SLOVENSKI STANDARD
SIST EN 61851-1:2011

01-oktober-2011

Sistem za napajanje električnih vozil prek kabla - 1. del: Splošne zahteve

Electric vehicle conductive charging system - Part 1: General requirements

Système de charge conductive pour véhicules électriques - Partie 1: Règles générales

Ta slovenski standard je istoveten z: EN 61851-1:2011

<u>ICS:</u>

43.120	Električna cestna vozila	Electric road vehicles

SIST EN 61851-1:2011 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61851-1

August 2011

ICS 43.120

Supersedes EN 61851-1:2001

English version

Electric vehicle conductive charging system - Part 1: General requirements
(IEC 61851-1:2010)

Système de charge conductive pour véhicules électriques -
Partie 1: Règles générales
(CEI 61851-1:2010)

Elektrische Ausrüstung von Elektro-Straßenfahrzeugen -
Konduktive Ladesysteme für Elektrofahrzeuge -
Teil 1: Allgemeine Anforderungen
(IEC 61851-1:2010)

This European Standard was approved by CENELEC on 2011-04-12. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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

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

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 61851-1:2011 E

Foreword

The text of document 69/173/FDIS, future edition 2 of IEC 61851-1, prepared by IEC TC 69, Electric road vehicles and electric industrial trucks, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61851-1 on 2011-04-12.

This European Standard supersedes EN 61851-1:2001.

The main changes with respect to EN 61851-1:2001 are the following:

– revision of connector definitions and current levels (Clause 8);

– modification definition of pilot wire to pilot function;

– division of Clause 9 to create Clauses 9 and 11;

– Clause 9: specific requirements for inlet, plug and socket–outlet;

– Clause 11: EVSE requirements: the basic generic requirements for charging stations;

– renumbering of annexes;

– deletion of previous Annex A and integration of charging cable requirements into new Clause 10;

– Annex B becomes Annex A and is normative for all systems using a PWM pilot function with a pilot wire;

– Annex C becomes Annex B;

– replacement of previous Annex D (coding tables for power indicator) with B.4 in Annex B using new values;

– new informative Annex C describing an alternative pilot function system.

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

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-01-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-04-01

Annexes ZA, ZB and ZC have been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61851-1:2010 was approved by CENELEC as a European Standard without any modification.

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

IEC 60068-2-1:2007	NOTE	Harmonized as EN 60068-2-1:2007 (not modified).
IEC 60068-2-14:2009	NOTE	Harmonized as EN 60068-2-14:2009 (not modified).
IEC 60364-6:2006	NOTE	Harmonized as HD 60364-6:2007 (modified).

IEC 60947-1:2007	NOTE	Harmonized as EN 60947-1:2007 (not modified).
IEC 60947-6-1:2005	NOTE	Harmonized as EN 60947-6-1:2005 (not modified).
IEC 61140	NOTE	Harmonized as EN 61140.
IEC 61851-21	NOTE	Harmonized as EN 61851-21.
IEC 61851-22	NOTE	Harmonized as EN 61851-22.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
-	-	Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances	EN 50065-1	2001
IEC 60038 (mod)	2009	IEC standard voltages	FprEN 60038[1)]	2011
IEC 60068-2-30	2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	2005
IEC 60068-2-75	1997	Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests	EN 60068-2-75	1997
IEC 60068-2-78	2001	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	2001
IEC 60276	-	Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip-rings	EN 60276	-
IEC 60309-1	1999	Plugs, socket-outlets and couplers for industrial purposes - Part 1: General requirements	EN 60309-1 + A11	1999 2004
IEC 60309-2	1999	Plugs, socket-outlets and couplers for industrial purposes - Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories	EN 60309-2 + A11	1999 2004
IEC 60364-4-41 (mod)	2005	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock	HD 60364-4-41 + corr. July	2007 2007
IEC 60529	1989	Degrees of protection provided by enclosures (IP Code)	EN 60529 + corr. May	1991 1993
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC/TR 60755	2008	General requirements for residual current operated protective devices	-	-
IEC 60884-1	2002	Plugs and socket-outlets for household and similar purposes - Part 1: General requirements	-	-

[1)] At draft stage.

Publication	Year	Title	EN/HD	Year
IEC 60884-2-5	1995	Plugs and socket-outlets for household and similar purposes - Part 2: Particular requirements for adaptors	-	-
IEC 60947-3	2008	Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units	EN 60947-3	2009
IEC 60950-1 (mod) + corr. August	2005 2006	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1 + A11 + A12	2006 2009 2011
IEC 60990	1999	Methods of measurement of touch current and protective conductor current	EN 60990	1999
IEC 61000-6-1	2005	Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments	EN 61000-6-1	2007
IEC 61000-6-3	2006	Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments	EN 61000-6-3	2007
IEC 61008-1 (mod)	2010	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) - Part 1: General rules	FprEN 61008-1	200X[1)]
IEC 61009-1 (mod)	2010	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) - Part 1: General rules	FprEN 61009-1	200X[1)]
IEC 61180-1	1992	High-voltage test techniques for low-voltage equipment - Part 1: Definitions, test and procedure requirements	EN 61180-1	1994
IEC 62196-1	2003	Plugs, socket-outlets, vehicle couplers and vehicle inlets - Conductive charging of electric vehicles - Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c.	EN 62196-1	2003
ISO 6469-2	2009	Electrically propelled road vehicles - Safety specifications - Part 2: Vehicle operational safety means and protection against failures	-	-
ISO 6469-3	2001	Electric road vehicles - Safety specifications - Part 3: Protection of persons against electric hazards	-	-
SAE J1772	2010	Recommended practices: SAE Electric Vehicle and Plug In Hybrid Electric Vehicle Conductive Charge Coupler	-	-

Annex ZB
(normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the European Standard or Harmonization Document.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Clause	Special national condition
6.2	**Germany** In Germany the inline control box (EVSE) shall be in the plug or located within 2,0 m of the plug.
6.3.3, Note 3	**Finland** The use of adaptors from mode 1 socket outlets to mode 3 vehicle cable assembly, that maintain the overall safety requirements of this standard is allowed in Finland.
11.3.2, Note 1	**Finland** In Finland IPXXD is not required for mode 1.
11.3.2, Note 1	**The Netherlands** In The Netherlands IPXXD is not required for mode 1.

Annex ZC
(informative)

A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CENELEC national member.

This European Standard does fall under LVD (2006/95/EC).

In the relevant CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Clause	Deviation
2	**United Kingdom**
	IEC 60884-1 is not indispensable for the application of this document.
	IEC 60884-1 is not applicable in UK.
	The BS 1363 Series of standards applies to domestic socket-outlets, fused plugs, fused connection units, fused conversion plugs and to adaptors in the UK.
6.2	**Germany**
	Mode 1 cables without an in-cable RCD shall not be used but only Mode 1 cables **with** an in-cable RCD.
	All Mode 1 cables **without** an in-cable RCD shall bear the following safety information: “Shall not be used in Germany".
	Due to article 14 in the constitutional law of Germany which frames the preservation of status quo of existing electrical installations it cannot be ensured that fixed electrical installations at all times provide an RCD in Germany.
6.3.3	**United Kingdom**
	IEC 60884-2-5 is not applicable in UK.
	BS 1363-3 and BS 1363-5 apply to domestic adaptors and fused conversion plugs in the UK.
9.1	**United Kingdom**
	IEC 60884-1 is not applicable in UK.
	The BS 1363 Series of standards applies to domestic socket-outlets, fused plugs, fused connection units, fused conversion plugs and to adaptors in the UK.
9.2	**United Kingdom**
	IEC 60884-1 is not applicable in UK.
	The BS 1363 Series of standards applies to domestic socket-outlets, fused plugs, fused connection units, fused conversion plugs and to adaptors in the UK.
9.3	**United Kingdom**
	IEC 60884-1 is not applicable in UK.
	The BS 1363 Series of standards applies to domestic socket-outlets, fused plugs, fused

connection units, fused conversion plugs and to adaptors in the UK.

11.6 United Kingdom

IEC 60884-1 is not applicable in UK.

The BS 1363 Series of standards applies to domestic socket-outlets, fused plugs, fused connection units, fused conversion plugs and to adaptors in the UK.

IEC 61851-1

Edition 2.0 2010-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electric vehicle conductive charging system – Part 1: General requirements

Système de charge conductive pour véhicules électriques – Partie 1: Règles générales

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 1: General requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition published in 2001. It constitutes a technical revision.

The main changes with respect to the first edition of this standard are the following:

– revision of connector definitions and current levels (Clause 8);
– modification definition of pilot wire to pilot function;
– division of Clause 9 to create Clauses 9 and 11;
– Clause 9: specific requirements for inlet, plug and socket–outlet;
– Clause 11: EVSE requirements: the basic generic requirements for charging stations;
– renumbering of annexes;

– deletion of previous Annex A and integration of charging cable requirements into new Clause 10;
– Annex B becomes Annex A and is normative for all systems using a PWM pilot function with a pilot wire;
– Annex C becomes Annex B;
– replacement of previous Annex D (coding tables for power indicator) with B.4 in Annex B using new values;
– new informative Annex C describing an alternative pilot function system.

The text of this standard is based on the following documents:

FDIS	Report on voting
69/173/FDIS	69/179/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 date 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.

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

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 1: General requirements

1 Scope

This part of IEC 61851 applies to on-board and off-board equipment for charging electric road vehicles at standard a.c. supply voltages (as per IEC 60038) up to 1 000 V and at d.c. voltages up to 1 500 V, and for providing electrical power for any additional services on the vehicle if required when connected to the supply network.

Electric road vehicles (EV) implies all road vehicles, including plug in hybrid road vehicles (PHEV), that derive all or part of their energy from on-board batteries.

The aspects covered include characteristics and operating conditions of the supply device and the connection to the vehicle; operators and third party electrical safety, and the characteristics to be complied with by the vehicle with respect to the a.c./d.c. EVSE, only when the EV is earthed.

NOTE 1 Class II vehicles are not defined, but the lack of information for this type of vehicle means that the requirements for the standard are under consideration.

NOTE 2 This standard also applies to EVSE with on-site storage capability.

Requirements for specific inlet, connector, plug and socket-outlets for EVs are contained in IEC 62196-1:2003. Standard sheets for the vehicle connector and inlet are also under consideration. They will be incorporated in a separate part of standard IEC 62196.

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

This standard is not applicable to trolley buses, rail vehicles, industrial trucks and vehicles designed primarily for use off-road.

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.

IEC 60038:2009, *IEC standard voltages*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12 h cycle)*

IEC 60068-2-75:1997, *Environmental testing – Part 2: Tests – Test Eh: Hammer tests*

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60276, *Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip-rings*

IEC 60309-1:1999, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

IEC 60309-2:1999, *Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

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

IEC 60664-1:2007*, Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC/TR 60755:2008, *General requirements for residual current operated protective devices*

IEC 60884-1:2002, *Plugs and socket-outlets for household and similar purposes – Part 1:General requirements*

IEC 60884-2-5:1995*, Plugs and socket-outlets for household and similar purposes – Part 2 particular requirements for adaptors*

IEC 60947-3:2008, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC 60990:1999*, Methods of measurement of touch current and protective conductor current*

IEC 61000-6-1:2005, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-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 61008-1:2010, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – General rules*

IEC 61009-1:2010, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – General rules*

IEC 61180-1:1992, *High-voltage test techniques for low-voltage equipment – Part 1: definitions, test and procedure requirements*

IEC 62196-1:2003, *Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles – Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c.*

ISO 6469-2:2009, *Electrically propelled road vehicles – Safety specifications – Part 2: Vehicle operational safety means and protection against failures*

ISO 6469-3:2001, *Electric road vehicles – Safety specifications – Part 3: Protection of persons against electric hazards*

EN 50065-1:2001*, Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz – Part 1: General requirements, frequency bands and electromagnetic disturbances*

SAE J1772:2010, *Recommended practices: SAE Electric Vehicle and Plug In Hybrid Electric Vehicle Conductive Charge Coupler*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
basic insulation
insulation of hazardous-live-parts which provides basic protection

3.2
cable assembly
piece of equipment used to establish the connection between the EV and socket-outlet (in case A and case B) or to the fixed charger (in case C)

NOTE 1 It may be either fixed or be included in the vehicle or the EVSE, or detachable.

NOTE 2 It includes the flexible cable and the connector and/or plug that are required for proper connection.

NOTE 3 See Figures 1 to 3 for description of cases A, B and C.

NOTE 4 A detachable cable assembly is not considered as a part of the fixed installation.

3.3
charger
power converter that performs the necessary functions for charging a battery

3.3.1
class I charger
charger with basic insulation as provision for basic protection and protective bonding as provision for fault protection

NOTE Protective bonding consists of connection of all exposed conductive parts to the charger earth terminal.

3.3.2
class II charger
charger with

– basic insulation as provision for basic protection, and
– supplementary insulation as provision for fault protection,

or in which

– basic and fault protection are provided by reinforced insulation

3.3.3
off-board charger
charger connected to the premises wiring of the a.c. supply network (mains) and designed to operate entirely off the vehicle. In this case, direct current electrical power is delivered to the vehicle

3.3.3.1
dedicated off-board charger
off-board charger designed to be used only by a specific type of EV, which may have control charging functions and/or communication

3.3.4
on-board charger
charger mounted on the vehicle and designed to operate only on the vehicle

3.4
charging
all functions necessary to condition standard voltage and frequency a.c. supply current to a regulated voltage/current level to assure proper charging of the EV traction battery and/or supply of energy to the EV traction battery bus, for operating on-board electrical equipment in a controlled manner to assure proper energy transfer

3.5
connection
single conductive path

3.6
control pilot
the control conductor in the cable assembly connecting the in-cable control box or the fixed part of the EVSE, and the EV earth through the control circuitry on the vehicle. It may be used to perform several functions

3.7
earth terminal
accessible connection point for all exposed conductive parts electrically bound together

NOTE In the U.S.A., the term "ground" is used instead of "earth".

3.8
electric vehicle
EV
electric road vehicle (ISO)
any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways

3.8.1
class I EV
an EV with basic insulation as provision for basic protection and protective bonding as provision for fault protection

NOTE This consists of connection of all exposed conductive parts to the EV earth terminal.

3.8.2
class II EV
EV in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions

3.9
EV supply equipment
EVSE
conductors, including the phase, neutral and protective earth conductors, the EV couplers, attachment plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them if required

3.9.1
a.c. EV charging station
all equipment for delivering a.c. current to EVs, installed in an enclosure(s) and with special control functions

3.9.2
d.c. EV charging station
all equipment for delivering d.c. current to EVs, installed in an enclosure(s), with special control functions and communication and located off the vehicle

NOTE DC charging includes pulse mode charging.

3.9.3
exposed conductive part
conductive part of equipment, which can be touched and which is not normally live, but which can become live when basic insulation fails

3.9.4
direct contact
contact of persons with live parts

3.9.5
indirect contact
contact of persons with exposed conductive parts made live by an insulation failure

3.10
live part
any conductor or conductive part intended to be electrically energized in normal use

3.10.1
hazardous live part
live part, which under certain conditions, can result in an electric shock

3.11
in-cable control box
a device incorporated in the cable assembly, which performs control functions and safety functions

NOTE The in-cable control box is located in a detachable cable assembly or plug that is not part of the fixed installation.

3.12
plug and socket-outlet
means of enabling the manual connection of a flexible cable to fixed wiring

NOTE It consists of two parts: a socket-outlet and a plug.

3.12.1
plug
part of a plug and socket-outlet integral with or intended to be attached to the flexible cable connected to the socket-outlet

3.12.2
socket-outlet
part of a plug and socket-outlet intended to be installed with the fixed wiring

3.13
power indicator
resistor value identifying supply rating recognition by the vehicle

3.14
retaining device
mechanical arrangement which holds a plug or connector in position when it is in proper engagement, and prevents unintentional withdrawal of the plug or connector

NOTE The retaining device can be electrically or mechanically operated.

3.15
vehicle coupler
means of enabling the manual connection of a flexible cable to an EV for the purpose of charging the traction batteries

NOTE It consists of two parts: a vehicle connector and a vehicle inlet.

3.15.1
vehicle connector
part of a vehicle coupler integral with, or intended to be attached to, the flexible cable connected to the a.c. supply network (mains)

3.15.2
vehicle inlet
part of a vehicle coupler incorporated in, or fixed to, the EV or intended to be fixed to it

3.16
function
any means, electronic or mechanical, that insure that the conditions related to the safety or the transmission of data required for the mode of operation are respected

3.17
pilot function
any means, electronic or mechanical, that insures the conditions related to the safety or the transmission of data required for the mode of operation

3.18
proximity function
a means, electrical or mechanical, in a coupler to indicate the presence of the vehicle connector to the vehicle

3.19
standardized socket-outlet
socket-outlet which meets the requirements of any IEC and/or national standard

3.20
residual current device
RCD
mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

NOTE 1 A residual current device can be a combination of various separate elements designed to detect and evaluate the residual current and to make and break current.

NOTE 2 In the following countries an RCD may be either electrical, electronic, mechanical or a combination thereof: US, JP, UK.

[IEC 60050-44:1998, 442-05-02]

3.21
pulse mode charging
charging of storage batteries using modulated direct current

3.22
standard interface
interface that is defined by any of the following standards IEC 60309-1, IEC 60309-2, or IEC 60884-1 and/or national standard having an equivalent scope, and is not fitted with any supplementary pilot or auxiliary contacts

3.23
basic interface
interface as defined by the IEC 62196-1 and for which a functional description is given in 8.4

3.24
universal interface
interface as defined by the IEC 62196-1 and for which a functional description is given in 8.5

3.25
plug in hybrid electric road vehicle
PHEV
any electrical vehicle that can charge the rechargeable electrical energy storage device from an external electric source and also derives part of its energy from an other source

3.26
cord extension set
assembly consisting of a flexible cable or cord fitted with both a plug and a connector of a standard interface type

NOTE A mode 2 or a mode 1 cable assembly is not considered as a cord extension set.

3.27
adaptor
a portable accessory constructed as an integral unit incorporating both a plug portion and one socket-outlet

NOTE The socket-outlet may accept different configurations and ratings.

3.28
indoor use
equipment designed to be exclusively used in a weather protected locations

3.29
outdoor use
equipment designed to be allowed to be used in non weather protected locations

4 General requirements

The EV shall be connected to the EVSE so that in normal conditions of use, the conductive energy transfer function operates safely.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard, and compliance is checked by carrying out all relevant tests.

5 Rating of the supply a.c. voltage

The rated value of the a.c. supplied voltage for the charging equipment is up to 1 000 V. The equipment shall operate correctly within ±10 % of the standard nominal voltage. The rated value of the frequency is 50 Hz ± 1 % or 60 Hz ± 1 %.

NOTE Nominal voltage values can be found in IEC 60038.

6 General system requirement and interface

6.1 General description

One method for EV charging is to connect the a.c. supply network (mains) to an on-board charger. An alternative method for charging an EV is to use an off-board charger for delivering direct current. For charging in a short period of time, special charging facilities operating at high power levels could be utilized.

6.2 EV charging modes

A residual current device with characteristics that are at least equivalent to type A as defined in IEC 61008-1 or IEC 61009-1, or IEC/TR 60755 in conjunction with an over-current protection device shall be required for all modes of charging.

NOTE 1 Some vehicle electric topologies may require additional protection on the vehicle.

Mode 1 charging: connection of the EV to the a.c. supply network (mains) utilizing standardized socket-outlets not exceeding 16 A and not exceeding 250 V a.c. single-phase or 480 V a.c. three-phase, at the supply side, and utilizing the power and protective earth conductors.

NOTE 2 In the following countries, mode 1 charging is prohibited by national codes: US.

NOTE 3 The use of an in-cable RCD can be used to add supplementary protection for connection to existing a.c. supply networks.

NOTE 4 Some countries may allow the use of an RCD of type AC for mode 1 vehicles connected to existing domestic installations: JP, SE.

Mode 2 charging: connection of the EV to the a.c. supply network (mains) not exceeding 32 A and not exceeding 250 V a.c. single-phase or 480 V a.c. three-phase utilizing standardized single-phase or three-phase socket-outlets, and utilizing the power and protective earth conductors together with a control pilot function and system of personnel protection against electric shock (RCD) between the EV and the plug or as a part of the in-cable control box. The inline control box shall be located within 0,3 m of the plug or the EVSE or in the plug.

NOTE 5 In the USA, a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency is required.

NOTE 6 In the following countries, according to national codes, additional requirements are necessary to allow cord and plug connection to a.c. supply networks greater than 20 A, 125 V a.c.: US.

NOTE 7 For mode 2, portable RCD as defined in IEC 61540 and IEC 62335 is applicable.

NOTE 8 In Germany the inline control box (EVSE) shall be in the plug or located within 2,0 m of the plug.

Mode 3 charging: connection of the EV to the a.c. supply network (mains) utilizing dedicated EVSE where the control pilot function extends to control equipment in the EVSE, permanently connected to the a.c. supply network (mains).

Mode 4 charging: connection of the EV to the a.c. supply network (mains) utilizing an off-board charger where the control pilot function extends to equipment permanently connected to the a.c. supply.

6.3 Types of EV connection using cables and plugs (cases A, B, and C)

6.3.1 General description

The connection of EVs using cables may be carried out in one or more of three different ways:

a) Case "A" connection: the connection of an EV to the a.c. supply network (mains) utilizing a supply cable and plug permanently attached to the EV (see Figure 1).

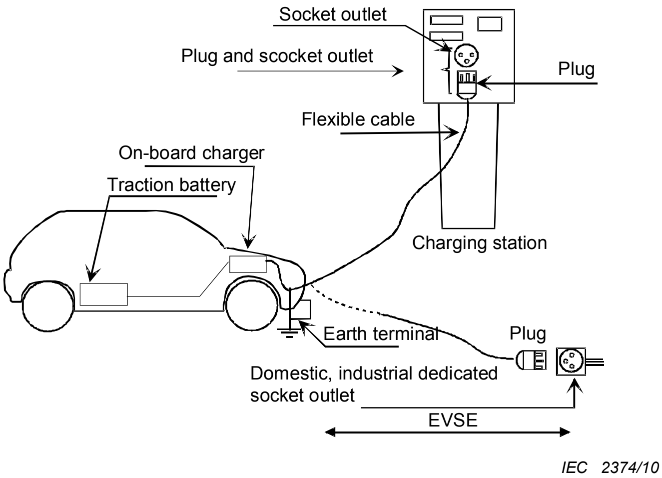
b) Case "B" connection: the connection of an EV to the a.c. supply network (mains) utilizing a detachable cable assembly with a vehicle connector and a.c. supply equipment (see Figure 2).

Case B1 corresponds to a connection to wall mounted socket.

Case B2 corresponds to a specific charging station.

c) Case "C" connection: the connection of an EV to the a.c. supply network (mains) utilizing a supply cable and vehicle connector permanently attached to the supply equipment (see Figure 3). Only case "C" is allowed for mode 4 charging.

NOTE Specific mechanical connecting systems can be utilized instead of cables and plug.

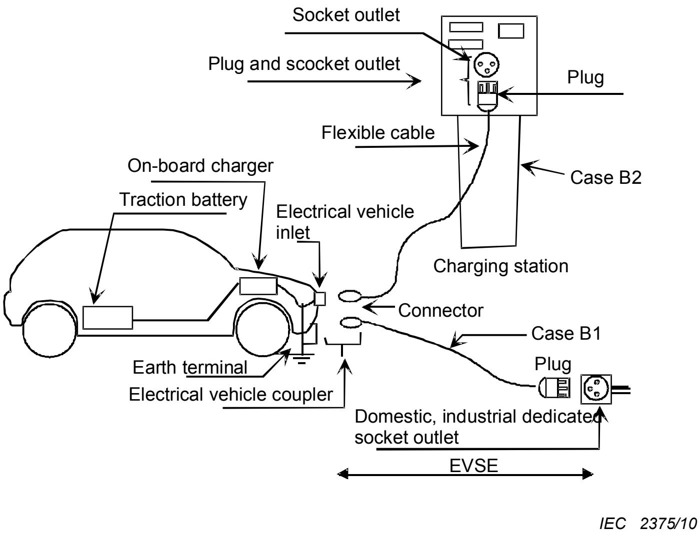


Connection of an EV to an a.c. supply utilizing supply cable and plug permanently attached to the EV

A1: charging cable connected to a domestic or industrial socket

A2: charging cable connected to a specific charging station

Figure 1 – Case "A" connection

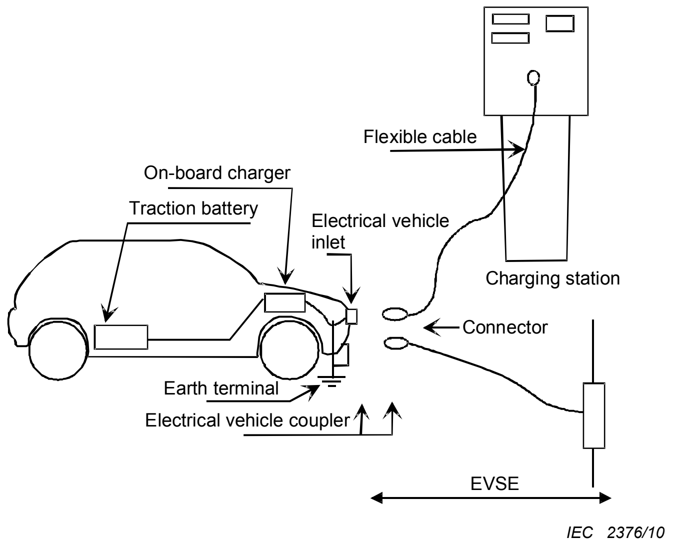


Connection of an EV to an a.c. supply utilizing a detachable cable assembly with a vehicle connector and a.c. supply equipment

B1: charging cable connected to a domestic or industrial socket

B2: charging cable connected to a specific charging station

Figure 2 – Case "B" connection



Connection of an EV to a.c. supply utilizing supply cable and connector permanently attached to the supply equipment

Figure 3 – Case "C" connection

6.3.2 Cord extension set

A cord extension set or second cable assembly shall not be used in addition to the cable assembly for the connection of the EV to the EVSE. The vehicle manual shall clearly indicate this. A cable assembly shall be so constructed so that it cannot be used as a cord extension set.

NOTE As in IEC 62196-1, plugs and connectors are designed not be intermateable.

6.3.3 Adaptors

Adaptors shall not be used to connect a vehicle connector to a vehicle inlet.

A conversion adaptor from the socket outlet of the EVSE shall only be used if specifically designated and approved by the vehicle manufacturer or by the EVSE manufacturer. Such adaptors shall be comply with the requirements of this standard, IEC 60884-2-5 and the other relevant Standards governing either the plug or socket-outlet portions of the adaptor. The manufacturer shall clearly indicate the obligation to use adaptors with such a specific designation. Such adaptors shall be marked to indicate their specific conditions of use. Such adaptors shall not allow transitions from one mode to another. They shall meet the requirements of this standard and IEC 62196-1.

NOTE 1 Specific mechanical connecting systems can be utilized instead of cables and plug.

NOTE 2 In some countries the connection between the in-cable control box and the socket outlet may be made by means of a removable adaptor cord of less than 30 cm in length , using non rewireable accessories: JP, FR.

NOTE 3 The use of adaptors from mode 1 socket outlets to mode 3 vehicle cable assembly, that maintain the overall safety requirements of this standard is allowed in the following countries: IT, SE, BE, FR, CH.

NOTE 4 Short cord extension sets, with no mode change, of less than 30 cm in length may be used on the EVSE in the following countries: SE.

6.4 Functions provided in each mode of charging for modes 2, 3, and 4

6.4.1 Modes 2, 3 and 4 functions

These functions shall be provided by the EVSE or the EVSE and vehicle system as given below:

- verification that the vehicle is properly connected;
- continuous protective earth conductor continuity checking;
- energization of the system;
- de-energization of the system.

NOTE 1 The pilot functions can be achieved using PWM pilot control as described in Annex A or any other non PWM system that provides the same results. An example is provided in Annex C.

NOTE 2 Specific communication and functions for mode 4 is described in IEC 61851-23.

NOTE 3 Some of these functions may also exist for mode 1 charging.

6.4.2 Optional functions for modes 2, 3 and 4

The following functions should be provided by the EVSE or the EVSE and vehicle system as given below:

– selection of charging rate;
– determination of ventilation requirements of the charging area;
– detection/adjustment of the real time available load current of the supply equipment;
– retaining/releasing of the coupling;
– control of bi-directional power flow to and from the vehicle.

Other additional functions may be provided.

NOTE 1 Un-intentional live disconnect avoidance functions may be incorporated in the latching function interlock system.

NOTE 2 A positive means to prevent an intentional disconnect is required in some countries: US.

NOTE 3 Charging rate is mandatory for pilot functions using PWM signals as described in normative Annex A.

NOTE 4 Some of these functions may also exist for mode 1 charging.

6.4.3 Details of functions for modes 2, 3 and 4

6.4.3.1 Verification that the vehicle is properly connected

The EVSE shall be able to determine that the connector is properly inserted in the vehicle inlet and properly connected to the EVSE.

Vehicle movement by its own propulsion system shall be impossible as long as the vehicle is physically connected to the EVSE as required in ISO 6469-2.

6.4.3.2 Continuous protective earth continuity checking

Equipment earth continuity between the EVSE and the vehicle shall be continuously verified.

6.4.3.3 Energization of the system

Energization of the system shall not be performed until the pilot function between EVSE and EV has been established correctly.

Energization may also be subject to other conditions being fulfilled.

6.4.3.4 De-energization of the system

If the pilot function is interrupted, the power supply to the cable assembly shall be interrupted but the control circuit may remain energized.

6.4.4 Details of optional functions

6.4.4.1 Determination of ventilation requirements during charging

If additional ventilation is required during charging, charging shall only be allowed if such ventilation is provided.

6.4.4.2 Detection/adjustment of the real time available load current of EVSE

Means shall be provided to ensure that the charging rate shall not exceed the real time available load current of the EVSE and its power supply.

NOTE The function of 6.4.4.2 may be required under certain national codes.

6.4.4.3 Retaining/releasing of the coupler

A mechanical means shall be provided to retain/release the coupler.

6.4.4.4 Selection of charging rate

A manual or automatic means shall be provided to ensure that the charging rate does not exceed the rated capacity of the a.c. supply network (mains), vehicle or battery capabilities.

6.4.4.5 Details of optional functions for mode 3

Bi-directional power flow requires additional control functions that are not treated in this edition.

6.4.5 Details of pilot function

For modes 2, 3 and 4, a pilot function is mandatory.

The pilot function shall be capable of performing at least the mandatory functions described above in 6.4.3.1 to 6.4.3.4, may be capable of performing optional functions 6.4.4.1 and 6.4.4.2 and may contribute to other functions, for instance 6.4.4.3 and 6.4.4.4.

NOTE Examples of pilot functions are given in Annex A, Annex B and Annex C. Other options are possible.

6.5 Serial data communication

The applicability of serial data communication for all charging modes is specified as follows.

Serial data communication is optional for mode 1, 2 and 3.

Serial data information exchange shall be provided for mode 4 to allow the vehicle to control the off-board charger, except in the case of dedicated off-board chargers.

7 Protection against electric shock

7.1 General requirements

Hazardous live parts shall not be accessible.

Exposed conductive parts shall not become a hazardous live part under normal conditions (operation as intended use and in the absence of a fault), and under single-fault conditions.

Protection against electric shock is provided by the application of appropriate measures for protection both in normal service and in case of a fault.

- for systems or equipments on board the vehicle, the requirements are defined in ISO 6469-3;
- for systems or equipments external to the vehicle, the requirements are defined in Clause 411 of IEC 60364-4-41:2005

Protection in normal service (Provisions for basic protection), is defined in Annexes A and B of IEC 60364-4-41:2005. Measures for fault protections are defined in Clauses 411, 412 and 413, additional protection is defined in 415 of IEC 60364-4-41:2005

NOTE 1 In some countries national regulations require shutters or equivalent protection methods with equivalent safety levels, For example: installation heights, blocking objects against touchability, interlocking, locking cover etc.: FR, SE, IT.

NOTE 2 In some countries alternative measures to IEC 60364-4-41 may be applicable : JP.

7.2 Protection against direct contact

7.2.1 General

Protection against direct contact shall consist of one or more provisions that under normal conditions prevent contact with hazardous-live parts. For systems or equipments on board the vehicle, the requirements are defined in ISO 6469-3.

Protective bonding shall consist of connection of all exposed conductive parts to the EV earth terminal.

7.2.2 Accessibility of live parts

When connected to the supply network, the EVSE shall not have any accessible hazardous live part, even after removal of parts that can be removed without a tool.

Compliance is checked by inspection and according to the requirements of IEC 60529 (IPXXB).

NOTE Extra low voltage (ELV) auxiliary circuits which are galvanically connected to the vehicle body are accessible. Particular attention is drawn to the requirements for extra low voltage (ELV) circuit isolation when the traction battery is being charged using a non-isolated charger.

7.2.3 Stored energy – discharge of capacitors

7.2.3.1 Disconnection of EV

One second after having disconnected the EV from the supply (mains), the voltage between accessible conductive parts or any accessible conductive part and earth shall be less than or equal to 42,4 V peak, or 60 V d.c., and the stored energy available shall be less than 20 J (see IEC 60950). If the voltage is greater than 42,4 V peak (30 V rms) or 60 V d.c., or the energy is 20 J or more, a warning label shall be attached in an appropriate position.

EV inlet, when unconnected, is according to ISO 6469-3.

Compliance is checked by inspection and by test.

7.2.3.2 Disconnection of EVSE

Conditions for the disconnections of the EVSE from the supply mains are identical to those required for the disconnection of the EV as indicated in 7.2.3.1.

7.3 Fault protection

Protection against indirect contact shall consist of one or more recognized provision(s).

According to IEC 60364-4-41:2005, recognized individual provisions for fault protection are:

- supplementary or reinforced insulation;
- protective equipotential bonding;
- protective screening;
- automatic disconnection of supply;
- simple separation.

NOTE In some countries, other systems are required.

7.4 Supplementary measures

To avoid indirect contact in case of failure of the basic and/or fault protection or carelessness by users, additional protection against electric shock shall be required.

An RCD ($I_{\Delta n} \leq 30$ mA) shall be provided as a part of the EV conductive supply equipment for earthed systems. The RCD shall have a performance at least equal to Type A and be in conformity with standard IEC 60364-4-41

NOTE In some countries, other systems of personnel protection are required.

Where power supply circuits that are galvanically separated from mains and are galvanically isolated from earth, electrical isolation between the isolated circuits and earth, and between the isolated circuits and exposed conductive parts of vehicle and EVSE shall be monitored. When a fault condition related to the electrical isolation is detected, the power supply circuits shall be automatically de-energized or disconnected by the EVSE.

7.5 Provision for mode 4 EVSE

Specific measures for mode 4 EVSEs are treated in IEC 61581-23.

7.6 Additional requirements

Under normal conditions, malfunction and single-fault conditions, the charging system shall be designed to limit the introduction of harmonic, d.c. and non-sinusoidal currents that could affect the proper functioning of residual current devices or other equipment.

Class II chargers may have a lead- through protective conductor for earthing the EV chassis.

8 Connection between the power supply and the EV

8.1 General

This clause provides a description of the physical conductive electrical interface requirements between the vehicle and the EVSE.

Table 1 – Overview of the vehicle interface options and suggested contact ratings

Contact number [k]	Standard		Basic [h]		Example Universal [h]		Coupler for DC charging [l]	Functions
	Single phase	Three phase	Single phase	Three phase	High power AC/AC	High power AC/DC		
1	-	-	-	-	500 V [a] 250 A[g]	600 V [a] 400 A[g]	1 000 V 400 A [l]	High power AC/DC
2	-	-	-	-	500 V [a] 250 A[g]	600 V [a] 400 A[g]	1 000 V 400 A [l]	High power AC/DC
3	-	-	-	-	500 V [a] 250 A	-	-	High power AC/DC
4	250 V[e] 32 A[b]	480 V[e] 32 A[b]	250 V[e] 32 A[c,d]	480 V 32 A[c,d]	480 V 32 A	480 V 32 A		L1
5	-	480 V 32 A[b]	-	480 V 32 A[c,d]	480 V 32 A	480 V 32 A		L2
6	-	480 V 32 A[b]	-	480 V 32 A[c,d]	480 V 32 A	480 V 32 A		L3
7	250 V[e] 32 A[b]	480 V[e] 32 A[b]	250 V[e] 32 A[c,d]	480 V 32 A[c,d,i]	480 V 32 A	480 V 32 A		Neutral [m]
8	Rated for fault	Rated for fault	Rated for fault	Rated for fault	Rated for fault	Rated for fault	[k]	PE
9			30 V 2 A	30 V 2 A	30 V 2 A	30 V 2 A	[l]	Control pilot
10	-	-	-	-	30 V 2 A	30 V 2 A	[l]	Communication 1 (+)
11	-	-	-	-	30 V 2 A	30 V 2 A	[l]	Communication 2 (-)
12	-	-	-	-	30 V 2 A	30 V 2 A	[l]	Clean data earth
13	-	-	30 V 2 A [f]	30 V 2 A [f]	30 V 2 A [f]	30 V 2 A [f]	[l]	Proximity [i]

NOTE 1 In some countries, the branch circuit over current protection is based on 125 % of the rated current.

NOTE 2 The voltage and current ratings assigned shall be in accordance with National regulations.

NOTE 3 Couplers for DC charging are under development.

[a] For high power contacts, the duty cycle is under consideration.

[b] Typical maximum current ratings are indicated. Maximum current for Mode 1 is 16 A. Rated current is function of contact and other associated element specification. Preferred values depend on regional requirements. In some countries 10 A (only 1 phase) and 16 A is ordinary.

[c] Ratings not to exceed 70 A single phase or 63 A three-phase are acceptable if the coupler is designed to support these values.

[d] Typical current ratings: in certain countries 30 A is the standard current rating; 10 A and 16 A can also be ordinary ratings in some countries.

[e] Voltage ratings are suggested design maximum values. Higher or lower values may be specified by manufacturers.

[f] For contacts 9 to 13 environmental conditions may demand larger conductor cross-sections.

[g] In the absence of a control pilot on pin 9 this may be used as a power indicator provided it does not interfere with the pilot function.

[h] Higher currents are admitted provided the contacts and the thermal behaviour are designed accordingly.

[i] Neutral wire may be absent for balanced load.

[j] The contact used for the proximity function may also perform other functions (see B.4).

[k] “Number” does not refer to a particular position.

[l] Couplers for DC charging are under development. The column is included for information only. Definitions and specifications for DC charging are to be included in IEC 61851-23.

[m] In some countries L2 may be used for neutral in single phase circuits.

EXAMPLE 1: For single-phase (mains) supply, the voltage may be 100/200 V (Japan) or 120/208 - 240 V (North America). For three-phase, the standard voltage ratings in North America are 208 V and 480 V.

EXAMPLE 2: The standard current rating in North America and in Japan is 30 A.

EXAMPLE 3: In Japan, for the basic interface the maximum current for mode 1 is 20 A with 200 V supply voltage and 15 A with 100 V supply voltage.

8.2 Contact sequencing

For safety reasons, the contact sequence during the connection process shall be such that the earth connection is made first and the pilot connection is made last. The order of connection of the other contacts is not specified. During disconnection, the pilot connection shall be broken first and the earth connection shall be broken last.

8.3 Functional description of a standard interface

A standard earthing type plug, socket-outlet and vehicle coupler may be used for modes 1, 2 and 3, provided the pilot function is included for modes 2 and 3.

Standard interfaces shall not be used on vehicles that do not comply with Clause 7.2.3.1.

NOTE The use of standard interfaces is not permitted in certain regions.

8.4 Functional description of a basic interface

The basic interface may contain up to seven contacts, with standard physical configurations of contact positions either for single-phase or for three-phase or both.

The electrical ratings and their function are described in Table 1.

The basic vehicle inlet shall be intermateable with either the single-phase or the three-phase connector or both. It shall not be intermateable with accessories of the universal interface type unless the two are designed to prevent mismatching and designed to be fail-safe.

A three-phase interface may be used to supply single phase.

The preferred rating of the interface is 250 V 32 A single-phase or 480 V 32 A three-phase. It may include additional contacts for control pilot and proximity detection.

Lower current values are available.

Ratings not to exceed 70 A single-phase or 63 A three-phase are acceptable if the interface is designed to support these values.

The voltage and current ratings assigned shall be in accordance with National regulations.

8.5 Functional description of a universal interface

The universal vehicle inlet shall be intermateable with either the high power a.c. connector or the high power d.c. connector.

The basic vehicle connector may be intermateable with the universal vehicle inlet if the two are designed to prevent mismatching and designed to be fail-safe.

A means shall be used on the vehicle inlet and the vehicle connectors to ensure that the d.c. power connector cannot be mated with the a.c. vehicle inlet and vice versa.

The maximum rated voltage and current values of the universal interface are in accordance with Table 1, where applicable. Lower currents values are available.

9 Specific requirements for vehicle inlet, connector, plug and socket-outlet

9.1 General requirements

The requirements for accessories of the standard interface are specified in IEC 60309-1, IEC 60309-2 (industrial type) and IEC 60884-1 (domestic type) (as examples A1 and B1 in 6.3).

The requirements of EVSE systems are specified in IEC 62196-1 (cases A2 and B2 in 6.3).

The requirements for accessories of the basic and the universal interface are specified in IEC 62196-1.

NOTE In the following countries, national requirements apply for the plug and sockets: US, Canada, Japan.

9.2 Operating temperature

Operating temperature is defined in accordance with IEC 60309-1, IEC 60309-2 and IEC 60884-1 (as examples A1 and B1 in 6.3) or IEC 62196-1 (cases A2 and B2 in 6.3).

NOTE National codes and regulations may require different operating temperature ranges to those indicated in these standards.

9.3 Service life of inlet/connector and plug/socket-outlet

The requirements for accessories of the standard interface are specified in IEC 60309-1, IEC 60309-2 (industrial type) and IEC 60884-1 (domestic type) (as examples A1 and B1 in 6.3).

The requirements for accessories of the basic interface are specified in IEC 62196-1.

9.4 Breaking capacity

The requirement shall be in accordance with IEC 62196-1.

For personal safety and to avoid damage due to disconnection under nominal current, the plug, the inlet, the connector or the socket-outlet shall have sufficient breaking capacity unless there is a switch with sufficient breaking capacity. Acceptable breaking capacity is reached by breaker level for a.c. application AC22A or for d.c. application DC-21A contactor as defined in IEC 60947-3, or breaker level for a.c. application AC2 and for d.c. application DC-3 as defined in IEC 60947-6.

Avoidance of breaking under load can be achieved by a specific means on the connector or a system with interlock.

For mode 4 charging: disconnection shall not take place under load. In the case of disconnection under d.c. load due to a fault, no hazardous condition shall occur. For up to three making and breaking operations at rated voltage, 1,25 times rated current, a.c. power factor 0,8 and d.c. resistive load, there shall be no indication of a fire or shock hazard. The device does need not to remain functional.

9.5 IP degrees

IP degrees for accessories are treated in 11.3.

9.6 Insertion and extraction force

The force required for connecting and disconnecting operations for the connector and inlet is in accordance with 16.15 of IEC 62196-1 (latching device being deactivated).

The force required for connecting and disconnecting operations for the plug and socket is in accordance with 16.15 of IEC 62196-1.

For cases A1 and B1 refer to the relevant standards.

9.7 Latching of the retaining device

Latching or retaining if required may be a function of the complete system or the connector.

10 Charging cable assembly requirements

10.1 Electrical rating

The rated voltage of each conductor shall correspond to the rated voltage of the connecting means. The rated current shall correspond to the rating of the line circuit breaker.

10.2 Electrical characteristics

The voltage and current ratings of the cable shall be compatible with those of the charger.

The cable may be fitted with an earth-connected metal shielding. The cable insulation shall be wear resistant and maintain flexibility over the full temperature range.

A proposition of appropriate standard is under consideration.

NOTE 1 IEC 60245-6 cable has been proposed as an adequate standard that defines cable properties.

NOTE 2 In some countries, other cable types are required by national regulations: US (type cable EV,EVJ families), JP (VCT etc.).

10.3 Dielectric withstand characteristics

Dielectric withstand characteristics shall be as indicated for the EVSE in 11.4.

10.4 Mechanical characteristics

The mechanical characteristics of the cable should be equivalent or superior to those of IEC 60245-6 cable, as well as for fire resistance, chemical withstand, UV resistance.

NOTE In some countries, special cable for cold climate is needed. In some countries, other cable types are required by national regulations/ US (type cable EV, EVJ families), JP (VCT etc.).

A compression test for crossing of cable by a vehicle is currently under consideration.

The anchorage force of the cable in the connector or plug shall be greater than the retaining device force, if used.

10.5 Functional characteristics

The maximum cord length may be specified by some national codes.

NOTE In the following countries, the overall length of the EVSE cable shall not exceed 7,5 m unless equipped with a cable management system as required by national codes and regulations: US.

11 EVSE requirements

11.1 General test requirements

- All tests in this standard are type tests.
- Unless otherwise specified, type tests shall be carried out on a single specimen as delivered and configured in accordance with the manufacturer's instructions.
- The tests in 11.12 may be conducted on separate samples at the discretion of the manufacturer. Unless otherwise specified, all other tests shall be carried out in the order of the clauses and subclauses in this part.
- The tests shall be carried out with the specimen, or any movable part of it, placed in the most unfavorable position which may occur in normal use.
- Unless otherwise specified, the tests shall be carried out in a draught-free location and at an ambient temperature of 20 °C ± 5 °C.
- The characteristics of the test voltages in 11.4 shall comply with IEC 61180-1.

Additional specific requirements for the:

– AC charging station (EVSE) are specified in IEC 61851-22,

– DC charging stations (EVSE) are specified in IEC 61851-23.

NOTE Standard Interface requirements are covered in their appropriate standards as defined in 9.1. National codes and regulations should be taken into account.

11.2 Classification

EVSE shall be classified according to exposure to environmental conditions:

- outdoor use;
- indoor use.

NOTE 1 In some countries, national regulations require ventilation for indoor charging: USA, Canada.

NOTE 2 EVSEs classified for outdoor use can be used for indoor use, provided ventilation requirements are satisfied.

11.3 IP degrees for basic and universal interfaces

11.3.1 IP degrees for ingress of objects

Compliance is checked by test in accordance with IEC 60529.

The minimum IP degrees for ingress of object and liquids shall be:

Indoor use:

– vehicle inlet mated with connector: IP21,

– plug mated with socket outlet: IP21,

– connector for case C when not mated, indoor: IP21.

Outdoor use:

– vehicle inlet mated with connector: IP44,

– plug mated with socket outlet: IP44.

All cable assemblies shall meet outdoor requirements.

– EV inlet in "road" position: IP55.

– connector when not mated: IP24,

– socket-outlet when not mated: IP24.

NOTE 1 IPX4 may be obtained by the combination of the socket-outlet or connector and the lid or cap, EVSE enclosure, or EV enclosure.

NOTE 2 EV inlet protection may be obtained by the combination of the inlet and vehicle design.

NOTE 3 In the following countries the UL articulated finger probe is used according to national regulations: US, CA.

11.3.2 Protection against electric shock

- vehicle inlet mated with connector: IPXXD;
- plug mated with socket outlet: IPXXD;
- connector intended for mode 1 use, not mated: IPXXD (1);
- connector intended for mode 2 and mode 3 use, not mated: IPXXB;
- socket-outlet not mated: IPXXD (2).

Energy transfer from vehicle to grid:

- vehicle inlet not mated: IPXXD (3);
- plug not mated: IPXXD (3).

Compliance is checked with the accessory in the installed position.

(1) In the following countries, IPXXD is not required for mode 1: JP, SE.

(2) Equivalent protection to IPXXD may also be obtained with IPXXB accessories if an isolating function is used according to IEC 60364-5-53. In some countries, shutters are mandatory in residential, domestic and/or public environments. Conformity with regulations should be verified.

(3) Equivalent protection to IPXXD may also be obtained with IPXXB accessories if an isolating function is used on the vehicle according to requirements described in 7.2.3.1 and 7.10.1 of ISO 6469-3.

NOTE In some countries the use of software controlled means cannot be used to control isolating devices.

11.4 Dielectric withstand characteristics

11.4.1 Dielectric withstand voltage

The dielectric withstand voltage at power frequency (50 Hz or 60 Hz) shall be applied for 1 min as follows:

a) For a class I chargers

U_n + 1 200 V r.m.s. in common mode (all circuits in relation to the exposed conductive parts) and differential mode (between each electrically independent circuit and all other exposed conductive parts or circuits) as specified in 5.3.3.2.3 of IEC 60664-1.

NOTE U_n is the nominal line to neutral voltage of the neutral-earthed supply system.

b) For a class II chargers

2 × (U_n +1 200 V) r.m.s. in common mode (all circuits in relation to the exposed conductive parts) and differential mode (between each electrically independent circuit and all other exposed conductive parts or circuits) as specified in 5.3.3.2.3 of IEC 60664-1.

For both class 1 and class 2 a.c. supply equipment, if the insulation between the mains and the extra low voltage circuit is double or reinforced insulation, 2 × (U_n + 1 200 V) r.m.s. shall be applied to the insulation.

Equivalent values of the DC voltage can be used instead of the AC peak values.

For this test, all the electrical equipment shall be connected, except those items of apparatus which, according to the relevant specifications, are designed for a lower test voltage; current-consuming apparatus (e.g. windings, measuring instruments, voltage surge suppression devices) in which the application of the test voltage would cause the flow of a current, shall be disconnected. Such apparatus shall be disconnected at one of their terminals unless they are not designed to withstand the full test voltage, in which case all terminals may be disconnected.

For test voltage tolerances and the selection of test equipment, see IEC 61180-1.

11.4.2 Impulse dielectric withstand (1,2/50 μs)

The dielectric withstand of the power circuits at impulse shall be checked using values as indicated in Table F.1 of IEC 60664-1 Category III.

The test shall be carried out in accordance with the requirements of IEC 61180-1.

Test conditions for supply voltages in excess of 400/690 V shall use the values indicated in the IEC 60664-1 for an overvoltage category III.

11.5 Insulation resistance

The insulation resistance with a 500 V d.c. voltage applied between all inputs/outputs connected together (power source included) and the accessible parts shall be:

– for a class I station: $R > 1$ MΩ;
– for a class II station: $R > 7$ MΩ.

The measurement of insulation resistance shall be carried out after applying the test voltage during 1 min and immediately after the damp heat test.

11.6 Clearances and creepage distances

Clearance and creepage distances shall be in accordance with IEC 60664-1.

Equipment when mounted in its enclosure shall be designed to operate in an external environment with a minimum pollution degree 3 and overvoltage category III.

Equipment intended for indoor use only shall be designed to operate in an environment with a minimum pollution degree 2 and overvoltage category II.

Equipment intended for outdoor use shall be designed to operate in an environment with a minimum pollution degree 3 and overvoltage category III.

The equipment shall be evaluated when mounted in its enclosure, as intended by the manufacturer.

Socket outlets and plugs for mode 1 and mode 2 are designed to IEC 60884-1 or IEC 60309-1 and IEC 60309-2.

11.7 Leakage – touch current

This paragraph applies only to cord and plug connected equipment.

The touch current shall be measured after the damp heat test (see 11.8.3), with the a.c. electric vehicle charging station connected to a.c. supply network (mains) in accordance with Clause 6 of IEC 60990. The supply voltage shall be 1,1 times the nominal rated voltage.

The touch current between any a.c. supply network poles and the accessible metal parts connected with each other and with a metal foil covering insulated external parts, measured in accordance with IEC 60950-1, shall not exceed the values indicated in Table 2.

Table 2 – Touch current limits

	Class I	Class II
Between any network poles and the accessible metal parts connected with each other and a metal foil covering insulated external parts	3,5 mA	0,25 mA
Between any network poles and the metal inaccessible parts normally non-activated (in the case of double insulation)	Not applicable	3,5 mA
Between inaccessible and accessible parts connected with each other and a metal foil covering insulated external parts (additional insulation)	Not applicable	0,5 mA

This test shall be made when the electric vehicle charging station is functioning with a resistive load at rated output power.

NOTE Circuitry which is connected through a fixed resistance or referenced to earth (for example, EV connection check) should be disconnected before this test.

The equipment is fed through an isolating transformer or installed in such a manner that it is isolated from the earth.

Specific conditions for DC charging stations are treated in IEC 61851-23.

11.8 Environmental tests

11.8.1 General

During the following tests, the electric vehicle charging station shall function at its nominal voltage with maximum output power and current. After each test, the original requirements shall still be met.

11.8.2 Ambient air temperature

The electric vehicle charging station shall be designed to operate within the temperature range –25 °C to +40 °C for outdoor unit and –5 °C to +40 °C for indoor.

The ambient air temperature does not exceed +40 °C and its average over a period of 24 hours does not exceed +35 °C.

The equipment shall be tested at the specified ambient temperature, the maximum temperature and minimum temperatures at the power levels guaranteed by the manufacturer under those conditions.

The equipment shall go through a start and stop cycle at each temperature.

NOTE National codes and regulations may require different operating temperature ranges.

11.8.3 Ambient humidity

The electric vehicle charging station shall be designed to operate with a relative humidity rate between 5 % and 95 %. One of the two types of tests below shall be conducted.

1) Damp heat continuous test

The test shall be carried out in accordance with IEC 60068-2-78, test Ca, at 40 °C ± 2 °C and 93 % relative humidity for four days.

2) Damp heat cycle test

The test shall be carried out in accordance with IEC 60068-2-30, test Db, at 40 °C for six cycles.

11.8.4 Ambient air pressure

The electric vehicle charging station shall be designed to operate at an atmospheric pressure between 860 hPa and 1 060 hPa.

11.9 Permissible surface temperature

The maximum permissible surface temperature of the EVSE that is hand-grasped for lifting, carrying and holding for the means of operation, at the maximum rated current and at ambient temperature of 40 °C, shall be:

– 50 °C for metal parts;
– 60 °C for non-metallic parts.

For parts which may be touched but not grasped, maximum permissible surface temperature under the same conditions shall be:

– 60 °C for metal parts;
– 85 °C for non-metallic parts.

11.10 Environmental conditions

The EVSE shall be designed to resist the effect of normal automotive solvents and fluids, vibration and shock, material flammability standards and other conditions appropriate to the application.

11.11 Mechanical environmental tests

11.11.1 General

After the following tests, no degradation of performance is permitted.

Compliance is checked by verification after the test that:

1) the IP degree is not affected;
2) the operation of the doors and locking points is not impaired;
3) the electrical clearances have remained satisfactory for the duration of the tests; and,
4) for a charging station having a metallic enclosure, no contact between live parts and the enclosure has occurred, caused by permanent or temporary distortion.

For a charging station having an enclosure of insulating material, if the conditions above are satisfied, then damage such as small dents or small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the charging station.

11.11.2 Mechanical impact

The electric vehicle charging station body shall not be damaged by mechanical impact as defined below.

Compliance is checked according to the test procedure described in IEC 60068-2-75.

A solid smooth steel ball, approximately 50 mm in diameter and with a mass of 500 g ± 25 g, is permitted to fall freely from rest through a vertical distance (H) of 1,3 m onto the sample (vertical surfaces are exempted from this test). In addition, the steel ball is suspended by a cord and swung as a pendulum in order to apply a horizontal impact, dropping through a vertical distance (H) of 1,3 m (horizontal surfaces are exempted from this test). Alternatively, the sample is rotated 90° about each of its horizontal axes and the ball dropped as in the vertical impact test.

11.12 Electromagnetic compatibility tests

Emission testing is conducted according to IEC 61000-6-3.

Immunity testing is conducted according to IEC 61000-6-1.

Specific performance criteria are defined in IEC 61851-22 and IEC 61851-23.

11.13 Latching of the retaining device

An interlock may rely on the retaining device to avoid disconnection under load if this function is not provided by the connector.

11.14 Service

The socket-outlet should be designed so that a certified technician could remove, service and replace it if is necessary.

11.15 Marking and instructions

11.15.1 Connection instructions

Instructions for the connection of the electric vehicle to the electric vehicle charging station shall be provided with the vehicle, with the user's manual and on the a.c. electric vehicle charging station.

11.15.2 Legibility

The markings required by this standard shall be legible with corrected vision, durable and visible during use.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

After all the tests of this standard, the marking shall be easily legible; it shall not be easily possible to remove marking plates and they shall show no curling.

11.15.3 Marking of electric vehicle charging station

The station shall bear the following markings in a clear manner:

– name or initials of manufacturer;
– equipment reference;
– serial number;
– date of manufacture;
– rated voltage in V;
– rated frequency in Hz;
– rated current in A;
– number of phases;

– IP degrees;
– "indoor use only", or the equivalent, if intended for indoor use only;
– for a class II station, the symbol shall clearly appear in the markings;
– some minimal additional information can possibly appear on the station itself (phone number, address of contractor).

Compliance is checked by inspection and tests.

11.16 Telecommunication network

Tests on any telecommunication network or telecommunication port on the EVSE, if present, shall comply with IEC 60950-1.

Annex A
(normative)

Pilot function through a control pilot circuit using PWM modulation and a control pilot wire

A.1 General

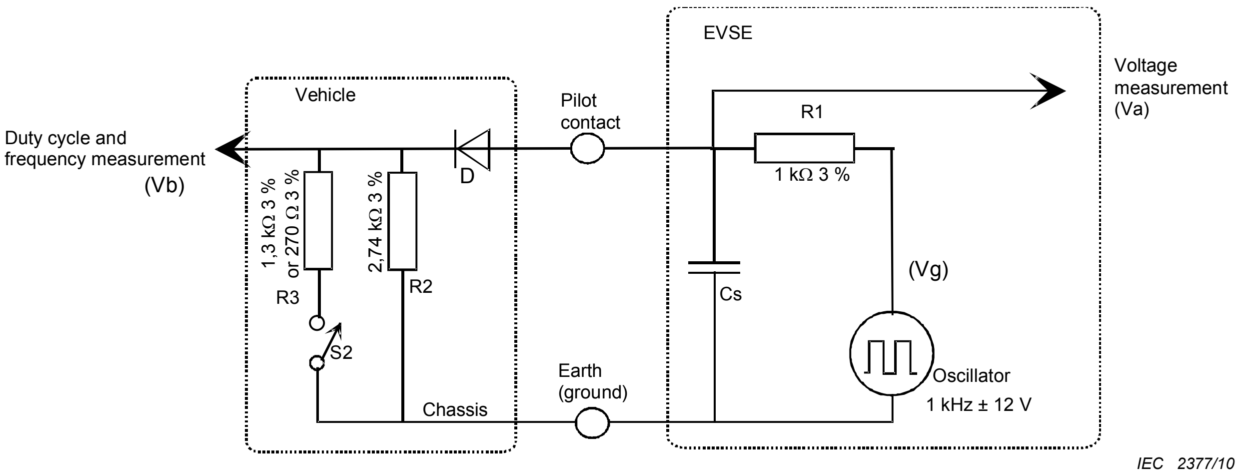
This annex concerns all charging systems that ensure the pilot function with a pilot wire circuit with PWM modulation in order to define the available current level for mode 2 and mode 3 charging. This annex describes the functions and sequencing of events for this circuit based on the recommended typical implementation circuit parameters. The parameters indicated in this annex have been chosen in order to ensure the interoperability of systems with those designed according to the standard SAE J1772.

NOTE This annex is not applicable to vehicles using pilot functions that are not based on a PWM signal and a pilot wire.

A.2 Control pilot circuit

Figure A.1 and A.2 show the basic principle of operation of the control pilot circuit.

Parameters of the circuits are defined in Table A.1, Table A.2, Table A.3, Table A.5, Table A.6, and Table A.7.



NOTE Stray capacities (Cv and Cc) between pilot and earth are not shown on figure (see Tables A.1 and A.2).

Figure A.1 – Typical control pilot circuit

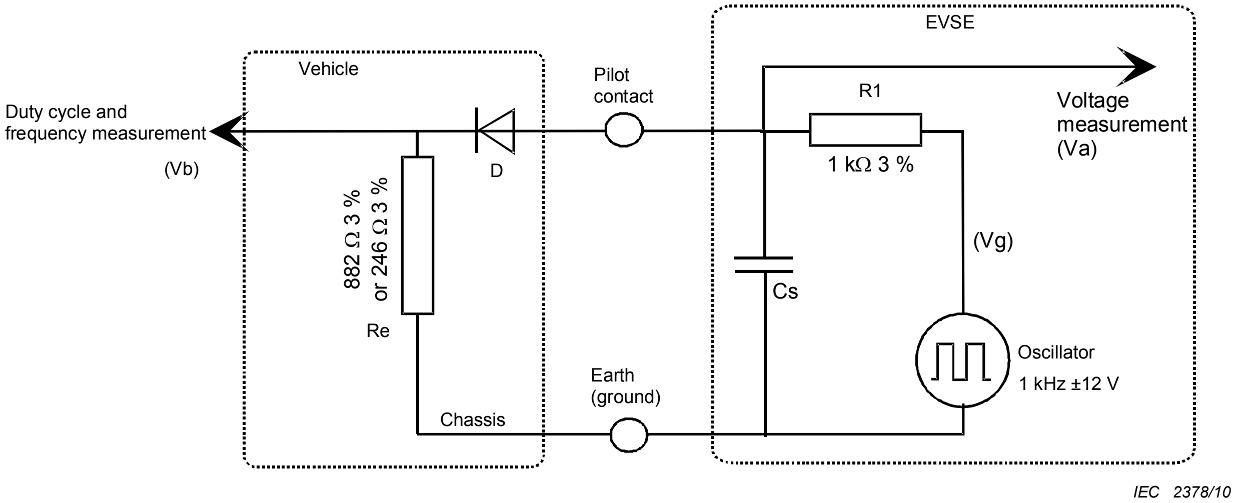


Figure A.2 – Simplified control pilot circuit

The simplified circuit shall not be used for vehicles drawing more than 16 A single phase. It shall not be used with 3-phase supply.

NOTE This circuit gives an equivalent result to the circuit shown in Figure A.1 when the switch S2 is closed. The simplified control pilot circuit cannot create vehicle states A and B as defined in Table A.3.

Table A.1 – EVSE control pilot circuit parameters (see Figures A.1 and A.2)

Parameter[a]	Symbol	Value	Units
Generator open circuit positive voltage [c]	Voch	12,00 (± 0,6)	V
Generator open circuit negative voltage[c]	Vocl	– 12,00 (± 0,6)	V
Frequency	Fo	1 000 (± 0,5 %)	Hz
Pulse width [b, c]	Pwo	Per Table A.4 (± 25 μs)	μs
Maximum rise time (10 % to 90 %) [c]	Trg	2	μs
Maximum fall time (90 % to 10 %)[c]	Tfg	2	μs
Minimum settling time to 95 % steady state [c]	Tsg	3	μs
Equivalent source resistance[c]	R1	1 000 ± 3 %	Ω
Recommended EMI suppression	Cs	300	pF
Maximum total cable[d] capacity + Cs	Cs + Cc	3 100	pF

[a] Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.

[b] Measured at 0 V crossing of the ± 12 V signal.

[c] Measured at point Vg as indicated on Figure A.1.

[d] Typical vehicle cord capacities (Cc) should be minimized and less than 2 000 pF.

Table A.2 – Vehicle control pilot circuit values and parameters (see Figures A.1, A.2)

Parameter	Symbol	Value	Units
Permanent resistor value	R2	2,74 k (± 3 %)	Ω
Switched resistor value for vehicles not requiring ventilation	R3	1,3 k (± 3 %)	Ω
Switched resistor value for vehicles requiring ventilation	R3	270 (± 3 %)	Ω
Equivalent total resistor value no ventilation (Figure A.2)	Re	882 (± 3 %)	Ω
Equivalent total resistor ventilation required (Figure A.2)	Re	246 (± 3 %)	Ω
Diode voltage drop (2,75 – 10 mA, -40 °C to + 85 °C)	Vd	0,7 (± 0,15)	V
Maximum total equivalent input capacity	Cv	2 400	pF

Tolerances are to be maintained over full useful life and under design environmental conditions.

Table A.3 – Pilot functions

<table>
<tr><th>Vehicle state</th><th></th><th>Vehicle connected</th><th>S2</th><th>Charging possible</th><th></th><th>Va [a]</th><th></th></tr>
<tr><td>A</td><td></td><td>no</td><td>open</td><td>no</td><td></td><td>12 V [d]</td><td>Vb = 0 V</td></tr>
<tr><td>B</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>9 V [b]</td><td>R2 detected</td></tr>
<tr><td>C</td><td rowspan="2">}</td><td rowspan="2">yes</td><td rowspan="2">closed</td><td rowspan="2">Vehicle ready</td><td rowspan="2">{</td><td>6 V [c]</td><td>R3 = 1,3 kΩ ± 3 %
Charging area ventilation not required</td></tr>
<tr><td>D</td><td>3 V [c]</td><td>R3 = 270 Ω ± 3 %
Charging area ventilation required</td></tr>
<tr><td>E</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>0 V</td><td>Vb = 0: EVSE, utility problem or utility power not available, pilot short to earth …</td></tr>
<tr><td>F</td><td></td><td>yes</td><td>open</td><td>no</td><td></td><td>-12 V</td><td>EVSE not available</td></tr>
</table>

[a] All voltages are measured after stabilization period, tolerance ±1 V.

[b] The EVSE generator may apply a steady state DC voltage or a ±12 V square wave during this period. The duty cycle indicates the available current as in Table A.5.

[c] The voltage measured is function of the value of R3 in Figure A.1 (indicated as Re in Figure A.2).

[d] 12 V static voltage.

Typical start-up and shut-down sequence:

The Figure A.3 shows the sequence of a typical charging cycle under normal operating conditions. The sequences are detailed in Table A.4.

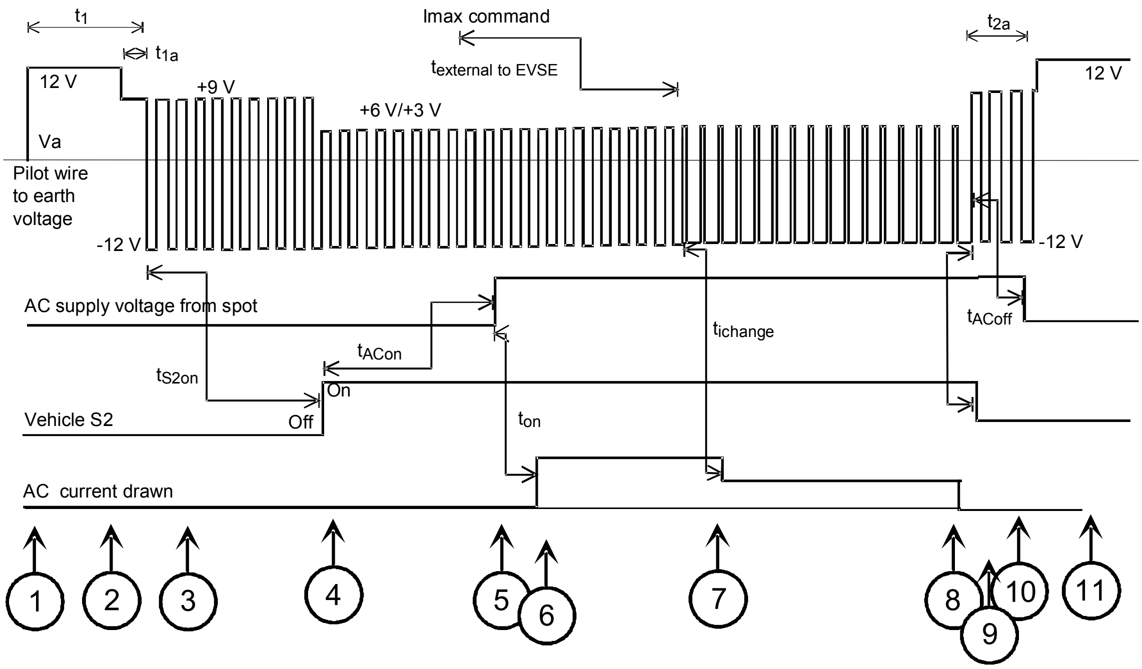


Figure A.3 – Typical charging cycle under normal operating conditions

Table A.4 – description of connecting sequences as shown on Figure A.3

	State	Conditions
1	A	Vehicle unconnected – the full generator voltage is measured by the EVSE at Va (see Figure A.1). The generator signal Vg is a +12 V DC voltage
2	B	The cable assembly is connected to the vehicle and to the EVSE. This condition is detected by the 9 V signal measured at Va. The voltage from the signal generator (Vg) may be either a steady state +12 V DC or a ±12 V, 1 kHz signal in conformity with Table A.1 if the EVSE is immediately available for the supply of energy.
3	B	The EVSE is now able to supply energy and indicated the available current to the vehicle by the duty cycle in conformity with Table A.5. The presence of the diode D (see Figure A.1) is detected by the – 12 V and gives added guarantee that the 9 V signal is a reliable indication of a vehicle connected.
4	B → C,D	S2 is closed by vehicle as a function of requirements to indicate that the vehicle can receive energy. There are no timing requirements for the closing of On.
5	C,D	EVSE closes circuit. The timing of switch closure may be subject other requirements (payment, data exchange). If state D is detected, the switch will close only if ventilation requirements are met.
6	C,D	Current drawn from the vehicle. The timing and current profile are determined by the vehicle. Current may not exceed that indicated by the duty cycle (Table A.5).
7	C,D	External demand for power reduction. Such a demand may originate from the grid or by manual setting on EVSE. The Vehicle adjusts the current demand to that indicated by the duty cycle.
8	C,D	End of charge, decided by the vehicle.
9	C,D →B	Vehicle asks for disconnect. This may be the result of the proximity contact being opened.
10	B	EVSE detects state B (created by opening of S2 on vehicle) and opens the contactor.
11	A	Complete removal of cable assembly from vehicle or EVSE is detected by the 12V signal.
NOTE The EVSE should allow removal of the plug if the end of the charging session is ended by entering state A.		

Table A.5 – Pilot duty cycle provided by EVSE

Available line current	Nominal duty cycle provided by EVSE (Tolerance ± 1 percentage point)
Digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger.	5 % Duty Cycle
Current from 6 A to 51 A:	(% duty cycle) = current[A] / 0,6 10 % ≤ duty cycle ≤ 85 %
Current from 51 A to 80 A:	(% duty cycle) = (current[A] / 2,5) + 64 85 % < duty cycle ≤ 96 %

Table A.6 – Maximum current to be drawn by vehicle

Nominal duty cycle interpretation by vehicle	Maximum current to be drawn by vehicle
Duty cycle < 3 %	Charging not allowed
3 % ≤ duty cycle ≤ 7 %	Indicates that digital communication will be used to control an off-board DC charger or communicate available line current for an on-board charger. Digital communication may also be used with other duty cycles. Charging is not allowed without digital communication. 5 % duty cycle shall be used if the pilot function wire is used for digital communication
7 % < duty cycle < 8 %	Charging not allowed
8 % ≤ duty cycle < 10 %	6 A
10 % ≤ duty cycle ≤ 85 %	Available current = (% duty cycle) × 0,6 A
85 % < duty cycle ≤ 96 %	Available current = (% duty cycle - 64) × 2,5 A
96 % < duty cycle ≤ 97 %	80 A
Duty cycle > 97 %	charging not allowed
If the PWM signal is between 8 % and 97 %, the maximum current may not exceed the values indicated by the PWM even if the digital signal indicates a higher current.	

Table A.7 – EVSE timing (see Figure A.3)

t_1 and t_{1a}	No maximum	Turn on of 1 kHz oscillator	The frequency and voltage shall always conform to the values indicated in Table A.1
t_{ACon}	3 s	Beginning of supply of AC power after detection of state C or state D (vehicle request for energy) This time can be extended if there is digital communication established within this time	If conditions cannot be met EVSE should send one of following: steady state voltage 5 % PWM, state E or F
$t_{external}$	10 s	Modification of pulse-width in response to an external command to EVSE	The external command may be a manual setting or command from grid managements systems
t_{ACoff1}	100 ms maximum	Delay until contactor opens and terminates AC energy transfer in response to S2 opened	S2 will cause pilot voltage change which, when detected by EVSE causes opening of contactors
T_{2a}	No maximum	The state B is be maintained while the vehicle is connected provided the EVSE is capable of supplying further energy	The duty cycle shall indicate the current available as in Table A.5
$t_{ventilation}$ (not shown on Figure A.3)	3 s maximum	Delay for ventilation command turn on after transition from state C (6 V) to state D (3 V)	
Other conditions for termination of energy supply			
	3 s maximum	Delay for opening of contacts to terminate energy supply if abnormal conditions are encountered	This typically includes out of spec voltages of pilot, ventilation, non respect of current drawn (if measured by EVSE)
	3 s maximum	Delay for turning off the square wave oscillator after transition from state B,C or D to state A	
	100 ms maximum	Delay for opening contact if local proximity switch is opened	This applies to connectors using the proximity contact defined in B.4
	2 s maximum	Delay for applying a static 12 V signal after transition from state B, C or D, to state A.	
EV timing (see Figure A.3)			
T_{S2}	No maximum	S2 turn - request for AC supply	Determined by EV requirements
t_{on}	No maximum	Beginning of charging	The charging profile and timing are controlled by the vehicle. Ramp-up of current should only be possible when voltage is detected.
t_{ACoff2}	3 s maximum	Stop charger current draw, set S2 open if Pilot signal out of tolerance, state E or state F detected	Only applies to systems using complete pilot circuit described in Figure A.1
$t_{ichange}$	5 s maximum	Change of current following change in PWM duty cycle	
	100 ms	Delay for stopping charging current drawn by vehicle if proximity contact opened	Not shown on diagram

Annex B
(informative)

Example of a circuit diagram for a basic and universal vehicle coupler

B.1 General

This annex describes circuit diagrams for the mode 1, mode 2, and mode 3 charging methods using the basic interface (see Figures B.1 to B.5).

Mode 4 charging is presented with the universal vehicle coupler (see Figure B.7).

B.2 Circuits diagrams for mode 1, mode 2 and mode 3, using a basic single phase vehicle coupler

Clause B.2 of this annex shows the application of a single phase basic interface fitted with a switch on the proximity circuits.

Clause B.3 of this annex shows the application of a three phase basic interface that is not fitted with a switch on the proximity circuit, used for single and three-phase supply.

Components and functions in the circuit diagrams shown in Figures B.1 to B.5 are as follows.

The pilot function controller is located on the mains side.

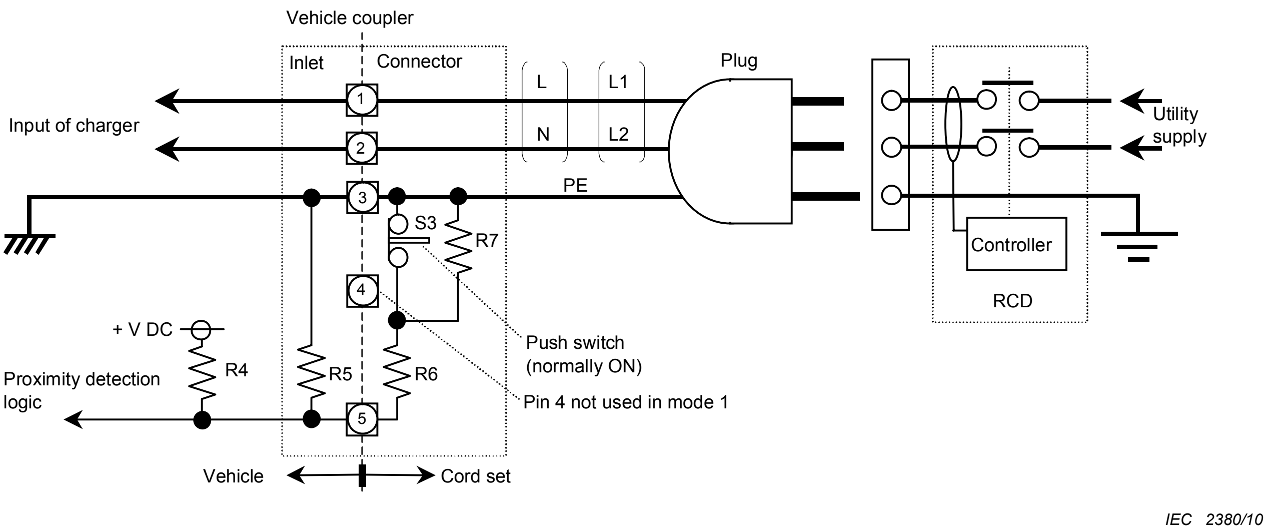
This circuit realizes the basic functions described in Annex A. The circuit is normally supplied from a low voltage source that is isolated from the mains by a transformer and contains a ±12 V 1 000 Hz pulse width modulated oscillator that indicates the power available from the socket.

Pilot function circuit:

Both mode 2 diagram shown in Figure B.2 and mode 3 diagram shown in Figures B.3 and B.4 have been drawn with a hard wired pilot functions as described in Annex A. The basic functions described in Annex A are represented by R1, R2, R3, D and S2 (see Figure A.1). The values indicated in Annex A should be used (see Table A.2) This function could also be achieved using the control function indicated in Annex C. The pin number 4 would not be used in this case.

Table B.1 – Identification of components used with basic single phase connector

	Name of component	Functions
1, 2	Phase and neutral contacts	Vehicle coupler power contacts
3	Earth protection contact	
4	Pilot function contact	
5	Proximity detection contact	Indicates the presence of the connector to vehicle. Used to signal correct insertion of the vehicle connector into the vehicle inlet. Can be used to avoid Un-intentional live disconnect (see Figure B.1 and Note).
R1,R2,R3, D,S1,S2,	Resistances, diodes and control switch	Components necessary for hard wired control pilot function
R4,R5,R6, R7,S3	Resistances and push button switch	Components necessary for proximity detection function
NOTE The auxiliary coupler contact can be used for un-intentional live disconnect avoidance using switch on vehicle connector. For this function, the push button is linked to a mechanical locking device. The depressing S3 un-locks the coupler and opens the circuit. The opening of S3 stops charging operation and contributes to prevention of un-intentional live disconnect. This function may also be achieved using proximity switches or contacts on the vehicle inlet cover or on the locking device		



NOTE 1 There is no pilot function in mode 1and pins 4 is not compulsory.

NOTE 2 In this drawing the switch S3 can be used for prevention of un-intentional live disconnect.

Figure B.1 – Mode 1 case B using the basic single phase vehicle coupler

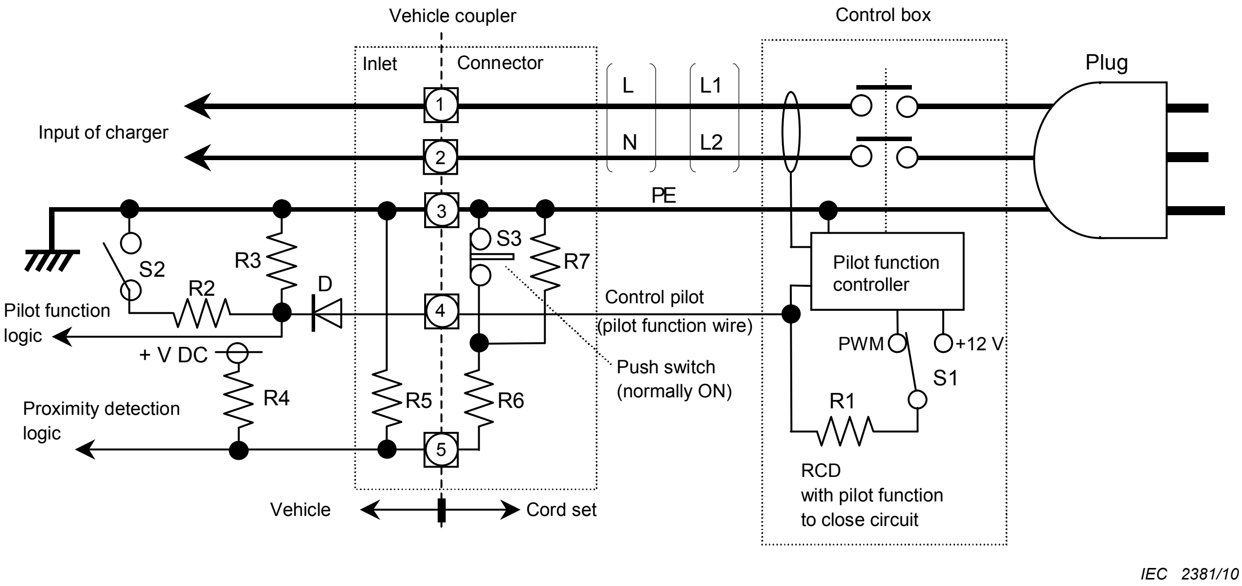


Figure B.2 – Mode 2 case B using the basic single phase vehicle coupler

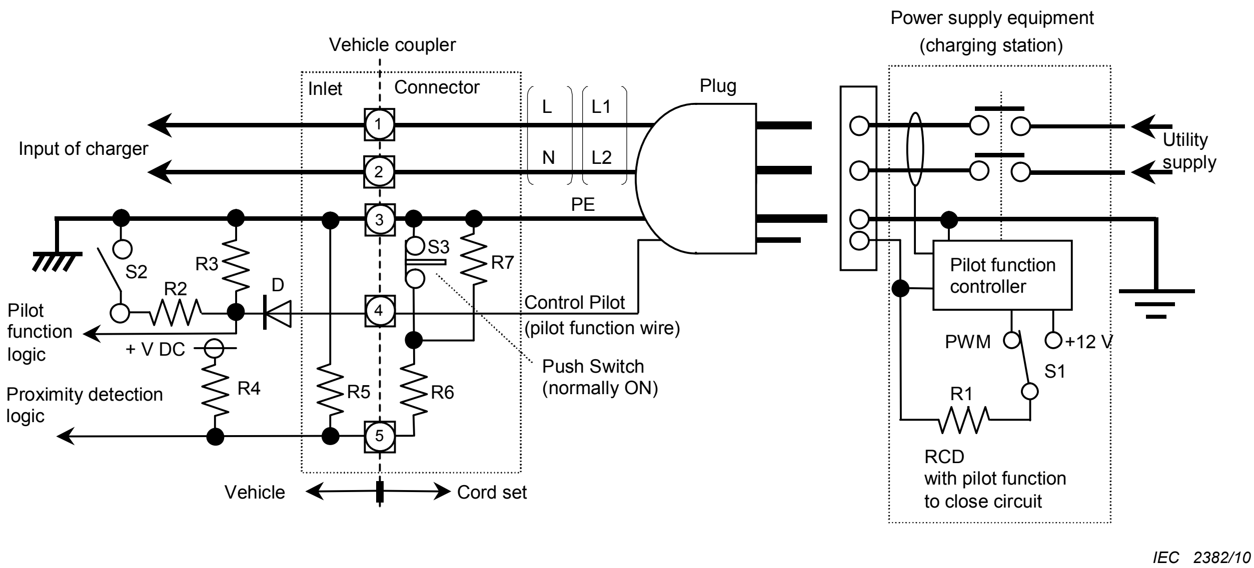


Figure B.3 – Mode 3 case B using the basic single phase vehicle coupler

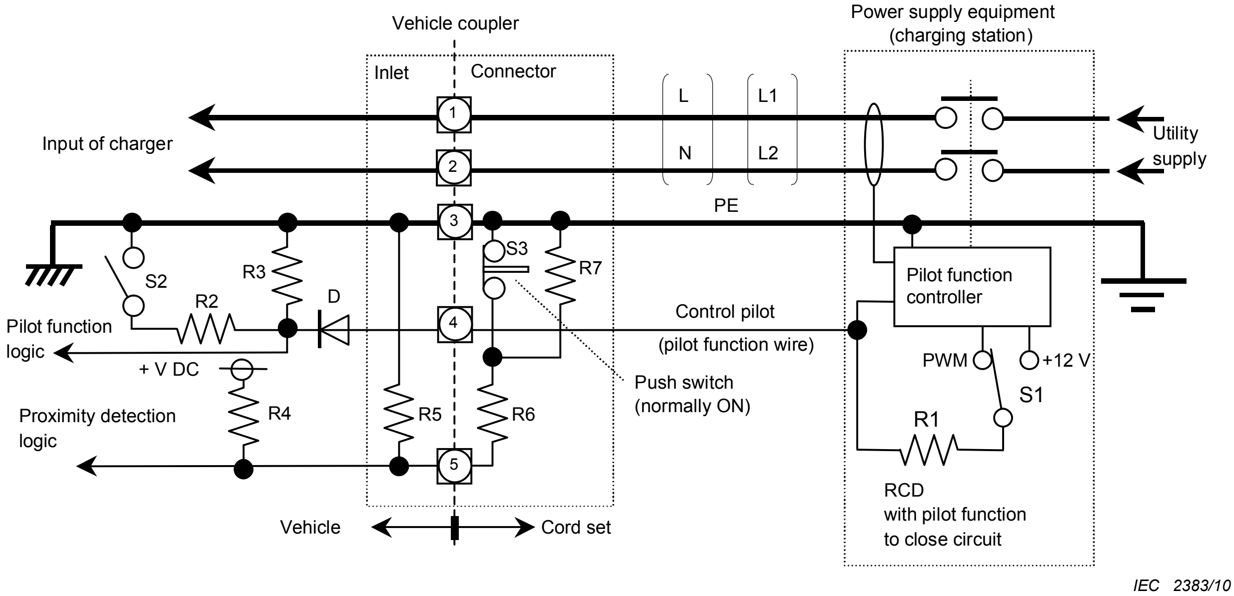


Figure B.4 – Mode 3 case C using the basic single phase vehicle coupler

B.3 Component values for all diagrams in Figures B.1 to B.5

Component values for all diagrams in Figures B.1 to B.5 are specified in Table B.2.

Table B.2 – Component values for all drawings

	Value	Tolerance
R1, R2, R3	As defined in Tables A.1 and A.2	
R4	330 Ω	± 10 %
R5	2 700 Ω	± 10 %
R6	150 Ω	± 10 %
R7	330 Ω	± 10 %
+V DC	Low voltage supply [a]	
[a] A +5 V regulated supply is recommended.		

B.4 Circuits diagrams for mode 3, using a basic single phase or three-phase accessory without proximity switch

Figure B.5 shows a three phase interface accessory that is used for either single phase or three phase supply. The same circuit diagram is also valid for single phase accessories. The current coding function described in B.4 is indicated. Values of the pull-up resistances and the Rc are indicated in Table B.3.

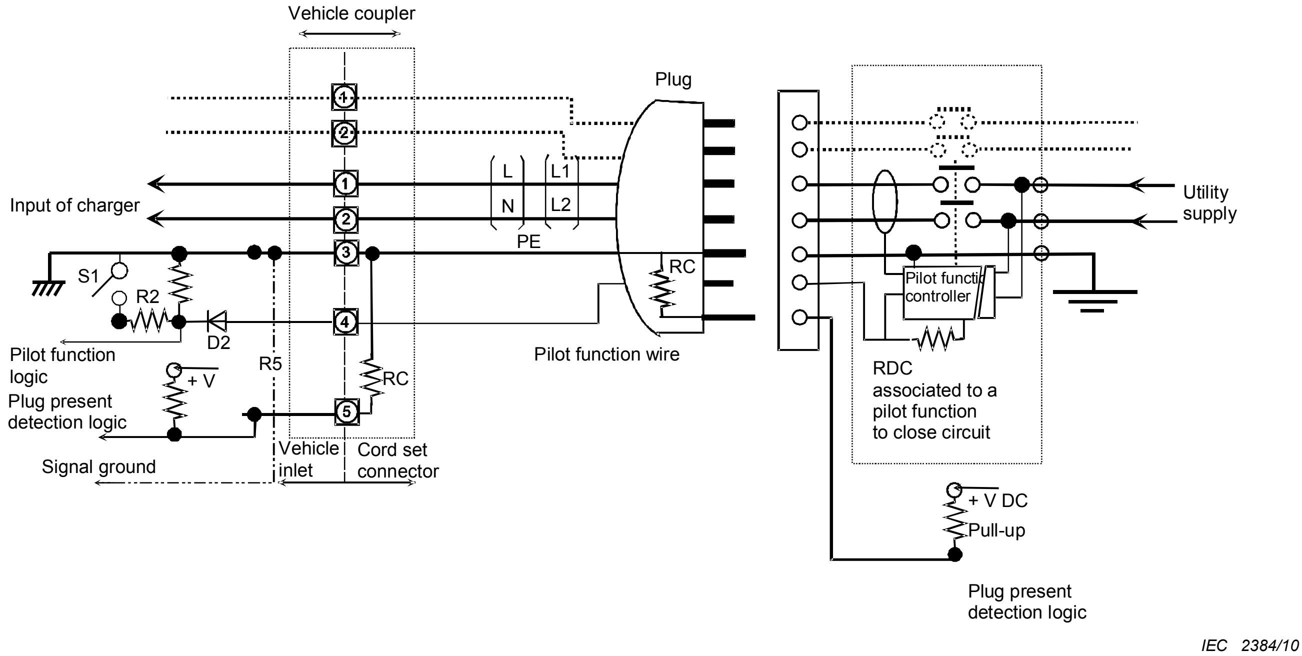


Figure B.5 – Mode 3 case B using the basic single phase vehicle coupler without proximity push button switch S3

NOTE The schemes indicated in Figures 1, 2 and 3 can also be realized with this connector provided the switch S3 is not required.

B.5 System for simultaneous proximity detection and current coding for vehicle connectors and plugs

Vehicle connectors and plugs using the proximity contact for simultaneous proximity detection and current capability coding of the cable assembly set shall have a resistor electrically placed between proximity contact and earthing contact (see Figure B.6) with a value as indicated in Table B.3.

The resistor shall be coded to the maximum current capability of the cable assembly.

The EVSE shall interrupt the current supply if the current capability of the cable is exceeded as defined by the value of Rc.

The resistor is also used for proximity detection.

Table B.3 – Resistor coding for vehicle connectors and plugs

Current capability of the cable assembly	Equivalent resistance of Rc Tolerance ± 3% [c]
13 A	1,5 kΩ 0,5 W [a, b]
20 A	680 Ω 0,5 W [a, b]
32 A	220 Ω 0,5 W [a, b]
63 A (3 phase) / 70 A (1 phase)	100 Ω 0,5 W [a, b]

[a] The power dissipation of the resistor caused by the detection circuit shall not exceed the value given above. The value of the pull-up resistor shall be chosen accordingly.

[b] Resistors used should preferably fail open circuit failure mode. Metal film resistors commonly show acceptable properties for this application.

[c] Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.

Coding resistors, as indicated in Table B.3 shall be used in vehicle connectors and plugs, Type 2.

NOTE Type 2 vehicle connectors and plugs are being included in IEC 62196-2 (under development).

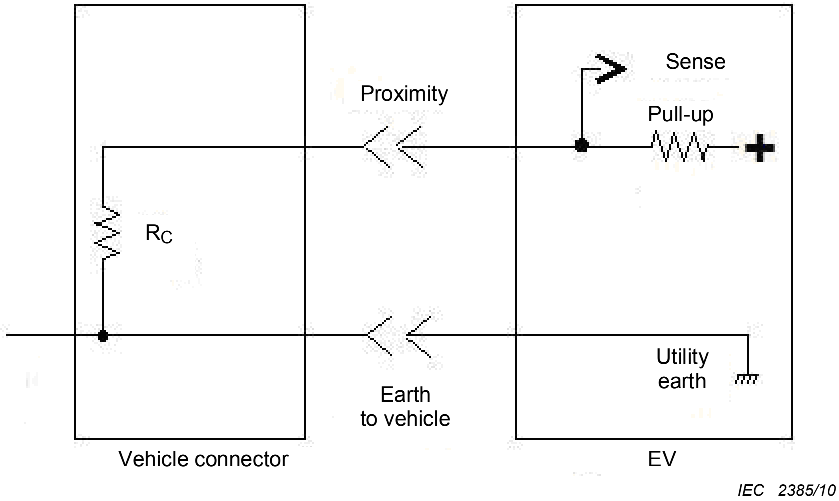


Figure B.6 – Diagram for current capability coding of the cable assembly

The same circuit diagram is used for the plug and EVSE outlet.

B.6 Circuit diagram for mode 4 connection using universal coupler

B.6.1 Parts list and function/characteristics

Parts list and function/characteristics in the circuit diagram for mode 4 connection are shown in Table B.4 and Figure B.7.

Table B.4 – Component description for Figure B.7 mode 4 case C

Reference	Parts list	Function/characteristics
A	Auxiliary contact	– detection of the connector – start for the on-board charger (option) – pilot circuit
BP	Locking release of the connector	– opens the pilot circuit to de-energize the system before the main contacts open: $t > 100$ ms
C1	Main contactor on the supply equipment	– closed on nominal operation if: $0{,}5\ k\Omega < R_o < 2\ k\Omega$
C2 (option)	Main contactor on the vehicle	– closed on normal operation
E1	Auxiliary supply	– extra-low d.c. voltage to energize the pilot circuit: earth protection connector + pilot + chassis
D1	Diode	– not used – prevent the energization of the vehicle computer by the supply equipment
D2	Diode	– prevent the energization of the auxiliary supply circuit E1 and M1, by the vehicle
D3	Diode	– prevent short-circuit between the auxiliary supply E1 and the earth, inside the charging station

Reference	Parts list	Function/characteristics
FC (option)	Trap door close	– start for the on-board charger
G	Pilot contact (last closed during the connection)	– earth for detection of the connector – earth for the pilot circuit – clean data earth

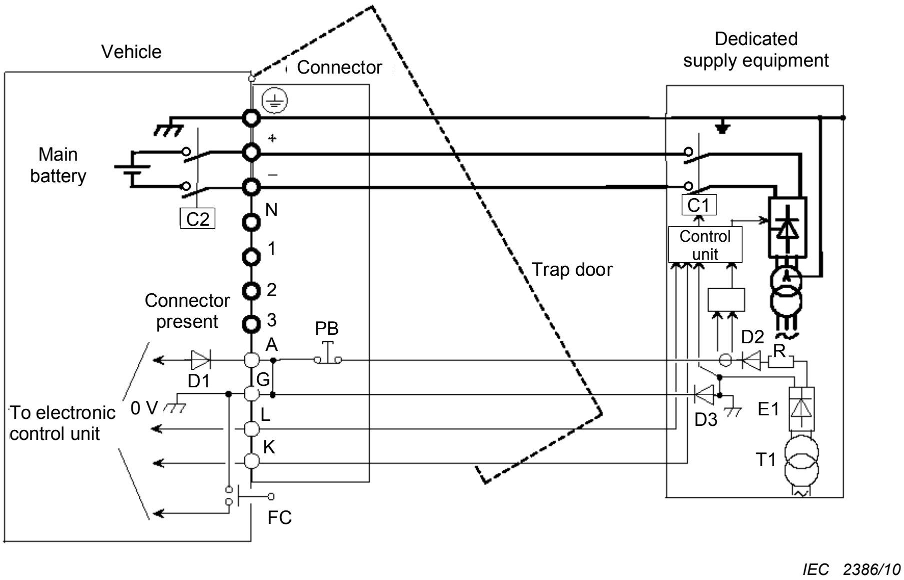


Figure B.7 – Mode 4 case C using the universal vehicle coupler

Annex C
(informative)

Example of a method that provides the pilot function equivalent to a hard wired system

Verification of the continuity of the ground wire connecting the car to EVSE can be done by verifying the presence of a signal that is transmitted on one or more of the power lines and the ground wire.

This is one of the possible systems that can provide a pilot function. The Figure C.1 shows an example using a ferrite core (preferably in the shape of a torus) that transfers data between the EVSE and the vehicle. In the event of the ground wire being cut, communications are interrupted and recharging stops, ensuring the same functionality as those required by mode 3.

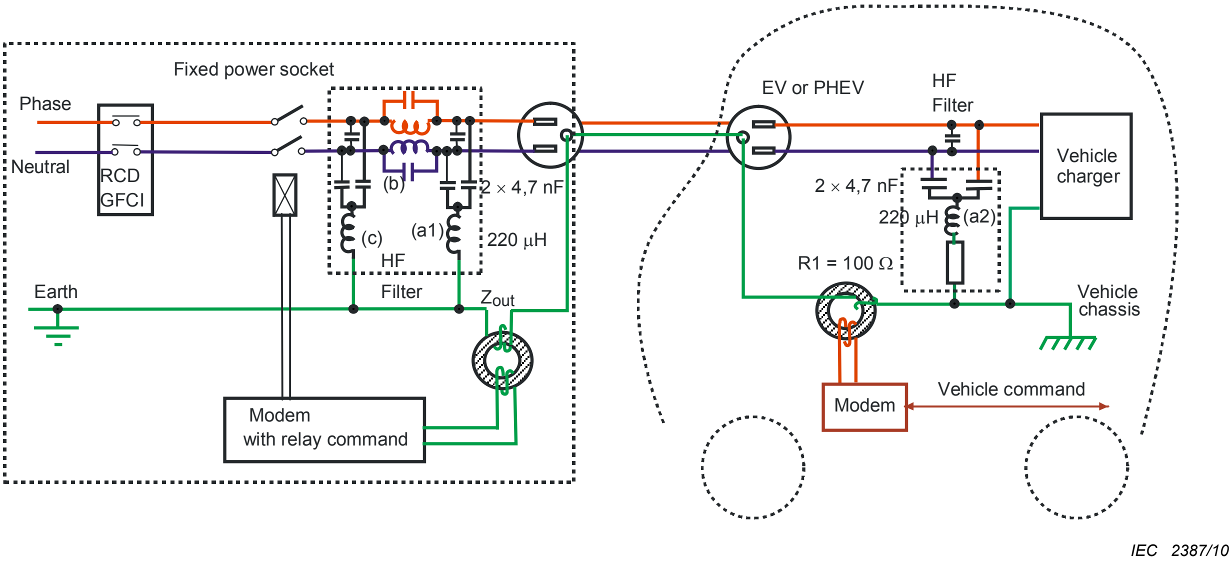


Figure C.1 – Example of a pilot function without a supplementary wire

NOTE This mode of operation is proposed for protection and dialog with the vehicle. It is not intended for data transmission towards the mains supply equipment.

The system can also be used to provide supplementary functions (payment, identification etc.).

The vehicle and/or the fixed socket installation may include further data transmission systems provided they do not interfere with the pilot function.

Band stop filtering (shown by series circuit and two phase/neutral band pass filters) is to be provided to avoid data transmission by the pilot function system to the mains supply in order to ensure independence of the pilot function and to avoid communication with external equipment to comply with the standard EN 50065-1 requirements. This filter should be designed to limit the emissions the mains supply below the out-of-band limit in Clause 7 of EN 50065-1. This is equal to a quasi peak value of 68 dB(µV) at the 110 kHz carrier frequency.

The band pass filters from phase/neutral to (a1 and a2) are designed to give minimum impedance at the carrier frequencies. The schema gives typical values that may be used for a 110 kHz carrier.

The resistor R1 in the vehicle circuit is included to limit the carrier current in the earth loop. Good results are obtained for load resistors of 100 Ω used with transmitters having an internal impedance less than 15 Ω and an output of 1 V rms as measured at the output of the ferrite tore (Zout on diagram). Sensitivity of the receiver is set to detect only high level signals (typically > 100 mV rms) in order to render the system independent of stray wiring capacities that could transmit the earth signal.

The system should be designed to exceed immunity specifications as defined by IEC 61000-6-1 to avoid dysfunction under extreme interference conditions.

All emissions of the vehicle pilot function system to the mains shall be inhibited in the absence of coded information supplied by the EVSE.

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