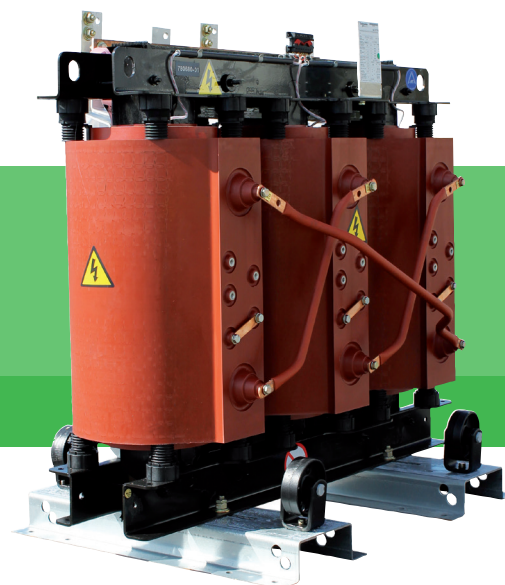


2016 Catalog



# Trihal

Cast resin transformer

Distribution Transformers



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# Presentation

# Presentation

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PM105911



Trihal with enclosure

## Setting a new standard for dry-type cast resin transformers

For a high level of safety and exceptional environmental friendliness, there's nothing to beat a dry-type cast resin transformer.

The epoxy resin insulation used in this kind of transformer means no oil is used, greatly reducing the risk of fire and improving recyclability, all without loss of performance compared to other transformer types. Dry-type cast resin transformers are therefore ideal for critical applications and high-traffic areas.

Even among dry-type cast resin transformers, Trihal from Schneider Electric stands out due to its outstanding performance and unrivalled certifications.

Trihal is a best-in-class range of dry-type cast resin transformers, rated from 160 kVA up to 15 MVA, with insulation rated up to 36 kV. It's perfectly suited to a wide variety of industries, from densely-populated buildings and critical infrastructure to heavy industry and renewable energy production.

Crucially, Trihal's safety and performance certifications are without equal, and the range is compliant with IEC60076-11 and IEC60076-16, as well as ISO 9001, ISO 14001 and ISO 18001.

All this results in optimum efficiency with very little maintenance, for a long service life.



Hospitals



Data centers

Food and  
beverage

Airports



Nuclear



Buildings

Mining, metal  
& minerals

Automotive



Wind



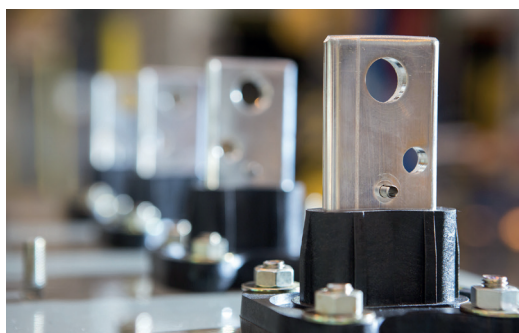
Oil and gas

PM105912



Magnetic core

PM105913



Assembly line

## Technology and construction

Trihal benefits from two key processes:

- a linear voltage gradient from top to bottom of the HV coil, generally used
- a fireproof casting system

This technology developed by Schneider Electric has wide variety of applications and meets different customer requirements.

## Type and range

Trihal is a three-phase dry-type transformer cast under vacuum in epoxy resin with an active filler.

This active filler, composed of alumina trihydrate, is the origin of the Trihal trademark.

Trihal transformers are supplied with or without an enclosure and from 160 kVA to 15 MVA and up to 36 kV.

## Environmental protection

The Trihal competence center was the first French facility to be certified ISO 14001 in this sector, and has been since 1998.

Trihal is designed and manufactured to be environmentally-friendly, providing an ecological solution for HV/LV transformers.

Environmental protection is integrated in our management systems in order to promote the protection of all natural resources and continuously improve conditions for a clean environment.

The product design focuses on minimizing its environmental impact.

## Standards and configurations

	Standard design	Possible adaptation
<b>Manufacturing standards</b>	IEC 60076-11, EN 50588, EN 50629	GOST-R, BS, IEEE
<b>Class tests</b>	C3*, E3, F1, $\leq 5$ pC	
<b>HV/LV coils</b>	HV encapsulated in cast resin/LV impregnated	HV and LV encapsulated in cast resin
<b>Installations</b>	Indoor use: <ul style="list-style-type: none"> <li>IP00 (without enclosure)/IP31 (with enclosure)</li> <li>C2 Corrosivity class, Medium durability (in compliance with ISO 12944-6)</li> </ul>	Outdoor use with properly designed enclosure: <ul style="list-style-type: none"> <li>From IP35 up to IP44 (with enclosure)</li> <li>Up to C5-Marine, Medium durability (in compliance with ISO 12944-6)</li> </ul>
<b>Winding material</b>	According to manufacturer optimization (Cu)	Cu/Cu
<b>Phases</b>	Three-phase	Single-phase
<b>Cooling system</b>	Standard: <ul style="list-style-type: none"> <li>AN (natural air)</li> </ul> Option: <ul style="list-style-type: none"> <li>AF (air forced)</li> <li>40% performance reserves</li> </ul>	AFWF (air forced water forced)
<b>Maximum T°C/altitude</b>	40°C at any time/1000 m	Up to 65°C/Above 1000 m
<b>Thermal class insulation</b>	According to IEC 60085, Class F	
<b>Temperature rise</b>	100 K	80 K (for 40°C) Temperature rise adapted to maximum T°C
<b>Rated frequency</b>	50 Hz or 60 Hz	
<b>Rated power</b>	Up to 3150 kVA	Up to 15 MVA
<b>Impedance voltage Uk</b>	From 4 to 6%	<ul style="list-style-type: none"> <li>Lower than 4%</li> <li>Higher than 6% - Up to 11%</li> </ul>
<b>Vector groups</b>	Dyn, YNd	All others according to IEC
<b>Rated HV insulation</b>	Up to 36 kV (IEC)	Up to 40.5 kV (GOST-R)
<b>HV tapping</b>	Off-circuit tapping links: 3 or 5 positions, +/- 2.5%	Off-circuit tapping links: up to 9 positions, +/- 2.5% or higher
<b>HV terminals</b>	Standard HV connections	HV/MV plug-in or porcelain bushings through dedicated cable boxes (IEC, BS or NEMA compliant)
<b>Rated LV (MV) insulation</b>	1.1 kV	Up to 7.2 kV
<b>LV terminals</b>	<ul style="list-style-type: none"> <li>Standard LV connections</li> <li>Top or bottom entry (on request)</li> </ul>	<ul style="list-style-type: none"> <li>LV cable ducting interface (Canalis)</li> <li>Side entry through dedicated cable boxes (IEC, BS or NEMA compliant)</li> </ul>
<b>Thermal protection</b>	<ul style="list-style-type: none"> <li>AN cooling system: 6 PTC sensors (or 3 PT100) + Thermal Relay</li> <li>AF cooling system: 9 PTC sensors (or 6 PT100) + Thermal Relay</li> </ul>	



## Standards and configurations

	Standard design	Possible adaptation
Accessories	<ul style="list-style-type: none"><li>Standard: 4 bi-directional flat rollers, 4 lifting holes, 4 carriage holes on the sub-base, 2 earthing points, rating plate</li><li>Most common options: Anti-vibration pads, remote communication for thermal relay, marshalling box, earthing ball, surge arresters</li></ul>	Locking device for plug-in bushings, current transformers, automatic voltage regulator panel, On Load Tap Changer, special paint color for enclosure
Test certificate	Routine tests: in accordance with IEC 60076-11	<ul style="list-style-type: none"><li>Type tests: in accordance with IEC 60076-11: temperature rise test, lightning impulse test</li><li>Special tests: in accordance with IEC 60076-11: noise level measurement, short-circuit test</li><li>Others: seismic test resistance, climatic, environmental or fire class tests</li></ul>

# Technology

# Technology

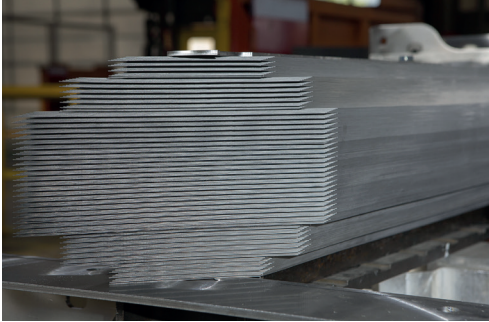
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Control of the industrial process: very low partial discharge rate ( $\leq 5$  pC).

PM105914



Magnetic core being assembled

PM105915



LV winding with foil technology

## Magnetic core

The magnetic core is made from laminated grain-oriented silicon steel.

The choice and grade of steel and the cutting pattern and method of assembly minimize the loss level and the no-load current, resulting in a very low noise level.

Once assembled, it is protected against corrosion.

## LV winding

The LV winding is made of either aluminium or copper foil to eliminate axial stress under short-circuit conditions; the foil is insulated by a Class F inter-layer film, pre-impregnated with heat-activated epoxy resin.

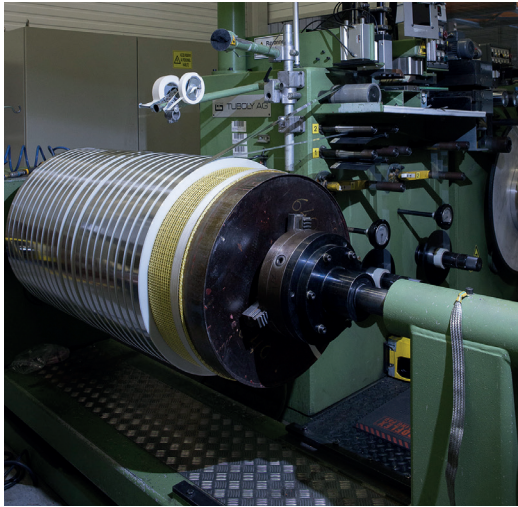
The ends of the windings are protected and insulated using end packing made of Class F materials.

The whole winding is polymerized by being placed in an autoclave for 2 hours at 130°C, which guarantees:

- outstanding resistance to harsh industrial atmospheres
- excellent dielectric withstand
- very good resistance to radial stress under short-circuit conditions

Each LV winding ends in a tin-plated aluminum or copper connection point, enabling connections to be made without using a contact interface.

PM105916



HV winding with strip technology

## HV winding

The HV winding is usually wound from insulated aluminum or copper wire, using a method developed and patented by Schneider Electric: “a linear voltage gradient from top to bottom”.

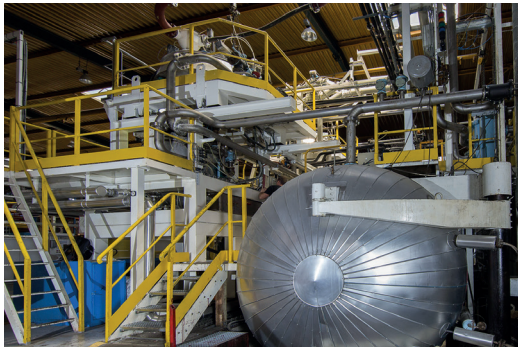
For higher currents, the MV winding can be wound using “strip” technology. These methods are used to obtain very low stress levels between adjacent conductors.

This winding is casted and molded under vacuum using Class F filling and fireproofed resin: the Trihal casting system.

These processes give coils very high dielectric properties with very low partial discharge level (guaranteed  $\leq 5 \text{ Pc}$ )<sup>(1)</sup> which is a decisive factor in influencing the transformer's life span and its lightning impulse withstand<sup>(2)</sup>.

HV tapping points on the copper connection bars enable connections to be made without using a contact interface (grease, bi-metallic strip).

PM105917



HV casting process

## HV casting system

The system provides a vacuum-cast coating of fire-resistant filled resin, a technology developed and patented by Schneider Electric.

The Class F casting system comprises:

- A bisphenol-based epoxy resin with sufficient viscosity to ensure excellent impregnation of the windings
- An anhydride hardener ensures very good thermal and mechanical properties. A flexibilizing additive gives the casting system the necessary elasticity to prevent cracking during operation
- An active powdered filler consisting of silica and especially of alumina trihydrate thoroughly mixed with the resin and the hardener
- Silica, which reinforces the casting's mechanical strength and improves heat dissipation.

The alumina trihydrate guarantees the Trihal transformer's intrinsic fire performance. Alumina trihydrate produces 3 fire-retardant effects which occur in the event of calcination of the casting system (when the transformer is exposed to flames).

- 1st fire-retardant effect: refracting shield of alumina
- 2nd fire-retardant effect: barrier of water vapor
- 3rd fire-retardant effect: temperature held below the fire point

The result of all 3 fire-retardant effects is immediate self-extinguishing of the Trihal transformer.

In addition to its dielectric qualities, the casting system gives the Trihal transformer excellent self-extinguishing fire resistance and excellent environmental protection against harsh industrial atmospheres.

(1) Validated in external laboratory.

(2) It is important to note that the level of partial discharge remains the same throughout the transformer's service life.

## HV coil casting process

The process, from proportioning the resin through to polymerization, is fully controlled by microprocessor, preventing any inopportune manual operation.

The alumina trihydrate and the silica are vacuum-dried and degassed to eliminate all traces of humidity and air which could degrade the casting system's dielectric characteristics.

Half is mixed with the resin and half with the hardener under hard vacuum and at a controlled temperature, to give two homogenous pre-mixes.

Another thin film degassing precedes the final mixing. Vacuum casting is then carried out in dried and pre-heated molds at an optimal impregnation temperature.

The polymerization cycle begins with gelification at 80°C and ends with long polymerization at 140°C.

These temperatures are close to those of a transformer in service, enabling mechanical stresses to be eliminated which could lead to the coating cracking.

PM105918



HV coil support wedges

## HV coil support wedges

The high voltage winding is centered on the magnetic core and held in place vertically by an efficient wedging system. Thanks to the unique design of these wedges they can be assembled in a variety of ways to suit different levels of HV insulation.

The wedges are designed according to customers' needs to cope with different environmental and mechanical conditions (seismic withstand, vibration etc.).



# Options and accessories



# Options and accessories

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Z thermal protection using PTC sensors	20
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## Trihal Cast/Cast benefits:

- Guaranteed against fire hazards (self-extinguishing)
- Totally insensitive to harsh environments (pollution or condensation)
- Easy and quick to install with a minimum maintenance
- Enhances the mechanical stability and shock withstandability during the thermal overloads
- Adapts itself to significant temperature and load changes

## Trihal Cast / Cast

Trihal Cast / Cast Cast Resin transformers provide high reliability and long durability with both MV and LV windings casted under vacuum. It is a perfect solution for harsh environmental conditions such as high pollution or humidity. It also provides enhanced mechanical and thermal features.

### Application fields:

- O&G, MMM,
- Utilities, Power plants, Water, Nuclear
- Infrastructure: Public and commercial buildings such as Airports, Hospitals, etc.
- Small Industries: Textile, Automotive, Pharmaceuticals, Food, etc.

## Trihal LV/LV benefits:

- Guaranteed against fire hazards (self-extinguishing)
- Totally insensitive to harsh environments (pollution or condensation)
- Easy and quick to install with a minimum maintenance

## Trihal LV/LV up to 400 kVA - 1.1 kV

Trihal LV/LV Cast Resin transformers provide reliability and longevity in harsh environmental conditions such as high pollution or humidity. It adapts to significant temperature and charge variation constraints.

### Description:

Trihal LV/LV is suitable for:

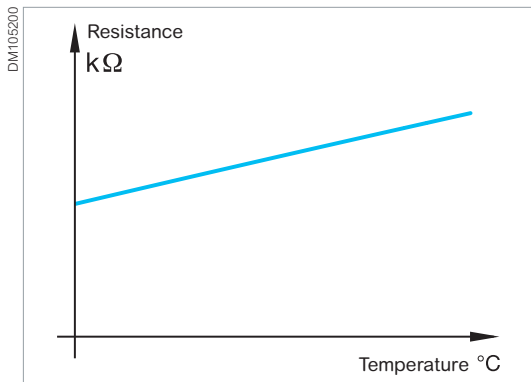
- Earthing transformer
- Change of earthing system
- Isolate network disturbances
- Change of network voltage
- Galvanic isolation
- Energy conversion
- Dimmer monitoring
- High power transformer pre-magnetization

### Application fields:

- Buildings
- Industry
- Oil & Gas
- Marine
- Secure Networks



Trihal LV/LV



Typical graph of a PT100 sensor

The Trihal cast resin transformer can be protected by monitoring the winding temperature.

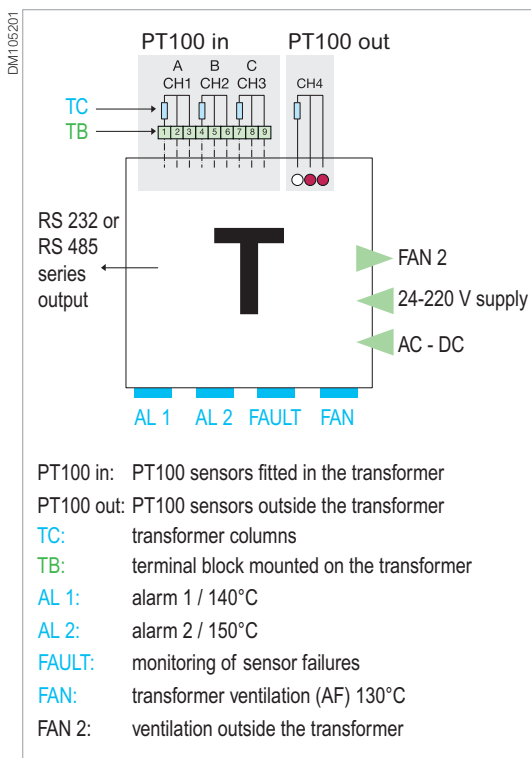
This monitoring is done by:

- PT100 sensors + associated relay for alarm and trip and real-time temperature monitoring
- PTC sensors + associated relay for alarm and trip

## T thermal protection using PT100 sensors

This thermal protection device gives a digital display of the winding temperatures and includes:

- **PT100 sensors**
  - The main feature of a PT100 sensor is that it gives the real-time temperature on a scale of 0°C to 200°C, see graph opposite (accuracy 0.5% of the measurement scale 1 degree).
  - Temperature control and display functions are performed via a digital thermometer. The 3 sensors, each comprising 1 white wire and 2 red wires, are installed in the live part of the Trihal transformer with 1 located on each phase
  - They are placed in a tube, allowing them to be replaced if necessary.
- **1 terminal block for connecting the PT100 sensors to the T digital thermometer**
  - The terminal block is equipped with a plug-in connector. PT100 sensors are supplied connected to the terminal block fixed to the top of the transformer.
- **1 T digital thermometer characterized by 3 independent circuits.**
  - 2 of the circuits monitor the temperature captured by the PT100 sensors, one for alarm 1, the other for alarm 2. When the temperature reaches 140°C (or 150°C) the alarm 1 information (or alarm 2/tripping) is processed by 2 independent output relays equipped with changeover contacts. The position of these relays is indicated by 2 diodes (LEDs).
  - The third circuit monitors sensor or electrical supply failure. The corresponding relay (FAULT), which is independent and equipped with changeover contacts, is instantly switched as soon as the device is supplied with power. Its position is also indicated by a diode (LED).



Schematic diagram for the T digital thermometer



Please note: since the transformer is thermal Class F, the user has responsibility for setting the T digital thermometer with a maximum temperature of 140°C for alarm 1 and 150°C for alarm 2 (tripping). Failure to comply with these maximum temperatures absolves Schneider Electric of any liability for damage that could possibly be incurred by the transformer.

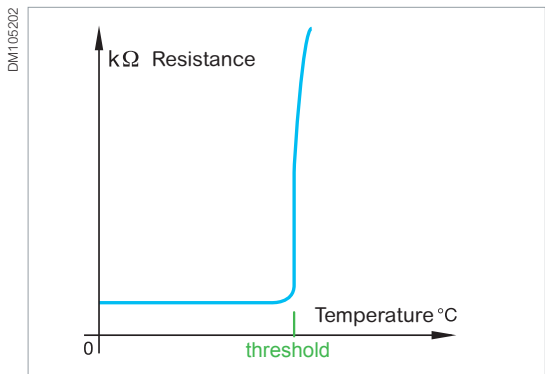
The purpose of a FAN output is to control starting of tangential fans in the event of forced ventilation of the transformer (AF): this option is shown on page 21.

An additional input (CH4) can be connected to a sensor outside the transformer (not supplied), intended to measure the ambient temperature in the HV/LV substation.

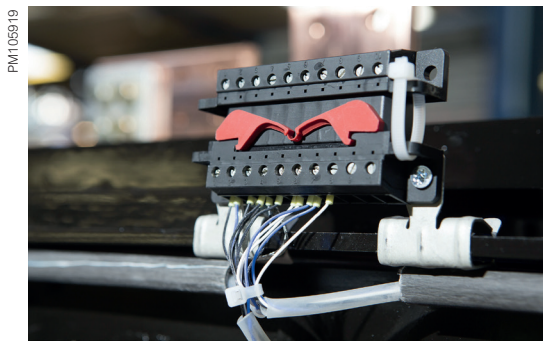
A digital output (RS 232 or 485) or a 4-20 mA analog output is available for connection to a PLC or computer.

A FAN 2 output is available as an option to control starting of an additional fan.

The T digital thermometer is delivered with an installation manual.



Typical graph of a PTC sensor

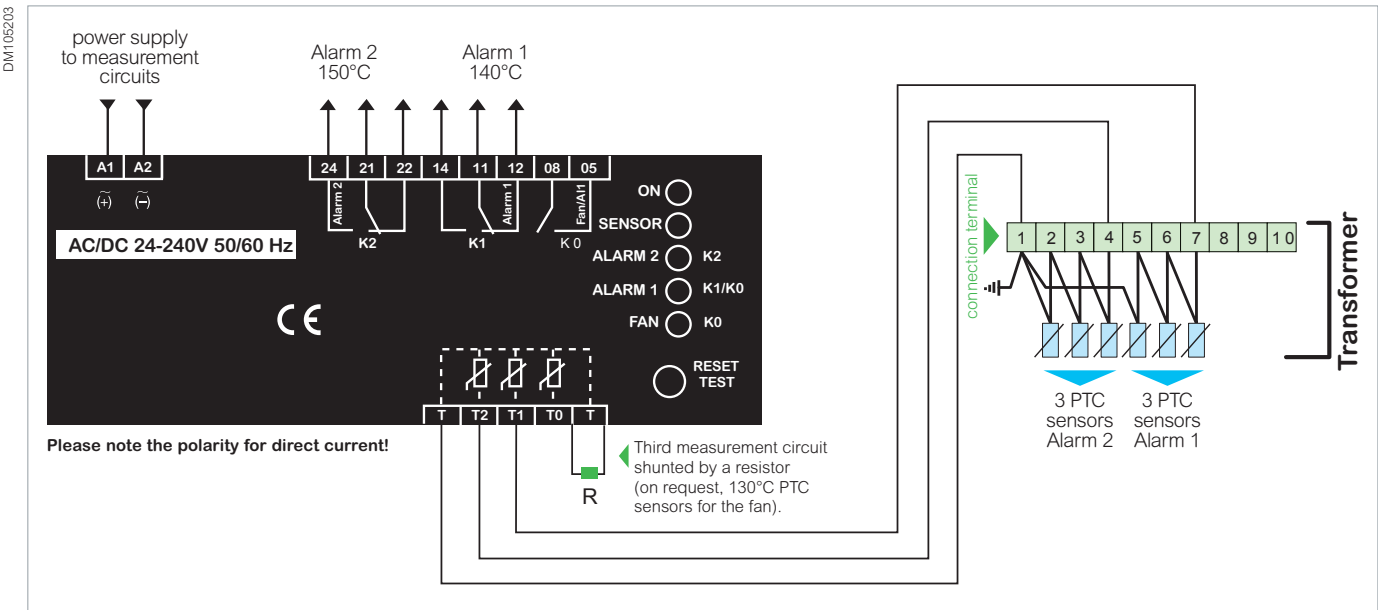


Terminal block for connecting sensors to the electronic converter

## Z thermal protection using PTC sensors

The standard version for naturally cooled (AN) transformers comprises:

- **2 PTC sensor sets, positive temperature coefficient thermistors mounted in series:** the first set for alarm 1, the second set for alarm 2.  
The PTC sensor resistance increases very steeply at a rated and factory-set threshold temperature which is not adjustable (see graph opposite). This abrupt increase is detected by a Z electronic converter.  
These sensors are installed in the live part of the Trihal transformer with one alarm 1 sensor and one alarm 2 sensor on each phase. They are placed in a tube, allowing them to be replaced as necessary.
- **1 terminal block for connecting the PTC sensors to the Z electronic converter.** The terminal is equipped with a plug-in connector. The PTC sensors are supplied connected to the terminal, attached to the top of the transformer.
- **1 Z electronic converter characterized by 3 independent measurement circuits.** 2 of these circuits respectively control the variation in resistance in the 2 PTC sensor sets. When the temperature increases too much, the alarm 1 (or alarm 2) information is processed respectively by the 2 independent output relays equipped with a changeover contact; the status of these 2 relays is indicated via 2 LED diodes.  
The third measurement circuit is shunted by a resistor R outside the terminal block; it can control a third set of PTC sensors as long as this resistor is removed. In this case ("forced air" option available on request), the FAN information is processed by a third independent output relay, equipped with a closing contact and is intended to control fans; the position of this relay is shown by an LED diode marked FAN.  
In the event of one of these 3 sensor circuits failing (power failure or short-circuit), an LED diode marked SENSOR lights up and indication of the incriminated circuit flashes. An LED diode marked ON signals the presence of voltage to the terminal block.



Z thermal protection connection diagram (normal use), equipment de-energized

PM105920



Force-ventilated transformer in IP31 enclosure

In the event of a temporary overload, to avoid overheating of the windings, it is possible to install forced ventilation.

It is then possible to increase the transformer power up to 40%.

In this case, the following points must be considered:

- the cross-sections of the cables and Prefabricated Busbar Trunking (PBT)
- the rating of the transformer's protective circuit breaker
- the size of the inlet and outlet air vents in the transformer room
- the life span of fans in service

This option includes the supply of:

- 2 sets of tangential fans, pre-cabled and connected to a single power connector per set
- 1 temperature measurement device, either Z or T type

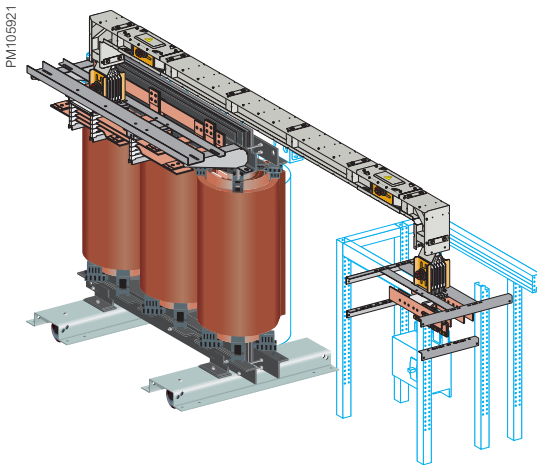
**For Z type**, a third set of PTC sensors is added to the standard thermal protection instead of the R resistor which originally shunted the third Z converter measurement circuit (see diagram shown in the Z thermal protection option).

**For T type**, the digital converter comprises an output (FAN) intended to start the tangential fans (see diagram shown in the T thermal protection option).

This option includes, depending on transformer type:

- a wiring box, mounted outside the protective enclosure, to which sensors and power supplies for the fan sets are connected on a terminal block
- a control cabinet, supplied separately (transformer IP00) or mounted on the protective enclosure, including:
  - motor protection fuses
  - starting contactors
  - thermal protection device

This unit is connected to the temperature sensors and fan sets if the transformer is supplied with an enclosure.



Tangential fans on IP00

## Low voltage connection

### Cable ducting interface

Connection using Prefabricated Busbar Trunking (PBT) provides advantages in terms of safety and also saves time during connection.

This solution ensures maximum safety for people and property due to its outstanding fire behaviour, in line with that of Trihal. It also ensures the absence of halogenated products, which is not the case for cabling.

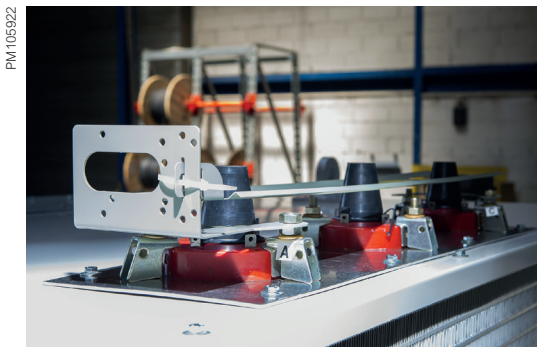
The option includes the connection interface, together with the junction block, with the whole assembly delivered already mounted on the LV cable connectors.

If the protective enclosure is provided, a removable aluminum plate is screwed to the roof, vertical relative to the junction block.

It will be adapted on site in order to fit the sealing system connecting the PBT. If the transformer enclosure is supplied, the sealing system is supplied with the PBT.

### Additional cable connectors

Additional cable connections can be provided according to the number of the cables.



HV connections

## High voltage connection

### Plug-in bushings

Plug-in bushings can be provided for the HV plug-in connectors. They can be fitted:

- on a horizontal panel, on the top of the HV side for transformers without a protective enclosure (IP00)
- on the enclosure roof, HV side, for transformers with a protective enclosure

A locking system for the connectors can also be supplied and installed in plug-in bushings.

PM105923



High voltage surge arresters on the lower part

## High voltage surge arresters

If the installation is likely to be subjected to overvoltage of any kind (atmospheric or switching), the transformer must be protected by phase-to-earth surge arresters, installed directly on the transformer's HV connection terminals (either at the top or the bottom).

It is essential to install these surge arresters:

- where the lightning impact level  $N_k$  is greater than 25. The risk of direct or induced atmospheric overvoltage is directly proportional to  $N_k$
- during occasional switching (less than 10 operations a year) of a transformer with a weak load, or during a magnetization phase.

It is also highly recommended to install them:

where the substation is supplied by a network including overhead parts, then a cable longer than 20 m (case of an overhead-underground network)

Surge arresters can be installed in an IP 31 enclosure, or even on existing equipment, provided that insulation distances are adhered to.

PM105481



PM105479



Anti-damping accessories

## Vibration damping

### Roller anti-vibration pads

This accessory, placed under the rollers, avoids vibrations being transmitted from the transformer to its environment.

### Damper unit

This device is installed instead of the roller and enables transmission of vibrations to the transformer environment to be attenuated.



# Protective Enclosure



Protective enclosure IP31, IK7

The IP and IK protective indices refer to the following criteria:

## IP protection indices

	First Figure	Second Figure
definition	protection against solid bodies	protection against liquids
scale	0 to 6	0 to 8
IP 31	protection against solid bodies 2.5 mm	protects against vertical splashing by water
IP 21	protection against solid bodies 12 mm	protects against vertical splashing by water
IP 35	protection against solid bodies 2.5 mm	protects against water jets from all directions
IP 44	protection against solid bodies 1 mm	protects against water jets from all directions

## IK protection indices

definition	protection against mechanical impact
scale <sup>(1)</sup>	0 to 10
IK7	protection against mechanical impact <=2 joules
IK10	protection against mechanical impact <=20 joules

(1) 0 = no protection

With IP 35 and IP 44, transformers can be installed outdoors.

## Bracket for HV cables entering the bottom of the enclosure

Where required, an HV cable bracket is available as an option to guide and support cables entering the enclosure from the bottom, via a removable, screw-on aluminum plate.





# Tests and technical information

# Tests and technical information

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<b>Tests</b>	<b>28</b>
C3* Climatic Test	28
E3 Environmental Test	28
Fire Withstand	29
Partial Discharge $\leq 5\text{pC}$	29
Electrical Test	30

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<b>EcoDesign Regulation EU 548-2014</b>	<b>31</b>
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The new worldwide quality reference:  
C3\*E3F1 with partial discharge  $\leq 5\text{pC!}$

PM102677



\* C2 thermal shock test carried out at -50°C

## C3\* climatic tests

Trihal takes climatic testing to a new level.

The highest certification described by IEC 60076-11, C2 imposes thermal shock testing to a maximum of -25°C.

Trihal passes the same tests at -50°C, ensuring optimal performance even in extreme climates.

### Lowest ambient temperatures:

- Operation -50°C
- Storage -50°C

### Benefits:

- Resistance to thermal shock
- Optimum performance under severe ambient conditions
- Superior behaviour on load changes
- Extended service life

## E3 environmental test

Test conducted in two parts according to standards IEC 60076-11 and IEC 60076-16:

### Condensation test

- 6 hours with 95% humidity (by indirect spraying of water with conductivity of between 3.6 and 4 S/m)
- Induced voltage test

### Humidity penetration test

- 6 days at 50°C with 90% (+/-5%) humidity
- Dielectric tests
- Visual inspection

PM102678



E3 environmental test

PM102679



### F1 fire withstand tests

PM102680



F1 fire withstand

The fire behaviour test is conducted in a specific test chamber according to the procedure described in standard IEC60076-11:

- 1 tank of ethyl alcohol (sufficient quantity for 20 mins combustion) burns under the tested coil
- 1 panel heater in front of the tested coil
- 1 reflector, concentric to the coil, is fitted opposite the panel heater

The 2 fire-proof effects of the resin used in Trihal made it possible to observe:

- Immediate self-extinguishing of Trihal as soon as the flames from the alcohol tank die down and the panel heater is switched off
- Absence of halogen products, toxic emissions and opaque smoke

Partial discharge  $\leq 5\text{pC}$

A partial discharge is the dissipation of energy caused by the build-up of localized electrical field intensity.

These phenomena, defined by standard IEC 60270, cause the insulation to deteriorate progressively and can lead to electrical breakdown.


The integrity of the transformer insulation is confirmed during Partial Discharge Analysis and used as a tool to judge the state of the device and the quality of its manufacture.

As proof of our progress in terms of quality, the acceptance criteria applicable to all new Trihal are now  $\leq 10$  pC during routine tests or  $\leq 5$  pC in the case of special tests ordered by the customer according to standard IEC 60076-11.

PM102681

[illegible]

M102682



**Page 10**

**Labels**
ISO 9001:2015 Partial discharge test after electrical test


**Standard and date** IEC 60270-6, Clause 12.2 used as a guide

**Test dates** 28-9-2019

**Environmental conditions**

Temperature of test object	25 °C	Ambient air pressure	1020 mPa
Temperature of oil	25 °C	Humidity	13 %

**Characteristic test data**

Direct	5 kV	
Calibration	5 kV	
Preheating	2000 s	
Coupling inductors	2000 pF	
Test frequency	100 Hz	

100 Hz: 100 Hz  
 50 Hz: 50 Hz  
 100 Hz: 100 Hz  
 50 Hz: 50 Hz

Phase	Test voltage cycle-to-earth		Harmonic		Partial discharge level		Insulation		Exclusion	
	80V	100V	80V	100V	80V	100V	80V	100V	80V	100V
U	100V	100V	100V	100V	100V	100V	100V	100V	100V	100V
V	100V	100V	100V	100V	100V	100V	100V	100V	100V	100V
W	100V	100V	100V	100V	100V	100V	100V	100V	100V	100V
0	100V	100V	100V	100V	100V	100V	100V	100V	100V	100V

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**Note:**

The partial discharge measurement was carried out on the transformer without enclosures.

The results of these measurements are representative for the partial discharge measurement before the short-circuit test.

**Result:**

The results are for information only.

## Partial discharge test reports

PM105925



Routine test lab

## Electrical tests

These tests verify the contractual electrical characteristics. They include:

### Routine tests

These tests are systematically carried out on all Trihal transformers at the end of manufacturing and are subject to an official test report.

They comprise:

- **Measurement of characteristics:**
  - winding resistance
  - transformation ratio and vector group
  - impedance voltage
  - load losses
  - no-load losses and no-load current
- **Dielectric tests:**
  - applied voltage tests 10 kV as standard in LV
  - induced voltage tests at  $2.5 U_n$
  - measurement of partial discharge

### Type tests and special tests

On request as per relevant standards.

These are carried out on request and at the customer's expense.

- Lightning test
  - Done as standard for 36 kV insulation level and high keraunic level.
- Short-circuit tests
- Noise level measurements
- Others on request



EcoDesign is a European Union regulation which came into force on 11th June 2014 in the 28 countries of the European Union.

This new legislation imposes, within the EU, the maximum level of losses for transformers placed on the market or commissioned from 1st July 2015 and purchased after 11th June 2014.

After the date of entry into force, manufacturers should not enter into new framework contracts for transformers with energy efficiency specifications below the minimum requirements outlined in the regulation.

Framework contracts signed before 11th June 2014 can continue until the end date, even with deliveries after 1st July 2015.

- EcoDesign has two major objectives for the Transformer product:
- Reducing electrical losses (1st phase in 2015/2nd phase in 2021)
- Clarifying and improving the visibility of indication of performance
- Harmonization of maximum loss levels in the European Union
- Efficiency request on medium-power transformers for the first time.

The following equipment is affected:

- All transformers exceeding 1 kVA and with voltage higher than 1 kV
- Oil Distribution and Dry-type transformers ( $\leq 3150$  kVA) with high voltage winding above 1.1 kV and up to 36 kV
- Medium power and Large power transformers  $> 3150$  kVA and higher than 36 kV (limited to 10 MVA 36 kV for Dry-type Transformers).

Special transformers are not affected by this regulation (please refer to restriction list for details).

## Authorized loss levels for Oil Distribution and Dry-type Transformers ( $\leq 3150$ kVA):

Maximum loss levels	Rated power	Tier 1: from 01.07.2015	Tier 2: from 01.07.2021
Pole-mounted	25, 50 and 100 kVA	AoCk	AoBk
	160 kVA	CoCk+32%	Co-10% Ck+32%
	200, 250 and 315 kVA	CoCk	BoBk
Oil-Immersed transformers	$\leq 1000$ kVA	AoCk	Ao-10% Ak
	$> 1000$ kVA	AoBk	
Dry-Type transformers	$\leq 630$ kVA	AoBk	Ao-10% Ak
	$> 630$ kVA	AoAk	

- Loss levels to be applied (reference of MV  $\leq 24$  kV and LV  $\leq 1.1$  kV)
- ODT and CRT not covered by reference transformers:  
(additional losses allowed compared to standard loss ranges)

Other requirements	Impact on no-load losses compared to standard losses table	Impact on load losses compared to standard losses table
MV insulation level $\leq$ 24 kV LV insulation level $>$ 1.1 kV	10%	10%
MV insulation level = 36 kV LV insulation level $\leq$ 1.1 kV	15%	10%
MV insulation level = 36 kV LV insulation level $>$ 1.1 kV	20%	15%
Dual voltage on MV winding and 85% power limitation on higher MV voltage	No impact	No impact
Dual voltage on MV winding and 85% power limitation on higher LV voltage	No impact	No impact
Dual voltage on one winding (MV or LV) and full power on all voltages considered	15%	10%
Dual voltage on both windings (MV and LV)	20%	20%
Transformers with tapplings for operation while energized (such as Voltage Regulation Distribution Transformers)	20% (reduced to +10% in 01-07-2021)	5%

E.g.: ODT 630 kVA, 33 kV - 410 V max. losses to be considered: A0+15% - Ck +10%





# Internet

# Internet

Transformer selector	36
Total Cost of Ownership (TCO) tool	36

Transformer selector

Choosing the right transformer for the job can be a real nightmare. This web selector has ben developed to help you find it more easily.

Select your segment, function, type and voltage range and hey presto! Your best-in-class MV transformer is here:

<http://selectorservice.schneider-electric.com/transformers/>

A pragmatic way to choose the right transformer!

<http://www.schneider-electric.com/en/tools/tco-for-transformer/>

Total Cost of Ownership (TCO)

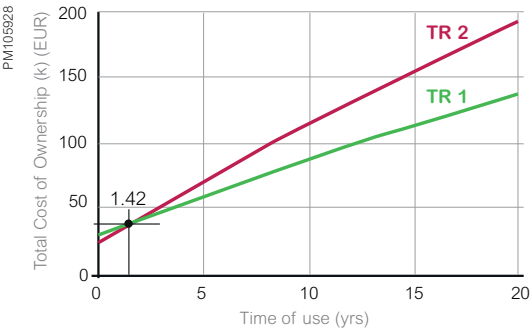
When purchasing a transformer and especially when comparing two different solutions, the right choice is driven by an economic analysis of the equipment. Total Cost of Ownership, giving the cost of transformer operation throughout their life including purchasing, operating and maintenance costs.

Basically some simplification can be done when comparing two different transformers with the same technology: installation, maintenance and decommissioning will generate the same costs and then be excluded from the comparison.

The calculation has to take into consideration changes in the cost of energy during the transformer life span. The interest rate also has to be considered as stated below.

PM105927

Calculate TCO	CompareTCO (2)		
Compare TCO of Transformers			
Print/Save PDF   Help   Feedback			
Product Family (Dry Type, Oil immersed or MPT/LPT)	Units	Transformer 1 ★	Transformer 2
Rated Power:	kVA	1000	
Maximum HV isolation level:	kV	<=24	
Maximum LV isolation level:	kV	<=1.1	
No load losses Level:		AAAD	
Load losses Level:		AK	
No load losses (PO):	W	890	2100
Load losses (PK):	W	9000	12000
Purchase price:	EUR	30000	25000
Transformer Total Cost of Ownership:	EUR	136484	190526
Payback Period Configuration coherence:	Yrs		1.42
VIEW COMPARISON GRAPH			



Calculation of the TCO

The simplified calculation formula of the Total Cost of Ownership is as follows:

**Total Cost of Ownership =**  
**Purchasing Price + No-Load Losses Cost + Load Losses Cost**

With:

**No-Load Losses Cost:**  $NLLC = (1+i)^n - 1 / i(1+i)^n * C * Time$

**Load Losses Cost:**  $LLC = (1+i)^n - 1 / i(1+i)^n * C * Time * Load\ factor^2$

- Where:
- i:** interest rate [%/year]
  - n:** lifetime [years]
  - C:** kWh price [USD/kWh]
  - Time:** number of hours in a year [h/year] = 8760
  - Load factor:** average load of the transformer during its life time



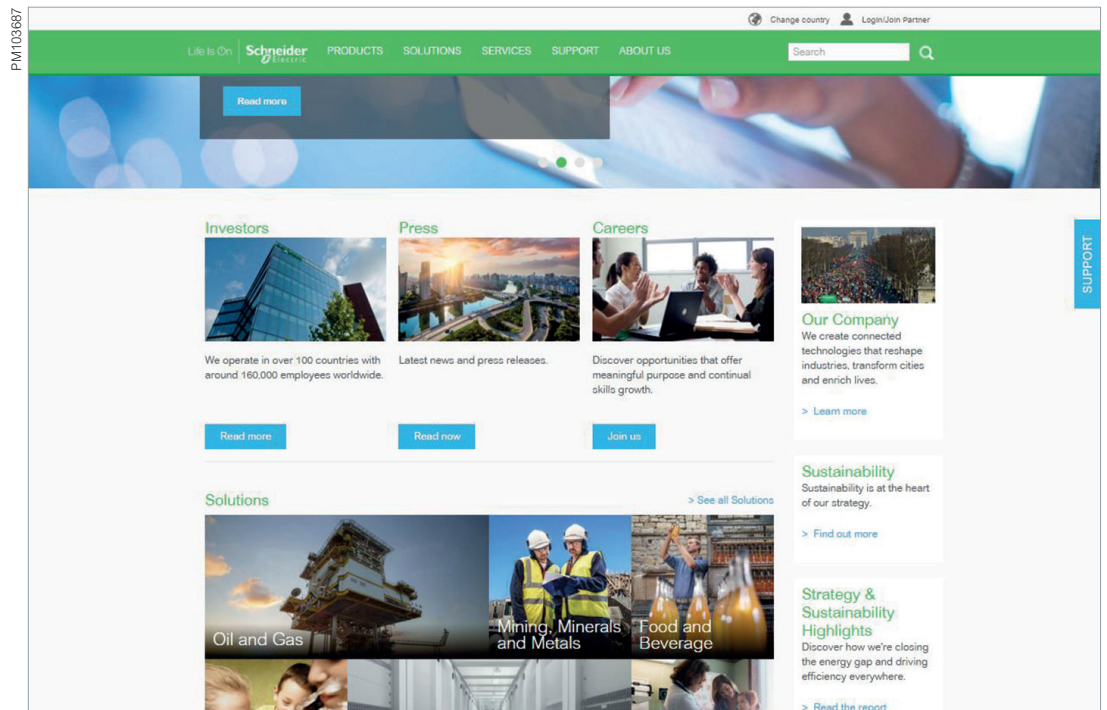
# TOOLS

[schneider-electric.com](https://schneider-electric.com)

This international web site allows you to access all the Schneider Electric solutions and product information via:

- Comprehensive descriptions
- Range datasheets
- A download area
- Product selectors

You can also access information dedicated to your business and contact your Schneider Electric country support.





# TOOLS

## Web selector

This site allows you to access the Schneider Electric products in just two clicks via a comprehensive range of datasheets, with direct links to:

- Complete libraries: technical documents, catalogs, FAQs, brochures
- Selection guides from the e-catalog
- Product discovery sites and their animations

You will also find illustrated overviews, news to which you can subscribe, and a list of country contacts

## Training

Training allows you to acquire the expertise (installation design, work with power on, etc.) to increase efficiency and improve customer service.

The training catalog includes beginner's courses in electrical distribution, knowledge of MV and LV switchgear, operation and maintenance of installations, and design of LV installations to give a few examples.



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