INSTALLATION MANUAL

MAINTENANCE FOR CAST RESIN TRASFORMER

ELETRAFO SRL
TRASFORMATORI ELETTRICI

Summary

1. HANDLING AND STORAGE

1.1 Transport and reception

The transformers are shipped from the factory ready for installation; however, any relays and thermometers are not programmed.
To reduce the risks of damage during transportation, the transformers must be secured with cables using the special hooks provided on the machine.
The cables should be positioned in a way that does not damage the connections, and it is mandatory for the customer to inspect the transformer's condition upon arrival.
Any damages must be immediately reported to the carrier, and Eletrafo must be informed.
For sea transportation of the transformers, they are packaged in a sturdy wooden crate with internal waterproof linings.
The packaging must appear intact and free of defects, and the crate should not have been opened, even partially.

1.2 Recommendations for maintenance

To perform the movement, it is necessary to attach directly to the lifting rings of the transformer **(fig.1).** In the case where the transformer is equipped with a protective enclosure, move the central plate to the top of the enclosure and perform the previously described operation. **(fig.2).**
For a craneless movement, it is possible to use a forklift by inserting the forks into the brackets of the transformer and lifting it carefully. **(fig.3)**
This type of operation is strongly discouraged, and Eletrafo will not be in any way responsible for any damage to the machine.

Attention: Since the center of gravity of the transformer is very high, movement with a forklift should only be carried out on flat, smooth, and perfectly horizontal ground. On steep and uneven terrain, there is a risk of tipping the transformer with serious consequences for the safety of individuals and the transformer itself.

- The transfer, with or without the protective enclosure, can only be done using the lifting rings and must be carried out in the direction where the wheels will be mounted.

- For the installation of the volumetric rollers, the transformer must be lifted using the upper lifting rings, and then the wheels should be secured in the desired direction, allowing the transformer to land on them

1.3 Storage

The transformer must be stored in a covered, clean, and dry place with a minimum degree of protection IP21. Any protective cover (such as a wooden box or plastic sheets) should only be removed at the time of installation. The storage temperature should not be lower than -25°C.

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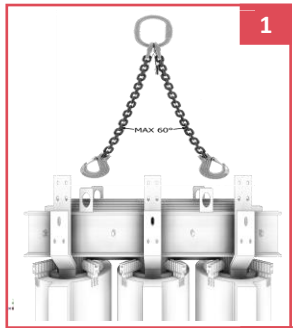

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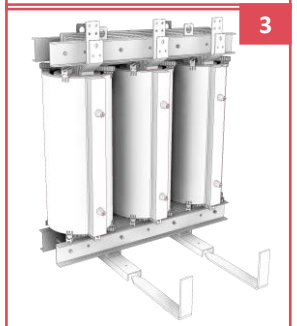


2. TRANSFORMER ACCESSORIES

2.1 Standard accessories

No load tap changer - It allows you to adjust the primary voltage of the transformer based on the line voltage. It should only be operated when the transformer is disconnected from the power grid. The switch is equipped with numbers or symbols to indicate its position (refer to the standard 5-position switch diagram in the appendix sheet of this manual)

Rating plate- reports, according to IEC – IEC standards, the electrical characteristics, weight and registration number of the transformer.

Eathing clamps- allow the transformer to be connected to the plant's ground network

4 lifting lugs (depending on the power)- It allows for the lifting of the transformer.

4 bidirectional wheels -Sliding wheels are steered in both perpendicular directions

4 traction fastening elements - allow horizontal transfer of the transformer

2.1 Accessories on request

PT100 Sensor - These temperature sensors can be installed on the BT windings and/or the magnetic core. Connected to the thermometric control unit, they allow for the acquisition of the temperature of the windings and/or the core, and, if necessary, the signal can be transmitted remotely

Thermometer relay for PT100 - It acquires signals from PT100 (max 4) and displays the measured temperature on each BT winding and the magnetic core (on request). This electronic relay includes two relays with a threshold that can be calibrated for alarm and disconnection signaling and a FAN contact that allows control of a set of ventilation bars if necessary.

PTC Sensor - They can be requested on BT windings and/or the magnetic core; connected to a specific electronic relay, they form a system that emits a signal at a predefined threshold. With this type of thermosensor, it is not possible to measure the temperature, but only to control the threshold, so a set of PTCs is required for each required threshold.

Relays for PTC - will be mounted on the transformer or simply supplied separately

Elastimold plug-in insulators MV side (fixed part)- The line terminals on the MT coils are designed to be connected to medium voltage cables with Elastimold plug-in insulators. Plug-in insulators allow for quick connections, so it is advantageous when the connection changes frequently. Please note that the use of plug-in insulators on resin transformers does not alter the obligations established at the time of design for protection against contact with live parts because the entire MT coil is considered a live part.

Elastimold plug-in insulators MV side (movable part)): - they are used to make MT cable heads that can be disconnected. The choice of the mobile part is linked to the characteristics of the cable used. In case of request of the mobile part it is advisable to send to Eletrafo a technical sheet of the cable.

Anti-vibration pads - These are separate devices that must be installed by the customer under the wheels and the feet of the transformer (depending on the demand and the type of anti-vibration system). They allow for a significant reduction in vibrations transmitted to the structure, and therefore reduce noise.

Auxiliary circuit connection box - It centralizes the auxiliaries and protects the terminal block. The size of the auxiliary enclosure varies depending on the number of terminals contained and has an IP54 protection rating

Air Forced (AF) Cooling Vent Bars - It consists of a group of fans that varies depending on the power of the transformer on which they are installed. For proper operation, the ventilation bars require a separate control and command relay

Surge Arresters MT- They will be installed to protect the transformer from overvoltages of atmospheric origin or due to opening or closing maneuvers of the switch located upstream of the transformer, and they will be chosen based on the required insulation level.

3. INSTALLATION

3.1 Ambient temperature and load conditions

Cast Resin transformer are designed to distribute the rated power in a normal distribution network, the conditions of which are defined in the CEI EN 60076-11 standard. An altitude exceeding 1000 meters, an ambient temperature exceeding 40°C, or specific network or load conditions (presence of overvoltages, harmonics, and overloads) subject the transformer to dielectric, mechanical, or thermal stresses and must be taken into account during the design phase to ensure the reliability and longevity of the machine

3.2 Room dimensions (fig.4)

Many parts of the cast resin transformer are easily accessible when the machine is energized. The epoxy-insulated MT coils and the triangle closure connections, typically covered by a rubber sheath, should be considered live parts. Therefore, it is essential for the transformer to be adequately insulated. The room where the transformer will be installed must allow for adequate air circulation (at least 5-6 m^3/minute of air per kW dissipated). For the calculation of the surface area Sc (in m^2), use the following formula

$$Sc = \frac{0{,}18p}{\sqrt{H}} \quad \text{et} \quad Sc' = 1{,}10 \times \text{Sc}$$

This formula is valid for an average annual ambient temperature of 20°C and a maximum altitude of 1000 meters

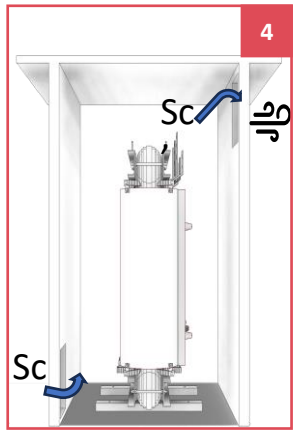
The distance from the walls to active parts must comply with local regulations and in any case not be less than the values provided in **TABLE 1.**

3.3 Protective enclosure

Normally, the transformer is supplied in IP00. Upon request, it is possible to provide the transformer with an internal installation enclosure with a degree of protection as specified by the customer. In this case, the enclosure itself protects the transformer from accidental contact. However, the installation room must have dimensions and distances that allow for adequate air circulation (typically, there should be at least 600mm between the enclosure wall and the room wall, both to allow for proper air circulation and for the normal inspection/maintenance of the machine)

3.4 Connections

The transformers in standard execution are designed for connection to the MT and BT lines from below. The rules to follow for the connection are part of the normal and widely practiced guidelines by installers. Eletrafo recommends adequately supporting and securing the connection cables so that their weight and, especially, the electrodynamic forces in case of failure do not burden the transformer.It is recommended to treat the sheaths of the MT cables in the same way as grounded parts, so they must be kept at a distance from the active parts of the transformer exactly as would be done with other accessories, following the guidelines in TABLE 1. Upon the specific request of the customer, it is possible to implement all types of connections and bars



P= The sum of no-load losses and losses due to transformer load expressed in kW at 75°C, as well as losses emitted by any equipment in the room.
Sc = The surface area of the external air intake door (minus any grille) expressed in m^2.
Sc'= Surface of the air outlet (deduced grid if any) expressed in m^2.
H = The height between the two doors expressed in meters

TABLE 1

MAXIMUM VOLTAGE (effective kv)	RESISTANCE VOLTAGE INSULATION LEVEL		MINIMUM INSULATION DISTANCE (mm)
	AN OPERATING FREQUENCY(kV effective)	ATMOSPHERIC PULSE(kV effective)	
3.6	10	20	/
		40	60
7.2	20	40	60
		60	90
12	28	60	90
		75	125
17.5	38	75	125
		95	170
24	50	95	170
		125	225
36	70	145	275
		170	315

3.5 Electrical connections

To make connections to the MT and BT lines, follow the phase indication on the terminals and ensure that the weight of the connections does not put pressure on them. In the event that the connections of the BT terminals are made with untreated copper bars, upon request, Eletrafo can provide special Cupal plates

Tightening on HV - BT connections

STEEL SCREWS		BRASS SCREWS	
M10	65Nm	M10	35Nm
M12	75Nm	M12	50Nm
M14	100Nm	M14	70Nm
M16	130Nm	M16	90Nm

Tightening on switching terminals for voltage change

BRASS SCREWS	
M10	7Nm
M12	10Nm
M14	25Nm
M16	35Nm

Tightening on the electrostatic shield connection

STEEL SCREWS		BRASS SCREWS	
M12	75Nm	M12	50Nm

Mechanical connections

SCREWS	
M12	95Nm
M14	150Nm
M16	235Nm
M18	320Nm
M20	455Nm
M22	615Nm

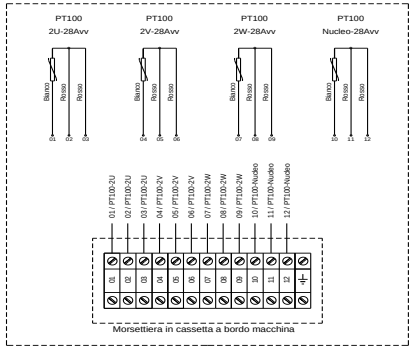
The connection to the HV - BT terminals will be made with a torque wrench and with the following torque values:

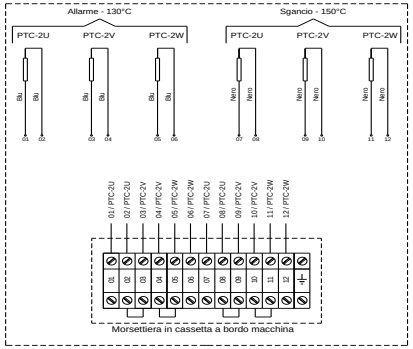
3.6 Ground connection

Connect the system ground to the plate provided on the transformer with M12 stainless steel bolts tightened to a torque of 70 Nm.

3.7 Auxiliary connections

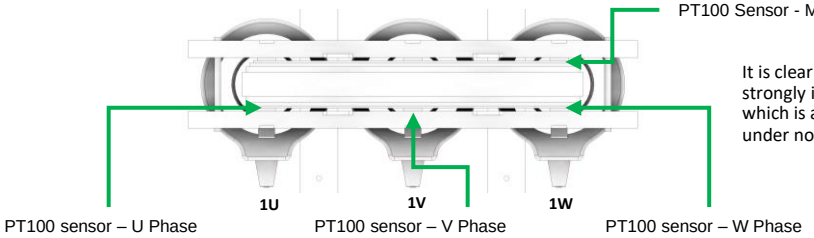
If the transformer is equipped with a temperature sensor, connect it to the terminals of the centralized connection box mounted on the machine, as indicated in the following diagrams. Make the connections between the terminals of the temperature sensor and the relay in the panel using shielded cable. Please note that the temperature relay will not be powered directly from the BT terminals but through an isolation transformer. It is advisable to separate the small relay sensor connection cables from the power cables to avoid possible interference.





3.8 Operating temperatures

The measurement of temperatures using the system composed of temperature sensors and relays depends on the placement of the sensors in the windings. Eletrafo has chosen this type of reading to serve as actual protection for the operation of the transformer and has therefore decided to always position the sensors in the most thermally stressed location. The diagram below indicates the positions of the sensors on the transformer



It is clear that the temperature of the sensor is strongly influenced by that of the magnetic core, which is approximately 150°C even during operation under no load conditions.

3.9 Internal operating temperatures

Upon the customer's request, it is possible to insert a fourth sensor, which will be positioned in the magnetic core. The recorded temperature, even under no load conditions (independent of the load), at the hottest point (at the top), is approximately 160°C (with an ambient temperature of 40°C) for class F transformers, while it is approximately 140°C (with an ambient temperature of 40°C) for class B transformers.

3.10 Programming the electronic temperature relay with 2 thresholds

Note: In MT/MT transformers, it is not possible to insert the sensors into the windings; instead, they will be inserted into the core, and the recorded temperature will have no connection with the load

4. BEFORE COMMISSIONING

Before commissioning the transformer, some fundamental checks must be carried out.

4.1 Preliminary checks and verification of the condition of the transformer

Rating plate: Firstly, it is necessary to check the characteristics indicated on the identification plate located on the transformer. In the case of parallel operation, it is essential to ensure that the transformation ratio, connection group, and rated short-circuit current are identical on all transformers.

Cleaning : If the transformer has been stored in a very dirty environment, it is necessary to perform a thorough cleaning using dry compressed air or an inert gas such as nitrogen, etc. It will be important to pay special attention to the MT terminals, communication boards, and cooling channels

Switching : Check that the switching bars are in the desired position, equal on all three phases, and tightened.

Insulation resistance: Check the insulation resistance using a Megger at 2500V between MT and ground, between BT and ground, and finally between MT and BT. The values measured at a temperature of 20°C (if they are not reported on the operating certificate) are as follows
MT – Ground = 250MΩ
BT – Ground = 50MΩ
MT – BT = 200MΩ
If the values are significantly lower than those indicated (or those reported on the operating certificate), it is necessary to
- Check the correct position of the upper and lower spacers (any significant impacts could have caused internal breakage of the spacers from MT to BT)
- Dry the transformer in an oven at 130°C with dry air circulation

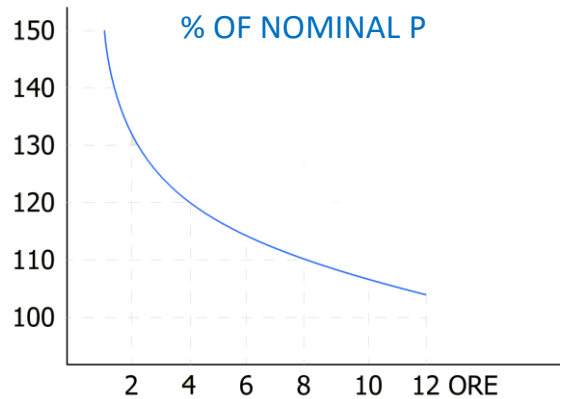
4.2 Accessory control

Check the protection relay with an auxiliary network and verify that the temperature indicated is identical for all three columns and matches the ambient temperature. If the transformer comes from storage at < -5°C, it is necessary, before the first startup, to wait at least 24 hours at ambient temperature > -5°C. Check the opening and closing of the alarm and disconnection contacts of the relay by programming the temperature threshold < and > ambient temperature

5. COMMISSIONING

The transformers are sized to provide the rated power in continuous service at a normal ambient temperature (as defined by the **CEI EN 60076-11 standards**), with a maximum of **40°C**, a daily average of **30°C**, and an annual average of **20°C**. Overloads are allowed without compromising the transformer's lifespan.

Overloads are determined based on the ratio between the usual load and the rated power relative to the weighted average value of the ambient temperature. The normal ambient temperature (as defined by the **CEI EN 60076-11 standard**) is **30°C.**



To put the machine into operation, it is necessary to follow all the operations described in paragraph 3. In addition, it is necessary to check the no-load BT output voltage, which should be equal to the nominal voltage indicated on the plate.

If the measured voltage is higher than the nominal voltage, set the switch of the three columns to the + position, while if the measured voltage is lower than the nominal voltage, set the switches of all columns to the - position. Of course, these operations must be performed with the transformer de-energized.

During the commissioning of the transformer, it is possible to observe some discharges on the lower carriage or lower armatures due to the homopolar insertion flux. These discharges, which do not affect the windings, have no influence and will decrease over time as a phenomenon.

This phenomenon has a physical explanation and does not affect the operation, so it does not represent a defect from a quality perspective.

6. MAINTENANCE

Eletrafo recommends performing the following maintenance according to the frequency indicated in the table.

CHECKS TO BE PERFORMED	FREQUENCY OF MONITORING	TOOLS TO USE
Tightening MV/LV cables and switching bars	One year after commissioning and/or after an exceptional event	Torque wrench with indicated tightening torque (on page 5)
Verification of auxiliary terminals	One year after commissioning	Compare with the PT100 sensor relay manual
Alarm and interruption of relays and thermosonde	One year after commissioning	Internal function of the relay
Cleaning of dust and deposits	Annually and/or on the occasion of a possible arrest	Dry compressed air at low pressure
MT/LV insulation resistance	One year after commissioning	Megohmmeter Megger with the values given in point 4.1. (on page 7)

7. DEFECTS AND CORRECTIVE ACTIONS

DEFECTS	POSSIBLE CAUSES	HOW TO PROCEED
Overheating	- Uneven load distribution - High ambient temperature	- Check the position of the switching bars, adjusting the voltage to that of the network with voltage variation. - Ensure that the openings for air circulation are not blocked.
Excessive heating of the magnetic core	Possible eddy currents in the core, due to rupture or lack of insulation of the tie rods	Isolate the central tie rods on the armatures with small tubes or washers made of insulating material.
Noise	-Supply voltage too high - Rigid connections with bar ducts or with the ground	- Adapt the switches according to the voltage. -Replace rigid connections with flexible connections or think about using anti-vibration brackets
Intervention/disconnection of the thermometric relay alarm	- Probe or relay failure - Current consumption higher than the limits shown on the data plate - Irregular air circulation	- Replace the item that may be broken or defective. - Check the paragraph related to the size of the room and see if all the conditions are met

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