HIGH VOLT
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8.72/4 Type WRV M

APPLIED VOLTAGE TEST SYSTEM FOR TRANSFORMERS

- Applied voltage test
- PD diagnostics

APPLIED VOLTAGE TEST SYSTEM FOR TRANSFORMERS

Fig. 1 **Applied voltage test system for on-site testing of power transformers, type WRV 5/360 M**

Fig. 2 **Applied voltage test system for testing of power transformers, type WRV 5/360 M**

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 WRM)
- 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.

Test system and test object form a series resonant circuit that, due to the physics, guarantees a pure sinusoidal waveform of the test voltage. In case of transformer failure, only minimal damage may occur due to the limited amount of energy stored in the test circuit. The IEC 60076-3 requests a test frequency exceeding 80 percent of the rated frequency. This requirement will be fulfilled by the resonant test system with variable frequency, type WRV M. The test system is characterized by a compact and lightweight, yet robust design. Generally, the test system can be set up on-site within an hour, because it contains few system components. There is no need for additional lifting or assembly up to test voltages of 360 kV. A standard three-phase diesel generator or substation power supply can be used for the feeding of the test system.

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 WRV M test system has a fixed inductance that ensures a very low noise emission.

Besides the testing of large power transformers up to 1,000 MVA, the applied voltage test system can be used for testing of GIS and short HV cables, as well.

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
- PURE SINUSOIDAL WAVEFORM
- EASY AND FAST TEST SETUP
- FEW SYSTEM COMPONENTS
- LOW NOISE EMISSION
- LOW LIFECYCLE COSTS
- MAINTENANCE-FREE

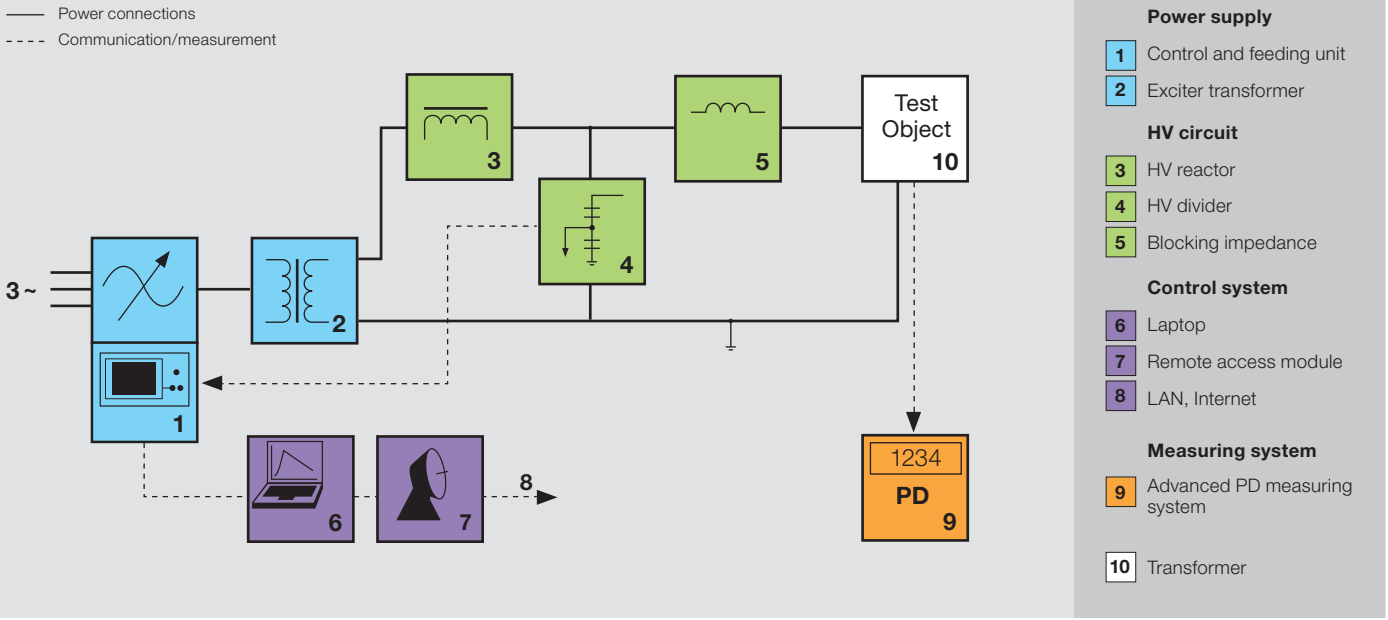

Fig. 3 **Block diagram of a WRV M applied voltage test system**

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.

- OPERATING RANGE 40 Hz TO 300 Hz ACCORDING TO IEC 60076-3
- SENSITIVE PD MEASUREMENT DUE TO LOW PD NOISE LEVEL < 10 pC
- LOW LOSSES
- LOW FEEDING POWER DUE TO HIGH QUALITY FACTOR

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.

The frequency is automatically adapted by the control and feeding unit exactly to the resonant frequency of the HV series resonant circuit formed by the resonant reactor (3) and the transformer to be tested. The test voltage is regulated by the inverter output voltage and measured by a calibrated measuring system consisting of a peak voltmeter and voltage measuring divider (4).

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 (5) 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).

APPLIED VOLTAGE TEST SYSTEM FOR TRANSFORMERS

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.

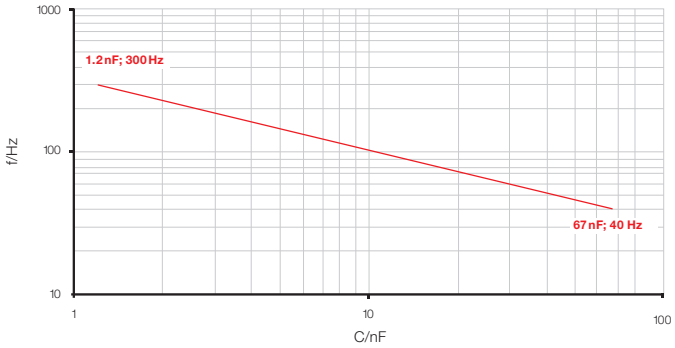

Fig. 4 **Test frequency depending on total load capacitance (WRV 5/360 M)**

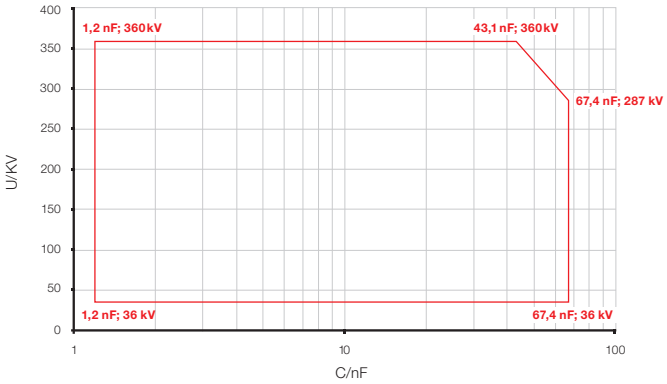

Fig. 5 **Operating range of test system (WRV 5/360 M)**

Table 1 **Parameters of test system**

Test system	WRV 5/360 M	WRV 5/720 M
Rated voltage	360 kV	720 kV
Rated current	5 A	5 A
Minimum frequency of the rated voltage	50 Hz	50 Hz
Inductance of the reactor	235 H	470 H
Minimum capacitance at 300 Hz	1.2 nF	0.6 nF
Maximum capacitance at design frequency	43.1 nF	21.6 nF
Maximum capacitance at 40 Hz	67.4 nF	33.7 nF
Reduced voltage at 40 Hz	287 kV	574 kV
Frequency	40...300 Hz	40...300 Hz
Rated duty cycle	15 min ON/1hr OFF*	15 min ON/1hr OFF*

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

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