

# HVAC POWER FREQUENCY RESONANT TEST SYSTEMS

- AC withstand tests on cables and cable samples
- Applied voltage tests on transformers
- AC withstand tests on GIS, capacitors, generators and motors
- HV tests on voltage and current transformers



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Fig. 1 HVAC resonant test system type WRM



Fig. 2 Portable HVAC resonant test system type WR container variation

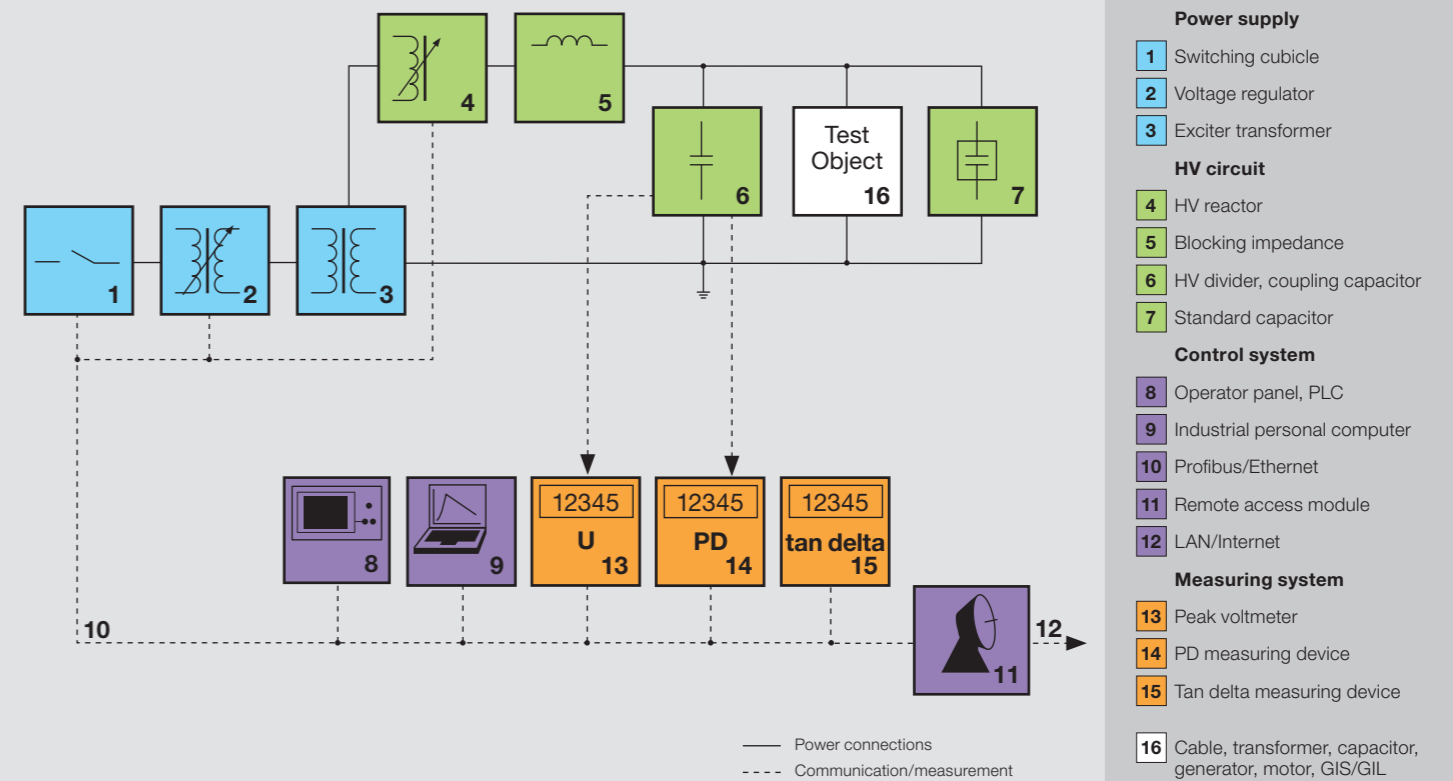


Fig. 3 Principle single line diagram of HVAC resonant test system

## FACTS IN BRIEF

Resonant test systems are applied for the generation of high-voltage AC of power frequency for routine, type and development testing of capacitive test objects. There are two types: steel tank type WR and modular insulating case type WRM.

The main advantage of the resonant test systems is the low power demand because only the losses in the test circuit must be covered by the power supply. Therefore a resonant test system is remarkably lighter and more economic than an AC transformer test system.

The resonant test systems are characterized by a low PD noise level due to their sophisticated design. The test power and the test voltage can be adapted to customer's needs and can be increased by a parallel and series connection of reactors, as well as by using a virtual electric shaft. The customized design of the test systems makes it possible to arrange the HV components in a space-saving manner.

## APPLICATION

The test systems enable testing according to IEC standards, other international standards and customer's specifications.

Main applications are:

- Cable testing on delivery length, cable samples and cable accessories with type WR or WRM
- Applied voltage tests for transformer testing with type WRM
- Current and voltage transformer testing (CTs and VTs) with type WRM
- Capacitor testing with type WR
- Generator and motor testing with type WR
- GIS/GIL and accessories testing with type WRM

Because of their precise sine wave, series resonant test systems are well suited for HVAC tests with PD and tan delta measurements. Resonant test systems also enable tests at other frequencies, e.g. for instrument transformers, or dynamic tests with fast voltage changes for capacitors.

## SYSTEM AND COMPONENTS

The system is supplied with the feeding power from the power network via a switching cubicle (1) [see fig. 3], a voltage regulator (2) and an exciter transformer (3). The exciter transformer is equipped with taps for an ideal adaptation of the output voltage. In case of tank-type reactors the exciter transformer is built into the tank of the HV reactor.

The HV reactor (4) varies its inductance by a magnetic core that can be adjusted to a precise distance. The moveable part of the core is driven by a frequency-controlled motor.

The test object (16) is connected via a HV filter. The filter consisting of a blocking impedance (5) and a HV capacitor (6) has several functions: It reduces the conductor-connected HF noise for PD measurement, protects the HV reactor in case of a breakdown and acts as a basic load which guarantees resonance if no test object is connected. The capacitor (6) is the divider for voltage measurement (13) and the coupling capacitor for PD measurement (14). For very precise voltage or tan delta measurement (15) a compressed-gas standard capacitor (7) can be added.

The test system can be controlled by the modular HiCOS control system.

HiCOS Basic is based on an operator device (8) and a PLC firmware for controlling the programmable logic controllers (SIMATIC PLC) connected by an optic Ethernet (10). This enables manual and automatic operation of the test system including automatic tuning to resonance, pre-selection of voltage cycles, etc.

HiCOS Advanced extends HiCOS Basic with a computer control based on an industrial personal computer (9) with installed PC software package. It enables the printing of customized test records including PD and tan delta measuring results. Furthermore it can be connected to the user's LAN and via the Internet (12) to the HIGHVOLT Service Center for technical support, software updates and trouble shooting.

## BENEFITS

- LOW POWER DEMAND DUE TO HIGH QUALITY FACTOR
- LOWEST PD NOISE LEVEL
- HIGHEST VOLTAGES BY CASCADING OF MODULES
- LARGE VARIETY BY SINGLE, SERIES AND PARALLEL CIRCUITRIES
- LOW ACOUSTIC NOISE LEVEL

# HVAC POWER FREQUENCY RESONANT TEST SYSTEMS

## TECHNICAL PARAMETERS

### Systems with metal tank reactors type WR

#### For cable testing

- Series resonant test systems
- Rated voltages from 35 kV up to 400 kV
- Rated power from 300 kVA up to 10,000 kVA

#### For capacitor testing

- Series and parallel resonant test systems
- Rated voltages from 6 kV up to 60 kV
- Rated power from 5,000 kVA up to 10,000 kVA
- Dynamic tests optional

#### For generator and motor testing

- Series and parallel resonant test systems
- Rated voltages from 15 kV up to 60 kV
- Rated power from 300 kVA up to 1,000 kVA

### Systems with insulating case modular reactors type WRM

#### For cable testing

- Series resonant test systems
- Rated voltages from 250 kV up to 1,600 kV
- Rated power from 1,600 kVA up to 56,000 kVA

#### For power transformer, GIS/GIL, and cable accessories testing

- Series resonant test systems
- Rated voltages from 250 kV up to 1,600 kV
- Rated power from 1,000 kVA up to 22,500 kVA

#### For instrument transformer testing

- Series resonant test systems for applied and induced tests
- Rated voltages from 250 kV up to 1,600 kV
- Rated power from 1,000 kVA up to 10,000 kVA
- Systems for higher frequencies and dynamic tests

The duty cycles of the test systems are adapted to the respectively required test procedures. Power performance can be enhanced by parallel operation of HV reactors controlled by a virtual electric shaft. The virtual electric shaft synchronizes the reactors without using a mechanical connection.

### Main characteristic of a resonant test system:

The connection of a HV reactor to a capacitive test object forms an oscillating circuit with the natural resonance frequency  $f_0$ . By a variable inductance this frequency  $f_0$  can be tuned to that of the power supply (50/60 Hz). The capacitive test power  $S$  exceeds the feeding power  $P$  according to the quality factor  $Q$  of the test circuit.

The inductance of the HV reactor can be adjusted within a specific range  $L_{max}$  to  $L_{min}$ . For series resonance circuits the load capacitance is therefore in the corresponding load range  $C_{max}$  to  $C_{min}$  (typically 20:1). If the test system is equipped with a basic load capacitor  $C_0 > C_{min}$  the test system already operates without a connected test object.

Fig. 4 shows the respective load voltage characteristic for a system with two taps at the HV reactor of type WR or with two reactor modules of type WRM. The rectangle areas enclose the load range of HV reactor for each tap or module. The load cases  $C$  (test object capacitance, test voltage) found within this area can be tested. While load case  $C_1$  can only be tested with tap 1,

$C_3$  could be tested either with tap 1 or tap 2. For testing of  $C_4$  only the parallel connection of modules 1 and 2 covers the required testing power.

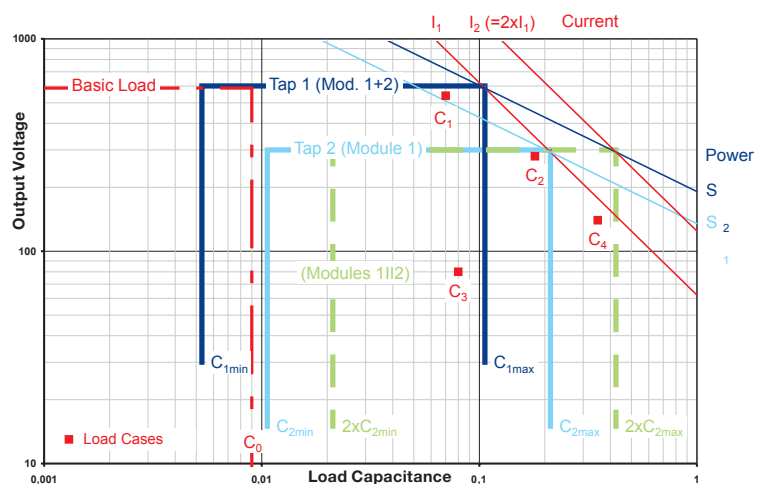


Fig. 4 Typical load diagram

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