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Siemens cast-resin transformer digital operating instructions, with detailed video modules on installation, commissioning, and maintenance. Simply scan the relevant QR code and install the instructions as an app.
Scope

These operating instructions are applicable to all GEAFOL cast-resin transformers of three-phase and single-phase design, including special versions such as rectifier and star-point transformers.

Application

GEAFOL cast-resin transformers are particularly suitable for applications where fire or ground-water regulations would involve additional expense if liquid-immersed transformers were used, for example on ships, offshore, and in wind turbines, department stores, data centers, hospitals, subways, sports stadiums, meeting halls, pumping stations, and water catchment areas. They are also being used more frequently in industrial applications for load-center substations and supply feeder stations because, with cast-resin transformers, there are no structural costs for oil collecting troughs and fire protection. This also greatly facilitates relocation of the transformers, should this be necessary.
Fig. 1a: 630 kVA GEAFOL cast-resin transformer
10 ± 2 x 2.5%/0.4 kV high-voltage connection side

1. Low-voltage terminals
2. Lifting lugs
3. Lashing lugs
4. High-voltage terminals
5. Delta connection
6. Grounding screw
7. Lower core frame
8. Wheels, can be turned 90°
9. Pulling lugs
10. High-voltage tappings
    (these may also be on the low-voltage terminal side)
11. Casted high-voltage winding
12. Connection for temperature monitoring system
13. Upper core frame
14. Low-voltage winding
Description

Core
Only grain-oriented, cold-rolled sheets insulated on both sides are used for the iron core.

The leg and yoke cross-sections are staggered with different lamination widths. The outer legs have miter joints. Legs and yokes are connected by 45° cuts, and the middle leg with a pointed miter joint at the yoke junction.

Windings
The high-voltage coils are made of aluminum foils and high-quality insulating films. Each phase winding is formed from several separate coils connected in series; these are encapsulated in resin under vacuum. The winding ends and tappings are routed to threaded bushes and are encapsulated with the remainder of the winding. The low-voltage coils are made of aluminum strips and resin-impregnated insulating film (prepreg).

Insulation
The insulation structure is dimensioned on the basis of the impulse voltage distribution. It ensures freedom from partial discharge up to twice the rated voltage, as well as thermal and mechanical strength.

Supports
A clamping arrangement designed specifically for the characteristics of the strip/foil windings and the flexible bracing of the coils ensure both high short-circuit strength and a very low noise level.

With GEAFOL Neo, the coils do not need to be clamped.
**Installation**

**Unloading, transporting, unpacking, inspecting, cleaning, and storing**

GEAFOL transformers may be unloaded and transported only by means of four individual cords attached to the lifting lugs on the upper constructional core frames (see Fig. 1, page 5). If the transformer will be delivered within a completely assembled housing, the relevant information on the housing must be taken into consideration. The instructions on the labels at the lifting lugs about pulling at an angle must be observed (see Fig. 2, below). If a transformer is moved on its wheels, the points of action are the pulling lugs on the lower core frames (see Fig. 1, page 5) or on the truck.

Do not push or pull on the high-voltage windings or their connecting tubes.

GEAFOL cast-resin transformers may be transported by forklift truck only if the transporting party ensures that
- the transformer is adequately secured against the risk of tipping and/or falling and
- damage to the iron core between the core frames and any attached accessories like fans or grounding switches is reliably prevented.

If signs prohibiting transport by forklift are attached near the bottom of the transformer, transport of the transformer by forklift is absolutely prohibited!

GEAFOL transformers should be unloaded and unpacked in a sheltered area and inspected immediately for transportation damage. Any visible damage must be noted in the transport papers and confirmed by the deliverer. The sender must be informed immediately so that a suitable claims settlement procedure can be initiated, if necessary with the participation of the transport insurance company.

If necessary, the transformer must be cleaned before commissioning (see recommendations for cleaning and inspecting GEAFOL cast-resin transformers on page 14).

If the transformer is not commissioned immediately it must be stored in a sheltered area that is dry and protected from sunlight.

The transformer must be packed in a protective film when being transported on-site or being stored temporarily. This effectively prevents the ingress of dust and foreign matter. In order to prevent condensation from forming, an adequate quantity of desiccant agent (such as silica gel) must be enclosed in the packaging.

**Minimum temperatures**

GEAFOL transformers are designed for operation at a minimum temperature of –30° Celsius (–22° F), unless otherwise agreed for a specific project. This minimum temperature applies to transportation, storage, and operation (under load, no-load, as well as in standby) at all times. For lower ambient temperatures (below –30° Celsius/–22° F), suitable external pre-heating facilities must be provided on-site. In case of doubt, please contact the Siemens factory.
Setting up
GEAFOL cast-resin transformers should be installed only in a sheltered area or cell that is dry and protected from sunlight, where the degree of protection assured is at least IP 20. If appropriately coated with special paint and if an outdoor housing is used, they are also suitable for installation outdoors (minimum IP 23). GEAFOL cast-resin transformers need an adequate supply of fresh air to dissipate the heat loss. Approximately 200 m³ of fresh air per hour and for each kW of heat loss is the recommended value; more information can be found in the GEAFOL Planning Guidelines.

Fig. 3: Minimum clearances around GEAFOL cast-resin transformers with switching strip (1)

Fig. 4: Minimum clearances around GEAFOL cast-resin transformers with bare tappings and delta connection tubes (2)

Also make sure that the clearances from the surface of the cast-resin coils to the walls, busbars, grounded parts, and other elements satisfy the applicable installation and safety regulations (see Figs. 3 and 4).

Cast-resin transformers are not safe to touch.
The power must be shut off before work is performed on the transformers. Applicable regulations must be observed.

<table>
<thead>
<tr>
<th>Maximum voltage for equipment $U_m$ (rms value)</th>
<th>Rated lightning impulse withstand voltage $U_{li}$</th>
<th>Minimum clearances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>List 1</td>
<td>List 2</td>
</tr>
<tr>
<td>[kV]</td>
<td>[kV]</td>
<td>[kV]</td>
</tr>
<tr>
<td>12</td>
<td>–</td>
<td>75</td>
</tr>
<tr>
<td>24</td>
<td>95</td>
<td>–</td>
</tr>
<tr>
<td>24</td>
<td>–</td>
<td>125</td>
</tr>
<tr>
<td>36</td>
<td>145</td>
<td>–</td>
</tr>
<tr>
<td>36</td>
<td>–</td>
<td>170</td>
</tr>
</tbody>
</table>

Table 1

1) See IEC 60071/HD 637 S1

* If there are high-voltage tappings on this side, the value in column a applies to the clearance b; otherwise, the value in column c applies.

** Distance to walls or HV-cables.
Unless otherwise agreed, the transformers are designed in accordance with the applicable standards for the following cooling air values:

- 40° Celsius at any given time
- 30° Celsius monthly average of the hottest month
- 20° Celsius yearly average

If operated normally, the transformer should attain its expected service life. In particular, the average annual temperature and the load crucially influence the service life.

GEAFOL cast-resin transformers intended for installation at altitudes over 1,000 m above sea level are identified as such on the rating plate, which cites the maximum permissible installation elevation. When these transformers are installed, the minimum clearances listed in Table 1 (see page 8) must be increased by one percent for each 100 m above the altitudes of 1,000 m.

**Housings**
When housings are used, note that all bolted connections must be firmly tightened during installation to avoid damage to the transformer, for example due to nuts falling out.

**Minimum clearances**
Adequate clearance must always be ensured around the transformer to enable connections to be made and also to adhere to the necessary electrical clearances. The minimum clearances to prevent flashover are shown in Table 1 (see page 8) in conjunction with the diagrams in Fig. 3 and 4 (see page 8).
Connecting

On the high-voltage side, the transformer is connected to the surfaces of the delta connecting tubes or the terminals provided on the casted delta connection bar, or to the cast-on post insulators on the high-voltage pottings (Y connection). When connecting cables, make sure that they feature adequate strain relief and are routed so that the voltage clearances are maintained in line with relevant regulations. The minimum clearances for cable connections shown in Table 1 (see page 8) and Fig. 5 must be observed.

On the low-voltage side, the transformer is connected to the aluminum terminals provided for this purpose. Here again it must be ensured when connecting cables, that they feature adequate strain relief to avoid undue mechanical stress at the terminals. The following guidelines must be observed when connecting the transformer terminals via expansion straps.

Surface preparation
Before making any bolted or terminal connections, it is necessary to remove the thin, invisible layer of oxide, which is a poor conductor of electricity, from the aluminum surface.

To make connections, the contact surfaces must be polished bare metal. Every time a point of contact is opened, the aluminum contact surface must be subjected to the full preparation process again before it is bolted back together.

If the transformer is installed indoors in a room where condensation is expected, or where corrosive gases are present, and if the transformer will be connected to copper busbars, an aluminum sheet that is copper plated on one side (the product known by the trade name “Cupal”, for example), must be inserted between Cu-Al contact points so that the aluminum side is in contact with the aluminum terminal. All edges of this sheet must protrude several millimeters to ensure that any corrosion occurring in the transition area remains outside the contact zone. Corrosion can be avoided for the most part by applying a protective coating to the cut edges of this Cupal sheet. Tin-plated terminals can be combined with bare aluminum, copper or silver-plated surfaces.
Expansion strap

Fastenings
Corrosion-proof parts must be used for bolted connections. Bolts in strength class 8.8 or 10.9 should be used. In order to transmit the bolting force to the largest possible contact surface, stiffened washers should be inserted under the bolt head and the nut. Spring elements are also necessary to resiliently accommodate heat-generated tension, to compensate for plastic deformation and maintain the required minimum contact pressure at all times. Both conditions can be met by conical spring washers per DIN 6796, which are used in particular for conductor bar threaded fastenings.

Contact pressure
The bolts should be tightened with a torque wrench. This ensures that the bolt connections are made with adequate contact pressure.

To compensate for any settling in the joints, it’s advisable to retighten the bolts after a few hours. However, the torque then applied should not be greater than the torque applied in the initial installation.

<table>
<thead>
<tr>
<th>Bolt</th>
<th>Torque [Nm] dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>10</td>
</tr>
<tr>
<td>M8</td>
<td>20</td>
</tr>
<tr>
<td>M10</td>
<td>45</td>
</tr>
<tr>
<td>M12</td>
<td>75</td>
</tr>
<tr>
<td>M16</td>
<td>140</td>
</tr>
</tbody>
</table>

Table 2: Tightening torque values for the phase connections and tappings

We recommend the tightening torque values listed in Table 2 for tightening the ungreased (dry) bolted joints. If the low-voltage connection is established with busbars, an expansion strap (flexible connection element) must be installed between the transformer and the busbars. This keeps mechanical stresses away from the transformer (see Fig. 8) and largely prevents transmission of structure-borne transformer noise. Detailed information on bolted busbar connections can be found in DIN 43673.

Grounding
Make sure that the necessary ground connection is established on accessories installed that are connected to the transformer after installation. Transformer housings must also be grounded in accordance with the known grounding specifications.

Fig. 7: Transformer connection with cable lug

1 Hexagon bolt, ISO 4014 or ISO 4017
2 Conical spring washer, DIN 6796
3 Hexagon nut, ISO 4032
4 Washer, EN ISO 7093 or outer diameter > conical spring washer diameter
5 Washer, ISO 7089

Fig. 8: GEAFOL cast-resin transformer low-voltage end connection with expansion strap
Temperature monitoring

General
The measuring sensors in the temperature monitoring system record the winding temperature. This acts as overload protection against excessive heat generation in the transformer windings. This protection does not prevent an increased rate of service life consumption if the cooling air temperatures are not maintained within specified limits (see list, page 9). The following versions or combinations can be installed:

Description
The temperature monitoring system in the GEAFOL cast-resin transformers consists of PTC thermistors, according to DIN 44082 or platinum resistance thermometers (PT100) in accordance with IEC 60751, and the associated monitoring devices. The positioning of overload protection is identical for both systems. The monitoring devices must be designed to process the signals from the particular system.

Version with PTC
At least two PTC thermistors are installed in each of the low-voltage windings to be monitored for purposes of warning and triggering. A third thermistor can be added either during installation or subsequently, for example, to monitor the fans. The PTCs of a particular functional stage are connected in series and are routed to a terminal strip (max. 4 mm²) on the upper pressed metal sheet.

Version with PT100
At least one resistance thermometer (PT100) is installed in each low-voltage winding to be monitored. The warning, triggering, or fan control functions must be set on the monitoring device. The corresponding setting values can be found on the information plate attached to the transformer. By default, the PT100s are routed in a three-conductor circuit to a terminal strip (max. 4.0 mm²) on the upper pressed metal sheet.

Evaluation devices
For connection and operation of the monitoring devices, refer to the respective operating instructions. Information about the devices can be found at www.ziehl.de and www.tecsystem.it.
Commissioning

The transformer must have been cleaned and it should not contain any foreign objects (see also Installing, page 7).
• Compare the technical data on the rating plate attached to the transformer to the customer’s requirements.
• Tighten all contact connections to the torque stated in Table 2 (see page 11).
• Adjust any connecting brackets on the high-voltage tappings to the prevalent voltage.
• The correct tapping connection is provided on the rating plate. All connecting brackets at the HV windings must be fixed at the same voltage tapping. Tightening torques of the bolts are specified in Table 2 (see page 11).

⚠️ Adjust the connecting brackets only in the de-energized state.

When large transformers are switched on, in isolated cases visible sparks may occur on the outside (especially in the area of the core and the clamped parts), but these will soon subside. This effect occurs for reasons of physics and has no influence on operating safety; it is not a defect. Due to the low attenuation, it may take the switch-on currents of GEAFOL cast-resin transformers some time to decay. Refer to the test report for the exact values. This must be considered when selecting fuses and/or relay times.

If protection settings are incorrect, the transformer will be switched off during the transient response of the current. This will lead to high excess voltages in the transformer windings, where they may cause damage.
GEAFOL cast-resin transformers are practically maintenance-free. If they are operated in very dusty installations, for instance in rolling mills, we recommend cleaning several times a year.

Typically once every year, the contact bolts, warning functions, and the operation of any attached fans should be checked.

The transformer must be switched off on all sides before starting maintenance work. All terminals must be short-circuited and grounded. The safety regulations must be observed.

Cleaning transformers
Special care must be given to cleaning all horizontal surfaces and support blocks in the area between the low-voltage and high-voltage coils where, according to experience, deposits can accumulate very easily.

Cleaning method
- Rub the soiled surfaces with a cloth soaked in a conventional tenside-based cleaning agent. Then wipe with a dry cloth.
- Use a vacuum cleaner to remove loose particles and dirt in the cooling ducts as far as they are accessible. In addition, pressurized air can be used as a supporting measure.

Checking the torque values of bolted connections
The torque values of the transformer's ground terminals – especially the bolted connections of all electrical terminals, the high-voltage tappings, and the connections from one system to another in the case of double-tier transformers – should be checked once a year. Use a torque wrench or a force-limiting wrench to check bolted connections against the values listed in Table 2 (see page 11).
Checking warning functions
The Inspection function of the monitoring devices can be conducted as specified in the operating instructions. A visual inspection of the terminal connections on the transformer is recommended.

Checking mounted fans
If possible, the functioning and operating characteristics of any attached fans should be checked once a year.

Please note:
On delivery, the default setting of the monitoring system types T154 and NT935 includes a functional test for fans. If run in the factory default setting, every 96 hours the fans will undergo a short test lasting 5–10 minutes.

Protective housings
Protective housings can be cleaned in the same way as control cabinets. In particular, make sure that air inlet and outlet openings are free of dust and dirt deposits.

Faults
In the event of faults that cannot be cleared by the customer, the service department at Siemens AG should be notified.

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