

INTERNATIONAL STANDARD

NORME INTERNATIONALE



INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

**Industrial, scientific and medical equipment – Radio-frequency disturbance
characteristics – Limits and methods of measurement**

**Appareils industriels, scientifiques et médicaux – Caractéristiques de
perturbations radioélectriques – Limites et méthodes de mesure**



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

CQ

ICS 33.100.10

ISBN 978-2-88910-002-6

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INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**INDUSTRIAL, SCIENTIFIC AND MEDICAL EQUIPMENT –
RADIO-FREQUENCY DISTURBANCE CHARACTERISTICS –
LIMITS AND METHODS OF MEASUREMENT**

FOREWORD

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This consolidated version of CISPR 11 consists of the fifth edition (2009) [documents CISPR/B/478/FDIS and CISPR/B/482/RVD] and its amendment 1 (2010) [documents CISPR/B/492/FDIS and CISPR/B/496/RVD]. It bears the edition number 5.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard CISPR 11 has been prepared by CISPR Subcommittee 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.

This fifth edition of CISPR 11 got a more transparent structure, introduces another set of particular limits for conducted and radiated disturbances of "heavy duty" general purpose equipment of class A group 1 with a rated input power in excess of 20 kVA, in accordance with the needs of the industries and refers to the full approach in respect of the measurement instrumentation uncertainty specified in CISPR-~~16-4-4~~ 16-4-2. Furthermore, any kind of "legal statements" were removed from the normative main body of this International Standard.

It has the status of a Product Family EMC standard in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications* (2009).

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

The main content of this standard is based on CISPR Recommendation No. 39/2 given below:

RECOMMENDATION No. 39/2

Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

The CISPR

CONSIDERING

- a) that ISM RF equipment is an important source of disturbance;
- b) that methods of measuring such disturbances have been prescribed by the CISPR;
- c) that certain frequencies are designated by the International Telecommunication Union (ITU) for unrestricted radiation from ISM equipment,

RECOMMENDS

that the latest edition of CISPR 11 be used for the application of limits and methods of measurement of ISM equipment.

INTRODUCTION

This CISPR publication contains, amongst common requirements for the control of RF disturbances from equipment intended for use in industrial, scientific, and medical (ISM) electrical applications, specific requirements for the control of RF disturbances caused by ISM RF applications in the meaning of the definition of the International Telecommunication Union (ITU), see also Definition 3.1 in this International Standard. CISPR and ITU share their responsibility for the protection of radio services in respect of the use of ISM RF applications.

The CISPR is concerned with the control of RF disturbances from ISM RF applications by means of an assessment of these disturbances, either at a standardised test site or, for an individual ISM RF application which cannot be tested at such a site, at its place of operation. Consequently, this CISPR publication covers requirements for conformity assessment of both, equipment assessed by means of type tests at standardised test sites or of individual equipment under *in situ* conditions.

The ITU is concerned with the control of RF disturbances from ISM RF applications during normal operation and use of the respective equipment at its place of operation. There, use of radio-frequency energy decoupled from the ISM RF application by radiation, induction or capacitive coupling is restricted to the location of that individual application.

This CISPR publication contains, in 6.2 and 6.3, the essential emission requirements for an assessment of RF disturbances from ISM RF applications at standardised test sites. These requirements allow for type testing of ISM RF applications operated at frequencies up to 18 GHz. It further contains, in 6.4, the essential emission requirements for an *in situ* assessment of RF disturbances from individual ISM RF applications in the frequency range up to 18 GHz. All requirements were established in close collaboration with the ITU and enjoy approval of the ITU.

However, for operation and use of several types of ISM RF applications, the manufacturer, installer and/or customer should be aware of additional national provisions regarding possible licensing and particular protection needs of local radio services and applications. Depending on the country concerned, such additional provisions may apply to individual ISM RF applications operated at frequencies outside designated ISM bands (see Table 1). They also may apply to ISM RF applications operated at frequencies above 18 GHz. For the latter type of applications, local protection of radio services and appliances requires an accomplishment of the conformity assessment by application of the relevant national provisions in the frequency range above 18 GHz in accordance with vested interests of the ITU and national administrations. These additional national provisions may apply to spurious emissions, emissions appearing at harmonics of the operation frequency, and to wanted emissions at the operation frequency allocated outside a designated ISM band in the frequency range above 18 GHz.

Recommendations of CISPR for the protection of radio services in particular areas are found in Annex E of this International Standard.

INDUSTRIAL, SCIENTIFIC AND MEDICAL EQUIPMENT – RADIO-FREQUENCY DISTURBANCE CHARACTERISTICS – LIMITS AND METHODS OF MEASUREMENT

1 Scope

This International Standard applies to industrial, scientific and medical electrical equipment operating in the frequency range 0 Hz to 400 GHz and to domestic and similar appliances designed to generate and/or use locally radio-frequency energy.

This standard covers emission requirements related to radio-frequency (RF) disturbances in the frequency range of 9 kHz to 400 GHz. Measurements need only be performed in frequency ranges where limits are specified in Clause 6.

For ISM RF applications in the meaning of the definition found in the ITU Radio Regulations (see Definition 3.1), this standard covers emission requirements related to radio-frequency disturbances in the frequency range of 9 kHz to 18 GHz.

Requirements for ISM RF lighting apparatus and UV irradiators operating at frequencies within the ISM frequency bands defined by the ITU Radio Regulations are contained in this standard.

Equipment covered by other CISPR product and product family emission standards are excluded from the scope of this standard.

NOTE Induction cooking appliances are in the process of being transferred from CISPR 11 to CISPR 14-1. Until the removal of induction cooking appliances from the scope of CISPR 11, users of the standards may choose either CISPR 11 or CISPR 14-1 for testing.

2 Normative references

The following referenced documents are indispensable for the application 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.

CISPR 16-1-1:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

Amendment 1 (2006)

Amendment 2 (2007)

CISPR 16-1-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances*

Amendment 1 (2004)

Amendment 2 (2006)

CISPR 16-1-4:2007, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radiated disturbances*

Amendment 1 (2007)

Amendment 2 (2008)

CISPR 16-2-3:2006, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

CISPR 16-4-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements*

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*
Amendment 1 (1990)
Amendment 2 (1998)

IEC 60601-1-2:2007, *Medical electrical equipment – Part 1-2: General requirements for basic safety and essential performance – Collateral standard: Electromagnetic compatibility – Requirements and tests*

IEC 60601-2-2:2009, *Medical electrical equipment – Part 2-2: Particular requirements for the basic safety and essential performance of high frequency surgical equipment and high frequency surgical accessories*

IEC 60974-10:2007, *Arc welding equipment – Part 10: Electromagnetic compatibility (EMC) requirements*

IEC 61307:2006, *Industrial microwave heating installations – Test methods for the determination of power output*

IEC 62135-2:2007, *Resistance welding equipment – Part 2: Electromagnetic compatibility (EMC) requirements*

ITU Radio Regulations (2008), *Radio regulations, Volume 3 – Resolutions and recommendations, resolution no. 63*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60050-161 and the following apply.

3.1

industrial, scientific and medical (ISM) applications (of radio frequency energy)

operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications

[ITU Radio Regulations Volume 1: 2004 – Articles, Definition 1.15]

NOTE 1 Typical applications are the production of physical, biological, or chemical effects such as heating, ionisation of gases, mechanical vibrations, hair removal, acceleration of charged particles. A non-exhaustive list of examples is given in Annex A.

NOTE 2 The abbreviation ISM RF is used throughout this standard for such equipment or appliances.

3.2

ISM equipment and appliances

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

3.3**(electromagnetic) radiation**

1. 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.

[IEV 161-01-10:1990]

3.4**boundary of the equipment under test**

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

3.5**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

3.6**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

3.7**arc welding equipment**

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

3.8**equipment for resistance welding and allied processes**

all equipment associated with carrying out the processes of resistance welding or allied processes consisting of e.g. power source, electrodes, tooling and associated control equipment, which may be a separate unit or part of a complex machine

3.9**low voltage****LV**

a set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V a.c.

[IEV 601-01-26:1985]

3.10**small equipment**

equipment, either positioned on a table top or standing on the floor which, including its cables fits in a cylindrical test volume of 1,2 m in diameter and 1,5 m above the ground plane

4 Frequencies designated for ISM use

Certain frequencies are designated by the International Telecommunication Union (ITU) for use as fundamental frequencies for ISM RF applications (see also Definition 3.1). These frequencies are listed in Table 1.

NOTE In individual countries, different or additional frequencies may be designated for use by ISM equipment.

Table 1 – Frequencies in the radio-frequency (RF) range designated by ITU for use as fundamental ISM frequencies

Centre frequency MHz	Frequency range MHz	Maximum radiation limit ^b	Number of appropriate footnote to the table of frequency allocation of the ITU Radio Regulations ^a
6,780	6,765 – 6,795	Under consideration	5.138
13,560	13,553 – 13,567	Unrestricted	5.150
27,120	26,957 – 27,283	Unrestricted	5.150
40,680	40,66 – 40,70	Unrestricted	5.150
433,920	433,05 – 434,79	Under consideration	5.138 in Region 1, except countries mentioned in 5.280
915,000	902 – 928	Unrestricted	5.150 in Region 2 only
2 450	2 400 – 2 500	Unrestricted	5.150
5 800	5 725 – 5 875	Unrestricted	5.150
24 125	24 000 – 24 250	Unrestricted	5.150
61 250	61 000 – 61 500	Under consideration	5.138
122 500	122 000 – 123 000	Under consideration	5.138
245 000	244 000 – 246 000	Under consideration	5.138

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

^b The term “unrestricted” applies to the fundamental and all other frequency components falling within the designated band. Outside of ITU designated ISM bands, the limits for the disturbance voltage and radiation disturbance in this standard apply.

5 Classification of ISM equipment

5.1 Information for the user

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.

In the case of arc welding equipment which contains arc striking or stabilizing devices or in the case of stand-alone arc striking or stabilizing devices for arc welding, the manufacturer shall inform the user that such equipment is class A equipment.

5.2 Separation into groups

Group 1 equipment: group 1 contains all equipment in the scope of this standard which is not classified as group 2 equipment.

Group 2 equipment: group 2 contains all ISM RF equipment in which radio-frequency energy in the frequency range 9 kHz to 400 GHz is intentionally generated and used or only used, in the form of electromagnetic radiation, inductive and/or capacitive coupling, for the treatment of material or inspection/analysis purposes.

NOTE See Annex A for examples of the separation of equipment into group 1 or 2.

5.3 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.

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.

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.

6 Limits of electromagnetic disturbances

6.1 General

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

NOTE 1 Due to size, complexity or operating conditions, some equipment may have to be measured *in situ* in order to show compliance with the radiation disturbance limits specified herein.

Class B equipment shall be measured on a test site.

NOTE 2 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.

The lower limit shall apply at all transition frequencies.

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

Measuring apparatus and methods of measurement are specified in Clauses 7, 8 and 9.

6.2 Group 1 equipment measured on a test site

6.2.1 Limits of terminal disturbance voltage

6.2.1.1 General

The equipment under test shall meet either:

- a) both the average limit specified for measurements with an average detector and the quasi-peak limit specified for measurements with a quasi-peak detector (see 7.3); or
- b) the average limit when using a quasi-peak detector (see 7.3).

6.2.1.2 Frequency range 9 kHz to 150 kHz

For group 1 equipment, no limits apply in this frequency range.

6.2.1.3 Frequency range 150 kHz to 30 MHz

Limits for mains terminal disturbance voltages in the frequency range 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 7.3.3 and Figure 4) are given in Tables 2 and 3.

Table 2 – Mains terminal disturbance voltage limits for class A group 1 equipment measured on a test site

Frequency range MHz	Rated input power of ≤ 20 kVA		Rated input power of > 20 kVA ^a	
	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)
0,15 – 0,50	79	66	100	90
0,50 – 5	73	60	86	76
5 – 30	73	60	90 decreasing linearly with logarithm of frequency to 73	80 60
At the transition frequency, the more stringent limit shall apply.				
NOTE 1 Limits only apply to low voltage a.c. mains input ports.				
NOTE 2 For class A equipment intended to be connected solely to isolated neutral or high impedance earthed (IT) industrial power distribution networks (see IEC 60364-1), the limits defined for group 2 equipment with a rated input power > 75 kVA in Table 6 can be applied.				
a These limits apply to equipment with a rated input power > 20 kVA and intended to be powered by a dedicated power transformer or generator, and which is not connected to Low Voltage (LV) overhead power lines. For equipment not intended to be powered by a user specific power transformer, the limits for ≤20 kVA apply. The manufacturer and/or supplier shall provide information on installation measures that can be used to reduce emissions from the installed equipment. In particular, it shall be indicated that this equipment is intended to be powered by a dedicated power transformer or generator and not by LV overhead power lines.				

NOTE The rated input power consumption of 20 kVA corresponds for example to a current of approximately 29 A per phase in case of 400 V three-phase power supply networks, and to a current of approximately 58 A per phase in case of 200 V three phase power supply networks.

Table 3 – Mains terminal disturbance voltage limits for class B group 1 equipment measured on a test site

Frequency range MHz	Quasi-peak dB(μV)	Average dB(μV)
0,15 – 0,50	66 Decreasing linearly with logarithm of frequency to 56	56 Decreasing linearly with logarithm of frequency to 46
0,50 – 5	56	46
5 – 30	60	50
At the transition frequency, the more stringent limit shall apply.		

For diagnostic X-ray generators operating in intermittent mode, the quasi-peak limits of Table 2 or Table 3 can be relaxed by 20 dB.

6.2.2 Limits of electromagnetic radiation disturbance

6.2.2.1 General

The equipment under test shall meet the quasi-peak limits when using a quasi-peak detector.

6.2.2.2 Frequency range 9 kHz to 150 kHz

For group 1 equipment, no limits apply in the frequency range 9 kHz to 150 kHz.

6.2.2.3 Frequency range 150 kHz to 1 GHz

For group 1 equipment, no limits apply in the frequency range 150 kHz to 30 MHz. In the frequency range above 30 MHz, the limits refer to the electric field strength component of the electromagnetic radiation disturbance.

The electromagnetic radiation disturbance limits for the frequency range 30 MHz to 1 GHz for group 1, classes A and B equipment are specified in Table 4 and 5, respectively. Recommendations for the protection of specific safety-related radio services are given in Annex E and Table E.1.

~~On a test site, class A equipment can be measured at a distance of 10 m or 30 m (see information in Table 4), and class B equipment at a distance of 3 m or 10 m (see information in Table 5).~~

On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m (see information in Table 4), and class B equipment at a nominal distance of 3 m or 10 m (see information in Table 5). A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10.

The limits specified for the 3 m separation distance apply to small equipment only.

Table 4 – Electromagnetic radiation disturbance limits for class A group 1 equipment measured on a test site

Frequency range MHz	10 m measuring distance rated input power of	
	≤ 20 kVA	> 20 kVA ^a
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30—230 230—1 000	40 47	50 50
~~On a test site, class A equipment can be measured at a distance of 10 m or 30 m. An inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.~~ ~~At the transition frequency, the more stringent limit shall apply.~~		
~~a—These limits apply to equipment with a rated input power of > 20 kVA and intended to be used at locations where there is a distance greater than 30 m between the equipment and third party sensitive radio communications. The manufacturer shall indicate in the technical documentation that this equipment is intended to be used at locations where the separation distance to third party sensitive radio services is > 30 m. If the manufacturer does not include the particular conditions of use of the equipment in the technical documentation for the user, then the limits for equipment with a rated input power of ≤ 20 kVA shall apply.~~		

Frequency range MHz	10 m measuring distance		3 m measuring distance ^b	
	rated input power of		rated input power of	
	≤ 20 kVA	> 20 kVA ^a	≤ 20 kVA	> 20 kVA ^a
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30 – 230	40	50	50	60
230 – 1 000	47	50	57	60
On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10. In case of measurements at a separation distance of 30 m, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance. At the transition frequency, the more stringent limit shall apply. ^a These limits apply to equipment with a rated input power of > 20 kVA and intended to be used at locations where there is a distance greater than 30 m between the equipment and third party sensitive radio communications. The manufacturer shall indicate in the technical documentation that this equipment is intended to be used at locations where the separation distance to third party sensitive radio services is > 30 m. If these conditions are not met, then the limits for ≤ 20 kVA apply. ^b The limits specified for the 3 m separation distance apply only to small equipment meeting the size criterion defined in 3.10.				

Table 5 – Electromagnetic radiation disturbance limits for class B group 1 equipment measured on a test site

Frequency range MHz	10 m measuring distance
	Quasi-peak dB(μV/m)
30—230	30
230—1 000	37
On a test site, class B equipment can be measured at a distance of 3 m or 10 m. An inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance. At the transition frequency, the more stringent limit shall apply.	

Frequency range MHz	10 m measuring distance	3 m measuring distance ^a
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30 – 230	30	40
230 – 1 000	37	47
On a test site, class B equipment can be measured at a nominal distance of 3 m or 10 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10. At the transition frequency, the more stringent limit shall apply. ^a The limits specified for the 3 m separation distance apply only to small equipment meeting the size criterion defined in 3.10.		

For medical electrical equipment intended to be permanently installed in shielded locations, further provisions with regard to the measurement arrangement and load conditions are found in IEC 60601-1-2.

6.2.2.4 Frequency range 1 GHz to 18 GHz

For group 1 equipment, no limits apply in the frequency range 1 GHz to 18 GHz.

6.2.2.5 Frequency range 18 GHz to 400 GHz

For group 1 equipment, no limits apply in the frequency range 18 GHz to 400 GHz.

6.3 Group 2 equipment measured on a test site

6.3.1 Limits of terminal disturbance voltage

6.3.1.1 General

The equipment under test shall meet either:

- a) both the average limit specified for measurements with an average detector and the quasi-peak limit specified for measurements with a quasi-peak detector (see 7.3); or
- b) the average limit when using a quasi-peak detector (see 7.3).

6.3.1.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz, limits for mains terminal disturbance voltages apply to induction cooking appliances only, see Table 8.

6.3.1.3 Frequency range 150 kHz to 30 MHz

Limits for mains terminal disturbance voltages in the frequency range 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 7.3.3 and Figure 4) are given in Tables 6 and 7, except for the ITU designated frequency bands listed in Table 1 where no limits apply.

For electric welding equipment, the limits of Table 6 or 7 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 2 or 3 apply.

For ISM RF lighting devices operating in dedicated ISM frequency bands (defined by the ITU in Table 1), the limits of Table 7 apply.

For induction cooking appliances for domestic or for commercial use, the limits of Table 8 apply.

Table 6 – Mains terminal disturbance voltage limits for class A group 2 equipment measured on a test site

Frequency range MHz	Rated input power of ≤ 75 kVA		Rated input power of > 75 kVA ^a	
	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)
0,15 – 0,50	100	90	130	120
0,50 – 5	86	76	125	115
5 – 30	90	80	115	105
	decreasing linearly with logarithm of frequency to			
	73	60		
At the transition frequency, the more stringent limit shall apply.				
NOTE 1 Limits only apply to Low Voltage (LV) a.c. mains input ports.				
NOTE 2 For class A equipment with a rated power ≤ 75 kVA intended to be connected solely to isolated neutral or high impedance earthed (IT) industrial power distribution networks (see IEC 60364-1), the limits defined for group 2 equipment with a rated input power > 75 kVA can be applied.				
a The manufacturer and/or supplier shall provide information on installation measures that can be used to reduce emissions from the installed equipment.				

NOTE The rated input power consumption of 75 kVA corresponds for example to a current of approximately 108 A per phase in case of 400 V three phase power supply networks and to a current of approximately 216 A per phase in case of 200 V three phase power supply networks.

High-frequency (HF) surgical equipment shall meet the limits of Table 2 or 3 specified for group 1 equipment, in stand-by mode of operation. For high-frequency (HF) surgical equipment operating at frequencies outside designated ISM bands (see Table 1), these limits also apply at the operating frequency and inside the designated frequency bands. The related measurements shall be performed in a test arrangement in accordance with IEC 60601-2-2.

Table 7 – Mains terminal disturbance voltage limits for class B group 2 equipment measured on a test site

Frequency range MHz	Quasi-peak dB(μV)	Average dB(μV)
0,15 – 0,50	66 Decreasing linearly with logarithm of frequency to 56	56 Decreasing linearly with logarithm of frequency to 46
0,50 – 5	56	46
5 – 30	60	50
At the transition frequency, the more stringent limit shall apply.		

Table 8 – Mains terminal disturbance voltage limits for induction cooking appliances

Frequency range MHz	Induction cooking appliance limits			
	All appliances except 100 V rated appliances without an earth connection		100 V rated appliances without an earth connection	
	Quasi-peak dB(μV)	Average dB(μV)	Quasi-peak dB(μV)	Average dB(μV)
0,009 – 0,050	110	–	122	–
0,050 – 0,148 5	90 Decreasing linearly with logarithm of frequency to 80	–	102 Decreasing linearly with logarithm of frequency to 92	–
0,148 5 – 0,5	66 Decreasing linearly with logarithm of frequency to 56	56 Decreasing linearly with logarithm of frequency to 46	72 Decreasing linearly with logarithm of frequency to 62	62 Decreasing linearly with logarithm of frequency to 52
0,5 – 5	56	46	56	46
5 – 30	60	50	60	50
At the transition frequency, the more stringent limit shall apply.				

6.3.2 Limits of electromagnetic radiation disturbance

6.3.2.1 General

The equipment under test shall meet the limits when using a measuring instrument with a peak, quasi-peak or average detector, as indicated in the appropriate table.

Up to 30 MHz, the limits refer to the magnetic component of the electromagnetic radiation disturbance. Above 30 MHz, the limits refer to the electric field strength component of the electromagnetic radiation disturbance.

6.3.2.2 Frequency range 9 kHz to 150 kHz

In the frequency range 9 kHz to 150 kHz, limits apply to induction cooking appliances only, see Tables 12 and 13.

6.3.2.3 Frequency range 150 kHz to 1 GHz

Except for the designated frequency range listed in Table 1, the electromagnetic radiation disturbance limits for the frequency range 150 kHz to 1 GHz for group 2 class A equipment are specified in Table 9; and for group 2 class B equipment in Table 11.

The limits in Tables 9 and 11 apply to all electromagnetic disturbances at all frequencies not exempted according to Table 1 Footnote b).

For class A resistance welding equipment, the limits of Table 9 apply in the frequency range 30 MHz to 1 GHz in active mode of operation. In stand-by (or idle) mode, the limits of Table 4 apply. For class B resistance welding equipment, the limits of Table 11 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 5 apply.

For arc welding equipment, the limits of Table 10 or 11 apply in active mode of operation. In stand-by (or idle) mode, the limits of Table 4 or 5 apply.

For class A EDM equipment, the limits of Table 10 apply.

For ISM RF lighting devices operating in dedicated ISM frequency bands (defined by the ITU in Table 1), the limits of Table 11 apply.

For induction cooking appliances, limits in the frequency range up to 30 MHz are specified in Table 12 (commercial use) and 13 (domestic use), respectively, and in Table 11 for the frequency range above 30 MHz.

For high-frequency (HF) surgical equipment, the limits of Table 4 or 5 apply. High-frequency (HF) surgical equipment shall meet the respective limits when tested in stand-by mode of operation.

Recommendations for the protection of specific safety services are given in Annex E and Table E.1.

~~On a test site, class A equipment can be measured at a distance of 10 m or 30 m, and class B equipment at a distance of 3 m or 10 m (see Tables 9 and 11).~~

On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m, and class B equipment at a nominal distance of 3 m or 10 m (see Tables 9 and 11).

A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10.

The limits specified for the 3 m separation distance apply to *small equipment* only.

Table 9 – Electromagnetic radiation disturbance limits for class A group 2 equipment measured on a test site

Frequency range MHz	Limits for a measuring distance of <i>D</i> in m			
	On a test site <i>D</i> = 30 m from the equipment		On a test site <i>D</i> = 10 m from the equipment	
	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak dB(µA/m)	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak dB(µA/m)
0,15 — 0,49	-	33,5	-	57,5
0,49 — 1,705	-	23,5	-	47,5
1,705 — 2,194	-	28,5	-	52,5
2,194 — 3,95	-	23,5	-	43,5
3,95 — 20	-	8,5	-	18,5
20 — 30	-	-1,5	-	8,5
30 — 47	58	-	68	-
47 — 53,91	40	-	50	-
53,91 — 54,56	40	-	50	-
54,56 — 68	40	-	50	-
68 — 80,872	53	-	63	-
80,872 — 81,848	68	-	78	-
81,848 — 87	53	-	63	-
87 — 134,786	50	-	60	-
134,786 — 136,414	60	-	70	-
136,414 — 156	50	-	60	-
156 — 174	64	-	74	-
174 — 188,7	40	-	50	-
188,7 — 190,979	50	-	60	-
190,979 — 230	40	-	50	-
230 — 400	50	-	60	-
400 — 470	53	-	63	-
470 — 1 000	50	-	60	-
At the transition frequency, the more stringent limit shall apply.				
NOTE — On a test site, class A equipment can be measured at a distance of 10 m or 30 m.				

Frequency range MHz	Limits for a measuring distance D in m					
	On a test site $D = 30$ m from the equipment		On a test site $D = 10$ m from the equipment		On a test site $D = 3$ m from the equipment ^a	
	Electric field Quasi-peak dB(μV/m)	Magnetic field Quasi-peak dB(μA/m)	Electric field Quasi-peak dB(μV/m)	Magnetic field Quasi-peak dB(μA/m)	Electric field Quasi-peak dB(μV/m)	Magnetic field Quasi-peak dB(μA/m)
0,15 – 0,49	–	33,5	–	57,5	–	57,5
0,49 – 1,705	–	23,5	–	47,5	–	47,5
1,705 – 2,194	–	28,5	–	52,5	–	52,5
2,194 – 3,95	–	23,5	–	43,5	–	43,5
3,95 – 20	–	8,5	–	18,5	–	18,5
20 – 30	–	–1,5	–	8,5	–	8,5
30 – 47	58	–	68	–	78	–
47 – 53,91	40	–	50	–	60	–
53,91 – 54,56	40	–	50	–	60	–
54,56 – 68	40	–	50	–	60	–
68 – 80,872	53	–	63	–	73	–
80,872 – 81,848	68	–	78	–	88	–
81,848 – 87	53	–	63	–	73	–
87 – 134,786	50	–	60	–	70	–
134,786 – 136,414	60	–	70	–	80	–
136,414 – 156	50	–	60	–	70	–
156 – 174	64	–	74	–	84	–
174 – 188,7	40	–	50	–	60	–
188,7 – 190,979	50	–	60	–	70	–
190,979 – 230	40	–	50	–	60	–
230 – 400	50	–	60	–	70	–
400 – 470	53	–	63	–	73	–
470 – 1 000	50	–	60	–	70	–
On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10.						
At the transition frequency, the more stringent limit shall apply.						
^a The limits specified for the 3 m separation distance apply only to small equipment meeting the size criterion defined in 3.10.						

Table 10 – Electromagnetic radiation disturbance limits for class A EDM and arc welding equipment measured on a test site

Frequency range MHz	Limits for a measuring distance of 10 m Quasi-peak dB(μV/m)
30 – 230	80 Decreasing linearly with logarithm of frequency to 60
230 – 1 000	60

Frequency range MHz	Limits for a measuring distance D in m	
	$D = 10$ m	$D = 3$ m ^a
	Quasi-peak dB(μV/m)	Quasi-peak dB(μV/m)
30 – 230	80 Decreasing linearly with logarithm of frequency to 60	90 Decreasing linearly with logarithm of frequency to 70
230 – 1 000	60	70
On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10. In case of measurements at a separation distance of 30 m, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.		
^a The limits specified for the 3 m separation distance apply only to small equipment meeting the size criterion defined in 3.10.		

Table 11 – Electromagnetic radiation disturbance limits for class B group 2 equipment measured on a test site

Frequency range MHz	Limits for a measuring distance of D in m		
	Electric field Measurement distance 10 m		Magnetic field Measurement distance 3 m
	Quasi-peak dB(μV/m)	Average ^a dB(μV/m)	Quasi-peak dB(μA/m)
0,15 – 30	–	–	39 Decreasing linearly with logarithm of frequency to 3
30 – 80,872	30	25	–
80,872 – 81,848	50	45	–
81,848 – 134,786	30	25	–
134,786 – 136,414	50	45	–
136,414 – 230	30	25	–
230 – 1 000	37	32	–
On a test site, class B equipment can be measured at a distance of 3 m or 10 m. In the frequency range above 30 MHz, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.			
At the transition frequency, the more stringent limit shall apply.			
^a The average limits apply to magnetron-driven equipment only. If magnetron-driven equipment exceeds the quasi-peak limit at certain frequencies, then the measurement shall be repeated at these frequencies with the average detector and the average limits specified in this table apply.			

Frequency range MHz	Limits for a measuring distance D in m				
	Electric field				Magnetic field
	$D = 10$ m		$D = 3$ m ^b		$D = 3$ m
	Quasi-peak dB(μV/m)	Average ^a	Quasi-peak dB(μV/m)	Average ^a	Quasi-peak dB(μA/m)
0,15 – 30	–	–	–	–	39 Decreasing linearly with the logarithm of frequency to 3
30 – 80,872	30	25	40	35	–
80,872 – 81,848	50	45	60	55	–
81,848 – 134,786	30	25	40	35	–
134,786 – 136,414	50	45	60	55	–
136,414 – 230	30	25	40	35	–
230 – 1 000	37	32	47	42	–
On a test site, class B equipment can be measured at a nominal distance of 3 m or 10 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.10. At the transition frequency, the more stringent limit should apply.					
^a The average limits apply to magnetron driven equipment only. If magnetron driven equipment exceeds the quasi-peak limit at certain frequencies, then the measurement shall be repeated at these frequencies with the average detector, and the average limits specified in this table apply.					
^b The limits specified for the 3 m separation distance apply only to small equipment meeting the size criterion defined in 3.10.					

**Table 12 – Limits of the magnetic field strength
for induction cooking appliances intended for commercial use**

Frequency range MHz	Limits at 3 m distance Quasi-peak dB(μA/m)
0,009 – 0,070	69
0,070 – 0,148 5	69 Decreasing linearly with logarithm of frequency to 39
0,148 5 – 4,0	39 Decreasing linearly with logarithm of frequency to 3
4,0 – 30	3
The limits of this table apply to induction cooking appliances intended for commercial use and those for domestic use with a diagonal diameter of more than 1,6 m. The measurements are performed at 3 m distance with a 0,6 m loop antenna as described in 4.2.1 of CISPR 16-1-4. The antenna shall be vertically installed, with the lower edge of the loop at 1 m height above the floor.	

Table 13 – Limits of the magnetic field induced current in a 2 m loop antenna for induction cooking appliances for domestic use

Frequency range MHz	Quasi-peak dB(μA)	
	Horizontal component	Vertical component
0,009 – 0,070	88	106
0,070 – 0,148 5	88 Decreasing linearly with logarithm of frequency to 58	106 Decreasing linearly with logarithm of frequency to 76
0,148 5 – 30	58 Decreasing linearly with logarithm of frequency to 22	76 Decreasing linearly with logarithm of frequency to 40
The limits of this table apply to induction cooking appliances for domestic use which have a diagonal dimension of less than 1,6 m. The measurement is performed using the loop antenna system (LAS) as described in 7.6 of CISPR 16-2-3.		

6.3.2.4 Frequency range 1 GHz to 18 GHz

The limits in the frequency range 1 GHz to 18 GHz apply only to group 2 equipment operating at frequencies above 400 MHz. The limits specified in the Tables 14 to 16 apply only to RF disturbances appearing outside designated ISM bands as listed in Table 1.

The electromagnetic radiation disturbance limits for the frequency range 1 GHz to 18 GHz are specified in Tables 14 to 16; the equipment shall meet either the limits of Table 14 or the limits of both Table 15 and 16 (see decision tree, Figure 5).

ISM RF lighting devices operating in dedicated ISM frequency bands (defined by the ITU in Table 1) shall either meet the class B limits of Table 14 or the limits of both Tables 15 and 16.

For microwave-powered UV irradiators, the limits specified in Table 14 apply.

Recommendations for the protection of specific safety services are given in Annex E and Table E.1.

Table 14 – Electromagnetic radiation disturbance peak limits for group 2 equipment producing CW type disturbances and operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measurement distance of 3 m Peak dB(μV/m)	
	Class A	Class B
1 – 18		
Within harmonic frequency bands	82 ^a	70
Outside harmonic frequency bands	70	70
Peak measurements with a resolution bandwidth of 1 MHz and a video signal bandwidth higher than or equal to 1 MHz.		
NOTE In this table, “harmonic frequency bands” means the frequency bands which are multiples of the ISM bands allocated above 1 GHz.		
a At the upper and lower edge frequency of harmonic frequency bands, the more stringent limit of 70 dB(μV/m) applies.		

Table 15 – Electromagnetic radiation disturbance peak limits for class B group 2 equipment producing fluctuating disturbances other than CW and operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measuring distance of 3 m Peak dB(μV/m)
1 – 2,3	92
2,3 – 2,4	110
2,5 – 5,725	92
5,875 – 11,7	92
11,7 – 12,7	73
12,7 – 18	92
Peak measurements with a resolution bandwidth of 1 MHz and a video signal bandwidth higher or equal to 1 MHz.	
At the transition frequency, the more stringent limit shall apply.	
NOTE Limits in this table were derived considering fluctuating sources such as magnetron-driven microwave ovens.	

Table 16 – Electromagnetic radiation disturbance weighted limits for class B group 2 equipment producing fluctuating disturbances other than CW and operating at frequencies above 400 MHz

Frequency range GHz	Limits for a measuring distance of 3 m Peak dB(µV/m)
1 – 2,4	60
2,5 – 5,725	60
5,875 – 18	60

Weighted measurements with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

NOTE To check the limits of this table, measurements need only be performed around two centre frequencies: the highest emission in the 1 005 MHz – 2 395 MHz range and the highest peak emission in the 2 505 MHz to 17 995 MHz range (outside the band 5 720 MHz – 5 880 MHz). At these two centre frequencies, measurements are performed with a span of 10 MHz on the spectrum analyser.

6.4 Group 1 and group 2 class A equipment measured *in situ*

6.4.1 Limits of terminal disturbance voltage

Under *in situ* conditions, an assessment of conducted disturbances is not required.

6.4.2 Limits of electromagnetic radiation disturbance

The limits given in Table 17 apply to class A group 1 equipment and the limits given in Table 18 apply to class A group 2 equipment.

Table 17 – Electromagnetic radiation disturbance limits for class A group 1 equipment measured *in situ*

Frequency range MHz	Limits with measuring distance 30 m from the outer face of the exterior wall of the building in which the equipment is situated	
	Electric field Quasi-peak dB(µV/m)	Magnetic field Quasi-peak ^a dB(µA/m)
0,15 – 0,49	–	13,5
0,49 – 3,95	–	3,5
3,95 – 20	–	-11,5
20 – 30	–	-21,5
30 – 230	30	–
230 – 1 000	37	–

At the transition frequency, the more stringent limit shall apply.

If local conditions do not allow for measurements at 30 m, then a larger distance can be used. In this case, an inverse proportionality factor of 20 dB per decade shall be used to normalize the measured data to the specified distance for determining compliance.

a These limits apply in addition to the limits in the frequency range 30 MHz to 1 GHz to radiated disturbances originating from the operation frequency and its harmonics appearing in the frequency range 150 kHz to 30 MHz, caused by the installed class A group 1 equipment with a rated input power exceeding 20 kVA. In the event that the ambient noise level exceeds the above limits, the emissions of the EUT shall not increase this noise floor by more than 3 dB.

Table 18 – Electromagnetic radiation disturbance limits for class A group 2 equipment measured *in situ*

Frequency range MHz	Limits for a measuring distance of D in m from the exterior wall of the building	
	Electric field Quasi-peak dB(μ V/m)	Magnetic field Quasi-peak dB(μ A/m)
0,15 – 0,49	-	23,5
0,49 – 1,705	-	13,5
1,705 – 2,194	-	18,5
2,194 – 3,95	-	13,5
3,95 – 20	-	-1,5
20 – 30	-	-11,5
30 – 47	48	-
47 – 53,91	30	-
53,91 – 54,56	30	-
54,56 – 68	30	-
68 – 80,872	43	-
80,872 – 81,848	58	-
81,848 – 87	43	-
87 – 134,786	40	-
134,786 – 136,414	50	-
136,414 – 156	40	-
156 – 174	54	-
174 – 188,7	30	-
188,7 – 190,979	40	-
190,979 – 230	30	-
230 – 400	40	-
400 – 470	43	-
470 – 1 000	40	-
At the transition frequency, the more stringent limit shall apply.		

For group 2 equipment measured *in situ*, the measuring distance D from the exterior wall of the building in which the equipment is situated equals $(30 + x/a)$ m or 100 m whichever is smaller, provided that the measuring distance D is within the boundary of the premises. In the case where the calculated distance D is beyond the boundary of the premises, the measuring distance D equals x or 30 m, whichever is longer.

For the calculation of the above values:

x is the nearest distance between the outside wall of the building in which the equipment is situated and the boundary of the user's premises in each measuring direction;

$a = 2,5$ for frequencies lower than 1 MHz;

$a = 4,5$ for frequencies equal to or higher than 1 MHz.

7 Measurement requirements

7.1 General

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

Specific requirements for making measurements on a test site are given in Clauses 8 and 9, for making measurements *in situ* in Clause 10.

The requirements of the present clause are to be met for both, test site and/or *in situ* measurements.

Measurements need only be performed in frequency ranges where limits are specified in Clause 6.

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

7.2 Ambient noise

A test site for type testing shall allow emissions from the equipment under test to be distinguished from ambient noise. The suitability in this respect can be determined by measuring the ambient noise levels with the equipment under test inoperative and ensuring that the ambient noise levels are at least 6 dB below the limits specified in 6.2 or 6.3, as appropriate for the measurement being carried out.

It is not necessary to reduce the ambient noise level to 6 dB below the specified limit where the combination of the ambient noise plus the emission from the equipment under test does not exceed the specified limit. Under these conditions, the equipment under test is considered to satisfy the specified limit.

When carrying out measurements on mains terminal disturbance voltage, local radio transmissions may increase the ambient noise level at some frequencies. A suitable radio-frequency filter may be inserted between the artificial mains network and the mains supply, or measurements may be performed in a shielded enclosure. The components forming the radio-frequency filter should be enclosed in a metallic screen directly connected to the reference earth of the measuring system. The requirements for the impedance of the artificial mains network shall be satisfied at the frequency of measurement when the radio-frequency filter is connected.

If, when measuring the electromagnetic radiation disturbance, the 6 dB ambient noise conditions cannot be met, then the antenna may be located at a distance closer to the equipment under test than specified in Clause 6 (see 8.3.4).

7.3 Measuring equipment

7.3.1 Measuring instruments

Receivers with quasi-peak detectors shall be in accordance with CISPR 16-1-1. Receivers with average detectors shall be in accordance with CISPR 16-1-1.

NOTE 1 Both detectors may be incorporated in a single receiver and measurements carried out by alternately using the quasi-peak detector and the average detector.

The measuring receiver used shall be operated in such a way that a variation in frequency of the disturbance being measured does not affect the results.

NOTE 2 Measuring instruments having other detector characteristics may be used provided the measurement of the disturbance values can be proved to be the same. Attention is drawn to the convenience of using a panoramic receiver or a spectrum analyzer, particularly if the working frequency of the equipment under test changes appreciably during the work cycle.

To avoid the possibility of the measuring instrument incorrectly indicating non-compliance with the limits, the measuring receiver shall not be tuned closer to the edge of one of the bands designated for ISM use than the frequency at which its 6 dB bandwidth point aligns with the edge of the designated band.

NOTE 3 Care should be taken to ensure that screening and the spurious response rejection characteristics of the measuring receiver are adequate when making measurements on high power equipment.

For measurements at frequencies above 1 GHz, a spectrum analyser with characteristics as defined in CISPR 16-1-1 shall be used.

NOTE 4 Precautions which should be taken in the use of a spectrum analyzer are given in Annex B.

7.3.2 Artificial mains network

Measurement of the mains terminal disturbance voltage shall be made using an artificial mains network as specified in CISPR 16-1-2.

The artificial network is required to provide a defined impedance at radio frequencies across the mains supply at the point of measurement and also to provide for isolation of the equipment under test from ambient noise on the power lines.

7.3.3 Voltage probe

The voltage probe shown in Figure 4 shall be used when the artificial mains network cannot be used. The probe is connected sequentially between each line and the reference earth chosen (metal plate, metal tube). The probe consists mainly of a blocking capacitor and a resistor such that the total resistance between the line and earth is at least 1 500 Ω . The effect on the accuracy of measurement of the capacitor or any other device which may be used to protect the measuring receiver against dangerous currents shall be either less than 1 dB or allowed for in calibration.

7.3.4 Antennas

7.3.4.1 Frequency range below 30 MHz

In the frequency range below 30 MHz, the antenna shall be a loop as specified in CISPR 16-1-4. The antenna shall be supported in the vertical plane and be rotatable about a vertical axis. The lowest point of the loop shall be 1 m above ground level.

7.3.4.2 Frequency range from 30 MHz to 1 GHz

In the frequency range from 30 MHz to 1 GHz the antenna used shall be as specified in CISPR 16-1-4. Measurements shall be made for both horizontal and vertical polarization. The nearest point of the antenna to the ground shall be not less than 0,2 m.

For measurements on a test site, the centre of the antenna shall be varied between 1 m and 4 m height for maximum indication at each test frequency.

For measurements *in situ*, the centre of the antenna shall be fixed at 2,0 m $\pm$ 0,2 m height above the ground.

NOTE Other antennas may be used provided the results can be shown to be within ± 2 dB of the results which would have been obtained using a balanced dipole antenna.

7.3.4.3 Frequency range above 1 GHz

For measurements at frequencies above 1 GHz, the antenna used shall be as specified in CISPR 16-1-4.

7.3.5 Artificial hand

In order to simulate the influence of the user's hand, application of the artificial hand is required for hand-held equipment during the mains disturbance voltage measurement.

The artificial hand consists of metal foil which is connected to one terminal (terminal M) of an RC element consisting of a capacitor of $220 \text{ pF} \pm 20 \%$ in series with a resistance of $510 \Omega \pm 10 \%$ (see Figure 6); the other terminal of the RC element shall be connected to the reference ground of the measuring system (see CISPR 16-1-2). The RC element of the artificial hand may be incorporated in the housing of the artificial mains network.

7.4 Frequency measurement

For equipment which is intended to operate with a fundamental frequency in one of the designated bands listed in Table 1, the frequency shall be checked with measuring equipment having an inherent error of measurement not greater than 1/10 of the permissible tolerance for the midband frequency of the designated band. The frequency shall be measured over all the load range from the lowest power normally used up to the maximum.

7.5 Configuration of equipment under test

7.5.1 General

Consistent with typical applications of the equipment under test, the level of the disturbance shall be maximized by varying the configuration of the equipment.

NOTE The extent to which this subclause is applicable to the measurement of an installation *in situ* will depend on the flexibility inherent in each particular installation. The provisions of this subclause apply to *in situ* measurements in so far as a particular installation allows for the position of cables to be varied and different units within the installation to be operated independently, the extent to which the position of the installation can be moved within the premises, etc.

For a separation distance of 3 m the assessment of the radiation from the cabling of the EUT shall be restricted to those fractions of interconnecting cables (see 7.5.2) and mains cables (see 7.5.3) which are within the test volume of 1,2 m diameter times 1,5 m height above ground. Peripheral equipment not fitting into the test volume shall be excluded from the measurements or decoupled from the test environment.

The configuration of the equipment under test shall be precisely noted in the test report.

7.5.2 Interconnecting cables

This subclause applies to equipment in which there are interconnecting cables between various parts of the equipment, or systems where a number of equipments are interconnected.

NOTE 1 The observation of all provisions in this subclause permits the application of the results of an evaluation to a number of system configurations using the same types of equipment and cables as tested, but no other, each system configuration being in effect a subsystem of the one evaluated.

Interconnecting cables shall be of the type and length specified in the individual equipment requirements. If the length can be varied, the length shall be selected to produce maximum emission when performing field strength measurements.

If shielded or special cables are used during the tests, then the use of such cables shall be specified in the instruction manual.

The connection of signal leads, except for the leads supplied by the manufacturer, is not required during radio-frequency emission measurements for portable test and measurement apparatus, group 1, or those intended for use in laboratories and operated by competent persons. Examples are signal generators, network and logic analysers, and spectrum analysers.

When performing terminal voltage measurements, excess length of cables shall be bundled at the approximate centre of the cable with bundles of 30 cm to 40 cm in length. If it is impracticable to do so, the disposition of the excess cable shall be noted precisely in the test report.

Where there are multiple interface ports all of the same type, connecting a cable to just one of that type of port is sufficient provided that it can be shown that the additional cables would not significantly affect the results.

Any set of results shall be accompanied by a complete description of the cable and equipment orientation so that results can be repeated. If there are conditions of use, those conditions shall be specified, documented and included in the instructions for use.

If an equipment can perform separately any one of a number of functions, then the equipment shall be tested while performing each of these functions. For systems which may include a number of different equipments, one of each type of equipment which is included in the system configuration shall be included in the evaluation.

A system which contains a number of identical equipments, but has been evaluated using only one of those equipments, does not require further evaluation if the initial evaluation was satisfactory.

NOTE 2 This is permissible because it has been found that in practice emissions from identical modules are not additive.

When equipment is being evaluated which interacts with other equipment to form a system, then the evaluation may be carried out using either additional equipment to represent the total system or with the use of simulators. In either method, care shall be taken to ensure that the equipment under test is evaluated with the effects of the rest of the system or simulators satisfying the ambient noise conditions specified in 7.2. Any simulator used in lieu of actual equipment shall properly represent the electrical and, in some cases, the mechanical characteristics of the interface, especially with respect to radio-frequency signals and impedances, as well as cable configuration and types.

NOTE 3 This procedure is required to permit the evaluation of equipment which will be combined with other equipment from different manufacturers to form a system.

7.5.3 Connection to the electricity supply network on a test site

When performing measurements on a test site, the V-network specified in 7.3.2 is to be used whenever possible. The V-network shall be located so that its closest surface is no less than 0,8 m from the nearest boundary of the equipment under test.

Where a flexible mains cord is provided by the manufacturer this shall be 1 m long or, if in excess of 1 m, the excess cable shall be folded to and forth to form a bundle not exceeding 0,4 m in length.

Mains power at the nominal voltage shall be supplied.

Where a mains cable is specified in the manufacturer's installation instructions, a 1 m length of the type specified shall be connected between the test unit and the V-network.

Earth connections, where required for safety purposes, shall be connected to the reference “earth” point of the V-network and where not otherwise provided or specified by the manufacturer shall be 1 m long and run parallel to the mains connection at a distance of not more than 0,1 m.

Other earth connections (e.g. for EMC purposes) either specified or supplied by the manufacturer for connection to the same terminal as the safety earth connection shall also be connected to the reference earth of the V-network.

Where the equipment under test is a system comprising more than one unit, each unit having its own power cord, the point of connection for the V-network is determined from the following rules:

- a) each mains cable which is terminated in a mains supply plug of a standard design (e.g., IEC 60083) shall be tested separately;
- b) mains cables or terminals which are not specified by the manufacturer to be connected to another unit in the system for the purposes of supplying mains power shall be tested separately;
- c) mains cables or terminals which are specified by the manufacturer to be connected to another unit in the system for the purposes of supplying mains power shall be connected to that unit, and the mains cables or terminals of that unit are connected to the V-network;
- d) where a special connection is specified, the necessary hardware to effect the connection shall be used during the evaluation of the equipment under test.

7.6 Load conditions of equipment under test

7.6.1 General

Load conditions of the equipment under test are specified in this subclause. Equipment not covered by this subclause are to be operated so as to maximize the interference generated while still conforming with normal operating procedures, as provided in the operating manual of the equipment.

7.6.2 Medical equipment

7.6.2.1 Therapeutic equipment using frequencies from 0,15 MHz to 300 MHz

All measurements shall be made under operating conditions, as provided in the operating manual of the equipment. The output circuit to be used to load the equipment depends on the nature of the electrodes with which it is to be used.

For equipment of the capacitive type, a dummy load shall be used for the measurements. The general arrangement is shown in Figure 3. The dummy load shall be substantially resistive and capable of absorbing the rated maximum output power of the equipment.

The two terminals of the dummy load shall be at opposite ends of the load and each terminal shall be joined directly to a circular flat metal plate having a diameter of $170 \text{ mm} \pm 10 \text{ mm}$. Measurements shall be made with each of the output cables and capacitive electrodes supplied with the equipment. The capacitive electrodes are to be disposed parallel to the circular metal plates at the ends of the dummy load, the spacing between them being adjusted to produce the appropriate power dissipation in the dummy load.

Measurements shall be made with the dummy load both horizontal and vertical (see Figure 3). In each case, the equipment, together with the output cables, capacitive electrodes and dummy load, shall be rotated around its vertical axis during measurements of electromagnetic radiation disturbance in order that the maximum value can be measured.

NOTE The following arrangement of lamps has been found suitable for testing many types of equipment in the power range tested:

- a) nominal output power 100 W to 300 W:
four lamps 110 V/60 W in parallel, or five lamps 125 V/60 W in parallel;
- b) nominal output power 300 W to 500 W:
four lamps 125 V/100 W in parallel, or five lamps 150 V/100 W in parallel.

For equipment of the inductive type, measurements shall be made using the cables and coils supplied with the equipment for the treatment of the patient. The test load shall consist of a vertical tubular container of insulating material, having a diameter of 10 cm, filled to a height of 50 cm with a solution consisting of 9 g of sodium chloride to 1 litre of distilled water.

The container shall be placed within the coil with the axis of the container coincident with the axis of the coil. The centres of the coil and the liquid load shall also coincide.

Measurements shall be made at both maximum and half-maximum power and, where the output circuit can be tuned, it shall be tuned to resonance with the fundamental frequency of the apparatus.

All measurements shall be made under all operating conditions, as provided in the operating manual of the equipment.

7.6.2.2 UHF and microwave therapeutic equipment using frequencies above 300 MHz

Measurements shall be made initially with the output circuit of the equipment connected to a load resistor having the same value as the characteristic impedance of the cable used to supply the equipment load.

Secondly, having regard to the specifications in the operating manual of the equipment, measurements shall be made with each of the applicators supplied with the equipment in each possible position and direction and with no absorbing medium.

The highest of the levels measured using the two arrangements shall be used to determine compliance with the limits.

NOTE 1 Where necessary, the maximum power output of the equipment should be measured with the first arrangement. In order to determine the matching of the terminating resistor to the output-circuit of the equipment, the standing wave ratio should be measured on the line between the generator and the terminating resistor. The voltage standing wave ratio VSWR should not exceed the value of 1,5.

NOTE 2 Methods of loading other medical equipment are under consideration.

7.6.2.3 Ultrasonic therapy equipment

Measurements shall be made with the transducer connected to the generator. The transducer shall be dipped in a non-metallic container having a diameter of about 10 cm and filled with distilled water.

Measurement shall be made at both maximum and half-maximum power and, where the output circuit can be tuned, it shall be tuned to resonance and then detuned. The specifications in the operating manual of the equipment are to be considered.

NOTE The measurement of the maximum output of the equipment should be made, where necessary, in accordance with the method published in IEC 61689 or using a derived arrangement.

7.6.3 Industrial equipment

The load used when industrial equipment is tested may be either the load used in service or an equivalent device.

Where means for connecting auxiliary services such as water, gas, air, etc. are provided, connection of these services to the equipment under test shall be made by insulating tubing not less than 3 m long. When testing with the load used in service, the electrodes and cables shall