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**Electrically propelled road vehicles —  
Conductive power transfer — Safety  
requirements**

*Véhicules routiers à propulsion électrique — Transfert d'énergie  
conductive — Exigences de sécurité*

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CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared jointly by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 37, *Electrically propelled road vehicles*, and Technical Committee IEC/TC 69, *Electric road vehicles and electric industrial trucks*.

This second edition replaces the first edition (ISO 17409:2015), which has been technically revised. The main changes compared to the previous edition are as follows:

- terms and definitions have been updated,
- requirements for mode 1 have been removed because it is no longer relevant for new designs,
- requirements for reverse power transfer have been added,
- requirements for a DC connection with a thermal management system have been added,
- short circuit during DC charging has been reworked, and
- requirements for charging with pantograph have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

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# Electrically propelled road vehicles — Conductive power transfer — Safety requirements

## 1 Scope

This document specifies electric safety requirements for conductive connection of electrically propelled road vehicles to external electric circuits. External electric circuits include external electric power supplies and external electric loads. This document provides requirements for the charging modes 2, 3, 4, as defined in IEC 61851-1, and reverse power transfer. For mode 4, this document provides requirements regarding the connection to an isolated DC EV charging station according to IEC 61851-23.

NOTE 1 This edition does not provide requirements for mode 1.

NOTE 2 External electric circuits are not part of the vehicle.

This document applies to the on-board sections of vehicle power supply circuits. It applies also to dedicated power supply control functions used for the connection of the vehicle to an external electric circuit.

It does not provide comprehensive safety information for manufacturing, maintenance and repair personnel.

NOTE 3 ISO 6469-3 provides general electrical safety requirements for electrically propelled road vehicles.

NOTE 4 With this edition of this document the limitation of y-capacitance for protection against electric shock under single failure conditions is no longer applicable as a fault protection provision when the vehicle has a conductive DC connection to an external electric circuit.

## 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.

ISO 6469-3, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

ISO 15118 (all parts), *Road vehicles — Vehicle to grid communication interface*

ISO 20653, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

ISO 26262 (all parts), *Road vehicles — Functional safety*

IEC 60038, *IEC standard voltages*

IEC 60364-4-41:2005, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock*

IEC 60364-4-43:2008, *Electrical installations of buildings — Part 4-43: Protection for safety — Protection against overcurrent*

IEC 60364-5-54, *Low-voltage electrical installations — Part 5-54: Selection and erection of electrical equipment — Earthing arrangements and protective conductors*

IEC 60364-6, *Low-voltage electrical installations — Part 6: Verification*

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

IEC 61000-3-3, *Electromagnetic compatibility (EMC) — Part 3-3: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection*

IEC 61000-3-11, *Electromagnetic compatibility (EMC) — Part 3-11: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems — Equipment with rated current ≤ 75 A and subject to conditional connection*

IEC 61032, *Protection of persons and equipment by enclosures — Probes for verification*

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

IEC 61851-23:—, *Electric vehicle conductive charging system — Part 23: DC electric vehicle charging station*

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

IEC 62196-2, *Plugs, socket-outlets, vehicle connectors and vehicle inlets — Conductive charging of electric vehicles — Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories*

IEC 62196-3:2015, *Plugs, socket-outlets, vehicle connectors and vehicle inlets — conductive charging of electric vehicles — Part 3: Dimensional compatibility and interchangeability requirements for dedicated d.c. and combined a.c./d.c. pin and contact-tube vehicle couplers*

IEC/TS 62196-3-1:—, *Plugs, socket-outlets, vehicle connectors and vehicle inlets — conductive charging of electric vehicles — Part 3-1: Vehicle connector, vehicle inlet and cable assembly intended to be used with a thermal management system for DC charging*

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### 3 Terms and definitions

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

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

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

#### 3.1 active factor

**cos φ**

for a two-terminal element or a two-terminal circuit under sinusoidal conditions, ratio of the active power to the apparent power

[SOURCE: IEC 60050-131:2001, 131-11-49, modified — The symbol “cos φ” was added and the note deleted.]

#### 3.2 automated connection device ACD

active device where the physical connection between *EV supply equipment* (3.25) and vehicle is made and broken without user interaction providing an electromechanical interface

[SOURCE: IEC 61851-23-1:—<sup>1)</sup>, 3.1.203, modified — The phrase “and broken” was added.]

1) Under preparation. Stage at the time of publication: IEC/ACDV 61851-23-1:2020.



**3.3****ACD counterpart**

passive device which is used in combination with an *ACD* (3.2) to make and break the physical connection between *EV supply equipment* (3.25) and vehicle providing an electromechanical interface without user interaction

[SOURCE: IEC 61851-23-1:—<sup>1</sup>, 3.1.204, modified — The phrase “and break” was added.]

**3.4****automatic coupler**

system comprising an *ACD* (3.2) and *ACD counterpart* (3.3)

[SOURCE: IEC 61851-23-1:—<sup>1</sup>, 3.1.205, modified — The word “of” was deleted.]

**3.5****basic insulation**

insulation of *hazardous live parts* (3.30) which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: ISO 6469-3:2018, 3.3, modified — Note 2 to entry removed.]

**3.6****case A**

connection of an *EV* (3.19) to the *supply network* (3.53) with a *plug* (3.43) and cable permanently attached to the EV

Note 1 to entry: The cable assembly is part of the vehicle.

[SOURCE: IEC 61851-1:2017, 3.1.10]

**3.7****case B**

connection of an *EV* (3.19) to the *supply network* (3.53) with a cable assembly detachable at both ends

Note 1 to entry: The cable assembly is not part of the vehicle or the *EV charging station* (3.23).

[SOURCE: IEC 61851-1:2017, 3.1.11]

**3.8****case C**

connection of an *EV* (3.19) to the *supply network* (3.53) utilizing a cable and *vehicle connector* (3.58) permanently attached to the *EV charging station* (3.23).

Note 1 to entry: The cable assembly is part of the EV charging station.

[SOURCE: IEC 61851-1:2017, 3.1.12]

**3.9****case D**

connection of an *EV* (3.19) to a *supply network* (3.53) utilizing an *automatic coupler* (3.4) which has an *ACD* (3.2) on the *EV supply equipment* (3.25)

[SOURCE: IEC 61851-23-1:—<sup>1</sup>, 3.1.201]

**3.10****case E**

connection of an *EV* (3.19) to a *supply network* (3.53) utilizing an *automatic coupler* (3.4) which has an *ACD* (3.2) on the EV

[SOURCE: IEC 61851-23-1:—<sup>1</sup>, 3.1.202]

**3.11  
charger**

power converter at the on-board section of the *vehicle power supply circuit* (3.61) which supplies electric power

EXAMPLE For charging a *RESS* (3.47).

**3.12  
conductive part**

part which can carry electric current

[SOURCE: ISO 6469-3:2018, 3.6]

**3.13  
control pilot function**

function used to monitor and control the interaction between the *EV* (3.19) and the *EV supply equipment* (3.25)

[SOURCE: IEC 61851-1:2017, 3.3.3]

**3.14  
cut-off current**

let-through current

maximum instantaneous value of current attained during the breaking operation of a switching device or a fuse

Note 1 to entry: This concept is of particular importance when the switching device or the fuse operates in such a manner that the prospective peak current of the circuit is not reached.

[SOURCE: IEC 60050-441:1984, 441-17-12, modified — “the” deleted from definition, “is” added to the Note to entry.]

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**3.15  
DC EV charging station**

*EV charging station* (3.23) that supplies direct current to an *EV* (3.19)

[SOURCE: IEC 61851-1:2017, 3.1.6]

**3.16  
degree of protection**

protection provided by an enclosure against access, foreign objects and/or water and verified by standardized test methods

[SOURCE: ISO 20653:2013, 3.2]

**3.17  
direct contact**

electric contact of persons or animals with *live parts* (3.35)

[SOURCE: ISO 6469-3:2018, 3.10]

**3.18  
double insulation**

insulation comprising both *basic insulation* (3.5) and *supplementary insulation* (3.52)

[SOURCE: ISO 6469-3:2018, 3.11]

**3.19  
electrically propelled vehicle**

**EV**  
vehicle with one or more *electric drive(s)* (3.21) for vehicle propulsion

[SOURCE: ISO 6469-3:2018, 3.15, modified — “EV” added as an equivalent term.]

**3.20****electric chassis**

*conductive parts* (3.12) of a vehicle that are electrically connected and whose potential is taken as reference

[SOURCE: ISO 6469-3:2018, 3.12]

**3.21****electric drive**

combination of traction motor, power electronics and their associated controls for the conversion of electric to mechanical power and vice versa

[SOURCE: ISO 6469-3:2018, 3.13]

**3.22****electric shock**

physiological effect resulting from an electric current through a human body or animal body

[SOURCE: ISO 6469-3:2018, 3.14]

**3.23****EV charging station**

stationary part of *EV supply equipment* (3.25) connected to the *supply network* (3.53)

[SOURCE: IEC 61851-1:2017, 3.1.5]

**3.24****EV plug**

specific *plug* (3.43) intended to be used as part of *EV supply equipment* (3.25) or for the connection of *EV* (3.19) to EV supply equipment, and defined in the IEC 62196 series

[SOURCE: IEC 61851-1:2017, 3.5.8]  
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**3.25****EV supply equipment**

equipment or a combination of equipment, providing dedicated functions to supply electric energy from a fixed electrical installation or *supply network* (3.53) to an *EV* (3.19) for the purpose of charging

EXAMPLE 1 For *mode 3* (3.39) *case B* (3.7), the EV supply equipment consists of the *EV charging station* (3.23) and the cable assembly.

EXAMPLE 2 For *mode 3 case C* (3.8), the EV supply equipment consists of the EV charging station with its cable assembly.

[SOURCE: IEC 61851-1:2017, 3.1.1]

**3.26****exposed conductive part**

*conductive part* (3.12) of equipment which can be touched and which is not normally live, but which can become live when *basic insulation* (3.5) fails

[SOURCE: ISO 6469-3:2018, 3.18, modified — Note 1 to entry deleted.]

**3.27****external electric circuit**

electric circuit which connects to the *vehicle power supply circuit* (3.61) using the *plug* (3.43) [*case A* (3.6)], the *vehicle inlet* (3.60) [*case B* (3.7) and *case C* (3.8)], the *ACD counterpart* (3.3) [*case D* (3.9)] or the *ACD* (3.2) [*case E* (3.10)]

EXAMPLE *EV charging station* (3.23), external electric load.

**3.28**

**external electric power supply**

electric power source that is not part of the vehicle for supplying electric energy to an *EV* (3.19) using an *EV supply equipment* (3.25)

**3.29**

**hazard**

potential source of harm

[SOURCE: IEC 60050-903:2013, 903-01-02, modified — Notes to entry 1, 2, and 3 deleted.]

**3.30**

**hazardous live part**

*live part* (3.35) which, under certain conditions, can give a harmful *electric shock* (3.22)

[SOURCE: ISO 6469-3:2018, 3.22, modified — Note 1 to entry removed.]

**3.31**

**interlock function**

function that prevents the power contacts of a *socket-outlet* (3.51)/*vehicle connector* (3.58) from becoming live before it is in proper engagement with a *plug* (3.43)/*vehicle inlet* (3.60), and which either prevents the plug/vehicle connector from being withdrawn while its power contacts are live or makes the power contacts dead before separation

[SOURCE: IEC 61851-1:2017, 3.5.16, modified — term changed from “interlock” to “interlock function”, definition changed from “device or combination of devices” to “function”.]

**3.32**

**isolation resistance**

**insulation resistance**

resistance between *live parts* (3.35) of an electric circuit and the *electric chassis* (3.20) as well as other electric circuits which are insulated from this electric circuit

[SOURCE: ISO 6469-3:2018, 3.23]

**3.33**

**isolation resistance monitoring system**

system that periodically or continuously monitors the *isolation resistance* (3.32) between *live parts* (3.35) and the *electric chassis* (3.20)

[SOURCE: ISO 6469-3:2018, 3.24]

**3.34**

**live conductor**

conductor which is energized in normal operation and capable of contributing to the transmission or distribution of electric energy

Note 1 to entry: Live conductors include line conductors (including DC+ conductors and DC- conductors) and neutral conductors.

**3.35**

**live part**

conductor or *conductive part* (3.12) intended to be energized in normal use, but by convention not the *electric chassis* (3.20)

[SOURCE: ISO 6469-3:2018, 3.25]

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**3.36****maximum working voltage**

highest value of AC voltage (rms) or of DC voltage that can occur under normal operating conditions according to the manufacturer's specifications, disregarding transients and ripple

[SOURCE: ISO 6469-3:2018, 3.26, modified — The word “any” was deleted from “normal operating conditions”.]

**3.37****mode 1**

method for the connection of an *EV* (3.19) to a standard *socket-outlet* (3.51) of an AC supply network, utilizing a cable and *plug* (3.43), both of which are not fitted with any supplementary pilot or auxiliary contacts

[SOURCE: IEC 61851-1:2017, 6.2.1]

**3.38****mode 2**

method for the connection of an *EV* (3.19) to a standard *socket-outlet* (3.51) of an AC supply network utilizing an AC EV supply equipment with a cable and *plug* (3.43), with a *control pilot function* (3.13) and system for personal protection against *electric shock* (3.22) placed between the standard plug and the EV

[SOURCE: IEC 61851-1:2017, 6.2.2]

**3.39****mode 3**

method for the connection of an *EV* (3.19) to an AC EV supply equipment permanently connected to an AC supply network, with a *control pilot function* (3.13) that extends from the AC EV supply equipment to the EV

Note 1 to entry: Mode 3 includes the use of cable assembly not permanently connected to the AC supply network [case A (3.6) and case B (3.7)].

[SOURCE: IEC 61851-1:2017, 6.2.3, modified — Note 1 to entry added.]

**3.40****mode 4**

method for the connection of an *EV* (3.19) to an AC or DC *supply network* (3.53) utilizing a DC EV supply equipment, with a *control pilot function* (3.13) that extends from the DC EV supply equipment to the EV

[SOURCE: IEC 61851-1:2017, 6.2.4]

**3.41****overcurrent protection**

protection intended to operate when the current is in excess of a predetermined value

Note 1 to entry: a charge control function is not considered an overcurrent protection

[SOURCE: ISO 6469-3:2018, 3.28]

**3.42****overload protection**

protection intended to operate in the event of overload on the protected section

[SOURCE: ISO 6469-3:2018, 3.27]

**3.43****plug**

accessory having contacts designed to engage with the contacts of a *socket-outlet* (3.51), also incorporating means for the electrical connection and mechanical retention of flexible cables or cords

[SOURCE: IEC 61851-1:2017, 3.5.9]