Study Committee B3

Substations and Electrical Installations

Paper 10905_2022

New approach for the on-site calibration of a LPIT in GIS and lessons learned

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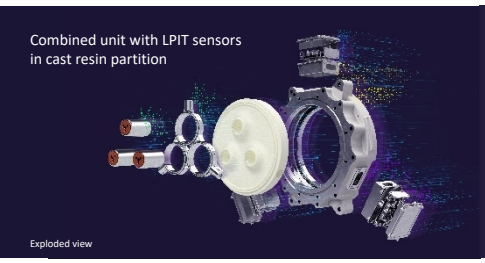
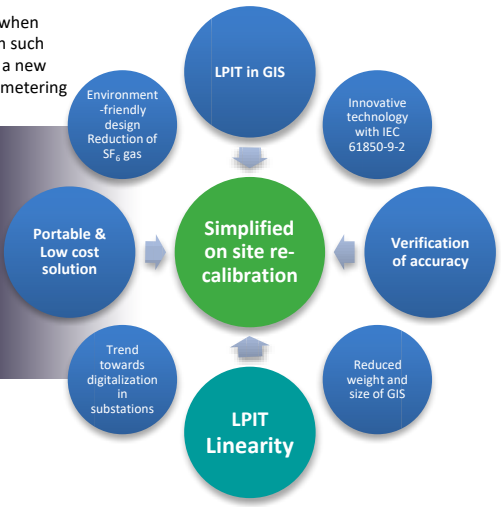
RTE, Siemens, Siemens, Siemens, Siemens Energy

Motivation

Well designed LPIT systems do not require a re-calibration at site when components are replaced. Nevertheless, there are occasions when such a feature is of benefit: e.g., when major design changes occur like a new generation of Merging Unit or when legal obligations for revenue metering would require a re-calibration in certain time intervals.



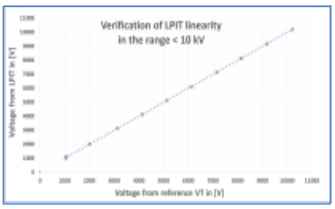


Method/Approach

- Using LPIT's high linearity of measurement
- Calibration at lower voltage/current using portable comparator with analog and digital inputs.

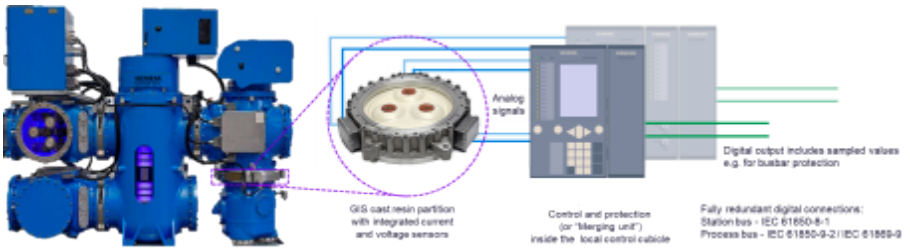
LPIT Design – w. HIGH LINEARITY

- Combined unit for measurement of current and voltage with non-conventional low-power sensors
- SF_6-free design with sensors integrated in cast resin partition
- Merging Unit for digitalization of measured values (IEC 61850-9-2 data output)
- One-time calibration of LPIT sensors needed



Conclusion

- With the advantage of the high linearity of LPIT sensors, it was proved that the on-site calibration of LPITs with only low values of test voltage and current and thus with small, portable test setup is possible and brings sufficient good results
- Achieved values are in line with requirements for precision class instrument transformer and with complete digital chain for data acquisition
- Considering the design of the GIS substation, it is recommended to have an isolated earthing switch on GIS to simplify the on-site injection of test signals
- Nowadays the major test equipment suppliers are developing even more convenient and light weight test devices for on-site LPIT accuracy tests



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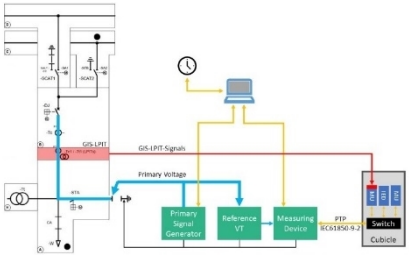
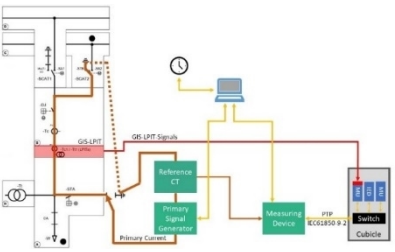
Test setup for on-site calibration of low power voltage sensors



- Injection of up to 10 kV single-phase test voltage to GIS bay via contacts of the isolated earthing switch

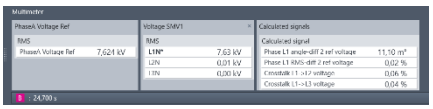
Test setup for on-site calibration of low power current sensors



- Injection of up to 1000 A single-phase test current to GIS bay via contacts of the isolated earthing switch

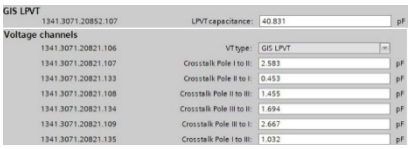
- Other two GIS phases remain earthed by connections to the GIS-housing.
- Comparison of instantaneous signals from reference CT/VT with IEC 61850 sample values from merging unit by hybrid measuring device (analog / digital value)

Measurement of voltage - view on values of hot phase and adjacent phases

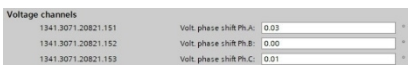


- Hot phase voltage value deviation to reference voltage in phase angle and magnitude
- Crosstalk impact to adjacent phases measurement voltage relative to reference voltage values

LPVT configuration in merging unit calculated based on measured values



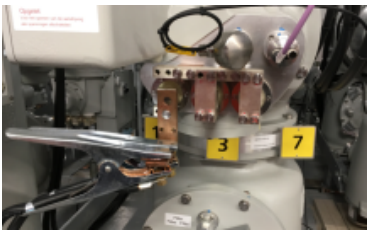
- Voltage sensor coupling capacitance parameter of one phase
- 6 Crosstalk capacitance parameters relating to coupling capacitances



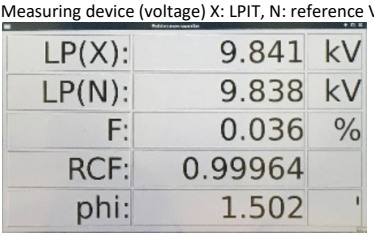
- Voltage phase shift parameters relating to reference VT

- Voltage magnitude correction parameter e.g., phase A

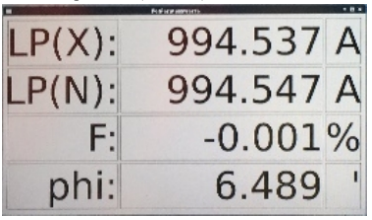
The connection to the GIS (injection of test current)



Measuring device (voltage) X: LPIT, N: reference VT



Measuring device (current) X: LPIT, N: reference CT



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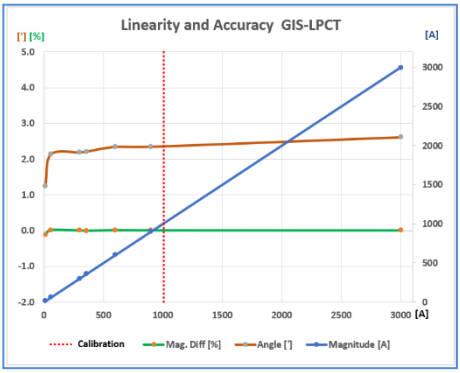
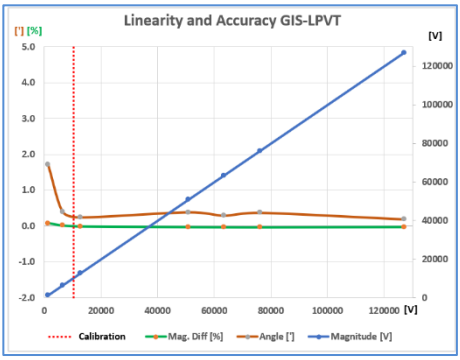
LPIT linearity

- An on-site calibration of installed instrument transformer requires to test their accuracy at several values of voltage and current including the nominal values. This implies to use test setup with a generator of high voltage and current which is not easy to install in a limited area of the indoor GIS substation.
- The linearity of the LPIT has been verified during the type tests up to 1.9*Ur (= 275 kV) and up to 1,5*Ir (= 3000 A). The idea for this LPIT is to use their high linearity as an advantage for calibration. This technology feature allows to perform the calibration at levels of test voltage and current below the nominal values
- With this insight, the usage of the low test-voltages (e.g., between 1 - 10 kV, see diagram on the right) and low test-currents (e.g., 25 – 1000 A) for accuracy tests is fully sufficient with results valid also for higher primary voltages (63/ √ 3 kV) or currents (2500 A).



Features supporting accuracy measurements with IEC61850-9-2 sample values
Hybrid measuring devices with IEC 61869-9 and conventional CT interface
Accuracy class 0.1 or better for voltage and current sensors
Galvanic isolated analogue inputs
Support of flexible IEC 61850-9-2 signal channel combinations according to the profile laid down in the standard IEC 61869-9
Support of sample rates independent from of the nominal frequency according to the IEC 61869-9 standard
Easy configuration of the IEC 61850-9-2 telegram address data with a minimum of needed parameters (destination MAC-address, APPId and maybe SVId)
Support of time synchronization protocols IEEE 1588 PTP and IRIG-B to synchronize digitalization in the measuring device (optional PPS with optical ST-Interface)
Optional configuration of offsets for magnitude and phase shifts
Support of IEC 61850-9-2LE sample rates 80 samples / cycle, (256 samples / cycle)
Indicator for correct sample value reception: SV synchronized; no SV lost.
Configuration of averaging of measured values: number of cycles to considered, display updating time, resolution

Table 1: Mandatory features supporting accuracy measurements with IEC 61850-9-2 sample value



- With this approach more simple, portable equipment for necessary generation and injection of test voltages and currents and for the reference measurement can be used for the calibration of LPIT on-site.
- This method may also be useful for future cyclical verifications of accuracy, e.g., for metering applications at approvals for metering authorities according to the local / national official regulations