

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

REDLINE VERSION

Elektromagnetisk kompatibilitet (EMC) – Del 2-4: Miljöbetingelser – Kompatibilitetsnivåer för lågfrekventa ledningsbundna störningar i industrimiljö

Electromagnetic compatibility (EMC) –

Part 2-4: Environment –

*Compatibility levels in power distribution systems in industrial locations
for low-frequency conducted disturbances*

En så kallad ”Redline version” (RLV) innehåller både standarden som fastställts som SEK-publikation och en ändringsmarkerad IEC-standard. Alla tillägg och borttagningar sedan den tidigare utgåvan av IEC-standarderna är markerade med färg. Med en RLV sparar du mycket tid när du ska identifiera och bedöma aktuella ändringar i standarden. SEK Svensk Elstandard kan bara ge ut RLV i de fall den finns tillgänglig från IEC.



IEC 61000-2-4

Edition 3.0 2024-07
REDLINE VERSION

INTERNATIONAL STANDARD



Electromagnetic compatibility (EMC) –
Part 2-4: Environment – Compatibility levels in power distribution systems in
industrial-plants locations for low-frequency conducted disturbances

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-9462-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	9
3 Terms, definitions and abbreviated terms	9
3.1 General definitions.....	10
3.2 Phenomena-related definitions.....	12
3.3 Abbreviated terms.....	16
4 Electromagnetic environment classes	16
5 Introduction to the setting of compatibility levels for different types of electromagnetic disturbances	18
5.1 General comment.....	18
5.2 Voltage deviations	19
5.3 Voltage dips and short interruptions.....	19
5.4 Voltage unbalance -(imbalance).....	19
5.5 Temporary power-frequency variation	20
5.6 Harmonics	20
5.7 Interharmonics.....	21
5.8 Voltage components at higher frequencies (above 50 40 th harmonic).....	21
5.9 Transient overvoltages.....	21
5.10 DC component.....	21
6 Compatibility levels.....	22
Annex A (informative) Explanations and examples for interharmonics	27
A.1 Resolution of non-sinusoidal voltages and currents.....	27
A.2 Time varying phenomena	28
A.3 Definition of additional terms.....	28
Annex B (informative) Examples of expected disturbance levels in typical industrial networks	30
B.1 General.....	30
B.2 Voltage disturbance levels in industrial networks due to large converters.....	30
B.3 Voltage disturbance levels in industrial networks at high load	32
B.4 Voltage dips and short interruptions.....	34
B.4.1 Description	34
B.4.2 Adaptation	35
B.5 Transient overvoltages.....	36
Annex C (informative) Interharmonics and voltages at higher frequencies and mitigation methods.....	38
C.1 Sources of interharmonics	38
C.1.1 Identification.....	38
C.1.2 Different types of sources of interharmonics	38
C.1.3 Effects of interharmonics and compatibility	40
C.1.4 Guidance levels	41
C.2 Mitigation methods.....	42
C.2.1 General	42
C.2.2 Decrease emission levels	42
C.2.3 Increase immunity	43

C.2.4	Protection of ripple control system mains signaling	43
C.3	Voltages at higher frequencies	43
Annex D (informative)	Proving compatibility in the frequency range above 2 kHz in industrial MV networks	45
Annex E (informative)	Examples of locations and installations covered by IEC 61000-2-4	46
E.1	General	46
E.2	Mixed locations	46
E.3	Examples for industrial locations	46
Annex F (informative)	Rationale for increased individual even and triplen compatibility levels and for splitting class 2 into class 2a, class 2b and class 2L	50
F.1	Rationale for increased individual even and triplen compatibility levels	50
F.1.1	Target	50
F.1.2	The needs of modern power electronic equipment	50
F.1.3	Maintaining the overall disturbance level	51
F.2	Rationale for splitting class 2 into class 2a, class 2b and class 2L	51
F.2.1	Target	51
F.2.2	Class 2a	51
F.2.3	Class 2b	51
F.2.4	Class 2L	52
Bibliography		53
Figure 1	Examples of the application of different electromagnetic environment classes in different industrial locations	17
Figure 2	Example of different parts of an installation separated by filters, where different electromagnetic environment classes are applied	18
Figure 4 3	Interharmonic compatibility levels (flickermeter response for $P_{st} = 1$ related to 60 W incandescent lamps)	26
Figure B.1	Example of power distribution in industry with rolling mills	31
Figure B.2	Example of power distribution in the paper industry	32
Figure B.3	Example of power distribution in a generic manufacturing industry	34
Figure B.4	ITI (CBEMA) – Curve of tolerance envelope of ITE	36
Figure E.1	Example of class 1 environment	46
Figure E.2	Example of class 2a and class 2b environments	47
Figure E.3	Example of an LV grid in a building supplied by a dedicated transformer	47
Figure E.4	Example of an LV grid in a building including residential and industrial locations	48
Figure E.5	Example of an LV grid for a data center	48
Figure F.1	Emission spectrum of an active infeed converter	50
Table 1	Compatibility levels for voltage tolerance, voltage unbalance imbalance and power-frequency variations	22
Table 2	Compatibility levels for harmonics – Harmonic voltage components	23
Table 3	Compatibility levels for harmonics – Harmonic voltage components	23
Table 4	Compatibility levels – Harmonic voltage components even order	23
Table 2	Compatibility levels for harmonics – Harmonic voltage components	23

Table 5 3 – Compatibility levels for total voltage harmonic distortion.....	24
Table 4 – Compatibility levels for low voltage networks in the frequency range from 2 kHz to 9 kHz	25
Table 5 – Compatibility levels for low voltage networks in the frequency range from 9 kHz to 150 kHz	25
Table B.1 – Type of network	30
Table B.2 – Voltage disturbance levels in a typical manufacturing industry	33
Table C.1 – Indicative values for interharmonic voltages in low-voltage networks with respect to the flicker effect.....	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

**Part 2-4: Environment –
Compatibility levels in power distribution systems
in industrial ~~plants~~ locations for low-frequency conducted disturbances**

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61000-2-4:2002. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61000-2-4 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility. It is an International Standard.

This third edition cancels and replaces the second edition published in 2002. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) introduction of new classes 2a, 2b and 2L (former class 2);
- b) modification of existing compatibility levels for class 3;
- c) addition of compatibility levels in the frequency range 2 kHz to 150 kHz;
- d) addition of compatibility levels using a new quantity: partial weighted harmonic distortion (PWHB).

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

Draft	Report on voting
77A/1215/FDIS	77A/1221/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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.

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, 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 61000-3-11).

Detailed information on the various types of disturbances that can be expected on public power supply systems can be found in IEC 61000-2-1 and IEC 61000-2-12.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 2-4: Environment –

Compatibility levels in power distribution systems in industrial ~~plants~~ locations for low-frequency conducted disturbances

1 Scope

This part of IEC 61000 is related to conducted disturbances in the frequency range from 0 kHz to ~~9~~ 150 kHz. It gives ~~numerical~~ compatibility levels in differential mode (L-L and L-N) for industrial ~~locations and non-public power distribution systems~~, with a nominal voltage up to 35 kV and a nominal frequency of 50 Hz or 60 Hz.

NOTE 1 Industrial locations are defined in 3.1.8.

Power ~~supply~~ distribution systems on ships, aircraft, offshore platforms and railways are not included.

~~The compatibility levels specified in this standard apply at the in-plant point of coupling. At the power input terminals of equipment receiving its supply from the above systems, the severity levels of the disturbances can, for the most part, be taken to be the same as the levels at the in-plant point of coupling. In some situations this is not so, particularly in the case of a long feeder dedicated to the supply of a particular load, or in the case of a disturbance generated or amplified within the installation of which the equipment forms a part.~~

NOTE 2 See also Annex E. The compatibility levels specified in this document apply at the in-plant point of coupling (IPC). The level of the low-frequency disturbances at the terminals of equipment receiving its supply from the IPC is generally assumed to be similar to the disturbance level at the IPC itself. However, in some situations this is not the case, particularly when a long feeder is dedicated to the supply of a particular load, or when a disturbance is generated or amplified within the installation of which the equipment forms a part.

Compatibility levels are specified for the types of low-frequency electromagnetic disturbances ~~of the types which can be~~ expected at any in-plant point of coupling (IPC) within industrial ~~plants or other non-public networks~~ locations, for guidance in the definition of:

- a) limits for disturbance emissions in industrial power ~~supply~~ distribution systems (including the planning levels defined in 3.1.5);

NOTE 3 A very wide range of conditions is possible in the electromagnetic environments of industrial ~~and other non-public~~ networks. These are approximated in this document by the three classes described in Clause 4. However, it is the responsibility of the operator of such a network to take account of the particular electromagnetic and economic conditions, including equipment characteristics, in setting the above-mentioned limits.

- b) ~~the choice of~~ immunity levels for the equipment within these systems.

The disturbance phenomena considered are:

- voltage deviations;
- voltage dips and short interruptions;
- voltage ~~unbalance~~ imbalance;
- power-frequency variations;
- harmonics up to order ~~50~~ 40;
- interharmonics up to the ~~50~~ 40th harmonic;
- voltage components ~~at higher frequencies (above 50th harmonic)~~ above the 40th harmonic up to 150 kHz;
- DC component;

- transient overvoltages.

The compatibility levels are given for different classes of ~~the electromagnetic~~ environment determined by the characteristics of the supply network and loads.

NOTE 4 Compatibility levels at the point of common coupling (PCC) on public networks are specified in IEC 61000-2-2 for low-voltage networks and IEC 61000-2-12 for medium-voltage networks. IEC TR 61000-3-6 and IEC TR 61000-3-7 describe the approach of ~~supply authorities~~ power distribution system operators to the limitation of emissions from installations and large loads.

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 60050-101, International Electrotechnical Vocabulary (IEV) – Part 101: Mathematics~~

~~IEC 60050-161, International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility~~

~~IEC 60050-551, International Electrotechnical Vocabulary (IEV) – Part 551: Power electronics~~

IEC 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-2-2:2002/AMD1:2017

IEC 61000-2-2:2002/AMD2:2018

IEC 61000-2-12, *Electromagnetic compatibility (EMC) – Part 2-12: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems*⁴

IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-2-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

⁴~~To be published.~~

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

Elektromagnetisk kompatibilitet (EMC) – Del 2-4: Miljöbetingelser – Kompatibilitetsnivåer för lågfrekventa ledningsbundna störningar i industrimiljö

Electromagnetic compatibility (EMC) –

Part 2-4: Environment –

*Compatibility levels in power distribution systems in industrial locations
for low-frequency conducted disturbances*

Som svensk standard gäller europastandarden EN IEC 61000-2-4:2024. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61000-2-4:2024.

Nationellt förord

Europastandarden EN IEC 61000-2-4:2024

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61000-2-4, Third edition, 2024 - Electromagnetic compatibility (EMC) - Part 2-4: Environment - Compatibility levels in power distribution systems in industrial locations for low-frequency conducted disturbances**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 61000-2-4, utg 2:2003 med eventuella tillägg, ändringar och rättelser gäller ej fr o m 2027-08-29.

ICS 33.100.10; 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. Internet: 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

English Version

Electromagnetic compatibility (EMC) - Part 2-4: Environment -
Compatibility levels in power distribution systems in industrial
locations for low-frequency conducted disturbances
(IEC 61000-2-4:2024)

Compatibilité électromagnétique (CEM) - Partie 2-4:
Environnement - Niveaux de compatibilité dans les réseaux
de distribution d'électricité sur des sites industriels pour les
perturbations conduites à basse fréquence
(IEC 61000-2-4:2024)

Elektromagnetische Verträglichkeit (EMV) - Teil 2-4:
Umgebungsbedingungen - Verträglichkeitspegel für
niederfrequente leitungsgeführte Störgrößen in
Industrieanlagen
(IEC 61000-2-4:2024)

This European Standard was approved by CENELEC on 2024-08-29. 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 77A/1215/FDIS, future edition 3 of IEC 61000-2-4, prepared by SC 77A "EMC - Low frequency phenomena" of IEC/TC 77 "Electromagnetic compatibility" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61000-2-4:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-05-29 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-08-29 document have to be withdrawn

This document supersedes EN 61000-2-4:2002 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 61000-2-4:2024 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 60038:2009	NOTE	Approved as EN 60038:2011
IEC 61000-1-2	NOTE	Approved as EN 61000-1-2
IEC 61000-4-15:2010	NOTE	Approved as EN 61000-4-15:2011 (not modified)
IEC 61511-1:2016	NOTE	Approved as EN 61511-1:2017 (not modified)

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.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61000-2-2	2002	Electromagnetic compatibility (EMC) - Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	EN 61000-2-2	2002
+ A1	2017		+ A1	2017
+ A2	2018		+ A2	2019
IEC 61000-2-12	-	Electromagnetic compatibility (EMC) - Part 2-12: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems	EN 61000-2-12	-
IEC 61000-4-7	-	Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto	EN 61000-4-7	-
CISPR 16-1-1	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus	EN IEC 55016-1-1	-
CISPR 16-2-1	-	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements	EN 55016-2-1	-

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electromagnetic compatibility (EMC) –
Part 2-4: Environment – Compatibility levels in power distribution systems in
industrial locations for low-frequency conducted disturbances**

**Compatibilité électromagnétique (CEM) –
Partie 2-4: Environnement – Niveaux de compatibilité dans les réseaux de
distribution d'électricité sur des sites industriels pour les perturbations
conduites à basse fréquence**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-9416-1

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	9
3 Terms, definitions and abbreviated terms	9
3.1 General definitions.....	9
3.2 Phenomena-related definitions.....	11
3.3 Abbreviated terms.....	15
4 Electromagnetic environment classes	15
5 Introduction to the setting of compatibility levels for different types of electromagnetic disturbances	17
5.1 General comment.....	17
5.2 Voltage deviations	17
5.3 Voltage dips and short interruptions.....	17
5.4 Voltage imbalance	18
5.5 Temporary power-frequency variation	18
5.6 Harmonics	18
5.7 Interharmonics	19
5.8 Voltage components at higher frequencies (above 40 th harmonic).....	19
5.9 Transient overvoltages.....	20
5.10 DC component.....	20
6 Compatibility levels.....	20
Annex A (informative) Explanations and examples for interharmonics	24
A.1 Resolution of non-sinusoidal voltages and currents.....	24
A.2 Time varying phenomena	25
Annex B (informative) Examples of expected disturbance levels in typical industrial networks	26
B.1 General.....	26
B.2 Voltage disturbance levels in industrial networks due to large converters.....	26
B.3 Voltage disturbance levels in industrial networks at high load	28
B.4 Voltage dips and short interruptions.....	30
B.4.1 Description	30
B.4.2 Adaptation	31
B.5 Transient overvoltages.....	31
Annex C (informative) Interharmonics and voltages at higher frequencies and mitigation methods.....	33
C.1 Sources of interharmonics	33
C.1.1 Identification.....	33
C.1.2 Different types of sources of interharmonics	33
C.1.3 Effects of interharmonics and compatibility	35
C.1.4 Guidance levels	35
C.2 Mitigation methods.....	37
C.2.1 General	37
C.2.2 Decrease emission levels	37
C.2.3 Increase immunity	38
C.2.4 Protection of mains signaling	38

Annex D (informative) Proving compatibility in the frequency range above 2 kHz in industrial MV networks	39
Annex E (informative) Examples of locations and installations covered by IEC 61000-2-4	40
E.1 General	40
E.2 Mixed locations	40
E.3 Examples for industrial locations	40
Annex F (informative) Rationale for increased individual even and triplen compatibility levels and for splitting class 2 into class 2a, class 2b and class 2L	44
F.1 Rationale for increased individual even and triplen compatibility levels	44
F.1.1 Target	44
F.1.2 The needs of modern power electronic equipment	44
F.1.3 Maintaining the overall disturbance level	45
F.2 Rationale for splitting class 2 into class 2a, class 2b and class 2L	45
F.2.1 Target	45
F.2.2 Class 2a	45
F.2.3 Class 2b	45
F.2.4 Class 2L	46
Bibliography	47
Figure 1 – Examples of the application of different electromagnetic environment classes in different industrial locations	16
Figure 2 – Example of different parts of an installation separated by filters, where different electromagnetic environment classes are applied	16
Figure 3 – Interharmonic compatibility levels (flickermeter response for $P_{St} = 1$ related to 60 W incandescent lamps)	23
Figure B.1 – Example of power distribution in industry with rolling mills	27
Figure B.2 – Example of power distribution in the paper industry	28
Figure B.3 – Example of power distribution in a generic manufacturing industry	30
Figure B.4 – ITI (CBEMA) – Curve of tolerance envelope of ITE	32
Figure E.1 – Example of class 1 environment	40
Figure E.2 – Example of class 2a and class 2b environments	41
Figure E.3 – Example of an LV grid in a building supplied by a dedicated transformer	41
Figure E.4 – Example of an LV grid in a building including residential and industrial locations	42
Figure E.5 – Example of an LV grid for a data center	42
Figure F.1 – Emission spectrum of an active infeed converter	44
Table 1 – Compatibility levels for voltage tolerance, voltage imbalance and power-frequency variations	20
Table 2 – Compatibility levels for harmonics – Harmonic voltage components	21
Table 3 – Compatibility levels for total voltage harmonic distortion	22
Table 4 – Compatibility levels for low voltage networks in the frequency range from 2 kHz to 9 kHz	22
Table 5 – Compatibility levels for low voltage networks in the frequency range from 9 kHz to 150 kHz	22
Table B.1 – Type of network	26

Table B.2 – Voltage disturbance levels in a typical manufacturing industry	29
Table C.1 – Indicative values for interharmonic voltages in low-voltage networks with respect to the flicker effect.....	36

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 2-4: Environment –
Compatibility levels in power distribution systems
in industrial locations for low-frequency conducted disturbances****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 61000-2-4 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility. It is an International Standard.

This third edition cancels and replaces the second edition published in 2002. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) introduction of new classes 2a, 2b and 2L (former class 2);
- b) modification of existing compatibility levels for class 3;
- c) addition of compatibility levels in the frequency range 2 kHz to 150 kHz;

- d) addition of compatibility levels using a new quantity: partial weighted harmonic distortion (PWHD).

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

Draft	Report on voting
77A/1215/FDIS	77A/1221/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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.

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, 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 61000-3-11).

Detailed information on the various types of disturbances that can be expected on public power supply systems can be found in IEC 61000-2-1 and IEC 61000-2-12.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 2-4: Environment – Compatibility levels in power distribution systems in industrial locations for low-frequency conducted disturbances

1 Scope

This part of IEC 61000 is related to conducted disturbances in the frequency range from 0 kHz to 150 kHz. It gives compatibility levels in differential mode (L-L and L-N) for industrial locations, with a nominal voltage up to 35 kV and a nominal frequency of 50 Hz or 60 Hz.

NOTE 1 Industrial locations are defined in 3.1.8.

Power distribution systems on ships, aircraft, offshore platforms and railways are not included.

NOTE 2 See also Annex E. The compatibility levels specified in this document apply at the in-plant point of coupling (IPC). The level of the low-frequency disturbances at the terminals of equipment receiving its supply from the IPC is generally assumed to be similar to the disturbance level at the IPC itself. However, in some situations this is not the case, particularly when a long feeder is dedicated to the supply of a particular load, or when a disturbance is generated or amplified within the installation of which the equipment forms a part.

Compatibility levels are specified for the types of low-frequency electromagnetic disturbances expected at any in-plant point of coupling (IPC) within industrial locations, for guidance in the definition of:

- a) limits for disturbance emissions in industrial power distribution systems (including the planning levels defined in 3.1.5);

NOTE 3 A very wide range of conditions is possible in the electromagnetic environments of industrial networks. These are approximated in this document by the three classes described in Clause 4. However, it is the responsibility of the operator of such a network to take account of the particular electromagnetic and economic conditions, including equipment characteristics, in setting the above-mentioned limits.

- b) immunity levels for the equipment within these systems.

The disturbance phenomena considered are:

- voltage deviations;
- voltage dips and short interruptions;
- voltage imbalance;
- power-frequency variations;
- harmonics up to order 40;
- interharmonics up to the 40th harmonic;
- voltage components above the 40th harmonic up to 150 kHz;
- DC component;
- transient overvoltages.

The compatibility levels are given for different classes of environment determined by the characteristics of the supply network and loads.

NOTE 4 Compatibility levels at the point of common coupling (PCC) on public networks are specified in IEC 61000-2-2 for low-voltage networks and IEC 61000-2-12 for medium-voltage networks. IEC TR 61000-3-6 and IEC TR 61000-3-7 describe the approach of power distribution system operators to the limitation of emissions from installations and large loads.

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 61000-2-2:2002, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-2-2:2002/AMD1:2017

IEC 61000-2-2:2002/AMD2:2018

IEC 61000-2-12, *Electromagnetic compatibility (EMC) – Part 2-12: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems*

IEC 61000-4-7, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-2-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*