भारतीय मानक
Indian Standard

IS 17017 (Part 31) : 2024

विधुत वाहन प्रवाहकीय चार्जिंग प्रणाली

भाग 31 ए.सी. या डी.सी. ईवी आपूर्ति उपकरण जहाँ सुरक्षा विद्युत पृथक्करण पर निर्भरता

Electric Vehicle Conductive Charging System

Part 31 a.c. or d.c. Ev Supply Equipment for Where Protection Relies on Electrical Separation

ICS 43.120

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FOREWORD

This Indian Standard (Part 31) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrotechnology in Mobility Sectional Committee had been approved by the Electrotechnical Division Council.

This standard (Part 31) is part of the series of standards which covers the mechanical, electrical and performance requirements for dedicated plugs, socket outlets, vehicle connectors and vehicle inlets for interfacing between such dedicated charging equipment and the electric vehicle.

This standard is to be read in conjunction with IS 17017 (Part 2/Sec 1) : 2020.

The cross references of IEC have been modified to refer to Indian Standards whenever available. Where corresponding Indian Standards are not available, the IEC references have been retained. The committee has decided that these IEC standards are suitable to be used till equivalent/corresponding Indian Standards are published.

The composition of the Committee responsible for formulation of this standard is given in Annex H.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding of numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standards

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM

PART 31 a.c. OR d.c. EV SUPPLY EQUIPMENT FOR WHERE PROTECTION RELIES ON ELECTRICAL SEPARATION

1 SCOPE

1.1 This part of IS 17017 (Part 31), applies to electric road vehicle (EV) supply equipment for charging electric road vehicles, with a rated supply voltage up to 480 V a.c. or up to 600 V d.c. and a rated output voltage in case of a.c. not exceeding 240 V a.c. and output current not exceeding 32 A a.c. and in case of d.c. not exceeding 120 V d.c. and output current not exceeding 100 A d.c.

1.2 This standard provides the requirements for a.c. and/or d.c. EV supply equipment where the secondary circuit is protected from the primary circuit by electrical separation.

1.3 This standard also applies to EV supply equipment supplied from on-site storage systems (for example, buffer batteries and Inverter power supplies).

1.4 The aspects covered in this standard include:

a) The characteristics and operating conditions of the EV supply equipment;

b) The specification of the connection between the EV supply equipment and the EV; and

c) The requirements for electrical safety EV supply equipment.

Additional requirements may apply to equipment designed for specific environments or conditions, for example:

a) EV supply equipment located in hazardous areas where flammable gas or vapour and/or combustible materials, fuels or other combustible, or explosive materials are present;

b) EV supply equipment designed to be installed at an altitude of more than 2 000 m; and

c) EV supply equipment intended to be used on board on ships.

1.5 Requirements for electrical devices and components used in EV supply equipment are not included in this standard and are covered by their specific product standards.

1.6 Requirements for bi-directional power flow are not covered in this standard.

1.7 This standard does not apply to:

a) Safety aspects related to maintenance;

b) Charging of trolley buses, rail vehicles, industrial trucks and vehicles designed primarily for use off-road;

c) Equipment on the EV;

d) EMC requirements for equipment on the EV while connected, which are covered in IS 17017 (Part 21/Sec 1);

e) Charging RESS off board of the EV; and

f) Bi-directional energy transfer.

2 REFERENCES

The standards listed in Annex A contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

3 TERMINOLOGY

For the purposes of this document, the following terms and definitions shall apply in addition to IS 17017 (Part 1).

3.1 Electric Supply Equipment — This clause of IS 17017 (Part 1) is applicable except as follows:

3.1.1 *a.c./d.c. EV Supply Equipment* — EV supply equipment that supplies alternating current or direct current to an EV.

3.2 Insulation

3.2.1 *Electrical Separation* — Protective measure in which hazardous-live-parts are insulated from all other electric circuits and parts, from local earth and from touch.

3.3 Functions

3.3.1 *Normal Start-Up Sequence* — Beginning of an energy transfer sequence with the commands and parameters that are used to transfer energy to an EV when no error condition arises during the energy transfer sequence.

3.3.2 *Normal Shutdown* — Termination of the energy transfer process initiated by the user, by the EV or by the a.c./and/or d.c. EV supply equipment, and not caused by a failure.

3.3.3 *Error Shutdown* — Termination of the energy transfer process caused by a failure detected by the a.c. and/or d.c. EV supply equipment or the EV.

3.3.4 *Emergency Shutdown* —Termination of the energy transfer process caused by a failure detected by the a.c. and/or d.c. EV supply equipment or the EV that may present a safety hazard.

3.3.5 *Control Pilot Wire* — Insulated wire incorporated in a cable assembly which is part of the control pilot circuit.

3.3.6 *Digital Communication* — Digitally encoded information exchanged between a.c. and/or d.c. EV supply equipment and an EV, as well as the method by which it is exchanged.

3.3.7 *Signal* — Data element that is communicated between a.c. and/or d.c. EV supply equipment and an EV using any means other than digital communication.

3.3.8 *Device under Test* — DUT-sample of a.c. and/or d.c. EV supply equipment that is submitted for testing.

3.4 General Terms

3.4.1 *Available a.c. Output Power* — Maximum a.c. output power that the a.c. EV supply equipment can supply.

3.4.2 *Available d.c. Output Power* — Maximum d.c. output power that the d.c. EV supply equipment can supply.

3.4.3 *Available a.c. Output Power Parameter* — Parameter transmitted to the EV indicating the available a.c. output power.

3.4.4 *Available d.c. Output Power Parameter* — Parameter transmitted to the EV indicating the available d.c. output power.

3.4.5 a.c. *Output Current* — a.c. current supplied to the EV by the EV supply equipment.

3.4.6 *d.c. Output Current — d.c.* current supplied to the EV by the EV supply equipment.

3.4.7 *Available a.c. Output Current* — Value of the highest a.c. current that the EV supply equipment can supply to the EV at a given time.

3.4.8 *Available d.c. Output Current* — Value of the highest d.c. current that the EV supply equipment can supply to the EV at a given time.

3.4.9 *Available a.c. Output Current Parameter* — Parameter sent by the EV supply equipment to the vehicle that indicates the highest current that can be supplied to the EV.

3.4.10 *Available d.c. Output Current Parameter* — Parameter sent by the EV supply equipment to the vehicle that indicates the highest d.c. current that can be supplied to the EV.

3.4.11 *Rated a.c. Output Current* — Output current assigned to the a.c. EV supply equipment by the manufacturer under normal operating conditions.

3.4.12 *Rated d.c. Output Current* — Output current assigned to the d.c. EV supply equipment by the manufacturer under normal operating conditions.

3.4.13 *Requested a.c. Output Current* — Value of the a.c. output current that is requested by the EV.

3.4.14 *Requested d.c. Output Current* — Value of the d.c. output current that is requested by the EV.

3.4.15 *Requested a.c. Output Current Parameter* — Parameter sent by the EV to the EV supply equipment indicating the requested a.c. output current.

3.4.16 *Requested d.c. Output Current Parameter* — Parameter sent by the EV to the EV supply equipment indicating the requested d.c. output current.

3.4.17 *d.c. Output Voltage* — Voltage present between the d.c.+ and d.c.– terminals at the vehicle connector.

3.4.18 *Rated d.c. Output Voltage* — Output voltage assigned to the EV supply equipment by the manufacturer.

3.4.19 *Rated d.c. Output Voltage Parameter* — Parameter sent by the EV supply equipment to indicate the rated d.c. output voltage.

3.4.20 *d.c. Output Voltage Target Parameter* — Value sent by the EV to the EV supply equipment that indicates the requested value of the d.c. output voltage.

3.4.21 *d.c. Output Voltage Limit Parameter* — Value sent by the EV to the EV supply equipment that indicates the allowable d.c. output voltage.

3.4.22 *a.c. Output Voltage Parameter* — Parameter sent by the EV supply equipment to indicate the maximum and minimum a.c. output voltage parameters.

3.4.23 *a.c. Output Voltage* — Voltage present between the line (L) and neutral (N) terminals at the vehicle connector.

4 GENERAL REQUIREMENTS

This clause of IS 17017 (Part 1) is applicable.

5 CLASSIFICATION

This clause of IS 17017 (Part 1) is applicable, except as follows:

5.1 Replacement

Characteristics of power supply output:

The EV supply equipment shall be classified according to the type of current the EV supply equipment delivers:

a) a.c. EV supply equipment;
b) d.c. EV supply equipment; and
c) a.c. or d.c. EV supply equipment.

5.2 Protection Against Electric Shock

Clause **5.6** of IS 17017 (Part 1) is not applicable.

6 CHARGING MODES AND FUNCTIONS

This clause of IS 17017 (Part 1) is applicable, except as follows:

6.1 Replacement

General **6** describes the functions for energy transfer to EVs.

6.2 Charging Modes

Not applicable

6.3. Functions Provided in Mode 2, 3 and 4

Clause **6.3** of IS 17017 (Part 1) is replaced with **6.4** and **6.5** of this standard.

6.4 Addition

Mandatory functions for d.c. EV supply equipment.

6.4.1 *General*

The d.c. EV supply equipment shall supply a d.c. output current to the EV in accordance with the requested d.c. output current parameter from the EV, subject to the requirements of the mandatory functions as indicated below.

NOTE — The d.c. EV supply equipment acts as a slave to the EV. Further details are given in Annex B, Annex C and Annex F. Values, timing and tolerances for the d.c. output current and the d.c. output voltages shall be tested in accordance with Annex C.

The following functions shall be provided by the d.c. EV supply equipment:

a) verification that the EV is properly connected to the d.c. EV supply equipment in accordance with **6.4.2**;
b) verification of the latching of the vehicle coupler in accordance with **6.4.3**;
c) latching and unlatching of the vehicle coupler in accordance with **6.4.4**;
d) communication with the vehicle in accordance with **6.4.5**;
e) monitoring of the continuity of the control pilot circuit in accordance with **6.4.6**;
f) verification function before energy transfer in accordance with **6.4.7**;
g) energization and control of the power supply to the EV in accordance with **6.4.8**;
h) protection against overvoltage in accordance with **6.4.9**;
j) de-energization of the power supply to the EV in accordance with **6.4.10**; and
k) shutdown of d.c. EV supply equipment in accordance with **6.4.10.2**, **6.4.10.3**, **6.4.10.4**.

Values, timing and tolerances for the d.c. output current and the d.c. output voltages shall be tested in accordance with Annex C.

6.4.2 *Verification that the EV is Properly Connected to the d.c. EV Supply Equipment*

The d.c. EV supply equipment shall determine that the EV is properly connected to the d.c. EV supply equipment. Proper connection is assumed when the continuity of the control pilot circuit is detected. Compliance is checked in accordance with **E-3.1**.

6.4.3 *Verification of the Latching of the Vehicle Coupler*

The d.c. EV supply equipment shall determine that the vehicle connector is properly latched to the vehicle inlet.

The d.c. EV supply equipment shall not energize the conductors in the cable assembly when the vehicle connector is not latched to a vehicle inlet.

The d.c. EV supply equipment shall enter into an emergency shutdown if the vehicle connector is disconnected from the vehicle inlet while under power.

Compliance is checked in accordance with **E-3.8.6** (emergency shutdown).

6.4.4 *Latching and Unlatching of the Vehicle Coupler*

A mechanical or electromechanical means shall be provided to prevent intentional and unintentional disconnection under load of the vehicle connector according to IS 17017 (Part 2/Sec 7). Compliance is checked by inspection.

6.4.5 Com*munication with the Vehicle in Accordance with* **6.4.5**

6.4.5.1 *General*

Digital communication shall be established between the EV and the d.c. EV supply equipment to validate and control the energy transfer.

The d.c. EV supply equipment shall be able to receive and interpret all mandatory digital communication data as described in Annex G.

Compliance is checked in accordance by **E-3**.

The vehicle connector shall not be energized until the compatibility assessment is successfully completed in accordance with **6.4.7.2**. Compliance is checked by the test in Annex E applying the messages defined in Table 15 and Table 16 of Annex G

6.4.5.2 *Available d.c. output current parameter*

The EV supply equipment shall inform the EV of the value of the available d.c. output current that can be provided by the EV supply equipment.

The value may be changed and retransmitted during energy transfer, to adapt to power limitations, (for example, for load management), without exceeding the rated d.c. output current.

The d.c. EV supply equipment shall limit the d.c. output current to the available output current parameter or interrupt the energy supply if the d.c. output current drawn by the EV exceeds the available d.c. output current parameter. Compliance is checked in accordance with **E-3.7** and **E-3.8**.

6.4.5.3 *Available d.c. output power parameter*

A means shall be provided to inform the EV on the available d.c. output power of the d.c. EV supply equipment. The d.c. EV supply equipment may decrease the d.c. output current if the power demand exceeds this value. Compliance is checked in accordance with **E-3.7**.

NOTE — Available d.c. output power is indicated before the beginning of energy transfer. Dynamic power limitation due to the a.c. supply network limitations is an option that could modify the available d.c. output power during energy transfer on some d.c. EV supply equipment (*see* **EE-5**).

6.4.5.4 *d.c. output voltage target parameter and d.c. output voltage limit parameter*

The d.c. EV supply equipment shall compare the d.c. output voltage with the values of the d.c. output voltage target parameter and the d.c. output voltage limit parameter received from the EV, and with the rated d.c. output voltage. Shutdown conditions are in accordance with **6.4.10** if one of these values is exceeded. Timing and tolerances that are applicable are indicated in Annex C.

NOTE — The values of the d.c. output voltage target parameter and the d.c. output voltage limit parameter are set before the beginning of the energy transfer. They can be modified during energy transfer.

6.4.5.5 *Monitoring of the energy transfer requirements of the EV and adjustment of energy supply conditions*

A means shall be provided to continuously monitor the data transmitted by the EV and to adjust the d.c. output current and/or d.c. output voltage and all associated parameters.

The d.c. EV supply equipment shall initiate an error shutdown if valid data is not received for more than 1 s. An energy transfer cycle can be reinitiated by the EV after such a shutdown.

The d.c. EV supply equipment shall be able to deliver d.c. output power up to the rated d.c. output voltage and up to the rated d.c. output current within the limit of its rated d.c. output power at the ambient temperature 0 °C to + 55 °C below 1 000 m above sea level. The d.c. EV supply equipment shall not exceed its available d.c. output power, even if the power requested by the EV is higher than the available d.c. output power. Outside this operating range the d.c. EV supply equipment is allowed to reduce the power.

NOTE — Tolerances and timing for the d.c. output current are given in Annex C. Compliance is checked in accordance with **E-3.7**.

6.4.6 *Monitoring of the Continuity of the Control Pilot Circuit*

The EV supply equipment shall monitor the continuity of the control pilot circuit. The EV supply equipment shall initiate an emergency shutdown on detection of interruption of the control pilot circuit. Re-initialisation of the complete energy transfer procedure according to **E-3.5** shall be required in order to restart the energy transfer cycle. Compliance is checked in accordance with **E-3.5** and **E-3.8.6**.

6.4.7 *Verification Function before d.c. Energy Transfer*

6.4.7.1 *General verification*

The verification function is carried out when the vehicle connector has been fully inserted, latched and the control pilot circuit verified (*see* **E-3.5** and **F-1.2**), and before energy is supplied to the EV.

6.4.7.2 *Compatibility assessment before energy transfer*

The d.c. EV supply equipment shall complete a compatibility assessment with the EV before starting the energy transfer cycle. The check shall include, at least the elements mentioned from **6.4.7.2.1** to **6.4.7.2.5**.

NOTE — Energy transfer shall only proceed if the compatibility assessment is completed correctly. Compliance is checked in accordance with **E-3.3** applying the messages defined in Table 15 and Table 16

6.4.7.2.1 *Reception of d.c. energy transfer requirements from the EV*:

a) d.c. output voltage target parameter; and
b) d.c. output voltage limit parameter.

6.4.7.2.2 Validation by the d.c. EV supply equipment of information received from the EV.

6.4.7.2.2 *Transmission of d.c. EV supply equipment energy transfer parameters*:

a) available d.c. output current;
b) rated d.c. output voltage; and
c) available d.c. output power.

6.4.7.2.4 Transmission by d.c. EV supply equipment of the confirmed d.c. output voltage limit parameter

6.4.7.2.5 Reception of validation information transmitted by the EV indicating that the information is accepted. Energy transfer shall only proceed if the compatibility assessment is completed correctly.

Compliance is checked in accordance with **E-3.3** applying the messages defined in Table 15 and Table 16

6.4.7.3 *Verification of the absence of a short-circuit on the cable assembly*

With the EV connected to the d.c. EV supply equipment and before the beginning of energy transfer from the d.c. EV supply equipment to EV the d.c. EV supply equipment shall have a means to check for a short circuit between d.c. + and d.c. - of the output circuit, the cable and vehicle coupler. Compliance is checked in accordance with **E-3.4**.

6.4.8 *Energization and Control of the Power Supply to the EV*

The vehicle connector shall not be energised unless energy exchange has been allowed by both the control pilot function and digital communication.

Compliance is checked in accordance with **E-3.5**.

The d.c. output current and the d.c. output voltage of the d.c. EV supply equipment shall not exceed the values of the parameters transmitted by the EV.

Compliance is checked in accordance with **E-3.6** and **E-3.8**

Requirements on the rate change of current, timing and tolerance are given in Annex C.

6.4.8 *Protection against Overvoltage*

The d.c. output voltage of the d.c. EV supply equipment shall not be greater than + 2 percent of the d.c. output voltage limit parameter

The d.c. EV supply equipment shall perform an emergency shutdown if the measured d.c. output voltage exceeds for more than 2 s the d.c. output voltage limit parameter sent by the EV by 1.5 V or 2 percent, whichever is the greater or exceeds 150 V for more than 30 ms.

The d.c. EV supply equipment shall perform an error shutdown if the d.c. output voltage exceeds the d.c. output voltage target parameter sent by the EV by 1 percent for 1 s

Compliance is checked in accordance with **E-3.7** and **E-3.8**.

6.4.10 *De-Energization of the Power Supply to the EV*

6.4.10.1 *General requirement de-energization of the power supply to the EV*

Shutdown of d.c. EV supply equipment in accordance with **6.4.10.2**, **6.4.10.3** and **6.4.10.4**

If the signal status from the EV control energy transfer function no longer allows energization, the power supply to the EV shall be interrupted but the control pilot circuit may remain in operation.

Three shutdown procedures are possible:

a) normal shutdown;

b) error shutdown; and

c) emergency shutdown.

The d.c. EV supply equipment shall have a means to allow the user to initiate normal or emergency shutdown.

Compliance is checked by inspection.

6.4.10.2 *Normal shut down*

The d.c. EV supply equipment shall stop energy transfer by controlled interruption of d.c. output current to the EV, where d.c. output current descends with a controlled slope under the control of the EV and the d.c. EV supply equipment.

The data exchange and protocol are indicated in Annex F.

Table 1 shows events and reducing conditions for normal shutdown. Compliance is tested in accordance with **E-3.8.4**.

6.4.10.3 *Error shut down*

The d.c. EV supply equipment shall stop the energy transfer by controlled interruption of the d.c. output current to the EV, where the d.c. output current descends with a controlled slope, after the error shutdown is triggered by the d.c. EV supply equipment or by a message from the EV. Table 2 indicates the main events and reducing conditions for error shutdown.

Compliance is tested in accordance with **E-3.8.5**.

6.4.10.4 *Emergency shut down*

The d.c. EV supply equipment shall stop power transfer within 30 ms after the emergency shutdown was triggered. The d.c. output voltage shall fall (between d.c.+ and d.c. −) ≤ 60 V d.c. within 1 s after the emergency shutdown was triggered.

The emergency shutdown shall be initiated by:

a) the voltage of the control pilot circuit < 4.0 V d.c.;

b) disconnection of vehicle connector under load; and

c) the d.c. output voltage exceeds d.c. output voltage limit sent by the EV or exceeds 150 V d.c. for more than 30 ms, as described in **6.4.9**; and

d) reception of emergency shutdown signal from EV or initiated by the user.

The d.c. output voltage of the d.c. EV supply equipment shall not be greater than + 2 percent of the rated d.c. output voltage.

Compliance is tested in accordance with **E-3.8.6**.

Table 1 Normal Shutdown Events and Conditions

(*Clauses* 6.4.10.2 *and G*-1)

Sl No.	Event	Particular	Time for Starting to Reduce d.c. Output Current	Minimum Rate of d.c. Output Current Ramp Down
(1)	(2)	(3)	(4)	(5)
i)	Normal shutdown request from EV	Shutdown signal from EV(a) is received.	Within 1 s after reception of the digital data frame	100 A/sec
ii)	Normal shutdown by d.c. EV supply equipment	d.c. EV supply equipment detects internal events(b)	According to the manufacturer’s definition and less than 1 minute	100 A/sec
iii)	Normal shutdown by d.c. EV supply equipment	User pushes on the stop button	Within 1 s after reception of the digital data frame	100 A/sec

(a) Signal definitions are given in Annex G.

(b) For example, time limit exceeded.

Table 2 Error Shutdown Events and Conditions

(*Clause* 6.4.10.3)

Sl No.	Event	Particular	Time for Starting to reduce d.c. Output Current	Minimum Rate of d.c. Output Current Ramp Down
(1)	(2)	(3)	(4)	(5)
i)	Pilot wire voltage error	State of CP is "Error" in Table 3 (a)	Less than 100 ms	200 A/sec
ii)	Digital communication reception error	A valid digital data frame is not received for more than 1 s	Less than 100 ms after the 1 s time-out	200 A/sec
iii)	Overvoltage	d.c. output voltage exceeds d.c. output voltage target parameter sent by EV equipment for more than 1 s	Less than 100 ms after the 1 s time-out	200 A/sec
iv)	Reception of shutdown signal from EV	Shutdown signal from EV is received	Within 1 s after reception of the digital data frame	200 A/sec

NOTE — The error signals are defined in Annex G.

(a) This error becomes an emergency shutdown when the voltage is < 3.9 V d.c. (*see* **6.4.10.4**).

6.5 Addition

Mandatory functions a.c. EV Supply Equipment

6.5.1 *General Mandatory Functio*ns

a.c. EC supply equipment

The a.c. EV supply equipment shall supply a.c. power to the EV, subject to the requirements of the mandatory functions as indicated below.

NOTE — The a.c. EV supply equipment acts as a slave to the EV. Further details are given in Annex B, Annex C and Annex F.

The following functions shall be provided by the a.c. EV supply equipment:

a) verification that the EV is properly connected to the a.c. EV supply equipment in accordance with **6.5.2**.

b) verification of the latching of the vehicle coupler in accordance with **6.5.3**;

c) latching and unlatching of the vehicle coupler in accordance with **6.5.4**;

d) communication with the vehicle in accordance with **6.5.5**;

e) monitoring of the continuity of the control pilot circuit in accordance with **6.5.6**;

f) verification function before energy transfer in accordance with **6.5.7**;

g) energization and control of the power supply to the EV in accordance with **6.5.8**;

h) protection against surge in accordance with **6.5.9**; and

j) de-energization of the a.c. power supply to the EV in accordance with **6.5.10**.

6.5.2 *Verification that the EV is Properly Connected to the a.c. EV Supply Equipment*

The a.c. EV supply equipment shall determine that the EV is properly connected to the a.c. EV supply equipment. Proper connection is assumed when the continuity of the control pilot circuit is detected.

Compliance is checked in accordance with **E-3.1**.

6.5.3 *Verification of the Latching of the Vehicle Coupler*

The a.c. EV supply equipment shall determine that the vehicle connector is properly latched to the vehicle inlet.

The a.c. EV supply equipment shall not energize the conductors in the cable assembly when the vehicle connector is not latched to a vehicle inlet.

The a.c. EV supply equipment shall enter into an emergency shutdown if the vehicle connector is disconnected from the vehicle inlet while under power.

Compliance is checked in accordance with **E-3.8.6** (emergency shutdown).

6.5.4 *Latching and Unlatching of the Vehicle Coupler*

A mechanical or electromechanical means shall be provided to prevent intentional and unintentional disconnection under load of the vehicle connector according to IS 17017 (Part 2/Sec 7).

Compliance is checked by inspection.

6.5.5 *Communication with the Vehicle in Accordance with* **6.5.5**

6.5.5.1 *Genera*l

Digital communication shall be established between the EV and the a.c. EV supply equipment to validate and control.

The a.c. EV supply equipment shall be able to receive and interpret all mandatory digital communication data as described in Annex G.

The vehicle connector shall not be energized until the compatibility assessment is successfully completed in accordance with **6.5.7.2**.

Compliance is checked by the test in Annex E applying the messages defined in Table 15 and Table 16 of Annex G

6.5.5.2 *Available a.c. output current parameter*

The EV supply equipment shall inform the EV of the value of the available a.c. output current that can be provided by the EV supply equipment.

The value may be changed and retransmitted during energy transfer, to adapt to power limitations, (for example, for load management), without exceeding the rated a.c. output current.

6.5.5.3 *Available a.c. output voltage parameter*

A means shall be provided to inform the EV on the available a.c. output Voltage of the a.c. EV supply equipment.

6.5.5.4 *Rated a.c. output voltage parameter and a.c. output voltage limit parameter*

The a.c. EV supply equipment shall compare the a.c. output voltage with the values of the rated a.c. output voltage parameter and the a.c. output voltage limit parameter received from the EV

6.5.6 *Monitoring of the Continuity of the Control Pilot Circuit*

The EV supply equipment shall monitor the continuity of the control pilot circuit. The EV supply equipment shall initiate an emergency shutdown on detection of interruption of the control pilot circuit.

Re-initialisation of the complete energy transfer procedure according to **E-3.5** shall be required in order to restart the energy transfer cycle. Compliance is checked in accordance with **E-3.5** and **E-3.8.6**.

6.5.7 *Verification Before a.c. Energy Transfer*

6.5.7.1 *General*

The verification function is carried out when the vehicle connector has been fully inserted, latched and the control pilot circuit verified (*see* **E-3.5** and **F-1.2**), and before energy is supplied to the EV.

6.5.7.2 *Compatibility assessment before a.c. energy transfer*

The a.c. EV supply equipment shall complete a compatibility assessment with the EV before starting the energy transfer cycle. The check shall include, at least the elements mentioned **6.5.7.2.1** and **6.5.7.2.2**.

NOTE — Energy transfer shall only proceed if the compatibility assessment is completed correctly Compliance is checked in accordance with **E-3.3** applying the messages defined in Table 15 and Table 16

6.5.7.2.1 *Verification of phase, neutral and earth safety*:

a) Phase to neutral reversal test;
b) Phase to earth and/or neutral to earth voltage check test; and
c) EVSE contactor/relay weld detection test.

6.4.7.2.2 Validation by the a.c. EV supply equipment of information received from the EV

6.5.7.2.3 *Reception of energy transfer requirements from the EV*:

a) Rated a.c. output voltage parameter; and
b) a.c. output voltage limit parameter.

6.5.7.2.4 *Transmission by a.c. EV supply equipment of the confirmed*:

a) Rated a.c. output voltage parameter;
b) a.c. output voltage limit parameter; and
c) Available a.c. output current parameter.

6.5.8 *Energization of the a.c. Power Supply to the EV*

The vehicle connector shall not be energised unless energy exchange has been allowed by the control pilot function.

Demand for a.c. output current shall be less than or equal to rated output current of a.c. EV supply equipment. The available a.c. output voltage shall be within the operating limits of the a.c. output voltage limit parameters. The vehicle connector shall not be energised if verification of phase, neutral and earth safety as per **6.5.7.2.1** is compromised

6.5.9 *Protection Against Surge*

Protection against surge in accordance with 17017-21-1 Electric Vehicle conductive charging system for on board chargers and 17017-21-2 electric vehicle conductive charging system for off board chargers

6.5.10 *De-Energization of the a.c. Power Supply to the EV*

6.5.10.1 *General*

Shutdown of d.c. EV supply equipment in accordance with **6.5.10.2**, **6.5.10.3** and **6.5.10.4**.

If the signal status from the EV control energy transfer function no longer allows energization, the a.c. power supply to the EV shall be interrupted but the control pilot circuit may remain in operation.

Three shutdown procedures are possible:

a) normal shutdown;
b) error shutdown; and
c) emergency shutdown.

The a.c. EV supply equipment shall have a means to allow the user to initiate normal or emergency shutdown. Compliance is checked by inspection.

6.5.10.2 *Normal a.c. shutdown*

The a.c. EV supply equipment shall stop energy transfer by controlled interruption of a.c. output to the EV.

The data exchange and protocol are indicated in Annex F.

6.5.10.3 *Error a.c. shutdown*

The a.c. EV supply equipment shall stop the energy transfer by controlled interruption of the a.c. output to the EV, after the error shutdown is triggered by the a.c. EV supply equipment or by a message from the EV.

6.5.10.4 *Emergency a.c. shutdown*

The a.c. EV supply equipment shall stop power transfer within 100 ms after the emergency shutdown was triggered. The a.c. output voltage shall fall below required safety limits within requisite time as per IEC 62368-1 after the emergency shutdown was triggered.

The emergency shutdown shall be initiated by:

a) Loss of control pilot circuit function;
b) Disconnection of vehicle connector under load;
c) Bad earth (compromised on phase to earth and/or neutral to earth voltages); and
d) Reception of emergency shutdown signal from EV or initiated by the use.

7 COMMUNICATIONS

Clause **7** of IS 17017 (Part 1) is replaced with the following replacement:

7.1 Digital Communication between the EV Supply

Digital communication for a.c. or d.c. EV supply equipment are mentioned in Annex F and Annex G of this document.

7.2 Digital Communication between the EV Supply Equipment and the Management System

Telecommunication network or telecommunication port of the EV supply equipment, connected to the telecommunication network, if any, shall comply with the requirements for connection to telecommunication networks according to **6** of IS 13252 (Part 1).

8 PROTECTION AGAINST ELECTRIC SHOCK

Clause **8** of IS 17017 (Part 1) is applicable, except as follows:

8.1 Degrees of Protection against Access to Hazardous-Live-Parts Replacement

The EV supply equipment shall fulfil the following IP ratings for protection against electric shock:

a) vehicle connector when mated with vehicle inlet: IPXXD; and
b) IP rating for dedicated d.c. accessories: IPXXB.

NOTE — IP rating for the enclosure are indicated in **12.4.1**.

Compliance is checked by inspection and measurement in accordance with IS/IEC 60529.

8.2 Stored Energy

Clause **8.2** of IS 17017 (Part 1) is applicable.

8.3 Fault Protection

Clause **8.3** of IS 17017 (Part 1) is replaced with the following replacement:

Fault protection shall consist of one or more protective measures as permitted according to IS 732:

a) Automatic disconnection of supply;
b) Double or reinforced insulation;
c) Electrical separation if limited to the supply of one item of current-using equipment; and
d) Extra low-voltage [safety extra low voltage (SELV) and protected extra low voltage (PELV)]. Electric separation is fulfilled if there is one electrically separated circuit for each EV. Compliance is checked by inspection.

8.3.1 *General Protective Measures for Mode* 4

Electrical separation between the primary and the secondary circuit according to IEC 61140 shall be provided. The following requirements shall be met:

a) basic protection is provided by basic insulation, rated for the highest voltage present in the equipment, between hazardous live parts, other circuits and exposed conductive parts of the separated circuit; and
b) fault protection is provided via compliance of both below mentioned points:
    1) by simple separation of the separated circuit from other circuits and earth; and
    2) by a protective equipotential bonding interconnecting exposed conductive parts of the separated circuit where more than one item of equipment is connected to the separated circuit. This protective equipotential bonding system shall not be earthed.

Intentional connection of exposed-conductive-parts to a protective earthing conductor or to an earthing conductor is not permitted.

d.c. EV supply equipment shall be fitted with a single cable and single vehicle connector. Compliance is checked by inspection.

8.3.2 *Description and Test of Elements for Electric Separation* (*Type Test*) *d.c.-EVSE*

Protection by separation is achieved by the use of an isolating transformer in compliance with IS/IEC 61558 (Part 2/Sec 4).

Compliance is checked by inspection and the dielectric tests indicated in **12.7.1**.

8.4 Replacement

Protective conductor

The protective earthing conductor and the protective conductor shall be of sufficient rating in accordance with requirements of IEC TS 61439-7. For a.c. or d.c. EV supply equipment, a protective earthing conductor shall be provided between the a.c. supply input earthing terminal of the EV supply equipment and the EV. Compliance is checked by inspection.

8.5 Residual Current Protective Devices for a.c. EVSE

EV supply equipment can have one or more connecting points to supply energy to EVs. Where connecting points can be used simultaneously and are connected to a common input terminal of the EV supply equipment, they shall have individual protection incorporated in the EV supply equipment. If the EV supply equipment has more than one connecting point that cannot be used simultaneously then such connecting points can have common protection devices.

EV supply equipment that includes a residual current device (RCD) and that does not use the protective measure of electrical separation shall comply with the following:

a) The connecting point of the EV supply equipment shall be protected by an RCD having a rated residual operating current not exceeding 30 mA;
b) RCD(s) protecting connecting points shall be at least type A;
c) RCDs shall comply with one of the following standards: IS 12640 (Part 1), IS 12640 (Part 2), IS/IEC 609472; and
d) RCDs shall disconnect all live conductors.

    NOTE — This applies to single-phase or three-phase connecting points.

Where the EV supply equipment is equipped with a socket-outlet or vehicle connector for a.c. use in accordance with IEC 62196 (all parts), protective measures against d.c. fault current shall be taken. The appropriate measures shall be:

a) RCD type B; or
b) RCD type A and appropriate equipment that ensures the disconnection of the supply in case of d.c. fault current above 6 mA.

NOTES

1 The RCDs or the appropriate equipment that ensure the disconnection of the supply in case of d.c. fault can be provided inside the EV supply equipment, in the installation or in both places.

2 Selectivity can be maintained between the RCD protecting a connecting point and an RCD installed upstream when required for service purposes.

9 CONDUCTIVE ELECTRICAL INTERFACE REQUIREMENTS

Clause **9** of IS 17017 (Part 1) is applicable, except as follows.

9.1 General

Clause **9.1** of IS 17017 (Part 1) is applicable

9.2 Functional Description of Standard Accessories

Clause **9.2** of IS 17017 (Part 1) is applicable

9.3 Functional Description of the a.c. Interface Replacement

General requirements and ratings shall be in accordance with the requirements specified in IS 17017 (Part 2/Sec 1).

The basic interface is specified in **6.5** of IS 17017 (Part 2/Sec 7).

9.4 Functional Description of the Universal Interface under Consideration

Clause **9.4** of IS 17017 (Part 1) is not applicable

9.5 Functional Description of the d.c. Interface Replacement

General requirements and ratings shall be in accordance with the requirements specified in IS 17017 (Part 2/Sec 1).

The basic interface is specified in **6.6** of IS 17017 (Part 2/Sec 7).

9.6 Functional Description of the Combined Interface Replacement

General requirements and ratings shall be in Accordance with the requirements specified in IS 17017 (Part 2/Sec 1).

The basic interface is specified in **6.7** of IS 17017 (Part 2/Sec 7).

10 REQUIREMENTS FOR ADAPTORS

Clause **10** of IS 17017 (Part 1) is applicable

11 CABLE ASSEMBLY REQUIREMENTS

Clause **11** of IS 17017 (Part 1) is applicable, except as follows:

11.1 Electrical Rating Replacement

The voltage and current ratings of the output cable assembly shall be equal or greater than the rating of the EV supply equipment.

11.2 Dielectric Withstand Characteristics Replacement

Dielectric withstand characteristics of the cable assembly shall be as indicated for the EV supply equipment in **12.7**.

11.3 Surface temperature of the cable assembly Addition:

The surface temperature of the cable assembly shall comply with the following requirements at the maximum rated current and at an ambient temperature of 40 °C:

a) parts designed to be grasped in normal use shall not exceed the following temperatures:
    1) for non-metal parts: 60 °C; and
    2) for metal parts: 50 °C.
b) parts which may be touched but are not intended to be grasped shall not exceed the following temperatures:
    1) for non-metal parts: 85 °C; and
    2) for metal parts: 60 °C.

The temperature of the graspable part of the cable shall be prevented from exceeding 60 °C by means such as a grip or handle. If there are any additional regulations which need to be satisfied regarding the installment of the grip or the handle for the country, these shall also be met.

Compliance is tested by measurement at rated output current when the temperature change rate is less than 2 °C per hour.

12 EVSE CONSTRUCTIONAL REQUIREMENTS AND TESTS

Clause **12** of IS 17017 (Part 1) is applicable, except as follows:

12.1 Insulation Resistance Replacement

The insulation resistance, is measured with 500 V d.c. applied between all inputs/outputs connected together (power source included) and the accessible parts shall be greater than 1 MΩ;

The measurement of insulation resistance shall be carried out after applying the test voltage for 1 minute and immediately after the damp heat steady state test of IEC 60068-2-78, test Ca at 40 °C ± 2 °C and 93 percent relative humidity for four days.

12.2 Touch Current

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, is measured in accordance with IS/IEC 60990 and shall not exceed the values as indicated:

Between any network poles and the accessible metal parts connected with each other and a metal foil covering insulated external parts Class I = 3.5 mA and Class II = 0.25 mA

Between any network poles and the metal inaccessible parts normally non activated (in the case of double insulation) Class I = not applicable. Class II = 3.5 mA

Between inaccessible and accessible parts connected with each other and a metal foil covering insulated external parts (additional insulation). Class I = not applicable. Class II = 0.5 mA.

The touch current shall be measured within one hour after the damp heat continuous test of IS 9000 (Part 4), at 40 °C ± 2 °C and 93 percent relative humidity for four days, with the electric vehicle charging station connected to a.c. supply network in accordance with IS/IEC 60990.

The test voltage shall be 1.1 times the rated voltage. This test shall be made when the EV supply equipment is functioning with a resistive load at rated output power. Circuitry that is connected through a fixed resistance or referenced to earth (for example, proximity function and control pilot function) are 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.

In case of touch current not meeting the above requirements, it shall comply in accordance to **4.4.4.3.3** of IEC 62477-1.

12.3 Dielectric Withstand Voltage

Clause **12.3** of IS 17017 (Part 1) is applicable except as follows:

12.3.1 *a.c. Withstand Voltage*

Replacement

12.3.1.1 *Dielectric withstand between primary and secondary circuits "For isolating transformers not using an earthed shield:*

a) application of the dielectric withstand voltage of 2 Un + 2 400 V (RMS), at power frequency of 50 Hz, applied simultaneously for 1 minute between:
   1) all conductors of the power supply input, including the earth connection and the exposed conductive parts of the circuit, if present; and
   2) all conductors of the output connector.

For isolating transformers with earthed protective shield:

b) application of the dielectric withstand voltage of Un+ 1 200 V (RMS), at power frequency of 50 Hz, applied simultaneously for 1 minute between:
   1) all conductors of the power supply input, including the earth connection and the exposed conductive parts of the circuit; and
   2) all conductors of the output connection.
c) application of the dielectric withstands voltage of Un + 1 200 V (RMS), at power frequency of 50 Hz, applied simultaneously for 1 minute between all conductors of the power supply input and the earth connection; and
d) verification of the earthed shield by inspection and verification of design."

12.3.1.2 a.c. *withstand voltage between other circuits*

The dielectric withstand voltage (Un + 1 200 V) (RMS) at power frequency (50 Hz) shall be applied, for 1 minute as follows:

a) between all input and output circuits connected together in relation to the exposed conductive parts (in common mode); and

b) between each electrically independent circuit and all other exposed conductive parts or circuits (in differential mode).

NOTE — Un is the nominal voltage between the line to neutral of the a.c. supply network connection to the primary circuit of the d.c. EV supply equipment.

For the d.c. EV supply equipment, if the insulation between the supply network and the extra-low voltage circuit is double or reinforced insulation, 2 × (Un + 1 200 V) (RMS) shall be applied to the insulation. Alternatively, the test can be carried out using a d.c. voltage equal to the a.c. peak values.

NOTE — For test voltage tolerances and the selection of test equipment, see IS 16826: 2018/IEC 61180.

12.3.2 *Impulse Dielectric Withstand* (1.2 μs/50 μs)

The dielectric withstand of the power circuits at impulse shall be checked according to IS 15382 (Part 1).

The impulse voltage shall be applied to live parts and exposed conductive parts.

The test shall be carried out in accordance with the requirements of IS 16826 : 2018/IEC 61180. Test conditions for supply voltages in excess of 400/690 V shall use the values indicated in IS 15382 (Part 1) for an overvoltage category III.

NOTE — For an explanation of the overvoltage categories, *see* **4.3.3.2.2** of IS 15382 (Part 1). Equipment may be used under the conditions of a higher overvoltage category where appropriate overvoltage reduction is provided [*see* **4.3.3.6** of IS 15382 (Part 1)].

A lower overvoltage category can apply if appropriate overvoltage reduction as specified in IS 15382 (Part 1) is provided.

NOTE — Dielectric withstand and isolation requirements for EVs during energy transfer are covered in ISO/IEC 18246.

12.4 Temperature Rise

EV supply equipment shall comply with IEC TS 61439-7.

12.5 Damp Heat Functional Test

Clause **12.5** of IS 17017 (Part 1) is replaced with the following replacement:

Following the conditioning defined below, the EV supply equipment is deemed to pass the test, if it passes all cases mentioned in the state transition diagram. The precision of the timing does not need to be verified Conditioning:

a) For indoor units, 6 cycles of 24 h each to a damp heat cycling test according to IS 9000 (Part 5/Sec 2) at (40 ± 3) °C and relative humidity of 95 percent; and

b) For outdoor units, two 12 day periods, with each period consisting of 5 cycles of 24 h each to a damp heat cycling test according to IS 9000 (Part 5/Sec 2) at (40 ± 3) °C and relative humidity of 95 percent.

12.6 Operating Temperature Limits

Clause **12.6** of IS 17017 (Part 1) is replaced with the following replacement:

The EV supply equipment shall remain functional at the prescribed ambient temperature limits. The equipment shall withstand the following tests.

12.6.1 *Minimum Temperature Functional Test*

The EV supply equipment shall be pre-conditioned in accordance with IS/IEC 60068 (Part 2/Sec 1), at the minimum operating temperature either at - 5 °C or value declared by the manufacturer, whichever is lower ± 3 K) for (16 ± 1) h. The EV supply equipment is deemed to pass the test, if, immediately after the preconditioning, it passes the cases mentioned in the state transition diagram, while at the minimum operating temperature. The precision of the timing does not need to be verified.

12.6.2 *Maximum Temperature Functional Test*

The EV supply equipment shall be pre-conditioned in accordance with IS 9000 (Part 3/Sec 3) or IS 9000 (Part 3/Sec 5) as applicable, at the maximum operating temperature (55 °C or value declared by the manufacturer, whichever is higher ± 2 K) for (16 ± 1) h. The EV supply equipment is deemed to pass the test, if, immediately after the preconditioning, it passes the cases mentioned in the state transition diagram while at the maximum operating temperature. The precision of the timing does not need to be verified.

12.7 Mechanical Strength

Clause **12.7** of IS 17017 (Part 1) is applicable.

13 OVERLOAD AND SHORT CIRCUIT PROTECTION

Item **13** of IS 17017 (Part1) is applicable, except as follows:

13.1 Short-Circuit Protection of the Cable Assembly

Clause **13.1** of IS 17017 (Part 1) is replaced with the following:

The EV supply equipment shall provide short-circuit current protection for all intended cable conductor sizes if not provided by the supply network.

The short-circuit protection may be provided by a circuit breaker, fuse or combination thereof.

NOTE — The requirements for EVs are specified in ISO 18246.

13.1.1 *Addition*:

Protection against uncontrolled reverse power flow from the EV

The d.c. EV supply equipment shall be equipped with a protective means against uncontrolled reverse power flow from the EV. Uncontrolled power flow does not include instantaneous reverse power flow, which may occur with the closing of contactors within the tolerances and duration specified in Annex C. Compliance is tested through analysis of the circuit diagram and test of impedance as indicated in **E-3.10**.

14 AUTOMATIC RECLOSING OF PROTECTIVE DEVICES

Item **14** of IS 17017 (Part 1) is applicable.

15 EMERGENCY SWITCHING OR DISCONNECT (OPTIONAL)

Item **15** of IS 17017 (Part 1) is applicable.

16 MARKING AND INSTRUCTIONS

Item **16** of IS 17017 (Part 1) is applicable.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No/IEC No.	*Title*
IS 732: 2019	Code of practice for electrical wiring installations (*fourth revision*)
IS/IEC 60068-2-1 : 2007	Environmental testing: Part 2 Test, Section Test A: cold
IS 9000 (Part 3/ Sec 1 to 5) : 1977	Basic environmental testing procedures for electronic and electrical items: Part 3 Dry heat test
IS 9000 (Part 4) : 2008/IEC 60068-2-78 : 2012	Environmental Testing Part 4 Tests - Test Cab: Damp Heat, Steady State (Second Revision)
IS 9000 (Part 5/ Sec 1 and 2) : 1981	Basic environmental testing procedures for electronic and electrical items: Part 5 Damp heat (cyclic) test.
IS 13703 (all parts)	Low voltage fuses
IS 15382 (Part 1) : 2014	Insulation coordination for equipment within low-voltage Systems: Part 1 Principles, requirements, and tests (*first revision*)
ISO 15118-1 : 2013	Road vehicles — Vehicle to grid communication interface — Part 1: General information and use-case definition
ISO 17409: 2015	Electrically propelled road vehicles — Connection to an external electric power supply — Safety requirements
IS/IEC 60309-1 : 2002	Plugs, socket-outlets and couplers for industrial purposes: Part 1 General requirements
IS/IEC 60309-2 : 2002	Plugs, socket-outlets and couplers for industrial purposes: Part 2 Dimensional interchangeability requirements for pin and contact-tube accessories
IS 12640 (Part 1) : 2016/IEC 61008-1 :2012	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs): Part 1 General rules (*second revision*)
IS 12640 (Part 2) : 2016/IEC 61009 -1 : 2012	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs): Part 2 General rules (*second revision*)
IS/IEC 61439-1 : 2011	Low-voltage switchgear and controlgear assemblies: Part 1 General rules (under print)
IEC TS 61439-7 : 2023	Low-voltage switchgear and controlgear assemblies — Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicles charging stations (*first revision*)
IS/IEC 61508 (all parts)	Functional safety of electrical/electronic/programmable electronic safety related systems
IS 17017-24 : 2021	Electric vehicle conductive charging system — Part 24: Digital communication between a d.c. electric vehicle supply equipment and an electric vehicle for control of d.c. charging
IEC 62335 : 2008	Circuit breakers — Switched protective earth portable residual current devices for class I and battery powered vehicle applications
IS 17120 : 2019	In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD)
IS 17017 (Part 2/ Sec 7) : 2023	Electric vehicle conductive charging system: Plugs, socket - outlets, vehicle connectors and vehicle inlets, Section 7: Dimensional compatibility and interchangeability requirements for a.c., d.c. and a.c./d.c. pin and contact-tube vehicle couplers intended to be used for a.c./d.c. EV supply equipment where

IS No/IEC No.	*Title*
	protection relies on electrical separation
IS 12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency
IS 17017 (Part 23) : 2021	Electric vehicle conductive charging system — Part 23: d.c. electric vehicle charging station
IS 13252 (Part 1) : 2010	Information technology equipment — Safety: Part 1 General requirements (*second revision*)
IS/IEC 60529 : 2001	Degrees of protection provided by enclosures (IP code)
IS/IEC 60898-1 : 2015	Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations: Part 1 Circuit-breakers for a.c. operation (*first revision*)
IS/IEC 60898-2 : 2016	Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations: Part 2 Circuit-breakers for a.c. and d.c. operation
IS/IEC 60947-2 : 2016	Low-voltage switchgear and controlgear: Part 2 Circuit-breakers (*first revision*)
IS/IEC 60947-3 : 2012	Low-voltage switchgear and controlgear: Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units (*first revision*)
IS/IEC 60947-4-1 : 2012	Low voltage switchgear and controlgear: Part 4 Contactors and motor-starters, Sec 1 Electromechanical contactors and motor-starters (*first revision*)
IS 17039 : 2018/ IEC 61316 : 1999	Industrial cable reels
IS/IEC 61558-1 : 1997	Safety of power transformers, power supply units and similar: Part 1 General requirements and tests
IEC 61558-2-4 : 2009	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V — Part 2-4: Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers
IS/IEC 60947-6-2 : 2020	Low-voltage switchgear and controlgear — Part 6-2: Multiple function equipment — Control and protective switching devices (or equipment) (CPS)
IS/IEC 60990 : 2016	Methods of measurement of touch current and protective conductor current (*first revision*)
IEC 61180 : 2016	High-voltage test techniques for low-voltage equipment — Definitions, test and procedure requirements, test equipment
IS/IEC 61810	Electromechanical elementary relays: Part 1 General and safety requirements (under print)
IS 17050 : 2023/ IEC 62262 : 2002+AMD1 : 2021	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IS 9409 : 2023 1980/IEC 61140 : 2016	Classification of electrical and electronic equipment with regard to protection against electric shock
IS 10101 : 2019/ ISO 3297 : 2017	Information and documentation — International standard serial number (ISSN) (*third revision*)
IS 16826 : 2018/ IEC 61180 : 2016	High-voltage test techniques for low-voltage equipment — Definitions, test and procedure requirements, test equipment
IS/IEC 61439-7 : 2022	Low-voltage switchgear and controlgear assemblies: Part 7 Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
IEC 62477-1 : 2022	Safety requirements for power electronic converter systems and equipment: Part 1 General

IS No/IEC No.		*Title*
IEC 62893-4-1 2020	:	Charging cables for electric vehicles of rated voltages up to and including 0.6/1 kV — Part 4-1: Cables for d.c. charging according to mode 4 of IEC61851-1 — d.c. charging without use of a thermal management system
ISO 11898-1 2015	:	Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signaling
ISO 11898-2 2016	:	Road vehicles — Controller area network (CAN) — Part 2: High-speed medium access unit
IEC 62368-1 2018	:	Audio/video, information and communication technology equipment — Part 1: Safety requirements

ANNEX B

(*Clauses* 6.4.1 *and* 6.5.1)

(NORMATIVE)

INTERFACE BETWEEN a.c./d.c. EV SUPPLY EQUIPMENT AND EV

B-1 GENERAL

This annex provides the technical description and requirements of the ac/d.c. EV supply equipment interface circuit with the EV. The control circuit of the ac/d.c. EV supply equipment uses dedicated digital data wires to communicate with the EV. The specific requirements for digital communication and details of the communication actions and parameters of the ac/d.c. EV supply equipment are defined in Annex G.

B-2 d.c. OUTPUT CURRENT CONTROL

The d.c. current drawn by the EV is controlled by the power electronics of the EV supply equipment as requested by the EV by digital communication.

The actual current drawn by the EV may not be equal to the value indicated by digital communication.

B-3 CONTROL PILOT CIRCUIT

Energy transfer conditions, CP-R configuration and voltage levels of the Control pilot wire for different states of operation of the interface are indicated in Table 3

B-3.1 Control Pilot Circuit Functional Description

The 12V d.c. output of CP-PS is applied to an 887 Ω resistor (specification in Table 4) and applied to the CP pin of the charging connector. The EV based on the state (as per Table 3), connects the appropriate value of CP-R in the circuit. CP-D section determines the voltage level of CP signal with respect to PE and communicates to SE-CCF through the isolation barrier. SE-CCF feeds the CP state in the charging flow.

Table 3 Voltage of Control Pilot Circuit

(*Clauses* B-3 *and* B-3.1, F-1.2)

Sl No.	Configuration of CP-R Resistor	Voltage of Control Pilot Wire (V)	State	Condition of EVSE	Condition of EV	Comments
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Open, or ∞ Ω	+ 8V < V ≤ + 12V(or CP-PS output)	Wait		EV Not present/No. energy transfer permitted	d.c. output current stops and d.c. EV supply equipment waits for a new state change. This state may be due to an open control pilot circuit or an unconnected EV connector
ii)	887 Ω	+ 4V < V ≤ + 8V	Permission to supply energy to the EV	Energy transfer possible	Energy transfer permitted	The system continues energy transfer
iii)		0 < V ≤ + 4V	Error	Abnormal		Energy transfer stops with error shutdown and gives error information
iv)		V > CP-PS output Voltage	Error	Abnormal		Energy transfer stops with error shutdown and gives error information

B-4 VEHICLE CONNECTOR LATCHING AND MONITORING

The vehicle connector shall be provided with a latching device to prevent unintentional disconnection from the vehicle inlet during energy transfer.

Compliance is checked by inspection.

The d.c. EV supply equipment shall not supply energy if the latch is not engaged. Compliance is verified according to **E-3.6**.

B-5 DIAGRAM OF THE VEHICLE INTERFACE CIRCUIT

The interface circuit between d.c. EV supply equipment and an EV is represented in Fig. 1. Parameter values are given in Table 4. Further details on the data interface are given in Annex F and Annex G.

B-6 PROXIMITY PILOT

A 150 Ω resistor connected across PP pin and PE pin of the charging connector (EVSE end), when connected to EV is detected by PP-Detect module of EV. Since the resistor is w.r.t PE, the vehicle needs to have an appropriate isolation barrier defined in Sec 6, through which PP-Detect information is passed on to the EV-CCF module for use in charging flow.

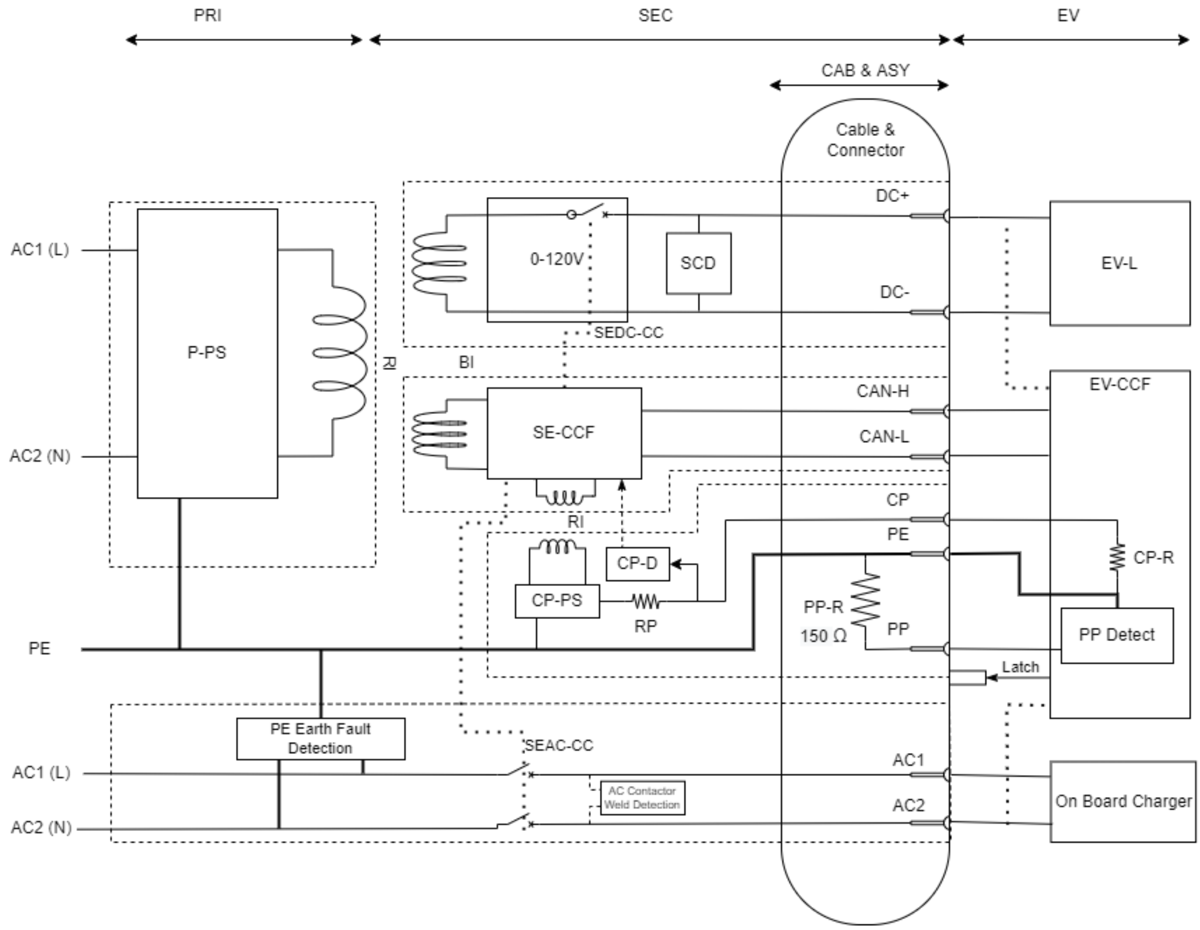


FIG. 1 INTERFACE CIRCUIT FOR ENERGY TRANSFER CONTROL SHOWING ISOLATION BARRIERS

Key	*Description*
PRI	Primary side of EVSE Power supply
SEC	Secondary side of EVSE
EV	Electric vehicle
CAB and ASY	Cable assembly and charging connector of EVSE
AC1	Input a.c. mains phase/neutral
AC2	Input a.c. mains neutral/phase
PE3	Input protective earth
P-PS -	Primary of power supply
0-120V	Power supply circuit for output power
SE-CCF	Supply equipment charging control function
CP-PS	+ 12 V d.c. Isolated power supply for control pilot
CP-D	Control pilot signal level detection
d.c.+ / d.c.-	Charging connector : d.c. power output pins
PE	Charging connector : protective earth pin
CP	Charging connector : control pilot pin
PP-R	Proximity pilot resistor
RP	Control pilot sense resistor
PP	Charging connector : Proximity pilot pin
CAN-H	Charging connector : CAN high signal pin
CAN-L	Charging connector : CAN low signal pin
EV-L	Electric vehicle battery module as charging load
EV-CCF	Electric vehicle charging control function
CP-R	Equivalent control pilot resistor at EV end
PP-Detect	Proximity pilot detect
Latch	EV driven interlock of charging interface
SEd.c.-CC	d.c. contactor control EVSE side
SEAC-CC	a.c. contactor control EVSE side
AC contactor weld detection	a.c. contactor weld detection circuit
L-PE, N-PE voltage measurement	L to earth and N to earth measurement module to check for earth faults
SCD	d.c. output line short circuit detection

Table 4 Parameter Values for Interface Circuit

(*Clauses* B-3.1 *and* B-5)

Sl No.	Parameter	Nominal value	Tolerance	Units
(1)	(2)	(3)	(4)	(5)
i)	CP-PS output voltage	12	± 1 V	V
ii)	RP control pilot sense resistance	887	± 5 %	Ω
iii)	PP-R proximity pilot sense resistance	150	± 5 %	Ω

ANNEX C

(*Clauses* E-3.6.1, 6.4.1, 6.4.5.4, 6.4.5.5, 6.4.8, 6.5.1 *and* 13.3)

(NORMATIVE)

LEVEL, TIMING AND TOLERANCE OF OUTPUT CURRENT AND OUTPUT VOLTAGE

C-1 GENERAL

The EV supply equipment in d.c. mode supplies d.c. output current to the EV in response to the data received from the EV provided the energy transfer requirements of **6** are met. The EV acts as the master and the d.c. EV supply equipment, as the slave.

NOTES

1 The EV limits the requested d.c. output current parameter to a lower level in order to reduce the d.c. output voltage to the d.c. output voltage target parameter set by the vehicle. As an option it is possible to indicate to the d.c. EV supply equipment that the d.c. EV supply equipment automatically limits the d.c. output voltage below the d.c. output voltage target parameter by reducing the d.c. output current.

2 Vs are equipped with propulsion batteries with various technologies and voltages. The current and voltage supplied by the d.c. EV supply equipment are managed by the EV in order to ensure the proper energy transfer to fit with different types of on-board energy storage systems. This is done by the EV which manages the energy transfer process.

Under normal energy transfer conditions, in d.c. mode the EV supply equipment shall supply a d.c. output current that is equal to the requested d.c. output current parameter from the EV if the d.c. output voltage measured by the d.c. EV supply equipment is less than the d.c. output voltage limit parameter and the d.c. output voltage target parameter indicated by the EV;

The EV supply equipment in a.c. mode supplies a.c. output current by directly connecting the grid supply to EV based on closure of a.c. contactor subject to meeting the requirement as per the charging flow defined in Annex F.

Under normal energy transfer conditions, in a.c. mode the EV supply equipment shall supply a.c. output current that is less than its rated a.c. output current.

C-2 d.c. OUTPUT CURRENT REGULATION

The variation of the d.c. output current of the d.c. EV supply equipment from the required value (d.c. output current target) sent by the EV in steady state operation shall be less than or equal to that indicated in Table 5 and in Fig. 3, unless:

a) the requested d.c. output current parameter exceeds the rated d.c. output current of the d.c. EV supply equipment; and

b) the requested d.c. output current parameter exceeds the available d.c. output current parameter indicated by the d.c. EV supply equipment.

The d.c. EV supply equipment shall limit the d.c. output current to the lowest of these two values.

NOTE — An error shutdown can occur on request from the EV if the difference between the requested d.c. output current parameter and the d.c. output current exceeds a value predetermined by the vehicle.

Compliance is checked by the test indicated in **E-3.6**.

C-3 d.c. OUTPUT VOLTAGE REGULATION

For constant current charging (option for automatic voltage control not set-*see* below), the d.c. EV supply equipment does not regulate the d.c. output voltage but goes into shutdown if the d.c. output voltage limit parameter is exceeded (*see* **E-3.7** and **E-3.8**). The d.c. output voltage is defined by the load.

As an option, if the flag for automatic voltage control is set, the d.c. output voltage is regulated as follows:

a) If the d.c. output voltage is higher than the d.c. output voltage target for the requested d.c. output current, the charger shall adjust (reduce) the d.c. output current in order to maintain the d.c. output voltage to within + 2 V and − 5 V of the d.c. output voltage target over the range from 20 V to the rated d.c. output voltage; and

b) The d.c. output voltage of the d.c. EV supply equipment shall not be greater than the rated d.c. output voltage of the d.c. EV supply equipment. Shutdown conditions are indicated in **E-3.8**.

Compliance is checked by measurement according to **E-3**.

C-4 CURRENT CONTROL DELAY OF d.c. OUTPUT CURRENT

The d.c. EV supply equipment shall control the d.c. output current within 1 s after a receiving change in the requested d.c. output current parameter, with a current control accuracy as specified in Table 5, and with a minimum changing rate (dI/dt) of 20 A/s.

If the change in the requested d.c. output current parameter, is lower than or equal to 20 A the d.c. output current of the d.c. EV supply equipment shall be within the tolerance limits given in Table 5 within 1 s.

If the requested d.c. output current parameter change is greater than 20 A the d.c. output current of the d.c. EV supply equipment shall be within the tolerance limits given in Table 5 within a delay time, Td, as defined in Formula (1), and as shown in Fig. 2.

where

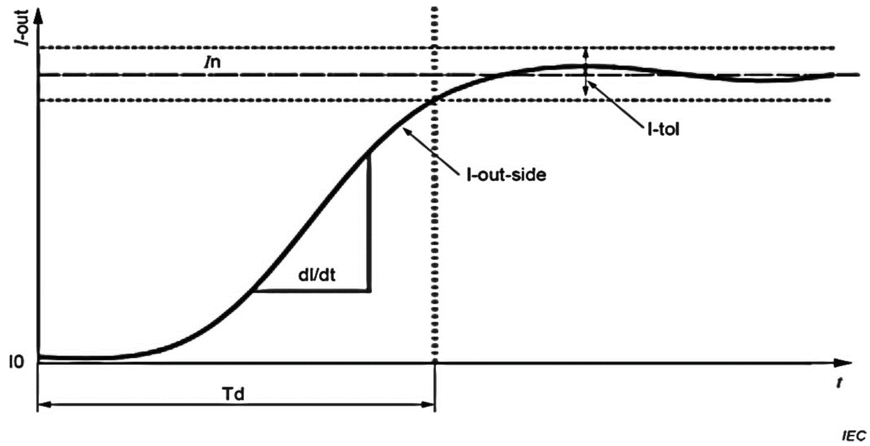
Td = is the control delay of the d.c. output current;

IN = is the value for the target current; and

I0 = is the value for the base current, that is, d.c. output current at the time of the new request; and

(dI/dt)min = is the minimum current change rate.

IN − I0 gives the absolute value of the difference between IN and I0.



Vertical axis I-out = d.c. output current In requested current
I-tol d.c. output current tolerance as defined in Table 5 Iout-instantaneous
d.c. output current dI/dt Instantaneous current change rate Td controlled time delay for current rise

FIG. 2 STEP RESPONSE FOR CONSTANT VALUE CONTROL

Compliance is checked by the test procedure in **E-3.6**.

C-5 RESPONSE TO EV COMMAND FOR A CHANGE OF REQUESTED CURRENT PARAMETER

The d.c. EV supply equipment shall be able to reduce current at a rate of 100 A/s or more in normal operation

For emergency shutdown and in order to fulfil the general requirements in **10.3**, much higher descending rates are necessary. The values are indicated in Table 5.

Fig. BB.2 shows an example of d.c. output current from the DUT (*see* Fig. 5) with optional automatic voltage control as described in BB.3, using a simple battery model, without automatic internal voltage adjustment, as the load. A complete energy transfer, under the control of an EV simulator is shown. The d.c. output voltage is initially lower than the d.c. output voltage target parameter; the d.c. output current follows the requested current parameter value within the tolerances indicated in the Table 5.

When the d.c. output voltage reaches the d.c. output voltage target parameter, the DUT limits the d.c. output voltage by reducing the d.c. output current. The requested d.c. output current parameter is then reduced by the EV simulator.

NOTE — Under these conditions with a real battery, the d.c. output voltage limit parameter would rise to the charging voltage imposed by the battery and the EV would once again reduce the requested d.c. output current parameter.

The d.c. EV supply equipment shall limit the d.c. output voltage to the d.c. output voltage limit parameter until the EV reduces the requested d.c. output current parameter.

These events might occur repeatedly until either the current reaches zero or the EV simulator starts a shutdown procedure.

NOTES

1 The charging algorithm is under the control of the EV and will depend on the battery technology.

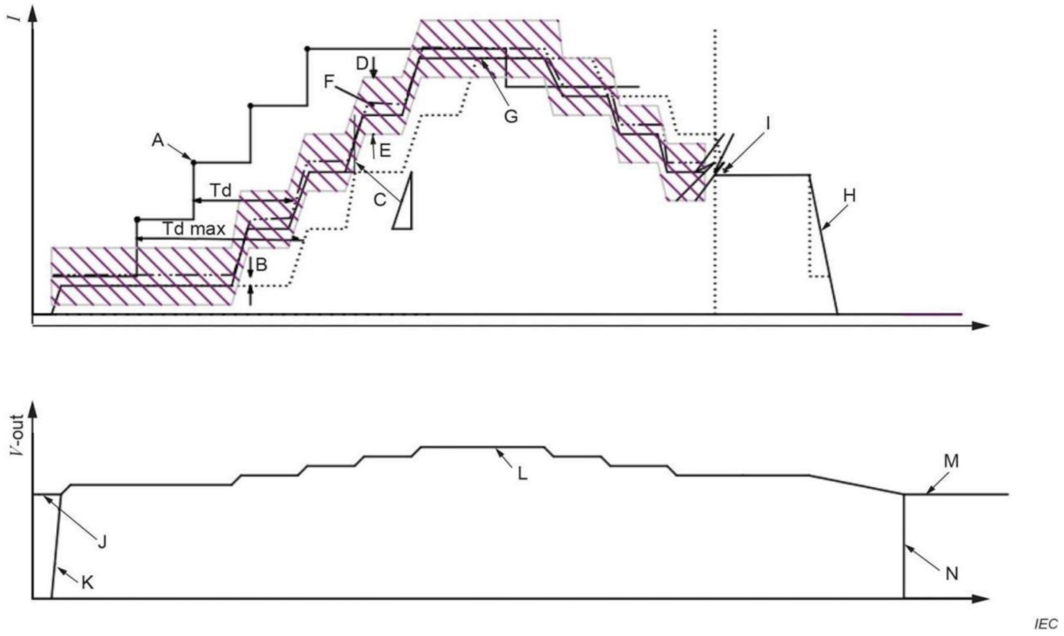
2 The values measured at the output of the d.c. EV supply equipment depend on the battery model used for the test. Close representation of battery response can only be achieved by active voltage control of the battery model. Only the simple battery model is used for these tests. Tests on real batteries might give quite different voltage measurements.

Table 5 Requirements for the output Response Performance of d.c. EV Supply Equipment

(*Clauses* C-4, C-5 *and* E-3.6.1)

Sl No.	Parameter	from EV	Output Response
(1)	(2)	(3)	(4)
i)	d.c. output current	Ireq = 0	Iout = 0
		0 <Ireq ≤ 50 A	Iout = Ireq ± 0,5 A or ± 5 % (Whichever is the greater)
		50 < Ireq ≤ 100	Iout = Ireq ± 5 %
ii)	Normal d.c. output current ramp-up	ΔIreq 1/Δt	+ 20 A/s
iii)	Normal d.c. output current ramp-down	ΔIreq 1/Δt	− 100 A/s
iv)	Current ramp down for normal shutdown	ΔIreq 1/Δt	− 100 A/s
v)	Error current ramp-down	ΔIreq 1/Δt	− 200 A/s
vi)	Response time after reception of message		< 1 s

NOTE — Shutdown timing is indicated in **6.3.10**.



Key

Vertical axis I = d.c. output current

Vertical axis V = voltage at the terminals of a battery model using constant internal voltage Horizontal axis = time

A Requested d.c. output current parameter transmitted by the EV simulator: each black dot corresponds to digital communication data received by the d.c. EV supply equipment from the EV requesting a change in d.c. output current

B Example of permanent error between the requested d.c. output current from the EV and the d.c. output current

C rate of change of current in output (20 A/s)

D,E Tolerance of the d.c. output current with respect to the requested d.c. output current parameter.

E Indication of the expected d.c. output current in response to the requested d.c. output current parameter

G Actual d.c. output current

H d.c. output current during shutdown I start of shutdown

K Voltage limiting phase when the requested d.c. output current parameter would normally cause a d.c. output voltage above d.c. output voltage target parameter

J,M Battery open terminal voltage (EV switch open) K,N d.c. output voltage from DUT (EV switch open)

Td Delay between reception of the requested d.c. output current parameter and a change in the d.c. output current.

Td_{max} Maximum allowable delay

FIG. 3 EXAMPLE OF d.c. OUTPUT CURRENT FLOW CONTROLLED BY THE d.c. EV SUPPLY EQUIPMENT AND THE CORRESPONDING TERMINAL VOLTAGE USING A SIMPLE BATTERY MODEL

In the event that the d.c. output voltage exceeds the d.c. output voltage target parameter, the d.c. EV supply equipment adjusts the d.c. output current below the rated d.c. output current, the available d.c. output current and the requested d.c. output current parameter, and thereby limit the d.c. output voltage to the d.c. output voltage target parameter without provoking a shutdown procedure.

Fig. 4 shows an example of current limiting followed by a voltage limit (shown for a resistive load). The d.c. output voltage is initially lower than the d.c. output voltage limit parameter, the d.c. output current is approximately equal to the requested d.c. output current parameter. If the requested d.c. output current parameter is increased and the d.c. output voltage becomes greater than the d.c. output voltage target parameter, the d.c. EV supply equipment will decrease (adjust) the d.c. output current until it is below the d.c. output voltage target parameter. The voltage variations during this adjustment shall remain between +2 V and − 5 V of the d.c. output voltage target parameter.

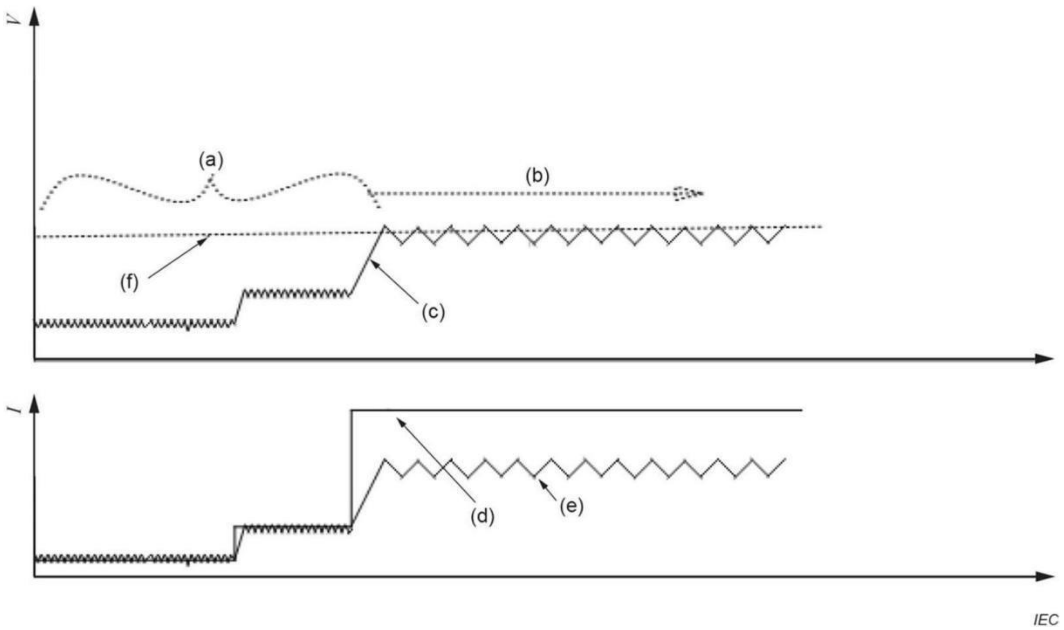


FIG. 4 EXAMPLE OF CURRENT LIMITING FOLLOWED BY VOLTAGE LIMITING FOR RESISTIVE LOAD

Key

(a) Current limiting mode: the d.c. output current is controlled by the DUT;
(b) Voltage limiting mode: the DUT reduces the d.c. output current to limit the d.c. output voltage;
(c) d.c. output voltage;
(d) Requested d.c. output current parameter;
(e) d.c. output current; and
(f) d.c. output voltage target parameter.

Compliance is checked according to Annex E.

C-6 PERIODIC AND RANDOM DEVIATION (CURRENT RIPPLE)

The current ripple of the d.c. EV supply equipment during current regulation shall not exceed the limit as defined in Table 6. Measurement shall be made at the rated d.c. output power and the rated d.c. output current, or for the worst case, where the d.c. output voltage and d.c. output current correspond to the maximum current ripple. The current ripple is not included in the tolerance defined in Table 6.

Compliance is checked by the test indicated in **E-3.6**.

C-7 LOAD DUMP

Voltage at d.c. + and d.c. - shall not exceed 150 V when the EV is unintentionally disconnected while the d.c. output current is equal to the rated d.c. output current and the d.c. output voltage is equal to the rated d.c. output voltage.

The maximum slew rate of d.c. output voltage in case of load dump shall not exceed 250 V/µs.

Compliance is checked by the test indicated in **E-3.10**.

Table 6 Current Ripple Limit of d.c. EV Supply Equipment

(*Clause* C-6)

Sl No.	Peak to Peak Current Limit [a]		Frequency Range
	0 < d.c. output current ≤ 10 A	10 A < d.c. output current ≤ 100 A	
(1)	(2)	(3)	(4)
i)	0.5	1.5	0 Hz to 10 Hz
ii)	1.0	6	10 Hz to 5 kHz
iii)	1.5	9	5 kHz to 150 kHz

[a] Difference between positive peak top and negative peak top at full scale output.

ANNEX D

(*Clauses* E-1 *and* E-2)

(NORMATIVE)

DESCRIPTION OF TEST EQUIPMENT, TEST REPORTING AND TEST ENVIRONMENT

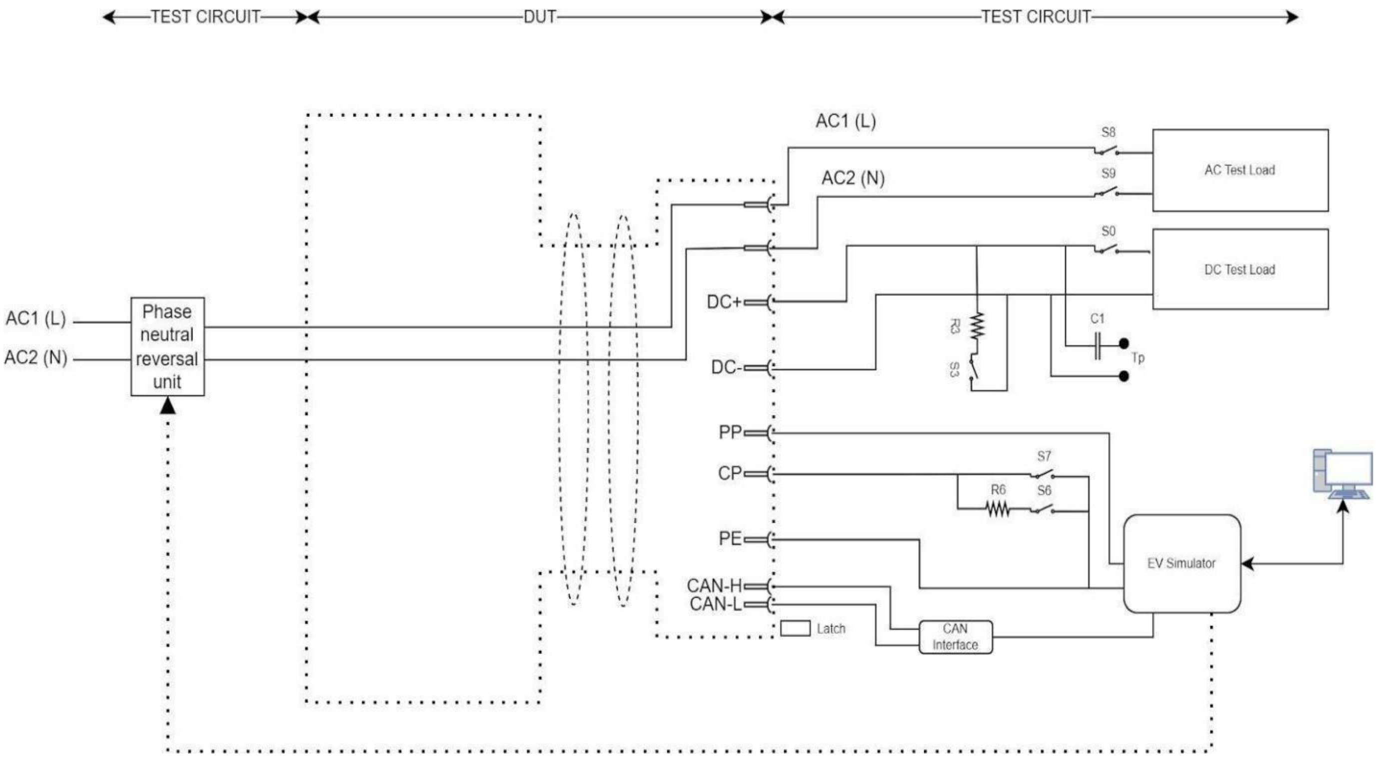
D-1 GENERAL

This annex gives examples of test circuits proposed as a basis for the tests indicated in Annex E. Components and values indicated in Annex E refer to the references in Fig. 5, Fig. 6 and Fig. 7 In this text DUT refers to the EV supply equipment under test.

D-2 DESCRIPTION OF TYPICAL TEST EQUIPMENT

D-2.1 Example of Test Circuit

Fig. 5 shows an example of a possible test circuit. Not all measurement devices are shown in Fig. 5 and Fig. 6.



Key

S0	switch that simulates the d.c. load switch
S8, S9	switch that simulates the a.c. load switch
S3, R3	output short-circuit simulation of d.c. output Lines
R6, S6 and S7	simulation of control pilot states and fault
C1, Tp	capacitor and test points for output capacitance test (*see* **DD 3.10**)
Latch	latch pin actuation
EV simulator	simulator circuit that controls the control EV side Charging functionality, simulation may be done automatically or manually.
d.c. Test load	*See* example in Fig. 6
AC Test Load	*See* example in Fig. 6
CAN int	CAN interface
DUT	the d.c. EV supply equipment under test,(*see* Fig. 1) Ph-N Reversal unit typically relay based Ph-N reversal

FIG. 5 EXAMPLE OF TEST CIRCUIT FOR DUT USING A COMPUTER AND EXTERNAL EV SIMULATION CIRCUIT

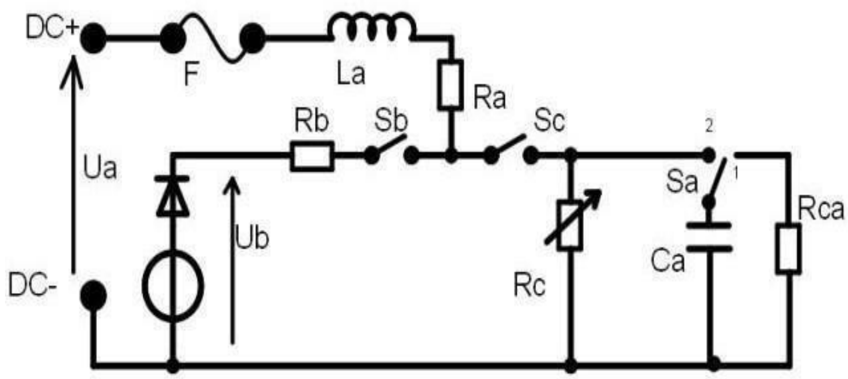
The switch S0 shall be designed to withstand the d.c. output current opening under load at the rated d.c. output current of the DUT.

The switches S8, S9 shall be designed to withstand the a.c. output current opening under load at the rated a.c. output current of the DUT.

D-2.2 Example of d.c. Test Load

For d.c. test load an artificial load, such as a resistive load, an electronic load and a voltage source (for example, battery), or an actual EV may be used. An electronic load operating under constant resistance mode is not considered as a resistive load. The artificial load requires an additional EV control simulator to establish the analogue interface and/or digital communication with the DUT.

Unless otherwise specified, a resistive load or an electronic load shall be used for the compliance tests indicated in Annex E. An example of the test load, represented by a simplified equivalent circuit diagram, is shown in Fig. 6.



Key

La	stray inductance < 100 μH
Ra	nominal battery impedance (10 mΩ for 100 A battery)
Rb	electronic voltage supply impedance (typically 10 mΩ)
Rc	variable resistance – rated for at least the rated d.c. output current Uainput to battery model from DUT
Ub	electronic voltage supply for battery simulation (self-protecting), programmable or manually adjustable (shown as a non-reversible supply)
Ca	capacitor for the simulation of battery high-current capacity (5 700 μF) Sa, Sb, Sc switching devices for test
F	fuse designed to protect all components of battery simulator
Rca	capacitor discharge resistance (the value does not influence the tests)

FIG. 6 EXAMPLE OF d.c. TEST LOAD

D-2.3 Example of a.c. Test Load

For a.c. test load an artificial load, such as a variable resistive load, a rheostat, a switched incandescent bulb load box, or an actual EV may be used. The a.c. load is also equipped with a.c. VIP measurement device to monitor these parameters during the test execution. The artificial load requires an additional EV control simulator to establish the analogue interface and/or digital communication with the DUT, also the control simulator has a communication module to fetch the parameters at the load end.

Unless otherwise specified, a resistive load or an electronic load shall be used for the compliance tests indicated in Annex E. An example of the test load, represented by a simplified equivalent circuit diagram, is shown in Fig. 7.

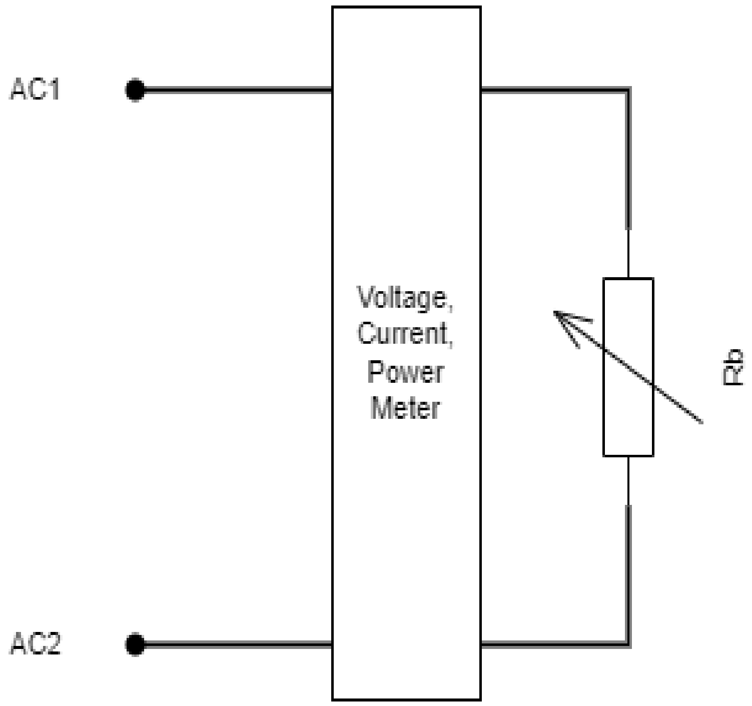


FIG. 7 EXAMPLE OF a.c. TEST LOAD

D-3 FUNCTIONS PROVIDED BY THE EV SIMULATION AND MEASUREMENT SYSTEM

D-3.1 General

The test circuit shall be capable of carrying out the tests described in this annex.

D-3.2 Control Pilot Test Emulation

The test installation shall provide CP resistor R6 of value 887 Ω with a series switch S6 to emulate CP state.

It shall also provide an additional switch S7 to simulate CP shorted to PE. Note switch state of S6 and S7 shall be controlled by EV simulator.

D-3.3 Load Test and Input a.c. Fault Simulation

Fig. CC1 shows the following resistors and switches. Similar functions could be supplied by other means:

S0 – closed by EV simulation to start d.c. energy transfer; S8, S9 closed by EV simulation to start a.c. energy transfer;

A phase-neutral reversal system is used; may comprise of relays to emulate a.c. Phase-Neutral reversal for the test case defined in Annex E.

All resistances shown may be variable and the values are chosen as a function of the test requirements.

D-3.4 Digital Communication Data by CAN

The test equipment shall be able to transmit and receive all CAN data frames as defined in Annex G.

D-3.5 Measured Information

The values of all parameters and all voltage and current measurements shall be displayed or recorded.

D-4 TEST ENVIRONMENT CONDITIONS

Unless otherwise specified, all tests shall be carried out under the following test conditions:

a) temperature: (25 ± 10) °C;
b) atmospheric pressure: 86 kPa to 106 kPa (86 kPa); and
c) relative humidity 30 percent to 90 percent; (except condensation).

D-4.2 Test Power Requirements

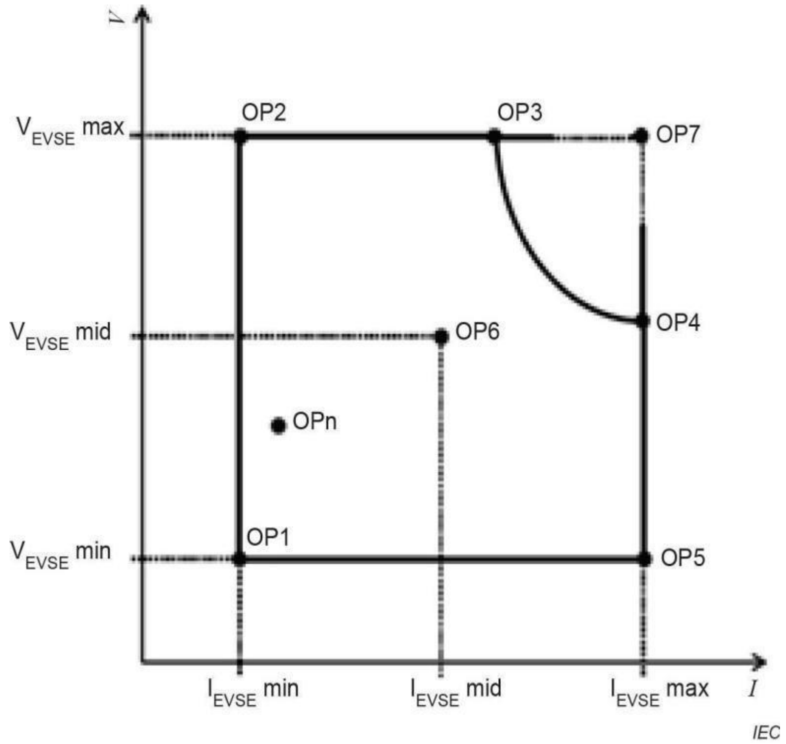
Power to the tested device shall be in accordance with IEC 60038, if designed to be supplied by the utility grid.

D-5 OPERATION POINT (INFORMATION ONLY)

The combined value of the d.c. output current and the d.c. output voltage defines an operating point for the d.c. EV supply equipment.

If the DUT shows any discontinuous behavior in its operating range, for example, in case of cascaded architecture of power modules, it might be necessary to add additional testing points. In the event that the operating area boundaries are reached, additional operation points or shifting of existing points shall be performed in order to fulfill the test requirements.

Fig. 8 shows an example of the range of d.c. output voltage and d.c. output current which can be output by the DUT, and some representative operation points. These values may be stated in the test schedule.



Key

I_{EVSE} max I_{EVSE} mid

Rated d.c. output current of EV supply equipment (V_{EVSE} max + V_{EVSE} min)/2

OP1 OP2

V_{EVSE}min and I_{EVSE} min V_{EVSE} max and I_{EVSE} min

Key			
I_{EVSE} max I_{EVSE} mid	Rated d.c. output current of EV supply equipment (V_{EVSE} max + V_{EVSE} min) / 2		
I_{EVSE} min	minimum d.c. output current of EV supply equipment operation point	OP3	V_{EVSE} max and Pmax OP
		OP4	I_{EVSE} max and Pmax
V_{EVSE} max	Rated d.c. output voltage of EV supply equipment	OP5	V_{EVSE} min and I_{EVSE} max
V_{EVSE} mid	(I_{EVSE} max + I_{EVSE} min) / 2	OP6	V_{EVSE} mid and I_{EVSE} mid
V_{EVSE} min	minimum d.c. output voltage of EV supply equipment	OP7	V_{EVSE} max and I_{EVSE} max
OPn	Operating d.c. output voltage and operating d.c. output current depending on test conditions		

OP4 I_{EVSE} max and Pmax V_{EVSE} max Rated d.c. output voltage of EV supply equipment OP5 V_{EVSE} min and I_{EVSE} max V_{EVSE} mid (I_{EVSE} max + I_{EVSE} min)/2 OP6 V_{EVSE} mid and I_{EVSE} mid V_{EVSE} min minimum d.c. output voltage of EV supply equipment OP7 V_{EVSE} max and I_{EVSE} max.

OPn Operating d.c. output voltage and operating d.c. output current depending on test conditions.

FIG. 8 OPERATION POINTS

ANNEX E

(*Clauses* 6.4.5.1, 6.5.5.1, C-5, D-1, D-2.2, D-2.3, D-3.3 *and* F-3.5)

(NORMATIVE)

COMPLIANCE TESTS

E-1 GENERAL

This annex gives the compliance test requirements for the control functions that are used for the energy transfer. Examples of test circuits and requirements for the testing equipment are given in Annex D. These tests represent minimal requirements and do not guarantee the operation of the equipment under all possible operational and environmental conditions.

In this annex the term DUT is used to refer to the EV supply equipment undergoing test.

The consecutive states of the energy supply procedure are indicated in the Fig. 9 and Table 12. Each state is referred to by the letters in this table. These states are used in this clause to define the operating state of the EV supply equipment undergoing test (DUT).

The numbers used to identify components used for the testing correspond to the identifying numbers in Fig. 5, Fig. 6, Fig. 7 and Fig. 8. The Fig. in Annex D are only given as examples of possible test set-ups. The numbers and letters on the Fig. of Annex D are used throughout this annex.

The steps indicated in this annex correspond to the identifiers indicated in Annex F.

Unless otherwise indicated, all tests will start by applying the energy transfer sequence given in Annex F. Start-up is initiated up to the reference state indicated for the test, in the order given in Table 12 and in Fig. 9 (state diagram). Tests may also be carried out sequentially without start-up between each test if this does not modify the initial state of the equipment.

Some tests require that specific states be set up by CAN commands allowing the correct conditions to exist.

Table 7 and Table 8 indicates the tests given in this annex and the corresponding requirements.

Tests may be conducted in any order. They have been ordered to minimize the set-up time between each test. The tests may be done sequentially with no intermediate start-up procedure, if compatible with the test.

CAN data frames shall be analyzed for each test, where necessary.

The tests shall be carried out on equipment that has undergone the environmental test of **12**.

E-2 INITIALISATION AND SEQUENCE PREPARATION

The DUT is disconnected from the load and connected to the a.c. supply network for 10 minutes before starting the test sequence.

The normal start-up sequence for each test is as described in Annex F using the parameter for the test circuit (*see* Annex D) and the test load (*see* Annex D) as indicated in Table 9, unless otherwise mentioned. The required testing starts at the start-up sequence stage (as defined in Table 12) and the normal start-up sequence is modified from this point onwards to allow for testing.

Table 7 Correspondence between Requirements and Test Descriptions for a.c. EV Supply Equipment

(*Clause* E-1)

Sl No.	Test	Title	Requirement
(1)	(2)	(3)	(4)
i)	**E-3.1**	Verification that the EV is properly connected to the a.c. EV supply equipment at start-up	**6.5.2**
ii)	**E-3.2**	EVSE a.c. input phase-neutral reversal check	**B-4**
iii)	**E-3.3**	Verification function before energy transfer	**6.5.5**, **6.5.6**,**6.5.7**
iv)	**E-3.5**	Energization of the power supply to the EV and test of the control pilot circuit	**6.5.8**
v)	**E-3.6**	Test of output response performance	**C-6**

Table 8 Correspondence between Requirements and Test Descriptions for d.c. EV Supply Equipment

(*Clauses* E-1 *and* E-2)

Sl No.	Test	Title	Requirement
(1)	(2)	(3)	(4)
i)	**E-3.1**	Verification that the EV is properly connected to the d.c. EV supply equipment at start-up	**6.4.2**
ii)	**E-3.2**	EVSE a.c. input phase-neutral reversal check	**B-4**
iii)	**E-3.3**	Verification function before energy transfer	**6.4.5**, **6.4.6**, **6.4.7**
iv)	**E-3.4**	Verification of the absence of a short-circuit on the cable assembly	**6.4.7.3**
v)	**E-3.5**	Energization of the power supply to the EV and test of the control pilot circuit	**6.4.8**
vi)	**E-3.6**	Test of output response performance	**C-6**
vii)	**E-3.7.3**	Test of voltage limiting	**6.4.9**
viii)	**E-3.8**	De-energization of the power supply to the EV and shutdown	**6.4.4**, **6.4.10**

Table 9 Initial Switch and Parameter Values for a Normal Start-up Sequence

(*Clause* E-2)

Sl No.	Parameter	Value	Note
(1)	(2)	(3)	(4)
i)	S0	Open	EV contactor is open
ii)	S1 to S6	Open	No fault simulation at beginning of test
iii)	S7	Initially open	S7 will be closed during the energy transfer sequence
iv)	LD	Initially open	The locking latching device is closed during the energy transfer sequence
v)	Sa	Open (position 1)	Capacitor not connected (passive resistive load)
vi)	Sb	Open	No imposed voltage for starting
vii)	Sc	Closed	Resistive load connected
viii)	Rc	= Vmax/Imax	Load can absorb full d.c. output power. If the output is limited in power, Rc is increased accordingly.

E-3 DESCRIPTION OF COMPLIANCE TESTS

E-3.1 Verification that the EV is Properly Connected to the a.c. or d.c. EV Supply Equipment. at Start-up

In the following text the control pilot wire voltage is measured between the control pilot wire and the PE (power earth) line of the supply equipment (*see* Fig. 1).

The energy transfer cycle shall not start under either (or both) of the following conditions:

a) the mechanical latch is disabled; and/or
b) the control pilot circuit is opened (S6 open) or the voltage of the control pilot circuit is within the range 4 V to 8 V (*see* test of **E-3.5)**.

Compliance for the mechanical latch is tested by inspection.

Compliance for the control pilot circuit is tested according to **E-3.5**.

E-3.2 EVSE a.c. Input Phase-Neutral Reversal Check

Start by setting the phase-neutral reversal unit to reverse the a.c. lines and start the energy transfer cycle up to state C1.

Here the DUT shall perform the phase-neutral reversal test and flag the test as failed, along with the termination of a.c. charging flow.

Now set the phase and neutral in correct order and repreate the test, consequently achieving energy transfer.

E-3.3 Verification Function Before Energy Transfer

The CAN data logger is used to verify the correct information exchange. Start the energy transfer sequence up to the end of state-B2, where the test setup requests a.c. or d.c. charging mode based on the mode under test and moves to state C1 (for a.c.) or D1(for d.c.).

The test system starts the exchange protocol as indicated in Annex G.

For this test the test equipment shall give incorrect parameters in order to test the compatibility between the d.c. EV supply equipment and the EV.

For d.c. The test system transmits:

a) d.c. output voltage target parameter;
b) d.c. output voltage limit parameter;
c) Requested d.c. output current;
d) The DUT shall transmit;
e) Rated d.c. output current;
f) Rated d.c. output voltage;
g) Rated d.c. output power;
h) In addition to a test with correct parameters, tests shall be made with at least three parameters that are known to be incompatible with the d.c. EV supply equipment ratings as follows;
j) d.c. output voltage limit parameter > rated d.c. output voltage of EVSE;
k) d.c. output voltage limit parameter > 120 V;
m) d.c. requested output current parameter > available d.c. output current; and
n) One test shall be done with all transmitted parameters within the rating of the DUT.

For a.c. The test system transmits:

a) a.c. output voltage limit parameters (min, max limits);
b) Maximum requested a.c. output current;
c) Maximum requested a.c. output power;
d) The DUT shall transmit;
e) Available a.c. output voltage (minimum and maximum output voltage parameters);
f) Available a.c. output current;
g) In addition to a test with correct parameters, tests shall be made with at least three parameters that are known to be incompatible with the a.c. EV supply equipment ratings as follows;
h) a.c. output voltage limit parameter > rated a.c. output voltage of EVSE;
j) a.c. output voltage limit parameter > 480 V ac; and
k) Maximum requested a.c. output current > rated a.c. output current.

One test shall be done with all transmitted parameters within the rating of the DUT

Compliance is determined if the following conditions are satisfied.

The reason for not transferring energy shall be indicated by the DUT.

The DUT shall not modify the initial settings to accommodate the incompatibility with the EV, unless this modification is done under a specific procedure as defined by the manufacturer and maintains the output within ratings of the DUT and the a.c. supply network.

These error conditions shall inhibit the continuation of the energy transfer procedure until the compatibility check is successfully completed. The DUT shall resend the parameters until the compatibility check is fulfilled.

NOTES

1 The parameters can change during the energy transfer. If the parameters are incompatible the error conditions in **6** apply.

2 Parameters are defined in Table 15 and Table 16

E-3.4 Verification of the Absence of a Short-Circuit on the d.c. Cable Assembly (6.4.7.3)

For this test, resistance R3 shall have a value of 1 000 Ω (± 5 percent) 10 W maximum. S3 is initially closed.

NOTE — Warning, the R3 can become very hot under failure conditions if the rated d.c. output voltage is applied continually.

Start the energy transfer sequence. The sequence will not proceed beyond state-D1 and will initiate a fault condition over CAN bus and termination of the energy transfer schedule.

Measure the d.c. output voltage during the test. The test d.c. output voltage from DUT shall not be below 3 V d.c. or exceed 15 V d.c..

NOTE — R3 limits the short circuit test current to 12 mA. at 12 V d.c..

Open S3 and repeat the test. The test sequence shall proceed beyond state D1 and not fail due to short circuit.

E-3.5 Energization of the Power Supply to the EV and Test of the Control Pilot Circuit

The state of CP is set to allow energy transfer by closing S6 and setting R6 in circuit.

NOTE — The value of 6 V is the midpoint of the high voltage state.

Start the output sequence into state C3 (a.c. mode) (Table 13) and in state D3 (in d.c. mode) (Table 12). The DUT will supply current as indicated by the requested d.c. output current parameter of the test system (for d.c. mode) or as set by a.c. load (for a.c. mode).

Test the following output voltages to the control pilot wire (two voltage levels for each state).

The sequence will be restarted between each test. Changes between each voltage level will be done in less than 1 ms.

E-3.6 Test of Output Response Performance

E-3.6.1 *For d.c. Mode*

For this test the d.c. test load (*see* **D-2.2**) will operate as a constant voltage sink that can operate at the rated d.c. output voltage and the rated d.c. output current of the DUT. This can be achieved by the use of an electronic reversible controlled voltage source or a non-reversible voltage source that is able to supply the rated d.c. output current to the load resistance Rc. Stabilization of the voltage and low impedance to high frequency current variation is achieved by the use of a capacitor Ca. This description of the test is given for a non-reversible voltage source.

NOTE — The capacitor is also used to check the ripple current due to the d.c. EV supply equipment.

Initially, close Sa, Sb and Sc. Set the voltage on the load to 70 percent of the rated d.c. output voltage. Set the value of Rc of the test load to enable current sinking of at least the rated d.c. output current.

Use the following settings for a non-reversible test load:

a) Rc = (rated d.c. output voltage)/(rated d.c. output current). Set the test equipment to the following settings;
b) d.c. output voltage target parameter = 85 percent of rated d.c. output voltage; and
c) d.c. output voltage limit parameter = 90 percent of rated d.c. output voltage;

NOTE — The setup corresponds to the voltage limiting mode as shown on Fig. B3 of Annex C-6.

Start the energy transfer sequence with requested d.c. output current parameter = 20 of the rated d.c. output current.

Enable the energy transfer sequence up to and into state **D3**.

The DUT will now supply approximately 20 percent of the rated d.c. output current with an d.c. output voltage equal to 70 percent of the rated d.c. output voltage (determined by the voltage source of the test load).

Increase the d.c. output current by steps of 20 percent of the rated d.c. output current every 5 s (minimum) up to the rated d.c. output current.

The d.c. output voltage of the DUT should remain at 70 percent of the rated d.c. output voltage during the first steps and will rise to 80 percent of the rated d.c. output voltage.

At the next step:

a) for d.c. output voltage regulation (**C-3**) the d.c. output voltage shall be limited to 85 percent of the rated d.c. output voltage (within the tolerance of + 2 V d.c. and - 5 V d.c.); and
b) for d.c. output current regulation (**C-2**) the d.c. output voltage will rise above the d.c. output voltage target parameter and the EV supply equipment shall go to error shut-down.

The d.c. output currents shall be according to the tolerances as indicated in table 5.

Maintain the DUT at the rated d.c. output current for 10 s.

Decrease the requested d.c. output current parameter by steps of 20 percent of the rated d.c. output current every 5 s (minimum).

The change of d.c. output current, shall be according to Table 5.

The current flow into the capacitor Ca is measured with a high frequency current probe.

The high frequency currents measured 3 s after each current step shall according to Table 5.

Table 10 Test Value for Control Pilot Circuit

(*Clauses* E-3.7.2 *and* E-3.7.3)

Sl No.	Test Condition	Result
(1)	(2)	(3)
i)	S6 - Open S7 - Open	d.c. EV supply equipment stops power transfer. This state may be due to an open control pilot circuit or a disconnected vehicle connector.
ii)	S6 - Dont Care S7 - Closed	Energy transfer stops with error and gives error information.
iii)	S6 - Closed S7 - Open	The system continues energy transfer

E-3.6.2 *For a.c. Mode*

For this test the a.c. test load (*see* **D-2.3**) will operate as a resistive load that can operate at the rated a.c. output voltage and the rated a.c. output current of the DUT.

Start by setting the load to the minimum current setting. Enable the energy transfer sequence up to and into state-C3 Increase the a.c. load to 20 percent of the rated a.c. output current.

Increase the a.c. output current by steps of 20 percent of the rated d.c. output current every 5 s (minimum) up to the rated a.c. output current, DUT shall maintain state C3 in this step.

Further Increase the load to 120 percent of rated a.c. current. EV supply equipment shall go into fault condition and terminate the charging session as per flow defined in Annex F.

E-3.7 Test of Voltage Limiting

E-3.7.1 *General*

The initialization procedure for these tests is identical to that of **E-3.6** for respective modes.

The test for voltage limits with respect to the d.c. output voltage limit parameter while operating under d.c. output voltage regulation (according to **C-3**) is included in the test of output response of **E-3.6**.

E-3.7.2 *Testing of Maximum Voltage Without Voltage Limiting*

The DUT works under d.c. output current regulation according to **C-2**.

TEST 1

The energy transfer sequence is taken up to and including state **D3** with requested d.c. output current parameter at 20 percent of the rated d.c. output current. The DUT will now supply 20 percent of the rated d.c. output current.

Change the test load to increase the current drawn by the test device to 90 percent of the rated d.c. output current.

If the d.c. output voltage exceeds one of the following limits for more than 2 s:

a) the d.c. output voltage limit + 1.5V;

b) 101, 5 percent of the d.c. output voltage limit; and

c) the rated d.c. output voltage + 2 V.

The DUT shall initiate an error shutdown so that the d.c. output current is reduced below 1 A within the time indicated for error shutdown in Table 10.

TEST 2

The energy transfer sequence is taken up to and including state-D3 with requested d.c. output current parameter at 20 percent of the rated d.c. output current. The DUT will now supply 20 percent of the rated d.c. output current.

Impose a voltage of 123 V on the DUT using an external supply.

The DUT shall initiate an error shutdown so that the d.c. output current is reduced below 1 A within the time indicated for error shutdown in table 10

The DUT is deemed to fail the test if it is not fully functional after the tests and after being reinitialized.

E-3.7.3 *Testing of Vervoltage on the d.c. Output*

Two tests shall be carried out.

TEST 1

Restart the energy transfer sequence and go up to and including state **D3** with the requested d.c. output current parameter at 20 percent of the rated d.c.

output current. The DUT shall supply 20 percent of the rated d.c. output current.

Increase the requested d.c. output current parameter 95 percent of the rated d.c. output current.

If the d.c. output voltage rises above 150 V d.c. EV supply equipment shall initiate an emergency shutdown so that the d.c. output current is reduced below 1 A within the time indicated for emergency shutdown in Table 10.

TEST 2

Restart the energy transfer sequence and go up to and including state-D3 with the requested d.c. output current parameter at 20 percent of the rated d.c. output current. The DUT shall supply 20 percent of the rated d.c. output current.

After at least 5 seconds impose, using an external supply, a voltage of 151 V between the d.c. + and d.c. - of the vehicle coupler. The DUT shall reduce the d.c. output current is reduced below 1 A within the time indicated for emergency shutdown in Table DD 3.

The DUT is deemed to fail the test if it is not fully functional after the tests and after being reinitialized.

E-3.8 De-Energization of the Power Supply to the EV and Shutdown

E-3.8.1 *General*

The voltage of the control pilot circuits set to 6 V d.c. ± 0.5 V

NOTES

1 The value of 9 V is the midpoint of the high voltage state.

2 Start the output sequence into state -C with d.c. output current set to 90 percent of the rated output and the load resistor set to give an d.c. output voltage of 80 percent of the rated d.c. output voltage. The d.c. output voltage limit parameter is set to the rated d.c. output voltage. The DUT will supply current as indicated by the requested d.c. output current parameter of the test system. (S7 and LD will have been closed to get to this stage).

3 If the DUT is limited in power, the d.C. output current and d.c. output voltage are set to within the rated d.c. output power limits, applying the same perent decrease in current and voltage.

E-3.8.2 *Shutdown Timing for Tests*

Table 11 indicates the maximum shutdown times required for the above tests. The d.c. output current and d.c. output voltage shall be measured during the shutdown phase and the time required for complete shutdown measured.

E-3.8.3 *User Initiated Shutdown Commands*

The presence of user shutdown and emergency shutdown commands is checked by inspection and by test.

E-3.8.4 *Normal Shutdown*

Normal shutdown is tested during the output response of the performance test. The ramp-down rate shall be as shown in Table 11.

E-3.8.5 *Error Shutdown*

The following events shall be simulated:

a) loss of digital communication for more than 1 s;
b) d.c. output voltage exceeds the target voltage parameter for more than 2 s; and
c) reception of insulation fault signal from the EV.

For each test, start the output sequence into state C. The DUT and the test load will be adjusted to give a d.c. output current equal to 90 percent of the rated d.c. output current, and the d.c. output voltage equal to 80 percent of the rated d.c. output voltage. (S7 and LD are closed, *see* Fig. 5)

Error shutdown is tested during the test of the control pilot circuit. Shutdown shall occur with the parameters indicated in Table 11.

E-3.8.6 *Emergency Shutdown*

The following events shall be simulated:

a) loss of the signal of the control pilot (voltage below 4 V d.c.) for more than 30 ms (opening of S7 of test equipment);
b) disconnection of vehicle connector under load;
c) d.c. output voltage exceeds the voltage limit parameter set by EV or 150 V for more than 30 ms; and
d) reception of emergency shutdown signal from EV or initiated by the user.

For each test, start the output sequence up to state C. The DUT and the test load will be adjusted to give a d.c. output current equal to 90 percent of the rated d.c. output current and the d.c. output voltage equal to 80 percent of the rated d.c. output voltage. (S7 and LD are closed, *see* Fig. 5).

After shutdown, the switch S0 (*see* Fig. 5) shall be opened immediately when the d.c. output current is less than 1 A.

The test is passed if the emergency shutdown requirements are in accordance with table 11 and if after emergency shutdown the d.c. output voltage falls below 60 V within 1s.

E-3.9 Reverse Current Flow

The circuit diagram of the DUT shall be analyzed to verify the presence of diodes or similar electronic components that render reverse current flow impossible.

Compliance is determined by inspection.

Compliance is not obtained if the means to prevent reverse current flow cannot be identified.

E-3.10 Load Dump

Compliance for load dump according to **C-7** shall be tested as follows:

1/set up the DUT and the test load to supply the rated d.c. output current at the rated d.c. output voltage. 2/open S0 (*see* Fig. 5)

Compliance is not obtained if:

The voltage between d.c. + and d.c. - at the vehicle connector exceeds 150 V d.c. The rate of increase exceeds 250 V/µs.

Table 11 Shutdown Requirements

(*Clauses* E-3.8.2, 3.8.4, 3.8.5 *and* 3.8.6)

Sl No.	Type of Shutdown	Test Fall Time (Seconds)[a]
(1)	(2)	(3)
i)	Normal	$Iro^{b}/20$
ii)	Error	$5 + Iro^{b}/100$
iii)	Emergency	$0.03 + Iro^{b}/200$

[a] This is the maximum time that may occur from the from the event causing shutdown and the reduction of the d.c. output current to 1 Amp.

[b] This is the value of the d.c. output current at the beginning of the event.

ANNEX F

(*Clauses* 6.4.1 *and* 6.4.10.2, 6.5.1, 6.5.10.2, 7.1, C-1, E-1, E-2, E-3.6.2)

(NORMATIVE)

ENERGY TRANSFER PROCESS AND COMMUNICATION

F-1 ENERGY TRANSFER PROCESS AND COMMUNICATION BETWEEN THE EV SUPPLY EQUIPMENT AND THE EV FOR ENERGY TRANSFER CONTROL

F-1.1 Energy Transfer State

Table 12 and Table 13 defines the energy transfer state of EV supply equipment. The energy transfer states show the physical status of the EV energy transfer system.

The EV supply equipment and the EV can exchange their energy transfer state through digital communication.

F-1.2 Communication Measures

Communication between the EV supply equipment and the EV is carried out through the digital communication circuits CAN_H and CAN_L.

The control pilot circuit is used to detect the physical presence of a vehicle for charging transmit instructions to start energy transfer or shutdown, from the EV to the EV supply equipment, according to Table 3.

The digital communication circuit transmits signals such as "ready to transfer energy" and "end of transfer" from the charger to the EV. Numerical parameters indicated in **6.4.7** and **6.5.7**. Are also exchanged through this digital communication circuit. (*see* Annex G).

F-2 ENERGY TRANSFER CONTROL PROCESS

F-2.1 State Transition Diagram and Sequence Diagram

The energy transfer process shall comply with the state transition diagram as shown in Fig. 9, which gives the energy transfer control sequence under normal operating conditions.

Table 12 Energy Transfer State of d.c. EV Supply Equipment

(*Clauses* E-1, E-2, E-3.5 *and* F-1.1)

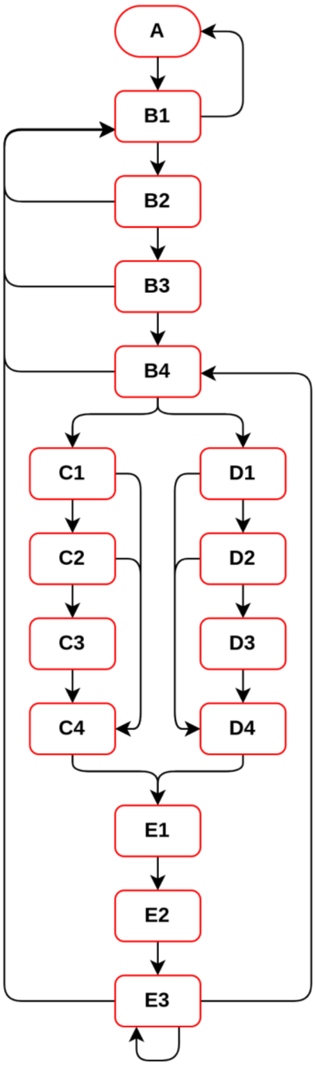
Sl No.	State	Connection	EV Connected	Digital Communication		CP	PP	Connector Latched	Evse Contactor	Energy Transfer
				EV	EVSE					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	A	EV not connected	No	No	No	Low	Low	No	Open	No
ii)	B1	Detection	Yes	Yes	Yes	High	High	No	Open	No
iii)	B2	Handshake	Yes	Yes	Yes	High	High	No	Open	No
iv)	B3	Latching	Yes	Yes	Yes	High	High	Yes	Open	No
v)	B4	EV permission wait	Yes	Yes	Yes	High	High	Yes	Open	No
vi)	D1	Energy transfer initiation, monitoring and shutdown	Yes	Yes	Yes	High	High	Yes	Open	No
vii)	D2		Yes	Yes	Yes	High	High	Yes	Open	No
viii)	D3		Yes	Yes	Yes	High	High	Yes	Closed	Yes
ix)	D4		Yes	Yes	Yes	High	High	Yes	Closed	No[1]
x)	E1	De-initialization	Yes	Yes	Yes	High	High	Yes	Open	No
xi)	E2		Yes	Yes	Yes	High	High	Yes	Open	No
xii)	E3	Error monitoring	Yes	Yes	Yes	High	High	Yes	Open	No

NOTE — In state D4 the contactors will be getting opened hence a leakage current may be present till the completion of contactor open operation

Table 13 Energy Transfer State of a.c. EV Supply Equipment

(*Clause* E-3.5)

Sl No.	**State**	**Connection**	**EV Connected**	**Digital Communication**		**CP**	**PP**	**Connector Latched**	**Evse Contactor**	**Energy Transfer**
				EV	EVSE					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	A	EV not connected	No	No	No	Low	Low	No	Open	No
ii)	B1	Detection	Yes	Yes	Yes	High	High	No	Open	No
iii)	B2	Handshake	Yes	Yes	Yes	High	High	No	Open	No
iv)	B3	Latching	Yes	Yes	Yes	High	High	Yes	Open	No
v)	B4	EV permission wait	Yes	Yes	Yes	High	High	Yes	Open	No
vi)	C1	Energy transfer initiation, monitoring and shutdown	Yes	Yes	Yes	High	High	Yes	Open	No
vii)	C2		Yes	Yes	Yes	High	High	Yes	Open	No
viii)	C3		Yes	Yes	Yes	High	High	Yes	Closed	Yes
ix)	C4		Yes	Yes	Yes	High	High	Yes	Closed	No[1]
x)	E1	De-initialization	Yes	Yes	Yes	High	High	Yes	Open	No
xi)	E2		Yes	Yes	Yes	High	High	Yes	Open	No
xii)	E3	Error monitoring	Yes	Yes	Yes	High	High	Yes	Open	No



Initialization

A : EV unconnected

A → B1 :

- Connection of EV

B1 : EV connected

- Vehicle connector inserted into vehicle inlet (CP-PP detected)
- Waiting the initiation by the user (optional and left to EVSE's discretion)

B1 → A :

- Disconnection of EV

B1 → B2 :

- On valid CP detection and optional user initiation, EVSE starts communication with EV over CAN.
- On valid PP detection, EV starts communication with EVSE over CAN
- Both EV and EVSE start receiving CAN messages from the counterpart.

B2 : Handshake

- EVSE sets all parameters of available charging modes, and corresponding capabilities.
- EVSE checks compatibility of EV parameters and sets/resets the EV Incompatibility Flag.
- Waiting for EV authentication (optional and left to EVSE's discretion)

B2 → B1 :

- Compatibility with EV not achieved.

B2 → B3 :

- EV-EVSE compatibility achieved with respect to available and requested charging mode and parameters.

B3 : Latching

- Latch is closed
- Verification of latch circuit

B3 → B1 :

- Latching failure.

B3 → B4 :

- EV latches the connector.
- "Connector latch status" = 1

B4 : Waiting for EV permission

- EVSE waits until EV permits charging start.

B4 → E3 :

- Any shutdown event.

B4 → C1 :

- EV permits charging "vehicle charging enabled" = 1
- "EV - charging mode" = 0

B4 → D1 :

- EV permits charging "vehicle charging enabled" = 1
- "EV - charging mode" = 1

	a.c. charging **C1 : a.c. tests** - EVSE performs the tests listed below - Phase to neutral reversal test - Phase to earth and/or neutral to earth voltage check test - EVSE contactor/relay weld detection test C1 → C4 : - Failure in any a.c. charging circuit tests. - Any shutdown event. C1 → C2 : - All a.c. charging circuit tests pass "EVSE ready" = 1 **C2 : Energy transfer initiation** - EVSE closes its a.c. contactors C2 → C4 : - Any shutdown event. C2 → C3 : - EVSE a.c. contactors closed "EVSE status" = 1. **C3 : Energy transfer** - EVSE and EV will monitor for faults and stop charging request from either the EVSE or EV, and initiate shutdown when required C3 → C4 : - Shutdown event : - EV initiated shutdown : "EV stop control" = 1 or - EVSE initiated shutdown : "EVSE stop control" = 1 **C4 : Energy transfer termination** - EVSE opens its contactors. C4 → E1 : - EVSE a.c. contactors opened "EVSE status" = 0.

	d.c. charging **D1 : d.c. short-circuit test on the d.c. cable assembly** - EVSE performs short-circuit test on the d.c. cable assembly on the d.c. charging circuit D1 → D4 : - Failure of short-circuit test on the d.c. cable assembly. - Any shutdown event. D1 → D2 : - short-circuit test on the d.c. cable assembly pass "EVSE ready" = 1 **D2 : Energy transfer initiation** - EVSE closes its d.c. contactor D2 → D4 : - Any shutdown event. D2 → D3 : - EVSE d.c. contactors closed "EVSE status" = 1. **D3 : Energy transfer** - EVSE and EV will monitor for faults and stop charging request from either the EVSE or EV, and initiate shutdown when required D3 → D4 : - Shutdown event: - EV initiated shutdown: "EV stop control" = 1 or - EVSE initiated shutdown: "EVSE stop control" = 1 **D4 : Energy transfer termination** - EVSE opens its contactors. D4 → E1 : - EVSE d.c. contactors opened "EVSE status" = 0.
	De-initialization **E1 : EVSE test status reset** E1 → E2: - "EVSE ready" = 0 **E2 : EV charging permission reset** E2 → E3: - EV permits charging "vehicle charging enabled" = 1 **E3 : Error monitoring** - EVSE and EV will keep monitoring for any faults/errors present and remain in this state as long as any faults/errors exist. E3 → B4: - No faults/error present E3 → B1: - Connector unlatched.

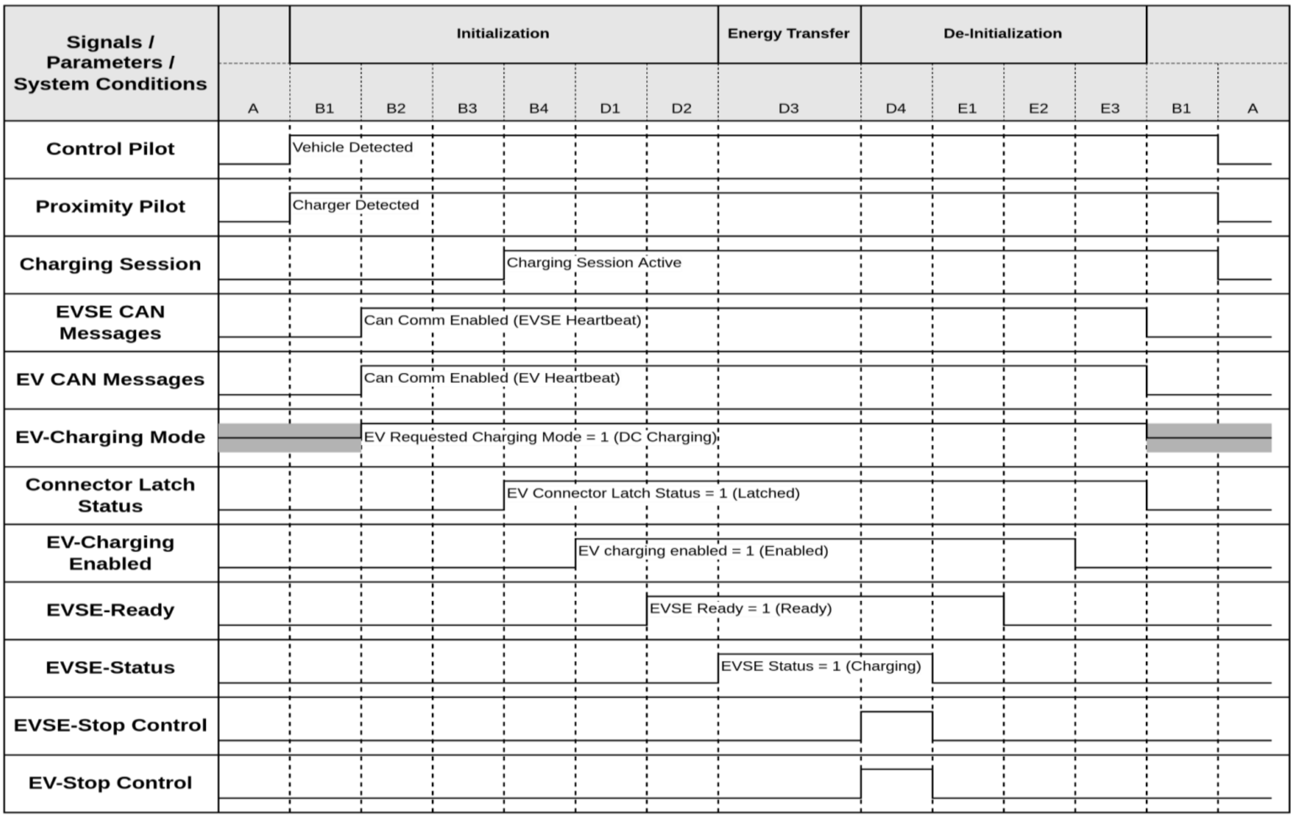


FIG. 9 STATE TRANSITION DIAGRAM OF d.c. CHARGING PROCESS

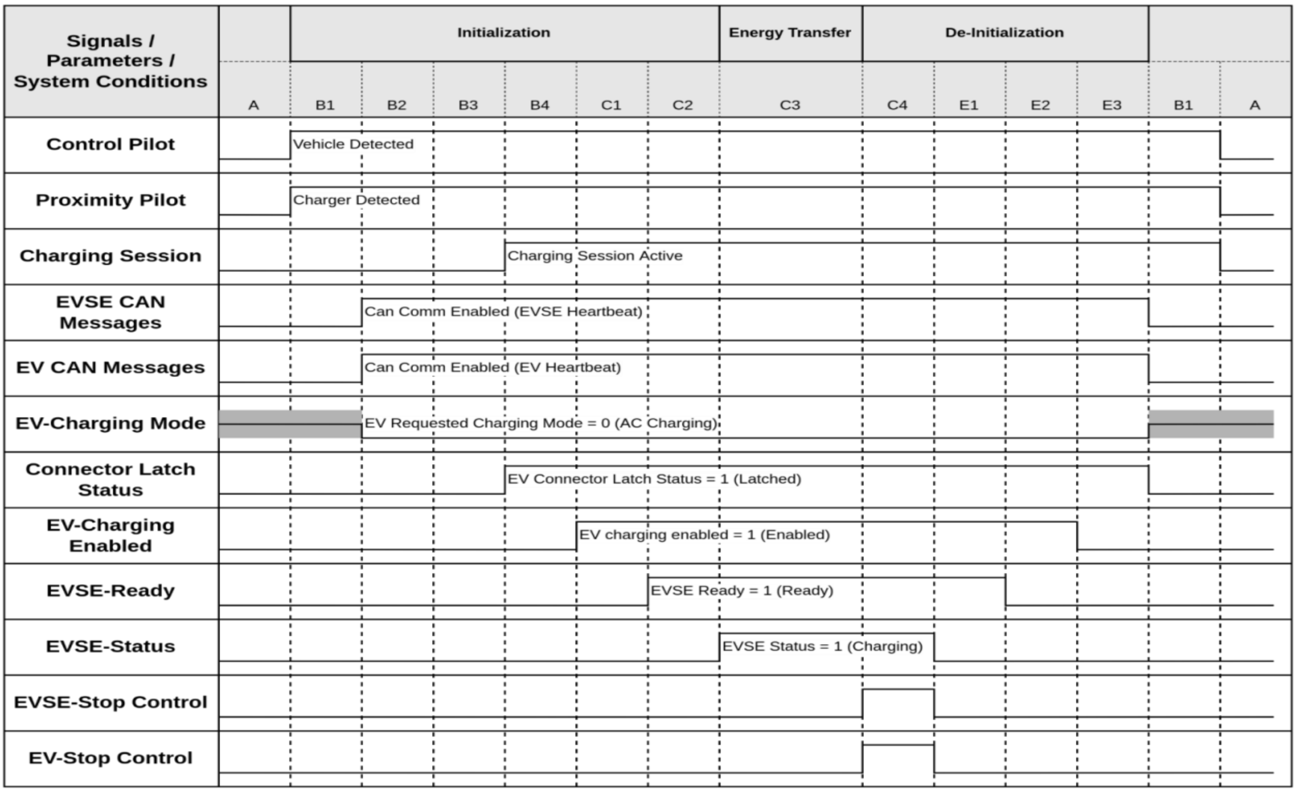


FIG. 10 STATE TRANSITION DIAGRAM OF a.c. CHARGING PROCESS

F-3 COMMUNICATION PROCESS

F-3.1 Initialisation

When the charging connector is connected, the energy transfer process is initiated simultaneously by EV supply equipment and the EV, by starting to transmit their respective CAN messages upon detection of CP and PP respectively.

"Energy transfer status" shall not be ready until the end of the short-circuit test on the d.c. cable assembly in **F-1.3.4**.

F-3.2 Handshake Procedure

The data transfer starts at state B2 as indicated on Fig. 9 The EV initially sends CAN frames 500H, 501H, 503H and 504H (*see* Note)

The EV supply equipment then responds with the CAN frames 508H and 509H, 50AH and 50BH (*see* Note)

NOTE — 504H and 50BH CAN messages are meant only EV/EVSE with a.c. charging capabilities.

The EV and the EV supply equipment verifies the coherence of the data exchanged, verifies Requested Charging mode against Supported Ones, along with respective parameters, and flags the error if found to be incompatible.

NOTE — EV can change the requested charging mode and parameters in order to be compatible with those of the EV supply equipment to allow for energy transfer.

The EV supply equipment performs a shutdown if the handshake is not established within 6 s.

F-3.3 Short-Circuit Test on the d.c. Cable Assembly before Energy Transfer

The EV informs the EV supply equipment that the connector is latched before initiating the test.

The short-circuit test on the d.c. cable assembly shall start only after the digital data from the EV indicates that the test may start (EV charging enabled = 1).

Test procedure is given in **E-3.4**.

F-3.3.1 a.c. *Charging Circuit Tests Before Energy Transfer*

The EV informs the EV supply equipment that the connector is latched before initiating the test.

The a.c. verification tests shall start only after the digital data from the EV indicates that the test may start (EV charging enabled = 1).

Test procedure is given in **E-3.2**.

F-3.4 Energy Transfer

The EV supply equipment operating in d.c. Charging Mode shall change the d.c. output current and the d.c. output voltage according to the parameters requested by the EV as described in **C-2** or **C-3**.

The EV supply equipment operating in a.c. Charging Mode shall supply the a.c. Output Current and Voltage within the relevant ranges according to the parameters requested by the EV as described in **6.5.8**.

F-3.5 Shutdown Procedure

For shutdown the EV supply equipment shall comply with the following procedure:

a) EV supply equipment shall notify the EV of the start of shutdown process by digital communication;

b) EV supply equipment shall stop the output current; and

c) The vehicle connector is not unlocked until the EVSE indicates that it is safe to unlatch the same tests for requirements are given in Annex E.

F-4 BI-DIRECTIONAL POWER FLOW

Bi-directional power flow is not treated in this document.

F-5 CHANGE OF AVAILABLE d.c. OUTPUT PARAMETER DURING ENERGY TRANSFER

The EV supply equipment operating in d.c. charging mode may modify the value of the available d.c. output current parameter during energy transfer.

Such modifications shall not be done more than once every 20 s.

ANNEX G

(*Clauses* 6.4.5.1 *and* 6.4.10.2, 6.4.10.2, 6.4.10.4, 6.5.5.1, 7.1, B-1, D-3.4, E-3.3, F-1.2)

(NORMATIVE)

DIGITAL COMMUNICATION FOR CONTROL OF ENERGY TRANSFER

G-1 GENERAL

This annex shows the specification of digital communication for control of the EV supply equipment according to the implementation with classical CAN frame format only (the flexible data rate frame format is not supported) in accordance with ISO 11898-1 and with ISO 11898-2.

In the context of this document, a direct data link (with no other nodes) is used between the d.c. EV supply equipment and the EV.

The physical/data link layer specifications are shown in Table 14.

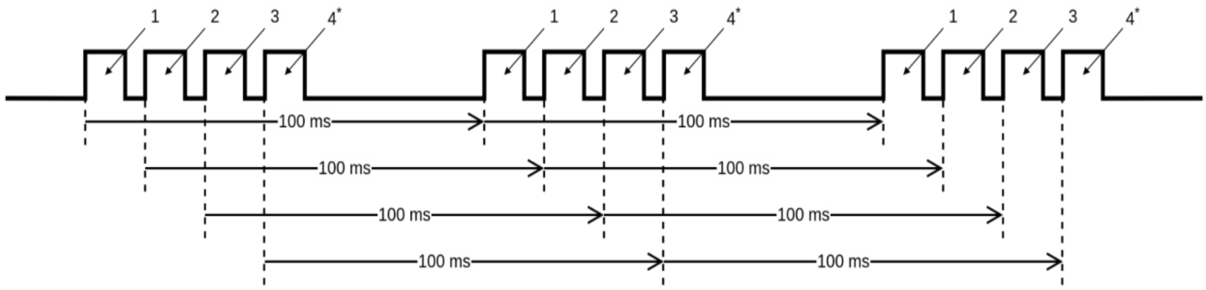
Table 14 Physical/Data Link Layer Specification

(*Clause* G-1)

Sl No.	**Specification of Communication Control Item**	**Requirements**
(1)	(2)	(3)
i)	Communication standard	ISO 11898-1, ISO 11898-2
ii)	Protocol	Classical base frame format
iii)	Operating mode of high-speed physical media attachment	Normal-mode[a]
iv)	Communication speed	500 kbps
v)	Bit sample point	72.5 % to 87.5 %

Operating mode is described in Table 1 of ISO 11898-2.

The transmission cycle of the data frames is indicated in Fig. 11.



Key

1. CAN data frame 1 (for example, EV: CAN-ID #500; EVSE: CAN-ID #508)
2. CAN data frame 2 (for example, EV: CAN-ID #501; EVSE: CAN-ID #509)
3. CAN data frame 3 (for example, EV: CAN-ID #503; EVSE: CAN-ID #50A)
4. CAN data frame 4 (for example, EV: CAN-ID #504; EVSE: CAN-ID #50B)

NOTES

1 The 100 ms timing can be longer if there are transmission problems.

2 Data frame 4 is mandatory only when EV/EVSE supports a.c. charging mode.

FIG. 11 TRANSMISSION CYCLE

The d.c. EV supply equipment shall stop energy transfer if any of the defined CAN data frames are not received during 1 000 ms.

G-2 DIGITAL COMMUNICATION ACTIONS DURING ENERGY TRANSFER CONTROL PROCESS

The communication actions and parameters according to the energy transfer control process are shown in Table 15 and in Table 16

Table 15 Received Parameters During Energy Transfer. [EV to Evse]

(*Clauses* 6.4.5.1, 6.4.7.2, 6.4.7.2e, 6.5.5.1, 6.5.7.2, E-3.3 *and* G-2)

CAN-ID (H')	Byte	Bit	Parameter	Content	Resolution per bit	Un it	Initial	Min	Max	Status Flag
	1	0	EV charging enabled	Status flag indicating charge permission status of EV	-	-	0	0	1	0: disabled 1: enabled
		1	EV contactor status	Status flag indicating that EV contactor is closed before charging or that welding detection is finished	-	-	1	0	1	0 : others 1 : EV contactor open before charging or welding detection finished
		2	EV charging position	Status flag indicating whether or not the EV position is appropriate for charging	-	-	0	0	1	0 : appropriate position 1 : inappropriate position
		3	EV charging stop control	Status flag indicating the transition to stop process of EV energy transfer	-	-	0	0	1	0 : Before transition 1 : After transition
		4	Wait request to delay energy transfer	Status flag for request to delay the energy transfer procedure (the EV contactor is open)	-	-	0	0	1	0 : No Request 1 : Request to Wait
		5	Digital communication toggle	Status flag put as 1 to indicate that communication is to be stopped	-	-	0	0	1	0 : Normal Conduction during communication 1: Requestto stop communication
		6-7		(Reserved)	-	-	-	-	-	
	2	0-7	Requested d.c. output current (lower 8 bits)	Current value requested by EV during charging	0.1	A	0	0	120	-
	3	0-7	Requested d.c. output current (higher 8 bits)							

Table 15 (*Continued*)

	4	0-7	d.c. output voltage target parameter (lower 8 bits)	Targeted charging voltage at the vehicle inlet terminals	0.1	V	6553.5	0	120	-
	5	0-7	d.c. output voltage target parameter (higher 8 bits)							
	6	0-7	d.c. output voltage limit parameter (lower 8 bits)	The maximum voltage value at the vehicle inlet terminals, at which the EV supply equipment stops charging to protect the EV battery	0.1	V	6553.5	0	120	-
	7	0-7	d.c. output voltage limit parameter (higher 8 bits)							
501	0	0-7	Control Protocol number	Software version number of control protocol or charging sequences that the EV deals with	1	-	-	0	254	
	1	v	Charging rate	Charging rate of battery	1	%	255	0	100	-
	2	0-7	Maximum charging time (lower 8 bits)	Maximum charging time permitted by EV	1	min	6 553 5	0	6553 4	-
	3	0-7	Maximum charging time (higher 8 bits)							
	4	0-7	Estimated charging time (lower 8 bits)	Estimated remaining time before the end of charging, calculated by EV	1	min	6 553 5	0	6553 4	-
	5	0-7	Estimated charging time (higher 8 bits)							
	6-7	0-7		(Reserved)	-	-	-	-	-	

Table 15 (*Continued*)

502	0	0	Voltage control option	Status flag indicating the EV requires that the d.c. EV supply equipment is operating so that the d.c. output voltage will remain at the d.c. output voltage target parameter	-	-	-	-	-	0: no voltage control 1: voltage control enabled
	1 - 7	0-7		(Reserved)	-	-	-	-	-	
503	0	0	Requested charging mode	Status flag indicating EV's charging mode request	-	-	1	0	1	0: a.c. Charging 1: d.c. Charging
		1	EV connector latch status	Status flag indicating the electromagnetic latching status of vehicle connector	-	-	0	0	1	0: unlatched 1: latched
		2	EV charging error	Generic Status flag indicating any fault present on EV preventing charging.	-	-	0	0	1	0: error-free 1: error
		3	AC voltage error	Status flag indicating an error in the a.c. Voltage from EVSE.	-	-	0	0	1	0: error-free 1: error
		4	EV on board charger error	Status flag indicating a Error caused by the on-board charger on the EV	-	-	0	0	1	0: error-free 1: error
		5-7		(Reserved)	-	-	-	-	-	
	1-7	0-7		(Reserved)	-	-	-	-	-	
504	0	0-7	a.c. voltage limit max parameter (lower 8 bits)	Maximum rated voltage the on-board charger can operate at	0.1	V	6 553.5	0	500	-
	1	0-7	a.c. voltage limit max parameter (higher 8 bits)							
	2	0-7	a.c. voltage limit min parameter (lower 8 bits)	Minimum rated voltage the on-board charger can operate at	0.1	V	6 553.5	0	500	-
	3	0-7	a.c. voltage limit min parameter (higher 8 bits)							

Table 15 (*Concluded*)

	4	0-7	Rated on-board charger current (lower 8 bits)	Maximum rated current the on-board charger can operate at	0.1	A	6 553.5	0	32	-
	5	0-7	Rated on-board charger current (higher 8 bits)							
	6	0-7	Rated on-board charger power	Maximum rated power the on-board charger can operate at	0.1	kW	25.5	0	18	-
	7	0-7		(Reserved)	-	-	-	-	-	
580	0-7	0-7	EV identification low byte	Serial number according to ISO 3297	-	-	-	-	-	-
581	0-7	0-7	EV identification high byte	Serial number according to ISO 3297	-	-	-	-	-	-
582	0-7	0-7	Protocol identifier low byte	For future development	-	-	-	-	-	-
583	0-7	0-7	Protocol identifier high byte	For future development	-	-	-	-	-	-
588	0-7	0-7	EV VIN Lower 8 bytes		-	-	-	-	-	-
589	0-7	0-7	EV VIN Middle 8 bytes		-	-	-	-	-	-
58A	0-7	0-7	EV VIN Higher 8 bytes		-	-	-	-	-	-
58B-5FF	0-7	0-7		(Reserved)	-	-	-	-	-	-

Table 16 Transmitted Parameters During Energy Transfer [Evse to EV]

(*Clauses* 6.4.5.1 *and* 6.4.7.2, 6.4.7.2e, 6.5.5.1, 6.5.7.2, E-3.3, G-2)

CAN-ID (H')	Byte	Bit	Parameter	Content	Resolution per bit	Unit	Initial	*Min*	*Max*	Status Flag
508	0	0	Charging system error	Status flag indicating a malfunction caused by EV or by the EV supply equipment, and detected by EV supply equipment	-	-	0	0	1	0: error-free 1: error
		1	EV Supply equipment Malfunction	Status flag for indicating whether or not there is a malfunction caused by the EV Supply equipment	-	-	0	0	1	0: error-free 1: error
		2	EV incompatibility	Status flag indicating the compatibility of EV (including EV battery) with the d.c. output voltage of EV supply equipment	-	-	0	0	1	0: compatible 1: incompatible
		3-7		(Reserved)	-	-	-	-	-	
	1	0	EV supply equipment stop control	Status flag indicating whether or not the EV supply equipment proceeds with shutdown process	-	-	0	0	1	0: operating 1: shutdown or stop charging
		1	EV supply equipment status	Status flag indicating the energy transfer from the EV supply equipment	-	-	0	0	1	0: standby 1: charging
		2	Vehicle connector latched	Status flag indicating the electromagnetic latching status of vehicle connector	-	-	0	0	1	0: Unlatched 1: latched
		3	EV supply equipment ready	Status flag indicating the EV supply equipment is ready for charging (not waiting)	-	-	0	0	1	0: not ready 1: ready

Table 1 (*Continued*)

		4	Waiting state before charging start	Confirmation status flag indicating that EV is delaying charging (EV contactor is open)	-	-	0	0	1	0: waiting 1: energy transfer
		5-7		(Reserved)	-	-	-	-	-	
	2	0-7	Rated d.c. output voltage (lower 8 bits)	rated d.c. output voltage value at the vehicle connector terminals	0.1	V	6 553. 5	0	120	-
	3	0-7	Rated d.c. output voltage (higher 8 bits)							
	4	0-7	Available d.c. output current (lower 8 bits)	Supply current value of the output circuit in the EV supply equipment	0.1	A	6 553. 5	0	100	-
	5	0-7	Available d.c. output current (higher 8 bits)							
	6	0-7	Confirmed d.c. output voltage limit (lower 8 bits)	Threshold voltage to stop the charging process in order to protect EV battery	0.1	V	6 553. 5	0	120	-
	7	0-7	Confirmed d.c. output voltage limit (higher 8 bits)							
509	0	0-7	Control protocol number	Software version number of control protocol or charging sequences that the EV supply equipment deals with	1	-		0	254	-
	1	0-7	Available d.c. output power	Rated d.c. output power value of the EV supply equipment	50	W	127 50	0	1270 0	
	2	0-7	d.c. Output voltage (lower 8 bits)	d.c. Supply voltage value of the output circuit in the EVSE	0.1	V	6 553. 5	0	250	-
	3	0-7	d.c. Output voltage (higher 8 bits)							
	4	0-7	d.c. output current (lower 8 bits)	Supply current value of the output circuit in the EV supply equipment	0.1	A	6 553. 5	0	150	-

Table 15 (*Continued*)

	5	0-7	d.c. output current (higher 8 bits)							
	6	0-7	Remaining charging time (lower 8 bits)	Remaining time before the end of charging	1	mi n	655 3 5	0	655 3 4	-
	7	0-7	Remaining charging time (higher 8 bits)							
510	0	1	Voltage control option	Status flag indicating that the d.c. EV supply equipment is operating so that the d.c. output voltage will remain at the d.c. output voltage target parameter	-	-	-	-	-	0: no voltage control 1: voltage control enabled
50A	0	0	a.c. charging capability	Indicates whether a.c. charging mode is supported	-	-	0	0	1	0 : Unsupported 1 : Supported
		1	d.c. charging capability	Indicates whether d.c. charging mode is supported	-	-	0	0	1	0 : Unsupported 1 : Supported
		2	EV supply equipment - safe to unlatch connector	Status flag indicating if it's safe to unlatch connector on the EV	-	-	0	0	1	0: Keep Latched 1: Safe to Unlatch
		3-7		(Reserved)	-	-	-	-	-	
	1 (d.c. Chargi ng Errors)	0	Rectifier overload alarm	Status flag indicating the mentioned fault	-	-	0	0	1	0: error-free 1: error
		1	Over current	Status flag indicating over-current	-	-	0	0	1	0: error-free 1: error
		2	Over voltage	Status flag indicating over-voltage	-	-	0	0	1	0: error-free 1: error

		3	Under voltage	Status flag indicating under-voltage	-	-	0	0	1	0: error-free 1: error
		4	Over Temperature	Status flag indicating over-temperature	-	-	0	0	1	0: error-free 1: error
		5	CAN comm. fail	Status flag indicating error with CAN communication.	-	-	0	0	1	0: error-free 1: error
		6-7		(Reserved)	-	-	-	-	-	
	2 (a.c. Charging Error)	0	MCB	Status flag indicating MCB error	-	-	0	0	1	0: error-free 1: error
		1	Input OC	Status flag indicating a.c. over-current	-	-	0	0	1	0: error-free 1: error
		2	Input OV	Status flag indicating a.c. over-voltage	-	-	0	0	1	0: error-free 1: error
		3	Input UV	Status flag indicating a.c. under-voltage	-	-	0	0	1	0: error-free 1: error
		4	Earth fault	Status flag indicating earth fault	-	-	0	0	1	0: error-free 1: error
		5 -7		(Reserved)	-	-	-	-	-	
50B	0	0-7	Available a.c. output current (lower 8 bits)	Maximum output current value of the EV supply equipment	0.1	A	6 553.5	0	32	-
	1	0-7	Available a.c. output current (higher 8 bits)							

Table 15 (*Continued*)

Table 15 (*Concluded*)

	2	0-7	a.c. output voltage limit max parameter (lower 8 bits)	Maximum rated voltage the EVSE can operate at	0.1	V	6 553.5	0	500	-
	3	0-7	a.c. output voltage limit max parameter (higher 8 bits)							
	4	0-7	a.c. output voltage limit min parameter (lower 8 bits)	Minimum rated voltage the EVSE can operate at	0.1	V	6 553.5	0	500	-
	5	0-7	a.c. output voltage limit min parameter (higher 8 bits)							
	4	0-7	a.c. output current (lower 8 bits)	Supply current value of the output circuit in the EV supply equipment	0.1	A	6 553.5	0	100	-
	5	0-7	a.c. output current (higher 8 bits)							
584	0-7	0-7	EVSE identification low byte	Serial number according to ISO 3297						
585	0-7	0-7	EVSE identification high byte	Serial number according to ISO 3297						
586	0-7	0-7	Protocol identifier low byte	For future development						
587	0-7	0-7	Protocol identifier high byte	For future development						
58B-5FF	0-7	0-7		(Reserved)	-	-	-	-	-	

ANNEX H

(*Foreword*)

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