

INTERNATIONAL STANDARD

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 - Antennas and test sites for radiated disturbance measurements

get full document from standards.iteh.ai



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, 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 either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

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

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	9
1 Scope	11
2 Normative references	11
3 Terms, definitions and abbreviated terms	12
3.1 Terms and definitions.....	12
3.2 Abbreviated terms.....	18
4 Antennas for measurement of radiated radio disturbance	18
4.1 General.....	18
4.2 Physical parameter (measurand) for radiated disturbance measurements	19
4.3 Antennas for the frequency range 9 kHz to 150 kHz.....	19
4.3.1 General	19
4.3.2 Magnetic field antenna.....	19
4.3.3 Shielding of loop antenna	21
4.4 Antennas for the frequency range 150 kHz to 30 MHz.....	21
4.4.1 Electric field antenna	21
4.4.2 Magnetic field antenna.....	21
4.4.3 Balance and electric field discrimination of antennas	21
4.5 Antennas for the frequency range 30 MHz to 1 000 MHz.....	21
4.5.1 General	21
4.5.2 Low-uncertainty antenna for use if there is an alleged non-compliance to the electric disturbance field strength limit	22
4.5.3 Antenna characteristics	22
4.5.4 Balance of antenna.....	24
4.5.5 Cross-polar response of antenna.....	25
4.6 Antennas for the frequency range 1 GHz to 18 GHz.....	26
4.6.1 General	26
4.6.2 Receive antenna.....	27
4.7 Special antenna arrangements – large-loop antenna system.....	29
5 Test sites for measurement of radio disturbance field strength for the frequency range of 9 kHz to 30 MHz	30
5.1 General.....	30
5.2 Radio-frequency ambient environment of a test site	30
5.3 Measurement distance and test volume	30
5.4 Set-up table and antenna positioner.....	30
5.5 Validation procedure of test site.....	31
5.5.1 General	31
5.5.2 Normalized site insertion loss (NSIL)	35
5.5.3 Reference site method.....	35
5.5.4 Acceptance criterion	36
6 Test sites for measurement of radio disturbance field strength for the frequency range of 30 MHz to 1 000 MHz	36
6.1 General.....	36
6.2 OATS.....	37
6.2.1 General	37
6.2.2 Weather-protection enclosure	37
6.2.3 Obstruction-free area.....	37
6.2.4 Radio-frequency ambient environment of a test site.....	38

6.2.5	Ground plane.....	39
6.3	Suitability of other test sites.....	39
6.3.1	Other ground-plane test sites.....	39
6.3.2	Test sites without ground plane (FAR).....	39
6.4	Test site validations.....	40
6.4.1	General.....	40
6.4.2	Overview of test site validations.....	40
6.5	Basic parameters of the NSA method for OATS and SAC.....	41
6.5.1	General equation and table of theoretical NSA values.....	41
6.5.2	Antenna calibration.....	45
6.6	Reference site method for OATS and SAC.....	45
6.6.1	General.....	45
6.6.2	Antennas not permitted for RSM measurements.....	46
6.6.3	Determination of the antenna pair reference site attenuation on a REFTS.....	46
6.6.4	Determination of the antenna pair reference site attenuation using an averaging technique on a large OATS.....	47
6.7	Validation of an OATS by the NSA method.....	50
6.7.1	Discrete frequency method.....	50
6.7.2	Swept frequency method.....	51
6.8	Validation of a weather-protection-enclosed OATS or a SAC.....	52
6.9	Possible causes for exceeding site acceptability limits.....	55
6.10	Site validation for FAR sites.....	55
6.10.1	General.....	55
6.10.2	RSM for FAR sites.....	59
6.10.3	NSA method for FAR sites.....	61
6.10.4	Site validation criteria for FAR sites.....	63
6.11	Evaluation of set-up table and antenna tower.....	63
6.11.1	General.....	63
6.11.2	Evaluation procedure for set-up table influences.....	64
7	Test sites for measurement of radio disturbance field strength for the frequency range 1 GHz to 18 GHz.....	66
7.1	General.....	66
7.2	Reference test site.....	66
7.3	Test site validation.....	66
7.3.1	General.....	66
7.3.2	Acceptance criterion for site validation.....	68
7.4	Antenna requirements for S_{VSWR} standard test procedure.....	68
7.4.1	General.....	68
7.4.2	Transmit antenna.....	68
7.4.3	Antennas and test equipment for the S_{VSWR} reciprocal test procedure.....	71
7.5	Required positions for site validation testing.....	72
7.5.1	General.....	72
7.5.2	Descriptions of S_{VSWR} measurement positions in a horizontal plane (Figure 27).....	73
7.5.3	Descriptions of S_{VSWR} additional measurement positions (Figure 28).....	74
7.5.4	Summary of S_{VSWR} measurement positions.....	74
7.6	S_{VSWR} site validation – standard test procedure.....	77

7.7	S_{VSWR} site validation – reciprocal test procedure using an isotropic field probe	78
7.8	S_{VSWR} conditional measurement position requirements	79
7.9	S_{VSWR} site validation test report	80
7.10	Limitations of the S_{VSWR} site validation method	81
7.11	Alternative test sites	81
8	Cable termination devices used in radiated emission testing	81
8.1	Common-mode absorption devices	81
8.1.1	General	81
8.1.2	CMAD S -parameter measurements	82
8.1.3	CMAD test jig	82
8.1.4	Measurement method using the TRL calibration	83
8.1.5	Specification of ferrite clamp-type CMAD	85
8.1.6	CMAD performance (degradation) check using spectrum analyzer and tracking generator	86
8.2	VHF-LISN cable termination devices	88
8.2.1	General	88
8.2.2	Balanced VHF-LISN	89
8.2.3	Unbalanced VHF-LISN	90
8.2.4	Measurement of the VHF-LISN impedance	92
9	Reverberating chamber for total radiated power measurement	98
10	TEM waveguides for radiated disturbance measurements	98
Annex A	(normative) Parameters of antennas	99
A.1	General	99
A.2	Preferred antennas	99
A.2.1	General	99
A.2.2	Calculable antenna	99
A.2.3	Low-uncertainty antennas	100
A.3	Simple dipole antennas	101
A.3.1	General	101
A.3.2	Tuned dipole	101
A.3.3	Shortened dipole	101
A.4	Broadband antenna parameters	103
A.4.1	General	103
A.4.2	Antenna type	103
A.4.3	Specification of the antenna	103
A.4.4	Antenna calibration	104
A.4.5	Antenna user information	104
Annex B	(normative) Large-loop antenna system for magnetic field induced-current measurements in the frequency range of 9 kHz to 30 MHz	106
B.1	General	106
B.2	Construction of an LLAS	106
B.3	Construction of a large-loop antenna (LLA)	106
B.4	Validation of an LLAS	111
B.5	Construction of the LLAS verification dipole antenna	113
B.6	Conversion factors	114
B.6.1	General	114
B.6.2	Current conversion factors for an LLAS with non-standard diameter	115

B.6.3	Conversion of LLAS measured current to magnetic field strength	116
B.7	Examples	118
Annex C (normative)	Construction details for open area test sites in the frequency range of 30 MHz to 1 000 MHz (see Clause 6)	119
C.1	General	119
C.2	Ground plane construction	119
C.2.1	Material	119
C.2.2	Roughness	119
C.3	Services to EUT	120
C.4	Weather-protection enclosure construction	120
C.4.1	Materials and fasteners	120
C.4.2	Internal arrangements	121
C.4.3	Size	121
C.4.4	Uniformity with time and weather	121
C.5	Turntable and set-up table	121
C.6	Receive antenna mast installation	122
Annex D (informative)	Basis for the ± 4 dB site acceptability criterion (see Clause 6)	123
D.1	General	123
D.2	Error analysis	123
Annex E (informative)	Examples of uncertainty budgets for site validation of a COMTS using RSM with a calibrated antenna pair (see 6.6)	125
E.1	Quantities to be considered for antenna pair reference site attenuation calibration using the averaging technique	125
E.2	Quantities to be considered for antenna pair reference site attenuation calibration using a REFTS	126
E.3	Quantities to be considered for COMTS validation using an antenna pair reference site attenuation	126
Annex F (informative)	Definition of uncertainty in cross-polar response measurement	128
F.1	General	128
F.2	Example uncertainty estimate	131
F.3	Rationale for the estimates of input quantities in Table F.1 and Table F.3	132
F.4	Measurement of XPR below 100 MHz at an OATS	134
Annex G (informative)	Measurement uncertainties of COMTS validation results in the frequency range 9 kHz to 30 MHz	135
G.1	Quantities to be considered for COMTS validation using the NSIL method	135
G.2	Quantities to be considered for COMTS validation using the RSM method	137
Annex H (normative)	Derivation of NSIL values in the frequency range 9 kHz to 30 MHz	140
H.1	General	140
H.2	Magnetic field antenna factor	141
H.3	Site insertion loss	142
H.4	Normalized site insertion loss	144
H.5	NSIL tables	147
Annex I (informative)	Recommendations for the design of test sites in the frequency range 9 kHz to 30 MHz	152
I.1	General	152
I.2	Dimensions and quality of the ground plane	152
I.3	Obstruction free area	153
I.4	Resonance-free area	153

Annex J (informative) Accuracy of NSIL values in the frequency range of 9 kHz to 30 MHz	155
J.1 General.....	155
J.2 Cross-check of NEC with analytic formulas	155
J.3 Recommended NEC versions.....	156
J.4 Instabilities at the lower frequency end	157
J.5 Extrapolation methods to solve instabilities.....	157
J.6 Reducing the number of segments to solve instabilities	158
Annex K (informative) Example calculation for 10 m SAC sites that do not fulfil the ± 4 dB criterion within 9 kHz to 30 MHz.....	159
Annex L (normative) Calibration of the sum of magnetic field antenna factors in the frequency range of 9 kHz to 30 MHz	162
L.1 General.....	162
L.2 Calibration procedure.....	162
L.3 Measurement uncertainties	163
Bibliography.....	165
 Figure 1 – Example of size-compliant loop antenna	20
Figure 2 – Schematic of radiation from EUT reaching an LPDA antenna directly and via ground reflection at a 3 m site, showing the beamwidth half-angle, φ , at the reflected ray.....	24
Figure 3 – RX antenna E-plane radiation pattern example, with limit area shaded for 3 m distance and 2 m EUT width.....	28
Figure 4 – Determination of maximum useable EUT width using half-power beamwidth	29
Figure 5 – General arrangement of the three measurement orientations H_x , H_y and H_z , where d is the measurement distance and h is the height of the reference point.....	32
Figure 6 – Antenna positions (top view)	33
Figure 7 – Antenna positions (3D view).....	34
Figure 8 – Test set-up for V_{DIRECT} with power amplifier and attenuator	35
Figure 9 – Obstruction-free area of a test site with a turntable	38
Figure 10 – Obstruction-free area with stationary EUT	38
Figure 11 – Test point locations for 3 m and 10 m test distances	47
Figure 12 – Paired test point locations for all test distances.....	49
Figure 13 – Example of paired test point selection for a test distance of 10 m.....	49
Figure 14 – Illustration of an investigation of influence of antenna mast on A_{APR}	50
Figure 15 – Typical antenna positions for a weather-protected OATS or a SAC – vertical polarization validation measurements	53
Figure 16 – Typical antenna positions for a weather-protected OATS or a SAC – horizontal polarization validation measurements	53
Figure 17 – Typical antenna positions for a weather-protected OATS or a SAC – vertical polarization validation measurements for a smaller EUT	54
Figure 18 – Typical antenna positions for a weather-protected OATS or a SAC – horizontal polarization validation measurements for a smaller EUT	54
Figure 19 – Measurement positions for FAR site validation	57
Figure 20 – Example of one measurement position and antenna tilt for FAR site validation	58
Figure 21 – Typical quasi free-space test site reference SA measurement set-up	60

Figure 22 – Theoretical free-space NSA as a function of frequency for different measurement distances [see Equation (18)].....	63
Figure 23 – Position of the antenna relative to the edge above a rectangle set-up table (top view).....	66
Figure 24 – Antenna position above the set-up table (side view).....	66
Figure 25 – Transmit antenna E-plane radiation pattern example (this example is for informative purposes only).....	69
Figure 26 – Transmit antenna H-plane radiation pattern (this example is for informative purposes only).....	71
Figure 27 – S_{VSWR} measurement positions in a horizontal plane (see 7.5.2 for description).....	72
Figure 28 – S_{VSWR} positions (height requirements).....	74
Figure 29 – S_{VSWR} conditional measurement position requirements.....	80
Figure 30 – Definition of the reference planes inside the test jig.....	83
Figure 31 – The four configurations for the TRL calibration.....	85
Figure 32 – Limits for the magnitude of S_{11} , measured according to the provisions of 8.1.1 to 8.1.3.....	86
Figure 33 – Example of a 50 Ω adaptor construction in the vertical flange of the jig.....	87
Figure 34 – Example of a matching adaptor with balun or transformer.....	87
Figure 35 – Example of a matching adaptor with resistive matching network.....	88
Figure 36 – Example circuit diagram of a balanced VHF-LISN.....	90
Figure 37 – Example circuit diagram of an unbalanced VHF-LISN.....	91
Figure 38 – Terminal-to-reference ground impedances of the VHF-LISN at the EUT mains port.....	93
Figure 39 – Example VHF-LISN impedance measurement set-up geometry.....	95
Figure 40 – Example IMA.....	96
Figure 41 – Connection between the IMA and the VHF-LISN.....	97
Figure A.1 – Short dipole antenna factors for $R_L = 50 \Omega$	102
Figure B.1 – The LLAS, consisting of three mutually perpendicular large-loop antennas.....	108
Figure B.2 – An LLA containing two opposite slits, positioned symmetrically with respect to the current probe C.....	109
Figure B.3 – Construction of an LLA slit.....	109
Figure B.4 – Example of an LLA slit construction using a strap of printed circuit board to obtain a rigid construction.....	110
Figure B.5 – Construction of the metal box containing the current probe.....	110
Figure B.6 – Example showing the routing of several cables from an EUT to minimize capacitive coupling from the leads to the LLAS.....	111
Figure B.7 – The eight positions of the LLAS verification dipole during validation of an LLA.....	112
Figure B.8 – Reference validation factors for loops of 2 m, 3 m, and 4 m diameters.....	112
Figure B.9 – Construction of the LLAS verification dipole antenna.....	114
Figure B.10 – Sensitivity S_D of an LLA with diameter D relative to an LLA with 2 m diameter.....	116
Figure B.11 – Conversion factor C_{dA} [for conversion into dB(μ A/m)] for three standard measurement distances d	117
Figure C.1 – The Rayleigh criterion for roughness in the ground plane.....	120

Figure H.1 – Investigation of wire radius, normalized to 0,001 m.....	144
Figure H.2 – Investigation of feed point location (not to scale)	145
Figure H.3 – Variation of NSIL values for various set-ups, for a distance of 3 m, $h = 1,3$	147
Figure H.4 – Specification of feed point location for tabular values (not to scale)	148
Figure H.5 – Calculation examples, loop diameter 60 cm, feed point location per Figure H.4.....	150
Figure I.1 – Recommended minimum dimensions of the ground plane (top view)	152
Figure I.2 – Recommended obstruction free area (top view).....	153
Figure J.1 – Comparison of NSIL values by analytic formulas and computer simulation	156
Figure K.1 – Example site validation result	160
Figure K.2 – U_{lab} calculated from site validation result	161
Figure K.3 – Frequency-dependent correction factor	161
Figure L.1 – Antenna arrangement for the sum of antenna factors method	163
Table 1 – Maximum frequency step size	32
Table 2 – Acceptance criterion.....	36
Table 3 – Site validation methods applicable for OATS, OATS-based, SAC, and FAR site types	40
Table 4 – Theoretical normalized site attenuation, A_N – recommended geometries for broadband antennas ^a	43
Table 5 – Example template for A_{APR} data sets	46
Table 6 – RSM frequency steps	46
Table 7 – Maximum dimensions of test volume versus test distance	55
Table 8 – Frequency ranges and step sizes for FAR site validation.....	57
Table 9 – S_{VSWR} measurement position designations.....	75
Table 10 – S_{VSWR} reporting requirements	80
Table 11 – Specifications for the EUT mains port of the balanced VHF-LISN	89
Table 12 – Specifications for the EUT mains port of the unbalanced VHF-LISN	91
Table B.1 – Reference validation factors of Figure B.8 for loops of 2 m, 3 m, and 4 m diameters.....	113
Table B.2 – Sensitivity S_D of an LLA with diameter D relative to an LLA with 2 m diameter (Figure B.10).....	115
Table B.3 – Magnetic field strength conversion factor C_{dA} for three measurement distances (Figure B.11).....	118
Table C.1 – Maximum roughness for 3 m, 10 m and 30 m measurement distances	120
Table D.1 – Error budget	124
Table E.1 – Antenna pair reference site attenuation calibration using the large-OATS averaging technique	125
Table E.2 – Antenna pair reference site attenuation calibration using REFTS	126
Table E.3 – COMTS validation using an antenna pair reference site attenuation	127
Table F.1 – Example uncertainty estimate for XPR measurement in a FAR and assumed $a_{XPT} = 22$ dB, $a_{XPR} = 34$ dB	132
Table F.2 – Uncertainties depending on other values of A_{XPT} (other assumptions as in Table F.1).....	134

Table F.3 – Example uncertainty estimate for XPR measurement at an OATS and assumed $a_{\text{xpT}} = 22$ dB, $a_{\text{xpR}} = 34$ dB	134
Table G.1 – Example measurement uncertainty budget for COMTS validation using the NSIL method.....	135
Table G.2 – Example measurement uncertainty budget for COMTS validation using the RSM method.....	138
Table H.1 – Calculation examples (loop diameter 60 cm, $d = 3$ m, $h = 1,3$ m).....	150
Table H.2 – Calculation examples (loop diameter 60 cm, $d = 5$ m, $h = 1,3$ m).....	150
Table H.3 – Calculation examples (loop diameter 60 cm, $d = 10$ m, $h = 1,3$ m).....	151
Table I.1 – Skin depth for some practical materials at 9 kHz	153
Table J.1 – Recommended NEC implementations	157
Table J.2 – Observed instabilities	157
Table K.1 – Measurement uncertainty of radiated disturbance results from 9 kHz to 30 MHz	159
Table K.2 – Influence of δA_i on U_{lab}	159
Table L.1 – Example of an uncertainty budget for sum of antenna factors method	163

Sample Document

get full document from standards.iteh.ai

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

**Specification for radio disturbance and
immunity measuring apparatus and methods -
Part 1-4: Radio disturbance and immunity measuring apparatus -
Antennas and test sites for radiated 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

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

This fifth edition cancels and replaces the fourth edition published in 2019, Amendment 1:2020 and Amendment 2:2023. This edition constitutes a technical revision.

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

- a) revision of the definition 3.1.7 and of the general introduction 8.1.1 for CMAD;
- b) introduction of a new cable termination device, the very high frequency line impedance stabilization network (VHF-LISN) in 8.2;
- c) addition of definition 3.1.34 for VHF-LISN, 3.1.20 for reference ground, 3.1.21 for reference ground plane and 3.1.31 for TN-C-S power system;
- d) various non-technical editorial, style, and wording adjustments for consistency with drafting rules.

The text of this International Standard is based on the following documents:

Draft	Report on voting
CIS/A/1466/FDIS	CIS/A/1475/RVD

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

The language used for the development of this International Standard is English.

It has the status of a basic EMC publication in accordance with IEC Guide 107 [1], *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

1 Scope

This part of CISPR 16 specifies the characteristics and performance of equipment for the measurement of radiated disturbances in the frequency range 9 kHz to 18 GHz. Specifications for antennas and test sites are included.

NOTE In accordance with IEC Guide 107 [1],¹ CISPR 16-1-4 is a basic EMC publication 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 cooperate with product committees in the evaluation of the value of particular EMC tests for specific products.

The requirements of this publication apply 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 CISPR 16-2-3, further information on radio disturbance is given in CISPR TR 16-3 [2], and uncertainties, statistics, and limit modelling are covered in CISPR 16-4 series [3].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CISPR 16-1-1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus*

CISPR 16-1-2:2014, *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/AMD1:2017

CISPR 16-1-5:2014, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-5: Radio disturbance and immunity measuring apparatus - Antenna calibration sites and reference test sites for 5 MHz to 18 GHz*
CISPR 16-1-5:2014/AMD1:2016

CISPR 16-1-6:2014, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration*
CISPR 16-1-6:2014/AMD1:2017
CISPR 16-1-6:2014/AMD2:2022

CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements*
CISPR 16-2-3:2016/AMD1:2019
CISPR 16-2-3:2016/AMD2:2023

IEC 60050-161:2014, *International Electrotechnical Vocabulary (IEV) - Part 161: Electromagnetic compatibility*

¹ Numbers in square brackets refer to the bibliography.

IEC 60050-195:2021, *International Electrotechnical Vocabulary (IEV) - Part 195: Earthing and protection against electric shock*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms, definitions and abbreviated terms given in CISPR 16-1-1, CISPR 16-1-5, IEC 60050-161, IEC 60050-195 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

antenna

transducer that converts the guided electromagnetic energy of the feed line into a radiated wave in space and vice versa

Note 1 to entry: In the context of this document, for antennas for which a balun is intrinsic to the functioning of the antenna, the term "antenna" includes the balun.

3.1.2

antenna factor

AF

F_a

ratio of the electric field strength of a plane wave incident from the direction corresponding to the mechanical boresight (i.e. the main axis of the antenna) to the voltage induced across a specified load connected to the antenna, measured in a free-space environment

Note 1 to entry: The abbreviation AF is used as a general term to denote antenna factor, whereas F_a denotes the boresight AF in free-space. AF is affected by the load impedance (typically 50 Ω) connected to the antenna, and is frequency dependent. For a biconical antenna this impedance could be up to 200 Ω . For antennas with no balun the impedance is equal to the load impedance, typically 50 Ω . AF can be affected by mutual coupling of the antenna to the ground plane, and is directivity dependent. For more details, see the definitions and 4.2 in CISPR 16-1-6:2014.

Note 2 to entry: The AF has the physical dimension of m^{-1} and measured data are normally expressed in dB relative to 1/m [dB(m^{-1})]. In radiated disturbance measurements, if F_a is known, the strength of an incident field, E , can be estimated from a reading, V , of a measuring receiver connected to the antenna as follows:

$$E = V + F_a$$

where E is in dB($\mu V/m$), V is in dB(μV) and F_a is in dB(m^{-1}).

3.1.3

antenna pair reference site attenuation

A_{APR}

30 MHz to 1 GHz site attenuation for both vertical and horizontal polarizations using a pair of antennas separated by a specified distance at an ideal open-area test site, with one antenna at a specified fixed height above the ground plane, and the other antenna scanned over a specified height range in which the minimum insertion loss is recorded

Note 1 to entry: While ideal A_{APR} is based on an ideal site, actual A_{APR} is also measured at a reference test site (REFTS) (see 6.6.3), or at a large open-area test site (OATS) (see 6.6.4), and the measured values are used as a reference for comparing corresponding site attenuation measurement results at a compliance test site (COMTS) as well as for determining the suitability of an OATS for use in the reference site method (RSM).

Note 2 to entry: Because A_{APR} is defined in terms of an ideal OATS, the difference between the actual OATS and an ideal OATS is treated as an uncertainty contribution.

3.1.4**antenna pair reference site insertion loss** A_{LPR}

9 kHz to 30 MHz site insertion loss for three orientations using a pair of antennas separated by a specified distance at an ideal open-area test site, with both antennas at a specified fixed height above the ground plane and with specified feed point locations

Note 1 to entry: While ideal A_{LPR} is based on an ideal site, actual A_{LPR} is measured at a REFTS (see 5.5.3) and the measured values are used as a reference for comparing corresponding site insertion loss measurement results at a REFTS to evaluate the performance of the COMTS.

Note 2 to entry: Because A_{LPR} is defined in terms of an ideal OATS, the difference between the actual OATS and an ideal OATS is treated as an uncertainty contribution.

3.1.5**antenna reference point**

midpoint of an antenna from which the distance to the equipment under test (EUT) or second antenna is measured

Note 1 to entry: The antenna reference point is either defined by the manufacturer using a marker on log-periodic dipole array (LPDA) antennas or by the calibration laboratory.

3.1.6**balun**

device for transforming an unbalanced transmission line to a balanced transmission line and vice versa

Note 1 to entry: A balun is used, for example, to couple balanced antenna elements to an unbalanced feed line, such as a coaxial cable. A balun may exhibit inherent impedance transformation differing from unity.

3.1.7**common mode absorption device****CMAD**

device that can be applied to cables of the EUT at the point leaving the test volume in radiated disturbance measurements to control the common-mode impedance

Note 1 to entry: The CMAD has no effect on the differential-mode current flowing through the conductors that comprise the cable in the CMAD.

3.1.8**compliance test site****COMTS**

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

3.1.9**cross-polar response****XPR**

measure of the rejection by the antenna of the cross-polarized field, when the antenna is rotated in a linearly polarized electromagnetic field that is uniform in phase and amplitude over the aperture of the antenna under test

3.1.10**EUT volume**

cylinder defined by EUT boundary diameter and height that fully encompasses all portions of the actual EUT, including cable racks and 1,6 m of cable length (30 MHz to 1 GHz) and 0,3 m of cable length (1 GHz and above)

Note 1 to entry: The test volume is one of several criteria limiting the EUT volume (see CISPR 16-2-3).

Note 2 to entry: The EUT volume has a diameter D (boundary diameter) and height h .