

Edition 1:2003 consolidated with amendments 1:2004 and 2:2006

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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

Part 1-2:

**Radio disturbance and immunity measuring
apparatus – Ancillary equipment –
Conducted 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.*

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

Edition 1:2003 consolidated with amendments 1:2004 and 2:2006

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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

Part 1-2:

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

(<https://standards.iteh.ai>)
Document Preview

<https://standards.iteh.ai>
CISPR 16-1-2:2003

<https://standards.iteh.ai/catalog/standards/iec/4a261412-5bca-4b18-ac73-e7689ba33463/cispr-16-1-2-2003>

© IEC 2006 Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

CT

For price, see current catalogue

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	9
TABLE RECAPITULATING CROSS-REFERENCES.....	11
1 Scope.....	13
2 Normative references.....	13
3 Definitions.....	15
4 Artificial mains networks.....	17
5 Current and voltage probes.....	35
6 Coupling units for conducted current immunity measurement.....	45
7 Coupling devices for measuring signal lines.....	47
8 The artificial hand and series RC element.....	55
Annex A (normative) Artificial mains networks (clause 4).....	65
Annex B (informative) Construction, frequency range, and calibration of current probes (clause 5).....	83
Annex C (informative) Construction of the coupling units for current injection for the frequency range 0,15 MHz to 30 MHz (clause 6).....	101
Annex D (informative) Principle of operation and examples of coupling units for conducted current immunity measurements (clause 6).....	113
Annex E (normative) Example and measurement of the parameters of the asymmetric artificial network (AAN).....	121
Annex F (normative) Example and measurement of the parameters of the AN for coaxial and other screened cables.....	131
Annex G (informative) Construction and evaluation of capacitive voltage probe (subclause 5.2.2).....	135
Annex H (informative) Rationale for the introduction of a minimum decoupling factor between mains and EUT/receiver ports for the V-AMN.....	149
Annex I (informative) Rationale for the introduction of a phase tolerance for the V-AMN input impedance.....	151

INTERNATIONAL ELECTROTECHNICAL COMMISSION
INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

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

**Part 1-2: Radio disturbance and immunity measuring apparatus –
Ancillary equipment – Conducted disturbances**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard CISPR 16-1-2 has been prepared by CISPR subcommittee A: Radio interference measurements and statistical methods.

This consolidated version of CISPR 16-1-2 consists of the first edition (2003), its amendment 1 (2004) [documents CIS/A/503/FDIS and CIS/A/521/RVD] and its amendment 2 (2006) [documents CIS/A/654/FDIS and CIS/A/670/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 1.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

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

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the 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.

Withdawn

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

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 16-4-2 Measurement instrumentation uncertainty
		→	CISPR 16-4-3 Statistical considerations in the determination of EMC compliance of mass-produced products
CISPR 16-4	Uncertainty in EMC measurements	→	CISPR 16-4-4 Statistics of complaints and a model for the calculation of limits

More specific information on the relation between the 'old' CISPR 16-1 and the present 'new' CISPR 16-1-2 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

First edition of CISPR 16-1-2

Clauses, subclauses

Clauses, subclauses

2
3.8, ..., 3.10
3.20, .., 3.23

2
3.1, ..., 3.3
3.4, ..., 3.7

5.1
5.2
5.8
5.10
5.11

4
5
6
7
8

Annexes

Annexes

F
I
M
N
Q
Z

A
B
C
D
E
F

Tables

Tables

18, 22

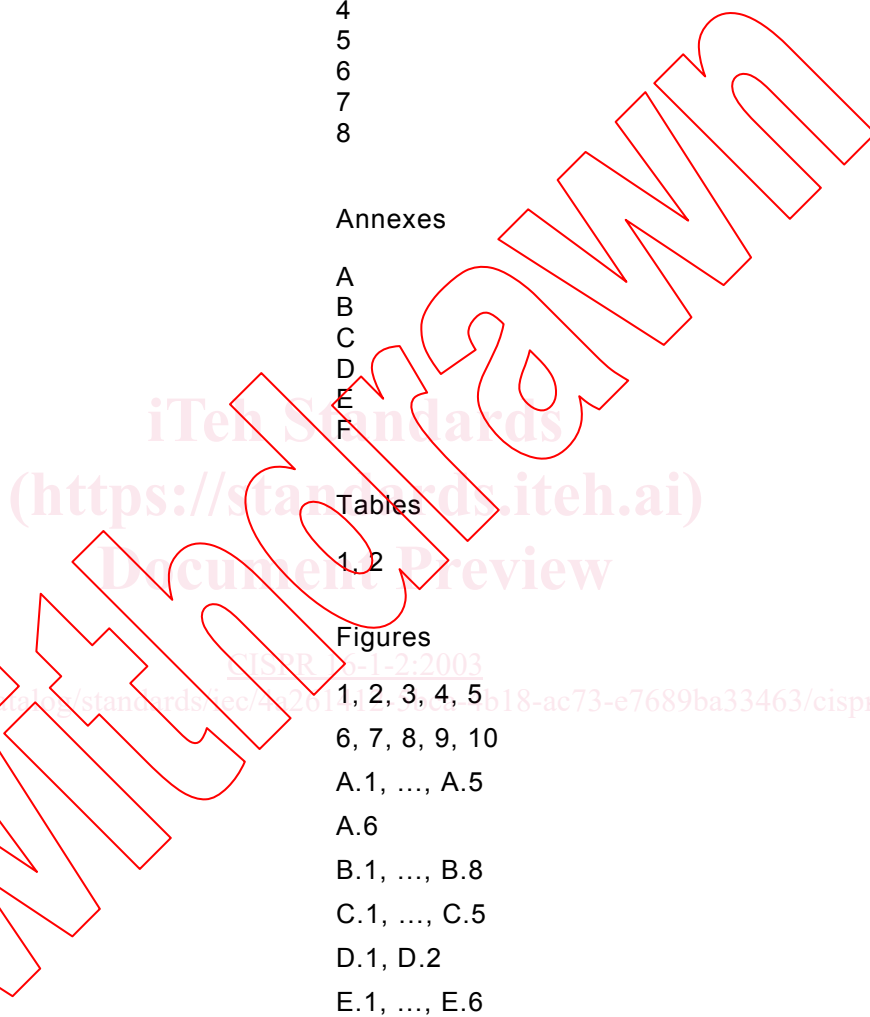
1, 2

Figures

Figures

7, 8, 9, 23, 24
10, 20, 52, 53, 54
25, ..., 29
F.1
30, ..., 37
44, ..., 48
49, 50
Q.1, ..., Q.6

1, 2, 3, 4, 5
6, 7, 8, 9, 10
A.1, ..., A.5
A.6
B.1, ..., B.8
C.1, ..., C.5
D.1, D.2
E.1, ..., E.6



SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted 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 radio disturbance voltages and currents in the frequency range 9 kHz to 1 GHz.

Specifications for ancillary apparatus are included for: artificial mains networks, current and voltage probes and coupling units for current injection on cables.

The requirements of this publication shall be complied with at all frequencies and for all levels of radio disturbance voltages and currents within the CISPR indicating range of the measuring equipment.

Methods of measurement are covered in Part 2, and further information on radio disturbance is given in Part 3 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 16-2-1:2003, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of immunity and disturbance – Conducted disturbance measurements*

CISPR 16-3:2003, *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

symmetric voltage

in a two-wire circuit, such as a single-phase mains supply, the symmetric voltage is the radio-frequency disturbance voltage appearing between the two wires. This is sometimes called the differential mode voltage. If V_a is the vector voltage between one of the mains terminals and earth and V_b is the vector voltage between the other mains terminal and earth, the symmetric voltage is the vector difference ($V_a - V_b$)

3.2

asymmetric voltage

the asymmetric voltage is the radio-frequency disturbance voltage appearing between the electrical mid-point of the mains terminals and earth. It is sometimes called the common mode voltage and is half the vector sum of V_a and V_b , i.e., $(V_a + V_b)/2$

3.3

unsymmetric voltage

the amplitude of the vector voltage, V_a or V_b defined in 3.1 and 3.2. This is the voltage measured by the use of an artificial mains V-network

3.4

artificial mains network AMN

provides a defined impedance to the EUT at radio frequencies, couples the disturbance voltage to the measuring receiver and decouples the test circuit from the supply mains. There are two basic types of AMN, the V-network (V-AMN) which couples the unsymmetrical voltages, and the delta-network which couples the symmetric and the asymmetric voltages separately. The terms line impedance stabilization network (LISN) and V-AMN are used interchangeably

3.5

asymmetric artificial network (AAN)

network used to measure (or inject) asymmetric (common mode) voltages on unshielded symmetric signal (e.g. telecommunication) lines while rejecting the symmetric (differential mode) signal

NOTE The term "Y-network" is a synonym for AAN.

3.6

impedance stabilization network (ISN)

generally an artificial network that provides a stabilized impedance to the EUT; often (e.g. in CISPR 22) used as a synonym for AAN

3.7

coupling/decoupling network (CDN)

artificial network for the measurement or injection of signals on one circuit while preventing signals from being measured or injected on another circuit

3.8

longitudinal conversion loss (LCL)

in a one- or two-port network, a measure (a ratio expressed in dB) of the degree of unwanted transverse (symmetric mode) signal produced at the terminals of the network due to the presence of a longitudinal (asymmetric mode) signal on the connecting leads (definition from ITU-T Recommendation O.9¹⁾)

4 Artificial mains networks

An artificial mains network is required to provide a defined impedance at radio frequencies at the terminals of the equipment under test, to isolate the test circuit from unwanted radio-frequency signals on the supply mains, and to couple the disturbance voltage to the measuring receiver.

There are two basic types of artificial mains networks, the V-network which couples the unsymmetric voltages, and the delta-network which couples the symmetric and the asymmetric voltages separately.

For each mains conductor, there are three terminals: the mains terminal for connection to the supply mains, the equipment terminal for connection to the equipment under test, and the disturbance output terminal for connection to the measuring equipment.

NOTE 1 Examples of circuits of artificial mains networks are given in annex A.

NOTE 2 This clause specifies impedance and isolation requirements for the AMN including the corresponding measurement methods. Some background and rationale on the AMN related uncertainties is given in 6.2.3 of CISPR 16-4-1 and in CISPR 16-4-2.

4.1 AMN impedance

The specification of the impedance of an artificial mains network includes magnitude and phase of the impedance measured at an EUT terminal with respect to reference earth, when the receiver port is terminated with 50 Ω .

The impedance at the EUT terminals of the artificial mains network defines the termination impedance presented to the equipment under test. For this reason, when a disturbance output terminal is not connected to the measuring receiver, it shall be terminated by 50 Ω . In order to assure accurate termination into 50 Ω of the receiver port, a 10-dB attenuator shall be used either inside or external to the network, the VSWR of which (seen from either side) shall be less than or equal to 1.2 to 1. The attenuation shall be included in the measurement of the voltage division factor (see 4.10).

The impedance between each conductor (except PE) of the EUT terminal and reference earth shall comply with 4.2, 4.3, 4.4, 4.5 or 4.6 as appropriate for any value of external impedance, including a short circuit connected between the corresponding mains terminal and reference earth. This requirement shall be met at all temperatures which the network may reach under normal conditions for continuous currents up to the specified maximum. The requirement shall also be met for peak currents up to the specified maximum.

1) ITU-T Recommendation O.9, *Measuring arrangements to assess the degree of unbalance about earth.*

Where the phase requirement cannot be met, the measured phase angles may be taken into account in the uncertainty budget according to CISPR 16-4-2. Annex I gives guidelines for the calculation of the uncertainty contribution of the phase if the tolerance is exceeded.

NOTE Since EUT connectors are not optimized for radio frequencies up to 30 MHz, the measurement of the network impedance must be carried out with special measurement adaptors to enable short connections. The NWA's OSM (open/short/matched) calibration is used to characterize the adaptors, taking the insertion loss and the conductor lengths of the adaptors into account.

4.2 50 Ω/50 μH + 5 Ω artificial mains V-network (for use in the frequency range 9 kHz to 150 kHz)

The AMN shall have the impedance (magnitude and phase) versus frequency characteristic shown in Table 3 and Figure 1a in the relevant frequency range. Tolerances of ±20 % for the magnitude and of ±11,5° for the phase are permitted.

Table 3 – Magnitudes and phase angles of the V-network (see Figure 1a)

Frequency MHz	Impedance magnitude Ω	Phase angle Degree
0,009	5,22	26,55
0,015	6,22	38,41
0,020	7,25	44,97
0,025	8,38	49,39
0,030	9,56	52,33
0,040	11,99	55,43
0,050	14,41	56,40
0,060	16,77	56,23
0,070	19,04	55,40
0,080	21,19	54,19
0,090	23,22	52,77
0,100	25,11	51,22
0,150	32,72	43,35

NOTE If this AMN meets the combined impedance requirements of this subclause and 4.3., it can be used in the frequency range 150 kHz to 30 MHz as well.

4.3 50 Ω/50 μH artificial mains V-network (for use in the frequency range 0,15 MHz to 30 MHz)

The AMN shall have the impedance (magnitude and phase) versus frequency characteristic shown in Table 4 and Figure 1b in the relevant frequency range. Tolerances of ±20 % for the magnitude and of ±11,5° for the phase are permitted.

Table 4 – Magnitudes and phase angles of the V-Network (see Figure 1b)

Frequency MHz	Impedance magnitude Ω	Phase angle Degree
0,15	34,29	46,70
0,17	36,50	43,11
0,20	39,12	38,51
0,25	42,18	32,48
0,30	44,17	27,95
0,35	45,52	24,45
0,40	46,46	21,70
0,50	47,65	17,66
0,60	48,33	14,86
0,70	48,76	12,81
0,80	49,04	11,25
0,90	49,24	10,03
1,00	49,38	9,04
1,20	49,57	7,56
1,50	49,72	6,06
2,00	49,84	4,55
2,50	49,90	3,64
3,00	49,93	3,04
4,00	49,96	2,28
5,00	49,98	1,82
7,00	49,99	1,30
10,00	49,99	0,91
15,00	50,00	0,61
20,00	50,00	0,46
30,00	50,00	0,30

4.4 50 Ω/5 μH + 1 Ω artificial mains V-network (for use in the frequency range 150 kHz to 100 MHz)

The AMN shall have the impedance (magnitude and phase) versus frequency characteristic shown in Table 5 and Figure 2. Tolerances of ±20 % for the magnitude and of ±11,5° for the phase are permitted.

Table 5 – Magnitudes and phase angles of the V-Network (see Figure 2)

Frequency MHz	Impedance magnitude Ω	Phase angle Degree
0,15	4,70	72,74
0,20	6,19	73,93
0,30	9,14	73,47
0,40	12,00	71,61
0,50	14,75	69,24
0,70	19,82	64,07
1,00	26,24	56,54
1,50	33,94	46,05
2,00	38,83	38,15
2,50	41,94	32,27
3,00	43,98	27,81
4,00	46,33	21,63
5,00	47,56	17,62
7,00	48,71	12,80
10,00	49,35	9,04
15,00	49,71	6,06
20,00	49,84	4,55
30,00	49,93	3,04
50,00	49,97	1,82
100,00	49,99	0,91
108,00	49,99	0,84