IEC 61558-2-2

Edition 3.0 2022-10
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

GROUP SAFETY PUBLICATION

Safety of ~~power~~ transformers, ~~power supplies,~~ reactors, power supply units and ~~similar products~~ combinations thereof –
Part 2-2: Particular requirements and tests for control transformers and power ~~supplies~~ supply units incorporating control transformers

IEC 61558-2-2:2022-10 RLV(en)

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INTERNATIONAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF ~~POWER~~ TRANSFORMERS, ~~POWER SUPPLIES,~~ REACTORS, POWER SUPPLY UNITS AND ~~SIMILAR PRODUCTS~~ COMBINATIONS THEREOF –

Part 2-2: Particular requirements and tests for control transformers and power ~~supplies~~ supply units incorporating control transformers

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61558-2-2:2007. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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International standard IEC 61558-2-2 has been prepared by IEC technical committee 96: Transformers, reactors, power supply units and combinations thereof.

This third edition cancels and replaces the second edition published in 2007. This edition constitutes a technical revision.

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

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

b) new general symbol for control transformers;

c) new symbol for power supply unit with linearly regulated output voltage.

The text of this document is based on the following documents:

Draft	Report on voting
96/548/FDIS	96/554/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 document 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 document 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 control transformers and power supply units incorporating control transformers.*

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.

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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 www.webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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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, 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 example 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 the IEC 61558-2 series 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 ~~POWER~~ TRANSFORMERS, ~~POWER SUPPLIES,~~ REACTORS, POWER SUPPLY UNITS AND ~~SIMILAR PRODUCTS~~ COMBINATIONS THEREOF –

Part 2-2: Particular requirements and tests for control transformers and power ~~supplies~~ supply units incorporating control transformers

1 Scope

Replacement:

This part of IEC 61558 deals with the safety ~~aspects~~ of **control transformers** and **power ~~supplies~~ supply units** incorporating **control transformers**. **Transformers** incorporating **electronic circuits** are also covered by this document.

NOTE 1 Safety includes electrical, thermal and mechanical ~~safety~~ aspects.

~~This Part 2-2 is applicable to **control transformers** and **power supplies** incorporating both **control transformers** and **electronic circuits**. This Part 2-2 is not applicable to external circuits and their components intended to be connected to the input terminals, output terminals or socket-outlets of the **transformer** and **power supplies**.~~

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

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.

This document does not apply to **transformers** covered by IEC 60076-11.

~~This Part 2-2 applies to **stationary** or **portable**, single-phase or poly-phase, air-cooled (natural or forced), **independent** or **associated control transformers** and **power supplies** incorporating a **control transformer**, having a **rated supply voltage** not exceeding 1 000 V a.c. and **rated supply** and **internal operating frequency** not exceeding 500 Hz.~~

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.

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 thermal output** does not exceed:

- 25 kVA for single-phase ~~**control**~~ **transformers** ~~and **power supplies** incorporating **control transformers**~~**,**
- 40 kVA for polyphase ~~**control**~~ **transformers** ~~and **power supplies** incorporating **control transformers**~~.

This document is applicable to ~~**control**~~ **transformers** ~~and **power supplies** incorporating **control transformers**~~ without limitation of the **rated thermal output**, subject to an agreement between the purchaser and the manufacturer.

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~~This Part 2-2 is applicable to **dry-type transformers**. The windings may be encapsulated or non-encapsulated.~~

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

The **no-load output voltage** or the **rated output voltage** does not exceed 1 000 V AC or 1 415 V ripple-free DC. For **independent** ~~**control**~~ **transformers** ~~and independent **power supplies** incorporating **control transformers**,~~ the **no-load output voltage** and / or the **rated output voltage** is not less than 50 V AC or 120 V ripple-free DC.

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

NOTE 4 Normally the **control transformers** ~~and **power supplies** incorporating **control 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 ~~may~~ can be provided ~~(~~or completed~~)~~ by other features of the equipment, such as the **body**. Parts of **output circuits** ~~may~~ can be connected to the **input circuits** or to protective earthing.

~~This Part 2-2 is applicable to **control transformers** and **power supplies** incorporating **control transformers** associated with specific equipment, to the extent decided upon by the relevant IEC technical committees.~~

~~NOTE 2~~ Attention is drawn to the following, if necessary:

- for ~~**control**~~ **transformers** ~~and **power supplies** incorporating **control transformers**~~ intended to be used in vehicles, on board ships, and ~~on board~~ 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 ~~**control**~~ **transformers** ~~and **power supplies** incorporating **control transformers** should also be considered~~;
- additional requirements in accordance with other appropriate standards and national rules ~~may~~ can be applicable to ~~**control transformers** and **power supplies** incorporating **control**~~ **transformers** intended for use in special environments~~, such as tropical environments~~.

~~NOTE 3~~ Future technological development of ~~**control transformers** and **power supplies** incorporating **control**~~ **transformers** ~~may~~ can necessitate a need to increase the upper limit of the frequencies. Until then this document ~~may~~ 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

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

Addition:

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

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 2-16: 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

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

~~*Replacement of the third paragraph:*~~

~~When the term **transformer** is used from here forward, it covers **control transformers** and **power supplies** incorporating **control transformer(s)** where applicable.~~

For the purposes of this document, the terms and definitions given in IEC 61558-1:2017 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

Addition:

3.1.101
control transformer
transformer intended to supply power to control circuits (e.g. controlling, signalling, interlocking, etc.)

3.5.101
rated thermal output
product of the **rated output voltage** and the **rated output current**, or for polyphase **transformers**, the appropriate factor (e. g. for three-phase transformers $\sqrt{3}$) times the product of the **rated output voltage** and the **rated output current** delivered in continuous operation loaded at **power factor** 1

Note 1 to entry: If the **transformer** has more than one **output winding** or~~/and~~ tapped **output winding** (or both), the **rated output** denotes the sum of the products of **rated output voltage** and **rated output current** for **output circuits** intended to be loaded simultaneously.

3.5.102
admissible instantaneous output
product of the **rated output voltage** and the **rated instantaneous output current**, or for polyphase **transformers**, the appropriate factor (e. g. for three-phase transformers $\sqrt{3}$) times the product of the **rated output voltage** and the **rated instantaneous output current** delivered at **power factor** 0,5

Note 1 to entry: If the **transformer** has more than one **output winding** or~~/and~~ tapped **output winding** (or both), the **rated output** denotes the sum of the products of **rated output voltage** and **rated instantaneous output current** for **output circuits** intended to be loaded simultaneously.

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3.5.103
rated instantaneous output current
output current for the specific operating conditions at the **rated output voltage** and the **rated supply frequency** at **power factor** 0,5 assigned to the **transformer** by the manufacturer

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:

~~*Replacement*~~ *Addition:*

6.101 The **rated output voltage** shall not exceed 1 000 V AC or 1 415 V ripple-free DC and for **independent transformers** shall exceed 50 V AC or 120 V ripple-free DC.

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

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

- 25 kVA for single-phase **transformers**~~ except~~,
- 40 kVA for polyphase **transformers**~~ except for **transformers** subject to an agreement between the purchaser and the manufacturer~~.

Transformers without limitation of the **rated thermal 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

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

7.8

Replacement

Control transformers shall be classified for **overvoltage category III**.

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8 Marking and other information

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

8.1 c)

Replacement:

the **transformers** shall be marked with the **rated thermal output** and the **admissible instantaneous output** in volt-ampere, separated by an oblique stroke (e.g. 100/300 VA);

d)

Replacement:

Item d) is not applicable.

h)

~~*Replacement:*~~

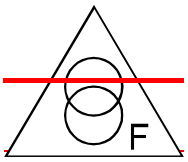
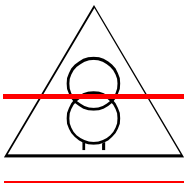
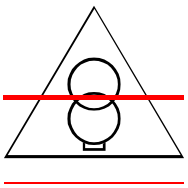
~~**the** transformers **shall be marked with one of the graphical symbols shown in 8.11.**~~

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

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

8.11

Addition:

~~**Symbol or graphical symbol**~~	~~**Explanation or title**~~	~~**Identification**~~
	~~Fail-safe **control transformer**~~	
	~~Non-short-circuit proof **control transformer**~~	
	~~Short-circuit proof **control transformer** (inherently or non-inherently)~~	

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

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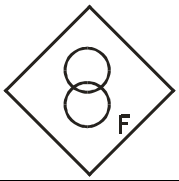
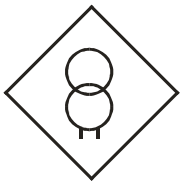
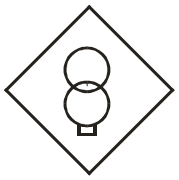
Table 101 – Symbols indicating the kind of transformer

Symbol or graphical symbol	Explanation or title	Identification
	**Fail-safe control transformer**	IEC 60417-6036:2010-08
	**Non-short-circuit-proof control transformer**	IEC 60417-6037:2010-08
	**Short-circuit-proof control transformer** (inherently or non-inherently)	IEC 60417-6038:2010-08
	Power supply unit, linear	IEC 60417-6210:2013-10

Addition:

8.101 If **transformers** are provided with input tappings to allow adjustments to the supply voltage, these tappings shall be marked with the value or the variation (e.g. +5 V or –5 V) of the input voltage corresponding to the tapping.

NOTE If **control transformers** are provided with input tappings to allow adjustments to the supply voltage, tappings in steps of 5 % are preferred.

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.

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11 Output voltage and output current under load

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

11.1

Replacement:

When the **transformer** is connected to the **rated supply voltage**, at **rated supply frequency**, and loaded with an impedance at **power factor** 1 resulting in the **rated thermal output** at the **rated output voltage**, the output voltage shall not differ from the rated value by more than ±5 %.

Compliance is checked by measuring the output voltage when steady-state conditions are established.

Immediately after the **transformer** is loaded with an impedance resulting in the **admissible instantaneous output** at the **rated output voltage** at **power factor** 0,5 (inductive), the output voltage measured shall not be less than 95 % of the measured voltage at the **rated thermal output**.

~~NOTE~~ The output voltage measurement for the **admissible instantaneous output** should be carried out within 50 ms after applying this overload to minimise the effects of supplementary heating of the **transformer**.

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

12 No-load output voltage

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

Addition:

12.101 The **no-load output voltage** shall not exceed 1 000 V AC or 1 415 V ripple-free DC and for **independent transformers** shall exceed 50 V AC or 120 V ripple-free DC.

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

NOTE The requirement for series connection does not apply to associated or IP 00 **transformers**.

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 %.

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~~NOTE~~ The ratio is ~~defined~~ 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 is checked by measuring the **no-load output voltage** ~~when~~ at the **ambient temperature**~~,~~ when the **transformer** ~~being~~ is connected to **the rated supply voltage** at the **rated supply frequency** and at the **rated thermal output**.*

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

Replacement of the ~~tenth~~ eleventh paragraph:

***Transformers** are supplied at the **rated supply voltage** and loaded with an impedance producing the **rated thermal output**, at the **rated output voltage** and, for AC current, at the **rated power factor**. The value of the output current is measured when steady state is established. Then the supply voltage is increased by 10 % and the output current is adjusted to the same value measured ~~before~~ previously. The output current is not adjusted for **independent transformers**. After this increase of the supply voltage, no change is made in the circuit. The test is repeated under no-load condition, if this is a more unfavourable situation.*

15 Short-circuit and overload protection

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

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:

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18.3 Dielectric strength test

~~*Add the following paragraph and note before Table 8a:*~~

~~For **transformers,** the values of test voltages for **basic insulation** (boxes 1) and 3) in Table 8a) are multiplied by a factor of 1,4.~~

Addition:

The required values of the dielectric strength test voltages for **basic insulation** of Table 14 shall be multiplied by a factor of 1,4.

NOTE **Basic insulation** has been increased because **transformers** are subjected to surge voltages due to the inductive nature of their loads.

19 Construction

This clause of IEC 61558-1:2017 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~~ via other **conductive parts**, except by deliberate action.

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

19.1.1 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 requirements apply:

- 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**).

19.1.2 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** or between the **intermediate conductive parts** and the **output windings** shall consist of at least **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 a **basic insulation** is considered to be connected to the relevant part(s).

In addition, the following requirements apply:

– 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**);

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– 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 **working voltage**).

Addition:

19.101 There shall be no connections between the **output circuits** and the protective earth unless allowed by the relevant equipment standard for **associated transformers**.

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

Compliance is checked by inspection.

20 Components

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

21 Internal wiring

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

22 Supply connection and other external flexible cables or cords

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

23 Terminals for external conductors

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

24 Provisions for protective earthing

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

25 Screws and connections

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

26 Creepage distances, clearances and distances through insulation

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

26.1 General

Replacement of the first paragraph:

~~**Creepage distances**, **clearances** and **distances through insulation** shall not be less than the values shown in Table 13, the values for **basic insulation** (boxes 1, 3 and 5) being multiplied by a factor of 1,4.~~

The required values of **creepage distances and clearances** for **basic insulation** in accordance with Table 20 and Table 21 shall be multiplied by a factor of 1,4.

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