Product note
SACE Emax 2 and IEC61850

SACE Emax 2, the new Air Circuit-breaker by ABB, is the first Low Voltage Circuit-breaker mapped as an IEC61850 Intelligent Electronic Device. A dedicated optional communication module Ekip Com IEC61850 is the port by which Emax 2 can access to the IEC61850 world. The module is an accessory of Ekip Touch & Ekip Hi Touch , the new trip units embedded in Emax 2 ACB.

Background

A protection and supervision system, like those used in Medium Voltage substations, typically includes several protection devices (relays), each of which implements a specific function – e.g. differential protection, line protection, etc. In order to implement a given logic, relays exchange signals via hard-wired connections. Other hard-wired connections distribute signals about the status of devices (alarms, trips, open/closed conditions, etc...) allowing interlocks and other system-level functions to be realized.

In the last years, electro-mechanical relays are being replaced by digital devices: such electronic devices often feature a network connection, allowing precise time synchronization and supervision. However, connection between relays is still implemented by hard-wired signals. Because of increasing complexity of station design, the number of such interconnections may easily reach several hundreds per bay, making installation, commissioning and testing long and expensive.

An innovative technology to keep such complexity to an acceptable level is IEC61850: by this standard, hard wired signals are replaced by exchanges of data frames. TCP/IP telegrams over Ethernet or optic fiber are used: a single Ethernet cable is typically used to link all devices in a bay/station, making wiring very simple to deploy and test.

We can consider a Medium Voltage protection and control system: several MV Relays connected via hard-wired signals (in black), a station bus (Modbus TCP/IP in the example, in orange) connecting the relays to a local Supervision and Control System (SCS), a clock signal given by a GPS (in yellow).
Now we can take a look to the same sketch of installation but with the IEC61850 Substation Automation Standard at work (in our example we can consider it implemented on TCP/IP over Ethernet network):
Several of wirings have disappeared, and now all the information is mapped on IEC61850.
It seems like magic… but how can IEC61850 do this?

Figure 1: Traditional MV system architecture

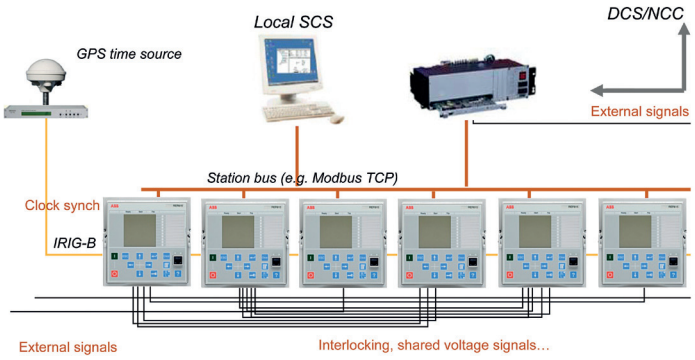
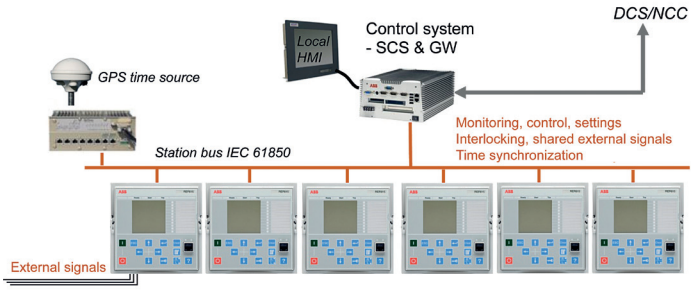


Figure 2: MV system architecture with IEC61850



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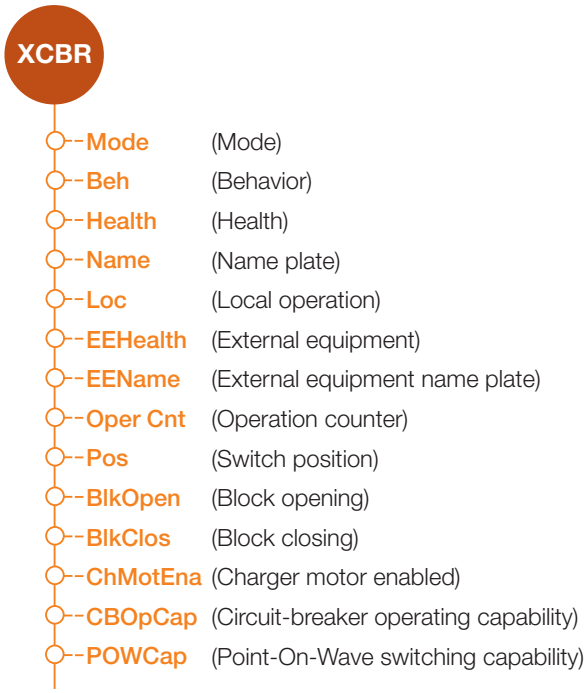
One of the most important concepts of IEC61850 is based on is the Logical Node. All functions performed in substations first and in other ambits after (Wind Power, Distributed Energy Resources) have been split into their smallest entities: each entity is characterized by having a small number of inputs and outputs. Such entities (objects) are called Logical Nodes (LN) and they contain several attributes. The LNs have a standardized speaking codes of four letters.

Figure 3: XCBR (circuit-breaker) attributes



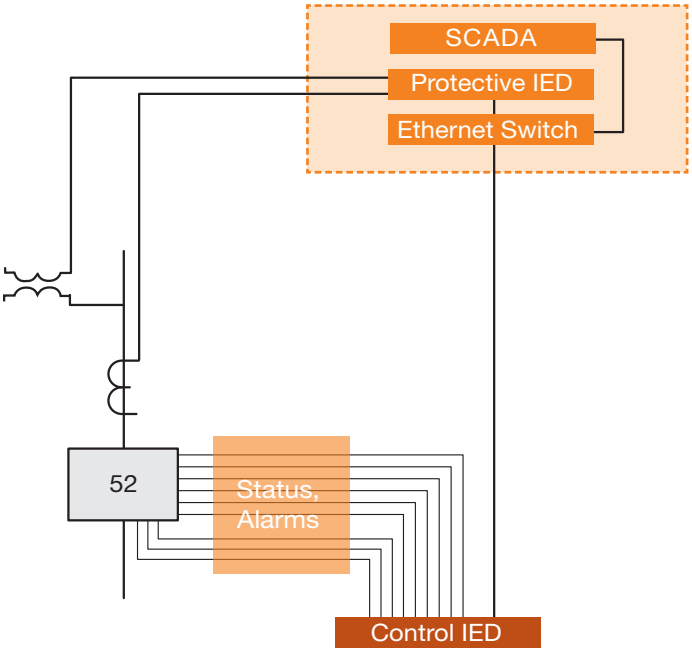
In the figure above the attributes of the LN XCBR (representing a Circuit-breaker) have been listed.
Thanks to this architecture, rather than a low level name such as “register 3069” or “signal A-12”, the engineer can refer to a, for instance, Protection-Undervoltage (PTUV), with some well defined properties.

Logical nodes for common applications are grouped into Logical Devices (LD): one or more LDs are hosted in physical devices, i. e. so called IEDs (Intelligent Electronic Devices).

IEC61850 is independent from the physical layers , and from specific manufacturers protocols: its flexibility and its general approach make it perfect for integration between electronic devices of any type (it is indispensable to have the right LN though).

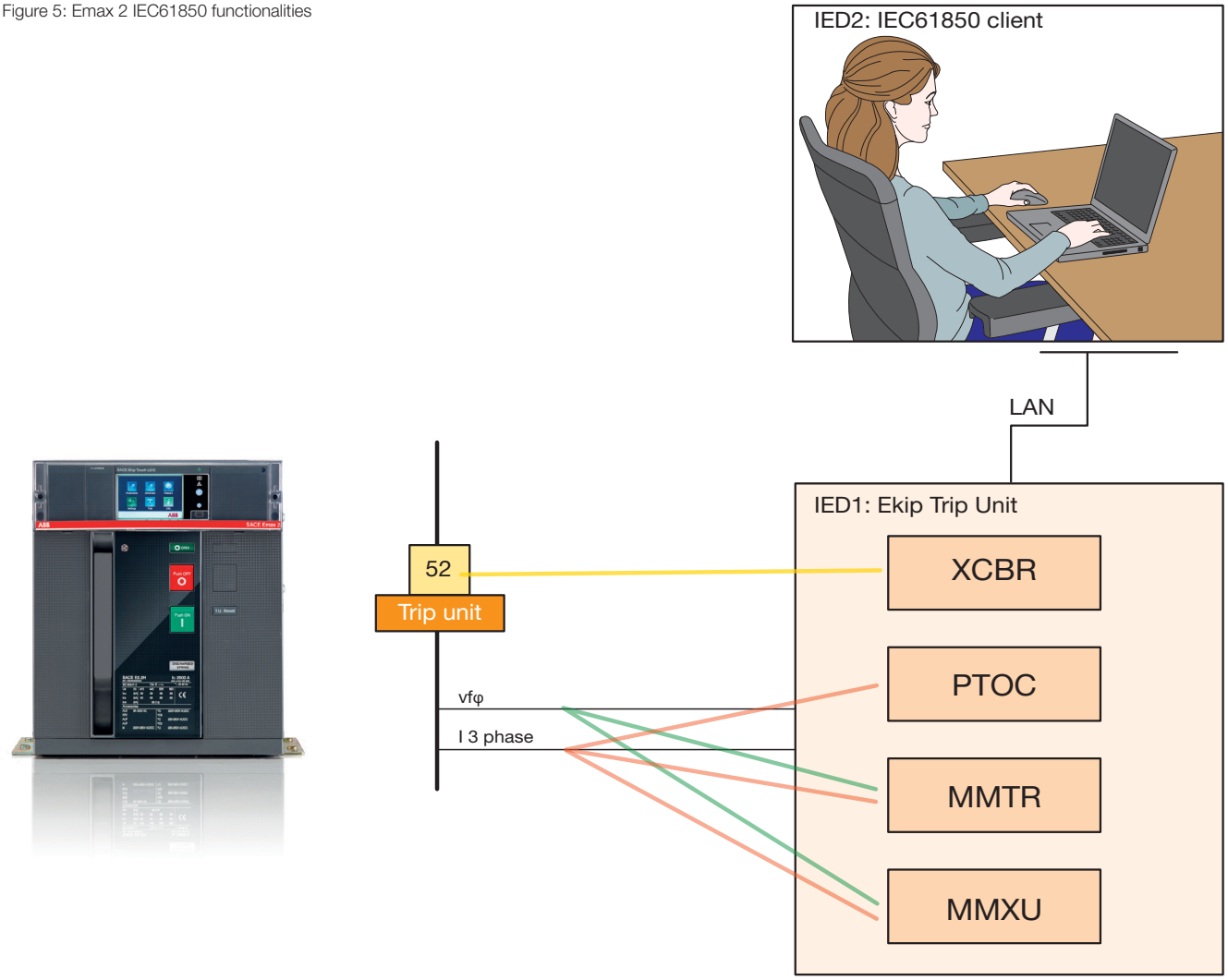
The above examples considered only MV integration.
Till today, if we would have liked to do the same also with Low Voltage networks, integrating Low Voltage Circuit-breakers, we would have had to use MV relays in combination with low voltage switch-disconnectors. Because no LV trip unit had an IEC61850 mapping available.
Unfortunately, this sounds like a lot of cabling, and this way the simplicity of the LV automatic CB (with measurement & protections granted by the trip unit embedded in the breaker) seems lost.

Figure 4: LV switch-disconnector and relevant current sensors and voltage sensors with external IEC61850 control and protective IEDs



In the example above a switch-disconnector (acting as a circuit-breaker and therefore identified as function ANSI 52) and associated external current and voltage sensors are connected to suitable IEC61850 IEDs via physical cabling.
In this way, the simplicity that IEC61850 is pursuing seems lost. IEC61850 can reduce complexity, but at this level it seems to actually increase the complexity.
But today a solution has been implemented. Emax 2 with IEC61850 data model and communication architecture (MMS, Report Control Block, GOOSE) as an accessory of the trip unit inside the trip unit. The first LV trip unit ever to carry all the Logical Nodes relevant to a LV automatic circuit-breaker: XCBR, CSWI, PTOC, MMXU ….
All the functions are listed and “ready to use” in the .icd file of the Emax 2.

Figure 5: Emax 2 IEC61850 functionalities



In the picture above, we can recognize some of the IEC61850 capabilities of Emax 2. They are mapped inside the trip unit (the physical device that carries them): in the example we show XCBR (the circuit-breaker Logical Node), PTOC (protection from overcurrent), MMTR (energies metered), MMXU (currents and voltages measured). The process level is inside the breaker and consists of status of the breaker (yellow line), voltage measurements (green line), current measurements (orange line).
The Ekip trip unit is obviously an IED, and we can call it IED1. By means of a Local Area Network, we can connect IED1 with another IED (IED2): in our example IED2 is a remote control panel that monitors voltages, currents and energies.

Conclusions

Integrating Low Voltage in IEC61850 architecture is sometimes necessary. Utilities, Oil&Gas, Smart Grids customers look for easy and cost-effective Medium Voltage & Low Voltage solutions in IEC61850. The easiest way for integrating the LV breakers inside an IEC61850 scheme is to use Emax 2 : Emax 2 is the only LV breaker that can be connected directly, withouth external gateway and dedicated programming, to an IEC61850 system.

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