



GEAFOL Cast-Resin Transformers Operating Instructions

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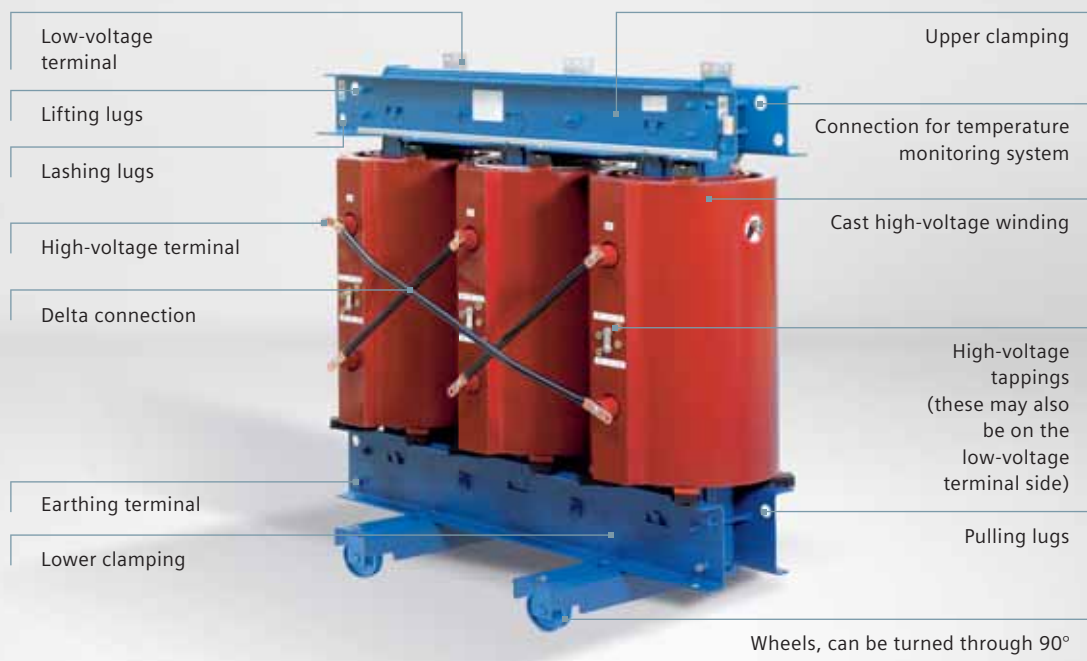


Fig. 1: 630 kVA GEA FOL cast-resin transformer $10 \pm 2 \times 2.5 \% / 0.4$ kV low-voltage connection side

Range covered

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

Application

GEA FOL cast-resin transformers are particularly suitable for applications where fire or ground-water regulations would involve additional expense if liquid-immersed transformers were used, e.g. in ships, offshore and wind power plants, department stores, underground railways, sports stadiums and 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 civil works costs for oil catch pits and fire protection. This also greatly facilitates relocation of the transformers should it be necessary.



Description

Core

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

The leg and yoke cross-sections are staggered by different lamination widths. The outer legs have miter joints and the middle leg a double miter joint at the yoke junction.

Windings

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

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 windings and flexible bracing of the coils ensure both high short-circuit strength and also a very low noise level.

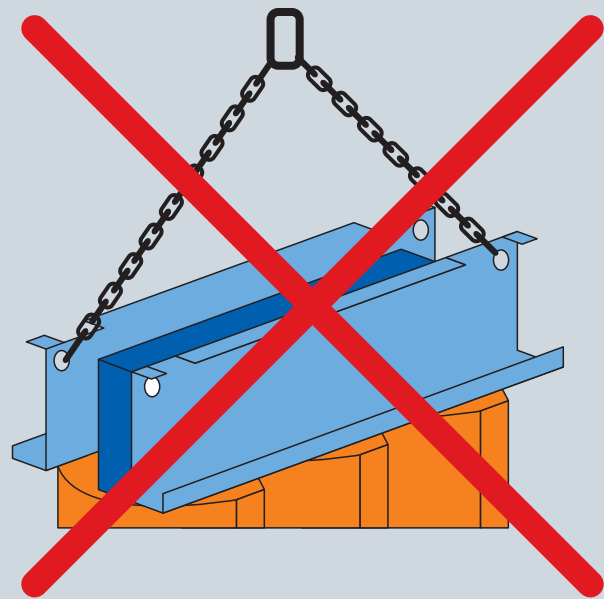
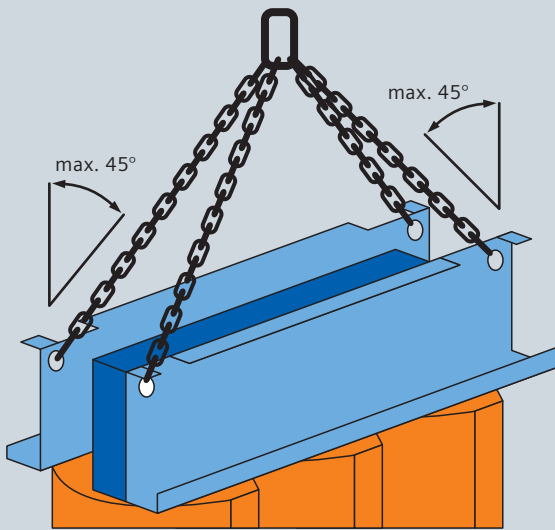


Fig. 2: Lifting of the transformer

Installation

Unloading, handling, unpacking, inspection, cleaning and storage

GEAFOL transformers may only be unloaded and transported by means of the lifting lugs provided on the upper constructional cross beam (see Fig. 1). In general four individual cords have to be used. The information about pulling at an angle provided on the labels on the lifting lugs must be observed (see Fig. 2). If a transformer is moved on its rollers, the points of action are the pulling lugs provided in the lower cross beams (see Fig. 1) or on the truck.

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

GEAFOL cast-resin transformers may only be transported by fork-lift truck 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 cross beams and any attached accessories such as fans or make-proof earthing switches is reliably prevented.

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



GEAFOL transformers should be unpacked in a covered area and inspected immediately for transportation damage. Any damage visible on delivery must be noted in the transport papers and confirmed by the supplier. The sender must be informed immediately so that a suitable loss adjustment 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 checking GEAFOL cast-resin transformers on Page 11).

If the transformer is not commissioned straight away, it must be stored in a roofed room that is dry and protected from sunlight. The room's temperature must not drop below $-25\text{ }^{\circ}\text{C}$ (unless otherwise agreed). It is not recommended to cover it with plastic film, owing to the risk of condensation.

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

Setting up

GEAFOL cast-resin transformers should only be installed in a roofed room or cell that is dry and protected from sunlight, where the degree of protection assured is at least IP 23. If appropriately coated with special paint and if an outdoor housing is used they are also suitable for installation outdoors. GEAFOL cast-resin transformers need an adequate supply of fresh air to dissipate the heat losses. Approx. 200 m^3 of fresh air per hour and for each kW of heat loss is the recommended value; further information can be found in the GEAFOL planning notes).

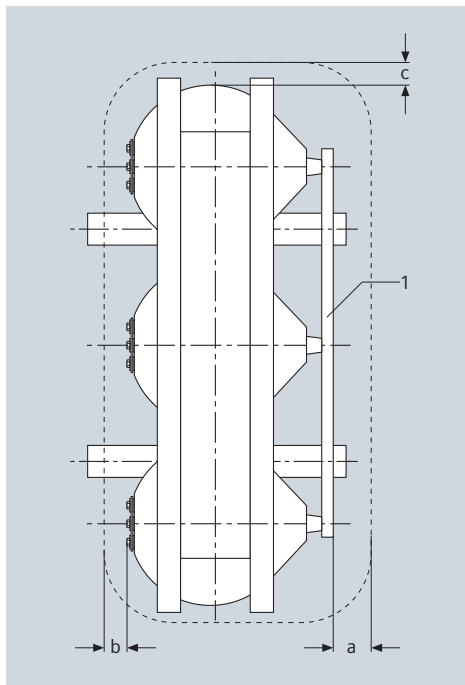


Fig. 3: Minimum clearances around GEAFOLE cast-resin transformers with switching strip (1)

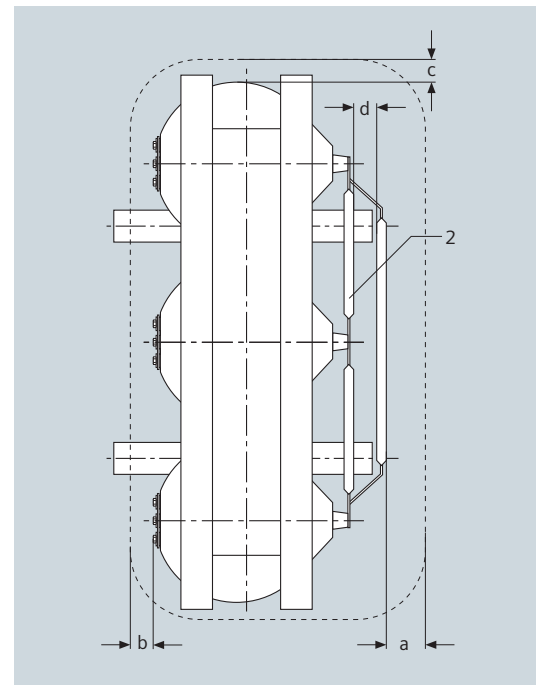


Fig. 4: Minimum clearances around GEAFOLE cast-resin transformers with contact tubes (2)

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

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

Transformers are designed in accordance with the applicable standards for the following cooling air values:

- 40 °C maximum
- 30 °C daily average
- 20 °C annual 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.

GEAFOLE cast-resin transformers for installation at high altitudes over 1,000 m above mean sea level are identified on the rating plate with the maximum permissible installation altitude. When installed accordingly the minimum clearances listed in Table 1 must be increased by 1 % for each 100 m above the altitude of 1,000 m.

Housings

When using housings, note that all bolted connections must be firmly tightened during installation, thus avoiding damage to the transformer, e.g. as a result of nuts falling out.

Minimum clearances

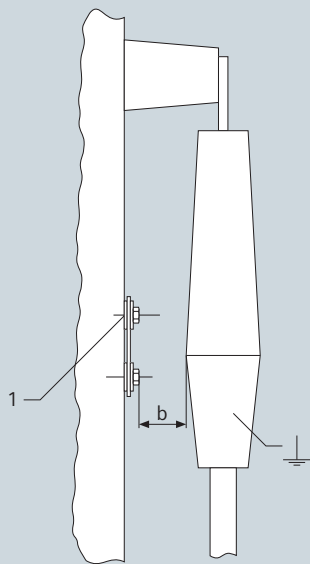
Adequate space must always be ensured around the transformer to enable connections to be made and also to keep to the necessary electrical clearances. The minimum distances to prevent flashover are shown in Table 1 in conjunction with the sketch in Fig. 3 or 4.

Maximum voltage for equipment $U_m^{1)}$ (rms value)	Rated lightning impulse withstand voltage $U_{LI}^{1)}$		Minimum clearances			
	List 1	List 2	a	b	c	d
kV	kV	kV	mm	mm	mm	mm
12	–	75	120	*	50	40
24	95	–	160	*	80	50
24	–	125	220	*	100	70
36	145	–	270	*	120	90
36	–	170	320	*	160	110

1) See IEC 60071

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

Table 1

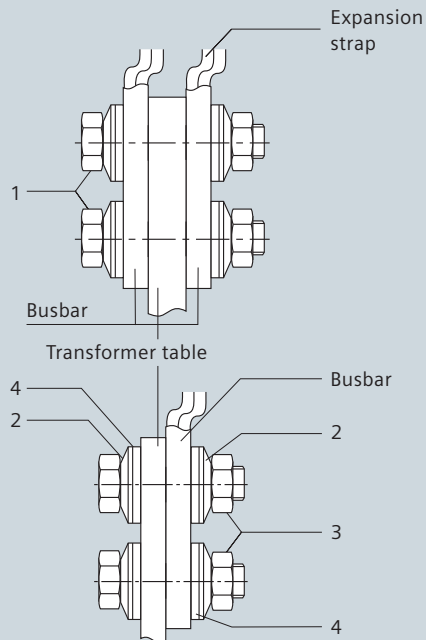


1 Bare tap

Fig. 5: Minimum clearance for cable connection; see Table 1

Methods of bolting

Example



- 1 Hexagon screw, ISO 4014 or ISO 4017
- 2 Conical spring washer, DIN 6796
- 3 Hexagon nut, ISO 4032
- 4 Washer, DIN 7349

Fig. 6: Transformer connection with busbar

Connecting

On the high-voltage side, the transformer is connected to the surfaces of the connecting tubes or the terminals provided on the strip (delta connection), or to the cast-on post insulators of the high-voltage pottings (Y connection). When connecting by means of 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 must be observed as shown in Table 1 and Fig. 5.

On the low-voltage end, the transformer is connected to the aluminum bars provided for this purpose (in special cases, to copper bars). The following guidelines must be observed when connecting conductor bars via expansion straps.

Surface preparation

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

For this purpose, 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 whole preparation process again before it is screwed back together. If the transformer is installed indoors in a room where condensation is frequently to be expected or where corrosive gases are present, an aluminum sheet copper-plated on one side (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 bar and the copper side is in contact with the copper terminal. All edges of this sheet must protrude some millimeters so as to ensure that any corrosion occurring in the transition area remains outside the contact zone. Corrosion can be largely avoided by applying a protective coating to the cut edges of this "Cupal" sheet. Tinned terminals can be combined with bare copper, aluminum or silver-plated surfaces.

Fastenings

Corrosion-proof parts must be used for bolted connections. Preference should be given to bolts belonging to strength class 8.8 or 10.9. 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 accommodate heat-generated tension resiliently, so as to compensate for plastic deformation and to thus maintain the required minimum contact pressure at all times. Both conditions are met by conical spring washers to DIN 6796, which are widely used particularly for conductor bar threaded fastenings.

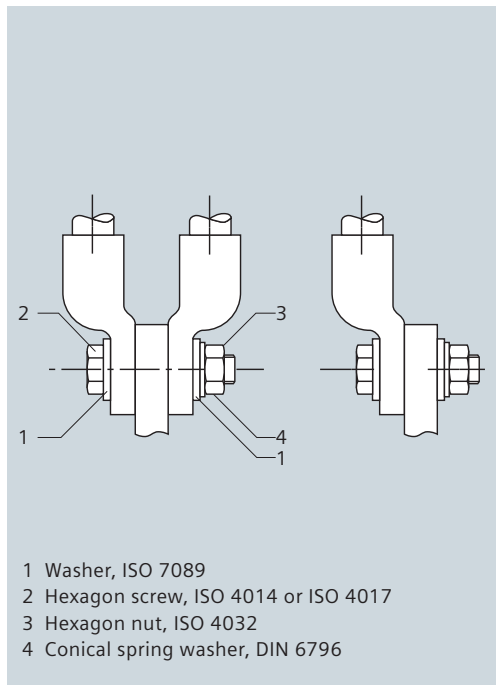


Fig. 7: Transformer connection with cable lug

- 1 Washer, ISO 7089
- 2 Hexagon screw, ISO 4014 or ISO 4017
- 3 Hexagon nut, ISO 4032
- 4 Conical spring washer, DIN 6796

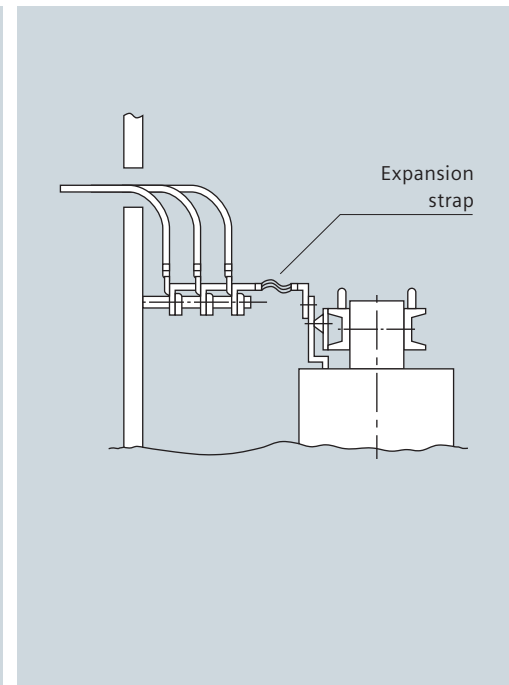


Fig. 8: GEAFOL cast-resin transformers
Low-voltage end connection

Contact pressure

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

To eliminate any settling in the joints, it is advisable to retighten the bolts after a few hours. However, the torque then applied should not be greater than the torque applied during the first installation. We recommend the tightening torque values listed in Table 2 for tightening the ungreased (dry) bolted joints.

Bolt	Torque [Nm] dry
M6	10
M8	20
M10	40
M12	75
M16	140

Table 2: Tightening torque values for the phase connections and tapping links

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.

Earthing

Make sure that the necessary earthing connection is established on accessories installed on the transformer after installation. Transformer housings must also be earthed in accordance with the known earthing specifications.



Temperature monitoring

General

The measuring sensors of the temperature monitoring system record the winding temperature. This acts as overload protection against excessive heat generation in the transformer winding. This protection does not prevent increased rate of service life consumption if the cooling air temperatures are not kept within specified limits (see list, page 6). The following versions or combinations can be installed:

Description

The temperature monitoring system for GEAFOL cast resin transformers consists of PTC thermistor, DIN 44082-compliant temperature sensors or platinum resistance thermometers (PT100) in accordance with IEC 60751 and the associated evaluation devices. Positioning of the overload protection is identical for both systems. The evaluation devices must be designed for processing the signals from the particular system.

Version with PTC

At least one PTC thermistor is installed in one of the low-voltage windings to be monitored. This is provided for triggering. Further systems can be installed, likely-wise retrospectively, e.g. for warning (coil temperature) and controlling fans. The PTCs of the particular functional stage are connected in series and are routed to a terminal strip (max. 2.5 mm²) on the upper pressed metal sheet.

Version with PT 100

At least one resistance thermometer (PT 100) is installed in each of low voltage winding to be monitored. The warning, triggering or fan control functions must be set on the evaluation device. The corresponding setting values can be found on the information plate attached to the transformer. By default the PT 100s are routed in a three-conductor circuit to a terminal strip (max. 2.5 mm²) on the upper pressed metal sheet.

Evaluation devices

For the function and connection of the evaluation devices refer to the particular operating instructions. Information about the devices can be found at www.ziehl.de and www.tecsystem.it

The setting values for the corresponding trigger device in the case of PT 100 temperature monitoring can be found on the information plate attached to the transformer.



Commissioning

The transformer must have been cleaned and it must not contain any foreign matter (see also Installation, Page 5).

- Check technical data on the rating plate attached to the transformer against the customer's requirements.
- Tighten all contact connections to the torque stated in Table 2.
- Adjust any connecting brackets on the high-voltage tapplings to the prevalent voltage.

When large idling transformers are switched on, in isolated cases visible sparks may occur on the outside (particularly 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 borne in mind when selecting fuses and relay times.

If protection settings are wrong, the transformer will be switched off during the power-on current surge. This will lead to high excess voltages in the transformer windings, where they may cause damage.



Faults

In case of faults that cannot be cleared by the customer itself, a service department of Siemens AG should be notified.

Phone: +49 (0) 7021/508-549

+49 (0) 7021/508-512

Fax: +49 (0) 7021/508-588

+49 (0) 7021/508-514

Mobile: +49 (0) 172/622 4291

+49 (0) 172/765 5074

E-mail: weber.guenther@siemens.com

daniel.tiefenthaler@siemens.com

Recommendations for cleaning and inspection

GEAFOL cast-resin transformers are practically maintenance-free. If they are operated in very dusty installations, e.g. in rolling mills, we recommend cleaning several times a year.

In parallel, generally once every year, the contact bolts, warning facilities and functioning of any fitted fans should be checked.

The transformer must be switched off on all sides before maintenance work is begun. All terminals must be shortcircuited and earthed. The safety regulations must be observed.

Cleaning transformers

Particular care must be paid to cleaning all horizontal surfaces and support blocks in the area between the low-voltage and high-voltage coils where, according to experience, dirt can accumulate very easily.

Cleaning method

- Rub the soiled surface with a cloth soaked in a conventional tenside-based cleaning agent. Then wipe over with a dry cloth.
- Use a vacuum cleaner to remove loose parts and dirt in the cooling ducts as far as they are accessible.

Checking the torque values of bolted connections

The torque values of the transformers' earthing terminals (and above all the bolted connections of all electrical terminals), the high-voltage tapplings, and the connections from one system to another in the case of double-tier transformers should be checked once every year. Use a torque wrench or a force-limiting spanner to check bolted connections against the values listed in Table 2.

Checking warning facilities

The "Inspection" function for the evaluation devices can be carried out as specified in the operating instructions. Visual inspection of the terminal connections on the transformer is recommended.

Checking fitted fans

If possible, the functioning and running characteristics of fitted fans should be checked once every 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 standard 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. Ensure particularly that air inlet and outlet openings are clean of dust and dirt deposits.

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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Transformatorenwerk Kirchheim
Power Transmission Division
Transformers
Hegelstrasse 20
73230 Kirchheim/Teck, Germany
Phone: +49 (0) 7021 508-0
Fax: +49 (0) 7021 508-495

Siemens Transzformátor Kft.
1214 Budapest
II. Rákóczi Ferenc u.189.
Hungary
Phone: +36 (1) 278 5300
Fax: +36 (1) 278 5335

For more information, please contact
our Customer Support Center.
Phone: +49 180/524 70 00
Fax: +49 180/524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

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