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INTERNATIONAL STANDARD

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GROUP ENERGY EFFICIENCY PUBLICATION

Safety of transformers, reactors, power supply units and combinations thereof – Part 2-23: Particular requirements and tests for transformers and power supply units for construction sites

IEC 61558-2-23:2024-06 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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SAFETY OF TRANSFORMERS, REACTORS, POWER SUPPLY UNITS AND COMBINATIONS THEREOF –

Part 2-23: Particular requirements and tests for transformers and power supply units for construction sites

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61558-2-23:2010. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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IEC 61558-2-23 has been prepared by IEC technical committee 96: Transformers, reactors, power supply units and combinations thereof. It is an International Standard.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) adjustment of structure and references in accordance with IEC 61558-1:2017;

b) new symbol for power supply units with linearly regulated output voltage.

The text of this International Standard is based on the following documents:

Draft	Report on voting
96/590/FDIS	96/596/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

It has the status of a group safety publication in accordance with IEC Guide 104.

This International Standard is to be used in conjunction with IEC 61558-1:2017.

This document supplements or modifies the corresponding clauses in IEC 61558-1:2017, so as to convert that publication into the IEC standard: *Particular requirements and tests for transformers and power supply units for construction sites.*

A list of all parts in the IEC 61558 series published under the general title *Safety of transformers, reactors, power supply units and combinations thereof,* can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

Where this document states "*addition*", "*modification*" or "*replacement*", the relevant text of IEC 61558-1:2017 is to be adapted accordingly.

In this document, the following print types are used:

– requirements proper: in roman type;

– *test specifications: in italic type*;

– explanatory matter: in smaller roman type.

In the text of this document, the words in **bold** are defined in Clause 3.

Subclauses, notes, figures and tables additional to those in IEC 61558-1:2017 are numbered starting from 101; supplementary annexes are entitled AA, BB, etc.

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The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

IEC/TC 96 has a group safety function in accordance with IEC Guide 104 for transformers other than those intended to supply distribution networks, in particular transformers and power supply units intended to allow the application of protective measures against electric shock as defined by TC 64, which is about electrical installations and protection against electric shock, but in certain cases including the limitation of voltage and horizontal safety function for **SELV**, in accordance with IEC 60364-4-41.

The group safety function (GSF) is used because of responsibility for **safety extra-low voltage** (**SELV**) in accordance with IEC 61140:2016, 5.2.6 and IEC 60364-4-41:2005, 414.3.1 or control circuits in accordance with IEC 60204-1:2016, 7.2.4.

The group safety function is used for each part of IEC 61558-2 because different standards of the IEC 61558 series can be combined in one construction but in certain cases with no limitation of **rated output** power.

For example an **auto-transformer** in accordance with IEC 61558-2-13 can be designed with a separate **SELV-circuit** in accordance with the particular requirements for IEC 61558-2-6 relating to the general requirements of IEC 61558-1.

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SAFETY OF TRANSFORMERS, REACTORS, POWER SUPPLY UNITS AND COMBINATIONS THEREOF –

Part 2-23: Particular requirements and tests for transformers and power supply units for construction sites

1 Scope

Replacement:

This part of IEC 61558 deals with the safety of **transformers** for construction sites and **power supply units** incorporating **transformers** for construction sites. **Transformers** incorporating **electronic circuits** are also covered by this document.

NOTE 1 Safety includes electrical, thermal and mechanical aspects.

Unless otherwise specified, from here onward, the term **transformer** covers **transformers** for construction sites and **power supply units** incorporating **transformers** for construction sites.

This document is applicable to **stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced) **independent** or **associated transformers,** being **isolating** or **safety isolating dry-type transformers** for the use on construction sites. The windings ~~may~~ can be encapsulated or non-encapsulated.

For **power supply units** (linear) this document is applicable. For **switch mode power supply units**, IEC 61558-2-16 is applicable together with this document. Where two requirements are in conflict, the most severe takes precedence.

The **rated supply voltage** does not exceed 1 000 V AC, and the **rated supply frequency** and the **internal operating frequencies** do not exceed 500 Hz.

~~This standard used in combination with Part 2-16 for **Switch mode power supply units** (**SMPS**) is also applicable to **power supplies** with **internal operating frequencies** higher than 500 Hz. Where the two requirements are in conflict the most severe take precedence~~

The **rated output** does not exceed:

– 25 kVA for single-phase **transformers**;
– 40 kVA for polyphase **transformers**.

This document is applicable to **transformers** without limitation of the **rated output** subject to an agreement between the purchaser and the manufacturer.

NOTE 2 **Transformers** intended to supply distribution networks are not included in the scope.

~~**Isolating transformers** and **power supply units** incorporating~~ **Isolating transformers** for construction sites have a **no-load output voltage** and a **rated output voltage** exceeding 50 V AC and not exceeding 250 V AC.

~~**Safety isolating transformers** and **power supply units** incorporating~~ **Safety isolating transformers** for construction sites have a **no-load output voltage** and a **rated output voltage** not exceeding 50 V AC.

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NOTE 3 This document is applicable to **transformers** for the supply of electricity in locations as specified in IEC 60364-7-704. The latter also specifies the protection by using an earthed midpoint or starpoint of the **output winding**.

NOTE 4 **Transformers** ~~and **power supply units**~~ covered by this document are used in applications where it is required by the installation rules or by the appliance specification for protection purposes.

When the **transformers** ~~or **power supply units**~~ are incorporated into **low voltage switchgear and controlgear assemblies for construction sites** as specified in ~~IEC 60439-4~~ IEC 61439-4, the additional requirements of ~~IEC 60439-4~~ IEC 61439-4 apply to the assembly.

NOTE ~~4~~ 5 For **transformers** filled with liquid dielectric or pulverised material, such as sand, additional requirements are under consideration.

~~NOTE 5~~ Attention is drawn to the following if necessary:

- for **transformers** intended to be used in vehicles, on board ships, and aircraft, additional requirements (from other applicable standards, national rules, etc.);
- measures to protect the **enclosure** and the components inside the **enclosure** against external influences such as fungus, vermin, termites, solar-radiation, and icing ~~should also be considered~~;
- the different conditions for transportation, storage, and operation of the **trans**formers ~~and **power supply units** should also be considered~~;
- additional requirements in accordance with other appropriate standards and national rules ~~may~~ can be applicable to **transformers** ~~and **power supply units**~~ intended for use in special environments ~~such as tropical environment~~.

~~NOTE 6~~ It is possible that the future technological development of **transformers** ~~may necessitate a need to~~ will require an increase in the upper limit of the frequencies. Until then this document may be used as a guidance document.

This group safety publication focusing on safety guidance is primarily intended to be used as a product safety standard for the products mentioned in the scope, but is also intended to be used by technical committees in the preparation of publications for products similar to those mentioned in the scope of this group safety publication, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications and/or group safety publications in the preparation of its publications.

2 Normative references

IEC 61558-1:2017, Clause 2 is applicable, except as follows:

Addition:

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

~~*IEC 60439-4, Low-voltage switchgear and controlgear assemblies – Part 4: Particular requirements for assemblies for construction sites (ACS)*~~

IEC 60245-4:2011, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 4: Cords and flexible cables*

IEC 61558-1:~~2005~~2017, ~~*Safety of power transformers, power supplies, reactors and similar products*~~ *Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61558-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 General terms

Addition:

3.2.101
low voltage switchgear and controlgear assembly for construction sites ~~**(ACS)**~~
combination of one or several transforming or switching devices with associated control, measuring, signalling, protective and regulating equipment complete with all their internal electrical and mechanical connections and structural parts, designed and built for use on all construction sites, indoors or outdoors~~.~~

4 General requirements

IEC 61558-1:2017, Clause 4 is applicable.

5 General notes on tests

IEC 61558-1:2017, Clause 5 is applicable.

6 Ratings

IEC 61558-1:2017, Clause 6 is applicable except as follows:

Addition:

6.101 The **rated output voltage** shall not exceed:

- 250 V AC for **isolating transformers** with a non-earthed mid-point (single-phase) or a non-earthed star-point (three-phase) or delta connection (three-phase)~~ and for **power supply units** incorporating such **transformers**~~;
- ~~110~~ 115 V AC for **isolating transformers** with a mid-point (single-phase) earthed in the construction or a star-point (three-phase) earthed in the construction~~ and for **power supply units** incorporating such **transformers**~~;
- 50 V AC for **safety isolating transformers**~~ and for **power supply units** incorporating **safety isolating transformers**~~.

The **rated output voltage** shall exceed:

- 50 V AC for isolating transformers~~ and for **power supply units** incorporating **isolating transformers**.~~

Preferred values for the **rated output voltage** are

- ~~110~~ 115 V and 230 V for **portable**, single-phase **isolating transformers**;
- 72 V, ~~110~~ 115 V and 230 V for other **isolating transformers**;

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– 6 V, 12 V, 24 V, 42 V and 48 V for **safety isolating transformers**.

6.102 The **rated output** shall not exceed:

– 25 kVA for single-phase isolating and **safety isolating transformers** ~~and **power supply units** incorporating such **transformers**~~;

– 40 kVA for polyphase isolating and **safety isolating transformers** ~~and **power supply units** incorporating such **transformers**~~;

Preferred values for the **rated output** are

– 25 VA, 40 VA, 63 VA, 100 VA, 160 VA, 250 VA, 400 VA, 630 VA, 1 000 VA, 1 600 VA, 2 500 VA, 4 000 VA, 6 300 VA, 10 kVA, 16 kVA and 25 kVA for single-phase **transformers**;

– 630 VA, 1 000 VA, 1 600 VA, 2 500 VA, 4 000 VA, 6 300 VA, 10 kVA, 16 kVA, 25 kVA and 40 kVA for polyphase **transformers**.

Intermittent duty cycle ~~may~~ can be assigned only to **portable transformers** ~~and **power supply units**~~ having a **rated output** not exceeding 6,3 kVA.

Transformers without limitation of the **rated output** shall be subject to agreement between the purchaser and the manufacturer.

6.103 The **rated supply frequency** shall not exceed 500 Hz.

6.104 The **rated supply voltage** shall not exceed 1 000 V AC.

6.105 **Transformers** with **intermittent duty cycle** shall be intended for a **rated** operating time of 5 min "on" and a resting time of 15 min "off".

6.106 The supply current is limited to a maximum of 125 A, and in the case of flexible cable or socket outlet, to 63 A.

Compliance with 6.101 to 6.106 is checked by inspection of the marking.

7 Classification

IEC 61558-1:2017, Clause 7 is applicable, except as follows:

Replacement:

7.5 **Transformers** are classified in accordance with their duty type:

– **continuous duty**;

– **intermittent duty cycle**.

8 Marking and other information

IEC 61558-1:2017, Clause 8 is applicable, except as follows:

8.1 h)

~~*Replacement:*~~

~~The **transformers** shall be marked with one of the graphical symbols shown in 8.11;~~

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Replacement of the content up to the first semi-colon with the following:

relevant graphical symbols shown in Table 101 that indicate the kind of **transformer**

8.11

Addition:

The symbol for linear **power supply units** shall be used in conjunction with the symbol indicating the kind of **transformer**.

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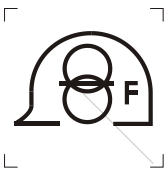
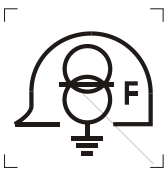
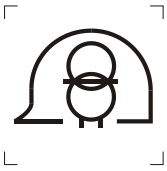
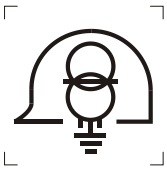
Table 101 – Symbols indicating the kind of transformer

Symbol or graphical symbol	Explanation or title	Identification
	**Isolating transformer for construction ~~site~~sites, fail-safe**	IEC 60417-6010-1:2007-02
	Safety isolating transformer for construction ~~site~~sites, fail-safe~~, safety~~	IEC 60417-6010-2:2007-02
	**Isolating transformer for construction ~~site~~sites, fail-safe**, mid-point or star-point earthed	IEC 60417-6010-3:2007-02
	**Isolating transformer for construction sites**, non-short-circuit proof	IEC 60417-6010-4:2007-02
	Safety isolating transformer for construction sites, non-short-circuit proof~~, safety~~	IEC 60417-6010-5:2007-02
	**Isolating transformer for construction sites**, non-short-circuit proof, mid-point or star-point earthed	IEC 60417-6010-6:2007-02
	Isolating transformer for construction sites, short-circuit proof (inherently or non-inherently)	IEC 60417-6010-7:2007-02
	Safety isolating transformer for construction sites, short-circuit proof~~, safety~~ (inherently or non-inherently)	IEC 60417-6010-8:2007-02

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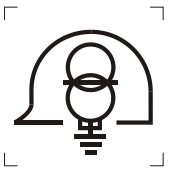
Symbol or graphical symbol	Explanation or title	Identification
	**Isolating transformer for construction sites**, short-circuit proof (inherently or non-inherently), mid-point or star-point earthed	IEC 60417-6010-9:2007-02
	Power supply unit, linear To identify the electronic device incorporating **transformer**(s) and electronic circuitry(ies), that converts electrical power into single or multiple power outputs, the output voltage is linearly regulated. The internal operating frequency does not exceed 500 Hz.	IEC 60417-6210:2013-10

9 Protection against electric shock

IEC 61558-1:2017, Clause 9 is applicable.

10 Change of input voltage setting

IEC 61558-1:2017, Clause 10 is applicable.

11 Output voltage and output current under load

IEC 61558-1:2017, Clause 11 is applicable.

12 No-load output voltage

IEC 61558-1:2017, Clause 12 is applicable except as follows:

Addition:

12.101 The **no-load output voltage** shall not exceed:

- 250 V AC for **isolating transformers** with a non-earthed mid-point (single-phase) or a non-earthed star-point (three-phase) or delta connection (three-phase)~~ and for **power supply units** incorporating such **transformers**~~);
- ~~116~~ 115 V AC for **isolating transformers** with a mid-point (single-phase) earthed in the construction or a star-point (three-phase) earthed in the construction~~ and for **power supply units** incorporating such **transformers**~~;
- 50 V AC for **safety isolating transformers**~~ and for **power supply units** incorporating **safety isolating transformers**~~.

For **independent transformers**, the **no-load output voltage** limitation applies even when **output windings**, not intended for interconnection, are connected in series.

The **no-load output voltage** shall exceed:

- 50 V AC for isolating **transformers**~~ and **power supply units** incorporating **isolating transformers**~~.

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12.102 The difference between the **no-load output voltage** and the **output voltage** under load shall not be excessive.

~~*Compliance with the requirements of 12.101 and 12.102 is checked by measuring the* **no-load output voltage** *at the* **ambient temperature** *when the* **transformer** *is connected to the* **rated supply voltage** *at the* **rated supply frequency**.~~

The ~~*difference*~~ ratio between the **no-load output voltage** measured in Clause 12 and the **output voltage** under load measured during the test of Clause 11, expressed as a percentage of the latter voltage, shall not exceed the values shown in Table 102 or Table 103.

~~NOTE~~ The ratio is determined by Formula (1):

$$\frac{U_{\text{no-load}} - U_{\text{load}}}{U_{\text{load}}} \times 100(\%) \quad (1)$$

where

$U_{\text{no-load}}$ is the no-load output voltage, expressed in V;

U_{load} is the output voltage under load, expressed in V.

Table ~~101~~ 102 – ~~Ratio of output voltages~~ Output voltage ratio for safety isolating transformers

Type of transformer Rated output VA	Ratio between no-load output voltage and output voltage under load %
Inherently short-circuit proof transformers:	
– up to and including 63	100
– over 63 up to and including 630	50
– over 630	20
Other **transformers**:	
– up to and including 10	100
– over 10 up to and including 25	50
– over 25 up to and including 63	20
– over 63 up to and including 250	15
– over 250 up to and including 630	10
– over 630	5

Table ~~102~~ 103 – ~~Ratio of output voltages~~ Output voltage ratio for isolating transformers

Type of transformer Rated output VA	Ratio between no-load output voltage and output voltage under load %
All type of transformers:	
– up to and including 63	20
– over 63 up to and including 250	15
– over 250 up to and including 630	10
– over 630	5

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For single-phase **transformers** with earthed midpoint, the voltage between any pole of the **output circuit** and earthing shall not exceed the result of Formula (2):

~~$\left(\frac{\text{no - load output voltage}}{2}\right) \pm 2{,}5\ \%$~~

$$\frac{U_{\text{no-load}}}{2} \pm 2{,}5\ \% \qquad (2)$$

For three-phase **transformers** with earthed star-point, the voltage between any pole of the **output circuit** and earthing shall not exceed the result of Formula (3):

~~$\left(\frac{\text{no - load output voltage}}{\sqrt{3}}\right) \pm 2{,}5\ \%$~~

$$\frac{U_{\text{no-load}}}{\sqrt{3}} \pm 2{,}5\ \% \qquad (3)$$

*Compliance with the requirements of 12.101 and 12.102 shall be checked by measuring **the no-load output voltage** at **ambient temperature** when the **transformer** is connected to the **rated supply voltage** at the **rated supply frequency**.*

13 Short-circuit voltage

IEC 61558-1:2017, Clause 13 is applicable.

14 Heating

IEC 61558-1:2017, Clause 14 is applicable.

15 Short-circuit and overload protection

IEC 61558-1:2017, Clause 15 is applicable.

16 Mechanical strength

IEC 61558-1:2017, Clause 16 is applicable except as follows:

16.1 General

Replacement:

Transformers ~~and **power supply units**~~ for construction sites shall have adequate mechanical strength and be so constructed as to withstand such rough handling and transport as ~~may~~ can be expected in normal use.

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*Compliance is checked by the tests of 16.2 for **stationary transformers** and ~~**power supply units** and~~ by the tests of 16.2, 16.3 and 16.4 as appropriate, for **portable transformers** ~~and **portable power supply units**~~.*

*After the tests, the **transformers** ~~or **power supply units**~~ shall show no damage within the meaning of this document. In particular, **hazardous live parts** shall not become accessible, when tested as described in 9.2. Insulating barriers shall not be damaged and handles, levers, knobs and the like shall not move on their shafts.*

NOTE 1 Damage to the finish, small dents which do not reduce **creepage distances** or **clearances** below the values specified in Clause 26, and small chips which do not adversely affect the protection against electric shock or moisture, are ignored.

NOTE 2 Cracks not visible with normal vision or corrected vision without magnification and surface cracks in fibre reinforced mouldings and the like are ignored.

In addition, with respect to the test of 16.4, bending of the pins during the test is considered acceptable.

16.2 Stationary transformers

Replacement:

16.2 Impact test and shock test

16.2.1 Impact test

NOTE This test simulates collisions between the **transformer** ~~or **power supply unit**~~ and mechanical handling equipment for construction site.

*The complete **transformer** ~~or **power supply unit**~~, as applicable, shall be subjected to a series of impacts of 6 J applied to the **enclosure** as follows:*

*The equipment to be tested shall be fixed on a support of adequate rigidity to restrict movement of the **transformers** ~~or **power supply units**~~ to 0,1 mm under the effect of the prescribed impact. Three successive impacts shall be applied to the most unfavourable point of the **enclosure** by means of either:*

*a) a solid smooth steel sphere approximately 50 mm in diameter and with a mass of 500 g ± 25 g, falling freely from a rest position from a vertical height of 1,2 m onto the **enclosure** surface held in a horizontal plane. The hardness of the sphere shall be not less than 50 HR and not more than 58 HR (see Figure 101), or*

b) a similar steel sphere, which shall be suspended by a cord and swung as a pendulum in order to apply a horizontal impact, falling through a vertical distance of 1,2 m (see Figure 102).

*Sloping surfaces ~~may~~ can be tested using the pendulum but if this is not convenient the surface will be aligned in the horizontal plane by turning the **transformers** ~~or the **power supply units**~~, as applicable, on the support and the test a) is used. Before each test, an inspection of the sphere shall be made to ensure that it is free of burrs and defects.*

*The test shall be so arranged that the impacts are applied at positions where the weaknesses are most likely to be revealed. A minimum of 18 impacts shall be applied to the **transformers** ~~or **power supply units**~~, as applicable.*

The test is not applicable to components such as socket-outlets, operating handles, illuminating lights, push buttons, actuators, etc., when these components are mounted in recesses with respect to the main surfaces, so that the distance between the most exposed parts of these components and the ~~said~~ surfaces is at least 10 mm.

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*After the test, the **enclosure** shall continue to provide the degrees of protection specified in 19.16; any distortions or deformations of the **enclosure** and components shall neither be detrimental to the proper functioning of the **transformer**, nor decrease **creepage distances** and **clearances** to below the required values; actuators, handles, etc. shall still be operable.*

Superficial damage, removed paint, broken cooling ribs or similar parts, small indentations, cracks not visible with normal or corrected vision without further magnification, or surface cracks shall not constitute test failures.

16.2.2 Shock test

NOTE This test simulates the shocks received by **transformers** ~~and **power supply units**~~ carried loose on board vehicles on normal roads or on railway cars for long periods of time.

*The complete **transformers** ~~or **power supply units**~~, as applicable, in working order shall be tested in accordance with IEC 60068-2-27 with a severity of 500 m/s^2 peak acceleration and duration of 11 ms.*

*After the test, the **enclosure** shall continue to provide the degrees of protection specified in 19.16; any distortions or deformations of the **enclosure** and components shall neither be detrimental to the proper functioning of the **transformer**, nor decrease **creepage distances** and **clearances** to below the required values; actuators, handles, etc., shall still be operable.*

Superficial damage, removed paint, broken cooling ribs or similar parts, small indentations, cracks not visible with normal or corrected vision without further magnification, or surface cracks shall not constitute test failures.

17 Protection against harmful ingress of dust, solid objects and moisture

IEC 61558-1:2017, Clause 17 is applicable.

18 Insulation resistance, dielectric strength and leakage current

IEC 61558-1:2017, Clause 18 is applicable.

19 Construction

IEC 61558-1:2017, Clause 19 is applicable except as follows:

19.1 General construction

Replacement:

19.1.1 The **input** and **output circuits** shall be electrically separated from each other, and the construction shall be such that there is no possibility of any connection between these circuits, either directly or indirectly, via other **conductive parts**, except by deliberate action.

Compliance is checked by inspection and measurements~~, taking Clauses 18 and 26 into consideration~~ in accordance with Clause 18 and Clause 26.

19.1.~~1~~2 The insulation between **input** and **output winding(s)** shall consist of **double** or **reinforced insulation** (rated for the **working voltage**).

In addition, the following applies:

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- for **class I transformers** not intended for connection to the mains supply by means of a plug, the insulation between the **input windings** and the **body** connected to earthing shall consist of at least **basic insulation** rated for the **input voltage**. The insulation between the **output windings** and the **body** connected to earthing, shall consist of at least **basic insulation** (rated for the **output voltage**);
- for **class I transformers** intended for connection to the mains supply by means of a plug, the insulation between the **input windings** and the **body** shall consist of at least **basic insulation**, and the insulation between the **output windings** and the **body** shall consist of at least **supplementary insulation** (both basic and **supplementary insulations** rated for the **working voltage**);
- for **class II transformers**, the insulation between the **input windings** and the **body** shall consist of **double** or **reinforced insulation** (rated for the **input voltage**). The insulation between the **output windings** and the **body** shall consist of **double** or **reinforced insulation** (rated for the **output voltage**).

19.1.~~2~~3 For **transformers** with **intermediate conductive parts** (e.g. the iron core) not connected to the **body** and located between the **input** and **output windings** the insulation between the **input windings** and any **intermediate conductive part** shall consist of at least **basic insulation**, and the insulation between the **output windings** and any **intermediate conductive part** shall consist of at least **supplementary insulation** (both **basic** and **supplementary insulations** rated for the **working voltage**).

NOTE 1 An **intermediate conductive part** not separated from the **input** or **output windings** or the **body** by at least **basic insulation** is considered to be connected to the relevant part(s).

NOTE 2 **Basic insulation** and **supplementary insulation** are interchangeable.

In addition, the following applies:

- for **class I transformers**, the insulation between the **input** and **output windings** via the **intermediate conductive parts** (even if they are connected to earthing) shall consist of **double** or **reinforced insulation** (rated for the **working voltage**);
- for **class II transformers**, the insulation between the **input windings** and the **body**, and between the **output windings** and the **body** via the **intermediate conductive parts** shall consist of **double** or **reinforced insulation** (rated for the **input** and **output voltage);**
- for **transformers** different from independent transformers (IP00), the insulation between the **input** and **output windings** via the **intermediate conductive parts** shall consist of **double** or **reinforced insulation** (rated for the **working voltage**).

~~NOTE 3~~ In this Subclause 19.1.3 the possibility to consider the **intermediate ~~metal~~ conductive part** connected to earthing and consequently to require **basic insulation** in both circuits (primary and secondary) is not allowed for the following reason:

- the **intermediate ~~metal~~ conductive part** is normally the iron core made by laminated strips insulated from other by oxide coatings. It is not assured that all laminations are correctly connected to earthing.
- for **transformers** different from independent, it is not assured that in the final applications the iron core will be connected to earthing.

19.1.~~3~~4 For **class I transformers** not intended for connection to the mains supply by means of a plug, the insulation between the **input** and **output windings ~~may~~** can consist of **basic insulation** plus **protective screening** instead of **double** or **reinforced insulation**, provided the following conditions are complied with:

- the insulation between the **input winding** and the **protective screen** shall comply with the requirements for **basic insulation** (rated for the **input voltage**);
- the insulation between the **protective screen** and the **output winding** shall comply with the requirements for **basic insulation** (rated for the **output voltage**);

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- the **protective screen** shall, unless otherwise specified, consist of a metal foil or of a wire wound screen extending at least the full width of the **input winding** and shall have no gaps or holes;
- where the **protective screen** does not cover the entire width of the **input winding**, additional adhesive tapes or equivalent insulation shall be used to ensure **double insulation** in that area;
- if the **protective screen** is made of a foil, the turns shall be insulated from each other. In case of only one turn, it shall have an isolated overlap of at least 3 mm;
- the wire of a wire wound screen and the lead out wire of the **protective screen** shall have a cross-sectional area at least corresponding to the **rated current** of the overload device to ensure that if a breakdown of insulation should occur, the overload protective device will open the circuit before the lead-out wire is destroyed;
- the lead-out wire shall be soldered to the **protective screen** or secured in an equally reliable manner.

NOTE 4 For the purpose of this Subclause 19.1.4, the term "windings" does not include **internal circuits.**

NOTE 5 Examples of construction of windings are given in IEC 61558-1:2017, Annex M.

19.16 Portable transformers for use in irregular or harsh conditions

Addition:

Transformers ~~and **power supply units for construction sites**~~ shall be conform to the protection ~~code of~~ index not less than IP44 for **fixed transformers** ~~and **power supply units**~~, and not less than IP54 for **portable transformers** ~~and **portable power supply units**~~, except socket-outlet(s) shall have a protection ~~code~~ index not less than IP44.

Addition:

19.101 There shall be no connections between the **output circuit** and the protective earthing, unless this is allowed by the relevant equipment standard for **associated transformers** ~~and **power supply units**~~.

19.102 There shall be no connections between the **output circuit** and the **body**, unless this is allowed by the relevant equipment standard for **associated transformers**.

Compliance is checked by inspection.

19.103 The input and output terminals for the connection of external wiring shall be so located that the distance measured between the points of introduction of the conductors into these terminals is not less than 25 mm. If a barrier is used to obtain this distance, the measurement shall be made over and around the barrier and it shall be of insulating material and be permanently fixed to the **transformer**.

*Compliance is checked by inspection and by measurement disregarding **intermediate conductive parts**.*

19.104 **Portable transformers** having a **rated output** not exceeding 630 VA shall be class II.

19.105 ~~to **19.110** Void~~

~~**19.111**~~ **Output circuits** shall provide protection against electric shock by one of the following means:

- the socket-outlets are supplied by **SELV**;

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- the socket-outlets are supplied by an **output circuit** not exceeding ~~110~~ 115 V AC with the mid-point or star-point earthed to provide a line to earthing voltage not exceeding 55 V AC single-phase or 63,5 V AC three-phase;
- the socket-outlets are supplied by **output circuits** not connected to earthing and exceeding 50 V AC;
- each **output circuit** shall supply only one socket outlet.

~~NOTE~~ The above methods of protection do not require an additional protection by means of an RCD in accordance with 704.410.3 of IEC 60364-7-704:2017.

19.~~112~~106 For **transformers** with mid-point or star-point at **output windings** intended to be connected to earthing, the connection to earthing shall be made in the field. These **transformers** shall not have the **output winding** tapped at any other point.

20 Components

IEC 61558-1:2017, Clause 20 is applicable.

21 Internal wiring

IEC 61558-1:2017, Clause 21 is applicable.

22 Supply connection and other external flexible cable or cords

IEC 61558-1:2017, Clause 22 is applicable except as follows:

Replacement

22.5 Transformers ~~and **power supply units for use on construction sites**~~ shall be provided with at least heavy polychloroprene cords ~~according to code designation 66 of~~ in accordance with IEC 60245-4:2011 – type 60245 IEC 66.

23 Terminals for external conductors

IEC 61558-1:2017, Clause 23 is applicable.

24 Provisions for protective earthing

IEC 61558-1:2017, Clause 24 is applicable.

25 Screws and connections

IEC 61558-1:2017, Clause 25 is applicable.

26 Creepage distances, clearances and distances through insulation

IEC 61558-1:2017, Clause 26 is applicable.

27 Resistance to heat, fire and tracking

~~This clause of Part 1 is applicable.~~

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27.1 IEC 61558-1:2017, 27.1 is applicable.

28 Resistance to rusting

IEC 61558-1:2017, Clause 28 is applicable.

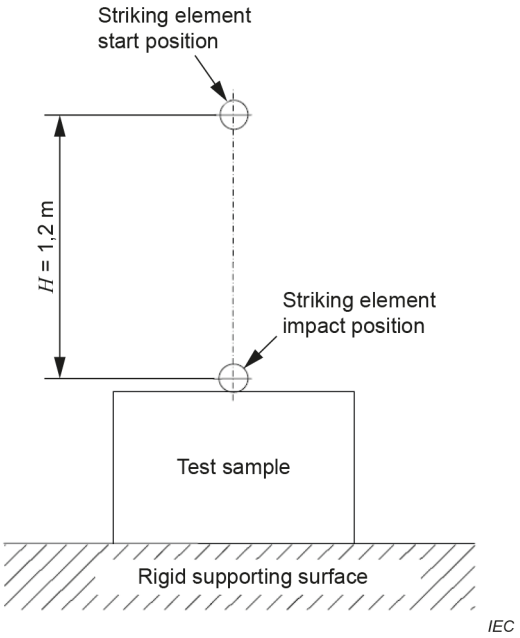

Figure 101 – Impact test for horizontal surface

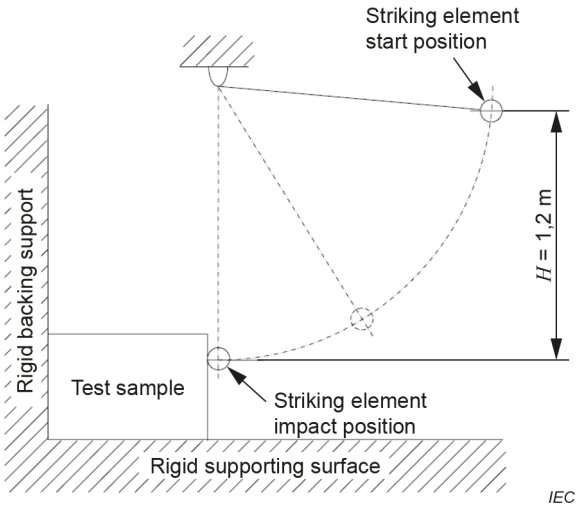

Figure 102 – Impact test for vertical surface

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