

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

This document is a preview generated by EVS

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN 61000-4-6:2014 sisaldab Euroopa standardi EN 61000-4-6:2014 inglisekeelset teksti.	This Estonian standard EVS-EN 61000-4-6:2014 consists of the English text of the European standard EN 61000-4-6:2014.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 21.02.2014.	Date of Availability of the European standard is 21.02.2014.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 33.100.20

### **Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele**

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Aru 10, 10317 Tallinn, Eesti; [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

### **The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation**

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:  
Aru 10, 10317 Tallinn, Estonia; [www.evs.ee](http://www.evs.ee); phone 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

English version

**Electromagnetic compatibility (EMC) -  
Part 4-6: Testing and measurement techniques -  
Immunity to conducted disturbances, induced by radio-frequency fields  
(IEC 61000-4-6:2013)**

Compatibilité électromagnétique (CEM) -  
Partie 4-6: Techniques d'essai et de  
mesure - Immunité aux perturbations  
conduites, induites par les champs  
radioélectriques  
(CEI 61000-4-6:2013)

Elektromagnetische Verträglichkeit (EMV)  
- Teil 4-6: Prüf- und Messverfahren -  
Störfestigkeit gegen leitungsgeführte  
Störgrößen, induziert durch hochfrequente  
Felder  
(IEC 61000-4-6:2013)

This European Standard was approved by CENELEC on 2013-11-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels**

## Foreword

The text of document 77B/691/FDIS, future edition 4 of IEC 61000-4-6, prepared by SC 77B "High frequency phenomena" of IEC/TC 77 "Electromagnetic compatibility" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61000-4-6:2014.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2014-08-27
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-11-27

This document supersedes EN 61000-4-6:2009.

EN 61000-4-6:2014 includes the following significant technical changes with respect to EN 61000-4-6:2009:

- a) use of the CDNs;
- b) calibration of the clamps;
- c) reorganization of Clause 7 on test setup and injection methods;
- d) Annex A which is now dedicated to EM and decoupling clamps;
- e) Annex G which now addresses the measurement uncertainty of the voltage test level;
- f) informative Annexes H, I and J which are new.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

## Endorsement notice

The text of the International Standard IEC 61000-4-6:2013 was approved by CENELEC as a European Standard without any modification.

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

IEC 61000-4-3	NOTE	Harmonised as EN 61000-4-3.
CISPR 16-1-2	NOTE	Harmonised as EN 55016-1-2.
CISPR 16-1-4	NOTE	Harmonised as EN 55016-1-4.
CISPR 20	NOTE	Harmonised as EN 55020.

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 General.....	10
5 Test levels.....	12
6 Test equipment and level adjustment procedures .....	13
6.1 Test generator .....	13
6.2 Coupling and decoupling devices .....	15
6.2.1 General .....	15
6.2.2 Coupling/decoupling networks (CDNs).....	18
6.2.3 Clamp injection devices .....	20
6.2.4 Direct injection devices.....	22
6.2.5 Decoupling networks .....	22
6.3 Verification of the common mode impedance at the EUT port of coupling and decoupling devices.....	23
6.3.1 General .....	23
6.3.2 Insertion loss of the 150 Ω to 50 Ω adapters .....	23
6.4 Setting of the test generator.....	25
6.4.1 General .....	25
6.4.2 Setting of the output level at the EUT port of the coupling device.....	26
7 Test setup and injection methods .....	28
7.1 Test setup.....	28
7.2 EUT comprising a single unit.....	28
7.3 EUT comprising several units.....	29
7.4 Rules for selecting injection methods and test points .....	30
7.4.1 General .....	30
7.4.2 Injection method .....	30
7.4.3 Ports to be tested .....	31
7.5 CDN injection application .....	32
7.6 Clamp injection application when the common mode impedance requirements can be met.....	33
7.7 Clamp injection application when the common mode impedance requirements cannot be met.....	35
7.8 Direct injection application .....	35
8 Test procedure .....	36
9 Evaluation of the test results .....	37
10 Test report.....	37
Annex A (normative) EM and decoupling clamps.....	39
Annex B (informative) Selection criteria for the frequency range of application .....	49
Annex C (informative) Guide for selecting test levels .....	51
Annex D (informative) Information on coupling and decoupling networks .....	52
Annex E (informative) Information for the test generator specification .....	57
Annex F (informative) Test setup for large EUTs.....	58

Annex G (informative) Measurement uncertainty of the voltage test level .....	61
Annex H (informative) Measurement of AE impedance .....	72
Annex I (informative) Port to port injection .....	76
Annex J (informative) Amplifier compression and non-linearity .....	78
Bibliography .....	83
Figure 1 – Immunity test to RF conducted disturbances .....	12
Figure 2 – Open circuit waveforms at the EUT port of a coupling device for test level 1 .....	13
Figure 3 – Test generator setup .....	15
Figure 4 – Principle of coupling and decoupling .....	18
Figure 5 – Principle of coupling and decoupling according to the clamp injection method .....	20
Figure 6 – Example of circuit for level setting setup in a 150 $\Omega$ test jig .....	21
Figure 7 – Example circuit for evaluating the performance of the current clamp .....	22
Figure 8 – Details of setups and components to verify the essential characteristics of coupling and decoupling devices and the 150 $\Omega$ to 50 $\Omega$ adapters .....	25
Figure 9 – Setup for level setting .....	27
Figure 10 – Example of test setup with a single unit EUT (top view) .....	29
Figure 11 – Example of a test setup with a multi-unit EUT (top view) .....	30
Figure 12 – Rules for selecting the injection method .....	31
Figure 13 – Immunity test to 2-port EUT (when only one CDN can be used) .....	33
Figure 14 – General principle of a test setup using clamp injection devices .....	34
Figure 15 – Example of the test unit locations on the ground plane when using injection clamps (top view) .....	35
Figure A.1 – Example: Construction details of the EM clamp .....	40
Figure A.2 – Example: Concept of the EM clamp .....	41
Figure A.3 – Dimension of a reference plane .....	42
Figure A.4 – Test jig .....	42
Figure A.5 – Test jig with inserted clamp .....	42
Figure A.6 – Impedance / decoupling factor measurement setup .....	43
Figure A.7 – Typical examples for clamp impedance, 3 typical clamps .....	44
Figure A.8 – Typical examples for decoupling factors, 3 typical clamps .....	45
Figure A.9 – Normalization setup for coupling factor measurement .....	45
Figure A.10 – $S_{21}$ coupling factor measurement setup .....	46
Figure A.11 – Typical examples for coupling factor, 3 typical clamps .....	46
Figure A.12 – Decoupling clamp characterization measurement setup .....	47
Figure A.13 – Typical examples for the decoupling clamp impedance .....	47
Figure A.14 – Typical examples for decoupling factors .....	48
Figure B.1 – Start frequency as function of cable length and equipment size .....	50
Figure D.1 – Example of a simplified diagram for the circuit of CDN-S1 used with screened cables (see 6.2.2.5) .....	53
Figure D.2 – Example of simplified diagram for the circuit of CDN-M1/-M2/-M3 used with unscreened supply (mains) lines (see 6.2.2.2) .....	53
Figure D.3 – Example of a simplified diagram for the circuit of CDN-AF2 used with unscreened unbalanced lines (see 6.2.2.4) .....	54

Figure D.4 – Example of a simplified diagram for the circuit of a CDN-T2, used with an unscreened balanced pair (see 6.2.2.3) .....	54
Figure D.5 – Example of a simplified diagram of the circuit of a CDN-T4 used with unscreened balanced pairs (see 6.2.2.3) .....	55
Figure D.6 – Example of a simplified diagram of the circuit of a CDN AF8 used with unscreened unbalanced lines (see 6.2.2.4) .....	55
Figure D.7 – Example of a simplified diagram of the circuit of a CDN-T8 used with unscreened balanced pairs (see 6.2.2.3) .....	56
Figure F.1 – Example of large EUT test setup with elevated horizontal reference ground plane.....	59
Figure F.2 – Example of large EUT test setup with vertical reference ground plane .....	60
Figure G.1 – Example of influences upon voltage test level using CDN .....	62
Figure G.2 – Example of influences upon voltage test level using EM clamp .....	62
Figure G.3 – Example of influences upon voltage test level using current clamp .....	63
Figure G.4 – Example of influences upon voltage test level using direct injection.....	63
Figure G.5 – Circuit for level setting setup .....	64
Figure H.1 – Impedance measurement using a voltmeter .....	73
Figure H.2 – Impedance measurement using a current probe.....	74
Figure I.1 – Example of setup, port-port injection .....	77
Figure J.1 – Amplifier linearity measurement setup .....	80
Figure J.2 – Linearity characteristic .....	81
Figure J.3 – Measurement setup for modulation depth .....	81
Figure J.4 – Spectrum of AM modulated signal .....	82
Table 1 – Test levels.....	13
Table 2 – Characteristics of the test generator .....	14
Table 3 – Main parameter of the combination of the coupling and decoupling device .....	15
Table 4 – Usage of CDNs .....	18
Table B.1 – Main parameter of the combination of the coupling and decoupling device when the frequency range of test is extended above 80 MHz .....	49
Table E.1 – Required power amplifier output power to obtain a test level of 10 V.....	57
Table G.1 – CDN level setting process.....	65
Table G.2 – CDN test process .....	65
Table G.3 – EM clamp level setting process.....	67
Table G.4 – EM clamp test process.....	67
Table G.5 – Current clamp level setting process .....	68
Table G.6 – Current clamp test process .....	69
Table G.7 – Direct injection level setting process .....	70
Table G.8 – Direct injection test process.....	70
Table H.1 – Impedance requirements for the AE .....	72
Table H.2 – Derived voltage division ratios for AE impedance measurements .....	73
Table H.3 – Derived voltage ratios for AE impedance measurements.....	74

## INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

### **Part 1: General**

General considerations (introduction, fundamental principles)  
Definitions, terminology

### **Part 2: Environment**

Description of the environment  
Classification of the environment  
Compatibility levels

### **Part 3: Limits**

Emission limits  
Immunity limits (in so far as they do not fall under the responsibility of the product committees)

### **Part 4: Testing and measurement techniques**

Measurement techniques  
Testing techniques

### **Part 5: Installation and mitigation guidelines**

Installation guidelines  
Mitigation methods and devices

### **Part 6: Generic standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts, published either as international standards or as technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

This part is an international standard which gives immunity requirements and test procedures related to conducted disturbances induced by radio-frequency fields.



## ELECTROMAGNETIC COMPATIBILITY (EMC) –

### Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields

#### 1 Scope

This part of IEC 61000 relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 150 kHz up to 80 MHz. Equipment not having at least one conducting wire and/or cable (such as mains supply, signal line or earth connection) which can couple the equipment to the disturbing RF fields is excluded from the scope of this publication.

NOTE 1 Test methods are defined in this part of IEC 61000 to assess the effect that conducted disturbing signals, induced by electromagnetic radiation, have on the equipment concerned. The simulation and measurement of these conducted disturbances are not adequately exact for the quantitative determination of effects. The test methods defined are structured for the primary objective of establishing adequate repeatability of results at various facilities for quantitative analysis of effects.

The object of this standard is to establish a common reference for evaluating the functional immunity of electrical and electronic equipment when subjected to conducted disturbances induced by RF fields. The test method documented in this part of IEC 61000 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon.

NOTE 2 As described in IEC Guide 107, this standard is a basic EMC publication for use by product committees of the IEC. As also stated in Guide 107, the IEC product committees are responsible for determining whether this immunity test standard should be applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria.

#### 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 (IEV)* (available at <http://www.electropedia.org>)

#### 3 Terms and definitions

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

##### 3.1

##### **artificial hand**

electrical network simulating the impedance of the human body under average operational conditions between a hand-held electrical appliance and earth

Note 1 to entry: The construction should be in accordance with CISPR 16-1-2.

[SOURCE: IEC 60050-161:1990, 161-04-27]