FACTS IN BRIEF

Fig. 15 **Calibration of measuring instruments**

Fig. 16 **Calibration of the 2000 kV DC Test System**

APPLICATION

The HIGHVOLT Calibration Laboratory offers the following services:

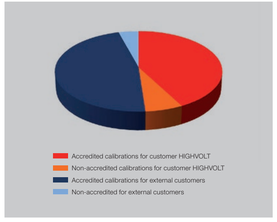
Calibration objects

- Peak voltmeters, digital recorders
- Compressed gas standard capacitors
- High voltage dividers and measuring systems
- High voltage reference measuring systems
- Capacitance and dissipation factor measuring systems
- Impulse current measuring systems and components
- Power measuring systems

Calibration procedures

- Component calibration (peak voltmeters, capacitors, dividers, etc.)
- System calibration
- Linearity check
- Performance checks of the measuring systems

CUSTOMER'S STRUCTURE



BENEFITS

- CALIBRATION PROCEDURES ARE APPROVED BY ACCREDITATION BOARD
- MEASUREMENT UNCERTAINTY IS DETERMINED IN ACCORDANCE WITH GUM/BIPM
- MEASUREMENTS TRACEABLE TO NATIONAL STANDARDS
- FOR ALL HV MEASURING EQUIPMENT INDEPENDENT OF MANUFACTURER

OVERVIEW

D-K-19153-01-00 CALIBRATION LABORATORY ACCREDITED MEASURING QUANTITIES

Device	Quantity		Measuring range	
Instruments, digital analyzers, impulse calibrators	DC		1 V...1000 V	
	AC		1 V...700 V	
	LI		9 V...1000 V	
	LIC		50 V...750 V	
	SI		9 V...850 V	
	Step		9 V...330 V	
Measuring systems Measuring dividers	DC		1 kV...3000 kV	
	AC		1 kV...2000 kV*) **)/4000 kV*) **)	
	LI		10 kV...4000 kV*)	
	LIC		180 kV...4000 kV	
	SI		50 kV...3500 kV*)	
Capacitors, C/tan δ-measuring devices	C		10 pF...10 nF	5 kV...200 kV, 50 Hz
	tan δ		$1 \cdot 10^{-5}$...$1 \cdot 10^{-2}$	
Impulse current shunts	IC	I	200 A...40 kA*)	8/20 µs $T_1 \pm 20\,\%$ $T_2 \pm 20\,\%$
Impulse current sensors	IC	I	200 A...200 kA*)	
Loss measuring systems	AC	U_{eff}	40 V...100 kV	$16.7 \le f \le 60$ Hz
	AC	I_{eff}	0.4 A...2000 A	
	AC	P	16 W...200 MW	40 V ≤ U ≤ 100 kV 0.4 A ≤ I ≤ 2000 A - 90° ≤ $\varphi_{U,I}$ ≤ 90°
	AC	Q	16 var...200 Mvar	$16.7 \le f \le 60$ Hz
	AC	S	16 VA...200 MVA	

*) on-site
**) at HIGHVOLT Calibration Laboratory
***) with linearity test

HIGHVOLT CALIBRATIONS MEASURING QUANTITIES

Device	Quantity		Measuring range	
PD calibrators		Q	1 pC...1000 pC	
PD measuring systems		Q	1 pC...1000 pC	
AC current shunts	AC	I	0.4...3000 A	40 Hz ≤ f ≤ 70 Hz
Impulse current sensors and shunts	IC	I	All other standard wave forms which are not covered by the DAkkS accreditation	
More calibrations available on request				

For further information please contact:

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10.30/2 Calibration

CALIBRATION LABORATORY SERVICES

- Accredited calibration laboratory D-K-19153-01-00 specialized in high voltage measurands
- AC, DC, impulse voltage, impulse current and power
- Capacitance and dissipation factor calibration
- Measuring systems and components
- Worldwide on-site calibration service available

CALIBRATION LABORATORY

Fig. 1 **Accreditation certificate**

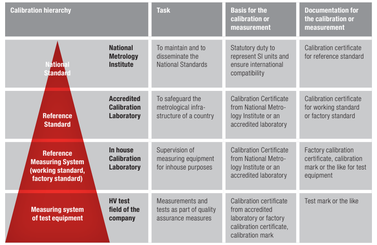

Fig. 2 **Calibration hierarchy**

ACCREDITED CALIBRATION LABORATORY SINCE 1999

Accreditation of a laboratory means validating the procedures and working methods by a relevant independent accreditation body and a trust that the working processes are implemented. Accredited calibration laboratories are established to safeguard the metrological infrastructure of a country and perform most of the routine calibration work by validated calibration methods. They operate industrially manufactured reference standards with the best possible characteristic. Therefore a Calibration Laboratory was established at HIGHVOLT, accredited by Germany's accreditation body DAkkS according to DIN EN ISO/IEC 17025.

The DAkkS is a signatory to the multilateral agreement of the "European Co-Operation for Accreditation" (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.

The DAkkS-accredited laboratories issue Calibration Certificates with a fixed structure regarding the international recommendations. This prescribed structure contains detailed information about the calibration object, the calibration procedure, measuring conditions, measuring results and uncertainty of measurement.

The Calibration Certificate may contain a conformity declaration concerning appropriate IEC standard if the conformity was proven by measurements.

Calibration Certificates are valid only at the moment and under the conditions of the calibration. The user is obliged to have the object recalibrated at appropriate intervals.

The IEC Standards recommend annual performance tests, but require a minimum of one every five years. Because of the requirements of IEC 60060-2 and IEC 62475 and the existence of an accreditation system in Germany, the first calibration has to be done by an accredited calibration laboratory.

Users of measuring technique, also in high voltage applications, are confronted with demands of technical and quality assurance standards as the ISO 9000 series and the IEC 60060-2 in order to work with measuring systems calibrated traceable according to national standards.

All standards of the Calibration Laboratory D-K-19153-01-00 are traceable according to Germany's national standards, which are maintained by the PTB (*Physikalisch-Technische Bundesanstalt* = German National Metrology Institute).

BENEFITS

- ACCREDITED ACCORDING TO IEC 17025
- WORLDWIDE RECOGNITION OF CALIBRATION CERTIFICATES GUARANTEED
- CALIBRATION IN HOUSE OR ON SITE (WORLDWIDE)
- CALIBRATION CERTIFICATES IN ENGLISH OR GERMAN
- HIGHLY FLEXIBLE COORDINATION WITH THE CUSTOMER

CALIBRATION CORE COMPETENCES

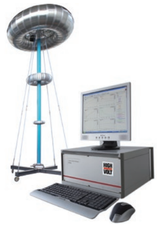

Fig. 3 **Impulse voltage measuring systems**

Fig. 4 **Gas-filled standard capacitance with C/tan ∂ measuring bridge**

HIGH VOLTAGE

The measurand voltage is our core competence since the founding of our calibration department at HIGHVOLT. We are specialized in calibration of voltage measuring systems and their components on the full range of the definition of IEC 60060-2.

- AC voltage up to 1800 kV
- DC voltage up to 2000 kV
- Lightning impulse voltage LI up to 3500 kV
- Switching impulse voltage SI up to 2500 kV

Calibration objects

- Voltage measuring systems
- Measuring instruments (e.g., peak voltmeter)
- Digital recorders

CAPACITANCE AND DISSIPATION FACTOR

The calibration of the capacitance and dissipation factor (also known as tan ∂) at high voltage is one of the oldest key competences of our laboratory. The calibration is provided at high voltage above 5 kV up to 100 kV for measuring bridges or up to 800 kV for capacitors.

Calibration objects

- Capacitance standards
- Dissipation factor standards and simulators
- Capacitance and dissipation factor measuring bridges

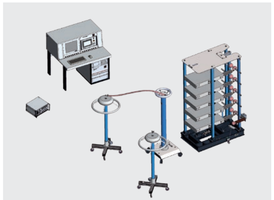

Fig. 5 **Calibration of impulse voltage divider by comparison measurement**

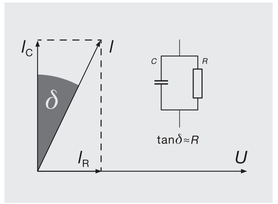

Fig. 6 **Dissipation factor of the capacitor is represented by tangent of angle between the phasors of the current components. It represents the quality of the capacitors or insulators.**

POWER CALIBRATION

Fig. 7 **Power Calibration System in a logistical standard 40-ft container**

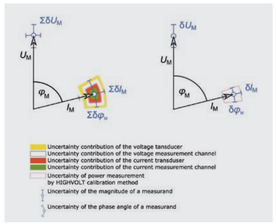

Fig. 8 **Reduced phase angle uncertainty by reducing of uncertainty contribution**

TRUE AC POWER CALIBRATION PROCEDURE

To determine the apparent power *S* the amplitude and wave shape of the voltage and current signal need to be measured. For active power *P* and reactive power *Q* it is necessary to determine the phase angle φ between voltage and current.
The most commonly used calibration procedure for power measurement systems is based on component calibration of the voltage and current measurement branch and additional separate calibration of the measuring instruments.

Disadvantages of the component calibration method:

- It is usually necessary to order two different calibrations at two different calibration laboratories for such calibrations (time intensive)
- The components calibration procedure produces many partial uncertainties that need to be added to procure the final measurement uncertainty
- The operator of the power measurement system is required to calculate the final measurement uncertainty of the measuring system by itself
- The most important contributions are the two angle errors of current and voltage sensors. The angle errors are U-distributed values and therefore significant at 0° and 90° where the most measurements are done

The subject of the True AC Power Calibration Procedure provided by HIGHVOLT is the whole power measuring system at once including

- Measuring instrument
- Measuring cables and
- Voltage and current transducer

The whole system is calibrated in one step by comparison measurement based on simultaneous measurement of voltage, current and phase angle φ between current and voltage (see figure above). All measurands are recorded simultaneously by calibration object and standard.

Advantages:

- Lower measurement uncertainty of power measuring system
- Most of all, contributions to the measurement uncertainty are already included in the measurement
- Measuring of the phase shift angle between current and voltage the phase angle uncertainty is reduced and constant between 0° and 90°
- Automated calibration procedure and data collection can reduce the calibration duration significantly
- Highly customizable calibration procedure especially at desired working points of the measuring systems

BENEFITS

- ACCREDITED TRUE POWER CALIBRATION PROCEDURE
- CALIBRATION OF THE WHOLE MEASURING SYSTEM IN ONE STEP
- AUTOMATIC CALIBRATION PROCEDURES AND DATA COLLECTION POSSIBLE
- CUSTOMIZABLE CALIBRATION PROCEDURE AT DESIRED WORKING POINTS

IMPULSE CURRENT CALIBRATION

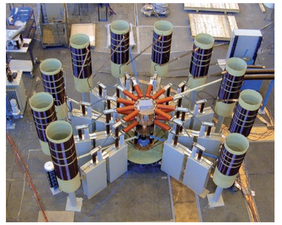

Fig. 9 **Impulse current generator for 150 kA 4/10 µs**

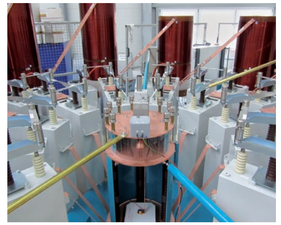

Fig. 10 **Impulse current generator for custom current wave shape**

PARAMETERS

As overvoltage protection and the development of as surge protection devices and overvoltage arresters have grown, the importance of impulse current calibration has increased. The current monitors for current measurement during dielectric tests at transformers need to be calibrated, as well. In this case the time parameters are more important than the scale factor. One of the widely used impulse current wave shape is 8/20 µs.

Calibration objects

- Shunts up to 25 kA
- Inductive current monitors up to 200 kA
- Current monitors for current measurement at dielectrics tests

The typical applications for impulse current measurement are:

Calibration objects

- Impulse current measurement in impulse current generators
- Arrester testing equipment
- Impulse current measurement during dielectric tests on transformers

Calibration procedures

- Component calibration or
- System calibration
- Linearity check for inductive current monitors up to 200 kA

Fig. 11 **Impulse current shunt usually used for impulse current measurement at dielectric tests on transformers**

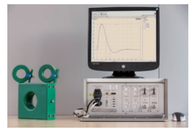

Fig. 12 **Impulse current standards for 5 and 40 kA**

APPLICATIONS

- IMPULSE CURRENT MEASURING SYSTEMS WITH ENHANCED REQUIREMENTS
- IMPULSE VOLTAGE TEST SYSTEMS
- SURGE PROTECTION DEVICES AND VOLTAGE ARRESTERS TEST SYSTEMS

BENEFITS

- TRACEABILITY OF THE CURRENT MEASUREMENTS
- REPRODUCIBLE MEASUREMENT RESULTS
- QUALITY ASSURANCE OF THE MEASURING SYSTEMS

OTHER SERVICES

Fig. 13 **Metrological training sessions and tutorials are important for understanding and avoiding the measurement errors**

Fig. 14 **Measuring instrument calibration of the digital recorder with impulse voltage calibrator**

TUTORIALS

Our Calibration Laboratory provides personnel education and training in many topics related to metrology

Topics

- Calibration of the measuring systems
- Preparation of high voltage measurement circuits
- Measurement uncertainty in high voltage measurement
- Statistical data processing and evaluation
- High voltage measuring systems and the associated maintenance
- Measuring systems documentation

Location

- In-house
- On-site

CALIBRATION OF MEASURING DEVICES

The measuring instruments need to be calibrated separately, at least before their initial use. Therefore the HIGHVOLT Calibration Laboratory also calibrates measuring devices that are used for measuring high voltage. The air-conditioned laboratory for instrument calibration can be used to calibrate the instruments under precisely defined climatic conditions.

Calibration objects

- Peak voltmeters for AC, DC, impulse voltage
- Digital recorders for impulse voltage
- Capacitance and dissipation factor measuring bridges

Location

- In-house (preferred)
- On-site (only if possible)

BENEFITS

- UNDERSTANDING HV-MEASURING TECHNIQUES AND THEIR SPECIFIC PROPERTIES
- LEARNING TO CREATE A MEASUREMENT UNCERTAINTY BUDGET
- LEARNING THE CALIBRATION TECHNIQUES

BENEFITS

- EXACTLY DEFINED CLIMATIC CONDITION IN LABORATORY FOR INSTRUMENT CALIBRATION IN-HOUSE
- POSSIBILITY TO ADJUST OR SERVICE THE HIGHVOLT MEASURING INSTRUMENTS