

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

## Elektromagnetisk kompatibilitet (EMC) – Del 4-41: Mät- och provningsmetoder – Provning av immunitet mot bredbandiga utstrålade störningar

*Electromagnetic compatibility (EMC) –  
Part 4-41: Testing and measurement techniques –  
Broadband radiated immunity tests*

Som svensk standard gäller europastandarden EN IEC 61000-4-41:2025. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61000-4-41:2025.

### Nationellt förord

Europastandarden EN IEC 61000-4-41:2025

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61000-4-41, First edition, 2024 - Electromagnetic compatibility (EMC) - Part 4-41: Testing and measurement techniques - Broadband radiated immunity tests**

utarbetad inom International Electrotechnical Commission, IEC.

---

ICS 33.100.20

---

Denna standard är fastställd av SEK Svensk Elstandard,  
som också kan lämna upplysningar om **sakinnehållet** i standarden.  
Postadress: Box 1042, 172 21 Sundbyberg  
Telefon: 08 - 444 14 00.  
E-post: [sek@elstandard.se](mailto:sek@elstandard.se). Internet: [elstandard.se](http://elstandard.se)

---

## Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

## SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

## Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

## Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

## SEK Svensk Elstandard

Box 1042  
172 21 Sundbyberg  
Tel 08-444 14 00  
elstandard.se

ICS 33.100.20

English Version

**Electromagnetic compatibility (EMC) - Part 4-41: Testing and measurement techniques - Broadband radiated immunity tests (IEC 61000-4-41:2024)**

Compatibilité électromagnétique (CEM) - Partie 4-41:  
Techniques d'essai et de mesure - Essais d'immunité aux rayonnements à large bande  
(IEC 61000-4-41:2024)

Elektromagnetische Verträglichkeit (EMV) - Teil 4-41: Prüf- und Messverfahren - Prüfungen der breitbandigen Störfestigkeit  
(IEC 61000-4-41:2024)

This European Standard was approved by CENELEC on 2024-12-27. 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, 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/892/FDIS, future edition 1 of IEC 61000-4-41, 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 61000-4-41:2025.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2026-01-31 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2028-01-31 document have to be withdrawn

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.

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 61000-4-41:2024 was approved by CENELEC as a European Standard without any modification.

## 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](http://www.cencenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61000-4-3	2020	Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN IEC 61000-4-3	2020

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



---

**Electromagnetic compatibility (EMC) –  
Part 4-41: Testing and measurement techniques – Broadband radiated immunity  
tests**

**Compatibilité électromagnétique (CEM) –  
Partie 4-41: Techniques d'essai et de mesure – Essais d'immunité aux  
rayonnements à large bande**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 33.100.20

ISBN 978-2-8327-0019-8

**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

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms, definitions and abbreviated terms .....	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	10
4 General .....	11
5 Test levels and test signal .....	11
5.1 Test levels .....	11
5.2 Test signal .....	12
5.3 Frequency range and test signal bandwidth .....	14
5.4 Spectrum mask.....	15
5.5 Frequency stepping .....	16
5.6 Selection of level .....	17
6 Test equipment and level adjustment procedure .....	17
6.1 Test instrumentation .....	17
6.2 Description of the test facility .....	18
6.3 UFA and validation of the spectrum shape .....	18
6.3.1 General .....	18
6.3.2 Saturation check and spectrum validation.....	18
7 Test setup .....	20
8 Test procedure .....	20
8.1 Step size and test signal bandwidth .....	20
8.2 Test signal and level setting.....	20
9 Evaluation of the test results .....	20
10 Test report.....	21
Annex A (informative) Information on test signal generation.....	22
A.1 General.....	22
A.2 True noise generation .....	22
A.3 Pseudo-random noise sequence .....	23
Annex B (informative) Field generating antennas .....	26
Annex C (informative) 4G and 5G signals .....	27
C.1 Overview of the radio interface technology of 4G and 5G.....	27
C.1.1 General .....	27
C.1.2 Overview of the component RIT: E-UTRA/LTE .....	27
C.1.3 Overview of the component RIT: NR.....	30
C.2 Simulation of the 5G signal .....	30
C.3 Application of a test model signal.....	33
Annex D (informative) Guidelines for selecting test levels .....	35
D.1 General.....	35
D.2 Test levels related to general purposes.....	36
D.3 Test levels related to the protection against RF emissions from 4G/5G communications .....	36
D.4 Guidelines to derive a test level from a field distribution.....	39

Annex E (informative) Measurement uncertainty due to test instrumentation .....	42
Annex F (informative) Test signal characterization .....	43
F.1 General.....	43
F.2 Test signal generation.....	43
F.3 Definition of the crest factor .....	43
F.4 Crest factor determination.....	44
F.4.1 Mathematical determination for arbitrary waveform generator use .....	44
F.4.2 Complementary cumulative distribution function (CCDF).....	44
F.5 Amplifier saturation .....	45
F.6 Measurement methods.....	46
F.6.1 General .....	46
F.6.2 Spectrum analyser method .....	46
F.6.3 Time domain measurement with a fast oscilloscope .....	47
F.6.4 Power meter method.....	48
F.7 Comparison of crest factor measurement results.....	49
Bibliography.....	50
Figure 1 – Example of the envelope of a 100 MHz wide test signal in frequency domain .....	13
Figure 2 – Example of the envelope of a 100 MHz wide test signal in time domain.....	13
Figure 3 – Pulse modulated test signal, with a period of 10 ms, and 50 % duty cycle .....	14
Figure 4 – Spectrum mask of the broadband test signal at the output of the power amplifier.....	16
Figure A.1 – Principle of true noise generation.....	22
Figure A.2 – Example of a 100 MHz wide band-limited true noise signal at a centre frequency of 1 GHz.....	22
Figure A.3 – Principle of band-limited broadband signal generation with an arbitrary waveform generator .....	23
Figure A.4 – Example signal spectrum of a band-limited pseudo random noise signal (measured with 120 kHz bandwidth) .....	24
Figure A.5 – Extract of the band-limited pseudo random noise signal in time domain (measured with an oscilloscope) .....	25
Figure A.6 – Extract of the signal spectrum of a band-limited pseudo random noise signal (measured with 10 Hz bandwidth, normalized to 1 Hz bandwidth) .....	25
Figure C.1 – Uplink/downlink time/frequency structure for FDD and TDD .....	28
Figure C.2 – Uplink-downlink asymmetries supported by the E-UTRA/LTE RIT (TDD).....	29
Figure C.3 – Example of an OFDM spectrum .....	31
Figure C.4 – Examples of a spectrum of the test signal in frequency domain .....	32
Figure C.5 – Examples of a spectrum of the test signal in time domain .....	32
Figure C.6 – Example of an equivalent power waveform and spectrum for NR-FR1-TM1.1 .....	34
Figure C.7 – Example of a channel power measurement for NR-FR1-TM1.1 .....	34
Figure D.1 – Example of a channel power measurement on a 5G spectrum .....	41
Figure F.1 – CCDF of a band-limited white gaussian noise signal .....	45
Figure F.2 – CCDF of a band-limited white gaussian noise signal at the output of the amplifier for different signal generator levels.....	45
Figure F.3 – Test setup diagram for radiated immunity testing .....	46

Figure F.4 – Oscillogram of a 20 MHz wide gaussian noise signal with a centre frequency of 700 MHz at the signal generator ..... 48

Table 1 – Test levels..... 11

Table 2 – Pulse modulation of test signal ..... 12

Table 3 – Frequency ranges and test signal bandwidth ..... 14

Table 4 – Test signal requirements ..... 15

Table C.1 – Examples of the test model signal..... 33

Table D.1 – Examples of test levels, associated protection distances – Mobile and portable phones of 4G/5G communications ..... 37

Table D.2 – Examples of test levels, associated protection distances – Base stations of 4G/5G communications ..... 38

Table F.1 – Measurement of crest factors with different methods ..... 49

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 4-41: Testing and measurement techniques –  
Broadband radiated immunity tests**

## 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61000-4-41 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility. It is an International Standard.

It forms Part 4-41 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

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

Draft	Report on voting
77B/892/FDIS	77B/895/RVD

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/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

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, or
- revised.

**IMPORTANT – The "colour inside" logo on the cover page of this document 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

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 radiated disturbances generated by broadband signals.

Modern digital communication signals operate on multiple frequencies such as orthogonal frequency division multiplexing (OFDM) and use bandwidths ranging from tens of MHz to hundreds of MHz, all while employing in-band time division duplexing (TDD) or frequency division duplexing (FDD) transmission technology, or both. Such broadband signals can cause a performance degradation or malfunction of other equipment, or both. In this document, the disturbance is not a frequency sweep of a narrowband signal but a broadband signal with coexisting multiple frequencies which is stepped through the desired frequency range.

Examples of broadband signals are LTE signals and 5G mobile communication signals.

# **ELECTROMAGNETIC COMPATIBILITY (EMC) –**

## **Part 4-41: Testing and measurement techniques –**

### **Broadband radiated immunity tests**

#### **1 Scope**

This part of IEC 61000 relates to broadband radiated disturbances generated by, for example, communication devices or services, transmitters or industrial electromagnetic sources or any other devices capable of generating such a signal.

The object of this document is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to broadband radiated electromagnetic fields.

This document specifies testing in the frequency ranges above 80 MHz, limited only by the capabilities of commercially available test instrumentation.

#### **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 61000-4-3:2020, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*