BS EN 55016-1-2:2014+A1:2018



BSI Standards Publication

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 (CISPR 16-1-2:2014)

bsi.

National foreword

This British Standard is the UK implementation of EN 55016-1-2:2014, including amendment A1:2018. It is identical to CISPR 16-1-2:2014, including amendment 1:2017. It supersedes BS EN 55016-1-2:2014, which will be withdrawn on 12 December 2020.

The text of IEC amendment 1:2017 has been provided in its entirety at the beginning of this document. BSI's policy of providing consolidated content remains unchanged; however, in the interest of expediency, in this instance BSI have chosen to collate the relevant content at the beginning of this document.

The UK participation in its preparation was entrusted to Technical Committee GEL/210/11, EMC - Standards Committee.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2018
Published by BSI Standards Limited 2018

ISBN 978 0 580 91654 0

ICS 33.100.10; 33.100.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2014.

Amendments/corrigenda issued since publication

Date	Text affected
31 March 2018	Implementation of IEC amendment 1:2017 with CENELEC endorsement A1:2018

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 55016-1-2

July 2014

ICS 33.100.10; 33.100.20

Supersedes EN 55016-1-2:2004

English Version

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 (CISPR 16-1-2:2014)

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 (CISPR 16-1-2:2014)

Anforderungen an Geräte und Einrichtungen sowie Festlegung der Verfahren zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Teil 1-2: Geräte und Einrichtungen zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Koppeleinrichtungen zur Messung der leitungsgeführten Störaussendung (CISPR 16-1-2:2014)

This European Standard was approved by CENELEC on 2014-04-25. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard 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 CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2014 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

Ref. No. EN 55016-1-2:2014 E

Foreword

The text of document CISPR/A/1051/FDIS, future edition 2 of CISPR 16-1-2, prepared by SC A "Radio-interference measurements and statistical methods" of IEC/TC CISPR "International special committee on radio interference" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 55016-1-2:2014.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-01-25
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-04-25

This document supersedes EN 55016-1-2:2004.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard CISPR 16-1-2:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

CISPR 16-2 Series	NOTE	Harmonized as EN 55016-2 Series (not modified).
CISPR 16-4 Series	NOTE	Only Part 4-2 harmonized as EN 55016-4-2.
CISPR 22	NOTE	Harmonized as EN 55022.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 55016-1-2:2014/A1

February 2018

ICS 33.100.10; 33.100.20

English Version

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 (CISPR 16-1-2:2014/A1:2017)

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 (CISPR 16-1-2:2014/A1:2017)

Anforderungen an Geräte und Einrichtungen sowie Festlegung der Verfahren zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Teil 1-2: Geräte und Einrichtungen zur Messung der hochfrequenten Störaussendung (Funkstörungen) und Störfestigkeit - Koppeleinrichtungen zur Messung der leitungsgeführten Störaussendung (CISPR 16-1-2:2014/A1:2017)

This amendment A1 modifies the European Standard EN 55016-1-2:2014; it was approved by CENELEC on 2017-12-12. 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 CEN-CENELEC Management Centre or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2018 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

European foreword

The text of document CISPR/A/1222/FDIS, future edition 1 of CISPR 16-1-2:2014/A1, prepared by IEC/SC CISPR A "Radio-interference measurements and statistical methods" of IEC/TC CISPR "International special committee on radio interference" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 55016-1-2:2014/A1:2018.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2018-09-12
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2020-12-12

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard CISPR 16-1-2:2014/A1:2017 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
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	EN 55016-1-1	2010
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	EN 55016-2-1	2014
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	EN 55016-4-2	2011
IEC 61000-4-6	2008	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	2009
IEC 60050	Series	International Electrotechnical Vocabulary - Part 802: Ultrasonics	-	-

CISPR 16-1-2

Edition 2.0 2017-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

AMENDMENT 1
AMENDEMENT 1

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-4890-4

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

FOREWORD

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

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

FDIS	Report on voting
CIS/A/1222/FDIS	CIS/A/1232/RVD

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC website 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.

_____

3.1.3
asymmetric voltage

Replace the existing definition and note by the following new definition and new note:

RF disturbance voltage appearing between the electrical mid-point of the individual terminals or leads in a two- or multi-wire circuit and reference ground, sometimes called the CM voltage

Note 1 to entry If, in case of an LV AC mains power port, V_a is the vector voltage between one of the mains terminals and reference ground, and V_b is the vector voltage between the other mains terminal and reference 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

Replace the existing definition and note by the following new definition and new note:

RF disturbance voltage appearing between any pair of wires not comprising the wire at ground potential in a two- or multi-wire circuit, such as a single-phase mains supply or a bundle of twisted pairs in a communication cable, sometimes called the DM voltage

Note 1 to entry In case of an LV AC mains power port, the symmetric voltage is the vector difference $(V_a - V_b)$.

3.1.5
unsymmetric voltage

Replace the existing definition and notes by the following new definition and new note:

RF disturbance voltage appearing between an individual terminal or lead and reference ground, in a two- or multi-wire circuit

Note 1 to entry The unsymmetric voltage is the voltage measured by the use of a V-AMN. It denotes the amplitude of the vector voltage, V_a or V_b (mentioned in the Note 1 to entry in 3.1.3 and 3.1.4).

3.1.6
artificial mains network
AMN

Replace the existing Note 1 to entry by the following new note:

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

The addition of a new Note 4 to entry applies to the French language only.

3.1.14
reference ground plane
RGP

Replace the existing definition and note by the following new definition and new notes:

flat, conductive surface that is at the same electric potential as reference ground, which is used as a common reference, and which contributes to a reproducible parasitic capacitance with the surroundings of the EUT

Note 1 to entry A reference ground plane is needed for the measurement of conducted disturbances, and serves as reference for the measurement of unsymmetric and asymmetric disturbance voltages.

Note 2 to entry In some regions, the term ‘reference earth’ is used in place of ‘reference ground’.

Add, after the existing definition 3.1.14, the following new definition and note:

3.1.15
artificial network
AN
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 mains network or other power lines or from signal lines with associated equipment

Note 1 to entry There are four basic types of this network, the V-network (V-AN) which couples the unsymmetric voltages, the delta-network (Δ-AN), which couples symmetric (DM) and asymmetric (CM) voltages separately, the Y-network (Y-AN) and the coaxial (screened cable) network which couple asymmetric (CM) voltages.

3.2 Abbreviations

Delete the abbreviation AN from the existing list.

Add, to the existing list, the following new abbreviations:

CM	Common mode
Δ-AMN	Artificial mains Δ-network (‘Δ’ is pronounced ‘delta’)
Δ-AN	Artificial Δ-network (‘Δ’ is pronounced ‘delta’)
DM	Differential mode

LV Low voltage

V-AMN Artificial mains V-network

V-AN Artificial V-network

UM Unsymmetric mode

4 Artificial mains networks

Replace the existing title by the following new title:

4 Artificial networks for AC mains and other power ports

4.1 General

Replace the existing text, including Notes 1 and 2, by the following new text and new notes:

An AN is required to provide a defined impedance at radio frequencies at the terminals of the EUT's port under test, to isolate the test circuit from unwanted RF signals on the laboratory AC or DC supply mains, other power source or load connected to the EUT but not subject to testing in relation with that EUT, and to couple the disturbance voltage to the measuring receiver.

For use with measurements on LV AC mains power ports, there are two basic types of AMN, the V-AMN, which couples the unsymmetric voltages, and the Δ-AMN, which couples the symmetric and the asymmetric voltages separately. Use of practical implementations of these AMNs is not restricted to LV AC mains power ports. In principle they can be used for measurements on any kind of power port. The user of such artificial networks is recommended to consult the respective product standard for guidance. The information and advice in this standard for the AMN is hence valid for use of that AMN or another AN at power ports other than LV AC mains power ports.

The AN or AMN is furnished with three ports, the port for connection to the laboratory AC or DC supply mains or other power source or load (power/load port), the port for connection of the EUT (EUT port), and the disturbance output port for connection of the measuring receiver (receiver port).

NOTE 1 Examples of circuits of AMNs and ANs are given in Annex A.

NOTE 2 This clause specifies impedance and isolation requirements for ANs 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

Replace the existing title by the following new title:

4.2 AN impedances

Replace the existing text, including the note, by the following new text and new note:

The specification of the UM termination impedance of a V-AN includes the magnitude and the phase of the impedance measured at an EUT terminal with respect to the reference ground, when the V-AN’s receiver port is terminated with 50 Ω.

In case of a Δ-AMN or Δ-AN, the specification of the termination impedances includes the magnitude and phase of the asymmetric (CM) termination impedance and the magnitude and phase of the symmetric (DM) termination impedance. The asymmetric termination impedance

is measured with the two (or more) active EUT terminals joined together relative to the reference ground (as in Figure E.2). The symmetric termination impedance is measured between each active pair of EUT terminals without relation to reference ground and requires the use of a balun (see Figure K.2). For the impedance measurements, also for Δ-ANs the receiver port shall be terminated by 50 Ω.

The impedance at the EUT terminals of the AN defines the termination impedance presented to the EUT's port under test. 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 AN, 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, if any) of the EUT port and reference ground shall comply with the provisions of 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 or other power supply terminal and reference ground of the power/load port. This requirement shall be met at all temperatures which the AN 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.

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.

4.6 150 Ω artificial mains V-network (V-AMN) for use in the frequency range 150 kHz to 30 MHz

Replace the existing title and text by the following:

4.6 (Void)

4.7 150 Ω artificial mains delta-network (Δ-AMN) for use in the frequency range 150 kHz to 30 MHz

Replace the existing title and text (including Figure 4) by the following new title, new text and new tables:

4.7 150 Ω artificial delta-network (Δ-AN) for mains and other power ports for use in the frequency range 150 kHz to 30 MHz

4.7.1 Requirements

In the frequency range of interest from 150 kHz to 30 MHz the AN shall have an impedance of magnitude (150 ± 30) Ω with a phase angle not exceeding 40°, both between the EUT terminals not including reference ground and between these two EUT terminals joined together and the reference ground; see Table 8.

For proper performance in the range 150 kHz to 30 MHz, the AN shall also meet the characteristics specified in Table 9 in the frequency range 9 kHz to 150 kHz. Adherence to these characteristics does not however qualify the 150 Ω Δ-AN for use with measurements of disturbance voltages in the range below 150 kHz. If necessary, another Δ-AN needs to be specified for such measurements.

Table 8 – Parameters of the 150 Ω Δ-AN (150 kHz to 30 MHz)

	Description of the parameter	Nominal value and tolerance
1	Frequency range	150 kHz to 30 MHz
2	Asymmetric (CM) termination impedance at the EUT port, magnitude and phase	(150 ± 30) Ω (0 ± 40)°
3	Symmetric (DM) termination impedance at the EUT port, magnitude and phase [a]	(150 ± 30) Ω (0 ± 40)°
4	Longitudinal conversion loss (LCL) at the EUT port [b]	≥ 26 dB (symmetric 150 Ω system)
5	Asymmetric (CM) insertion loss power/load port – EUT port	≥ 20 dB (asymmetric 50 Ω system)
6	Symmetric (DM) insertion loss power/load port – EUT port	≥ 20 dB (symmetric 150 Ω system) > 40 dB, with external capacitor
7	Discharge resistors for blocking capacitors in the current path (for measurements on DC power ports	≥ 1,5 MΩ

[a] If needed, product committees can define a different symmetric termination impedance.

[b] The LCL of the AN should be significantly larger than the internal LCL of the EUT.

Table 9 – Parameters of the 150 Ω Δ-AN (9 kHz to 150 kHz)

	Description of the parameter	Nominal value and tolerance
1	Extended frequency range	9 kHz to 150 kHz
2	Asymmetric (CM) termination impedance at the EUT port, magnitude only	≥ 10 Ω (power/load port open)
3	Symmetric (DM) termination impedance at the EUT port, magnitude only	≥ 1 Ω (power/load port open)
4	Longitudinal conversion loss (LCL) at the EUT port	≥ 26 dB (symmetric 150 Ω system)
5	Asymmetric (CM) insertion loss of power/load port to EUT port	≥ 20 dB at 150 kHz (asymmetric 50 Ω system), decreasing with decreasing frequency with 40 dB/decade
6	Symmetric (DM) insertion loss of power/load port to EUT port	≥ 20 dB at 150 kHz > 40 dB with external capacitor (symmetric 150 Ω system), decreasing with decreasing frequency with 40 dB/decade

NOTE Specifications are given for proper operation of typical EUTs only – not for disturbance measurements < 150 kHz.

4.7.2 Measurement of the Δ-AN parameters

Measurements for determination of characteristics of the Δ-ANs are described in Annex K.

4.7.3 Current carrying capacity and series voltage drop

The maximum continuous currents and the maximum peak current shall be specified. The voltage applied to the EUT when passing continuous currents up to the maximum shall be not less than 95 % of the mains or other power supply voltage at the mains or other power input terminals of the Δ-AN.

Annex A – AMNs

Replace the existing title of this annex by the following new title:

Annex A
(normative)

Characteristics and their measurement, circuit schemes and examples of modern implementations of AMNs and other ANs for use with power or load ports of EUTs

A.5 An example of the 150 Ω artificial mains V-network

Replace the existing title and text by the following:

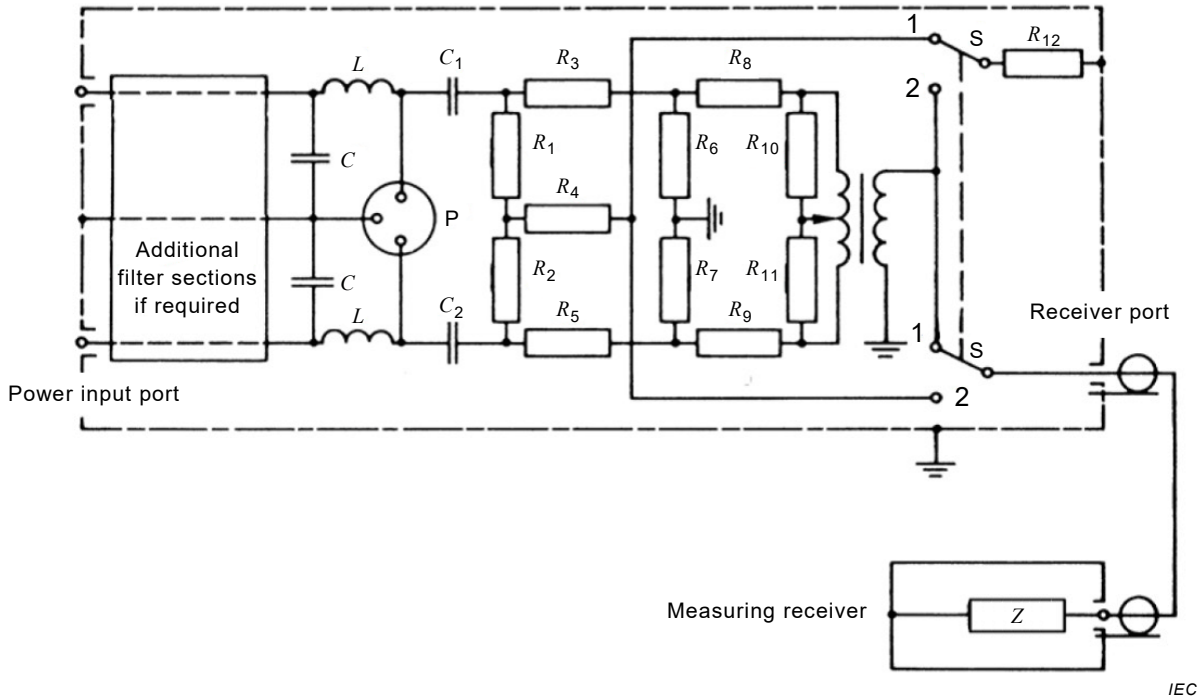
A.5 (Void)

A.6 Example of the 150 Ω artificial mains delta-network

Replace the existing title and text (including Figure A.2 and Table A.5) by the following new title, new text, new figures and tables:

A.6 Examples of the 150 Ω Δ-AN

Figure A.2 shows a suitable circuit for a delta-network. The component values are given in Table A.5.



Key

P EUT port of the AN

1 switch position for measurement of the symmetric voltage component

2 switch position for measurement of the asymmetric voltage component

S double pole double throw switch

Z measuring receiver input impedance

Figure A.2 – Example of a 150 Ω Δ-AN for low current drain across the AN for the measurement of asymmetric and symmetric disturbance voltages

Table A.4 – Component values of the 150 Ω Δ-AN shown in Figure A.2

Component	Value
R_1, R_2	118,7 (120) Ω
R_3, R_5	152,9 (150) Ω
R_4	390,7 (390) Ω
R_6, R_7	275,7 (270) Ω
R_8, R_9	22,8 (22) Ω
R_{10}, R_{11}	107,8 (110) Ω
R_{12}	50 Ω
C_1, C_2	0,1 µF
L, C	Suitable value to achieve specified impedance
NOTE 1 The turns ratio of the balanced to unbalanced transformer is assumed to be 1:2,5 with centre tap.	
NOTE 2 Resistance values shown in brackets are the nearest preferred values (± 5 % tolerance).	

Calculations give the following network performance. Values in brackets are based on the resistance values in brackets.

Insertion loss AE port to EUT port:	Symmetric	20	(20) dB
	Asymmetric	20	(19,9) dB
Termination impedance at EUT port:	Symmetric	150	(150) Ω
	Asymmetric	150	(148) Ω

Another example for a 150 Ω Δ-AN is shown in Figure A.7. Such delta-networks are commercially available with rated current throughputs up to 100 A DC and 1 500 V DC rated voltage.

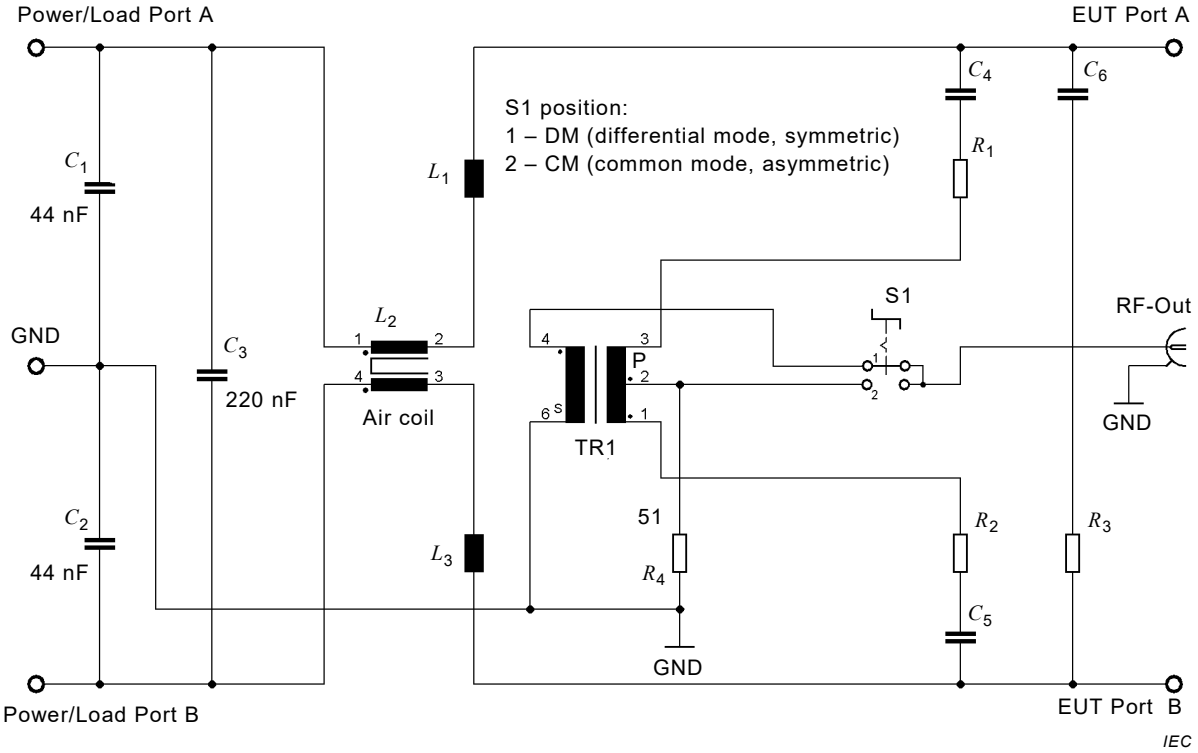


Figure A.7 – Example of a 150 Ω Δ-AN for high current drain across the AN for the measurement of asymmetric and symmetric disturbance voltages

Add, after the existing Annex J, the following new Annex K:

Annex K
(normative)

Measurement of Δ-AN parameters

Most of the typical characteristics of Δ-ANs are measured according to the instructions for measurements on asymmetric artificial networks (AANs) in Annex E of this standard.

The asymmetric impedance at the EUT port of the Δ-AN is measured according to Figure E.2.

The calibration set-up and the set-up for measurement of the symmetric impedance at the EUT port of the Δ-AN are shown in Figures K.1 and K.2, respectively.

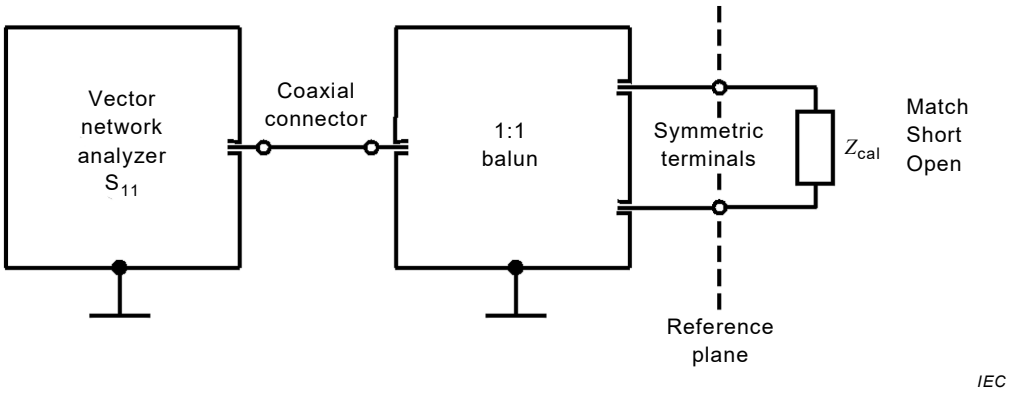


Figure K.1 – Calibration of the set-up with an open, short and match (50 Ω) standard reference termination

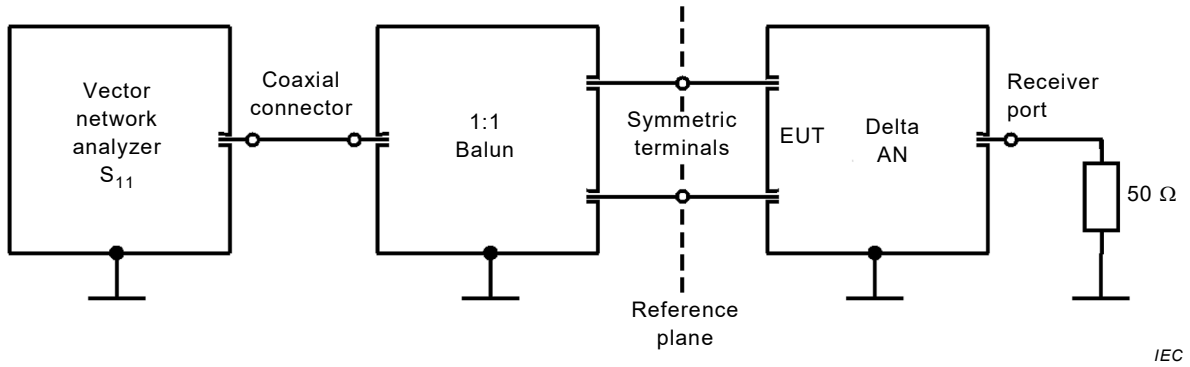


Figure K.2 – Set-up for the measurement of the symmetric impedance

The LCL of the Δ-AN is measured according to Figure E.5 (however with modified resistor values for a symmetric impedance of 150 Ω, instead of 100 Ω).

The asymmetric insertion loss between the EUT port and the port of the AN for connection to the external power source or load is measured according to Figure E.6.

The symmetric insertion loss between the EUT port and the port of the AN for connection to the external power source or load is measured according to Figure E.7.

The voltage division factor for asymmetric measurements is measured according to Figure E.8.

The voltage division factor for symmetric measurements is measured according to the Figures K.3 and K.4 taking the balun loss measured according to Figure K.5 into account.

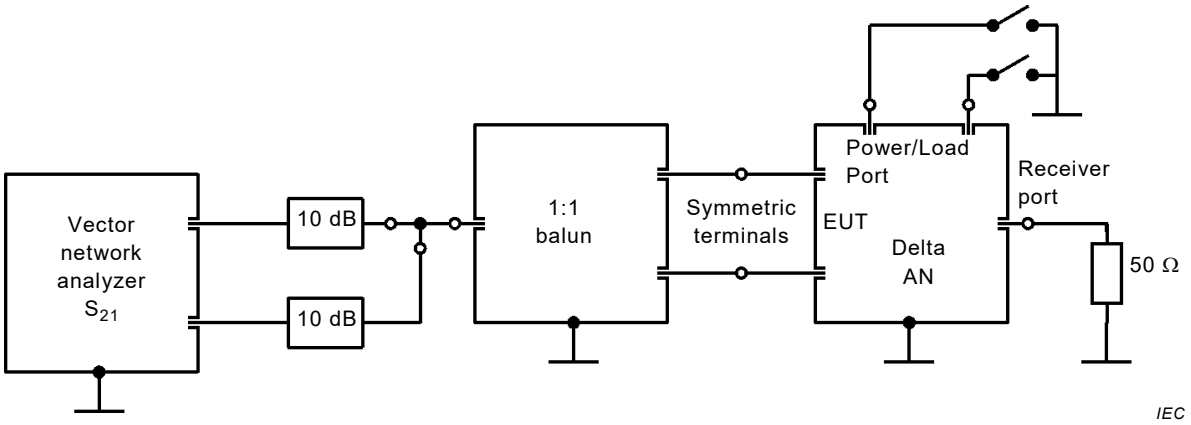


Figure K.3 – Set-up for test system normalization

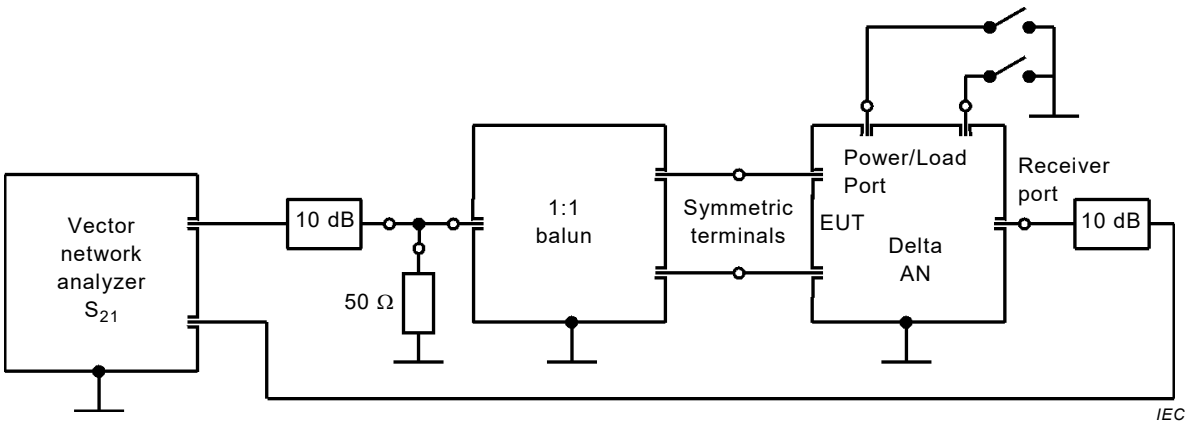


Figure K.4 – Set-up for symmetric voltage division factor measurement

The voltage division factor needs to be measured with both AE-port terminals open and shorted. Subtract the insertion loss of the 1:1 balun measured according to Figure K.5 from the voltage division factor measured according to Figure K.4.

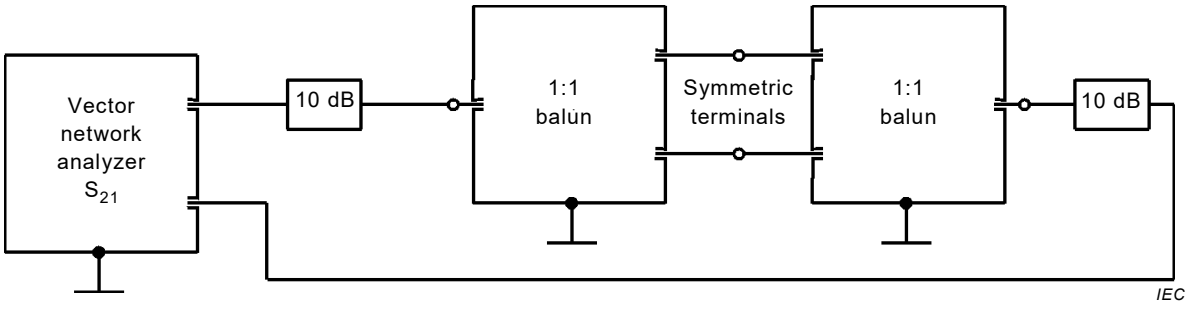


Figure K.5 – Set-up for the measurement of the insertion loss of a balun by measuring the insertion loss of two identical baluns

CONTENTS

FOREWORD 7
1 Scope 9
2 Normative references 9
3 Terms, definitions and abbreviations 10
3.1 Terms and definitions 10
3.2 Abbreviations 12
4 Artificial mains networks 12
4.1 General 12
4.2 AMN impedance 12
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 13
4.4 50 Ω/50 μH artificial mains V-network (V-AMN) for use in the frequency range 0,15 MHz to 30 MHz 14
4.5 50 Ω/5 μH + 1 Ω artificial mains V-network (V-AMN) for use in the frequency range 150 kHz to 108 MHz 15
4.6 150 Ω artificial mains V-network (V-AMN) for use in the frequency range 150 kHz to 30 MHz 17
4.7 150 Ω artificial mains delta-network (Δ-AMN) for use in the frequency range 150 kHz to 30 MHz 17
4.7.1 General parameters 17
4.7.2 Balance of the 150 Ω artificial mains delta-network 17
4.8 Isolation 18
4.8.1 Requirement 18
4.8.2 Measurement procedure 18
4.9 Current carrying capacity and series voltage drop 19
4.10 Modified reference ground connection 19
4.11 Measurement of the voltage division factor of artificial mains V-networks 20
5 Current and voltage probes 21
5.1 Current probes 21
5.1.1 General 21
5.1.2 Construction 21
5.1.3 Characteristics 21
5.2 Voltage probe 22
5.2.1 High impedance voltage probe 22
5.2.2 Capacitive voltage probe 23
6 Coupling units for conducted current immunity measurement 25
6.1 General 25
6.2 Characteristics 25
6.2.1 General 25
6.2.2 Impedance 25
6.2.3 Insertion loss 25
7 Coupling devices for measuring signal lines 26
7.1 General 26
7.2 Requirements for AANs (or Y-networks) 26
7.3 Requirements for artificial networks for coaxial and other screened cables 30
8 The artificial hand and series RC element 30

8.1 General 30
8.2 Construction of the artificial hand and RC element 30
8.3 The use of the artificial hand 31
9 CDNE for measurement of disturbance voltage in frequency range 30 MHz to 300 MHz 34
9.1 Instrumentation 34
9.1.1 General 34
9.1.2 Description of the CDNE measurement 35
9.1.3 Description of the RGP 35
9.2 Technical requirements for the CDNE-*X* 36
9.2.1 Mechanical and electrical parameters 36
9.2.2 Validation of the CDNE 36
9.3 Technical requirement for the RGP 39
Annex A (normative) AMNs 40
A.1 General 40
A.2 An example of the 50 Ω/50 μH + 5 Ω artificial mains V-network 40
A.3 An example of the 50 Ω/50 μH artificial mains V-network 41
A.4 Examples of the 50 Ω/5 μH + 1 Ω artificial mains V-network 41
A.5 An example of the 150 Ω artificial mains V-network 42
A.6 Example of the 150 Ω artificial mains delta-network 43
A.7 Example design for an AMN with a 50 μH inductor 44
A.7.1 The inductor 44
A.7.2 The case of the inductor 45
A.7.3 Isolation of the inductor 46
A.8 Measurement of the voltage division factor of an artificial mains V-network 46
Annex B (informative) Construction, frequency range, and calibration of current probes 49
B.1 Physical and electrical considerations for current probes 49
B.2 Equivalent electrical circuit of current probe 51
B.3 Detrimental effects of current probe measurements 51
B.4 Typical frequency response characteristics of current probes 52
B.5 A shielding structure for use with current probes 53
B.5.1 General 53
B.5.2 Theoretical model 54
B.5.3 Construction of the shielding structure 55
B.5.4 High-pass filter 55
B.6 Calibration of current probes 55
Annex C (informative) Construction of the coupling units for current injection for the frequency range 0,15 MHz to 30 MHz 59
C.1 Coupling unit type A for coaxial antenna input 59
C.2 Coupling unit type M, for mains leads 59
C.3 Coupling unit type L, for loudspeaker leads 62
C.4 Coupling unit type Sw, for audio-frequency signals 63
C.5 Coupling unit type Sw, for audio, video, and control signals 63
Annex D (informative) Principle of operation and examples of coupling units for conducted current immunity measurements 65
D.1 Principle of operation 65
D.2 Types of unit and their construction 65

Annex E (normative) Example and measurement of the parameters of the asymmetric artificial network (AAN) 69
E.1 Description of an example of an AAN: the T-network 69
E.2 Measurements of the parameters of an asymmetric artificial network (AAN) 69
Annex F (normative) Example and measurement of the parameters of the AN for coaxial and other screened cables 75
F.1 Description of ANs for coaxial and other screened cables 75
F.2 Measurements of parameters of an AN for coaxial and other screened cables 75
Annex G (informative) Construction and evaluation of capacitive voltage probe 77
G.1 General 77
G.2 Physical and electrical considerations for CVP 77
G.3 Determination of the frequency response of the voltage division factor 77
G.4 Method of measurement to determine the influence of external electric fields 78
G.4.1 Influence of external electric field 78
G.4.2 Method of measurement to determine the influence of the external electric field 78
G.5 Pulse response 78
G.6 Voltage division factor dependence 79
Annex H (informative) Rationale for the introduction of a minimum decoupling factor between mains and EUT/receiver ports for the V-AMN 84
Annex I (informative) Rationale for the introduction of a phase tolerance for the V-AMN input impedance 85
Annex J (informative) Example CDNE set-up diagrams 87
J.1 CDNE-M2 and CDNE-M3 87
J.2 CDNE-S*x* 89
Bibliography 90

Figure 1 – Impedance (magnitude and phase) of the V-network for Band A (see 4.3, the relevant frequency range is from 9 kHz to 150 kHz) 16
Figure 2 – Impedance (magnitude and phase) of the V-network for Band B (see 4.4) 16
Figure 3 – Impedance (magnitude and phase) of the V-network for Bands B and C (from 150 kHz to 108 MHz; see 4.5) 17
Figure 4 – Method for checking the balance of the arrangement for the measurement of symmetrical voltages 18
Figure 5 – Example of artificial mains 50 Ω/50 μH + 5 Ω V-network (see 4.3 and A.2) 20
Figure 6 – Example of artificial mains V-networks, 50 Ω/50 μH, 50 Ω /5 μH + 1 Ω or 150 Ω (see 4.4, 4.5, 4.6, A.3, A.4 and A.5, respectively) 20
Figure 7 – Circuit for RF voltage measurement on supply mains 23
Figure 8 – Circuit used to make voltage measurements between a cable and reference ground 24
Figure 9 – Measuring set-up to check the insertion loss of the coupling units in the frequency range 30 MHz to 150 MHz 26
Figure 10 – Principal circuit and LCL requirements of an AAN 28
Figure 11 – Application of the artificial hand 33
Figure 12 – Examples of application of artificial hand to ITE 34
Figure 13 – Arrangement for validation of a CDNE 37

Figure 14 – IMA arrangement for correcting the electrical length 38
Figure 15 – Test arrangement for the measurement of the symmetric impedance (Z_{DM}) 39
Figure A.1 – Example of an alternative 50 Ω/5 μH + 1 Ω V-AMN for devices used with low impedance power sources 42
Figure A.2 – Example of a Δ-AMN for a measuring receiver with unbalanced input 43
Figure A.3 – Schematic of 50 μH inductor 45
Figure A.4 – General view of an AMN 45
Figure A.5 – Attenuation of an AMN filter 46
Figure A.6 – Test set-up for determining the voltage division factor 47
Figure B.1 – Typical current probe configuration 50
Figure B.2 – High-pass filter with cut-off frequency of 9 kHz 52
Figure B.3 – Transfer impedance of typical current probes 53
Figure B.4 – Set-up for current measurement using the AMN 54
Figure B.5 – Shield configuration used with current transformer 55
Figure B.6 – Schematic diagram of circuit with coaxial adaptor and current probe transfer admittance Y_T measurement 56
Figure B.7 – Transfer admittance Y_T as a function of frequency 57
Figure B.8 – Return loss of the coaxial adaptor terminated with 50 Ω and with the current probe (also terminated with 50 Ω) inside 57
Figure B.9 – Current probe between the two halves of the coaxial adaptor 58
Figure C.1 – Example of coupling unit type A, for coaxial input schematic diagram and construction details (see C.1 and D.2) 60
Figure C.2 – Example of coupling unit type M, for mains leads, schematic diagram and construction details (see C.2 and D.2) 61
Figure C.3 – Example of coupling unit type L for loudspeaker leads, schematic diagram and simplified construction drawing (see D.2) 62
Figure C.4 – Example of coupling unit type Sw, for audio signals. Schematic diagram and simplified construction drawing (see D.2) 63
Figure C.5 – Example of coupling unit type Sw, for audio, video and control signals, schematic diagram and simplified construction drawing (see D.2) 64
Figure D.1 – General principle of the current-injection method (see D.1) 67
Figure D.2 – Coupling unit type Sr with load resistances – Schematic diagram and simplified construction drawing (see D.2) 68
Figure E.1 – Example of a T-network circuit for one pair of wires 70
Figure E.2 – Arrangement for the termination impedance measurement 71
Figure E.3 – Arrangement for LCL probe verification 71
Figure E.4 – Arrangement for the LCL probe calibration using an L-circuit 72
Figure E.5 – LCL measurement of the AAN using an LCL probe 72
Figure E.6 – Test set-up for the decoupling attenuation (isolation) of the AAN $a_{decoup} = 20\lg\left|\frac{V_1}{V_2}\right| - a_{vdiv}$ in dB for asymmetric signals between AE port and EUT port 73
Figure E.7 – Test set-up for the insertion loss (symmetric) of the AAN 73
Figure E.8 – Calibration test set-up for the AAN voltage division factor of the asymmetric circuit: $F_{AAN} = a_{vdiv} = 20\lg\left|\frac{V_1}{V_2}\right|$ in dB 74
Figure F.1 – Example of a coaxial cable AN 75

Figure F.2 – Test set-up for the coaxial and screened cable AN voltage division factor $F_{AN} = 20 \lg \left| \frac{V_1}{V_2} \right|$ in dB 76

Figure G.1 – Configuration of a CVP 80

Figure G.2 – Equivalent circuit of a CVP 81

Figure G.3 – Test set-up to measure the frequency response 81

Figure G.4 – Electrostatic coupling model and its equivalent circuit 82

Figure G.5 – Test set-up to measure the reduction, through the shielding effect, of the influence of the external electric field caused by electrostatic coupling 82

Figure G.6 – Conversion factor deviation when cable position is changed 83

Figure G.7 – Investigation result of the cable radius dependence 83

Figure H.1 – Isolation measurement arrangement 84

Figure I.1 – Definition of impedance magnitude and phase tolerances 85

Figure J.1 – CDNE-M3 with internal attenuator a_{meas} of at least 6 dB 87

Figure J.2 – CDNE-M2 with internal attenuator a_{meas} of at least 6 dB 88

Figure J.3 – CDNE-Sx for screened cable with x internal wires and an internal attenuator of at least 6 dB 89

Table 1 – Magnitudes and phase angles of the V-network (see Figure 1) 13

Table 2 – Magnitudes and phase angles of the V-network (see Figure 2) 14

Table 3 – Magnitudes and phase angles of the V-network (see Figure 3) 15

Table 4 – Values of minimum isolation for V-networks 18

Table 5 – Characteristics of the AAN for the measurement of asymmetric disturbance voltage 29

Table 6 – Characteristics of artificial networks for coaxial and other screened cables 30

Table 7 – Electrical parameters of the CDNE-X 36

Table A.1 – Component values of 50 Ω/50 μH + 5 Ω V-network 40

Table A.2 – Component values of 50 Ω/50 μH V-network 41

Table A.3 – Component values of 50 Ω/5 μH + 1 Ω V-network 42

Table A.4 – Component values of the 150 Ω V-network 43

Table A.5 – Component values of the 150 Ω delta-network 44

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 – Coupling devices for conducted disturbance measurements

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 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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*