

Institut luxembourgeois de la normalisation de l'accréditation, de la sécurité et qualité des produits et services

ILNAS-EN IEC 61000-4-6:2023

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

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

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

01011010010 0011010010110100101010101111

#### **National Foreword**

This European Standard EN IEC 61000-4-6:2023 was adopted as Luxembourgish Standard ILNAS-EN IEC 61000-4-6:2023.

Every interested party, which is member of an organization based in Luxembourg, can participate for FREE in the development of Luxembourgish (ILNAS), European (CEN, CENELEC) and International (ISO, IEC) standards:

- Participate in the design of standards
- Foresee future developments
- Participate in technical committee meetings

https://portail-qualite.public.lu/fr/normes-normalisation/participer-normalisation.html

### THIS PUBLICATION IS COPYRIGHT PROTECTED

Nothing from this publication may be reproduced or utilized in any form or by any mean - electronic, mechanical, photocopying or any other data carries without prior permission!

# EUROPEAN STANDARD LILNAS-EN IEC 61000-4-6:2033 IEC 61000-4-6

# NORME EUROPÉENNE

## **EUROPÄISCHE NORM**

July 2023

ICS 33.100.20

Supersedes EN 61000-4-6:2014; EN 61000-4-6:2014/AC:2015

### **English Version**

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

(IEC 61000-4-6:2023)

Compatibilité électromagnétique (CEM) - Partie 4-6: Techniques d'essai et de mesure - Immunité aux perturbations conduites, induites par les champs aux fréquences radioélectriques (IEC 61000-4-6:2023) Elektromagnetische Verträglichkeit (EMV) - Teil 4-6: Prüfund Messverfahren - Störfestigkeit gegen leitungsgeführte Störgrößen, induziert durch hochfrequente Felder (IEC 61000-4-6:2023)

This European Standard was approved by CENELEC on 2023-07-11. 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

### **European foreword**

The text of document 77B/863/FDIS, future edition 5 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 IEC 61000-4-6:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2024-04-11
   level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2026-07-11 document have to be withdrawn

This document supersedes EN 61000-4-6:2014 and all of its amendments and corrigenda (if any).

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

This document has been prepared under a standardization request addressed to CENELEC by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

### **Endorsement notice**

The text of the International Standard IEC 61000-4-6:2023 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 standard indicated:

IEC 61000-4-3 NOTE Approved as EN IEC 61000-4-3

CISPR 16-1-4 NOTE Approved as EN IEC 55016-1-4

# 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.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	EN/HD	<u>Year</u>
CISPR 16-1-2	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements	EN 55016-1-2	-



# IEC 61000-4-6

Edition 5.0 2023-06

# INTERNATIONAL STANDARD



### **BASIC EMC PUBLICATION**

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



## **CONTENTS**

Ε(	DREWO	PRD	6
IN	TRODU	JCTION	8
1	Scop	pe	9
2	Norm	native references	9
3	Term	ns and definitions	9
4		eral	
5		levels	
6		equipment and level adjustment procedure	
U	6.1	Test generator	
	6.2	Coupling and decoupling devices	
	6.2.1		
	6.2.2		
	6.2.3		
	6.2.4	• •	
	6.2.5	•	
	6.3	Verification of the common-mode impedance at the EUT port of coupling and	
	0.0	decoupling devices	22
	6.3.1	General	22
	6.3.2	Insertion loss of the 150 $\Omega$ to 50 $\Omega$ 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	25
7	Test	setup and injection methods	27
	7.1	Test setup	27
	7.2	EUT comprising a single unit	28
	7.3	EUT comprising several units	30
	7.4	Rules for selecting injection methods and test points	31
	7.4.1	General	31
	7.4.2	Injection method	31
	7.4.3	Ports to be tested	32
	7.5	CDN injection application	32
	7.6	Clamp injection application	34
	7.7	Direct injection application	36
8	Test	procedure	36
9	Evalu	uation of the test results	37
10	Test	report	38
Ar	nnex A (	(normative) EM and decoupling clamps	39
	A.1	EM clamps	
	A.1.1	•	
	A.1.2		
	A.2	EM clamp characterization	
	A.2.1	·	
	A.2.2	·	
	A.3	Decoupling clamp characterization	
	A.3.1		
	A.3.2		

## IEC 61000-4-6:2023 © IEC 2023

61000-4	-6:2023 © IEC 2023 — 3 —	
A.3.3	Impedance	47
A.3.4	Decoupling factor	48
ex B (info	ormative) Selection criteria for the frequency range of application	50
ex C (inf	ormative). Guidelines for selecting test levels	52

A.3.4 Decoupling factor	48
Annex B (informative) Selection criteria for the frequency range of application	50
Annex C (informative) Guidelines for selecting test levels	52
Annex D (informative) Information on coupling and decoupling networks	53
D.1 Basic features of the coupling and decoupling networks	53
D.2 Examples of coupling and decoupling networks	53
Annex E (informative) Information for the test generator specification	58
Annex F (informative) Test setup for large EUTs	59
F.1 General	59
F.2 Test setup for large EUTs	59
Annex G (informative) Measurement uncertainty of the voltage test level	62
G.1 General	62
G.2 General symbols	62
G.3 Uncertainty budgets for test methods	
G.3.1 Definition of the measurand	62
G.3.2 MU contributors of the measurand	
G.3.3 Input quantities and calculation examples for expanded uncertainty	64
G.4 Expression of the calculated measurement uncertainty and its application	
Annex H (informative) Testing with multiple signals	73
H.1 General	73
H.2 Intermodulation	73
H.3 Power requirements	74
H.4 Level-setting requirements	75
H.5 Linearity check and harmonics checks of the test generator	75
H.6 EUT performance criteria with multiple signals	75
Annex I (informative) Port-to-port injection	76
I.1 General	76
I.2 Test setup for injection on identical ports	76
I.2.1 Selection of ports	76
I.2.2 Procedure for port-to-port injection	76
Annex J (informative) Amplifier compression and non-linearity	78
J.1 Objective of limiting amplifier distortion	78
J.2 Possible problems caused by harmonics and saturation	78
J.3 Limiting the harmonic content in the disturbance signal	78
J.4 Effect of linearity characteristic on the immunity test	79
J.4.1 General	79
J.4.2 Evaluation of the amplifier linearity characteristic	79
Bibliography	83
Figure 1 – Diagram showing EM fields near the EUT due to common-mode currents on its cables	12
Figure 2 – Schematic setup for immunity test to RF conducted disturbances	
Figure 3 – Example of unmodulated and modulated RF signal	
Figure 4 – Test generator setup	16
Figure 5 – Principle of coupling and decoupling – Symbols used for the indicated setup	17

Figure 6 – Principle of coupling and decoupling – Principle of direct injection to screened cables	17
Figure 7 – Principle of coupling and decoupling – Principle of coupling to unscreened cables according to the CDN method	18
Figure 8 – Principle of coupling and decoupling – Principle of decoupling	18
Figure 9 – Example of circuit for evaluating the transmission loss of the current clamp level-setting	21
Figure 10 – Example of circuit for level-setting setup in a 150 $\Omega$ test jig	21
Figure 11 – Example of the setup geometry to verify the impedance characteristics of the coupling and decoupling devices	23
Figure 12 – Setup principle to verify $Z_{ extsf{Ce}}$ of the coupling and decoupling device	24
Figure 13 – Setup principle for measuring the insertion loss of two 150 $\Omega$ to 50 $\Omega$ adapters	24
Figure 14 – Circuit and construction of the 150 $\Omega$ to 50 $\Omega$ adapter	24
Figure 15 – Definition of a common-mode point for unscreened and screened cables	26
Figure 16 – Setup for level-setting at the EUT port of the coupling/decoupling devices	27
Figure 17 – Example of test setup with a single unit EUT with only one CDN for injection (top view)	28
Figure 18 – Example of test setup with a single unit EUT (top view) using multiple CDNs	29
Figure 19 – Example of a test setup with a multi-unit EUT (top view)	30
Figure 20 – Rules for selecting the injection method	31
Figure 21 – Immunity test for two-port EUT (when only one CDN can be used)	34
Figure 22 – General principle of a test setup using clamp injection devices	35
Figure 23 – Example of the test unit locations on the ground plane when using injection clamps (top view)	36
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, three typical clamps	45
Figure A.8 – Typical examples for decoupling factors, three typical clamps	45
Figure A.9 – Normalization setup for coupling factor measurement	46
Figure A.10 – S <sub>21</sub> coupling factor measurement setup	46
Figure A.11 – Typical examples for coupling factor, three typical clamps	47
Figure A.12 – Decoupling clamp characterization measurement setup	48
Figure A.13 – Typical examples for the decoupling clamp impedance	48
Figure A.14 – Typical examples for decoupling factors	49
Figure B.1 – Start frequency as function of cable length and equipment size	51
Figure D.1 – Example of a simplified diagram for the circuit of CDN-S1 used with screened cables (see 6.2.2.5)	54
Figure D.2 – Example of simplified diagram for the circuit of CDN-M1, CDN-M2 and CDN-M3 used with unscreened supply (mains) lines (see 6.2.2.2)	54

IEC 61000-4-6:2023 © IEC 2023

Figure D.3 – Example of a simplified diagram for the circuit of CDN-AF2 used with unscreened unbalanced lines (see 6.2.2.4)	55
Figure D.4 – Example of a simplified diagram for the circuit of CDN-T2, used with an unscreened balanced pair (see 6.2.2.3)	55
Figure D.5 – Example of a simplified diagram of the circuit of CDN-T4 used with unscreened balanced pairs (see 6.2.2.3)	56
Figure D.6 – Example of a simplified diagram of the circuit of CDN AF8 used with unscreened unbalanced lines (see 6.2.2.4)	56
Figure D.7 – Example of a simplified diagram of the circuit of CDN-T8 used with unscreened balanced pairs (see 6.2.2.3)	57
Figure F.1 – Example of large EUT test setup with elevated horizontal reference ground plane	60
Figure F.2 – Example of large EUT test setup with vertical reference ground plane	61
Figure G.1 – Example of influences upon voltage test level using CDN	63
Figure G.2 – Example of influences upon voltage test level using EM clamp	63
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	64
Figure G.5 – Circuit for level-setting setup of CDN	65
Figure H.1 – Test frequencies $f_1$ and $f_2$ and intermodulation frequencies of the second	70
and third order	
Figure I.1 – Example of setup, port-to-port injection	
Figure J.1 – Amplifier linearity measurement setup	
Figure J.2 – Linearity characteristic	
Figure J.3 – Measurement setup for modulation depth	
Figure J.4 – Spectrum of AM modulated signal	82
Table 1 – Test levels	
Table 2 – Characteristics of the test generator	15
Table 3 – Main parameter of the combination of the coupling and decoupling device	
Table 4 – Usage of CDNs	19
Table B.1 – Main parameter of the combination of the coupling and decoupling device when the frequency range of the test is extended above 80 MHz	50
Table E.1 – Required power amplifier output power to obtain a test level of 10 V	58
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	68
Table G.5 – Current clamp level-setting process	69
Table G.6 – Current clamp test process	69
Table G.7 – Direct injection level-setting process	70
Table G.8 – Direct injection test process	71