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Title: BS EN IEC 61851-21-1 Electric vehicle conductive charging system

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

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER: IEC 61851-21-1 ED2	
DATE OF CIRCULATION: 2024-05-17	CLOSING DATE FOR COMMENTS: 2024-08-09
SUPERSEDES DOCUMENTS: 69/780/RR	

IEC TC 69 : ELECTRICAL POWER/ENERGY TRANSFER SYSTEMS FOR ELECTRICALLY PROPELLED ROAD VEHICLES AND INDUSTRIAL TRUCKS	
SECRETARIAT: Belgium	SECRETARY: Mr Peter Van den Bossche
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 77,CISPR	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☒ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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

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4 **Electric vehicle conductive charging system –**
5 **Part 21-1: Electric vehicle on-board charger EMC requirements**
6 **for conductive connection to an a.c./d.c. supply**
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –
Part 21-1: Electric vehicle on-board charger EMC requirements
for conductive connection to an a.c./d.c. supply**

FOREWORD

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

This second edition, cancels and replaces IEC 61851-21-1:2017. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61851-21-1:2017:

- a) Clause 1: The Scope has been defined more precisely;
- b) Clause 2: Normative references have been updated;
- c) Clause 3: Some definitions have been added;
- d) Clause 4: A bidirectional charging mode has been added;

- e) Clause 5: The test setup for vehicle in charging mode has been described more precisely, the figures and their keys have been updated and in table 1 pulse modulation test (1.2) has been added as well as higher frequency range up to 6 GHz (1.3) and the emission test operating conditions have been defined more precisely
- f) Annex A: DC Charging AN has been defined more precisely
- g) Annex B has been added
- h) Annex C has been added
- i) Annex D has been added
- The text of this standard is based on the following documents:

FDIS	Report on voting
69/XX/FDIS	69/XX/RVD

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

This publication 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 publication will remain unchanged until the stability date¹⁾ indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

¹⁾ The National Committees are requested to note that for this publication the stability date is 2024.

**ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –
Part 21-1: Electric vehicle on-board charger EMC requirements
for conductive connection to an a.c./ d.c. supply**

1 Scope

This part of IEC 61851 covers Electromagnetic Compatibility (EMC) requirements for conductive connection of an electric vehicle (EV) to an a.c. or d.c. supply. It applies only to on-board charging systems either tested on the complete vehicle or tested on the charging system component level (ESA – electronic sub assembly).

This part is also recommended for industrial trucks and vehicles designed primarily to be used off-road, e.g. forestry and construction machines, in charging mode.

This part of the standard is not applicable to trolley buses and rail vehicles.

Bi-directional power transfer between EV REESS and the grid (for vehicle to grid in grid-feeding mode) or a load/islanded installation (for vehicle to load or home in grid-forming mode) will be treated in a future revision of this standard.

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 referenced documents are indispensable for the application 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. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61851 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

IEC 60038:2009/AMD1:2021 Amendment 1, *IEC standard voltages*

IEC 61000-3-2: 2018+AMD1: 2020, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3: 2013+AMD1: 2017+AMD2: 2021+COR1: 2022, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuation and flicker in public low voltage supply systems for equipment with rated current ≤ 16 A per phase and not subject to condition connection*

IEC 61000-3-11: 2017, *Electromagnetic compatibility (EMC) – Part 3-11 – Limits – Limitation of voltage changes, voltage fluctuation and flicker in public low voltage supply systems for equipment with rated current ≤ 75 A per phase and subject to conditional connection*

IEC 61000-3-12: 2011+AMD1: 2021, *Electromagnetic compatibility (EMC) – Part 3-12 – Limits for harmonic current emissions 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+AMD1: 2017, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

- 243 IEC 61000-4-11: 2020, *Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement*
244 *techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment*
245 *with input current up to 16 A per phase*
- 246 IEC 61000-4-34: 2005/AMD1: 2009 Amendment 1, *Electromagnetic compatibility (EMC) - Part 4-*
247 *34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations*
248 *immunity tests for equipment with mains current more than 16 A per phase*
- 249 IEC 61000-6-2: 2016, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards –*
250 *Immunity for industrial environments*
- 251 IEC 61000-6-3: 2020, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards –*
252 *Emission standard for residential, commercial and light-industrial environments*
- 253 IEC 61851-1: 2017, *Electric vehicle conductive charging system – Part 1: General requirements*
- 254 IEC 61851-21-2: 2018, *Electric vehicle conductive charging system - Part 21-2: Electric vehicle*
255 *requirements for conductive connection to an AC/DC supply - EMC requirements for off board*
256 *electric vehicle charging systems*
- 257 CISPR 12: 2007+AMD1: 2009, *Vehicles, boats and internal combustion engines - Radio*
258 *disturbance characteristics - Limits and methods of measurement for the protection of off-board*
259 *receivers*
- 260 CISPR 16-1-2: 2014+AMD1:2017, *Specification for radio disturbance and immunity measuring*
261 *apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus –*
262 *Ancillary equipment – Conducted disturbances*
- 263 CISPR 16-2-1: 2014+AMD1: 2017, *Specification for radio disturbance and immunity measuring*
264 *apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity –*
265 *Conducted disturbance measurements*
- 266 CISPR 16-2-3: 2016+AMD1: 2019+AMD2: 2023, *Specification for radio disturbance and immunity*
267 *measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and*
268 *immunity - Radiated disturbance measurements*
- 269 CISPR 25: 2021 *Vehicles, boats and internal combustion engines – Radio disturbance*
270 *characteristics –Limits and methods of measurement for the protection of on-board receivers*
- 271 CISPR 32: 2015+AMD1:2019, *Electromagnetic compatibility of multimedia equipment - Emission*
272 *requirements*
- 273 ISO 8713: 2019, *Electrically propelled road vehicles – Vocabulary*
- 274 ISO 11451 *Road vehicles - Electrical disturbances by narrowband radiated electromagnetic*
275 *energy - Vehicle test methods*
- 276 *Part 1: General and definitions (ISO 11451-1: 2015);*
277 *Part 2: Off-vehicle radiation source (ISO 11451-2: 2015)*
278
- 279 ISO 11452, *Road vehicles - Electrical disturbances by narrowband radiated electromagnetic*
280 *energy - Component test methods*
- 281 *Part 1: General and definitions (ISO 11452-1: 2015);*
282 *Part 2: Absorber-lined chamber (ISO 11452-2: 2019);*
283 *Part 4: Bulk current injection (BCI) (ISO 11452-4: 2020);*

284 ISO/DIS 15118-3: 2015, *Road vehicles – Vehicle to Grid Communication Interface - Part 3:*
285 *Physical and data link layer requirements*

286 IEC 61000-4-13:2002+AMD1:2009+AMD2: 2015, *Electromagnetic compatibility (EMC) - Part 4-13:*
287 *Testing and measurement techniques - Harmonics and interharmonics including mains signalling*
288 *at a.c. power port, low frequency immunity tests*

289 IEC 61000-4-19: 2014, *Electromagnetic compatibility (EMC) - Part 4-19: Testing and measurement*
290 *techniques - Test for immunity to conducted, differential mode disturbances and signalling in the*
291 *frequency range 2 kHz to 150 kHz at a.c. power ports*

292 **3 Definitions**

293 IEC61851-1 and ISO8713 provide definitions and terminology of electrical propelled vehicles.
294 Additional definitions are listed below.

295 **3.1**

296 **Rechargeable Energy Storage System (REESS)**

297 the rechargeable energy storage system that provides electric energy for electric propulsion of the
298 vehicle

299 **3.2**

300 **on-board EV charging system**

301 all equipment in the charge power supply chain inside the vehicle including the plug and charging
302 cable if physically connected to the vehicle (charging cable cannot be removed without any tool,
303 i.e. case A as defined in IEC 61851-1)

304 **3.3**

305 **off-board EV charging system**

306 supplies a.c. or d.c. to the on-board EV charging system or vehicle battery. It includes electronics
307 for communications and control of charging system. This includes off-board equipment covering
308 modes 1, 2, 3 and 4 charging as defined in IEC 61851-1

309 **3.4**

310 **electrical/electronic sub-assembly (ESA)**

311 an electrical and/or electronic device or set(s) of devices intended to be part of a vehicle, together
312 with any associated electrical connections and wiring, which performs one or more specialized
313 functions

314 **3.5**

315 **voltage class A**

316 classification of an electric component or circuit with a maximum working voltage of ≤ 30 V a.c.(rms)
317 or ≤ 60 V d.c. respectively.

318 Note to entry: Master publication in ISO/TC 22/SC 37: ISO 6469-1:20xx), also defined in ISO 12405-4:2018, ISO
319 17409:2015 and ISO 6469-4:2015

320 **3.6**

321 **voltage class A harness**

322 low voltage harness with operating voltages of ≤ 30 V a.c.(rms) or ≤ 60 V d.c. respectively.

323 **3.7**

324 **voltage class B**

325 classification of an electric component or circuit with a maximum working voltage of (>30 and ≤ 1
326 000) V a.c. (rms) or (>60 and $\leq 1\ 500$) V d.c., respectively.

327 Note to entry: Master publication in ISO/TC 22/SC 37: ISO 6469-1:20xx), also defined in ISO 12405-4:2018, ISO
328 17409:2015 and ISO 6469-4:2015.

- 329 **3.8**
330 **voltage class B harness**
331 high voltage harness with operating voltages of (>30 and $\leq 1\,000$) V a.c. (rms) or (>60 and $\leq 1\,500$)
332 V d.c., respectively.
- 333 **3.9**
334 **Vehicle to everything (V2X)**
335 communication between a vehicle and any other device, e.g. another vehicle, traffic infrastructure,
336 power grid infrastructure, buildings, etc.
- 337 **3.10**
338 **Rated charging/input current**
339 of an on-board-charger will refer to the commonly used setpoints defined by the manufacturer, e.g.
340 32A single-phase and 16A three-phase.
- 341 **3.11**
342 **conductive power transfer port**
343 **CPT port**
344 power output port of EV supply equipment for EVs serving conductive power transfer (CPT) of LV
345 AC or DC electrical energy to the secondary device of the charging system and also providing all
346 required signalling/controlling and/or communication functions.
- 347 EXAMPLE 1 Secondary device of the charging system can be. to the load to be charged or supplied with power.
348 EXAMPLE 2 Signalling/controlling and/or communication functions can be control pilot, CAN and private PLC/T.
- 349 **3.12**
350 **rated current and rated power of the equipment**
351 input current of the piece of equipment as declared by the manufacturer and marked as such
352 on the rating plate of the piece of equipment or stated in the product documents
- 353 **3.13**
354 **rated power of the equipment**
355 input power of the piece of equipment as declared by the manufacturer and marked as such
356 on the rating plate of the piece of equipment or stated in the product documents
357

4 General test conditions

The vehicle systems shall operate correctly within +10 % / -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. The rated value of the frequency is 50 Hz $\pm$ 1 % or 60 Hz $\pm$ 1 %.

NOTE IEC60038 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 (bidirectional-) charging mode coupled to the power grid or V2X”. 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.

The vehicle shall be immobilized, engine OFF, and in charging mode.

All other equipment which can be switched on permanently by the driver or passenger shall be OFF.

The tests shall be carried out with the equipment under test (EUT) including its sensors and actuators as defined in the test plan.

Unless otherwise specified, the tests shall be carried out in a draught-free location and at an ambient temperature of 23 °C $\pm$ 5 °C according to standards ISO 11451-1 and ISO 11452-1.

5 Test methods and requirements

5.1 Test setup for vehicle in charging mode

5.1.1 Vehicle in charging mode 1 or mode 2 (AC power charging without communication)

5.1.1.1 General

This configuration concerns only charging mode 1 and charging mode 2.

5.1.1.2 Artificial network

The artificial (mains) networks (AN/AMN) for power supply and asymmetric artificial networks (AAN) for charging communications to be used for these tests are described in Annex A of this document.

5.1.1.3 Power charging cable

The power charging cable shall be laid out in a straight line between the AMN(s) and the vehicle charging inlet and shall be routed perpendicularly to the vehicle's longitudinal axis (see Figure 6 to Figure 9). The projected cable length from the side of the AMN(s) to the side of the vehicle shall be (800 (+200 / -0)) mm as shown in Figure 6 to Figure 9.

For a longer cable, the extraneous length shall be “Z-folded” symmetrically. No contact or overlap is allowed between windings. The width of the Z-folded cable shall be between 500 mm and 1 000 mm. If it is impractical to do so because of cable bulk or stiffness, or because the testing is being done at a user's installation, the disposition of the excess cable length shall be precisely noted in the test report.

The charging cable at the vehicle side shall hang vertically at a distance of (100 (+200 / -0)) mm from the vehicle body.

The whole cable shall be placed on a non-conductive, low relative permittivity (dielectric-constant) material ($\epsilon_r \leq 1,4$), at (100 $\pm$ 25) mm above the ground plane (ALSE or OATS) or floor (OTS).

- 398 Unless otherwise specified, the mode 1 or mode 2 charging cable provided by the manufacturer
399 shall be used and shall have a maximum length of 10 m.
- 400 If the vehicle manufacturer delivers more than one mode 1 or mode 2 cable, the measurements
401 may be performed with one representative cable for each mode only.
- 402 **5.1.2 Vehicle in charging mode 3 (AC power charging with communication) or mode 4 (DC**
403 **power charging with communication)**
- 404 **5.1.2.1 General**
- 405 This configuration concerns charging mode 3 and charging mode 4.
- 406 **5.1.2.2 Charging station / Power mains**
- 407 The charging station may be placed either in the test site or outside the test site.
- 408 If the communication between the vehicle and the charging station can be simulated, the charging
409 station may be replaced by a power supply connected to the AC power mains network.
- 410 In both cases, power mains/supply and communication or signal lines socket(s) shall be placed in
411 the test site with the following conditions:
- 412 – the socket(s) shall be placed on the ground plane (ALSE or OATS) or floor (OTS);
 - 413 – the length of the cable between the power mains/supply socket(s) and the AMN(s) or DC-
414 charging-AN(s) should be kept as short as possible and shall be placed directly on the ground
415 plane (ALSE or OATS) or floor (OTS);
 - 416 – the length of the cable between the communication socket(s) and the AAN(s) should be kept
417 as short as possible and shall be placed directly on the ground plane (ALSE or OATS) or floor
418 (OTS);
- 419 If the charging station is placed inside the test site, then the harnesses between the charging
420 station and the power mains or communication socket shall satisfy the following conditions:
- 421 – the harness at charging station side shall hang vertically down to the ground plane (ALSE or
422 OATS) or floor (OTS);
 - 423 – the extraneous length shall be placed directly on the ground plane (ALSE or OATS) or floor
424 (OTS) and “Z-folded” if necessary. If it is impractical to do so because of cable bulk or stiffness,
425 or because the testing is being done at a user's installation, the disposition of the excess cable
426 shall be precisely noted in the test report.
- 427 The charging station should be placed outside the beamwidth of the receiving antenna.
- 428 **5.1.2.3 Artificial networks**
- 429 The artificial (mains) networks (AN/AMN) for power supply and asymmetric artificial networks
430 (AAN) for charging communications to be used for these tests are described in Annex A of this
431 document.
- 432 **5.1.2.4 Asymmetric artificial network**
- 433 Communication lines connected to signal/control ports and lines connected to wired network ports
434 shall be applied to the vehicle through AAN(s).
- 435 The various AAN(s) to be used are defined in Annex A.4. Asymmetric artificial networks (AAN):
- 436 – A.4.2 for signal/control ports with symmetric lines,
 - 437 – A.4.3 for signal/control ports with PLC technology on the control pilot line and
 - 438 – A.4.4 for signal/control ports with a control pilot line.

The AAN(s) shall be mounted directly on the ground plane (ALSE or OATS) or floor (OTS). The case of the AAN(s) shall be bonded to the ground plane (ALSE or OATS) or connected to protective earth (OTS, for example, an earth rod).

The measuring port of each AAN shall be terminated with a 50 Ω load.

If a charging station is used, AAN(s) are not required for the signal/control ports and/or for the wired network ports. The communication lines between the vehicle and the charging station shall be connected to the associated equipment on the charging station side as in typical installations.

If communication is emulated (i.e. the charging station is replaced by a power supply) and if the presence of the AAN prevents proper communication then no AAN shall be used.

5.1.2.5 Power (charging) harness

The power (charging) harness, including the power and the communication wires/cables, shall be laid out in a straight line between the AMN(s)/DC-charging-AN(s) / AAN(s) and the vehicle charging inlet and shall be routed perpendicularly to the vehicle's longitudinal axis (see Figure 6 to Figure 9). The projected harness length from the side of the AMN(s)/DC-charging-AN(s) / AAN(s) to the side of the vehicle shall be (800 (+200 / -0)) mm.

For a longer harness, the extraneous length shall be "Z-folded" symmetrically. No contact or overlap is allowed between windings. The width of the Z-folded cable shall be between 500 mm and 1 000 mm. If it is impractical to do so because of harness bulk or stiffness, or because the testing is being done at a user installation, the disposition of the excess harness shall be precisely noted in the test report.

The power (charging) harness, including the power and the communication wires/cables, at the vehicle side, shall hang vertically at a distance of (100 (+200 / -0)) mm from the vehicle body.

The whole harness shall be placed on a non-conductive, low relative permittivity (dielectric-constant) material ($\epsilon_r \leq 1,4$), at (100 $\pm$ 25) mm above the ground plane (ALSE or OATS) or floor (OTS).

Unless otherwise specified, the mode 3 charging cable provided by the manufacturer shall be used and it shall have a length greater than 2 m but shorter or equal to 10 m.

If the vehicle manufacturer delivers more than one mode 3 cable, the measurements may be performed with one representative mode 3 cable.

Unless otherwise specified the mode 4 charging cable of the test facility shall be used.

5.2 Component test setup

For ESA separated on-board charger tests an appropriate load shall be used to simulate the vehicle voltage class B-systems terminations, e.g. voltage class B battery. If specific load boxes are used, these shall also be described in the test plan.

5.2.1 Exceptions

Vehicles and / or ESA which are intended to be used in "REESS charging mode coupled to the power grid" in the configuration connected to a DC-charging station with a length of a DC network cable shorter than 30 m do not have to fulfil the requirements of conducted emissions, surge and fast transients (burst) neither on vehicle nor ESA level.

In this case, the manufacturer shall provide a statement that the vehicle and/or ESA can be used in "REESS charging mode coupled to the power grid" only with cables shorter than 30 m. This information shall be made publicly available following the type approval.