AC RESONANT CABLE TEST SYSTEM

TECHNICAL PARAMETERS

Standard test systems are available for test voltages up to 260 kV and test currents up to 190 A [see table 1]. Test systems can be combined in series or parallel if higher test voltages or higher testing power are required. This allows a maximum test voltage of up to 520 kV and a maximum test current up to 500 A. For series connection, there needs to be an insulating support for the second reactor.

Tests on short cables corresponding to a low capacitance value will be done at high frequencies up to 300 Hz and on long cables corresponding to a high capacitance value at low frequencies down to 20 Hz [see fig. 3, table 2].

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. 4, table 2].

Parallel operation of two systems doubles the output current and, in the process, the cable length that can be tested. Series operation doubles the output voltage but bisects the testable cable length [see table 2].

Table 1 Standard test systems

<table>
<thead>
<tr>
<th>WRV 190/110 T</th>
<th>Output voltage</th>
<th>110 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output current</td>
<td>110 A</td>
<td></td>
</tr>
<tr>
<td>Rated voltage</td>
<td>190 A</td>
<td></td>
</tr>
<tr>
<td>Rated current</td>
<td>83 A</td>
<td></td>
</tr>
<tr>
<td>Normal frequency of the rated voltage</td>
<td>31 Hz</td>
<td></td>
</tr>
<tr>
<td>Inductance of the reactor</td>
<td>16.2 H</td>
<td></td>
</tr>
<tr>
<td>Minimum capacitance at 260 kV</td>
<td>17 nF</td>
<td></td>
</tr>
<tr>
<td>Maximum capacitance at 300 Hz</td>
<td>1651 nF</td>
<td></td>
</tr>
<tr>
<td>Reduced voltage at 20 Hz</td>
<td>169 kV</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 Combination of two test systems and corresponding parameters (example type WRV 83/260 T)

<table>
<thead>
<tr>
<th>Test system</th>
<th>WRV 83/260 T</th>
<th>2 x WRV 83/260 T parallel</th>
<th>2 x WRV 83/260 T series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>260 kV</td>
<td>260 kV</td>
<td>520 kV</td>
</tr>
<tr>
<td>Rated current</td>
<td>83 A</td>
<td>166 A</td>
<td>83 A</td>
</tr>
<tr>
<td>Normal frequency of the rated voltage</td>
<td>31 Hz</td>
<td>31 Hz</td>
<td>31 Hz</td>
</tr>
<tr>
<td>Inductance of the reactor</td>
<td>16.2 H</td>
<td>8.1 H</td>
<td>32.4 H</td>
</tr>
<tr>
<td>Minimum capacitance at 300 Hz</td>
<td>17 nF</td>
<td>34 nF</td>
<td>8 nF</td>
</tr>
<tr>
<td>Maximum capacitance at 20 Hz</td>
<td>1651 nF</td>
<td>3300 nF</td>
<td>825 nF</td>
</tr>
<tr>
<td>Reduced voltage at 20 Hz</td>
<td>169 kV</td>
<td>169 kV</td>
<td>338 kV</td>
</tr>
</tbody>
</table>

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These test systems are able to perform tests on extruded cables according to IEC 60840 and 62067 after they have been installed. These standards require testing with AC voltage in the frequency range \( f_{\text{min}} = 20 \text{ Hz} \) to \( f_{\text{max}} = 300 \text{ Hz} \) only and do not allow DC, damped AC (DAC) or VLF.

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 cable failure, only minimal damage may occur due to the limited amount of energy stored in the test circuit.

The operating frequency range determines the wide load range for testing very short cables to cable lengths of several kilometers. Generally, the test system can be set up on site within an hour. There is no need for additional “lifting” or “assembly”. A standard three-phase diesel generator can be used for the feeding of the test system. The modular design allows several test systems to be connected in series or parallel to enable testing with higher voltages or power requirements.

The control and feeding unit (1) [see fig. 2] consists of a static power inverter and a control system. The power inverter converts the three-phase input voltage into a single-phase output voltage with a rectangular waveform. The frequency is automatically adapted exactly to the resonant frequency of the HV series resonant circuit formed by the resonant reactor (3) and the cable to be tested. The test voltage is regulated by the duty of the inverter output voltage and measured by a calibrated measuring system consisting of a peak voltmeter and voltage measuring divider (4).

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. In case of failure in the cable to be tested, high transient voltages can be generated in the HV circuit. 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. Optionally, a connected computer (6) allows the operator to comfortably perform complex testing and data recording.

Sensitive PD measurement on joints and cable terminations can be performed by means of an advanced PD measuring system (7).

### FACTS IN BRIEF
- Pure Sinusoidal Waveform
- Frequency range 20 to 300 Hz
- PD Noise level < 10 pC
- Low Losses

### BENEFITS
- Pure Sinusoidal Waveform
- Frequency range 20 to 300 Hz
- PD Noise level < 10 pC
- Low Losses

### APPLICATION
1) On-site tests
   - The main application for the AC resonant test system is the AC withstand testing after the cable system has been installed. This test is often combined with PD diagnosis on cable joints and terminations. Additional AC tests can be performed during the lifetime of the cable system for diagnostic purposes or after repair.

2) Factory test
   - The system can also be used for tests on super-long submarine cables in the factory. For testing long submarine cables in the factory as well as on-site, the frequency range can be extended down to 10 Hz to reduce the cable losses during testing. In combination with suitable reactors and base load capacitors long-term prequalification tests can be performed.

### SYSTEM AND COMPONENTS
- Power supply
- Control and feeding unit
- Exciter transformer
- HV circuit
- HV reactor
- HV divider
- Blocking impedance
- Control system
- Computer
- Measuring system
- Advanced PD measuring system
- Cable