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REDLINE VERSION

INTERNATIONAL STANDARD



GROUP ENERGY EFFICIENCY PUBLICATION

**Safety of transformers, reactors, power supply units and combinations thereof –
Part 2-10: Particular requirements and tests for separating transformers with
high insulation level and separating transformers with output voltages
exceeding 1 000 V**

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2-10: Particular requirements and tests for separating transformers with high insulation level and separating transformers with output voltages exceeding 1 000 V

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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 61558-2-10:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61558-2-10 has been prepared by IEC technical committee 96: Transformers, reactors, power supply units and combinations thereof. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. 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) overvoltage categories I, II, III and IV for clearances and dielectric strength tests are included;
- c) clearances for homogenous field conditions deleted.

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

Draft	Report on voting
96/589/FDIS	96/595/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 separating transformers with high insulation level and separating transformers with output voltages exceeding 1 000 V*.

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.

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 2-10: Particular requirements and tests for separating transformers with high insulation level and separating transformers with output voltages exceeding 1 000 V

1 Scope

Replacement:

This part of IEC 61558 deals with the safety of **separating transformers with high insulation level** and **separating transformers with output voltages exceeding 1 000 V**. 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 **separating transformers with high insulation level** and **separating transformers with output voltages exceeding 1 000 V AC or 1 500 V DC**.

This document is applicable to **stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced) **independent** or **associated dry-type transformers**. The windings ~~may~~ can be encapsulated or non-encapsulated.

~~This standard is applicable to **transformers** and **power supply** (linear) with **internal operational frequencies** not exceeding 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 operational frequencies** higher than 500 Hz. Where the two requirements are in conflict the most severe take precedence.~~

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.

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.

Where applicable the **no-load output voltage** or the **rated output voltage**:

- does not exceed 1 000 V AC or 1 500 V DC for **separating transformers with high insulation level**;
- does exceed 1 000 V AC or 1 500 V DC and does not exceed 15 000 V AC or 15 000 V DC for **separating transformers with output voltage exceeding 1 000 V**.

This document does not apply to:

- **transformers** covered by IEC 60076-11;
- neon **transformers** covered by IEC 61050; and
- **power supplies** and converters for use with or in products according to IEC 61347-2-10.

This document is not applicable to external circuits and their components intended to be connected to the input terminals and output terminals of the **transformers**.

NOTE 2 **Transformers** covered by this document are used only in applications where **double or reinforced insulation** between circuits is not required by the installation rules or by the end product standard.

NOTE 2 3 Normally, the **transformers** are intended to be used with equipment to provide voltages different from the **supply voltage** for the functional requirements of the equipment. The protection against electric shock can be provided (or completed) by other features of the equipment, such as the **body**. Parts of **output circuits** can be connected to the **input circuits** or to **protective earthing**.

This document is applicable to **transformers** associated with specific equipment, to the extent decided upon by the relevant IEC technical committees.

NOTE 3 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.) ~~can be necessary~~;
- measures to protect the **enclosure** and the components inside the **enclosure** against external influences such as fungus, vermin, termites, solar-radiation, and icing ~~can also be considered~~;
- the different conditions for transportation, storage, and operation of the **transformers** ~~can also be considered~~;
- additional requirements in accordance with other appropriate standards and national rules can be applicable to **transformers** intended for use in special environments, ~~such as tropical environment~~.

NOTE 4 It is possible that future technological development of **transformers** ~~can necessitate a need to~~ will require an increase in the upper limit of the frequencies. Until then this document can 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 61558-1:2005, Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests
Amendment 1:2009~~

~~IEC 61558-2-16, Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units~~

IEC 61558-1:2017, Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests

3 Terms and definitions

~~This clause of Part 1 is applicable except as follows:~~

~~The third paragraph is not applicable.~~

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>

3.1 Transformers

Addition:

3.1.101

separating transformer with high insulation level

separating transformer where the **output voltage** does not exceed 1 000 V AC or 1 500 V DC and does exceed 50 V AC or DC for **independent transformers**, the **output winding(s)** is (are) isolated from both, **input winding(s)** and **body** for a **working voltage** exceeding 1 000 V AC or 1 500 V DC but not exceeding 15 000 V AC or 15 000 V DC

~~Note 1 to entry: The output winding(s) are isolated from both, input winding(s) and body for a working voltage exceeding 1 000 V a.c or 1 500 V d.c but not exceeding 15 000 V a.c or 15 000 V d.c.~~

3.1.102

separating transformer with output voltages exceeding 1 000 V

separating transformer where the **output circuits** of which are designed to give voltages exceeding 1 000 V AC or 1 500 V DC and not exceeding 15 000 V AC or 15 000 V DC

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

~~This clause of Part 1 is not applicable.~~

Replacement:

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

Addition:

6.101 The **rated output voltage** is limited as follows.

For **separating transformers with high insulation level**:

- the **no-load output voltage** or the **rated output voltage** shall not exceed 1 000 V AC or 1 500 V DC;
- for **independent transformers** the **rated output voltage** shall exceed 50 V AC or 50 V DC and this **output voltage** applies even when **output windings**, not intended for interconnection, are connected in series.

For **separating transformers with no load output voltages exceeding 1 000 V**:

- the **rated output voltage** shall exceed 1 000 V AC or 1 500 V DC and shall not exceed 15 000 V AC or 15 000 V DC;
- for **independent transformers** these **output voltage** limitations apply even when **output windings**, not intended for interconnection, are connected in series.

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

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

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

6.103 The **rated supply frequency** and the **internal operating frequencies** shall not exceed 500 Hz.

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

Compliance with the requirements of 6.101 to 6.104 is checked by inspection of the marking.

7 Classification

IEC 61558-1:2017, Clause 7 is applicable.

8 Marking and other information

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

8.1 h)

Replacement:

~~Replace the first sentence by the following: relevant graphical symbols shown in 8.11 indicating the kind of transformer;~~

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

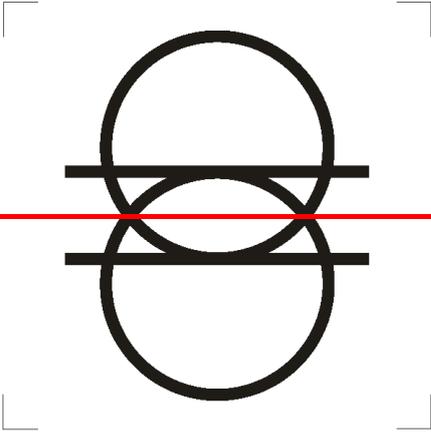
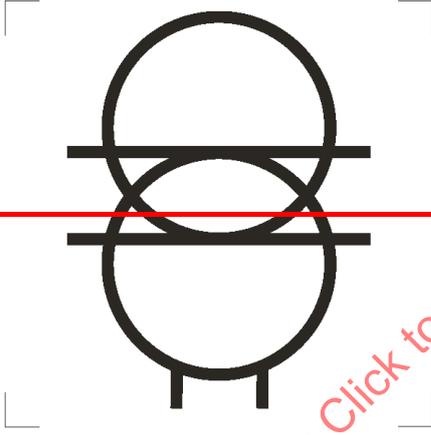
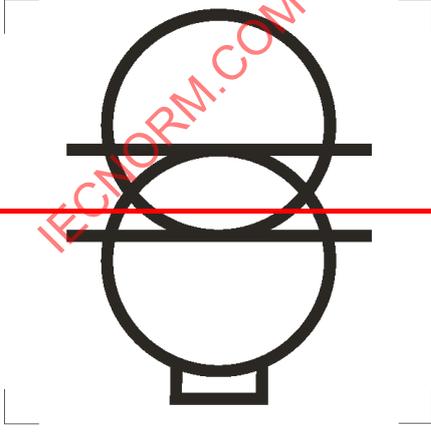
relevant graphical symbols shown in Table 101 that indicate the kind of **transformer**

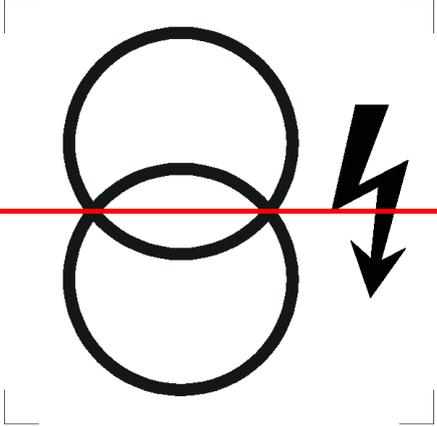
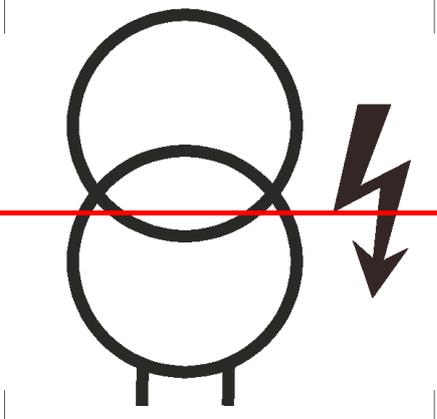
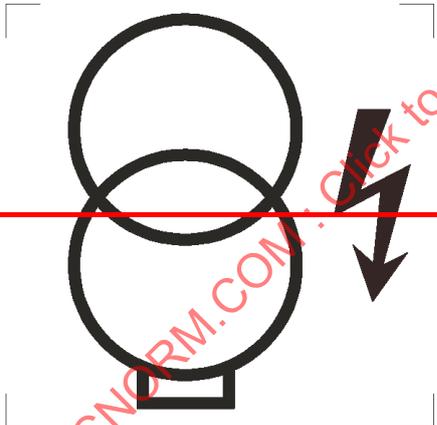
The voltage of the **insulation level**, expressed in kV is not a part of the symbol.

8.11

Addition:

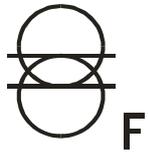
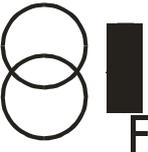
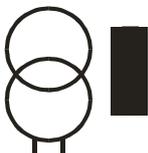
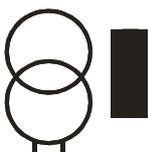
The symbol for linear **power supply units** shall be used in conjunction with the symbol indicating the kind of **transformer**.

Symbol or graphical symbol	Explanation or title	Identification
	<p>Separating transformer, high insulation level, general</p> <p>To identify the separating transformer with high insulation level, where the letter "F" may be used adjacent to the symbol to indicate a fail-safe function.</p> <p>The voltage of the insulation level, expressed in kV, may be added adjacent to the symbol.</p>	IEC 60417-6063
	<p>Separating transformer, high insulation level, non-short-circuit-proof</p> <p>To identify the non-short-circuit-proof separating transformer with high insulation level.</p> <p>The voltage of the insulation level, expressed in kV, may be added adjacent to the symbol.</p>	IEC 60417-6064
	<p>Separating transformer, high insulation level, short-circuit-proof</p> <p>To identify the short-circuit-proof (inherently or non-inherently) separating transformer with high insulation level.</p> <p>The voltage of the insulation level, expressed in kV, may be added adjacent to the symbol.</p>	IEC 60417-6065

Symbol or graphical symbol	Explanation or title	Identification
	<p>Separating transformer, output voltages exceeding 1 kV, general</p> <p>To identify the separating transformer with output voltages exceeding 1 000 V and not exceeding 15 000 V, where the letter "F" may be used adjacent to the symbol to indicate a fail-safe function.</p>	<p>IEC 60417-6066</p>
	<p>Separating transformer, output voltages exceeding 1 kV, non-short-circuit-proof</p> <p>To identify the non-short-circuit-proof separating transformer with output voltages exceeding 1 000 V and not exceeding 15 000 V.</p>	<p>IEC 60417-6067</p>
	<p>Separating transformer, output voltages exceeding 1 kV, short-circuit-proof</p> <p>To identify the short-circuit-proof (inherently or non-inherently) separating transformer with output voltages exceeding 1 000 V and not exceeding 15 000 V.</p>	<p>IEC 60417-6068</p>

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Table 101 – Symbols indicating the kind of transformer

Symbol or graphical symbol	Explanation or title	Identification
	Fail-safe separating transformers with high insulation level The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.	IEC 60417-6063:2011-05
	Non-short-circuit proof separating transformer with high insulation level The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.	IEC 60417-6064:2011-05
	Short-circuit-proof separating transformer with high insulation level (inherently or non-inherently) The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.	IEC 60417-6065:2011-05
	Fail-safe separating transformers with output voltages exceeding 1 000 V	IEC 60417-6066:2011-06
	Non-short-circuit-proof separating transformer with output voltages exceeding 1 000 V	IEC 60417-6067:2011-06
	Short-circuit-proof separating transformer with output voltages exceeding 1 000 V (inherently or non-inherently)	IEC 60417-6068:2011-06
	Power supply unit, linear	IEC 60417-6210:2013-10

Addition:

8.101 Separating transformers with high insulation level shall be marked with the voltage of the **insulation level**, expressed in kV on the right side of the symbol.

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:

The **no-load voltage** is measured when the **transformer** is connected to the **rated supply voltage** at the **rated supply frequency** at ambient temperature.

12.101 For separating transformers with high insulation level:

- the **no load output voltage** shall not exceed 1 000 V AC or 1 500 V DC. For **independent transformers** the **no-load output voltage** shall exceed 50 V AC or 50 V DC. This limitation applies even when independent **output windings**, not intended for interconnection, are connected in series.

12.102 For separating transformers with output voltages exceeding 1 000 V:

- the **no-load output voltage** shall exceed 1 000 V AC or 1 500 V DC and shall not exceed 15 000 V AC or DC. For **independent transformers** this limitation applies even when independent **output windings**, not intended for interconnection, are connected in series.

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

The 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.

~~The difference is expressed as a percentage of the latter voltage calculated according to the following 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. ~~The difference shall not exceed the values shown in Table 101.~~

Table 102 – Output voltage difference

Type of transformer Rated output VA	Difference 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 630	20
– over 630	15

Compliance with the requirements of 12.101, 12.102 and 12.103 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.

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 except as follows:

18.3 Dielectric strength test

Replacement:

Immediately after the test of 18.2 the **insulation** is subjected for 1 min to a dielectric strength voltage of substantially sinusoidal wave form at 50 Hz or 60 Hz. The value of the dielectric strength test voltage and the points of application are given in **Table 102** Table 103.

Resistors, capacitors and other components are disconnected before carrying out the test.

For **working voltages** up to and including 1 000 V the dielectric strength voltage shall not be less than the values shown in Table 14 of IEC 61558-1:2017.

Table 103 – Table of dielectric strength test voltages for working voltages above 1 000 V

Application of dielectric strength test voltage	Working voltage over 1 000 V, up to and including 15 000 V
Additional value for the corresponding transients of the different overvoltage categories	$U_{OVC I} = 500 \text{ V}$ $U_{OVC II} = 750 \text{ V}$ $U_{OVC III} = 1\,000 \text{ V}$ $U_{OVC IV} = 1\,250 \text{ V}$
1) Between live parts of input circuits and live parts of output circuits basic insulation	$2 \times \text{working voltage} + 1\,000 \text{ V} + U_{OVC}$
2) Over basic insulation or supplementary insulation between: <ul style="list-style-type: none"> a) live parts of different polarity. Test is not applicable within the same winding b) live parts and the body, if intended to be connected to the protective earthing c) accessible conductive parts and a metal rod of the same diameter as the flexible cable or cord (or metallic foil wrapped round the cord) inserted inside inlet bushing, cord guards and anchorage, and the like d) live parts and an intermediate conductive part e) conductive parts and the body f) each input circuit and all other input circuits connected together 	$2 \times \text{working voltage} + 1\,000 \text{ V} + U_{OVC}$
Dielectric strength test voltages for double or reinforced insulation (e.g. for a class II transformer insulation) shall be twice the values for basic insulation .	

19 Construction

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

19.1 General construction

Replacement:

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, through other **conductive parts**, except by deliberate action.

Compliance is checked by inspection and measurements, taking Clause 18 and Clause 26 into consideration.

Addition:

19.1.101 The **insulation** between **input** and **output winding(s)** shall consist of at least **basic insulation** (rated for the **working voltage**).

In addition, the following applies:

- for **class I transformers**, the **insulation** between the **input windings** and the **body**, and between the **output windings** and the **body**, shall consist of **basic insulation** (both **basic insulations** 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**, shall consist of **double or reinforced insulation** (both **double or reinforced insulations** rated for the **working voltage**).

19.1.102 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 **intermediate conductive parts** and the **input windings**, and between the **intermediate conductive parts** and the **output windings** shall consist of **basic insulation** (rated for the **working voltage**).

NOTE 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).

In addition, the following applies:

- for **class I transformers**, the **insulation** between the **input** and **output windings** via the **intermediate conductive parts** shall consist of at least **basic 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**).

Addition:

19.101 Parts of **output circuits** ~~may~~ can be connected to **protective earthing**.

19.102 There shall be no connection between the **output circuits** and the **body**, unless – for **associated transformers** – allowed by the relevant equipment standard.

Compliance is checked by inspection.

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 cables or cords

IEC 61558-1:2017, Clause 22 is applicable.

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 except as follows:

Replacement:

26.1 General

Replacement of the first and second paragraph ~~by~~ together with the note with the following:

~~For working voltages up to and including 1 000 V the creepage distances, clearances and distances through insulation shall not be less than the values shown in Table 13 for insulating materials of group III a (see IEC 60664-1).~~

~~For working voltages over 1 000 V, up to and including 15 000 V the creepage distances, clearances and distances through insulation shall not be less than the values shown in Table 103 for insulating materials of at least group III a (see IEC 60664-1)~~

~~Compliance is checked by measurements under the provisions of 26.2 and 26.3~~

~~NOTE 1~~

~~— For working voltages up to and including 1 000 V: For materials of groups I and II, see Tables C.1 and D.1.~~

~~— For working voltages exceeding 1 000 V and up to and including 15 000 V: For material groups II and I see Table 103.~~

~~NOTE 2 Table 13, Table C.1 and Table D.1 and Table 102 are applicable only for frequencies up to and including 30 kHz.~~

~~Replacement of NOTE 7 by the following:~~

~~NOTE 7 Table 13, Table C.1 and Table D.1 take into consideration over voltage category II for basic insulation and over voltage category III for double or reinforced insulation.~~

For working voltages up to and including 1 000 V the clearances, creepage distances and distances through insulation shall not be less than the values shown in Table 20, Table 21 and Table 22 of IEC 61558-1:2017.

For working voltages above 1 000 V, up to and including 15 000 V the clearances and creepage distances shall not be less than the values shown in Table 104 and Table 105.

Compliance is checked by measurements in accordance with the provisions of 26.2 and 26.3.

NOTE 1 Table 20, Table 21 and Table 22 of IEC 61558-1:2017, and Table 104 and Table 105 of this document are applicable only for frequencies up to and including 30 kHz.

26.2 Creepage distances and clearances

Addition:

26.2.101

Table 103 – Clearances distances for homogenous fields and inhomogeneous fields

Minimum clearances in air up to 2 000 m above sea level		
Working voltage V	Inhomogeneous field	Homogeneous field
1 000	8,0	3,0
1 500	11,5	4,0
3 000	21,0	6,5
6 000	47,0	14,0
10 000	78,0	23,0
15 000	117,0	35,0

NOTE 1—The values from EN 50178 and IEC 62103 are also applicable.

NOTE 2—Interpolation is allowed.

Creepage distances, clearances and distances through insulation shall not be less than the values shown in Table 104.

Table 104 – Minimum clearances in air up to 2 000 m above sea level

Working voltage V	Overvoltage category			
	OVC I	OVC II	OVC III	OVC IV
1 000	3,0	5,5	8,0	14,0
1 500	5,5	8,0	11,0	18,0
3 000	8,0	11,0	18,0	25,0
6 000	25,0	33,0	40,0	60,0
10 000	40,0	60,0	75,0	90,0
15 000	75,0	90,0	130,0	170,0

The values from EN 50178 and IEC 62477-1 are also applicable.

Clearances for double or reinforced insulation (e.g. for a class II transformer insulation) shall be the next higher **overvoltage category**. If no higher **overvoltage category** exists use the next higher **working voltage** or 160 % of the **clearance for basic insulation**.

Table 104 105 – Creepage distances for material group III a, II and I (CTI > 175) for basic or supplementary insulation Minimum creepage distances for basic or supplementary insulation

Minimum creepage distance							
Working voltage V	Pollution degree						
	1	2			3		
	All material groups mm	Material group I mm	Material group II mm	Material group IIIa mm	Material group I mm	Material group II mm	Material group IIIa mm
1 000	3,2	5,0	7,1	10,0	12,5	14,0	16,0
1 250	4,2	6,3	9,0	12,5	16,0	18,0	20,0
1 600	5,6	8,0	11,0	16,0	20,0	22,0	25,0
2 000	7,5	10,0	14,0	20,0	25,0	28,0	32,0
2 500	10,0	12,5	18,0	25,0	32,0	36,0	40,0
3 200	12,5	16,0	22,0	32,0	40,0	45,0	50,0
4 000	16,0	20,0	28,0	40,0	50,0	56,0	63,0
5 000	20,0	25,0	36,0	50,0	63,0	71,0	80,0
6 300	25,0	32,0	45,0	63,0	80,0	90,0	100,0
8 000	32,0	40,0	56,0	80,0	100,0	110,0	125,0
10 000	40,0	50,0	71,0	100,0	125,0	140,0	160,0
12 500	50,0	63,0	90,0	125,0	155,0	180,0	200,0
15 000	59,60,0	75,0	103,2	105,0	150,0	200,0	240,0

NOTE 1 P1 = pollution degree 1; P2 = pollution degree 2; P3 = pollution degree 3.

NOTE 2 When a numeric figure is replaced with a dash in a column of the table, it means that no value is given.

NOTE 3 The minimum values of clearance in this table are applicable in air up to 2 000 m above sea level.

NOTE 4 Material group IIIb is not allowed.

NOTE 5 Interpolation is allowed.

NOTE 6 The values of IEC 60664-1:2007/2020, Table F4F.5 are also applicable.

NOTE 7 Creepage distance for double or reinforced insulation shall be twice the creepage distance for basic insulation from this tables.

27 Resistance to heat, fire and tracking

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

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

28 Resistance to rusting

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

Annexes

The annexes of IEC 61558-1:2017 are applicable.

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Bibliography

The Bibliography of IEC 61558-1:2017 is applicable, except as follows.

Addition:

IEC 60076-11:2018, *Power transformers – Part 11: Dry-type transformers*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-1:2016/AMD1:2021

IEC 61050:1991, *Transformers for tubular discharge lamps having a no-load output voltage exceeding 1000 V (generally called neon-transformers) – General and safety requirements*

IEC 61050:1991/AMD1:1994

IEC 61347-2-10:2000, *Lamp controlgear – Part 2-10: Particular requirements for electronic invertors and convertors for high-frequency operation of cold start tubular discharge lamps (neon tubes)*

IEC 61347-2-10:2000/AMD1:2008

IEC 61558 (all parts), *Safety of transformers, reactors, power supply units and combinations thereof*

IEC 61558-2-16:2021, *Safety of transformers, reactors, power supply units and combinations thereof – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units for general applications*

IEC 62103¹:2003, *Electronic equipment for use in power installations*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

EN 50178:1997, *Electronic equipment for use in power installations*

¹ This publication was withdrawn and replaced with IEC 62477-1:2022.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

GROUP ENERGY EFFICIENCY PUBLICATION
PUBLICATION GROUPEE SUR L'EFFICACITE ENERGETIQUE

**Safety of transformers, reactors, power supply units and combinations thereof –
Part 2-10: Particular requirements and tests for separating transformers with
high insulation level and separating transformers with output voltages
exceeding 1 000 V**

**Sécurité des transformateurs, bobines d'inductance, blocs d'alimentation et des
combinaisons de ces éléments –**

**Partie 2-10 : Exigences particulières et essais pour les transformateurs
d'isolement à enroulements séparés à niveau d'isolement élevé et pour les
transformateurs d'isolement à enroulements séparés à tensions secondaires
supérieures à 1 000 V.**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF TRANSFORMERS, REACTORS,
POWER SUPPLY UNITS AND COMBINATIONS THEREOF –****Part 2-10: Particular requirements and tests for separating
transformers with high insulation level and separating
transformers with output voltages exceeding 1 000 V**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
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IEC 61558-2-10 has been prepared by IEC technical committee 96: Transformers, reactors, power supply units and combinations thereof. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. 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) overvoltage categories I, II, III and IV for clearances and dielectric strength tests are included;

c) clearances for homogenous field conditions deleted.

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

Draft	Report on voting
96/589/FDIS	96/595/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 separating transformers with high insulation level and separating transformers with output voltages exceeding 1 000 V*.

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.

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.

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 2-10: Particular requirements and tests for separating transformers with high insulation level and separating transformers with output voltages exceeding 1 000 V

1 Scope

Replacement:

This part of IEC 61558 deals with the safety of **separating transformers with high insulation level** and **separating transformers with output voltages exceeding 1 000 V**. 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 **separating transformers** with **high insulation level** and **separating transformers** with **output voltages** exceeding 1 000 V AC or 1 500 V DC.

This document is applicable to **stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced) **independent** or **associated dry-type transformers**. The windings 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.

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.

Where applicable the **no-load output voltage** or the **rated output voltage**:

- does not exceed 1 000 V AC or 1 500 V DC for **separating transformers with high insulation level**;
- does exceed 1 000 V AC or 1 500 V DC and does not exceed 15 000 V AC or 15 000 V DC for **separating transformers with output voltage exceeding 1 000 V**.

This document does not apply to:

- **transformers** covered by IEC 60076-11;
- neon **transformers** covered by IEC 61050; and
- **power supplies** and converters for use with or in products according to IEC 61347-2-10.

This document is not applicable to external circuits and their components intended to be connected to the input terminals and output terminals of the **transformers**.

NOTE 2 **Transformers** covered by this document are used only in applications where **double or reinforced insulation** between circuits is not required by the installation rules or by the end product standard.

NOTE 3 Normally, the **transformers** are intended to be used with equipment to provide voltages different from the **supply voltage** for the functional requirements of the equipment. The protection against electric shock can be provided (or completed) by other features of the equipment, such as the **body**. Parts of **output circuits** can be connected to the **input circuits** or to **protective earthing**.

This document is applicable to **transformers** associated with specific equipment, to the extent decided upon by the relevant IEC technical committees.

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;
- the different conditions for transportation, storage, and operation of the **transformers**;
- additional requirements in accordance with other appropriate standards and national rules can be applicable to **transformers** intended for use in special environments.

It is possible that future technological development of **transformers** will require an increase in the upper limit of the frequencies. Until then this document can 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 61558-1:2017, *Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests*

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>

3.1 Transformers

Addition:

3.1.101

separating transformer with high insulation level

separating transformer where the **output voltage** does not exceed 1 000 V AC or 1 500 V DC and does exceed 50 V AC or DC for **independent transformers**, the **output winding(s)** is (are) isolated from both, **input winding(s)** and **body** for a **working voltage** exceeding 1 000 V AC or 1 500 V DC but not exceeding 15 000 V AC or 15 000 V DC

3.1.102

separating transformer with output voltages exceeding 1 000 V

separating transformer where the **output circuits** of which are designed to give voltages exceeding 1 000 V AC or 1 500 V DC and not exceeding 15 000 V AC or 15 000 V DC

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** is limited as follows.

For **separating transformers with high insulation level**:

- the **no-load output voltage** or the **rated output voltage** shall not exceed 1 000 V AC or 1 500 V DC;
- for **independent transformers** the **rated output voltage** shall exceed 50 V AC or 50 V DC and this **output voltage** applies even when **output windings**, not intended for interconnection, are connected in series.

For **separating transformers with no load output voltages exceeding 1 000 V**:

- the **rated output voltage** shall exceed 1 000 V AC or 1 500 V DC and shall not exceed 15 000 V AC or 15 000 V DC;
- for **independent transformers** these **output voltage** limitations apply even when **output windings**, not intended for interconnection, are connected in series.

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

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

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

6.103 The **rated supply frequency** and the **internal operating frequencies** shall not exceed 500 Hz.

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

Compliance with the requirements of 6.101 to 6.104 is checked by inspection of the marking.

7 Classification

IEC 61558-1:2017, Clause 7 is applicable.

8 Marking and other information

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

8.1 h)

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**

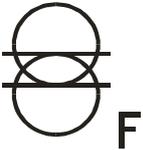
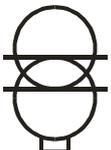
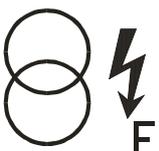
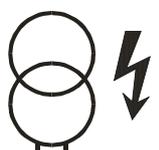
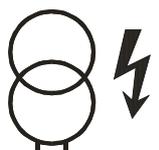
The voltage of the **insulation level**, expressed in kV is not a part of the symbol.

8.11

Addition:

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

Table 101 – Symbols indicating the kind of transformer

Symbol or graphical symbol	Explanation or title	Identification
	<p>Fail-safe separating transformers with high insulation level</p> <p>The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.</p>	IEC 60417-6063:2011-05
	<p>Non-short-circuit proof separating transformer with high insulation level</p> <p>The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.</p>	IEC 60417-6064:2011-05
	<p>Short-circuit-proof separating transformer with high insulation level (inherently or non-inherently)</p> <p>The voltage of the insulation level, expressed in kV, shall be marked adjacent to the symbol.</p>	IEC 60417-6065:2011-05
	<p>Fail-safe separating transformers with output voltages exceeding 1 000 V</p>	IEC 60417-6066:2011-06
	<p>Non-short-circuit-proof separating transformer with output voltages exceeding 1 000 V</p>	IEC 60417-6067:2011-06
	<p>Short-circuit-proof separating transformer with output voltages exceeding 1 000 V (inherently or non-inherently)</p>	IEC 60417-6068:2011-06
	<p>Power supply unit, linear</p>	IEC 60417-6210:2013-10

Addition:

8.101 Separating transformers with high insulation level shall be marked with the voltage of the **insulation level**, expressed in kV on the right side of the symbol.

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:

The **no-load voltage** is measured when the **transformer** is connected to the **rated supply voltage** at the **rated supply frequency** at ambient temperature.

12.101 For separating transformers with high insulation level:

- the **no load output voltage** shall not exceed 1 000 V AC or 1 500 V DC. For **independent transformers** the **no-load output voltage** shall exceed 50 V AC or 50 V DC. This limitation applies even when independent **output windings**, not intended for interconnection, are connected in series.

12.102 For separating transformers with output voltages exceeding 1 000 V:

- the **no-load output voltage** shall exceed 1 000 V AC or 1 500 V DC and shall not exceed 15 000 V AC or DC. For **independent transformers** this limitation applies even when independent **output windings**, not intended for interconnection, are connected in series.

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

The 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.

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 102 – Output voltage difference

Type of transformer Rated output VA	Difference 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 630	20
– over 630	15

Compliance with the requirements of 12.101, 12.102 and 12.103 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.

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 except as follows:

18.3 Dielectric strength test

Replacement:

Immediately after the test of 18.2 the **insulation** is subjected for 1 min to a dielectric strength voltage of substantially sinusoidal wave form at 50 Hz or 60 Hz. The value of the dielectric strength test voltage and the points of application are given in Table 103.

Resistors, capacitors and other components are disconnected before carrying out the test.

For **working voltages** up to and including 1 000 V the dielectric strength voltage shall not be less than the values shown in Table 14 of IEC 61558-1:2017.

Table 103 – Table of dielectric strength test voltages for working voltages above 1 000 V

Application of dielectric strength test voltage	Working voltage over 1 000 V, up to and including 15 000 V
Additional value for the corresponding transients of the different overvoltage categories	$U_{OVC I} = 500 \text{ V}$ $U_{OVC II} = 750 \text{ V}$ $U_{OVC III} = 1\,000 \text{ V}$ $U_{OVC IV} = 1\,250 \text{ V}$
1) Between live parts of input circuits and live parts of output circuits basic insulation	$2 \times \text{working voltage} + U_{OVC}$
2) Over basic insulation or supplementary insulation between: <ol style="list-style-type: none"> live parts of different polarity. Test is not applicable within the same winding live parts and the body, if intended to be connected to the protective earthing accessible conductive parts and a metal rod of the same diameter as the flexible cable or cord (or metallic foil wrapped round the cord) inserted inside inlet bushing, cord guards and anchorage, and the like live parts and an intermediate conductive part conductive parts and the body each input circuit and all other input circuits connected together 	$2 \times \text{working voltage} + U_{OVC}$
Dielectric strength test voltages for double or reinforced insulation (e.g. for a class II transformer insulation) shall be twice the values for basic insulation .	

19 Construction

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

19.1 General construction

Replacement:

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, through other **conductive parts**, except by deliberate action.

Compliance is checked by inspection and measurements, taking Clause 18 and Clause 26 into consideration.

Addition:

19.1.101 The **insulation** between **input** and **output winding(s)** shall consist of at least **basic insulation** (rated for the **working voltage**).

In addition, the following applies:

- for **class I transformers**, the **insulation** between the **input windings** and the **body**, and between the **output windings** and the **body**, shall consist of **basic insulation** (both **basic insulations** 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**, shall consist of **double** or **reinforced insulation** (both **double** or **reinforced insulations** rated for the **working voltage**).

19.1.102 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 **intermediate conductive parts** and the **input windings**, and between the **intermediate conductive parts** and the **output windings** shall consist of **basic insulation** (rated for the **working voltage**).

NOTE 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).

In addition, the following applies:

- for **class I transformers**, the **insulation** between the **input** and **output windings** via the **intermediate conductive parts** shall consist of at least **basic 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**).

Addition:

19.101 Parts of **output circuits** can be connected to **protective earthing**.

19.102 There shall be no connection between the **output circuits** and the **body**, unless – for **associated transformers** – allowed by the relevant equipment standard.

Compliance is checked by inspection.

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 cables or cords

IEC 61558-1:2017, Clause 22 is applicable.

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 except as follows:

Replacement:

26.1 General

Replacement of the first and second paragraph together with the note with the following:

For **working voltages** up to and including 1 000 V the **clearances, creepage distances** and distances through **insulation** shall not be less than the values shown in Table 20, Table 21 and Table 22 of IEC 61558-1:2017.

For **working voltages** above 1 000 V, up to and including 15 000 V the **clearances** and **creepage distances** shall not be less than the values shown in Table 104 and Table 105.

Compliance is checked by measurements in accordance with the provisions of 26.2 and 26.3.

NOTE 1 Table 20, Table 21 and Table 22 of IEC 61558-1:2017, and Table 104 and Table 105 of this document are applicable only for frequencies up to and including 30 kHz.

26.2 Creepage distances and clearances

Addition:

26.2.101

Table 104 – Minimum clearances in air up to 2 000 m above sea level

Working voltage V	Overvoltage category			
	OVC I	OVC II	OVC III	OVC IV
1 000	3,0	5,5	8,0	14,0
1 500	5,5	8,0	11,0	18,0
3 000	8,0	11,0	18,0	25,0
6 000	25,0	33,0	40,0	60,0
10 000	40,0	60,0	75,0	90,0
15 000	75,0	90,0	130,0	170,0

The values from EN 50178 and IEC 62477-1 are also applicable.

Clearances for double or reinforced insulation (e.g. for a class II transformer insulation) shall be the next higher **overvoltage category**. If no higher **overvoltage category** exists use the next higher **working voltage** or 160 % of the **clearance for basic insulation**.

Table 105 – Minimum creepage distances for basic or supplementary insulation

Working voltage V	Pollution degree						
	1 All material groups mm	Material group I mm	2 Material group II mm	Material group IIIa mm	Material group I mm	3 Material group II mm	Material group IIIa mm
1 000	3,2	5,0	7,1	10,0	12,5	14,0	16,0
1 250	4,2	6,3	9,0	12,5	16,0	18,0	20,0
1 600	5,6	8,0	11,0	16,0	20,0	22,0	25,0
2 000	7,5	10,0	14,0	20,0	25,0	28,0	32,0
2 500	10,0	12,5	18,0	25,0	32,0	36,0	40,0
3 200	12,5	16,0	22,0	32,0	40,0	45,0	50,0
4 000	16,0	20,0	28,0	40,0	50,0	56,0	63,0
5 000	20,0	25,0	36,0	50,0	63,0	71,0	80,0
6 300	25,0	32,0	45,0	63,0	80,0	90,0	100,0
8 000	32,0	40,0	56,0	80,0	100,0	110,0	125,0
10 000	40,0	50,0	71,0	100,0	125,0	140,0	160,0
12 500	50,0	63,0	90,0	125,0	155,0	180,0	200,0
15 000	60,0	75,0	105,0	150,0	200,0	230,0	240,0

NOTE P1 = pollution degree 1; P2 = pollution degree 2; P3 = pollution degree 3.

The minimum values of **clearance** in this table are applicable in air up to 2 000 m above sea level.

Material group IIIb is not allowed.

Interpolation is allowed.

The values of IEC 60664-1:2020, Table F.5 are also applicable.

Creepage distance for double or reinforced insulation shall be twice the creepage distance for basic insulation from this tables.

27 Resistance to heat, fire and tracking

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

28 Resistance to rusting

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

Annexes

The annexes of IEC 61558-1:2017 are applicable.

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Bibliography

The Bibliography of IEC 61558-1:2017 is applicable, except as follows.

Addition:

IEC 60076-11:2018, *Power transformers – Part 11: Dry-type transformers*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-1:2016/AMD1:2021

IEC 61050:1991, *Transformers for tubular discharge lamps having a no-load output voltage exceeding 1000 V (generally called neon-transformers) – General and safety requirements*
IEC 61050:1991/AMD1:1994

IEC 61347-2-10:2000, *Lamp controlgear – Part 2-10: Particular requirements for electronic invertors and convertors for high-frequency operation of cold start tubular discharge lamps (neon tubes)*

IEC 61347-2-10:2000/AMD1:2008

IEC 61558 (all parts), *Safety of transformers, reactors, power supply units and combinations thereof*

IEC 61558-2-16:2021, *Safety of transformers, reactors, power supply units and combinations thereof – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units for general applications*

IEC 62103¹:2003, *Electronic equipment for use in power installations*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

EN 50178:1997, *Electronic equipment for use in power installations*

¹ This publication was withdrawn and replaced with IEC 62477-1:2022.

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

SÉCURITÉ DES TRANSFORMATEURS, BOBINES D'INDUCTANCE, BLOCS D'ALIMENTATION ET DES COMBINAISONS DE CES ÉLÉMENTS –**Partie 2-10: Exigences particulières et essais pour les transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé et pour les transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V**

AVANT-PROPOS

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L'IEC 61558-2-10 a été établie par le comité d'études 96 de l'IEC: Transformateurs, bobines d'inductance, blocs d'alimentation et combinaisons de ces éléments. Il s'agit d'une Norme internationale.

Cette seconde édition annule et remplace la première édition parue en 2014. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) la structure et les références ont été alignées sur l'IEC 61558-1:2017;
- b) les catégories de surtension I, II, III et IV pour les essais de rigidité diélectrique et les distances d'isolement ont été ajoutées;
- c) les distances d'isolement relatives aux conditions de champs homogènes ont été supprimées.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
96/589/FDIS	96/595/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Il a le statut de publication groupée de sécurité conformément au Guide 104 de l'IEC.

La présente Norme internationale doit être utilisée conjointement avec l'IEC 61558-1:2017.

Le présent document complète ou modifie les articles correspondants de l'IEC 61558-1:2017, de façon à transformer cette publication en norme IEC: *Exigences particulières et essais pour les transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé et pour les transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V.*

Une liste de toutes les parties de la série IEC 61558, publiées sous le titre général *Sécurité des transformateurs, bobines d'inductance, blocs d'alimentation et combinaisons de ces éléments*, se trouve sur le site web de l'IEC.

Les futures normes de cette série porteront le nouveau titre général cité ci-dessus. Le titre des normes qui existent déjà dans cette série sera mis à jour lors de leur prochaine édition.

Lorsque le présent document mentionne "*addition*", "*modification*" ou "*remplacement*", le texte correspondant de l'IEC 61558-1:2017 doit être adapté en conséquence.

Dans le présent document, les caractères d'imprimerie suivants sont utilisés:

- exigences proprement dites: caractères romains;
- *modalités d'essais: caractères italiques;*
- commentaires: petits caractères romains.

Dans le texte du présent document, les termes en **gras** sont définis à l'Article 3.

Les paragraphes, notes, figures et tableaux qui s'ajoutent à ceux de l'IEC 61558-1:2017 sont numérotés à partir de 101; les annexes qui sont ajoutées sont désignées AA, BB, etc.

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INTRODUCTION

Le CE 96 de l'IEC a une fonction groupée de sécurité, conformément au Guide 104 de l'IEC relatif aux transformateurs autres que ceux destinés à alimenter les réseaux de distribution, notamment les transformateurs et les **blocs d'alimentation** destinés à permettre l'application de mesures de protection contre les chocs électriques, comme cela est défini par le CE 64, qui traite des installations électriques et de la protection contre les chocs électriques, mais qui incluent également dans certains cas la limitation de la tension et de la fonction de sécurité horizontale pour la TBTS, conformément à l'IEC 60364-4-41.

La fonction groupée de sécurité (GSF, *Group Safety Function*) est utilisée en raison de la responsabilité de la **très basse tension de sécurité (TBTS)**, conformément au 5.2.6 de l'IEC 61140:2016 et au 414.3.1 de l'IEC 60364-4-41:2005, ou des circuits de commande, conformément au 7.2.4 de l'IEC 60204-1:2016.

La fonction groupée de sécurité est utilisée pour chacune des parties de l'IEC 61558-2, car différentes normes de la série IEC 61558 peuvent être combinées en une seule et même construction, mais dans certains cas sans aucune limitation de la **puissance assignée**.

Un autotransformateur conforme à l'IEC 61558-2-13 peut par exemple être conçu avec un **circuit TBTS** distinct, conformément aux exigences particulières de l'IEC 61558-2-6 liées aux exigences générales de l'IEC 61558-1.

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SÉCURITÉ DES TRANSFORMATEURS, BOBINES D'INDUCTANCE, BLOCS D'ALIMENTATION ET DES COMBINAISONS DE CES ÉLÉMENTS –

Partie 2-10: Exigences particulières et essais pour les transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé et pour les transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V

1 Domaine d'application

Remplacement:

La présente partie de l'IEC 61558 traite de la sécurité des **transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé** et des **transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V**. Les **transformateurs** qui incorporent des **circuits électroniques** sont également couverts par le présent document.

NOTE 1 La sécurité comprend les aspects électrique, thermique et mécanique.

Sauf spécification contraire, dans la suite du document, le terme **transformateur** couvre les **transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé** et les **transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V** en courant alternatif ou 1 500 V en courant continu.

Le présent document s'applique aux **transformateurs** de **type sec fixes** ou **mobiles**, monophasés ou polyphasés, à refroidissement par air (naturel ou forcé) **indépendants** ou **associés**. Les enroulements peuvent être enrobés ou non enrobés.

Pour les **blocs d'alimentation** (linéaires), le présent document s'applique. Pour les **blocs d'alimentation à découpage**, l'IEC 61558-2-16 et le présent document s'appliquent. Lorsque deux exigences sont contradictoires, la plus contraignante prévaut.

La **tension primaire assignée** ne dépasse pas 1 000 V en courant alternatif, et la **fréquence d'alimentation assignée** et les **fréquences de fonctionnement interne** ne dépassent pas 500 Hz.

La **puissance assignée** ne dépasse pas:

- 25 kVA pour les **transformateurs** monophasés;
- 40 kVA pour les **transformateurs** polyphasés.

Le présent document s'applique aux **transformateurs** sans limitation de la **puissance assignée**, qui font l'objet d'un accord entre l'acheteur et le fabricant.

Le cas échéant, la **tension secondaire à vide** ou la **tension secondaire assignée**:

- ne dépasse pas 1 000 V en courant alternatif ou 1 500 V en courant continu pour les **transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé**;
- dépasse 1 000 V en courant alternatif ou 1 500 V en courant continu et ne dépasse pas 15 000 V en courant alternatif ou 15 000 V en courant continu pour les **transformateurs d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V**.

Le présent document ne s'applique pas:

- aux **transformateurs** couverts par l'IEC 60076-11;
- aux **transformateurs**-néon couverts par l'IEC 61050; et
- aux **alimentations** et convertisseurs destinés à être utilisés avec ou dans des produits conformes à l'IEC 61347-2-10.

Le présent document ne s'applique pas aux circuits externes et à leurs composants destinés à être connectés aux bornes primaires et bornes secondaires des **transformateurs**.

NOTE 2 Les **transformateurs** couverts par le présent document ne sont utilisés que dans le cadre d'applications pour lesquelles les règles d'installation ou la norme du produit final n'exigent aucune **isolation double ou renforcée** entre les circuits.

NOTE 3 Normalement, les **transformateurs** sont destinés à être utilisés avec des équipements dans le but de fournir des tensions différentes de la **tension primaire** afin de satisfaire aux exigences fonctionnelles de l'équipement. La protection contre les chocs électriques peut être procurée (ou complétée) par d'autres particularités de l'équipement, telles que la **masse**. Des parties de **circuits secondaires** peuvent être connectées aux **circuits primaires** ou à la **terre de protection**.

Le présent document s'applique aux **transformateurs** associés à des équipements spécifiques, suivant les exigences des comités d'études de l'IEC appropriés.

L'attention est attirée sur les points suivants, si nécessaire:

- exigences supplémentaires (issues d'autres normes applicables, règles nationales, etc.) pour les **transformateurs** destinés à être utilisés dans des véhicules, à bord de navires et d'avions;
- mesures qui visent à protéger l'**enveloppe** et les composants situés à l'intérieur de celle-ci contre les facteurs d'influence externes comme les champignons, la vermine, les termites, les rayonnements solaires et le givre;
- différentes conditions de transport, de stockage et de fonctionnement pour les **transformateurs**;
- exigences supplémentaires qui peuvent s'appliquer aux **transformateurs** destinés à être utilisés dans un environnement particulier, au regard d'autres normes et règles nationales applicables.

Il est possible que les évolutions techniques futures des **transformateurs** exigent une augmentation de la limite supérieure des fréquences. En attendant, le présent document peut être utilisé à titre de recommandation.

La présente publication groupée de sécurité portant sur des recommandations de sécurité est avant tout destinée à être utilisée en tant que norme en matière de sécurité des produits pour les produits cités dans le domaine d'application, mais elle est également destinée à être utilisée par les comités d'études dans le cadre de l'élaboration de publications pour des produits similaires à ceux cités dans le domaine d'application de la présente publication groupée de sécurité, conformément aux principes établis dans le Guide 104 de l'IEC et le Guide 51 de l'ISO/IEC.

L'une des responsabilités d'un comité d'études consiste, le cas échéant, à utiliser les publications fondamentales de sécurité et/ou les publications groupées de sécurité dans le cadre de l'élaboration de ses publications.

2 Références normatives

L'Article 2 de l'IEC 61558-1:2017 s'applique, avec l'exception suivante:

Addition:

IEC 61558-1:2017, *Sécurité des transformateurs, bobines d'inductance, blocs d'alimentation et des combinaisons de ces éléments – Partie 1: Exigences générales et essais*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 61558-1 s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

3.1 Transformateurs

Addition:

3.1.101

transformateur d'isolement à enroulements séparés à niveau d'isolement élevé
transformateur d'isolement dans lequel la **tension secondaire** ne dépasse pas 1 000 V en courant alternatif ou 1 500 V en courant continu et dépasse 50 V en courant alternatif ou 50 V en courant continu pour les **transformateurs indépendants**, le ou les **enroulements secondaires** étant isolés à la fois de l'**enroulement** ou des **enroulements primaires** et de la **masse** pour une **tension locale** qui dépasse 1 000 V en courant alternatif ou 1 500 V en courant continu, mais qui ne dépasse pas 15 000 V en courant alternatif ou 15 000 V en courant continu

3.1.102

transformateur d'isolement à enroulements séparés à tensions secondaires supérieures à 1 000 V

transformateur d'isolement à enroulements séparés dans lequel les **circuits secondaires** sont conçus pour donner des tensions qui dépassent 1 000 V en courant alternatif ou 1 500 V en courant continu, mais qui ne dépassent pas 15 000 V en courant alternatif ou 15 000 V en courant continu

4 Exigences générales

L'Article 4 de l'IEC 61558-1:2017 s'applique.

5 Généralités sur les essais

L'Article 5 de l'IEC 61558-1:2017 s'applique.

6 Caractéristiques assignées

L'Article 6 de l'IEC 61558-1:2017 s'applique, avec les exceptions suivantes:

Addition:

6.101 La **tension secondaire assignée** est limitée de la manière suivante.

Pour les **transformateurs d'isolement à enroulements séparés à niveau d'isolement élevé**:

- la **tension secondaire à vide** ou la **tension secondaire assignée** ne doit pas dépasser 1 000 V en courant alternatif ou 1 500 V en courant continu;
- pour les **transformateurs indépendants**, la **tension secondaire assignée** doit dépasser 50 V en courant alternatif ou 50 V en courant continu et cette **tension secondaire** s'applique même lorsque les **enroulements secondaires**, non destinés à l'interconnexion, sont connectés en série.

Pour les **transformateurs d'isolement à enroulements séparés à tensions secondaires à vide supérieures à 1 000 V**:

- la **tension secondaire assignée** doit dépasser 1 000 V en courant alternatif ou 1 500 V en courant continu et ne doit pas dépasser 15 000 V en courant alternatif ou 15 000 V en courant continu;
- pour les **transformateurs indépendants**, les limitations de la **tension secondaire** s'appliquent même lorsque les **enroulements secondaires**, non destinés à l'interconnexion, sont connectés en série.

6.102 La **puissance assignée** ne doit pas dépasser:

- 25 kVA pour les **transformateurs** monophasés;
- 40 kVA pour les **transformateurs** polyphasés.

Les **transformateurs** sans limitation de la **puissance assignée** doivent faire l'objet d'un accord entre l'acheteur et le fabricant.

6.103 La **fréquence d'alimentation assignée** et les **fréquences de fonctionnement interne** ne doivent pas dépasser 500 Hz.

6.104 La **tension primaire assignée** ne doit pas dépasser 1 000 V en courant alternatif.

La conformité aux exigences du 6.101 au 6.104 est vérifiée par examen du marquage.

7 Classification

L'Article 7 de l'IEC 61558-1:2017 s'applique.