



**BSI Standards Publication**

# **Integrated circuits — Measurement of electromagnetic emissions**

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Part 4: Measurement of conducted emissions —  
1  $\Omega$ /150  $\Omega$  direct coupling method

## National foreword

This British Standard is the UK implementation of EN IEC 61967-4:2021. It is identical to IEC 61967-4:2021. It supersedes BS EN 61967-4:2002+A1:2006, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

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English Version

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- Part 4: Measurement of conducted emissions - 1  $\Omega$ /150  $\Omega$   
direct coupling method  
(IEC 61967-4:2021)

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(IEC 61967-4:2021)

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(IEC 61967-4:2021)

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## **European foreword**

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- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2022-01-20
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-04-20

This document supersedes EN 61967-4:2002 and all of its amendments and corrigenda (if any).

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

CISPR 16-1-2 NOTE Harmonized as EN 55016-1-2

CISPR 25 NOTE Harmonized as EN 55025

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu).

| <u>Publication</u> | <u>Year</u> | <u>Title</u>                                                                                                                                               | <u>EN/HD</u>   | <u>Year</u> |
|--------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|
| IEC 61000-4-6      | -           | Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields | EN 61000-4-6   | -           |
| IEC 61967-1        | -           | Integrated circuits - Measurement of electromagnetic emissions - Part 1: General conditions and definitions                                                | EN IEC 61967-1 | -           |

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INTEGRATED CIRCUITS –  
MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –****Part 4: Measurement of conducted emissions –  
1  $\Omega$ /150  $\Omega$  direct coupling method**

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IEC 61967-4 has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices. It is an International Standard.

This second edition cancels and replaces the first edition published in 2002 and Amendment 1:2006. This edition constitutes a technical revision.

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

- a) frequency range of 150 kHz to 1 GHz has been deleted from the title;
- b) recommended frequency range for 1  $\Omega$  method has been reduced to 30 MHz;
- c) Annex G with recommendations and guidelines for frequency range extension beyond 1 GHz has been added.

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

| Draft        | Report on voting |
|--------------|------------------|
| 47A/1101/CDV | 47A/1107/RVC     |

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 International Standard 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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

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 [webstore.iec.ch](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.

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## INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

### Part 4: Measurement of conducted emissions – 1 $\Omega$ /150 $\Omega$ direct coupling method

#### 1 Scope

This part of IEC 61967 specifies a method to measure the conducted electromagnetic emission (EME) of integrated circuits by direct radio frequency (RF) current measurement with a 1  $\Omega$  resistive probe and RF voltage measurement using a 150  $\Omega$  coupling network. These methods ensure a high degree of reproducibility and correlation of EME measurement results.

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

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions – Part 1: General conditions and definitions*

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 61967-1 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>

#### 4 General

##### 4.1 Measurement basics

The maximum tolerated emission level from an integrated circuit (IC) depends on the permitted maximum emission level of the electronic system, which includes the IC, and also on the immunity level of other parts of the electronic system itself (so called inherent EMC). The value of this emission level is dependent on system and application specific (ambient) parameters. To characterise ICs, i.e. to provide typical EME values for a data sheet, a simple measurement procedure and non-resonant measurement setup are required to guarantee a high degree of reproducibility. Subclause 4.1 describes the basis of this test procedure.

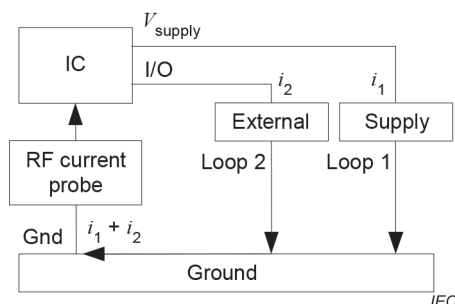


**Figure 1 – Example of two emitting loops returning to the IC via common ground**

The emission of an IC is generated by sufficiently fast changes of voltages and currents inside the IC. These changes drive RF currents inside and outside the IC. The RF currents cause conducted EME, which is mainly distributed via the IC pins conductor loops in the printed circuit board (PCB) and the cabling. These loops are regarded as the emitting loop antennas. In comparison to the dimension of these loops, the loops in the internal IC structure are considered to be small.

The RF currents that accompany ICs action are different in amplitude, phase and spectral content. Any RF current has its own loop that returns to the IC. All loops return mostly via the ground or supply connection back to the IC. In Figure 1, this is shown for two loops returning via ground. Loop 1 represents the supply wiring harness for the IC while loop 2 represents the routing of an output signal. The common return path via ground is a suitable location to measure the conducted EME as the measurement of the common RF sum current of the ground pin. This test is named the “RF current measurement”.

If the IC under test has only one ground pin and all other pins are suspected to contribute essentially to the EME, then the RF sum current is measured between the ground pin of the IC under test and the ground (see  $i_1 + i_2$  in Figure 1).

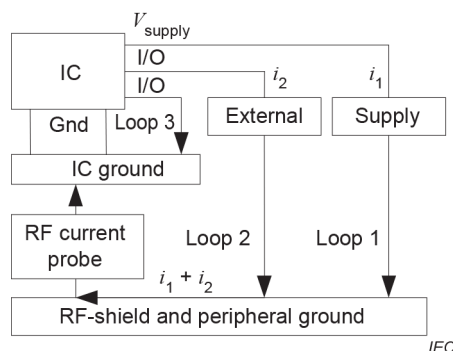


**Figure 2 – Example of IC with two ground pins, a small I/O loop and two emitting loops**

If the IC under test has more than one ground pin or some of the pins are not suspected to contribute much to the whole EME, then the IC under test gets its own ground plane as shown in Figure 2. This ground plane is named “IC ground”. It is kept separately from the other ground, that is named “RF-shield and peripheral ground”. The RF current is measured between the IC ground and the peripheral ground.

ICs are often used in different configurations based on the application. For instance, a microcontroller could be used as a single chip controller, with the I/O ports directly connected to the external cabling system. In order to understand the influence of a single I/O pin on the emission level of the IC, an additional measurement procedure, using the same equipment, is provided. This measurement is named “single pin RF voltage measurement at IC pins” (see also 4.3). In addition to the RF sum current measurement, the RF current measurement of a

single supply pin can be of interest in the analysis of an IC. This can also be attained with application of the RF current measurement probe. For example, the RF current probe can be applied to any of the multiple ground or supply pins in order to quantify the contribution of the measured pin to the whole emission.

## 4.2 RF current measurement

In the test procedure, this measurement shall be made by measuring the voltage across the  $1\ \Omega$  resistance of a RF current probe using a measurement receiver. The measurement shall be made at the location shown in Figure 1 and Figure 2. The construction of the RF current probe is specified in 6.2. The RF voltage level measured by the receiver is the voltage resulting from all of RF currents returning to the IC through the probe impedance. The voltage measurement can be converted to current by dividing the voltage by the probe impedance, if the probe impedance is determined for the applicable frequency range e.g. in a verification report.

NOTE 1 The probe impedance can be frequency dependant, caused by stray inductances of the probe, and thus the usable frequency range can be limited.

NOTE 2 The probe impedance causes, depending on the IC current consumption, a voltage drop that can affect the proper operation of the IC and limit the application of this method.

## 4.3 RF voltage measurement at IC pins

This measurement is used to identify the contribution of a single pin or a group of pins to the EME of the IC under test. This measurement is only applied to those pins of the IC under test that are intended to be connected directly to long (longer than 10 cm) PCB traces or wiring harnesses (e.g. I/O, supply). These pins are loaded by a typical common mode impedance of  $150\ \Omega$ , as specified in IEC 61000-4-6. In order to connect the measurement receiver, that has an input-impedance of  $50\ \Omega$ , the load has to be built as an impedance matching network. This matching network is defined in 6.4.

Other I/O-pins of an IC may be loaded as specified in the general part of IEC 61967-1.

## 4.4 Assessment of the measurement technique

The above techniques have the following properties:

- high measurement reproducibility, because few parameters influence the result;
- capability to compare different IC configurations (e.g. packages);
- single pin EME measurements of the various I/O pins are dependent on their importance for the emission in a specific application;
- assessment of the EME contribution of the IC using current sum measurement;
- simple verification of the measurement impedance using insertion loss measurement;
- measurement is also possible at very low frequencies.

With these characteristics, it is possible to measure the EME of ICs with a high degree of reproducibility and therefore this technique offers a good method for comparison.

Annex D gives an example of how the measurement techniques can be used for the assessment of ICs.

## 5 Test conditions

All test conditions required in this document are specified in IEC 61967-1.

## 6 Test equipment

### 6.1 RF measuring instrument

The measurement equipment shall fulfil the requirements described in IEC 61967-1.

### 6.2 RF current probe specification

Figure 3 shows the basic construction of the 1  $\Omega$  RF current probe.

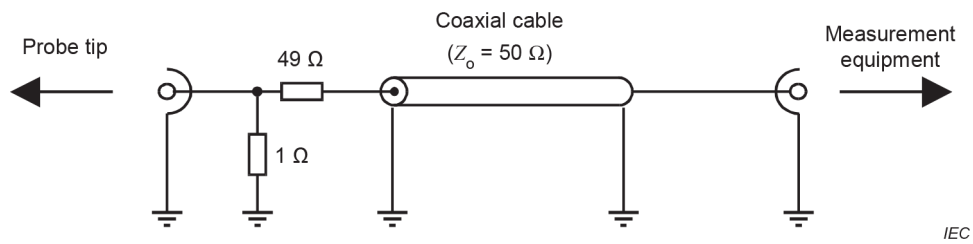


**Figure 3 – Construction of the 1  $\Omega$  RF current probe**

Table 1 presents a detailed specification of the RF current probe.

To prevent the measurement equipment from being damaged by DC voltage, the use of a DC block is recommended. This shall have an attenuation of <0,5 dB at the lowest frequency to be measured.