Challenges in power transformer testing

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Content & Glossar

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Large power transformer testing – the challenges

Measurements in transformer plants are mandatory.
Main purpose is to guarantee the output and quality of the delivered equipment.

But increasing demand of measurements means increasing internal challenges, as:

- Increasing importance of quality control
- Improve company workflow and output of test systems
- Flexibility for working according to different standards
- Decrease Lab off-time for better company activities
- Ensure accuracy and stability

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Increasing importance of quality control

More and more device tests are requested by the customer and therefore mandatory. This ensures the delivered equipments technical abilities according to customers requirements for a long time operation in stable and good conditions. Often customers are demanding more and more complicated tests without willing of accepting any extra charge.

Cost reduction by using modern test equipment is necessary, and can be provided by following benefits:

- Reduction of wiring time and step-by-step developing of test database reduces cycle time and thus labor cost
- The right technician at the right time doing the right task. Engineers designing test routines, operators processing the tests.
- Easy and structured paperwork – automatic generation for test protocol and archives.
- Test automation – definition of equipment under test and corresponding test routines. This increases the throughput of the lab, often bottleneck of production.

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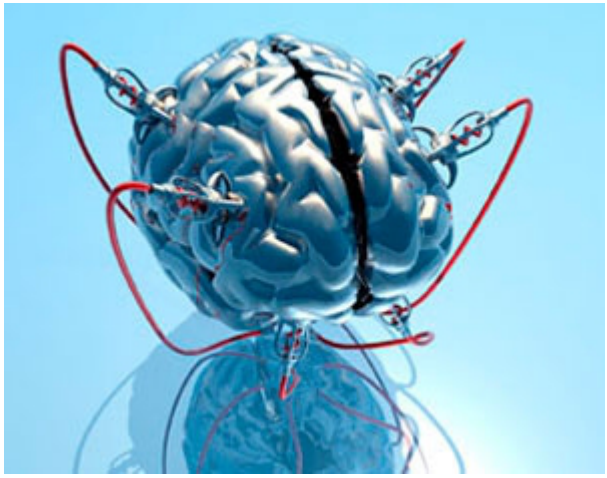
Integration of the automatic test system in the company workflow

A state of the art measuring system has to take part in the companies system architecture.

In case of a modernizing of the test lab the new parts have to be integrated into the existing infrastructure. This is the only way to secure benefits of a new measuring center and benefits of existing infrastructure.

The tasks of a modern measuring center can be compared to a human brain:

- Centralizing information
- Commanding measuring devices and actuators
- Processing and analyzing of information received by different devices



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Challenges due to measurements

Large power transformer measurements or transformer measurements in general means big investments for power supply, test equipment,…

Investing in an integrated, automatic test system must not mean changing the complete infrastructure. The goal is to integrate the existing equipment as much as possible to avoid changing of useable and existing test equipment.

Further it can be seen that the trend is moving to the replacement of high voltage and high power sources by semiconductor driven inverters. This means testing at higher frequencies. But this also has its challenges to face like:

- Partial discharge problems
- Wide spectrum electromagnetic noise on the measurement devices

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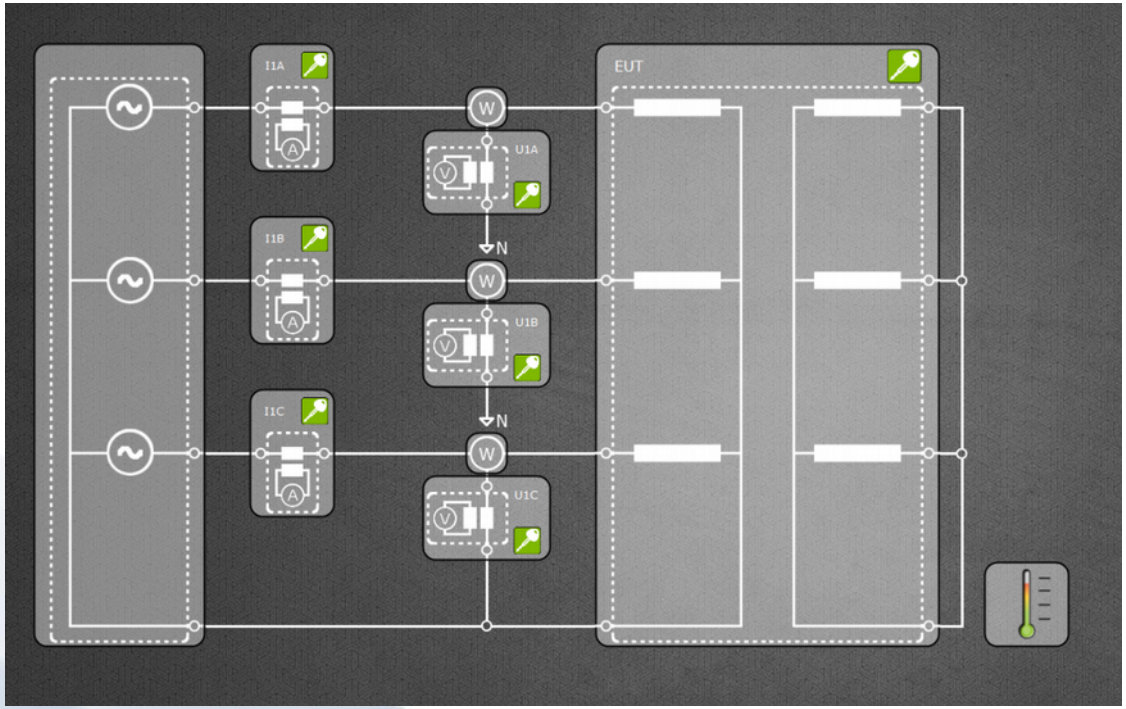
Analysis of measurement signal path

Example: Load Loss test – see the different signal paths appearing in the picture below.

In this test the measured current values have usually an important amplitude, the measured voltage will be at a low level in comparison to current during this test.

In these cases it is mandatory to eliminate the effects of noise sources on the measurement results.

It is clear that a noise applied on any of the phases affects the quality of the voltage measurements.



Analysis of noise sources and their effect on measurements

As per our example there are many possibilities known for working on the noise reduction. A state of the art measuring system has to avoid noises and other drawbacks. Everybody knows that avoid noise at the source is better than fighting it afterwards.

Options:

•Usage of standard voltage transformers for voltage measurement instead of capacitive dividers which catch up the noise. Taking advantage of the low pass filter effects from magnetics.

•Avoid noise coupling on the measurement cables while they are connecting a long way in a noisy environment

•Propose advanced signal analysis to reduce the noise effects

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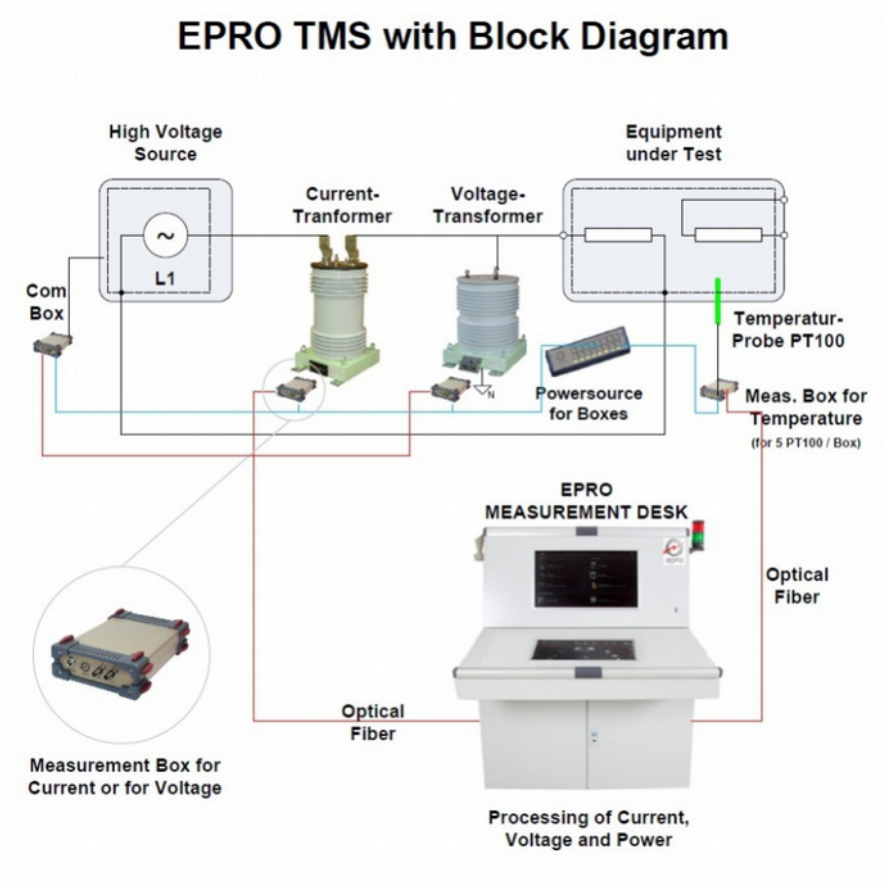
Modular solution benefits

The complexity of modern test labs, especially in large power transformer plants, is only to solve by modular system architecture. A modular solution offers a variety of benefits in the daily business:

- Close location of measuring devices and current/voltage sensors. This reduces cable length and noise problems.
- Fiber optics for communication allows long distance and high immunity. It avoids the flashovers and is an integral part of the safety concept.
- Complete galvanic separation between control desk and test room. This ensures the possibility of connecting the control desk to the company infrastructure (i.e. LAN network). Modern data processing is now possible for the test reports and other database.



Modularity and calibration

The main issue in the field of calibration are the electronic components.

Also in the calibration process not the complete parts have to be calibrated at the same time.

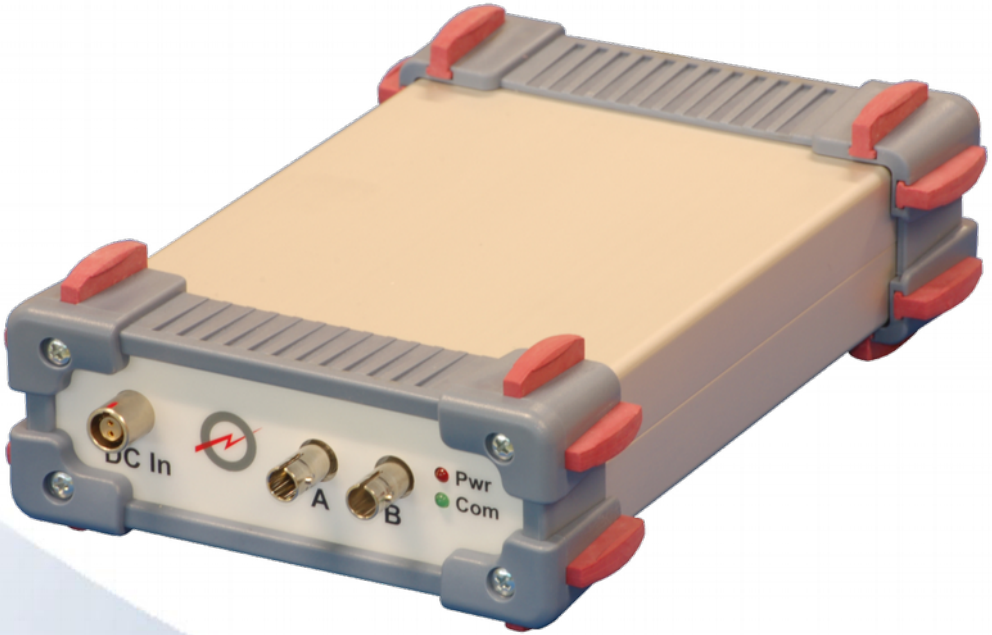
•Only the relevant parts have to be calibrated

•Small size items can be sent easily all around the world

•Any decision about measuring equipment has also to take into consideration the calibration routines and periods

→ Calibration over the years is one of the major cost factors in a test lab.

→ Investments in devices with more economic calibration process will pay back very fast!!!



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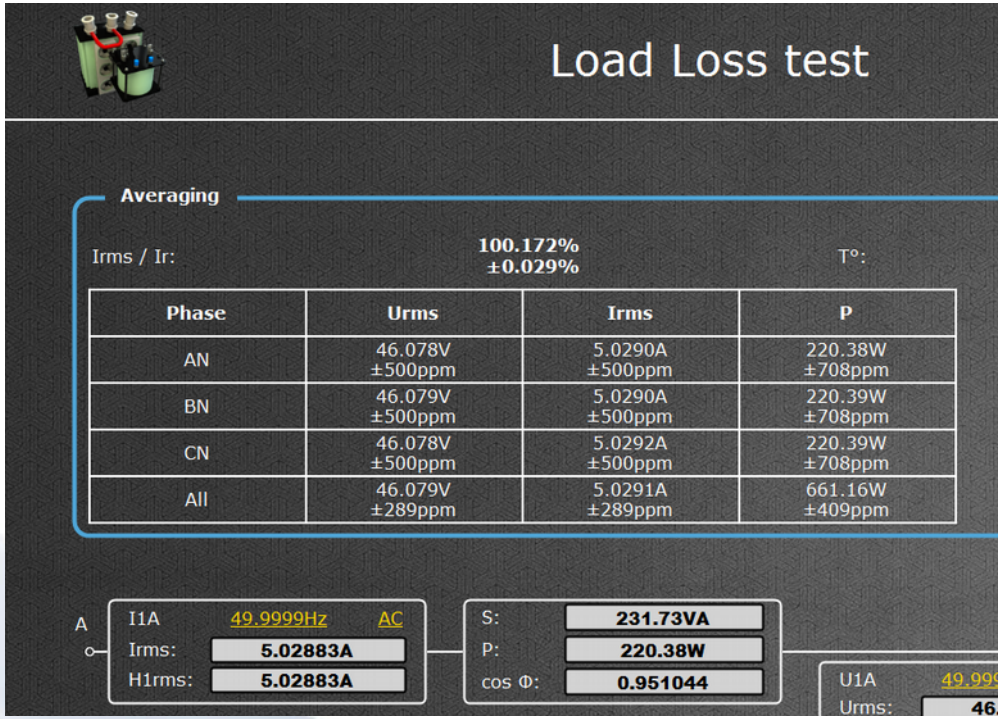
Measurements and Metrological factors

Discussing measurements in general very fast ends at discussions about measurement uncertainty…

Evaluating this uncertainty is not an easy challenge

A state of the art measuring system must be as accurate as possible, but a modern test system must also ease the evaluation the measurement uncertainties.

The measuring system should provide the uncertainties and the spreading of the uncertainties. The best would be a system providing these data according to given standards (like the ISO/IEC GUM)



Ease of use as critical factor

Targeting the right people demand a modern man machine interface for automatic test systems. The user interface has to be clear, robust and the operation has to be intuitive. Operators who are processing the tests can be different groups of people:

•Test engineers are designing the test routines according to technical backgrounds as well as defining groups of the equipment to be tested.

•Test technicians with basic engineering knowledge should be able to load the defined routines and process routine tests on a daily basis.

•Also other groups, for example sales people can take the role of the test technicians for showing product abilities to customers.

This multi person use and general laws are demanding the maximum safety features for avoiding faults and danger:

•Avoiding hardware failures on the equipment under test

•Avoiding unauthorized changes in important test parameters or automatic routines.

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Tracability, the benefits of database

In order to keep trace of all measurement results but also from the measurement setup, it is a good practice to create database.

These database have to be multi-level in order to be combined together, and bring a full flexibility for the reporting and archiving of the data:

- EUT database for the different devices produced in the plant
- Routine test or type test database, linked to the EUT database
- Test results database, linked to EUT database, Test Setup and measurement devices
- Reports database linked to the EUT

All these database provide a good tracability, but also generate a huge quantity of data. For this reason, a modular system where the “brain” of the system is connected to the company network and a good backup system is of the main importance. The safety aspect against flashover makes this possible.

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Automatic report generation

Generating test reports always come with its paperwork drawbacks and is often negligated for internal measurements for example.

The measurement system able to generate these reports automatically is of a great interest in this case.

Some features of this report generators can also help reducing the documentation time:
•Easily design the templates of the generated reports
•Generate secured documents like pdf format
•Export data in a flexible format for external layout or modification of the document

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