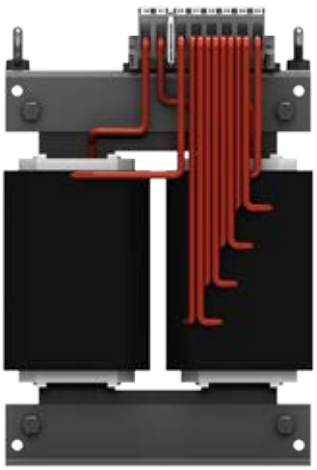
UNITRAFO

POWER QUALITY - SAFE ENVIRONMENT

Dry-insulated Transformers

Manual for Installation, Operation & Maintenance



Trafox

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I - INTRODUCTION

1.1. PREFACE

The purpose of this manual is to provide all the explanations and information required to guarantee the correct use of our dry-insulated transformers, as well as the information required for inspection and maintenance.

1.2. REFERENCE STANDARDS

- **IEC 60076** **Power transformers**
- **IEC 61558** **Air-cooled power transformers**

1.3. DESIGN

This transformer is of the dry-insulated low-voltage transformer type with a maximum rated voltage of 1000 V. It is normally manufactured according to the above mentioned standards. If necessary, also other standards (e.g. for ship transformers, isolation transformers and transformers for medical use) can be applied. In that case, this must be agreed before ordering. The transformer is designed for temperature class F/155° C unless otherwise agreed.

The most important insulation materials, for example the insulation of the winding wire, impregnation varnish and glass fiber support have temperature class H/180° C or C/220° C. This makes the design very safe and the transformer can withstand momentary overload very well. Encased transformers are delivered in an enclosure according to the customer's wishes with a degree of protection from IP23 to IP54 or even IP65 in special cases. Other enclosure classes are delivered by agreement.

II - INSTALLATION

2.1. PACKING AND TRANSPORT

The packaging material must be suitably designed so that the transport can be carried out safely. It is possible to use different types of packaging material, depending on the size and type of transformer.
For transformers of a smaller format, wooden pallets are used to facilitate loading and unloading, while cardboard and/or polystyrene are used for larger transformers to avoid damage caused by impact with foreign objects.

Although the transformers have a solid and robust design, they cannot withstand violent hits or impacts during the transport.
It is a good rule of thumb to anchor the transformer to the transport vehicle with tension straps or fixed structures.
It is a good rule to protect the transformers against rain, dust and moisture using e.g. polyethylene foil. In addition to what is stated above, the transformers must be handled carefully and stored in a dry place.

In case provided, the wheels should be removed from the transformer during transport.

2.2. LIFTING AND DISPLACEMENT OF THE TRANSFORMERS

Unloading the transformer is rarely included in the price and it is therefore the responsibility of the buyer/customer to provide for the unloading upon delivery at the destination.
During unloading, lifting straps of suitable length and strength must be used. This is illustrated in the picture (fig 1) the distance B must be greater than the distance A.

The transformers are sometimes equipped with rotating wheels, which is illustrated below (fig 2). Before putting the transformer into operation, it must be ensured that it has not been damaged during transport or storage.

fig 1

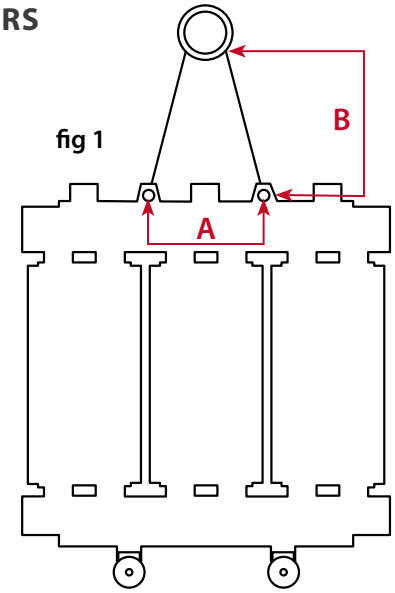

fig 2

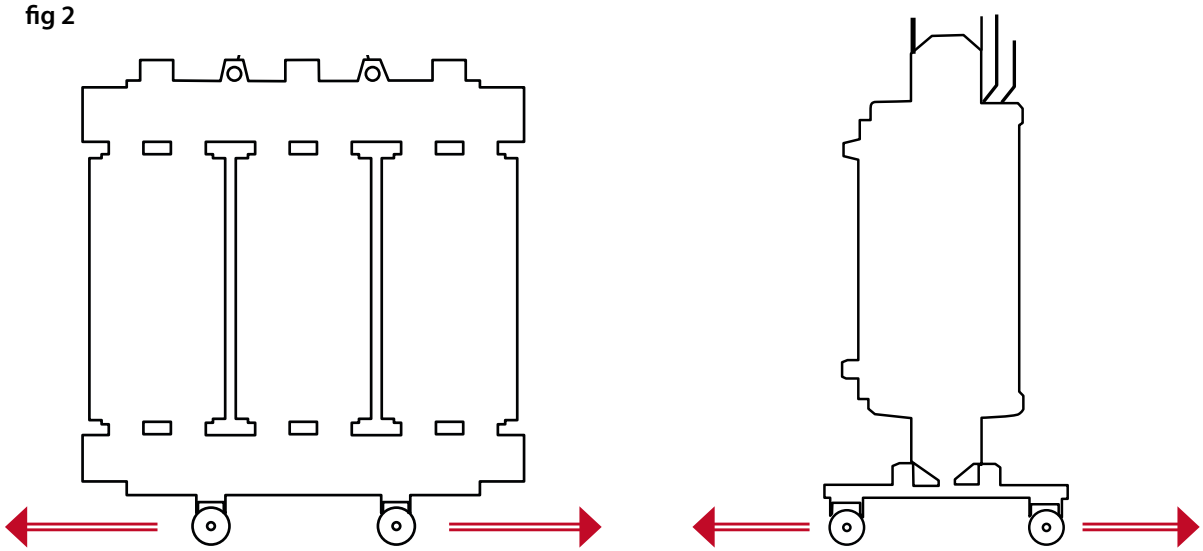

Figure 3 below shows exactly how to use the forklift truck without damaging the transformer.

Before setting up, check that the transformer has not been damaged during transport or storage.

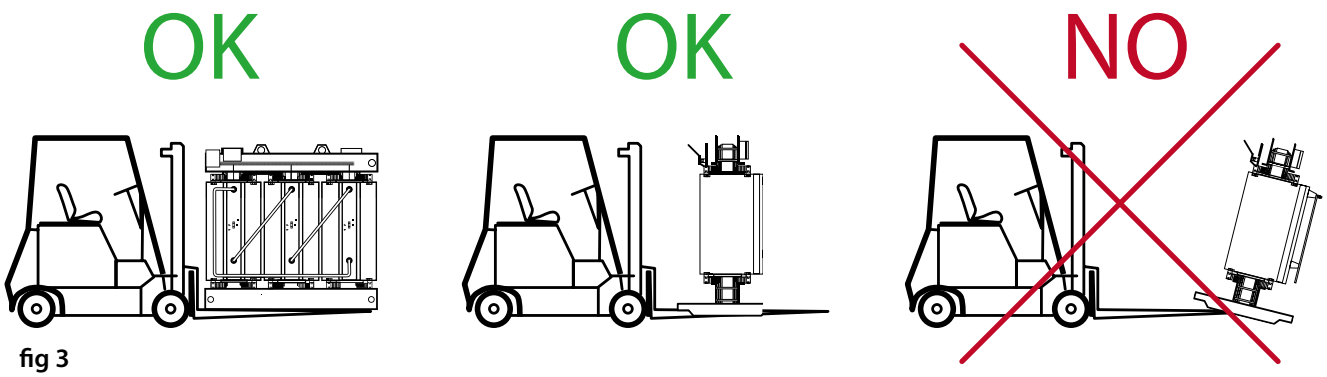

fig 3

Before lifting the transformer make sure that the forklift is correctly inserted under the complete length of the transformer. Faliure to do so may cause the transformer to overturn.

2.3. INSTALLATION

The transformer must be installed upright in a dry and ventilated room, indoors. We recommend floor installation. Transformers with an open design less than 20 kVA and of the horizontal type can also be installed upright (winding ventilation ducts upwards), provided that the installation surface is sufficiently stable. There must be at least 100mm of free space between the wall and the transformer enclosure to allow free air circulation. The temperature of the cooling air to the transformer must not exceed 40° C. Otherwise, it must be ensured that the cooling of the installation space is met in another way. If an open transformer is installed in a closed enclosure, the air exchange must be at least 2.5m^3/min.

The transformer is (depending on power) equipped with connection flags, cable lugs or terminals, where you can connect copper or aluminum cables intended for rated current. If aluminum cable and copper cables with a different size will be used, this must be stated when ordering. The transformer housing has a flange opening for the cables. Flange and cable lugs are normally not included in the delivery.

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2.4. INFORMATION ABOUT PROTECTION DEVICES

The temperature monitoring is performed according to the below diagram. Three different types of monitoring devices can be supplied as options, allowing visual and acoustic monitoring as well as automatic connection through alarm- and trip contacts.
For normal application the tripping temperature for the alarm is in accordance to applicable STANDARDS and specifically indicated in this manual.

The devices illustrated are:

- Dial thermometer with two contacts (Fig. 4-5)
- Electronic device with thermal contacts or PTC (Fig 6-7)
- Electronic device with PT100 sensors control (Fig 8)

THERMOMETER WITH ELECTRICAL CONTACTS **(OPTION)**
Using a thermometer with separate electrical contacts is the simplest control method for measuring and monitoring the temperature in dry-insulated transformers.
This equipment can be supplied with two normally open alts. closed contacts as indicated in the wiring diagram in the figure below. For setting the alarm limit and tripping, see point 2.6 below.
The maximum capacity of the contacts is 2.5A/250V.
The thermometer is very reliable.

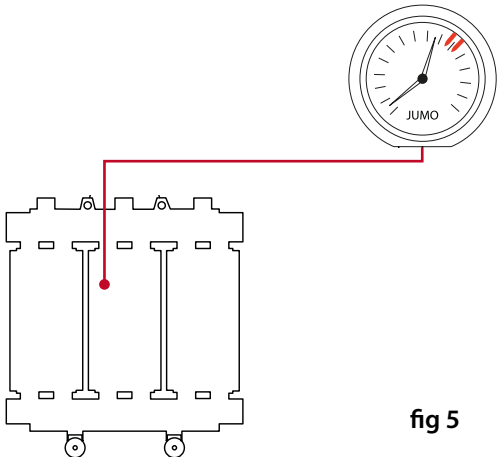
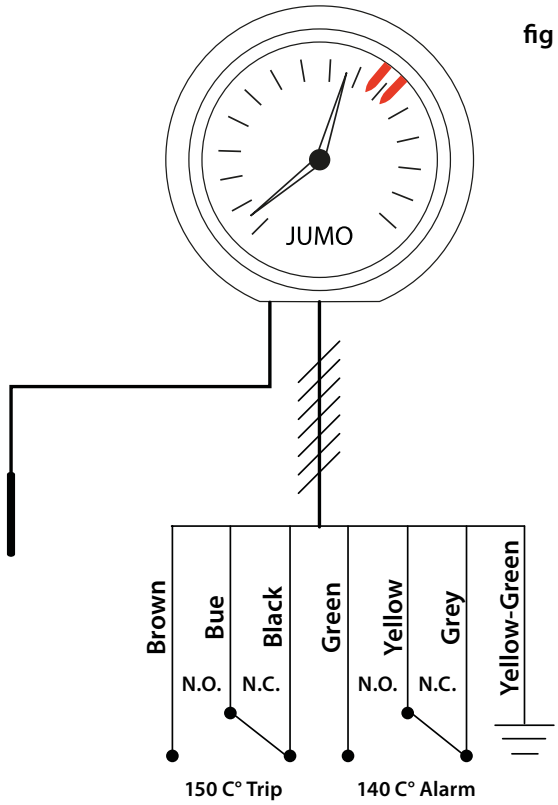


fig 5

fig 4



ELECTRONIC EQUIPMENT WITH THERMAL CONTACTS AND PTC

An electronic device with thermal contacts makes it possible to monitor the temperature in the middle phase, as well as to monitor the temperature in all three phases by means of 3 + 3 normally open or closed contacts, which are adjusted for alarm or trip.

Power supply 230 VAC. The contacts' maximum capacity is 2.5 A- 250 V.

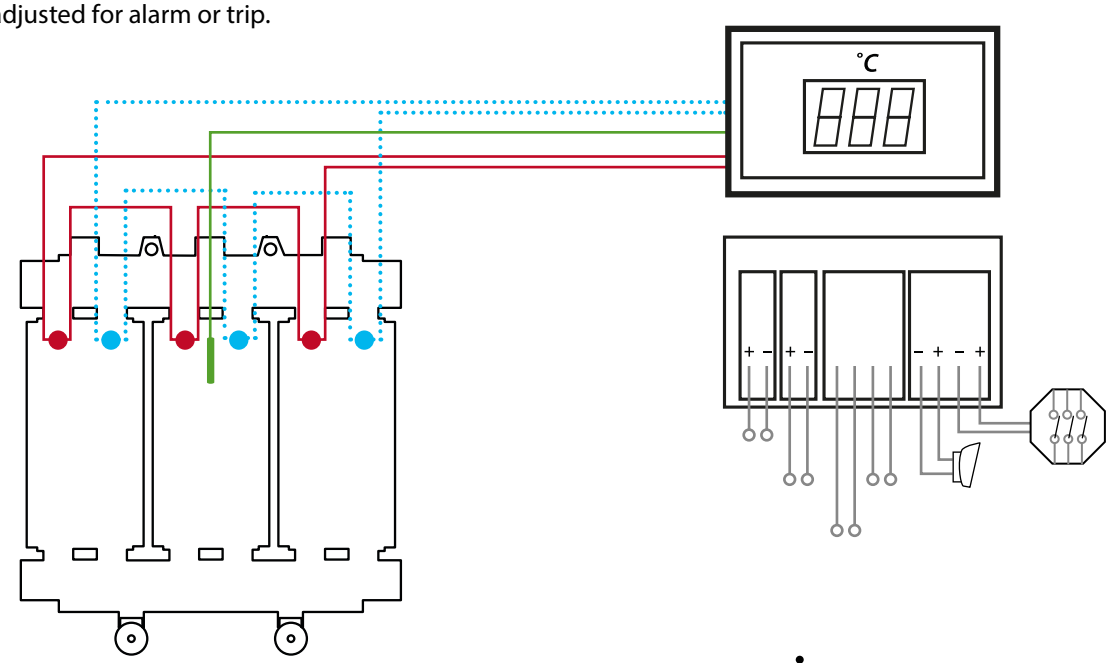


fig 6

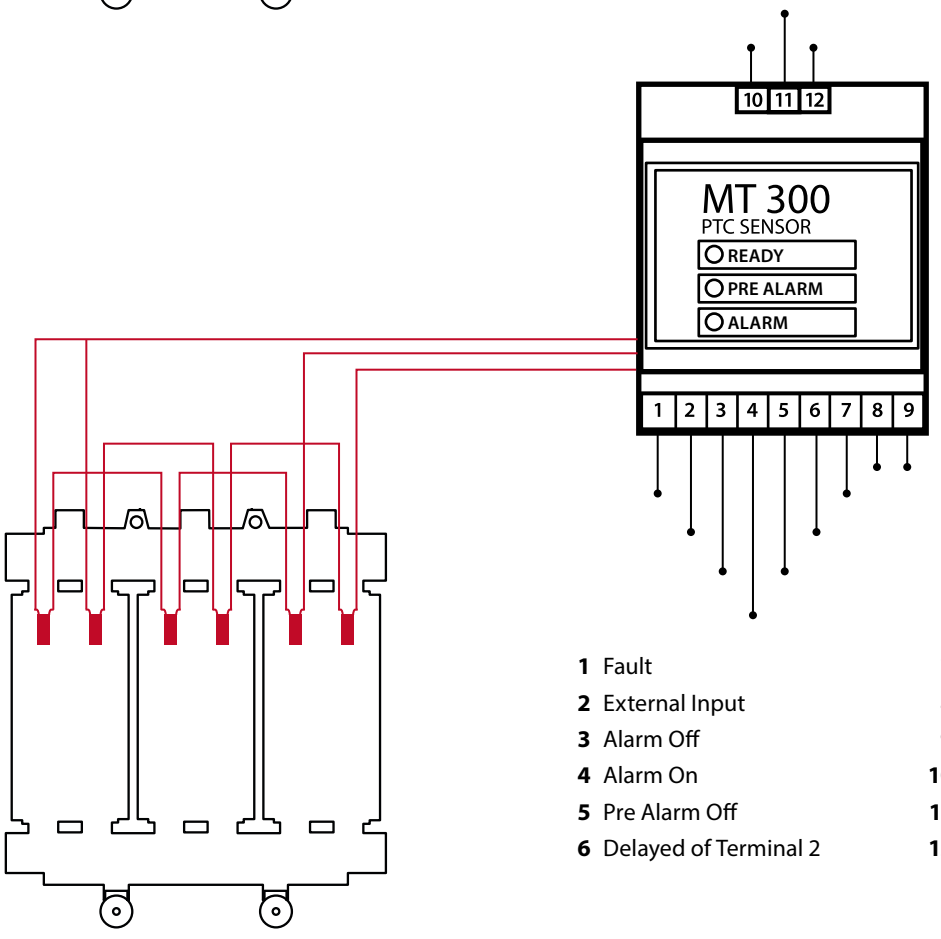


fig 7

1 Fault
2 External Input
3 Alarm Off
4 Alarm On
5 Pre Alarm Off
6 Delayed of Terminal 2
7 Pre Alarm On
8 220V AC
9 220V AC
10 Alam Group
11 Pre Alarm Group
12 PTC Ref

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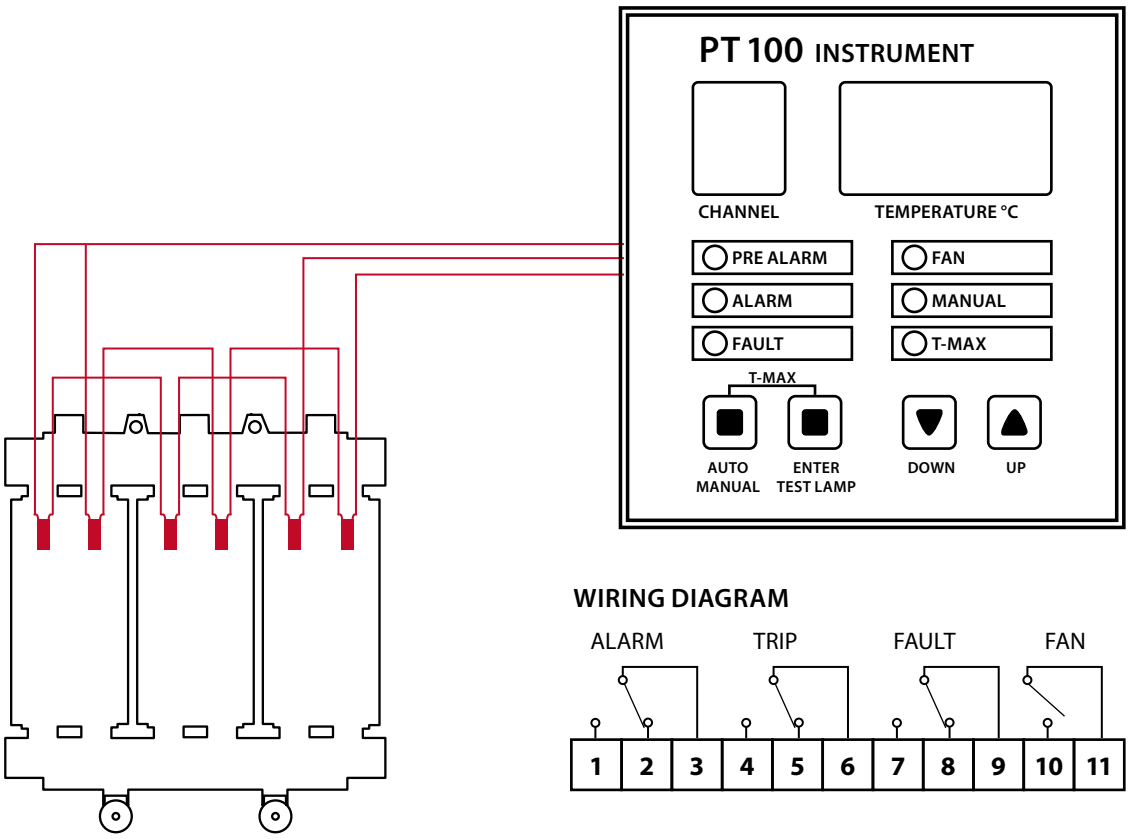
ELECTRONIC DEVICE FOR PT100

This device has the function to monitor the temperature of all three phases and, if required, of the core. The electronic monitoring of the temperature is obtained by means of PT100 sensors (100 Ohm at 0°C). The electronic device shows the highest temperature in the three phases. The operator can also check the temperature with a logical sequence in all three phases. The functions warning and trip are obtained by means of electrical output contacts -Open/Close- according to the diagram figure 7. Operation temperatures can be selected by the operator, but normally we set 140°C for warning and 150°C for trip. On the electronic device there is also one output contact for signal of sensor's faults and for start of possible cooling fans
(5A – 250V) (available as option).

fig 8



WIRING DIAGRAM

2.5. OVERLOAD AND WORKING CONDITIONS

For special operating conditions as well as for special applications that require temporary power increases, it may be appropriate to know the main characteristics of dry-insulated transformers.

Dry-insulated transformers are characterized by a marked thermal inertia and can withstand even considerable short-term overloads. In the following, the overload process is reproduced as a function of time and as a function of the room temperature.

Overload capacity and time according to the overload, the pre-load and an ambient temperature of 20 °C

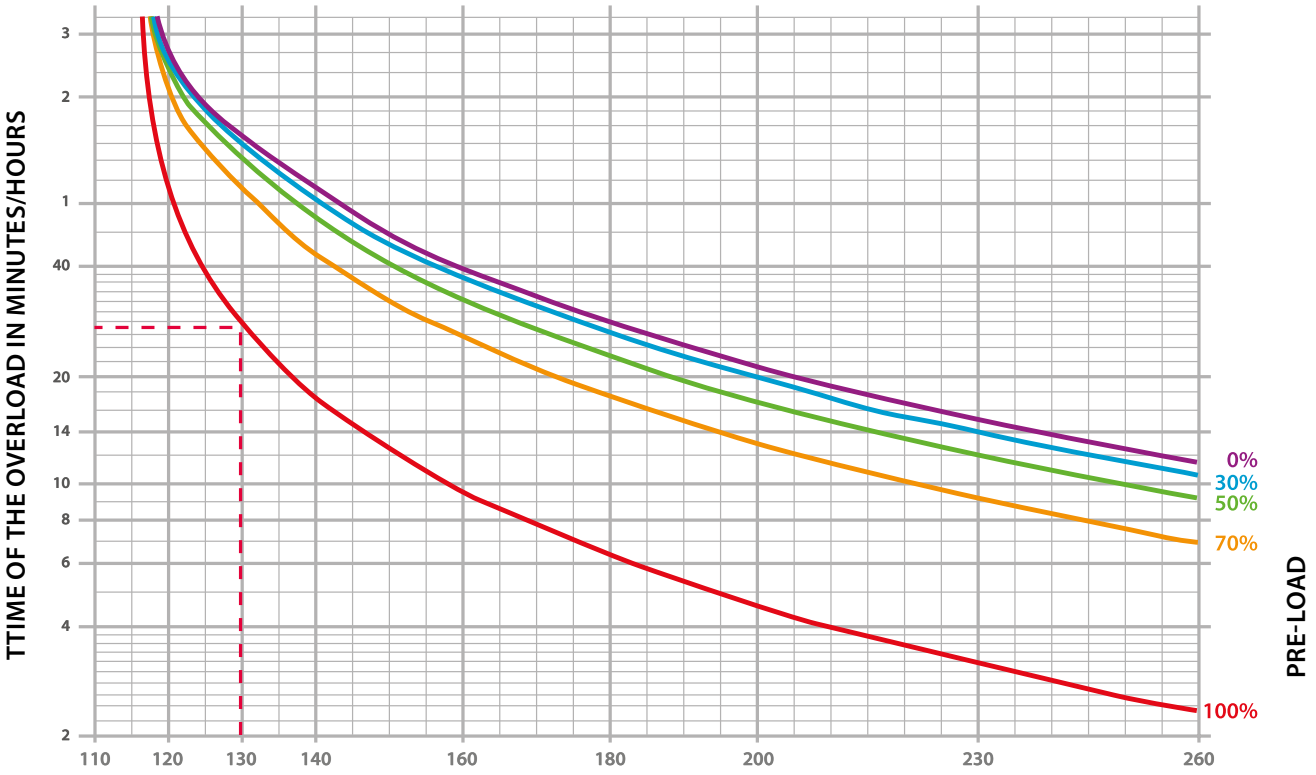


fig 8

2.6. WORKING TEMPERATURES

The operating temperature of the transformers varies depending on the temperature class and climate class based on IEC 60076, and is reproduced here (table 1).

Table 1

Insulation class	Service range C1 class	Service range C2 class
B	from - 5 to 120 °C	from -25 to 120 °C
F	from - 5 to 155 °C	from -25 to 155 °C
H	from - 5 to 180 °C	from -25 to 180 °C

All transformers are equipped with some kind of temperature monitoring with one or more sensors. For example, a signal thermometer, PT100 sensor(s) or PTC thermistors. Some models may have a sensor for each winding, as well as a sensor in the core. These sensors must be connected to the control unit, which is normally equipped with two trip levels. We recommend the adjacent setting values, according to table 2.

Table 2

Insulation class	Alarm	Trip
B	120°C	130°C
F	140°C	150°C
H	160°C	170°C

2.7.INSULATION

It is an absolute necessity to observe a minimum distance between the live parts of the transformer, the surrounding metal masses and other elements of the device during working, according to applicable standards.

Table 3 below shows the minimum insulation distances to respect.

Table 3 – Insulation distance		
Highest voltage for the equipment	**Insulation level according to SS-EN (IEC) 60076, list 2 (kV)**	**Minimum allowed insulation distance (mm)**
3,6 kV	10 / 40	60
7,2 kV	20 / 60	90
12 kV	28 / 75	120
17,5 kV	38 / 95	160
24 kV	50 / 125	220
36 kV	70 / 170	360

INSTRUCTION FOR CABLE CONNECTION

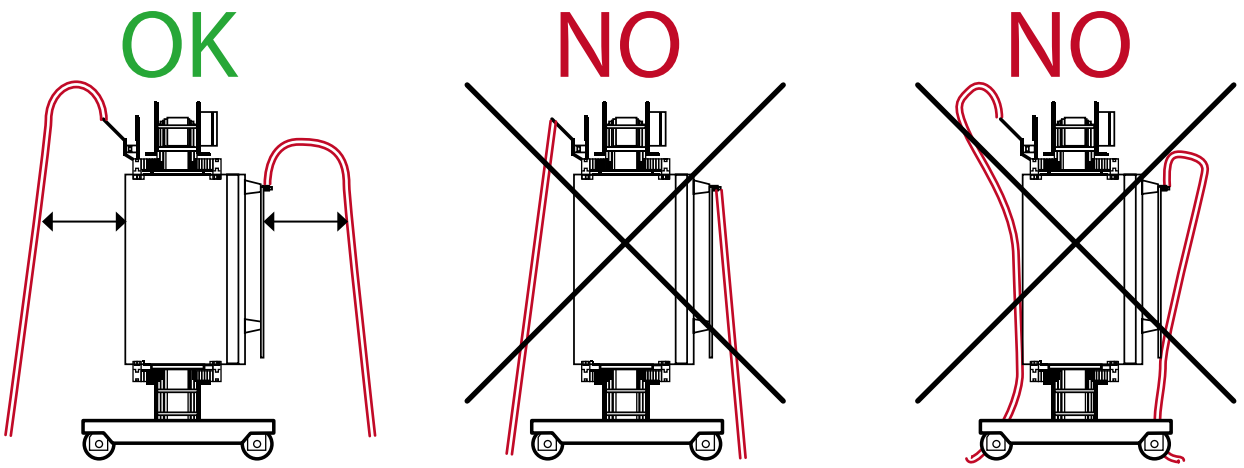


fig 9

Observe the minimum permissible insulation distance between cables and transformer according to the table above.

2.8. SAFETY DISTANCE

The transformer must be set up and installed in such a way that involuntary contact between people, live parts is avoided. The heat produced by the transformer must be allowed to escape and the highest temperature of the windings must be kept below the values specified under point 2.6 above.

To protect people against unintentional contact, the distances specified below (table 4) must be respected in accordance with the current standard.

Table 4 – Security distance		
Highest voltage for the equipment	**Insulation level according to SS-EN (IEC) 60076, list 2 (kV)**	**Safety distance (mm)**
3,6 kV	10 / 40	150
7,2 kV	20 / 60	150
12 kV	28 / 75	150
17,5 kV	38 / 95	200
24 kV	50 / 125	280
36 kV	70 / 170	400

2.9. PROTECTION AGAINST OVER-VOLTAGE AND OVER-CURRENT

OVER-VOLTAGE

If there is any risk that the transformer could be exposed to over-voltage (e.g. lightning impulse, switching impulse or any other reason) it is necessary to provide it with surge arresters suitable for the required insulation level. In particular, the most potentially dangerous over voltage condition is when a transformer is overhead line connected. This situation has to be avoided by the use of these surge arresters.

OVER-CURRENT

The transformer needs to be equipped with protection devices against the thermal and dynamic effects of over-currents due to short circuits. The transformer should be protected with breakers equipped with customized fuses for the possible overloads on site.

2.10. MECHANICAL FASTENINGS AND ELECTRICAL CONNECTIONS

All the external wirings – on the Low voltage side, on the High voltage side and on the earthing points – must be properly performed and insulation distances, cable sections and positions must be taken into consideration.

The locking and/or the gripping of electrical connections and of mechanical fastenings shall be carried out according to the diagram below (table 5 and 6).

Table 5 – Tightening Torque (NM)'		
Bolts and screws	**Mechanical Connection**	**Electrical Connection**
M 6	10	/
M 8	23	23
M 10	50	40
M 12	85	50
M 14	130	80
M 16	205	125

* With torque wrench calibrated in kg-m, divide the values by 10.

For the bolts and screw-nuts auto-locked of the yoke pressure profiles, the torque has to be lower according to table 6 below

Table 6 – Tightening Torque (NM)'	
Bolts and screws	**Mechanical Connection**
M 8	8
M 10	9
M 12	11
M 14	17
M 16	21

* Applies to steel screws / bolts (type 8.8). Divide values by 10 for torque wrench calibrated in kg-m.

2.11. INSTALLATION ADVICE FOR HEAT DISSIPATION

To ensure the expected life of the transformer, the heat produced in the core and windings must be released to avoid exceeding the temperature limits.
If the air circulation is insufficient, the transformer overheats in an abnormal way, which in the worst case can cause the thermal protection to trip.

Ventilation becomes effective when the difference in height between the thermal axis of the transformer and the midpoint of the outlet the opening is large enough.

The cooling surfaces must be in contact with the circulating air through suitable intakes (approx 2,5 m³/min. per kW losses).

The room where the transformer is installed must have correct ventilation. Air circulation shortage causes an abnormal overheat that in the most serious case can require the thermal protection relays intervention.

III - COMMISSIONING

3.1. GENERAL INFORMATION

If the transformer will be delivered with wheels, they are mounted on the upper side of the truck or separately fastened or packed.

3.2. USE

The transformer is designed to be used with 100% continuous load according to the agreed standard.

The nominal power of the transformer is the maximum permitted continuous load (the power factor cos φ =1). Change of voltage on the sockets must be done in a de-energized state.

3.3. UNLOADING INSPECTIONS

Upon receipt of the transformer, the plastic must be removed in order to detect any transport damage. This must be done at reception regardless of when the transformer is to be installed. Inspect the transformer and check that all parts are included.

Before unloading the unit, it is extremely important to verify that the transformer has not been damaged during transport. (For example: bent low voltage bars, broken medium voltage bushings, weakened or lacerated connections in between medium voltage phases, coils not perfectly concentric with the core axis).

In the event of a complaint and other contact with Unitrafo, it facilitates communication if the following information about the transformer is stated in the correspondence:

- **Type**
- **Rating Power**
- **Serial Number**
- **Manufacturing Year**
- **Voltages**

This information is stated on the nameplate on the transformer and a photo of this can be attached to an email.

If you find damage or other problems, make a note of the carrier's name and describe the problem on the consignment note and notify the dealer (Unitrafo Electric AB) immediately! If this is not done, the carrier does not take responsibility for any damage. The damage must also be photo-documented. Contact your dealer (Unitrafo Electric AB) for further instructions.

3.4. VISUAL INSPECTIONS

Before energizing the unit, it is necessary to verify that no foreign objects are left behind in the transformer, as it could seriously damage the transformer.

Be aware of the risk that nuts, bolts, washers or other objekts from surrounding equipment gets stuck in the winding ducts during connection- or installation work or during warehousing.

It is well advised that after a storing or stoppage, to clean the MV and LV windings, to eliminate dust, condensation and dirt blowing dried compressed air or wiping them with a dry cloth.

3.5. CHECK BEFORE COMMISSIONING

Before energising the unit, an inspection should be carried out in order to verify that installation and connection of the transformer has been done correctly.

The following points must be carefully considered:

A Clean the HV- and LV-windings and the winding ducts from dust and dirt by blowing dried compressed air and/or wiping them with a dry cloth.

B Preheating of the transformer must be done if condensation has formed during storage or transport. This is most conveniently done with a fan heater or similar.

C Check the accurate functioning of the probes. It is enough to measure the probes resistance in the centralization auxiliary box. The obtained value converted to °C by using the special conversion schedule shall confirm the ambient temperature.

D Check the tightening of HV and LV connections, as well as all the external connections and the tapping.

E Fix the transformaer to the flooring if designated fixing points/lugs are available.

F Check that the windings are concentric to the core axis. Check carefully that the cooling duct between the windings is symmetric. In case of extreme non-symmetries in the cooling ducts, contact the supplier.

G Inspect the insulation of the windings, among themselves and towards earth, with a megohmmeter type Megger with a voltage over 3 kV.

H Check that all connections are intended for the specific feeding voltage, see the data plate/wiring diagram on the transformer.

I Check all the transformer protection devices against eventual overvoltages.

J Check the positions of the connection bars on the primary voltage regulation tapping board. It must be the same on all three HV-windings and must correspond with the specified feeding and loading voltages. In case the voltage exceeds the one allowed, the no load losses and the noise will increase.

K Check the motors of the fans – if provided.

L Connect to ground the designated points of the transformer.

M After the assembly is carried out, verify the connections and the adjustments of the auxiliary box, see the manual provided with this unit – if foreseen.

N In case the transformer is working in parallel service with other units, the correspondence of phases must be checked by the use of a voltmeter. (Remember that, for the choice of voltmeter, in case of parallel mistake the voltage can be the double of the phase voltage and remember that nominal features shall be the same or compatible. Otherwise it will be impossible to make the parallel connection.)

O Check that all metal parts, such as frames, walls or ducts, are placed at correct insulation distances from all the active parts, as indicated in this manual.

P It is strictly forbidden to place HV- and/or LV-voltage wiring, metal parts or any other objects close to the windings. The windings are live parts. Wiring that is fitted too close to the windings or a Delta connection can cause serious damage to the transformer.

Q Check that bolts and nuts are securely tightened. This is important, especially if the transport has been characterized by several loadings and unloadings. – For accurate mechanical tightening, see information included in this manual.

R Check carefully that the windings have not been damaged during transport.

S Check that the cooling duct of the high- and low voltage windings are free from packaging material, such as nylon, paper, adhesive tape etc.

T Carefully check that the cooling duct between high and low voltage winding is symmetrical. If there are large asymmetries in the cooling ducts, contact your dealer (Unitrafo).

IV – OPERATION AND MAINTENANCE

4.1. GENERAL INFORMATION

A thorough check of the unit during its operation can prevent defects and permit a longer life of the transformer.

The client shall:

- perform most of the controls mentioned in the previous section when suitable for the client's requirements
- document the results of these controls
- arrange a maintenance and intervention program for the transformer to analyse the unit performance during a longer period of time.

4.2. VOLTAGE CHANGE OPERATION (IF REQUIRED)

Pay special attention when a change of voltage is required in transformers with double primary windings.

When performing this operation, it is advisable to carefully read the information on the rating plate on the transformer and the wiring diagram included in the documentation.

Should any doubt arise after a voltage change, the follwing test can be made to verify:

- *Feed the primary winding with a suitable low voltage available on site.*
- *With a manual tester (high precision is not required since the measure to perform is only a few volts) measure the line voltage on the low voltage side.*
- *Calculate the ratio between the voltages and compare it with the required transformer ratio.*
- *It is obviously well advised to avoid performing test feeding the low voltage side.*

4.3. VOLTAGE TAPPING OPERATION

If it is necessary to adapt the voltage conversion of the transformer to the supply voltage, these instructions must be followed:

1. Disconnect the high and low voltage connections and connect the transformer to ground.
2. Place the switching plates in the desired position and tighten carefully with a tightening torque acc. 2.10, table 5 on page 11.
3. Reconnect the transformer and remove any
4. Temporary grounding.
5. Re-energize the transformer.

4.4. PERIODICAL CONTROLS

This type of transformer normally requires no special service measures. We still recommend that the tightening of power connections be checked within approx.: 3-12 months after commissioning. In a very dirty environment, it is recommended that the transformer is cleaned, e.g. with compressed air if necessary.

The need for cleaning depends on the environment at the installation site and this should be followed up at the beginning, if it is feared that the transformer may become very heavily soiled. After storage, the transformer should always be checked and, if necessary, cleaned.

4.5. WARRANTY

All transformers are covered by a warranty during the agreed period from the date of delivery. The warranty applies to Ex Works, Helsinki, Finland.

Please note that the warranty only covers replacement or repair at our factory in Helsinki, Finland, excluding transport. Damages that the customer may suffer as a result of a fault are not covered by the warranty.