APPLIED VOLTAGE TEST SYSTEM FOR TRANSFORMERS

- Applied voltage test
- PD diagnostics
BENEFITS

- APPLIED VOLTAGE TEST ON TRANSFORMERS UP TO 1,000 MVA
- ADDITIONAL USE FOR GIS AND CABLE TESTING
- USE IN FACTORY AS WELL AS ON-SITE TESTING

FACTS IN BRIEF

Applied voltage tests are an essential part of factory and on-site testing of power transformers. HIGHVOLT offers three different technical solutions to generate the applied voltage:

- Transformer based test systems (type WP)
- Resonant voltage test systems with variable inductance (type WRV M)
- Resonant voltage test systems with variable frequency (type WRV M).

In the following, the test system with variable frequency will be described, because it offers a variety of advantages in contrast to the other technical solutions.

The main components of the applied voltage test system will be installed either in the test field for factory testing or on an 11-m trailer together with a control container including operator room. The WRVM test system has a fixed inductance that ensures a very low noise emission. The main components of the applied voltage test system will be installed either in the test field for factory testing or on an 11-m trailer together with a control container including operator room. The WRVM test system has a fixed inductance that ensures a very low noise emission.

The frequency is automatically adapted by the control and feeding unit to the resonant frequency of the HV series resonant circuit and increases the inverter output voltage, depending on the required test voltage and losses of the HV series resonant circuit.

APPLICATION

The test system is mainly designed for applied voltage tests. During the applied voltage test, the transformer winding reacts as a simple capacitive load. Therefore, the applied voltage test can be performed by using a resonant circuit.

An oscillating circuit is formed between the test object as a capacitive load and a reactor with fixed inductance. By tuning the frequency to the natural frequency of the circuit, the system is tuned to resonance in the frequency range of 40/50 Hz to 300 Hz.

PD diagnostics

The test system can be equipped with a PD measuring system for additional analysis. The PD signal can be decoupled either from the tap of the bushing or via an additional HV coupling capacitor. The test system has a low PD noise level of less than 10 pC which results in a sensitive PD measurement.

SYSTEM AND COMPONENTS

The control and feeding unit (1) (see fig. 3) consists of a static power inverter and control system. The three-phase power inverter delivers a single-phase frequency-variable output voltage and frequency.

The exciter transformer (2) isolates the inverter from the test circuit and increases the inverter output voltage, depending on the required test voltage and losses of the HV series resonant circuit.

High transient voltages can be generated in the HV circuit, in case of a failure in the transformer to be tested. Therefore, the blocking impedance (9) protects the reactor against such transient overvoltages.

The test system can be conveniently controlled by a PLC and an operator panel implemented in the control and feeding unit (1). Optionally, a connected laptop (6) allows the operator to comfortably perform complex testing and data recording.

Sensitive PD measurement can be performed by means of an advanced PD measuring system (9).
TECHNICAL PARAMETERS

Standard test systems are available for test voltages up to 360 kV and test currents up to 5 A [see table 1]. If required, two reactors can be combined in series or parallel to achieve higher test voltages or higher testing power. They allow a maximum test voltage of up to 720 kV at 5 A (series connection) or alternatively 360 kV at 10 A (parallel connection). For series connection, the second reactor has to be assembled on top of the first reactor.

The load range of a test system is determined by the inductance, design frequency, rated voltage, and current of the reactor. The full voltage can be generated between the design frequency and 300 Hz. Below the design frequency, the output voltage is reduced. This limitation is given by the rated current [see fig. 5, table 1].

The duty cycle of the test system with 15 min ON, 1 hr OFF* has been optimized according to IEC 60076-3 for testing of power transformers. However, this cycle can be further extended to 1 hr ON, 1 hr OFF, if necessary, for special test jobs or for testing of other test objects (e.g., cables). In this case, the test current has to be reduced accordingly.

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**Table 1 Parameters of test system**

<table>
<thead>
<tr>
<th>Test system</th>
<th>WRV 5/360 M</th>
<th>WRV 5/720 M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>360 kV</td>
<td>720 kV</td>
</tr>
<tr>
<td>Rated current</td>
<td>5 A</td>
<td>5 A</td>
</tr>
<tr>
<td>Minimum frequency of the rated voltage</td>
<td>50 Hz</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Inductance of the reactor</td>
<td>235 H</td>
<td>470 H</td>
</tr>
<tr>
<td>Minimum capacitance at 300 Hz</td>
<td>1.2 nF</td>
<td>0.6 nF</td>
</tr>
<tr>
<td>Maximum capacitance at design frequency</td>
<td>43 nF</td>
<td>21.5 nF</td>
</tr>
<tr>
<td>Maximum capacitance at 40 Hz</td>
<td>67 nF</td>
<td>33.5 nF</td>
</tr>
<tr>
<td>Reduced voltage at 40 Hz</td>
<td>288 kV</td>
<td>476 kV</td>
</tr>
<tr>
<td>Frequency</td>
<td>40...300 Hz</td>
<td>40...300 Hz</td>
</tr>
<tr>
<td>Rated duty cycle</td>
<td>15 min ON / 1 hr OFF *</td>
<td>15 min ON / 1 hr OFF *</td>
</tr>
</tbody>
</table>

* actual duty cycle depends on ON-time, current, and environmental temperature

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Fig. 4 Test frequency depending on total load capacitance (WRV 5/360 M)

Fig. 5 Operating range of test system (WRV 5/360 M)