TMC TRAFO

USER MANUAL WITH INSTRUCTIONS

FOR OPERATION, INSTALLATION AND MAINTENANCE OF CAST RESIN DISTRIBUTION TRANSFORMERS

TABLE OF CONTENTS

1. GENERAL INFORMATION

The purpose of this document is to recommed the procedures to be followed for safe installation and use in compliance with safety regulations of dry type transformers with cast resin windings, manufactured in compliance with the applicable Standards and intended for use in industrial plants and commercial and service facilities.

If properly used, the cast resin transformers have the following advantages:

- They are resistant to combustion and self-extinguishing in the event of fire whereby the cause of fire has ceased
- Reduced maintenance time and costs.
- Reduced overall dimensions.
- High resistance to dynamic short-circuit stress.

1.1 Standards of reference

IEC EN 60076-11 - IEC EN 60076-1
Power transformers – Part 11 : Dry Type transformers

And any other standard that is required by customer specifications.

2. TRANSPORT, UNLOADING AND STORAGE

2.1 Acceptance of Delivery and Unloading

The transformer is delivered completely assembled and ready for connection both on the MV (Medium Voltage) and on the LV (Low Voltage) side. At the time of receipt, it is recommended that a careful check is made in order to find out any transportation damages to be reported immediately on the transportation document. To enable the manufacturer and the carrier to reply promptly, any non-conformity shall be noted on the delivery note.
Make sure that the features on the plate comply with the inspection report attached and the features noted on the order. Moreover, make sure that the transformer is complete with all the requested accessories (e.g. handling wheels, thermoresistance, temperature control equipment, etc.)

2.2 Handling

During handling, never apply pressure to the coils or HV/LV connections (Fig.1) . If the transformer needs to be handled manually for positioning of the wheels, a jack can be used ensuring that a suitable piece of wood is placed between the jack and the metallic supports bearing the machine (Fig.2). Jacking the transformer up by the HV/LV coils or by the magnetic core must be absolutely avoided.

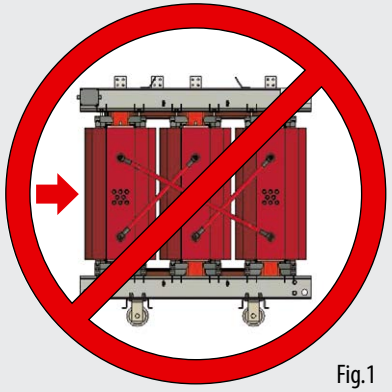


Fig.1

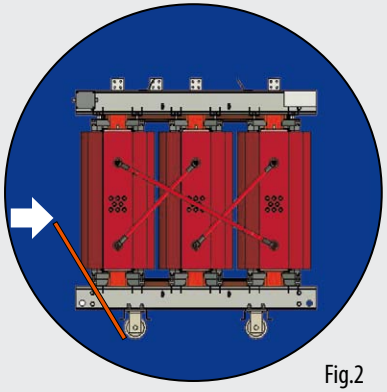


Fig.2

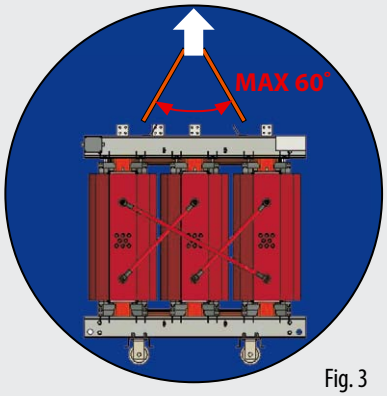


Fig. 3

2.3 Lifting

The transformer shall be lifted by using the eyebolts located on the upper supports and cables long enough to get max. 60° angle between them (Fig. 3).

2.4 Storage

The resin transformer is intended for indoor installation, therefore it must not be stored outdoors. If the transformer is not installed immediately, it is advisable not to remove the original packaging; this will prevent it from accumulating dust.

2.5 Altitude of installation

Unless otherwise specified in the order, the maximum altitude of installation shall be the one envisaged in the relevant standards, that is 1.000 m. above sea level.

2.6 Ambient temperature

The ambient temperatures shall meet the requirements specified in the ECI standard, in particular:

- Temperature of the air cooling the transformer max 40°C
- Max. daily average value 30°C
- Max. yearly average value 20°C
- Transportation and storage temperature up to -25°C.

3. INSTALLATION

The resin transformers are designed for indoor installation, if the provided degree of protection is IP00, they shall be located in a dry and isolated room, in which no risk of water leakage is present.

When installing the transformer, always refer to the following recommendations:

- Earth all non-live metallic parts by means of the earth point, which is always provided and marked.
- Earth the neutral point, if provided, according to the earth-fault protection system.
- Make sure that the cables are properly connected and supported, and far enough from the surface of the windings as per Table A.
- Make sure that the transformer is properly fastened to the floor and avoid any metal parts in the vicinity in order to prevent any vibration when the transformer is operating.
- In the case of transformers with dual primary or secondary voltage, check that the transformer is set on the correct value corresponding to the supply voltage or to the voltage output.
- Check that the adjustment tappings are set on the value corresponding to the mains voltage; if the value needs to be modified, follow the indications on the transformer rating plate and refer to paragraph "Commissioning" - Adjusting the input voltage (page 12).
- Connect the temperature monitoring system according to the supplied diagram.
- Check the absence of foreign objects (metallic items, screws, etc) near or on the transformer.
- Check that both HV and LV coils are perfectly concentric and that the rubber blocks are correctly centered and tightened.

3.1 Transformer installation inside the substation

Each part of the resin transformer shall be considered as live; therefore it is absolutely forbidden to touch the transformer when it is energized. For this reason, the transformer shall always be in an isolated room (ref. Table B). This room will be accessible exclusively through a door which is interlocked with the MV switch so that the switch opens, hence there is no voltage when accessing the room. When positioning the transformer, observe the safety distances indicated in the Table A-B between coils and walls and between earth and HV and LV cables. Furthermore, make sure that all metallic parts (ducting for auxiliary cables, supporting metallic bars, etc) are at the correct distance from the surface of the coils, from delta connection and from any other live part, in accordance with the insulation class. As already stated, the istance depends on the max. insulation voltage (Um) of the transformer and on the type of enclosure/substation walls.
The surfaces of the coils shall be considered as "live parts" **KEEP THE SAFETY DISTANCE.**

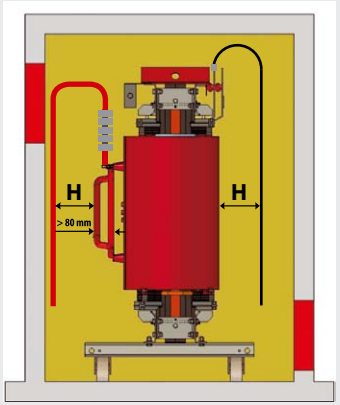


Table A	Um (kV)	12	17,5	24	36
	120	220	220	220	320

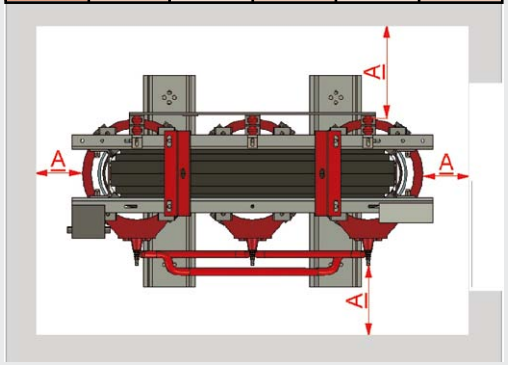


Table B		
Um (kV)	A (mm) Full Part	A (mm) Part Griey
12	120	300
17,5	220	300
24	220	300
36	220	320

3.2 Rules for installing the temperature monitor unit and the sensors

In order to ensure proper and reliable operation of the system to control the temperature of the transformer, you must follow the guidelines for installation of the temperature monitor unit and the sensors.

Power Supply

The temperature monitor unit must be powered with a correct voltage, as reported in the manual. When the unit is powered directly from the secondary of the transformer to be protected, it can be demaged by high-intensity over voltages: in this case, we suggest the use of a surge arrester or an insulating transfomer.

PT100 Sensors connection

For a proper connection of the sensors, please take into consideration the following rules:

1. Each PTC/PT100 should be connected with a cable with three conductors with a minimum diameter of 0,35 ^{2} and a maxiumum of 1 mm ^{2}.
2. Extension cable must be shielded with 80% tinned copper braid covering.
3. Conductors must be twisted.
4. Cable shield must be grounded only on one end, preferably on the side of the unit.
5. Cable signal transfer PTC/PT100 should not be near power transmission cable, low voltage and high voltage ones.
6. Cable signal transfer PTC/PT100 must be placed in a linear way, without entanglements.

7. The terminals must be tightened to avoid contact that could cause false readings of temperatures.
8. Any tips of the conductors must be properly crimped to avoid false contacts
9. The unit should not be installed close to equipment DC/AC or AC/DC.

For further information not contained in this paragraph please refer to the specific manual installation of control units and sensors.

4. TRANSFORMER PROTECTION

4.1 Over voltage protection

In case of overvoltage on the transformer the use of surge arresters, which earth any possible peak on the supply network, is suggested.
The arrester type shall be selected depending on the system requirements and arrester ratings

4.2 Overcurrent protection

The transformer also requires protection devices against the thermal and dynamic effects of over current phenomena due to short circuits.
In the event of short circuits the transformer should be protected by an automatic switch with over current disconnection devices intervening in the prescribed times, but consideration should be given to possible overloads.

4.3 Electrical connections and clamps / Torque settings

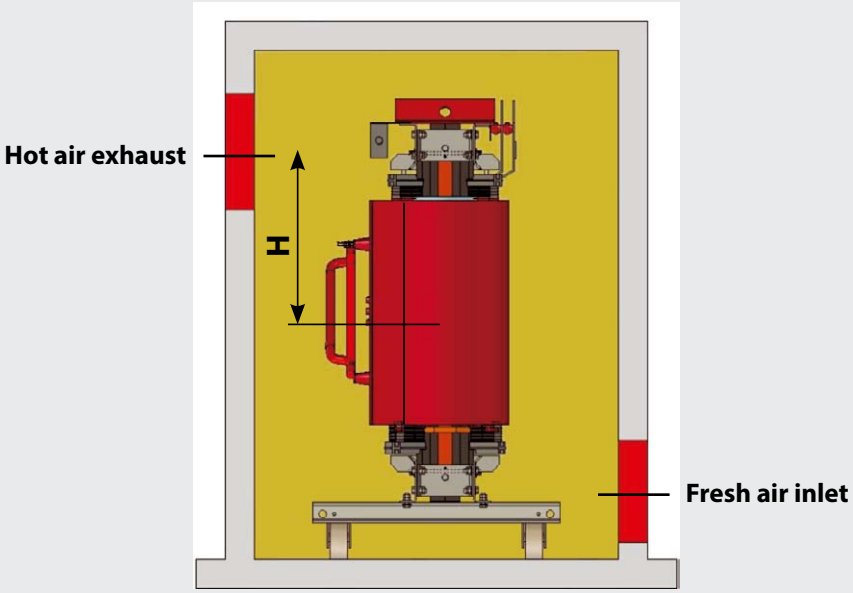
The electric connections and the mechanical fasteners shall be tightened according to the following tables.
*Note: 1 Nm ~ 0,1 kgm

Electrical connections	
Screw type	**Tightening torque [Nm]***
M 6	5
M 8	11
M 10	25
M 12	40
M 14	60
M 16	85

Electrical connections	
Screw type	**Torque value [Nm]***
M 12	85
M 14	135
M 16	210
M 18	290
M 20	410
M 22	560
M 24	710
Friction Coefficient	0,14

5. TRANSFORMER COOLING

To prevent incorrect cooling from damaging the transformer irreparably, the heat generated by no-load losses on the magnetic core and by the load losses produced by the windings during transformer operation shall be completely dissipated.
Overheating occurs if the transformer is installed in a small room and/or where the air flow inlet is reduced with respect to the effective requirements, or when it is positioned incorrectly. In these cases, the air change might be improved by using an forced air system through ventilators or aspirators in the upper part of the substation and by an inlet duct at the bottom.
For natural circulation, the inlet shall always be located in the lower part of the room, with maximum height no greater then the bottom of the HV winding, to produce the stack effect and allow the air flow in the duct between the HV and LV coils. If the supporting wheels are removed, the transformer shall be raised from the floor in order to achieve the required height and allow proper airflow.
As regards the openings to be provided for air input and output, the lower one shall be located under the transformer at floor level. The upper opening shall normally have a section higher than 10 - 15 % allowing for the higher volume of the hot output air and avoid accumulation.



Air volume and input section

Given that:

Pt Total loss to be dissipated expressed in KW.

ΔO Temperature gradient expressed in °C between input and output air.

Q Air change expressed in m^3/s

H Distance expressed in m between the central line of the transformer and the central line of the opening.

S Usable surface of the lower opening in m^2 (grate excluded)

The volume required for a correct cooling can be calculated as follows:

$$Q = Pt / (1,15 * \Delta O) [m^3 / s]$$

The usable area of the lower opening area can be calculated as follows:

$$S = 10,752 * (Pt / (\sqrt{(H*\Delta O3)})[m^2]$$

Event to be avoided:

- Cooling air temperature above the values foreseen in the standards or in the design.
- Transformer installation in small rooms having walls exposed to sunlight.
- Transformer installation in environments equipped with heat-radiating systems.
- Installation in poorly ventilated environments, in which air change could be insufficient (sometimes, this problem can be compensated for by installing forced-ventilation air-change systems see above).
- Installing the transformer peripherally to the normal airflow from input-to-output, which shall always pass through the transformer from the bottom upwards, taking the transformer centre line as a reference.

6. COMMISSIONING

6.1 Transformer Earthing

Check that the transformer is earthed through the plates with proper earthing braids complying with the relevant standards.

6.2 Connection

Check the coils for eventual damages or movements due to transport and handling; also check the fastening blocks for proper positioning and tightness.
Check the connections and tightening of the connection bolts of both high voltage and low voltage cables.
With regards to the low-voltage cables, check that they are suitably supported by the appropriate plates.
Check that no earth cable or connection runs close to live parts or the coils surfaces (for minimum distance, refer to the relevant TABLE A on page 7), and also that there is continuity between the connections of all the elements that must be earthed.
If the transformer is equipped with temperature control devices (thermometers, electronic control unit), check that they are set at the correct alarm and trip temperatures and that the unit is working properly.
Check that the cooling ducts are not clogged.

INSULATION CLASS	WORKING RANGE
B	From -25°C to 120°C
F	From -25°C to 140°C

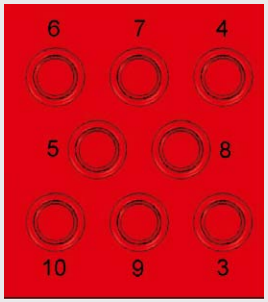
INSULATION CLASS	ALARM	TRIP
B	110°C	120°C
F	130°C	140°C

6.3 Cleaning

If the transformer has been stored in a dusty environment for a long time, clean it thoroughly. Remove dust from the coils and clean dirt traces, if any, use low-pressure air jets and dry cloths.

6.4 Adjusting the input voltage

This operation is to be carried out with the transformer off load. The variation of the supply voltage (within range ± 5%) as guaranteed by the supply company, can be adjusted by means of the tappings in order to obtain the correct output ratio. Usually there are five taps, ± 2 x 2.5 %. If the medium voltage value at the input is other than the nominal voltage value, it is recommended to follow the instructions supplied for the connections on the plate in order to achieve a value that is as close as possible to the one delivered by the electricity company. It is recommended to place all regulations in the same position.



6.5 Energising

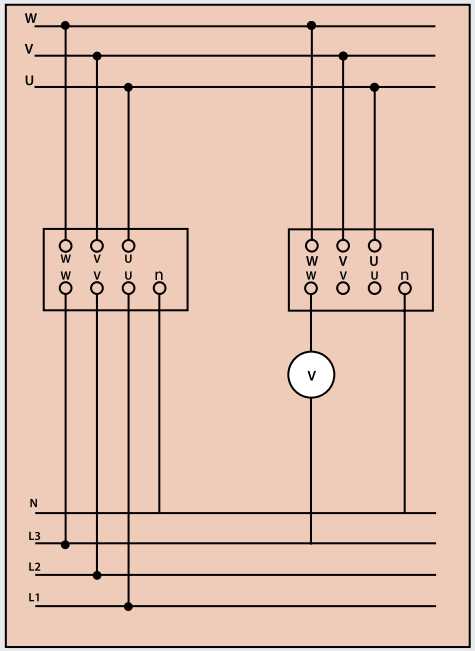
After checking the appliances and ensuring that no foreign bodies have accidentally entered the transformer (between the HV and LV coils, between the LV coil and the core, between HV/LV connections), enable the switch/circuit breaker from the HV side with transformer in no-load condition. Then enable load on the LV side through the relevant switch/circuit breaker.

6.6 Parallel operation

For correct parallel operation, the following conditions shall be observed:

- The coil ratio in all tapping positions shall be the same for all the transformers in parallel
- The vector group shall be the same.
- The short circuit voltage value shall be the same and shall fall within the tolerances allowed by the IEC standards.

The standards suggest the parallel operation of the transformers with output ratio not higher than 1 / 2; take this fact into account when selecting the machine. Start by establishing the parallel connection. Then before closing the connection, check that the HV and LV cables are connected in the same phase to each transformer and that the switching bars are all positioned at the same position on each one of the terminal boxes. This will result in the same voltage being supplied to each phase and to each transformer and the same voltage ratio being evident at the output (which will correspond to the foreseen voltage ratio).



Please note that to achieve this, a metal connecting bridge must be fitted between the transformer's secondary coils to permit comparison of the different phase voltages. It is advisable to create the metal connection in presence of a neutral wire. A voltmeter should be used to determine the value of the potential difference that exists between wL3, vL2, uL1. A recorded value that is consistently zero signifies that all of the paralleling conditions have been met and that the low voltage switches can be closed.

7. MAINTENANCE

A dry transformer with cast resin windings requires little maintenance. However, a series of checks will be required, the frequency of which is dependent on general environmental and operating conditions. In relatively clean and dry environments and in normal operating conditions, checks can be made at fairly long intervals. It is advisable however to carry out an inspection at least once a year. It is recommended to reduce the interval time for any installation that is located in a particularly dirty and / or dusty environment or that is subject to variable intensity loads or peaks. Dry cloths and compressed air should be used to dust and clean the coil. A check should also be made to ensure that no dirt is blocking the cooling channels that are located between either the HV and LV coils or that are located between the LV coil and the core. The cables should be checked to ensure that they have been fitted to the connectors at the correct tensioning torque. Check that the voltage tapping links are also tightened to the correct torque. Finally check that the coil spacing blocks have been fitted into place correctly. Please note that all of the aforementioned fixings can work themselves loose as a result of a momentary overload or due to vibrations within the core that occur when the transformer is in operation. Sometimes, the transformer may absorb humidity for a variety of different reasons. The transformer would then need to be put through a dehydration process and the insulation resistance value would need to be checked before the transformer is energized again. The average value of insulation resistance should be measured using a megaohmeter. Checks should be made between each LV phase and earth, between HV and LV coils and between HV coils and earth.

8. MAINTENANCE SCHEDULE

INSPECTION REQUIRED	MAINTENANCE INTERVAL	RESULT
Inspect the thermo-resistances	Annual inspection and following any non-routine work	Electrical continuity measured using a tester
Check the ability of the safety equipment to deal with an overload	In accordance with planned schedule	In accordance with the instructions
Remove any dirt or dust as well as any foreign bodies from the windings	Six-monthly inspection and inspection following a shutdown	Clean with compressed air and cloths
HV/LV terminal and delta / star connection bolts	Annual inspection and following any non-routine work	Torque tightening (please refer to table 4.3) using a torque wrench
Bolts and nuts intended to secure the transformer to the floor	Annual inspection and following any non-routine work	Electrical continuity measured using a tester
Inspect the insulation between the windings and between the windings and earth	Whenever the transformer remains unused for a long period of time	HV to earth, min. 250 MΩ LV to earth, min. 50 MΩ MT/LV, min. 250 MΩ Mega-ohmmeter (megger-type) with a voltage that exceeds 1000 V min. and LV insulaton class
Check the phase fixing block torque values	Annual inspection and following any non-routine work	Tightening torque values min 10 Nm - max 15 Nm using a torque wrench

9. MALFUNCTIONS AND INITIAL CORRECTION WORK

MALFUNTION	FAULTY PARTS / PROBABLE CAUSES	SOLUTIONS
Low insulation resistance	Presence of dirt Dielectric humidity absorption	Clean using dry air, dry by ventilation
	Dielectric fault caused by ageing or dirt	Contact the manufacturer
Automatic cut-off activated	Insulation problem with the HV coil	Contact the manufacturer
	Change in voltage / the value of the voltage in the primary coil does not coincide with that reported at the terminal box	Make sure that the position indicated to the voltage change position is the same as the line one
	Time and current intensity of protection relay are not properly adjusted	Review the timing and adjust the intensity value
Erroneous secondary voltage value	Voltage in the primary is not equal to the nominal value. No voltage in the primary	Contact the electricity supply and distribution company
	Incorrectly positioned voltage tappings	Correct position of tappings

10. TRANSFORMER INSTALLATION CHECKLIST

Serial Number: _____ Date: _____

Check:	Result:
• Verify absence bodies (screws, washers, metal shavings etc..)	☐ Pass ☐ Fail (See Notes)
• Verify correct insulation distance between transformer live parts and power cables/extraneous metalwork **(Note: Cast Resin windings are to be considered live parts)**	☐ Pass ☐ Fail (See Notes)
• Verify support and fixing of supply cables and bus-ducts, in order to ensure that no undue strain is placed on the transformers insulators and conductors	☐ Pass ☐ Fail (See Notes)
• Verify correct installation and operation of all auxiliary circuits/ protection systems / ventilation measures	☐ Pass ☐ Fail (See Notes)
• Verify all mechanical and electrical connections torque settings	☐ Pass ☐ Fail (See Notes)
• Verify correct earthing of transformer (and enclosure if provided)	☐ Pass ☐ Fail (See Notes)
• Verify correct ventilation measures are in place and operational	☐ Pass ☐ Fail (See Notes)
• Verify correct positioning of Input Voltage no-load tapping connections	☐ Pass ☐ Fail (See Notes)
• For parallel operation, verify phase/voltage/vector group/short circuit voltage value match.	☐ Pass ☐ Fail (See Notes)

NOTES: