SLOVENSKI STANDARD
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Elektromagnetna združljivost (EMC) - 4-21. del: Preskusne in merilne tehnike - Preskusne metode za odbojne sobe

Electromagnetic compatibility (EMC) -- Part 4-21: Testing and measurement techniques - Reverberation chamber test methods

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77B/619/CDV

COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITÉ POUR VOTE (CDV)

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Also of interest to the following committees Intéresse également les comités suivants CISPR/A	Supersedes document Remplace le document 77B/576/CD & 77B/589A/CC

Proposed horizontal standard
Norme horizontale suggérée

☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the TC/SC secretary
Les autres CE/SC sont requis d'indiquer leur intérêt, si nécessaire, dans ce CDV à l'intention du secrétaire du CE/SC

Functions concerned
Fonctions concernées

☐ Safety Sécurité	☒ EMC CEM	☐ Environment Environnement	☐ Quality assurance Assurance qualité

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Titre : CEI 61000-4-21 - COMPATIBILITE ELECTROMAGNETIQUE (CEM) - Partie 4-21: Techniques d'essai et de mesure - Méthodes d'essais en chambres réverbérantes

Title : IEC 61000-4-21 - ELECTROMAGNETIC COMPATIBILITY (EMC) – Part 4-21:Testing and measurement techniques – Reverberation chamber test methods

Note d'introduction

Ce CDV a été préparé par la JTF REV commune aux CISPR/A et SC 77B.

Le SC 77B a la responsabilité administrative de ce projet, aussi il est demandé aux comités nationaux de fournir leurs commentaires et votes au travers de leur comité miroir du SC 77B.

Les comités miroirs du CISPR/A doivent donner leurs commentaires à leurs collègues des comités miroirs du SC 77B, qui alors fourniront une compilation consolidée des commentaires à la CEI.

Merci de respecter ces demandes.

Introductory note

This CDV has been prepared by the JTF REV which is common to CISPR/A and SC 77B.

SC 77B is responsible for this project from an administrative standpoint, so national committees are requested to provide their comments and votes via their SC 77B mirror committee.

CISPR/A mirror committees must give their comments to their colleagues of SC 77B mirror committees which then will provide a consolidated compilation of comments to the IEC.

Thank you for respecting these requirements.

La version française sera diffusée dans au plus 60 jours.

The French version will be circulated within 60 days.

ATTENTION
VOTE PARALLÈLE
CEI – CENELEC

L'attention des Comités nationaux de la CEI, membres du CENELEC, est attirée sur le fait que ce projet de comité pour vote (CDV) de Norme internationale est soumis au vote parallèle.
Les membres du CENELEC sont invités à voter via le système de vote en ligne du CENELEC.

ATTENTION
IEC – CENELEC
PARALLEL VOTING

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) for an International Standard is submitted for parallel voting.
The CENELEC members are invited to vote through the CENELEC online voting system.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-21: Testing and measurement techniques – Reverberation chamber test methods

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, 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.
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International Standard IEC 61000-4-21 has been prepared by subcommittee 77B: High-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility, in co-operation with CISPR subcommittee A: Radio interference measurements and statistical methods.

It forms Part 4-21 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The main changes with respect to the first edition of this standard are the following:

- In Clause 8, the use and specifications of E-field probes for application to reverberation chambers has been added. Additional Notes refer to general aspects and procedures of probe calibrations. The specified range for linearity of the probe response is larger and covers an asymmetric interval compared to that for use in anechoic chambers (see Annex I of IEC 61000-4-3), because
    - the fluctuations of power and fields in reverberation chambers exhibit a larger dynamic range, and

- the chamber validation procedure is based on using maximum field values, as opposed to the field itself or its average value,

respectively.

- In Annex A, additional guidance and clarifications on the use of reverberation chambers at relatively low frequencies of operation (i.e., close to the lowest usable frequency of a given chamber) are given, and its implications on the estimation of field uncertainty are outlined. Guidelines on cable-layout have been added. A rationale has been added that explains the relaxation of the field uniformity requirement below 400 MHz, being a compromise between scientific-technical and economical reasons when using chambers around 100 MHz. A first-order correction for the threshold value of the correlation coefficient at relatively low numbers of tuner positions has been added. Issues regarding the use of non-equidistant tuner positions at low frequencies are discussed in an additional Note.

- In Annex B, symmetric location of the field probes when the chamber exhibits cylindrical symmetry has been disallowed, as such placement could otherwise yield a false indication of field uniformity and chamber performance at different locations. The difference between start frequency for chamber validation and lowest test frequency has been clarified. The tuner sequencing for chamber validation and testing is now specified to be equal in both cases. In sample requirements for chamber validation, emphasis is now on the required minimum number of independent tuner steps to be used, whereas the minimum recommended number of samples per frequency interval has been replaced with he number of independent samples that the tuner can provide per frequency, for use in case when the chamber validation fails for the required minimum number.

- Annex C now contains more quantitative guidance on the setting of the maximum permissible stirring speeds that warrant quasi-static conditions of operation for chamber validation and testing. Consideration is given to all characteristic time scales of all components or subsystems of a measurement or test. Specific issues relating to chamber validation, immunity testing and bandwidth are addressed. Particular requirements for field probes when used with mode stirred operation are listed.

- In Annex D, a requirement for the EUT and equipment not to occupy more than 8 % of the total chamber volume in immunity testing has been added. The maximum number of frequency points and the formula to calculate these points have been generalized. A mandatory specification for including the measurement equipment, test plan and cable layout in the test report has been added to resolve any dispute in case of discrepancies, particularly for low-frequency immunity testing.

- Annex E has been extended with further guidance on the value of EUT directivity to be used in the estimation of radiated power and field. Extended estimates have been added for the maximum directivity of electrically large, anisotropically radiating EUTs and for radiated emissions in the presence of a ground plane. A mandatory specification for including the measurement equipment, test plan and cable layout in the test report has been added to resolve any dispute in case of discrepancies, particularly for low-frequency emissions testing.

- In Annex I, some clarifications on antenna efficiency measurements have been added.

- A new Annex K has been added that covers measurement uncertainty in reverberation chambers. The intrinsic field uncertainty for chamber validation, immunity and emissions measurements is quantified. Other contributors to measurement uncertainty are listed.

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

FDIS	Report on voting
77B/ /FDIS	77B/ /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.

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

The committee has decided that the contents of the base publication will remain unchanged until the maintenance result date[1] 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.

[1] The National Committees are requested to note that for this publication the maintenance result date is 2015.

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 or as technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-21: Testing and measurement techniques – Reverberation chamber test methods

1 Scope

This part of IEC 61000 considers tests of immunity and intentional or unintentional emissions for electric and/or electronic equipment and tests of screening effectiveness in reverberation chambers. It establishes the required test procedures for performing such tests. Only radiated phenomena are considered.

The objective of this part is to establish a common reference for using reverberation chambers to evaluate the performance of electric and electronic equipment when subjected to radio-frequency electromagnetic fields and for determining the levels of radio-frequency radiation emitted from electric and electronic equipment.

NOTE Test methods are defined in this part for measuring the effect of electromagnetic radiation on equipment and the electromagnetic emissions from equipment concerned. The simulation and measurement of electromagnetic radiation is not adequate for quantitative determination of effects. The defined test methods are organized with the aim to establish adequate reproducibility and repeatability of test results and qualitative analysis of effects.

This part of IEC 61000 does not intend to specify the tests to be applied to a particular apparatus or system. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees should select emission limits and test methods in consultation with CISPR. The product committees remain responsible for the appropriate choice of the immunity tests and the immunity test limits to be applied to their equipment. Other methods, such as those covered in IEC 61000-4-3 and CISPR-16-2-3&4 may be used in consultation with CISPR and TC77, if specified by product committees.

2 Normative references

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

IEC 60050(161):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

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

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

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

3 Definitions and acronyms

3.1 Definitions

For the purposes of this part of IEC 61000-4, the following definitions together with those in IEC 60050(161) apply.

3.1.1
antenna
that part of a radio transmitting or receiving system which is designed to provide the required coupling between a transmitter or a receiver and the medium in which the radio wave propagates

[IEV 712-01-01]

NOTE For the purpose of this procedure, antennas are assumed to have an efficiency of 75 % or greater.

3.1.2
electromagnetic (EM) wave
a wave characterized by the propagation of a time-varying electromagnetic field and caused by acceleration of electric charges

[IEV 705-01-09, modified]

3.1.3
far field region
that region of the electromagnetic field of an antenna or unintentional radiator wherein the predominant components of the field are those which represent a propagation of energy and wherein the angular field distribution is essentially independent of the distance from the antenna

NOTE 1 In the far field region, all the components of the electromagnetic field decrease in inverse proportion to the distance from the antenna.

NOTE 2 For a *broadside* antenna having a maximum overall dimension, *D*, which is large compared to the wave-length, λ, the far field region is commonly taken to exist at distances greater than $2D^2/\lambda$ from the antenna in the direction of maximum radiation.

[IEV 712-02-92]

The region far from a source or aperture where the radiation pattern does not vary with distance from the source.

[IEV 731-03-92]

3.1.4
field strength
the magnitude of the electromagnetic field created at a given point by a radio transmitting system operating at a specified characteristic frequency with specified installation and modulation conditions

[IEV 705-08-31]

NOTE The term "electric field strength" (in V/m) or "magnetic field strength" (in A/m) is used according to whether the magnitude of the electric or magnetic field, respectively, is measured. In the near-field region, the relationship between the electric and magnetic field strength and distance depends on the specific configuration involved. The power flux density of the field is similarly indeterminate.

NOTE In the far zone, field strength is sometimes identified with power flux density *P*. For a plane wave in free space, $P = E^2 / \eta_V$, where

E is the electric field strength, and

η_V is the intrinsic impedance of free space, approximately equal to 120π ohm.

3.1.5
polarization
the property of a sinusoidal electromagnetic wave or field vector defined at a fixed point in space by the direction of the electric field strength vector or of any specified field vector; when this direction varies with time, the property may be characterized by the locus described by the extremity of the considered field vector

[IEV 726-04-01]

3.1.6
reverberation chamber
a room specially designed to have a very long reverberation time

[IEV 723-03-30]

(reverberation room) room having a long reverberation time, especially designed to make the field therein as diffuse as possible. The room consists of a shielded enclosure that is generally equipped with mechanical tuners/stirrers that change (stir) the boundary conditions within the enclosure and, thus, alter the structure of the electromagnetic fields within the enclosure

[IEV 801-31-13, modified]

NOTE 1 Reverberation rooms are used in particular for the measurement of absorption coefficients of materials and measurement of the power emitted by intentional or unintentional radiating sources.

NOTE 2 Testing in a reverberation chamber can be described as a stochastic process in which the mechanical tuners/stirrers "stir" the "modes" inside the enclosure. Therefore, such a chambers is also called stirred-mode, mode-stirred or mode-tuned chamber.

3.1.7
quality factor (*Q*) of a reverberation chamber
(quality factor) frequency-dependent measure of sharpness of the resonance, equal to 2π times the ratio of the maximum stored energy to the energy dissipated during one period

[IEV 151-15-46, modified]

measure of how well the chamber stores energy (see A.6[2][2)]). For a given chamber, *Q* varies as a function of frequency and can be calculated using the following formula:

$$Q = \frac{16\pi^2 V}{\eta_{Tx}\eta_{Rx}\lambda^3}\left\langle \frac{P_{AveRec}}{P_{input}} \right\rangle \quad (4)$$

where

V	is the chamber volume (in units m^3),
λ	is the wavelength (in units m),
$(\langle P_{AveRec}/P_{inpu}\rangle_t)$	is the ratio of the received power to the input power averaged over one complete tuner/stirrer sequence (and, where applicable, averaged over all antenna locations and orientations),

[2)] Numbers in brackets refer to the reference documents in the respective annexes.

η_{Tx} and η_{Rx} are the antenna efficiency factors (dimensionless) for the Transmit (Tx) and Receive (Rx) antennas, respectively. If manufacturer's data is not available then the efficiency can be assumed to be 0,75 for log periodic antennas and 0,9 for horn antennas.

3.1.8
***Q*-bandwidth (*BW_Q*) of a reverberation chamber**
a measure of the frequency range over which the modes in a reverberation chamber are correlated (see Clause A.2). The BW_Q of a reverberation chamber can be calculated using the following formula:

$$BW_Q = f/Q \tag{5}$$

where

f is the frequency (in units Hz),

Q is the quality factor defined in 3.1.7.

3.1.9
malfunction
loss of capability of the equipment to initiate or sustain a required function, or the initiation of undesired spurious action which might result in adverse consequences

NOTE The criteria of functional acceptance have to be precisely specified.

[IEV 303-17-79]

3.1.10
emission
The phenomenon by which energy emanates from a source in the form of waves or particles.

[IEV 702-02-03]

3.1.11
tuner/stirrer
mechanical device constructed from low-loss electrically conductive material which alters the electromagnetic boundary conditions inside a reverberation chamber

NOTE In general, a reverberation chamber is a shielded enclosure with the smallest dimension being large with respect to the wavelength at the lowest useable frequency. The chamber is normally equipped with a mechanical tuning/stirring device whose dimensions are significant fractions of the chamber dimensions and of the wavelength at the lowest useable frequency. When the chamber is excited with RF energy, the boundary conditions of the resulting multi-mode electromagnetic environment can be altered by the mechanical tuner/stirrer. The resulting environment is statistically uniform and statistically isotropic (i.e., the energy arriving from all aspect angles with all directions of polarizations) when considered over a sufficiently large number of positions of the mechanical tuner/stirrer.

3.1.12
electromagnetic mode
one solution of Maxwell's equations representing an electromagnetic field in a certain space domain and belonging to a family of independent solutions defined by specified boundary conditions

[IEV 705-01-12]

3.1.13
validation
process of confirming that a finalized instrumentation, control system (hardware and software) and test facility complies with all of its functional, performance and interface requirements

[IEV 394-40-42 (modified)]

3.1.14
chamber validation
process of confirming that a chamber complies with all of its functional, performance and interface requirements

[IEV 394-40-42 (modified)]

3.1.15
intrinsic field uncertainty (IFU)

contribution to the overall uncertainty budget that is caused by the random (statistical) nature of the field inside a reverberation chamber

NOTE Typically, the intrinsic field uncertainty is considerably larger than the measurement instrumentation uncertainty in typical operation of a reverberation chamber, except when the chamber has an exceptionally high quality factor. As a result, the IFU is typically the only or main contribution to be considered in estimating the overall uncertainty during test or measurement.

3.1.16
working volume

region defined by 8 points inside the chamber at sufficient distance away from the walls to avoid boundary effects, for rectangular chambers typically defined by the corners of a cubic or parallelepiped region at quarter-wavelength distance from the nearest walls

NOTE For frequencies below 1 GHz, the distances are restricted to 0,75 m.

3.2 Acronyms

AVF	Antenna Validation Factor
CVF	Chamber Validation Factor
CDF	Cumulative Distribution Function
CISPR	Comité International Spécial des Perturbations Radioélectriques
CLF	Chamber Loading Factor
CW	Continuous Wave
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment Under Test
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEV	International Electrotechnical Vocabulary
IF	Image Frequency
IFU	Intrinsic Field Uncertainty
IL	Insertion Loss
ISO	International Standardisation Organisation
LUF	Lowest Usable Frequency
OATS	Open Area Test Site
PDF	Probability Density Function