Voltage Regulated Distribution Transformer

SmartActiveTransformer
The economical alternative to grid expansion – optimal grid capacity utilisation: the integration of increasingly decentralised energy sources feeding renewable energy into low-voltage systems presents energy providers with increasingly greater challenges.

The specified nominal voltage range of +/- 10% according to DIN 50160 only allows a maximum voltage rise of 3% for decentralised energy sources. The remaining bandwidth must be available for medium voltage, voltage drops, and setting accuracy.

In this context, more and more network operators are being forced to undertake expensive expansion activities in their grids, even though the available power capacity in the affected low-voltage distribution network is still far from being reached.

This is precisely where the core problem of adherence to the voltage range becomes the focus of a variable local network transformer, which adjusts the voltage dynamically. By decoupling the voltages in the medium and low-voltage networks, 11 percent, rather than 3 percent, are now available for voltage spikes that occur while feeding into the low-voltage network. In many cases, use of this type of controllable local network transformer enables network expansion to be omitted completely or at least significantly reduced in the few remaining cases.

In each case, the already available operating equipment can be utilised to a high degree by the network operator resulting in more economical operation.
The economical alternative
J. Schneider Elektrotechnik GmbH
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The ideal solution for power distribution network operators

Maintenance-free, long-lasting
· no lifetime-limited electronics in the circuit breaker
· maintenance-free for its entire lifespan thanks to vacuum technology
· lifetime analogy to conventional local network transformers

Low lifecycle costs
· 700,000 reliable circuits make maintenance unnecessary
· the on-load tap changer operates reliably throughout the entire lifetime of the transformer
· motor and controller may be easily replaced as required

Maximum operating reliability
· critical operating conditions are excluded by the reactor principle
· a communication interface enables integration with the control room as required
· the SmartActiveTransformer features the entire know-how of more than 35,000 vacuum switches and over 10,000 reactor switches developed by Maschinenfabrik Reinhagen, which are used around the world

Fit for the future
· a maximum of 9 operating positions and step spacing of up to 3% enable a control range up to 24%
· the on-load tap changer is also configurable asymmetrically for situations primarily featuring loads or primarily featuring feeds
· The voltage range of +/- 10% as per DIN 50160 can be fully utilised

Control algorithm
The integrated voltage regulator enables completely autonomous operation, whereby the SmartActiveTransformer independently adapts to the current network conditions. For this purpose, the voltage carried by the low-voltage bus bar includes all 3 phases, and the control parameters react accordingly. Threshold hunting also prevents build up in the switch due to phase asymmetry.

The definable parameters for the control algorithm include the target voltage (Usoll), the step voltage (Ustep), the dead time (t1), and the threshold for the high-speed transfer switch (So). In addition to parameterisable standard algorithm, individual alternative algorithms may also be implemented as required. Standard protocols also make communicative connection with cross-systems possible.
The SmartActiveTransformer suits any compact station

The on-load tap changer was specially developed and optimally integrated with the transformer tank in which the switches operate in special vacuum cells to exclude the possibility of oil contamination, thus no second oil vessel is required for the circuit. The innovative design enables the SmartActiveTransformer to correspond with the dimensions of local network transformers, and it is easily integrated with conventional compact stations. In connection with the control cabinets, it also includes all of the functions that are required for self-sufficient voltage regulation.
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**Drive function**
- step motor
- duration less than 1 second per cycle

**Load switching function**
- on-load tap changer based on the reactor principle
- electric arcs are quenched in specially developed vacuum switch tubes
- space-saving integration
- maintenance-free for the lifetime of the transformer (up to 700,000 cycles)
- regulation on the upper voltage side

**Regulator function**
- voltage regulation on the low-voltage bus bar
- three-phase voltage measurement
- automatic, remote and manual modes
- higher/lower operation
- Ethernet and RS232 interfaces
- IEC 60870-5-101, IEC 60780-5-104 and IEC 61850 control system protocols
- powder-coated sheet metal housing
- IP54 degree of protection
Technical data

J. Schneider Elektrotechnik GmbH

Technical data

<table>
<thead>
<tr>
<th>Winding material</th>
<th>SmartActiveTransformer</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>copper / alu at B – C</td>
<td>selectable, max. 24 kV voltage class</td>
<td>more on request</td>
</tr>
<tr>
<td>high voltage steps</td>
<td>up to max 9 steps, configuration selectable</td>
<td></td>
</tr>
<tr>
<td>step voltages</td>
<td>e.g. +/- 4 x „X%“; +4/-3 x „X%“; +6/-2 x „X%“</td>
<td></td>
</tr>
<tr>
<td>frequency low voltage</td>
<td>selectable, max. 600V, common 1.5%, 2%, 2.5%</td>
<td></td>
</tr>
<tr>
<td>vector group cooling</td>
<td>Dyn 5</td>
<td></td>
</tr>
<tr>
<td>max. installation altitude HV bushings</td>
<td>1000 m over NN</td>
<td></td>
</tr>
<tr>
<td>LV-bushings</td>
<td>flange connection DIN 43675</td>
<td></td>
</tr>
<tr>
<td>tank type protective device</td>
<td>hermetic-corrugated tank</td>
<td></td>
</tr>
<tr>
<td>thermometer pocket driving rolls coating</td>
<td>thermometer pocket according to DIN 42554 on LV side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lengthwise and crosswise DIN EN 50216-4, material: steel</td>
<td>RAL 7033, total coating thickness &gt;= 140 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Power loss

| $S_n$ [kVA] | $u_k$ | $P_0$ (Trafo) $A_0$ [W] | $P_0$ (Trafo+PA) $B_0$ [W] | $P_0$ (Trafo+PA) $C_0$ [W] | $P_0$ (Trafo+PA) $D_0$ [W] | $P_0$ (Trafo+PA) $E_0$ [W] | $P_0$ (Trafo+PA) $F_0$ [W] | $P_0$ (Trafo+PA) $G_0$ [W] | $P_0$ (Trafo+PA) $H_0$ [W] | $P_0$ (Trafo+PA) $J_0$ [W] | $P_0$ (Trafo+PA) $K_0$ [W] | $P_0$ (Trafo+PA) $L_0$ [W] | $P_0$ (Trafo+PA) $M_0$ [W] | $P_0$ (Trafo+PA) $N_0$ [W] | $P_0$ (Trafo+PA) $O_0$ [W] | $P_0$ (Trafo+PA) $P_0$ [W] | $P_0$ (Trafo+PA) $Q_0$ [W] | $P_0$ (Trafo+PA) $R_0$ [W] | $P_0$ (Trafo+PA) $S_0$ [W] | $P_0$ (Trafo+PA) $T_0$ [W] | $P_0$ (Trafo+PA) $U_0$ [W] | $P_0$ (Trafo+PA) $V_0$ [W] | $P_0$ (Trafo+PA) $W_0$ [W] | $P_0$ (Trafo+PA) $X_0$ [W] | $P_0$ (Trafo+PA) $Y_0$ [W] | $P_0$ (Trafo+PA) $Z_0$ [W] | $P_0$ (Trafo+PA) $[kg]$ |
|-------------|-----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 250         | 4   | 300           | 415           | 2750          | 1910          | 360           | 480           | 2750          | 1740          | 360           | 480           | 3250          | 1650          | 670           | 670           | 150           | 265           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            |
| 400         | 4   | 430           | 590           | 3850          | 2380          | 520           | 680           | 3850          | 2200          | 520           | 680           | 4600          | 2000          | 670           | 670           | 150           | 265           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            |
| 630         | 4   | 600           | 780           | 5400          | 2950          | 730           | 910           | 5400          | 2600          | 730           | 910           | 6500          | 2400          | 670           | 670           | 150           | 265           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            |
| 630         | 6   | 560           | 740           | 5600          | 3150          | 680           | 860           | 5600          | 2750          | 680           | 860           | 6750          | 2550          | 670           | 670           | 150           | 265           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            |
| 800         | 6   | 650           | 900           | 7000          | 3500          | 800           | 1050          | 7000          | 2950          | 800           | 1050          | 8400          | 2750          | 670           | 670           | 150           | 265           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            | Ø              | 125           | 40            |

Technical data voltage regulator and control cabinet

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
<th>Frequency</th>
<th>Test voltage to ground</th>
<th>Duration of tap change operation</th>
<th>Shortest gap between tap-change operation</th>
<th>Interfaces</th>
<th>Protocols</th>
<th>Housing (W x H x D)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 400 V</td>
<td>1.0 A</td>
<td>50 Hz</td>
<td>2 kV / 1 minute</td>
<td>0.9 s</td>
<td>3 s</td>
<td>Ethernet, RS 232</td>
<td>IEC 60870-5-101, IEC 60870-5-104, IEC 61850</td>
<td>380 x 380 x 180 mm</td>
<td>15 kg</td>
</tr>
</tbody>
</table>
**Technical data**

- Copper / Alu at B – C 0 K selectable, max. 24 kV voltage class up to max 9 steps, configuration selectable e.g. +/- 4 x "X%"; +4/-3 x "X%"; +6/-2 x "X%"
- Selectable, max. 600V, common 1.5%, 2%, 2.5%
- 50 Hz selectable
- Dyn 5
- ONAN
- 1000 m over NN
- 12 - 24 kV / 250 A plug-bushing DIN 50190
- Flange connection DIN 43675
- Hermetic-corrugated tank
- Non-thermometer pocket according to DIN 42554 on LV side
- Lengthwise and crosswise DIN EN 50216-4, material: steel RAL 7033, total coating thickness >= 140 µm
- More on request

**Options**

**Technical data**

<table>
<thead>
<tr>
<th>SmartActiveTransformer</th>
<th>[mm]</th>
</tr>
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<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
</tr>
<tr>
<td>250 kVA 10/20 kV</td>
<td></td>
</tr>
<tr>
<td>400 kVA 10/20 kV</td>
<td></td>
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<tr>
<td>630 kVA 10/20 kV</td>
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<tr>
<td>800 kVA 10/20 kV</td>
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<tr>
<th>uk</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
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<tbody>
<tr>
<td>4 %</td>
<td>1080</td>
<td>810</td>
<td>1650</td>
<td>520</td>
<td>520</td>
<td>265</td>
<td>40</td>
<td>Ø 125</td>
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<tr>
<td>4 %</td>
<td>1260</td>
<td>900</td>
<td>1650</td>
<td>670</td>
<td>670</td>
<td>265</td>
<td>40</td>
<td>Ø 125</td>
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<tr>
<td>4 %</td>
<td>1410</td>
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<td>1040</td>
<td>1800</td>
<td>670</td>
<td>670</td>
<td>265</td>
<td>40</td>
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<tr>
<td>6 %</td>
<td>150</td>
<td>150</td>
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<td>150</td>
<td>150</td>
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<td>40</td>
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<tr>
<td>6 %</td>
<td>1500</td>
<td>1500</td>
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<td>Ø 125</td>
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</tr>
<tr>
<td>6 %</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
<td>1800</td>
<td>265</td>
<td>40</td>
<td>Ø 125</td>
<td></td>
</tr>
</tbody>
</table>

**Power loss**

- **S**
- **N**
- **P**
- **0 (Trafo)**
- **P**
- **0 (Trafo+PA)**
- **P**
- **0 (Trafo+PA)**
- **P**
- **0 (Trafo+PA)**
- **P**
- **0 (Trafo+PA)**

**Weight**

- **A**
- **B**
- **C**
- **D**
- **E**
- **F**
- **G**
- **H**
- **J**

**Weight**

- **A**
- **B**
- **C**
- **D**
- **E**
- **F**
- **G**
- **H**
- **J**

**Voltage regulator and control cabinet**

- Dimensions: 380 x 380 x 180 mm
- Weight: 15 kg

**Interfaces and protocols**

- Ethernet, RS 232
- IEC 60870-5-101, IEC 60870-5-104, IEC 61850