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INTERNATIONAL STANDARD

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

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements

Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Partie 1-2: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Dispositifs de couplage pour la mesure des perturbations conduites

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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CONTENTS

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SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements

FOREWORD

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International Standard CISPR 16-1-2 has been prepared by subcommittee A: Radio-interference measurements and statistical methods, of IEC technical committee CISPR: International special committee on radio interference.

This second edition cancels and replaces the first edition published in 2003 and its Amendment 1 (2004) and Amendment 2 (2006). This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) requirements from CISPR 22 for the AAN have been copied to this standard;
b) the CDNE for measurement of disturbance voltage in the frequency range 30 MHz to 300 MHz is added;
c) additional maintenance is included.

It has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications.*

The text of this standard is based on the following documents:

FDIS	Report on voting
CISPR/A/1051/FDIS	CISPR/A/1059/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.

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.

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 the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

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SPECIFICATION FOR RADIO DISTURBANCE AND IMMUNITY MEASURING APPARATUS AND METHODS –

Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements

1 Scope

This part of the CISPR 16 series 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.

NOTE In accordance with IEC Guide 107, CISPR 16 is a basic EMC standard for use by product committees of the IEC. As stated in Guide 107, product committees are responsible for determining the applicability of the EMC standard. CISPR and its sub-committees are prepared to co-operate with product committees in the evaluation of the value of particular EMC tests for specific products.

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

It is intended that the requirements of this publication are fulfilled 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 the CISPR 16-2 series, and further information on radio disturbance is given in CISPR 16-3, while uncertainties, statistics and limit modelling are covered in the CISPR 16-4 series.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-4-2:2011, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty*

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 61000-4-6:2008, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050, as well as the following apply.

3.1.1
ancillary equipment
transducers connected to a measuring receiver or (test) signal generator and used in the disturbance signal transfer between the EUT and the measuring or test equipment

Note 1 to entry: Examples of transducers are current and voltage probes and artificial networks.

3.1.2
associated equipment
AE
apparatus that is not part of the system under test but is required for the functioning of the EUT

3.1.3
asymmetric voltage
radio-frequency disturbance voltage appearing between the electrical mid-point of the mains terminals and ground, sometimes called the common mode voltage

Note 1 to entry: If V_a is the vector voltage between one of the mains terminals and ground, and V_b is the vector voltage between the other mains terminal and ground, the asymmetric voltage is half the vector sum of V_a and V_b, i.e. $(V_a + V_b)/2$.

3.1.4
symmetric voltage
radio-frequency disturbance voltage appearing between the two wires in a two-wire circuit, such as a single-phase mains supply, sometimes called the differential mode voltage

Note 1 to entry: The symmetric voltage is the vector difference $(V_a - V_b)$.

3.1.5
unsymmetric voltage
amplitude of the vector voltage, V_a or V_b defined in 3.1.3 and 3.1.4

Note 1 to entry: The unsymmetric voltage is the voltage measured by the use of an artificial mains V-network.

Note 2 to entry: See notes in 3.1.3 and 3.1.4 for details on V_a and V_b.

3.1.6
artificial mains network
AMN
network that 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

Note 1 to entry: There are two basic types of this network, the V-network (V-AMN) which couple the unsymmetric voltages, and the delta-network (Δ-AMN), which couple the symmetric and the unsymmetric voltages separately.

Note 2 to entry: The terms line impedance stabilization network (LISN) and V-AMN are used interchangeably .

3.1.7
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 1 to entry: The term "Y-network" is a synonym for AAN.

3.1.8
auxiliary equipment
AuxEq
peripheral equipment that is part of the system under test

3.1.9
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

3.1.10
CDNE-*X*
coupling/decoupling network for emission measurement in the frequency range 30 MHz to 300 MHz; where the "*X*" suffix can be "M2" for unscreened two-wire mains, DC or control ports, "M3" for unscreened three-wire mains, DC or control ports, and "S*x*" for screened cable with *x* internal wires

Note 1 to entry: See Annex J for further details on the CDNE-*X*.

3.1.11
equipment under test
EUT
equipment (devices, appliances and systems) subjected to EMC (emission) compliance tests

3.1.12
impedance measurement adaptor
IMA
metallic vertical plane, 0,1 m by 0,1 m, bonded to the reference ground plane, which contains connection ports for a network analyzer and a CDNE

3.1.13
longitudinal conversion loss
LCL
in a one- or two-port network, a measure 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

Note 1 to entry: LCL is a ratio expressed in dB.

[SOURCE: ITU-T Recommendation O.9 [8] [1)]]

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1) Numbers in square brackets refer to the Bibliography.

3.1.14
reference ground plane
RGP
flat conductive surface that is used as a common reference and that allows a defined parasitic capacitance to the surroundings of an EUT

Note 1 to entry: A reference ground plane is needed for conducted emission measurements, and serves as reference ground for the measurement of unsymmetrical and asymmetrical disturbance voltages.

3.2 Abbreviations

The following are abbreviations used in this standard that are not already provided in 3.1.

AN Artificial network

CVP Capacitive voltage probe

E.m.f. Electromotive force

ISN Impedance stabilization network

ITE Information technology equipment

LCL Longitudinal conversion loss

NWA Network analyser

PE Protective earth

RF Radio frequency

4 Artificial mains networks

4.1 General

An artificial mains network is required to provide a defined impedance at radio frequencies at the terminals of the EUT, 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 AMN, the V-network AMN (V-AMN), which couples the unsymmetric voltages, and the delta-network AMN (Δ-AMN), 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 EUT, and the disturbance output terminal for connection to the measuring equipment.

NOTE 1 Examples of circuits of AMNs 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 are given in 6.2.3 of CISPR/TR 16-4-1:2009 and in CISPR 16-4-2.

4.2 AMN impedance

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

The impedance at the EUT terminals of the AMN defines the termination impedance presented to the EUT. For this reason, when a disturbance output terminal is not connected to the measuring receiver, it shall be terminated by 50 Ω. 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 4.11).

The impedance between each conductor (except PE) of the EUT terminal and the reference ground shall comply with the provisions of 4.3, 4.4, 4.5, 4.6 or 4.7, as appropriate, for any value of external impedance, including a short circuit connected between the corresponding mains terminal and reference ground. 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.

Where the phase requirement cannot be met, the measured phase angles shall 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 Because EUT connectors are not optimized for radio frequencies up to 30 MHz, the measurement of the network impedance is carried out with special measurement adaptors to enable short-length connections. The OSM (open/short/matched) calibration of the network analyzer is used to characterize the adaptors, taking the insertion loss and the conductor lengths of the adaptors into account.

4.3 50 Ω/50 µH + 5 Ω artificial mains V-network (V-AMN) 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 1 and Figure 1 in the relevant frequency range. Tolerances of ± 20 % for the magnitude and ± 11,5° for the phase are permitted.

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

Frequency MHz	**Impedance magnitude** Ω	**Phase angle** Degrees
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 4.3 and 4.4., it can be used in the frequency range 150 kHz to 30 MHz as well.