

Translation of
DIN V VDE V 0126-5

Gelöscht: 2 Pfg 1162/07.2007¶
Requirements for¶
Junction Boxes for¶
Photovoltaic Systems

Content

Seite

1	Scope	4
2	Normative references	4
3	Definitions	6
4	Constructional requirements and performance	9
4.1	General	9
4.2	Marking and identification	9
4.3	Protection against electric shock	10
4.4	Terminations and connection methods	10
4.5	Connectors	11
4.6	Cable	11
4.7	Resistance to ageing	11
4.8	General construction	11
4.9	Degree of protection (IP)	12
4.10	Dielectric strength	12
4.11	Ambient temperature range	12
4.12	Cord anchorage	12
4.13	Mechanical strength	13
4.14	Clearances and creepage distances	13
4.15	Insulation	14
4.16	Insulation parts	14
4.17	Current carrying parts and resistance against corrosion	15
4.18	Sealing	15
4.19	Bypass-diode	15
4.20	Knock-out inlets (outlets) intended to be removed by mechanical impact	15
4.21	Junction box with cord anchorage	15
5	Tests	16
5.1	General	16
5.2	Preparation of specimens	16
5.3	Performance of tests	17
5.4	Test schedule	28
Annex A (normative)	Warning label „No disconnection under load“	36
Annex B (normative)	Number of specimen	37
Figure 1	Thermal cycling test	34
Figure 2	Humidity-freeze cycle	34
Figure 3	Typical arrangement for the cable anchorage pull test	35
Figure 4	Typical arrangement for torsion test	35

Formatiert	... [1]
Formatiert	... [2]
Feldfunktion geändert	... [3]
Formatiert	... [4]
Formatiert	... [5]
Formatiert	... [6]
Feldfunktion geändert	... [7]
Formatiert	... [8]
Formatiert	... [9]
Feldfunktion geändert	... [10]
Formatiert	... [11]
Formatiert	... [12]
Feldfunktion geändert	... [13]
Formatiert	... [14]
Feldfunktion geändert	... [15]
Formatiert	... [16]
Formatiert	... [17]
Feldfunktion geändert	... [18]
Formatiert	... [19]
Formatiert	... [20]
Formatiert	... [21]
Feldfunktion geändert	... [22]
Formatiert	... [23]
Feldfunktion geändert	... [24]
Formatiert	... [25]
Formatiert	... [26]
Feldfunktion geändert	... [27]
Formatiert	... [28]
Formatiert	... [29]
Formatiert	... [30]
Feldfunktion geändert	... [31]
Formatiert	... [32]
Feldfunktion geändert	... [33]
Formatiert	... [34]
Formatiert	... [35]
Feldfunktion geändert	... [36]
Formatiert	... [37]
Formatiert	... [38]
Feldfunktion geändert	... [39]
Formatiert	... [40]
Formatiert	... [41]
Feldfunktion geändert	... [42]
Formatiert	... [43]
Formatiert	... [44]
Feldfunktion geändert	... [45]
Formatiert	... [46]
Formatiert	... [47]
Feldfunktion geändert	... [48]
Formatiert	... [49]
Formatiert	... [50]
Feldfunktion geändert	... [51]
Formatiert	... [52]
Formatiert	... [53]
Feldfunktion geändert	... [54]
Formatiert	... [55]
Formatiert	... [56]
Feldfunktion geändert	... [57]
Formatiert	... [58]
Formatiert	... [59]
Feldfunktion geändert	... [60]
Formatiert	... [61]
Formatiert	... [62]
Feldfunktion geändert	... [63]
Formatiert	... [64]
Formatiert	... [65]
Feldfunktion geändert	... [66]
Formatiert	... [67]

Table 1 – Rated impulse voltage.....	13
Table 2 – Values of torque for screw-type clamping units.....	17
Table 3 – Pull forces for cord anchorage.....	25
Table 4 – Values for torsion test.....	26
Table 5 Group A Marking, information, documentation.....	28
Table 6 Group B Material test (single tests).....	29
Table 7 Group C Construction (single tests).....	30
Table 8 Group D Mechanical tests (single tests).....	31
Table 9 Group E Testsequenz 1 (Tests consequently in this order).....	32
Table 10 Group F Testsequenz 2 (Tests consequently in this order).....	33
Table 11 Group G Testsequenz 3 (Tests consequently in this order).....	33
Table 12 Group H Bypass-Diode-Test.....	33
Table B.1 Number of specimen.....	37

1 Scope

This standard applies to junction boxes up to 1000 V DC for use on photovoltaic modules according to application class A of IEC 61730-1.

Note – For junction boxes according to application classes B and C of IEC 61730 in photovoltaic-systems this standard can be used as guideline.

Kommentar [V01]: Changed due to the insufficient values in IEC 60664-1

Kommentar [V02]:

Gelöscht: 1500

Formatiert: Schriftartfarbe: Rot, Hervorheben

2 Normative references

The following normative documents are necessary for application of this documents. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

IEC 60050-581, *International Electrotechnical Vocabulary (IEV) – Chapter 581: Electromechanical components for electronic equipment*

IEC 60050-826, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations of buildings*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-14, *Basic environmental testing procedures Part 2: Tests - Test N: Change of temperature*

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

IEC 60068-2-70:1995, *Environmental testing – Part 2: Tests – Test Xb: Abrasion of marking and letterings caused by rubbing of fingers and hands*

IEC 60112:1979, *Method for determining the comparative and proof tracking indices of solid insulating materials under moist conditions*

IEC 60352-2, *Solderless connections – Part 2: Solderless crimped connections – General requirements, test methods and practical guidance*

IEC 60352-3, *Solderless connections – Part 3: Solderless accessible insulation displacement connections –General requirements, test methods and practical guidance*

IEC 60352-4, *Solderless connections – Part 4: Solderless non-accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-5, *Solderless connections – Part 5: Solderless press-in connections – General requirements, test methods and practical guidance*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41:Protection against electric shock*

IEC 60364-5-51:2001, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 51:Common rules*

IEC 60364-7-712, *Electrical installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems*

IEC 60417-2:1998, *Graphical symbols for use on equipment – Part 2: Symbol originals*

IEC 60423:1993, *Conduits for electrical purposes – Outside diameters of conduits for electrical installations and threads for conduits and fittings.*

IEC 60512 (all parts), *Electromechanical components for electronic equipment*

IEC 60512-1, *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods – Part 1: General*

IEC 60512-11-7:1996, *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods – Part 11: Climatic tests – Section 7: Test 11g: Flowing mixed gas corrosion test*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:1992, *Insulation coordination for equipment within low voltage systems – Part 1: Principles, requirements and tests Amendment 1 (2000)*

IEC 60695-2-10, *Fire hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure*

IEC 60695-2-11, *Fire hazard testing – Part 2: Test methods – Section 11: Glow-wire end product test and guidance.*

IEC 60695-10-2, *Fire hazard testing – Part 10: Guidance and test method for the minimization of the effects of abnormal heat on electrotechnical products involved in fires – Section 2: Method for testing products made from non-metallic materials for resistance to heat using the ball pressure test.*

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

IEC 60695-11-20, *Fire hazard testing - Part 11-20: Test flames - 500 W flame test methods*

IEC 60760:1989, *Flat, quick-connect terminations*

IEC 60981:1989, *Extra-heavy duty rigid steel conduits for electrical installations.*

IEC 60998-2-3, *Connecting devices for low-voltage circuits for household and similar purposes - Part 2-3: Particular requirements for connecting devices as separate entities with insulation-piercing clamping units*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm²*

IEC 60999-2:1995, *Connecting devices – Safety requirements for screw-type and screwless-type clamping units for electrical copper conductors – Part 2: Particular requirements for conductors from 35 mm² up to 300 mm²*

IEC 61032:1997, *Protection of persons and equipment by enclosure – Probes for verification.*

IEC 61084 series: 1991, *Cable trunking and ducting systems for electrical installations.*

IEC 61140:1997, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61210:1993, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

IEC 61215:1993, *Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval*

IEC 61646, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730-1:2004, *Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction*

IEC 61730-2:2004, *Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing*

ISO 4892-2, *Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc sources*

ISO 4892-3, *Plastics - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamp*

ISO 6988:1985, *Metallic and other non organic coatings – Sulfur dioxide test with general condensation of moisture*

EN 50262:1998 + A1:2001, *Metric cable glands for electrical installations*

3 Definitions

For the purpose of this International Standard, definitions from IEC 60050-581, IEC 60050-826, IEC 60664-1, IEC 60999-1 and IEC 61140, together with the following, apply.

3.1

Junction box

combination of parts, such as boxes, covers, cover-plates, lids, box extensions, accessories, etc., providing after assembly and installation at the photovoltaic-module as in normal use, an appropriate protection against external influences, and a defined protection against contact with enclosed live parts from any accessible direction.

3.1.1

Box for re-opening

Junction box which can be opened at any time. It may contain rewirable and non rewirable connections.

3.1.1.1

Junction box for factory wiring

PV-cables in the box and/or PV-connectors integrated in the enclosure are connected in the end application under controlled conditions, usually at manufacturer's location.

3.1.1.2

Junction box for field wiring

Wiring connections are made in the field.

3.1.2

Box, not intended to be re-opened

Junction box which can not be opened after mounting in the end application. It may contain rewirable and non rewirable connections.

3.2

cable gland

housing usually of cylindrical, hollow form a secondary member usually threaded to compress the associated seal around the cable passing through the gland. It may have additional functions like insulation, buckle protection, strain relief or combination of them.

3.3

sealing

sealing material which will be inserted between two surfaces of the box and which will form a sealed connection after compression

3.4

spout (hub)

open entry of a box permitting the insertion and containment of a conduit

3.5

cable anchorage

the ability to limit the displacement of a fitted flexible cable against pull and push forces and torques

3.6

connector (for photovoltaic-systems)

component suitable for use in PV-systems which terminates conductors for the purpose of providing connection to and disconnection from a suitable mating component. It is specially designed to be engaged or disengaged in normal use when live but not under load.

3.7

cable (for photovoltaic-systems)

cable suitable for use as connection for PV-modules as a PV-string

3.8

intended use

application conditions of junction boxes which are included within the permissible rated values and environmental conditions and characteristics assigned by the manufacturer

3.9

Terminals

part(s) of the terminal necessary for the mechanical clamping and the electrical connection of the conductor(s), including the parts which are necessary to ensure the correct contact pressure [IEC 60999-1, Definition 3.1]

Gelöscht: Klemmstelle

3.10

clearance

the shortest distance in air between two conductive parts [IEC 60664-1, definition 1.3.2]

3.11

creepage distance

shortest distance along the surface of the insulating material between two conductive parts [IEC 60664-1, definition 1.3.3]

3.12

overvoltage category

numeral defining a transient overvoltage condition [IEC 60664-1, definition 1.3.10]

3.13

pollution

any addition of foreign matter, solid, liquid, or gaseous, that can result in a reduction of electric strength or surface resistivity of the insulation [IEC 60664-1, definition 1.3.11]

3.14

pollution degree

numeral characterizing the expected pollution of the micro-environment

[IEC 60664-1, definition 1.3.13]

3.15

rated voltage

value of voltage assigned by the manufacturer to the junction box and to which operation and performance characteristics are referred. [IEC 60664-1, definition 1.3.9 modified]

The rated voltage of junction box shall not be less than open circuit voltage (U_{OC}) of the PV-system

NOTE Rated Voltage is equivalent to the rated system voltage according to IEC 61730-1.

3.16

rated insulation voltage

r.m.s. withstand voltage value assigned by the manufacturer to the junction box, characterising the specified (long term) withstand capability of its insulation

NOTE The rated insulation voltage is not necessarily equal to the rated voltage, which is primarily related to functional performance.

[IEC 60664-1, definition 1.3.9.1 modified]

3.17

rated impulse voltage

impulse withstand voltage value assigned by the manufacturer to the junction box, characterising the specified withstand capability of its insulation against transient overvoltages [IEC 60664-1, definition 1.3.9.2 modified]

3.18 impulse withstand voltage

highest peak value of impulse voltage, of prescribed form and polarity which does not cause breakdown of the insulation under specified conditions [IEC 60664-1, definition 1.3.8.1]

NOTE The impulse withstand voltage is equal to or higher than the rated impulse voltage.

3.19 r.m.s. withstand voltage (power-frequency withstand voltage)

highest r.m.s. value of a voltage which does not cause breakdown of the insulation under specified conditions

[IEC 60664-1, definition 1.3.8.2]

3.20 rated current

current value assigned by the manufacturer, which the junction box can carry continuously (without interruption) and simultaneously through all its contacts and bypass-diodes, if applicable, wired with the largest specified conductor, preferably at an ambient temperature of 85 °C, without the upper limiting temperature being exceeded.

The rated current of the junction box shall not be less than the maximum short-circuit-current (I_{SC}) of the PV-system.

Gelöscht: 3.20
maximum working voltage
voltage value assigned by the manufacturer to the junction box, characterising the specified (long term) withstand capability of its insulation at module side. The working voltage of the junction box shall not be less than the open-circuit-voltage of the PV-module. ¶

Gelöscht: 21

Gelöscht: 22

3.21 functional insulation

insulation between conductive parts which is necessary only for the proper functioning of the equipment. [IEC 60664-1, definition 1.3.17.1]

Gelöscht: 23

3.22 basic insulation

insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes (see 3.10.1 of IEC 61140).

3.23 supplementary insulation

independent insulation applied in addition to basic insulation, in order to provide protection against electric shock in the event of a failure of basic insulation (see 3.10.2 of IEC 61140)

[IEC 60664-1, definition 1.3.17.3]

Gelöscht: 24

3.24 double insulation

insulation comprising both basic insulation and supplementary insulation (see 3.10.3 of IEC 61140) [IEC 60664-1, definition 1.3.17.4]

Gelöscht: 25

3.25 reinforced insulation

single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant IEC standard (see 3.10.4 of IEC 61140)

NOTE A single insulation system does not imply that the insulation must be a homogeneous piece. It may comprise several layers which cannot be tested singly as basic or supplementary insulation.

[IEC 60664-1, definition 1.3.17.5]

Gelöscht: 26

3.26 Utilization category A according to IEC 61730

Junction boxes which are provided for using in this utilization category can be used in systems where free access are expected and rated values exceed 50 V DC or 240W.

Gelöscht: 27

Junction boxes which comply with the requirements of this standard and which are classified in this utilization category are considered to meet the requirements of protection class II. [IEC 61730-1]

3.27

Utilization category B according to IEC 61730

Junction boxes which are provided for using in this utilization category may only be used in systems where free access are protected by fences, locality etc.

Junction boxes which are classified in this utilization category and which are protected by basic insulation are considered to meet the requirements of protection class 0. [IEC 61730-1]

3.28

Utilization category C according to IEC 61730

Junction boxes which are provided for using in this utilization category can be used in systems where free access are expected and rated values less than 50 V DC or 240W.

Junction boxes which comply with the requirements of this standard and which are classified in this utilization category are considered to meet the requirements of protection class III.

Hint: Protection class are defined in IEC 61140

3.29

maximum working voltage

voltage value assigned by the manufacturer to the junction box, characterising the specified (long term) withstand capability of its insulation at module side.

NOTE: The working voltage of the junction box shall not be less than the open-circuit-voltage of the PV-module.

4 Constructional requirements and performance

4.1 General

For junction boxes according to the present standard no values have been defined for electric rated characteristics voltage and current. These values must be declared by the manufacturer.

Junction boxes must be suitable for the durable use outside in an ambient temperature area from -40 °C to +85 °C.

Junction boxes shall be so designed and dimensioned that they can withstand the electrical, mechanical, thermal and corrosive stresses which occur in their intended use and present no danger to the user or the environment.

Compliance with these requirements are verified by specified tests of this standard.

4.2 Marking and identification

4.2.1 Identification

Junction boxes shall be identified and characterised by the following markings:

- manufacturer's name, trademark or mark of origin;
- type identification;
- rated current in amperes (A);
- rated voltages or rated insulation voltages
- rated impulse voltage in kilovolts (kV), if specified;
- Maximum working voltage;
- pollution degree;

Gelöscht: 4 . Classification¶
In order to apply the relevant test requirements, junction boxes shall be classified by the manufacturer's specification according to their intended use under consideration of classes A according to IEC 61730. ¶
5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Formatiert: Einzug: Links: 0 cm, Hängend: 0,71 cm, Nummerierte Liste + Ebene: 1 + Nummerierungsformatvorlage: a, b, c, ... + Beginnen bei: 5 + Ausrichtung: Links + Ausgerichtet an: 0,63 cm + Tabstopp nach: 1,32 cm + Einzug bei: 1,32 cm, Tabstopps: 0,18 cm, Listentabstopp + Nicht an 0,63 cm + 1,32 cm

- h) degree of protection by enclosure according to IEC 60529,
- i) range of temperature; (lowest und upper ambient temperature), if differ from this standard
- j) type of terminals;
- k) connectable conductors;
- l) reference to this standard, if applicable;
- m) Hint „Not connecting or disconnecting under load“ or adequate symbol. (see Annex A);
- n) Polarity of connector, if applicable;
- o) Type and number of bypass-diodes, if applicable.

NOTE for m) alternatively an adequate warning notice can be found in particular national language.

4.2.2 Marking

The marking shall be indelible and easily legible.

The minimum marking on the junction boxes shall be that of item a), b) and n) in 4.2.1.

If connection of junction box is performed by connectors the warning notice listed in m) of 4.2.1 must be on a label or similar on or close to connector.

If connection of junction box is performed by a fixed cable which has implemented a connector on its end the warning notice listed in m) of 4.2.1 must be on a label or similar on or close to connector. A notice to attaching the sticker must be specified in technical documentation. For connectors VDE 0126-3 is applicable.

Markings a) and b) of 4.2.1 shall be found on the smallest unit of packaging.

All other markings of 4.2.1 and following information shall be given in the technical documentation or catalogue of the manufacturer:

- Information regarding the connectable cable, if applicable
- Information regarding the connector (-system), if applicable
- Information regarding mounting (e.g. backsheet-material of module) and mounting material (e.g. sealing material), if applicable.

4.3 Protection against electric shock

4.3.1 A connector shall be so designed that, after mounting, its live parts are not accessible by the IEC test finger in accordance with IEC 60529.

This requirement must be fulfilled even if there is any deformation of the housing and/or cover as a result of mechanic and thermal stress, which can occur during normal use; furthermore the degree of protection of the housing may not be impaired by this possible deformation.

4.3.2 The cover can only be detached with the aid of tools. Covers which are attached without screws must have one or several detectable facilities, e.g. recesses, which enable tools to be deployed in order to remove them. If the lid is removed correctly the tools and instruments may not come into contact with the active parts.

4.3.3 Parts shall be prevented from loosening or turning concerning to the type of mounting as described in 3.1.1.2 if such loosening or turning may result in a risk of fire, electric shock, or injury to persons.

4.4 Terminations and connection methods

Note Following requirements are also applicable for cell-connections.

4.4.1 Terminations shall be suitable for the type and range of conductor cross-sectional areas according to manufacturer's information.

Formatiert: Einzug: Hängend:
1,27 cm, Nummerierte Liste +
Ebene: 1 +
Nummerierungsformatvorlage: a,
b, c, ... + Beginnen bei: 14 +
Ausrichtung: Links +
Ausgerichtet an: 0,63 cm +
Tabstopp nach: 1,27 cm +
Einzug bei: 1,27 cm, Tabstopps:
Nicht an 1,27 cm

Gelöscht: 5

Gelöscht: 1

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Formatiert: Schriftart: Fett

Formatiert: Keine
Aufzählungen oder
Nummerierungen, Tabstopps:
Nicht an 0,63 cm

Gelöscht: 5

Formatiert: Schriftart: Fett

Formatiert: Keine
Aufzählungen oder
Nummerierungen, Tabstopps:
Nicht an 0,63 cm

Not insulated terminals must be held in position such that a possible disposition which may result in a reduction of clearances and creepage distances is prevented.

4.4.2 Terminals must meet following requirements:

Clamping units must fulfil the requirements of IEC 60999-1 or IEC 60999-2 under the conditions prevailing in the junction box.

Other terminals shall meet:

IEC 60998-2-1, IEC 60998-2-2 or IEC 60947-7-1 under the conditions prevailing in the junction box.

Other type attachments and connecting methods may be used if they fulfil a comparable level of safety as the above mentioned standards.

Furthermore connections by soldering, welding, crimping and pressing may be used.

The cables must be so mounted or fixed that they are not hold in position only from the connections by soldering, welding, crimping and pressing, unless it is ensured by construction that clearances and creepage distances according to clause 4.14 will not be reduced in case of break of conductor at soldering- or welding-connection or slipping out of crimping- or pressure-connection.

Gelöscht: 5

NOTE In general, hooking-in before soldering is considered to be a suitable means for retaining the conductor in position.

4.4.3 Tests occur to clause 5.3.19 if no certification of above mentioned standards are existent.

Gelöscht: 5

Gelöscht: 6

Gelöscht: 20

Electrical and thermal tests on terminations shall be carried out in conjunction with the test on the junction box.

4.4.4 Electrical connections shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material (see clause 7 of IEC 60999-1 or IEC 60999-2).

Gelöscht: 5

4.5 Connectors

Formatiert: Nummerierung und
Aufzählungszeichen

PV-connectors which are part of the junction box and PV-connectors connected via a cable with the junction box shall comply with the requirements of VDE 0126-3. The values of the rated current and the rated voltage must minimum correlate with the rated values of the junction box.

4.6 Cable

Formatiert: Nummerierung und
Aufzählungszeichen

Cables connected at the junction box must be suitable for use in PV-systems. The values of the rated current and the rated voltage must minimum correlate with the rated values of the junction box.

4.7 Resistance to ageing

Formatiert: Nummerierung und
Aufzählungszeichen

Parts which, due to ageing, might impair safety shall be so resistant that the specified characteristics will be provided by testing of test program.

4.8 General construction

Gelöscht: 5

Junction boxes shall be so designed and dimensioned that they provide sufficient protection for cables and terminations against electrical, mechanical, and environmental stresses which occur in normal use.

4.8.1 Fixing means, actuated in the mounting and in the connection of junction boxes, shall not be used to fix live parts, where as a result of their change of position their efficiency might be impaired and creepage distances and clearances be reduced.

Formatiert: Schriftart: Fett

Formatiert: Keine
Aufzählungen oder
Nummerierungen, Tabstopps:
Nicht an 1,41 cm

4.8.2 The thickness of outer walls of the junction box shall not be less than 3,0 mm, unless the (finished) box meet the end-product flammability test according to IEC 60695-11-20, category 5-V.

Formatiert: Schriftart: Fett

4.8.3 Junction boxes shall be so designed that connection of conductors of the type and cross-sectional areas as specified by the manufacturer shall be possible. Besides the termination of the conductor, precautions shall be taken that no damage of the insulation is possible, e.g. by avoiding of sharp edges.

4.8.4 All openings shall be provided with appropriate coverings (such as lids, plugs, etc.), whose functions comply with the requirements of 5.3.15. They should only be able to be removed by the use of a tool.

These requirements are also applicable for knock-outs.

4.8.5 A barrier of polymeric insulating material providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall be of adequate thickness and of a material appropriate for the application. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties fall below the minimum acceptable values for the application

4.8.6 Junction boxes for reopening according to 3.1.1 with rewirable connections shall be designed such that

- precautions are taken that the conductor is the wires is protected against shear and tensile stress at the termination and be secured to prevent twisting;
- the mounted conductor is verified with rated values of the connectors and suitable for the use in photovoltaic systems or an assignation for using of suitable cables is given in the manufacturer's specification;
- the clamping units fulfill the requirements of 4.4.2;
- there's sufficient volume for connecting the conductor.

Gelöscht: 5

4.9 Degree of protection (IP)

A junction box shall have a degree of protection of IP55, category 1 according to IEC 60529.

Gelöscht: 5

4.10 Dielectric strength

A junction box shall withstand the specified test voltage, preferably the impulse withstand voltage (1,2/50 µs) and r.m.s. withstand voltage depending on its rated voltage.

Gelöscht: 5

4.11 Ambient temperature range

Junction boxes must withstand the upper and lowest values of temperature rise listed in manufacturers specification.

Gelöscht: 5

4.12 Cord anchorage

Gelöscht: 11

The cord anchorage shall be suitable for the cable to be connected. The range of acceptable cable diameters shall be specified in the manufacturer's specification.

Gelöscht: Tensile and torsion
requirements shall be as
specified as in 6.3.23.

Loose parts inserted to obtain clamping of the cable are permissible if they are fixed in the junction box in the assembled state.

The cord anchorage can be made of insulating material or metal. If it consists of metal, it shall meet one of the following requirements:

- a) be provided with a covering of insulating material to prevent any accessible metal part becoming live in case of a fault;
- b) no contact shall be possible with the test finger according to IEC 60529;

Compliance is checked by the tests in D3.

Gelöscht: of 6.3.23

4.13 Mechanical strength

4.13.1 A junction box shall show no damage likely to impair safety after exposure to mechanical stress according to the test program.

4.13.2 In a junction box assembled for final use, the contacts shall be securely retained in the contact insert.

4.13.3 After exposure to the stresses according to the test schedule, the internal insulation shall show no damage which could impair normal use.

4.14 Clearances and creepage distances

Clearances and creepage distances shall be dimensioned according to the following specifications.

4.14.1 Clearances

Clearances between live parts and accessible surfaces shall be dimensioned according to IEC 60664-1 for reinforced or double insulation based on the rated impulse voltage derived from table 1 of this standard.

Clearances through slots and openings in enclosures of insulating material shall meet the values of case A of table 2 of IEC 60664-1.

Rewireable junction boxes shall meet the requirements according to IEC 60664-1 of reinforced insulation between clamping units for the terminals for flexible cords relating on the rated voltage of junction box.

All other clearances within the junction box shall meet the requirements of basic insulation according to IEC 60664-1 relating on the maximum working voltage specified by the manufacturer.

4.14.1.1 Rated impulse voltage

The rated impulse voltage shall be selected according to table 1 and the rated voltage of the junction box.

4.14.1.2 Overvoltage category

The assignment of junction box shall carried out according to the rules as given in IEC 60664-1 for overvoltage categorie III.

Gelöscht: 5

Gelöscht: 13

Gelöscht: or double

Gelöscht: 5

Gelöscht: 13

Gelöscht: 5

Gelöscht: 13

Table 1 – Rated impulse voltage

Rated voltage V	Values for the rated impulse voltage in kV (1,2/50µs)
100	1,5
150	2,5
300	4,0
600	6,0
1000	8,0

4.14.2 Creepage distances

Creepage distances between live parts and accessible surfaces shall be dimensioned for double reinforced or double insulation according to IEC 60664-1 related to the rated voltage, the pollution degree 3.

Gelöscht: 5

Gelöscht: 13

Gelöscht: according

Gelöscht: and the insulating material as specified in IEC 60664-1

For the relationship between creepage distances and clearances see 3.2.1.5 of IEC 60664-1

Rewireable junction boxes shall meet the requirements of reinforced or double insulation according to IEC 60664-1 between clamping units of the terminals for flexible cords relating on the rated voltage of junction box.

All other creepage distances within the junction box shall meet the requirements of basic insulation according to IEC 60664-1 relating on the maximum working voltage specified by the manufacturer.

The sufficient insulation of splice between module and junction box will be approved by tests of test sequence E and F of 6.4.

Gelöscht: 5

Gelöscht: 13

4.14.2.1 Pollution degree

For a junction box complying with this standard, isolating parts (clearances and creepage distances) inside of the enclosure shall be dimensioned for pollution degree 2.

Gelöscht: 5

Gelöscht: 13

4.14.2.2 Shape of insulating surfaces

For insulating surfaces determinations of IEC 60664-1 are applicable.

Gelöscht: 5

Gelöscht: 14

4.15 Insulation

Gelöscht: 5

Gelöscht: 14

4.15.1 Functional and basic insulation

Functional and basic insulation shall be such that it withstands the impulse withstand voltage or the r.m.s. withstand voltage as specified in the manufacturer's specification, as derived from the rated insulation voltage of the junction box.

Gelöscht: 5

Gelöscht: 14

4.15.2 Supplementary insulation

For the supplementary insulation, the same requirements are valid as for the basic insulation.

Gelöscht: 5

Gelöscht: 14

4.15.3 Double insulation

Double insulation shall be so designed that the breakdown of one part (basic or supplementary insulation) does not impair the protective function of the other part. It shall not be possible to remove the supplementary insulation without using a tool.

For double insulation, where basic and supplementary insulation cannot be tested separately, the insulation system shall be considered as reinforced insulation.

Gelöscht: 5

Gelöscht: 14

4.15.4 Reinforced insulation

For the assessment of clearances for reinforced insulation, the rated impulse voltage shall be selected from table 1.

The creepage distances shall be doubled in comparison with the basic insulation.

Gelöscht: 5

Gelöscht: 15

4.16 Insulation parts

Gelöscht: 5

Gelöscht: 15

4.16.1 General requirements

Insulation parts shall be so designed that they withstand the expected thermal requirements.

Gelöscht: of 6.4

Compliance is checked by the test of test group B.

4.16.2 Outer accessible parts

Outer accessible parts consisting of isolating material whose deterioration could impair the safety of the junction box shall meet following requirements:

- a) Category of the vertical burning HB, V-2, V-1, or V-0 according to IEC 60695-11-10. This shall be proved by a data sheet of the material supplier or a test in the end-product.

NOTE: IEC 61730 requires category 5V

- b) Weather resistance according to ISO 4892-2 method A or ISO 4892-3 with total duration of 500 h. After test the glow wire test according to 5.3.14 a) must be passed.
- c) Temperature resistance at ball pressure test of 5.3.13a)

Gelöscht: on parts which are provided direct sunlight in normal use

Gelöscht: 6

Gelöscht: 15

Gelöscht: 6

Gelöscht: 14a

Gelöscht: 5.15

4.16.3 Inner parts

Inner parts consisting of isolating material whose keep active parts in a position shall meet following requirements:

- a) Category of the vertical burning HB, V-2, V-1, or V-0 according to IEC 60695-11-10. This shall be proved by a data sheet of the material supplier or a test in the final product..
- b) Isolating material must have a CTI-value complying to the rated values of this standard according to IEC 60664.
- c) Glow wire test with 750°C according to 5.3.14b).
- d) Temperature resistance at ball pressure test of 5.3.13b)

Gelöscht: 6

Gelöscht: 15b

Gelöscht: 6

Gelöscht: 14b

Gelöscht: 5

Gelöscht: 16

Gelöscht: 5

Gelöscht: 16

The requirements of a) and b) applies also for potting material which are in contact to live parts.

4.17 Current carrying parts and resistance against corrosion

4.17.1 All current carrying parts must be of metal and shall be so designed that corrosion shall not impair safety with regard to electrical and mechanical characteristics.

Gelöscht: is

During the normal function under the occurring conditions a sufficient mechanical strength, electrical conductivity and corrosion resistance shall be given.

4.17.2 Under wet ambient conditions all metal parts may not be in contact with each other which have a difference of their electrochemical potentials from > 350mV according to IEC 60943.

Gelöscht: 5

Gelöscht: 16

Gelöscht: 5

Gelöscht: 17

4.18 Sealing

Gaskets and seals shall not deteriorate beyond limits during accelerated ageing of 5.3.15.

Gelöscht: 6

Gelöscht: 16

4.19 Bypass-diode

The bypass-diode and the adequacy of the thermal design and relative long-term reliability used to limit the detrimental effects of module hot-spot susceptibility must be sufficient.

Gelöscht: 5

Gelöscht: 18

Gelöscht: 5

4.20 Knock-out inlets (outlets)intended to be removed by mechanical impact

Gelöscht: 19

It shall be possible to remove knock-out inlets (outlets) intended to be removed by mechanical impact without damaging the box.

For knock-out inlets (outlets) for cables, chips or burrs are not accepted.

For knock-out inlets (outlets) for conduits and/or for use with a grommet or a membrane, chips and burrs are disregarded.

Formatiert: Schriftartfarbe:
Automatisch

Formatiert: Überschrift 2,
Abstand Vor: 0 pt, Nach: 0 pt,
Abstand zwischen asiatischem
und westlichem Text anpassen,
Abstand zwischen asiatischem
Text und Zahlen anpassen

4.21 Junction box with cord anchorage

Mistake from DKE, see also 4.12

5 Tests

5.1 General

5.1.1 The test program consist both of safety-tests and of qualification-tests according to the rules of valid standards for components and for PV-modules and –systems.

5.1.2 The tests shall be carried out in the sequence specified for each test group using the number of specimens as given in annex B. For each test group a separate set of new specimens shall be used.

5.1.3 The tests shall be made under the standard atmospheric conditions of IEC 60068-1, unless otherwise specified in the test schedule.

5.1.4 The tests on the terminations shall be made on three terminations per specimen, if available.

5.1.5 The specimen is deemed not to comply with this standard if the specimen fails in more than one of the tests of any test group. If the specimen fails in one of the tests, this test and the preceding tests which have affected its result shall be repeated on a new specimen, which shall then pass the repeated tests.

5.1.6 All visual examination tests should be performed with the naked eye, unless otherwise specified.

5.2 Preparation of specimens

5.2.1 Specimens shall be pre-conditioned under standard conditions for testing, for a period of 24 h at $(25 \pm 5)^\circ\text{C}$.

5.2.2 The tests shall be carried out with copper conductors unless otherwise specified by the manufacturer and with the type of conductor specified for the junction box. If terminations are provided for all types of conductors, (solid, stranded and flexible), the tests shall be carried out with conductors which represent the worst case.

5.2.3 For the cell-connections conductors specified from the manufacturer representing the worst case must be connected. For some tests it is necessary to connect these cell connections.

5.2.4 Screw-type clamping units shall be tightened with the value of the torque stipulated in table 2 according to IEC 60999-1 unless otherwise specified by the manufacturer.

5.2.5 Unless otherwise specified in the test schedule, all tests shall be made on the specimen completely assembled according to the manufacturer's instructions.

A sufficient number of specimen must be glued on a mounting surface as in normal use. The mounting surface must consist of the same material like the back-sheet material of the module, the box is intended to be fixed. If the box is intended to be fixed with several adhesive on several backsheet materials a sufficient number of specimen for each material must be tested.

The cell-connections will be bent down and fixed such that they have a conductive connection to mounting surface. For some tests it is necessary to connect the cell connections.

Table 2 – Values of torque for screw-type clamping units

Gewinde-Nennendurchmesser mm	Drehmoment für metallische und nichtmetallische Schrauben Nm			
	I	II	III	IV
bis einschließlich 2,8	0,20	0,40	0,40	0,70
über 2,8 bis einschließlich 3,0	0,25	0,50	0,50	0,90
über 3,0 bis einschließlich 3,2	0,30	0,60	0,60	1,10
über 3,2 bis einschließlich 3,6	0,40	0,80	0,80	1,40
über 3,6 bis einschließlich 4,1	0,70	1,20	1,20	1,80
über 4,1 bis einschließlich 4,7	0,80	1,80	1,80	2,30
über 4,7 bis einschließlich 5,3	0,80	2,00	2,00	4,00
über 5,3 bis einschließlich 6,0	1,20	2,50	3,00	4,40
über 6,0 bis einschließlich 8,0	2,50	3,50	6,00	4,70
über 8,0	3,00 ^a	4,00	10,00	5,00
^a Oder durch den Hersteller festzulegen				

Column I applies to screws without heads if the screw, when tightened, does not protrude from the screw hole and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column II applies to nuts of mantle clamping units which are tightened by means of a screwdriver.

Column III applies to screws and nuts, other than nuts of mantle clamping units, which are tightened by means other than a screwdriver

Column IV applies to screws tightened by means of a cross-slotted screwdriver.

5.3 Performance of tests

5.3.1 General

In accordance with the test schedule given in 5.4, the general test methods specified in tables 5 to 12 shall be applied.

5.3.2 Durability of marking

The test of the durability of marking shall be done as a wet test according to test Xb (abrasion of marking) of IEC 60068-2-70. For the test piston, size 1 shall be used and the test liquid shall be water. A force of 5 N shall be applied for a duration of 10 cycles.

After test the marking shall still be legible.

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

This test shall be also carried out at an additional sticker (if applicable) with specified warning indication listed under m) from 4.2.1, if applicable.

The test will not be carried out with imprinted markings.

Gelöscht: 6

5.3.3 Fixing of lid at rewirable junction box

Tests according to 5.3.3.1 and 5.3.3.2 will be performed at specimen which passed through test sequences of test group E and F.

Gelöscht: 6

Gelöscht: 6

5.3.3.1 Lid with fixing of screws

Screws of the lid are tightened and loosened:

- 10-times for a screw in engagement with a thread of insulating material;
- 5-times for other screws.

Gelöscht: 6

Formatiert: Schriftart: Arial,
Fett, Schriftartfarbe:
Automatisch

Screws and nuts in engagement with a thread of insulating material and screws of insulating material are completely removed and reinserted each time. The test is made by using a suitable screwdriver or an appropriate tool applying a torque as indicated in table 2. Greater values of torque may be used if so stated by the manufacturer, when the relevant information is provided.

During the test, there shall be no damage, such as breakage of screw or damage to the head slot (rendering the use of the appropriate screwdriver impossible) or to the threads or to the enclosure impairing the further use of the fixing means. The screws shall not be tightened in jerks.

Gelöscht: 6

5.3.3.2 Screwless fixing of lid

Enclosures shall be tested with the test probe 11 according to IEC 61032 applied with a force of 75N for one minute to all points where this could cause a loosening of the lid. During test the lid shall not come off.

However the lid must come off without any damage when using a suitable tool as described in manufacturers specification.

Gelöscht: 6

5.3.4 Protection against electric shock

5.3.4.1 Connectors shall be tested by the IEC test finger in accordance to IEC 60529 using a test force of 20 N.

Gelöscht: 6

Gelöscht: with clause 5 of

For the test all covers and housing parts shall be removed which are detachable without a tool.

5.3.4.2 The relevant tests for the specified IP-Code according to IEC 60529 are performed at specimen described in 5.2.5 with connected cables and/or mated plugs and connected cell-connections. Gaskets must be aged according to 5.3.15.

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

Gelöscht: 16

5.3.5 Measurement of clearances and creepage distances

Clearances and creepage distances shall be measured according to IEC 60664-1.

5.3.6 Dielectric strength

For check of the insulation following tests are applicable:

a) Impulse withstand test

The impulse withstand test shall be carried out with a voltage having a 1,2/50 μ s waveform according to IEC 60060-1 with three impulses of each polarity and an interval of at least 1 s between pulses. The output impedance of the impulse generator should not be higher than 500 Ω . The test voltage shall comply with the rated impulse voltage under consideration of IEC 60664-1.

b) r.m.s. withstand voltage test

The voltage proof test shall be performed by applying a r.m.s. withstand voltage (50/60 Hz) with a rms-value of 2000V + 4 times rated voltage. The test duration shall be 1 min.

5.3.7 Resistance to corrosion

Ferrous parts of boxes and enclosures shall be adequately protected against rusting.

Compliance is checked by the following test:

All grease is removed from the parts to be tested, by immersion in a degreasing agent for (10 ± 1) min. The parts are then immersed for (10 ± 1) min in a 10% solution of ammonium chloride in water at a temperature of (20 ± 5) °C.

Without drying, but after shaking off any drops, the parts are placed for (10 ± 1) min in a box containing air saturated with moisture to a level of 91% to 95 % at a temperature of (20 ± 5) °C.

After the parts have been dried for (10 ± 1) min in a heating cabinet at a temperature of (100 ± 5) °C, their surface shall show no sign of rust.

NOTE Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

5.3.8 Mechanical strength at lower temperatures

Before the tests the specimens and test apparatus are stored for 5 h by a temperature of -40 °C on a 20 mm thick steel plate. The tests are carried out immediately after the end of the storage duration in the cold chamber.

An energy of 1 joule by means of a suitable impact test facility according to IEC 60068-2-75 shall be occurred. Per one impact at four of the circumference spread places.

The test is considered to be passed if no losses have appeared which impair the usability of the connectors.

5.3.9 Thermal cycle test (IEC 60068-2-14 Test Nb)

The test is performed at specimen described in 5.2.5 with connected and short circuited cell-connections.

The specimens are inserted in a climatic chamber without pre-treatment. Afterwards a thermal cycle with temperatures between (-40 ± 2) °C and (+85 ± 2) °C according to the profile of figure 1 is to be applied.

The transfer duration between upper and lower temperature shall not exceed 100 °C/h and the temperature at the limit values must be constant for minimum 10 min.

5.3.9.1 The number of cycles for test sequence E is 200**5.3.9.2 The number of cycles for test sequence F is 50****5.3.10 Damp heat test (see clause 10.13 of IEC 61215)**

The test shall be carried out according to IEC 60068-2-78 at specimen described in 6.2.5 with connected and short circuited cell-connections under the following test conditions:

Test temperature: +85 °C ± 2 °C

Relative humidity: +85 % ± 5%

Test duration: 1000 h

Gelöscht: Mechanical strength of adhesive¶

Tests according to 6.3.5.1 and 6.3.5.2 will be performed at specimen which passed through test sequences of test group E and F. During test there should be no deposition of the box at the mounting surface which impairs isolating characteristics.¶ The test is performed under consideration of requirements of 6.2.5.¶

6.3.5.1 . A force of 40N is gradually applied for 30 min in each direction parallel to the mounting surface.¶

6.3.5.2 . A force of 40N is gradually applied for 30 min without jerks, in a direction perpendicular to the mounting surfaces.¶

6.3.6 . Measurement of clearances and creepage distances¶

Clearances and creepage distances shall be measured according to IEC 60664-1.¶

6.3.7 . Dielectric strength¶

For check of the insulation following tests are applicable:¶

a) . Impulse withstand test¶

The impulse withstand test shall be carried out with a voltage having a 1,2/50 µs waveform according to IEC 60060-1 with three impulses of each polarity and an interval of at least 1 s between pulses. The output impedance of the impulse generator should not be higher than 500 Ω. The test voltage shall comply with the rated impulse voltage under consideration of IEC 60664-1.¶

b) . r.m.s. withstand voltage test¶

The voltage proof test shall be performed by applying a r.m.s. withstand voltage (50/60 Hz) with a rms-value of 2000V + 4 times rated voltage. The test duration shall be 1 min. ¶

6.3.8 . Resistance to corrosion¶

Ferrous parts of boxes and enclosures shall be adequately protected against rusting. ¶

Compliance is checked by the following test: ¶

All grease is removed from the parts to be tested, by immersion in a degreasing agent for (10 ± 1) min. The parts are then ... [100]

Gelöscht: 9

Gelöscht: 6

Gelöscht: 10

Gelöscht: 6

5.3.11 Weather resistance test

The weather resistance test is performed according to the requirements of ISO 4892-2 or ISO 4892-3 under following conditions:

Irradiance:	min. 60W/m ²
Wave band:	300-400nm
Blackstandardtemperature:	65°C
Rel. Humidity:	65%
Cykles:	18 min spraying, 102 min drying with Xenonlamp or equivalent lamp
Duration:	500h

Gelöscht: 6.3.10.1 . The number of cycles for test sequence E is 200¶
6.3.10.2 . The number of cycles for test sequence F is 50¶
6.3.11 . Damp heat test (see clause 10.13 of IEC 61215)¶
 The test shall be carried out according to IEC 60068-2-78 at specimen described in 6.2.5 with connected and short circuited cell-connections under the following test conditions:¶
 Test temperature: . +85 °C ± 2 °C¶
 Relative humidity: . +85 % ± 5%¶
 Test duration: . . 1000 h ¶
 6

Gelöscht: 12

Gelöscht: 6

Gelöscht: 3

Gelöscht: 6

Gelöscht: 13

5.3.12 Class of flammability

5.3.12.1 The tests are performed according the flammability class HB, V-0, V-1, or V-2 of IEC 60695-11-10 at an relevant material-probe.

5.3.12.2 The tests are performed according the flammability class 5V of IEC 60695-11-20 at an end-product. The result is assessed for flammability class 5VB.

Formatiert: Schriftart:
Helvetica-Bold, Fett, Deutsch
(Deutschland)

Formatiert: Keine
Aufzählungen oder
Nummerierungen, Tabstopps:
Nicht an 1,76 cm

5.3.13 Ballpressure test

The ballpressure test is performed according to IEC 60695-10-2. The test temperature is:

- 90°C for outer materials providing protection against electric shock.
- 125°C, for materials necessary to retain current carrying parts in position.

Gelöscht: 6

Gelöscht: 14

5.3.14 Glowwire test

The glowwire test is performed according to IEC 60695-2-11. The test temperature is:

- 650°C for outer materials providing protection against electric shock.

Gelöscht: 6

Gelöscht: 15

- b) 750 °C, for materials necessary to retain current carrying parts in position and for potting material, if applicable.

Gelöscht: 6

Gelöscht: 16

5.3.15 Resistance against ageing

Before testing the IP-code in accordance with DIN EN 60529, the gasket, e.g. separate sealing rings, are to be stored in a heating cabinet for 240 hrs at (100+2) °C and subsequently cooled down for 16 hrs at ambient temperature.

After test the characteristic concerning the sealing should not be impaired.

Gaskets which couldn't be loosened from the box or the lid are tested with lid or box.

5.3.16 Wet leakage current test (clause 10.15 of IEC 61215)

The test is carried out at specimen described in 5.2.5 with connected and short circuited cell-connections under the following test conditions:

Formatiert: Nummerierung und
Aufzählungszeichen

Gelöscht: 6

Gelöscht: 6

Gelöscht: 17

5.3.16.1 Apparatus

- a) A shallow trough or tank of sufficient size to enable the module with frame to be placed in the solution in a flat, horizontal position. It shall contain a water/wetting agent solution meeting the following requirements:

Resistivity: 3 500 Ω·cm or less

Surface tension: 0,03 N·m⁻¹ or less

Kommentar [VO3]: This requirement is cancelled in the new edition of IEC 61215

Temperature: 22 °C ± 3 °C

The depth of the solution shall be sufficient to cover all surfaces between mounting surface and box.

- b) Spray equipment containing the same solution.
c) DC voltage source, with current limitation, capable of applying 500 V.
d) Instrument to measure insulation resistance.

Gelöscht: 6

Gelöscht: 17

5.3.16.2 Procedure

All connections shall be representative of the recommended field wiring installation and precautions shall be taken to ensure that leakage currents do not originate from the instrumentation wiring attached to the module.

- a) Immerse the specimen in the tank of the required solution to a depth sufficient to cover all surfaces between mounting surface and box. The cable entries shall be thoroughly sprayed with solution. If the specimen is provided with a mating connector, the connector should be immersed during the test.

Kommentar [VO4]: Many discussions between TIE and TRPS => Inquiry to TC82

- b) Connect the shorted output terminals of the module to the positive terminal of the test equipment. Connect the liquid test solution to the negative terminal of the test equipment using a suitable metallic conductor.

- c) Increase the voltage applied by the test equipment at a rate not to exceed 500 V s⁻¹ to 500 V. Maintain the voltage at this level for 2 min. Then determine the insulation resistance.

- d) Reduce the applied voltage to zero and short-circuit the terminals of the test equipment to discharge the voltage build-up on the module.

Gelöscht: 6

Gelöscht: 17

5.3.16.3 Requirements

The insulation resistance shall be not less 400 MΩ.

5.3.17 Humidity-freeze-test

The test is carried out at specimen described in 5.2.5 with connected and short circuited cell-connections under the following test conditions:

5.3.17.1 Apparatus

a) A climatic chamber with automatic temperature and humidity control, capable of subjecting one or more specimen to the humidity-freeze cycle specified in Figure 2.

b) Means for mounting or supporting the module(s) in the chamber, so as to allow free circulation of the surrounding air. The thermal conduction of the mount or support shall be low, so that, for practical purposes, the module(s) is (are) thermally isolated.

5.3.17.2 Procedure

a) Attach a suitable temperature sensor to the front or back surface of the specimen(s) near the middle.

b) Install the specimen(s) at room temperature in the climatic chamber.

c) After closing the chamber, subject the specimen(s) to 10 complete cycles in accordance with the profile in Figure 2. The maximum and minimum temperatures shall be within ± 2 °C of the specified levels and the relative humidity shall be maintained within ± 5 % of the specified value at all temperatures above room temperature.

d) Throughout the test, record the module temperature.

e) Then the specimen (s) are stored for a recovery time between 2 h and 4 h at room temperature.

5.3.17.3 Final measurements

A visual check and the r.m.s. withstand voltage test according to 5.3.6 b) are performed. For this wrap a conductive foil around the edges of specimen(s)

5.3.17.4 Requirements

The requirements are as follows:

- a) No evidence of major visual defects;
- b) No flashover or breakdown of test voltage

5.3.18 Bypass diode thermal test (clause 10.18 of IEC 61215)

The test is carried out at specimen described in 5.2.5.

5.3.18.1 Apparatus

- a) Means for heating the specimen to a temperature of $75\text{ °C} \pm 5\text{ °C}$.
- b) Means for measuring and recording the temperature of the specimen(s) to an accuracy of $\pm 1\text{ °C}$.
- c) Means for measuring the temperature of any bypass diodes provided with the junction box. Care should be taken to minimize any alteration of the properties of the diode or its heat transfer path.
- d) Means for applying a current equal to 1,25 times the rated current of the junction box under test and means for monitoring the flow of current through the specimen throughout the test.

Gelöscht: Figure 2 Humidity-freeze cycle¶
6

Gelöscht: 19

Gelöscht: 6

Gelöscht: 6

Gelöscht: 19

5.3.18.2 Procedure

- a) Operation of diodes in direction of current-flow.
- b) Connect wires of the manufacturer's minimum recommended wire gauge to the output terminals of the junction box.

NOTE Some boxes have overlapping bypass diode circuits. In this case it may be necessary to install a jumper cable to assure that all of the current is flowing through one bypass diode.

- c) Heat the specimen to $75\text{ °C} \pm 5\text{ °C}$. Apply a current to the specimen equal to the rated current $\pm 2\%$ of the junction box. After 1 h measure the temperature of each bypass diode. Using the information provided by the diode manufacturer calculate the junction temperature from the measured case temperature and the power dissipated in the diode using the following formula.

$$T_j = T_{\text{case}} + R_{\text{THjc}} \cdot U_D \cdot I_D$$

where

- T_j is the diode junction temperature;
- T_{case} is the measure diode case temperature;
- R_{THjc} is the manufacturer's value relating junction temperature to case temperature;
- U_D is the diode voltage;
- I_D is the diode current.

NOTE If the manufacturer of diode has specified another R_{TH} as R_{THjc} this value is to be inserted in the formula and the thermal sensor shall be fixed at specified position.

- d) Increase the applied current to 1,25 times the rated current of the junction box while maintaining the box temperature at $75\text{ °C} \pm 5\text{ °C}$. Maintain the current flow for 1 h.

Gelöscht: f

- e) Verify that the diode is still operational.

Gelöscht: g

5.3.18.3 Requirements

Gelöscht: 6

Gelöscht: 19

The requirements are as follows:

- the diode junction temperature as determined in 5.3.18.2 c) shall not exceed the diode manufacturer's maximum junction temperature rating;
- no evidence of major visual defects
- the diode shall still function as a diode after the conclusion of the test.

5.3.19 Test of terminations and connection methods

- a) For crimped connections,
visual and dimensional tests on the crimp barrel and tensile strength test of the crimp connection as specified in IEC 60352-2.
- b) For the screwless-type clamping unit,
mechanical tests on the conductor connection as specified in IEC 60999-1 or IEC 60999-2.
- c) For the screw-type clamping unit,
mechanical tests on the conductor connection as specified in IEC 60999-1 or IEC 60999-2.

NOTE For prepared conductors the specific standard for the preparation applies.

- d) Soldered connections,

The test for soldered connections shall be carried out according to IEC 60512, test 12a or 12b.

5.3.20 Knock-out inlets (outlets) intended to be removed by mechanical impact

Test: Inspection and tests according to 5.3.20.1 and 5.3.20.2

5.3.20.1 Knock-out retention

For boxes and enclosures having knock-outs accessible after installation, a force of (45 ± 1) N shall be applied to a knock-out for (15 ± 1) s by means of a 6 mm diameter mandrel with a flat end. The force is to be applied without a blow in a direction perpendicular to the plane of the knock-out and at a point most likely to cause movement.

The knock-out shall remain in place and the degree of protection of the enclosure shall be unchanged when measured 1 h after the force has been removed.

5.3.20.2 Knock-out removal

The knock-outs shall be removed by means of a tool, as stated by the manufacturer. The side edge of a screwdriver may be run along the edge of the knock-out opening once to remove any fragile tabs remaining along the edge.

The test is repeated with one box or enclosure which has been conditioned for $5 \text{ h} \pm 10 \text{ min}$ in air maintained at the temperature $(-20 \pm 2)^\circ\text{C}$. Immediately following this conditioning, the knock-out is to be removed as above. For a box and an enclosure employing multi-stage knock-outs, there shall be no displacement of a larger stage when a smaller stage is removed.

After the test there shall be no sharp edges except for knock-out inlets (outlets) for conduits and/or for use with a grommet or a membrane and the box and enclosure shall not be damaged.

5.3.21 Test of cord anchorage

5.3.21.1 For junction box with cable specified by manufacturer the tests have to be performed with the conductors as stated by the manufacturer.

The cable is marked when unloaded so that any displacement relative to the gland can be easily detected.

The cable is pulled for a duration of 1 s, 50 times, without jerks in the direction of the axis with the relevant force specified in table 3

At the end of this period the displacement shall not exceed 2 mm. This measurement is to be carried out after unloading the force from the test mandrel.

Following the specimen is mounted in the test apparatus for torque test.

The cable is marked when unloaded so that any torsion relative to the gland can be easily detected, and then a torque specified in table 4 is applied for 1 min.

During test the torsion shall not exceed 45°.

5.3.21.2 For other junction boxes the test is to be performed as followed:

A test mandrel equivalent to the minimum value of the anchorage range of the cable gland as declared by the manufacturer or supplier, with a sleeve thickness as specified in table 3 is fixed to the sample.

The test mandrel is marked when unloaded so that any displacement relative to the gland can be easily detected.

The test mandrel is pulled for a duration of 1 s, 50 times, without jerks in the direction of the axis with the relevant force specified in table 3

At the end of this period the displacement shall not exceed 2 mm. This measurement is to be carried out after unloading the force from the test mandrel.

Unless otherwise specified test mandrels shall consist of a metallic rod with an elastomeric sleeving having a hardness of 70 Shore D \pm 10 points in accordance with ISO 868, a sleeve thickness as specified in table 3 or table 4. The complete test mandrel shall have a tolerance of \pm 0,2 mm for mandrels up to and including 16 mm diameter and \pm 0,3 mm for mandrels larger than 16 mm diameter. The shape shall be circular or a profile simulating the outer dimension of the cable as declared by the manufacturer or supplier.

Formatiert: Schriftart:
Helvetica-Bold, Fett, Deutsch
(Deutschland)Formatiert: Nummerierung und
Aufzählungszeichen

Gelöscht: ¶

Table 3 – Pull forces for cord anchorage

Cable diameter	Pull force	Minimum sleeve thickness of test mandrel
mm	N	mm
Up to 4	–	1*)
> 4 to 8	30	1
> 8 to 11	42	2
> 11 to 16	55	2
> 16 to 23	70	2
> 23 to 31	80	2
> 31 to 43	90	2
> 43 to 55	100	2
> 55	115	2
*) For cable diameters up to 4 mm, a suitable non-metallic mandrel may be used..		

A typical arrangement for pull test is shown in figure 3.

Following the specimen is mounted in the test apparatus for torque test.

The cable is marked when unloaded so that any torsion relative to the gland can be easily detected, and then a torque specified in table 4 is applied for 1 min.

During test the torsion shall not exceed 45°.

The torsion test is performed by a test mandrel equivalent to the maximum value of the anchorage range of the cable gland as declared by the manufacturer or supplier, with a torque for the appropriate maximum cable diameter as specified in table 4.

A typical arrangement for torsion test is shown in figure 4.

Table 4 – Values for torsion test

Cable diametre	torque	Minimum sleeve thickness of test mandrel
mm	Nm	mm
> 4 to 8	0,10	1
> 8 to 11	0,15	2
> 11 to 16	0,35	2
> 16 to 23	0,60	2
> 23 to 31	0,80	2
> 31 to 43	0,90	2
> 43 to 55	1,00	2
> 55	1,20	2

Gelöscht: ¶

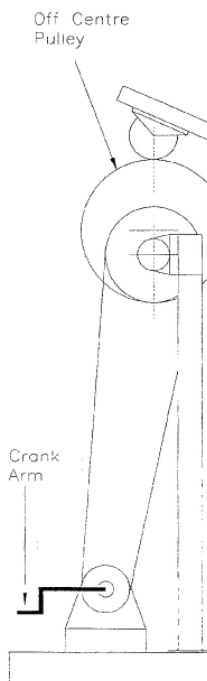


Figure 3 – Typical arrangement for the cable anchorage pull test¶

Gelöscht: Following the specimen is mounted in the test apparatus for torque test.¶
The cable is marked when unloaded so that any torsion relative to the gland can be easily detected, and then a torque specified in table 4 is applied for 1 min.¶
During test the torsion shall not exceed 45°.¶
The torsion test is performed by a test mandrel equivalent to the maximum value of the anchorage range of the cable gland as declared by the manufacturer or supplier, with a torque for the appropriate maximum cable diameter as specified in table 4.¶

Gelöscht: <sp>

Gelöscht: Figure 4 – Typical arrangement for torsion test¶

5.3.22 Mechanical strength of adhesive

Tests according to 5.3.22.1 and 5.3.22.2 will be performed at specimen which passed through test sequences of test group E and F. During test there should be no deposition of the box at the mounting surface which impairs isolating characteristics.

The test is performed under consideration of requirements of 5.2.5.

6.3.5.1 A force of 40N is gradually applied for 30 min in each direction parallel to the mounting surface.

6.3.5.2 A force of 40N is gradually applied for 30 min without jerks, in a direction perpendicular to the mounting surfaces.

5.4 Test schedule

Table 5 Group A Marking, information, documentation

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
A1	Check of marking	4.2.1	Label, sticker (or similar) with warning indication,	Visual check	Marking acc. to 4.2
A2	Check of technical documentation	4.2.2	Mounting instruction, warning indication, manual or similar	Visual check	Information according to 4.2.2 and additional information
A3	Check of approvals of components		Approval by data sheets or certificates for cable, connectors, cable glands etc.	Visual check	4.4, 4.5, 4.6, Components must comply with their relevant standards.

Gelöscht: Kennzeichnung

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Table 6 Group B Material test (single tests)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
B1	Durability of marking	5.3.2	Label, sticker (or similar) with warning indication,	Wet test	Marking easily legible
B2	Corrosion test	5.3.8	Metal parts	Chemical test	No corrosion at surface
B3	Flammability test	5.3.12.1	Plates for polymers serving as an enclosure and for polymers serving as a support for live metal parts	Flammability test or approval of manufacturer of material	Requirements according to HB, V-2, V-1, V-0 of IEC 60695-11-10
B4	Weather resistance	5.3.11	polymers serving as an enclosure,	Weather resistance test acc. to ISO 4892-standards	No cracks, following test of B5
B5	Glow wire test	5.3.14 a)	Specimen from B4	Glow wire test with 650 °C	No ignition of material or support, or self extinguishing within 30 s
B6	Glow wire test	5.3.14 b)	polymers serving as a support for live metal parts and potting material (Test-plate)	Glow wire test with 750 °C	No ignition of material or support, or self extinguishing within 30 s
B7	Thermal resistance	5.3.13 a)	polymers serving as an enclosure	Ball pressure test with 90 °C	Impression < 2,0mm
B8	Thermal resistance	5.3.13 b)	polymers serving as a support for live metal parts	Ball pressure test with 125 °C	Impression < 2,0mm
B9	Resistance against ageing	5.3.15	gaskets	Accelerated ageing in oven	No change of sealing characteristic.
B10	Flammability test	5.3.12.2	Specimen from C7	Flammability test	Requirements acc. to 5-VB of IEC 60695-11-20

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

Gelöscht: 13

Gelöscht: 6

Gelöscht: 12

Gelöscht: 6

Gelöscht: 15

Gelöscht: 6

Gelöscht: 15

Gelöscht: 6

Gelöscht: 14

Gelöscht: 6

Gelöscht: 14

Gelöscht: 6

Gelöscht: 16

Gelöscht: 6

Gelöscht: 13

Table 7 Group C Construction (single tests)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
C1	Protection against electric shock	4.3.3	Complete specimen as described in 5.2.5	Visual check	No loosening or displacement
C2		5.3.4.1		Test with test finger 20N	No live part are accessible
C3	General construction	4.8.5	Complete specimen	Visual check and measurement	Sufficient wall thickness acc. To IEC 61140 and fixing
C4		4.8.3	Complete specimen	Visual check	No sharp edges
C5	Connections and terminations	4.4.1 and 4.4.4	Complete specimen	Visual check	Fix position of terminals
C6	Clearances and creepage distances	5.3.5	Complete specimen terminated	Measurement	Requirements of 4.14 must be fulfilled
C7	Wall thickness	4.8.2	Complete specimen	Measurement	Wall thickness min. 3,0mm, otherwise test acc. to B10
C8	Lid	4.3.2	Complete specimen	Visual check	Requirements of 4.3.2 must be fulfilled

Gelöscht: 5

Gelöscht: 6

Gelöscht: 6

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 6

Gelöscht: 6

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Gelöscht: 5

Table 8 Group D Mechanical tests (single tests)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
D1	Connections and terminations Test	5.3.19	Complete specimen	Mechanical test of suitability of terminals and connections	Requirements of relevant clauses must be fulfilled
D2	Covers of openings	5.3.20	4 complete specimen	Mechanical test	No damage in sense of 6.3.21
D3	Cord anchorage	5.3.21	Cord anchorage	Pull- and torsion test	No excessive displacement of cable
D4	Mechanical strength at low temperatures	5.3.8	Complete specimen	Impact test	No damage
D5	Fixing of lid	5.3.3	2 aged specimen from Group E and F	Mechanical test	No damage of screws or threads No damage of screwless fixation
D6	Fixing of junction box at backsheet material	5.3.22	2 aged specimen from Group E and F	Mechanical test	No loosening or displacement of specimen Following test acc. to 5.3.16

Gelöscht: 6

Gelöscht: 20

Gelöscht: 6

Gelöscht: 21

Gelöscht: 6

Gelöscht: 22

Gelöscht: 6

Gelöscht: 9

Gelöscht: 6

Gelöscht: 6

Gelöscht: 5

Kommentar [V05]: This is missing in DIN V VDE V 0126-5

Gelöscht: 6

Gelöscht: 17



Table 9 Group E Testsequenz 1 (Tests consequently in this order)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
E1	Degree of protection	5.3.4	Specimen described in 5.2.5	IP-protection	No ingress of dust and water.
E2	Dielectric strength	5.3.6 b)	Samples from E1	r.m.s high voltage test 2000V + (4x rated voltage)	No flashover or breakdown of voltage
E3	Wet leakage current test	5.3.16	Samples from E1	Insulation resistance	Insulation resistance not less than 400 MΩ.
E4	Thermal cycle test	5.3.9.1	Samples from E1	Cycle test 200 cycles	No visible damages
E5	Dielectric strength	5.3.6 b)	Samples from E1	r.m.s high voltage test 2000V + (4x rated voltage)	No flashover or breakdown of voltage
E6	Dielectric strength	5.3.6 a)	Samples from E1	Impulse voltage test	No flashover or breakdown of voltage

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

Gelöscht: 7

Gelöscht: 6

Gelöscht: 17

Gelöscht: 6

Gelöscht: 10

Gelöscht: 6

Gelöscht: 7

Gelöscht: 6

Gelöscht: 7

Table 10 Group F Testsequenz 2 (Tests consequently in this order)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
F1	Wet leakage current test	5.3.16	Specimen described in 5.2.5	Insulation resistance	Insulation resistance not less than 400 MΩ.
F2	Damp heat	5.3.10	Samples from F1	Ageing testg	No visible damages
F3	Dielectric strength	5.3.6 b)	Samples from F1	r.m.s high voltage test 2000V + (4x rated voltage)	No flashover or breakdown of voltage
F4	Wet leakage current test	5.3.16	Samples from F1	Insulation resistance	Insulation resistance not less than 400 MΩ.

Gelöscht: 6

Gelöscht: 17

Gelöscht: 6

Gelöscht: 6

Gelöscht: 11

Gelöscht: 6

Gelöscht: 7

Gelöscht: 6

Gelöscht: 17

Table 11 Group G Testsequenz 3 (Tests consequently in this order)

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
G1	Thermal cycle test	5.3.9.2	Specimen described in 5.2.5	Cycle test 50 cycles	No visible damages
G2	Humidity-freeze test	5.3.17	Samples from G1	Ageing test	No visible damages
G3	Wet leakage current test	5.3.16	Samples from G1	Insulation resistance	Insulation resistance not less than 400 MΩ.

Gelöscht: 6

Gelöscht: 10

Gelöscht: 6

Gelöscht: 6

Gelöscht: 8

Gelöscht: 6

Gelöscht: 17

Table 12 Group H Bypass-Diode-Test

1	2	3	4	5	6
Test phase	Designation	Test according to	Specimen	Measurements, designation	Requirements
H1	Thermal bypass-diode-test	5.3.18	Specimen described in 5.2.5	Heating test	No exceeding temperatures at bypass-diode
H2	Wet leakage current test	5.3.16	Samples from H1	Insulation resistance	Insulation resistance not less than 400 MΩ.

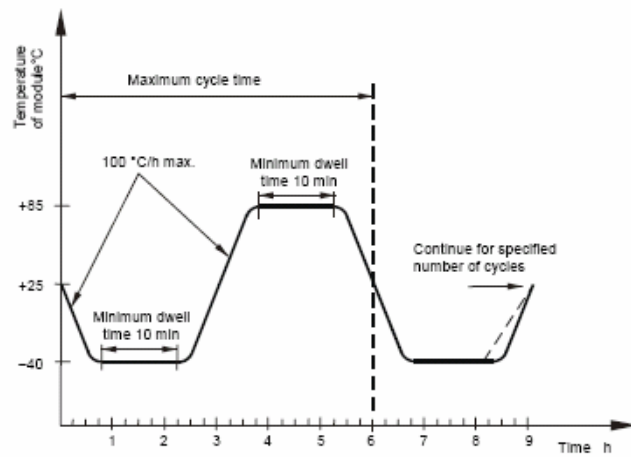
Gelöscht: 6

Gelöscht: 19

Gelöscht: 6

Gelöscht: 6

Gelöscht: 17



Formatiert: PARAGRAPH

Figure 1 Thermal cycling test

Kommentar [VO6]: This Figure is wrong! A new one is in new edition of IEC 60646

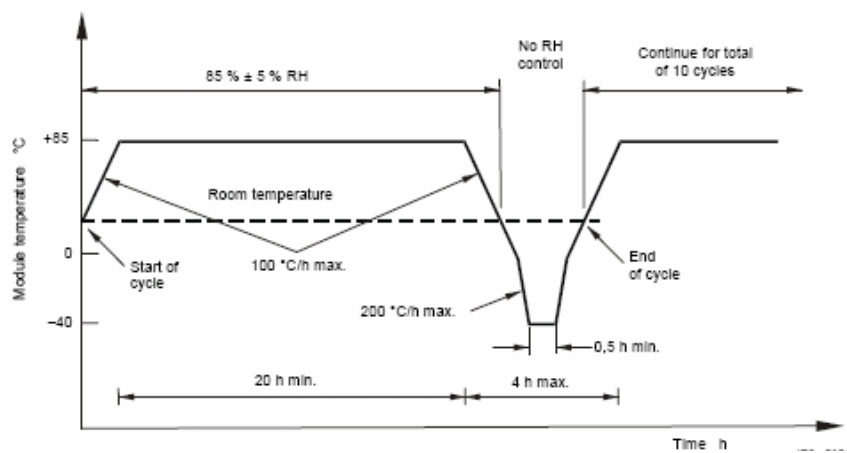


Figure 2 Humidity-freeze cycle

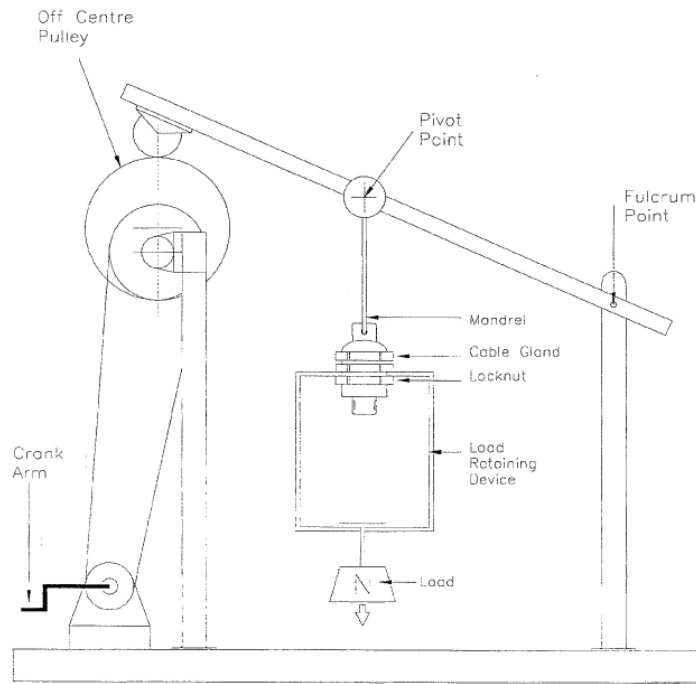


Figure 3 – Typical arrangement for the cable anchorage pull test

Formatiert: PARAGRAPH

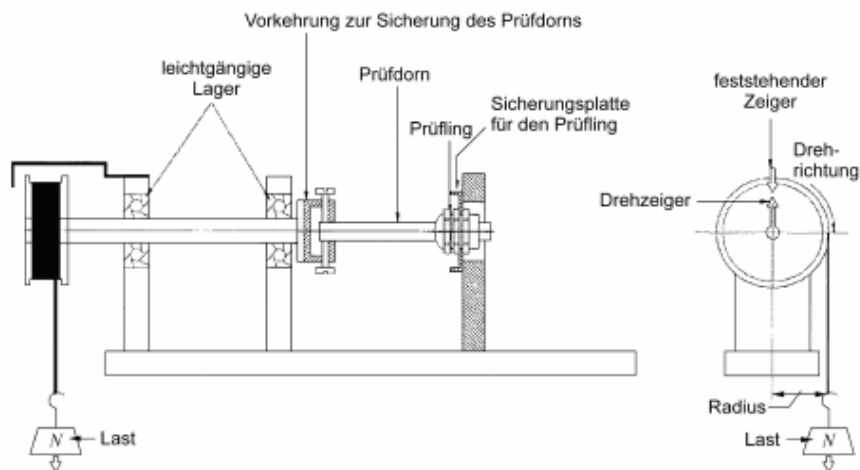
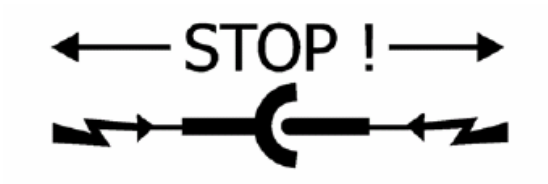


Figure 4 – Typical arrangement for torsion test

Annex A (normative)

Warning label „No disconnection under load“



Annex B (normative)

Number of specimen

The tests must be performed with following number of specimen and plates (material). If one specimen fails the tests as described in 5.1.5 a relevant number of specimen must be presented according to table B.1

Gelöscht: 6

Table B.1 Number of specimen

Test	Description of specimen	Number
Group A	Separate specimen, provided with all markings and components	1
Group B	Separate specimen, provided with all markings and components	3
B3	Test plates of polymer materials serving as an enclosure and of polymers serving as support for live metal parts, each	1
B6	Additional test plate of potting material, if applicable.	1
Group C	Separate specimen, provided with all markings and components	1
Group D	Separate specimen, provided with all markings and components	5
Group E	Specimen mounted on relevant backsheet material with relevant adhesive, potted (if applicable). Cell connections bended and connected as described in 5.2.3. Intended cable must be connected..	1 ^{a)}
Group F	Specimen mounted on relevant backsheet material with relevant adhesive, potted (if applicable). Cell connections bended and connected as described in 5.2.3. Intended cable must be connected.	1 ^{a)}
Group G	Specimen mounted on relevant backsheet material with relevant adhesive, potted (if applicable). Cell connections bended and connected as described in 5.2.3. Intended cable must be connected.	1 ^{a)}
H1	Specimen mounted on relevant backsheet material with relevant adhesive, potted (if applicable). Cell connections bended and connected as described in 5.2.3. Intended cable must be connected.	1 ^{a) b) c)}

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

Gelöscht: 6

^{a)} If the junction box is intended to be mounted at several backsheet materials and/or fixed with several adhesive an/or potted with several potting materials the tests must be performed at all possible constellations with relevant number of specimen.

^{b)} If the junction box is intended to be used with several types and/or combinations of bypass-diodes and/or several rated currents of junction box the tests must be performed at all possible constellations with relevant number of specimen.

^{c)} Is the junction box intended to be potted such that the bypass-diodes are not accessible the thermal couples must be fixed before potting upon consultation with the testing body.



Seite 1: [1] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:11:00
Seite 1: [1] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:11:00
Seite 2: [2] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [2] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [3] Ändern Feldfunktion geändert	Unknown	
Seite 2: [4] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [5] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [5] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [6] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [7] Ändern Feldfunktion geändert	Unknown	
Seite 2: [8] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [8] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [9] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [10] Ändern Feldfunktion geändert	Unknown	

Seite 2: [11] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [11] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [12] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [13] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [14] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [14] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [15] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [16] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [17] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [17] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [18] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [19] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [20] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [20] Formatiert	G. Volberg	29.08.2008 12:13:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 2: [21] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [22] Ändern	Unknown
Feldfunktion geändert	

Seite 2: [23] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [23] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [24] Ändern	Unknown
Feldfunktion geändert	

Seite 2: [25] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [26] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [26] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [27] Ändern	Unknown
Feldfunktion geändert	

Seite 2: [28] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [29] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [29] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [30] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [31] Ändern Feldfunktion geändert	Unknown	
Seite 2: [32] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [32] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [33] Ändern Feldfunktion geändert	Unknown	
Seite 2: [34] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [35] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [35] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [36] Ändern Feldfunktion geändert	Unknown	
Seite 2: [37] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [38] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [38] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [39] Ändern Feldfunktion geändert	Unknown	
Seite 2: [40] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [41] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00

Seite 2: [41] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [42] Ändern Feldfunktion geändert	Unknown	
Seite 2: [43] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [44] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [44] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [45] Ändern Feldfunktion geändert	Unknown	
Seite 2: [46] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [47] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [47] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [48] Ändern Feldfunktion geändert	Unknown	
Seite 2: [49] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [50] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [50] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
Seite 2: [51] Ändern	Unknown	

Feldfunktion geändert

Seite 2: [52] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [53] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [53] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [54] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [55] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [56] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [57] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [58] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [59] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [59] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [60] Ändern Feldfunktion geändert	Unknown	
--	----------------	--

Seite 2: [61] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [62] Formatiert Englisch (Großbritannien)	G. Volberg	29.08.2008 12:13:00
--	-------------------	----------------------------

Seite 2: [63] Ändern	Unknown
Feldfunktion geändert	

Seite 2: [64] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [65] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [65] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [66] Ändern	Unknown
Feldfunktion geändert	

Seite 2: [67] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [68] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [68] Formatiert	G. Volberg	29.08.2008 12:13:00
Englisch (Großbritannien)		

Seite 2: [69] Ändern	Unknown
Feldfunktion geändert	

Seite 1: [70] Formatiert	G. Volberg	29.08.2008 12:11:00
Englisch (Großbritannien)		

Seite 3: [71] Gelöscht	G. Volberg	29.08.2008 12:15:00
-------------------------------	-------------------	----------------------------

Figure 1 Thermal cycling test.....	20
Figure 2 Humidity-freeze cycle	23
Figure 3 – Typical arrangement for the cable anchorage pull test	26
Figure 4 – Typical arrangement for torsion test.....	27

Seite 3: [72] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [73] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [74] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [75] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [76] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [77] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [78] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [79] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [80] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [81] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [82] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [83] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [84] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [85] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [86] Formatiert	G. Volberg	29.08.2008 12:15:00
---------------------------------	-------------------	----------------------------

Englisch (Großbritannien)

Seite 3: [87] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [88] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [89] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [90] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [91] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [92] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [93] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [94] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [95] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [96] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [97] Formatiert	G. Volberg	29.08.2008 12:15:00
Englisch (Großbritannien)		

Seite 3: [98] Gelöscht	G. Volberg	29.08.2008 12:15:00
-------------------------------	-------------------	----------------------------

Table 1 – Rated impulse voltage	13
Table 2 – Values of torque for screw-type clamping units	17
Table 3 – Pull forces for cord anchorage	25
Table 4 – Values for torsion test	27
Table 5 Group A Marking, information, documentation	28

Seite 3: [99] Gelöscht	G. Volberg	29.08.2008 12:15:00
-------------------------------	-------------------	----------------------------

Table 6 Group B Material test (single tests)	29
Table 7 Group C Construction (single tests)	30
Table 8 Group D Mechanical tests (single tests)	31
Table 9 Group E Testsequenz 1 (Tests consequently in this order)	32
Table 10 Group F Testsequenz 2 (Tests consequently in this order)	33
Table 11 Group G Testsequenz 3 (Tests consequently in this order)	33
Table 12 Group H Bypass-Diode-Test	33
Table B.1 Number of specimen	35

Mechanical strength of adhesive

Tests according to 6.3.5.1 and 6.3.5.2 will be performed at specimen which passed through test sequences of test group E and F. During test there should be no deposition of the box at the mounting surface which impairs isolating characteristics.

The test is performed under consideration of requirements of 6.2.5.

6.3.5.1 A force of 40N is gradually applied for 30 min in each direction parallel to the mounting surface.

6.3.5.2 A force of 40N is gradually applied for 30 min without jerks, in a direction perpendicular to the mounting surfaces.

6.3.6 Measurement of clearances and creepage distances

Clearances and creepage distances shall be measured according to IEC 60664-1.

6.3.7 Dielectric strength

For check of the insulation following tests are applicable:

a) Impulse withstand test

The impulse withstand test shall be carried out with a voltage having a 1,2/50 μ s waveform according to IEC 60060-1 with three impulses of each polarity and an interval of at least 1 s between pulses. The output impedance of the impulse generator should not be higher than 500 Ω . The test voltage shall comply with the rated impulse voltage under consideration of IEC 60664-1.

b) r.m.s. withstand voltage test

The voltage proof test shall be performed by applying a r.m.s. withstand voltage (50/60 Hz) with a rms-value of 2000V + 4 times rated voltage. The test duration shall be 1 min.

6.3.8 Resistance to corrosion

Ferrous parts of boxes and enclosures shall be adequately protected against rusting.

Compliance is checked by the following test:

All grease is removed from the parts to be tested, by immersion in a degreasing agent for (10 \pm 1) min. The parts are then immersed for (10 \pm 1) min in a 10% solution of ammonium chloride in water at a temperature of (20 \pm 5) °C.

Without drying, but after shaking off any drops, the parts, are placed for (10 ± 1) min in a box containing air saturated with moisture to a level of 91% to 95 % at a temperature of (20 ± 5) °C.

After the parts have been dried for (10 ± 1) min in a heating cabinet at a temperature of (100 ± 5) °C, their surface shall show no sign of rust.

NOTE Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.