

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electric vehicle conductive charging system –
Part 23: DC electric vehicle charging station**

**Système de charge conductive pour véhicules électriques –
Partie 23: Borne de charge en courant continu pour véhicules électriques**



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ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –**Part 23: DC electric vehicle charging station**

FOREWORD

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International Standard IEC 61851-23 has been prepared by IEC technical committee 69: Electric road vehicles and electric industrial trucks.

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

FDIS	Report on voting
69/272/FDIS	69/279/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.

This standard is to be read in conjunction with IEC 61851-1:2010. It was established on the basis of the second edition (2010) of that standard.

The clauses of particular requirements in this standard supplement or modify the corresponding clauses in IEC 61851-1:2010. Where the text of subsequent clauses indicates an "*addition*" to or a "*replacement*" of the relevant requirement, test specification or explanation of Part 1, these changes are made to the relevant text of Part 1, which then becomes part of this standard. Where no change is necessary, the words "This clause of Part 1 is applicable" are used. Additional clauses, tables and figures which are not included in Part 1, have a number starting from 101. Additional annexes are lettered AA, BB etc.

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

In this standard, the following print types are used:

- *test specifications and instructions regarding application of Part 1: italic type.*
- notes: smaller roman type.

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

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- replaced by a revised edition, or
- amended.

The contents of the corrigendum of May 2016 have been included in this copy.

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INTRODUCTION

The introduction and commercialisation of electric vehicles has been accelerated in the global market, responding to the global concerns on CO₂ reduction and energy security. Concurrently, the development of charging infrastructure for electric vehicles has also been expanding. As a complement to the a.c. charging system, d.c. charging is recognized as an effective solution to extend the available range of electric vehicles. The international standardization of charging infrastructure is indispensable for the diffusion of electric vehicles, and this standard is developed for the manufacturers' convenience by providing general and basic requirements for d.c. EV charging stations for conductive connection to the vehicle.

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

Part 23: DC electric vehicle charging station

1 Scope

This part of IEC 61851, together with IEC 61851-1:2010, gives the requirements for d.c. electric vehicle (EV) charging stations, herein also referred to as "DC charger", for conductive connection to the vehicle, with an a.c. or d.c. input voltage up to 1 000 V a.c. and up to 1 500 V d.c. according to IEC 60038.

NOTE 1 This standard includes information on EV for conductive connection, but limited to the necessary content for describing the power and signaling interface.

This part covers d.c. output voltages up to 1 500 V.

Requirements for bi-directional power flow are under consideration.

NOTE 2 Typical diagrams and variation of d.c. charging systems are shown in Annex DD.

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

This part specifies the d.c. charging systems A, B and C as defined in Annexes AA, BB and CC.

NOTE 3 Typical configuration of d.c. EV charging system is shown in Annex EE.

EMC requirements for d.c. EV charging stations are defined in IEC 61851-21-2.

This standard provides the general requirements for the control communication between a d.c. EV charging station and an EV. The requirements for digital communication between d.c. EV charging station and electric vehicle for control of d.c. charging are defined in IEC 61851-24.

2 Normative references

This clause of Part 1 is applicable except as follows:

Addition:

IEC 60364-5-54:2011, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC/TS 60479-1:2005, *Effects of current on human beings and livestock - Part 1: General aspects*

IEC 60950-1:2005, *Information technology equipment - Safety - Part 1: General requirements*
Amendment 1:2009
Amendment 2:2013

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61439-1:2011, *Low voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61557-8, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 8: Insulation monitoring devices for IT systems*

IEC 61558-1:2005, *Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests*

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

IEC 61851-24:2014, *Electric vehicle conductive charging system – Part 24: Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging*

IEC 62052-11, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*

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

IEC 62196-3:—¹, *Plugs, socket-outlets, and vehicle couplers – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and tube-type contact vehicle couplers*

ISO/IEC 15118-2:—¹, *Road Vehicles – Vehicle to grid communication interface – Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements*

ISO/IEC 15118-3:—¹, *Road Vehicles – Vehicle to grid communication interface – Part 3: Physical layer and data link layer requirements*

ISO 11898-1, *Road vehicles – Controller area network (CAN) – Part 1: Data link layer and physical signalling*

DIN SPEC 70121, *Electromobility – Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging System*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61851-1 and IEC 61668-1, as well as the following apply.

NOTE The definitions included in this part are those having general application herein. Definitions applying to isolating transformers, safety isolating transformers, switch mode power supplies, and their construction are included in IEC 61558-1.

3.101

d.c. EV charging system

system composed of a DC charger, cable assembly and the equipment on EV that is required to fulfil the charging function including digital communication for charging control

3.102**isolated d.c. EV charging station**

d.c. EV charging station with d.c. circuit on output side which is electrically separated by at least basic insulation from a.c. circuit on power system side

3.103**non-isolated d.c. EV charging station**

d.c. EV charging station with d.c. circuit on output side which is not electrically separated by at least basic insulation from the supply system

3.104**regulated d.c. EV charging station**

d.c. EV charging station that supplies vehicle battery with a charging current or charging voltage in accordance with the request from vehicle

3.105**non-regulated d.c. EV charging station**

under consideration

3.106**d.c. charging control function****DCCCF**

function embedded in a d.c. EV charging station which controls d.c. power output following VCCF direction

Note 1 to entry: This note applies to the French language only.

3.107**vehicle charging control function****VCCF**

function in a vehicle which controls the charging parameters of off-board d.c. EV charging station

Note 1 to entry: This note applies to the French language only.

3.108**CCC****controlled current charging**

energy transfer method that the d.c. EV charging station regulates charging current according to the current value requested by the vehicle

Note 1 to entry: This note applies to the French language only.

3.109**CVC****controlled voltage charging**

energy transfer method that the d.c. EV charging station regulates charging voltage according to the voltage value requested by the vehicle

Note 1 to entry: This note applies to the French language only.

3.110**control circuit**

circuit for signal and digital communication with vehicle, and for the management of charging control process

3.111**primary circuit**

a circuit that is directly connected to the a.c. mains supply, and includes the primary windings of transformers, other loading devices and the means of connection to the a.c. mains supply

3.112

secondary circuit

circuit that has no direct connection to a primary circuit and derives its power from a transformer, converter or equivalent isolation device

3.113

insulation

all the materials and parts used to insulate conductive elements of a device, or a set of properties which characterize the ability of an insulation to provide its function

[SOURCE: IEC 60050-151:2001, 151.15.41 and IEC 60050-151:2001, 151.15.42, modified — Both these definitions have been combined and the note to entry has been deleted.]

3.114

isolation

function intended to make dead for reasons of safety all or a discrete section of the electrical installation by separating the electrical installation or section from every source of electric energy

[SOURCE: IEC 60050-826:2004, 826.17.01]

3.115

maximum voltage limit

upper limit value of charging voltage that is notified by the vehicle to the d.c. EV charging station, and is used for overvoltage protection of vehicle battery

3.116

protective conductor

PE

conductor provided for purposes of safety, for example protection against electric shock

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-195:1998, 195.02.09]

3.117

charging state

physical status of d.c. EV charging system

3.118

emergency shutdown

shutdown of d.c. EV charging station that results in the termination of charging, caused by a failure detected by the d.c. EV charging station or the vehicle.

4 General requirements

This clause of Part 1 is applicable.

5 Rating of the supply a.c. voltage

This clause of Part 1 is applicable.

6 General system requirement and interface

This clause of Part 1 is applicable except as follows:

6.2 EV charging mode

Replacement:

EV charging mode of this standard is Mode 4.

Mode 4 charging in this part means the connection of the EV to the supply network utilizing a d.c. EV charging station (e.g. off-board charger) where the control pilot function extends to the d.c. EV charging station.

Pluggable d.c. EV charging stations, which are intended to be connected to the a.c. supply network (mains) using standard plugs and socket outlets, shall be compatible with residual current device with characteristics of type A. The pluggable d.c. EV charging station shall be provided with an RCD, and may be equipped with an overcurrent protection device.

Further requirements for pluggable d.c. EV charging stations are under consideration.

NOTE 1 In some countries, the use of an RCD of Type AC for d.c. EV charging station (a.c. mains) is allowed: JP.

NOTE 2 In some countries, US and CA, the use of a system of protection is required that is intended to interrupt the electric circuit to the load when:

- a) a fault current to earth (ground) exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit,
- b) the earthing (grounding) path becomes open-circuited or of excessively high impedance, or
- c) a path to earth (ground) is detected on an isolated (ungrounded) system.

Replacement:

6.3 Types of EV connection

Replacement:

6.3.1 General description

The connection of EVs using cables shall be carried out in case of C connection as specified in Part 1.

6.3.3 Adaptors

Replacement:

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

Replacement:

6.4 Functions provided in d.c. charging

The d.c. EV charging station shall supply a d.c. current or voltage to the vehicle battery in accordance with a VCCF request.

For non-regulated charging: under consideration.

Replacement:

6.4.1 Mode 4 charging functions

These functions shall be provided by d.c. charging system as given below:

- verification that the vehicle is properly connected;
- protective conductor continuity checking (6.4.3.2);
- energization of the system;
- de-energization of the system (6.4.3.4);
- d.c supply for EV (6.4.3.101);
- measuring current and voltage (6.4.3.102);
- retaining / releasing coupler (6.4.3.103);
- locking of the coupler (6.4.3.104);
- compatibility assessment (6.4.3.105);
- insulation test before charging (6.4.3.106);
- protection against overvoltage at the battery (6.4.3.107);
- verification of vehicle connector voltage (6.4.3.108);
- control circuit supply integrity (6.4.3.109);
- short circuit test before charging (6.4.3.110);
- user initiated shutdown (6.4.3.111);
- overload protection for parallel conductors (conditional function) (6.4.3.112);
- protection against temporary overvoltage (6.4.3.113);
- emergency shutdown (6.4.3.114).

Replacement:

6.4.2 Optional functions

These functions, if provided, should be provided by d.c. charging system as optional as given below:

- determination of ventilation requirements of the charging area;
- detection/adjustment of the real time available load current of the DC charger;
- selection of charging current;
- wake up of d.c. EV charging station by EV (6.4.4.101);
- indicating means to notify users of locked status of vehicle coupler.

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 unintentional disconnect is required in some countries: US

NOTE 3 Primary protection against overvoltage and overcurrent of vehicle battery is the responsibility of the vehicle.

Replacement:

6.4.3 Details of functions for DC charging

Replacement:

6.4.3.2 Protective conductor continuity checking

For isolated systems, protective conductor continuity between the d.c. EV charging station and the vehicle shall be monitored. For the rated voltage of d.c. 60 V or higher, the d.c. EV

charging station shall perform an emergency shutdown (see 6.4.3.114) within 10 s after a loss of electrical continuity of the protective conductor between d.c. EV charging station and EV (emergency shutdown).

For non-isolated systems, in case of loss of earthing conductor continuity, the non-isolated d.c. EV charging station shall be disconnected from a.c. supply network (mains). Earthing conductor continuity between the d.c. EV charging station and the vehicle shall be monitored. For the rated voltage of d.c. 60 V or higher, the d.c. EV charging station shall perform an emergency shutdown within 5 s after a loss of electrical continuity of the protective conductor between d.c. EV charging station and EV.

NOTE The isolated d.c. EV charging station can be disconnected from a.c. mains when protective conductor continuity is lost.

6.4.3.4 De-energization of the system

Addition:

In the case of failure in control circuit of d.c. EV charging station, such as short-circuit, earth leakage, CPU failure or excess temperature, the d.c. EV charging station shall terminate the supply of charging current, and disconnect the supply of control circuit. In addition, the conductor, in which earth fault or overcurrent is detected, shall be disconnected from its supply.

Requirement for disconnection of EV is defined in 7.2.3.1.

Compliance check: under consideration.

Addition:

6.4.3.101 DC supply for EV

The d.c. EV charging station shall supply d.c. voltage and current to the vehicle battery in accordance with VCCF's controlling.

For regulated systems, the d.c. EV charging station shall supply regulated d.c. voltage or current (not simultaneously, but as requested by the vehicle during charging) to the vehicle battery in accordance with VCCF's controlling. Requirements for charging performance of regulated d.c. current / voltage are given in 101.2.1.1, 101.2.1.2 and 101.2.1.3 and 101.2.1.4.

In either case mentioned above, the maximum ratings of the d.c EV charging station shall not be exceeded.

The vehicle can change the requested current and/or requested voltage.

6.4.3.102 Measuring current and voltage

The d.c. EV charging station shall measure the output current and output voltage. The accuracy of output measurement is defined for each system in Annexes AA, BB and CC.

6.4.3.103 Retaining/releasing coupler

A means shall be provided to retain and release the vehicle coupler. Such means may be mechanical, electrical interlock, or combination of interlock and latch.

6.4.3.104 Locking of the coupler

A vehicle connector used for d.c. charging shall be locked on a vehicle inlet if the voltage is higher than 60 V d.c.

The vehicle connector shall not be unlocked (if the locking mechanism is engaged) when hazardous voltage is detected through charging process including after the end of charging. In case of charging system malfunction, a means for safe disconnection may be provided.

NOTE 1 The actuation portion of the locking function can be in either the vehicle connector or the vehicle inlet. It is configuration dependent.

The d.c. EV charging station shall have the following functions in case the locking is done by the d.c. EV charging station:

- electrical or mechanical locking function to retain the locked status, and
- function to detect the disconnection of the electrical circuits for the locking function.

NOTE 2 The locking function for each system is defined in Annexes AA, BB and CC.

NOTE 3 An example of lock function and disconnection detection circuit is shown in Annex AA.

For the tests of mechanical strength, refer to IEC 62196-3.

6.4.3.105 Compatibility assessment

Compatibility of EV and d.c. EV charging station shall be checked with the information exchanged at the initialization phase as specified in 102.5.1.

6.4.3.106 Insulation test before charging

The d.c. EV charging station shall confirm the insulation resistance between its d.c. output circuit and protective conductor to the vehicle chassis, including the charging station enclosure, before the EV contactors are allowed to close.

If the required value is not met, the d.c. EV charging station shall send the signal to the vehicle that the charging is not allowed.

Conformance is determined by measuring the insulation resistance as follows:

Any relays in the d.c. output circuit of the d.c. EV charging station shall be closed during the test.

The required value of insulation resistance R shall be as shown in Formula (1):

$$R \geq 100 \, \Omega/V \times U \quad (1)$$

where

U is rated output voltage of the d.c. EV charging station.

6.4.3.107 Protection against overvoltage at the battery

The d.c. EV charging station shall perform an emergency shutdown and disconnect its supply to prevent overvoltage at the battery, if output voltage exceeds maximum voltage limit sent by the vehicle. In case of vehicle failure, disconnection from a.c. mains may not be necessary.

Specific requirement for detection and shutdown are defined in Annexes AA, BB and CC.

The vehicle may change the maximum voltage limit during charging process.

Compliance is checked according to the following test.

The d.c. EV charging station is connected to a d.c. voltage source or artificial load.

The voltage of the d.c. voltage source or artificial load should be within the operating range of the charging station.

The d.c. EV charging station is set to charge the d.c. voltage source at a current of more than 10 % of the maximum rated current of d.c. EV charging station.

A maximum voltage limit command lower than the voltage of the voltage source shall be sent to the d.c. EV charging station.

Both the time between when the command is sent and the beginning of charging current reduction, and the rate of reduction shall be measured.

The voltage of the voltage source, the way the command voltage limit is sent and the value of the voltage limit can be chosen freely to comply with this test.

NOTE The selection of charging current can be made by the system or the user.

6.4.3.108 Verification of vehicle connector voltage

This clause is only applicable for charging stations which are responsible for locking of vehicle connector, such as system A and system B.

The d.c. EV charging station shall not energize the charging cable when the vehicle connector is unlocked. The voltage at which the vehicle connector unlocks shall be lower than 60 V.

6.4.3.109 Control circuit supply integrity

If an earth fault, short circuit or overcurrent is detected in output circuit of d.c. EV charging station, the power circuit shall be disconnected from its supply, but the power supply for control circuit shall not be interrupted unless the power circuit interruption is due to a loss of a.c. supply network (mains).

6.4.3.110 Short circuit test before charging

With the EV connected to the d.c. EV charging station and before the EV contactor is closed, the d.c. EV charging station shall have a means to check for a short circuit between d.c. output circuit positive and negative for the cable and vehicle coupler.

Compliance test specifications are defined in Annexes AA, BB and CC (under consideration).

6.4.3.111 User initiated shutdown

The d.c. EV charging station shall have a means to allow the user to shut down the charging process.

6.4.3.112 Overload protection for parallel conductors (conditional function)

If more than one conductor or wire and/or vehicle connector contact is used in parallel for d.c. current supply to the vehicle, the d.c. EV charging station shall have a mean to ensure, that none of the conductors or wires will be overloaded.

NOTE For example, the currents on the different paths can be monitored or more than one power source can be used.

6.4.3.113 Protection against temporary overvoltage

For stations serving a maximum output voltage up to 500 V, no voltage higher than 550 V shall occur for more than 5 s at the output between DC+ and PE or between DC- and PE.

For stations serving a maximum output voltage above 500 V and up to 1 000 V, no voltage higher than 110 % of d.c. output voltage shall occur for more than 5 s at the output between DC+ and PE or between DC- and PE. See Figure 101.

For voltage above 1 000 V: under consideration.

The d.c. EV charging station shall terminate the supply of charging current and disconnect the d.c. power circuit from its supply within 5 s, to remove the source of overvoltage (see 5.3.3.2.3 in IEC 60664-1:2007). This shall also apply in case of a first earth fault within the isolated output part of the d.c. EV charging station.

For U_n , as the minimum DC charger output voltage, the d.c. EV charging station shall limit the voltage between DC+/- and PE at:

$$(2 U_n + 1\,000) \times 1,41 \text{ V or;}$$

$$(U_n + 1\,200) \times 1,41 \text{ V, whichever is less.}$$

NOTE The voltage can be limited by reducing the overvoltage category or by adding a surge protection device with sufficient clamping voltage.

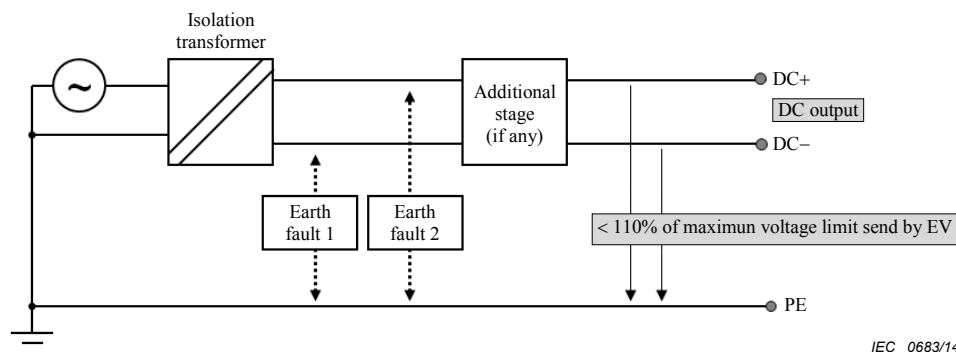


Figure 101 – Overvoltage protection in case of earth fault

6.4.3.114 Emergency shutdown

When the d.c. EV charging station detects an abnormality in the station and/or the vehicle, the safety shall be ensured by the emergency shutdown as follows.

Stop charging by:

- controlled expedited interruption of charging current or voltage to the vehicle, where d.c. current descends with a controlled slope, and appropriate signaling to the vehicle, or
- uncontrolled abrupt termination of charging under specific fault conditions, where there is no control of current, and the vehicle may not be informed in time.

NOTE The d.c. EV charging station can achieve this requirement by exchange of information with the vehicle (see 102.4 and Annex AA, BB or CC).

Under specific conditions, the following disconnection, for example, is required according to the risk assessment of the abnormality in the station or the vehicle:

- disconnection of the supply to the conductor in which an earth leakage is detected;

- disconnection of the conductor in which an overcurrent is detected;
- disconnection of the d.c. power circuit from the supply if an insulation failure is detected.

General procedure of shutdown in the charging control process is given in 102.5.3.

6.4.4 Detail of optional function

6.4.4.3 Retaining/releasing of the coupler

Not applicable

6.4.4.5 Details of optional functions for mode 3

Not applicable.

Addition:

6.4.4.101 Wake up of d.c. EV charging station by EV

The charging station may support a standby mode to minimize power consumption. In this case, the station shall be able to be woken up by the EV.

6.4.5 Details of pilot function

Replacement:

For d.c. charging, control pilot function is mandatory. The control pilot function shall be capable of performing at least the mandatory functions described in 6.4.3.1, 6.4.3.2, 6.4.3.3 and 6.4.3.4, and may also be capable of contributing to optional functions described in 6.4.4.

Addition:

6.101 Classification

DC EV charging stations and systems may be classified as follows.

6.101.1 Category

6.101.1.1 According to system structure:

- isolated d.c. EV charging station, according to the type of insulation between input and output:
 - a) basic insulation,
 - b) reinforced insulation,
 - c) double insulation,
- non-isolated d.c. EV charging station.

6.101.1.2 According to system control:

- regulated d.c. EV charging station:
 - a) controlled current charging,
 - b) controlled voltage charging,
 - c) combination of a) and b),
- non-regulated d.c. EV charging station.

6.101.1.3 According to power receiving:

- d.c. EV charging station connected to a.c. mains;
- d.c. EV charging station connected to d.c. mains.

6.101.1.4 According to environmental conditions:

- outdoor use,
- indoor use.

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

NOTE 2 DC EV charging stations classified for outdoor use can be used for indoor use, provided ventilation requirements are satisfied.

6.101.1.5 According to the system used:

- system A (see Annex AA),
- system B (see Annex BB),
- system C (see Annex CC).

6.101.2 Rating

According to d.c. output voltage:

- up to and including 60 V,
- over 60 V up to and including 1 500 V.

7 Protection against electric shock

This clause of Part 1 is applicable except as follows:

7.2.3.1 Disconnection of EV

Replacement of the 1st sentence:

One second after having disconnected the EV from the supply, the voltage between accessible conductive parts or any accessible conductive part and protective conductor shall be less than or equal to 60 V d.c., and the stored energy available shall be less than 20 J (see IEC 60950-1).

Replacement:

7.2.3.2 Disconnection of d.c. EV charging station

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

7.4 Supplementary measures

Not applicable except for the mobile d.c. EV charging station.

Replacement:

7.5 Protective measures for d.c. EV charging stations

The types of d.c. EV charging stations covered by these requirements, including all accessible conductive parts on the equipment shall have the following protective measures as described in IEC 61140.

- protective measures by automatic disconnection of supply by connecting all exposed-conductive-parts to a protective conductor during battery charging, unless protective measure by reinforced or double insulation or protective measure by electrical separation is used for the d.c. EV charging stations.

Addition:

7.5.101 Requirements of the isolated d.c. EV charging station

Requirements for the isolated d.c. EV charging station for protection against electric shock are defined for each system in AA.3.1, BB.2 or CC.4.1.

In addition, if the d.c. EV charging station has multiple d.c. outputs designed for simultaneous operation, each output circuit shall be isolated from each other by basic insulation or reinforced insulation.

NOTE 1 Requirements for multiple simultaneous outputs, which are non-isolated from each other, are under consideration.

NOTE 2 In the following countries, both isolated and non-isolated electric vehicle supply equipment and d.c. EV charging stations comply with the requirements in national standards: US, CA.

For multiple output, see IEC 60364-7-722¹.

7.5.102 Requirements of the non-isolated d.c. EV charging station

For non-isolated d.c. EV charging stations: under consideration.

NOTE In the following countries, both isolated and non-isolated electric vehicle supply equipment and d.c. EV charging stations comply with the requirements in national standards: US, CA.

7.5.103 Protective conductor dimension cross-sectional area

Protective conductor shall be of sufficient cross-sectional area to satisfy the requirements of IEC 60364-5-54.

NOTE In some countries, the size and rating of the protective conductor is specified in national codes and regulations.

7.6 Additional requirements

Replacement:

The d.c. EV charging station shall be compatible with RCD Type A in the installation, i.e. a.c. supply network (mains).

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

8 Connection between the power supply and the EV

This clause of Part 1 is applicable except as follows:

8.1 General

Replacement:

¹ To be published.

The physical conductive electrical interface requirements between the vehicle and the d.c. EV charging station are as defined in IEC 62196-3.

For non-isolated systems: under consideration.

8.2 Contact sequencing

Replacement

6.7 in IEC 62196-3:— is applicable.

8.3 Functional description of a standard interface

Not applicable.

8.4 Functional description of a basic interface

Not applicable.

Replacement:

9 Specific requirements for vehicle coupler

This clause of Part 1 is applicable except as follows:

9.1 General requirements

Replacement:

The construction and performance requirements of vehicle coupler are specified in IEC 62196-1.

The requirements for the d.c. interfaces are specified in IEC 62196-3.

Replacement:

9.3 Service life of vehicle coupler

The construction and performance requirements of vehicle coupler are specified in IEC 62196-1.

9.4 Breaking capacity

Replacement:

For d.c. charging, the vehicle couplers are rated "not for current interruption." A 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.

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

In addition to locking mechanism defined in 6.4.3.104, in case of unintended disconnection of the vehicle coupler, the output current of the d.c. EV charging station shall be turned off within a defined time to contain a possible arc within the vehicle coupler housing. This turn-off time

shall comply with the value specified in Annexes AA, BB and CC, using a speed of separation of the vehicle connector of $(0,8 \pm 0,1)$ m/s according to IEC 60309-1.

Disconnection of vehicle coupler can be detected when one of the following occurs:

- loss of digital communication;
- interruption of interlock circuit(s), e.g. control pilot, proximity circuit, to mitigate electrical arcing and shock hazards.

The system specific requirement for breaking capacity and system redundancy are defined in Annexes AA, BB and CC.

10 Charging cable assembly requirements

This clause of Part 1 is applicable except as follows:

10.1 Electrical rating

Replacement:

The rated voltage and current of each conductor shall correspond to the rated voltage and current of the d.c. output of the d.c. EV charging station.

11 EVSE requirements

This clause of Part 1 is applicable except as follows:

11.4 Dielectric withstand characteristics

11.4.2 Impulse dielectric withstand (1,2/50 μ s)

Replacement:

The dielectric withstand of the power circuits at impulse shall be checked using values as indicated in Table F.1 of IEC 60664-1:2007, category III for fixed d.c. EV charging stations, and category II for detachable d.c. EV charging stations. Lower overvoltage category can apply if appropriate overvoltage reduction specified in IEC 60664-1 is provided.

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

Addition:

11.4.101 Suppression of overvoltage category

The isolated d.c. EV charging station shall reduce overvoltage to the EV to the rated impulse voltage of 2 500 V.

Primary circuit of d.c. charging station in outdoor is overvoltage category (OVC) III according to Part 1.

NOTE The overvoltage reduction can be achieved by combination of one or more attenuation means in accordance with 4.3.3.6 of IEC 60664-1:2007.

11.5 Insulation resistance

Add the following sentence:

Insulation resistance according to 11.5 does not include components bridging insulation according to 1.5.6 and 1.5.7 of IEC 60950-1:2005, Amendment 1:2009, Amendment 2:2013.

NOTE The test is made without an insulation monitoring system.

11.6 Clearances and creepage distances

Replacement:

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

The minimum pollution degrees shall be as specified below:

- outdoor use: pollution degree 3,
- indoor use: pollution degree 2, except industrial areas: pollution degree 3.

The pollution degree of the micro environment for the d.c. EV charging station may be influenced by installation in an enclosure.

NOTE The macro environment for indoor use only is assumed to be a pollution degree of at least 2 for mild conditions.

11.7 Leakage-touch-current

Replacement:

This subclause defines the measurement of current through networks simulating the impedance of the human body (touch current).

Addition:

11.7.101 Touch-current limit

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 shall not exceed the values indicated in Table 2 of Part 1.

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

For Class I d.c. EV charging station, 11.7.106 is applicable, if the test touch current exceeds 3,5 mA.

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

11.7.102 Test configuration

Test configurations for measurement of leakage current are given in 5.4.1 of IEC 60990:1999.

11.7.103 Application of measuring network

The measuring network is defined in Figure 102. In Figure 102, terminal B of the measuring network is connected to the earthed (neutral) conductor of the supply. Terminal A of the measuring network is connected to each conductive or unearthed accessible surface in turn. All accessible conductive or unearthed surfaces are to be tested for touch currents. The measuring network of Figure 102 is from Figure 4 of IEC 60990:1999.

For an accessible non-conductive part, the test is made to metal foil having dimensions of 100 mm by 200 mm in contact with the part.

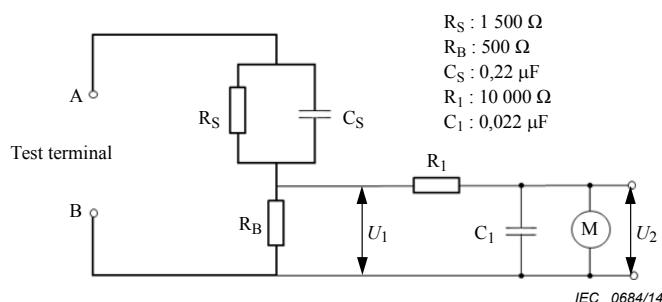


Figure 102 – Measuring network of touch current weighted for perception or reaction

11.7.104 Test condition

The touch current shall be measured after the damp heat test, with the d.c. EV charging station connected to a.c. supply network (mains) in accordance with Clause 6 of IEC 60990:1999. The supply voltage shall be 1,1 times the nominal rated voltage.

Measurements shall be made with each of the applicable fault conditions specified in 6.2.2 of IEC 60990:1999.

11.7.105 Test measurements

The r.m.s. value of the voltage, U_2 , shall be measured using the measuring instrument M in Figure 102. Formula (2) shall be used to calculate the touch current:

$$\text{TOUCH CURRENT(A)} = U_2 / 500 \quad (2)$$

None of the values measured in accordance with 11.7.104 shall exceed the relevant limits specified in 11.7.101.

11.7.106 Protection measures for the touch current exceeding 3,5 mA

For Class I d.c. EV charging station, if the test touch current exceeds 3,5 mA r.m.s, any of the following requirements shall be met. The touch current shall be measured under the fault condition with earthing conductor closed.

- The protective conductor shall have a cross-sectional area of at least 10 mm² Cu or 16 mm² Al, through its total run.
- Where the protective conductor has a cross-sectional area of less than 10 mm² Cu or 16 mm² Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm² Cu or 16 mm² Al.

NOTE This can require that the d.c. EV charging station has a separate terminal for a second protective conductor.

- Automatic disconnection of the supply in case of loss of continuity of the protective conductor.

A caution symbol  shall be placed on the outside of the d.c. EV charging station, visible to the user.

The minimum size of the protective earthing conductor shall comply with the local safety regulations, and shall be indicated in the installation manual.

11.12 Electromagnetic compatibility tests

Replacement:

The EMC requirements for d.c. EV charging stations are defined in IEC 61851-21-2.²

Addition:

11.101 Metering

If electric metering is provided, it shall comply with IEC 62052-11 and IEC 62053-21.

NOTE 1 National regulations for electric metering may be applied.

NOTE 2 Usage can be determined by other means e.g. measurement of time period used for charging.

Addition:

101 Specific requirements for d.c. EV charging station

NOTE In some countries, national regulations provide requirements on the enclosure of d.c. EV charging station: US, JP

101.1 General

101.1.1 Emergency switching

An emergency disconnection device may be installed to isolate the a.c. supply network (mains) from the d.c. electric vehicle charging station in case of risk of electric shock, fire or explosion. The disconnection device may be provided with a means to prevent accidental operation.

101.1.2 IP degrees for ingress of objects

The minimum IP degrees shall be as specified below:

- indoor : IP21,
- outdoor : IP44.

Compliance is checked with the accessory such as cable assembly and vehicle connector in the installed position.

NOTE For the d.c. EV charging station of stationary type, the test conditions can be defined in accordance with installation conditions.

101.1.3 Storage means of the cable assembly and vehicle connector

For d.c. EV charging stations, a storage means shall be provided for the cable assembly and vehicle connector when not in use.

The storage means provided for the vehicle connector shall be located at a height between 0,4 m and 1,5 m above ground level.

101.1.4 Stability

The d.c. electric vehicle charging station shall be installed as intended by the manufacturer's installation instructions. A force of 500 N shall be applied for 5 min in the horizontal direction

² Under consideration.

to the top of the d.c. electric vehicle charging station in each of the four directions or in the worst possible horizontal direction. There shall be neither deterioration of the d.c. electric vehicle charging station nor deformation at its summit greater than:

- 50 mm during the load application;
- 10 mm after the load application.

101.1.5 Protection against uncontrolled reverse power flow from vehicle

The d.c. EV charging station shall be equipped with a protective device against the uncontrolled reverse power flow from vehicle. Uncontrolled power flow does not include instantaneous reverse power flow, which may occur with closing of contactors within the tolerances and duration specified in Annexes AA, BB and CC.

101.2 Specific requirements for isolated systems

101.2.1 DC output

101.2.1.1 Rated outputs and maximum output power

The d.c. EV charging station may limit its maximum current under the given condition independent of the rated and demanded power.

The d.c. EV charging station shall be able to deliver d.c. power in the voltage range [$V_{\min}$, $V_{\max}$] and the regulated current range [$I_{\min}$, $I_{\max}$] within the limit of its maximum rated power [$P_{\max}$] at the ambient temperature $-5\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$ below 1 000 m above sea level. The d.c. EV charging station shall not exceed its maximum rated power, even if the maximum power requested by the EV is beyond the rated maximum power of DC charger. Outside this operating range the DC charger is allowed to de-rate the power or the current.

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

101.2.1.2 Output voltage and current tolerance

101.2.1.2.1 Output current regulation in CCC

The tolerance between the output current of the d.c. EV charging station compared to the required value sent by the electric vehicle shall be $\pm 2,5\text{ A}$ for the requirement below 50 A, and $\pm 5\%$ of the required value for 50 A or more.

101.2.1.2.2 Output voltage regulation in CVC

The tolerance between the output voltages of the d.c. EV charging station compared to the required value sent by the electric vehicle in steady state operation shall not be greater than 2 % for the maximum rated voltage of the d.c. EV charging station.

101.2.1.3 Control delay of charging current in CCC

The d.c. EV charging station shall control the output current within 1 s after the request from vehicle, with a current control accuracy specified in 101.2.1.2.1, and with a changing rate $dI_{\min}$ of 20 A/s or more.

If the vehicle requests a target current I_N , which shows deviation lower than or equal to 20 A compared to the base current value I_0 , the output current of d.c. EV charging station shall be within the tolerance limits given in 101.2.1.2.1 within a delay time of 1 s.

If the vehicle requests any target current I_N , which shows deviation higher than 20 A compared to the base current value I_0 , the output current of d.c. EV charging station shall be within the tolerance limits given in 101.2.1.2.1 within a delay time T_d as defined in Formula (3), and as shown in Figure 103.

$$T_d \leq \frac{|I_N - I_0|}{dI_{\min}} \quad \text{for } |I_N - I_0| \geq 20 \text{ A} \quad (3)$$

where

T_d is the control delay of charging current;

I_N is the value for the target current;

I_0 is the value for the base current, i.e. output current at the time of new request;

$dI_{\min}$ is the minimum current change rate.

$|I_N - I_0|$ gives the absolute value of the difference between I_N and I_0 .

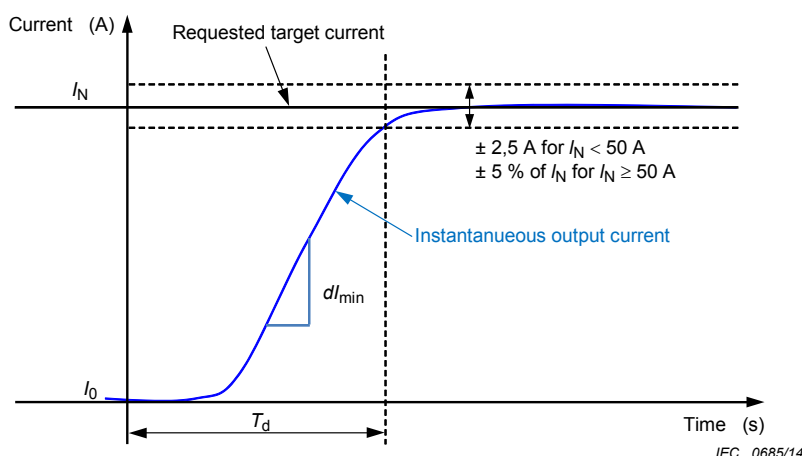


Figure 103 – Step response for constant value control

101.2.1.4 Descending rate of charging current

The d.c. EV charging station shall be able to reduce current with the descending rate of 100 A/s or more in normal operation.

For emergency shutdown and for fulfilling general requirements in 9.4, even much higher descending rates are necessary. For detailed values refer to Annexes AA, BB and CC.

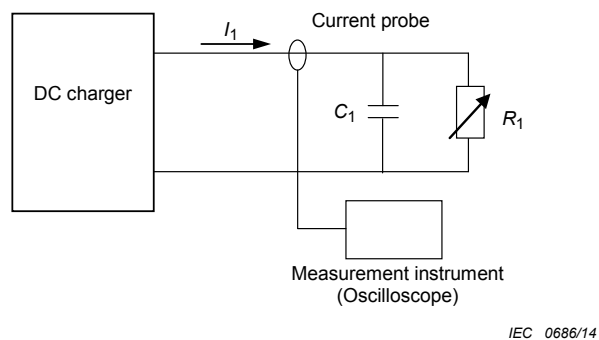
101.2.1.5 Periodic and random deviation (current ripple)

Current ripple of d.c. EV charging station during current regulation shall not exceed the limit as defined in Table 101. Measurement shall be made at maximum rated power and maximum rated current, or in the worst case where the output voltage and output current correspond theoretically to the maximum current ripple. The current ripple is not included in the tolerance defined in 101.2.1.2.1.

The measurement principle shown in Figure 104 shall be used.

Table 101 – Current ripple limit of d.c. EV charging station

Limit ^a	Frequency
1,5 A	below 10 Hz
6 A	below 5 000 Hz
9 A	below 150 kHz
^a difference between positive peak top and negative peak top at full scale output	

**Key** R_1 variable resistance C_1 value set to prevent internal dissipation of ripple current in d.c. EV charging station; (5 600 μ F or more) I_1 d.c. current (measuring current)**Figure 104 – Current ripple measurement equipment with capacitor****101.2.1.6 Periodic and random deviation (voltage ripple in CVC)**

For CVC, the maximum voltage deviation during pre-charge state and during charging of the vehicle/traction battery shall not exceed ± 5 % of the requested voltage. The maximum voltage ripple in normal operation shall not exceed ± 5 V. The maximum voltage slew rate in normal operation shall not exceed ± 20 V/ms.

For explanation of terms, see Figure 105.

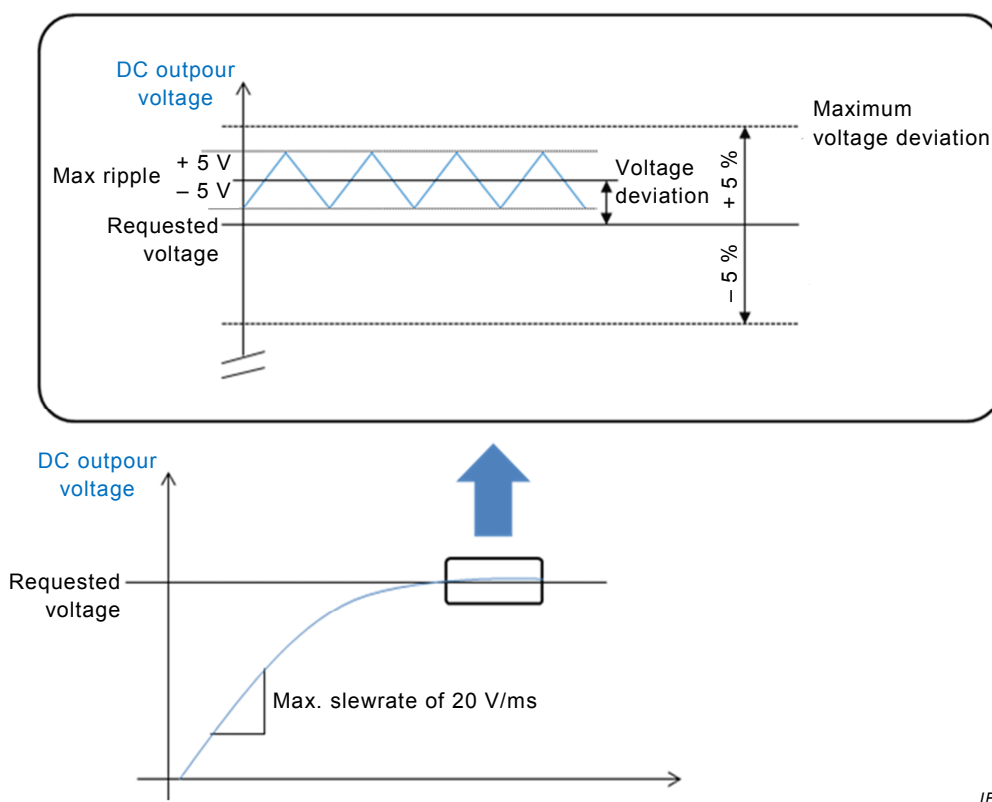


Figure 105 – Maximum ratings for voltage dynamics

For CVC, when the vehicle battery is not connected: under consideration.

101.2.1.7 Load dump

Worst case of load dump is a reduction of output current from 100 % nominal value to 0 %, e.g. caused by disconnecting the vehicle battery while other loads in the EV stay connected. In any case of load dump, voltage overshoot shall not exceed the limit specified for each system in Annexes AA, BB or CC.

Maximum slew rate of output voltage in case of load dump shall not exceed 250 V/ms.

101.2.2 Effective earth continuity between the enclosure and the external protective circuit

Exposed conductive part of d.c. EV charging station shall be connected to the terminal for the external protective conductor. The test shall be conducted in accordance with 10.5.2 in IEC 61439-1:2011 unless otherwise specified by national regulations.

101.3 Specific requirement for non-isolated systems

Under consideration

Addition:

102 Communication between EV and d.c. EV charging station

102.1 General

This clause provides the general requirements for the control communication function and the system between EV and d.c. EV charging station. The specific requirements of digital communication of charging control between off-board d.c. charging system and electric road vehicle are defined in IEC 61851-24.

EVs are equipped with propulsion batteries with different technologies and voltages. Accordingly, the charging process shall be managed by the vehicle in order to ensure the charging of different types of on-board energy storage systems.

EVs are equipped with VCCF for charging process management. The general-purpose d.c. EV charging stations shall have a means allowing the vehicles to control the charging parameters of d.c. EV charging station.

102.2 System configuration

The communication between the d.c. EV charging station and the vehicle can be established via basic communication and high level communications.

Key steps in the charging control process, such as start of charging and normal/emergency shutdown, shall be managed through the basic communication with signal exchange via the control pilot lines in d.c. EV charging system.

In addition to the basic communication, the d.c. EV charging station shall be equipped with digital communication means in order to exchange the control parameters for d.c. charging between the d.c. EV charging station and the vehicle through the high level communication. The following digital communication means are used by the systems defined in Annexes AA, BB and CC:

- a) control area network (CAN) over dedicated digital communication circuit according to ISO 11898-1, or
- b) power line communication (PLC) over control pilot circuit.

102.3 Basic communication

102.3.1 Interface

Typical interfaces of control pilot function on d.c. EV charging systems are specified in Annexes AA, BB and CC. Each system shall carry out control pilot function through the control pilot conductors and terminals specified in IEC 62196-3.

102.3.2 Charging state

Table 102 defines the charging state of d.c. EV charging station. The charging states show physical status of d.c. EV charging system. The d.c. EV charging station and the vehicle can exchange their charging state through the signal communication and the digital communication.

Table 102 – Charging state of d.c. EV charging station

State		Vehicle connected	Vehicle contactor	Charging possible	Description
DC-A	Not connected	No	Open	No	Vehicle unconnected
DC-B1	Initialization	Yes	Open	No	Vehicle connected / not ready to accept energy / communication not established / connector unlocked / vehicle contactor open
DC-B2		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector unlocked / vehicle contactor open
DC-B3		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector locked / vehicle contactor open / other supplemental processes not completed
DC-C	Energy transfer	Yes	Close	Yes	Vehicle connected / ready to accept energy / indoor charging area ventilation not required / communication established / connector locked / vehicle contactor close / other supplemental processes completed
DC-D		Yes	Close	Yes	Vehicle connected / ready to accept energy / indoor charging area ventilation required / communication established / connector locked / vehicle contactor close / other supplemental processes completed
DC-B'1	Shutdown	Yes	Close	Yes	Vehicle connected / charging finished / communication maintained / connector locked / vehicle contactor close
DC-B'2		Yes	Open	No	Vehicle connected / charging finished / communication maintained / connector locked / vehicle contactor open / other supplemental processes completed
DC-B'3		Yes	Open	No	Vehicle connected / charging finished / communication maintained / connector unlocked / vehicle contactor open
DC-B'4		Yes	Open	No	Vehicle connected / charging finished / communication finished / connector unlocked / vehicle contactor open
DC-E	Error	Yes	Open	No	DC charger disconnected from vehicle / DC charger disconnected from utility, DC charger loss of utility power or control pilot short to control pilot reference.
DC-F	Malfunction	Yes	Open	No	Other DC charger problem

NOTE The control pilot functions as specified in Table 102 can be achieved using PWM pilot control as described in Part 1 or any other system that provides the same results.

102.4 Digital communication

Digital communication is specified in IEC 61851-24.

102.5 Charging control process and state

102.5.1 General

Charging control process of general-purpose d.c. EV charging stations shall consist of the following three stages:

- process before the start of charging (initialization);
- process during charging (energy transfer);

- process of shutdown (shutdown).

The d.c. EV charging station and the vehicle shall synchronize control process with each other. The following signals and information shall be used for the synchronization:

- signals through the pilot wire circuit;
- parameters through the digital communication circuit;
- measurement values such as voltage and current level of the d.c. charging circuit.

The d.c. EV charging station and the vehicle shall preserve specified time constraints and control timings for ensuring smooth charging control and operation.

Charging control process as system action level is shown in Table 103. General sequence diagrams are specified in Annex AA, Annex BB, and Annex CC. Digital communication parameters, formats, and other communication requirements are specified in IEC 61851-24.

Table 103 – Charging control process of d.c. EV charging station at system action level

Charging control stage (process)		State	High level action ^a
Initialization	Handshaking	DC-A	Vehicle unconnected
		DC-B1	Connector plugged in
		DC-B1	Wake up of DCCCF and VCCF
		DC-B1	Communication data initialization
		DC-B1→DC-B2	Communication established, parameters exchanged, and compatibility checked
	Charge preparation	DC-B2→DC-B3	Connector locked
		DC-B3	Insulation test for d.c. power line
		DC-B3	Pre-charge (depending on the system architecture)
Energy transfer		DC-C or DC-D	Vehicle side contactors closed
		DC-C or DC-D	Charging by current demand (for CCC)
		DC-C or DC-D	Charging by voltage demand (for CVC)
		DC-C or DC-D→DC-B'1	Current suppression
		DC-C or DC-D	Renegotiate parameter limits (option)
Shutdown		DC-B'1	Zero current confirmed
		DC-B'1→DC-B'2	Welding detection (by vehicle, option)
		DC-B'2	Vehicle side contactors open
		DC-B'2	DC. power line voltage verification
		DC-B'3	Connector unlocked
		DC-B'4	End of charge at communication level
		DC-A	Connector unplugged

^a The order of actions does not refer to the procedure of charging control process.

^a The order of actions does not refer to the procedure of charging control process.

102.5.2 Description of the process before the start of charging (initialization)

In this process, the vehicle and the d.c. EV charging station exchange their operational limitations and relevant parameters for charging control. Messages, such as the voltage limit of vehicle battery, maximum charging current, etc. are also transferred to each other. Circuit voltage shall be measured for checking whether the batteries and the d.c. EV charging station are connected before the start of charging and whether the batteries and the d.c. EV charging

station are disconnected after the end of charging. The d.c. EV charging station shall not proceed with the next stage of charging process unless it verifies the compatibility with the vehicle. After compatibility check, the d.c. EV charging station shall conduct the insulation test between the d.c. power lines and the enclosures, including vehicle chassis. The vehicle connector shall be locked before the insulation test.

102.5.3 Description of the process during charging (energy transfer)

In this process, the vehicle continues to send a setting value of charging current or voltage to the d.c. EV charging station throughout the charging process. Either of the following two algorithms shall be taken.

a) CCC

- The vehicle battery can be charged using CCC with the vehicle as master and the d.c. EV charging station as slave.
- The d.c. EV charging station shall receive the charging current value the vehicle requested (command value), throughout the charging control process.
- The d.c. EV charging station shall set the command value as control target, and regulate the d.c. charging current.
- The command value from the vehicle shall be notified to the d.c. EV charging station at regular intervals according to the system requirements.
- The d.c. EV charging station shall regulate the d.c. charging current responding to the change of command value of the vehicle.

b) CVC

- The vehicle battery can be charged using CVC with the vehicle as master and the d.c. EV charging station as slave.
- The d.c. EV charging station shall receive the charging voltage value the vehicle requested (command value) throughout the charging process.
- The d.c. EV charging station shall set the command value as control target, and regulate the d.c. charging voltage.
- The command value from the vehicle shall be notified to the d.c. EV charging station at regular intervals according to the system requirements.
- The d.c. EV charging station shall regulate the d.c. charging voltage responding to the change of command value of the vehicle.

102.5.4 Description of process of shutdown

Normal shutdown shall occur when the vehicle battery capacity reaches a certain limit, or when the charging process is stopped by the user with a normal stop means. Emergency shutdown shall occur under a fault condition (see 6.4.3.114). After completion of charging session, the shutdown phase allows the vehicle and the d.c. EV charging station to return to the conditions so that the user can safely handle the charging cable and the vehicle connector. When the end of charging is notified by the vehicle, the d.c. EV charging station shall reduce the charge current to zero. The vehicle side contactors open at near zero current. After the inlet voltage reaches at the safety level, the vehicle connector can be unlocked by the d.c. EV charging station or the vehicle, and the user can remove the vehicle connector from the inlet (see 6.4.3.108). Minimum requirement on the safety voltage is specified in 7.2.3.1.

Annexes

The annexes of Part 1 apply with the following new annexes.

Annex AA (normative)

DC EV charging station of system A

AA.1 General

This annex provides the specific requirements for the d.c. EV charging stations of system A (hereinafter referred to as "system A station" or "station"), in addition to the general requirements as defined in the body text of this standard. System A is a regulated d.c. charging system using a dedicated CAN communication circuit for digital communication between a d.c. EV charging station and an EV for control of d.c. charging. The vehicle coupler of configuration AA as specified in IEC 62196-3 is applicable to system A. The specific requirements for digital communication and details of the communication actions and parameters of system A are defined in Annex A of IEC 61851-24:—.

The rated voltage of d.c. output for system A station is limited to 500 V d.c.

This system is suitable for the passenger vehicles and light trucks.

This annex defines the system with an a.c. input, but does not prohibit d.c. input. This annex includes information on the circuits on vehicle side.

More detailed information on system A is defined in JIS/TSD0007.

AA.2 Schematic and interface circuit diagram

The schematic block diagram of system A is given in Figure AA.1. The interface circuit between the station and the vehicle for charging control is shown in Figure AA.2. CAN-bus circuit is provided for digital communication with the vehicle. The definition and description of symbols and terms in Figure AA.1 and Figure AA.2 are given in Table AA.1. The values of the parameters for the interface circuit are given in Table AA.2.

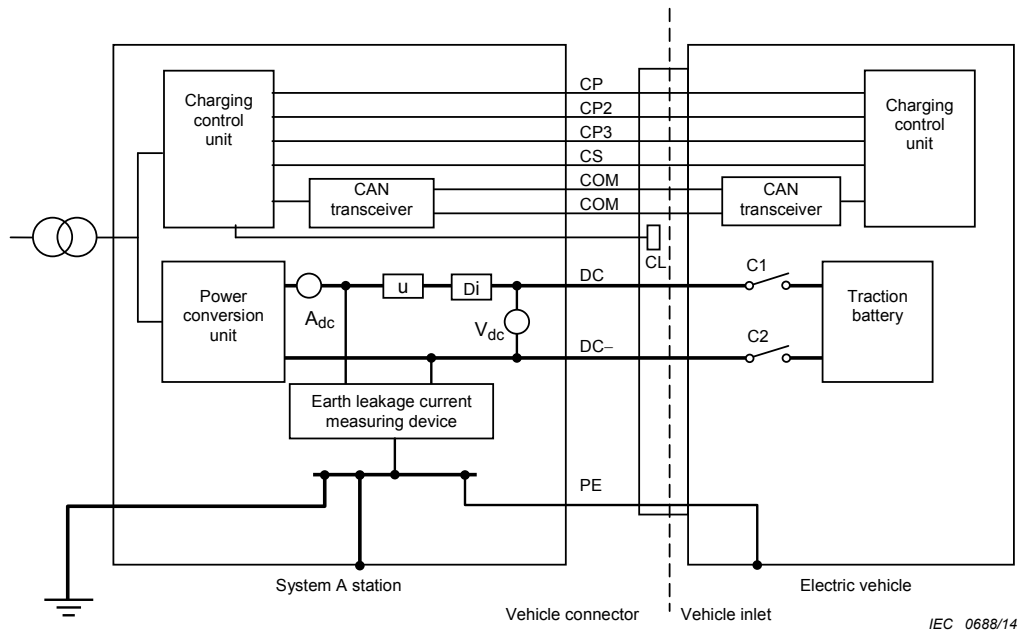
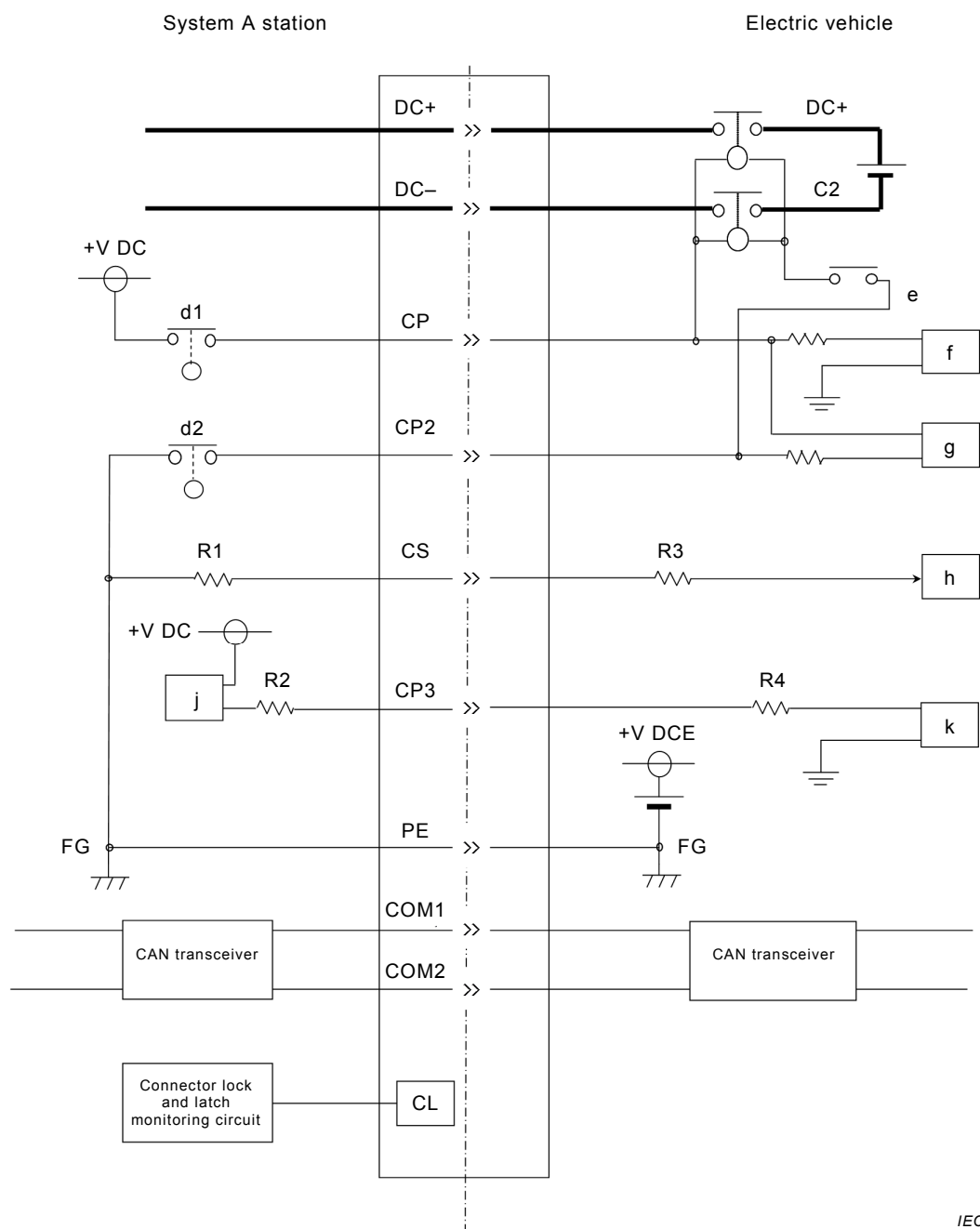


Figure AA.1 – Overall schematic of system A station and EV



IEC

Figure AA.2 – Interface circuit for charging control of system A station

Table AA.1 – Definition of symbols in Figure AA.1 and Figure AA.2

	Symbols	Definitions	Requirements
System A station	Di	Reverse-current-prevention device (e.g. diode: cathode on the vehicle side, anode on the station side)	AA.3.3
	d1	Switch on CP for controlling the charging start/stop signals from the station to the vehicle	AA.3.5, Clause AA.4
	d2	Switch on CP for controlling the charging start/stop signals from the station to the vehicle	AA.3.5, Clause AA.4
	j	Signal sensing device to detect vehicle ready/not ready to accept energy	AA.3.6
	V _{dc}	Voltage measurement device	AA.3.2, Clause AA.4
	A _{dc}	Current measurement device	Clause AA.4
	u	Short-circuit protection device (e.g. current limiting fuse)	AA.3.3
	R1	Resistor	Table AA.2
	R2	Resistor	Table AA.2
	+V DC	DC power supply to EV contactors	Table AA.2
Electric vehicle	C1,C2	Disconnection switch for d.c. power lines (EV contactors)	AA.3.5, AA.3.7, Clause AA.4
	e	Relay for turning on EV contactors	Clause AA.4
	f	Signal sensing device to detect the status of d1	Clause AA.4
	g	Signal sensing device to detect the status of d2	Clause AA.4
	h	Signal sensing device to detect connection / disconnection of vehicle coupler	Clause AA.4
	k	Switch to give the go ahead / stop to charge	Clause AA.4
	R3	Resistor	Table AA.2
	R4	Resistor	Table AA.2
	+V DCE	DC power supply in the vehicle	Table AA.2
Terminal and wire	DC+	DC power supply (positive)	AA.3.7, Clause AA.4
	DC-	DC power supply (negative)	AA.3.7, Clause AA.4
	CP	Control pilot which indicates the start/stop status of station	Clause AA. 2, AA.3.5, Clause AA.4
	CP2	Control pilot which indicates the start/stop status of station	Clause AA. 2, AA.3.5, Clause AA.4
	CS	Pilot wire which indicates the status of vehicle coupler connection	Table AA.2
	CP3	Control pilot which confirms that the vehicle is ready for charging	Clause AA. 2, AA.3.6, Clause AA.4
	COM1 COM2	Signal line pair for digital communication	Clause AA.4, Annex A of IEC 61851-24:—
	PE	Protective conductor between the station and EV for detecting the first d.c. earth fault	AA.3.1
Vehicle connector	CL	Connector latching and locking mechanism	AA.3.4

Table AA.2 – Parameters and values for interface circuit in Figure AA.2

System A station					
Terminal/ Wire	Parameters	Minimum value	Typical value	Maximum value	Unit
CP	+V DC	10,8	12,0	13,2	V
CS	Resistor R1	190	200	210	Ω
CP3	Resistor R2	950	1 000	1 050	Ω
CP	Load current of switch d1	2		2 000	mA
CP2	Load current of switch d2	2		2 000	mA
Electric vehicle					
CP	Load current (when d1 and d2 closing)	10		2 000	mA
CP2	Load current (when d1 and d2 closing)	10		2 000	mA
CS	Resistor R3	950	1 000	1 050	Ω
	+V DCE	8	12	16	V
CP3	Resistor R4	190	200	210	Ω

AA.3 Specific safety requirements

AA.3.1 Fault protection in the secondary circuit

AA.3.1.1 General

For fault protection in the secondary circuit, system A station shall have the following measures:

- reinforced isolating transformer;
- earth leakage current measurement using a grounding resistor between the d.c. power lines DC+/DC- and earth (enclosure and chassis);
- automatic disconnection of supply to d.c. power circuit at the first d.c. earth fault;
- charging cable consisting of line conductors that are individually insulated.

When PE forms part of a charging cable, the cross-sectional area of PE shall be determined by the formula in 543.1.2 of IEC 60364-5-54:2011.

Table AA.3 shows the principle of fault protection, in which case 1 is applicable to system A.

Table AA.3 – Principle of fault protection

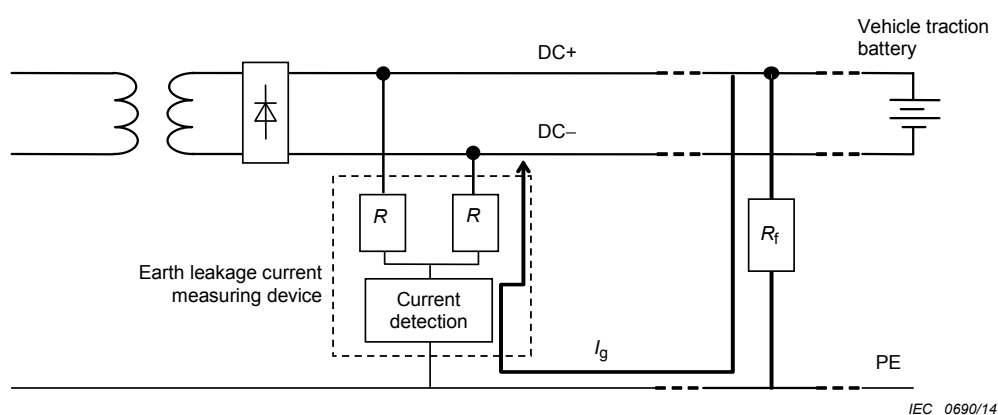
	Power supply in case of the first fault	Protection measure in case of the first fault	Protection against the secondary fault
Case 1	Not required	Automatic shutdown	Prohibition of operation at the first fault
Case 2	Required	- Detection and notice of the first fault using an insulation monitoring device - Recommendation for elimination of the first fault with the shortest practicable delay	- PE equivalent to TN ground required - Visible warning for system operator at the detection of symmetric fault

AA.3.1.2 Automatic disconnection and earth fault monitoring

System A station shall measure the earth leakage current between the secondary circuit and its enclosure, or between the secondary circuit and the vehicle chassis.

When an earth fault is detected during charging, the station shall reduce the d.c. output current to 5 A or less. Then, the switch d1 shall be open in order to prevent the vehicle to close EV contactor. The line-to-line voltage of d.c. output V_{dc} shall be reduced to less than 60 V. The automatic disconnection process shall be accomplished within 5 s from the detection of earth fault. Fault current detection principle and performance requirements are defined in Figure AA.3 and Table AA.4.

A method to detect a d.c. fault current is required for the first earth fault. System A station shall detect an earth fault current caused by the first fault in the secondary circuit as specified in Table AA.4.



Key

R_f insulation resistance between DC+/DC- and vehicle or enclosure at the first fault

R grounding resistor to detect and limit the first fault current

I_g earth leakage current at the first earth fault

Figure AA.3 – Failure detection principle by detection of d.c. leakage current

Table AA.4 – Requirements for earth fault monitoring

Item	Detection performance
Maximum detection time ^a	1 s or less
Nuisance trip prevention	Minimum response time shall be 0,2 s or more with continuous threshold monitoring
Sensitivity ^b	Sensitivity of earth leakage current measuring device and grounding resistor of 'R' shall be designed so that the body current of human at the first earth fault is within DC-2 zone in Figure 22 of IEC/TS 60479-1:2005.
Example Set-up condition 1: When the body current I_h exceeds DC-2 zone calculated by Formula (AA.1), a measurement device is designed to detect the deterioration of insulation resistance R_f as the first earth fault by measuring earth leakage current shown in Formula (AA.2). $I_h = V_{dc} \times (R + R_f) / (R \times R_f) \quad (\text{AA.1})$ where I_h is the body current V_{dc} is the line to line voltage of d.c. output circuit R is a grounding resistor R_f is an insulation resistance $I_g = V_{dc} / (R + 2 \times R_f) \quad (\text{AA.2})$ where I_g is the measuring current Set-up condition 2: The measurement device is designed to detect the body current within DC-2 zone, except the set-up condition 1.	
^a The detection time does not include shutdown time of d.c. output current.	
^b The actual body current may differ from the measured leakage current I_g , which should be taken into account when designing the station.	

AA.3.2 Voltage measurement of d.c. power line for vehicle connector unlock

According to 6.4.3.104, the vehicle connector shall not be unlocked when hazardous voltage is detected. To unlock the vehicle connector, the voltage of d.c. power line shall be measured at V_{dc} in Figure AA.1, and be confirmed to be within safe levels, i.e. 10 V or less.

AA.3.3 Prevention of the hazard due to vehicle battery short-circuit

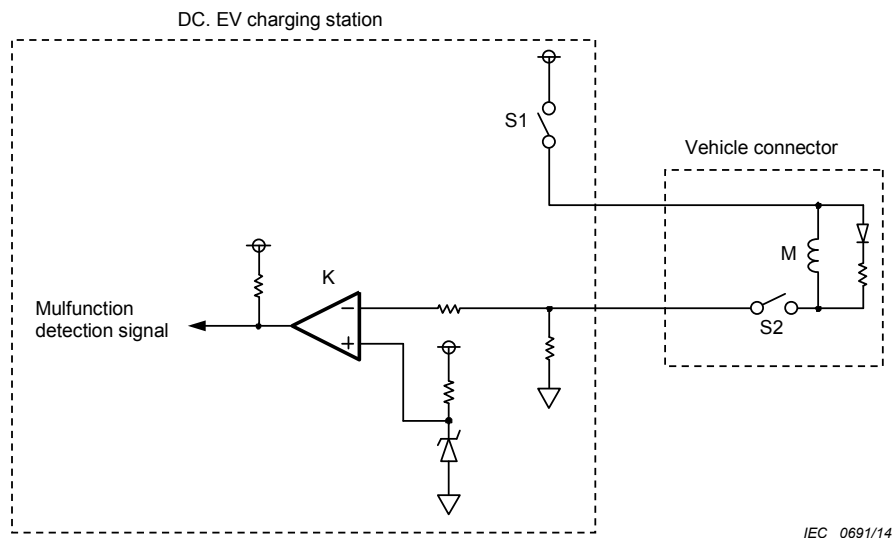
Overcurrent protection device, such as current-limiting fuse u , shall be provided in the output circuit of system A station in order to prevent the hazard due to short-circuit current of vehicle battery caused by the reverse connection of charging cable by mistake, i.e. when DC+/DC- on vehicle or station side are connected to DC-/DC+ of vehicle connector terminal by faulty maintenance. The overcurrent protection device shall have a current rating of 250 A or less, and be a quick-break type.

AA.3.4 Lock and latch monitoring for vehicle connector

The vehicle connector shall have a means of mechanical latching, electrical locking, and lock and latch monitoring.

In case of failure of mechanical latching or electrical locking of the vehicle connector, the station shall not energize the d.c. power lines connected to the vehicle connector. If the failure is detected during charging, the station shall reduce the d.c. output current to 5 A or less within 2 s. Then, the switch d1 shall open.

The vehicle connector shall have a means to provide system A station with information on anomaly detection in monitoring of latch and electrical locking. Figure AA.4 shows an example of a detection means in vehicle connector and system A station.



Key

- K comparator
- S1 switch
- S2 switch, interlocked with locking and latching
- M solenoid

Figure AA.4 – Example of vehicle connector latch and lock monitoring circuit

AA.3.5 Protection of EV contactor

In order to prevent the welding of EV contactor, switches d1 and d2 shall not open at current exceeding 5 A.

AA.3.6 Emergency shutdown at control pilot disconnection

If a control pilot is disconnected during charging, system A station shall decrease output current to 5 A or less within 30 ms. Detection may be made using CP, CP2 or CP3 as defined by the manufacturer.

AA.3.7 Turn on inrush current for vehicle circuit

Inrush current on d.c. power line of system A station shall not exceed 20 A at vehicle connector.

AA.3.8 Protection against overvoltage at the battery

System A station shall reduce the d.c. output current to 5 A or less of rated current within 3 s to prevent overvoltage at the battery, if output voltage exceeds maximum voltage limit sent by the vehicle.

AA.3.9 Load dump

In any case of load dump, voltage overshoot of d.c. output of the station shall not exceed 600 V.

AA.4 Charging process and communication between the d.c. EV charging station and the vehicle for charging control

AA.4.1 Communication measures

Communication between the station and the vehicle is carried out through the control pilots CP, CP2 and CP3, proximity circuit CS, and the digital communication circuits COM1 and COM2. CP and CP2 transmit signals such as "ready to charge" and "end of charge" from the station to the vehicle. CP3 is used to transmit instructions to start charging or shutdown, from the vehicle to the station. Numerical parameters in Annex A of IEC 61851-24:— such as output rating of station and maximum voltage of battery are exchanged through COM1 and COM2.

AA.4.2 Charging control process

AA.4.2.1 State transition diagram and sequence diagram

The charging process of system A shall conform to the state transition diagram as shown in Figure AA.5. Figure AA.6 gives the charging control sequence under normal conditions.

AA.4.2.2 Start of charging

When the charging process is initiated by system A station, d1 shall be closed. The switch d2 shall be open until the end of insulation test in AA.4.2.3.

AA.4.2.3 Insulation test before charging

The insulation test shall not start until the vehicle provides system A station with a permission signal through CP3, and permission parameters by digital communication as shown in Annex A of IEC 61851-24:— Before the insulation test, system A station shall inform the vehicle through digital communication that the vehicle connector is locked.

The insulation test shall be performed in accordance with 6.4.3.106 and as per the following procedure.

- a) Before the test, the station shall measure V_{dc} of d.c. power line and confirm that the EV contactors open. The voltage of d.c. power line, measured at V_{dc} , shall be 10 V or less. If the measured voltage exceeds 10 V, the charging process shall be shut down (see Figure AA.5).
- b) The voltage U that is applied to the d.c. power line shall be the maximum output voltage of the station.
- c) After the test, it shall be confirmed that the voltage at V_{dc} is 20 V or less. Then, the station shall inform the vehicle of the termination of test with closing d2 switch.

During the insulation test, the earth fault shall be monitored in accordance with AA.3.1.2.

AA.4.2.4 Energy transfer

System A shall continuously monitor the charging current value requested by the vehicle. The charging current shall be changed responding to the vehicle requested value, in accordance with CCC requirements in 101.2.1.2.1 and 101.2.1.3. The characteristics of charging current control shall meet Table AA.5 and Figure AA.8.

AA.4.2.5 Shutdown

In order to terminate the charging safely, system A station shall comply with the following procedure.

- a) The station shall notify the vehicle of start of shutdown process by digital communication.

- b) The station shall reduce the output current to 5 A or less.
- c) In normal conditions, switches d1 and d2 shall not be open until the welding detection of EV contactor by vehicle is finished.
- d) After d1 and d2 open, and before the vehicle connector unlocks, it shall be confirmed that the voltage at V_{dc} is 10 V or less.

AA.4.3 Measuring current and voltage

The accuracy of output measurement of system A shall be within the following values:

- current: $\pm (1,5\% \text{ of actual current} + 1) \text{ A}$;
- voltage: $\pm 5 \text{ V}$.

AA.5 Response to vehicle command on charge current

System A station shall supply d.c. current to the vehicle using CCC with the vehicle as the master and DC charger as the slave. Recommended specification for the charge current request from the vehicle and the response performance of system A station are given in Table AA.5 and Figure AA.7 for the vehicle, and in Table AA.6 and Figure AA.8 for system A station.

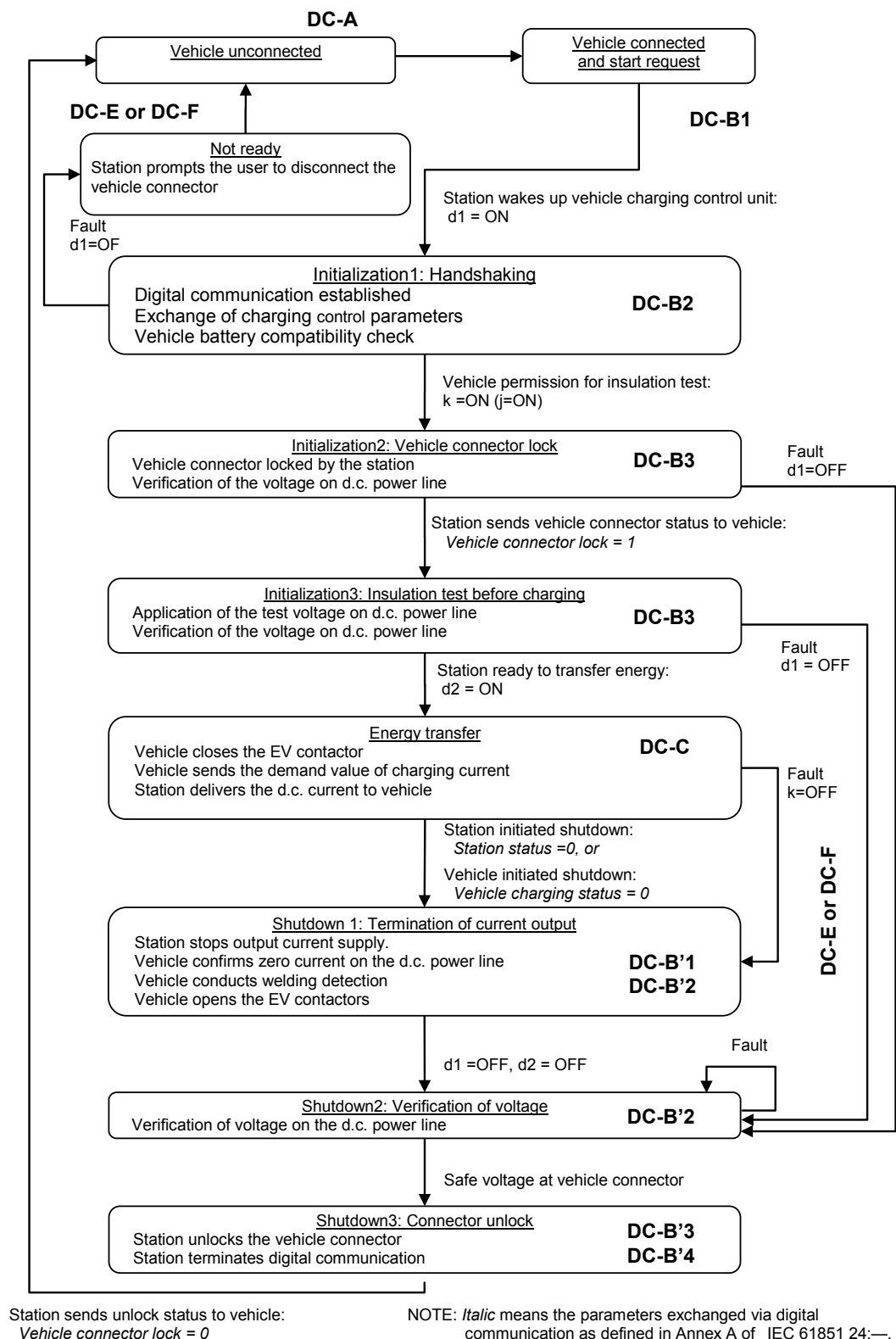
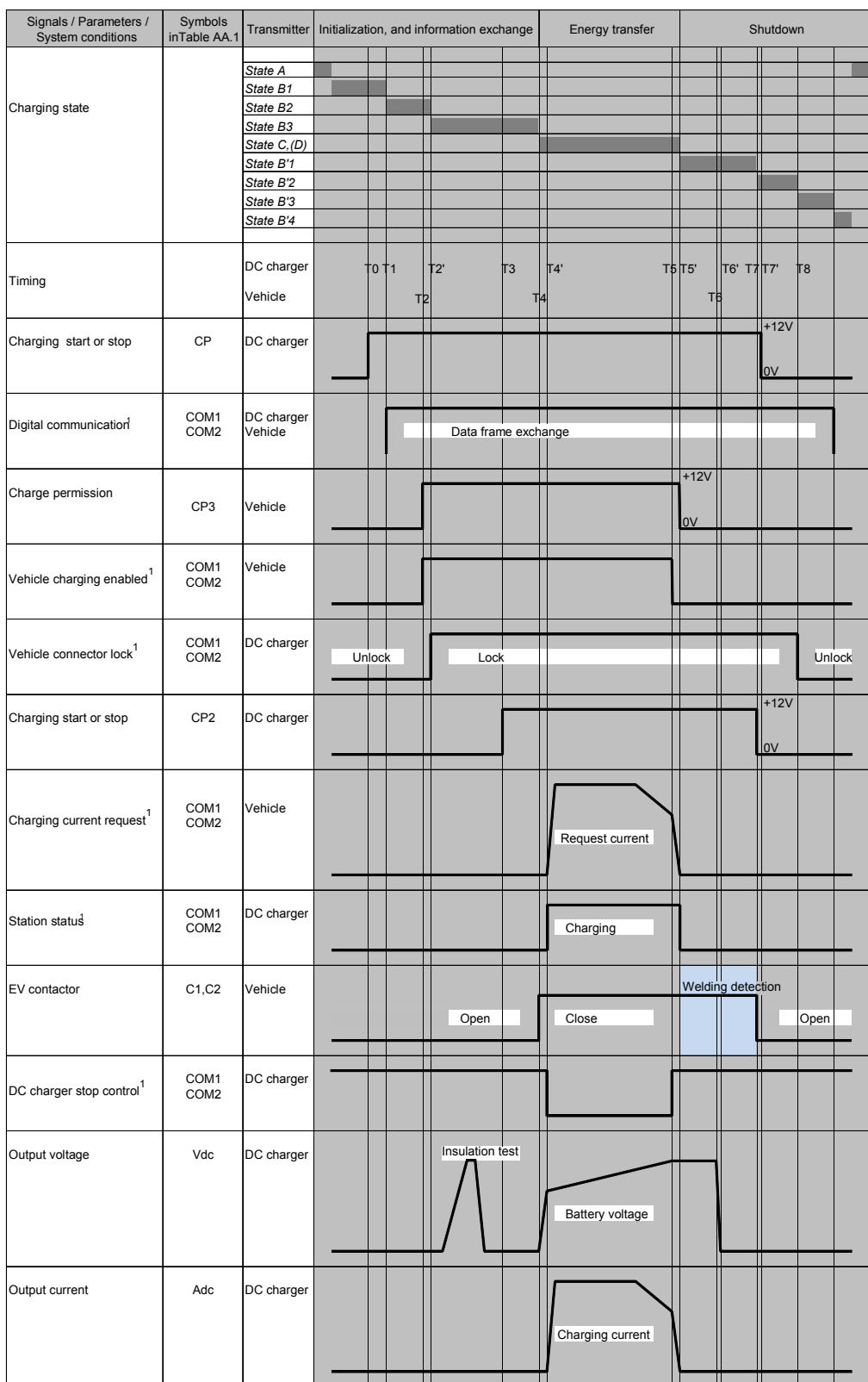


Figure AA.5 – State transition diagram of charging process for system A

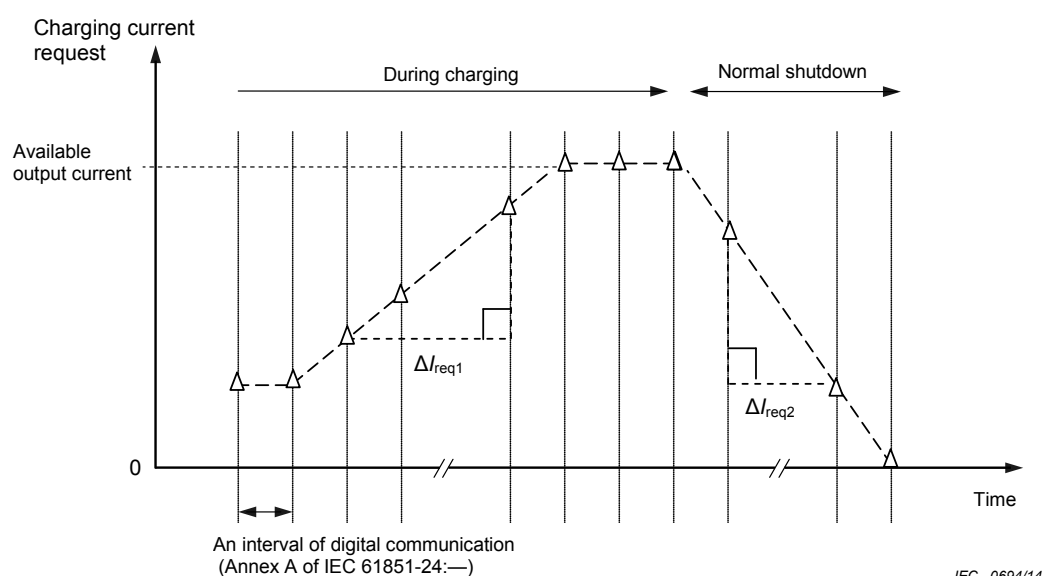


¹ See Annex A of IEC 61851-24:-

Figure AA.6 – Sequence diagram of system A

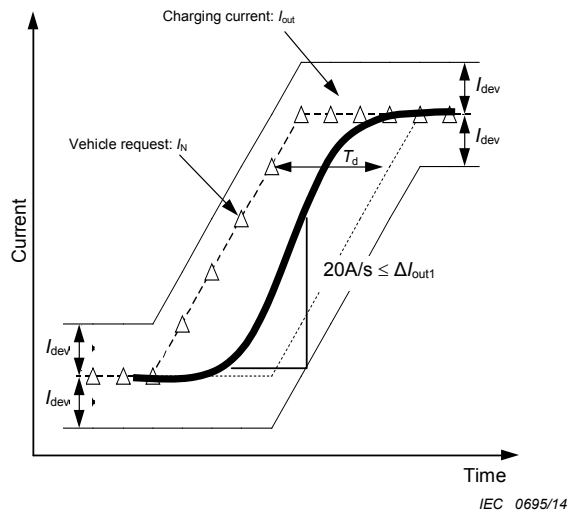
Table AA.5 – Recommended specification of charging current requested by the vehicle

Item	Symbol	Condition	Specification		
			Minimum	Maximum	Unit
Charging current request range	I_{req}		0	Available output current (IEC 61851-24:—, Annex A)	A
Rate of demand value change	ΔI_{req1}		–20	20	A/s
Descending speed at the time of shutdown	ΔI_{req2}	Normal shutdown	NA	200	A/s

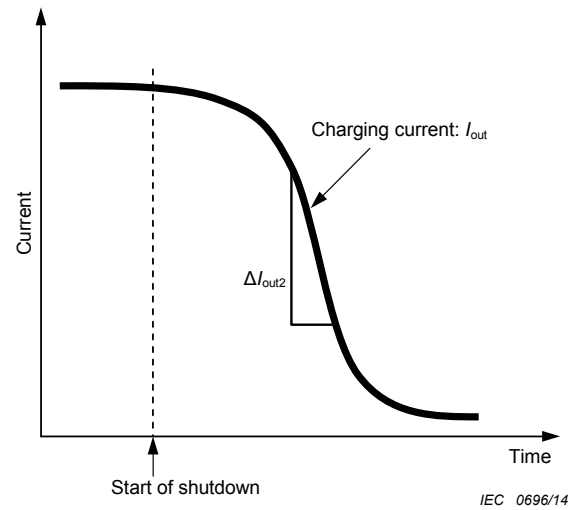
**Figure AA.7 – Charging current value requested by the vehicle****Table AA.6 – Requirements for the output response performance of d.c. EV charging station**

Item	Symbol	Condition	Specification		
			Minimum	Maximum	Unit
Output accuracy	I_{dev}	Charging current request: 0 A to 50 A	$I - 2,5 \text{ A}$	$I + 2,5 \text{ A}$	A
		Charging current request: 50 A to 125 A	$I \times 95 \%$	$I \times 105 \%$	
Control delay to vehicle request	T_d		-	1,0	s
Output response speed	ΔI_{out1}	At charging	20	-	A/s
Output current descending speed	ΔI_{out2}	Normal shutdown	100	200	
		Emergency shutdown	200 ^a	-	

^a In case of disconnection of CP, CP2 or CP3 during charging, faster termination of charging current is required. See AA.3.6.



a) Energy transfer



b) Shutdown

Figure AA.8 – Output response performance of d.c. EV charging station

Annex BB (normative)

DC EV charging station of system B

NOTE This annex is not applicable to Europe.

BB.1 General

This annex shows the specification of the d.c. EV charging station of system B using dedicated d.c. vehicle coupler of configuration BB as specified in IEC 62196-3.

BB.2 Basic solution to d.c. charging security system

Figure BB.1 shows the basic solution of d.c. charging system for charging mode 4, including DC charger control unit, resistors R1, R2, R3, R4 and R5, switch S, AC supply circuit contactor K0, isolating transformer T, AC/DC inverter, d.c. supply circuit contactors K1 and K2, low voltage auxiliary supply circuit contactors K3 and K4, charging circuit contactors K5 and K6, reverse-current-prevention device including diode K7 and R6, electrical interlock, and vehicle control unit. Vehicle control unit can be integrated in the BMS (battery management system). Resistors R2 and R3 are installed on the vehicle connector, and resistance R4 is installed in the vehicle inlet. Switch S is the inner switch of vehicle connector, and it will close when the vehicle connector and vehicle inlet are properly connected. During the whole charging process, DC charger control unit should detect and control the states of K1, K2, K3 and K4, while the vehicle control unit detects and controls K5 and K6. During the charging procedure, if the IMD (insulation monitoring device) detects that the insulation resistance drops below the setting value, the setting value shall be no less than a value calculated by $100 \Omega/V$ multiplied by the maximum output voltage rating of the d.c. EV charging station.

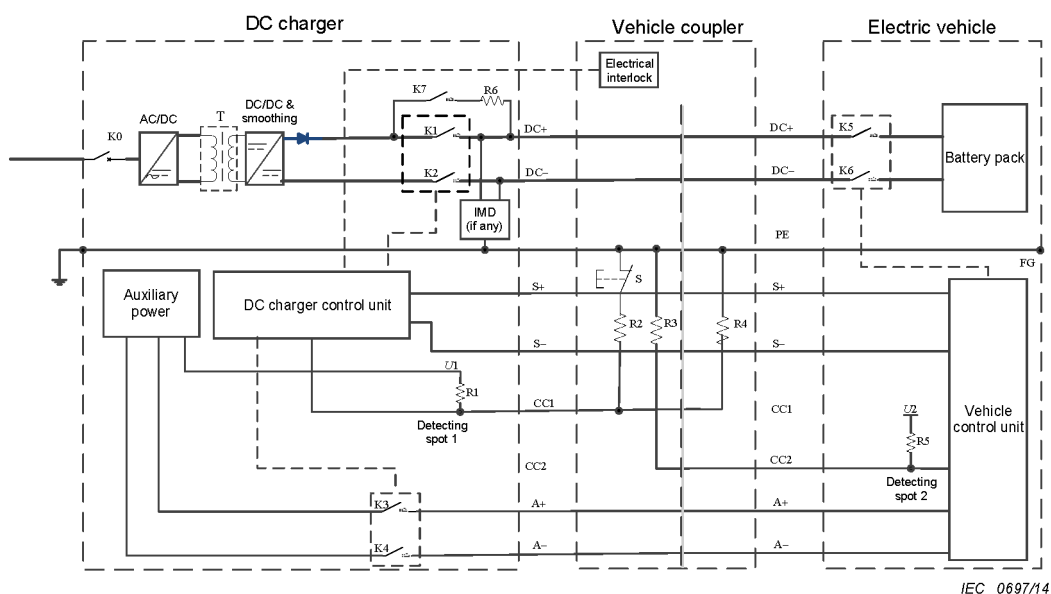


Figure BB.1 – Schematic diagram for basic solution for d.c. charging system

BB.3 The operation and control procedure of charging process

BB.3.1 Measurement accuracy of current and voltage

The accuracy of output measurement of system B shall be within the following values:

- voltage measurement: $\pm 0,5\%$
- current measurement:
 - $\pm 2\%$ of the actual current if the actual current is above ($>$) 50 A;
 - ± 1 A if the actual current is less than or equal to ($\leq$) 50 A.

BB.3.2 Proximity function

When the vehicle connector is inserted into the vehicle inlet, the proximity function will be active. Namely once the voltage of detecting point 2 changes from 12 V to 6 V, the vehicle confirms the presence of the vehicle connector.

BB.3.3 Confirmation of connection state of vehicle interface (state 3).

When the operator initiates the charging configuration for the d.c. EV charging station, the DC charger control unit can determine whether the vehicle connector is properly connected to the vehicle inlet by the voltage measurement of detecting point 1. For example, if the voltage of detecting point 1 is 4 V, it can be determined that the vehicle interface is properly connected. When the operator completes the human-machine interaction setup and the d.c. EV charging station is properly connected, the DC charger control unit retains electrical interlock. The releasing of electrical interlock cannot be achieved unless the following three conditions are fully met:

- charging terminates (there is no charging current output);
- K1 – K6 are all disconnected;
- unlock command is received from operator.

BB.3.4 DC charger self detection is finished (state 4)

After the vehicle interface is properly connected, if the DC charger self detection (including insulation monitoring) is finished, close K3 and K4 to initiate low voltage auxiliary supply circuit. Meanwhile “Charger identification broadcast message” is sent periodically. After the energy is transferred to the low voltage supply power circuit by DC charger, the EV vehicle control unit determines whether the vehicle interface is properly connected by the voltage measurement of detecting point 2. If the voltage of detecting point 2 is 6 V, then the vehicle control unit begins to send “vehicle control unit (or battery management system) identification broadcast message” periodically. The signal can be considered as one of the trigger conditions of non-driving state.

BB.3.5 Charger ready (state 5)

After handshaking and configuration for the vehicle control unit and the DC charger control unit is finished by communication, the vehicle control unit closes K5 and K6 to energize charging supply output circuit; and the DC charger control unit closes K1 and K2 to energize the d.c. power supply circuit.

BB.3.6 Charging stage (state 5)

During the whole charging process, the vehicle control unit controls the charging process by sending the battery charge level requirements to the DC charger control unit. The DC charger control unit adjusts the charging voltage and current to ensure normal operation of charging procedure according to the battery charge level requirements. In addition, the vehicle control unit and the DC charger control unit send charging status to each other