

INTERNATIONAL STANDARD



**Passive RF and microwave devices, intermodulation level measurement –
Part 3: Measurement of passive intermodulation in coaxial connectors**

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Part 3: Measurement of passive intermodulation in coaxial connectors**

INTERNATIONAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PASSIVE RF AND MICROWAVE DEVICES,
INTERMODULATION LEVEL MEASUREMENT –****Part 3: Measurement of passive intermodulation in coaxial connectors****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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- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62037-3:2012. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 62037-3 has been prepared by IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories. It is an International Standard.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

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

- a) impact method changed to utilize a steel ball rather than a brass rod;
- b) impact energy required to test each connector type added;
- c) method added to calculate impact energy for connector types not listed in the document.

The text of this International Standard is based on the following documents:

Draft	Report on voting
46/836/FDIS	46/857/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all the parts in the IEC 62037 series, published under the general title *Passive RF and microwave devices, intermodulation level measurement* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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PASSIVE RF AND MICROWAVE DEVICES, INTERMODULATION LEVEL MEASUREMENT –

Part 3: Measurement of passive intermodulation in coaxial connectors

1 Scope

This part of IEC 62037 defines the impact test on coaxial connectors to evaluate their robustness against weak connections and particles inside the connector, as independently as possible from the effects of cable PIM (passive intermodulation).

For other connectors (e.g. panel mounted connectors), the cable can be replaced by an adequate transmission-line (e.g. airline, stripline). In order to evaluate the effects of mechanical stresses on the connectors, a series of impacts is applied to the connectors while measuring the PIM.

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 62037-1, *Passive RF and microwave devices, intermodulation level measurement – Part 1: General requirements and measuring methods*⁴

IEC 62037-4, *Passive RF and microwave devices, intermodulation level measurement – Part 4: Measurement of passive intermodulation in coaxial cables*²

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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>

3.2 Abbreviated terms

DUT Device under test

IM Intermodulation

PIM Passive intermodulation

⁴~~To be published.~~

²~~To be published.~~

4 Test method

4.1 Samples for testing

One of the two following set-ups may be used.

NOTE Correct assembly methods and techniques are critical to the proper operation of the connector on the cable.

a) Set-up 1 – Multi-port DUT

In order to minimize the effect of the transmission line, a short assembly should be tested. Identical connectors should be assembled at each end. An assembly, as short as physically practical, should be constructed.

a) Set-up 2 – One-port DUT

A single connector can be assembled on a length of transmission line for which it is designed, ~~loss or low loss~~, that exhibits at least 10 dB of attenuation in one direction at the lowest frequency in the receive band.

4.2 Connection of unit

The unit ~~should~~ shall be connected as described in IEC 62307-1.

4.3 Set-up 1 – Fixed frequency test considerations

Due to the phase interaction of the connectors and the length of the transmission line (configuration A) when measured in the reverse (reflected) mode, the frequency at which maximum PIM occurs within the band can vary and shall be determined.

An accepted method of sweeping is to fix ~~F1~~ f_1 at the low end of the transmit band and step ~~F2~~ f_2 down, starting at the top of the band for all combinations of frequencies that result in IM in the receive band. If desired, this procedure can be reversed by fixing ~~F1~~ f_2 at the highest frequency in the transmit band and then stepping ~~F2~~ f_1 up, starting at the bottom of the band.

If fixed frequency is used, assemblies of varying lengths shall be made to ensure that the PIM adds in-phase. Assemble two additional DUTs. The first one is to be $\lambda/6$ longer and the second one is to be $\lambda/3$ longer at the receive frequency of the test. The PIM of the three (3) assemblies is measured to determine which DUT exhibits maximum PIM. The impact test shall be performed on this DUT.

Multiple fixed frequencies may be used in lieu of varying the cable length.

The impact test is to be conducted at the frequency where the maximum PIM is measured.

The cable used as a load ~~should~~ shall be verified as having suitable PIM performance prior to being used in testing as measured by IEC 62037-4.

4.4 Set-up 2 considerations

The cable used as a load ~~should~~ shall be verified as having suitable PIM performance prior to being used in testing as measured by IEC 62037-4.

4.5 Impacts

Mount the DUT as shown in Figure 1. A minimum of five (5) impacts in accordance with Table 1 ~~should~~ shall be applied. (See Figure 1 for impact set-up ~~and Figure 2 for description of drop mass and tube~~.)

~~The tube should be vertical to the axis of the DUT to $\pm 3^\circ$.~~

The drop mass is a steel ball, ensuring that no sharp edge will damage the DUT and minimizing variation in the impact force. The steel ball is remotely released via a solenoid to prevent impact force variation due to manual operation.

The points of impact should cover as many different areas along the length of the connector as possible, but it is not necessary to rotate or otherwise disconnect and reposition the DUT.

The PIM is measured prior to, during, and after the impact.

Table 1 – Impact information for some popular connectors

Connector interface	Mass (min.) g	Drop height (min.) mm
7-16	30	300
N	30	300
TNC	30	300
SMA	30	300

Connector interface	Connector nominal hex dimension mm	Impact energy J	Steel ball diameter mm	Mass g	Drop height (min.) mm
7-16	31,8	0,083	19	28,4	300
4.3-10	22,2	0,058	19	28,4	210
N	19,1	0,050	19	28,4	180
TNC	14,3	0,037	19	28,4	130
SMA	7,9	0,021	19	28,4	75

~~The length dimension of the brass rod shall be greater than its diameter.~~

~~The given values are guidelines, and other connectors can be used as determined between customer and supplier.~~

Different steel ball diameters and drop heights may be used as long as equivalent impact energy is maintained. See Annex A for guidelines for calculating equivalent impact energy.

Other connector types can be tested in accordance with this document. The required impact energy for different connector types can be calculated as specified in Annex B.

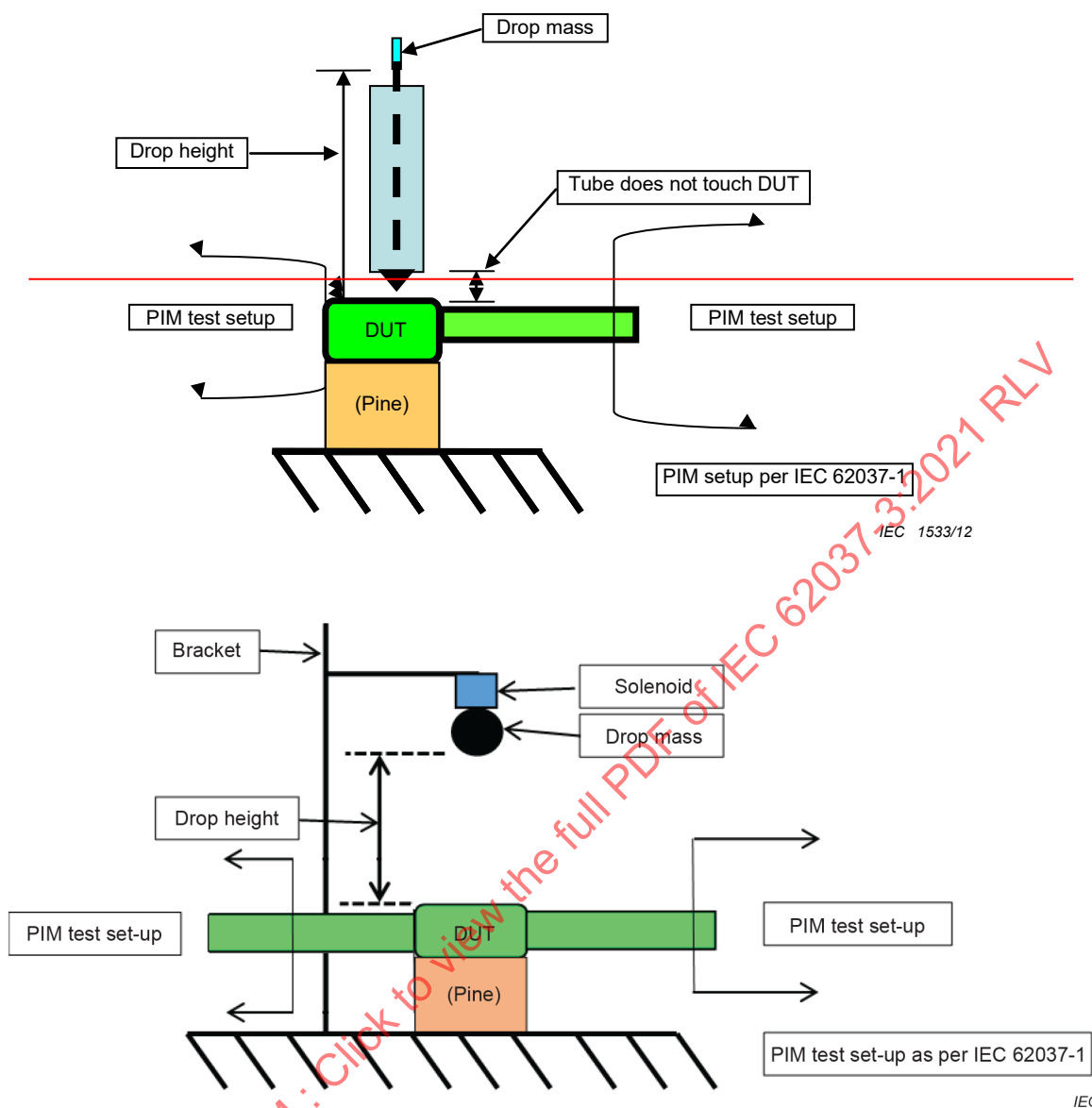


Figure 1 – Impact test illustration

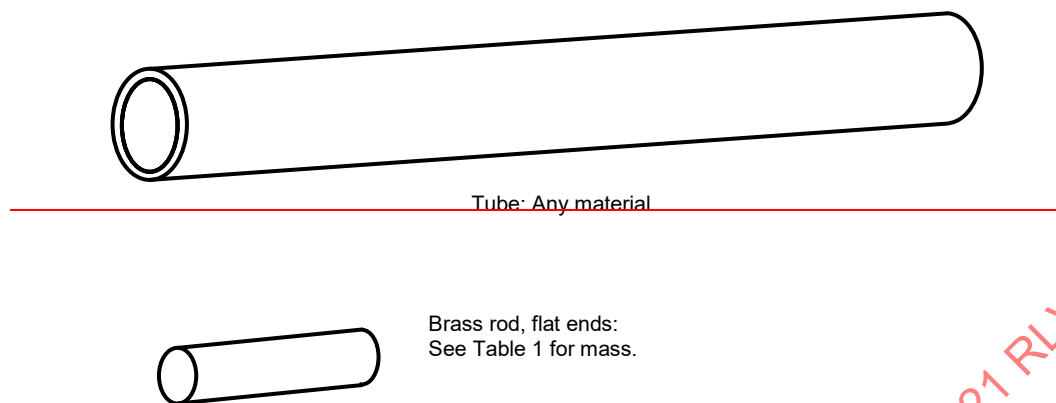


Figure 2 — Impact device

5 Report

The report should document the height, mass, and distance dropped if different from the table and the PIM values prior to each impact, during impact, and after impact.

The report should document the drop height, steel ball mass and impact energy if different from Table 1 and the peak PIM values prior to, during, and after each impact.

Annex A (normative)

Calculating equivalent impact energy

Impact energy in Joules = potential energy = PE = $m \times g \times h$

where:

m is the mass of the steel ball (kg);

g is the acceleration due to gravity = 9,8 m/s²;

h is the drop height (m).

Using an average density for carbon steel of 7,9 g/cm³, the mass of the steel ball can be calculated based on the volume of the steel ball.

Table A.1 provides the estimated mass of various diameter steel balls.

Table A.1 – Estimated mass of various diameter steel balls

Diameter mm	Mass kg
10	0,004 14
11	0,005 51
12	0,007 15
13	0,009 09
14	0,011 35
15	0,013 96
16	0,016 94
17	0,020 32
18	0,024 12
19	0,028 37
20	0,033 09

EXAMPLE: If a 12 mm diameter ball is used to test an SMA connector instead of the 19 mm diameter ball and in order to calculate a drop height that yields an equivalent impact energy, then:

Algebra is used to re-arrange the formula:

$$h = PE / (m \times g)$$

$$h = 0,021 \text{ kg m}^2/\text{s}^2 / (0,007 15 \text{ kg} \times 9,8 \text{ m/s}^2)$$

$$h = 0,299 7 \text{ m} = 299,7 \text{ mm, which rounds to 300 mm}$$

Annex B (normative)

Calculating impact energy for different connector types

The energy at impact is intended to mechanically shock the DUT by accelerating the connector body. Since the mass of a connector is roughly proportional to the physical size of the connector, the impact energy can be scaled based on the size of the connector. Distance across the wrench flats for the male connector can be used as a basis of comparison. For round connectors, the diameter of the male connector's outer housing can be used.

Using the 7-16 DIN connector as a reference, the impact energy for other connector styles can be calculated by multiplying the specified impact energy for the 7-16 DIN connector by the ratio in size between connectors. Table B.1 demonstrates this calculation for the RF connector types shown in Table 1.

Table B.1 – Impact energy calculation for RF connector type

Connector interface	Connector nominal hex dimension mm	Size ratio compared to 7-16 connector	Calculated impact energy J
7-16	31,8	1,00	$1,00 \times 0,083 \text{ J} = 0,083 \text{ J}$
4,3-10	22,2	0,70	$0,70 \times 0,083 \text{ J} = 0,058 \text{ J}$
N	19,1	0,60	$0,60 \times 0,083 \text{ J} = 0,050 \text{ J}$
TNC	14,3	0,45	$0,45 \times 0,083 \text{ J} = 0,037 \text{ J}$
SMA	7,9	0,25	$0,25 \times 0,083 \text{ J} = 0,021 \text{ J}$

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**Passive RF and microwave devices, intermodulation level measurement –
Part 3: Measurement of passive intermodulation in coaxial connectors**

**Dispositifs RF et à micro-ondes passifs, mesure du niveau d'intermodulation –
Partie 3: Mesure de l'intermodulation passive dans les connecteurs coaxiaux**

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Part 3: Measurement of passive intermodulation in coaxial connectors

1 Scope

This part of IEC 62037 defines the impact test on coaxial connectors to evaluate their robustness against weak connections and particles inside the connector, as independently as possible from the effects of cable PIM (passive intermodulation).

For other connectors (e.g. panel mounted connectors), the cable can be replaced by an adequate transmission-line (e.g. airline, stripline). In order to evaluate the effects of mechanical stresses on the connectors, a series of impacts is applied to the connectors while measuring the PIM.

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3 Terms, definitions and abbreviated terms

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

3.2 Abbreviated terms

DUT	Device under test
IM	Intermodulation
PIM	Passive intermodulation

4 Test method

4.1 Samples for testing

One of the two following set-ups may be used.

NOTE Correct assembly methods and techniques are critical to the proper operation of the connector on the cable.

a) Set-up 1 – Multi-port DUT

In order to minimize the effect of the transmission line, a short assembly should be tested. Identical connectors should be assembled at each end. An assembly, as short as physically practical, should be constructed.

b) Set-up 2 – One-port DUT

A single connector can be assembled on a length of transmission line for which it is designed that exhibits at least 10 dB of attenuation in one direction at the lowest frequency in the receive band.

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The unit shall be connected as described in IEC 62307-1.

4.3 Set-up 1 – Fixed frequency test considerations

Due to the phase interaction of the connectors and the length of the transmission line (configuration A) when measured in the reverse (reflected) mode, the frequency at which maximum PIM occurs within the band can vary and shall be determined.

An accepted method of sweeping is to fix f_1 at the low end of the transmit band and step f_2 down, starting at the top of the band for all combinations of frequencies that result in IM in the receive band. If desired, this procedure can be reversed by fixing f_2 at the highest frequency in the transmit band and then stepping f_1 up, starting at the bottom of the band.

If fixed frequency is used, assemblies of varying lengths shall be made to ensure that the PIM adds in-phase. Assemble two additional DUTs. The first one is to be $\lambda/6$ longer and the second one is to be $\lambda/3$ longer at the receive frequency of the test. The PIM of the three (3) assemblies is measured to determine which DUT exhibits maximum PIM. The impact test shall be performed on this DUT.

Multiple fixed frequencies may be used in lieu of varying the cable length.

The impact test is to be conducted at the frequency where the maximum PIM is measured.

The cable used as a load shall be verified as having suitable PIM performance prior to being used in testing as measured by IEC 62037-4.

4.4 Set-up 2 considerations

The cable used as a load shall be verified as having suitable PIM performance prior to being used in testing as measured by IEC 62037-4.

4.5 Impacts

Mount the DUT as shown in Figure 1. A minimum of five (5) impacts in accordance with Table 1 shall be applied. (See Figure 1 for impact set-up.)

The drop mass is a steel ball, ensuring that no sharp edge will damage the DUT and minimizing variation in the impact force. The steel ball is remotely released via a solenoid to prevent impact force variation due to manual operation.

The points of impact should cover as many different areas along the length of the connector as possible, but it is not necessary to rotate or otherwise disconnect and reposition the DUT.

The PIM is measured prior to, during, and after the impact.

Table 1 – Impact information for some popular connectors

Connector interface	Connector nominal hex dimension mm	Impact energy J	Steel ball diameter mm	Mass g	Drop height (min.) mm
7-16	31,8	0,083	19	28,4	300
4.3-10	22,2	0,058	19	28,4	210
N	19,1	0,050	19	28,4	180
TNC	14,3	0,037	19	28,4	130
SMA	7,9	0,021	19	28,4	75

Different steel ball diameters and drop heights may be used as long as equivalent impact energy is maintained. See Annex A for guidelines for calculating equivalent impact energy.

Other connector types can be tested in accordance with this document. The required impact energy for different connector types can be calculated as specified in Annex B.

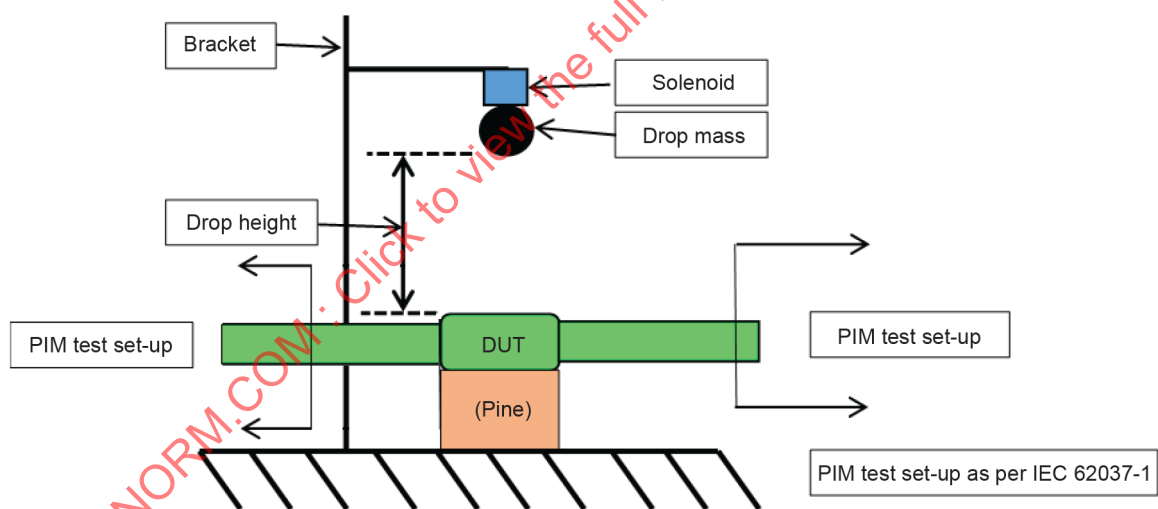


Figure 1 – Impact test illustration

5 Report

The report should document the drop height, steel ball mass and impact energy if different from Table 1 and the peak PIM values prior to, during, and after each impact.

Annex A (normative)

Calculating equivalent impact energy

Impact energy in Joules = potential energy = $PE = m \times g \times h$

where:

m is the mass of the steel ball (kg);

g is the acceleration due to gravity = $9,8 \text{ m/s}^2$;

h is the drop height (m).

Using an average density for carbon steel of $7,9 \text{ g/cm}^3$, the mass of the steel ball can be calculated based on the volume of the steel ball.

Table A.1 provides the estimated mass of various diameter steel balls.

Table A.1 – Estimated mass of various diameter steel balls

Diameter mm	Mass kg
10	0,004 14
11	0,005 51
12	0,007 15
13	0,009 09
14	0,011 35
15	0,013 96
16	0,016 94
17	0,020 32
18	0,024 12
19	0,028 37
20	0,033 09

EXAMPLE: If a 12 mm diameter ball is used to test an SMA connector instead of the 19 mm diameter ball and in order to calculate a drop height that yields an equivalent impact energy, then:

Algebra is used to re-arrange the formula:

$$h = PE / (m \times g)$$

$$h = 0,021 \text{ kg m}^2/\text{s}^2 / (0,007 15 \text{ kg} \times 9,8 \text{ m/s}^2)$$

$$h = 0,299 7 \text{ m} = 299,7 \text{ mm, which rounds to 300 mm}$$

Annex B (normative)

Calculating impact energy for different connector types

The energy at impact is intended to mechanically shock the DUT by accelerating the connector body. Since the mass of a connector is roughly proportional to the physical size of the connector, the impact energy can be scaled based on the size of the connector. Distance across the wrench flats for the male connector can be used as a basis of comparison. For round connectors, the diameter of the male connector's outer housing can be used.

Using the 7-16 DIN connector as a reference, the impact energy for other connector styles can be calculated by multiplying the specified impact energy for the 7-16 DIN connector by the ratio in size between connectors. Table B.1 demonstrates this calculation for the RF connector types shown in Table 1.

Table B.1 – Impact energy calculation for RF connector type

Connector interface	Connector nominal hex dimension mm	Size ratio compared to 7-16 connector	Calculated impact energy J
7-16	31,8	1,00	$1,00 \times 0,083 \text{ J} = 0,083 \text{ J}$
4,3-10	22,2	0,70	$0,70 \times 0,083 \text{ J} = 0,058 \text{ J}$
N	19,1	0,60	$0,60 \times 0,083 \text{ J} = 0,050 \text{ J}$
TNC	14,3	0,45	$0,45 \times 0,083 \text{ J} = 0,037 \text{ J}$
SMA	7,9	0,25	$0,25 \times 0,083 \text{ J} = 0,021 \text{ J}$

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**DISPOSITIFS RF ET À MICRO-ONDES PASSIFS,
MESURE DU NIVEAU D'INTERMODULATION –****Partie 3: Mesure de l'intermodulation passive dans les connecteurs
coaxiaux****AVANT-PROPOS**

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L'IEC 62037-3 a été établie par le comité d'études 46 de l'IEC: Câbles, fils, guides d'ondes, connecteurs, composants passifs pour micro-onde et accessoires. Il s'agit d'une Norme internationale.

Cette seconde édition annule et remplace la première édition parue en 2012. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) modification de la méthode d'impact pour utiliser une bille en acier plutôt qu'une tige en laiton;
- b) ajout de l'énergie de choc exigée pour soumettre à l'essai chaque type de connecteur;

- c) ajout de la méthode pour calculer l'énergie de choc pour les types de connecteurs non répertoriés dans le document.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
46/836/FDIS	46/857/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue utilisée pour l'élaboration de la présente Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 62037, publiées sous le titre général *Dispositifs RF et à micro-ondes passifs, mesure du niveau d'intermodulation*, est disponible sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

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DISPOSITIFS RF ET À MICRO-ONDES PASSIFS, MESURE DU NIVEAU D'INTERMODULATION –

Partie 3: Mesure de l'intermodulation passive dans les connecteurs coaxiaux

1 Domaine d'application

La présente partie de l'IEC 62037 définit l'essai de choc sur des connecteurs coaxiaux pour évaluer leur robustesse dans le cas de connexions faibles et de particules à l'intérieur des connecteurs, aussi indépendamment que possible des effets de l'intermodulation passive des câbles.

Pour les autres connecteurs (par exemple les connecteurs montés sur panneaux), le câble peut être remplacé par une ligne de transmission adéquate (par exemple une ligne à air, une ligne à ruban). Afin d'évaluer les effets des contraintes mécaniques sur les connecteurs, une série de chocs est appliquée aux connecteurs, tout en mesurant l'intermodulation passive.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 62037-1, *Dispositifs RF et à micro-ondes passifs, mesure du niveau d'intermodulation – Partie 1: Exigences générales et méthodes de mesure*

IEC 62037-4, *Dispositifs RF et à micro-ondes passifs, mesure du niveau d'intermodulation – Partie 4: Mesure de l'intermodulation passive dans les câbles coaxiaux*

3 Termes, définitions et termes abrégés

3.1 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

3.2 Termes abrégés

DUT Device under test (dispositif en essai)

IM Intermodulation

PIM Passive intermodulation (intermodulation passive)