

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Safety of transformers, reactors, power supply units and combinations thereof –
EMC requirements**

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



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

R

ICS 29.180, 33.100

ISBN 978-2-88912-157-1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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 62041 has been prepared by Technical Committee 96: Transformers, reactors, power supply units and combinations thereof.

This second edition cancels and replaces the first edition published in 2003. It constitutes a technical revision.

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

- the frequency range for tests according to IEC 61000-4-3 has been extended above 1 GHz according to technologies used in this frequency area;
- the testing requirements according to IEC 61000-4-11 have been amended significantly;
- the inclusion of a clause on tests in series production;
- the inclusion of a new clause on measurement uncertainty, and
- the inclusion of requirements on DC **power ports** and telecommunication **ports**.

It has the status of a product family EMC standard in accordance with IEC Guide 107:2009, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

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

FDIS	Report on voting
96/358/FDIS	96/367/RVD

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 standard is to be used in conjunction with IEC 61558 series.

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 this publication, the words in **bold** are defined in Clause 3 of this standard and in the IEC 61558 series.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months from the date of publication.

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

1 Scope

This international product family standard applies to **transformers, reactors, power supply** units and combinations thereof covered by the IEC 61558 series of standards. This standard deals with the electromagnetic compatibility requirements for emission and immunity within the frequency range 0 Hz - 400 GHz. No measurement needs to be performed at frequencies where no requirement is specified.

Transformers, reactors, power supply units and combinations thereof delivered with or incorporated in an appliance or equipment should follow the relevant EMC standard applicable to that appliance or equipment. However, this standard may be used as a guide to test the **transformers, reactors, power supply** units and combinations thereof separately before incorporating them in the appliance or equipment.

This EMC standard covers performance only. Other operations of the **transformers, reactors** and **power supply** units (e.g. simulated faults in the electric circuitry for testing purposes or functional safety due to the effects of the electromagnetic phenomena, or evaluation of human being for exposure to electromagnetic fields (EMF)) have not been taken into consideration in this standard.

NOTE When **EUT** (Equipment under Test) is used, it covers **transformers, reactors, power supply** units and combinations thereof where applicable.

This standard does not apply to:

- uninterruptible **power supplies** (UPS) covered by IEC 62040 series;
- **power supply** units covered by IEC 61204-3,
(i.e. DC-DC converters, DC power and distribution equipment and **power supply** units for use in applications covered by IEC 60950-1, IEC 61010-1, IEC 60601-1, IEC 60065 and IEC 62368-1),
- **power supplies** and converters for use with or in products covered by IEC 61347-1.

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 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤75 A per phase*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61558 (all parts), *Safety of power transformers, power supplies, reactors and similar products*

CISPR 14-1:2005, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 16-1-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances*

CISPR 16-2-1:2008, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-3, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 22, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

environment 1

residential, commercial and light-industrial locations, both indoor and outdoor

NOTE 1 Locations which are characterised by being supplied directly from a **low voltage** from the **public mains network** are considered to be residential, commercial or light-industrial.

NOTE 2 The following list, although not comprehensive, gives an indication of location which are included:

- residential properties, e.g. houses, apartments, hotels, etc.;
- retail outlets, e.g. shops, supermarkets, etc.;
- business premises, e.g. offices, banks, etc.;
- areas of public entertainment, e.g. cinemas, public bars, dance halls, restaurants, etc.;
- outdoor locations, e.g. petrol stations, car parks, amusement and sports centres, etc.;
- light-industrial locations, e.g. workshops, laboratories, service centres, etc.

3.2 environment 2 industrial environments, both indoor and outdoor

NOTE Industrial locations are connected to a power network supplied from a high or medium **transformer** dedicated to the supply of an installation feeding manufacturing or similar plant, and in addition characterised by the existence of one or more of the following:

- industrial, scientific and medical (ISM) apparatus (as defined in CISPR 11);
- heavy inductive or capacitive loads are frequently switched;
- currents and associated magnetic fields are high.

3.3 equipment under test EUT

it refers to **transformers, reactors, power supply units** and combinations thereof where applicable

3.4 port

particular interface of the specified **EUT** with the external electromagnetic environment (see Figure 1)

NOTE In some cases, different **ports** may be combined.

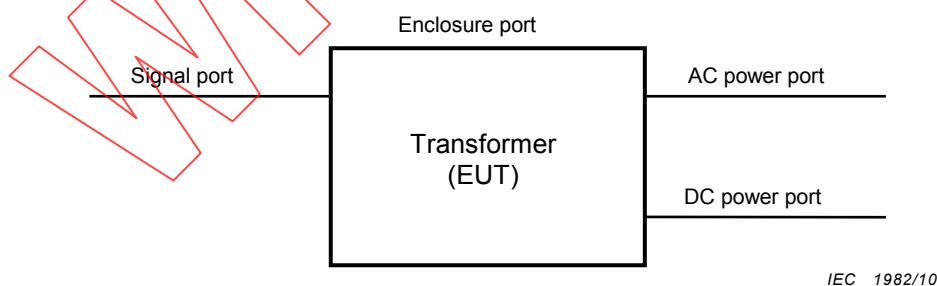


Figure 1 – Example of ports

3.5 enclosure port

physical boundary of the **EUT** which electromagnetic fields may radiate through or impinge on

3.6 cable port

port at which a conductor or a cable is connected to the **EUT**

NOTE Examples are signal and **power ports**.

3.7 signal port

port at which a conductor or cable intended to carry signals is connected to the **EUT**

NOTE Examples are analogue **inputs**, **outputs** and control lines, data busses, communication networks, etc.

3.8 power port

port at which a conductor or cable carrying the primary electrical power needed for the operation (functioning) of an **EUT** is connected

3.9 public mains network

power lines to which all categories of consumers have access to and that are operated by an electrical **power supply** and/or distribution organization for the purpose of supplying electrical energy

3.10 long distance lines

lines connected to a **signal port** and which inside a building are longer than 30 m, or which leave the building (including lines of outdoor installations)

3.11 low voltage

voltage having a value below a conventionally adopted limit

[IEC 60050-151:2001, 151-15-03]

4 Classification

EUT are classified according to the incorporation of components and **electronic circuits** as follows:

- category 0: **EUT** with or without passive protection component(s) and without **electronic circuits**;
- category 1: **EUT** with passive components, and without **electronic circuits**;
- category 2: **EUT** with **electronic circuits**.

NOTE 1 Examples of passive protection components are fuses, thermal links, **thermal cut-outs**, circuit-breakers, PTC's, NTC's and resistors.

NOTE 2 Examples of passive components are capacitors, inductors, diodes, LED's, relays, VDR's.

NOTE 3 Examples of **electronic circuits** are active semiconductors.

5 Test specifications

5.1 Immunity

5.1.1 Immunity against disturbances

EUT shall have sufficient immunity against disturbances from their surroundings.

Category 0 **EUT** are not sensitive to normal electromagnetic perturbations. Consequently, they are deemed to fulfil the immunity requirements without testing.

Category 1 **EUT** shall fulfil the following requirements:

- electrostatic discharge;

NOTE 1 Some passive components such as small capacitors (e.g. Y-type), diodes, LEDs or relays may be sensitive to electrostatic discharges.

- electrical fast transient/burst;

NOTE 2 Some passive components such as small capacitors (e.g. Y-type), diodes, LEDs, or relays may be sensitive to electrical fast transients.

- surge.

NOTE 3 Some passive components such as small capacitors (e.g. Y-type), diodes, LED or relays may be sensitive to surges.

For the requirements on a **port-by-port** basis, see 5.1.2.2 to 5.1.2.7 inclusive.

Category 2 **EUT** shall fulfil the following requirements:

- electrostatic discharge;
- electrical fast transient/burst;
- surge;
- conducted disturbances, inducted by radio-frequency fields;
- radiated, radio-frequency electromagnetic fields;
- **voltage** dips and short interruptions.

The requirements are given in 5.1.2.2 to 5.1.2.7 on a **port-by-port** basis.

The relevant **ports** of the **EUT** shall be subjected to the required test in accordance with the applicable subclauses. Tests shall be carried out only when the relevant **ports** exist.

Tests shall be conducted under the no-load condition at the **rated voltage** and the **rated frequency**, unless otherwise specified in the generic EMC standard as indicated in Clause 5. If **EUT** is not intended to operate under the no load condition, for some tests, a load may need to be applied for perturbation. In this case, the specification of the load shall be stated in the test report.

Tests shall be conducted sequentially. The sequence of testing is optional.

The necessity to conduct some of the tests may be determined in accordance with the electrical characteristics and the specific application of the particular **transformer**. In such cases the rationale for not conducting the tests shall be stated in the test report.

The description of the tests, the test generator, the test methods and the test set-up are specified in the generic EMC standard for testing in accordance with Clause 5.

The tests are carried out following the manufacturer's documentation. This includes a functional description and explanation of performance criteria, during or as a consequence of the EMC testing. This shall be provided by the manufacturer and included in the test report, based on the following criteria. In case of no documentation, necessary conductors, the cross section, the type and the length of the conductors used shall be reported in the test report.

Performance criterion A: The **EUT** shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the **EUT** is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the **EUT** if used as intended.

Performance criterion B: The **EUT** shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the **EUT** is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is, however, allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the **EUT** if used as intended.

Performance criterion C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

If, as a result of the application of the tests defined in this standard, the **transformer** becomes dangerous or unsafe (e.g., by an insulation breakdown), the **EUT** is deemed to have failed the tests.

5.1.2 Test levels

5.1.2.1 General

Levels for test stated in this standard correspond to typical condition for **environment 1** and **2**. However, if special conditions prevail for the use of the final product, the relevant values in the basic standard shall be applied and stated in the test report.

5.1.2.2 Electrostatic discharges

These tests are carried out according to IEC 61000-4-2, with test levels as given in Table 1.

Except for metallic parts for which a contact discharge test is made, only air discharge test is required.

Ten positive and ten negative pulses shall be applied to each selected point. The time interval between each successive single discharge is 1 s.

**Table 1 – Electrostatic discharges –
Test levels at enclosure**

Characteristics	Environment 1		Environment 2	
	Test values	Level	Test values	Level
Air discharge	8 kV	3	8 kV	3
Contact discharge	4 kV	2	4 kV	2

The device shall comply with performance criterion B.

5.1.2.3 Radiated, radio frequency electromagnetic field

These tests are carried out according to IEC 61000-4-3, with test levels as given in Table 2.

**Table 2 – Radiated, radio frequency electromagnetic field –
Test levels at enclosure**

Characteristics	Environment 1		Environment 2	
	Test values	Level	Test values	Level
Frequency range	80 MHz to 1 000 MHz	2	80 MHz to 1 000 MHz	3
Test level	3 V/m (unmodulated)		10 V/m (unmodulated)	
Modulation	1 kHz, 80 % AM, sine wave		1 kHz, 80 % AM, sine wave	
Frequency range	1,4 GHz to 2,0 GHz	2	1,4 GHz to 2,0 GHz	2
Test level	3 V/m (unmodulated)		3 V/m (unmodulated)	
Modulation	1 kHz, 80 % AM, sine wave		1 kHz, 80 % AM, sine wave	
Frequency range	2,0 GHz to 2,7 GHz	1	2,0 GHz to 2,7 GHz	1
Test level	1 V/m (unmodulated)		1 V/m (unmodulated)	
Modulation	1 kHz, 80 % AM, sine wave		1 kHz, 80 % AM, sine wave	

The tests are normally performed without gaps in the frequency range 80 MHz to 1 000 MHz. For testing frequencies above 1 000 MHz is to reach an agreement with the customer.

The device shall comply with performance criterion A.

5.1.2.4 Electrical fast transient/burst

These tests are carried out according to IEC 61000-4-4, with test levels as given in Tables 3 to 5. The device shall comply with performance criterion B.

Electrical fast transients are applied with a positive polarity and a negative polarity for not less than 1 minute each.

**Table 3 – Electrical fast transient/burst –
Test levels at signal port**

Characteristics	Environment 1		Environment 2	
	Test values	Level	Test values	Level
EUT Category ^a	1	2	1	2
Test level ^b	0,5 kV	0,5 kV	1,0 kV	1,0 kV
Rise time/hold time	5/50 ns	5/50 ns	5/50 ns	5/50 ns
Repetition Frequency	5 kHz	100 kHz	5 kHz	100 kHz

^a referring to 5.1.1 no testing required for category 0 EUT.

^b open circuit test **voltage**.

For this test, the capacitive coupling clamp is to be used. Applicable only to **ports** interfacing with cables whose total length according to manufacturer's functional specification may exceed 3 m.

NOTE 1 Use of 5 kHz repetition rates is traditional; however, 100 kHz is closer to reality.