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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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



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

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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;
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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/LLNSE 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.