

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



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

**Fiches, socles de prise de courant, prises mobiles de véhicule et socles de connecteurs de véhicule – Charge conductive des véhicules électriques –  
Partie 1: Exigences générales**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

---

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Recherche de publications IEC - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



---

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

**Fiches, socles de prise de courant, prises mobiles de véhicule et socles de connecteurs de véhicule – Charge conductive des véhicules électriques –  
Partie 1: Exigences générales**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 29.120.30; 43.120

ISBN 978-2-8322-1101-1

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD .....	6
INTRODUCTION .....	8
1 Scope .....	9
2 Normative references .....	9
3 Terms and definitions .....	11
4 General .....	21
4.1 General requirements .....	21
4.2 Components .....	21
4.2.1 Ratings .....	21
4.2.2 Mechanical assembly .....	21
4.2.3 Current-carrying parts of incorporated components .....	21
4.2.4 Electrical connections .....	21
4.3 General notes on tests .....	22
5 Ratings .....	23
5.1 Preferred rated operating voltage ranges .....	23
5.2 Preferred rated currents .....	23
5.2.1 General .....	23
5.2.2 Rated current for signal or control purposes .....	24
5.2.3 Accessories not suitable for making and breaking an electrical circuit under load .....	24
5.2.4 Accessories suitable for, or not suitable for, making and breaking an electrical circuit under load .....	24
6 Connection between the power supply and the electric vehicle .....	24
6.1 Interfaces .....	24
6.2 Basic interface .....	24
6.3 DC interface .....	24
6.4 Combined interface .....	24
7 Classification of accessories .....	25
7.1 According to purpose .....	25
7.2 According to the method of connecting the conductors .....	25
7.3 According to serviceability .....	25
7.4 According to electrical operation .....	25
7.5 According to interface .....	25
7.6 According to locking facilities .....	25
7.7 According to interlock facilities .....	25
7.8 According to the presence of shutter(s) .....	25
8 Marking .....	25
9 Dimensions .....	28
10 Protection against electric shock .....	29
10.1 General .....	29
10.2 Accessories with shutters .....	29
10.3 Contact sequencing and order of contact insertion and withdrawal .....	32
10.4 Misassembly .....	33
11 Size and colour of protective earthing and neutral conductors .....	33
12 Provisions for earthing .....	34

13	Terminals .....	36
13.1	Common requirements .....	36
13.2	Screw type terminals .....	38
13.3	Mechanical tests on terminals .....	40
14	Interlocks .....	43
14.1	Accessories with interlock .....	43
14.2	Accessories with integral switching device .....	48
14.3	Control circuit devices and switching elements .....	48
14.4	Pilot contacts and auxiliary circuits .....	48
15	Resistance to ageing of rubber and thermoplastic material .....	48
16	General construction .....	49
17	Construction of EV socket-outlets – General .....	53
18	Construction of EV plugs and vehicle connectors .....	53
19	Construction of vehicle inlets .....	54
20	Degrees of protection .....	54
21	Insulation resistance and dielectric strength .....	56
22	Breaking capacity .....	57
23	Normal operation .....	60
23.1	Mechanical, electrical, and thermal stresses and contaminants .....	60
23.2	Load endurance test .....	60
23.3	No-load endurance test .....	61
23.4	Lid springs .....	62
24	Temperature rise .....	62
25	Flexible cables and their connection .....	64
25.1	Strain relief .....	64
25.2	Requirements for EV plugs and vehicle connectors .....	64
25.2.1	Non-rewirable EV plugs and vehicle connectors .....	64
25.2.2	Rewirable EV plugs and vehicle connectors .....	64
25.3	EV plugs and vehicle connectors provided with a flexible cable .....	65
26	Mechanical strength .....	67
26.1	General .....	67
26.2	Ball impact .....	68
26.3	Drop test .....	69
26.4	Flexing test .....	70
26.5	Cable gland test .....	72
26.6	Shutters .....	73
26.7	Insulated end caps .....	73
26.7.1	General .....	73
26.7.2	Insulated end caps – Change of temperature test .....	74
26.7.3	Insulated end caps – Pull test .....	74
27	Screws, current-carrying parts and connections .....	74
28	Creepage distances, clearances and distances through sealing compound .....	77
29	Resistance to heat and to fire .....	78
30	Corrosion and resistance to rusting .....	79
31	Conditional short-circuit current .....	80
31.1	General .....	80

31.2	Ratings and test conditions .....	80
31.3	Test circuit.....	81
31.4	Calibration .....	84
31.5	Test procedure.....	84
31.6	Behaviour of the equipment under test.....	85
31.7	Acceptance conditions .....	85
32	Electromagnetic compatibility .....	85
32.1	Immunity.....	85
32.2	Emission.....	85
33	Vehicle drive over.....	85
34	Thermal cycling .....	86
34.1	General.....	86
34.2	Initial temperature rise test .....	86
34.3	Thermal cycling test.....	86
34.4	Final temperature rise test .....	86
35	Humidity exposure.....	87
35.1	General.....	87
35.2	Initial temperature rise test .....	87
35.3	Humidity test.....	87
35.4	Final temperature rise test .....	87
36	Misalignment .....	87
36.1	General.....	87
36.2	Samples.....	88
36.3	Misalignment test.....	88
37	Contact endurance test.....	90
37.1	Equipment .....	90
37.2	Test sequence .....	91
37.3	Compliance.....	92
	Bibliography.....	94
	Figure 1 – Diagram showing the use of the accessories.....	12
	Figure 2 – Lug terminals .....	16
	Figure 3 – Mantle terminals.....	16
	Figure 4 – Pillar terminals .....	17
	Figure 5 – Saddle terminals .....	18
	Figure 6 – Screw-type terminals.....	19
	Figure 7 – Stud terminals .....	20
	Figure 8 – Test piston .....	28
	Figure 9 – Gauge "A" for checking shutters.....	31
	Figure 10 – Gauge "B" for checking shutters.....	32
	Figure 11 – Gauges for testing insertability of round unprepared conductors having the maximum specified cross-section.....	39
	Figure 12 – Equipment test arrangement .....	41
	Figure 13 – Apparatus for checking the withdrawal force.....	46
	Figure 14 – Verification of the latching device.....	47
	Figure 15 – Circuit diagrams for breaking capacity and normal operation tests .....	59

Figure 16 – Points of measurement.....	64
Figure 17 – Apparatus for testing the cable anchorage .....	66
Figure 18 – Ball impact test .....	68
Figure 19 – Arrangement for mechanical strength test for EV plugs and vehicle connectors.....	70
Figure 20 – Apparatus for flexing test .....	72
Figure 21 – Diagram of the test circuit for the verification of short-circuit current withstand of two-pole equipment on a single-phase AC or DC.....	82
Figure 22 – Diagram of the test circuit for the verification of short-circuit current withstand of three-pole equipment .....	83
Figure 23 – Diagram of the test circuit for the verification of short-circuit current withstand of four-pole equipment .....	84
Figure 24 – Overview of the mechanical load test .....	89
Figure 25 – Application of external mechanical load (mounted according to Figure 24) .....	89
Figure 26 – Temperature rise criteria under external mechanical load.....	90
Figure 27 – Forced-air circulating oven .....	90
Figure 28 – Thermal cycling.....	92
Figure 29 – Pass/fail based on temperature rise criteria.....	93
Table 1 – Size for conductors .....	34
Table 2 – Short-time test currents .....	35
Table 3 – Values for flexing under mechanical load test.....	42
Table 4 – Value for terminal pull test.....	43
Table 5 – Withdrawal force with respect to ratings .....	47
Table 6 – Cable length used to determine pull force on retaining means .....	50
Table 7 – Test voltage for dielectric strength test.....	57
Table 8 – Breaking capacity .....	60
Table 9 – Normal operation.....	61
Table 10 – Test current and nominal cross-sectional areas of copper conductors for temperature rise test.....	63
Table 11 – Pull force and torque test values for cable anchorage.....	67
Table 12 – Summary of mechanical tests.....	67
Table 13 – Impact energy for ball impact test.....	69
Table 14 – Mechanical load flexing test .....	71
Table 15 – Torque test values for glands .....	73
Table 16 – Pulling force on insulated end caps .....	74
Table 17 – Tightening torque for verification of mechanical strength of screw-type terminals.....	75

# INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

## **PLUGS, SOCKET-OUTLETS, VEHICLE CONNECTORS AND VEHICLE INLETS – CONDUCTIVE CHARGING OF ELECTRIC VEHICLES –**

### **Part 1: General requirements**

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62196-1 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.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) deletion of references to universal AC and DC interfaces;
- b) additional requirements for contact materials and plating;
- c) changes to the temperature rise test to include additional points of measurement;
- d) additional tests for accessories to address thermal stresses and stability, mechanical wear and abuse, and exposure to contaminants;

e) relocation of information and requirements for DC charging to IEC 62196-3.

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

Draft	Report on voting
23H/499/FDIS	23H/503/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

A list of all parts in the IEC 62196 series, published under the general title *Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles*, can be found on the IEC website.

Subsequent parts of IEC 62196 deal with the requirements of particular types of accessories. The clauses of those particular requirements supplement or modify the corresponding clauses in this document.

In this document, the following print types are used:

- requirements proper: in roman type;
- *test specifications: in italic type;*
- notes: in smaller roman type.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

<p><b>IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.</b></p>
--

## INTRODUCTION

IEC 61851 (all parts) specifies requirements for electric vehicle (EV) conductive charging systems.

IEC 62196 (all parts) specifies the requirements for plugs, socket-outlets, vehicle connectors, vehicle inlets and cable assemblies as described in the IEC 61851 series.

Some charging can be achieved by direct connection from an electric vehicle to standard socket-outlets connected to a supply network (mains or electrical grid).

Some modes of charging require a dedicated supply and charging equipment incorporating control and communication circuits.

IEC 62196 (all parts) covers the mechanical, electrical and performance requirements for plugs, socket-outlets, vehicle connectors and vehicle inlets for the connection between the EV supply equipment and the electric vehicle.

The IEC 62196 series consists of the following parts:

- Part 1: General requirements, comprising clauses of a general character.
- Part 2: Dimensional compatibility and interchangeability requirements for AC pin and contact-tube accessories.
- Part 3: Dimensional compatibility and interchangeability requirements for DC and AC/DC pin and contact-tube vehicle couplers.
- Part 3-1: Vehicle connector, vehicle inlet and cable assembly intended to be used with a thermal management system for DC charging.
- Part 4<sup>1</sup>: Dimensional compatibility and interchangeability requirements for DC pin and contact-tube accessories for Class II or Class III applications.
- Part 6: Dimensional compatibility and interchangeability requirements for DC pin and contact-tube couplers for applications using a system of protective electrical separation.

---

<sup>1</sup> Pending publication.

# PLUGS, SOCKET-OUTLETS, VEHICLE CONNECTORS AND VEHICLE INLETS – CONDUCTIVE CHARGING OF ELECTRIC VEHICLES –

## Part 1: General requirements

### 1 Scope

This part of IEC 62196 is applicable to EV plugs, EV socket-outlets, vehicle connectors, vehicle inlets, herein referred to as "accessories", and to cable assemblies for electric vehicles (EV) intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding:

- 690 V AC 50 Hz to 60 Hz, at a rated current not exceeding 250 A;
- 1 500 V DC at a rated current not exceeding 800 A.

These accessories and cable assemblies are intended to be installed by instructed persons (IEV 195-04-02) or skilled persons (IEV 195-04-01) only.

These accessories and cable assemblies are intended to be used for circuits specified in IEC 61851 (all parts), which operate at different voltages and frequencies, and which can include extra-low voltage and communication signals.

These accessories and cable assemblies are intended to be used at an ambient temperature between  $-30\text{ °C}$  and  $+40\text{ °C}$ .

NOTE 1 In some countries, other requirements can apply.

NOTE 2 In the following country,  $-35\text{ °C}$  applies: SE.

NOTE 3 The manufacturer can enlarge the temperature range on the condition that the specified range information is provided.

These accessories are intended to be connected only to cables with copper or copper-alloy conductors.

The accessories covered by this document are intended for use in electric vehicle supply equipment in accordance with IEC 61851 (all parts).

This document does not apply to standard plug and socket-outlets used for mode 1 and mode 2 according to IEC 61851-1:2017, 6.2.

NOTE 4 In the following countries, mode 1 is not allowed: UK, US, CA, SG.

### 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 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*