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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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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding* and allied mechanical joining.

This third edition cancels and replaces the second edition (ISO 5826:1999), which has been technically revised.

Requests for official interpretations of any aspect of this standard should be directed to the Secretariat of ISO/TC 44/SC 6 via your national standards body, a complete listing of which can be found at www.iso.org.

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

1 Scope

This International Standard gives specifications applicable to the following types of transformers for use in resistance welding equipment:

— single-phase transformers for a.c. welding, typically operating at 50 Hz or 60 Hz;

— single-phase transformers with connected rectifier for d.c. welding, typically operating at 50 Hz or 60 Hz;

— single-phase inverter transformers with connected rectifier for d.c. welding, typically operating at 400 Hz to 2 kHz;

— three-phase transformers with connected rectifier for d.c. welding, typically operating at 50 Hz or 60 Hz.

For the purposes of this International Standard, the term *transformer* can refer to the transformer alone or with connected rectifier (transformer-rectifier unit).

This International Standard applies to transformers built to protection class I or II according to IEC 61140.

NOTE The requirements of this International Standard can be supplemented by other resistance welding transformer standards, e.g. ISO 22829 and ISO 10656.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60085, *Electrical insulation — Thermal evaluation and designation*

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

IEC 61140, *Protection against electric shock — Common aspects for installation and equipment*

ISO 17657-3, *Resistance welding — Welding current measurement for resistance welding — Part 3: Current sensing coil*

ISO 17657-4, *Resistance welding — Welding current measurement for resistance welding — Part 4: Calibration system*

ISO 17677-1, *Resistance welding — Vocabulary — Part 1: Spot, projection and seam welding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17677-1 and ISO 669, and the following apply.

3.1
transformer-rectifier unit
transformer with connected rectifier
transformer incorporating a full-wave rectifier in its output circuit

3.2
input voltage
U_1
RMS value of the voltage applied to the primary terminals of the transformer

3.3
rated supply voltage
U_{1N}
RMS value of the supply voltage (applied to the input terminals) for which the transformer is constructed

Note 1 to entry: This voltage can be different from the mains voltage.

3.4
d.c. no load voltage
U_{2d}
for transformers, RMS value of the voltage at the output when a load resistance is connected across the output terminals

3.5
input current
I_1
RMS value of the current at the input terminals of the transformer

3.6
output current
I_2
RMS value of the current at the output terminals of the transformer

3.7
output current at a given duty factor
I_{2X}
RMS value of the current at the output terminals of the transformer at a duty factor, X

3.8
no-load input current
I_{10}
RMS value of the current at the input terminals of the transformer with open circuit output terminals

3.9
permanent input current
I_{1p}, I_{Lp}
maximum rated value of the current at the input terminals corresponding to the permanent output current

Note 1 to entry: The relationship between input and output currents depends on the type of transformer.

Note 2 to entry: I_{1p} is used for single-phase transformers; I_{Lp} is used for three-phase transformers.

3.10
permanent output current
I_{2p}
highest output current on all settings of the regulator, for continuous operation (100 % duty factor)

[SOURCE: ISO 669]

Note 1 to entry: The permanent output current is a standardized parameter that is used for comparison and characterization between different transformers. The value of the permanent output current is dependent on the test conditions as described in this standard.

3.11
output current under load condition
I_{2R}
instantaneous RMS value of the output current delivered by the transformer with a load resistance, R

3.12
rated permanent apparent input power
S_{1p}
rated permanent apparent power calculated by $U_{1N} \times I_{1p}$

Note 1 to entry: Welding equipment permanent power, S_p, determined in accordance with ISO 669, may be different from its welding transformer rated permanent apparent input power, S_{1p}.

4 Symbols and abbreviated terms

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

Table 1 — Symbols

Symbol	Description	Used in [section]
I_1	input current	3.5, 9.3
I_{10}	no-load input current	3.8, Clause 11
I_{1p}	rated permanent input current (single-phase transformers)	3.9, 9.1, Clause 12
I_{Lp}	rated permanent input current (three-phase transformers)	3.9, 9.1
I_2	output current	3.6, 9.3, Annex C
I_{2p}	permanent output current at 100 % duty factor	3.10, 9.1, 9.3, 16.2, Annex C
I_{2R}	output current on load condition	3.11, Clause 13
I_{2X}	output current at a given duty factor	3.7, Annex C
m	mass	16.2
S_X	input power at a given duty factor	Annex C
S_{1p}	rated permanent apparent input power	3.12, 9.1, 16.2, Annex C
Q	rated cooling liquid flow	Clause 14, 16.2
R_1	initial resistance of a winding	9.3.5, 9.4.3
R_2	resistance of a winding at end of heating test	9.4.3
T	Time	Annex C
t_1	on-load time	Annex C
T	cycle time	Annex C
U_1	input voltage	3.2, Clause 13
U_{cc}	rated short-circuit voltage	Clause 12, Annex C
U_{1cc}	input short-circuit voltage	Clause 12

Table 1 *(continued)*

Symbol	Description	Used in [section]
U_{1N}	rated supply voltage	3.3, 9.1, 9.3, 10.2, 10.3, Clauses 11, 13, 16.2, Annex C
U_{20}	a.c. no-load voltage	10.1, 10.2, 16.2
U_{2d}	d.c. no-load voltage	3.4, 10.1, 10.3, 16.2
X	duty factor	9.3, Annex C
X_m	duty factor of magnetic circuit	Annex C
Z_2	total impedance referred to output	Clauses 12 and 17
Δ_p	pressure drop of cooling liquid circuit	Clause 14, 16.2
$\Delta\theta_{1,2}$	temperature differences	Annex C
θ	temperature	Annex C
θ_a	cooling medium temperature	9.4.3, Annex B, Annex C
θ_m	equilibrium temperature	Annex C
θ_n	temperature when transformer starts to cool	Annex C
$\theta_{0,1,2}$	temperatures for calculation of thermal time constant or winding temperatures during heating test	9.3.5, 9.4.3, 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 Construction, additional equipment

5.1 Thermal protection

If the transformer and/or the rectifier are equipped with thermoswitches, they shall have a normally closed contact. The insulation shall be suitable for the test conditions prescribed in this standard.

5.2 Output current sensing coil

If the transformer is equipped with an output current sensing coil, the degree of protection of an externally mounted coil shall be lP 55.

The conversion coefficient shall be:

— 50 Hz mains frequency: 150 mV/kA with a load resistance of 1 000 Ω under full sine wave up to 80 °C;

— 60 Hz mains frequency: 180 mV/kA with a load resistance of 1 000 Ω under full sine wave up to 80 °C

The tolerance of the conversion coefficient after mounting in the transformer shall be ± 3 %.

The current sensing coil shall be a Rogowski type. The internal resistance of the current sensing coil shall be 5 to 50 Ω. White and brown colour coding shall be used for the wiring.

6 Physical environment and operating conditions

6.1 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, for example, IEC 60204-1:1997, Annex B).

NOTE Examples of these conditions are: outdoor use, different altitude, different temperature of cooling medium, high humidity, unusually corrosive fumes, steam, excessive oil vapour, abnormal vibration or shock, excessive dust, unusual sea coast or shipboard conditions.

6.2 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.

6.3 Humidity

Transformers shall be capable of operating correctly with a relative humidity up to 95 %.

Harmful effects of condensation shall be avoided by:

— appropriate design of the transformer (e.g. application of electrical potting or encapsulation);

— appropriate design of the welding equipment (e.g. built in heaters, air conditioners, drain holes);

— additional measures (e.g. cooling liquid temperature regulation).

6.4 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.

NOTE At altitudes over 1 000 m, additional electrical safety considerations can be required: see IEC 60664–1.

6.5 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.

Consideration should be given to frost or freezing protection and draining of the cooling water before shipping or storage.

6.6 Provisions for handling

Transformers that weigh over 25 kg shall be provided with suitable means for handling by hoists, cranes or similar equipment such as threaded holes or lifting lugs as appropriate.

6.7 Cooling liquid temperature

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

For cooling liquid temperatures above 30 °C, see Annex B.

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

NOTE For air cooled transformers, see 6.2 and Annex B.

7 Tests

7.1 Test conditions

The tests shall be carried out on a new, dry and completely assembled transformer at an ambient air temperature between + 10 °C and + 40 °C. The ventilation shall be identical with that prevailing under normal service conditions. 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: ± 1,0 % full-scale;

b) output current measuring instruments: ± 5 % full-scale, except for instruments used for verification of the current sensing coil: ± 2 % full-scale;

c) temperature measuring devices: ± 2 K.

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

7.2 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 g), h), i) and j).

a) general visual inspection;

b) insulation resistance (see 8.1) preliminary check;

NOTE The preliminary check on insulation resistance is required to determine whether the transformer is safe before carrying out the remaining tests.

c) thermal rating (see Clause 9);

d) short-circuit voltage, where applicable (see Clause 12);

e) output current under load condition, where applicable (see Clause 13);

f) protection provided by the enclosure (see 8.4);

g) insulation resistance (see 8.1);

h) dielectric strength (see 8.2);

i) dynamic characteristic, where applicable (see Clause 15);

j) general visual inspection.

