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Resistance welding equipment — Transformers — General specifications applicable to all transformers

Matériel de soudage par résistance — Transformateurs — Spécifications générales applicables à tous les transformateurs

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Contents

Page

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5826 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding*.

This second edition cancels and replaces the first edition (ISO 5826:1983), which has been technically revised.

Annexes B, C and D form a normative part of this International Standard. Annex A is for information only.

Resistance welding equipment — Transformers — General specifications applicable to all transformers

1 Scope

This International Standard give specifications applicable to transformers for resistance welding equipment without connected rectifier.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 669, *Resistance welding equipment — Mechanical and electrical requirements.*

IEC 60051-2, *Direct acting indicating analogue electrical measuring instruments and their accessories — Part 2: Special requirements for ammmeters and voltmeters*.

IEC 60085, *Thermal evaluation and classification of electrical insulation*.

IEC 60204-1, *Electrical equipment of industrial machines — Part 1: General requirements*.

IEC 60529, *Degrees of protection provided by enclosures (IP code).*

IEC 60536-2, *Classification of electrical and electronic equipment with regard to protection against electric shock — Part 2: Guidelines to requirements for protection against electric shock*.

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*.

IEC 60905, *Loading guide for dry-type power transformers*.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 669 apply.

4 Symbols

The symbols used in this International Standard are listed in Table 1.

Table 1 — List of symbols

Symbol	Description	Reference
I_{1p}	rated permanent input current	10, 12
I_{1X}	input current at a given duty factor	annex C
I_2	output current	annex C
I_{2p}	permanent output current at 100 % duty factor	13.2, annex C
I_{2X}	output current at a given duty factor	annex C
$I_{2/50}$	output current at 50 % duty factor	13.2
m	mass	13.2
P	power	annex C
P_p	permanent input power (at 100 % duty factor)	10, 11, 13.2, annex C
P_X	input power at a given duty factor	annex C
P_{50}	input power at 50 % duty factor	13.2
Q	required total rate of cooling liquid flow	11, 13.2
R_1	initial resistance of a winding	8.2.1, 8.3.2
R_2	resistance of a winding at the end of the heating test	8.3.2
t	time	annex C
t_1	on-load time	annex C
T	cycle time	annex C
U_{cc}	rated short-circuit voltage	10
U_{1cc}	input short-circuit voltage	10
U_{1N}	rated supply voltage	9, 10, 13.2
U_{20}	rated output no-load voltage	9, 13.2
X	duty factor	annex C
X_m	duty factor of the magnetic circuit	annex C
Z_2	total impedance refered to the output	10
Δp	pressure drop of the cooling liquid circuit	11, 13.2
$\Delta\theta_{1,2}$	temperature differences	annex C
θ	temperature	annex C
θ_a	cooling medium temperature	annex C
θ_m	equilibrium temperature	annex C
θ_n	temperature when the transformer starts to cool	annex C
$\theta_{0,1,2}$	temperatures for calculation of the thermal time constant or the winding temperatures during the heating test	8.2.1, 8.3.2, annex C
τ	thermal time constant	annex C
τ_2	thermal time constant at given on-load time	annex C
τ_{2p}	thermal time constant at permanent output current	annex C

5 Physical environment and operating conditions

5.1 General

Transformers shall be suitable for use in the physical environment and operating conditions as specified below.

When the physical environment and/or operating conditions are outside those specified below, an agreement may be needed between the supplier and the user, (see e.g. annex B of IEC 60204-1:1997).

5.2 Ambient air temperature

Transformers shall be capable of operating correctly in an ambient air temperature between + 5 °C and + 40 °C.

In case of other maximum temperatures of the cooling medium, see annex B.

5.3 Humidity

Transformers shall be capable of operating correctly within a relative humidity range of 30 % to 95 %.

Harmful effects of occasional condensation shall be avoided by proper design of the equipment or, where necessary, by proper additional measures (e.g. air conditioners, drain holes).

5.4 Altitude

Transformers shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.

In case of other altitudes, see annex B.

5.5 Transportation and storage

Transformers shall be designed to withstand, or suitable precautions shall be taken to protect against, transportation and storage temperatures between − 25 °C and + 55 °C and for short periods not exceeding 24 h up to + 70 °C. Suitable means shall be provided to prevent damage from humidity, vibration and shock.

5.6 Provisions for handling

Transformers shall be provided with suitable means for handling by cranes or similar equipment.

5.7 Temperature of the cooling liquid

The temperature of the cooling liquid may be up to + 30 °C at the inlet of the transformer.

NOTE Condensation caused by high cooling liquid flow or low cooling liquid temperature in relation to the relative humidity should be prevented.

6 Test conditions

6.1 General

The tests shall be carried out on new, dry and completely assembled transformers at an ambient air temperature between + 10 °C and + 40 °C. The ventilation shall be identical with that prevailing under normal service conditions. When placing the measuring devices, the only access permitted shall be through openings with cover plates, inspection doors or easily removable panels provided by the manufacturer. The measuring devices used shall not interfere with the normal ventilation of the transformer or cause transfer of heat to or from it.

Liquid cooled transformers shall be tested with liquid conditions as specified by the manufacturer.

The accuracy of measuring instruments shall be:

a) electrical measuring instruments: Class 0,5 (0,5 % full scale, see IEC 60051-2);

b) thermometer: ± 2 K.

Unless otherwise specified, the tests required in this International Standard are type tests.

The sequence for some of the type tests is specified in 6.2.

The routine tests are specified in 6.3.

Compliance with other standards referred to shall be checked according to these standards.

6.2 Type tests

All type tests shall be carried out on the same transformer except otherwise specified.

Those type tests given below shall be carried out in the following sequence without delay between f), g), h) and i).

a) General visual inspection;

b) Insulation resistance (see 7.1) preliminary check;

c) Thermal rating (see clause 8);

d) Rated short-circuit voltage (see clause 10);

e) Protection provided by the enclosure (see 7.3.1);

f) Insulation resistance (see 7.1);

g) Dielectric strength (see 7.2);

h) Dynamic characteristic (see clause 12);

i) General visual inspection.

The other tests of this International Standard not mentioned above may be carried out in any convenient sequence.

NOTE The preliminary check on insulation resistance is required to determine whether the transformer is safe to connect to the supply.

6.3 Routine tests

Each transformer shall be submitted successively to the following routine tests.

a) General visual inspection;

b) Dielectric strength (see 7.2);

c) Rated no-load output voltage (see clause 9);

d) Cooling liquid circuit (see clause 11);

e) General visual inspection.

7 Protection against electric shock

7.1 Insulation resistance

The insulation resistance shall not be less than 50 MΩ.

Compliance is checked by measuring the insulation resistance using a d.c. voltage of 500 V between

a) the input and output windings and

b) the windings and the frame.

7.2 Dielectric strength (routine test)

The insulation shall withstand the following test voltages without any flashover or breakdown and no damage shall occur which might impair the function of the insulation.

Compliance is checked according to IEC 60664-1 and the following test.

An a.c. voltage, having the frequency of the mains supply, of:

a) 4 000 V r.m.s. for integrated gun transformers and

b) 2 500 V r.m.s. for all other transformers

is applied between the inlet and one winding of the outlet circuit, of class I or class II transformers. However, if the design of class I is so that one point of the secondary is connected to earth, the test voltage can be decreased to 2 500 V r.m.s.

An a.c. voltage of 1 000 V r.m.s. having the same shape is applied between one winding of the outlet circuit and earth.

The 1 000 V test voltage shall be applied instantaneously.

The 2 500 V and 4 000 V test voltages shall be applied progressively so that the prescribed value is reached in about 20 s.

In both cases, the test voltage shall be continuously maintained at the required value for 60 s, then stopped as quickly as the equipment allows, without creating overvoltage during stopping.

NOTE Dielectric tests shall not normally be repeated on a same transformer. If, for any reason, they should be, they should be tested again with a test voltage of only 75 % of the above-mentioned values.

7.3 Protection against electric shock in normal service (direct contact)

The minimum degree of protection for transformers provided by the enclosure shall be IP 54 as specified in IEC 60529.

If the transformer is intended to be in-built, the degree of protection may be IP 00.

Compliance is checked according to IEC 60529.

7.4 Protection against electric shock in case of a fault condition (indirect contact)

Transformers shall be built to protection class I or II according to IEC 60536-2.

Compliance is checked by visual inspection.

7.5 Isolation of input and output circuits

The welding circuit shall be electrically isolated from the input circuit and from all other circuits having a voltage higher than the no-load voltage by reinforced or double insulation. If another circuit is connected to the output circuit, the power of the other circuit shall be supplied by an isolating transformer or equivalent means.

Compliance is checked by visual inspection of the design.

8 Thermal requirements

8.1 Limits of temperature rise

The thermal requirements for transformers are given as follows:

a) for windings: in accordance with 8.1.1;

b) for accessible surfaces: in accordance with 8.1.2.

8.1.1 Windings

The temperature rise of windings shall not exceed the values given in Table 2.

No part shall be allowed to reach any temperature that will damage another part even though that part might be in compliance with Table 2.

Table 2 — Temperature limits for windings

Class of insulation in accordance with IEC 60085 °C	Peak temperature in accordance with IEC 60905 °C	Limits of temperature rise K			
		Air cooled windings		Liquid cooled windings	
		Embedded temperature sensor	Resistance	Embedded temperature sensor	Resistance
105 (A)	140	60	60	70	70
120 (E)	155	75	75	85	85
130 (B)	165	85	85	95	95
155 (F)	190	110	105	120	115
180 (H)	220	135	130	145	140
200	235	155	145	165	155
220	250	175	160	185	170

NOTE 1 The highest temperature occuring in a winding (hot spot) can be measured by embedded temperature sensors. The temperature measured by the resistance method gives the average between all temperatures occurring in the windings.

NOTE 2 Other classes of insulation having higher temperature limits than those given in Table 2 are available, see IEC 60085.

Compliance is checked by measurement in accordance with 8.2.

8.1.2 Accessible surfaces

The temperature rise with reference to the ambient air temperature (see 5.2) and the cooling liquid (see 5.7) for accessible surfaces shall not exceed the limits given in Table 3.

Table 3 — Limits of temperature rise for accessible surfaces

Accessible surface	Limits of temperature rise K	
	Air cooled transformers	Liquid cooled transformers
Bare metal enclosures	25	35
Painted metal enclosures	35	45
Non-metallic enclosures	45	55
Metal handles	10	20
Non-metallic handles	30	40

Compliance is checked by measurement in accordance with 8.2 using a surface temperature sensor (see 8.3.3).

8.2 Heating test

The test shall be carried out for all settings.

For liquid cooled transformers the flow rate shall be specified for a 100 % duty factor.

The actual values during the heating test shall meet the rated values within the following tolerances:

a) output current: ± 2 % of the permanent output current;

b) cooling liquid flow (if applicable): ± 5 % of the rated value.

The test is carried out at reduced voltage on a new transformer being short-circuited. In case of two output windings, they are short-circuited in parallel.

8.2.1 Start of the heating test

a) In the case of embedded or surface temperature sensors (see 8.3.1 or 8.3.3) the test may be started before a temperature balance between the transformer and the cooling liquid is reached.

b) In the case of resistance measurement (see 8.3.2) the test shall be started only when the temperature difference between cooling liquid inlet and outlet is within 1 K.

The temperature θ_1 of the cooling liquid shall be taken as the initial temperature of the winding during which the initial resistance R_1 is measured.

8.2.2 Duration of the heating test

The heating test shall be carried out until the rate of the temperature rise does not exceed 2 K/h on any component of the transformer.

8.3 Methods of temperature measurements

One method to determine the temperature of any particular part is sufficient.

8.3.1 Embedded temperature sensor

The temperature is measured by one or more embedded thermocouples or other suitable temperature measuring instruments of comparable size applied during the manufacturing of the transformer to the predicted hottest points of the windings.

A thermocouple applied to the hottest point of a single layer winding shall be considered as embedded.