IEC TS 62132-9

Edition 1.0 2014-08

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

Integrated circuits – Measurement of electromagnetic immunity – Part 9: Measurement of radiated immunity – Surface scan method

Circuits intégrés – Mesure de l'immunité électromagnétique – Partie 9: Mesure de l'immunité rayonnée – Méthode de balayage en surface

IEC TS 62132-9:2014-08(en-fr)

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

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue
Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,…). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org
Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 14 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
Plus de 55 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC TS 62132-9

Edition 1.0 2014-08

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

Integrated circuits – Measurement of electromagnetic immunity – Part 9: Measurement of radiated immunity – Surface scan method

Circuits intégrés – Mesure de l'immunité électromagnétique – Partie 9: Mesure de l'immunité rayonnée – Méthode de balayage en surface

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX
U

ICS 31.200
ISBN 978-2-8322-1808-2

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

INTEGRATED CIRCUITS –
MEASUREMENT OF ELECTROMAGNETIC IMMUNITY –

Part 9: Measurement of radiated immunity –
Surface scan method

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

IEC TS 62132-9, which is a technical specification, has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

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

Enquiry draft	Report on voting
47A/924/DTS	47A/936/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 62132 series, published under the general title *Integrated circuits – Measurement of electromagnetic immunity*, 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
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Techniques for generating near-fields over integrated circuits and their surrounding environment can identify the areas susceptible to radiation, which could cause errors in the device. 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 efficiency, bandwidth and spatial resolution of the probes offer analysis of integrated circuits operating into the gigahertz range. Post-processing can considerably enhance the resolution of a near-field scan test bench and the measured data can be shown in various ways per user's choice.

INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC IMMUNITY –

Part 9: Measurement of radiated immunity – Surface scan method

1 Scope

This part of IEC 62132 provides a test procedure, which defines a method for evaluating the effect of near electric, magnetic or electromagnetic field components on 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 testing 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 immunity between different ICs, the standardized test board defined in IEC 62132-1 should be used.

This measurement method provides a mapping of the sensitivity (immunity) to electric- or magnetic-near-field disturbance over the IC. The resolution of the test is determined by the capability of the test 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. The tests described in this document are carried out in the frequency domain using continuous wave (CW), amplitude modulated (AM) or pulse modulated (PM) signals.

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 62132-1, *Integrated circuits – Measurement of electromagnetic immunity, 150 kHz to 1 GHz – Part 1: General conditions and definitions*

IEC TS 61967-3, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 3: Measurement of radiated emissions – Surface scan method*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purpose of this document, the definitions and definitions given in IEC 62132-1, 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.

[SOURCE: IEC 61967-3:2014, 3.1.1]

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

[SOURCE: IEC 61967-3:2014, 3.1.2]

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

[SOURCE: IEC 61967-3:2014, 3.1.3]

3.2 Abbreviations

DUT: device under test

NFS: near-field scan

PCB: printed circuit board

[SOURCE: IEC 61967-3:2014, 3.2]

4 General

The electric and magnetic fields applied by scanning over the surface of an IC yields information on the relative sensitivity of blocks within the IC package. It enables the comparisons between different architectures to facilitate improvements in RF immunity of the IC. Default criteria are defined to determine the immunity level at a specific location.

Characterizing an IC involves the acquisition of a series of measurements of applied power to the probe at specific frequencies. 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 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 test 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, the number of locations tested, and the capability of the data collection system.

Due to the wide array of IC processes, packaging technologies, and 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 testing 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 described in the test report.

The probe position step size 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 larger step size.

5 Test Conditions

5.1 General

Test conditions shall meet the requirements as described in IEC 62132-1. In addition, the following test conditions shall apply.

5.2 Supply voltage

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

5.3 Frequency range

An effective frequency range of this radiated immunity 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

Test equipment shall meet the requirements as described in IEC 62132-1. In addition, the following test equipment requirements shall apply.

6.2 Shielding

Double shielded or semi-rigid coaxial cables are recommended for interconnections between the probe and the measuring equipment. Depending on the RF power applied to the near-field probe, it may also be necessary to carry out the tests in a shielded room.

6.3 RF disturbance generator

An RF disturbance generator with sufficient power-handling capabilities shall be used. The RF disturbance generator consists of an RF signal source with or without a modulation function, as required, and an optional RF power amplifier. The power amplifier shall be capable of handling the type of disturbing signal used (CW, AM or PM) without creating undue distortion. The VSWR (Voltage Standing Wave Ratio) at the output of the RF disturbance generator shall be less than 1,5 over the frequency range being measured. The output power of the RF disturbance generator terminated with a 50 Ω load shall have accuracy of +/- 0,5 dB or smaller.

NOTE Near-field probes usually present very poor return loss. If the probe does not present a good impedance match, the electric or magnetic field strength generated by the probe will vary with frequency. Moreover, in order to avoid damage to the power amplifier, specific care is to be taken during power amplifier selection in regards to its stability and ability to sustain high reflected power. If necessary, an attenuator capable of sustaining the power level can be inserted between the RF disturbance generator and the probe.

6.4 Cables

The scanning motion of the probe requires the use of flexible cables between the 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, the cables shall be calibrated before each test.

6.5 Near-field probe

6.5.1 General

The near-field probe employed for surface scanning can take various forms depending on users' preferences, the type of field to be measured, the capabilities of the RF disturbance generator, and the desired spatial resolution of the test. Probe calibration is detailed in Annex A. Calibration of the probe provides the field strength at a given distance in the axis of the probe. In practice the probe is used to inject a disturbance into a DUT which, by its presence, modifies the field strength and direction at the point of interest. It is possible to use post-processing to correct any distortion of the field [1][1]. Some probes generate a field only in a specific direction. In order to generate 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 testing shall be included in the test report. In order to improve the return loss of the probe, it is good practice to place a suitable resistive load in series with the probe or to insert an attenuator close to the probe. Various types of near-field probe are discussed in 6.5.2 and 6.5.3.

6.5.2 Magnetic (H) field probe

For magnetic field tests, 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 [2].

6.5.3 Electric (E) field probe

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

6.6 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 scanning are also possible. Annex C 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. Although not shown in Figure 1, the DUT is installed on a test circuit board that is typically mounted on a test fixture to improve stability.

---

[1] Numbers in square brackets refer to the Bibliography.

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.

6.7 DUT monitor

The DUT shall be monitored to detect any degradation of the performance. The monitoring equipment shall not be adversely affected by the injected RF disturbance signal.

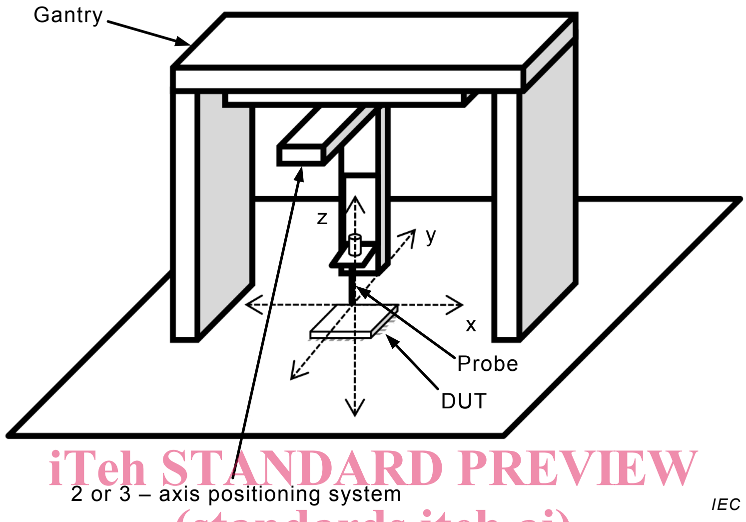

Figure 1 – Example of a probe-positioning system

7 Test setup

7.1 General

Test setup shall meet the requirements as described in IEC 62132-1. In addition, the following test setup requirements shall apply.

7.2 Test configuration

The general test setup is shown in Figure 2.

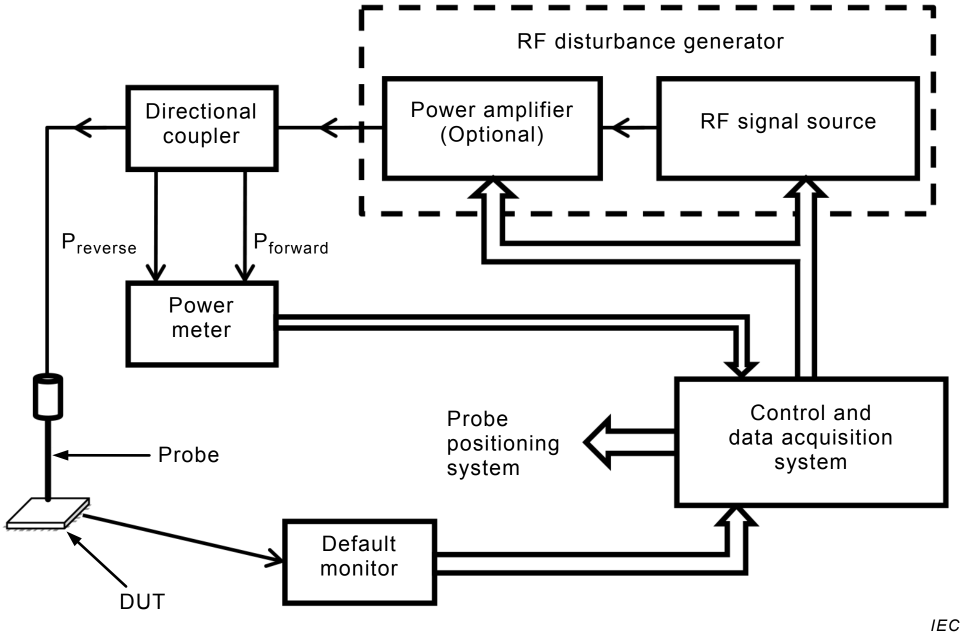

Figure 2 – Test setup

7.3 Test circuit board

The test circuit board, on which the DUT is mounted and scanned, may be any board accessible to the scanning probe. If ICs are to be evaluated for comparison purposes, they shall be tested on identical PCBs. The PCB may be an application PCB or a standardized test circuit board designed in accordance with IEC 62132-1.

The test circuit board shall be firmly installed in the probe-positioning system to enhance test reproducibility. This shall be accomplished by the use of a test fixture having a minimum impact on the radiated field.

7.4 Probe-positioning system software setup

After the DUT and its test circuit board are set up, verify that the probe-positioning system software is configured for the desired scan parameters, in particular those concerning the desired area to be scanned. Ensure that there are no obstacles that could damage the probe within the desired scan area. Some scanner software requires reference points to compensate for alignment errors, origin offsets, etc., as well as to improve the reproducibility of the tests. Cameras, lasers and other such artifices may be used to assist the alignment. Images of the DUT may be recorded and used as a background for the field tests (see 9.4). The brief description of such procedures shall be included in the test report.

7.5 DUT Software

Appropriate software shall be implemented in the DUT during the measurement to meet the requirements of IEC 62132-1. The description of the software shall be included in the test report.

8 Test procedure

8.1 General

The test procedure shall be in accordance with IEC 62132-1 except as modified herein. These default test conditions are intended to assure a consistent test environment. The following steps shall be performed:

a) operational check (see 8.2);

b) immunity test (see 8.3).

If other test conditions are applied, they shall be documented in the test report.

8.2 Operational check

Energize the DUT and complete an operational check to verify proper function of the device (i.e. Run DUT software) in the ambient test condition. During the operational check, the RF disturbance generator and any monitoring equipment shall be powered; however, the output of the RF disturbance generator shall be disabled and the probe positioned well away from the DUT. The performance of the DUT shall not be degraded by ambient conditions.

8.3 Immunity test

8.3.1 General

With the test circuit board energized and the DUT operated in the intended test mode, measure the level of the injected RF disturbance signal over the desired frequency range, while monitoring the DUT for performance degradation.

8.3.2 Amplitude modulation

The RF disturbance signal can be:

- CW (continuous wave, no modulation)
- sinusoidal modulated with 80 % amplitude modulated by a 1 kHz sine wave, and
- pulse modulated with 50 % duty cycle and 1 kHz pulse repetition rate.
- other modulation can be applied if appropriate.

8.3.3 Test frequency steps and ranges

The RF immunity of the DUT is generally evaluated in the frequency range from 150 kHz to 6 GHz. Test frequencies shall be applied according to Table 1.

Table 1 – Frequency step size versus frequency range

Frequency range (MHz)	0,15 to 1	1 to 100	100 to 1 000	1 000 to 6 000
Linear steps (MHz)	≤0,1	≤1	≤10	≤20
Logarithmic steps	≤5 % increment			

Immunity scanning over a wide range of frequencies is extremely time-consuming. In order to reduce the test time, the RF immunity of the DUT may be evaluated only at and near critical frequencies. Critical frequencies are frequencies critical to DUT; including crystal frequencies, oscillator frequencies, clock frequencies, data frequencies; which are generated by, received by, or operated on by the DUT.

8.3.4 Test levels and dwell time

The applied test level shall be incrementally changed and the DUT shall be monitored according to 8.3.6.2. The step size and test level shall be documented in the test report.

At each test level and frequency, the RF disturbance signal shall be applied for the time necessary for the DUT to respond and for the monitoring system to detect any performance degradation (typically 1 s).