

Electromagnetic compatibility (EMC) - Part 4-20:
Testing and measurement techniques - Emission and
immunity testing in transverse electromagnetic (TEM)
waveguides

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 61000-4-20:2022 sisaldab Euroopa standardi EN IEC 61000-4-20:2022 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 61000-4-20:2022 consists of the English text of the European standard EN IEC 61000-4-20:2022.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 01.04.2022.	Date of Availability of the European standard is 01.04.2022.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 33.100.10, 33.100.20

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis-ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis-ja Akrediteerimiskeskusega: Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

English Version

**Electromagnetic compatibility (EMC) - Part 4-20: Testing and
measurement techniques - Emission and immunity testing in
transverse electromagnetic (TEM) waveguides
(IEC 61000-4-20:2022)**

Compatibilité électromagnétique (CEM) - Partie 4-20:
Techniques d'essai et de mesure - Essais d'émission et
d'immunité dans les guides d'onde TEM
(IEC 61000-4-20:2022)

Elektromagnetische Verträglichkeit (EMV) - Teil 4-20: Prüf-
und Messverfahren - Messung der Störaussendung und
Prüfung der Störfestigkeit in transversal-
elektromagnetischen (TEM-)Wellenleitern
(IEC 61000-4-20:2022)

This European Standard was approved by CENELEC on 2022-03-25. 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, 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

European foreword

The text of document 77B/853/FDIS, future edition 3 of IEC 61000-4-20, prepared by SC 77B "High frequency phenomena" of IEC/TC 77 "Electromagnetic compatibility" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61000-4-20:2022.

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) 2022-12-25
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-03-25

This document supersedes EN 61000-4-20:2010 and all of its amendments and corrigenda (if any).

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.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61000-4-20:2022 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:

IEC 60068-1	NOTE Harmonized as EN 60068-1
IEC 60118-13	NOTE Harmonized as EN IEC 60118-13
IEC 61967-2	NOTE Harmonized as EN 61967-2
IEC 62132-2	NOTE Harmonized as EN 62132-2
CISPR 25	NOTE Harmonized as EN IEC 55025
CISPR 14 (series)	NOTE Harmonized as EN IEC 55014-2 (series)
CISPR 16-4-2	NOTE Harmonized as EN 55016-4-2
IEC 61000-2-9	NOTE Harmonized as EN 61000-2-9
IEC 61000-4-3	NOTE Harmonized as EN IEC 61000-4-3
CISPR 16-2-3:2016	NOTE Harmonized as EN 55016-2-3:2017 (not modified)
CISPR 32	NOTE Harmonized as EN 55032
CISPR 20:2006	NOTE Harmonized as EN 55020:2007 (not modified) +A11:2011

INTERNATIONAL STANDARD

NORME INTERNATIONALE



BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

**Electromagnetic compatibility (EMC) –
Part 4-20: Testing and measurement techniques – Emission and immunity
testing in transverse electromagnetic (TEM) waveguides**

**Compatibilité électromagnétique (CEM) –
Partie 4-20: Techniques d'essai et de mesure – Essais d'émission et d'immunité
dans les guides d'onde TEM**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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. 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 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

**Electromagnetic compatibility (EMC) –
Part 4-20: Testing and measurement techniques – Emission and immunity
testing in transverse electromagnetic (TEM) waveguides**

**Compatibilité électromagnétique (CEM) –
Partie 4-20: Techniques d'essai et de mesure – Essais d'émission et d'immunité
dans les guides d'onde TEM**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.100.10; 33.100.20

ISBN 978-2-8322-1083-0

**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.**

CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references	11
3 Terms, definitions and abbreviated terms	11
3.1 Terms and definitions.....	11
3.2 Abbreviated terms.....	14
4 General	15
5 TEM waveguide requirements.....	15
5.1 General.....	15
5.2 General requirements for the use of TEM waveguides	16
5.2.1 Test volume and maximum EUT size	16
5.2.2 Validation of usable test volume	16
5.3 Special requirements and recommendations for certain types of TEM waveguides.....	23
5.3.1 Set-up of open TEM waveguides	23
5.3.2 Alternative TEM mode verification for a two-port TEM waveguide	23
5.3.3 TEM mode generation for a four-port TEM waveguide	23
5.4 Figures for Clause 5	24
6 Overview of EUT types	26
6.1 General.....	26
6.2 Small EUT	26
6.3 Large EUT	26
7 Laboratory test conditions.....	26
7.1 General.....	26
7.2 Climatic conditions.....	26
7.3 Electromagnetic conditions	26
8 Evaluation and reporting of test results.....	27
Annex A (normative) Emission measurements in TEM waveguides	28
A.1 Overview.....	28
A.2 Test equipment	28
A.3 Correlating TEM waveguide voltages to electric field strength data	28
A.3.1 General	28
A.3.2 Correlation algorithms	29
A.4 Emission measurement correction factors	33
A.4.1 Reference emission sources	33
A.4.2 Arrangement of small EUTs	34
A.4.3 Calculation of the small EUT correction factor	34
A.5 Emission measurement procedures in TEM waveguides	37
A.5.1 EUT types.....	37
A.5.2 EUT arrangement	37
A.6 Test report.....	38
A.7 Figures for Annex A	39
Annex B (normative) Immunity testing in TEM waveguides.....	44
B.1 Overview.....	44
B.2 Test equipment	44

B.2.1	General	44
B.2.2	Description of the test facility	44
B.3	Field uniformity area calibration	45
B.4	Test levels	45
B.5	Test set-up	45
B.5.1	Arrangement of table-top equipment	45
B.5.2	Arrangement of floor-standing equipment	46
B.5.3	Arrangement of wiring	46
B.6	Test procedures	46
B.7	Test results and test report	46
B.8	Figures for Annex B	47
Annex C (normative)	HEMP transient testing in TEM waveguides	49
C.1	Overview	49
C.2	Immunity tests	49
C.2.1	General	49
C.2.2	Radiated test facilities	50
C.2.3	Frequency domain spectrum requirements	51
C.3	Test equipment	51
C.4	Test set-up	52
C.5	Test procedure	52
C.5.1	General	52
C.5.2	Severity level and test exposures	53
C.5.3	Test procedure	53
C.5.4	Test execution	54
C.5.5	Execution of the radiated immunity test	54
C.6	Figure for Annex C	55
Annex D (informative)	TEM waveguide characterization	56
D.1	Overview	56
D.2	Distinction between wave impedance and characteristic impedance	56
D.3	TEM wave	57
D.3.1	General	57
D.3.2	Free-space TEM mode	57
D.3.3	Waveguides	57
D.4	Wave propagation	58
D.4.1	General	58
D.4.2	Spherical propagation	58
D.4.3	Plane wave propagation in free space	58
D.4.4	Velocity of propagation	58
D.5	Polarization	58
D.6	Types of TEM waveguides	59
D.6.1	General	59
D.6.2	Open TEM waveguides (striplines, etc.)	60
D.6.3	Closed TEM waveguides (TEM cells)	60
D.7	Frequency limitations	60
D.8	Figures for Annex D	61
Annex E (informative)	Calibration method for E-field probes in TEM waveguides	69
E.1	Overview	69
E.2	Probe calibration requirements	69
E.2.1	General	69

E.2.2	Calibration frequency range	69
E.2.3	Calibration volume	70
E.2.4	Probe dimensions	70
E.2.5	Perturbations of TEM waveguide fields due to the probe	70
E.2.6	Frequency steps	71
E.2.7	Field strength	71
E.3	Requirements for calibration instrumentation	71
E.3.1	Specifications of TEM waveguide	71
E.3.2	Harmonics and spurious signals	72
E.3.3	Probe fixture	72
E.3.4	Measuring net power to a transmitting device using directional couplers	72
E.4	E-field probe calibration	73
E.4.1	Calibration methods	73
E.4.2	Calibration procedure using a two-port TEM waveguide	73
E.4.3	Calibration procedure using one-port TEM waveguide	74
E.5	Figures for Annex E	77
Annex F (informative)	Instrumentation uncertainty of emission measurement results	79
F.1	Radiated disturbance measurements using a TEM waveguide	79
F.1.1	Measurand for radiated disturbance measurements using a TEM waveguide	79
F.1.2	Symbols of input quantities common to all disturbance measurements	79
F.1.3	Symbols of input quantities specific to TEM waveguide measurements	79
F.2	Input quantities to be considered for radiated disturbance measurements using a TEM waveguide	79
F.3	Uncertainty budget and rationale for the input quantities for radiated disturbance measurements using a TEM waveguide	80
F.3.1	Uncertainty budget for radiated disturbance measurements using a TEM waveguide	80
F.3.2	Rationale for the estimates of input quantities for radiated disturbance measurements using a TEM waveguide	81
F.4	Figures for Annex F	87
Annex G (informative)	Measurement uncertainty of immunity testing due to test instrumentation	89
G.1	General symbols	89
G.2	Symbol and definition of the measurand	89
G.3	Symbols for input quantities	89
G.4	Example: Uncertainty budget for immunity test	89
G.5	Rationale for the estimates of input quantities	90
Annex H (informative)	Correlation of emission and immunity limits between EMC test facilities	93
H.1	Overview	93
H.2	Dipole in free space (representing FAR set-up)	93
H.3	Dipole in half space (representing OATS or SAC set-up)	95
H.4	Dipole in a TEM-mode transmission line	96
H.5	Dipole in a reverberation chamber	97
H.6	Correlation	98
H.7	Example of emission limits	99
H.8	Figures for Annex H	100
Annex I (informative)	TEM waveguide transient characterization	103
I.1	Overview	103

I.2	Test equipment	103
I.3	Test set-up	103
I.4	TEM waveguide characterization by correlation	104
I.5	Quantification of the Pcc	105
I.6	Performable transient test signals	105
I.7	Figures for Annex I	106
	Bibliography	108

Figure 1 – Flowchart of TEM mode and field uniformity verification procedure with the “constant forward power” method (see 5.2.2.4.1)	24
Figure 2 – Flowchart of TEM mode and field uniformity verification procedure with the “constant field strength” method (see 5.2.2.4.2)	25
Figure A.1 – Routing the exit cable to the corner at the ortho-angle and the lower edge of the test volume in a TEM waveguide (see A.5.2)	39
Figure A.2 – Basic ortho-axis EUT positioner or manipulator (see 3.1.13, A.4.2, A.5.1.2, A.5.2)	40
Figure A.3 – Die pattern and axis alignment for an EUT [26] (see A.3.2.3.2)	41
Figure A.4 – Non-redundant twelve-face and axis orientations for a typical EUT [26] (see A.3.2.3.2)	42
Figure A.5 – Open-area test site (OATS) emission measurements geometry (see A.3.2.4)	43
Figure B.1 – Example of test set-up for single-polarization TEM waveguide (see Clause B.5)	47
Figure B.2 – Uniform area calibration points in a TEM waveguide (see Clause B.3)	48
Figure C.1 – Pulse waveform frequency domain spectral magnitude between 100 kHz and 300 MHz (see C.2.1)	55
Figure D.1 – Simple waveguide (no TEM mode) (see D.3.3)	61
Figure D.2 – Example of waveguides supporting TEM-mode propagation (see D.3.3)	61
Figure D.3 – E-field polarization vector (see Clause D.5)	61
Figure D.4 – Simple transmission line model for TEM mode propagation (see D.6.1)	62
Figure D.5 – One- and two-port TEM waveguide concepts (see D.6.1)	62
Figure D.6 – Operation of four-port TEM waveguides (see D.6.1)	62
Figure D.7 – Two-port TEM cell (symmetric septum) (see D.6.1 and D.6.3)	63
Figure D.8 – One-port TEM cell (asymmetric septum) (see D.6.1 and D.6.3)	64
Figure D.9 – Stripline (two plates) (see D.6.1 and D.6.2)	66
Figure D.10 – Stripline (four plates, balanced feed) (see D.6.1)	67
Figure D.11 – Four-port TEM waveguide (symmetric parallel septa) (see D.6.1 and D.6.3)	68
Figure E.1 – Example of test points for calibration volume validation (see E.2.3)	77
Figure E.2 – Set-up for validation of probe perturbation (see E.2.5)	77
Figure E.3 – Set-up for measuring net power to a transmitting device (not to scale) (see E.3.4)	77
Figure E.4 – Example set-up for E-field probe calibration with two-port TEM waveguide (see E.4.2)	78
Figure E.5 – Example set-up for E-field probe calibration with one-port TEM waveguide and alternative method (see E.4.3.2)	78
Figure E.6 – Equivalent circuit of monopole antenna and measuring apparatus (see E.4.3.3)	78

Figure F.1 – Deviation of the QP detector level indication from the signal level at receiver input for two cases, a sine-wave signal and an impulsive signal with a pulse repetition frequency of 100 Hz	87
Figure F.2 – Deviation of the peak detector level indication from the signal level at receiver input for two cases, a sine-wave signal and an impulsive signal with a pulse repetition frequency of 100 Hz	88
Figure H.1 – Representation of a short centre-fed dipole and a more general source representing an EUT (see Clause H.2)	100
Figure H.2 – Vertical source and receiving dipoles located over a perfectly-conducting ground plane of infinite extent (see Clause H.3)	100
Figure H.3 – Two types of TEM cells with a vertically polarized dipole source and the source to receive port geometry defined (see Clause H.4)	101
Figure H.4 – Reverberation chamber with a source dipole, a stirrer to randomize the fields, and a general receive antenna (see Clause H.5)	101
Figure H.5 – TEM waveguide Class A and Class B emission limits correlated from CISPR 32 [68] (see Clause H.7)	102
Figure I.1 – Test set-up	106
Figure I.2 – Signal windowing	107
Figure I.3 – Example of a heatmap – Pcc for a test point in the uniform area	107
Table 1 – Values k for expanded uncertainty with normal distribution	18
Table B.1 – Uniform area calibration points	45
Table B.2 – Test levels	45
Table C.1 – Radiated immunity test levels defined for this document	50
Table E.1 – Calibration frequencies	71
Table E.2 – Calibration field strength level	71
Table F.1 – Uncertainty budget for radiated disturbance measurement results using a TEM waveguide from 30 MHz to 1 000 MHz (example)	80
Table F.2 – Uncertainty budget for radiated disturbance measurement results using a TEM waveguide from 1 GHz to 6 GHz (example)	81
Table F.3 – Values of S_{lim} for 30 MHz to 1 000 MHz	83
Table F.4 – Values of S_{lim} for 1 GHz to 6 GHz	84
Table G.1 – Example uncertainty budget of the immunity test level	90
Table H.1 – Summary of the emission correlation parameters	99

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-20: Testing and measurement techniques –
Emission and immunity testing in transverse
electromagnetic (TEM) waveguides**

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) 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 IEC 61000-4-20 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility, in cooperation with CISPR (International Special Committee on Radio Interference) subcommittee A: Radio-interference measurements and statistical methods.

It forms Part 4-20 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

- a) provide information on the testing of large EUTs (including cables);

- b) apply the work on measurement uncertainties by adapting the work completed in CISPR and TC 77 (for emissions and immunity);
- c) update the validation procedure for the test volume regarding field uniformity and TEM mode verification;
- d) provide information concerning two-port and four-port TEM waveguides;
- e) add a new informative annex (Annex I) dealing with transient TEM waveguide characterization; and
- f) add information dealing with dielectric test stands for EUTs.

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

Draft	Report on voting
77B/853/FDIS	77B/855/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.

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/standardsdev/publications.

A list of all parts of the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, 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,
- 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.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

Immunity limits (in so far as they do not fall under the responsibility of the product committees)

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

Part 6: Generic standards

Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as International Standards, Technical Specifications or Technical Reports, some of which have already been published as sections. Others are and will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

This part is an International Standard which gives emission, immunity and HEMP and IEMI transient testing requirements.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides

1 Scope

This part of IEC 61000 focuses on emission and immunity test methods for electrical and electronic equipment using various types of transverse electromagnetic (TEM) waveguides. These types include open structures (for example striplines and electromagnetic pulse simulators) and closed structures (for example TEM cells). These structures can be further classified as one-port, two-port, or multi-port TEM waveguides. The frequency range depends on the specific testing requirements and the specific TEM waveguide type.

The object of this document is to describe

- TEM waveguide characteristics, including typical frequency ranges and equipment-under-test (EUT) size limitations;
- TEM waveguide validation methods for electromagnetic compatibility (EMC) tests;
- the EUT (i.e. EUT cabinet and cabling) definition;
- test set-ups, procedures, and requirements for radiated emission measurements in TEM waveguides; and
- test set-ups, procedures, and requirements for radiated immunity testing in TEM waveguides.

NOTE Test methods are defined in this document to measure the effects of electromagnetic radiation on equipment and the electromagnetic emissions from the equipment concerned. The simulation and measurement of electromagnetic radiation is not adequately exact for the quantitative determination of effects for all end-use installations. The test methods defined are structured for a primary objective of establishing adequate reproducibility of results at various test facilities for qualitative analysis of effects.

This document does not intend to specify the tests to be applied to any particular apparatus or system(s). The main intention of this document is to provide a general basic reference for all interested product committees of the IEC. For radiated emission measurements, product committees select emission limits and measurement methods in consultation with CISPR standards. For radiated immunity testing, product committees remain responsible for the appropriate choice of immunity tests and immunity test limits to be applied to equipment within their scope. This document describes test methods that are separate from those of IEC 61000-4-3 [34].¹

¹ Numbers in square brackets refer to the Bibliography.

These other distinct test methods may be used when so specified by product committees, in consultation with CISPR and TC 77.

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.

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

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

CISPR 16-1-4, *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*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

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

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

3.1.1

anechoic material

material that exhibits the property of absorbing, or otherwise reducing, the level of electromagnetic energy reflected from that material

3.1.2

broadband transmission-line termination

termination which combines a low-frequency discrete-component load, to match the characteristic impedance of the TEM waveguides (typically 50 Ω), and a volume of high-frequency anechoic material

3.1.3

characteristic impedance

for any constant phase wave-front, magnitude of the ratio of the voltage between the inner conductor and the outer conductor to the current on either conductor and which is independent of the voltage/current magnitudes and depends only on the cross-sectional geometry of the transmission line

Note 1 to entry: TEM waveguides are typically designed to have a characteristic impedance of 50 Ω . TEM waveguides with a characteristic impedance of 100 Ω are often used for transient testing.

3.1.4

correlation algorithm

mathematical routine for converting TEM waveguide voltage measurements to open-area test sites (OATS), semi-anechoic chamber (SAC), or free space field strength levels