

Operating Manual
Heating Transformers

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1 General

- Besides technical description of the product, the Operating Manual “Transformers for Heating Technology” contains important information about handling, transportation, assembly, and installation of EXPERT transformers and components in order to ensure utmost safety both for man and machine and proper function.
- Product use as directed in accordance with the following guidelines of the European Union:

2006/95/EC Electrical Equipment for Use Within Certain Voltage Limits (Low-voltage Guideline)

2004/108/EC Electromagnetic Compatibility (EMC Guideline)

2006/42/EC Machine Safety (Machine Guideline)

Regulation (EG) 765/2008 CE-marking (electrical safety label)

Beyond that the national regulations for erection and commissioning of electrotechnical installations and the current safety regulations need to be observed.

- The user shall receive necessary notes on safety in the following (see section 2).
- The Operating Manual addresses the following user groups:
 - Project planning and design staff
 - Installation and commissioning personnel
 - Maintenance and repair staff
 - Transportation and storage staff

2 Notes on Safety

2.1 General Remarks

- Flawless and safe operation presupposes proper transportation, professional storage, assembly, and installation as well as careful handling and maintenance.
- The transformers are meant for incorporation in machines and installations in commercial areas. The specific safety instructions and regulations need to be observed for the application in hand.
- Transformer operation is only permissible in combination with effective protective measures against touching conducting parts in case of fault. This also applies to short-time operation for check and test purposes.
- Prior to switching on the transformer, live parts must be safely covered in order to prevent accidental contact.
- Before commencing installation or maintenance work, the machine or system must be placed into a condition that allows safe work (e.g. normal position).
- The part of machine or installation to be worked on shall be disconnected from the supply. Transformers may have inverse voltages under certain conditions. Isolate primary and secondary side in such cases. Beware of dangerous moving parts from adjoining parts of the installation. With such hazards present, neighboring parts of the installation need to be isolated too.

Caution: Power modules on semiconductor basis (thyristors, IGBTs, etc.) do not realize electrical isolation of the circuit even when their driving was switched off! Over and above, actuate master switch anyway!

Secure switches that have been used for isolation against accidental reclosure. Mark equipment with a danger sign, e.g. “*DO NOT SWITCH ON! – Repair work in progress –*” stating period of repair and name of responsible employee.

- Verify all-pole safe isolation from supply by an appropriate measuring or test instrument (e.g. voltage indicator, voltmeter) on the transformer.
- Cover neighboring live parts.
- Enter machinery or installations only as instructed (e.g. by opening the protective doors).
- Disconnect cooling water supply for the transformer.

2.2 Protection Against Direct and Indirect Contact with Electrically Conductive Parts

2.2.1 Protection Against Direct Contact

EXPERT transformers for heating technology correspond to class of protection I, and their standard design is IP00, open terminals on the low-voltage end. When contacting these parts, there will be operational voltages up to the level of the transformer secondary-side open-circuit voltage.

DIN VDE 0100 part 410 determines the contact voltage maximum values.

They are for:

- AC voltage installations (50 – 60 Hz) $U_L = 25 V$
- DC voltage installations $U_L = 60 V$.



Danger by undue high contact voltage!

If the secondary voltage of a transformer is higher than the permissible contact voltage (25 volt AC, 60 volt DC), the user shall provide appropriate protective measures against direct contact (covers, casing, etc.).

2.2.2 Protection Against Indirect Contact in Case of Fault

EXPERT welding transformers correspond to class of protection I according to DIN VDE0551, part 1.

As protection from undue high contact voltages in case of fault, carry out additional protective measures (connection to protective conductor, residual current-operated protective device) in compliance with DIN VDE 0100 – 410 anyway.

All parts of the housing are directly connected to the protective conductor through the primary-side protective conductor connection.

In this connection, definitely observe the information on the transformer instruction plates and the notes in the data sheets.

In case of further questions please refer to one of the addresses given.

2.3 Protection from Electromagnetic Field Influences

Depending on level of heating current, electric heating equipment causes appearance of more or less strong magnetic fields due to intrinsic physical properties. On account of the current level, the highest magnetic field concentrations mainly develop in the transformer secondary circuits area.

Take this into account when designing such installations and determining operator consoles.

In order to avoid possible excess of electromagnetic radiation concentration at the working place, prove that by measurements if so required.

Notes on Safety

Depending on power setting kind and mode of operation (e.g. phase-angle control), besides of formation of magnetic alternating fields, additional guided and radiated interferences of electromagnetic waves across a wide frequency range will develop.

Concerning this, the determinations according to the EMC guideline rule.



Danger through influences of electromagnetic fields!

Persons with auxiliary medical devices (e.g. pacemakers, etc.) must **not** stay in the area of the heating facility and its leads! Danger of malfunctions that may possibly cause death or severe health injuries.

Additional notes:

- Observe limit values for electromagnetic radiation when erecting electrically operated heating installations.
- Do not carry information-bearing media (e.g. tapes and video tapes, EC cards, etc.) near heavy-current lines. This also applies to wrist watches and other precision mechanical products.

3 Technical Data

3.1 General

The heater transformer technical data is contained in the respective data sheets.

Its is subject to technical modifications in the sense of technical progress. Please ask for the current data sheet if needed.

3.2 Information on the type designation plate

The information on the EXPERT heater transformer type designation plate bears important characteristic values for the user.

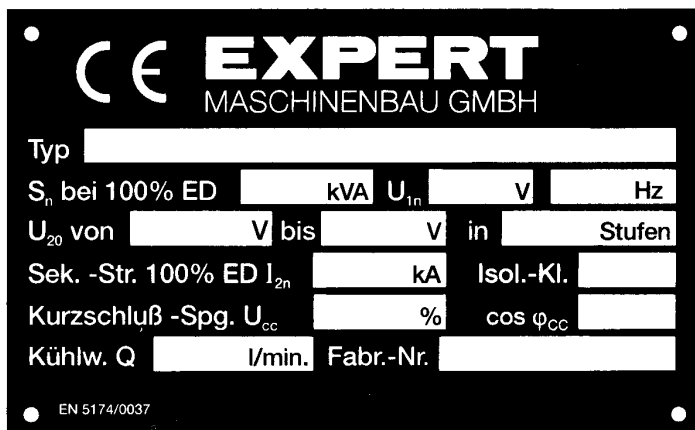


Figure 3–1 Type designation plate of an EXPERT heater transformer

Explanation of the electrical characteristic values:

S_n Transformer output rating at $X = 100\%$ c.d.f. (continuous output)

U_{1n} Rated value of nominal voltage, number of phases and nominal frequency information

U_{20} Secondary open-circuit voltage, number of voltage steps

Technical Data

I_{2n} Secondary nominal current at $X = 100\%$ c.d.f. (continuous nominal current)

u_{cc} Transformer percentage reactance


$\cos\varphi_{cc}$ Transformer short-circuit power factor

Q Required cooling water supply in l/min , inlet temperature *max.* 30 °C

4 Usage As Specified

Water-cooled EXPERT transformer for heating purposes are similar to the design of water-cooled transformers for resistance-welding. There are standards for the production and testing of press-package transformers predominantly used in the automobile industry developed and proven since many years.

The general and technical design of our heater transformers is according to ISO 5826 and ISO 669. Special, type-bound standards reaching beyond are considered.

	<p>Danger through usage not as directed! Usage not as directed can result in personal injuries and damages to material and environment! In case of short circuit there is danger of material evaporation due to high short-circuit currents and high energies associated with that. Only use the transformers as directed!</p>
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4.1 Application Fields for Transformers


The transformers are supplied as fully encapsulated type (cast resin insulation), i.e. the windings are optimally protected against humidity, contamination, and effects of electrodynamic forces.

Standard system of protection is IP54 for encapsulated input-side terminals.

The system of protection for the secondary terminal is IP00 (open clamping units).

The transformer must not be used in potentially explosive areas! Please observe the permissible environmental conditions.

Generally check for each application whether the transformer is suitable for the intended specific use (see also section 7.2).

	<p>Danger by non-intended application fields! The transformers shall only be used and operated in those areas that correspond to the system of protection (according to data sheet) stated. These transformers must not be used for operation in potentially explosive areas!</p>
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4.2 Operating Transformers at Other Mains Frequencies

It may be generally said that transformers can be operated on a **slightly** higher operating frequency without negative influence on their performance. This also applies to

transformers having a nominal frequency of 50 Hz and being operated at 60 Hz (frequency rise 20 %).

Depending on type, there will be slightly higher losses in the transformer windings on account of the higher frequency (approx. 2 – 3 %) which, however, can be neglected if sufficiently cooled according to data sheet.

Therefore, a transformer with a nominal voltage of **380 V / 50 Hz** can be operated at a nominal voltage of **380 V / 60 Hz** without problems.

The other way around, however, is not permissible just like that!

Beyond that it is technically possible to operate a 50 Hz transformer at 60 Hz with a mains voltage being 20 % higher ($480\text{ V} / 400\text{ V} = 60\text{ Hz} / 50\text{ Hz} = 1.2$).

Therefore, a transformer with a nominal voltage of **400 V / 50 Hz** can be connected to **480 V / 60 Hz** (and vice versa).

The secondary voltage rises by $480\text{ V} / 400\text{ V} = 1.2$ at 480 V.

This enables the transformer to output higher heating power.

In case of further questions on this problems please refer to one of the addresses given.

4.3 Power Control Requirements

When an inductive load (e.g. transformer with connected heating circuit) is switched on, more or less high start-up peaks will occur together with transient DC components

Depending on the kind of power setting, phase-angle controls or wave-pack controls are used for heating installations.

We can recommend the following for selecting suitable controls:

- The control must be suitable for driving **inductive loads**. The primary current must be nearly free from DC components over the entire control range. DC components mostly develop in thyristor controls when ignition pulse synchronization is not precise enough causing ignition delay times to be different during positive and negative half-wave. DC components in the transformer primary circuit effect DC magnetic biasing of the iron core. Depending on the transformer winding ratios, relatively small DC components of some amperes will do to effect core saturation. Core saturation means in any case very high core losses in combination with high core heating. In an extreme case this circumstance will lead to insulation damages in the transformer and thus to its failure.
- Turning on thyristor controls, reduce start-up peaks and minimize transient DC components by always having the first half-wave of the first period fixed with a turn-on delay that is greater than the phase angle.

In case of further questions on this range of problems please refer to one of the addresses given.

5 Transformers Set-up and Function

5.1 Transformer Set-up

EXPERT transformers for resistance heatings differ basically from the type of water cooling coming under directly or indirectly cooled transformers.

- **Directly cooled transformers:**

The transformer secondary winding is **directly** flown through by the cooling water, and the primary winding indirectly-coupled to the secondary circuit, and the iron core is also indirectly cooled by thermal conduction. The cooling water connection is a **direct** non-floating connection to the transformer secondary circuit. There is a voltage difference between cooling water inlet and outlet amounting to the transformer secondary voltage level that becomes effective as contact voltage.



Danger by non-floating cooling water connections!

Very high short-circuit currents can develop when touching or bridging cooling water inlet and outlet with metallic objects such as tools. There is danger of personal injury due to burns or metal splashes.

Due to this specific feature, this type is only standard used for low secondary voltages (= 25 V)

- **Indirectly cooled transformers:**

The transformer primary and secondary windings are both in indirect-coupled configuration to each other and the cooling circuit. The cooling of the windings is generally made **indirectly**.

The internal cooling circuit consists of metallic pipes and is connected to the protective conductor as a rule.

If there is requirement to accommodate several cooling windings in a transformer, the individual cooling pipes are connected such that induced voltages compensate each other.

There are almost no potential differences ($> 1\text{ V}$) between the cooling-water connecting flanges (water inlet and outlet).

Due to the low input resistance of the materials used (copper or copper alloys), these little potential differences, however, can cause remarkable currents on an externally generated short circuit, e.g. by tools or by using metal water pipes!



External water connection

Generally provide water connection for directly and indirectly cooled transformers by non-conductive rubber or plastic hose or pipe connections of 0.5 m length and electric resistance of $1\text{ M}\Omega/\text{m}$ minimum.

The specific resistance of the water column should be $20\text{ }\Omega\text{m}$ minimum (cf. EN50063, section 5.1.3.1)

• **Multistage transformers:**

The transformer primary winding can be equipped with taps.

This renders the level of secondary voltage adjustable in several steps by connecting or disconnecting individual windings. The overall control range is $1:\sqrt{2}$ in general and can be extended to $1:2$ in special cases.

On account of this specific feature, higher voltages than the connected mains voltage across the non-connected terminals of the primary winding occur according to the autotransformer principle.

Depending on the transformer control range and the voltage step selected, voltages double the amount of the mains voltage can occur across the non-connected terminals!



Danger by voltage transformation!

On the transformer primary side, depending on winding arrangement, voltages double the amount of the mains voltage occur across the non-connected terminals!

5.2 Subcircuits

EXPERT transformers can be equipped with monitoring devices such as temperature monitoring and/or current-measuring coils.

5.2.1 Temperature Monitoring

Bimetal sensitive switches with double-break feature are used as thermal protectors. The contacts are of break type.

Typical version:

Mechanical life-cycle: 10^4 (according to VDE category 1)

Rated insulation voltage: 1.5 kV

Maximum ambient temperature: $+180\text{ }^\circ\text{C}$ (operating)

Nominal voltage: $250\text{ V AC} / 50\text{-}60\text{ Hz}$

Nominal current: 2.5 A at $\cos\varphi = 1$ or 1.6 A at $\cos\varphi = 0,6$

Number of operations: $10,000$ cycles

Standard version: 2 break contacts for primary circuit, current-insensitive, series-connected, floating

The contact design is current-insensitive, i.e. the response temperature is independent from the current loading. Standard per transformer are two temperature detectors with $140\text{ }^\circ\text{C}$ response temperature attached to the primary winding, and they are also encapsulated.

PTC temperature sensors, temperature shunts, or thermocouples for monitoring the transformer temperature are built-in as desired. Because of the compact transformer mass, operational temperature changes are subjected to large time constants. This means that temperature compensation will be but very slow. Built-in temperature detectors, therefore, signal exclusively transformer overload or lack of sufficient cooling. The temperature detectors are not in a position to react or trip on short-time overloading such as overvoltage, shock load, and the like.

5.2.2 Current-measuring Coils

Transformers are optionally equipped with current-measuring coils. These are toroid current transformers that are concentrically arranged around the secondary conductor. A voltage proportional to the secondary current is induced into these coils.

The standardized measuring voltage amounts to 150 mV/kA at a load resistor of $1 \text{ k}\Omega$ (input resistance of the evaluation electronics).

With suitable control modules, this measured quantity can be used as true current value for current control.

The toroid measuring coils used for EXPERT transformers have a basic accuracy of $\pm 2.5\%$; after installation the calibration accuracy for the standard types is $\pm 3.0\%$.

Connection of the subcircuits would be normally through plug connection or clipped connection

6 Transportation and Storage

Before shipment, the transformers are subjected to final inspection and are properly packed up. Inspect the transformer for possible transportation damages upon reception. Inform the carrier or forwarding agent immediately about actual damages occurred. Later complaints cannot be considered.

6.1 Transportation

Contingent on the high weight of a transformer, its transportation needs to be carried out with appropriate devices. If not properly transported, the transformer can tilt or fall. There is danger of personal injury.



Danger through improper transportation!

Only use suitable transportation devices! Do not stay beneath hanging loads! There is danger of personal injuries by bruising, shearing, cutting, bumping.

The transformer itself may also be damaged.

General protective measures:

- Use suitable devices for transportation.
- Take precautions against being squeezed in and bruised.
- Employ lifting devices (observe permissible load) and tools professionally.
- Use suitable protective outfit (e.g. safety boots, safety gloves).
- Do not stay beneath hanging loads.
- Immediately remove leaking cooling liquid (slip hazard).

Transportation devices:

Due to its relatively high weight, proper transportation mostly is only possible with suitable aid in the form of e.g. lifting gear, cranes, forklift trucks, and transfer cars. If lifting gear is used for transportation, then the ring bolts must only be attached to the mounting holes provided for that purpose.

Under no circumstances use the tapped holes of the primary or secondary terminals for mounting the transportation devices!

Note: Observe maximum loads for ring bolts according to DIN 580!

DIN 580 determined the permissible maximum loads for ring bolts. There are two basic options to hoist the cargo (see Table 6–1 Values of peak stress for ring bolts according to DIN580).

On the one hand with only one ring bolt (load 1), and on the other hand with two or more ring bolts (load 2).

It is important to note that the load information always relates to only one ring bolt.

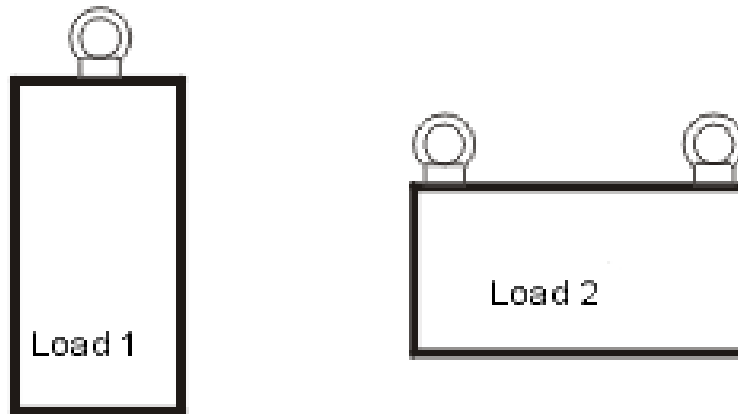


Figure 6–1 Mounting options for transformers

Table 6–1 Values of peak stress for ring bolts according to DIN580

Thread	Load 1 in kg	Load 2 in kg
M8	140	95
M10	230	170
M12	340	240
M16	700	500

6.2 Storage

If transformers are subjected to strong external magnetic fields, e.g. when stored in immediate vicinity of induction-heated furnaces, lifting magnets, etc., then these fields can induce voltages into the transformer non-connected windings. Depending on the transformer nature and design it cannot be excluded that these induced values can assume impermissible high values. Therefore storage in the influence area of large alternating magnetic fields is not allowed.

The following conditions apply for the storage of EXPERT transformers.

Storage conditions:

Permissible storage altitude above sea level:	no restriction
Permissible ambient temperature:	- 25 to +60 °C, (water circuit drained)
Permissible relative air humidity:	20 – 80 % (no condensation)
Stacking height:	max. 2 transformers one flat upon the other, take care of possibly projecting screw fittings!



Danger through frost damages!

Storage of non-drained transformers below freezing point can cause the cooling pipe to crack due to residual water's change of volume. Absolutely drain the entire transformer water circuit completely!

7 Installation, Electrical Connection and Commissioning

Non-observation of the following general notes can lead to exclusion of warranty claims (“caveat emptor”) by EXPERT Maschinenbau GmbH.



Installation personnel requirements:

Professional electricians only are allowed to carry out connection (installation) as well as subsequent commissioning!

7.1 Mounting and Electrical Installation

Please observe the following notes:

- There is danger on handling and mounting transformers due to their high weights.



Danger through improper handling!

There is danger of personal injuries by bruising, shearing, cutting, bumping!

- Places of installation and attachments need to be dimensioned for the transformer weights.
- Always use suitable installation and transportation devices.
- Use lifting devices and tools professionally. Observe the permissible load.
- Take care that the terminals for primary, secondary, and subcircuits remain accessible.
- The type plate shall be easily readable or repeat the technical data where visible.
- Carry out the cooling water connection professionally. The cooling-water connections on the transformer can have potential differences. To avoid a short circuit through the water connections, use only non-conductive hoses or pipes with a length on 0.5 m and an electric resistance of 1 M Ω /m minimum. The specific resistance of the water column should be 20 Ω m minimum (cf. EN50063, section 5.1.3.1)
- Check the cooling water connection for tightness and function.
- Electrical connections by professional electricians only.

Explanation of the term “professional”:

A professional is who has knowledge and experience owing to professional training as well as knowledge

of the relevant standards for the work entrusted to him/her. A passed vocational training as skilled worker, master craftsman/craftswoman, technician, or qualified engineer is considered proof of the required professional training. In addition, a professional (skilled person) needs to know all standards relevant to his/her sphere of activity and command sufficient experience within a certain scope of work enabling him/her to assess work entrusted with and to identify dangers. The skilled person, furthermore, is trained, instructed, or authorized to switch on and off electric circuits and equipment according to the regulations, to ground them and to mark them. The skilled person has appropriate technical equipment and is trained in first aid.

- The primary and secondary terminal faces need to be plane and have bright contacts.
- Tighten the terminal studs in the primary area with a torque wrench. We recommend tightening torques according to Table 7–2 Screwed connections for electrical terminals at different material pairing (Specification in Nm for screws and nuts strength 8.8)
- All live parts need to be covered and hence secured against direct contact.
- Keep and check following tightening torques for screwed connections:

Table 7–1 Tightening torques, general, for transformer attachment (transformer housing) in Nm, screw strength 8.8

Thread	M5	M6	M8	M10	M12	M16	M18	M20
Tightening torque / Nm	5.75	9.9	24	48	83	200	275	390

Table 7–2 Screwed connections for electrical terminals at different material pairing (Specification in Nm for screws and nuts strength 8.8)

Thread	Cu flange Cu busbar	Cu flange Cu flexible	Contact piece/ Cable lug
M5	5.5	5.5	5.5
M6	9	9	8
M8	23	23	20
M10	45	45	42
M12	85	85	80
M16	160	160	150
M18	220	220	200
M20	250	250	220

There is no standard regulation for maximum permissible tightening torques for screwed Cu connections right now. The tightening torques stated in *Table 7–2 Screwed connections for electrical terminals at different material pairing (Specification in Nm for screws and nuts strength 8.8)* have been determined by experiments. Take care not to have screwed Copper connections overstressed. Overtightening can deform copper due to its yielding behavior.

7.2 Permissible Environmental Conditions

The transformer fulfills, in its standard version, IP54 (= International Protection) for the primary connection. The system of protection for the secondary terminal is IP00.

Use in potentially explosive rooms is not permissible.

The following environmental conditions are valid for operation:

Permissible guaranteed site altitude: *1000 m above sea level*

Permissible ambient temperature: *+ 5 to + 40 °C*

(varying ambient temperatures possible for special types, shown in the data sheet)

Temperature of cooling water: *max. 30 °C (flow)*

Permissible relative air humidity: *30 to 95 %*

8 Notes on Operation of Transformers

8.1 Cooling Water Quality

Insufficient quality of the cooling water can limit the function of the transformer considerably. Use of closed-circuit cooling in which processed water can be cooled back would be advantageous in any case. In order not to increase specific electrical cooling water conductivity, we advise to install an ion exchanger into the cooling circuit of larger installations, or to provide for regular exchange of the cooling water. Metal ions such as iron, copper, etc. are released into the cooling water due to potential differences in the cooling pipes. The ions increase the cooling water specific electrical conductivity.

Beyond that, the metal ions of the transformer cooling circuit (copper pipe) contained in the cooling water can form local corrosion centers according to their position in the electrochemical series of metals.

Since the secondary circuit is directly flown through by the cooling water, it should have relatively good insulating properties in order to avoid formation of parasitic voltages (cf. EN50063, section 5.1.3.1).

Cooling water requirements:

- Mechanically clean, filter degree of fineness approx. *100 Micron*
- Natural water, optically clear, without turbidity, no bottom settling

pH value: 7-8

Spec. electr. conductivity: max. *500 μ S*

Water hardness: max. *6 °DH*

Iron: < *0.3 mg/l*

Manganese: < *0.05 mg/l*

Sulphates: < *250 mg/l*

Chlorides: $< 100\text{mg/l}$
Ammonia: must not be detectable
Aggressive carbonic acid: must not be detectable
Cooling water inlet temp. : approx. $18\text{ }^{\circ}\text{C}$ up to max. $30\text{ }^{\circ}\text{C}$

- If adequate inhibitors are added to the cooling water to prevent lime deposits, we would recommend organic inhibitors in the first instance since they would raise the cooling water specific electrical conductivity but insignificantly.



Danger of transformer overheating!

Heat loss cannot sufficiently be dissipated to the cooling water with contamination or deposits in the cooling pipes present.

Relatively little deposits are sufficient to impair cooling efficiency.



Formation of condensate (condensed water)!

The transformer cooling water inlet temperature should be approx. $18\text{ }^{\circ}\text{C}$ up to max. $30\text{ }^{\circ}\text{C}$.
If the cooling water inlet temperature is considerably less than the ambient temperature, there will be danger of condensed water formation!

8.2 Cooling Water Quantity, Cooling Circuit Differential Pressure

Water-cooled transformers are designed such that nearly all the heat loss generated in the windings must be dissipated through the cooling water. Heat release by convection via the housing is negligibly low.

Depending on the transformer continuous output, the following guide values apply for cooling water flow volumes (binding values see data sheet):

- Up to 100 kVA approx. 2 – 4 l/min
- $> 100\text{ kVA}$ approx. 6 – 8 l/min

Notes on Operation of Transformers

- Pressure drop in the transformer is approx. 0.5 – 1.0 bar (pressure difference between water inlet and water outlet)

Additional pressure losses develop in the external cooling circuit (hoses, screw fittings, etc.).

The user needs to determine the differential pressure between the cooling water inlet and outlet such that the cooling water quantity stated in the data sheet is reached. For checking the cooling water quantity, we recommend installation of a flowmeter.

Depending on the amount of the transformer no-load losses, the cooling water outlet temperature is approx. 10 – 30 K higher than the inlet temperature.



Water connection

The transformer cooling water inlet temperature can be **30 °C** maximum.

Cooling circuit series connection of several transformers is not allowed.

Pressure in the cooling system may be maximum 8 bar higher than external pressure (atmosphere).

9 Inspection and Maintenance

Regular inspection enhances installation dependability.

EXPERT transformers are of low-maintenance type thanks to their compact and fully encapsulated design.

9.1 Primary and Secondary Terminals

We recommend maintenance cycles of approx. 10 – 12 weeks. Inspect particularly the condition of the connection points (corrosion and tightness of connections) as well as heavy-current lines themselves for wear or damages.

- Prior to commencing work, observe the notes on safety according to section 2.
- Isolate the transformer and protect it against reclosure (see section 2.1).
- Primary or secondary lines should be replaced if damaged.
- Check primary and secondary tightening torques (see Table 7–2 Screwed connections for electrical terminals at different material pairing (Specification in Nm for screws and nuts strength 8.8)). It is not necessary, to unmount the screw connections.
- In case of fault, check efficiency of protective measures against indirect contact with suitable measuring equipment (e.g. condition and function of protective conductor connections, function of current-operated ground-leakage protection, or similar).

Commissioning to take place observing sections 2 and 0.

9.2 Cooling circuit

Frequency of maintenance work depends on the quality of the cooling water used (see also section 8.1).

Deposits in the cooling channels may reduce the transformer temperature difference rating drastically. Transformer thermal overload is quite often the consequence (e.g. tripping of temperature monitoring). Beyond that, deposits reduce the hydraulic cross section in the cooling channels. This increases transformer pressure drop as consequence.

Performing cleaning work on the cooling circuit:

Inspection and Maintenance

- Prior to commencing work, observe the notes in section 2.
- Disconnect cooling water supply for the transformer.
- Remove the hoses for the transformer cooling water connection.
- Rinse transformer cooling circuits with appropriate solvents for degrading lime and scale residue. Observe solvent manufacturer' s information on safety and directions for use. Strong deposits may require repetition of the rinsing procedures several times or extend exposure time.
- Commercially available agents such as **NALCO 68**, **SILIT**, etc. are suitable for removing deposits from the cooling circuits.

10 Standards and Regulations

- DIN EN 294 Safety of machinery. Safety distances to prevent danger zones from being reached by the upper limbs
- DIN EN 418 Safety of machinery, emergency stop equipment, functional aspects, principles for design
- DIN EN 50063 Safety requirements for the construction and the installation of equipment for resistance welding and allied processes.
- DIN EN 50081-2 Electromagnetic compatibility (EMC), basic specification Emitted Interference
- DIN EN 60204-1 Safety of machinery – Electrical equipment of machines, general requirements
- E DIN ISO 5826 Resistance welding equipment - Transformers - General specifications applicable to all transformers
- ISO/DIN 5828 Resistance welding equipment - Secondary connecting cables with terminals connected to water-cooled lugs - Dimensions and characteristics
- DIN EN ISO 8205-1 Water-cooled secondary connection cables for resistance welding - Part 1: Dimensions and requirements for double-conductor connection cables
- DIN EN ISO 8205-2 Water-cooled secondary connection cables for resistance welding - Part 2: Dimensions and requirements for double-conductor connection cables
- DIN VDE 0545-1 Safety requirements for the construction and the installation of equipment for resistance welding and allied processes.

Notes :