AC Voltage Test Systems
With Transformers, Type WP

1.10/3

Application Requirements

HVAC Test Systems are intended to generate a continuously variable AC test voltage at power frequency. They are designed for testing all types of electrical insulations up to the highest voltages, preferably of electrical apparatus used in power transmission and distribution systems (e.g. insulators in dry, wet or polluted conditions, switchgear, power and measuring transformers, cables, test lines, etc.). AC Voltage Test Systems are not only used for these tasks in industry, but also for research, development and students training.

When a test object is a pure capacitance (cable, GIS) the HV testing can be performed by an HVAC Resonant System (see leaflet no. 1.20). When a resistive current must be supplied during an HV test (e.g. due to heavy partial discharges or leakage currents), an AC Voltage Test System with an HV transformer is the only possible source. Therefore HVAC Test Systems with transformers belong to the basic universal equipment of all multi-purpose HV test fields and laboratories.

A HIGHVOLT HVAC Test System, type WP generates test voltages full in line with IEC 60060-1, characterized by:

- a sinusoidal alternating voltage of a frequency between 45 and 65Hz,
- a low content of harmonics, described by the ratio between peak and r.m.s. value or by the content of harmonics THD < 5%,
- a stability of voltage value within ± 1% (for test duration 1min) or ± 3% (for long term tests),
- a short-circuit current > 0.1A for dry tests and internal insulation, > 0.5A for rain tests and up to 15A for pollution test,
- a sufficiently low PD noise level to enable sensitive PD measurement at the test object.

Test System Components

The main component of an HVAC Test System is the HV generator (no. 7 in fig.1) consisting of a single test transformer or a transformer cascade including a base frame (e.g. for air cushion transportation) and top electrode. The HV generator is fed via the switchgear cubicle (1) and the voltage regulator (2), which can be combined with a booster transformer. To reduce the mainly capacitive load currents, compensating reactors on the LV side (3) (in special cases also on the HV side) can be applied.

To guarantee the sinusoidal voltage shape, filters for harmonics (4) are arranged on the LV side (for cascades also on the intermediate HV stages). When the system shall be used for PD measurement the application of a low-pass filter (6) for suppressing noise signals from the mains is useful.

In addition to the voltage divider (9) an HV filter including blocking impedance (10) and a coupling capacitor (11) must be applied when partial discharges are measured at the test object. For capacitance or tan delta measurement, compressed gas standard capacitor (12) is necessary. In the case of a breakdown, the energy flow and the overvoltages are limited by the rapid switch-off unit (5).

The control and measuring system (19) includes the operator device (13) and/or an industrial PC (14) as well as the measuring instruments for voltage (15), partial discharges (16) and C/tan delta (17). The communication links (Profibus or Ethernet) between these components as well as with the programmable logic controllers (PLC) in the switchgear cubicle (1) are realized by optic-links.

For the computer control see the leaflets 1.52 and 1.55. The control system can be connected via the RDA-module (Data Sheet 1.56) to the LAN of the user or – via Internet – to the HIGHVOLT Service Center.

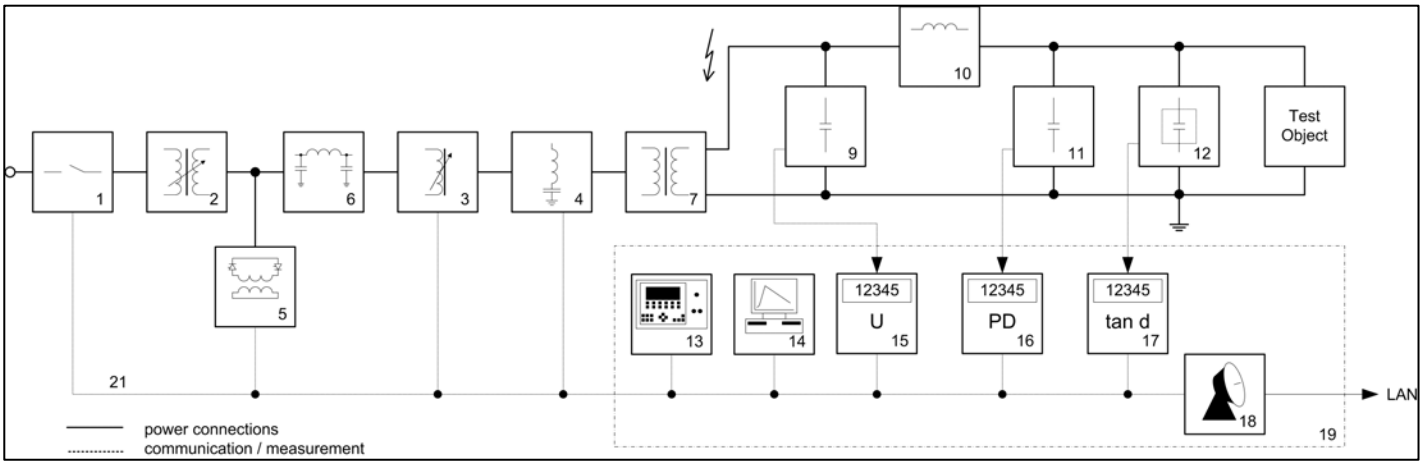

Fig. 1: Principle circuit diagram of an HVAC test system

Insulating case transformers are well suited for cascade connection (Title: 1-MV-cascade at BTU Cottbus) and also for parallel connection (therefore they are sometimes called „modular type transformers“). Their iron core is connected to the midpoint potential of the two HV windings (Fig. 2). The oil-filled case is a fibreglass reinforced plastic (FRP) tube with steel covers. It is suitable for indoor operation.

Insulating case transformers are usually designed for short term operation (up to 10h per day) at rated current which is usually limited up to 2A. After the operation with a certain current for the maximum operation time, the transformer must cool down to ambient temperature. Therefore the usual mode is an interval operation (ON/OFF) as described below.

HIGHVOLT supplies insulating case transformers with rated voltages between 100kV and 500kV and transformer cascades up to 1000kV. For more details see Data Sheet 1.11.

Metal Tank Transformers are used as single test transformers with an earthed tank. They are very space-saving, because the tank can be placed very near to the wall or even outside and only the bushing projects into the lab. But they are also provided for cascade or parallel connections. For cascades the second and a possible third transformer must be arranged on an insulating structure. Metal tank transformers allow a higher power than insulating case transformers, they can be supplied up to the highest power necessary for HV pollution testing, test lines and continuous operation. Furthermore their design is best suited for the outdoor operation. Therefore metal tank transformers are especially recommended for all heavy climatic conditions, especially in very humid and tropic countries.

Metal Tank Transformers are designed for higher currents and continuous operation. Therefore they are well suited for artificial rain and pollution tests. Metal Tank Transformers are often equipped with an oil-to-SF_6 bushing for testing GIS in a completely enclosed HV circuit. For details see Data Sheet 1.12.

HIGHVOLT supplies metal tank transformers with rated voltages up to 800kV and transformer cascades up to 1800kV (higher voltages on request). For more details see Data Sheet 1.12.

Both types of test transformers can also be supplied on a base frame provided for air cushion transportation inside the HV test laboratory.

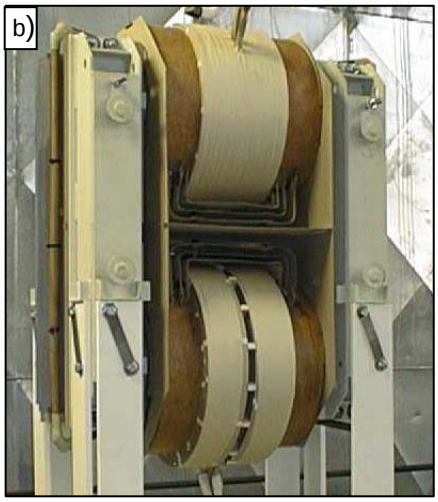

Fig. 2: Insulating case transformer

a) Type PEOI 500/500

b) Active part

Fig. 3: PEO 400/450

Parameter Selection

The rated voltage (peak value divided by the square root of two) of rated frequency (usually 50 or 60 Hz) shall be not lower than 1.1 - times the highest rated withstand voltage usually used for withstand tests. But it should be in minimum 1.4 - times higher, if the system shall be used for research and development, because in such cases also the insulation breakdown must be investigated.

The rated current (RMS value) on the HV side must be higher than that necessary for the test object and that necessary for the voltage divider and/or coupling capacitor (see the mentioned requirements).

The rated power of a test system is the product of the rated voltage and the rated current.

The operation mode determines the rated current (and therefore the rated power) remarkably. The power limitations are caused by limitations of the temperature of the test transformer insulation, which can be reached by the heating due to the operation current under consideration of the ambient temperature. The detailed relation between the operation time and the output current is given in the load curves (Fig. 4). In the HIGHVOLT Data Sheets of test transformers only the operation modes are given:

- „DB = continuous operation“ means that the related current is continuously available.
- „KB x = short time operation” means that the related current is available for x hours, after that starting from ambient temperature.
- „ON x/OFF y = interval operation“ means that the related current is available for x hours when a break off y hours follows. The cycle can be repeated continuously, or several times a day.

The short-circuit current flows at the adjusted test voltage in the case of a breakdown of the test object. It is mainly determined by the impedance of the test transformer and its regulator. The values given in the HIGHVOLT Data Sheets include a regulator appropriate to the test transformer.

The impedance voltages of the test and regulating transformer are the main basis for the calculation of the short circuit current. It is the percentage of the rated voltage necessary for the rated current on the short circuited secondary side of the transformer.

The impedance voltage of the test system results as the sum of those of the test transformer, the regulator and any protection reactance in the circuit.

The specified partial discharge (PD) level of the test system refers to the connection point of the test object.

The ambient conditions are usually specified for a temperature range +5 … 40°C, a relative humidity ≤90% at temperatures ≤30°C and an altitude for erection ≤1000m. Other conditions, especially for outdoor use, can be agreed. Reference conditions according to IEC 60060-1 are 20°C, 1013mbar and 11g/m³ humidity.

Further options as outdoor application, earthquake resistance, transportability, etc. can be specified. For your inquiry use the HIGHVOLT Questionnaire 1.101, please.

The type designation for an AC Voltage Test System with transformers (WP, for outdoor operation: FWP) is derived from the rated power (a) in kVA and the rated voltage (b) in kV: WP a/b or FWP a/b. Examples: WP 350/700 means a 350kVA, 700kV indoor test system, FWP 2000/600 a 2000kVA, 600kV outdoor system.

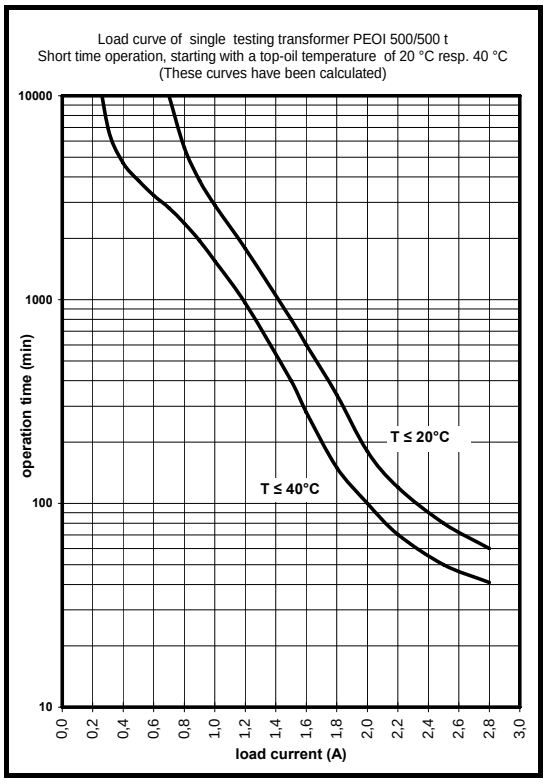

Fig. 4: Load curves (PEOI 500/500)

For further information please contact:

HIGHVOLT Prüftechnik Dresden GmbH
Marie-Curie-Strasse 10
D-01139 Dresden / Germany

Telephone: ++49 351 84 25-648
Fax: ++49 351 84 25-679

e-mail: dresden@highvolt.de
web site: www.highvolt.de

or our local representative: