

## **Specification for a communicating Switchboard system to monitor, control and maintain building LV electrical installations**

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A system for:

- Monitoring the protections, delivering predictive maintenance information in an electrical installation and controlling devices with information on their status.
- Transmitting orders from the BMS or through web pages access to the switchboard control devices
- Metering and transmitting electrical installation power consumption data to the BMS or FTP Server
- Offering simple switchboard dashboard
- Delivering email alarm on events

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**1. General recommendations:**

Communicating low voltage switchboards are a response to regulatory incentives and the need to control power consumption and energy costs

They also improve continuity of service by increasing the availability of power.

The installation switchboard shall therefore be equipped with a communicating system that makes it possible to monitor and control protection units with information on their status, to deliver maintenance equipment information using an open protocol such as Modbus TCP/IP or Modbus RS485 serial line:

Energy cost management: energy saving & optimization (water, air, gas, electricity steam)

Electrical Distribution network management: protection, monitoring & control

Asset management: use optimization, predictive maintenance, equipment alarming.

Transmit data to the BMS or FTP Server

Communicating low voltage switchboard shall offer Ethernet TCP/IP 10/100 Mbps ports to be connected on the building Local Area Network (LAN) and shall offer a real time access to device data by using a standard internet web browser.

**2. Applicable standards:**

Number	Title	Use
IEC / UL 60950	?	
IEC 60947-6-2 and UL508	?	?
IEC/EN – 61131-2	Programmable controllers - Equipment requirements and tests	Define Input and Output signal characteristics
IEC/EN – 60947-5-1 Part 5-1	Control circuit devices and switching elements – Electromechanical control circuit devices	Performance and tests of auxiliary contacts
IEC 60947-5-4	Control circuit devices and switching elements – Method of assessing the performance of low-energy contacts	Performances of low energy auxiliary contacts
IEC/EN 61439-1 & 2	Low-voltage switchgear and controlgear assemblies	Performance of the electrical assembly
IEC/ EN – 60664-1	Insulation coordination	Characteristics of devices for insulation
IEC 61557-12	Combined performance measuring and monitoring devices for electrical parameters	Accuracy class
IEC/EN – 62053-21 & 31	Meter standard	Pulse metering

**3. Characteristics, operating principle and indications:**

**3.1 General characteristics**

The communicating switchboard system comprises:

- One or more interfaces

The following information shall be accessible: in accordance with the IEC/EN 60947-5-1 standard for circuit breakers at all the layers of electrical distribution architecture (modular feeders up to incomer circuit breakers) :

- ON/OFF position (O/F) / trip indication (SD) / fault-trip indication (SDE).
- Cradle management : Draw out position
- The following commands shall be possible in accordance with the IEC/EN 60947-5-1 standard
  - Open / close / reset.

- When advanced trip units are used the following information shall be accessible:
  - instantaneous and demand values, maximeters/minimeters, energy metering, demand current and power, power quality.
  - protection and alarm settings
  - time-stamped trip and alarm histories and event tables
  - Maintenance indicators.
- Gathering digital and analog inputs and controlling output
- Energy meter in accordance with the IEC/EN – 62053-21 & 31 standard

### 3.2 Interfaces

Energy management system shall offer main interface and secondary interfaces for energy management issue. Data shall be collected via Ethernet TCP/IP and ModBus networks which communicating circuit breakers, I/O digital and analog input modules, pulse counter, power meter and energy meter will be connected to interface.

A switchboard display shall be connected via Ethernet TCP/IP network to switchboard interface and shall offer a real time direct data access to monitor and control devices and load.

Ethernet Communication interfaces will be compliant to Device Profile Web Service (DPWS) for discovery on the local area network (LAN).

Energy management interface shall offer direct access to data collection to monitor and control devices and load.

Energy management interface shall collect:

- Data from communicating circuit breaker with embedded measurement capability
- Pulse from metering pulse electrical, gas, water counters
- Data from communicating energy meters or power meters
- Logic state of technical devices or equipment
- **Device alarms with time logs**
- Temperature analog sensor value.

Energy management interface shall display via web pages:

- Energy consumption
- **Electrical data network monitoring**
- **Alarms and events**
- Energy quality monitoring
- Equipment or devices status (open, close, tripped, NA) and indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
- Operation and predictive maintenance monitoring.

Energy management interface shall integrate simple control functions via web pages:

- Load and devices via digital output
- Orders of actuator

#### 3.2.1 Main Interface

The main interface enables an intelligent modular unit (IMU), for Air or Molded Case circuit breakers to be connected to an Ethernet network and enables gateway to Modbus serial line connection.

An intelligent modular unit is a mechanical and electrical assembly containing one or more products to perform a function in a switchboard (incoming protection, motor command, and control). The modular units are easily installed in the switchboard.

The features of the main interface are:

- Dual Ethernet port for simple daisy chain connection
- Device Profile Web Service (DPWS) for discovery on the local area network (LAN)
- Dual Universal Logic Plug (ULP) compliant for advanced connection with Air or Molded Case circuit breaker

- Gateway for Modbus-SL connected devices
- Embedded set-up web pages
- Embedded monitoring web pages
- Embedded control web pages
- Built-in e-mail alarm notification
- The interface mounts on a DIN rail
- A stacking accessory enables the user to connect several Modbus interface for Air or Molded Case circuit breaker without additional wiring.
- The interface must be always supplied with 24 Vdc using an UL listed and recognized limited voltage/limited current or a class 2 power supply with 3 A maximum.
- The interface provides DC supply to the Modbus interfaces for Air or Molded Case circuit breaker and it is not necessary to supply them separately.
- The interface indicates the status of the interface, the Ethernet communication dual color ports, ULP and Modbus connections by using LED on the front panel.
- A locking pad on the front panel of the interface enables or disables to send the remote control commands over the Ethernet network to the interface, and to the other modules of the connected IMU.
- Pre-defined application adds new functions to the IMU in a simple way:
  - selection by the application rotary switch on the I/O application module, defining the application with pre-defined input/output assignment and wiring diagram
  - no additional setting with the customer engineering tool required. The resources not assigned to the pre-defined application are free for additional user-defined applications: cradle management, breaker operation, cradle management and Energy Reduction Maintenance Setting (ERMS) light and load control and other custom for protection / control / energy management / monitoring.
- The firmware can be updated using: FTP connection or customer engineering tool.

### 3.2.2 Secondary Interface

The secondary interface shall collect data from communicating circuit breakers, I/O digital and analog input modules, pulse counter, power meter and energy meter.

Secondary Communication interface enables Ethernet or Modbus serial line port connection.

The secondary communication interface comprises:

- Data concentrator
  - using an open protocol such as Modbus RS485 serial line or Modbus TCP/IP
  - Gathering digital and analog inputs and controlling output
  - whose inputs / outputs are organized by channel, with each channel used to connect one electrical device
  - compliant with the IEC/EN – 61131-2 standard
  - supplied by safety extra low voltage  $\leq 24$  V DC
- Indication auxiliaries that signal modular circuit breaker open/closed and tripped status
  - compliant with the IEC/EN 60947-5-4 standard
  - output voltage 24 V DC
- Auxiliaries for control and indication of open/closed status of breakers or control units (contactors and impulse relays) in accordance with the IEC/EN 60947-5-1 standard
  - Output voltages 24 V DC and 230 V AC
- Energy meter in accordance with the IEC/EN – 62053-21 & 31 standard
- Connection cables between the data concentrator and the devices or auxiliaries equipped with **plug-in** connectors

The system shall allow the connection of monitoring and control units equipped with 24 V DC contacts.

### 3.2.3 Switchboard display

Energy management system shall integrate a switchboard display. Switchboard display will be connected to switchboard interface via Ethernet TCP/IP network to offer:

- Real time display monitoring of devices
- Simple control of devices and load.

Switchboard display shall integrate functions to monitor:

- Energy consumption
- **Electrical network data**
- **Alarms and events**
- Energy quality
- Equipment or devices status (open, close, tripped, NA) and indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
- and predictive maintenance monitoring in the case of feeder up to 120 Amps.

Switchboard display will integrate functions of simple control of load and devices.

### 3.3 Measure

#### 3.3.1 – Incomer and Feeder over 120A / Air or Molded Case circuit breaker

Measure units shall offer measurement without additional module to circuit breakers. Measures shall be either:

- Currents (Phases, Neutral, average, max), voltage, power, Energy, Total Voltage Harmonic distortion, Total current harmonic distortion.
- Accuracies of the entire measurement system, including the sensors shall be :
  - Current: Class 1 as per IEC 61557-12
  - Voltage: 0.5 %
  - Power and energy: Class 2 as per IEC 61557-12
- Rogowski current transformers shall be used to ensure accurate measurements from low current up to high currents
- For safety reason, protection functions shall be electronically managed independently of measurement function by a dedicated ASIC.
- The measurements shall be displayed on the breaker itself and on a remote system via Ethernet or Modbus communication. In addition to these solutions it shall be possible to connect a remote display.

#### 3.3.2 – modular Feeder

Energy metering counter should be or offer

- direct measure up to 125A without external current transformer,
- 1P+N, 3P, 3P+N LV network monitoring
- DC power self supply without external DC power supply
- equipped with LCD display.
- Measurement features:
  - Active Energy (kWh) total counter
  - Active Energy (kWh) part-time counter with reset
- Equipped with setting pulse output to communicate Active energy consumption

Product measurement capability shall offer:

- To communicate indication of
  - fault types (LT, ST, instantaneous, ground fault), Interrupted current.
  - Status of circuit breaker operations: Open/Close/Tripped/NA
  -
- Ti24 direct device connexion with pre-connectorize patchcords (100 to 860 mm)

### 3.4 Operating and installation principles

#### 3.4.1 – Positioning, installation and connection of communicating data concentrators

When the application requires the usage of several data interfaces:

- The device interface enabling communication with the monitoring system (outside the switchboard) could be using a Modbus TCP/IP
- The others device interfaces inside the switchboard shall be using Modbus RS485 SL
- The different device interface shall be interconnected by Modbus RS485 SL chaining, inside the switchboard, using stackable connector
- The device interfaces shall be positioned in DIN rail for quick viewing of the network set up and status

- The data concentrators shall be equipped with plug-in type input/output terminal blocks
- The interfaces / devices links shall preferably be of the prefabricated type with RJ45 connectors that allow the device to be connected to the interface in a single operation and with no risk of error

### 3.4.2 – Operation of the communicating system

- The device interfaces shall be capable of being easily integrated into the installation’s communication network thanks to automatic adaptation of their communication parameters to match those of the network
- They shall provide data to the supervisor in Modbus tables, at fixed addresses that require no configuration
- The data shall be of the following type:
  - position of inputs/outputs or
  - calculated values: number of switching operations of downstream devices, load operating time, pulse metering with conversion to significant values
- The device interfaces shall be capable of receiving from the supervisor, by writing in the Modbus table at fixed addresses requiring no configuration, “open / close” type orders (0 or 1) applicable on each channel
- They shall be capable of having the orders executed by the control devices, after having taken into account the devices’ real positions
- The modular auxiliaries for control and indication of the open/closed status of control units (contactors and impulse relays) shall be capable of processing both 24 V DC and 230 V AC controls and of managing priorities between 24 V DC and 230 V AC.
- The Modbus TCP/IP device interface should enable to monitor and control auxiliaries and devices using integrated web page
- The Modbus TCP/IP device interface should enable to monitor analog sensors

### 3.4.3 – Testing of the system in the switchboard

The manufacturer shall supply a (software) tool for overall testing of the system, within the limits of the switchboard: the entire data transmission and control chain between the modular devices and all of the concentrators, including communication.

The test tool shall supply a report that includes the list of all the devices connected to each channel of the data concentrators as well as a diagram describing the configuration of the system with indication of the associated Modbus addresses.

## 4. Operation and maintenance

### 4.1 Incomer / Air or Molded Case circuit breaker

Product measurement and communication capability shall offer operating assistance function:

- Status of circuit breaker operations: Open/Close/Tripped/NA
- Indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
- trips history
- alarms history
- events history (setting changes, test...)
- These functions and indicators shall be available by remote display, communication or Engineering tool

The main interface web pages and switchboard display allow the authorize group to :

- execute one or more reset commands per device type
- control the following applications remotely:
  - circuit breaker operations: Open/Close/Tripped/NA
  - Reset input counters, Reset output counters, Light control, Load control, User-defined output control
- To provide maintenance log information
  - the date and time the entry was made, and the name of the user who made it.
  - the maintenance counter information for the selected device : circuit breaker operation counters, trip and alarm counters, load profile, contact wear counters, and the cradle counters.
- To send and display alarms
  - User shall be able to activate alarms based on measurement (I, U, F, P, Q, S, THD, CosPhi, FP, Idemand, Pdemand,) or counters
  - Alarms shall be time stamped
  - Alarms could activate a digital output for local indication
  - These functions and indicators shall be available by remote display, communication or Engineering tool.

## 4.2 Feeder

Product measurement and communication capability shall offer operating assistance function:

- Status of circuit breaker operations: Open/Close/Tripped/NA
- Indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
- trips history
- The communicating interfaces shall store all of the calculated values, including in the event of a 24 V DC power failure.
- They shall be replaceable without requiring any reconfiguration other than that related to the meters
- The system shall be capable of taking into account new modular devices added to the installation without requiring any reconfiguration of the data concentrator.
- control the following applications remotely:
  - circuit breaker operations: Open/Close/Tripped/NA

## 5. Sustainable development

Production site organization shall comply with the requirements of the ISO 9002 and ISO 14001 standards.

For the devices, the manufacturer should be able to provide following arguments:

- Hazardous substances content (RoHS conformity declaration & REACH assessment referring to last update of SVHC candidate list).
- Environmental impacts characterized by several indicators (through Life Cycle Analysis & Product Environmental Profile) with at least:
  - Raw material depletion
  - Energy depletion
  - Global warming / carbon footprint
  - Water depletion
- Recyclability information (Product Environmental Profile / End of Life Instruction).

The devices shall be delivered in packaging compliant with European Directive 2004/12/CE