

Industrial, scientific and medical (ISM) radio-frequency equipment — Radio disturbance characteristics — Limits and methods of measurement

The European Standard EN 55011:1998, with the incorporation of amendments A1:1999 and A2:2002 has the status of a British Standard

ICS 33.100.10

National foreword

This British Standard is the English language version of EN 55011:1998, including amendments A1:1999 and A2:2002. It was derived by CENELEC from CISPR 11:1997, including amendments 1:1999 and 2:2002. It supersedes BS EN 55011:1991 which will be withdrawn on 2001-01-01.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags [C] [C]. Where a common modification has been introduced by amendment, the tags carry the number of the amendment. For example, the common modifications introduced by CENELEC amendment A1 are indicated by [C1] [C1].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [A1]. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by [A1] [A1].

The CENELEC changes to Annex ZA introduced by amendment A1:1999 are also indicated by [A1] [A1].

The UK participation in its preparation was entrusted by Technical Committee GEL/210, Electromagnetic Compatibility, to Subcommittee GEL/210/2, R.F. heating, electromedical and allied equipment, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 33 and a back cover.

The BSI copyright displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments
10796	August 2000	
14477	23 July 2003	See national foreword

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 September 1998

© BSI 23 July 2003

ISBN 0 580 29033 6

Industrial, scientific and medical (ISM) radio-frequency equipment — Radio disturbance characteristics — Limits and methods of measurement

(includes amendments A1:1999 and A2:2002)

(CISPR 11:1997 + A1:1999 + A2:2002, modified)

Appareils industriels, scientifiques et médicaux (ISM) fréquence radioélectrique — Caractéristiques de perturbations radioélectriques — Limites et méthodes de mesure (inclut les amendements A1:1999 et A2:2002) (CISPR 11:1997, + A1:1999 + A2:2002, modifiée)

Industrielle, wissenschaftliche und medizinische Hochfrequenzgeräten (ISM-Geräten) — Funkstörungen — Grenzwerte und Meßverfahren (enthält Änderungen A1:1999 und A2:2002) (CISPR 11:1997, + A1:1999 + A2:2002, modifiziert)

This European Standard was approved by CENELEC on 1997-10-01. 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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document CISPR/B/189/FDIS, future edition 3 of CISPR 11, prepared by CISPR SC B, Interference relating to industrial, scientific and medical radio-frequency apparatus, was submitted to the IEC-CENELEC parallel vote.

The text of the draft together with common modifications prepared by the SC 210A, EMC Products, of the Technical Committee CENELEC TC 210, EMC, was approved by CENELEC as EN 55011 on 1997-10-01.

This European Standard replaces EN 55011:1991 and its amendments A1:1997 and A2:1996.

The following dates are applicable:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-03-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2001-01-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex C and Annex ZA are normative and Annex A, Annex B, Annex D, Annex E and Annex F are informative.

Annex ZA has been added by CENELEC.

Foreword to amendment A1

The text of document CISPR/B/222/FDIS, future amendment 1 to CISPR 11, prepared by CISPR SC B, Interference relating to industrial, scientific and medical radio-frequency apparatus, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC with some common modifications as amendment A1 to EN 55011:1998 on 1999-08-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-05-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2002-08-01

Annexes designated “normative” are part of the body of the standard.

In this standard, Annex ZA is normative.

Annex ZA has been added by CENELEC.

Foreword to amendment A2

The text of document CISPR/B/281/FDIS, future amendment 2 to CISPR 11:1997, prepared by CISPR SC B, Interference relating to industrial, scientific and medical radio-frequency apparatus, to other (heavy) industrial equipment, to overhead power lines, to high voltage equipment and to electric traction, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 55011:1998 on 2002-09-24.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-07-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2005-07-01

Annexes designated “normative” are part of the body of the standard.

In this standard, Annex ZA is normative.

Annex ZA has been added by CENELEC.

Contents

	Page	Page
Foreword	2	Annex A (informative) Examples of equipment classification 28
1 General	5	Annex B (informative) Precautions to be taken in the use of a spectrum analyzer (6.2.1) 29
1.1 Scope and object	5	Annex C (normative) Measurement of electromagnetic radiation disturbance in the presence of signals from radio transmitters 30
1.2 Normative references	5	Annex D (informative) Propagation of interference from industrial r.f. equipment at frequencies between 30 MHz and 300 MHz 30
2 Definitions	5	Annex E (informative) Safety related service bands 31
3 National measures and frequencies designated for ISM use	6	Annex F (informative) Sensitive service bands (continued) 32
4 Classification of ISM equipment	8	Annex ZA (normative) Normative references to international publications with their corresponding European publications 33
4.1 Separation into groups	8	Figure 1 — Test site 24
4.2 Division into classes	8	Figure 2 — Minimum size of metal ground plane 24
5 Limits of electromagnetic disturbances	8	Figure 3 — Disposition of medical (capacitive type) and dummy load (see 6.5.1.1) 25
5.1 Limits of terminal disturbance voltage	9	Figure 4 — Circuit for disturbance voltage measurements on mains supply (see 6.2.2) 25
5.2 Limits of electromagnetic radiation disturbance	11	Figure 5 — Decision tree for the measurement of emissions from 1 GHz to 18 GHz of class B, group 2, ISM equipment operating at frequencies above 400 MHz 26
5.3 Provisions for protection of safety services	14	Table 1a — Frequencies designated by ITU for use as fundamental ISM frequencies 7
5.4 Provisions for protection of specific sensitive radio services	14	Table 1b — Frequencies designated on a national basis in CENELEC countries for use as fundamental ISM frequencies 7
6 General measurement requirements	14	Table 2a — Mains terminal disturbance voltage limits for class A equipment measured on a test site 9
6.1 Ambient noise	14	Table 2b — Mains terminal disturbance voltage limits for class B equipment measured on a test site 10
6.2 Measuring equipment	15	Table 2c — Mains terminal disturbance voltage for induction cooking appliances 10
6.3 Frequency measurement	16	Table 3 — Electromagnetic radiation disturbance limits for group 1 equipment 10
6.4 Configuration of equipment under test	16	Table 3a — Limits of the magnetic field induced current in a 2 m loop antenna around the device under test 11
6.5 Load conditions of equipment under test	18	Table 3b — Limits of the magnetic field strength 12
7 Special provisions for test site measurements (9 kHz to 1 GHz)	20	
7.1 Measurement of mains terminal disturbance voltage	20	
7.2 Radiation test site for 9 kHz to 1 GHz	21	
7.3 Alternative radiation test sites for the frequency range 30 MHz to 1 GHz	21	
8 Radiation measurements: 1 GHz to 18 GHz	22	
8.1 Test arrangement	22	
8.2 Receiving antenna	22	
8.3 Validation and calibration of test site	22	
8.4 Measuring procedure	22	
9 Measurement <i>in situ</i>	22	
10 Safety precautions	22	
11 Assessment of conformity of equipment	23	
11.1 Statistical assessment of compliance of series produced equipment	23	
11.2 Equipment in small-scale production	23	
11.3 Equipment produced on an individual basis	23	

	Page
Table 4 — Electromagnetic radiation disturbance limits for group 2, class B equipment measured on a test site	12
Table 5a — Electromagnetic radiation disturbance limits for group 2 class A equipment	13
Table 5b — Electromagnetic radiation disturbance limits for class A EDM and arc welding equipment measured on a test site	14
Table 6 — Limits for electromagnetic radiation disturbances to protect specific safety services in particular areas	14
Table 7 — The non-central t -distribution factor k as a function of the sample size n	23
Table 8 — Electromagnetic radiation disturbance peak limits for group 2, class B ISM equipment producing CW type disturbances and operating at frequencies above 400 MHz	26
Table 9 — Electromagnetic radiation disturbance peak limits for group 2, class B ISM equipment producing fluctuating disturbances other than CW and operating at frequencies above 400 MHz	27
Table 10 — Electromagnetic radiation disturbance weighted limits for group 2, class B ISM equipment operating at frequencies above 400 MHz	27

1 General

1.1 Scope and object

The limits and methods of measurement laid down in this International Standard apply to industrial, scientific and medical (ISM) equipment as defined in Clause 2, and to **A2** electro-discharge machining (EDM) and arc welding equipment. **A2**

NOTE The limits have been determined on a probabilistic basis taking into account the likelihood of interference. In cases of interference, additional provisions may be required.

Procedures are given for the measurement of radio-frequency disturbances and limits are laid down within the frequency range 9 kHz to 400 GHz.

A1 Requirements for ISM lighting apparatus operating in the ISM frequency bands of 915 MHz (only allowed in region 2 as defined by the ITU Radio Regulations), 2,45 GHz and 5,8 GHz are contained in this standard.

Requirements for other types of lighting apparatus are covered in CISPR 15. **A1**

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

CISPR 15:1996, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*.

A2 CISPR 16-1:1999, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1: Radio disturbance and immunity measuring apparatus*. **A2**

CISPR 16-2:1996, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 2: Methods of measurement of disturbances and immunity*.

CISPR 19:1983, *Guidance on the use of the substitution method for measurements of radiation from microwave ovens for frequencies above 1 GHz*.

CISPR 20:1996, *Limits and methods of measurement of immunity characteristics of sound and television broadcast receivers and associated equipment*.

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) — Chapter 161: Electromagnetic compatibility*.

IEC 60083:1975, *Plugs and socket-outlets for domestic and similar general use — Standards*.

A1 IEC 60705:1999, *Household microwave ovens — Methods for measuring performance*. **A1**

A2 IEC 60974-10:2002, *Arc welding equipment — Part 10: EMC requirements*. **A2**

IEC 61689:1996, *Ultrasonics — Physiotherapy systems — Performance requirements and methods of measurement in the frequency range 0,5 MHz to 5 MHz*.

2 Definitions

For the purpose of this International Standard, the definitions of IEC 60050(161) and the following definitions apply.

2.1

ISM equipment; ISM appliance

equipment or appliances designed to generate and/or use locally radio-frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications and information technology and other applications covered by other CISPR publications

2.2**electromagnetic radiation [IEV 161-01-10]**

- 1) The phenomenon by which energy in the form of electromagnetic waves emanates from a source into space.
- 2) Energy transferred through space in the form of electromagnetic waves.

NOTE By extension, the term “electromagnetic radiation” sometimes also covers induction phenomena.

2.3**boundary of the equipment under test**

imaginary straight line periphery describing a simple geometric configuration encompassing the equipment under test. All interconnecting cables shall be included within this boundary

2.4**click**

disturbance which exceeds the limit of continuous disturbance no longer than 200 ms and which is separated from a subsequent disturbance by at least 200 ms. Both intervals are related to the level of the limit of continuous disturbance

A click may contain a number of impulses, in which case the relevant time is that from the beginning of the first to the end of the last impulse.

Ⓐ 2.5**electro-discharge machining (EDM) equipment**

all the necessary units for the spark erosion process including the machine tool, the generator, control circuits, the working fluid container and integral devices

2.6**spark erosion**

removal of material in a dielectric working fluid by electro-discharges, which are separated in time and randomly distributed in space, between two electrically conductive electrodes (the tool electrode and the work piece electrode), and where the energy in the discharge is controlled

2.7**arc welding equipment**

equipment for applying current and voltage and having the required characteristics suitable for arc welding and allied processes

2.8**arc welding**

fusion welding in which the heat for welding is obtained from an electric arc or arcs Ⓐ

Ⓒ Ⓐ 2.9 Ⓐ**low voltage**

a set of voltage levels used for the distribution of electricity and whose upper limit is 1 000 V a.c. rms Ⓒ

Ⓒ 3 National measures and frequencies designated for ISM use

3.1 Certain frequencies are designated by the International Telecommunication Union (ITU) for use as fundamental frequencies for ISM equipment.

The limits have been determined on a probabilistic basis taking into account the likelihood of interference. In cases of interference additional provisions may be required.

3.2 National Authorities may allow the installation and use of class A apparatus in a domestic establishment or in an establishment connected directly to domestic electricity power supplies, with whatever national measures they consider necessary.

3.3 The frequencies designated for ISM use are listed in Table 1a.

Ⓒ In some CENELEC countries different or additional frequencies may be designated for ISM equipment. These frequencies are listed in Table 1b.

The limits for terminal voltages and radiation do not apply to these ISM frequencies. If ISM equipment uses fundamental frequencies other than the ITU or nationally designated frequencies the limits for terminal voltage and radiation in this standard apply also to the fundamental frequencies.

3.4 When ISM equipment cannot be brought in conformity with the limits of Table 5a, the National Authorities shall be notified by the manufacturer or importer before the equipment is being placed on the market.

For equipment measured on a test site the notification shall be accompanied by the results of the measurements. For equipment measured *in situ* the user shall inform the National Authorities of the installation of the equipment before it is set into operation.

National Authorities may apply whatever national measures they consider necessary to protect radio communications. Ⓒ

Ⓒ **Table 1a — Frequencies designated by ITU for use as fundamental ISM frequencies^a**

Centre frequency MHz	Frequency range MHz	Maximum radiation limit ^c	Number of appropriate footnote to the table of frequency allocation to the ITU Radio Regulations
6,780	6,765 – 6,795	Under consideration	524 ^b
13,560	13,553 – 12,567	Unrestricted	534
27,120	26,957 – 27,283	Unrestricted	546
40,680	40,66 – 40,70	Unrestricted	548
433,920	433,05 – 434,79	Under consideration	661 ^b , 662
2 450	2 400 – 2 500	Unrestricted	752
5 800	5 725 – 5 875	Unrestricted	806
24 125	24 000 – 25 250	Unrestricted	881
61 250	61 000 – 61 500	Under consideration	911 ^b
122 500	122 000 – 123 000	Under consideration	916 ^b
245 000	244 000 – 246 000	Under consideration	922 ^b

^a Resolution No. 63 of the ITU Radio Regulations applies.

^b Use of these frequency bands is subject to special authorization by administrations concerned in agreement with other administrations whose radio communication services might be affected.

^c The term “Unrestricted” applies to the fundamental and all other frequency components falling within the designated band. Special measures to achieve compatibility may be necessary where other equipment satisfying immunity requirements (e.g. EN 55020), is placed close to ISM equipment.

Table 1b — Frequencies designated on a national basis in CENELEC countries for use as fundamental ISM frequencies

Frequency MHz	Maximum radiation limit ^a	Notes
0,009 – 0,010	Unlimited	Germany only
3,370 – 3,410	Unlimited	Netherlands only
13,533 – 13,553	110 dB(μV/m) at 100 m	United Kingdom only
13,567 – 13,587	110 dB(μV/m) at 100 m	United Kingdom only
83,996 – 84,004	130 dB(μV/m) at 30 m	United Kingdom only
167,992 – 168,008	130 dB(μV/m) at 30 m	United Kingdom only
886,000 – 906,000	120 dB(μV/m) at 30 m	United Kingdom only

^a Distance measured from the exterior wall outside the building in which the equipment is situated.

Ⓒ Text deleted Ⓒ

Ⓒ

4 Classification of ISM equipment

A2 The manufacturer and/or supplier of ISM equipment shall ensure that the user is informed about the class and group of the equipment, either by labelling or by the accompanying documentation. In both cases the manufacturer/supplier shall explain the meaning of both the class and the group in the documentation accompanying the equipment. **A2**

NOTE See Annex A for examples of the classification of ISM equipment.

4.1 Separation into groups

Group 1 ISM equipment: group 1 contains all ISM equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the equipment itself.

Group 2 ISM equipment: group 2 contains all ISM equipment in which radio-frequency energy is intentionally generated and/or used in the form of electromagnetic radiation for the treatment of material, **A2** and EDM and arc welding equipment. **A2**

Excluded from the testing requirements and limits of this standard are components and subassemblies not intended to perform any stand-alone ISM function.

4.2 Division into classes

Class A equipment is equipment suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class A equipment shall meet class A limits.

NOTE 1 Operation of equipment which does not meet the class A limits but does not result in unacceptable degradation of radio services may be sanctioned on a case-by-case basis by the competent national authority.

NOTE 2 Although class A limits have been derived for industrial and commercial establishments, administrations may allow, with whatever additional measures are necessary, the installation and use of class A ISM equipment in a domestic establishment or in an establishment connected directly to domestic electricity power supplies.

Class B equipment is equipment suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Class B equipment shall meet class B limits.

5 Limits of electromagnetic disturbances

Class A ISM equipment may be measured either on a test site or *in situ* as preferred by the manufacturer.

NOTE Due to size, complexity or operating conditions some ISM equipment may have to be measured *in situ* in order to show compliance with the radiation disturbance limits specified herein.

Class B ISM equipment shall be measured on a test site.

Limits are under consideration for:

- **A2** arc stud welding equipment and arc striking and stabilizing devices for arc welding; **A2**
- radiology equipment;
- radio-frequency surgical diathermy equipment.

The limits given in Table 2a to Table 6 are applicable to all electromagnetic disturbances at all frequencies not exempted according to Table 1a.

The lower limit shall apply at all transition frequencies.

A2 For ISM lighting devices operating in the ISM frequency bands 2,45 GHz and 5,8 GHz (and 915 MHz for Region 2 as defined by the ITU Radio Regulations), the limits to be applied are those for class B, group 2 ISM equipment. **A1**

5.1 Limits of terminal disturbance voltage

The equipment under test shall meet either:

- i) both the average limit specified for measurements with an average detector receiver and the quasi-peak limit specified for measurements with a quasi-peak detector (see 6.2); or
- ii) the average limit when using a quasi-peak detector receiver (see 6.2).

Limits for signal line disturbance voltage are under consideration.

5.1.1 Frequency band 9 kHz to 150 kHz

Limits for mains terminal disturbance voltages in the frequency band 9 kHz to 150 kHz are under consideration, except for induction cooking appliances.

For class A, group 2 ISM equipment *in situ*, no limits apply unless otherwise specified in this standard.

5.1.2 Frequency band 150 kHz to 30 MHz

5.1.2.1 Continuous disturbance

Limits for mains terminal disturbance voltages in the frequency band 150 kHz to 30 MHz for equipment measured on a test site using the 50 Ω /50 μ H CISPR network or the CISPR voltage probe (see 6.2.3 and Figure 4) are given in Table 2a and Table 2b, except for the ITU designated frequency bands listed in Table 1a for which the mains terminal disturbance voltage limits are under consideration.

For class A, group 2 ISM equipment *in situ*, no limits apply unless otherwise specified in this standard.

A2 5.1.2.2 **A2** Induction cooking appliances for domestic or commercial use

For induction cooking appliances for domestic or for commercial use (group 2 class B equipment), the limits of Table 2c apply.

A2 5.1.2.3 **A2** Discontinuous disturbance

For diagnostic X-ray generators, operating in intermittent mode, the limit for clicks shall be the quasi-peak limit, as formulated in Table 2a or Table 2b for continuous disturbance, increased by 20 dB.

Table 2a — Mains terminal disturbance voltage limits for class A equipment measured on a test site

Frequency band MHz	Class A equipment limits dB(μ V)					
	Group 1		Group 2		Group 2 ^a	
	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average
0,15 – 0,50	79	66	100	90	130	120
0,50 – 5	73	60	86	76	125	115
5 – 30	73	60	90 decreasing linearly with logarithm of frequency to 70	80 60	115	105

NOTE Care should be taken to comply with leakage current requirements.

^a Mains supply currents in excess of 100 A per phase when using the CISPR voltage probe **A2** or a suitable V-network (LISN or AMN). **A2**

A2 For class A EDM and arc welding equipment measured on a test site, the mains terminal disturbance voltage limits of Table 2a apply.

WARNING Class A equipment is intended for use in an industrial environment. In the documentation for the user, a statement shall be included drawing attention to the fact that there may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances. **A2**