Instructions Manual
for dry-type Transformers

MITS/97
Dear client:

You have acquired an Asea Brown Boveri, S.A., encapsulated dry-type transformer of proven quality that offers the following advantages:

- Good resistance to short-circuits.
- Low flammability.
- Self-extinguishing.
- Unaffected by humidity.
- Great thermal inertia.
- Minimum partial discharges.
- Compact design.
- Lower installation costs.
- Low maintenance.

Please read these instructions carefully before putting the transformer into operation.
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1. Design, manufacture and testing

The dry-type transformer whose test record sheet is enclosed, is manufactured by Asea Brown Boveri, S.A. and has been designed and built to meet the compulsory Standards stipulated by the High Voltage Electrotechnical Regulations in force on the date of its manufacture as well as to comply with the client’s specifications.

In order to check the above, the following tests have been carried out:

1.1 Individual or routine tests (accredited by ENAC with no. 262/LE591)

<table>
<thead>
<tr>
<th>STANDARDS</th>
<th>UNE-EN</th>
<th>IEC</th>
<th>CENELEC</th>
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</thead>
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<tr>
<td>Measurements of windings resistances</td>
<td>60.076-1</td>
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<td>Voltage ratio measurement and check of phase displacement</td>
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<td>60.076-3</td>
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<td>Partial discharges measurements</td>
<td>EN 60.076-11</td>
<td>60.076-11</td>
<td>HD464</td>
</tr>
</tbody>
</table>
1.2. Standard and special tests (accredited by ENAC with no. 262/LE591)

Other tests such as standard and special tests can be carried out in the Asea Brown Boveri test laboratory. These tests are normally carried out to check the quality in design and process changes. They can also be performed on demand when requested by our clients.

These tests are:

<table>
<thead>
<tr>
<th>Standard and special tests</th>
<th>UNE-EN</th>
<th>IEC</th>
<th>CENELEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound level measurement</td>
<td>60076-10</td>
<td>60076-10</td>
<td>-</td>
</tr>
</tbody>
</table>

Some of the special tests that we can carry out at our facilities are:

- Measuring zero-sequence impedance.
- Measuring insulation resistance.
- Measuring of harmonics of the no-load current.
- Measuring of the dissipation factor (tag δ) of the insulation resistance capacitances
- Anti-corrosion protection measurement.

These tests are carried out in accordance with the relative IEC, IEEE, ANSI and/or UNE standards and the internal test procedures are at the disposal of our clients.

2. Certificates and homologation. Quality policy

2.1 Company register certificate

On 21.02.1995 ASEA BROWN BOVERI, S.A. was awarded the Company Register certificate N° ER-046/1/95 by AENOR which guarantees that our Quality Assurance System satisfies standard UNE-EN-ISO 9001 and is applied throughout the process, from the design and development stages to after-sales service, establishes management criteria and procedures, and processes that ensure that our transformers are free of defects. This system also includes suppliers and the application of know-how and expertise obtained from research and from the standard and special tests carried out, guaranteeing homogeneity in the design of product components, manufacturing procedures and tests, staff training and the continuous improvement of the whole process.

2.2 Environmental certification

The environmental certificate no. 023/MA/07/00 granted by ECA (Certification and Assurance Entity) guarantees that the environmental management system satisfies standard UNE-EN-ISO 14001 and is applied to the design, production, after-sales service and repair phases of transformers, and is developed as expressed by ABB in its environmental policy. Asea Brown Boveri, S.A. Zaragoza is adhered to CE regulation 761/2001 (EMAS) with the number (ES-AR-0000011) as well.

2.3 Accreditation of the tests laboratory

Accreditation of the tests laboratory for the accomplishment of the routine and type tests defined in this manual and granted by ENAC with nº 262/LE591, which indicates that the tests laboratory meets norm UNE-EN-ISO/CEI 17025.

2.4 Product certifications obtained

The following product certificates have been obtained by Asea Brown Boveri, S.A. (Zaragoza):

- The class C1 “Climatic” certificate in accordance with CENELEC-HD S1 1988/A2:1991 Appendix ZB.2 obtained in Calor-Emag Laboratories on 29.03.94, test no.: KI 715 W 009.

- The class F1 “Burning Behaviour” certificate obtained in homologated tests in accordance with CENELEC-HD 464 S1/A3 (November 1992), dated 07.07.97 in the laboratory of C.E.S.I. test number: BC-97/022127.
• The class E2 “Condensation and humidity” certificate, in accordance with CENELEC-HD 464 S1:1988/A2.1991, Appendix ZA.2.2A obtained in ABB Trafo BB GmbH on 29.03.94 test no.: KI 715 W 009.

• Suitability to endure short-circuits according to IEC 60076-5 obtained in C.E.S.I. on 01.03.01, certificate no.: MP-A1/006927.

• The class C2 “Climatic” certificate in accordance with CENELEC HD464 S1:1988/ A2:1991, obtained in LGAI on 29.03.01, Certificate no.: 20020462.

• Test Certificate of seismic qualification made by VIRLAB, S.A. with no. 210971, dated on 25.09.01.

• Vibration test Certificate made by VIRLAB, S.A. with no. 221001, dated on 18.06.02.

• The class C2 “Climatic” certificate in accordance with CENELEC HD464 S1:1988/ A2:1991 obtained in LGAI on 31.07.02, Certificate no.: 22020105.


• Suitability to endure short-circuits according to IEC 60076-5 certified by LABEIN dated on 08.10.04. Certificate no. B125-04-BM-EE-01.

• The class C2 “Climatic” certificate in accordance with EN 60726:2003 Anexo ZB3 method 1, obtained in APPLUS on 29.11.04, Certificate no.: 4039843.

• Vibration test Certificate made by VIRLAB, S.A. with no. 241154, dated on 14.02.05.

• Vibration test Certificate made by VIRLAB, S.A. with no. 251175, dated on 19.09.05.

• Suitability to endure short-circuits according to IEC 60076-5 certified by LABEIN dated on 09.01.06. Certificate no. B125-06-AD-EE-01.
2.5 Quality Policy

ABB

Quality Policy

Our most important quality criterion is the satisfaction of our customers.
Their needs will be satisfied by our commitments and products conforming to agreed terms. Each product delivery and each action with respect to the customer must create a recommendation for later business transactions.
We will ensure that all our employees are a source of quality and productivity through:

- Quality improvement programmes resulting from motivation reached through trust, respect, participation and recognition.

- Education and training provided to guarantee that each employee understands, supports and contributes to achieving continuous improvement and total quality.

- Economically produce the quality of the services and products that will satisfy the needs and expectations of the customers.

We will ensure that our suppliers are an extension of our business. They will be selected, evaluated and acknowledged based on their potential and real value contribution to satisfy the requirements of our total quality objective. We adhere to the standard UNE-EN ISO 9001/2000, that shapes the requirements of the quality assurance in our business and we undertake to comply with the legal, legislative and regulatory requirements of the customer.

Rev. 12

Antonio González
General Manager
3. Test record sheet

All the information on the tests the transformer has passed, is recorded on the Test Record Sheet and included with the information attached the transformer.

The Record Sheet indicates important data such as the no-load and load losses as well as the impedance voltage, no-load current and the level of partial discharges.

Without exception, each transformer manufactured by Asea Brown Boveri, S.A., has its own particular test record which is kept on file for a minimum period of 13 years and is at the disposal of our clients at their request.

The test protocol satisfies standard UNE-EN-ISO/CEI 17025 and is identified with the ENAC logotype and approval no. 262/LE591, which means that the tests targeted by the document are approved by this organisation.
4. Reliability and safety

The transformer leaves the factory free of all defects (as shown by the tests it has passed) and ready to be put into operation for the whole of its working life.

This level of reliability must be maintained during its handling, storage, and transport and the appropriate checks must be made when it is put into service, with the protections established by the H.V. Regulations from each country. In addition, the maintenance standards detailed in this manual must be applied.

At the installation site, all necessary measures must be taken to protect those persons who work regularly, or from time to time, in the proximity of the transformer whilst at the same time ensuring that all those persons not involved in its operation do not have access to it.

Attention!

Pay special attention to safety recommendations

– Signal indications

Following the signal indications that the transformers carry out.

– Regulations

Carrying out the of the protection and safety requests defined in the High Voltage Regulations that have been established by the regulations from each country, in force at the time.

– Fire extinction

It is not necessary to provide a device for collecting dielectric liquid or to install fire extinction systems. These transformers should be installed in such a way that the heat generated does not represent a fire risk for the materials nearby.
5. Construction details

The dry-type transformer can be supplied with or without enclosure. The cooling system can be by natural air (AN) or forced air by means of fans (ANAF).

The insulating system is designed to withstand temperature increments of 100 °K as average value on conductor, and a maximum temperature of 155°C, in accordance with class F defined in UNE-EN 60076 standard, part 2, and IEC 60076 standard, part 2.

Moreover, the construction details satisfy standard UNE 21538 and adapt to the technical requirements of our clients' specifications.

The normal operating conditions are:
- Altitude ≤1000 m.
- Ambient temperature:
  - -5°C up to +40°C (C1 type)
  - -25°C up to + 40°C (C2 type)

The customer must specify all those environmental conditions that are not normal, in order to include the necessary design modifications.
6. Receipt, transport, handling and storage

6.1 Receipt

The transformer is supplied totally mounted and ready to be connected to the H.V. and L.V. lines and inside a plastic cover (transformer without enclosure) that protects it from dust and rain.

In some cases HV outer connection bar can be delivered disassembled in order to avoid damages during transportation.

When the transformer is received, either at the client’s warehouse or at its final site, the following points should be checked:

- The characteristics of the transformer, indicated on the Name Plate, should coincide with those that appear on the Test Record Sheet and these, at the same time, should match the order specifications.

- Check that the transformer has all relevant safety warnings.

- Check the general state of the machine. There should be no dents in encapsulated phases or connections.

- The state of the paint: check that there is no flaking, scratches, etc. on the enclosure (if the transformer is of this type) or on metallic parts.

- Check all of the transformer’s accessories (wheels, thermometer, etc.) If any damage is observed, or if any of these have been lost during transport, the transport company and manufacturer should be informed immediately to determine who is responsible and to calculate the cost involved.

- Before unpacking the transformer, especially during winter or when the difference in temperature between indoors and outdoors is considerable, a prudential period of time should be waited (8 to 24 hour) so that the transformer’s temperature can stabilize. This is to prevent undesired condensation on the transformer surface.
Important:

In case that an anomaly is discovered when the transformer is received, the manufacturer should be contacted immediately. If, within a period of 5 days, the manufacturer has not received notification of anomalies or defects it will be considered that the transformer is in perfect condition and the manufacturer will not be liable for what may occur to the transformer during operation nor its consequences.

6.2 Transport and handling

During transport the transformer should not be moved by pushing on coils or connections. The transformer is fitted with four rings on the wheel base profiles where cables for dragging can be attached. If the transformer has to be pushed, then this can be carried out by pushing on the flanges that hold the magnetic circuit in place.

The top flanges have 4 lifting lugs or holes and hoisting can be carried out by attaching slings that form an angle of 50-70º to the lifting lugs or to the transformer enclosure roof.

- The name plate indicates the total weight of the transformer. This must be taken into account when deciding on the device used for lifting.

- The attachment holes or lifting lugs have a minimum diameter of 40 mm.

- The base and cooling elements (in case of fans) are designed to ensure that the transformer can be moved using a lever and do not impede handling; however, care must be taken not to push on the encapsulated phases. If levers are used, we recommend using wooden stops to protect those elements.

6.3 Storage

The dry-type transformer is for indoor installation. Do not store in places where it is exposed to effects of the weather.

If the transformer is not going to be put into operation immediately then it should be stored bearing in mind the following recommendations:
6.3.1 The temperature in the storage place can not be below than –25°C (C1 and C2 type).

When C1 type transformers storage will be lengthy with temperatures lower than –25°C it must be consult with the manufacturer.

6.3.2 The place will be dry, clean and good ventilated.

When is stored, this type of transformer should remain inside its plastic packaging cover.

In particularly damp places, bags with humidity absorbing products like silicagel should be placed near the coils and to provide an adequate ventilation.

6.3.3 The indications given in point 6.2 will be followed for lifting and transporting the transformer.

6.3.4 The indications given in point 6.2 will be taken into account during transport and handling. Do not pressure on encapsulated phases, connections or terminals. Do not damage paintwork.

6.3.5 If the transformer is lifted and transported by means of a fork-lift truck, the prongs of the truck should be inserted inside the wheel coupling profiles, protecting the cooling elements (in case of fans) from any possible damaged that could be caused by the lifting machine.

6.3.6 If the transformer is equipped with plug-in terminals, these should all have cone protectors to ensure that the terminal contacts remain clean and undamaged.

* Asea Brown Boveri is not to be held responsible for possible damage if the storage conditions are not respected. *
7. Installation

The transformer manufacturer is not responsible for its installation. Installation must be carried out in accordance with the laws currently in force and following the instructions given by the manufacturer.

The following points must be taken into account when installing the machine:

- Bolt HV outer connection bar to free terminals in the extreme windings (when delivered disassembly). Check torques with table in section 11.

- Earth all voltageless metallic parts by means of the screw available for this purpose.

- Connect the L.V. neutral to earth when this is compulsory or when it is a requirement of the earth fault protection system.

- Ensure that terminals and bridges are correctly connected and that all of the transformer's mobile parts are securely fixed.

- In transformers with a dual ratio in H.V. or L.V. ensure that the transformer is connected to the corresponding mains voltage or output voltage.

- Check that the position of the tap changer is correct in accordance with the mains.

- Consult the name plate when the position is changed.

- Connect the thermal protection system in accordance with the diagram supplied.

- Revise the tight-fitting of all the screws according to the list of chapter 11.4

The electric current passing through the windings and the magnetisation of the magnetic circuit produce electric losses that are transformed into heat. To prevent this heat from accumulating in the transformer with the consequent risks involved, the transformer is designed to cool naturally, however, there should also be adequate ventilation at the installation site.

The transformer is designed and built to withstand abnormal situations of overvoltage and overcurrents including those of a short-circuit in the secondary winding; however, the magnitude and duration of these should be limited by means of the appropriate elements.
7.1 Installation site and protection of persons

The site conditions and design, both for technical reasons and for the protection and safety of persons and property, are defined in the High Voltage Regulations established by Spanish law (or the corresponding country law) in force at the time.

The instructions of the Electricity Company, which is familiar both with the Regulations and the specific characteristics of the system to which the transformer is to be connected, must also be taken into account.

A horizontal base that can withstand the weight of the transformer without deformation should be prepared. The total weight is indicated on the transformer's name plate.

The wheels should also be blocked to prevent the transformer from moving during operation.

7.2 Transformer protection

Although the H.V. Regulations from each country indicate the type of protection that the transformer must have, the following is essential to ensure the reliability and operation of the transformer.

7.2.1 Protection from overcurrents and overheating

The transformer must be protected from thermal and dynamic effects caused by overcurrents and shortcircuits.

For this purpose there should be an automatic tap changer or short-circuit fuses which take into account the possible overloads and are calibrated to prevent currents from passing that are 1.5 or 2 times greater than the assigned current (see name plate).

7.2.2 Ventilation of the transformer cell

As already indicated, there should be suitable ventilation to prevent the transformer from overheating above the limits established by the standards.

If the transformer is mounted inside a cell, it should be ensured that it is well-ventilated and that it is of the correct size to allow air to pass in and out.

The transformer must be located at least 100 mm from the cell walls and its HV&LV connections must be at least 350 mm from the cell roof and walls.

The input E and output S surfaces should have at least the surface areas in m² given by the following formulas:

\[ E = 0.185 \times \frac{P}{\sqrt{H}} \]

\[ S=1,15E \]
Where:

H = Distance between the centres of openings, expressed in metres.

P = The sum of the no-load and full-load losses of the transformer in kW.

NOTE: This formula is valid for a maximum room temperature of 40°C and a maximum altitude of 1000 m.

The following should be avoided:

- The ambient air temperature should not exceed that indicated by the standards.

- The transformer should not be installed in small rooms with blinds or metallic walls exposed to direct sunlight.

- The air for cooling the transformer should not be aspired or expelled in the same room in which it is installed.

- The transformer should not be installed in rooms that are destined for other uses; in particular in those in which there are machines that work at high temperatures: boilers, steam generators, etc.

- If the transformer cannot be installed in rooms with sufficient natural ventilation, forced ventilation should be used.

7.2.3 Fire extinction systems

It is not necessary to provide a device for collecting dielectric liquid or to install fire extinction systems. These transformers should be installed in such a way that the heat generated does not represent a fire risk for the materials nearby.

7.2.4 Protection from overvoltages

To protect the transformer from industrial frequency overvoltages and those of an atmospheric origin, variable resistance lightning arresters should be used. The characteristics of the lightning arresters will depend on the level of insulation of the transformer and characteristics of the mains system. They will be earthed in accordance with H.V. Regulations from each country.

At this point it is essential to receive the collaboration of the Electricity Company to whose system the transformer is going to be connected.
8. Connections

8.1 Coupling

When the transformer is connected to the H.V. and L.V. circuits, connecting should be carried out in such a way that it does not apply any strain on the terminals and should have a large enough section to prevent excessive heating. Connections should also be able to dilate.

It is important to ensure a suitable connection and tightening of all the bolts.

Important

Check that the tap changer is in the correct position and, in case of multi-voltage transformers, that the H.V. winding is connected at what is going to be the working voltage.

The tap changers should always be manipulated without voltage!

- Use an ohmmeter to check the continuity of the circuit with the tap changer in all of the positions and check that the bridges are correctly fixed in the working position.

- The enclosure or lower flange of the transformer should be securely and permanently connected to earth by means of the earthing screws on the bottom right of the two larger, lower, opposite faces of the enclosure or flange. The earthing conductor should be of the dimensions indicated in the H.V. Regulations from each country and in accordance with the characteristics of the transformer.

8.2 Parallel Coupling

If the transformer has to be parallel-coupled to other transformers, check that it fulfils the voltage compatibility conditions established by the standards, check the position of tap changer, impedance voltage and connections unit. See standards no. IEC 60076-4 y IEC 60606-4.

- Identical rated voltages and frequencies (voltage tolerance 0,5%).
- The transformers should belong to the same vectorial group.
- Identical short-circuit voltage (tolerance ±10%).
- Power ratio of (maximum) 3/1 at continuous load.
9. Prevention of noise and electrical breakdown discharges

9.1 Noises

- When the transformer is connected to the mains, check that the position of the tap changer and the H.V. winding connection (if there is more than one) is that of the working voltage. Otherwise the magnetic circuit may become over saturated and the noise level will increase notably.

- Check that the transformers four wheels are firmly resting on the ground.

- Do not attach grids or guards to the metallic walls of the transformer.

- Fit flexible L.V. cables, held in place by means of insulating brackets.

<table>
<thead>
<tr>
<th>Rated power kVA</th>
<th>Power noise level dB(A) (UNE 21538)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 24 kV</td>
</tr>
<tr>
<td>50</td>
<td>59</td>
</tr>
<tr>
<td>100</td>
<td>59</td>
</tr>
<tr>
<td>160</td>
<td>62</td>
</tr>
<tr>
<td>250</td>
<td>65</td>
</tr>
<tr>
<td>400</td>
<td>68</td>
</tr>
<tr>
<td>630</td>
<td>70</td>
</tr>
<tr>
<td>1000</td>
<td>73</td>
</tr>
<tr>
<td>1600</td>
<td>76</td>
</tr>
<tr>
<td>2500</td>
<td>81</td>
</tr>
</tbody>
</table>

The acoustic power level values indicated in the table are the maximum admissible and are determined based on the acoustic pressure values measured in the transformer axles in four positions at 0.3 m according to standard UNE-EN 60076-10.
9.2 Electrical Breakdown discharges

To prevent electrical breakdown discharges, maintain the distances indicated in the table, between H.V. and L.V., or metallic parts.

These distances are:

<table>
<thead>
<tr>
<th>Highest voltage for equipment (kv)</th>
<th>Distance (x) (mm) From insulated parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>24</td>
<td>120</td>
</tr>
<tr>
<td>36</td>
<td>200</td>
</tr>
</tbody>
</table>

It is very important to maintain the minimum distance x from the insulated parts High Voltage windings or connections to the metallic parts or Low Voltage, to avoid a possible breakdown.

For distances between High Voltage non-insulated parts and Low Voltage metallic parts the suitable values in the High Voltage regulations or applicable standards in each country will be taken.

**Asea Brown Boveri does not accept any liability for possible failures if this distance is not respected.**

**Very important**

The insulation of the coils does not guarantee the safety of persons in the event of accidental contact. For this reason these transformers should not be installed in easily accessible places.

Warning and danger signs that are easily visible should be placed on the coil covering.
10. Checks to be carried out before putting the transformer into operation

10.1 Checks

- The transformer is supplied ready for installation but before proceeding to put it into operation the following checks should be carried out:


- The transformer should also be cleaned with a vacuum cleaner to eliminate any dust.

- Check the thermal protection device (see Chap. 14 “Accessories”).

- Check insulation resistance according to the following table:

<table>
<thead>
<tr>
<th>Insulation between</th>
<th>Test Voltage</th>
<th>Minimum Value in MΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.T./B.T.</td>
<td>5.000 v</td>
<td>1 per kV A.T.</td>
</tr>
<tr>
<td>A.T./Earth</td>
<td>5.000 v</td>
<td>1 per kV A.T.</td>
</tr>
<tr>
<td>B.T./Earth</td>
<td>2.000 v</td>
<td>2</td>
</tr>
</tbody>
</table>

10.2 Putting the transformer into operation

Once the transformer has been connected to the H.V. mains:

- Voltage will be applied in a non-load state and observed for one hour. No anomalies should occur during this period of time.

- After storage or disconnection for a longer period, it is recommendable to connect the transformer during four hours in no-load in order to dehumidity through core heating. After this period it can be put into a normal operation.

- The voltage will be measured at the L.V. terminals to check the corresponding output voltage depending on the transformation ratio.

- Apply the load progressively until the rated power is reached and check the increase in temperature.
11. Maintenance

11.1 Frequency of checks

Annually: transformers in normal environments.
Quarterly: transformers in environments that are contaminated with dust or industrial fumes, or placed in windmills and exposed to vibrations.

11.2 Precautions

All the precautions defined by current legislation must be taken. The following measures are amongst the most important ones.

Before examining or carrying out maintenance work on the transformer:

- Disconnect the H.V. and L.V. switches so that the transformer is de-energised and out of service.
- Using an insulating rod the transformer bushings should be earthed to ensure that there is no remaining static charge.
- The bushings are then short-circuited and earthed.

11.3 Checks

- Check and tighten screws, connections, voltage change bridges and coil support blocks.
- Clean any dust surfaces using a vacuum cleaner or by blowing with dry air or nitrogen (maximum pressure 3 Kg/cm²). Nitrogen bottles as normally supplied, equipped with a pressure reducer, can also be used.
- Check the thermal protection device that includes the sensors (Pt100 type or thermistors) and the measuring control unit (see chapter 14 “Accessories”).

Attention!
This is a low-maintenance transformer
The points above indicated do not imply the exemption from fulfilling the requirements established by current laws concerning Transformation Centres with regards to:

The protection of persons and the integrity and functionality of the goods that may be affected by the installations themselves.

This inspection must be carried out on all transformers. If less than ten years have passed since the manufacture, the inspection must be carried out in cooperation with the manufacturer who should be informed of the results in order to be able to recommend corrective actions, if necessary.

### 11.4 Tightening torque of connections

Instructions to make screwed joints in low and high voltage

<table>
<thead>
<tr>
<th><strong>H.V. &amp; L.V. electrical connections</strong></th>
<th>Indoors</th>
<th>Outdoors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of nuts and bolts</td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Lubricant for nut and bolt</td>
<td>Oil SAE 30 or 40</td>
<td>Molybdenum bisulphide grease (MOS₂)</td>
</tr>
<tr>
<td></td>
<td>Vaseline grease</td>
<td></td>
</tr>
<tr>
<td><strong>Nuts / Bolts</strong></td>
<td>Grip torques (Nm)</td>
<td></td>
</tr>
<tr>
<td>M 8</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>M 10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>M 12</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>M16</td>
<td>80</td>
<td>120</td>
</tr>
</tbody>
</table>
When one or both of the bars to be joined together are aluminum, the layer of aluminum oxide must be removed by brushing or sandpapering. This layer is practically invisible and extremely resistant, so its presence prevents making a good contact. This operation must be repeated if the connection bars are dismounted for any reason.

Once clean, apply a very fine coat of special grease for electrical contacts.

Aluminum/copper joints must have a bi-metal plate.

The grip torques, indicated on the table, correspond to greased bolts.

Greasing oil or white vaseline grease can be used, in order to not soil the area around the connection.

Molybdenum bisulphide grease must be used for stainless or hot galvanised nuts and bolts. Any excess must be cleaned after tightening.

<table>
<thead>
<tr>
<th>Brass H.V. screwed connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuts/bolts</td>
</tr>
<tr>
<td>Grip torques (Nm)</td>
</tr>
</tbody>
</table>

H.V. bolts must not be greased because are screwed in brass.
12. Environment

12.1 Introduction

Asea Brown Boveri, S.A., has implemented and certified at its plant in Zaragoza, an Environmental Management System as per standard UNE-EN-ISO 14001 and Regulation CE 761/2001 (EMAS) and it has identified the possible accidents, incidents and situations that could produce environmental effects that are detrimental to the Environment.

The environmental management system is applied both in the manufacturing processes and in the product operation as set out in the environmental policy.

Our commitment is for continuous improvement and within this context we offer our customers environmental information concerning the product laid out in points 3, 4 and 5 of this chapter. This information is based on our current knowledge and with the commitment to improve it as our knowledge increases.

We inform you, too, that the existing legislation is broad and extensive and is continuously evolving, which makes it difficult to offer an updated overview of it. However, you will find legislation of the European community, of the country itself and of the autonomous communities and Town Councils in several pages of Internet.

The Quality and Environment Dept. of Asea Brown Boveri Zaragoza places itself at the disposal of its customers to answer any queries or give assistance on Environment-related issues.
12.2. Environmental Policy

Our criterion on the Environment is respect for Nature and life.

All the activities, processes and services are aimed at complying with the environmental requirements, at continuous improvement and preventing contamination.

We undertake to:

- Comply with the regulatory requirements and the legislation.
- Avoid contaminating the atmosphere, the water and the soil.
- Evolve towards a continuous improvement system in Environmental issues.
- Minimise and prevent harmful environmental effects.
- Establish, review and publish environmental objectives, goals and reports.
- Minimise the production of waste and try to use re-utilisable materials.
- Update the Environmental Policy, making it public and internally and externally accessible.
- Involve suppliers and subcontracted companies.

We guarantee that the aforementioned aspects are understood and assumed at all organisation levels, by means of training, sensitization and continuous improvement programmes.

We adhere to the Standard **UNE-EN ISO 14001/1996, Regulations CE 761/2001 (EMAS)** and Regulations of the Environmental Management System applicable that shape the environmental requirements in our business.

![Signature](signature.png)

Rev. 5

Antonio González
General Manager
12.3 Environmental impact of the transformer in use

Environmental impact

This is any action, whether it be harmful or beneficial, that transforms the environment; said action being caused directly by the activities, products and services.

Environmental impacts identified with the transformer in use:

- Electricity consumption.
- Noise emission.
- Increase of surrounding temperature.

12.3.1 Electricity consumption

The transformer is a static electrical machine, which has an efficiency of approximately 98%. This 2% power is inverted into losses in its magnetic circuit and in the windings. These losses are dissipated into heat in the surrounding environment and they are limited and subject to compliance with Standards and/or specifications of our customers.

12.3.2 Noise emission

The transformer has a magnetic circuit, which, due to the effect of magnetostriction caused by the magnetic flow, issues a noise, which may be troublesome for people, as well as vibrations, which are transmitted through the floor or structure causing noises in places close to the location of the transformer.

The sound level of the transformers is regulated by the relative UNE-EN/IEC standards, as well as by town council regulations, which depend on whether it is located in urban or industrial areas.

We can limit its impact if we follow the instructions given in chapter 9.
12.3.3 Increase of the surrounding temperature

The dissipation of losses in the magnetic core and in the windings gives rise to an increase in the temperature around the transformer, which, in turn, dissipates into the medium preferred by the lowest surrounding temperature.

The non-existent emission of gases or losses of coolant make the environmental impact minimal.

12.4 Environmental aspects in emergency situations

The dry-type transformer doesn't contain any cooling liquid and it isn't necessary any liquid retention device

**Electricity consumption.**
* Causes: Excessive voltage or current supply.

**Excessive noise level.**
* Causes: Excessive voltage supply. Slackening of the magnetic core. Foreign objects close to the transformer, bad location of the transformer near reflecting objects. Bad support. Rigid connection in L.V.

**Excessive heating.**
* Causes: Excessive voltage or current supply, nearby objects that prevent the natural cooling and/or foreign bodies are blocking the cooling channels.

**Fire.**
* The trafo is self-extinguishing.

**Combustion gases.**
* Causes: Fire.
* These gases are not harmful for health or environment.
12.5. Waste

This type of transformer does not generate waste in normal operation.

The packaging and/or the palets that are included in the transformer delivery are wooden and can be recycled or used again according to its condition. Standard packaging are made of recyclable plastic as well.

¡Please be respectful with the environmental.
Use again or recycle these products!

During their maintenance they do not generate waste and at the end of their lifespan the following can be generated:

- Encapsulated windings. Any aluminium or copper scrap can be recovered if the resin coating is destroyed. The resin is managed in the same way as inert urban waste and the copper or aluminium can be recycled.

- Copper or aluminium L.V. windings. They can be recycled by eliminating the insulating coating adhered to its surface.

- The magnetic plate can be eliminated as scrap or to retrain.

- The flanges, casings, wheels, nuts and bolts and in general the metal parts can be eliminated as scrap or to retrain.

12.6. Fire

This transformer is self-extinguishing and resistant to burning; nevertheless, the following measures must be taken into account to extinguish it:

WARNING!
Do NOT use WATER to try to fight the fire

Extinguishing means

• Carbon dioxide
• Foam
• Dry powder
13. Repairs

- If an anomaly in the operation of the transformer is observed, this should be reported to the manufacturer who will then advise the appropriate actions.

- If, having checked the transformer, it is found that it has to be repaired or altered, these operations will be carried out by the manufacturer.

**WARNING!**

If you receive the transformer in damaged conditions, you should contact the factory immediately. Please bear in mind that it might also be important to take pictures of the anomalies before unloading the transformer and to make a note of them in the carriers CMR.

**Note:**

If these instructions are not followed, the original manufacturer is no longer responsible for the functionality of the transformer and its reliability. This responsibility falls on the person who has carried out the repair.
14. Accessories

The transformer is fitted with the following accessories, in accordance with current standards or customer specifications.

- Name plate.
- Two earthing terminals.
- Safety warning notices.
- Thermal protection. Temperature sensors mounted in a compartment on the L.V. phases (Optional: control unit for temperature measurement).
- Fans.
- Enclosure.

14.1 Thermal protection

The thermal protection system or temperature control is supplied packed along with the transformer so that our clients can install it wherever required.

Two protection systems are used:

- Protection consisting of thermistors with alarm and triggering signal in control unit. Diagram 1.
- Protection consisting of Pt100 sensors with measuring and alarm and triggering signals in control unit. Diagram 2.

The instructions for the adjustment of control units and for changing alarm and trigger signals are indicated in the information supplied with the control unit.

The advised programmed temperature values for the alarm and trip signals, when speaking of an average winding heating of 100 K and a maximum ambient temperature of 40°C for F class are:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>PT100</th>
<th>Thermistor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm (°C)</td>
<td>130</td>
<td>130 Blue-Blue</td>
</tr>
<tr>
<td>Trip (°C)</td>
<td>150</td>
<td>150 Black-Black</td>
</tr>
<tr>
<td>Fans (Connect./ disconnect.) (°C)</td>
<td>120/110</td>
<td>110 Brown-Brown</td>
</tr>
</tbody>
</table>

For H class the temperatures indicated will be increase in 20°C.
Interconnection between transformer and control temperature unit

The interconnection between the transformer terminal strip and the control temperature unit is carried out with three/four wires.

The plugs marked 1, 2 and 4 (3 optional), on the transformer and those on the control temperature unit should be connected.

**Diagram 1**

**PTC/FAN (Optional)**
Connection between the transformer and the control temperature unit

The transformer includes three/four Pt-100 sensors, one per phase, which must be connected to the control temperature.

The connection of the three Pt-100 sensors from the transformer to the temperature unit is carried out with nine/twelve wires.

The nine transformer terminals and the temperature unit are numbered in exactly the same way.

Channel 1 of the control temperature unit corresponds to the U phase of the transformer, channel 2 to the V phase and channel 3 to the W phase.

These interconnections may vary depending on the model of temperature unit used. The numbers indicated on the terminal strip always coincide with the numbers on the temperature unit.

Diagram 2
## 15. Possible anomalies and recommended solutions

The following table briefly describes anomalies which may be found during operation or when periodic checks are carried out and indicates how to resolve them.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Affected elements</th>
<th>Probable causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The automatic protection device is triggered at the transformer connection</td>
<td>Windings.</td>
<td>Defective windings.</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>Tap changer</td>
<td></td>
<td>The primary voltage does not coincide with the tap changer.</td>
<td>Check that the position of the switch coincides with the primary voltage.</td>
</tr>
<tr>
<td>Fuses</td>
<td></td>
<td>Incorrectly calibrated</td>
<td>Change fuse.</td>
</tr>
<tr>
<td>Protection relays</td>
<td></td>
<td>Timing and/or current is incorrectly adjusted.</td>
<td>Check timing and current setting.</td>
</tr>
<tr>
<td>Abnormal secondary voltage</td>
<td>Primary Voltage</td>
<td>Absence of primary voltage.</td>
<td>Check installation and contact Electricity Company.</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Affected elements</td>
<td>Probable causes</td>
<td>Solutions</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
<td>-----------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td><strong>Tap changer</strong></td>
<td></td>
<td>Incorrectly positioned.</td>
<td>Change positioning.</td>
</tr>
<tr>
<td><strong>Windings</strong></td>
<td></td>
<td>No continuity in windings.</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td><strong>Very low voltage</strong></td>
<td><strong>Primary voltage</strong></td>
<td>Very low</td>
<td>Check installation and contact Electricity Company.</td>
</tr>
<tr>
<td><strong>Very high voltage</strong></td>
<td><strong>Primary voltage</strong></td>
<td>Very high</td>
<td>Check installation and contact Electricity Company.</td>
</tr>
<tr>
<td><strong>Unbalanced voltage</strong></td>
<td><strong>Tap changer</strong></td>
<td>Incorrectly positioned in one of the phases.</td>
<td>Check the position of the 3 switches. Check installation and contact the Electricity Company.</td>
</tr>
<tr>
<td><strong>Fuse</strong></td>
<td></td>
<td>Fuse has blown.</td>
<td>Change fuse.</td>
</tr>
<tr>
<td><strong>Windings</strong></td>
<td></td>
<td>No continuity in windings.</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td><strong>L.V. installation</strong></td>
<td><strong>L.V. installation</strong></td>
<td>Load imbalance. Incorrect coupling.</td>
<td>Check L.V. installation. Check L.V. connections.</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Affected elements</td>
<td>Probable causes</td>
<td>Solutions</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-------------------</td>
<td>------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Spurious triggering during operation</td>
<td>Thermometer</td>
<td>Incorrect operation.</td>
<td>Check. Change.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triggering and alarm incorrect set.</td>
<td>Check setting. Correct.</td>
</tr>
<tr>
<td>Pt100 sensors or thermistors</td>
<td></td>
<td>Defect of sensors or thermistors.</td>
<td>Check sensors or thermistors.</td>
</tr>
<tr>
<td>Windings</td>
<td></td>
<td>Perforation of insulating material.</td>
<td>Contact manufacturer.</td>
</tr>
<tr>
<td>Fuse</td>
<td></td>
<td>Blown fuse</td>
<td>Change fuse.</td>
</tr>
<tr>
<td>Relays</td>
<td></td>
<td>Incorrect timing.</td>
<td>Check timing.</td>
</tr>
<tr>
<td>Abnormal operating temperature</td>
<td>Installation</td>
<td>Insufficient ventilation.</td>
<td>Check ventilation of the room.</td>
</tr>
<tr>
<td></td>
<td>premises</td>
<td>High ambient temperature.</td>
<td></td>
</tr>
<tr>
<td>L.V. mains</td>
<td></td>
<td>Overloaded</td>
<td>Check for possible power increases and discharge the trafo.</td>
</tr>
<tr>
<td>High level of noise</td>
<td>Magnetic core</td>
<td>High supply voltage</td>
<td>Adjust tap changer or regulator.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loose accessories</td>
<td>Check over.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Certain elements have been poorly</td>
<td>Re-tighten.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mounted, producing vibrations.</td>
<td></td>
</tr>
<tr>
<td>Not enough distance to walls</td>
<td></td>
<td>Reflecting elements.</td>
<td>Remove elements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Study of the area.</td>
<td></td>
</tr>
</tbody>
</table>
16. Rating plate

All of the transformers have a name plate indicating and defining all of its basic characteristics.

This plate is placed (unless indicated otherwise by our clients) on the L.V. side and is riveted, stuck or screwed to the top flange on a welded bracket or on the enclosure of the transformer.
17. Guarantee

On behalf and in representation of Asea Brown Boveri, S.A., Distribution Transformers at its site in Zaragoza, the manager of Quality Assurance

Certifies:

That the transformer indicated in the attached record sheet has been manufactured and tested in accordance with order specifications and applicable standards and codes, obtaining satisfactory results.

And thus, issues

Guarantee:

For all manufacturing defects for a period of twelve months from its commissioning or eighteen months from its date of dispatch for said transformer.

This guarantee does not cover the effects caused by handling or misuse of the transformer.

Quality Assurance
Asea Brown Boveri, S.A.
18. Notes