

Environmental testing —

Part 2: Tests —

Test Ea and guidance: Shock

This Part should be read in conjunction with Part 1.1 General and guidance

The European Standard EN 60068-2-27:1993 has the status of a
British Standard

UDC 621.3:620.193:620.178.153

This British Standard, having been prepared under the direction of the General Electrotechnical Engineering Standards Committee, was published under the authority of the Board of BSI and comes into effect on 29 January 1988

© BSI 01-1999

First published August 1977
First revision

The following BSI references relate to the work on this standard:
Committee reference GEL/15
Draft for comment 83/27946 DC

ISBN 0 580 16362 8

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

	Page
National foreword	ii
Foreword	2
Introduction	3
1 Object	3
2 General description	3
3 Definitions	3
4 Description of test apparatus	4
5 Severities	4
6 Pre-conditioning	5
7 Initial measurements	5
8 Conditioning	5
9 Recovery	5
10 Final measurements	5
11 Information to be given in the relevant specification	6
Appendix A Guidance	7
Appendix B Shock response spectra and other characteristics of pulse shapes	11
Appendix C Comparison between impact tests	14
Annex ZA (normative) Other international publications quoted in this standard with the references of the relevant European publications	27
Figure 1 — Final-peak saw-tooth pulse	15
Figure 2 — Half-sine pulse	16
Figure 3 — Trapezoidal pulse	17
Figure 4 — Frequency characteristics of the measuring system	18
Figure 5 — Shock response spectrum of a final-peak saw-tooth pulse	19
Figure 6 — Shock response spectrum of a symmetrical half-sine pulse	20
Figure 7 — Shock response spectrum of a symmetrical trapezoidal pulse	21
Figure 8 — Framework or box containing oscillatory systems of which f_1 , f_2 and f_3 are examples of resonance frequencies	22
Figure 9a — Exciting pulse	23
Figure 9b — Responses for f_1 , f_2 and f_3	23
Figure 9c — Spectra which result from an infinite number of frequencies, with f_1 , f_2 and f_3 shown as finite points on the continuous curves	23
Figure 10 — Framework containing damped multi-degree-of-freedom system	24
Figure 11 — Shock response spectrum of a half-sine pulse with ripple	25
Figure 12 — Spectrum of a final-peak saw-tooth 300 m/s ² , 18 ms pulse compared with the spectra of 200 m/s ² half-sine pulses with durations between 3 ms and 20 ms	26
Table I — Acceleration and duration of the pulse	5
Table II — Examples of pulse shapes and test severities typically employed for various applications	8
Publications referred to	Inside back cover

National foreword

This Part of BS 2011 has been prepared under the direction of the General Electrotechnical Engineering Standards Committee. It is identical with IEC Publication 68-2-27:1987 “*Basic environmental testing procedures*”.
Part 2: “Tests — Test Ea and guidance: Shock”, published by the International Electrotechnical Commission (IEC).

In 1993 the European Committee for Electrotechnical Standardization (CENELEC) accepted IEC 68-2-27:1987 as European Standard EN 60068-2-27:1993. As a consequence of implementing the European Standard this British Standard is renumbered as BS EN 60068-2-27 and any reference to BS 2011-2.1Ea should be read as a reference to BS EN 60068-2-27.

The title of this Part of BS EN 60068 has been changed to “*Environmental testing*” to correspond with the change in title of IEC Publication 68. This change reflects the fact that IEC Publication 68 and BS EN 60068 are concerned with the whole subject of testing and avoids any possible confusion over whether it is the “procedures” or the “testing” that are basic. Amendments are not being issued to the other Parts of BS EN 60068, but their titles are being changed when these Parts are revised.

This revision supersedes BS 2011-2.1Ea:1977 which is withdrawn.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

For the purposes of this Part of this standard, the scope clause is given in BS 2011-1.1

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Wherever page numbers are quoted, they are IEC page numbers.

Cross-references

International standard ^a	Corresponding British Standard
IEC 68-1:1982	BS 2011 Basic environmental testing procedures Part 1.1:1983 General and guidance (Identical)
IEC 68-2-29:1987	Part 2.1Eb:1987 Test Eb. Bump (Identical)
IEC 68-2-31:1969	Part 2.1Ec:1977 Test Ec. Drop and topple, primarily for equipment-type specimens (Identical)
IEC 68-2-32:1975	Part 2.1Ed:1977 Test Ed. Free fall (Identical)
IEC 68-2-47:1982	Section 4.1:1983 Specification for mounting of components, equipment and other articles for dynamic tests (Identical)
IEC 68-2-55:1987 ^b	2.1Ee:Test Ee. Bounce (Identical)

^a Undated in the text.
^b Already published and referred to in the text as IEC 68-2-XX. The identical British Standard to IEC 68-2-55 is BS 2011-2.1Ee which is in preparation.

The Technical Committee has reviewed the provisions of IEC 721-3-1 and IEC 721-3-5 and also of ISO 2041, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. BS 3015:1976 “Glossary of terms relating to mechanical vibration and shock” is a related standard for ISO 2041.

WARNING NOTE. This British Standard calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any time.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 28, 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: Electricity, components, equipment, mechanical test, shock test, procedures, components specification writing, equipment specifications writing

English version

Basic environmental testing procedures Part 2: Tests Test Ea and guidance: Shock

(IEC 68-2-27:1987)

Essais fondamentaux climatiques et de
robustesse mécanique
Deuxième partie: Essais
Essai Ea et guide: Chocs
(CEI 68-2-27:1987)

Grundlegende Umweltprüfverfahren
Teil 2: Prüfungen
Prüfung Ea und Leitfaden: Schocken
(IEC 68-2-27:1987)

This European Standard was approved by CENELEC on 1993-03-09. 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 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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

At the request of CENELEC Reporting Secretariat SR 50A, HD 323.2.27 S2:1988 (IEC 68-2-27:1987) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The text of the International Standard was approved by CENELEC as EN 60068-2-27 on 9 March 1993.

The following dates were fixed:

- latest date of publication
of an identical national
standard (dop) 1994-03-01
- latest date of withdrawal
of conflicting national
standards (dow) —

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

Introduction

This test is applicable to components, equipments and other electrotechnical products, hereinafter referred to as “specimens”, which, during transportation or in use, may be subjected to conditions involving relatively infrequent non-repetitive shocks. The shock test may also be used as a means of establishing the satisfactory design of a specimen in so far as its structural integrity is concerned and as a means of quality control. It consists basically of subjecting a specimen to non-repetitive shocks of standard pulse shapes with specified peak acceleration and duration.

Specification writers will find in Clause 11 a list of details to be considered for inclusion in specifications and in Appendix A the necessary guidance.

1 Object

To provide a standard procedure for determining the ability of a specimen to withstand specified severities of shock.

2 General description

This standard is written in terms of prescribed pulse shapes. Guidance for the selection and application of these pulses is given in Appendix A and the characteristics of the different pulse shapes are discussed in Appendix B. Three types of pulse, namely the half-sine pulse, the final-peak saw-tooth pulse and the trapezoidal pulse are included in this standard. The choice of pulse shape depends on a number of factors, and the difficulties inherent in making such a choice preclude a preferred order being given in this standard (see Clause A3).

The purpose of the test is to reveal mechanical weakness and/or degradation in specified performance and to use this information, in conjunction with the relevant specification, to decide whether a specimen is acceptable or not. It may also be used, in some cases, to determine the structural integrity of specimens or as a means of quality control (see Clause A2).

This test is primarily intended for unpackaged specimens and for items in their transport case when the latter may be considered as part of the specimen itself.

The shocks are not intended to reproduce those encountered in practice. Wherever possible, the test severity and the shape of the shock pulse applied to the specimen should be such as to reproduce the effects of the actual transport or operational environment to which the specimen will be subjected, or to satisfy the design requirements if the object of the test is to assess structural integrity (see Clauses A2 and A4).

For the purpose of this test the specimen is always fastened to the fixture or the table of the shock-testing machine during conditioning.

In order to facilitate the use of this standard, references are given in the main part where the reader is invited to refer to Appendix A and also the clause numbers in the main part are referred to in Appendix A.

This standard is to be used in conjunction with IEC Publication 68-1: Basic Environmental Testing Procedures, Part 1: General and Guidance.

3 Definitions

The terms used are generally defined in ISO Standard 2041 or IEC Publication 68-1.

The following additional terms and definitions are also applicable for the purposes of this standard.

3.1

fixing point

part of the specimen in contact with the fixture or the table of the shock testing machine and which is normally used to fasten the specimen in service

3.2

check point

fixing point nearest to the centre of the table surface of the shock testing machine, unless there is a fixing point having a more rigid connection to the table, in which case this latter point shall be used

NOTE This definition applies as there is only one nominated check point. Other standards in IEC Publication 68-2 contain definitions of “check point” applicable where provision is made for the control of the test by nomination of more than one check point.

3.3

shock severity

combination of the peak acceleration and the duration of the nominal pulse

3.4

velocity change

absolute value of the sudden change of speed resulting from the application of the specified acceleration

NOTE The change is normally considered sudden if it takes place in a time that is short compared with the fundamental period of concern.

3.5

g_n

standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude

NOTE For the purposes of this standard, the value of g_n is rounded up to the nearest unity, that is 10 m/s².

4 Description of test apparatus

4.1 Required characteristics

When the shock testing machine and/or fixture are loaded with the specimen, the shock applied at the check point shall consist of a pulse approximating to one of the nominal acceleration against time curves given by the broken lines in Figure 1, Figure 2 and Figure 3, pages 38 to 40.

4.1.1 Basic pulse shapes

The true value of the actual pulse shall be within the limits of tolerance shown by the solid lines in the relevant figure.

NOTE Where it is not practicable to achieve a pulse shape falling within the specified tolerance, the relevant specification should state the alternative procedure to be applied (see Clause A5).

The prescribed pulse shapes are given below. The order in which they are given does not indicate a preference.

Final-peak saw-tooth: asymmetrical triangle with short fall time, as shown in Figure 1.

Half-sine: one half-cycle of a sine wave, as shown in Figure 2.

Trapezoidal: symmetrical trapezoid with short rise and fall times, as shown in Figure 3.

4.1.2 Velocity change tolerances

For all pulse shapes, the actual velocity change shall be within $\pm 15\%$ of the value corresponding to the nominal pulse.

Where the velocity change is determined by integration of the actual pulse, this shall be done from $0.4D$ before the pulse to $0.1D$ beyond the pulse, where D is the duration of the nominal pulse.

NOTE If the velocity change tolerance cannot be achieved without the use of elaborate facilities, the relevant specification should state the alternative procedure to be adopted (see Clauses A5 and A6).

4.1.3 Transverse motion

The positive or negative peak acceleration at the check point, perpendicular to the intended shock direction, shall not exceed 30% of the value of the peak acceleration of the nominal pulse in the intended direction, when determined with a measuring system in accordance with Sub-clause 4.2 (see Clause A5).

NOTE If the transverse motion tolerance cannot be achieved, the relevant specification should state the alternative procedure to be adopted (see Clause A5).

4.2 Measuring system

The characteristics of the measuring system shall be such that it can be determined that the true value of the actual pulse as measured in the intended direction at the check point is within the tolerances required by the figures referenced in Sub-clause 4.1.1

The frequency response of the overall measuring system, which includes the accelerometer, can have a significant effect on the accuracy and shall be within the limits shown in Figure 4, page 41 (see Clause A5).

4.3 Mounting

The specimen shall be fastened to the shock testing machine table or fixture by its normal mounting means during conditioning. Mounting requirements are specified in IEC Publication 68-2-47.

5 Severities

The relevant specification shall prescribe both the pulse shape and the shock severity. One of the pulse shapes given in Sub-clause 4.1.1 and a severity given in Table I shall be chosen.

Unless otherwise specified, one of the combinations shown on the same line in Table I shall be used. The preferred combinations are underlined. The corresponding velocity changes are also given (see Clause A4).

NOTE If the effects of the known environment on the specimen cannot be reproduced by severities given here the relevant specification may prescribe an appropriate severity using one of the standard pulse shapes, shown in Figure 1, Figure 2 and Figure 3 (see Clause A4).

Table I — Acceleration and duration of the pulse

Peak acceleration (A) g _n (Equivalent m/s ²)	Corresponding duration of the nominal pulse (D) ms	Corresponding velocity change (ΔV)		
		Half-sine $\Delta V = \frac{2}{\pi} AD \times 10^{-3}$ m/s	Final-peak saw-tooth $\Delta V = 0.5 AD \times 10^{-3}$ m/s	Trapezoidal $\Delta V = 0.9 AD \times 10^{-3}$ m/s
5 (50)	30	1.0	—	—
15 (150)	11	1.0	0.8	1.5
30 (300)	18	3.4	2.6	4.8
30 (300)	11	2.1	1.6	2.9
30 (300)	6	1.1	0.9	1.6
50 (500)	11	3.4	2.7	4.9
50 (500)	3	0.9	0.7	1.3
100 (1 000)	11	6.9	5.4	9.7
100 (1 000)	6	3.7	2.9	5.3
200 (2 000)	6	7.5	5.9	10.6
200 (2 000)	3	3.7	2.9	5.3
500 (5 000)	1	3.1	—	—
1 000 (10 000)	1	6.2	—	—
1 500 (15 000)	0.5	4.7	—	—
3 000 (30 000)	0.2	3.7	—	—

6 Pre-conditioning

The relevant specification may call for pre-conditioning.

7 Initial measurements

The specimen shall be submitted to the visual, dimensional and functional checks prescribed by the relevant specification.

8 Conditioning

8.1 Application of shocks

Unless otherwise prescribed by the relevant specification, three successive shocks shall be applied in each direction of three mutually perpendicular axes of the specimen, that is a total of 18 shocks.

When testing a number of identical specimens they may be so oriented that the shocks are applied simultaneously along the axes and in the directions referred to above (see Clause A7).

8.2 Operating mode and functional monitoring

The relevant specification shall state whether the specimen shall:

a) operate during shock and if any functional monitoring is required;

and/or

b) survive the conditions of shock.

For both cases the relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

9 Recovery

The relevant specification may call for recovery.

10 Final measurements

The specimen shall be submitted to the visual, dimensional and functional checks prescribed by the relevant specification.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.