SLOVENSKI STANDARD
SIST EN 61851-21-1:2018

01-januar-2018

Nadomešča:
SIST EN 61851-21:2002

Sistem kabelskega napajanja električnih vozil - 21-1. del: Zahteve EMC za vgrajen napajalnik pri kabelski priključitvi na izmenično/enosmerno napajanje

Electric vehicle conductive charging system - Part 21-1: Electric vehicle onboard charger EMC requirements for conductive connection to an a.c./d.c. supply

Ta slovenski standard je istoveten z: EN 61851-21-1:2017

ICS:

43.120	Električna cestna vozila	Electric road vehicles

SIST EN 61851-21-1:2018 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61851-21-1

October 2017

ICS 43.120

English Version

Electric vehicle conductive charging system - Part 21-1: Electric vehicle on-board charger EMC requirements for conductive connection to an AC/DC supply (IEC 61851-21-1:2017)

Système de charge conductive pour véhicules électriques - Partie 21-1: Exigences relatives à la CEM concernant les chargeurs embarqués pour véhicules électriques pour la connexion conductive à une alimentation en courant alternatif ou continu (IEC 61851-21-1:2017)

Konduktive Ladesysteme für Elektrofahrzeuge - Teil 21-1: EMV-Anforderungen an Bordladegeräte für Elektrofahrzeuge mit Wechselstrom/Gleichstrom-Versorgung (IEC 61851-21-1:2017)

This European Standard was approved by CENELEC on 2017-07-24. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 61851-21-1:2017 E

European foreword

The text of document 69/507/FDIS, future edition 1 of IEC 61851-21-1, prepared by IEC/TC 69 "Electric road vehicles and electric industrial trucks" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61851-21-1:2017.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2018-04-27
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2020-10-27

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

Endorsement notice

The text of the International Standard IEC 61851-21-1:2017 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61851-21-2:—[1]	NOTE	Harmonized as EN 61851-21-2:—[2].
ISO 15118-3	NOTE	Harmonized as EN ISO 15118-3.
CISPR 16-1-4:2010	NOTE	Harmonized as EN 55016-1-4:2010 (not modified).
CISPR 16-1-4:2010/A1:2012	NOTE	Harmonized as EN 55016-1-4:2010/A1:2012 (not modified).
CISPR 16-1-4:2010/A2:2017	NOTE	Harmonized as EN 55016-1-4:2010/A2:2017 (not modified).

[1] Under preparation. Stage at the time of publication: IEC PRVC 61851-21-2:2017.

[2] Under preparation. Stage at the time of publication: FprEN 61851-21-2:2017.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60038 (mod)	2009	IEC standard voltages	EN 60038 [3]	2011
IEC 61000-3-2	2014	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	EN 61000-3-2	2014
IEC 61000-3-3	2013	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	EN 61000-3-3	2013
IEC 61000-3-11	2000	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	EN 61000-3-11	2000
IEC 61000-3-12	2011	Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase	EN 61000-3-12	2011
IEC 61000-4-4	2012	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	2012
IEC 61000-4-5	2014	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	2014
IEC 61000-6-3	2006	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	2007
+A1	2010		+A1	2011
IEC 61851-1	2010	Electric vehicle conductive charging system - Part 1: General requirements	EN 61851-1	2011

[3] The title of EN 60038 is "CENELEC standard voltages".

Publication	Year	Title	EN/HD	Year
CISPR 12	2007	Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers	EN 55012	2007
+A1	2009		+A1	2009
CISPR 16-1-2	2014	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-2: Radio disturbance and immunity measuring apparatus - Coupling devices for conducted disturbance measurements	EN 55016-1-2	2014
CISPR 16-2-1	2014	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements	EN 55016-2-1	2014
CISPR 22 (mod)	2008	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	EN 55022 +AC	2010 [4] 2011 [4]
CISPR 25	2016	Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers	EN 55025	2017
ISO/TR 8713	2012	Electrically propelled road vehicles - Vocabulary	-	-
ISO 7637-2	2011	Road vehicles - Electrical disturbances from conduction and coupling - Part 2: Electrical transient conduction along supply lines only	-	-
ISO 11451-1	2015	Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 1: General principles and terminology	-	-
ISO 11451-2	2015	Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Off-vehicle radiation sources	-	-
ISO 11452-1	2015	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 1: General principles and terminology	-	-
ISO 11452-2	2004	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Absorber-lined shielded enclosure	-	-
ISO 11452-4	2011	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part-4: Harness excitation methods	-	-

[4] Superseded by EN 55032:2012 (CISPR 32:2012) and EN 50561-1:2013.

IEC 61851-21-1

Edition 1.0 2017-06

INTERNATIONAL STANDARD

colour inside

Electric vehicle conductive charging system – Part 21-1: Electric vehicle on-board charger EMC requirements for conductive connection to an AC/DC supply

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 43.120

ISBN 978-2-8322-4432-6

CONTENTS

FOREWORD 5
1 Scope 7
2 Normative references 7
3 Terms and definitions 8
4 General test conditions 9
5 Test methods and requirements 10
5.1 General 10
5.1.1 Overview 10
5.1.2 Exceptions 10
5.2 Immunity 10
5.2.1 General 10
5.2.2 Function performance criteria 11
5.2.3 Test severity level 11
5.2.4 Immunity of vehicles to electrical fast transient/burst disturbances conducted along AC and DC power lines 12
5.2.5 Immunity of vehicles to surges conducted along AC and DC power lines 12
5.2.6 Immunity to electromagnetic radiated RF-fields 15
5.2.7 Immunity to pulses on supply lines 20
5.2.8 Immunity test and severity level overview 20
5.3 Emissions 23
5.3.1 Test conditions 23
5.3.2 Emissions of harmonics on AC power lines 23
5.3.3 Emission of voltage changes, voltage fluctuations and flicker on AC power lines 26
5.3.4 High-frequency conducted disturbances on AC or DC power lines 27
5.3.5 High-frequency conducted disturbances on network and telecommunication access 30
5.3.6 High-frequency radiated disturbances 32
5.3.7 Radiated disturbances on supply lines 37
Annex A (normative) Artificial networks, asymmetric artificial networks and integration of charging stations into the test setup 38
A.1 Overview 38
A.2 Charging station and power mains connection 38
A.3 Artificial networks (AN) 39
A.3.1 General 39
A.3.2 Low voltage (LV) powered component 39
A.3.3 High voltage (HV) powered component 40
A.3.4 Components involved in charging mode connected to DC power supply 42
A.4 Artificial mains networks (AMN) 43
A.5 Asymmetric artificial networks (AAN) 43
A.5.1 General 43
A.5.2 Symmetric communication lines (e.g. CAN) 43
A.5.3 PLC on power lines 44
A.5.4 PLC (technology) on control pilot 45
Bibliography 47

Figure 1 – Electrical fast transient/burst test vehicle setup 12

Figure 2 – Vehicle in configuration "REESS charging mode coupled to the power grid" – coupling between lines for AC (single phase) and DC power lines 13
Figure 3 – Vehicle in configuration "REESS charging mode coupled to the power grid" – coupling between each line and earth for AC (single phase) and DC power lines 13
Figure 4 – Vehicle in configuration "REESS charging mode coupled to the power grid" – coupling between lines for AC (three phases) power lines 14
Figure 5 – Vehicle in configuration "REESS charging mode coupled to the power grid" – coupling between each line and earth for AC (three phases) power lines 14
Figure 6 – Example of test setup for vehicle with inlet located on the vehicle side (AC/DC power charging without communication) 16
Figure 7 – Example of test setup for vehicle with inlet located at the front/rear of the vehicle (AC/DC power charging without communication) 17
Figure 8 – Example of test setup for vehicle with inlet located on vehicle side (AC or DC power charging with communication) 18
Figure 9 – Example of test setup for vehicle with inlet located at the front/rear of the vehicle (AC or DC power charging with communication) 19
Figure 10 – Vehicle in configuration "REESS charging mode coupled to the power grid" – Single-phase charger test setup 25
Figure 11 – Vehicle in configuration "REESS charging mode coupled to the power grid" – Three-phase charger test setup 25
Figure 12 – Vehicle in configuration "REESS charging mode coupled to the power grid" 26
Figure 13 – Vehicle in configuration "REESS charging mode coupled to the power grid" 29
Figure 14 – Vehicle in configuration "REESS charging mode coupled to the power grid" 31
Figure 15 – Example of vehicle in configuration "REESS charging mode coupled to the power grid" 34
Figure 16 – Test configuration for ESAs involved in REESS charging mode coupled to the power grid (example for horn antenna) 36
Figure A.1 – Example of 5 μH AN schematic 39
Figure A.2 – Characteristics of the AN impedance 40
Figure A.3 – Example of 5 μH HV AN schematic 41
Figure A.4 – Characteristics of the HV AN impedance 41
Figure A.5 – Example of 5 μH HV AN combination in a single shielded box 42
Figure A.6 – Impedance matching network attached between HV ANs and EUT 42
Figure A.7 – Example of an impedance stabilization network for symmetric communication lines 44
Figure A.8 – Example of a circuit for emission tests of PLC on AC or DC powerlines 45
Figure A.9 – Example of a circuit for immunity tests of PLC on AC or DC powerlines 45
Figure A.10 – Example of a circuit for emission tests of PLC on control pilot line 46
Figure A.11 – Example of a circuit for immunity tests of PLC on control pilot line 46

Table 1 – Immunity tests 21
Table 2 – Maximum allowed harmonics (input current ≤ 16 A per phase) 24
Table 3 – Acceptable harmonics for R_{sce} = 33 (16 A < I_j ≤ 75 A) 24
Table 4 – Maximum allowed radiofrequency conducted disturbances on AC power lines 27
Table 5 – Maximum allowed radiofrequency conducted disturbances on DC power lines 28
Table 6 – Maximum allowed radiofrequency conducted disturbances on network and telecommunication access 30

Table 7 – Maximum allowed vehicle high-frequency radiated disturbances 32
Table 8 – Maximum allowed ESA high-frequency radiated disturbances 35
Table 9 – Maximum allowed ESA radiated disturbances on supply lines 37

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 21-1: Electric vehicle on-board charger EMC requirements for conductive connection to an AC/DC supply

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.

International Standard IEC 61851-21-1 has been prepared by subcommittee 69: Electric road vehicles and electric industrial trucks.

This first edition, together with IEC 61851-21-2, cancels and replaces IEC 61851-21:2001. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61851-21:2001:

a) this document addresses now only EMC tests instead of other electrical tests;
b) test setups are defined more precisely;
c) Annex A "Artificial networks, asymmetric artificial networks and integration of charging stations into the test setup" was added.

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

FDIS	Report on voting
69/507/FDIS	69/516/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61851 series, under the general title: *Electric vehicle conductive charging system,* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 21-1: Electric vehicle on-board charger EMC requirements for conductive connection to an AC/DC supply

1 Scope

This part of IEC 61851, together with IEC 61851-1:2010, gives requirements for conductive connection of an electric vehicle (EV) to an AC or DC supply. It applies only to on-board charging units either tested on the complete vehicle or tested on the charging system component level (ESA – electronic sub assembly).

This document covers the electromagnetic compatibility (EMC) requirements for electrically propelled vehicles in any charging mode while connected to the mains supply.

This document is not applicable to trolley buses, rail vehicles, industrial trucks and vehicles designed primarily to be used off-road, such as forestry and construction machines.

NOTE 1 Specific safety requirements that apply to equipment on the vehicle during charging are treated in separate documents as indicated in the corresponding clauses of this document.

NOTE 2 Electric vehicle (EV) includes pure electric vehicles as well as plug-in hybrid electric vehicles with additional combustion engine.

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 60038:2009, *IEC standard voltages*

IEC 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3:2013, *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 61000-3-11:2000, *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 61000-3-12:2011, *Electromagnetic compatibility (EMC) – Part 3-12 – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*
IEC 61000-6-3:2006/AMD1:2010

IEC 61851-1:2010, *Electric vehicle conductive charging system – Part 1: General requirements*

CISPR 12:2007, *Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers*
CISPR 12:2007/AMD1:2009

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 22:2008, *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement*

CISPR 25:2016, *Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers*

ISO/TR 8713:2012, *Electrically propelled road vehicles – Vocabulary*

ISO 7637-2:2011, *Road vehicles – Electrical disturbances from conduction and coupling -- Part 2: Electrical transient conduction along supply lines only*

ISO 11451-1:2015, *Road vehicles – Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology*

ISO 11451-2:2015, *Road vehicles – Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Off-vehicle radiation sources*

ISO 11452-1:2015, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology*

ISO 11452-2:2004, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Absorber-lined shielded enclosure*

ISO 11452-4:2011, *Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 4: Harness excitation methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61851-1:2010 and ISO/TR 8713:2012, as well as the following apply.

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

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

3.1
REESS
rechargeable energy storage system that provides electric energy for electric propulsion of the vehicle

3.2
on-board EV charging system
all equipment in the charge power supply chain inside the vehicle

Note 1 to entry: It includes the plug and cable if physically connected to the vehicle (cable cannot be removed without any tool, i.e. case A as defined in IEC 61851-1:2010).

3.3
electrical/electronic sub-assembly
ESA
electrical and/or electronic device or set(s) of devices intended to be part of a vehicle, together with any associated electrical connections and wiring, which performs one or more specialized functions

3.4
low voltage
LV
operating DC voltage below 60 V

EXAMPLE Nominal voltages of 12 V, 24 V, 48 V.

3.5
LV harness
low voltage harness with operating voltages below 60 V

3.6
high voltage
HV
operating voltages of 60 V to 1000 V

Note 1 to entry: HV+ and HV- are abbreviations for the positive and negative terminal line, respectively.

Note 2 to entry: HV definition is in accordance to CISPR 25, ISO 11451-1 and ISO 11452-1.

3.7
electric vehicle
EV
pure electric vehicles as well as plug-in hybrid electric vehicles with additional combustion engine

4 General test conditions

The vehicle systems shall operate correctly within +10 % to –15 % of the standard nominal supply voltage. This takes into account variations that are induced by the installation as defined in Annex A of IEC 60038:2009. The rated value of the frequency is 50 Hz ± 1 % or 60 Hz ± 1 %.

NOTE IEC 60038:2009 specifies the voltage at the delivery point. Annex A proposes to specify wider values to allow for further voltage variations due to installations.

Test methods concern only the electric vehicle charging system with "REESS in charging mode coupled to the power grid". Tests shall be performed either on separate samples or on the whole vehicle at the vehicle manufacturer’s request as defined in the test plan.

The vehicle shall be in an unladen condition except for necessary test equipment.