

Typical arrangement; may differ from the actual transformer concerned.

OPERATING MANUAL

SGB Cast Resin Transformers

01.10.2019 EN (USA Rev. E)

IMPORTANT

READ CAREFULLY BEFORE USE

KEEP THE MANUAL FOR FUTURE REFERENCE



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Information about this operating manual

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1 INFORMATION ABOUT THIS OPERATING MANUAL

1.1 Important information about this manual



Make sure that you read this operating manual carefully and understand it before you perform work on the transformer. SGB cannot be held liable for damage caused by non-compliance with the information provided in this manual.

This manual

- is an integral part of the documentation of a cast resin transformer.
- is intended for the plant designer, plant operating company, person in charge of the plant and for the qualified Personnel deployed for the task in question.
- contains important information regarding the safe and trouble-free operation of the transformer.
- only refers to the transformer and does not contain any information about particularities and dangers on site.

Comply with all specifications of this operating manual, the enclosed documentation of external manufacturers and the local standards and regulations! This is a prerequisite for

- correct and appropriate operation of the transformer.
- proper storage, transport, installation, commissioning and decommissioning, maintenance and inspection of the transformer.
- avoidance of dangers and compliance with the required technical safety provisions.

1.2 Availability of this manual

Keep this manual so that it is available for reference.

This Operating Manual is part of the unit and must be passed on to the subsequent owner if the unit is sold.

1.3 Conventions regarding instructions and other highlighted text

In addition to the warnings and safety provisions described in *section 2*, which you have to comply with at all times, this manual contains other highlighted text:

- 1,2,3 ... or a, b, c,... Instructions involving a chronological sequence are identified by figures or letters. Comply with the specified sequence of operations.
- Enumerations which do not involve a chronological sequence are identified by indents. Such operations can be performed in any order.

Keywords or supplementary information

Keywords or supplementary information appear in italics in special areas.

RECOMMENDATION

Contains recommendations on how to improve the product or the workflow.

2 SAFETY

2.1 Intended use

The transformer must be used exclusively for transforming alternating voltage.

It must be operated according to the underlying standards and regulations in the scope of the electrical data specified in the data sheet and within a closed electrical operating area.

The term "closed electrical operating area" designates a "room or a site which is used exclusively for the operation of electrical equipment and is kept securely closed". Access is to be limited to authorized electricians and trained personnel, Persons without proper training should only be admitted when they are accompanied by authorized personnel.

The intended use includes:

- compliance with the operating manual.
- operation within the specified performance limits.
- compliance with the specified inspection and maintenance work.
- compliance with the supplier documentation or the separate documentation of the external suppliers of attachments and accessories.

Any other use is considered to be inappropriate and may result in personal and material damage.

2.2 Incorrect use

Inappropriate use (meaning use OTHER than intended) includes but not limited to:

- Unauthorized design changes to the transformer
- Assembly of monitoring and protective equipment other than recommended or supplied with the unit
- Deactivating or bypassing safety equipment, and operation of the unit with faulty safety equipment
- Operation and maintenance of the transformer by non-qualified staff
- Inappropriate assembly, operation, maintenance or commissioning of the transformer
- Non-compliance with the instructions in the operating manual and the supplier documentation or the separate documentation of the external suppliers of attachments and accessories.

2.3 Modifications to the transformer

Any modifications to the transformer or to any other parts of the shipment that has not been previously agreed upon in writing by SGB will immediately void or restrict the warranty and liability.

2.4 Warranty and liability

The warranty period and the liability are specified in the contract. Deviations from the intended use described in this operating manual shall restrict or void the warranty and liability.

2.5 Disclaimer

The contents of this manual have been checked for matching the product described. Deviations nevertheless cannot be ruled out. Thus, SGB cannot guarantee full agreement with the product in question. This manual is subject to revision on a regular basis; thus, any necessary corrections will be reflected in subsequent versions.

2.6 Requirements regarding staff

The transformer may only be handled by personnel (=specialists) qualified for the task in question.

The term "specialists" or "qualified personnel" within the meaning of this manual shall refer to persons who due to their education, knowledge, experience and instructions from the person in control of work activity are able to recognize and avoid the hazards, which might emanate from their area of work.



Notice

Any person who is entrusted with working on the unit has the responsibility to read this manual thoroughly and understand it, particularly the "Safety" chapter.

The authorized personnel must:

- Utilize and be trained in the proper usage of required Personal Protection Equipment (PPE).
- be aware of the local safety-specific mounting / erection provisions and comply with these at all times.
- have been authorized and instructed by the appropriate person in charge to perform the work on the transformer.
- Ensure unauthorized persons are not present in the danger zone.

2.7 Warning and safety provision system

The warnings and safety provisions in this manual are to ensure your own safety, the safety of other persons and the prevention of damage to the transformer or the plant.

The information given always reflects the highest hazard level. This means that an instruction regarding personal injury may also include an instruction regarding material damage.

The warning information below is shown with a descending degree of hazard:

⚠ DANGER
<p>Risk of fatal injuries!</p> <p>This symbol in conjunction with the signal word "DANGER" indicates a life-threatening situation that results directly in the death of or severe injury to the person.</p>

⚠ WARNING
<p>Risk of severe injuries!</p> <p>This symbol in conjunction with the signal word „WARNING“ indicates a dangerous situation that results in the death of or severe injury to the person.</p>

⚠ CAUTION
<p>Risk of minor to medium injuries!</p> <p>This symbol in conjunction with the signal word "CAUTION" indicates a potentially dangerous situation that may result in minor or medium injury to the person.</p>

ATTENTION
<p>Risk of damage to property!</p> <p>Describes a situation that could lead to property and/or environmental damage.</p>



Notice

Describes malfunctions, application information, and provides useful information.

2.8 Personal protection measures

Use exclusively protective equipment which has been certified for the specific tasks by nationally recognized independent agencies.

Always wear safety shoes for the entire duration of the work!

Use additional protective equipment as required, according to local regulations and common sense.



2.9 Safety information for risk avoidance associated with the transformer's life cycle phases

2.9.1 General rules for each phase of the transformer's life cycle

All work shall be performed by authorized qualified Personnel only.
Installation is only admissible within electrical operating areas.

- Applies in general for working at heights

- Do not rest ladders against the transformer.
- Only use suitable stepladders which are free from damage.
- Place stepladder only on solid, level ground and ensure a stable position.
- Secure stepladder against slipping or tipping over.
- When performing work, stand on the ladder with both feet on the rung.
- Comply with OSHA fall protection requirements when working above ground level.

2.9.2 Transport and installation

- Transport with a crane:

- Make sure that the transformer is moved only in an upright (vertical) position with the carriage aligned horizontally.
- Never work or move under suspended loads and never move suspended loads over persons.
- When using lifting equipment use:
 - all four lifting lugs provided to lift the unit.
 - all four lifting lugs simultaneously.
 - load lifting equipment designed for the transformer's weight.

- load lifting equipment and transport securing devices which have been certified for such tasks by nationally recognized independent agencies.
 - Never lift the transformer via the tie-down rings.
- **When mounting the castors or machine bases:**
- While mounting the castors, protect the transformer from tipping over. Support transformer on supports or squared timbers that are slightly taller than the castors or machine bases and capable of bearing the transformer's weight.
 - Mount the castors so that all 4 of them are either aligned either longitudinally or transversely.
 - Secure the castors in the selected orientation.
- **When moving the transformer using its castors:**
- Do not move the transformer along curved routes but only straight in the direction of the castors.
 - When pulling, always use both pulling eyelets located in the direction you want to pull the transformer.
 - Never use electrical components (windings, terminals, etc...) to pull on when moving the transformer.
- **Transport with a forklift truck:**
- Transport by forklift truck is only permitted for transformers with "forklift lifting" design.
 - Lift only with correctly positioned tilt safeguards.
 - Only use forklift trucks that can carry the weight of the transformer.
 - Ensure that the center of gravity of the load is centered between the forks.
 - Always place the load on the forks to the stop and tilt the forks backward.
 - Always secure unstable loads that tend to tilt.
 - If necessary, use a slip-on shoe on the forks to hold and protect the load securely.
 - Never transport multiple loads.
 - Ensure that no one is in the danger zone.
 - Always drive with the load lowered.
 - Always drive with a load facing uphill. This applies to uphill and downhill.
- **During installation:**
- When positioning the transformer and routing the cables, comply with the specified minimum air clearances between
 - the live conductors and the windings, and the earthed parts!

- the conductors and the windings, and other live parts of the transformer!
- Comply with these clearances when installation is within an enclosure.
- Secure the transformer on site to prevent it from rolling, using locking devices, machine bases or special transformer mountings (structurally supported anti-vibration mountings).
- Leave a minimum distance of 30 cm between the wall and the air vents of the enclosure.

2.9.3 Commissioning

- Before and during commissioning work, the following applies as a general rule:

For the entire duration of commissioning work, apply the following five safety rules, hereinafter called "Safety measures" in the specified order! These rules are as follows:

1. Isolate main and auxiliary power circuits from the supply voltage.
2. Prevent switching-ON again (Lock out, tag out).
3. Verify that there is no voltage present.
4. Ground and short-circuit transformer.
5. Cover or cordon-off adjacent live parts.

- When completing commissioning work, comply with the following as a general rule:

- Reverse the "Safety measures" and leave the room or enclosure in a safe condition complying with local requirements.
- Before closing the room or enclosure, verify that no persons or animals are in it.
- Make sure that no debris and foreign matter (e. g. screws and bolts, tools, metal chips etc.) are left on any transformer surfaces.
- Make sure that all debris and foreign matter (e. g. screws, tools, metal chips etc.) are eliminated from inside the enclosure and other plant components.
- Do not apply voltage to damaged transformers!
- Apply voltage only if you are authorized and have been commissioned to do so!
- Do not switch transformer off and then switch on without allowing at least one minute of time to pass.

- Changing voltage taps:

- Before changing voltages, make sure that the surfaces of the transformer have cooled down to a temperature lower than 40°C (104°F).
- When tightening or releasing the threaded connections on the connection links, compensate the torque with an open-end wrench size 20 or 21.

- Phase connection:

- In case of copper-aluminum connections, insert a copper-clad aluminum sheet in the contact area.
- Before screw-fastening the contact surfaces, polish them to make them bright.
- Make sure that no metal dust is left on any transformer surface after polishing.
- When connecting the components in question, make sure that the transformer terminals are not subject to mechanical stress.
- When tightening or releasing the threaded connections on the connection links, compensate the torque with an open-end wrench size 20 or 21.
- When routing the cables, comply with the specified minimum clearances between
 - the live conductors and the windings, and the earthed parts!
 - the conductors and the windings and other live parts of the transformer!

- Temperature monitoring:

- Do not replace thermistors with such that have temperature settings higher than specified by the factory.
- If a programmable temperature monitor is used: Do not set the nominal functioning temperatures of the devices higher than specified by the factory.
- Attach suitable surge protection devices as close as possible to the terminal strip of the transformer, in order to protect the electronics.

2.9.4 Operation

- General instructions regarding operation:

- Operate the cast resin transformers exclusively in closed electrical operating areas.
- If voltage is applied to a transformer without enclosure or if the enclosure is considered as not closed "safe to touch", **never approach the windings or other conductive transformer components closer than 1.5 m or 5 feet!**
- Persons with pacemakers and/or other medical implants or aids must never approach more closely than is permitted by the limits specified for their devices or implants regarding electromagnetic interferences! **The following examples for field intensities only refer to the transformer and do not take the remaining part of the plant into account. At a distance of 2 m (6.5 feet) from a transformer of 50 Hz / 630 kVA/ 20 kV-0.4 kV, 5 μ T can be measured. At a distance of 5 m from a transformer of 50 Hz/ 3000 kVA / 20 kV-0.69 kV, there is a field intensity of 10 μ T.**

- Consider the applicable regulations for exposure to electric, magnetic and electromagnetic fields regarding working near a transformer.

- **Temperature monitoring:**

- Only operate the transformer with the temperature monitoring device connected and functioning.

2.9.5 Maintenance

- **Before and during maintenance work, the following applies as a general rule:**

- For the entire duration of maintenance work, apply the following five safety measures in the specified order!

These rules are as follows:

1. Isolate main and auxiliary power circuits from the supply voltage.
2. Prevent switching-ON again (Lock Out, tag out).
3. Verify that there is no voltage present.
4. Ground and short-circuit transformer.
5. Cover or cordon-off adjacent live parts.

- Before commencing maintenance work, make sure that the surfaces of the transformer have cooled down to a temperature lower than 40°C (104°F).

- **When completing maintenance work, comply with the following as a general rule:**

- Cancel the condition established by applying the safety measures according to the applicable local requirements, or, if there are no such requirements, restore the previous condition by canceling the five previously performed safety measures in the inverse order.
- Before closing the plant / enclosure, verify that no persons / animals are in it.
- Make sure that no impurities and foreign matter (e. g. screws and bolts, tools, metal chips etc.) are left on any transformer surfaces.
- Make sure that all impurities and foreign matter (e. g. screws, tools, metal chips etc.) are eliminated from inside the enclosure and other plant components.
- Do not apply voltage to damaged transformers!
- Apply voltage only if you are authorized and have been commissioned to do so!
- Switch-on/switch-off operations in direct succession are not permitted. There must be a time window of at least one minute between switching operations.

- **Cleaning the transformer:**

- When cleaning the transformer,

- do not use water
 - do not use metal brushes or wire wool
 - Make sure that no impurities and foreign matter (e. g. screws and bolts, tools, metal chips etc.) are left on any transformer surfaces.
 - Make sure that all impurities and foreign matter (e. g. screws, tools, metal chips etc.) are eliminated from inside the enclosure and other plant components.
- To check the temperature sensors:
- Use ohmmeters with a service voltage of ≤ 2.5 Volt!
 - Attach suitable surge protection devices as close as possible to the terminal strip of the transformer, in order to protect the electronics.
- If electrical terminals have been disconnected during maintenance:
- In case of copper-aluminum connections, insert a copper-clad aluminum sheet in the contact area.
 - Before screw-fastening the contact surfaces, polish them to make them bright.
 - Make sure that no metal dust is left on any transformer surface after polishing.
 - When connecting the components in question, make sure that the transformer terminals are not subject to mechanical stress.
 - When tightening or releasing the threaded connections on the reconnection links, compensate the torque by holding them up by means of an open-end wrench size 20 or 21.
 - When routing the cables, comply with the specified minimum clearance between
 - the live conductors and the windings, and the earthed parts!
 - the conductors and the windings and other live parts of the transformer!
- Maintenance of the fans:
- Wear protective gloves when working on rotor blades.
 - Make sure that the fan is disconnected from the electrical circuit and protected against being switched on again.
 - Do not switch on the fan before it has been installed correctly into the enclosure and tested.
- Maintenance of the enclosure:
- When finishing work, make sure that
 - all impurities and foreign matter (e. g. screws, tools, metal chips etc.) are eliminated from inside the enclosure and other plant components.

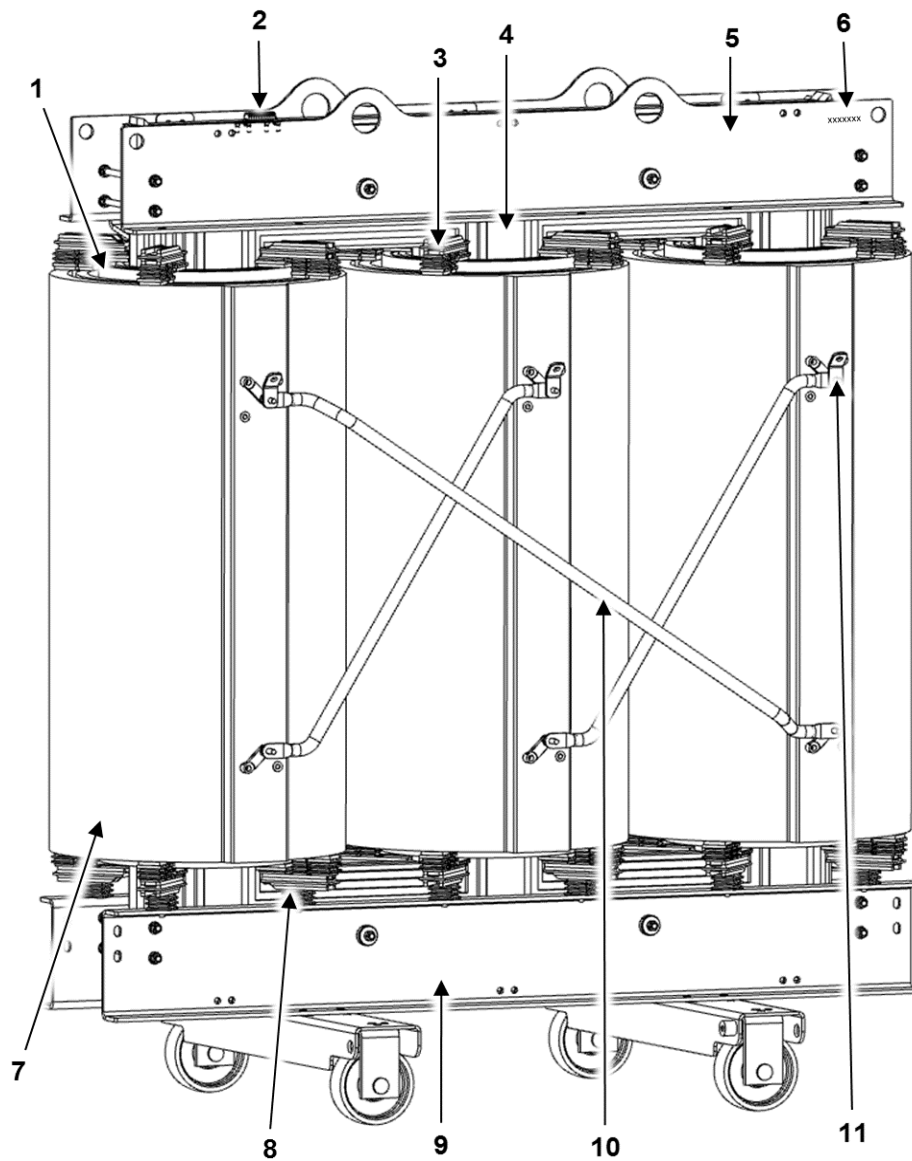
- the equipotential bonding lines which have been removed for access are re-connected!
- the transformer, fan and enclosure are dry.
- air inlets outside of the enclosure are not blocked.
- all warning labels are present and free from damage.

2.9.6 Decommissioning

- In general:

- For the entire duration of work, apply the following five safety measures in the specified order!
These rules are as follows:
 1. Isolate main and auxiliary power circuits from the supply voltage.
 2. Prevent switching-ON again (Lock out / tag out).
 3. Verify that there is no zero voltage present.
 4. Ground and short-circuit transformer.
 5. Cover or cordon off adjacent live components.
- Before commencing work, make sure that the surfaces of the transformer have cooled down to a temperature lower than 40°C (104°F).
- Observe the safety information provided in "Transport and installation".

3 DESCRIPTION OF THE TRANSFORMER

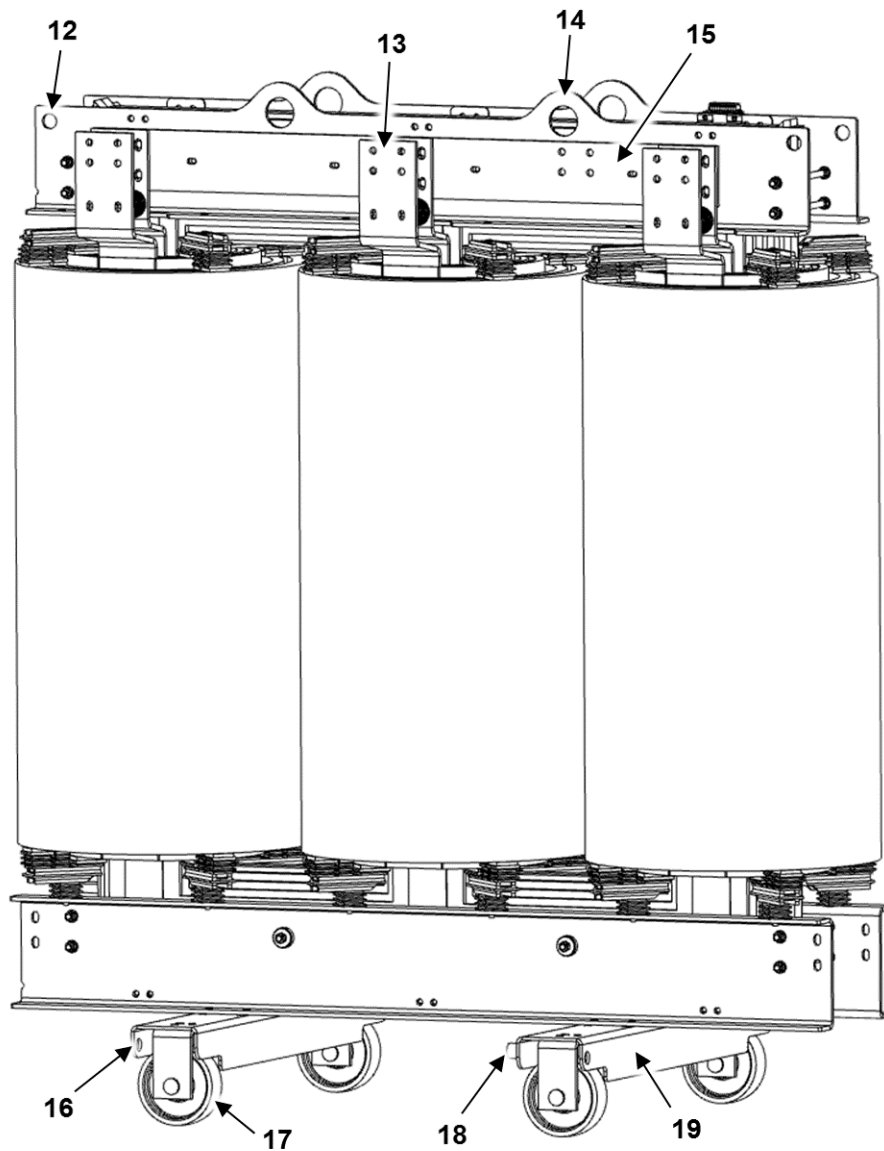


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Fig. 1: High-voltage side (HV) of a standard cast resin transformer (example)

1	Low-voltage winding	6	Transformer serial number
2	Terminal strip for connection of temperature monitoring device	7	High-voltage winding
3	Upper supporting blocks	8	Lower supporting blocks
4	Core	9	Lower steel clamps
5	Upper steel clamp	10	Connection links
		11	High-voltage terminal

Description of the transformer



000005

Fig. 2: Low-voltage side (LV) of a standard cast resin transformer (example)

- | | |
|---------------------------------|---|
| 12 Tie-down rings for transport | 16 Towing eyelets for longitudinal and transverse movements |
| 13 Low-voltage terminal | 17 Castors, can be installed for moving in either longitudinal or transverse directions |
| 14 Lifting lugs | 18 Earth terminals |
| 15 Neutral bar (N terminal) | 19 Carriage |

Transformers are used to transform AC voltages.

Cast resin transformers are classified as dry-type transformers per IEEE Standard C57.12.01. Air is used as coolant.

Description of the transformer

Transformer standards

In general, technical characteristics and the design are based on IEEE C57.12.01 and order-specifically according to the customer's specifications.

Transformer design - concise description

The transformer core consists of grain-oriented cold-rolled soft magnetic steel sheets which are insulated from each other. The individual laminations are shaped so as to ensure that their optimized geometrical arrangement (so-called step-lap) results in reduction of the no-load losses and the transformer noise.

The low-voltage windings are mostly designed as strip windings. Utilization of this winding type for the low-voltage windings enhances short-circuit strength.

A special characteristic of the cast resin transformers are the high-voltage windings which are completely encapsulated in cast resin under vacuum. This ensures, compared to conventional dry-type transformers, a high partial discharge, short-circuit and dielectric strength and a lower sensitivity to environmental stress, such as that caused by humidity and dust.

Further technical details are either visible, as cast resin transformers do not feature a tank, or specified in the following documents.

These documents are located on the transformer.

Nameplate, circuit plate, label showing terminal arrangement for connection of the temperature monitoring device, table of torque values for HV and LV terminals, jacking sketch with indication of specified angles, 1x label "Do not touch" with supplementary information indicating the minimum clearances from the HV windings, 1x SGB logo, 1x label "Warning, electric voltage", 2x label prohibiting transport by means of industrial trucks

These documents can be requested again stating the transformer serial number.

Dimension drawing with parts list, measuring and test records, manufacturer documents regarding the accessories provided by SGB.

Description of the transformer

4 PLANNING DETAILS

Unless otherwise specified in the contract, SGB cast resin transformers comply with the following requirements of IEEE Standard C57.12.01 and C57.12.91 and the following documents:

- Climate class: IEEE Standard C57.12.55
- Environmental class: National Electric Code or NFPA 70
- Fire classification: National Electric Code or NFPA 70
- Short-circuit strength per IEEE Standard C57.12.01

4.1 Conditions on site

Unless otherwise stipulated in the contract, the transformers are required to satisfy the following conditions on site:

- The cooling air does not exceed the following temperatures:
 - + 40°C (104°F) at any given time;
 - + 30°C (86°F) monthly average of the hottest month of the year;
 - + 20°C (68°F) annual average;
- and does not fall below the following temperatures:
 - 25°C (-13 F) for an outdoor installation within a protective enclosure
 - 5°C (23°F) for an indoor installation.
- The installation altitude is less than 1,000 m (3300ft.) above sea level.
- The installation is in a closed electrical operating area.
- The installation site shall comply with the national and local building code and fire regulations for transformer rooms.
- The installation surface must be level, clean and designed to bear the transformer weight.

The transformer's center of gravity may be assumed to be in the horizontal plane in the center of the middle core column. In case of installation on castors, each castor bears one-fourth of the transformer's weight.

Asymmetric supplementary attachments such as unilateral supports or earthing switches or fans mounted on one side only may shift the center of gravity relative to the longitudinal axis and must be taken into consideration.

4.2 Normative references for requirements regarding the site of installation

Requirements for the installation sites of transformers are provided in the following standards.

- IEEE C57.94 – IEEE Recommended Practices for Installation, Application, Operation, and Maintenance of Dry-type distribution and power transformers
- NFPA 70 – National Electric Code (NEC) (specifically addresses requirements for Dry-type transformers operating in hazardous locations)

4.3 Important information to be complied with regarding transformer!

Please take the following into account:

- The SGB cast resin transformers are exclusively intended for operation in closed electrical operating areas.
- When installing the transformer in a transformer cell, comply with the mandatory structural condition of the room.
- Always comply with the minimum clearances between the earthed parts
 - And the live conductors and the windings!
 - The conductors and the windings and other live parts of the transformer!

These clearances are indicated in the "circle of electrical clearance" on the dimensional diagram of the transformer or, in *section 8.1* of this manual.

Whenever planning any work in the vicinity of the transformers, please note that the "circle of electrical clearance" does not specify the limits of the danger zone, but defines only the distance required for operation free of disturbances.

- Despite the cast resin insulation, the **windings** of the cast resin transformers are **not safe to touch**. This is a functional insulation. **The insulation does not offer protection against dangerous shock in case of contact or against flashover in case of approach.** Take protective measures to prevent persons from entering the danger zone of the windings! When planning and implementing the protective measures, treat **the windings as non-protected active parts!**
- The SGB dry-type transformers must **not be installed in potentially explosive atmospheres (EX)** without supplementary precautions! Refer to NFPA 70, National Electric Code for specific requirements when operating a dry-type transformer in a hazardous location.
- Take precautions to prevent the **transformer room from being flooded**.
- SGB cast-resin transformers feature the degree of protection **IP00** and **are designed for use in indoor installation**.

In case of **outdoor installations**, use an enclosure which prevents windblown water from entering enclosure (**IP23C**).

RECOMMENDATION

In environmental conditions where high humidity is present and which might condense on the windings, it is recommended equipping the enclosure with **anti-condensation heating, especially in cases of outdoor installation**.

- If the transformer is operated in an enclosure in the vicinity of a wall and if the wall-facing enclosure side contains air vents:
Provide a distance of at least **30 cm (12 in.) between the enclosure side and the wall**.

RECOMMENDATION

To improve ventilation and accessibility, we recommend increasing the distance to 40 cm (16 in.).

4.4 Electromagnetic behaviour / compatibility

When designing electrical operating areas adjacent to areas accessible to the general public, it must be taken into consideration that persons with implants or pacemakers are subject to increased risk when approaching such areas. The intensity of the magnetic field in the vicinity of a transformer depends on its power, voltages, short-circuit voltage and distance. At a distance of 5 m, (16.5') a transformer rated 3 MVA, impedance=6 % HV=20kV, LV=690V will reach a magnetic field intensity of 10 µT at a power frequency of 50 Hz. These values apply exclusively to the transformer, not to influences by other components in the vicinity.

4.5 Ventilation of the transformer rooms



ATTENTION

Crack formation on winding surfaces!

Cooling air that is blown directly onto windings can cause cracks in the resin coating of the windings, due to the extreme temperature differential.

- Do not blow cooling air directly onto hot windings.

Equip the installation room with **properly designed ventilation**. When operating the transformer, losses occur in the form of heat, which must be dissipated. Total transformer losses are comprised of no-load losses and load losses at operating temperature. Operating temperature is the sum of the ambient temperature and the transformer temperature rise. Always provide the cooling air inlet opening at the bottom with a maximum height up to the lower edge of the HV winding. This promotes the chimney effect and circulation of the air flow in the duct between the HV and LV windings. The configuration of the cooling in a naturally ventilated room is described in IEEE Standard C57.94.

For **force-ventilated rooms**, the required air volume must be assumed as 3.2 cubic meters (113 Cubic feet) per kilowatt losses per minute.

Consider the increased power dissipation during AF mode (forced cooling with air)! The losses increase approximately by the square of the load current or kVA rating. For example, in AF mode at 140% load, load losses increase by a factor of 1.96 and must be dissipated accordingly:
 $(140\% / 100)^2 = 1.96$

4.6 Temperature monitoring

The temperature influences the transformer's service life directly. To prevent premature aging of the insulation and dangerous excess temperatures, the transformer temperature must be monitored continuously during operation.

The SGB standard provides devices for monitoring 2 nominal functioning temperatures (hereinafter called "NAT").

NAT for alarm is the temperature at which the temperature rise at rated continuous load is reached. Any further increase of the load should be avoided, as it reduces the transformer's service life.

If NAT for tripping is reached, the temperature limit of the insulation system is exceeded. There is a risk of permanently damaging the transformer. This operating condition is not permitted for continuous operation and should be used only in emergencies. In all the other cases, we recommend shutting off the transformer once this situation has occurred.

The thermistors or PT100 resistors are positioned in the low-voltage windings, the color of the leads identifying the NAT of the thermistors.

The terminal strip connecting the thermistor leads to the tripping unit is located, as a rule, on the upper steel clamp. A label showing the terminal arrangement is provided in the direct vicinity. For example:

Fig. 3: Example for terminal arrangement in case of a standard temperature monitoring device.



Temperatures for alarm (terminals 1 and 4) and tripping (terminals 5 and 8) may be monitored.

If the tripping devices have been ordered together with the transformer, they are normally supplied uninstalled and are intended for installation in the switch cabinet.

5 PACKAGING



Please contact us should you need advice regarding the selection of the packaging mode.

ATTENTION

Corrosion through condensation!

During longer storage in foil covers, condensation may occur. This causes zinc corrosion (white rust).

- Remove foil covers immediately after receiving the transformer.
- For longer storage periods pack the transformer into a wooden crate. Provide air circulation within the packaging or use silica gel in order to prevent condensation.
- Commission the transformer as quickly as possible, at least in no-load operation.

Cast resin transformers are not sensitive to natural air humidity.

Short transport on vehicles with tarpaulin normally does not require packaging.

For extended transport, foil covers, wooden crates or containers should be used.

This is stipulated in detail in the sales agreement between the customer and the manufacturer.

If foil packaging is required, proceed as follows:

- Arrange the foil cover so that the foil cannot slip during transport or storage!
- Cut the foil in the area of the lifting points and fasten it by means of adhesive tape in order to avoid having to provide additional cuts in the subsequent handling process.
- Remove foil covers immediately after receiving the transformer.
- For longer storage periods pack the transformer into a wooden crate.
- For longer storage in foil covers provide air circulation within the packaging or use silica gel in order to prevent condensation. Without these measures longer storage in foil covers is forbidden.

6 TRANSPORT

This section informs about loading and unloading, transport of the transformer using a truck and checks upon receipt of the goods.

6.1 Fastening the suspension gear and transport by means of a crane



⚠WARNING

Risk due to suspended load!

The load is very heavy.

Non-compliance can result in death or serious injury!

- Never step under the suspended load!
- Never move the suspended load above people!



⚠WARNING

Risk of lifting equipment breaking!

Non-compliance can result in death or serious injury!

Unsuitable lifting equipment may break.

Use 4-line lifting gear with lines of equal length which

- has been designed for the weight of the load to be lifted.
- are not damaged.
- have been properly inspected and certified suitable for use.

Lifting gear must be attached to all four lifting lugs prior to lifting the transformer.

Comply with the maximum allowed spreading angle of the lifting gear.



⚠ WARNING

Risk of the tie-down rings getting torn out!

Non-compliance can result in death or serious injury!

Tie-down rings are not provided for lifting the transformer and may tear.

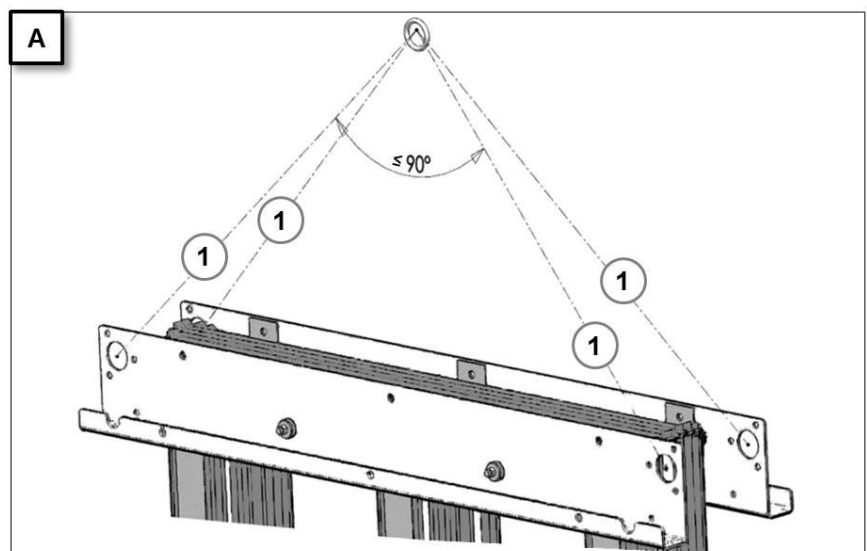
- Pay attention to the differing lifting lugs in case of various steel clamp designs.

Fasten the lifting gear to all four lifting lugs so that the **spreading angle of the lifting gear is maximum 90°!**

Version A

1 Lifting lugs or tie-down rings

✓ Lifting allowed



Version B

1 Lifting lugs

✓ Lifting allowed

2 Tie-down rings



Lifting prohibited

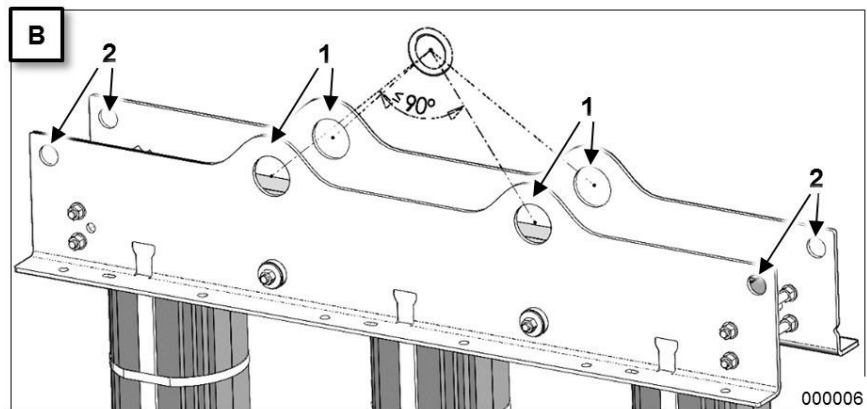


Fig. 4: Different versions of lifting lugs

In version A, the lifting lugs also serve as tie-down rings.

Version B has lugs that serve exclusively as tie-down rings (2). Lifting here is strictly forbidden!

Lift and move the load to its destination. Avoid jerky lifting and depositing!



⚠WARNING

Risk of falling! Risk of stumbling!

Non-compliance may result in death or serious injury!

The enclosure top

- features hidden raised parts.
- may be slippery, e.g. due to moisture of contamination.

Use OSHA approved fall protection.

Check the stability where you step before putting weight on it.

If the transformer is delivered with an enclosure that is mounted on the chassis of the transformer, the lifting points on the enclosure roof must only be used to lift the roof.

To lift the active part together with the enclosure, use the lifting lugs on the transformer!

Walking on the roof of the enclosure is restricted with regard to mechanical strength. Only one person at a time, with a maximum weight of 90 kg, (200lbs), may walk on the roof to attach the lifting gear, or to perform installation tasks on the transformer that has been de-energized and grounded.

RECOMMENDATION

If the transformer should need to be rolled (e.g. for insertion into the transformer cell), this is a good time to attach rollers, while it is still suspended from the crane. See *section 6.2.1*.

6.2 Transport on castors

6.2.1 Mounting the castors to the undercarriage



⚠WARNING

Severe injuries! Risk of tipping over the transformer.

The transformer is extremely heavy. Non-compliance may result in death or serious injury!

While mounting the castors, protect the transformer from tipping over! Support transformer on mechanical beams or squared timbers that are slightly taller than the castors and capable of bearing the weight of the transformer.

The four castors have been designed for mounting in either the longitudinal or the transverse sense. Mounting in any other direction (e. g. diagonally) is prohibited and may result in an unsafe condition!

- 1 Index pin
- 2 Index bore-hole for rolling in longitudinal direction
- 3 Index bore-hole for rolling in transverse direction
- 4 Towing eyelet

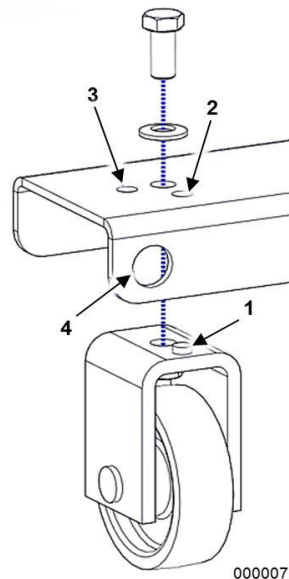


Fig. 5: Fastening the castors to the carriage

Implementation:

1. Lift the transformer so that the castors can be mounted below the carriage.
2. Protect the transformer against tipping over.
3. Mount the four castors as shown in the previous illustration, aligning them all in the same moving direction.
4. Position the index pin (1) in the required index bore-hole (2, 3).

5. Lock the connection by tightening the M16 hex. bolt! The tightening torque without lubricant is 135 Nm (100ft-lbs). Please note that in case of larger castors, another M16 bolt is used instead of the index pins. The same tightening torque applies to that bolt.
6. Remove the tilt protections and place the transformer on the floor.

6.2.2 Rolling the transformer



⚠WARNING

Severe injuries! Risk of tipping over the transformer.

The transformer is very heavy.

Non-compliance may result in death or serious injury!

- Roll the transformer in the longitudinal or transverse directions only!
- Do not roll transformer on a curved path!



ATTENTION

The transformer may be damaged!

When rolling the transformer, please make sure that force is only transmitted to the carriage.

Pushing or pulling the transformer by grasping other parts of it will most probably cause damage to the unit.

The transformer features towing eyelets on the carriage (Refer to Fig. 5) and should be pulled only via these.

If pushing is required, please note that

- the force may only be transmitted to the carriage!
- when doing so, do not damage the corrosion protection (paint) and do not shift other parts!

Attach the load fastening equipment to the two towing eyelets according to your driving direction and pull the transformer to its site of installation. To change the driving direction, reposition the transformer by means of a crane or change the direction of the castors accordingly.

6.3 Transport by means of a forklift truck



⚠WARNING

Warning of the transformer tilting!

The transformer is very heavy.

Non-compliance can result in death or serious injury!

In case of inappropriate handling of forklift trucks, there is a risk of serious accidents and damage to plant components.

The following instructions must be observed on principle:

- Transport by forklift truck is only permitted for transformers with "forklift lifting" design.
- Lift only with correctly positioned tilt safeguards.
- Only use forklift trucks that can carry the weight of the transformer.
- Ensure that the center of gravity of the load is centered between the forks.
- Always place the load on the forks to the stop and tilt the forks backward.
- Always secure unstable loads that tend to tilt.
- If necessary, use a slip-on shoe on the forks to hold and protect the load securely.
- Never transport multiple loads.
- Ensure that no one is in the danger zone.
- Always drive with the load lowered.
- Always drive with a load facing uphill. This applies to uphill and downhill.

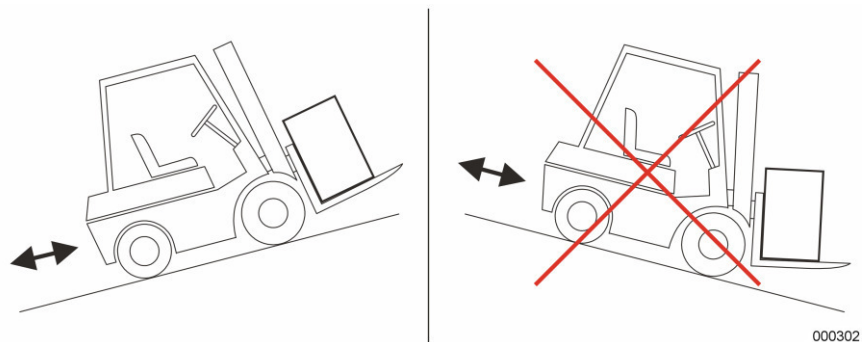


Fig. 6: Forklift truck on uphill / downhill gradients

6.3.1 Tilt protection for forklift transport



⚠WARNING

Warning – do not tilt the transformer!

The transformer is very heavy.

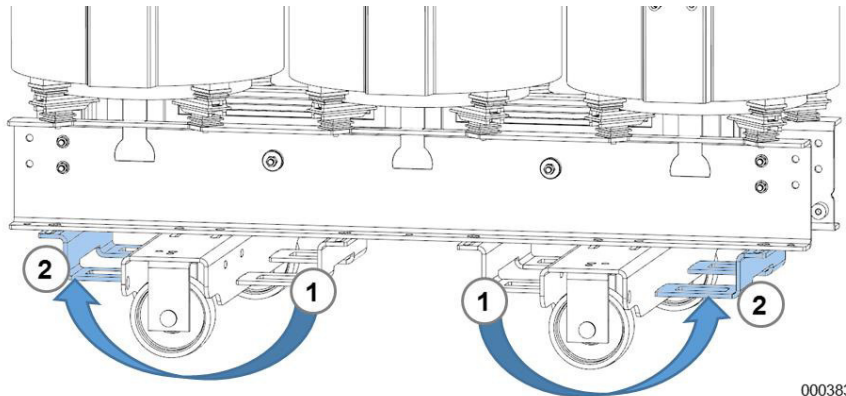
Failure to comply with these instructions can result in death or serious injury!

When lifting with a forklift under the bottom steel clamp, the transformer can tilt.

- Before lifting, check for correct positioning of the tilt protection elements at the attachment points of the forklift on the steel clamp.
- Always mount both tilt protection elements either both inside or outside of the carriage. Never attach one tilt protection element on the inside, and the other tilt protection element on the outside of the carriage.
- Ensure that the tightening torque is correct.

Steel supports are mounted on the steel clamp and carriage as tilt protection elements for forklift transport. The tilt protection elements can be mounted either on the inside or outside of the carriage as required. Never attach one tilt protection element on the inside, and the other tilt protection element on the outside!

- 1 Position, carriage inside
- 2 Position, carriage outside



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Fig. 7: Positions of the tilt protection elements

Tightening torques for threaded fittings – tilt protection elements, strength class 8.8 and higher:

Thread size	Tightening torque
M10	45 Nm (33 ft-lb)
M12	80 Nm (59 ft-lb)
M16	200 Nm (147.5 ft-lb)

6.4 Instructions regarding load securing for road transport



ATTENTION

Tie transformer down using all 4 tie-down rings provided on the upper steel clamp.
Load securing directly via the yoke or other structural parts is inadmissible. Damage may occur to the unit if proper tie-down rings are not used.

When loading the transformer onto the transport vehicle, properly secure it to prevent movement or shifting.

6.5 Requirements regarding transport vehicles for transformers with a maximum weight of 10tons

If special transport conditions have not been agreed in advance, **the transport vehicle must, in addition to the statutory requirements, meet all four requirements** listed here:

- Air suspension ride
- Vehicle must have open top allowing loading with crane.
- Open top must be able to be closed to be covered with tarpaulin to form closed area.
- Each transformer must sit on an 8 mm (5/16 inch) non-slip mat and be secured with at least four straps to four different tie-down rings.

Transportation forces must not exceed 1 G ($\cong 10\text{m/s}^2$) movement in any direction unless prior agreement has been made.

Transformers must be loaded so the length of the unit is in the direction to travel (longitudinally) and only one unit wide per row. Transverse loads or loading in several rows is not permitted.

6.6 Rail transport

Transportation by rail is not recommended due to higher travel forces. Transportation by rail must be specified at quotation stage to allow for a stouter design.

6.7 Checking the consignment before unloading

Inspect the shipment for **completeness** against the packing list.
Inspect the shipment visually before unloading it.

► Note

If damage is noted on the transformer, enclosure or parts supplied in loose condition, or if the shipment is incomplete:

1. Do not unload.
2. **Document** the **damage** or any missing parts detected **on the packing list** and **take photos** to document the damage and the nameplate on the damaged transformer.
3. **Contact SGB USA** to coordinate the next steps. Ask for the **Service** department.

During the visual inspection, please note the following damage:

- Damage to paint (e. g. flaking, deep scratches)
- Damage to the core such as seriously deformed core tips, core tips touching one another, laminations which have fallen out (recognizable by missing or discolored paint)
- Damage to the insulation (e. g. chipping or delaminating of cast resin windings, dents on the switching connector)
- Shifting of windings, recognizable by their considerably asymmetric arrangement relative to the core or tipped-over windings.

Photos showing examples of damage:

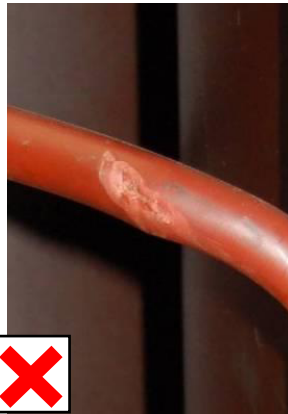


Fig. 8:
Deformed insulation of a delta connection



Fig. 9:
Surface chipping due to impact on delta connection



Fig. 10:
Core tips on yoke are seriously deformed and touch one another



Fig. 11:
OK
Minor irregularities of surface and paint



Fig. 12:
Windings have been shifted. Recognizable by torn-out or tilting supports.

If you have not detected any damage, unload the transformer. Proceed as described in *section 6.1*.

7 STORAGE

Unless otherwise stipulated, the provisions of the IEEE Standard C57.12.01 apply.



ATTENTION

Corrosion through condensation!

During longer storage in foil covers, condensation may occur. This causes zinc corrosion (white rust).

- Remove foil covers immediately after receiving the transformer.
- For longer storage periods pack the transformer into a wooden crate. Provide air circulation within the packaging or use silica gel in order to prevent condensation.
- Commission the transformer as quickly as possible, at least in no-load operation.



ATTENTION

Transformers and enclosures must **never be stored in rooms where caustic chemicals are stored**, as this might result in deposits and damage to the transformer or the enclosure.

Before storing the transformers, **pack them** as described in *section 5*.

Comply with the storage instructions in the manufacturer's instructions for the attachments, e. g. fans.

Store the transformers in an **environment** where the following conditions are satisfied:

- **dry and weatherproof** (covered room with a max. relative humidity of 93%)
- non-corrosive and non-explosive atmosphere
- **ambient temperature higher than -25°C** (may differ subject to agreement)

8 INSTALLATION

The transformer must be installed at a location that corresponds to the descriptions in chapter *section 4*.

Depending on the transformer version, transport to the installation site occurs:

- with crane (see *section 6.1*)
- On rollers (see *section 6.2*)
- with forklift (see *section 6.3*)

8.1 Position the transformer on its site of operation



U_m is the highest voltage for operating equipment

LI is the test level for full wave lightning impulse voltage

⚠ DANGER

Risk of electric arc or electric shock.

Non-compliance will result in death, serious injury or destruction of the plant!

When positioning the transformer, comply with the minimum clearance between

- the live conductors and the windings, and the earthed parts!
- the conductors and the windings and other live parts of the transformer!

Always **maintain** the **minimum clearance of**

- the live conductors and the windings to grounded parts!
- the conductors to the windings and other live parts of the transformer!

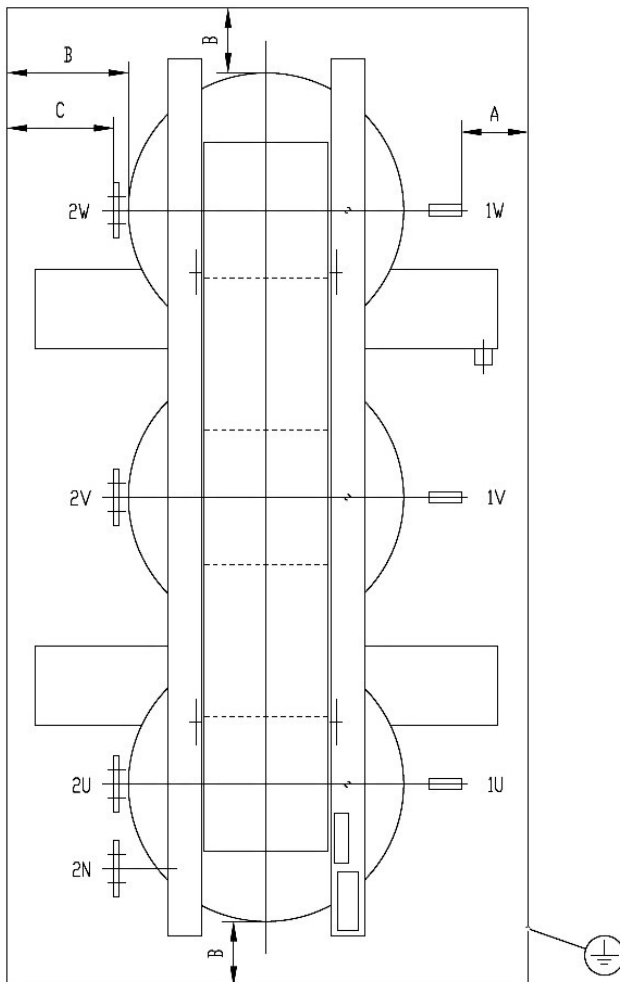
Minimum clearances depend on the installation altitude above sea level and the U_m / LI values of the respective winding.

Also maintain the minimum clearance when routing the cables.

Maintain the minimum clearance even when the unit is installed in an enclosure.

Minimum clearance / minimum distances from earthed conductive parts:

Voltages Um / LI [kV]	A [mm/in]	B [mm/in]	C [mm/in]
1.1 / --	40/1.6	20/0.8	40/1.6
3.6/20	60/2.4	30/1.2	60/2.4
3.6/40	60/2.4	30/1.2	60/2.4
7.2/60	90/3.5	45/1.8	90/3.5
7.2/75	120/4.7	65/2.6	120/4.7
12/75	120/4.7	65/2.6	120/4.7
12/95	160/6.3	85/3.3	160/6.3
12/110	200/7.9	115/4.5	200/7.9
17.5/95	160/6.3	85/3.3	160/6.3
17.5/125	220/8.7	115/4.5	220/8.7
24/125	220/8.7	115/4.5	220/8.7
24/140	270/10.6	140/5.5	270/10.6
24/145	270/10.6	140/5.5	270/10.6
36/170	320/12.6	160/6.3	320/12.6
36/200	380/15.0	180/7.1	380/15.0
40,5/200	380/15.0	180/7.1	380/15.0



1U, 1V, 1W: High-voltage terminals

2U, 2V, 2W, 2N: Low-voltage terminals

A: Distance from high-voltage terminal

B: Distance from insulated surfaces of the outer winding

C: Distance from low-voltage terminal

– None of the given minimum clearance may be undercut!

– If 2 values are available at choice, the value of the larger distance must always be selected!

All values apply to installation altitudes ≤ 1,000m (3300 ft.) above sea level!

Fig. 13: Schematic diagram of minimum clearance from earthed conductive components

The minimum clearances are also specified in the dimension drawing as "arc of electrical clearance".

When planning any tasks in the vicinity of the transformers, bear in mind that the "arc of electrical clearances" does not prescribe the limits of the danger zone, but rather only the distance required for trouble-free operation.

8.2 Removal of packaging and transport safeguards

Remove existing packaging and transport safeguards, e.g. marked inclined supports. In this regard refer to the dimensional drawing of the transformer.

8.3 Stable bearing in the station

Ensure a stable bearing in the station.
To do this, fix any existing castors, in position.
When using bearing elements for structure-borne sound insulation, properly position the transformer for stability.

8.4 Mount parts which have been removed for transport

Unpack all parts removed for transport such as connecting lugs, control boxes etc. and mount them.
Comply with the supplier documentation or the separate documentation of the external suppliers of attachments and accessories.

8.5 Mount the protective enclosure

If a **protective enclosure** has been supplied with the unit, **install** it according to the enclosed plans and, in case of floor installation, **secure** it to **prevent slipping**.

Make sure to comply with the specified minimum clearance (*section 8.1*). Leave a minimum distance of **30 cm (12")** between any wall and the air vents of the enclosure.

RECOMMENDATION

To improve ventilation and accessibility, we recommend increasing the distance to 40 cm (16") between any wall and air vents on the enclosure.

8.6 In case of possible soiling in the meantime between installation and commissioning

If unit is exposed to air borne dirt or dust due to construction in the period between installation and commissioning, **protect the transformer** as described in *section 5* Packaging.

9 COMMISSIONING

Do not switch transformer off and then switch on without allowing at least one minute of time to pass.

Every switching operation involves a risk of damage, therefore the maximum recommended number of switching operations per year should be limited to 24.

The following safety notices apply for the **entire duration** of the work:



⚠ DANGER

Risk of electric shock!

Non-compliance will result in death or serious injury!

Apply the following five safety measures for the entire duration of the work, in the specified sequence (section “Working in the zero voltage state)!)

The rules are:

1. De-energize main and auxiliary circuits
2. Lock out, tag out to prevent switching on
3. Verify there is no voltage present
4. Ground and short-circuit the transformer
5. Cover or block off adjacent live components

After completing the work:

Remove the safety measures according to applicable local regulations or, if there are none, reverse the five safety measures listed above in the opposite sequence.

Only perform switching on if you are authorized to do so!



⚠ WARNING

Flashover due to foreign matter!

Non-compliance may result in death or serious injury.

Foreign matter or debris on transformer surfaces during energizing cause damage to windings, flashover and fire.

- Make sure that there is no debris or foreign matter on any transformer surfaces.
- Remove metal dust and other dust which might be on any transformer surfaces.
- When working, do not place tools, screws or metal parts on any transformer surface.
- Make sure that no debris or foreign matter is left in the enclosure or on other plant components.



⚠ CAUTION

Risk of burns when touching hot surfaces!

Non-compliance may result in injury.

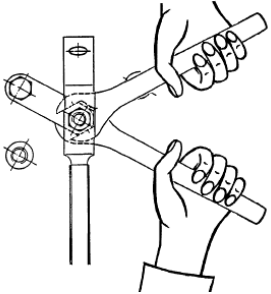
Before starting to work, make sure that the transformer's surfaces have cooled down to a temperature below 40°C (104°F), in order to avoid burns caused by unintentional contact!

9.1 Preparations

1. Remove any packaging material.
2. Connect the transformer's earth terminal to the earthing system and verify the connection.
3. Check the transformer for debris or foreign matter (e. g. screws, tools, metal chips, etc.) on all transformer surfaces, also on and between the windings, in the cooling ducts and between windings and core. If necessary, clean once more and remove any foreign matter. There must not be any other adhesive labels on the HV windings, except the tapping and phase designations.
4. Check the windings and the upper supporting blocks for tightness. The rubber bases must be slightly compressed and the supporting blocks must fit tightly. If necessary, increase the pressure of the upper supporting blocks by tightening the adjusting nut.

9.2 Tightening torques



ATTENTION	
Damage to high-voltage windings!	
<p>When tightening or releasing the threaded bolts on the reconnection links, do not let the reconnection link rotate. Use an open-end wrench, size 20 or 21 to hold the reconnection link in place while torquing the bolts, as shown in the figure on the right.</p> <p>This avoids damage to the windings.</p>	

Check all the threaded electrical connections and, if necessary, correct the torques. Make sure that the cable terminals do not transfer mechanical forces to the transformer terminals.

Tightening torques without addition of lubricants

Busbar connections		HV reconnection links and encapsulated bushings	
Thread size	Tightening torque	Thread size	Tightening torque
M10	40 Nm (29.5 ft-lb)	M8	10 Nm (7.4 ft-lb)
M12	70 Nm (51.6 ft-lb)	M10	20 Nm (14.7 ft-lb)
M16	140 Nm (103.3 ft-lb)	M12	35 Nm (25.8 ft-lb)

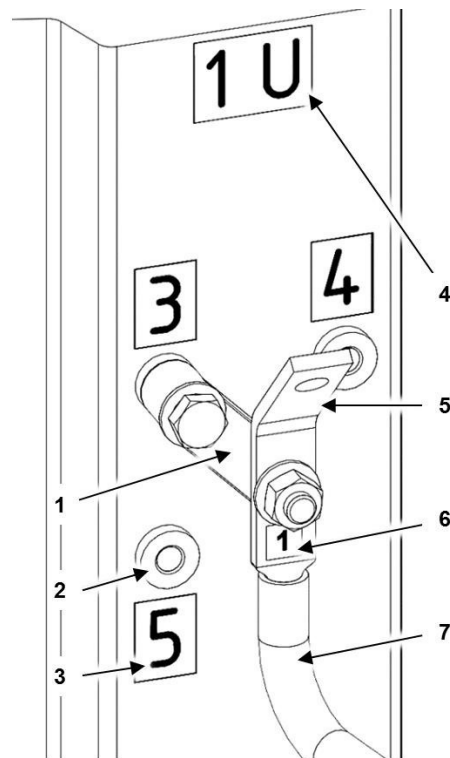
9.3 Voltage conversion

Unless otherwise stipulated, SGB cast-resin transformers are equipped with reconnection links to permit changing voltages. The transformer must be de-energized to change voltage taps.

Taps are changed by moving the reconnection link to the appropriate tap location identified on the circuit plate.

The circuit plate shows the possible voltages and the proper connection point. The circuit plate is positioned at the upper yoke of the transformer on the side where the reconnection links are provided.

- 1 Reconnection link
- 2 Voltage tapping
- 3 Number plate of tapping
- 4 Designation of the HV terminal
- 5 High-voltage terminal
- 6 Number plate of connection link
- 7 Connection link



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Fig. 14: Design of an HV connection link

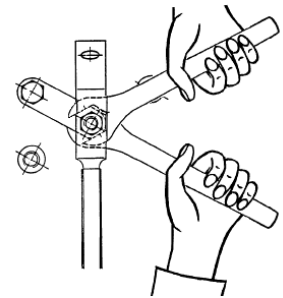


ATTENTION

Damage to high-voltage windings!

When tightening or releasing the threaded bolts on the reconnection links, do not let the reconnection link rotate. Use an open-end wrench, size 20 or 21 to hold the reconnection link in place while torquing the bolts, as shown in the figure on the right.

This avoids damage to the windings.



For voltage conversion, proceed as follows:

Switch the reconnection links individually without changing the position of the connection links!

1. Release the threaded connection "reconnection link / connection link" (1, 7).
2. Remove the securing bolt from the tapping / connecting socket (2).
3. Polish the contact surfaces to a bright surface finish to remove invisible oxide layer on the electrical contact, making sure that no metal residue is left on any transformer surface.
4. Rotate the reconnection link over the voltage tapping (2) point corresponding to the voltage selected.
5. In case of aluminum to copper connections, a washer of copper-plated aluminum sheet must be inserted between the contact surfaces, ensuring that the copper-plated side rests against the copper terminal.
6. Replace the securing bolt and re-tighten through the reconnection link / connection link securely applying the required torque (see section 9.2).

9.4 Phase terminals



⚠ DANGER

Risk of electric arc or electric shock.

Non-compliance will result in death, serious injury or destruction of the plant!

When routing the cables, comply with the specified minimum clearances between

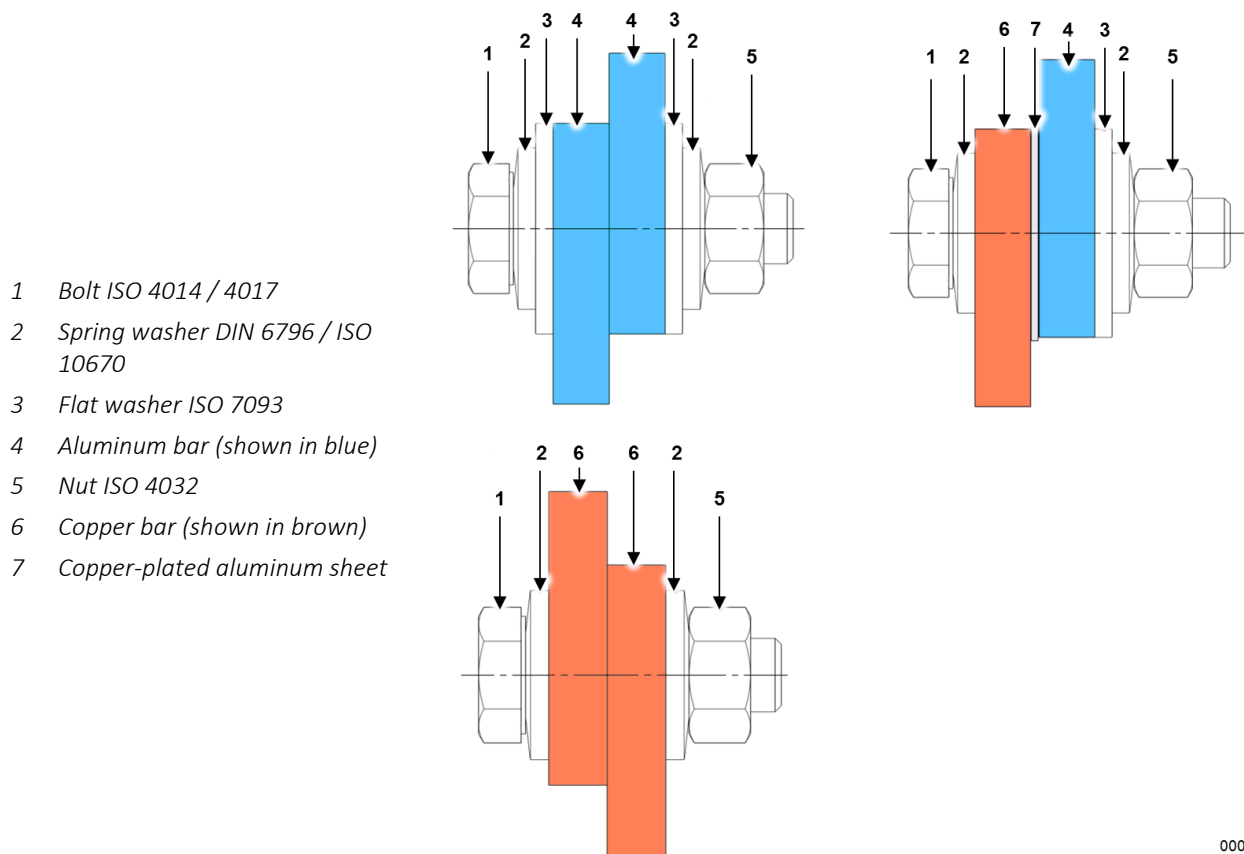
- the live conductors and the windings, and the earthed parts!
- the conductors and the windings, and other live parts of the transformer!

Refer to section 8.1, page 38.

Connect the **phase terminals according to the circuit plate**. Here, the electrical terminals of the transformer may be made of aluminum or of copper.

- Route the cables to the transformer terminals so that the terminals are not subjected to mechanical stress.
- To avoid corrosion at the connection area, **insert a copper-plated aluminum washer between the copper/aluminum contact surfaces**, ensuring that the copper-plated side rests against the copper terminal.
- Polish the **contact surfaces** to a bright surface finish to **remove oxide layer** on the electrical contact. Repeat this procedure every time after the contact is opened, making sure that no metal residue is left on any transformer surface.
- On the aluminum side of the link, a flat washer must be inserted in the threaded connection as shown in the following figure.

The general design of threaded connections of electrical connections:



- 1 Bolt ISO 4014 / 4017
- 2 Spring washer DIN 6796 / ISO 10670
- 3 Flat washer ISO 7093
- 4 Aluminum bar (shown in blue)
- 5 Nut ISO 4032
- 6 Copper bar (shown in brown)
- 7 Copper-plated aluminum sheet

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Fig. 15: General design of threaded connections of electrical connections (sectional view)

9.5 Temperature monitoring



⚠WARNING

Fire hazard!

Non-compliance may result in death or serious injury!
If this instruction is disregarded, the transformer may be overloaded and the insulation system will age prematurely.

Do not replace the thermistors with others of a higher nominal response temperature!



⚠WARNING

Warning – electric shock!

Failure to comply with these instructions can result in death or serious injury!

High voltage can be applied on temperature sensors in the event of a fault.

- Provide suitable surge protection devices as close as possible to the terminal strip of the transformer.

Connect the temperature monitoring sensors to the appropriate inputs of the temperature monitoring device.

Verify that the temperature sensors are operating properly by temporarily disconnecting the Positive Temperature Coefficient (PTC) leads and/or by comparing to a secondary testing device.

Program the temperature monitoring device for the nominal functioning temperatures. Consult SGB USA for the set values for warning and tripping in case of utilization of a temperature monitoring device which does not comprise PTC sensors. This step is not necessary for temperature monitoring devices which use PTC thermistors.

9.6 Fan



⚠ CAUTION

Risk of hand injuries caused by cutting or crushing

Non-compliance may result in injury.

- Wear protective gloves when working on fan blades.
- Make sure that the fan is disconnected from the power circuit and prevented from switching-ON again.
- Do not activate fan motors until the fans are correctly installed into the housing and properly checked.

If fans are present:

- Observe the supplier documentation for the fan.
- Check the mechanical installation (e. g. does the blade rotate without touching the enclosure? Are the screws properly torqued?).
- Check for the correct rotation of the fan blades.
- Verify the control is working properly.

9.7 Minimum clearances around transformer



⚠ DANGER

Risk of electric arc or electric shock.

Non-compliance will result in death, serious injury or destruction of the plant!

When positioning the transformer, comply with the minimum clearance between

- the live conductors and the windings, and the earthed parts!
- the conductors and the windings and other live parts of the transformer!

Check the minimum clearances between conductors and earth, between winding surfaces and earth and between conductors with different voltages. Correct if necessary!

For minimum clearances for installation altitudes $\leq 1,000$ m above sea level, see the Table in *section 8.1*.

Also maintain the minimum clearance when routing the cables.

9.8 Checks before applying voltage

Before applying voltage, make sure that the following conditions are satisfied:

- There is no debris or foreign matter (e. g. screws, tools, metal chips, etc.) on any of the transformer surfaces, on or between the windings, in the cooling ducts or between windings and core.
- There is no debris and foreign matter within the enclosure or on other plant components.
- The cooling air temperature is within the stipulated limits (standard: -25°C to +40°C).
- The windings are aligned symmetrically to the core, and properly clamped. The supporting blocks are properly placed, and the rubber pads are slightly compressed.
- The torques of the electrical threaded connections have been verified (see *section 9.2* Tightening torques).
- The core is not damaged nor shifted (recognizable damages e. g. protruding laminations, core tips which touch one another, core tips without paint or out of alignment).
- Windings are not damaged (recognizable by nicks or cracks on the surface).
- All clearances have been verified for the voltage rating of the transformer (see *section 8.1* Position the transformer on its site of operation).
- Verify room is clear of persons and animals.
- The transformer room and/or enclosure are secured and safely locked (access / opening is only possible using a key or a special tool).
- Other locally applicable safety provisions have been satisfied.

10 OPERATION

Operate cast resin transformers exclusively in closed electrical operating rooms or enclosures!

Unless different customer specifications have been stipulated, cast resin transformers are subject to the general operating conditions of IEEE std. C57.12.01.



⚠ DANGER

Risk of electric arc or electric shock!

Non-compliance will result in death or serious injury!

Despite the cast resin insulation, the **windings** are **not safe to touch**.

This is a functional insulation. This insulation does not protect against dangerous shock in case of contact or against flashover in case of approach.

- Never approach the windings or other conductive transformer components to less than 1.5 m (5 feet)!
- Transformer must be operated in a closed electrical operating area.



⚠ DANGER

Danger due to electromagnetic disturbances affecting pacemakers!

Non-compliance will result in death or serious injury!

Electromagnetic radiation disturbs pacemakers or other medical implants and aids.

- Never approach more closely than is permitted by the limits specified for their devices or implants regarding electromagnetic interferences!
- Take the applicable provisions regarding loads imposed by electrical, magnetic and electromagnetic fields into account when working in the proximity of the transformer.



⚠ WARNING

Fire hazard!

Non-compliance can result in death or serious injury!

Overheating causes the transformer to degrade.

- Only operate the transformer with a connected and functioning temperature monitoring device!
- Temperature sensors must be serviced on a regular basis. Maximum maintenance interval: 1 year.
- Thermistors must not be replaced with other type thermistors with a higher nominal functioning temperature.

1. Temperature monitoring device

The transformer temperature during operation directly affects its service life.

Only operate the transformer with a connected and functioning temperature monitoring device!

Maintaining normal operating temperatures prevents premature aging of the insulation system and helps to detect malfunctions and defects due to excessive temperatures sooner. The installation of the sensors is described in *section 9.5*. The functioning of the temperature monitoring device is described in *section 4.6*.

2. Overload capacity

Compared to liquid filled transformers, cast resin transformers have a different thermal capacity, the temperature of the insulation system and heating time constant which determine the overload capacity of the transformer and depends on the initial loading, the coolant temperature and duration of the overload. Due to the various design and implementation options, there are no generally applicable overload guidelines. They must be calculated individually by the factory and may be requested if required.

11 MAINTENANCE

The following safety notices apply for the **entire duration** of the work:



⚠ DANGER

Risk of electric shock!

Non-compliance will result in death or serious injury!

Apply the following five safety measures for the entire duration of the work, in the specified sequence (section "Working in the zero voltage state)!)

The rules are:

1. De-energize main and auxiliary circuits
2. Lock out, tag out to prevent switching on
3. Verify there is no voltage present
4. Ground and short-circuit the transformer
5. Cover or block off adjacent live components

After completing the work:

Remove the safety measures according to applicable local regulations or, if there are none, reverse the five safety measures listed above in the opposite sequence.

Only perform switching on if you are authorized to do so!



⚠ WARNING

Flashover due to foreign matter!

Non-compliance may result in death or serious injury.

Foreign matter or debris on transformer surfaces during energizing cause damage to windings, flashover and fire.

- Make sure that there is no debris or foreign matter on any transformer surfaces.
- Remove metal dust and other dust which might be on any transformer surfaces.
- When working, do not place tools, screws or metal parts on any transformer surface.
- Make sure that no debris or foreign matter is left in the enclosure or on other plant components.



⚠ CAUTION

Risk of burns when touching hot surfaces!

Non-compliance may result in injury.

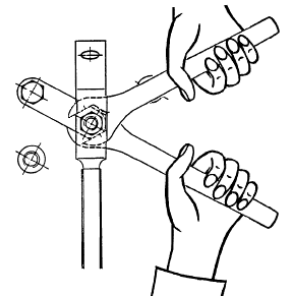
Before starting to work, make sure that the transformer's surfaces have cooled down to a temperature below 40°C (104°F), in order to avoid burns caused by unintentional contact!



ATTENTION

Damage to high-voltage windings!

When tightening or releasing the threaded bolts on the reconnection links, do not let the reconnection link rotate. Use an open-end wrench, size 20 or 21 to hold the reconnection link in place while torquing the bolts, as shown in the figure on the right.



This avoids damage to the windings.

RECOMMENDATION

Switch the transformer OFF at least 3 or 4 hours before commencing work. Leave the fans running (if applicable). Do not turn off the fans until just before commencing work. This will reduce the waiting times for cooling down on site. Depending on the load involved, longer cooling periods may have to be observed.

Maintenance intervals

Perform transformer maintenance at intervals to be defined by yourself.

We recommend an **initial inspection after a maximum of 6 months**.

The inspection intervals depend on the transformer's degree of contamination. In case of minor contamination, the maintenance interval can be extended. If serious contamination is detected, reduce the intervals accordingly. The maintenance interval must **not exceed one year**.

Regarding all attachments and accessories, comply with the supplier documentation of the external supplier.

11.1 Cleaning



ATTENTION

The transformer may be damaged when voltage is applied!

When cleaning,

- do not use any water for cleaning on any part of the transformer.
- do not use metal brushes or wire wool.

Determine the degree of contamination of the windings and clean these.

Make sure the surfaces of the windings and cooling ducts are clean. **Clean the cooling ducts and gaps between the windings** with special care. When using liquid cleaning products, allow the transformer to **dry thoroughly** (approx. 1 hour).

Degrees of contamination of the transformer:

Degree	Recognizable by	Recommendations regarding cleaning
minor	minor deposits of dry dust on the transformer	Clean the transformer using dry rags and soft brushes. If necessary, compressed air may also be used to remove dust in places which are difficult to reach.
medium	Deposits of dust containing moisture and/or salt on the transformer.	Clean the surfaces using soft brushes, sponges and rags. If it should become necessary to use special cleaning products, contact SGB USA.
major	Appearance as in case of a medium degree of contamination, however with electrical creepage paths or clearly visible traces of partial discharge	In case of major contamination, contact SGB USA for instructions on how to proceed

The SGB-Service will be pleased to assist in choosing a cleaning method for SGB cast resin transformers.

Contact: sgb@sgb-usa.com

11.1.1.1 White rust (zinc corrosion)

Zinc corrosion or white rust is a white, voluminous coating that can occur due to presence of water on the surface over a longer period of time during storage or transport. In the majority of cases, formation of white rust is merely a visual impairment of the zinc coating.

1 White rust



Fig 16: White rust

If there are **low levels of white rust**, removal of the thin, whitish coating is not absolutely necessary.

Light white rust can be removed with the aid of a non-metallic sponge and cleaning agents that contain acetone.

If there are high levels of **white rust**, any repair measures to be carried out must be made dependent on the extent of the damage. If measurement of the remaining thickness of the zinc coating shows that the minimum values required by standard DIN EN ISO 1461 have been met, then it suffices to carefully remove the whitish coating. If the standard-conformant layer thicknesses are below the standard, an additional, professional repair of the corrosion protection must occur locally.

11.2 Temperature monitoring



⚠WARNING

Fire hazard!

Non-compliance may result in death or serious injury!
If this instruction is disregarded, the transformer may be overloaded and the insulation system will age prematurely.

Do not replace the thermistors with others of a higher nominal response temperature!



⚠WARNING

Warning – electric shock!

Failure to comply with these instructions can result in death or serious injury!

High voltage can be applied on temperature sensors in the event of a fault.

- Provide suitable surge protection devices as close as possible to the terminal strip of the transformer.



ATTENTION

Damage to temperature sensors!

Use ohmmeters with a service voltage of ≤ 2.5 Volt!
Otherwise, the sensors might be damaged!

Measure the resistance of the temperature sensors and compare the values with the information on the routine inspection certificate.

Measure the PT100 twice, always against the common white conductor.

Resistance of the PT100 at an ambient temperature of 20 °C is approx. 110 ohm.

Measure the PTCs together as a 3-strand chain (sensor conductors of the same color) for a tripping temperature. The resistance of an intact chain at 20 °C ambient temperature is **between 60 and 750 ohm.**

11.3 Main terminals and bars



⚠ DANGER

Risk of electric arc or electric shock.

Non-compliance will result in death, serious injury or destruction of the plant!

When routing the cables, comply with the specified minimum clearances between

- the live conductors and the windings, and the earthed parts!
- the conductors and the windings, and other live parts of the transformer!

Refer to section 8.1, page 38.

- If electrical terminals have been disconnected during maintenance work, polish the contact surfaces to a bright surface finish before reconnecting them, making sure that no metal dust is left on any transformer surface.
- Check existing insulations for damage.
- Make sure that the cable terminals do not transfer any mechanical forces to the transformer terminals.
- Make sure that the bending radii specified for the conductor cross section are not exceeded.
- Check all the threaded electrical connections for tightness and, if necessary, correct the torques as described in *section 9.2*.

11.4 Windings

- Check that the windings on all legs of the transformer core are arranged symmetrically.
- Check the windings for tight fit. Retighten the clamping devices as required. The rubber elements between the windings and the clamping devices must be slightly compressed.
- In case of vibration-proof models with clamping devices, the preload must be checked and, if necessary, readjusted. The appropriate values are available from the SGB Service. Subsequently, the clamping devices must be secured again using a locking compound.
- Make sure there is no debris and foreign matter (e. g. screws, tools, metal chips, etc.) on any transformer surfaces, on or between the windings, in the cooling ducts or between windings and core. If necessary, clean once more and remove foreign matter.

11.5 Other maintenance activities

- Check the safety clearances from earthed conductive components. For the clearances, refer to the warning on the transformer, the Table in *section 8.1* or the protective circle on the dimension drawing of the transformer.
- Check that all labels, plates and warning information are located on the transformer and that there are no other adhesive labels on the HV windings, except the tapping and phase designations.

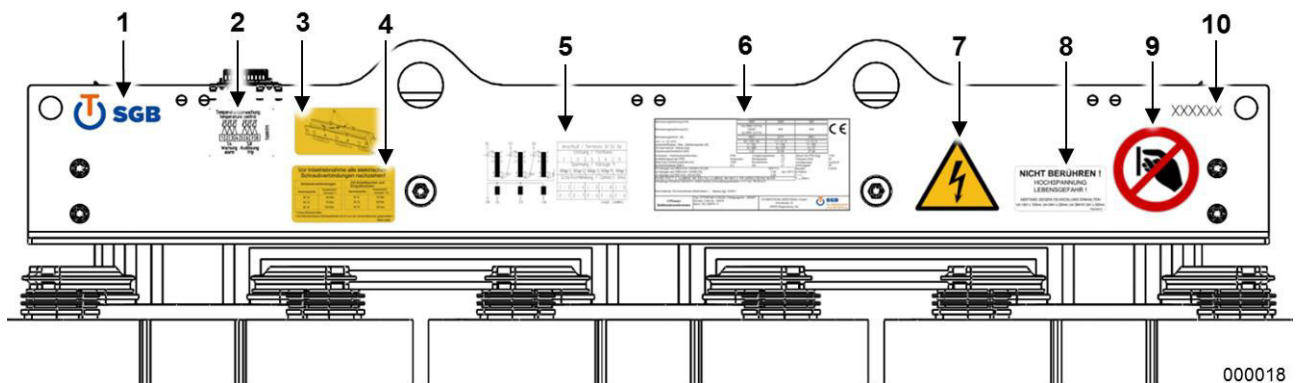


Fig. 17: Labels for upper steel clamp, HV side (example)

1	Company logo	6	Nameplate
2	Terminal assignment	7	Warning sign "danger voltage"
3	Instruction sign – lifting lugs	8	Supplementary sign "Do not touch"
4	Instruction sign "Tightening torques"	9	Prohibition sign "Do not touch"
5	Vector plate	10	Transformer serial number

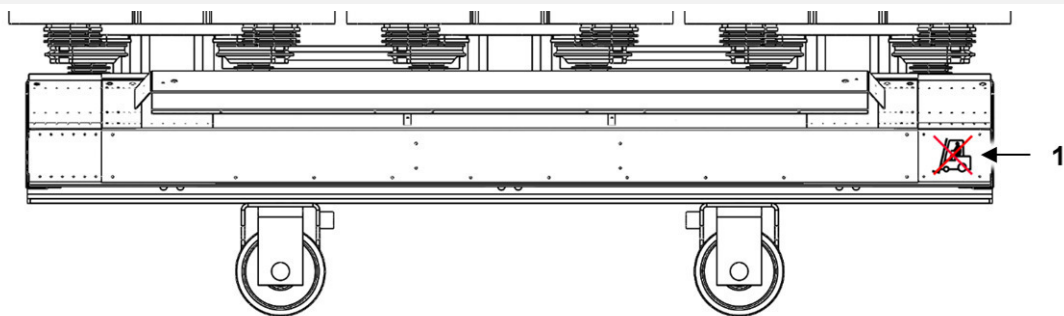


Fig. 18: Label, lower steel clamp

- | | |
|---|---|
| 1 | Prohibition sign "Forklift truck" (not applicable for transformers with forklift brackets!) |
|---|---|

11.6 Fan



⚠ CAUTION

Risk of hand injuries caused by cutting or crushing

Non-compliance may result in injury.

- Wear protective gloves when working on fan blades.
- Make sure that the fan is disconnected from the power circuit and prevented from switching-ON again.
- Do not activate fan motors until the fans are correctly installed into the housing and properly checked.

This part applies only if the fans have been supplied by SGB. Otherwise, use the maintenance instructions of your fan manufacturer!

- Clean the air ducts using a dry rag!
- Check that
 - the fans are mounted securely and the mounting screws are properly tightened. Re-tighten as required!
 - no lubricant is leaking from bearings or motors. In this case, replace the fans!
 - the fan blades - especially welds - are not cracked. Replace the fans in case of damage!

11.7 Enclosure

This section applies only if an enclosure has been supplied by SGB. Otherwise, use the maintenance instructions of your enclosure manufacturer!

- Check the enclosure for damage which may impair personal safety or the proper working order of the transformer. Replace the damaged parts.
- Clean the inside of the transformer enclosure, the post insulators and the air inlets.
- Check to ensure that no cracks appear on the surfaces of the post insulators or bushings. Replace, if necessary.
- Eliminate all debris and foreign matter (e. g. screws, tools, metal chips etc.) from inside the enclosure and other plant components.
- Reconnect the equipotential bonding lines which have been removed for access.
- Make sure that the transformer, fan and enclosure are dry.
- Make sure that no persons or animals are within the enclosure, secure and lock it.
- Make sure that the air inlets outside the enclosure are not blocked (minimum clearance 300 mm/12 in.).
- Make sure that all warning signs are available and undamaged. All sides of the enclosure featuring access covers must be equipped with labels "Warning - dangerous voltage".

Check the positioning of the transformer in the enclosure for the minimum clearances between

- the live conductors and the windings to grounded parts.
- the conductors to the windings and other live parts of the transformer.

Refer to section 8.1, page 38.

11.8 Checks before applying voltage

Refer to *section 11.8*.

12 TROUBLESHOOTING

Responding to early signs of trouble may minimize damage and increased costs. In many cases, the problem can be determined and eliminated quickly, and the transformer recommissioned in a short time.



⚠ DANGER

Risk of electrical shock!

Fire hazard!

Non-compliance will result in death, serious injury or destruction of the plant!

If one of the symptoms listed below is detected, shut down the transformer immediately!



⚠ DANGER

Risk of electrical shock!

Fire hazard!

Non-compliance will result in death, serious injury or destruction of the plant!

If the problem cannot be eliminated, re-energization of the transformer is not recommended!

- Contact the manufacturer immediately. Further investigations may require further testing or disassembly of the transformer.
- This work should only be performed by representatives of SGB or by an authorized repair workshop.

Fault symptom	Possible causes
Electrical circuit	
<i>Overheating, temperature warning</i>	<ul style="list-style-type: none"> – Permanent overloads – External transformer connection incorrect – Poor, insufficient cooling air circulation – Excessive ambient temperature (max. admissible temperature 40°C, daily mean temp. of 30°C) – Damaged fans, wrong direction of rotation, improperly sized for application – Load with high harmonic content – Load unbalanced
<i>Reduced no-load voltage</i>	<ul style="list-style-type: none"> – Turn-to-turn fault – Reconnection link for HV tapping loose, not tightened
<i>Excessive secondary voltage</i>	<ul style="list-style-type: none"> – Excessive input voltage – HV taps incorrectly set
<i>Unbalanced secondary voltage; deviation between phases</i>	<ul style="list-style-type: none"> – Overload – HV taps not set to same voltage on all phases – Neutral terminal not grounded
<i>Insulation faults, insulation resistances insufficient</i>	<ul style="list-style-type: none"> – Perpetual overload – Dirt deposited on windings/in cooling ducts – Mechanical damage caused during handling (transport/installation) – Overvoltage due to lightning or switching operation – Humidity – Condensation
<i>Switches or fuses tripped</i>	<ul style="list-style-type: none"> – Short-circuit – Overload
<i>Cables overheating</i>	<ul style="list-style-type: none"> – Poor, insufficient screw connections – Incorrect conductor cross section, insufficient for load – Wrong bundling and/or laying/routing of cables
<i>Flashover - high voltage to earth</i>	<ul style="list-style-type: none"> – High static charge – Overvoltage within the grid – Insufficient voltage clearance to adjoining parts
Magnetic circuit	
<i>Vibrations, loud operating noise</i>	<ul style="list-style-type: none"> – Excessive input voltage and/or under-frequency condition – Core clamping loose (incorrect, rough handling during transport and installation) – HV taps incorrectly set
<i>Overheating</i>	<ul style="list-style-type: none"> – Excessive input voltage and/or insufficient system frequency – Load with high harmonic content – Load unbalanced – Serious contamination on the core
<i>High excitation current</i>	<ul style="list-style-type: none"> – Frequency too low – Input voltage too high
<i>Switches or fuses</i>	<ul style="list-style-type: none"> – Inrush – Turn-to-turn fault, short-circuit between strands
Dielectric circuit (isolation)	

Fault symptom	Possible causes
<i>Smoke</i>	Insulation fault
<i>Burnt insulation</i>	<ul style="list-style-type: none"> – Lightning overvoltage – Switching/line fault – Damaged connector sockets, taps or surge arresters – Major quantities of dirt and/or dust deposited on or clinging to winding surfaces /in cooling ducts
<i>Overheating</i>	<ul style="list-style-type: none"> – Clogged ventilation ducts – Insufficient ventilation
<i>Switches or fuses tripped</i>	<ul style="list-style-type: none"> – Insulation fault

13 RECYCLING OF CAST RESIN TRANSFORMERS

According to the currently valid legal provisions, cast resin transformers do not contain any parts that are toxic waste.

Most of the transformer parts (approx. 95%) can be recycled.

Transformer parts	Disposal / recycling
Laminations, steel structures and carriage	Scrap iron
LV windings	Copper or aluminum scrap
HV windings (shredded)	Copper or aluminum scrap, epoxy resin / glass fiber components in domestic waste
Small parts: post insulators, supporting blocks, spacers etc.	In domestic waste

SGB offers free disposal / recycling of cast resin transformers manufactured by SGB. Upon prior clarification / by appointment, the units must be delivered to SGB by the customer.

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