

Electromagnetic compatibility — Requirements for household appliances, electric tools and similar apparatus —

Part 1: Emission

ICS 33.100.10

National foreword

This British Standard is the UK implementation of EN 55014-1:2006+A2:2011. It is identical with CISPR 14-1:2005 incorporating amendments 1:2008 and 2:2011, and corrigendum January 2009. It supersedes BS EN 55014-1:2006+A1:2009, which will be withdrawn on 16 August 2014.

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

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

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**Electromagnetic compatibility -
Requirements for household appliances, electric tools and similar
apparatus -
Part 1: Emission
(CISPR 14-1:2005/A2:2011)**

Compatibilité électromagnétique -
Exigences pour les appareils
électrodomestiques, outillages électriques
et appareils analogues -
Partie 1: Emission
(CISPR 14-1:2005/A2:2011)

Elektromagnetische Verträglichkeit -
Anforderungen an Haushaltgeräte,
Elektrowerkzeuge und ähnliche
Elektrogeräte -
Teil 1: Störaussendung
(CISPR 14-1:2005/A2:2011)

This amendment A2 modifies the European Standard EN 55014-1:2006; it was approved by CENELEC on 2011-08-16. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment 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.

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CENELEC

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

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Foreword

The text of document CISPR/F/404/FDIS, future edition 5 of CISPR 14-1, prepared by CISPR SC F, Interference relating to household appliances, tools, lighting equipment and similar apparatus, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 55014-1 on 2006-09-12.

This European Standard supersedes EN 55014-1:2000 + A1:2001 + A2:2002.

The following dates were fixed:

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This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directives 89/336/EEC and 2004/108/EC. See Annex ZZ.

Annexes ZA and ZZ have been added by CENELEC.

Endorsement notice

The text of the International Standard CISPR 14-1:2005 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

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Foreword to amendment A2

The text of document CISPR/F/537/FDIS, future edition 5 of CISPR 14-1:2005/A2, prepared by CISPR SC F, "Interference relating to household appliances, tools, lighting equipment and similar apparatus" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 55014-1:2006/A2:2011.

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Endorsement notice

The text of the International Standard CISPR 14-1:2005/A2:2011 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

The intention of this standard is to establish uniform requirements for the radio disturbance level of the equipment contained in the scope, to fix limits of disturbance, to describe methods of measurement and to standardize operating conditions and interpretation of results.

ELECTROMAGNETIC COMPATIBILITY – REQUIREMENTS FOR HOUSEHOLD APPLIANCES, ELECTRIC TOOLS AND SIMILAR APPARATUS –

Part 1: Emission

1 Scope

1.1 This standard applies to the conduction and radiation of radio-frequency disturbances from appliances whose main functions are performed by motors, switching or regulating devices, or by r.f. generators used in induction cooking appliances.

It includes such equipment as: household electrical appliances, electric tools, regulating controls using semiconductor devices, motor-driven electro-medical apparatus, electric/electronic toys, automatic dispensing machines as well as cine or slide projectors. Both mains powered appliances and battery powered appliances are included.

Also included in the scope of this standard are:

- separate parts of the above mentioned equipment such as motors, switching devices e.g. (power or protective) relays, however no emission requirements apply unless formulated in this standard.

Excluded from the scope of this standard are:

- apparatus for which all emission requirements in the radio frequency range are explicitly formulated in other IEC or CISPR standards;

NOTE 1 Examples are:

- luminaires, including portable luminaires for children, discharge lamps and other lighting devices: CISPR 15;
- audio and video equipment and electronic music instruments, other than toys: CISPR 13 and CISPR 20 (see also 7.3.5.4.2);
- mains communication devices, as well as baby surveillance systems: IEC 61000-3-8;
- equipment for generation and use of radio frequency energy for heating (other than induction cooking) and therapeutic purposes: CISPR 11;
- microwave ovens: CISPR 11 (but be aware of 1.3 on multifunction equipment);
- information technology equipment, e.g. home computers, personal computers, electronic copying machines: CISPR 22;
- electronic equipment to be used on motor vehicles: CISPR 12;
- radio controls, walkie-talkies and other types of radio-transmitters, also when used with toys.
- arc welding equipment: CISPR 11.
- regulating controls and equipment with regulating controls incorporating semiconductor devices with a rated input current of more than 25 A per phase;
- stand-alone power supplies.

NOTE 2 Toys powered by the supply system of a motor-powered vehicle, ship or aircraft are not covered by this standard.

NOTE 3 Until induction cooking appliances are removed from the scope of CISPR 11, either CISPR 11 or CISPR 14-1 may be chosen for compliance.

1.2 The frequency range covered is 9 kHz to 400 GHz.

1.3 Multifunction equipment which is subjected simultaneously to different clauses of this standard and/or other standards shall meet the provisions of each clause/standard with the relevant functions in operation; details are given in 7.2.1.

1.4 The limits in this standard have been determined on a probabilistic basis, to keep the suppression of disturbances economically feasible while still achieving an adequate radio protection. In exceptional cases radio frequency interference may occur, in spite of compliance with the limits. In such a case, additional provisions may be required.

1.5 The effects of electromagnetic phenomena relating to the safety of apparatus are excluded from the scope of this standard.

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.

IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*
Amendment 1: 1997
Amendment 2: 1998

IEC 60335-2-76:2002, *Household and similar electrical appliances – Safety – Part 2-76: Particular requirements for electric fence energizers.*

IEC 60598-2-4:1997, *Luminaires – Part 2-4: Particular requirements – Section 4 : Portable general purpose luminaires*

IEC 60598-2-10:2003, *Luminaires – Part 2-10: Particular requirements – Portable luminaires for children.*

Ⓐ IEC 61000-4-20:2003, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides* Ⓐ

CISPR 15:2000, *Limits and methods of measurement of radio disturbance characteristics electrical lighting and similar equipment.*

CISPR 16-1-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

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*

CISPR 16-1-3:2004, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-3: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Disturbance power*

CISPR 16-2-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-2: Methods of measurement of disturbances and immunity – Measurement of disturbance power*

CISPR 22:2005, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

■^{A1} 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)

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* ^{A1}■

3 Definitions

For the purpose of this standard, the definitions contained in IEC 60050-161 apply extended with the specific definitions as follows:

3.1 Definitions of the following terms are specified in CISPR 16-2-1 or CISPR 16-2-2:

Reference ground

Equipment under test (EUT)

Level

Weighting

3.2 **click**

a disturbance, the amplitude of which exceeds the quasi-peak limit of continuous disturbance, the duration of which is not longer than 200 ms and which is separated from a subsequent disturbance by at least 200 ms. The durations are determined from the signal which exceeds the i.f. reference level of the measuring receiver

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.

NOTE Under certain conditions, some kinds of disturbances are exempted from this definition (see 4.2.3)

3.3 **i.f. reference level**

the corresponding value on the intermediate frequency output of the measuring receiver of an unmodulated sinusoidal signal which produces a quasi-peak indication equal to the limit for continuous disturbance

3.4 **switching operation**

one opening or one closing of a switch or contact

NOTE Independent of whether clicks are observed or not.

3.5

minimum observation time

T

the minimum time necessary when counting clicks (or where relevant counting switching operations) to provide sufficiently firm evidence for the statistical interpretation of the number of clicks (or switching operations) per time unit (see also 7.4.2.1)

3.6

click rate

N

in general the number of clicks or switching operations within one minute; this Figure is being used to determine the click limit (see also 7.4.2.3)

3.7

click limit

L_q

the relevant limit L for continuous disturbance, as given in 4.1.1 for the measurement with the quasi-peak detector, increased by a certain value determined from the click rate N (see also 4.2.2.2)

The click limit applies to the disturbance assessed according to the upper quartile method.

3.8

upper quartile method

a quarter of the number of the clicks registered during the observation time T is allowed to exceed the click limit L_q

In the case of switching operations a quarter of the number of the switching operations registered during the observation time is allowed to produce clicks exceeding the click limit L_q (see also 7.4.2.6).

3.9

toy

product designed for, or clearly intended for use in play by children under 14 years old.

Toys may incorporate motors, heating elements, electronic circuits and their combination.

The supply voltage of a toy shall not exceed 24 V a.c. (r.m.s) or ripple-free d.c. and may be provided by a battery or by means of an adapter or a safety transformer connected to the mains supply

NOTE Transformers, converters and chargers for toys are considered not to be part of the toy (see IEC 61558-2-7).

3.10

battery toy

toy which contains or uses one or more batteries as the only source of electrical energy

3.11

transformer toy

toy which is connected to the supply mains through a transformer for toys and using the supply mains as the only source of electrical energy

3.12

dual supply toy

toy which can be operated simultaneously or alternatively as a battery toy and a transformer toy

3.13**battery box**

compartment which is separate from the toy  or appliance and in which the batteries are placed 

3.14**safety isolating transformer**

transformer, the input winding of which is electrically separated from the output winding by an insulation at least equivalent to double insulation or reinforced insulation, and which is designed to supply an appliance or circuit at safety extra-low voltage

3.15**safety transformer for toys**

safety isolating transformer specially designed to supply toys operating at safety extra-low voltage not exceeding 24 V

NOTE Either a.c. or d.c. or both may be delivered from the transformer unit.

3.16**constructional kit**

collection of electric, electronic or mechanical parts intended to be assembled as various toys

3.17**experimental kit**

collection of electric or electronic components intended to be assembled in various combinations

NOTE The main aim of an experimental set is to facilitate the acquiring of knowledge by experiment and research. It is not intended to create a toy or equipment for practical use.

3.18**functional toy**

toy with a rated voltage not exceeding 24 V and which is a model of an appliance or installation used by adults

NOTE A product with a rated voltage exceeding 24 V, intended to be used by children under the direct supervision of an adult and which is a model of an appliance or installation and used in the same way, is known as a functional product.

3.19**portable luminaire for children**

luminaire that in normal use can be moved from one place to another while connected to the supply and which is designed to provide a level of safety in excess of that provided by a portable general purpose luminaire conforming with IEC 60598-2-4

NOTE A portable luminaire for children is intended for use by children who may not be under the supervision of more competent persons at the time of use.

[IEC 60598-2-10: 10.3.1]

3.20**video toy**

toy consisting of a screen and activating means by which the child can play and interact with the picture shown on the screen

NOTE All parts necessary for the operation of the video toy, such as control box, joy stick, keyboard, monitor and connections, are considered to be part of the toy.

3.21

electronic circuit

circuit incorporating at least one electronic component

3.22

electronic component

part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor

NOTE Electronic components do not include resistors, capacitors and inductors.

3.23

normal operation of toys

condition under which the toy, connected to the recommended power supply, is played with as intended or in a foreseeable way, bearing in mind the normal behaviour of children

A1 3.24

clock frequency

the fundamental frequency of any signal used in the device excluding those which are solely used inside integrated circuits (IC)

NOTE High frequencies are often generated inside of integrated circuits (IC) by phase-locked-loop (PLL) circuits from lower clock oscillator frequencies outside the IC.

3.25

battery-operated appliance

appliance which is operated only from batteries and has no provision for performing its intended function when connected to the mains, either directly or via a power supply

NOTE 1 Toys are not considered to be appliances.

NOTE 2 An appliance which has provision for charging but cannot perform its intended function during charging is considered to be a battery-operated appliance.

3.26

mains-operated appliance

all appliances which are not battery-operated appliances

NOTE Toys are not considered to be appliances. **A1**

4 Limits of disturbance

Radio disturbance measurements below 148,5 kHz and above **A1** 1 000 MHz do not need to be carried out. **A1** **A2** The requirements for induction cooking appliances are given in Annex B. **A2**

4.1 Continuous disturbance

Commutator motors, as well as other devices incorporated in household appliances, electric tools and similar electrical apparatus may cause continuous disturbance.

Continuous disturbance may be either broadband, caused by switching devices such as mechanical switches, commutators and semiconductor regulators, or may be narrowband, caused by electronic control devices such as microprocessors.

NOTE Instead of the concept of "broadband" and "narrowband" disturbances, in this standard a distinction is made between two related kinds of disturbance, defined by the type of the applied detector. For this purpose limits have been defined with respect to the measurement with the quasi-peak detector and with the average detector (see 5.1.1 and 6.1.1).

4.1.1 Frequency range 148,5 kHz to 30 MHz (terminal voltages)

NOTE The World Administrative Radiocommunications Conference (WARC) has in 1979 reduced the lower frequency limit in Region 1 to 148,5 kHz; for applications falling in the scope of this standard, tests at 150 kHz are considered adequate, since 148,5 kHz falls within the receiver bandwidth.

The limits of the terminal disturbance voltages are given in Table 1. Terminal voltages are measured, in accordance with Clause 5, on each terminal with respect to ground.

Terminals are defined as conductive parts, suitable for re-usable electrical connection to external circuits.

4.1.1.1 The limits in columns 2 and 3 shall be met on the phase(s) and the neutral of the mains terminals of all appliances except those of electric tools.

4.1.1.2 On additional terminals of appliances as well as on load and additional terminals of regulating controls incorporating semiconductor devices the relaxed limits given for "additional terminals" in columns 4 and 5 apply.

Terminals which may be used as either mains terminals or load/additional terminals are subject to the limits for mains terminals.

No terminal voltage limits apply for leads, which are not easily extensible by the user (permanently connected, or provided with a specific connector), which are shorter than 2 m, and which connect the equipment with an auxiliary apparatus or device, (e.g. semiconductor speed controls, power plugs with AC-DC converters).

No terminal voltage limits apply to leads integrated in the suction hose of vacuum cleaners, even if the length exceeds 2 m.

NOTE For the measurement at the load terminals and additional terminals of regulating controls incorporating semiconductor devices see 5.2.4, for additional terminals of other appliances see 5.2.3.

4.1.1.3 For the mains terminals of electric tools the particular limits given in columns 6 to 11 apply according to the rated power of the motor, the power of any heating device is to be excluded (for instance heating power in a blower for plastic welding). For the load terminals and additional terminals of electric tools, columns 4 and 5 apply without further relaxation.

Table 1 – Terminal voltage limits for the frequency range 148,5 kHz to 30 MHz
(see Figures 1 and 2)

HOUSEHOLD APPLIANCES AND EQUIPMENT CAUSING SIMILAR DISTURBANCES
AND REGULATING CONTROLS INCORPORATING SEMICONDUCTOR DEVICES

Frequency range	At mains terminals		At load terminals and additional terminals	
1	2	3	4	5
(MHz)	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*
0,15 to 0,50	Decreasing linearly with the logarithm of the frequency from: 66 to 56		80	70
0,50 to 5	56	46	74	64
5 to 30	60	50	74	64

MAINS TERMINALS OF TOOLS

1	6	7	8	9	10	11
Frequency range	Rated motor power not exceeding 700 W		Rated motor power above 700 W and not exceeding 1 000 W		Rated motor power above 1 000 W	
(MHz)	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*	dB (µV) Quasi-peak	dB (µV) Average*
0,15 to 0,35	Decreasing linearly with the logarithm of the frequency from: 66 to 59					
	66 to 59	59 to 49	70 to 63	63 to 53	76 to 69	69 to 59
0,35 to 5	59	49	63	53	69	59
5 to 30	64	54	68	58	74	64
* If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.						

NOTE The limits for the measurement with the average detector are tentative and may be modified after a period of experience.

4.1.1.4 Limits for electric fence energizers apply to

- a) the fence terminals on all energizers (columns 4 and 5 of Table 1);
- b) the mains terminals on energizers designed for connection to the mains (columns 2 and 3 of Table 1);
- c) the battery terminals on energizers designed for operation from a battery (columns 4 and 5 of Table 1).

However, no limits apply to the battery terminals of energizers with built-in batteries which cannot be connected to the mains supply, or energizers with external batteries if the connecting lead between the energizer and the battery is shorter than 2 m and is not applicable of being easily extended by the user without special tools.

Type D energizers, according to IEC 60335-2-76, are measured as battery operated energizers with connecting leads between the energizer and the battery greater than 2 m in length.

NOTE In practice, the fence wire can also act as an active source of disturbances, due to the high-voltage discharges, in particular to radio and telecommunication networks. Manufacturers of electric fence energizers should instruct the users to eliminate discharge points such as touching vegetation or a broken fence wire.

4.1.1.5 For battery operated appliances (with built-in batteries, as well as with external batteries) which can be connected to the mains the limits of columns 2 and 3 of Table 1 apply to the mains terminals.

No radio disturbance limits apply to appliances with built-in batteries, which cannot be connected to the mains supply.

No radio disturbance limits apply to appliances with external batteries, if the connecting lead between appliance and battery is shorter than 2 m. If the connecting lead is longer than 2 m or easily extendable by the user without special tools, then the limits of columns 4 and 5 of Table 1 apply to these leads.

A1 4.1.2 Frequency range 30 MHz to 1 000 MHz

4.1.2.1 Disturbance power measurement in the frequency range 30 MHz to 300 MHz

The limits of the disturbance power are given in Table 2a. Disturbance power is measured in accordance with Clause 6, at all terminals.

Table 2a – Disturbance power limits for the frequency range 30 MHz to 300 MHz

	Household and similar appliances		Tools					
1	2	3	4	5	6	7	8	9
Frequency range			Rated motor power not exceeding 700 W		Rated motor power above 700 W and not exceeding 1 000 W		Rated motor power above 1 000 W	
(MHz)	dB (pW) Quasi-peak	dB (pW) Average ^a	dB (pW) Quasi-peak	dB (pW) Average ^a	dB (pW) Quasi-peak	dB (pW) Average ^a	dB (pW) Quasi-peak	dB (pW) Average ^a
30 to 300	45 to 55	35 to 45	45 to 55	35 to 45	49 to 59	39 to 49	55 to 65	45 to 55
^a If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.								

Table 2b – Margin when performing disturbance power measurement in the frequency range 30 MHz to 300 MHz

	Household and similar appliances		Tools					
1	2	3	4	5	6	7	8	9
Frequency range			Rated motor power not exceeding 700 W		Rated motor power above 700 W and not exceeding 1 000 W		Rated motor power above 1 000 W	
(MHz)	dB (pW) Quasi-peak	dB (pW) Average	dB (pW) Quasi-peak	dB (pW) Average	dB (pW) Quasi-peak	dB (pW) Average	dB (pW) Quasi-peak	dB (pW) Average
	Increasing linearly with the frequency from:							
200 to 300	0 to 10 dB	-	0 to 10 dB	-	0 to 10 dB	-	0 to 10 dB	-
NOTE 1 This table only applies if specified in 4.1.2.3.2.								
NOTE 2 The measured result at a particular frequency shall be less than the relevant limit minus the corresponding margin (at that frequency).								

A1

4.1.2.2 Radiated disturbances measurement in the frequency range 30 MHz to 1 000 MHz

The limits of radiated disturbances are given in Table 3. Radiated disturbances are measured in accordance with the standards and testing methods given in Table 3.

Table 3 – Radiated disturbance limits and testing methods for the frequency range 30 MHz to 1 000 MHz

Testing method	Standard	Frequency range MHz	Limit dB μ V/m Quasi-peak	Remark
OATS ^a or SAC ^{b d}	CISPR 16-2-3	30 – 230	30	Measurement distance 10 m
		230 – 300	37	
		300 – 1 000	37	
FAR ^e	CISPR 16-2-3	30 – 230	42 to 35 ^f	Measurement distance 3 m
		230 – 1 000	42	
TEM-Waveguide ^c	IEC 61000-4-20	30 – 230	30	–
		230 – 1 000	37	

NOTE The lower limit is applicable at the transition frequency.

^a OATS = open area test site

^b SAC = semi-anechoic chamber

^c The TEM-waveguide is limited to devices without cables attached and with a maximum size according to subclause 6.1 of IEC 61000-4-20 (The largest dimension of the enclosure at 1 GHz measuring frequency is one wavelength, 300 mm at 1 GHz)

^d Measurements may be made at closer distance, down to 3 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.

^e FAR = fully anechoic room. All equipment, including floor-standing equipment, shall be measured within the test volume as described in Figure 6 of CISPR 16-2-3.

^f Decreasing linearly with the logarithm of the frequency.

In any situation where it is necessary to verify the original measurement, the measuring method and measuring distance originally chosen shall be used in order to ensure consistency of the results.

4.1.2.3 Application of the limits

4.1.2.3.1 General

This subclause describes application of the limits for all appliances (see Figure 10).

Regulating controls which incorporate semiconductor devices, electric fence energizers, rectifiers, battery chargers and converters, which do not contain any clock frequency higher than 9 kHz, are not subject to the requirements in the frequency range 30 MHz to 1 000 MHz.

4.1.2.3.2 Mains operated appliances

The equipment under test shall be evaluated for emissions in the 30 MHz to 1 000 MHz range by testing in accordance with either method a) or b), see also Figure 10. 

- A1** a) The limits in columns 2 and 3 of Table 2a for the frequency range from 30 MHz to 300 MHz shall be met by all appliances except for electric tools. For electric tools the particular limits given in columns 4 to 9 of Table 2a apply according to the rated power of the motor, excluding the power of any heating device (for instance heating power in a blower for plastic welding).

Appliances are deemed to comply in the frequency range from 300 MHz to 1 000 MHz if both of the following conditions (1) and 2)) are fulfilled:

- 1) all emission readings from the equipment under test shall be lower than the applicable limits (Table 2a) reduced by the margin (Table 2b);
- 2) the maximum clock frequency shall be less than 30 MHz.

If either of condition 1) or 2) is not fulfilled, radiated measurements in the frequency range from 300 MHz to 1 000 MHz shall be conducted and the limits of Table 3 for that range applied. In any case the limits of Table 2a in the frequency range 30 MHz to 300 MHz shall be met.

- b) The limits in Table 3 shall be met. Any of the measurement methods mentioned in Table 3 can be selected by the manufacturer except that the TEM-waveguide shall be used only for battery powered appliances not intended to have external cables attached (see also Note c in Table 3).

The test report shall state which method was used and which limits were applied.

4.1.2.3.3 Battery operated appliances

For all battery operated appliances the limits in Table 3 apply for the frequency range from 30 MHz to 1 000 MHz (See also Figure 11). Any of the measurement methods mentioned in Table 3 can be selected by the manufacturer except that the TEM-waveguide shall be used only for battery powered appliances not intended to have external cables attached.

The test report shall state which method was used and which limits were applied. Battery operated appliances which do not contain active electronic circuits or motors shall not be measured. These appliances are considered to comply without testing.

NOTE Examples of active electronic circuits include circuits containing transistors, thyristors and relays. A LED connected to a battery via a manual switch is not an active electronic circuit if the current is limited only by a resistor or a transistor operating linearly, but it is an active switching circuit if the current is pulsed using a transistor. **A1**

4.2 Discontinuous disturbance

Switching operations in thermostatically controlled appliances, automatic programme controlled machines and other electrically controlled or operated appliances generate discontinuous disturbance. The subjective effect of discontinuous disturbance varies with repetition rate and amplitude in audio and video presentation. Therefore distinction is made between various kinds of discontinuous disturbance.

The discontinuous disturbance is only measured with a measuring receiver including a quasi-peak detector as mentioned in 5.1.1 and specified in Clause 4 of CISPR 16-1-1.

See Annex C for guidance.

4.2.1 The limits for discontinuous disturbance depend mainly on the character of the disturbance and on the click rate N as given in detail in 4.2.2 and 4.2.3.

No discontinuous disturbance limits apply in the frequency range 30 MHz to $\sqrt{A_1}$ 1 000 $\sqrt{A_1}$ MHz.

NOTE The level of disturbances below 30 MHz is interpreted as an indication for the level above 30 MHz.

4.2.2 Frequency range 148,5 kHz to 30 MHz (terminal voltages)

4.2.2.1 The limits of Table 1 apply also to discontinuous disturbances from all equipment which produce:

- a) disturbances other than clicks, or
- b) clicks with a click rate N equal to or greater than 30.

Appliances as described in 4.2.3 are exempted.

NOTE Examples of discontinuous disturbances for which the limits for continuous disturbance apply are shown in Figures 4a and 4b.

4.2.2.2 For discontinuous disturbance, the click limit L_q is attained by increasing the relevant limit L (as given in 4.1.1) with:

$$\begin{aligned} &44 \text{ dB} && \text{for } N < 0,2, \text{ or} \\ &20 \lg (30/N) \text{ dB} && \text{for } 0,2 \leq N < 30 \end{aligned}$$

NOTE Examples of discontinuous disturbances which are classified as clicks are shown in Figures 3a, 3b and 3c.

See also Annex A, Table A.1 and Table A.2.

4.2.2.3 The click limit L_q applies for click rates N determined under operating conditions and interpretation of results as specified in Clause 7.

4.2.3 Exceptions from the click definition

Under certain conditions some kinds of discontinuous disturbances are exempted from the definition of a click (see 3.2).

This subclause contains these exceptions which are applicable in combination with subclauses 4.2.1 and 4.2.2 to all kinds of appliances. In Figure 9, a flow diagram shows how to take these conditions into account in the verification procedure.

Product specific relaxations are contained in Annex A, which contains also Table A.2, a list of appliances for which the switching operations are counted, to derive the click rate N .

4.2.3.1 Individual switching operations

The disturbance from individual switching operations, caused directly or indirectly, manually or by similar activities on a switch or a control which is included in an appliance or otherwise to be used for:

- a) the purpose of mains connection or disconnection only;
- b) the purpose of programme selection only;

- c) the control of energy or speed by switching between a limited number of fixed positions;
- d) the changing of the manual setting of a continuously adjustable control such as a variable speed device for water extraction or electronic thermostats, is to be disregarded for the purpose of testing the appliance for compliance with the limits of radio disturbance set out in this standard.

Examples of switches included in this subclause are the on/off switches for apparatus (including foot activated), for instance the switch for an electric typewriter, manual switches for heat and air flow control in fan heaters and hair dryers, as well as the indirectly operated switch in a cupboard, wardrobe or refrigerator, and sensor-operated switches, etc. Switches which usually will be repeatedly operated are not included in this subclause, e.g. for sewing machines, calculating machines, soldering equipment, etc. (see 7.2.3. and 7.3.2.4.c).

Also the disturbance caused by the operation of any switching device or control which is included in an appliance for the purpose of mains disconnection for safety only, is to be disregarded for the purpose of testing the appliance for compliance with the limits of radio disturbance as described in this standard.

4.2.3.2 Combination of clicks in a time frame less than 600 ms

In programme controlled appliances a combination of clicks in a time frame less than 600 ms is allowed once per selected programme cycle.

For other appliances such a combination of clicks is allowed once during the minimum observation time. This is also valid for thermostatically controlled three-phase switches, causing three disturbances sequentially in each of the three phases and the neutral. The combination of clicks is considered as one click.

4.2.3.3 Instantaneous switching

Appliances which fulfil the following conditions:

- the click rate is not more than 5,
- none of the caused clicks has a duration longer than 20 ms,
- 90 % of the caused clicks have a duration less than 10 ms,

shall be deemed to comply with the limits, independent of the amplitude of the clicks (see tables A.1 and A.2). If one of these conditions is not satisfied then the limits in accordance with 4.2.2 apply.

4.2.3.4 Separation of clicks less than 200 ms

For appliances which have a click rate less than 5, any two disturbances each having a maximum duration of 200 ms, shall be evaluated as two clicks even when the separation between the disturbances is less than 200 ms.

In this case, for instance observed with refrigerators, the example shown in Figure 4b, would be evaluated as two clicks and not as continuous disturbance.

5 Methods of measurement of terminal disturbance voltages (148,5 kHz to 30 MHz)

This clause lays down the general requirements for the measurement of disturbance voltage produced at the terminals of apparatus.

The operating conditions are given in Clause 7 of this standard.

5.1 Measuring devices

The measuring devices given below are to be used:

5.1.1 Measuring receivers

Receivers with quasi-peak detectors shall be in accordance with Clause 4 of CISPR 16-1-1; receivers with average detectors shall be in accordance with Clause 6 of CISPR 16-1-1.

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

5.1.2 Artificial mains network

The artificial mains V-network is required to provide a defined impedance at high frequencies between the terminals of the equipment under test and reference ground, and also to isolate the test circuit from unwanted radio-frequency signals on the supply mains.

The artificial mains V-network $50\ \Omega/50\ \mu\text{H}$ (or $50\ \Omega/50\ \mu\text{H} + 5\ \Omega$) as defined in Clause 4 of CISPR 16-1-2 shall be used.

To ensure that, at the frequency of measurement, the impedance of the mains does not materially affect the impedance of the artificial mains V-network, a suitable radio-frequency impedance shall be inserted between the artificial mains V-network and the supply mains. This impedance will also reduce the effect of unwanted signals which occur on the supply mains (see also 5.3).

The connection between the artificial mains V-network and the measuring receiver shall be made by means of a coaxial cable with a characteristic impedance of $50\ \Omega$.

5.1.3 Voltage probe

The voltage probe shall be used when measuring on terminals other than mains terminals (see 5.2.3.2) e.g. load and control terminals (5.2.4.4). The voltage probe shall also be used on mains terminals when the artificial mains V-network cannot be used without unduly influencing the equipment under test or the test equipment, e.g. while measuring motors and heating devices operating at more than 25 A per phase.

The voltage probe contains a resistor having a resistance value of at least $1\ 500\ \Omega$ in series with a capacitor with a reactive value negligible to the resistance (in the range 150 kHz to 30 MHz) (see 5.2 of CISPR 16-1-2).

The measuring results shall be corrected according to the voltage division between the probe and the measuring set. For this correction only the resistive parts of the impedances shall be taken into account.

If the function of the equipment under test is affected by the impedance of the probe being too low, its impedance (at 50/60 Hz and at radio frequencies) shall be increased as needed (for example 15 k Ω in series with 500 pF).

5.1.4 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 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 pF $\pm$ 20 % in series with a resistor of 510 Ω $\pm$ 10 % (see Figure 8a); 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.

5.1.5 Disturbance analyzer for discontinuous disturbance

The measuring equipment for discontinuous disturbance shall comply with Clause 10 of CISPR 16-1-1. An alternative method using an oscilloscope may be applied provided that the degree of accuracy is sufficient.

For the measurement of the duration of the disturbance, see CISPR 16-1-1.

5.2 Measuring procedures and arrangements

5.2.1 Arrangement of the leads of the equipment under test

NOTE Clause 5 and Annex A of CISPR 16-2-1 give more information about the connection of the electrical appliances to the measuring equipment.

5.2.1.1 Mains lead

During all measurements of disturbance terminal voltages (on the mains terminals or on other terminals) the artificial mains V-network is connected to the mains terminals in order to provide a defined termination. As described in detail in 5.2.2 the V-network is situated at a distance of 0,8 m from the appliance.

The disturbance voltage measurements are normally to be made at the plug end of the lead.

If the mains lead of the appliance under test is longer than necessary to be connected to the V-network the length of this lead in excess of 0,8 m shall be folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0,3 m and 0,4 m. In the case of controversy with regard to the banning of sales or withdrawal of a type approval it may be replaced by a lead of similar quality with a length of 1 m.

If the lead on which the measurements are to be made is shorter than the required distance between the appliance and the mains V-network, it shall be extended to the necessary length.

If the mains lead of the appliance under test includes the earthing conductor, the plug end of the earthing conductor shall be connected to the reference ground of the measuring equipment.

Where an earthing conductor is required, but is not included in the lead, the connection of the earth terminal of the appliance to the reference ground of the measuring equipment shall be made by a lead not longer than necessary to be connected to the V-network running parallel to the mains lead at a distance of not more than 0,1 m from it.

If the appliance is not supplied with a lead it is to be connected to the artificial mains V-network by a lead not longer than 1 m (also in case of plug or socket-outlet).

5.2.1.2 Other leads

The lead connecting the appliance with an auxiliary apparatus and the leads to regulating controls or to batteries of battery-powered appliances shall be treated in accordance with 5.2.1.1 except where otherwise stated in this standard.

5.2.2 Disposition of appliances under test and their connection to the artificial mains V-network

5.2.2.1 Appliances normally operated without an earth connection and not held in the hand

The appliance shall be placed 0,4 m above an earthed conducting surface of at least 2 m × 2 m in size and at a distance of 0,8 m from the artificial mains V-network and shall be kept at least 0,8 m from any other earthed conducting surface. If the measurements are made in a screened enclosure, the distance of 0,4 m may be referred to one of the walls of the enclosure.

Equipment that, according to its design and/or weight, usually stands on the floor while in use (so-called floor standing equipment) is subject to the same provisions as above.

However,

- the equipment shall be placed on a horizontal metal ground plane (the reference ground plane), but isolated from it by a non-metallic support (such as a pallet) of 0,1 m ± 25 % in height;
- the lead shall be led downward along the EUT to the level of the non-metallic support and be led horizontally to the artificial V-network;
- the artificial V-network shall be bonded to the reference ground plane (see CISPR 16-2-1);
- the reference ground plane shall extend at least 0,5 m beyond the boundaries of the EUT and have minimum dimensions of 2 m by 2 m.

5.2.2.2 Handheld appliances which are normally operated without an earth connection

Measurements shall first be made in accordance with 5.2.2.1.

Additional measurements shall then be made using the artificial hand described in 5.1.4.

The general principle to be followed in the application of the artificial hand is that the metal foil shall be wrapped around all handles, both fixed and detachable, supplied with the appliance and the terminal M shall additionally be connected to any exposed non-rotating metalwork as specified in 5.2.2.2.2 to 5.2.2.2.4.

Metalwork which is covered with paint or lacquer is considered as exposed metalwork and shall be directly connected to the terminal M of the RC element.

The artificial hand shall be applied only on the handles and grips and those parts of the appliance specified as such by the manufacturer. Failing the manufacturer's specification, the artificial hand shall be applied in the following way:

5.2.2.2.1 When the casing of the appliance is entirely of metal, no metal foil is needed, but the terminal M of the RC element shall be connected directly to the body of the appliance.

5.2.2.2.2 When the casing of the appliance is of insulating material, metal foil shall be wrapped round the handles, e.g. in Figure 8b, around handle B, and also round the second handle D, if present. Also metal foil 60 mm wide shall be wrapped round the body C at that point where the iron core of the motor stator is located, or around the gearbox if this gives a higher disturbance level. All these pieces of metal foil, and the ring or bushing A, if present, shall be connected together and to the terminal M of the RC element.

5.2.2.2.3 When the casing of the appliance is partly metal and partly insulating material, and has insulating handles, metal foil shall be wrapped round the handles, as handles B and D in Figure 8b. If the case is non-metallic at the location of the motor, a metal foil 60 mm wide shall be wrapped round the body C at that point where the iron core of the motor stator is located, or alternatively around the gearbox, if this is of insulating material and a higher disturbance level is obtained. The metal part of the body, the point A, the metal foil round the handles B and D and the metal foil on the body C shall be connected together and to the terminal M of the RC element.

5.2.2.2.4 When a class II appliance has two handles of insulating material A and B and a case of metal C, for example an electric saw (Figure 8c), metal foil shall be wrapped round the handles A and B. The metal foil at A and B and the metal body C shall be connected together and to the terminal M of the RC element.

NOTE Classes 0, I, II and III according to IEC 61140: Classification of electrical and electronic equipment with regard to protection against electric shock.

5.2.2.3 Appliances normally required to be operated with an earth connection

The appliance shall be placed at a distance of 0,8 m from the artificial mains V-network, the disturbance voltages to be measured in accordance with 5.2.1.

The measurements shall be made with the earth terminal of the appliance connected to the reference ground of the measuring equipment.

If the appliance is not supplied with a lead the connection of the earth terminal of the appliance to the reference ground of the measuring equipment shall be made by a lead running parallel to the mains lead and of the same length and at a distance of not more than 0,1 m from it.

If the enclosure of the appliance is of non-conducting material, the appliance shall be tested as described in 5.2.2.1.

Appliance that, according to its design and/or weight, usually is standing on the floor while being in use (so-called floor standing equipment) is subject to the same provision as above.

However,

- it shall be placed on a horizontal metal ground plane (the reference ground plane), but insulated from it by a non-metallic support (e.g. a pallet) of $0,1\text{ m} \pm 25\%$ in height. If the measurements are made in a screened enclosure, the distance of $0,1\text{ m} \pm 25\%$ shall be referred to the metal ground of the screened enclosure;
- the boundaries of the appliance shall have a distance of at least 0,4 m to a grounded vertical conducting surface of at least $2\text{ m} \times 2\text{ m}$ in size. If the measurements are made in a screened enclosure, the distance of 0,4 m shall be referred to the nearest wall of the enclosure;
- the reference ground plane shall extend at least 0,5 m beyond the boundaries of EUT.
- the V-network shall be bonded with metal straps to the reference ground plane (see CISPR 16-2-1);

- the reference ground plane shall be bonded with the vertical surface by a low impedance connection.

5.2.3 Appliances having auxiliary apparatus connected at the end of a lead other than the mains lead

NOTE 1 Regulating controls incorporating semiconductor devices are excluded from this subclause, as these are covered in 5.2.4.

NOTE 2 When the auxiliary apparatus is not essential to the operation of the appliance and has a separate test procedure specified elsewhere in this standard (e.g. power nozzle of a vacuum cleaner) this subclause does not apply. The main appliance is tested as an individual appliance.

Connecting leads exceeding 1 m in length are arranged in accordance with 5.2.1.1.

Measurements need not to be made when the connecting lead between the appliance and the auxiliary apparatus is permanently fixed at both ends, and is either shorter than 2 m, or if it has a shielding whose ends are connected to the metal housing of the appliance and that of the auxiliary apparatus.

The measurement of the terminal voltage on non-rewirable leads longer than 2 m and shorter than 10 m shall be started at a frequency according to the following formula:

$$f_{\text{start}} = 60 / L$$

where

f_{start} is the start frequency for the measurement of the terminal voltage, in megahertz;

L is the length of the connecting lead between the appliance and the auxiliary apparatus, in metres.

NOTE This calculation is based on the requirement that the length of the auxiliary lead shall not exceed one-fifth of the wave length, corresponding to the start frequency of the measurement.

5.2.3.1 Measuring arrangement

The equipment under test shall be arranged in accordance with 5.2.2 with the following additional requirements:

- a) The auxiliary apparatus shall be placed at the same height and distance from the earthed conducting surface as the main appliance, and if the auxiliary lead is long enough, at a distance of 0,8 m from the main appliance, 5.2.1.1 shall be observed.

If the auxiliary lead is shorter than 0,8 m, the auxiliary apparatus shall be placed at the longest possible distance from the main apparatus.

If the auxiliary lead is longer than 0,8 m, the length of the auxiliary lead in excess of 0,8 m shall be folded parallel to itself so as to form a horizontal bundle with a length between 0,3 m and 0,4 m.

The auxiliary lead is stretched in the opposite direction to the mains lead.

When the auxiliary apparatus contains controls, the arrangements for its operation must not unduly affect the level of disturbance;

- b) If an appliance having an auxiliary apparatus is earthed, no artificial hand shall be connected. If the appliance itself is made to be held in the hand, the artificial hand shall be connected to the appliance and not to any auxiliary apparatus;
- c) If the appliance is not made to be held in the hand, the auxiliary apparatus which is not earthed and is made to be held in the hand shall be connected to the artificial hand; if the auxiliary apparatus is not made to be held in the hand either, it shall be placed above an earthed conducting surface as described in 5.2.2.1.

5.2.3.2 Measuring procedure

In addition to the measurement on the terminals for the mains connection, measurements are conducted on all other terminals for incoming and outgoing leads (e.g. control and load lines) using a probe as described in 5.1.3 in series with the input of the measuring receiver.

The auxiliary apparatus, control or load is connected to allow measurements to be made under all provided operating conditions and during interactions between the appliance and the auxiliary apparatus.

Measurements are performed both on the terminals of the appliance and on those of the auxiliary apparatus.

5.2.4 Regulating controls incorporating semiconductor devices

5.2.4.1 The regulating control shall be arranged as shown in Figure 5. The output terminal of the control shall be connected to a load of the correct rated value by leads of 0,5 m to 1 m length.

Unless otherwise specified by the manufacturer, the load shall consist of incandescent lamps.

5.2.4.2 When a regulating control or its load is to be operated with an earth connection (i.e. Class I equipment) then the earth terminal of the regulating control shall be connected to the earth terminal of the artificial mains V-network. The earth terminal of the load, if any, is connected to the earth terminal of the regulating control, or, if not available, directly to the earth terminal of the artificial mains V-network.

5.2.4.3 The control shall first be measured in accordance with the provisions of 5.2.2.1 or 5.2.2.3.

5.2.4.4 Secondly, measurement of the disturbance voltage is made at the load terminals using a probe as described in 5.1.3 in series with the input of the measuring receiver.

5.2.4.5 For regulating controls having additional terminals for connection to a remote sensor or control unit, the following further provisions apply:

- a) The additional terminals shall be connected to the remote sensor or control unit by leads of 0,5 m to 1 m length. If a special lead is provided, the length of this lead in excess of 0,8 m shall be folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0,3 m and 0,4 m.
- b) Measurement of the disturbance voltage at the additional terminals of the regulating control shall be carried out in the same way as described in 5.2.4.4 for the load terminals.

5.3 Reduction of disturbance not produced by the equipment under test

Any measurable disturbance voltage not caused by the equipment under test (arising from the supply mains or produced by extraneous fields), shall give an indication on the measuring set at least 20 dB below the lowest voltage to which it is desired to measure.

Should the background noise not be at least 20 dB below the measurement level, it should be quoted in the results of measurement.

The disturbance voltages not caused by the equipment to be tested are measured when the equipment under test is connected but not operated.