

**Specification for radio disturbance and immunity  
measuring apparatus and methods –**

**Part 1-4:**

**Radio disturbance and immunity measuring  
apparatus – Ancillary equipment –  
Radiated disturbances**

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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## CONTENTS

FOREWORD.....	9
1 Scope.....	13
2 Normative references.....	13
3 Terms and definitions .....	15
4 Antennas for measurement of radiated radio disturbance .....	17
4.1 Accuracy of field-strength measurements.....	17
4.2 Frequency range 9 kHz to 150 kHz .....	19
4.3 Frequency range 150 kHz to 30 MHz.....	19
4.4 Frequency range 30 MHz to 300 MHz.....	21
4.5 Frequency range 300 MHz to 1 000 MHz.....	29
4.6 Frequency range 1 GHz to 18 GHz.....	31
4.7 Special antenna arrangements.....	31
5 Test sites for measurement of radio disturbance field strength for the frequency range of 30 MHz to 1 000 MHz.....	33
5.1 Open area test site .....	33
5.2 Weather protection enclosure.....	33
5.3 Obstruction-free area.....	33
5.4 Ambient radio frequency environment of a test site .....	35
5.5 Ground plane.....	39
5.6 Open area site validation procedure.....	39
5.7 Test site suitability with ground-plane.....	47
5.8 Test site suitability without ground-plane.....	57
5.9 Evaluation of set-up table and antenna tower .....	75
6 Reverberating chamber for total radiated power measurement .....	79
6.1 Chamber .....	79
7 TEM cells for immunity to radiated disturbance measurement.....	85
8 Test sites for measurement of radio disturbance field strength for the frequency range 1 GHz to 18 GHz.....	85
8.1 Reference test site .....	85
8.2 Validation of the test site.....	85
8.3 Alternative test site .....	113
Annex A (normative) Parameters of broadband antennas.....	115
Annex B (normative) Monopole (1 m rod antenna) performance equations and characterization of the associated antenna matching network .....	123
Annex C (normative) Loop antenna system for magnetic field induced current measurements in the frequency range of 9 kHz to 30 MHz.....	133
Annex D (informative) Construction details for open area test sites in the frequency range of 30 MHz to 1 000 MHz (Clause 5) .....	151
Annex E (normative) Validation procedure of the open area test site for the frequency range of 30 MHz to 1 000 MHz (Clause 5) .....	159
Annex F (informative) Basis for 4 dB site acceptability criterion (Clause 5).....	175
Bibliography .....	179

Figure 1 – Short dipole antenna factors for $R_L = 50 \Omega$ .....	23
Figure 2 – Obstruction-free area of a test site with a turntable (see 5.3).....	37
Figure 3 – Obstruction-free area with stationary EUT (see 5.3) .....	37
Figure 4 – Configuration of equipment for measuring site attenuation in horizontal polarization (see 5.6 and Annex E) .....	41
Figure 5 – Configuration of equipment for measuring site attenuation in vertical polarization using tuned dipoles (see 5.6 and Annex E) .....	41
Figure 6a – Typical antenna positions for alternative test site – Vertical polarization NSA measurements .....	51
Figure 6b – Typical antenna positions for alternative test site – Horizontal polarization NSA measurements .....	51
Figure 6c – Typical antenna positions for alternative test site – Vertical polarization NSA measurements for an EUT that does not exceed a volume of 1 m depth, 1,5 m width, 1,5 m height, with the periphery greater than 1 m from the closest material that may cause undesirable reflections .....	53
Figure 6d – Typical antenna positions for alternative test site – Horizontal polarization NSA measurements for an EUT that does not exceed a volume of 1 m depth, 1,5 m width and 1,5 m height, with the periphery greater than 1 m from the closest material that may cause undesirable reflections .....	53
Figure 6 – Typical antenna positions for alternative test sites .....	53
Figure 7 – Graph of theoretical free-space NSA as a function of the frequency for different measurement distances (see Equation 4) .....	59
Figure 8 – Measurement positions for the site validation procedure.....	65
Figure 9 – Example of one measurement position and antenna tilt for the site validation procedure .....	67
Figure 10 – Typical free-space site reference measurement set-up.....	73
Figure 11 – Position of the antenna relative to the edge above a rectangle set-up table (top view).....	79
Figure 12 – Antenna position above the set-up table (side view) .....	79
Figure 13 – Example of a typical paddle stirrer .....	81
Figure 14 – Range of coupling attenuation as a function of frequency for a chamber using the stirrer in Figure 13.....	83
Figure 15 – Transmit antenna E-Plane radiation pattern example (for informative purposes only) .....	91
Figure 16 – Transmit antenna H-plane radiation pattern (for informative purposes only).....	93
Figure 17 – $S_{VSWR}$ measurement positions in a horizontal plane – see 8.2.2.2.1 for description .....	95
Figure 18 – $S_{VSWR}$ positions (height requirements).....	99
Figure 19 – Conditional test position requirements.....	111
Figure B.1 – Method using network analyser.....	127
Figure B.2 – Method using radio-noise meter and signal generator .....	127
Figure B.3 – Example of mounting capacitor in dummy antenna.....	129
Figure C.1 – The loop-antenna system, consisting of three mutually perpendicular large-loop antennas .....	135
Figure C.2 – A large-loop antenna containing two opposite slits, positioned symmetrically with respect to the current probe C .....	137

Figure C.3 – Construction of the antenna slit .....	139
Figure C.4 – Example of antenna-slit construction using a strap of printed circuit board to obtain a rigid construction .....	139
Figure C.5 – Construction for the metal box containing the current probe .....	141
Figure C.6 – Example showing the routing of several cables from an EUT to ensure that there is no capacitive coupling from the leads to the loop.....	141
Figure C.7 – The eight positions of the balun-dipole during validation of the large-loop antenna .....	143
Figure C.8 – Validation factor for a large loop-antenna of 2 m diameter .....	143
Figure C.9 – Construction of the balun-dipole .....	145
Figure C.10 – Conversion factors $C_{dA}$ (for conversion into dB ( $\mu A/m$ )) and $C_{dV}$ (for conversion into dB ( $\mu V/m$ )) for two standardized measuring distances $d$ .....	147
Figure C.11 – Sensitivity $S_D$ of a large-loop antenna with diameter $D$ relative to a large-loop antenna having a diameter of 2 m .....	147
Figure D.1 – The Rayleigh criterion for roughness in the ground plane.....	153
Table 1 – Normalized site attenuation (recommended geometries for tuned half-wave dipoles with horizontal polarization) .....	55
Table 2 – Normalized site attenuation* (recommended geometries for broadband antennas).....	57
Table 3 – Maximum dimensions of test volume versus test distance .....	63
Table 4 – Frequency ranges and step sizes .....	69
Table 5 – $S_{VSWR}$ test positions .....	101
Table 6 – $S_{VSWR}$ reporting requirements.....	113
Table E.1 – Normalized site attenuation* (Recommended geometries for broadband antennas).....	167
Table E.2 – Normalized site attenuation (Recommended geometries for tuned half-wave dipoles, horizontal polarization) .....	169
Table E.3 – Normalized site attenuation (Recommended geometries for tuned half-wave dipoles – vertical polarization) .....	171
Table E.4 – Mutual coupling correction factors for geometry using resonant tunable dipoles spaced 3 m apart .....	173
Table F.1 – Error budget .....	175

INTERNATIONAL ELECTROTECHNICAL COMMISSION  
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY  
MEASURING APPARATUS AND METHODS –**

**Part 1-4: Radio disturbance and immunity measuring apparatus –  
Ancillary equipment – Radiated disturbances**

FOREWORD

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International Standard CISPR 16-1-4 has been prepared by CISPR subcommittee A: Radio interference measurements and statistical methods.

This second edition of CISPR 16-1-4 cancels and replaces the first edition published in 2003, amendment 1 (2004) and amendment 2 (2005).

The document CISPR/A/710/FDIS, circulated to the National Committees as amendment 3, led to the publication of the new edition.

The text of this standard is based on the first edition, its Amendment 1, Amendment 2 and the following documents:

FDIS	Report on voting
CISPR/A/710/FDIS	CISPR/A/722/RVD

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

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

A list of all parts of CISPR 16 series, under the general title *Specification for radio disturbance and immunity measuring apparatus and methods*, can be found on the IEC website.

CISPR 16-1 consists of the following parts, under the general title *Specification for radio disturbance and immunity measuring apparatus and methods – Radio disturbance and immunity measuring apparatus*:

Part 1-1: Measuring apparatus

Part 1-2: Ancillary equipment – Conducted disturbances

Part 1-3: Ancillary equipment – Disturbance power

Part 1-4: Ancillary equipment – Radiated disturbances

Part 1-5: Antenna calibration test sites for 30 MHz to 1 000 MHz

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.



## SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

### Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radiated disturbances

#### 1 Scope

This part of CISPR 16 is designated a basic standard, which specifies the characteristics and performance of equipment for the measurement of radiated disturbances in the frequency range 9 kHz to 18 GHz.

Specifications for ancillary apparatus are included for: antennas and test sites, TEM cells, and reverberating chambers.

The requirements of this publication must be complied with at all frequencies and for all levels of radiated disturbances within the CISPR indicating range of the measuring equipment.

Methods of measurement are covered in Part 2-3, and further information on radio disturbance is given in Part 3 of CISPR 16. Uncertainties, statistics and limit modelling are covered in Part 4 of CISPR 16.

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

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

CISPR 16-3, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 3: CISPR technical reports*

CISPR 16-4 (all parts), *Specification for radio disturbance and immunity measuring apparatus and methods – Uncertainties, statistics and limit modelling*

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, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. Also see IEC 60050(161).

#### 3.1

##### **bandwidth**

##### **$B_n$**

width of the overall selectivity curve of the receiver between two points at a stated attenuation, below the midband response

NOTE The bandwidth is represented by the symbol  $B_n$ , where  $n$  is the stated attenuation in decibels.

#### 3.2

##### **CISPR indicating range**

range specified by the manufacturer which gives the maximum and the minimum meter indications within which the receiver meets the requirements of this part of CISPR 16

#### 3.3

##### **calibration test site**

##### **CALTS**

open area test site with metallic ground plane and tightly specified site attenuation performance in horizontal and vertical electric field polarization

NOTE 1 A CALTS is used for determining the free-space antenna factor of an antenna.

NOTE 2 Site attenuation measurements of a CALTS are used for comparison to corresponding site attenuation measurements of a compliance test site, in order to evaluate the performance of the compliance test site.

#### 3.4

##### **compliance test site**

##### **COMTS**

environment which assures valid, repeatable measurement results of disturbance field strength from equipment under test for comparison to a compliance limit

#### 3.5

##### **antenna**

that part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves in a specified way

NOTE 1 In the context of this standard, the balun is a part of the antenna.

NOTE 2 See also the term "wire antenna".

#### 3.6

##### **balun**

passive electrical network for the transformation from a balanced to an unbalanced transmission line or device or vice versa

#### 3.7

##### **free-space-resonant dipole**

wire antenna consisting of two straight colinear conductors of equal length, placed end to end, separated by a small gap, with each conductor approximately a quarter-wavelength long such that at the specified frequency the input impedance of the wire antenna measured across the gap is pure real when the dipole is located in the free space

NOTE 1 In the context of this standard, this wire antenna connected to the balun is also called the "test antenna".

NOTE 2 This wire antenna is also referred to as "tuned dipole".

### 3.8

#### **site attenuation**

insertion loss determined by a two-port measurement, when a direct electrical connection between the generator output and receiver input is replaced by transmitting and receiving antennas placed at the specified positions

### 3.9

#### **test antenna**

combination of the free-space-resonant dipole and the specified balun

NOTE For the purpose of this standard only.

### 3.10

#### **wire antenna**

a specified structure consisting of one or more metallic wires or rods for radiating or receiving electromagnetic waves

NOTE A wire antenna does not contain a balun.

### 3.11

#### **fully anechoic room**

##### **FAR**

shielded enclosure, the internal surfaces of which are lined with radio-frequency absorbing material (i.e. RF absorber), which absorbs electromagnetic energy in the frequency range of interest

### 3.12

#### **quasi-free space test-site**

test-site for which the site attenuation measured with vertically polarized tuned dipoles deviates by no more than  $\pm 1$  dB from the calculated free-space attenuation at any frequency

### 3.13

#### **test volume**

volume in the FAR in which the EUT is positioned

NOTE In this volume the quasi-free space condition is met and this volume is typically 0,5 m or more from the absorbing material of the FAR.

## 4 Antennas for measurement of radiated radio disturbance

The antenna and the circuits inserted between it and the measuring receiver shall not appreciably affect the overall characteristics of the measuring receiver. When the antenna is connected to the measuring receiver, the measuring system shall comply with the bandwidth requirements of CISPR 16-1-1 appropriate to the frequency band concerned.

The antenna shall be substantially plane polarized. It shall be orientable so that all polarizations of incident radiation can be measured. The height of the centre of the antenna above ground may have to be adjustable according to a specific test procedure.

For additional information about the parameters of broadband antennas see Annex A.

### 4.1 Accuracy of field-strength measurements

The accuracy of field-strength measurement of a uniform field of a sine-wave shall be better than  $\pm 3$  dB when an antenna meeting the requirements of this subclause is used with a measuring receiver meeting the requirements of CISPR 16-1-1.

NOTE This requirement does not include the effect due to a test site.

## 4.2 Frequency range 9 kHz to 150 kHz

Experience has shown that, in this frequency range, it is the magnetic field component that is primarily responsible for observed instances of interference.

### 4.2.1 Magnetic antenna

For measurement of the magnetic component of the radiation, either an electrically-screened loop antenna of dimension such that the antenna can be completely enclosed by a square having sides of 60 cm in length, or an appropriate ferrite-rod antenna, may be used.

The unit of the magnetic field strength is  $\mu\text{A/m}$  or, in logarithmic units,  $20 \log(\mu\text{A/m}) = \text{dB}(\mu\text{A/m})$ . The associated emission limit shall be expressed in the same units.

NOTE Direct measurements can be made of the strength of the magnetic component, in  $\text{dB}(\mu\text{A/m})$  or  $\mu\text{A/m}$  of a radiated field under all conditions, that is, both in the near field and in the far field. However, many field strength measuring receivers are calibrated in terms of the equivalent plane wave electric field strength in  $\text{dB}(\mu\text{V/m})$ , i.e. assuming that the ratio of the  $E$  and  $H$  components is  $120 \pi$  or  $377 \Omega$ . This assumption is justified under far-field conditions at distances from the source exceeding one sixth of a wavelength ( $\lambda/2\pi$ ), and in such cases the correct value for the  $H$  component can be obtained by dividing the  $E$  value indicated on the receiver by 377, or by subtracting 51,5 dB from the  $E$  level in  $\text{dB}(\mu\text{V/m})$  to give the  $H$  level in  $\text{dB}(\mu\text{A/m})$ .

It should be clearly understood that the above fixed  $E$  and  $H$  ratio applies only under far-field conditions.

To obtain the reading of  $H$  ( $\mu\text{A/m}$ ), the reading  $E$  ( $\mu\text{V/m}$ ) is divided by 377  $\Omega$ :

$$H (\mu\text{A/m}) = E (\mu\text{V/m}) \times 377 \Omega \quad (1)$$

To obtain the reading of  $H$   $\text{dB}(\mu\text{A/m})$ , 51,5  $\text{dB}(\Omega)$  is subtracted from the reading  $E$   $\text{dB}(\mu\text{V/m})$ :

$$H \text{ dB}(\mu\text{A/m}) = E \text{ dB}(\mu\text{V/m}) - 51,5 \text{ dB}(\Omega) \quad (2)$$

The impedance  $Z = 377 \Omega$ , with  $20 \log Z = 51,5 \text{ dB}(\Omega)$ , used in the above conversions is a constant originating from the calibration of field strength measuring equipment indicating the magnetic field in  $\mu\text{V/m}$  (or  $\text{dB}(\mu\text{V/m})$ ).

### 4.2.2 Balance of antenna

The balance of the antenna shall be such that, when the antenna is rotated in a uniform field, the level in the cross-polarization direction is at least 20 dB below that in the parallel polarization direction.

## 4.3 Frequency range 150 kHz to 30 MHz

### 4.3.1 Electric antenna

For the measurement of the electric component of the radiation, either a balanced or an unbalanced antenna may be used. If an unbalanced antenna is used, the measurement will refer only to the effect of the electric field on a vertical rod antenna. The type of antenna used shall be stated with the results of the measurements.

Information pertaining to calculating the performance characteristics of a 1 m length monopole (rod) antenna and the characterization of its matching network is specified in Annex B.

Where the distance between the source of radiation and the antenna is 10 m or less, the total length of the antenna shall be 1 m. For distances greater than 10 m the preferred antenna length is 1 m, but in no case shall it exceed 10 % of the distance.

The unit of electric field strength shall be  $\mu\text{V/m}$  or, in logarithmic units,  $20 \log(\mu\text{V/m}) = \text{dB}(\mu\text{V/m})$ . The associated emission limit shall be expressed in the same units.

### 4.3.2 Magnetic antenna

For the measurement of the magnetic component of the radiation, an electrically-screened loop antenna, as described in 4.2.1 shall be used.

Tuned electrically balanced loop antennas may be used to make measurements at lower field strengths than untuned electrically-screened loop antennas.

### 4.3.3 Balance of antenna

If a balanced electric or a magnetic antenna is used, it shall comply with the requirement of 4.2.2.

## 4.4 Frequency range 30 MHz to 300 MHz

### 4.4.1 Electric antenna

The reference antenna shall be a balanced dipole.

#### 4.4.1.1 Balanced dipole

For frequencies 80 MHz or above, the antenna shall be resonant in length, and for frequencies below 80 MHz it shall have a length equal to the 80 MHz resonant length and shall be tuned and matched to the feeder by a suitable transforming device. Connection to the input of the measuring apparatus shall be made through a symmetric-asymmetric transformer arrangement.

#### 4.4.1.2 Shortened dipole

A dipole shorter than a half wavelength may be used provided:

- the total length is greater than 1/10 of a wavelength at the frequency of measurement;
- it is connected to a cable sufficiently well matched at the receiver end to ensure a voltage standing wave ratio (v.s.w.r.) on the cable of less than 2.0 to 1. The calibration shall take account of the v.s.w.r.;
- it has a polarization discrimination equivalent to that of a tuned dipole (see 4.4.2). To obtain this, a balun may be helpful;
- for determination of the measured field strength, a calibration curve (antenna factor) is determined and used in the measuring distance (i.e., at a distance of at least three times the length of the dipole);

NOTE The antenna factors thus obtained should make it possible to fulfil the requirement of measuring uniform sine-wave fields with an accuracy not worse than  $\pm 3$  dB. Examples of calibration curves are given in Figure 1 which shows the theoretical relation between field strength and receiver input voltage for a receiver of input impedance of  $50 \Omega$ , and for various  $l/d$  ratios. On these figures, the balun is considered as an ideal 1:1 transformer. It should be noted, however, that these curves do not account for the losses of the balun, the cable and any mismatch between the cable and the receiver.

- in spite of the sensitivity loss of the field-strength meter due to a high antenna factor attributed to the shortened length of the dipole, the measuring limit of the field-strength meter (determined for example by the noise of the receiver and the transmission factor of the dipole) shall remain at least 10 dB below the level of the measured signal.

