

INTERNATIONAL STANDARD



GROUP ENERGY EFFICIENCY PUBLICATION

**Safety of transformers, reactors, power supply units and combination thereof –
Part 2-12: Particular requirements and tests for constant voltage transformers
and power supply units for constant voltage**



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INTERNATIONAL STANDARD



GROUP ENERGY EFFICIENCY PUBLICATION

**Safety of transformers, reactors, power supply units and combination thereof –
Part 2-12: Particular requirements and tests for constant voltage transformers
and power supply units for constant voltage**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF TRANSFORMERS, REACTORS,
POWER SUPPLY UNITS AND COMBINATIONS THEREOF –****Part 2-12: Particular requirements and tests for constant voltage
transformers and power supply units for constant voltage**

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 61558-2-12:2011. 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 61558-2-12 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 2011. 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) description of constructions moved to IEC 61558-1:2017;
- c) new symbol for power supply unit with linearly regulated output voltage.

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

Draft	Report on voting
96/587/FDIS	96/591/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 constant voltage transformers and power supply units for constant voltage*.

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 adopted 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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

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

Part 2-12: Particular requirements and tests for constant voltage transformers and power supply units for constant voltage

1 Scope

Replacement:

This part of IEC 61558 deals with the safety of **constant voltage transformers** for general applications and **power supply units for constant voltage** for general applications. **Constant voltage 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 **constant voltage transformers** for general applications and **power supply units for constant voltage** for general applications.

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

- **constant voltage auto-transformers**;
- **constant voltage separating transformers**;
- **constant voltage isolating transformers**;
- **constant voltage safety isolating transformers**.

The windings ~~may~~ can be encapsulated or non-encapsulated.

~~This standard is applicable to **transformers** and **power supply** (linear) with internal operating frequencies not exceeding 500 Hz.~~

~~This standard used in combination with Part 2-16 for **switch mode power supply** (SMPS) units 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.~~

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 take precedence.

The **rated supply voltage** does not exceed 1 000 V AC. The **rated supply frequency** does not exceed 500 Hz, the **internal operating resonant frequency** does not exceed 30 kHz and the **internal operating frequency** does not exceed 100 MHz.

The **rated output** does not exceed:

- 40 kVA for single-phase **constant voltage auto-transformers**;
- 200 kVA for polyphase **constant voltage auto-transformers**;
- 25 kVA for single-phase **constant voltage separating transformers** and **constant voltage isolating transformers**;

- 40 kVA for polyphase **constant voltage separating transformers** and **constant voltage isolating transformers**;
- 10 kVA for single-phase **constant voltage safety isolating transformers**;
- 16 kVA for polyphase **constant voltage safety isolating 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.

Where applicable to **constant voltage auto-transformers**

- the **no-load output voltage** or the **rated output voltage** does not exceed 1 000 V AC or 1 415 V ripple-free DC, and for **independent constant voltage auto-transformers** the **no-load output voltage** and the **rated output voltage** exceed 50 V AC or 120 V ripple-free DC;
- **constant voltage auto-transformers** covered by this document are used only in applications where no **insulation** between circuits is required by the installation rules or by the end product standard.

Where applicable to **constant voltage separating transformers**

- the **no-load output voltage** or the **rated output voltage** does not exceed 1 000 V AC or 1 415 V ripple-free DC, and for **independent constant voltage separating transformers** the **no-load output voltage** and the **rated output voltage** exceed 50 V AC or 120 V ripple-free DC;
- **constant voltage separating 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.

Where applicable to **constant voltage isolating transformers**

- the **no-load output voltage** or the **rated output voltage** does exceed 50 V AC or 120 V ripple-free DC and where applicable, does not exceed 500 V AC or 708 V ripple-free DC. The **no-load output voltage** and the **rated output voltage** ~~may~~ can be up to 1 000 V AC or 1 415 V ripple-free DC for special applications;
- **constant voltage isolating transformers** covered by this document are used only in applications where **double** or **reinforced insulation** between circuits is required by the installation rules or by the end product standard.

Where applicable to **constant voltage safety isolating transformers**

- the **no-load output voltage** or the **rated output voltage** does not exceed 50 V AC or 120 V ripple-free DC;
- **constant voltage safety isolating transformers** covered by this document are used only in applications where **double** or **reinforced insulation** between circuits is required by the installation rules or by the end product standard.

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 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.) ~~may 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 ~~should also be considered~~;

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

~~NOTE 4~~ Future technological development of **transformers** may necessitate a need to increase 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

This clause of IEC 61558-1:2017 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*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61558-1 apply, except as follows:

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

constant voltage transformer

transformer intended to limit the influence of the input voltage variations

Note 1 to entry: This type of **transformer** ~~may~~ can also limit the influence of transients.

3.5 Ratings

Addition

3.1025.101**regulation tolerance**

deviation in per cent of the **rated output voltage** when the **constant voltage transformer** is supplied within the **rated supply voltage** variation

3.1035.102**internal operating resonant frequency**

frequency produced within a **constant voltage transformer**

4 General requirements

This clause of IEC 61558-1:2017 is applicable.

5 General notes on tests

This clause of IEC 61558-1:2017 is applicable.

6 Ratings

This clause of IEC 61558-1:2017 is applicable except as follows:

Addition:

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

- 1 000 V AC or 1 415 V ripple-free DC for **constant voltage auto-transformers** and **constant voltage separating transformers**;
- 250 V AC for single-phase **portable constant voltage isolating transformers**;
- 400 V AC for polyphase **portable constant voltage isolating transformers**, and
- 500 V AC or 708 V ripple-free DC for **constant voltage isolating transformers**. For **constant voltage isolating transformers**, the **rated output voltage** ~~may~~ can be up to 1 000 V AC or 1 415 V ripple-free DC to be in accordance with the national wiring rules or for a special purpose;
- 50 V AC or 120 V ripple-free DC for **constant voltage safety isolating transformers**;

The **rated output voltage** shall exceed:

- 50 V AC or 120 V ripple-free DC for **independent constant voltage auto-transformers**, **constant voltage separating transformers** and **constant voltage isolating transformers**.

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

- 40 kVA for single-phase **constant voltage auto-transformers**,
- 200 kVA for polyphase **constant voltage auto-transformers**,
- 25 kVA for single-phase **constant voltage separating** and **isolating transformers**,
- 40 kVA for polyphase **constant voltage separating** and **isolating transformers**,
- 10 kVA for single-phase **constant voltage safety isolating transformers**,
- 16 kVA for polyphase **constant voltage safety isolating transformers**,

except for **constant voltage transformers** subject to an agreement between the purchaser and the manufacturer.

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

6.104 The rated value of the output **regulation tolerance** shall be given at the **rated supply voltage** range, the **rated output**, and the power factor of 1.

6.105 For ~~constant-voltage~~ **independent transformers** the input voltage variation shall not be less than 10 %.

6.106 The **internal operating resonant frequency** shall not exceed 30 kHz.

6.107 The **internal operating frequency** shall not exceed 100 MHz.

Compliance with the requirements of 6.101 to 6.107 is checked by inspection of the marking.

7 Classification

This clause of IEC 61558-1:2017 is applicable.

8 Marking and other information

This clause of IEC 61558-1:2017 is applicable except as follows:

8.1

a)

Replacement of the first sentence by the following:

rated supply voltage(s) and the input voltage variation in %;

b)

Replacement of the first sentence by the following:

rated output voltage(s) and the **regulation tolerance** of this voltage(s) in %;

h)

Replacement of the ~~first sentence~~ content up to the first semi-colon by the following:

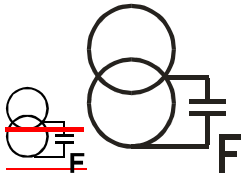
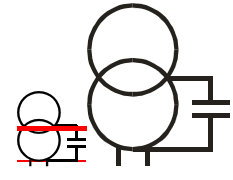
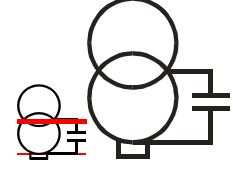
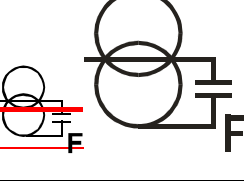
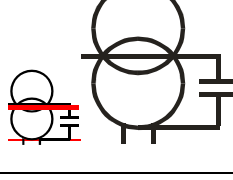
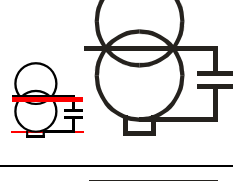
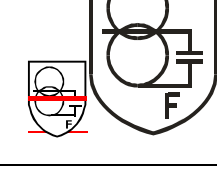
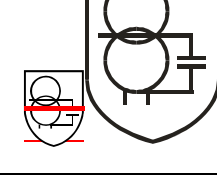
relevant graphical symbols shown in ~~8.11~~ Table 101 ~~indicating~~ that indicate the kind of **transformer**;

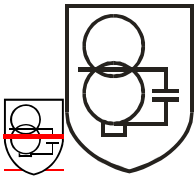
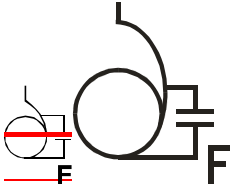
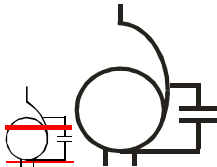
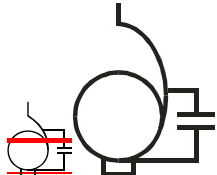
8.11

Addition:

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

Table 101 – Symbols indicating the kind of transformer

Symbol or graphical symbol	Explanation or title	Identification
	Fail-safe constant voltage separating transformer	IEC 60417-6011:2008-02
	Non-short-circuit-proof constant voltage separating transformer	IEC 60417-6011:2008-02
	Short-circuit-proof constant voltage separating transformer	IEC 60417-6011:2008-02
	Fail-safe constant voltage isolating transformer	IEC 60417-6012:2008-09
	Non-short-circuit-proof constant voltage isolating transformer	IEC 60417-6012:2008-09
	Short-circuit-proof constant voltage isolating transformer	IEC 60417-6012:2008-09
	Fail-safe constant voltage safety isolating transformer	IEC 60417-6013:2008-02
	Non-short-circuit-proof constant voltage safety isolating transformer	IEC 60417-6013:2008-02

Symbol or graphical symbol	Explanation or title	Identification
	Short-circuit-proof constant voltage safety isolating transformer	IEC 60417-6013:2008-02
	Fail-safe constant voltage auto-transformer	IEC 60417-6017:2008-02
	Non-short-circuit-proof constant voltage autotransformer	IEC 60417-6017:2008-02
	Short-circuit-proof constant voltage autotransformer	IEC 60417-6017:2008-02
	Power supply unit, linear	IEC 60417-6210:2013-10

9 Protection against electric shock

This clause of IEC 61558-1:2017 is applicable.

10 Change of input voltage setting

This clause of IEC 61558-1:2017 is applicable.

11 Output voltage and output current under load

This clause of IEC 61558-1:2017 is applicable except as follows:

11.1

Replacement:

11.1 When the **transformer** is connected to the **rated supply voltage** plus or minus the input voltage variation declared by the manufacturer, at the **rated supply frequency**, and loaded with an impedance resulting in the **rated output** at the **rated output voltage** and, for AC, at the **rated power factor**, the output voltage shall not differ from the rated value by more than the **regulation tolerance**.

*Compliance is checked by measuring the output voltage when steady-state conditions are established. During the test, the **transformer** is connected to the **rated supply voltage**, plus or minus the highest input voltage variation, at the **rated supply frequency**, and loaded with an impedance resulting in the **rated output** at the **rated output voltage** and the **rated power factor**.*

*For **transformers** incorporating a rectifier, the output voltage shall be measured at the terminals of the DC circuit by means of a voltmeter giving the arithmetical mean value, unless the effective (RMS) value is specifically stated (see 8.1).*

*For **transformers** with more than one **rated supply voltage**, the requirement is applicable for each of the **rated supply voltages**.*

*For **transformers** with multiple **output windings**, the loads are applied to every multiple section simultaneously, unless otherwise declared.*

12 No-load output voltage

This clause of IEC 61558-1:2017 is applicable except as follows:

Addition:

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

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

- 1 000 V AC or 1 415 V ripple-free DC for **constant voltage auto-transformers** and **constant voltage separating transformers**;
- 250 V AC for single-phase **portable constant voltage isolating transformers**;
- 400 V AC for polyphase **portable constant voltage isolating transformers**, and
- 500 V AC or 708 V ripple-free DC for other **constant voltage isolating transformers**.

In this case, the **no-load output voltage** can be up to 1 000 V AC or 1 415 V ripple-free DC to be in accordance with the national wiring rules or for a special purpose;

- 50 V AC or 120 V ripple-free DC for **constant voltage safety isolating transformers**.

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

- 50 V AC or 120 V ripple-free DC for **constant voltage independent auto-, separating and isolating transformers**.

For **independent transformers**, this output voltage limitation applies even when **output windings**, not intended for interconnection, are connected in series.

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

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 10 %.

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;

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

13 Short-circuit voltage

This clause of IEC 61558-1:2017 is applicable.

14 Heating

This clause of IEC 61558-1:2017 is applicable, except as follows:

14.1.1 Temperature-rise test

Replacement of the ~~10th~~ 11th paragraph ~~starting with "Transformers are supplied..." by the following~~ as follows:

~~The constant voltage transformers~~ are connected to the **rated supply voltage** and loaded with an impedance resulting in the **rated output**, at the **rated output voltage** and, for AC, at the **rated power factor**. The supply voltage is then increased to the value of the highest input voltage variation declared by the manufacturer. After this voltage increase, no change or adjustment is made in the circuit. The test is repeated under no-load condition with the highest or the lowest input voltage variation if this is a more unfavourable condition.

15 Short-circuit and overload protection

This clause of IEC 61558-1:2017 is applicable except as follows:

15.1.1 Short circuit and overload test method

Replacement of the 2nd paragraph ~~starting with "Compliance is checked..." by the following~~ as follows:

Compliance is checked by inspection and by the following tests, which are carried out immediately after the test in accordance with 14.1, at the same ambient temperature, and without changing the position of the ~~constant voltage transformer~~ at the maximum value of the **rated supply voltage** designed for the ~~constant voltage transformer~~.

15.2 Inherently short-circuit proof transformers

Replacement:

Inherently short-circuit-proof constant voltage transformers shall be tested as follows:

Before starting the test, it is necessary to determine the highest output current of the ~~constant voltage transformer~~ at the maximum value of the supply voltage designed for the ~~constant voltage transformer~~. The ~~constant voltage transformer~~ is then loaded with the maximum output current or the **output winding(s)** short-circuited, whichever results in the maximum temperature.

15.3 Non-inherently short-circuit proof transformers

Replacement:

Non-inherently short-circuit-proof constant voltage transformers are tested as follows:

15.3.1 ~~Replacement:~~

The **output windings** are short-circuited or overloaded as stated in 15.2. The incorporated overload protection device shall operate before the temperature exceeds the values shown in Table ~~3~~ 5 for any value of the supply voltage between the marked values of **rated supply voltage**.

15.5 Fail-safe transformers

15.5.1

Replacement:

Three additional specimens are required, only for the following test. ~~Constant voltage Transformers~~ used in other tests are not subjected to this test.

Each of the three specimens is mounted as for normal use on a 20 mm thick dull black painted plywood surface. Each ~~constant voltage transformer~~ is operated at **rated supply voltage** plus or minus the input voltage variation declared by the manufacturer. The **output winding** which produced the highest temperature during the test of 14.1 being initially loaded with 1,5 times the **rated output current** (or, if this is not possible, the maximum value of the output current obtainable) until steady-state conditions are reached or the ~~constant voltage transformer~~ fails (whichever occurs first).

If the ~~constant voltage transformer~~ fails, it shall comply, during and after the tests, with the criteria given in 15.5.2.

If the ~~constant voltage transformer~~ does not fail, the time to reach steady-state conditions is noted and the chosen **output winding** is then short-circuited. The test is continued until the ~~constant voltage transformer~~ fails. Each specimen shall do so within a duration, for this part of the test, which is no longer than that necessary to attain steady-state conditions, but in any case it shall not exceed 5 h.

The ~~constant voltage transformer~~ shall fail safely. It shall comply, during and after the test, with the criteria given in 15.5.2.

16 Mechanical strength

This clause of IEC 61558-1:2017 is applicable.

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

This clause of IEC 61558-1:2017 is applicable.

18 Insulation resistance, dielectric strength and leakage current

This clause of IEC 61558-1:2017 is applicable, except as follows:

18.2 Insulation resistance

This subclause of IEC 61558-1 is applicable, except as follows:

Modification for **constant voltage auto-transformers**:

~~Table 7: values between each input circuit and all other input circuits, between each output circuits and all other output circuits are not applicable.~~

In accordance with Table 13 the values between **input circuits** and **output circuits**, between each **input circuit** and all other **input circuits**, between each **output circuits** and all other **output circuits** are not applicable.

18.3 Dielectric strength test

This subclause of IEC 61558-1 is applicable, except as follows:

Modification for **constant voltage auto-transformers**:

~~Table 8a: lines 1) and 2) are not applicable.~~

In accordance with Table 14 the values between **input circuits** and **output circuits** are not applicable.

18.4 Insulation between and within windings

This subclause of IEC 61558-1:2017 is applicable, except as follows:

Addition for **constant voltage auto-transformers**:

For windings intended to be connected in series or parallel the dielectric strength test for **functional insulation** in accordance with Table 14 shall be applied.

~~18.101~~

~~Table 101 – Dielectric strength test voltages for constant voltage auto-transformers~~

Application of dielectrical strength test voltage	Working-voltage				
	V				
	>50	150	300		
Over functional insulation for windings intended to be connected in series or parallel	Working-voltage + 500 V				

19 Construction

Replacement of this clause:

NOTE—This clause reads slightly differently for each type of **constant voltage transformer**:

—constant voltage auto-transformers (see 19.1);

—constant voltage separating transformers (see 19.2);

—constant voltage isolating and safety isolating transformers (see 19.3).

19.1 Constant voltage auto-transformers

19.1.1 ~~Plug connected constant voltage auto-transformers, where the rated input voltage is higher than the rated output voltage, shall not have any potential to earth at the output socket higher than the rated output voltage.~~

This requirement shall be fulfilled by using one of the following methods:

a) ~~Polarized input and output plug and socket outlet system~~

In this case, an instruction shall be given for not using such a transformer with a non-polarized plug and socket outlet system.

b) ~~Polarity detecting device (for non polarised input and output plug and socket outlet system)~~

A polarity detecting device shall only energise the output circuit when the potential to earth at the poles of the output socket does not exceed the **rated output voltage**. The contact separation of the breaking device shall be at least of 3 mm in each pole.

NOTE A magnetic relay is an example of polarity detecting device.

Compliance is checked by the following test:

~~The auto-transformer is connected to the mains at 1,06 times the rated input voltage under the most unfavourable condition of load and output voltage. The test is repeated with the polarity of the input reversed. During the test, the measured potential to earth of each pole shall not exceed the maximum output voltage under load (1,06 times the rated output voltage taking into account the permissible deviations of Clause 11).~~

The contact separation of the device shall be 3 mm minimum in each pole.

Compliance is checked by measurement.

If the polarity detecting device uses a current flowing to the earth for the detection, this current shall not exceed 0,75 mA and shall only be flowing for the period of measurement until the polarity is reversed.

Compliance is checked by measurement.

All the tests are repeated under the fault conditions of H.2.3 of Part 1. In this case, the potential to earth of each pole shall not exceed 1,1 times the maximum output voltage under load for more than 5 s.

Compliance is checked by measurement.

19.1.2 ~~Protection against direct contact with electrical and moving mechanical parts (contact path and drive) shall be ensured.~~

~~Compliance is checked by inspection.~~

~~19.2 Constant voltage separating transformers~~

~~19.2.1 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 of Part 1 into consideration.~~

~~19.2.2 The insulation between the 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 at least 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).~~

~~19.2.3 For constant voltage transformers with intermediate conductive part (e.g. the iron core) or a resonant circuit not connected to the body and located between the input and output windings, the insulation between the intermediate conductive part (or a resonant circuit) and the input windings and between the intermediate conductive part (or a resonant circuit) and the output windings shall consist of at least basic insulation (rated for the working voltage).~~

~~NOTE—An intermediate conductive part (or a resonant circuit) 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).~~

~~19.2.4 Parts of output circuits may be connected to protective earth.~~

~~19.2.5 There shall be no connections between the output circuit and the body, unless for associated transformers—allowed by the relevant equipment standard.~~

~~Compliance is checked by inspection.~~

~~19.3 Constant voltage isolating and safety isolating transformers~~

~~19.3.1 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 of Part 1 into consideration.~~

~~19.3.1.1 The insulation between the input and output winding(s) shall consist of double or reinforced insulation (rated for the working voltage) unless the requirements of 19.3.1.3 are complied with.~~

In addition, the following applies:

- ~~— 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 earth shall consist of at least basic insulation rated for the input voltage. The insulation between the output windings and the body connected to earth, 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);~~

~~19.3.1.2 For constant voltage transformers with intermediate conductive parts (e.g. the iron core) or a resonant circuit not connected to the body and located between the input and output windings, the following requirements are applicable:~~

- ~~a) for class I and class II transformers, 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);~~
 - ~~— 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 SELV circuits basic insulation only is required.~~
 - ~~— for transformer different from independent (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);~~
- ~~b) as alternative to a) for class I transformer not intended to be connected by means of a plug and for transformer different from independent (IP00), if the construction assure that all laminated plates of the iron core are connected to earth (e.g. by soldering / welding) and if in the data sheet or instruction sheet clearly state that the safety of the transformer depends on the earth connection and that is not possible to use in class II equipment, than the following apply: the insulation between the input windings and the intermediate conductive part connected to earth, and between the output windings and the intermediate conductive part connected to earth, shall consist of at least basic insulation (rated for the input and output voltage);~~
- ~~c) in addition to a) and b) the insulation between the intermediate conductive parts and the input windings, and between the intermediate conductive parts and the output windings shall consist of at least basic insulation (rated for the input and output voltage). 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).~~

~~19.3.1.3 For class I constant voltage transformers not intended for connection to the mains supply by means of a plug, the insulation between the input and output windings may consist of basic insulation plus protective screening instead of double or reinforced insulation, provided the following conditions are complied with:~~