

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Transformers, power supplies, reactors and similar products –  
EMC requirements**

(standards.iteh.ai)

**Transformateurs, alimentations, bobines d'inductance et produits analogues –  
Exigences CEM**

<https://standards.iteh.ai/catalog/standards/sist/39af9976-e51c-4f76-bbfd-8c542f60ce0e/iec-62041-2017>



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

This third edition cancels and replaces the second edition published in 2010. It constitutes a technical revision.

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

- the inclusion of a clause on tests in series production;
- the inclusion of a new clause on measurement uncertainty, and
- the status of a harmonized standard for this third edition.

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.*

This bilingual version (2018-01) corresponds to the monolingual English version, published in 2017-08.

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

FDIS	Report on voting
96/465/FDIS	96/467/RVD

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

The French version of this standard has not been voted upon.

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

This standard is to be used in conjunction with the 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 document and in the IEC 61558 series.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://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- withdrawn,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.

NOTE The attention of the 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 or not later than 3 years from the date of publication.

The transitional period is no longer than 3 years after the publication of this standard.

# TRANSFORMERS, POWER SUPPLIES, REACTORS AND SIMILAR PRODUCTS –

## EMC requirements

### 1 Scope

This document is applicable to transformers, reactors and power supply units covered by the IEC 61558 series of standards. This document deals with the electromagnetic compatibility requirements for emission and immunity within the frequency range 0 Hz to 400 GHz. No tests need to be performed at frequencies where no requirements are specified.

For associated transformers, associated reactors and associated power supply units either supplied with or incorporated into an appliance or equipment, the relevant EMC standard for that appliance or equipment applies.

This document covers normal operating conditions 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 document.

Requirements are specified for each port considered. If requirements are different, the most severe takes precedence.

This document may also be used as a guide to test transformers, reactors and power supply units separately before these are incorporated into an appliance or equipment.

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

This document does not apply to:

- uninterruptible power supplies (UPS) covered by IEC 62040 (all parts);
- power supply units covered by IEC 61204,  
(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 and IEC 60065);
- power supplies and converters for use with or in products covered by IEC 61347 (all parts).

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-161, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

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  $\leq 16$  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  $\leq 75$  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  $\leq 75$  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 61000-4-34, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

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 14-1:2016, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*  
CISPR 16-1-4:2010/AMD1:2012

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 16-4-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

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### 3 Terms, definitions and abbreviations

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

##### 3.1.1

##### **equipment under test**

transformers, reactors and power supply units where applicable

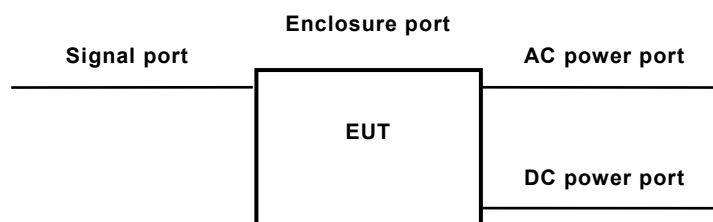
##### 3.1.2

##### **port**

particular interface of the specified **EUT** with the external electromagnetic environment.

Note 1 to entry: Examples of ports of interest are shown in Figure 1. The enclosure port is the physical boundary of the equipment (e.g. enclosure). The enclosure port provides for radiated and electrostatic discharge (ESD) energy transfer, whereas the other ports provide for conducted energy transfer, either by direct injection or by induction.

Note 2 to entry: In some cases, different **ports** may be combined.



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**Figure 1 – Ports covered by Table A.1 to Table A.16****3.1.3****enclosure port**

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

**3.1.4****cable port**

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

Note 1 to entry: Examples are signal, control and **power ports**.

**3.1.5****signal port**

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

Note 1 to entry: Examples are analogue inputs, outputs and control lines, data busses, communication networks, etc.

**3.1.6****power port**

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

**3.1.7****public mains network**

electricity lines to which all categories of consumers have access and which are operated by a supply or distribution undertaking for the purpose of supplying electrical energy

**3.1.8****low voltage**

voltage having a value below a conventionally adopted limit

Note 1 to entry: For the distribution of AC electric power, the upper limit is generally accepted to be 1 000 V.

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

**3.2 Abbreviations**

AC	Alternating Current
AM	Amplitude Modulation
DC	Direct Current
EUT	Equipment Under Test
FAR	Fully Anechoic Room
ISN	Impedance Stabilization Network
LV	Low Voltage
OATS	Open Area Test Site

SAC Semi Anechoic Chamber  
TEM Transverse Electromagnetic Mode

## 4 General considerations

### 4.1 Categories

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

- category 0: **EUT** with or without passive protection components 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.

### 4.2 Measurement uncertainty

Compliance testing with the limits described in this document shall be carried out statistically according to Table 1. Emission tests shall be executed in accordance with Annex A by using at least 5 samples. In case of exceptional conditions, the sum of test samples can be reduced to 3 or 4 samples.

The requirements are fulfilled, if the measured emissions of all individual samples are in compliance with the limits and the gap to the limit is not smaller than specified in Table 1.

**Table 1 – Additional acceptance limit for statistical determination**

Sample size	3	4	5	6
Additional acceptance limit (dB)	3,8	2,5	1,5	0,7

This procedure shall not be used to show the non-compliance of the product.

NOTE This procedure is based on CISPR TR 16-4-3.

Compliance is constituted by

$$x_{\max} + k_E \times \sigma_{\max} < L$$

where

- $x_{\max}$  is the highest (unfavourable) value of all samples of the sample size;  
 $k_E$  is the coefficient taken from the Table 2 in view of sample size;  
 $\sigma_{\max}$  is the conservative standard regression of product group;  
 $L$  is the permissible limit.

**Table 2 – Values of  $k_E$  according to CISPR TR 16-4-3:2004, Table C.1**

Sample size	3	4	5	6
Coefficient $k_E$	0,63	0,4	0,24	0,12

IEC/CISPR/TR 16-4-3 recommends  $\sigma_{\max} = 6$  dB for conducted emissions. For radiated emissions the same value of  $\sigma_{\max}$  can be used. Values shown in Table 1 constitute a simple multiplication of  $k_E$  and  $\sigma_{\max} = 6$  dB.

Table 1 is only valid for sample sizes up to 6. If more samples are used to check compliance, a different procedure may be used (binominal distribution without additional gap to the limit).

### 4.3 Routine tests (production tests)

The assessment of compliance with the requirements of this document shall be carried out by normative tests. The uncertainty of measurement shall be taken into account.

Wherever possible, the measurement uncertainty shall be covered in accordance with CISPR 16-4-2.

NOTE 1 Measurements conducted at the place of installation, the share of place is not taken into account.

Measurements carried out at distances smaller than 10 m, higher uncertainty may need to be used.

**Table 3 – Uncertainties for emission tests**

Test	Uncertainty dB
Conducted emissions (150 kHz to 30 MHz) using a 50Ω/50μH ISN <sup>a</sup>	3,44
Radiated emissions (30 MHz to 200 MHz) – Horizontal polarisation – 10 m <sup>b</sup>	5,05
Radiated emissions (30 MHz to 200 MHz) – Vertical polarisation – 10 m <sup>b</sup>	5,03
Radiated emissions (200 MHz to 1 GHz) – Horizontal polarisation – 10 m <sup>c</sup>	5,21
Radiated emissions (200 MHz to 1 GHz) – Vertical polarisation – 10 m <sup>c</sup>	5,22
<sup>a</sup> Impedance stabilisation network (ISN). <sup>b</sup> Uncertainty for the use of biconical antennas. <sup>c</sup> Uncertainty for the use of logarithmical-periodical antennas.	

## 5 Product documentation

The user documentation and/or manual shall contain details of any special measures required to be taken by the purchaser or user to ensure the EMC compliance of the EUT with the requirements of this publication. One example would be the need to use shielded or special cables.

## 6 Applicability

The application of tests for evaluation of immunity depends on the particular apparatus, its configuration, its **ports**, its technology and its operating conditions.

Tests shall be applied to the relevant **ports** of the **EUT** according to Table A.1 to Table A.16. Tests shall only be carried out where the relevant **ports** exist.

It may be determined from consideration of the electrical characteristics and usage of a particular **EUT** that some of the tests are inappropriate and therefore unnecessary. In such a case, it is required that the decision and justification not to test shall be recorded in the test report.

## 7 Test equipment

The description of the measurement, the measurement instrumentation, the measurement methods and the measurement set up to be used is given in Tables A.1 to A.16.

## 8 Conditions during testing

If the apparatus is part of a system, or can be connected to auxiliary apparatus, the apparatus shall be tested while connected to the minimum representative configuration of auxiliary apparatus necessary to exercise the **ports** in a similar manner to that described in CISPR 32.

In cases where manufacturer's specification requires external filtering and/or shielding devices or measures that are clearly specified in the user's manual, the measurement requirements of this document shall be applied with the specified devices or measures in place.

The configuration and mode of operation during the measurements shall be precisely noted in the test report. If the apparatus has a large number of similar **ports** or **ports** with many similar connections, a sufficient number shall be selected to simulate actual operating conditions and to ensure that all different types of determination are covered.

The measurements shall be carried out at one single set of parameters within the operating ranges of temperature, humidity and atmospheric pressure specified for the product and at the rated supply voltage, unless otherwise indicated in the basic standard.

Where applicable, additional information on **EUT** configuration can be found in CISPR 16-2 (all parts) and CISPR 32.

## 9 Measurement procedures

### 9.1 Emission

The **equipment under test (EUT)** shall be tested in the operating mode producing the largest emission in the frequency band being investigated, e.g. based on limited pre-tests and consistent with normal applications. The configuration of the test sample shall be varied to achieve maximum emission consistent with typical applications and installation practice.

The emission requirements for **EUT** covered by this document are given on a **port** by **port** basis. These requirements are stated in Tables A.9 to A.16.

Measurements shall be conducted in a well-defined and reproducible manner. The measurements may be performed in any order.

### 9.2 Immunity

The **equipment under test (EUT)** shall be tested in the expected most susceptible operating mode e.g. identified by performing limited pre-tests. This mode shall be consistent with

normal applications. The configuration of the test sample shall be varied to archive maximum susceptibility with typical applications and installation practice.

The immunity test requirements for **EUT** covered by this document are given on a **port** by **port** basis.

Tests shall be conducted in a well-defined and reproducible manner.

The tests shall be carried out individually as single tests in sequence. The tests may be performed in any order. If requirements are in conflict the most severe takes precedence.

The description of the test, relevant generator, appropriate methods, and the set up to be used are given in basic standards, which are referred to in Tables A.1 to A.8.

The contents of these basic standards are not repeated here, however modifications or additional information and test levels needed for the practical application of the tests are given in this document.

## 10 Performance criteria

The variety and the diversity of the **EUT** within the scope of this document makes it difficult to define precise criteria for the evaluation of the immunity test results.

If, as a result of the application of the tests defined in this document, the apparatus becomes dangerous or unsafe, the apparatus shall be deemed to have failed the test.

A functional description and a definition of performance criteria, during or as a consequence of the EMC testing, shall be provided by the manufacturer and noted in the test report, based on one of the following criteria for each test as specified in Tables A.1 to A.8.

**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.