BS EN 61587-1:2017

BSI Standards Publication

Mechanical structures for electronic equipment — Tests for IEC 60917 and IEC 60297 series

Part 1: Environmental requirements, test set-up and safety aspects for cabinets, racks, subracks and chassis under indoor condition use and transportation

bsi.

National foreword

This British Standard is the UK implementation of EN 61587-1:2017. It is identical to IEC 61587-1:2016. It supersedes BS EN 61587-1:2012, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/48, Electromechanical components and mechanical structures for electronic equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Mechanical structures for electronic equipment - Tests for IEC 60917 and IEC 60297 series - Part 1: Environmental requirements, test set-up and safety aspects for cabinets, racks, subracks and chassis under indoor condition use and transportation (IEC 61587-1:2016)

Structures mécaniques pour équipement électronique - Essais pour les séries IEC 60917 et IEC 60297 - Partie 1: Exigences environnementales, montage d'essai et aspects liés à la sécurité des baies, bâtis, bacs à cartes et châssis dans des conditions d'utilisation intérieure ou de transport (IEC 61587-1:2016)

Mechanische Bauweisen für elektronische Einrichtungen - Prüfungen für die Reihen IEC 60917 und IEC 60297 - Teil 1: Umgebungsanforderungen, Prüfaufbau und Sicherheitsaspekte für Schränke, Gestelle, Baugruppenträger und Einschübe bei Bedingungen in Innenräumen und beim Transport (IEC 61587-1:2016)

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European foreword

The text of document 48D/623/FDIS, future edition 4 of IEC 61587-1, prepared by SC 48D “Mechanical structures for electrical and electronic equipment” of IEC/TC 48 “Electrical connectors and mechanical structures for electrical and electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61587-1:2017.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-10-21
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2020-04-21

This document supersedes EN 61587-1:2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61587-1:2016 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068 (series)	NOTE	Harmonized as EN 60068 (series).
IEC 60068-2-75	NOTE	Harmonized as EN 600068-2-75.
IEC 62262	NOTE	Harmonized as EN 62262.

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	-	Environmental testing -- Part 1: General and guidance	EN 60068-1	-
IEC 60068-2-1	-	Environmental testing -- Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing -- Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing -- Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-11	-	Basic environmental testing procedures - Part 2-11: Tests - Test Ka: Salt mist	EN 60068-2-11	-
IEC 60068-2-27	-	Environmental testing -- Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60068-2-30	-	Environmental testing -- Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	-
IEC 60068-2-42	-	Environmental testing -- Part 2-42: Tests - Test Kc: Sulphur dioxide test for contacts and connections	EN 60068-2-42	-
IEC 60068-2-43	-	Environmental testing -- Part 2-43: Tests - Test Kd: Hydrogen sulphide test for contacts and connections	EN 60068-2-43	-
IEC 60068-2-49	-	Environmental testing -- Part 2: Tests - Guidance to Test Kc: Sulphur dioxide test for contacts and connections	-	-
IEC 60068-2-52	-	Environmental testing -- Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)	EN 60068-2-52	-
IEC 60068-2-64	-	Environmental testing -- Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance	EN 60068-2-64	-
IEC 60297	series	Dimensions of mechanical structures of the 482,6 mm (19 in) series	-	series
IEC 60297-3-100	-	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series -- Part 3-100: Basic dimensions of front panels, subracks, chassis, racks and cabinets	EN 60297-3-100	-
IEC 60297-3-101	-	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series -- Part 3-101: Subracks and associated plug-in units	EN 60297-3-101	-

IEC 60297-3-107	-	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series -- Part 3-107: Dimensions of subracks and plug-in units, small form factor	EN 60297-3-107	-
IEC 60297-3-108	-	Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series -- Part 108: Dimensions of R-type subracks and plug-in units	EN 60297-3-108	-
IEC 60512-1-1	-	Connectors for electronic equipment - Tests and measurements -- Part 1-1: General examination - Test 1a: Visual examination	EN 60512-1-1	-
IEC 60529	-	Degrees of protection provided by enclosures (IP Code)	-	-
IEC 60654-4	-	Operating conditions for industrial-process measurement and control equipment -- Part 4: Corrosive and erosive influences	EN 60654-4	-
IEC 60695-11-10	-	Fire hazard testing -- Part 11-10: Test flames - 50 W horizontal and vertical flame test methods	EN 60695-11-10	-
IEC 60721-3-3	-	Classification of environmental conditions - - Part 3: Classification of groups of environmental parameters and their severities -- Section 3: Stationary use at weatherprotected locations	EN 60721-3-3	-
IEC 60917	series	Modular order for the development of mechanical structures for electronic equipment practices	EN 60917	series
IEC 60917-2-1	-	Modular order for the development of mechanical structures for electronic equipment practices -- Part 2: Sectional specification - Interface co-ordination dimensions for the 25 mm equipment practice -- Section 1: Detail specification - Dimensions for cabinets and racks	EN 60917-2-1	-
IEC 60917-2-2	-	Modular order for the development of mechanical structures for electronic equipment practices -- Part 2: Sectional specification - Interface co-ordination dimensions for the 25 mm equipment practice -- Section 2: Detail specification - Dimensions for subracks, chassis, backplanes, front panels and plug-in units	EN 60917-2-2	-
IEC 60917-2-3	-	Modular order for the development of mechanical structures for electronic equipment practices -- Part 2-3: Sectional specification - Interface co-ordination dimensions for the 25 mm equipment practice - Extended detail specification - Dimensions for subracks, chassis, backplanes, front panels and plug-in units	EN 60917-2-3	-
IEC 60950-1 (mod)	2005	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1	2006
-	-		+ A11	2009
+ A1 (mod)	2009		+ A1	2010
-	-		+ A12	2011
-	-		+ AC	2011
+ A2 (mod)	2013		+ A2	2013

IEC 61010-1	-	Safety requirements for electrical equipment for measurement, control and laboratory use -- Part 1: General requirements	EN 61010-1	-
IEC 61373	-	Railway applications - Rolling stock equipment - Shock and vibration tests	EN 61373	-
IEC 61587-2	-	Mechanical structures for electronic equipment - Tests for IEC 60917 and IEC 60297 -- Part 2: Seismic tests for cabinets and racks	EN 61587-2	-
IEC 61587-3	-	Mechanical structures for electronic equipment - Tests for IEC 60917 and IEC 60297 - Part 3: Electromagnetic shielding performance tests for cabinets and subracks	EN 61587-3	-
IEC 61587-5	-	Mechanical structures for electronic equipment - Tests for IEC 60917 and IEC 60297 - Part 5: Seismic tests for chassis, subracks, and plug-in units	EN 61587-5	-

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MECHANICAL STRUCTURES FOR ELECTRONIC EQUIPMENT – TESTS FOR IEC 60917 AND IEC 60297 SERIES –

Part 1: Environmental requirements, test set-up and safety aspects for cabinets, racks, subracks and chassis under indoor condition use and transportation

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, Publicly Available Specifications (PAS) 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 61587-1 has been prepared by IEC subcommittee 48D: Mechanical structures for electronic equipment, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) total overhaul of Clause 7 “Mechanical tests”;
b) compatibility with IEC 61587-5.

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

FDIS	Report on voting
48D/623/FDIS	48D/628/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.

A list of all parts of the IEC 61587 series, under the general title *Mechanical structures for electronic equipment – Tests for IEC 60917 and IEC 60297 series*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The purpose of this standard is to provide a common methodology to perform and report conformance tests of IEC 60917 or IEC 60297 compliant cabinets, racks, subracks, chassis with integrated subracks and associated plug-in units under indoor condition use and transportation. Based upon the most recent specification/standard developments in the industry (such as PICMG, ANSI/VITA, ATIS, etc.) and to address new requirements, this edition 4 of IEC 61587-1 includes the following significant technical changes with respect to the previous edition:

a) Document title change to read: IEC 61587-1: Mechanical structures for electronic equipment – Tests for the IEC 60917 and IEC 60297 series – Part 1: Environmental requirements, test set-up and safety aspects for cabinets, racks, subracks and chassis under indoor condition use and transportation.

b) Total overhaul of Clause 7 “Mechanical tests” so as to make it compatible with legacy equipment (i.e., equipment commercially available prior to the publication of the standard). In particular:

   1) Subclause 7.2 “Tests for subracks or chassis with an integrated subrack and associated plug-in units” has been considerably expanded and provides for a more realistic intended use test environment (simulation of service condition).

   2) Subclause 7.2.1 “Static mechanical load tests of a subrack or a chassis with an integrated subrack” cabinet or rack static load test categories such as cabinets or racks with lifting eye test only and cabinets or racks without the use of lifting eyes have been added.

   3) Subclause 7.2.3 “Vibration and shock test of a mass loaded plug-in unit” has been updated to be in line with IEC 62262, which defines the way cabinets should be mounted when impact tests are carried out, the atmospheric conditions that should prevail, the number of impacts, and their distribution, and the physical size, dimensions, etc. of the various styles of hammers designed to produce the test energy level required.

c) Compatibility with IEC 61587-5.

MECHANICAL STRUCTURES FOR ELECTRONIC EQUIPMENT – TESTS FOR IEC 60917 AND IEC 60297 SERIES –

Part 1: Environmental requirements, test set-up and safety aspects for cabinets, racks, subracks and chassis under indoor condition use and transportation

1 Scope

This part of IEC 61587 specifies environmental requirements, test set-up, as well as safety aspects for empty enclosures, i.e., cabinets, racks, subracks, chassis with an integrated subrack, and associated plug-in units under indoor condition use and transportation.

The purpose of this standard is to establish defined levels of physical performance in order to meet certain requirements of storage, transport and final location conditions. It applies in whole or part only to the mechanical structures of cabinets, racks, subracks, chassis with an integrated subrack, and associated plug-in units, but it does not apply to electronic equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-11, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests– Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-42, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-43, *Environmental testing – Part 2-43: Tests – Test Kd: Hydrogen sulphide test for contacts and connections*

IEC 60068-2-49, *Environmental testing – Part 2-49: Tests – Guidance to test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-52, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random and guidance*

IEC 60297 (all parts), *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series*

IEC 60297-3-100, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-100: Basic dimensions of front panels, subracks, chassis, racks and cabinets*

IEC 60297-3-101, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-101: Subracks and associated plug-in units*

IEC 60297-3-107:2012, *Mechanical structures for electronic equipment - Dimensions of mechanical structures of the 482,6 mm (19 in) series - Part 3-107: Dimensions of subracks and plug-in units, small form factor*

IEC 60297-3-107, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-107: Dimensions of subracks and plug-in units, small form factor*

IEC 60297-3-108, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-108: Dimensions of R-type subracks and plug-in units*

IEC 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60654-4, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather protected locations*

IEC 60917, (all parts), *Modular order for the development of mechanical structures for electronic equipment practices*

IEC 60917-2-1, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2-1: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice – Detail specification – Dimensions for cabinets and racks*

IEC 60917-2-2, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2-2: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice – Detail specification – Dimensions for subracks, chassis, backplanes, front panels and plug-in units*

IEC 60917-2-3, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2-3: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice – Extended detail specification – Dimensions for subracks, chassis, backplanes, front panels and plug-in units*

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*
IEC 60950-1:2005/AMD1:2009
IEC 60950-1:2005/AMD2:2013

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*

IEC 61373, *Railway applications – Rolling stock equipment – Shock and vibration tests*

IEC 61587-2, *Mechanical structures for electronic equipment – Tests for IEC 60917 and IEC 60297 – Part 2: Seismic tests for cabinets and racks*

IEC 61587-3, *Mechanical structures for electronic equipment – Tests for IEC 60917 and IEC 60297 – Part 3: Electromagnetic shielding performance tests for cabinets and subracks*

IEC 61587-5, *Mechanical structures for electronic equipment – Tests for IEC 60917 and IEC 60297 – Part 5: Seismic tests for chassis, subracks, and associated plug-in units*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
indoor condition
location at which the product is protected from weather influences

3.2
mezzanine plug-in unit
module installed in a plug-in unit that can be removed from a subrack without removing its host plug-in unit

3.3
test sample
unit under test, dummy loaded where necessary in order to achieve repeatable results

4 Classification of environmental conditions

The climatic conditions are derived from IEC 60721-3-3 and IEC 60654-4.

The shock and vibration conditions are derived from IEC 60721-3-3.

The shock and vibration severity classes per Table 17 have been separated permitting the user to choose either the shock (DLxS) or vibration (DLxV) severity class or any combination thereof. The existing DLx severity classes are maintained. For example: DL1 (IEC 61587-1:2011) = DL1V and DL1S (IEC 61587-1/Ed4).

5 General

The purpose of the mechanical tests is to ensure that cabinets, racks, subracks and chassis will survive the normal handling during manufacture, storage, transportation, installation and in the service environment.

In order to have, for the enclosure itself, some safety margin built-in, all classification parameters are higher than parameters for the overall application itself. This should ensure proper working of a complete unit in an application.

Unless otherwise specified all tests shall be done at an ambient (room) temperature range of nominal +20 °C to +25 °C.

The specified classifications of performance and kinds of tests of this standard can be combined as required. Compliance to individual subclauses and levels is permissible. Individual tests and severities are referred to by letters and numbers (see Table 1 for examples which show a selection of representative values from each subclause and relevant table).

The various tests should be performed using the same sample wherever it is possible. Experience has shown that the sequence of tests listed in this standard (see also IEC 60068-1) enables the test sequence to be performed using the same test sample except where the individual test results preclude further testing of the same sample, i.e., the test has damaged (destroyed) the sample.

Table 1 – Examples showing references to tests

<table>
<tr><th>Test</th><th>Subrack, chassis IEC 60917 or IEC 60297 series</th><th>Plug-in unit IEC 60917 series</th><th>Plug-in unit IEC 60297 series</th><th>Cabinet, rack IEC 60917 or IEC 60297 series</th></tr>
<tr><td>Climatic</td><td colspan="3">C1 C2 C3</td><td></td></tr>
<tr><td>Industrial atmosphere</td><td colspan="3">A1 A2 A3</td><td></td></tr>
<tr><td>Static load</td><td>SL1 SL2 SL3 SL7 SL8 SL9 SL10 –
SLH1 SLH2 SLH3 SLH4 SLH5 SLH6 SLH7 SLH8 SLH9</td><td colspan="2">–</td><td>SL4 SL5 SL6 SL11 SL12 –
LT1 LT2 LT3 LT4 LT5 –
ST1 ST2 ST3 ST4 ST5 –
NL1 NL2 NL3 NL4 NL5</td></tr>
<tr><td>Dynamic load (vibration)</td><td>DL1V DL2V DL3V DL11V DL12V</td><td rowspan="2">PA12 PA21 PA31 PA32 PA41</td><td rowspan="2">PA11 PA12 PA13 PA21 PA22 PA31 PA32 PA41</td><td>DL4V DL5V DL6V</td></tr>
<tr><td>Dynamic load (shock)</td><td>DL1S DL2S DL3S DL11S</td><td>DL4S DL5S DL6S</td></tr>
<tr><td>Impact</td><td colspan="3">–</td><td>IK04 IK07 IK08</td></tr>
<tr><td>Protection (IP)</td><td colspan="3">IP20</td><td>IP20 IP30 IP42 IP54</td></tr>
<tr><td>Seismic performance</td><td colspan="3">Reference IEC 61587-5</td><td>Reference IEC 61587-2</td></tr>
<tr><td>Shielding performance</td><td colspan="4">Reference IEC 61587-3</td></tr>
</table>

Application example:

A subrack in accordance with IEC 60917-2-3 complies with the following test requirements:

- climatic: C2 (see Table 2);
- industrial atmosphere: A1 (see Table 3);
- static load: SL2 (see Table 4);
- vibration: DL1V (see Table 17);
- shock: DL1S (see Table 17);
- safety aspects: 8.2.1;
- protection to: IP30 (see Table 30).

6 Climatic tests

6.1 General

It is the objective of the climatic tests to ensure that cabinets, racks, subracks, chassis with an integrated subrack and associated plug-in units will survive the particular environment in which they will normally operate without degradation or creating a hazard.

Climatic tests shall be selected by reference to the application examples given in Table 2 for cabinets, racks, subracks or chassis with an integrated subrack and associated plug-in units.

In order to claim compliance at a given level, all test criteria for that requirement level shall be met.

6.2 Cold, dry heat and damp heat (cyclic)

Table 2 – Classifications for cold, dry heat and damp heat

Classification	Application examples	Cold according to IEC 60068-2-1		Dry heat according to IEC 60068-2-2		Damp heat according to IEC 60068-2-30 (cyclic 2×), variant 2, upper limit
		Temperature	Duration[a]	Temperature	Duration[a]	
		°C	h	°C	h	°C
C1	Enclosed spaces without particular stresses (for example office, laboratory) with temperatures between −10 °C and +55 °C, 20 % to 80 % RH: non-condensing	−10	16	55	16	55
C2	Enclosed spaces subject to climatic stress (for example production halls) with temperatures between −25 °C and +70 °C, 20 % to 80 % RH: non-condensing	−25	16	70	16	55
C3	Extreme climatic stresses (for example open air, tropical climate) with temperatures between −40 °C and +85 °C, 20 % to 95 % RH: non-condensing	−40	16	85	16	55

[a] The duration shall be measured from the moment temperature stability of the test sample is reached.

Assessment following the tests:

a) Visual examination (see IEC 60512-1-1, test 1a).

b) Earth bond continuity check to be carried out in accordance with 8.2.

c) For shielding performance examination, see IEC 61587-3:2013 (Table 1).

6.3 Industrial atmosphere

Table 3 – Classifications for industrial atmosphere

Classification	Application examples	Test conditions			Assessment following the test
		Sulphur dioxide test and hydrogen sulphide test, at 25 °C and 75 % RH (extended range at 40 °C and 80 % RH) according to IEC 60068-2-42, IEC 60068-2-43 and IEC 60068-2-49		Salt mist test Ka according to IEC 60068-2-11 at 35 °C (extended range as IEC 60068-2-52)	
		SO_2	H_2S	NaCl	
A1	Moderate concentration of harmful substances, general industrial use with low chemical emissions (for example enclosed spaces) and concentrations according to IEC 60654-4, namely; SO_2: mean 0,1 cm^3/m^3 maximum 0,5 cm^3/m^3	10 cm^3/m^3 4 days	1 cm^3/m^3 4 days	–	Visual examination (for example alteration in surface finish, traces of corrosion, colour, degree of lustre) For shielding gasket performance examination see IEC 61587-3
A2	Heavy concentration of harmful substances, with considerable chemical emissions (for example chemical industry, field work) and concentrations according to IEC 60654-4 namely: SO_2: mean 5 cm^3/m^3 maximum 15 cm^3/m^3 H_2S: mean 10 cm^3/m^3 maximum 50 cm^3/m^3	25 cm^3/m^3 4 days	10 cm^3/m^3 to 15 cm^3/m^3 4 days	–	Visual examination (for example alteration in surface finish, traces of corrosion, colour, degree of lustre). Variation in resistance of earthing conductor junctions, see 8.2 For shielding gasket performance examination see IEC 61587-3
A3	Heavy concentration of harmful substances combined with stress due to maritime climate (for example seaborne chemical processing technology, drilling rigs) and concentrations according to IEC 60654-4, namely: SO_2: mean 5 cm^3/m^3 maximum 15 cm^3/m^3 H_2S: mean 10 cm^3/m^3 maximum 50 cm^3/m^3	25 cm^3/m^3 4 days	10 cm^3/m^3 to 15 cm^3/m^3 4 days	5 % 96 h at 35°C Extended range: 5% 1 cycle: 146 h at 35 °C	Visual examination (for example alteration in surface finish, traces of corrosion, colour, degree of lustre) Variation in resistance of earthing conductor junctions, see 8.2 For shielding gasket performance examination see IEC 61587-3
NOTE The tests can be performed on individual components and sample units or component assemblies instead of the original units (cabinets, racks and subracks, chassis) if the replacement items and the original sample share the same materials and surface treatments.					

7 Mechanical tests

7.1 General

Mechanical tests shall be selected from the following subclauses according to the required application. Compliance to a given subclause is only achieved when all test criteria from that subclause are met.

7.2 Tests for subracks or chassis with an integrated subrack and associated plug-in units according to IEC 60917 or IEC 60297

7.2.1 Static mechanical load tests of a subrack or a chassis with an integrated subrack

7.2.1.1 Load bearing – General

The purpose of the test is to evaluate the load bearing capability of the structural parts of the IEC 60917 or IEC 60297 series of subracks or chassis with an integrated subrack. This includes subracks per IEC 60297-3-101 (conventional 19 in subrack), IEC 60297-3-107 (small form factor 19 in subrack), and IEC 60297-3-108 (R-type 19 in subrack).

7.2.1.2 Static mechanical load test fixture for subracks or chassis with an integrated subrack

An IEC 60917 or IEC 60297 series compliant subrack or chassis with an integrated subrack shall be mounted in a rigid test fixture via the standard mounting flanges as shown in Figure 1. This applies to subracks designed for either vertically or horizontally oriented plug-in units.

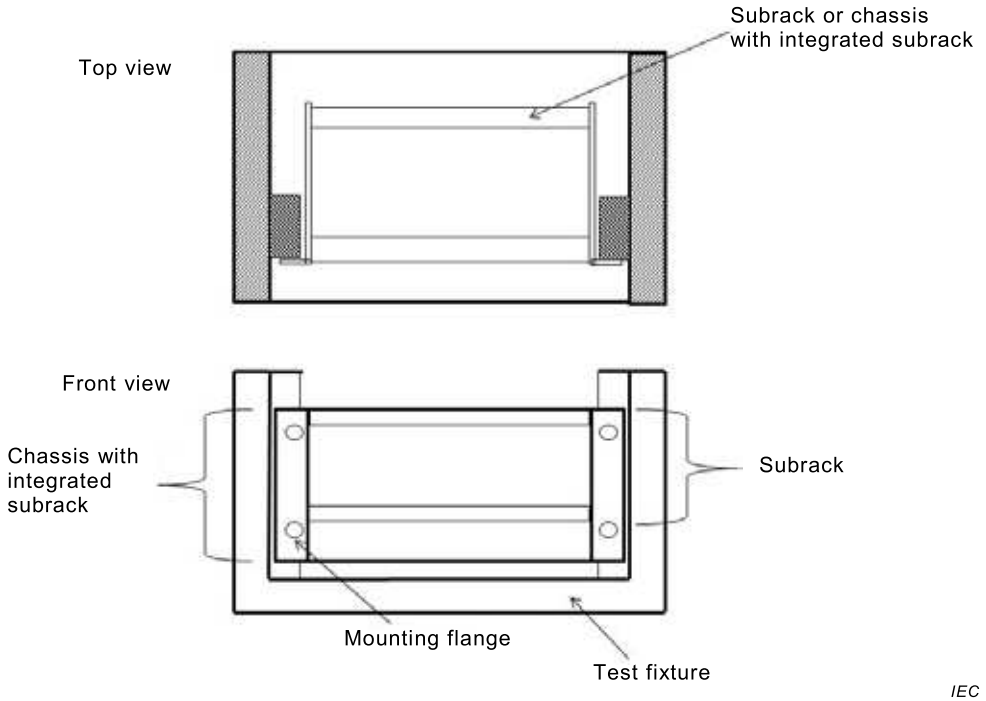


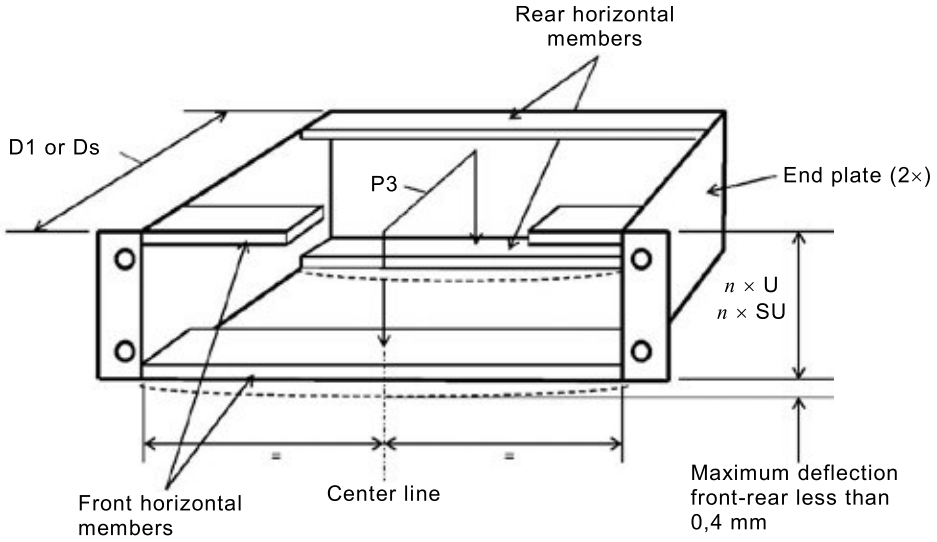
Figure 1 – Static mechanical load test fixture for a subrack or a chassis with an integrated subrack

7.2.1.3 Subrack mechanical load test and assessment – Vertical mounted plug-in units

7.2.1.3.1 General

The minimum definition of the subrack for the mechanical load test is shown in Figure 2 and consists of 2 end plates connected by 2 front horizontal members and 2 rear horizontal members or combinations thereof. The deflection of the lower front/rear subrack load bearing horizontal members is used as an indirect measure of the load bearing capability of the subrack and deflection shall be less than the defined value. Thus the front subrack horizontal members will prevent disengagement of the plug-in units from the guide rails, misalignment with plug-in unit front panel alignment pins and plug-in unit front panel retention devices. The rear horizontal members may be braced by an application specific component such as a backplane, a backpanel or a direct mounted fixed connector system warranting application specific rear horizontal members. It shall be reported if the subrack under test is assembled with such a component. If the subrack is an integral part of a chassis the same subrack/plug-in unit interfaces are tested.

A single point load P3 shall be applied equally to all lower horizontal members along the centre line of the subrack as outlined in Figure 2 and Table 4.



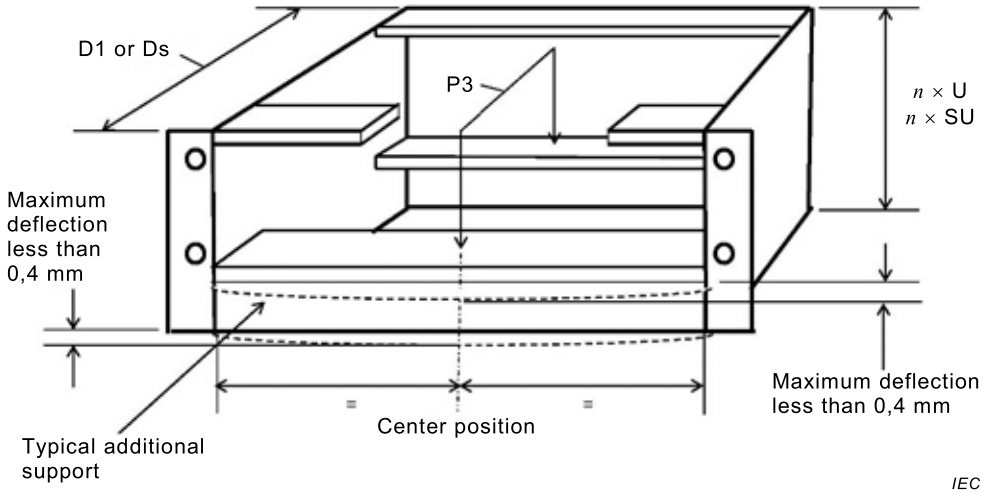
Key

For U	see IEC 60297-3-100
For D1	see IEC 60297-3-101
For SU	see IEC 60917-2-2
For Ds	see IEC 60917-2-2

Figure 2 – Single point (P3) load test for a subrack

7.2.1.3.2 Chassis with an integrated subrack mechanical load test – Vertical mounted plug-in units

The maximum deflection of the subrack load bearing members as an integral part of the chassis and the deflection of the chassis under load shall be less than the defined value. See Figure 3 and Table 4. The performance levels chosen are based on industry specifications for the intended applications.



Key

For U see IEC 60297-3-100

For D1 see IEC 60297-3-101

For SU see IEC 60917-2-2

For Ds see IEC 60917-2-2

Figure 3 – Single point (P3) load test for a chassis with an integrated subrack

Table 4 – Static mechanical load performance levels for subracks – Vertical mounted plug-in units

Performance level	Single point load P3 N
SL1	46
SL2	69
SL3	92
SL7	120
SL8	156
SL9	200
SL10	260

7.2.1.3.3 Assessment following the vertical plug-in unit P3 load test

The acceptance criteria are the following.

a) The maximum deflection of the lower subrack members or the underside of the chassis shall be less than 0,4 mm.

b) There shall be no structural deformation affecting form, fit and function.

c) If the load P3 cannot be applied at the location specified in Figure 2 or Figure 3 the location used for testing shall be reported.

d) A typical report of the test results for the subrack is shown in Table 5.

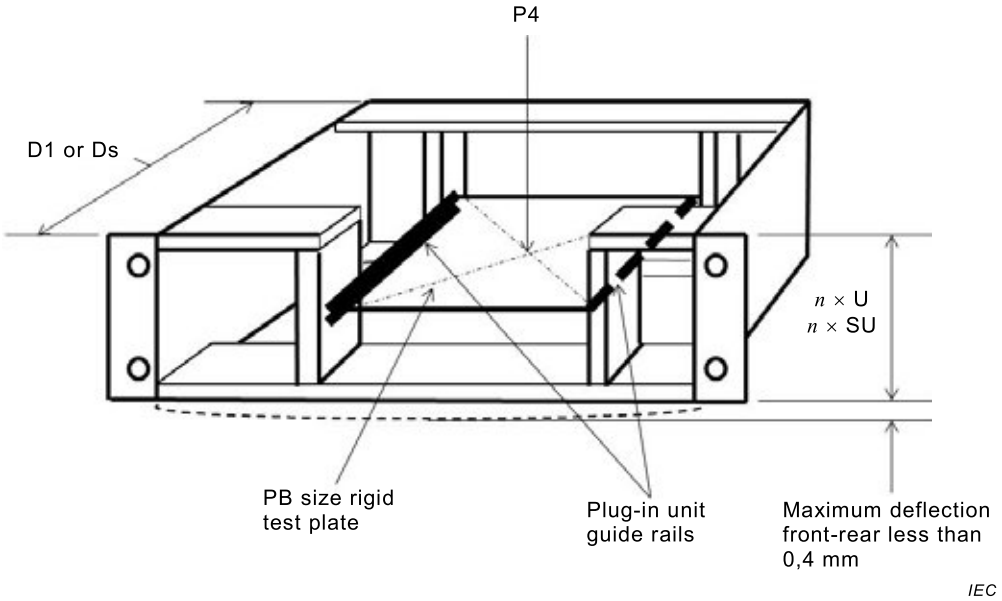
Table 5 – Typical test report of the mechanical P3 load test

Subrack per IEC	Subrack width	Performance level
IEC 60297-3-101	84HP	SL3

7.2.1.4 Subrack mechanical load test and assessment – Horizontal mounted plug-in units

7.2.1.4.1 General

Plug-in units may be placed horizontally into a subrack or a chassis with an integrated subrack. For the purpose of testing the rigidity of the plug-in unit guide rails a rigid test plate simulating the intended use PB (Printed Board) form factor shall be inserted into a plug-in unit guide rail position. Pressure simulating the plug-in unit mass categories as per Table 6 shall be exerted on position P4. See Figure 4.



Key

For U see IEC 60297-3-100

For D1 see IEC 60297-3-101

For SU see IEC 60917-2-2

For Ds see IEC 60917-2-2

Figure 4 – Single point (P4) load test for a subrack or a chassis with an integrated subrack

Table 6 – Static mechanical load performance levels for subracks – Horizontal mounted plug-in units

Performance level	Single point load P4 N
SLH1	2,5
SLH2	3,5
SLH3	5,0
SLH4	7,0
SLH5	10,0
SLH6	15,0
SLH7	26,0
SLH8	52,0
SLH9	78,0

7.2.1.4.2 Assessment following the horizontal plug-in unit P4 load test

The acceptance criteria are the following.

a) The maximum deflection of the lower subrack members or the underside of the chassis shall be less than 0,4 mm.

b) There shall be no evidence of guide rail deflection, damage, dislocation, shearing or loosening.

c) There shall be no structural deformation affecting form, fit and function.

d) If the load P4 cannot be applied at the location specified in Figure 4 the location used for testing shall be reported.

e) A typical report of the test results for the subrack is shown in Table 7.

Table 7 – Typical test report of the mechanical P4 load test

Subrack per IEC	Subrack Width	Performance Level
IEC 60297-3-101	84HP	SLH5

7.2.2 Dynamic mechanical load tests for a subrack or a chassis with an integrated subrack

7.2.2.1 Subrack and chassis with an integrated subrack vibration and shock test – General

The physical size of the subrack or chassis with an integrated subrack shall be selected from the IEC 60917 or IEC 60297 series. This includes subracks per IEC 60297-3-101 (conventional 19 in subrack), IEC 60297-3-107 (small form factor 19 in subrack), and IEC 60297-3-108 (R-type 19 in subrack).

The subrack or the chassis with an integrated subrack under test shall be mounted in a rigid test fixture via the standard subrack or chassis with integrated subrack mounting flanges as shown in Figure 5 and Figure 6. Table 8 and Table 9 provide detailed load instructions. It shall be reported if subrack or chassis slides (support rails) are required for the test.

Mass loaded plug-in units shall be mounted into the subrack retained by their defined front panel retention devices. Mass loaded plug-in units shall use free connectors and engage with subrack mounted fixed connectors which are either directly mounted to the subrack rear horizontal members or mounted to a backplane or fixed connector bracket or panel.

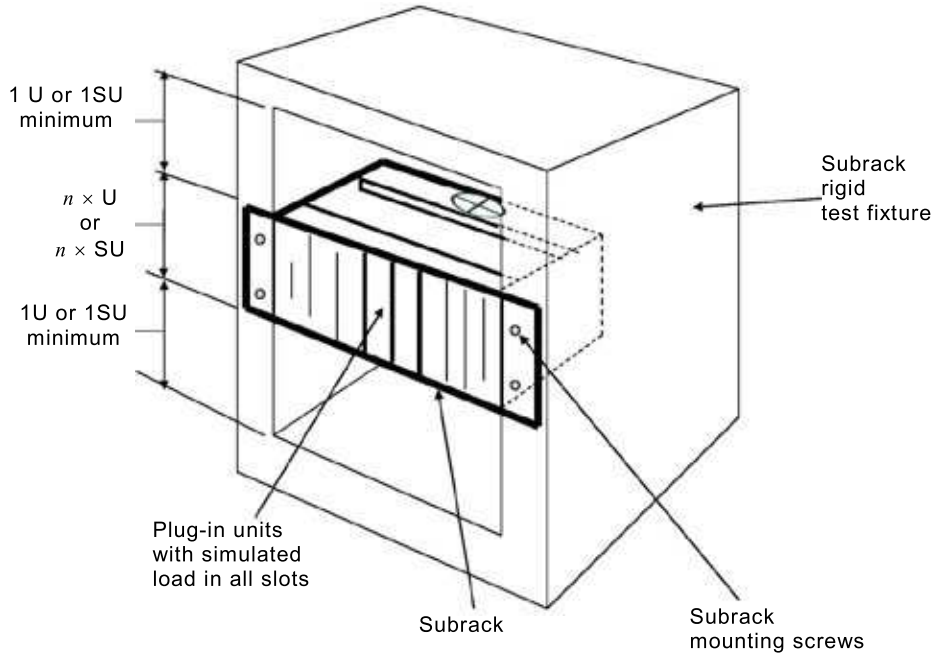
Mass loaded plug-in units shall be evenly distributed over the width of the subrack. See Figure 7 and Table 8 and Table 9. Mass loaded plug-in units shall be inserted into the subrack provided plug-in unit guide rail positions.

Subracks shall be assembled in accordance with the manufacturer's instructions. Subrack/chassis mounting screws to the test fixture (see Figure 5 and Figure 6) and all subrack structural assembly screws shall be tightened to the manufacturers recommended torque values.

The chosen connector system (fixed and free) used for the purpose of the test shall be reported. The defined connector test conditions shall be observed.

7.2.2.2 Subrack or chassis with an integrated subrack – Rigid test fixture

Vibration and shock tests shall be performed on a subrack or a chassis with integrated subrack assembled with mass loaded plug-in units according to the IEC 60068 references as shown in Table 17 of this standard. The test fixture shall be mounted directly to the vibration table.

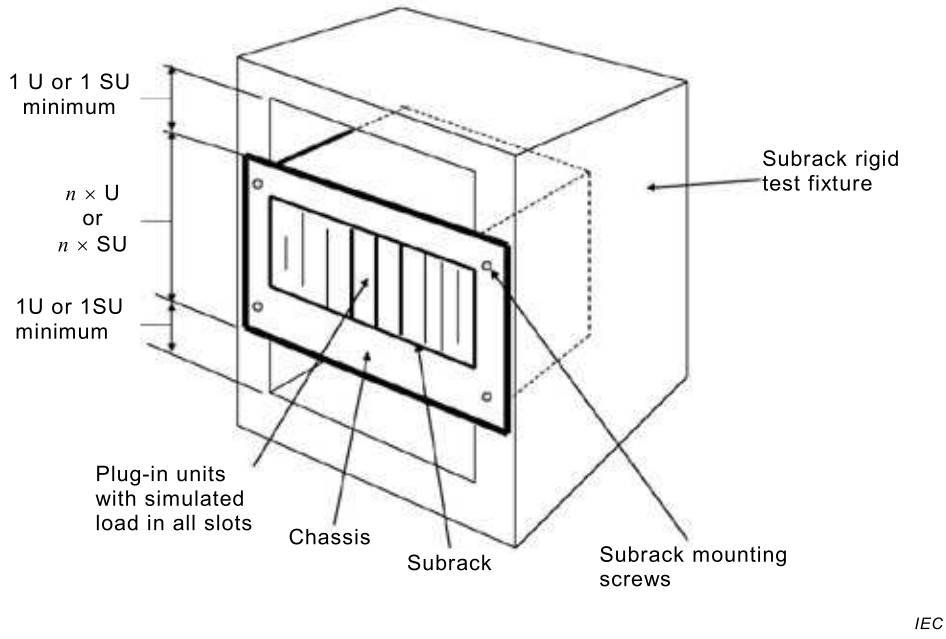


Key

For U see IEC 60297-3-100

For SU see IEC 60917-2-2

Figure 5 – Test fixture with a subrack under test



Key

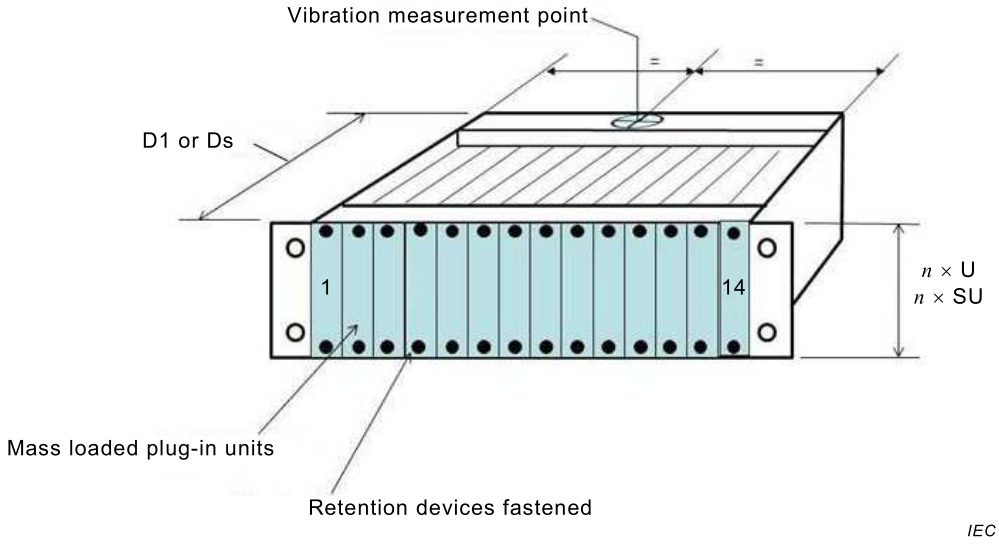
For U see IEC 60297-3-100

For SU see IEC 60917-2-2

Figure 6 – Test fixture with a chassis with an integrated subrack under test

7.2.2.3 Subrack or chassis with an integrated subrack test setup

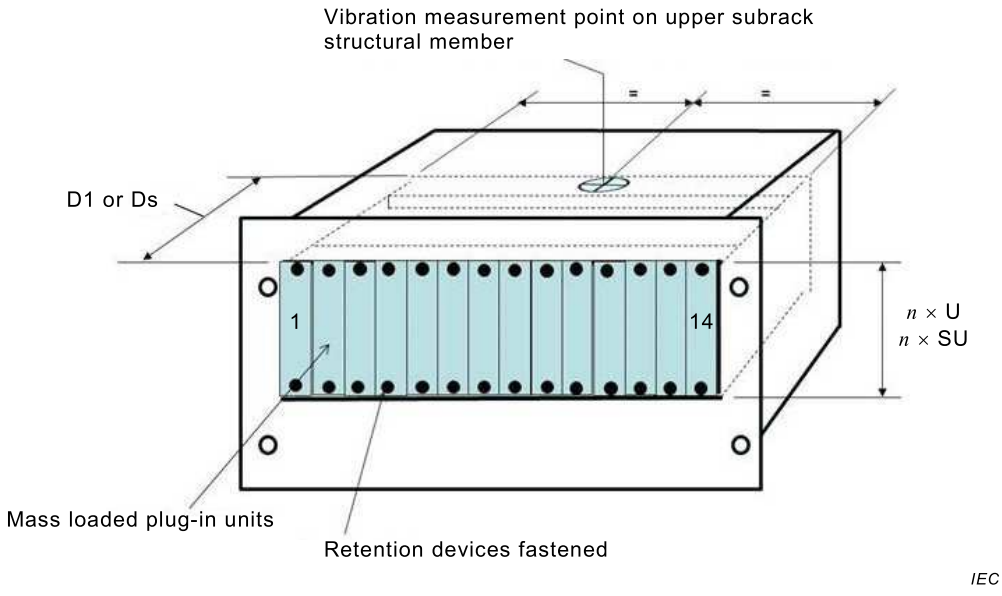
The mixed vertical mounted plug-in unit test set up and the horizontal mounted plug-in unit test set up or a mix of horizontal mounted, vertical mounted plug-in units and other devices is considered application specific. However, the vibration measurement point shall be observed. See Figure 7c and Figure 7d.



Key

For U see IEC 60297-3-100
For D1 see IEC 60297-3-101
For SU see IEC 60917-2-2
For Ds see IEC 60917-2-2

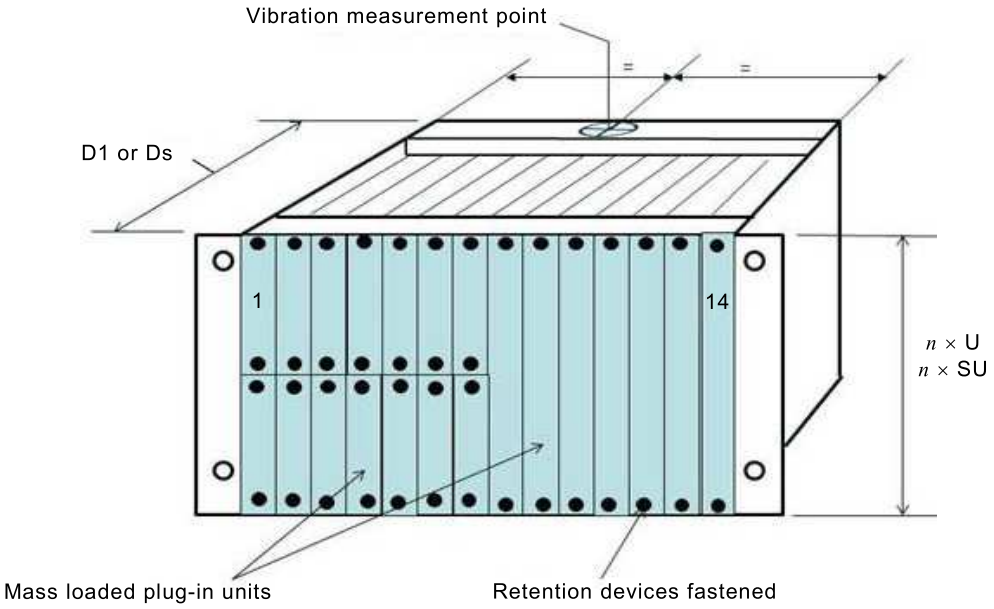
a) Subrack with vertical mounted plug-in units



Key

For U see IEC 60297-3-100
For D1 see IEC 60297-3-101
For SU see IEC 60917-2-2
For Ds see IEC 60917-2-2

b) Chassis with integrated subrack



Key

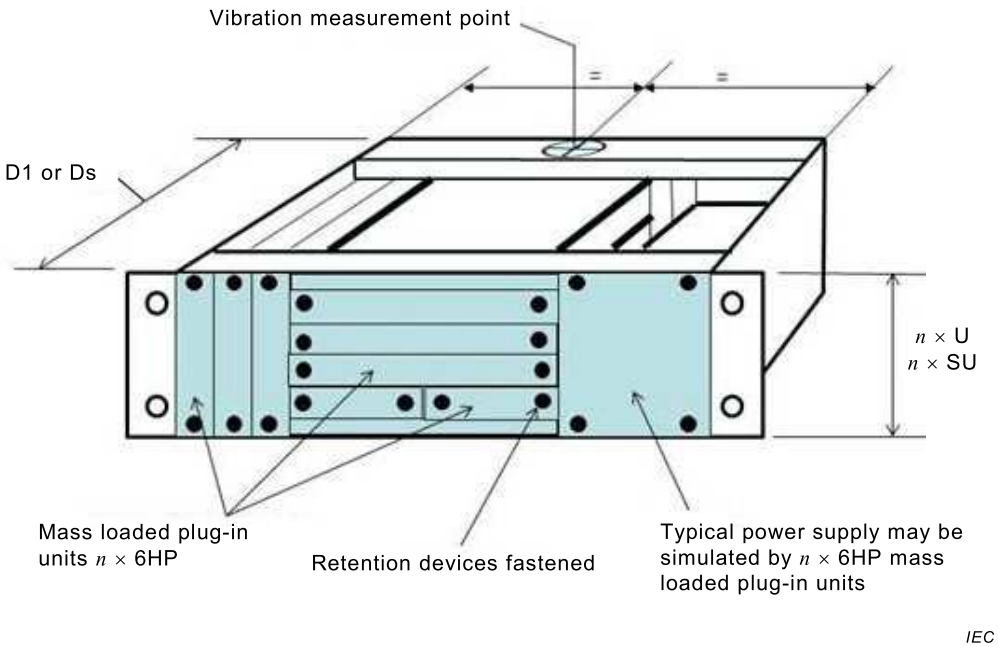
For U see IEC 60297-3-100

For D1 see IEC 60297-3-101

For SU see IEC 60917-2-2

For Ds see IEC 60917-2-2

c) Example of subrack with mixed height vertical mounted plug-in units



Key

For U see IEC 60297-3-100

For D1 see IEC 60297-3-101

For SU see IEC 60917-2-2

For Ds see IEC 60917-2-2

d) Example of subrack with horizontal mounted or mixed mounted plug-in units

Figure 7 – Test setup and measurement point

7.2.2.4 Subrack and chassis with an integrated subrack – Load categories

7.2.2.4.1 General

The subrack load category (SLC) defines a choice of subracks and their associated total plug-in unit mass load. See Table 8 and Table 9.

7.2.2.4.2 Subrack load categories for the IEC 60297 series

Table 8 – IEC 60297 series subracks with mass loaded plug-in units

Subrack load category SLC	IEC 60297-3-x	Plug-in unit Single mass kg	Plug-in unit quantity 6HP	Plug-in unit Total mass kg
SLC1	Select depth D1 and U height	0,25	14	3,50
SLC2		0,50		7,00
SLC3		0,70		9,80
SLC4		1,00		14,00
SLC5		1,50		21,00
SLC6		2,00		28,00
SLC7		4,00		56,00
SLC8		6,00		84,00

7.2.2.4.3 Subrack load categories for the IEC 60917 series

Table 9 – IEC 60917 series subracks with mass loaded plug-in units

Subrack load category SLC	Subrack Width Ws1 mm	IEC 60917-2-2	Plug-in unit Single mass kg	Plug-in unit quantity Ws4=30 mm	Plug-in unit Total mass kg
SLC2	425	Select depth Ds2 and SU height	0,50	14	7,00
SLC9	475			15	7,50
SLC10	600			20	10,00
SLC4	425		1,00	14	14,00
SLC11	475			15	15,00
SLC12	600			20	20,00
SLC6	425		2,00	14	28,00
SLC13	475			15	30,00
SLC14	600			20	40,00

7.2.2.5 Test setup for the subrack and chassis with an integrated subrack – Total mass categories

7.2.2.5.1 General

The total mass category defines the mass of the subrack assembled with the total mass of the plug-in units or the mass of a chassis with an integrated subrack assembled with the total mass of the plug-in units. The mass categories Bx are defined in IEC 61587-5. The same mass categories apply for the IEC 60917 series and the IEC 60297 series. The test setup, the test method and test acceptance criteria for the selected category shall be applied throughout the testing. The mass of a subrack or chassis with integrated subrack assembled with plug-in units shall fall into the total mass test categories as defined in Table 10. For shock and vibration test classifications, see 7.2.3.4, Table 17.

Table 10 – Subrack or chassis with integrated subrack – Total mass test categories

Total mass test category	kg
B1	<23
B2	≥23 to <68
B3	≥68 to <181

7.2.2.5.2 Assessment following the IEC 60917-2-2 or the IEC 60297-3-x subrack or chassis with an integrated subrack shock and vibration test

The acceptance criteria are the following.

a) No visible mechanical damage – perform visual examination for such failures as crack formation, permanent deformation (dimensions), loosened screw connection, abrasion on the subrack, abrasion on the connector.

b) Earth bond continuity check to be carried out in accordance with 8.2.1.

c) Subrack or chassis EMC gaskets and plug-in unit ESD clips (if used) shall maintain form, fit and function.

d) Typical reports of the test results for the subrack or chassis with an integrated subrack in accordance with IEC 60917-2-2 or IEC 60297-3-x are shown in Table 11 and Table 12.

Table 11 – Typical shock test report of subrack or chassis with an integrated subrack

Subrack per IEC (report selected size)	Subrack load category SLC	Subrack total mass category B	Shock classification DLxS
IEC 60297-3-101	SLC6	B2	DL1S

Table 12 – Typical vibration test report of subrack or chassis with an integrated subrack

Subrack per IEC (report selected size)	Subrack load category SLC	Subrack total mass category B	Vibration classification DLxV
IEC 60297-3-101	SLC6	B2	DL3V

7.2.3 Vibration and shock test of a mass loaded plug-in unit

7.2.3.1 Plug-in unit vibration and shock test – General

The physical size of the plug-in unit shall be selected from the IEC 60917 or IEC 60297 series. The test will permit the qualification of the plug-in unit mounted free connector / subrack mounted fixed connector interface, the plug-in unit front panel retention device, EMC and ESD components, and the subrack guide rail design feature. The chosen connector system (fixed and free) used for the purpose of the test shall be reported. The defined connector test conditions shall be observed. The plug-in unit retention devices shall be in locked position.

7.2.3.2 Plug-in unit – Typical rigid test fixture

7.2.3.2.1 General

The test fixture shall be of a rigid design and shall include the fixed connector interface which is either backplane mounted or bracket mounted simulating the intended use environment (simulation of service condition). The rigid test fixture shall provide for a plug-in unit guide rail design and plug-in unit retention device interface simulating the intended use environment (simulation of service condition). A typical rigid test fixture for plug-in units is shown in Figure 8 and Figure 9. The test fixture internal plug-in unit interface dimensions shall comply

with IEC 60917-2-2 or IEC 60297-3-101. The test fixture external dimensions are considered design specific. The test fixture shall be mounted directly to the vibration table. The vibration and shock tests shall be performed on a mass loaded plug-in unit in accordance with the IEC 60068 references as shown in Table 17 of this standard.

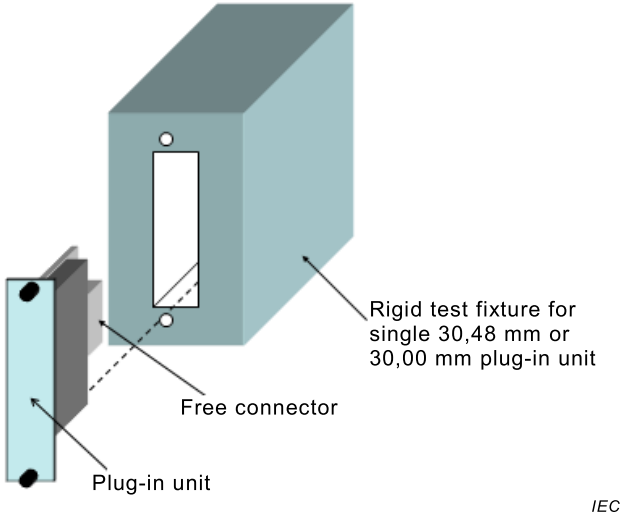


Figure 8 – Overview of a typical plug-in unit and test fixture

7.2.3.2.2 Typical test setup for a plug-in unit test fixture – Sectional views

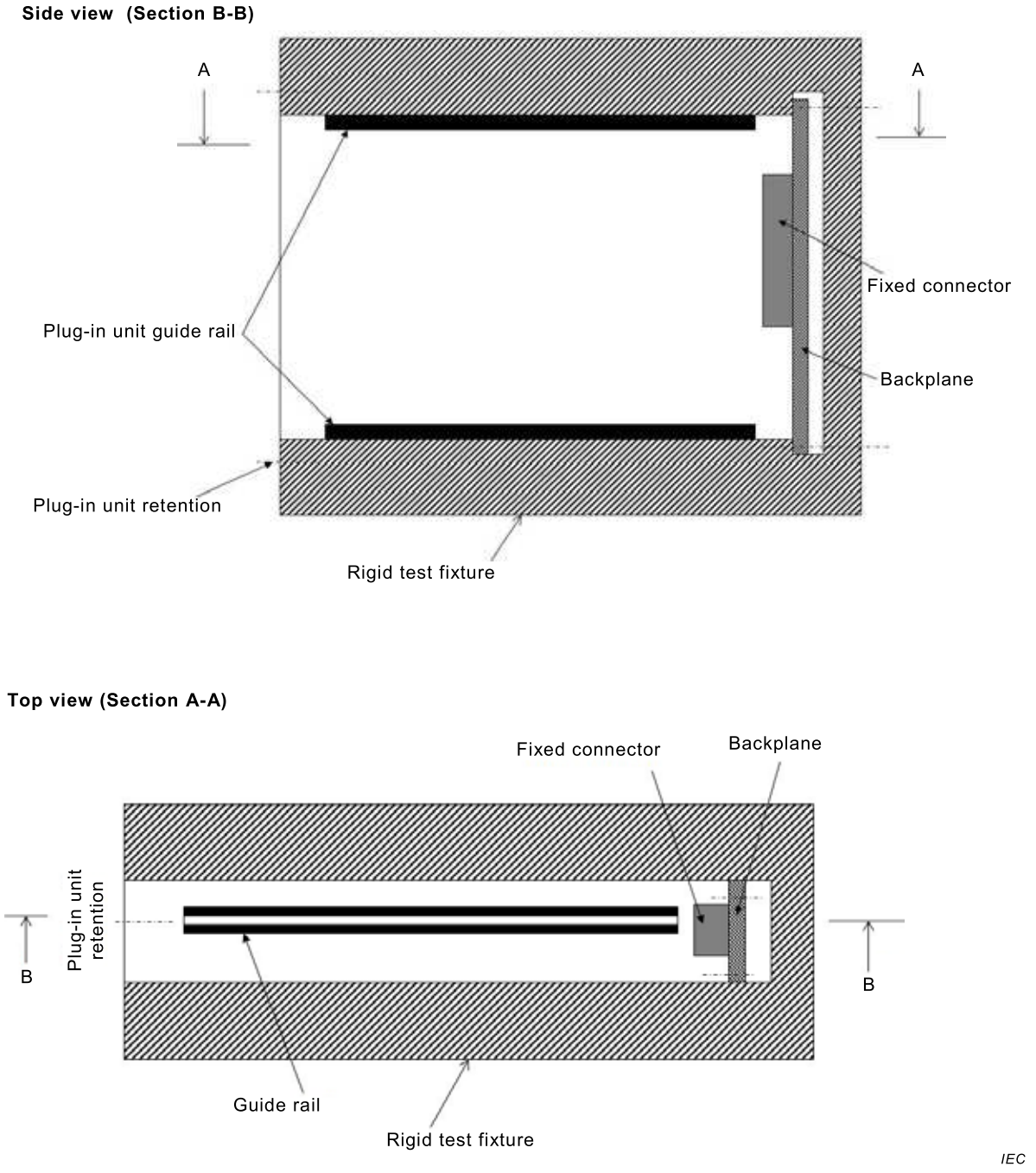
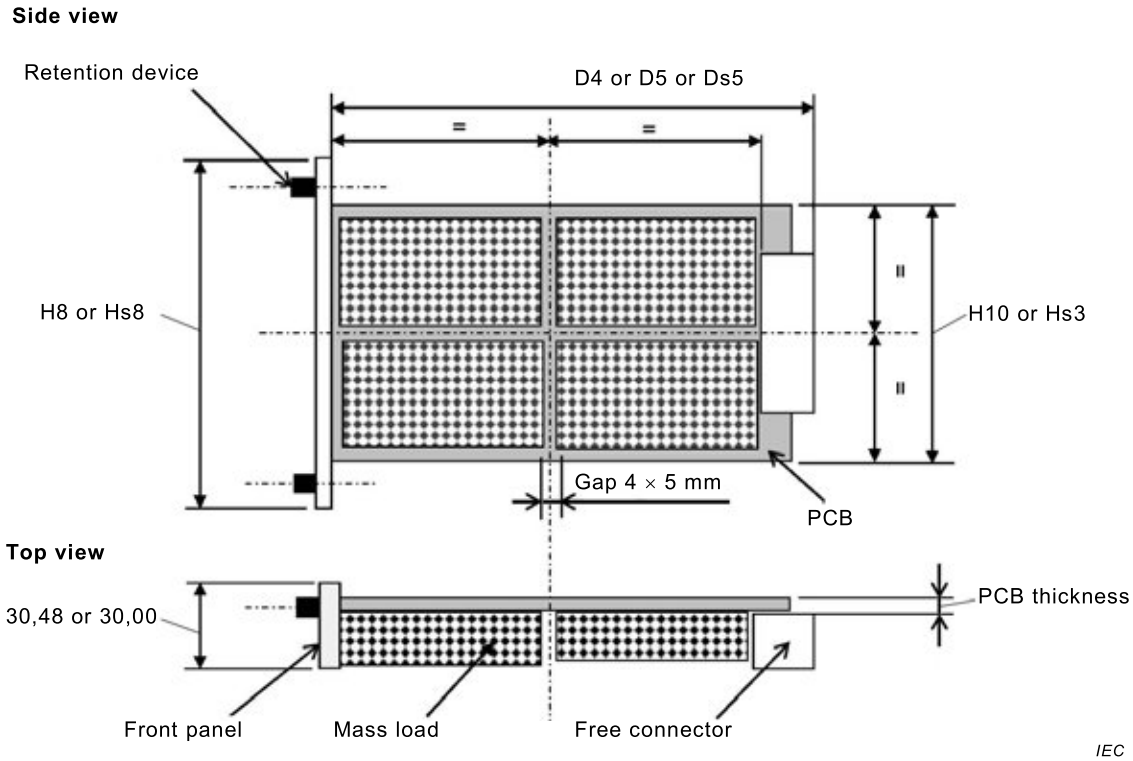


Figure 9 – Overview of a typical plug-in unit test fixture – Sectional views

7.2.3.2.3 Mass loaded plug-in unit

The equally distributed mass attached to the plug-in unit PB shall be in compliance with the IEC 60917 or IEC 60297 series plug-in unit boundaries. The mass loaded plug-in unit requires the assembly of a front panel and a free connector typically mounted to the PB. The attached load may be constructed of any type of material. A typical mass loaded plug-in unit configuration is shown in Figure 10. Table 13 and Table 14 provide details.



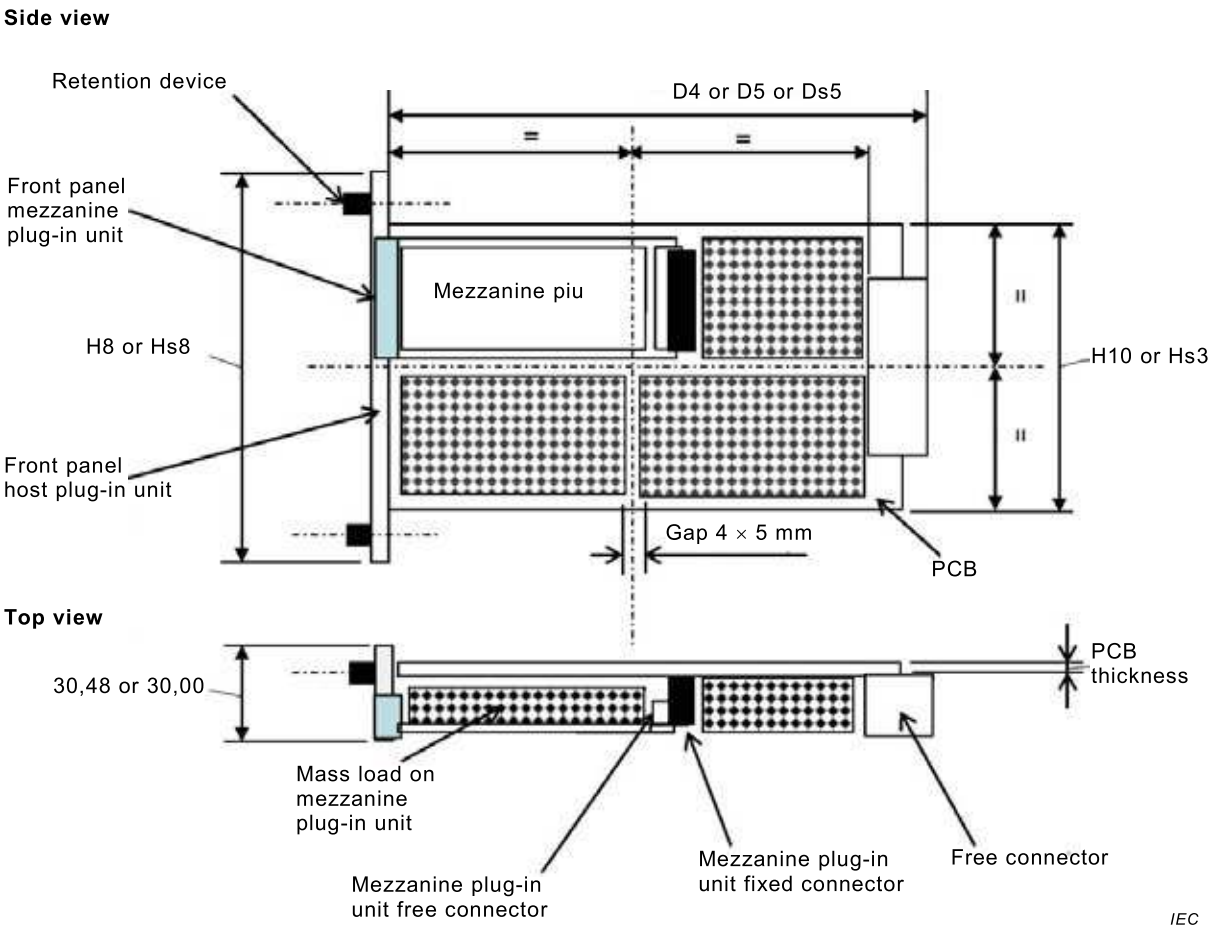
Key

For H8, H10 or D4 and 30,48	see IEC 60297-3-101
For H8, H10 or D5 and 30,48	see IEC 60297-3-107
For Hs3, Hs8 or Ds5 and 30,00	see IEC 60917-2-2
PCB (Printed Circuit Board)	

Figure 10 – Typical mass loaded plug-in unit

7.2.3.2.4 Mass loaded plug-in unit assembled with mezzanine plug-in units

Plug-in units in accordance with the IEC 60917 or IEC 60297 series may become the host for one or more “mezzanine” plug-in units. A typical mass loaded mezzanine plug-in unit can be removed from the subrack without removing the host plug-in unit. IEC 60297-3-107 plug-in unit sizes are typically used as mezzanine plug-in units, but are not limited to this use. A typical configuration is shown in Figure 11. For the purpose of the dynamic test, Table 13 and Table 14 provide for plug-in unit total mass load test categories for host plug-in units assembled without mezzanine plug-in units or assembled with mezzanine plug-in units. The mass load for a mezzanine plug-in unit shall simulate the intended use and is considered part of the plug-in unit total mass load category PAxx.



Key

For H8, H10 or D4 and 30,48	see IEC 60297-3-101
For H8, H10 or D5 and 30,48	see IEC 60297-3-107
For Hs3, Hs8 or Ds5 and 30,00	see IEC 60917-2-2

Figure 11 – Typical mass loaded host plug-in unit assembled with a mass loaded mezzanine plug-in unit

7.2.3.3 Plug-in unit total mass categories

7.2.3.3.1 General

The total mass categories Ax limits are defined in IEC 61587-5. To be able to test individual plug-in units the IEC 61587-5 stated limits A1, A2, A3, A4, have been subdivided into actual plug-in unit PAxx mass categories. The same PAxx mass categories apply to the IEC 60917 and the IEC 60297 series. For the purpose of the test, the plug-in unit total mass category may or may not include the assembly of a mezzanine plug-in unit. However, if mezzanine plug-in units are part of the host (or carrier) plug-in unit functionality, the host plug-in unit under test shall include the mass loaded mezzanine plug-in unit(s). The mechanical interfaces of the host plug-in unit/mezzanine plug-in unit(s) shall be tested and reported.

7.2.3.3.2 Total mass categories for the IEC 60297 plug-in unit series

Table 13 – IEC 60297 series mass loaded plug-in units

Plug-in unit mass category PA	**Plug-in unit width 6HP**	**Plug-in unit (with or without mezzanine plug-in unit) mass** kg
PA11	Select depth D4 and U height	0,25
PA12		0,50
PA13		0,70
PA21		1,00
PA22		1,50
PA31		2,00
PA32		4,00
PA41		6,00

7.2.3.3.3 Total mass categories for the IEC 60917 plug-in unit series

Table 14 – IEC 60917 series mass loaded plug-in units

Plug-in unit mass category PA	**Plug-in unit width Ws4 = 30mm**	**Plug-in unit (with or without mezzanine plug-in unit) mass** kg
PA12	Select depth Ds5 and SU height	0,50
PA21		1,00
PA31		2,00
PA32		4,00
PA41		6,00

7.2.3.3.4 Assessment following the plug-in unit shock and vibration load test

The acceptance criteria are the following.

a) The defined connector test conditions shall be met (see connector standard).

b) The chosen connector system(s) (for the host and the mezzanine plug-in units) shall meet at all its interfaces the set out form, fit and function conditions.

c) The test fixture mounted plug-in unit guide rails shall be visibly undamaged.

d) The plug-in unit/test fixture retention devices shall be undamaged and in locked position.

e) Plug-in unit front panel EMC gaskets (if used) and plug-in unit/test fixture mounted ESD clips (if used) shall maintain their form, fit and function.

f) Typical reports of the test results for a plug-in unit in accordance with IEC 60297-3-x or IEC 60917-2-3 are shown in Table 15 and Table 16.

Table 15 – Typical shock test report of a plug-in unit

Plug-in unit per IEC (report selected size)	Plug-in unit mass category PAxx	Shock classification DLxS
IEC 60297-3-101	PA21	DL2S

Table 16 – Typical vibration test report of a plug-in unit

Plug-in unit per IEC (report selected size)	Plug-in unit mass category PAxx	Vibration classification DLxV
IEC 60297-3-101	PA21	DL3V

7.2.3.4 Shock and vibration test classifications

7.2.3.4.1 General

This standard distiguishes between compliance for vibration (DLxV) and compliance for shock (DLxS) tests to permit users to choose specific application tests (see Clause 5, paragraph 4).

Table 17 – Vibration and shock classifications for subracks, chassis with integrated subracks and associated plug-in units

Classifications Vibration	Intended application	Test Fc: Vibration, sinusoidal, according to IEC 60068-2-6			Classifications Shock	Test Ea: Shock, according to IEC 60068-2-27		
		Frequency range Hz	Deflection amplitude mm	Acceleration amplitude m/s^2		Peak acceleration m/s^2	Duration time ms	Number of shocks
DL1V	Low level of shock and vibration. Fixed application at power stations and general industrial applications (class 3M3, IEC 60721-3-3).	2 to 9 9 to 200	1,5 –	– 5	DL1S	70	11	18
DL2V	Moderate level of shock and vibration, stationary and mobile use. Loaded cabinet for railway, motorway signalling applications, close to rotating machines (class 3M4, IEC 60721-3-3).	2 to 9 9 to 200	3,0 –	– 10	DL2S	100	18	18
DL3V	High level of shock and vibration. Mobile applications subject to high stress, heavy rotating machinery, ships (class 3M7, IEC 60721-3-3).	2 to 9 9 to 200	10 –	– 30	DL3S	250	18	18
		Test Fh: Vibration, random, according to IEC 60068-2-64				Test Ea: Shock, according to IEC 60068-2-27		
DL11V	Severe mobile applications on wheels IEC 61373 Cat. 2	IEC 60068-2-64:2008, Table A.5 and Table A.6 Category 4 a, b, c			DL11S	400	11	18
DL12V	Airborne applications IEC 60068-2-64 referring to RTCA DO-160D	IEC 60068-2-64:2008, Table A.7 and Table A.8 Category 1 a,b,c,d						

For seismic tests, see IEC 61587-5.

7.2.3.4.2 Test procedure: vibration – Sinusoidal

Test axes: x-y-z

Transit time: 1 octave/minutes

Test duration/axis: 10 frequency cycles

Resonance search: 10 Hz to 150 Hz, 2 m/s^2 acceleration

Resonance test: Resonance with a magnification factor of 3 to 4 shall have the vibration amplitude increased until the magnification factor reaches 7 to 8. This level shall be maintained for a period of not less than 10 min.

7.2.3.4.3 Test procedure: vibration – random

Test axes: vertical, horizontal, longitudinal and transversal

Transit time: 1 octave / axis

Test duration / axis: 5 h / axis

7.2.3.4.4 Test procedure: airborne

Test axes: x-y-z

Transit time: 3 octave / axis

Test duration / axis: 1 h / axis

7.2.3.4.5 Test procedure: shock

Three shocks each in both directions for the three main axes x-y-z.

7.3 Static and dynamic mechanical load tests for cabinets or racks

7.3.1 General

According to IEC 60917-2-1 a rack differs from a cabinet by being an open structure without doors and or covers. A rack consisting of 2 vertical structural members only is not covered by this standard. The purpose of the static test(s) is to evaluate the structural stiffness of a cabinet or rack as a minimum measure of durability against handling, transportation forces, and normal operation. Static test severities are defined to simulate a selection of service conditions, see 7.3.2.2, 7.3.2.3 and 7.3.2.4. Lifting tests (LT), stiffness tests (ST), or nominal load (NL) tests may be reported individually, as defined in Table 19, Table 20, Table 21 and Table 22 or reported in a combination of lifting, stiffness, and nominal load selection (SL), as defined in Table 18. For the dynamic test severity applied to the cabinet or rack, see 7.3.3.

7.3.2 Cabinet and rack – Static load tests

7.3.2.1 General

Table 18 – Combined classification levels for cabinet or rack nominal load, lifting, and stiffness tests

Classification	Nominal load (NL) cabinet kg	Lifting test (LT) Force P1 N	Stiffness test (ST) Force P2 N
SL4	200	3 000	500
SL5	400	6 000	1 000
SL6	800	12 000	2 000
SL11	1 000	15 000	2 500
SL12	1 500	22 500	3 750

a) The nominal load is the stated load carrying capacity of the cabinet or rack.

b) The load capacity of the building floor should be considered, especially in the case of 1 000 kg and 1 500 kg nominal load cabinets.

Table 19 – Classification levels for individually reported cabinet or rack nominal load tests

Classification	Nominal load (NL) cabinet kg
NL1	200
NL2	400
NL3	800
NL4	1 000
NL5	1 500
a) The nominal load is the stated load carrying capacity of the cabinet or rack. b) The load capacity of the building floor should be considered, especially in the case of 1 000 kg and 1 500 kg nominal load cabinets.	

Table 20 – Classification levels for individually reported cabinet or rack lift tests

Classification	Nominal load (NL) cabinet kg	Lifting test (LT) Force P1 N
LT1	200	3 000
LT2	400	6 000
LT3	800	12 000
LT4	1 000	15 000
LT5	1 500	22 500
a) The nominal load is the stated load carrying capacity of the cabinet or rack. b) The load capacity of the building floor should be considered, especially in the case of 1 000 kg and 1 500 kg nominal load cabinets.		

Table 21 – Classification levels for individually reported cabinet or rack stiffness test

Classification	Stiffness test (ST) Force P2 N
ST1	500
ST2	1 000
ST3	2 000
ST4	2 500
ST5	3 750

7.3.2.2 Cabinet or rack – Lifting test

7.3.2.2.1 General

The purpose of the lifting test (LT) is to assess the lifting capability of a cabinet or rack (see Figure 12) with a simulated nominal load (NLx) and force (LTx) selected from Table 18 or Table 20.

The test sample shall at a minimum comply with the LT1 of 200 kg at 3 000 N.

7.3.2.2.2 Test conditions

a) The test sample shall not be bolted to the floor and may or may not use feet, a plinth/base or castors.

b) The internal load (NLx) shall be selected from Table 18 or Table 20 and placed at the base of the cabinet or rack, see Figure 14, dummy load M4 (for the load location only).

7.3.2.2.3 Test procedure

a) Apply force at P1 by steady force.

b) Maintain load for a period of 1 min minimum.

c) Two lifting cycles to be carried out.

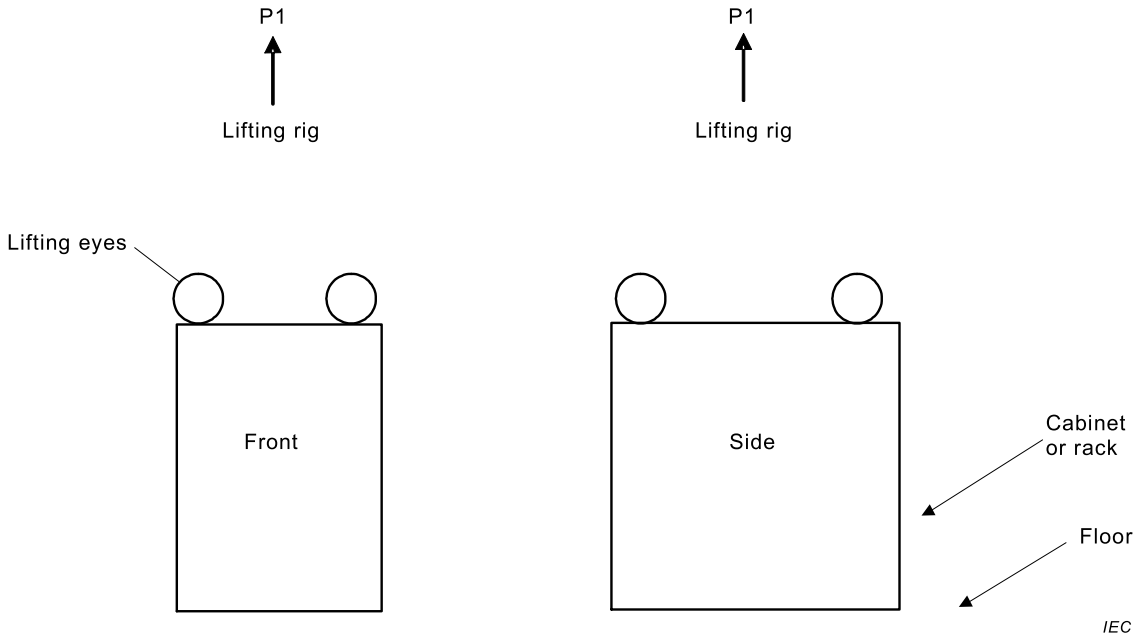


Figure 12 – Lifting test for cabinets or racks

7.3.2.2.4 Assessment following the test

a) No deformation or damage of parts that affect form, fit or function shall be allowed after the tests.

b) Earth bond continuity check to be carried out in accordance with 8.2.

c) A typical report of the test results of a cabinet or rack lifting test is shown in Table 22.

Table 22 – Typical test report of a cabinet or rack lifting test

Cabinet per IEC (report selected size)	Cabinet size H × W × D	Cabinet lifting test LT
IEC 60297-3-100	1 800 × 600 × 600	LT2

7.3.2.3 Cabinet or rack – Stiffness test

7.3.2.3.1 General

The purpose of the stiffness test (ST) is to evaluate the structural stiffness of an empty cabinet and rack as a minimum measure of durability against handling and transportation forces. The empty cabinet or rack shall be configured reflecting the simulation of service conditions. The force (STx) shall be selected from Table 18 or Table 21. The test sample shall at a minimum comply with the ST1 of 500 N, see Table 18 or Table 21.

7.3.2.3.2 Test conditions

a) The test sample shall be bolted to the floor using the standard bolt-down positions and shall not use a plinth/base, castors or feet.

b) No nominal loads (NL) shall be used for this test.

7.3.2.3.3 Test procedure

a) Apply a steady force (P2), evenly distributed over the shaded area of Figure 13, on the front of the cabinet and rack under test.

b) Maintain load for a period of 1 min minimum, then remove load.

c) Apply a steady force (P2), evenly distributed over the shaded area of Figure 13, on the side of the cabinet and rack under test.

d) Maintain load for a period of 1 min minimum.

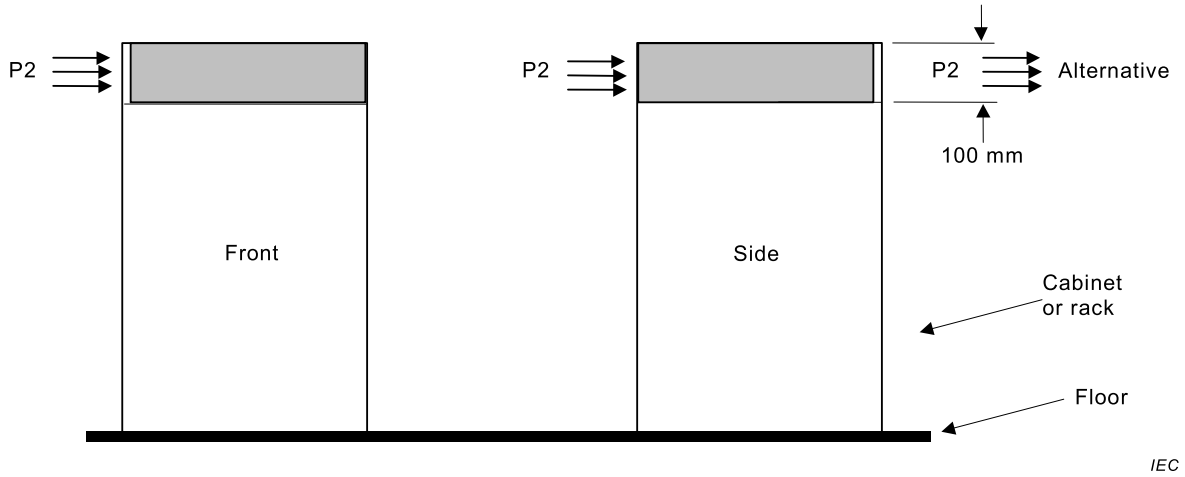


Figure 13 – Stiffness test for cabinets or racks

7.3.2.3.4 Assessment following the tests

a) After the front and side tests no deformation of parts that affect form, fit or function with regard to the relevant detail specification shall be allowed.

b) Earth bond continuity check to be carried out in accordance with 8.2.

c) A typical report of the test results of the cabinet or rack stiffness test is shown in Table 23.

Table 23 – Typical test report of the cabinet or rack stiffness test

Cabinet per IEC (report selected size)	Cabinet size H × W × D	Cabinet stiffness test ST
IEC 60297-3-100	1 800 × 600 × 800	ST4

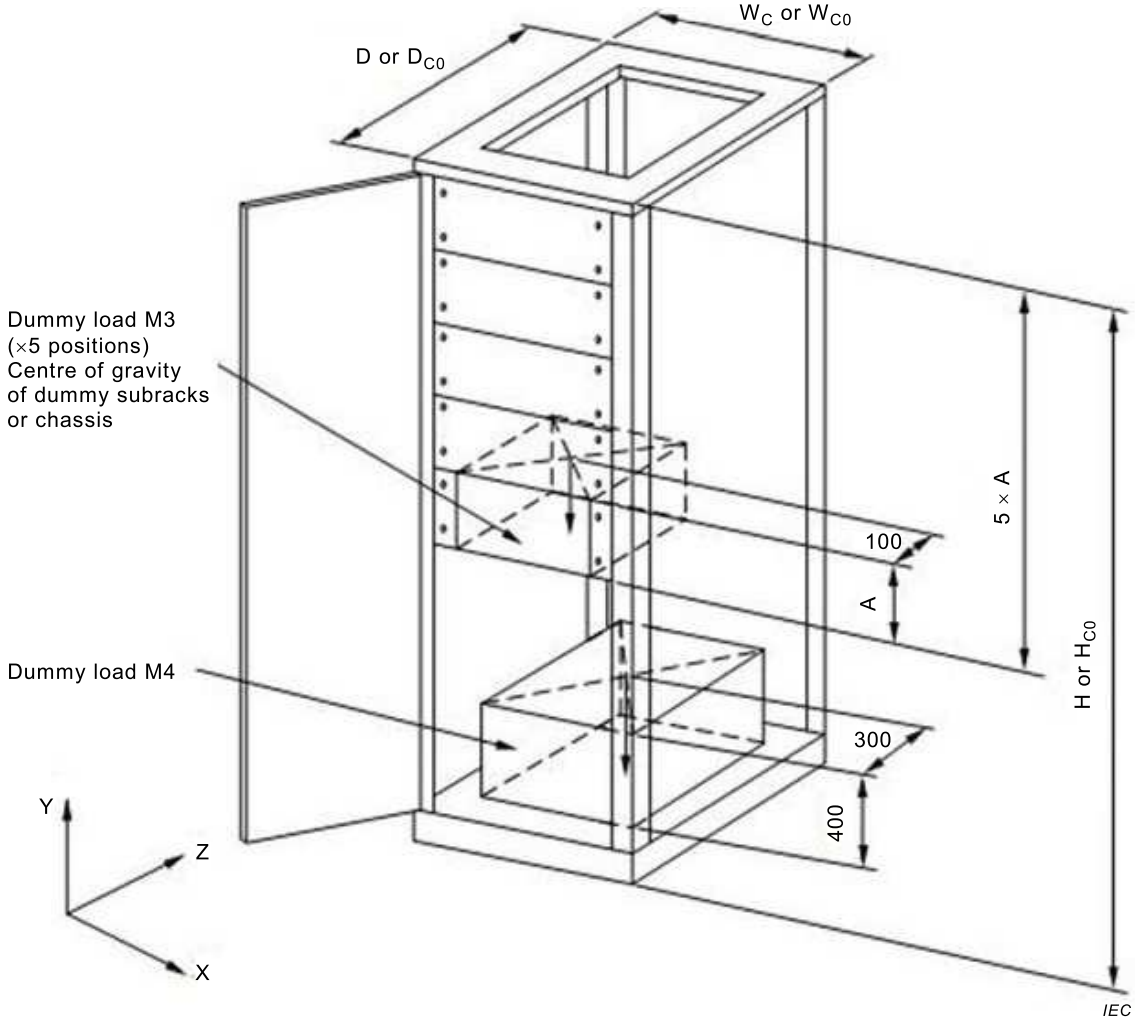
7.3.2.4 Cabinet or rack – Nominal load test

7.3.2.4.1 General

For the purpose of the nominal load test a set up per the cabinet or rack example in Figure 14 should be followed to keep cabinet loading consistent. However, the vertical members of an empty cabinet or rack according to IEC 60917 or IEC 60297 accepting the attachment of subracks or chassis in accordance with IEC 60917 or IEC 60297 may be configured either front mounted or recessed mounted or both. For the purpose of a load test the load distribution shall be as shown in Figure 14. If the cabinet or rack is not designed to support loads similar to load M4, M4 may be omitted and replaced with additional M3 loads. The nominal load (NLx) shall be selected from Table 18 or Table 19 and distributed in the cabinet

or rack according to Table 24. The test sample shall at a minimum comply with the NL1 of 200 kg, see Table 18 or Table 19.

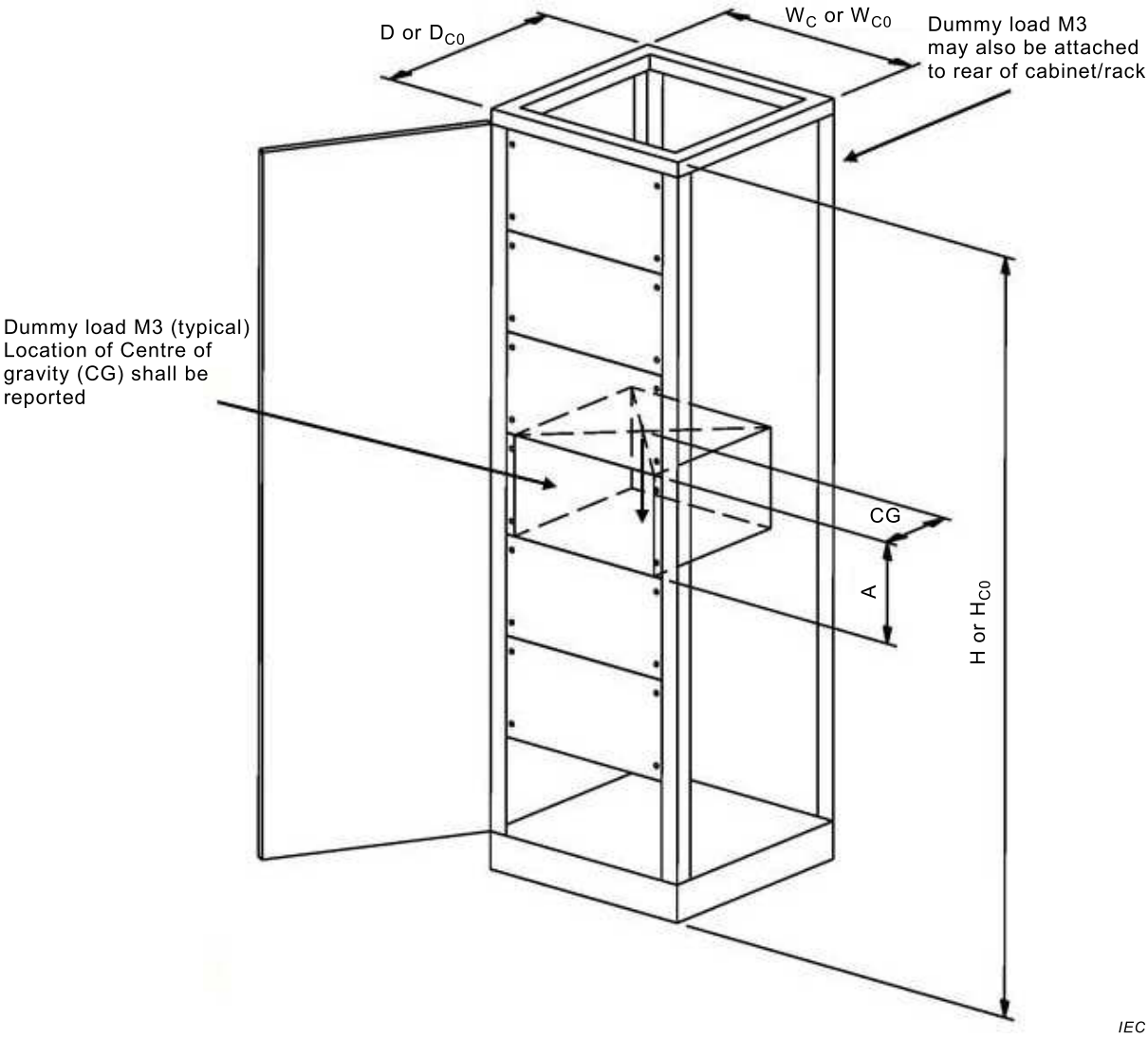
Dimensions in millimetres



Key

For D, W_C and H	see IEC 60297-3-100
For D_{C0}, W_{C0} and H_{C0}	see IEC 60917-2-1

a) Test set up using M4 load



Key

For D, W_C and H	see IEC 60297-3-100
For D_{C0}, W_{C0} and H_{C0}	see IEC 60917-2-1

b) Alternative test set up without M4 load

Figure 14 – Test set up for cabinets and racks – Nominal load test

Table 24 – Cabinet or rack, nominal load test values

Cabinets or racks according to	A mm	M3 kg	M4 kg	Total load (NLx) kg
IEC 60297-3-100	265,9	23	85	200
		23	285	400
		68	460	800
		68	660	1 000
		100	1 000	1 500
IEC 60917-2-1	250	23	85	200
		23	285	400
		68	460	800
		68	660	1 000
		100	1 000	1 500

Total load NLx may be achieved either by combined M3 and M4 loads as indicated above or by using only M3 loads distributed throughout the height and depth of the cabinet or rack. Details of load distribution shall be included in the test report.

Key

– A = Height of the dummy loads M3 in the upper section.

– M4 = Dummy load weight in the lower section of the cabinet.

7.3.2.4.2 Test conditions

a) The test sample shall not be bolted to the floor but placed on a rigid floor.

b) The test sample shall be assembled as per the intended use condition (i.e. feet or castors or a plinth/base is attached). Details of the assembly used for the test shall be reported.

c) The cabinet front may or may not be assembled with a front door according to the intended use. Details of the assembly used for the test shall be reported.

d) The cabinet rear may or may not be assembled with a rear panel or a rear door according to the intended use. Details of the assembly used for the test shall be reported.

e) The cabinet side(s) may or may not be assembled with a side cover(s) according to the intended use. Details of the assembly used for the test shall be reported.

7.3.2.4.3 Test procedure

a) The test load distribution is according to Figure 14.

b) The test sample load is to be selected from Table 24.

c) The M3 dummy loads shall be assembled to the cabinet or rack via the front mounted cabinet or rack mounting flanges, and optionally via the additional mounting flanges in accordance with IEC 60917-2-1 or rear vertical members according to Figure 7 and Figure 8 of IEC 60297-3-100:2008, see Figure 14. If additional mounting flanges are used this should be noted in the report. The dummy load mounting flanges shall be in accordance with IEC 60917-2-1 or IEC 60297-3-100 and rigid enough to support the dummy load M3 without deflection. The M3 dummy loads shall be bolted to the cabinet or rack vertical members via a minimum of 4 M6 screws and be tightened to the recommended torque values.

d) The M4 dummy load (if used) shall be assembled to the cabinet or rack base as shown in Figure 14a. For the 1 000 kg load the weight may be distributed on the entire base area, maintaining the 400 mm height, so that steel may be used for the weight.

e) Maintain load for a period of 5 min minimum.

f) Deformation of all vertical members in the Y direction relative to the floor shall be less than 3 mm.

g) Earth bond continuity check to be carried out in accordance with 8.2.

h) No deformation that would affect form, fit or function (e.g., opening or closing of cabinet doors) shall be allowed.

7.3.2.4.4 Assessment following the test

a) No deformation that would affect form, fit or function (e.g., opening or closing of cabinet doors) shall be allowed.

b) Earth bond continuity check to be carried out in accordance to 8.2.

c) Typical reports of the test results of the cabinet or rack nominal load test and the combined static load test are shown in Table 25 and Table 26.

Table 25 – Typical test report of the cabinet or rack nominal load test

Cabinet per IEC (report selected size)	**Cabinet size** H × W × D	**Cabinet load test** NL	**Cabinet assembly**
IEC 60297-3-100	2 000 × 600 × 600	NL3	Cabinet tested with front and rear doors, side panels, and casters attached

Table 26 – Typical test report of the cabinet or rack combined static load test

Cabinet per IEC (report selected size)	**Cabinet size** H × W × D	**Cabinet load test** NL	**Cabinet lifting test** LT	**Cabinet stiffness test** ST
IEC 60297-3-100	2 000 × 600 × 600	SL6		

7.3.3 Cabinet or rack – Vibration and shock tests

7.3.3.1 General

This standard distiguishes between compliance for vibration (DLxV) and compliance for shock (DLxS) tests to permit users to choose specific application tests (see Clause 5, paragraph 4).

The tests shall be carried out on a cabinet set-up as shown in Figure 15 and Table 27. The test cabinet consists of a frame, front door, rear door, two side panels and a top cover. The rack consists of a frame only. Mounting of the test sample to the test table is via the bottom (floor) mounting points. The vibration and shock classification levels are shown in Table 28.

Dimensions in millimetres

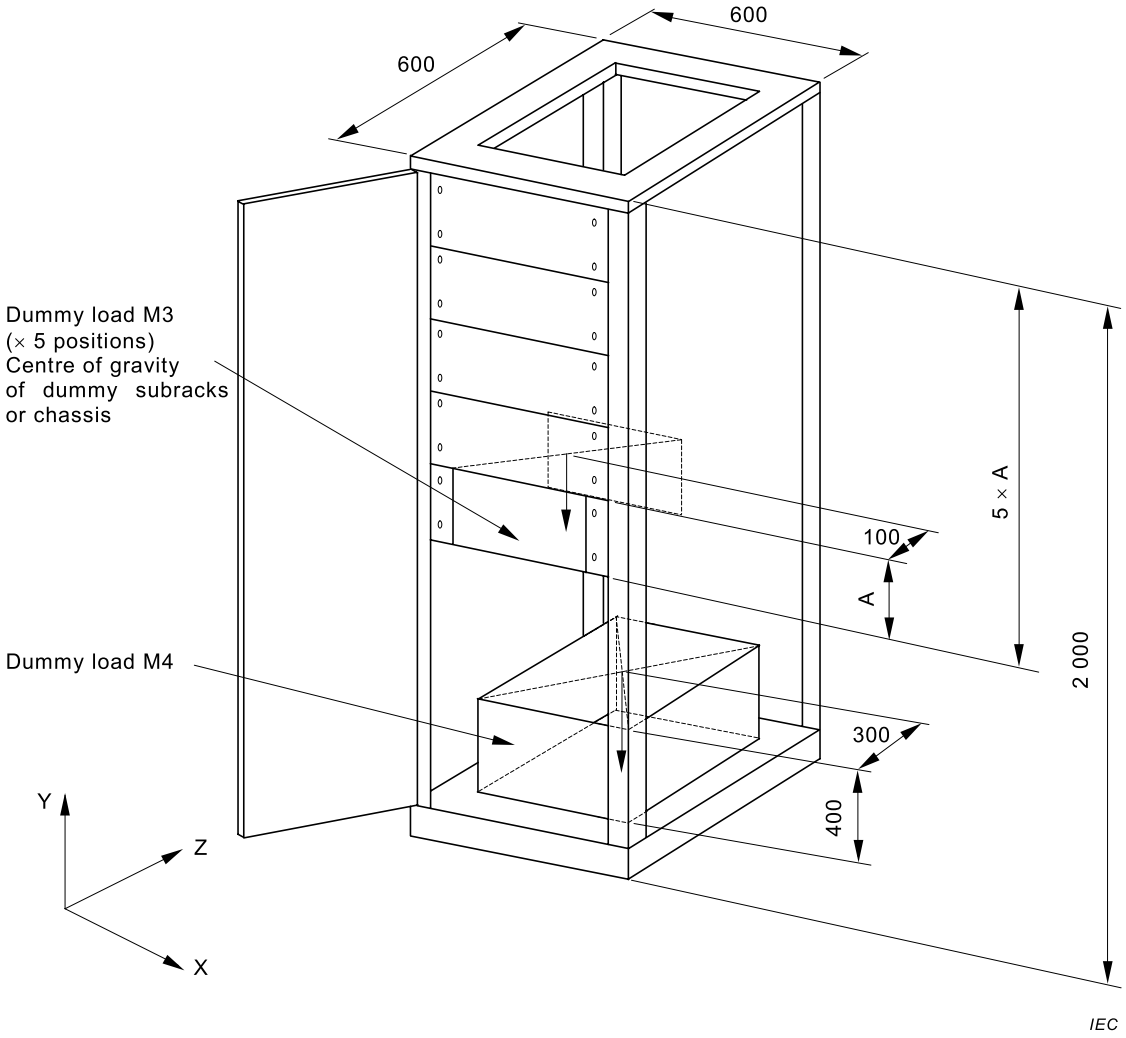


Figure 15 – Test set up for cabinets or racks – Vibration and shock tests

Table 27 – Static load distribution within the cabinet or rack

Cabinets according to	**A** mm	**M3** kg	**M4** kg	**Total load** kg
IEC 60297-3-100	265,9	10	100	150
IEC 60917-2-1	250	10	100	150
Amplitude, waveforms and duration of shock differ significantly from seismic tests as specified in IEC 61587-2. **Key** – A = Height of the dummy loads M3 in the upper section. – M4 = Dummy load weight in the lower section of the cabinet.				

Table 28 – Vibration and shock classifications for cabinets or racks

Classification Vibration	Application examples	Test Fc: Vibration sinusoidal, according to IEC 60068-2-6			Classification Shock	Test Ea: Shock test Y-axes only, half sine wave, according to IEC 60068-2-27		
		Frequency range	Deflection amplitude	Acceleration amplitude		Peak acceleration	Duration time	Number of shocks
		Hz	mm	m/s^2		m/s^2	ms	
DL4V	Low level of shock and vibration, mainly stationary use. Loaded cabinet for normal handling and service in factories and offices (class 3M2, IEC 60721-3-3).	2 to 9 9 to 200	1,5 –	– 5	**DL4S**	40	18	3
DL5V	Moderate level of shock and vibration, stationary and mobile use. Loaded cabinet for railway, motorway signalling applications, close to rotating machines (class 3M4, IEC 60721-3-3).	2 to 9 9 to 200	3,0 –	– 10	**DL5S**	100	11	3
DL6V	High level of shock and vibration. Applications such as commercial ships – low level military requirements (class 3M6, IEC 60721-3-3).	2 to 9 9 to 200	7,0 –	– 20	**DL6S**	250	11	3

7.3.3.2 Test condition

a) The cabinet and rack under test shall be mounted to the vibration or shock table via intended bolt-down (floor) positions.

b) In order to simulate the operating conditions, rear or top structural supports may be used. Details of the assembly used for the test shall be reported.

c) The cabinet front may or may not be assembled with a front door according to the intended use. Details of the assembly used for the test shall be reported.

d) The cabinet rear may or may not be assembled with a rear panel or a rear door according to the intended use. Details of the assembly used for the test shall be reported.

e) The cabinet side(s) may or may not be assembled with a side cover(s) according to the intended use. Details of the assembly used for the test shall be reported.

f) The M3 dummy loads shall be assembled to the cabinet or rack via the front mounted cabinet or rack mounting flanges, see Figure 15. The dummy load mounting flanges shall be in accordance with IEC 60917-2-1 or IEC 60297-3-100 and rigid enough to support the dummy load M3 without deflection. The M3 dummy loads shall be bolted to the cabinet or

rack vertical members via a minimum of 4 M6 screws and be tightened to the recommended torque values.

g) The M4 dummy load shall be assembled to the cabinet or rack base as shown in Figure 15.

7.3.3.3 Test procedure

According to IEC 60068-2-6

Transit time:	1 octave/minute.
Test axes:	x-y-z (Y axis is selected as being the most severe).
Test duration/axis:	10 frequency cycles.
Resonance search:	5 Hz to 100 Hz, 1 m/s^2 acceleration.
Resonance test:	Resonance with a magnification factor of 3 to 4 shall have the vibration amplitude increased until the magnification factor reaches 7 to 8. This level shall be maintained for a period of not less than 10 min.

7.3.3.4 Assessment following the test

a) No deformation or damage of parts that affect form, fit or function shall be allowed after the tests.

b) Earth bond continuity check to be carried out in accordance with 8.2.

7.3.4 Cabinet – Impact tests

7.3.4.1 General

The purpose of these tests is to evaluate the impact resistance of the outer parts of a cabinet, such as doors, covers or window or display sections. Equipment shall not cause a hazard when subjected to impact likely to occur in normal use. To achieve this requirement, equipment shall have adequate mechanical strength and electrical insulation. Severity classification should be selected according to IEC 62262 (superceding the prior IEC 60068-2-75 requirement). The applicable selection is shown in Table 29.

Other classes should be selected according to IEC 62262.

Table 29 – Impact classifications for cabinets

Classification	Application examples	Energy value J	
		Metal cover surfaces of cabinet	Door view panels, windows using glass, plastic, etc.
IK04	Equipment for general electronics (measurement, laboratory) use	0,5	0,2 (IK02)
IK07	Equipment for general industrial electronics (office, laboratory) use	2	0,2 (IK02)
IK08	Equipment for general industrial electronics, mobile applications (factory, outdoor) use	5	0,35 (IK03)

7.3.4.2 Test procedure

Number of impacts: five in each of the three axes (x, y, z) of the sample.

The sample shall be mounted on a rigid support that may be assumed to be rigid enough if it does not move more than 0,1 mm under the effect of a directly applied impact of the specified level of energy for the test.

The impact test shall be performed only on individual cabinet parts such as doors and covers (not a subrack or chassis) installed in their intended configuration. Parts have their mounting screws tightened with the manufacturers recommended torque applied.

If the pendulum test is inconvenient, it is permitted to simulate horizontal impacts on vertical or sloping surfaces by mounting the sample at 90° to its normal position and applying the vertical impact test instead of the pendulum test.

Impact locations shall be determined on the sample, corresponding to where damage is most likely to occur in practice.

7.3.4.3 Assessment following the tests

a) No deformation or damage of parts that affect form, fit or function shall be allowed after the tests.

b) Earth bond continuity check to be carried out in accordance with 8.2.

8 Safety aspects

8.1 Safety aspects – General

Safety aspects cover both human hazard and product safety and are mandatory for full compliance with this part of IEC 61587. The mechanical design of cabinets, racks, subracks, chassis with an integrated subrack and associated plug-in units shall have adequate design considerations to prevent danger or hazards to people and to be an adequate barrier against unauthorized access to the interior.

The mechanical parts of the enclosure shall be free of sharp edges, burrs, etc. that could present a safety hazard to personnel involved in their assembly, installation, use or maintenance.

IEC 60950-1 contains additional safety requirements for information technology equipment, including electrical business equipment, that is mains-powered or battery-powered, or is connected directly to a telecommunications network. Cabinets, racks, subracks, chassis with an integrated subrack and associated plug-in units intended for use in this environment should review IEC 60950-1:2005, Clause 4 for safety compliance.

8.2 Earth bond

8.2.1 Earth bond – General

Safety aspects shall be in accordance with IEC 61010-1.

In order to protect against contact with shock hazard voltages, all metallic components of the cabinet, rack, subrack, chassis with an integrated subrack and associated plug-in units which can be touched shall be electrically interconnected. Experience has shown that mounting screws alone do not represent sufficiently reliable conductive connections. Additional measures shall be taken, such as are required for example in front panels made from insulating material and using metallic locks, hinges, etc. The resistance of the connection between the protective earthing terminal or earthing contact and parts required to be earthed shall be less than 0,1 Ω.

8.2.2 Test procedure – Earth bond

The test shall be in accordance with IEC 61010-1. The test current used for determining the impedance shall be reported.

8.3 Flammability

All materials used in the construction, components and parts inside a cabinet, racks or subracks shall minimize the propagation of fire. Flammability is covered in IEC 60695-11-10.

In order to prevent a fire, all materials shall comply with flammability class of V2, or better, according to IEC 60695-11-10.

8.4 Degrees of protection provided by enclosures (IP Code)

It is the intention of this subclause to ensure that the relevant level of human protection against hazard is maintained. Use Table 30 for classification selection only. Refer to IEC 60529 for full details.

Table 30 – Degrees of protection provided by enclosures (IP Code)

Classification	Protection against	Test conditions	Assessment during or following the test
IP20	Contact with hazardous components by finger or solid foreign body, diameter 12,5 mm or above.	Articulated test finger 12 mm diameter and object probe 12,5 mm diameter (ball).	Test finger is able to penetrate by up to 80 mm and shall have sufficient clearance from hazardous components. Object probe shall be unable to penetrate through an opening.
IP30	Contact with hazardous components by tool and solid foreign body, diameter 2,5 mm or above.	Object probe, 2,5 mm diameter.	Object probe shall be unable to penetrate and sufficient clearance shall be maintained.
IP42	Contact with hazardous components by probe and solid foreign body, diameter 1 mm or above: water drip up to 15° inclination of object.	Object probe, 1 mm diameter. Drip box.	Object probe shall be unable to penetrate and sufficient clearance shall be maintained. Water drip shall not have any damaging effect.
IP54	Contact with hazardous components by wire. Small quantities of dust. Water splashed from all directions.	Object probe, 1 mm diameter. Dust chamber. Water spraying equipment, swing pipe.	Object probe shall be unable to penetrate and sufficient clearance shall be maintained. Only small quantities of dust shall be able to penetrate, function and safety (generation of leakage currents) shall be unimpaired. Water splashed from all directions shall not have any damaging effect.

Bibliography

IEC 60068 (all parts), *Environmental testing*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

SOMMAIRE

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