IEC TS 61967-3

Edition 2.0 2014-08

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

Integrated circuits – Measurement of electromagnetic emissions – Part 3: Measurement of radiated emissions – Surface scan method

Circuits intégrés – Mesure des émissions électromagnétiques – Partie 3: Mesure des émissions rayonnées – Méthode de balayage en surface

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 3: Measurement of radiated emissions – Surface scan method

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61967-3, which is a technical specification, 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 2005. This edition constitutes a technical revision.

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

a) Removal of:
   – 9.4 Data analysis;
   – Annex D – Analysing the data from near-field surface scanning.

b) Addition of:
   – Introduction
   – 9.4 Measurement data
   – 9.5 Post-processing
   – 9.6 Data exchange
   – Annex D – Coordinate systems

c) Expansion of:
   – 8.4 Test technique
   – Annex A – Calibration of near-field probes

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
47A/925/DTS	47A/937/RVC

Full information on the voting for the approval of this technical specification 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.

A list of all parts in the IEC 61967 series, published under the general title *Integrated circuits – Measurement of electromagnetic emissions*, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

Techniques for scanning near-fields radiated by integrated circuits and their surrounding environment can identify the areas of radiation, which may cause interference to nearby devices. The ability to associate magnetic or electric field strengths with a particular location on a device can provide valuable information for improvement of an IC both in terms of functionality and EMC performance.

Near-field scan techniques have considerably evolved over recent years. The improved sensitivity, bandwidth and spatial resolution of the probes offer analysis of integrated circuits operating into the gigahertz range. The ability to measure radiation both in the frequency and time domain allows not only analysis of fields generated by an IC, but also fields generated by externally applied disturbances propagating through the device. Post-processing can considerably enhance the resolution of a near-field scan measurement and the measured data can be shown in various ways, per user's choice.

INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 3: Measurement of radiated emissions – Surface scan method

1 Scope

This part of IEC 61967 provides a test procedure which defines an evaluation method for the near electric, magnetic or electromagnetic field components at or near the surface of an integrated circuit (IC). This diagnostic procedure is intended for IC architectural analysis such as floor planning and power distribution optimization. This test procedure is applicable to measurements on an IC mounted on any circuit board that is accessible to the scanning probe. In some cases it is useful to scan not only the IC but also its environment. For comparison of surface scan emissions between different ICs, the standardized test board defined in IEC 61967-1 should be used.

This measurement method provides a mapping of the electric or magnetic near-field emissions over the IC. The resolution of the measurement is determined by the capability of the measurement probe and the precision of the probe-positioning system. This method is intended for use up to 6 GHz. Extending the upper limit of frequency is possible with existing probe technology but is beyond the scope of this specification. Measurements may be carried out in the frequency domain or in the time domain.

2 Normative references

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

IEC 60050(all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 1: General conditions and definitions*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purpose of this document, the terms and definitions given in IEC 61967-1, IEC 60050-131 and IEC 60050-161, as well as the following apply.

3.1.1
altitude
distance between the tip of the near-field probe and the reference plane of the scan (e.g. the PCB, the upper surface of the package)

Note 1 to entry: The term “altitude” refers to the vertical direction in a Cartesian coordinate system (Z-axis) in this document.

3.1.2
probe factor
ratio of electric or magnetic field strength at a specified location in near-field evaluation to the signal level measured at the output connection or applied to the input connection of a probe

3.1.3
spatial resolution
aptitude of a probe to distinguish measured field between two points

3.2 Abbreviations

DUT: device under test

NFS: near-field scan

PCB: printed circuit board

4 General

The electric and magnetic fields measured by scanning over the surface of the IC yield information on the relative strength of emission sources within the IC package. It enables the comparisons between different architectures to facilitate reductions in RF emissions from the IC. The electric and magnetic field patterns over the surface of the IC are related to the electromagnetic radiation potential of the IC and its constituting electronic module. However, this procedure is intended to provide a comparative measure for ICs and not to predict far field levels for the IC or its circuit board.

Characterizing an IC involves the acquisition of a series of magnitude and/or phase measurements at specific frequencies or times. Each scan over a die or package collects a large amount of data depending on the number of locations scanned and the number of frequencies or times measured at each location. Because of the required precision and the amount of measured data, this test method uses a computer-controlled probe-positioning and measurement system to achieve accurate and repeatable probe data. Control software shall be prepared or adapted to control the optical, precision stepper motors typically used in such systems. This method also requires an analysis and handling of a large amount of data typically performed by dedicated software programs. The scanning time depends on the number of frequencies or times, the number of locations measured, and the capability of the data collection system.

Due to the wide array of IC processes, packaging technologies, as well as their physical dimensions, this document does not specify the designs of probe-positioning systems or near-field probes. The designs of the positioning system and the probes depend on the desired measurement frequency range, spatial resolution, field type, and the performance of the available components (such as stepper motors).

The spatial resolution depends on the physical dimensions and construction of the probe. If the spatial resolution is known, it shall be included in the test report.

The altitude of the probe above the IC surface is not specified. The actual probe height shall be included in the test report.

The step size of the probe position shall be chosen to fully utilize the spatial resolution while minimizing the number of measurement points. Step size can be smaller in particular areas of the die or package for higher resolution. With post-processing the data for higher resolution, the spatial resolution at the measurement can be reduced, which allows a larger step size.

5 Test conditions

5.1 General

Test conditions shall meet the requirements of IEC 61967-1. In addition, the following test conditions shall apply.

5.2 Supply voltage

A supply voltage should follow the IC manufacturer's specification. If the user uses other voltage, it shall be documented in the test report.

5.3 Frequency range

An effective frequency range of this radiated emission measurement procedure is 150 kHz to 6 GHz. If a single probe is not able to cover the whole frequency range, the frequency range may be divided into sub-ranges to allow the use of multiple probes, each of which suits individual frequency sub-range.

6 Test equipment

6.1 General

The test equipment shall meet the requirements as described in IEC 61967-1. In addition, the following test equipment requirements shall apply.

6.2 Shielding

Double shielded or semi-rigid coaxial cable is recommended for interconnections between the probe and the measuring equipment. Depending on the local ambient conditions, it may also be necessary to carry out the measurements in a shielded room.

6.3 RF measuring instrument

The RF measuring instrument utilized for this test method depends on the type of probe selected and whether phase or time information is to be acquired. In the case of utilizing a electric or magnetic field probe and measuring only emission amplitude, a one-input device such as a spectrum analyser, EMI receiver or oscilloscope shall be used. For time domain measurements an oscilloscope may be used.

In the case of utilizing an electric or magnetic field probe to measure both emission amplitude and phase, a two-input device such as a vector signal measuring instrument shall be used.

NOTE To measure phase and amplitude with a vector signal measuring instrument, the reference input (R) and another input (A or B) are used. The S-parameter ports cannot be generally used for this measurement.

The resolution bandwidth of the spectrum analyser or receiver shall be adjusted to ensure sufficient noise margin (greater than 6 dB) while allowing adequate sweep time, depending on the chosen test procedure. The video bandwidth shall not be less than three times the resolution bandwidth. The resolution bandwidth and video bandwidth shall be described in the test report.

6.4 Preamplifier

A low noise high gain preamplifier may be used to enhance sensitivity or to meet the ambient requirements in 8.2. In order to achieve the lowest noise floor for the measurements, the pre-amplifier shall be connected to the probe with the shortest possible cable. Its characteristics (e.g. gain, noise figure, etc.) should be included in the test report.

Near-field probes usually present very poor return loss. If the probe does not present a good impedance match, noise figure and gain of the system will be modified. In order to avoid unwanted effects such as oscillations or preamplifier damage, specific care is to be taken during preamplifier selection in regards to its stability in near-field scan setup environment.

6.5 Cables

The scanning motion of the probe requires the use of flexible cables between certain elements of the setup. Care shall be taken to choose cables that are durable for the scanning motion of the probe besides maintaining their high frequency performance. The cable losses as a function of frequency should be included in the test report.

Owing to the repeated movement of the cables, which can accelerate their deterioration, calibration of the cables shall be carried out regularly. When the test frequency is higher than 1 GHz or phase measurements are to be carried out, the cables shall be calibrated before each test.

6.6 Near-field probe

6.6.1 General

The near-field probes employed for surface scanning can take various forms depending on the users' preferences, the type of field to be measured, the capabilities of the measurement equipment, and the desired spatial resolution of the measurement. Probe calibration is detailed in Annex A. Some probes receive a field only in a specific direction. In order to receive fields in several directions, it is necessary to change the probe or rotate it during the scan process. A brief description of the probe(s) used for the measurement shall be included in the test report. Various types of near-field probes are discussed below.

NOTE The structures of magnetic and/or electric probes are shown in Annexes B and C. However, the applicable frequency range depends on the probe structure and calibration method.

6.6.2 Magnetic (H) field probe

For magnetic field measurements, a single turn, miniature magnetic loop probe is often used. The typical probe is composed of wire, coaxial cable, PCB traces, or any other suitable material. An example of a magnetic field probe is shown in Annex B and in IEC 61967-6 [1][1].

6.6.3 Electric (E) field probe

For electric field measurements, a miniature electric field probe is typically used. The probe may be constructed of wire, coaxial cable, PCB traces, or any other suitable material. An example electric field probe is shown in Annex B.

6.6.4 Combined electric and magnetic (E/H) field probe

For combined electric and magnetic field measurements, a single turn, miniature magnetic loop probe is typically used. The probe may be constructed of wire, coaxial cable, PCB traces, or any other suitable material. An example electromagnetic field probe is shown in Annex C.

6.6.5 Probe-positioning and data acquisition system

A precise probe-positioning system and data acquisition system are required. The probe-positioning system shall be able to move the probe in at least two axes (parallel to the DUT surface) and shall be capable of positioning the probe with a mechanical step at least ten times less than the minimum required step size. Although this specification describes the use of Cartesian scanning (X, Y and, optionally, Z-axis), polar and cylindrical scannings are also

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1 Numbers in square brackets refer to the Bibliography.

possible. Annex D defines the three coordinate systems and how the position information can be converted between them. When using Cartesian coordinates, the right-hand system is preferred. If the left-hand system is used, it shall be indicated in the test report. In some cases the probe-positioning system has a mechanical structure to rotate the probe for adjusting probe orientation. It may be controlled by the data acquisition system.

The x, y and z position of the near-field probe may be out of alignment after the rotation. Care should be taken to compensate the resulting offset by repositioning the probe.

An example of a probe-positioning system is shown in Figure 1. While not shown in Figure 1, the DUT is installed on a PCB that is typically mounted on a test fixture to improve stability.

The data acquisition system is typically a computer with software enabling the desired scan parameters, controlling the measuring instrument and the probe scanning system, and acquiring the data. The system configurations and the controlling software shall be described in the test report.

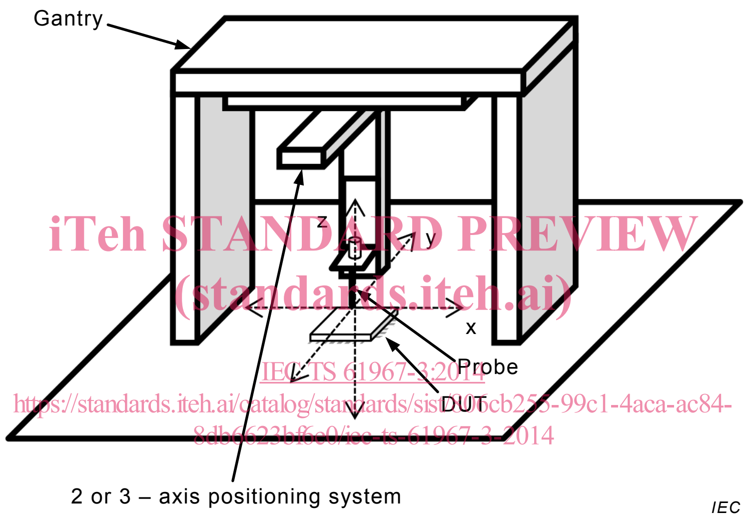

Figure 1 – Example of probe-positioning system

7 Test setup

7.1 General

Test setup shall meet the requirements as described in IEC 61967-1. In addition, the following test setup requirements shall apply.

7.2 Test configuration

The general test setups are shown in Figures 2, 3 and 4.

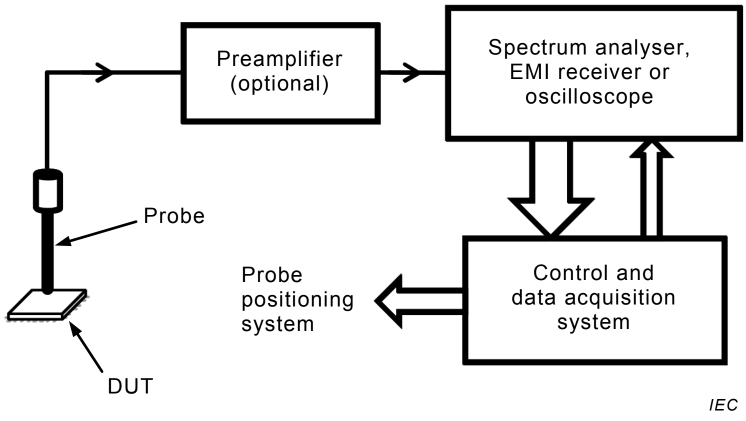

Figure 2 – One-input RF measurement setup

The setup of Figure 2 allows measurement of only magnitude. The setups of Figures 3 and 4 allow magnitude measurements with phase or time domain measurements.

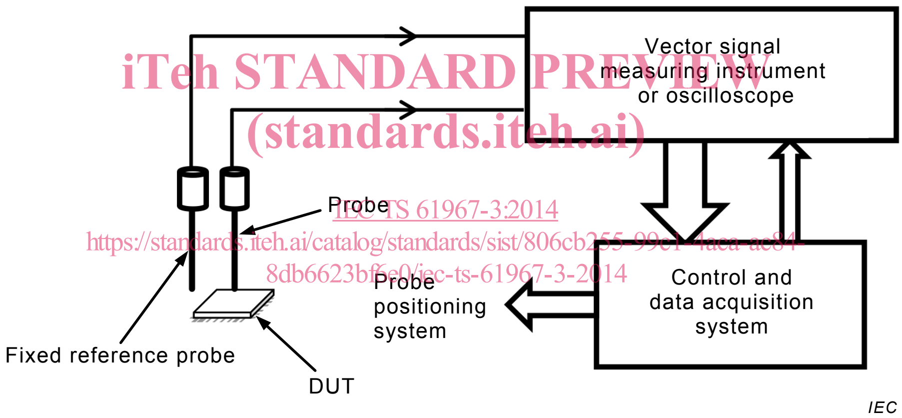

Figure 3 – Two-input RF measurement setup with reference probe

For phase or time domain measurements, a reference signal is required. This signal may be applied externally to a pin of the device, output from the device via a pin or captured with a stationary auxiliary probe.

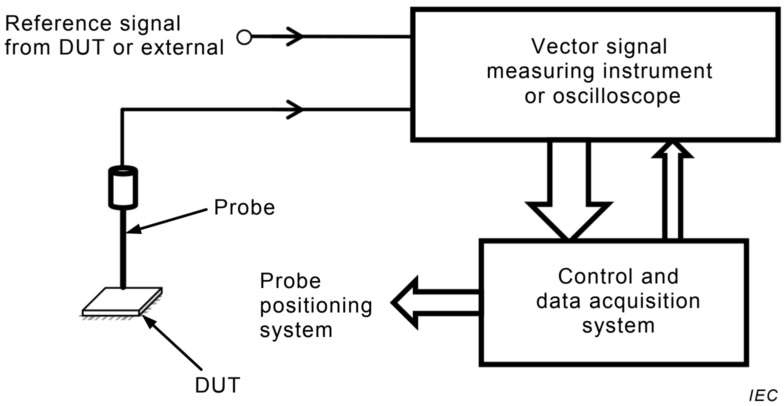

Figure 4 – Two-input RF measurement setup with reference signal