

Electromagnetic compatibility for industrial-process measurement and control equipment —

Part 2: Electrostatic discharge requirements

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British Standard

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Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Foreword	2
Text of EN 60801-2	3
National annex NA (informative) Committees responsible	Inside back cover
National annex NB (informative) Cross-references	Inside back cover

National foreword

This British Standard has been prepared under the direction of the Industrial-process Measurement and Control Standards Policy Committee and is the English language version of EN 60801-2:1993 *Electromagnetic compatibility for industrial-process measurement and control equipment — Part 2: Electrostatic discharge requirements*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 801-2:1991 published by the International Electrotechnical Commission (IEC).

This Standard supersedes BS 6667-2:1985, which is withdrawn.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Descriptors: Industrial-process measurement and control, electromagnetic compatibility, electrostatic interference, test protocol
with respect to electrostatic interference, severity levels with respect to electrostatic interference

English version

Electromagnetic compatibility for industrial-process measurement and control equipment Part 2: Electrostatic discharge requirements

(IEC 801-2:1991)

Compatibilité électromagnétique pour les
matériels de mesure et de commande dans les
processus industriels
Partie 2: Prescriptions relatives aux décharges
électrostatiques
(IEC 801-2:1991)

Elektromagnetische Verträglichkeit von Meß-,
Steuer- und Regeleinrichtungen in der
industriellen Prozeßtechnik
Teil 2: Störfestigkeit gegen die Entladung
statischer Elektrizität
(IEC 801-2:1991)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat 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 Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 801-2:1991 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 60801-2 on 9 December 1992.

The following dates were fixed:

- latest date of publication of an identical national standard (dop)1993-12-01
- latest date of withdrawal of conflicting national standards (dow)1993-12-01

For products which have complied with HD 481.2 S1:1987 before 1993-12-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1998-12-01.

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex A is informative and Annex B and Annex ZA are normative.

Contents

	Page
Foreword	2
1 Scope and object	3
2 Normative reference	3
3 General	3
4 Definitions/Terminology	3
5 Severity levels	4
6 Test generator (ESD)	4
6.1 Characteristics and performance of the ESD generator	5
6.2 Verification of the characteristics of the ESD generator	5
7 Test set-up	5
7.1 Test set-up for tests performed in laboratories	6
7.2 Test set-up for post-installation tests	7
8 Test procedure	7
8.1 Laboratory reference conditions	7
8.2 EUT exercising	7
8.3 Application of the static electricity discharges	7
9 Evaluation of the test results	8
Annex A (informative) — Explanatory notes	16
Annex B (normative) — Constructional details	19
Annex ZA (normative) Other international publications quoted in this standard with the references of the relevant European publications	25
Figure 1 — Simplified diagram of the ESD generator	9
Figure 2 — Typical arrangement for verification of the ESD generator performance	10
Figure 3 — Typical waveform of the output current of the ESD generator	11
Figure 4 — Discharge electrodes of the ESD generator	12
Figure 5 — Example of test set-up for table-top equipment, laboratory tests	13
Figure 6 — Example of test set-up for floor-standing equipment, laboratory tests	14
Figure 7 — Example of test set-up for equipment, post-installation tests	15
Figure A.1 — Maximum values of electrostatic voltages to which operators may be charged while in contact with the materials mentioned in clause A.2	18
Figure B.1 — Construction details of the resistive load	20
Figure B.2 — Material and finish: silver-plated copper or silver-plated brass	21
Figure B.3 — Material and finish: silver-plated copper or silver-plated brass	22
Figure B.4 — Material and finish: silver-plated copper or silver-plated brass 1 mm thick	23
Figure B.5 — Material and finish: silver-plated copper or silver-plated brass 1 m thick	23
Figure B.6 — Material and finish: silver-plated copper or silver-plated brass	24
Figure B.7 — Material and finish: silver-plated copper or silver-plated	24
Table 1.a — Severity levels	4
Table 1.b — Severity levels	4
Table 2 — Waveform parameters	6

1 Scope and object

This part 2 of the International Standard defines the immunity requirements and test methods for equipment which must withstand electrostatic discharges, from operators directly, and to adjacent objects. Several severity levels are defined which relate to different environmental and installation conditions.

These requirements are primarily developed for, and are applicable to, industrial-process measurement and control instrumentation.

Most aspects of the standard, such as simulation parameters and test set-ups, may apply to other equipment, yet other aspects such as severity levels and performance criteria may not apply to other equipment.

This document is intended to be identified as a basic EMC publication, in accordance with IEC Guide 107.

The object of this Part 2 is to establish a common reference for evaluating the performance of industrial-process measurement and control instrumentation when subjected to electrostatic discharges. In addition, it includes electrostatic discharges which may occur from personnel to objects near vital instrumentation.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. IEC 50(161):1990, *International Electrotechnical Vocabulary — Chapter 161: Electromagnetic compatibility*.

3 General

This part relates to equipment, systems, sub-systems and peripherals which may be involved in static electricity discharges owing to environmental and installation conditions, such as low relative humidity, use of low conductivity (artificial fibre) carpets, vinyl garments, etc. which may exist in all locations classified in standards relevant to industrial process measuring and control instrumentation (for more detailed information, see clause A.1 of Annex A).

The tests described in this Part 2 are considered to be a first step in the direction of commonly used tests for the qualitative evaluation of the performance of all electronic equipment as referred to in clause 1.

NOTE From the technical point of view the precise term for this phenomenon would be “static electricity discharge”. However, the term “electrostatic discharge” (ESD) is widely used in the technical world and in technical literature. Therefore, it has been decided to retain the term ESD in the title of this Part 2.

4 Definitions/Terminology

For the purposes of this International Standard, the following definitions apply.

4.1 degradation (of performance)

an undesired departure in the operational performance of any device, equipment or system from its intended performance [IEV 161-01-19]

NOTE The term “degradation” can apply to temporary or permanent failure.

4.2 electromagnetic compatibility (EMC)

the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment [IEV 161-01-07]

4.3 antistatic material

ESD-protective material having a surface resistivity greater than 10^5 but not greater than 10^{11} ohms per square

4.4 energy storage capacitor

the capacitor of the ESD-generator representing the capacity of a human body charged to the test voltage value. This may be provided as a discrete component, or a distributed capacitance

4.5 ESD

refers to static electricity discharge

4.6 EUT

equipment under test

4.7 ground reference plane (GRP)

a flat conductive surface whose potential is used as a common reference [IEV 161-04-36]

4.8**coupling plane**

a metal sheet or plate, to which discharges are applied to simulate electrostatic discharge to objects adjacent to the EUT

HCP: Horizontal Coupling Plane; VCP: Vertical Coupling Plane

4.9**holding time**

interval of time within which the decrease of the test voltage due to leakage, prior to the discharge, is not greater than 10 %

4.10**static electricity discharge; ESD**

a transfer of electrostatic charge between bodies of different electrostatic potential, in proximity or through direct contact [IEV 161-01-22]

4.11**immunity (to a disturbance)**

the ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance [IEV 161-01-20]

4.12**contact discharge method**

a method of testing, in which the electrode of the test generator is held in contact with the EUT, and the discharge actuated by the discharge switch within the generator

4.13**air discharge method**

a method of testing, in which the charged electrode of the test generator is approached to the EUT, and the discharge actuated by a spark to the EUT

4.14**direct application**

application of the test directly to the EUT

4.15**indirect application**

application of the test to a coupling plane in the vicinity of the EUT, and simulation of personnel discharge to objects which are adjacent to the EUT

5 Severity levels

The severity levels shown in Table 1 are recommended for the ESD test. All lower levels must be satisfied.

Details concerning the various parameters which may influence the voltage level to which the human body may be charged are given in clause A.2 of Annex A. Annex A.4 also contains examples of the application of the severity levels related to environmental (installation) classes.

Contact discharge is the preferred test method. Air discharges shall be used where contact discharge cannot be applied. Voltages for each test method are given in Table 1.a and Table 1.b. The voltages shown are different for each method due to the differing methods of test. It is not intended to imply that the test severity is equivalent between test methods. Further information is given in clauses A.3, A.4 and A.5 of Annex A.

Table 1.a — Severity levels

Level	Test voltage Contact discharge kV
1	2
2	4
3	6
4	8
x ^a	Special
^a "x" is an open level. The level is subject to negotiations and has to be specified in the dedicated equipment specification. If higher voltages than those shown are specified, special test equipment may be needed.	

Table 1.b — Severity levels

Level	Test voltage Air discharge kV
1	2
2	4
3	8
4	15
x ^a	Special
^a "x" is an open level. The level is subject to negotiations and has to be specified in the dedicated equipment specification. If higher voltages than those shown are specified, special test equipment may be needed.	

6 Test generator (ESD)

The test generator consists, in its main parts, of:

- charging resistor R_{ch};
- energy-storage capacitor C_s;
- distributed capacitance C_d;
- discharge resistor R_d;
- voltage indicator;
- discharge switch;
- interchangeable tips of the discharge electrode (see Figure 4);
- discharge return cable;
- power supply unit.

A simplified diagram of the ESD generator is given in Figure 1. Constructional details are not given. The generator shall meet the requirements of 6.1 and 6.2.

6.1 Characteristics and performance of the ESD generator

- energy storage capacitance ($C_s + C_d$): $150 \text{ pF} \pm 10 \%$;
- discharge resistance (R_d): $330 \Omega \pm 10 \%$;
- charging resistance (R_{ch}): between $50 \text{ M}\Omega$ and $100 \text{ M}\Omega$;
- output voltage (see note 1):
up to 8 kV (nominal) for contact discharge;
up to 15 kV (nominal) for air discharge;
- tolerance of the output voltage indication: $\pm 5 \%$;
- polarity of the output voltage: positive and negative;
- holding time: at least 5 s ;
- discharge, mode of operation (see note 2): single discharge (time between successive discharges at least 1 s);
- waveshape of the discharge current: see 6.2.

NOTE 1 Open circuit voltage measured at the energy storage capacitor.

NOTE 2 The generator should be able to generate at a repetition rate of at least 20 discharges per second for exploratory purposes only.

The generator shall be provided with means of preventing unintended radiated or conducted emissions, of either pulse or continuous type, so as not to disturb the EUT or auxiliary test equipment by parasitic effects.

The energy storage capacitor, the discharge resistor, and the discharge switch shall be placed as close as possible to the discharge electrode. The dimensions of the discharge tips are given in Figure 4. For the air discharge test method the same generator is used and the discharge switch has to be closed. The tip of the generator has to be the round IEC tip.

The discharge return cable of the test generator shall be in general 2 m long, and constructed to allow the generator to meet the waveform specification. It shall be sufficiently insulated to prevent the flow of the discharge current to personnel or conducting surfaces other than via its termination, during the ESD test.

In cases where a 2 m length of the discharge return cable is insufficient (e.g. for tall EUTs), a length not exceeding 3 m may be used, but compliance with the waveform specification shall be verified.

6.2 Verification of the characteristics of the ESD generator

In order to compare the test results obtained from different test generators, the characteristics shown in Table 2 shall be verified using the discharge return cable to be used in the testing.

The waveform of the output current of the ESD generator for the verification procedure shall conform to Figure 3.

The values of the parameters of the discharge current shall be verified with $1\,000 \text{ MHz}$ bandwidth measuring instrumentation. A lower bandwidth implies limitations in the measurement of rise time and amplitude of the first current peak.

For verification, the tip of the discharge electrode shall be contacted directly to the current-sensing transducer, and the generator operated in the contact discharge mode.

The constructional arrangement of the current-sensing transducer for verifying the ESD generator characteristics is given in Figure 2.

Further details of a possible form of the current-sensing transducer are given in Annex B.

Other arrangements that imply the use of a laboratory Faraday cage having dimensions different from those in Figure 2 are allowed; separation of the Faraday cage from the target plane is also allowed, but in both cases the distance between the sensor and the grounding terminal point of the ESD generator shall be respected (1 m), as well as the layout of the discharge return cable.

The ESD generator shall be recalibrated at defined time periods in accordance with a recognized quality assurance system.

7 Test set-up

The test set-up consists of the test generator, EUT and auxiliary instrumentation necessary to perform direct and indirect application of discharges to the EUT as applicable, in the following manner:

- a) contact discharge to the conductive surfaces and to coupling planes;
- b) air discharge at insulating surfaces.

Two different types of tests can be distinguished:

- type (conformance) tests performed in laboratories;
- post installation tests performed on equipment in its final installed conditions.

Table 2 — Waveform parameters

Level	Indicated voltage kV	First peak current of discharge $\pm 10\%$ A	Rise time t_r with discharge switch ns	Current ($\pm 30\%$) at 30 ns A	Current ($\pm 30\%$) at 60 ns A
1	2	7,5	0,7 to 1	4	2
2	4	15	0,7 to 1	8	4
3	6	22,5	0,7 to 1	12	6
4	8	30	0,7 to 1	16	8

The preferred test method is that of type tests performed in laboratories and the only accepted method of demonstrating conformance with this standard. The EUT shall be arranged as closely as possible to arrangement in final installed conditions.

7.1 Test set-up for tests performed in laboratories

The following requirements apply to tests performed in laboratories under environmental reference conditions outlines in 8.1.

A ground reference plane shall be provided on the floor of the laboratory. It shall be a metallic sheet (copper or aluminium) of 0,25 mm minimum thickness; other metallic materials may be used but they shall have at least 0,65 mm thickness. The minimum size of the reference plane is 1 m² the exact size depending on the dimensions of the EUT. It shall project beyond the EUT or coupling plane by at least 0,5 m on all sides, and shall be connected to the protective grounding system. Local safety regulations shall always be met.

The EUT shall be arranged and connected according to its functional requirements. A distance of 1 m minimum shall be provided between the equipment under test and the walls of the laboratory and any other metallic structure.

The EUT shall be connected to the grounding system in accordance with its installation specifications. No additional grounding connections are allowed.

The positioning of the power and signal cables shall be representative of installation practice.

The discharge return cable of the ESD generator shall be connected to the ground reference plane. The total length of this cable is in general 2 m.

In cases where this length exceeds the length necessary to apply the discharges to the selected points, the excess length shall, where possible, be placed non-inductively off the ground reference plane and shall not come closer than 0,2 m to other conductive parts in the test set-up.

The connection of the earth cables to the ground reference plane and all bondings shall be of low impedance, for example by using clamping devices for high frequency applications.

Where coupling planes are specified, for example to allow indirect application of the discharge, they shall be constructed from the same material type and thickness as that of the ground reference plane, and shall be connected to the GRP via a cable with a 470 k Ω resistor located at each end. These resistors shall be capable of withstanding the discharge voltage and shall be insulated to avoid short circuits to the GRP when the cable lies on the GRP.

Additional specifications for the different types of equipment are given below.

7.1.1 Table-top equipment

The test set-up shall consist of a wooden table, 0,8 m high, standing on the ground reference plane. A horizontal coupling plane (HCP), 1,6 m $\times$ 0,8 m, shall be placed on the table. The EUT and cables shall be isolated from the coupling plane by an insulating support 0,5 mm thick.

If the EUT is too large to be located 0,1 m minimum from all sides of the HCP, an additional, identical HCP shall be used, placed 0,3 m from the first, with the short sides adjacent. The table has to be enlarged or two tables may be used. The HCPs shall not be bonded together, other than via the resistive cable to the GRP.

Any mounting feet associated with the EUT shall remain in place.

An example of the test set-up for table-top equipment is given in Figure 5.

7.1.2 Floor-standing equipment

The EUT and cables shall be isolated from the ground reference plane by an insulating support about 0,1 m thick.

An example of the test set-up for floor-standing equipment is given in Figure 6.

Any mounting feet associated with the EUT shall remain in place.