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Reliable.
Proven.
Simply fact.

Cast Resin Transformers

SGB STARKSTROM

Partners in Power

SMIT TRANSFORMERS
NIJMEGEN | THE NETHERLANDS

Why cast resin transformers made by SGB-SMIT?

The range of SGB-SMIT cast resin transformers includes power ratings up to 25 MVA and rated insulation voltages up to 36 kV as well as converter, distribution and special transformers. With its over 30 years of experience in the construction of cast resin transformers, SGB-SMIT's scope of special expertise is one of the largest world-wide, a fact which is reflected by the extremely high quality level such as our MTBF (mean time between failures) of over 2,400 years.

Thanks to their special design, SGB-SMIT cast resin transformers offer a range of features which, on the one hand, distinguish them from other cast resin transformers in terms of technology and, on the other hand, make them a highly reliable and extremely safe solution.

The operative benefits for you, our customer, are the following:

- **Thanks to the multi-layer winding principle, high surge voltages and switching voltages are handled safely.**
- **Cooling ducts provide thermal reserves and allow for overload.**
- **The use of glass-fibre reinforced plastics (GFK) in the encapsulated windings provides resistance to temperature shocks.**
- **Long service lives are ensured.**

High voltage winding

The high voltage winding (HV winding) is the heart of the cast resin transformer. It embodies the enormous technical know-how of SGB-SMIT.

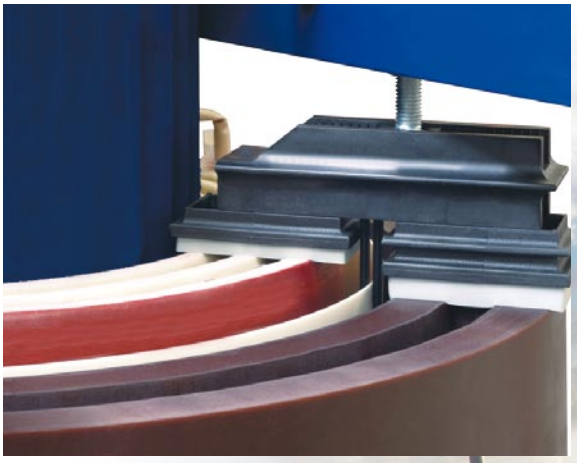
Cast resin transformers are characterized by the conductors of the HV winding being embedded completely in an enclosed cast resin body with a smooth surface. Even if not specified so explicitly by the standard, this can be achieved in production of high voltage applications only using vacuum-encapsulated moulds. To this effect, the SGB-SMIT production technology and the materials used feature important USPs (USP = unique selling proposition) which distinguish them on the one hand from other cast resin transformers in terms of technology and, on the other hand, make them a highly reliable and extremely safe solution.

R|eserves-equipped
Thermal reserves due to special primary insulation allow for overload.

E|ndurance-enhanced
Cooling ducts ensure long service life.

S|urge-proof
Double-layer winding enables the handling of high surge voltages.

Q|uantum-leap
Glass-fibre reinforced plastics ensure safe transport and operation, even in the case of temperature shocks.



For our customers, these special features imply a high degree of safety both regarding operation and security regarding their investment decision.

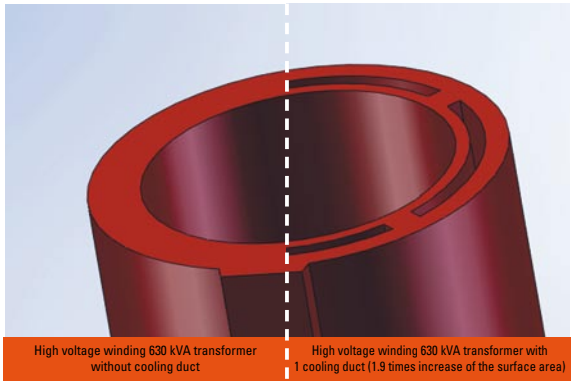
“Resin Quality by SGB-SMIT“:
Below, please find a detailed explanation of these exceptional quality factors.

R|eserves-equipped

Thermal reserves allow for overload

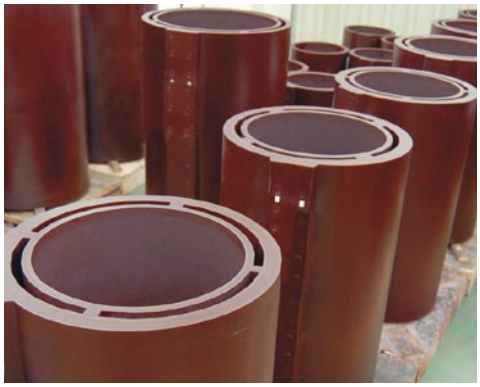
In this regard, SGB-SMIT cast resin transformers are not only one step ahead of oil transformers, but also of cast resin transformers made according to conventional technology. These use a continuously wound coil whose conductor consists of an aluminium coil and the winding/layer insulation of foil. The insulation corresponds only to insulation class F and even this qualification is only reached in conjunction with the entire insulation system - without thermal reserves.

This is completely different in the case of SGB-SMIT cast resin transformers, as SGB-SMIT uses for the double-layer winding insulated profile wires whose primary insulation consists either of highly heat-resistant polyesterimide varnish with a temperature index of 200°C or a Nomex thread covering of temperature class C (220°C). As SGB-SMIT cast resin transformers are utilized, due to their design, mainly according to temperature class F (155°C), primary insulation features considerable temperature reserves.



High voltage winding 630 kVA transformer without cooling duct

High voltage winding 630 kVA transformer with 1 cooling duct (1.9 times increase of the surface area)



E|ndurance-enhanced

Ensuring a long service life

Cast resin transformers must dissipate the thermal loss produced in the windings to the cooling air via the coil surfaces. The coils are dimensioned so that the over temperatures admissible due to the insulation class are not exceeded.

Cooling of conventional technology cast resin transformers with continuously wound coil is only possible via the two inside and outside surfaces of the cylindrical coil. To provide the required surface, the coils must be larger than required by the electrical parameters in many cases. The double-layer winding technology chosen by SGB-SMIT, on the other hand, permits straightforward introduction of additional cooling ducts within the coil. Thus, the cooling surface is gained and the design of the coils is ideal in view of their mechanical dimensions. SGB-SMIT cast resin coils can even feature multiple cooling ducts.

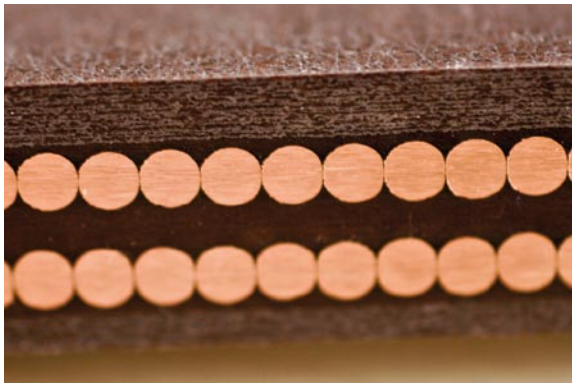
SGB-SMIT cast resin transformers ensure a uniform temperature distribution within the coil in line with a reasonable material utilization. The optimized coil permits temperature reduction for the HV winding and additionally a uniform temperature distribution for the entire transformer.

Surge-proof

Reliable handling of high surge voltages

Only SGB-SMIT cast resin transformers feature vacuum-encapsulated high voltage coils whose winding is designed as a double-layer winding. This means safety in the handling of surge voltages as are caused by lightning strikes or by vacuum circuit-breakers.

- The continuous coil winding of other transformers results in a strongly fluctuating voltage stress, especially of the input windings, as 70 % of the surge voltage stress is taken up by the first 30 % of the windings. Thus, the risk of short-circuited coils increases considerably for these winding types.
- On the contrary, the SGB-SMIT double-layer winding ensures a linear surge voltage stress for all windings.



Quantum-leap

Reliably resistant to temperature shocks

During transport, cast resin transformers are subject to mechanical and – especially during operation – strong thermal shock stress. Thus, the transformer's capability of handling steep or extreme temperature increases safely is paramount. This feature depends decisively on the design of the cast resin composite material, the matrix, into which the conductors are encapsulated.

For the usual cast resin transformers, this composite material consists of an epoxy resin which is mixed by over 70 % with a mineral based filler, primarily quartz powder. Such composite material can only reach the tensile strength of the epoxy resin, i. e. approx. 50 N/mm.

Quite the opposite is the case with SGB-SMIT. Here, the composite system consists of a glass-fibre reinforced epoxy resin between the layers and on the surface, with a high tensile strength in the range of 120 N/mm. The advantage of the composite system chosen by SGB-SMIT has proved its worth in various tests. The thermal shock tests according to IEC 60076-11, which are required for climate classification C2, based on a temperature of -25°C, were passed successfully by SGB-SMIT cast resin coils even at an initial temperature of -50°C.

Low voltage winding

The low voltage winding of SGB-SMIT cast resin transformers is almost always designed as coil-winding. The benefits of this winding design are self-explanatory:

- **Reduction of extra losses**
- **Balanced temperature distribution within the winding**
- **High short-circuit capability**

Exceptions exist, for technical reasons, only in case of minor ratings below 250 kVA and for higher system voltages (> 3.6 kV).

For over 40 years, SGB-SMIT has manufactured coil windings for distribution transformers and cast resin transformers. This long-standing experience is the reason for specificities ensuring quality:

- There are two established processes to connect the end lead bars to the coils: inert gas welding or cold pressure welding under high pressure (400 kN). For over 20 years, SGB-SMIT has only used the cold pressure welding process. Advantages: · no metallurgical change to the conductor metal by a thermal process · no foreign matter as might occur during welding

- By using multi-layer prepregs with subsequent bonding, a highly resistant cylinder is created which, other than the usual solutions, is capable of absorbing the radial short-circuit forces in a self-supporting fashion. The simple support to the core is used only for centering.

- The winding edges are stiffened additionally, thus affording reliable protection against the penetration of humidity and enhancing mechanical resistance. This technology has proven its worth over many decades, including in terms of extreme applications, and is equivalent to an encapsulated winding.

The core

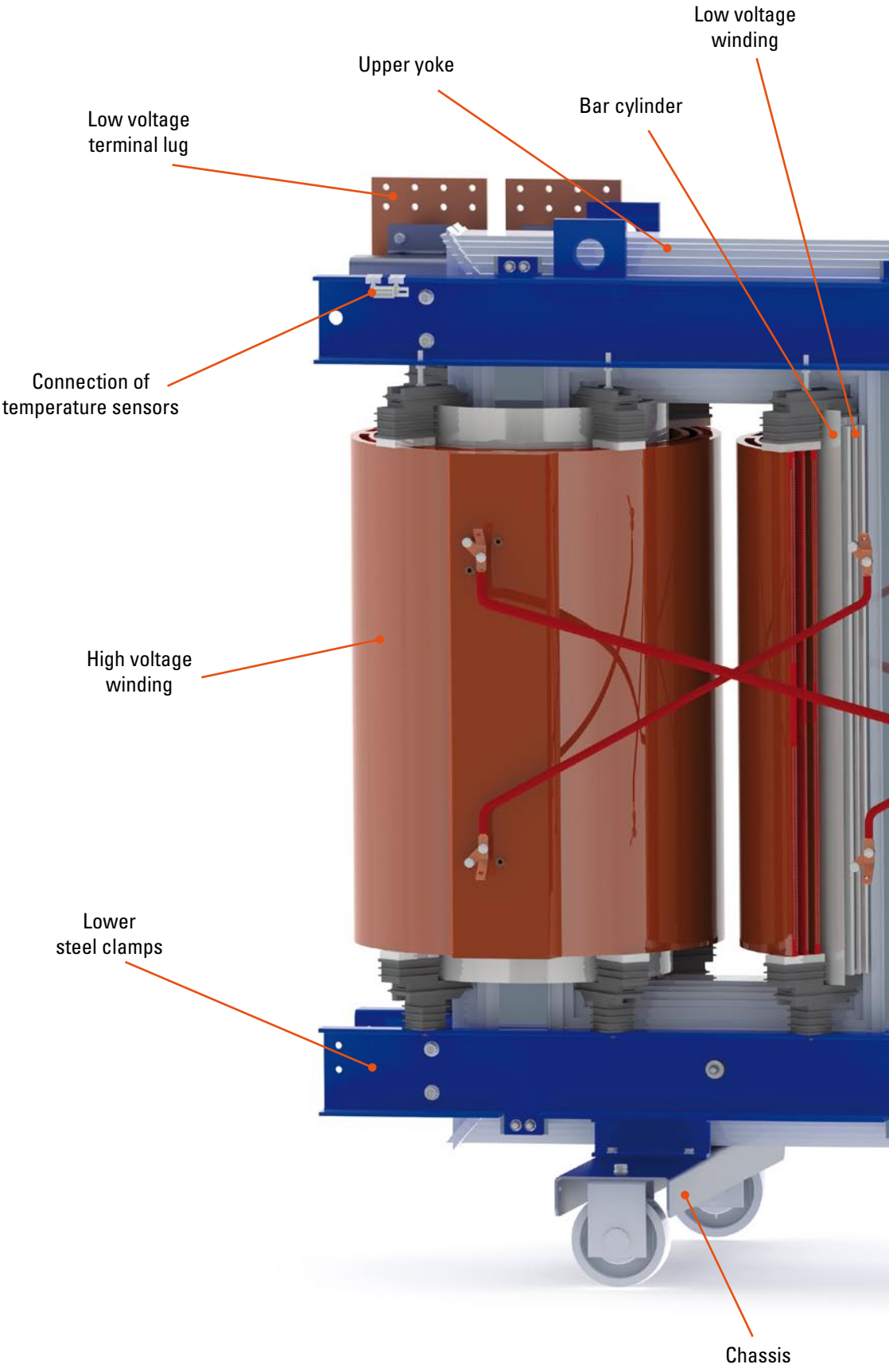
For specifying cores for cast resin transformers, no-load losses, noise and no-load current are essential quality features which are, in many cases, of decisive importance. Thus, the core design is an important engineering task. This includes the precise geometrical design, determination of the material properties of the magnetic sheet to be used and many details, including design measures such as those to control vibrations, slanting positions and other mechanical requirements.

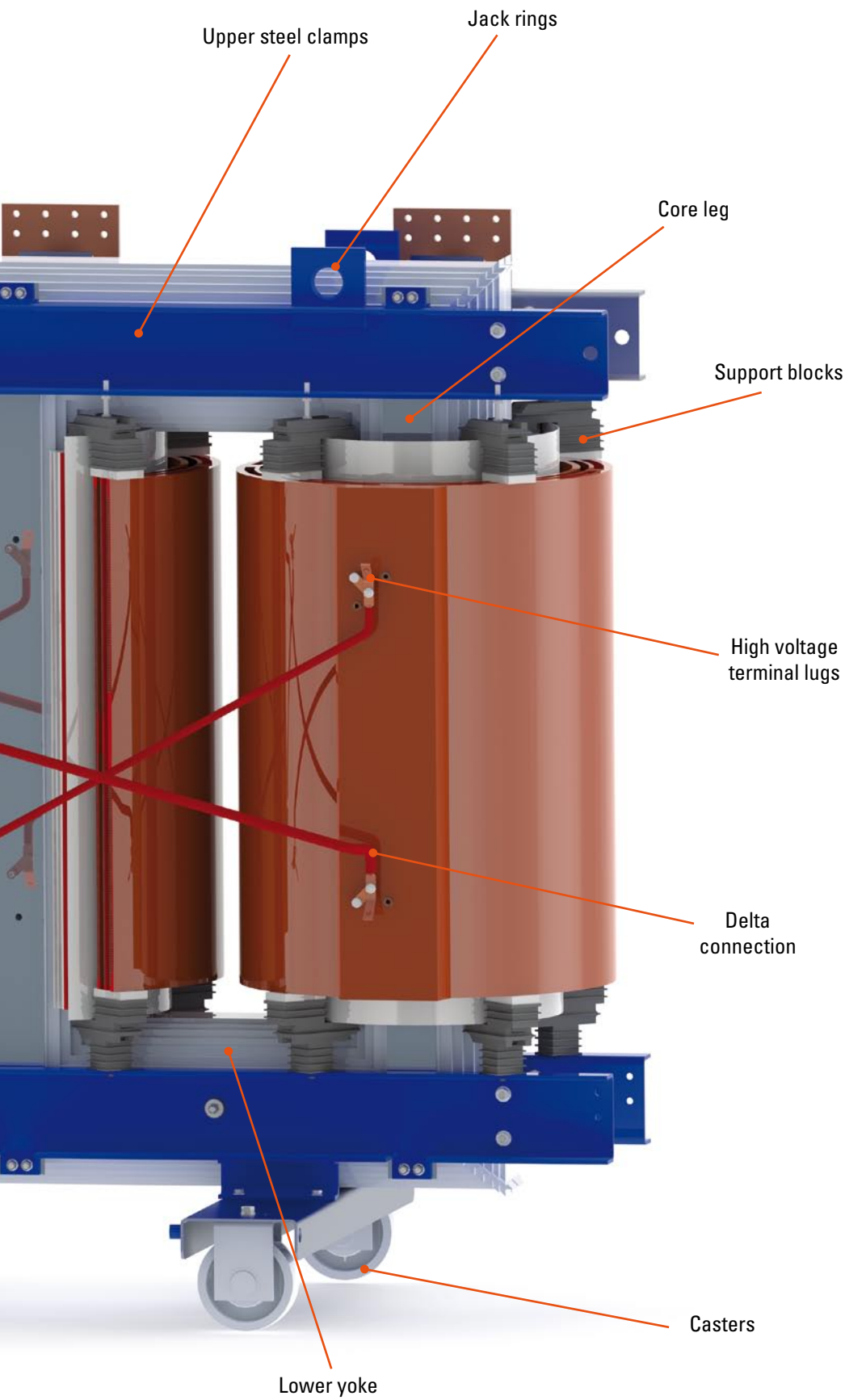
Today, transformer cores are produced on special machines which manufacture complete cores in accordance with our specifications out of prefabricated and precisely pre-measured sheet coils. To this effect, SGB-SMIT deploys top-quality specialists and cooperates with these experts very closely in long-term partnerships. Our logistics concept means that material is supplied daily on a just-in-time basis.

Core lamination with high-temperature resistant varnish is suitable for all – even extreme – installation conditions. This provides not only corrosion protection, but also enhances the core's stability, as the SGB-SMIT varnish penetrates between the individual laminations, bonding them to one another.

The core is fastened by a holding frame which consists of upper and lower steel clamps and flat tie bars resting directly against the core. The tie bars consist of non-magnetic flat steel and connect the lower and upper steel clamps via forces. The holding frame is designed so that the laminations are largely kept free of traction and pressure strain, as this is the only way to ensure that they retain their excellent loss- and noise-related properties. The lower yoke rests, supported by moulded parts of glass-fibre reinforced plastic, on the lower chassis beams to which bi-directionally adjustable rollers can be fastened. Depending on the requirements at the site of installation, various fastenings can be selected such as additional foot bridges, skids, vibration-reducing elements etc.

Cast resin transformer – key components




Upper steel clamps
Jack rings
Core leg
Support blocks
High voltage terminal lugs
Delta connection
Casters
Lower yoke

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With production starting in the late 1970's, SGB-SMIT were one of the first manufacturers of cast resin transformers, thus we are able to offer our customers the benefit of our extensive experience and know how. This extraordinary know-how is reflected by a especially high quality score, e.g. an **MTBF of over 2,400 years.**

It goes without saying that SGB-SMIT cast resin transformers meet all the established quality conditions: Fire classification F1 • Environmental class E2 • Climate classification C2

And as a matter of course, the product sector Cast-Resin Transformers at SGB-SMIT has been certified according to ISO 9001 and ISO 14001.

The extremely high quality of SGB-SMIT cast resin transformers has a name: Uni|Q.
Uni|Q is synonymous with the special quality and test features which make our cast resin transformers so unique:

- **Several Decades of Experience**
  - Comprehensive operating experience world-wide including international production sites
  - First-class international references in all sectors
  - Ample know-how and long-term experience in the field of onshore wind power plants including special cooling systems: Jet System
  - Transformer system tailored to open sea conditions for offshore wind power plants with many years of operating experience: Safe-System
  - Optimum solutions for all industrial applications with extreme climate conditions – no matter whether extremely hot or cold: All Climate Safe System

- **Unique design**
  - The multi-layer winding is electrically the best and most reliable option. Thus, almost all oil distribution transformer manufacturers apply this principle. Millions of these have been securing the energy supply in many countries for several decades world-wide. SGB-SMIT is the only manufacturer of cast resin transformers who uses this principle!

- **Computerised monitoring of the production process**
  - Based on a precise analysis according to automotive standards, all relevant production parameters of each transformer are recorded continuously and compared online to the set-point values. The next production step only follows if everything is found to be correct.
  - This system makes it possible to achieve a uniform level of quality over large production quantities at all locations of the SGB-SMIT Group on an international basis.

Special feature:
internal test equipment – a cutting-edge test laboratory

SGB-SMIT cast resin transformers are designed and manufactured as standard in accordance with IEC 60076-11. In line with the value-added chain at SGB-SMIT, all routine and type tests specified in this standard and the most important special tests are performed in our own, modern test area. Thus, the special characteristics stipulated in the customer's specification can also be verified.

- **Routine tests: Fig. 1**
  - Measurement of the winding resistance
  - Measurement of the transformer ratio and verification of the polarity or vector group
  - Measurement of the short-circuit impedance and the short-circuit losses
  - Measurement of the no-load losses and of the no-load current
  - Test with applied power frequency withstand voltage
  - Test with induced power frequency withstand voltage
  - Partial discharge measurement

- **Type tests:**
  - Lightning impulse voltage test
  - Temperature rise test: Fig. 2

- **Special tests:**
  - Noise measurement: Fig. 3
  - Verification of the climate classification (C2/C3): Fig. 4
  - Verification of the environmental class (E2/E3): Fig. 5

  SGB-SMIT is the first transformer manufacturer world-wide with internal C2/C3 and E2/E3 testing facilities!

- **External special tests:**
  - Test of fire behaviour (destructive test)
  - Dynamic short-circuit test according to IEC and GOST

Moreover, we have performed detailed measurements for the following areas together with external institutes:

- EMC Electro-magnetic compatibility, together with Systron EMV GmbH, Rednitzhembach
- Analysis of fire gases or low-temperature carbonization gases of cast resin transformer components, together with the "Allianz Zentrum für Technik", Munich
- Vibration test, together with IABG, Ottobrunn
- Certification for -50°C, together with Standard Elektro, Moscow

SGB-SMIT cast resin transformers are delivered in over 50 countries, and, of course, design, manufacture and testing are based on the standards relevant in these countries such as ANSI, IEEE or GOST.

1


2


3


4


5


Installation conditions

SGB-SMIT cast resin transformers make minimum demands on the site of installation. This results from the above-mentioned regulations regarding groundwater protection, fire protection, functional integrity in DIN VDE 0101, DIN VDE 0108 and ELT Bau VO (Body of regulations for the building trade). With SGB-SMIT cast resin transformers, no measures are required for water protection.

If however, the cast resin transformer with a rated voltage of over 1 kV is to be used for facilities accommodating crowds of people according to DIN VDE 0108 and ELT Bau VO, the additional requirements specified in these bodies of regulations apply.

SGB-SMIT cast resin transformers feature the degree of protection IP 00 and are intended for indoor installation. The cast resin surface of the transformer winding is not safe to touch in operation.

Cast resin transformers can be located in the same room as medium- and low voltage switchgear, thus permitting electrical connection over an extremely short distance. As in this case, no additional measures are required for oil collecting pans or fire protection, considerable costs can be saved for transformer cells as far as buildings are concerned. In case of outdoor installation, a housing is mandatory. To this effect, the IP type of enclosure of the housing must be specified by the customer.

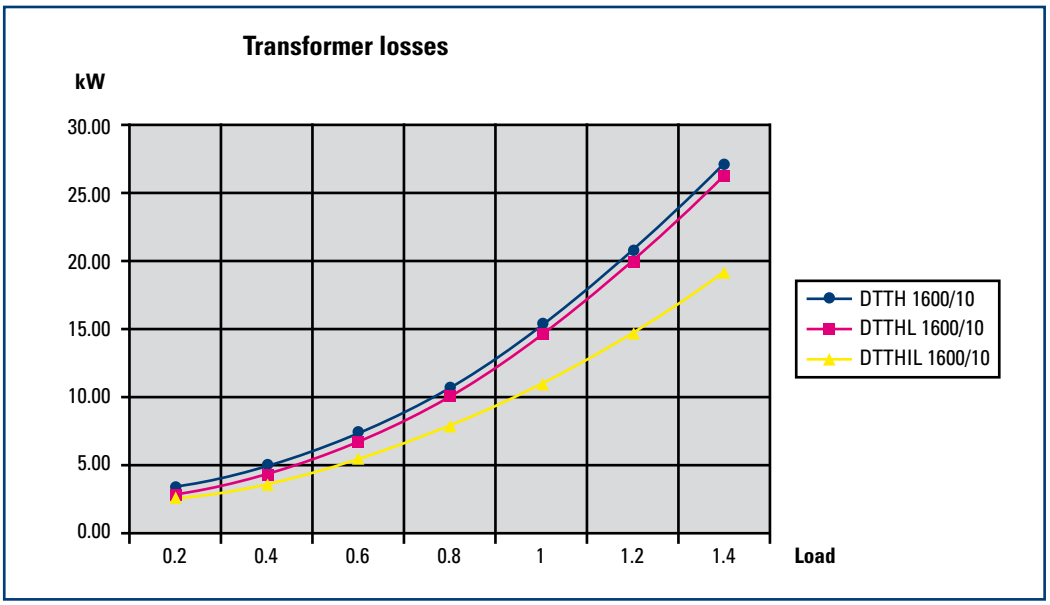
Especially extreme installation conditions on site must be taken into account when planning switchgear. Thus, special measures are required e. g. in case of utilization of a cast resin transformer at altitudes above 1,000 m due to the low air density. SGB-SMIT cast resin transformers are specially designed for utilization of cast resin transformers in ships, excavators, seismic areas, wind power plants etc. where increased mechanical strain is involved. SGB-SMIT also takes extreme temperature conditions into account in individual cases such as installation in especially cold or tropical areas, and the transformer design is adapted to local conditions accordingly.

Moreover, SGB-SMIT cast resin transformers feature the decisive advantage that all components are always visible, permitting any mechanical damage to be detected and repaired immediately.

Efficiency

Transformers are capital goods with a service life of many decades; thus, the purchaser should not only focus on the comparison of acquisition prices, but also and especially of the presumable maintenance costs and those resulting from no-load losses (iron core) and load losses (windings).

SGB-SMIT offers different loss variants from normal to highly reduced values.

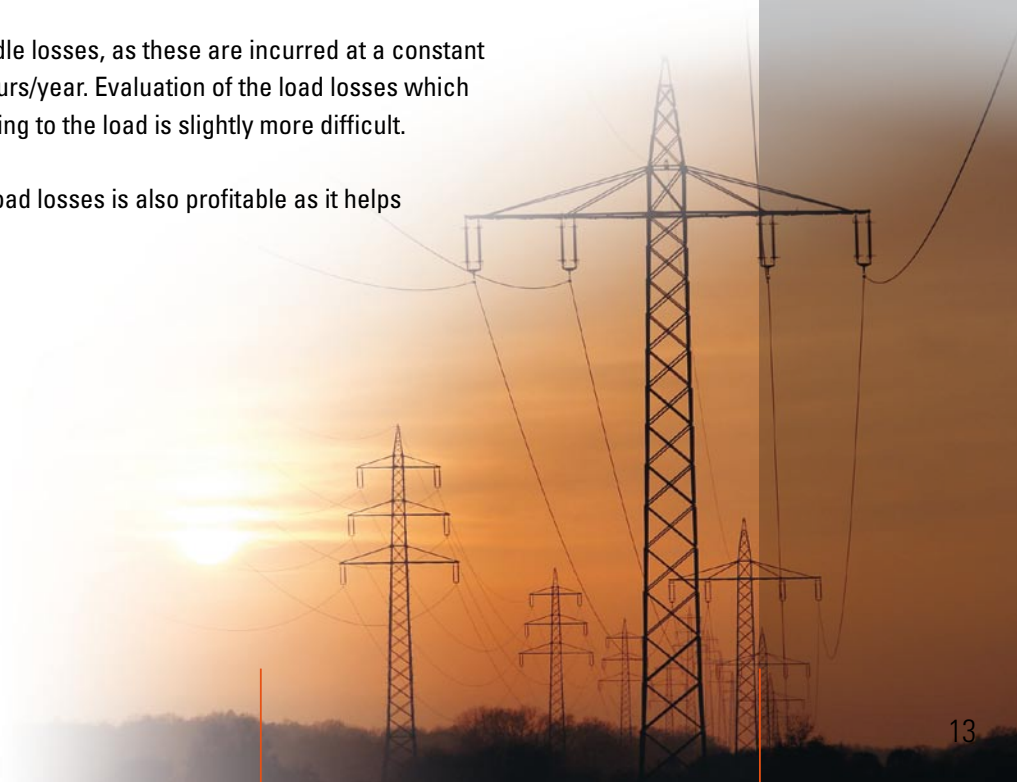


Basic diagram "Own consumption" as a function of the load

Higher acquisition costs due to higher outlay for laminations and winding materials coincide with lower operating costs.

It is relatively straightforward to evaluate idle losses, as these are incurred at a constant level over the entire service life of 8,760 hours/year. Evaluation of the load losses which exhibit quadratic growth or decline according to the load is slightly more difficult.

The use of transformers with reduced no-load losses is also profitable as it helps reduce noise emission.



Noise

Alongside selection of the appropriate induction and core material, the method of dovetailing legs and yokes in step-lap design as used at SGB-SMIT has a positive impact on the transformers' noise emissions and losses.

Electronic switching elements cause harmonics which may increase noise levels during operation considerably. This can be decreased by reducing induction.

The following characteristic figures for the noise emitted by cast resin transformers in AN operation can be used in practical application:

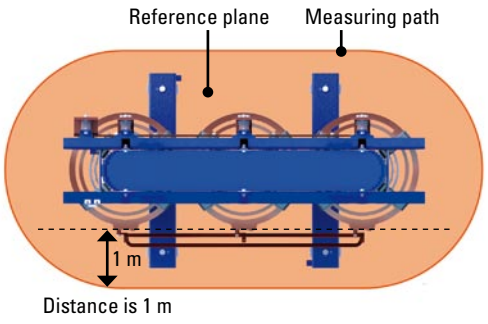
A – weighted emission sound pressure level $L_{\overline{PA}}$ expressed in dB
A – weighted emission sound pressure level L_{WA} expressed in dB
and appropriate measurement surface L_S expressed in dB.

The definition of these values and the manner in which noise measurement is to be performed has been defined in DIN EN 60076-10.
Important terms in this context are:

- Reference surface (of tight string length which includes the radiating surface)
- Length of measuring path p_m in m
- Area of measurement surface S in m^2

(To this effect, refer to the adjacent drawing.)

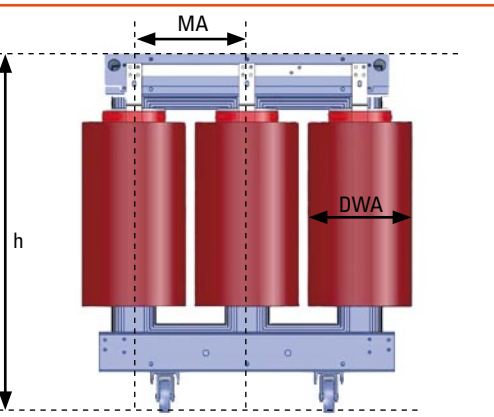
Measuring point arrangement for noise measurements on dry-type transformers without enclosure



As measurement of dry transformers cannot be effected, as in case of oil-filled transformers with their safe-to-touch tanks, at a distance of 0.3 m from the tank, measurement is performed at a distance of 1 m from the reference surface for safety reasons.

The following relationship between L_{WA} and $L_{\overline{PA}}$ with L_S has been defined in DIN EN 60076-10:

L_{WA} = $L_{\overline{PA}} + L_S$
L_S = 10 lg S : S_0 dB
S = 1,25 h x pm and S_0 = 1 m^2
pm = 4 MA + (DWA + 2) ϖ
MA = spacing in m
DWA = outer winding diameter in m
h = core height in m



Overload capacity

Thanks to the use of glass-fibre reinforced windings and of cooling ducts, our transformers are especially well suited for high short-time overloads – an especially important characteristic when the application involves great load fluctuations as occur with drives, wind or solar systems.

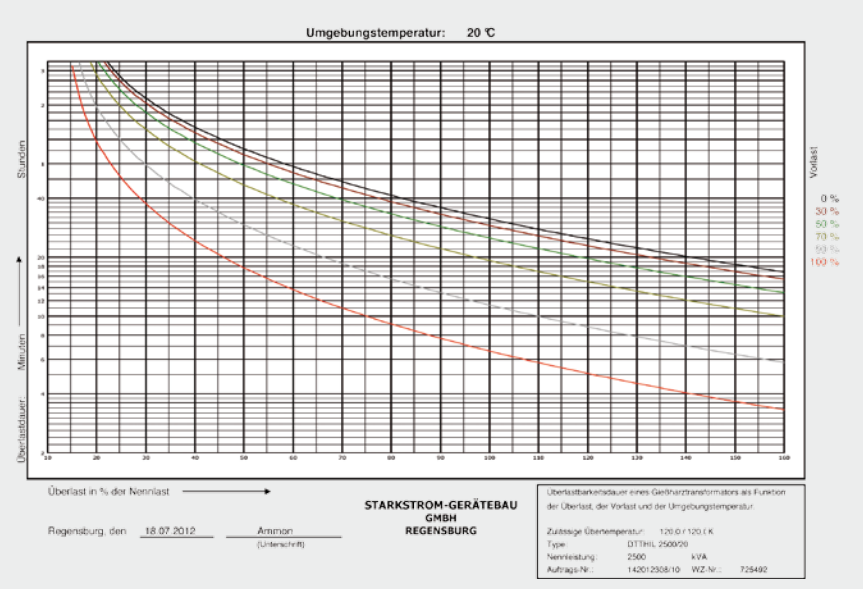
The IEC standard specifies that a transformer of insulation class F must withstand a short-time temperature of 180°C without suffering immediately damage. Our choice of the nominal functioning temperature is based on the admissible heating of the LV winding. It amounts, including the hot spot rate on the measuring point, to 120°C - 150°C, depending on the winding temperature rise, referred to the maximum coolant temperature of 40°C specified according to VDE 0532, part 6.

If the load in practical operation is below the rated power and the coolant temperature below 40°C, this results in winding temperatures below the admissible limits. This range can be utilized for overloads until the defined operating temperature of the thermistors is reached. The extent and the duration of the overload are determined by the preload, the actual ambient temperature and the winding time constant. This connection shows the diagram for a 2,500 kVA cast resin transformer, based on a coolant temperature of 20°C and various permanent preloads. Consequently, the transformer can be operated at 100 % of the permanent preload for a further approximately 40 minutes at 130 % of its rated power before the temperature monitoring system reacts.

As the parameter "winding time constant" depends to a great extent on the required technical data and the design, no generally valid overload diagrams can be displayed. On request, we will be pleased to create these via our calculation software, considering all design-specific parameters.

We have deliberately pointed out the overload capacity for the trigger temperature of the temperature monitoring system. Thus, we do not utilize a range exceeding the temperature limit.

And there are still reserves available ...



Electronic switching elements

Today, controllers are not only used for large consumers, but for almost all consumers, especially drive systems of all sizes. Furthermore, utilization of electronic switching elements has resulted in a considerable harmonic load in the supply grids.

In designing our transformers, we take the following into account:

- **Voltage harmonics influence induction and enhance no-load losses, noise and temperature increase.**
- **Current harmonics enhance especially the scattering losses in the windings.**
- **High voltage rises and high-frequency pulses impose strain on insulation.**
- **High load fluctuations impose both thermal and mechanical strain on the windings, core and supporting structures.**

Customers' specifications, especially regarding harmonics, enable SGB-SMIT to adapt the application accordingly.

SGB-SMIT cast resin transformers are especially well suited for high short-time overloads and current converter operation. Thanks to the encapsulation, the windings cannot shift in case of load surges – the low current density and induction and the high temperature class are important arguments.

According to customer requirements, we also design multi-layer winding-type transformers. To this effect, it is not only important to ensure that the transformer is suitable for operation, but also that performance and impedance are designed according to the grid code in question.

Temperature monitoring

Temperature monitoring via PTC (resistors whose resistance changes quickly once the operating temperature is reached) is provided in general for each cast resin transformer. As the LV and HV windings are thermally balanced, the thermistors are located on the LV winding for reasons of insulation. They offer special protection of the vacuum-encapsulated high voltage windings against inadmissibly high temperatures which may occur in situations of overload, insufficient cooling and high ambient temperatures. Subject to customer's request, PT100 and core monitoring by PT100 or PTC are also possible. Non-contact temperature monitoring is also available.

As a rule, two systems are installed:

- **Trip**
  This system signals exceeding of the temperature on which the normal service life consumption is based, i.e. rated continuous load at a coolant temperature of 20°C. It serves to warn operators and to instigate them to take remedial measures.
- **Alarm**
  This second system is tuned to match the temperature limit of the declared temperature class. In this case, the transformer must be switched off. Operation at excess temperature reduces the service life. The cables of the three resistors are series-connected to a terminal strip. From here, a two-wire connection is routed to the triggering unit which is supplied loose for free installation in the switchgear.

Analyzer	TS-01 / TS-02	Tec119 / Tec154	TR250	TR600	TR800
AC	24/40 - 270 V	24 - 240 V	24 - 240 V	24 - 60 V / 90 - 240 V	24 - 240 V
DC	40/24 - 240 V	24 - 240 V	24 - 240 V	24 - 60 V / 90 - 240 V	24 - 240 V
PT100	0 / 1	0 / 4	3	6	8
PTC	2 chains	3 chains[1] / 0	3 chains	no	8
Fan control	no / yes	yes	yes	yes	yes
Alarm	Change-over contact	Change-over contact	Change-over contact	Change-over contact	Change-over contact
Trip	Change-over contact	Change-over contact	Change-over contact	no	Change-over contact
Error	no / Change-over contact	Change-over contact	Change-over contact	no	Change-over contact
LED	Alarm, Trip, Voltage, Fan (TS-02)	Alarm, Trip, Voltage, Fan	Trip, Sensors	Trip, Sensors	Alarm, Trip, Voltage, Fan
Sensor monitoring	no / yes	yes	yes	yes	yes
contacts	6 A; 230 VAC	5 A; 250 VAC	5 A; 400 VAC 330 VDC	AC: 415 V x 5 A DC: 24 V x 48 W	AC 250 V x 8 A
Ambient temp.	-10°C to +50 °C	-20°C to +60 °C	-20°C to +65°C	-20°C to +65°C	-20°C to +65°C
CDigital display	no / yes	no / yes	no	yes	yes
Programmable	no / only fan	yes[2] / yes	yes	yes	yes
RS232 / RS485	no	no	no	RS485	RS485 and Web
Analog [mA]	no	no	no	no (possible TR400)	no
Specific feature		3 chains 1 to 6 PTC thermistors each	Motor transformer monitoring 2 to 3 point controller	Very flexible assignment of the inputs to the output signals	Access via internet

[1] 1 to 6 PTC thermistors each --> suitable for double-tier transformer

[2] only fan controller

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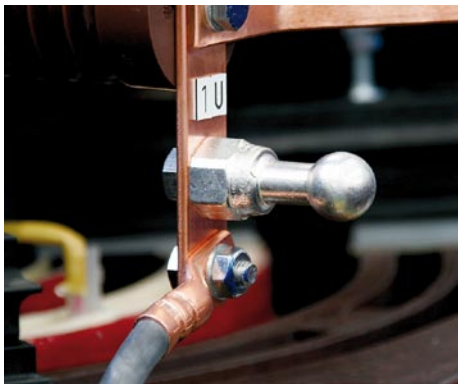
Accessories and optional equipment

Transformer equipment

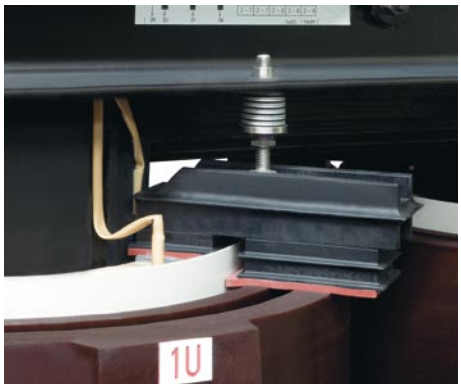
In addition to the basic elements core, windings and mechanical holding frame, additional equipment is often required to integrate the transformer into the electrical systen concerned.

We offer the following options:

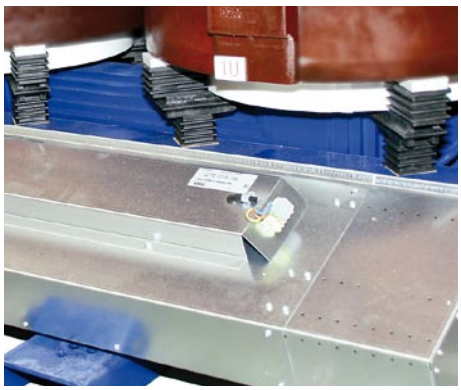
- Chassis with castors
- Locking device
- Transformer bearing
- Spherical-head connector
- Earthing switch, Earthing kit
- Fan (output increase up to 40 %)
- Temperature measurement
- Deadening of vibrations by mat or vibration absorber
- Vibration-proof design
- Seismic design
- Shielding winding
- Switchability, high voltage
- PTC / PT100 thermo sensor
- Dial thermometer
- Premagnetizing unit
- Current transformer (HV or LV)
- Special tests (e.g. inflammability)
- E2/C2 tests in internal test chambers

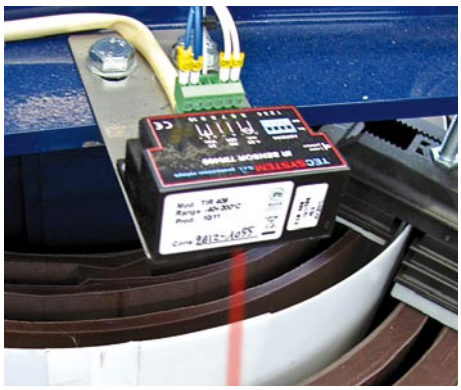


Spherical-head connector



PTC/PT100 thermo sensor


Fan


Temperature measurement

Housing

As a result of their design, cast resin transformers are not safe to touch. Thus, in case of installation in an accessible location, protective equipment and/or housings are required; their protection degree can be selected according to DIN 40 050 and DIN 57 101 / VDD 101.

SGB-SMIT housings:

- Protection class IP20 to IP44 available
- Design of cooling from AN (convection-cooled) via AF (fan-cooled) to AFWF (air/water-cooled)
- Low-cost standard housings with various equipment options
- Straightforward assembly on site by delivery in preassembled condition
- For indoor installation, we offer IP23 and, for outdoor installation, IP33
- Roof coolers can be provided
- Standard paint RAL 7032 or 7035. Other paint available on request
- For cable connection from below, entry plates and metal supports are provided.
- Entry from above via divided housing top.

The housings feature air entry and outlet ports to dissipate the transformer's power loss for natural or forced air cooling. On the installation site, free supply and discharge of the required cooling air must be ensured.

Favourable standard housings:

- 3 sizes
- Type of protection IP 21
- Suitable for floor installation
- With integrated NIEDAX cable fastening
- Delivery in ready-assembled condition or as modular kit for assembly by the customer
- Housing components manufactured of hot-galvanized sheet metal

Type	Length	Width	Height	Weight	up to
SGB 1	1.700 mm	1.100 mm	1.700 mm	ca. 150 kg	800 kVA/20 kV
SGB 2	2.200 mm	1.200 mm	2.200 mm	ca. 215 kg	1.600 kVA/20 kV
SGB 3	2.700 mm	1.500 mm	2.400 mm	ca. 300 kg	2.500 kVA/20 kV

Further housings available on request.

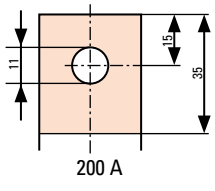
Special housing designs:

Electrical connections

- As standard, high voltage and low voltage terminals are positioned vis-à-vis on the longitudinal sides of the transformer. (Fig. 1)
- The low voltage connecting bars, including the star point, are routed out at the top. (Fig. 2)
- The HV terminal points are integrated mechanically and electrically into the HV cast resin coil, together with the tapping lugs for voltage change-over. (Fig. 3)

HV terminal with tapping sleeves

LV terminals drilled according to DIN 46206 (Fig. 2)



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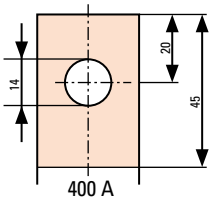
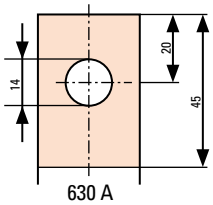
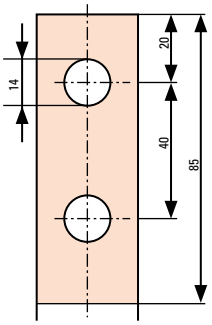


400 A



630 A



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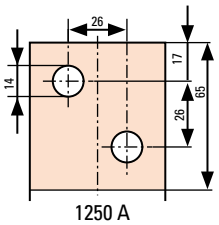
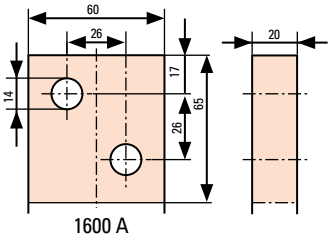
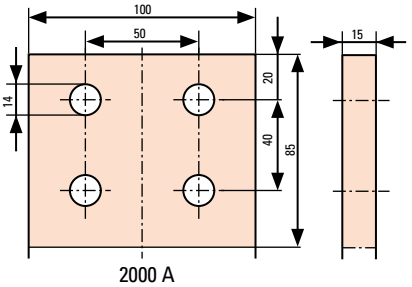


1250 A



1600 A



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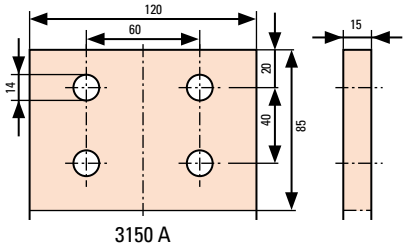
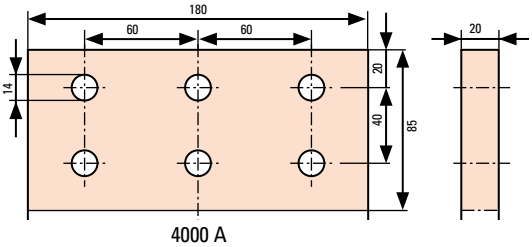


3150 A



4000 A

Selection Table, series 10 (U_m = 12 kV)

DTTH (EN 50541-1, Bk/Co); DTTHL (EN 50541-1, Bk/B0), DTTHN (EN 50541-1, Ak/A0)

DTTHM: Special execution with especially reduced L_{WA}

DTTHIL: Especially reduced losses

Power kVA	Type	HV - LV kV	P_0 W	P_k 120°C W	U_k %	L_{WA} dB (A)	Length mm	Width mm	Height mm	Total Weight kg
100	DTTHL	10 - 0,4	330	2000	4	51	920	670	1050	550
160	DTTHL	10 - 0,4	450	2700	4	54	1100	670	1100	850
250	DTTHL	10 - 0,4	610	3500	4	57	1140	670	1200	1050
250	DTTHM	10 - 0,4	500	3500	4	52	1160	670	1150	1200
400	DTTH	10 - 0,4	1150	4900	4	68	1300	820	1400	1200
400	DTTHL	10 - 0,4	880	4900	4	60	1300	820	1400	1400
400	DTTHM	10 - 0,4	700	4900	4	54	1400	820	1400	1700
400	DTTHYL	10 - 0,4	880	4900	6	60	1350	820	1400	1300
630	DTTH	10 - 0,4	1500	7300	4	70	1450	820	1500	1750
630	DTTHL	10 - 0,4	1150	7300	4	62	1400	820	1500	2000
630	DTTHM	10 - 0,4	950	7300	4	53	1450	820	1600	2000
630	DTTHN	10 - 0,4	1000	6700	4	62	1400	820	1800	2000
630	DTTHYL	10 - 0,4	1150	7300	6	62	1520	820	1440	1800
800	DTTH	10 - 0,4	1800	9000	6	71	1600	820	1450	1900
800	DTTHL	10 - 0,4	1300	9000	6	65	1600	820	1500	2000
800	DTTHN	10 - 0,4	1100	8000	6	64	1560	820	1980	2500
800	DTTHIL	10 - 0,4	1350	5700	6	61	1640	820	1700	2600
1000	DTTH	10 - 0,4	2100	10000	6	73	1600	980	1600	2150
1000	DTTHL	10 - 0,4	1500	10000	6	67	1660	980	1760	2300
1000	DTTHN	10 - 0,4	1300	9000	6	65	1700	980	1950	3100
1000	DTTHIL	10 - 0,4	1550	6800	6	63	1750	980	1850	3200
1250	DTTH	10 - 0,4	2500	12000	6	75	1740	980	1760	2700
1250	DTTHL	10 - 0,4	1800	12000	6	69	1780	980	1850	3100
1250	DTTHN	10 - 0,4	1500	11000	6	67	1800	980	2050	3700
1250	DTTHIL	10 - 0,4	1850	8700	6	64	1800	980	2050	3650
1600	DTTH	10 - 0,4	2800	14500	6	76	1750	980	2050	3250
1600	DTTHL	10 - 0,4	2200	14500	6	71	1820	980	2000	3750
1600	DTTHN	10 - 0,4	1800	13000	6	68	1900	980	2050	4350
1600	DTTHIL	10 - 0,4	2250	10000	6	65	1950	980	2150	4600
2000	DTTH	10 - 0,4	3600	18000	6	78	2040	1270	2100	4300
2000	DTTHL	10 - 0,4	2600	18000	6	71	1900	1270	2200	4400
2000	DTTHN	10 - 0,4	2200	15500	6	70	2000	1270	2100	5000
2000	DTTHIL	10 - 0,4	2800	13300	6	67	1960	1270	2200	4800
2500	DTTH	10 - 0,4	4300	21000	6	81	2100	1270	2200	4900
2500	DTTHL	10 - 0,4	3200	21000	6	75	2100	1270	2240	5600
2500	DTTHN	10 - 0,4	2600	18500	6	71	2050	1270	2350	5500
2500	DTTHIL	10 - 0,4	3150	17000	6	68	2100	1270	2200	5900
3150	DTTH	10 - 0,4	5300	26000	6	83	2250	1270	2250	5800
3150	DTTHL	10 - 0,4	3800	26000	6	77	2250	1270	2350	6600
3150	DTTHN	10 - 0,4	3150	22000	6	74	2250	1270	2500	7600
4000	DTTHIL	10 - 0,69	6500	30000	8	74	2550	1270	2350	7400
4000	DTTHIL	10 - 6,0	5500	22000	8	74	2700	1270	2650	7800
5000	DTTHIL	10 - 0,69	8000	26500	8	76	2700	1270	2550	10500
5000	DTTHIL	10 - 6,0	6500	25500	7	77	2700	1705	2450	11500
6300	DTTHIL	10 - 6,0	9000	30500	7	78	3000	1705	2600	13000
8000	DTTHIL	10 - 6,0	12000	33500	7	81	3100	1705	2750	16500
10000	DTTH	10 - 6,0	14000	50500	10	84	3450	1705	2500	18400

Selection Table, series 20 (U_m = 24 kV)

DTTH (EN 50541-1, Bk/Co); DTTHL (EN 50541-1, Bk/B0), DTTHN (EN 50541-1, Ak/A0)

DTTHM: Special execution with especially reduced L_{WA}

DTTHIL: Especially reduced losses

Power kVA	Type	HV - LV kV	P_0 W	P_k 120°C W	U_k %	L_{WA} dB (A)	Length mm	Width mm	Height mm	Total Weight kg
100	DTTHL	20 - 0,4	340	2050	6	51	1280	670	1350	800
160	DTTHL	20 - 0,4	480	2900	6	54	1150	670	1250	850
250	DTTHL	20 - 0,4	650	3800	6	57	1340	670	1300	1100
250	DTTHM	20 - 0,4	530	3800	6	49	1400	670	120	1150
400	DTTH	20 - 0,4	1200	5500	6	68	1500	820	1460	1350
400	DTTHL	20 - 0,4	940	5500	6	60	1500	820	1500	1400
400	DTTHM	20 - 0,4	770	5500	6	52	1550	820	1460	1800
400	DTTHXL	20 - 0,4	1100	4900	4	68	1450	820	1480	1500
630	DTTH	20 - 0,4	1650	7600	6	70	1600	820	1550	1750
630	DTTHL	20 - 0,4	1250	7600	6	62	1600	820	1650	2100
630	DTTHM	20 - 0,4	1000	7600	6	56	1600	820	1700	2350
630	DTTHN	20 - 0,4	1100	7100	6	62	1620	820	1750	2150
630	DTTHXL	20 - 0,4	1600	6900	4	70	1500	820	1600	2350
800	DTTH	20 - 0,4	2000	9400	6	72	1600	820	1750	2100
800	DTTHL	20 - 0,4	1500	9400	6	64	1660	820	1660	2250
800	DTTHN	20 - 0,4	1300	8000	6	64	1720	820	1850	2700
800	DTTHIL	20 - 0,4	1450	5900	6	62	1820	820	1660	2700
1000	DTTH	20 - 0,4	2300	11000	6	73	1700	980	1840	2400
1000	DTTHL	20 - 0,4	1800	11000	6	65	1800	980	1850	2650
1000	DTTHN	20 - 0,4	1550	9000	6	65	1800	980	2000	3100
1000	DTTHIL	20 - 0,4	1700	7200	6	62	1840	980	2000	3350
1250	DTTH	20 - 0,4	2800	13000	6	75	1850	980	1900	3000
1250	DTTHL	20 - 0,4	2100	13000	6	67	1900	980	2100	3500
1250	DTTHN	20 - 0,4	1800	11000	6	67	1900	980	2100	3700
1250	DTTHIL	20 - 0,4	2200	8650	6	53	1900	980	1950	3700
1600	DTTH	20 - 0,4	3100	16000	6	76	1940	980	2100	3600
1600	DTTHL	20 - 0,4	2400	16000	6	68	1900	980	2200	4100
1600	DTTHN	20 - 0,4	2200	13000	6	68	2000	980	2100	4350
1600	DTTHIL	20 - 0,4	2450	10450	6	65	1960	980	2200	4600
2000	DTTH	20 - 0,4	4000	19500	6	78	2100	1270	2200	4300
2000	DTTHL	20 - 0,4	3000	18000	6	73	2100	1270	2250	4800
2000	DTTHN	20 - 0,4	2600	16000	6	70	2100	1270	2250	4900
2000	DTTHIL	20 - 0,4	3000	13500	6	68	2100	1270	2250	5400
2500	DTTH	20 - 0,4	5000	23000	6	81	2250	1270	2300	5400
2500	DTTHL	20 - 0,4	3600	23000	6	71	2200	1270	2300	6100
2500	DTTHN	20 - 0,4	3100	19000	6	71	2100	1270	2350	5700
2500	DTTHIL	20 - 0,4	3700	16300	6	68	2200	1270	2300	6350
3150	DTTH	20 - 0,4	6000	28000	6	83	2300	1270	2400	6400
3150	DTTHL	20 - 0,4	4300	28000	6	74	2450	1270	2450	7200
3150	DTTHN	20 - 0,4	3800	22000	6	74	2350	1270	2550	8200
4000	DTTHIL	20 - 0,69	7200	22500	6	74	2500	1270	2500	8500
5000	DTTHIL	20 - 0,69	8000	25000	7	76	2700	1270	2550	10500
6300	DTTHIL	20 - 6,0	9000	30500	7	78	3000	1705	2600	13000
8000	DTTHIL	20 - 6,0	12000	33500	7	81	3100	1705	2750	16500
10000	DTTHIL	20 - 6,0	14000	41500	7	84	3200	2050	2800	18000

Selection Table, series 30 (U_m = 36 kV)

DTTH (EN 50541-1, Ck/Co); DTTHL (EN 50541-1, Bk/B0), DTTHN (EN 50541-1, Bk/A0)

DTTHM: Special execution with especially reduced L_{WA}

DTTHIL: Especially reduced losses

Power kVA	Type	HV - LV kV	P_0 W	P_k 120°C W	U_k %	L_{WA} dB (A)	Length mm	Width mm	Height mm	Total Weight kg
630	DTTH	30 - 0,4	2200	8000	6	71	1850	670	2050	2350
630	DTTHL	30 - 0,4	1600	7500	6	68	1900	670	2050	2550
630	DTTHN	30 - 0,4	1400	7500	6	63	1850	670	2050	2750
630	DTTHIL	30 - 0,4	1400	7000	6	63	1850	670	2050	2800
800	DTTH	30 - 0,4	2700	9600	6	72	1900	820	2050	2500
800	DTTHL	30 - 0,4	1900	9000	6	69	1900	820	2050	2650
800	DTTHN	30 - 0,4	1650	9000	6	64	1850	820	2050	2900
800	DTTHIL	30 - 0,4	1650	8400	6	64	1850	820	2050	3000
1000	DTTH	30 - 0,4	3100	11500	6	73	2050	980	2050	2950
1000	DTTHL	30 - 0,4	2250	11000	6	70	2050	980	2150	3150
1000	DTTHN	30 - 0,4	1900	11000	6	65	2000	820	2200	3600
1000	DTTHIL	30 - 0,4	1900	10000	6	65	2000	820	2200	3700
1250	DTTH	30 - 0,4	3600	14000	6	75	2150	980	2100	3500
1250	DTTHL	30 - 0,4	2600	13000	6	72	2050	980	2300	3850
1250	DTTHN	30 - 0,4	2200	13000	6	67	2150	980	2300	4250
1250	DTTHIL	30 - 0,4	2200	12000	6	67	2100	980	2300	4350
1600	DTTH	30 - 0,4	4200	17000	6	76	2200	980	2300	4200
1600	DTTHL	30 - 0,4	3000	16000	6	73	2200	980	2350	4850
1600	DTTHN	30 - 0,4	2550	16000	6	68	2250	980	2450	5100
1600	DTTHIL	30 - 0,4	2550	14000	6	68	2300	980	2450	5250
2000	DTTH	30 - 0,4	5000	21000	6	78	2350	1270	2400	5000
2000	DTTHL	30 - 0,4	3500	19500	6	74	2400	1270	2400	6200
2000	DTTHN	30 - 0,4	3000	18500	6	72	2400	1270	2550	7700
2000	DTTHIL	30 - 0,4	3000	17000	6	72	2450	1270	2550	7800
2500	DTTH	30 - 0,4	5800	25000	6	81	2500	1270	2450	6100
2500	DTTHL	30 - 0,4	4200	22500	6	78	2500	1270	2500	7500
2500	DTTHN	30 - 0,4	3500	22500	6	73	2550	1270	2650	9150
2500	DTTHIL	30 - 0,4	3500	20000	6	73	2550	1270	2650	9300
3150	DTTH	30 – 0,4	6700	30000	6	83	2650	1270	2650	7750
3150	DTTHL	30 – 0,4	5000	27500	6	81	2650	1270	2650	8850
3150	DTTHN	30 – 0,4	4100	27500	6	76	2700	1270	2700	10900
3150	DTTHIL	30 – 0,4	4100	25000	6	76	2700	1270	2700	11400
4000	DTTHIL	30 – 0,69	8000	28200	8	76	2750	1270	2700	8750
5000	DTTHIL	30 - 0,69	8500	32000	8	76	2900	1270	2350	11000
5000	DTTHIL	30 - 6,0	8500	30000	7	77	3000	1705	2650	12500
6300	DTTHIL	30 - 6,0	10000	30000	7	79	3100	1705	2800	15000
8000	DTTHIL	30 - 6,0	14500	37000	8	81	3320	1815	2630	13650
10000	DTTHIL	30 - 6,0	17500	49500	8	85	3540	1835	2700	19000

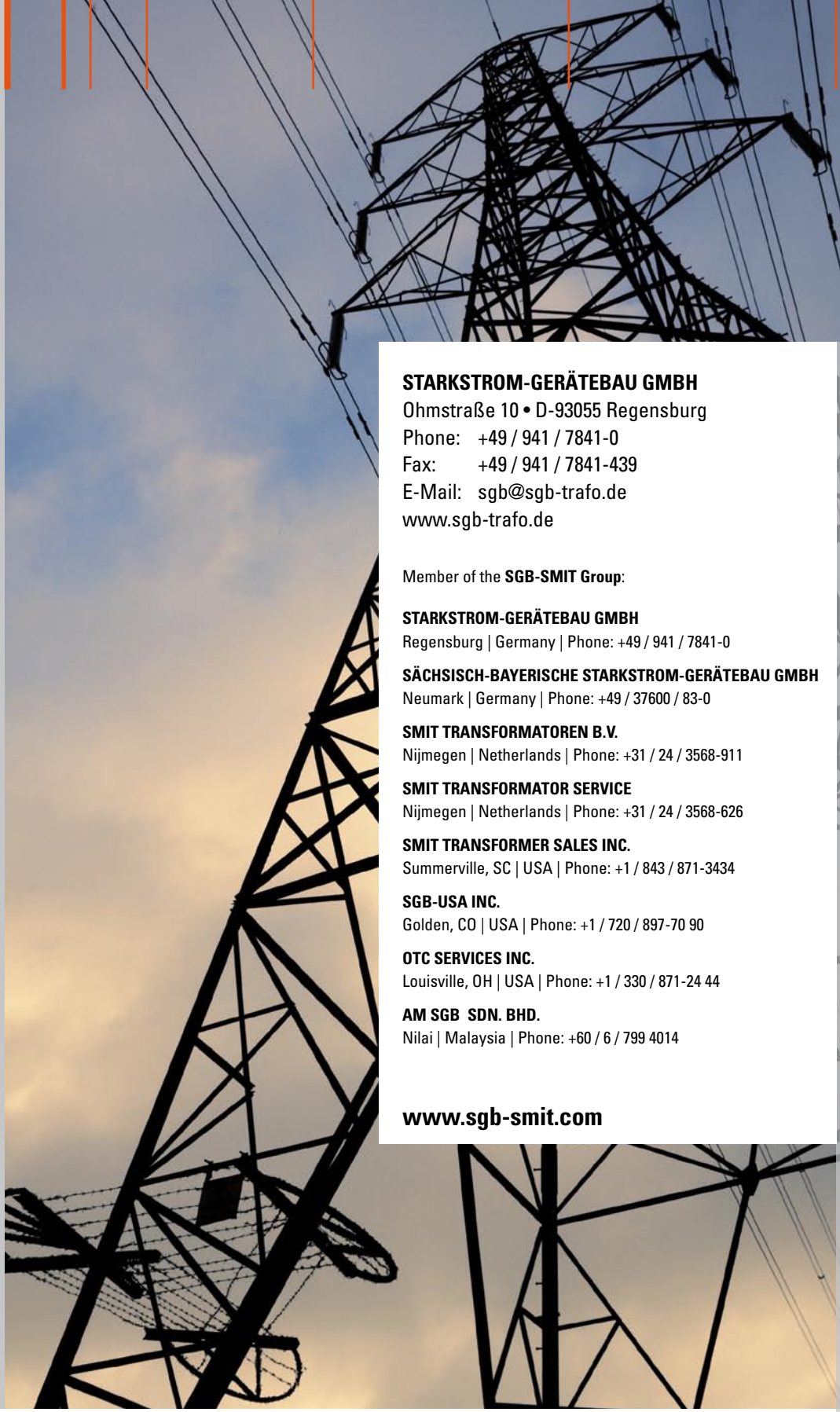
The following applies to all Tables on pages 21 - 23:

- Indoor design E2; C2; F1 with taps ±2 x 2.5%, Vector group Dyn 5
- Dimensions, weights and sound levels are standard values.
- Specified sound levels apply for AN operation without housing.
- Lightning impulse voltages in according with IEC 60 076.
- Sound pressure level, measuring distance 1 m { L_p(A) in [dB(A)] }

Diverging power ratings, vector groups and diverging test levels available on request.

Details regarding general engineering instructions, installation conditions or terminals are available on the internet at: **www.sgb-smit.com/de/produkte/giessharztransformatoren.html**

Partners in Power



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