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Edition 2.0 2018-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Integrated circuits – Measurement of electromagnetic emissions – Part 1: General conditions and definitions

Circuits intégrés – Mesure des émissions électromagnétiques – Partie 1: Conditions générales et définitions

IEC 61967-1:2018-12(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 1: General conditions and definitions

FOREWORD

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International Standard IEC 61967-1 has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

This second edition cancels and replaces the first edition published in 2002. This edition constitutes a technical revision.

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

a) the frequency range of 150 kHz to 1 GHz has been deleted from the title;
b) the frequency step above 1 GHz has been added to Table 1, Table 2 and to 5.4;
c) Table A.1 has been divided into two tables, and IEC 61967-8 has been added to Table A.2 of Annex A;
d) the general test board description has been moved to Annex D.

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

FDIS	Report on voting
47A/1062/FDIS	47A/1066/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.

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

A list of all parts of the IEC 61967 series, under the general title *Integrated circuits – Measurement of electromagnetic emissions*, 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.

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- withdrawn,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.

INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 1: General conditions and definitions

1 Scope

This part of IEC 61967 provides general information and definitions on the measurement of conducted and radiated electromagnetic disturbances from integrated circuits. It also provides a description of measurement conditions, test equipment and set-up as well as the test procedures and content of the test reports. Test method comparison tables are included in Annex A to assist in selecting the appropriate measurement method(s).

The object of this document is to describe general conditions in order to establish a uniform testing environment and to obtain a quantitative measure of RF disturbances from integrated circuits (IC). Critical parameters that are expected to influence the test results are described. Deviations from this document are noted explicitly in the individual test report. The measurement results can be used for comparison or other purposes.

Measurement of the voltage and current of conducted RF emissions or radiated RF disturbances, coming from an integrated circuit under controlled conditions, yields information about the potential for RF disturbances in an application of the integrated circuit.

The applicable frequency range is described in each part of IEC 61967.

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.

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
artificial network
AN
network presenting a reference load impedance (simulated) to the DUT (e.g. extended power or communication lines) across which the RF disturbance voltage is measured and which isolates the apparatus from the power supply or loads in a given frequency range

Note 1 to entry: This note applies to the French language only.

3.2
associated equipment
transducers (e.g. probes, networks and antennae) connected to a measuring receiver or test generator, also transducers used in the signal or disturbance transmission path between a DUT and measuring equipment or a (test-) signal generator

3.3
broadband disturbance
broadband emission
electromagnetic disturbance which has a bandwidth greater than that of a particular measuring apparatus, receiver or susceptible device

Note 1 to entry: For some purposes, particular spectral components of a broadband disturbance may be considered as narrowband disturbances.

Note 2 to entry: Emission that has a bandwidth greater than that of a particular measuring apparatus or receiver.

[SOURCE: IEC 60050-161:1990, 161-06-11, modified – Note 2 to entry and the second preferred term "broadband emission" have been added.]

3.4
common mode voltage
asymmetrical disturbance voltage
mean of the phasor voltages appearing between each conductor and a specified reference, usually earth or frame

[SOURCE: IEC 60050-161:1990, 161-04-09, modified – The word "disturbance" has been added to the admitted term.]

3.5
common mode current
vector sum of the currents flowing through two or more conductors at a specified cross-section of a mathematical plane intersected by these conductors

3.6
conducted emission
transient and/or other disturbance observed on the external terminals of a device during its normal operation

3.7
continuous disturbance
electromagnetic disturbance the effects of which on a particular device or equipment cannot be resolved into a succession of distinct effects

Note 1 to entry: RF disturbance with a duration of more than 200 ms at the IF-output of a measuring receiver that causes a deflection on the meter of a measuring receiver in quasi-peak detection mode that does not decrease immediately.

[SOURCE: IEC 60050-161:1990, 161-02-11, modified – Note 1 to entry has been added.]

3.8
DUT
device under test
device, equipment or system being evaluated

Note 1 to entry: As used in this document, DUT refers to a semiconductor device being tested.

Note 2 to entry: This note applies to the French language only.

3.9
die shrink
reduction of die size by using an advanced fabrication process including finer lithography node and masks

3.10
differential mode current
in a two-conductor cable, or for two particular conductors in a multi-conductor cable, half the magnitude of the difference of the phasors representing the currents in each conductor

[SOURCE: IEC 60050-161:1990, 161-04-38]

3.11
differential mode voltage
voltage between any two of a specified set of active conductors

[SOURCE: IEC 60050-161:1990, 161-04-08, modified – The second preferred term "symmetrical voltage" has been removed.]

3.12
discontinuous disturbance
electromagnetic disturbance, the effects of which on a particular device or equipment can be resolved into a succession of distinct effects

Note 1 to entry: It is recognised that this definition does not characterise the disturbance independently of the effect that it produces. As a practical matter, any measure of a disturbance should be relatable to its effect on a susceptible device.

Note 2 to entry: For counted clicks, disturbance with a duration of less than 200 ms at the IF-output of a measuring receiver, which causes a transient deflection on the meter of a measuring receiver in quasi-peak detection mode.

[SOURCE: IEC 60050-161:1990, 161-02-28, modified – Note 2 to entry has been added.]

3.13
electrically small PCB
printed circuit board with length and width shorter than $\lambda/2$, for example 100 mm to 150 mm at 1 GHz

3.14
EMC
electromagnetic compatibility
ability of an apparatus or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

3.15
electromagnetic emission
phenomenon by which electromagnetic energy emanates from a source

3.16
electromagnetic radiation
radiated emission
1) phenomenon by which energy in the form of electromagnetic waves emanates from a source into space

2) energy transferred through space in the form of electromagnetic waves

[SOURCE: IEC 60050-161:1990, 161-01-10, modified – The second preferred term "radiated emission" has been added and the Note to entry has been omitted.]

3.17
emission limit
<from a disturbing source> specified maximum emission level of a source of electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-03-12]

3.18
ground reference plane
flat conductive surface whose potential is used as a common reference

[SOURCE: IEC 60050-161:2014, 161-04-36, modified – The term "reference-ground plane" has been changed to "ground reference plane", the definition has been condensed and the notes to entry, omitted.]

3.19
lead frame
supporting structure for the silicon die that interfaces the external pins to the die

3.20
measuring receiver
receiver for the measurement of disturbances with different detectors

Note 1 to entry: The bandwidth of the receiver should be as specified in CISPR 16-1-1.

3.21
narrowband emission
electromagnetic disturbance, or spectral component thereof, which has a bandwidth less than or equal to that of a particular measuring apparatus, receiver or susceptible device

Note 1 to entry: Emission with bandwidth less than that of a particular measuring apparatus or receiver.

[SOURCE: IEC 60050-161:1990, 161-06-13, modified – The term "narrowband disturbance" has been changed to "narrowband emission" and Note 1 to entry has been added.]

3.22
peak detector
detector, the output voltage of which is the peak value of the applied signal

[SOURCE: IEC 60050-161:1990, 161-04-24]

3.23
preamp noise floor
inherent thermal noise generated by the first stage amplifier that limits the signal resolution of the measurement system

3.24
receiver terminal voltage
antenna voltage
voltage generated by a source of radio disturbance and measured in dB (µV) by a radio disturbance measuring instrument conforming to the requirements of CISPR 16

Note 1 to entry: External voltage measured in dB (µV) at the input of a radio interference measuring instrument conforming to the requirements of CISPR 16-1-1.

[SOURCE: CISPR 25:2008, 3.8, modified – Note 1 to entry has been added.]

3.25
reference point
specific port or point on the test set-up where the measurement of the sampled parameter is made

3.26
repetition rate
number of surges, spikes, or pulses per unit of time

3.27
radio frequency ambient
RF ambient
electromagnetic environment
totality of electromagnetic phenomena existing at a given location

[SOURCE: IEC 60050-161:1990, 161-01-01, modified – The preferred terms "radio frequency ambient" and "RF ambient" have been added and Note 1 to entry has been removed.]

3.28
shielded enclosure
mesh or sheet metallic housing designed expressly for the purpose of separating electromagnetically the internal and external environment

[SOURCE: IEC 60050-161:1990, 161-04-37, modified – The second preferred term "screened room" has been omitted.]]

3.29
significant IC change
changes that may influence the electromagnetic emissions of an IC

Note 1 to entry: Examples include changes to a new device, new manufacturer or process line, die shrink, new package type, significant manufacturing process, internal/external clock, I/O drive capability.

3.30
system gain
gain (or attenuation) of the measurement path between the reference point and the input of the RF measuring instrument

3.31
test plan
document provided by the test requester to define the tests to be carried out, the object of the testing, the DUT operating status, the conditions for the test and performance objectives

Note 1 to entry: The test plan completely guides the implementation of the test, by reference to the standard test procedure, or by detailing revisions or additions for the specific DUT.

4 Test conditions

4.1 General

These default test conditions are intended to ensure a consistent test environment. If other values are agreed by the users of this procedure, they shall be documented in the test report.

4.2 Ambient conditions

4.2.1 General

The following ambient conditions shall be met.

4.2.2 Ambient temperature

The ambient temperature during the test shall be 23 °C ± 5 °C for repeatability. IC emissions may vary with temperature.

4.2.3 Ambient RF field strength

The ambient RF noise level shall be at least 6 dB below the lowest emission level(s) to be measured. This shall be verified before measurements of the IC are made. The DUT shall be installed in the test set-up, as used for testing. The DUT shall not be activated (for example, the power supply voltage shall be disconnected). A scan shall be made to measure the residual noise. A description of the ambient RF noise level shall be part of the test report.

4.2.4 Other ambient conditions

All other ambient conditions that can affect the result shall be stated in the individual test report.

4.2.5 IC stability over time

The functional behaviour of the IC shall be stable over time so that two measurements, separated by an interval of time, shall yield the same results within the expected variation of the measurement technique.

5 Test equipment

5.1 General

The equipment described in Clause 5 is common to all test procedures described in this document. Specific equipment shall be itemized in the individual test procedures.

5.2 Shielding

The necessary shielding depends upon the specific test method and the ambient noise level. A shielded room may be required to provide a controlled ambient noise level for emission measurements. A non-shielded set-up can be used if ambient noise levels are at least 6 dB below the lowest level to be measured.

5.3 RF measuring instrument

5.3.1 General

Either measuring receivers or spectrum analysers can be used (see Tables 1 and 2 for default settings). The measuring receiver, if used, shall meet the bandwidth requirements as stated in CISPR 16-1-1.

5.3.2 Measuring receiver

Table 1 – Measuring receiver bands and resolution bandwidth (RBW) default settings

Frequency range	150 kHz to 30 MHz	≥ 30 MHz
Measuring receiver RBW at 6 dB	9 kHz	120 kHz

5.3.3 Spectrum analyser

Table 2 – Spectrum analyser bands and RBW default settings

Frequency range	150 kHz to 30 MHz	≥ 30 MHz
Spectrum analyser RBW at 3 dB	10 kHz	100 kHz

5.3.4 Other RBW for narrowband emissions

Where the RF emissions can be verified as being narrowband, and the measurement technique requires a lower noise floor for resolution of the measured signals from the ambient RF noise, a reduced RBW can be used.

5.3.5 Emission type, detector type and sweep speed

A determination of whether the emissions are predominately narrowband or broadband can be made by measuring at the default bandwidth and at the next narrower (one-third) increment of bandwidth. If the measured level of peak values of the spectrum is reduced by 5 dB or more when the bandwidth is reduced by one-third, then the emissions can be considered to be predominately broadband.

Examples of narrowband sources are digital ICs operated by a synchronous clock. They will typically produce a continuous emission spectrum dominated by clock harmonics and fractions. For this reason, the detector chosen will not influence the readings. The peak detector shall be used for narrowband sources.

Examples of possible broadband sources are ICs producing a non-continuous spectrum such as converters and non-synchronous logic. These devices shall be measured, preferably using the peak detector with the sweep speed set to reflect the modulation rate, according to the following formula:

$$V_s \leq \frac{2}{3} \times RBW \times f_m$$

where

V_s is the sweep speed in MHz/s;

f_{RBW} is the resolution bandwidth in MHz;

f_m is the modulation frequency in Hz, defined as the lowest repetition rate of a software routine or other IC operating parameter that may affect the measured RF emissions.

The sweep speed used shall be selected in such a way that a slower sweep speed will not result in a significant change in the measured emissions.

5.3.6 Video bandwidth

The video bandwidth (VBW) shall be at least three times the RBW when a spectrum analyser is used for measurements.

5.3.7 Verification of calibration for the RF measuring instrument

The calibration of the RF measuring instrument shall be verified by comparison with an independent calibrated instrument, traceable to a recognized standard body, if absolute levels are to be reported.

5.4 Frequency range

The recommended frequency range is 150 kHz to 1 GHz, but this may be extended if the specific procedure is usable over an extended frequency range. The range of interest may be smaller when, by function, the IC produces emissions only in that reduced range.

The applicable frequency range is described in each part of IEC 61967.

5.5 Preamplifier or attenuator

If necessary, a preamp or attenuator, either internal or external, can be used. The noise figure of the preamplifier or attenuator shall be less than 10 dB. The minimum resolution for calibration of the preamplifier is 10 points per decade.

5.6 System gain

The gain (or attenuation) between the reference point and the input of the RF measuring instrument shall be verified to within an accuracy of ±0,5 dB.

5.7 Other components

The characteristics of cables, connectors and terminators not in the measurement path between the reference point and the input of the RF measuring instrument that can, however, affect the measurement result, shall be verified over the intended frequency range.

6 Test set-up

6.1 General

Tests shall take place according to a test plan, which shall be included in the test report. This report shall also include:

a) a circuit diagram of the application (supply decoupling, bus load, peripheral ICs, etc.);
b) a description of the PCB on which the IC is applied (layout);
c) actual operating conditions of the IC (supply voltage, output signals, etc.);
d) a description of the type of software exercising the IC(s), if applicable.

All variations shall be included in the test report. Connection to auxiliary equipment shall not influence the test results.

Other particular requirements are described in the individual test procedure.

6.2 Test circuit board

The test PCB to be used depends on the specific measurement method. The specifications of a general basic test board for this family of standards are described in Annex D of this document. The test PCB should be designed in accordance with these general specifications and with the additional specifications as required for the individual measurement methods. Any deviation from this description shall be stated in the individual test reports.

For the comparison of measurement results from different devices it is necessary to use a similar PCB design, as close as possible within the same measurement method.

6.3 IC pin loading

If no other loads are required by a specific test method, the pins of the DUT shall be loaded according to the following default value table, with exceptions as noted.