Safety of power transformers, power supplies, reactors and similar products –

Part 1:
General requirements and tests

This English-language version is derived from the original bilingual publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.
Safety of power transformers, power supplies, reactors and similar products –

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General requirements and tests
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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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International Standard IEC 61558-1 has been prepared by IEC technical committee 96: Small power transformers, reactors and power supply units and similar products

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

This second edition of IEC 61558-1 cancels and replaces the first edition (1997), amendment 1 (1998) and IS 01. This new edition represents a complete revision of the previous edition. The changes were necessitated by the introduction of new technology and implementation of requirements from equipment committees.
The text of this standard is based on the following documents:

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This second edition of Part 1 is only to be used in conjunction with parts 2 based on this edition. The parts 2 contain clauses to supplement or modify the corresponding clauses of this Part 1 in order to provide the relevant requirements for each type of transformer.

However, individual countries may wish to consider its application, to the extent reasonable, to transformers not mentioned in the parts 2, and to transformers designed on new principles.

NOTE  Annex U contains the optional twisted system (marking, requirements and tests).

IEC 61558 consists of the following parts, under the general title Safety of power transformers, power supplies, reactors and similar products:¹)

Part 1:  General requirements and tests
Part 2-1: Particular requirements for separating transformers for general use
Part 2-2: Particular requirements for control transformers
Part 2-3: Particular requirements for ignition transformers for gas and oil burners
Part 2-4: Particular requirements for isolating transformers for general use
Part 2-5: Particular requirements for shaver transformers and shaver supply units
Part 2-6: Particular requirements for safety isolating transformers for general use
Part 2-7: Particular requirements for transformers for toys
Part 2-8: Particular requirements for bell and chime transformers
Part 2-9: Particular requirements for transformers for class III handlamps for tungsten filament lamps
Part 2-12: Particular requirements for constant voltage transformers
Part 2-13: Particular requirements for auto-transformers for general use
Part 2-14: Particular requirements for variable transformers (in preparation)
Part 2-15: Particular requirements for isolating transformers for the supply of medical locations
Part 2-16: Particular requirements for switch mode power supplies and transformers for switch mode power supplies (in preparation)

¹) Some of the parts of this series published earlier appeared under the general title Safety of power transformers, power supply units and similar or Safety of power transformers, power supply units and similar devices. Future editions of these parts will be issued under the new general title indicated above.
Part 2-17: Particular requirements for transformers for switch mode power supplies
Part 2-19: Particular requirements for perturbation attenuation transformers
Part 2-20: Particular requirements for small reactors
Part 2-23: Particular requirements for transformers for construction sites

Other parts are under consideration.

In this standard, 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 the standard, the words in **bold** are defined in Clause 3.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed;
• withdrawn;
• replaced by a revised edition, or
• amended.
INTRODUCTION

This International Standard covers safety requirements for transformers. Where the term transformer is used, it covers transformers, reactors and power supplies where applicable.

During the development of this standard, to the extent possible, the requirements of IEC 60364 were taken into consideration, so that a transformer may be installed in accordance with the wiring rules contained in that standard. However, national wiring rules may differ.

This standard recognizes the internationally accepted levels of protection against the possible electrical, mechanical, and fire hazards caused by transformers operating under normal conditions in accordance with the manufacturer's instructions. It also, covers abnormal conditions which may occur in practice.

A transformer complying with this standard will not necessarily be judged to comply with the safety principles of this standard if when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

A transformer employing materials or having forms of construction differing from those detailed in this standard may be examined and tested according to the intent of the requirements, and if found to be substantially equivalent, may be judged to comply with the safety principles of this standard.

The standard dealing with non-safety aspects of electromagnetic compatibility (EMC) of transformers is IEC 62041: Power transformers, power supply units, reactors and similar products – EMC requirements. However, that standard also includes tests which may subject the transformer to conditions involving the safety aspects.

The objective of Part 1 of IEC 61558 is to provide a set of requirements and tests considered to be generally applicable to most types of transformers, and which can be called up as required by the relevant part 2 of IEC 61558. Part 1 is thus not to be regarded as a specification by itself for any type of transformer, and its provisions apply only to particular types of transformers to the extent determined by the appropriate part 2. Part 1 of IEC 61558 also contains normative routine tests.

Each part 2 in conjunction with Part 1 contains all the necessary requirements for the transformer being covered and does not contain references to other parts 2. For transformers with a protection index IP00 and associated transformers, it is possible to have circuits corresponding to different parts 2 within the same construction (e.g. SELV output circuit according to Part 2-6 and 230 V output circuit according to Part 2-4). However, if the transformer is covered by different parts 2 of IEC 61558, to the extent reasonable, the relevant part 2 is applied to each function/application separately. If applicable, the effect of one function on the other is taken into consideration.

If, an appropriate part 2 for a particular transformer or group of transformers does not exist, the nearest applicable part 2 may be used as a guide to the requirements and tests.

Where the requirements of any of the clauses of a part 2 refer to Part 1 by the phrase "This clause of Part 1 is applicable", this phrase means all the requirements of that clause of Part 1 are applicable, except those requirements that are, clearly, not applicable to the particular type of transformer covered by that part 2.

The principle for preparation of the different parts 2 is as follows:
Figure 0 – IEC 61558 principle
Relevant clauses of this standard (e.g. clauses dealing with thermal endurance test for windings) apply also to transformers forming an integral part of an appliance and which cannot be tested separately.

As an option, the thermal characteristics of transformers can be specified by the rated maximum operating temperature of the winding (symbol $t_w$) which shall not be exceeded to ensure a minimum lifetime as specified in Annex U. In addition, for transformers subjected to abnormal conditions as specified in Clause 15, the specified temperature limit shall not be exceeded when the transformer is built into an appliance or used as an independent transformer.
SAFETY OF POWER TRANSFORMERS, POWER SUPPLIES,
REACTORS AND SIMILAR PRODUCTS –

Part 1: General requirements and tests

1 Scope

This International Standard deals with safety aspects of power transformers, power supplies, reactors and similar products such as electrical, thermal and mechanical safety.

This standard covers the following types of dry-type transformers, power supplies, including switch mode power supplies, and reactors, the windings of which may be encapsulated or non-encapsulated:

NOTE 1 The distinction between transformers, power supplies and switch mode power supplies is as follows:
– for transformers, there is no change in frequency. However, transformers (e.g. constant voltage transformers) may have an internal resonance frequency not exceeding 30 kHz;
– for power supplies, the internal operational frequency and waveform are different from the supply frequency and waveform, and the internal operational frequency does not exceed 500 Hz (see definition 3.1.19);
– for switch mode power supplies, the internal operational frequency and waveform are different from the supply frequency and waveform and the internal operational frequency exceeds 500 Hz and does not exceed 100 MHz.

The relevant parts 2 may be found in the introduction of this standard.

a) Stationary or portable, single-phase or poly-phase, air-cooled (natural or forced), isolating and safety isolating transformers, independent or associated, not forming a part of distribution networks and with the following characteristics:

– rated supply voltage not exceeding 1 000 V a.c.;
– rated supply frequency not exceeding 500 Hz;

and complying with the following values, unless otherwise specified in the relevant part 2:

• for isolating transformers:
  – rated output for single phase transformers, not exceeding 25 kVA, and for poly-phase transformers not exceeding 40 kVA.
  – no-load output voltage and the rated output voltage exceeding 50 V a.c., and not exceeding 500 V a.c. or 1 000 V a.c. to be in accordance with the National Wiring Rules or for a special application.

• for safety isolating transformers:
  – rated output for single phase transformers not exceeding 10 kVA, and for poly-phase transformers not exceeding 16 kVA.
  – no-load output voltage and the rated output voltage not exceeding 50 V a.c. between conductors, or between any conductor and protective earth.

NOTE 1 Isolating and safety isolating transformers are used where double or reinforced insulation between circuits is required by the installation rules or by the appliance specification (for example toys, bells, portable tools, handlamps).
b) **Stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced) separating transformers, auto-transformers, variable transformers and small reactors, independent or associated, not forming a part of distribution networks and with the following characteristics:

- **rated supply voltage** not exceeding 1 000 V a.c.;
- **rated supply frequency** not exceeding 500 Hz;

and complying with the following values, unless otherwise specified in the relevant part 2:

- no-load output voltage or a rated output voltage for both independent and associated transformers not exceeding 15 kV a.c., and for independent transformers, a rated output voltage not less than 50 V a.c.;
- **rated output** not exceeding the following values:
  - 1 kVA for single-phase transformers;
  - 2 kVAR for single-phase reactors;
  - 5 kVA for poly-phase transformers;
  - 10 kVAR for poly-phase reactors.

**NOTE 2** Separating transformers are used where double or reinforced insulation between circuits is not required by the installation rules or by the appliance specification.

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

c) **Stationary** or **portable**, single-phase or polyphase, air-cooled (natural or forced), independent or associated power supplies and switch mode power supplies incorporating one or more transformer(s) of type a) or b), not forming a part of distribution networks and with the following characteristics:

- **rated supply voltage** not exceeding 1 000 V a.c.;
- **rated supply frequency** not exceeding 500 Hz;
- internal operational frequency for power supplies not exceeding 500 Hz and for switch mode power supplies not exceeding 100 MHz;

and with the following values, unless otherwise specified in the relevant part 2:

- for power supplies and switch mode power supplies incorporating isolating transformers:
  - **rated output** for single-phase or polyphase power supplies or switch mode power supplies not exceeding 1 kVA;
  - no-load output voltage and the rated output voltage exceeding 50 V a.c. or 120 V ripple-free d.c., and not exceeding 500 V a.c. or 708 V ripple-free d.c., or 1 000 V a.c. or 1 415 V ripple-free d.c. to be in accordance with national wiring rules or for a special application;

- for power supplies and switch mode power supplies incorporating safety isolating transformers:
  - **rated output** for single-phase or polyphase power supplies and switch mode power supplies not exceeding 1 kVA;
  - no-load output voltage and rated output voltage not exceeding 50 V a.c. or 120 V ripple-free d.c. between conductors, or between any conductor and protective earth.
NOTE 4 Power supplies and switch mode power supplies incorporating isolating and safety isolating transformers are used where double or reinforced insulation between circuits is required by the installation rules or by the appliance specification (for example toys, bells, portable tools, handlamps).

- for power supplies and switch mode power supplies incorporating separating transformers, auto-transformers, and variable transformers:
  - rated output for single-phase or polyphase power supplies and switch mode power supplies not exceeding 1 kVA;
  - no-load output voltage and rated output voltage for both, independent and associated transformers not exceeding 15 kV a.c., and for independent transformers, a rated output voltage not less than 50 V a.c.;

NOTE 5 Power supplies and switch mode power supplies incorporating separating transformers are used where double or reinforced insulation between circuits is not required by the installation rules or by the appliance specification.

d) This standard is also applicable to $t_w$-marked transformers with a rated output not exceeding 1 000 VA and where the $t_w$-temperature does not exceed 140 °C ($t_w$ 140). However, $t_w$-marking of transformers is optional.

This standard also applies to transformers, power supplies, switch mode power supplies, and reactors incorporating electronic circuits.

This standard does not apply to external circuits and their components intended to be connected to the input and output terminals or socket-outlets of the transformers, power supplies and switch mode power supplies, and reactors.

NOTE 6 Attention is drawn to the following:
- 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 like 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, such as tropical environment

NOTE 7 Future technological development of transformers may necessitate a need to increase the upper limit of the frequencies; until then this standard may be used as a guidance document.

2 Normative references

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

IEC 60065:2001, Safety requirements for mains operated electronic and related apparatus for household and similar general use


IEC 60068-2-6, Environmental testing – Part 2: Tests – Test FC: Vibration (sinusoidal)

IEC 60068-2-75, Environmental testing – Part 2: Tests – Test Eh: Hammer tests

IEC 60076-1, Power transformers – Part 1: General

IEC 60083, Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC

IEC 60085:1984, Thermal evaluation and classification of electrical insulation

IEC 60112:2003, Method for the determination of the proof and the comparative tracking indices of solid insulating materials

IEC 60127-3, Miniature fuses – Part 3: Sub-miniature fuse-links

IEC 60216 (all parts), Electrical insulating materials – Properties of thermal endurance

IEC 60227 (all parts), Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V

IEC 60245 (all parts), Rubber insulated cables – Rated voltages up to and including 450/750 V

IEC 60269 (all parts), Low voltage fuses

IEC 60269-2, Low voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)

IEC 60269-2-1, Low voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Sections I to VI: Examples of types of standardized fuses

IEC 60269-3, Low voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)

IEC 60269-3-1, Low voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Sections I to IV: examples of types of standardized fuses

IEC 60309 (all parts), Plugs, socket-outlets and couplers for industrial purposes

IEC 60317 (all parts), Specifications for particular types of windings wires

IEC 60320 (all parts), Appliance couplers for household and similar general purposes

IEC 60320-2-3, Appliance couplers for household and similar general purposes – Part 2-3: Appliance couplers with a degree of protection higher than IPX0

IEC 60384-14, Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

IEC 60417-DB:20022), Graphical symbols for use on equipment

IEC 60449:1973, Voltage bands for electrical installations of buildings

2) "DB" refers to the IEC on-line database.
IEC 60454 (all parts), Specification for pressure-sensitive adhesive tapes for electrical purposes

IEC 60529:1989, Degrees of protection provided by enclosures (IP Code)

IEC 60664-1:1992, Insulation co-ordination for equipment within low voltage systems – Part 1: Principles, requirements and tests

IEC 60664-3:2003, Insulation co-ordination for equipment within low voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution


IEC 60695-2-10, Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure


IEC 60695-10-2, Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test

IEC 60730 (all parts), Automatic electrical controls for household and similar use

IEC 60730-1:1999, Automatic electrical controls for household and similar use – Part 1: General requirements


IEC 60884-1:2002, Plugs and socket-outlets for household and similar purposes – Part 1: General requirements

IEC 60884-2-4, Plugs and socket-outlets for household and similar purposes – Part 2: Particular requirements for plugs and socket-outlets for SELV

IEC 60898 (all parts), Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations3)


IEC 60947-7-1, Low-voltage switchgear and controlgear – Part 7: Ancillary equipment – Section 1: Terminal blocks for copper conductors

IEC 60990:1990, Methods of measurement of touch current and protective conductor current

3) IEC 60898-2 is published under the general title Circuit-breakers for overcurrent protection for household and similar installations (i.e. without the element of “Electrical accessories” in the title).
IEC 60998-2-1, Connecting devices for low voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units

IEC 60998-2-2, Connecting devices for low voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units

IEC 60999-1, Connecting devices – Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors – Part 1: General requirements and particular requirements for conductors from 0,5 mm² up to 35 mm² (included)

IEC 61032:1997, Protection of persons and equipment by enclosures - Probes for verification

IEC 61058-1:2000, Switches for appliances – Part 1: General requirements

IEC 61140: Protection against electric shock – Common aspects for installation and equipment


ISO 8820 (all parts), Road vehicles – Fuse-links