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

Part 3:  
DC power transfer

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## Foreword

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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)).

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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](http://www.iso.org/members.html).

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

## Part 3: DC power transfer

### 1 Scope

This document in combination with ISO 5474-1 specifies requirements for conductive power transfer using direct current (DC) with a voltage up to 1 500 V ~~DC~~dc between electrically propelled road vehicles and external electric circuits.

This document provides requirements for conductive charging in mode 4 according to IEC 61851-1. For mode 4, this document provides requirements regarding the power transfer only with isolated DC EV supply equipment according to IEC 61851-23.

The requirements in this document are applicable to vehicle power supply circuits

An outlook of requirements for megawatt charging applications is given in ~~Annex B~~Annex B.

This document does not provide:

- requirements for simultaneous operation of multiple power transfer interfaces 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);
- 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 5474-1:—1, *Electrically propelled road vehicles — Functional requirements and safety requirements for power transfer — Part 1: General requirements for conductive power transfer*

~~ISO 6469-1, *Electrically propelled road vehicles — Safety specifications — Part 1: Rechargeable energy storage system (RESS)*~~

ISO 6469-3:2021, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

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

<sup>1</sup> ~~First edition under~~ Under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023/2024.

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IEC 60364-4-43, *Low-voltage electrical installations — Part 4-43: Protection for safety — Protection against overcurrent (relevant parts will be specified during the project)*~~],~~

[IEC 61000-4-5, Electromagnetic compatibility \(EMC\) — Part 4-5: Testing and measurement techniques - Surge immunity test](#)

[IEC 61180, High-voltage test techniques for low-voltage equipment — Definitions, test and procedure requirements, test equipment](#)

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

IEC 61851-23:2023, *Electric vehicle conductive charging system — Part 23: DC electric vehicle charging station*

IEC 62196-3, *Plugs, socket-outlets, vehicle connectors and vehicle inlets — Conductive charging of electric vehicles — Part 3: Dimensional compatibility and interchangeability requirements for d.c. and 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 for DC charging intended to be used with a thermal management system*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5474-1 and the following 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 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 — “is” added to the Note to entry.]

#### 3.2 insulation monitoring device IMD

device which permanently monitors the insulation resistance to earth of unearthed AC IT systems, AC IT systems with galvanically connected DC circuits having nominal voltages up to 1 000 V AC, as well as monitoring the insulation resistance of unearthed DC IT systems with voltages up to 1 500 V DC, independent from the method of measuring

[SOURCE: IEC 61557-8:2014, 3.1.14]

<sup>2</sup>Under preparation. Stage at the time of publication: IEC/PRCV 61951-23:2022.



### 3.3

#### **insulation resistance monitoring system**

system that periodically or continuously monitors the insulation resistance between live parts and the electric chassis

[SOURCE: ISO 6469-3:2021, 3.24, ~~modified~~ — "isolation" has been replaced by "insulation".]

### 3.4

#### **thermal cut-out**

temperature sensing control device intended to switch-off automatically under abnormal operating conditions and which has no provision for adjustment by the user

[SOURCE: IEC 60050-442:1998, 442-01-43]

### 3.5

#### **thermal sensing**

means for providing temperature data of accessories, cable assemblies or parts thereof

[SOURCE: IEC 61851-23:—<sup>3</sup>:2023, 3.3.109]

### 3.6

#### **RESS SOC**

rechargeable energy storage system state of charge  
residual capacity of RESS available to be discharged

Note 1 to entry: RESS state of charge is normally expressed as a percentage of full charge.

[SOURCE: ISO/TR 11954:2008, 2.2]

### 3.7

#### **leakage current monitoring device**

passive electrical device for monitoring insulation resistance of separated DC system by measuring leakage current between live parts and exposed conductive parts or the protective conductor

[SOURCE: IEC 61851-23:—<sup>4</sup>:2023, 3.2.104]

### 3.8

#### **SPD**

surge protective device

device that contains at least one non-linear component that is intended to limit surge voltages and divert surge currents

[SOURCE: IEC 61643-11:2011, 3.1.1, ~~modified~~]

## 4 System architecture

ISO 5474-1:—<sup>5</sup>, Clause 4 applies.

<sup>3</sup> Under preparation. Stage at the time of publication: IEC/PRCV 61851-23:2022.

<sup>4</sup> Under preparation. Stage at the time of publication: IEC/PRCV 61851-23:2022.

<sup>5</sup> First edition under ~~Under~~ preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023/2024.

## 5 Environmental and operational conditions

ISO 5474-1:2017, Clause 5 applies.

## 6 General safety requirements

### 6.1 General

ISO 5474-1:2017, Clause 6.1 applies except as follows.

#### Addition:

Protection against electric shock for the vehicle power supply circuit shall comprise a provision for basic protection and a provision for fault protection according to the requirements in 6.2 clause.

Unless specified otherwise, "Alternative ~~Protection Measures~~ protection measures" according to ISO 6469-3:2021, 6.3.5 shall be applied directly between live parts of the vehicle power supply circuit and an ordinary person.

For all safety related functions, the vehicle shall carry out its own measurement of current and voltage, and shall not solely rely on values communicated via digital communication by the EV supply equipment.

NOTE Digital communication is considered to be not reliable in terms of safety.

### 6.2 Protection of persons against electric shock

#### 6.2.1 General

ISO 5474-1:2017, Clause 6.2.1 applies.

#### 6.2.2 Compatibility with external safety devices

##### 6.2.2.1 Insulation resistance monitoring system

The operation of the insulation monitoring device or/and the leakage current monitoring device of the external electric circuit, as specified in IEC 61851-23, shall not be affected. The vehicle should deactivate or disconnect its insulation resistance monitoring system to avoid such interference.

##### 6.2.2.2 Compatibility of a 1000-1000 V vehicle with 500 V EV supply equipment

If the vehicle contains circuits with a maximum working voltage between DC+ and DC- above 500 V and it is intended to be connected to DC EV supply equipment with a rated maximum DC output voltage below or equal to 500 V ~~DC d.c.~~, there is a risk that the voltage between the live conductors and protective conductor in the EV supply equipment exceeds 500 V. It can be caused by, but is not limited to, an insulation fault, see Figure 1, or asymmetric distribution of the insulation resistance between DC+/- ~~+/DC-~~ and the protective conductor in the section of the vehicle with a working voltage above 500 V ~~DC d.c.~~

The temporary overvoltage can trip SPDs in the EV supply equipment or damage components in the EV supply equipment.

The current caused by those effects can subsequently:

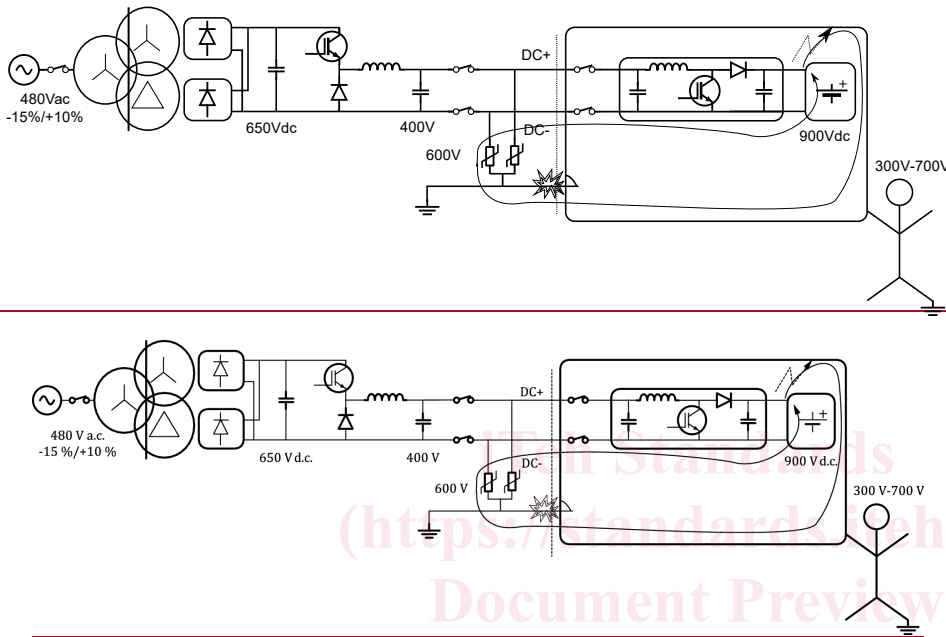
- ~~cause a touch voltage between earth and vehicle chassis, and/or~~

<sup>6</sup> First edition under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023.

<sup>7</sup> First edition under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023.

<sup>8</sup> First edition under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023.

- damage the protective conductor connection between the vehicle and the DC supply equipment as a secondary effect.



**Figure 1** — Single fault scenario of a ~~4000-1 000~~ V vehicle with 500 V EV supply equipment

The vehicle manufacturer shall perform a safety analysis to minimize the risk of a hazardous electric shock caused by the effects above. The protection measures are, but not limited to:

- ~~The~~ vehicle shall disconnect the vehicle power supply circuit from the EV supply equipment in less than 5 s if the voltage between the live conductors and protective conductor exceeds 500 V in the section of the vehicle power supply circuit with a working voltage of less than or equal to 500 V.

and

the vehicle shall either:

- ~~a)~~ have a vehicle power supply circuit with a maximum working voltage up to 500 V and provide simple separation between the vehicle power supply circuit and any circuit which has a working voltage above 500 V

or

- ~~b)~~ implement double or reinforced insulation between the live parts of the vehicle power supply circuit (including the RESS) with a working voltage above 500 V and electric chassis/voltage class A circuit

or

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- c) ~~e)~~ limit the operating joule integral  $\int i^2 dt$  in consideration of IEC 60364-5-54 and limit the duration of touch voltage between electric chassis and earth or EV supply equipment housing in consideration of IEC 60479 series.

### 6.2.2.3 Y-capacitance coordination

The total y-capacitance of the vehicle power supply circuit shall not exceed 4  $\mu$ F.

For a vehicle equipped with a vehicle inlet according to IEC ~~TS~~ 62196-3-1 or IEC 62196-3 configuration AA with a maximum working voltage up to 500 V ~~DC, d.c.~~, the y-capacitance of the vehicle power supply circuit shall not exceed 1,1  $\mu$ F per live conductor and 2,2  $\mu$ F in total y-capacitance.

For a vehicle with a vehicle inlet according to IEC ~~TS~~ 62196-3-1 or IEC 62196-3 configuration AA, configuration EE or configuration FF and a maximum working voltage above 500 V ~~DC, d.c.~~, the total y-capacitance of the vehicle power supply circuit shall not exceed the limits according to Formula (1) ~~Formula (1)~~.

$$C_y = \frac{1,6}{1000 \cdot U} \quad (1)$$

where

$C_y$  is the total y-capacitance, expressed in Farad (F);

$U$  is the maximum working voltage, expressed in Volt (V).

NOTE The formula assumes a measurement current of the IMD of 1 mA and limits the time to perform a single measurement for one live conductor to 8 s. This supports a total time for a complete measurement cycle for the vehicle of 30 s without consideration of the added y-capacitance of the external electric circuit.

For a vehicle with a vehicle inlet according to IEC ~~TS~~ 62196-3-1 or IEC 62196-3 configuration BB the Y-capacitance of the EV supply equipment shall be considered.

The y-capacitance per live conductor should be balanced by choosing appropriate design values.

Conformance is checked by inspection and by test. An example for a test is given in [Annex A](#).

### 6.2.2.4 Compatibility with the special protection of the DC EV supply equipment

To support the special protection of the DC EV supply equipment, the total y-capacitance of the vehicle power supply circuit shall not exceed the limits according to ~~6.2.2.3 sub-clause~~.

NOTE 1 The special protection is provided by the DC EV supply equipment according to ~~clause 8.105.1 of IEC 61851-23~~; ~~2023, 8.105.1~~.

NOTE 2 The Y capacitance threshold from ~~6.2.2.3~~ by itself does not provide additional protection for vehicles with a maximum working voltage above 500 V ~~DC, d.c.~~ when the vehicle is disconnected from the DC EV supply equipment. For protection of persons against electric shock when not connected to an external electric circuit, see ISO 6469-3.

## 6.2.3 Insulation resistance

ISO 5474-1: ~~10, Clause 1~~; ~~6.2.3~~ applies.

## 6.2.4 Touch current

ISO 5474-1: ~~10, Clause~~; ~~6.2.4~~ applies except as follows.

<sup>9</sup> Under preparation. Stage at the time of publication: IEC/PRCV 61851-23:2022.

<sup>10</sup> First edition under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023.

<sup>11</sup> First edition under preparation. Stage at the time of publication: ISO/FDIS 5474-1:2023.