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Edition 1.0 2018-04

INTERNATIONAL STANDARD

Electric vehicle conductive charging system – Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply – EMC requirements for off-board electric vehicle charging systems

IEC 61851-21-2:2018-04(en)

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ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply – EMC requirements for off-board electric vehicle charging systems

FOREWORD

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International Standard IEC 61851-21-2 has been prepared by IEC technical committee 69: Electric road vehicles and electric industrial trucks.

This first edition, together with IEC 61851-21-1, 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 related tests instead of other electrical tests;
b) Clauses 2 and 3 have been updated;
c) the port definition, the test-setups and their corresponding limits as well as the operation modes are defined more precisely;

d) Annexes A to F have been added.

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

FDIS	Report on voting
69/531/FDIS	69/545/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, published 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- withdrawn,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.

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply – EMC requirements for off-board electric vehicle charging systems

1 Scope

This part of IEC 61851 defines the EMC requirements for any off-board components or equipment of such systems used to supply or charge electric vehicles with electric power by conductive power transfer (CPT), with a rated input voltage, according to IEC 60038:2009, up to 1 000 V AC or 1 500 V DC and an output voltage up to 1 000 V AC or 1 500 V DC.

This document covers off-board charging equipment for mode 1, mode 2, mode 3 and mode 4 charging as defined in IEC 61851-1:2017.

Cables where there is no electronics or no electric/electronic switching are considered as passive (benign) and are deemed to comply with the emission and immunity requirements of this document without any need for testing.

This document does not apply to any on-board components or equipment of charging or power supply systems being part of the vehicles. The EMC requirements for such equipment are covered by IEC 61851-21-1: 2017.

Compliance with the emission and immunity requirements of this document is verified where it can be demonstrated that the equipment under test (EUT) meets the respective limits, during type tests in the measuring arrangement of this document.

Requirements for electric vehicle wireless power transfer (WPT) systems are covered in IEC 61980 (all parts).

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

IEC 61851-23:2014, *Electric vehicle conductive charging system – Part 23: DC electric vehicle charging station*

IEC 60038:2009, *IEC standard voltages*

IEC 62053-21:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

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 connexion*

IEC 61000-3-11:2017, *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 – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*
IEC 61000-4-3:2006/AMD1:2007
IEC 61000-4-3:2006/AMD2:2010

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 61000-4-5:2014/AMD1:2017

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*
IEC 61000-4-11:2004/AMD1:2017

IEC 61000-4-34:2005, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*
IEC 61000-4-34:2005/AMD1:2009

IEC 61000-6-1:2016, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

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 61000-6-4:2006, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*
IEC 61000-6-4:2006/AMD1:2010

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 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*
CISPR 16-1-4:2010/AMD1:2012
CISPR 16-1-4:2010/AMD2:2017

CISPR 25:2008, *Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers*[1]

CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

MIL-STD-461F:2007, *Department of Defense interface standard requirements for the control of electromagnetic interference characteristics of subsystems and equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61851-1 and 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
associated equipment
AE
equipment needed to exercise and/or monitor the operation of the EUT

3.2
port
particular interface of the specified apparatus with external electromagnetic environment

Note 1 to entry: See Figure 1.

1 3rd edition (2008). This 3rd edition has been replaced in 2016 by a 4th edition CISPR 25:2016, Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers.

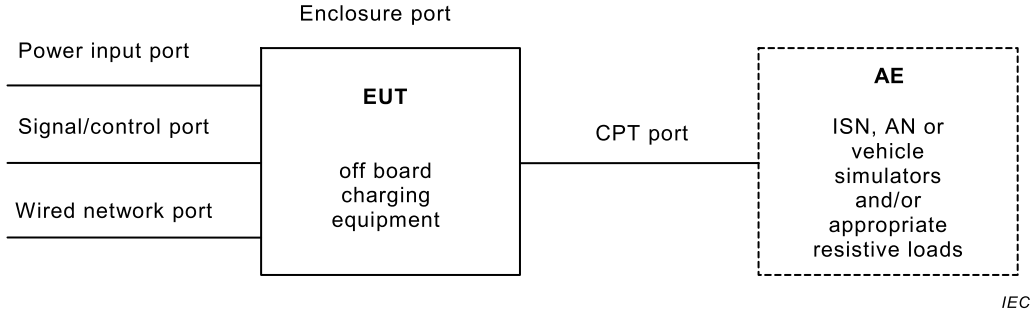


Figure 1 – Examples of ports of off- board charging equipment

3.3
enclosure port
physical boundary of the apparatus through which electromagnetic fields may radiate or impinge on

[SOURCE: IEC 60050-445:2010, 445-07-04, modified – The words "time relay" have been replaced by "apparatus".]

3.4
power input port
input port at which a conductor or cable carrying the electrical power needed for the operation (functioning) of an apparatus or associated apparatus is connected to the apparatus

Note 1 to entry: A power input port can be AC or DC.

3.5
wired network port
port of connection for voice, data and signaling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network

Note 1 to entry: Examples of these include CATV, PSTN, ISDN, xDSL, LAN and similar networks.

Note 2 to entry: These ports can support screened or unscreened cables and can also carry AC or DC power where this is an integral part of the telecommunication specification.

[SOURCE: CISPR 32:2015, 3.1.32]

3.6
signal/control port
port at which a cable or conductor is connected for the purpose of transmission of signals excluding wired network and CPT ports

Note 1 to entry: Examples include RS-232, Universal Serial Bus (USB), High-Definition Multimedia Interface (HDMI), IEEE Standard 1394 ("Fire Wire"), analogue/digital input/outputs.

Note 2 to entry: An example of a control port is a port used to start the charging operation when a signal indicates that the energy tariff is lower and/or charging is delayed for energy management purposes.

3.7
conductive power transfer port
CPT port
power output port of charging equipment for electric vehicles serving conductive power transfer (CPT) of LV AC or DC electrical energy to the secondary device of the charging system (i.e. to the load to be charged or supplied with power) and also providing all required signaling/controlling and/or communication functions, for example control pilot, CAN and private PLC/T

3.8
equipment under test
EUT
off-board components or equipment of systems that are used to supply or charge electric vehicles with electric power by conductive power transfer (CPT) which are covered by the scope of this document

3.9
powerline telecommunication
PLT
powerline communication
PLC
signal transmission technology used for connection to a wire-line PSTN (public switched telephone network) via the LV AC (or DC) mains grid

Note 1 to entry: PLT/C is a transmission technology used for communications, data transfer, signaling/controlling and similar purposes in private and/or local area networks via a variety of types of power lines such as charger cables of off-board charging equipment for electric vehicles.

3.10
portable equipment
cord and plug connected equipment, cable assembly, adaptors or other accessories that are capable to be carried by one person and designed and intended to be carried within the EV

[SOURCE: IEC 61851-1:2017, 3.6.5]

3.11
high voltage
HV
operating voltage between 60 V to 1 000 V

Note 1 to entry: The term "high voltage" may be defined with a different voltage range in other standards.

3.12
low voltage
LV
operating DC voltage below 60 V, for example nominal voltages of 12 V, 24 V or 48 V

Note 1 to entry: The term "low voltage" may be defined with a different voltage range in other standards.

4 Test plan

4.1 General

An EMC test plan shall be established prior to testing. It shall contain, as a minimum, the elements given in Clause 4.

4.2 Configuration of EUT

All tests shall be carried out using a representative EUT and charge cable (at the conductive power transfer port – CPT port) to the AE/vehicle simulator as supplied by the manufacturer. Where the charge cable is not provided with the EUT (e.g. case B according to IEC 61851-1:2017), tests shall be performed with a typical length and geometry of the charge cable.

The contents of the standards referenced in this document are not repeated here; however modifications or additional information needed for practical application of the measurements of EUT’s is given in this document.

The tests shall be carried out within the specified operating range of the EUT and at its rated supply voltage.

Test setups according to Annex A shall be used for the immunity and emission tests above 150 kHz.

In-cable control and protection devices (IC-CPDs), other portable equipment and mode 2 equipment shall be tested as per table top equipment.

4.3 Termination of the EUT during testing

All ports of the EUT shall be terminated with ANs/ISN or respectively CDNs as appropriate. The power input port, signal control port and wired network port shall be terminated according to Annex C.

The CPT port of the EUT shall be connected to the associated equipment (AE) covering the artificial networks (ANs) and/or impedance stabilization networks (ISNs) according to Annex C forming the vehicle simulator and connecting to an appropriate load.

The signalling/control lines of the CPT port shall be terminated according to Annex C and provide communication by respective simulation and fed in via suitable coupling devices.

4.4 Operating and test conditions

4.4.1 General

The following measurements and assessments may be performed in any order.

4.4.2 Immunity

The immunity requirements are specified in Table 1, Table 2, Table 3 and Table 4 according to the type of power input (AC or DC) and environmental classification (residential or non-residential) of the EUT to be tested.

Testing shall be performed in the following two operating modes:

- waiting mode: to simulate when the EUT is fully powered up and connected to a vehicle but not charging (for example, when the batteries are fully charged or if waiting for the power grid to decide when to charge);
- charge mode: during testing, the EUT shall be operated at 20 % of the maximum rated power ±10 %. If this is not possible according to IEC 61851-1:2017, the percentage may be raised.

It has been considered that no assessment is required when no load is connected since waiting mode adequately addresses this mode of operation.

In-cable control and protection devices (IC-CPD) shall be tested as off-board AC charging equipment.

The mode of operation shall be specified and the actual conditions, during the tests, shall be precisely noted in the test report.

4.4.3 Emissions

Emission requirements are specified in Table 7 to Table 14 and Table 16 to Table 19.

Testing shall be performed in the following operating modes:

- 20 % of maximum rated power ±10 % (if this is not possible according to IEC 61851-1:2017 the percentage may be raised); and
- 80 % of maximum rated power ±10 %; or
- with any load allowing the operation of the electrical vehicle supply equipment (EVSE), if the power input and output are directly connected in charge mode (mode 2 and mode 3 EVSE using mechanical switching devices). In this special case, testing with 20 % and 80 % is not necessary.

For low frequency phenomena (Table 5), tests shall be performed in accordance with the applicable product family standards (IEC 61000-3-X series).

The operating mode for testing according to 6.2.3 shall be one complete charge cycle with all outlets.

During the test time, all power output ports (CPT ports) shall be controlled according to the procedure described here:

- the single outlets/CPT ports shall be started/set in charge mode one by one (sequentially);
- all outlets/CPT ports shall be operated in charge mode simultaneously;
- the single outlets/CPT ports shall be stopped one by one (sequentially).

If parallel operation is not possible the power outputs shall be operated one by one (sequentially) in the test time. The power output (CPT port) shall operate with a constant load, and the power input of the EUT shall reach at least 80 % of maximum rated power ±10 % during testing.

If communication over control pilot circuits or other signal lines (e.g. powerline communication – PLC) is used between the EUT and the vehicle, for example to control the charging, tests shall be performed with the worst case communication signals, for example with (highest) data rates according to the manufacturer's specification.

If the data rate is limited by the EUT, this maximum data rate shall be used for testing.

4.4.4 Environmental conditions/limitations

This document has been prepared taking into account the normal EMC environments for all types of EUTs. By their very nature however, EUTs can be used and installed in a variety of locations. This document covers all residential, commercial, light industrial (see IEC 61000-6-1:2016, and IEC 61000-6-3:2006 and IEC 61000-6-3:2006/AMD1:2010) and industrial environments (see IEC 61000-6-2:2005, and IEC 61000-6-4:2006 and IEC 61000-6-4:2006/AMD1:2010) irrespective of whether the equipment is located indoor or outdoor. Where the EUT manufacturer does not define the environment in which the EUT is intended to be used, the most stringent emission and immunity tests shall be performed (i.e. the lowest emission limits and highest immunity test levels shall be applied).

5 Immunity requirements

5.1 General

In addition to the normal EMC environments for all types of EUTs in the scope of the generic EMC standards of IEC 61000-6 (all parts), the specific EUTs in the scope of this document have a dedicated port (CPT port) to connect to electric vehicles (see Figure 1).

Testing shall be performed against one of the tables (Table 1, Table 2, Table 3 and Table 4) as appropriate, based on the type of EUT and environment in which it is intended to be operated (see also 4.4.4).

All in-cable control and protection devices (IC-CPD) and other portable equipment shall meet the immunity requirements for environments other than residential defined in Table 1 or Table 3.

Table 1 – AC charging immunity requirements – Environments other than residential

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
Enclosure	Waiting and charge mode	Electrostatic discharge (ESD)	IEC 61000-4-2:2008	±4 (contact) ±8 (Air)	kV kV	B
		Radiated RF fields	IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	10 80 to 1000 80	V/m [c] MHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 1,4 to 2 80	V/m [c] GHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 2 to 2,7 80	V/m [c] GHz % AM (1 kHz)	A
		Magnetic fields [j]	IEC 61000-4-8:2009	50, 60 30 (for systems ≤ 32 A) 100 (for systems > 32 A)	Hz A/m A/m	A
Power input (AC) [i]	Waiting and charge mode	Electrical fast transients/ bursts [l]	IEC 61000-4-4:2012	±4 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage surges [j] [l]	IEC 61000-4-5:2014	1,2/50 (8/20) ±4 [a] ±2 [b]	µs kV kV	B
		Conducted RF fields	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A
		Voltage dips and interruptions	IEC 61000-4-11:2004 (≤ 16 A) IEC 61000-4-34:2005 and IEC 61000-4-34:2005/AMD1:2009 (> 16 A)	40 % residual voltage 70 % residual voltage 0 % residual voltage 0 % residual voltage	for 10/12 cycles at 50/60 Hz for 25/30 cycles at 50/60 Hz for 1 cycle at 50/60 Hz for 250/300 cycles at 50/60 Hz	B [e] B [e] B [e] C
Wired network and signal/ control	Waiting and charge mode	Electrical fast transients/ bursts [g] [h]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage surges [f] [l]	IEC 61000-4-5:2014	1,2/50 (8/20) ±1	µs kV	B
		Conducted RF fields [g]	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
CPT	Waiting and charge mode	Electrical fast transients/bursts [d) h)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [d) f) j) m)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a)] ±1 [b)]	µs kV kV	B
		Conducted RF fields [k)]	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c)] MHz % AM (1 kHz)	A

a) Line to earth (ground), applicable to power lines only.

b) Line to line, applicable to power lines only.

c) The test level specified is the RMS value of the unmodulated carrier.

d) Tests are not required if the power input and output are directly connected in charge mode using a mechanical switching device.

e) Primary functions may degrade during the test but shall resume to the original condition after the test.

f) Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 30 m.

g) Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 3 m.

h) Tested using the capacitive coupling clamp defined in IEC 61000-4-4:2012; at the CPT port, the clamp shall be over the whole charging cable.

i) Test also applies to signal/control ports where they are directly connected to the power port (e.g. open relay contacts that can be directly connected to the AC mains).

j) Tests shall be done only in charge mode (surge: since surge protection devices wear out; magnetic field: charge current has influence).

k) Tested using the EM coupling clamp defined in IEC 61000-4-6:2013; at the CPT port, the clamp shall be over the whole charging cable.

l) For surge/burst testing, use a capable CDN.

m) For surge on power lines of CPT port, use a capable CDN.

Table 2 – AC charging immunity requirements – Residential environments

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
Enclosure	Waiting and charge mode	Electrostatic discharge (ESD)	IEC 61000-4-2:2008	±4 (contact) ±8 (air)	kV kV	B
		Radiated RF fields	IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 80 to 1000 80	V/m [c)] MHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 1,4 to 2 80	V/m [c)] GHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 2 to 2,7 80	V/m [c)] GHz % AM (1 kHz)	A
		Magnetic fields [j)]	IEC 61000-4-8:2009	50, 60 30 (for systems ≤ 32 A) 100 (for systems > 32 A)	Hz A/m A/m	A
Power input (AC) [i)]	Waiting and charge mode	Electrical fast transients/bursts [l)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage Surges [j)] [l)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a)] ±1 [b)]	µs kV kV	B
		Conducted RF fields	IEC 61000-4-6:2013	3 0,15 to 80 80	V (RMS) [c)] MHz % AM (1 kHz)	A
		Voltage dips and interruptions	IEC 61000-4-11:2004 (≤ 16 A) IEC 61000-4-34:2005 and IEC 61000-4-34:2005/AMD1:2009 (> 16 A)	40 % residual voltage 70 % residual voltage 0 % residual voltage 0 % residual voltage	for 10/12 cycles at 50/60 Hz for 25/30 cycles at 50/60 Hz for 1 cycle at 50/60 Hz for 250/300 cycles at 50/60 Hz	B [e)] B [e)] B [e)] C
Wired network and signal/control	Waiting and charge mode	Electrical fast transients/bursts [g) h)]	IEC 61000-4-4:2012	±1 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage surges [f)] [l)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±1	µs kV	B
		Conducted RF fields [g)]	IEC 61000-4-6:2013	3 0,15 to 80 80	V (RMS) MHz % AM (1kHz)	A
CPT	Waiting and charge mode	Electrical fast transients/bursts [g) h)]	IEC 61000-4-4:2012	±2 5/50	kV Tr/Th ns	B

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
				5	repetition frequency, kHz	
		Voltage surges [d] [i] [j] [m]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a] ±1 [b]	µs kV kV	B
		Conducted RF fields [k]	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A

[a] Line to earth (ground), applicable to power lines only.

[b] Line to line, applicable to power lines only.

[c] The test level specified is the RMS value of the unmodulated carrier.

[d] Tests are not required if the power input and output are directly connected in charge mode using a mechanical switching device.

[e] Primary functions may degrade during the test but shall resume to the original condition after the test.

[f] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 30 m.

[g] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 3 m.

[h] Tested using the capacitive coupling clamp defined in IEC 61000-4-4:2012; at the CPT port, the clamp shall be over the whole charging cable.

[i] Test also applies to signal/control ports where they are directly connected to the power port (e.g. open relay contacts that can be directly connected to the AC mains).

[j] Tests shall be done only in charge mode (surge: since surge protection devices wear out; magnetic field: charge current has influence).

[k] Tested using the EM coupling clamp defined in IEC 61000-4-6:2013; at the CPT port, the clamp shall be over the whole charging cable.

[l] For surge/burst testing, use a capable CDN.

[m] For surge on power lines of CPT port, use a capable CDN.

Table 3 – DC charging immunity requirements – Environments other than residential

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
Enclosure	Waiting and charge mode	Electrostatic Discharge (ESD)	IEC 61000-4-2:2008	±4 (contact) ±8 (air)	kV kV	B
		Radiated RF fields	IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	10 80 to 1000 80	V/m [c)] MHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 1,4 to 2 80	V/m [c)] GHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 2 to 2,7 80	V/m [c)] GHz % AM (1 kHz)	A
		Magnetic fields [j)]	IEC 61000-4-8:2009	50, 60 30 (for systems ≤ 32 A) 100 (for systems > 32 A)	Hz A/m A/m	A
Power input (AC) [i)]	Waiting and charge mode	Electrical fast transients/bursts [i)]	IEC 61000-4-4:2012	±4 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage surges [j)] [i)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±4 [a)] ±2 [b)]	µs kV kV	B
		Conducted RF fields	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c)] MHz % AM (1 kHz)	A
		Voltage dips and interruptions	IEC 61000-4-11:2004 (≤ 16 A) IEC 61000-4-34:2005 and IEC 61000-4-34:2005/AMD1:2009 (> 16 A)	40 % residual voltage 70 % residual voltage 0 % residual voltage 0 % residual voltage	for 10/12 cycles at 50/60 Hz for 25/30 cycles at 50/60 Hz for 1 cycle at 50/60 Hz for 250/300 cycles at 50/60 Hz	B [e)] B [e)] B [e)] C
Power input (DC) [i)]	Waiting and charge mode	Electrical fast transients/bursts [i)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [j)] [i)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a)] ±1 [b)]	µs kV kV	B
		Conducted RF fields	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c)] MHz % AM (1 kHz)	A
Wired Network and signal/control	Waiting and charge mode	Electrical fast transients/ bursts [g)] [h)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [f)] [i)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±1	µs kV	B
		Conducted RF	IEC 61000-4-	10	V (RMS) [c)]	A

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
		fields [g]	6:2013	0,15 to 80 80	MHz % AM (1 kHz)	
CPT	Waiting and charge mode	Electrical fast transients/bursts [d] [h]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage Surges [d] [f] [j] [m]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a] ±1 [b]	µs kV kV	B
		Conducted RF fields [k]	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A

[a] Line to earth (ground), applicable to power lines only.

[b] Line to line, applicable to power lines only.

[c] The test level specified is the RMS value of the unmodulated carrier.

[d] Tests are not required if the power input and output are directly connected in charge mode using a mechanical switching device.

[e] Primary functions may degrade during the test but shall resume to the original condition after the test.

[f] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 30 m.

[g] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 3 m.

[h] Tested using the capacitive coupling clamp defined in IEC 61000-4-4:2012; at the CPT port, the clamp shall be over the whole charging cable.

[i] Test also applies to signal/control ports where they are directly connected to the power port (e.g. open relay contacts that can be directly connected to the power port).

[j] Tests shall be done only in charge mode (surge: since surge protection devices wear out; magnetic field: charge current has influence).

[k] Tested using the EM coupling clamp defined in IEC 61000-4-6:2013; at the CPT port, the clamp shall be over the whole charging cable.

[l] For surge/burst testing, use a capable CDN.

[m] For surge on power lines of CPT port, use a capable CDN.

Table 4 – DC charging immunity requirements – Residential environments

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
Enclosure	Waiting and charge mode	Electrostatic discharge (ESD)	IEC 61000-4-2:2008	±4 (contact) ±8 (air)	kV kV	B
		Radiated RF fields	IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 80 to 1000 80	V/m [c)] MHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 1,4 to 2 80	V/m [c)] GHz % AM (1 kHz)	A
			IEC 61000-4-3:2006 and IEC 61000-4-3:2006/AMD1:2007 and IEC 61000-4-3:2006/AMD2:2010	3 2 to 2,7 80	V/m [c)] GHz % AM (1 kHz)	A
		Magnetic fields [j)]	IEC 61000-4-8:2009	50, 60 30 (for systems ≤ 32 A) 100 (for systems > 32 A)	Hz A/m A/m	A
Power input (AC) [i)]	Waiting and charge mode	Electrical fast transients/ bursts [l)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th, ns repetition frequency, kHz	B
		Voltage surges [j) l)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a)] ±1 [b)]	µs kV kV	B
		Conducted RF fields	IEC 61000-4-6:2013	3 0,15 to 80 80	V (RMS) [c)] MHz % AM (1 kHz)	A
		Voltage dips and interruptions	IEC 61000-4-11:2004 (≤ 16 A) IEC 61000-4-34:2005 and IEC 61000-4-34:2005/AMD1:2009 (> 16 A)	40 % residual voltage 70 % residual voltage 0 % residual voltage 0 % residual voltage	for 10/12 cycles at 50/60 Hz for 25/30 cycles at 50/60 Hz for 1 cycle at 50/60 Hz for 250/300 cycles at 50/60 Hz	B [e)] B [e)] B [e)] C
Power input (DC) [i)]	Waiting and charge mode	Electrical fast transients/ bursts [l)]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [j) l)]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a)]	µs kV	B

Port	Test applicability	Phenomenon	Basic standard	Test specification	Units	Performance criteria
				±1 [b]	kV	
		Conducted RF fields	IEC 61000-4-6:2013	3 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A
Wired network and signal/control	Waiting and charge mode	Electrical fast transients/ bursts [g] [h]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [f] [i]	IEC 61000-4-5:2014	1,2/50 (8/20) ±1	µs kV	B
		Conducted RF fields [g]	IEC 61000-4-6:2013	3 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A
CPT	Waiting and charge mode	Electrical fast transients/ bursts [d] [h]	IEC 61000-4-4:2012	±2 5/50 5	kV Tr/Th ns repetition frequency, kHz	B
		Voltage surges [d] [f] [j] [m]	IEC 61000-4-5:2014	1,2/50 (8/20) ±2 [a] ±1 [b]	µs kV kV	B
		Conducted RF fields [k]	IEC 61000-4-6:2013	10 0,15 to 80 80	V (RMS) [c] MHz % AM (1 kHz)	A

[a] Line to earth (ground), applicable to power lines only.

[b] Line to line, applicable to power lines only.

[c] The test level specified is the RMS value of the unmodulated carrier.

[d] Tests are not required if the power input and output are directly connected in charge mode using a mechanical switching device.

[e] Primary functions may degrade during the test but shall resume to the original condition after the test.

[f] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 30 m.

[g] Applicable only to ports interfacing with cables whose total length according to the manufacturer's functional specification is greater than 3 m.

[h] Tested using the capacitive coupling clamp defined in IEC 61000-4-4:2012; at the CPT port, the clamp shall be over the whole charging cable.

[i] Test also applies to signal/control ports where they are directly connected to the power port (e.g. open relay contacts that can be directly connected to the power port).

[j] Tests shall be done only in charge mode (surge: since surge protection devices wear out; magnetic field: charge current has influence).

[h] Tested using the EM coupling clamp defined in IEC 61000-4-6:2013; at the CPT port, the clamp shall be over the whole charging cable.

[i] For surge/burst testing, use a capable CDN.

[j] For surge on power lines of CPT port, use a capable CDN.

5.2 Performance criteria

5.2.1 General

The EUT shall remain in a safe condition as a result of the application of the tests defined in this document. See IEC 61851-1:2017 (AC and DC) for further guidance.

There are different performance criteria based on the charge mode of the EUT, especially for mode 2, 3 and mode 4.

During the application of voltage surges (IEC 61000-4-5:2014) on the power input port, a measurement shall be performed of the amplitude of the associated transient on the CPT port, when supplying DC. This measurement shall be made according to the setup described in Annex E. The requirements of Figure E.1 shall be met.

When metering and billing is available, the corresponding performance criteria shall be defined according to the applicable product standards, for example IEC 62053-21:2003.

When residual current protective devices RCD are incorporated inside the EUT, they shall fulfil the requirements according to their product standards.

A functional description and a definition of performance criteria during, or as a consequence of, the EMC testing shall be provided by the EUT manufacturer and noted in the test report based on the following criteria.

5.2.2 Performance criteria A

The EUT shall continue to operate as intended within the tolerances defined by the EUT manufacturer during and after the application of the appropriate tests. It shall not change the state in which it is operating (i.e. charging shall continue if in charge mode and shall remain idle if in waiting mode).

NOTE A change of state includes the control/communication lines of the CPT port and any change in charging current for DC charging (beyond the tolerance defined by the manufacturer).

5.2.3 Performance criteria B

The EUT shall continue to operate as intended within the tolerances defined by the EUT manufacturer at the completion of the applicable tests. Additionally, during the application of the appropriate tests the primary functions of the charger shall be maintained (within the tolerances defined by the EUT manufacturer). Secondary functions (for example displays, etc.) may degrade in performance during the test but shall resume to the original condition subsequent to testing.

Subsequent to the application of the applicable test, the EUT shall not have changed the state in which it is operating (i.e. charging shall continue if in charge mode and shall remain idle if in waiting mode).

NOTE A change of state includes the control/communication lines of the CPT port and any change in charging current for DC charging (beyond the tolerance defined by the charging equipment manufacturer).

5.2.4 Performance criteria C

During and after completion of the appropriate tests, the EUT can change to a failsafe condition. This state requires user intervention to restart the charge cycle or the automatic resumption of charging if the safety conditions have been fulfilled as defined in IEC 61851-1:2017 (simplified mode 3).

6 Emission requirements

6.1 General

Measurements shall be performed in well-defined and reproducible conditions for each type of disturbance.

6.2 Limits and test conditions for disturbances in the low frequency (LF) range

6.2.1 Overview

An overview showing the references for evaluation of disturbance phenomena in the low frequency (LF) range is given in Table 5.

Table 5 – References for evaluation of low frequency (LF) phenomena

Port	Phenomenon	Reference standard	Reference in this document
Power input (AC)	Harmonic currents [a)]	IEC 61000-3-2:2014 (≤ 16 A/phase) IEC 61000-3-12:2011 (> 16 A, ≤ 75 A/phase)	6.2.2
	Voltage fluctuations and flicker [a)]	IEC 61000-3-3:2013 (≤ 16 A/phase) IEC 61000-3-11:2017 (> 16 A, ≤ 75 A/phase) [b)]	6.2.3

[a)] Applicable to charging equipment covered within the scope of IEC 61000-3-2:2014, IEC 61000-3-3:2013, IEC 61000-3-11:2017 and IEC 61000-3-12:2011.

[b)] Equipment which meets the requirements of IEC 61000-3-3:2013 is excluded from application of IEC 61000-3-11:2017.

6.2.2 Harmonic currents

The emission of harmonic currents produced by the EUT is detailed in Table 5.

NOTE In some countries, equipment that has an input exceeding 75 A per phase or that is connected to in-plant equipment could comply with national regulations or contractual agreements between the distribution company and customers.

6.2.3 Voltage fluctuations and flicker

The emission of voltage fluctuations and flicker produced by the EUT is detailed in Table 5. The operation mode is described in 4.4.3.

6.3 Limits and test conditions for disturbances in the radio frequency (RF) range

6.3.1 Overview

An overview showing the references for evaluation of disturbances in the radio frequency (RF) range is given in Table 6.

For the purposes of this document, off-board electric vehicle charging systems are grouped into their environmental classification. These definitions are specified in CISPR 11:2015, 5.2, and are summarised as follows:

1) Class A off-board electric vehicle charging systems is equipment suitable for use in all locations other than residential ones and those directly connected to a low voltage power supply network which supplies buildings used for residential purposes.

   Class A equipment shall meet class A limits.

For Class A off-board electric vehicle charging systems, the instructions for use accompanying the product shall contain the following warning:

Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

2) Class B off-board electric vehicle charging systems is equipment suitable for use in residential establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for residential purposes.

Class B equipment shall meet class B limits.

In-cable control and protective devices (IC-CPD) and other mobile charging equipment shall be tested as off-board charging equipment meeting Class B emission requirements (residential).

Warning: Even if meeting the requirements for residential environments, on-board radio reception can be disturbed by noise generated by the off-board electric vehicle charging systems. To protect the on board radio reception, some vehicle manufacturers may use CISPR 25 limits for their vehicles. These limits are not applicable to off-board electric vehicle charging systems (EUT).

NOTE Portable equipment can be carried easily in the vehicle to different environments since the usage of the vehicle is not restricted to one of these environments.

Table 6 – References for evaluation of disturbances appearing in the radio frequency (RF) range

Type of port	Phenomenon	Reference in this document
Power input (LV AC or DC) (PLC/T optional)	Conducted disturbances (150 kHz to 30 MHz)	6.3.2
CPT (LV AC or DC)	Conducted disturbances (150 kHz to 30 MHz)	6.3.3
Wired network and signal/control	Conducted disturbances (150 kHz to 30 MHz)	6.3.4
Enclosure	Radiated disturbances (above 30 MHz)	6.3.5
Enclosure	Radiated disturbances (2 kHz to 185 kHz)	Annex B
CPT [a)]	Transient emissions	Annex D
[a)] Applicable only to DC charging equipment.		

6.3.2 Power input port (150 kHz to 30 MHz)

The disturbance voltage limits of Table 7, Table 8 or Table 9 apply for the power input port, respectively to the type of power input (AC or DC) and environmental classification (Class A or Class B) of the EUT to be tested.

If the power input port is also used for powerline communications (PLC) or powerline telecommunications (PLT) and the limits are not met, the EUT shall be tested to the appropriate PLT standard for assessing the communication function only. The disturbance voltage limits of Table 7, Table 8 or Table 9 shall be met with the communication switched off.

This procedure is only applicable if intentional PLC communication to infrastructure via the power input port of the EUT (e.g. mains) is used. For the CPT port the worst case communication has to be used in each case.

Worst case communication on CPT port has to be tested to avoid coupling of interferences due to communication at CPT port to the power input port.

Table 7 – Disturbance voltage limits for class A equipment for AC power input port

Frequency range MHz	**Rated power of ≤ 20 kVA**		**Rated power of > 20 kVA** [a]		**High power electronic systems and equipment, rated power of > 75 kVA** [b]	
	Quasi-peak dB(μV)	**Average** dB(μV)	**Quasi-peak** dB(μV)	**Average** dB(μV)	**Quasi-peak** dB(μV)	**Average** dB(μV)
0,15 to 0,50	79	66	100	90	130	120
0,50 to 5	73	60	86	76	125	115
			90	80		
5 to 30	73	60	decreasing linearly with logarithm of frequency to		115	105
			73	60		

At the transition frequency, the more stringent limit shall apply.

a) These limits apply to equipment with a rated power > 20 kVA and intended to be connected to a dedicated power transformer or generator, and which is not connected to low voltage (LV) overhead power lines. For equipment not intended to be connected to a user specific power transformer, the limits for ≤ 20 kVA apply. The manufacturer, and/or supplier shall provide information on installation measures that can be used to reduce emissions from the installed equipment. In particular, it shall be indicated that this equipment is intended to be connected to a dedicated power transformer or generator and not to LV overhead power lines.

b) These limits apply only to high power electronic systems and equipment with a rated power > 75 kVA when intended to be installed as follows:

- installation is supplied from a dedicated power transformer or generator, and which is not connected to low voltage (LV) overhead power lines;
- installation is physically separated from residential environments by distance greater than 30 m or by a structure which acts as a barrier to radiated phenomena;
- the manufacturer and/or supplier shall indicate that this equipment meets the disturbance voltage limits for high power electronic systems and equipment of rated input power > 75 kVA and provide information on installation measures to be applied by the installer. In particular, it shall be indicated that this equipment is intended to be used in an installation which is powered by a dedicated power transformer or generator and not by LV overhead power lines.

Table 8 – Disturbance voltage limits for class B equipment for AC power input port

Frequency range MHz	**Quasi-peak** dB(μV)	**Average** dB(μV)
0,15 to 0,50	66 decreasing linearly with logarithm of frequency to 56	56 decreasing linearly with logarithm of frequency to 46
0,50 to 5	56	46
5 to 30	60	50

Table 9 – Disturbance voltage limits for DC power input port

Frequency range MHz	**Rated power of ≤ 75 kVA**		**Rated power of > 75 kVA**	
	Quasi-peak dB(µV)	**Average** dB(µV)	**Quasi-peak** dB(µV)	**Average** dB(µV)
0,15 to 0,50	79	66	100	90
0,50 to 5	73	60	86	76
			90	80
5 to 30	73	60	decreasing linearly with logarithm of frequency to	
			73	60

6.3.3 CPT port (150 kHz to 30 MHz)

The disturbance voltage limits of Table 10 and Table 11 apply for the AC power lines of the CPT port, respectively to the EUT's environmental classification.

The disturbance voltage limits of Table 12 apply for the DC power lines of the CPT port in any environment.

Measurement of the disturbance voltage shall be done at those lines of the CPT port serving conductive power transfer only.

If the AC charging EUT does not contain any electronic power converters or the like, but only switches and safety disconnectors, then it is sufficient to measure the disturbance voltage at its LV AC power input port only (see 6.3.2).

The disturbance voltage limits of Table 10 and Table 11 apply for AC, and Table 12 applies for DC.

Table 10 – Disturbance voltage limits for class A equipment for AC CPT port

Frequency range MHz	**Quasi-peak** dB(µV)	**Average** dB(µV)
0,15 to 0,50	79	66
0.50 to 30	73	60

Table 11 – Disturbance voltage limits for class B equipment for AC CPT port

Frequency range MHz	**Quasi-peak** dB(µV)	**Average** dB(µV)
0,15 to 0,50	66 decreasing linearly with logarithm of frequency to 56	56 decreasing linearly with logarithm of frequency to 46
0,50 to 5	56	46
5 to 30	60	50

Table 12 – Disturbance voltage limits for DC CPT port

Frequency range MHz	**Rated power of** ≤ 75 kVA		**Rated power of** > 75 kVA	
	Quasi-peak dB(µV)	**Average** dB(µV)	**Quasi-peak** dB(µV)	**Average** dB(µV)
0,15 to 0,50	79	66	100	90
0,50 to 5	73	60	86	76
			90	80
5 to 30	73	60	decreasing linearly with logarithm of frequency to	
			73	60

6.3.4 Wired network port or signal/control port (150 kHz to 30 MHz)

Measurements at wired network ports of equipment in the scope of this document shall be performed if they are intended for connection to physical subscriber lines of public switched telecommunication networks (PSTN).

Measurements at signal/control ports of equipment in the scope of this document shall be performed if they are intended for connection to a local supervision or power dispatch system intended to manage the power transfer via more than one local off-board charging equipment.

The measurements shall be made in accordance with CISPR 32:2015, using test equipment referenced in CISPR 32:2015 as appropriate.

For Class A EUTs, the limits in Table 13 apply, and for Class B EUTs the limits in Table 14 apply.

Table 13 – Requirements for asymmetric mode conducted emissions from Class A equipment

Table clause	Frequency range MHz	Coupling device	Detector type/ bandwidth	Class A voltage limits dB(μV)	Class A current limits dB(μA)
13.1	0,15 to 0,5	AAN	Quasi peak/9 kHz	97 to 87	n/a
	0,5 to 30			87	
	0,15 to 0,5	AAN	Average/9 kHz	84 to 74	
	0,5 to 30			74	
13.2	0,15 to 0,5	CVP and current probe	Quasi peak/9 kHz	97 to 87	53 to 43
	0,5 to 30			87	43
	0,15 0,5	CVP and current probe	Average/9 kHz	84 to 74	40 to 30
	0,5 to 30			74	30
13.3	0,15 to 0,5	Current probe	Quasi peak/9 kHz	n/a	53 to 43
	0,5 to 30				43
	0,15 to 0,5	Current probe	Average/9 kHz		40 to 30
	0,5 to 30				30
The choice of coupling device and measurement is defined in Annex C of CISPR 32:2015. AC mains ports that also have the function of a wired network port shall meet the limits given in Table 7. The application of the voltage and/or current limits is dependent on the measurement procedure used. Refer to Table C.1 of CISPR 32:2015 for applicability. Testing is required at only one EUT supply voltage and frequency. Applicable to ports listed above and intended to connect to cables longer than 3 m.					

Table 14 – Requirements for asymmetric mode conducted emissions from Class B equipment

Table clause	Frequency range MHz	Coupling device	Detector type/ bandwidth	Class B voltage limits dB(μV)	Class B current limits dB(μA)
14.1	0,15 to 0,5	AAN	Quasi peak/9 kHz	84 to 74	n/a
	0,5 to 30			74	
	0,15 to 0,5	AAN	Average/9 kHz	74 to 64	
	0,5 to 30			64	
14.2	0,15 to 0,5	CVP and current probe	Quasi peak/9 kHz	84 to 74	40 to 30
	0,5 to 30			74	30
	0,15 0,5	CVP and current probe	Average/9 kHz	74 to 64	30 to 20
	0,5 to 30			64	20
14.3	0,15 to 0,5	Current probe	Quasi peak/9 kHz	n/a	40 to 30
	0,5 to 30				30
	0,15 to 0,5	Current probe	Average/9 kHz		30 to 20
	0,5 to 30				20
The choice of coupling device and measurement is defined in Annex C of CISPR 32:2015. Screened ports are tested with a common-mode impedance of 150 Ω. This is typically accomplished with the screen terminated by 150 Ω to earth. AC mains ports that also have the function of a wired network port shall meet the limits given in Table 8. The application of the voltage and/or current limits is dependent on the measurement procedure used. Refer to Table C.1 of CISPR 32:2015 for applicability Testing is required at only one EUT supply voltage and frequency. Applicable to ports listed above and intended to connect to cables longer than 3 m.					

Compliance with the emission requirements of this document is verified where it can be demonstrated that the EUT meets the respective limits, during type tests in the measuring arrangement according to CISPR 32:2015.

6.3.5 Enclosure port (above 30 MHz)

The electromagnetic disturbances above 30 MHz caused by the EUT shall not exceed the limits specified in Table 16 to Table 19 for class A and class B respectively. The test setup is defined in Annex A, and the terminations as defined in Annex C shall be used.

The highest frequency up to which radiated emission measurements shall be performed is defined in Table 15. Based upon the value of F_x, Table 15 specifies the highest frequency applicable for the limits given in Table 17 or Table 19.

Table 15 – Required highest frequency for radiated measurement

Highest internal frequency (F_x)	Highest measured frequency
F_x ≤ 108 MHz	1 GHz
108 MHz < F_x ≤ 500 MHz	2 GHz
500 MHz < F_x ≤ 1 GHz	5 GHz
F_x > 1 GHz	5 x F_x up to a maximum of 6 GHz

Where F_x is unknown, the radiated emission measurements shall be performed up to 6 GHz.

Table 16 – Requirements for radiated emissions at frequencies up to 1 GHz for Class A equipment

Table clause	Frequency range MHz	Measurement		Class A limits dB(µV/m)
		Distance m	Detector/ bandwidth	Test site: OATS or SAC acc. to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012
16.1	30 to 230	10	quasi peak/ 120 kHz	40
	230 to 1 000			47
16.2	30 to 230	3		50
	230 to 1 000			57
Apply only 16.1 or 16.2 across entire frequency range. Other measurement distances may be used. The corresponding limits have to be calculated according to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012.				

Table 17 – Requirements for radiated emissions at frequencies above 1 GHz for Class A equipment

Table clause	Frequency range MHz	Measurement		Class A limits dB(µV/m)
		Distance m	Detector/ bandwidth	Test site: FSOATS acc. to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012
17.1	1 000 to 3 000	3	Average/ 1 MHz	56
	3 000 to 6 000			60
17.2	1 000 to 3 000		Peak/ 1 MHz	76
	3 000 to 6 000			80
17.1	1 000 to 3 000	10	Average/ 1 MHz	46
	3 000 to 6 000			50
17.2	1 000 to 3 000		Peak/ 1 MHz	66
	3 000 to 6 000			70
Apply 17.1 and 17.2 at the same distance across the frequency range from 1 000 MHz to the highest required frequency of measurement derived from Table 15. Other measurement distances may be used. The corresponding limits have to be calculated according to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012.				

Table 18 – Requirements for radiated emissions at frequencies up to 1 GHz for Class B equipment

Table clause	Frequency range MHz	Measurement		Class B limits dB(µV/m)
		Distance m	Detector/ bandwidth	Test site: OATS or SAC acc. to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012
18.1	30 to 230	10	Quasi peak/ 120 kHz	30
	230 to 1 000			37
18.2	30 to 230	3		40
	230 to 1 000			47
Apply only 18.1 or 18.2 across entire frequency range. Other measurement distances may be used. The corresponding limits have to be calculated according to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012.				

Table 19 – Requirements for radiated emissions at frequencies above 1 GHz for Class B equipment

Table clause	Frequency range MHz	Measurement		Class B limits dB(µV/m)
		Distance m	Detector/ bandwidth	Test site: FSOATS acc. to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012
19.1	1 000 to 3 000	3	Average/ 1 MHz	50
	3 000 to 6 000			54
19.2	1 000 to 3 000		Peak/ 1 MHz	70
	3 000 to 6 000			74
19.1	1 000 to 3 000	10	Average/ 1 MHz	40
	3 000 to 6 000			44
19.2	1 000 to 3 000		Peak/ 1 MHz	60
	3 000 to 6 000			64
Apply 19.1 and 19.2 at the same distance across the frequency range from 1000 MHz to the highest required frequency of measurement derived from Table 15. Other measurement distances may be used. The corresponding limits have to be calculated according to CISPR 16-1-4:2010 and CISPR 16-1-4:2010/AMD1:2012.				

7 Test results and test report

The test results shall be documented in a comprehensive test report with sufficient detail to enable test repeatability.

The test report shall contain the following minimum information:

- EUT description;
- EMC test plan;
- test data and results;
- test equipment and setup.

Annex A
(normative)

Example test setups

The test setups in Figure A.1 and Figure A.2 are suitable for emission and immunity tests as appropriate. The terminations according to Annex C shall be used. Further advice is found in the appropriate basic standards (for example the use of assigned coupling/decoupling networks).

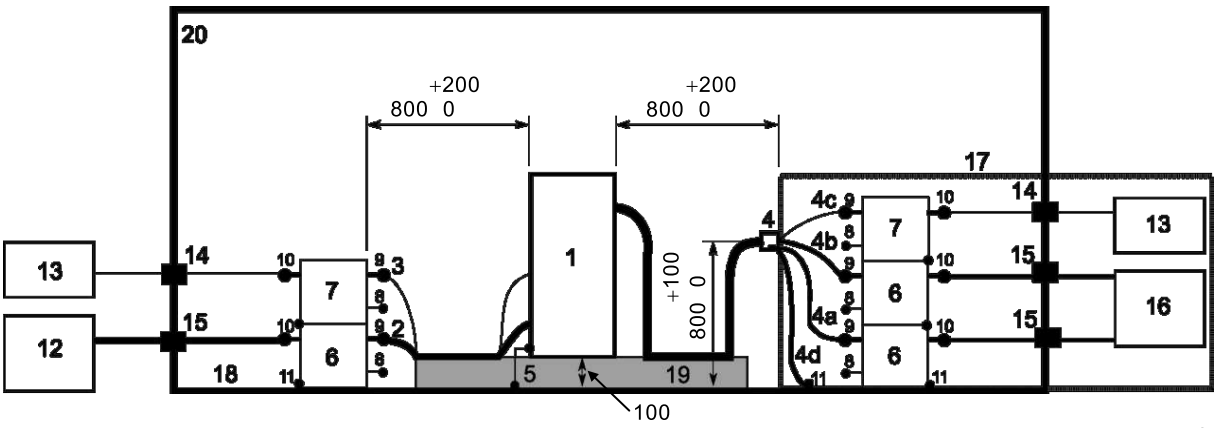
The cables of the EUT shall

- hang vertically at the side of the EUT to the insulation support ($\varepsilon r \leq 1,4$), at (100 ± 25) mm above the ground plane, and
- be such that any extraneous length thereof shall be placed on the insulation support (z-folded, if necessary).

The terminations (ANs/ISNs) shall be connected to the ground plane of the test site as indicated in Figures A.1 and A.2 with short ground straps.

Figure A.1 shows an example test setup to be used for EUT’s incorporating an isolation transformer between the AC and DC (CPT) port.

Dimensions in millimetres



Key

1 EUT (floor standing)

2 power input port

3 signal/control port or wired network port

4 CPT port (end of charging cable/vehicle inlet)

- 4a CPT port – power line 1
- 4b CPT port – power line 2
- 4c CPT port – other than power lines
- 4d PE-ground connection

5 ground strap of EUT chassis (only if this is required in the EUT manual)

6 termination of power lines (AMN (for AC) or AN (for DC) acc. to Annex C)

7 termination for signal/control port or wired network port (ISN acc. to Annex C)

8 measuring port terminated with 50 Ω

9 EUT port of termination

10 supply/load port of termination

11 low impedance ground connection of termination chassis

12 AC mains or DC power supply (placed outside of test site or inside if non disturbing)

13 communication simulator/ stimulating and monitoring system (placed outside of test site or inside if non disturbing)

14 feed through filter

15 AC/DC power feed through filter

16 power load (placed outside of test site or inside if non disturbing)

17 AE/vehicle simulator (shielding might be necessary)

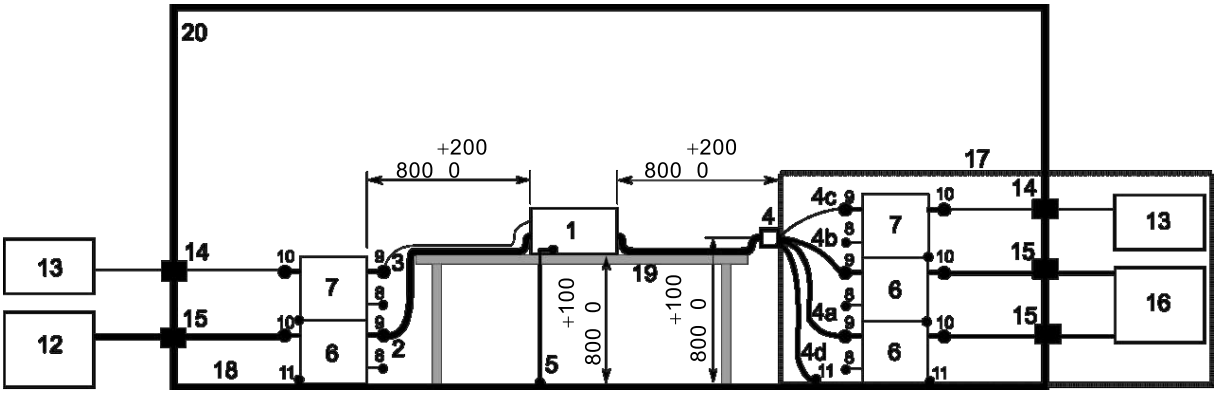
18 ground plane

19 insulation support with low permittivity

20 shielded enclosure or ALSE or test site

Figure A.1 – Example test setup for floor standing equipment for radiated and conducted emission and immunity

Dimensions in millimetres



IEC

Key

1) EUT (table top and wall mounted)
2) power input port
3) signal/control port or wired network port
4) CPT port (end of charging cable/vehicle inlet)
   - 4a CPT port power line 1
   - 4b CPT port power line 2
   - 4c CPT port other than power lines
   - 4d PE-ground connection
5) ground strap of EUT chassis (only if this is required in the EUT manual)
6) termination of power lines (AMN (for AC) or AN (for DC) acc. to Annex C)
7) termination for signal/control port or wired network port (ISN acc. to Annex C)
8) measuring port terminated with 50 Ω
9) EUT port of termination
10) supply/load port of termination
11) Low impedance ground connection of termination chassis
12) AC mains or DC power supply (placed outside of test site or inside if non disturbing)
13) communication simulator/ stimulating and monitoring system (placed outside of test site or inside if non disturbing)
14) feed through filter
15) AC/DC power feed through filter
16) power load (placed outside of test site or inside if non disturbing)
17) AE/vehicle simulator (shielding might be necessary)
18) ground plane
19) non-conductive table
20) shielded enclosure or ALSE or test site

Attention is drawn to the user of such test setups in regard of hazardous voltages due to high earth leakage currents. Advice should be sought from duly qualified personnel before switching on the laboratory's system power sources to ensure that injury or damage is not caused to test personnel or equipment.

Figure A.2 – Example test setup for table top and wall mounted equipment for emission and immunity

Annex B
(informative)

Radiated disturbance test for keyless entry

B.1 General

The purpose of this test is to simulate the effects of the radiated magnetic fields on a keyless entry system for a vehicle. This requirement is introduced due to the large magnetic fields generated by charging systems in close proximity to other vehicles.

The test method is based on that of MIL-STD-461F:2007 however is modified as follows:

- increase the measuring distance from 7 cm to 1 m;
- use a fixed height of measurement;
- use a fixed measurement bandwidth of 200 Hz across the whole frequency range of measurement.

The EUT shall be configured and operated as defined in 4.3. and 4.4. Under these conditions, the measurement shall be performed using the following test procedure.

B.2 Test setup

The test setup according to Annex A and terminations according to Annex C shall be used. The loop sensor shall be located as defined in Figure B.1. The test procedure is based on MIL-STD-461F:2007 and uses a loop sensor for the measuring transducer as defined in MIL-STD-461F:2007.

B.3 Test method

The test setup according to Annex A and terminations according to Annex C shall be used.

1) Turn on the EUT and allow sufficient time for stabilization.
2) Locate the loop sensor 1 m from the EUT's face. Orient the plane of the loop sensor parallel to the face of the EUT.
3) Scan the measurement receiver over the frequency range (2 kHz to185 kHz) stepping at 0,5 × w, where w is the measurement bandwidth.
4) Repeat steps 2) to 3) above with the loop sensor in each orthogonal plane.
5) Repeat steps 2) to 4) above for each face of the EUT and compare the level of maximum radiation against the limit values contained in Table B.1.

The measured value is calculated as follows:

$$R = L + F - 2{,}0$$

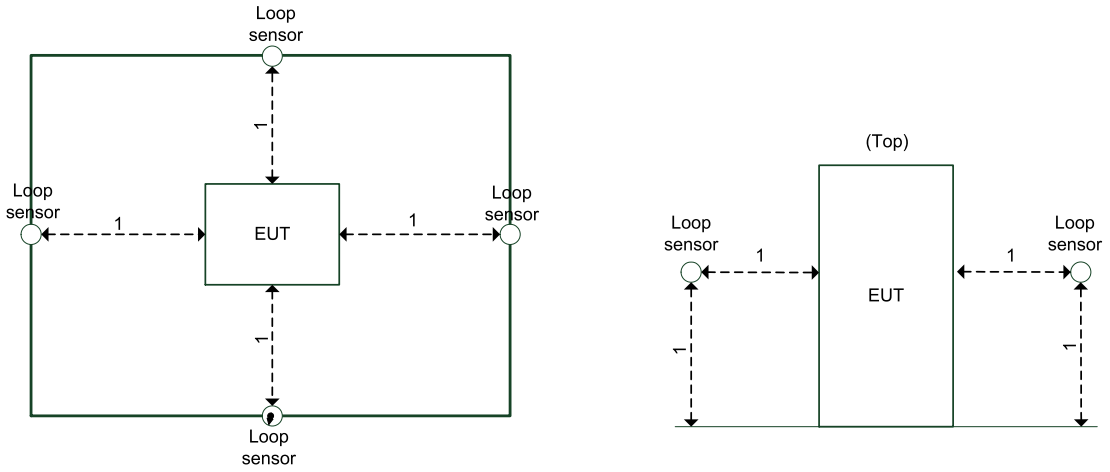
where

R is the measurement result (dBuA/m);

L is the measuring receiver level (dBuV);

F is the loop correction factor (dB/pT).

Dimensions in metres



NOTE Left side is top view and right side is side view.

Figure B.1 – Example of a test setup for measurement of radiated disturbances to keyless entry (layout and spacing for the loop sensor)

B.4 Limits for radiated disturbances keyless entry (2 kHz to 185 kHz)

The electromagnetic radiation disturbance in the frequency range 2 kHz to 185 kHz caused by the EUT shall not exceed the limits specified in Table B.1.

This test is applicable only to DC charging equipment.

Table B.1 – Limit values of radiated disturbances (2 kHz to 185 kHz)

Frequency (kHz)	**Limit value/peak value** dB (μA/m)
2 to 10	62 to 60 [a)]
10 to 30	60
30 to 75	60 to 95 [b)]
75 to 120	95 to 55 [a)]
120 to 140	55
140 to 185	55 to 95 [b)]

[a)] The limit decreases linearly with frequency.

[b)] The limit increases linearly with frequency.

Annex C
(normative)

Termination of ports

C.1 General

Annex C describes the artificial networks (AN) for the termination of the power lines (AC or DC/power input/CPT port power lines) of the EUT and the impedance stabilization networks (ISN) for the termination of symmetric communication lines (e.g. CAN, CHAdeMO) and asymmetric communication lines (e.g. PLC via control pilot) used for charging communications and data transfer.

The CPT port consists of "CPT port – power lines" and "other than power lines" (signal lines) as shown in Figure 1 and Figure A.1 and Figure A.2. The different types of lines need different terminations which shall be connected as close as possible to the CPT port (socket outlet or vehicle connector). All of these lines are integral part of the charging cable.

The terminations according to Table C.1 shall be used.

Table C.1 – Termination of ports

Port type	AC	DC
Power input	V-AMN 50 µH/50 Ω CISPR 16-1-2:2014	HV-AN 5 µH/50 Ω CISPR 25:2008
CPT – power lines	V-AMN 50 µH/50 Ω CISPR 16-1-2:2014	HV-AN 5 µH/50 Ω CISPR 25:2008
Communication lines	ISN as described in Clause C.2	ISN as described in Clause C.2

C.2 Termination of communication lines – Impedance stabilization networks (ISN)

C.2.1 General

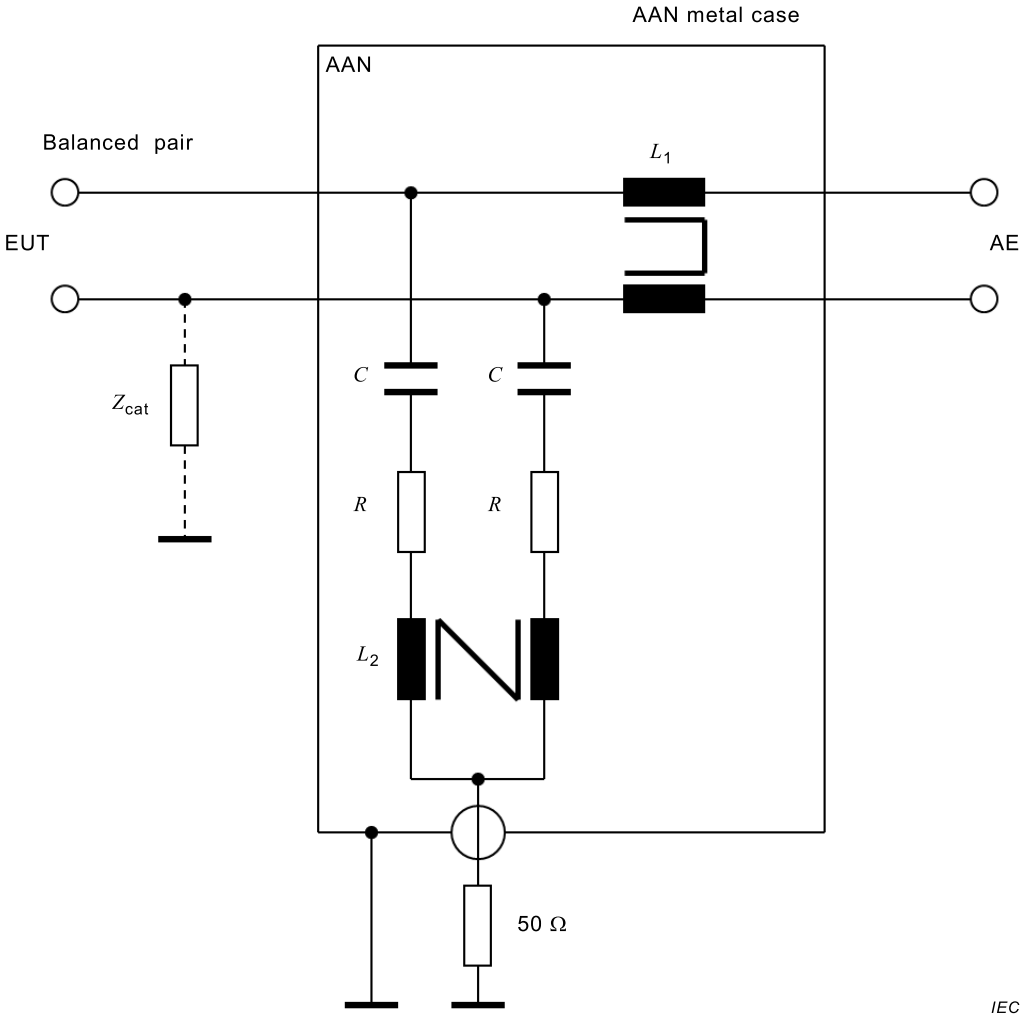
Currently, different types of communication systems and communication cabling are used for the communication between the EUT and the vehicle. Therefore, a distinction between some specific cabling/operation types is necessary.

C.2.2 Symmetric communication lines (e.g. CAN)

ISNs or specification conform circuits shall be used.

For example, an impedance stabilization network (ISN) to be connected between the load simulator (i.e. the replacement for the vehicle, or respectively the communication simulation) and the EUT is defined in CISPR 32:2015, C.4.1.2 and Annex G (see example in Figure C.1). The ISN has a common mode (CM) impedance of 150 Ω. The impedance Z_{cat} adjusts the symmetry of the cabling and attached periphery and is typically denoted as longitudinal conversion loss (LCL). The value of LCL shall be chosen according to Table C.2 and C.4.1.2 of CISPR 32:2015, cable category 3 (or better) for CAN bus. For all other communication lines, the LCL value shall be predetermined by measurements or be defined by the manufacturer of the charging station/charging cable. The selected value for LCL and its origin shall be stated in the test report.

NOTE The ISN is not intended for any conducted emission measurement but only to ensure adequate decoupling between modems.



Key

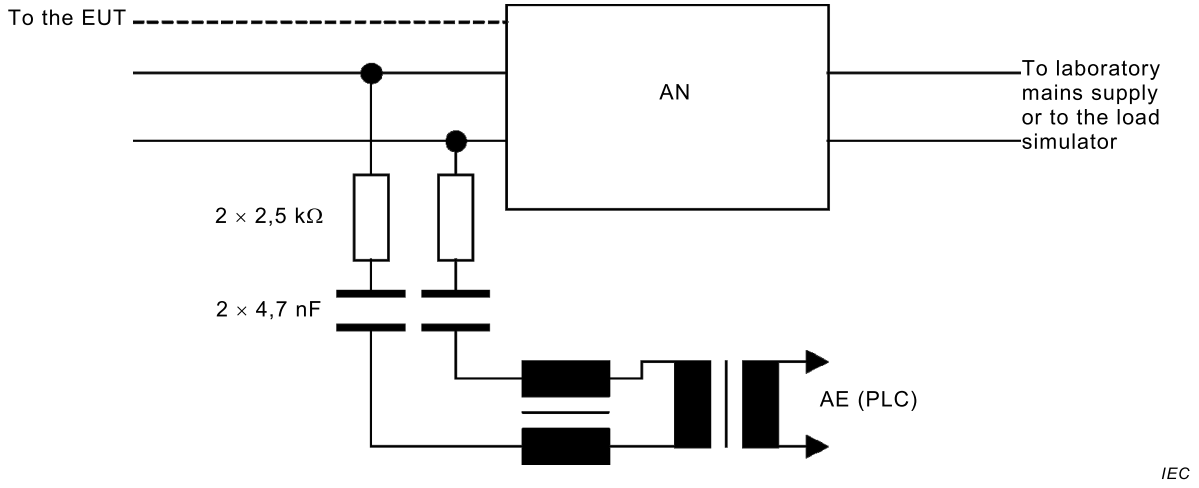
C	4,7 µF
R	200 Ω
L_1	2 × 38 mH
L_2	2 × 38 mH
AAN	asymmetric artificial network
AE	associated equipment
EUT	equipment under test

Source CISPR 32:2015, Figure G.1.

Figure C.1 – Example of an impedance stabilization network for symmetric communication lines

C.2.3 Coupling devices for PLC on power lines

For PLC on power lines, termination/coupling devices according to the appropriate PLC standards shall be used. The circuits shown in Figures C.2 and C.3 allow emission measurements for out-of-band emissions and immunity tests. They can be used as PLC coupling devices for the measurement of conducted disturbances at the mains power supply cable (i.e. at the power port) and at the charger cable (i.e. at the CPT port) of the EUT. They shall be used in combination with the usual artificial networks (ANs) used for termination of the power lines of the power port and CPT port of the EUT. The circuit in Figure C.2 provides a common mode termination by the AN. For emission testing, only the emissions from the PLC modem of the EUT should be evaluated. Therefore, an attenuator is located between the power line and the PLC modem at the AE side in the circuit for emission tests. This attenuator consists of two resistors in combination with the input/output impedance of the PLC modem. The value of the resistors depends on the design impedance of the PLC modems and the allowed attenuation for the PLC system.



NOTE The values of the resistors depend on the allowed attenuation and the design impedance of the PLC modem (here: 40 dB attenuation, 100 Ω PLC design impedance).

Figure C.2 – Example of a circuit for emission tests of PLC on AC or DC power lines

The attenuator between the two PLC modems will reduce the signal-to-noise ratio on the line, which would give unrealistic results during immunity testing. Therefore, immunity tests should be performed without the attenuator (see Figure C.3).

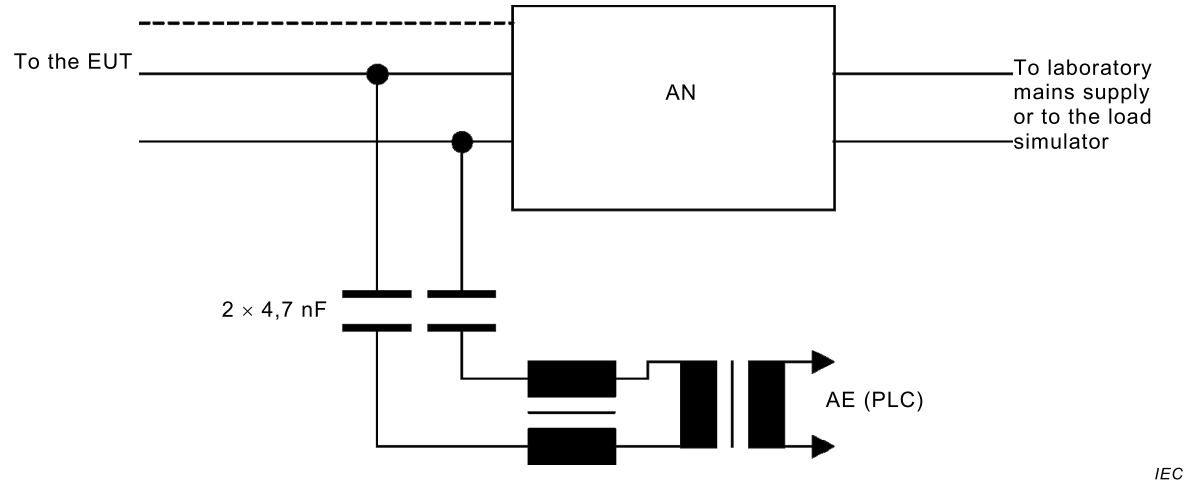
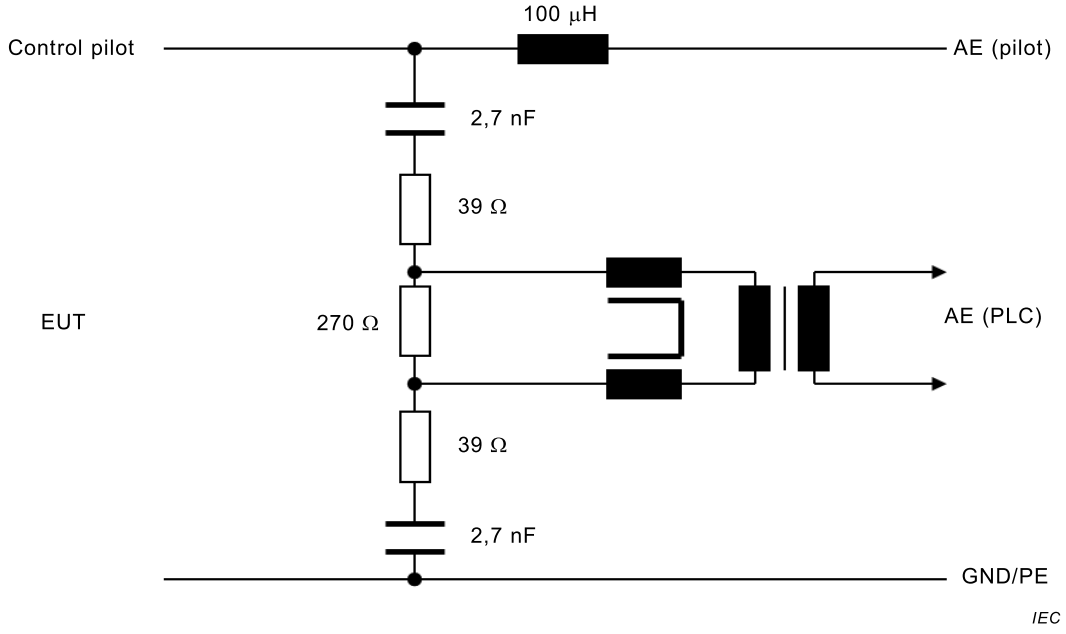


Figure C.3 – Example of a circuit for immunity tests of PLC on AC or DC power lines

C.2.4 PLC (technology) on control pilot

Some communication systems make use of the control pilot line (versus PE) with a superimposed (high frequency) communication. Typically, the technology developed for power line communication (PLC) is used for that purpose. On the one hand, the communication lines are operated unsymmetrically; on the other hand, two different communication systems operate on the same line. Therefore, a special artificial network (AN) shall be used. The network shown in Figure C.4 provides a common mode impedance of (150 ± 20) Ω in the range 150 kHz to 30 MHz on the control pilot line (assuming a design impedance of the modem of 100 Ω). Both types of communications (control pilot, PLC) are separated by the network. Therefore, typically a communication simulation is used in combination with this network. The attenuator built by the resistors and the design impedance of the PLC modem makes sure that the signal on the charging cable is dominated by the EUT's communication signals rather than the AE PLC modem.

To assure that the signal is dominated by the EUT's communication signal the transmission power of the AE PLC modem needs to be defined to be lower than the EUTs T_X-power. ISO 15118-3:2015, Annex A, only defines a maximum power spectrum density, not a minimum. From the experience, an attenuator between EUT and AE of ≥ 10dB gives suitable attenuation of the AE.



NOTE The values of the three resistors depend on the design impedance of the PLC modem connected at AE side. The values given in the schematic are valid for a design impedance of 100 Ω.

Figure C.4 – Example of a circuit for emission tests of PLC on control pilot line

The attenuator between the two PLC modems will reduce the signal-to-noise ratio on the line, which would give unrealistic results during immunity testing. Therefore, immunity tests should be performed without the attenuator (see Figure C.5).

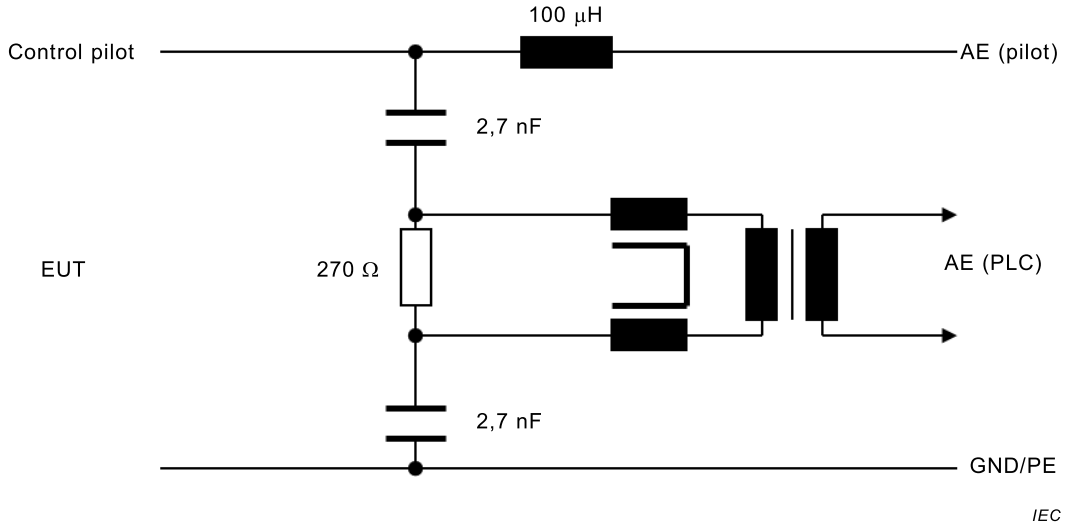
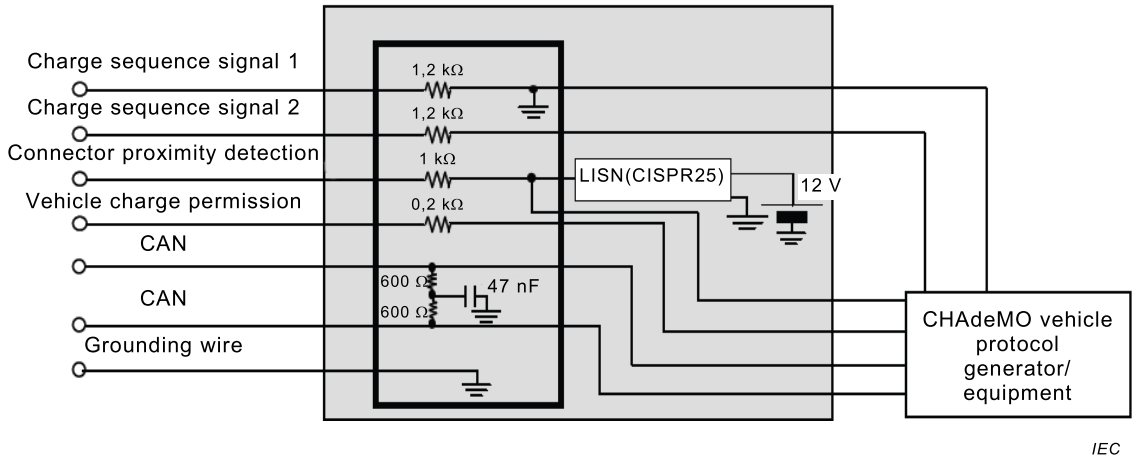


Figure C.5 – Example of a circuit for immunity tests of PLC on control pilot line

C.3 Coupling and termination devices for other communication and signalling lines

For termination of these lines, use the appropriate functional termination circuits as defined in IEC 61851-23:2014, Annexes AA, BB and CC (see Figure C.6).



NOTE Please consider that these circuits describe the functional termination and not the EMC termination of the lines. Therefore, the use of typical AN or AAN can be appropriate.

Figure C.6 – Example of a termination circuit for testing of system A

For control pilot, see for example IEC 61851-1:2017.

Annex D
(normative)

Voltage transient disturbances from DC charging equipment

Voltage transients caused by the EUT shall not exceed the limit value in Table D.1. This test is only applicable to DC charging EUTs.

Table D.1 – Voltage transient limit of EUT

Measuring point	Between positive (+) and negative (-)	Between positive (+) and ground	Between negative (-) and ground
Limit/dU(+) dU(-)	50 V	50 V	50 V

The following requirements are for the type test.

The test shall be carried out in the steady state operating condition as described in 4.4.

Figure D.1 shows the illustration and definition of voltage transient of DC charging EUT.

The measurement equipment shown in Figure D.2 may be used.

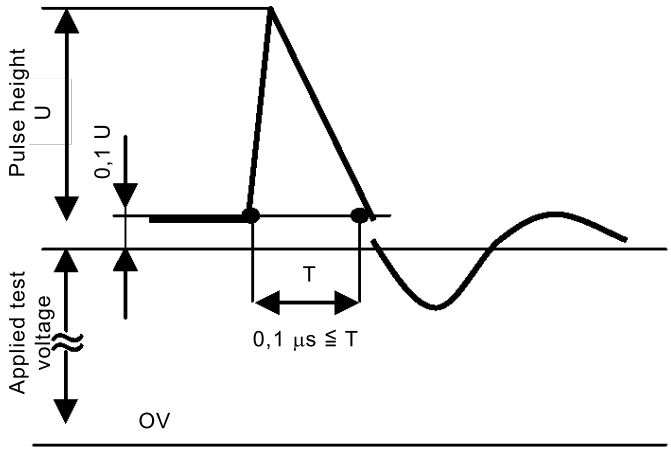
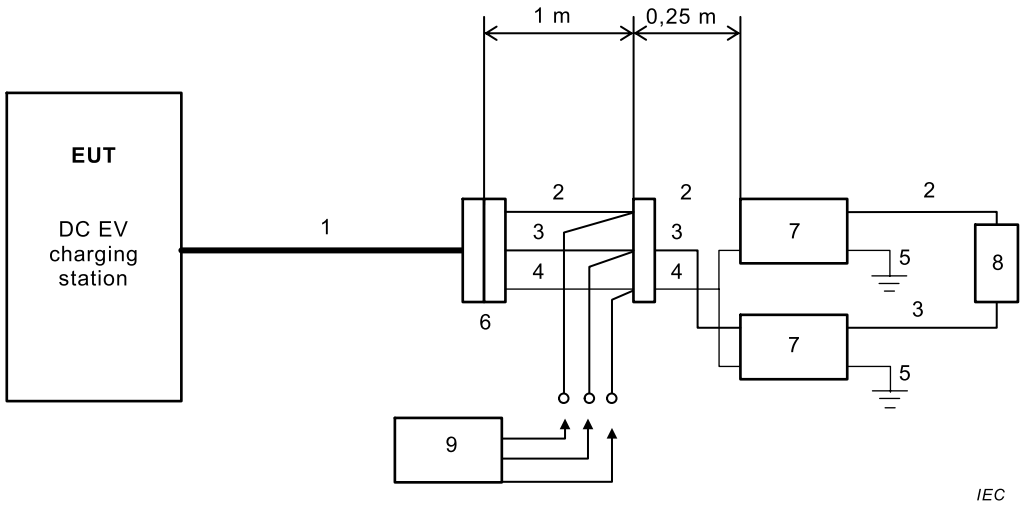


Figure D.1 – Voltage transient of DC charging EUT



Key

1 charging cable (CPT port)

2 DC power supply line (positive)

3 DC power supply line (negative)

4 ground line

5 earth

6 vehicle coupler (charger cable plug plus socket for that plug)

7 artificial network according to Annex C.

8 variable resistive load and termination R(term)

9 high-impedance differential voltage probes (AC coupled and covering 100 MHz signals) and appropriate oscilloscope

The cable identified above as 1, i.e. the charging cable (CPT port), shall be the shortest length specified by the manufacturer to an end user.

Figure D.2 – Voltage transient measurement equipment

Annex E
(normative)

Voltage surge test setup for DC charging EUT

During the application of voltage surges (IEC 61000-4-5:2014) on the AC or DC power input port, a measurement shall be made using a suitable instrument that measures the associated amplitude of the transient appearing on the CPT port at the vehicle coupler terminals. High-impedance differential voltage probes (AC coupled and covering 100 MHz signals) shall be used with an appropriate oscilloscope. The oscilloscope should be battery powered or floating to decouple from the test setup.

The AC coupled voltage measured on the DC power output port lines and signal lines of the CPT port shall not exceed the limits in Table E.1, during the application of voltage surges (according to IEC 61000-4-5:2014) on the AC or DC power input port of the DC charging EUT.

Table E.1 – Maximum voltage to be measured on the CPT

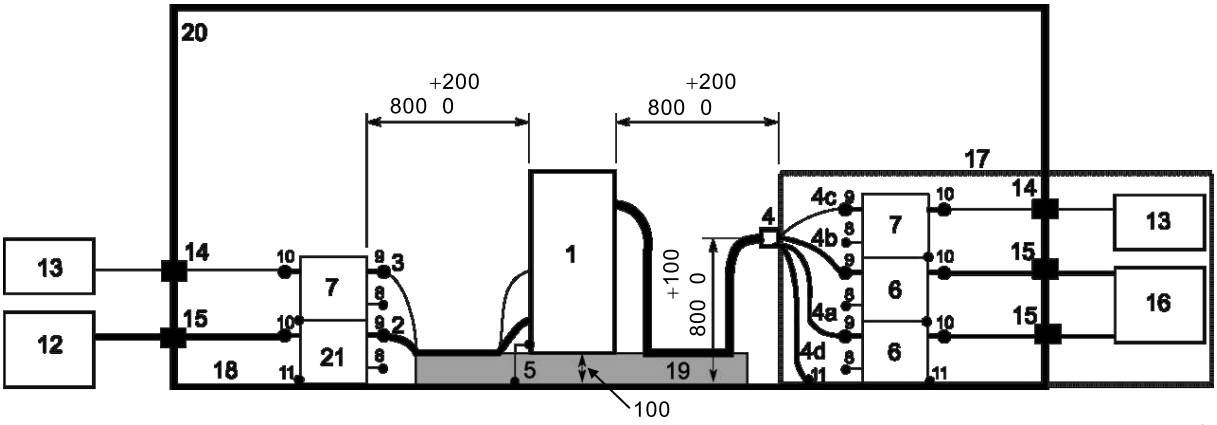
Type of immunity test	Voltage limit (peak-to-peak), AC-coupled between			
	DC+ (4a) and DC- (4b)	DC+ (4a) and GND (4d)	DC- (4b) and GND (4d)	CPT port signal lines (4ci) and GND (4d)
Voltage surge (IEC 61000-4-5:2014)	500 Vpp	500 Vpp	500 Vpp	500 Vpp

The test setup is shown in Figure E.1. The length of the power input cable shall be in accordance with IEC 61000-4-5:2014, as appropriate. At the CPT port, the original, unshortened charge cable (consisting of DC+, DC-, PE and CPT signal lines) supplied by the manufacturer shall be used. If the manufacturer offers charging cables with different length, the shortest cable shall be used. The distance between the EUT and AN as well as EUT and IS are determined in Figure E.1. Extraneous length shall be z-folded with 40 cm z-length.

In accordance with Annex A, ANs and ISNs shall be positioned directly onto the ground (GND). The measuring port shall be terminated with 50 Ω.

- Only for surge tests according to IEC 61000-4-5:2014, the PE-line can be grounded if the wave form is in accordance with IEC 61000-4-5:2014 (since there might be an extra inductance in the PE path present in some CDNs, that is not part of IEC 61000-4-5:2014).
- Indicate a grounding of the EUT chassis if this is required in the EUT manual.
- The surge generator, CDN, AN and ISN shall be bonded to GND with short low impedance ground straps.

Dimensions in millimetres



Key

1) EUT (floor standing)
2) power input port
3) signal/control port or wired network port
4) CPT port (end of charging cable/vehicle inlet)
   - 4a CPT port – power line 1
   - 4b CPT port – power line 2
   - 4c CPT port – other than power lines
   - 4d PE-ground connection
5) ground strap of EUT chassis (only if this is required in the EUT manual)
6) termination of power lines (AMN (for AC) or AN (for DC) acc. to Annex C)
7) termination for signal/control port or wired network port (ISN acc. to Annex C)
8) measuring port terminated with 50 Ω
9) EUT port of termination
10) supply/load port of termination
11) low impedance ground connection of termination chassis
12) AC mains or DC power supply (placed outside of test site or inside if non disturbing)
13) communication simulator/ stimulating and monitoring system (placed outside of test site or inside if non disturbing)
14) feed through filter
15) AC/DC power feed through filter
16) power load (placed outside of test site or inside if non disturbing)
17) AE/vehicle simulator (shielding might be necessary)
18) ground plane
19) insulation support with low permittivity
20) shielded enclosure or ALSE or test site
21) surge generator with CDN

Figure E.1 – Example of transient test setup

Annex F
(informative)

Transient immunity test for DC charging EUT

Annex F describes test setups and values for voltage ripples and pulsed sinusoidal disturbances on power lines of the CPT port.

Annex F is informative since work is ongoing on this issue, and will be updated when ISO 7637-4[2] will be published. Annex F may become normative at that time.

2 Under preparation. Stage at the time of publication: ISO/DTS 7637-4:2017.

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IEC 61980 (all parts), *Electric vehicle wireless power transfer (WPT) systems*

CISPR 11:2015*, Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

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*

ISO 7637-4, *Road Vehicles – Electrical disturbance by conduction and coupling – Part 4: Electrical transient conduction along shielded high voltage supply lines only*[3]

ISO 15118-3:2015, *Road vehicles – Vehicle to grid communication interface – Part 3: Physical and data link layer requirements*

IEEE Std 1394, *IEEE Standard for a High-Performance Serial Bus*

RS-232, *Interface between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange*

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3 Under preparation. Stage at the time of publication: ISO/DTS 7637-4:2017.

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