

ABB 1LES100028-ZD transformers datasheet

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This operating manual is intended to help you use the VCC dry-type transformer – or simply transformer for short – properly, safely and economically.

The manual is addressed to all persons who carry out any of the following activities, with or on the transformer.

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Instruction manual

Vacuum cast coil transformers EcoDry transformers



Power and productivity
for a better world™



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1

Information about the manual and the manufacturer

This operating manual is intended to help you use the VCC dry-type transformer – or simply transformer for short – properly, safely and economically.

The manual is addressed to all persons who carry out any of the following activities, with or on the transformer:

- Transportation
- Installation
- Connection
- Placing into operation
- Operation
- Taking out of service
- Maintenance
- Cleaning
- Disposal

In particular this operating manual is addressed to customer service engineers, qualified professional personnel and authorized operating personnel.

Every one of these persons must be familiar with the contents of this operating manual and must have understood those contents. Following the instructions contained in this manual will help towards avoiding danger and increasing the reliability and service life of the transformer. In addition to observing the information and instructions contained in this operating manual, it is essential that you also comply with all statutory regulations and other regulations applicable at the place of installation, eg.:

- Accident prevention regulations.
- Regulations concerned with safe and proper working practices.

1.1

Keeping the operating manual available

This operating manual must be kept with the documentation for the transformer at all times and readily available to the user.

The operating manual is an integral part of the transformer. If you sell the transformer or pass it on in any other way, give this operating manual to the new owner when you do so.

1.2

Text formatting and symbols

The different elements in this operating manual are distinguished by predefined text formatting and symbols. This is to enable you to easily distinguish between the following elements:

Normal text

– Bulleted list, first level

– Bulleted list, second level

► Action

ⓘ Tips. These provide you with additional information, such as specific information about how to use the device economically.

1.3

Contact address

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Safety

This chapter provides you with information on the following:

- Obligations of the user
- Personnel qualification
- Prohibition of unauthorized modifications or alterations
- Personal protective measures
- Intended use
- Basic safety information
- Safety devices
- Explanation of information symbols warning of risks of damage to property and harm to the environment

2.1

Obligations of the owner/user

- The owner/user of the transformer is required by law, or applicable regulations, to draw up instructions for ensuring the device is operated without danger
- The owner/user of the transformer must obtain an operating permit from the relevant authorities and comply with the associated laws and regulations, eg.:
 - Safety for personnel
 - Safety for material
- The owner/user of the transformer must ensure the following activities are carried out by qualified and authorized personnel only:
 - Transportation
 - Installation
 - Connection
 - Placing into operation
 - Taking out of service
 - Maintenance
 - Disposal
- The owner/user of the transformer must ensure the following documents are made available to operating and maintenance personnel:
 - This operating manual
 - The documentation for the transformer, eg. circuit diagrams, terminal layouts, test reports and operating manuals for installed accessories
 - The respective valid accident prevention regulations applicable at the workplace
 - Other applicable national regulations
- The owner/user of the transformer must ensure all safety information/instructions are observed

- Before the transformer is placed into operation the owner/user or person authorized by the owner/user must check for compliance with the following:
 - The transformer will be used in accordance with its intended use
 - Compliance with all safety regulations

2.2 Personnel qualification

Qualified professional personnel must have knowledge and experience in the following fields, depending on the specific work to be carried out:

- Disconnection of electrical equipment
- Securing to prevent accidental activation by unauthorized persons
- Verification of disconnection from the power supply
- Earthing and short-circuiting of electrical equipment
- Covering or safeguarding of adjacent live components
- Transportation of transformers
- Installation of transformers
- Connection of transformers
- Operation of transformers
- Cleaning of transformers
- Maintenance of transformers
- Disposal of transformers

2.3 Prohibition of unauthorized modifications or alterations

Modifications or alterations are only permitted if approved by the manufacturer. This applies in particular to the alteration and blocking of safety devices.

- Only use accessories approved by ABB
- Never override or bypass any supplied protective devices

2.4 Personal protective measures

- Wear safety footwear in accordance with EN ISO 20345 to prevent injuries to your feet
- Wear safety gloves in accordance with EN 388 to prevent injuries to your hands
- Wear a safety helmet with full visor in accordance with EN 397 to prevent injuries to your head and face
- Follow the instructions of the owner/user

2.5

Intended use

The VCC dry-type transformer transforms voltage. You must only ever operate the transformer in accordance with the electrical data set out in the rating plate and the operating conditions agreed by contract.

The definition of intended use also encompasses observing and following all of the information and instructions contained in this operating manual. In particular this means observing and following the safety information/instructions and warnings and observing the cleaning and maintenance intervals.

Any other use or use over and above the intended use shall be regarded as improper use and may result in damage to property or personal injury.

The following uses in particular shall be regarded as improper use:

- Overriding and/or manipulation of the settings of monitoring devices
- Alterations to attachment parts, eg. fans, cooling systems, etc.
- Attachment of adhesive labels to the surface of the coil
- Removal of information and warning signs
- Connections, for which no provision is made in the relevant diagram.
- Application of a higher level of voltage to the respective tapping connection than is shown on the rating plate
- Drawing of a higher level of power than is shown on the rating plate
- Use of a different supply voltage frequency to that shown on the rating plate
- Mechanical loads on the consumer terminals and terminal lugs
- Parallel connection with unsuitable transformers
- Regular loading with transient voltage rises of the type which can occur in association. For example: with the switching of vacuum switches connected to the transformer over short cable distances.
- Operation in networks with high voltage harmonics.

Any improper use of the transformer shall lead to the exclusion of liability for physical defects.

2.6 Basic safety information

2.6.1 Prevention of risk of fatal injury caused by electric shock

- Only qualified professional personnel with appropriate qualifications are permitted to carry out any work on or with the transformer. Instructed personnel are only permitted to work on the transformer under the supervision of qualified professional personnel.
- Always complete the following measures before commencing any work on the transformer:
 - Disconnect
 - Secure it to prevent it being switched on by unauthorized persons
 - Verify that it is disconnected from the power supply
 - Earth and short-circuit
 - Covering or safeguarding of adjacent live components
- Never place a transformer into operation if it is damaged.
- The insulation on the outside of the windings is not touch-proof in terms of the applicable IEC 60076-11 standard. The transformer must always be in a de-energized and earthed state when you carry out any work on it.
- Operate transformers with IP23 or other protection enclosures only with fully fitted and closed enclosure
- Wear the requisite protective equipment for all work
- In the event of a fire on the transformer, do not use water to extinguish the fire, use a suitable quenching agent instead, eg. CO₂ quenching agent

2.6.2 Prevention of risk of fatal injury caused by powerful magnetic fields

- Any persons with a cardiac pacemaker should not come any closer than three meters to the transformer when it is in operation.
- Any persons with a metal implant should not come any closer than three meters to the transformer when it is in operation.

2.6.3

Prevention of risk of fatal injury caused by improper transportation and installation

- Only qualified professional personnel with appropriate qualifications are permitted to undertake off-site and on-site transportation of the transformer.
- Only qualified professional personnel with appropriate qualifications are permitted to install the transformer.
- Make sure that no one is standing beneath the suspended load
- Make sure that the slinging and lashing arrangements are suitable for the weight of the transformer.
- Only lift the transformer by fork lift truck if the transformer is fixed on a pallet

2.6.4

Prevention of risk of injury caused by powerful magnetic fields

- Any persons with jewelry/piercing jewelry should not come any closer to the transformer than three meters.

2.6.5

Prevention of risk of burns caused by hot surfaces

- The surface of the transformer becomes hot during operation. Wear the requisite personal protective equipment.
- Always allow the transformer to cool down until it is only warm to the touch before commencing any work.
- Check the temperature of the transformer, eg. using an infrared thermometer.

2.6.6

Prevention of harm to the environment caused by improper disposal

- If you intend to dispose of the transformer, make sure you do so in accordance with the applicable regulations at the place of use.

2.7

Prevention of damage to property or of malfunctions

- Never place a transformer into operation if it is damaged.
- Do not step onto the top cover of the enclosure.
- Only ever stand the transformer up on the feet or bidirectional wheels provided for it.

2.8 Safety devices

2.8.1 Temperature sensors

Each of the coils in the transformer has at least one temperature sensor fitted inside it. The temperature monitoring device included in delivery has to be connected by the owner/user, in proper working order, to the transformer circuit-breaker, or to the protection system. If the transformer is supplied without a temperature monitoring device, the owner/user must connect the sensors directly to their own peripheral equipment.

If the coil temperature reaches Alarm temperature, the transformer load must be reduced.

If the coil temperature reaches Trip temperature, the transformer must be shut down (the transformer has to be disconnected from the mains).

Alarm and Trip temperature depend on the thermal class of the insulation materials used for the transformer.

Class	Alarm temperature	Trip temperature
F	140 °C	155 °C
H	160 °C	175 °C

The preset values of the supplied temperature monitoring device may differ from those in the table.

► Make sure that the Alarm and Trip temperature of the temperature monitoring device are set in accordance with the values in the table.

- ⓘ If the temperature sensors are mounted on the core, the Alarm and Trip temperatures will differ from those listed in the table. In this case use the values for the Alarm and Trip temperature which are to be found on the related connection diagram.

2.8.2

Warning signs and information signs

- ▶ Observe and follow the warning and information signs affixed to the transformer.
- ▶ Make sure the warning and information signs affixed to the transformer are never covered over and are always easily readable.
- ▶ Replace damaged warning and information signs.

The following warning signs and information signs are affixed to the transformer:

Sign	Meaning
	Do not lift by fork lift truck
	Do not touch, surface area is live
	Danger - High voltage
	Do not step on surface
	Earth symbol

The connections are marked in accordance with the corresponding circuit diagram:

- Phase marking for high voltage in accordance with IEC/TR 60616, eg. 1U, 1V, 1W or in accordance with IEEE C57.12.70-2000, eg. H1, H2, H3
- Phase marking for low voltage in accordance with IEC/TR 60616, eg. 2U, 2V, 2W or in accordance with IEEE C57.12.70-2000, eg. X1, X2, X3
- Marking of the tapping connections with number or letter, eg. 3 or C

Other signs:

- Rating plate with connection diagram
- Trailer diagram for transport

2.9 Explanation of warning symbols



DANGER

Information or instructions accompanied by the word DANGER provide a warning about a hazardous situation that will lead to fatal or serious injuries.



WARNING

Information or instructions accompanied by the word WARNING provide a warning about a hazardous situation that may possibly lead to fatal or serious injuries.



CAUTION

Information or instructions accompanied by the word CAUTION provide a warning about a situation that can lead to minor or moderate injuries.

2.10 Explanation of information symbols warning of risks of damage to property

ATTENTION!

Information and instructions of this kind provide a warning about a situation that will lead to damage to property.

3 Description

Vacuum Cast Coil (VCC) transformers fall within the category known as dry-type transformers. The materials used are flame-retardant and have only a low fire load. This means that the risk of a fire has been reduced to a minimum.

3.1 Design features

The key features of the transformers are as follows:

- No danger of contamination for humans and the environment
- Non-explosive
- Flame-retardant
- Resistant to loading caused by harmonics, if they are specified with the order
- Minimal maintenance requirements

Unless otherwise specified, the transformers are compliant with the following requirements in accordance with IEC 60076-11:

- Environment class E2
- Climatic class C2
- Fire class F1

3.2 Differences in design features

The transformers described in this operating manual are the transformers with IP00 protection (without enclosure) and those with an enclosure, eg. with IP23 protection, without optional accessories.

In order to be used as intended, the transformers with IP00 protection may only be installed in closed electrical operating indoor areas.

Transformers with IP23 protection and higher are fitted with an enclosure and, in order to be used as intended, must be installed indoors.

Depending on the purpose of use and the operating conditions, the transformers can be fitted with optional accessories. Please refer to the documents included in delivery if you require details about accessories.

Every transformer is routine tested and inspected at the factory. The results of the tests are documented in a test report. The test report forms part of the supplied documentation.

3.3 Function and assembly

The transformer transmits alternating voltage and alternating current of the same frequency between two or more windings of generally different voltage and current values.

Temperature sensors for measuring the coil temperature are included as standard.

Depending on region and specification, the transformer comes with four wheels to enable it to be moved about at the installation location. All of the wheels must be fitted and aligned in the same desired running direction before installation.

3.3.1 Low-voltage and high-voltage windings

Aluminium or copper conductors are used for the low-voltage and high-voltage windings, along with interturn insulation to thermal class F or H, according to the insulation system temperature indicated on the rating plate. The high-voltage winding is encapsulated with epoxy resin under vacuum.

The transformer is comprised of an individual encapsulated high-voltage winding installed above the low-voltage windings on a coaxial basis.

The epoxy resin contains a mineral filler. This improves the following characteristics:

- Thermal conductivity
- Mechanical load capacity
- Arc resistance
- Adhesion of the pure epoxy resin to the conductor

The windings encapsulated under vacuum are reinforced with glass fiber mats.

3.3.2

Core assembly

The material used for the core is either grain-oriented transformer magnetic sheet steel or amorphous metal.

Grain-oriented transformer magnetic sheet steel:

The steel sheets are laminated to form leg and yoke packages. High-precision production ensures that noise and losses are reduced to a minimum.

In order to achieve optimum alignment of the flux distribution with the preferred direction of magnetization, the joints between the leg and yoke plates are in 45° steps and are laminated on an overlapped basis. The core has a coating on an epoxy-resin basis to protect it against corrosion. The high-voltage and low-voltage windings are supported at top and bottom against the core yokes by plastic sections.

- ① Transformers of type EcoDry^{Basic} and EcoDry^{Ultra} have cores made of amorphous metal.

Amorphous metal:

Amorphous metals are alloys that the atomic level have an amorphous (random) as opposed to crystalline structure. This atomic arrangement, which is highly unusual for metals, gives rise to a unique combination of physical properties. These special properties in turn make it possible to use amorphous metal for the core material in transformers to reduce no-load losses and, hence, increase performance.

Conventional core sheet is 0.3 mm thick. Amorphous core sheet is 0.025 mm (25 µm) thick.

ATTENTION!

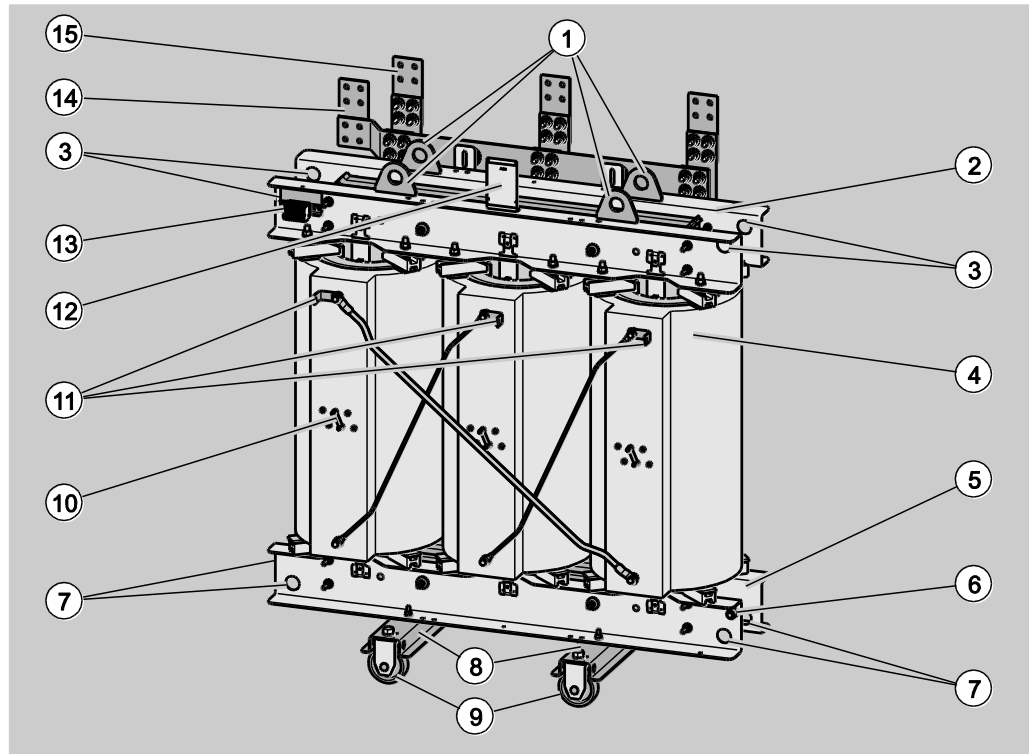
Risk of damage to the amorphous transformer core caused by improper treatment.

Damage to the surface of the amorphous core can lead to corrosion.

- ▶ Never subject the core to impacts, eg. from a hammer.
 - ▶ If the amorphous core becomes damaged, contact the manufacturer.
-

3.4

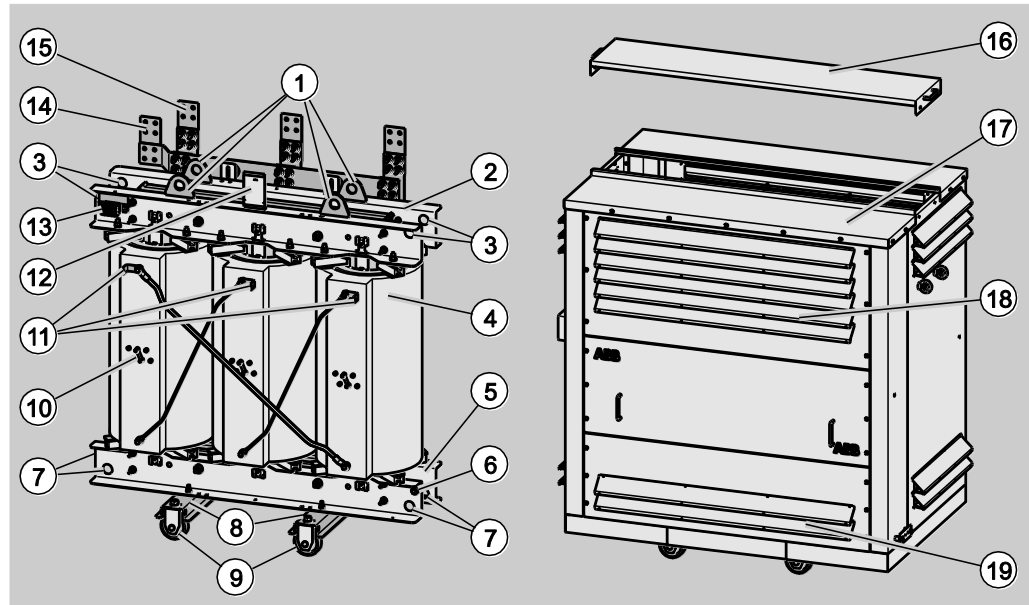
Overview of the IP00 version



- ① Lifting eyelets
- ② Upper press beam
- ③ Lashing eyelets
- ④ Coil
- ⑤ Lower press beam
- ⑥ Earthing tabs
- ⑦ Towing eyelets
- ⑧ Castor supports
- ⑨ Castor or foot (optional and dependent on equipment)
- ⑩ High-voltage tapping connections
- ⑪ High-voltage terminal
- ⑫ Rating plate and connection diagram
- ⑬ Temperature monitoring device, terminal strip
- ⑭ Neutral point terminal
- ⑮ Low-voltage terminal

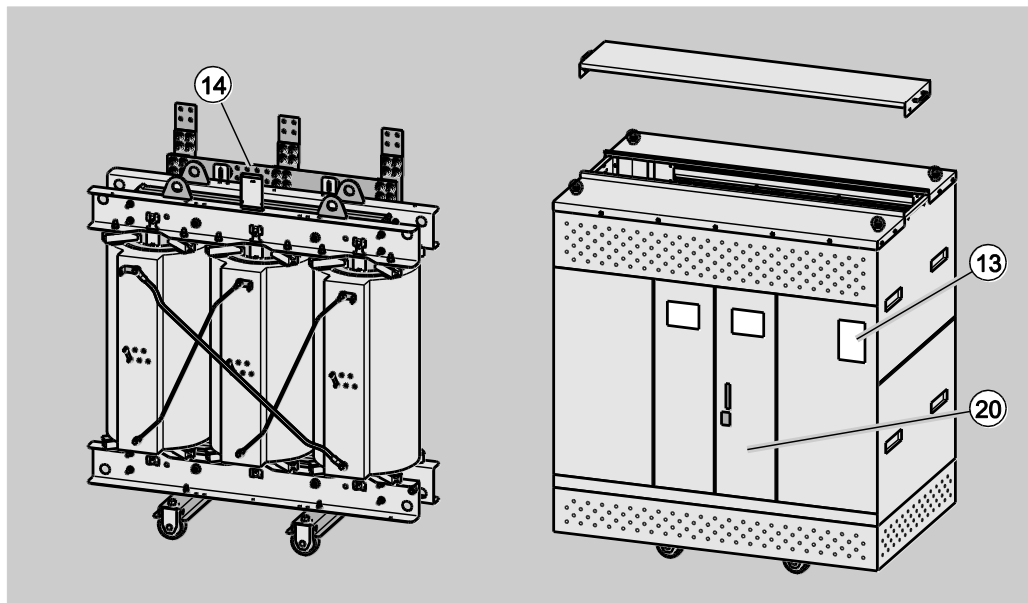
3.5

Overview of the IP23 version



- ① Lifting eyelets
- ② Upper press beam
- ③ Lashing eyelets
- ④ Coil
- ⑤ Lower press beam
- ⑥ Earthing tabs
- ⑦ Towing eyelets
- ⑧ Castor supports
- ⑨ Castor or foot (optional and dependent on equipment)
- ⑩ High-voltage tapping connections
- ⑪ High-voltage terminal
- ⑫ Rating plate and connection diagram
- ⑬ Temperature monitoring device, terminal strip
- ⑭ Neutral point terminal
- ⑮ Low-voltage terminal
- ⑯ Cover; can be removed for transportation by crane
- ⑰ Housing
- ⑱ Air outlet openings
- ⑲ Air inlet openings

- ① Alternative versions are possible for the neutral point terminal and for the design of the protective enclosure.



- ⑬ Temperature monitoring device
⑭ Neutral point terminal
⑳ Doors

3.6

Rating plate

Every transformer or transformer enclosure has a rating plate affixed to it. The rating plate contains the following information according to IEC 60076-11:

- Transformer type
- Number and year of publication of the key applicable standard
- Manufacturer's name
- Manufacturer's production number
- Year of construction
- Temperature of the insulation system for each winding
- Number of phases
- Rated power for each type of cooling system
- Rated frequency
- Rated voltage including the tapping voltages, if provided
- Rated current for each type of cooling system
- Connection symbol
- Short-circuit impedance for rated current and for the applicable reference temperature
- Type of cooling system
- Total weight
- Insulation level
- Type of protection
- Environment class
- Climatic class
- Fire class
- Connection diagram (optional)

4 Transportation and storage of the transformer

4.1 Personnel qualification

The personnel assigned to carry out transportation must be trained in the following:

- Safety precautions during transportation
- Safe handling of heavy loads
- Securing of loads on the transport vehicle
- Protection of the load against the elements

4.2 Loading and unloading

Only use a crane to load and unload transformers which do not come packed on a pallet. To do so, only use the lifting eyelets provided on the transformer.

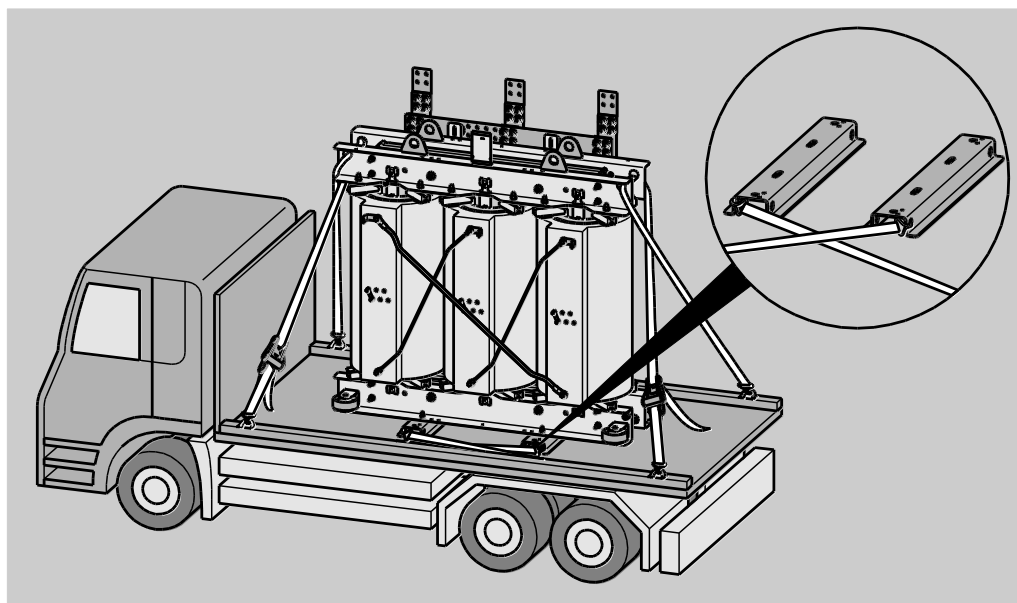
4.3 Off-site transportation

The following conditions must be observed during off-site transportation:

- The transformer's wheels must be removed
- The transformer must be in an upright position at all times during transportation
- The transformer must be protected against the elements
- The ambient temperature on the transformer must be between -25 °C and $+50\text{ °C}$, unless agreed otherwise by contract
- The ambient temperature on any accessories provided, eg. temperature monitoring device, thermometers, fans, must be between -25 °C and $+50\text{ °C}$
- Take precautions to prevent the impact of force on the coils or any parts attached to them
- Ensure the fastening equipment and mode of transport you select will not cause any damage to the transformer
- Take precautions to prevent the transformer from being exposed to vibrations and oscillations
- Comply with valid applicable regulations relating to work with transport vehicles
- Secure the transformer to prevent it from slipping; see the following page

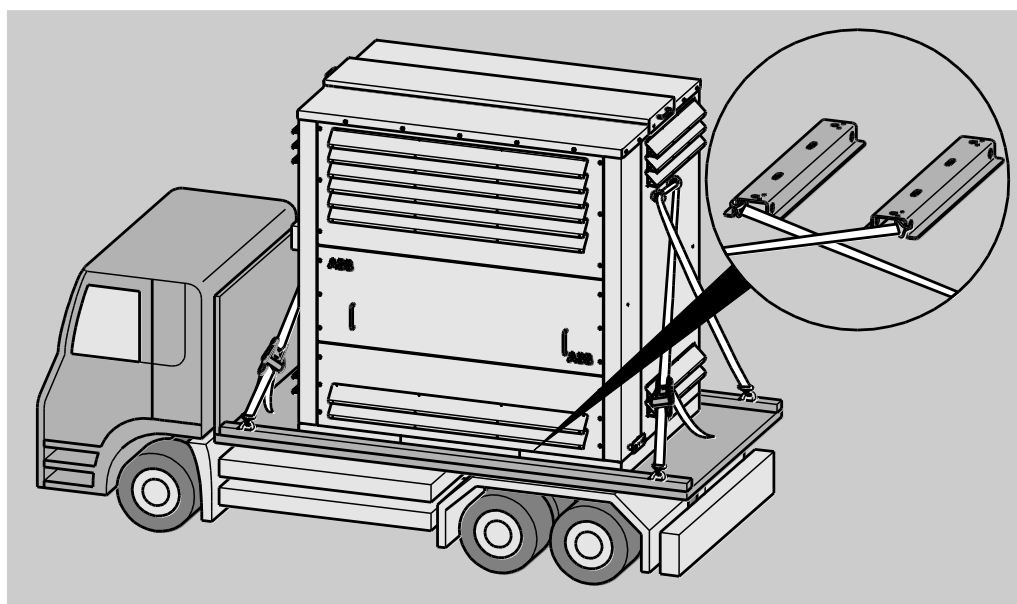
Schematic representation showing transportation of a transformer with IP00 protection

To secure a transformer with IP00 protection effectively to prevent it from slipping during transportation, lashing eyelets are provided on the upper press beam to enable it to be tied down.



Schematic representation showing transportation of a transformer with a protective enclosure, eg. with IP23 protection

To secure a transformer with IP23 protection effectively to prevent it from slipping during transportation, lashing eyelets are provided on the protective enclosure to enable it to be tied down.



► Make sure that a crane with sufficient load capacity is provided for unloading and loading.

❗ The total weight is shown on the rating plate.

ATTENTION!

Damage to property or malfunctions on the transformer caused by lifting by a fork lift truck.

- ▶ Lift the transformer by crane only.
-

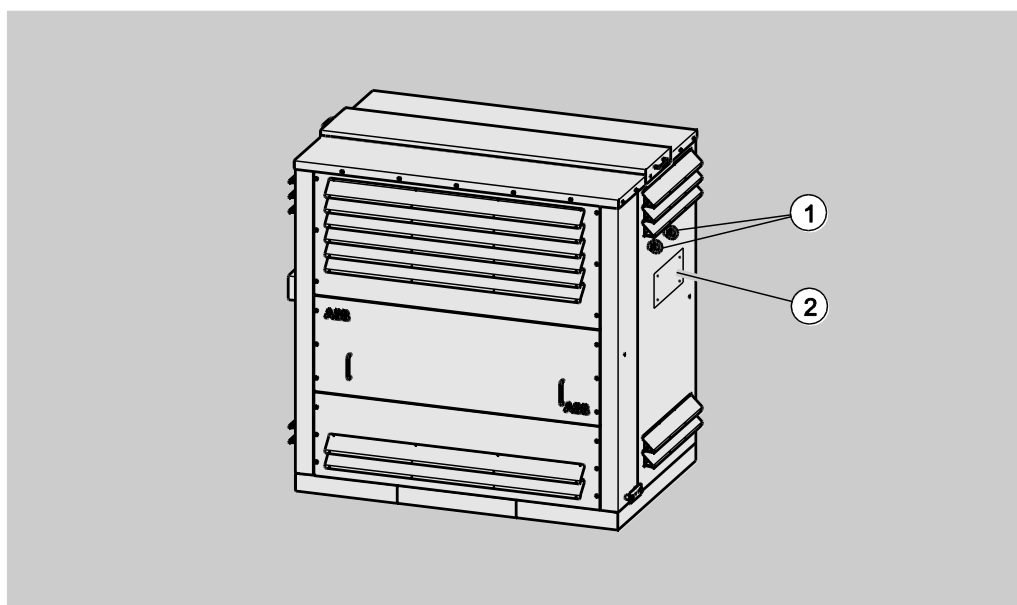
You may use a fork lift truck to lift a transformer ABB has packed on a pallet (unless there is a prohibition sign).

If the transformer is to be delivered to a building site, proceed as follows:

- ▶ Check the situation on site a few days before delivery.
- ▶ Inform all those concerned about the delivery.

If the transformer is to be installed in a closed room, proceed as follows:

- ▶ Make sure that an area is available in front of the room which is suitable for the transformer's type of protection and its weight.
- ▶ Set the transformer down in this area.
- ▶ Fit the wheels as described in page 29.
- ▶ Move the transformer into the closed room from this area.
- ▶ In the case of transformers with a protective enclosure, remove the lashing eyelets (1) which are fitted to the side.
- ▶ Remove the plate (2) underneath the lashing eyelets (dependent on mode).
- ▶ Use the plate to close the opening in the enclosure for the lashing eyelets (dependent on model).





DANGER

Risk of fatal injury caused by a transformer that is visibly damaged.

- ▶ Never place a transformer into operation if it is visibly damaged.
 - ▶ Contact the manufacturer.
-

Check the transformer and additional components for completeness and damage with reference to the following list when they arrive:

- Is the transformer specification in accordance with the test report and the name plate?
- Are all parts specified on the delivery note present?
- Are the fastenings and/or packaging damaged or damp?
- Are the fastenings for the transformer damaged?
- Are there any indications that the load was reloaded or slipped while in transit?
- Are the connection elements or insulated supports on the coils twisted or broken?
- Is there any damage to the coils, eg. from scratches?
- Is there any damage to the coating?

If you should discover any non-conformities, proceed as follows:

- ▶ Enter the type of damage on the consignment note.
- ▶ Send the consignment note to the manufacturer.
- ▶ Send a damage report to the haulage firm.
- ▶ Do not place the transformer into operation.

If you should discover that any parts are missing, proceed as follows:

- ▶ Notify the haulage firm.
- ▶ Do not place the transformer into operation.

If the information on the packaging does not correspond with the information on the delivery note, proceed as follows:

- ▶ Contact the manufacturer without delay.

4.5

On-site transportation

Make sure that the following conditions are observed during on-site transportation:

- Transport the transformer in an upright position only
- The transformer must be protected against the elements
- Take precautions to prevent the impact of force on the coils or any parts attached to them
- The ambient temperature on the transformer must be between -25 °C and $+50\text{ °C}$, unless agreed otherwise by contract
- The ambient temperature on any accessories which may be provided, eg. temperature monitoring device, thermometers, fans, must be between -25 °C and $+50\text{ °C}$
- Make sure that the fastening equipment and mode of transport you select will not cause any damage to the transformer
- Take precautions to prevent the transformer being exposed to vibrations or oscillations
- Secure the transformer to prevent it from slipping
- Before transporting the transformer, make sure that it has cooled down enough so as not to cause any burns if touched.

4.5.1

Using a crane to transport a transformer without a protective enclosure



DANGER

Risk of fatal injury caused by falling loads.

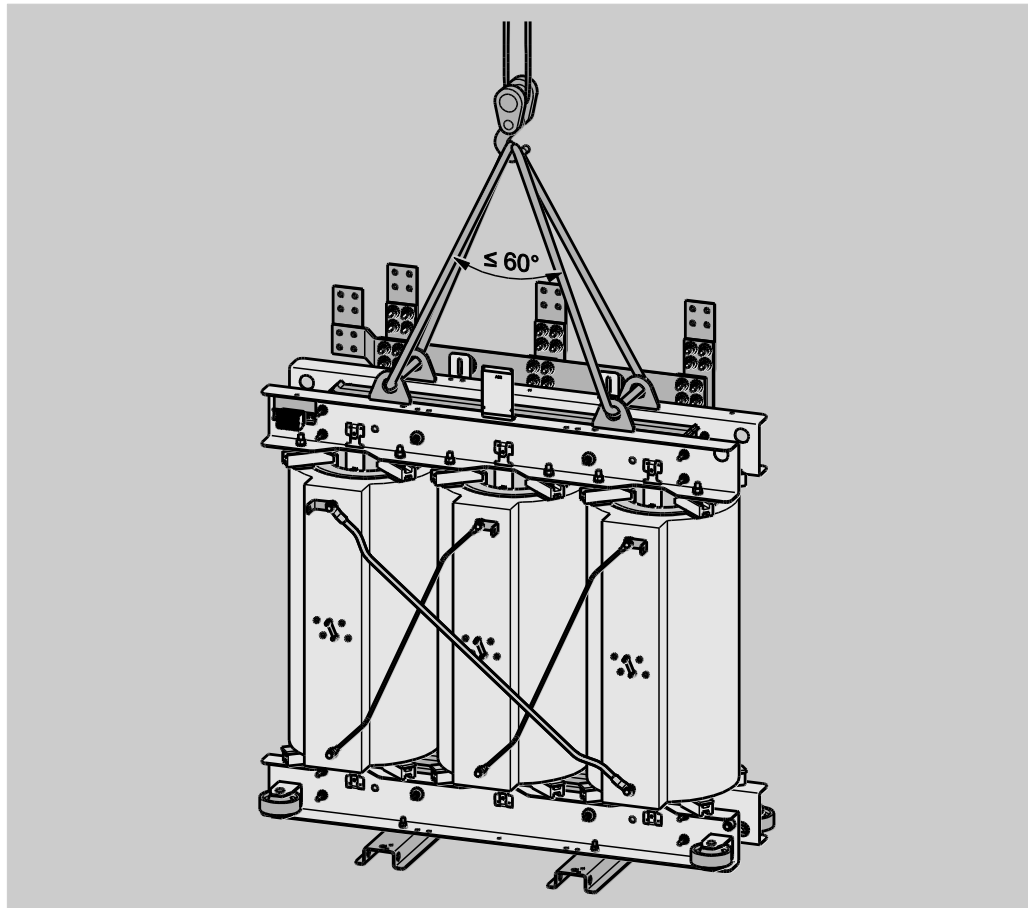
- ▶ Cordon off the transportation route for the duration of transportation.
- ▶ Only use load suspension equipment and slings suitable for the load in question and that are free from damage.
- ▶ Make sure no one is standing beneath suspended loads.



The total weight is shown on the rating plate.

To use a crane to lift the transformer with IP00 protection, proceed as follows:

- ▶ Make sure that the transformer will not get wet, eg. from rain.
- ▶ Secure the slings to the four slinging points provided on the upper press frame.
- ▶ Make sure that the slinging angle does not exceed 60°.



- ▶ Lift the transformer by the crane.
- ▶ Fasten the bidirectional wheels or feet in accordance with the instructions.
- ▶ Set the transformer down in the area provided.
- ▶ Remove the slings from the transformer.

4.5.2

Using a crane to transport a transformer with a protective enclosure



DANGER

Risk of fatal injury caused by falling loads.

- ▶ Cordon off the transportation route for the duration of transportation.
 - ▶ Only use load suspension equipment and slings suitable for the load in question and that are free from damage.
 - ▶ Make sure no one is standing beneath suspended loads.
-
-



CAUTION

Risk of falling because the top cover on the enclosure has insufficient load bearing capacity.

- ▶ Do not step onto the top cover of the enclosure.
-
-

ATTENTION!

Risk of damage to property caused by stepping on the top cover on the enclosure.

- ▶ Do not step onto the top cover of the enclosure.
-



The total weight is shown on the rating plate.

To use a crane to lift a transformer with a protective enclosure, eg. with IP23 protection, proceed as follows:

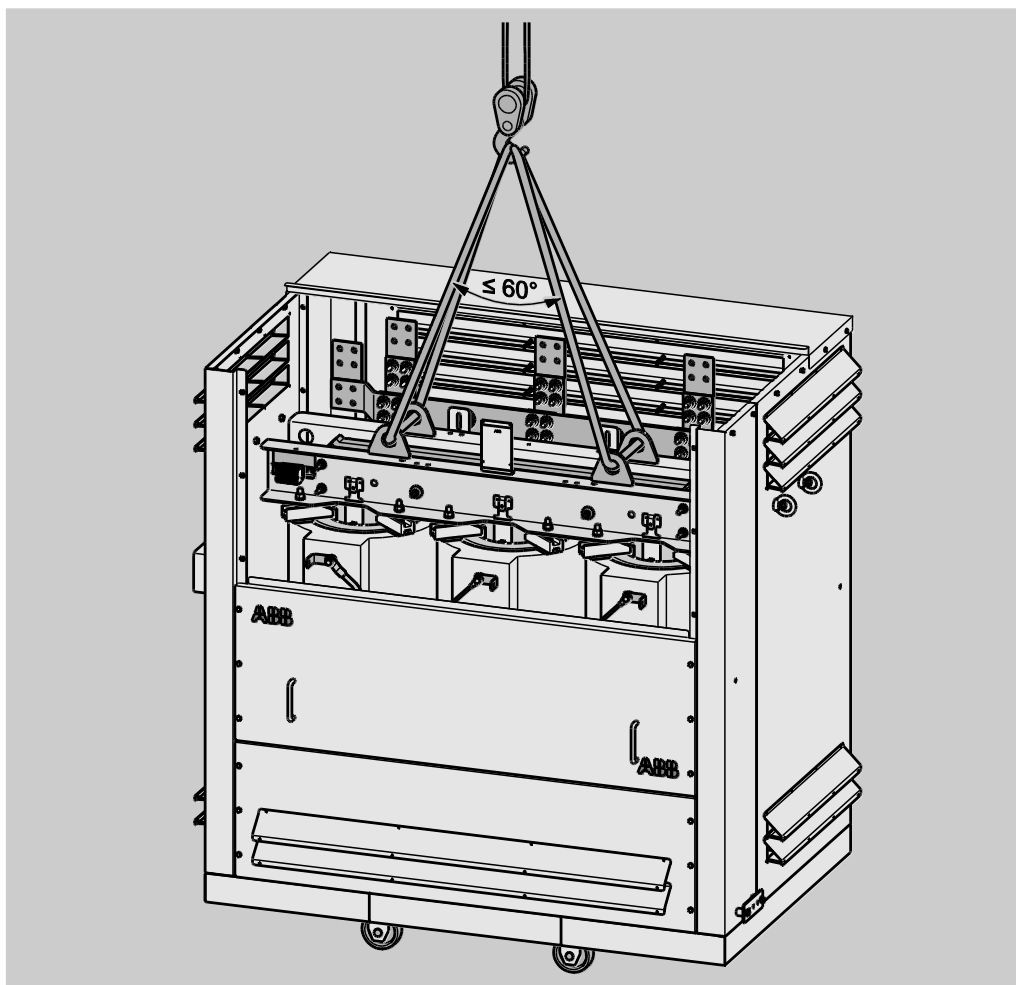
- ▶ Make sure that the transformer and enclosure will not get wet, eg. from rain.
-

ATTENTION!

Risk of damage to property caused by the use of incorrect slinging points.

- ▶ Make sure that the slings are only secured to the four slinging points provided for the purpose on the upper press frame.
 - ▶ Never secure the slings to the lashing eyelets on the enclosure.
-

- ▶ Remove the top cover from the protective enclosure.
- ▶ Secure the slings to the four slinging points provided on the upper press frame.
- ▶ Make sure that the slinging angle does not exceed 60°.



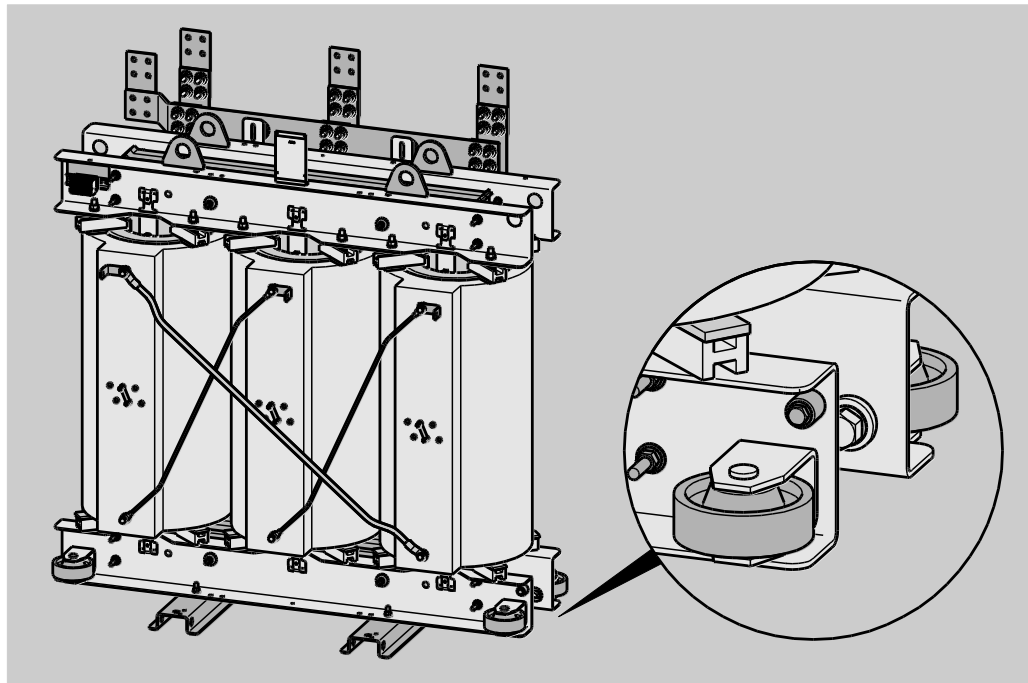
- ▶ Lift the transformer by the crane.
- ▶ Fasten the bidirectional wheels or feet in accordance with the instructions.
- ▶ Set the transformer down in the area provided.
- ▶ Remove the slings from the transformer.
- ▶ Replace the top cover on the protective enclosure.

4.5.3

Fitting the bidirectional wheels (optional)

The bidirectional wheels are fitted in the same way for transformers with and without a protective enclosure. For a better overview the illustrations show a transformer with IP00 protection.

For on-site transportation you can fit bidirectional wheels to the wheel support of the transformer. For off-site transportation the bidirectional wheels are screwed to the inside or outside of the lower press frame or on the wheel supports.



To fit the bidirectional wheels, proceed as follows:

- ▶ Remove the bidirectional wheels from the lower press beam.

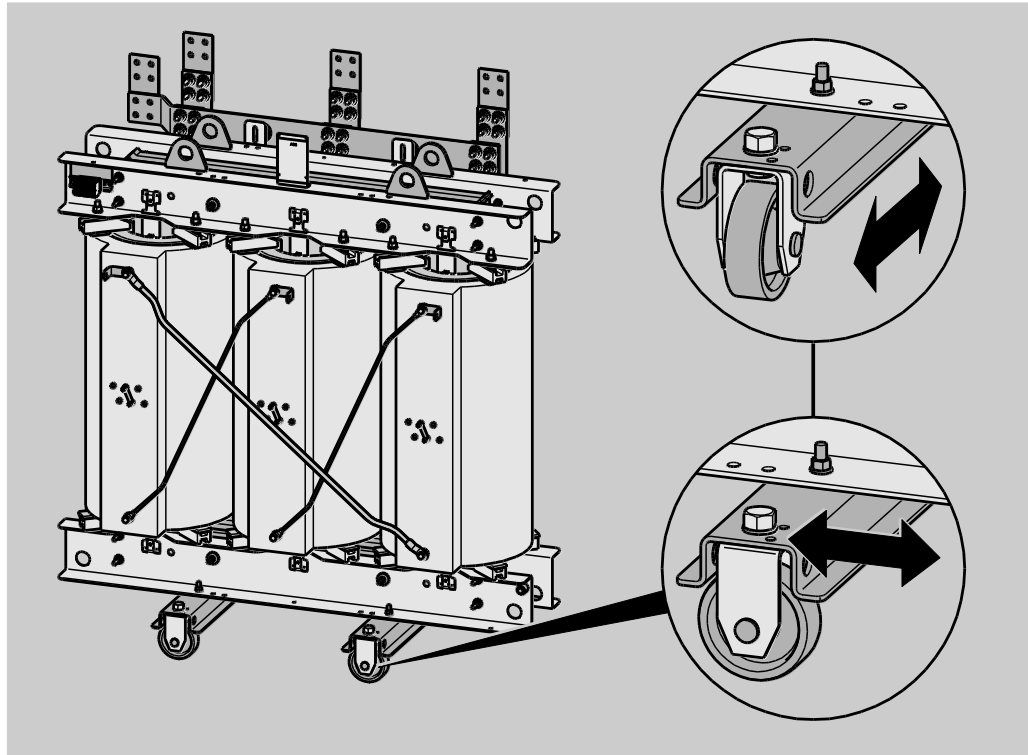


DANGER

Risk of fatal injury caused by falling loads.

- ▶ Cordon off the transportation route for the duration of transportation.
- ▶ Only use load suspension equipment and slings suitable for the load in question and that are free from damage.
- ▶ Make sure no one is standing beneath suspended loads.

- ▶ Lift the transformer by crane.
- ▶ Set the transformer down on a substructure with sufficient load bearing capacity that is higher than the bidirectional wheels, and will permit the bidirectional wheels to be fitted.
- ▶ Fasten the bidirectional wheels to the wheel support and ensure they are all aligned in the desired running direction.
- ▶ Check that the bidirectional wheels are all aligned in the same running direction once you have fitted them.
- ▶ Lift the transformer off the substructure.
- ▶ Set the transformer down on the fitted bidirectional wheels.



4.5.4

Using a fork lift truck

ATTENTION!

Damage to property or malfunctions on the transformer caused by lifting by a fork lift truck.

- ▶ Lift the transformer by crane only.
-

You may use a fork lift truck to lift a transformer ABB has packed on a pallet (unless there is a prohibition sign).

You can tow the transformer on its bidirectional wheels using a fork lift truck.

- ▶ Check that the wheels on the transformer are fitted aligned in the running direction.

- ① The total weight is shown on the rating plate.
-



DANGER

Risk of fatal injury caused by an unsecured load running on wheels.

- ▶ Cordon off the transportation route for the duration of transportation.
 - ▶ Only use load suspension equipment and slings suitable for the load in question and that are free from damage.
 - ▶ Make sure that the transformer cannot run uncontrolled when moved on slopes with a maximum angle of 15°.
 - ▶ Secure the wheels with wedges each time you stop.
-
- ▶ Secure load suspension equipment and slings, suitable for the load in question to the lashing eyelets on the transformer.
 - ▶ Secure the other end of the load suspension equipment and slings to the lashing eyelets on the fork lift truck.
 - ▶ Tow the transformer with care to the desired location.

4.6

Storage of the transformer

For temporary or longer term storage, the following conditions must be observed:

- Store the transformer in a room that is dry, clean and well ventilated
- Store the transformer at an ambient temperature between -25 °C and $+50\text{ °C}$. If the transformer has to be stored at lower temperatures, please ask the supplier.
- Cover the transformer with heavy plastic to protect it from dirt.
- If the transformer is to be stored for a longer period (more than one month), provide the packed transformer with a suitable drying agent, eg. silica gel.
- Check the drying agent at regular intervals for moisture.
- Replace the drying agent in accordance with the manufacturer's instructions, if it should contain too much moisture.

5

Installation of the transformer



DANGER

Risk of fatal injury caused by an unsuitable installation location.

- ▶ Make sure that if a transformer has IP00 protection it is only used in a closed operating area.
 - ▶ Make sure that access to the transformer is only possible when it is in a de-energized state.
-
-

ATTENTION!

Risk of damage to property caused by improper storage before installation.

- ▶ Protect the transformer from dirt and damp while in storage.
-
-

ATTENTION!

Risk of inadequate cooling caused by incorrect installation.

The distance between wheel supports and floor needs to be large enough to allow sufficient air flow for cooling of the inner part of the transformer.

- ▶ Install the transformer only on the wheels or the feet provided by the manufacturer.
-

You can install the transformer with and without a protective enclosure in the following ways:

- On the bidirectional wheels
- On the feet

If you wish to install the transformer on the bidirectional wheels, proceed as follows:

- ▶ Make sure that the transformer has a sufficient supply of cooling air.
- ▶ Make sure that the distance between the floor and bidirectional wheels support corresponds to that shown in the applicable dimension diagram.
- ▶ Secure the bidirectional wheels with wedges to prevent the transformer rolling away.

5.1

Installation location conditions

ATTENTION!

Risk of damage to property caused by an excessively low ambient temperature on provided accessories, eg. temperature monitoring device, thermometers, fans.

- ▶ Do not expose any such accessories to temperatures lower than -25 °C .
 - ▶ Contact the manufacturer if you expect lower temperatures.
-

Make sure that the following conditions are observed at the installation location:

- The location must not be greater than 1,000 m above sea level, unless a different altitude for the installation location is given on the rating plate.
- The installation location must meet the requirements of IP23 type of protection as a minimum.
- Keep away from direct sunshine.
- The subsurface on which it stands must be flat, dry and suitable to accommodate the weight of the transformer.
- Comply with local building regulations.
- Unless otherwise agreed with the manufacturer, observe the following ambient temperatures:
 - Annual average $+20\text{ °C}$
 - Monthly average $+30\text{ °C}$
 - Maximum temperature $+40\text{ °C}$
 - Minimum temperature -5 °C for operation of transformers of climatic class 1
 - Minimum temperature -25 °C for operation of transformers of climatic class 2 (C1 oder C2 as indicated on rating plate)
 - Minimum temperature -25 °C for storage

- ① ▶ Check and document the ambient temperatures at regular intervals.

5.2

Ventilation

All transformers, regardless of their power levels, are always designed for a certain type of ventilation. It makes no difference whether the transformers are operated on a self-cooling (AN cooling) basis, or with fitted fans for enhanced performance (AF). The ventilation system must be designed to allow for the maximum possible heat loss.

5.2.1 Electrical operating room for transformers with AN/AF cooling

The design of the electrical operating room for the transformer, in particular, the ventilation aspects of the room need to be taken into consideration at the outset in the planning phase. The ventilation of transformer rooms needs to fulfill the temperature requirements of 5.1 and needs to be designed to allow for all of the expected sources of heat in the room; including the heat loss for all of the transformers and any other heat sources, eg. electrical equipment such as fans, lighting, etc. It is important that possible increases in transformer power at a later date are also taken into account. The supply and exhaust air openings must lead directly to the open air. The rooms need to be ventilated effectively enough for the waste heat generated when the transformers are in operation to be completely dissipated at all times.

5.2.2 Supply air and exhaust air

The supply air for the rooms must be drawn in from the open air either directly or through special ventilation ducts, while the exhaust air must be conveyed separately out to the open air either directly or through special ventilation ducts. Ventilation ducts which run through other rooms have to be installed in such a way that there is no risk of fire and smoke being transferred to other rooms. The openings of ventilation ducts to the open air must be provided with protective grates. If the supply air is contaminated, it has to be filtered before it enters the room, see page 39.

Air inlet and outlet openings must be arranged in such a way that ensures that the transformers are ventilated with fresh air. The air inlet openings need to be low down in the transformer room, while the air outlet openings need to be high up. Do not install any facilities in the air supply and outlet ducts for transformer rooms which would obstruct the free flow of the air. Ventilation ducts for natural ventilation should lead directly to the inlet and outlet openings. The air outlet needs to be at least 0.9 m above the transformers. The angle of fan ducts must not deviate by more than 45° from the vertical.

Particularly effective cooling can be achieved if the cooling air flows into the room low down on one side of the room and out again just beneath the ceiling on the opposite side (Fig. 1).

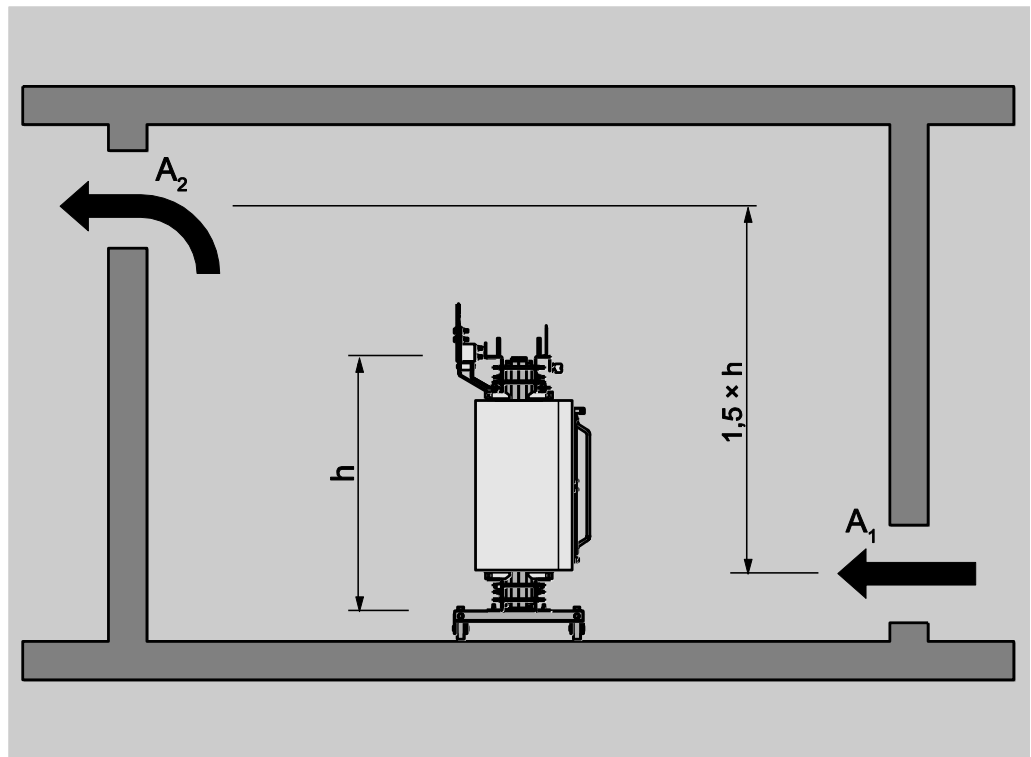
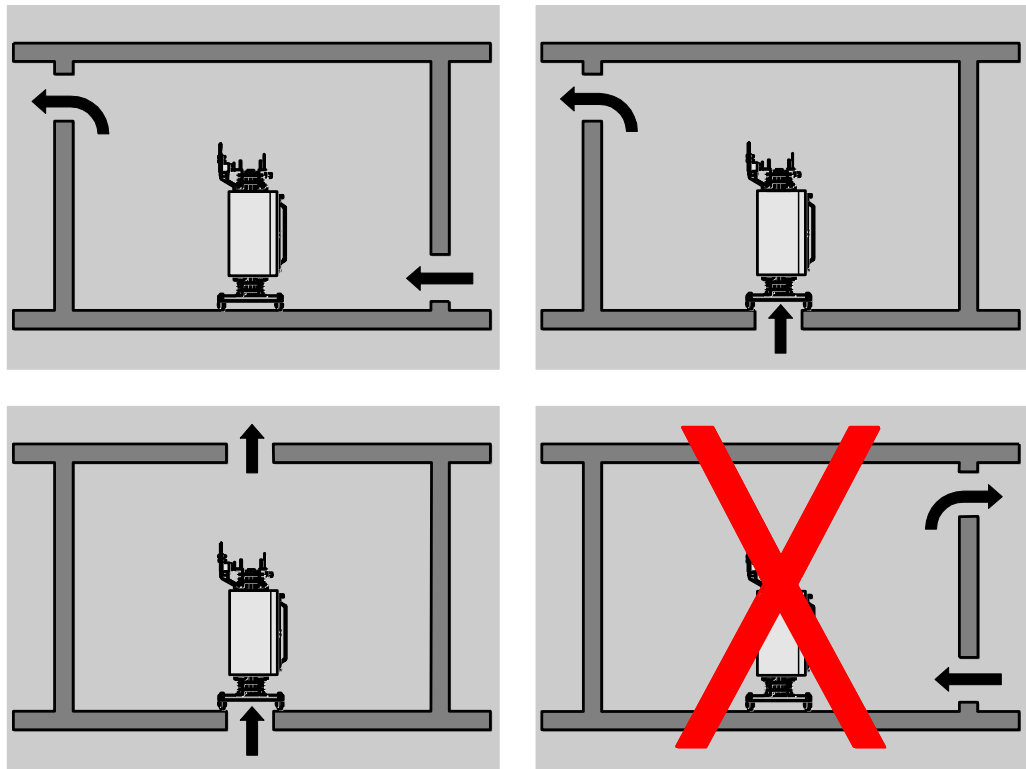


Fig. 1

A_1 : Supply air

A_2 : Exhaust air

Other supply air and exhaust air alternatives. The exhaust air alternative shown bottom right requires special consideration.



- ▶ Observe the rules set out in the applicable technical literature when designing the installation room.
- ▶ Make sure the air cooling rate is more than 4 m³/min per kW of total power loss of the transformer.
- ▶ Refer to the precise details included in the supplied test reports.
- ▶ Make sure the temperature of the supplied cooling air does not exceed the aforementioned ambient temperatures.

The air inlet and outlet cross-sections must be dimensioned in such away that the flow rate of the cooling air within the installation room does not exceed 1.5 m/s. To prevent the chimney effect (natural flow of cooling air) from being obstructed, do not use forced ventilation for the installation room.

5.2.3

Basic requirements to be met for adequate interior ventilation for AN/AF operation

For an efficient supply of sufficient cooling air to the transformer, the following limits must be complied with.

Air volume:	>4 m ³ per minute and kW of power loss	
Air speed:	<1.5 m/s	
Air temperature:	Annual average	20 °C
	Monthly average	30 °C
	Maximum temperature	40 °C
Installation altitude	<1,000 m above sea level	

The size of the air inlets and outlets required for the above can be determined using the following rules of thumb for an initial approximation.

$$A_1 = \frac{0,18 \times P_v}{\sqrt{H}} \qquad A_2 = 1,1 \times A_1$$

A₁ Cross-sectional area for supply air in m²

A₂ Cross-sectional area for exhaust air in m²

P_v Total power loss in kW

H Difference in height between the center of the inlet and the center of the outlet in meters

If blinds, filters or similar are to be installed in the intake for the supply air, the area of the inlet/outlet must be enlarged accordingly.

5.2.4

Special conditions

Under certain circumstances it may not be possible to provide an electrical operating area with the requisite dimensioning (eg. if existing rooms are used). In room cases, it can still be possible to provide sufficient cooling for the transformer if the room is provided with active cooling (ACCS = Assisted Cooling Convection System). In this case the use of suitably dimensioned fans in the exhaust air duct and suitable air ducting provides the transformer coils with a forced air flow. This solution generally allows operating areas to be used where only the requirements in terms of electrical conditions (clearances, etc.) have to be met.

5.2.5

Using filter elements

If the cooling air contains harmful substances that form a conductive layer in a dry or damp state, they must be filtered out. Examples of such harmful substances include the following:

- Cement dust
- Salt deposits
- Dust containing metal
- Carbon dust, etc.

ATTENTION!

Risk of an inadequate supply of cooling air and excessive temperature rise caused by the installation of filters.

- ▶ Take measurements to make sure there is an adequate supply of cooling air if filters are used.
 - ▶ Enlarge the cross-section of the ventilation openings if the supply of cooling air is inadequate.
 - ▶ Make sure that the air flow is sufficient for both, the air inlet and the air outlet openings.
-
- ▶ Clean the filter elements at suitable intervals.
 - ▶ Replace used or damaged filter elements with new ones.

5.2.6

Ventilation for transformers with a protective enclosure, eg. IP23

For transformers with protective enclosures, the following information and instructions must also be observed.

- In order to ensure adequate air circulation is provided, the protective enclosure must be installed at a sufficient distance from the floor and the walls.
 - The minimum distance between the protective enclosure and the floor must be at least the height of the bidirectional wheels.
 - For the minimum distance between the floor and the bottom edge of the enclosure, please refer to the up-to-date drawings included in the supplied documentation.
 - If you remove the bidirectional wheels, you must take appropriate measures on site to ensure the minimum distance between the floor and the bottom edge of the enclosure is not less than the specified limit.
 - Ensure the minimum distance between the transformer and the walls on all sides is 0.3 m. Also, make provisions in your plans for sufficient space for installation and maintenance work.
 - Ensure there is sufficient distance to the walls at the level of the air outlet openings. For transformers with protective enclosures you must ensure the distance to the wall equates to 2/3 of the ventilation grating height.
Example: A ventilation grating height of 540 mm results in a wall distance of 360 mm.
 - Ensure the minimum distance between any two transformers is not less than 0.5 m. In addition, you must also comply with the minimum distances for electrical components (see the table in the following section).
- The required minimum distance between the floor and the bottom edge of the enclosure does not have to be met if the floor immediately below the transformer is provided with ventilation openings with cross-sections of sufficient size.
- Ventilation gratings or flaps in the air inlet and outlet openings must be designed in such a way as to not impede the flow of air.

5.3

Space requirements, planning and minimum clearances to be adhered to

- ▶ Please refer to the dimension diagram in the documents included in delivery for the dimensions of the transformer.
- ▶ Install the transformer in the installation room in such a way that the following conditions are met:
 - You must be able to read the rating plate without having to enter the installation room.
 - You must be able to read the provided measuring instruments without having to enter the installation room.
- ⓘ The insulation of the coils is not safe in the event of accidental contact during operation.
 - ▶ Do not install the transformer in easily accessible places.
 - ▶ Place clearly visible warning and danger signs on the surface of the coils.

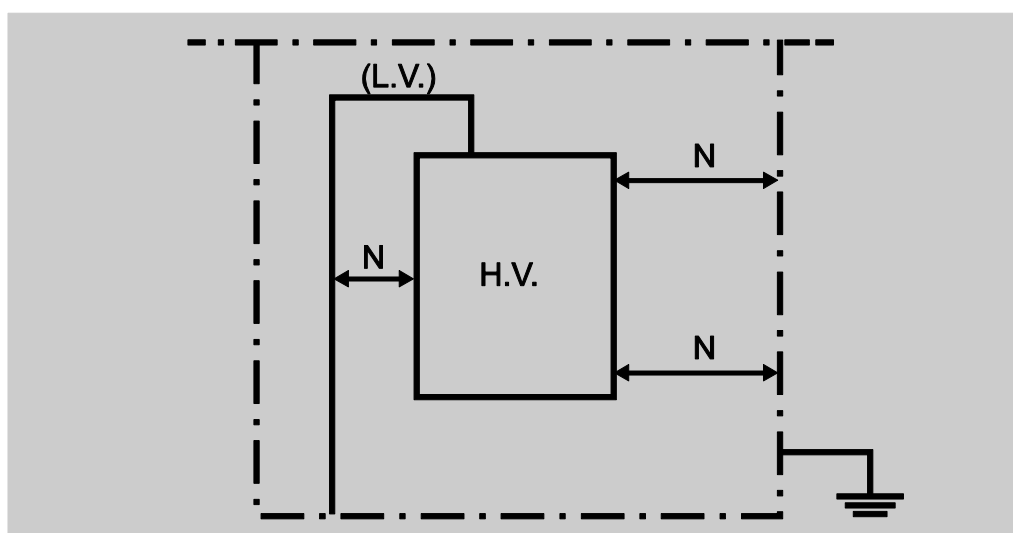
Comply with the minimum clearances between live parts and between live parts and earth as set out in the following table.

The minimum distances must be observed for steel-reinforced concrete walls as well.

Maximum voltage for operating resources U_m [kV]	Rated short-time power-frequency withstand voltage [kV]	Rated lightning impulse voltage 1.2/50 μ s U_{rB} [kV]	Minimum distance (N) Conductor/earth and conductor/conductor	
			Indoorsystems [mm]	Outdoor-systems [mm]
3.6	10	20	60	120
3.6	10	40	60	120
7.2	20	40	60	120
7.2	20	60	90	120
12.0	28	60	90	150
12.0	28*	75	120	150
17.5	38	75	120	160
17.5	38	95	160	160
24.0	50	95	160	
24.0	50	125	220	
36.0	70	145	270	
36.0	70	170	320	
41.5	80	170	320	
41.5	80	200	360	
52.0	95	250	480	
72.5	140	325	630	

In accordance with IEC 61936-1:2010

*) 35 kV according to GB 1094.11-2007



kV class	Clearance	
	Inches	Millimeters
1,2	4	102
2,5	5	127
5	5,5	140
8,7	6,5	165
15	8	203
25	11	279
34,5	15	381

These distances are based on standard BIL insulation levels. Additional clearances may be necessary for alternative BIL ratings.

Ref: IEEE/ANSI C57.12.51:2008

In case the specified minimum distances are too large for a specific installation, please contact us and depending on the specific case we might be able to propose you reduced values.

6 Connection of the transformer

The transformer is always connected in the same way regardless of whether it comes with or without a protective enclosure.

6.1 Personnel qualification

The personnel assigned to carry out the job of connection must be trained in the following:

- Disconnection of electrical equipment
- Securing to prevent accidental activation by unauthorized persons
- Verification of disconnection from the power supply
- Earthing and short-circuiting of electrical equipment
- Covering or safeguarding of adjacent live components
- Making electrical connections
- Connection of transformers

6.2 Electrical and mechanical connections

Ensure the following conditions are met before you start to connect the transformer:

- All the provided cables and the earthing system must be suitably prepared in accordance with requirements.
- All cables must have cross-sections suitable for the power to be transmitted.
- The electrical data for the transformer (see the rating plate) must be the same as the electrical data for the low-voltage and high-voltage mains.
- Clean the contact surfaces and remove oxidized surfaces in order to ensure low contact resistance.
- Comply with the minimum distances between live and earthed parts. This applies particularly to the distances between cables and the high-voltage windings.
- Secure the transformers to prevent them moving at the installation location, eg. with wedges.

Ensure all the connections fit tightly and are mechanically secure when you connect them, proceed as follows:

- ▶ Use high tensile (A2-70, A4-70, 8.8) stainless steel bolts and nuts for the electrical connections.
- ▶ Use a suitable torque wrench to tighten the screws or bolts on electrical connections.
- ▶ Please refer to the following table for the torques.

The following torques apply only to the tightening of screws or bolts without the use of lubricant. If lubricants are used, the quoted torques can be reduced slightly. The use of lubricant is recommended.

Screw/bolt size	Torque [N m]	
	Steel: A2-70/A4-70/8.8	Brass
M3	0.9	–
M4	2.3	–
M5	4.5	–
M6	8	5
M8	20	12
M10	40	25
M12	70	40
M14	110	60
M16	170	90
M18	240	120
M20	360	180
M24	600	–
M30	1200	–

- ⓘ The quote torques do not apply for the tightening of screw connections which have flexible material, eg. rubber, in between.

6.2.1

Setting the voltage ratio on transformers with vacuum cast coil windings

Changing over the tapping connections is carried out by changing the connections of the taps on all high voltage windings while the transformer is in an earthed state.



DANGER

Risk of fatal injury caused by a transformer that has not been disconnected from the power supply and is not earthed.

- ▶ Disconnect the transformer from the power supply.
 - ▶ Secure the transformer to prevent incidental activation by unauthorized persons (lock-out/tag-out).
 - ▶ Check that the transformer has been disconnected from the power supply.
 - ▶ Earth the transformer.
 - ▶ Short the transformer.
 - ▶ Cover or safeguard adjacent live components.
-

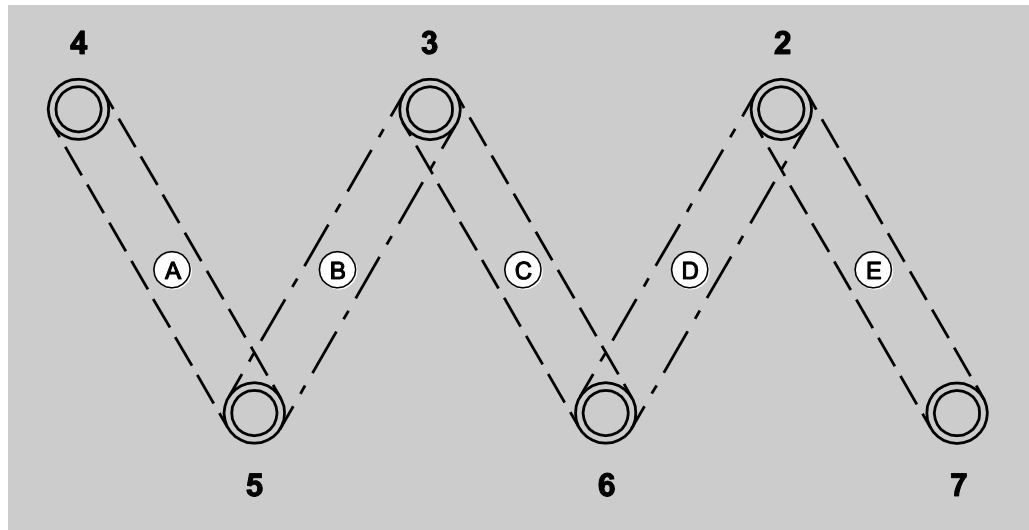
ATTENTION!

Damage to the transformer.

- ▶ Make sure that all of the windings are set to the same tapping connection.
 - ▶ Please refer to the connection diagram on the transformer for the assignment of the tapping connections.
-

To adjust the voltage ratio between the input voltage and output voltage, you must move the tapping connection on each winding into the corresponding position. Consult the connection diagram on the transformer for details of the position.

Position „C“ in the below example corresponds to the voltage ratio given by the rated secondary and primary voltage.



Setting	Connection between	Voltage regulation
A	4+5	-5%
B	3+5	-2,5%
C	3+6	0%
D	2+6	+2,5%
E	2+7	+5%

i The position and numbering of taps may vary from the above information.

► Tighten the connections with the required torque (see the table on page 45).

6.2.2 Making connections

Make the connections in accordance with IEC 61936-1:2010, EN 50522 or your national standard.

The following applies for transformers where the neutral point is led through on the low-voltage side:

Carry out the following before you start to connect to the high-voltage side:

► On the low-voltage side, install an electrical connection between the zero conductor on the low-voltage side and the zero conductor of the mains.

This is to prevent excessive potential being transmitted to the low-voltage winding due to capacitive couplings in the event of an earth fault in the mains.

To connect the transformer, proceed as follows:

- ▶ Earth the transformer with the earth screws on the wheel support.
- ▶ For reconnectable transformers, check the voltage ratio with reference to the connection diagram on the transformer.
- ▶ If necessary, set the voltage ratio with reference to the connection diagram on the transformer. See „*Setting the voltage ratio on transformers with vacuum cast coil windings*“ from page 46.

ATTENTION!

Risk of damage to the transformer caused by incorrect insulating resistance.

- ▶ Check that the insulating resistance is at least 1000 Ohm per volt of operating voltage in each case.

To check the insulating resistance, proceed as follows:

- ▶ Use an insulation tester to check the electrically isolated windings against each other.
- ▶ Use a test voltage of 5 kV between primary and secondary winding.
- ▶ Use an insulation tester to check each of the electrically isolated windings against earth.
- ▶ Use a test voltage of 5 kV between primary winding and earth.
- ▶ Use a test voltage of 2 kV between secondary winding and earth.

The insulating resistance must be at least 1000 Ohm per volt of operating voltage in each case.

If for any unusual reasons a transformer should become damp, this will reduce the insulating resistance. In this case, the transformer must be dried. The manufacturer can advise you about suitable drying methods.

- ▶ Check the voltage and phasing of the mains.
- ▶ Clean all connection points on the insulated supports and terminal lugs and make them bright.

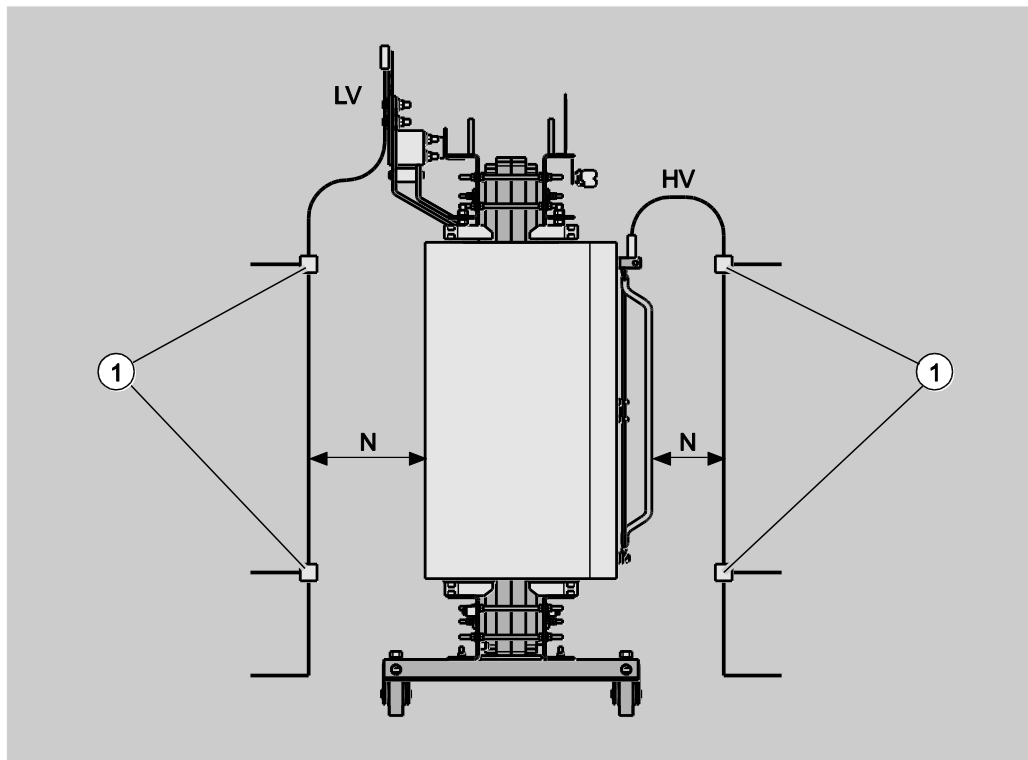
To connect aluminum with copper parts, proceed as follows:

- ▶ Insert the Cupal sheets (copper-clad aluminum sheets) in such a way that the same materials always come into contact with each other.
- ▶ In the case of aluminum connections, apply corrosion protection between the aluminum and the Cupal sheets, eg. Vaseline or contact grease.
- ▶ Apply corrosion protection to all bright areas on electrical connections, eg. Vaseline or contact grease.
- ▶ Connect the monitoring device(s).
- ▶ Check that the monitoring device(s) is/are in proper working order.

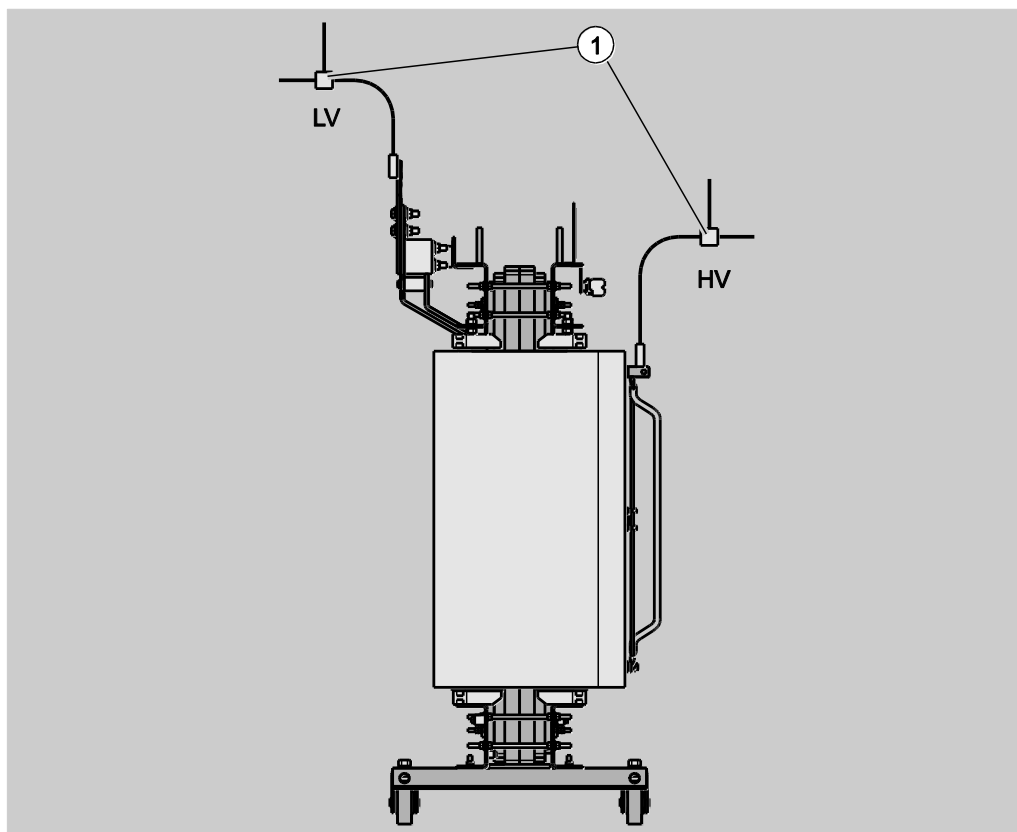
When you install the cables, follow the instructions below:

- ▶ Ensure there are no severe bends in the cables.
- ▶ Ensure they are not subjected to mechanical strain.
- ▶ Ensure the cables are not twisted.
- ▶ For currents in excess of 1000 A, use flexible connectors between the busbars and the connecting terminals on the transformer.
- ▶ Use suitable cable holders (1) to fasten the cables. See the following examples.
- ▶ Take the dimension N from the table on page 42.

Standard high-voltage and low-voltage connection (HV, LV) from the bottom.



Standard high-voltage and low-voltage connection (HV, LV) from the top.



- ▶ Fit strain relief devices to the cables.
- ▶ Ensure the required contact pressure is maintained.
- ▶ Please refer to the connection diagram on the transformer for the assignment of the high-voltage connections.
- ▶ Make the required electric connections.
- ▶ Apply corrosion protection to all screw connections, eg. Vaseline or contact grease.
- ▶ In order to restore the type of protection, seal off any unused cable entries on transformers with enclosures by inserting suitable plugs in them.

6.3 Parallel operation of transformers

If several transformers are to be operated in parallel mode, proceed as follows:

- ▶ Check that the requirements for the parallel operation of transformers are met.

Relevant information can be found in the standard IEC 60076-1, eg.

- Transformer designed for identical rated voltage (tolerance 0.5%) and frequency
- Identical connection symbol
- Identical short-circuit impedance (tolerance 10%)
- Maximum ratio of the power ratings: 3:1

7 Placing the transformer into operation

The transformer is always placed into operation in the same way regardless of whether it comes with or without a protective enclosure.

7.1 Personnel qualification

The personnel assigned to carry out the job of placing the transformer into operation must be trained in the following:

- Disconnection of electrical equipment
- Securing to prevent incidental activation by unauthorized persons
- Verification of disconnection from the power supply
- Earthing and short-circuiting of electrical equipment
- Covering or safeguarding of adjacent live components
- Making electrical connections
- Connection of transformers
- Placing transformers into operation

7.2 Preparation for placing into operation



DANGER

Risk of fatal injury caused by a transformer that has not been disconnected from the power supply and is not earthed.

- ▶ Disconnect the transformer from the power supply.
 - ▶ Secure the transformer to prevent incidental activation by unauthorized persons (lock-out/tag-out).
 - ▶ Check that the transformer has been disconnected from the power supply.
 - ▶ Earth the transformer.
 - ▶ Short the transformer.
 - ▶ Cover or safeguard adjacent live components.
-

Make sure that the following conditions are met before you start to place the transformer into operation:

- The information on the delivery note must correspond with the information on the rating plate on the transformer.
If this is not the case, contact the manufacturer. Let them know the serial number of the transformer.
- After being moved to the installation location the transformer must be given at least eight hours to adopt the prevailing ambient temperature.
- Comply with the valid applicable statutory regulations in the country of use when you place the transformer into operation.
- If the transformer is dirty, it must be cleaned before you place it into operation (see page 67)
- Connect the temperature monitoring device(s).
- The owner/user must affix safety signs at all points where, in spite of the provision of protective measures, there is a danger to the safety of persons. The relevant mandatory action and prohibition signs in accordance with the regulations applicable at the place of use (DIN ISO 3864-1, ANSI Z535.4 etc.) must be affixed in clearly visible locations in the installation room and at its entrance.

To prepare for placing the transformer into operation, proceed as follows:

- ▶ Make sure all packaging materials and any transport restraints have been cleared away.
- ▶ To prevent corrosion, touch up any damage to the paintwork.

ATTENTION!

Risk of damage to the transformer due to flashovers during operation caused by the wheels fitted to the lower press beam.

- ▶ Ensure the wheels, if provided, are fitted to the wheel support during operation.
- ▶ Ensure wheels that are not used are removed from the press beam.

-
- ▶ Fit provided bidirectional wheels as described in page 29 onwards.
 - ▶ In order to check individual cables you have to separate them from the transformer first.
 - ▶ Tighten all screw connections with the specified torque (see page 45).
 - ▶ Ensure all connections on the high-voltage and low-voltage sides are securely fitted and are not dirty.
 - ▶ Ensure the earth has been connected correctly.
 - ▶ Check whether the flashover distances listed below in accordance with the table on page 42 have been adhered to:

- Between live parts
- Between live parts and earthed parts
- Between cables and high-voltage windings
- Between cables and the high-voltage relay

7.2.1 Checking the temperature monitoring device

To check the temperature monitoring device with Pt100 sensors, proceed as follows:

- ▶ Check that all of the connections are securely tightened.
- ▶ Tighten any loose connections (see the table on page 45).
- ▶ Measure the resistance at the ambient temperature and compare it with those given in IEC 60751.
- ▶ Replace faulty components with faultless ones if any non-conformities are found.

To check the temperature monitoring device with PTC thermistor sensors, proceed as follows:

- ▶ Check that all of the connections are securely tightened.
- ▶ Tighten any loose connections (see the table on page 45).
- ▶ Interrupt the sensor circuit.

The temperature monitoring device must indicate a malfunction.

- ▶ If a malfunction is not indicated, check whether the components and the connection of the temperature monitoring device are in proper working order.
- ▶ Replace faulty components with faultless ones.
- ▶ Connect all the sensors again in accordance with regulations.

- ① If a different temperature monitoring device (eg. a dial thermometer) is used, the instruction manual of this device is applicable.

7.2.2 Checking the connections

- ▶ Check the installation of the control circuit for damaged insulation and loose connections.
- ▶ Check that the connections correspond with those on the connection diagram on the transformer.
- ▶ Check that the rated voltage to be applied corresponds with the connected position of the windings.

7.2.3 Checking the ventilation system

- ▶ Check whether the ventilation is effective enough.

For transformers with fans, check the following:

- ▶ Make sure that the fans are connected in accordance with the circuit diagram.
- ▶ Check that the fans are in proper working order and that their direction of rotation is correct.
- ▶ In the case of air-to-water coolers and air-to-air coolers there is a direction of rotation arrow on the fan impeller.
- ▶ If the direction of rotation of the air-to-water cooler or air-to-air cooler is incorrect, change the electrical direction of rotation.

7.2.4 Checking for cleanliness

- ▶ Check that the transformer is clean and free of any foreign particles.
- ▶ Use a vacuum cleaner and/or dry, oil-free compressed air (max. 3 bar) to remove any small parts in the ventilation ducts of the windings.
- ▶ Ensure all tools and equipment have been removed from the transformer.

7.2.5 Checking for protection devices

- ▶ Make sure that settings of overcurrent and short-circuit current protection relays are adequately set.
- ▶ In case of operation with frequent transient voltage, install eg. surge arresters.

7.3

Placing into operation



DANGER

Risk of fatal injury caused by high voltage during operation.

- ▶ Operate transformers without protective enclosures in closed rooms only.
 - ▶ Never enter the room during operation.
-

- ▶ Apply the power to the high-voltage side of the transformer.

When the transformer is placed into operation for the first time, it is possible that fumes may be generated for a short time, this is simply residual moisture evaporating and is not a malfunction.

- ▶ Run the transformer without load for about an hour.
- ▶ Monitor the voltage.

No irregularities should occur during this period.

- ▶ In order to check the output voltage in dependency on the voltage ratio, measure the voltage on the terminal lugs on the secondary winding.

7.4

High Noise Level

In case the sound level of a transformer exceeds the specified value, check for the following:

- ▶ Check all connections and all supports for HV and LV cables. Vibrations from the cable trays can increase the noise level.
- ▶ Check the fixing of all accessories to the main body of the transformer. For instance a loose rating plate can be a source of noise.
- ▶ Check that the taps are correctly connected to the right position. If not the core can be saturated and create additional noise.
- ▶ Try to perform noise measurements on the transformer to verify the noise level.
- ▶ Analyze the transformer load component. Unexpected DC currents or harmonics can bring the core into saturation.
- ▶ Check that all four wheels or feet of the transformer are stable and well support the transformer on the floor.
- ▶ Transmission of vibrations through the floor can be much reduced by using anti-vibration pads at the wheels.
- ▶ Flexible connections on the LV terminals can also help to reduce the noise level, but this is normally a final fine tuning step.
- ▶ Do not attach grids or guards to the metallic walls of the transformer. Check for sound wall reverberation.

The transformer itself is not always the only source of noise, also the environment or location of the transformer can have an effect.

8

Operation

The information on operation of the transformer is identical for transformers with and without a protective enclosure.



DANGER

Risk of fatal injury caused by high voltage during operation.

- ▶ Operate transformers without protective enclosures in closed rooms only.
- ▶ Never enter the room during operation.

The ambient temperatures and regulations set out in IEC 60076-11 were used as a basis when designing the transformer, unless agreed with the manufacturer otherwise.

8.1

Monitoring the operating temperature

You must monitor the operating temperature of the transformer. This means that the transformer must be fitted with a temperature monitoring device. The temperature monitoring device must shut down the transformer if Trip temperature is reached.

Class	Alarm temperature	Trip temperature
F	140 °C	155 °C
H	160 °C	175 °C

8.2

Normal operation

- ▶ Ensure the transformer's operating temperature is monitored on a permanent basis.

8.3 Short-term overload

The transformer can be operated at above its power rating for a limited period without this leading to the average winding temperature, in accordance with IEC 60076-11, being exceeded. This can be necessary when large quantities of electricity are required for a short period, eg. when starting up motors.

Overload operation is only possible if the transformer was not being run under full load immediately prior to this, i. e. if the maximum permissible temperature has not yet been reached. As soon as it reaches Trip temperature, overload operation must be shut down automatically.

Class	Alarm temperature	Trip temperature
F	140 °C	155 °C
H	160 °C	175 °C

- i** Operating a transformer for longer periods at above the following temperatures reduces its service life:

140 °C for class F insulation

160 °C for class H insulation

The permissible duration of overload operation depends on the ambient temperature and the previous load (consistent loading before and after the peak load). The permissible overload sizes are directly dependent on the increase in temperature during the rated load and the thermal delay times of the windings. These sizes can vary considerably between the different transformer versions and can be different for the high-voltage and low-voltage windings on a single transformer.

For these reasons, we are unable to give you any binding overload sizes here. If you should require overload operation, please contact the manufacturer. Quote the ambient temperature, the required overload cycle and the serial number of the transformer. The manufacturer will then be able to calculate the permissible overload sizes for your transformer and inform you accordingly.

8.4 Converter operation

Transformers, which are retroactively used for rectifier operation cannot be operated at full load. Operation at full load can in this case lead to an inadmissible increase in the temperature because of the harmonics caused by the converter. If you should require a rectifier to be connected, please contact the manufacturer.

8.5 Overvoltages

The insulation values for the transformer are given on the connection diagram and in the test report. You must ensure the high-voltage connections are protected against abrupt increases in voltage. If there is a risk that transient overvoltages are frequently to occur, adequate protection means like eg. surge arresters should be installed.

8.6 Intensive air cooling

For a higher rated load the transformer can be operated with forced air flow (AF) and be fitted with radial-flow fans. Sensors and a relay for the control of the radial-flow fans are installed. The radial-flow fans switch on and off depending on the operating temperature.

Class	Switch-on temperature	Shutdown temperature
F	120 °C	100 °C
H	140 °C	120 °C

- ⓘ The average service life of the fan motors is 30,000 operating hours. This means they cannot be used for continuous overloads for the total service life of the transformer.

To increase the performance of the transformer retroactively, it may be possible to install radial-flow fans as retrofits. Please consult the manufacturer.

9

Breakdowns and troubleshooting

Problem	Possible cause	Action
Loud noises on transformer when switching on.	<p>Transient reactions after switching on.</p> <p>An increased noise level can arise after switching on, especially on transformers with low no-load losses. This noise level reduces after a few hours.</p>	<p>Wait for a few hours to see if there is a reduction in the noise level.</p> <p>If there is no reduction in the noise level, contact the manufacturer.</p>
Smell coming from the transformer after just a short time in operation.	Evaporation of accessory agents used in the production of the transformer.	The annoying smell is harmless and generally stops after a few hours of operation.
<p>The measured temperature is between 100 °C and 120 °C in a no-load state.</p> <p>(Pt100 sensors only)</p>	<p>The temperature sensors are positioned in the first cooling duct.</p> <p>They are influenced by the heated core when in a no-load state.</p> <p>The actual winding temperature is not displayed until the winding temperature exceeds the temperature indicated in the no-load state.</p>	No action required.

Problem	Possible cause	Action
The temperature monitoring device issues a warning.	One or more of the fitted temperature sensors (PTC or Pt100) is faulty.	Replace faulty temperature sensors with faultless ones of the same type.
	The temperature monitoring device is faulty.	Replace the faulty temperature monitoring device with a faultless one of the same type.
	The actuation of optional fans is incorrectly set or faulty.	Set correct temperature values on the temperature monitoring device (see corresponding operating manual). Replace the faulty temperature monitoring device with a faultless one of the same type.
	One or more of the fans fitted as an option is faulty.	Replace the faulty fan with a faultless one of the same type.
	The transformer is loaded 100 % and the ambient temperature is 5 Kelvin higher than the average annual ambient temperature. Permanent further operation of the transformer will lead to a considerable reduction in its service life.	Reduce the load. Lower the ambient temperature, eg. by improving the cooling of the installation location. Install radial-flow fans on the transformer.
	The transformer is operated with rectifiers at a load of less than 100 %, but is not designed for operation with rectifiers.	Contact the manufacturer.
	The transformer load is higher than 100 %.	Contact the manufacturer.
	The transformer is not mounted on wheels or support feet and its inner part has insufficient cooling.	Install wheels or support feet according to chapter „ <i>Installation of the transformer</i> “.

Problem	Possible cause	Action
The temperature monitoring device leads to transformer shutdown.	One or more of the fitted temperature sensors (PTC or Pt100) is faulty.	Replace faulty temperature sensors with faultless ones of the same type.
	The temperature monitoring device is faulty.	Replace the faulty temperature monitoring device with a faultless one of the same type.
	The actuation of optional fans is incorrectly set or faulty.	Set correct temperature values on the temperature monitoring device (see corresponding operating manual). Replace the faulty temperature monitoring device with a faultless one of the same type.
	One or more of the fans fitted as an option is faulty.	Replace the faulty fan with a faultless one of the same type.
	The transformer is loaded 100 % and the maximum permissible ambient temperature has been exceeded. Permanent further operation of the transformer would lead to premature breakdown of the transformer.	Reduce the load. Lower the ambient temperature, eg. by improving the cooling of the installation location. Install radial-flow fans on the transformer.
	The transformer is operated with rectifiers at a load of less than 100 %, but is not designed for operation with rectifiers.	Contact the manufacturer.
	The transformer load is higher than 100 %.	Reduce the load.
	The transformer is not mounted on wheels or support feet and its inner part has insufficient cooling.	Install wheels or support feet according to chapter „ <i>Installation of the transformer</i> “.

Problem	Possible cause	Action
<p>The transformer has been shut down by the safety devices.</p>	<p>Faulty safety device.</p>	<p>Check the safety devices. Replace the faulty safety device with a faultless one of the same type.</p>
	<p>Damage to one or more of the transformer's windings. The damage is not necessarily visible from the outside.</p> <p>Examples: Insufficient voltage distances due to twisted main leads. Short-circuits due to small animals, metal parts or tools forgotten and left behind.</p>	<p>Do not place the transformer back into operation. Contact the manufacturer.</p>
<p>Corona discharges at earthed metal parts of the transformer during switching operations.</p>	<p>At least one loose connection on metal parts of the transformer.</p>	<p>Check that the connections are securely tightened. Tighten the connections with the required torque (see the table on page 45).</p>
	<p>Pre-ignition or re-ignition in the switch during switching operation.</p>	<p>Controlled activation of the transformer. Transformer RC protective circuit and/or use of overvoltage conductors.</p>

Problem	Possible cause	Action
Accumulation of dust on certain areas of the coil surface, eg. in the center of the coil.	The coil surface can be subjected to electrostatic charging and this can lead to an accumulation of dust on certain areas of the coil.	Clean the transformer at regular intervals.
Development of white deposits on certain areas of the coil surface, eg. in the center of the coil.	Under certain unfavorable ambient conditions, corona discharges may occur on the surface of the coil.	Clean the transformer at regular intervals.
Formation of condensation water in the enclosures of air-to-water cooled transformers.	Condensation water can develop at below the dew point on the heat exchanger of the cooler.	This is not a fault. Dry the inside of the enclosure.

If you are unable to eliminate the problem in spite of the information provided in the table, please contact the manufacturer. Give the manufacturer the following details:

- Serial number
- Description of the problem
- Installation location/ambient conditions

10 Taking the transformer out of service

The information on taking the transformer out of service is identical for transformers with and without a protective enclosure.

10.1 Personnel qualification

The personnel assigned to carry out the job of taking the transformer out of service must be trained in the following:

- Disconnection of electrical equipment
- Securing to prevent incidental activation by unauthorized persons
- Verification of disconnection from the power supply
- Earthing and short-circuiting of electrical equipment
- Covering or safeguarding of adjacent live components
- Disconnection of electrical connections
- Taking transformers out of service

10.2 Taking out of service

The transformer must be taken out of service or must not be taken into operation whenever the following conditions apply:

- The transformer is visibly damaged.
- A safety device has disconnected the transformer from the mains.
- The transformer has been stored for some time under unfavorable conditions, eg. exposed to damp in combination with accumulation of dust.
- The transformer was subjected to severe mechanical strain during transportation, eg. severe movements.



DANGER

Risk of fatal injury caused by a transformer that has not been disconnected from the power supply and is not earthed.

- ▶ Disconnect the transformer from the power supply.
 - ▶ Secure the transformer to prevent incidental activation by unauthorized persons (lock-out/tag-out).
 - ▶ Check that the transformer has been disconnected from the power supply.
 - ▶ Earth the transformer.
 - ▶ Short the transformer.
 - ▶ Cover or safeguard adjacent live components.
-

To take the transformer out of service, proceed as follows:

- ▶ Shut down the low-voltage.
- ▶ Shut down the high-voltage.
- ▶ Secure the transformer to prevent incidental activation by unauthorized persons.
- ▶ Allow the transformer to cool down.
- ▶ Earth the transformer terminals by using an insulating rod to ensure that it is disconnected and there is no remaining static charge.
- ▶ Earth and short-circuit the low-voltage and the high-voltage terminals.
- ▶ Disconnect the connections on the low-voltage side from the transformer.
- ▶ Disconnect the connections on the high-voltage side from the transformer.
- ▶ Disconnect the connections on any provided additional components from the transformer.
- ▶ Disconnect the earth terminal from the transformer.

11

Maintenance of the transformer

The transformer is a low-maintenance device. If the transformer is used in plants or on sites with high levels of dust, eg. in steelworks and rolling mills, quarries or building sites, it requires regular cleaning. Otherwise, there is a risk of the insulation surfaces becoming extremely dirty and impeding effective cooling. This can lead to reduced voltage distances resulting in a danger of flashovers.

No longer than one month after the transformer has been placed into operation, the owner/user must carry out an assessment of the existing situation and implement suitable cleaning intervals.

To ensure the transformer offers trouble-free service, you need to check it and any provided additional components at regular intervals. Due to the uniqueness of each installation, the owner/user is responsible for specifying the intervals which may vary, depending on their own situation. In case of environments that are contaminated with dust or industrial fumes, or that are exposed to heavy vibration as in windmills, a quarterly check is recommended.

- ▶ Check the temperature of the transformer on the provided measuring instrument at regular intervals.
- ▶ Check and document the ambient temperature at the installation location at regular intervals.
- ▶ Check any fans if they are provided to make sure they are in proper working order.
- ▶ Check any other additional components if they are provided to make sure they are in proper working order.

11.1

Personnel qualification

The personnel assigned to carry out the job of cleaning and checking must be trained in the following:

- Safety precautions in relation to the work to be carried out
- Cleaning of transformers
- Checking of transformers and any provided additional components
- Documentation of work carried out

11.2

Cleaning



DANGER

Risk of fatal injury caused by a transformer that has not been disconnected from the power supply and is not earthed.

- ▶ Disconnect the transformer from the power supply.
 - ▶ Secure the transformer to prevent incidental activation by unauthorized persons (lock-out/tag-out).
 - ▶ Check that the transformer has been disconnected from the power supply.
 - ▶ Earth the transformer.
 - ▶ Short the transformer.
 - ▶ Cover or safeguard adjacent live components.
-

To prepare for cleaning, proceed as follows:

- ▶ De-energize the transformer.
- ▶ Cordon off the work area.
- ▶ Put up signs to provide warning of the work to be carried out.
- ▶ Earth the transformer terminals by using an insulating rod to ensure that it is disconnected and there is no remaining static charge.
- ▶ Permanently earth and short-circuit the low-voltage and the high-voltage terminals.

11.2.1

Cleaning the transformer

- ▶ Remove accumulations of dust with a vacuum cleaner.
- ▶ Clean hard to reach areas, such as the cooling ducts, using dry, oil-free compressed air (max. 3 bar).
- ▶ Remove the dirt dislodged using the vacuum cleaner again.
- ▶ Clean all electrically active surfaces, eg. coil surface and the surfaces of insulators, with a clean, dry cloth.
- ▶ Remove coarse dirt with a cloth and methylated spirit.
- ▶ Any dirt that cannot be removed by the above means can be removed with the help of electric high-performance cleaners such as the Rivolta S.L.X. Top or with a dry ice cleaner.
- ▶ Check that the transformer is completely dry before switching it on again.

11.2.2 Cleaning the protective enclosure and fans

If the transformer is provided with a protective enclosure or with fans, proceed as follows:

- ▶ Clean the fans with a vacuum cleaner.
- ▶ Check the fans to make sure they are in proper working order.
- ▶ Clean the protective enclosure in the same way as you would clean a control cabinet, eg. with dry ice.
- ▶ Clean the air inlet and outlet openings with a vacuum cleaner.
- ▶ Check any air filters for dirt, if provided.
- ▶ Replace dirty air filters with clean ones.

11.3 Checking the transformer



DANGER

Risk of fatal injury caused by a transformer that has not been disconnected from the power supply and is not earthed.

- ▶ Disconnect the transformer from the power supply.
 - ▶ Secure the transformer to prevent incidental activation by unauthorized persons (lock-out/tag-out).
 - ▶ Check that the transformer has been disconnected from the power supply.
 - ▶ Earth the transformer.
 - ▶ Short the transformer.
 - ▶ Cover or safeguard adjacent live components.
-

Before starting to check the transformer, proceed as follows:

- ▶ De-energize the transformer.
- ▶ Cordon off the work area.
- ▶ Put up signs to provide warning of the work to be carried out.

11.3.1 Visual examination

- ▶ Check the following components for visible damage:
 - The coils
 - All cables and lines
 - The temperature monitoring device
 - Any additional components if provided

If you should discover any visible damage, proceed as follows:

- ▶ Document the damage.
- ▶ Report the damage to the person responsible.

11.3.2 Mechanical check

Risk of high temperatures caused by inadequately secured connections.

- ▶ Tighten all screw connections with a torque wrench to the specified torque settings (see the table on page 45).
- ▶ Check the existing voltage distances.

11.3.3 Electrical check

- ▶ Check the insulating resistances and the temperature monitoring device to make sure they are in proper working order.

ATTENTION!

Risk of damage to the transformer caused by incorrect insulating resistance.

- ▶ Check that the insulating resistance is at least 1000 Ohm per volt of operating voltage in each case.

To check the insulating resistance, proceed as follows:

- ▶ Use an insulation tester to check the electrically isolated windings against each other.
- ▶ Use an insulation tester to check each of the electrically isolated windings against earth.

The insulating resistance must be at least 1000 Ohm per volt of operating voltage in each case.

To check the temperature monitoring device with Pt100 sensors, proceed as follows:

- ▶ Check that all of the connections are securely tightened.
- ▶ Tighten any loose connections (see the table on page 45).
- ▶ Measure the resistance at the ambient temperature and compare it with those given in IEC 60751.
- ▶ Replace faulty components with faultless ones if any non-conformities are found.

To check the temperature monitoring device with PTC thermistor sensors, proceed as follows:

- ▶ Check that all of the connections are securely tightened.
- ▶ Tighten any loose connections (see the table on page 45).
- ▶ Interrupt the sensor circuit.

The temperature monitoring device must indicate a malfunction.

- ▶ If a malfunction is not indicated, check whether the components and the connection of the temperature monitoring device are in proper working order.
 - ▶ Replace faulty components with faultless ones.
 - ▶ Connect all the sensors again in accordance with regulations.
- ① If a different temperature monitoring device (eg. a dial thermometer) is used, the instruction manual of this device is applicable.
- ▶ Document the work that has been carried out by recording it in writing in the provided documents.

12 Disposal of the transformer

If a transformer needs to be disposed of because it is no longer required or is faulty, please contact the manufacturer. The manufacturer can advise you of the components that must be separated out in accordance with environmental regulations and those materials that can be recycled.

The transformer is made mainly of the following materials:

Component	Material
Cast resin high-voltage winding	Aluminium and/or copper, cast resin with mineral filler or glass fiber
Cast resin low-voltage winding	Aluminium and/or copper
Core sheet	Steel
Press beam, wheel support, screws, nuts	Steel

13 Accessories

The transformers can be ordered with a range of different accessories. Please refer to the corresponding operating manuals for information about accessories.

If you wish to fit any accessories to your transformer retroactively, please contact the manufacturer.

Examples of available accessories:

- Devices for temperature monitoring
- PTC or Pt100 temperature sensors
- Dial thermometers
- Radial-flow fans
- Roof fans
- Feet
- Rails
- Manual earthing switches
- Motor-operated earthing switches
- Enclosures for different types of protection
- Air-to-air or air-to-water cooling systems
- Surge Arresters
- Cable plug-in bushings
- On-load tap changer
- Current or voltage transformers

14 Technical data

- ① Please refer to the rating plate and/or the documents included in delivery for the technical data for the transformer.

For more information, please contact:

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