

INTERNATIONAL STANDARD

**Conductive charging of electric vehicles - Contact interface for automated
connection device (ACD)**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Conductive charging of electric vehicles - Contact interface for automated connection device (ACD)

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IEC 63407 has been prepared by subcommittee 23H: Plugs, socket-outlets and couplers for industrial and similar applications, and for electric vehicles, of IEC technical committee 23: Electrical accessories. It is an International Standard.

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

Draft	Report on voting
23H/614/FDIS	23H/624/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.

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INTRODUCTION

The electrical interface for charging electrically propelled vehicles with plugs, socket-outlets, vehicle connectors and vehicle inlets is described in the IEC 62196 series and in IEC 61851-23. For heavier vehicles such as buses and trucks, requirements of short charging times with high energy present a problem of handling, and safety with hand-held connecting devices. For these high current charging applications, an automated connection device (ACD) is of interest.

An automatic coupler consists of a mobile assembly with electrical contacts, called "ACD", and fixed electrical contacts, called "ACD counterpart". Automatic couplers allow an unmanned connection of high-current, signal, and control contacts.

This document contains requirements for all type of ACDs. Annex A, Annex B, Annex C and Annex D describe specific implementations and specific requirements.

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1 Scope

This document is applicable to automatic couplers, consisting of an automated connection device (ACD) and an ACD counterpart, of standardized configuration, intended for use in electric vehicle conductive charging systems which incorporate control means, with rated operating voltage up to 1 500 V DC. This document applies to high power DC interfaces intended for use in isolated conductive charging systems, for circuits specified in IEC 61851-23-1.

The requirements of this document apply only to automatic couplers defined in Annex A, Annex B, Annex C and Annex D of this document.

The ACDs covered by this document are used only in charging mode 4, according to case D (IEC 61851-23-1:2026, 3.1.201) or case E (IEC 61851-23-1:2026, 3.1.202).

This document describes the requirements for automatic couplers in regard of safety, function and testing. This document describes basic parameters that can be standardized for different automatic couplers. Automatic couplers following these standardized parameters will have the benefit of being compatible, even if they are based on different technologies.

This document does not apply to solutions based on a vehicle connector described in IEC 62196-3 or in IEC TS 63379 driven by an automatic mechanism, as, for instance, a robotic arm.

This document does not apply to ACD systems described in IEC TS 61851-26.

This document does not cover all safety aspects related to maintenance.

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 60068-2-11:2021, *Environmental testing - Part 2-11: Tests - Test Ka: Salt mist*

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

IEC 60364-5-54:2011, *Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors*

IEC 60512-2-2:2003, *Connectors for electronic equipment - Tests and measurements - Part 2-2: Electrical continuity and contact resistance tests - Test 2b: Contact resistance - Specified test current method*

IEC 60512-5-1:2002, *Connectors for electronic equipment - Tests and measurements - Part 5-1: Current-carrying capacity tests - Test 5a: Temperature rise*

IEC 60512-5-2:2002, *Connectors for electronic equipment - Tests and measurements - Part 5-2: Current-carrying capacity tests - Test 5b: Current-temperature derating*

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

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013

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

IEC 61851-23-1:2026, *Electric vehicle conductive charging system - Part 23-1: DC electric vehicle supply equipment - Automated connection device*

IEC 61984:2008, *Connectors - Safety requirements and tests*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment - Part 1: General*

IEC 62497-1:2010, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*
IEC 62497-1:2010/AMD1:2013

ISO 5474-3:2024, *Electrically propelled road vehicles - Functional and safety requirements for power transfer between vehicle and external electric circuit - Part 3: DC power transfer*

EN 1652:1998, *Copper and copper alloys - Plate, sheet, strip and circles for general purposes*

EN 12163:2024, *Copper and copper alloys - Rod for general purposes*

EN 12167:2024, *Copper and copper alloys - Profiles and bars for general purposes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61851-23-1 and the following 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

working position

position reached when the ACD and the ACD counterpart have mated and conductive physical contact is established, and electric energy transfer is allowed

Note 1 to entry: The working position is identical to the definition of "charging device status" in IEC 61851-23-1:2026, 3.1.209.

3.2

home position

position where the ACD is not engaged with its counterpart and where safe clearance is present with street, vehicle and infrastructure

3.3

keep-out zone

space around an automatic coupler, where no items are installed to avoid collision with any moving part of the ACD or ACD counterpart

4 Electrical requirements

4.1 Voltage and current requirements

4.1.1 Number of contacts and their function

For systems described in IEC 61851-23-1:2026, Annexes BB and CC:

- four contacts: DC+, DC–, PE and CP (IEC 61851-23-1:2026, Figure BB.201 and IEC 61851-23-1:2026, Figure CC.202).

For systems described in IEC 61851-23-1:2026, Annex BBB:

- three contacts: DC+, DC–, PE (IEC 61851-23-1:2026, Figure BBB.3).

4.1.2 Quality of DC charging voltage

Since the ACD is part of the power transmitting system, its influence on the quality of DC charging voltage shall be considered, to not exceed the levels indicated in IEC 61851-23-1:2026, 101.1.6.

4.1.3 Rated continuous current

The rated current can be a continuous current or the average of an intermittent current.

The rated current is defined by the vehicle and the application. The manufacturer of the ACD shall guarantee that his system is sized and safe for this current by confirming the physical values described in this document.

In the case of an automatic coupler consisting of an ACD and an ACD counterpart from different or unknown manufacturers, the minimum current requirements that fulfil the requirements for a particular annex of this document shall be assumed unless there are sensing devices that can reliably determine if the ACD is operating within the defined limits of this document. However, if the ACD and the ACD counterpart can be definitively determined to be of a particular type and manufacturer, higher currents with or without sensing devices can be used, according to manufacturer's specifications.

4.1.4 Short-circuit current

In case of a short circuit between DC+ and DC– or between DC+ and PE or between DC– and PE, the ACD shall not cause a dangerous situation such as an explosion or a fire. After such a short circuit, the ACD shall be checked for proper function prior to further service. The procedure for checking proper function shall be part of the maintenance manual.

The values of short circuit current and short circuit energy that shall be considered are 30 kA and 12 MA²s respectively.

NOTE In case a first fault is not detected, a second fault can lead to currents in the protective conductor up to the short-circuit current of the system. The fault current is based on the requirements in ISO 5474-3, i.e. 30 kA short circuit current, and the let through energy is based on 12 MA²s from ISO 17409:2015¹ provided by the vehicle and 1 MA²s provided by the EVSE. Compliance of short-circuit current is checked by inspection.

¹ This publication has been withdrawn.

4.1.5 Maximum temperature of contacts

The contacts of the automatic coupler heat up depending on the charging current (continuous or intermittent current). This temperature rise shall be considered by the system integrator to ensure that there can be no harmful effects on materials or devices near the coupler on both the vehicle and infrastructure sides. The ACD and ACD counterpart manufacturers shall indicate the maximum temperature rise for a rated current and the ambient temperature at which it is reached in their documentation.

Compliance is checked by inspection.

4.2 Signals

The minimum signals required are the status (the position) of the ACD. All other signalling necessary for pairing or charging are described in IEC 61851-23-1 or in the ISO 15118 series.

Signal 1: ACD is in home position, in IEC 61851-23-1:2026, 201.3.

Signal 2: ACD has reached working position, IEC 61851-23-1:2026, 6.3.1.3.

Compliance is checked by the test in Table 2, test no. B.8.

The home position signal is a "safety-related part of a control system (SRP/CS)" as defined in ISO 13849-1:2023, 3.1.1 (see IEC 61851-23-1:2026, 201.3).

There can be a timeout if ACD is moved but the working position has not been reached in a specific time frame. This time frame shall be defined by the ACD manufacturer in their documentation.

Compliance is checked by inspection.

5 Safety requirements

5.1 General

Additional relevant safety requirements in regard of the system are given in IEC 61851-23-1.

5.2 Size and colour of protective earthing conductors

The conductor connected to the protective earthing terminal shall be identified by the colour combination green-and-yellow.

NOTE 1 In the following countries, the colour green may be used to identify the earthing conductor: JP, US, CA. Compliance is checked by inspection and measurement.

Compliance is checked by inspection.

The protective earthing conductor or protective conductor shall fulfil for a short-circuit current supplied by the EV supply equipment due to the following fault conditions.

The limit of the peak current for a short-circuit current, including transient effects, is 30 kA at the protective earthing conductor or protective conductor according to IEC 61851-23-1:2026, 13.101. The protective earthing conductor or protective conductor shall comply with the requirements of IEC 61851-23-1:2026, Table 202, or shall be of sufficient cross-sectional area calculated by the I^2t -methodology according to the formula in IEC 60364-5-54:2011, 543.1.2, by using I^2t_{SUM} .

NOTE 2 The minimum cross-sectional area of the protective conductor is 35 mm² according to IEC 61851-23-1:2026, Clause BB.14, for system B, IEC 61851-23-1:2026, Clause CC.4.6, for system C, and IEC 61851-23-1:2026, Clause BBB.4.6, for system C with three contacts automatic coupler.

The $I^2t_{\text{EV supply equipment}}$ -values for the respective protective earthing conductor or protective conductor, used in the calculation, shall be 1 MA²s provided by the EVSE based on IEC 61851-23-1:2026, 13.101.

The I^2t_{EV} -values for the vehicle live parts for the respective protective earthing conductor or protective conductor, used in the calculation, shall be 12 MA²s provided by the EV based on ISO 17409:2015, 6.1.3.

The summarized I^2t -value shall be determined by the following formula:

$$I^2t_{\text{SUM}} = \left(\sqrt{I^2t_{\text{EV supply equipment}}} + \sqrt{I^2t_{\text{EV}}} \right)^2$$

The protective earthing conductor shall be of sufficient cross-sectional area calculated by the I^2t -methodology according to the formula in 543.1.2 of IEC 60364-5-54:2011 by using I^2t_{SUM} . The manufacturer shall state the I^2t_{SUM} value of the conductor in the product data sheet (PDS).

NOTE 3 In the following country, the size and rating of the protective conductor is specified in national codes and regulations: CA.

Compliance is checked by inspection.

5.3 Malfunction in reaching home position

In case of blocking physical obstacles or other reasons, it is possible that the ACD does not reach the home position. There shall be an installed signal (signal 1) that monitors the ACD to reach the home position (see 4.2). This shall be realized by the ACD itself and communicated to the overall system (EV or EV supply equipment).

NOTE For reaction of this missing home position signal, refer to IEC 61851-23-1:2026, CC.5.202, BBB.5.202.

5.4 Contact sequence

According to IEC 61851-23-1:2026, CC.5.201 and BBB.5.201, the connection and disconnection of the ACD is done without current and voltage less than 60 V under normal operation; therefore, it is not necessary to have a contact sequence.

However, if a contact sequence is applied, the order of disconnection shall be one or more of:

- CP contact;
- DC power contacts;
- PE contact;

Or

- PE contact;
- DC power contacts;
- CP contact;

Or

- CP and PE contacts;
- DC power contacts.

The ACD shall be classified by the manufacturer as either suitable or not suitable to break under load depending on whether or not breaking under load is possible under normal operation, see IEC 61851-23-1:2026, 9.101.

NOTE It has been demonstrated that an ACD coupler according to Clause A.2 and Clause A.3 cannot be constructed as being suitable to break under load unless the three disconnection sequences above are applicable. For example, an unexpected loss of contact force or a bus that kneels during charging could cause the ACD rails to slide relative to the ACD counterpart, causing a disconnection of one or more contacts. It is possible to build an ACD coupler according to Clause A.2 or Clause A.3 to disconnect the CP and/or PE before the power contacts to avoid arcing if the disconnection sequence follows one or more of the above sequences.

Compliance is checked by test in 8.2.2.

5.5 Return to home position

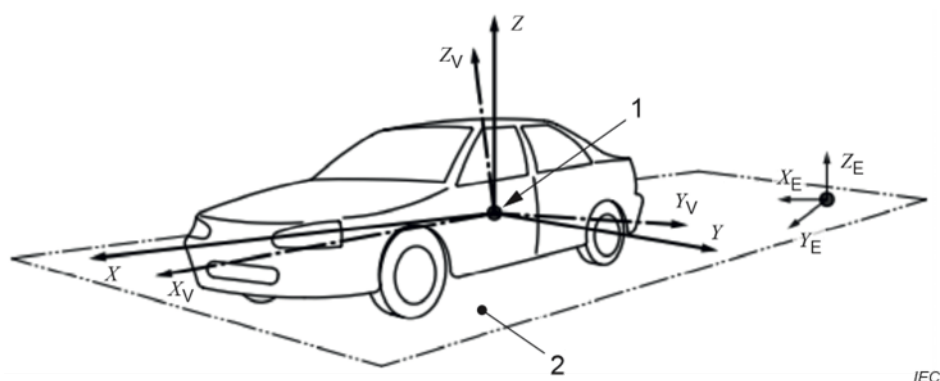
In case of an intentional or unintentional loss of supply power for the actuator of the ACD, the ACD shall return to its home position. For details, refer to IEC 61851-23-1:2026, 201.4.

Compliance is checked by test in Table 2, test no.B3.

6 Mechanical requirements

6.1 Grid of parallels and meridians

The coordinate system used within this document is shown in Figure 1.



Key

- 1 reference point
- 2 ground level

Figure 1 – Grid of parallels and meridians according to ISO 8855