

TESTHOTNEWS

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IEC 61850

An Important New Standard for the Electrical Power Industry

IEC 61850 is on its Way -

- there is no longer any doubt about this. The commissioning of the first pilot projects has been published in late 2004, meanwhile the number of implemented projects have grown to dozens, and the major vendors claim to have hundreds of IEC 61850 projects on their order books. The technology is already established and gets deployed on a broad scale; it is not a hobbyhorse for some technology-addicted freaks. Everyone in the electrical power industry will, in the near future, have to deal with IEC 61850 in some way.

The Scope: The Substation

The standard is called "Communication Networks and Systems in Substations" and covers much more than just the communication issues in the substation.



The standard is laid out comprehensively in fourteen parts and sub-parts on more than a thousand pages. Besides the general issues in the introductory parts, the issues covered can be roughly grouped into four main fields: Data Models and Services, Communication Protocols, Configuration, and Conformance Testing.

Data Models and Services

IEC 61850 introduces data models for substation devices, made up from building blocks called "Logical Nodes", exposing the data from the devices in a standardized way. The devices are "self descriptive", they not only provide the data itself, but also information on how the data are structured. Standardized namings (semantics) ease the interpretation of the data without device specific cross-references.

Services are well defined procedures on how information is exchanged. IEC 61850 defines services for control (even complete sequences for complex operations such as select-before-operate), logging, reporting, real-time messaging, self description, etc.

Communication Protocols

The communication for the classical substation control (SCADA) is structured as a Client / Server concept. Clients are typically substation controllers or master stations, servers are typically the substation devices such as protective relays. A server may serve multiple clients. Clients can enable reports from the servers, which are then sent unsolicited when a corresponding event occurs. Thus, the concept works without a polling scheme to interrogate the field devices. Different types of real-time communications have been introduced to provide process bus applications over the substation network.

Fast messages for inter-device signaling (GOOSE) replace tons of copper wires needed for connecting binary I/Os between the field devices. Sampled Values may be used to send digitized measured values from the CTs and PTs to protective relays and meters. Priority control in the network components assures the preferred delivery of mission critical data.

Today's Networking Base: Ethernet

The common base for the communications is Ethernet. This choice provides access to a wide range of "mainstream" communications equipment. Ethernet is already widely in use in industrial control applications, serving even critical purposes. The industry grade networking devices and methods used for this are cost effective and powerful. The substation applications can benefit from many features developed and maintained by a big community.

Nevertheless, the IEC 61850 standard models the application issues independent from the underlying transport mechanisms, thus future-proofing the whole concept in order to eventually use other transport protocols and media that may evolve in the future.

Configuration

The Substation Configuration Language (SCL) puts the engineering of a substation and the integration of devices from different vendors into an interoperable system on a compatible base.

To claim conformance, all vendors have to provide SCL data describing their devices to support the engineering process.

Conformance Testing

Firm conformance requirements and related testing methods guarantee that the devices from different vendors "understand" each other and provide the required interoperability to form a working substation control and protection system.

New Tools for Working with IEC 61850 Devices

(Continued from page 1)

A New Challenge

Working in an IEC 61850 environment is a new challenge. Lots of new knowledge and skills are required to master the new systems. As an example, the protection engineer needs new ways to wire up his test equipment when the dedicated wires are replaced by virtual connections over the substation network.

Education is the key to face this challenge – seminars and training courses with different focuses are already available.

Consulting and services provided by experienced partners that took an active role in the standardizing process help to speed up IEC 61850 projects and to exploit the benefits.

IEC 61850 – The Facts

- Covers the communication issues in the substation
- Communication mechanism for substation control (SCADA) applications with unsolicited reporting
- Real-time communication mechanisms for inter-device signaling (GOOSE) for replacing conventional wiring
- Real-time communication mechanism for digitized measured values from CTs and PTs (Sampled Values)
- Priority control for safe delivery of mission critical messages
- Standardized modeling of data in substation devices
- Defined naming and meaning (semantics) for data attributes
- Substation Configuration Language (SCL) for efficient engineering and integration of devices from different vendors
- Standardized conformance testing procedures assure the pre-condition for interoperability
- Ethernet as common network infrastructure with wide availability of cost effective network equipment

With the deployment of the first IEC 61850 devices in substations, protection engineers need new tools for different purposes. OMICRON is able to provide these vital new tools.

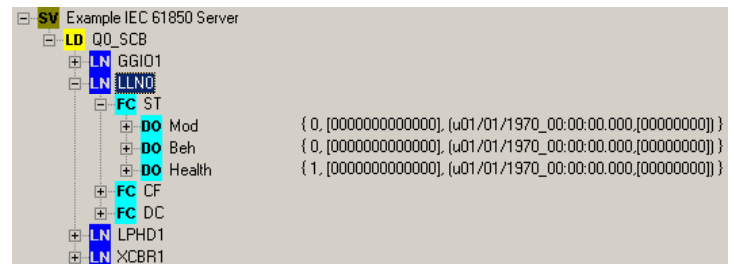
Protection Testing with GOOSE Messages

Real-time signaling over the substation network between field devices will replace most dedicated wire-loops between binary outputs and inputs. These messages will potentially contain the information needed in many test tasks. Protection test sets and test software need to hook up to this "virtual wiring".

The NET-1 option for the CMC 256 test set provides the required Ethernet interfaces for testing with GOOSE. The complementing part on the test software side is the GOOSE module. Received GOOSEs are used to activate the binary inputs of the test set (for instance Trip and Start signals), the generation of GOOSEs is also possible. Standardized configuration data in SCL format can be utilized through an import function. This feature eases the test set configuration tremendously. Examples explain common use cases.

Examining IEC 61850 Devices On-Line

There are situations, especially during commissioning and troubleshooting, where detailed investigation of the IEDs is required. IEC 61850 devices provide a common way to expose their data to the outside world. The IEDScout is a browser tool that connects to any IEC 61850 compatible device, discovers its internal data structure and displays the contents.



Numerous features are provided, such as writing to attributes, receiving reports, polling data, subscribing GOOSEs, etc.

In ad-hoc testing situations, where no access to the station configuration (SCL) may be provided, the use of the IEDScout is still the most convenient way to obtain necessary information (e.g. GOOSE configuration data) for further testing. The IEDScout can also be used to create SCL files from the data obtained from the IEDs.

Faults on Transformer Windings

FRAnalyzer - New Powerful Test Instrument for SFRA Measurements

Transformers have to withstand high mechanical stress during through faults with high currents. The magnetic flux in the stray channel causes high forces between the turns of the windings. In particular, when the clamping pressure is not capable of restraining the forces involved, substantial permanent winding deformation or even collapse can occur. Often the deformation of transformer windings is not recognized and the transformers remain in service. In many cases deformed windings have a reduced ability to withstand high forces subsequently and so high through faults can lead to an unpredictable breakdown of the whole transformer.

Transformer windings can also be stressed due to high mechanical shocks during transportation from the factory to the substation or from one substation to another. To be sure that the transformer windings are in a good condition, diagnostic tools are necessary. An effective tool for detecting deformed windings is the Swept Frequency Response Analysis (SFRA).

For high frequencies the equivalent circuit diagram of a transformer winding can be drawn as a complex network of resistors, inductors and capacitors. The frequency response of this network is unique to each transformer, rather like a fingerprint. Winding deformation causes the value of one or more of the capacitors in this network to be changed. To identify these changes, which can be quite small, the new fingerprint is compared to that taken in a healthy condition. Deviations are an indicator of:

- Coil deformation - axial and radial
- Faulty core-grounding
- Partial winding collapse
- Hoop buckling
- Broken or loosened clamps
- Shorted turns and open windings

OMICRON offers the new powerful FRAnalyzer test instrument for SFRA measurements with unique features:

- High reliability of results due to the applied measurement method and innovative connection technique
- Extremely small size through the use of leading edge technology
- Ease of use provided by creative software
- Portability as a result of the battery operation

The input amplifiers work with a very small bandwidth to prevent interference signals being superimposed on the measurement signal. For higher frequencies this principle is also very sensitive as the generated signal has constant amplitude over the whole frequency range. The internal 24 MBit AD converter of the FRAnalyzer enables it to operate at very a high accuracy. Using leading-edge technology, FRAnalyzer is the smallest and lightest instrument on the market, providing excellent value for a competitive price.



FRAnalyzer in use at customer facility

Tangent Delta / Power Factor Accessories

Quality of Transformer Oil

The CP TC12 is used in conjunction with the CPC 100 and the CP TD1 to measure the Permittivity and Tangent Delta / Power Factor of insulation liquids, e.g. transformer oil. The three-electrode design with guard allows precise measurement, especially of small losses. The circular electrodes are constructed from rigid stainless steel and require a sample of 1.2 to 2 liters (41 to 68 fl.oz.). Electrical connection to the Test Cell is made using the standard cables provided with the CP TD1.



Diagnosis of Generator and Motor Insulation

The CP CR500 allows Power Factor / Tangent Delta measurements of large motors and generators. In combination with the multifunctional Primary Test Set CPC 100 and the Tangent Delta / Power Factor unit CP TD1 one CP CR500 compensates capacities of up to 500 nF. To compensate even larger capacities, two devices can be connected in parallel. This allows compensation of up to 1000 nF.

- Portable high power solution due to size and weight
- Flexible by using different numbers of units and/or by changing the test frequency (35 ... 85 Hz)
- Expandable by connecting two devices in parallel





FOR THE RECORD WITH **COMICRON**

A series of questions most commonly asked, and responses from OMICRON's renowned test Guru...

UPCOMING EVENTS

IEEE PES T&D Conference &
Exposition, Booth #1841
Dallas, Texas, USA
May 21 - 24, 2006
www.iecee-t-d.org

GLEMS
Crowne Plaza
Grand Rapids, Michigan, USA
www.ferris.edu/ucel/GLEMS
July 31 - August 4, 2006

Cigré 2006
Palais des Congrès
Paris, France
August 28 - September 1, 2006
www.cigre2006.com

IEEE-PCIC Conference
Philadelphia Marriott
Philadelphia, Pennsylvania, USA
September 11 - 13, 2006
www.ieee-pcic.org

Diagnostic Measurements on
Power Transformers
Martinspark Dornbirn / OMICRON
Klaus, Austria
September 12 - 13, 2006

International Protection Testing
Symposium (IPTs)
Martinspark Dornbirn / OMICRON
Klaus, Austria
September 14 - 15, 2006

Q: Is it necessary to manually configure the Microsoft Firewall of Windows XP (SP2) when working with a CMC 256 NET1 unit?

A: No, there is no need to do this as we have already implemented the required settings for the Windows Firewall in the installation routine, therefore it will be a Plug & Play solution. When using a different make of Firewall the UDP port 4987 needs to be included in the corresponding exceptions of the Firewall.

Q: I have to measure the LV winding resistance of a big power transformer with a fairly low value of approximately 1 mΩ. Is there a possibility of using the 400 A DC instead of the 6 A DC output of the CPC 100?

A: Yes, this is feasible with the software version 1.40 of the CPC 100 where the winding resistance can be measured with up to 100 A DC. The current is directly measured at the 400 A DC output and the voltage with the VDC measuring input. For this measurement an external discharge box CP SA1 is provided (depending on the CPC 100 package ordered). This gives extra protection to the operating staff and the CPC 100 against high-voltage hazards while performing power transformer winding



Usage of CP SA1 with CPC 100

resistance measurements. In the event of a disruption of the current path, a high voltage will appear at the transformer terminals due to the high inductance of the transformer's windings. If this situation occurs the surge arrester in the discharge box CP SA1 will short circuit the transformer terminals to ground, ensuring the safety of the operator and protecting the CPC. The use of the CP SA1 is also recommended when working with the 6 A DC output. If the protection circuit in the unit operates in response to an open-circuit condition, the CP SA1 will need to be replaced. It can be ordered from OMICRON by quoting part number VEHZ0665.