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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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Proposed horizontal standard Norme horizontale suggérée <input type="checkbox"/> 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 <input type="checkbox"/> Safety Sécurité <input checked="" type="checkbox"/> EMC CEM <input type="checkbox"/> Environment Environnement <input type="checkbox"/> 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.

La version française sera diffusée dans au plus 60 jours.

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.

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.

The French version will be circulated within 60 days.

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

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

- 154 ○ the chamber validation procedure is based on using maximum field values, as
155 opposed to the field itself or its average value,
- 156 respectively.
- 157 • In Annex A, additional guidance and clarifications on the use of reverberation
158 chambers at relatively low frequencies of operation (i.e., close to the lowest usable
159 frequency of a given chamber) are given, and its implications on the estimation of field
160 uncertainty are outlined. Guidelines on cable-layout have been added. A rationale has been
161 added that explains the relaxation of the field uniformity requirement below 400 MHz, being a
162 compromise between scientific-technical and economical reasons when using chambers
163 around 100 MHz. A first-order correction for the threshold value of the correlation coefficient at
164 relatively low numbers of tuner positions has been added. Issues regarding the use of non-
165 equidistant tuner positions at low frequencies are discussed in an additional Note.
- 166 • In Annex B, symmetric location of the field probes when the chamber exhibits
167 cylindrical symmetry has been disallowed, as such placement could otherwise yield a
168 false indication of field uniformity and chamber performance at different locations. The
169 difference between start frequency for chamber validation and lowest test frequency has been
170 clarified. The tuner sequencing for chamber validation and testing is now specified to be equal
171 in both cases. In sample requirements for chamber validation, emphasis is now on the
172 required minimum number of independent tuner steps to be used, whereas the minimum
173 recommended number of samples per frequency interval has been replaced with the number
174 of independent samples that the tuner can provide per frequency, for use in case when the
175 chamber validation fails for the required minimum number.
- 176 • Annex C now contains more quantitative guidance on the setting of the maximum
177 permissible stirring speeds that warrant quasi-static conditions of operation for
178 chamber validation and testing. Consideration is given to all characteristic time scales
179 of all components or subsystems of a measurement or test. Specific issues relating to
180 chamber validation, immunity testing and bandwidth are addressed. Particular
181 requirements for field probes when used with mode stirred operation are listed.
- 182 • In Annex D, a requirement for the EUT and equipment not to occupy more than 8 % of
183 the total chamber volume in immunity testing has been added. The maximum number
184 of frequency points and the formula to calculate these points have been generalized. A
185 mandatory specification for including the measurement equipment, test plan and cable
186 layout in the test report has been added to resolve any dispute in case of
187 discrepancies, particularly for low-frequency immunity testing.
- 188 • Annex E has been extended with further guidance on the value of EUT directivity to be
189 used in the estimation of radiated power and field. Extended estimates have been
190 added for the maximum directivity of electrically large, anisotropically radiating EUTs
191 and for radiated emissions in the presence of a ground plane. A mandatory
192 specification for including the measurement equipment, test plan and cable layout in
193 the test report has been added to resolve any dispute in case of discrepancies,
194 particularly for low-frequency emissions testing.
- 195 • In Annex I, some clarifications on antenna efficiency measurements have been added.
- 196 • A new Annex K has been added that covers measurement uncertainty in reverberation
197 chambers. The intrinsic field uncertainty for chamber validation, immunity and
198 emissions measurements is quantified. Other contributors to measurement uncertainty
199 are listed.

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

FDIS	Report on voting
77B/ /FDIS	77B/ /RVD

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

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

204 The committee has decided that the contents of the base publication will remain unchanged
205 until the maintenance result date¹⁾ indicated on the IEC web site under
206 "http://webstore.iec.ch" in the data related to the specific publication. At this date, the
207 publication will be

- 208 • reconfirmed;
- 209 • withdrawn;
- 210 • replaced by a revised edition, or
- 211 • amended.

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

212 INTRODUCTION

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

214

215 **Part 1: General**

216 General considerations (introduction, fundamental principles)

217 Definitions, terminology

218

219 **Part 2: Environment**

220 Description of the environment

221 Classification of the environment

222 Compatibility levels

223

224 **Part 3: Limits**

225 Emission limits

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

228

229 **Part 4: Testing and measurement techniques**

230 Measurement techniques

231 Testing techniques

232

233 **Part 5: Installation and mitigation guidelines**

234 Installation guidelines

235 Mitigation methods and devices

236

237 **Part 6: Generic standards**

238

239 **Part 9: Miscellaneous**

240

241 Each part is further subdivided into several parts, published either as international standards
242 or as technical specifications or technical reports, some of which have already been published
243 as sections. Others will be published with the part number followed by a dash and a second
244 number identifying the subdivision (example: IEC 61000-6-1).

245 **ELECTROMAGNETIC COMPATIBILITY (EMC) –**
246
247 **Part 4-21: Testing and measurement techniques –**
248 **Reverberation chamber test methods**
249
250

251 **1 Scope**

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

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

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

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

272 **2 Normative references**

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

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

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

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

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

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

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

287 3 Definitions and acronyms

288 3.1 Definitions

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

291

292 3.1.1

293 antenna

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

297 [IEV 712-01-01]

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

299

300 3.1.2

301 electromagnetic (EM) wave

302 a wave characterized by the propagation of a time-varying electromagnetic field and caused
303 by acceleration of electric charges

304 [IEV 705-01-09, modified]

305

306 3.1.3

307 far field region

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

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

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

317 [IEV 712-02-92]

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

320 [IEV 731-03-92]

321

322 3.1.4

323 field strength

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

327 [IEV 705-08-31]

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

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

334 E is the electric field strength, and

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

336 3.1.5 337 polarization

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

342 [IEV 726-04-01]

343

344 3.1.6 345 reverberation chamber

346 a room specially designed to have a very long reverberation time

347 [IEV 723-03-30]

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

353 [IEV 801-31-13, modified]

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

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

359

360 3.1.7 361 quality factor (Q) of a reverberation chamber

362 (quality factor) frequency-dependent measure of sharpness of the resonance, equal to 2π
363 times the ratio of the maximum stored energy to the energy dissipated during one period

364 [IEV 151-15-46, modified]

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

$$367 \quad Q = \frac{16\pi^2 V}{\eta_{Tx} \eta_{Rx} \lambda^3} \left\langle \frac{P_{AveRec}}{P_{input}} \right\rangle \quad (4)$$

368 where

369 V is the chamber volume (in units m^3),

370 λ is the wavelength (in units m),

371 $\langle (P_{AveRec}/P_{input})_t \rangle$ is the ratio of the received power to the input power averaged over one
372 complete tuner/stirrer sequence (and, where applicable, averaged over all
373 antenna locations and orientations),

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

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

378

379 **3.1.8**
 380 **Q-bandwidth (BW_Q) of a reverberation chamber**

381 a measure of the frequency range over which the modes in a reverberation chamber are
 382 correlated (see Clause A.2). The BW_Q of a reverberation chamber can be calculated using the
 383 following formula:

$$384 \quad \quad \quad BW_Q = f/Q \quad \quad \quad (5)$$

385 where

386 f is the frequency (in units Hz),

387 Q is the quality factor defined in 3.1.7.

388

389 **3.1.9**
 390 **malfunction**

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

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

394 [IEV 303-17-79]

396

397 **3.1.10**
 398 **emission**

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

400 [IEV 702-02-03]

401

402 **3.1.11**
 403 **tuner/stirrer**

404 mechanical device constructed from low-loss electrically conductive material which alters the
 405 electromagnetic boundary conditions inside a reverberation chamber

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

414

415 **3.1.12**
 416 **electromagnetic mode**

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

420 [IEV 705-01-12]

421

422 **3.1.13**423 **validation**

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

426 [IEV 394-40-42 (modified)]

427

428 **3.1.14**429 **chamber validation**

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

432 [IEV 394-40-42 (modified)]

433

434 **3.1.15**435 **intrinsic field uncertainty (IFU)**

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

438

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

443

444 **3.1.16**445 **working volume**

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

449

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

451

452 **3.2 Acronyms**

453	AVF	Antenna Validation Factor
454	CVF	Chamber Validation Factor
455	CDF	Cumulative Distribution Function
456	CISPR	Comité International Spécial des Perturbations Radioélectriques
457	CLF	Chamber Loading Factor
458	CW	Continuous Wave
459	EM	Electromagnetic
460	EMC	Electromagnetic Compatibility
461	EMI	Electromagnetic Interference
462	EUT	Equipment Under Test
463	IEC	International Electrotechnical Commission
464	IEEE	Institute of Electrical and Electronics Engineers
465	IEV	International Electrotechnical Vocabulary
466	IF	Image Frequency
467	IFU	Intrinsic Field Uncertainty
468	IL	Insertion Loss
469	ISO	International Standardisation Organisation
470	LUF	Lowest Usable Frequency
471	OATS	Open Area Test Site
472	PDF	Probability Density Function