BS EN IEC 61000-4-41:2025

BSI Standards Publication

Electromagnetic compatibility (EMC)

Part 4-41: Testing and measurement techniques —
Broadband radiated immunity tests

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National foreword

This British Standard is the UK implementation of EN IEC 61000-4-41:2025. It is identical to IEC 61000-4-41:2024.

The UK participation in its preparation was entrusted to Technical Committee GEL/210, EMC - Policy committee.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2025

ISBN 978 0 539 15040 7

ICS 33.100; 33.100.20

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 January 2025.

Amendments/corrigenda issued since publication

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61000-4-41

January 2025

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)

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•	latest date by which the national standards conflicting with the document have to be withdrawn	(dow) 2028-01-31

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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.

Publication	Year	Title	EN/HD	Year
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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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.
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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.

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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. The main document types developed by IEC are described in greater detail at 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 in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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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.

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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*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61000-4-3 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
auxiliary equipment
AE
equipment necessary to provide the equipment under test (EUT) with the signals required for normal operation and equipment to verify the performance of the EUT

3.1.2
equivalent carrier electric field strength
electric field strength at carrier frequency equivalent to the square root of the cumulative electric field power (E^2) caused by the radiation of broadband signal

Note 1 to entry: Equivalent carrier electric field strength is expressed in V/m.

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3.1.3
broadband signal
signal where the energy is distributed over several megahertz, either by the broadband nature of the signal itself or by a modulation, for example by a collection of subcarriers

Note 1 to entry: In typical applications a broadband signal can be as wide as 5 MHz to 100 MHz.

3.1.4
duty cycle
fraction of the period where a repetitive signal is above a specified threshold

Note 1 to entry: That period is the duration of time for one cycle of a repeating event. It is the reciprocal of repetition frequency.

3.1.5
test generator
generator capable of generating the required test signal

Note 1 to entry: The test generator can, for example, include a vector signal generator, modulation sources, attenuators, broadband power amplifiers and filters, etc. See Annex A for additional information on test generator.

3.1.6
white noise
random noise which has a continuous spectrum and a constant power spectral density in the frequency band considered

[SOURCE: IEC 60050-702:1992, 702-08-39, modified – In the term “flat random noise” has been removed.]

3.1.7
electric field spectral density
quantity derived from the electric power spectral density (PSD) of a broadband signal

Note 1 to entry: Further information can be found in Annex D.

Note 2 to entry: For electric field spectral density, the unit is (V/m)/ $\sqrt{\text{Hz}}$.

3.1.8

power spectral density
PSD
distribution as a function of frequency of the power per unit bandwidth of the spectral components of a signal or a noise having a continuous spectrum and a finite mean power

Note 1 to entry: A PSD is the measure of signal's power content versus frequency. A PSD is typically used to characterize broadband signals. The amplitude of the PSD is normalized by the spectral resolution employed to measure the signal.

[SOURCE: IEC 60050-713:1998, 713-09-12, modified – In the term “power spectrum density” has been removed and Note 1 has been added.]

3.1.9
crest factor
ratio between peak amplitude (envelope) and RMS value, usually expressed in dB

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3.2 Abbreviated terms

ACLR	adjacent channel leakage power ratio
AE	auxiliary equipment
AWG	arbitrary waveform generator
BPSK	binary phase shift keying
BS	base station
BW	bandwidth
CA	carrier aggregation
CCDF	complementary cumulative distribution function
CW	continuous wave
DFTS-OFDM	discrete Fourier transform spread-OFDM
DL	downlink
eMBB	enhanced Mobile BroadBand
eMTC	enhanced MachineType Communication
eNB	evolved Node B
EUT	equipment under test
E-UTRA	Evolved-Universal mobile telecommunication system Terrestrial Radio Access
EVM	error vector magnitude
FDD	frequency division duplexing
GP	Guard Period
IMT	International Mobile Telecommunications
LTE	Long-Term Evolution
mMTC	massive Machine Type Communication
NB-IoT	narrow band-Internet of Things
NR	New Radio
OFDM	orthogonal frequency division multiplexing
PAPR	peak-to-average power ratio
PM	pulse modulation
PSD	power spectral density
QAM	quadrature amplitude modulation
QPSK	quadrature phase shift keying
RB	resource block
RF	radio frequency
RIT	radio interface technology
SEM	spectral emission mask
TDD	time division duplexing
TTI	transmission time interval
UE	user equipment
UFA	uniform field area
UL	uplink
URLLC	Ultra Reliable Low Latency Communication
WGN	white gaussian noise

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3GPP 3rd Generation Partnership Project

4 General

The source of disturbance covered by this document is an electromagnetic field, consisting of broadband signals, generated by, for example, communication devices or services, transmitters or industrial electromagnetic sources or any other devices capable of generating such a signal.

The frequency range covered by this document is specified in Table 3.

5 Test levels and test signal

5.1 Test levels

The test levels are given in terms of an equivalent carrier electric field strength consistent with the level-setting process and the electric field spectral density spread out to the test signal bandwidth.

The levels in columns 3 to 6 of Table 1 show the electric field spectral density derived from the power spectral density of the broadband test signal assuming that the different spectrum components are uncorrelated.

The test level is derived from the uniform field area (UFA) level-setting process. The signal power to generate the test levels of Table 1 should be equal to the total power of the broadband signal.

Table 1 – Test levels

Test level	Equivalent carrier electric field strength V/m	Electric field spectral density $dB\left(\frac{\mu V}{m \cdot \sqrt{Hz}}\right)$			
		BW = 5 MHz	BW = 20 MHz	BW = 40 MHz	BW = 100 MHz
1	1	53,0	47,0	44,0	40,0
2	3	62,5	56,5	53,5	49,5
3	10	73,0	67,0	64,0	60,0
4	30	82,5	76,5	73,5	69,5
NOTE 5 MHz and 40 MHz bandwidth (BW) are indicated for the convenience of the product committee.					

This document does not suggest that a single test level is applicable over the entire frequency range. The product committees shall select the frequency range(s) to be tested as well as the appropriate test level(s). Annex D provides guidance for product committees on the selection of test levels.

Product committees may use test levels other than those listed in Table 1. However, once the equivalent carrier electric field strength is determined, the test levels for each bandwidth follow the relationship between the test levels in Table 1.

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5.2 Test signal

Real broadband communication signals are largely based on orthogonal frequency division multiplexing (OFDM). The parameters (number of carriers, modulation per carrier, etc.) are so diverse that an internationally agreed set of parameters that is representative of all conceivable broadband communication services does not seem to make sense. In accordance with the nature of the interference, a band-limited noise is therefore specified as the test signal. The signal can be generated by a physical noise generator with a filter or by an arbitrary waveform generator, which periodically plays a pseudo-random code. With the latter, care shall be taken that the sequence is long enough to produce a spectrum that is as continuous as possible.

An additional important parameter of the test signal is the crest factor. The crest factor of the signal generator output signal shall be at least 10 dB. Information on test signal characterization is given in Annex F.

NOTE 1 The higher the crest factor, the higher the demands on the dynamic reserves of the power amplifier.

The broadband signals used as test signals in this document are time variant to simulate changes in amplitude due to time division transmission scheme. For testing purposes, a pulse modulation is selected. A 50 % duty cycle is preferred. The modulation is specified in Table 2.

Product committees may select other duty cycles if specific transmission signals are supposed to be emulated by test signals.

Table 2 – Pulse modulation of test signal

Parameter	Value
Modulation frequency	100 Hz ± 10 Hz
Rise/fall time of the envelope (between 10 % and 90 % of amplitude)	< 20 µs
Duty cycle	(50 ± 2) %

Figure 1 and Figure 2 show an example of a test signal with a bandwidth of 100 MHz in the frequency domain and time domain, respectively.

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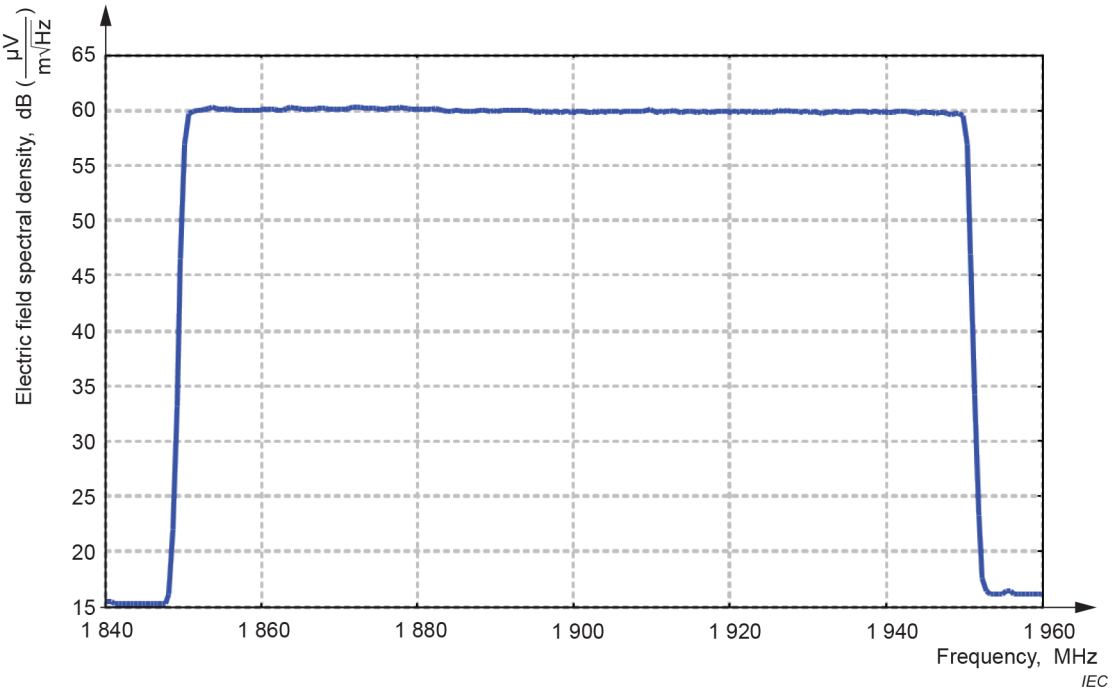

Figure 1 – Example of the envelope of a 100 MHz wide test signal in frequency domain

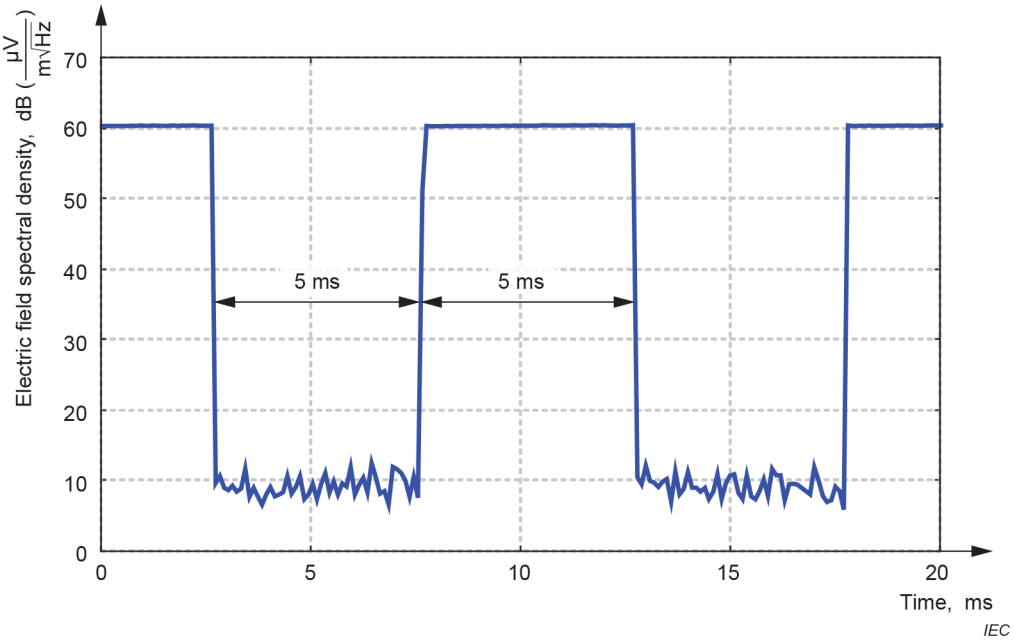

Figure 2 – Example of the envelope of a 100 MHz wide test signal in time domain

The characteristics of a modulated test signal are shown in Figure 3. Note that when the pulse modulation is activated, the energy of the test signal is reduced to 50 % (-3 dB) because the amplitude is close to zero while the signal is “OFF”. The test amplitude during the “ON” period should however remain unchanged at the level derived from the UFA level-setting process.

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