

# CAST RESIN TRANSFORMERS



FOR DISTRIBUTION,  
RECTIFICATION,  
TRACTION AND  
SPECIAL SOLUTIONS



GLOBAL SPECIALIST IN ELECTRICAL  
AND DIGITAL BUILDING INFRASTRUCTURE



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# General features of transformers

The transformer is an electric electromagnetic induction machine whose function is to transfer electrical power between two different voltage systems at the same frequency. Transformers are available on the market in different constructional technologies which have a considerable influence on the electrical properties and the fields of application.

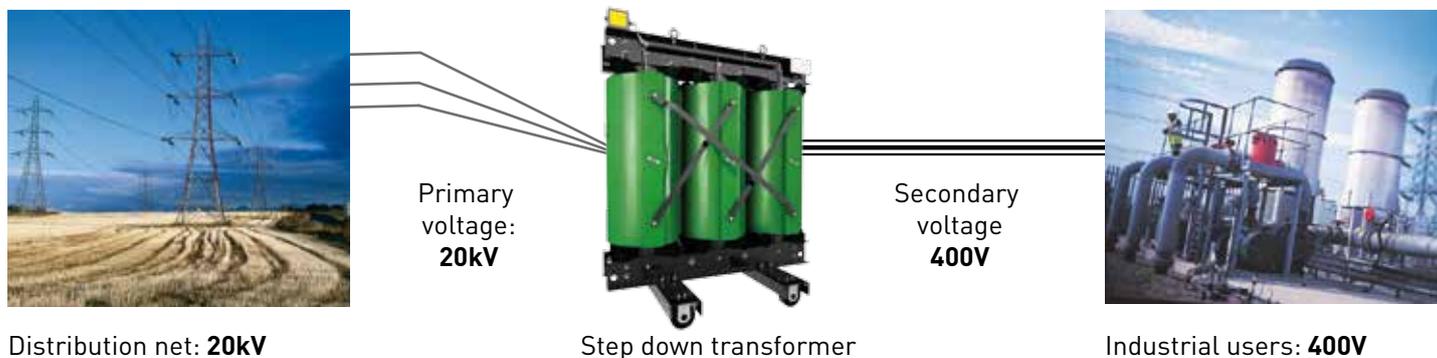
To correctly select the type of transformer it is necessary to know its different electrical and thermal properties and

the resistance to stresses due to faults or normal service of the transformer itself.

The transformer manufacturing technology thus also determines the selection of the adequate protection.

Another key parameter, when selecting the transformer, is the type of operation for which it is intended.

## TYPICAL EXAMPLE OF DISTRIBUTION OF ENERGY



High-Voltage transformers are generally classified in three types depending on their construction. Features comparisons between cast resin, oil and air transformers are below described.

Properties	Resin	Oil	Air
Inflammability	<b>NO</b>	YES	YES
Self-extinguishing in the case of an electric fault	<b>YES</b>	NO	NO
Need for anti-fire structures such as oil collection pit and anti-flame walls	<b>NO</b>	YES	YES
Hygroscopicity of the insulation materials	<b>NO</b>	YES	YES
Environmental pollution	<b>NO</b>	YES	NO
Strip windings and good resistance to short-circuit	<b>YES</b>	NO	NO
Stability of the heating element to short-circuit over the machine lifetime	<b>YES</b>	NO	NO
Special commissioning procedures	<b>NO</b>	NO	YES
Regular maintenance	<b>NO</b>	YES	YES
Risks of environmental pollution because of leak of liquid	<b>NO</b>	YES	NO
Deterioration of the dielectric properties because of the effect of time and environmental effects	<b>NO</b>	YES	YES
Lack of sensitivity to humid, saline and tropical environments	<b>YES</b>	YES	NO
Location at the centre of gravity of the load and reduction of system and management costs	<b>YES</b>	NO	NO
Reliability when not maintained and when labour specialised in installation is not readily available	<b>YES</b>	NO	NO
Capacity of withstanding high instantaneous overloads of short duration thanks to the lower current density and high thermal constant	<b>YES</b>	NO	NO

**Legrand** is one of the most important producers of cast resin transformers. Thanks to a long experience in the production of cast resin transformers up to 36 kV and constant investment in R&D, Legrand is capable to grant high quality products, with excellent performance in many and varied applications.

Correspondence to the specific International and National Standards and conformity to classes **C2**, **E2** and **F1** mean that transformers can be used in many installation and environmental contexts. The absence of insulating liquids, being self-extinguishing without emissions of toxic gases and the low noise levels represent a safeguard for the environment and public health.



## INTEGRATION OF PRODUCTS

Legrand group offers a wide range of solutions for distribution, protection, control and management of plants and electrical installations for all types of applications, from industrial and commercial sectors to infrastructures. Green T.HE cast resin transformers can be integrated with a complete range of products.



# Applications

Cast resin transformers can be used in a wide range of applications and represent the most reliable answer for distribution systems, power production, rectification, traction and for special solutions.

## SERVICE SECTOR

- Hospitals
- Hotels
- Banks
- Schools
- Shopping and cultural centres
- Management centres



## DATA CENTER



## INFRASTRUCTURES

- Airports
- Military installations
- Ports
- Off-shore installations



## INDUSTRY

- Automotive technology
- Mechanical industries
- Chemical industries
- Paper mills
- Foundries



**CONVERSION AND RECTIFICATION**

- Air-conditioning systems
- Continuity units
- Lifting systems
- Welding lines
- Induction furnaces
- Pumping stations



**STEP-UP TRANSFORMERS FOR THE PRODUCTION OF ENERGY POWER**

- Wind parks
- Photovoltaic systems
- Cogeneration systems
- Industrial applications
- Hydroelectric power plants



**TRANSFORMERS FOR TRACTION**

- Railways;
- Tramways



**TRANSFORMERS FOR MARINE APPLICATIONS**

- Cruise ships
- Multifunctional ships
- LNG carriers
- Offshore drilling rigs



# Standard

## EUROPEAN REGULATION (EU) n°548/2014

On 21 May 2014, the European Commission issued Regulation No 548/2014 (hereinafter the Regulation), with rules for the application of Council Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the development of specifications for eco-design of energy-related products.

The Regulation concerns the electric power small, medium and large transformers. The Regulation sets out the requirements (mandatory) on ecodesign requirements for electric transformers with a minimum power rating of 1 kVA used in electricity transmission and distribution networks. It indicates the maximum load and no-load losses that must be fulfilled by various types of transformers.

The maximum losses to be respected refer to date of placing on the market of the transformer, with two different timeframes or steps:

- 1) From 1<sup>st</sup> July 2015
- 2) From 1<sup>st</sup> July 2021

The requirements relating to the design requirements of transformers, provided by the Regulations, relate only to the products that are placed on the market from 1<sup>st</sup> July 2015 (tier 1) and from 1<sup>st</sup> July 2021 (tier 2).

**The Regulation 548/2014 it will be valid only in 28 countries of European Union. Only the transformer manufactured according reg.548 are CE marked.**

## EN 50588-1 : 2015 – Standard

The EN 50588-1 : 2015 standard in accordance with UE Regulation 548/2014 replaces and supersedes the previous EN 50541-1 : 2011.

The EN 50588-1 applies to the medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36kV.

## IEC 60076-1 GENERAL STANDARD OF POWER TRANSFORMERS

### Specific Standards related to transformers

- **IEC 60076-1** : Power transformers - Part 1: General;
- **IEC 60076-3** : Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air;
- **IEC 60076-5** : Power transformers - Part 5: Ability to withstand short circuit;
- **IEC 60076-6** : Power transformers - Part 6: Reactors;
- **IEC 60076-8** : Power transformers - Part 8: Application guide;
- **IEC 60076-10-1** : Power transformers - Part 10-1: Determination of sound levels - Application guide;
- **IEC 60076-11** : Power transformers - Part 11: Dry-type transformers;
- **IEC 60076-12** : Power transformers - Part 12: Loading guide for dry-type power transformers ;
- **IEC TS 60076-19** : Power transformers - Part 19: Rules for the determination of uncertainties in the measurement of the losses on power transformers and reactors ;
- **IEC TR 60616** : Terminal and tapping markings for power transformers;
- **IEC 61378-1** : Converter transformers - Part 1: Transformers for industrial applications;
- **IEC 61378-3** : Converter transformers - Part 3: Application guide;
- **IEC 62032** : Guide for the Application, Specification and Testing of Phase-Shifting Transformers;
- **IEC 60529** : Degrees of protection provided by enclosures (IP Code);
- **IEC 60068-3-3** : Environmental testing - Part 3-3: Guidance - Seismic test methods for equipments;
- **EN 50588-1:2015** : Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements;

## MAIN TESTS (Acceptance, Type and Special)

### ACCEPTANCE TESTS

■ Measurement of winding resistance	<b>IEC 60076-11 (clause 15)</b>
■ Measurement of voltage ratio and check of phase displacement	<b>IEC 60076-11 (clause 16)</b>
■ Measurement of short-circuit impedance and load loss	<b>IEC 60076-11 (clause 17)</b>
■ Measurement of no-load loss and current	<b>IEC 60076-11 (clause 18)</b>
■ Separate-source AC withstand voltage test	<b>IEC 60076-11 (clause 19)</b>
■ Induced AC withstand voltage test	<b>IEC 60076-11 (clause 20)</b>
■ Partial discharges measurement	<b>IEC 60076-11 (clause 22)</b>

### TYPE TESTS (on request)

■ Lightning impulse test	<b>IEC 60076-11 (clause 21)</b>
■ Temperature-rise test	<b>IEC 60076-11 (clause 23)</b>

### SPECIAL TESTS (on request)

■ Measurement of sound level	<b>IEC 60076-11 (clause 24)</b>
■ Short-circuit test	<b>IEC 60076-11 (clause 25)</b>

## CERTIFICATIONS

The transformers are manufactured and certified to Bureau Veritas by ISO 9001:2008, ISO 14001-2004 and GOST R for design and manufacture of Power Transformers.

Cast resin transformers have been designed and manufactured according to the provisions laid down by the main national and international standards and certified by the following certification body:

- **ABS:** American Bureau of Shipping
- **DNV:** Det Norske Veritas
- **GL:** Germanischer Lloyd
- **RMRS:** Russian Maritime Register of Shipping
- **LR:** Lloyd's register
- **RINA:** Registro Italiano Navale
- **CCS:** China Classification Society
- **ACAE:** Associazione per la Certificazione delle Apparecchiature Elettriche



## TESTS AND INSPECTION

Before the cast resin transformers are supplied to the customer, they are individually inspected and must pass the acceptance tests and, where necessary, type tests, if these are requested in the order phase. At the end of the acceptance tests a specific inspection note is affixed to each transformer. Both the ordering company and any final customer can reserve the right to be present at the inspections in the Legrand test room and, on prior notification, can make inspection visits before and during the carrying out of the order.

## LABORATORY

The Legrand test lab "IB03" has recently received the qualification by ACAE to work according to the 17025 standard on all routine tests and on some tests for medium-voltage transformers. Such acknowledgement and qualification is a very important plus obtained and Legrand with few others around the world can offer this to their customers.



Legrand is present on the ENEA ANIE Energia website that represents an important instrument to help the operators to discover power transformers in compliance with the Regulation 548/2014.

# Advantages of cast resin transformers

The manufacturing characteristics of cast resin transformers mean that they can be used for most installations. Their main advantages with respect to oil transformers can be expressed in three characteristics:

1. reduction of environmental impact
2. simplification of installation
3. flexibility in use

## 1. REDUCTION OF ENVIRONMENTAL IMPACT

### • Higher safety (low risk of fire)

Thanks to the use of high-quality epoxy resin, Legrand cast resin transformers reduce environmental impact to a minimum and conform to the international environmental standards IEC 60076-11. The transformers are entirely manufactured with flame-retardant and self-extinguishing materials. They therefore have reduced inflammability (self-extinguishing) and a minimum emission of toxic gases and opaque smokes (F1 fire resistance classification); they can work in damp, dusty, saline or polluted environments (E2 environmental test classification) and offer high resistance to thermal shocks (C2 climatic test classification).

### • No cooling fluids

Because they have no cooling fluids cast resin transformers do not present risks of pollution and drastically reduce their contribution when there is a fire, as compared with transformers using insulating liquid.

### • Recovery of materials at the end of life

Cast resin transformers can be considered as the construction which more respects the environment. This is particularly important when the machine has come to the end of its working life and must be disposed. At the end of the disposal the resin is considered an inert material and the primary and secondary windings can easily be recycled.

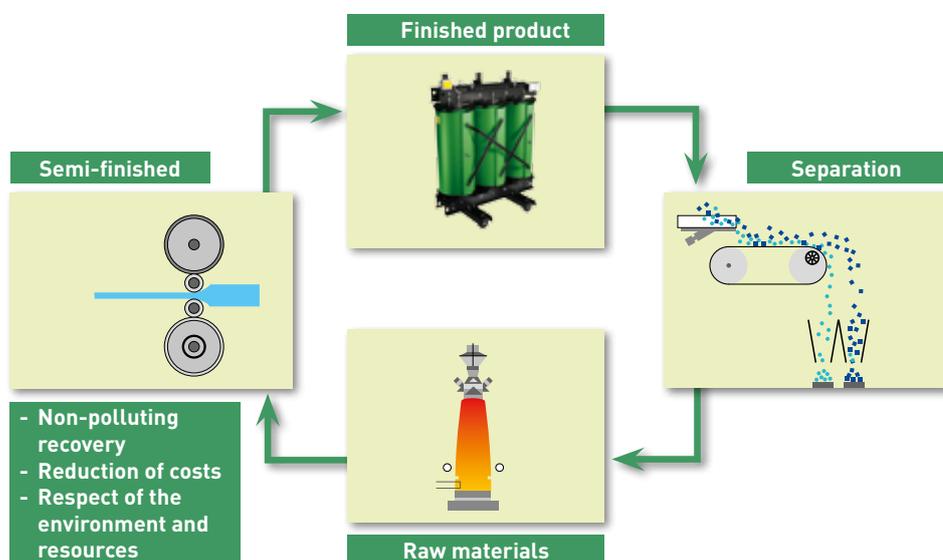
### • Low CO<sub>2</sub> emissions

Reducing the consumptions of a transformer also means decreasing CO<sub>2</sub> emissions, limiting the impact of the machine on the environment.

Taking the example of potential saving as reference, it is clear that during the 20 years of operation, Green T.HE ensures a reduction of over 112 tonnes in emissions of CO<sub>2</sub> into the atmosphere.

This extremely important environmental advantage also becomes an economical advantage in those countries where carbon emissions laws based on the quantity of CO<sub>2</sub> emitted has been introduced.

In these countries, companies who do not comply with fixed carbon dioxide limits must pay for any excess, while companies that are committed to preserving the environment will not have to sustain the burden of this additional charge, in addition to being able to sell carbon credits, and therefore turn them into financial advantage, CO<sub>2</sub> credits.



Once the transformer has exhausted its own operating cycle, all of the accompanying materials can be easily recycled or disposed of, as indicated in the **PEP (Product Environmental Profile)** document, which describes the environmental impact of a product during its life cycle (from the extraction of the raw materials needed for its construction, through to its disposal).



## 2. SIMPLIFICATION OF INSTALLATION

- **Reduction of building laying works**

Cast resin transformers do not need the expensive civil works which are instead required for oil transformers, such as collection pits, extinguishing grids and fire-resistant separation barriers, to prevent the propagation of fire and the spreading of insulating liquids.

These cast resin transformers are class F1 no separation provision with fire barrier is needed.

- **Installation inside buildings**

Thanks to the reduction of expensive building works, the greater safety (low fire risk) and the absence of cooling fluids, cast resin transformers can be installed inside buildings, even near to rooms where people are present. The space occupied and the installation costs can thus be contained.

Moreover transformers installed inside the building can be closer to the loads, with the advantage of saving in connection costs and reducing losses in the supply line

## 3. FLEXIBILITY IN USE

- **Greater overloading capacity**

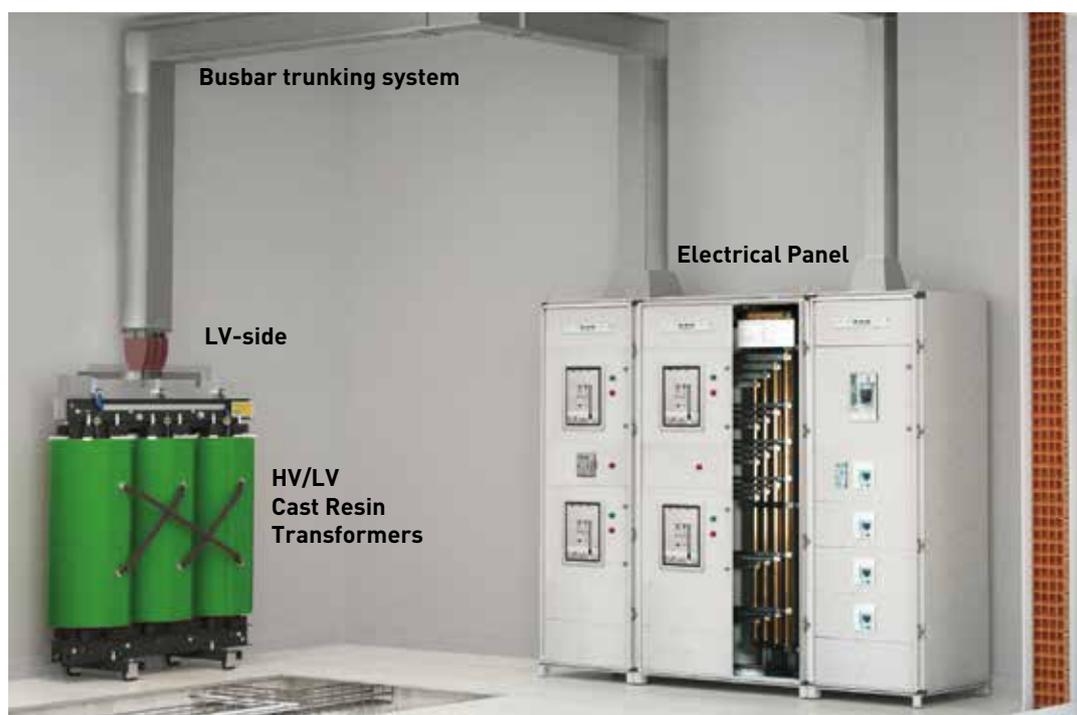
As cast resin transformers use air cooling and take longer to reach operation temperature, they can be more overloaded than insulating liquid transformers and are thus particularly suitable to feed loads with frequent current breakaway starting current.

The transformers can be overloaded, as long as the temperature rise on the windings does not remain above the allowable value for long periods of time.

The power supplied can be temporarily increased by means of the application of ventilation systems, to be used to tackle particular operating situations (temporary overloads or high room temperature) or to make available a temporary reserve of power when there is an emergency (e.g. when a transformer is out of service).

- **Reduction of maintenance**

Cast resin transformers have lower maintenance costs because they need only be inspected regularly to check that there is no accumulation of dust and dirt. Oil transformers instead must be monitored to guarantee the level of insulating liquid and to check that its dielectric properties have not changed (e.g. the dielectric strength of mineral oils reduces considerably when there are small traces of humidity).



# Economic advantages

From the economic point of view a transformer must be chosen evaluating all the costs shown below:

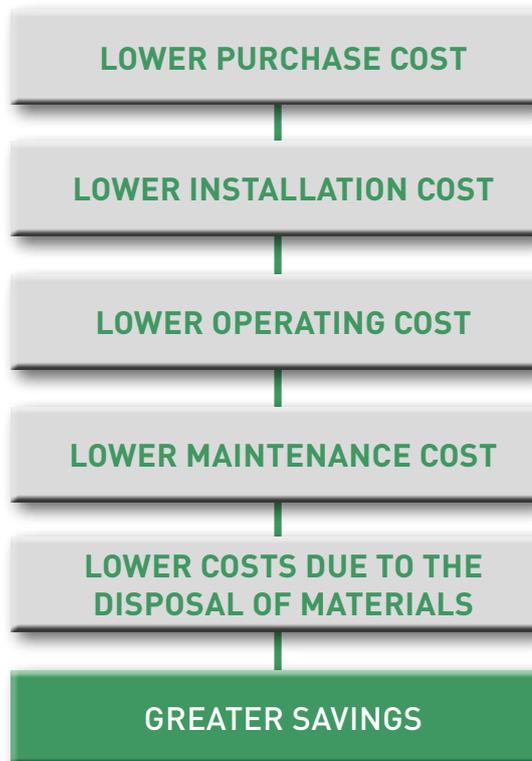
- purchase cost
- building modification to adapt rooms
- cost of installation
- operating costs
- maintenance costs
- costs due to the disposal of materials

To correctly check a transformer's operating costs, one must check the values of no-load losses (**Po**) and load losses (**Pk**). The first are independent of the load and are constant for the whole time the transformer is connected to the mains (generally 365 days a year), considering the power supply voltage and frequency as constant.

Load losses are instead proportional to the square of the current and are variable, as a function of the oscillations of the load itself. From the expenditure point of view often the choice of a transformer is based exclusively on the purchasing cost or initial cost (**Ci**).

To evaluate the real cost of a transformer however the operating cost (**Ce**), or the cost of the electricity consumed by the transformer in its lifetime, should be considered as well.

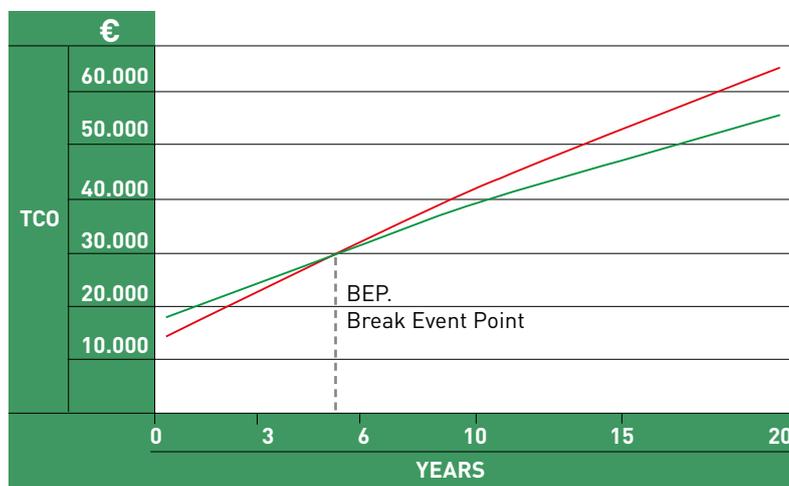
This is particularly important if one considers the need for energy saving which all businesses must face nowadays.



For a correct economic assessment, when purchasing a transformer the OPERATING COST of the machine needs special consideration.

The purchase price of the transformer is only a marginal part of the Total Ownership Cost of the machine (TCO), while the operating cost (mainly connected with losses), represents over 80% of the total cost.

This means that in a relatively short time it will be possible to recover the extra cost invested for the purchase of a Green T.HE cost, compared with the cost of a standard loss transformer.



**Note:** The time required to reach the break even point changes depending on energy costs, and therefore on the country in which the analysis is carried out. The chart takes into account Europe, and an energy cost of 0.1170 €/kWh.

**TCO (Total Ownership Costs) = PURCHASE COST + OPERATING COST of the transformer**

### EXAMPLE OF POTENTIAL SAVINGS OBTAINED USING A GREEN TRANSFORMER HIGH EFFICIENCY

EUROPE	Class N transformer	Class AA Green T.HE
Rated power (Sr): 1000 kVA		
Primary no-load voltage (V10): 20 kV		
Secondary no-load voltage (V20): 400 V		
Uk: 6%		
Transformer lifetime: 20 years		
	Purchase price	14,000 €
	Operating cost (20 years)	50,971 €
	TOTAL Cost	64,971 €
		18,500 €
		37,923 €
		56,423 €
In this example, the extra 4,500 € required for the purchase of the Green T.HE transformer is recovered in less than six years, while the total saving for the 20 year period will be approximately 8,500 €.	<b>FINANCIAL SAVING</b> <b>8,548 €</b>	<b>SAVING IN TERMS OF CO<sub>2</sub> EMISSIONS</b> <b>112 Ton CO<sub>2</sub></b>

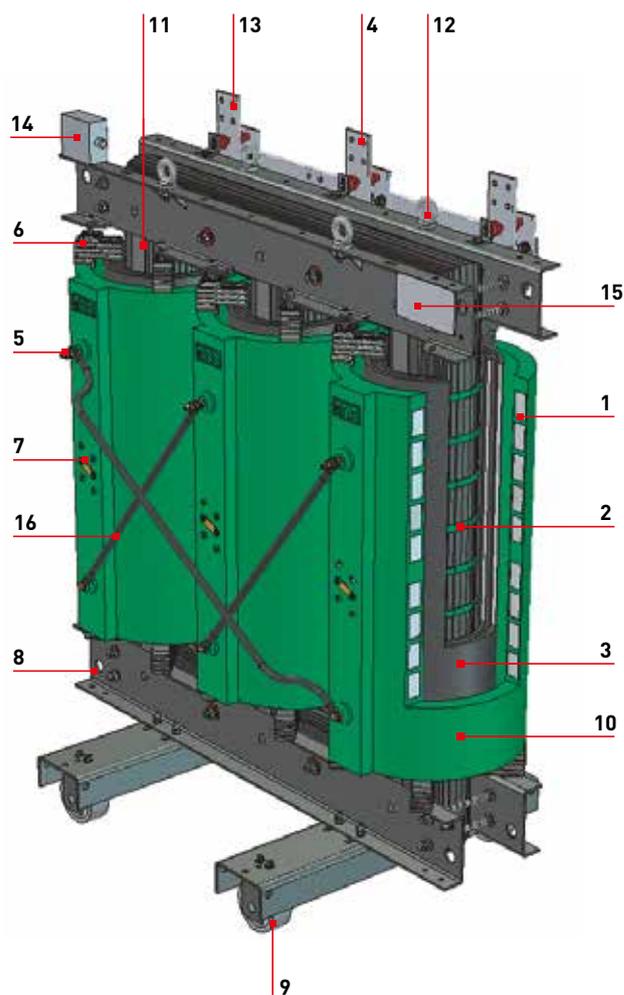
**Note:** Financial savings have been calculated taking into account the electric power supply costs listed on the EUROSTAT website. EU-28: cost of energy 0,1170 €/kWh. Equivalence 0,5778 kgCO<sub>2</sub>/kWh.

# CRT technology

Legrand is recognized for its high-quality production. Using state of the art constructional techniques and equipment, constant attention throughout the production process (ISO 9001:2008) and rigorous checks in the final phase, Legrand guarantees quality for 100% of the production.

1. HV windings: made of aluminium strip coils (available in copper) and cast in resin under vacuum.
2. Core in three columns made of magnetic steel laminations with high-permeability oriented crystals, available with different level of losses.
3. LV windings: made of aluminium strip foil (available in copper) impregnated in resin under vacuum.
4. LV connections upwards (standard) or downwards version (on request).
5. HV connections upwards (standard) or downwards version (on request).
6. Rubber inserts attenuate the transmission of vibrations between core and windings and reduce to a minimum the operating noise generated by the transformer as well as absorbing the thermal expansion of the components.
7. Off-load tapping links on the HV side to adapt the primary voltage to the mains, which can be set with transformer switched OFF.
8. Structure, armatures and carriage, made in strong painted sheet steel (available on request hot – dip galvanized )
9. Carriage with bi-directional rollers. The carriage allows safe movement and is pre-equipped for the mounting of an IP reinforced boxes.

10. HV epoxy resin insulation makes the transformer suitable for low maintenance. Class 155°C (F) insulating material, withstanding a temperature rise of 100K.
11. The operating temperature is checked by Pt100 sensor or PTC which are mounted in the LV windings.
12. Lifting eyebolts conform to the DIN-580 standards with safety hooking at 4 points.
13. LV terminals with optional pre-equipment for connection of the LV - Zucchini busbar trunking system.
14. Terminal box for temperature probes
15. Rating plate
16. Delta connection



## (HV) - HIGH VOLTAGE WINDINGS

The High Voltage windings are manufactured using highly automatic winding machines, constructed using the continuous disk technique, and made of aluminium\* strips with a double layer of insulating material.

On these disks here will be a glass fibre mesh providing static support to the winding.

The winding will then be enclosed in a vacuum mould with epoxy resin with the addition of inner charges and alumina, in order to guarantee the F1 fire behaviour set in the EN 60076-11 standard.

The thermal class for the insulating materials used will be class 155°C (F): the consequent permitted over temperature shall be 100 K, in accordance with EN 60076-11 standard.

The partial discharge level will be **less than <math>\lt; 5\text{pC}</math>**.

The HV coils are in light green colour RAL 6024 or in red color RAL 3013.

On the primary winding there will be the terminal links for primary voltage change with  $\pm 2 \times 2,5\%$  variations as standard. These are made with bushings protruding from the resins, bolts and bars in brass, while the associated numbering, corresponding to that found on the name plate, shall be permanently imprinted on the windings (no adhesive or difficult to read labels shall be permitted).

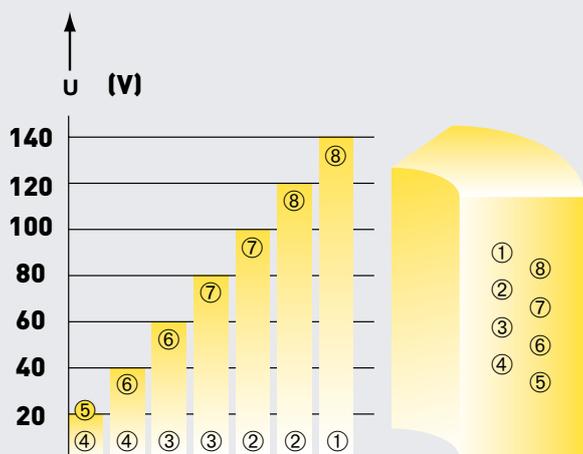
The thermal class for the insulating materials used will be class 155°C (F): the consequent permitted over temperature shall be 100 K, in accordance with EN 60076-11 standard.

HV windings in strip, rather than in wire, cause less stress on the insulation between the turns.

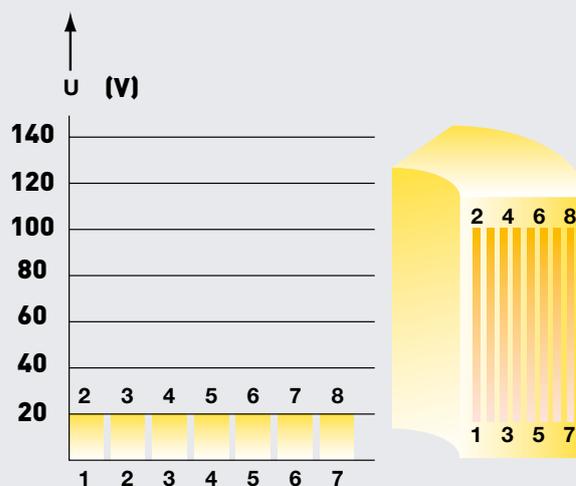


Modern electronically controlled winding machines

### DIVISION OF THE VOLTAGE BETWEEN THE TURNS OF THE MEDIUM-VOLTAGE WINDING



Winding made with wire conductors: the voltage increases with the number of turns.



Winding made with strip conductors: the voltage is divided and distributed uniformly.

Transformers with strip windings thus have a greater capacity to seal to impulse voltages and at industrial frequency, as well as a lower probability of being the location of partial discharges.

Strip winding also has the advantage of drastically reducing the axial forces due to short-circuit currents.

\*copper strips available on request

# CRT technology

## (LV) - LOW VOLTAGE WINDINGS

The Low Voltage winding, made of one single aluminium\* strip, has a height equal to the height of the HV winding, with an insulating sheet made of polyester material.

All weldings between the conductor strip and the aluminium\* LV terminals are butt welded, executed in inert atmosphere under electronic control, avoiding the formation of any material deposits that may potentially affect or damage the insulation between the output end and the next layer.

LV winding shall then be impregnated by resin under vacuum. Afterwards, it is polymerized, forming a unique compact cylinder resistant to the axial and radial electro-dynamic stresses that may occur during short circuits in the downstream circuits powered by the transformer.

Insulations using pre-impregnated (Pre-preg and similar) materials are not permitted.

The thermal class for the insulating materials used in low voltage coils shall be class 155°C (F): the consequent permitted over temperature shall be 100 K, in accordance with EN60076-11 standard.

## ASSEMBLING OF THE WINDINGS

HV and LV windings are assembled one inside the other, around the column of the magnetic core. The Primary winding shall be mounted outwards.

Appropriate spacers keep constant distances between the core and the secondary winding, and between the secondary winding and the primary winding, in order to avoid magnetic stress due to dangerous geometrical dissymmetry.



LV windings



LV winding system



TIG welding in controlled atmosphere for LV connections.

\*copper strips available on request

## TERMINALS HV AND LV

**HV terminals**, connected to the winding, are made of brass pins protruding from the resin, in order to:

- facilitate connection to the HV cables, irrespective of their direction of entry
- avoid galvanic couplings among the various materials that may coexist in the connection

The delta connection between the HV windings are completed using aluminium tube/plate to ensure that the relative positions and the performances remain unchanged over a long period of time.

The **LV terminals**, welded to the layer across the overall height of the coil, are on the top section of the transformer (at the bottom only when clearly requested), and are made of flat aluminium profile suitable for the connection of tin plated copper lugs.



Example of HV terminals



Example of LV terminals

## MAGNETIC CORE

The three-column magnetic core is made of magnetic Grain-Oriented steel sheet.

At the junctions between the columns and the yoke, the sheets are cut at 45° following the step-lap procedure, to reduce the corresponding air gaps as much as possible.

A disconnectable equipotential connection is guaranteed between the metal structure and the magnetic sheet packet.

All the magnetic cores are protected against corrosion by black non-hygroscopic paints (RAL 9005), with minimum thickness >100 µm (microns).



Example of magnetic core

# Service Conditions

Legrand includes a range that can also be used under the most severe environmental conditions. The standard installation is carried out indoors, protected from direct sunlight and with normal industrial atmosphere.

The transformers, in standard configuration, are capable of withstanding seismic disturbance with ground acceleration level **up to 0,2g**.

The transformers are capable of withstanding the following environmental conditions during storage, transport, and use.

- minimum ambient temperature: -25°C
- maximum ambient temperature: 40°C
- maximum relative humidity: 93%

Standard IEC 60076-11 uses an alphanumeric code to identify the environmental, climatic and fire behaviour classes of dry-type cast resin transformers. The whole Legrand range can also be used to withstand the most severe conditions:

- Environmental class E2
- Climatic class C2
- Fire-behaviour class F1

\*  $g=9,81m/s^2$  (gravity acceleration)

<p><b>E2</b> ENVIRONMENTAL TESTS</p>	<p><b>C2</b> CLIMATIC TESTS</p>	<p><b>F1</b> FIRE RESISTANCE</p>
<p><b>E0</b> No condensation on the transformer, negligible pollution, installation in a clean and dry room.</p>	<p><b>C1</b> The transformer will not operate at temperatures lower than -5°C, but may be exposed to -25°C during transport and storage.</p>	<p><b>F0</b> The risk of fire is not expected and no measures are taken to limit inflammability.</p>
<p><b>E1</b> Occasional condensation and little pollution.</p>	<p><b>C2</b> The transformer can operate and be transported and stored at temperatures down to -25°C.</p>	<p><b>F1</b> The transformer is subject to the risk of fire and reduced inflammability is required. Fire on the transformer must be extinguished within laid-down limits.</p>
<p><b>E2</b> The transformer is subject to consistent condensation, to intense pollution, or to both phenomena.</p>	<p><b>C2</b> The transformer can operate and be transported and stored at temperatures down to -25°C.</p>	<p><b>F1</b> The transformer is subject to the risk of fire and reduced inflammability is required. Fire on the transformer must be extinguished within laid-down limits.</p>

Seismic disturbance, Environmental (E), climatic features (C) and fire resistance (F), the perfect solutions for any condition

Minimum temperature required for carrying and storage operations:  
**-25°C**

Minimum temperature required for the installation environment:  
**-25°C**

Maximum temperature required for the installation environment: (unless otherwise requested by the customer)  
**40°C**

Maximum relative humidity value:  
**93%**

# Protection against overvoltages

Transformers may be affected by transient induced overvoltages on the net to which they are connected. These overvoltages, due to direct or indirect lightning strikes or to electrical operation on units installed on the LV side, can stress the transformer dielectric causing its rapid ageing and its consequent possible damage as well as failure of the transformer.

The most critical conditions normally occur when the voltage feeding the transformer is cut by non-automatic circuit breakers which interrupt the currents.

The harmful effects of an overvoltage depend on the peak value and the speed variation voltage, being factors leading to an irregular distribution of the stresses in the windings. The risk of exposure to overvoltages is, in the first instance, linked to the place of installation and then to the following factors:

- type of HV distribution network and type of LV network (above or underground);
- whether there are any overvoltage limitation devices;
- length and type of mains/transformer connection;
- type of equipment connected and operation conditions;
- quality of the earth and cabin connections.

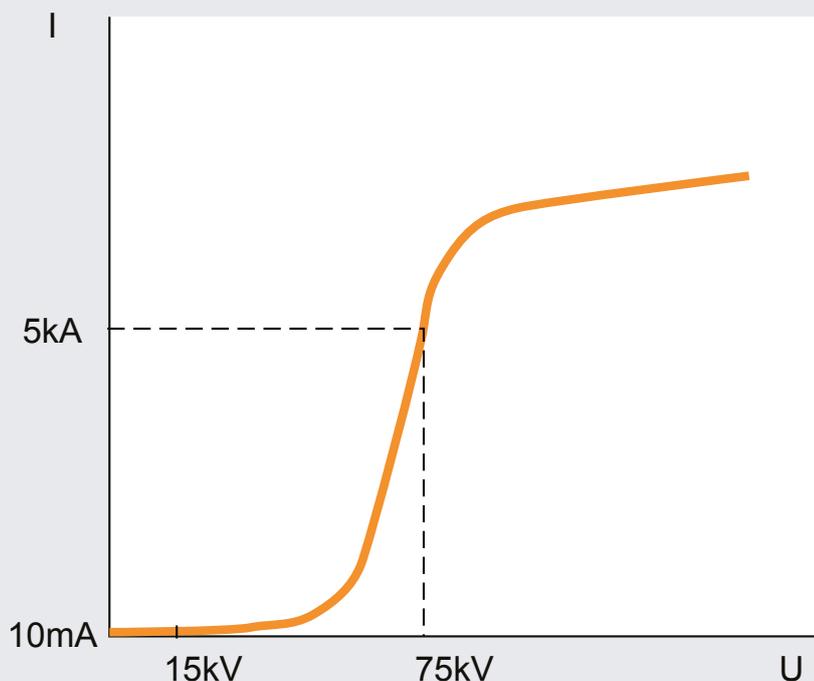
Faults caused by overvoltages affect the insulation of the transformer and its components.

They can be divided into:

- faults between the turns of the same winding (most frequent case);
- faults between windings;
- faults between the stressed winding and a conductor part (core or metal structure).

Surge arresters may be used to efficiently protect transformers against overvoltages.

For more information on surge arresters see the chapter dedicated to accessories.



Example of a characteristic curve of a Zinc Oxide (ZnO) arrester for 20kV mains with "impulse" 125 kV insulation level.

# Protection against temperature rise

During its normal operation a transformer has no-load losses and load losses which generate thermal energy. This energy depends on the construction of the transformer, its power and the installation conditions. It should be remembered that the transfer of thermal energy is proportional to the temperature difference between the transformer and the room (ambient). At a given room temperature, the transformer temperature depends mainly on the load losses. As the load increases, losses and room temperature increase favouring a more rapid degradation of the insulation materials and thus a higher probability of failure of the dielectric. This situation could also occur when, with equal losses due to load, the room temperature and consequently the transformer temperature increase. The standards define insulation classes indicate the maximum temperatures which can be reached by the transformers in their normal operation and which must not be exceeded.

Temperature rises depend not only on the load and the overcurrents which may be detected by the protection devices, but also on environmental factors (inefficiency of the cooling system, fault on the forced ventilation and increase of the room temperature) which influence the dissipation of heat produced by the transformer's losses. For this reason, electronic temperature measuring devices are normally provided. These are necessary to give the alarm or to trigger the transformer protection. For LEGRAND transformers the following temperature sensors are available: Pt100 thermosensors and PTC thermistors.

- **Pt100**: supplies a signal proportional to the measured temperature;
- **PTC**: supplies an ON/OFF signal depending on whether the measured temperature is less or more than the sensor's threshold.

The sensors are positioned in the hot point of the winding. Both the Pt100 and PTC signals must be processed by the temperature control unit, which is not part of the standard equipment.

On request, other accessories to check the temperature are available:

- a separate temperature display, to be installed on the control panel;
- an output relay for alarm and trip and control of the fans.



Pt100 probe

Terminal box (cast aluminium) for temperature probes, Pt100 sensor to check the temperature

## CHECKING THE TEMPERATURE

The temperature may be checked using Pt100 temperature sensors or thermometers. An alternative solution is to use PTC sensors, which however has the disadvantage that the temperature cannot be displayed.

These systems are used to check the temperature of the low-voltage windings (LV).

For transformers for the supply of static current converters, the temperature of the magnetic core should also be checked.



PTC sensors



Pt100 sensors

## USING PTC SENSORS

In three-phase transformers, the checking system is made of three sensors, one per phase, connected in series.

The sensors are just resistances which send the release signal to a relay when the reaction temperature threshold is exceeded.

The sensor working conditions are quickly reset when the temperature drops 3K below the threshold. When there are two monitoring systems, one gives the alarm signal and the other the release.

The temperature values of the two systems deviate by 20K. When the protection relay is fed by the mains served by the transformer, a delayed contact inhibits the alarm and releases signals starting when the transformer is put into service until the relay coil is powered.

# Ventilation of the Transformers

During service, a transformer generates heat due to losses (fig.1). This heat must be dissipated from the room where the transformer is installed. For this purpose, if the adequate natural ventilation in the room is not sufficient, forced ventilation has to be installed. IEC 60076-11 standards specify that the ambient temperature of the installation must not exceed the following values:

- 20°C yearly average
- 30°C monthly average of the hottest month
- 40°C at any time

The system protecting against temperature rises must be calibrated based on the max cooling air increase by the max temperature rise.

A good cooling system is obtained when the air current enters from the bottom, crosses the room where the transformer is installed and exits from the top on the opposite part (fig.2).

To evaluate the effectiveness of the **natural ventilation** and to consequently check the section of the ventilation openings and the possible positioning heights, consider the following variables:

**TL** = total losses in kW  
sum of the no load (Po) and load losses (Pk) in kW generated by the CRT referred to 120°C and of the other losses in kW generated by any other equipment in the same room

**dT** = temperature difference in °C between air inflow (entrance) and outflow (outlet)

**Q** = airflow through the lower opening in m<sup>3</sup>/s

**H** = distance in metres between the median of the cabin and the median of the upper opening (outlet).

**S** = net surface on entry in m<sup>2</sup>, is the surface of the bottom opening (inflow) in m<sup>2</sup>, into which possible, and advisable, grids have to be reduced [m<sup>3</sup>/s].

**S'** = net surface of exit in m<sup>2</sup>

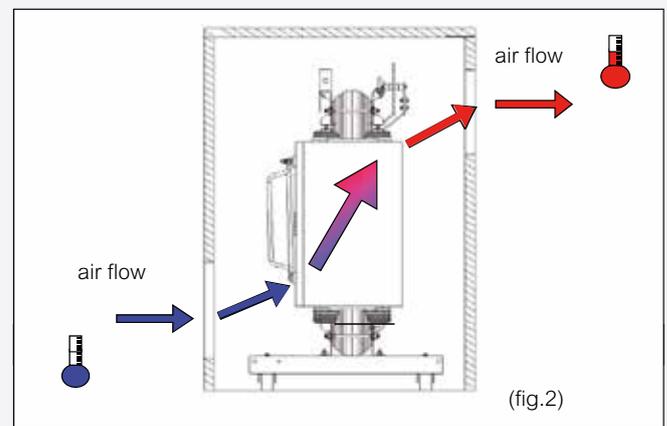
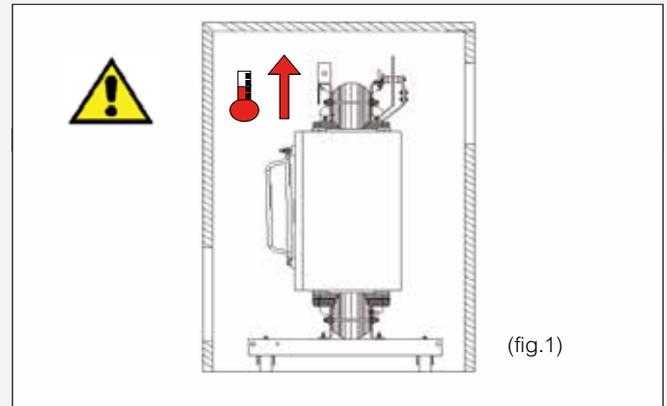
$$TL = P_o + P_k \text{ [kW]}$$

$$Q = TL / (1,15 \times dT)$$

$$S = (10,752 \times TL) / \sqrt{(H \times dT^3)} \text{ [m}^2\text{]}$$

Assuming dT = 15°C, the formula to dimension the inlet opening is:

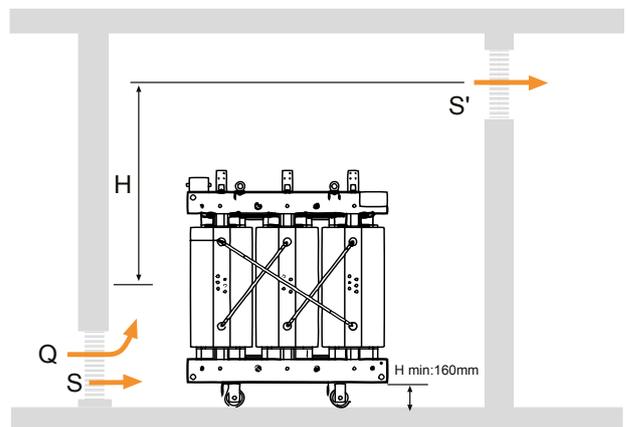
$$S = 0,185 \times (TL / \sqrt{H}) \text{ [m}^2\text{]}$$



Formula valid for an average year temperature of 20°C and a height of max 100 mt on sea level.

The outlet opening (S') must be about 15% larger than the inflow (entrance) opening, due to the different density of the air at different temperatures.

$$S' = S \times 1,15 \text{ [m}^2\text{]}$$



# Ventilation of the Transformers

Following Table 1 refers to the most frequent cases and gives the advised surface of the bottom openings, related to the kW generated in the room. To ensure a sufficient ventilation, the CRTs have to be positioned at at least 0,5 mt from the walls and from other CRTs. For CRTs without rollers, it is advisable that they are positioned higher from the floor, to allow a sufficient air flow from the bottom.

- The values in the table refer to the necessary net surface of the windows; the presence of a grid (advisable) reduces the net surface achieved
- For dT different from 15°C multiply the value in the table by  $\sqrt{(dT^3/58)}$

If the air flow so calculated cannot be obtained, use ventilation bars, i.e. forced ventilation.



Example of transformer with ventilation bars

**TABLE 1**

Relating surface **S** in function of the height of the windows and the total losses in the room.

Total Losses (kW)	Height (m)					
	0.5	1.0	1.5	2.0	2.5	3.0
	S (m <sup>2</sup> )					
3,0	0.8	0.6	0.5	0.4	0.4	0.3
4,0	1.0	0.7	0.6	0.5	0.5	0.4
5,0	1.3	0.9	0.8	0.7	0.6	0.5
6,0	1.6	1.1	0.9	0.8	0.7	0.6
7,0	1.8	1.3	1.1	0.9	0.8	0.7
8,0	2.1	1.5	1.2	1.0	0.9	0.9
9,0	2.4	1.7	1.4	1.2	1.1	1.0
10,0	2.6	1.9	1.5	1.3	1.2	1.1
11,0	2.9	2.0	1.7	1.4	1.3	1.2
12,0	3.1	2.2	1.8	1.6	1.4	1.3
13,0	3.4	2.4	2.0	1.7	1.5	1.4
14,0	3.7	2.6	2.1	1.8	1.6	1.5
15,0	3.9	2.8	2.3	2.0	1.8	1.6
16,0	4.2	3.0	2.4	2.1	1.9	1.7
17,0	4.4	3.1	2.6	2.2	2.0	1.8
18,0	4.7	3.3	2.7	2.4	2.1	1.9
19,0	5.0	3.5	2.9	2.5	2.2	2.0
20,0	5.2	3.7	3.0	2.6	2.3	2.1
21,0	5.5	3.9	3.2	2.7	2.5	2.2
22,0	5.8	4.1	3.3	2.9	2.6	2.4
23,0	6.0	4.3	3.5	3.0	2.7	2.5
24,0	6.3	4.4	3.6	3.1	2.8	2.6
25,0	6.5	4.6	3.8	3.3	2.9	2.7
26,0	6.8	4.8	3.9	3.4	3.0	2.8
27,0	7.1	5.0	4.1	3.5	3.2	2.9
28,0	7.3	5.2	4.2	3.7	3.3	3.0
29,0	7.6	5.4	4.4	3.8	3.4	3.1
30,0	7.9	5.6	4.5	3.9	3.5	3.2
31,0	8.1	5.7	4.7	4.1	3.6	3.3
32,0	8.4	5.9	4.8	4.2	3.7	3.4

## FORCED VENTILATION

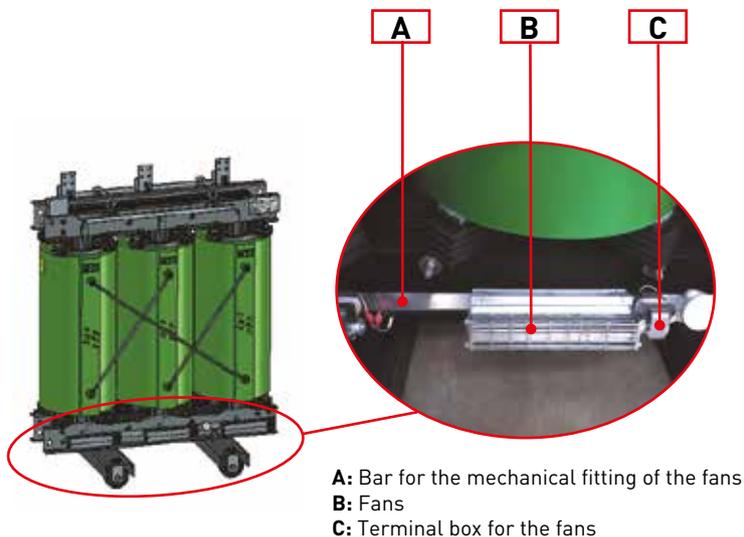
Forced ventilation is necessary in the following cases:

- frequent overloads
- small room
- room with poor ventilation / air exchange
- annual average temperature higher than 20 °C

Forced ventilation can be achieved with:

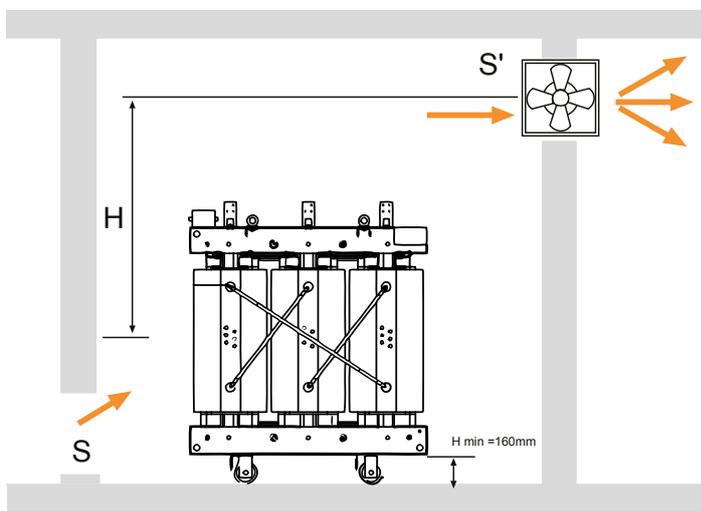
- Ventilation fans (installed directly by the manufacturer, or successively). The fans have to be dimensioned according to the rating of the CRT and the overtemperature to be dissipated.

\*If the CRT is fitted with ventilation bars, the expected life of the fans is approx 20.000 hours. After this period fans must be changed. For this reason ventilation bars should be used only for temporary increase of power and not for continuous conditions.



If the transformer room is small or poorly ventilated, we suggest to use forced ventilation. This is also necessary when the average annual temperature is higher than 20°C or when there are frequent transformer overloads. To avoid affecting the natural convection in the room, an air extractor may be installed in the upper opening, possibly controlled by a thermostat.

Installation of an air extraction system, switched on by a thermostat or directly by the protection relay of the CRT. Advised air flow is 3,5 - 4,0 m<sup>3</sup> / min of fresh air every kW of losses, referred to 120°C



It is advisable to install the extraction system on the upper opening of the room

**ATTENTION:** an insufficient air flow reduces the expected life of the CRT. Increasing the temperature of the devices can cause the intervention of the protection relay.

The user should always specify any operating or ambient condition that could cause restrictions in the availability of ventilation flow. Insufficient air flow reduces the nominal rating of the CRT.

# Vectorial groups

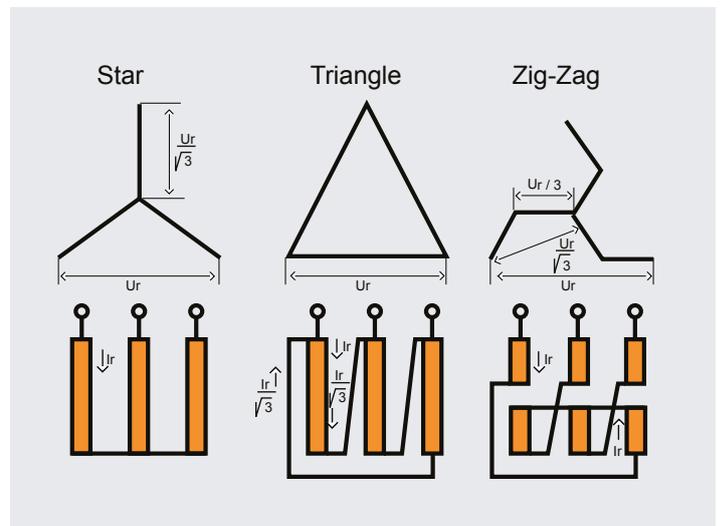
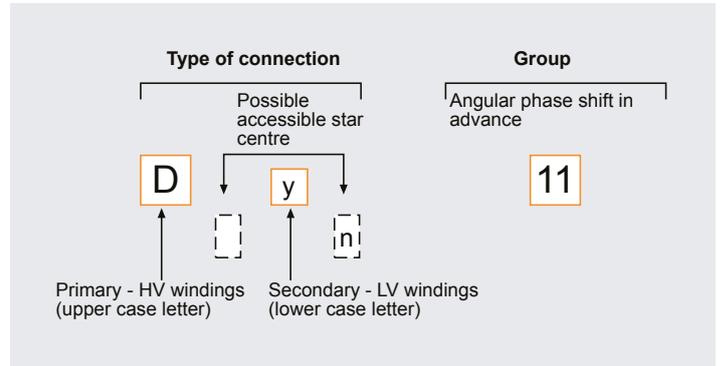
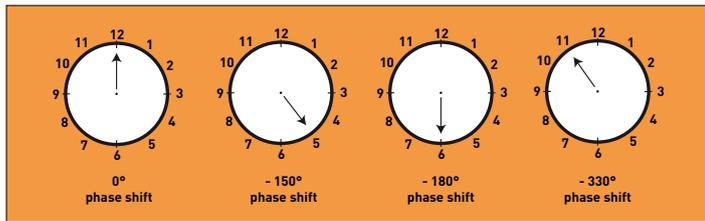
Internal windings can be star, triangle or zigzag connected. Depending on the connection type, the system of induced voltages on the low-voltage side is out of phase, with respect to the system of the primary voltages, by angles which are multiples of  $30^\circ$ .

The winding connection method is identified by 3 letters (uppercase for high voltage winding, the winding having the highest rated voltage and lower case for low-voltage winding, the winding having the lowest rated voltage):

- Y** - star connection
- D** - triangle connection
- Z** - zigzag connection

Associated with these letters some numbers represent the phase shift, dividing it into 4 groups:

- Group 0 – no phase shift
- Group 5 –  $150^\circ$
- Group 6 –  $180^\circ$
- Group 11 –  $330^\circ$



The winding which receives active power from the supply source is referred to as "primary winding" and delivers active power to a load referred to "secondary winding". These terms have no significance as to which of the windings has the higher rated voltage and should not be used except in the context of direction of active power flow.

	<b>Dd0</b>		<b>Dd6</b>
	<b>Yy0</b>		<b>Yy6</b>
	<b>Dz0</b>		<b>Dz6</b>
	<b>Dy11</b>		<b>Dy5</b>
	<b>Yd11</b>		<b>Yd5</b>
	<b>Yz11</b>		<b>Yz5</b>

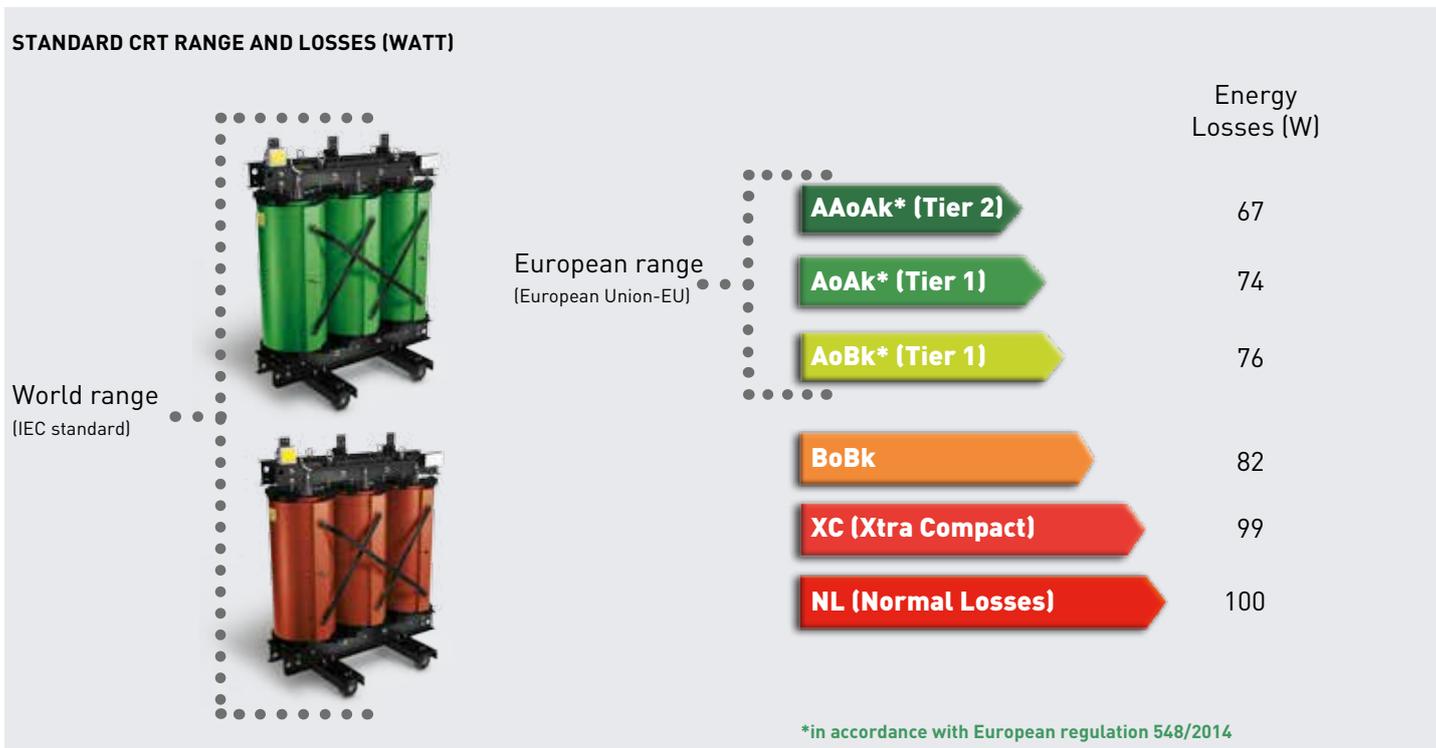
# CRT Range

To meet any requirement of the market, Legrand has developed different models of transformers (standard and special versions) that allow customers to choose within a competitive range, suitable for each installation and oriented to energy savings.

Standard solutions are divided in two categories:

**Green** (High efficiency transformers), in compliance with European Regulation 548 and **Red**, dedicated to all competitive markets outside European union (EU), in compliance with IEC standard.

Special products are customized following specific request.



## STANDARD SOLUTIONS:

### Distribution transformers

- Rated power: **100 – 3150 kVA**
- Primary rated voltage: **up to 36kV**
- Secondary rated voltage: **up to 433V**

### GREEN THE TRANSFORMERS

- AAoAk - reg 548 Tier 2
- AoAk - reg.548 Tier 1
- AoBk - reg.548 Tier 1 (≤ 630)

### RED TRANSFORMERS

- BoBk
- XC – Xtra compact
- NL – Normal losses

## SPECIAL SOLUTIONS:

### Special transformers

- Rated power: **up to 20 MVA**
- Primary insulation level: **up to 36kV**
- Secondary insulation level: **on request**

Please contact LEGRAND for special transformers. You will receive all necessary assistance and technical competence to identify the best solution for specific applications.

# CRT Range

## Equipment

- HV terminals (n°3 pieces)
- LV bar terminals (n°4 pieces)
- Off load tapping links (n°3 pieces)
- Rating plate (n°1 pieces)
- Lifting lugs (n°4 pieces)
- Earth terminals (n°2 pieces)
- Orientable rollers (n°4 pieces)

## Materials of windings

- Aluminium (Al)
- at request special version (Cu/Cu or Al/Cu or Cu/Al)

## Accessories (on request)

- Pt100 thermosensors with connection box
- PTC thermistors (as an alternative to the Pt100 thermosensors)
- Electronic unit for thermal control, with inputs for Pt100 and temperature display
- Electronic unit for thermal control, with inputs for PTC, without temperature display
- Forced ventilation systems (for temporary power increase)
- Electronic unit for ventilation system
- Transformer protective enclosure (degree protection IP23 & IP31)
- Surge arresters kit
- Antivibration pads
- HV terminals for plug-in connections (Elastimold)
- Antiseismic frame (in base of level of earthquake)
- OLTC (On-Load Tap-Changers)
- CT and VT instrument transformer



**Example of standard transformers**



**Example of special transformers**

Contact Legrand for further accessories

## DIMENSIONS AND WEIGHT



100 kVA



150 kg

1000 kVA



2500 kg

17 MVA



19000 kg

# Green T.HE

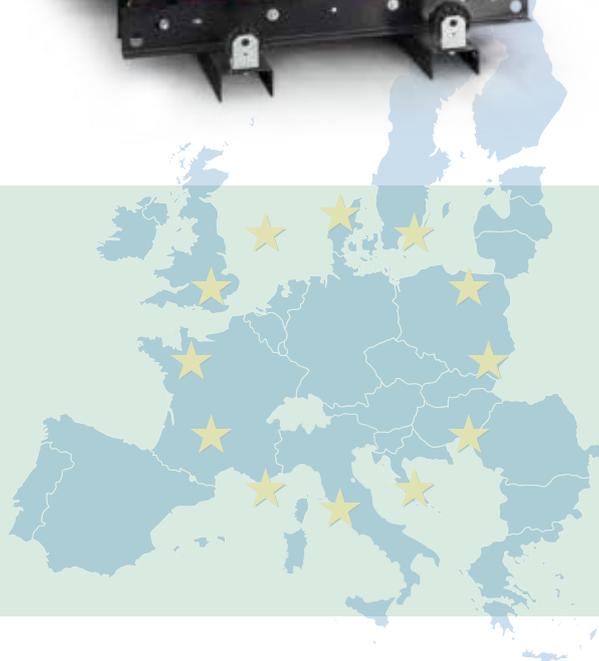
## standard solutions for European market

With the application in July 2015 of the European Commission Regulation for ecodesign, efficiency of transformers will be increased.

The Green T.HE transformers comply with the **EN 50588-1** Standard. They are designed and manufactured according to the **Regulation 548/2014** of European Commission and the new Ecodesign guidelines 2009/125/CE.

Legrand Green T.HE Transformers, designed and manufactured in accordance with new Regulation, **ensure a consistent reduction in energy consumption**, resulting in economic savings and the decrease of CO<sub>2</sub> emissions released into the atmosphere.

**AoBk - AoAk - AAoAk**



MARKETS	AAoAk reg548 Tier2	AoAk reg548 Tier1	AoBk reg548 Tier1	BoBk	XC	NL
EUROPE (UE)	Yes	Yes	Yes	No	No	No

Regulation 548/2014 will be valid only in the countries of the European Union, where it will be possible to sell only the GREEN T.HE transformers.  
(It is also possible to sell this type of transformers in other countries which respect IEC standard)

\*For more information see on page 8, dedicated to Regulation 548/2014

# Green T.HE

standard solutions for European market

## CLASSIFICATION

The classification of a cast resin transformer is referred to the value of the no-load losses ( $P_0$ ), as well as the load losses ( $P_k$ ).

$P_0$  losses are independent from the load and they remain constant for the entire period when the transformer is connected to the electric power network.

$P_k$  losses occur only when the transformer is connected to a load and they are proportional to the square of the current.

NO-LOAD LOSSES ( $P_0$ )	LOAD LOSSES ( $P_k$ )
$A_0$	$A_k$
$A_0$	$B_k$

According to the European Regulation 548/2014, two different application deadlines are fixed;

**TIER 1** in year 2015 and **TIER 2** in 2021 (future). Thanks to our constant innovation and research, we are able to offer to the market transformers environmentally friendly, with technical characteristics ready for the future (requests for year 2021), with a further lowering of the no load  $P_0$  losses. The value of even lower losses mean a complete environment respect and at the same time a further saving on costs of electricity compared to transformers designed for phase 1 of the European Regulation 548/2014.

For more information see the comparison between two transformers designed for the two phases of Regulation:

Rated power (kVA)	COMPARISON	
	CRT 1 AoAk - TIER 1 (phase 1/2015) FK4AAAGBA	CRT 2 AAoAk - TIER 2 (phase 2/2021) FK4A3AGBA
Power: 1000kVA Primary voltage: 20kV Secondary voltage: 0,400V UCC%: 6% AL / AL	$P_0 = 1550W$ $P_k = 9000W$	$P_0 = 1395W$ $P_k = 9000W$

## ECODESIGN REQUIREMENTS

Rated power (kVA)	TIER 1 (from 1 July 2015)		TIER 2* (from 1 July 2021). Legrand range called "AAoAk"	
	Maximum load losses $P_k$ (W)	Maximum no-load losses $P_0$ (W)	Maximum load losses $P_k$ (W)	Maximum no-load losses $P_0$ (W)
≤ 50	$B_k$ (1700)	$A_0$ (200)	$A_k$ (1500)	$A_0 - 10%$ (180)
100	$B_k$ (2050)	$A_0$ (280)	$A_k$ (1800)	$A_0 - 10%$ (252)
160	$B_k$ (2900)	$A_0$ (400)	$A_k$ (2600)	$A_0 - 10%$ (360)
250	$B_k$ (3800)	$A_0$ (520)	$A_k$ (3400)	$A_0 - 10%$ (468)
400	$B_k$ (5500)	$A_0$ (750)	$A_k$ (4500)	$A_0 - 10%$ (675)
630	$B_k$ (7600)	$A_0$ (1100)	$A_k$ (7100)	$A_0 - 10%$ (990)
800	$A_k$ (8000)	$A_0$ (1300)	$A_k$ (8000)	$A_0 - 10%$ (1170)
1000	$A_k$ (9000)	$A_0$ (1550)	$A_k$ (9000)	$A_0 - 10%$ (1395)
1250	$A_k$ (11000)	$A_0$ (1800)	$A_k$ (11000)	$A_0 - 10%$ (1620)
1600	$A_k$ (13000)	$A_0$ (2200)	$A_k$ (13000)	$A_0 - 10%$ (1980)
2000	$A_k$ (16000)	$A_0$ (2600)	$A_k$ (16000)	$A_0 - 10%$ (2340)
2500	$A_k$ (19000)	$A_0$ (3100)	$A_k$ (19000)	$A_0 - 10%$ (2790)
3150	$A_k$ (22000)	$A_0$ (3800)	$A_k$ (22000)	$A_0 - 10%$ (3420)

Requirements applicable (losses value) to three phase dry type transformers with rated power ≤ 3150 kVA with one winding with  $U_m \leq 24$  kV and the other one with  $U_m \leq 1,1$  kV.

## LOW, PARTIAL DISCHARGES, HIGH QUALITY

According to the product standard related to design of resin transformers (CEI EN 60076-11, i.e. IEC 60076-11), all the windings with a voltage  $\geq 3.6\text{kV}$  should be subjected to the measurement of the **partial discharges and the value measured should not exceed 10 picocoulombs (pC)**.

Partial discharges are a microscopic phenomena occurring inside insulating resin cavities that can speed up ageing.

For this reason, it is important that the values of such currents are limited.



A low value of partial discharges gives an indication of the positive factors, such as:

- solid design criteria
- high quality of raw materials used
- high precision during the conductor winding phases
- high competence level during the epoxy resin pouring around the high-voltage winding
- high impregnation coefficient of low voltage coil
- accuracy in final assembling of semi-manufacturers

It is easy comprehending that **a Lower level of partial discharges means a Higher Quality of transformers and higher life expectancy.**

## GUARANTEED RELIABILITY

When the Green T.HE transformers are subjected to partial discharges, values under **5 pC** have been always been achieved (this result exceeds the requirement of the standard which establishes the maximum value at 10 pC). **Thanks to the excellent quality of products, Legrand has extended its GUARANTEE to 8 YEARS for all its transformers with standard features (\*).**



Label on the std GreenT.HE transformer

### TYPE OF THE PARTIAL DISCHARGES

Depending on the type, discharges can be divided into:

- **Corona effect:** is the discharge that happen in air or in a gas surrounding a conductor, this usually occurs in relation to points and edges present on the conductors.
- **Surface discharges:** it occurs on the surface of an insulator and which generally causes damage on the surface of the insulation itself, reducing the efficiency
- **Internal discharges:** represents the main cause of life-cycle decrease of the insulating material]
- **Treering** (branched discharge channel): is the channel of pre-discharge which is formed following the degradation of the insulation and which leads to a destructive discharge.



(\* standard features:

all transformers according to the European Directive 548/2014 and with the code starting with "F", such as FK4AAAGBA Green T.HE-eu AA KVA 1000 kV 20/0,4. All the transformer accessories shown on pages 49 and 50 of this catalogue are expressly excluded from the guarantee extension.

# Red transformers

standard solutions for markets outside Europe

Red transformers are dedicated to all competitive markets outside European Union (EU), in compliance with IEC standards.

These types of products are divided into 3 different families, depending on the values of losses: BoBk, XC and NL.



## RANGES:

- **BoBk**
- **XC** – Xtra compact – Dedicated to standard distribution applications
- **NL** – Normal losses

MARKETS	AAoAk reg548 Tier2	AoAk reg548 Tier1	AoBk reg548 Tier1	BoBk	XC	NL
WORLD (IEC Standard)	Yes	Yes	Yes	Yes	Yes	Yes

In the table below, you can see an example of comparison between load losses and no-load losses of NL, XC and BoBk red transformers in insulation class 12 kV.

For all other technical informations and different insulation classes, see dedicated chapter.

#### LOAD COMPARISON IN INSULATION CLASS 12 kV

Rated power (kVA)	NL		XC		BoBk	
	Maximum load losses $P_k$ (W)	Maximum no-load losses $P_0$ (W)	Maximum load losses $P_k$ (W)	Maximum no-load losses $P_0$ (W)	Maximum load losses $P_k$ (W)	Maximum no-load losses $P_0$ (W)
100	1900	420			2000	330
160	2700	550			2700	450
200	3500	680			3050	520
250	3700	750	4200	700	3500	610
315	4600	850	5100	800	4100	730
400	5400	1000	5500	960	4900	880
500	6700	1200	7000	1150	5950	1000
630	7600	1450	8200	1400	7300	1150
800	9400	1750	9300	1700	9000	1300
1000	10000	2000	10500	1950	10000	1500
1250	12700	2300	12500	2350	12000	1800
1600	14000	2800	15300	2750	14500	2200
2000	18000	3300	18800	3400	18000	2600
2500	21000	4300	21000	4200	21000	3200
3150	26000	4600	26000	5000	26000	3800

The Green T.HE reg.548 transformers (see previous chapter), can be sold worldwide (i.e. inside and outside the european union):

- AAoAk reg.548 Tier 2
- AoAk reg.548 Tier 1
- AoBk reg.548 Tier 1



# Special offer

## TRANSFORMERS FOR MARINE APPLICATIONS



Legrand has developed specific transformers for supply and propulsion in a wide range of applications, including marine, shipping vessels and offshore oil rigs.

### TECHNICAL CHARACTERISTICS

Modern **cruise ships** and **high tech ships** use electric propulsion systems that require special transformers to cope with strict on-board technical requirements such as reduced noise and vibration levels, limited space, reduced maintenance system, high resistance to the corrosive action of sea water and sea air, and a high degree of security to avoid risk to humans.

Legrand cast resin transformers and reactors for marine applications are designed and manufactured according to the highest International Standards and are approved by the most stringent certification bodies.

Our design, production and control procedures are certified by ISO 9001:2008 (Bureau Veritas).

This allows us to offer to the customer a reliable product in terms of quality, safety and performance. Moreover, thanks to our specialism in the production of cast resin transformers, we are able to design reliable solutions that meet the exact needs of our customers.

Our products are suitable for specialist applications, particularly in petrochemical and gas environments.

### MAIN FEATURES

- optimised design based on specific harmonic loads
- compact dimensions, lightweight materials
- designs can be adapted to the dimensional constraints of any installation
- specific cooling enclosure
- rated power: max 20 MVA;
- insulation levels: max 36 kV;
- frequency: 50 or 60 Hz;
- degree of protection: max IP55;
- standard colour (UK): RAL 7035 (color available on request);
- cooling system: AN (Natural Air), AN / AF (natural air/forced air) or AF / WF (forced air/forced water);
- constructive configuration for each transformer: max 24 pulse;

### WORKING CONDITIONS:

- good resistance to humid and salty environments
- heavy-duty use, working even in the presence of vibrations and considerable mechanical stresses
- meeting the most stringent Standards and specifications

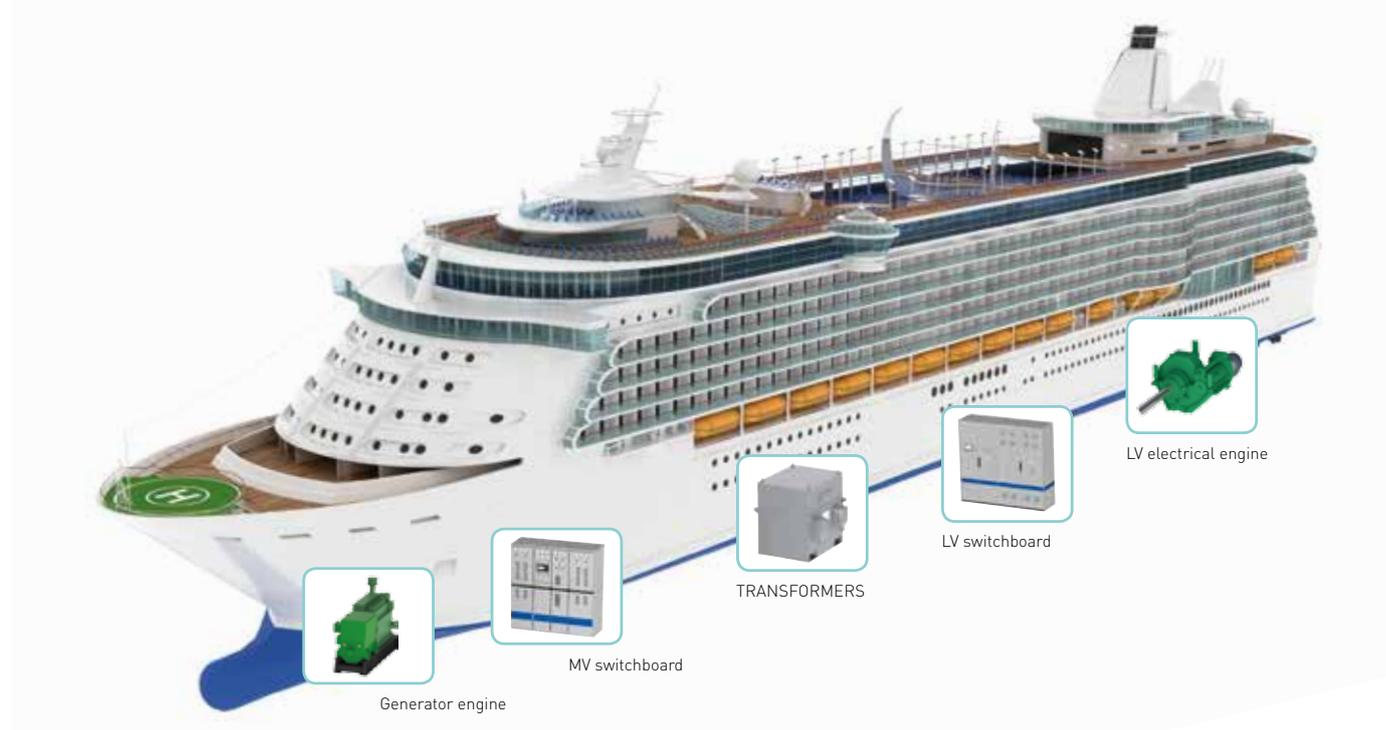
Custom transformers are also available and can be equipped with temperature, current and voltage control systems, PreMag transformers, antivibration devices and IR temperature control.

## A WIDE RANGE OF APPLICATIONS

Legrand has a wide range of cast resin transformers for naval and offshore applications, manufactured for a high level of performance and reliability in terms of quality and safety. Legrand's cast resin transformers are the perfect choice for energy and power distribution, as well as propulsion, in this type of environment.

## EXPERIENCE AND TECHNOLOGY

Legrand's R&D are recognised for their design expertise, and employ the most up-to-date calculation and simulation software tools in order to guarantee the best designs for each project.



# Special offer

## TRANSFORMERS FOR MARINE APPLICATIONS

### TYPICAL TRANSFORMERS



#### CRUISE SHIPS

Power: 2200 kVA  
 Primary voltage: 11 kV 60 Hz  
 Secondary voltage: 0,705-0,403 kV  
 Cooling: AN/AF  
 Degree of protection: IP23



#### OFFSHORE DRILLING RIGS

Power: 5600 kVA  
 Primary voltage: 11 kV 60 Hz  
 Secondary voltage: 0,69-0,69/0,69-0,69 kV  
 Cooling: AFWF  
 Degree of protection: IP44



#### LNG CARRIERS

Power: 7700 kVA  
 Primary voltage: 6,6 kV 60 Hz  
 Secondary voltage: 1,88-1,88 kV  
 Cooling: AFWF  
 Degree of protection: IP44



#### MULTIFUNCTIONAL SHIPS

Power: 4900 kVA  
 Primary voltage: 6,6 kV 60 Hz  
 Secondary voltage: 0,69-0,69/0,69-0,69 kV  
 Cooling: AFWF  
 Degree of protection: IP44

### CERTIFICATIONS

Legrand transformers are certified by the most important Certification bodies, including:

**ABS:** American Bureau of Shipping

**DNV:** Det Norske Veritas

**GL:** Germanischer Lloyd

**RMRS:** Russian Maritime Register of Shipping

**LR:** Lloyd's register

**RINA:** Registro Italiano Navale

**CCS:** China Classification Society



# Special offer

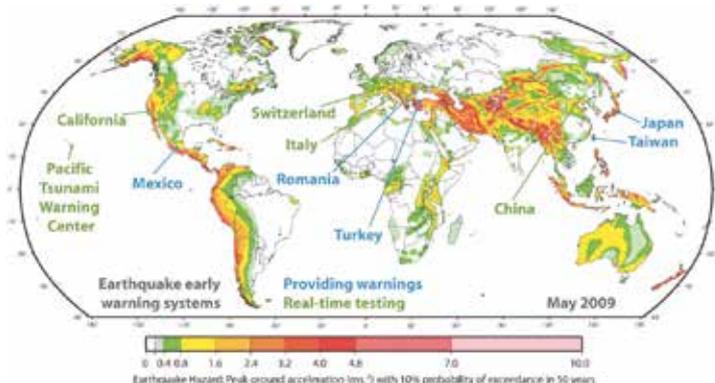
## ANTISEISMIC TRANSFORMERS

### EARTHQUAKE - SEISMICITY

An earthquake, or sisma, is a sudden ground vibration, produced by a abrupt release of energy and this energy is propagated in all directions in form of waves.

- it is a natural phenomenon
- it is not predictable
- it usually has short duration (less than 1 minute)
- it usually occurs in the same areas

### SEISMIC ZONES IN THE WORLD



### ANTISEISMIC TRANSFORMERS MAIN FEATURES

In order to operate in different seismic zones in the world, Legrand has integrated its range including Antiseismic Transformers especially developed.

- Special Transformers (designed for the seismicity of the area)
- 4 different configurations:  
 PGA\*  $\leq 0,2g$  – withstand available in our standard offer (light earthquakes)  
 $\leq 0,3g$  (medium to strong earthquakes)  
 $\leq 0,4g$  (strong earthquakes)  
 $\leq 0,5g$  (very strong earthquakes)

\* PGA (Peak ground acceleration): horizontal acceleration to the ground



Example of antiseismic transformer

### CERTIFICATIONS

The Antiseismic Transformer has been tested and certified by the laboratory \*VIRLAB S.A., passing successfully antiseismic test.

The transformer has been submitted to five (5) S1 (50%S2) level tests plus one (1) S2 level test, carried out in the two main horizontal directions, front-to-back and side-side, simultaneously with the vertical direction. The test has been done in the worst condition, which is the one with **PGA  $\leq 0,5g$**  (very strong earthquakes)



\*VIRLAB S.A.  
 Accredited by ENAC, Spanish National Accreditation Entity

### STANDARDS:

Legrand antiseismic transformers are certified:

- **European Standards EN 60068-3-3: 1993:** Environmental testing – Part 3: Guidance. Seismic test methods for equipments.
- **European Standards EN 60068-2-57: 2000:** Environmental testing – Part 2-57: Tests - Test Ff Vibration, time-history method.
- **European Standards EN 60068-2-6: 2008:** Environmental testing – Part 2: Tests – Fc: Vibration ( sinusoidal )
- **European Standards EN 60068-2-47: 2005:** “Environmental testing – Part 2-47: Tests. Mounting of specimens for vibration impact and similar dynamic tests”.

For more informations please contact directly Legrand

# Special offer

## POLE MOUNTED DRY TRANSFORMERS

To minimize environmental impact, Legrand has developed a specific **pole mounted transformers** range for distribution of electrical energy where there is the need of HV/LV zero environmental impact equipment.

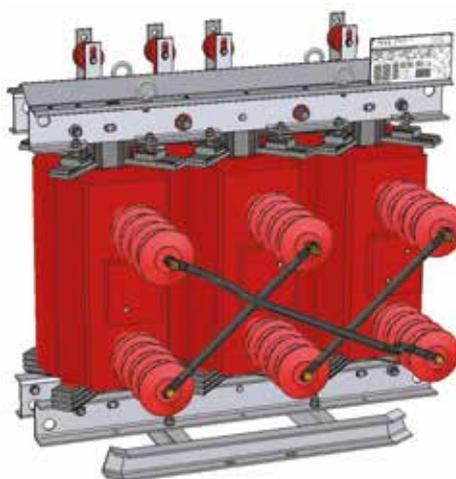
Legrand Pole Mounted cast resin transformers are designed and manufactured according to CEI EN 60076-11 climatic and environmental classes.

### Suitable for all outdoor installation

- Places with high environmental risk (parks, and protected areas);
- near wells, springs and ground waters;
- near rivers, lakes and streams.

### MAIN FEATURES

- Dimension, weight and noise are similar to the oil solution;
- the insulation mean is solid (there are NO liquids);
- it is not polluting;
- there is NO risk of explosion caused by internal gas generation;
- there is NO need of special maintenance as for oil:
  - oil analysis;
  - refilling (in case of leakages);
  - check of tank leakages;
  - check of gasket sealing;
  - verifications of highly toxic and harmful substances;
- NO enclosure is needed; no protection enclosure is needed although the installation is outdoor. Animal nesting does not constitute a risk because it does not generate a short-circuit and it is not dangerous during line maintenance activities.
- NO copper content; risk of tampering is very low because windings are in aluminum, a less valuable material than copper.
- NO oil content; risk of tampering is very low because there is no oil to steal.
- NO risk of pollution; there is no risk of pollution because there is no oil content.
- Nominal Rated Power :  $\leq 100\text{kVA}$
- Primary insulation level :  $\leq 24\text{kV}$
- Secondary insulation level :  $\leq 1,1\text{kV}$
- Off-load tapping links :  $\pm 2 \times 2,5\%$
- Vector Group : Dyn
- Frequency : 50-60Hz



### MAIN FEATURES

- Outdoor insulators on MV side;
- triangle cables protected with heat shrink sleeves;
- canopy for core weather protection;
- resin suitable for outdoor applications;
- hot galvanized steel structure;
- hermetic resin cover for tap changer board, for outdoor use;
- lifting lugs;
- special supporting devices (slides) for pole shelves.

For more informations please contact directly Legrand

# Special offer

## REACTORS

Legrand has developed very specific solutions for reactors.

Reactors can be installed at any industrial, distribution, or transmission current and voltage level from few Amperes to 10.000 A and fault-current levels up to 100.000 A.

### APPLICATIONS

- Fault-current limiting;
- inrush-current limiting (for capacitor and motors)
- harmonic filtering;
- VAR compensation;
- reduction of ripple currents;
- blocking of power-line carrier signals
- neutral Grounding
- flicker reduction for arc-furnace application;
- circuit detuning;
- load balancing

### RANGE OF REACTORS

**A wide range of reactors that we can produce:**

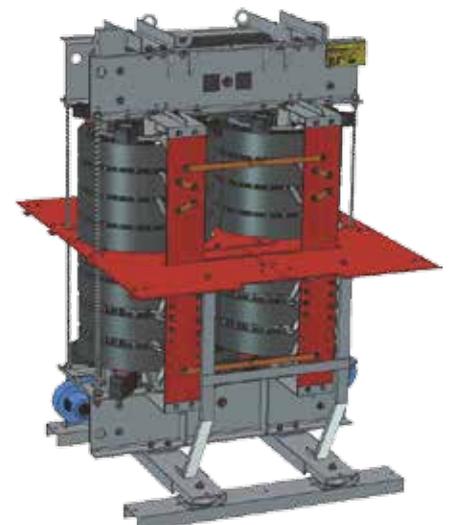
1. shunt reactor;
2. current-limiting reactor;
3. neutral-earthing reactor;
4. motor starting reactor;
5. filter reactor;
6. earthing transformer (neutral coupler);
7. smoothing reactor;

### STANDARDS

Reactors have been designed and manufactured according to the national and international standards. International Standard: IEC 60076-6



Reactors are used provide inductive reactance in power circuit.



Example of reactors

For more informations please contact directly Legrand

# Special offer

## CLE SYSTEM

### (certified low electromagnetic emission)

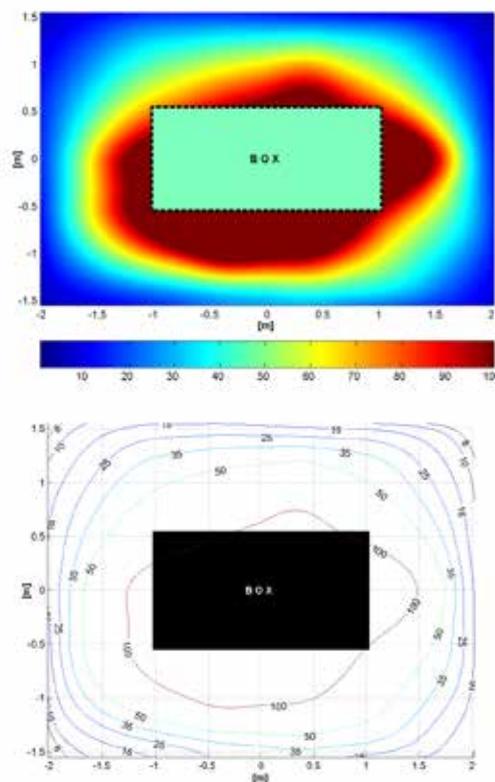
The CLE system with low electromagnetic emission is applied to substations and electrical cabinets in medium and low voltage.

The CLE (Certified Low Electromagnetic Emission) system consists in a special solution of cast resin transformers and enclosures, designed for special environment.

The construction adopted for CLE transformers limit the electromagnetic emission to values much lower than 10 microTesla **(the LEGRAND quality objective is 3 microTesla)** in any direction.

Every CLE transformer is supplied with a specific electromagnetic emission certificate.

Thanks to the availability of a modern anechoic chamber, CLE systems can also come with a measurement report of the noise subdivided by emission range.



Example of an electromagnetic emission and noise measurement report

## SPECIAL INSULATION TRANSFORMERS

### (max 25 kVA)

Protect the electrical equipment from lightning and other overvoltage transients originated in the net.

#### MAIN FEATURES

- Full cast execution for enhanced protection and easy handling
- Low inrush current
- Harmonic distortion < 1%
- Very low total losses
- Attenuation of impulsive transients
- Attenuation of high frequency components (< 4%)
- Voltage impulse withstand capability 45 kV
- High mechanical resistance



# Special offer

## LOW VOLTAGE DRY TYPE TRANSFORMERS

### APPLICATIONS

- Safety isolating with protective separation between the input windings and output windings
- Galvanic potential-free separation with a high insulation degree
- Testing room specially designed to be used in a circuit to produce a specific voltage of current
- Reduction of the short circuit current in case of fault
- Filtering function to blocks harmonics current and voltage generated from non linear loads
- IT centers
- Lighting system
- Motors

### MAIN FEATURES

- Rating from **5 kVA to ~ 5000 kVA** depeding on the ratio
- Voltage usually 231, 400 or 690 V
- The winding material is usually aluminum foil, copper at request.
- The insulation thermal class is usually F (overtemperature 100 K).

All windings are impregnated under vacuum to ensure the best possible protection from external agents (dust, humidity) and mechanical strength.

For special applications requiring a high degree of protection, it is possible to supply fully cast windings.



400kVA with aluminium windings



100kVA 690-400 V

# Special offer

## TRACTION TRANSFORMERS

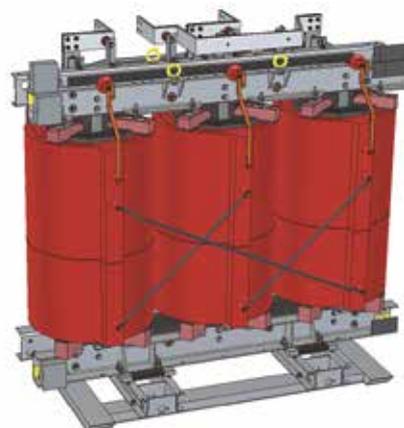
The transformers used in traction substations, for the supply of power to A.C. and D.C. traction system, can be:

- Single-phase traction transformers
- Three-phase rectifier transformers
- Three-phase converter/inverter-transformers for D.C. or A.C. contact line
- Single or three-phase auxiliary transformers at traction supply voltage



### MAIN FEATURES

- Design according to EN 50329
- Heavy harmonic content
- High loads cycle
- Duty classes from I to IX
- Special insulation voltage and test values
- Limitation of transferred overvoltage between primary and secondary windings
- Frequent short-circuit and current shocks withstand



Example of traction transformer

# Green T.HE TIER 1 and TIER 2

## HV/LV Cast Resin Transformers

Compliance with standard: IEC 60076-11 / EN 50558-1 / Reg.548/2014

Rating (kVA): **100-3150**

Frequency (Hz): **50**

Tapping links, HV side: **± 2 x 2.5%**

Materials: Aluminium for primary and secondary windings (copper on request)

Vectorial group: **Dyn11**

Thermal class of the insulating system: **155 °C (F) / 155 °C (F)**

Temperature rise: **100/100 K**

Class of use: **E2-C2-F1** Certified CESI A9032391 IEC 60076-11

Tolerances: According to **IEC /CEI**

Tolerances on losses: **0%**

Partial discharge **< 5 pC**

### 12 kV INSULATION CLASS

Primary voltages (kV): **6-10-11**. Insulation class: **12 kV BIL 60 kV** (BIL 75 kV available on request).

Secondary voltages no-load (V): **400-433** (insulation class 1.1 kV)

### 17,5 kV INSULATION CLASS

Primary voltages (kV): **12-13,2-15**. Insulation class: **17,5 kV BIL 75 kV** (BIL 95 kV available on request).

Secondary voltages no-load (V): **400-410-420** (insulation class 1.1 kV)

### 24 kV INSULATION CLASS

Primary voltages (kV): **20-23**. Insulation class: **24 kV BIL 95 kV** (BIL 125 kV available on request).

Secondary voltages no-load (V): **400-410-420** (insulation class 1.1 kV)

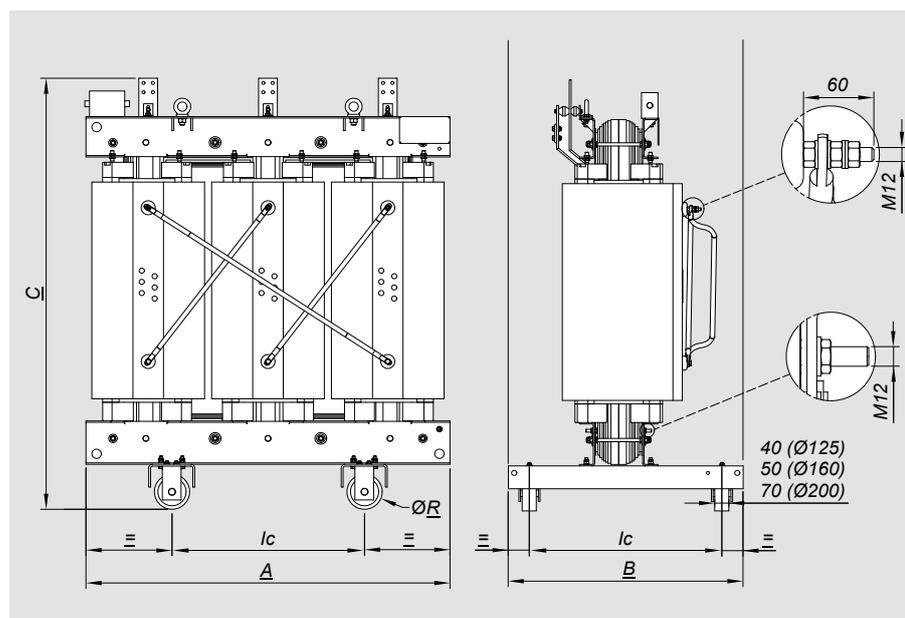
### 36 kV INSULATION CLASS

Primary voltages (kV): **25-33**. Insulation class: **36 kV BIL 170 kV**

Secondary voltages no-load (V): **400-420** (insulation class 1.1 kV)



$S_R$ [kVA]	Series (Reg548)	Item	Uk [%]	Primary voltage [kV]	Secondary voltage [V]	Po [W]	Pk [W] a 120 °C	Io [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB2AAACBA	6	10	400	280	1800	1,8	51	1200	640	1270	520	125	850	2
	AoBk	FB2ABACBA	6	10	400	280	2050	1,8	51	1200	640	1270	520	125	800	2
160	AoAk	FC2AAACBA	6	10	400	400	2600	1,6	54	1200	650	1350	520	125	950	2
	AoBk	FC2ABACBA	6	10	400	400	2900	1,6	54	1250	650	1300	520	125	1000	2
200	AoAk	FD2AAACBA	6	10	400	450	2955	1,4	55	1250	650	1360	520	125	1050	3
	AoBk	FD2ABACBA	6	10	400	450	3300	1,4	55	1250	650	1350	520	125	1100	3
250	AoAk	FE2AAACBA	6	10	400	520	3400	1,2	57	1350	650	1380	520	125	1200	3
	AoBk	FE2ABACBA	6	10	400	520	3800	1,2	57	1250	650	1360	520	125	1150	3
315	AoAk	FF2AAACBA	6	10	400	615	3875	1,1	58	1350	750	1460	670	125	1350	3
	AoBk	FF2ABACBA	6	10	400	615	4535	1,1	58	1350	750	1450	670	125	1350	3
400	AoAk	FG2AAACBA	6	10	400	750	4500	1	60	1350	750	1560	670	125	1600	4
	AoBk	FG2ABACBA	6	10	400	750	5500	1	60	1350	750	1560	670	125	1500	4
500	AoAk	FH2AAACBA	6	10	400	900	5630	0,9	60	1350	750	1670	670	125	1650	4
	AoBk	FH2ABACBA	6	10	400	900	6410	0,9	60	1400	750	1650	670	125	1650	4
630	AoAk	FI2AAACBA	6	10	400	1100	7100	0,9	62	1450	850	1700	670	160	2000	5
	AoBk	FI2ABACBA	6	10	400	1100	7600	0,9	62	1450	750	1760	670	125	1950	5
800	AoAk	FJ2AAACBA	6	10	400	1300	8000	0,8	64	1500	850	1880	670	160	2350	5
1000	AoAk	FK2AAACBA	6	10	400	1550	9000	0,7	65	1600	1000	2030	820	160	2900	6
1250	AoAk	FL2AAACBA	6	10	400	1800	11000	0,7	67	1650	1000	2160	820	160	3300	6
1600	AoAk	FM2AAACBA	6	10	400	2200	13000	0,5	68	1800	1000	2230	820	160	4050	7
2000	AoAk	FN2AAACBA	6	10	400	2600	16000	0,5	70	1950	1310	2270	1070	200	4850	7
2500	AoAk	FO2AAACBA	6	10	400	3100	19000	0,4	71	2050	1400	2430	1070	200	5950	8
3150	AoAk	FP2AAACBA	6	10	400	3800	22000	0,4	74	2150	1400	2450	1070	200	7000	8



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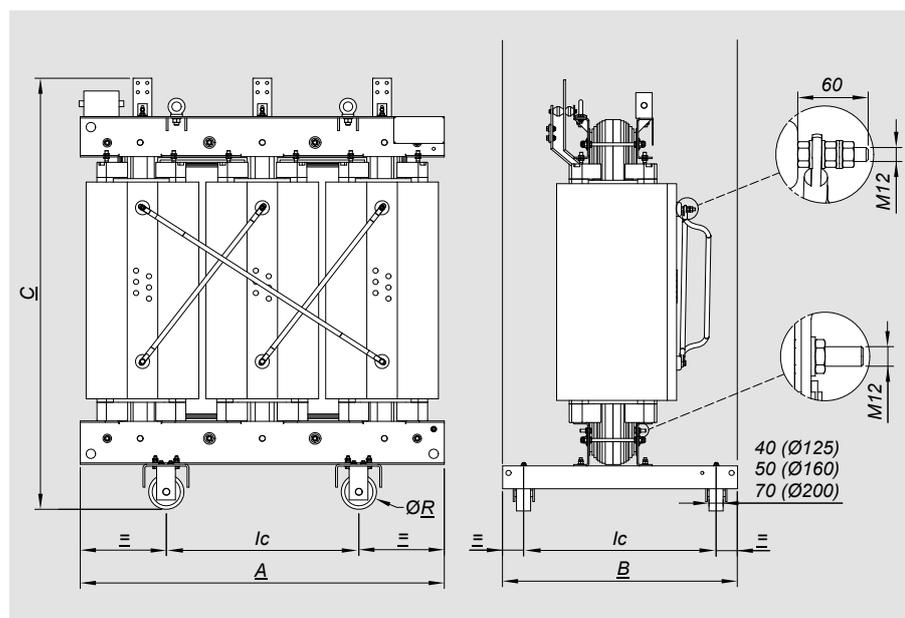
Copper windings available on request

\* For information on enclosure see p. 50

# GREEN T.HE TIER 1

insulation class 17,5 kV

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB3AAAFBA	6	15	400	280	1800	1,8	51	1250	650	1260	520	125	850	2
	AoBk	FB3ABAFBA	6	15	400	280	2050	1,8	51	1250	650	1250	520	125	850	2
160	AoAk	FC3AAAFBA	6	15	400	400	2600	1,6	54	1300	660	1340	520	125	1050	2
	AoBk	FC3ABAFBA	6	15	400	400	2900	1,6	54	1250	660	1300	520	125	1050	2
200	AoAk	FD3AAAFBA	6	15	400	450	2955	1,4	55	1300	660	1350	520	125	1150	3
	AoBk	FD3ABAFBA	6	15	400	450	3300	1,4	55	1300	660	1360	520	125	1100	3
250	AoAk	FE3AAAFBA	6	15	400	520	3400	1,2	57	1350	680	1380	520	125	1250	3
	AoBk	FE3ABAFBA	6	15	400	520	3800	1,2	57	1350	680	1300	520	125	1300	3
315	AoAk	FF3AAAFBA	6	15	400	615	3875	1,1	58	1350	750	1450	670	125	1350	3
	AoBk	FF3ABAFBA	6	15	400	615	4535	1,1	58	1350	750	1400	670	125	1350	3
400	AoAk	FG3AAAFBA	6	15	400	750	4500	1	60	1450	750	1550	670	125	1600	4
	AoBk	FG3ABAFBA	6	15	400	750	5500	1	60	1350	750	1530	670	125	1450	4
500	AoAk	FH3AAAFBA	6	15	400	900	5630	0,9	60	1450	750	1680	670	125	1750	4
	AoBk	FH3ABAFBA	6	15	400	900	6410	0,9	60	1400	750	1600	670	125	1700	4
630	AoAk	FI3AAAFBA	6	15	400	1100	7100	0,9	62	1550	850	1830	670	160	2100	5
	AoBk	FI3ABAFBA	6	15	400	1100	7600	0,9	62	1500	850	1750	670	160	2050	5
800	AoAk	FJ3AAAFBA	6	15	400	1300	8000	0,8	64	1550	850	1890	670	160	2450	5
1000	AoAk	FK3AAAFBA	6	15	400	1550	9000	0,7	65	1650	1000	2050	820	160	3050	6
1250	AoAk	FL3AAAFBA	6	15	400	1800	11000	0,7	67	1700	1000	2160	820	160	3550	6
1600	AoAk	FM3AAAFBA	6	15	400	2200	13000	0,5	68	1850	1000	2240	820	160	4400	7
2000	AoAk	FN3AAAFBA	6	15	400	2600	16000	0,5	70	2000	1310	2300	1070	200	5300	7
2500	AoAk	FO3AAAFBA	6	15	400	3100	19000	0,4	71	2150	1400	2430	1070	200	6100	8
3150	AoAk	FP3AAAFBA	6	15	400	3800	22000	0,4	74	2300	1400	2600	1070	200	8200	8

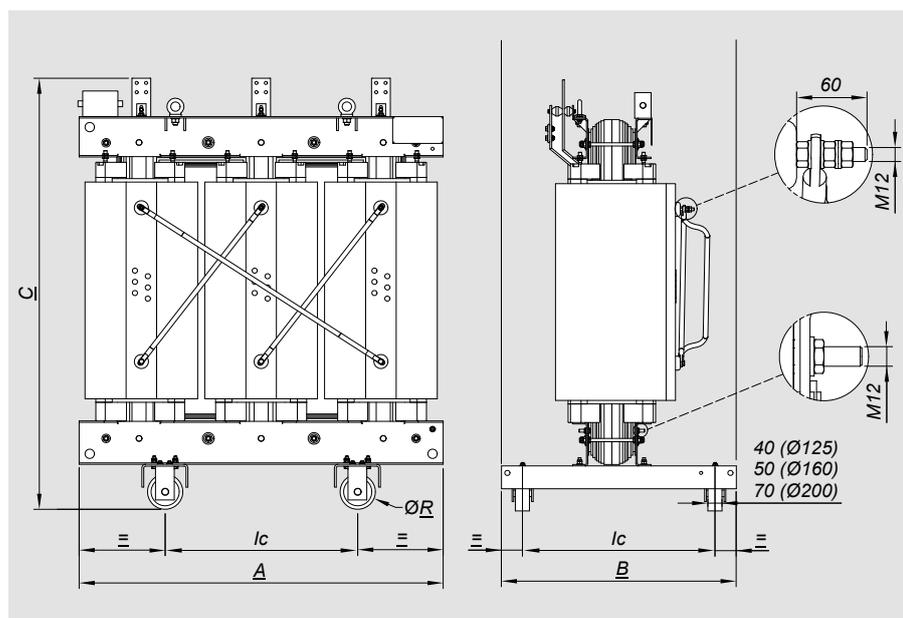


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Copper windings available on request

\* For information on enclosure see p. 50

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	I <sub>c</sub> - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB4AAAGBA	6	20	400	280	1800	1,8	51	1300	660	1290	520	125	950	2
	AoBk	FB4ABAGBA	6	20	400	280	2050	1,8	51	1250	660	1250	520	125	900	2
160	AoAk	FC4AAAGBA	6	20	400	400	2600	1,6	54	1250	660	1370	520	125	1050	2
	AoBk	FC4ABAGBA	6	20	400	400	2900	1,6	54	1250	660	1300	520	125	1050	2
200	AoAk	FD4AAAGBA	6	20	400	450	2955	1,4	55	1350	660	1370	520	125	1200	3
	AoBk	FD4ABAGBA	6	20	400	450	3300	1,4	55	1350	660	1300	520	125	1200	3
250	AoAk	FE4AAAGBA	6	20	400	520	3400	1,2	57	1350	680	1420	520	125	1350	3
	AoBk	FE4ABAGBA	6	20	400	520	3800	1,2	57	1350	680	1420	520	125	1350	3
315	AoAk	FF4AAAGBA	6	20	400	615	3875	1,1	58	1350	750	1480	670	125	1450	3
	AoBk	FF4ABAGBA	6	20	400	615	4535	1,1	58	1350	750	1400	670	125	1450	3
400	AoAk	FG4AAAGBA	6	20	400	750	4500	1	60	1450	750	1570	670	125	1680	4
	AoBk	FG4ABAGBA	6	20	400	750	5500	1	60	1450	750	1570	670	125	1600	4
500	AoAk	FH4AAAGBA	6	20	400	900	5630	0,9	60	1450	750	1700	670	125	1800	4
	AoBk	FH4ABAGBA	6	20	400	900	6410	0,9	60	1450	750	1650	670	125	1800	4
630	AoAk	FI4AAAGBA	6	20	400	1100	7100	0,9	62	1550	850	1830	670	160	2150	5
	AoBk	FI4ABAGBA	6	20	400	1100	7600	0,9	62	1550	850	1830	670	160	2150	5
800	AoAk	FJ4AAAGBA	6	20	400	1300	8000	0,8	64	1550	850	1920	670	160	2550	5
1000	AoAk	FK4AAAGBA	6	20	400	1550	9000	0,7	65	1650	1000	2090	820	160	3150	6
1250	AoAk	FL4AAAGBA	6	20	400	1800	11000	0,7	67	1750	1000	2180	820	160	3650	6
1600	AoAk	FM4AAAGBA	6	20	400	2200	13000	0,5	68	1900	1000	2260	820	160	4600	7
2000	AoAk	FN4AAAGBA	6	20	400	2600	16000	0,5	70	2000	1310	2320	1070	200	5550	7
2500	AoAk	FO4AAAGBA	6	20	400	3100	19000	0,4	71	2150	1400	2450	1070	200	6300	8
3150	AoAk	FP4AAAGBA	6	20	400	3800	22000	0,4	74	2300	1400	2560	1070	200	8100	8



Copper windings available on request

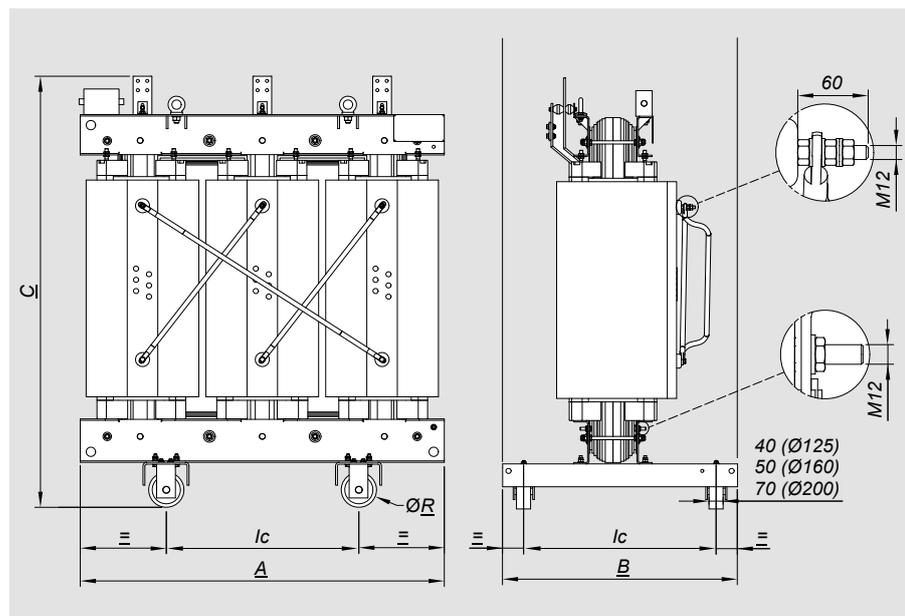
\* For information on enclosure see p. 50

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# GREEN T.HE TIER 1

insulation class 36 kV

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	l <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	l <sub>c</sub> - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
160	AoAk	FC5AAAQBA	6,5	33	400	460	2860	1,5	57	1650	750	1600	670	125	1650	3
	AoBk	FC5ABAQBA	6,5	33	400	460	3190	1,5	57	1650	750	1650	670	125	1700	3
200	AoAk	FD5AAAQBA	6,5	33	400	515	3250	1,4	57	1650	750	1700	670	125	1850	3
	AoBk	FD5ABAQBA	6,5	33	400	515	3630	1,4	57	1650	750	1750	670	125	1850	3
250	AoAk	FE5AAAQBA	6,5	33	400	595	3740	1,3	59	1650	850	1750	670	160	1900	4
	AoBk	FE5ABAQBA	6,5	33	400	595	4180	1,3	59	1650	850	1800	670	160	1950	4
315	AoAk	FF5AAAQBA	6,5	33	400	705	4260	1,2	59	1650	850	1800	670	160	2100	4
	AoBk	FF5ABAQBA	6,5	33	400	705	4985	1,2	59	1650	850	1850	670	160	2100	4
400	AoAk	FG5AAAQBA	6,5	33	400	860	4950	1,1	61	1700	850	1850	670	160	2200	5
	AoBk	FG5ABAQBA	6,5	33	400	860	6050	1,1	61	1650	850	1900	670	160	2300	5
500	AoAk	FH5AAAQBA	6,5	33	400	1035	6190	1,1	61	1750	850	1950	670	160	2550	5
	AoBk	FH5ABAQBA	6,5	33	400	1035	7050	1,1	61	1650	850	2000	670	160	2550	5
630	AoAk	FI5AAAQBA	6,5	33	400	1265	7810	1	63	1800	1000	2000	820	160	2800	6
	AoBk	FI5ABAQBA	6,5	33	400	1265	8360	1	63	1700	1000	2050	820	160	2850	6
800	AoAk	FJ5AAAQBA	6,5	33	400	1495	8800	0,9	64	1850	1000	2100	820	160	3400	6
1000	AoAk	FK5AAAQBA	6,5	33	400	1780	9900	0,8	65	1950	1000	2200	820	160	3700	6
1250	AoAk	FL5AAAQBA	6,5	33	400	2070	12100	0,7	67	2000	1000	2350	820	160	4500	7
1600	AoAk	FM5AAAQBA	6,5	33	400	2530	14300	0,6	68	2150	1310	2400	1070	200	5300	7
2000	AoAk	FN5AAAQBA	6,5	33	400	2990	17600	0,6	72	2300	1310	2500	1070	200	6600	8
2500	AoAk	FO5AAAQBA	6,5	33	400	3565	20900	0,5	73	2500	1310	2600	1070	200	7500	8



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

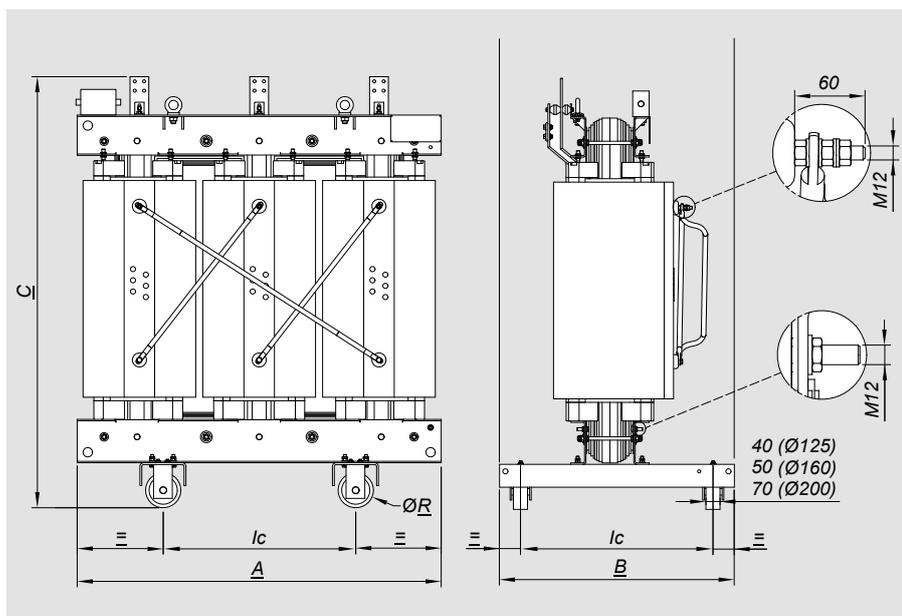
Copper windings available on request

\* For information on enclosure see p. 50

## GREEN T.HE TIER 2

insulation class 12 kV

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB2A3ACBA	6	10	400	252	1800	1,6	50	1200	600	1350	520	125	950	2
160	AoAk	FC2A3ACBA	6	10	400	360	2600	1,4	53	1250	600	1360	520	125	1050	3
200	AoAk	FD2A3ACBA	6	10	400	408	2955	1,2	57	1350	600	1380	520	125	1200	3
250	AoAk	FE2A3ACBA	6	10	400	468	3400	1,1	56	1350	750	1450	670	125	1350	3
315	AoAk	FF2A3ACBA	6	10	400	557	3875	1	60	1350	750	1560	670	125	1350	4
400	AoAk	FG2A3ACBA	6	10	400	675	4500	0,9	59	1350	750	1670	670	125	1650	4
500	AoAk	FH2A3ACBA	6	10	400	810	5630	0,9	62	1450	850	1700	670	160	2000	5
630	AoAk	FI2A3ACBA	6	10	400	990	7100	0,8	61	1500	850	1880	670	160	2350	5
800	AoAk	FJ2A3ACBA	6	10	400	1170	8000	0,7	63	1600	1000	2020	820	160	2900	6
1000	AoAk	FK2A3ACBA	6	10	400	1395	9000	0,7	64	1650	1000	2150	820	160	3300	6
1250	AoAk	FL2A3ACBA	6	10	400	1620	11000	0,5	66	1800	1000	2220	820	160	4050	7
1600	AoAk	FM2A3ACBA	6	10	400	1980	13000	0,5	67	1900	1310	2270	1070	200	4800	7
2000	AoAk	FN2A3ACBA	6	10	400	2340	16000	0,4	69	2050	1400	2430	1070	200	5950	8
2500	AoAk	FO2A3ACBA	6	10	400	2790	19000	0,4	70	2150	1400	2450	1070	200	7000	8
3150	AoAk	FP2A3ACBA	6	10	400	3420	22000	0,4	73	2350	1540	2550	1300	200	9100	**



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 50

## GREEN T.HE TIER 2

insulation class 17,5 kV

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (0) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB3A3AFBA	6	15	400	252	1800	1,6	50	1300	600	1330	520	125	1050	2
160	AoAk	FC3A3AFBA	6	15	400	360	2600	1,4	53	1350	600	1350	520	125	1150	3
200	AoAk	FD3A3AFBA	6	15	400	408	2955	1,2	57	1350	600	1380	520	125	1250	3
250	AoAk	FE3A3AFBA	6	15	400	468	3400	1,1	56	1350	750	1440	670	125	1350	3
315	AoAk	FF3A3AFBA	6	15	400	557	3875	1	60	1450	750	1550	670	125	1600	4
400	AoAk	FG3A3AFBA	6	15	400	675	4500	0,9	59	1450	750	1680	670	125	1750	4
500	AoAk	FH3A3AFBA	6	15	400	810	5630	0,9	62	1550	850	1800	670	160	2100	5
630	AoAk	FI3A3AFBA	6	15	400	990	7100	0,8	61	1550	850	1890	670	160	2450	5
800	AoAk	FJ3A3AFBA	6	15	400	1170	8000	0,7	63	1650	1000	2050	820	160	3050	6
1000	AoAk	FK3A3AFBA	6	15	400	1395	9000	0,7	64	1700	1000	2160	820	160	3550	6
1250	AoAk	FL3A3AFBA	6	15	400	1620	11000	0,5	66	1850	1000	2240	820	160	4400	7
1600	AoAk	FM3A3AFBA	6	15	400	1980	13000	0,5	67	2000	1310	2300	1070	200	5300	7
2000	AoAk	FN3A3AFBA	6	15	400	2340	16000	0,4	69	2150	1400	2430	1070	200	6100	8
2500	AoAk	FO3A3AFBA	6	15	400	2790	19000	0,4	70	2300	1400	2550	1070	200	8000	8
3150	AoAk	FP3A3AFBA	6	15	400	3420	22000	0,4	73	2400	1540	2600	1300	200	9400	**

## GREEN T.HE TIER 2

insulation class 24 kV

S <sub>R</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (0) [mm]	Weight [kg]	Enclosure type*
100	AoAk	FB4A3AGBA	6	20	400	252	1800	1,6	50	1250	600	1360	520	125	1050	2
160	AoAk	FC4A3AGBA	6	20	400	360	2600	1,4	53	1350	600	1370	520	125	1200	3
200	AoAk	FD4A3AGBA	6	20	400	408	2955	1,2	57	1350	600	1410	520	125	1350	3
250	AoAk	FE4A3AGBA	6	20	400	468	3400	1,1	56	1350	750	1470	670	125	1450	3
315	AoAk	FF4A3AGBA	6	20	400	557	3875	1	60	1450	750	1570	670	125	1700	4
400	AoAk	FG4A3AGBA	6	20	400	675	4500	0,9	59	1450	750	1700	670	125	1800	4
500	AoAk	FH4A3AGBA	6	20	400	810	5630	0,9	62	1550	850	1820	670	160	2150	5
630	AoAk	FI4A3AGBA	6	20	400	990	7100	0,8	61	1550	850	1920	670	160	2550	5
800	AoAk	FJ4A3AGBA	6	20	400	1170	8000	0,7	63	1650	1000	2090	820	160	3150	6
1000	AoAk	FK4A3AGBA	6	20	400	1395	9000	0,7	64	1750	1000	2180	820	160	3650	6
1250	AoAk	FL4A3AGBA	6	20	400	1620	11000	0,5	66	1900	1000	2260	820	160	4600	7
1600	AoAk	FM4A3AGBA	6	20	400	1980	13000	0,5	67	2000	1310	2320	1070	200	5550	7
2000	AoAk	FN4A3AGBA	6	20	400	2340	16000	0,4	69	2150	1310	2450	1070	200	6300	8
2500	AoAk	FO4A3AGBA	6	20	400	2790	19000	0,4	70	2300	1400	2560	1070	200	8100	8
3150	AoAk	FP4A3AGBA	6	20	400	3420	22000	0,4	73	2450	1540	2650	1300	200	9500	**

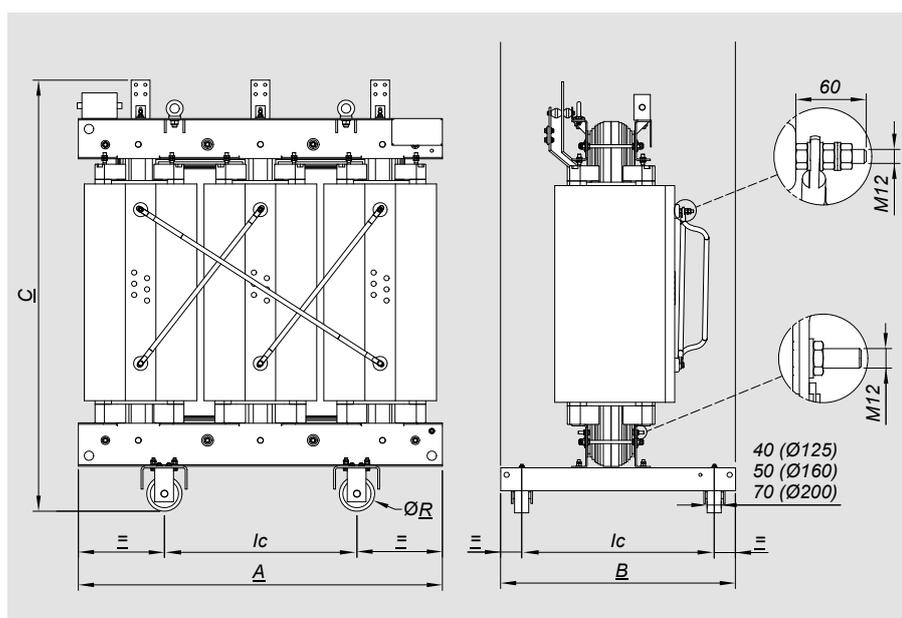
Copper windings available on request

\* For information on enclosure see p. 50

## GREEN T.HE TIER 2

insulation class 36 kV

S <sub>e</sub> [kVA]	Series (Reg548)	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
160	AoAk	FC5A3AQBA	6,5	33	400	410	2860	1,5	57	1650	750	1700	670	125	1850	3
200	AoAk	FD5A3AQBA	6,5	33	400	469	3250	1,4	57	1650	850	1750	670	160	1900	4
250	AoAk	FE5A3AQBA	6,5	33	400	538	3740	1,3	59	1650	850	1800	670	160	2100	4
315	AoAk	FF5A3AQBA	6,5	33	400	640	4260	1,2	59	1700	850	1850	670	160	2200	5
400	AoAk	FG5A3AQBA	6,5	33	400	780	4950	1,1	61	1750	850	1950	670	160	2550	5
500	AoAk	FH5A3AQBA	6,5	33	400	933	6190	1,1	61	1800	1000	2000	820	160	2800	6
630	AoAk	FI5A3AQBA	6,5	33	400	1140	7810	1	63	1850	1000	2100	820	160	3400	6
800	AoAk	FJ5A3AQBA	6,5	33	400	1345	8800	0,9	64	1950	1000	2200	820	160	3700	6
1000	AoAk	FK5A3AQBA	6,5	33	400	1600	9900	0,8	65	2000	1000	2350	820	160	4500	7
1250	AoAk	FL5A3AQBA	6,5	33	400	1860	12100	0,7	66	2150	1310	2400	1070	200	5300	7
1600	AoAk	FM5A3AQBA	6,5	33	400	2275	14300	0,6	67	2300	1310	2500	1070	200	6600	8
2000	AoAk	FN5A3AQBA	6,5	33	400	2690	17600	0,6	69	2500	1310	2600	1070	200	7500	8
2500	AoAk	FO5A3AQBA	6,5	33	400	3205	20900	0,5	70	2550	1540	2900	1300	200	10000	**



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 50

# GREEN T.HE Cast resin transformers

## installation accessories



### Cat. Nos. Ventilation bars

The ventilation bars temporarily increase the transformer rated power (under normal service conditions). According to standard IEC 60076-1, a transformer is AN even if it is equipped with ventilation bars for temporary use. If a transformer is requested AF, please contact Legrand.

Cat. Nos.	Rating (kVA)	ΔPower (%)	Notes
<b>CB02444</b>	100 - 315	+ 40	Temporary increase at rated conditions (50Hz)
<b>CB02454</b>	400 - 500	+ 40	
<b>CB02464</b>	630 - 1000	+ 40	
<b>CB01414</b>	1250 - 2000	+ 40	
<b>CB01412</b>	2500 - 3150	+ 40	

### Temperature measurement probes

Probes are supplied mounted on the transformer and wired to the aluminium IP66 junction box.

Type	Rating (kVA)	N°	Δt (°C)	Installation
<b>200073</b>	Pt100 ≤2000	3	-	on the LV (3) windings
<b>200074</b>	Pt100 ≥2500	3	-	on the LV (3) windings
<b>200137</b>	Pt100 ≤2000	3+1	-	on the LV (3) windings + on the core (1)
<b>200138</b>	Pt100 ≥2500	3+1	-	on the LV (3) windings + on the core (1)
<b>CB00120</b>	PTC -	3+3	130-140	on the LV (3 pairs) windings for alarm and trip.
<b>CB02400</b>	PTC -	3+3	110-120	on the LV (3 pairs) windings for alarm and trip.
<b>CB0272</b>	PTC -	3+3+3	130-140-90	on the LV (3 pairs) windings for alarm, trip and fan control.

### Temperature control devices

Central units are supplied unassembled

Type	Description
<b>220002</b>	T154 temperature control for 4 Pt100 probes
<b>220023</b>	MT200L temperature control for 4 Pt100 probes
<b>220004</b>	T 119 temperature control for PTC probes
<b>220010</b>	T119 DIN temperature control for PTC probes, preset for DIN rail mounting
<b>220197</b>	NT935AD temperature control for 4 Pt100 probe with analogue and digital output
<b>220035</b>	VRT200 fan control
<b>220174</b>	AT100 fan control

### Cat. Nos. Surge arrester kit

Cat. Nos.	HV*(kV)	Ur (kV)
<b>130075D</b>	6	9
<b>130054D</b>	10-11	12
<b>130055D</b>	15	18
<b>130056D</b>	20	24

\* other values of HV on request  
Ur: rated voltage of surge arrester

### Rubber supports (anti vibration)

Cat. Nos.	Rating (kVA)		Description
	TIER 1	TIER 2	
<b>170019</b>	≤1600	≤1250	4 antivibration pads supplied for mounting under the transformer wheels
<b>170020</b>	≥2000	≥1600	4 antivibration pads supplied for mounting under the transformer wheels

Wheels in "Cast Iron" on request

### Cupal plates

Cupal is a bimetal sheet made of one copper sheet and one aluminium sheet welded together through a special mechanical procedure.

Cat. Nos.	Rating (kVA)		Description
	TIER 1	TIER 2	
<b>030014 **</b>	≤ 160	≤ 100	40 x 40 CUPAL plate
<b>030008 **</b>	≥ 200 and ≤ 315	≥ 160 and ≤ 200	50 x 50 CUPAL plate
<b>030009 **</b>	≥ 400 and ≤ 500	≥ 315 and ≤ 400	60 x 60 CUPAL plate
<b>030010 **</b>	≥ 630 and ≤ 800	≥ 500 and ≤ 630	80 x 80 CUPAL plate
<b>030011 **</b>	1000	800	100 x 100 CUPAL plate
<b>030012 **</b>	≥ 1250	≥ 1000	120 x 120 CUPAL plate

\*\* The codes refer to a single CUPAL plate

### Example:

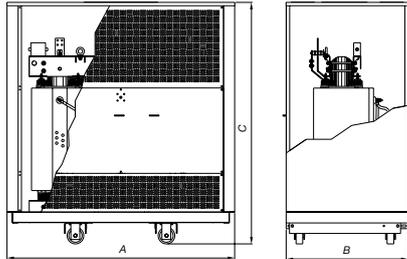
- For a transformer rated 1250 kVA, the correct CUPAL plate is item 030012
- Quantity calculation: 2 plates x 4 BT terminals = 8 CUPAL plates

# GREEN T.HE Cast resin transformers

## installation accessories



**ENCLOSURES**  
RAL 7035 colour  
AREL door lock on the box, Cat. Nos. 230076



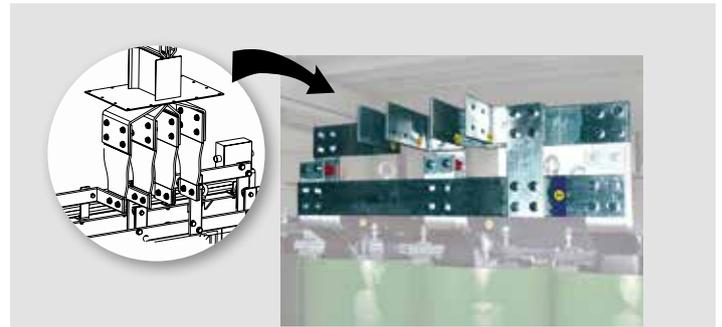
Class 12kV-17,5kV-24kV								
Cat. Nos.	Enclosure type	IP degree	Dimensions (mm)			Weight (kg)	Rating [kVA]**	
			Length (A)	Width (B)	Height (C)		TIER 1	TIER 2
230273	2	23	1700	950	1580	155	100-160	100
230263	2	31	1700	950	1580	150	100-160	100
230215	3	23	1800	1000	1680	170	200-250	160-200-250
230234	3	31	1800	1000	1680	165	200-250	160-200-250
230277	4	23	1900	1050	1950	185	400-500	315-400
230222	4	31	1900	1050	1950	180	400-500	315-400
230221	5	23	2050	1100	2200	235	630-800	500-630
230223	5	31	2050	1100	2200	225	630-800	500-630
230267	6	23	2300	1310	2500	325	1000-1250	800-1000
230249	6	31	2300	1310	2500	315	1000-1250	800-1000
230309	7	23	2500	1310	2700	365	1600-2000	1250-1600
230371	7	31	2500	1310	2700	350	1600-2000	1250-1600
231044	8	23	2700	1400	2900	400	2500-3150	2000-2500
231043	8	31	2700	1400	2900	370	2500-3150	2000-2500
Class 36kV								
231120	3	23	2200	1400	2050	280	160-200	160
231119	3	31	2200	1400	2050	265	160-200	160
231123	4	23	2300	1400	2150	300	250-315	200-250
230665	4	31	2300	1400	2150	285	250-315	200-250
231124	5	23	2450	1450	2500	355	400-500	315-400
230667	5	31	2450	1450	2500	335	400-500	315-400
231125	6	23	2600	1500	2700	395	630-800	500-630-800
230669	6	31	2600	1500	2700	370	630-800	500-630-800
231122	7	23	2900	1700	2800	470	1250-1600	1000-1250
231121	7	31	2900	1700	2800	440	1250-1600	1000-1250
231128*	8	23	3100	2000	3000	780	2000-2500	1600-2000
231127*	8	31	3100	2000	3000	750	2000-2500	1600-2000

Enclosures can be supplied non-assembled or assembled on the transformer. The above references are of non-assembled enclosures. If an assembled enclosure is requested, add the "M" suffix to the enclosure code (e.g. 231043M).

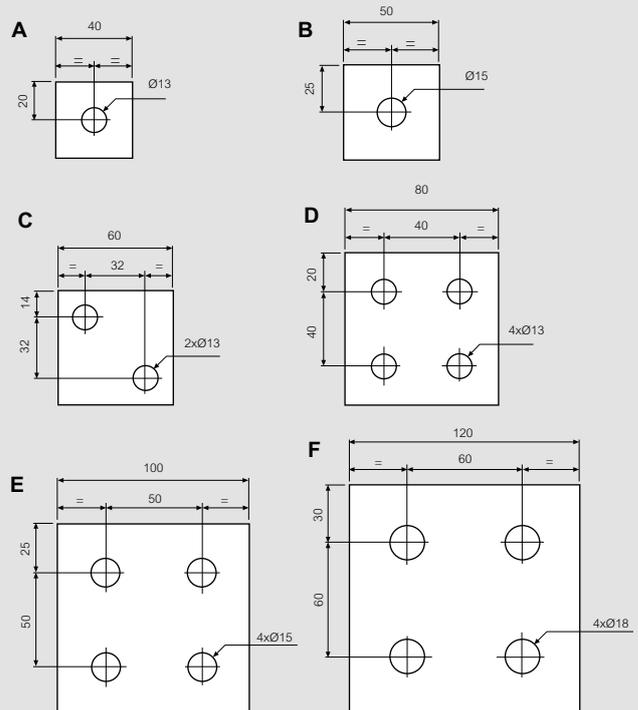
\*Placed on the ground and delivered already mounted as a separate piece.

\*\*Transformer rating per enclosure type and reference. Please note that surge arresters and/or connections to the busbar are not considered.

For enclosure Tier 2 (3150 kVA - class 12-17,5-24 kV) and (2500 kVA - class 36 kV), please contact Legrand



### SIZES AND DRILLING OF LV CONNECTION TERMINALS



### DRILLING STANDARD

LV connection terminals are made of aluminium. Special CUPAL bimetallic plates can be supplied for the connection of copper cables on bars.

Drawing	TIER 1		Drawing	TIER 2	
	Rating (kVA)	Thickness (mm)		Rating (kVA)	Thickness (mm)
A	100	4	A	100	4
	160	4		160	5
B	200	5	B	200	5
	250	5		250	5
C	315	5	C	315	6
	400	6		400	8
D	500	8	D	500	8
	630	8		630	8
E	800	8	E	800	8
	1000	8		1000	10
F	1250	10	F	1250	12
	1600	12		1600	16
	2000	16		2000	20
	2500	20		2500	24
	3150	24		3150	24

Legrand reserves the right to modify the content of this booklet at any time and to communicate, in any form and modality, the changes brought to the same.

# BoBk, XC, NL – Red transformers

## HV/LV Cast Resin Transformers

Compliance with standard: **IEC 60076-11**

Rating (kVA): **100-3150**

Frequency (Hz): **50**

Tapping links, HV side: **± 2 x 2.5%**

Aluminium for primary and secondary windings (copper on request)

Vectorial group: **Dyn11**

Thermal class of the insulating system: **155 °C (F) / 155 °C (F)**

Temperature rise: **100/100 K**

Class of use: **E2-C2-F1** Certified CESI A9032391 IEC 60076-11

Tolerances: According to **IEC /CEI**

Partial discharge: **(BoBk < 5 pC) - (XC < 10 pC) - (NL < 5 pC)**

### BoBk - XC - NL

#### 12 kV INSULATION CLASS

Primary voltages (kV): **6-10-11**. Insulation class: **12 kV BIL 60 kV** (**BIL 75 kV** available on request).

Secondary voltages no-load (V): **400-433** (insulation class 1.1 kV)

#### 17,5 kV INSULATION CLASS

Primary voltages (kV): **12-13,2-15**. Insulation class: **17,5 kV BIL 75 kV** (**BIL 95 kV** available on request).

Secondary voltages no-load (V): **400-410-420** (insulation class 1.1 kV)

#### 24 kV INSULATION CLASS

Primary voltages (kV): **20-23**. Insulation class: **24 kV BIL 95 kV** (**BIL 125 kV** available on request).

Secondary voltages no-load (V): **400-410-420** (insulation class 1.1 kV)

Other voltage ratios of BoBk transformers are available on request

### NL

#### 36 kV INSULATION CLASS

Primary voltages (kV): **25-33**. Insulation class: **36 kV BIL 170 kV**

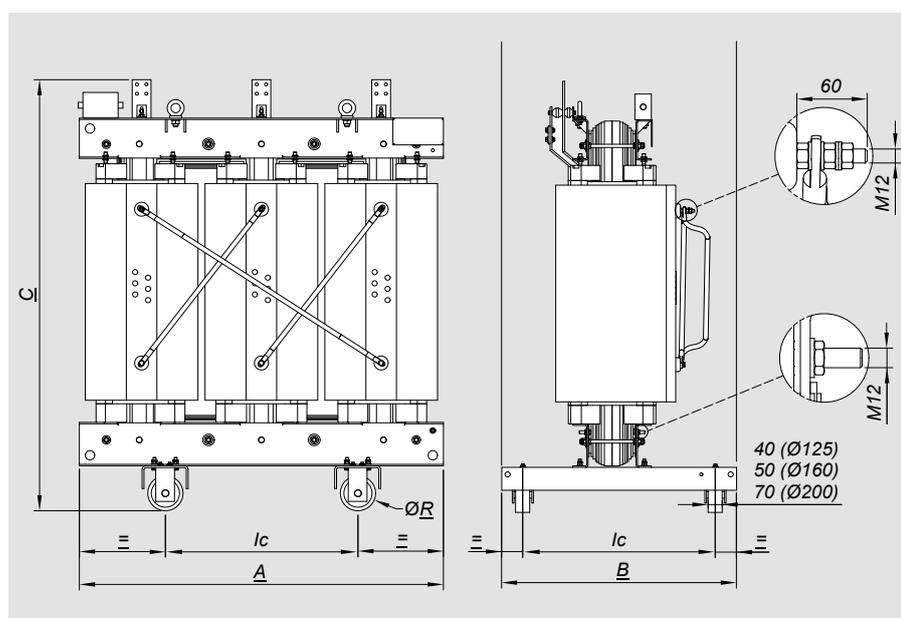
Secondary voltages no-load (V): **400-420** (insulation class 1.1 kV)



# BoBk - RED TRANSFORMERS

insulation class 12 kV

$S_R$ [kVA]	Series	Item	Uk [%]	Primary voltage [kV]	Secondary voltage [V]	Po [W]	Pk [W] a 120 °C	Io [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	BoBk	EB2RACBA	6	10	400	330	2000	1,8	51	1000	600	1100	520	125	550	1
160	BoBk	EC2RACBA	6	10	400	450	2700	1,6	54	1100	600	1200	520	125	700	1
200	BoBk	ED2RACBA	6	10	400	520	3050	1,4	55	1150	620	1200	520	125	800	1
250	BoBk	EE2RACBA	6	10	400	610	3500	1,1	57	1250	630	1220	520	125	910	2
315	BoBk	EF2RACBA	6	10	400	730	4100	1	58	1250	750	1250	670	125	1000	2
400	BoBk	EG2RACBA	6	10	400	880	4900	0,9	60	1300	750	1320	670	125	1200	3
500	BoBk	EH2RACBA	6	10	400	1000	5950	0,8	61	1300	750	1500	670	125	1400	3
630	BoBk	EI2RACBA	6	10	400	1150	7300	0,7	62	1500	850	1590	670	160	1600	4
800	BoBk	EJ2RACBA	6	10	400	1300	9000	0,7	65	1500	850	1740	670	160	1950	4
1000	BoBk	EK2RACBA	6	10	400	1500	10000	0,6	67	1550	1000	1820	820	160	2300	5
1250	BoBk	EL2RACBA	6	10	400	1800	12000	0,5	69	1550	1000	2000	820	160	2700	5
1600	BoBk	EM2RACBA	6	10	400	2200	14500	0,4	71	1650	1000	2180	820	160	3300	6
2000	BoBk	EN2RACBA	6	10	400	2600	18000	0,4	73	1800	1310	2260	1070	200	4000	6
2500	BoBk	EO2RACBA	6	10	400	3200	21000	0,3	75	2050	1310	2390	1070	200	4800	7
3150	BoBk	EP2RACBA	6	10	400	3800	26000	0,3	77	2150	1310	2400	1070	200	5900	7



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 60

## BoBk - RED TRANSFORMERS

insulation class **17,5 kV**

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	BoBk	EB3RAFBA	6	15	400	340	2050	1,9	51	1050	600	1090	520	125	560	1
160	BoBk	EC3RAFBA	6	15	400	480	2900	1,6	54	1200	630	1210	520	125	750	1
200	BoBk	ED3RAFBA	6	15	400	560	3300	1,4	56	1250	630	1230	520	125	800	1
250	BoBk	EE3RAFBA	6	15	400	650	3800	1,2	57	1250	640	1240	520	125	950	2
315	BoBk	EF3RAFBA	6	15	400	780	4550	1,1	59	1250	750	1300	670	125	1050	2
400	BoBk	EG3RAFBA	6	15	400	940	5500	1	59	1350	750	1390	670	125	1250	3
500	BoBk	EH3RAFBA	6	15	400	1080	6400	0,9	61	1350	750	1520	670	125	1400	3
630	BoBk	EI3RAFBA	6	15	400	1250	7600	0,9	62	1500	850	1630	670	160	1700	4
800	BoBk	EJ3RAFBA	6	15	400	1500	9400	0,8	64	1500	850	1780	670	160	2000	4
1000	BoBk	EK3RAFBA	6	15	400	1800	11000	0,7	65	1550	1000	1870	820	160	2300	5
1250	BoBk	EL3RAFBA	6	15	400	2100	13000	0,6	67	1550	1000	2010	820	160	2750	5
1600	BoBk	EM3RAFBA	6	15	400	2400	16000	0,5	68	1650	1000	2190	820	160	3300	6
2000	BoBk	EN3RAFBA	6	15	400	3000	18000	0,5	70	1800	1310	2250	1070	200	4000	6
2500	BoBk	EO3RAFBA	6	15	400	3600	23000	0,4	71	1950	1310	2320	1070	200	4950	7
3150	BoBk	EP3RAFBA	6	15	400	4300	28000	0,3	74	2150	1310	2492	1070	200	6050	7

## BoBk - RED TRANSFORMERS

insulation class **24 kV**

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
100	BoBk	EB4RAGBA	6	20	400	340	2050	2	51	1050	600	1110	520	125	570	1
160	BoBk	EC4RAGBA	6	20	400	480	2900	1,7	54	1250	640	1240	520	125	800	1
200	BoBk	ED4RAGBA	6	20	400	560	3300	1,5	56	1250	640	1250	520	125	900	1
250	BoBk	EE4RAGBA	6	20	400	650	3800	1,3	57	1350	640	1260	520	125	1000	2
315	BoBk	EF4RAGBA	6	20	400	780	4550	1,2	59	1350	750	1350	670	125	1200	2
400	BoBk	EG4RAGBA	6	20	400	940	5500	1,1	60	1500	750	1440	670	125	1350	3
500	BoBk	EH4RAGBA	6	20	400	1080	6400	1,1	61	1500	750	1560	670	125	1500	3
630	BoBk	EI4RAGBA	6	20	400	1250	7600	1	62	1500	850	1650	670	160	1800	4
800	BoBk	EJ4RAGBA	6	20	400	1500	9400	0,9	64	1550	850	1810	670	160	2100	4
1000	BoBk	EK4RAGBA	6	20	400	1800	11000	0,8	65	1650	1000	1890	820	160	2500	5
1250	BoBk	EL4RAGBA	6	20	400	2100	13000	0,7	67	1650	1000	2030	820	160	2900	5
1600	BoBk	EM4RAGBA	6	20	400	2400	16000	0,6	68	1750	1000	2200	820	160	3550	6
2000	BoBk	EN4RAGBA	6	20	400	3000	18000	0,5	70	1900	1310	2270	1070	200	4300	6
2500	BoBk	EO4RAGBA	6	20	400	3600	23000	0,4	71	1950	1310	2350	1070	200	5250	7
3150	BoBk	EP4RAGBA	6	20	400	4300	28000	0,4	74	2200	1310	2512	1070	200	6700	7

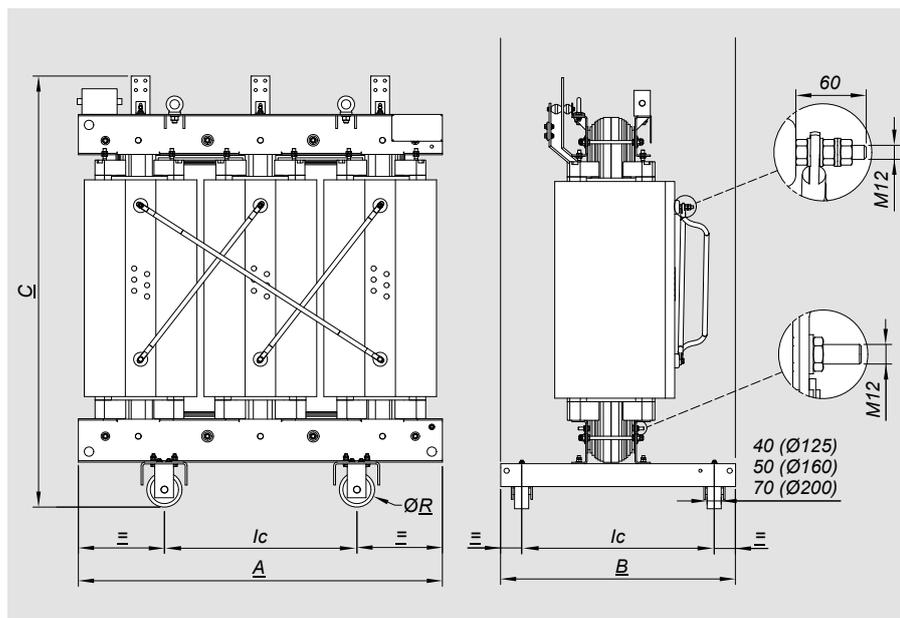
Copper windings available on request

\* For information on enclosure see p. 60

## XC - RED TRANSFORMERS

insulation class 12 kV

$S_R$ [kVA]	Series	Item	Uk [%]	Primary voltage [kV]	Secondary voltage [V]	Po [W]	Pk [W] a 120 °C	Io [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
250	XC	EE2XACBA	6	10	400	700	4200	1,2	67	1150	600	1230	520	125	850	2
315	XC	EF2XACBA	6	10	400	800	5100	1,1	69	1150	750	1325	670	125	950	3
400	XC	EG2XACBA	6	10	400	960	5500	1	70	1250	750	1490	670	125	1200	3
500	XC	EH2XACBA	6	10	400	1150	7000	0,9	71	1300	750	1540	670	125	1300	4
630	XC	EI2XACBA	6	10	400	1400	8200	0,8	72	1350	750	1610	670	160	1550	4
800	XC	EJ2XACBA	6	10	400	1700	9300	0,8	73	1400	750	1740	670	160	1850	4
1000	XC	EK2XACBA	6	10	400	1950	10500	0,7	74	1450	850	1900	820	160	2250	5
1250	XC	EL2XACBA	6	10	400	2350	12500	0,6	75	1550	1000	1970	820	160	2600	6
1600	XC	EM2XACBA	6	10	400	2750	15300	0,5	77	1600	1000	2100	820	160	3150	6
2000	XC	EN2XACBA	6,5	10	400	3400	18800	0,5	80	1750	1310	2230	1070	200	3850	6
2500	XC	EO2XACBA	6,5	10	400	4200	21000	0,4	82	1900	1310	2250	1070	200	4600	7
3150	XC	EP2XACBA	7	10	400	5000	26000	0,4	84	2050	1310	2370	1070	200	5600	7



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 60

## XC - RED TRANSFORMERS

insulation class **17,5 kV**

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	l <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
250	XC	EE3XAFBA	6	15	400	730	4200	1,3	67	1200	600	1240	520	125	900	2
315	XC	EF3XAFBA	6	15	400	840	5100	1,2	69	1200	750	1320	670	125	1000	3
400	XC	EG3XAFBA	6	15	400	1000	5500	1,1	70	1250	750	1410	670	125	1150	3
500	XC	EH3XAFBA	6	15	400	1200	7000	1	71	1300	750	1460	670	125	1300	4
630	XC	EI3XAFBA	6	15	400	1450	8200	1	72	1400	750	1530	670	160	1600	4
800	XC	EJ3XAFBA	6	15	400	1750	9300	0,9	73	1400	750	1670	670	160	1850	4
1000	XC	EK3XAFBA	6	15	400	2050	10500	0,8	74	1450	850	1810	820	160	2200	5
1250	XC	EL3XAFBA	6	15	400	2350	12500	0,7	75	1550	1000	1960	820	160	2600	6
1600	XC	EM3XAFBA	6	15	400	2750	15300	0,6	77	1650	1000	2090	820	160	3200	6
2000	XC	EN3XAFBA	6,5	15	400	3400	18800	0,6	80	1800	1310	2200	1070	200	3850	6
2500	XC	EO3XAFBA	6,5	15	400	4200	21000	0,5	82	1900	1310	2230	1070	200	4650	7
3150	XC	EP3XAFBA	7	15	400	5000	26000	0,4	84	2150	1310	2290	1070	200	5700	7

## XC - RED TRANSFORMERS

insulation class **24 kV**

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	l <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter (Ø) [mm]	Weight [kg]	Enclosure type*
250	XC	EE4XAGBA	6	20	400	840	4500	1,5	67	1250	630	1280	520	125	950	2
315	XC	EF4XAGBA	6	20	400	990	4700	1,4	69	1300	750	1370	670	125	1100	3
400	XC	EG4XAGBA	6	20	400	1100	5800	1,3	70	1350	750	1460	670	125	1250	4
500	XC	EH4XAGBA	6	20	400	1320	7200	1,2	71	1400	750	1510	670	125	1400	4
630	XC	EI4XAGBA	6	20	400	1600	8200	1,1	72	1450	750	1580	670	160	1700	4
800	XC	EJ4XAGBA	6	20	400	1880	9200	1	73	1500	750	1720	670	160	2000	5
1000	XC	EK4XAGBA	6	20	400	2250	10600	0,9	74	1550	850	1840	820	160	2350	5
1250	XC	EL4XAGBA	6	20	400	2500	12800	0,8	75	1600	1000	1990	820	160	2750	6
1600	XC	EM4XAGBA	6	20	400	2980	15400	0,7	77	1700	1000	2120	820	160	3350	6
2000	XC	EN4XAGBA	6,5	20	400	3700	19000	0,6	80	1800	1310	2200	1070	200	4000	6
2500	XC	EO4XAGBA	6,5	20	400	4500	21500	0,5	82	1950	1310	2280	1070	200	4900	7
3150	XC	EP4XAGBA	7	20	400	5600	26000	0,5	85	2150	1310	2340	1070	200	6050	7

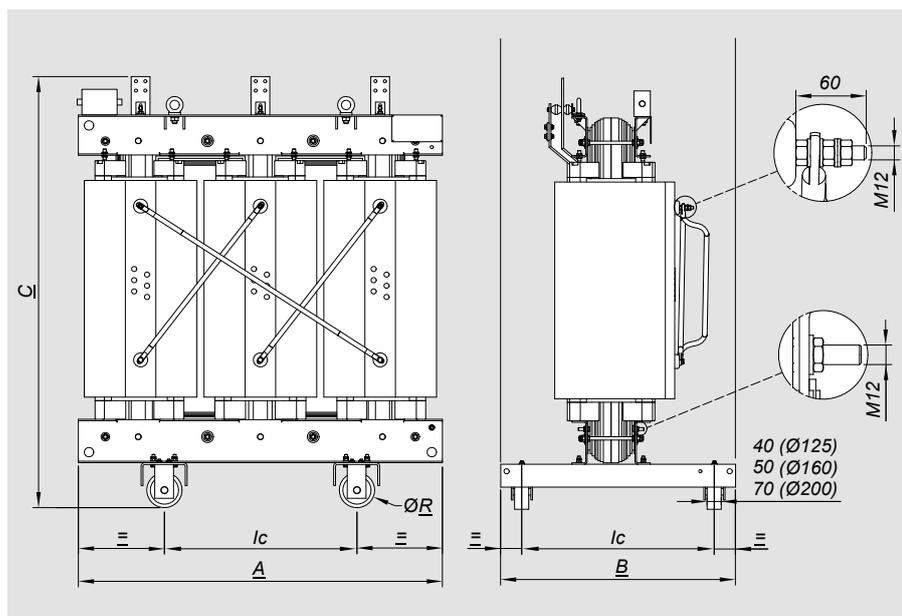
Copper windings available on request

\* For information on enclosure see p. 60

# NL - RED TRANSFORMERS

insulation class 12 kV

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>o</sub> [W]	P <sub>k</sub> [W] a 120 °C	I <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	Enclosure type*
100	NL	EB2NBCBA	4	10	400	440	2000	1,9	59	1000	600	1100	520	125	550	1
	NL	EB2NACBA	6	10	400	420	1900	1,9	59	1000	600	1100	520	125	550	1
160	NL	EC2NBCBA	4	10	400	610	2700	1,7	62	1100	600	1200	520	125	750	1
	NL	EC2NACBA	6	10	400	550	2700	1,7	62	1100	600	1200	520	125	750	1
200	NL	ED2NBCBA	4	10	400	720	3150	1,5	63	1150	620	1200	520	125	800	1
	NL	ED2NACBA	6	10	400	680	3500	1,5	63	1150	620	1200	520	125	800	1
250	NL	EE2NBCBA	4	10	400	820	3500	1,2	65	1250	630	1270	520	125	950	2
	NL	EE2NACBA	6	10	400	750	3700	1,2	65	1250	630	1220	520	125	950	2
315	NL	EF2NBCBA	4	10	400	880	4400	1,1	67	1200	750	1300	670	125	1050	2
	NL	EF2NACBA	6	10	400	850	4600	1,1	67	1250	750	1250	670	125	1000	2
400	NL	EG2NBCBA	4	10	400	1150	4900	1	68	1250	750	1370	670	125	1250	3
	NL	EG2NACBA	6	10	400	1000	5400	1	68	1300	750	1320	670	125	1200	3
500	NL	EH2NBCBA	4	10	400	1300	6500	0,9	69	1250	750	1550	670	125	1450	3
	NL	EH2NACBA	6	10	400	1200	6700	0,9	69	1300	750	1500	670	125	1400	3
630	NL	EI2NBCBA	4	10	400	1500	7300	0,8	70	1350	850	1600	670	160	1650	4
	NL	EI2NACBA	6	10	400	1450	7600	0,8	70	1500	850	1590	670	160	1600	4
800	NL	EJ2NACBA	6	10	400	1750	9400	0,8	71	1500	850	1740	670	160	1950	4
1000	NL	EK2NACBA	6	10	400	2000	10000	0,7	73	1550	1000	1820	820	160	2300	5
1250	NL	EL2NACBA	6	10	400	2300	12700	0,6	74	1550	1000	2000	820	160	2700	5
1600	NL	EM2NACBA	6	10	400	2800	14000	0,5	76	1650	1000	2180	820	160	3300	6
2000	NL	EN2NACBA	6	10	400	3300	18000	0,5	79	1800	1310	2260	1070	200	4000	6
2500	NL	EO2NACBA	6	10	400	4300	21000	0,4	81	2050	1310	2390	1070	200	4800	7
3150	NL	EP2NACBA	7	10	400	4600	26000	0,4	83	2150	1310	2400	1070	200	5400	7



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 60

## NL - RED TRANSFORMERS

insulation class **17,5 kV**

S <sub>R</sub> [kVA]	Series	Item	Uk [%]	Primary voltage [kV]	Secondary voltage [V]	Po [W]	Pk [W] a 120 °C	Io [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	Enclosure type*
100	NL	EB3NAFBA	6	15	400	430	1900	2	59	1000	600	1090	520	125	600	1
160	NL	EC3NAFBA	6	15	400	570	2800	1,7	62	1200	630	1210	520	125	750	1
200	NL	ED3NAFBA	6	15	400	680	3600	1,5	63	1250	630	1230	520	125	800	1
250	NL	EE3NAFBA	6	15	400	750	3650	1,3	65	1250	640	1240	520	125	950	2
315	NL	EF3NAFBA	6	15	400	880	4500	1,2	67	1250	750	1300	670	125	1050	2
400	NL	EG3NAFBA	6	15	400	1000	5200	1,1	67	1350	750	1390	670	125	1250	3
500	NL	EH3NAFBA	6	15	400	1200	6700	1	69	1350	750	1520	670	125	1400	3
630	NL	EI3NAFBA	6	15	400	1600	7800	1	70	1500	850	1630	670	160	1700	4
800	NL	EJ3NAFBA	6	15	400	1780	9300	0,9	71	1500	850	1780	670	160	2000	4
1000	NL	EK3NAFBA	6	15	400	2000	10800	0,8	73	1550	1000	1870	820	160	2300	5
1250	NL	EL3NAFBA	6	15	400	2350	12600	0,7	74	1550	1000	2010	820	160	2750	5
1600	NL	EM3NAFBA	6	15	400	2750	15500	0,6	76	1650	1000	2190	820	160	3300	6
2000	NL	EN3NAFBA	6	15	400	3350	18500	0,6	79	1800	1310	2250	1070	200	4000	6
2500	NL	EO3NAFBA	6	15	400	4300	21800	0,5	81	1950	1310	2320	1070	200	4950	7
3150	NL	EP3NAFBA	7	15	400	4700	26000	0,4	83	2150	1310	2350	1070	200	5750	7

## NL - RED TRANSFORMERS

insulation class **24 kV**

S <sub>R</sub> [kVA]	Series	Item	Uk [%]	Primary voltage [kV]	Secondary voltage [V]	Po [W]	Pk [W] a 120 °C	Io [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	lc - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	Enclosure type*
100	NL	EB4NBGBA	4	20	400	540	1750	2,1	59	1200	600	1160	520	125	650	1
	NL	EB4NAGBA	6	20	400	480	2000	2,1	59	1050	600	1110	520	125	600	1
160	NL	EC4NBGBA	4	20	400	750	2500	1,8	62	1250	640	1260	520	125	900	1
	NL	EC4NAGBA	6	20	400	650	2800	1,8	62	1250	640	1240	520	125	800	1
200	NL	ED4NBGBA	4	20	400	900	2900	1,7	63	1350	640	1320	520	125	1050	1
	NL	ED4NAGBA	6	20	400	800	3600	1,7	63	1250	640	1250	520	125	900	1
250	NL	EE4NBGBA	4	20	400	1000	3450	1,5	65	1350	640	1360	520	125	1150	2
	NL	EE4NAGBA	6	20	400	850	3700	1,5	65	1350	640	1260	520	125	1000	2
315	NL	EF4NBGBA	4	20	400	1150	4500	1,4	67	1350	750	1450	670	125	1350	2
	NL	EF4NAGBA	6	20	400	950	4500	1,4	67	1350	750	1350	670	125	1200	2
400	NL	EG4NBGBA	4	20	400	1360	4900	1,3	68	1450	750	1530	670	125	1500	3
	NL	EG4NAGBA	6	20	400	1150	5400	1,3	68	1500	750	1440	670	125	1350	3
500	NL	EH4NBGBA	4	20	400	1580	6400	1,2	69	1450	750	1610	670	125	1650	3
	NL	EH4NAGBA	6	20	400	1350	6700	1,2	69	1500	750	1560	670	125	1500	3
630	NL	EI4NBGBA	4	20	400	1950	6900	1,1	70	1500	850	1690	670	160	2000	4
	NL	EI4NAGBA	6	20	400	1650	7800	1,1	70	1500	850	1650	670	160	1800	4
800	NL	EJ4NAGBA	6	20	400	1850	9300	1	71	1550	850	1810	670	160	2100	4
1000	NL	EK4NAGBA	6	20	400	2200	10800	0,9	73	1650	1000	1890	820	160	2500	5
1250	NL	EL4NAGBA	6	20	400	2600	12800	0,8	74	1650	1000	2030	820	160	2900	5
1600	NL	EM4NAGBA	6	20	400	2950	15500	0,7	76	1750	1000	2200	820	160	3550	6
2000	NL	EN4NAGBA	6	20	400	3800	18600	0,6	79	1900	1310	2270	1070	200	4300	6
2500	NL	EO4NAGBA	6	20	400	4800	22000	0,5	81	1950	1310	2350	1070	200	5250	7
3150	NL	EP4NAGBA	7	20	400	5100	26000	0,5	83	2250	1310	2400	1070	200	6250	7

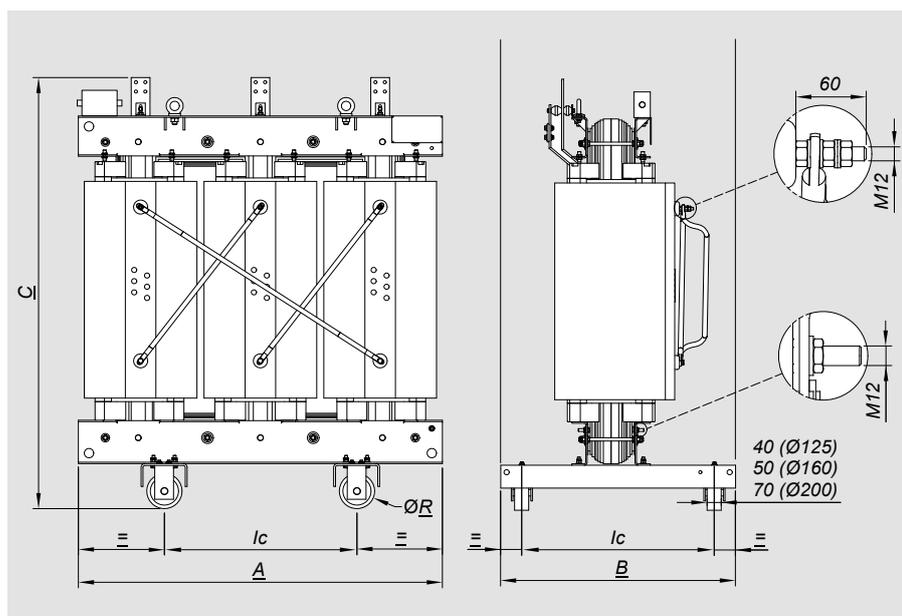
Copper windings available on request

\* For information on enclosure see p. 60

# NL - RED TRANSFORMERS

insulation class **36 kV**

S <sub>R</sub> [kVA]	Series	Item	U <sub>k</sub> [%]	Primary voltage [kV]	Secondary voltage [V]	P <sub>0</sub> [W]	P <sub>k</sub> [W] a 120 °C	l <sub>o</sub> [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	l <sub>c</sub> - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	Enclosure type*
315	NL	EF5NAQBA	6	33	400	1300	4500	1,4	69	1600	820	1580	670	125	1550	3
400	NL	EG5NAQBA	6	33	400	1500	5800	1,3	70	1600	880	1620	670	160	1650	3
500	NL	EH5NAQBA	6	33	400	1700	6600	1,2	71	1650	890	1750	670	160	1900	4
630	NL	EI5NAQBA	6	33	400	2000	7500	1	73	1650	900	1760	670	160	2200	4
800	NL	EJ5NAQBA	6	33	400	2450	9700	0,9	74	1750	920	1920	670	160	2650	5
1000	NL	EK5NAQBA	7	33	400	2600	11300	0,8	75	1900	1000	2040	820	160	2950	6
1250	NL	EL5NAQBA	8	33	400	2900	14000	0,7	76	1950	1020	2180	820	160	3450	6
1600	NL	EM5NAQBA	8	33	400	3400	16000	0,6	77	2050	1030	2220	820	160	4000	7
2000	NL	EN5NAQBA**	8	33	400	4200	18000	0,5	79	2100	1310	2290	1070	200	4800	7
2500	NL	EO5NAQBA**	8	33	400	5200	22000	0,5	80	2300	1310	2350	1070	200	5950	7



Values are for reference only. Construction drawings must be used for design. Data provided may be modified without notice for reasons of technical production or product improvement.

Copper windings available on request

\* For information on enclosure see p. 60

\*\* Placed on the ground

# BoBk - XC - NL Cast resin transformers

## installation accessories



### Cat. Nos. Ventilation bars

The ventilation bars temporarily increase the transformer rated power (under normal service conditions) According to standard IEC 60076-1, a transformer is called AN even if it is equipped with ventilation bars for temporary use  
If a transformer is requested AF, please contact Legrand

	Rating (kVA)	ΔPower (%)	Notes
<b>CB02444</b>	100 - 315	+ 40	
<b>CB02454</b>	400 - 500	+ 40	
<b>CB02464</b>	630 - 1000	+ 40	
<b>CB01414</b>	1250 - 2000	+ 40	
<b>CB01412</b>	2500 - 3150	+ 40	Temporary increase at rated conditions (50Hz)

### Temperature measurement probes

Probes are supplied mounted on the transformer and wired to the aluminium IP66 junction box

	Type	Rating (kVA)	N°	Δt (°C)	Installation
<b>200073</b>	Pt100	≤2000	3	-	on the LV (3) windings
<b>200074</b>	Pt100	≥2500	3	-	on the LV (3) windings
<b>200137</b>	Pt100	≤2000	3+1	-	on the LV (3) windings + on the core (1)
<b>200138</b>	Pt100	≥2500	3+1	-	on the LV (3) windings + on the core (1)
<b>CB00120</b>	PTC	-	3+3	130-140	on the LV (3 pairs) windings for alarm and trip.
<b>CB02400</b>	PTC	-	3+3	110-120	on the LV (3 pairs) windings for alarm and trip.
<b>CB0272</b>	PTC	-	3+3+3	130-140-90	on the LV (3 pairs) windings for alarm, trip and fan control.

### Temperature control devices

Central units are supplied unassembled

	Type	Description
<b>220002</b>	T154	temperature control for 4 Pt100 probes
<b>220023</b>	MT200L	temperature control for 4 Pt100 probes
<b>220004</b>	T 119	temperature control for PTC probes
<b>220010</b>	T119DIN	temperature control for PTC probes, preset for DIN rail mounting
<b>220197</b>	NT935AD	temperature control for 4 Pt100 probe with analogue and digital output
<b>220035</b>	VRT200	fan control
<b>220174</b>	AT100	fan control

### Cat. Nos. Surge arrester kit

	HV*(kV)	Ur (kV)
<b>130075D</b>	6	9
<b>130054D</b>	10-11	12
<b>130055D</b>	15	18
<b>130056D</b>	20	24

\* other values of HV on request  
Ur: rated voltage of surge arrester

### Rubber supports (anti vibration)

	Rating (kVA)	Description
<b>170019</b>	≤1600	4 antivibration pads supplied for mounting under the transformer wheels
<b>170020</b>	≥2000	4 antivibration pads supplied for mounting under the transformer wheels

Wheels in "Cast Iron" on request

### Cupal plates BoBk - NL

Cupal is a bimetal sheet made of one copper sheet and one aluminium sheet welded together through a special mechanical procedure

	Rating (kVA)	Description
<b>030014 **</b>	≤160	40 x 40 CUPAL plate
<b>030008 **</b>	≥ 200 and ≤ 400	50 x 50 CUPAL plate
<b>030009 **</b>	≥ 500 and ≤ 800	60 x 60 CUPAL plate
<b>030010 **</b>	1000	80 x 80 CUPAL plate
<b>030011 **</b>	1250	100 x 100 CUPAL plate
<b>030012 **</b>	≥ 1600	120 x 120 CUPAL plate

\*\* The codes refer to a single CUPAL plate

### Example:

- For a transformer rated 1250 kVA, the correct CUPAL plate is item 030011
- Quantity calculation: 2 plates x 4 BT terminals = 8 CUPAL plates

### Cupal plates XC

Cupal is a bimetal sheet made up of one copper sheet and one aluminium sheet inseparably welded together through a special mechanical procedure

	Rating (kVA)	Description
<b>030008 **</b>	≥ 250 and ≤ 315	50 x 50 CUPAL plate
<b>030009 **</b>	≥ 400 and ≤ 630	60 x 60 CUPAL plate
<b>030010 **</b>	800	80 x 80 CUPAL plate
<b>030011 **</b>	1000	100 x 100 CUPAL plate
<b>030012 **</b>	≥ 1250	120 x 120 CUPAL plate

\*\* The codes refer to a single CUPAL plate

### Example:

- For a transformer rated 1250 kVA, the correct CUPAL plate is item 030012
- Quantity calculation: 2 plates x 4 BT terminals = 8 CUPAL plates

# Cast resin transformers **BoBk - XC - NL**

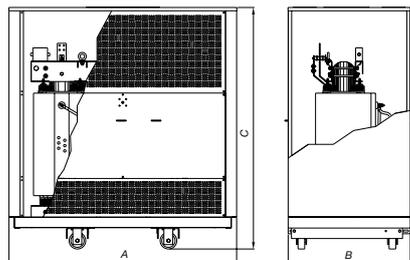
## installation accessories



### ENCLOSURES

RAL 7035 colour

**AREL door lock on the box, Cat. Nos. 230076**

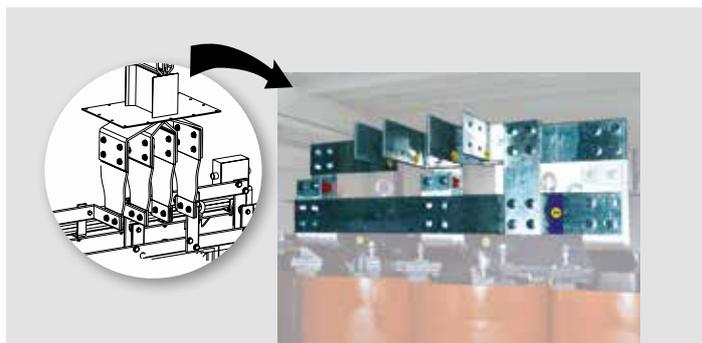


Class 12kV-17,5kV-24kV							
Cat. Nos.	Enclosure type	IP degree	Dimensions (mm)			Weight (kg)	Rating** [kVA]
			Length (A)	Width (B)	Height (C)		
230288	1	23	1600	900	1470	140	100 - 160 - 200
230353	1	31	1600	900	1470	135	
230273	2	23	1700	950	1580	155	250-315
230263	2	31	1700	950	1580	150	
230215	3	23	1800	1000	1680	170	400-500
230234	3	31	1800	1000	1680	165	
230277	4	23	1900	1050	1950	185	630-800
230222	4	31	1900	1050	1950	180	
230221	5	23	2050	1100	2200	235	1000-1250
230223	5	31	2050	1100	2200	225	
230267	6	23	2300	1310	2500	325	1600 - 2000
230249	6	31	2300	1310	2500	315	
230309	7	23	2500	1310	2700	365	2500 - 3150
230371	7	31	2500	1310	2700	350	
Class 36kV							
231120	3	23	2200	1400	2050	280	315 - 400
231119	3	31	2200	1400	2050	265	
231123	4	23	2300	1400	2150	300	500 - 630
230665	4	31	2300	1400	2150	285	
231124	5	23	2450	1450	2500	355	800
230667	5	31	2450	1450	2500	335	
231125	6	23	2600	1500	2700	395	1000 - 1250
230669	6	31	2600	1500	2700	370	
231122	7	23	2900	1700	2800	470	1600 - 2000 - 2500
231121	7	31	2900	1700	2800	440	

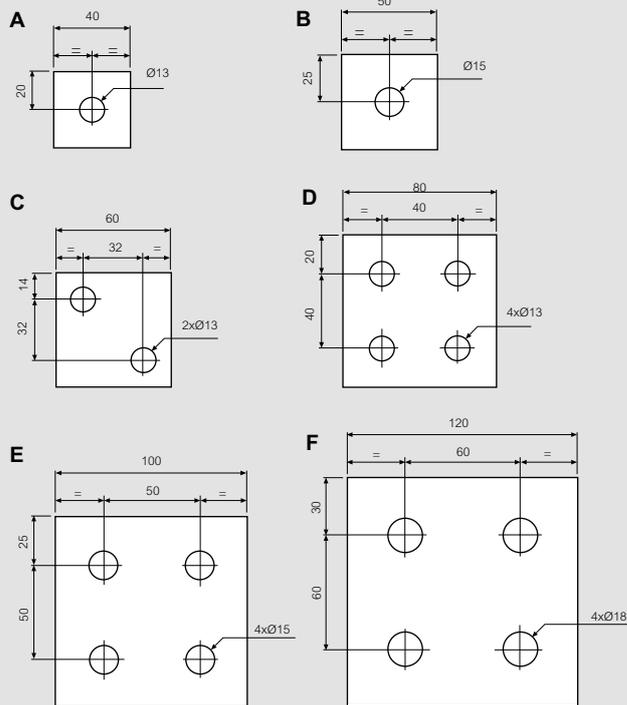
Enclosures can be supplied non-assembled or assembled on the transformer

The above references are of non-assembled enclosures. If an assembled enclosure is requested, add the "M" suffix to the enclosure code (e.g. 231043M)

\*\*Transformer rating per enclosure type and reference. Please note that surge arresters and/or connections to the busbar are not considered.



### ■ SIZES AND DRILLING OF LV CONNECTION TERMINALS



### DRILLING STANDARD

LV connection terminals are made of from aluminium. Special CUPAL bimetallic plates can be supplied for the connection of copper cables on bars.

Drawing	BoBk - NL		XC	
	Rating (kVA)	Thickness (mm)	Rating (kVA)	Thickness (mm)
A	100	4	-	-
	160	4	-	-
B	200	5	-	-
	250	5	250	5
	315	5	315	5
	400	5	-	-
C	500	6	400	6
	630	8	500	8
	800	8	630	8
D	1000	8	800	8
E	1250	8	1000	8
F	-	-	1250	8
	1600	10	1600	12
	2000	12	2000	16
	2500	16	2500	18
	3150	20	3150	22

Legrand reserves the right to modify the content of this booklet at any time and to communicate, in any form and modality, the changes brought to the same.

# Installation and maintenance



## TABLE OF CONTENTS

- Safety guidelines
- Rating plate
- Transport, receipt and storage
- Installation
- Commissioning
- Maintenance
- Technical glossary

# Safety guidelines



A cast resin transformer is an electrical equipment. It must be installed, protected and used in compliance with the existing national and international Standards and Regulations.

The possible improper installation and use of a cast resin transformer may cause risks of electric shock or fire.



Please, read this installation manually carefully before: lifting, moving or energising the transformer.



Every operation on the transformer must be performed when the transformer is not energised.



Do not get close to the cast resin transformer before having connected the windings to earth.



Before operating on the CRT, make sure that the transformer cannot be put undervoltage without your permission.



Do not energise the transformer before having connected the core to earth.



Do not energise the transformer before having carefully and completely inspected it.



Do not access the transformer's operation area or remove the protection devices when the transformer is undervoltage.



Each transformer generates a magnetic field. For this reason, any carrier of metallic devices as pacemakers should not get closer than 3 m to an energised transformer.



This transformer must be installed according to the installation directions and preferably by a skilled and qualified HV electrician.

Do not open, disassemble, alter or modify the transformer with the exception of special indications reported in the Installation Manual.

All Legrand products must be opened and repaired only by personnel trained and authorized by Legrand.

Legrand is not responsible for any non-authorized opening or repair.



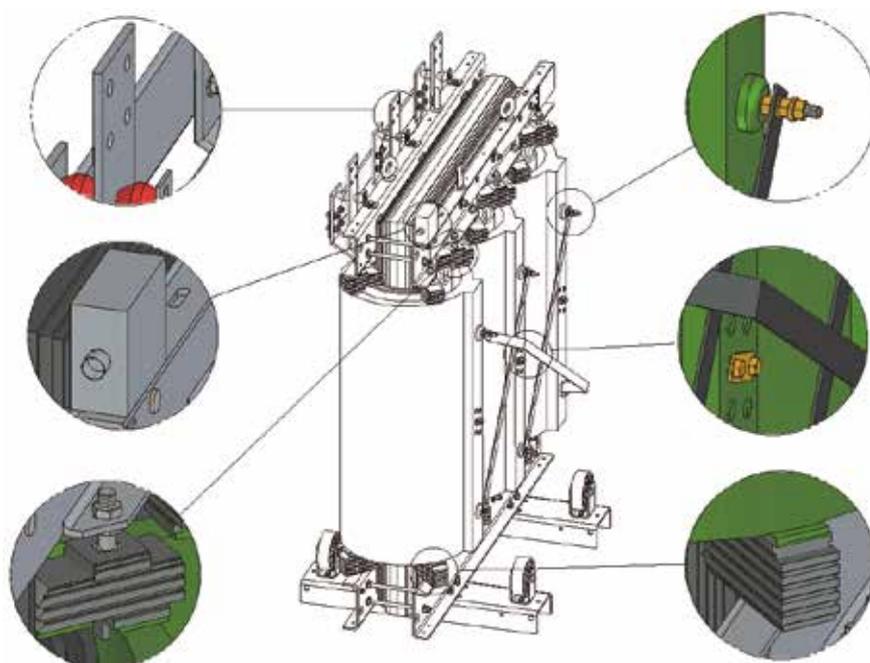
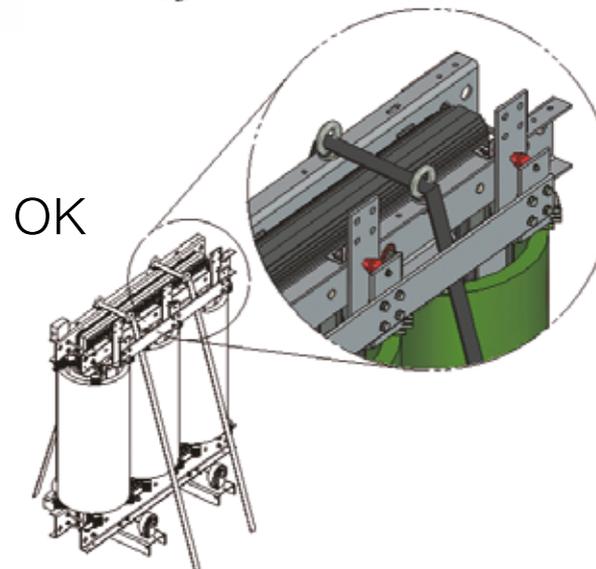
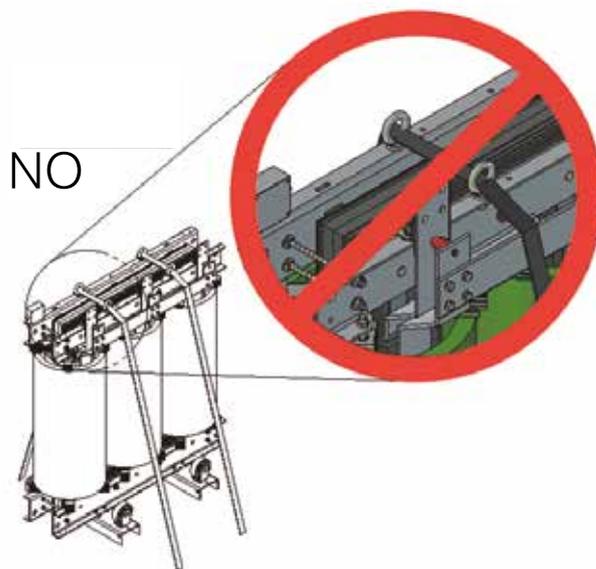
# Transport, receipt and storage

During transport, the transformers must be adequately fixed as indicated in the explanatory images. HV and LV connections must not be stressed by the retaining straps.

Once the transformer is at its destination, it is highly recommended to carefully examine it. In particular the following details have to be verified: HV and LV terminals and connections, presence of scratches and/or cracks on the windings of HV and their centering with respect to the windings of LV, integrity of the protection enclosure (if present), presence of impurities, dirt, foreign body, moisture or water.

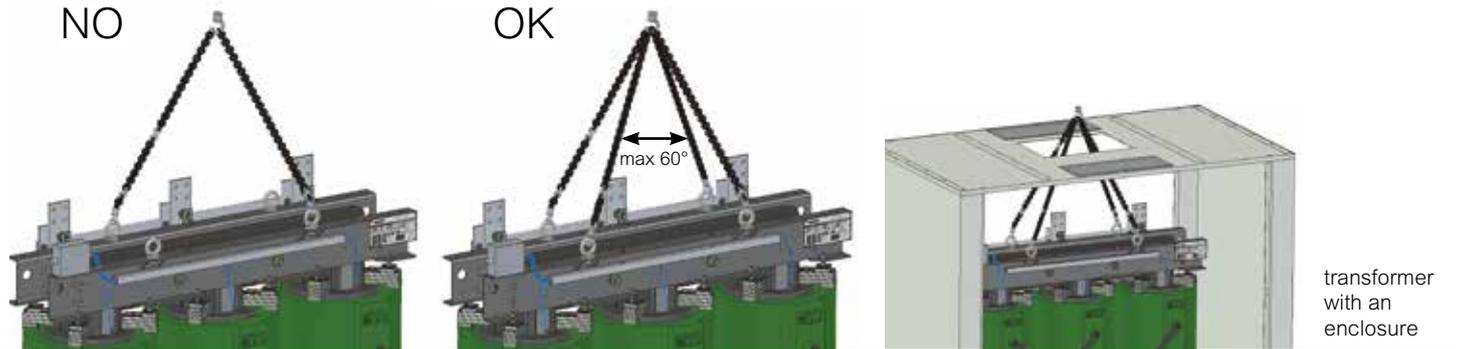
It has to be verified that the data on the rating plate are the same data reported on shipping documents and test reports of the transformer. It has to be verified that each transformer is provided with contractual accessories such as rollers, temperature sensors, control thermometer, etc. ...

Any non conformity must be recorded on the delivery note and notified to the forwarding agent or to Legrand. If after 5 days no report of anomalies and / or defects will be received by Legrand, we will consider that the transformer has been delivered in perfect condition.

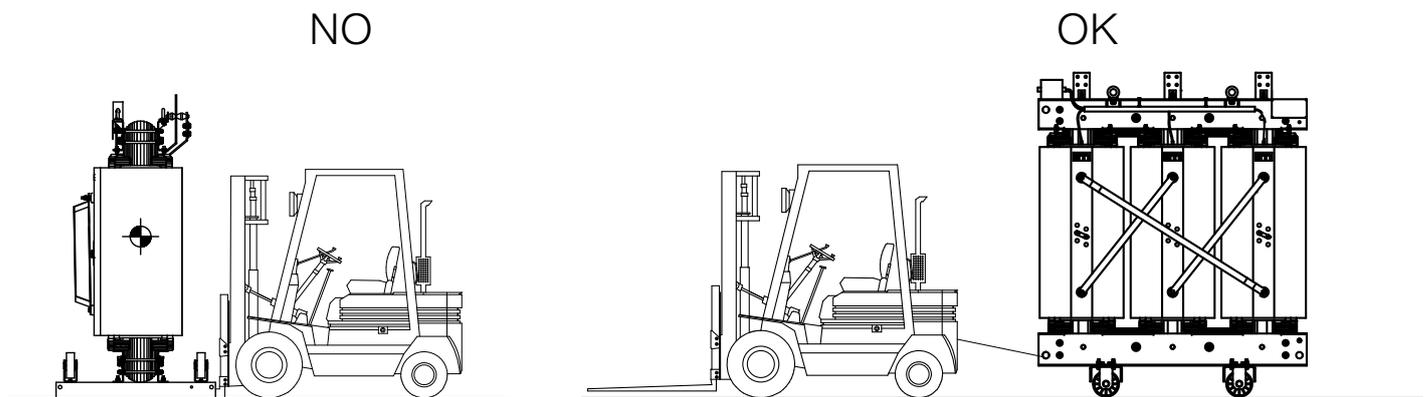


• **LIFTING THE TRANSFORMER**

Use all 4 eye bolts during lifting. Do not allow that the angle between the ropes to exceed 60°. Gradually increase the tension on the lifting cables to avoid sudden shock or stress to the transformer. If the transformer is supplied with an enclosure, remove the top window for the attachment of the ropes.



Do not leave the transformer elevated for prolonged periods. Move the transformer only in vertical position. Lift the transformer avoiding improper lifting (that may cause it to tip over): be careful about the high centre of gravity of the transformer. It is prohibited to lift the transformer by inserting the forks of the forklift in the upper part of the core.

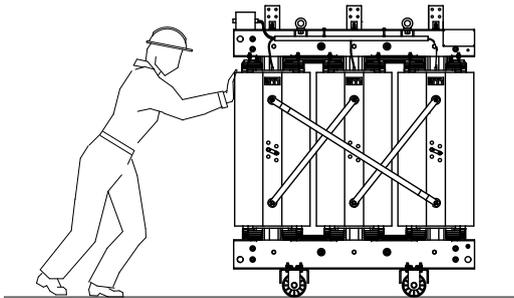


# Transport, receipt and storage

## • MOVING THE TRANSFORMER

The transformer (with or without enclosure) must be moved using the track or lower joles where the proper holes are located.

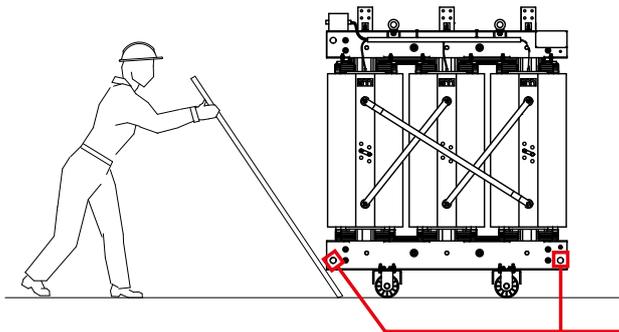
NO



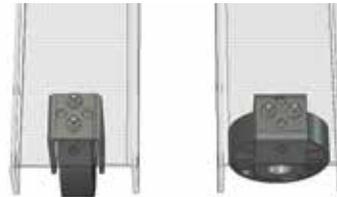
Do not move the transformers by applying force on the windings or on their connections.

It is recommended to avoid moving the transformer on the rollers more than 10 m.

OK



Movement can be made only in two directions, according to the rollers orientation.



...or towing holes for horizontal moving

## • STORING THE TRANSFORMER

If the transformer is not installed immediately, it has to be protected against water, dust, humidity and sunlight even if provided with enclosure.

In case of storage the packaging supplied with the transformer must not be removed.



The temperature during storage and installation must not decrease below  $-25^{\circ}\text{C}$  (unless otherwise agreed order stage). After a long storage at very low temperatures or in an environment with high humidity, the transformer must be dried before being placed in service.



# Installation



During the operations for the connection and installation, always protect the windings to avoid external parts such as bolts, washers, cable parts, etc. following into the windings and jeopardizing the insulation capability of the transformer.

Dry type cast resin transformers are designed for indoor installations, in a site protected from direct sunlight, in clean and dry environments, without risk of water intrusion.

Standard installation must be:

1. At a sea level height not above 1000 m.
2. At a temperature of the cooling air not exceeding the following values :
  - a. 20 ° C yearly average
  - b. 30°C warmest month average
  - c. 40°C maximum
3. According to all other normal operating conditions as per IEC 60076-11 Standard.

During the installation refer to the safety rules existing in your country.

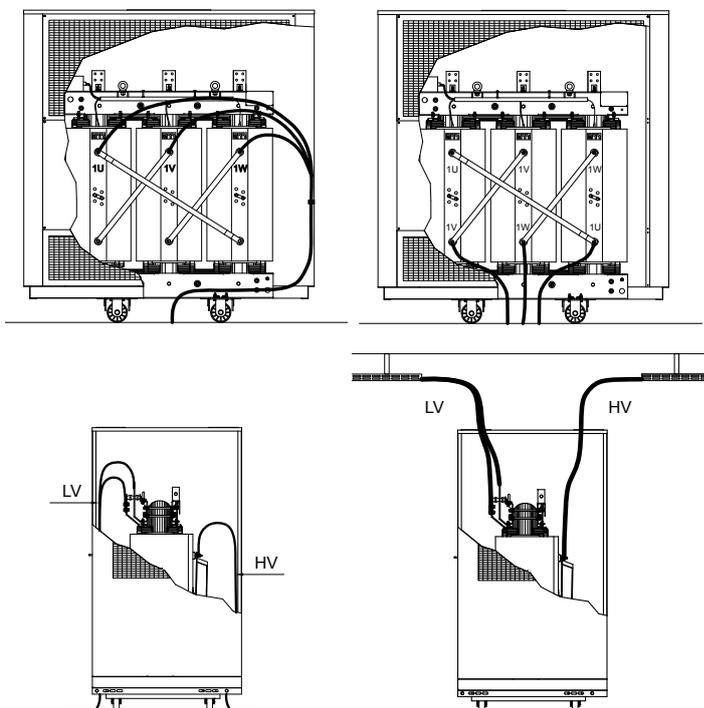
## • INSTALLATION EXAMPLES

The cable connections of Medium and Low Voltage can be done with cables coming from the bottom or the top. Some examples are listed below.

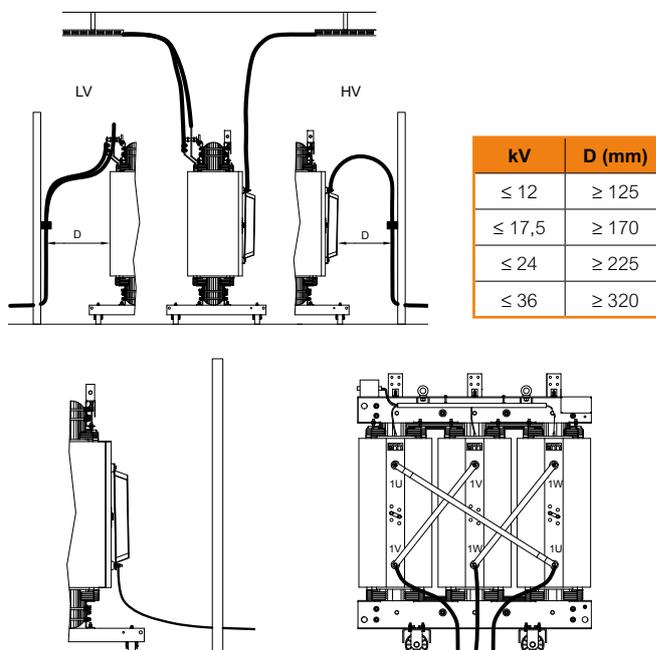
- **Installation in protection enclosure (Fig.1)**
- **Installation without protection enclosure/box (IP00) (Fig.2)**

Between HV and LV connections and transformers windings and delta connections, the minimum distances shown in the table must be respected. HV and LV cables must always be supported to avoid mechanical stress on the terminals.

**Installation in protection enclosure (Fig.1)**



**Installation without protection enclosure/box (IP00) (Fig.2)**



HV cable from	Sequence of the phases	Activities to be performed
Top	U - V - W	None
Bottom	V - W - U	Move the bolts from the top to the bottom terminals

HV cables, even if shelded, must not pass inside delta connection on HV side.

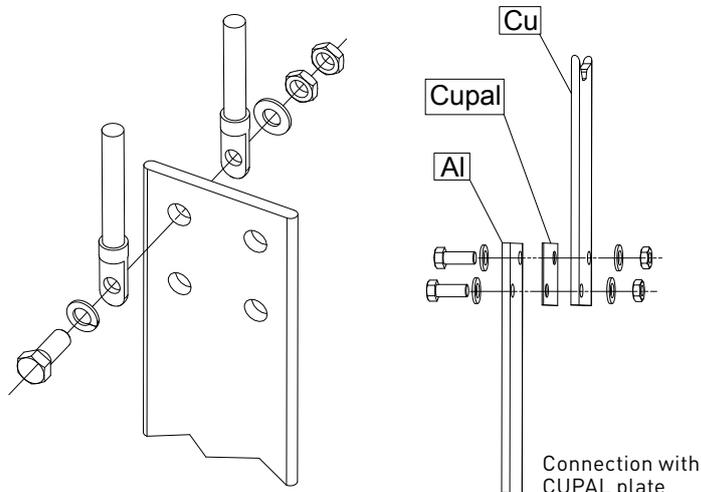
# Installation

## • CONNECTIONS ON THE LOW VOLTAGE SIDE – LV

LV terminals are positioned on the upper part of the transformer and they are in aluminium as standard. We recommend to make the cable connection with tinned-copper cable terminals, connecting one or two cables in each hole.

In the case of connections with busbar it is necessary to use flexible connections to mechanically isolate the transformer from busbars.

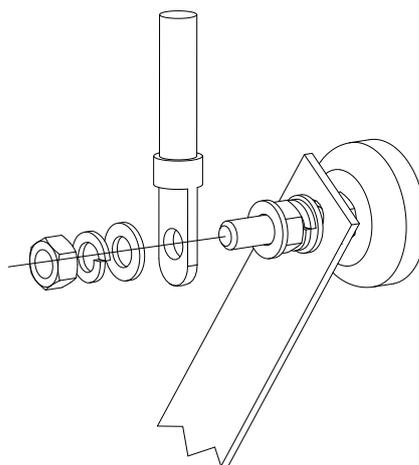
In order to prevent corrosion caused by the direct connection between copper and aluminium, it is necessary to use **CUPAL** intermediate plates (supplied on request) when connecting untreated copper busbars to the LV aluminium terminals.



## • CONNECTIONS ON THE HIGH VOLTAGE SIDE – HV

The HV terminals positioned on the opposite side to the LV terminals, are made with brass bolts placed at the two ends of the winding.

In case of connection of cables from the bottom, the upper pins can be inserted on the lower end by inverting the sequence of phases in accordance to the example previously reported in the figure.



Do not replace the brass bolts with bolts of a different material: this could alter the

## • TIGHTENING TORQUE FOR ELECTRICAL AND MECHANICAL CONNECTIONS

Tighten screws and bolts of electrical and mechanical connections in accordance with the values reported in the table: it is recommended to re-test after a few hours of operation to eliminate the effects of any adjustments. During the operations of clamping always use two wrenches to prevent distortion or damage.

Screw/Bolt	Electrical connection [Nm]		Mechanical connection	
	Steel	Brass	[Nm] (mm)	
M6	10-15	5-10	20	10
M8	30-40	10-15	35	13
M10	50-60	20-30	45	17
M12	60-70	40-50	60	19
M14	90-100	60-70	100	22
M16	120-130	80-90	150	24
M18	-	-	200	27
M20	-	-	270	30
M22	-	-	360	32
M24	-	-	460	36

## • POSITIONING

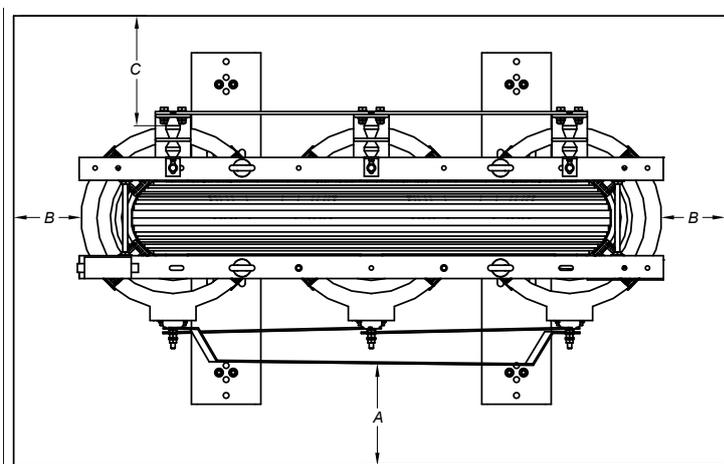
Cast resin transformers do not ensure contact insulation.



It is absolutely forbidden to touch the cast HV coils while the transformer is energised.

Therefore the transformer must always be installed in a metal enclosure, inside a cage or in a room with doors enabling access only when the transformer is de-energised.

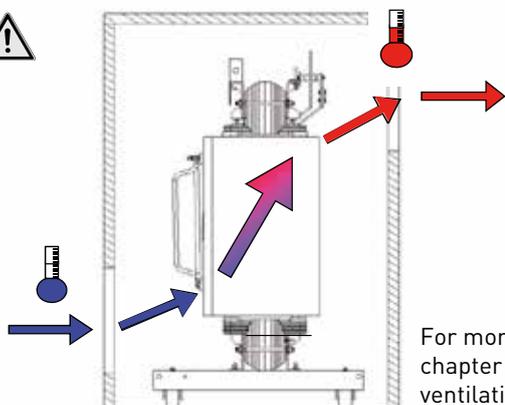
Inside this electrical enclosure the transformer has to be positioned complying with minimal insulation distance from the walls. They are related to the insulation class shown in the Rating plate.



kV	A (mm)	B (mm)	C (mm)
≤ 12	≥ 125	≥ 60	(*)
≤ 17,5	≥ 170	≥ 80	(*)
≤ 24	≥ 225	≥ 120	(*)
≤ 36	≥ 320	≥ 200	(*)

C=B except when there is a voltage switch present on the LV side whereby C = A. In order to prevent horizontal movement of the transformer the mounting direction of the wheels can be modified.

## • VENTILATION



For more details see chapter dedicated to ventilation on page 21-22-23

# Installation

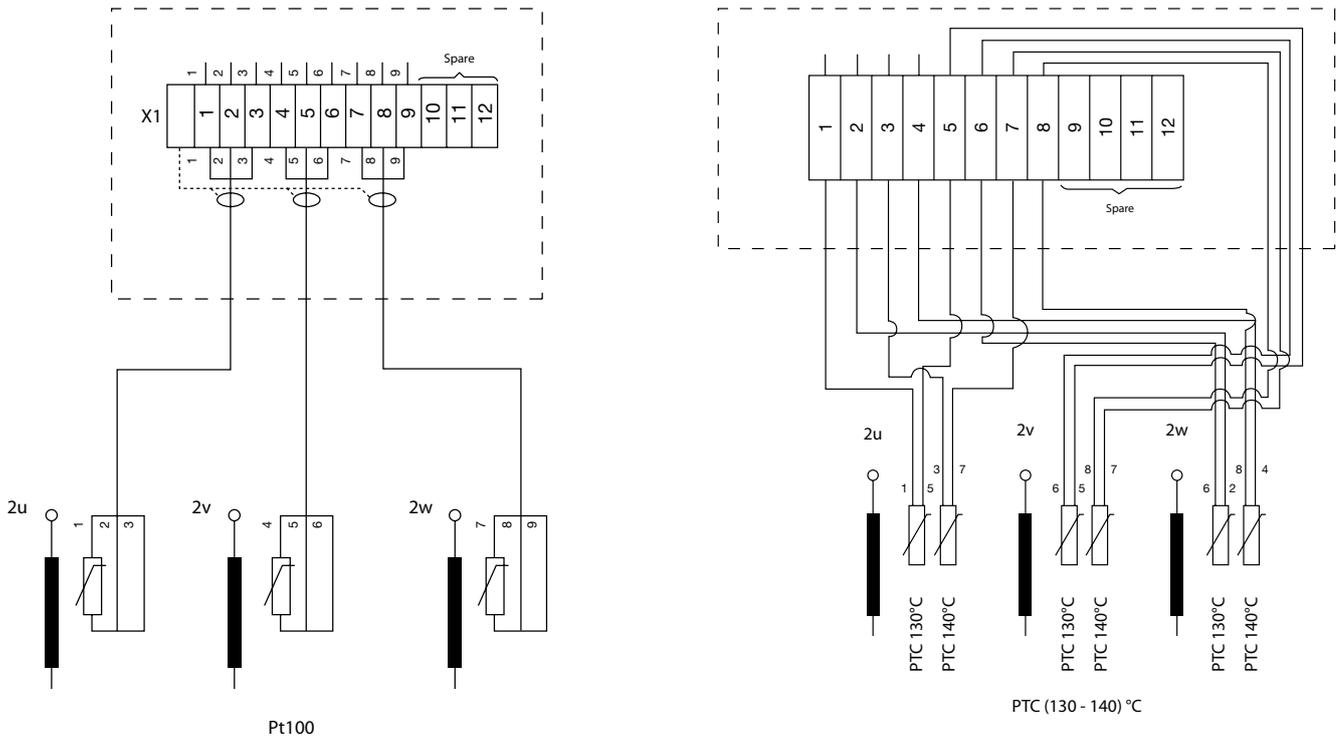
## • PROTECTION AGAINST OVERVOLTAGES

To protect the transformer from overvoltage at power frequency or of atmospheric origin, adequate surge arresters must be installed. They need to have technical characteristics depending on the level of insulation of the transformer and on the characteristics of the HV distribution system. Possible equipment for the correction of the power factor connected close to the transformer must be equipped with limiters for the inrush current in order to prevent the generation of transient overvoltages.

## • TEMPERATURE MONITORING SYSTEMS

In standard execution the transformers are equipped with Pt100 temperature probes, realized in accordance with the IEC 60751 Standards.

### Connection of the probes:



### Spare terminals

These are the recommended settings when the transformer is equipped with a temperature monitor device:  
Recommended setting:

Recommended setting for transformer equipped with a temperature monitor device		
Class	Alarm (°C)	Trip (°C)
180°C (H)	140	155
155°C (F)	130	140
130°C (B)	110	120

Electrical connection diagram, number and function of the electrical contacts, and terminals numeration are detailed on the manuals of the temperature control devices.

# Commissioning

Legrand is not responsible for the installation of the transformer. Checks need to be done before energised the transformer.

## • EARTH CONNECTION

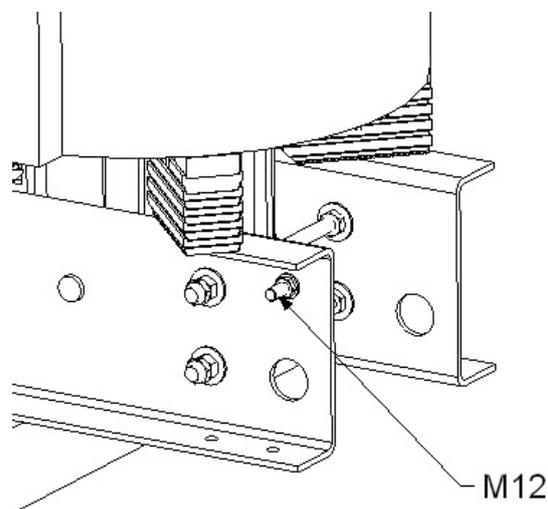
The earth conductor must be connected to the appropriate terminals which are on the transformer core.

The size of earth conductor must be defined according to fault current and to the current standards.

In any case the earth conductor should never be lower than the following sections:

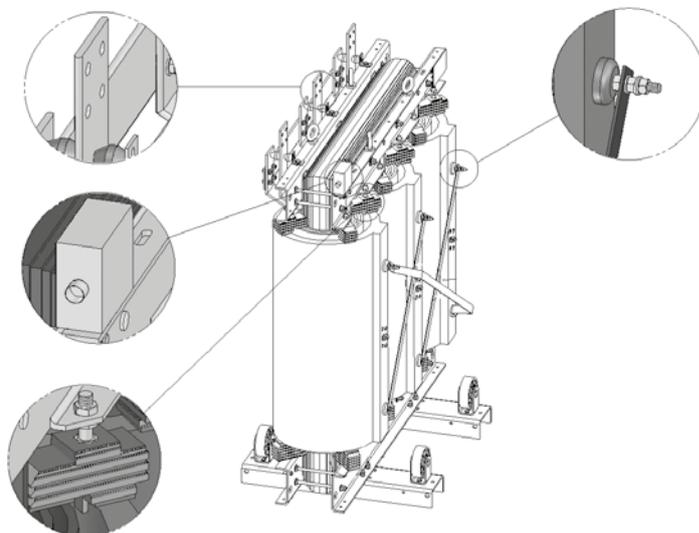
- copper: 16 mm<sup>2</sup>
- aluminium 35 mm<sup>2</sup>
- Steel 50 mm<sup>2</sup>

Insulation distances between earth conductor and live parts must always be respected.



## • HV AND LV CONNECTIONS

1. Verify the mutual position of LV and HV windings which must be according to our drawings. Verify that the compression bolts are centred on the spacers. The spacers must be slightly pressed.
2. Check the connections between cables and HV terminals and between cables or flexibles and LV terminals. Tightening torques must be the ones indicated in the table.
3. Verify the correct operation of the temperature control device.
4. If the transformer is equipped with fans, check that fans are correctly positioned and that they work in the right direction.



# Commissioning

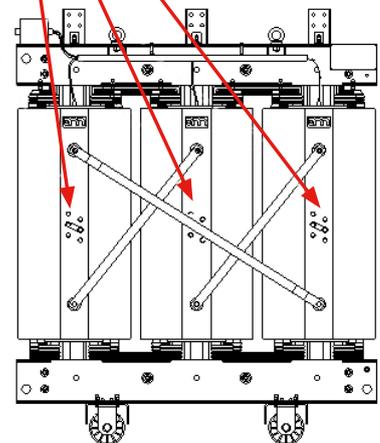
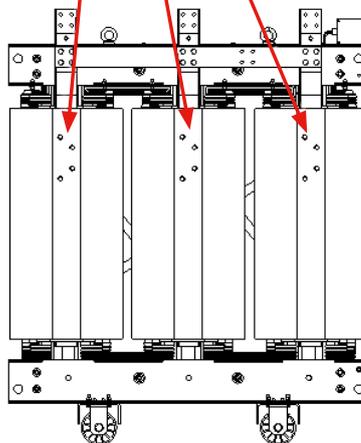
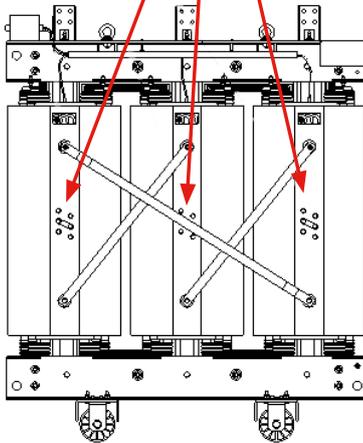
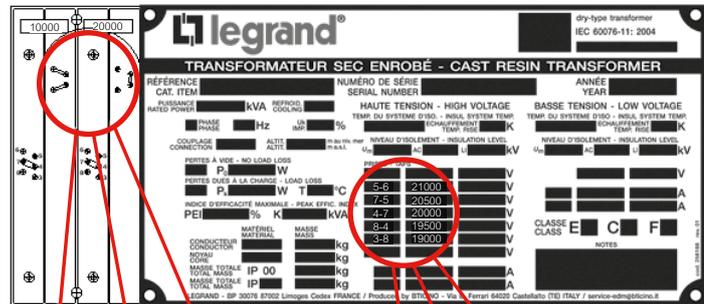
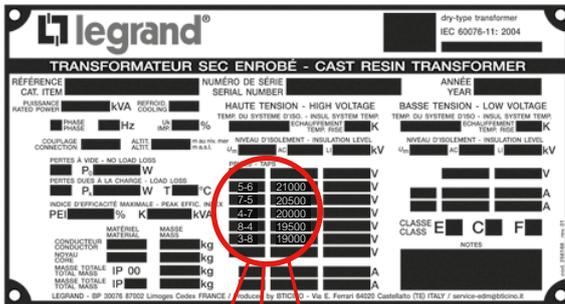
## • TAPPINGS FOR VOLTAGE SETTING ON HV WINDINGS

The variation of the nominal HV supplied by the electrical authority can be compensated by the tapplings setting in order to keep the nominal LV required and detailed on the rating plate. The voltage setting is made by changing the position of the plates on the tapplings.

Standard transformers are equipped with 5 tapplings:  $\pm 5\%$  in steps of 2.5%.

Before operating on the tapplings and modifying the voltage setting, it is necessary that the transformer is off-load.

For transformers with one or two primary voltage windings, the voltage setting indications are detailed on the rating plate.



Tappings for voltage setting on HV windings



It is important to set the same tapplings on all three HV windings in order to avoid possible damages to the transformer.

Platelets are located in the standard version on the front of the HV windings

- **CLEANING**

If the transformer has been stored for a long period, clean carefully LV and HV windings from dust, dirt and possible condensation.

Clean the HV and LV windings from dust deposits, dirt and condensation.

Use a vacuum cleaner to avoid dispersion of dirt and dust on the transformer.

Make sure the room is dry, clean, with sufficient ventilation and without the risk of ingress of water.

Do not attach accessories or ducts to the windings and the core of the transformer.

- **MEASUREMENT OF WINDINGS EARTH RESISTANCE**

The measurement must be performed with a Megohmmeter (Megger), working up to 5000V. HV and LV terminals must be disconnected from the electrical system, during the measurement.

The measured values should be approximately as follows:

- 5000 V for 60 s: Terminals HV / LV terminals to earth  $\geq 20 \text{ M}\Omega$
- 2500 V for 60 s: Terminals LV / HV terminals to earth  $\geq 10 \text{ M}\Omega$
- 2500 V for 60 s: Terminals HV - LV terminals / earth  $\geq 10 \text{ M}\Omega$

If the measured values are significantly lower, dry the transformer and, if necessary, contact the after sales department.

- **ENERGIZING**

When the transformer is connected to the electrical system, some sparkles could be visible close to the magnetic core. This physical phenomenon does not influence the correct working of the transformer and it is not related to the quality.

If the protection systems are not correctly set, inrush current will open the circuit breaker which protects the transformer.

This can generate high voltages which can damage the windings.

For this reason, it is recommended to activate the second harmonic restraint.

After checking the installation and ensuring that no object/tool has been left on the transformer, it is possible to close the circuit breaker on the HV side.

After energizing the transformer from the HV side, close the LV circuit breaker.

# Maintenance

In normal operating conditions cast resin transformers do not require specific maintenance except for that indicated in the following table. All the operations performed must be recorded in order to be shown to Legrand in case of necessity. Maintaining within recommended timescales will help to prevent break downs.

## • INDICATIVE TABLE ON THE MAIN MAINTENANCE OPERATIONS

Pos.	Control activity	Frequency of checks	Tools to be used	Result
1	Correct operation of the temperature sensors Pt100 / PTC	Every 6 months and after exceptional events	Hot air tool for simulated heating	Normal behaviour of the different temperature sensors
2	Correct operation of the temperature control device	Every 6 months and after exceptional events.	Hot air tool for simulated heating	Simulated alarm and trip
			Follow the instructions given in the installation manuals	
3	Cleaning of the windings from dust, dirt, grease and possible foreign bodies	Yearly. If the environment is particularly dusty, the frequency must be adequately increased	Clean, dry compressed air, maximum pressure 3 bar Dry rag	The ventilation gaps between the windings must be completely clean and open
4	Cleaning of the windings from condensation	After a period with no applied voltage	Heat by short circuit up to 80 ° C	External and internal surfaces of the windings perfectly dry
5	Tightening of the bolts of HV and LV terminals and of all the electrical connections	Yearly / after exceptional events	Torque wrench	Tightening torque according to page 69
6	Measurement of insulation resistance to earth of the windings	After a period with no applied voltage	Mega-ohmmeter (Megger)	See page 73
7	Verify that each couple of LV and HV windings is perfectly aligned	After exceptional events such as accidental shock or short circuit downstream of the transformer.	Metro	Uniform centering
8	Tightening of the upper spacer	Yearly / after exceptional events	Torque wrench	Tightening torque between 20 and 40 Nm
9	Tightening of mechanical parts and fixing to the floor	Yearly and after exceptional events	Torque wrench	Tightening torque according to what is indicated in the table page 69

## • GUIDE FOR TROUBLE-SHOOTING

Pos.	Problem	Possible reason	Corrective action
1	Overtemperature of a single winding	Load is not distributed uniformly	Check the position of the connection on the tapings
		Faulty temperature sensors or temperature control device	Replace the faulty piece
2	General overheating	High ambient temperature	Possible damaged fans Clean possible openings of the room or of the box which have been blocked Check as per pag 69
3	Overheating in the core	Eddy currents in the magnetic core, due to a damage on the insulation of the ties	Contact Technical Assistance service After Sales.
4	Abnormal noise	Primary voltage too high	Verify that the voltage on the off-load secondary windings is lower or equal to the one written on the rating plate. Check as per pag 72
	Abnormal noise	Rigid connection with the Busbar Rigid connection with the floor. Bolts of tie rods the lens nucleus	Insert flexible connections between transformer and Busbar. Insert anti-vibration pads under the rollers. Tighten loose bolts of tie rods.
5	Intervention of the alarm and tripping relay of the temperature control device, due to overtemperature	Faulty temperature sensors or temperature control device	Replace the faulty piece
		Load current higher than the nominal value on the rating plate / high content of harmonics in the load current.	Reduce the load in order to have the nominal rated current or install the air circulation system
		Difficult or not enough ventilation air flow	Check as per pag 69
		Possible poor electrical contact of the temperature sensors	Check, clean and tighten all contacts of the sensors
6	Untimely intervention of the electrical system protections due to transformer insertion	The setting of the HV circuit breaker for the CRT insertion current is too low	Modify the protection setting paying attention to the H2 control (second harmonic)

### Note:

The supplier does not assume any responsibility for the use or inappropriate use of the products mentioned in this chapter.

This guide does not cover all the details or possible variations of the entire series of connections, installation and possible operations.

For further information or to solve specific problems that are not included in this guide, contact Legrand.

## READ THIS ENTIRE DOCUMENT BEFORE YOU COMMENCE THE INSTALLATION.

### • CUSTOMER CARE

For any information or spare parts do not hesitate to get in contact with our customer service. Call +39 030 2017100 or send a mail to: [service-edm@bticino.it](mailto:service-edm@bticino.it)

Do not forget the serial number of your transformer.

# Technical glossary

## Rated Power $S_r$ [kVA]

rated power is the conventional value of the power assigned to a winding which, together with the rated voltage, allows us to determine the rated current.

## Rated voltage of a winding $U_r$ [kV or V]

voltage assigned to be applied, or developed at no-load, between the terminals of a winding. For a three-phase winding it is the voltage between line terminals

## HV (high-voltage) winding

The winding having the highest rated voltage

## LV (low-voltage) winding

The winding having the lowest rated voltage

## Primary winding

A winding which, in service, receives active power from the supply network

## Secondary winding

A winding which, in service, delivers active power to the load circuit

## Connection symbol

a conventional notation indicating the connections of the high-voltage and low-voltage windings and their relative phase displacement expressed as a combination of letters and clock-hour figure

The star, delta, or zigzag connection of a set of phase windings of a three-phase transformer shall be indicated by the capital letters Y, D or Z for the high-voltage (HV) winding and small letters y, d or z for the low-voltage (LV) winding.

Letter symbols for the different windings of a transformer are noted in descending order of rated voltage independently of the intended power flow.

## Short-circuit voltage $U_k$ (%)

is the voltage to be applied between the winding line terminals so that the rated current circulates between them when the terminals of the other winding are in short-circuit. This voltage may be divided into a resistive component and an inductive component.

This voltage value allows calculation of the short circuit current ( $I_{cc}$ ) at the secondary terminals if the impedance upstream is neglected, according to the formula:  $I_{cc} = 100 * I_n / U_k$

The transformer impedance is also calculated with this magnitude. It is necessary to calculate this short-circuit current in the Low-Voltage distribution system according to the formula:  $Z = U_k \% * V_n / 100 * I_n$

The transformer short-circuit currents are a function of the transformer power and are standardised on the values 4% and 6%.

## No-load current ( $I_0$ )

is the magnetic circuit magnetisation current which is established in a winding when this is supplied at rated voltage and frequency (the other winding is open circuit). This current value is expressed in % of the transformer rated current. The magnetic circuit is made up of insulated laminations.

## Inrush current ( $x I_n$ )

is the pick-up current peak which occurs when the transformer is powered. Its initial value can be even 8 – 10 times the winding rated current. The pick-up current of a transformer must be known to determine the calibrations for the associated protection devices.

## Noise [dB(A)]

is caused by magnetostriction of the magnetic circuit laminations. The noise is a function of the transformer magnetic work induction and the quality of the laminations. The noise level can be expressed in terms of **sound power  $L_{wA}$  - Acoustic power [dB(A)]** and is independent of the load.

## No-load loss $P_0$ [W]

represent the active power absorbed by the transformer when the rated voltage is applied at the rated frequency to one of the two windings and with the other winding with open circuit. No-load losses, also called iron losses, are independent of the load and are equivalent to the sum of the losses caused by the hysteresis and the eddy currents (Foucault).

## Load loss $P_k$ [W] at 120°C

are instead the losses due to the ohmic currents on the main circuits, to the additional losses in the windings and to the losses on the metallic masses. These losses are proportional to the square of the load current and are expressed at a standardised reference current of 75°C for oil transformers and 120°C for cast resin transformers.

## Routine test

a test to which each individual transformer is subjected

## Type test

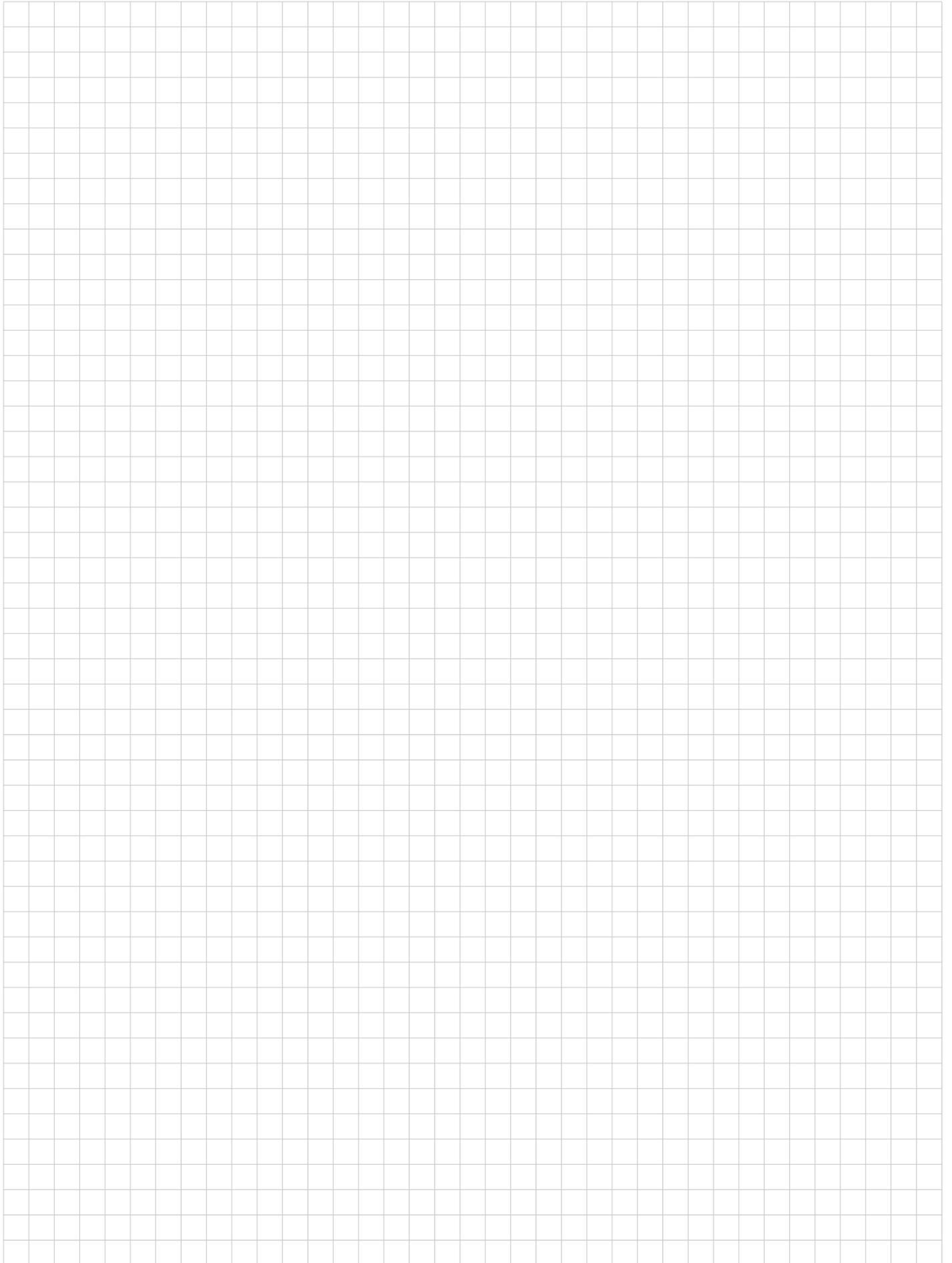
a test made on a transformer which is representative of other transformers, to demonstrate that these transformers comply with the specified requirements not covered by the routine tests: a transformer is considered to be representative of others if it is built to the same drawings using the same techniques and materials in the same factory

## Special test

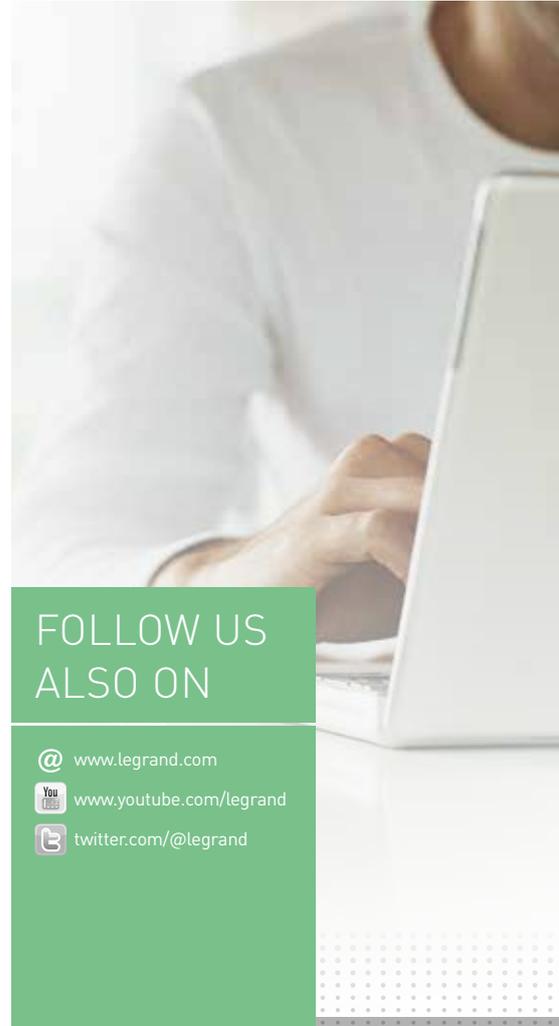
a test other than a type test or a routine test, agreed by the manufacturer and the purchaser



# NOTE







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