INTERNATIONAL ELECTROTECHNICAL COMMISSION

CISPR 16-1-4

First edition
2003-11

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

*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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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 first edition of CISPR 16-1-4, together with CISPR 16-1-1, CISPR 16-1-2, CISPR 16-1-3 and CISPR 16-1-5, cancels and replaces the second edition of CISPR 16-1, published in 1999, amendment 1 (2002) and amendment 2 (2003). It contains the relevant clauses of CISPR 16-1 without technical changes.

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

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

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- withdrawn;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

INTRODUCTION

CISPR 16-1, CISPR 16-2, CISPR 16-3 and CISPR 16-4 have been reorganised into 14 parts, to accommodate growth and easier maintenance. The new parts have also been renumbered. See the list given below.

Old CISPR 16 publications		New CISPR 16 publications	
CISPR 16-1	Radio disturbance and immunity measuring apparatus	CISPR 16-1-1	Measuring apparatus
		CISPR 16-1-2	Ancillary equipment – Conducted disturbances
		CISPR 16-1-3	Ancillary equipment – Disturbance power
		CISPR 16-1-4	Ancillary equipment – Radiated disturbances
		CISPR 16-1-5	Antenna calibration test sites for 30 MHz to 1 000 MHz
CISPR 16-2	Methods of measurement of disturbances and immunity	CISPR 16-2-1	Conducted disturbance measurements
		CISPR 16-2-2	Measurement of disturbance power
		CISPR 16-2-3	Radiated disturbance measurements
		CISPR 16-2-4	Immunity measurements
CISPR 16-3	Reports and recommendations of CISPR	CISPR 16-3	CISPR technical reports
		CISPR 16-4-1	Uncertainties in standardised EMC tests
		CISPR 16-4-3	Statistical considerations in the determination of EMC compliance of mass-produced products
		CISPR 16-4-4	Statistics of complaints and a model for the calculation of limits
CISPR 16-4	Uncertainty in EMC measurements	CISPR 16-4-2	Measurement instrumentation uncertainty

More specific information on the relation between the 'old' CISPR 16-1 and the present 'new' CISPR 16-1-4 is given in the table after this introduction (TABLE RECAPITULATING CROSS REFERENCES).

Measurement instrumentation specifications are given in five new parts of CISPR 16-1, while the methods of measurement are covered now in four new parts of CISPR 16-2. Various reports with further information and background on CISPR and radio disturbances in general are given in CISPR 16-3. CISPR 16-4 contains information related to uncertainties, statistics and limit modelling.

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.

TABLE RECAPITULATING CROSS REFERENCES

Second edition of CISPR 16-1 Clauses, subclauses	First edition of CISPR 16-1-4 Clauses, subclauses
1	1
2	2
3	3
5.5	4
5.6	5
5.7	6
5.9	7
5.12	8
Annexes	Annexes
O	A
X	B
P	C
K	D
G	E
L	F
Figures	Figures
13, …, 17	1, .., 5
51	6
18,19	7,8
43	B.1
P.1, …, P.11	C.1, …, C.11
Tables	Tables
16,17	1,2

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 shall 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 14-1:2000, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

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 16-1-5:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-5: Radio disturbance and immunity measuring apparatus – Antenna calibration and site validation*

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

CISPR 16-2-3:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of immunity and disturbance – Radiated disturbance measurements*

CISPR 16-3:2003, *Specification for radio disturbance and Immunity measuring apparatus and methods – Part 3: CISPR technical reports*

CISPR 16-4-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-1: Uncertainties, statistics and limit modelling – Uncertainties in standardized EMC tests*

CISPR 16-4-2:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainties*

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

International Vocabulary of Basic and General Terms in Metrology, International Organization for Standardization, Geneva, 2nd edition, 1993

3 Definitions

For the purpose of this part of CISPR 16, the following definitions apply. Also see IEC 60050(161).

3.1
bandwidth (B_n)
the width of the overall selectivity curve of the receiver between two points at a stated attenuation, below the midband response. The bandwidth is represented by the symbol B_n, where *n* is the stated attenuation in decibels

3.2
CISPR indicating range
it is the 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.

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

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
site attenuation between two specified positions on a test site is the 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 antennae 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.

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 ±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 μA/m or, in logarithmic units, 20 log(μA/m) = dB(μA/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 dB(μA/m) or μA/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 dB(μV/m), i.e. assuming that the ratio of the *E* and *H* components is 120 π or 377 Ω. This assumption is justified under far-field conditions at distances from the source exceeding one sixth of a wavelength (λ/2π), 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 dB(μV/m) to give the *H* level in dB(μA/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* (μA/m), the reading *E* (μV/m) is divided by 377 Ω:

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

To obtain the reading of *H* dB(μA/m), 51,5 dB(Ω) is subtracted from the reading *E* dB(μV/m):

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

The impedance *Z* = 377 Ω, with 20 log *Z* = 51,5 dB(Ω), used in the above conversions is a constant originating from the calibration of field strength measuring equipment indicating the magnetic field in μV/m (or dB(μV/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 µV/m or, in logarithmic units, 20 log(µV/m) = dB(µVm). 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:

a) the total length is greater than 1/10 of a wavelength at the frequency of measurement;
b) 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.;
c) it has a polarization discrimination equivalent to that of a tuned dipole (see 4.4.2). To obtain this, a balun may be helpful;
d) 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 ±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 Ω, 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.

e) 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.

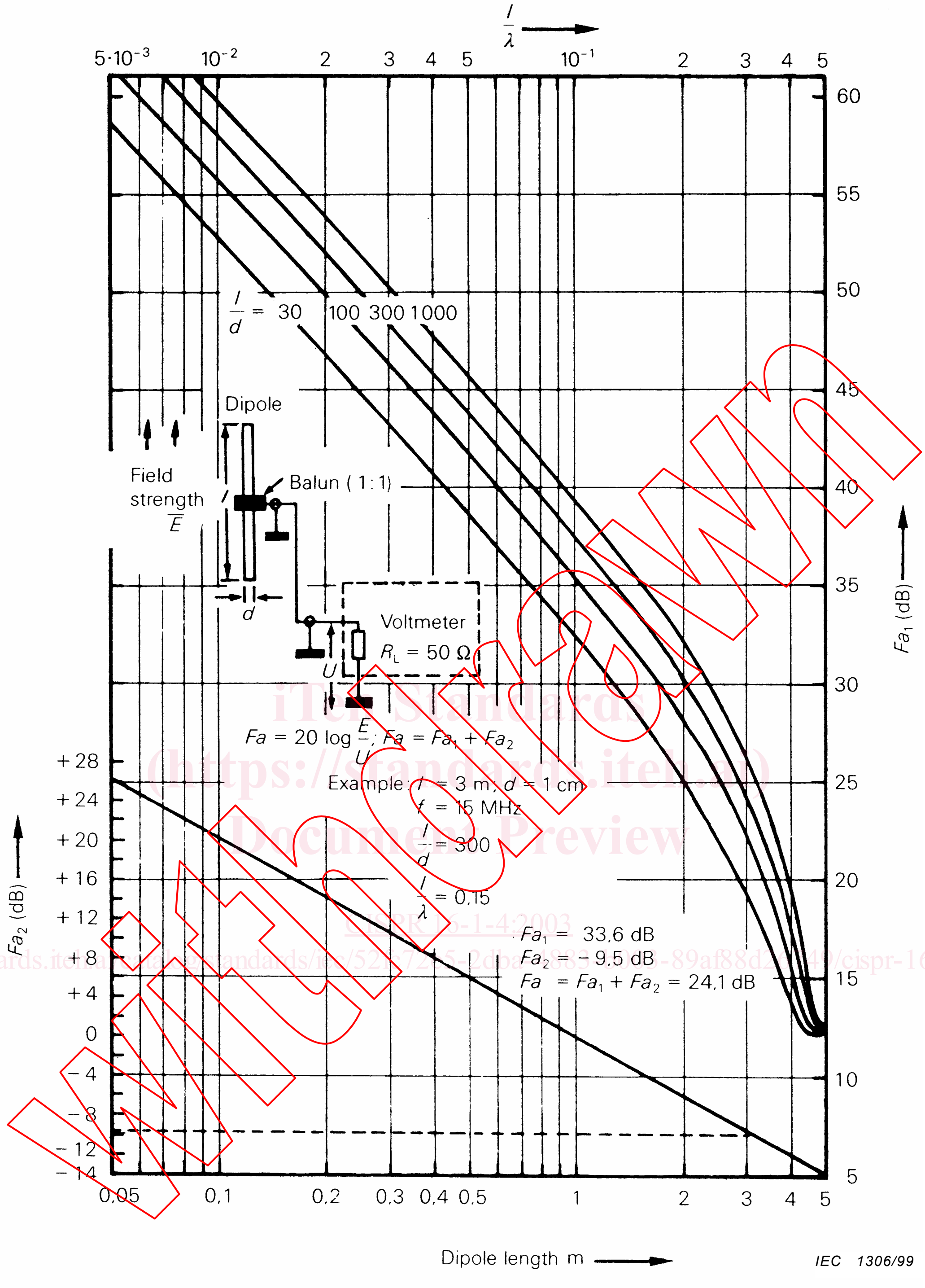

Figure 1 – Short dipole antenna factors for R_L = 50 Ω