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Electrically propelled road vehicles — Functional and safety requirements for power transfer between vehicle and external electric circuit —

Part 1: General requirements for conductive power transfer

Véhicules routiers à propulsion électrique — Exigences fonctionnelles et exigences de sécurité pour le transfert de puissance entre le véhicule et le circuit électrique externe —

Partie 1: Exigences générales pour le transfert de puissance par conduction

Reference number
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Foreword

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This document was prepared by Technical Committee ISO/TC 22 *Road vehicles*, Subcommittee SC 37 *Electrically propelled vehicles*.

A list of all parts in the ISO 5474 series can be found on the ISO website.

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.

Introduction

The ISO 5474 series reorganizes, cancels and replaces ISO 17409:2020 and ISO 19363:2020, both standards have been technically revised.

Electrically propelled road vehicles — Functional and safety requirements for power transfer between vehicle and external electric circuit —

Part 1:
General requirements for conductive power transfer

1 Scope

This document specifies general requirements for conductive power transfer with a voltage up to 1 000 V a.c. (alternative current) and up to 1 500 V d.c. (direct current) between electrically propelled road vehicles and external electric circuits.

This document provides general requirements for conductive charging in modes 2, 3 and 4 according to IEC 61851-1, and for reverse power transfer. This document does not provide requirements for mode 1. For mode 4, this document provides requirements regarding the power transfer only with isolated DC EV supply equipment according to IEC 61851-23.

NOTE External electric circuits are not part of the vehicle.

This document applies to the vehicle power supply circuits.

This document does not provide;

— requirements for simultaneous operation of multiple EV plugs or vehicle inlets, and

— requirements for power transfer while driving (electric road systems),

but they are under consideration.

This document does not provide:

— requirements for mopeds and motorcycles (which are specified in ISO 18246), and

— comprehensive safety information for manufacturing, maintenance and repair personnel.

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*

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

ISO 20653:2023, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

IEC 60479-2:2019, *Effects of current on human beings and livestock — Part 2: Special aspects Low-voltage electrical installations*

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage supply systems*

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

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

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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 General

3.1.1
basic insulation
insulation of hazardous live parts which provides basic protection

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

[SOURCE: IEC 60050-195:2021, 195-06-06, modified — The phrase "hazardous live parts" has been added.]

3.1.2
conductive part
part which can carry electric current

[SOURCE: IEC 60050-195:2021, 195-01-06]

3.1.3
degree of protection
protection provided by an enclosure against access, foreign objects and/or water and verified by standardized test methods

[SOURCE: ISO 20653:2023, 3.2]

3.1.4
electrically propelled vehicle
EV
vehicle with one or more *electric drive(s)* (3.1.6) for vehicle propulsion

Note 1 to entry: Electrically propelled vehicle is called electric vehicle in IEC standards.

[SOURCE: ISO 6469-3:2021, 3.15, modified — "EV" added as an equivalent term and Note 1 to entry added.]

3.1.5
electric chassis
conductive parts (3.1.2) of a vehicle that are electrically connected and whose potential is taken as reference

[SOURCE: ISO 6469-3:2021, 3.12]

3.1.6
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 6469-3:2021, 3.13]

3.1.7
electric power source
system that provides electric energy

Note 1 to entry: The electric power source can also be the power source for reverse power.

EXAMPLE *Rechargeable energy storage system (RESS)* (3.1.19), fuel cell system, photovoltaic system, motor/generator, *EV charging station* (3.2.6).

[SOURCE: ISO 6469-3:2021, 3.37, modified — Note 1 to entry added, EV charging station added in Example.]

3.1.8
electric shock
physiological effect resulting from an electric current through a human body or animal body

[SOURCE: IEC 60050-195:2021, 195-01-04, modified — "animal body" replaces "livestock".]

3.1.9
exposed conductive part
conductive part (3.1.2) of equipment which can be touched and which is not normally live, but which can become live when *basic insulation* (3.1.1) fails

[SOURCE: IEC 60050-442:1998, 442-01-21, modified — "equipment" replaces "electric equipment" and Note 1 to entry deleted.]

3.1.10
external electric circuit
electric circuit external to the vehicle which exchanges energy with the vehicle

Note 1 to entry: The external electric circuit includes a *conductively connected external electric circuit* (3.2.5) and magnetically coupled external electric circuit.

3.1.11
hazard
potential source of harm

[SOURCE: ISO/IEC Guide 51:2014, 3.2]

3.1.12
insulation resistance
resistance between *live parts* (3.1.14) of an electric circuit and the *electric chassis* (3.1.5) as well as other electric circuits which are insulated from this electric circuit

Note 1 to entry: In UN R100, the equivalent term for "insulation resistance" is "isolation resistance".

[SOURCE: ISO 6469-3:2021, 3.23, modified — Equivalent term "isolation resistance" deleted, note 1 to entry added.]

3.1.13
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.

3.1.14
live part
conductor or *conductive part* (3.1.2) intended to be energized in normal use, but by convention not the *electric chassis* (3.1.5)

[SOURCE: ISO 6469-3:2021, 3.25]

3.1.15
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: IEC 60050-448:1995, 448-14-26, modified — Note 1 to entry added.]

3.1.16
overload protection
protection intended to operate in the event of overload on the protected section

[SOURCE: IEC 60050-448:1995, 448-14-31]

3.1.17
protective conductor
conductor provided for purposes of safety, for example, protection against *electric shock* (3.1.8)

EXAMPLE Protective bonding conductor, protective earthing conductor and an earthing conductor when used for protection against electric shock.

[SOURCE: IEC 60050-581:2008, 581-27-26]

3.1.18
rated current
current assigned by the manufacturer for a specified operating condition

[SOURCE: IEC 60050-442:1998, 442-01-02, modified — The phrase "of an accessory" was removed from end of definition.]

3.1.19
rechargeable energy storage system
RESS
rechargeable system that stores energy for delivery of electric energy for the *electric drive* (3.1.6)

EXAMPLE Battery, capacitor, flywheel.

[SOURCE: ISO 6469-1:2019, 3.22]

3.1.20
reverse power transfer
supply of electric power from an *electrically propelled vehicle (EV)* (3.1.4) using the *EV plug* (3.2.7), the *vehicle inlet* (3.2.17) or on-board *standard socket-outlet* (3.2.15) conductively connected to a *vehicle power supply circuit* (3.2.18) to an *external electric circuit* (3.1.10)

Note 1 to entry: Unintended power transfer flow from an EV to an external electric circuit is not considered as a reverse power transfer. (See Clause 8.)

3.1.21
simple separation
separation between electric circuits or between an electric circuit and local earth by means of *basic insulation* (3.1.1)

[SOURCE: IEC 60050-195:2021, 195-06-30]

3.1.22
supply network
any source of electric energy

EXAMPLE Mains or electric grid, distributed energy resources (DER), battery bank, PV installation generator.

[SOURCE: IEC 61851-1:2017, 3.7.1, modified — The information in the example was previously part of the definition.]

3.1.23
switching device
device designed to make or break the current in one or more electric circuits

[SOURCE: IEC 60050-441:1984, 441-14-01]

3.1.24
touch current
electric current passing through a human body or through livestock when it touches one or more accessible parts of an installation or of equipment

[SOURCE: IEC 60050-195:2021, 195-05-21]

3.1.25
voltage class
classification of an electric component or circuit according to its maximum working voltage

Note 1 to entry: The classification to the voltage classes A and B is according to ISO 6469-3:2021.

[SOURCE: ISO 6469-3:2021, 3.36, modified — Note 1 to entry was added.]

3.2 AC and DC power transfer

3.2.1
case A
connection of an *electrically propelled vehicle (EV)* (3.1.4) to the *supply network* (3.1.22) with a *plug* (3.2.13) 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]

3.2.2
case B
connection of an *electrically propelled vehicle (EV)* (3.1.4) to the *supply network* (3.1.22) 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* (3.2.6).

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

3.2.3
case C
connection of an *electrically propelled vehicle (EV)* (3.1.4) to the *supply network* (3.1.22) utilizing a cable and vehicle connector permanently attached to the *EV charging station* (3.2.6)

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

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

3.2.4
charger
power converter at the *vehicle power supply circuit* (3.2.18) which supplies electric power

EXAMPLE For charging a *rechargeable energy storage system (RESS)* (3.1.19).

3.2.5
conductively connected external electric circuit
electric circuit that connects to the *vehicle power supply circuit* (3.2.18) using the *plug* (3.2.13) [*case A* (3.2.1)] or the *vehicle inlet* (3.2.17) [*case B* (3.2.2) and *case C* (3.2.3)]

EXAMPLE *EV charging station* (3.2.6), external electric load.

3.2.6
EV charging station
stationary part of the *EV supply equipment* (3.2.8) connected to the *supply network* (3.1.22)

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

3.2.7
EV plug
specific *plug* (3.2.13) intended to be used as part of the *EV supply equipment* (3.2.8) or for the connection of an *electrically propelled vehicle (EV)* (3.1.4) to the EV supply equipment, and defined in the IEC 62196 series

[SOURCE: IEC 61851-1:2017, 3.5.8]

3.2.8
EV supply equipment
equipment or a combination of equipment, providing dedicated functions to supply electric energy from a fixed electrical installation or *supply network* (3.1.22) to an *electrically propelled vehicle (EV)* (3.1.4) for the purpose of charging

EXAMPLE 1 For *mode 3* (3.2.11) *case B* (3.2.2), the EV supply equipment consists of the *EV charging station* (3.2.6) and the cable assembly.

EXAMPLE 2 For *mode 3* (3.2.11) *case C* (3.2.3), the EV supply equipment consists of the EV charging station with its cable assembly.

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

3.2.9
interlock function
function that prevents the power contacts of an EV socket-outlet/vehicle connector from becoming live before it is in proper engagement with an *EV plug* (3.2.7)/vehicle connector, and which either prevents the EV 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”, phrase “device or combination of devices” replaced by “function”, terms “plug” changed to “EV plug”.]

3.2.10
mode 2
method for the connection of an *electrically propelled vehicle (EV)* (3.1.4) to a *standard socket-outlet* (3.2.15) of an AC *supply network* (3.1.22) utilizing an AC *EV supply equipment* (3.2.8) with a cable and *plug* (3.2.13), with a control pilot function and system for personal protection against *electric shock* (3.1.8) placed between the standard plug and the EV

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

3.2.11
mode 3
method for the connection of an *electrically propelled vehicle (EV)* (3.1.4) to an AC *EV supply equipment* (3.2.8) permanently connected to an AC *supply network* (3.1.22), with a control pilot function 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* (3.2.1) and *case B* (3.2.2)].

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

3.2.12
mode 4
method for the connection of an *electrically propelled vehicle (EV)* (3.1.4) to an AC or DC *supply network* (3.1.22) utilizing a DC *EV supply equipment* (3.2.8), with a control pilot function that extends from the DC EV supply equipment to the EV

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

3.2.13
plug
accessory having contacts designed to engage with the contacts of a *socket-outlet* (3.2.14), also incorporating means for the electrical connection and mechanical retention of flexible cables or cords

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

3.2.14
socket-outlet
accessory having socket-contacts designed to engage with the contacts of a *plug* (3.2.13) and having terminals for the connection of cables or cords

[SOURCE: IEC 61851-1:2017, 3.5.10]

3.2.15
standard socket-outlet
socket-outlet (3.2.14) which meets the requirements of any IEC and/or any national standard that provides interchangeability by standard sheets, excluding the specific EV accessories as defined in the IEC 62196 series

[SOURCE: IEC 61851-1:2017, 3.5.11, modified — The phrase "plug and" was removed.]

3.2.16
vehicle coupler
means of connecting or disconnecting a flexible cable to an *electrically propelled vehicle* (3.1.4)

Note 1 to entry: It consists of a vehicle connector and a *vehicle inlet* (3.2.17).

[SOURCE: IEC 62196-1:2014, 3.3]

3.2.17
vehicle inlet
part integral with, or intended to be attached to, one flexible cable

[SOURCE: IEC 62196-1:2014, 3.3.2]

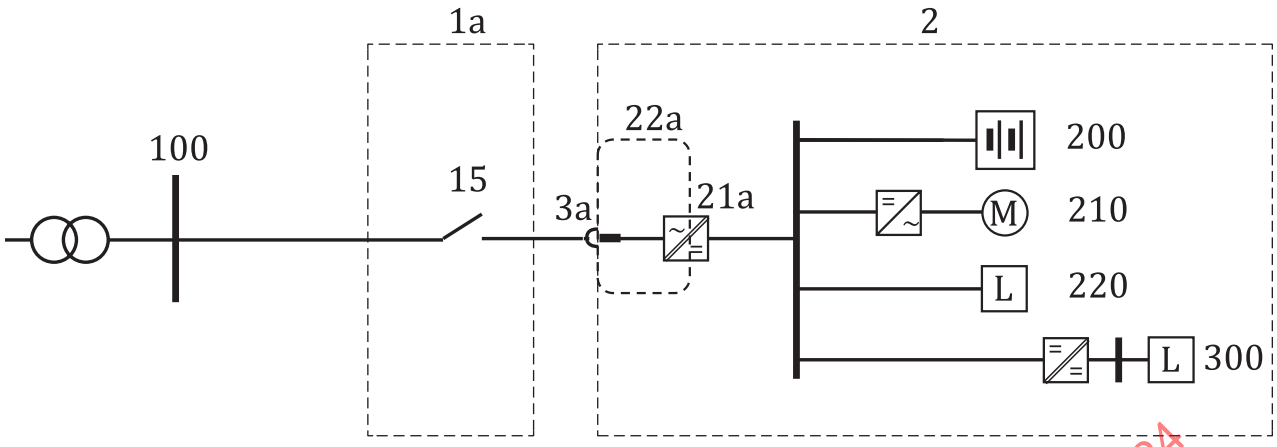
3.2.18
vehicle power supply circuit
voltage class B electric circuit which includes all parts that are conductively connected to the *vehicle inlet* (3.2.17) [*case B* (3.2.2), *case C* (3.2.3)] or the *plug* (3.2.13) [*case A* (3.2.1)] that are mounted on the *electrically propelled vehicle (EV)* (3.1.4) and that is energized during the power transfer between the EV and the *external electric circuit* (3.1.10)

Note 1 to entry: The definition is different from that in ISO 17409 edition 2. In this document, the vehicle power supply circuit does not include anything off-board of the electric vehicle.

4 System architecture

An example for an AC power transfer system is provided in Figures 1 and 2.

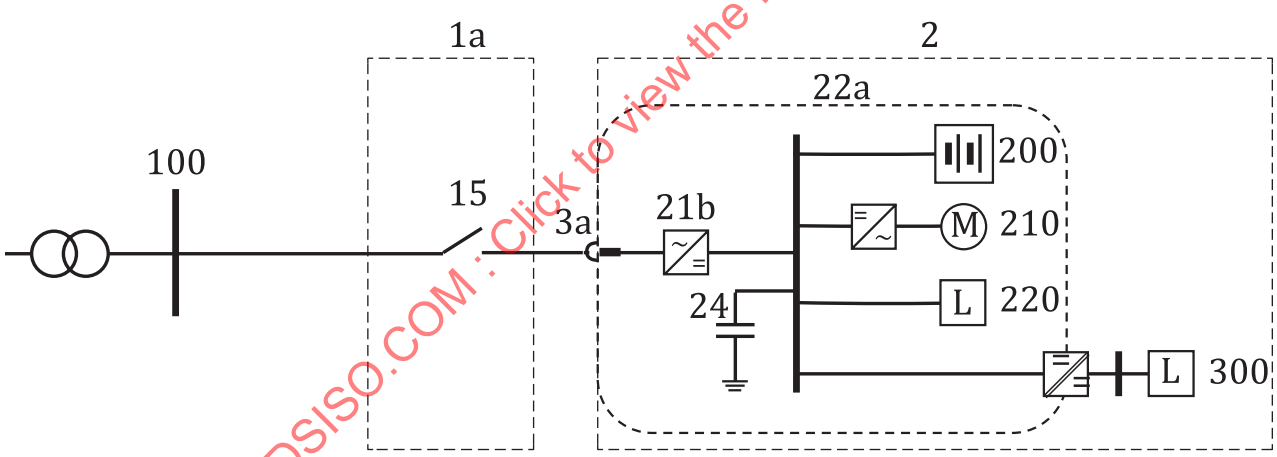
An example for a DC power transfer system is provided in Figure 3.



Key

1a	AC EV supply equipment	100	supply network
2	EV	200	RESS
3a	AC vehicle coupler	210	electric drive
15	switching device	220	other voltage class B electric loads
21a	charger with at least simple separation	300	voltage class A electric loads
22a	vehicle power supply circuit according to ISO 5474-2		

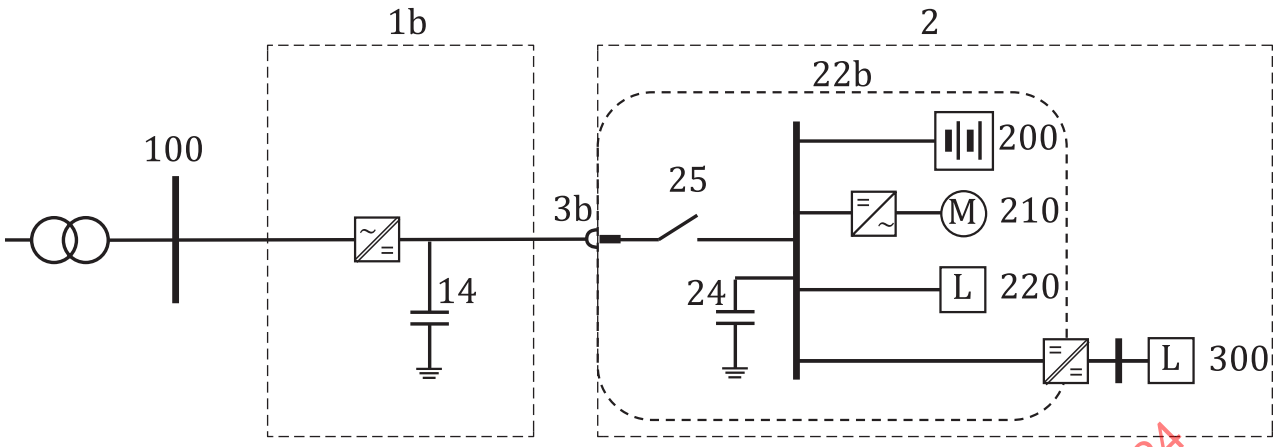
Figure 1 — Single-line diagram of example of AC power transfer system using charger with at least simple separation



Key

1a	AC EV supply equipment	24	total y capacitance of vehicle power supply circuit
2	EV	100	supply network
3a	AC vehicle coupler	200	RESS
15	switching device	210	electric drive
21b	charger with less than simple separation	220	other voltage class B electric loads
22a	vehicle power supply circuit according to ISO 5474-2	300	voltage class A electric loads

Figure 2 — Single-line diagram of example of AC power transfer system using charger with less than simple separation



Key

1b	DC EV supply equipment	25	disconnection device
2	EV	100	supply network
3b	DC vehicle coupler	200	RESS
14	total y capacitance of DC EV supply equipment	210	electric drive
22b	vehicle power supply circuit according to ISO 5474-3	220	other voltage class B electric loads
24	total y capacitance of vehicle power supply circuit	300	voltage class A electric load

Figure 3 — Single-line diagram of example of DC power transfer system

5 Environmental and operational conditions

The requirements given in this document shall be met across the range of environmental and operational conditions including all relevant energy levels of the electric power sources of the vehicle (e.g. SOC of RESS), as specified by the vehicle manufacturer.

The environmental conditions applicable to a component depend on its mounting position. The component shall withstand and retain its degree of protection under the typical loads and stresses it is subjected to in its intended mounting position.

NOTE See the ISO 16750 series, the ISO 21498 series and the ISO 19453 series for guidance.

6 Safety requirements

6.1 General

Unless otherwise specified in this document, the requirements given in ISO 6469-3 apply to the vehicle power supply circuit.

NOTE Requirements on post-crash electrical safety are specified in ISO 6469-4.

6.2 Protection of persons against electric shock

6.2.1 General

The vehicle shall provide at least basic insulation between the live parts of the vehicle power supply circuit and electric chassis.

Conformance is checked by design review.

6.2.2 Compatibility with external safety devices

The specific requirements for each technology are defined in other parts of the ISO 5474 series.

6.2.3 Insulation resistance

Conformance to the requirements in ISO 6469-3:2021, 6.3.2 is checked in accordance with 12.3.

6.2.4 Touch current

When the vehicle is conductively connected to an external electric circuit (i.e. in mated position), the steady-state touch current measured at the vehicle shall not exceed any of the following values:

a) in normal conditions:

   0,5 mA (rms) a.c.;

   2 mA d.c.;

b) in case of loss of continuity of protective conductor:

   3,5 mA (rms) a.c.;

   10 mA d.c.

The contribution of the EV supply equipment to the touch current shall be considered.

Test procedures are defined in other parts of the ISO 5474 series.

6.2.5 Insulation coordination

For charge mode specific insulation requirements, see respective parts for AC power transfer and DC power transfer (ISO 5474-2 and ISO 5474-3).

Clearance, creepage distance and solid insulation of the vehicle power supply circuit shall be designed according to the applicable sections of the IEC 60664 series.

Test procedures are defined in other parts of the ISO 5474 series.

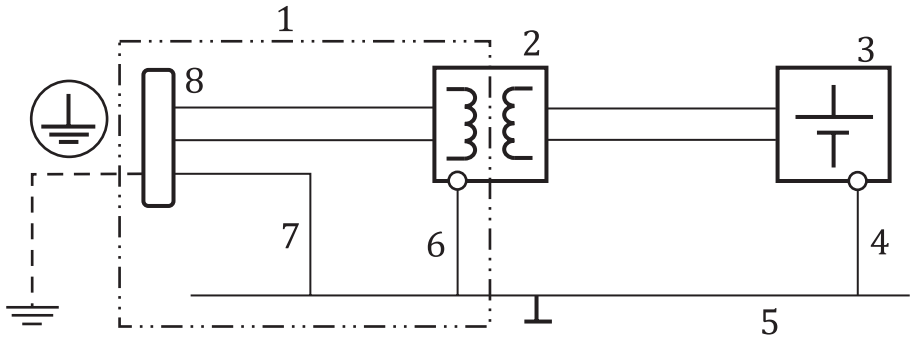
6.2.6 Protective conductor

The plug (case A) or the vehicle inlet (case B and case C) shall have a contact for connecting the vehicle's electric chassis to the protective conductor of a conductively connected external electric circuit.

The protective conductor terminal of the plug (case A) or the vehicle inlet (case B and case C) shall be connected:

a) to the vehicle electric chassis with a protective conductor, see Figure 4, or

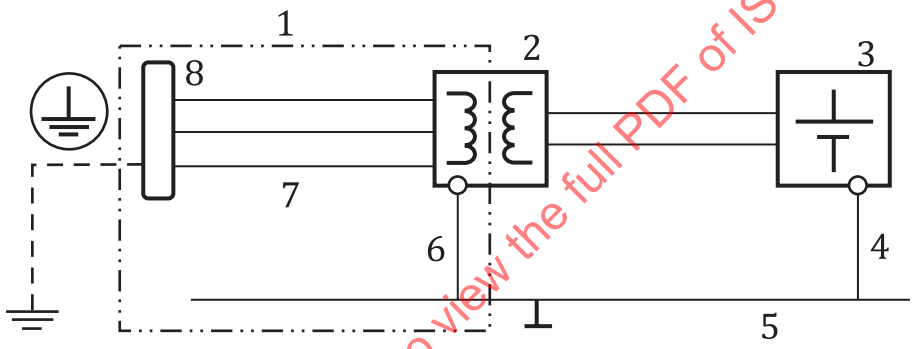
b) to the exposed conductive parts of the components of the vehicle power supply circuit with a protective conductor, see Figure 5.



Key

1	vehicle power supply circuit according to ISO 5474-2	5	electric chassis
2	charger with at least simple separation	6	protective conductor
3	RESS	7	protective conductor
4	equipotential bonding according to ISO 6469-3	8	vehicle inlet

Figure 4 — Connection between protective conductor and electric chassis (example for option 1)



Key

1	vehicle power supply circuit according to ISO 5474-2	5	electric chassis
2	charger with at least simple separation	6	protective conductor
3	RESS	7	protective conductor
4	equipotential bonding according to ISO 6469-3	8	vehicle inlet

Figure 5 — Connection between protective conductor and electric chassis (example for option 2)

The cross-sectional area of the protective conductor shall be designed in accordance with IEC 60364-5-54.

The protective conductor of the vehicle power supply circuit shall be dimensioned according to the relevant quantities (e.g. fault current and disconnecting time) taking into account both energy sources, vehicle and conductively connected external electric circuit.

The resistance of the protective conductor connection between the protective conductor contact of the plug (case A) or the vehicle inlet (case B, case C) and the vehicle electrical chassis shall be less than 0,1 Ω.

The resistance of the protective conductor shall be tested in accordance with 12.2.

6.2.7 Basic protection when connected to an external electric circuit

In case A, the degree of protection against contact with voltage class B live parts shall be at least IPXXD in accordance with ISO 20653 when the plug is mated to the corresponding socket-outlet.

NOTE 1 This requirement is deemed to be met if the vehicle is equipped with an EV plug according to the IEC 62196 series.

In cases B and C, the degree of protection against contact with voltage class B live parts shall be at least IPXXD in accordance with ISO 20653 when the vehicle connector is mated to the vehicle inlet.

NOTE 2 This requirement is deemed to be met if the vehicle is equipped with a vehicle inlet according to the IEC 62196 series.

Conformance is checked by inspection.

6.2.8 Requirements for unmated vehicle contacts

6.2.8.1 General

This subclause specifies the safety requirements for the contacts of the EV plug (case A) or the vehicle inlet (case B and case C) when they are not mated.

NOTE For reverse power transfer, the requirements for de-energization of the vehicle contacts are given in Clause 10.

The vehicle manufacturer shall consider hazards caused by ingress of water.

6.2.8.2 Basic protection

At least one of the following provisions for basic protection shall be provided for each contact of the EV plug (case A) or the vehicle inlet (case B and case C) when it is not mated:

— protection against direct contact:

  — the contact shall be protected by the degree of protection IPXXB according to ISO 20653;

— limitation of voltage:

  — the voltage between the contact and any other contact as well as the voltage between the contact and the electric chassis shall be below 60 V d.c. and 30 V a.c. within 1 s after un-mating;

— limitation of steady-state touch current and energy:

  — the steady-state touch current between the contact and any other contact as well as the steady-state touch current between the contact and the electric chassis shall be below 0,5 mA a.c. and 2 mA d.c. within 1 s after un-mating, and,

  — the available energy between the contact and any other contact as well as the available energy between the contact and the electric chassis shall not exceed the Curve B of IEC 60479-2:2019, Figure 22 up to 1 000 V d.c. within 1 s after un-mating.

The steady-state touch current requirement is deemed to be fulfilled if it can be proven by design review, that there is no conductive path from electric power sources (e.g. RESS) to accessible conductive parts.

NOTE 1 The thresholds for steady-state touch current are derived from IEC 61140 and IEC 60479-1.

NOTE 2 Curve B of IEC 60479-2:2019, Figure 22 shows the typical threshold of pain.

Conformance is checked by design review.

6.2.8.3 Fault protection

In addition to the basic protection, at least one of the following provisions for fault protection shall be provided for each contact of the EV plug (case A) or the vehicle inlet (case B and case C) when it is not mated. The provision for fault protection shall be independent of and additional to that for the basic protection.

— protection against direct contact:

  — the contact shall be protected by the degree of protection IPXXD according to ISO 20653 within 1 s after un-mating.

— limitation of voltage:

  — the voltage between the contact and any other contact as well as the voltage between the contact and the electric chassis shall be below 60 V d.c and 30 V a.c. within the time specified in Table 1 after un-mating, depending on the degree of protection of the contacts against direct contact.

— limitation of steady-state touch current and energy:

  — the steady-state touch current between the contact and any other contact as well as the steady-state touch current between the contact and the electric chassis shall be below 3,5 mA a.c. and 10 mA d.c. within the time specified in Table 1 after un-mating, depending on the degree of protection of the contacts against direct contact, and

  — the available energy between the contact and any other contact as well as the available energy between the contact and the electric chassis shall provide adequate margin from the limit of ventricular fibrillation within the time specified in Table 1 after un-mating, depending on the degree of protection of the contacts against direct contact. The margin shall be specified by the vehicle manufacturer.

Table 1 — Time limit of de-energization

Degree of protection of contacts	Time limit
Contacts cannot be touched by a test probe 18 according to IEC 61032	10 s
Contacts are protected by IPXXB in accordance with ISO 20653	5 s
Contacts are not protected by IPXXB in accordance with ISO 20653	1 s

The steady-state touch current requirement is deemed to be fulfilled if it can be proven by design review, that there is no conductive path from electric power sources (e.g. RESS) to accessible conductive parts.

NOTE 1 The degree of protection IPXXD can be obtained, e.g. by automatically closing shutter.

NOTE 2 The thresholds for steady-state touch current are derived from IEC 61140 and IEC 60479-1.

NOTE 3 For the limit of ventricular fibrillation, see the IEC 60479-2.

Conformance is checked by design review.

6.3 Protection against thermal incident

6.3.1 Requirements for normal operation

The cross-sectional area of the live conductors of the vehicle power supply circuit shall be according to the rated current of the vehicle power supply circuit.

Conformance is checked by inspection.

6.3.2 Overcurrent protection

6.3.2.1 General

The vehicle power supply circuit shall have means to prevent a thermal incident caused by:

— an overload;

— a short circuit.

Different means to provide overcurrent protection may be used for different sections of a circuit.

NOTE Overcurrent protection is not a means for detection and interruption of serial or parallel arcing. Arcing can cause harm. Appropriate means to avoid arcing can be, for example, service plan, pollution degree, insulation, clearance, creepage distance.

6.3.2.2 Overload protection

The vehicle shall provide an overload protection to prevent the current exceeding the rated current of the vehicle power supply circuit, or to prevent exceeding the temperature limits of the vehicle power supply circuit.

NOTE The rated current of an external electric circuit can be higher than the rated current of the vehicle power supply circuit.

Conformance is checked by design review.

6.3.2.3 Short-circuit protection

The requirements in a) or b) shall be fulfilled for short-circuit protection.

a) The cross-sectional area of the live conductors of the vehicle power supply circuit shall have a short-circuit current withstand rating (I^2t) according to the maximum short-circuit currents of all applicable electric power sources.

b) Overcurrent protection shall be provided for live conductors of the vehicle power supply circuit according to their cross-sectional area.

Specific requirements are defined in other parts of the ISO 5474 series.

6.3.3 Residual energy after disconnection related to thermal incident

For the protection against thermal incident, one second after having disconnected the vehicle from the conductively connected external electric circuit (e.g. external electric power source), the stored energy at the voltage class B live parts at the plug (case A) or vehicle inlet (case B and case C) shall be less than 20 J.

NOTE 1 This requirement does not include a voltage limit.

NOTE 2 Circuits whose voltages are safe to touch according to 6.2.8 can become hazardous with respect to thermal hazards.

NOTE 3 The threshold value of 20 J is cited from IEC 60950-1:2005, 1.2.8.10.

Conformance is checked by design review.

6.3.4 Arc protection

If a vehicle is equipped with a vehicle inlet that is not suitable for making and breaking an electrical circuit under load, interlock function shall be provided.

NOTE Suitability for making and breaking under load is specified in the IEC 62196 series.