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**Extending metering technology limits with new
approach to combined instrument transformers using
IEC61850-9-2LE protocol**

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Recent trend towards the substation digitalization has led to increasing utilization of electronic Current and Voltage Transformers (VTs and CTs). Thus, the numbers of digital VT and CT installations are gradually evolving from the stage of single pilot projects to the level, when introduction of digital instrument transformers becoming one of the approved methods that solve existing tasks in power engineering industry. During the last several years, a significant experience in installation and real-life operation of optical current transformers and electronic voltage transformers was earned. To summarize our results, the main efforts were put into the achievement of the following most urgent tasks in application of digital instrument transformers by integration of extended intellectual signal processing functions into electronic processing units of the VTs and CTs:

1. Research and development, testing and certification of the new product, that combines the capabilities of optical current transformer and electronic voltage transformer in a single unit. One of the most challenging element of this design was the requirement to place fiber optical cable inside the high-voltage column containing also the capacitance voltage divider. This Combined Non-Conventional Instrument Transformer (CNCIT) allows creating complete digital measurements in a twice less space than required for usual solution with stand alone VT and CTs.
2. Ensure high accuracy of the measurements, to provide temperature stability of the characteristics in the great temperature range from -60 degrees C to +70 degrees centigrade, and to guaranty long-term reliability and stability of all high-voltage insulating parameters. This temperature range enables installation and operation of such CNCITs in any climatic zones worldwide.
3. The most significant NCIT advantages of the highest dynamic range were implemented in a single unit. Range of the rated voltages, that can be measured by the same NCIT extended from 100 to 145kV. Range of possible rated currents (50 – 4000A) and shortcut currents (12 – 90kA) are covered by only 3 subranges: 50..1000, 400..2000 and 1000..4000A. For all subranges accuracy class 0.2S is ensured, from as low as 1% from the lower border and up to 120% of the upper margin of rated current values. This extremely wide dynamic characteristics allows to significantly decrease the number of different Instrument Transformers in the grid and enable savings on emergency stock of spare parts.

4. Basing on the feedback from our clients after a number of pilot projects, we have re-designed our electronic board that outputs digital dataflow IEC61850 as follows: the pairs of reserved IEC61850 ports is now increased to 3 (considering redundancy according to PRP/HSR/ RSTP). That enables physical separation of the process bus, substation bus and revenue metering bus.
5. Functional improvements allows to get extra data from the NCIT – not only usual IEC61850-9-2 samples, but precisely calculated RMS of voltage and current, frequency and even the power and $\cos \phi$ values as well. The power is calculated with hi frequency algorithms and are accurate even in the grids with low quality of electricity. To enable simultaneous measuring of the voltage, current and power the CNCIT can be produced and supplied with optional PCB boards, that helps to reduce necessary devices on the substations and to allow standalone operation even in cases of network and GPS time synchronization faults:
 - a. Power and quality metering - this give to Customer an extraordinary 0.2S Metering device that connected directly to the primary line.
 - b. Basic protection system – hi speed (64kHz rate) independent protection for most of applications except differential protections, which are supported by external protection terminals via IEC 61850-9-2 protocol.

New functionality implemented in the combined non-conventional instrument transformers allows cutting costs at Customer side, optimize substation network and improve its reliability.