



SLOVENSKI STANDARD
oSIST prEN IEC 61000-4-2:2024
01-julij-2024

**Elektromagnetna združljivost (EMC) - 4-2. del: Preskusne in merilne tehnike -
Preskus odpornosti proti elektrostatični razelektritvi**

Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques -
Electrostatic discharge immunity test

Elektromagnetische Verträglichkeit (EMV) - Teil 4-2: Prüf- und Messverfahren - Prüfung
der Störfestigkeit gegen die Entladung statischer Elektrizität

Compatibilité électromagnétique (CEM) - Partie 4-2: Techniques d'essai et de mesure -
Essai d'immunité aux décharges électrostatiques

Ta slovenski standard je istoveten z: prEN IEC 61000-4-2:2024

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ICS:

33.100.20 Imunost Immunity

oSIST prEN IEC 61000-4-2:2024 en



77B/890/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 61000-4-2 ED3

DATE OF CIRCULATION:

2024-05-03

CLOSING DATE FOR VOTING:

2024-07-26

SUPERSEDES DOCUMENTS:

77B/878/CD, 77B/889/CC

IEC SC 77B : HIGH FREQUENCY PHENOMENA	
SECRETARIAT: France	SECRETARY: Mr Franck GRUFFAZ
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 44,TC 61,TC 62,SC 65A,TC 66,TC 77,SC 77A,TC 82,TC 108,TC 124,CIS/B,CIS/F,CIS/I	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: <input checked="" type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING 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) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test

PROPOSED STABILITY DATE: 2027

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-2: Testing and measurement techniques –
Electrostatic discharge immunity test**

FOREWORD

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International Standard IEC 61000-4-2 has been prepared by subcommittee 77B: High-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This third edition cancels and replaces the second edition published in 2008 and constitutes a technical revision.

It forms Part 4-2 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 second edition of this standard are the following:

- Add a calibration requirement for ESD generators with air discharge tip;
- Add a normative annex for test setups for specific equipment;
- add a test method for wall mounted equipment and wearable devices (see Annex);
- add an informative annex for wearable devices;
- add an informative annex for improvement of how to select test points and give guidance on how to specify the number of pulses for direct contact discharges;

- 147 • moving clause 9 into a new informative annex;
- 148 • improvement of the current calibration procedure;
- 149 • improvement of the measurement uncertainty considerations with examples of uncertainty
- 150 budgets;
- 151 • Because post installation tests cannot be performed in a controlled environment, this test
- 152 method has been moved into a new Annex G.

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

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

154

155 Full information on the voting for the approval of this standard can be found in the report on

156 voting indicated in the above table.

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

158 A list of all parts of the IEC 61000 series, published under the general title *Electromagnetic*

159 *compatibility (EMC)*, can be found on the IEC website.

160 The committee has decided that the contents of this publication will remain unchanged until

161 the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in

162 the data related to the specific publication. At this date, the publication will be

- 163 • reconfirmed,
- 164 • withdrawn,
- 165 • replaced by a revised edition, or
- 166 • amended.

167

168

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169

INTRODUCTION

170 IEC 61000-4 is a part of the IEC 61000 series, according to the following structure:

171 Part 1: General

172 General consideration (introduction, fundamental principles)

173 Definitions, terminology

174 Part 2: Environment

175 Description of the environment

176 Classification of the environment

177 Compatibility levels

178 Part 3: Limits

179 Emission limits

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

182 Part 4: Testing and measurement techniques

183 Measurement techniques

184 Testing techniques

185 Part 5: Installation and mitigation guidelines

186 Installation guidelines

187 Mitigation methods and devices

188 Part 6: Generic standards

189 Part 9: Miscellaneous

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

194 This part of IEC 61000 is an International Standard which gives immunity requirements and
195 test procedures related to electrostatic discharge.

196

197 ELECTROMAGNETIC COMPATIBILITY (EMC) –

198

199 Part 4-2: Testing and measurement techniques –

200 Electrostatic discharge immunity test

201

202

203

204 1 Scope

205 This part of IEC 61000 relates to the immunity requirements and test methods for electrical
206 and electronic equipment subjected to static electricity discharges from operators directly and
207 from personnel to adjacent objects. It additionally specifies ranges of test levels which relate
208 to different environmental and installation conditions and establishes test procedures.

209 The object of this standard is to establish a common and reproducible basis for evaluating the
210 performance of electrical and electronic equipment when subjected to electrostatic
211 discharges. In addition, it includes electrostatic discharges which can occur from personnel to
212 objects near the equipment.

213 This standard specifies:

214 – nominal waveform of the discharge current;

215 – range of test levels;

216 – test equipment;

217 – test setup;

218 – test procedure;

219 – calibration procedure;

220 – measurement uncertainty.

221 This standard gives specifications for tests performed in laboratories and guidance to post-
222 installation tests.

223 This standard is not intended to specify the tests to be applied to particular apparatus or
224 systems. The main aim is to give a general basic reference to all concerned product
225 committees. The product committees remain responsible for the appropriate choice of the
226 tests and the severity level to be applied to their equipment.

227 This standard excludes tests intended to evaluate the ESD sensitivity of devices during
228 handling and packaging. It is not intended for use in characterizing the performance of ESD
229 protection circuits.

230 2 Normative references

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

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

236 **3 Terms, definitions and abbreviated terms**

237 **3.1 Terms and definitions**

238 For the purposes of this part of IEC 61000, the following terms and definitions apply and are
239 applicable to the restricted field of electrostatic discharge; not all of them are included in
240 IEC 60050(161) [IEV].

241 **3.1.1** 242 **accessible**

243 surfaces of the EUT which can be touched by means of the air discharge tip of the ESD
244 generator

245 [SOURCE: IEC 60050-442:1998, 442-01-15, modified]

246 **3.1.2** 247 **air discharge method**

248 method of testing in which the charged tip of the test generator is moved towards the EUT
249 until it touches the EUT

250 **3.1.3** 251 **calibration**

252 set of operations which establishes, by reference to standards, the relationship which exists,
253 under specified conditions, between an indication and a result of a measurement

254 NOTE 1 to entry This term is based on the "uncertainty" approach.

255 NOTE 2 to entry The relationship between the indications and the results of measurement can be expressed, in
256 principle, by a calibration diagram.

257 [SOURCE: IEC 60050-311:2001, 311-01-09]

258 **3.1.4** 259 **contact discharge method**

260 method of testing in which the tip of the test generator is kept in contact with the EUT or
261 coupling plane and the discharge is actuated by the discharge switch within the generator

262 **3.1.5** 263 **coupling plane**

264 metal sheet or plate, to which discharges are applied to simulate electrostatic discharge to
265 objects adjacent to the EUT; HCP: Horizontal Coupling Plane; VCP: Vertical Coupling Plane

266 **3.1.6** 267 **degradation (in performance)**

268 undesired departure in the operational performance of any device, equipment or system from
269 its intended performance

270 NOTE to entry The term "degradation" can apply to temporary or permanent failure.

271 [SOURCE: IEC 60050-161:1990, 161-01-19]

272 **3.1.7** 273 **direct application**

274 application of the discharge directly to the EUT

275 **3.1.8** 276 **electromagnetic compatibility (EMC)**

277 ability of equipment or a system to function satisfactorily in its electromagnetic environment
278 without introducing intolerable electromagnetic disturbances to anything in that environment

279 [SOURCE: IEC 60050-161:2018, 161-01-07]

280 **3.1.9**
281 **electrostatic discharge (ESD)**
282 transfer of electric charge between bodies of different electric potential in proximity or through
283 direct contact

284 NOTE to entry Literature and teaching generally refer to transfers of charge, although strictly speaking charge
285 carriers (113-06-25) are transferred.

286 [SOURCE: IEC 60050-161:2014, 161-01-22]

287 **3.1.10**
288 **energy storage capacitor**
289 capacitor of the ESD-generator representing the capacity of a human body charged to the test
290 voltage value

291 NOTE to entry This element can be provided as a discrete component or a distributed capacitance.

292 **3.1.11**
293 **EUT**
294 equipment under test

295 **3.1.12**
296 **holding time**
297 interval of time within which the decrease of the test voltage due to leakage, prior to the
298 discharge, is not greater than 10 %

299 **3.1.13**
300 **immunity (to a disturbance)**
301 ability of a device, equipment or system to perform without degradation in the presence of an
302 electromagnetic disturbance

303 [SOURCE: IEC 60050-161:1990, 161-01-20]

304 **3.1.14**
305 **indirect application**
306 application of the discharge to a coupling plane in the vicinity of the EUT to simulate
307 personnel discharge to objects which are adjacent to the EUT ⁰²⁴

308 **3.1.15**
309 **reference ground plane (RGP)**
310 flat conductive surface that is at the same electric potential as reference ground, which is
311 used as a common reference, and which contributes to a reproducible parasitic capacitance
312 with the surroundings of the equipment under test (EUT)

313 NOTE to entry In some regions, the term 'earth' is used in place of 'ground'.

314 [SOURCE: IEC 60050-161:2014, 161-04-36]

315 **3.1.16**
316 **rise time**
317 interval of time between the instants at which the instantaneous value of a pulse first reaches
318 the specified lower and upper limits

319 NOTE to entry Unless otherwise specified, the lower and upper values are fixed at 10 % and 90 % of the pulse
320 magnitude.

321 [SOURCE: IEC 60050-161:1990, 161-02-05, modified]

322 **3.1.17**
323 **verification**
324 set of operations which is used to check the test equipment system (e.g. the test generator
325 and the interconnecting cables) and to gain confidence that the test system is functioning.
326 Details are given in 7.2.2.

327 NOTE 1 The methods used for verification can be different from those used for calibration.

328 NOTE 2 For the purpose of this basic EMC standard this definition is different from the definition given in
329 IEC 311-01-13.

330 3.2 Abbreviated terms

331	AD	Air Discharge
332	AE	Auxiliary Equipment
333	CD	Contact Discharge
334	EMC	ElectroMagnetic Compatibility
335	ESD	ElectroStatic Discharge
336	EUT	Equipment Under Test
337	HCP	Horizontal Coupling Plane
338	HV	High Voltage
339	MU	Measurement Uncertainty
340	PE	Protective Earth
341	RGP	Reference Ground Plane
342	VCP	Vertical Coupling Plane

343 4 General

344 This standard relates to equipment, systems, subsystems and peripherals which can be
345 involved in static electricity discharges as a result of environmental and installation
346 conditions, such as low relative humidity, use of low-conductivity (artificial-fiber) carpets,
347 synthetic-fabric garments, etc., which can exist in all locations classified in standards relevant
348 to electrical and electronic equipment. Detailed information is specified in Annex A.

349 NOTE From the technical point of view, the precise term for the phenomenon would be static electricity
350 discharge. However, the term electrostatic discharge (ESD) is widely used in the technical world and in technical
351 literature. Therefore, it has been decided to retain the term electrostatic discharge in the title of this standard.

352 Electrostatic discharges are categorized as contact discharges and air discharges. In
353 addition, contact discharges are categorized as direct discharges and indirect discharges.
354 Direct discharges are applied to conductive surfaces while indirect discharges are applied to
355 coupling planes in the vicinity of EUTs.

356 5 Test levels

357 The preferred range of test levels for the ESD test is specified in Table 1.

358 Contact discharge is the preferred test method. Air discharges shall be used where contact
359 discharge cannot be applied. Voltages for each test method are specified in Table 1. The
360 voltages shown are different for each method due to the differing test methods. This does not
361 imply that the test severity is equivalent between test methods.

362 Details concerning the various parameters which can influence the voltage to which the
363 human body can be charged are given in Clause A.2. Clause A.8 also contains examples of
364 the application of the test levels related to environmental (installation) classes.

365 For air discharge testing, the test shall be applied at all test levels in Table 1 up to and
366 including the specified test level. For contact discharge testing, the test shall be applied at the
367 specified test level.

368 For further information on test level variations and applications between air and contact
369 discharge, refer to Annex A, specifically clause A.3 through clause A.7.

370

Table 1 – Test levels

Level	Test voltage	
	Contact discharge	Air discharge
1	2 kV	2 kV
2	4 kV	4 kV
3	6 kV	8 kV
4	8 kV	15 kV

371 NOTE Product committees can specify different test levels.

372 6 Test equipment

373 6.1 Overview

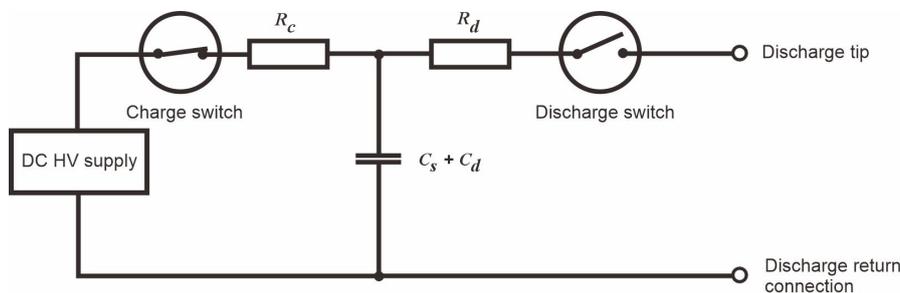
374 The ESD generator is designed to meet the characteristics in 6.2.2 and shall be calibrated in
 375 accordance with the procedure in clause 6.3 and Annex B to ensure that the intended current
 376 waveform shown in Figure 2 at the indicated voltage is delivered to the test point of the EUT
 377 or coupling plane.

378 6.2 ESD generator

379 6.2.1 General

380 A simplified circuit diagram of an ESD generator is shown in Figure 1. Although construction
 381 details (shape, size, weight, materials, etc.) of the generator are not specified, the following
 382 main items are used in the design of an ESD generator:

- 383 – charging resistor R_c ;
- 384 – energy-storage capacitor C_s ;
- 385 – distributed capacitance C_d ;
- 386 – discharge resistor R_d ;
- 387 – voltage indicator;
- 388 – discharge switch;
- 389 – charge switch;
- 390 – interchangeable discharge tips (see Figure 3 and Figure 4);
- 391 – discharge return cable;
- 392 – power supply unit.



393

IEC

394 Components

395 C_d is a distributed capacitance which exists between the generator and its
 396 surroundings.

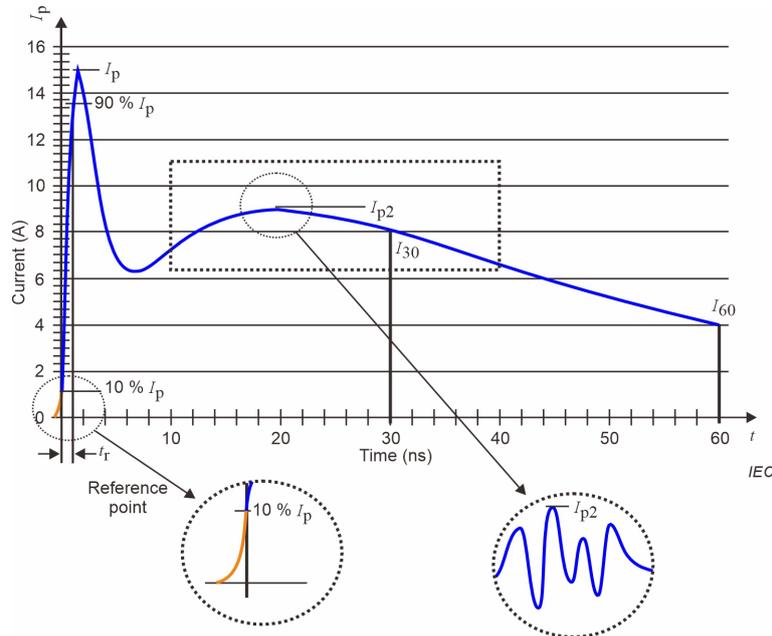
397 $C_s + C_d$ has a typical value of 150 pF.

398 R_d has a typical value of 330 Ω .

399

Figure 1 – Simplified diagram of the ESD generator

400 The ESD generator shall meet the requirements specified in 6.2.2 and indicated in Figure 2
 401 when evaluated according to the procedures in 6.3. Therefore, neither the diagram in
 402 Figure 1, nor the component values are specified in detail.



403

404

Figure 2 – Ideal contact discharge current waveform at 4 kV

405 An equation to generate the waveform in Figure 2, $I(t)$, is as follows:

$$406 \quad I(t) = \frac{I_1}{k_1} \times \frac{\left(\frac{t}{\tau_1}\right)^n}{1 + \left(\frac{t}{\tau_1}\right)^n} \times \exp\left(\frac{-t}{\tau_2}\right) + \frac{I_2}{k_2} \times \frac{\left(\frac{t}{\tau_3}\right)^n}{1 + \left(\frac{t}{\tau_3}\right)^n} \times \exp\left(\frac{-t}{\tau_4}\right)$$

407 where

408

$$k_1 = \exp\left(-\frac{\tau_1}{\tau_2} \left(\frac{n\tau_2}{\tau_1}\right)^{1/n}\right)$$

409

$$k_2 = \exp\left(-\frac{\tau_3}{\tau_4} \left(\frac{n\tau_4}{\tau_3}\right)^{1/n}\right)$$

410 and

411 $\tau_1 = 1,1$ ns; $\tau_2 = 2,0$ ns; $\tau_3 = 12,0$ ns; $\tau_4 = 37,0$ ns;

412 $I_1 = 16,6$ A (at 4 kV); $I_2 = 9,3$ A (at 4 kV);

413 $n = 1,8$.

414 6.2.2 General characteristics

415 6.2.2.1 Specifications of the ESD generator

416 The parameters of the ESD generator are specified in Table 2 and Table 3.