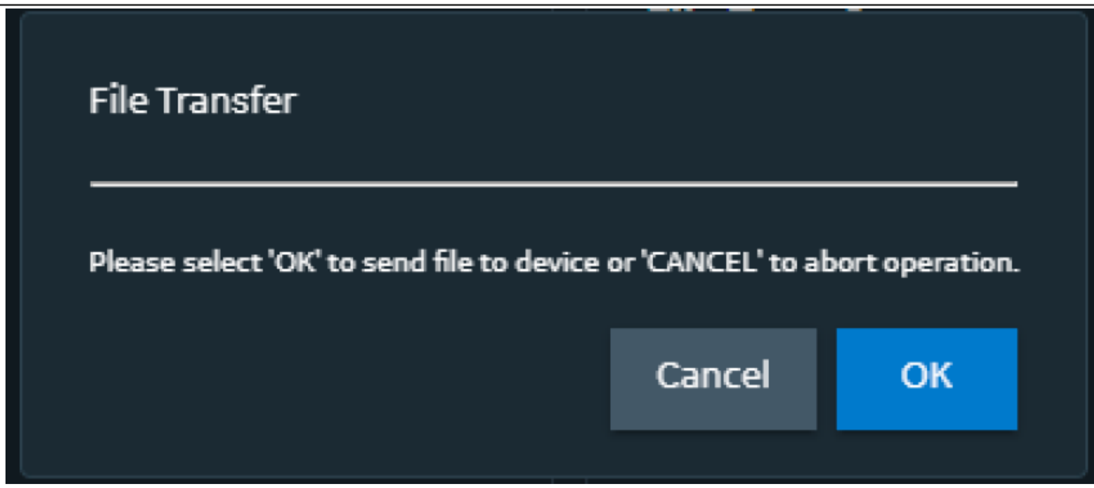


Figure 27: File transfer pop-up

The configuration status will be displayed in the logs section of the device menu.

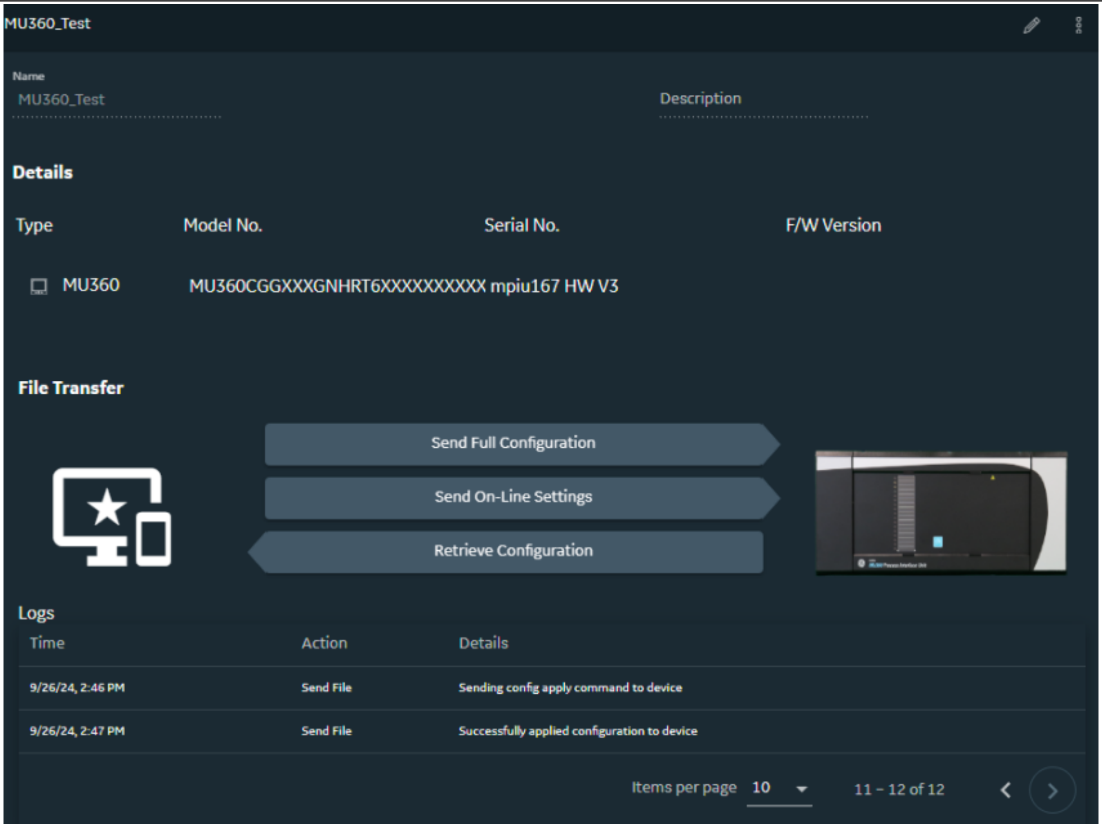


Figure 28: Device interaction logs

4.4.3 RUNTIME SETTINGS

For this operation you will follow similar steps. Select "Send On-Line Settings" on the device menu and follow the same steps from the configuration update.

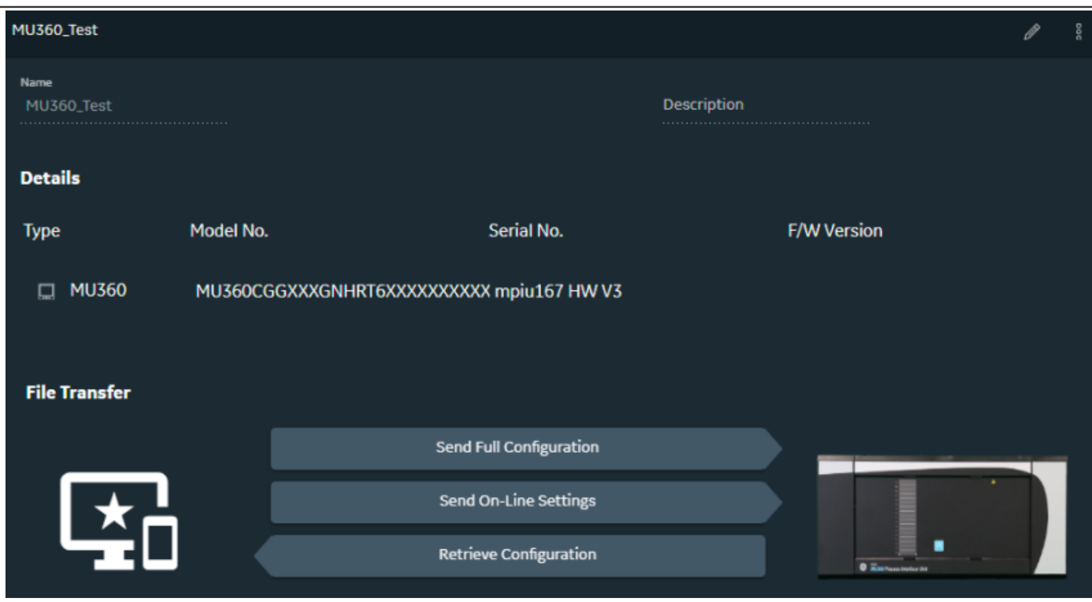


Figure 29: EnerVista Flex v2 send online settings

4.4.4 IMPORT DEVICE

To be able to retrieve a configuration into ICT from a working device, use “Retrieve Configuration” option in the device menu above. It will save the device configuration in a .zip file into your computer. Then, select the “Import Device” option to load the .zip configuration file into the project.

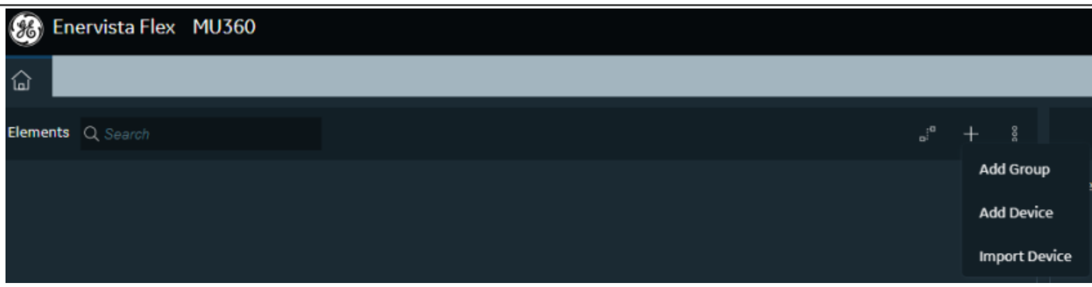


Figure 30: EnerVista Flex v2 import device

4.4.5 FIRMWARE UPDATE

First find the Firmware version required from the GE Vernova official website: https://www.gevernova.com/grid-solutions/multilin/catalog/mu360.htm. With the firmware file at hand, go to the “Maintenance” menu and select the firmware file you want to load and click in upgrade.

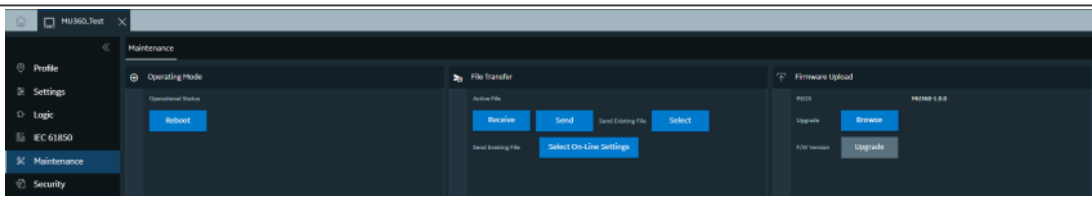


Figure 31: EnerVista Flex v2 maintenance menu

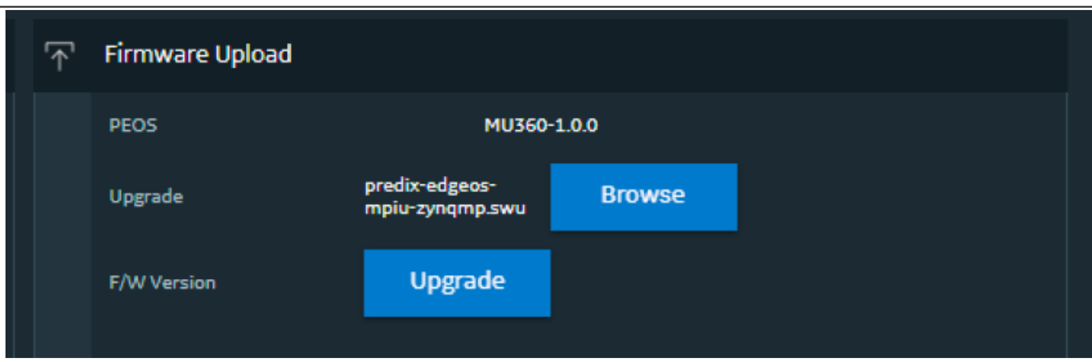


Figure 32: EnerVista Flex v2 firmware update

The configuration might take from 10 to 20 minutes depending on the file transfer speed and the size of the upgrade. A log on ICT will be available so you can check the upgrade status.

4.4.6 SELF-TEST

This section tries to summarize the procedures the device executes to check the operation integrity and health. It continuously checks the critical components by identifying deviant behaviors and, either generate alarms and logs, as to act upon it.

4.4.6.1 BOOT

When the device is powered on, it starts loading all the components and features it needs to start operation. At a first stage, only the Power LED on the HMI will be on. The device is not accessible from EnerVista Flex v2.

During this stage, the device checks if all the functional components are correctly loaded, if not, after a designated time, the device will re-install these components. Because of this, if any inconsistency is found, the boot and configuration might be delayed.

4.4.6.2 CONFIGURATION

After starting all the main components, the device starts to load the current working configuration. First the integrity of the configuration will be checked to ensure it is still valid. If anything happens, the configuration is aborted and there will be a rollback (to the default configuration or the latest working configuration if it is applying a new configuration from EnerVista Flex v2).

Next, the configurations will be applied to the components. The LEDs from the HMI will gradually turn on or off, depending on the actual state they are representing. As above, if it fails the rollback will be applied. Here, some error/warning details can be found in the device logs.

4.4.6.3 IN SERVICE

This state consists of all the main features being up and running. Still, it cannot be connected from EnerVista Flex v2 or MMS, but it is already subscribing to GOOSE, publishing it, and publishing SV. The “In Service” LED will be blinking at this point and the BIU relay will be closed.

4.4.6.4 FULL OPERATION

At this point all functions, like MMS, syslog and so on should be working according to the configuration applied. The “In Service” LED in the HMI will be on. After that it can be connected using EnerVista Flex v2.

4.5 COMMUNICATIONS

The MU360 supports different types of communication channels:

- Process bus
- Station bus
- Administration bus

4.5.1 PROCESS BUS

The Process Bus concept, as introduced by IEC61850-9-2, is where MU360 interfaces with process level current and voltage transformers (CT/VT) equipment and bay level protection and controller Intelligent Electronic Devices (IEDs). The following sections details the protocols that are supported to be running at process bus.

4.5.1.1 SAMPLED VALUES (SV) - IEC 61869-9, IEC 61850-9-2LE

Sampled Values, defined by IEC61869-9 and IEC61850-9-2LE, are digitized data acquired from CT/VT and sent to the process bus ethernet network. The data is gathered with Instrument Transformers (IT) which outputs are sampled, converted to digital values and then formatted for transmission through the process bus to other connected IEDs.

4.5.1.2 PRECISION TIME PROTOCOL (PTP) - IEEE1588

The IEEE 588 v2 standard defines the PTP protocol and is supported by MU360, which synchronizes its clock within the network (process or station bus) by adjusting its internal clock to keep synchronized with the network grandmaster clock.

MU360 works as a PTP client, which is synchronized with a grandmaster clock present in the network acting as a time server. If the time server is not available or the connection is lost, the MU360 continues updating its internal clock, but the status reported is that the device is not synchronized with a grandmaster clock.

4.5.1.3 GENERIC OBJECT ORIENTED SUBSTATION EVENT (GOOSE) - IEC 61850-8-1

MU360 supports fast GOOSE sending with the configured parameters to all the IEDs on process bus. The fast GOOSE frames for process bus are processed by a dedicated unit to attend the transmission and processing times defined in IEC61850-5 standard (type 1A “Trip” performance class).

4.5.1.4 MANUFACTURING MESSAGE SPECIFICATION (MMS) - IEC 61850-8-1

The IEC61850 standard defines the MMS protocol for the communication between servers of data the clients that can consumes them. It provides a set of features that enables the clients to gather data model of the IEDs in a standardized way, as well as modifying the data on the IEDs and send control commands.

4.5.2 STATION BUS

The station level is the part of a substation automation system typically includes operator workstations with human machine interfaces which can retrieve data from the IEDs. It may also include gateways to other facilities such as a control center. The following protocols are supported by station bus in MU360.

The station bus network of MU360 supports the MMS protocol mainly. It can also be configured, by the IED configurator tool, to support the PTP protocol, instead of the process bus. The MMS protocol is always on station bus if this bus is enabled by the configuration provided to MU360.

4.5.3 ADMINITSTRATION BUS

The administration bus is a dedicated communication channel in MU360 used for maintenance activities. It is reserved for secure communication with the IED configurator tool to configure the device, transfer files, retrieve logs and the device patrimonial data. The administration bus does not work on redundant mode, only one physical port is used for the communication.

4.5.3.1 SYSLOG

The syslog protocol, as defined by RFC 5424, is used to report event notification messages. The events can be sent to a remote server (syslog server) by configuring the appropriate parameters in the IED configurator tool.

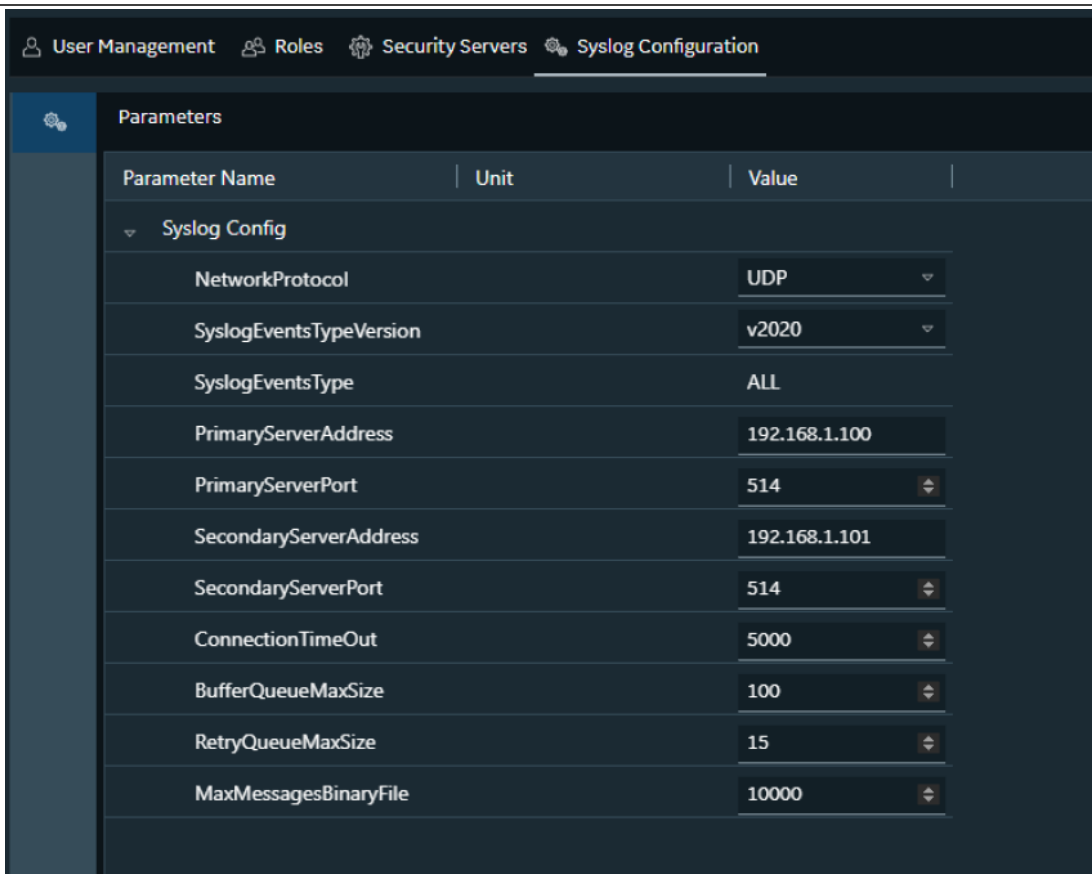


Figure 33: Syslog Configuration screen in EnerVista Flex v2

The following communication protocols are supported for syslog:

- TCP: the IED can detect loss of communication with syslog server and the messages are buffered locally. When the server is available again, they are sent.
- UDP: this protocol is not connection oriented, so the IED is not aware of the communication status with the syslog server. When the server is down the messages are stored locally but are not received by syslog server afterwards.

4.5.3.2 IED CONFIGURATOR TOOL

The communication with the IED configurator tool (Enervista Flex V2) is done through a proprietary protocol running over a TCP/TLS secure connection. The IED patrimonial data and status can be read from the IED and other actions are possible, such as configure the IED parameters, retrieve logs and upgrade the firmware of the device.

4.5.4 NETWORK TRAFFIC CONTROL

4.5.4.1 PARALLEL REDUNDANCY PROTOCOL (PRP)

The PRP protocol in MU360 is implemented according to IEC62439-3 Clause 4 standard. It allows the nodes (Doubly Attached Nodes obeying PRP – DANPs) to be connected to two independent Local Area Networks that operates in parallel. Each node sends frames to both networks and the destination nodes are responsible for receiving them, process the first frame received and discard the duplicated one.

On the other side, a Single Attached Node (SAN) is a device that is not aware of the redundancy protocol, such as a laptop, a printer or another IED without redundancy capability and it's connected to the redundant network through a DANP bridge.

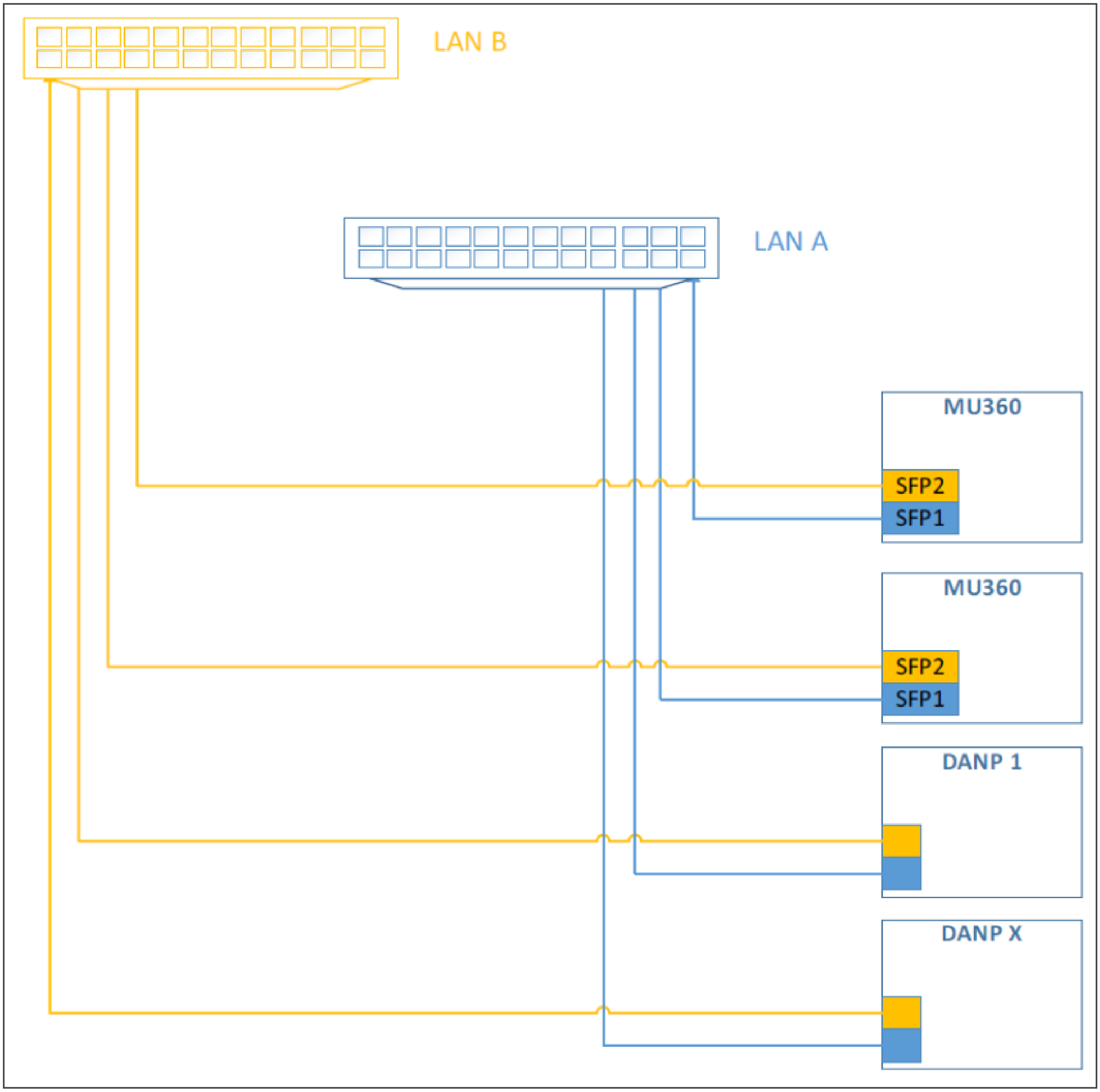


Figure 34: Example of a PRP network

4.5.4.2 HIGH-AVAILABILITY SEAMLESS REDUNDANCY (HSR)

The HSR protocol, implemented according to the standard IEC 62439-3 Clause 5, allows to connect the devices ports to the same LAN segment using typically a ring (as shown on the figure below) as well as other types of network topology.

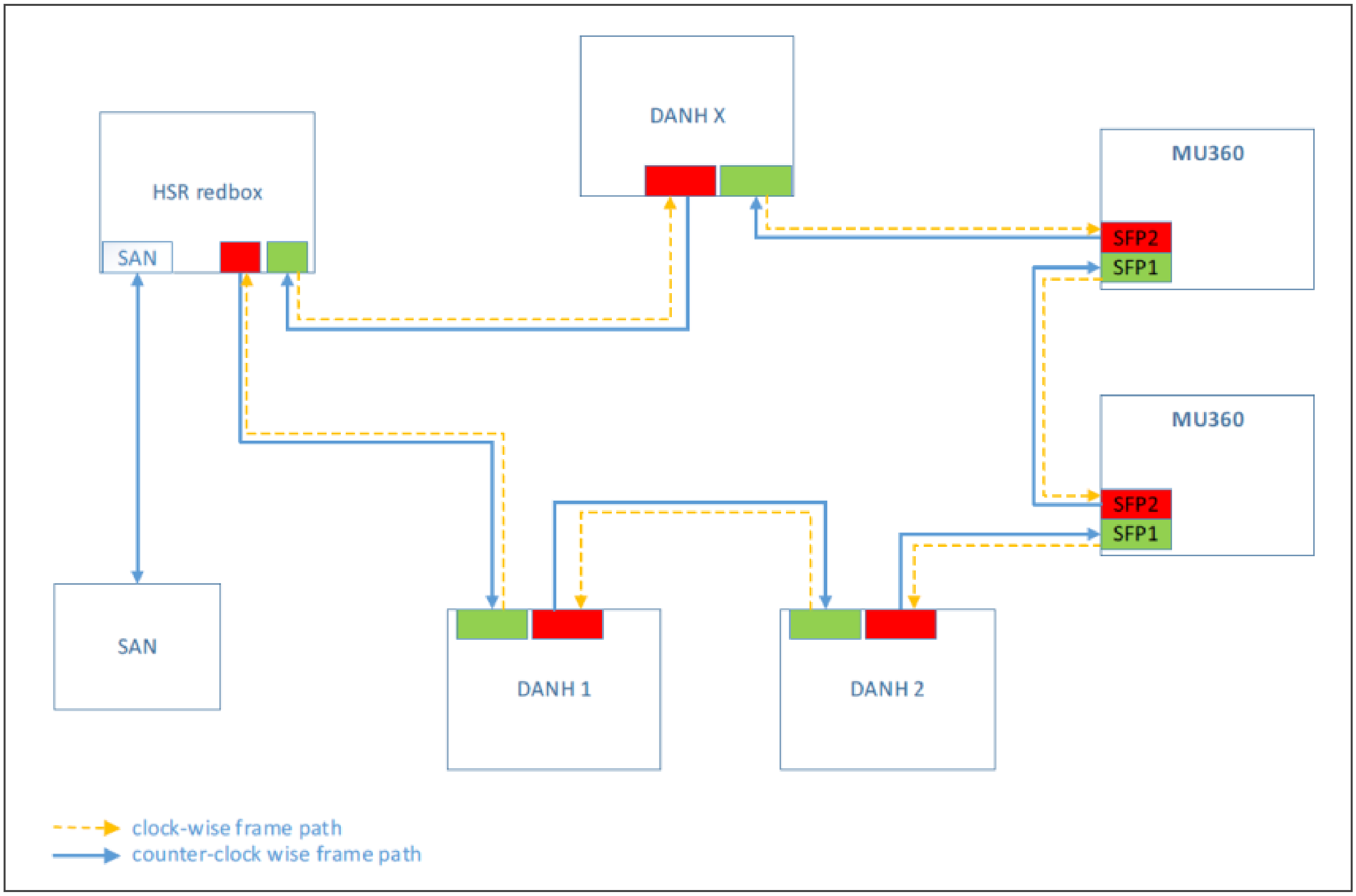


Figure 35: Example of an HSR ring network with MU360

As per IEC 62439-3 Clause 5, each HSR compatible device of an HSR network is called a Doubly Attached Node running HSR (DANH).

> **Caution:**
> **the DANH devices connections on an HSR ring network must follow a specific order to work properly, like shown on the figure above.**

If there is a single failure in one side of the ring, the other side will continue providing the communication seamlessly.

4.5.4.3 VLAN FILTERING

MU360 supports IEEE 802.1Q VLAN traffic segmentation on the IED. The device can isolate traffic of Sampled Values, GOOSE, PTP and MMS protocols using the VLANs solution. If different VLANs are assigned to each protocol, then a solution with isolated traffic per protocol will be achieved. As per IEEE 802.1Q, each VLAN is seen as a logical isolated network, saving costs and bringing more flexibility than separating them physically.

The MU360 VLAN filtering rules are applied to the device network interfaces. When receiving a VLAN tagged frame, the device compares the VLAN ID of the frame received to the enabled VLAN IDs of that network interface. If the

VLAN ID of the received frame is part of the enabled VLAN IDs for that port, the frame will be then processed by MU360. If not, the frame will be discarded.

Refer to the Communication chapter for more information on the default settings and values used for VLAN solution on MU360.

4.5.4.4 FIREWALL

MU360 device has an internal firewall installed to control incoming and outcoming network traffic on the device and to prevent unwanted traffic from the outside.

MU360 uses the firewall to control which ports should receive MMS, syslog and the configurator tool connection and data. For instance, MMS is enabled only on Process or Station bus, while Syslog and the IED configurator tool traffic are enabled only on the Administration Bus network interface.

4.6 ANALOG INTERFACES

This chapter is dedicated to understanding specifics about configuration and functions related to analog interfaces (CT/VT) and measurement.

> *Note:*
> *For the supported set of Analog Modules (TMU Boards) and hardware specifications, please refer to the hardware chapter.*

> *Note:*
> *For compliance to the IEC-61869-13 standard, please refer to the technical data chapter.*

4.6.1 CHANNEL CONFIGURATION

All MU360 analog channels, can be translated to an interface with CT/VTs, related to Measurement or Protection functions.

To configure the analog channels properly there are 2 parts to be considered:

- TMU Board inputs configuration
- Instrument Transformer (CT/TV) interface configuration

4.6.1.1 TMU BOARD INPUTS CONFIGURATION

It relates to the actual analog module TMU that is being configured and its set of available channels. Here it is possible to either check the physical connection references of each channel or also select a nominal magnitude for each channel (refer to the hardware chapter).

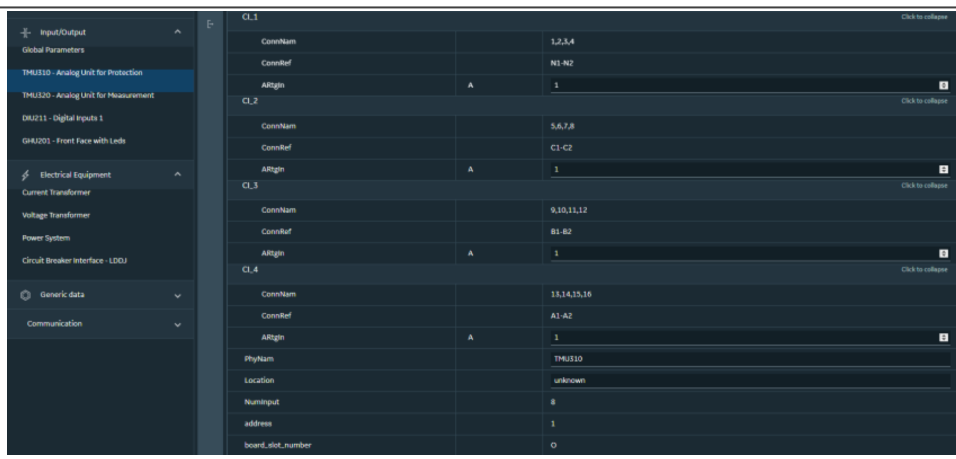


Figure 36: TMU input configuration

These will be later translated to the IEC61850 data model into the LDSUIED/LPAIx (Refer to LDSUIED-IED Supervision Logical Device) logical nodes which are used for the supervision of the TMU Analog boards. LPAIx information are used in further steps for binding the TMU analog board channels to the Instrument Transformers to be monitored by the MU360. Below an example where main parameters appear in a CID file, as depicted in figure below.

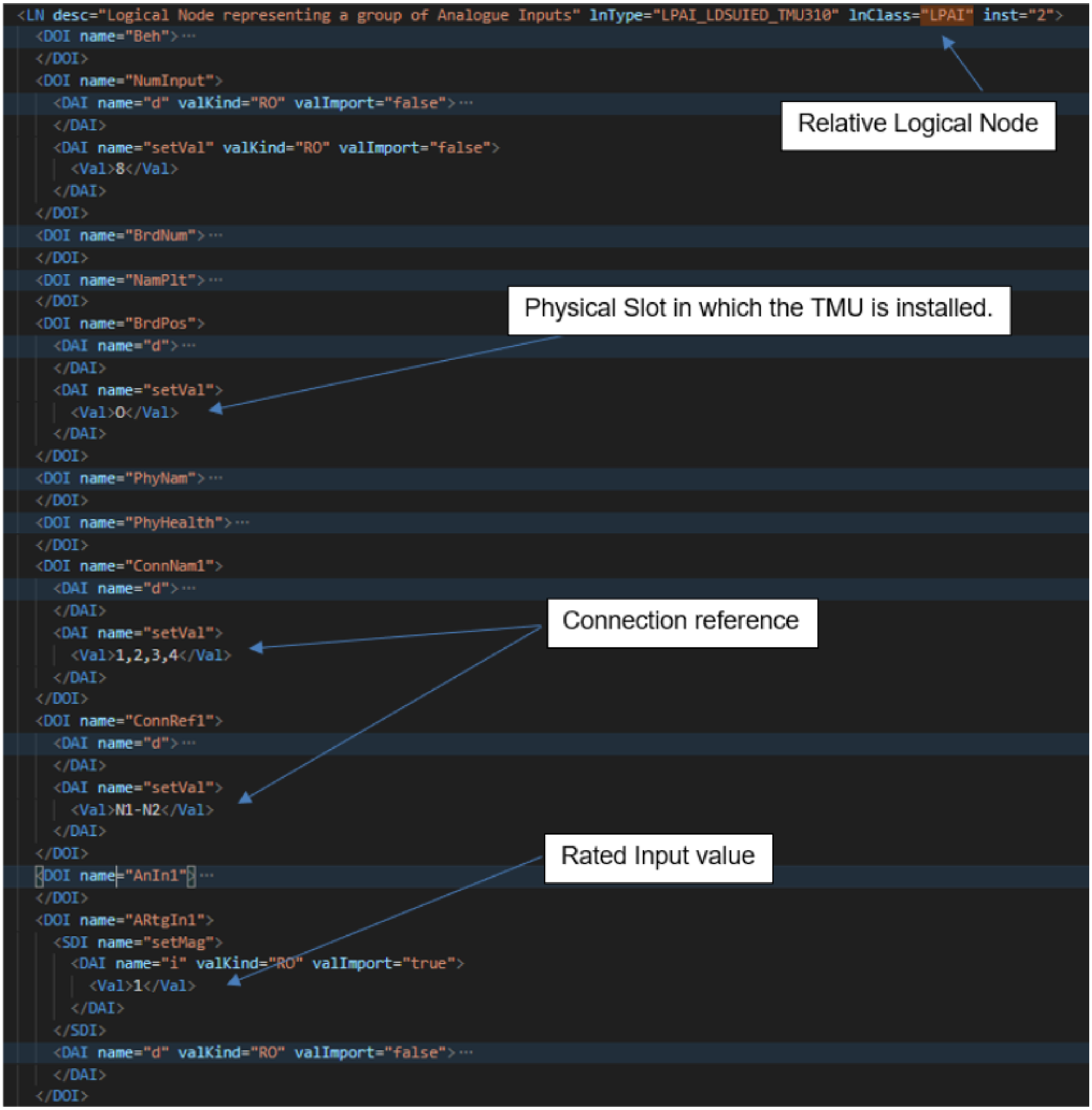


Figure 37: LPAI data modelling with reflected configurations

4.6.1.2 INSTRUMENT TRANSFORMER (CT/TV) INTERFACE CONFIGURATION

The next step refers to the parameters of the instrument transformers monitored by the MU360, CT/VTs, configuring the instrument transformer ratio and binding. The Instrument Transformer Primary to Secondary transformation ratio (Rat) can be set as presented in Figure below. It is important to highlight that by multiplying the rated value of the connection interface used in the TMU (LPAIx.ARtgIn.setMag or LPAIx.VRtgIn.setMag) by the Instrument Transformer Transformation Ratio (TCTRz.Rat or TVTRz.Rat) the product must be equal to the Instrument Transformer Rated Primary value. Example below: “VRtgIn x Rat = VRtg” so “100 x 1000 = 100kV”.

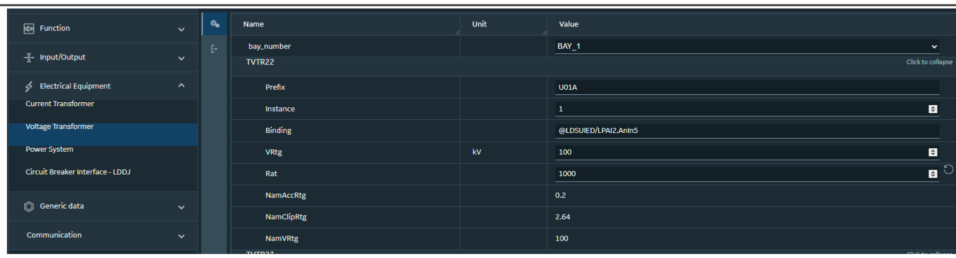


Figure 38: Instrument transformer configurations

Providing further flexibility, the links between the interfaces in the TMU and the monitored instruments transformer can be defined by the user in configuration time. That is, the electrical power system phases (A,B,C and N) modeled by TVTR and TCTR logical nodes can be assigned freely to any connection interface in the TMU (modeled by LDSUIED/LPAIx.AnIn). This is accomplished through a string formatted like: @LDSUIED/LPAI<X>.AnIn<Y>, where “<X>” is the LPAI logical node instance and “<Y>” is the channel input instance.

For example, if TVTR22 above should be connected to U1-U2 channels of the TMU represented by LPAI2, then the binding will be “@LDSUIED/LPAI2.AnIn5”. Below a picture depicting final result in the CID file.

```xml
<LN desc="Logical Node representing a group of Analogue Inputs" lnType="LPAI_LDSUIED_TMU310" lnClass="LPAI" inst="2">
  <DOI name="BrdPos">
    <DAI name="d">···
    </DAI>
    <DAI name="setVal">
      <Val>0</Val>
    </DAI>
  </DOI>
  <DOI name="ConnNam5">
    <DAI name="d">···
    </DAI>
    <DAI name="setVal">
      <Val>21,22</Val>
    </DAI>
  </DOI>
  <DOI name="ConnRef5">
    <DAI name="d">···
    </DAI>
    <DAI name="setVal">
      <Val>U1-U2</Val>
    </DAI>
  </DOI>
  <DOI name="AnIn5">
    <SDI name="mag">···
    </SDI>
    <SDI name="units">
      <DAI name="SIUnit">
        <Val>V</Val>
      </DAI>
      <DAI name="multiplier">
        <Val/>
      </DAI>
    </SDI>
    <DAI name="t"/>
    <DAI name="q"/>
  </DOI>
  <DOI name="VRtgIn5">
    <SDI name="setMag">
      <DAI name="i" valKind="RO" valImport="true">
        <Val>100</Val>
      </DAI>
    </SDI>
    <DAI name="d" valKind="RO" valImport="false">···
    </DAI>
  </DOI>
```


Figure 39: Analog channel bonding

Last, there is the power system configuration, where we select the frequency of the power system connected to. It applies to all analog channels.

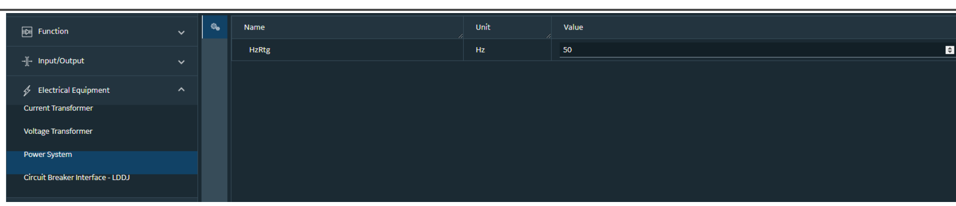


Figure 40: Power system frequency configuration

4.6.1.3 FINAL SYSTEM RELATIONSHIP

This section intends to show how complete conversion has been working based on the previous parameters, in the following depicted picture.

Symbols:

- **Vp**: Primary Voltage
- **Ip**: Primary Current
- **Vs**: Secundary Voltage
- **Is**: Secundary Current
- **VT**: Voltage Transformer
- **CT**: Current Transformer

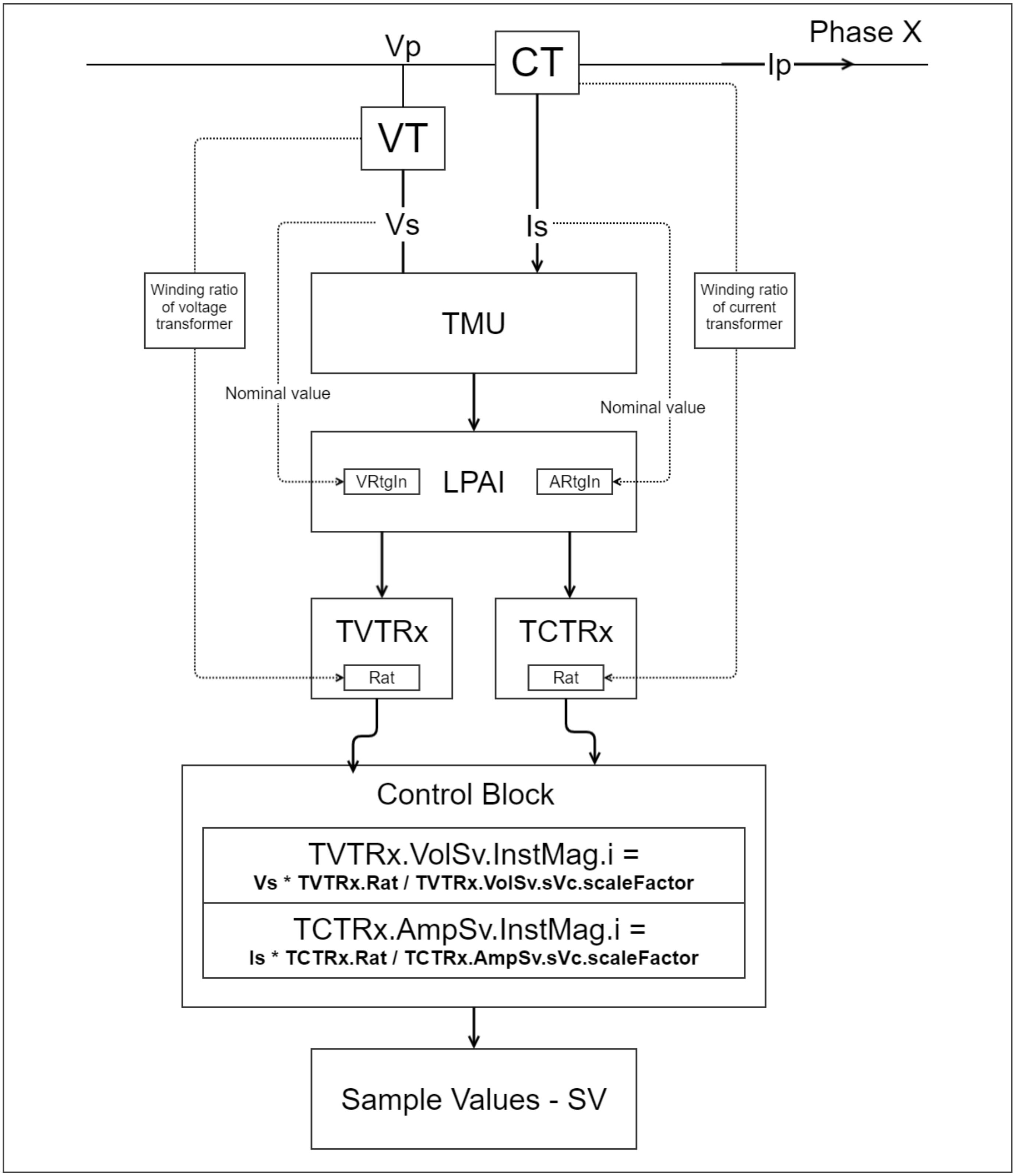


Figure 41: CT/TV conversion

4.6.2 MEASUREMENT BEHAVIOR

The quality of the data measured on the analog channels and presented to the user might be affected due to the magnitude of the input signal at the TMU board terminals. Also, it is affected by the health of the module, which is continuously monitored, so the protection systems can take the adequate actions.

4.6.2.1 THRESHOLDS

Defined by the constructive specifications of each analog module (TMUs), there will be an associate limit, in this case there are 2 relevant thresholds:

- Rated Accuracy Limit: The limit where the measurement of the input signal is fully trusted.
  - TMU310:
    V: 2.4 Vn
    A: 60 In
  - TMU320:
    V: 2.4 Vn
    A: 4 In
- Clipping: The maximum measuring limit where saturation is applied.
  - TMU310:
    V: 2.52 Vn
    A: 63 In
  - TMU320:
    V: 2.52 Vn
    A: 4.2 In

These thresholds are defined in reference to the TMU nominal input magnitude (Vn, nominal voltage; In, nominal current). Below a simplified diagram explaining the measurement of the analog signals and their thresholds, notice that as the signal goes above the accuracy limit, there is a more expressive error deviation outside of the precision class.

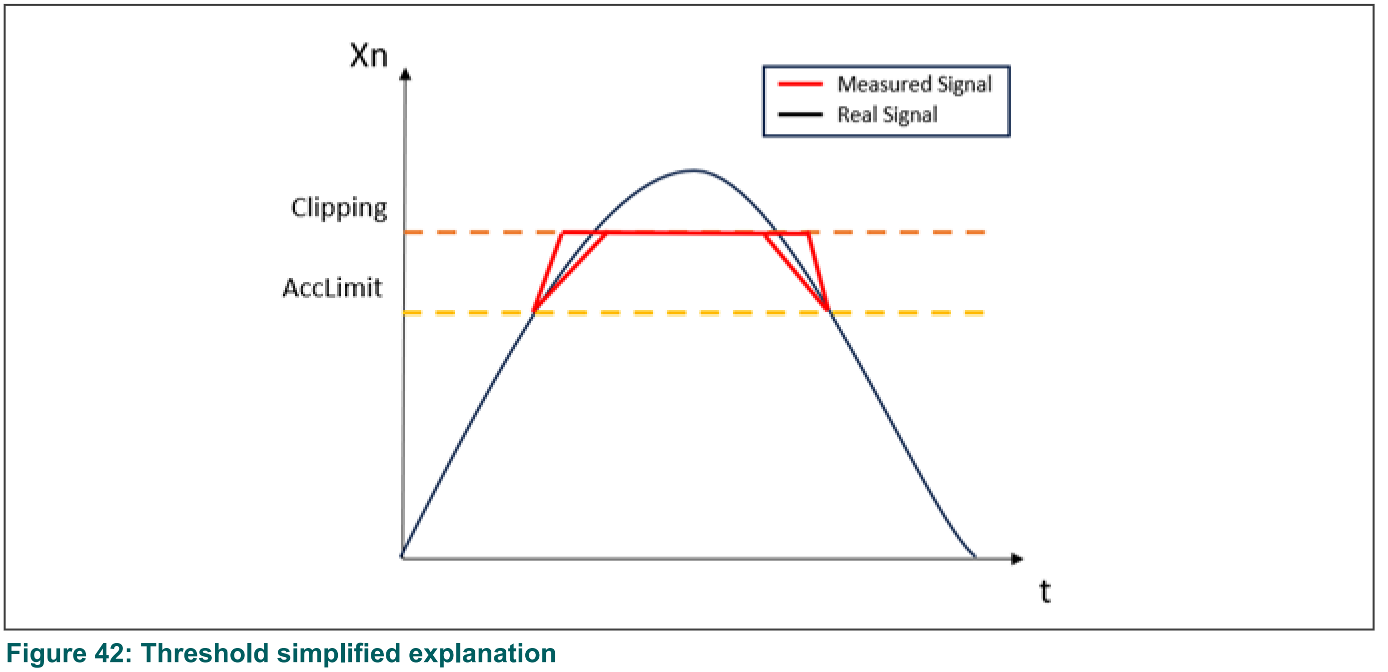


Figure 42: Threshold simplified explanation

For a more detailed specification of the precision class ranges, please refer to the hardware technical chapter related to the TMUs.

4.6.2.2 QUALITY

The quality of the analog channels can be translated to the IEC 61850 data model to the CT/VT logical nodes to their respective instantaneous measurement, AmpSv for current and VolSv for voltage. So, each channel will report their qualities and instantaneous measurement in either:

- Voltage:
  - Instantaneous value: TVTRx/VolSv.instMag.i
  - Quality: TVTRx/VolSv.q
  - Timestamp of last quality or value change: TVTRx/VolSv.t
- Current:
  - Instantaneous value: TCTRx/AmpSv.instMag.i
  - Quality: TCTRx/AmpSv.q
  - Timestamp of last quality or value change: TCTRx/AmpSv.t

4.6.2.2.1 THRESHOLD RELATED

The quality bits set according to the input magnitude will vary, depending on the signal peak value, lets see the 3 conditions below:

Peak < Clipping: Peak is below clipping rate

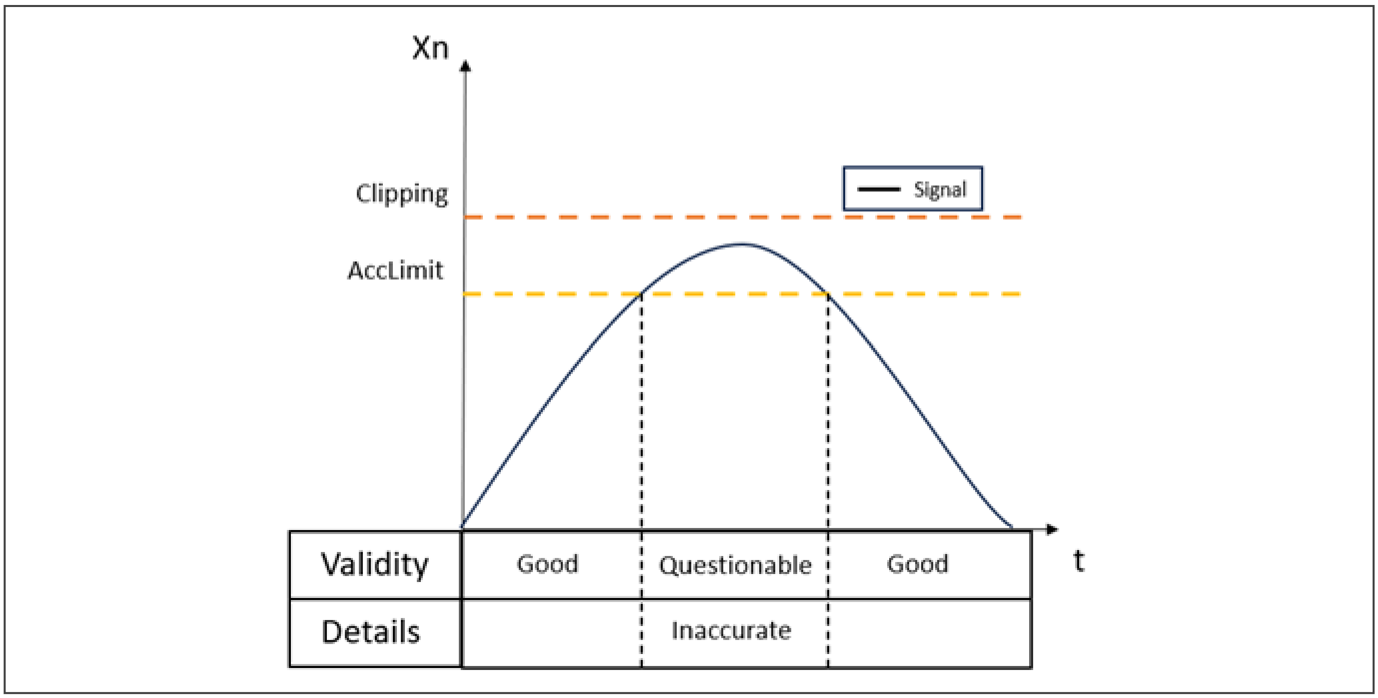


Figure 43: Qualities for signal peak < clipping

Peak - Clipping: Peak is around clipping rate (1%)

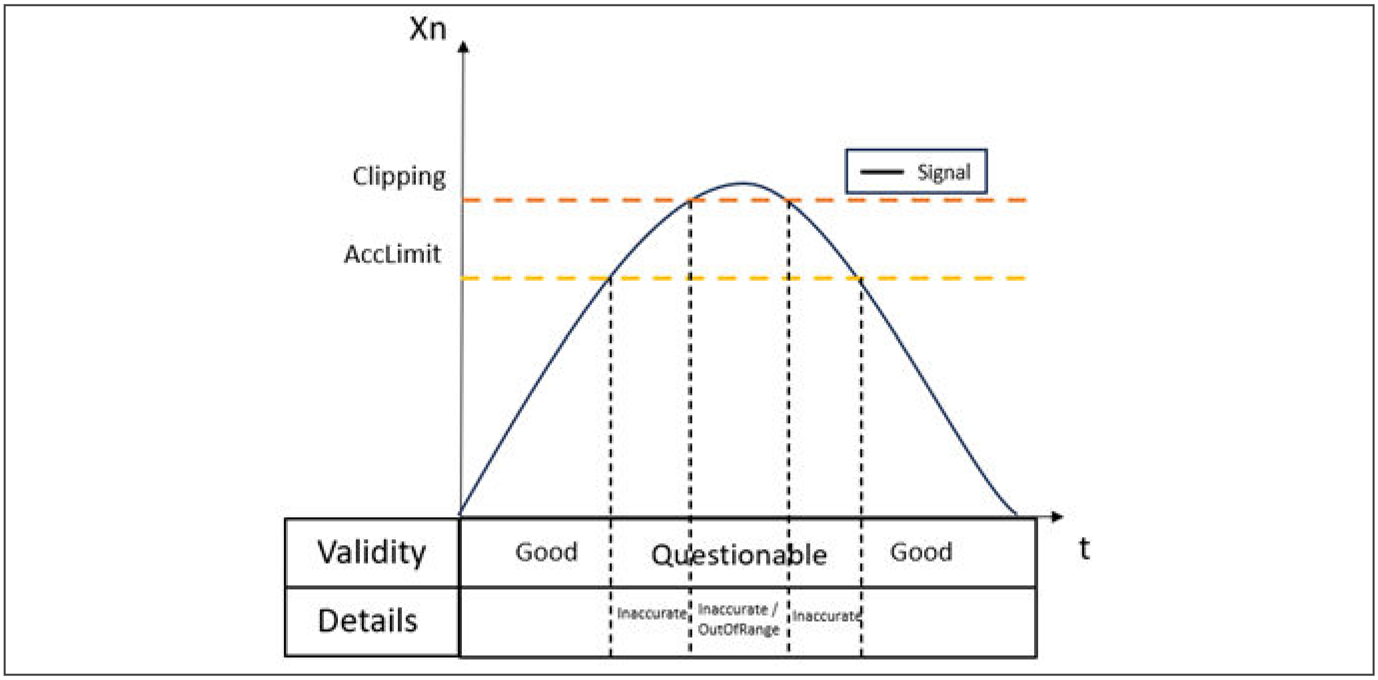


Figure 44: Qualities for signal peak - clipping

Peak > Clipping: Peak is above clipping rate

In this case there is a big interpolation happening above clipping threshold. As the window of points will be out of range, then final quality flags will affect points supposed to be in the good range, depending on the signal inclination, all range of samples can host wrong qualities, but at least, bad qualities. Therefore, this area should be avoided, MU360 will not ensure correct quality bits.

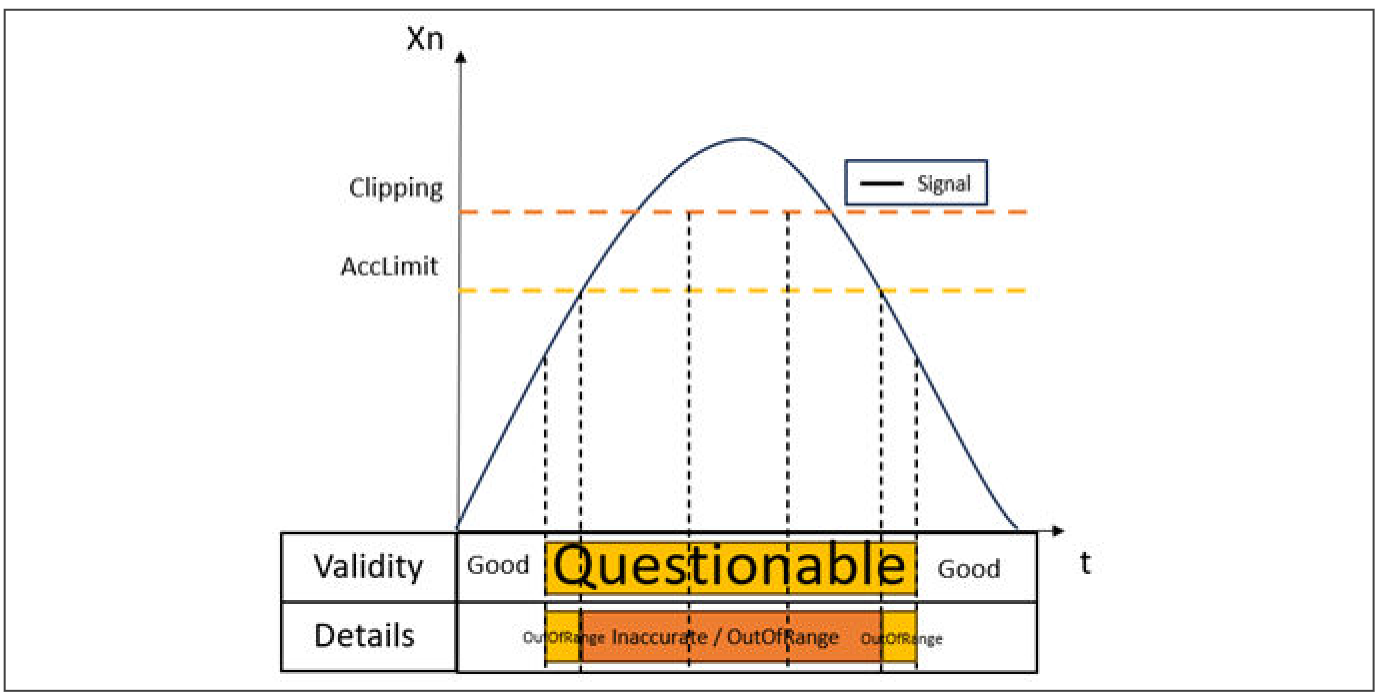


Figure 45: Qualities for signal peak > clipping

4.6.2.3 COMPLETE OVERVIEW

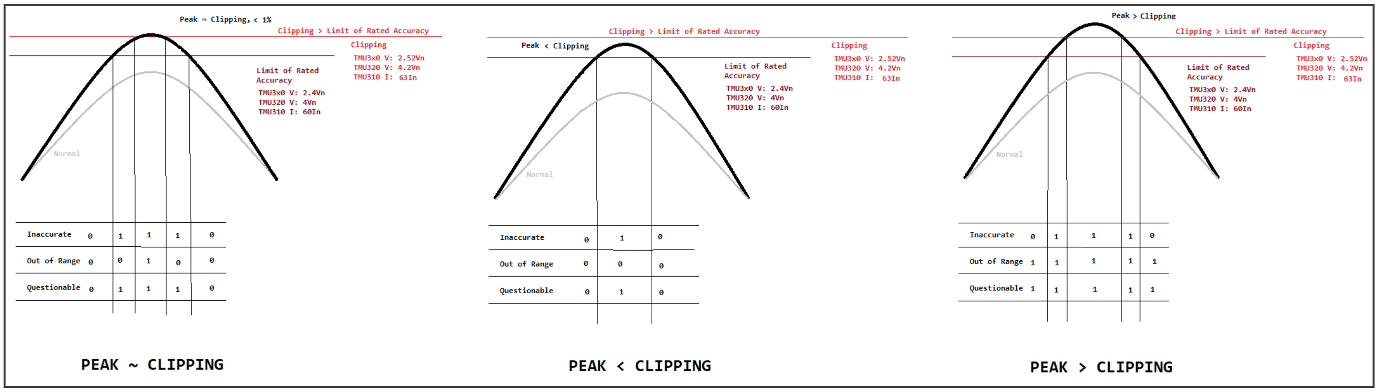


Figure 46: Complete overview of peak clipping

4.6.2.4 OTHER EVENTS

Cause	Validity	Detail
Voltage Fuse Alarm (FuFail)	Invalid	Failure
TMU not connected	Invalid	Failure
TMU communication issue	Invalid	Failure
TMU internal issue (Voltage/Temperature)	Invalid	Failure
Missing TMU calibration	Questionable	Inaccurate
Internal calculation saturation	Questionable	OutOfRange

4.6.3 ANALOG DATA PUBLISHHING

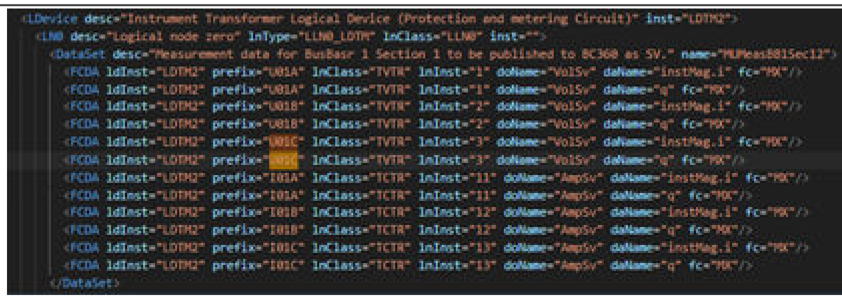
4.6.3.1 SAMPLED VALUES

The measurement and quality of data are always published in sampled values unless the user disables it by setting the related control block SvEna to false or it is set by configuration to be disabled.

Apart from that, SV streams are always being published according to the configured dataset and their analog channel settings.

```
<LN lnType="TVTR_LDTM" prefix="U01C" lnClass="TVTR" inst="3">
  <DOI name="VolSv">
    <Private type="GE-PhysicalTVTCbinding">
      <eGe:TVTC xmlns:eGe="http://www.ge.com">
        <TVTC>@LDSUIED/LPAI2.AnIn7</TVTC>
      </eGe:TVTC>
    </Private>
    <SDI name="instMag">
      <DAI name="i"/>
    </SDI>
    <DAI name="q"/>
    <DAI name="t"/>
```

Figure 47: SV data in data model



```
<LDevice desc="Instrument Transformer Logical Device (Protection and metering Circuit)" inst="LDTM2">
  <LN0 desc="Logical node zero" lnType="LLN0_LDTM" lnClass="LLN0" inst="">
    <DataSet desc="Measurement data for BusBasr 1 Section 1 to be published to BC360 as SV." name="MUMeasBB1Sec12">
      <FCDA ldInst="LDTM2" prefix="U01A" lnClass="TVTR" lnInst="1" doName="VolSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="U01A" lnClass="TVTR" lnInst="1" doName="VolSv" daName="q" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="U01B" lnClass="TVTR" lnInst="2" doName="VolSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="U01B" lnClass="TVTR" lnInst="2" doName="VolSv" daName="q" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="U01C" lnClass="TVTR" lnInst="3" doName="VolSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="U01C" lnClass="TVTR" lnInst="3" doName="VolSv" daName="q" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01A" lnClass="TCTR" lnInst="11" doName="AmpSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01A" lnClass="TCTR" lnInst="11" doName="AmpSv" daName="q" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01B" lnClass="TCTR" lnInst="12" doName="AmpSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01B" lnClass="TCTR" lnInst="12" doName="AmpSv" daName="q" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01C" lnClass="TCTR" lnInst="13" doName="AmpSv" daName="instMag.i" fc="MX"/>
      <FCDA ldInst="LDTM2" prefix="I01C" lnClass="TCTR" lnInst="13" doName="AmpSv" daName="q" fc="MX"/>
    </DataSet>
```

Figure 48: Sampled Values dataset with analog channel

4.6.3.2 MMS REPORT/GOOSE

As an exception, the instantaneous measurement cannot be published trough goose and report, only the channel quality. So, whenever a GOOSE or Report dataset contains the SAV Data objects, the data shown will be:

- instMag.i: Always 0, not used
- q: Analog channel quality as for Sampled Values
- t: Timestamp of the last quality change

This happens because the insMag.i value changes in such a high rate (minimum 4000Hz) that it does not make sense to publish it in MMS or GOOSE, so keeping this value 0 and only giving sense to the q/t attributes is more valuable.

4.6.3.2.1 QUALITY EVENT BURST

Given that there are thresholds for the signal magnitude of each analog channel of the TMU boards, there might happen some undesirable events when the signal runs around the threshold values, like multiple quality changes in a small period. Also, noisy signals might contribute to this behavior, so to avoid a burst of events flooding the user's communication channels and logs there is a protection mechanism to work around.

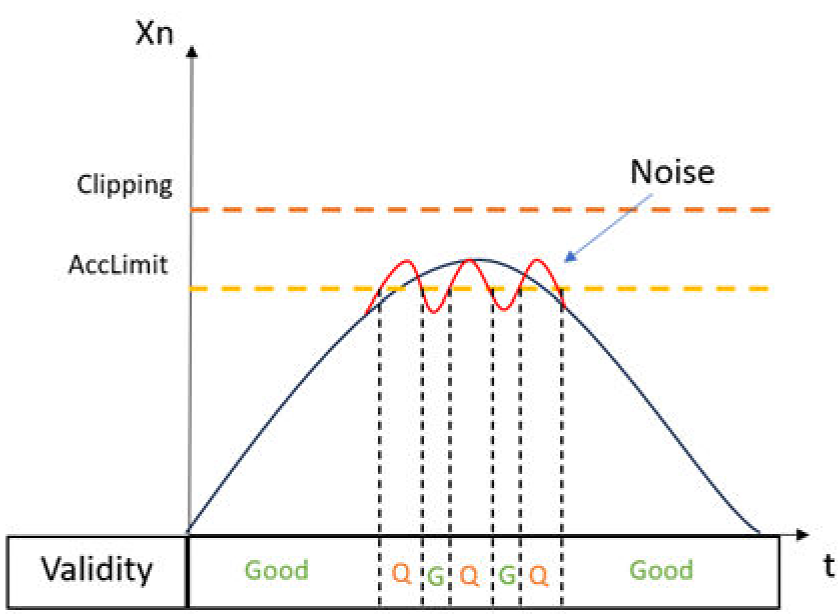


Figure 49: Noisy signal in analog channels

As in the example above, if every time the waveform goes through the threshold the quality changes, then there could be an enormous amount of quality change messages being exchanged. When this behavior is detected, the following mechanism takes place:

1. MU360 counts the number of quality change events in a second for each channel.
2. If 6 events happen in less than 1 second where the last quality is not good, then the channel goes to burst state.
3. The channel quality is held in the last value until there are no more quality change events in 1 second.

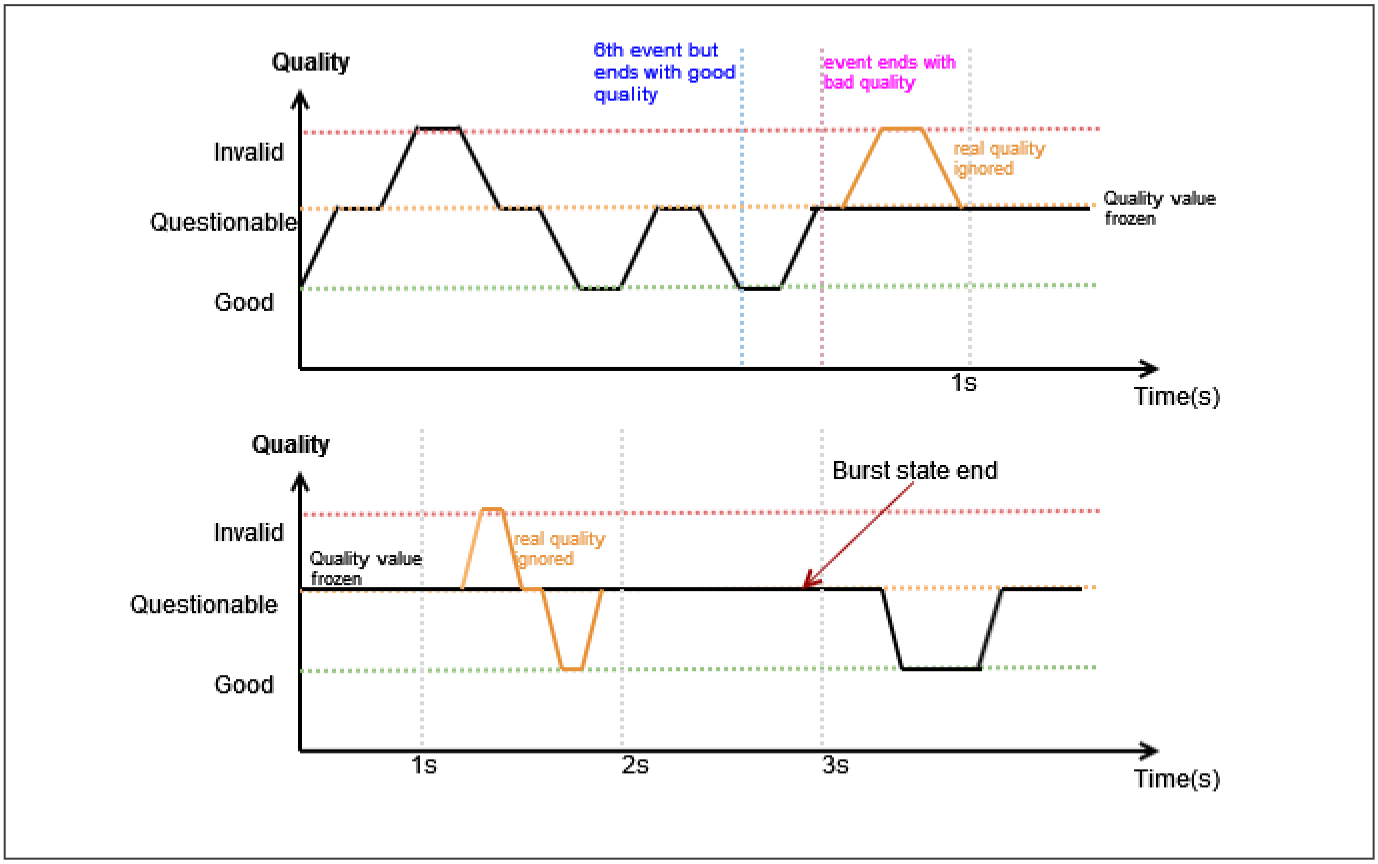


Figure 50: Burst mitigation

When a burst on a channel is detected, MU360 stores this information in the log files:

```
(Analog) Configuration in progress for SV publisher 0
(Analog) TUser of channel 0 changed from - to locked,gainOverflow,firOverflow,phaseSyncInvalid
(Analog) TUser of channel 0 changed from locked,gainOverflow,firOverflow,phaseSyncInvalid to locked,gainOverflow,phaseSyncInvalid
(Analog) Configuration in progress for SV publisher 0
(Analog) SV Publisher 0 enabled
(Analog) TUser of channel 0 changed from locked,gainOverflow,phaseSyncInvalid to locked,gainOverflow,firOverflow,phaseSyncInvalid
(Analog) TUser of channel 0 changed from locked,gainOverflow,firOverflow,phaseSyncInvalid to locked,gainOverflow,phaseSyncInvalid
(Analog) TUser of channel 0 changed from locked,gainOverflow,phaseSyncInvalid to locked,gainOverflow,firOverflow,phaseSyncInvalid
(Analog) TUser of channel 0 changed from locked,gainOverflow,firOverflow,phaseSyncInvalid to locked,gainOverflow,phaseSyncInvalid
(Analog) Too many events for channel 0 of board 0
```

Figure 51: Burst log detection

4.6.4 QUALITY BITS

Below are the quality bits that the MU360 supports.

4.6.4.1 SAMPLED VALUES QUALITY BITS (IEC-61869-9)

Quality Attribute	Value	Description
Validity	Good	invalid	reserved	questionable	Set according to detailQual: - Questionable = OutofRange	Inaccurate - Invalid = Failure	Overflow
detailQual		
Overflow	False	Always False according to IEC-61869-9
OutofRange	True	False	
BadReference	False	Always False according to IEC-61869-9
Oscillatory	False	Always False according to IEC-61869-9
Failure	True	False	Internal error different than sync
OldData	False	Always False according to IEC-61869-9
Inconsistent	False	Always False according to IEC-61869-9
Inaccurate	True	False	SV does not meet the nameplate measuring accuracy class
Source	Process	Always Process according to IEC-61869-9
Test	True	False	

4.6.4.2 GOOSE AND MMS QUALITY BITS

Validity
Good
Substituted
Questionable
Invalid
Source
Process
Test

4.7 BINARY INTERFACES

Binary interfaces are boards used to manage the input and output wired on the interfaces.

3 kinds of board are used.

Binary interfaces symbol meanings:

DI: Physical Digital Inputs managed by DIU board to acquire binary information related to an external signal.

DO: Physical Digital Outputs managed by DOU and HBU boards used to apply a switching voltage to an external device.

4.7.1 DIU211

Digital Inputs Unit provide 16 opto-isolated digital inputs with one common for 2 inputs (positive or negative). The digital inputs can be used for single or double status, pulse or digital measurement input on the same unit.

Input voltages from 24 to 220VDC with jumper selection.

The board address is set by positioning jumpers according to its slot in the rack. Refer to Digital Inputs Unit DIU211

4.7.2 DOU201

Digital Outputs Unit board provide 10 isolated digital outputs using integrated relays. 8 single pole relays with one normally open (NO) contact. 2 double pole relays with 1 common for 2 output contacts (NO/NC changeover)

Nominal operating voltage range of 24 VDC to 250 VDC / 230 VAC.

Making time < 7ms.

The board address is set by positioning jumpers according to it slot in the rack. Refer to Digital Outputs Unit DOU201

4.7.3 HBU210

High-Break Unit provide 6 high-speed output relay channels connected to external devices and monitors current flowing across the contacts during switching process.

The contacts are arranged to be independent with the option to configure for dual cutting.

Nominal operating voltage range of 24 VDC to 250 VDC / 250 VAC.

Making time < 0.5ms.

The board address is set by positioning jumpers according to it slot in the rack. Refer to High Break Unit HBU210

4.7.4 DIGITAL INPUTS (DI)

The DIU boards acquire binary information related to the presence or to the absence of an external signal delivered by a voltage source to manage digital inputs (DI). The signal polarity can be positive or negative. The acquisition period of digital inputs is fixed and is equal to 1ms in the controller range.

Digital Input (DI) value switch from 0 to 1 or from 1 to 0 when the external voltage is above or below a specified threshold. The configuration allows through EnerVista Flex v2 to invert the DI value by software.

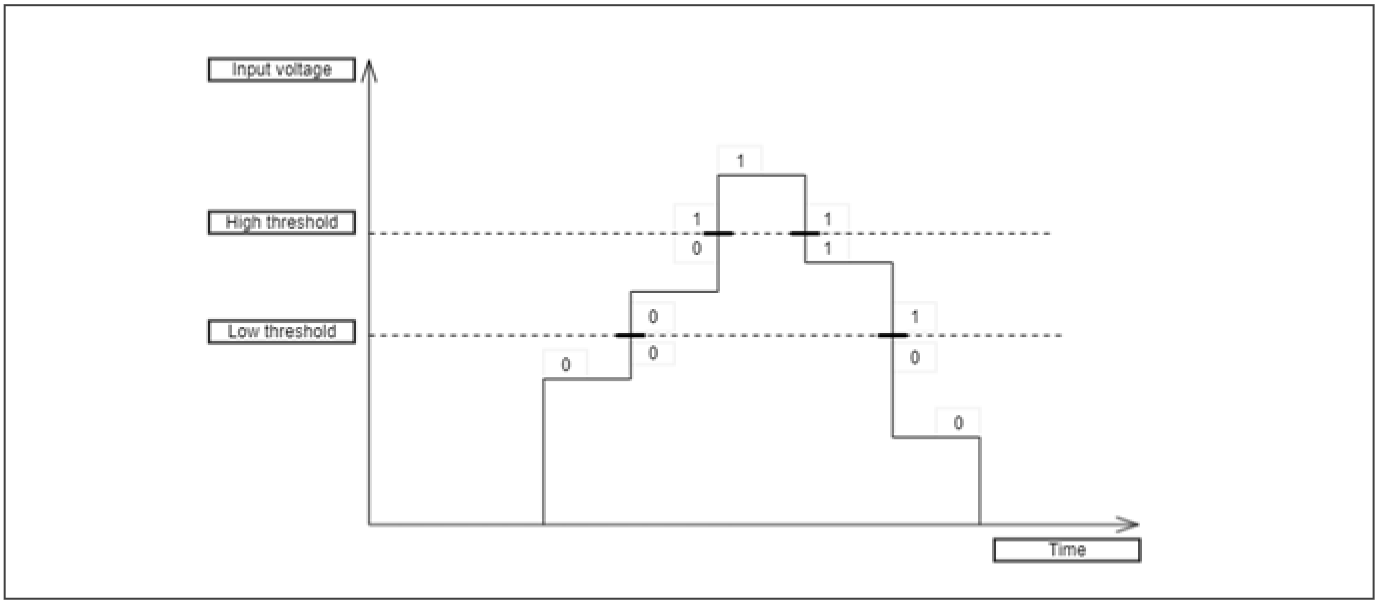


Figure 52: Digital Input value inversion

> *Note:*
> *0 indicates the DI is interpreted as FALSE.*

> *Note:*
> *1 indicates the DI is interpreted as TRUE.*

4.7.4.1 GLOBAL PROCESSING

Hardware acquisition -> Software acquisition -> Time stamping -> Debouncing/filtering -> Toggling -> Internal treatment

4.7.4.2 DEBOUNCING - FILTERING

A DI transition value is usually followed by a succession of transitions before the value stabilizes. Debouncing and stability filtering is applied in order to confirm the change of state of a digital input.

Debouncing and filtering are applied by driver on the digital inputs as follows:

- T0 is the instant of detection of the first transition
- T1 is the instant of validation of the change of state
- T2 is the end of the filtering: the signal remained stable from T1 to T2

The change of state is time stamped at T0 with 1ms precision due to DI driver acquisition period.

A change of state is validated as soon as it is detected.

Values configurable through EnerVista Flex v2 for debouncing and filtering:

	Min time (ms)	Max time (ms)	Step (ms)
DI debouncing time *	0	20	1
DI filtering time *	0	20	1

*A value of 0 means that no filter is applied.

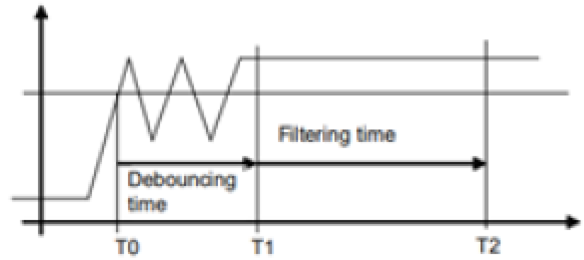


Figure 53: Debouncing and filtering diagram

4.7.4.3 TOGGLING

A digital input is put in toggling if its state has changed more than N times in a given time-period T1.

A toggling DI returns in the normal state if its state has not changed within another time-period T2.

T1 and T2 are parameters determined at configuration time on a per system basis.

The toggling applies only on DI that will be mapped.

A timer is launched at startup with 1 second delay to manage the toggling DI input state. This timer is unique and used for all the inputs of the system, means that is not possible to disassociate from a global computing. Each second all the input are analyzed and put in toggling state if the conditions for the input are raised (T1 + N + T2).

Range of Values configurable through EnerVista Flex v2:

	Min	Max	Step
Time before toggling (T1)	1 (s)	100 (s)	1 (s)
Number of transitions before toggling (N)	1	100	1
Time before end of toggling (T2)	1(s)	100(s)	1(s)

For instance, if user desires to detect 5 transitions, then all inputs will follow this configuration, it is global with just on procedure. So, a possible configuration should be:

	Value
Time before toggling (T1)	6 (s)
Number of transitions before toggling (N)	5
Time before end of toggling (T2)	6(s)

Note:
As it is global, always take into consideration 1 step more for time windows.

Place in the EnerVista Flex v2:

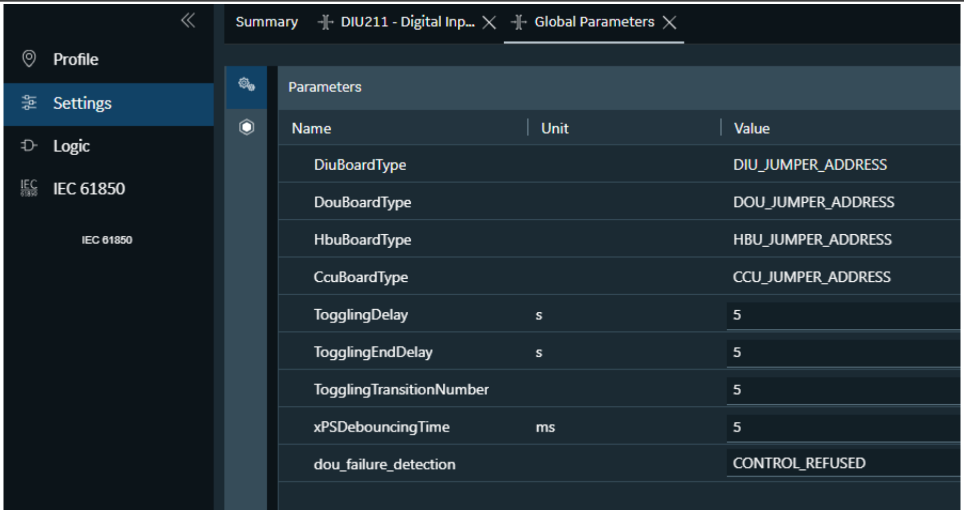


Figure 54: EnerVista Flex v2 global parameters tab

4.7.5 INMOD PARAMETER

InMod is a parameter configurable with the EnerVista Flex v2 and allow to change interpretation of a DI according to InMod state attribute: **ActiveHigh** or **ActiveLow**.

	LPDI.InMod = ActiveHigh	LPDI.InMod = ActiveLow
DI state Close	Close	Open
DI state Open	Open	Close

Parameter configuration with EnerVista Flex v2:

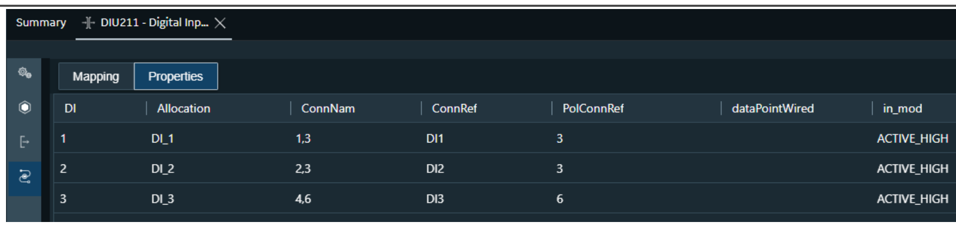


Figure 55: Parameters configuration

4.7.6 IEC LOGICAL NODE LPDI

The logical device LDSUIED support the logical node LPDI associated to a physical digital input system.

The number of instantiations of LPDI depends on the number of DI board in the IED rack. For each LPDI one instance of SPS data object “Ind” is defined per physical input.

The link between a physical input and its associated data object “Ind” is hard coded and it is not possible to configure it.

For x LPDI instance with y Ind, each LPDIx.Indy could be associated to a physical input of a function in the same IED using InRef. Refer to LDSUIED-IED Supervision Logical Device

LPDI processing:

DI acquisition -> Internal Driver Handler -> LDSUIED.LPDIx.Indy -> IED function InRef

LDPI IEC quality

	Quality : LDSUIED.LPDIx.Indy.q
Bad board	alarm
Bad configuration	questionable
Missing configuration	questionable
Toggling*	oscillatory

* ”oscillatory" until its stability is restored.

4.7.7 DIGITAL OUTPUTS (DO)

Digital outputs are used to apply a switching voltage to an external device in order to execute single or dual, transient or permanent commands. The applied voltage is fed from an external power supply. The external voltage is connected to the controlled device by a relay, thus isolating the logic part of the board from the external power supply. The relays can be single pole (one contact) or double pole (two contacts) N/O relays. There are also inverter relays (N/C) with one normally open and one normally closed contact, which can be used when positive security is required.

4.7.8 OUTMOD PARAMETER

OutMod is a parameter configurable with EnerVista Flex v2 and allow to change the value of the DO according to OutMod state True or False.

Outmod should be noted for correct conversion from data coming from ExtRefs (put link to input/output associations), depending on its state, final associated DO will have a different behavior as depicted in the following table:

> *Note:*
> *Each cell represents ExtRef state, but last line represents final associated physical DO state.*

ExtRef Type	Data Object Type	DO Open * with LPDOx.OutMody = ActiveHigh	DO Close* With LPDOx.OutMody = ActiveHigh	DO Open* with LPDOx.OutMody = ActiveLow	DO Close* with LPDOx.OutMody = ActiveLow
Health	EEHealth	OK / Warning	Alarm	Alarm	OK/Warning
Boolean	All	False	True	True	False
Boolean	Op.general	False	True	True	False
Boolean	Tr.general	False	True	True	False
DPC	GnCtl	Off	On	On	Off
DPC	Pos	Off/ Intermediate-state/ Bad-state	On	On/ Intermediate-state/ Bad-state	Off
Any	Any - Invalid quality	Force DO to Open	Force DO to Open	Force DO to Close	Force DO to Close

* With Physical Digital Output (DO) contact normally open type.

Parameter in EnerVista Flex v2 tool:

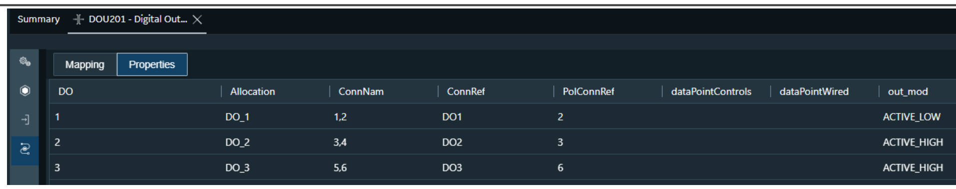


Figure 56: OutMod parameter

4.7.9 IEC LOGICAL NODE LPDO

The logical device LDSUIED supports the logical node LPDO associated to a physical digital output system.

The number of instantiations of LPDO depends on the number of DO board in the IED rack.

An InRef (Refer to Input/Output Associations) will interface order coming from an associated ExtRef to change an output DO, so it is fundamental to have a good configuration before trying animate any output.

For each LPDO, one instance of data object **"CmdDO"** is defined per physical output.

The link between a physical output and its associated data object **"CmdDO"** is determined by configuration automatically. Refer to Input/Output Associations.

LPDO processing:

IED function as ExtRef-> InRef -> LPDOx.CmdDOy-> Physical DO output

Behavior of a DO contact can be configured, as its time window duration, configured with the parameter: LPDO.CmdDO.pulseConfig

IEC Values configurable through EnerVista Flex v2 for duration:

	Min	Max	Step
pulseConfig.OnDur*	1 (ms)	15000 m(s)	10(ms)
pulseConfig.OffDur*	1 (ms)	15000 m(s)	10(ms)

* 0 = permanent

Place in EnerVista Flex v2:

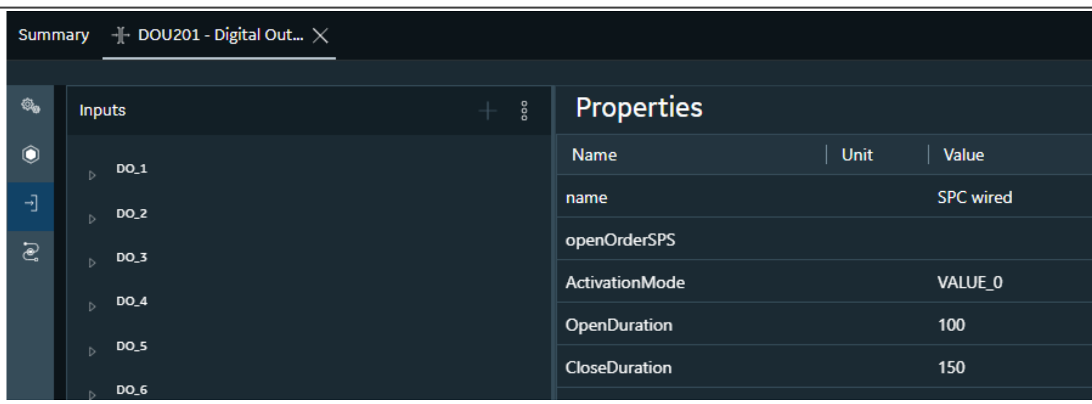


Figure 57: LPDO parameters

LPDO IEC quality

For DO board in failure the logical node LPDO is put in alarm.

LDSUIED.LPDOx.PhyHealth.q = Failure

4.7.10 LPDI-LPDO GENERAL USAGE DIAGRAM

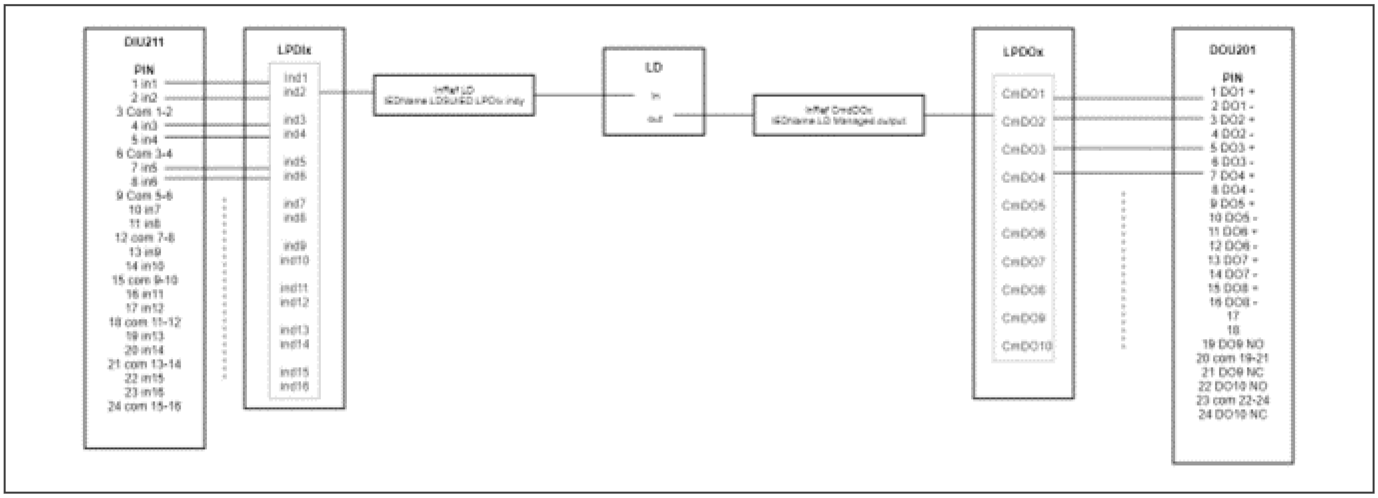


Figure 58: LPDI-LPDO usage diagram

4.8 TIME MANAGEMENT

MU360 can keep its internal clock synchronized to an external reference. Unique mechanism in place is based on PTP, having support to P2P method only, means that all network (switches, routers, etc.) should support peer delays requests and responses for a better precise time offset compensation between involved entities.

> *Note:*
> *It is not possible to make manual adjustments.*

4.8.1 TIMESTAMP PRECISION

A timestamp precision (quality fields of a timestamp) should follow synchronization class described by **IEC 61850-7-2** and **IEC 61850-5**, as depicted below:

- **bit 0, LeapSecondsKnown**: True indication, it is leaping second compensation enabled, that can happen sometimes, “at the last second of the UTC day, preferably at the end of June 30 or December 31”. IEEE 1588-2019, pg 376. It is a common mechanism used to be aligned to TAI (International Atomic Time).
- **bit 1, ClockFailure**: False when synchronized, otherwise is True.
- **bit 2, ClockNotSynchronized**: False when synchronized, locked.
- **bit 3..7, TimeAccuracy**: range 0..31. Code 31 is worse than 1s. Code 25 to 30: invalid, not possible. Code 0..24: indicates how many bits are deviated.

Value	Class	Description
31	No class	Clock either in free-running state or bigger deviation compared to the following situations.
7	T0, 10ms	7 <= Value <10
10	T1, 1ms	10 <= Value < 14
14	T2, 100us	14 <= Value < 15
16	T3, 25us	15 <= Value < 18
18	T4, 4us	18 <= Value < 20
20	T5, 1us	20 <= Value <= 24 (best situation to IEC 61850)

Precision for internal application

Application	Class	Description
Any binary changed	T1, 1ms	Detected and transmitted by Goose Publisher
SVs analog scan	T5, 1us	A Sample Value packet (TCTRs/TVTRs transmission) is based on SAV common class. MU360 is not hosting a timestamp since it is not a mandatory attribute.

4.8.2 STATE MACHINE

MU360 has a State Machine supporting synchronization statuses. This information has been presented by LDSUIED.LPLE1 (check LED3, Refer to section LPLE1 in LDSUIED-IED Supervision Logical Device) and LDSUIED.LTMS (Refer to LDSUIED-IED Supervision Logical Device). Over the course from operation some problems can affect all PTP chain of communication, then based on the current state, timestamps should be aligned to it, that can be one of the possibilities depicted in the figure below:

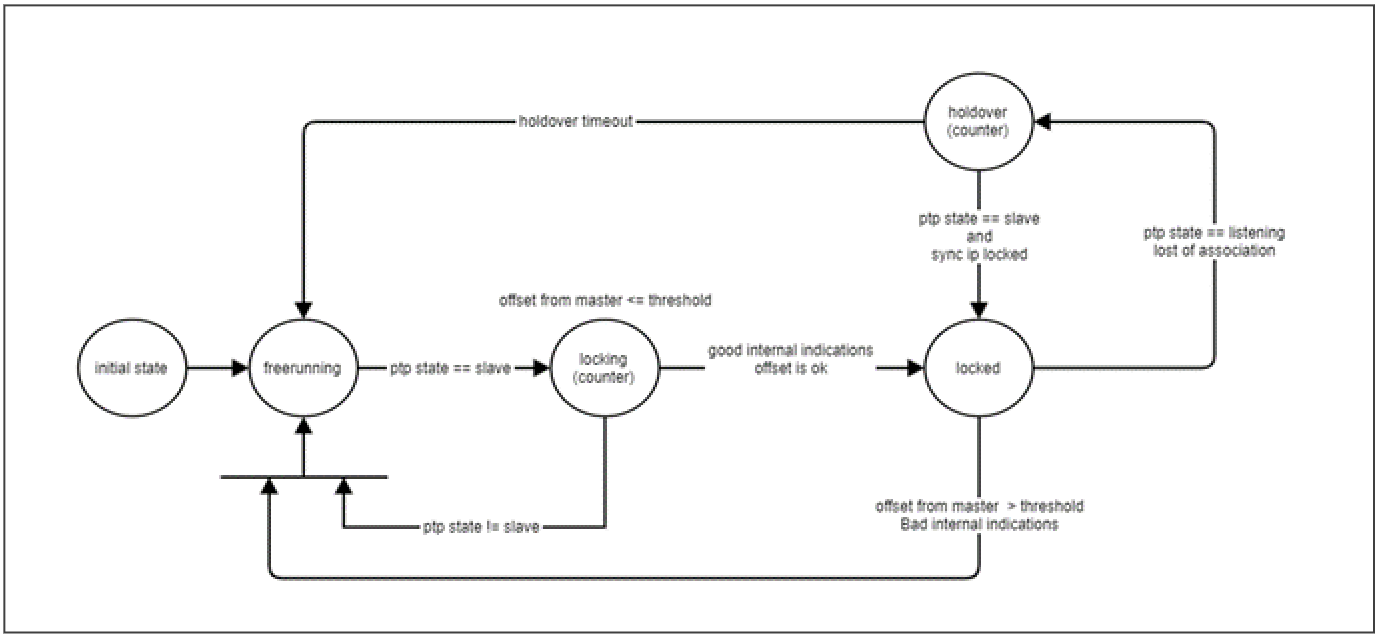


Figure 59: State machine

States:

- **Freerunning**: It represents internal clock reference, not aligned to an external clock. Big deviation from a Grand Master Clock will be in place.
- **Locking**: It is a timeout of 10s withing 1us of deviation.
- **Locked**: After passing through locking time window with good internal indication and master time offset in the best threshold limit. It can be:
  - **Local**: MU360 will follow a GPS receptor, but not aligned to a Global Clock.
  - **Global**: MU360 will follow a GPS receptor, but aligned to a Global Clock.
- **Holdover**: Means that internal clock is not anymore following grandmaster clock for some reason, deviating its offset. After passing thought holdover timeout, it will move to Free-running.

Behavior	Value
Holdover timeout	5 s
Locking timeout	10 s
Offset from master threshold (locked region)	±1 us

4.9 INPUT/OUTPUT ASSOCIATIONS

Before exposing how main MU360 functions will be organized, this section intends to explain how main functions will interact between each other. It is important to address that the way a LD will be linked depends on the application demand, then user can decide by configuration how to establish initial link of any involved LD. These links can be done between either internal or external LDs. Notice that user will do correct links between LDs guided by ICT Tool (show where, attached ICT manual), this chapter has a goal to explain how mechanism works.

4.9.1 APPLICATIVE INPUTS

Each logical device must have some input and output interfaces. Applicative inputs (App Input) are internal inputs that will allow a specific sub function (LN) to be connected to outputs from others Logical Devices. Notice scheme below:

Figure 60: Logical device interface

4.9.2 INREF

InRef is the mechanism for interfacing an applicative input to the real LD input. It is represented by a common class “ORG” always placed in the Logical Node 0 (LLN0) of each Logical Device. Relationship between an Applicative Input and an InRef is 1 to N, meaning that an applicative input can collect information from several InRefs. Field “Purpose” in an ORG structure represents an Applicative Input. Therefore InRefs can have the same purpose when it is needed to perform mentioned 1 to N above relationship. Below, depicted picture shows two InRefs with the same Applicative Input in a SCL file.

```
<LDevice desc="Circuit Breaker Interface" inst="LDDJ">
  <LN0 desc="Logical node zero" lnType="LLN0_LDDJ" lnClass="LLN0" inst="">
    <DataSet name="DataSet1">
    <DataSet name="DataSet2">
    <DataSet name="DataSet3">
    <DOI name="Beh">
    <DOI name="Health">
    <DOI name="Mod">
    <DOI name="NamPlt">
    <DOI name="InRef1">
    <DOI name="InRef2">
    <DOI name="InRef3">
    <DOI name="InRef4">
    <DOI name="InRef5">
    <DOI name="InRef6">
    <DOI name="InRef8">
    <DOI name="InRef9">
      <DAI name="tstEna" valKind="Set" valImport="false">
      <DAI name="purpose" valKind="RO" valImport="false">
        <Val>DYN_LDDJ_Ordre de declenchement triphase_1_BOOLEAN</Val>
      </DAI>
      <DAI name="setTstCB" valKind="Set" valImport="true"/>
      <DAI name="setSrcCB" valKind="Set" valImport="true"/>
      <DAI name="setTstRef" valKind="Set" valImport="true"/>
      <DAI sAddr="632" name="setSrcRef" valKind="Set" valImport="true"/>
    </DOI>
    <DOI name="InRef10">
      <DAI name="tstEna" valKind="Set" valImport="false">
      <DAI name="purpose" valKind="RO" valImport="false">
        <Val>DYN_LDDJ_Ordre de declenchement triphase_2_BOOLEAN</Val>
      </DAI>
      <DAI name="setTstRef" valKind="Set" valImport="true"/>
      <DAI name="setTstCB" valKind="Set" valImport="true"/>
      <DAI sAddr="633" name="setSrcRef" valKind="Set" valImport="true"/>
      <DAI name="setSrcCB" valKind="Set" valImport="true"/>
```

Figure 61: Applicative input vs InRef

4.9.3 EXTREF

ExtRef is the mechanism for interfacing an InRef to an output coming from any other logical device. It represents a copy of this output, and will work as main data source to the InRef, the real input of a LD. Each InRef can link up to 5 ExtRefs, meaning that an InRef can subscribe to up to 5 ExtRefs, so, latest ExtRef notification will overlap previous one.

In the SCL file, ExtRefs are hosted in the <Inputs> section, right after an InRef list as depicted below:

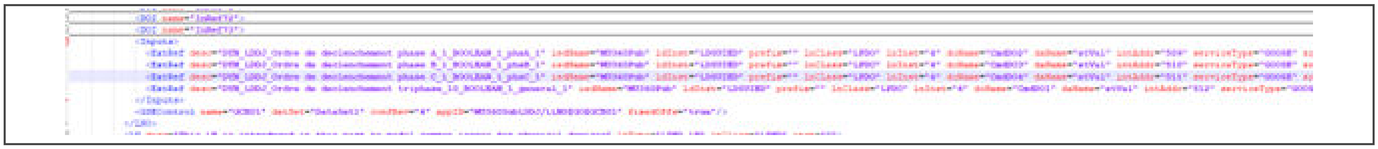


Figure 62: ExtRef associated to InRefs

4.9.4 INREF AND EXTREF ORGANIZATION

MU360 will organize any logical device same way, as depicted below by the following structure. Amount of ExtRefs by one InRef depends on the application demand.

<table>
<tr><th colspan="5">Logical Device</th></tr>
<tr><th>Inputs</th><th>InRefs</th><th>App Input</th><th>LN</th><th>Outputs</th></tr>
<tr><td>ExtRef 1
ExtRef 2
ExtRef 3</td><td>InRef 1</td><td>Purpose a</td><td rowspan="4">LN 1</td><td rowspan="4">Output 1
Output 2
Output 3
Output 4</td></tr>
<tr><td>ExtRef 4
ExtRef 5
ExtRef 6
ExtRef 7</td><td>InRef 2</td><td>Purpose b</td></tr>
<tr><td>ExtRef 8
ExtRef 9</td><td>InRef 3</td><td rowspan="2">Purpose c</td></tr>
<tr><td>ExtRef 10
ExtRef 11</td><td>InRef 4</td></tr>
<tr><td>ExtRef 12
ExtRef 13
ExtRef 14</td><td>InRef 5</td><td>Purpose d</td><td rowspan="4">LN N</td><td rowspan="4">Output 5
Output 6
Output 7
Output 8</td></tr>
<tr><td>ExtREf 15
ExtRef 16
ExtRef 17
ExtRef 18</td><td>InRef 6</td><td>Purpose e</td></tr>
<tr><td>ExtRef 19
ExtRef 20</td><td>InRef 7</td><td rowspan="2">Purpose f</td></tr>
<tr><td>ExtRef 21
ExtRef 22</td><td>InRef 8</td></tr>
</table>

4.9.5 BINDING OUTPUTS TO INPUTS

A bind must be done subscribing an ExtRef to the output from other LD. InRef will indicate which ExtRef is going to start communication. This action is going to be supported by ICT (Refer to Enervista Flex V2 user manual), but for understanding, take as example two Logical Devices: LDDJ Phase A Trip order (“DYN_LDDJ_Ordre de declenchement triphase_1”) linked to one LDSUIED physical output (CmdDO1.stVal), organized this way below:

LDDJ Structure:

LDDJ				
Inputs	**InRefs**	**App Input**	**LN**	**Outputs**
ExtRef 1 ExtRef 2 ExtRef 3	InRef 9	Three phase trip order or following purpose DYN_LDDJ_Ordre de declenchement triphase_1	XCMD	OpCls.general OpOpn.general OpOpn.phsA OpOpn.phsB ...
ExtRef4 ExtRef 5 ExtRef 6 ExtRef 7	InRef 31	Phase A trip order or following purpose DYN_LDDJ_Ordre de declenchement phase A_1		
ExtRef 8 ExtRef 9	InRef 13	Phase B trip order or following purpose DYN_LDDJ_Ordre de declenchement phase B		
ExtRef 10 ExtRef 11	InRef 32			
ExtRef 12 ExtRef 13 ExtRef 14	InRef k	Purpose d	LN N	Output 5 Output 6 Output 7 Output 8 ...
ExtRef 15 ExtRef 16 ExtRef 17 ExtRef 18	InRef x	Purpose e		
ExtRef 19 ExtRef 20	InRef y	Purpose f		
ExtRef 21 ExtRef 22	InRef z			

LDSUIEDStructure

LDSUIED				
Inputs	**InRefs**	**App Input**	**Function**	**Outputs**
ExtRef 1 ExtRef 2 ExtRef 3	InRef 1	STAT_LDSUIED_LPDO 1 Sortie 1	LPDO1	CmdDO1.stVal CmdDO2.stVal CmdDO3.stVal CmdDO4.stVal
ExtRef 4 ExtRef 5 ExtRef 6 ExtRef 7	InRef 218			
ExtRef 8 ExtRef 9 ExtRef 10 ExtRef 11	InRef 358			

LDSUIED				
Inputs	**InRefs**	**App Input**	**Function**	**Outputs**
ExtRef 12 ExtRef 13 ExtRef 14	InRef k	Purpose d	LN N	Output 5 Output 6 Output 7 Output 8
ExtRef 15 ExtRef 16 ExtRef 17 ExtRef 18	InRef x	Purpose e		
ExtRef 19 ExtRef 20	InRef y	Purpose f		
ExtRef 21 ExtRef 22	InRef z			

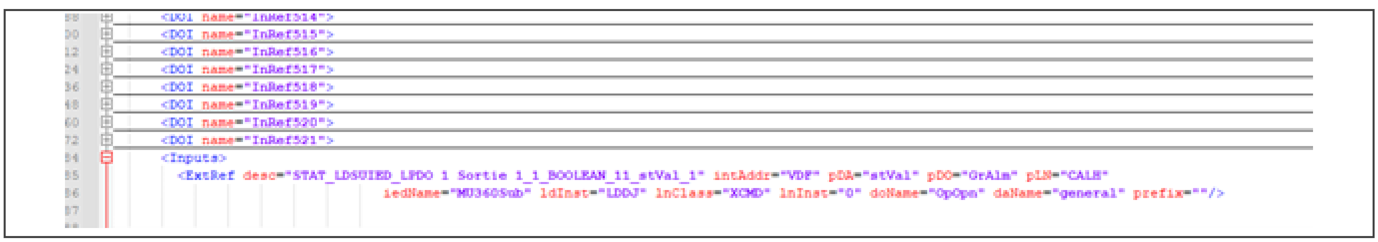
Therefore, the link will be in place following the way below:

Demand: LDSUIED.LPDO1.CmdDO1.stVal linked to LDDJ.XCMD. OpCls.general

Then **LDSUIED.Inputs.ExtRef1** will point to **LDDJ.XCMD.OpOpn.general**, and **LDSUIED.LLN0.InRef1.setSrcRef** will point to **LDSUIED.Inputs.ExtRef1 (ExtRef content)**, indicating initial selection among many possibilities. If IED name is MU360Sub, follows how SCL file will present them:

```
<LDevice desc="IED Monitoring Function" inst="LDSUIED">
  <LN0 desc="Logical node zero" inst="" lnClass="LLN0" lnType="LLN0_LDSUIED">
    <DOI name="Beh">
    <DOI name="Mod">
    <DOI name="Health">
    <DOI name="NamPlt">
    <DOI name="InRef1">
      <DAI name="purpose" valImport="false" valKind="RO">
      <DAI name="tstEna" valImport="false" valKind="Set">
      <DAI name="setTstCB" valImport="true" valKind="Set"/>
      <DAI name="setTstRef" valImport="true" valKind="Set"/>
      <DAI name="setSrcCB" valImport="true" valKind="Set"/>
      <DAI name="setSrcRef" sAddr="505" valImport="true" valKind="Set">
        <Val>MU360SubLDDJ/XCMD0.OpOpn</Val>
      </DAI>
    </DOI>
```

Figure 63: LDSUIED.LLN0.InRef1



```
<DOI name="InRef514">
<DOI name="InRef515">
<DOI name="InRef516">
<DOI name="InRef517">
<DOI name="InRef518">
<DOI name="InRef519">
<DOI name="InRef520">
<DOI name="InRef521">
<Inputs>
  <ExtRef desc="STAT_LDSUIED_LPDO 1 Sortie 1_1_BOOLEAN_11_stVal_1" intAddr="VDF" pDA="stVal" pDO="GrAlm" pLN="CALH"
          iedName="MU360Sub" ldInst="LDDJ" lnClass="XCMD" lnInst="0" doName="OpOpn" daName="general" prefix=""/>
```

Figure 64: LDSUIED.Inputs.ExtRef1

4.9.6 BAP - BASIC APPLICATION PROFILE

BAP is a set of rules included inside an InRef that should be assumed when receiving any bad quality flag. Depending on the field, different side effects can happen, as for instance to force its LD to be alarmed. Unique LD without BAP treatment is LDSUIED, all other will be guided by the following table of rules:

BAP	Flags	Overflow	Failure	Invalid	Oscillatory	Bad Reference	Out of Range	Old Data	Inconsistent	Inaccurate	Questionnable	Process	Substitute
0		I-A2	I-A2	I-A2	I-A2	V	V	I-A2	I-A2	V	V	V	V
1		I-A2	I-A2	I-A2	I-A2	V	V	I-A2	I-A2	V	I-A2	V	V
2		B-A3	B-A3	B-A3	B-A3	V	V	B-A3	B-A3	V	V	V	V

BAP	Flags	Overflow	Failure	Invalid	Oscillatory	Bad Reference	Out of Range	Old Data	Inconsistent	Inaccurate	Questionnable	Process	Substitute
3		I-A2	I-A2	I-A2	I-A2	I-A2	V	I-A2	I-A2	V	V	V	V
4		I-A2	I-A2	I-A2	I-A2	I-A2	V	I-A2	I-A2	V	I-A2	V	V
5		B-A3	B-A3	B-A3	B-A3	B-A3	V	B-A3	B-A3	V	V	V	V
6		B-A3	B-A3	B-A3	B-A3	B-A3	B-A3	B-A3	B-A3	B-A3	B-A3	V	V
7		V-R	V-R	V-R	V-R	V-R	V-R	V-R	V-R	V-R	V-R	V-R	V-R

- **I**: Ignore input
- **B:** Push function
- **R**: Push Inref quality to output
- **A**: force function (logical deviace) to be alarmed by health:
    - A2: minor, health = 2
    - A3: major, health = 3
- **V**: Treat InRef state as valid and its quality as good
- **V-R** Treat InRef state as valid but replicate its quality to output
- **I-A2**: Ignore InRef, Use BAP deault from configuration and its quality set to good, force LD to warning
- **B-A3**: Block LD and force all LD outputs quality to invalid

The following diagram shows some use cases:

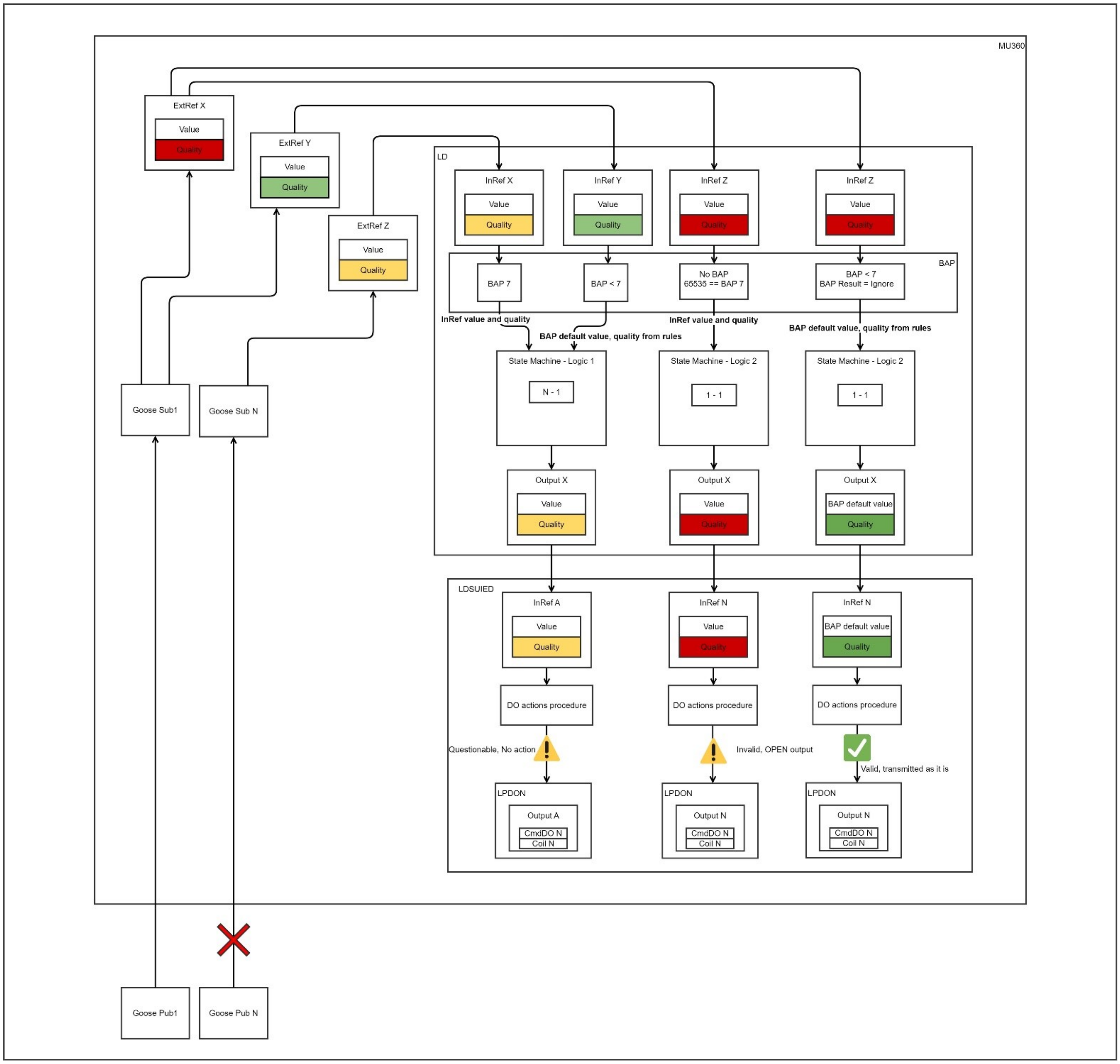


Figure 65: BAP treatment

4.9.7 FIP - FUNCTION INPUT PROFILE

FIP is the default initial state value an InRef should be used when there is not any input association. Its quality is assumed to be good.

4.10 MMS INTERACTIONS

MU360 has the main goal to be a data source of different kind of content, consumed by some MMS SCADA clients, that in general should monitor states. Its physical frontal HMI is intended to inform statuses from main internal services, but not able to trigger commands by real buttons, as those should either enable or disable specific features, as for instance to turn off in runtime a circuit breaker digital handler – LDDJ. Therefore, MMS has a second goal: intended to interface remote commands.

Remote commands, known as Controls, can be used in different kind of applications, so, this section is going to show where and how each of them are applied.

4.10.1 LIMITATIONS

Type	Server Only
VLAN ID	1 till 4095
Max number of MMS clients in parallel	8 connections
Max number of DataSets	256 instances
Max entries in a DataSet	1000 fields
Max number of Report Control Blocks (RCBs)	100 RCBs
Dataset instance location	Only in LLN0 from a logical device
Data model	MICS, depending on CORTEC
Conformance capabilities	PIXIT
Interoperability guide	PICS
Technical issues	TICS
Watchdog	Yes, timestamp being updated each cycle by adding LDSUIED.GAPC0.Ind1.stVal in a dataset

Note:
** Each dataset used to host a content used only by MMS RCB, GOOSE and SVs will have one dataset less available, and vice-versa*

4.10.2 OPERATING LOGICAL DEVICES - MOD BEHAVIOR

Each logical device is going to treat a whole feature by its LN0.Mod, that in general is a set of logical nodes treating sub small features, handled by sub LN.Mod.

Follows table showing context where each control is going to be operated. For example:

1. LDDJ.LN0.Mod is able to turn on all its features by either configuration during boot time or runtime using a remote MMS command.
2. LDSUIED.LN1.Mod is able to turn on all its specific feature in LN1 by configuration during boot time only.
3. Notice that LDSUIED.LN0.Mod is going to be handled only by configuration.

Logical Device - LD	Logical Node and its Control	Control Scope	By Configuration?	By Runtime? (MMS Remote Commands)
LDSUIED	LN0.Mod	Whole LDSUIED	Yes	No
	LN1.Mod	Local	Yes	No
	LN2.Mod	Local	Yes	No
	LNX.Mod	Local	Yes	No
LDDJ	LN0.Mod	Whole LDDJ	Yes	Yes
	LN1.Mod	Local	Yes	No
	LN2.Mod	Local	Yes	No
	LNX.Mod	Local	Yes	No
LDITFUA	LN0.Mod	Whole LDITFUA	Yes	Yes
	LN1.Mod	Local	Yes	No
	LN2.Mod	Local	Yes	No
	LNX.Mod	Local	Yes	No
LDXYZ (Any others)	LN0.Mod	Whole LDITFUA	Yes	Yes
	LN1.Mod	Local	Yes	No
	LN2.Mod	Local	Yes	No
	LNX.Mod	Local	Yes	No

* LN0, 1, 2, X … represent examples of instances of different logical nodes in one LD.

* LDXYZ represents examples of instances of different logical devices in one MU360.

4.10.3 INTERACTION BETWEEN MOD AND BEHAVIOR

Although Mod works as the main interface to inform if a feature is going to be enabled or not, it is not straight forward this conclusion. In fact, Mod is the main input to unleash a behavior computing. Therefore, after receiving a Mod, IED itself is going to decide ultimate result, publishing it then by Beh field.

As example, notice Beh in this context below: although some Mod informing On, final result can be Off.

Logical Device - LD	Logical Node and its Mod	Logical Node and its Beh
LDSUIED	LN0.Mod.stVal on	LN0.Beh.stVal on
	LN1.Mod.stVal off	LN1. Beh.stVal off
	LN2.Mod.stVal on	LN2. Beh.stVal on
	LNX.Mod.stVal on	LNX. Beh.stVal on
LDDJ	LN0.Mod.stVal off	LN0. Beh.stVal off
	LN1.Mod.stVal on	LN1. Beh.stVal off
	LN2.Mod.stVal on	LN2. Beh.stVal off
	LNX.Mod.stVal on	LNX. Beh.stVal off
LDITFUA	LN0.Mod.stVal on	LN0. Beh.stVal on
	LN1.Mod.stVal on	LN1. Beh.stVal on
	LN2.Mod.stVal on	LN2. Beh.stVal on
	LNX.Mod.stVal on	LNX. Beh.stVal on

Logical Device - LD	Logical Node and its Mod	Logical Node and its Beh
LDXYZ (Any others)	LN0.Mod.stVal on	LN0. Beh.stVal on
	LN1.Mod.stVal off	LN1. Beh.stVal off
	LN2.Mod.stVal on	LN2. Beh.stVal on
	LNX.Mod.stVal on	LNX. Beh.stVal on

* Examples shown as on and off only. Be aware that other variations can happen, as on-blocked, test and test-blocked too.

4.10.3.1 LDSUIED BEHAVIOR

This logical device is intended to handle all main physical IOs, working as the main background foundation, sharing basic local resources to any other logical device. As one example, this context is able to share output digital channels to be ordered by more than one foreign logical device. This shareable environment forces it to be always in “On” mode. That’s why any MMS command is going to be denied to change its mode in runtime.

4.10.3.2 ANY OTHER LOGICAL DEVICE BEHAVIOR

Any other logical device instance different of a LDSUIED is intended to treat all the following variations. There are four IEC 61850-compliant operating modes available for MU360:

- Mode ON: Normal operating mode variant.
  - In the transmitted messages the "test" bit associated with the value is set to FALSE, and their content represents the actual state of the process.
  - Received messages are only taken in account if their "test" quality attribute is also set to FALSE.
  - IED is going to work with complete features.
- Mode ON-BLOCKED: Normal operating mode variant.
  - Exactly same mode ON, but any order to activate a physical local output in the LDSUIED is going to be denied.
  - In the transmitted messages the "test” bit associated with the value is set to FALSE.
  - Received messages are only taken in account if their "test" quality attribute is also set to FALSE.
- Mode TEST: Test mode variant.
  - The device runs as ON mode.
  - In the transmitted messages the "test" bit associated with the value is set to TRUE.
  - Received messages are only taken in account if their "test" quality attribute is also set to TRUE.
- Mode TEST/BLOCKED:
  - The device runs as a BLOCKED and TEST mode at the same time.
  - In the transmitted messages the "test" bit associated with the value is set to TRUE.
  - Received messages are only considered if their "test" quality attribute is also set to TRUE.

4.10.4 COMMANDS - CONTROLS

Commands are going to be treated depending on the context it is faced by MU360, according to data model it is aligned to attend, always based on OPER structure. It means that variations of commands should happen distributed among functions. There are two types of them with support:

- Direct Control with Normal Security
- Direct Control with Enhanced Security

4.10.4.1 MU360_FT_DIRECTCONTROLWITHNORMALSECURITY

This variation is simpler, since it does not need to wait for either internal or external feedback from entity will be asked to execute it, therefore it works as an open loop. Once the command is received from MMS Client, its order is issued to destine and one answer is sent back to client just advising it was dispatched, without automatic feedback. Means that MMS Client should consult other associated fields to conclude if main goal was successful executed. In this context, as example, any LD.LLN0.Mod is going to work. Then, user (MMS Client) needs to check its associated behavior (LD.LLN0.Beh) manually, asking for it by MMS Client.

4.10.4.2 DIRECT CONTROL WITH ENHANCED SECURITY

This variation is intended to be used by situations that need a better security, waiting for process feedback. In fact, all procedure is similar to direct control mode, but with an extra termination feedback that will be sent to MMS Client after MU360 computing a final process checking.

4.10.4.3 CONTROLS DISTRIBUTION

Logical Device -LD	Logical Node	Type	Persistent
LDDJ	LLN0.Mod	Direct with Normal Security	Yes
	XCBR.Pos	Direct with Enhanced Security	No
LDTM	LLN0.Mod	Direct with Normal Security	Yes
	tlcoXSWI0.Pos	Direct with Enhanced Security	No
LDSXY	LLN0.Mod	Direct with Normal Security	Yes
	XSWI1.Pos	Direct with Enhanced Security	No
	XSWI2.Pos	Direct with Enhanced Security	No
	GAPC0.SPCSo1	Direct with Normal Security	No
LDITFTG	LLN0.Mod	Direct with Normal Security	Yes
LDITFSUDJ	LLN0.Mod	Direct with Normal Security	Yes
LDITFUA	LLN0.Mod	Direct with Normal Security	Yes
	XCBRx.Pos	Direct with Normal Security	No
LDITFRPTRPD	LLN0.Mod	Direct with Normal Security	Yes
LDBALIS	LLN0.Mod	Direct with Normal Security	Yes
	GAPC0.SPCSOx	Direct with Normal Security	No

4.11 GOOSE

Goose is the main service used to exchange data between IEDs. It works based on ethernet layer 2, means that it is based on broadcasts (802.1Q multicast frames), able to share information to lots of IEDs in a fast way, normally known as horizontal communication. Its main unit of data inside an Ethernet packet is known as PDU (Protocol Data Unit), that will host a Control Block associated to one Data Set. When an IED should consume information, it is known as Subscriber, and when it should issue packets, it is a Publisher. MU360 can attend both contexts. For more Goose infrastructure details access the IEC 61850-8-1 standard since this manual is addressed to attend applications on it.

Note:
For the formal MU360 conformance capabilities, refer to PIXIT documentation.

4.11.1 GOOSE LIMITATIONS

Subject	Goose Pub	Goose Sub
Ethernet Packet Max Size	1484 bytes	
Application ID	0x8000 to 0xBFFF	All range
MinTime (T1) Range	1ms to 2047ms	n/a
MaxTime (T0) Range	4ms to 60000ms	n/a
VLAN ID	1 till 4095	
Max Amount of DataSets	150 instances	
Max Entries in a DataSet	100 fields	
Max Amount of Control Blocks (CBs)	20 CBs	
Dataset instance location	Only in LLN0 from a Logical Device	
Functional Constraints	ST, MX	
Common classes	SPS, SPC, DPS, DPC, ENS, ENC	
Data model	Refer to MICS document, depending on CORTEC	
Conformance capabilities	Refer to PIXIT document	
Interoperability guide	Refer to PICS document	
Technical Issues	Refer to TICS document	
Origin.OrCAT and Origin.OrIdent	No	Yes
Watchdog	Yes, by LDSUIED.GAPC0.Ind1.stVal manually added in a datatset	No

Note:
** Each dataset used to host a content used only by MMS RCB, GOOSE and SVs will have one dataset less available, and vice-versa.*

4.11.2 GOOSE PUBLISHER

Depending on CORTEC, a different data model will be presented by EnerVista Flex v2 Tool. After making a basic configuration, user should follow steps below for creating configuration based on specific logical device.

4.11.2.1 SETTING A DATASET

A DataSet must be inside its logical device, LLN0, hosting fields from its logical device only. Then, in EnerVista Flex v2 Tool, Do the following sequence of action:

- In the IEC 61850 tab, select correct Project Device.

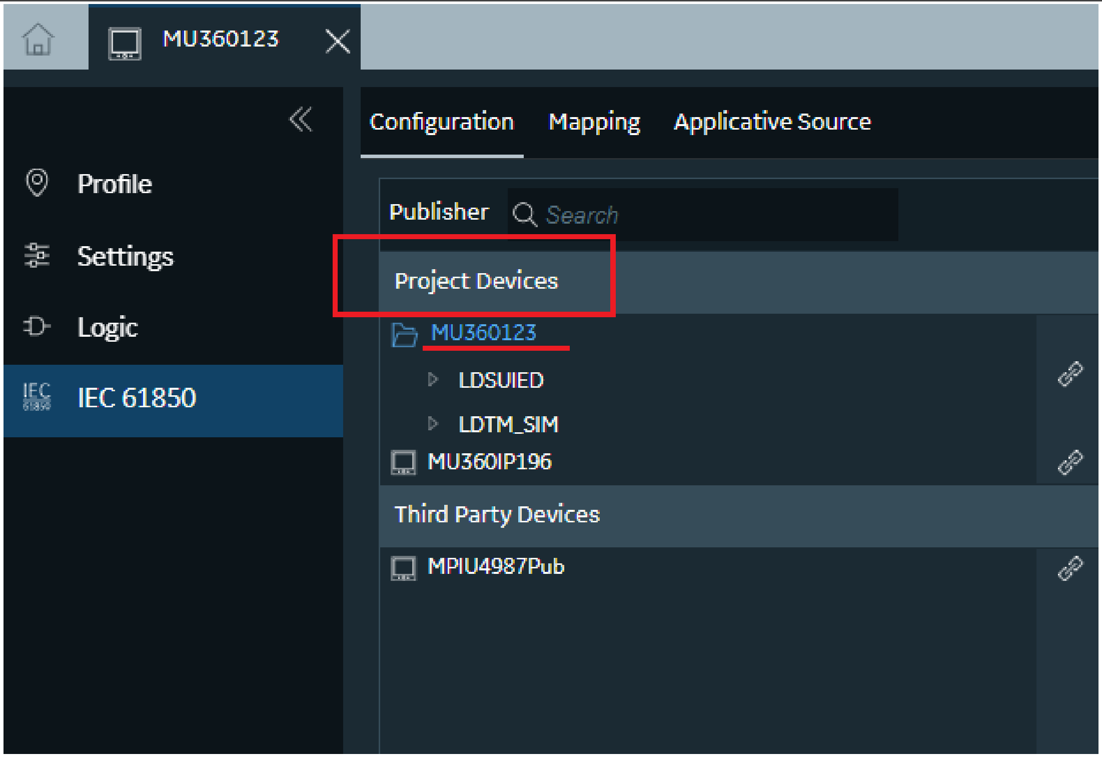


Figure 66: Project devices selection

- In Dataset column, add a new DataSet.

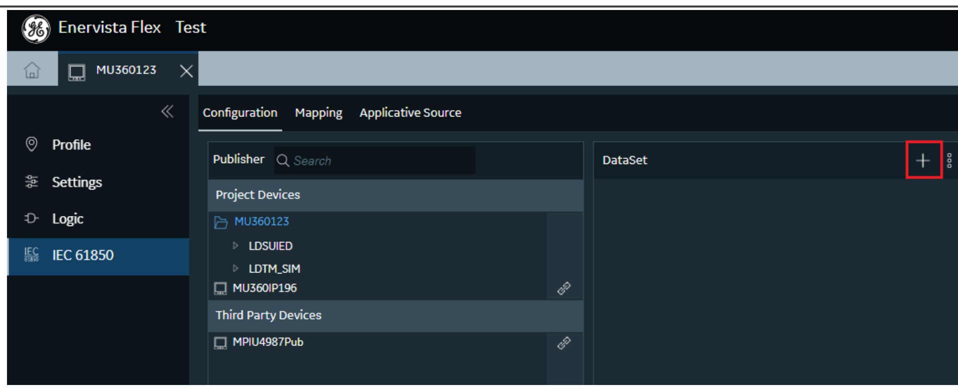


Figure 67: DataSet column

- Select Location in Logical Device/LLN0
- Drag and drop fields (DAs, data attributes) from IEC 61850 Model to DataSet content. (Max: 100 fields). Make sure that fields are aligned to Limitations as described before (Refer to GOOSE Limitations).

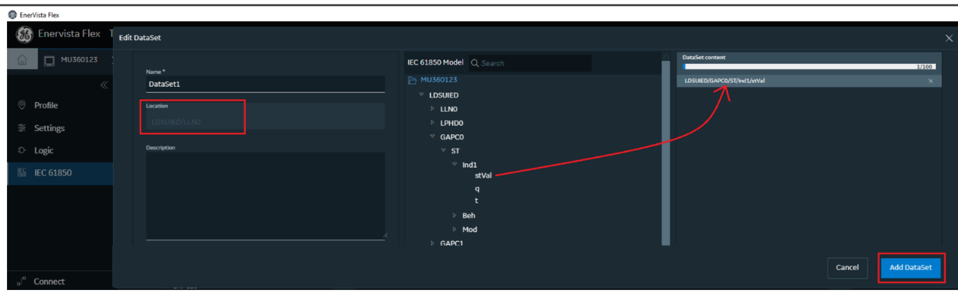


Figure 68: Field drag and drop

- Click on Add Dataset

4.11.2.2 SETTING A CONTROL BLOCK

A Goose Control Block will select a data set to be published. In the ICT, once at least one DataSet is present, follow steps below:

- In the IEC 61850 tab, Control Block column, add a new Control Block.

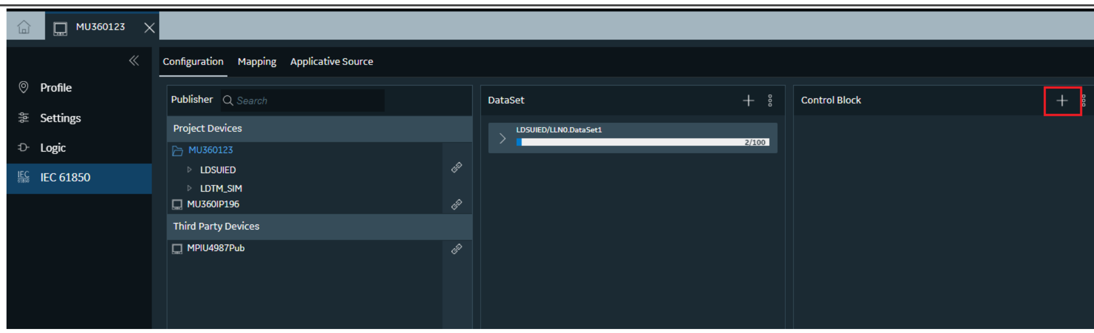


Figure 69: Add control block

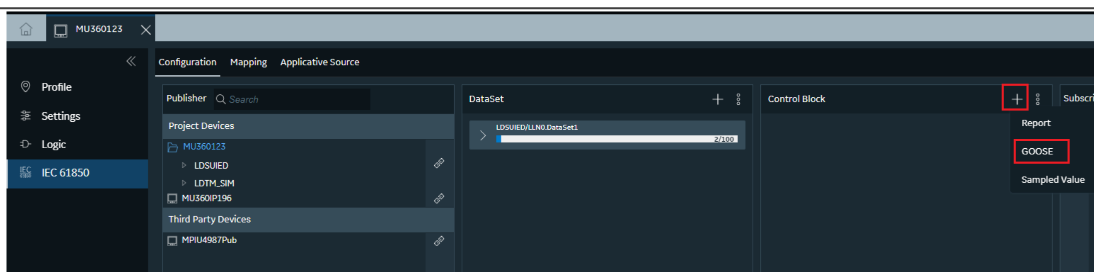


Figure 70: GOOSE selection

- Make sure correct location is well selected
- Select DataSet
- Define MAC Address for multicat
- Define Application ID. Check Limitations (put link here)
- Define VLAN ID. Check Limitations (put link here)
- Define VLAN priority
- Define MinTime (T1) and MaxTime (T0). Check IEC 61850-8-1:2011+AMD1:2020, Figure 8 for more details
- Enable it to be published since beginning. If not checked, then it can be enabled by MMS commands in Runtime
- Click on Add Goose Control Block

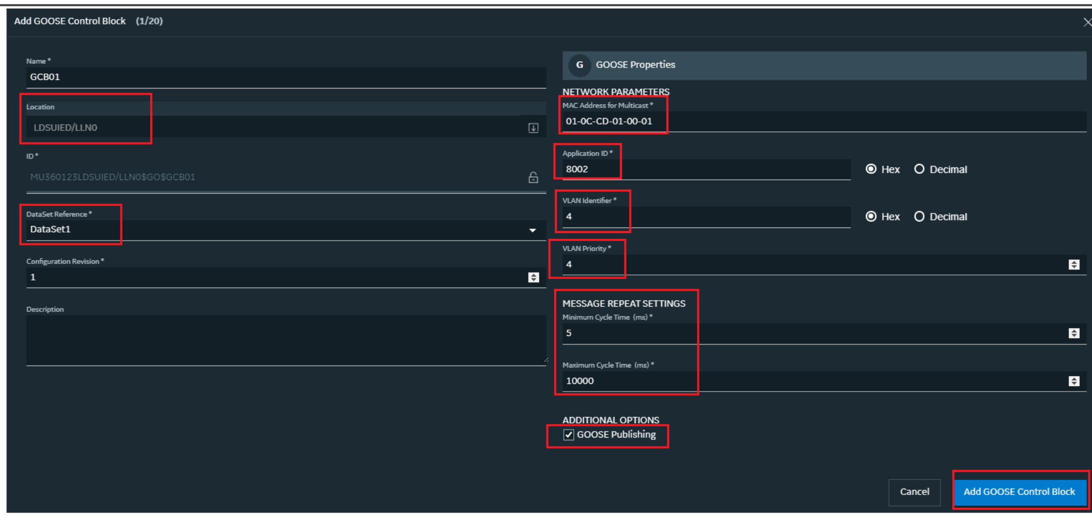


Figure 71: Add Goose control block

4.11.3 GOOSE SUBSCRIBER

A Goose Subscriber is a service hosted by MU360 that is intended to work as the main mechanism for consuming publishing Goose from other IEDs. Input/Output Associations (Refer to Input/Output Associations) section describes in detail how binding is done between outputs from logical devices (as for instance those hosted by other IEDs that publishes data by Goose) that could be mirrored by ExtRefs in MU360. This section is intended to show how ICT is treating it by front end.

4.11.3.1 TOP-DOWN APPROACH

This mechanism is one possibility of configuration when a SCD file is hosting MU360 device as a subscriber, binding some content from other IED hosted in the same file. It is going to work well if all rules described at Input/Output Associations (put link here) section have aligned each other (but not only, there are many sections in one SCD should be checked). Assuming that this SCD file is well configured, then follow steps below:

- In the Settings menu, select Project Management

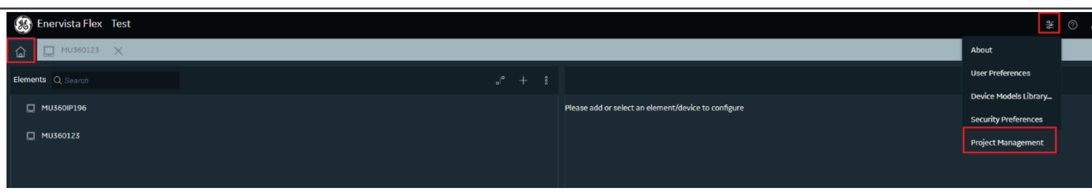


Figure 72: Project management selection

- Click on Import Project

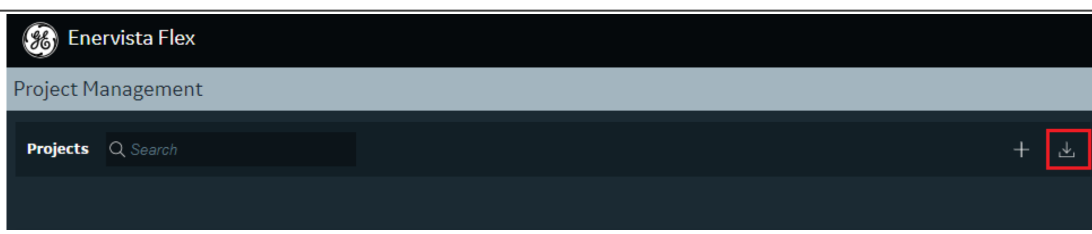


Figure 73: Import project

- Select SCD File

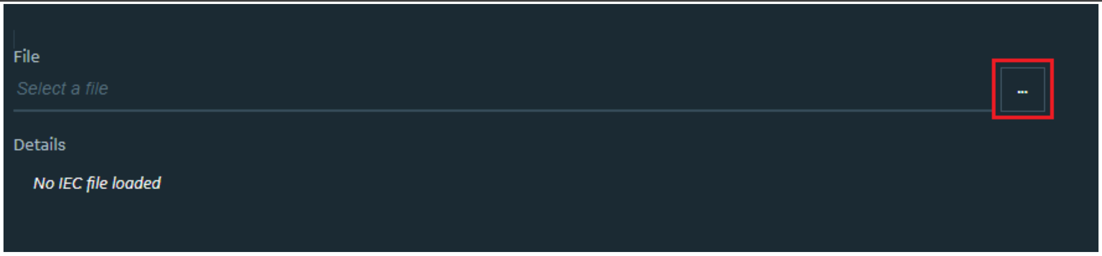


Figure 74: SCD file selection

- Click on Import Selection

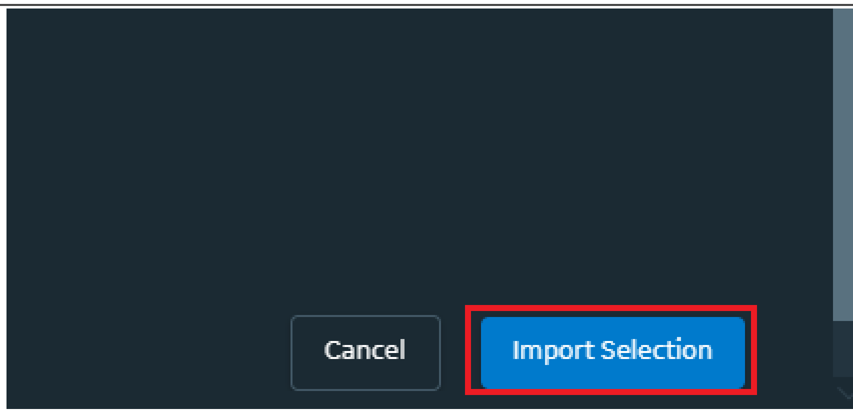


Figure 75: SCD import selection

- If no errors, then a final popup will inform procedure were well succeeded. Be aware, this method may take a long-time depending on SCD size.

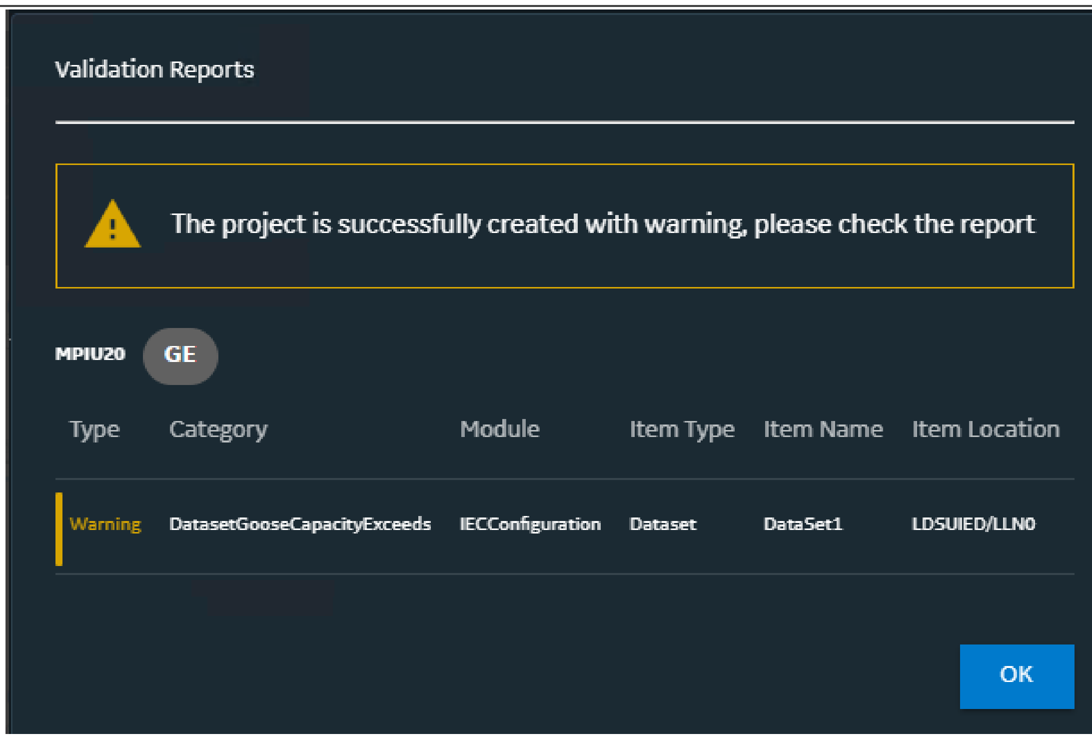


Figure 76: Successful validation report

- If errors, popup will indicate tips where in SCD problem happened.

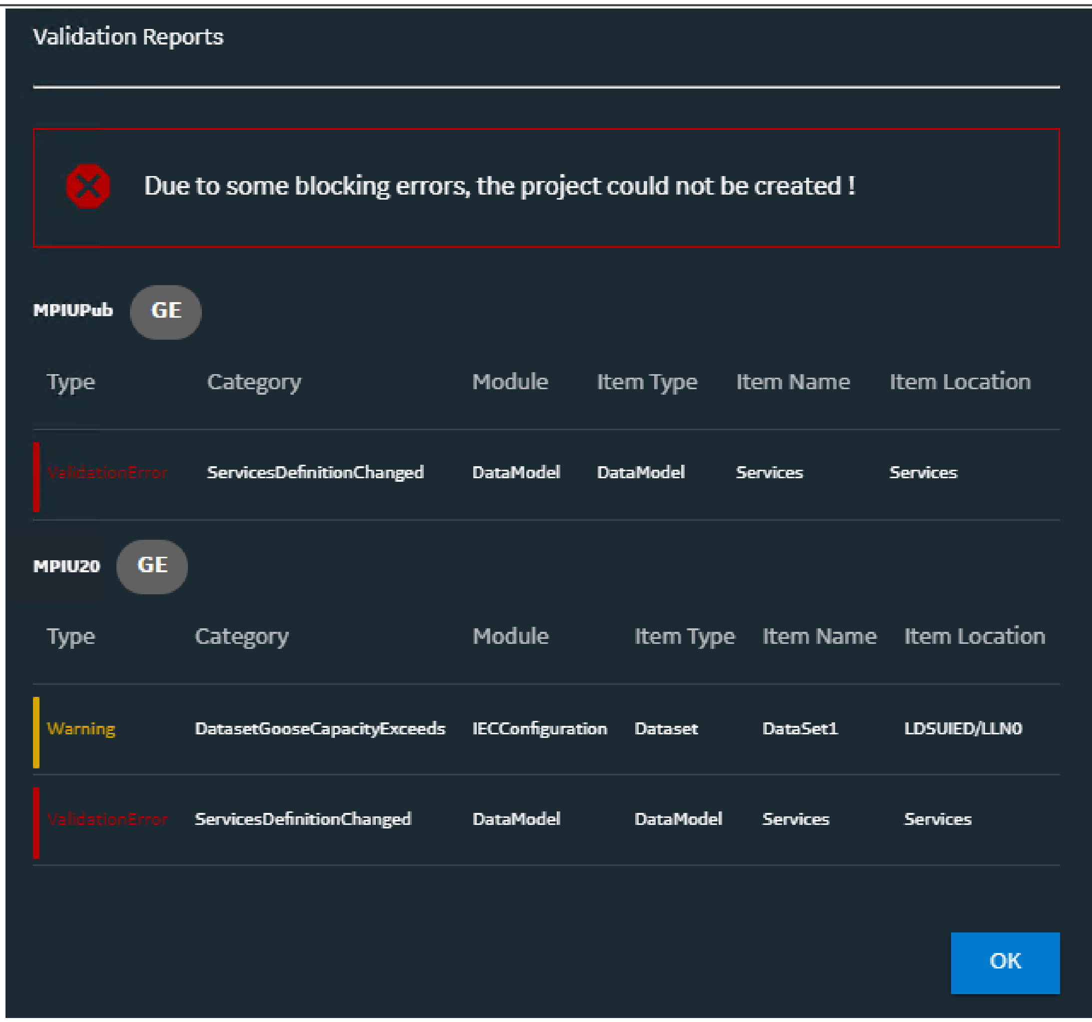


Figure 77: Validation report after issue faced during SCD import

4.11.3.2 BOTTOM-UP APPROACH

This mechanism is the most common use case MU360 should attend. It is mainly based on either making configuration manually by ICT or by importing CID file from an IED (Publisher side). Depending on the way each device is going to be created, each action will result same front-end disposition, but the ones imported will be segregated from the ones created by EnerVista Flex v2.

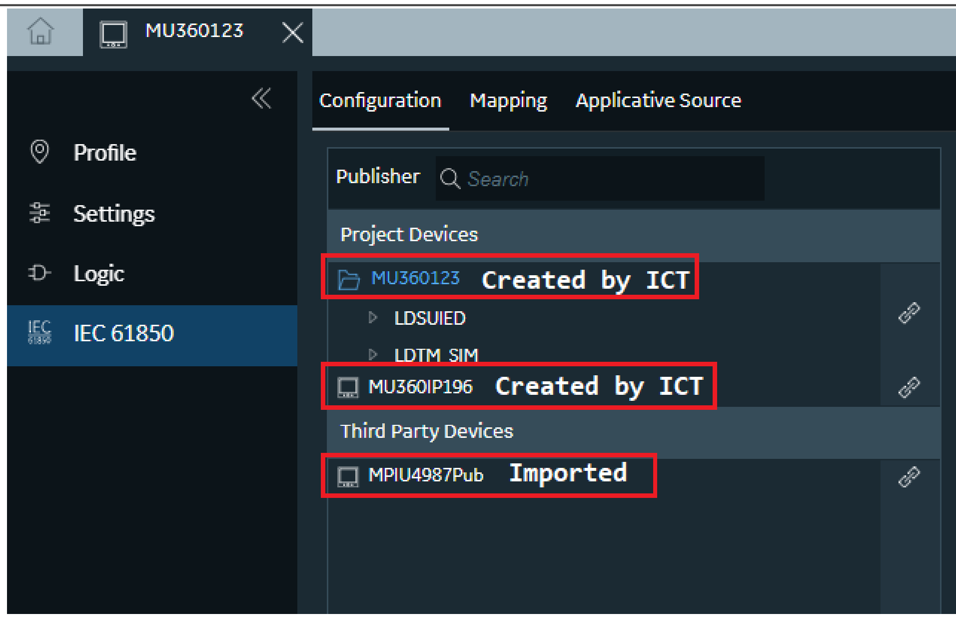


Figure 78: Project devices

After creating a device according to the CORTEC as described in Application Code and Hardware CORTEC, this section is addressed to explain how importing procedure works and how a final subscription will be in place, once all devices are set, procedure is the same for any situation.

Follow next steps to import a third part IED, from CID file:

- In IEC 61850 tab, select CID by import button.

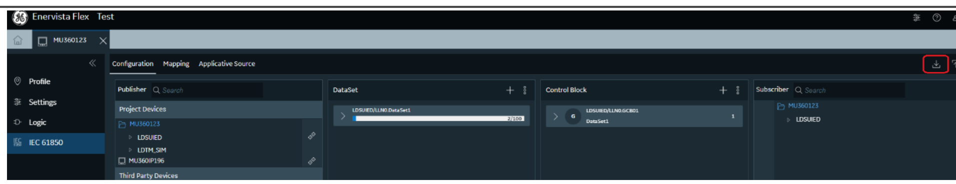


Figure 79: CID selection

- Select third part device will work as a Goose Publisher. This way Control Block will show third part fields.

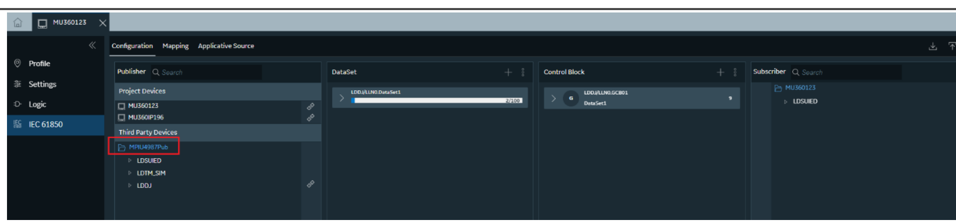


Figure 80: Third party device selection

- Figure out which ExtRef should be linked to, clicking on the ExtRef to select it.

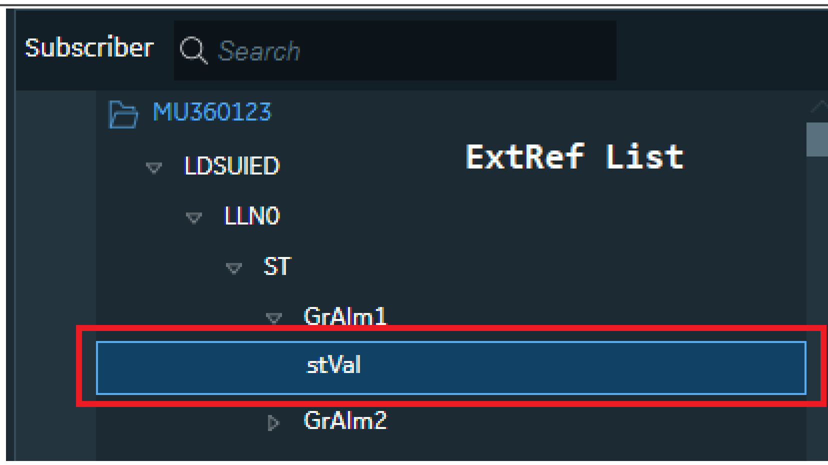


Figure 81: ExtRef selection

- Based on fields shown at Control Block list, drag and drop desired field on the ExtRef item.

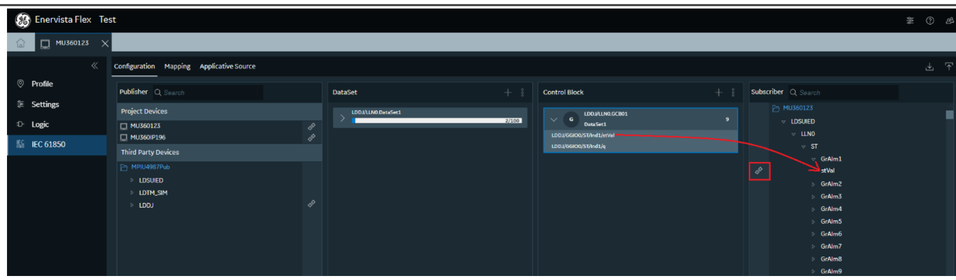


Figure 82: ExtRef field Selection

- Click on the Applicative Source Tab, then select which Applicative Input should be used based on its purpose. Go to Functions section (Refer to Built-in Automation) for more details about Applicative Inputs options. Purpose is a direct association to it.

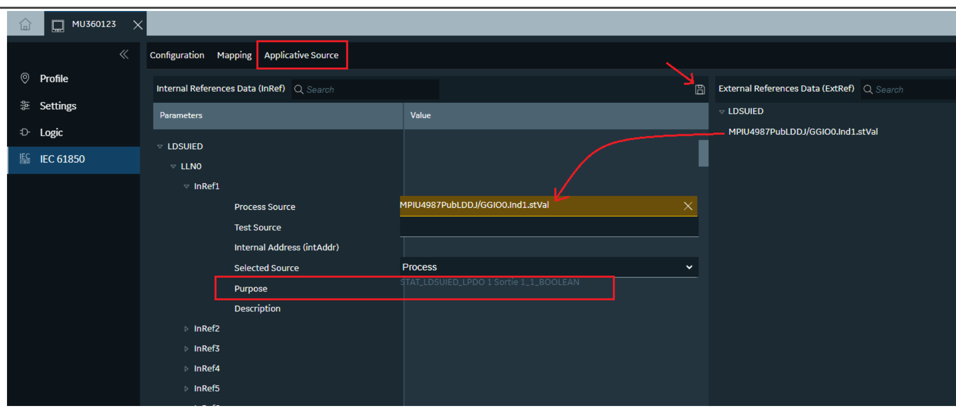


Figure 83: Applicative source selection

- Drag and drop ExtRef made from previous step on Process Source (depending on Selected Source, if Test, drop it on Test Source).
- (TBD) If previous link should be done in RunTime, make sure InRef should be used in future, clicking on the checkbox.
- Save.

4.12 SAMPLE VALUES

Sample Measured Values is the service used by MU360 to publish analog content, modeling TCTRs and TVTRS (Refer to Analog Interfaces) for interoperating third parties that will subscribe to this analog digital content, therefore aligned to IEC 61869-9 and IEC 61850-9-2. As a brief resume, It works based on ethernet layer 2, means that it is based on broadcasts (802.1Q multicast frames), able to share information to lots of IEDs in a fast way, normally known as horizontal communication. Its main unit of data inside an Ethernet packet is known as PDU (Protocol Data Unit), that will host a Control Block associated to one Data Set. When an IED should consume information, it is known as Subscriber, and when it should issue packets, it is a Publisher. MU360 is addressed to attend a Publisher context only. For infrastructure details access the IEC 61850-8-1 standard since this manual is addressed to applications on it. Formal MU360 conformance capabilities, please refer to PIXIT documentation.

4.12.1 LIMITATIONS

Subject	SV Pub
Ethernet packet max size	1484 bytes
Application ID	0x4000 to 0x7FFF
VLAN ID	1 till 4095
Max amount of DataSets	150 instances
Max entries in a DataSet	100 fields
Max amount of control blocks (CBs)	4 CBs
Dataset instance location	Only in LLN0 from a logical device
Functional constraints	MX
Common classes	SAV
Data model	MICS, depending on CORTEC, those with TMUs
Conformance capabilities	PIXIT
Interoperability guide	PICS
Technical issues	TICS

Sample Rates*				
4000 samples/s	50Hz*	80 samples/cycle	1 ASDU/frame*	4000 frames/s
4800 samples/s	50Hz, 60Hz	96 or 80 samples/cycle	1 or 2 ASDUs /frame	4800-2400 frames/s
12800 samples/s	50Hz	256 samples/cycle	8 ASDUs/frame	1600 frames/s
14400 samples/s	50Hz, 60Hz	288 or 240 samples/cycle	6 ASDUs/frame	2400 frames/s
15360 samples/s	60Hz	256 samples/cycle	8 ASDUs/frame	1920 frames/s

Optional Fields in Control Block Support	
Refresh time	**No, RefrTm in IEC 61850-9-2**
Sample Rate	Yes, smpRate in IEC 61850-9-2
Dataset Name	Yes, DatSet in IEC 61850-9-2
Security	**No, Security in IEC 61850-9-2**
Synchronization Source Identity	Yes, GmIdentity, Grand Master Identification, in IEC 61850-9-2

Note:
** ASDU is an application service data unit that means a sample from a set of data. Overall, is common to select 1 ASDU/ frame for a fast transmission once one sample is ready, otherwise MU360 will wait for complete bunch of samples to be ready for a posterior transmission.*

Note:
** Only two sample rates variations are allowed by IED.*

Note:
** Only one frequency is allowed by IED, means that all Control Blocks should be aligned to the same frequency.*

Note:
** Each dataset used to host a content used only by MMS RCB, GOOSE and SVs will have one dataset less available, and vice-versa.*

4.12.2 SAMPLE VALUE PUBLISHER

Depending on CORTEC, a different data model will be presented by EnerVista Flex v2. After making a basic configuration, user should follow steps below for creating configuration based on specific logical device.

4.12.2.1 MAKING A DATASET

A DataSet must be inside its logical device, some LDTM function, LLN0, hosting fields from its logical device only. Then, in ICT Tool, do:

- In IEC 61850 tab, select correct Project Device.

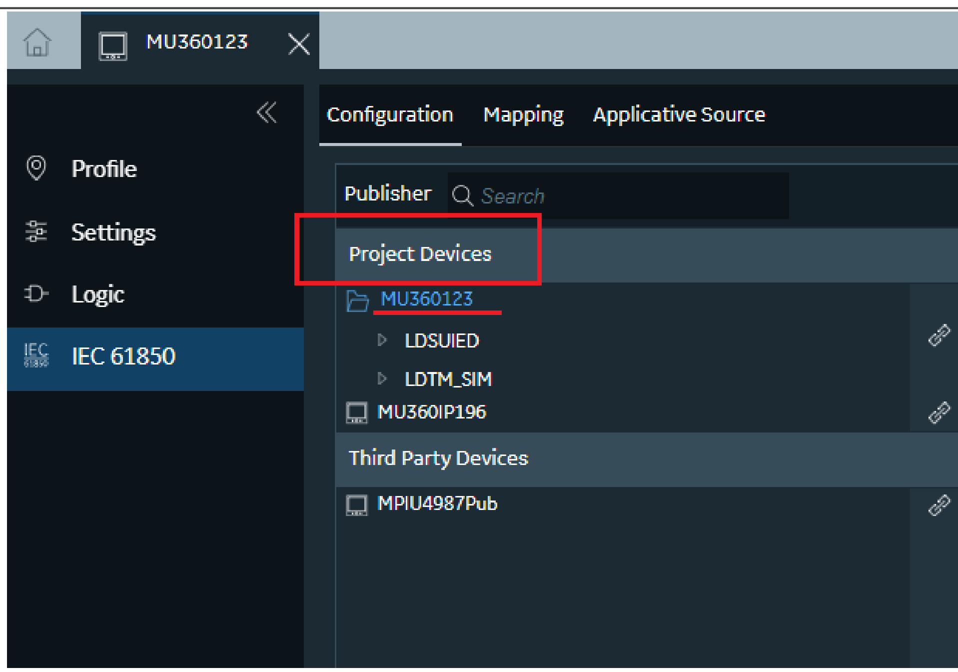


Figure 84: Project devices

- In Dataset column, add a new DataSet.

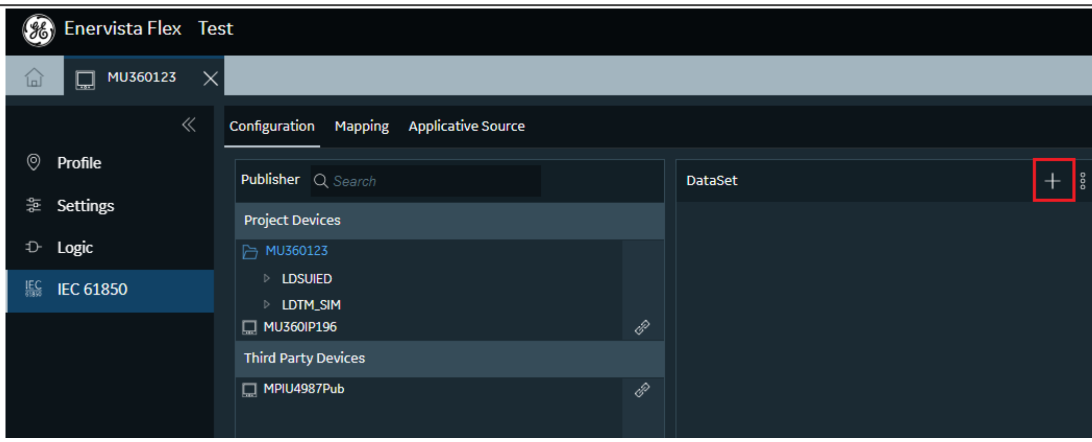


Figure 85: Add a dataset

- Select Location in LDTM/LLN0.
- Drag and drop fields (DAs, data attributes) from IEC61850 Model to DataSet content. (Max: 100 fields). Make sure that fields are aligned to Limitations as described before (Refer to Limitations).

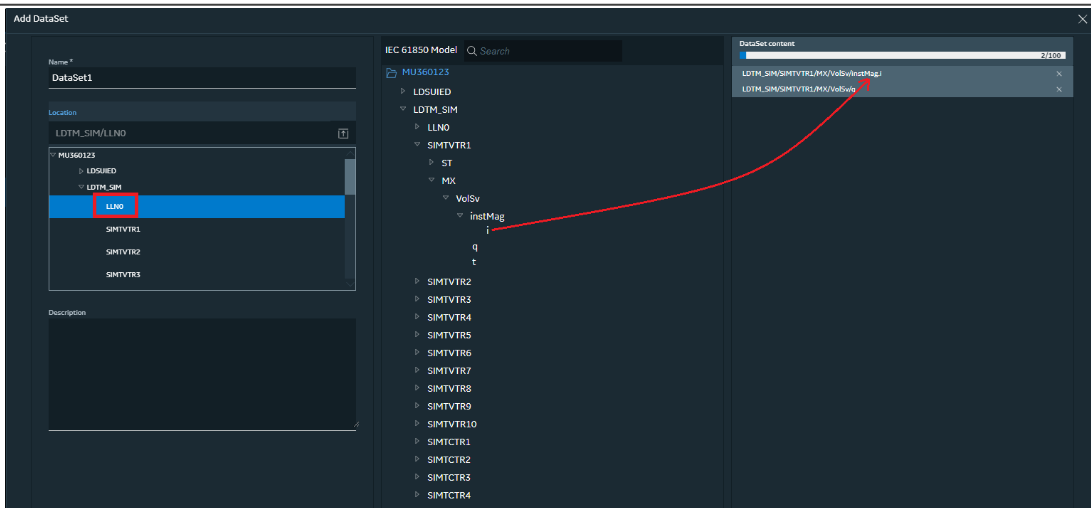


Figure 86: Fields drag and drop

- Click on Add Dataset

4.12.2.2 MAKING A CONTROL BLOCK

A Goose Control Block will select a data set to be published. In the EnerVista Flex v2, once one DataSet (those associated to some LDTM function) is present, follow steps below:

- In the IEC 61850 tab, Control Block column, add a new Control Block.
- Make sure correct location is well selected.
- Select DataSet.

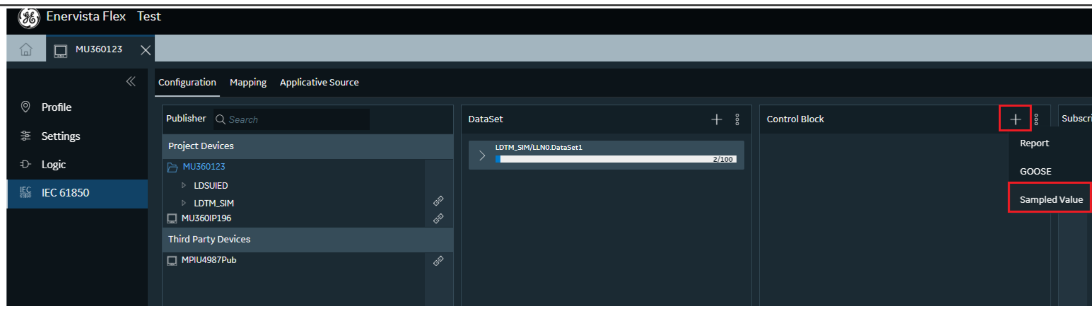


Figure 87: Add a dataset

- Define MAC Address for multicast.

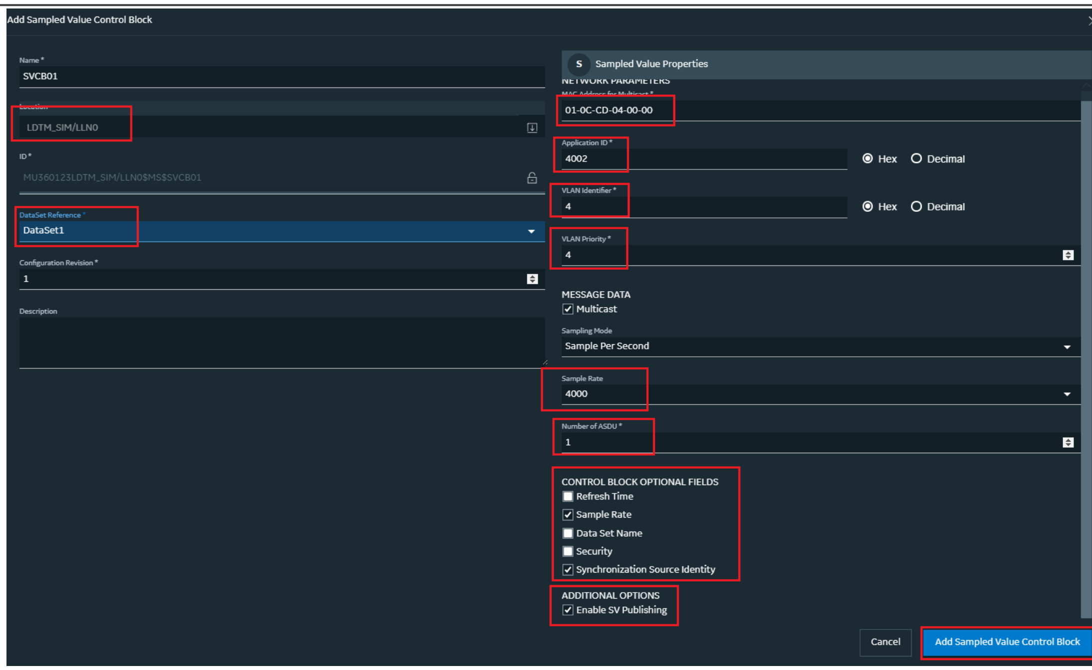


Figure 88: Configuration

- Define Application ID. Check Limitations (Refer to Limitations).
- Define VLAN ID. Check Limitations (Refer to Limitations).
- Define VLAN priority.
- Define Sample Rate. Check Limitations (Refer to Limitations).
- Select Optional Fields, if needed. Check Limitations (Refer to Limitations).
- Enable it to be published since beginning. If not checked, then it can be enabled by MMS commands in Runtime.
- Click on Add Sample Value Control Block.

4.12.2.3 PUBLISHING SIMULATED SAMPLE VALUES

All mechanism already described, in fact, works for every LDTM instance. Unique difference is about the source. A simulating LDTM instance will be always present in the data model. Then all any user should do is, as follows:

- In EnerVista Flex v2, go to Settings.
- Select Global.
- Select Sample Value Simulation.

- If a demand to simulate grand master clock source, set True for static synchronism.
- Imitate all content for current and voltage transformers.
- Save it.
- Then, do same normal steps for creating data set and control block, but picking data from simulating LDTM.

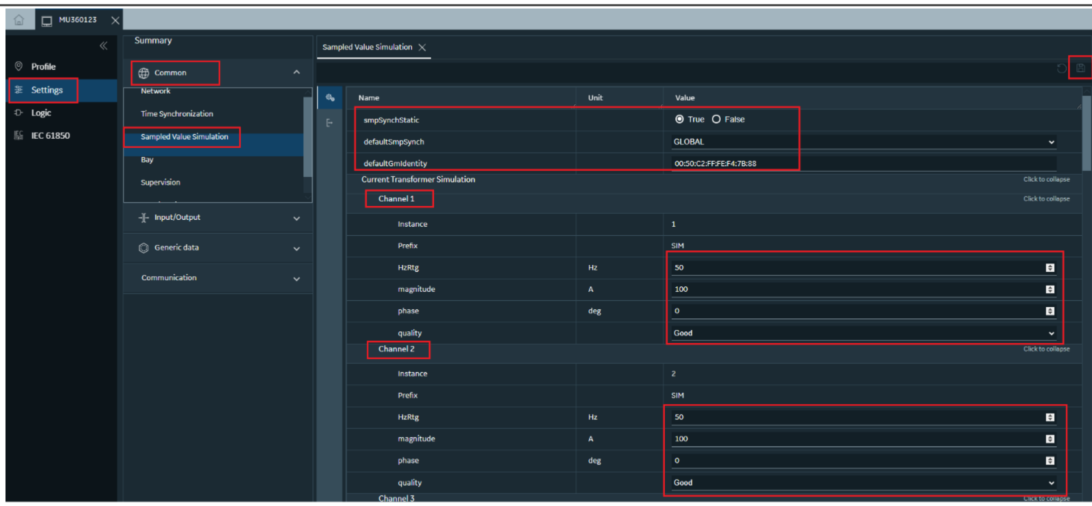


Figure 89: Publishing simulated sample values

4.13 CYBER SECURITY

This chapter lists best practices to securely install and operate MU360.

It applies to MU360 1.0 and later.

This document assumes that the reader is familiar with the product.

This document is the response to IEC 62443-4-1 “Practice 8 - Security Guidelines” requirements.

4.13.1 PRODUCT DEFENSE-IN-DEPTH STRATEGY

> *Note:*
> *This paragraph is the response to IEC 62443-4-1 SG-1 requirement.*

The product implements the following security features:

- Secure design process to ensure that cyber security is part of the design process and not an afterthought.
- Security and penetration testing to detect as much as possible vulnerabilities at the design stage.
- Digital signature of firmware/software package to allow integrity and authenticity verification before installation.
- Monitoring of software components vulnerabilities and security bulletins to inform users of the newly discovered vulnerabilities and threats.
- User authentication and personal account.
- Role based access control and least privileges to enforce area of responsibilities.
- Password and user account policies to prevent use of weak passwords and password brute force attack.
- Security event logging for post-incident analysis.
- Centralized security event logging using SYSLOG protocol to send event to a SOC and allow close to real time security monitoring.
- Secure configuration protocols using TLS to protect credentials and sensitive information while in transit.
- Hardening to reduce the attack surface.

To complement the defense in depth strategy, the product must be installed in a secure environment. Refer to Environment.

Particularly, the product cannot mitigate DoS attack through network interface overload.

4.13.2 ENVIRONMENT

> *Note:*
> *This paragraph is the response to IEC 62443-4-1 SG-2 requirement.*

MU360 1.0 is designed to be installed and operated in an industrial environment, connected to a private network.

While the rest of this guide describes security at the product level, requirements to achieve security go beyond just the product.

GE Vernova recommends that security applies to the whole system in which the MU360 1.0 is installed, following a defense-in-depth approach. Security includes (but is not restricted to):

- User security awareness training.
- Security policies.

- Access control.
- Network security measures, such as segmentation, use or firewalls, use of secure protocol.
- Security monitoring, such as network intrusion detection systems, security event logging.
- Physical security, such as building access control, locked cabinets.

In addition, remote configuration/monitoring of the device (i.e. not from the front panel) shall be done from a secure engineering workstation through a trusted network link.

4.13.3 SECURE INSTALLATION - HARDENING

> *Note:*
> *This paragraph is the response to IEC 62443-4-1 SG-3 and SG-6 requirements.*

4.13.3.1 VERIFYING SOFTWARE INTEGRITY

Before installing any firmware, the installation package integrity shall be verified.

GE Vernova firmware images are digitally signed. MU360 verifies the integrity of the firmware package upon downloading it. It also checks its firmware periodically to verify its integrity.

MU360 does not implement a secure boot process.

Recommendations in Product Defense-In-Depth Strategy and Environment shall be implemented to mitigate this limitation.

4.13.3.2 UPGRADING FIRMWARE TO THE LATEST VERSION

MU360 firmware must be upgraded to the latest version available for the major version used, to take advantage of all fixed known vulnerabilities.

The MU360 firmware upgrade procedure can be found in chapter MU360 firmware upgrade procedure can be found in section 4.4.5 Firmware Update.

4.13.3.3 DISABLING UNUSED PROTOCOLS

Hardening consists in disabling unused features in MU360.

Most features won't be enabled unless explicitly configured.

The features listed below are enabled by default (mostly to simplify installation) and shall be reviewed:

- PTP - disabled when not configured.
- MMS - cannot be disabled.

Refer to List of Supported Protocols for a list of all protocols and services that can be enabled by configuration.

4.13.3.4 CONFIGURING SECURE PROTOCOLS

The MU360 uses the TLS protocol in the following cases:

- Communication with the EnerVista Flex v2 tool.

Limitations:

- Default certificates cannot be upgraded.

4.13.3.5 USER ACCESS CONTROL

While creating user accounts, care must be taken to associate only a minimum number of roles to accomplish the needed tasks.

4.13.3.5.1 DEFAULT USER ACCOUNT

MU360 1.0 is delivered with the following default user accounts:

Username	Default Password	Roles
Viewer	Viewer	Observer
Engineer	Engineer	Observer System Engineer System Administrator
Admin	Admin	Observer System Engineer System Administrator Security Administrator

4.13.3.5.2 LOCAL USER ACCOUNT

MU360 supports the management of personal user accounts at EnerVista Flex v2 application level.

4.13.3.5.3 ROLE BASE ACCESS CONTROL

MU360 1.0 manages by default the following IEC62351-8 roles to provide required permissions to each user:VIEWER

- SECAUD
- RBACMNT
- OPERATOR
- INSTALLER
- ENGINEER

Additional roles and users can be created or deleted in the Security menu of EnerVistaFlex V2 software:

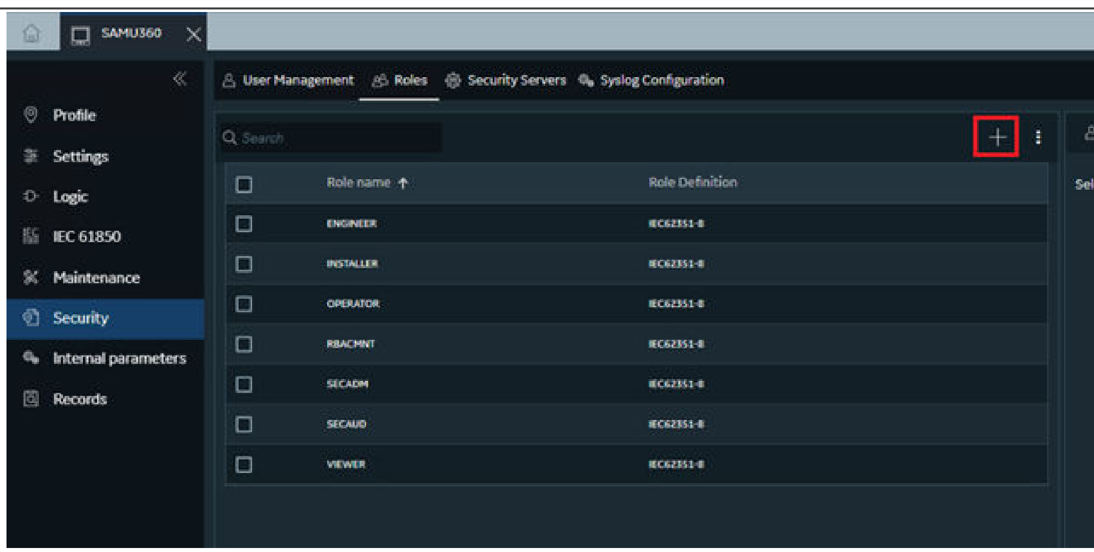


Figure 90: EnerVista Flex RBAC roles management

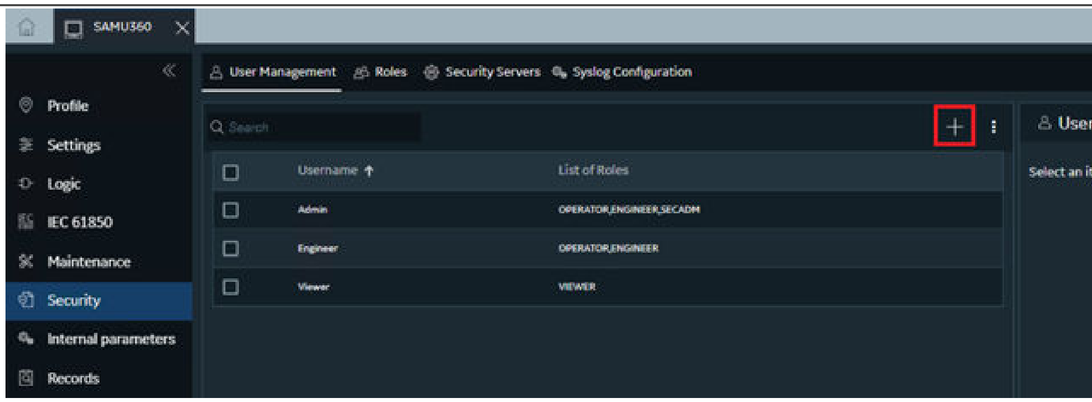


Figure 91: EnerVista Flex RBAC users management

4.13.3.5.4 LOCAL SECURITY POLICIES

Local security policies shall be configured:

- Login Banner
- Maximum user login retries: 10
- User locking period (in seconds): 60
- Session's inactivity timeout (in minutes): 10 min
- Password expiration period (in months): 0
- Maximum open sessions: 30

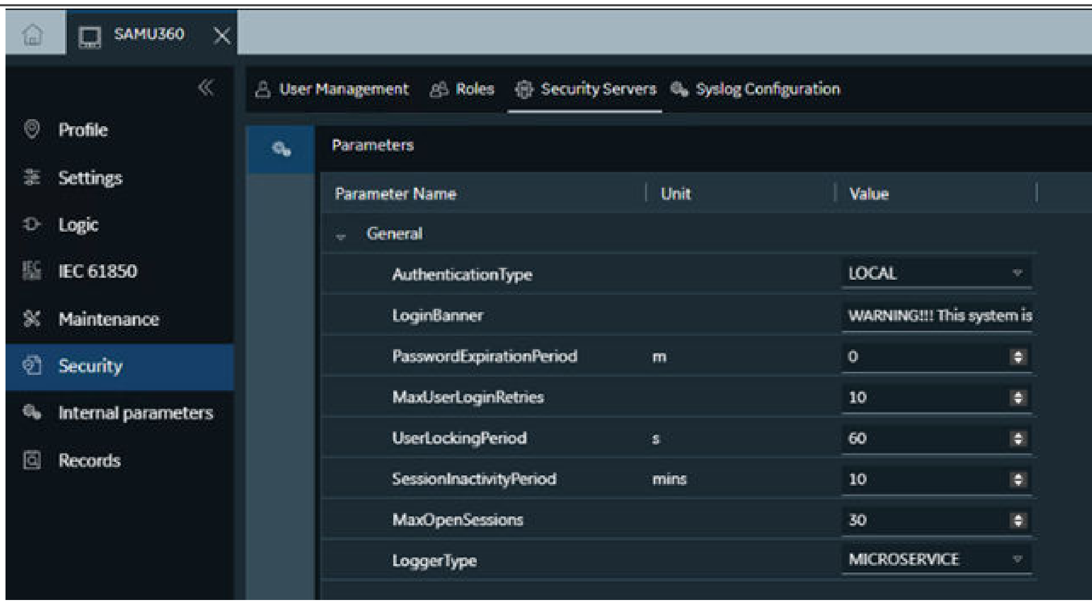


Figure 92: EnerVista Flex security policies configuration

4.13.3.6 CONFIGURING SECURITY EVENT LOGGING

4.13.3.6.1 LOCAL SECURITY EVENT LOGS

MU360 logs security events in a text file format, that can be downloaded using Enervista Flex v2 tool.

The log file cannot be modified. The file stores up to 2048 events and is circular: when full, the oldest event is deleted and the newest added.

Local security logging cannot be disabled and there is no need to configure it.

4.13.3.6.2 CENTRAL LOGGING

MU360 support logging security events to a central syslog server.

GE Vernova recommends forwarding all security logs to a central syslog server to provide a unique view of all system events as well as enforce log long term storage and integrity.

The security events can be accessed through a central repository (Syslog server) if it is defined in the configuration database.

Whether logs occurring during a communications loss are received depends on the communications protocol:

- UDP: The MU360 is not informed of the communications loss, therefore it continues to send the logs during the downtime. These logs are stored locally but are not received by the Syslog server.
- TCP: The MU360 is informed of the communications loss. It stores its date and time and sends the intervening logs when the communications are restored.

For more information refer to section 4.5.3.1 Syslog.

4.13.3.7 CONFIGURING NETWORK INTERFACES

4.13.3.7.1 DEDICATED ETHERNET PORT FOR CONFIGURATION

MU360 has a dedicated ethernet port for configuration, leaving only operational protocols (such as IEC 61850 and time synchronization) on the other ports.

4.13.3.7.2 ETHERNET INTERFACES

Currently, Ethernet interfaces are disabled if not configured.

4.13.3.7.3 VLAN AND MAC ADDRESS FILTERING

In order to enforce network segregation and reduce the network attack surface, GE Vernova recommends that VLAN filtering and MAC address filtering to be configured on all Ethernet ports.

Particularly because IEC 61850 extensively uses layer 2 broadcast, whitelisting multicast MAC addresses and VLANs (GOOSE, SV, PTP) on MU360 Ethernet interfaces will reduce the burden on the CPU board.

4.13.4 MAINTAINING SECURITY

Note:
This paragraph is the response to IEC 62443-4-1 SG-3 requirement.

Once security has been properly configured, it is important to create procedures to maintain security over time.

4.13.4.1 PERIODIC SECURITY AUDITS

The configuration applied in Secure installation paragraph shall be recorded.

Periodically, particularly after maintenance activity, the security configuration shall be audited, and deviations tracked and fixed.

4.13.4.2 BACKUP AND RESTORE PROCEDURES

Firmware installation packages and configuration files shall be backed up following any configuration/maintenance activity.

A restore procedure shall be prepared for quick service restoration following an incident.

4.13.4.3 VULNERABILITY MONITORING AND FIRMWARE UPDATES

GE Vernova responsibility discloses vulnerabilities found on its products.

Users shall periodically check for newly published vulnerabilities and available firmware updates and define a security update policy.

All GE Vernova software packages are digitally signed. Digital signature shall be verified before installation.

4.13.4.4 REPORTING A VULNERABILITY

Providing a legitimate pathway for vulnerability disclosure provides an essential link between GE Vernova and the cybersecurity community.

To submit a vulnerability in a Grid Solutions product to the GE Vernova PSIRT team, please fill up the form at https://www.gevernova.com/security. Please do not include identifiable sensitive data (e.g. personal data, specific system configuration) within the body of the communication or any attachments (e.g. screenshots, images or log files).

We actively encourage reports to be sent to us for remediation prior to a public disclosure, so that we can properly address any vulnerabilities.

We request the following when reporting a vulnerability:

- Please provide your report in English.
- Include specific information about affected products, including model or serial numbers, geographic location, software version, and the means of obtaining the product.
- If you have developed a proof-of-concept for exploiting the vulnerability, please include the code and explanation for the exploit.
- If you are aware of any incidents of this vulnerability being exploited on equipment in the field (e.g. a Grid Solutions' customer was directly impacted by this vulnerability).
- Information on how you discovered the vulnerability, your thoughts on impact or CVSS scoring, and potential remediations will help us to triage the vulnerability more quickly.
- Please include relevant information about yourself or the company/organization you are representing, or if you prefer to remain anonymous.
- Please let us know if you have a preferred method of contact during our internal triage process.
- Please include your intentions for disclosing the vulnerability to us, or if you intend to disclose the vulnerability to the public.

In response, you can expect the following from us:

- We will acknowledge receipt of your message within 48 hours.
- In the following phase of initial triage and assessments, an appropriate member of the GE Vernova PSIRT may reach out to you to:
  - Request additional information, or
  - Communicate an expected process and timeline, or
  - Notify you that the report is either out of scope or will not be triaged for other reasons;
- Once we have conducted our own assessment of the vulnerability, we will communicate our process and findings as a result of the investigation.
- We will provide public recognition for the security researcher (if requested) and if the report results in a public disclosure.

By submitting a request, you acknowledge that GE Vernova Grid Solutions may use in an unrestricted manner (and allow others to do the same) any data or information that you provide to GE Vernova Grid Solutions. Your submission does not grant you any rights under GE Vernova Grid Solutions intellectual property or create any obligations for GE Vernova Grid Solutions.

4.13.5 DECOMMISSIONING

> *Note:*
> *This paragraph is the response to IEC62443-4-1 SG-4 requirement.*

4.13.5.1 SECURE DECOMMISSIONING RECOMMENDATIONS

GE Vernova recommends preventing unauthorized disclosure of information from the device using an appropriate decommissioning method.

Decommissioning is a complex matter: physical destruction may be forbidden by recycling/waste management laws, filesystem format is ineffective, advanced technical may be conducted offsite introducing supply chain and audit complications.

Hence GE Vernova cannot recommend a decommissioning method.

For organizations to have appropriate controls on the information they are responsible for safeguarding, they must first identify and classify information.

Regarding MU360 1.0:

- Information is stored in soldiered flash memory.
- Passwords are stored locally protected by PBKDF2 with SHA-256 and a unique 64 bits salts to make clear text recovery extremely difficult per today’s standards.

4.13.6 SECURE OPERATION GUIDELINES

> *Note:*
> *This paragraph is the response to IEC 62443-4-1 SG-5 requirement.*

For a secure operation of the product, GE Vernova recommends that:

- Users be assigned a specific role at a level sufficient for the tasks they must perform.
- Users don’t share their passwords.
- Users change their passwords when they believe there might a possibility of unwanted disclosure.
- Default account passwords be changed before putting the device in operation.
- Users log out of their session when finished (although an inactivity timeout can be set to automatically terminate user sessions).
- The product never be connected to a public network, nor the Internet.
- Only the required services are configured and enabled.
- Transient asset that must be connected to the product be carefully controlled and checked for malware.

4.13.7 APPENDICES

4.13.7.1 LIST OF SUPPORTED PROTOCOLS

MU360 1.0 supports the following protocols:

Protocol	Port	Comment
MMS IEC 61850	102	
gRPC	10000	Connection to configuration tool
Syslog	-	Configurable TCP and UDP ports for primary and secondary servers

4.13.7.2 RESOURCE MANAGEMENT

By using the following features, MU360 makes sure that security function does not interfere with operations:

- Circular local log file (protect against filesystem over usage).
- Dedicated Ethernet management interface.

4.14 BUILT-IN AUTOMATION

Several functionalities can be in MU360. This concentration has a goal to organize lots of logical nodes, from different contexts, in one main function, simply named as logical device. This chapter is to present them according to their level of importance.

4.14.1 LDDJ - DISCONNECTOR LOGICAL DEVICE

LDDJ is a logical device in MU360 that has been working as the main physical interface to a circuit breaker. Its main goal is to collect commands from one or more linked modules, the ones demanded by application, as commands either coming from bay controllers (Goose) via “Input/Output Associations” (Refer to Input/Output Associations) or by SCADA MMS commands. There are mainly two types of commands:

- Trip orders: Will protect the circuit breaker, avoiding damages, disconnecting circuits.
- Close orders: Will push circuit breaker to work, connecting circuits physically.

As exposed by “Input/Output Associations” (Refer to Input/Output Associations) section, many inputs can interface an applicative input, then each one will be determined by a meaning, a text, known as purpose. As example, the applicative input will commit a three phase order is known as purpose “DYN_LDDJ_Ordre de declenchement triphase”.

MU360 has modeled LDDJ as a set of sub-functions and fields, as main examples below:

- XCMD: Main logical node will concentrate all trip and close orders to physical outputs. Orders should come either from goose or MMS.
- XCBR: logical node will indicate circuit breaker current position. MMS command (trip/close order) is hosted inside.
- GGIO.Ind1: Indication of a manual closing order by switchyard push button.
- XSWI0: used when withdrawable circuit breaker is in place, indicating if connected or not.

4.14.1.1 LDDJ MMS COMMANDS

In the XCMD, there is an OPER structure that allows user to operate this LDDJ manually, executing either trip or close orders. Be aware, MU360 will execute the order without checking if circuits are in the same frequency and phase. This kind of checking must be done by the main order origin (as example, either by Bay Controller Unit or by SCADA user), therefore a wrong evaluation can damage the circuit breaker and put all associated circuit in trouble.

4.14.1.2 LDDJ SETTINGS

Two following parameters should be configured by specific Enervista Flex v2 commands during runtime, without having a reboot:

- TDEC: it is the pulse length used by trip orders
- TENC: it is the pulse length used by close orders

4.14.1.3 LDDJ INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDDJ				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
ExtRef(s)	2	CB close order	XCMD	OpCls.general OpOpn.general OpOpn.phsA OpOpn.phsB OpOpn.phsC
ExtRef(s)	42	Three phase trip order		
ExtRef(s)	6	Phase A trip order		
ExtRef(s)	6	Phase B trip order		
ExtRef(s)	6	Phase C trip order		
ExtRef(s)	1	Trip Order due to low SF6 pressure		
ExtRef(s)	1	CB internal fault	XCBR0	EEHealth.stVal Pos.stVal BlkCls.stVal BlkOpn.stVal
ExtRef(s)	1	CB open position		
ExtRef(s)	1	CB close position		
ExtRef(s)	1	CB block to close		
ExtRef(s)	1	Blocking order due low SF6 pressure		
ExtRef(s)	1	CB close	GGIO0	Ind1.stVal
ExtRef(s)	1	Draw out CB (Rack-out)	XSWI0	Pos.stVal
ExtRef(s)	1	Draw-out CB (Rack-in)		

* Enervista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.1.4 LDDJ BLOCK DIAGRAM

All the internal flow between LNs is depicted in below figure:

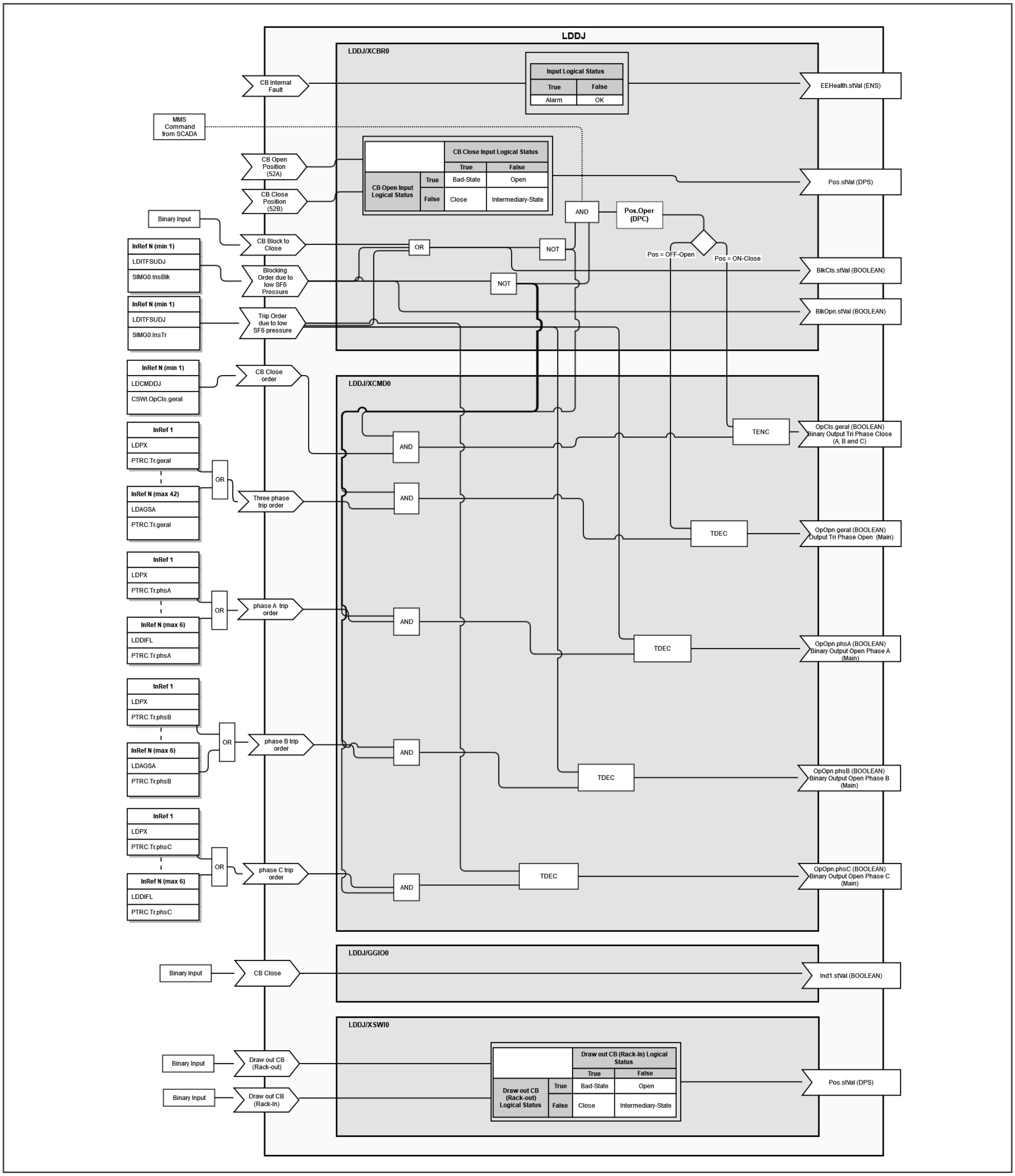


Figure 93: LDDJ Block Diagram

4.14.2 LDTM

This function interfaces Instrument Transformers. Its main goal is to publish Sampled Values representing the primary currents and voltages, but not only, associated operations too, as their protections (fuses) and analogue input circuit switches and disconnectors. LDTM is used for connecting IED (SAMU/MU) to either Conventional or Non-Conventional Instrument Transformers (CIT/NCIT).

LDTM can handle many analog physical inputs at same time, means that one LDTM can get signals from several channels. This limit is two physical boards (IED can handle only 2 TMUs at same time, REfer to). MU360 has modeled LDTM as a set of sub-functions and fields, mainly by logical nodes that represent current and voltages and their correspondent operations, as main examples below (notice that an instance is represented by letter x):

- TCTRx: Current Transformer model.
- TCTRx.AmpSv: main data object representing a current input. Main current source for transmitting current by Sample Values (check reference).
- ccscsXSWIx: Circuit Switch model that will show short circuit position for switches without its own circuit breaking capability.
- tlcoXSWI0: indicates if the Instrument Transformer is blocked for maintenance.
- tlcoXCMD0: represents the final order from tlcoXSWI0 to associated physical outputs.
- TVTRx Voltage Transformer model.
- TVTRx.VolSv: main data object representing a voltage input. Main voltage source for transmitting current by Sample Values (check reference).
- TVTRx.Fufail: data object representing a sensor will indicate if fuse is blown of an outgoing feeder.

4.14.2.1 LDTM MMS COMMANDS

In the tlcoXSWI, there is an OPER structure that allows user to block LDTM instance for maintenance.

4.14.2.2 LDTM INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table. As LDTM will get many analog physical inputs from its own IED, content will be the origin, the main digital data source, then many associated inputs are linked by proprietary way to the acquisition boards (TMUs, check reference). This behavior is noticed in the below table by empty ExtRef/ InRef associations (marked as n/a).

LDTM				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
ExtRef(s)	1	Three phase current protection position	ccscsXSWIx	Pos.stVal
ExtRef(s)	1	Single phase 1 current protection position		
ExtRef(s)	1	Single phase 2 current protection position		
ExtRef(s)	1	Single phase 3 current protection position		
ExtRef(s)	1	Three phase current measurement position		

LDTM				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
n/a	n/a	Single Phase Current Input 1 for protection	TCTRx	AmpSv
n/a	n/a	Single Phase Current Input 2 for protection		
n/a	n/a	Single Phase Current Input 3 for protection		
n/a	n/a	Three phase Current Input phA for protection		
n/a	n/a	Three phase Current Input phB for protection		
n/a	n/a	Three phase Current Input phC for protection		
n/a	n/a	Three phase Current Input phA for measurement		
n/a	n/a	Three phase Current Input phB for measurement		
n/a	n/a	Three phase Current Input phC for measurement		
n/a	n/a	Voltage three phase Input phA	TCTRx	VolSv FuFail.stVal
n/a	n/a	Voltage three phase Input phB		
n/a	n/a	Voltage three phase Input phC		
n/a	n/a	Single phase Voltage input 1		
n/a	n/a	Single phase Voltage input 2		
n/a	n/a	Single phase Voltage input 3		
n/a	n/a	Single phase Voltage input 4		
n/a	n/a	Single phase Voltage input 5		
n/a	n/a	Single phase Voltage input 6		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage single 1		
ExtRef(s)	1	Fuse fail voltage three phase		
ExtRef(s)	1	Telecommand Locked Switch Signal Feedback	tlcoXSWI0	Pos.stVal
ExtRef(s)	1	Telecommand Unlocked Switch Signal Feedback		
n/a	n/a	n/a	XCMD1	OpCls OpOpn
n/a	n/a	n/a		

* Enervista Flex v2 will select correct ones when demanded by user during procedure of Linking LDs.

4.14.2.3 LDTM BLOCK DIAGRAM

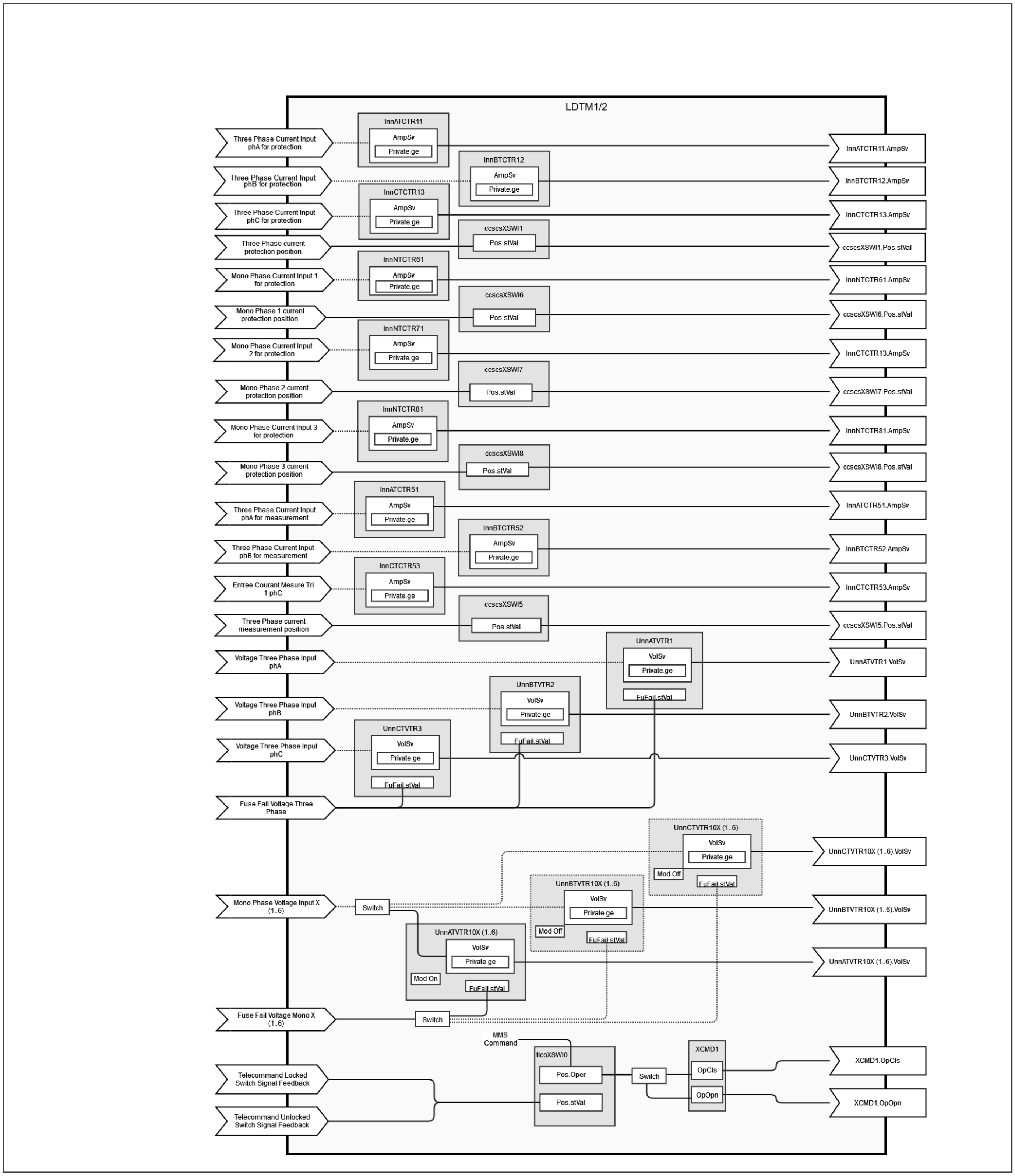


Figure 94: LDTM block diagram

4.14.3 LDITFUA - AUXILIARY SUPPLY UNIT INTERFACE LOGICAL DEVICE

MU360 has modeled this logical device as a specific function to monitor units are going to supply voltages (AC and DC power feeders) to the substation. Based on its data model, some LNs are going to alarm problems by either publishing goose or activating physical outputs, depending on user demand, input/output associations.

Follow main Logical Nodes:

- PTOCx: it will handle an indication of a circuit breaker (CB) trip for an auxiliary power supply feeder. “x” represents an instance of a specific auxiliary voltage supply circuit.
- SBATx: battery earth circuit faults. “x” is an instance for each battery.
- SIML1: Buchholz alarm came from auxiliary voltage transformer.
- TGDJBATT XCBRx: handles position statuses for batteries.
- XCMDx: each instance "x" will treat a command came from XCBRx instance, working as bridge to final physical output.
- XCBRx: each instance "x" represents a circuit breaker (Mini Circuit Breaker) will receive MMS commands for DC and AC auxiliary feeders.
- XSWI0: disconnector status position of a bay power supply, intended for checking maintenance.

ZAXNx: each instance "x" represents an auxiliary supply voltage failure.

- ZBATx: each instance "x" represents a battery. Intended to alarm voltage anomalies.
- ZBTCx: each instance "x" represents a battery. Intended to alarm changer anomalies.
- ZCON1: indicates converter or rectifier fault.
- ZGEN1: informs diesel unit fault.
- ISAFx: security alarm for battery rectifier.

4.14.3.1 LDITFUA MMS COMMANDS

In the XCBRx, there is an OPER structure that allows user to either open or close Mini Circuit Breakers (MCB).

4.14.3.2 LDITFUA INPUTS AND OUTPUTS

Main inputs and outputs are depicted in table below:

LDITFUA				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
ExtRef(s)	1	Trip No Priority RPD	PTOCx	Op.general
ExtRef(s)	1	Trip Aux Feeder CC RPD		
ExtRef(s)	1	Trip Aux Feeder CC RPT		
ExtRef(s)	1	Trip No Priority RPT		
ExtRef(s)	1	Trip Auxiliar Alternative of Security		
ExtRef(s)	1	Trip Auxilliar Alternative of Grid		
ExtRef(s)	1	Trip TSA (Auxiliary Transformer)		
ExtRef(s)	1	Trip Priority RPT		
ExtRef(s)	1	Trip Priority RPD		

LDITFUA				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
ExtRef(s)	1	Battery 1 Earth Circuit Fault	SBATx	BatEF.stVal
ExtRef(s)	1	Battery 2 Earth Circuit Fault		
ExtRef(s)	1	Battery 3 Earth Circuit Fault		
ExtRef(s)	1	Battery 5 Earth Circuit Fault		
ExtRef(s)	1	BUCHHOLZ TSA Alarm	SIML1	GasInsAlm.stVal
ExtRef(s)	1	CB Position of DC/AC Aux Feeder 1	TGDJBATT XCBRx	Pos.stVal
ExtRef(s)	1	CB Position of DC/AC Aux Feeder 2		
ExtRef(s)	1	CB Position of DC/AC Aux Feeder 3		
ExtRef(s)	1	CB Position of DC/AC Aux Feeder 5		
n/a	n/a	n/a	XCBRx	Pos.stVal
n/a	n/a	n/a	XCMDx	OpOpn.general OpCls.general
ExtRef(s)	1	Bay lockout disconnector (Bay maintenance)	XSWI0	Pos.stVal
ExtRef(s)	1	Auxiliary supply voltage failure 1 till Auxiliary supply voltage failure 28	ZAXNx	VPrs.stVal
ExtRef(s)	1	Battery 1 Voltage fault	ZBATx	EEHealth.stVal
ExtRef(s)	1	Battery 2 Voltage fault		
ExtRef(s)	1	Battery 3 Voltage fault		
ExtRef(s)	1	Battery 5 Voltage fault		
ExtRef(s)	1	Battery 1 Charger Fault	ZBTCx	EEHealth.stVal
ExtRef(s)	1	Battery 2 Charger Fault		
ExtRef(s)	1	Battery 3 Charger Fault		
ExtRef(s)	1	Battery 5 Charger Fault		
ExtRef(s)	1	Converter/Rectifier fault	ZCON1	EEHealth.stVal

LDITFUA				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
ExtRef(s)	1	Failure of Diesel Unit	ZGEN1	EEHealth.stVal GnSt.stVal
ExtRef(s)	1	Status of Diesel Unit		
ExtRef(s)	1	Battery 127 rectifier security alarm	ISAFx	Alm.stVal
ExtRef(s)	1	Battery 1 rectifier security alarm		
ExtRef(s)	1	Battery 2 rectifier security alarm		
ExtRef(s)	1	Battery 3 rectifier security alarm		

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.3.3 LDITFUA BLOCK DIAGRAM

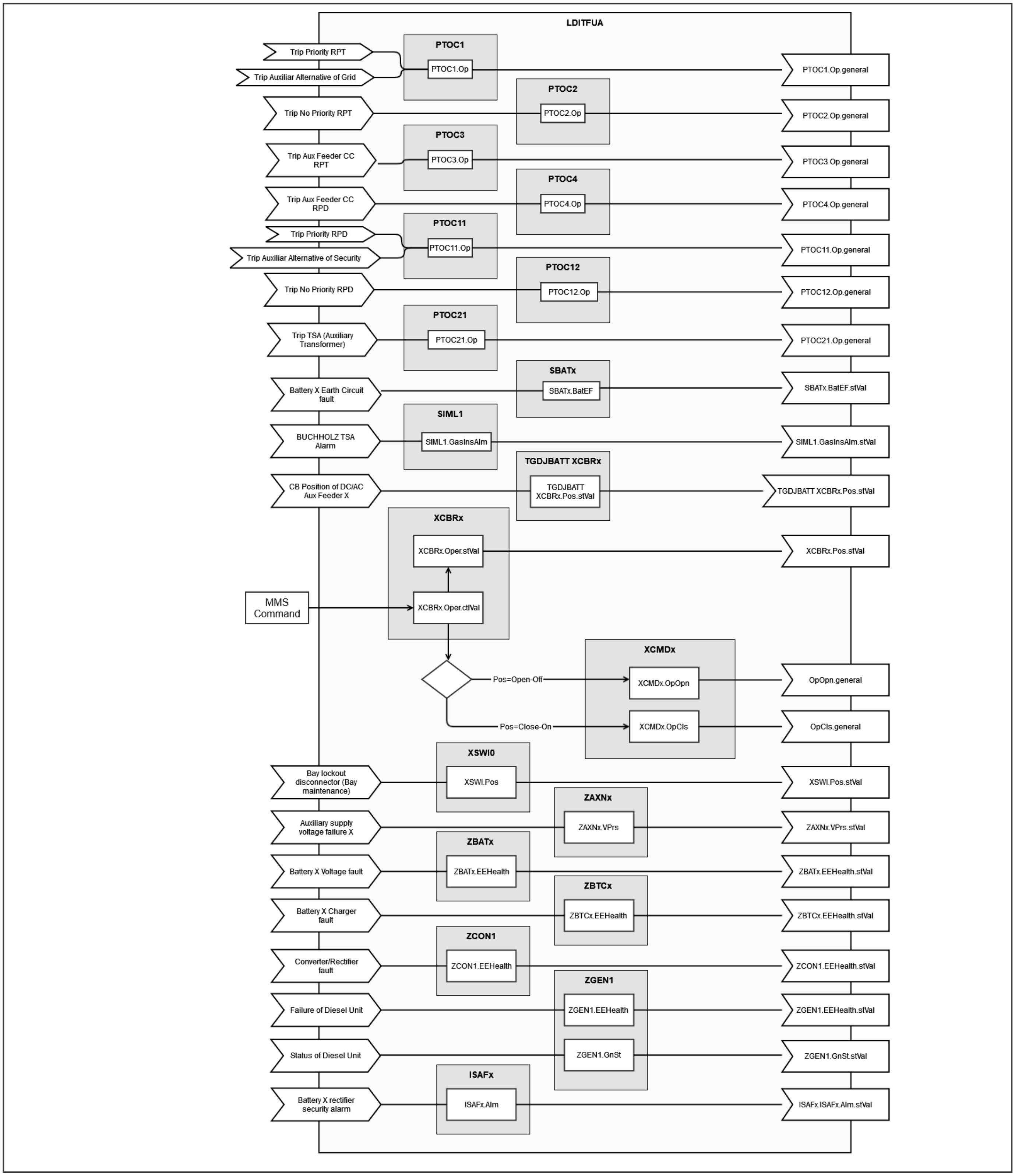


Figure 95: LDITFUA block diagram

4.14.4 LDITFRPTRPD - EXCHANGE INTERFACE TSO/DSO LOGICAL DEVICE

Before exposing this function, notice:

RPD: French symbol “Réseau Public de Distribution”, that means Distribution Grid, lower voltages from substations to end consumers.

RPT: French symbol “ Réseau Public de Transport”, that means Transmission Grid, higher voltages from power plants to substations.

TSO: Transmission System Operator.

DSO: Distribution System Operator.

LDITFRPTRPD is a logical device in MU360 that has been working as the main physical interface for data exchange between TSO and DSO for all the bay hosting the function. This LD is used in all IED with a physical interface between TSO and DSO. (General bay, busbar bay, ...) then data are exchanged with several functions (MQUB, …).

MU360 has modeled LDITFRPTRPD as a set of sub-functions and fields, mainly by logical nodes that exchange data between TSO and DSO as below:

- CALH: LN used group warnings, indications, and alarms.
- CSYN: LN used to control the synchronizing conditions.
- FXOT: LN used to set a high-level threshold on physical measurements for control sequences.
- FXUT: LN used to set a low-level threshold on physical measurements for control sequences.
- GAPC: LN used to set in a generic way the processing or automation functions not predefined.
- ISAF: LN used to manage a device that is used to provide an alarm in case of danger.
- KPMP: LN used to represent a pump.
- PTRC: LN used to connect the outputs of protection functions to XCBR “trip”.
- RBRF: LN used for circuit breaker failure and may send a trip order to other circuit breakers.
- SBAT: LN used for battery supervision.
- SFIR: LN used for fire supervision.
- SIML: LN used for insulation medium liquid management.
- XCBR: LN used for switches with short circuit breaking capability.
- XSWI: LN used for switches without short circuit breaking capability.
- ZAXN: LN used for auxiliary power supply system of other power systems installations.
- ZBAT: LN used for battery status and management.
- ZCON: LN used for frequency conversion and AC/DC conversion.

4.14.4.1 LDITFRPTRPD INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDITFRPTRPD				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	TCT error in RPD	CALH	CALH.GrAlm CALH.Grind
ExtRef(s)	1	Client presence to RPT 1		
ExtRef(s)	1	Client presence to RPT 2		
ExtRef(s)	1	DSO station failure		
ExtRef(s)	1	Bell voltage S		
ExtRef(s)	1	Horn voltage S		
ExtRef(s)	1	Bell voltage TC		
ExtRef(s)	1	Horn voltage TC		
ExtRef(s)	1	Emergency 1 for RPD		
ExtRef(s)	1	Emergency 2 for RPD		
ExtRef(s)	1	Presence 1		
ExtRef(s)	1	Presence 2		
ExtRef(s)	1	Anomaly UA		
ExtRef(s)	1	Default SA Emergency 2		
ExtRef(s)	1	Default SA Emergency 1		
ExtRef(s)	1	Air compressor failure warning		
ExtRef(s)	1	Air compressor failure alarm		
ExtRef(s)	1	Signal reclose CB 1	CSYN	CSYN.Rel
ExtRef(s)	1	Signal reclose CB 2		
ExtRef(s)	1	Signal reclose CB 3		
ExtRef(s)	1	Signal reclose CB 4		
ExtRef(s)	1	Times open door	FXOT	FXOT.Op.geral
ExtRef(s)	1	Substation flooded		
ExtRef(s)	6	Load shedding order 1		
ExtRef(s)	6	Load shedding order 2		
ExtRef(s)	6	Load shedding order 3		

LDITFRPTRPD				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Absence of busbar voltage 1 section 1	FXUT	FXUT.Op.geral
ExtRef(s)	1	Absence of busbar voltage 1 section 2		
ExtRef(s)	1	Absence of busbar voltage 1 section 3		
ExtRef(s)	1	Absence of busbar voltage 1 section 4		
ExtRef(s)	1	Absence of busbar voltage 1 section 5		
ExtRef(s)	1	Absence of busbar voltage 1 section 6		
ExtRef(s)	1	Absence of busbar voltage 2 section 1		
ExtRef(s)	1	Absence of busbar voltage 2 section 2		
ExtRef(s)	1	Instantaneous open door client	GAPC	GAPC.Ind GAPC.DPCSO
ExtRef(s)	1	Call door RTP		
ExtRef(s)	1	Remote control light		
ExtRef(s)	1	Substation light ON		
ExtRef(s)	1	Call door		
ExtRef(s)	1	Instantaneous open door		
ExtRef(s)	1	Technical Alarm		
ExtRef(s)	1	Backup alarm mode		
ExtRef(s)	1	Substation local mode or substation presence		
ExtRef(s)	1	CB filtered position		
ExtRef(s)	1	ICT position		
ExtRef(s)	1	Incoming phone call		
ExtRef(s)	1	AMU out of rder TR1		
ExtRef(s)	1	AMU running TR1		
ExtRef(s)	1	AMU out of order TR2		
ExtRef(s)	1	AMU running TR2		
ExtRef(s)	1	AMU out of order TR3		
ExtRef(s)	1	AMU running TR3		
ExtRef(s)	1	AMU out of order TR4		
ExtRef(s)	1	AMU running TR4		
ExtRef(s)	1	AMU out of order TR5		
ExtRef(s)	1	AMU running TR5		
ExtRef(s)	1	Danger Alarm from DSO or customer substation	ISAF	KPMP.Alm
ExtRef(s)	1	Danger alarm from TSO to DSO		

LDITFRPTRPD				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Pump failure	KPMP	KPMP.EEHealth
ExtRef(s)	1	Trip CB RPD priority	PTRC	PTRC.Op.geral
ExtRef(s)	1	Trip CB CC antenna RPD		
ExtRef(s)	1	Trip CB not RPD priority		
ExtRef(s)	1	Trip by PVH		
ExtRef(s)	1	Trip CB ground cable TR1		
ExtRef(s)	1	Trip CB ground cable TR2		
ExtRef(s)	1	Trip CB ground cable TR3		
ExtRef(s)	1	Trip CB ground cable TR4		
ExtRef(s)	1	Trip CB ground cable TR5		
ExtRef(s)	1	Trip AMU TR1		
ExtRef(s)	1	Trip AMU TR2		
ExtRef(s)	1	Trip AMU TR3		
ExtRef(s)	1	Trip AMU TR4		
ExtRef(s)	1	Trip AMU TR5		
ExtRef(s)	1	Trip order GR1		
ExtRef(s)	1	Trip order GR2		
ExtRef(s)	1	Trip order GR3		
ExtRef(s)	2	Signal CB failure transformer TR1		
ExtRef(s)	2	Signal CB failure transformer TR2		
ExtRef(s)	2	Signal CB failure transformer TR3		
ExtRef(s)	2	Signal CB failure transformer TR4		
ExtRef(s)	2	Signal CB failure transformer TR5		
ExtRef(s)	1	Signal CB failure TR1 +	RBRF	RBRF.OpEx.geral
ExtRef(s)	1	Signal CB failure TR1 -		
ExtRef(s)	1	Signal CB failure TR2 +		
ExtRef(s)	1	Signal CB failure TR2 -		
ExtRef(s)	1	Signal CB failure TR3 +		
ExtRef(s)	1	Signal CB failure TR3 -		
ExtRef(s)	1	Signal CB failure TR4 +		
ExtRef(s)	1	Signal CB failure TR4 -		
ExtRef(s)	1	Signal CB failure TR5 +		
ExtRef(s)	1	Signal CB failure TR5 -		

LDITFRPTRPD				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Battery 127V earth fault	SBAT	SBAT.BATEF
ExtRef(s)	1	Battery 48V eath fault		
ExtRef(s)	1	Fire alarm RPD	SFIR	SFIR.FireAlm
ExtRef(s)	1	Fire alarm		
ExtRef(s)	1	CB position 127v	XCBR	XCBR.Pos
ExtRef(s)	1	CB position 48v		
ExtRef(s)	1	CB position 48v TCM		
ExtRef(s)	1	CB Filtered position		
ExtRef(s)	1	CB position TR1 Open		
ExtRef(s)	1	CB position TR1 close		
ExtRef(s)	1	CB position TR2 Open		
ExtRef(s)	1	CB position TR2 close		
ExtRef(s)	1	CB position TR3 Open		
ExtRef(s)	1	CB position TR3 close		
ExtRef(s)	1	CB position TR4 Open		
ExtRef(s)	1	CB position TR4 close		
ExtRef(s)	1	CB position TR5 Open		
ExtRef(s)	1	CB position TR5 close		
ExtRef(s)	1	BusBarfiltered position SS112	XSWI	XSWI.Pos
ExtRef(s)	1	BusBarfiltered position SS123 or 212		
ExtRef(s)	1	BusBarfiltered position SS134		
ExtRef(s)	1	BusBarfiltered position SS145		
ExtRef(s)	1	BusBarfiltered position SS156		
ExtRef(s)	1	Transformer filtered position SA1		
ExtRef(s)	1	Transformer filtered position SA2		

LDITFRPTRPD				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	SR voltage failure	ZAXN	ZAXN.VPrs ZAXN.EEHealth
ExtRef(s)	1	Main voltage failure		
ExtRef(s)	1	AC voltage 1 failure		
ExtRef(s)	1	AC voltage 2 failure		
ExtRef(s)	1	Auxiliary AC voltage immediate failure		
ExtRef(s)	1	Auxiliary AC voltage delayed failure		
ExtRef(s)	1	Voltage 127V failure		
ExtRef(s)	1	Battery 1 or CC voltage failure		
ExtRef(s)	1	Battery 2 or CC voltage failure		
ExtRef(s)	1	Converter BAT 127 failure		
ExtRef(s)	1	Converter BAT1 or CC failure		
ExtRef(s)	1	Converter BAT2 or CC failure		

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.4.2 LDITFRPTRPD BLOCK DIAGRAMS

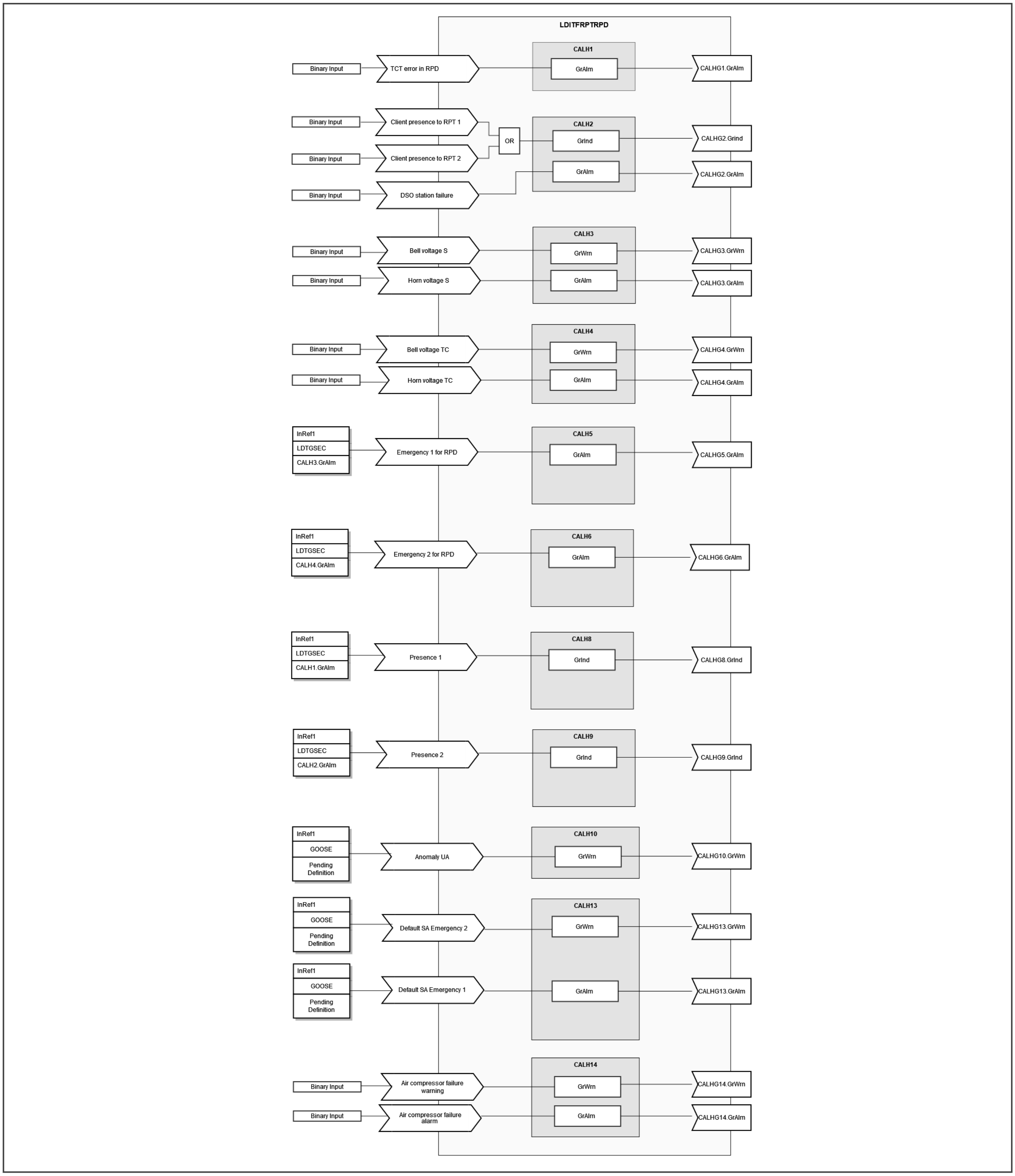


Figure 96: LDITFRPTRPD Block Diagram 1

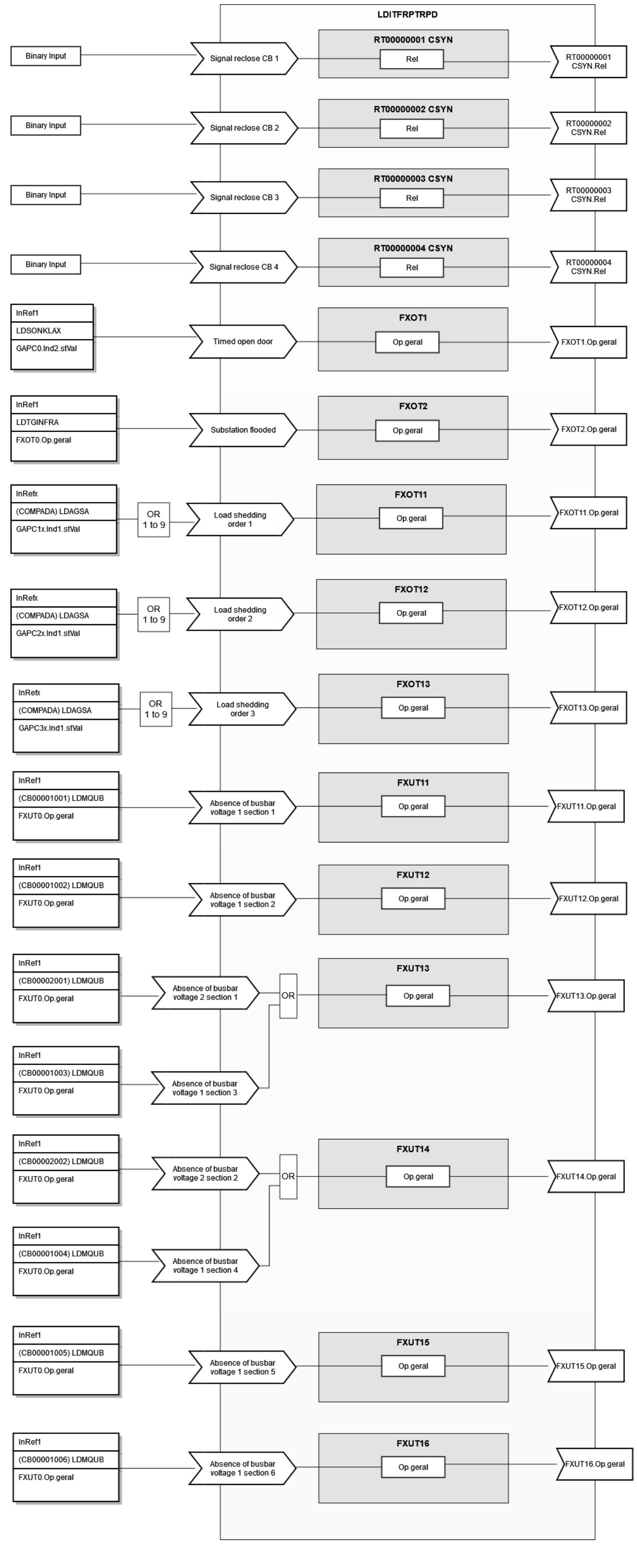


Figure 97: LDITFRPTRPD Block Diagram 2

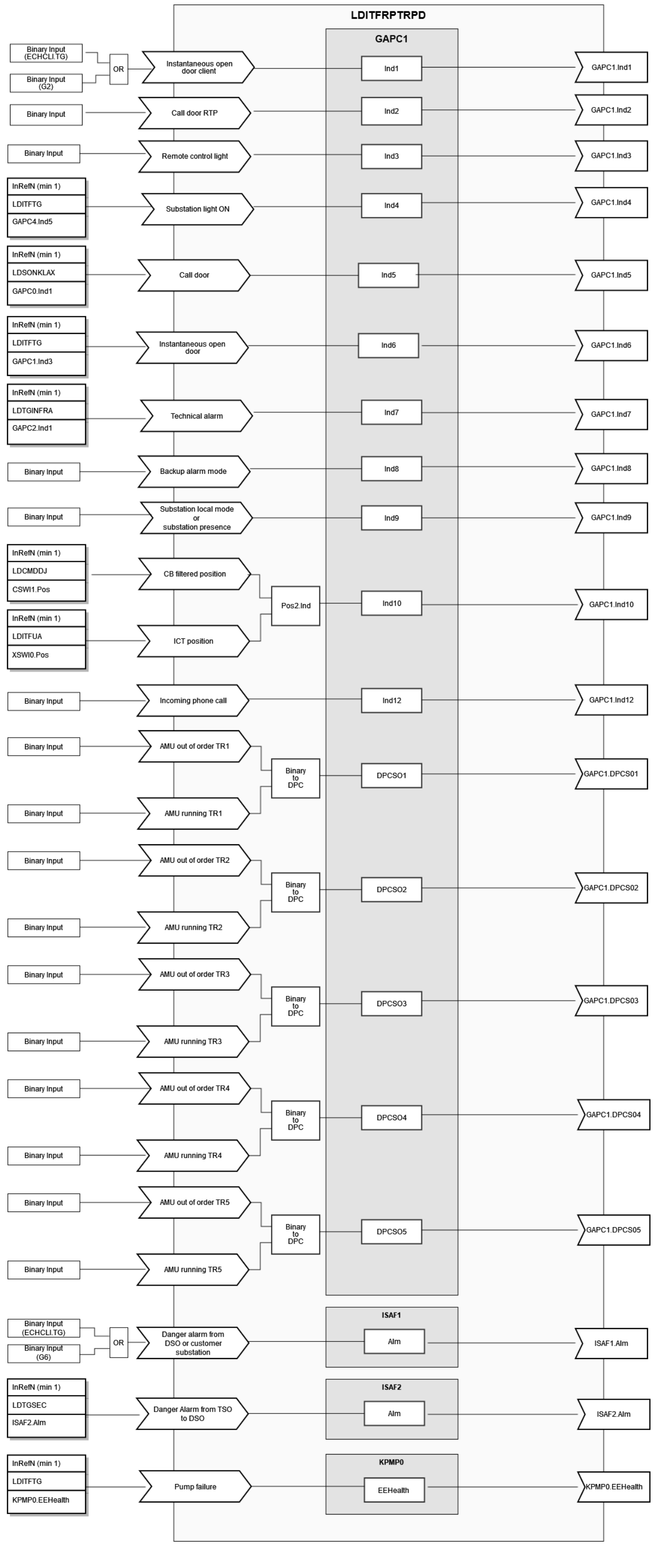


Figure 98: LDITFRPTRPD Block Diagram 3

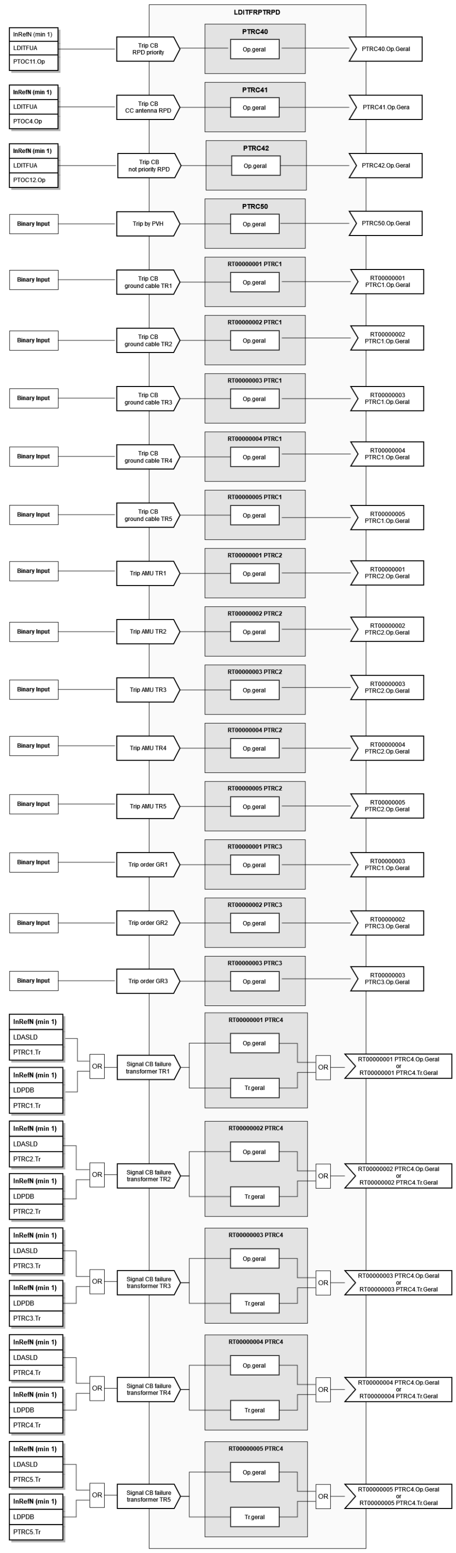


Figure 99: LDITFRPTRPD Block Diagram 4

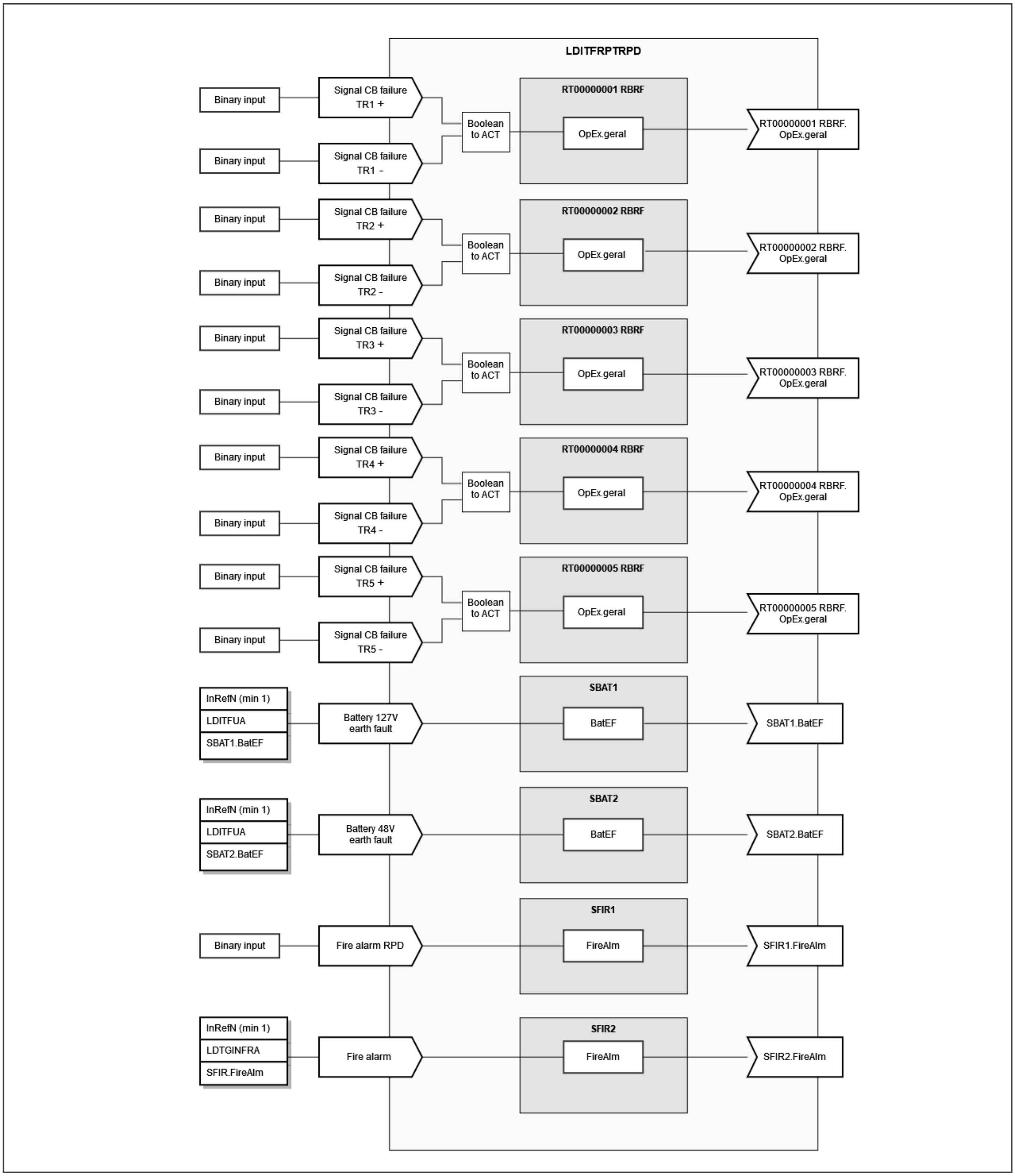


Figure 100: LDITFRPTRPD Block Diagram 5

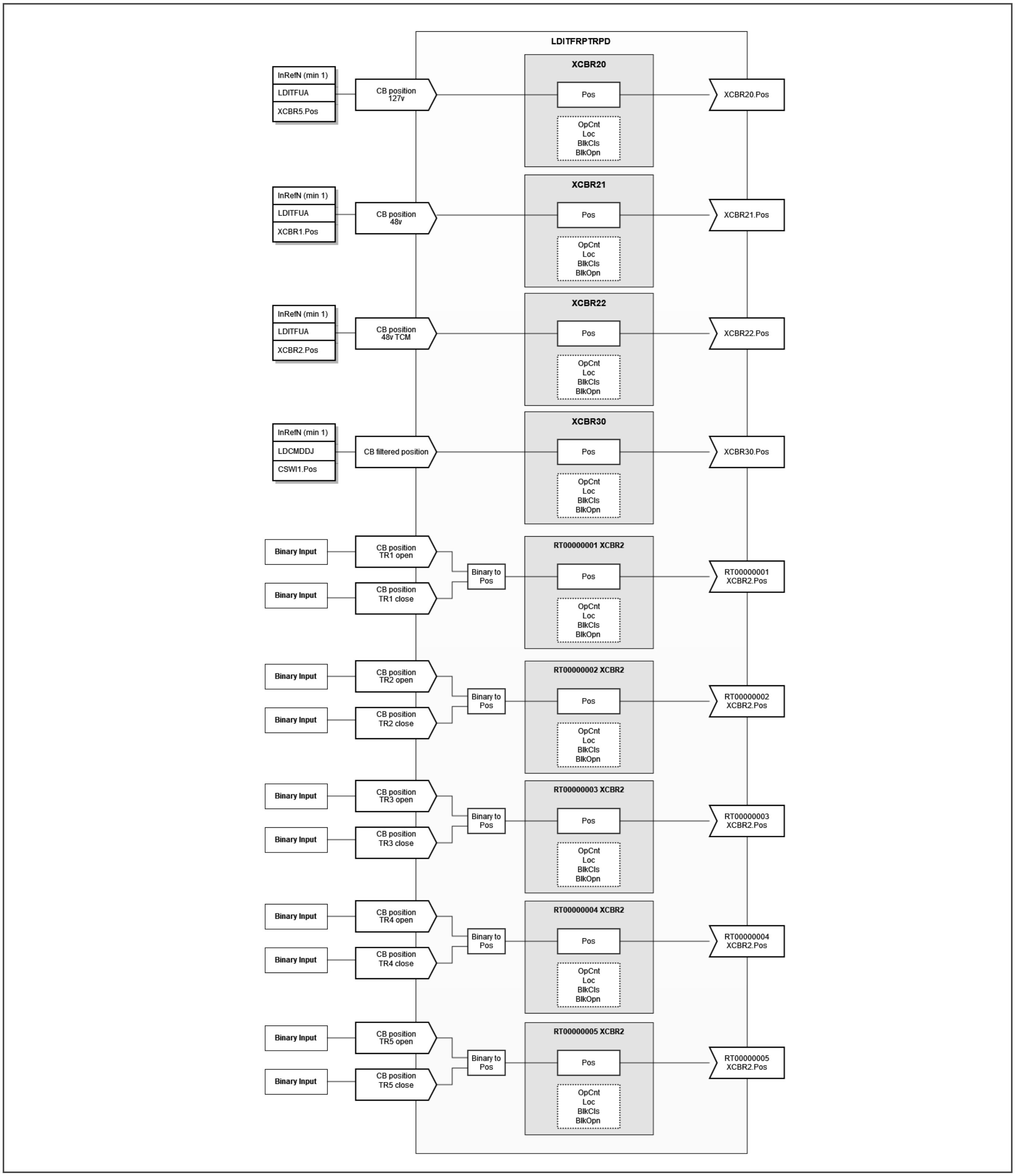


Figure 101: LDITFRPTRPD Block Diagram 6

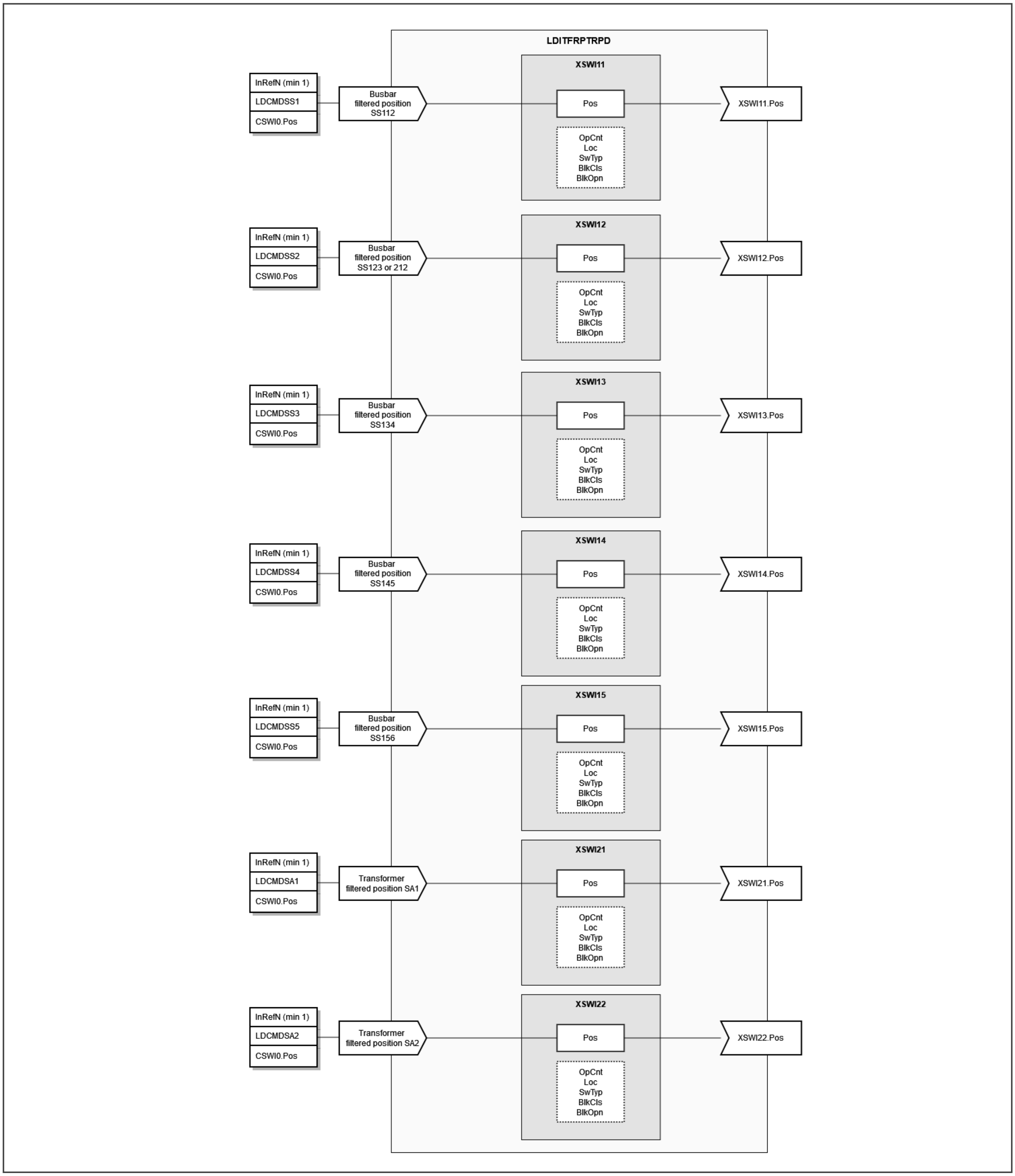


Figure 102: LDITFRPTRPD Block Diagram 7

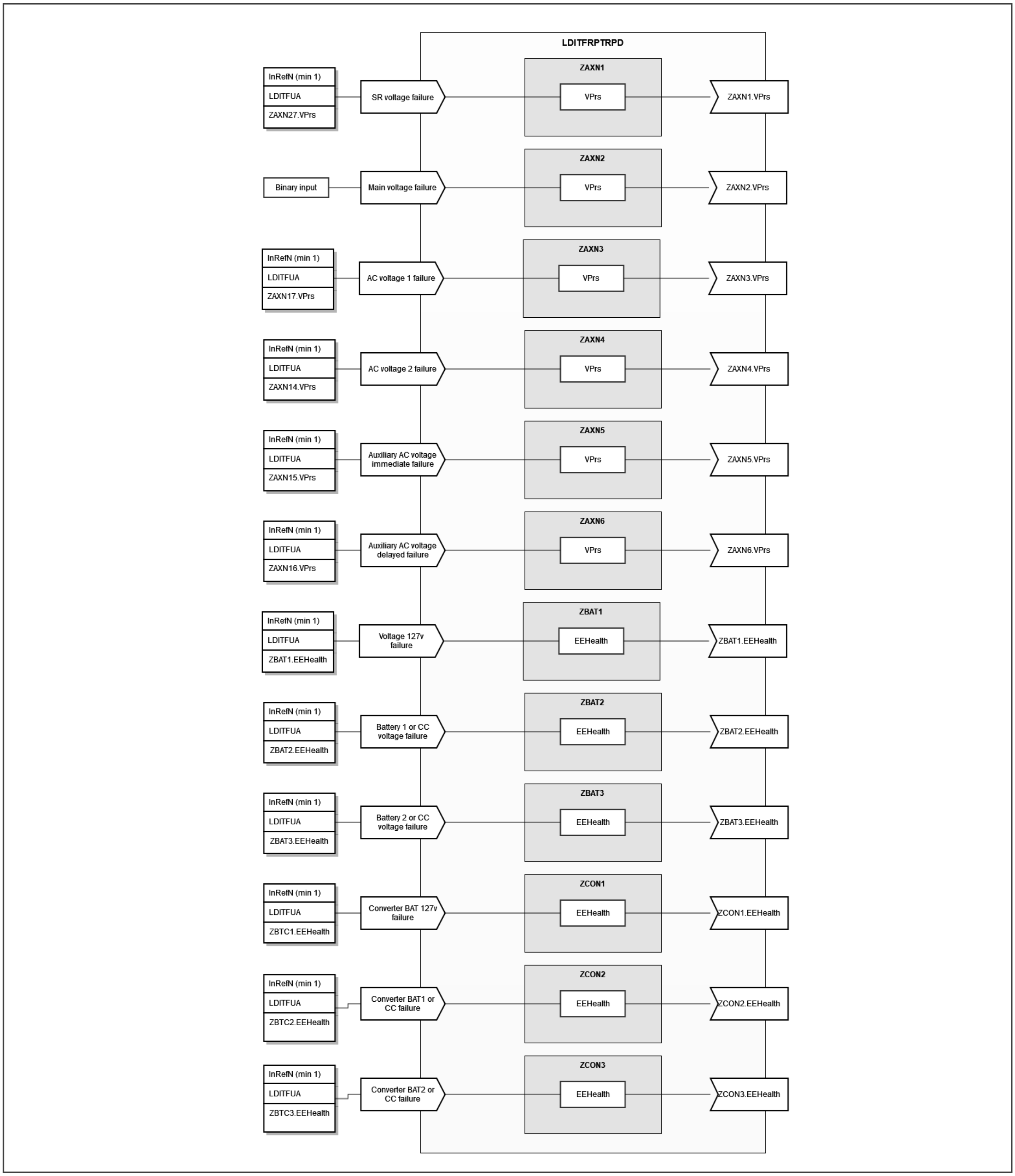


Figure 103: LDITFRPTRPD block diagram 8

4.14.5 LDITFTG - SUBSTATION BAY MANAGEMENT INTERFACE LOGICAL DEVICE

This function represents some interfaces for the Substation Management Bay, known as TG, interfacing binary signals. A detailed description of the mapping of the binary inputs to the DO's is given ahead.

Below is a brief description of the logical nodes:

- CALHx: Alarm Handler instance 'x'. This control group LN represents indicators, warnings and alarms.
- FXOTx: Function over Threshold instance 'x'. This LN is set if the value of any physical parameter is beyond its assumed threshold.
- GAPCx: Generic Automatic Process Control instance 'x'. This LN indicates the statuses of sequences, unknown functions.
- ISAFx: Safety Alarm Function instance 'x'. This LN represents any safety pushbutton or device that get triggered in case of danger to people or property.
- KFANx: 'x' refers to instance number. This LN represents the physical/mechanical fan.
- KPMPx: 'x' refers to instance number. This LN represents the physical/mechanical water pump.
- SFIRx: 'x' refers to instance number. This LN represents fire supervision system.

4.14.5.1 LDITFTG INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDITFTG				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Presence of staff (1) (TSO)	CALH1	CALH1.Grind.stVal
ExtRef(s)	1	Presence of staff (2) (DSO)	CALH2	CALH2.Grind.stVal
ExtRef(s)	1	Bell (Auxiliary Voltage S)	CALH3	CALH3.GrWrn.stVal CALH3.GrAlm.stVal
ExtRef(s)	1	Horn (Auxiliary Voltage S)		
ExtRef(s)	1	Bell (Auxiliary Voltage TC)	CALH4	CALH4.GrWrn.stVal CALH4.GrAlm.stVal
ExtRef(s)	1	Horn (Auxiliary Voltage S)		
ExtRef(s)	1	Additional Horn (Auxiliary Voltage S)	CALH5	CALH5.GrAlm.stVal
ExtRef(s)	1	Additional Horn (Auxiliary Voltage TC)	CALH6	CALH6.GrAlm.stVal
ExtRef(s)	1	Substation Failure or DSO Substation failure in backup Alarm mode	CALH8	CALH8.GrAlm.stVal
ExtRef(s)	1	Telecommunication Equipment Warning	CALH9	CALH9.GrWrn.stVal CALH9.GrAlm.stVal
ExtRef(s)	1	Telecommunication Equipment Alarm		

LDITFTG				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Substation Flooded	FXOT0	FXOT0.Op.general
ExtRef(s)	1	Call -- Door	GAPC1	GAPC1.Ind1.stVal GAPC1.Ind2.stVal GAPC1.Ind3.stVal GAPC1.Ind5.stVal
ExtRef(s)	1	Call - Telephone TSO		
ExtRef(s)	1	Door Open (Instantaneous)		
ExtRef(s)	1	Indication of "Presence of Staff or Local Substation or Feeder Mode Set"		
ExtRef(s)	1	Duration of maintenance exceeds time limit	GAPC3	GAPC3.Ind1.stVal GAPC3.Ind2.stVal GAPC3.Ind3.stVal GAPC3.Ind4.stVal
ExtRef(s)	1	Restart intervention timer button		
ExtRef(s)	1	Activation/Deactivation of intervention time function		
ExtRef(s)	1	Maintenance Intervention timer is counting and active		
ExtRef(s)	1	Button - Lighting of surrounding area	GAPC4	GAPC4.Ind1.stVal GAPC4.Ind5.stVal GAPC4.Ind6.stVal GAPC4.Ind10.stVal
ExtRef(s)	1	Substation Lighting		
ExtRef(s)	1	Order to switch on light in substation		
ExtRef(s)	1	Lighting Bustation Area from CPPT		
ExtRef(s)	1	Failure of Water extraction system	GAPC5	GAPC5.Ind1.stVal GAPC5.Ind3.stVal GAPC5.Ind4.stVal GAPC5.Ind5.stVal GAPC5.Ind6.stVal
ExtRef(s)	1	Technical Alam Air conditioning		
ExtRef(s)	1	Technical Alarm Smoke Extraction		
ExtRef(s)	1	Technical Alarm Reserved		
ExtRef(s)	1	Fire Detection System Active		
ExtRef(s)	1	Signal Remote Alarm Mode to TA Interface	GAPC6	GAPC6.Ind1.stVal
ExtRef(s)	1	Button Danger Alarm	ISAF1	ISAF1.Alm.stVal
ExtRef(s)	1	Signal Danger Alarm to TA Interface	ISAF2	ISAF2.Alm.stVal
ExtRef(s)	1	Technical Alarm Ventilation	KFAN0	KFAN0.EEHealthstVal
ExtRef(s)	1	Technical Alarm Pump	KPMP0	KPMP0.EEHealth.stVal

LDITFTG				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Technical Alarm Fire Detection System Failure	SFIR0	SFIR0.EEHealth.stVal
ExtRef(s)	1	Fire Alarm on TSO		SFIR0.FireAlm.stValue

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.5.2 LDITFTG BLOCK DIAGRAMS

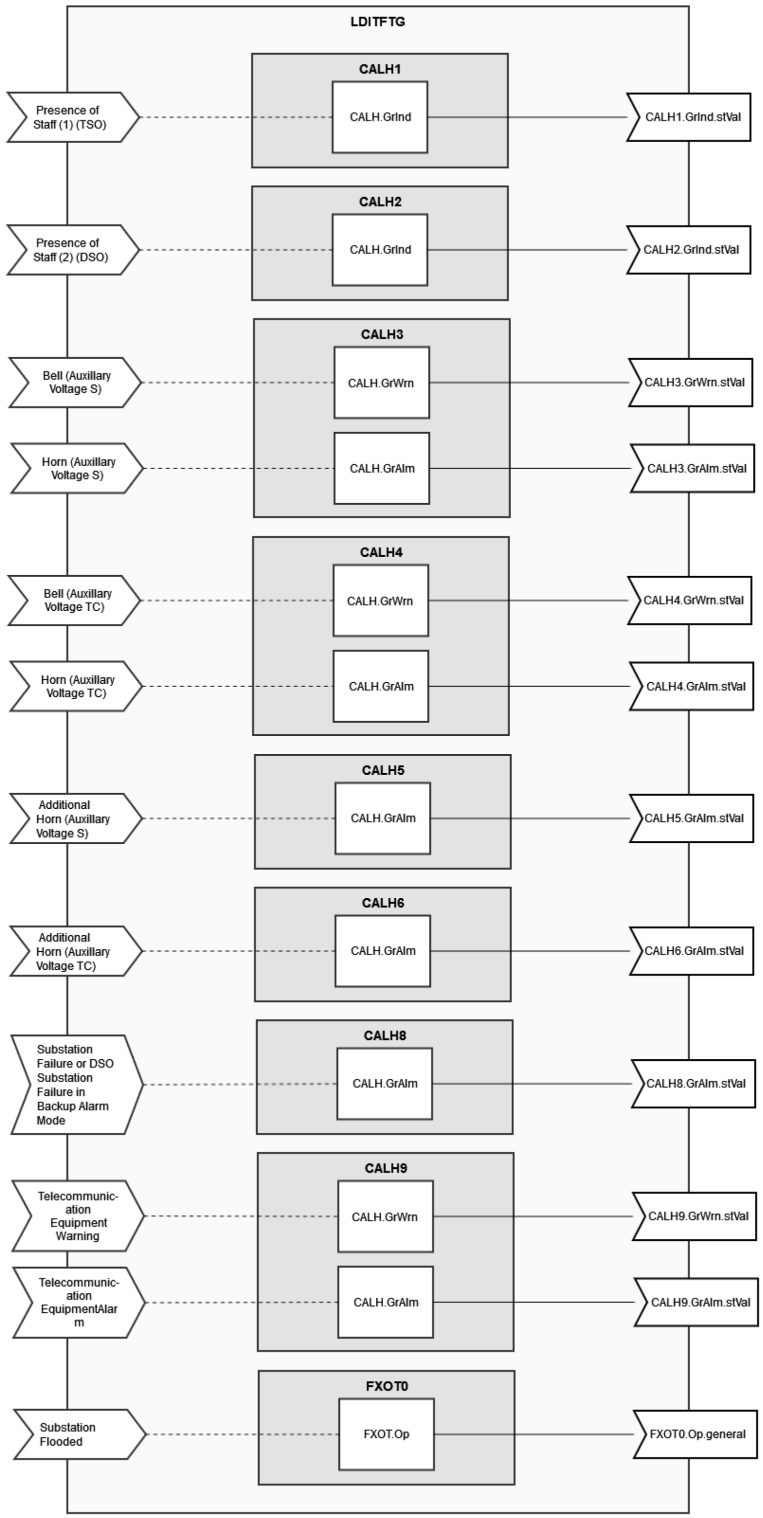


Figure 104: LDITFTG Block Diagram 1

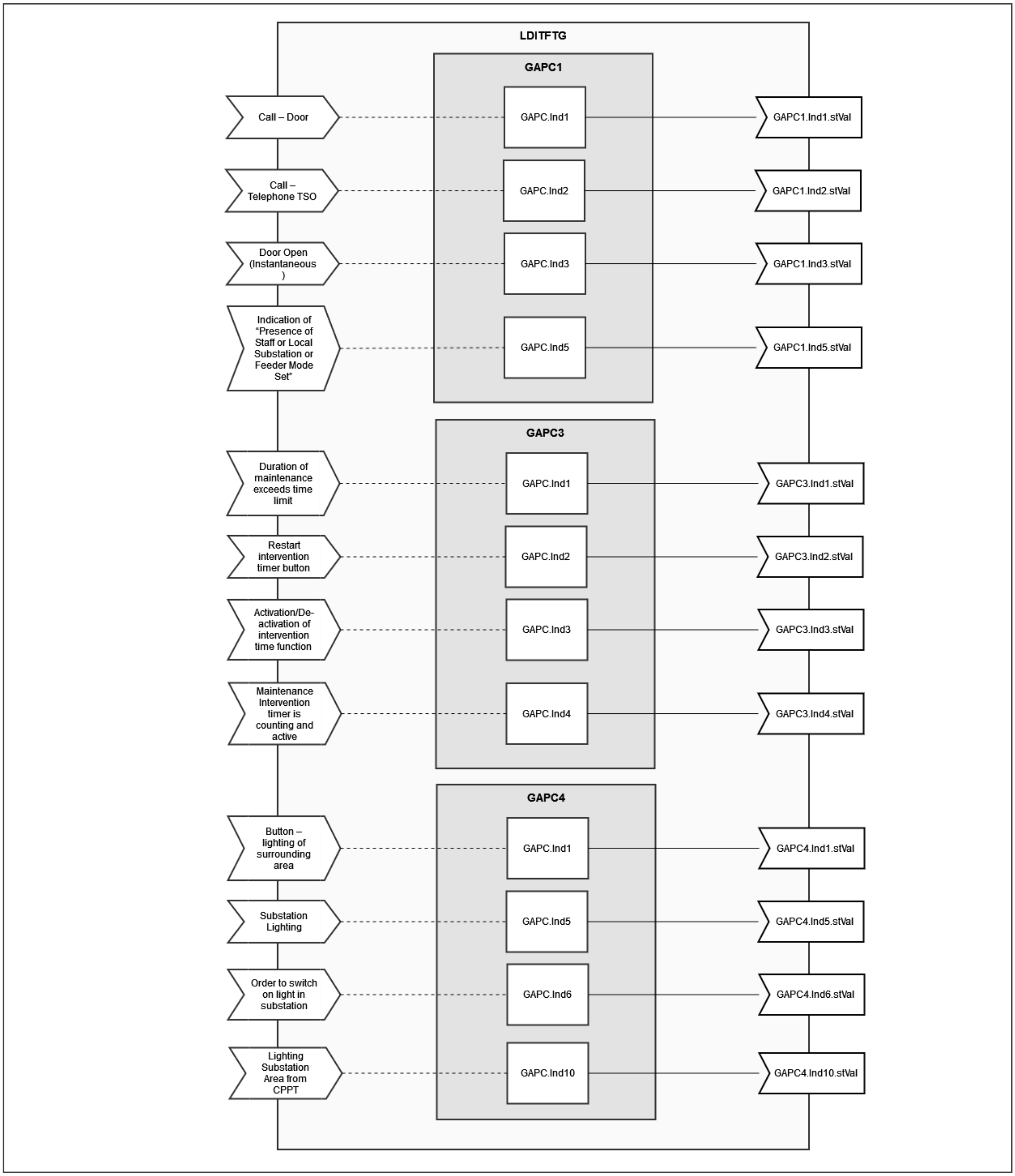


Figure 105: LDITFTG Block Diagram 2

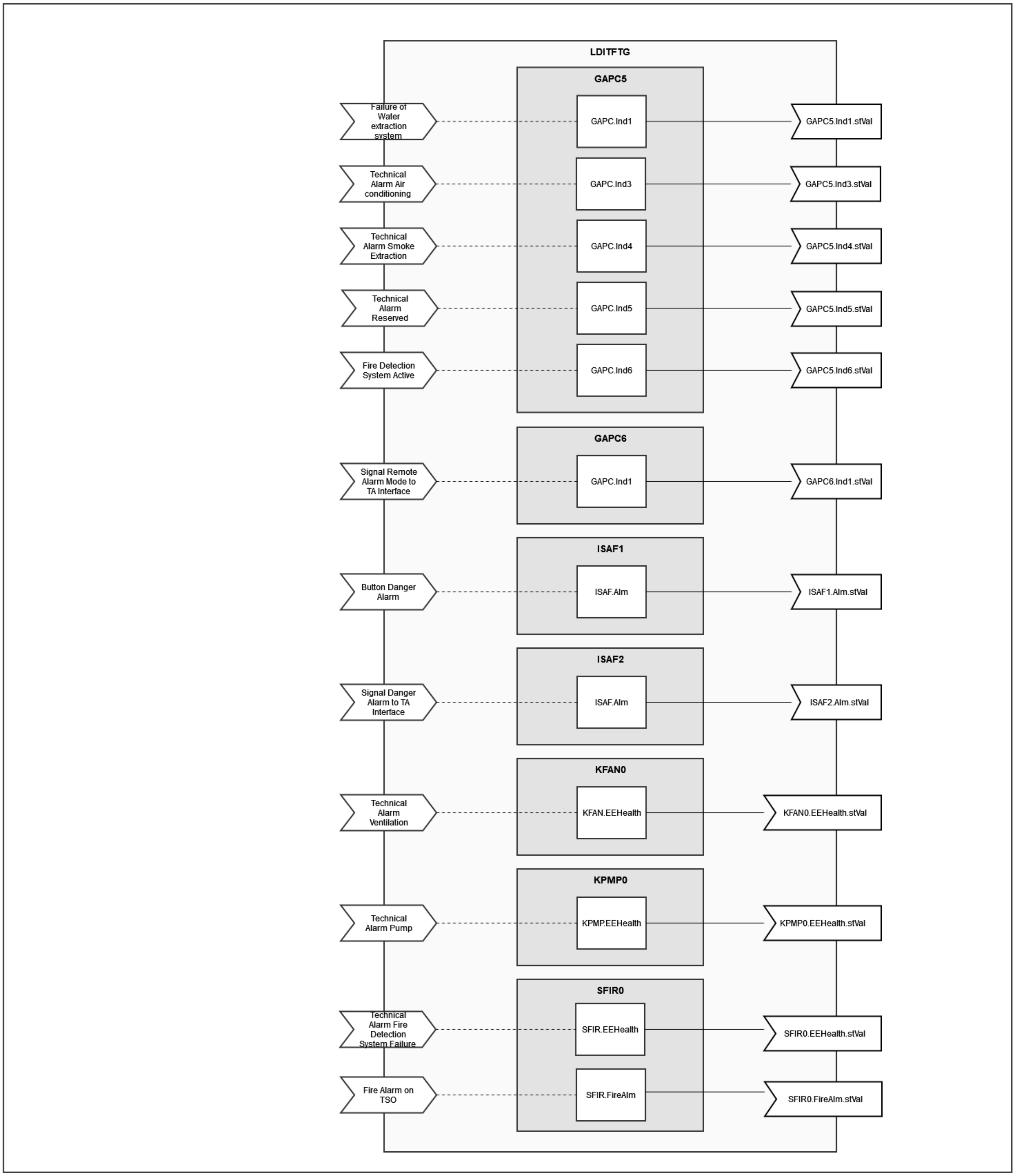


Figure 106: LDITFTG block diagram 3

4.14.6 LDSXY - DISCONNECTOR INTERFACE LOGICAL DEVICE

Before explaining the LDSxy function, note that x and y mean specific behavior, as follows:

x is described as:

- **A**: Feeder
- **L**: Line
- **T**: Ground
- **S**: Busbar

y is described as:

- **1**: Line to busbar disconnector, busbar 1
- **2**: Line to busbar disconnector, busbar 2
- **N**: Line to busbar disconnector, busbar N

MU360 is going to present its data model based on the possibilities listed above, naming each disconnector interface, representing the high voltage disconnectors to the bay, that could be operated by electrical or manual control commands. Blow are the main goals of LDSxy:

- Identify HV equipment for maintenance/operation.
- Block Remote System Commands to the HV equipment, making sure a maintenance will not face undesired change of position.
- Perform HV disconnector commands as Open/Close.

4.14.6.1 LDSXY MMS COMMANDS

There are three **OPER** structures in **LDSxy** that allows user to perform different operations as described below.

- **XSWI1.Pos.Oper**: activates the output contact via **XCMD1.OpOpn.general** / **XCMD1.OpCls.general** based on the command (Open/Close) received. This action will make a Disconnector switch its position.
- **XSWI2.Pos.Oper**: activates the output contact via **XCMD2.OpOpn.general / XCMD2.OpCls.general** based on the command (deactivation/activation) received. This action will either activate or deactivate remote blocking system for security.
- **GAPC0.SPCSOx.Oper**: activates the optical indicator (Indx.stVal) of disconnector, activating a LAMP when linked.

4.14.6.2 LDSXY INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDSxy				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Close Order	XCMD1	OpCls.general OpOpn.general
ExtRef(s)	1	Open Order		
n/a	n/a	n/a	XCMD2	OpCls.general OpOpn.general
ExtRef(s)	1	Sxy Close	XSWI1	Pos.stVal
ExtRef(s)	1	Sxy Open		

LDSxy				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Sxy Locked	XSWI2	Pos.stVal
ExtRef(s)	1	Sxy Unlocked		
n/a	n/a	n/a	GAPC0	Ind1.stVal

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.6.3 LDSXY BLOCK DIAGRAM

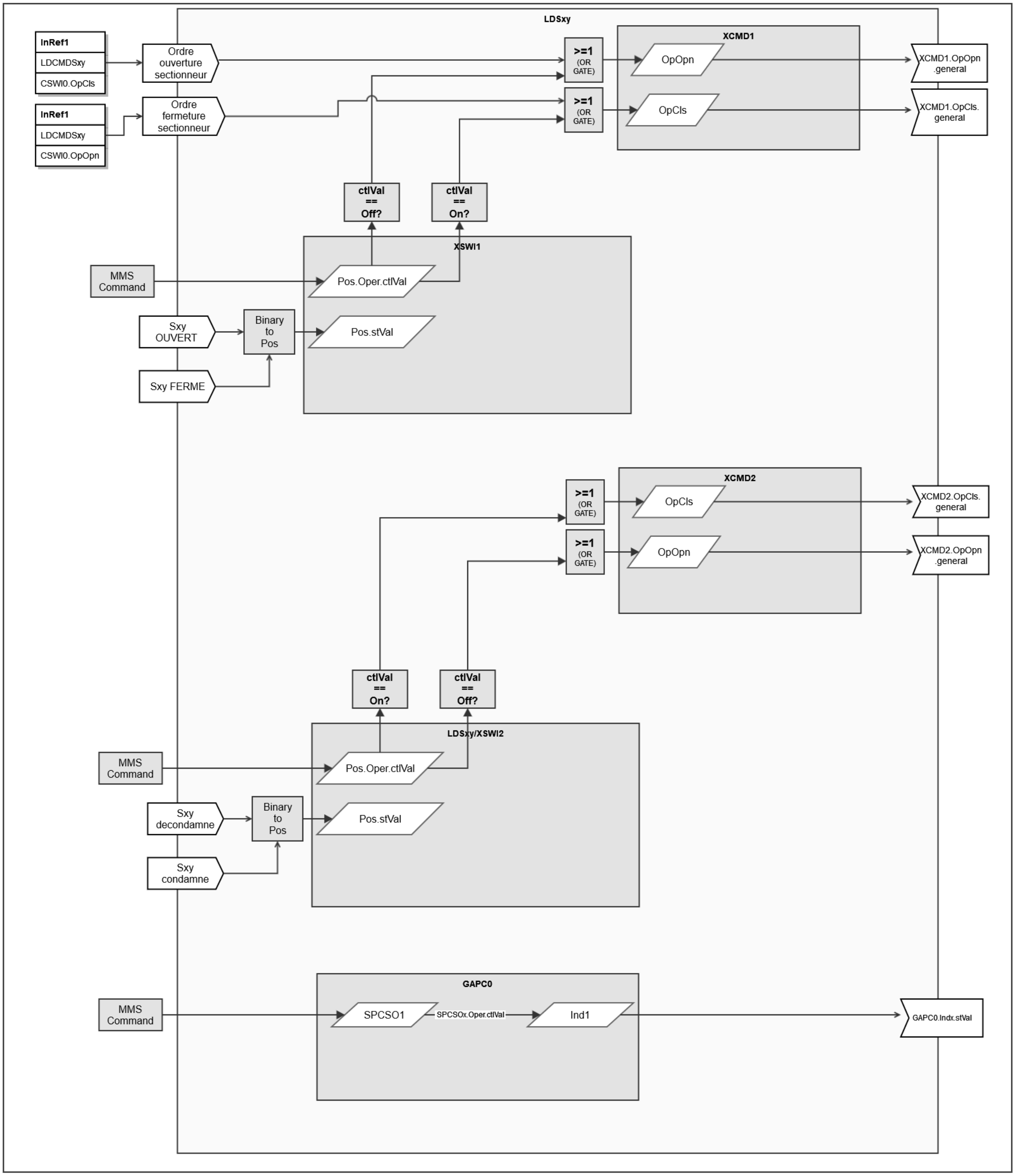


Figure 107: LDSxy block diagram

4.14.7 LDSUIED - IED SUPERVISION LOGICAL DEVICE

LDSUIED represents main interface to monitor MU360 at all. It works as main access to hardware, mapping it to correct virtualization, making data points shareable to other logical devices. Within this context, supervision examples of physical ports, network, CPU boards, auxiliary supply, and memory/hard disk space.

MU360 has modeled LDSUIED as a set of sub-functions by logical nodes, as follows:

GAPCX

It contains internal MPIU internal voltage and temperature status as well as watchdog status. Following, all possible instances:

Watchdog status (GAPC0)

A keep alive function is implemented to check MU360 internal status periodically. The periodicity is configured in milliseconds by using **LSET** logical node and can be found on **LSET0/DITmms**. It is recommended to keep the default value (5000ms). The watchdog status is a representation of the MU360 proper functioning. **GAPC0/Ind1 = 1** indicates that MU360 is ok. **GAPC0/Ind1 = 0** indicates that MU360 is faulty. In case of a problem in this layer, the IED should reboot, before logging traces.

MPIU internal voltage and temperature status (GAPC1 till GAPC36)

All status can be found in the modeled **HEALTH** kind of data (Ok, Warning, Alarm). There are specific thresholds for upper and lower values that will trigger alarms. Any alarm represents an MPIU internal board issue. See below every available internal and temperature sensor in MPIU and how it is modeled in the application:

IEC Address	Description
LDSUIED/GAPC0/Ind1	Watchdog
LDSUIED/GAPC2/Health	Specific temperature monitor: TMP100_U9
LDSUIED/GAPC3/Health	Specific temperature monitor: TMP100_U20
LDSUIED/GAPC4/Health	Specific temperature monitor: PL_Temp
LDSUIED/GAPC5/Health	Specific temperature monitor: PS_Temp
LDSUIED/GAPC2/Health	Specific temperature monitor: TMP100_U9
LDSUIED/GAPC6/Health	Specific voltage monitor: LTC2991_3v3Vcc
LDSUIED/GAPC7/Health	Specific voltage monitor: LTC2991_3v3
LDSUIED/GAPC8/Health	Specific voltage monitor: LTC2991_1v2
LDSUIED/GAPC9/Health	Specific voltage monitor: LTC2991_12v
LDSUIED/GAPC10/Health	Specific voltage monitor: LTC2991_1v1
LDSUIED/GAPC11/Health	Specific voltage monitor: LTC2991_0v6
LDSUIED/GAPC12/Health	Specific voltage monitor: LTC2991_2v5
LDSUIED/GAPC13/Health	Specific voltage monitor: vccpspll0
LDSUIED/GAPC14/Health	Specific voltage monitor: Vccpsddr
LDSUIED/GAPC15/Health	Specific voltage monitor: vccpsio0
LDSUIED/GAPC16/Health	Specific voltage monitor: vccpsio1
LDSUIED/GAPC17/Health	Specific voltage monitor: vccpsio2
LDSUIED/GAPC18/Health	Specific voltage monitor: vccpsio3
LDSUIED/GAPC19/Health	Specific voltage monitor: psmgtravcc

IEC Address	Description
LDSUIED/GAPC20/Health	Specific voltage monitor: psmgtravtt
LDSUIED/GAPC21/Health	Specific voltage monitor: vccamsps
LDSUIED/GAPC22/Health	Specific voltage monitor: vccintps
LDSUIED/GAPC23/Health	Specific voltage monitor: vccauxps
LDSUIED/GAPC24/Health	Specific voltage monitor: vccbramps
LDSUIED/GAPC25/Health	Specific voltage monitor: vccplintlp
LDSUIED/GAPC26/Health	Specific voltage monitor: vccplintfp
LDSUIED/GAPC27/Health	Specific voltage monitor: vccplaux
LDSUIED/GAPC28/Health	Specific voltage monitor: vccamspl
LDSUIED/GAPC29/Health	Specific voltage monitor: vccintpl
LDSUIED/GAPC30/Health	Specific voltage monitor: vccbrampl
LDSUIED/GAPC31/Health	Specific voltage monitor: vccauxpl
LDSUIED/GAPC32/Health	Specific voltage monitor: vccpsddrpll
LDSUIED/GAPC33/Health	Specific voltage monitor: vccpsintfpddr
LDSUIED/GAPC34/Health	Specific voltage monitor: vccpsintlp
LDSUIED/GAPC35/Health	Specific voltage monitor: vccpsintfp
LDSUIED/GAPC36/Health	Specific voltage monitor: vccpsaux

LSET0

Watchdog configuration:

IEC Address	Description
LDSUIED/LSET0/DITmms	Watchdog Toggling Period

LGOSX: GOOSE Subscription Monitoring

Each instance (x) of this LN represents a goose control block subscription (20 max). A complete configuration is performed by EnerVista Flex v2 (Refer to Enervista Flex v2 user manual for configuration).

IEC Address	Description
LDSUIED/LGOSx/LastSTNum	Last state number of the received GOOSE message
LDSUIED/LGOSx/NdsCom	If true, the subscription needs commissioning
LDSUIED/LGOSx/st	If true, the subscription is active and valid message forwarded to application
LDSUIED/LGOSx/SimSt	If true, subscription is receiving simulated messages
LDSUIED/LGOSx/ConfRevNum	Expected configuration revision number of the message
LDSUIED/LGOSx/GoCBRef	Object reference of subscribed GOOSE control block

LCPX: Communication Ethernet Ports Supervision

This Logical Node models the physical communication ports, meaning the network interfaces (SFP1-6). It holds the connection status, statistics, and settings for each of the interfaces. Each instance of LPCP is declared in LDSUIED to represent the supervision of a communication port, then **LDSUIED/LPCP1** represents SFP1, **LDSUIED/LPCP2** represents SFP2, and so on (Refer to Interfaces chapter for SFP disposition).

IEC Address	Range of Values	Description
LDSUIED/LPCPx/RxCnt	[0, 9223372036854775807]	Number of packets received in the port since last reset
LDSUIED/LPCPx/TxCnt	[0, 9223372036854775807]	Number of packets sent from the port since last reset
LDSUIED/LPCPx/PhyHealth	Ok - if connected. Alarm - if not connected	Health status
LDSUIED/LPCPx/AutoNgt	True - auto negotiation on False - auto negotiation off	Indicates if the channel is auto negotiated
LDSUIED/LPCPx/Mau	0 - "Unknown" 26 - "1000BASE-SX" 24 - "1000BASE-LX" 28 - "1000BASE-CX" 30 - "1000BASE-T" 46 - "100BASE-LX/LX10" 18 - "100BASE-FX" 47 - "1000BASE-BX10D" 50 - "1000BASE-PX10D"	Medium attachment unit link status
LDSUIED/LPCPx/PortMac	Not imported, produced as status by the application	Port MAC address as dash-separated hex number

LCCHX: Communication Channels Supervision

This Logical node is responsible for supervising the physical communication channel. The channel represents a set of interfaces that connect to an Access Point of the device MMS interface. In MU360 it can be either associated to simple ports connected to an AP (SFP6 – ADMIN_AP) or with redundancy (SFP1+SFP2 – PROCESS_AP). Each instance In LDSUIED will represent its own related channel (Ex: LDSUIED/LCCH1 – PROCESS_AP [SFP1/SFP2]).

IEC Address	Range of Values	Description
LDSUIED/LCCHx/Health	Ok - all interfaces are connected. Warning - one of the interfaces is disconnected. Alarm - all interfaces are disconnected	Health
LDSUIED/LCCHx /ChLiv	True - channel receives telegrams within a specified time interval. False - channel is not receiving telegrams within a specified time interval (ChLivTms)	Physical channel status
LDSUIED/LCCHx /RedChLiv	True - channel receives telegrams within a specified time interval. False - channel is not receiving telegrams within a specified time interval	Physical redundant channel status
LDSUIED/LCCHx /ApNam	PROCESS_AP, STATION_AP, ADMIN_AP	Access point name (symbol) to which this channel belongs
LDSUIED/LCCHx /ChLivTms		ChLiv timeout

Notice relationship:

Refer to Interfaces for SFP disposition:

1. LCCH1: LPCP1\SFP1: PROCESS_AP, known as Process Bus
2. LCCH1: LPCP2\SFP2: PROCESS_AP, known as Process Bus
3. LCCH2: LPCP3\SFP3: STATION_AP, known as Station Bus
4. LCCH2: LPCP4\SFP4: STATION_AP, known as Station Bus
5. LPCP5\SFP5: Spare
6. LCCH3: LPCP6\SFP6: ADMIN_AP, known as Administration Bus

LPLE1: HMI LEDS

This Logical Node models the interface with the HMI LEDs. There is only one of this in the whole data model, belonging to LDSUIED, as there is only one HMI and each LED is modelled in it.

IEC Address	Range of Values	Description
LDSUIED/LPLE1/CmdLedX	True - LED On False - LED off	LED1 till LED8: status command from activation by internal IED rules (Fixed LEDs) LED9 till LED17: status command from activation trough applicative inputs, check Input and Outputs sections more ahead)
LDSUIED/LPLE1/RdbStX	True - LED On or Blinking False - LED off	Read back of LED status
LDSUIED/LPLE1/PhyHealth	Ok - HMI is connected Alarm - HMI not connected	Health
LDSUIED/LPLE1/DisplayLabX	Configurable	Label of the LED
LDSUIED/LPLE1/FrontPNameX	Configurable	Front panel or display name of the LED
LDSUIED/LPLE1/FrontPRefX	Configurable	Reference of the LED on the Front Panel or Display

Notice that fixed LEDs (LED1 till LED8) will present at LDSUIED/LPLE1/RdbStX only binary states, either 1 or 0, but their associated physical behaviors may have one additional state, blink mode.

LED	LPLE1\RdbSt State	Physical State	Description
LED1	1	Up	LDSUIED/LPHD.PhyHealth in ALARM
		Blink	LDSUIED/LPHD.PhyHealth in WARNING
	0	Off	LDSUIED/LPHD.PhyHealth is OK
LED2	1	Up	In Service
	0	Off	Not ready
LED3	1	Up	LDSUIED/LTMS.TmSyn in GLOBAL/LOCAL
		Blink	LDSUIED/LTMS.TmSyn in HOLDOVER/LOCKING
	0	Off	LDSUIED/LTMS.TmSyn in FREERUNNING
LED4	1	Up	Powered On
	0	Off	Powered Off
LED5	1	Up	Any Logical Device in Test/Test-Blocked mode
		Blink	Any Logical Device in Blocked mode
	0	Off	All Logical Devices are either On or Off mode

LED	LPLE1\RdbSt State	Physical State	Description
LED6	1	Up	LDSUIED/LCCH1.Health in Alarm
		Blink	LDSUIED/LCCH1.Health in Warning
	0	Off	LDSUIED/LCCH1.Health is OK
LED7	1	Up	LDSUIED/LCCH2.Health in Alarm
		Blink	LDSUIED/LCCH2.Health in Warning
	0	Off	LDSUIED/LCCH2.Health is OK
LED8	1	Up	LDSUIED/LCCH3.Health in Alarm
		Blink	LDSUIED/LCCH3.Health in Warning
	0	Off	LDSUIED/LCCH3.Health is OK
LED9 tio LED17	1	Up	Depending on ExtRef->InRef association: Refer to LDSUIED Inputs and Outputs.
	0	Off	

LTMS: Time Master Supervision

This Logical Node models time master supervision, which means, monitors the status regarding the time synchronization master.

IEC Address	Range of Values	Description
LDSUIED/LTMS0/TmChSt1	True - Interface Up False - Interface Down	Time channel status
LDSUIED/LTMS0/TmSyn	0 - InternalClock 1 - LocalAreaClock 2 - GlobalAreaClock See: https://iec61850.tissue-db.com/tissues/1726	Time synchronization mode status
LDSUIED/LTMS0/TmSynLkd	1 - Locked 2 - Unlocked10s 3 - Unlocked100s 4 - Unlocked1000s 5 - UnlockedMoreThan1000s	Locked status of clock synchronization
LDSUIED/LTMS0/TmAcc	0 till 31	Number of significant bits in the Fraction of Second in the time accuracy part of the time stamp
LDSUIED/LTMS0/TmSrc	Grand Master Clock Id	Current time source

LPDIX

This logical node represents a group of digital binary inputs. The LDSUIED can have multiple instances of LPDI which is represented as LPDIx where ‘x’ refers to the LPDI instance number. The number of instances of LPDI depends on the number of digital input boards (also referred to as DIU) fitted in the MU360. Each digital input board supports up to a maximum of 16 digital inputs. These digital inputs are represented by the data objects as described in the Inputs and Outputs section below. For more details about how MU360 is performing a binding from physical boards to a LPDI.

IEC Address	Description
LDSUIED/LPDIx/Indy	Data point mapping a channel from a digital input physical board
LDSUIED/LPDIx/PhyHealth	Data object represents the physical health status of the input physical board. Ex: DIU

LPDOX

This logical node represents a group of digital binary outputs. The LDSUIED may comprise of multiple instances of LPDO's and is represented as LPDOx where 'x' refers to the LPDO instance number. The number of instances of LPDO's depends on the number of digital output boards(DOU or HBU boards) fitted in the MU360. Each digital output board supports up to max. of 10 digital outputs, while the HBU board supports up to 6 digital outputs. These digital outputs are represented by the logical nodes as described in the Inputs and Outputs section more ahead. For more details about how MU360 is performing a binding from physical boards to a LPDO.

IEC Address	Description
LDSUIED/LPDOx/CmdDOy	Data point mapping a channel from a digital output physical board.
LDSUIED/LPDOx/PhyHealth	Data object represents the physical health status of the output physical board. Ex: DOU, HBU

LPHD0: Physical Device Information

This logical node will concentrate common information will identify IED.

IEC Address	Description
LDSUIED\LPHD0\PhyNam.model	Displays the Physical Device System Nameplate Information, known as GE Cortec.
LDSUIED\LPHD0\PhyNam.swRev	Global IED Firmware version in place
LDSUIED\LPHD0\PhyNam.hwRev	Global IED Hardware version in place
LDSUIED\LPHD0\PhyHealth.stVal	Global IED Physical Health status
LDSUIED\LPHD0\Sim\Oper.ctlVal	Global IED Goose simulation MMS command. If commanded as True, after receiving first Goose simulated packet, a subscription will accept only simulated data. If commanded as False, any subscription will accept only normal data from this command (not waiting normal packet).

4.14.7.1 LDSUIED MMS COMMANDS

In the **LDSUIED\LPHD0.Sim**, there is an OPER structure that allows user to activate/deactivate simulated GOOSE messages reception. Check the LDSUIED\LPHD0 explanation in LDSUIED-IED Supervision Logical Device for more details.

4.14.7.2 LDSUIED INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDSUIED				
Inputs *	InRefs (Number of Possible Instances)	App Input	LN	Outputs
n/a	n/a	n/a	GAPC0	GAPC0.Ind1.stVal
n/a	n/a	n/a	GAPCX 1 <= x <= 36	GAPCX.Health.stVal

LDSUIED				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
n/a	n/A	n/A	LSET0	DITmms.setVal
n/a	n/a	n/a	LGOSx 1 <= x <= 20	LastSTNum.stVal NdsCom.stVal St.stVal SimSt.stVal ConfRevNum.stVal
n/a	n/a	n/a	LPCPX 1 <= x <= 6	LPCPX.PhyHealth.stVal LPCPX.TxCnt.actVal LPCPX.RxCnt.actVal LPCPX.PortMac.setVal LPCPX.AutoNgt.stVal LPCPX.Mau.stVal
n/a	n/a	n/a	LCCHX 1 <= x <= 3	LCCHX.Health.stVal LCCHX.ChLiv.stVal LCCHX.RedChLiv.stVal
ExtRef(s)	1	LED X 9 <= x <= 17	LPLE1	LPLE1.CmdLedX.stVal LPLE1.RdbStX.stVal X = LED index
n/a	n/a	n/a		
n/a	n/a	n/a	LTMS1	LTMS1.TmChSt1.stVal LTMS1.TmSyn.stVal LTMS1.TmSynLkd.stVal LTMS1.TmAcc.stVal LTMS1.TmSrc.stVal
ExtRef(s)	Amount of DOUs*10*3 + Amount of HBUs*6*3	Cmd DO X Ouput Y Z (X = LPDO Index, Y = Output Index Z = 1,2 or 3)	LDPOx 1 <= x <= 16	For DOU boards: LPDOx.CmdDOy.stVal (x = 1 to 14 max, y = 1 to 10)
				For HBU boards: LPDOx.CmdDOy.stVal (x = 15 or 16, y = 1 to 6)
n/a	n/a	n/a		LPDOx.PhyHealth.stVal
n/a	n/a	n/a	LPDIx 1 <= x <= 14	LPDIx.Indy.stVal (y = 1 to 16)
				LPDIx.PhyHealth.stVal

LDSUIED				
Inputs *	**InRefs (Number of Possible Instances)**	**App Input**	**LN**	**Outputs**
n/a	n/a	n/a	LPHD0	LPHD0.Sim.stVal LPHD0.PhyHealth.stVal LPHD0.PhyNam.hwRev LPHD0.PhyNam.swRev LPHD0.PhyNam.serNum LPHD0.PhyNam.model

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs

4.14.7.3 LDSUIED BLOCK DIAGRAMS

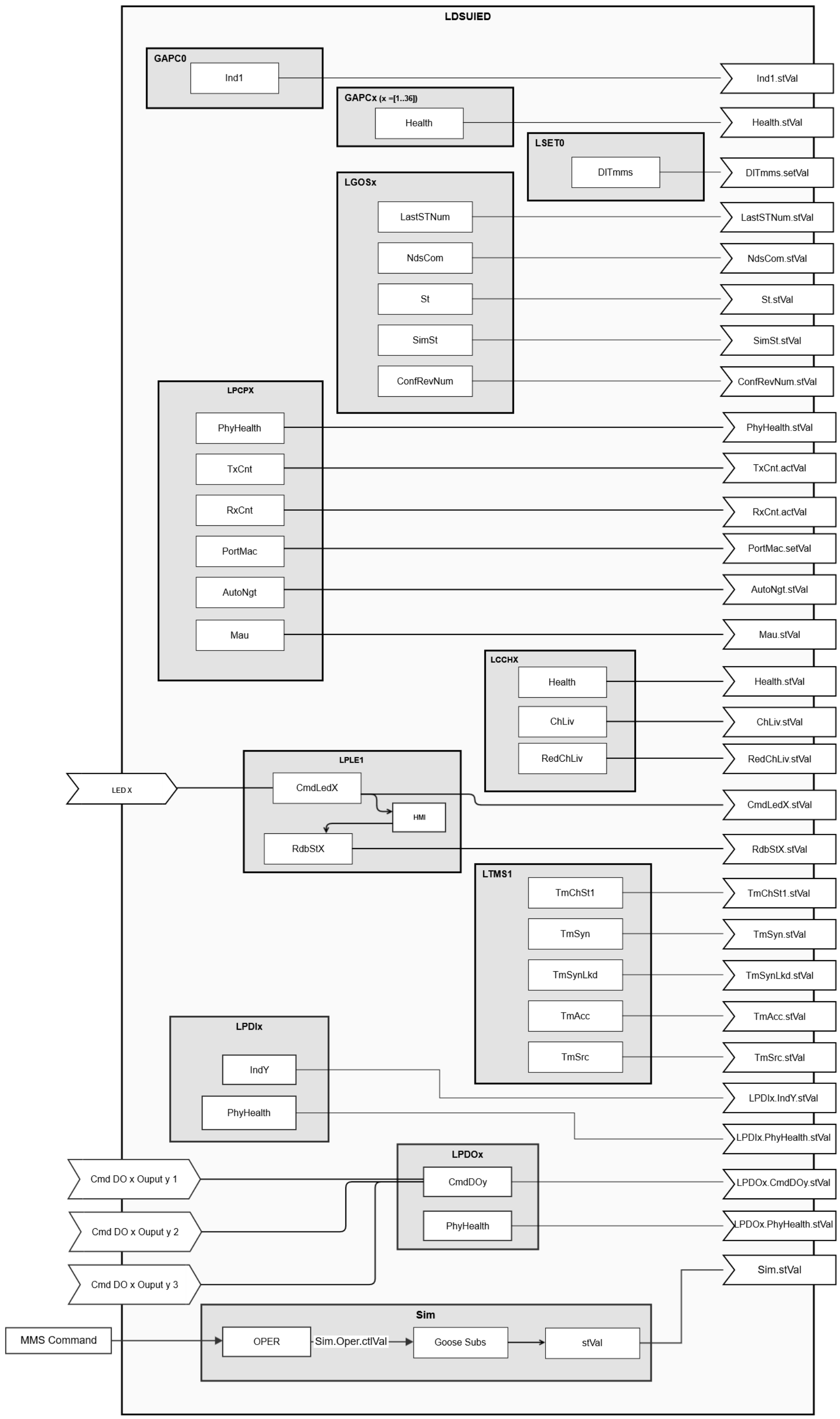


Figure 108: LDSUIED block diagram

4.14.8 LDITFSUDJ - MONITORING CIRCUIT-BREAKER INTERFACE

LDITFSUDJ is a logical device in MU360 that has been working as the main physical interface to monitor a high voltage circuit-breaker. Its main goal is to collect sensors depends on the technology. Sensors are used to detect pressure, sealing failure, arc counter, … to allow other LD to manage the circuit breaker.

MU360 has modeled LDITFSUDJ as a set of sub-functions and fields, mainly by logical nodes that manage gas state as below:

- GGIO0: LN used gas drying fault
- SIMG0: LN for SF6 pressure control for whole circuit stage 1 and 2
- SIMG1-3: LN for SF6 pressure control stage 1 for phase A, B and C
- SIMG4: LN used for SF6 probe connection (Unplugged socket)

4.14.8.1 LDITFSUDJ INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table:

LDITFSUDJ				
Inputs *	**InRefs (Number of Possible Interfaces)**	**App Input**	**LN**	**Outputs**
ExtRef(s)	1	Low pressure state 1 phase A	SIMG1-4	SIMG.insAlm
ExtRef(s)	1	Low pressure state 1 phase B		
ExtRef(s)	1	Low pressure state 1 phase C		
ExtRef(s)	1	Unplugged socket		
ExtRef(s)	1	Low pressure state 1	SIMG0	SIMG.insAlm SIMG.insBlk SIMG.insTr
ExtRef(s)	1	Low pressure state 2		
ExtRef(s)	1	Gas drying fault	GGIO0	GGIO.ind

* EnerVista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.8.2 LDITFSUDJ BLOCK DIAGRAM

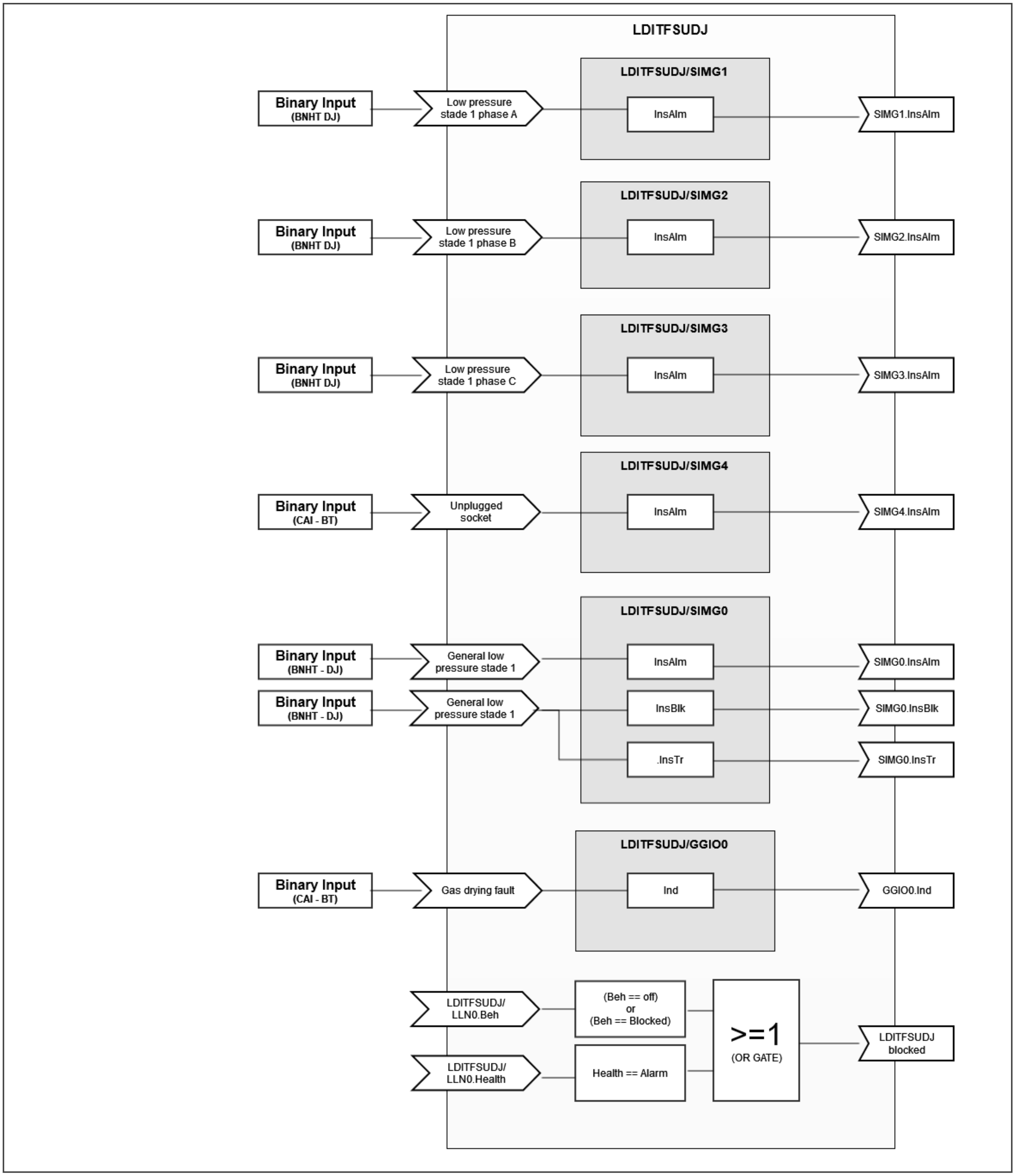


Figure 109: LDITFSUDJ block diagram

4.14.9 LDBALIS

This function interfaces IED identification indicator. The main goal of this function is to receive the activation command from user for each IED and drive the respective binary output associated to an IED. This allows the user to identify the IED for maintenance operation.

The MU360 has modeled LDBALIS as a set of IED identification indicators in GAPC0. Each IED instantiated by one SPCSO in GAPC0.

4.14.9.1 LDBALIS MMS COMMANDS

In the GAPC0.SPCSOx, there is an OPER structure that allows user to activate the identification indicator (Indx.stVal) for IED x.

The MU360 has 44 instances of "SPCSO" and "Ind" in GAPC0, instance is represented by letter x.

4.14.9.2 LDBALIS INPUTS AND OUTPUTS

Main inputs and outputs are depicted in below table.

LDBALIS				
Inputs *	**InRefs (Number of Possible Instances)**	**App input**	**LN**	**Outputs**
n/a	n/a	n/a	GAPC0	Indx.stVal

* Enervista Flex v2 will select correct ones when demanded by user during procedure of linking LDs.

4.14.9.3 LDBALIS BLOCK DIAGRAM

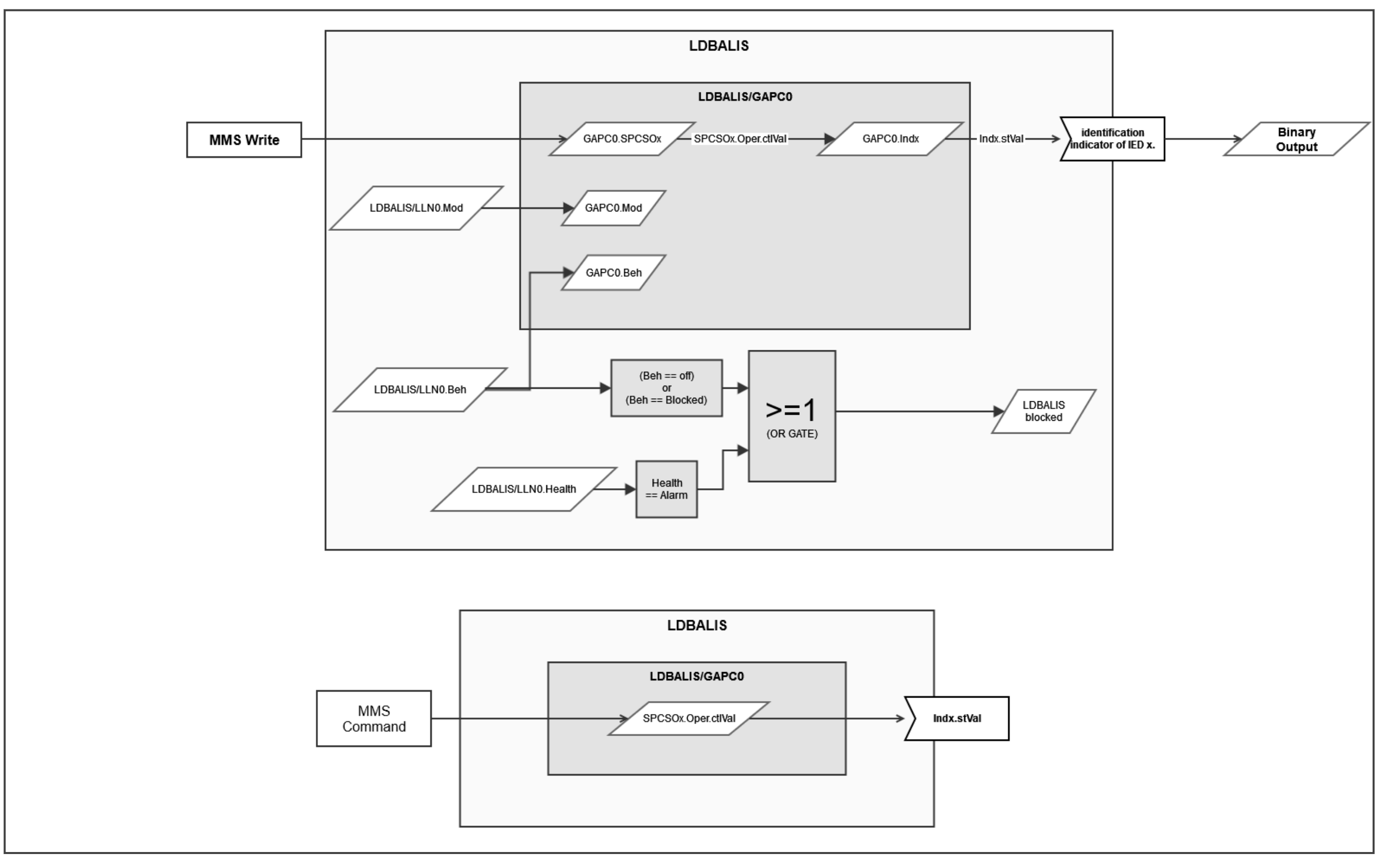


Figure 110: LDBALIS block diagram

4.15 WARNING AND ALARM MANAGEMENT

This chapter provides instructions for connecting, configuring, and updating the firmware of MU360. This section is designed for technicians, engineers, and system architects responsible for O&M of the devices and the final solution. It outlines the basic steps to achieve the desired device behavior, although detailed instructions for parametrization and advanced configurations can be found in the dedicated configurator manual.

4.15.1 GENERATING AND DOWNLOADING LOGS

The device can be managed using GE Vernova EnerVista Flex v2, connecting to it from the Administration network interface (SFP6) only.

- Access the device menu by clicking on top of the device name

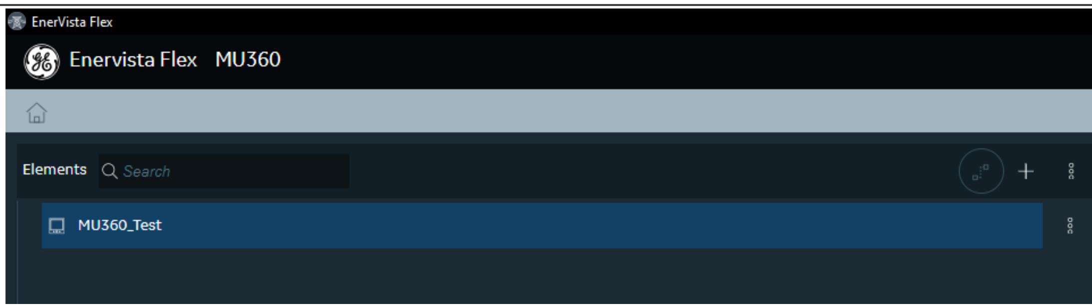


Figure 111: EnerVista Flex v2 Device Menu

- Click **Connect** on the bottom left corner of the screen

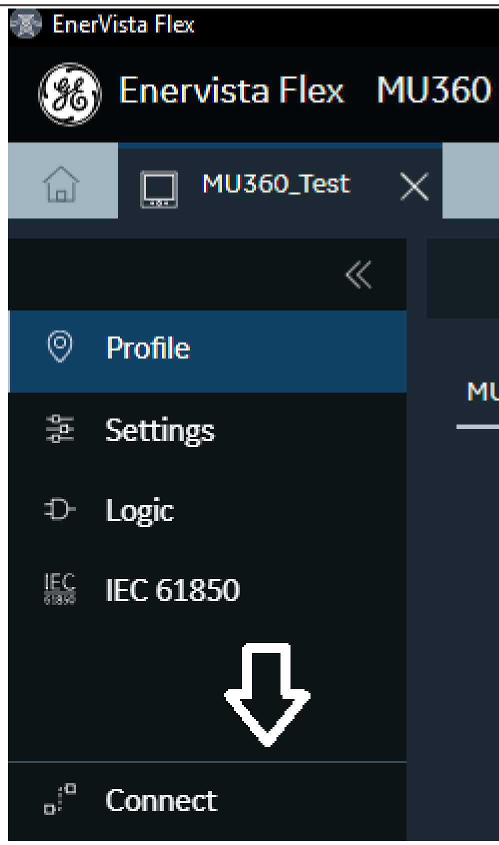


Figure 112: EnerVista Flex v2 Device Option Tab

- Add the Connection information of your device. Type in the correct MU360 Administrative Ethernet IP, User and Password. If your device was not already configured, it should be configured with the default administration IP: 192.168.1.199. Port: 10000. User: Admin. Password Admin.

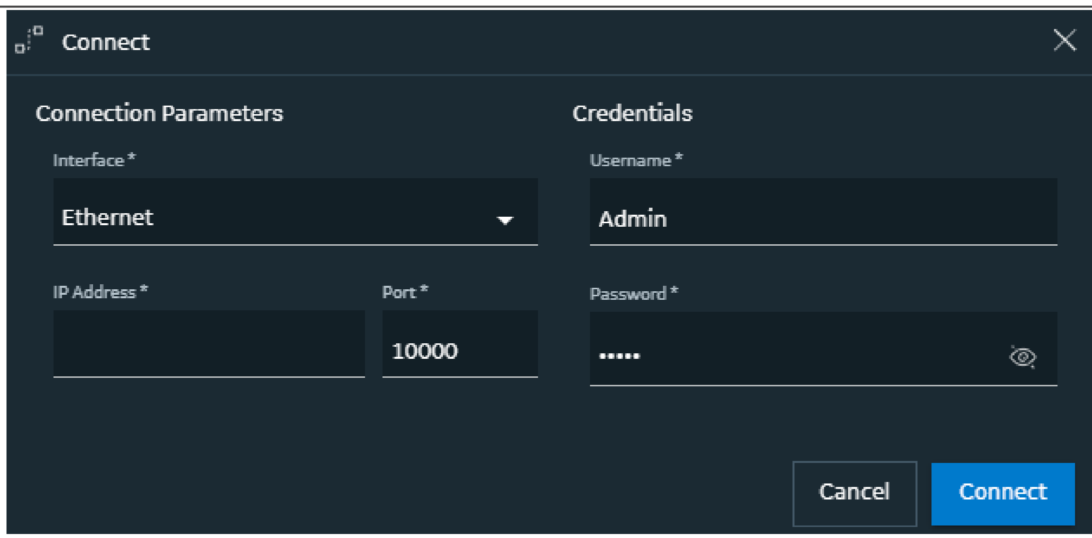


Figure 113: EnerVista Flex v2 connection pop-up

> *Note:*
> *Upon connection, the user will be able to access device information and send commands.*

- When connected click **Maintenance** menu

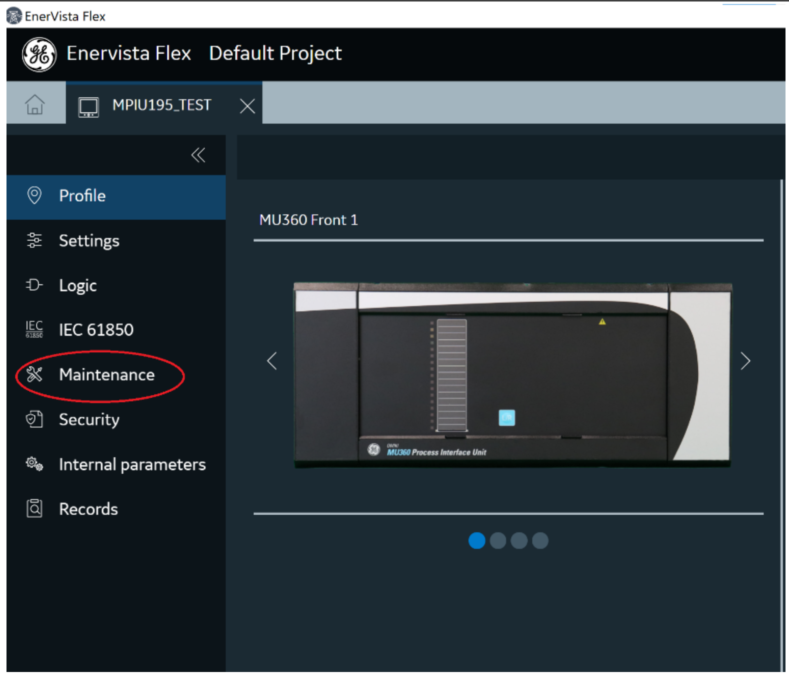


Figure 114: Maintenance tab

- Click **Generate Logs**

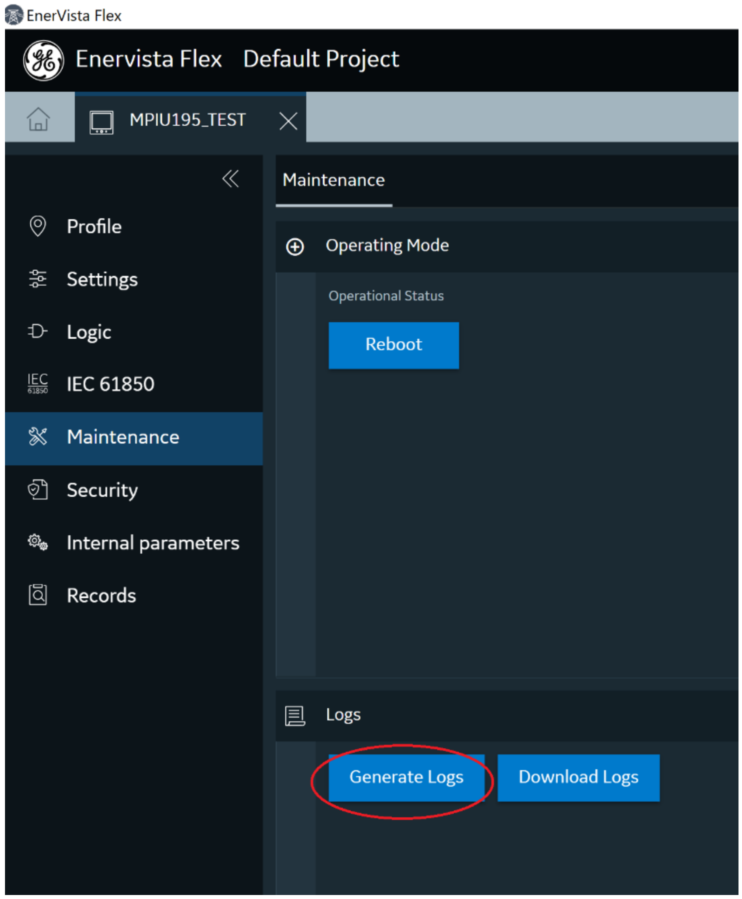


Figure 115: Generate logs

- A pop-up message should appear, click **OK** to confirm generation

Note:
It can last a while, about 1, 2min depending on the amount of local files.

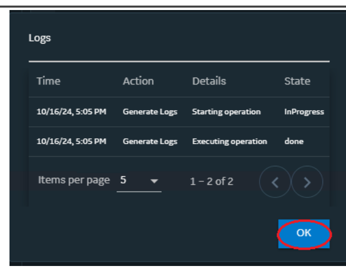


Figure 116: Logs generation

- Next click **Download Logs** button

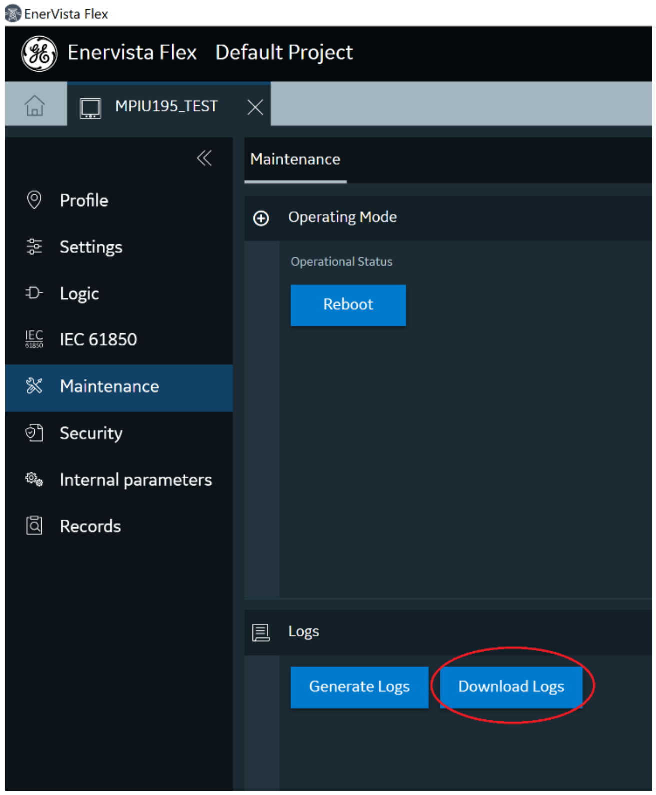


Figure 117: Download logs button

- A new pop-up message is presented, click **OK** to confirm download

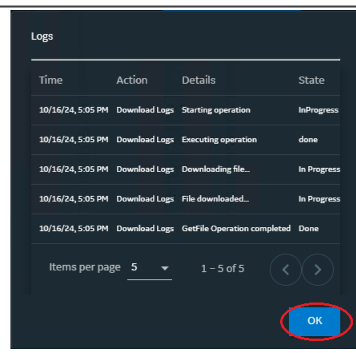


Figure 118: Download logs pop-up message

A file called AdvancedDiagnostics.zip will be downloaded. This file contains all MU360 internal generated logs, hosted at ServiceLogs folder.

ServiceLogs

These are internal logs related to the specific services from IED.

- Mpiu_Alarm_Log: It logs every status transition from MU360 internal alarms.
- Mpiu _GeneralStatistics_Log: It contains general statistics like CPU load (usage), total ram memory available in kb, and emmc/sdcard disk usage.
- Mpiu _Logbook_Log: Main IED journal.
- Mpiu _Maintenance_Log: it logs every maintenance event created by the IEDs.

- Mpiu _NetworkStatistics_Log: it logs specific statistics related to each network interface.
- Mpiu _SOERecorder_Log: It logs each digital input/output and board status transition.
- Mpiu _StateRecorder_Log: List of historical events and signals (binary and GOOSE I/O changes) associated with on-site operations.

All of them are formatted according to Syslog RFC 3164. See structured format:

<PRI> Header field: <VERSION> <time stamp> <IED Name> - - - (<Module>) <message>

Being PRI one of the following options:

PRI	Severity	Level
104	Emergency: system is unusable	
105	Alert: action must be taken immediately	
106	Critical: critical conditions	
107	Error: error conditions	Error
108	Warning: warning conditions	Warning
109	Notice: normal but significant condition	Notice
110	Informational: informational messages	Info
111	Debug: debug-level messages	

Please note an example of a log entry, It will present PRI code, time stamp, context (configuration deployed and internal module) and then the message.

<110>1 2021-09-01T16:57:50.948Z MUA_4CBO_X GE_RE_MU360 - - - (ConfigurationManager) Configuration in progress for Analog.

4.15.2 HMI ALARMS

Some of IED LEDs could indicate Alarm situations. Refer to LPLE1 section in LDSUIED-IED Supervision Logical Device.

Also, these same LED statuses are abstracted and virtually modeled in LDSUIED/LPLE. Refer to LDSUIED-IED Supervision Logical Device.

4.15.3 WATCHDOG/FAILSAFE ALARM

Watchdog/Failsafe status is a representation of the MU360 proper functioning. Refer to Central Processing Unit and Communication CPUMZ5.

4.15.4 GOOSE OR MMS

All logical devices have outputs that could be consumed as alarm, once well mapped on dataset/control-blocks.

4.15.4.1 BOARD HEALTH ALARM

All boards are virtually modeled and have its ALARM health statuses published in LDSUIED/LPDI.PhyHealth, LDSUIED/LPDO.PhyHealth and LDSUIED/LPAI.PhyHealth. Refer to LDSUIED Inputs and Outputs.

4.15.4.2 LOGICAL DEVICE ALARM

All modeled logical devices have its ALARM health statuses published in LDx/LLN0.Health.

4.16 ANNEX

This section provides the purpose for each App input used within the built-in automation functions.

4.16.1 LDDJ APP INPUTS AND PURPOSES

App Input	Purpose
CB Close Order	DYN_LDDJ_Ordre d enclenchement DJ_1 till DYN_LDDJ_Ordre d enclenchement DJ_2
Three phase trip order	DYN_LDDJ_Ordre de declenchement triphase_1 till DYN_LDDJ_Ordre de declenchement triphase_42
Phase A trip order	DYN_LDDJ_Ordre de declenchement phase A_1 till DYN_LDDJ_Ordre de declenchement phase A_6
Phase B trip order	DYN_LDDJ_Ordre de declenchement phase B_1 till DYN_LDDJ_Ordre de declenchement phase B_6
Phase C trip order	DYN_LDDJ_Ordre de declenchement phase C_1 till DYN_LDDJ_Ordre de declenchement phase C_6
Trip Order due to low SF6 pressure	DYN_LDDJ_Ordre de declenchement par baisse pression SF6_1
CB Internal Fault	STAT_LDDJ_DEFAUT INTERNE DJ_1
CB Open Position	STAT_LDDJ_POSITION DJ OUVERT_1
CB Close Position	STAT_LDDJ_POSITION DJ FERME_1
CB Block to Close	STAT_LDDJ_VERROUILLAGE ENCLENCHEMENT_1
Blocking Order due low SF6 Pressure	DYN_LDDJ_Ordre de declenchement par baisse pression SF6_1
CB Close	STAT_LDDJ_ENCLENCHEMENT DJ_1
Draw out CB (Rack-out)	STAT_LDDJ_DJ DEBROCHE_1
Draw out CB (Rack-In)	STAT_LDDJ_DJ EMBROCHE_1

4.16.2 LDTM APP INPUTS AND PURPOSES

App Input	Purpose
Three Phase Current Input phA for protection	STAT_LDTM1_Entree Courant Protection Tri 1 phA
Three Phase Current Input phB for protection	STAT_LDTM1_Entree Courant Protection Tri 1 phB
Three Phase Current Input phC for protection	STAT_LDTM1_Entree Courant Protection Tri 1 phC
Mono Phase Current Input 1 for protection	STAT_LDTM1_Entree Courant Protection Mono 1
Mono Phase Current Input 2 for protection	STAT_LDTM1_Entree Courant Protection Mono 2
Mono Phase Current Input 3 for protection	STAT_LDTM1_Entree Courant Protection Mono 3
Three Phase Current Input phA for measurement	STAT_LDTM1_Entree Courant Mesure Tri 1 phA
Three Phase Current Input phB for measurement	STAT_LDTM1_Entree Courant Mesure Tri 1 phB
Three Phase Current Input phB for measurement	STAT_LDTM1_Entree Courant Mesure Tri 1 phC
Voltage Three Phase Input phA	STAT_LDTM1_Entree Tension Tri 1 phA
Voltage Three Phase Input phB	STAT_LDTM1_Entree Tension Tri 1 phB
Voltage Three Phase Input phC	STAT_LDTM1_Entree Tension Tri 1 phC
Mono Phase Voltage Input 1	STAT_LDTM1_Entree Tension Mono 1

App Input	Purpose
Mono Phase Voltage Input 2	STAT_LDTM1_Entree Tension Mono 2
Mono Phase Voltage Input 3	STAT_LDTM1_Entree Tension Mono 3
Mono Phase Voltage Input 4	STAT_LDTM1_Entree Tension Mono 4
Mono Phase Voltage Input 5	STAT_LDTM1_Entree Tension Mono 5
Mono Phase Voltage Input 6	STAT_LDTM1_Entree Tension Mono 6
Fuse Fail Voltage Mono 1	STAT_LDTM1_Fusion fusible circuit tension Mono 1
Fuse Fail Voltage Mono 2	STAT_LDTM1_Fusion fusible circuit tension Mono 2
Fuse Fail Voltage Mono 3	STAT_LDTM1_Fusion fusible circuit tension Mono 3
Fuse Fail Voltage Mono 4	STAT_LDTM1_Fusion fusible circuit tension Mono 4
Fuse Fail Voltage Mono 5	STAT_LDTM1_Fusion fusible circuit tension Mono 5
Fuse Fail Voltage Mono 6	STAT_LDTM1_Fusion fusible circuit tension Mono 6
Fuse Fail Voltage Three Phase	STAT_LDTM1_Fusion fusible circuit tension Tri 1
Three Phase current protection position	STAT_LDTM1_CC ferme entree courant protection Tri 1
Mono Phase 1 current protection position	STAT_LDTM1_CC ferme entree courant protection Mono 1
Mono Phase 2 current protection position	STAT_LDTM1_CC ferme entree courant protection Mono 2
Mono Phase 3 current protection position	STAT_LDTM1_CC ferme entree courant protection Mono 3
Telecommand Locked Switch Signal Feedback	STAT_LDTM1_TT entree tension Tri condamne
Telecommand Unlocked Switch Signal Feedback	STAT_LDTM1_TT entree tension Tri decondamne
Three Phase current measurement position	STAT_LDTM1_CC ferme entree courant mesure Tri

4.16.3 LDITFSUDJ APP INPUTS AND PURPOSES

App Input	Purpose
Low pressure state 1 phase A	STAT_LDITFSUDJ_Baisse pression 1ier stade phase A_1
Low pressure state 1 phase B	STAT_LDITFSUDJ_Baisse pression 1ier stade phase B_1
Low pressure state 1 phase c	STAT_LDITFSUDJ_Baisse pression 1ier stade phase C_1
Low pressure state 1	STAT_LDITFSUDJ_Baisse pression 1ier stade_1 _1
Low pressure state 2	STAT_LDITFSUDJ_Baisse pression 2ier stade_1 _2
Drying fault	STAT_LDITFSUDJ_DEFAUT ASSECHEUR_1
Connection unplugged	STAT_LDITFSUDJ_PRISES DEBROCHEES_1

4.16.4 LDITFUA APP INPUTS AND PURPOSES

App Input	Purpose
Battery 127 rectifier security alarm	STAT_LDITFUA_ALARME SECURITE BAT127_1
Battery 1 Charger fault	STAT_LDITFUA_DEFAUT CHARGEUR BAT1 ou TCM_1
Auxiliary supply voltage failure 27	STAT_LDITFUA_Surveillance polarite 27_1
Battery 1 Voltage fault	STAT_LDITFUA_TENSION BATTERIE 1 ou TCM ANORMALE_1
Auxiliary supply voltage failure 21	STAT_LDITFUA_Surveillance polarite 21_1

App Input	Purpose
Auxiliary supply voltage failure 22	STAT_LDITFUA_Surveillance polarite 22_1
Trip No Priority RPD	STAT_LDITFUA_DT DJ NON PRIORITAIRE RPD_1
Auxiliary supply voltage failure 14	STAT_LDITFUA_Surveillance polarite 14_1
Auxiliary supply voltage failure 9	STAT_LDITFUA_Surveillance polarite 9_1
Trip Aux Feeder CC RPD	STAT_LDITFUA_DT DJ ANTENNE CC RPD_1
CB Position of DC/AC Aux feeder 2	STAT_LDITFUA_DISJONCTEUR BATTERIE 2 ou CC OUVERT_1
Auxiliary supply voltage failure 12	STAT_LDITFUA_Surveillance polarite 12_1
Auxiliary supply voltage failure 16	STAT_LDITFUA_Surveillance polarite 16_1
Auxiliary supply voltage failure 19	STAT_LDITFUA_Surveillance polarite 19_1
Auxiliary supply voltage failure 3	STAT_LDITFUA_Surveillance polarite 3_1
Trip Aux Feeder CC RPT	STAT_LDITFUA_DT DJ ANTENNE CC RPT_1
Battery 3 Earth Circuit fault	STAT_LDITFUA_TERRE BATTERIE BAT3_1
Battery 2 Earth Circuit fault	STAT_LDITFUA_TERRE BATTERIE BAT2 ou CC_1
Trip No Priority RPT	STAT_LDITFUA_DT DJ ALT NON PRIORITAIRE RPT_1
Bay lockout disconnector	STAT_LDITFUA_Position interrupteur de consignation ouvert_1
Failure of Diesel Unit	STAT_LDITFUA_FONCTIONNEMENT GROUPE ELECTROGENE_1
Auxiliary supply voltage failure 8	STAT_LDITFUA_Surveillance polarite 8_1
Auxiliary supply voltage failure 9	STAT_LDITFUA_Surveillance polarite 5_1
Battery 3 Charger fault	STAT_LDITFUA_DEFAUT CHARGEUR BAT3_1
Auxiliary supply voltage failure 17	STAT_LDITFUA_Surveillance polarite 17_1
Auxiliary supply voltage failure 1	STAT_LDITFUA_Surveillance polarite 1_1
Battery 2 rectifier security alarm	STAT_LDITFUA_ALARME SECURITE BAT2_1
Auxiliary supply voltage failure 13	STAT_LDITFUA_Surveillance polarite 13_1
BUCHHOLZ TSA Alarm	STAT_LDITFUA_ALARME BUCHHOLZ TSA_1
Auxiliary supply voltage failure 20	STAT_LDITFUA_Surveillance polarite 20_1
Auxiliary supply voltage failure 11	STAT_LDITFUA_Surveillance polarite 11_1
Auxiliary supply voltage failure 10	STAT_LDITFUA_Surveillance polarite 10_1
Auxiliary supply voltage failure 18	STAT_LDITFUA_Surveillance polarite 18_1
Auxiliary supply voltage failure 7	STAT_LDITFUA_Surveillance polarite 7_1
Auxiliary supply voltage failure 2	STAT_LDITFUA_Surveillance polarite 2_1
CB Position of DC/AC Aux feeder 5	STAT_LDITFUA_DISJONCTEUR BATTERIE 5 ou 127 OUVERT_1
Converter/Rectifier fault	STAT_LDITFUA_DF CONVERTISSEUR 48/125_1
Auxiliary supply voltage failure 4	STAT_LDITFUA_Surveillance polarite 4_1
Auxiliary supply voltage failure 6	STAT_LDITFUA_Surveillance polarite 6_1
Battery 5 Earth Circuit fault	STAT_LDITFUA_TERRE BATTERIE BAT5 ou 127_1
Auxiliary supply voltage failure 15	STAT_LDITFUA_Surveillance polarite 15_1
Auxiliary supply voltage failure 24	STAT_LDITFUA_Surveillance polarite 24_1

App Input	Purpose
Auxiliary supply voltage failure 26	STAT_LDITFUA_Surveillance polarite 26_1
Battery 3 Voltage fault	STAT_LDITFUA_TENSION BATTERIE 3 ANORMALE_1
CB Position of DC/AC Aux feeder 3	STAT_LDITFUA_DISJONCTEUR BATTERIE 3 OUVERT_1
Auxiliary supply voltage failure 23	STAT_LDITFUA_Surveillance polarite 23_1
Trip Auxiliar Alternative of Security	STAT_LDITFUA_DECL AUXILIAIRE ALT SECOURU_1
Trip Auxiliar Alternative of Grid	STAT_LDITFUA_DECL AUXILIAIRE ALT RESEAU_1
Battery 2 Voltage fault	STAT_LDITFUA_TENSION BATTERIE 2 ou CC ANORMALE_1
Battery 1 rectifier security alarm	STAT_LDITFUA_ALARME SECURITE BAT1_1
Auxiliary supply voltage failure 28	STAT_LDITFUA_Surveillance polarite 28_1
Battery 2 Charger fault	STAT_LDITFUA_DEFAUT CHARGEUR BAT2 ou CC_1
Battery 1 Earth Circuit fault	STAT_LDITFUA_TERRE BATTERIE BAT1 ou TCM_1
Status of Diesel Unit	STAT_LDITFUA_DEFAUT GROUPE ELECTROGENE_1
Battery 5 Charger fault	STAT_LDITFUA_DEFAUT CHARGEUR BAT5 ou 127_1
Battery 5 Voltage fault	STAT_LDITFUA_TENSION BATTERIE 5 ou 127 ANORMALE_1
Battery 3 rectifier security alarm	STAT_LDITFUA_ALARME SECURITE BAT3_1
Trip TSA (Auxiliary Transformer)	STAT_LDITFUA_DECLENCHEMENT TSA_1
Auxiliary supply voltage failure 25	STAT_LDITFUA_Surveillance polarite 25_1
CB Position of DC/AC Aux feeder 1	STAT_LDITFUA_DISJONCTEUR BATTERIE 1 ou TCM OUVERT_1
Trip Priority RPT	STAT_LDITFUA_DT DJ ALT PRIORITAIRE RPT_1
Trip Priority RPD	STAT_LDITFUA_DT DJ PRIORITAIRE RPD_1

4.16.5 LDITFRPTRPD APP INPUTS AND PURPOSES

App Input	Purpose
TCT error in RPD	STAT_LDITFRPTRPD1_ANOMALIE TCT DU RPD_1
Client presence to RPT 1	STAT_LDITFRPTRPD1_PRESENCE CLIENT VERS RPT_1
Client presence to RPT 2	STAT_LDITFRPTRPD1_PRESENCE CLIENT VERS RPT_2
DSO station failure	STAT_LDITFRPTRPD1_DEFAUT POSTE RPD EN AS_1
Bell voltage S	STAT_LDITFRPTRPD1_SONNERIE EN S PAR RPD _1
Horn voltage S	STAT_LDITFRPTRPD1_KLAXON EN TC PAR RPD _1
Bell voltage TC	STAT_LDITFRPTRPD1_SONNERIE EN TC PAR RPD _1
Horn voltage TC	STAT_LDITFRPTRPD1_KLAXON EN S PAR RPD _1
Emergency 1 for RPD	DYN_LDITFRPTRPD1_Urgence 1 pour RPD_1
Emergency 2 for RPD	DYN_LDITFRPTRPD1_Urgence 2 pour RPD_1
Presence 1	DYN_LDITFRPTRPD1_PRESENCE 1_1

App Input	Purpose
Presence 2	DYN_LDITFRPTRPD1_PRESENCE 2_1
Anomaly UA	DYN_LDITFRPTRPD1_Anomalie UA_1
Default SA Emergency 2	DYN_LDITFRPTRPD1_Defaut SA Urg2_1
Default SA Emergency 1	DYN_LDITFRPTRPD1_Defaut SA Urg1_1
Air compressor failure warning	STAT_LDITFRPTRPD1_ANOMALIE PRESSION AIR COMPRIME_1
Air compressor failure alarm	STAT_LDITFRPTRPD1_DEFAUT COMPRESSEUR_1
Signal reclose CB 1	STAT_LDITFRPTRPD1_AUT REPRISE DE SERVICE ISSU DU GR1_1
Signal reclose CB 2	STAT_LDITFRPTRPD1_AUT REPRISE DE SERVICE ISSU DU GR2_1
Signal reclose CB 3	STAT_LDITFRPTRPD1_AUT REPRISE DE SERVICE ISSU DU GR3_1
Signal reclose CB 4	STAT_LDITFRPTRPD1_AUT REPRISE DE SERVICE ISSU DU GR4_1
Timed open door	DYN_LDITFRPTRPD1_Porte ouverte temporisee_1
Substation flooded	DYN_LDITFRPTRPD1_Poste inonde_1
Load shedding order 1	DYN_LDITFRPTRPD1_Ordre delestage num 1_1 till DYN_LDITFRPTRPD1_Ordre delestage num 1_6
Load shedding order 2	DYN_LDITFRPTRPD1_Ordre delestage num 2_1 till DYN_LDITFRPTRPD1_Ordre delestage num 2_6
Load shedding order 3	DYN_LDITFRPTRPD1_Ordre delestage num 3_1 till DYN_LDITFRPTRPD1_Ordre delestage num 3_6
Absence of busbar voltage 1 section 1	DYN_LDITFRPTRPD1_MQU Barre 1 section 1_1
Absence of busbar voltage 1 section 2	DYN_LDITFRPTRPD1_MQU Barre 1 section 2_1
Absence of busbar voltage 1 section 3	DYN_LDITFRPTRPD1_MQU Barre 1 section 3_1
Absence of busbar voltage 1 section 4	DYN_LDITFRPTRPD1_MQU Barre 1 section 4_1
Absence of busbar voltage 1 section 5	DYN_LDITFRPTRPD1_MQU Barre 1 section 5_1
Absence of busbar voltage 1 section 6	DYN_LDITFRPTRPD1_MQU Barre 1 section 6_1
Absence of busbar voltage 2 section 1	DYN_LDITFRPTRPD1_MQU Barre 2 section 1_1
Absence of busbar voltage 2 section 2	DYN_LDITFRPTRPD1_MQU Barre 2 section 2_1
Instantaneous open door client	STAT_LDITFRPTRPD1_PORTE OUVERTE INST CLIENT_1 till STAT_LDITFRPTRPD1_PORTE OUVERTE INST CLIENT_2
Call Door RTP	STAT_LDITFRPTRPD1_APPEL PORTE POUR RPT_1

App Input	Purpose
Remote control light	STAT_LDITFRPTRPD1_POSTE ECLAIRE PAR RPD_1
Substation light ON	DYN_LDITFRPTRPD1_Eclairage abords_1
Call Door	DYN_LDITFRPTRPD1_Appel porte_1
Instantaneous open door	DYN_LDITFRPTRPD1_Porte ouverte instantanee_1
Technical alarm	DYN_LDITFRPTRPD1_Alarme technique_1
Backup alarm mode	STAT_LDITFRPTRPD1_POSTE RPD EN AS_1
Substation local mode or substation presence	STAT_LDITFRPTRPD1_LOCAL OU PRESENCE RPD_1
CB filtered position	DYN_LDITFRPTRPD1_Position filtree du DJ_1_Dbpos
ICT position	DYN_LDITFRPTRPD1_Position ICT_1_Dbpos
Incoming phone call	STAT_LDITFRPTRPD1_APPEL TELEPHONIQUE RPD_1
AMU out of order TR1	STAT_LDITFRPTRPD1_AMU HORS SERVICE TR1_1
AMU running TR1	STAT_LDITFRPTRPD1_AMU EN SERVICE TR1_1
AMU out of order TR2	STAT_LDITFRPTRPD1_AMU HORS SERVICE TR2_1
AMU running TR2	STAT_LDITFRPTRPD1_AMU EN SERVICE TR2_1
AMU out of order TR3	STAT_LDITFRPTRPD1_AMU HORS SERVICE TR3_1
AMU running TR3	STAT_LDITFRPTRPD1_AMU EN SERVICE TR3_1
AMU out of order TR4	STAT_LDITFRPTRPD1_AMU HORS SERVICE TR4_1
AMU running TR4	STAT_LDITFRPTRPD1_AMU EN SERVICE TR4_1
AMU out of order TR5	STAT_LDITFRPTRPD1_AMU HORS SERVICE TR5_1
AMU running TR5	STAT_LDITFRPTRPD1_AMU EN SERVICE TR5_1
Danger alarm from DSO or customer substation	STAT_LDITFRPTRPD1_ALARME DANGER DU CLIENT_1
	STAT_LDITFRPTRPD1_ALARME DANGER DU CLIENT_2
Danger Alarm from TSO to DSO	DYN_LDITFRPTRPD1_Alarme Danger vers RPD_1
Pump failure	DYN_LDITFRPTRPD1_Defaut equipement pompe_1_HealthKind
Trip CB RPD priority	DYN_LDITFRPTRPD1_Dec DJ prioritaire RPD_1
Trip CB CC antenna RPD	DYN_LDITFRPTRPD1_Dec DJ antenne CC RPD_1
Trip CB not priority RPD	DYN_LDITFRPTRPD1_Dec DJ non prioritaire RPD_1

App Input	Purpose
Trip by PVH	STAT_LDITFRPTRPD1_DECLENCHEMENT PAR PVH_1
Trip CB ground cable TR1	STAT_LDITFRPTRPD1_DECLENCHEMENT MASSE CABLE TR1_1
Trip CB ground cable TR2	STAT_LDITFRPTRPD1_DECLENCHEMENT MASSE CABLE TR2_1
Trip CB ground cable TR3	STAT_LDITFRPTRPD1_DECLENCHEMENT MASSE CABLE TR3_1
Trip CB ground cable TR4	STAT_LDITFRPTRPD1_DECLENCHEMENT MASSE CABLE TR4_1
Trip CB ground cable TR5	STAT_LDITFRPTRPD1_DECLENCHEMENT MASSE CABLE TR5_1
Trip AMU TR1	STAT_LDITFRPTRPD1_DECLENCHEMENT AMU TR1_1
Trip AMU TR2	STAT_LDITFRPTRPD1_DECLENCHEMENT AMU TR2_1
Trip AMU TR3	STAT_LDITFRPTRPD1_DECLENCHEMENT AMU TR3_1
Trip AMU TR4	STAT_LDITFRPTRPD1_DECLENCHEMENT AMU TR4_1
Trip AMU TR5	STAT_LDITFRPTRPD1_DECLENCHEMENT AMU TR5_1
Trip order GR1	STAT_LDITFRPTRPD1_RECEPTION ORDRE DEC GR1_1
Trip order GR2	STAT_LDITFRPTRPD1_RECEPTION ORDRE DEC GR2_1
Trip order GR3	STAT_LDITFRPTRPD1_RECEPTION ORDRE DEC GR3_1
Signal CB failure transformer TR1	DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr1_1 till DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr1_2
Signal CB failure transformer TR2	DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr2_1 till DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr2_2
Signal CB failure transformer TR3	DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr3_1 till DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr3_2
Signal CB failure transformer TR4	DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr4_1 till DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr4_2
Signal CB failure transformer TR5	DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr5_1 till DYN_LDITFRPTRPD1_emission defaillance disjoncteur Tr5_2
Signal CB failure TR1 +	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 1 EN +_1
Signal CB failure TR1 -	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 1 EN -_1
Signal CB failure TR2 +	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 2 EN +_1
Signal CB failure TR2 -	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 2 EN -_1
Signal CB failure TR3 +	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 3 EN +_1
Signal CB failure TR3 -	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 3 EN -_1
Signal CB failure TR4 +	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 4 EN +_1
Signal CB failure TR4 -	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 4 EN -_1
Signal CB failure TR5 +	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 5 EN +_1

App Input	Purpose
Signal CB failure TR5 -	STAT_LDITFRPTRPD1_RECEPTION DEFAI DJ TR 5 EN -_1
Battery 127V earth fault	DYN_LDITFRPTRPD1_Terre Batterie 127V_1
Battery 48V earth fault	DYN_LDITFRPTRPD1_Terre Batterie 48V_1
Fire alarm RPD	STAT_LDITFRPTRPD1_ALARME INCENDIE RPD_1
Fire alarm	DYN_LDITFRPTRPD1_Alarme Incendie_1
CB position 127v	DYN_LDITFRPTRPD1_Position DJ 127V_1_Dbpos
CB position 48v	DYN_LDITFRPTRPD1_Position DJ 48V CC ou BAT1_1_Dbpos
CB position 48v TCM	DYN_LDITFRPTRPD1_Position DJ 48 TCM ou BAT2_1_Dbpos
CB filtered position	DYN_LDITFRPTRPD1_Position filtree du DJ_1_Dbpos
CB position TR1 open	STAT_LDITFRPTRPD1_ DJ HT TR1 OUVERT_1
CB position TR1 close	STAT_LDITFRPTRPD1_POSITION DJ HT TR1 FERME_1
CB position TR2 open	STAT_LDITFRPTRPD1_POSITION DJ HT TR2 OUVERT_1
CB position TR2 close	STAT_LDITFRPTRPD1_POSITION DJ HT TR2 FERME_1
CB position TR3 open	STAT_LDITFRPTRPD1_POSITION DJ HT TR3 OUVERT_1
CB position TR3 close	STAT_LDITFRPTRPD1_POSITION DJ HT TR3 FERME_1
CB position TR4 open	STAT_LDITFRPTRPD1_POSITION DJ HT TR4 OUVERT_1
CB position TR4 close	STAT_LDITFRPTRPD1_POSITION DJ HT TR4 FERME_1
CB position TR5 open	STAT_LDITFRPTRPD1_POSITION DJ HT TR5 OUVERT_1
CB position TR5 close	STAT_LDITFRPTRPD1_POSITION DJ HT TR5 FERME_1
Busbar filtered position SS112	DYN_LDITFRPTRPD1_Position filtree SS112_1_Dbpos
Busbar filtered position SS123 or 212	DYN_LDITFRPTRPD1_Position filtree SS123 ou 212_1_Dbpos
Busbar filtered position SS134	DYN_LDITFRPTRPD1_Position filtree SS134_1_Dbpos
Busbar filtered position SS145	DYN_LDITFRPTRPD1_Position filtree SS145_1_Dbpos
Busbar filtered position SS156	DYN_LDITFRPTRPD1_Position filtree SS156_1_Dbpos
Transformer filtered position SA1	DYN_LDITFRPTRPD1_Position filtree SA1_1_Dbpos
Transformer filtered position SA2	DYN_LDITFRPTRPD1_Position filtree SA2_1_Dbpos

App Input	Purpose
SR voltage failure	DYN_LDITFRPTRPD1_defaut polarite principale SR RPD _1
Main voltage failure	STAT_LDITFRPTRPD1_DEFAUT POLARITE PRINCIPALE RPD_1
AC voltage 1 failure	DYN_LDITFRPTRPD1_Manque alternatif source 1_1
AC voltage 2 failure	DYN_LDITFRPTRPD1_Manque alternatif source 2_1
Auxiliary AC voltage immediate failure	DYN_LDITFRPTRPD1_Manque alternatif instantane_1
Auxiliary AC voltage delayed failure	DYN_LDITFRPTRPD1_Manque alternatif temporise_1
Voltage 127v failure	DYN_LDITFRPTRPD1_U anormale 127V_1_HealthKind
Battery 1 or CC voltage failure	DYN_LDITFRPTRPD1_U anormale CC ou BAT1_1_HealthKind
Battery 2 or CC voltage failure	DYN_LDITFRPTRPD1_U anormale TCM ou BAT2_1_HealthKind
Converter BAT 127v failure	DYN_LDITFRPTRPD1_Defaut chargeur Bat 127_1_HealthKind
Converter BAT1 or CC failure	DYN_LDITFRPTRPD1_Defaut chargeur CC ou BAT1_1_HealthKind
Converter BAT2 or CC failure	DYN_LDITFRPTRPD1_Defaut chargeur TCM ou BAT2_1_HealthKind

4.16.6 LDITFG APP INPUTS AND PURPOSES

App Input	Purpose
Presence of staff(1) (TSO)	STAT_LDITFTG_PRESENCE 1_1
Presence of staff(2) (DSO)	STAT_LDITFTG_PRESENCE 2_1
Bell (Auxillary Voltage S)	DYN_LDITFTG_Sonnerie_1
Horn (Auxillary Voltage S)	DYN_LDITFTG_Klaxon_1
Bell (Auxillary Voltage TC)	DYN_LDITFTG_Sonnerie_1
Horn (Auxillary Voltage S)	DYN_LDITFTG_Klaxon_1
Additional Horn (Auxillary Voltage S)	DYN_LDITFTG_Klaxon supplementaire_1
Additional Horn (Auxillary Voltage TC)	DYN_LDITFTG_Klaxon supplementaire_1
Substation Failure or DSO Substation failure in backup Alarm mode	DYN_LDITFTG_Defaut Poste ou Defaut RPD en AS_1
Telecommunication Equipment Warning	STAT_LDITFTG_DEFAUT TCM NON URGENT_1
Telecommunication Equipment Alarm	STAT_LDITFTG_DEFAUT TCM URGENT_1
Substation Flooded	STAT_LDITFTG_POSTE INONDE_1
Call - Door	STAT_LDITFTG_APPEL PORTE_1
Call - Telephone TSO	STAT_LDITFTG_APPEL TELEPHONIQUE RPT_1
Door Open (Instantaneous)	STAT_LDITFTG_PORTE OUVERTE_1
Indication of "Presence of Staff or Local Substation or Feeder Mode Set"	DYN_LDITFTG_Lampe flash local ou presence_1
Duration of maintenance exceeds time limit	DYN_LDITFTG_Reinitialisation de la duree d intervention_1

App Input	Purpose
Restart intervention timer button	STAT_LDITFTG_BP REARMEMENT COUPATAN_1
Activation/Deactivation of intervention time function	STAT_LDITFTG_BP DUREE INTERVENTION_1
Maintenance Intervention timer is counting and active	DYN_LDITFTG_Duree d intervention en cours_1
Button - lighting of surrounding area	STAT_LDITFTG_BP ECLAIRAGE DEPUIS AIP TG_1
Substation Lighting	STAT_LDITFTG_POSTE ECLAIRE_1
Order to switch on light in substation	DYN_LDITFTG_Eclairage abords_1
Lighting Substation Area from CPPT	STAT_LDITFTG_BP COMMANDE ABORDS_1
Failure of Water extraction system	STAT_LDITFTG_DEFAUT ASSECHEUR_1
Technical Alarm Air conditioning	STAT_LDITFTG_ALARME CLIMATISATION_1
Technical Alarm Smoke Extraction	STAT_LDITFTG_ALARME DESENFUMAGE_1
Technical Alarm Reserved	STAT_LDITFTG_ALARME TECHNIQUE RESERVE_1
Fire Detection System Active	STAT_LDITFTG_PROTECTION INCENDIE HS_1
Signal Remote Alarm Mode to TA Interface	DYN_LDITFTG_RPT en TA_1
Button Danger Alarm	STAT_LDITFTG_BP ALARME DANGER_1
Signal Danger Alarm to TA Interface	DYN_LDITFTG_Alarme Danger en TA_1
Technical Alarm Ventilation	STAT_LDITFTG_ALARME VENTILATION_1
Technical Alarm Pump	STAT_LDITFTG_ALARME POMPE DE RELEVAGE_1
Technical Alarm Fire Detection System Failure	STAT_LDITFTG_ALARME TECHNIQUE INCENDIE_1
Fire Alarm on TSO	STAT_LDITFTG_ALARME INCENDIE RPT_1

4.16.7 LDSXY APP INPUTS AND PURPOSES

App Input	Purpose
Close order	DYN_LDSxy_Ordre fermeture sectionneur_1
Open order	DYN_LDSxy_Ordre ouverture sectionneur_1
Sxy unlocked	STAT_LDSxy_Sxy decondamne_1
Sxy locked	STAT_LDSxy_Sxy condamne_1
Sxy Close	STAT_LDSxy_Sxy FERME_1
Sxy Open	STAT_LDSxy_Sxy OUVERT_1

4.16.8 LDSUIED APP INPUTS AND PURPOSES

App Input	Purpose
LED X	STAT_LDSUIED_LPLE 1 led X_1
Cmd DO X Ouput Y Z	STAT_LDSUIED_LPDO X Sortie Y_Z

CHAPTER 5

SOFTWARE APPLICATION

5.1 SOFTWARE APPLICATION CHAPTER OVERVIEW

This chapter defines the way to configure, set and use the application for MU360 use.

This chapter contains the following sections:

5.2 SOFTWARE MANAGEMENT

This topic is addressed to guide how user should operate important actions on MU360 IED keeping traceability from previous actions before updating either new configuration or new firmware. Therefore, based on Chapter 4, MU360 Management (Refer to MU360 Management), main goal, in fact, is to put user aware about problems would happen, as the following ones:

1. Previous Ethernet IP lost
2. Previous configuration lost
3. Previous trace of versions lost
4. Last user/password lost

5.2.1 DEFAULT FACTORY ENVIRONMENT

GE Vernova will deploy first environment from its Industrialization procedure, with the following Ethernet IPs:

- Administration Port (Admin Port) : **192.168.1.199, 255.255.255.0**
- User: **Admin**
- Password: **Admin**

5.2.2 RECOVERING DEFAULT ENVIRONMENT

For troubles and problems described in the introduction of this chapter which is not possible anymore to login or access to MU360 IED, user can try to reestablish default environment. Doing that is possible connecting USB cable between the MU360 frontal port and user´s laptop, as depicted below:

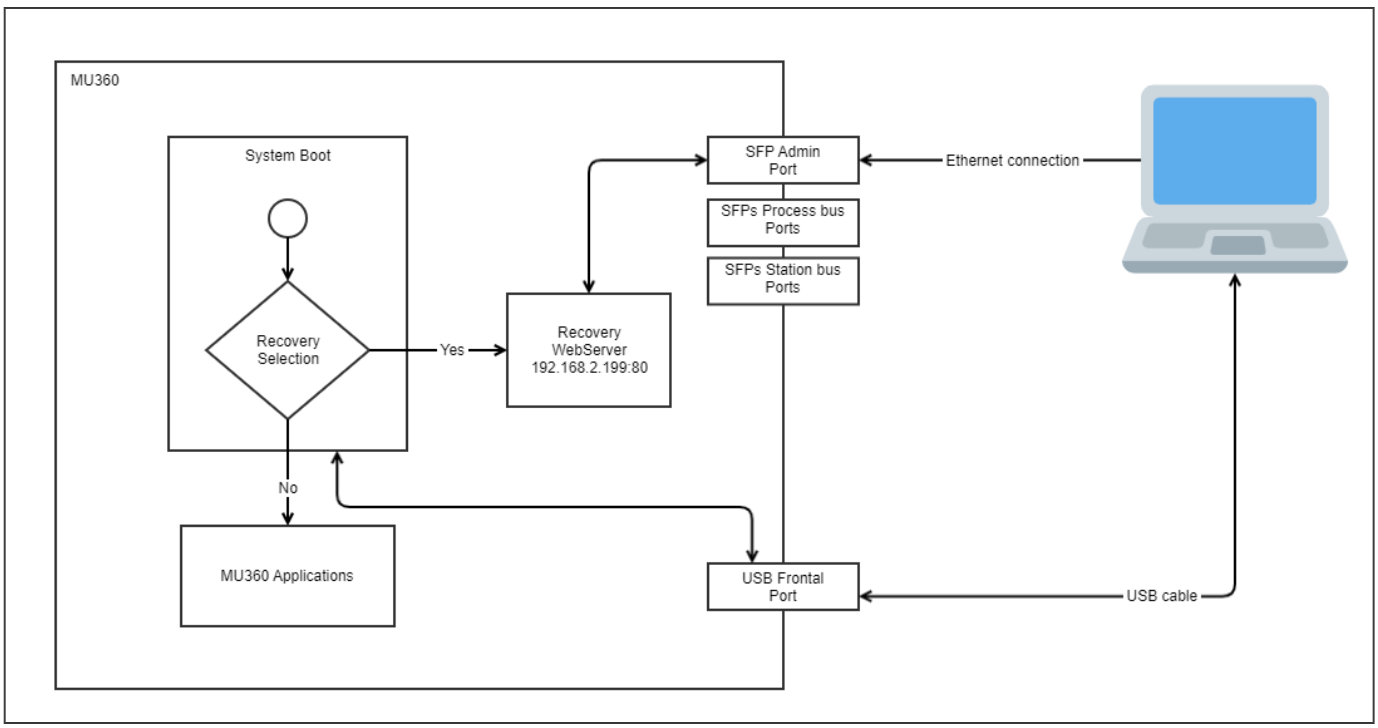


Figure 119: MU360 recovery diagram

Note:
MU360 Applications mean either "Default Factory Environment" or any application previously deployed.

Note:
Depending on kind of troubles, perhaps those associated to flash where MU360 are hosted, GE Vernova technical team should be demanded by user for a better investigation.

Then, Follow below sequence of actions:

1. Turn off MU360 IED.
2. Open a Tool able to map laptop´s USB port as serial port (115200, 8, N1), Examples: TeraTerm, Putty, etc.
3. Turn on MU360 IED.
4. Notice menu, select “Recovery”.
5. A basic Operating System will start with an unique Web Server able to deploy associated GE Vernova MU360 .swu installer file (https://www.gevernova.com/gridsolutions/multilin/catalog/mu360.htm).
6. Make sure Ethernet Connections are in place between laptop and MU360 IED .
7. By any web client from laptop, access MU360 Web Server by 192.168.2.199:80.
8. Get the correct .swu file from GE Vernova site (https://www.gevernova.com/gridsolutions/multilin/catalog/mu360.htm) associated to MU360 IED (at least the one compatible to IED).
9. Deploy it by WebServer from MU360 Recovery as depicted in Figure below.
10. Once the upload process is finished, the equipment will be automatically rebooted.
11. Wait till having LED in service turned on, in general time window is smaller than 30min, first boot. Once in service state Default Factory Environment section can be accessed again.

Figure 120: Software update

5.2.3 FIRMWARE UPDATE OR CONFIGURATION UPDATE

This section intends to guide user about correct way for any kind of update MU360 would face, avoiding information to be lost.

When accessing Default Factory Environment, is not needed to save any information since all info is hard coded as follows:

1. User\Password: Admin\Admin
2. Ethernet Admin Port IP\Mask: 192.168.1.199, 255.255.255.0

When a new configuration is needed to be deployed, then do:

- Make sure Ethernet Admin IP is well configured by ICT.

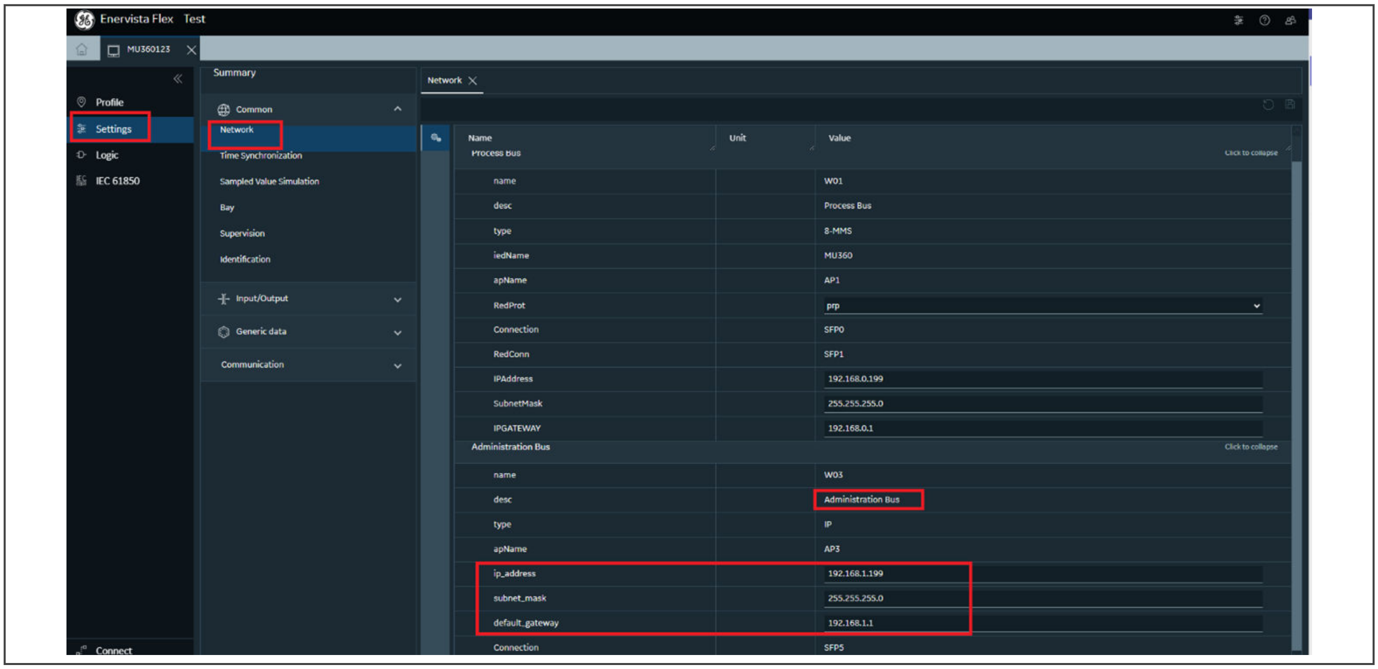


Figure 121: EnerVista Flex v2 settings page where admin port Ethernet IP is hosted

- Save Ethernet Admin IP for posterior use in future.

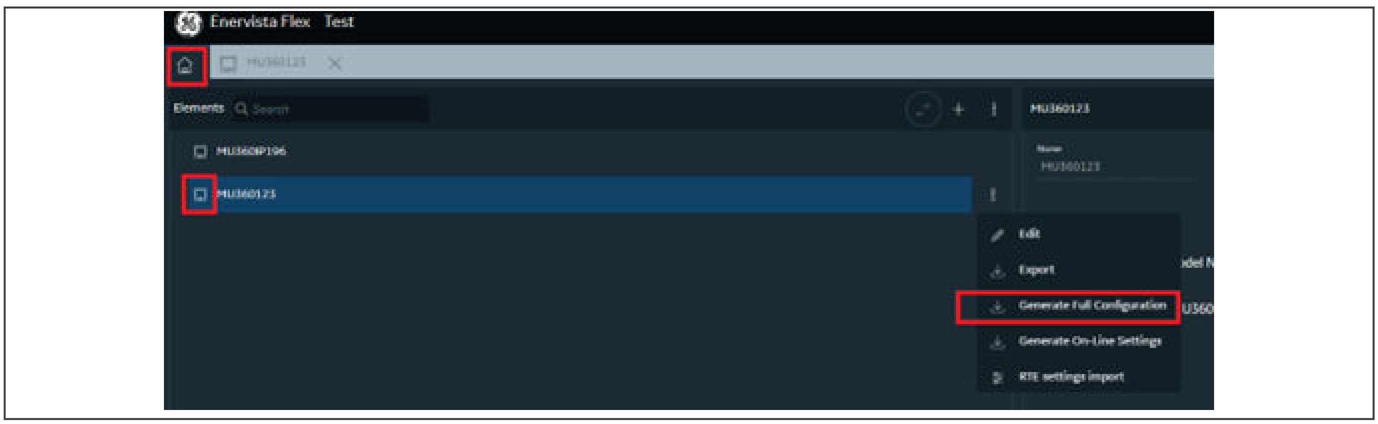


Figure 122: Saving complete configuration

- Ensure new configuration was well saved before any action.

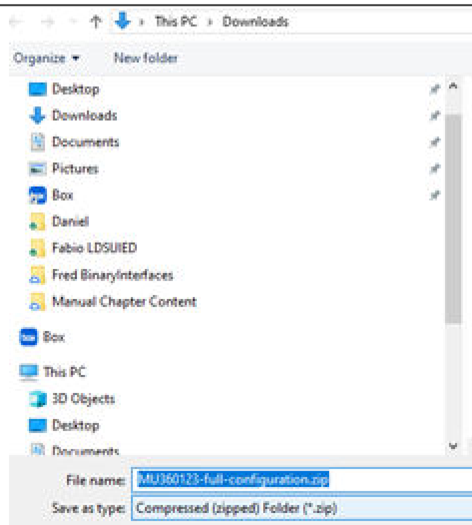


Figure 123: Example of set of complete files been created inside a .zip file

- Check if new configuration is IP Ethernet aligned to previous configuration already deployed (if previous one is different from Default Factory Environment), keeping same Admin Ethernet IP in fact.
- Save all important information for this new configuration as: ICT Tool version, FW update package, MU360 set of configuration files, Admin user and its password.

Figure 124: Saving specific settings

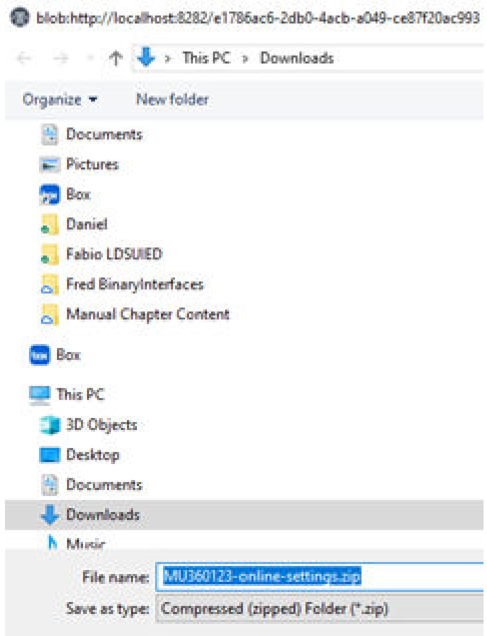


Figure 125: Example of set of specif settings created inside a .zip file

- Deploy new firmware update (if needed), already described in Chapter MU360 Management (Refer to MU360 Management).
- Deploy new config update, as described in Chapter MU360 Management (Refer to MU360 Management).

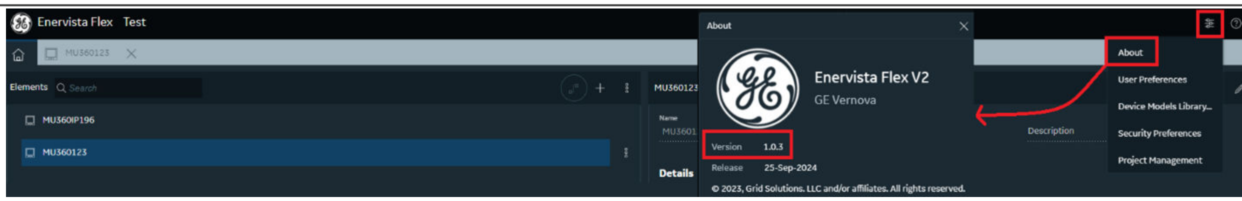


Figure 126: EnerVista Flex v2 version

Note:
For saving User Admin and its password, do it always when creating\editing one after first time.

5.2.4 RECOVERING OLD PROJECT

This section only makes sense when all artifacts were saved regarding section “1.3 Proceeding according to good directions for a new deployment (Firmware update or Configuration Update)”. For a good recovery, do:

- Use EnerVista Flex v2 Tool to create configuration user wants to deploy.
- Import a previous complete configuration done by associated ICT Tool from item 1.

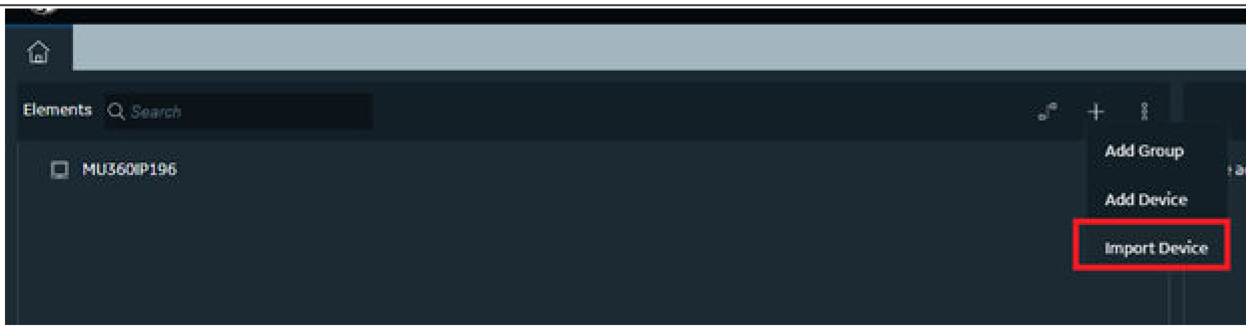


Figure 127: Importing old project

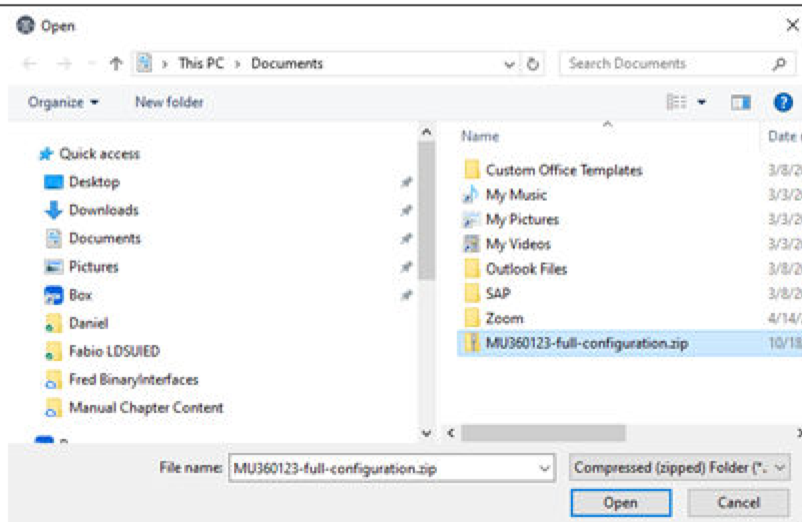


Figure 128: Selecting previous set of files (.zip)

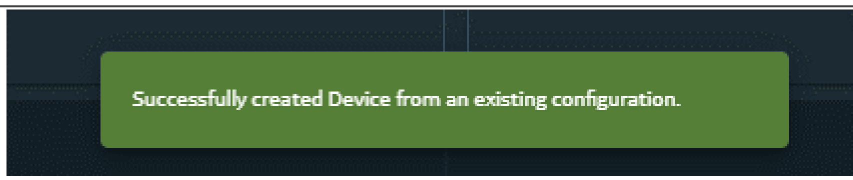


Figure 129: Final feedback associated with a successful operation

- Do all changes needed.
- Take care about all needed actions already described in Firmware update or Configuration Update.

CHAPTER 6

HARDWARE

6.1 CHAPTER OVERVIEW

This chapter provides information about the MU360 hardware design.

This chapter contains the following sections:

6.2 HARDWARE DESIGN OVERVIEW

The MU360 is based on a modular and scalable architecture to support dedicated hardware modules adapted to the plant data interfaces.

Each MU360 rack is equipped with the following modules:

- CPUMZ5: **C**entral **P**rocessing **U**nit and communications board
- **Front panel:**
  - GHU311 (for 80TE case) or GHU310 (for 40TE case): **G**raphical **H**uman machine interface **U**nit: Front Panel including 17 LEDs (12 are user configurable).
- **Power supply:**
  - BIU261: **B**asic **I**nterface **U**nit with universal input power supply: It also includes a watchdog relay.
- **Internal bus:**

One of the following options:

Bus Board for 80TE case for options with up to 1 CT/VT board

Bus Board for 80TE case for options with 2 CT/VT boards

Bus Board for 40TE case

Depending on the needs, additional modules may be added (optional):

- DIU211: Digital Inputs Unit, each with 16 digital inputs for voltages from 24 to 220VDC (versions are jumper-selected)
- DOU201: Digital Outputs Unit, each with 10 digital outputs
- HBU210: High Break Unit, each with 6 heavy duty digital outputs
- TMU320: Transducerless Measurements Unit, each with a 4 CT and 5 VT inputs for direct CT/VT measurement
- TMU310: Transducerless Measurements Unit, each with 4 CT and 4 VT inputs for direct CT/VT measurement

Caution:
50% of digital inputs and 50% of digital outputs may be energized simultaneously at the continuous ambient temperature (-25°C; +70°C).

Caution:
50% of digital inputs and 50% of digital outputs may be energized simultaneously at the temporary permissible (96 hours maximum) ambient temperature (-25°C; +70°C).

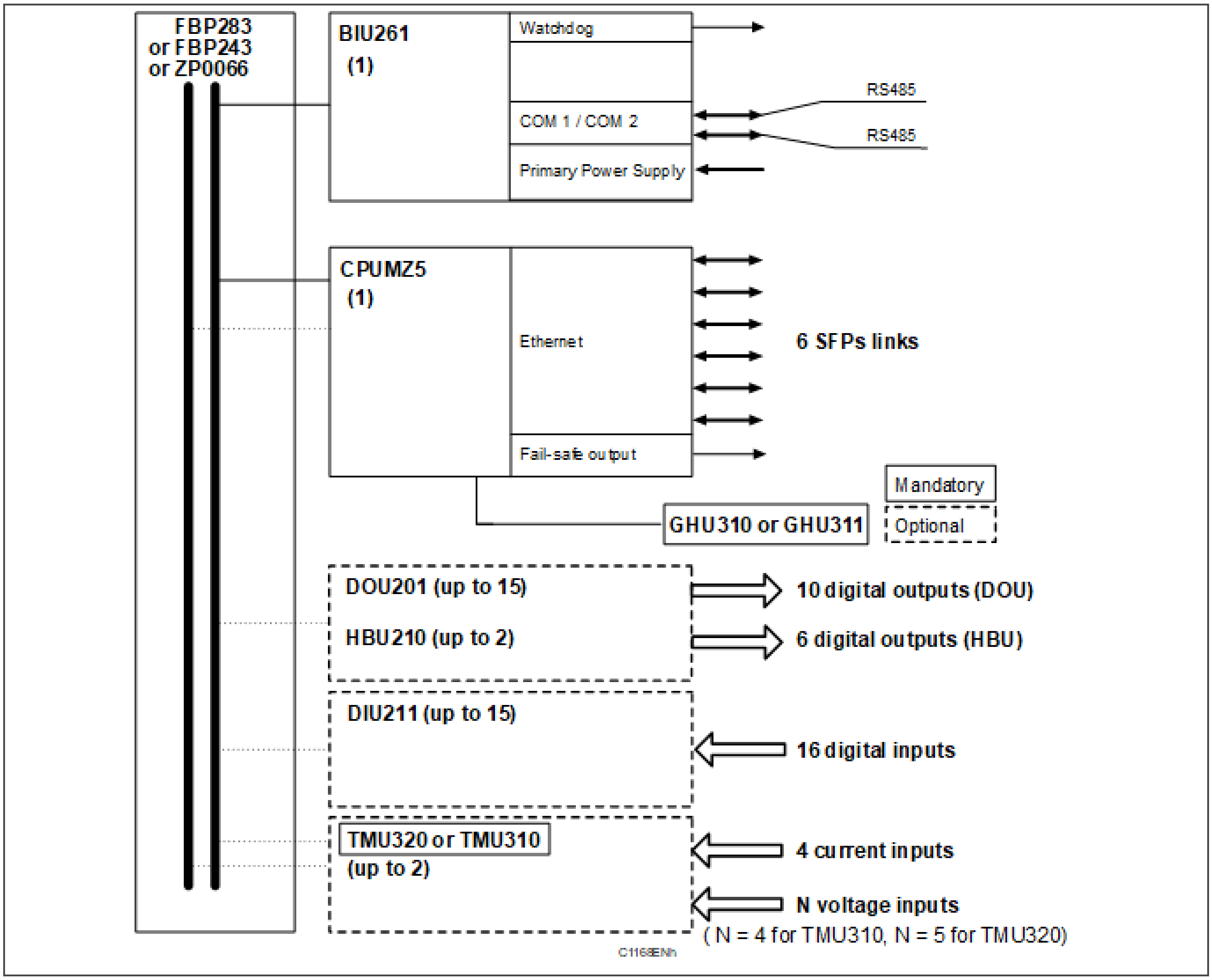


Figure 130: Hardware overview

6.3 MECHANICAL IMPLEMENTATION

The MU360 range of products are implemented in one of two case sizes.

Case dimensions for industrial products usually follow modular measurement units based on rack sizes.

These are: U for height and TE for width, where:

- 1U = 1.75 inches = 44.45 mm
- 1TE = 0.2 inches = 5.08 mm

All MU360 products are nominally 4U high. This equates to 177.8 mm or 7 inches.

The case width depends on the product type and its hardware options.

Two case widths are available:

- Compact case, 40TE-wide
- Standard case, 80TE-wide

6.3.1 COMPACT 40TE CASE

Overview

The dimensions of this rack are indicated in the figure below (in mm):

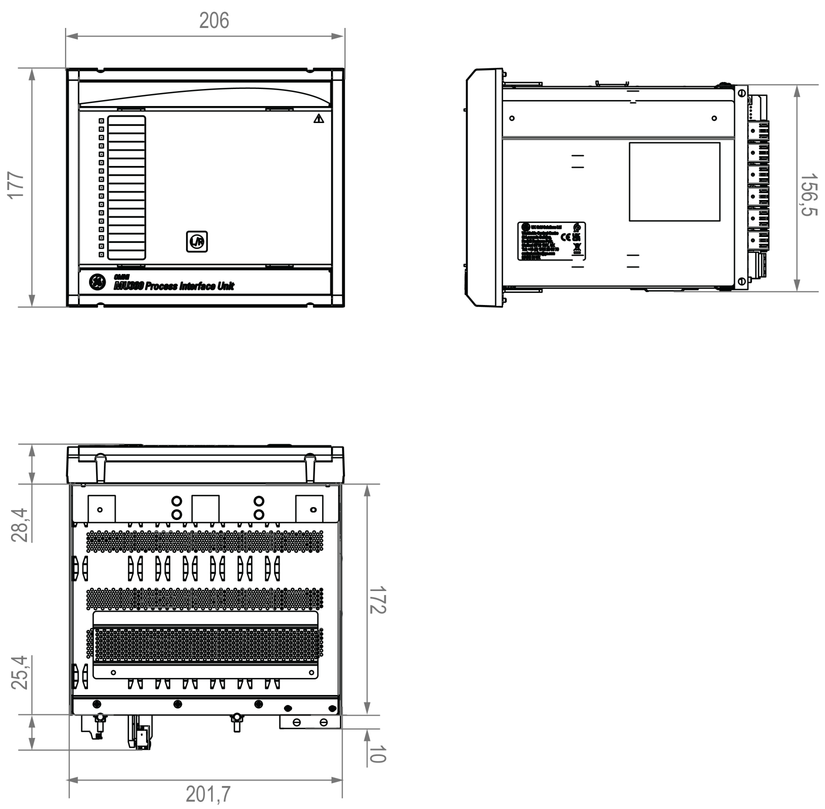


Figure 131: Compact 40TE case - rack size

Case Properties

- Degree of protection:
    - Case: IP2x as standard

Note:
IP2x for devices with TMU can be obtained by installing the Terminal Block Protection Shield accessories with order codes: GJ6079001 and GJ6078001.

- Front panel: IP40 for front panels with LEDs
- Rear panel: IP2x without TMU3xx board, IP1x with TMU3xx board

- Metallic case
- Mounting holes position for compact 40TE case:

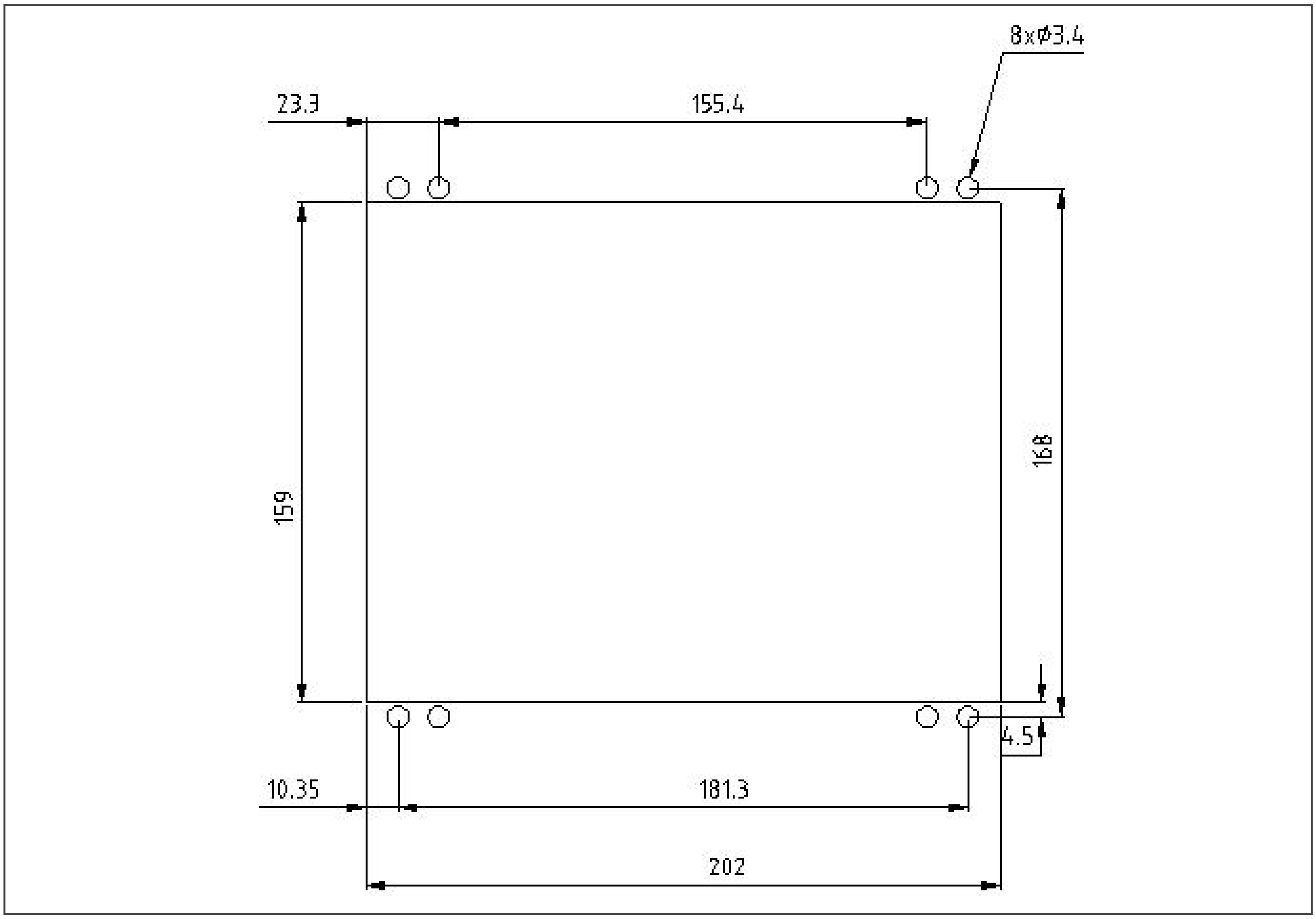


Figure 132: Compact 40TE case - mounting holes position

Front Panel - GHU310The GHU310 is the front panel with LEDs used for the 40TE case:

- 17 LEDs (12 are user-configurable)
- 1 pushbutton (L/R)
- USB link under the lower flap for maintenance operations

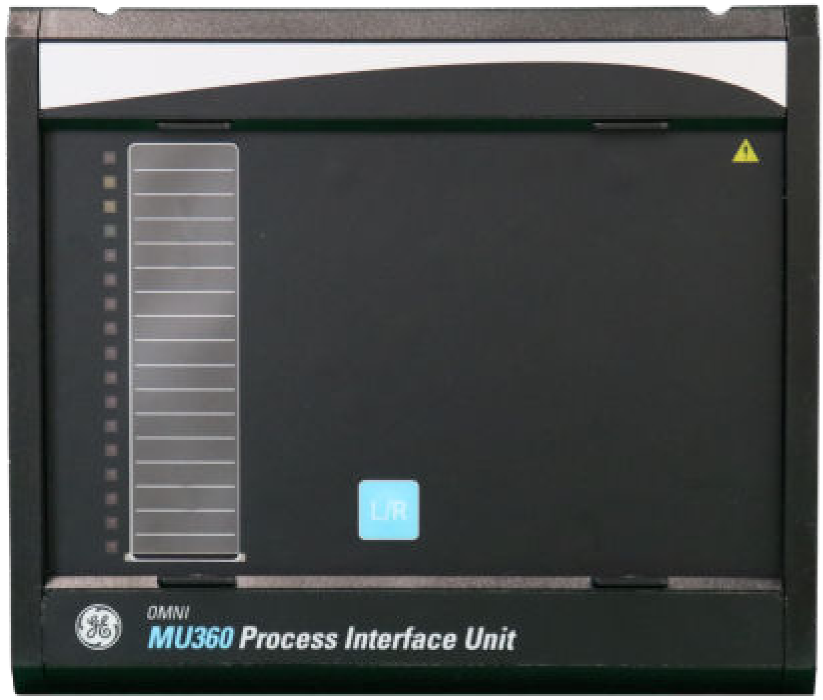


Figure 133: Compact 40TE case - GHU310 HMI

Rear Panels

With CT/VT board

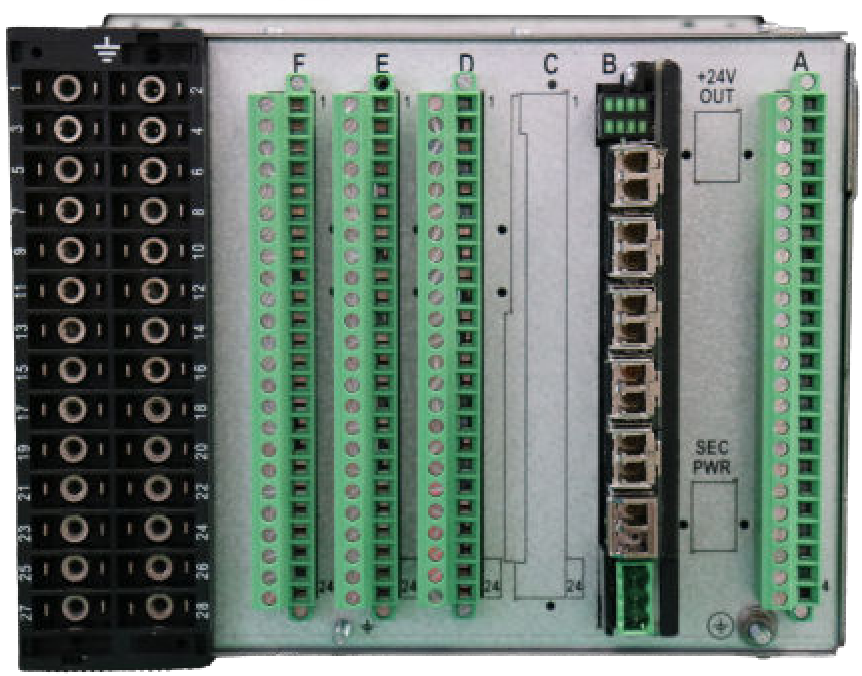


Figure 134: Compact 40TE case - rear panel with CT/VT connector (on TMU3xx)

Without CT/VT board

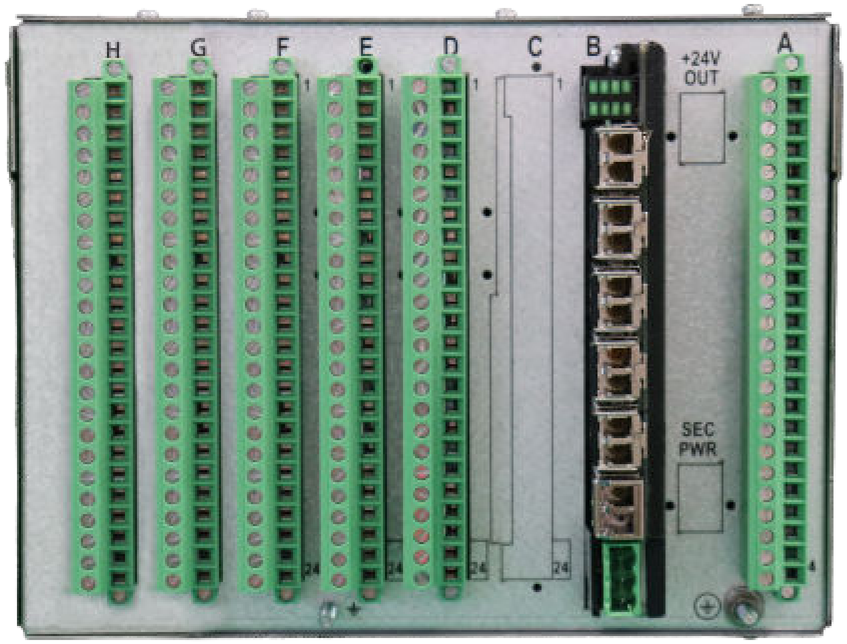


Figure 135: Compact 40TE case - rear panel without CT/VT

6.3.2 STANDARD 80TE CASE

Overview

The dimensions of this rack are indicated in the following figure (in mm):

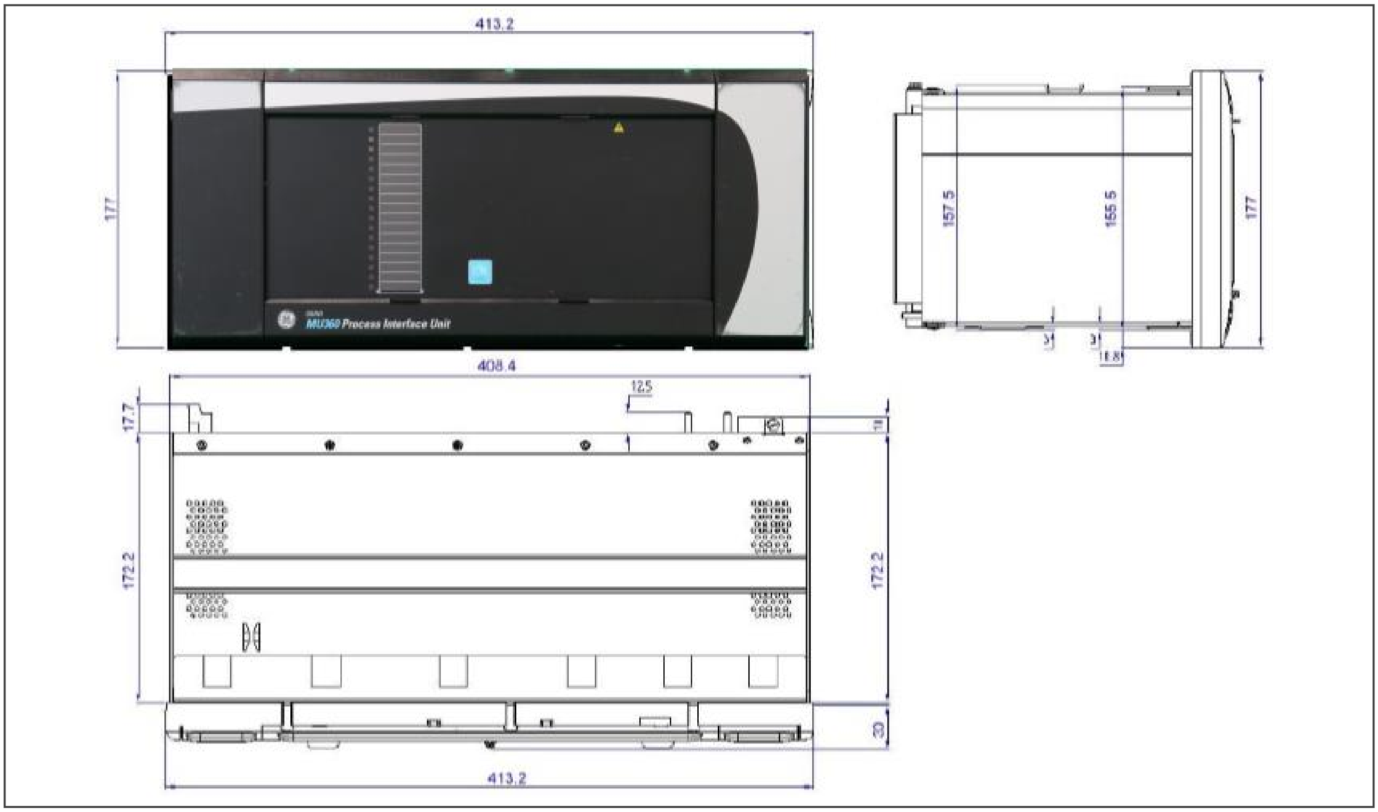


Figure 136: Front panel overview

Case Properties

- Degree of protection:
  - Case: IP2x as standard

> *Note:*
> *IP2x for devices with TMU can be obtained by installing the Terminal Block Protection Shield accessories with order codes: GJ6079001 and GJ6078001.*

  - Front panel: IP40 for front panels with LEDs
  - Rear panel: IP2x without TMU3xx board, IP1x with TMU3xx board
- Metallic case
- Mounting holes position for the standard 80TE case:

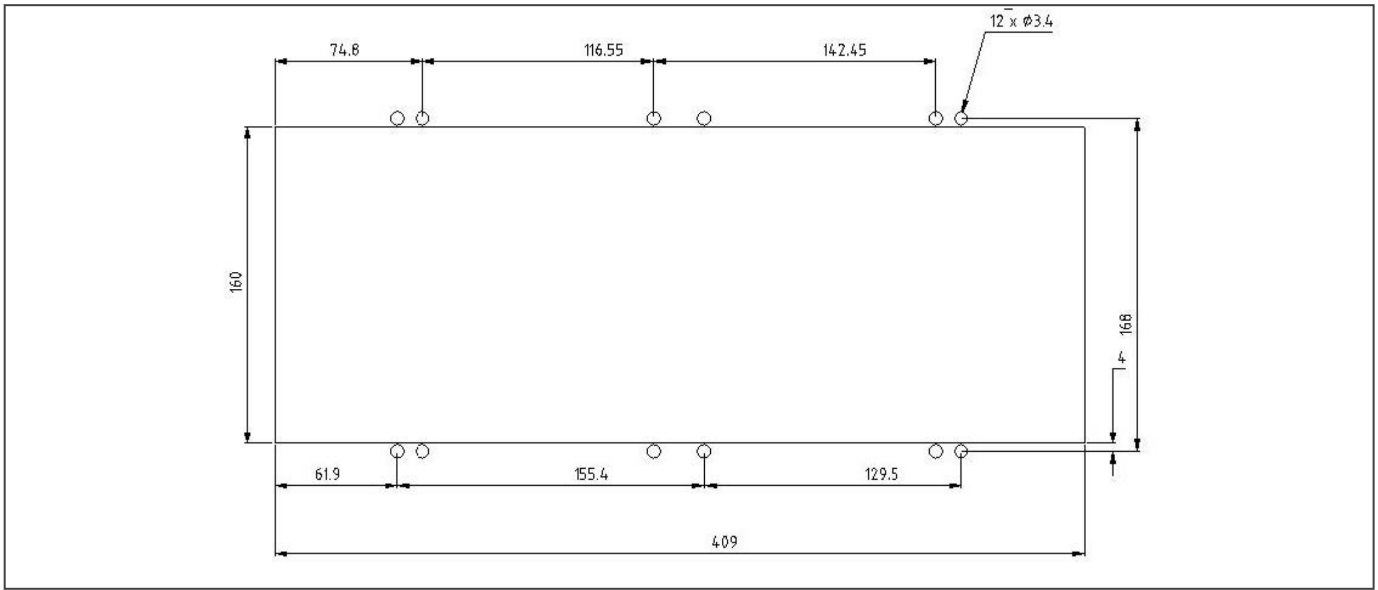


Figure 137: Standard 80TE case - mounting holes position

Front Panel - GHU311

The GHU311 is the front panel with LEDs used for the standard 80TE case:

- 17 LEDs (12 are user-configurable)
- 1 pushbutton (L/R)
- USB link under the lower flap for maintenance operations

Rear Panels

With one CT/VT board

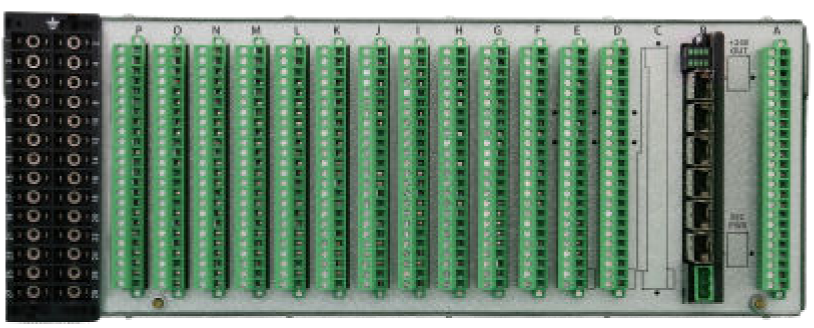


Figure 138: Standard 80TE case - rear panel with a CT/VT (TMU3xx)

With two CT/VT boards

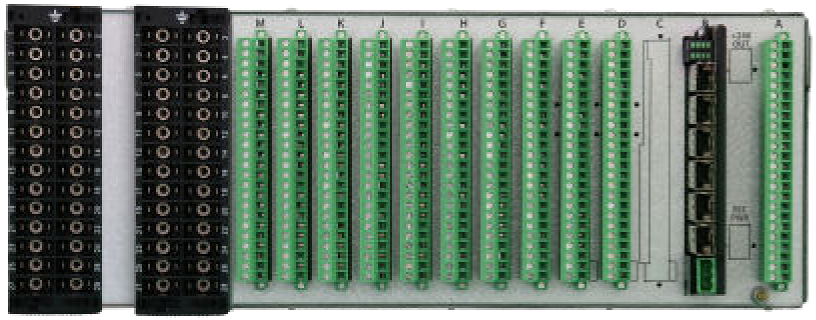


Figure 139: Standard 80TE case - rear panel with two CT/VT (TMU3xx)

Without CT/VT board

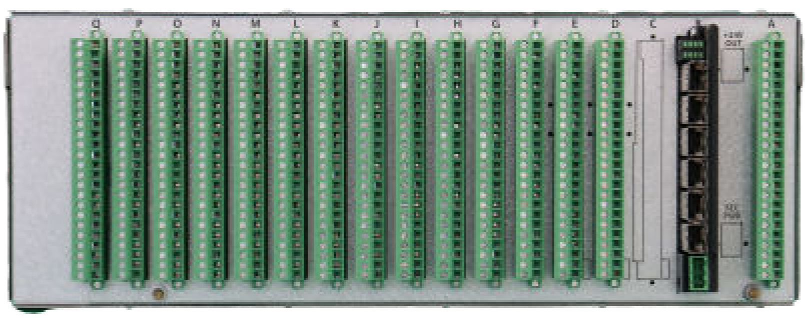


Figure 140: Standard 80TE case - rear panel without CT/VT (TMU3xx)

6.3.3 BONDING

In addition to its upper and lower sides, each board is grounded through a bracket (colored red in the figure below). A conductive screw is used to link that bracket to the case via a fixed lug:

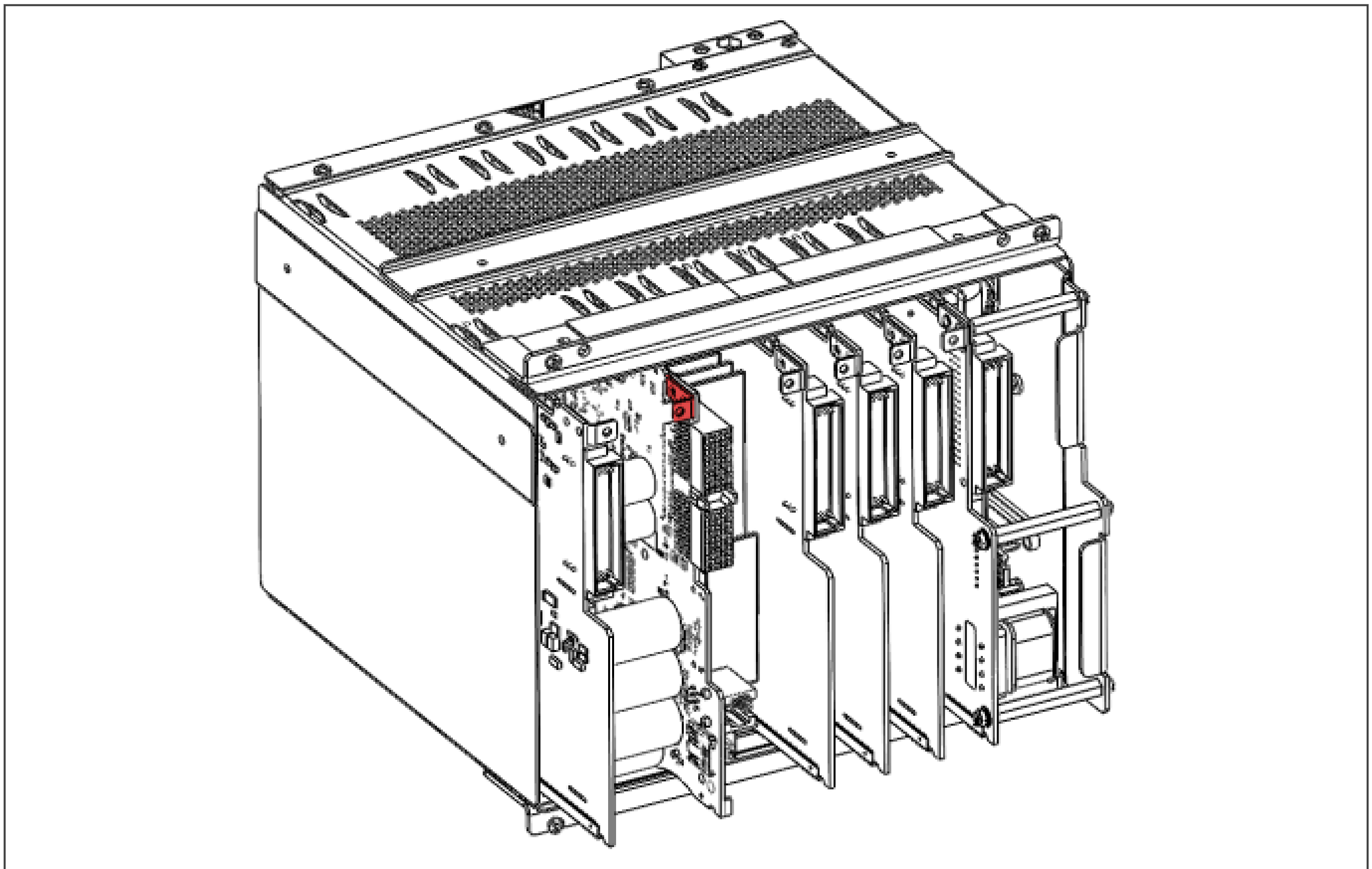


Figure 141: Bracket used for bonding

6.3.4 BOARD ADDRESS

The following rule is applicable to all I/O boards (DIU211, DOU201, HBU210) controlled by the CPU board:

Address by slot													
D	E	F	G	H	I	J	K	L	M	N	O	P	Q
0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110

Binary coding from 1 to 14 based on 4 jumpers top down:

Jumper

- missing => 1
- present => 0

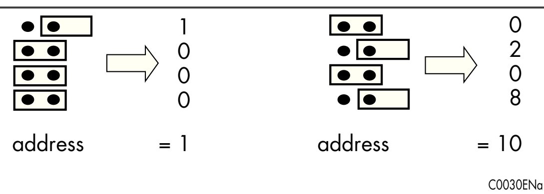


Figure 142: Jumper address

> *Note:*
> *Two boards of the same type must not have the same address.*

6.3.5 BOARD LOCATIONS

TMU310/TMU320

Whenever a single CT/VT TMU3xx board is present (either TMU310 or TMU320), it is always located at the far left of the rack, from the rear (at the far right from the front):

- 40TE rack: Slots G (one TMU3xx board)
- 80TE rack: Slots Q (one TMU3xx board)

Whenever two CT/VT TMU3x0 boards are used, the boards are located at the far left of the rack, from the rear (at the far right from the front), in their specific rack:

- 80TE rack: Slots Q-N (two TMU3x0 boards)

BIU261S

The power supply BIU261S board or module is always present and located at the far right of the rack, from the rear (at the far left, from the front):

- 40TE & 80TE: Slot A

CPUMZ5

The CPUMZ5 main processor board or module is always present and located next to the BIU261S board:

- 40TE & 80TE: Slot B

I/O Boards

The location of I/O boards varies depending on which boards are present and how many there are of each. The maximum number of I/O boards depends on the rack size (40TE: 5 slots, or 80TE: 14 slots) and on the presence of other boards such as TMU3x0.

> *Note:*
> *In the 40TE and 80TE rack, the TMU3xx board takes up 2 slots.*

The boards are selected as part of equipment CORTEC. They will be installed as requested (following a valid configuration). The HBU210 board is limited to a maximum of two per equipment

6.4 BOARD DESCRIPTION

6.4.1 UNIVERSAL SINGLE POWER SUPPLY - BIU261

The BIU261S module houses:

- The primary universal auxiliary power supply converter
- The watchdog relay (closed if the product is healthy)
- 2 isolated interfaces (both ports are RS485).

The power supply board is protected against polarity reversal.

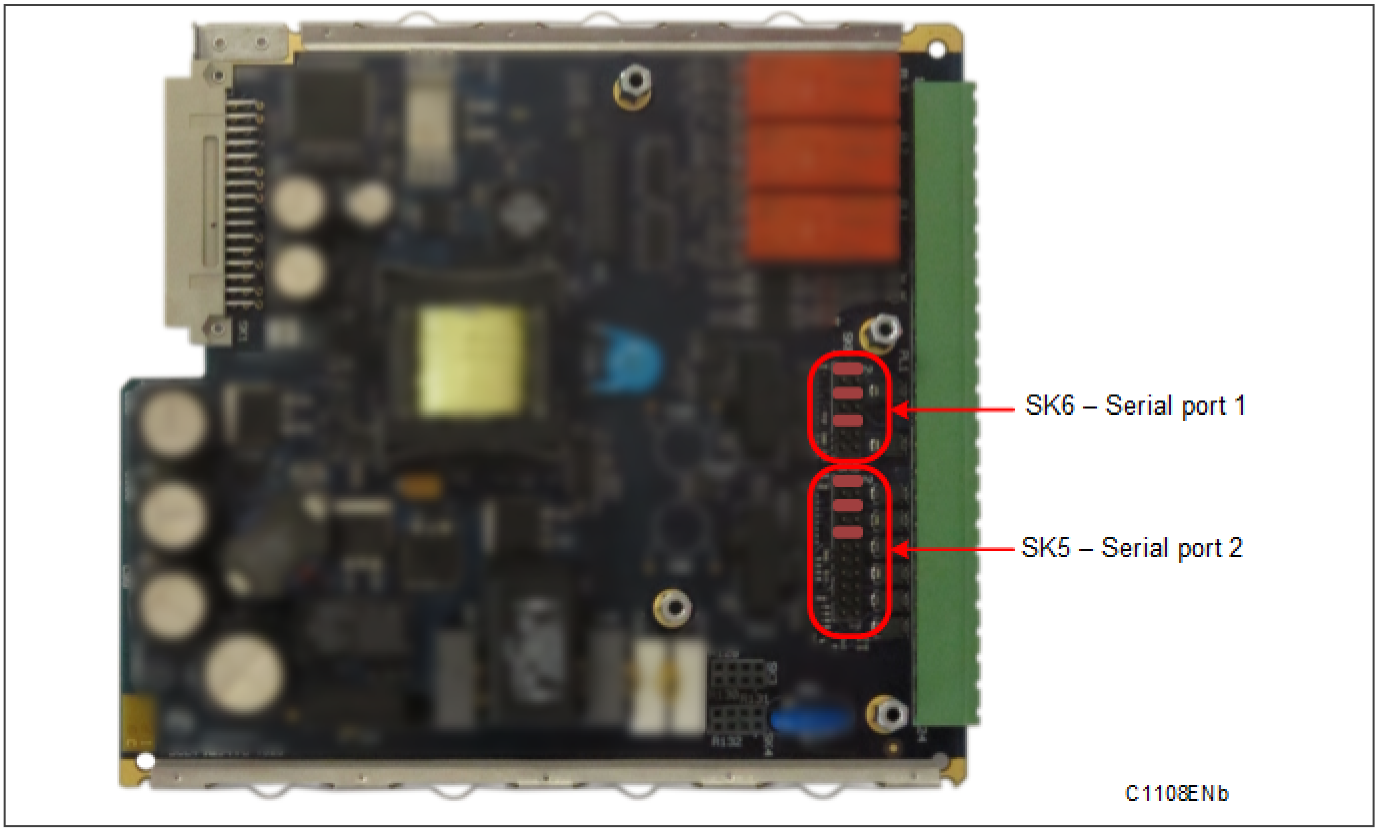


Figure 143: BIU261 without daughter board - serial port jumpers visible

I/O and Communication Ports

Configurations Port 1 - RS485

The communication link characteristics are:

- Full duplex serial protocol
- Transmission rate: 50 bps to 38400 bps (configurable in DS Agile SCE or settable on the front panel HMI)

Configuration

The hardware jumper arrangement is as follows (jumper block SK6):

- For RS485, set the jumpers 3-4, 7-8 and 11-12. It is possible to end the line with a 120 Ω resistor by setting 13-14. (See Universal Single Source Power Supply_BIU261S for information on when the resistor is required)

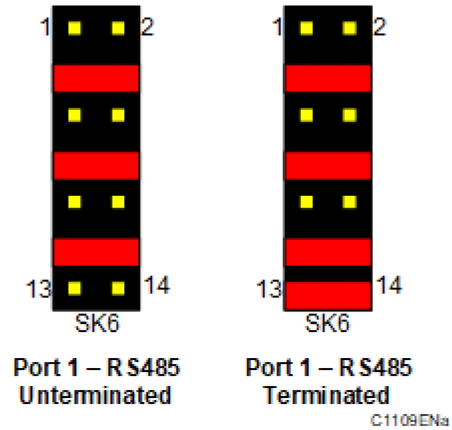


Figure 144: BIU261 - port 1 jumper settings

Configurations Port 2 - RS485

The communication link characteristics are:

- Full duplex serial protocol
- Transmission rate: 50 bps to 38400 bps (configurable in DS Agile SCE or settable on the front panel HMI)

Configuration

The hardware jumper arrangement is as follows (jumper block SK5):

- For RS485, set the jumpers 3-4, 7-8 and 11-12. It is possible to terminate the line with a 120 Ω resistor by setting 13-14. (See Universal Single Source Power Supply_BIU261S for information on when the resistor is required)

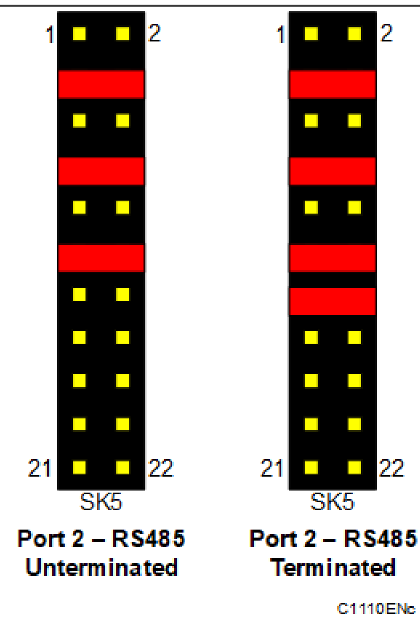


Figure 145: BIU261 - port 2 jumper settings

6.4.2 CENTRAL PROCESSING UNIT AND COMMUNICATION - CPUMZ5

The CPUMZ5 handles all the calculations for the unit. It is also the main communication board. It can manage standard and redundant (PRP/HSR) links and acquire digital process signals and sampled values received from the process bus.

It features on the rear, from top to bottom:

- 6 status LEDs
- 6 SFP cages
- A 3-pin connector (fail safe)

External Communications

Depending on the configuration, the 6 SFP cages at the rear of the MU360 case can contain:

- RJ45 plug for 10/100/1000BASE-Tx Ethernet port. The ports are half/full duplex and auto-sense the transmission speed. They auto-negotiate with the connected device to determine the optimal transmission speed: 10 Mbps, 100 Mbps or 1000 Mbps depending on the connected devices' capability.
- LC optical plugs for:
  - 100BASE-Sx port: 100 Mbps, single mode over 2 km
  - 1000BASE-Lx port: 1000 Mbps, single mode over 20 km

Internal Communications

The CPUMZ5 board is interfaced with:

- All the I/O boards and the BIU261 board through the standard bus
- The front panel HMI is connected through a cable using the RJ11 connector

Computing Characteristics

The CPUMZ5 board has 2 processors:

- The central "FPGA" processor, which manages most operations
- The network redundancy "FPGA" processor

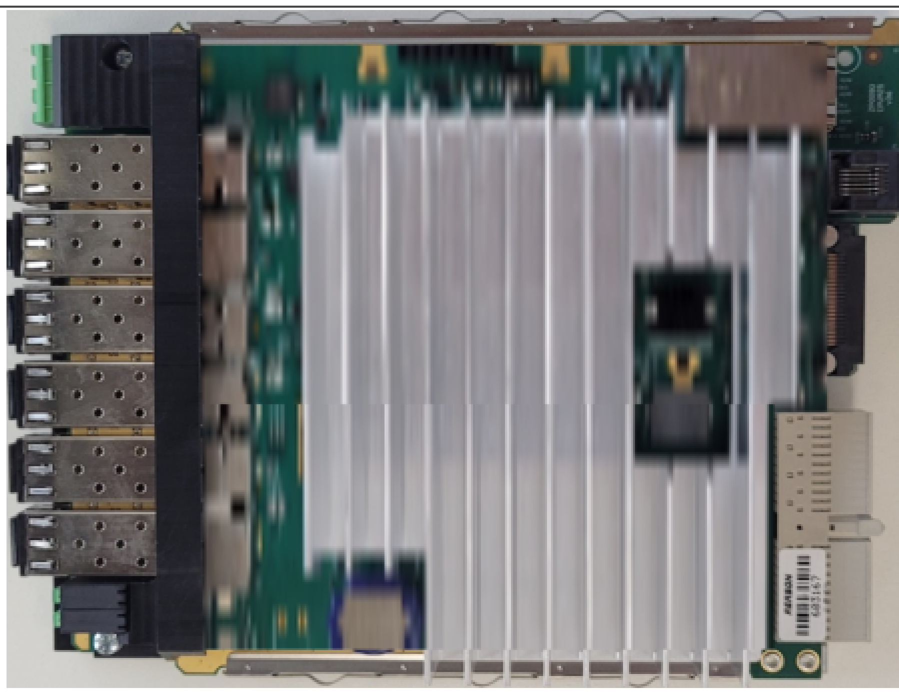


Figure 146: CPU4 board

LEDs

Eight LEDs are provided as shown in the diagram below, with their meaning indicated in the table that follows it. They are situated at the rear of the board.

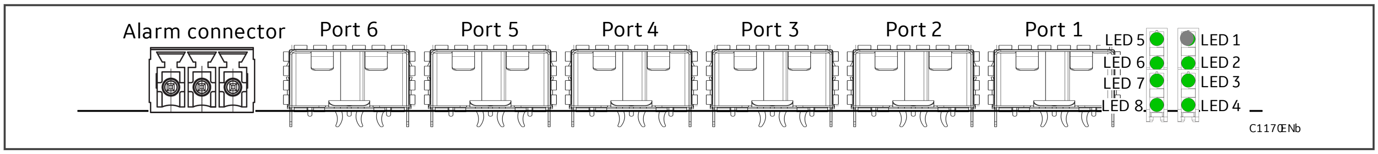


Figure 147: CPUMZ5 LED positions

LED	Function	
0	Conf done	
1	PS done	
2	SFP1 link/activity	LED on or blinking: communicating LED off: no communication
3	SFP2 link/activity	
4	SFP3 link/activity	
5	SFP4 link/activity	
6	SFP5 link/activity	
7	SFP6 link/activity	

Ethernet Optical Fibre

The cables are connected to the corresponding elements. The optical fibre connectors are LC-type small form-factor pluggable (SFP) transceivers that can use both single and multi-mode fibre.

Digital Process Signals

The CPUMZ5 board can send and receive, over an Ethernet network, digital signals to and from switchgear control units, such as Grid Solutions' DS Agile C264 SCU, UR relay oe MiCOM Relay located near the circuit breaker. The signals are transmitted in both directions using IEC 61850-8-1 GOOSE frames.

Sampled Values

The CPUMZ5 board can publish sampled value.

6.4.3 DIGITAL INPUTS UNIT - DIU211

The capabilities of the DIU211 boards are:

- 16 optically isolated digital inputs
- 1 common contact for 2 inputs (positive or negative)
- The digital inputs can be used for single or double status, pulse, or digital measurement input on the same unit.
- All voltages between 24 V_{DC} and 220 V_{DC}
- Pre-defined triggering thresholds selected using jumpers:

Variants

Variant	Input Voltage
A01	24 V_{DC}
A02	48 V_{DC} - 60 V_{DC}
A03	110 V_{DC} - 125 V_{DC}
A04	220 V_{DC}
A07	110 V_{DC} - 125 V_{DC} with 80% threshold

Variant	Input Voltage
A08	220 V_{DC} with 80% threshold

From 24 V_{DC} to 220 V_{DC}: a peak current (>27 mA) circulates during a short time (approximately 2 ms) to clean external relays' contacts:

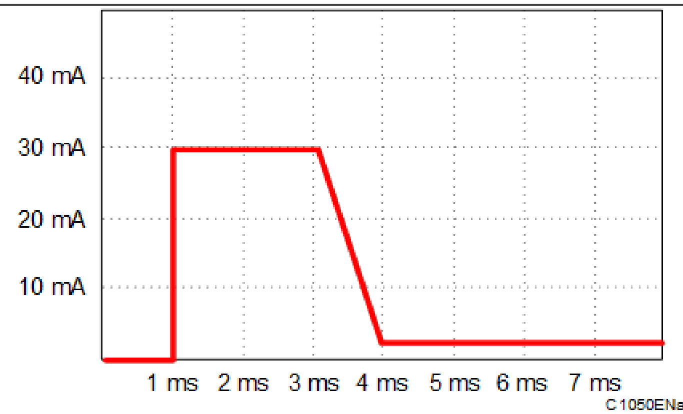


Figure 148: Peak current response curve

6.4.4 DIGITAL OUTPUTS UNIT - DOU201

The Digital Outputs Unit (DOU201) board provides 10 isolated digital outputs using integrated relays.

The DOU201 board capabilities are:

- 8 single pole relays with one normally open (NO) contact
- 2 double pole relays with 1 common for 2 output contacts (NO/NC changeover)
- Nominal operating voltage range of 24 V_{DC} to 250 V_{DC}/230 V_{AC}

The DOU201 has 8 single pole contacts that are normally open and 2 double pole contacts in which one pole contact is normally open and one pole contact is normally close.

The address of the board can be defined by the location of the DOU201 in the MU360 rack.

Figure 149: DOU201 board

6.4.5 HIGH BREAK UNIT - HBU210

The High Break Unit (HBU210) board provides 6 normally open single pole output channels. These can be configured to operate in pairs to give dual pole operation or parallel operation for enhanced current carrying capability.

The HBU210 board capabilities are:

- 6 single pole relays with one normally open (NO) contact
- Nominal operating voltage range of 24 V_{DC} to 300 V_{DC}
- Fault monitoring functions such as "channel relay coil monitor" and "contact monitor".

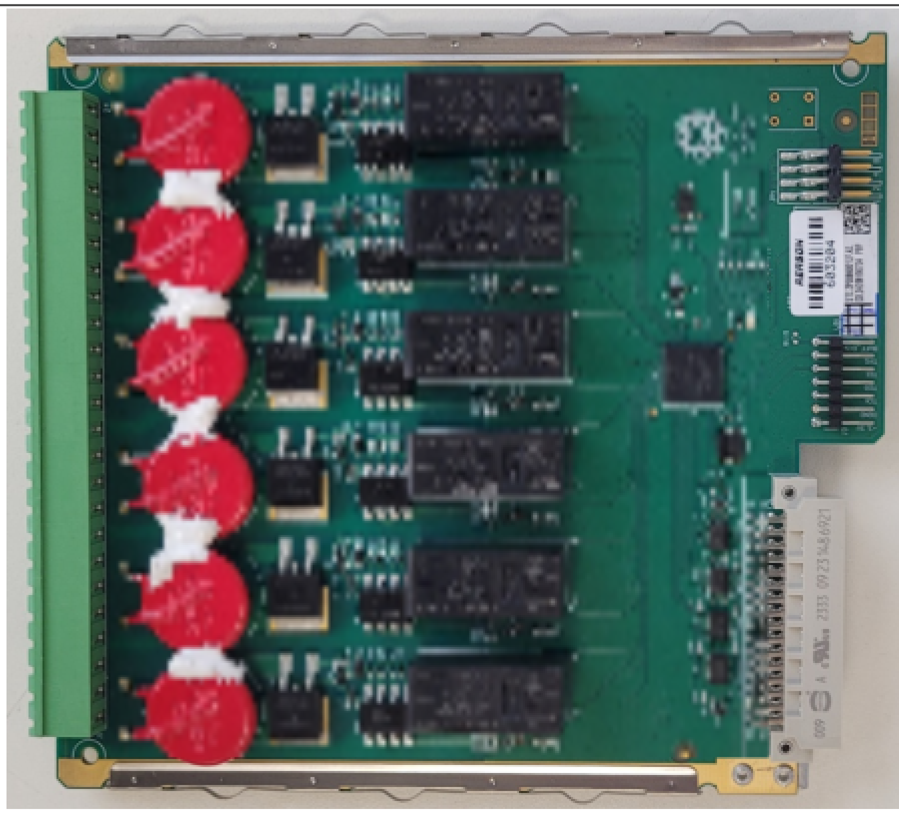


Figure 150: HBU210 board

6.4.6 CT/VT PROTECTION UNIT - TMU310

The TMU310 board is a Protection Current and Voltage acquisition board (CT/VT) module used in the DS Agile C26x device.

Figure 151: TMU310 board

The transducerless measurement capabilities are the following:

- 4 measurement Current Transformers (4 CT) inputs. Each transformer has tworated circuits 1A and 5A.
- 4 measurments Voltage Transformers (4 VT) inputs rated at $100V_{RMS}$.
- Frequency operating range: 50 or 60 Hz ± 10%.

6.4.7 SCT/VT MEASUREMENT UNIT - TMU320

The transducerless measurement capabilities are the following:

- 4 measurement Current Transformers (4 CT) inputs. Each transformer has two rated circuits 1A and 5A.
- 4 measurement Voltage Transformers (4 VT) inputs rated at $100V_{RMS}$.
- Frequency operating range: 50 or 60 Hz ± 10%.

1 use cases are available:

- A01 (default variant):
  - 4 voltage channels (100V)
  - 4 current channels (1A or 5A)

Figure 152: TMU320 board

1 use cases are available:

- A01 (default variant):
  - 4 voltage channels (100V)
  - 4 current channels (1A or 5A)

CHAPTER 7

COMMUNICATIONS

7.1 CHAPTER OVERVIEW

This chapter describes the MU360 communication interfaces and protocols. The physical communication interfaces provide the functions to communicate with other devices over an Ethernet network:

- Process Bus
- Station Bus
- Administration Bus

The Process Bus links the process level IEDs in an Ethernet network, allowing them to send the digitized data acquired from the primary equipment and receive data from other process level IEDs, based on the IEC 61850 standard protocols such as GOOSE (IEC 61850-8-1) and Sampled Values (IEC 61869-9, IEC 61850-9-2 LE and IEC 6869-9).

The Station Bus supports the communication with other IEDs which are compliant to Goose not supported in SB Report Control Block messages. MU360 Station Bus also supports communication with MMS (ISO 9506).

The Administration Bus is used for the IED configuration and maintenance activities, and to send the IED maintenance information over the Ethernet network.

This chapter contains the following sections:

7.2 INTERFACES

The MU360 has six physical communication interfaces, as shown below:

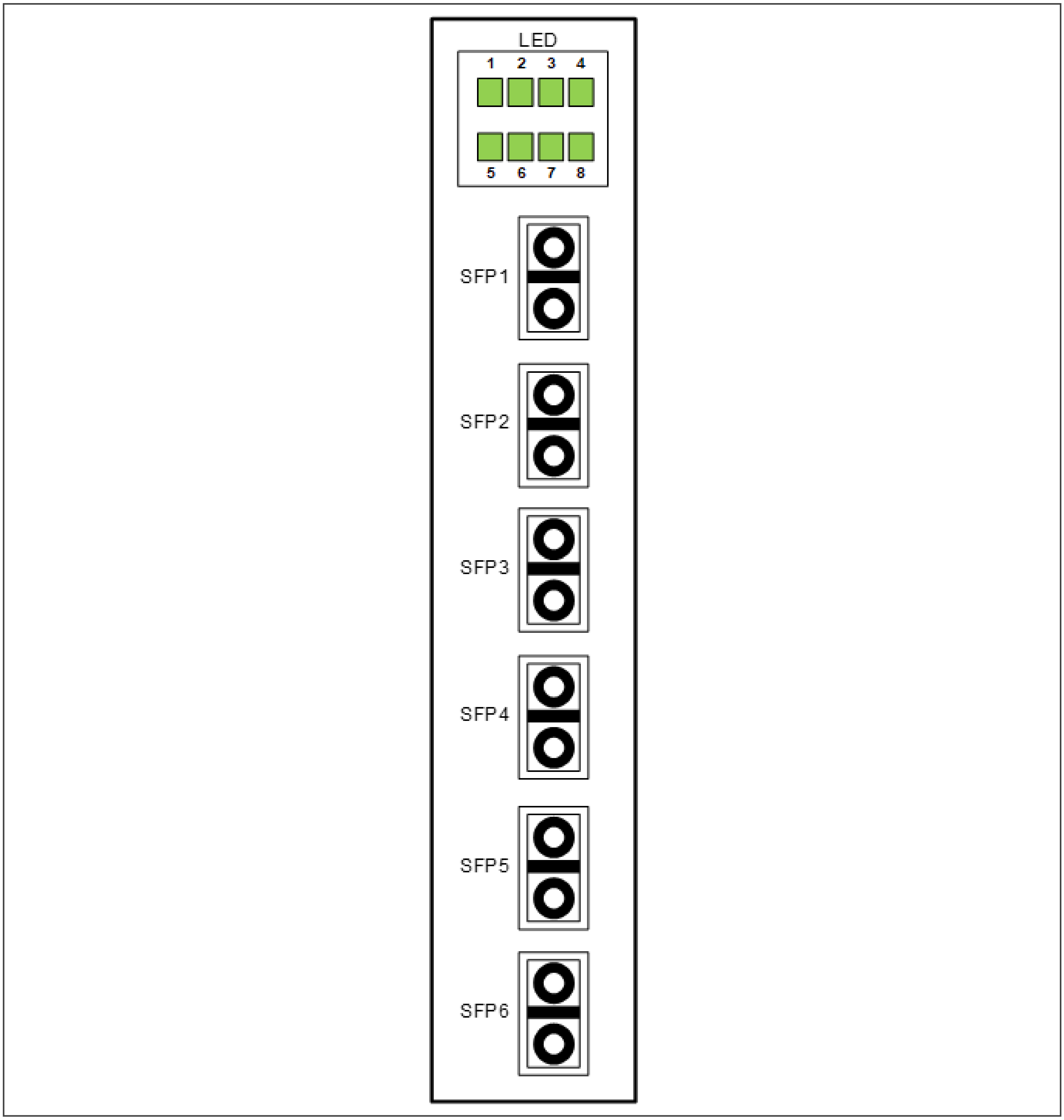


Figure 153: MU360 back view - communication interfaces

Each interface is compatible with 100BASE-LX (except SFP6) or 1000BASE-LX optical Small Form-factor Pluggable (SFP) transceivers, and a 1000BASE-T electrical SFP transceiver for administration bus. They can be configured to be used in redundant or non-redundant modes, as detailed below:

- Process Bus: SFP1 and SFP2 redundant interfaces
- Station Bus: SFP3 and SFP4 redundant interfaces
- Administration Bus: only SFP6 interface, only non-redundant

Note:
The SFP5 interface is disabled by default.

It is possible to configure MU360 to work in the following scenarios:

1. Process Bus + Administration Bus
2. Process Bus + Station Bus + Administration Bus

Depending on the equipment configuration, it is possible to have a physical segregation between the Process and Station buses, with each of them being responsible for enabling only a subset of communication protocols.

The LEDs tower shown in Figure 1 is configured as shown below:

LED	Function	
1	Conf done	Off: Configuration done (normal operation)
2	PS done	On or blinking: normal operation Off: factory mode or failsafe alarm
3	SFP1 link/activity	LED on or blinking: communicating LED off: no communication
4	SFP2 link/activity	
5	SFP3 link/activity	
6	SFP4 link/activity	
7	SFP5 link/activity	
8	SFP6 link/activity	

The redundancy protocols supported are the Parallel Redundancy Protocol (PRP) and the High-availability Seamless Redundancy (HSR), as per IEC 62439-3.

MU360 automatically enables and disables the communication interfaces of the Process and Station Buses, according to the configuration provided by the configurator tool. The following tables show which communication interfaces are enabled for each possible configuration, with or without redundancy. The redundancy can be set using Enervista Flex v2 byt setting values "none", "PRP" or "HSR" for each bus except for the administration bus:

Process Bus		
	Redundancy	No Redundancy
SFP1	YES	YES
SFP2	YES	NO
SFP3	NO	NO
SFP4	NO	NO

Process Bus + Station Bus		
	Redundancy	No Redundancy
SFP1	YES	YES
SFP2	YES	NO

Process Bus + Station Bus		
	Redundancy	**No Redundancy**
SFP3	YES	YES
SFP4	YES	NO

As shown in the previous tables, when there is no redundancy configured in MU360 and Station Bus is enabled, the communication interfaces selected are the SFP1 for Process Bus and SFP3 for Station Bus.

The Administration Bus communication interface is SFP6, and is always enabled with no redundant interface.

The following table shows the port speed configured for each MU360 physical communication interface:

Port	Configured Speed
SFP1	Auto
SFP2	Auto
SFP3	Auto
SFP4	Auto
SFP5	Disabled
SFP6	1 Gbps full-duplex

Note:
To avoid network connection issues, make sure the physical cable is connected and the port is enabled on the network switch which MU360 is connected to.

7.3 CONFIGURATION

The following table shows the port speed configured for each MU360 physical communication interface. The configuration below must match the configuration on the network switch connected to each port.

Port	Configured Speed
SFP1	Auto
SFP2	Auto
SFP3	Auto
SFP4	Auto
SFP5	Disabled
SFP6	1 Gbps full-duplex

Note:
To avoid network connection issues, make sure the physical cable is connected, and the port is enabled on the network switch that the MU360 is connected to.

The IED Configurator Tool (EnerVista Flex V2) provides the network configuration to the MU360 at the Settings -> Network menu. The figure below shows an example of the parameters that can be configured when Process Bus only is enabled. When Station Bus is enabled, the corresponding parameters for that configuration will be also shown.

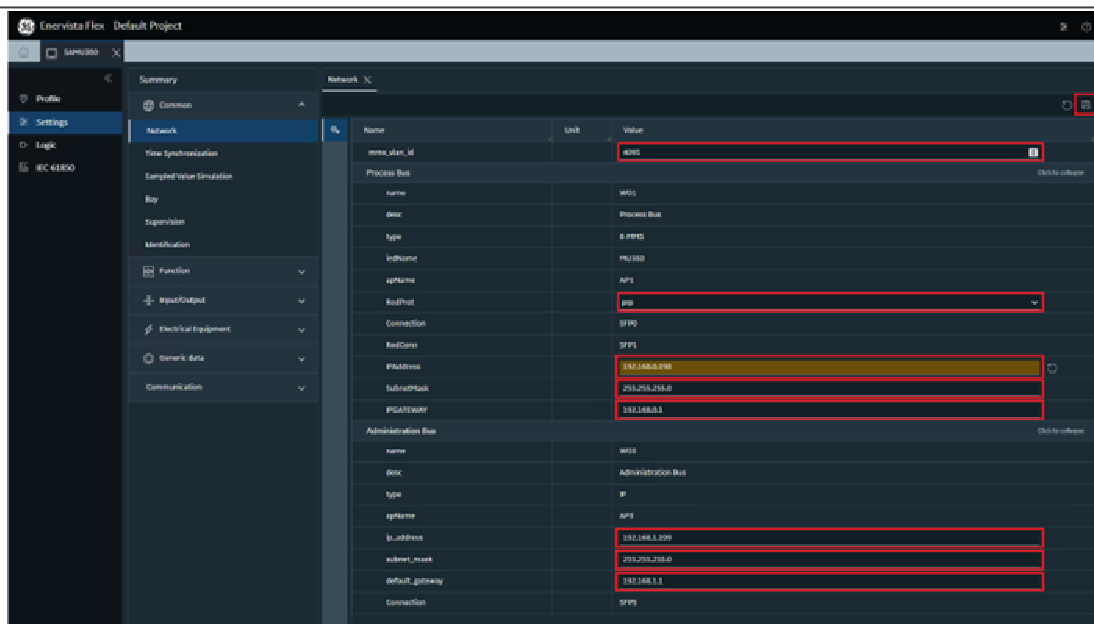


Figure 154: VLAN configuration examples on Enervista Flex V2

7.4 VLAN

MU360 supports VLAN filtering at the IED level.

MU360 allows VLAN configuration for Sampled Values, GOOSE, PTP and MMS. It is possible to select in the device configurator software - Enervista Flex <reference of Enervista Flex Manual> - which VLANs are enabled for each protocol. In addition, protocols such as Sampled Values and GOOSE allow the user to select different VLANs for each control block configured.

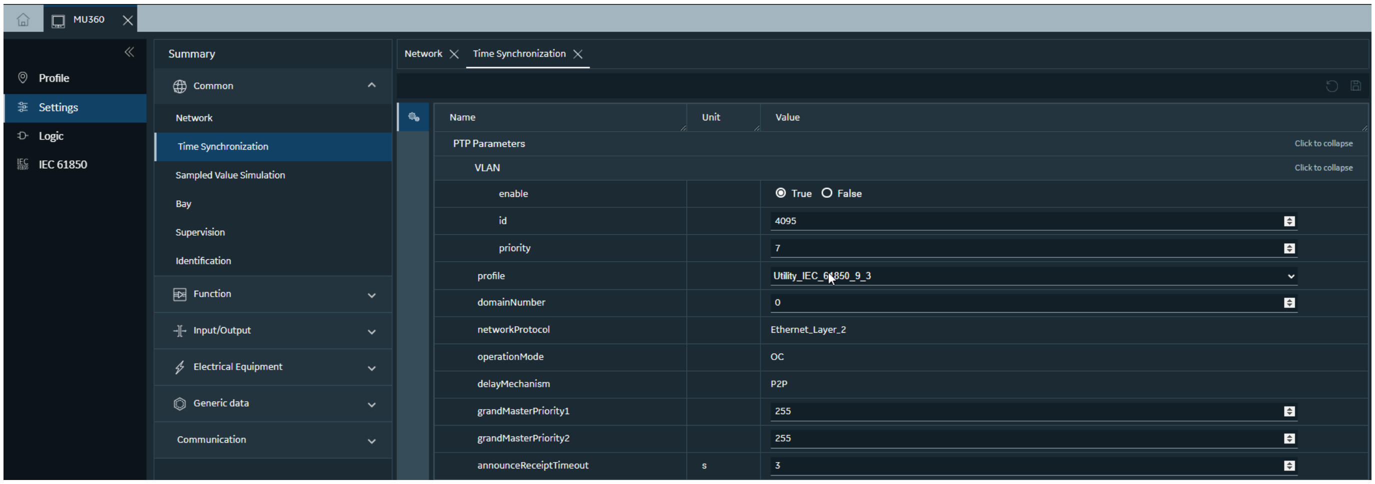


Figure 155: VLAN configuration in Enervista Flex >

The allowed VLANs will be configured for each physical interface, and the Ethernet frames with the VLANs that are not part of the configuration will not be processed by the device.

The VLAN ID values from 0 to 4095 are allowed to be configured, according to IEEE 802.1Q. The reserved values are used as stated below:

- 0: used for tagging the frames priority
- 4095: used to send/accept untagged frames

7.5 DEFAULT IP ADDRESSES

7.5.1 PROCESS AND ADMINISTRATION BUSES ENABLED

Process Bus Default Settings	
IP Adddress	192.168.0.199
Netmask	255.255.255.0
Broadcast	192.168.0.255

Administration Bus Default Settings	
IP Adddress	192.168.1.199
Netmask	255.255.255.0
Broadcast	192.168.1.255

7.5.2 PROCESS, STATION AND ADMINISTRATION BUSES ENABLED

Process Bus Default Settings	
IP Adddress	----
Netmask	----
Broadcast	----

Station Bus Default Settings	
IP Adddress	192.168.0.199
Netmask	255.255.255.0
Broadcast	192.168.0.255

Administration Bus Default Settings	
IP Adddress	192.168.1.199
Netmask	255.255.255.0
Broadcast	192.168.1.255

7.6 COMMUNICATION PORTS AND PROTOCOLS

In MU360, each bus is responsible for accepting and sending a different set of protocols:

- Process bus (SFP1/SFP2)
  - Sampled Values (IEC 61850-9-2LE)
  - GOOSE (IEC 61850-8-1)
  - PTP (IEEE 1588)
  - MMS ISO 9506 (when Station Bus is not enabled)
- Station Bus (SFP3/SFP4)
  - MMS (ISO 9506)
- Administration Bus (SFP6)
  - Configuration (TCP/IP)
  - Secure logging (IEC-62351-14)

CHAPTER 8

INSTALLATION

8.1 CHAPTER OVERVIEW

To start using the MU360, the first step is to install and connect the equipment to the system that will be protected.

For correct installation and connection, it is necessary that the user knows the key features and technical specifications, presented in the Introduction Chapter.

This chapter contains the information required for the MU360 installation, such as:

- The characteristics of the connection terminals
- The location and function of each connection
- Typical voltage and current connections

Following the guidelines in this chapter, the MU360 will be able to function properly.

This chapter contains the following sections:

8.2 HANDLING THE GOODS

Our products are of robust construction but require careful treatment before installation on site. This section discusses the requirements for receiving and unpacking the goods, as well as associated considerations regarding product care and personal safety.

Caution:
Before lifting or moving the equipment you should be familiar with the Safety Information chapter of this manual.

8.2.1 RECEIPT OF THE GOODS

On receipt, ensure the correct product has been delivered. Unpack the product immediately to ensure there has been no external damage in transit. If the product has been damaged, make a claim to the transport contractor, and notify us promptly.

For products not intended for immediate installation, re-pack them in their original delivery packaging.

8.2.2 UNPACKING THE GOODS

When unpacking and installing the product, take care not to damage any of the parts and make sure that additional components are not accidentally left in the packaging or lost. Do not discard any CDROMs or technical documentation. These should accompany the unit to its destination substation and be stored in a dedicated place.

The site should be well lit to aid inspection, and should also be clean, dry and reasonably free from dust and excessive vibration. In particular, this applies to an installation being carried out at the same time as construction work.

8.2.3 STORING THE GOODS

If the unit is not installed immediately, store it in a place free from dust and moisture in its original packaging. Keep any de-humidifier bags included in the packaging. The de-humidifier crystals lose their efficiency if the bag is exposed to ambient conditions.

Restore the de-humidifier crystals before replacing it in the carton. Ideally regeneration should be carried out in a ventilating, circulating oven at about 115°C. Bags should be placed on flat racks with space allowed to circulate around them. The time taken for regeneration will depend on the size of the bag. If a ventilating, circulating oven is not available, when using an ordinary oven, open the door on a regular basis to let out the steam produced by the regenerating silica gel.

On subsequent unpacking, make sure that any dust on the carton does not fall inside. Avoid storing in locations with high humidity. In locations with high humidity, the packaging may become impregnated with moisture and the de-humidifier crystals will lose their efficiency.

The device can be stored between -25° to +55°C for extended periods or between -40°C to +70°C for up to 96 hours (see Technical Specifications chapter).

8.2.4 DISMANTLING THE GOODS

If you need to dismantle the device, always observe standard ESD (Electrostatic Discharge) precautions. The minimum precautions to be followed are:

- Use an anti-static wrist band earthed to a suitable earthing point
- Avoid touching the electronic components and PCBs

8.3 NORMAL USE OF THE EQUIPMENT

In order to maintain the equipment's integrity and levels of protection, and assure user safety, the MU360 shall be installed in an enclosed panel with a recommended ingress protection rating of IP54 or above.

The enclosing panel will ensure that the equipment's rear connections and sides are unexposed and protected against impact and water, while maintaining adequate temperature and humidity conditions for the device. Furthermore, the equipment shall have all rear connectors attached, even if not being used, to keep the level of ingress protection as high as possible.

During normal use of the device only its front panel will be accessible.

8.4 MOUNTING THE DEVICE

To install the MU360 in the panel, drill the necessary holes as described in the Installation chapter - Case Dimensions. The screws used for fixing are M5 type.

There are two optional mounting chassis supports, which will enable the fitting of a 2 x 40TE or 1 x 80TE to a 19-inch rack. Chassis support is described in the Installation chapter - Case Dimensions.

8.5 CONNECTION

This section describes the type of wiring and connections that should be used when installing the device, as well as pin-out details.

Before carrying out any work on the equipment, you should be familiar with the Safety Section and the ratings on the equipment's rating label.

It is recommended that 0.8 mm2 cables are used, as follows:

- Screened multi-strand cable has to be used for digital input-output signals. For cables within the cubicle, the cable screen can be connected to the earth at both ends of the cable. If the cable is taken beyond the system cubicle, the cable screen should be earthed at one end only, to prevent current flowing in the screen due to any differences in ground potential.
- Screened and twisted pairs must be used for analogue input-output signals. The screen is connected to the earth by the end of Bay Module side.
- One or two screened and twisted pairs must be used for lower communication signals. The screen is connected to the earth by two cable ends.

It is recommended that cables are grouped and fitted as near as possible to an earth plane or to an element of an earth wire mesh.

8.5.1 PROTECTIVE CONDUCTOR CONNECTION

The MU360 racks must be earthed for safety reasons, by connection of the protective conductor (earth) to the M4 threaded stud allocated as the protective conductor terminal (PCT), marked with the symbol shown. The suggested tightening torque for M4 nuts is 1.5 N·m.

Warning:
To maintain the safety features of the equipment, it is essential that the protective conductor (earth) is not disturbed when connecting or disconnecting functional earth conductors, such as cable screens to the PCT stud.

Warning:
The protective conductor must be connected first, in such a way that it is unlikely to be loosened or removed during installation, commissioning or maintenance. It is recommended that this is achieved by using an additional locking nut.

The protective conductor (earth) must be as short as possible with low resistance and inductance. The best electrical conductivity must be maintained at all times, particularly the contact resistance of the plated steel stud surface. The resistance between the MU360 protective conductor (earth) terminal (PCT) and the protective earth conductor must be less than 10 mΩ at 12 Volt, 100 Hz.

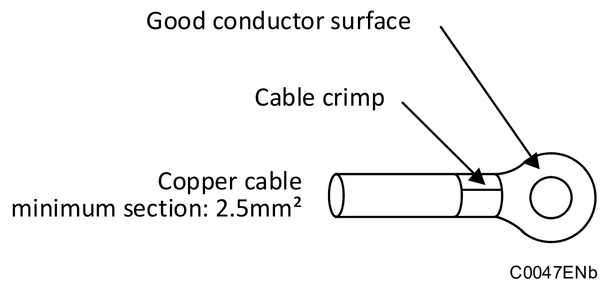


Figure 156: Earthing cable example

8.5.2 UNIVERSAL SINGLE SOURCE POWER SUPPLY - BIU261S

The BIU261S board houses the primary power supply trasformer, the watchdog relay, 2 inputs/outputs for MU360 redundancy and 2 legacy isolated RS485 serial ports (Ports N°1 / N°2).

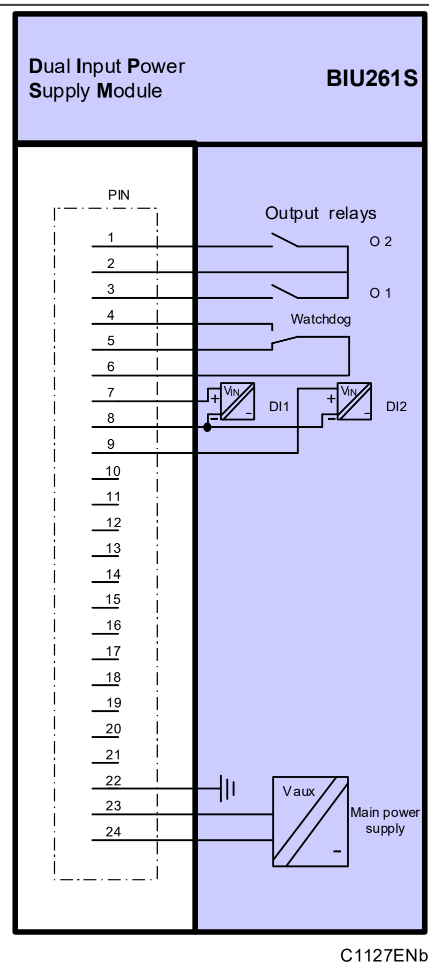


Figure 157: BIU261S board - block diagram

8.5.2.1 CONNECTOR DESCRIPTION - BIU261S

Pin No.	Signal
1	Redundancy relay 2 - NO contact
2	Redundancy relay - common 1-2

Pin No.	Signal
3	Redundancy relay 1 - NO contact
4	Watchdog relay - NO contact
5	Watchdog relay - NC contact
6	Watchdog relay - common
7	Redundancy input - 1+
8	Redundancy input - common 1/2
9	Redundancy input - 2+
10	
11	
12	RS232: RxD RS485: B - Port 1
13	GND - Port 1
14	RS232: TxD RS485: A - Port 1
15	GND - Port 2
16	RS232: CTS - Port 2
17	RS232: RxD RS485 B RS422: TB - Port 2
18	RS232: TxD RS485 A RS422: TA - Port 2
19	RS232: RTS RS422: RB - Port 2
20	RS422: RA - Port 2
21	RS232: DCD - Port 2
22	Voltage input: Gnd Gnd
23	Voltage input: AC/DC (+)
24	Voltage input: AC/DC (-)

8.5.3 CENTRAL PROCESSING AND COMMUNICATIONS UNIT - CPUMZ5

This board offers 6 SFP cages, which can hold any of the following, depending on the configuration:

LC optical plugs for:

- 100BASE-Lx port: 100 Mbps, 1310nm wavelength, single mode over 2 km
- 1000BASE-Lx port: 1000 Mbps, 1310nm wavelength, single mode over 20 km

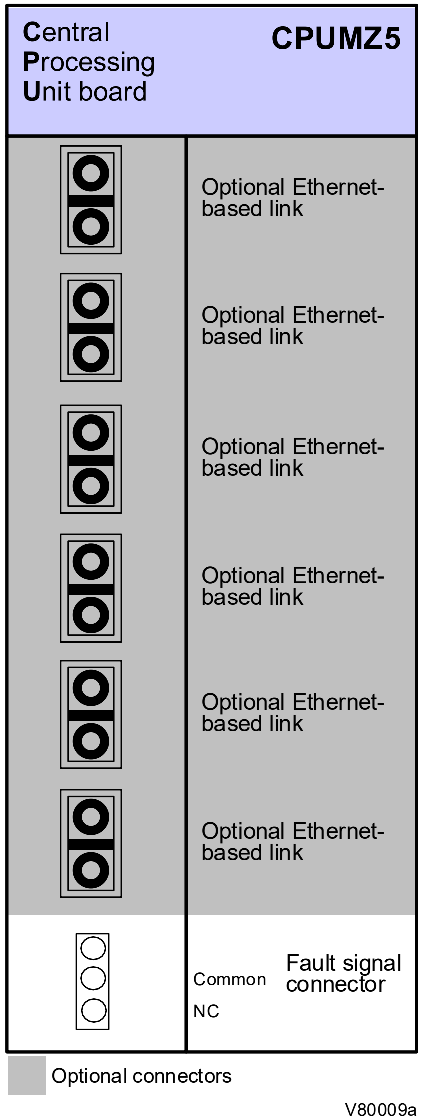


Figure 158: CPUMZ5 board - block diagram example

8.5.3.1 SMALL FORM-FACTOR PLUGGABLE MODULE (SFP)

Small Form-factor Pluggable module (SFP) can be used to connect to the network. The SFP module is a hot-swappable connector that provides high-speed performance. MU360 supports only Optical LC-type SFP modules. The table below lists the supported and recommended LC-type SFP and references:

Part Number	Manufacturer	Description
AXFD-1314-0W23	Axcen	Transceiver type SFP 100Mbps 1310nm 2KM
SFP-SX-MM-0102DI	Optone	Transceiver type SFP 100Mbps 1310nm 2KM
GP-3124-L2TD	Gigalight	Transceiver type SFP 1.25 Gbps 1310nm 20KM
GLC-T-A	Optone	Transceiver type SFP 1000BASE-T Cooper RJ45 100m Cat 5 UTP (Admin bus)

8.5.3.2 WATCHDOG CONNECTOR DESCRIPTION

The operational state of the board is indicated on contacts at the rear of the board, according to the diagram and table below. The alarm contacts share a common terminal.

Terminal Number	Assignment	Signal	Meaning
1	Operational State	NC	Open = Boot in progress/faulty Closed = Normal operation
2	Common	Common	Common
3	Not used	Not used	Not used

The characteristics of the alarm connector are presented below:

- Terminals: 1 normally closed (NC) contact
- DC voltage 300 VDC/250 VAC
- Continuous current: 80 mA

Wiring recommendations

For safety reasons and for compliance with the European Commission Low Voltage Directive (2014/35/EU), the authorized voltage rating to be applied on the watchdog terminals is limited to 70 VDC or 33 VAC.

Due to the proximity of port N°6 Ethernet connector, it is strongly recommended that the watchdog connections are visually checked before any handling of the Ethernet connectors. Do not damage the cable's isolation during the wiring phase.

The figure below shows the allocation of the CPUMZ5 alarm contacts.

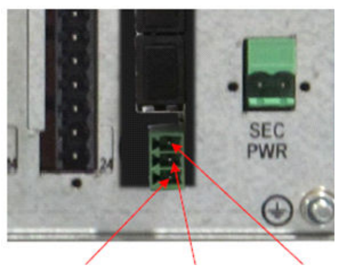


Figure 159: CPUMZ5 alarm contact connections

8.5.4 DIGITAL INPUTS MODULE - DIU211

The Digital Input module (DIU211) provides 16 optically isolated digital inputs with one common for two Dis. This common links the positive inputs of the two opto-couplers.

> *Note:*
> *The board supports polarity reversal.*

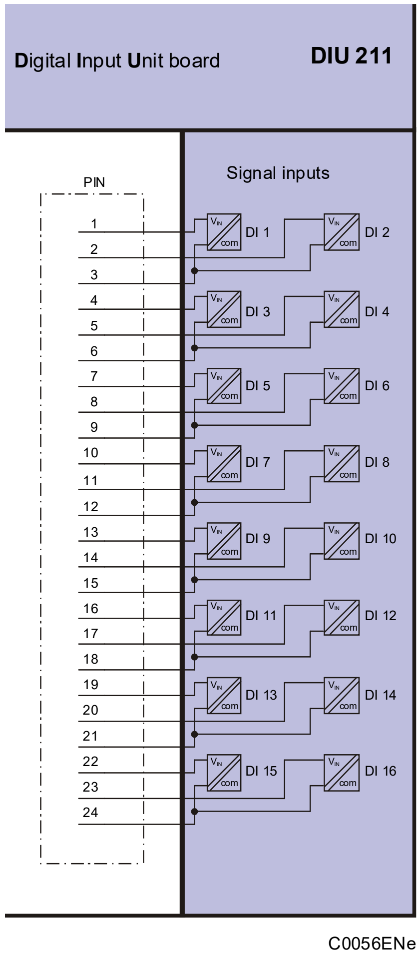


Figure 160: DIU211 board block diagram

Note:
Different variants of DIU211 boards are available according to the input voltage range.
Before connection, special attention is to be paid to the board variant:
- variant A01 for 24 VDC
- variant A02 for 48/60 VDC
- variant A03 for 110/125 VDC
- variant A04 for 220 VDC
- variant A07 for 110/125 VDC with 80% threshold
- variant A08 for 220 VDC with 80% threshold

8.5.4.1 CONNECTOR DESCRIPTION - DIU211

The DIU211 board is equipped with a standard connector with a 24-way and 5.08 mm pitch.

Pin No.	Signal
1	Digital Input 1-
2	Digital Input 2-
3	Positive Common Digital Input 1/2
4	Digital Input 3-
5	Digital Input 4-

Pin No.	Signal
6	Positive Common Digital Input 3/4
7	Digital Input 5-
8	Digital Input 6-
9	Positive Common Digital Input 5/6
10	Digital Input 7-
11	Digital Input 8-
12	Positive Common Digital Input 7/8
13	Digital Input 9-
14	Digital Input 10-
15	Positive Common Digital Input 9/10
16	Digital Input 11-
17	Digital Input 12-
18	Positive Common Digital Input 11/12
19	Digital Input 13-
20	Digital Input 14-
21	Positive Common Digital Input 13/14
22	Digital Input 15-
23	Digital Input 16-
24	Positive Common Digital Input 15/16

Note:
The triggering threshold depends on the jumper positions

Protect the opto-inputs and their wiring with a maximum 16 A high rupture capacity (HRC) type NIT or TIA fuse.

8.5.5 DIGITAL OUTPUTS MODULE - DOU201

The Digital Outputs Unit board DOU201 provides 10 isolated outputs using relays.

8.5.5.1 BLOCK DIAGRAM - DOU201

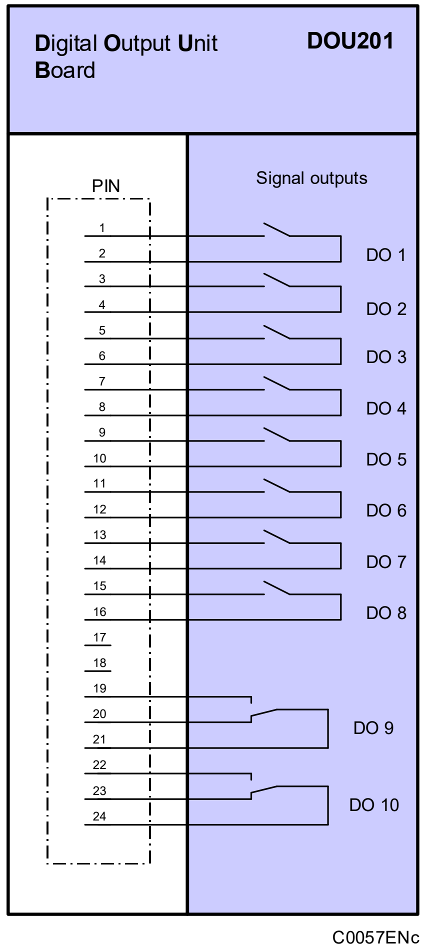


Figure 161: DOU201 board block diagram

8.5.5.2 CONNECTOR DESCRIPTION - DOU201

The DOU201 board is equipped with a 24-pin 5.08 mm pitch connector.

Pin No.	Signal
1	Digital output 1 +
2	Digital output 1 -
3	Digital output 2 +
4	Digital output 2 -
5	Digital output 3 +
6	Digital output 3 -
7	Digital output 4 +
8	Digital output 4 -
9	Digital output 5 +
10	Digital output 5 -
11	Digital output 6 +

Pin No.	Signal
12	Digital output 6 -
13	Digital output 7 +
14	Digital output 7 -
15	Digital output 8 +
16	Digital output 8 -
17	NC
18	NC
19	Digital output 9 - NO contact
20	Digital output 9 - NC contact
21	Common digital output 9
22	Digital output 10 - NO contact
23	Digital output 10 - NC contact
24	Common digital output 10

8.5.6 HIGH BREAK-HIGH SPEED OUTPUTS MODULE - HBU210

The High Break Unit board (HBU210) comprises 6 normally open output contacts, which are suitable for high breaking loads.

8.5.6.1 BLOCK DIAGRAM - HBU210

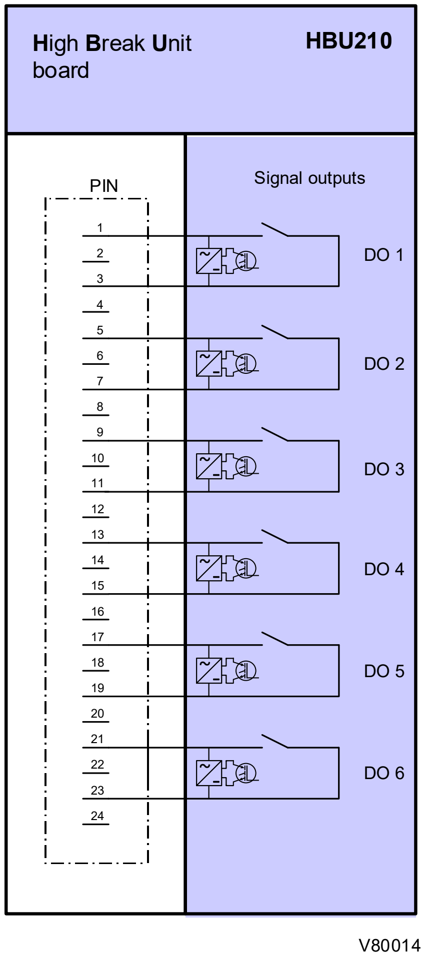


Figure 162: HBU210 board block diagram

8.5.6.2 CONNECTOR DESCRIPTION - HBU210

The HBU210 board is equipped with a 24-pin 5.08 mm pitch connector. The digital outputs on this board are designed to withstand reversed DC voltage applications.

Pin No.	Signal
1	Digital output 1
2	NC
3	Digital output 1
4	NC
5	Digital output 2
6	NC
7	Digital output 2
8	NC
9	Digital output 3
10	NC

Pin No.	Signal
11	Digital output 3
12	NC
13	Digital output 4
14	NC
15	Digital output 4
16	NC
17	Digital output 5
18	NC
19	Digital output 5
20	NC
21	Digital output 6
22	NC
23	Digital output 6
24	NC

The pin-out groups the channels into pairs that give a logical grouping for dual cutting operation, or for AC operation.

8.5.7 ANALOGUE INPUT MODULE - AIU211

The Analogue input board AIU211 provides 8 isolated Analogue inputs.

8.5.7.1 BLOCK DIAGRAM - AIU211

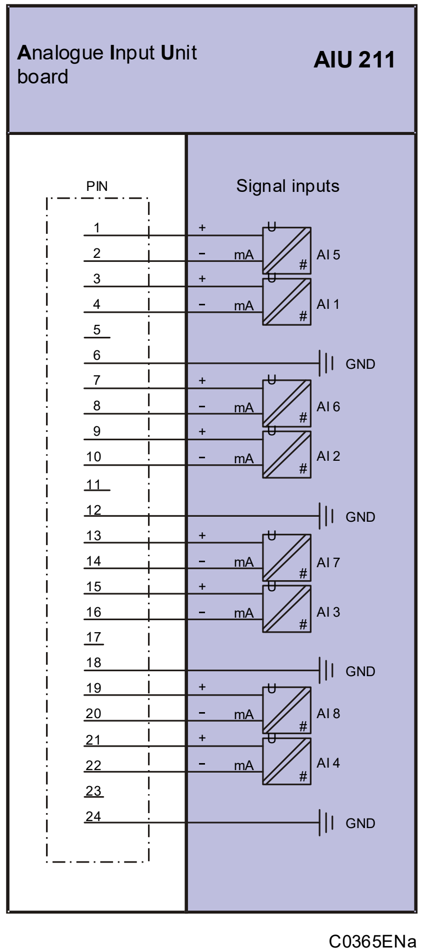


Figure 163: AIU211 board block diagram

8.5.7.2 CONNECTOR DESCRIPTION - AIU211

The AIU211 board is equipped with a 24-way 5.08 mm pitch connector.

Pin No.	Signal
1	Analogue Input 5+ (current)
2	Analogue Input 5- (current)
3	Analogue Input 1+ (current)
4	Analogue Input 1- (current)
5	Not Connected
6	Ground for cable shield
7	Analogue Input 6+ (current)
8	Analogue Input 6- (current)
9	Analogue Input 2+ (current)
10	Analogue Input 2- (current)
11	Not Connected

Pin No.	Signal
12	Ground for cable shield
13	Analogue Input 7+ (current)
14	Analogue Input 7- (current)
15	Analogue Input 3+ (current)
16	Analogue Input 3- (current)
17	Not Connected
18	Ground for cable shield
19	Analogue Input 8+ (current)
20	Analogue Input 8- (current)
21	Analogue Input 4+ (current)
22	Analogue Input 4- (current)
23	Not Connected
24	Ground for cable shield

8.5.7.3 CONNECTION OF SENSORS TO THE AIU211 ANALOGUE INPUT TERMINALS

Cable Shield Earthing

Wiring from the sensors may be enclosed in shielded cables and those shields may necessitate earthing. The BIU211 board offers 4 dedicated terminals to connect these cables to the case earth of the unit: pins 6, 12, 18 and 24. These terminals are internally linked to the case earth and are independent of the analogue inputs. Therefore, cable shields can be connected to any of those terminals, irrespective of which inputs the sensors are wired to.

If cable shield earthing is used, make sure to earth only one end of each shield, especially for long cables, as the ground loop created by the difference of potential between distant ends could generate noise that may render the measurements from the sensors inaccurate.

Analogue Inputs

Wiring of the sensors to the analogue inputs must be done according to the instructions in the sensors' user manuals. Because each analogue input channel has an impedance of 75 ohms, ensure that you only use sensors with outputs rated for 75 ohms.

8.5.8 TRANSDUCERLESS MEASUREMENTS UNIT MODULE - TMU310

The Transducerless Measurements Unit module (TMU310), provides 4 transducerless voltage inputs (VT) and 4 transducerless current inputs (CT).

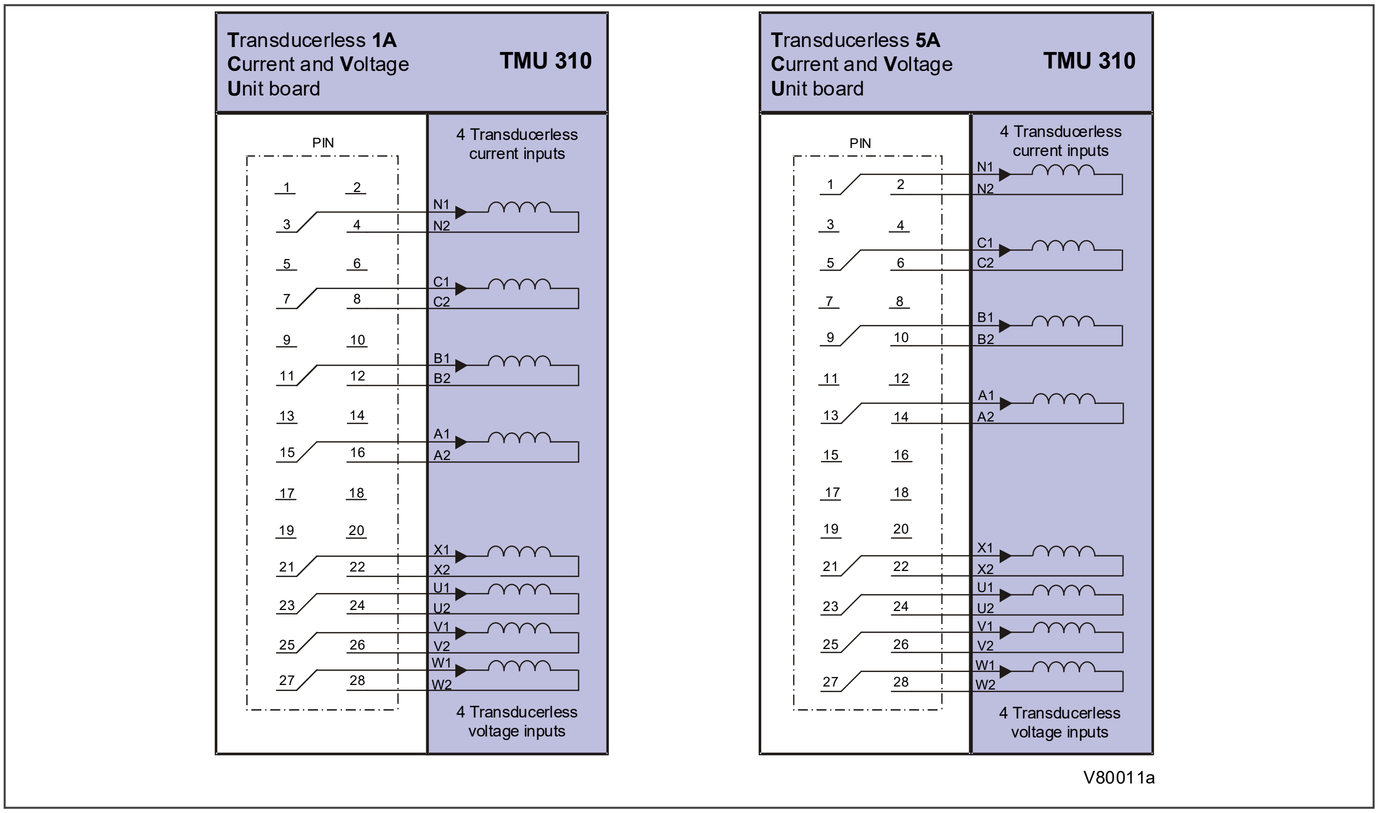


Figure 164: TMU310 board block diagram

8.5.8.1 CONNECTOR DESCRIPTION - TMU310

The TMU310 board is equipped with a standard MiDOS 28 connector. The current input (1 or 5A) is selected directly on the TMU310 board, by changing the connection position (one connector per CT channel as highlighted in the table below).

Pin No.	Signal
1	Current Input 5A - N1
2	Current Input 5A - N2
3	Current Input 1A - N1
4	Current Input 1A - N2
5	Current Input 5A - C1
6	Current Input 5A - C2
7	Current Input 1A - C1
8	Current Input 1A - C2
9	Current Input 5A - B1
10	Current Input 5A - B2
11	Current Input 1A - B1
12	Current Input 1A - B2
13	Current Input 5A - A1
14	Current Input 5A - A2
15	Current Input 1A - A1

Pin No.	Signal
16	Current Input 1A - A2
17	NC
18	NC
19	NC
20	NC
21	Voltage Input - X1
22	Voltage Input - X2
23	Voltage Input - U1
24	Voltage Input - U2
25	Voltage Input - V1
26	Voltage Input - V2
27	Voltage Input - W1
28	Voltage Input - W2

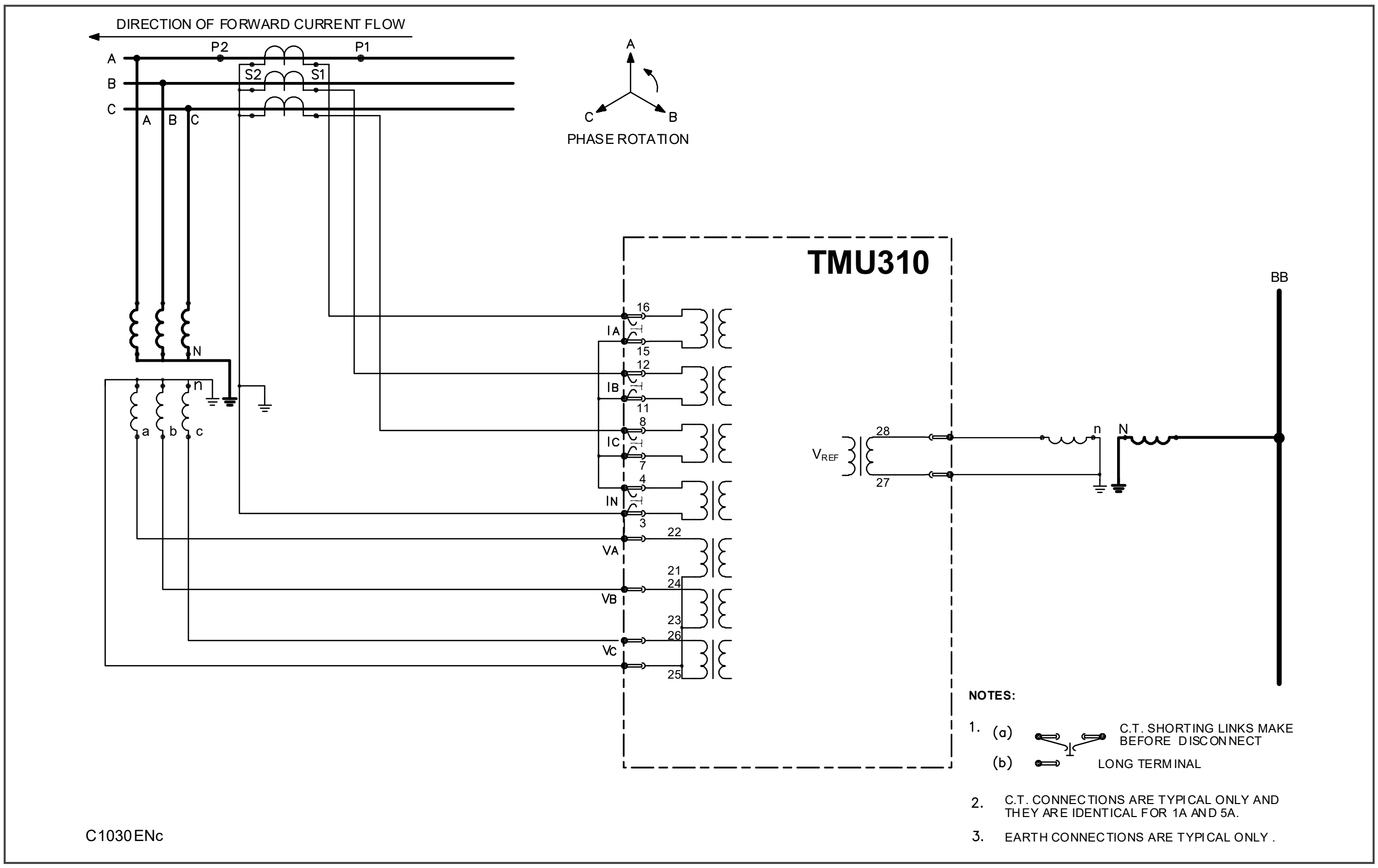


Figure 165: TMU310 board - external connection diagram with V_{REF}

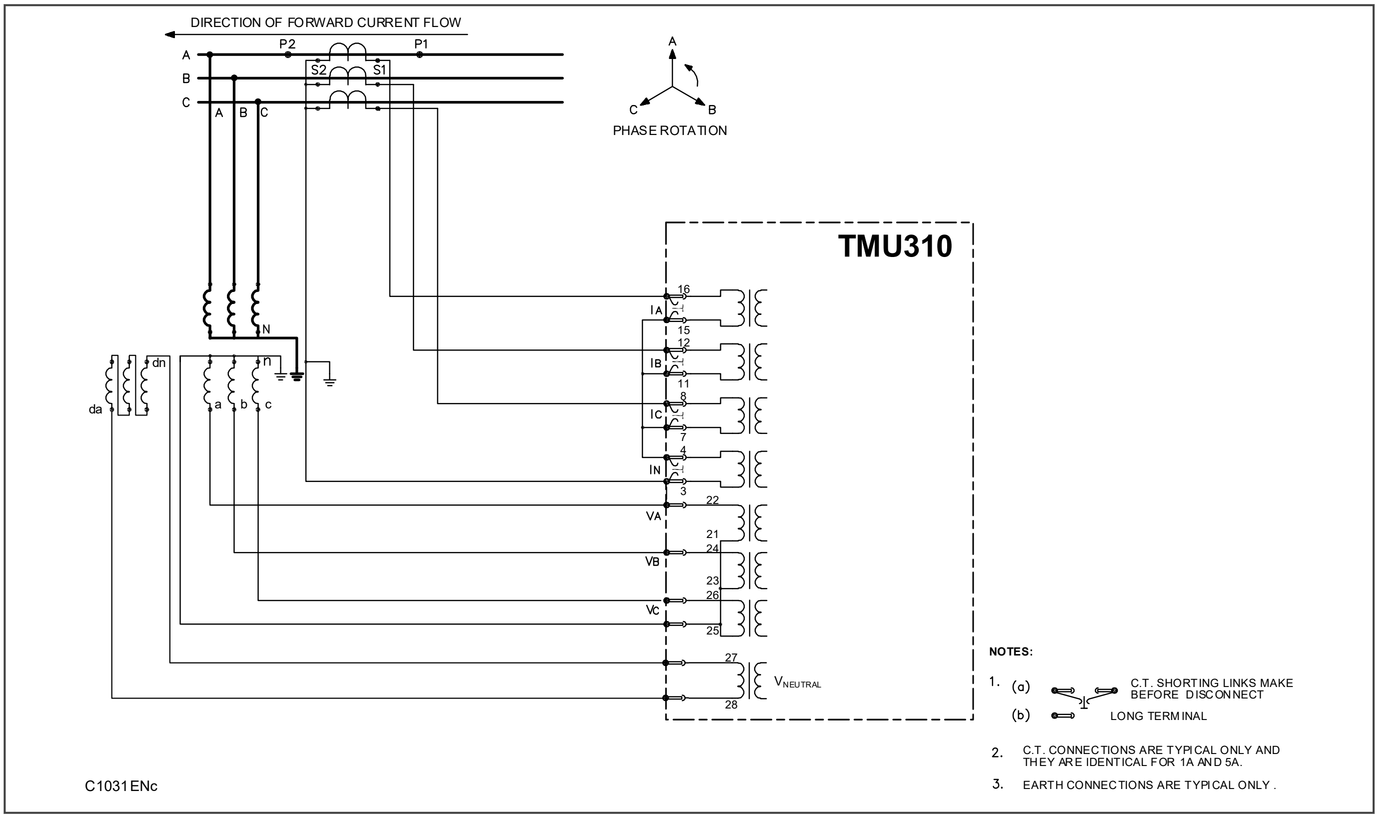


Figure 166: TMU310 board - external connection diagram with V_N

8.5.9 TRANSDUCERLESS MEASUREMENTS UNIT MODULE - TMU320

The Transducerless Measurements Unit module (TMU320), provides 5 transducerless voltage inputs (VT) and 4 transducerless current inputs (CT).

8.5.9.1 BLOCK DIAGRAM - TMU320

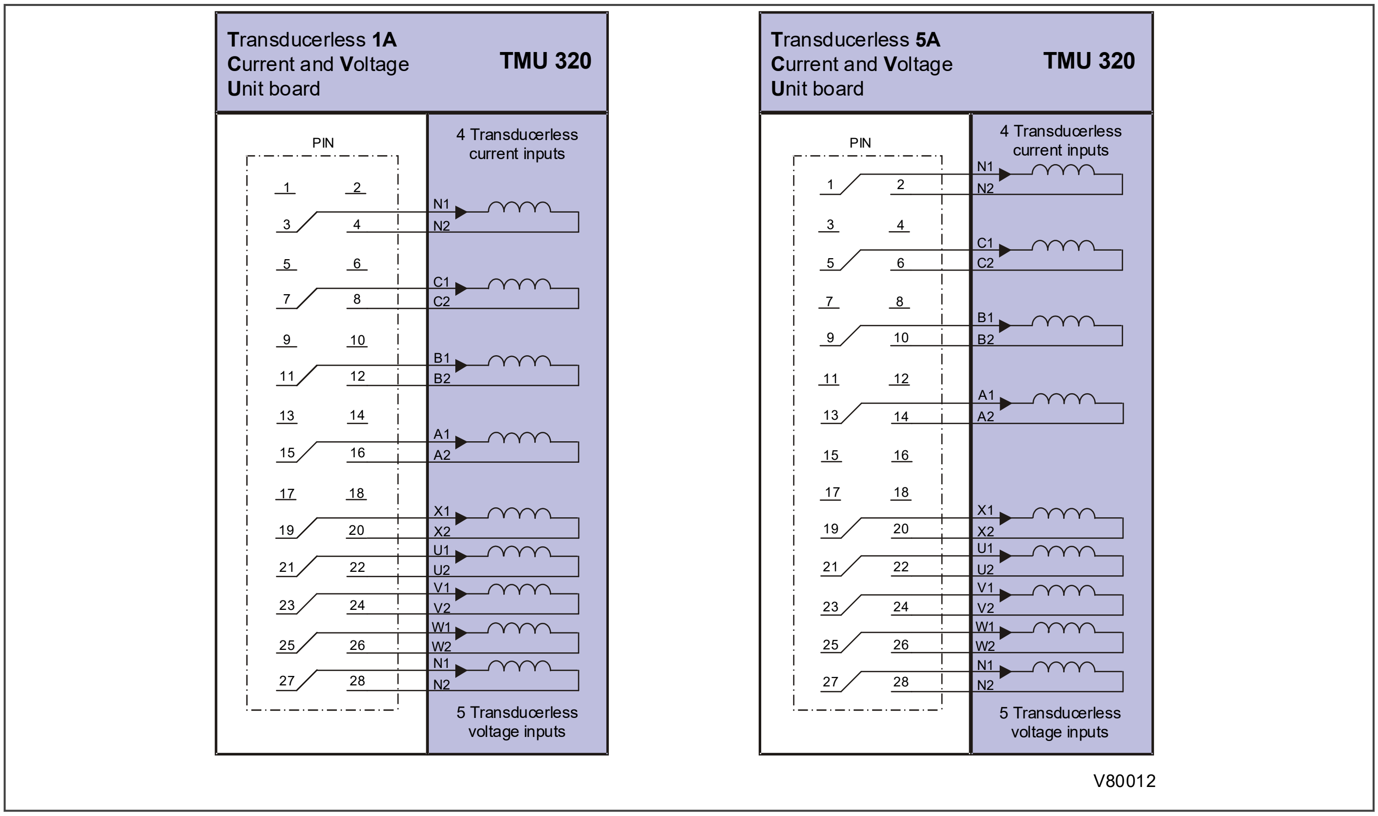


Figure 167: TMU320 board block diagram

8.5.9.2 CONNECTOR DESCRIPTION - TMU320

Pin No.	Signal
1	Current Input 5A - N1
2	Current Input 5A - N2
3	Current Input 1A - N1
4	Current Input 1A - N2
5	Current Input 5A - C1
6	Current Input 5A - C2
7	Current Input 1A - C1
8	Current Input 1A - C2
9	Current Input 5A - B1
10	Current Input 5A - B2
11	Current Input 1A - B1
12	Current Input 1A - B2
13	Current Input 5A - A1
14	Current Input 5A - A2
15	Current Input 1A - A1
16	Current Input 1A - A2

Pin No.	Signal
17	NC
18	NC
19	Voltage Input - X1
20	Voltage Input - X2
21	Voltage Input - U1
22	Voltage Input - U2
23	Voltage Input - V1
24	Voltage Input - V2
25	Voltage Input - W1
26	Voltage Input - W2
27	Voltage Input - N1
28	Voltage Input - N2

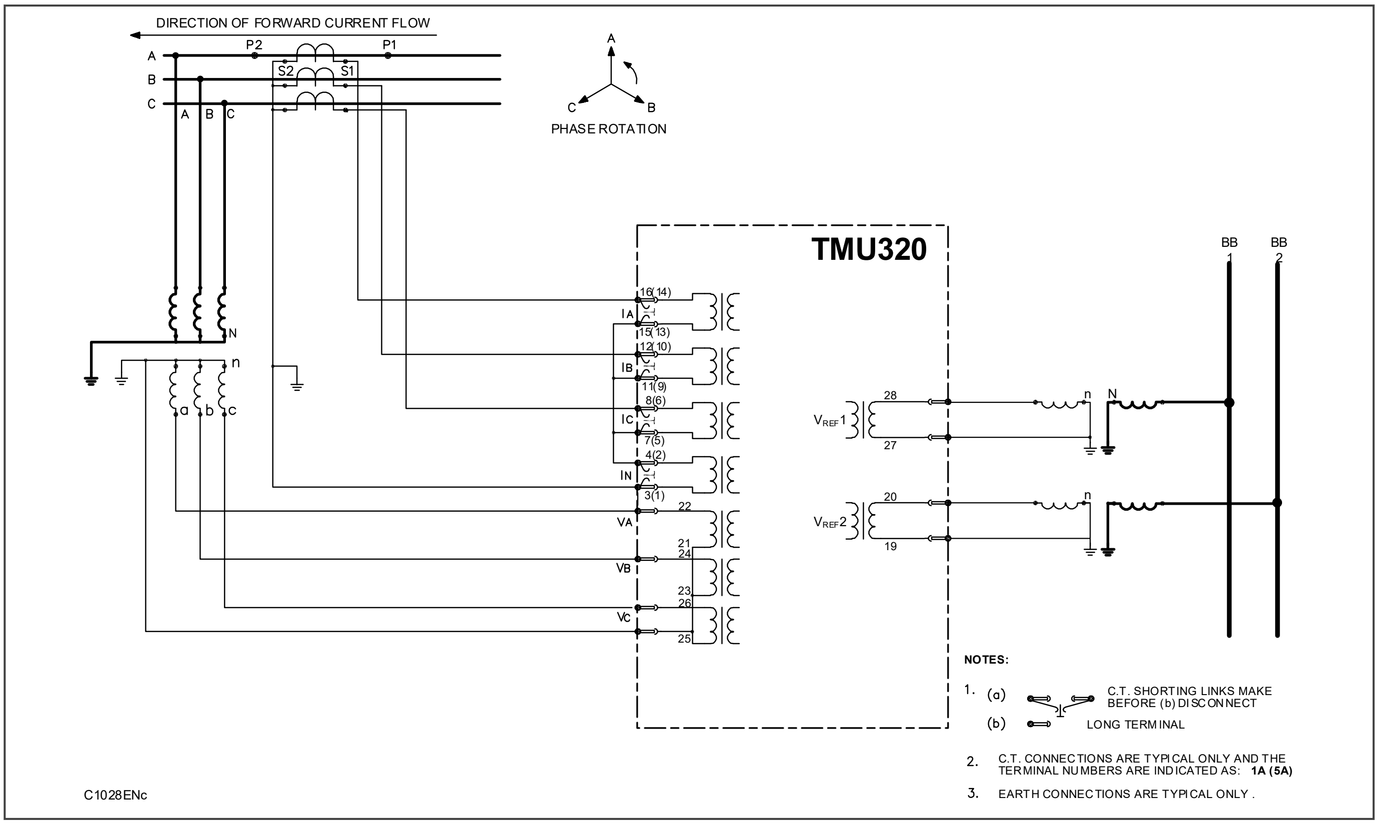


Figure 168: TMU320 board - external connection diagram with 2 x VREF

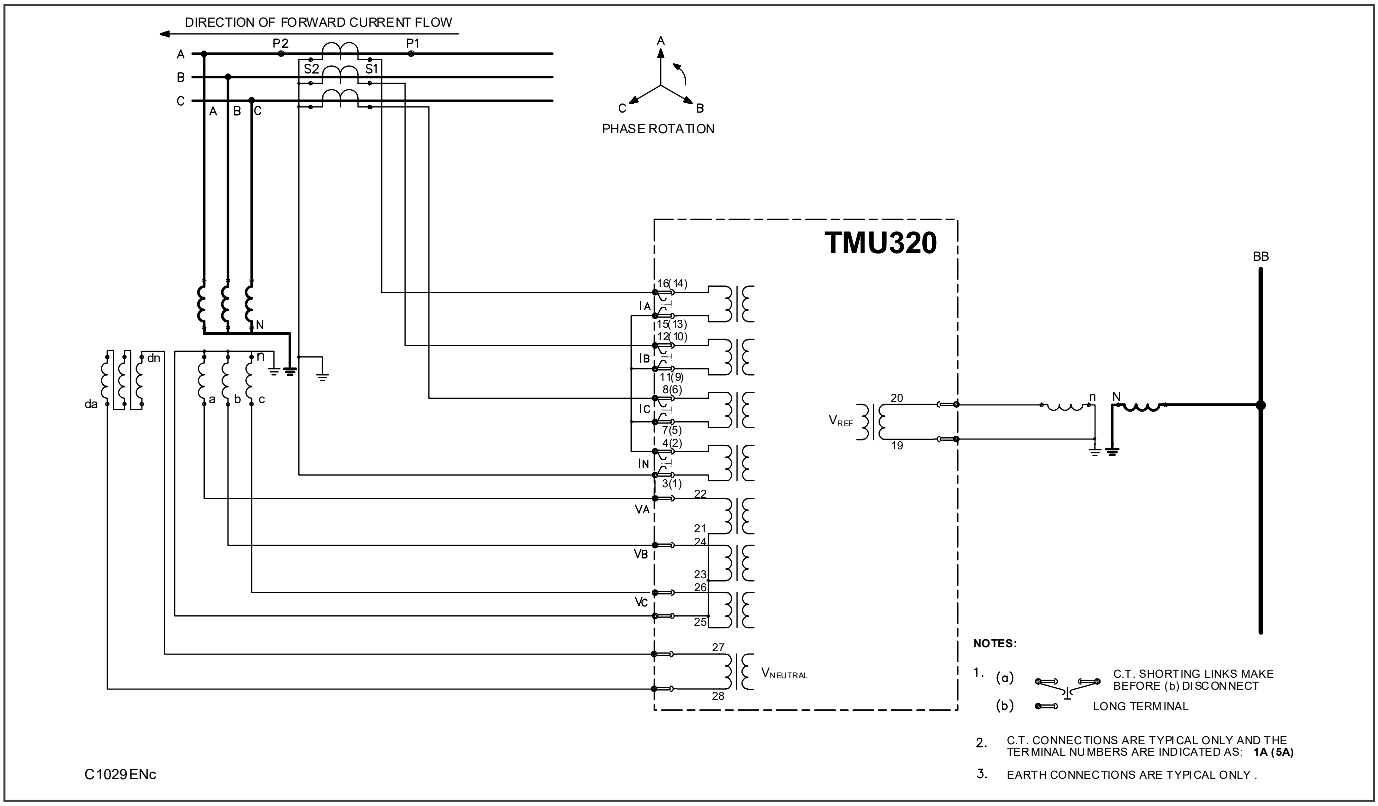


Figure 169: TMU320 board - external connection diagram with VREF +VN

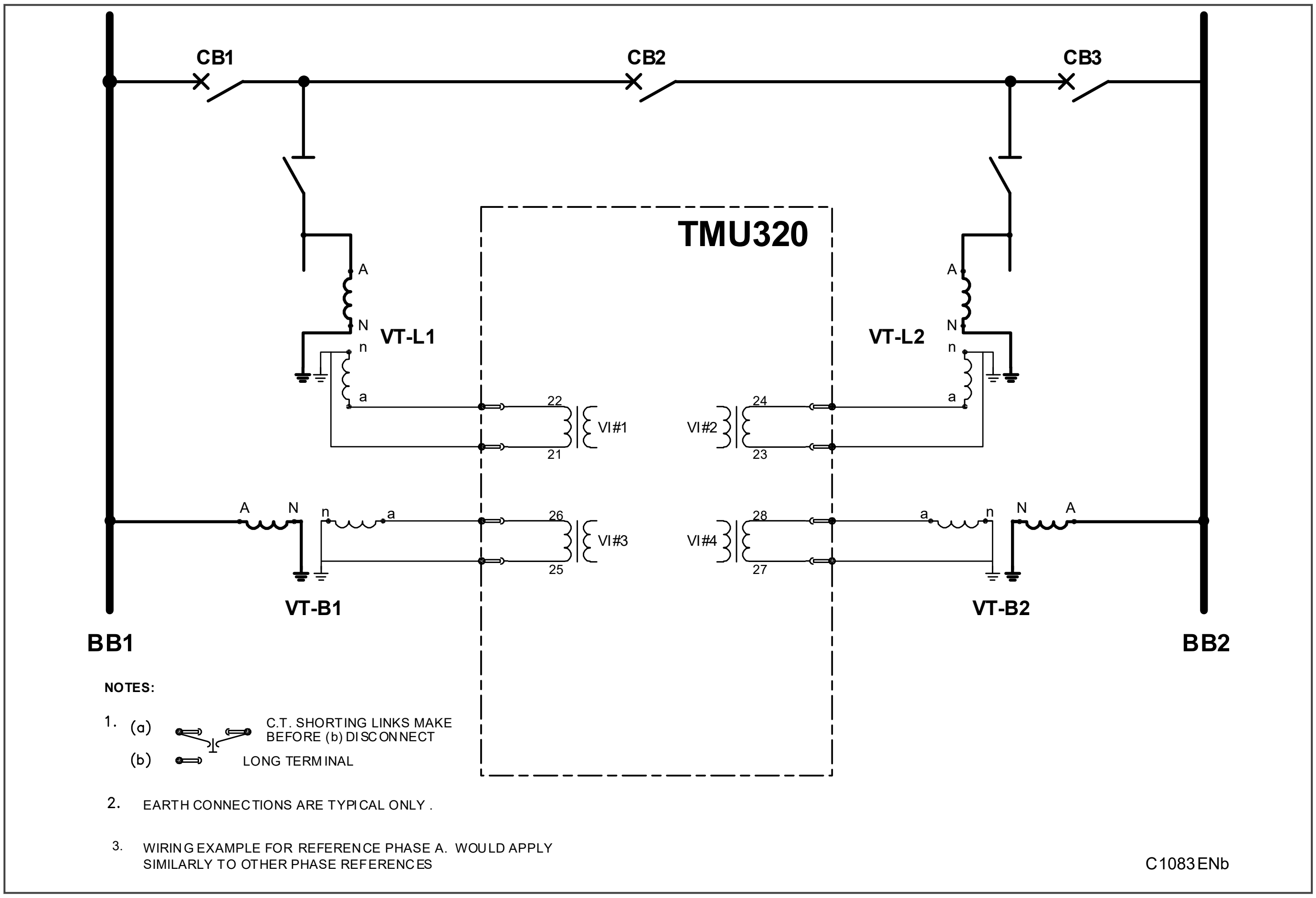


Figure 170: TMU320 board - external connection diagram for breaker-and-a-half topology

8.5.10 FRONT PANEL CONNECTION

The front panel includes a B-Type USB port intended for maintenance purpose only.

Warning:
The front serial USB port is intended for maintenance purpose only. It is isolated to ELV level and is not intended for user connection. ESD precautions should also be taken when accessing it.

The properties of the connector for the maintenance dialogue are:

- Baud rate: 115200 bit/s
- Data bits: 8
- Parity: No
- Stop bit: 1
- Control Xon/Xoff

Connector description:

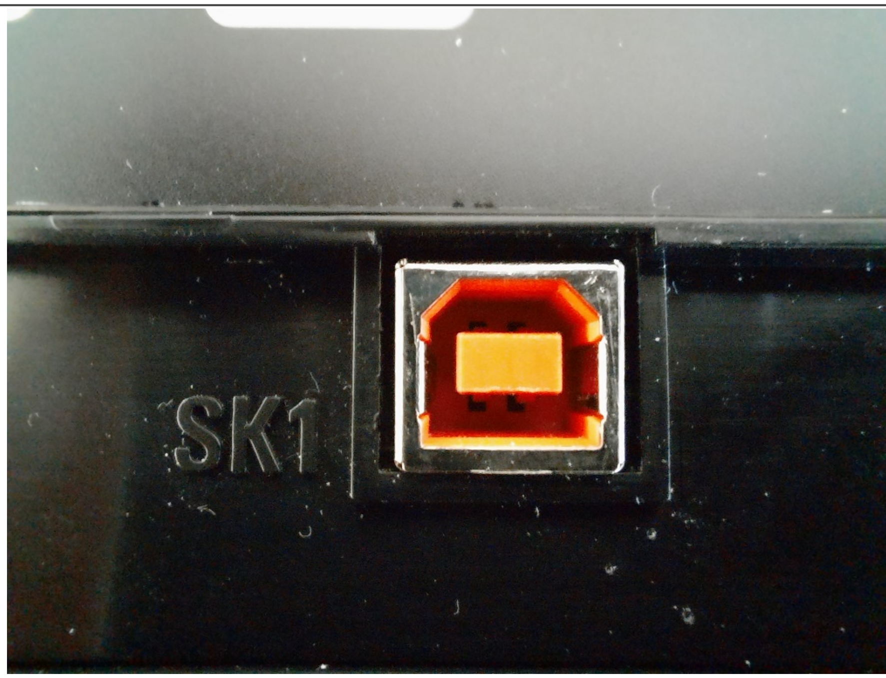


Figure 171: Front panel connector view

> *Note:*
> *Refer to Recovering Default Environment for use of front panel usb B-type port.*

8.6 POWERING UP

Refer to the Quick Installation Guide chapter.

8.7 ENERVISTA FLEX V2 INSTALLATION

For the complete installation process of the EnerVista Flex V2 tool, refer to EnerVista Flex user manual. The section here, describes the required material to properly install and use MU360.

Requirment for PC

In this section, “computer” refers to the MU360 and “(host) PC” to the PC that hosts the tools.

Hardware

- At least 700 MHz
- Windows 10 LTSC 2019 for Enterprise 64-bits edition
- At least 100 MB free space on hard disk
- USB type-B port or an USB/serial adaptor
- An Ethernet port

Certificates

To guaranty firmware integrity, all firmware uploaded into the MU360 is digitally signed.

The certificates are already integrated in MU360 upon delivery to ensure communication with Enervista Flex and it is not possible yet to manage the certificates.

The MU360 verifies the integrity of new firmware upon download. It also checks its firmware periodically, at intervals of less than 10 minutes to verify its integrity.

CHAPTER 9

MAINTENANCE, INSTALLATION AND ADMINISTRATION

9.1 CHAPTER OVERVIEW

This chapter provides information about proper equipment maintenance. It describes the Maintenance and Fault Finding procedures of the MU360. Reading the Safety Section is mandatory.

Caution:
Before carrying out any work on the equipment you should be familiar with the contents of the Safety Section.

This chapter contains the following sections:

9.2 COMMISSIONING

This section describes how to create specific small configuration for commissioning an associated CORTEC running in a MU360 IED.

This not an application commissioning but the subject here intends only to check if interfaces work fine. MU360 IEDs are well tested before unleashed to end customers, but if needed a procedure for final inputs and outputs, then this section can be used. Up to end user apply here a final configuration, since aligned to CORTEC and hardware disposition.

It is assumed that following instructions will be executed by a professional:

1. Well-read about network operations, can Inspect network by a sniffer tool, like Wireshark (Refer to Cyber Security).
2. Well-read how VLANs work.
3. Can check if network is well wired, that MU360 will not face troubles with VLAN configurations when using any fiber bridge, like S2024 switch (Refer to Configuring Network Interfaces).
4. Can check if boards are well wired for correct animations, following pinouts shown in this manual (Refer to Digital Inputs Unit DIU211, Digital Outputs Unit DOU201, High Break Unit HBU210, CT/VT Protection Unit TMU310 and SCT/VT Measurement Unit TMU320 sections) and positioned at correct slots (Refer to Application Code and Hardware CORTEC).
5. Can check correct power source (Refer to Power Supply).
6. Well-read about differences between ethernet layer 2 (Goose, Samples Values) and ethernet layer 3 (Ping, MMS, ICT connection) communication.
7. Aware that wrong ethernet binding to local site can provide bad side effects to an entire network, as Sample Values and Goose bursts, increasing local network load. *Keep it isolated during commissioning.
8. Aware that wrong deployments will force previous configurations to be lost (Refer to Software Management).
9. Knows how CORTEC is organized (Refer to Application Code and Hardware CORTEC).
10. Aware about Cyber Security best practices (Refer to Cyber Security).

9.2.1 CONFIGURATION

Any action in MU360 should be done based on some configuration. Basic one is deployed by GE Vernova, known as default configuration, but it is not able to validate based on user's actions, since end user will not have internal access same way GE Vernova has over the course from a previous industrialization procedure.

For creating a configuration, Refer to Application/Softwar. Follow steps below:

1. Check all interfaces needed: PTP, DIUs? DOUs? HBUs? TMUs? Process\Station bus? (Refer to Application Code and Hardware CORTEC, Analog Interfaces, Binary Interfaces and Time Management sections).
2. Do all correct physical interoperation and wirings for DIUs, DOUs, HBUs, Network, TMUs.
3. Create a configuration and ensure CORTEC area is well covered with all interfaces needed by previous item. If TMU in the context, make sure Application Code is hosting at least one LDTM function. (Refer to Analog Interfaces).
4. Configure Administration ethernet IP (Refer to Firmware update or Configuration Updatel).
5. *1 If needed MMS on process bus, configure Process bus ethernet IP. (Refer to Process Bus).
6. *1 If needed MMS on station bus, configure Station bus ethernet IP. CORTEC must indicate this option (Refer to Station Bus).
7. *2 Make subscriptions to animate DOUs\HBUs from another Logical device. (Refer to GOOSE and Input/Output Associations).
8. Configure Goose to publish any data point. If DIU inside, map any LDSUIED/LPDIX/IndX. If DOU/HBU map any LDSUIED/LPDOX/CmdDOX too.(Refer to GOOSE).

9. If TMU in the context, configure Sample Values to publish either TCTRs or TVTRs (Refer to Analog Interfaces).
10. Make sure PTP is well configured and wired to a Grand Master Clock, GPS receptor. Check if needed VLAN.
11. Deploy configuration to MU360.
12. Wait normalization (“In Service”), till having good indication. Check LEDs. (Refer to LDSUIED-IED Supervision Logical Device).

*1 MMS can work either on process bus or station bus only.

*2 An internal Indication data point from DIU (LDSUIED/LPDIX/IndX) can animate DOU and HBU data points (LDSUIED/LPDOX/CmdDOX). Check input/Output associations (Refer to Input/Output Associations). In fact any internal binary data point can bind to it. Useful when DOU/HBU is present.

9.2.2 CHECKING INTERFACES

Once a basic configuration (Refer to Configuration) is done to attend specific CORTEC, some tests are needed for a final checking.

1. Check if LEDs hosted on HMI as described by LDSUIED (Refer to LDSUIED-IED Supervision Logical Device) present good indications. Good configuration, good Hardware and good bindings expect good LEDs indications too.
2. Imitate troubles associated to PTP, see if corresponding LED changes.
3. Check by any Sniffer Tool if Samples Values are issued. Notice quality bits for good PTP and bad PTP. (Refer to Sampled Values (SV)-IEC61869-9IEC61850-9-2LE).
4. Check by any Sniffer Tool if Goose is issued. (Refer to Generic Object Oriented Substation Event (GOOSE)-IEC61850-8-1).
5. Check if Administrative IP is pinging.
6. Check if Station bus IP is pinging (when demanded by MMS).
7. Check if Process bus IP is pinging (when demanded by MMS).
8. If DIU in the context, animate electrical input channels and check bursts happening by any Sniffer Tool in Process bus coming from DIUs.
9. If DIU and DOU/HBU in the context, check relays from DOU/HBU switching. Check bursts happening by any Sniffer Tool in Process bus coming from DOUs/HBUs.
10. Check if EnerVista Flex v2 can connect to Administrative IP. (Refer to Connecting the Device).
11. Download all logs by EnerVista Flex v2 using previous connection. (Refer to Generating and Downloading Logs).

Any problem coming from an item here described can indicate either hardware problem or bad environment interoperation. If last one is well known, with low chance to be root cause from any trouble, contact GE Vernova for a better support on your MU360 IED.

9.3 TROUBLESHOOTING

The aim of this chapter is to describe standard methods to diagnose the MU360 status and provide common maintenance procedures for the replacement and/or addition of components.

Before carrying out any maintenance operation, please refer to the Safety Section and he GE Vernova Grid Solutions Safety Guide: SFTY/4L M/C11 (or later issue).

9.3.1 ETHERNET IP RECOVERY

The MU360 is following Cyber Security best practices, then no IED information is shown by itself. Although this limitation, when IP is not known anymore, it perhaps can be recovered checking Connectivity Issues (Refer to Connectivity Issues) for “No Ping” error. This action depends on a professional well-read about network operations. Better action is based on electrical SFP at Administration port using direct CAT6 cable between IED and user's computer. Use only the SFPs indicated in this manual, Refer to Small Form-Factor Pluggable Module (SFP).

9.3.2 FACTORY RESET

The MU360 can perform a complete Factory Reset, based on procedures shown at Software Management section (Refer to Software Management). This action should be done only when there is not any other alternative. Be aware, all application content will be lost, written by a whole new installation with default configuration.

9.3.3 SYNCHRONIZATION FAILURE (SYNC INDICATOR DOES NOT LIGHT UP)

The MU360 is based on PTP Peer to Peer association (P2P), refer to Time Management section (Refer to Time Management) for a better understanding, but means that all PTP network elements should attend PTP demand, performance. Actions depend on a professional well-read about network operations.

Error	Probable Cause	Solution
LDSUIED/LTMS0/TmChSt1 indicates bad state by MMS connection.	Wrong MU360 configuration	Check if VLAN ID is ok (Refer to VLAN).
	Grand Master Clock not working	Check if other IED is associated to same Grand Master Clock and working. Check if PTP packets can be noticed in the bridge switch interfacing MU360.
	PTP network based on E2E	All PTP network should be based on P2P. Time Management section (Refer to Time Management).
HMI LED3 off state	LED3 from HMI is not working	Check if other PTP indications show same bad side effect, as: Option1: Collecting logs (Refer to Generating and Downloading Logs). Option 2: check LDSUIED/LTMS0/TmChSt1 state by MMS connection (Refer to LDSUIED-IED Supervision Logical Device).
	Bad PTP	Check error "LDSUIED/LTMS0/TmChSt1 indicates bad state by MMS connection."

9.3.4 CONNECTIVITY ISSUES

The following table presents a guidance on how to detect and fix network connection issues on the MU360 device network interfaces:

Error	Probable Cause	Solution
No link detected	No cable connected	Ensure the cable is properly connected on both sides.
	Optical fiber cable broken	Replace optical fiber cable.
	Inverted TX and RX	Invert TX and RX fiber connections at one end.
	Different SFPs connected	Check if both sides have compatible SFP specifications.
	Incompatible SFP used	Check for homologated SFP list (Chapter 8).
	Wrong port speed setup on the network switch	Check if the port is configured properly on the network switch (Chapter 7).
No Ping at Admin port based on Electrical SFP	No link detected	Check the solution for error "No link detected".
	Wrong port speed	Be sure the Admin port speed is correctly set (Chapter 7).
	Lost the IED port IP address	Before actions, isolate the IED, connecting only the Administration port directly to the user´s computer using an electrical homologated SFP (Chapter 8) by CAT6 cable.
		Option 1: Perform a full scan of all the IP addresses on the IED network using any IP scanner tool from market.
		Option 2: Open command prompt as administrator from computer. Clean ARP table with "arp -d" command. Wait for a while (1min). Check ARP table with "arp -a" command. The IED interface IP and MAC Addresses are shown in ARP table.
		Option 3: Execute the factory reset on the IED to return to the default configuration. Refer to Software Management.

Error	Probable Cause	Solution
No ping (Any port based on Fiber SFP)	No link detected	Check the solution for "No link detected".
	IED IP address incorrect	Ensure the destination IP address is correct.
	No IED IP address configured for the port.	Ensure an IP address is configured for the communication channel (Chapter 5). If Station Bus is configured, no IP address is assigned to the Process bus.
	Wrong port speed setup on the network switch	Check if the port is configured properly on the network switch (Chapter 7).
	IP address misconfiguration on computer	Configure the computer network interface connected to the IED within the same network, assigning a different IP address of the IED and the same netmask.
	Lost the IED port IP address	Option 1: Perform a full scan of all the IP addresses on the IED network using any IP scanner tool from market.
		Option 2: Isolate the device from the network, connecting only the IED to a network switch properly configured and with a homologated SFP (Chapter 8). Deactivate all network interfaces except for the one connected to the IED. Deactivate wireless interface(s). Open command prompt as administrator. Clean ARP table with "arp -d" command. Wait for a while (1min). Check ARP table with "arp -a" command. The IED interface IP and MAC Addresses are shown in ARP table.
		Option 3: Check all possible actions before. Execute the factory reset on the IED to return to the default configuration. Link to Software Management.
	Network in loop, bridge switch overloaded.	Exchange SFP at Administration port to an Electrical SFP, check "No Ping at Admin port based on Electrical SFP". Refer to Small Form-Factor Pluggable Module (SFP).
Missing packets	Duplicated IP address	Check if there's other device with the same IP address on the network, by disconnecting the IED and trying to ping the same IP address.
	Optical fiber cable issue	Replace optical fiber cable.
	Network issue	Isolate the IED and make a direct connection to make sure there is no network issue affecting the communication.

Error	Probable Cause	Solution
No SV No GOOSE	No packets sent	Ensure the packets are sent and check their contents using a network protocol analyzer like Wireshark. If no packets are seen, check the next probable causes.
	No control block configured	Ensure there's a control block configured for GOOSE or Sampled Values.
	Control block disabled	Ensure the configured control blocks are enabled on the control block configuration on the IED configurator tool.
	VLAN mismatch	Check if the configured VLANs are enabled on the switch ports connected to the device, matching to the configuration.
No connection from the configurator tool - ICT (Enervista Flex)	IP address not reachable	Check the solution for "No ping".
	Device booting	Check if ping is working and the "In Service" LED is on.
	Firewall blocking the connection	Check if your computer firewall is not blocking the gRPC port connection (see Chapter 4 - Cyber Security).
	Unknown issue	Execute the factory reset on the IED to return to the default configuration Refer to Software Management.
No MMS connection	IP address not reachable	Check the solution for "No ping".
	Device booting	Wait for some time after the "In Service" LED is on, and ping starts working.
	Firewall blocking the port	Check if your computer firewall is not blocking the MMS port connection (Refer to Cyber Security).
	VLAN mismatch	Check if the configured MMS VLAN is enabled on the switch ports connected to the device. Check if the MMS client on the peer host is sending the packets with the same VLAN.

9.3.5 CONFIGURATION AND HARDWARE CHECK

Refer to the Quick Installation Guide Chapter.

9.4 HOW TO REPAIR AND/OR UPGRADE AN MU360

If the MU360 develop a fault whilst in service, depending on the nature of the fault, the watchdog contacts will change state and an alarm condition will be flagged. Due to the extensive use of surface-mount components (SMC) faulty boards should be replaced, as it is not possible to perform repairs on damaged circuits with SMC technology. Thus, either the complete MU360 or just the faulty board, identified by the built-in diagnostic software, can be replaced.

The preferred method is to replace the complete MU360, as it ensures that the internal circuitry is protected against electrostatic discharge and physical damage at all times, and overcomes the risk of incoherency with the new boards. In some cases, it may be difficult to remove an installed MU360 due to limited access in the back of the cubicle and rigidity of the scheme wiring, then only the faulty elements will be replaced.

Replacing boards can reduce transport costs but requires clean, dry on-site conditions and higher skills from the person performing the repair. If an unauthorized service centre performs the repair, the warranty will be invalidated.

Caution:
Before carrying out any work on the device, the user should be familiar with the contents of the Safety Section and Technical Specifications chapters, as well as GE Grid Solutions' Safety Guide: Pxxx-SG-4LM-1 or later issue, and have read the ratings on the equipment's rating label.
This should avoid incorrect handling of the electronic components and prevent damage.

Caution:
Only qualified personnel may carry out maintenance operations.
Always hold boards by their sides and DO NOT touch either the component side or the soldering side.
Always wear anti-static protection when handling printed circuit boards.

9.4.1 REPLACING AN ENTIRE MU360

The case and rear terminal blocks have been designed to facilitate removal of the complete MU360. Before working at the rear of the MU360, isolate all the voltages and currents connected to the MU360.

Note:
The MU360 units have current transformer shorting switches which close when the terminal block is removed.

Note:
Before any disconnection, check the labels correctly define the connectors and match with the wiring description you have. Otherwise, note the current wiring in order to prepare the new MU360 installation.

Replacing an entire MU360 guide:

1. Disconnect the power supply connector
2. Disconnect the fibre optic and serial links connected on the CPU board
3. Disconnect the input/output connectors
4. Disconnect the earth connection

There are two types of terminal blocks used on the MU360:

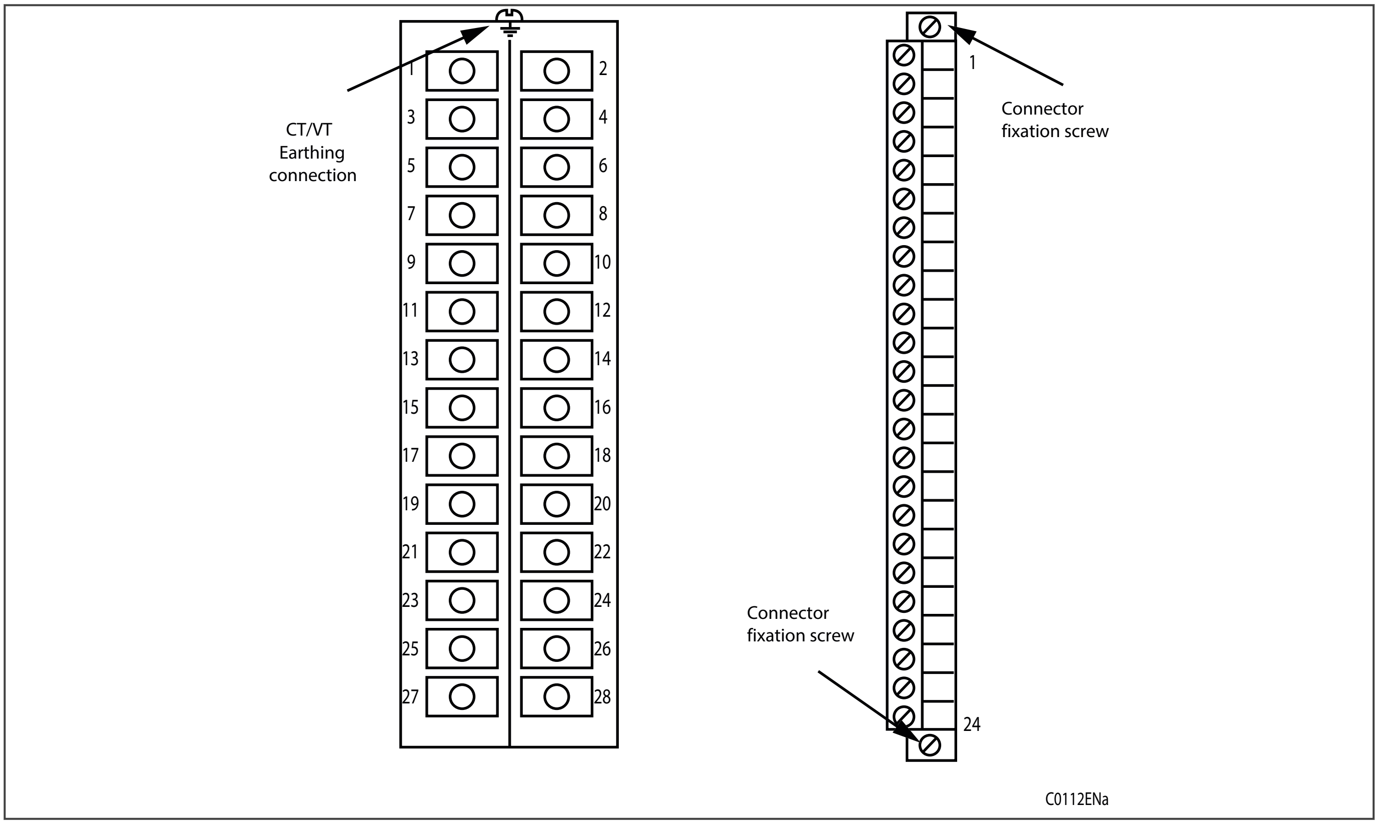


Figure 172: Location of securing screws for the terminal blocks

> *Note:*
> *The use of a magnetic bladed screwdriver is recommended to minimize the risk of the screws being left in the terminal block or lost. A 3 mm flat head screwdriver is recommended for fixing the screws. A 6 mm flat head screwdriver is recommended for the CT/VT earthing connections.*

Without exerting excessive force or damaging the scheme wiring, pull the terminal blocks away from their internal connectors.

Remove the screws used to fasten the MU360 to the panel or rack, etc. These are the screws with the larger diameter cross heads that are accessible when the access covers are fitted and open.

> **Caution:**
> **If the top and bottom access covers have been removed, do not remove the screws with smaller diameter heads, even if they are accessible. These screws hold the front panel onto the MU360.**

Withdraw the MU360 from the panel or rack carefully, and take care of its weight because there are some heavy parts due to the internal transformers.

To reinstall the repaired or new DS Agile C26x, follow the above procedure in reverse. Ensure that each terminal block is relocated in the correct position, the case correctly earthed and the IRIG-B and fibre optic connections are put back in place.

Once the re-installation is complete the DS Agile C26x should be commissioned again, using the instructions in chapter C26x/EN CM.

9.4.2 INSTALLING A BOARD

To replace any of the MU360 unit's boards it is necessary to remove the front panel.

Before removing the front panel, the auxiliary supply must be switched off. It is also strongly recommended that the voltage and current transformer connections and trip circuit are isolated.

Open the top and bottom access covers. With 80TE size cases the access covers have two hinge-assistance T-pieces, which clear the front panel moulding when the access covers are opened by more than 120°, allowing their removal.

If fitted, remove the transparent secondary front cover. A description of how to do this is given in C26x/EN IT (Introduction).

By applying outward pressure to the middle of the access covers, they can be bowed sufficiently to disengage the hinge lug, allowing the access cover to be removed. The screws that fasten the front panel to the case are now accessible.

The 40TE size case has four cross head screws fastening the front panel to the case, one in each corner, in recessed holes. The 80TE size case has an additional two screws, one midway along each of the top and bottom edges of the front plae. Undo and remove the screws.

Caution:
Do not remove the screws with larger diameter heads, accessible when the access covers are fitted and open. These screws hold the MU360 in its mounting (panel or cubicle).

When the screws have been removed, the complete front panel can be pulled forward and separated from the metal case.

Warning:
Caution should be observed at this stage because there is a cable connecting the front panel to the rest of the MU360 circuitry.

Additionally, the internal circuitry of the MU360 will now be exposed and not protected against electrostatic discharges and dust ingress, etc. Therefore, ESD precautions and clean working conditions should always be maintained.

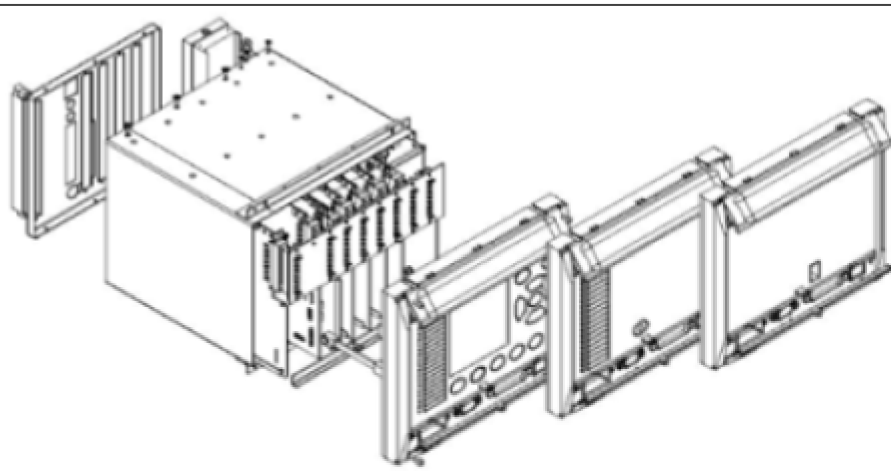


Figure 173: 40TE case with TMU3xx board

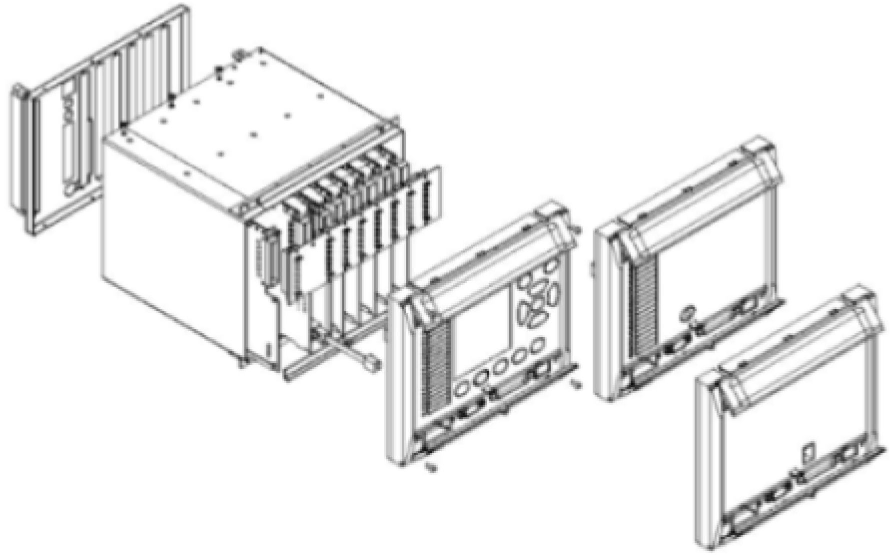


Figure 174: 40TE case without TMU3xx board

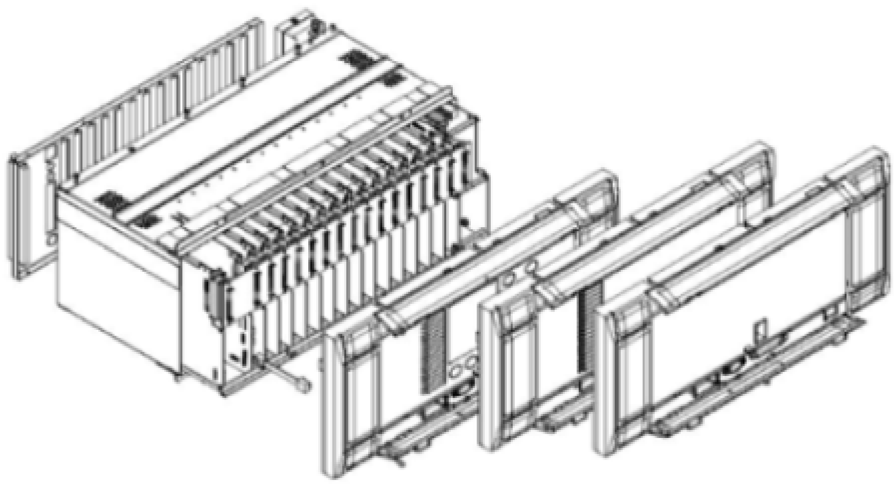


Figure 175: 80TE case with TMU3xx board

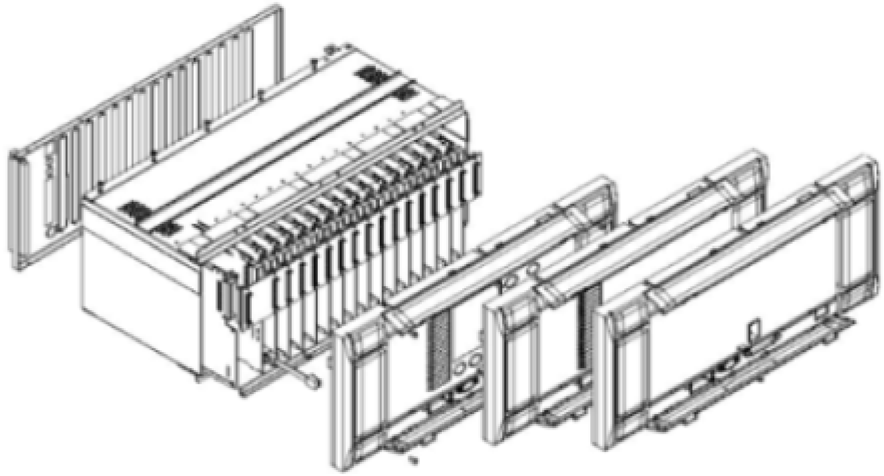


Figure 176: 80TE case without TMU3xx board

The boards within the MU360 are now accessible. The figures above show the board locations for the MU360 units in 40TE and 80TE size cases.

Looking to the front of the MU360 with the front panel off, you can have access to a printed circuit connecting all the boards together: this is the backplane board.

To remove a board, you need to:

- Pull the backplane board (FBP280 for 80TE case or FBP242 for 40TE case) out by holding it by the two extremities
- Remove the board screws at the top and the maintain bar at the bottom of the case.

> *Note:*
> *To ensure compatibility, always replace a faulty board with one of an identical part number and set jumpers in the identical position.*

All the boards are shown and described in MU360/EN HW.

9.4.2.1 INSTALLING A POWER SUPPLY

The BIU is the power supply board located on the extreme left-hand side (slot A) of MU360.

Pull the power supply module forward, away from the rear terminal blocks and out of the case. A reasonable amount of force will be required to achieve this due to the friction between the contacts of the two medium duty terminal blocks. It is recommended that the use of a special tool is used for extracting the board (internal reference is 2070860).

Do not forget to set the jumpers on the new board in the same position as the previous one, refer to the Hardware chapter for jumper positions.

9.4.2.2 INSTALLING A POWER SUPPLY

After replacement of the main processor board, all the settings required for the application must be reloaded, i.e.:

1. The firmware must be updated
2. The configuration database must be uploaded
3. The S1 setting file must be uploaded

The CPU board is located next to the BIU board (slot B/C).

Do not forget to disconnect the rear cables (optical fibers and fail-safe wire) before replacing the board, and reconnect them afterwards.

9.4.2.3 INSTALLING AN I/O BOARD

The I/O boards can be located in any slot from C to Q.

Do not forget to set the jumpers on the new board in the same position as the previous one.

9.4.2.4 INSTALLING A CT/VT MODULE

The measurement unit is on the extreme right-hand side of MU360.

Pull the TMU3xx module forward, away from the rear terminal blocks and out of the case. A reasonable amount of force will be required to achieve this due to the friction between the contacts of the heavy-duty terminal blocks.

9.4.3 RE-ASSEMBLING AN MU360

Before re-assembling the module with a replacement board, make sure the address for the replacement board is the same address as the replaced board, by checking the jumpers on the boards.

Address by Slot													
D	E	F	G	H	I	J	K	L	M	N	O	P	Q
0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110

Note:
1. Jumper fitted means "0"
2. TMU3x0 there are no jumpers

Insert the backplane board back into the rack.

Screw the bar to the bottom of the case.

Replace the front panel. After refitting and closing the access covers, press the hinge-assistance T-pieces until they click back into the front panel moulding.

Once the device has been reassembled, after repair, it must be commissioned again (see C26x/EN CM).

9.5 CLEANING INSTRUCTIONS

Before cleaning the MU360 ensure that all AC/DC supplies, current transformer, and voltage transformer connections are isolated, to prevent any risk of electric shock whilst cleaning.

Front panel cleaning:

- Use a smooth cloth
- Do not use abrasive material or detergent chemicals

9.6 MAINTENANCE RECORD SHEET

Product Serial Number	

Date	Engineer	Board Type	Slot Letter in the Rack (Between A and Q)	Previous Board Serial Number	New Board Serial Number
/ /					
/ /					
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CHAPTER 10

TECHNICAL SPECIFICATIONS

10.1 CHAPTER OVERVIEW

This document is a chapter of the MU360 documentation, listing its technical characteristics.

This chapter contains the following sections:

10.2 GENERAL DATA

10.2.1 ENVIRONMENTAL CONDITIONS

Environmental Conditions Specification	
Operating temperature range	-25°C (-13 °F) … + 55°C (+131°F)
Tested as per IEC 60068-2-1: 2013	-25°C (-13°F)
Tested as per IEC 60068-2-2: 2013	+70°C (+158°F)
Relative humidity	0 … 95 %, non-condensing
Temporarily permissible temperature under operation	-25°C (-13°F) … + 70°C (+ 158°F) (Tested for 96 hours with 50% of binary I/O continuously activated)

10.2.2 DEGREE OF PROTECTION

Enclosure Protection IEC 60529	
Front flush mounted with panel	IP52
Rear and sides (without TMU)	IP2X
Rear and sides (with TMU) *	IP1X

* IP2X for devices with TMU can be obtained by installing the Terminal Block Protection Shield accessories with order codes: GJ6079001 and GJ6078001.

10.2.3 DIMENSIONS AND WEIGHT

Dimensions of the Equipment	
Height	177.8 mm/7 inches (4 U)
Width	203 mm/8 in (40TE) 406, mm/16 in (80TE)
Depth	203 mm/8 in
Weight	< 4 kg/< 8.82 lb (40TE) < 8kg/< 17,6 lb (80TE)

10.3 RATINGS

10.3.1 POWER SUPPLY - BIU261S

Power Supply Specifications BIU261S	
Operating nominal voltage	48 to 250 VDC
Frequency	DC only
Operating voltage range	40 to 300 VDC
Inrush current	19.4 A @ 110 VDC for 110 ms 43.8 A @ 220 VDC for 92 ms
Power consumption	38.7 W @ 220 VDC 38.5 W @ 110 VDC
Insulation	> 100 MΩ at 500VDC
Dielectric Strength	2.2 kV - 60 Hz for 1 minute
Connector	28

10.3.2 IN SERVICE CONTACT

SERVICE Contact Specifications	
Description	**Values**
Switching voltage	24 to 250 VDC/230 VAC
Maximum continuous current	5 A
Making capacity (rated inrush current)	5 A continuously 30 A for 500 ms (open for 40 s afterwards) or 250 A for 30 ms
Making time	< 7 ms
Breaking capacity	Breaking capacity for 100 000 operations: DC: 150 W resistive, 15 W inductive (L/R = 20 ms) AC: 1500 VA resistive Breaking capacity reduced to 90 000 operations: AC: 1500 VA inductive (power factor = 0.7) Breaking capacity confirmed after 10 000 operations (contact resistance still lower than 250 mΩ): DC: 30 W inductive (L/R = 40 ms)
Dielectric strength of the coil and the contacts	5000 VAC
Isolation	2.2 kV (CM) at 60 Hz for 1 minute
Number of operations	Unloaded contact: > 100 000 Loaded contact: >10 000

10.3.3 BINARY INPUTS SPECIFICATIONS - DIU211

Digital Inputs Specifications						
Wetting Voltage (Jumper/CORTEC)	Input Voltage	Pick-up Threshold	Drop-off Threshold	Trigger Current	Current at Rated Voltage	Rated Power
A01	24 VDC	10 VDC	8 VDC	30 mA for 2 ms	3.2 mA	0.077 W
A02	48 VDC - 60 VDC	17.4 VDC	12.5 VDC	30 mA for 2 ms	2.9 mA at 48 V	0.14 W
A03	110 VDC - 125 VDC	50 VDC	29.9 VDC	30 mA for 2 ms	2.4 mA at 110 V	0.26 W
A04	220 VDC	86 VDC	67 VDC	30 mA for 2 ms	1.9 mA	0.42 W
A07	110 VDC - 125 VDC with 80% threshold	86 VDC	67 VDC	30 mA for 2 ms	2.4 mA at 110 V	0.26 W
A08	220 VDC with 80% threshold	176 VDC	132 VDC	30 mA for 2 ms	1.9 mA	0.42 W

10.3.4 BINARY OUTPUTS SPECIFICATIONS_DOU201

Binary Output Contact Specifications	
Description	Values
Switching voltage	24 to 250 VDC/230 VAC
Maximum continuous current	5 A
Making capacity (rated inrush current)	5 A continuously 30 A for 500 ms (open for 40 s afterwards) or 250 A for 30 ms
Making time	< 7 ms
Breaking capacity	Breaking capacity for 100 000 Operations: DC: 150 W resistive, 15 W inductive (L/R = 20 ms) AC: 1500 VA resistive Breaking capacity reduced to 90 000 operations: AC: 1500 VA inductive (power factor = 0.7) Breaking capacity confirmed after 10 000 operations (contact resistance still lower than 250 MΩ): DC: 30 W inductive (L/R = 40 ms)
Dielectric strength of the coil and the contacts	5000 VAC
Isolation	2.2 kV (CM) AT 60 Hz for 1 minute
8 single-pole relays	Normally open contacts
2 double-pole relays	1 common for 2 output contacts (NO/NC changeover)
Number of operations	Unloaded contact: > 100 000 Loaded contact: >10 000

10.3.5 HIGH SPEED OUTPUT - HBU210

High Speed Output Contact Specifications	
Description	Values
Nominal operating voltage range	Up to 250 VDC
Transient impulse clamping level	450 V minimum
Carry (steady state current)	Single pole: 10 x 10 A at 55°C Double pole: 5 x 16 A at 40°C

High Speed Output Contact Specifications	
Description	**Values**
Making capacity (rated inrush current)	33 A for 3 s
Maximum inrush current	100 A for 30 ms
Making time	< 0.5 ms
I^2t rating	300 A^2/s
Contact resistance	Make: 33 mΩ Carry: 10 mΩ
Breaking capacity	Breaking capacity for 10 000 operations: DC: 7500 W resistive, 2500 W inductive (L/R = 40 ms) AC: 7500 W resistive, 2500 W inductive
Number of operations	Unloaded contact: > 100 000 Loaded contact: > 10 000
Isolation	2.2 kV (CM) at 50 Hz for 1 minute, 5 kV impulse

High Speed Output Contact Monitor Specifications	
Description	**Values**
Applicable voltage	24 VDC to 300 VDC
Trickle current	< 2 mA

10.3.6 TRANSDUCERLESS MEASUREMENT UNIT (TMU) CT/VT ANALOG INPUTS

For MU360, you can install TMU310, and TMU320 boards.

The TMU320 provides 4 Current Transformer (CT) inputs & 5 Voltage Transformer (VT) inputs. The TMU310 provides 4 Current Transformer (CT) inputs & 4 Voltage Transformer (VT) inputs.

10.3.6.1 TMU320 - CURRENT TRANSFORMERS (CT)

On the terminal block, there are two available nominal currents, each with different attributes. The current measurement inputs to each of the 4 Current Transformers (CT) include the following attributes:

Analog Current Inputs		
Description	**Values**	**Values**
Model	1A	5A
Nominal AC current (In)	1 A_{RMS}	5 A_{RMS}
Minimum measurable current with same accuracy	12,5 mA @ 0.4% Error and 20' (0,0125 In 0.4% Error and 20'	62,5 mA @ 0.4% Error and 20' (0,0125 In 0.4% Error and 20')
Maximum measurable current	50 mA - 2 A @ 0.2% Error and 10' (0.05 In - 2 In 0.2% Error and 10) 0.2DR5-200	250 mA - 10 A 0.2% Error and 10' (0.05 In - 2 In 0.2% Error and 10')
Frequency	50 or 60 Hz ± 10%	50 or 60 Hz ± 10%
Overload	* 2,5 A Continuous * 10 A @ 5 s (2.5 In Continuous *10 In* @ 5 s	* 2,5 A Continuous * 50 A @ 5 s (2.5 In Continuous *10 In* @ 5 s

10.3.6.2 TMU320 - VOLTAGE TRANSFORMERS (VT)

The voltage measurement inputs to each of the 5 Voltage Transformers (VT) include the following attributes:

Analog Voltage Inputs	
Description	**Values**
Nominal AC voltage	Phase Voltage: 2 V - 240 V
Measurable range	2 V - 20 V @ 0.4% Error - 20’ 20 V - 200 V @ 0,2% Error - 10’ 200V - 240V @ 1.0% Error -120'
Overload withstand	2.4 Vn Continuous 2.6 Vn @ 10 s

10.3.6.3 TMU310 - CURRENT TRANSFORMERS (CT)

On the terminal block, there are two available nominal currents, each with different attributes. The current measurement inputs to each of the 4 Current Transformers (CT) include the following attributes:

Analog Current Inputs		
Description	**Values**	**Values**
Model	1A	5A
Nominal AC current (In)	1 A_{RMS}	5 A_{RMS}
Minimum measurable current with same accuracy	200 mA - 800 mA @ 0.4% Error and 20' (0,2 - 0,8 In 0.4% Error and 20'	1 A - 4 A @ 0.4% Error and 20' (0,2 In - 0,8 In 0.4% Error and 20')
Maximum measurable current	800 mA - 2 A @ 0.2% Error and 10' (0.8 In - 2 In 0.2% Error and 10) 2 A - 30 A @ 1% Error and 2° (120') (2 In - 30 In 1% Error and 2° (120')) 30 A - 60 A @ 6TPM10-180 30 In - 60 In (6TPM10-180)	4 A - 10 A @ 0.2% Error and 10' (0.8 In - 2 In 0.2% Error and 10) 10 A - 150 A @ 1% Error and 2° (120') (2 In - 30 In 1% Error and 2° (120')) 150 A - 300 A @ 6TPM10-180 30 In - 60 In (6TPM10-180)
Frequency	50 or 60 Hz ± 10%	50 or 60 Hz ± 10%
Overload withstand	*4 A Continuous *30 A @ 5 s *100 A @ 1 s *250 A @ 10 ms	*20 A Continuous *150 A @ 5 s *500 A @ 1 s *1250 A @ 10 ms

10.3.6.4 TMU310 - VOLTAGE TRANSFORMERS (VT)

The voltage measurement inputs to each of the 4 Voltage Transformers (VT) include the following attributes:

Analog Voltage Inputs	
Description	**Values**
Nominal AC voltage	Phase Voltage: 2 V - 240 V
Measurable range	2 V - 20 V @ 0.4% Error - 20’ 20 V - 200 V @ 0,2% Error - 10’ 200V - 240V @ 1.0% Error - 120'
Overload withstand	2.4 Vn Continuous 2.6 Vn @ 10 s

10.3.7 OPTICAL ETHERNET PORTS

Optical Ethernet Ports Specification	
Interface	1000 BASE-LX
Bitrate	1000 Mbps

Optical Ethernet Ports Specification	
Wavelength	1300 nm
Connector	LC
Fiber type	monomode 1310 nm
Emission power	-20 dBm
Sensitivity	-32 dBm
Maximum applicable power	-14 dBm

10.3.8 SERIAL PORTS

Serial Ports Specification	
Interface	RS485
Use	Modbus (disabled)
Bit rate	115200 bps
Connector	Eurostyle Terminal Blocks

10.4 TYPE TEST

10.4.1 SAFETY RELATED TESTS

Test	Test Standard	Test Level
Impulse voltage	IEC 60255-27:2013	5 kV, 1.2/50 μs, 0.5 J
Dielectric voltage	IEC 60255-27:2013	2.2 kV rms, 1 minute
Insulation resistance	IEC 60255-27:2013	> 100 MΩ, 500 V
Protective bonding resistance	IEC 60255-27:2013	< 0.1 Ω at 20 A

10.4.2 MECHANICAL TESTS

Test	Test Standard	Test Level
Vibration	IEC 60255-21-1: 1988	Class 1
Shock	IEC 60255-21-2: 1988	Class 1
Bump	IEC 60255-21-2: 1988	Class 1
Seismic	IEC 60255-21-3: 1993	Class 1

10.4.3 CLIMATIC TESTS

Test	Test Standard	Test Level
Cold test - Operational	EN 60068-2-1: 2007	Test Ad - 25°C, 96 hrs
Cold test - Storage	EN 60068-2-1: 2007	Test Ab - 40°C, 96 hrs
Dry heat test - Operational	EN 60068-2-2: 2007	Test Bd + 70°C, 96 hrs
Dry heat test - Storage	EN 60068-2-2: 2007	Test Bb + 70°C, 96 hrs
Change of temperature	EN 60068-2-14: 2009	Test Nb - 25°C to + 55°C
Damp heat cyclic	EN 60068-2-30: 2005	Test Db + 55°C, 93% RH + 25°C, 97% RH 6 days
Damp heat steady state	EN 60068-2-78: 2013	Test Ab + 40°C, 93% RH 10 days
Enclosure protection	IEC 60529: 2013	IP40 front face IP20 sides of case IP20 rear of case

10.4.4 DC AUXILIARY SUPPLY TESTS

Test	Test Standard	Test Level
Inrush current	IEC 60255-1: 2009 Sub-clause 6.10.4.3	110 VDC, I < 19.4 A, T < 110 ms 220 VDC, I < 43.8 A, T < 92 ms
DC voltage interruption and dips	IEC 61000-4-29: 2000	ΔU 100% for 50ms ΔU 30% for 100ms ΔU 60% for 100ms
Reverse polarity	IEC 60255-27: 2013 Sub-clause 10.6.6	Polarity - for the lower potential of the supply Polarity + for the lower potential of the supply
Voltage ripple in DC	IEC 61000-4-17: 1999	15% of rated DC value, 100Hz
Gradual shut-down/start-up	IEC 60255-26: 2013	Shut-down ramp 60 s Power off 5 min Start-up ramp 60 s

10.4.5 ELECTROMAGNETIC COMPATIBILITY (EMC) TESTS

Test	Test Standard	Test Level
Radiated emission	CISPR 11: 2010	Class A 30 MHz to 230 MHz 50 dB (μV/m) quasi peak at 3 m 230 MHz to 1 000 MHz 57 dB (μV/m) quasi peak at 3 m
	CISPR 22: 2008	Class A 1 GHz to 3 GHz 56 dB (μV/m) Average 76 dB (μV/m) peak at 3m 3 GHz to 6 GHz 60 dB (μV/m) Average 80 dB (μV/m) peak at 3m
Conducted emission	CISPR 22: 2008	Class A 0.15 MHz to 0.5 MHz 79 dB (uV) quasi peak 66 dB (uV) average 0.5MHz to 30MHz 73 dB (uV) quasi peak 60 dB (uV) average
Electrostatic discharge	IEC 61000-4-2: 2008	Level 4: 8 kV contact/15 kV air
Radiated immunity	IEC 61000-4-3: 2006	80 to 2700 MHz 10 Vrms @ 1 kHz 80% AM Spot tests at 80, 160, 380, 450, 900, 1850, 2150 MHz
Fast transient immunity	IEC 61000-4-4: 2012	Level 4: 4 kV 5 kHz and 100 kHz
Surge immunity	IEC 61000-4-5: 2005	Level 4: 4 kV (line-to-earth) 2 kV (line-to-line)

Test	Test Standard	Test Level
Conducted immunity	IEC 61000-4-6: 2008	10 Vrms @ 1 kHz 80% AM 150 kHz to 80 MHz Spot tests at 27 MHz, 68 MHz
Power frequency magnetic field	IEC 61000-4-8: 2009	100A/m continuous 1000A/m short duration (3 seconds)
Power frequency	IEC 61000-4-16: 1998	30 A/m continuous 300 A/m 10s
Damped oscillatory wave	IEC 61000-4-18: 2006	Level 3: 1 kV (line-to-line) 2.5 kV (line-to-earth) 100 kHz and 1 MHz

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