



BSI Standards Publication

In-cable control and protection device (IC-CPD) for mode 2 charging of electric road vehicles

National foreword

This British Standard is the UK implementation of EN 62752:2024. It is identical to IEC 62752:2024. It supersedes BS EN 62752:2016+A1:2020, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/23/1, Circuit breakers and similar equipment for household use.

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

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In-cable control and protection device (IC-CPD) for mode 2
charging of electric road vehicles
(IEC 62752:2024)

Dispositif de contrôle et de protection intégré au câble (IC-CPD) pour la charge en mode 2 des véhicules électriques
(IEC 62752:2024)

Ladeleitungsintegrierte Steuer- und Schutzeinrichtung für die Ladebetriebsart 2 von Elektro-Straßenfahrzeugen (IC-CPD)
(IEC 62752:2024)

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European foreword

The text of document 23E/1342/FDIS, future edition 2 of IEC 62752, prepared by SC 23E "Circuit-breakers and similar equipment for household use" of IEC/TC 23 "Electrical accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62752:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-10-31 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-10-31 document have to be withdrawn

This document supersedes EN 62752:2016 and all of its amendments and corrigenda (if any).

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

IEC 60269-1	NOTE	Approved as EN 60269-1
IEC 60309 series	NOTE	Approved as EN IEC 60309 series
IEC 60364 series	NOTE	Approved as HD 60364 series
IEC 60364-7-722	NOTE	Approved as HD 60364-7-722
IEC 60947-1:2020	NOTE	Approved as EN IEC 60947-1:2021 (not modified)
IEC 60999-1:1999	NOTE	Approved as EN 60999-1:2000 (not modified)
IEC 61140:2016	NOTE	Approved as EN 61140:2016 (not modified)
IEC 61249-2 series	NOTE	Approved as EN 61249-2 series
ISO 15118 series	NOTE	Approved as EN ISO 15118 series

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-5	2018	Environmental testing - Part 2-5: Tests - Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering	EN IEC 60068-2-5	2018
IEC 60068-2-11	-	Environmental testing - Part 2-11: Tests - Test Ka: Salt mist	EN IEC 60068-2-11	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60068-2-30	-	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	-
IEC 60068-2-31	-	Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens	EN 60068-2-31	-
IEC 60068-2-64	-	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance	EN 60068-2-64	-
IEC 60068-3-4	-	Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	EN IEC 60068-3-4	-
IEC 60112	-	Method for the determination of the proof and the comparative tracking indices of solid insulating materials	EN IEC 60112	-
IEC 60227	series	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 1: General requirements	-	
IEC 60245	series	Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 1: General requirements	-	

EN IEC 62752:2024 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60309-1	2021	Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes - Part 1: General requirements	EN IEC 60309-1	2022
IEC 60309-2	-	Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes - Part 2: Dimensional compatibility requirements for pin and contact-tube accessories	EN IEC 60309-2	-
IEC 60364-4-44 (mod)	2007	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances	HD 60364-4-442	2012
IEC 60384-14	2023	Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains	EN IEC 60384-14	2023
IEC 60417-DB	-	Graphical symbols for use on equipment	-	-
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529	1991
-	-		+ corrigendum May	1993
+ A1	1999		+ A1	2000
+ A2	2013		+ A2	2013
IEC 60664-1	2020	Insulation coordination for equipment within low-voltage supply systems - Part 1: Principles, requirements and tests	EN IEC 60664-1	2020
IEC 60664-3	-	Insulation coordination for equipment within low-voltage systems - Part 3: Use of coating, potting or moulding for protection against pollution	EN 60664-3	-
IEC 60695-2-10	-	Fire hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	EN IEC 60695-2-10	-
IEC 60695-2-11	-	Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end products (GWEPT)	EN IEC 60695-2-11	-
IEC 60884-1	2022	Plugs and socket-outlets for household and similar purposes - Part 1: General requirements	-	-
IEC 61000-4-2	-	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	-
IEC 61000-4-3	-	Electromagnetic compatibility (EMC) - Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN IEC 61000-4-3	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61000-4-4	-	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	-
IEC 61000-4-5	2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2014
+ A1	2017		+ A1	2017
IEC 61000-4-6	-	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN IEC 61000-4-6	-
IEC 61439-7	2022	Low-voltage switchgear and controlgear assemblies - Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations	EN IEC 61439-7	2023
IEC 61540	-	Portable residual current devices (PRCDs) without integral overcurrent protection for household and similar use	-	-
IEC 61543	2022	Residual current-operated protective devices (RCDs) for household and similar use - Electromagnetic compatibility	EN IEC 61543	2023
IEC 61851-1	2017	Electric vehicle conductive charging system - Part 1: General requirements	EN IEC 61851-1	2019
IEC 62196	series	Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 1: General requirements	EN IEC 62196	series
IEC 62196-1	2022	Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 1: General requirements	EN IEC 62196-1	2022
IEC 62262	-	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)	EN 62262	-
IEC 62368-1	2023	Audio/video, information and communication technology equipment - Part 1: Safety requirements	EN IEC 62368-1	2024
IEC 62893-3	-	Charging cables for electric vehicles for rated voltages up to and including 0,6/1 kV - Part 3: Cables for AC charging according to modes 1, 2 and 3 of IEC 61851-1 of rated voltages up to and including 450/750 V	-	-
CISPR 14-1	-	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission	-	-
ISO 178	-	Plastics - Determination of flexural properties	EN ISO 178	-

EN IEC 62752:2024 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO 179	series	Plastics - Determination of Charpy impact strength	EN ISO 179	series
ISO 2409	-	Paints and varnishes - Cross-cut test	EN ISO 2409	-
ISO 4628-3	-	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 3: Assessment of degree of rusting	EN ISO 4628-3	-
ISO 4892-2	2013	Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps	EN ISO 4892-2	2013
ISO 16750-5	2010	Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 5: Chemical loads	-	-
ISO 17409	2020	Electrically propelled road vehicles - Conductive power transfer - Safety requirements	EN ISO 17409	2020

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**IN-CABLE CONTROL AND PROTECTION DEVICE (IC-CPD) FOR MODE 2
CHARGING OF ELECTRIC ROAD VEHICLES**

FOREWORD

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IEC 62752 has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories, in co-operation with ISO TC 22/SC 37 Electrically propelled vehicles. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016, and Amendment 1:2018. This edition constitutes a technical revision.

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

- Subclause 8.3.1 revised to add requirements for a mandatory control device that detects the temperature of the current carrying parts in the household plug;
- Test requirements added in a new Subclause 9.36 for the temperature control device;
- Harmonization of EMC requirements with new edition of IEC 61543 and IEC 61851-21-2;
- General improvement of test and requirements.

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

Draft	Report on voting
23E/1342/FDIS	23E/1346/RVD

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

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

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

In this document, the following print types are used:

- Requirements proper, in roman type;
- *Test specifications, in italic type;*
- NOTES, in smaller roman type.

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

- reconfirmed,
- withdrawn, or
- revised.

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

INTRODUCTION

The essential purpose of this document is the safe and reliable access of electric vehicles to a supply system. The definition for "mode 2 charging of electric vehicle" is described in IEC 61851-1.

For all charging modes, protection against electric shock in case of failure of basic protection and/or fault protection is provided, at least by a type A residual current device (RCD) (see IEC 60364-7-722 and IEC 61851-1).

For mode 2 charging, including the situation where it cannot be guaranteed that the installation is equipped with RCDs, for example charging the electric vehicle at an unknown installation, a dedicated protection is used for the connected electric vehicle. The intention of this document is to describe the relevant requirements for an in-cable control and protection device (IC-CPD) to be used for mode 2 charging.

This version of IEC 62752 covers also the content of the former IEC 62335.

IN-CABLE CONTROL AND PROTECTION DEVICE (IC-CPD) FOR MODE 2 CHARGING OF ELECTRIC ROAD VEHICLES

1 Scope

This International Standard applies to in-cable control and protection devices (IC-CPDs) for mode 2 charging of electric road vehicles, hereafter referred to as "IC-CPD", including control and safety functions.

This document applies to portable devices performing simultaneously the functions of detection of the residual current, of comparison of the value of this current with the residual operating value and of opening of the protected circuit when the residual current exceeds this value.

The IC-CPD according to this document

- provides a control pilot function in accordance with IEC 61851-1:2017, Annex A;
- checks supply conditions and prevents charging in the event of supply faults under specified conditions;
- can have a switched protective conductor.

Residual currents with frequencies different from the rated frequency, DC residual currents and specific environmental situations are considered.

This document is applicable to IC-CPDs performing the safety and control functions as required in IEC 61851-1 for mode 2 charging of electric vehicles.

This document is applicable to IC-CPDs for single-phase circuits not exceeding 250 V or multi-phase circuits not exceeding 480 V, their maximum rated current being 32 A.

This document is applicable to IC-CPDs to be used in AC circuits only, with preferred values of rated frequency 50 Hz, 60 Hz or 50/60 Hz. IC-CPDs according to this document are not intended to be used for bidirectional or reverse power transfer, feeding back energy to the system for distribution of electricity.

This document is applicable to IC-CPDs having a rated residual operating current not exceeding 30 mA and which are intended to provide additional protection for the circuit downstream of the IC-CPD as it cannot be guaranteed that the upstream installation is equipped with an RCD rated $I_{\Delta n} \leq 30$ mA.

The IC-CPD consists of:

- a plug for connection to a socket-outlet in the fixed installation;
- one or more subassemblies containing the control and protection features;
- a cable between the plug and the subassemblies (optional);
- a cable between the subassemblies and the vehicle connector (optional);
- a vehicle connector for connection to the electric vehicle.

For plugs for household and similar use the respective requirements of the national standard and specific requirements defined by the national committee of the country where the product is placed on the market apply. If no national requirements exist, IEC 60884-1 applies. For industrial plugs IEC 60309-2 applies. For specific applications and areas non-interchangeable industrial plugs can be used. In this case IEC 60309-1 applies.

Plugs, connectors and cables which are part of the IC-CPD are tested according to relevant product standards.

The switching contacts of the IC-CPD are not intended to provide an isolation function, as isolation can be ensured by disconnecting the plug.

The IC-CPD is not considered to be a protective device for use in fixed installations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60068-2-5:2018, *Environmental testing – Part 2-5: Tests – Test S: Simulated solar radiation at ground level and guidance for solar radiation testing and weathering*

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

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

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

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

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

IEC 60068-3-4, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750 V*

IEC 60309-1:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes – Part 1: General requirements*

IEC 60309-2, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes – Part 2: Dimensional compatibility requirements for pin and contact-tube accessories*

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60384-14:2023, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

IEC 60417, *Graphical symbols for use on equipment* (available at: <https://www.graphical-symbols.info/equipment>)

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

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 60664-3, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

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 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end products (GWEPT)*

IEC 60884-1:2022, *Plugs and socket-outlets for household and similar purposes – Part 1: General requirements*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-5:2014/AMD1:2017

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61439-7:2022, *Low-voltage switchgear and controlgear assemblies – Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations*

IEC 61540, *Portable residual current devices (PRCDs) without integral overcurrent protection for household and similar use*

IEC 61543:2022, *Residual current-operated protective devices (RCDs) for household and similar use – Electromagnetic compatibility*

IEC 61851-1:2017, *Electric vehicle conductive charging system – Part 1: General requirements*

IEC 62196 (all parts), *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles*

IEC 62196-1:2022, *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 1: General requirements*

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

IEC 62368-1:2023, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62893-3, *Charging cables for electric vehicles for rated voltages up to and including 0,6/1 kV – Part 3: Cables for AC charging according to modes 1, 2 and 3 of IEC 61851-1 of rated voltages up to and including 450/750 V*

CISPR 14-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

ISO 178, *Plastics – Determination of flexural properties*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

ISO 2409, *Paints and varnishes – Cross-cut test*

ISO 4628-3, *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting*

ISO 4892-2:2013, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 16750-5:2010, *Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 5: Chemical loads*

ISO 17409:2020, *Electrically propelled road vehicles – Conductive power transfer – Safety requirements*

3 Terms and definitions

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

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

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

NOTE 1 Where the terms "voltage" and "current" are used, they imply RMS values, unless otherwise specified.

NOTE 2 Throughout this document, the word "earthing" is used for "protective earthing".

NOTE 3 The term "accessory" is used as a general term covering plugs, socket-outlets, vehicle connectors and vehicle inlets.

3.1 Terms and definitions relating to plugs and socket-outlets

3.1.1

plug

accessory having pins designed to engage with the contacts of a socket-outlet

Note 1 to entry: A plug allows the manual connection and disconnection of an electrical load to an electrical supply by an ordinary person.

[SOURCE: IEC 60884-1:2022, 3.1, modified – Notes to entry 2 to 4 deleted.]

3.1.2

interconnecting plug

accessory having pins designated to engage with the contacts of an interconnecting socket-outlet and intended to be accessible to the user for the express purpose of interchange of parts of the IC-CPD

3.1.3

socket-outlet

accessory having socket-contacts designed to engage with the pins of a plug

[SOURCE: IEC 60884-1:2022, 3.2, modified – Notes to entry 1 and 2 deleted.]

3.1.4

interconnecting socket-outlet

accessory having contacts designated to engage with the pins of an interconnecting plug and intended to be accessible to the user for the purpose of interchange of parts of the IC-CPD

3.1.5

non-rewirable accessory

accessory so constructed that it forms a complete unit with the flexible cable after connection and assembly by the manufacturer of the accessory

3.1.6

rewirable accessory by manufacturer

accessory so constructed that the flexible cable can be replaced by the manufacturer only

Note 1 to entry: The accessory is so constructed that it can only be rewired, repaired or replaced by the manufacturer's authorized personnel, its agent or similar qualified person.

3.1.7

vehicle connector

electric vehicle connector

part integral with, or intended to be attached to, one flexible cable

[SOURCE: IEC 62196-1:2022, 3.56]

3.1.8

vehicle inlet

electric vehicle inlet

part incorporated in, or fixed to, the electric vehicle

[SOURCE: IEC 62196-1:2022, 3.57, modified – Note to entry omitted.]

3.1.9

pluggable, adj.

electrical connection which is intended to be plugged or unplugged by the end-user

3.1.10

portable device

device that is capable of being carried by one person and that may be carried within the electric vehicle

3.1.11

adaptor

portable accessory constructed as an integral unit incorporating both a plug portion and a socket-outlet portion

[SOURCE: IEC 60050-442:1998, 442-03-19, modified – The domain "for accessories" has been omitted, and in the definition, "one or more socket-outlet portions" replaced with "a socket-outlet portion".]

3.1.12

direct plug-in equipment

equipment in which the plug forms an integral part of the function box enclosure

3.2 Terms and definitions relating to terminals

3.2.1

clamping unit

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

[SOURCE: IEC 60999-1:1999, 3.1]

3.2.2

terminal

conductive part of one pole, composed of one or more clamping unit(s) and insulation if necessary

[SOURCE: IEC 60999-1:1999, 3.2]

3.2.3

termination

part of an accessory to which a conductor is permanently attached

[SOURCE: IEC 60050-442:1998, 442-06-06]

3.2.4

screw-type terminal

terminal for the connection and subsequent disconnection of a conductor or for the interconnection of two or more conductors capable of being dismantled, the connection being made, directly or indirectly, by means of screws or nuts of any kind

3.2.5

screwless terminal

connecting terminal for the connection and subsequent disconnection of one conductor or the dismountable interconnection of two or more conductors capable of being dismantled, the connection being made, directly or indirectly, by means of springs, wedges, eccentrics or cones, etc., without special preparation of the conductor other than removal of insulation

3.3 Terms and definitions relating to residual current functions

3.3.1 Terms and definitions relating to currents flowing from live parts to earth

3.3.1.1

earth leakage current

current flowing from the live parts of the installation to earth in the absence of an insulation fault

3.3.1.2**pulsating direct current**

current of pulsating waveform which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0,006 A DC during one single interval of time, expressed in angular measure, of at least 150°

3.3.1.3**current delay angle** α

time, expressed in angular measure, by which the starting instant of current conduction is delayed by phase control

3.3.1.4**supply failure**

- open neutral;
- open line(s)

Note 1 to entry: See 3.3.3.16 for hazardous live protective conductor.

3.3.1.5**smooth direct current**

direct current which is ripple free

3.3.1.6**composite current**

current which consists of more than one significant sinusoidal frequency

3.3.2 Terms and definitions relating to the energization of the residual current function**3.3.2.1****residual current** I_{Δ}

vector sum of the instantaneous values of the current flowing in the main circuit of the residual current function (expressed as RMS value)

3.3.2.2**residual operating current**

value of residual current which causes the residual current function to operate under specified conditions

3.3.2.3**residual non-operating current**

value of residual current at which and below which the residual current function does not operate under specified conditions

3.3.3 Terms and definitions relating to the operation and to the functions of the IC-CPD**3.3.3.1****residual current function**

function incorporating the means of detection of a residual current, of comparison of its value to the residual current operating value and of opening the protected circuit when the residual current exceeds the residual current operating value

3.3.3.2

IC-CPD

in-cable control and protection device

assembly of linked parts or components including cables, plug and vehicle connector for supplying electric vehicles in charging mode 2, which performs control functions and safety functions

Note 1 to entry: For the use of the IC-CPD, see Figure 30.

Note 2 to entry: See Annex E for example of IC-CPD for mode 2 charging.

3.3.3.3

switching device

device designed to make or break the current in one or more electric circuits

3.3.3.4

break-time

time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles of an IC-CPD

3.3.3.5

closed position

position in which the predetermined continuity of the main circuit of the IC-CPD is secured

3.3.3.6

open position

position in which the predetermined clearance between open contacts in the main circuit of the IC-CPD is secured

3.3.3.7

pole

part of an IC-CPD associated exclusively with one electrically separated conducting path of its main circuit provided with contacts intended to connect and disconnect the main circuit itself and excluding those portions which provide a means for mounting and operating the poles together

3.3.3.8

main circuit

all conductive parts of an IC-CPD included in the current paths

3.3.3.9

control circuit

circuit (other than a path of the main circuit) intended for the closing operation or the opening operation, or both, of an IC-CPD

Note 1 to entry: See Figure E.1.

3.3.3.10

test device

device incorporated in the IC-CPD simulating the residual current conditions for the operation of the IC-CPD under specified conditions

3.3.3.11

IC-CPD type LNSE/LLSE

LNSE/LLSE type

device with a switched protective conductor that is used on a line (phase) to neutral supply (L, N, PE) and used on a line (phase) to a line or phase supply (L1, L2, PE)

Note 1 to entry: See Annex D for examples.

3.3.3.12**IC-CPD type LLLNSE****LLLNSE type**

device with a switched protective conductor that is used on a multiphase supply (L1, L2, L3, N, PE)

Note 1 to entry: A type LLLNSE IC-CPD uses one or more phases of a multiphase supply, e.g., LLNSE.

3.3.3.13**IC-CPD type LNE/LLE****LNE/LLE type**

device with a non-switched protective conductor that is used on a line (phase) to neutral supply (L, N, PE) and on a line (phase) to a line or phase supply (L1, L2, PE)

3.3.3.14**IC-CPD type LLLNE****LLLNE type**

device with a non-switched protective conductor that is used on a multiphase supply (L1, L2, L3, N, PE)

Note 1 to entry: A type LLLNE IC-CPD uses one or more phases of a multiphase supply, e.g., LLNE.

3.3.3.15**protective conductor****PE**

conductor provided for purposes of safety, for example protection against electric shock

[SOURCE: IEC 60050-195:2021, 195-02-09, modified – Abbreviated term "PE" added, and in the definition, "electrical safety" replaced with "safety" and "for example protection against electric shock" added.]

3.3.3.16**hazardous live protective conductor**

miswiring or fault condition where the protective contact of the socket outlet is live

Note 1 to entry: See 3.3.1.4 for supply failure.

3.3.3.17**control pilot function controller****CPFC**

device in the EV supply equipment and the EV responsible for the control pilot function and the generation of the PWM signal

Note 1 to entry: See Figure E.1.

[SOURCE: IEC 61851-1:2017, 3.3.4, modified – Note to entry added.]

3.3.3.18**switching function**

device to switch power and/or protective conductor to the EV to provide charging

Note 1 to entry: See Figure E.1.

3.3.4 Terms and definitions relating to values and ranges of energizing quantities**3.3.4.1****non-operating overcurrent**

maximum value of overcurrent of a single-phase load in the main circuit which, in the absence of any fault to frame or to earth, and in the absence of an earth leakage current, can flow through a two-pole IC-CPD without causing the IC-CPD to open the circuit

3.3.4.2

residual short-circuit withstand current

maximum value of the residual current for which the operation of the IC-CPD is ensured under specified conditions and above which the device may be damaged

3.3.4.3

prospective current

current that would flow in the circuit, if each main current path of the IC-CPD and of the overcurrent protective device (if any) were replaced by a conductor of negligible impedance

Note 1 to entry: This definition applies also in the same manner as an actual current, for example prospective breaking current, prospective peak current, prospective residual current.

3.3.4.4

making capacity

value of the AC component of a prospective current that an IC-CPD is capable of making at a stated voltage under prescribed conditions of use and behaviour

3.3.4.5

breaking capacity

value of the AC component of a prospective current that an IC-CPD is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.3.4.6

residual making and breaking capacity

value of the AC component of a residual prospective current which an IC-CPD can make, carry for its opening time and break under specified conditions of use and behaviour

3.3.4.7

conditional short-circuit current

value of the AC component of a prospective current, which an IC-CPD protected by a suitable short-circuit protective device (SCPD) in series can withstand under specified conditions of use and behaviour

3.3.4.8

conditional residual short-circuit current

value of the AC component of a residual prospective current which an IC-CPD, protected by a suitable SCPD in series, can withstand under specified conditions of use and behaviour

3.3.4.9

U_x

limiting value of the line voltage for an IC-CPD to perform its intended functions as declared by the manufacturer for the IC-CPD

3.3.4.10

I^2t

joule integral

integral of the square of the current, over a given time interval (t_0 , t_1):

$$I^2t = \int_{t_0}^{t_1} I^2 dt$$

3.3.4.11

recovery voltage

voltage which appears across the supply connections of an IC-CPD after the breaking of the current

Note 1 to entry: This voltage comprises two successive intervals of time, one during which a transient voltage exists, followed by a second one during which power-frequency voltage alone exists.

3.3.4.11.1

transient recovery voltage

recovery voltage during the time in which it has a significant transient character

Note 1 to entry: The transient voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and of the IC-CPD.

3.3.4.11.2

power-frequency recovery voltage

recovery voltage after the transient voltage phenomena have subsided

3.3.5 Terms and definitions relating to values and ranges of influencing quantities

3.3.5.1

influencing quantity

any quantity likely to modify the specified behaviour of an IC-CPD

3.3.5.2

ambient air temperature

temperature, determined under the prescribed conditions, of the air surrounding the IC-CPD

3.3.6 Terms and definitions relating to conditions of operation

3.3.6.1

operation

transfer of the moving contact(s) from the open position to the closed position or vice versa

Note 1 to entry: If distinction is necessary, an operation in the electrical sense (e.g., make or break) is referred to as a switching operation and an operation in the mechanical sense (e.g. close or open) is referred to as a mechanical operation.

3.3.6.2

closing operation

operation by which the IC-CPD is brought from the open position to the closed position

3.3.6.3

opening operation

operation by which the IC-CPD is brought from the closed position to the open position

3.3.6.4

operating cycle

succession of operations from one position to another and back to the first position

3.3.6.5

sequence of operations

succession of specified operations with specified time intervals

3.3.7 Terms and definitions relating to control functions between electric vehicle and IC-CPD

3.3.7.1

system state

state that indicates different states during the charging process according to IEC 61851-1:2017, Annex A

EXAMPLE Connected, ready to charge, charging.

3.3.7.2

control pilot conductor

insulated conductor incorporated in a cable assembly, which, together with the protective conductor, is part of the control pilot circuit

[SOURCE: IEC 61851-1:2017, 3.3.1]

3.3.7.3

control pilot function

function used to monitor and control the interaction between the EV and the function box

[SOURCE: IEC 61851-1:2017, 3.3.3, modified – "EV supply equipment" replaced by "function box".]

3.4 Terms and definitions relating to tests

3.4.1

type test

test of one or more devices made to a certain design to show that the design meets certain requirements

3.4.2

routine test

test to which each individual device is subjected during and/or after manufacture to ascertain whether it complies with certain criteria

3.4.3

self-test

automatically initiated verification of the ability of the IC-CPD to detect a residual current

3.5 Terms and definitions relating to construction

3.5.1

function box

control functions and/or safety functions integrated in appropriate enclosures which are part of the IC-CPD

3.5.2

class I equipment

equipment with basic insulation as provision for basic protection and protective bonding as provision for fault protection

4 Classification

4.1 According to the supply

4.1.1 General

An IC-CPD can be classified to be compatible with more than one supply system.

4.1.2 IC-CPD supplied from one phase and neutral and from two phases (LNSE/LLSE or LNE/LLE)

IC-CPDs according to this classification are supplied from one phase and neutral and from two phases.

4.1.3 IC-CPD supplied from three phases and neutral (LLLNE or LLLNE)

IC-CPDs according to this classification are supplied from three phase and neutral.

NOTE This classification covers IC-CPDs using one or more phases of a multiphase supply, e.g., LLNSE, LLNE.

4.2 According to the construction

4.2.1 General

An IC-CPD can be classified according to one of the following constructions (see Annex F for types of IC-CPD according to construction and assembly).

4.2.2 IC-CPD including the function box separated from the plug and vehicle connector

Residual current function, switching device and control pilot function integrated into a function box between the plug and the vehicle connector (see Figure F.1).

4.2.3 Modular IC-CPD

A modular IC-CPD can be one of the following constructions:

- a) residual current function and switching device integrated into the plug and control pilot function controller integrated into a separate function box between the plug and the vehicle connector (see Figure F.2);
- b) residual current function and switching device integrated into the plug and control pilot function controller integrated into the vehicle connector (see Figure F.3).

NOTE An additional switching device in series related to the control pilot function can be placed outside the plug portion.

4.3 According to the method of connecting the cable(s)

4.3.1 General

Cables in-between different components of the IC-CPD can be connected to these components by different methods. If in one cord set different connection methods are used the IC-CPD shall be classified according to all methods used and the different parts shall be declared separately.

4.3.2 Non-rewirable IC-CPDs

The IC-CPD or the declared part is provided as a fully functional cord set including all components. Cables in-between plug, in-cable housing (if any) and vehicle connectors are not intended to be replaced or exchanged by the user or others after connection and assembly by the manufacturer.

4.3.3 IC-CPDs wired by the manufacturer

Access to connections of the IC-CPD or to declared parts for the purposes of replacement shall be by use of a special tool only.

The IC-CPD is provided as a fully functional cord set or alternatively only the unit(s) containing the residual current function and the control pilot function are provided (see 3.1.6).

4.3.4 Pluggable IC-CPD

The IC-CPD or the declared part includes at least one interconnecting plug and interconnecting socket-outlet combination.

4.4 Classification according to the protective conductor path

4.4.1 General

An IC-CPD can be classified to have a switched or a non-switched protective conductor.

4.4.2 IC-CPDs with switched protective conductor

This classification covers IC-CPDs which have a switched protective conductor.

4.4.3 IC-CPDs with non-switched protective conductor

This classification covers IC-CPDs which have a non-switched protective conductor.

4.5 Classification according to the verification of availability of the upstream protective conductor

4.5.1 General

An IC-CPD can be classified according to its behaviour related to the availability of the upstream protective conductor.

4.5.2 IC-CPD with verification of the availability of the upstream protective conductor

An IC-CPD classified under this Subclause 4.5.2 is able to detect the presence and continuity of the protective conductor upstream of the socket-outlet. In IT-systems it may be the case that these devices cannot be used, as if they are used, the protective conductor verification will not be successful.

An IC-CPD classified according to 4.5.2 can have a function to deactivate the verification check of the availability of the upstream protective conductor. After plugging into a socket outlet, it shall be indicated for at least 30 s by a visual or audible signal that the detection function is deactivated. If the detection function is deactivated after plugging in, this shall be indicated in the same manner.

4.5.3 IC-CPD without verification of the availability of the upstream protective conductor

IC-CPD not detecting the presence and continuity of the protective conductor upstream of the socket-outlet. These devices are also suitable for use in IT-systems.

4.6 Classification according to the usage

4.6.1 IC-CPD for portable use

IC-CPD that can be used as a portable device.

4.6.2 IC-CPD for wall mounting

IC-CPD designed to be used only when hung in the intended operating position. Such devices can be easily removed from their hanging location.

NOTE This classification includes all positions in a height giving the same degree of protection as wall mounting, for example mounted on ceiling, pillars, etc.

4.6.3 IC-CPD for portable use and for wall mounting

IC-CPD that can be used both as a portable device and when hung in the intended operating position. Such devices can be easily removed from their hanging location.

5 Characteristics of IC-CPDs

5.1 Summary of characteristics

IC-CPDs are provided with switching contacts for line(s) and neutral, if applicable. IC-CPDs according to 4.4.2 are provided with a switching contact for the protective conductor.

IC-CPDs have a defined residual current operation function. This function provides protection against electric shock for the connected electric vehicle in case of failure of basic protection and/or fault protection in accordance with IEC 61851-1.

The residual current function of the IC-CPD shall be ensured:

- for residual sinusoidal alternating currents and residual pulsating direct currents;
- for a residual pulsating direct current superimposed on a smooth DC residual current up to 6 mA;
- for composite residual currents intended for circuits supplied between phase and neutral;
- with or without phase angle control, independent of polarity, whether suddenly applied or slowly rising.

In addition, IC-CPDs shall have a defined behaviour in case of supply failures or miswiring according to 9.7.6.

In addition, the IC-CPD:

- checks by means of the control pilot circuit/function electrical continuity of the protective conductor between the IC-CPD and the EV,
- trips if the DC residual current exceeds 6 mA,
- verifies that the electric vehicle is properly connected,

NOTE Proper connection is assumed when the continuity of the control pilot circuit is detected.

- switches on or off in response to the states according to IEC 61851-1:2017, Annex A.

5.2 Rated quantities and other characteristics

5.2.1 Rated voltages

5.2.1.1 Rated operational voltage (U_e)

The value of voltage or the voltage range, assigned by the manufacturer, to which the performance of the IC-CPD is referred.

NOTE The same IC-CPD can be assigned to more than one rated voltage.

5.2.1.2 Rated insulation voltage (U_i)

The value of voltage, assigned by the manufacturer, to which dielectric test voltages and creepage distances of the IC-CPD are referred.

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the IC-CPD. In no case shall the maximum rated voltage exceed the rated insulation voltage.

5.2.2 Rated current (I_n)

The value of current, assigned to the IC-CPD by the manufacturer, which the IC-CPD can carry under permanent load conditions.

5.2.3 Rated residual operating current ($I_{\Delta n}$)

The value of residual operating current (see 3.3.2.2), assigned to the IC-CPD by the manufacturer, at which the IC-CPD shall operate under specified conditions.

5.2.4 Rated residual non-operating current ($I_{\Delta no}$)

The value of residual non-operating current (see 3.3.2.3), assigned to the IC-CPD by the manufacturer, at which the IC-CPD does not operate under specified conditions.

5.2.5 Rated frequency

The power frequency for which the IC-CPD is designed and to which the values of the other characteristics correspond.

The same IC-CPD may be assigned to more than one rated frequency.

5.2.6 Rated making and breaking capacity (I_m)

The RMS value of the AC component of prospective current (see 3.3.4.3), assigned by the manufacturer, which an IC-CPD can make, carry and break under specified conditions.

The conditions are those specified in 9.9.2.2.

5.2.7 Rated residual making and breaking capacity ($I_{\Delta m}$)

The RMS value of the AC component of residual prospective current (see 3.3.2.1 and 3.3.4.3), assigned by the manufacturer, which an IC-CPD can make, carry and break under specified conditions.

The conditions are those specified in 9.9.2.3.

5.2.8 Operating characteristics in case of residual currents comprising a DC component

The operating characteristics of an IC-CPD are such that tripping is ensured for residual sinusoidal alternating currents, residual pulsating direct currents and smooth residual direct currents exceeding 6 mA, whether suddenly applied or slowly rising.

5.2.9 Insulation coordination including creepage distances and clearances

Creepage and clearance distances are given in 8.4.3.

5.2.10 Coordination with short-circuit protection devices (SCPDs)

5.2.10.1 General

Coordination between IC-CPDs and SCPDs shall be verified under the general conditions of 9.9.2.1, by means of the tests described in 9.9.2.4 which verify that there is adequate protection against currents up to the rated conditional short-circuit current I_{nc} and up to the rated conditional residual short-circuit current $I_{\Delta c}$.

5.2.10.2 Rated conditional short-circuit current (I_{nc})

The RMS value of prospective current, assigned by the manufacturer, which an IC-CPD protected by an SCPD can withstand under specified conditions without undergoing alterations impairing its functions. The conditions are those specified in 9.9.2.4 a).

5.2.10.3 **Rated conditional residual short-circuit current ($I_{\Delta c}$)**

The value of residual prospective current, assigned by the manufacturer, which an IC-CPD, protected by an SCPD, can withstand under specified conditions without undergoing damage. The conditions are those specified in 9.9.2.4 c).

5.3 **Standard and preferred values**

5.3.1 **Preferred values of rated operational voltage (U_e)**

Preferred values of rated voltage are 120 V, 230 V, 400 V and 480 V.

Wherever in this document there is a reference to "230 V", it may be read as "220 V" or "240 V". Whenever in this document there is a reference to "400 V", it may be read as "380 V" or "415 V".

Wherever in this document there is a reference to "120 V" or "120/240 V" or "240 V", they may be read as "100 V" or "100/200 V" or "200 V", respectively.

Wherever in this document there is a reference to "240 V three phases", it may be read as "100 V" or "120/208 V".

The rated operational voltage of the IC-CPD shall not be higher than the rated voltage of the plug.

5.3.2 **Preferred values of rated current (I_n)**

The preferred values of the rated current are indicated in Table 1.

Table 1 – Preferred values of rated current and corresponding preferred values of rated voltages

Type	Rated voltage V	Rated current A
Three-phase systems	480 ^a	6, 8, 10, 13, 15, 16, 20, 24, 30, 32
	400	6, 8, 10, 13, 15, 16, 20, 25, 32
	240	15, 20, 30
Single- and two-phase systems	230	6, 8, 10, 13, 15, 16, 20, 25, 30, 32
	120	6, 8, 10, 12, 15, 16, 20, 30, 32.
^a Only for mid-point or star-point earthed systems with voltage to earth 240 V or 277 V, as applicable.		

If the IC-CPD supports simplified control pilot circuit the rated current shall be 10 A or higher.

NOTE In some countries, the simplified control pilot circuit is not allowed: US

The rated current of an IC-CPD classified according to 4.3.2 or 4.3.3 shall not exceed the rated current of the plug.

5.3.3 **Standard values of rated residual operating current ($I_{\Delta n}$)**

Standard values of rated residual operating current are:

0,006 A – 0,01 A – 0,015 A – 0,02 A – 0,03 A.

5.3.4 Standard value of rated residual non-operating current ($I_{\Delta no}$)

The standard value of alternating residual non-operating current is $0,5 I_{\Delta n}$.

If for IC-CPD according to 4.4.2 the protective conductor is passed with more turns than the live conductors through the current transformer on a $I_{\Delta n} = 30$ mA device this value may be reduced to $0,25 I_{\Delta n}$.

5.3.5 Standard minimum value of the non-operating overcurrent through the IC-CPD

The standard minimum value of the non-operating overcurrent through the IC-CPD is $4 I_n$.

5.3.6 Preferred values of rated frequency

Preferred values of rated frequency are 50 Hz, 60 Hz or 50/60 Hz.

5.3.7 Minimum value of the rated making and breaking capacity (I_m)

The minimum value of the rated making and breaking capacity I_m is 100 A.

5.3.8 Minimum value of the rated residual making and breaking capacity ($I_{\Delta m}$)

The minimum value of the rated residual making and breaking capacity is 100 A.

5.3.9 Standard value of the rated conditional short-circuit current (I_{nc})

The standard value of the rated conditional short-circuit current is 1 500 A.

5.3.10 Standard value of the rated conditional residual short-circuit current ($I_{\Delta c}$)

The standard value of the rated conditional residual short-circuit current is 1 500 A.

5.3.11 Limit values of break time

The limit values of break time are given in Table 2 for AC residual currents, in Table 3 for smooth DC residual currents and in Table 4 for residual pulsating direct currents which may result from rectifying circuits supplied from two or three phases.

Table 2 – Limit values of break time for AC residual currents at rated frequency

Limit values of break time at a residual current (I_{Δ}) equal to			
s			
$I_{\Delta n}$	$2 I_{\Delta n}$	$5 I_{\Delta n}$	5 A, 10 A, 20 A, 50 A, 100 A ^a
0,3	0,15	0,04	0,04
The maximum value of the test current should not exceed I_m .			
NOTE For operation with residual currents having a DC component, see 9.7.3.			
^a The tests at 5 A, 10 A, 20 A, 50 A and 100 A are only made during the verification of the correct operation as mentioned in 9.7.2.5.			

Table 3 – Limit values of break time for smooth DC residual currents

Limit values of break time at a DC residual current equal to		
s		
6 mA	60 mA	300 mA
10,0	0,3	0,04

Table 4 – Limit values of break time for residual pulsating direct currents which may result from rectifying circuits supplied from two or three phases

Limit values of break time at a residual pulsating direct current (I_{Δ}) equal to			
s			
$2 I_{\Delta n}$	$4 I_{\Delta n}$	$10 I_{\Delta n}$	5 A, 10 A, 20 A, 50 A
0,3	0,15	0,04	0,04

6 Marking and other product information

6.1 Data to be marked on the IC-CPD

The IC-CPD shall be marked in a durable manner with the following data:

- a) the manufacturer's or distributor's name or trademark;
- b) type designation or catalogue number;
- c) rated voltage;
- d) rated frequency, if the IC-CPD is designed for frequencies other than 50 Hz, 60 Hz or 50/60 Hz (see 5.3.6);
- e) rated current;
- f) rated residual operating current;
- g) degree of protection. The IP degree is applicable to the function box only;
- h) the marking with the name of the product: IC-CPD;
- j) IC-CPD suitable for use at a lower temperature of -25°C (see 9.7.2.8) shall be marked with , if applicable. If a lower value than -25°C is declared by the manufacturer, the declared value shall be a multiple of 5°C ; the symbol shall indicate this value;
- k) for IC-CPD according to 4.5.2, a statement that it is possible that the IC-CPD will not operate if used on IT or other unearthed systems such as an isolated winding generator or isolating transformer.



Marking with the following symbol: IEC 60417-6293 (2015-05);

A statement is not needed for an IC-CPD according to 4.5.2 with a function to deactivate the verification check of the availability of the upstream protective conductor.

This information may be on a durable label attached to the cord.

- l) value of the residual non-operating current $I_{\Delta no}$, if different from $0,5 I_{\Delta n}$;
- m) indication according to the design of the protective conductor path as follows:



- classified according to 4.4.2 with marking IEC 60417-6289 (2015-03);

- classified according to 4.4.3 with marking:  IEC 60417-6290 (2015-03);
 - The symbol may be integrated in a wiring diagram;
- n) additional information about technical data at higher altitudes, if applicable;
- o) the maximum charging current of the IC-CPD, if lower than the rated current.

For the marking of rated current and rated voltage marking, numbers alone may be used. These numbers shall be placed on one line, separated or not by an oblique line, or the number for rated current shall be placed above the number for rated voltage, separated by a horizontal line.

The marking for the nature of supply shall be placed next to the marking for rated current and rated voltage.

Examples of marking for current, voltage and nature of supply:

16 A 230 V~, or $\frac{16}{230}$ ~, or 16 A 230 V AC, or 16/230 AC, etc.

When symbols are used, they shall be as follows:

amperes	A
volts	V
alternating current	~ IEC 60417-5032 (2002-10)
neutral	N
protective earth; protective ground	 IEC 60417-5019 (2006-08)

For details of the symbols for AC and protective conductor, see IEC 60417.

The markings a), b), c), d), e), f), g), h), j), k), l), m) and o) shall be on the enclosure of the function box itself or on a nameplate or nameplates attached to the IC-CPD and shall be located so that they are visible and legible when the IC-CPD is assembled as for normal use.

Information under item k) shall also be given in the instruction sheet. This information may be given within the car manual.

Information under item n) shall be given in the instruction sheet.

Operating and indication means shall be marked in accordance with the operating instructions.

Terminals, except for IC-CPDs according to 4.3.2, shall be marked as necessary with indication "L", "N" and the symbol for protective earth; protective ground  IEC 60417-5019 (2006-08).

If it is necessary to distinguish between the supply and the load terminals, they shall be clearly marked (e.g., by "line" and "load" placed near the corresponding terminals or by arrows indicating the direction of power flow).

In addition, screwless terminals of devices according to 4.3.3 shall be marked with an appropriate marking indicating the length of insulation to be removed before the insertion of the conductor into the screwless terminal.

Marking shall be indelible, legible and shall not be placed on screws, washers or other removable parts.

Compliance is checked by inspection and by the test of 9.3.

6.2 Information to be provided to the end-user

The information to be provided to the end-user is:

- a) information for the user about the automatic process of verification for the self-test;
- b) information that the device shall not be used if it fails to operate correctly in accordance with the instructions and to seek advice from the manufacturer, responsible vendor or an electrician;
- c) information warning against storage or use beyond the service conditions given in Table 5 and against misuse such as dropping, immersion, etc.;
- d) information instructing the user that the IC-CPD shall be plugged in without the use of an adaptor except if the adaptor is part of the IC-CPD and meets the requirements of a pluggable IC-CPD;
- e) information instructing the user that the IC-CPD shall be plugged in directly into the fixed socket-outlet without the use of a cord extension set;
- f) information about the detected failures and the related indications given by the product itself in the event of failure;
- g) information that the components of a pluggable IC-CPD shall not be connected or disconnected while the IC-CPD is in use (plug is engaged in a socket-outlet or the vehicle connector is engaged in a vehicle inlet);
- h) a list of instructions about how to connect the IC-CPD to the socket-outlet and to the car, and how to store it properly. This includes the information to the user that it is recommended for the electrical installation intended for electric vehicle (EV) charging to be checked by an electrical installer;
- i) information about which components of a pluggable IC-CPD are allowed to be used in combination.

NOTE ISO/IEC Guide 37 provides information on user instructions.

Compliance is checked by inspection.

7 Standard conditions for operation in service and for installation

7.1 Standard conditions

IC-CPDs complying with this document shall be capable of operating under the standard conditions shown in Table 5.

Table 5 – Standard conditions for operation in service

Influencing quantity	Standard range of application	Reference value	Test tolerances ^e
Ambient temperature ^{a, f, h}	–25 °C to +40 °C ^b	23 °C	±5 °C
Altitude	Up to 2 000 m ^g		
Relative humidity (maximum value at 40 °C)	75 % ^c		
External magnetic field	Not exceeding five times the earth's magnetic field in any direction	Earth's magnetic field	^d
Frequency	Reference value ±5 %	Rated value	±2 %
Sinusoidal wave distortion	Not exceeding 5 %	Zero	5 %
^a The maximum value of the mean daily temperature is +35 °C. ^b Values outside this range are admissible. The declared values shall be a multiple of 5 °C. ^c Higher relative humidities are admitted at lower temperature (for example 90 % at 20 °C). ^d IC-CPDs should not be used in the proximity of a strong magnetic field. If the IC-CPD is used in proximity of a strong magnetic field, supplementary requirements may be necessary. ^e The tolerances given apply unless otherwise specified in the relevant test. ^f Extreme limits of –40 °C and 85 °C, for IC-CPDs are admissible during storage and transportation. ^g For higher altitudes it is necessary to take into account the reduction of the dielectric strength and the cooling effect of the air. Therefore, the increased clearances and creepage distances according to Table 7 shall be considered and the manufacturer shall provide additional information about technical data for use at higher altitudes. ^h If the IC-CPD is equipped with a plug according to a standard with a lower standard maximum temperature or a higher standard minimum value, then this temperature is applicable for the whole IC-CPD. For plugs according to IEC 60884-1 the maximum temperature is 35 °C, the minimum temperature is –5 °C. Domestic plugs intended to be used in ambient temperatures below –5 °C down to and including –45 °C are covered by Annex G of IEC 60884-1:2022. For plugs according to IEC 60309-1 the upper temperature is 40 °C the minimum temperature is –25 °C unless higher performances are stated by the manufacturer.			

7.2 Conditions for installations

IC-CPDs shall be used in accordance with their instructions.

8 Requirements for construction and operation

8.1 Mechanical design

IC-CPDs shall be so designed and constructed that in normal use their performance is reliable and the risk of danger to the user or surroundings, even in the case of miswiring conditions as defined in this document, is minimised.

For devices according to 4.3.2 (non-rewirable) and 4.3.4 (pluggable), it shall be verified that it is not possible to change the wiring of the device without leaving permanent and visible damage.

For devices according to 4.3.3, it shall be verified that the user cannot tamper with the IC-CPD without leaving permanent and visible evidence.

Pluggable IC-CPDs according to 4.3.4 shall be provided with a retaining means which holds accessories in position when properly engaged and prevents their unintentional withdrawal.

Pluggable IC-CPDs according to 4.3.4 shall not be operational without engaged retaining means of interconnecting plug and socket-outlet combination.

The IC-CPD shall not be functional until all mandatory functions are properly connected.

The IC-CPD, without considering plugs and vehicle connector, shall have a minimum degree of protection of IPXXD according to IEC 60529 after assembly as for normal use.

Interconnecting plugs and interconnecting socket-outlets of pluggable IC-CPDs according to 4.3.4 shall have a minimum degree of protection of IPXXB according to IEC 60529 before being connected to each other.

NOTE 1 In Norway, interconnecting plugs and interconnecting socket-outlets of pluggable IC-CPDs according to 4.3.4 shall have degree of protection of IP67 according to IEC 60529 when being connected to each other.

A maximum length of cord of 1,7 m is allowed between the plug and the function box.

If the function box(es) is (are) located more than 0,3 m away from the plug, the function box(es) shall have drive-over capability as defined in 9.32.

It is recommended that the cable length between the function box and the plug is at least 250 mm, to allow users to plug the IC-CPD into publicly accessible socket outlets protected by covers (e.g. flap, lid).

NOTE 2 Annex E of IEC 61851-1:2017 provides recommendations for space dimensions to be left around socket-outlets used for EV energy supply.

If an interconnecting plug and interconnecting socket outlet combination of a pluggable IC-CPD according to 4.3.4 is located more than 0,3 m away from the plug, that combination shall have drive-over capability in mated condition as defined in 9.32.

For IC-CPDs the protective conductor shall be coloured green and yellow.

There shall be no provision to alter the residual operating characteristics of IC-CPDs.

The plugs of the IC-CPDs shall be mechanically and electrically compatible with the socket outlet system in which they are intended to be used. The requirements of the national standard can apply. If no national requirements exist, the requirements of IEC 60884-1 shall apply for plugs for household and similar use and the IEC 60309 series shall apply for industrial plugs.

Live pins of plugs shall be of solid metal construction or a folded-over metal blade construction.

For specific applications and areas, non-interchangeable industrial plugs may be used in conjunction with the IEC 60309 series.

Where reference is made to vehicle connectors, the IEC 62196 series applies.

Compliance is checked by inspection and by tests.

8.2 Pluggable electrical connections of pluggable IC-CPDs according to 4.3.4

8.2.1 General

Connections of an IC-CPD shall be designed in such a way that only accessories fulfilling the requirements of 8.2 can be connected. Interconnecting plugs and interconnecting socket-outlets shall not be intermateable in any other way than as declared by the manufacturer. Pluggable connections in accordance with this document shall not mate with systems specified in standard sheets, for example in the standard sheets of IEC 60309 (all parts), IEC 60320 (all parts).

IEC 60906 (all parts), or with the national household plug and socket-outlet systems of the country where the product is placed on the market.

NOTE Standardized values and configurations of existing systems of plugs and socket-outlets are reported in IEC/TR 60083.

If components of an IC-CPD with different rated currents are intermateable, an automatic means which the end-user cannot influence shall be provided to limit the maximum current given by the control pilot signal of the IC-CPD to the lowest rated current of any of the components.

The connection shall meet the requirements in Clause 22 of IEC 60309-1:2021 at the minimum level of engagement of each contact specified by the manufacturer for its use at nominal current.

For pluggable electrical connections which are intended to be plugged or unplugged, replacement, fitting or exchange of components of the IC-CPD assembly shall be in accordance with the relevant requirements of IEC 60309-1 as follows:

- accessories shall provide an earthing contact and shall comply with relevant requirements and tests related to the classification 6.3 of IEC 60309-1:2021.
- non-rewirable plugs and connectors shall comply with requirements and tests related to the classification 6.4 of IEC 60309-1:2021.
- accessories shall provide a minimum of IPXXB and shall comply with requirements and tests for socket-outlets and connectors classified according to 6.8 of IEC 60309-1:2021.
- the retaining means may be rendered ineffective before the test, if agreed upon by the manufacturer.

Compliance is checked by inspection and by the tests of the relevant clauses provided for each classification.

IC-CPDs shall be constructed so that in normal use, when plug pins are touched, there is no risk of electric shock from charged capacitors that result in a capacitance equal to or greater than 0,1 μ F across any two pins. Compliance is checked by the following test. The IC-CPD is supplied at rated voltage. The IC-CPD is disconnected from the supply mains at the instant of voltage peak. One second after disconnection, the voltage between the pins of the plug is measured with an instrument having an input impedance consisting of a resistance of 100 M Ω $\pm$ 5 M Ω in parallel with an input capacitance of 25 pF or less. The voltage shall not exceed 60 V.

8.2.2 Degree of protection of pluggable electrical connection against solid foreign objects and against water for pluggable IC-CPD

All accessories shall provide for IP55 in the mated position.

All accessories shall provide for IP24 minimum in the unmated position.

8.2.3 Breaking capacity of pluggable electrical connection for pluggable IC-CPD

The breaking capacity shall be tested according to Clause 20 of IEC 60309-1:2021.

The on-load tests shall be conducted according to Clause 21 of IEC 60309-1:2021.

The number of off-load tests according to Clause 21 of IEC 60309-1:2021 shall be determined by the rated current and the corresponding number of cycles given in Table 10 of IEC 60309-1:2021.

8.3 Construction

8.3.1 General

Suspension means of the IC-CPD, if any, shall be tested according to 24.12 of IEC 60884-1:2022.

It shall not be possible to disassemble an IC-CPD classified according to 4.3.2.

Parts of the assembly classified according to 4.3.3 shall be securely assembled and it shall not be possible to disassemble them without the aid of a special tool.

Except for the pluggable connections of IC-CPDs classified according to 4.3.4, it shall not be possible to disassemble the IC-CPD without the aid of a special tool.

The control pilot function controller shall not be able to close the switching device in the event of:

- single fault inside the control pilot function controller, or
- single fault of the control circuit of the switching device, or
- after residual current fault without a reset of the IC-CPD.

Under single fault conditions of the control pilot function (PWM), no critical overload situation shall appear.

Compliance is checked by fault analysis provided by the manufacturer (e.g. FMEA).

If the IC-CPD is fitted with a household plug, the IC-CPD shall be equipped with a control device that detects the temperature of the current carrying parts in the plug.

If the temperature of the current carrying parts in the plug reaches 70 °C, the IC-CPD shall switch off within 10 s.

The current carrying parts in the plug shall not exceed 70 °C.

NOTE 1 New charging sequences can be initiated by disconnecting and connecting the plug of the IC-CPD again. There are other options to initiate a new charging sequence, which are not covered by this note.

The temperature sensors shall be selected according to the expected accuracy and foreseeable temperature range for the measurement and shall be placed in the relevant location in the plug for a proper measurement of the temperature of the current carrying parts.

NOTE 2 In France, according to the Decree n°2021-546 of 4th May 2021, the charging current is limited to 8 A by the EV supply equipment or to the declared rating when using dedicated plugs and socket-outlets for EV charging according to NF C61-314.

NOTE 3 In the UK and in IE a control device for monitoring the plug temperature is not required. In the UK and in IE the maximum charging current shall be 13 A. Plugs shall comply with BS 1363-1, classified as suitable for EV charging and marked BS 1363-1/EV.

NOTE 4 In Austria, an IC-CPD equipped with a household plug according to OVE E 8684-1 with a rated current of 16 A can carry a permanent load of 10 A maximum.

NOTE 5 In Germany, if the IC-CPD is equipped with a household plug according to DIN VDE 0620-2-1:2021, the permanent charging current shall be limited to ≤ 10 A

NOTE 6 In Denmark, for IC-CPDs supplied with a plug for household and similar use, repeated continuous loads of long duration, shall be limited to 6 A.

NOTE 7 In Denmark, the requirements in this document cannot replace or change any part of the Danish National requirements for plugs for household and similar use according to DS 60884-2-D1.

NOTE 8 In Italy, the use of IEC 60309-2 accessories is recommended for Mode 2 connections for more than 10 A.

NOTE 9 In Norway, if the IC-CPD is equipped with a household plug according to NEK 502 (valid edition), the permanent charging current shall be limited to ≤ 10 A.

In the event of failure of the thermal control device the charging shall stop or not be possible.

Compliance is checked by the tests of 9.36.

Plugs of IC-CPD shall be non-rewirable.

Vehicle connectors and the connection to their cables shall be non-rewirable or rewirable by the manufacturer. The connection between a vehicle connector and its cable shall not be pluggable.

Compliance is checked by inspection.

8.3.2 Terminations of IC-CPDs

Terminations of IC-CPDs shall be so located or protected that they cannot create a dangerous situation.

Compliance is checked by the test of 9.4.

8.3.3 Enclosure of IC-CPDs according to 4.3.3

The enclosure of IC-CPDs according to 4.3.3 shall completely enclose the terminals and the ends of flexible cables and cords.

The construction shall be such that the conductors can be properly connected and such that, when the accessory is wired and assembled as for normal use, there is no risk that:

- the conductors are pressed against each other,
- a core, the conductor of which is connected to a live terminal, comes into contact with accessible metal parts,
- a core, the conductor of which is connected to the earthing terminal, comes into contact with live parts.

Compliance is checked by inspection and by manual test.

8.3.4 Terminal screws or nuts of IC-CPDs according to 4.3.3

The IC-CPD shall be so designed that terminal screws or nuts cannot become loose and fall out of position in such a way that they establish an electrical connection between live parts and the earthing terminal or metal parts connected to the earthing terminal.

Compliance is checked by inspection and by manual test.

8.3.5 Strain on the conductors of IC-CPDs according to 4.3.3

IC-CPDs according to 4.3.3 shall be designed with ample space for slack of the earthing conductor in such a way that, if the strain relief should fail, the connection of the earthing conductor is subjected to strain after the connections of the current-carrying conductors and such that, in case of excessive stresses, the earthing conductor will break after the live conductors. Control pilot conductor or similar conductors are not considered as live conductors.

Compliance is checked by the test of 9.21.

8.3.6 Additional requirements for IC-CPDs according to 4.3.3

For IC-CPDs according to 4.3.3 the following additional requirements apply:

- it shall be clear how the strain relief and the prevention of twisting is intended to be effected;
- the cord anchorage, or at least part of it, shall be integral with or permanently fixed to one of the component parts;
- makeshift methods, such as tying the cable or cord in a knot or tying the ends with string, shall not be used;
- cord anchorages shall be suitable for the different types of flexible cable or cord which may be connected, and their effectiveness shall not depend upon the assembly of the parts of the body;
- cord anchorages shall be of insulating material or be provided with an insulating lining fixed to the metal parts,
- metal parts of the cord anchorage, if any, including clamping screws, shall be insulated from the earthing circuit.

Compliance is checked by inspecting the construction and documents provided by the manufacturer.

8.3.7 Insulating parts which retain live parts in position

Insulating parts inside the IC-CPD which retain live parts in position shall be reliably fixed.

Compliance is checked by inspection and by the test of 9.35.

8.3.8 Screws for IC-CPD according to 4.3.3

The use of tight-fitting washers of cardboard or the like is deemed to be an adequate method for securing screws which are to be captive.

Compliance is checked by inspection.

8.3.9 Means for suspension from a wall or other mounting surfaces

An IC-CPD with means for suspension shall fulfil the requirements for protection against electric shock according to 8.5 in the mounted and in the unmounted position.

Compliance is checked by inspection.

8.3.10 Plug as an integral part of direct plug-in equipment

The direct plug-in equipment shall not cause overheating of the pins.

Compliance is checked by the tests of 9.6.

The direct plug-in equipment in accordance with 4.2.3 shall not impose undue strain on fixed socket-outlets.

For an IC-CPD with a plug for household and similar use compliance is checked by the test of 9.22.

8.3.11 Flexible cables and cords and their connection

8.3.11.1 Cord anchorage

Any part of IC-CPD according to 4.3.3 and 4.3.4, if relevant, shall be provided with a cord anchorage such that the conductors are relieved from strain, including twisting, when they are connected to the terminals or terminations, and their covering is protected from abrasion.

The sheath, if any, of the cord shall be clamped within the cord anchorage.

Compliance is checked by inspection and by the test of 9.23.

8.3.11.2 Minimum cross-sectional area of flexible cable or cords

IC-CPDs shall be provided with a flexible copper cable providing equivalent protection against electric shock as class II complying with the IEC 60227 series, or IEC 60245 series or IEC 62893-3, as applicable.

NOTE EN 50620:2017 and EN 50620:2017/A1:2019 have similar characteristics to IEC 62893-3.

The minimum cross-sectional areas of the load conductors and the protective earth conductor are given in Table 6 in relation to the current limit given by the control pilot signal.

Table 6 – Minimum cross-sectional area of flexible cable or cord

Current limit given by control pilot signal	Minimum cross-section mm ²	American Wire Gauge (AWG) Ø
≤ 13 A	1,5	16
13 A < I ≤ 20 A	2,5	14
20 A < I ≤ 32 A	6	10

The control pilot wire shall have a minimum cross-section of 0,5 mm²/AWG20.

Compliance is checked by inspection, by measurement and by checking that the flexible cables or cords are in accordance with the IEC 60227 series, IEC 60245 series or IEC 62893-3, as applicable.

8.3.11.3 Bending

Parts of IC-CPDs shall be so designed that the flexible cable or cord is protected against excessive bending where it enters the accessory.

Guards provided for this purpose shall be of insulating material and shall be fixed in a reliable manner.

NOTE Helical metal springs, whether bare or covered with insulating material are not suitable to be used as cord guards.

Compliance is checked by inspection and by the test of 9.24.

8.4 Electrical performance

8.4.1 Protective conductor path

The switched contact within the protective conductor path, if any, shall provide adequate contact pressure and shall not deteriorate in normal use.

The protective conductor may pass through the sensing toroid as long as the unit complies with the appropriate operating test.

It shall be verified by inspection that the protective conductor path does not have any semiconductor device connected in series.

Compliance is checked by the temperature rise test of 9.6.2, the residual short-circuit test of 9.9.2.3 and the conditional short-circuit test of 9.9.2.4 c).

8.4.2 Contact mechanism

Each line conductor and the neutral conductor, if any, of the IC-CPD shall be provided with switching contacts. For IC-CPDs according to 4.4.2 the protective conductor shall be provided with a switching contact. The line contacts and the neutral contact, if any, shall be mechanically or electrically coupled such that they make and break substantially together.

The protective conductor contact, if any, may be mechanically or electrically coupled to the line and neutral contacts.

The switching contact of the protective conductor path, if any, shall close before and open after the switching contacts of the live conductors or close and open substantially together with the live conductors.

It may be possible to switch off the IC-CPD when energized as in normal use. A test device may be used for that purpose.

The IC-CPD shall have means for manual reset after a residual current operation. This may be done by a dedicated means or by disconnecting from the socket-outlet.

A test device may be provided.

An automatic verification shall ensure detection of unintended closed contacts.

The IC-CPD shall have an indicator showing the status of the contacts and give a clear indication or response in the case of unintentionally closed contacts.

The action of the mechanism shall not be influenced by the position of enclosures or covers and shall be independent of any removable part.

A cover sealed in position by the manufacturer is considered to be a non-removable part.

Compliance with the above requirements is checked by inspection and by the relevant tests of 9.7.

8.4.3 Clearances and creepage distances (see Annex C)

Clearances and creepage distances shall not be less than the values shown in Table 7, when the IC-CPD is mounted as in normal use. The values in Table 7 are based on the IC-CPD being designed for operating in an environment with pollution degree 2 and overvoltage category II.

NOTE If higher altitudes, pollution degrees or overvoltage category are considered, the appropriate clearances and creepage distances are defined in IEC 60664-1.

Compliance for item 1 in Table 7 is checked by measurement or by the test of 9.5.5.3.1 and 9.5.5.3.2. The test is carried out with samples not submitted to the humidity treatment described in 9.5.1.

The clearances as specified in Table 7 may be reduced provided that the measured clearances are not shorter than the minimum allowed in IEC 60664-1 for homogenous field conditions. In this case, after the humidity treatment described in 9.5.1, compliance with Table 7 and the arrangements of 9.5.2, items b), c), d) and e) are checked in the following order:

- tests according to 9.5.2,
- test according to 9.5.5.2, applied with the test voltages given in Table 10 and with the test arrangements of 9.5.2 items b), c), d), e).

If the measurement does not show any reduced clearance, test 9.5.5.2 is not applied.

Double insulation or reinforced insulation shall be provided between hazardous-live parts and

- accessible surfaces of operating means,
- screws or other means for fixing covers which may be removed when connecting the connector,
- accessible metal parts.

Compliance is checked by the test of 9.5.5.2. The test voltage shall be multiplied by 1,6.

All measurements required in this Subclause 8.4.3 shall be carried out in Test sequence A on one sample and the tests of 9.5.5.2 shall be carried out before the tests of 9.5.1 on three samples of Test sequence B.

The insulating materials are classified into material groups on the basis of their comparative tracking index (CTI) according to 4.6.3 of IEC 60664-1:2020.

Plugs for household and similar purposes shall comply with the relevant national standard. In the absence of national standards IEC 60884-1 applies.

For industrial plugs, the IEC 60309 series applies. For vehicle connectors, IEC 62196-1 or IEC 62196-2 applies.

The verification of clearances and creepage distances on printed circuit boards for electronic circuits connected between live conductors (phases and neutral) and/or between live conductors and the earth circuit is made by the tests of 9.26.

Table 7 – Minimum clearances and creepage distances

	Minimum clearances ^g mm				Minimum creepage distances ^c mm											
					Group IIIa ^d (175 V ≤ CTI < 400 V) ^b				Group II (400 V ≤ CTI < 600 V) ^b				Group I (600 V ≤ CTI) ^b			
Item/ Description	Rated voltage V ^e				Working voltage V											
	U_{imp} 1,5 kV	U_{imp} 2,5 kV														
	120	250	230/ 400	480 ^h	120	250	400	480	120	250	400	480	120	250	400	480
1. Between live parts which are separated when the main contacts are in the open position ^a	0,5	1,5			1,5	2,5	4,0	5	1,05	1,8	2,8	3,6	0,75	1,5	2,0	2,5
2. Between live parts of different polarity	0,5	1,5			1,5	2,5	4,0	5	1,05	1,8	2,8	3,6	0,75	1,5	2,0	2,5
3. Void																

	Minimum clearances ^g mm				Minimum creepage distances ^c mm											
					Group IIIa ^d (175 V ≤ CTI < 400 V) ^b				Group II (400 V ≤ CTI < 600 V) ^b				Group I (600 V ≤ CTI) ^b			
Item/ Description	Rated voltage V ^e				Working voltage V											
	U _{imp} 1,5 kV	U _{imp} 2,5 kV														
	120	250	230/ 400	480 ^h	120	250	400	480	120	250	400	480	120	250	400	480
4. Basic insulation: Between live parts of the IC- CPD and PE	0,5	1,5			1,5	2,5	4	5	1,05	1,8	2,8	3,6	0,75	1,5	2,0	2,5
5. IC-CPD between hazardous live parts and - accessible surfaces of operating means - screws or other means for fixing covers which may be removed when connecting the connector - accessible metal parts ^f - SELV and PELV circuits of the PCB (e.g. CP circuit) ^j	1,5	3			3	5	8	10	2,1	3,6	5,6	7,2	1,5	3	4	5
NOTE 1 The parts of the neutral path, if any, are considered to be live parts.																
NOTE 2 Clearances and creepage distances of the secondary circuit and between the primary windings of the IC-CPD transformer are not considered.																
^a For auxiliary and control contacts the values are given in the relevant standard.																
^b See IEC 60112.																
^c Interpolation is allowed in determining creepage distances corresponding to voltage values intermediate to those listed as working voltage. When interpolating, linear interpolation shall be used and values shall be rounded to the same number of digits as the values picked up from the tables. For determination of creepage distances refer to Annex C.																
^d For material group IIIb (100 V ≤ CTI < 175 V) the values for material group IIIa multiplied by 1,6 apply.																
^e The rated voltage is the maximum operational voltage to earth.																
^f Including a metal foil in contact with the surfaces of insulating material which are accessible after installation for normal use. The foil is pushed into corners, grooves, etc., by means of a test wire according to 9.4 (see Figure 7).																
^g For altitudes of 3 000 m the values shall be multiplied by 1,14, for 4 000 m they shall be multiplied by 1,29.																
^h The application refers only to a 2P/3W with 480 V (line to neutral < 300 V). Table 7 is applicable for grounded power systems only.																
^j For extra low voltage values (SELV or PELV) see IEC 61140.																