IEC 61587-5

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INTERNATIONAL STANDARD

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

Structures mécaniques pour équipement électronique – Essais pour la CEI 60917 et la CEI 60297 – Partie 5: Essais sismiques pour châssis, bacs et unités enfichables

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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Structures mécaniques pour équipement électronique – Essais pour la CEI 60917 et la CEI 60297 – Partie 5: Essais sismiques pour châssis, bacs et unités enfichables

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

Part 5: Seismic tests for chassis, subracks and plug-in units

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

FDIS	Report on voting
48D/549/FDIS	48D/553/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.

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INTRODUCTION

This standard is based on IEC 61587-2: *Mechanical structures for electronic equipment – Tests for IEC 60917 and IEC 60297 – Part 2: Seismic tests for cabinets and racks* and ATIS-0600329:2008:*Network Equipment – Earthquake Resistance*.

This standard sets forth test setups, performance requirements, and acceptance criteria for determining the robustness of chassis, subracks, and associated plug-in units according to the IEC 60297 and IEC 60917 series that may provide a level of survivability and preserve functionality during and after a seismic occurrence (an earthquake). This standard does not replace regional seismic system, installation standards, or specifications.

The intent of this standard is to provide a common methodology to perform and report seismic test conformance of chassis, subracks, and plug-in units according to the IEC 60297 and IEC 60917 series within a specified weight category. Mass distribution is based on the intended use. The terms “intended use” or “simulation of service condition” or “worst-case simulated configuration” are widely used in the telecom industry but also in the electronics industry.

Seismic ground motion occurs simultaneously and randomly in all directions. Single-axis or tri-axis tests may be selected to simulate the seismic environment for testing.

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

Part 5: Seismic tests for chassis, subracks and plug-in units

1 Scope and object

This part of IEC 61587 specifies seismic test requirements for chassis, subracks, and plug-in units as defined in the IEC 60297 and IEC 60917 series. It applies in whole or in part, only to the mechanical structures of chassis, subracks, and plug-in units for electronic equipment, according to the IEC 60297 and IEC 60917 series, and does not apply to electronic components, equipment or systems within the mechanical structures.

NOTE Subracks may be an integral part of a chassis (often called in the industry a shelf or a crate).

The object of this standard is to establish a level of physical integrity of chassis, subracks, and plug-in units according to IEC 60297 and IEC 60917 series that may provide a level of survivability that will preserve functionality during and after a seismic occurrence. It is intended to provide the user with a high level of confidence in the selection of an equipment practice to meet such needs.

Since IEC 60297 and IEC 60917 series chassis, subracks, and plug-in units come in many sizes, weights and mechanical complexities, it is not possible to define a single minimum seismic test requirement for all weight categories. Therefore, overall mass categories are defined in this standard. However, the mass distribution inside a chassis and subrack is considered “application-specific” and herein defined as “intended use”.

The single-axis or tri-axis acceleration for the seismic testing is selectable.

2 Normative references

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.

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

IEC 60068-2-47, *Environmental testing – Part 2-47: Test – Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 60068-2-57, *Environmental testing – Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method*

IEC 60068-3-3, *Environmental testing – Part 3-3: Guidance – Seismic test methods for equipment*

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

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*

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IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60721-2-6, *Classification of environmental conditions – Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock*

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

IEC 61587-1, *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 conditions*

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*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in IEC 60068-2-6, IEC 60068-3-3, IEC 60068-2-47 and IEC 60068-2-57, apply as well as the following.

3.1
intended use
a method of use of the device under test that is the same as that recommended by the manufacturer for actual service of the device, and according to which the recommended configuration, bolt size, quantities, and torque values are used during testing

chassis
a mechanical structure according to IEC 60917-1. For the purpose of this standard a subrack may also be an integral part of the chassis

3.2
simulated load boards
simulated mass attached to plug-in units according to IEC 60917-1

3.3
simulated equipment
the total mass of a subrack, chassis with integrated subrack, chassis with components or plug-in unit fitted with simulated load

3.4
hot swap
managed plug-in units using electromechanical devices in the insertion and extraction process during actual service

4 Equipment test categories

Equipment (chassis, subracks, and plug-in units) being subjected to seismic testing shall be defined into one of the following mass categories. The test setup, the test method and acceptance criteria for the selected category shall be applied throughout the testing.

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Category A1 – Plug-in unit simulated equipment ≤ 1 kg

Category A2 – Plug-in unit simulated equipment > 1 kg and ≤ 2 kg

Category A3 – Plug-in unit simulated equipment > 2 kg and ≤ 5 kg

Category A4 – Plug-in unit simulated equipment > 5 kg and ≤ 10 kg

Category B1 – Chassis or subrack simulated equipment ≤ 23 kg

Category B2 – Chassis or subrack simulated equipment ≥ 23 kg and < 68 kg

Category B3 – Chassis or subrack simulated equipment ≥ 68 kg and < 181 kg

5 Test waveform and acceleration condition

5.1 General

The parameters such as time history, zero period acceleration, damping ratio, and severities (frequency range, required response spectrum, acceleration per axis) have been derived from methods stated in IEC 60068-3-3, IEC 60068-2-57 and environment zone 4 as defined in IEC 60721-2-6.

5.2 General conditions

The tests shall be performed as follows:

a) The test waveform for the seismic test shall be a synthesized waveform.

b) The test shall be performed either with single-axis or tri-axis condition, as defined in this standard and reported accordingly.

c) The duration of the strong part of the time history is defined from the time when the plot first reaches 25 % of the maximum value to the time when it falls for the last time to the 25 % level.

d) The TRS (Test Response Spectrum) shall equal or exceed the RRS (Required Response Spectrum) as shown in Figure 1 (for single-axis) and Figure 3 (for tri-axis). The damping ratio of 3 % or 2 % is applied to evaluate the TRS and RRS, and is not applied to the frequency range less than 0,5 Hz and more than 50 Hz. The value of g (standard acceleration of gravity of the earth), is rounded up to the nearest whole number, that is 10 m/s^2.

e) The test waveform shall satisfy the RRS.

f) It is acceptable that the TRS is lower than the RRS typically found at the frequency range lower than half or larger than twice the 1st natural frequency, but shall not exceed 20 % of RRS.

g) If the TRS does not satisfy the RRS with the limitation of the displacement of the vibration table, the TRS shall meet at the frequency range equal to or larger than 1 Hz.

5.3 Single-axis acceleration

a) Accelerate each axis of the vibration table independently.

b) The acceleration of the vibration table is measured during the test as described in 6.2.7 b) and 6.3.6 b).

c) The duration of the strong part of the time history shall be equal to or more than 18 s.

d) The zero period acceleration of the input test wave shall be 16 m/s^2, the RRS shall be according to Figure 1.

e) The time history of the test wave is per Figure 2.

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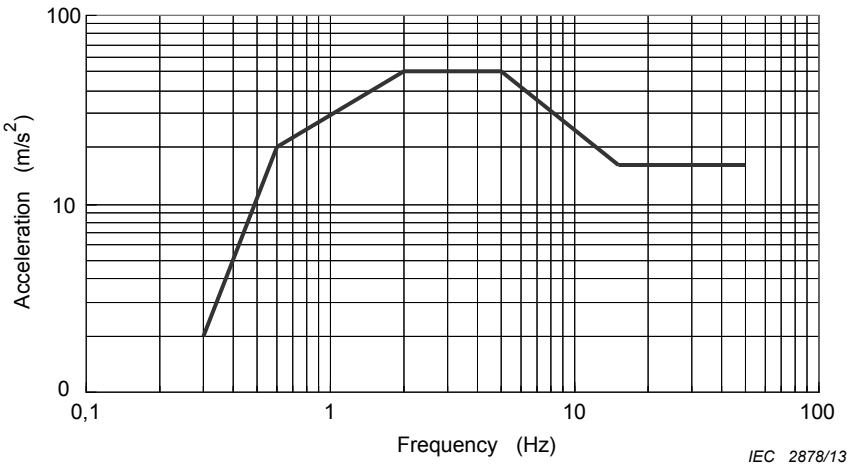

Figure 1 – RRS for the test wave (single-axis acceleration)(damping ratio 2,0 %)

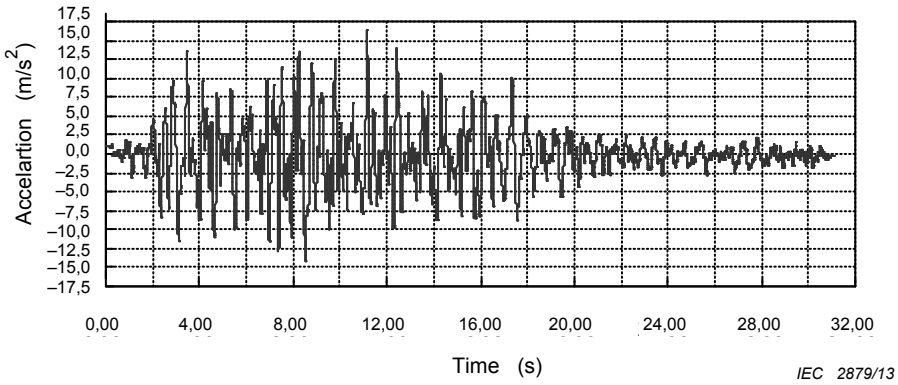

Figure 2 – Time history of the test wave (single-axis acceleration)

5.4 Tri-axial acceleration

a) Accelerate the table along the three axes simultaneously.

b) The acceleration of the individual axis differs from each other. The acceleration of the vibration table is measured during the test as described in 6.2.7 b) and 6.3.6 b).

c) The duration of the strong part of the time history shall be equal to or more than 30 s.

d) The required maximum acceleration (zero period acceleration) for the input test waveform shall be 12 m/s^2 for horizontal stroke and 6 m/s^2 for the up-and-down stroke, the RRS shall be according to Figure 3.

e) Examples of the time history for each axis are shown in Figure 4.

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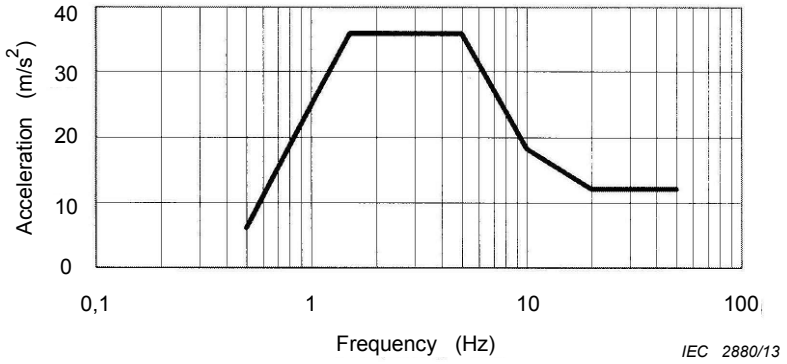
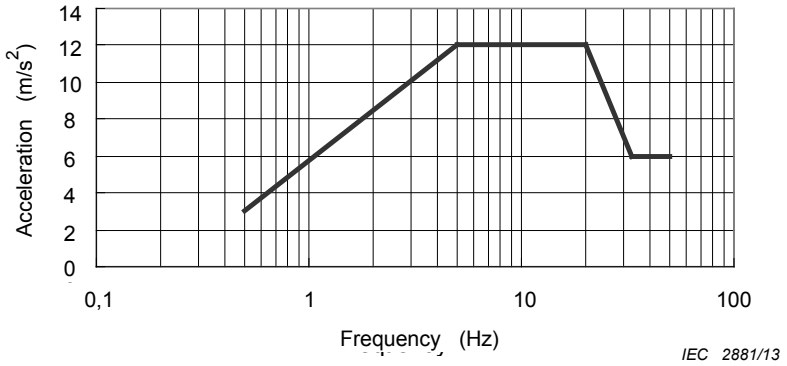


a) Horizontal



b) Up-and-down

Figure 3 – RRS for the test wave (tri-axial acceleration)(damping ratio 3 %)

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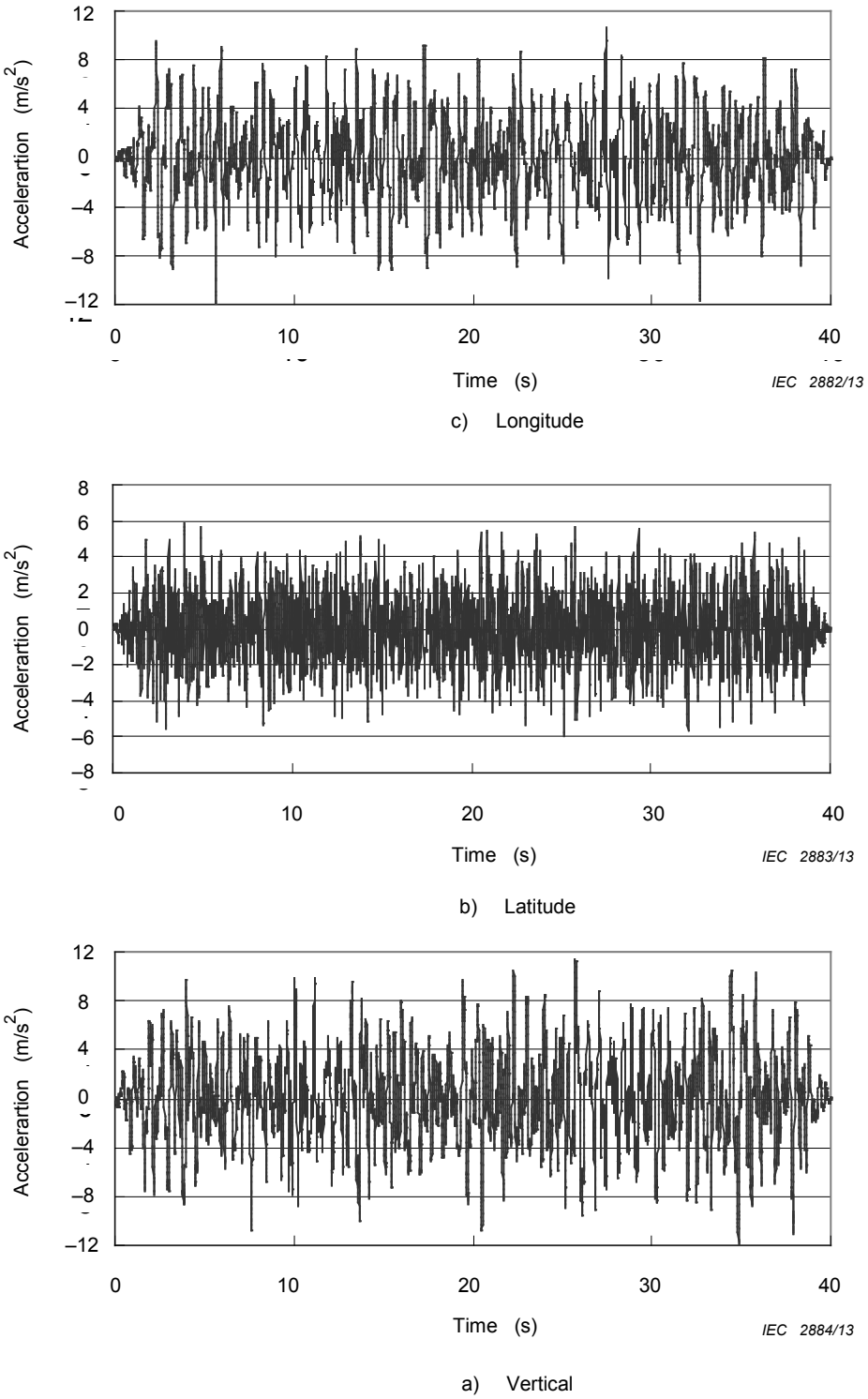

Figure 4 – Time history of the test wave for each axis (tri-axial acceleration)

5.5 Specimen monitoring

a) The functionality of the chassis, subrack or plug-in unit (in accordance to IEC 61587-1, IEC 61587-3 and the intended use) shall be monitored before and after the seismic test, and optionally during the test.

b) The chassis, subrack, or plug-in unit structural/mechanical condition shall be verified before and after testing.

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c) For additional connector LLCR (Low Level Contact Resistance) testing (see 6.2.7 and 6.2.9) monitoring instrumentation shall respond at a rate that is adequate to detect intermittent malfunctions during testing. Intermittent malfunctioning time, if acceptable, is considered application specific.

5.6 Seismic simulation

a) The chassis, subrack, or plug-in unit shall be subjected to vibration (resonance and seismic occurrence) tests along each of the three axes: longitudinal, transverse and vertical.

b) The chassis, subrack or plug-in unit shall be subjected to the seismic simulation test by using the reference waveform.

c) The resultant TRS shall be used to determine if the chassis, subrack or plug-in unit has been subjected to the adequate test level. The TRS shall meet or exceed the RRS over the frequency range of 1,0 Hz to 50 Hz.

d) As an objective, the TRS should not exceed the RRS by more than 30 % in the amplified region of the RRS, from 3,0 Hz to 7,0 Hz, to prevent over testing of the chassis, subrack or plug-in unit.

6 Test setup and parts to be monitored

6.1 General

The seismic test of the chassis, subrack or plug-in unit shall be performed under “intended use” and simulated load condition. The intent is to be able to undertake the seismic test to assess the structural/mechanical integrity of a single chassis, a single subrack or a single plug-in unit.

6.2 Category A – Plug-in units

6.2.1 General

Plug-in units according to IEC 60917 and IEC 60297 series interface with the subrack or chassis with integrated subrack. Plug-in units occupy a corresponding position (also called a “slot”) in the subrack. To be able to conduct a seismic test for a single plug-in unit the corresponding subrack position (slot) and interface condition have to be repeated in the intended use subrack. The plug-in unit guide feature in the subrack shall reflect the intended use condition (i.e. guide width, guide depth, guide rigidity, guide material).

- The subrack or chassis shall be pre-qualified to Clause 4 of this standard and comply with Category B1, B2, or B3.
- The plug-in unit under test shall have the intended use free connector attached. The corresponding intended use fixed connector in the subrack or chassis with integrated subrack shall be attached to the subrack as per the intended use.
- The plug-in unit under test shall be inserted into the centre most slot of the subrack and retained with the intended use retention devices tightened to the recommended torque values. See Figures 7, 8 and 9.
- The subrack or chassis with integrated subrack test fixture shall be rigid, see Figures 7, 8 and 9. The test fixture shall be designed using the practices outlined in IEC 60068-2-47.

6.2.2 Plug-in unit simulated load

The simulated mass of a plug-in unit is defined in Clause 4, Category A1 to A4. This reflects the intended use of the plug-in unit consisting of the plug-in unit mass and the added simulated load.

- For the purpose of testing a plug-in unit shall be loaded with simulated load of suitable mass (with worst condition in mind) as shown in Figure 5 (intended use A, discrete

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distribution of simulated load) or Figure 6 (intended use B, compact distribution of simulated load).

- The simulated load shall be attached to the plug-in unit PB without loosening during the test.
- Single or multiple free connectors shall be placed according to their mechanical and electrical mounting features and according to the intended use of the plug-in unit.
- Input and output cable(s) on the plug-in unit front panel shall be attached at their end(s) to the test fixture without loosening during the test.
- Intended use plug-in unit covers shall be attached.
- Plug-in unit front panel retention screws shall be used to lock the plug-in unit into the test chassis or subrack during the test. The retention screws shall be tightened to the intended use torque values.

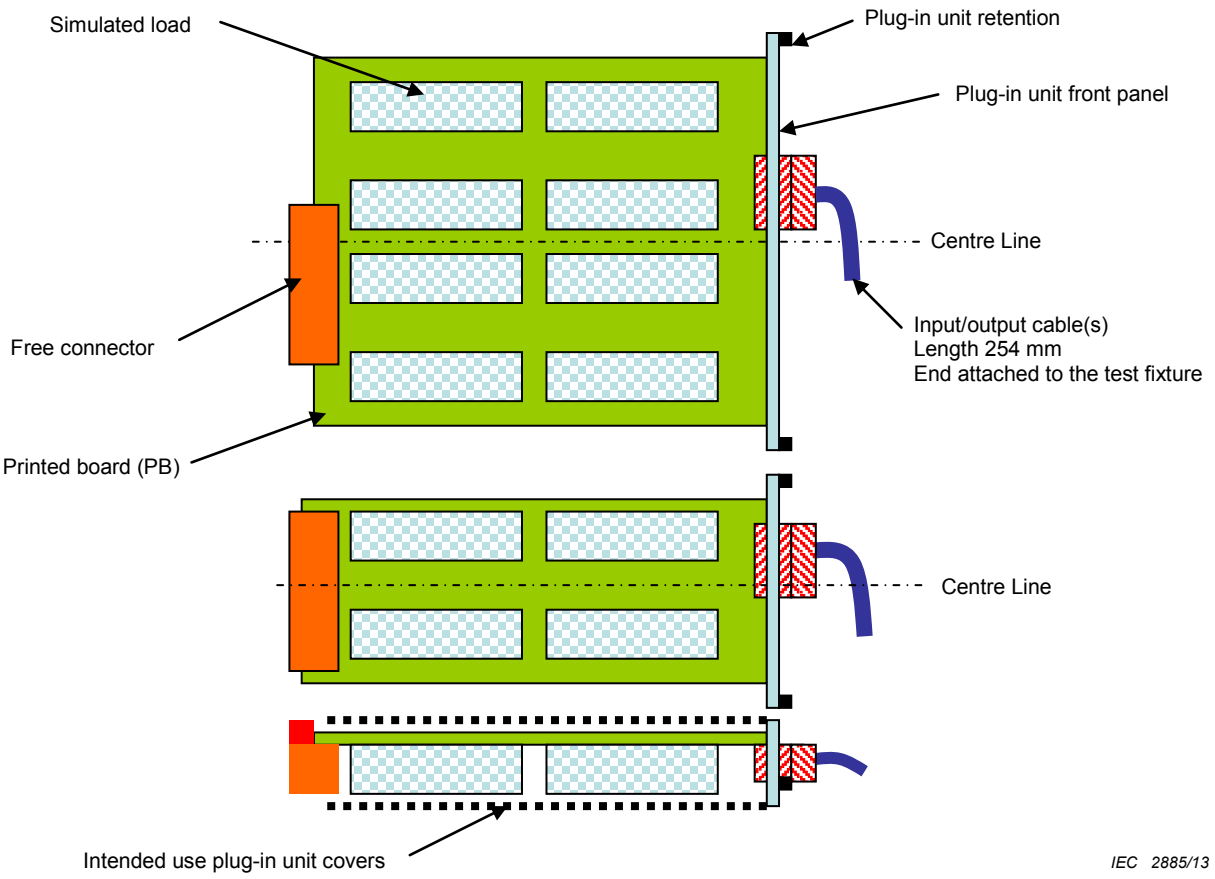

Figure 5 – Plug-in unit intended use A load distribution (discrete)

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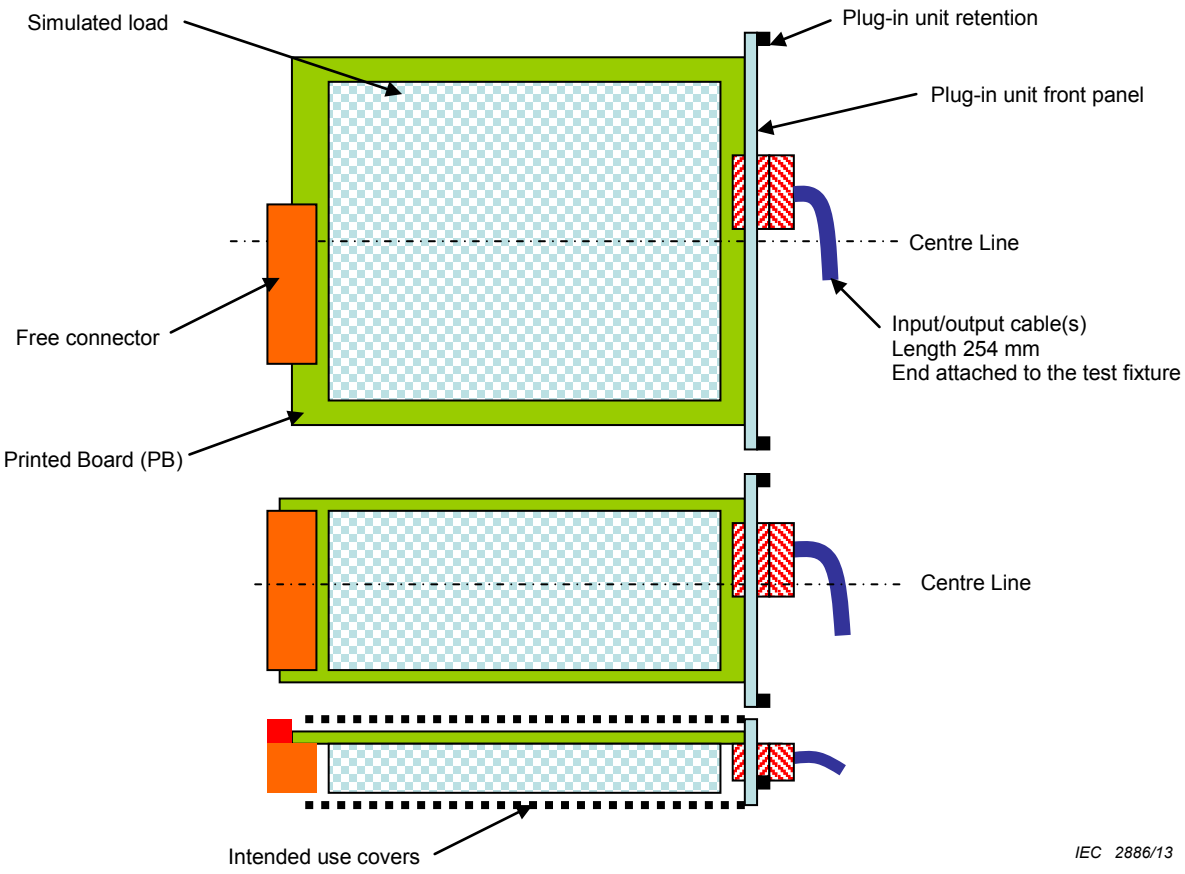

Figure 6 – Plug-in unit intended use B load distribution (compact)

6.2.3 Plug-in unit test setup onto the test fixture

The plug-in unit to be tested shall use a 6.2 intended use and pre-qualified subrack or chassis with integral subrack, mounted onto the vibration table using a rigid fixture.

Mounting condition is referred to in IEC 60068-2-6, in which there is a reference to IEC 60068-2-47.

The test fixture shall be designed using the practices outlined in IEC 60068-2-47 and shall allow for at least 1U (per IEC 60297) or 1SU (per IEC 60917) free space above and below the test specimen, see Figure 7 and Figure 8.

- The plug-in unit under test shall be mounted into the centre slot of the intended use chassis or subrack (with worst condition in mind).
- Filler panels (any type or size) shall be attached to close any open slot positions in the pre-qualified subrack or chassis.
- The choice of pretested chassis or subrack and filler panels shall comply with the type of plug-in unit under test (non-EMC or EMC).
- The plug-in unit under test and the filler panel retention screws shall be tightened to their recommended torque values.
- Input and output cable(s) on the plug-in unit front panel under test shall be attached at their end(s) to the test fixture without loosening during the test.

Documents
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