To:
The Principal Scientific Advisor, Government of India
Secretary, Department of Science & Technology

From:
V. Sumantran
Chairman
DST-PSAO Group to guide the development of Indian Standards for Electrical Vehicle Charging Infrastructure

Date:
16 September 2021

Subject: Status Report on the Group's activities
DST-PSAO Group to guide the development of Indian Standards for Electrical Vehicle Charging Infrastructure

Anticipating accelerated technological advances in the mobility domain, a 'Consultative Group on Future Technology (CGFT)' was constituted by the Office of Principal Scientific Adviser (PSA) to the GoI in 2018, to advice the government on matters related to emerging transportation technology.

Among the topics addressed in this forum, special attention was directed to our country's roadmap to accelerate migration to electric mobility motivated by (a) CO2 reduction opportunities, (b) addressing poor air quality arising from tail-pipe emissions from many conventional vehicles and (c) reduction of oil imports. While there has been an encouraging level of activity among many start-ups and established manufacturers to roll out new electric vehicles (EVs), it was observed that adoption of EVs would likely be paced by the availability of EV charging infrastructure. Hence this topic was assigned higher priority for attention.

Enhancing and Accelerating India's E-mobility Ecosystem

In the context of faster adoption of EVs, it has been observed that even as many high-profile announcements have been made by many start-ups indicating impressive levels of investment and scale of manufacturing, consumer sentiments towards purchase of EVs is cautious, paced understandably by the still inadequate EV charging infrastructure deployed in Indian cities. CGFT *inter alia* examined the charging infrastructure needs and other ecosystem enablers in the context of transition to e-mobility. In parallel, DST has been involved in developing appropriate standards in the country for products including Electric Vehicle Supply Equipment (EVSE).

Towards this goal, the Office of PSA jointly with the Department of Science and Technology (DST) in June 2020 year constituted a DST-PSAO Group (based on the Office Memorandum dated 8 June, 2020, attached as Annexure-A) to guide the development of Indian Standards for EV Charging Infrastructure under the Chairmanship of Dr. V. Sumantran, who has been a lead-member of the CGFT.

The Group as constituted ensured broad and relevant participation from automakers, suppliers from the auto industry and electronics industry, members of the committee of Bureau of Indian Standards (BIS), and homologation and certification agencies (including ARAI).

The Group was requested to address the following topics based on the Office Memorandum referred above:

1. Low-Power AC Charging Points at affordable cost for 2/3 wheelers
2. Normal Power Parking Bay Charging Infrastructure (both AC and DC)
3. High-Power Charging infrastructure for Buses

The following sections provide a status report of the activities:

1. Low-Power AC (2-w/3w) Charging Infrastructure

While most industrialized nations have focused on charging systems for cars (each usually costing in excess of several Lakhs of Rupees), for India, the initial scale will emerge from 2-Wheelers and 3-Wheelers. A large fraction of the charging systems needed in India will have to be sized suitably and be produced at extremely affordable cost to be viable and to achieve the required scale of deployment across the country.

Guided by this group set about to develop an innovative new solution with the help of a sub-committee drawn from industry, government agencies, and academia. The Group identified a breakthrough in affordability (each unite targeted to cost Rs 4000/-) while preserving the key elements of functionality (public access, smart-phone operation, user authentication, network protection, e-wallet payment, and back-end analytics). The specifications and standards were developed with close involvement of a wide cross-section of OEMs, component suppliers, Discoms, cellular operators and ARAI. The draft standards were developed after taking the additional step of manufacturing a limited number of representative prototypes (from multiple suppliers) and testing and validating them. The system was also configured to allow powerful data analytics at the back-end to monitor and improve performance. A basic smartphone app that would operationalise the system and allow extensions to back-end analytics was also a part of the testing and pilot.

A design competition was carried out for the students of the National Institute of Design (NID), Ahmadabad in June 2020. More than 17 proposals involving about 50 students resulted in aesthetically appealing and ergonomically novel designs. Best design was awarded with cash prize of Rs. 50,000/- along with citation. Runner-ups were given citation.

Based on the proposed product, draft specifications and standards for a low-cost AC charging point for 2-wheelers/3-wheelers were finalized. The objective is widespread proliferation of low-cost AC charging points, in urban areas to start with.

A status report was provided to VC NITI-AAYOG at the meeting convened on 29th October, 2020. (Annexure-B). At this meeting, VC-NITI endorsed the priority for this approach and facilitated acceleration of the activities and support from Ministry of Consumer Affairs and the Bureau of Indian Standards (BIS)

Supporting this initiative, in order to adequately test and validate the proposed smart charger architecture and system, a pilot project on **'Prototyping & Field Validation of Light Electric Vehicle AC Charge Point'** was initiated through the Automotive Research Association of India (ARAI), Pune, with fund support from DST. This project includes integration with and validation of the user-friendly mobile App that would handle the functions of charge points location finder, user e-authentication and e-wallet billing. The Charge Point Device is expected to cost under Rs. 4,000/- per charge point. 100 numbers of the prototyped device were deployed by August 2021 in the cities of Delhi and Bangalore and are being validated by several manufacturers and institutional users.

<u>Closure:</u>

The draft specification for the Low-Power AC Charging Points produced by the Group was endorsed by NITI Aayog and the same was referred to the Department of Consumer Affairs. Accordingly, the Bureau of Indian Standards (BIS) has notified the LEV AC Charge-point standards (Annexure-C) on August 31, 2021.

This is arguably the first ever formal standard on AC Charge-point for 2w/3w EVs anywhere in the world.

2. Normal Power Parking Bay Charging Infrastructure (both AC and DC)

Activities related to this domain are being led and undertaken by the BIS Sectional Committee ETD – 51.

A status report on this topic was provided on 19th February, 2021 (Annexure-D)

3. High-Power Charging infrastructure for Buses

Keeping in mind that the industry and fleet operators will need to deploy different kinds of systems, based on route demands, duty cycle, and space for infrastructure, the Group addressed the three mainly relevant alternate solutions for high power charging of e-Buses. These systems are similar to those also employed in most global markets, as below:

3b: High Power Automated Connector Charging (also called ACD/ Opportunistic Charging / Pantograph charging)
3b: High Power Plug-in DC Charging
3c: Swappable Batteries for eBus

Accordingly, three Subgroups (with membership from the main OEMs, Suppliers, infrastructure providers, Discoms, and ARAI) were set up in August 2020 to develop the draft Standards. In all cases, the sub-committee has debated the balance needed between allowing for evolving technologies and proliferation of new solutions with the need for standardisation. A key requirement to achieve economic savings at the national level was defined as **interoperability**. This would allow:

a. Transit authorities to ensure competitive bidding in multiple tenders while retaining invested infrastructure, and at the same time,
b. The Indian bus and manufacturing industry can invest in scale so that same charging systems would be applicable in multiple cities and regions.

Progress was reported via an Interim Report dated 16th June, 2021 (Annexure-E)

<u>3a: Automatic Connecting Device (ACD/ Pantograph)- eBuses</u>

A Standards draft document has been completed and written in 2 parts:

(i) ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES (Annexure-F)

(ii) ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES - Infrastructure – mounted pantograph (cross rail) connection (Annexure – G)

Unlike many previous efforts in this domain across the globe, the sub-committee has seen to it that interoperability has been incorporated to increase volume-driven efficiencies for the country as these systems get deployed across the nation.

Since many members of the BIS ETD-51 Group, as well as prominent technical specialists from industry and academia have been involved and consulted in the creation of these above draft standards, we are hopeful that they will see speedy processing as per BIS protocols.

For this technology, we have not seen the need for any specific proof-of-concept or pilot deployment since the engineering specifications and protocols are derived from contemporary designs that are already successfully working across the globe.

These standards will also be relevant for future e-Truck charging as well.

3b: Dual Gun Plug-In Charging- eBuses

Globally, single-gun plug-in charging systems are widely deployed. Most systems allow operation up to 250 kW, although operational systems in India allow up to 150 kW limited by higher ambient temperatures and equipment specification. To deliver higher quantum of power requires more complicated systems that are capable of both higher capacity of thermal management as well as more sophisticated electrical contact management.

Since Buses typically will have larger batteries (up to 300 kWh) and there fore require faster rates of charging, many bus systems choose to deploy “dual-gun” chargers where two guns that are each capable of up to 150 kW may be used simultaneously. This allows the delivery of up to 300 kW of power and hence shorter charging duration when the bus is not available for line operation. Managing the electrical and communication protocols for a dual-gun system requires more care and functionality from the charging system.

The Group has addressed this challenge with what is likely the world's first interoperable Dual Gun draft specifications. This system draws on most of the specifications and standards that have already been developed for the Single-gun charging system and for which standards have been deployed (Annexure-H and Annexure-I). Wherever, Dual-gun specifications are different or not applicable (compared to the Single-gun system) those specifications have been defined and prepared for drafting as parts of the new standard. Where the Single-gun system specifications remain valid, they have been carried over. In other words, most of the draft standard to be submitted to BIS will be based on BIS's existing standard for Plug-In charging with minimal modifications to suit Dual Gun and Interoperability needs. All aspects of specification and standards are agreed and signed off with Industry.

There is little need for any additional specific proof-of-concept or pilot applications since Dual gun charging is already implemented, with support from PSA Office, at Ahmedabad and is running successfully for the last 6 months after initial iterations. Experience from this deployment has been used in the development of the specifications.

A draft standard is being compiled for approval from the Group and subsequent transfer to BIS for their processing.

As against the earlier target of 31st August for this Draft, we have a 4-week delay in submission of the same. The delay is on account of certain specifications for Dual Gun as well as shortage of resources to prepare the documentation. It expected that this draft will be ready to be submitted to BIS by the 30th of September 2021 after approval from Sec-DST and PSA.

3c: Swapping of Batteries- eBuses

The third approach employed globally to charge buses is to have a system where the battery can be swapped. This requires unique design on the on-board system where the secure positioning of the battery is ensured and the design allows easy removal and fitment, and ensures safe and durable methods to connect (and dis-connect) the system electrically. At the same time, ground infrastructure also requires special care to handle and manoeuvre the heavy batteries for insertion and removal, as well as charging them off-line in a safe and efficient manner. The requirement for interoperability poses additional challenges in resolving the trade-offs. This inter-operability requirement is critical so that different manufacturers as well as transit operators across the country can depend on continuity of operations and tender processes. Without interoperability, there will be long-term adverse economic impact to the country.

The combined set of parameters and operational flexibility requirements give rise to a large number of options for battery size, capacity, anchoring methods, connector specifications, operating limits, etc. These require reconciliation against the goals articulated.

Given the nascent nature of this technology, the multiplicity of approaches of bus manufacturers, the variety of battery chemistries employed by battery solution providers, etc. there remains a lot of variability in how the system may be operated. Given the indifferent road conditions and dusty environment in many cities and towns across the country, the OEMs are also concerned about the contact resistance and durability of the connectors in harsh applications and running for up to 18 hours a day. Since some of these choices will have significant economic impact both for the Bus manufacturer/operator and the battery-swapping service provider, convergence to one set of specifications for at least a class of vehicles has remained a very difficult task thus far. For both technical reasons and economic reasons, the motivation to converge to a single design for key elements like battery dimensions, connector specifications, etc. remains low. Unlike in the other standards, thus far, industry participants are unable to find a common ground on technical parameters and concur on the key specifications.

At the same time, based on limited pilot applications, a few Bus manufacturers who have deployed such experimental systems seem to have deferred large-scale deployment for a combination of technical and economic reasons. It has been observed that as the cost of batteries come down (based on the trend forecast by NITI-Aayog) there is expected to be impact on the economics of swappable batteries both for the vehicle operator and the battery-swap system operator. Furthermore, the structure of FAME-2 subsidies encourages larger fixed batteries and this is an additional economic factor.

Other countries who have Standards for the same have limited their standards to simple guidelines for Safety and Communication protocols. Interoperability and the very tough Indian conditions are <u>not</u> factored into these standards abroad.

In view of the shifting operating environment and the pace of technology evolution, speedy convergence to an interoperable set of designs at this point of time is difficult. In terms of connectors and thermal management, there is a need to assess available technologies in real-world operating environments. Forcing the industry to conform to a specific interoperable standard prematurely may be unwise.

The Group, after detailed discussions involving technical, supply chain, operations and commercial review, see merit in undertaking a more elaborate approach where the technical solutions are more thoroughly tested and the field and operations aspects more fully comprehended. It would be wise to converge to a set of standards after these tasks have been completed.

For these reasons, at this time, I am unable to endorse an immediate finalisation of the open issues and declare a set of specifications that can lead to a robust and effective set of standards.

Additional comments on issues to address going forward:

I. For eBuses, since the Depot Charging connections will be very high capacities, there is merit in coming up with Standards and Operating protocols between the Grid and the Depots, with the various DISCOMs, Electrical Equipment manufacturers and Software providers.

II. For effective implementation of these standards, a regime for testing, homologation and certification of the systems is necessary. While the standards proposed by this Group are likely to be notified (after the BIS process) in the coming months, the GoI will need BIS to formally approve specific agencies like ARAI, ICAT and others to test and certify compliance to Standards. For the same, there will be a need to augment facilities and capabilities that will be required.

Acknowledgements:

This report is the outcome of the committed efforts of a large number of technically qualified specialists. We acknowledge the very significant contributions of:

- Participating manufacturers in the auto industry and their staff
- Participating suppliers and technology specialists in the auto/electrical industry and their staff
- Participating DISCOMs and their staff
- ARAI
- BIS and their committee members

Special acknowledgement is due to the invaluable support of Dr Suresh Kumar (PSAO), Dr Sajid Mubashir DST, Karthick Atmanadhan (IIT-M) and Suresh Babu (DST) who have led most of the discussions in the sub-groups and delivered the main outcomes.

The offices of Secretary, DST and that of the Principal Scientific Advisor (Government of India) as well as Vice-Chairman, NITI-Aayog have shown considerable interest in this topic and extended much needed support.

Signed:

Sumantran

V. Sumantran Ph.D.

Chairman

DST-PSAO Group to guide the development of Indian Standards for Electrical Vehicle Charging Infrastructure

Date: 16 September, 2021

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सत्यमेव जयते

No. TPEM/2019/EV-Stds/Vol-II

Government of India

Department of Science & Technology (DST)

Technology Bhawan, Shaheed Jeet Singh Marg,

New Delhi, the 08th June 2020

OFFICE MEMORANDUM

Subject: Constitution of a '**DST-PSAO Group to guide the development of Indian Standards for Electric Vehicle Charging Infrastructure**", regarding.

The undersigned has been directed to convey that a "DST-PSAO Group to guide the development of Indian Standards for Electric Vehicle Charging Infrastructure" has been constituted by Department of Science & Technology (DST). The Group will be chaired by Dr. V Sumantran, Member, Consultative Group for the Office of Principal Scientific Adviser (PSA) to GoI, on Future Transportation.

1. This Group has been set up to expedite the actions sought by the Vice Chairman, NITI Aayog during the specific review on EV Charging Standards held on 20th May 2020, with the participation of all ministries concerned with this matter.

   (a) It was decided that the DST and the Office of PSA will work jointly and provide NITI Aayog with the final recommendations regarding the Charging Infrastructure for the country and oversee the preparation of the Indian Standards documents work at the Bureau of Indian Standards.

   (b) The existing DST-BIS Joint Working Group (JWG) will also be linked to this Group, to enable coordinated actions and speedy completion of the Indian Standards. The DST-BIS JWG is chaired by Director General BIS, and is coordinated by DST officer.

2. The composition of 'Group' is given below:

   (a) Dr. V Sumantran, Member, Consultative Group for the Office of PSA on Future Transportation (Chairperson)

   (b) Shri Jayant Roy Chowdhary, Deputy Director General – Standards P&M, Bureau of Indian Standards (Member)

   (c) Shri K Suresh Kumar, Scientist F, Office of PSA to the Government of India (Member)

   (d) Shri S. Mubashir, Scientist G, Department of Science & Technology & Chair, BIS Sectional Committee ETD-51 for Electro Mobility Standards (Member-Secretary)

3. Terms of Reference

(a) The Group will recommend to the Principal Scientific Adviser to the Govt., and Secretary Department of Science & Technology on the specific measures to complete the EV Charging Standards for India. The scope excludes items already covered under Ministry of Power Guidelines issued on Dec 14, 2018, and amended on Oct.1, 2019 and June 8, 2020.

(b) Specific assignment is to provide the recommendations on the three items discussed in the review by the Vice Chairman NITI Aayog.

i. Low Power AC Charging Points at affordable cost for two/three wheelers
ii. Normal Power Parking Bay Charge Points (both AC & DC)
iii. High Power Charging Stations for Buses

(c) The Group may utilize the administrative (& financial) support from the PSAO, DST and the BIS for the envisaged work, which will include the following.

i. Finalise the specifications, in consultations with stake holders
ii. Guide the efforts to prototype and demonstrate the products in consultations with government testing agencies.
iii. Oversee the efforts to prepare the draft standards and its submission to the BIS, for publication of Indian Standards under Priority-1 Procedures of BIS.

This issue with the approval of the Secretary, Department of Science & Technology, GoI.

(Sajid Mubashir)
Scientist G , DST &
& Chair, BIS ETD-51

To :

1. Dr. V Sumantran, Member, Consultative Group for the Office of PSA on Future Transportation
2. Shri Jayant Roy Chowdhary, Deputy Director General – Standards P&M, Bureau of Indian Standards.
3. Shri. Suresh Kumar K, Scientist F, Office of PSA to the Government of India

Copy to :

1. Sr. PPS to Secretary, Department of Science & Technology, GoI
2. Additional Private Secretary to the Principal Scientific Adviser to the Government of India
3. Mr. Suresh Babu, Scientist D, DST.

(The PSAO, DST and BIS officials are requested to communicate this OM to the concerned groups actively participating in the development of Indian Standards for EV Charging).

<u>Minutes of Meeting held on October 29th 2020</u>

Subject: Light EV Charging standards for 2-W and 3-W Vehicles.

A virtual meeting chaired by the Vice Chairman, NITI Aayog was held on 20.09.2020 at 10:30 AM, NITI Aayog, New Delhi. The list of participants is placed at ***Annexure-I***.

2. Initiating the discussion, Sh. Randheer Singh, Sr. Specialist (Electric Vehicles), NITI Aayog welcomed all participants and requested Secretary, DST to make presentation on Light EV Charging standards for 2-W and 3-W Vehicles. Secretary DST informed that the development of Light EV charging standards was a collaborative effort of O/o Principal Scientific Adviser to Government of India and DST. He requested PSA to briefly speak on the initiative.

3. PSA to GoI apprised the chairman that on 8th June, 2020 a committee was constituted including officers from DST and O/o PSA to develop Indian standards for EV Charging. So far, the committee has developed draft EV charging standards for light 2Ws and 3Ws which constitute more than 80% of Indian automobile market sales.

4. Discussions were broadly held on affordability of charging devices, ease of charging, safety, payment mechanism and the finalization of the standards, as follows: -

4.1 Secretary, DST explained the focus of the project was also development of low-cost AC charging device covering communication, network protection, safety, user authentication and billing features. He mentioned that the proposed AC charging device is meant for public charging stations in parking lots, offices etc. The development is truly India centric and first of its kind.

4.2 Dr Sajid Mubashir, Scientist, DST further explained that almost all 2-Wheelers & 3-Wheelers are equipped with Chargers and need only AC Power Supply (usually 230V Max 15A). The device must be highly affordable (< INR 4,000/-) to allow widespread adoption and to allow scaling up. He also mentioned that multiple Energy Operators can set up one or more EVSE for 2W & 3W with output < 3 kW. Local shop owners also can own and operate the AC-EVSE. Leveraging widely available “smartphone” usage, the system for tracking usage and payment etc. can be simplified using smartphone communication.

4.3 Vice Chairman, NITI Aayog requested to clarify the focus of the penetration 0-3kW. Dr V. Sumantran, Lead Member, Consultative Group on Future Transportation (CGFT), informed that it is the rate at which power flows in the battery, which is different from the energy storage in the battery.

4.4 Dr Sajid Mubashir, Scientist, DST further explained about authentication for charging session utilizing Bluetooth BLE / QR code on each plug. Bluetooth communication would involve Bluetooth BLE auto to pair within 5-10 meters and a single notification before pairing. Places where mobile network connectivity is not available, local Operator may offer Wi-Fi hotspot to EV user, at nominal fee. All the specifications & functions are proposed and developed with consensus of stakeholders from OEMs, Discoms, Cellular, Tier-I suppliers, and ICT Industry.

4.5 Vice Chairman, NITI Aayog pointed that whether the committee has considered the problems associated with Commercially available Residual Current Device (RCD). Scientist, DST informed that the committee has borrowed the international specifications and taken care of the size, packaging and cost which are high in the commercially available RCD.

4.6 Dr V. Sumantran, Lead Member, Consultative Group on Future Transportation (CGFT) explained why Bluetooth connectivity is required for this charging standard. He informed that existing challenges for 2W EV consumers is that there is no track or trace, i.e. how much which individual is utilizing the common charging infrastructure (for instance in RWAs, Apartment complexes etc.) and also the payment mechanism. To address this, there is a need for a device which has user authentication and the entire transaction can be digital, along with ease of use and connection.

4.7 Dr Sajid Mubashir explained two processes involved in finalizing the standards developed by DST. The BIS Sectional Committee (ETD-5) Electromobility in Transportation has to approve the draft Standard. He informed that the current Process-I, which is a regular path for "known" technology will publish Indian Standard (IS) after consensus process. Typically, it will take 15 months to 2 years, and involves group of 100+ representatives from Industry and others. Volunteering a "Draft" will also help to speed up. Process-II is the method for "New" technology that is Indian Standard-Tentative (IS-T). In this process, we may implement prototype, verify and test the device. Correct IS-T, if necessary and publish Indian Standard after consensus. IS-T for Light EV charging standards can be published in approximately 3-4 months of time invoking the powers vested to DG, BIS. ARAI will supervise prototypes & test the units to finalize the Indian Standards.

4.8 Vice Chairman, NITI Aayog requested the committee to clarify whether the Process-I is as per any international standards and in Process-II, is there sufficient time for any destructive testing to be performed on the device? Dr Sajid, DST informed that the process is as per the WTO norms. Dr V Sumantran mentioned that the standard developed ensures that nothing is compromised in the architecture of the layout. He also informed that destructive testing comes subsequent to development of standard before the device is rolled out in the market. Short period for approval in process does not compromise on quality and safety.

4.9 PSA to GOI informed that the draft standards are already developed through an extensive consultation process and suggested that the committee to go through a fast track process to finalize the standards. Further, PSA requested DST to develop prototypes and test them. Secretary DST agreed to develop and get the prototypes tested.

4.10 Secretary DHI mentioned that existing electric 2Ws or 3Ws are charged by the consumers at their homes. Secretary requested the committee to clarify whether the new standards will be imposed on them too. Secretary DST explained that these Light EV standards are developed for commercial use in public places. VC, NITI Aayog requested the committee to focus on finalizing these standards and a review meeting may be called in 6 weeks' time.

5. The key decision points emerging from the meeting are summarized below:

i. Mission to draft a letter to the Hon'ble Minister Consumer Affairs requesting DG, BIS to explore the fast track process to finalize the standards.

ii. Mission to coordinate with BIS to finalize the standards within 3-4 months after the submission of final draft standard by DST.

iii. DST to develop the proto types of the device and test them within 3 months of time.

Meeting ended with a vote of thanks to Chair and participants.

Annexure-I

List of Participants:

1. Vice Chairman, NITI Aayog
2. Prof K. Vijay Raghavan, Principal Scientific Advisor, Government of India
3. Prof. Ashutosh Sharma, Secretary, Department of Science and Technology
4. Shri Arun Goel, Secretary, Department of Heavy Industries
5. Shri Amit Mehta, Joint Secretary, Department of Heavy Industries
6. Dr V. Sumantran, Lead Member, Consultative Group on Future Transportation (CGFT), O/o the Principal Scientific Adviser to the GoI
7. Shri Suresh Kumar K, Scientist, O/o the Principal Scientific Adviser to the GoI
8. Shri Sajid Mubashir, Scientist, Department of Science and Technology
9. Shri Suresh Babu M, Scientist, Department of Science and Technology
10. Shri P V Mathew, Scientist, Bureau of Indian Standards
11. Shri R P Singh, PS to VC, NITI Aayog
12. Shri Randheer Singh, Sr Specialist, E-Mobility, NITI Aayog
13. Shri Diewakarr Anupam Mittal, YP, NITI Aayog
14. Shri Joseph Teja, YP, NITI Aayog

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. No. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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असाधारण
EXTRAORDINARY

भाग III—खण्ड 4
PART III—Section 4

प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

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No. 357] NEW DELHI, TUESDAY, AUGUST 31, 2021/BHADRA 9, 1943

भारतीय मानक ब्यूरो

(उपभोक्ता मामले विभाग)

शुद्धिपत्र

नई दिल्ली, 18 अगस्त, 2021

सन्दर्भ : HQPUB012/1/2020-PUB-BIS (214).—भारतीय मानक ब्यूरो एतदद्वारा भारत के राजपत्र में नीचे दिए गए सन्दर्भ में भारतीय मानक ब्यूरो नियम, 2018 के नियम 15 के उपनियम (1) के अनुसरण में भारत के राजपत्र भाग III, खंड 4 में दिनांक 4 दिसम्बर 2020 को प्रकाशित भारतीय मानक ब्यूरो उपभोक्ता मामले, खाद्य एवं सार्वजानिक वितरण मंत्रालय, उपभोक्ता मामले विभाग के अंतर्गत भारत सरकार की अधिसूचनाओं में निम्नलिखित संशोधनकर्ता है:

1. संदर्भ HQ-PUB012/1/2020-PUB-BIS (103) दिनांक 19 नवम्बर 2021:

   आई एस 17425 : 2020 की स्थापना, और आई एस 14151 (भाग-1) : 1999 और आई एस 14151 (भाग-2): 2008 के रद्द होने की अनुसूची के क्रम संख्या (1), कालम (5) में – **'10 अगस्त 2021'** को **'10 फ़रवरी 2022'** से प्रतिस्थापित करें।

जे. राय चौधरी, वैज्ञानिक जी एवं उपमहानिदेशक (मानकीकरण – पी एवं एम)

[विज्ञापन-III/4/असा./221/2021-22]

BUREAU OF INDIAN STANDARDS

(Department of Consumer Affairs)

CORRIGENDUM

New Delhi, the 18th August, 2021

Ref : HQ-PUB012/1/2020-PUB-BIS (214).—Bureau of Indian Standards hereby makes the following AMENDMENT to the specified NOTIFICATION of Government of India under the Ministry of Consumer Affairs, Food and Public Distribution (Department of Consumer Affairs) published on 4 December 2020 in Part III, Section 4 of the Gazette of India in pursuance of Sub-rule (1) of Rule (15) of the Bureau of Indian Standards Rules, 2018:

Extraordinary vide Ref: HQ-PUB012/1/2020-PUB-BIS (103) dated 19 November 2020:

Sl No. 1, column (5) of the schedule establishing IS 17425 : 2020, and superseding IS 14151 (Part 1) : 1999 and IS 14151 (Part 2) : 2008, ─ Substitute '**10 February 2022**' for '**10 August 2021**'.

J. ROY CHOWDHURY, Scientist G & DDG (Standardization−P & M)

[ADVT.-III/4/Exty./221/2021-22]

अधिसूचना

नई दिल्ली, 31 अगस्त, 2021

संदर्भ : HQ-PUB013/1/2020-PUB-BIS (215).—भारतीय मानक ब्यूरो नियम, 2018 के नियम 15 के उपनियम (1) के अनुसरण में भारतीय मानक ब्यूरो एतदद्वारा अधिसूचित करता है की जिन भारतीय मानकों के विवरण इसमें संलग्न अनूसूची के द्वितीय स्तंभ में दिये गये हैं, तीसरे स्तंभ में इंगित तिथि को स्थापित हो गये हैं। चौथे स्तंभ में दिये गये मानकों के विवरण, यदि कोई हो तो वे भी साथ-साथ लागू रहेंगे जब तक वे पाँचवें स्तंभ में इंगित तिथि को वापस लिए जाने हैं।

अनुसूची

क्रम सं.	**स्थापित भारतीय मानकों की संख्या, वर्ष तथा शीर्षक**	**प्रतिस्थापन तिथि**	**भारतीय मानकों, यदि वापस लिए जाने हैं, की संख्या, वर्ष तथा शीर्षक**	**वापस होंने की तिथि**
(1)	**(2)**	**(3)**	**(4)**	**(5)**
1	आई एस 17017 (भाग 2/अनुभाग 6) : 2021 विद्युतीय वाहन चालकता चार्जिंग पद्धति भाग 2 प्लग, साकेट – निकास, वाहन कनेक्टर्स, ओर वाहन के इनलेट्स अनुभाग 6 डीसी पिन और संसंर्ग की आयामीय अनुकूलता अपेक्षाएं – विद्युत वियोजन पर निर्भर सुरक्षा के लिए डीसी ईवी आपूर्ति उपस्कर हेतु प्रयुक्त अभीष्ट टयूब वाहन युग्मक	**31 अगस्त 2021**	लागू नहीं	लागू नहीं
2	आई एस 17017 (भाग 22/अनुभाग 1) : 2021 विद्युतीय वाहन चालकता चार्जिंग पद्धति भाग 22 ए सी चार्ज विन्यास अनुभाग 1 लाइट इलेक्ट्रिक व्हीकल के लिए एसी चार्ज प्वाइंट	**31 अगस्त 2021**	लागू नहीं	लागू नहीं

क्रम सं.	स्थापित भारतीय मानकों की संख्या, वर्ष तथा शीर्षक	प्रतिस्थापन तिथि	भारतीय मानकों, यदि वापस लिए जाने हैं, की संख्या, वर्ष तथा शीर्षक	वापस होंने की तिथि
(1)	(2)	(3)	(4)	(5)
3	आई एस 17017 (भाग 25) : 2021 विद्युतीय वाहन चालकता चार्जिंग पद्धति भाग 25 संरक्षण विद्युत पृथक्करण पर आधारित डी सी विद्युतीय वाहन प्रदाय उपकरण	31 अगस्त 2021	लागू नहीं	लागू नहीं

इन मानकों की प्रतियाँ भारतीय मानक ब्यूरो, मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली 110002, क्षेत्रीय कार्यालयों:कोलकाता, चंडीगढ़, चेन्नई, मुम्बई तथा शाखा कार्यालयों : अहमदाबाद, बेंगलुरु, भोपाल, भुबनेश्वर, कोयम्बटूर, देहरादून, फरीदाबाद, गाज़ियाबाद, गुवाहाटी, हैदराबाद, जयपुर, जम्मु, जमशेदपुर, लखनऊ, नागपुर, परवानू, पटना, पुणे, रायपुर, राजकोट, कोच्चि, विशाखापटनम में बिक्री हेतु उप्लब्ध हैं. भारतीय मानकों को http://www.standardsbis.in पर आनलाईन खरीदा/ डाउनलोड किया जा सकता है।

जे. राय चौधरी, वैज्ञानिक जी एवं उपमहानिदेशक (मानकीकरण – पी एवं एम)

[विज्ञापन-III/4/असा./221/2021-22]

NOTIFICATION

New Delhi, the 31st August, 2021

Ref : HQ-PUB013/1/2020-PUB-BIS (215).—In pursuance of Sub-rule (1) of Rule (15) of the Bureau of Indian Standards Rules, 2018, the Bureau of Indian Standards hereby notifies that Indian standards, particulars of which are given in the second column of the schedule hereto annexed have been established on the date indicated against it in third column. The particulars of the standards, if any which are given in the fourth column shall also remain in force concurrently till they are withdrawn on the date indicated against them in the fifth column.

SCHEDULE

Sl No.	No., Year & Title of the Indian Standards Established	Date of Establishment	No. , Year & Title of the Indian Standards to be withdrawn, if any	Date of withdrawal
(1)	(2)	(3)	(4)	(5)
1	IS 17017 (Part 2/Sec 6) : 2021 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets — Conductive Charging of Electric Vehicles Part 2 Plugs, Socket — Outlets, Vehicle Connectors and Vehicle Inlets Section 6 Dimensional Compatibility Requirements for DC Pin and Contact — Tube Vehicle Couplers Intended to be used for DC EV Supply Equipment Where Protection Relies on Electrical Separation	31 Aug 2021	NA	NA

Sl. No.	No., Year & Title of the Indian Standards Established	Date of Establishment	No. , Year & Title of the Indian Standards to be withdrawn, if any	Date of withdrawal
(1)	(2)	(3)	(4)	(5)
2	IS 17017 (Part 22/Sec 1) : 2021 Electric Vehicle Conductive Charging Systems Part 22 AC Charging Configurations Section 1 AC Charge Point for Light Electric Vehicle	31 Aug 2021	NA	NA
3	IS 17017 (Part 25) : 2021 Electric Vehicle Conductive Charging System Part 25 DC EV Supply Equipment Where Protection Relies on Electrical Separation	31 Aug 2021	NA	NA

Copies of these standards are available for sale with Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi – 110 002; Regional Offices: Kolkata, Chandigarh, Chennai, Mumbai and Branch Offices: Ahmedabad, Bengaluru, Bhopal, Bhubaneshwar, Coimbatore, Dehradun, Faridabad, Ghaziabad, Guwahati, Hyderabad, Jaipur, Jammu, Jamshedpur, Lucknow, Nagpur, Parwanoo, Patna, Pune, Raipur, Rajkot, Kochi, Vishakhapatanam. Online purchase/downloading of Indian Standards can be made at http://www.standardsbis.in.

J. ROY CHOWDHURY, Scientist G & DDG (Standardization−P & M)

[ADVT.-III/4/Exty./221/2021-22]

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Summary Report

- EV Charging Standards work is in full pace.
- Group on EV Infrastructure
  - *Chaired by Dr. V. Sumantran,*
  - *Item-1: Revolutionary low cost 2W charge point*
  - *Item-2: eBus Charging Standards*
    - *a. Plug in Charging of eBus*
    - *b. Pantograph Charge Stations*
    - *c. Battery Swap for eBus.*
- BIS Sectional Committee ETD-51
  - *Supports all the above & writes Indian Standards. Additionally has developed*
    - *All standards for High Power Charging Stations*
    - *Draft DC Light EV Standard*
    - *Park Bay Charge Point Definition*
    - *Draft Battery Swap Standard for Light EV*

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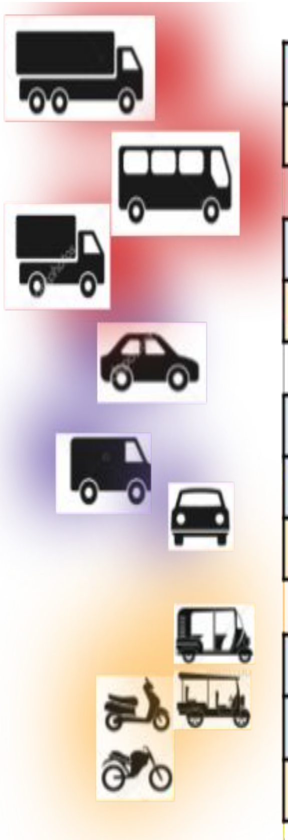
EV Charging Use Cases in India



Depot Charging Station	Automated Connection	Pantograph	4
100 kW to 600 kW	Overhead Pantograph		
Highway Charging Station	Plug-in Connection	Plug-in	3
50 kW to 250 kW	CCS & Chademo		
Normal Power	Plug-in Connection	Park-Bay	2
Park-Bay Charge Point	Type-2 | CCS & Chademo		
3-ϕ supply, <22kW	Infrastructure Socket		
Normal Power	Plug-in Connection	Light EV	1
Light EV Charge Point	IEC-DC & Indian-Combined		
1-ϕ supply, <7 kW	Infrastructure Socket		

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Indian Charging Standards

Pantograph 4

- Pantograph for Charging from 200 kW to 1MW
- A draft IEC standard is being studied for adoption in India

Plug-in 3

- Indian Standard for Charging Stations prepared, It is being studied for use in eBus Charging.
- Upto 180 kW can be delivered with one gun; so upto 350kW can be charged using plug in connectors

Park-Bay 2

- Parkbay Charge Point Approach Paper & City Guide for Installation, under preparation.
- Only small change required to Connection Standard

Light EV 1

- Light EV AC Charge oint - Draft Indian Standard prepared & circulated in BIS Committee.
- Light EV DC Charge Point drafts ready

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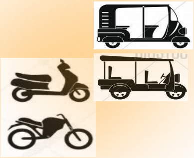
Scooter, Auto Rickshaw Charging

Light EV

1



Normal Power	Plug-in Connection
Light EV Charge Point	IEC-DC & Indian-Combined
1-ϕ supply, <7 kW	Infrastructure Socket

- Light EV can be charged anywhere
  - *Charge points in stores, roadside, apartments*
  - *Ubiquitous AC Charge Points*
  - *Dense network of DC Charge Points*
- Innovations are expected
  - *Battery Swapping*
  - *Fast Charging battery*
  - *Primary cells like Aluminium Air*
- Full conversion to eMobility is possible

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Light EV AC Charge Point 1Φ power supply

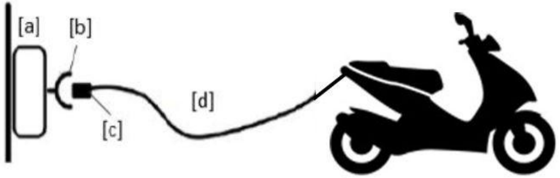

FIG. 1 CASE A CONNECTION

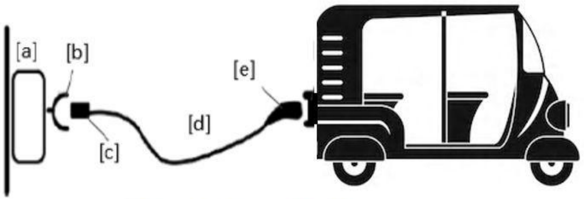

FIG. 2 CASE B CONNECTION

Bluetooth
4.0
Low Energy

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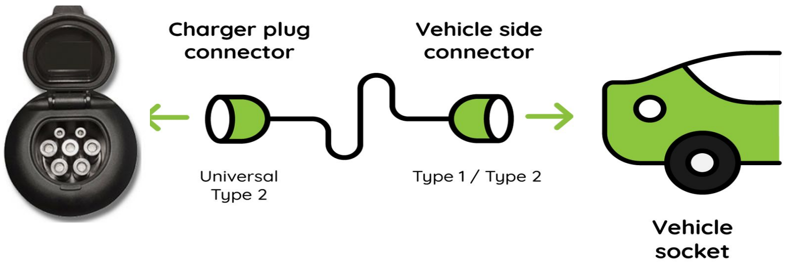
Park-Bay 2

Normal Power	Plug-in Connection
Park-Bay Charge Point	Type-2 | CCS & Chademo
3-ϕ supply, <22kW	Infrastructure Socket

Charge EV in the Parking itself



Charging Rate depends on the onboard charger. A small onboard charger = slow charging

Fast Charge a FAME car in parking lot with DC Unit

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Examples of Park-Bay Charge Points

These examples are from Europe. Such Park Bay Charge Points usually have a cable that can be detached. This is the key point. Some prototyping work has to be done in India (part funded by DST) to prove such systems can be used in Car Parks.

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Plug-in

3

Highway Charging Station	Plug-in Connection
50 kW to 250 kW	CCS & Chademo

Standards have been developed. Now we need to see if it enough for bus plugin charging

High Power Charging Stations

MoP/ DHI

Device & Charging Protocol Standards

1. 17017 Part-1
2. 17017 Part-21-1
3. 17017 Part-21-2
4. 17017 Part-2-1
5. 17017 Part-2-2
6. 17017 Part-2-3
7. Draft 17017 Part-23
8. Draft 17017 Part-24

EV to Grid Communication

1. 15118 Part-1
2. 15118 Part-2
3. 15118 Part-3
4. 15118 Part-4
5. 15118 Part_5
6. 15118 Part-8

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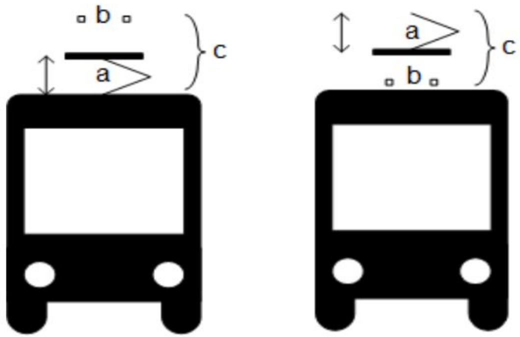
Per-trip Fast Charge eBus @ Depot.

Pantograph 4

Depot Charging Station	Automated Connection
100 kW to 600 kW	Overhead Pantograph



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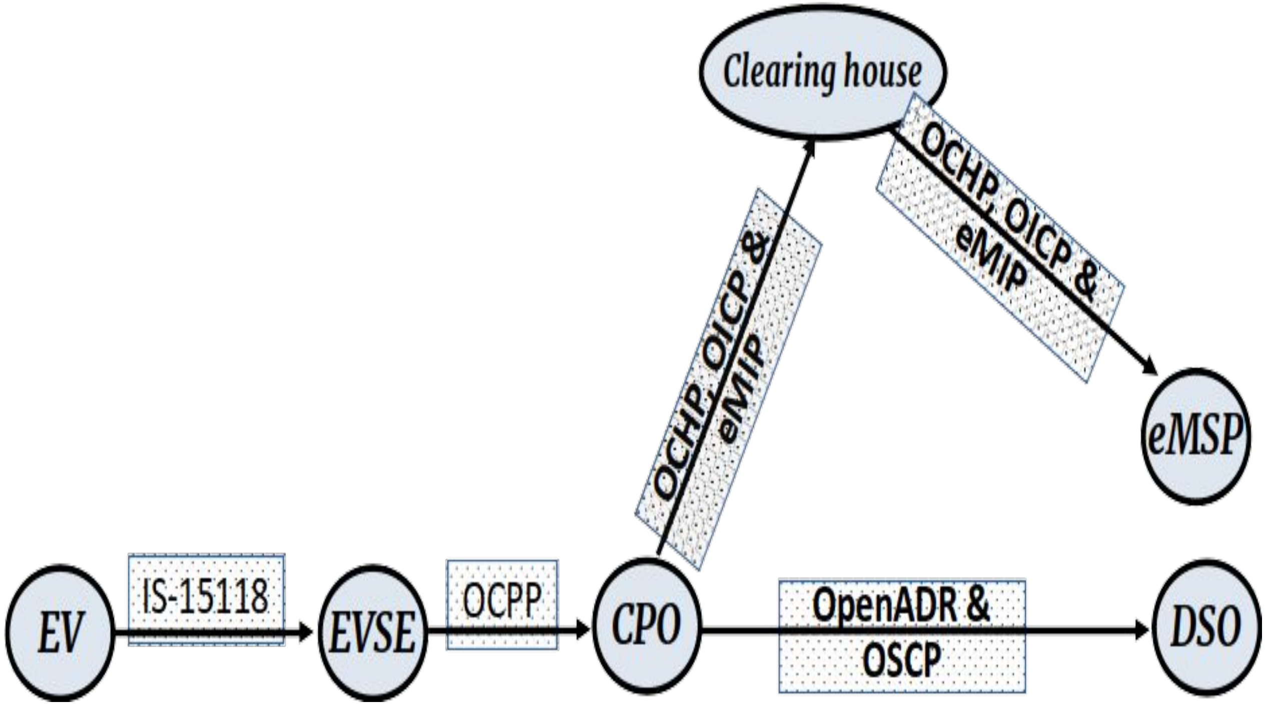
Backend Network



DST-PSAO Group on EV Infrastructure

Interim Report on Indian Standards

June 2021

1 Work undertaken by this Group

The Vice Chairman NITI Aayog had reviewed the status of Indian Standards for EV Charging during May 2020 and requested Secretary DST and Principal Scientific Advisor to facilitate the work.

The DST-PSAO Group to guide the development of Indian Standards was set up in June. The Group identified the priority "*Indian Use Cases*" as:

- ✓ Low Power Charging Points at affordable cost for two/three wheelers. Work began in July 2020 & was completed in May 2021.
- ✓ High Power Charging Stations for Buses. Work began in Dec. 2020; expected to complete the first set of draft standards by 31 August 2021.

Both teams have had their workings impacted by the COVID-related lock-downs, especially since the Low-Power Charge-Point involved manufacture of prototypes and testing them at multiple locations.

1.1 Light EV AC Charge Point activity

A project for Development & Deployment of the Prototypes for Light EV AC Charge Point was funded by DST, with the ARAI leading the team of 4 industries/ charger manufacturers and TCS agreeing to provide the Mobile app on pro-bono basis. Unique to this activity was the fact that

a. The Group identified a breakthrough in affordability (each unite targeted to cost Rs 3500/-) while preserving the key elements of functionality (public access, smart-phone operation, user authentication, network protection, e-wallet payment, and back-end analytics)
b. The specifications and standards were developed with close involvement of a wide cross-section of OEMs, component suppliers, Discoms, cellular operators and ARAI
c. The standards were developed after taking the additional step of manufacturing prototypes (from multiple suppliers) and testing and validating them.

The work accomplished includes:

a. Design of Charge Point Device including Electronics, Passive Identification (QR Code) & Metering & User Experience
b. Development, testing of prototypes and field demonstration.
c. Drafting of Indian Standards

Stakeholder Consultations	Develop Specifications	Recommend Specifications	Develop Prototypes	Draft Standards Document	Submit Preliminary-Draft to BIS	Approval by BIS Sectional Committee
Date ?	Date ?	Date ?	Date ?	Date ?	Date ?	Date ?

At the 2nd review by Vice Chairman NITI Aayog was held in October 2020. Configuration for Light EV AC Charge Point was presented and approved. The draft standards were handed over to BIS for their formal process of releasing the standards – this was estimated to take approximately 2.5 months. More details are provided in Appendix A.

In the review meeting on ___________VC NITI Aayog had suggested that the Group may now take up the work on drafting similar standards for the most widely used eBus Charging Systems.

1.2 eBus Charging, including Battery Swap

In Nov. 2020, the the VC NITI Aayog assigned to the Group the task of overseeing the development of Charging Standards for EV Bus.

Keeping in mind that the industry and fleet operators will need to deploy three different kinds of systems, based on route demands and duty cycle, the Group addressed the three alternate solutions for high power charging of eBus, employed in most global markets, as below:

- High Power **Plug-in** DC Charging
- High Power **Automated Connector** Charging (also called Opportunistic Charging or Pantograph charging)
- **Swappable Batteries** for eBus

Accordingly, three Subgroups (with membership from the main OEMs, Suppliers, infrastructure providers, Discoms, and ARAI) were set up in August 2020 to develop the draft Standards. In all cases, the sub-committee has debated the balance needed between evolving technologies and proliferation of new solutions with the need for standardisation. A key requirement to achieve economic savings at the national level was defined as **interoperability**. This would allow:

a. Transit authorities to ensure competitive bidding in multiple tenders while retaining invested infrastructure, and at the same time,
b. The Indian bus and manufacturing industry can invest in scale so that same charging systems would be applicable in multiple cities and regions.

With these requirements, the country would be served by better scale, lower cost, better asset utilisation and a very competitive marketplace.

1. Higher Power Charging “Dual Gun” system (an additional standard to the existing BIS High Power, single gun DC Charging Standard). The progress achieved by this sub-committee is shown below:

Stakeholder Consultations	Study potential methods	Decision on candidate configuration	Develop Specifications	Draft Standards Document	Submit Preliminary-Draft to BIS
✓	✓	✓	Δ	☐	☐
Date ?	**Date ?**	**Date ?**	**Date ?**	**1 month**	

2. Automated Pantograph System (Two standards documents specific to the pantograph method). Multiple configurations were evaluated and inputs from the main global suupliers and OEM operators was included. Their progress is shown below:

Stakeholder Consultations	Study potential methods	Decision on candidate configuration	Develop Specifications	Draft Standards Document	Submit Preliminary-Draft to BIS
✓	✓	✓	✓	Δ	☐
Date ?	**Date ?**	**Date ?**	**Date ?**	**1 month**	

3. eBus Battery Swapping System (six standards document for various aspects. General Methods, Safety Systems, Communication, Connector, Dimensions, Standard Operating Procedures).

Stakeholder Consultations	Study potential methods	Decision on candidate configuration	Develop Specifications	Draft Standards Document	Submit Preliminary-Draft to BIS
✓	Δ	☐	☐	☐	☐
Date ?	**6 weeks**		**1 month**	**1 month**	**1 month**

Appendix-A

Brief Report on Light EV AC Charge Point

1.3 Design finalized through stakeholder consultations

Three subgroups deliberated on (a) Charge Point Device (b) Electronics and (c) Metering and specifications and draft standards were prepared. It is a radically new design for a low-cost ($50/ Rs.3500), reliable, mobile app-based charge point that can be deployed by shopkeepers, parking facilities, malls, schools and offices.

The device communicates over Bluetooth to the Mobile phone of the EV User and Charge Point Operator. ARAI has filed patents & created a new bluetooth protocol. Mobile App will provide facilities like (A) Authentication of the user, (B) Wallet based payment, (C) Automated transactions where the money goes to the charge point operator account automatically, (D) Prior booking of the charging point etc.

- Prototype Development: 150 prototypes were developed by experienced manufacturers (Exicom, Masstech, Havells & Bharat Electronics Ltd).
- **Mobile App & Network**: The TCS had volunteered to develop the demo version of the Mobile App
- **Response**:
  - Enthusiastic response has come from industry; both large scale and start-ups
  - Delhi Government has already accepted this Light EV AC Chargepoint for their forthcoming tender that is currently being finalized.

1.4 BIS Standards Development

Draft Standard for Light EV AC Chargepoint has been approved by the BIS Sectional Committee. It has been sent for Wide Circulation, which is the final process at BIS, before publishing the Indian Standard.

Preliminary Draft Indian Standard

ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES

Electro Technology in Mobility Sectional Committee, ETD 51

FOREWORD

This Indian Standard (IS 17017-3-1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Elecrotechnology in Mobility Sectional Committee had been approved by the Electrotechnical Division Council.

This standard (IS 17017-3-1) is the series of standards which covers the general physical, electrical, functional, testing and performance requirements for conductive power transfer, primarily for vehicles using a conductive ACD connection capable of transferring DC power. The main document specifies conductive power transfer methods, including the infrastructure electrical contact interface, the vehicle connection interface, the electrical characteristics of the DC supply and the communication system. It also covers the functional and dimensional requirements for the vehicle connection interface and supply equipment interface.

This series consists of the following documents.

IS 17017-3-1: Main document including most requirements.

IS 17017-3-2: Specific requirements for Infrastructure-Mounted Cross Rail connection.

Considerable assistance has been obtained from SAE J3105, SAE J3105/1 while preparing this standard.

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

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: 1960 'Rules for rounding of numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this *Preliminary Draft Indian Standard*.

Table of Contents

Preliminary Draft Indian Standard

ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES

1 SCOPE

This document covers the general physical, electrical, functional, testing, and performance requirements for conductive power transfer, primarily for vehicles using a conductive ACD connection capable of transferring DC power. It defines conductive power transfer methods, including the infrastructure electrical contact interface, the vehicle connection interface, the electrical characteristics of the DC supply, and the communication system. It also covers the functional and dimensional requirements for the vehicle connection interface and supply equipment interface. There is also a sub-document which is identified by IS 17017-3-2, which will be specific requirements for a specific interface defined in the sub-document.

IS 17017-3-1: Main document, including most requirements.

a) IS 17017-3-2: Infrastructure-Mounted Cross Rail Connection

2 REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of publications shall apply.

2.1.1 SAE Publications

SAE J3105 Electric Vehicle Power Transfer System using Conductive Automated Connection Devices

SAE J3105/1 Electric Vehicle Power Transfer System using Conductive Automated Connection Devices: Infrastructure – mounted Pantograph (cross rail) connection

SAE J1772 SAE Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler

SAE J2836/2 Use Cases for Communication Between Plug-in Vehicles and Off-Board DC Chargers

SAE J2847/2 Communication Between Plug-in Vehicles and Off-Board DC Chargers

SAE J2910 Recommended Practice for the Design and Test for Hybrid Electric and Electric Trucks and Buses for Electrical Safety

SAE J2931/1 Digital Communications for Plug-in Electric Vehicles

SAE J2931/4 Broadband PLC Communication for Plug-in Electric Vehicles

SAE J2953/1 Plug-in Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)

SAE J2953/2 Test Procedures for the Plug-in Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)

2.1.2 IEEE Publications

IEEE 802.11n A set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication

2.1.3 IEC Publications

IEC TS 60479-2 Effects of Current on Human Beings and Livestock

IEC60068-2-6 Environmental Testing - Part 2: Tests - Test L: Dust and Sand - Edition 1 .0

IEC 61300-2-6 Fiber Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedure

2.1.4 UL Publications

UL 50 Standard for Enclosures for Electrical Equipment

UL 1439 Determination of Sharpness of Edges on Equipment

UL 2202 EV Charging System Equipment

UL 2231-1 Personnel Protection Systems for Electric Vehicle Supply Circuits: General Requirements

UL 2231-2 Personnel Protection Systems for Electric Vehicle Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

UL 2251 Plugs, Receptacles, and Couplers for Electric Vehicles

UL 2594 Electric Vehicle Supply Equipment

2.1.5 ISO Publications

ISO 7000 Graphical Symbols for Use on Equipment - Registered Symbols

ISO 15118-2 Road Vehicles - Vehicle to Grid Communication Interface - Part 2: Network and Application Protocol Requirements

2.1.6 National Fire Protection Agency Publications

National Electrical Code, NFPA 70, Article 625 (2020 edition)

3 DEFINITIONS

3.1 Automatic charging

Machine operates charging connection, not human.

3.2 Automatic connection device (ACD)

Active device where the physical connection between EV supply equipment and vehicle is made without user interaction providing an electromechanical interface.

3.3 Charger

An electrical device that converts alternating current energy to regulated direct current for replenishing the energy of a rechargeable energy storage device (i.e., battery) and may also provide energy for operating other vehicle electrical systems.

3.4 Chassis ground

The conductor used to connect the non-current carrying metal parts of the vehicle high voltage system to the equipment ground.

3.5 Conductive

Having the ability to transmit electricity through a physical path (conductor).

3.6 Contact (charge)

A conductive element on the infrastructure-side connection that mates with a corresponding element on the vehicle-side connection to provide an electrical path.

3.7 Control pilot

An electrical signal that is sourced by the electric vehicle supply equipment (EVSE). Control pilot is the control conductor and is connected to the equipment ground through control circuitry on the vehicle and performs the following functions:

a) Verifies that the vehicle is present and connected.
b) Permits energization/de-energization of the supply.
c) Serves as communication medium when using PLC.
d) Aids in monitoring the presence of the equipment ground.

3.8 DC Charging

A method that uses dedicated direct current (DC) supply equipment to provide energy from an appropriate off-board charger to the EV.

3.9 Earth Ground

A large conducting body, such as the earth or an electric circuit connected to the earth, used as an arbitrary zero of potential. Refer to ISO 7000/IEC 60417.

3.10 Electric Vehicle (EV)

A vehicle intended for highway use, powered by an electric motor that draws current from an on-vehicle energy storage device, such as a battery, which is chargeable from an off-vehicle source, such as residential or public electric service or an on-vehicle fuel-powered generator.

3.11 Electric Vehicle Charging System

The equipment required to condition and transfer energy from the constant frequency, constant voltage supply network to the direct current, variable voltage EV traction battery bus for the purpose of charging the battery, and/or operating vehicle electrical systems while connected.

3.12 Electric Vehicle Supply Equipment (EVSE)

The contacts, including the ungrounded, grounded, and equipment grounding contacts, the electric vehicle connections, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle.

3.13 Equipment Ground (grounding conductor)

A conductor used to connect the non-current carrying metal parts of the EV supply equipment to the system grounding conductor, the grounding electrode conductor, or both, at the service equipment.

3.14 Exposed Conductive Component

A conductive component of electrical equipment (e.g., an electric vehicle) that may be touched, and which is not normally energized, but which may become energized in case of a fault.

3.15 Extension

To straighten or spread out at full length.

3.16 Hazardous live component

A live component, which under certain conditions may give a harmful electric shock, burn, and arc flash.

3.17 Human Machine Interface (HMI)

A machine that takes human inputs and translates the inputs into machine activity.

3.18 Infrastructure-Side Connection (ISC)

The connections made for the ACD system on the infrastructure side of the connection. The connection is made when the infrastructure-side connection mates with the vehicle-side connection.

3.19 Insulator

The portion of a charging system that provides for the separation, support, sealing, and protection from live parts.

3.20 Live Component

Any conductor or conductive component intended to be electrically energized in normal use.

3.21 Protective Earthing

Earthing point or points in a system or in an installation or in equipment, for purposes of electrical safety.

3.22 Protective Earth (PE) protective conductor

PE (identification) conductor provided for purposes of safety, for example protection against electric shock.

3.23 Retraction

Draw back in or drawn back.

3.24 Serial testing

Serial testing is defined as intermittent product validation testing to confirm that variance in manufacturing and assembly have not affected the overall performance of the device.

3.25 Type testing

Type testing is defined as the initial evaluation of the system to conform to the given specification.

3.26 Vehicle Ground Clearance

The vertical distance between the pavement and the lowest part of the vehicle floor pan.

3.27 Vehicle-Side Connection (VSC)

The connections made for the ACD system on the vehicle-side of the connection. The connection is made when the infrastructure-side connection mates with the vehicle-side connection.

3.28 X, Y, and Z direction

The X direction is the longitudinal direction and positive is toward the front of the vehicle. The Y direction is the lateral direction and the positive direction is toward the left of vehicle. The Z direction is the vertical direction and the positive direction is upward.

4 ABBREVIATIONS AND SYMBOLS (ALL)

ACD	Automatic Connection Device
CAN	Controller Area Network
CFR	United States Code of Federal Regulations
CP	Control Pilot
DC-	DC Power Negative
DC+	DC Power Positive
EMC	Electromagnetic Compatibility
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCC	Federal Communications Commission (U.S.)

HMI	Human Machine Interface
IEC	International Electrotechnical Commission
IMD	Isolation Monitoring Device
ISC	Infrastructure-Side Connection
LIN	Local Interconnect Network
MAC	Medium Access Control Layer
NFPA	National Fire Protection Association
OEM	Original Equipment Manufacturer
PE	Protective Earth
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PHY	Physical Layer
PLC	Power Line Carrier
RESS	Rechargeable Energy Storage System
UL	Underwriters Laboratories
VSC	Vehicle-Side Connection

5 GENERAL SYSTEM REQUIREMENTS AND INTERFACE

5.1 General ACD Charging System Requirements

An ACD charging system transfers power between the infrastructure and the vehicle. This power transfer occurs when the correct alignment is complete and the ACD moves into place to electrically connect the infrastructure and the vehicle via conductive coupling. See Fig. 1 for two examples of application.

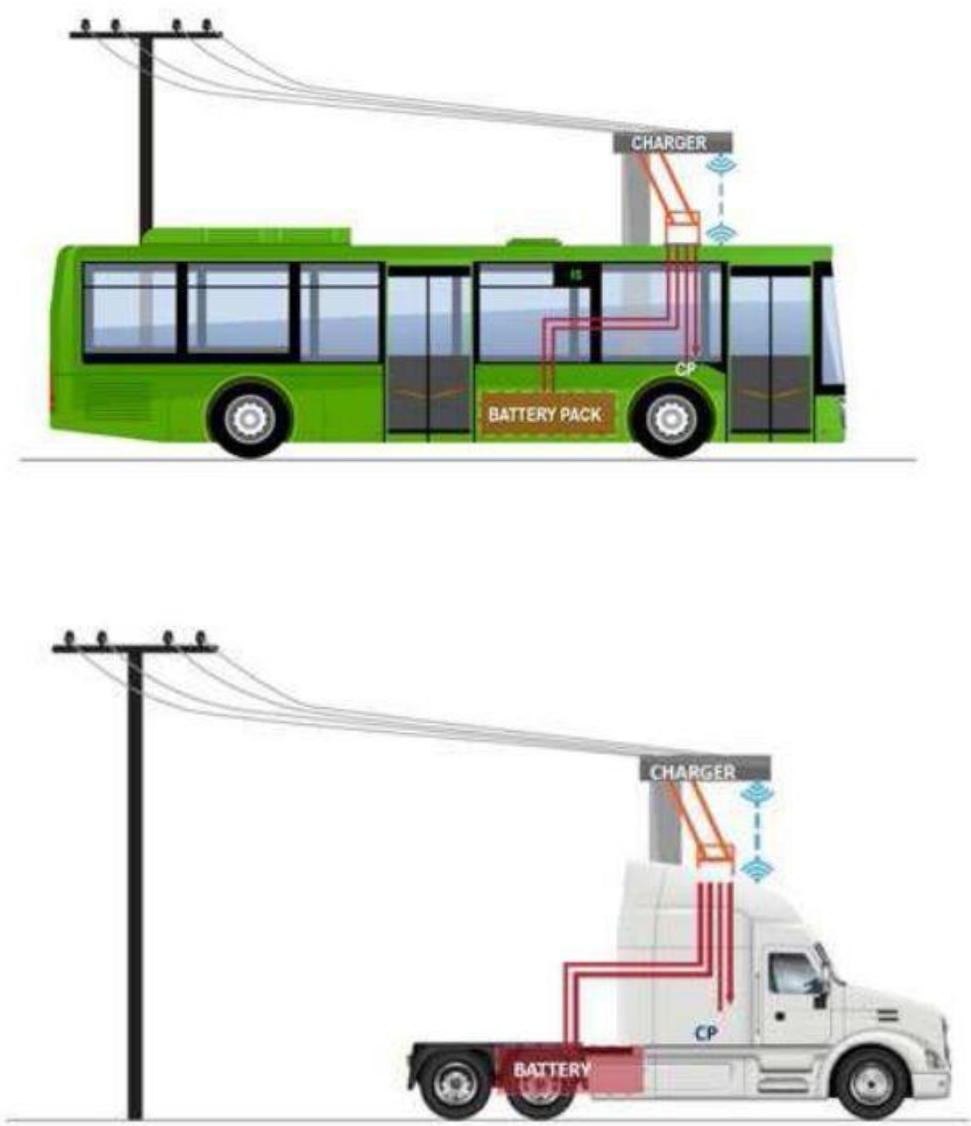


FIG. 1 – EXAMPLES DIAGRAM

This document states the requirements for the power level and configuration, vehicle alignment requirements and protocol, the physical locations of the contacts, the environmental requirements, and the safety aspects.

This document will have a main document with substantially most of the requirement. There will also be a sub-document which will be identified by IS 17017-3-2, which will be specific requirement for a specific interface defined in the sub-document.

IS 17017-3-1: Main document - including most requirements

a) IS 17017-3-2: Infrastructure-mounted cross rail connection

5.2 Functional/Physical Requirements

The ACD charging interface consists of four different contacts and the communications system shown in Fig. 2. The contacts are called out as the high voltage positive, the high voltage negative, the protective earth, and the control pilot. A communications interface is also defined between the infrastructure and the vehicle.

The overall performance evaluation shall be conducted per Appendix F. The guidelines set forth in this appendix will allow the manufacturer or end user to accurately characterize the performance and long-term stability of their system from a mechanical, environmental, and electrical standpoint.

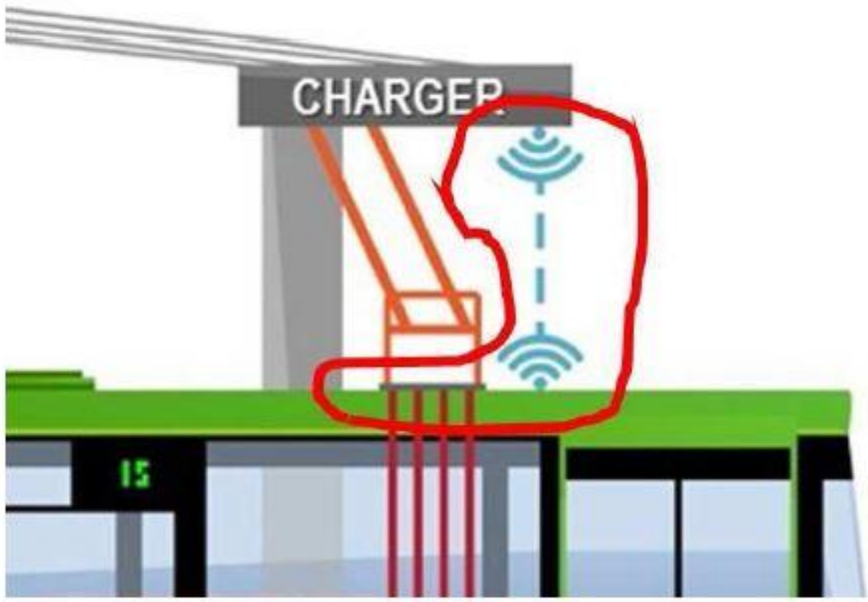


FIG. 2 – INTERFACE

5.2.1 Physical Partitions of the ACD Charging System

ACD charging technology for electric vehicles consists of three major partitions:

a) The EVSE as part of the infrastructure.
b) The conductive connections and communications.
c) The charged electric vehicle.

See Fig. 3 for the architecture.

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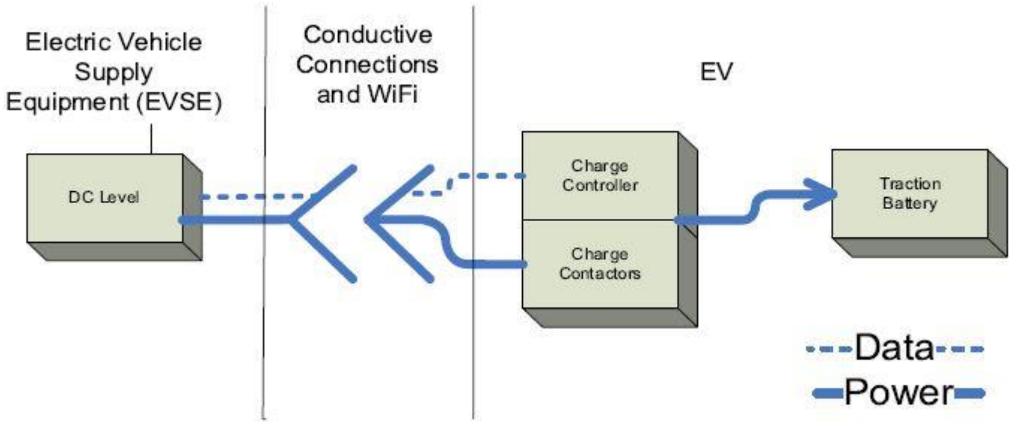

FIG. 3 – DC CONDUCTIVE CHARGING SYSTEM ARCHITECTURE

The conductive connections consist of two major partitions:

a) The infrastructure interface is the infrastructure-side connection (ISC).
b) The vehicle interface is the vehicle-side connections (VSC).

The conductive connections consist of four contacts that perform the interface functions as shown in Fig. 4.

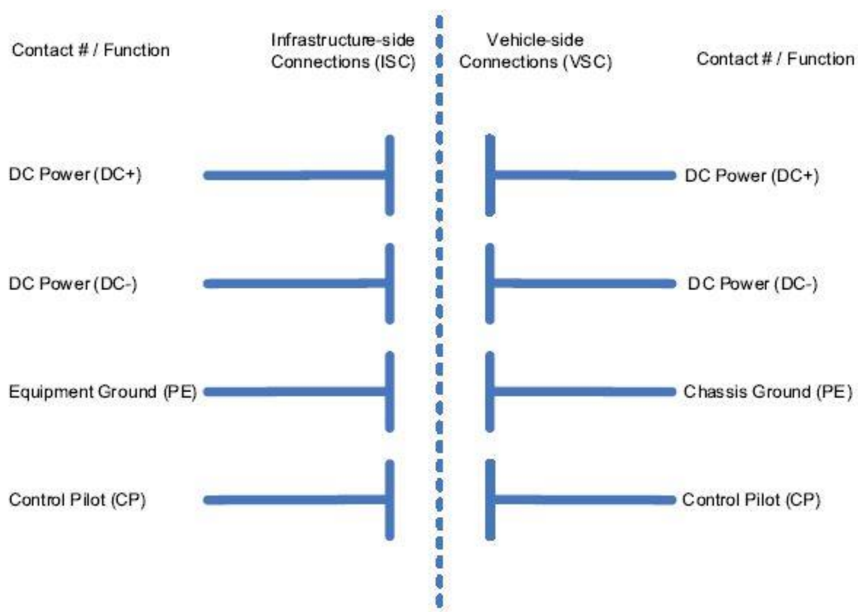

FIG. 4 – DC CONDUCTIVE CONTACT DEFINITION

5.2.2 Communications Link (Wireless Communications)

Communication between the EVSE and EV is necessary to enable the charging process. In a plug-in charging scenario (for example, according to SAE J1772), communication typically starts after the EV is connected to EVSE.

In case of ACD charging as described in IS 17017-3-2, communication shall start before EV is connected to EVSE so that the communication link can be used to control the connecting and disconnecting procedure of the ACD connecting system. Therefore, a wireless communication link is necessary for the ACD charging system. Additionally, the communication link can also be used for the exchange information for positioning of the EV, compatibility check between EV and EVSE, etc.

The wireless communication technology for this application is IEEE 802.11 n. The MAC/PHY layer implementation of the communication channel shall fulfil all requirements stated in ISO 15118-8 System Configuration.

Communications for IS 17017-3-2 use Wi-Fi and communications.

SAE Recommended Practice SAE J2847-2 establishes requirements and specifications for communication between Plugin Electric Vehicle (PEV) and the DC EVSE. Where relevant, this document notes, but does not formally specify, interactions between the vehicle and vehicle operator.

This document applies to the off-board DC EVSE for conductive charging, which supplies DC current to the Rechargeable Energy Storage System (RESS) of the electric vehicle. Communications can be on the control pilot for PLC communication or wireless network (WiFi modem). The details of Power Line communications (PLC) are found in SAE J2931 /4.

A typical method of DC charging is shown in Fig. 5. This configuration allows DC charging with the VSC and ISC. Fig. 5 is for illustration only and is not intended to constrain EVSE or EV design.

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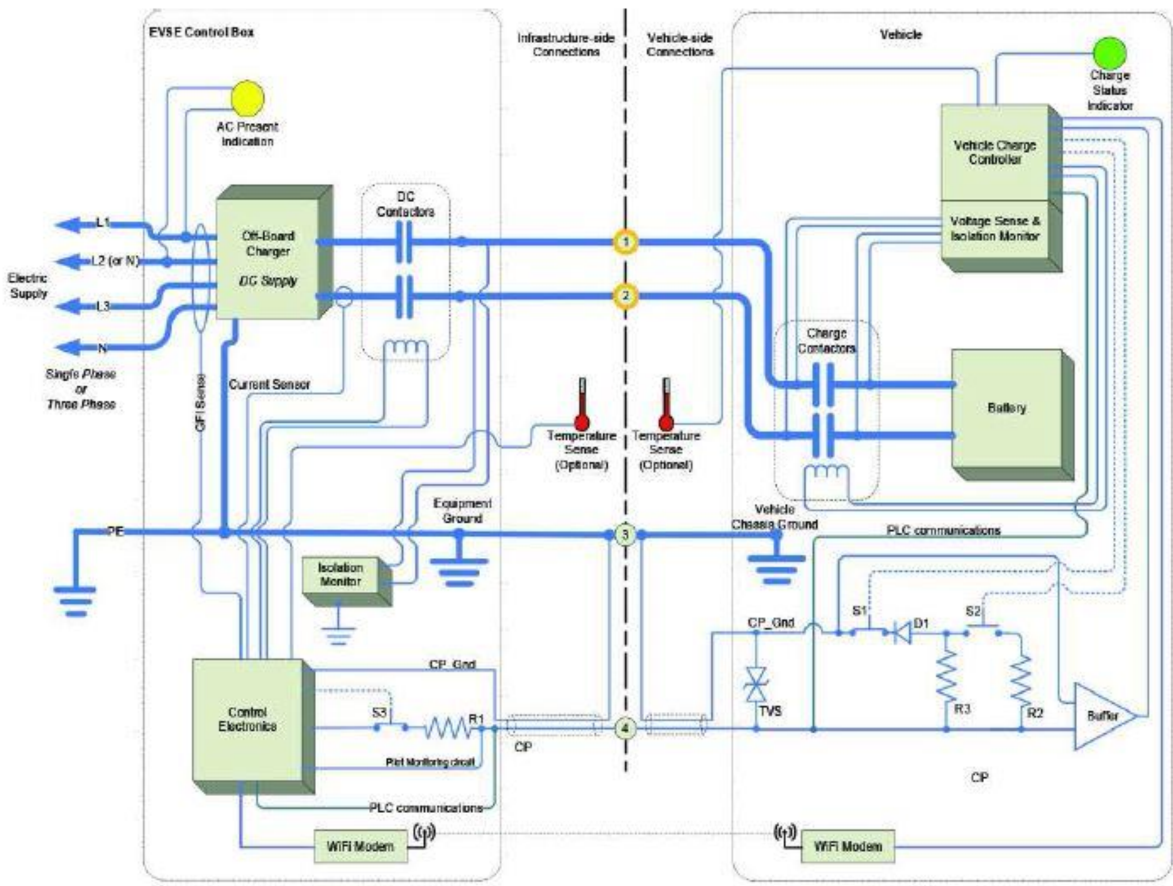


FIG. 5 – DC SYSTEM CONFIGURATION

5.3 Electrical Ratings

The DC voltage range between DC+ and DC- ranges from 250 to 800 VDC.

6 CHARGING REQUIREMENTS

6.1 Connection Requirements

6.1.1 ACD Extension and Retraction

The ACD shall extend only once the vehicle is properly positioned and immobilized.

Upon termination of charging session, vehicle shall remain immobilized until the ACD is completely retracted.

6.1.2 Hazard Conditions

6.1.2.1 Hazardous Conditions

The ISC and the VSC shall be designed to avoid or mitigate potentially hazardous conditions; fire, electric shock, or personnel injury.

6.1.2.2 Electrical Safety

Adopt SAE J2910.

6.1.3 Performance Requirements

The ISC shall comply with the performance requirements set forth in Appendix F.

6.1.3.1 Design Life

The manufacturer should specify the service interval and the number of cycles and the test used for a given use case. See Appendix F for details on each test.

6.1.3.2 Temperature Range

The ISC shall be designed to withstand continuous ambient temperatures in the range of -15°C to +55 °C during operation when supplied with the EVSE, and continuous ambient temperatures in the range of -40 to +80 °C during shipping or storage when the components parts are assembled or supplied with the EVSE. Temperature rise test shall be conducted as per the requirements of temperature rise test of UL 2251.

6.1.3.3 Fluid Resistance

The VSC and ISC shall be unaffected by automotive lubricants, solvents, and fuels.

6.1.4 General ISC Physical Description

The VSC designs shall be of a common physical configuration that can accept common ISC physical configurations as defined for each charging method. Additionally, the physical requirements shall ensure compatibility of ISCs and VSCs manufactured by the same manufacturer at different points in time as well as different manufacturers of the mating ISCs and VSCs. See Appendix A.

6.1.5 Contact Sequencing

Contact sequencing is defined in each of the supplemental documents.

6.1.6 Unintentional Disconnect

When there is an unintentional disconnect of a power contact, then the EVSE shall shut down current flow.

6.1.7 Unintentional Power Loss to Actuator

Under accidental power loss to the ACD actuator, the EV supply equipment shall perform an emergency stop. The unit shall fully retract to its home position within 60 seconds.

6.1.8 EV Movement

The connection method must be able to maintain contact continuity with movement of the EV in the X, Y, and Z axis.

a) The minimum dynamic tolerance dY = 110 mm for a 3. 1 m vehicle height and 2 degrees kneeling (Φz).
b) The minimum dynamic tolerance dX = 70 mm for back to front kneeling.
c) The minimum dynamic tolerance dZ = ±70 mm due to air suspension.
d) The minimum dynamic tolerance dZ = +0/-87 mm for 2500 mm vehicle width due to 2 degrees kneeling (Φz).

6.1.10 Pairing

Reserved for future use.

6.1.11 Physical Dimensions

The VSC shall comply with the key physical dimensions as defined in the specific Sub-document, IS 17017-3-2. Refer to this document for details.

6.1.12 Isolation

The VSC power contacts shall be electrically isolated from battery voltages when the ISC is removed from the VSC.

6.1.13 Exposure of Contacts

The ISC and the VSC shall assure the contact points are out of reach of personnel. Not readily accessible as described in NFPA 70®.

The contacts shall be mounted on high voltage insulators in order to isolate the live parts from the ground and to prevent conductivity of dust, salt, and water accumulations by time. The isolation resistance must be supervised during charging process. The isolation resistance when measured from any DC bus to the electrically conductive chassis should be at least 100 Ω/V (by itself).

6.1.14 Sharp Edges

The VSC shall be free of sharp edges and potentially injurious protrusions per UL 1439.

6.1.15 Environmental Considerations

The VSC should meet the performance requirements under weather and environmental conditions specified by the OEM. Table 1 specifies the environmental conditions.

Table 1 – VSC ENVIRONMENTAL CONSIDERATIONS

S.no	Environmental factor	Value
1	Ambient temperature	-15°C to + 55°C
2	Humidity (RH)	5% to 95%
3	Altitude (max in metres)	2500 m
4	Corrosion	As per requirements specified in Appendix F.

6.2 EV Requirements

6.2.1 Vehicle Movement with Mated ISC

The EV shall be immobilized and prevent operator-intended vehicle movement when ISC is connected to the VSC.

Kneeling of the vehicle shall be possible when the ISC is connected to the VSC.

6.2.2 Charging Process Effect on Auxiliary Systems

Charging process shall not affect function of the vehicle's auxiliary systems.

6.2.3 Alignment

6.2.3.1 Minimum Acceptable Lateral Tolerance

The minimum acceptable lateral tolerance for the EV from the reference point is 460 mm (18 inches). The reference point is commonly the curb.

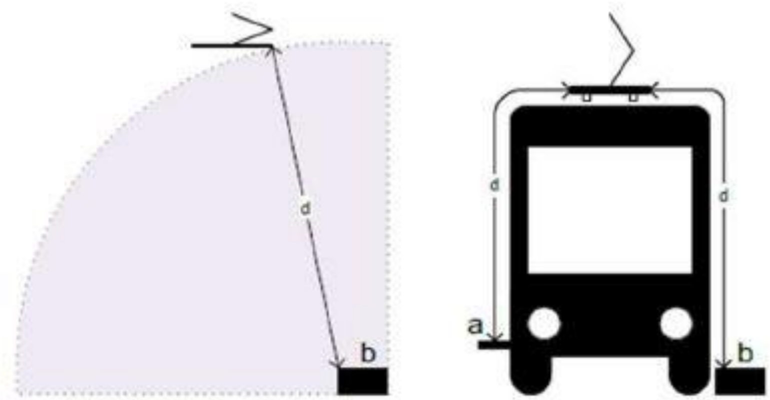
6.2.3.2 Longitudinal Reference

The longitudinal reference is defined by the centerline of the vehicle front axle.

6.2.3.3 Protection by Clearance Standing Surface

The VSC shall assure the contact points are out of reach of personnel. Not readily accessible as described in NFPA 70®.

The wrap around distance and the clearance with a margin of safety, for touching in a straight line from the standing surface or instep shall be at least 3.0 m to provide protection against direct contact with live parts of an ACD as shown in Fig. 6. The clearances given are the minimum values.



Key	
a	Vehicle Step
b	Standing Surface (e.g. platform)
d	> 3000 mm (118.1 inches)

FIG. 6 – MINIMUM CLEARANCES TO ACCESSIBLE LIVE PARTS

6.2.3.4 Alignment Procedure

ACD charging of EVs adds several communication requirements to those required to support manual conductive charging. Foremost among these is the need to be able to communicate between the VSC and the ISC over a wireless connection.

This also results in needing to be able to positively and securely identify the EV presently being charged by the ACD system. For communications, IS 17017-3-1 relies on the work of SAE J2836/6, SAE J2847/6, and SAE J2931/6 to support communications needed for ACD.

6.2.3.4.1 Functions Supported by Communication

As described in other parts of this document, communications are used to support a variety of functions that are of utility to the user as well as necessary to ensure efficient and safe transfer of power while complying with applicable regulations. The sections below give a high-level description of the functions supported; details can be found in the above referenced communications standards.

6.2.3.4.2 ACD Charging Information Exchange

ACD charging information exchange allows the EV to determine the EVSE's capabilities, compatibilities, and availability. Communication supporting this functionality is independent of the charging technology.

6.2.3.4.3 Guidance and Alignment

Reserved for future use.

6.2.4 Isolation Monitoring

The vehicle isolation monitoring system shall be disconnected during charging to prevent interference with the EVSE isolation monitoring system. The vehicle shall consider various EVSE isolation monitoring technologies (AC signal injection, bus shifting, etc.) to satisfy this requirement.

6.2.5 EV Maximum Y Capacitance

The maximum total parallel Y-capacitance shall not exceed 4 μF. This implies ≤2 μF Y-capacitance across each DC contact and ground for an EVSE with Y-capacitance equally distributed between each DC contact and ground.

NOTE 1: The capacitance limits are not for electrical safety.

NOTE 2: Y-capacitance is limited to ensure limited detection time for isolation faults.

NOTE 3: Y-capacitance may be added within the limits above for EMC reasons.

6.2.6 VSC Loss of Communications

When DC charging control communications with the EVSE is lost, the EV shall use the vehicle-initiated normal shutdown sequence; see Appendix C. After the current output achieves ≤1 A, the EV shall open charge contactors ≤500 ms. This will allow the EVSE to discharge the HV bus.

Emergency charge termination: In an emergency, the charge process shall be terminated by opening the S2, by changing CP State from C to B.

6.3 EVSE Requirements

6.3.1 EVSE EMC Requirements

For electromagnetic compatibility (EMC) requirements, refer to FCC Title 47, Part 15 and UL 2231-2.

6.3.2 Installation Requirements

The EVSE shall meet the requirements specified in the National Electrical Code - Article 625 and Canadian Electrical Code - Part 1, Section 86.

6.3.3 General Product Standards

The EVSE shall meet and be listed to the general product requirements for isolated circuits specified in UL 2202.

NOTE: For energy storage or renewable energy, it may be required to further evaluate standard(s) not listed.

6.3.4 Personnel Protection System

The EVSE shall incorporate a listed system of personnel protection for isolated circuits as specified in UL 2231 with the exception that "nominal system voltage" is replaced with "rated system voltage."

6.3.4.1 DC Output Isolation

Contact Isolation is the resistance between each DC contact and ground including any measuring device. Total Isolation is the parallel combination of both contact Isolation values. The Total Isolation of the EVSE DC output shall be ≥1 .25 MΩ including any measurement/monitoring devices. This implies ≥2.5 MΩ isolation between each DC contact and ground for an EVSE with isolation equally distributed between each DC contact and ground.

NOTE: Vehicle isolation requirements of 100 Ω/V (DC) or 500 Ω/V (AC or AC/DC) are stated in multiple documents including ECE R100, ISO 6469-3, and SAE J2344. EVSE DC output isolation requirements are stated in IEC 61851 -23-1 and UL 2231. These documents state that the EVSE shall terminate charge when the isolation of the output falls below 100 Ω/V. The EVSE shall implement one of the following time management strategies of isolation monitor self-test: directly prior to supply cycle with vehicle ISC connected to the VSC or at regular intervals with a maximum period of 24 hours. Independently, the vehicle and EVSE each meet their individual requirements for isolation. When connected as a system, the resulting isolation cannot be greater than the lowest isolation of either the vehicle or EVSE.

Because of EVSE tolerance and component aging, some vehicles with isolation as low as the allowable 100 Ω/V may not be able to charge.

The insulation monitoring device (IMD) shall comply with IEC 61557-8 or equivalent. The DC supply shall perform insulation monitoring between DC+ and PE and DC- and PE during the supply process and communicate the current state (Invalid, Valid, Warning, Fault) of the system periodically to the EV.

Prior to each supply cycle the following tests shall be performed. During these tests the DC output voltage shall not exceed the maximum voltage of the EV at ACD.

6.3.4.2 Self-Test

A self-test of the insulation monitoring function of the DC supply shall be done by applying a defined fault resistor between DC output rail and equipotential bonding (e.g., PE). At least one of the following three possibilities for time management of self-test shall be applied:

a) Directly prior to supply cycle;
b) At regular intervals with maximum period of 24 hours;
c) After self-test has successfully been performed the station may stay in valid state for a maximum time of 24 hours and during supply session under normal conditions.

NOTE 1: The self-test is done only on the IMD itself. The rest of the EV supply equipment should not react to the isolation fault generated during the self-test.

NOTE 2: A yearly check with the IMD in which the whole chain of the isolation fault is checked should be done; e.g., a fault resistor is applied between DC and PE, the IMD registers the fault and the charge session is stopped with an emergency shutdown.

NOTE 3: The supply session should not be stopped to do a self-test.

6.3.4.3 Insulation Check Prior to Charging

An insulation check of the system by the IMD shall be performed:

EVSE connected via ACD to vehicle: system comprises station, wiring to ACD, ACD counterpart, vehicle ACD contacts and vehicle cables.

6.3.4.4 DC Insulation Check During Charging

During the charge session, the insulation state of the system shall be monitored by the IMD of the DC EV charging station.

The insulation states of the system are defined as follows.

Invalid state: Self-test has not been carried out yet. Charging is not allowed.

Valid state: After self-test has successfully been performed, the station shall go into valid state. After each termination of energy transfer, the station shall remain in the valid state until the beginning of the next scheduled self-test.

Warning state: If the actual total physical insulation resistance between DC+/DC- to PE falls below a value calculated by 500 Ω/V multiplied by the maximum voltage of the EV the DC supply shall send a warning message and store the warning.

Fault state: If self-test has failed or the actual total physical insulation resistance between DC+/DC- to PE falls below a value calculated by 100 Ω/V multiplied by the maximum voltage of the EV, an optical and/or acoustical signal shall be issued by the DC supply to the user and the DC supply shall terminate the supply process. While the DC charging station is charging a vehicle, the DC charging station shall detect the fault state and indicate the invalid state ≤2 consecutive minutes of the insulation resistance ≤100 Ω/V.

If warning or fault state during energy transfer occurs, the station shall perform a self-test after disconnecting the ACD from the vehicle. If self-test is successfully passed, the station shall go into valid state; otherwise it shall go into invalid state and stay there until the insulation resistance remains ≤100 Ω/V.

The reaction time of the IMD shall be less than 100 seconds.

6.3.4.5 EVSE Measured Isolation Value (Optional)

The EVSE may optionally communicate the last valid measured isolation value to the EV. Refer to SAE J2847/2.

6.3.5 Maximum Output Y Capacitance

The maximum total parallel Y-capacitance shall not exceed 4 μF. This implies ≤ 2μF Y-capacitance across each DC contact and ground for an EVSE with Y-capacitance equally distributed between each DC contact and ground.

NOTE 1: The capacitance limits are not for electrical safety.

NOTE 2: Y-capacitance is limited to ensure limited detection time for isolation faults.

NOTE 3: Y-capacitance may be added within the limits above for EMC reasons.

6.3.6 DC Output Current Measurement Accuracy and Resolution

The measured current shall be within ±1% of the actual current if the actual current is >30 A; ±0.3 A if the actual current is ≤30 A of reading with a minimum resolution of ±1 .0 A.

6.3.7 DC Output Voltage Measurement Accuracy

The measured voltage reported shall be within ±1% of rated voltage of the EVSE or less.

6.3.8 DC Output Current Regulation

When in current regulation mode, the EVSE shall provide direct current to the vehicle. The maximum allowable error between the actual average DC current value and the vehicle commanded current value is:

a) ±1 .5 A when the commanded current value is less than or equal to 50 A.
b) ±3% of the charger’s maximum current output when the commanded current value is greater than 50 A.

6.3.9 DC Output Descending Current Output Slew Rate

Normal shutdown or zero current request: Slew rate shall attain a shut down in 1.0 second or less.

Malfunction or emergency shutdown: Slew rate shall attain a shut down in 30 ms or less.

6.3.10 DC Output Current Ripple

During regulation, the EVSE shall maintain a peak-to-peak current ripple as shown in Table 2.

Table 2 – PEAK-TO-PEAK RIPPLE

Limit I ≤ 125 A*	Limit I > 125 A*	Frequency (Hz)
1.5 A_{pp}	1.2% I	<10
6.0 A_{pp}	4.8% I	<5k
9.0 A_{pp}	7.2% I	<150k

* Difference between positive peak top and negative peak top at full scale output I (nom).

6.3.11 DC Output Voltage - No Load Voltage Regulation

Under no load conditions (for example, during pre-charge), the actual output of the charger will be +1 V/-20 V of the vehicle's request within 2 seconds. In steady state, the tolerance between requested and provided voltages is ≤2% for the maximum rated voltage of the EVSE.

The voltage difference between the EVSE and the EV is required to be measured from the EV.

6.3.12 DC Output Voltage Transient

DC output voltage transient shall be measured at the rated power and rated voltage. Voltage transients shall be limited ±50 V between any two power contacts.

6.3.13 DC Output Current Overshoot Time

If vehicle maximum current limit (message defined in SAE J2847/2) is exceeded by more than the amount specified in 6.3.8 for more than 400 ms, the EVSE shall shut down due to a fault condition. This is the case where the current output is no longer under the control of the vehicle, and the charging station will use its conversion circuitry to reduce current flow.

6.3.14 DC Output Inrush

The output inrush current shall not exceed 20 A.

6.3.15 DC Output Short Circuit Test

Prior to enabling its high voltage DC output, the EVSE shall check for a short circuit between the high voltage DC+ and DC- in the ISC, VSC, and vehicle cabling up to the vehicle DC charging disconnect. See Appendix C.

6.3.16 Touch Current

Touch current for EVSE, and EV while connected to EVSE for charging, shall be in accordance with the requirements of IEC 61851, clause 11 .7.

6.3.17 ISC Loss of Communications

When DC charging control communications with the EV is lost, the EVSE shall use the EVSE initiated normal shutdown sequence.

6.3.18 Protection Against Uncommanded Reverse Power Flow

The EVSE shall protect itself from uncommanded reverse power flow from the EV.

6.3.19 User-Initiated Emergency Charge Termination

The EVSE shall provide a means to allow the user to terminate charging cycle in an emergency event.

6.3.20 ISC Clearance Height

Some adjustment or installation variation may be required for near tolerance vehicles, such as double decker. Road clearance must always be compliant to local regulations, which can override the below specifications.

As the initial document is driven by the transit bus industry, rooftop positioning and road clearance are aligned with this vehicle type. Other types of vehicle may use this interface and may have various rooftop positioning or infrastructure clearances.

For other infrastructure installation than on-road usage, such as indoor or in-depot type, the installation height may be adjusted based on the local needs and installation requirements.

The minimum height clearance to the ground shall be at 4500 mm (14.7 feet).

.**6.3.22 Network an Application Protocol Requirements**

The application protocol requirements for EV and EVSE for ACD according to IS 17017-3-2 are described in Appendices C and D. The schema is in Appendix E.

APPENDIX A - CHARGING CONTROL AND INFORMATION

A.1 Control Pilot

The control pilot circuit is the primary control means to ensure proper operation when connecting a EV to the EVSE. This section describes the functions and sequencing of events for this circuit based on the recommended typical implementation or equivalent circuit parameters.

A.1.1 Control Pilot Circuit

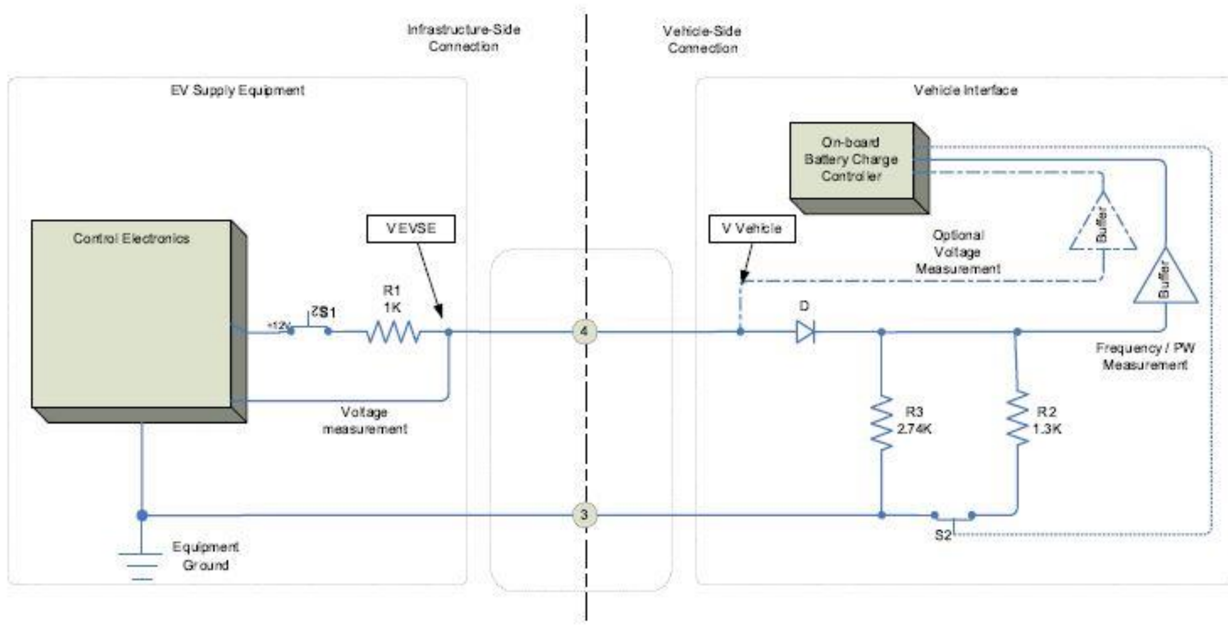


FIG. A1 – CONTROL PILOT CIRCUIT

A.1.2 Vehicle States

The vehicle states are defined in Tables A1, A2, A3, and A4.

Table A1 – DEFINITION OF VEHICLE / EVSE STATES WITH PLC

State Designation	EVSE (VDC Nominal)(5)	Vehicle (VDC Nominal)(5)	Description of Vehicle/EVSE State
State A	12.0(1)	0(1)	Vehicle not connected
State B1	9.0(1)	9.0(1)	Vehicle connected/not ready to accept energy
			EVSE not ready to supply energy
State B2	9.0(2)(3)	9.0(2)(3)	Vehicle connected/not ready to accept energy
			EVSE capable to supply energy
State C	6.0(2)	6.0(2)	Vehicle connected/ready to accept energy/indoor charging area ventilation not required
			EVSE capable to supply energy
State D	3.0(2)	3.0(2)	Vehicle connected/ready to accept energy/indoor charging area ventilation required
			EVSE capable to supply energy
State E(4)	0	0	EVSE disconnected from vehicle/EVSE disconnected from utility, EVSE loss of utility power or control pilot short to control pilot reference
State F	-12.0(1)(6)	-12.0(1)(6)	Other EVSE problem

a) Static voltage.

b) Positive portion of 1 kHz square wave, measured after transition has fully settled.

c) The transition from State B1 to State B2 begins as a static DC voltage which transitions to PWM upon the EVSE detection of vehicle connected/not ready to accept energy and EVSE capable to provide energy.

d) EVSE is not required to actively generate State E.

e) Voltage measured by EVSE/Vehicle as shown in Figure 6.

f) Optional state. The EVSE may enter State F upon detecting a self-diagnosed fault that prevents the EVSE from delivering power. Once the EVSE is in State F, self-restoring (automatic restart) is not required. This option would require user intervention to reset the EVSE to restore normal operation. If the EVSE decides to self-restore while connected to an EV/PHEV, a maximum of 20 re-tries shall be allowed with a 15-minute minimum time interval between re-tries. If the EVSE does not recover within a maximum of 20 re-tries, user intervention is required to reset the EVSE to restore normal operation.

Table A2 – CONTROL PILOT STATE VOLTAGE RANGE REFERENCE FROM MATED CHARGE CONNECTION

State	Min Voltage	Nominal Voltage	Max Voltage
A	10.5	12.0	>10.5
B	7.5	9.0	<10.5
C	2.0	4.75	<7.5
D	NA	NA	NA
E	0	1.0	<2.0
F	NA	NA	NA

NOTE: The tolerances described in table represent calculated values assuming 3% resistors in the EVSE circuitry. These values do not take into variances such as ground shift, chassis resistance, active accessory devices (air conditioning, rear defog, etc.) or other factors that may shift these values. The values do not include the EVSE cable. Vehicle manufacturers must minimize these factors in their vehicle designs.

Table A3 - EVSE CONTROL PILOT CIRCUIT PARAMETERS WITH PLC CONTROL (SEE FIGURE A1)

Parameter(1)	Symbol	Units	Nominal Value	Max Value	Min Value
Generator					
Voltage high, open circuit	Voch	V	12	12.6	11.4
Voltage low, open circuit	Vocl	V	-12.00	-12.60	-11.40
Frequency	Fo	Hz	1000	1020	980
Pulse width(2)	Pwo	μs	Per Figure 3	Nom, +5 μs	Nom, -5 μs
Rise time(3)	Trg	μs	NA	2	NA
Fall time(3)	Tfg	μs	NA	2	NA
Setting time(4)	Tsg	μs	NA	3	NA
Output Components					
Equivalent source resistance	R1	Ω	1000	1030(5)	970(5)
Total equivalent EVSE Capacitance, w/o cable	C1	pF	NA	NA	300(6)
Total equivalent EVSE capacitance, including cable	C1 + Cc	pF	NA	3100	NA

a) Tolerances to be maintained over the environmental conditions and useful life as specified by the manufacturer.
b) Measured at 50% points of complete negative-to-positive or positive-to-negative transitions.
c) 10 to 90% of complete negative-to-positive transition or 90 to 1 0% of complete positive-to-negative transition measured between the pulse generator output and R1 . Note that the term “generator” is referring to the EVSE circuitry prior to and driving the 1 KΩ source resistor with a ±1 2 V square wave. This circuitry should have rise/fall times faster than 2 µs. Rise/fall times slower than this will begin to add noticeably to the output rise/fall times dictated by the 1 KΩ resistor and all capacitance on the pilot line.
d) To 95% of steady-state value, measured from start of transition.
e) Maximum and minimum resistor values are ±3% about nominal.
f) Guarantees rise time slow enough to remove transmission line effects from cable.

Table A4 - EV CONTROL PILOT CIRCUIT PARAMETERS WITH PLC CONTROL (SEE FIGURE A1)

Parameter(1)	Symbol	Units	Nominal Value	Max Value	Min Value
Equivalent load Resistance - States B1 & B2	R2B	Ω	2740	2822(2)	2658(2)
Equivalent load Resistance - State C(3)	R2C	Ω	882	908(2)	856(2)
Equivalent load Resistance - State D(4)	R2D	Ω	246	253(2)	239(2)
Total equivalent capacitance	C2	pF	NA	2400	NA
Equivalent diode voltage drop(5)	Vd	V	0.7	0.85	0.55

a) Tolerances to be maintained over the environmental conditions and useful life as specified by the manufacturer.
b) Maximum and minimum resistor values are ±3% about nominal.
c) Vehicles not requiring ventilation for indoor charging areas.
d) Vehicles requiring ventilation for indoor charging areas.
e) Silicon small signal diode, -40 to 85 °C, forward current 3.00 to 10.0 mA.

A.1.3 Control Pilot Functions

The control pilot performs the following functions:

A.1.3.1 Verification of Vehicle Connection

The EVSE is able to determine that the ISC is connected to the VSC and properly connected to the EV by sensing resistance R3 as shown in Fig. A1. The diode, D1, is present to help an EVSE determine that an EV is connected rather than other potential low impedance loads. I f the EVSE does not detect diode D1 (missing or shorted), it may indicate a fault by entering State F. The EV may optionally monitor the control pilot on the anode side of diode D1 as shown in Fig. A1.

A.1.3.2 EVSE Not Ready to Supply Energy

The EVSE is able to indicate to the EV that it is not ready to supply energy by not turning on the oscillator and maintaining State B1. State B1 may be used by the EVSE to maintain the current charge session during load management, fee transaction, or other events.

The EVSE may turn off the oscillator at any time while in State C or D during the current charge session. When the EVSE turns off the oscillator, the EVSE shall terminate energy transfer. The EV then opens S2, resulting in State B1.

A.1.3.3 EVSE Ready to Supply Energy

The EVSE is able to indicate to the EV that it is ready to supply energy by turning on the oscillator and providing the square wave signal according to the value derived from Fig. 8. The EVSE shall not close contactors unless the oscillator is on and valid per Fig. A2. In each of the states specified in Tables A1 and A2, the EVSE may supply the pilot as a DC signal or as an oscillating signal. However, normally the oscillator is only turned on in State B2, State C, or State D.

A duty cycle of 5% indicates that digital communication is needed; see 6.3.

A.1.3.4 EV Ready to Accept Energy

The EV indicates that it is ready to accept energy from the EVSE by closing switch S2, as shown in Fig. A1, when the current profile on the control pilot oscillator is sensed. The EV may de-energize the EVSE at any time by opening switch S2.

A.1.3.5 Verification of Equipment Grounding Continuity

The equipment grounding conductor provides a return path for the control pilot current to ensure that the EVSE equipment ground is safely connected to the EV vehicle chassis ground during charging. Loss of this signal shall result in the automatic de-energization at the EVSE.

A.1.4 EVSE Shutdown - Control Pilot

The EVSE shall detect the loss of the control pilot (control pilot transition from State C (or D) to State A) and interrupt the DC output current to ≤5 A within ≤30 ms. See Appendix B.

A.1.5 Charge Status Indicator

The EV shall provide charge status information visible to the operator while connection is connected. The specific requirements (such as color, lamp type, styling, intensity, field of view, etc.) for the charge status indicator can be defined by the OEM.

A.1.6 Digital Data Transfer

A control pilot duty cycle of 5% indicates that digital communication is required and must be established between the EVSE and vehicle before charging. This is required for DC charging.

Digital data transfer is specified in the following SAE documents:

a) SAE J2836/2: Use Cases for Communication Between Plug-in Vehicles and Off-Board DC Chargers
b) SAE J2847/2: Communication Between Plug-in Vehicles and Off-Board DC Chargers
c) SAE J2931/1: Digital Communications for Plug-in Electric Vehicles
d) SAE J2931/4: Broadband PLC Communication for Plug-in Electric Vehicles
e) SAE J2953/1: Plug-in Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)
f) SAE J2953/2: Test Procedures for the Plug-in Electric Vehicle (EV) Interoperability with Electric Vehicle Supply Equipment (EVSE).

A.1.7 EVSE and PEV Sequence and Response Time Specifications

See Appendix C for sequencing and response time specifications.

APPENDIX B - EVSE AND PEV MESSAGE

The message ID in the table shown below directly aligns with the request/response messages identified by yellow stars in the sequence diagrams in SAE J2847. See 5.2.2.

Table B1 - EV CONTROL PILOT CIRCUIT PARAMETERS WITH PLC CONTROL (SEE FIGURE A1)

MSD ID	XML Message	Parameters
0A	SupportedAppProtocolReq	APPPROTOCOL
0B	SupportedAppProtocolRes	RESPONSE CODE *SCHEMAID*
1A	SessionSetupReq	EVCCID
1B	SessionSetupRes	RESPONSECODE EVSEID *DATETIMENOW*
2A	ServiceDiscoveryReq	*SERVICESCOPE* *SERVICECATEGORY*
2B	ServiceDiscoveryRes	RESPONSE CODE PAYMENTOPTIONS CHARGESERVICE SERVICELIST
XA	ServicePaymentSelectionReq	
XB	ServicePaymentSelectionRes	
YA	ContractAuthenticationReq	
VB	ContractAuthenticationRes	
3A	ChargeParameterDiscoveryReq	EVREQUESTEDENERGYTRANSFERTYPE DC_EVCHARGEPARAMETER
3B	ChargeParameterDiscoveryRes	RESPONSECODE SASCHEDULELIST DC_EVSECHARGEPARAMETER
4A	CableCheckReq	DC_EVSTATUS
4B	CableCheckRes	RESPONSECODE DC_EVSESTATUS
5A	PreChargeReq	DC_EVSTATUS EVTARGETVOLTAGE EVTARGETCURRENT
5B	PreChargeRes	RESPONSECODE DC_EVSESTATUS EVSEPRESENTVOLTAGE
6A	PowerDeliveryReq	READYTOCHARGESTATE CHARGINGPROFILE DC_EVPOWERDELIVERYPARAMETER
6B	PowerDeliveryRes	RESPONSECODE DC_EVSESTATUS

MSD ID	XML Message	Parameters
7A	CurrentDemandReq	DC_EVSTATUS EVTARGETCURRENT EVMAXIMUMVOLTAGELIMIT EVMAXIMUMCURRENTLIMIT EVMAXIMUMPOWERLIMIT *BULKCHARGINGCOMPLETE* CHARGINGCOMPLETE REMAININGTIMETOFULLSOC REMAININGTIMETOBULKSOC EVTARGETVOLTAGE
7B	CurrentDemandRes	RESPONSECODE DC_EVEVSESTATUS EVSEPRESENTVOLTAGE EVSEPRESENTCURRENT EVSECURRENTLIMITACHIEVED EVSEVOLTAGELIMITACHIEVED EVSEPOWERLIMITACHIEVED EVSEMAXIMUMVOLTAGELIMIT EVSEMAXIMUMCURRENTLIMIT EVSEMAXIMUMPOWERLIMIT
8A	PowerDeliveryReq	READYTOCHARGESTATE CHARGINGPROFILE DC_EVPOWERDELIVERYPARAMETER
8B	PowerDeliveryRes	RESPONSECODE DC_EVSESTATUS
9A	WeldingDetectionReq	DC_EVSTATUS
9B	WeldingDetectionRes	RESPONSECODE DC_EVSESTATUS EVSEPRESENTVOLTAGE
10A	SessionStopReq	(NONE)
10B	SessionStopRes	RESPONSECODE

APPENDIX C - EVSE AND PEV SEQUENCE AND RESPONSE TIME SPECIFICATIONS

The ASSURED project will perform interoperability testing between different vehicles and charging stations. At the time of ASSURED testing, the standardization related to the infrastructure mounted ACD is still in progress, and therefore the ASSURED project has decided to base the communications specification of the Type A system on the existing connection protocol. Interoperability testing in ASSURED shall be performed against the specification described in this chapter.

For conformance testing, all ASSURED solutions are tested against the ASSURED specification. Optionally, OEMs have an opportunity to perform conformance testing of their equipment against the upcoming ISO 15118-20 standard.

The first message of the protocol (supportedAppProtocol) determines which protocol version shall be used during the charging process (ASSURED or ISO 15118-20).

This appendix describes the solution based on references to published draft standards available for the ASSURED community. It will include definitions where the solution differs from the referenced standards and additional clarifications if deemed necessary.

C.1 Mechanical interface

The mechanical interface is described in prEN 50696 CD - Annex A (normative), ACD mounted on the infrastructure.

C.2 General

The process of supplying energy to the EV by the DC supply is initiated and controlled by the messages sent by means of wireless communication as described in ISO 15118-2 and -8 and shall follow the sequences shown in Fig. C1, C2, C3, and C4 for normal start up, normal shutdown, station initiated emergency shutdown and EV initiated emergency shutdown.

Legend for sequence diagrams and description:

(tx) = dedicated point in time

(tx □ ty) = time period between two dedicated points in time tx and ty

<1a> <1b> = reference to messages in high level communication (WLAN)

= possible time period in which described action can take place

in blue = communication signals and values described in ISO/IEC 15118-2

in orange = second variable from ISO 15118-2

in yellow = variable proposed for ISO 15118-2, 2nd edition CD

in red = not communicated value

C.2.1 Normal Start Up

Sequence diagram and description for normal start-up are shown in Fig. C1 and Table C1.

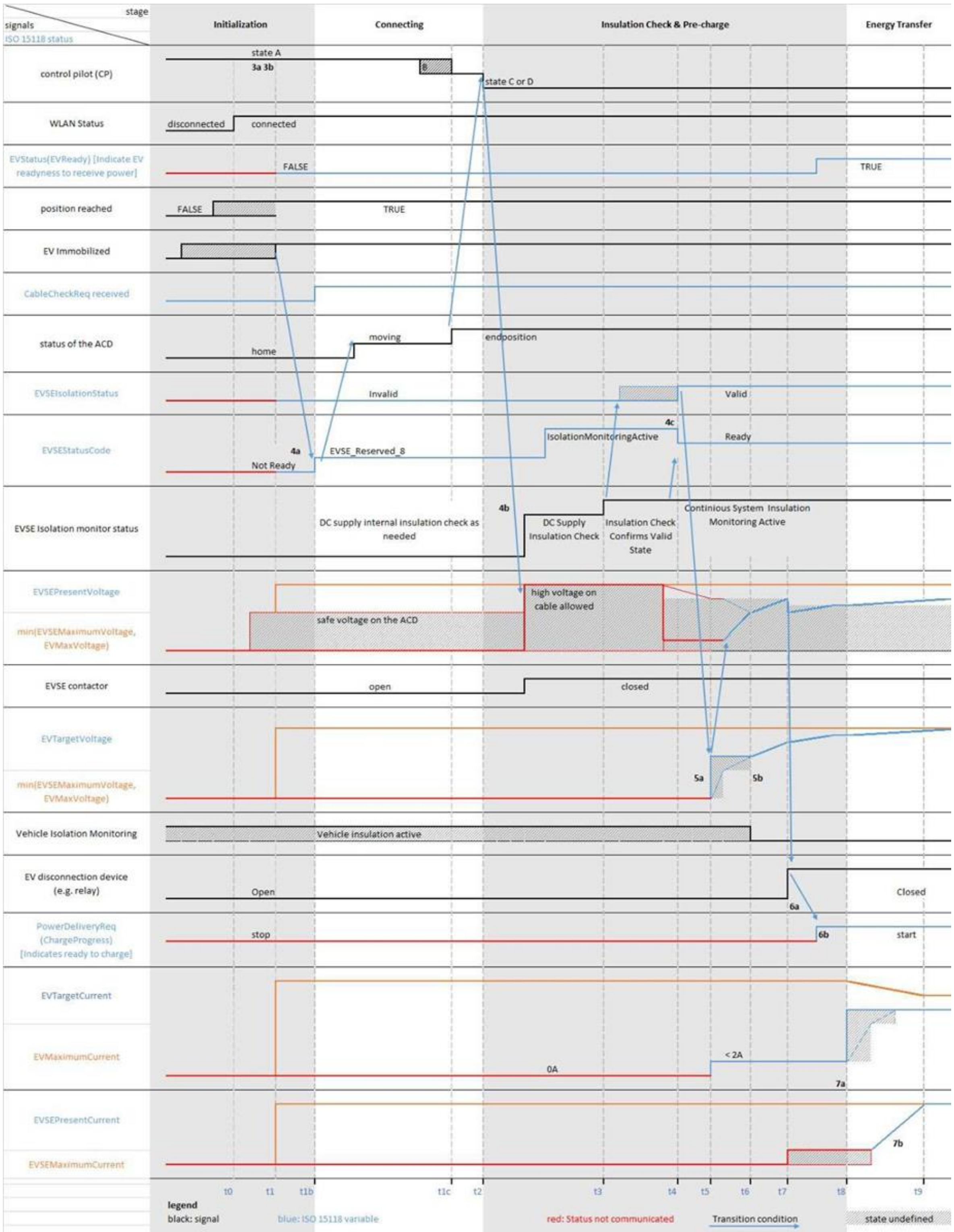


FIG. C1 – SEQUENCE DIAGRAM FOR NORMAL START-UP

Table C1 - SEQUENCE DESCRIPTION FOR NORMAL START UP

Phase	Description
(t0)	High level communication starts and handshaking with exchange of charging parameters takes place.
(t1)	EV sends its maximum limits (amongst other parameters) for DC supply output current and voltage with <3a>. Maximum values of the DC supply are responded to the EV with <3b>. DC supply can check internal insulation as long as no voltage is applied to the ACD. If EV and EV supply equipment are not compatible, then the vehicle will not go to Ready, and will transition to step t16 in the normal shutdown sequence.
(t1b)	EV has reached the correct position for charging. C supply checks if DC output voltage is less than 60 V and terminates supply session if 60 V is exceeded. V initiates connection process <4a> by sending CableCheckReq. DC supply sets its status to “EVSE_Reserved_8” until the ACD is in the working position.
(t1c)	EV supply equipment reports that the mechanical contact is secured DC supply checks if DC output voltage is less than 60 V and terminates supply session if 60 V is exceeded.
(t2)	EV changes CP state from B to C/D by closing S2 which ends connecting phase.
(t2 → 3)	EV requests cable and insulation check by <4b>. DC supply starts checking HV system insulation and continuously reports insulation state.
(t3)	DC supply determines that insulation resistance of system is above 100 Ω/V (cf. CC.4.1).
(t3 → t4)	After having successfully finished the insulation check, DC supply indicates status “valid” with subsequent message.
(t4)	EVSEStatusCode changes to “ready” with cable check response <4c>.
(t5)	Start of pre-charge phase with EV sending pre-charge request <5a>, which contains both requested DC current ≤ 2 A (maximum inrush current acc. to CC.5.2) and requested DC voltage.
(t5 → t6)	DC supply adapts DC output voltage to requested value in <5a> while limiting current to maximum value of 2 A (maximum inrush current according to CC.6.1) even if the requested current 0A.
(t6)	DC output voltages reaches requested voltage within tolerances given in 6.3.7.
(t6 → t7)	If necessary, EV adapts requested DC voltage with cyclic messages <5a> in order to limit deviation of DC output voltage from EV battery voltage to less than +1 V, -20 V. Before the EV closes any contactor the EV stops vehicle internal insulation monitoring.

(t7)	EV closes its disconnecting device after deviation of DC output voltage from EV battery voltage is less than 20 V.

Phase	Description
(t7 → t8)	EV sends power delivery request <6a> with ChargeProgress "start" to enable DC power supply output. EV sets EVReady status "TRUE." After disabling pre-charge circuit, if any, and switching on its power supply output, DC supply gives feedback <6b> that it is ready for energy transfer.
(t8)	EV sets DC current request with <7a> to start energy transfer phase.
(t8 → t9)	DC supply adapts its output current and voltage to the requested values. DC supply reports its present output current and output voltage, its present current limit and voltage limit, and its present status back to the EV in message <7b>. NOTE: EV may change its voltage request and current request even if output current has not reached the previous request.
(t9)	DC output current reaches DC current request within delay time Td. (Time span t9 - t8 = Td, if one request has been made, bold line shown this situation.)
(t9 →)	EV adapts DC current request and DC voltage request according to its charging/supply strategy with cyclic message <7a>.

C.2.2 Normal Shutdown

Sequence diagram and description for normal shutdown are shown in Fig. C2 and Table C2.

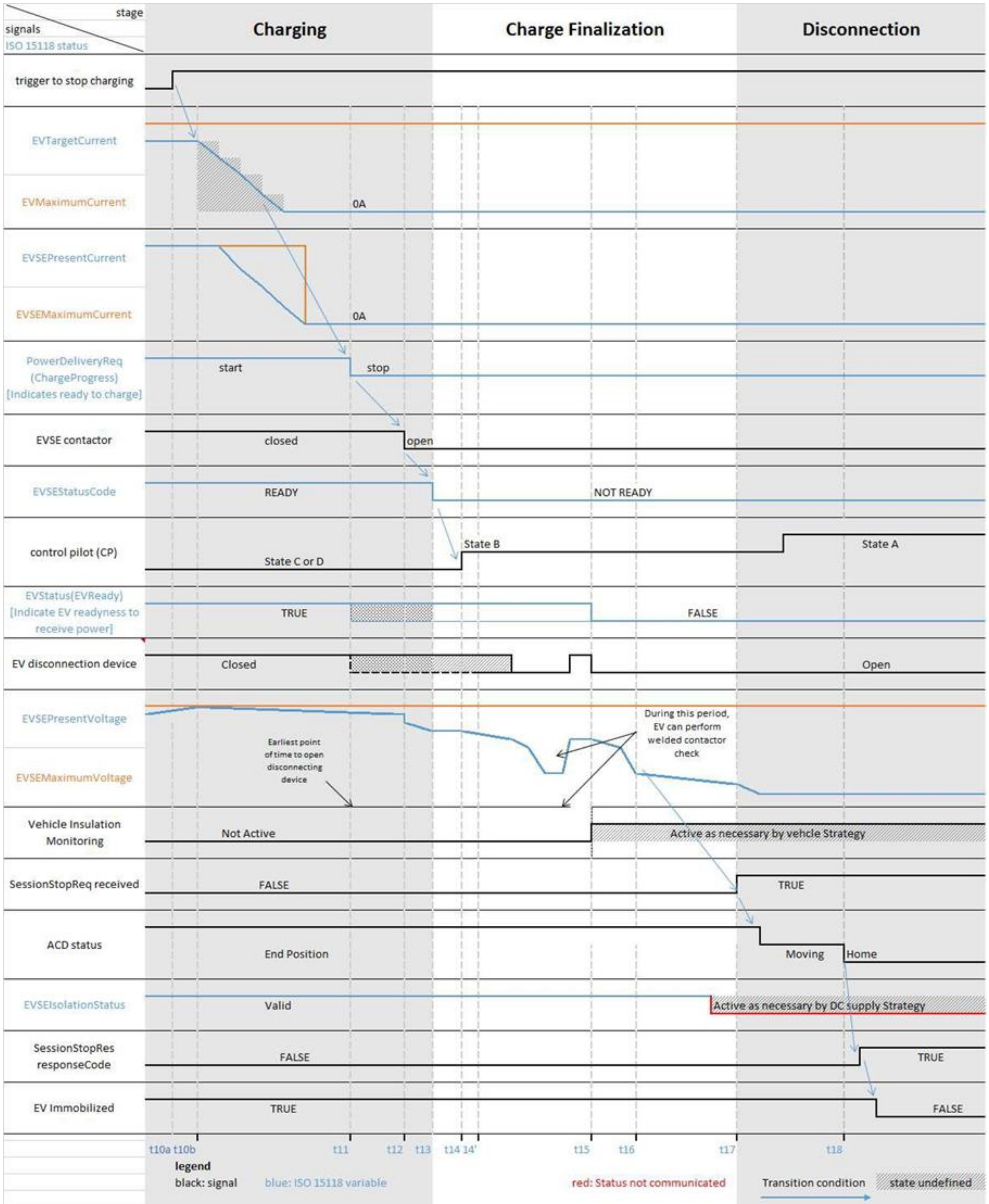


FIG. C2 – SEQUENCE DIAGRAM FOR NORMAL STOP

Table C2 – SEQUENCE DESCRIPTION FOR NORMAL STOP

Phase	Description
(t10a)	The user or vehicle system indicates that charging should be stopped.
(t10b)	The EV reduces the current request to complete the energy transfer. Reduction is done based on EV charging/supply strategy.
(t11)	When the current requests are reduced to 0A. The EV requests the DC supply to disable its output power. ChargeProgress set to stop.
(t12)	DC supply disables its output and opens contactors, if any. DC supply shall enable its circuit to actively discharge any internal capacitance on its output after receiving message with “PowerDeliveryReq(chargeProgress)” set to stop. DC supply shall not cause any current flow on EV input during discharge.
(t13)	DC supply reports EVSEStatusCode ”not ready” within 2 secpmds after the DC supply has disabled its output.
(t14)	EV changes CP state to B after receiving message PowerDeliveryRes() with EVSEStatusCode “not ready” or after timeout to ensure that DC supply has discharged its output at latest by t14 (in case message was lost).
(t14’)	EV can optionally perform its welded contactor check and indicating this to the DC supply.
(t15)	Earliest time for EV isolation monitoring active.
(t16)	The DC output voltage is checked to be below 60 VDC.
(t17)	The SessionStopReq is received.
(t17 → t18)	State A is observed.
(t18)	The EV shall be mobilized only when the ACD is confirmed to be in the home position by a sessionStopRes with responseCode = Ok.

C.2.3 DC Supply Initiated Emergency Shutdown

An emergency shutdown of the output current to less than 5 A within 1 second with a current descending rate of 200 A/s or more shall be applied by the DC supply. DC supply shall indicate supply initiated emergency shutdown by turning off CP.

NOTE: DC supply initiated emergency shut can be triggered by several causes or faults.

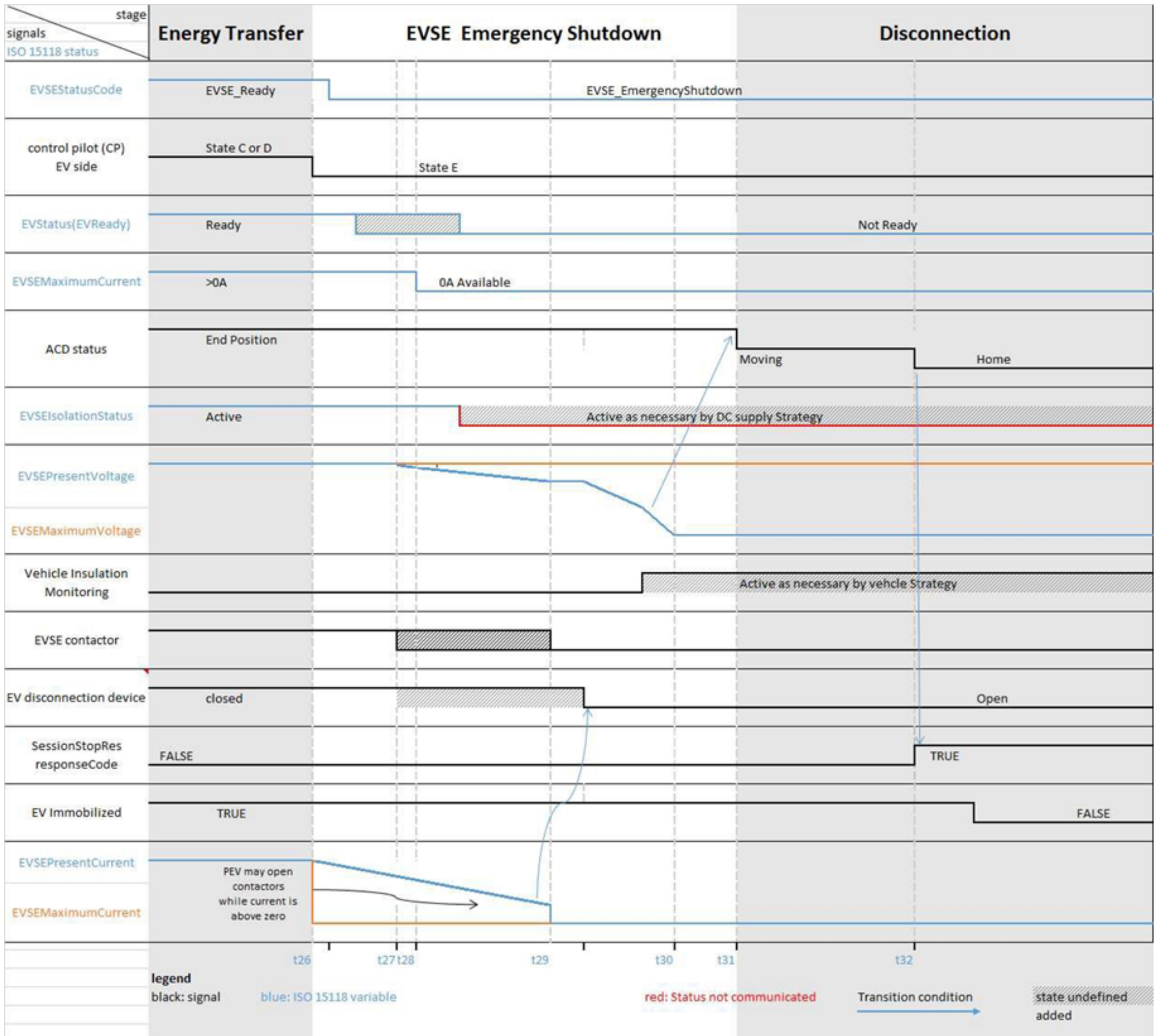


FIG. C3 – SEQUENCE DIAGRAM FOR DC SUPPLY INITIATED EMERGENCY STOP

Table C3 - SEQUENCE DESCRIPTION FOR DC SUPPLY INITIATED EMERGENCY STOP

Phase	Description
(t26)	EV supply equipment experiences an emergency (isolation fault, emergency button press, etc.) and sets the control pilot signal to state E. The EV supply equipment reduces its maximum current limit and start reducing its current.
(t27)	The EV reacts by disabling S2 and may open its contactor from this time.
(t29)	The EV supply equipment has reduced its current to <5 A and has opened its contactors. The EV has opened its contactors as well.
(t30)	The EV supply equipment reduced its voltage below 60 V.
(t31)	The EV supply equipment starts disconnecting the ACD.
(t32)	The EV observes state A and gets a confirmation that the ACD is in its home position indicated by a sessionStopRes with responseCode = Ok.

C.2.4 EV-Initiated Emergency Shutdown

EV triggers emergency shutdown by opening S2 and changing CP state from C/D to B. DC supply shall acknowledge emergency shutdown request from the EV by performing emergency shutdown.

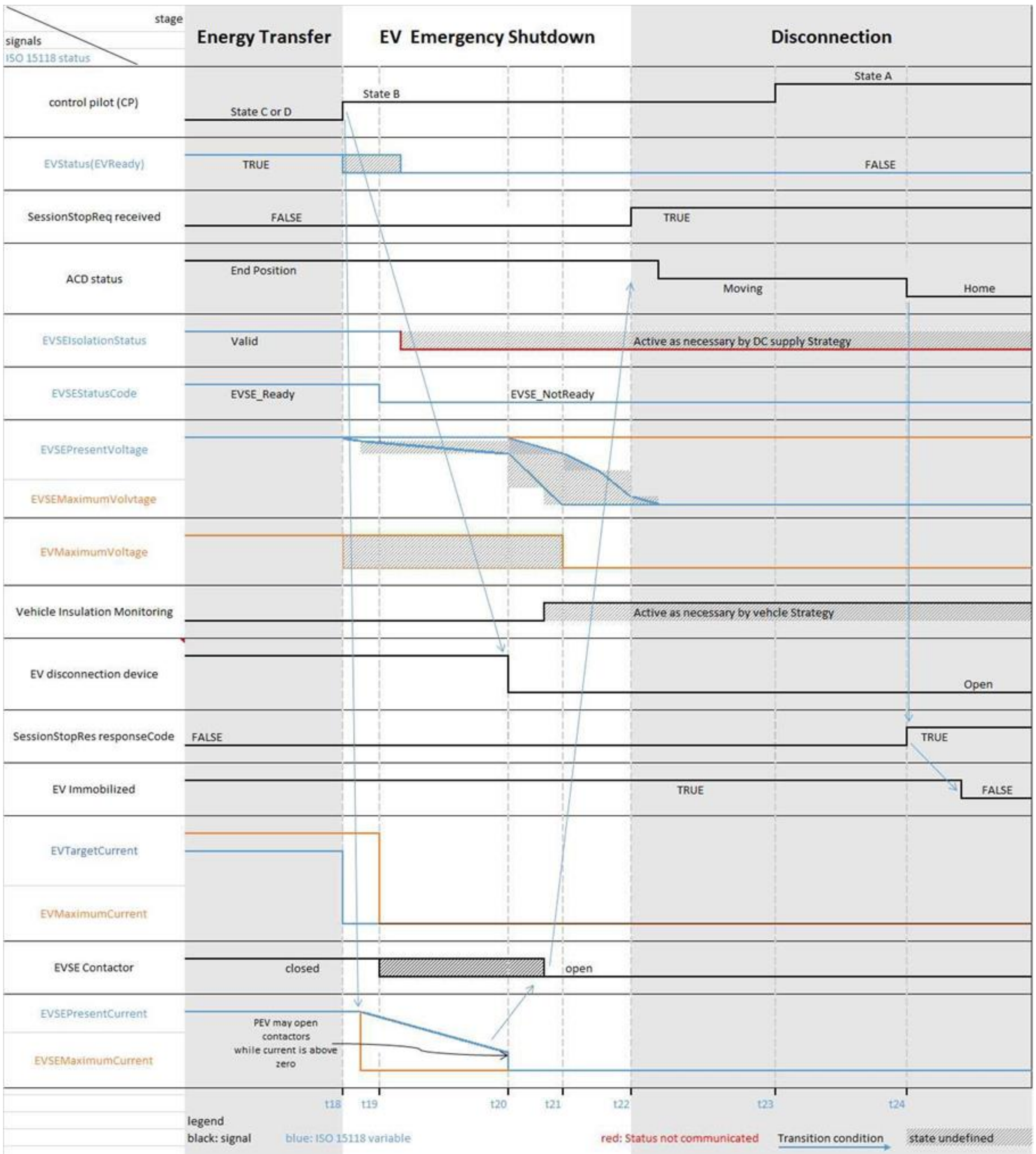


FIG. C4 – SEQUENCE DIAGRAM FOR EV-INITIATED EMERGENCY STOP

Table C4 - SEQUENCE DESCRIPTION FOR EV-INITIATED EMERGENCY STOP

Phase	Description
(t18)	The EVCC opens S2 switch on the CP-PE circuit and State B is reached.
(t19)	The EVSEStatusCode changes from "ready" to "not ready" and the EV maximum current limit value changes to 0 A.
(t20)	The current shall be reduced to <5 A by the EVSE (within 70 ms for an emergency shutdown and within 1 second for a normal shutdown). The maximum time for EV disconnection device to open its relays. The output current drops to <5 A the instant the EV disconnection device opens.
(t21)	The DC output voltage drops to <60 V.
(t22)	The SessionStopReq received.
(t23)	The ACD disconnects and State A is reached.
(t24)	The ACD has reached Home position indicated by a SessionStopRes with responseCode = Ok.

C.3 TLS/Certificates

TLS shall not be used in ASSURED project.

C.4 Session setup

A vehicle ID shall be sent for reference during interoperability testing with the following definition:

Two alphanumeric characters representing the OEM and six last digits of VIN; e.g., AB1 23456.

Table C5 - OEM IDs

OEM	ID
Irizar	IR
IVECO	IV
Solaris	SO
URBASER	UR
VDL	VD
Volvo	VO

C.5 Misalignment

When a misalignment is observed by the charger, the charger shall respond with CableCheckRes where the responseCode = failed and abort the charging session. After aborting the charging session, the charger shall prepare itself for a new charging session. The charger shall not enter a locked state by the failed charging session.

Condition to detect misalignment:

a) ACD is in the end position, i.e., completely extended.
b) Control pilot status is State A.

C.6 Cable check

During cable check the minimum of the maximum voltages of the vehicle and charger shall not be exceeded.

C.7 Voltage during cable check until precharge

During the period between CableCheck and PreCharge, the voltage of the charger shall be between zero and the minimum of the maximum voltages of the vehicle and charger. (V > 0 V) and [V < min(EVSEMaxVoltage,EVMaxVoltage)].

C.8 Precharge

During PreCharge, the charger shall supply the requested voltage, regardless of what the current setpoint is. The charger shall limit the current to maximum 2 A.

APPENDIX D - NETWORK AND APPLICATION PROTOCOL REQUIREMENTS

ISO 15118-2 DIS 2012 is applicable, except as follows:

Addition:

OppCharge Core Specification, Technical description of the OppCharge interface, Volvo Buses AB, December 201 6 (https: //www. oppcharge. org/dok/OppCharge_Core_Specification. pdf).

For detailed information, refer to OppCharge web site: https: //www. oppcharge. org/.

IEEE/Std 802. 1 1 ™ -201 2, IEEE Standard for Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — specific requirements: Part 1 1 : Wireless LAN Medium Access Control (M AC) and Physical Layer (PHY) Specifications.

The original requirements are quoted in italics and in the color blue. Deviations or restrictions to original requirements are specified under a new modified requirement number. A new number is attached to the original number in a schema [“original number”_n]. For example: [V2G2-OC-000_1], where [V2G-000] is the original requirement number.

If any mandatory parameter specified by ISO 15118-2 is not used for connection communication, a default value is set, “0” for integer type, an empty string “ ” for string type. I n case of other data types, the default value is given at the value definition.

If the usage of an element in the message is specified as “don’t care, ” it is not forbidden to send the information in this element, but this information may not be used by the receiver and the sender cannot expect the receiver to act on the sent information. It is comparable to an optional element, but to state out the difference to the standard “don’t care” is used instead and can also be applied to elements that are mandatory in ISO 15118-2.

D. 1 NETWORK AND APPLI CATION PROTOCOL REQUIREMENTS

These sections of ISO 15118-2 apply or not as noted below:

7. Basic requirements for V2G communication

7.1 General Information

This clause of ISO 15118-2 is applicable.

7.2 Service Primitive Concept of OSI Layered Architecture

This clause of ISO 15118-2 is applicable.

7.3 Security Concept

This clause of ISO 15118-2 is NOT applicable. Restriction:

In the first version of connection communication standard TLS, certificate-based authentication and contracts are not supported.

Communication takes place via WLAN. The WLAN connection is secured by WPA2.

7.4 V2G Communication States

This clause of ISO 15118-2 is applicable.

7.5 Data Link Layer

This clause of ISO 15118-2 is not applicable. Instead of wired communication connection wireless communication is compliant to IEEE/Std 802.11 TM-2012.

7.6 Network Layer

This clause of ISO 15118-2 is applicable.

7.7 Transport Layer

This clause of ISO 15118-2 is applicable, except as follows:

Restriction:

Sub clause 7.7.3 and its subclasses are not applicable.

7.8 V2G Transfer Protocol

This clause of ISO 15118-2 is applicable.

7.9 Presentation Layer

This clause of ISO 15118-2 is applicable.

7.10 Application Layer

This clause of ISO 15118-2 is applicable.

D.2 APPLICATION AND NETWORK REQUIREMENTS

These sections of ISO 15118-2 apply or not as noted below:

8. Application layer messages

8.1 General Information and Definitions

This clause of ISO 15118-2 is applicable.

8.2 Protocol Handshake Definition

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-166] The EVCC shall initiate the handshake sending a supportedAppProtocolReq message as depicted in Figure 1 6 to the SECC. This request message provides a list of charging protocols supported by the EVCC.

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Addition:

[V2G2-OC-166_1] The EVCC shall initiate the handshake sending a supported AppProtocolReq message only if following conditions are fulfilled:

- WLAN signal strength is not below -75 dBm.

Original requirement:

[V2G2-167] Each entry in the list of supported EVCC protocols shall include the ProtocolNamespace, the VersionNumberMajor and VersionNumberMinor, the unique SchemaID dynamically assigned by the EVCC and the priority of the protocol entry. The priority in the EVCC request message enables the EVCC to announce the preferred application layer protocol where Priority equal to 1 indicates the highest priority and priority equal to 20 indicates the lowest priority. The number of protocols included in the request message is limited to 20.

Restriction:

[V2G2-OC-167_1] In context of the connection communication V 1.3.0, only one valid entry is allowed as defined in Table D1.

Original requirement:

[V2G2-170] The SECC shall confirm (positively respond) an EVCC supported protocol even if the values of the VersionNumberMinor in EVCC request message does not match with the VersionNumberMinor of an SECC supported protocol where the VersionNumberMajor matches.

Deviation:

[V2G2-OC-170_1] VersionNumberMajor and VersionNumberMinor together with ProtocolNameSpace are used by SECC to match the protocol that is supported by both EVCC and SECC. SECC will send FAILED_NoNegotiation in case one of the criteria does not match. Refer to Table D2.

Original requirement:

[V2G2-172] Usually it is expected that the SECC is able to support the relevant application layer protocols indicated by the EVCC. However, when none of the application layer protocols included in the list received from the EVCC is supported by the SECC, the ResponseCode in the response message shall be equal to Failed_NoNegotiation indicating that the protocol negotiation was not successful. In this error scenario the response message shall not include a SchemaID.

Addition:

[V2G2-OC-172_1] Although a matching protocol version is found, ResponseCode Failed_NoNeogotiation shall also be used, if SECC is not ready due to technical reasons. SECC shall set ResponseCode to Failed_NoNeogotiation, in case of:

- Persistent isolation fault
- Positioning sensor error (EV not in position)
- E-stop active
- Wind speed limit exceeded
- the charging station is in fatal error mode

Tables D1 and D2 specify the usage of supportedAppProtocol in connection. Refer to the original Table 22 for semantics and type definition.

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Table D1 - Usage of message elements supportedAppProtocolReq

Element Name	EVCC
ProtocolNamespace	"urn: iso: 1 51 1 8: 2: 201 0: MsgDef"
VersionNumberMajor	1
VersionNumberMinor	0
SchemaI D	0
Priority	Don’t care

Table D2 - Usage of message elements supportedAppProtocolRes

Element Name	SECC
SchemaI D	Same as received from EV
ResponseCode	Used ResponseCode: - OK_SuccessfulNegotiation - Failed_N oNegotiation, if protocol mismatch or any HPC failure occurs; see [V2G2-OC-1 72_1]

New requirements:

[V2G2-OC-725] In case of an active charging session SECC shall not accept new sessions. SECC shall answer to a SupportedAppProtocol request with Supported AppProtocol response with “ResponseCode = FAILED_NoNegotiation.”

8.3 V2G Message Definition

This clause of ISO 15118-2 is applicable.

8.4 Body Element Definitions

8.4.1 Common Messages

8.4.1.1 Overview

This clause of ISO 15118-2 is applicable.

8.4.1.2 Session Setup

8.4.1.2.1 General

This clause of ISO 15118-2 is applicable.

8.4.1.2.2 Session Setup Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-1 89] The message elements of this message shall be used as defined in Table 26.

Deviation:

[V2G2-OC-1 89_1] Instead of MAC address, EVCCID is a string of length eight, starting with two letters representing the vehicle vendor, followed by six digits for enumeration of the specific vehicle. See Table D3.

NOTE: Format of the EVCCI D is “VVnnnnnn,” where the two characters VV stand for the vendor and “nnnnnn” is the specific vehicle number of the operator.

Table D3 specifies the usage of SessionSetupReq in connection. Refer to the original Table 26 for semantics and type definition.

Table D3 - Usage of message elements SessionSetupReq

Element Name	EVCC
EVCCID	Eight ASCII characters, starting with two letters followed by six digits

8.4.1.2.3 Session Setup Response

This clause of ISO 15118-2 is applicable, except as follows:

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Comments:

• Following response codes are used by SECC:

○ OK and OK_NewSessionEstablished if a new session is established successfully.

○ FAILED_SequenceError if a message is received other than sessionSetupReq.

○ FAILED if any internal error occurs.

• ResponseCode OK_OldSessionJoined and FAILED_SignatureError are not used. See [V2G2-OC-461 _1], [V2G2-OC-463_1] in 8.8.3.

Table D4 specifies the usage of SessionSetupRes in connection. Refer to the original Table 27 for semantics and type definition.

Table D4 - Usage of message elements SessionSetupRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK - OK_NewSessionEstablished - FAI LED - FAILED_SequenceError
EVSE ID	Up to 32 ASCII characters, no predefined format
DateTimeNow	Don’t care

8.4.1.3 Service Discovery

8.4.1.3.1 Service Discovery Handling

This clause of ISO 15118-2 is applicable.

8.4.1.3.2 Service Discovery Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-194] The message elements of this message shall be used as defined in Table D5.

Restrictions:

[V2G2-OC-1 94_1] The message elements of ServiceDiscoveryReq are not used by both EVCC and SECC; see Table D5.

Table D5 specifies the usage of ServiceDiscoveryReq in connection. Refer to the original Table 28 for semantics and type definition.

Table D5 - Usage of message elements ServiceDiscoveryReq

Eleme nt Name	EVCC
ServiceScope	Don t care
ServiceCategory	Don t care

8.4.1.3.3 ServiceDiscoveryRes

This clause of ISO 15118-2 is applicable, except as follows:

Comments:

• Following resonse codes are used by SECC:

○ OK if ServiceDiscoveryReq is successfully processed.

○ FAILED_SequenceError if a message is received other than ServiceDiscoveryReq. SessonStopReq is accepted to

go to session stop handling.

○ FAILED_UnknownSession if SessionID differs from the currently used one.

○ FAILED if any internal errors occur.

• ResponseCode FAILED_SignatureError is not used; see [V2G2-OC-461 _1] in 8.8.3.

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• EVCC accepts only PaymentOption = ExternalPayment. Otherwise, it will end charging session by termination of the

session and send SessionStopReq. See [V2G2-OC-283_1] in 8.5.2.9.

• SECC sets only one entry in payment option list, paymentOption = ExternalPayment. See [V2G2-OC-283_1] in 8.5.2.9.

Table D6 specifies the usage of ServiceDiscoveryRes in connection. Refer to the original Table 29 for semantics and type definition.

Table D6 - Usage of message elements ServiceDiscoveryRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK - FAILED - FAI LED_SequenceError - FAI LED_U nknownSession
PaymentOption	ExternalPayment. See [V2G2-OC-283_1] in 8. 5. 2. 9
ChargeService	See [V2G-OC-270_1] in 8. 5. 2. 3, [V2G-OC-272_1] in 8. 5. 2. 4
ServiceList	Don’t care; see 8. 5. 2. 2

8.4.1.4 Service Detail

This clause of ISO 15118-2 is not applicable.

8.4.1.5 Service and Payment Selection

8.4.1.5.1 Service and Payment Selection Handling

This clause of ISO 15118-2 is applicable, except as follows:

Based on the provided services and the corresponding payment options by the SECC, this message pair allows the transmission of the selected PaymentOption, SelectedServices, and related ParameterSets. Depending on the selected payment, additional messages (PaymentDetails message pair) are exchanged.

NOTE: The feature of service and payment selection is not used. The ServicePaymentSelectionReq/Res messages are passed through without any functions.

8.4.1.5.2 Service and Payment Selection Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-202] The message elements of this message shall be used as defined in Table 32.

Restriction:

[V2G2-OC-202_1] The parameters are not used; see Table D7.

Table D7 specifies the usage of ServicePaymentSelectionReq for connection. Refer to the original Table 32 for semantics and type definition.

Table D7 - Usage of message elements ServicePaymentSelectionReq

Element Name	EVCC
Selected PaymentOption	Don’t care (default value ExternalPayment)
Selected ServiceList	See 8. 5. 2.24

8.4.1.5.3 Service and Payment Selection Response

This clause of ISO 15118-2 is applicable, except as follows:

Comments:

• Following response codes are used by SECC:

○ OK if ServicePaymentSelectionReq is successfully processed.

○ FAILED_SequenceError if a message is received other than ServicePaymentSelectionReq. SessonStopReq is accepted to go to session stop handling.

○ FAILED_UnknownSession if SessionID differs from the currently used one.

○ FAILED if any internal errors occur.

• FAILED_SignatureError, FAILED_PaymentSelectionInvalid and FAILED_ServiceSelectionInvalid are not used. See [V2G2-OC-461 _1], [V2G2-OC-465_1], and [V2G2-OC-467_1] in 8.8.3.

8.4.1.6 Payment Details

This clause of ISO 15118-2 is not applicable.

8.4.1.7 Contract Authentication

8.4.1.7.1 Contract Authentication Request

This clause of ISO 15118-2 is applicable, except as follows:

Comment:

The Contract Authentication request/responce are passed through without loop sequence.

Original requirement:

[V2G2-211] The message elements of this message shall be used as defined in Table 36.

Restriction:

[V2G2-OC-21 1 _1] The parameters are not used for connection; see Table D8.

Table D8 specifies the usage of ContractAuthenticationReq for connection. Refer to the original Table 36 for semantics and type definition.

Table D8 - Usage of message elements ContractAuthenticationReq

Element Name	EVCC
Id	Dont care
GenChallenge	Dont care

8.4.1.7.2 Contract Authentication Response

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-213] The message elements of this message shall be used as defined in Table 37.

Restrictions:

[V2G2-OC-21 3_1] EVSEProcessing is not used for connection; see Table D9.

Comments:

• Following resonse codes are used by SECC:

○ OK if ContractAuthenticationReq is successfully processed.

○ FAILED_SequenceError if a message is received other than ContractAuthenticationReq. SessonStopReq is

accepted to go to session stop handling.

○ FAILED_UnknownSession if SessionID differs from the currently used one.

○ FAILED if any internal errors occur.

• FAILED_SignatureError and FAILED_CertificateExpired are not used. See [V2G2-OC-461 _1] and [V2G2-OC-475_1] in 8.8.3

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Table D9 specifies the usage of ContractAuthenticationRes in connection. Refer to the original Table 37 for semantics and type definition.

Table D9 - Usage of message elements ContractAuthenticationRes

Element Name	SECC
EVSEProcessing	Don't care (default Finished)
ResponseCode	Used ResponseCode: - OK - FAILED - FAI LED_SequenceError - FAILED_UnknownSession

8.4.1.8 Charge Parameter Discovery

8.4.1.8.1 Charge Parameter Discovery Handling

This clause of ISO 15118-2 is applicable.

8.4.1.8.2 Charge Parameter Discovery Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-217] The EVCC shall use the EVRequestedEnergyTransterType as defined in Table 39.

Restrictions:

[V2G2-OC-217_1] The EVCC shall only use DC_extended for EVRequestedEnergyTransferType as defined in Table D10.

Table D10 specifies the usage of ChargeParamenterDiscoveryReq in connection. Refer to the original Table 38 for semantics and type definition

Table D10 - Usage of message elements ChargeParameterDiscoveryReq

Element Name	EVCC
EVRequested EnergyTransferType	DC_extended
AC_EVChargeParameter	Not applied
DC_EVChargeParameter	See 8.5.4.3

8.4.1.8.3 Charge Parameter Discovery Response

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-220] The message elements of this message shall be used as defined in Table 40.

Restrictions:

[V2G2-OC-220_1] EVSEProcessing and SAScheduleList are not used for connection;

See Table D11.

Comments:

• Following resonse codes are used by SECC:

○ OK if ChargeParamenterDiscoveryReq is successfully processed.

○ FAILED_SequenceError if a message is received other than ChargeParamenterDiscoveryReq. SessonStopReq is

accepted to go to session stop handling.

○ FAILED_UnknownSession if SessionID differs from the currently used one.

○ FAILED_WrongChargeParameter if received EVRequestedEnergyTransferType is other than DC_extended.

○ FAILED if any internal errors occur.

• FAILED_SignatureError and FAILED_WrongEnergyTransferType are not used; see [V2G2-OC-461 _1] and [V2G2-OC-476_1] in 8.8.3.

• DC_EVSEStatus contained in DC_EVSEChargeParameter is not used; see 8.5.4.1.

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Table D11 specifies the usage of ChargeParamenterDiscoveryRes in connection. Refer to the original Table 40 for semantics and type definition.

Table D11 - Usage of message elements ChargeParameterDiscoveryRes

Element Name	SECC
EVSEProcessing	Don't care (default Finished)
ResponseCode	Used ResponseCode: - OK - FAILED - FAI LED_SequenceError - FAILED_UnknownSession - FAI LED_WrongChargeParameter
SAScheduleList	Don't care; see 8.5.2.12
AC_EVSEChargeParameter	Not applied
DC_EVSEChargeParameter	See 8.5.4.4

NOTE: Re-negotiation is not supported.

8.4.1.9 Power Delivery

8.4.1.9.1 Power Delivery Handling

This clause of ISO 15118-2 is applicable.

8.4.1.9.2 Power Delivery Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-222] The message elements of this message shall be used as defined in Table 41.

Restrictions:

[V2G2-OC-222_1] ReadyToChargeState parameter is used to request EVSE to start or stop charging process. See Table D12.

Table D12 specifies the usage of PowerDeliveryReq in connection. Refer to the original Table 41 for semantics and type definition.

Table D12 - Usage of message elements PowerDeliveryReq

Element Name	EVCC
ReadyToChargeState	True to start charging False to stop charging
ChargingProfile	Don't care; see 8.5.2.10
DC_EVPowerDeliveryParameter	Don't care; see 8.5.4.5

8.4.1.9.3 Power Delivery Response

This clause of ISO 15118-2 is applicable, except as follows:

Comments:

• Following response codes are used by SECC:

○ OK if PowerDeliveryReq is successfully processed.

○ FAILED_SequenceError if a message is received other than PowerDeliveryReq. SessonStopReq is accepted to go to session stop handling.

○ FAILED_UnknownSession if SessionID differs from the currently used one.

○ FAILED if any internal errors occur.

• FAILED_SignatureError, FAILED_ChargingProfileInvalid, FAILED_TariffSelectionInvalid and FAILED_PowerDeliveryNotApplied are not used; see [V2G2-OC-461 _1], [V2G2-OC-478_1], [V2G2-OC-479_1], and [V2G2-OC-480_1] in 8.8.3

Table D13 specifies the usage of PowerDeliveryRes in connection. Refer to the original Table 42 for semantics and type definition.

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Table D13 - Usage of message elements PowerDeliveryRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK, - FAILED - FAI LED_SequenceError - FAILED_UnknownSession
DC_EVSEStatus	Don't care; see 8.5.4.1

8.4.1.10 Certificate Update

This clause of ISO 15118-2 is not applicable. Not used in connection V 1.3.0.

8.4.1.11 Certificate Installation

This clause of ISO 15118-2 is not applicable. Not used in connection V 1.3.0.

8.4.1.12 Session Stop

8.4.1.12.1 SessionStopReq/Res Handling

This clause of ISO 15118-2 is applicable, except as follows:

Original statement:

This V2G message pair shall be used for terminating a V2G communication session initated by preceding SessionSetupReq message.

Addition:

Due to the nature of ACD charging, after termination of the charging process the pantograph has to be raised up at first. The electric vehicle shall be kept immobilized until the pantograph is in the upper home position. As long as the pantograph is not in the upper home position, the EVCC shall continuously send SessionStopReq and the SECC shall respond with response code FAILED. If the pantograph is in the upper home postion, SECC shall send SessionStopRes with response code OK.SessionStopReq can be sent at any communication state by EVCC to request termination of charging process. The response code FAILED_SequenceError is not applicable in this case.

The minimum time interval between two SessionStopReq messages shall be larger than 100 ms in order to limit the message load on the system.

8.4.1.12.2 Session Stop Request

This clause of ISO 15118-2 is applicable.

8.4.1.12.3 Session Stop Response

This clause of ISO 15118-2 is applicable, except as follows:

Deviations:

• Following SECC response codes are used:

○ OK if SessionStopReq is successfully processed and the pantograph is in upper home position.

○ FAILED if the pantograph is not in the upper home position or any internal errors occurs. See [V2G2-OC-572_1] in 8.8.4.3.1.

• In the case of "ResponseCode = FAILED," EVCC shall not terminate the session but continue to send SessionStopReq. See [V2G2-OC-507_1] in 8.8.4.2.1.

• In any error situation whether caused by an interrupted v2g communication or a hardware defect the ACD status is unknown to the EVCC. The EV cannot be released the regular way. The driver has to double check that the ACD is properly disconnected and the EV can safely leave the charge point. In that case the driver can abort the immobilization caused by the EVCC by using OEM specific means. See [V2G2-OC-507_2] in 8.8.4.2.1.

Table D14 specifies the usage of SessionStopRes in connection. Refer to the original Table 47 for semantics and type definition.

Table D14 - Usage of message elements SessionStopRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK, if the pantograph is in the upper home position then the vehicle can be released safely - FAILED, if the pantograph is not in the upper home position

8.4.2 AC-Messages

This clause of ISO 15118-2 is not applicable.

8.4.3 DC-Messages

8.4.3.1 Overview

This clause of ISO 15118-2 is applicable.

8.4.3.2 Cable Check

8.4.3.2.1 Cable Check Handling

This clause of ISO 15118-2 is applicable, except as follows:

Original statement:

For a safe DC charging, a cable check must be performed.

Addition:

For plug-in charging, the EVSE is connected by wire to the EV all the time from the beginning of the charge procedure until the end. In contrast to plug-in charging, the ACD/pantograph is not connected at this point of the procedure. Thus, the EVSE is not yet connected to the EV electrically.

As a precondition for cable check the ACD/pantograph has to be connected to the EV's charging interface first. Because of the lack of a corresponding message pair for the connection process in the underlying version of the ISO standard, the cable check message pair is used to integrate this process step into the sequences.

The first CableCheckReq message induces the EVSE to move down the pantograph. CableCheckReq/Res are repeated until the pantograph is connected to the EV's charging interface and the CP status changes from A to B. After that the regular cable check sequence continues.

8.4.3.2.2 Cable Check Request

This clause of ISO 15118-2 is applicable, except as follows:

Original statement:

The cable check request asks for the cable check status of the EVSE; e. g., tells the EVSE if the connector is locked on EVside and if the EV is ready to charge.

Deviation:

At first, the pantograph will be activated in order to connect the EVSE with the electrical circuits of the vehicle. As a precondition for this, the vehicle needs to be positioned within the ACD contact area tolerances correctly. The CableCheck message is repeated as long as the pantograph is moving, contacting, and while the insulation test is executed.

Original requirement:

[V2G2-250] The message elements of this message shall be used as defined in Table 51.

Restrictions:

[V2G2-OC-250_1] The DC_EVStatus may not be handled by EVSE as defined in Table D15.

Table D15 specifies the usage of CableCheckReq in connection. Refer to the original Table 51 for semantics and type definition.

Table D15 - Usage of message elements CableCheckReq

Element Name	EVCC
DC_EVStatus	Don't care; see 8.5.4.2

8.4.3.2.3 Cable Check Response

This clause of ISO 15118-2 is applicable, except as follows:

Comments:

EVSEProcessing variable is used to indicate whether the cable check has completed. EVSEProcessing is set to “Finished,” if the pantograph is connected and the isolation test has finished. Otherwise, EVSEProcessing is set to “Ongoing.” See Table D1 7.

- Following response codes are used by SECC:
    - OK if CableCheckReq is successfully processed.

- FAILED_SequenceError if a message is received other than CableCheckReq, or charge control is in a wrong state. SessonStopReq is accepted to go to session stop handling.
- FAILED_UnknownSession if SessionID differs from the currently used one.
- FAILED if any internal errors occur.

- FAILED_SignatureError is not used; see [V2G2-OC-461_1] in 8.8.3.
- EVSEStatusCode, contained in DC_EVSEStatusType (8.5.4.1), is used to indicate the state of the isolation test. In context of ACD DC_EVSEStatusCode is set to Reserved_8 to indicate the moving state until the pantograph is connected to the EV's charging interface. Status code EVSE_IsolationMonitoringActive indicates the processing of the the isolation monitor, see [V2G2-OC-365_1] defined in 8.5.4.1.
- EVSEIsolationStatus is used to indicate status of the isolation test. It is always set to invalid before the isolation test is finished, see [V2G2-OC-365_1] defined in 8.5.4.1.
- SECC shall carry out following steps as also shown in Figure D1:

New requirements:

[V2G2-OC-701] After receiving the first CableCheckReq, the SECC shall start activation of the pantograph and respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = Reserved_8 and EVSEIsolationStatus = Invalid and EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

[V2G2-OC-702] If the activation of the pantograph fails, the SECC shall respond with CableCheckRes containing "ResponseCode = FAILED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Invalid and EVSEProcessing = Finished. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to

Table D46.

[V2G2-OC-703] While waiting for the pantograph moving down to the end position, the SECC shall respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = Reserved_8 and EVSEIsolationStatus = Invalid and EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

[V2G2-OC-704] If the pantograph has not reached the end position within V2G_SECC_ACD_Connection_Timeout according to Table D1 6, the SECC shall respond with CableCheckRes containing "ResponseCode = FAI LED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Invalid and EVSEProcessing = Finished and the SECC commands the pantograph to its home position. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-705] If the pantograph has reached the end position and the SECC has measured CP state B with a related CP voltage to be smaller than 10.5 V and larger or equal than 7.5 V within V2G_SECC_ACD_Endpostion_to_B_Timeout according to Table D1 6, the SECC shall respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_IsolationMonitoringActive and EVSEIsolationStatus = Invalid and EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

[V2G2-OC-709] If the pantograph has reached the end position and the SECC has measured CP state to be C or D with a related CP voltage to be smaller than 7.5 V and larger or equal than 2 V without detecting state B before, the SECC shall activate the

DC-breaker and respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_IsolationMonitoringActive and EVSEIsolationStatus = Invalid and with EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

NOTE: In case EVCC reacts very fast on state B and changes control pilot to state C within a very short time, it is possible that the SECC does not detect state B but state C when it is waiting for state B. In the case the SECC detects a direct change from CP state A to C the timer for V2G_SECC_ACD_Endpostion_to_B_Timeout is not relevant anymore, and therefore reset.

[V2G2-OC-706] If the pantograph has reached the end position and the SECC has not measured CP state B, C or D within V2G_SECC_ACD_Endpostion_to_B_Timeout according to Table D16, the SECC shall respond with CableCheckRes containing "ResponseCode = FAILED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Invalid and EVSEProcessing = Finished and the SECC commands the pantograph to its home position. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-707] If the SECC has measured CP state to be C or D with a related CP voltage to be smaller than 7.5 V and larger or equal than 2 V within V2G_SECC_CP_Transition_B_to_C_Timeout according to Table D16, the SECC shall activate the DC-breaker, and respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_IsolationMonitoringActive and EVSEIsolationStatus = Invalid and EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

[V2G2-OC-708] If the pantograph has reached the end position and CP state B is active but the SECC has not measured CP state to be C or D with a related CP voltage to be smaller than 7, 5 V and larger or equal than 2 V within V2G_SECC_CP_Transition_B_to_C_Timeout according to Table D16, the SECC shall respond with CableCheckRes containing "ResponseCode = FAILED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Invalid and with EVSEProcessing = Finished and the SECC commands the pantograph to its home position. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-710] If DC-breaker closed within V2G_SECC_Breaker_Activation_Timeout according to Table D16, the SECC shall start the insulation monitoring and respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_IsolationMonitoringActive and EVSEIsolationStatus = Invalid and EVSEProcessing = Ongoing. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-711] If DC-breaker does not close within V2G_SECC_Breaker_Activation_Timeout according to Table D16, the SECC shall respond with CableCheckRes containing "ResponseCode = FAILED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Invalid and with EVSEProcessing = Finished. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-712] While the isolation test is processing the EVSE shall respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_IsolationMonitoringActive and EVSEIsolationStatus =

Invalid and EVSEProcessing = Ongoing within V2G_SECC_Msg_Performance_Time according to Table D46.

[V2G2-OC-713] If the insulation monitor indicates an insulation error after V2G_SECC_Isolation_Monitoring_Time according to Table D16, the SECC shall respond with CableCheckRes containing "ResponseCode = FAILED" and EVSEStatusCode = EVSE_NotReady and EVSEIsolationStatus = Fault (or Invalid) and with EVSEProcessing = Finished. The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-714] As soon as the isolation test has been finished successfully the SECC shall respond with CableCheckRes containing "ResponseCode = OK" and EVSEStatusCode = EVSE_Ready and EVSEIsolationStatus = Valid and EVSEProcessing = Finished. The allowed next request shall be PreChargeReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

SECC side

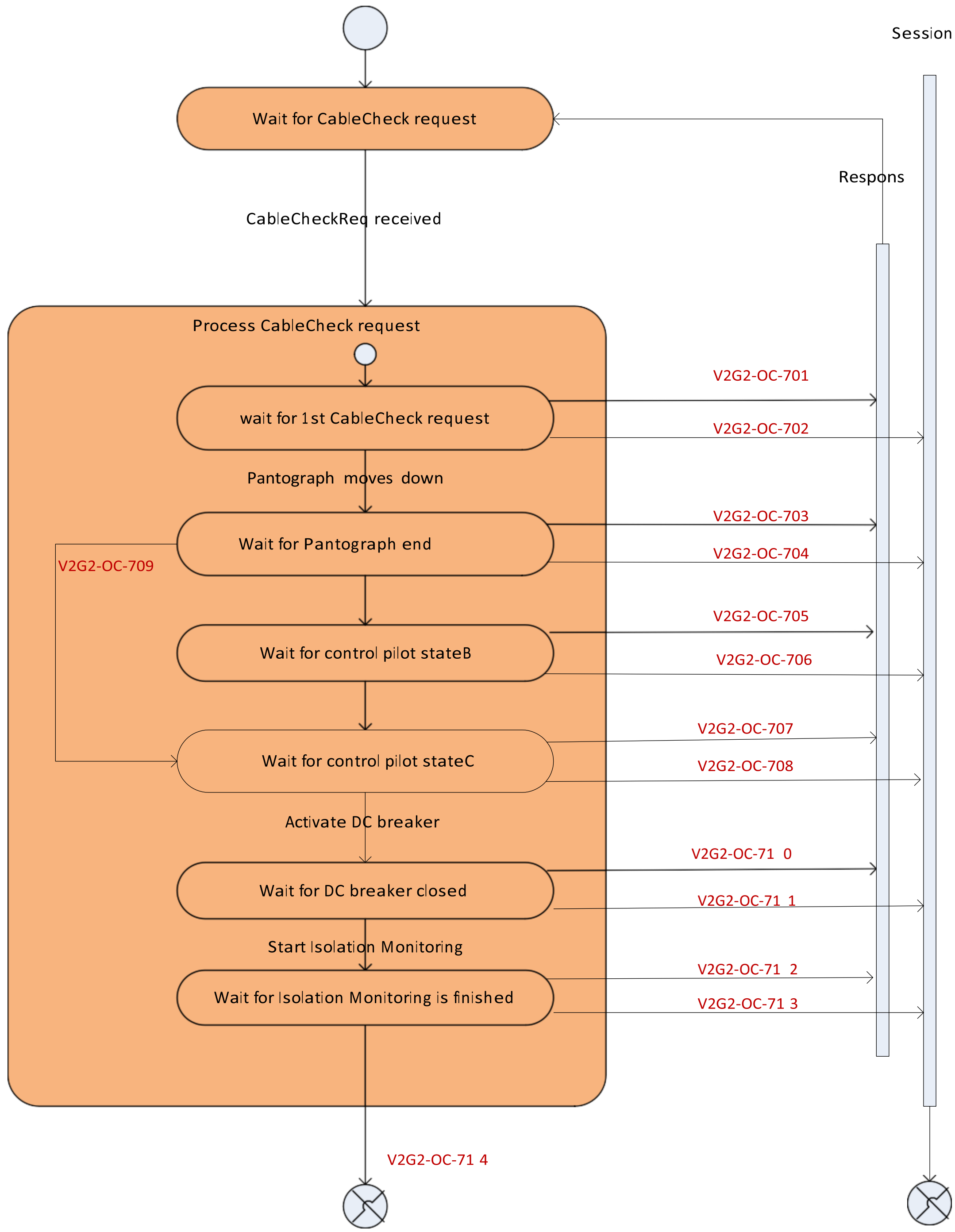

FIGURE D1- SECC CABLE CHECK HANDLING

Table D16 - Timeout value of cable check handling

Name	Value (seconds)
V2G_SECC_ACD_Connection_Timeout	20
V2G_SECC_ACD_Disconnection_Timeout	20
V2G_SECC_ACD_Endpostion_to_B_Timeout	2
V2G_SECC_CP_Transition_B_to_C_Timeout	2
V2G_SECC_Breaker_Activation_Timeout	1
V2G_SECC_Isolation_Monitoring_Time	10

NOTE: V2G_SECC_ACD_Endpostion_to_B_Timeout serves for the debouncing of the CP signal during the contacting process.

Table D17 specifies the usage of CableCheckRes in connection. Refer to the original Table 52 for semantics and type definition.

Table D17 - Usage of message elements CableCheckRes

Element Name	SECC
EVSEProcessing	Indicates if the conection and cable check process is finished: - Finished, if the pantograph is in end position and the isolation test is completed successfully - Ongoing, if pantograph is moving or isolation test is not yet finished
ResponseCode	Used ResponseCode: - OK - FAILED - FAI LED_SequenceError - FAILED_UnknownSession
DC_EVSEStatus	See 8.5.4.1

8.4.3.3 Pre-Charge

8.4.3.3.1 Pre-Charge Handling

This clause of ISO 15118-2 is applicable.

8.4.3.3.2 Pre-Charge Request

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-254] The message elements of this message shall be used as defined in Table 53.

Restriction:

[V2G2-OC-254_1] DC_EVStatus may not be handeled by EVSE; see Table D18.

Table D 18 specifies the usage of PreChargeReq in connection. Refer to the original Table 53 for semantics and type definition.

Table D18 - Usage of message elements PreChargeReq

Element Name	EVCC
DC_EVStatus	Don't care; see 8.5.4.2
EVTargetVoltage	Target Voltage requested by EV
EVTargetCurrent	Current demanded by EV set to 0, but don't care NOTE: The EVSE has to command the appropriate current to the AC/DC converter in oder to support the preCharge function at the least possible current level (OEM specific)

8.4.3.3.3 Pre-Charge Response

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-256] The message elements of this message shall be used as defined in Table 54.

Restriction:

[V2G2-OC-256_1] DC_EVSEStatus may not be handeled by EVSE; see Table D19.

Comments:

- Following response codes are used by SECC:
  - OK if PreChargeReq is successfully processed.
  - FAILED_SequenceError if a message is received other than PreChargeReq or charge control is in a wrong state. SessonStopReq is accepted to go to session stop handling.
  - FAILED_UnknownSession if SessionID differs from the currently used one.
  - FAILED if any internal errors occur.
- FAILED_SignatureError is not used; see [V2G2-OC-461_1] in 8.8.3.

Table D19 specifies the usage of PreChargeRes in connection. Refer to the original Table 54 for semantics and type definition.

Table D19 - Usage of message elements PreChargeRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK - FAILED - FAILED_SequenceError - FAILED_UnknownSession
DC_EVSEStatus	Don't care; see 8.5.4.1
EVSEPresentVoltage	Present voltage of EVSE (present EVSE output voltage)

8.4.3.4 Current Demand

8.4.3.4.1 Current Demand Handling

This clause of ISO 15118-2 is applicable.

8.4.3.4.2 Current Demand Request

This clause of ISO 15118-2 is applicable, except as follows:

Comment:

Parameter EVRESSSOC, contained in DC_EVStatus is used to communicate the available SOC to the SECC which is a fraction of the physical battery SOC and is defined by vehicle OEM. See 8.5.4.2. Table D 20 specifies the usage of CurrentDemandReq in connection. Refer to the original Table 55 for semantics and type definition.

Table D20 - Usage of message elements CurrentDemandReq

Element Name	EVCC
DC_EVStatus	Only EVRESSSOC is used, all other parameters may not be handeled by EVSE; see 8.5.4.2
EVTargetCurrent	BMS current requested by the EV
EVMaximumVoltageLimit	Maximum voltage allowed by the EV
EVMaximumCurrentLimit	Maximum current allowed by the EV
EVMaximumPowerLimit	Maximum power allowed by the EV
BulkChargingComplete	Don't care
ChargingComple	Don't care
RemainingTimeToFullSoc	Don't care
RemainingTimeToBulkSoC	Don't care
EVTargetVoltage	Voltage requested for charging

NOTE: EVMaximumPowerLimit is not necessarily the product of EVMaximumVoltageLimit and EVMaximumCurrentLimit.. It is the actual power limit that can be handled by the EV's RESS and wiring infrastructure.

8.4.3.4.3 Current Demand Response

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-260] The message elements of this message shall be used as defined in Table 56.

Restriction:

[V2G2-OC-260_1] The message elements of this message shall be used as defined in Table D21. DC_EVSEStatus is not used.

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Comments:

- Following response codes are used by SECC:
    - OK if CurrentDemandReq is successfully processed.
    - FAI LED_SequenceError if a message is received other than CurrentDemand Req, PowerDeliveryReq, or charge control is in a wrong state. SessonStopReq is accepted to go to session stop handling.
    - FAILED_UnknownSession if SessionID differs from the currently used one.
    - FAILED if any internal errors occur.
- FAILED_SignatureError is not used; see [V2G2-OC-461 _1] in 8.8.3.

Table D21 specifies the usage of CurrentDemandRes in connection. Refer to the original Table 56 for semantics and type definition.

Table D21 - Usage of message elements CurrentDemandRes

Element Name	SECC
ResponseCode	Used ResponseCode: - OK - FAILED - FAI LED_SequenceError - FAILED_UnknownSession
DC_EVSEStatus	Don't care; see 8.5.4.2
EVSEPressentVoltage	Present output voltage of the EVSE
EVSEPresentCurrent	Present out current of EVSE
EVSECurrentLimitAchieved	If set to TRUE, the EVSE has reached its current limit
EVSEVoltageLimitAchieved	If set to TRUE, the EVSE has reached its voltage limit
EVSEPowerLimitAchieved	If set to TRUE, the EVSE has reached its power limit
EVSEMaximumVoltageLimit	Deviation to standard: Minimum of EVMaximumVoltageLimit and the maximum voltage the EVSE can deliver
EVSEMaximumCurrentLimit	Deviation to standard: Minimum of EVMaximumCurrentLimit and the maximum current the EVSE can deliver
EVSEMaximumPowerLimit	Maximum power the EVSE can deliver

NOTE: The EVSE sends the minimum of EVMaximumVoltageLimit and the maximum voltage the EVSE can deliver. The value of EVMaximumVoltageLimit is sent as confirmation that the limit of the vehicle is accepted and can be provided by the station. Otherwise, in case the station can only provide less voltage than the EVMaximumVoltageLimit, it sends the stations limit value. The same approach is applied to the MaximumCurrentLimit.

8.4.3.5 Welding Detection

This clause of ISO 15118-2 is not used.

8.5 Complex data types

8.5.1 Overview

This clause of ISO 15118-2 is applicable.

8.5.2 Common

8.5.2.1 ServiceTagType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-266] The message element shall be used as defined in Table 59.

Restriction:

[V2G2-OC-266_1] The message element shall be used as defined in Table D22.

Table D22 specifies the usage of ServiceTagType in connection. Refer to the original Table 59 for semantics and type definition.

Table D22 - Usage of message element ServiceTagType

Element Name	SECC
ServiceID	1, only DC_extended is supported
ServiceName	Optional, recommend to use “connection”
ServiceCategory	recommend to use “EVCharging”
ServiceScope	Don't care

8.5.2.2 ServiceTagListType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-268] The message element shall be used as defined in Table 60.

Restriction:

[V2G2-OC-268_1] The message element shall be used as defined in Table D23.

Table D23 specifies the usage of ServiceTagListType in connection, contained in ServiceDiscoveryRes; see 8.4.1.3.3. Refer to the original Table 61 for semantics and type definition.

Table D23 - USAGE OF MESSAGE ELEMENT SERVICETAGLISTTYPE

Element Name	SECC
Service	Don't care; see 8.5.2.3

8.5.2.3 ServiceType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-270] The message element shall be used as defined in Table 61.

Restriction:

[V2G2-OC-270_1] The message element shall be used as defined in Table D24.

Table D 24 specifies the usage of ServiceType for connection, contained in ServiceDiscoveryRes (8.4.1.3.3). Refer to the original Table 61 for semantics and type definition.

Table D24 - USAGE OF MESSAGE ELEMENT SERVICETYPE

Element Name	SECC
ServiceTag	See 8.5.2.1
FreeService	Don't care

8.5.2.4 ServiceChargeType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-272] The message element shall be used as defined in Table 62.

Restriction:

[V2G2-OC-272_1] The message elements shall be used as defined in Table D25.

Table D25 specifies the usage of ServiceChargeType for connection, contained in ServiceDiscoveryRes (8.4.1.3.3). Refer to the original Table 62 for semantics and type definition.

Table D25 - USAGE OF MESSAGE ELEMENTS SERVICECHARGETYPE

Element Name	SECC
EnergyTransferType	Only DC_extended

8.5.2.5 CertificateChainType

This clause of ISO 15118-2 is not applicable. The messages PaymentDetailsReq, CertificateUpdateReq/Res, and CertificateInstallationRes which contains CertificateChainType are not used in connection V 1.3.0.

8.5.2.6 MeterInfoType

This clause of ISO 15118-2 is not applicable. The data type is contained in ChargingStatusRes and MeteringReceiptReq which are not used in connection V 1.3.0.

8.5.2.7 PhysicalValueType

This clause of ISO 15118-2 is applicable.

8.5.2.8 Notification Type

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-281] The message element shall be used as defined in Table 67.

Restriction:

[V2G2-OC-281_1] The message element shall be used as defined in Table D26.

Table D26 specifies the usage of NotificationType for connection, contained in the V2G message header. Refer to the original Table 67 for semantics and type definition.

Table D26 - USAGE OF MESSAGE ELEMENTS NOTIFICATIONTYPE

E ement Name	SECC
FaultCode	Don t care
FaultMsg	Don t care

8.5.2.9 PaymentOptionsType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-283] The message element shall be used as defined in Table 68.

Restriction:

[V2G2-OC-283_1] The list of payment options contains only one entry and only payment option type “ExternalPayment” is supported, option “Contract” is not used; see Table D27.

Table D27 specifies the usage of PaymentOptionsType in connection, contained in ServiceDiscoveryRes (8.4.1.3.3). Refer to the original Table 68 for semantics and type definition.

Table D27 - USAGE OF MESSAGE ELEMENTS PAYMENTOPTIONSTYPE

Element Name	SECC
PaymentOption	ExternalPayment

8.5.2.10 ChargingProfileType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-606] The message element shall be used as defined in Table 69.

Restriction:

[V2G2-OC-606_1] The message element shall be used as defined in Table D28.

Table D28 specifies the usage of ChargingProfileType for connection, contained in PowerDeliveryReq. Refer to the original Table 69 for semantics and type definition.

Table D28 - USAGE OF MESSAGE ELEMENTS CHARGINGPROFILETYPE

Element Name	SECC
SAScheduleTupleID	Don t care
ProfileEntry	Don t care

8.5.2.11 ProfileEntryType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-607] The message element shall be used as defined in Table 70.

Restriction:

[V2G2-OC-607_1] The message element shall be used as defined in Table D29.

Table D29 specifies the usage of PorfileEntryType for connection, contained in ChargingProfileType in PowerDeliveryReq; see 8.4.1.9.2. Refer to the original Table 70 for semantics and type definition.

Table D29 - USAGE OF MESSAGE ELEMENTS PROFILEENTRYTYPE

Element Name	SECC
ChargingProfileEntryStart	Don t care
ChargingProfileEntryMaxPower	Don t care

8.5.2.1.2 SAScheduleListType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-608] The message element shall be used as defined in Table 71.

Restriction:

[V2G2-OC-608_1] The message element shall be used as defined in Table D30.

Table D30 specifies the usage of SAScheduleListType for connection, contained in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 71 for semantics and type definition.

Table D30 - USAGE OF MESSAGE ELEMENTS SASCHEDULELISTTYPE

Element Name	SECC
SAScheduleTuple	Don't care; see 8.5.2.13

8.5.2.1.3 SAScheduleTupleType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-609] The message element shall be used as defined in Table 72.

Restriction:

[V2G2-OC-609_1] The message element shall be used as defined in Table D31.

Table D31 specifies the usage of SAScheduleTupleType for connection, contained in SAScheduleListType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 72 for semantics and type definition.

Table D31 - USAGE OF MESSAGE ELEMENTS SASCHEDULETUPLETYPE

Element Name	SECC
SAScheduleTupleID	Don't care
PMaxSchedule	Don't care; see 8.5.2.14
Sales Tariff	Don't care; see 8.5.2.16

8.5.2.14 PMaxScheduleType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-610] The message element shall be used as defined in Table 73.

Restriction:

[V2G2-OC-610_1] The message element shall be used as defined in Table D32.

Table D32 specifies the usage of PMaxScheduleType for connection, contained in SAScheduleTupleType in ChargeParameterDiscoveryRes; see 8.4.1. 8.3. Refer to the original Table 73 for semantics and type definition.

Table D32 - USAGE OF MESSAGE ELEMENTS PMAXSCHEDULETYPE

Element Name	SECC
PMaxScheduleID	Don't care
PMaxScheduleEntry	Don't care; see 8.5.2.15

8.5.2.15 PMaxScheduleEntryType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-611] The message element shall be used as defined in Table 74.

Restriction:

[V2G2-OC-611_1] The message element shall be used as defined in Table D33.

Table D33 specifies the usage of PMaxScheduleEntryType for connection, contained in SAScheduleTupleType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 74 for semantics and type definition.

Table D33 - USAGE OF MESSAGE ELEMENTS PMAXSCHEDULEENTRYTYPE

Element Name	SECC
RelativeTimeInterval	Don't care; see 8.5.2.18
PMax	Don't care

8.5.2.16 SalesTariffType

This clause of ISO 15118-2 is is applicable, except as follows:

Original requirement:

[V2G2-612] The message element shall be used as defined in Table 75.

Restriction:

[V2G2-OC-612_1] The message element shall be used as defined in Table D34.

Table D34 specifies the usage of SalesTariffType for connection, contained in SAScheduleTupleType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 75 for semantics and type definition.

Table D34 - USAGE OF MESSAGE ELEMENTS SALESTARIFFTYPE

Element Name	SECC
SalesTariffID	Don't care
SalesTariffDescription	Don't care

NumEPriceLevels	Don't care
SalesTariffEntry	Don't care; see 8.5.2.17

8.5.2.17 SalesTariffEntryType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement

[V2G2-613] The message element shall be used as defined in Table 76.

Restriction:

[V2G2-OC-613_1] The message element shall be used as defined in Table D35.

Table D35 specifies the usage of SalesTariffEntryType for connection, contained in SAScheduleTupleType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 76 for semantics and type definition.

Table D35 - USAGE OF MESSAGE ELEMENTS SALESTARIF TYPE

Element Name	SECC
RelativeTimeInterval	Don't care; see 8.5.2.18
EPriceLevel	Don't care
ConsumptionCost	Don't care; see 8.5.2.19

8.5.2.18 RelativeTimeIntervalType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-614] The message element shall be used as defined in Table 77.

Restriction:

[V2G2-OC-614_1] The message element shall be used as defined in Table D36.

Table D36 specifies the usage of RelativeTimeIntervalType for connection, contained in PMaxScheduleEntryType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 77 for semantics and type definition.

Table D36 - USAGE OF MESSAGE ELEMENTS PMAXSCHEDULEENTRYTYPE

E ement Name	SECC
duration	Don t care
start	Don t care

8.5.2.19 ConsumptionCostType

This clause of ISO 15118-2 is is applicable, except as follows:

Original requirement:

[V2G2-615] The message element shall be used as defined in Table 78.

Restriction:

[V2G2-OC-615_1] The message element shall be used as defined in Table D37.

Table D37 specifies the usage of ConsumptionCostType for connection contained in SalesTariffType in ChargeParameterDiscoveryRes; see 8.4.1.8.3. Refer to the original Table 78 for semantics and type definition.

Table D37 - USAGE OF MESSAGE ELEMENTS CONSUMPTIONCOSTTYPE

E ement Name	SECC
Cost	Don t care see 8 5 2 20
StartValue	Don t care

8.5.2.20 CostType

This clause of ISO 15118-2 is is applicable, except as follows:

Original requirement

[V2G2-616] The message element shall be used as defined in Table 79 and Table 80.

Restriction:

[V2G2-OC-616_1] The message element shall be used as defined in Table D38.

Table D38 specifies the usage of CostType and CostKindType for connection, contained in SalesTariffType in ChargeParameterDiscoveryRes; see 8.4.1.8.3.

Refer to the original Table 79 for semantics and type definition.

Table D38 - USAGE OF MESSAGE ELEMENTS COSTTYPE

Element Name	SECC
amount	Don t care
amountMultiplier	Don t care
costKind	Don t care

8.5.2.21 ServiceParameterListType

This clause of ISO 15118-2 is not applicable. The data type is contained in ServiceDetailRes which is not used in connection V1.3.0

8.5.2.22 ParameterSetType

This clause of ISO 15118-2 is not applicable. The data type is contained in ServiceParameterListType in ServiceDetailRes which is not used in connection V1.3.0

8.5.2.23 ParameterType

This clause of ISO 15118-2 is not applicable. The data type is contained in ParameterSetType in ServiceDetailRes which is not used in connection V1.3.0

8.5.2.24 SelectedServiceListType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-350] The message element shall be used as defined in Table 84.

Restriction:

[V2G2-OC-350_1] The message element shall be used as defined in Table D39.

Table D39 specifies the usage of SelectedServiceListType in connection, contained in ServicePaymentSelectionReq (8.4.1.5.2). Refer to the original Table 84 for semantics and type definition.

Table D39 - USAGE OF MESSAGE ELEMENTS SELECTEDSERVICE LISTTYPE

Element Name	SECC
SelectedService	See 8.5.2.25

8.5.2.25 SelectedServiceType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-352] The message element shall be used as defined in Table 85.

Restriction:

[V2G2-OC-352_1] ServiceID is always set to 1; see Table D40.

Table D40 specifies the usage of SelectedServiceType in connection, contained in SelectedServiceListType (8.5.2.24). Refer to the original Table 85 for semantics and type definition.

Table D40 - USAGE OF MESSAGE ELEMENTS SLECTED SERVICE TYPE

Element Name	SECC
ServiceID	1 (only DC_extended is supported)
ParameterSetID	Don't care

8.5.2.26 SubCertificatesType

This clause of ISO 15118-2 is not applicable. The data type is contained in CertificateChainType. The messages PaymentDetailsReq, CertificateUpdateReq/Res, and CertificateInstallationRes which contain this data type are not used in connection V 1.3.0.

8.5.2.27 ListOfRootCertificateIDsType

This clause of ISO 15118-2 is not applicable. The data type is

contained in CertificateUpdateReq and CertificateInstallationReq which are not used in connection V 1.3.0.

8.5.3 AC

This clause of ISO 15118-2 does not apply. Connection does not use AC power transfer.

8.5.4 DC

8.5.4.1 DC_EVSEStatusType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-365] The message element shall be used as defined in Table 91.

Restriction:

[V2G2-OC-365_1] The message elements shall be used as defined in Table D41. EVSEIsolationStatus is only used in CableCheckRes to signal if isolation test is completed. DC_EVSEStatusCode is only used in CableCheckRes to signal if pantograph is moving and if isolation test is in progress or complete, as defined in Table D41. Also see 8.4.3.2.3 for cable check response.

Table D41 specifies the usage of DC_EVSEStatusType in connection, contained in DC_EVSEChargeParameter (8.5.4.4) used by the following messages CableCheckRes (8.4.3.2.3), PreChargeRes (8.4.3.3.3), PowerDeliveryRes (8.

4.1.9.3), CurrentDemandRes (8.4.3.4.3). Refer to the original Table 91 for semantics and type definition.

Table D41 - USAGE OF MESSAGE ELEMENTS DC_EVSESTATUSTYPE

Element Name	SECC
NotificationMaxDelay	Don't care
EVSENotification	Allowed values: - None - StopCharging
EVSEIsolationStatus	Used only in CableCheckRes: - Invalid in case of ongoing isolation test - Safe in case of successful isolation test NOTE: In the related open V2G implementation, "valid" is used instead of "safe." This will not contradict interoperability.
DC_EVSEStatusCode	Used only in CableCheckRes: - Reserved_8: until pantograph is in lower position - EVSE_IsolationMonitoringActive: after pantograph is in lower postion, until isolation test is finished - EVSE_Ready: isolation test is finished

NOTE: EVSENotification = StopCharging is additionaly used in case of EVSE errors. It is expected that EVCC immediatetly aborts the charging process by going to session stop process.

8.5.4.2 DC_EVStatusType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-368] The message element shall be used as defined in Table 93.

Restriction:

[V2G2-OC-368_1] The message element shall be used as defined in Table D42. The parameter EVRESSSOC is mandatory in CurrentDemandReq; see 8.4.3.4.2

Table D42 specifies the usage of DC_EVStatusType for connection, contained in DC_EVChargeParameter (8.5.4.3) used in the following messages CableCheckReq (8.4.3.2.2), PreChargeReq (8.4.3.3.2), and CurrentDemandReq (8.4.3.4.2). Refer to the original Table 93 for semantics and type definition.

Table D42 - USAGE OF MESSAGE ELEMENTS DC_EVSTATUSTYPE

Element Name	EVCC
EVReady	Don't care (default TRUE)
EVCabinConditioning	Don't care
EVRESSConditioning	Don't care
EVErrorCode	Don't care (default NO_ERROR)
EVRESSSOC	Available SOC, mandatory use in CurrentDemandReq, optional for other messages; see 8.4.3.4.2

NOTE: Available SOC is fraction of the physical SOC of the battery and is defined by vehicle OEM (8.4.3.4.2).

8.5.4.3 DC_EVChargeParameterType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-371] The message element shall be used as defined in Table 95.

Restriction:

[V2G2-OC-371_1] The message element shall be used as defined in Table D43. DC_EVStatus may not be handeled by EVSE; see 8.5.4.2.

Table D43 specifies the usage of DC_EVChargeParameterType for connection, contained iin ChargeParameterDiscoveryReq (8.4.1.8.2). Refer to the original Table 95 for semantics and type definition.

Table D43 - USAGE OF MESSAGE ELEMENTS DC_EVCHARGEPARAMETERTYPE

Element Name	EVCC
DC_EVStatus	Don't care; see 8.5.4.2
EVMaximumCurrentLimit	Maximum current supported by EV
EVMaximumPowerLimit	Maximum power supported by EV
EVMaximumVoltageLimit	Maximum voltage supported by EV
EVEnergyCapacity	Don't care
EVEnergyRquest	Don't care

FullSOC	Don't care
BulkSOC	Don't care

8.5.4.4 DC_EVSEChargeParameterType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-373] The message element shall be used as defined in Table 96.

Restriction:

[V2G2-OC-373_1] The message element shall be used as defined in Table D44. DC_EVSEStatus is not used; see 8.5.4.1.

Table D44 specifies the usage of DC_EVSEChargeParameterType for connection, contained in ChargeParameterDiscoveryRes (8.4.1.8.3). Refer to the original Table 96 for semantics and type definition.

Table D44 - Usage of message parameter DC_EVSEChargeParameterType

Element Name	SECC
DC_EVSEStatus	Don't care; see 8.5.4.1
EVSEMaximumCurrentLimit	Deviation to standard: Minimum of EVMaximumCurrentLimit and the maximum current the EVSE can deliver
EVSEMaximumPowerLimit	Maximum power EVSE can deliver
EVSEMaximumVoltageLimit	Deviation to standard: Minimum of EVMaximumVoltageLimit and the maximum voltage the EVSE can deliver
EVSEMinimumCurrentLimit	Minimum current EVSE can deliver
EVSEMinimumVoltageLimit	Minimum voltage EVSE can deliver
EVSECurrentRegulationTolerance	Don't care
EVSEPeakCurrentRipple	Don't care
EVSEEnergyToBeDelivered	Don't care

NOTE: The EVSE sends the minimum of EVMaximumVoltageLimit and the maximum voltage the EVSE can deliver. The value of EVMaximumVoltageLimit is sent as confirmation that the limit of the vehicle is accepted and can be provided by the station. Otherwise, in case the station can only provide less voltage than the EVMaximumVoltageLimit, it sends the stations limit value. The same approach is applied to the MaximumCurrentLimit.

8.5.4.5 DC_EVPowerDeliveryParameterType

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-375] The message element shall be used as defined in Table 97.

Restriction:

[V2G2-OC-375_1] The message element shall be used as defined in Table D45. DC_EVStatus is not used; see 8.5.4.1.

Table D45 specifies the usage of DC_EVPowerDeliveryParameterType for connection, contained in PowerDeliveryReq (8.4.1.9.2). Refer to the original Table 97 for semantics and type definition.

Table D45 - Usage of message parameter DC_EVPowerDeliveryParameterType

Element Name	EVCC
DC_EVStatus	Don't care; see 8.5.4.2
BulkChargingComplete	Don't care
ChargingComplete	Don't care

8.6 Identification Modes and Message Set Definitions

This clause of ISO 15118-2 is not applicable. This document defines only messages and parameters used in connection V1.3.0.

8.7 V2G Communication Timing

8.7.1 Overview

This clause of ISO 15118-2 is applicable, except as follows:

Original statement:

The monitoring of a V2G Communication Session is based on two Timer categories:

- Commnunication Setup Timer: Monitors the time from plug-in until the Session Setup message. It allows deciding if the communication setup was successful.

- Ready to Charge Timer: Monitors the time from plug-in until the first Power Delivery message. It allows deciding if the request for power form the EVCC was successful.

Restriction:

Since connection is via WLAN communication, the plug-in charging timing is not applicable.

In version V1.3.0 of connection, the communication setup timer and ready-to-charge timer are not used.

8.7.2 Message Sequence and Communication Session

8.7.2.1 Definitions

This clause of ISO 15118-2 is applicable, except as follows:

Table D46 - EVCC and SECC message sequence and session timing parameter values

Name	MessageType	Value (seconds)
V2G_EVCC_Msg_Timeout	SupportedAppProtocol	2
	SessionSetup	2
	ServiceDiscovery	2
	ServicePaymentSelection	2
	PaymentDetails	NA
	ContractAuthentication	2 (not defined in the original Table 103)
	ChargeParameterDiscovery	2
	ChargingStatus	NA
	MeteringReceipt	NA
	PowerDelivery	,,2

	CableCheck	2 (deviation to standard)
	PreCharge	2 (deviation to standard)
	CurrentDemand	0.25
	WeldingDetection	NA
	SessionStop	2
	CertificateInstallation	NA
	CertificateUpdate	NA
V2G_SECC_Msg_Performance_Time	SupportedAppProtocol	1.5
	SessionSetup	1.5
	ServiceDiscovery	1.5
	ServicePaymentSelection	1.5
	PaymentDetails	NA
	ContractAuthentication	1.5
	ChargeParameterDiscovery	1.5
	ChargingStatus	NA
	MeteringReceipt	NA
	PowerDelivery	1.5
	CableCheck	20
	PreCharge	0.1
	CurrentDemand	0.025
	WeldingDetection	NA
	SessionStop	1.5
	CertificateInstallation	NA
	CertificateUpdate	NA

Name	MessageType	Value (seconds)
V2G_EVCC_Sequence_Performance_Time	ChargeParameterDiscovery	10
	CableCheck	40
	PreCharge	10
	PowerDelivery	10
	(all other messages)	Not used
V2G_SECC_Sequence_Timeout	CurrentDemandReq	10
	(all other messages)	60

NOTE: SessionStop, CableCheck, PreCharge, and CurrentDemand are looping messages and can cause high message load on communication channel, if transmission interval is too short. For that reason, it is recommended to allow up to ten requests per second.

8.7.2.2 EVCC Timing for Request-Response Message Pairs

This clause of ISO 15118-2 is applicable; see Table D46 for timeout values for each V2G message type.

8.7.2.3 SECC Timing for Response-Request Message Sequence

This clause of ISO 15118-2 is applicable; see Table D46 for timeout values for each V2G message type.

8.7.3 Session Setup and Ready to Charge

This clause of ISO 15118-2 is not applicable. Session setup timer and ready to charge timer are not used in connection V 1.3.0.

8.8 Message Sequencing and Error Handling

8.8.1 Overview

This clause of ISO 15118-2 is applicable.

8.8.2 Basic Definitions for Error Handling

This clause of ISO 15118-2 is applicable.

8.8.3 ResponseCode Handling

8.8.3.1 Common Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-461] The response message shall contain the ResponseCode "FAILED_SignatureError" if the validation of the Security element in the message header failed.

Restriction:

[V2G2-OC-461_1] ResponseCode "FAILED_SignatureError" is not used for all messages.

Original requirement:

[V2G2-463] The message “sessionSetupRes” shall contain the specific ResponseCode “OK_OldSessionJoined” if processing of the SessionSetupReq message was successful and the same SessionID as used in the request message is contained in the response message.

Restriction:

[V2G2-OC-463_1] The message “sessionSetupRes” does not use ResponseCode “OK_OldSessionJoined.”

NOTE: It is not a usecase for connection to suspend a session and resume it afterwards. Connection is designed to transfer high energy amounts within a short time. Therefore, sessions are not suspended, re-negotiation does not take place, and charge schedules and profiles are not applied.

Original requirement:

[V2G2-465] The message “servicePaymentSelectionRes” shall contain the ResponseCode “FAILED_PaymentSelectionInvalid” if the SelectedPaymentOption contained in the ServicePaymentSelectionReq message was not part of the of ered PaymentOptionList of ServiceDiscoveryRes.

Restriction:

[V2G2-OC-465_1] The message “servicePaymentSelectionRes” does not use the ResponseCode “FAILED_PaymentSelectionInvalid.”

Original requirement:

[V2G2-467] The message "servicePaymentSelectionRes" shall contain the ResponseCode "FAILED_ServiceSelectionInvalid" if the SelectedServiceList contained in the ServicePaymentSelectionReq message contains a ServiceID which was not contained in the offered ServiceList of ServiceDiscoveryRes.

Restriction:

[V2G2-OC-467_1] The message "servicePaymentSelectionRes" does not use the ResponseCode "FAILED_ServiceSelectionInvalid."

Original requirement:

[V2G2-475] The message "ContractAuthenticationRes" shall contain the ResponseCode "FAILED_ChallengeInvalid" if the challenge response contained in the ContractAuthenticationReq message in attribute GenChallenge is not valid versus the provided GenChallenge in PaymentDetailsRes.

Restriction:

[V2G2-OC-475_1] The message "ContractAuthenticationRes" does not use the ResponseCode "FAILED_ChallengeInvalid."

Original requirement:

[V2G2-476] The message "ChargeParameterDiscoveryRes" shall contain the ResponseCode "FAILED_WrongEnergyTransferMode" if the content of attribute "RequestedEnergyTransferMode" in the ChargeParameterDiscoveryReq message is not valid.

Restriction:

[V2G2-OC-476_1] The message "ChargeParameterDiscoveryRes" does not use the ResponseCode "FAILED_WrongEnergyTransferMode." If the content of attribute "RequestedEnergyTransferMode" in the ChargeParameterDiscoveryReq message is not valid, the ResponseCode "FAILED_WrongChargeParameter" is used.

Original requirement:

[V2G2-477] The message "ChargeParameterDiscoveryRes" shall contain the ResponseCode "FAILED_WrongChargeParameter" if the content of attribute "EVChargeParameter" in the ChargeParameterDiscoveryReq message is not valid; e. g. , wrong parameter set is provided, one or multiple parameters cannot be interpreted.

Restriction:

[V2G2-OC-477_1] The message "ChargeParameterDiscoveryRes" uses the ResponseCode "FAILED_WrongChargeParameter" only if the content of attribute "RequestedEnergyTransferMode" is not "DC_extended."

Original requirement:

[V2G2-478] The message "PowerDeliveryRes" shall contain the ResponseCode "FAILED_ChargingProfileInvalid" if the content of attribute "ChargingProfile" in the PowerDeliveryReq message violates a power limitation provided in "ChargeParameterDiscoveryRes."

Restriction:

[V2G2-OC-478_1] The message "PowerDeliveryRes" does not use the ResponseCode "FAILED_ChargingProfileInvalid."

Original requirement:

[V2G2-479] The message "PowerDeliveryRes" shall contain the ResponseCode "FAILED_Tarif SelectionInvalid" if the content of element "ChargingProfile" in the PowerDeliveryReq message contains a SAScheduleTupleID which was not contained in the "sAScheduleList" element provided in "ChargeParameterDiscoveryRes."

Restriction:

[V2G2-OC-479_1] The message "PowerDeliveryRes" does not use the ResponseCode "FAILED_TariffSelectionInvalid."

Original requirement:

[V2G2-480] The message "PowerDeliveryRes" shall contain the ResponseCode "FAILED_PowerDeliveryNotApplied" if the EV supply equipment is not able to deliver energy.

Restriction:

[V2G2-OC-480_1] The message "PowerDeliveryRes" does not use the ResponseCode "FAILED_PowerDeliveryNotApplied."

8.8.3.2 AC Specific Requirements

This clause of ISO 15118-2 does not apply. Connection does not use AC power transfer.

8.8.3.3 DC Specific Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Restriction:

[V2G2-669] and [V2G2-670] are not applied for connection. See 8.4.3.2.3 for related requirements for calble check handling.

8.8.4 Request-Response Message Sequence Requirements

8.8.4.1 General Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-679] If the parameter EVSENotification in EVSEStatus is equal to StopCharging, the EVCC shall stop charging within the value of the parameter NotificationMaxDelay is in the EVSEStatus.

Deviation:

[V2G2-OC-679_1] If the parameter EVSENotification in EVSEStatus is equal to StopCharging, the EVCC shall stop charging immediately; therefore, the parameter NotificationMaxDelay is not used. The next allowed request message is SessionStopReq.

Restriction:

Requirements [V2G2_672], [V2G2_673], [V2G2_674], [V2G2_675], [V2G2_676], and [V2G2_680] are not applicable for connection.

8.8.4.2 EVCC

This clause of ISO 15118-2 is applicable, except as follows:

The EVCC behavior defining all valid request-response message sequences for connection is shown in Figure D2.

8.8.4.2.1 Common Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-484] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout of "supportedAppProtocolRes" according to Table 103.

Deviation:

[V2G2-OC-484_1] The EVCC shall stop the V2G communication session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout of "supportedAppProtocolRes" according to Table D46,
or if the response message containing a "ResponseCode = FAILED_NoNegotiation."

Original requirement:

[V2G2-488] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "serviceDiscoveryRes" according to Table 103.

Deviation:

[V2G2-OC-488_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "serviceDiscoveryRes."

Original requirement:

[V2G2-492] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or “ResponseCode = FAIL” of “servicePaymentSelectionRes” according to Table 103.

Deviation:

[V2G2-OC-492_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or “ResponseCode = FAIL” of “servicePaymentSelectionRes.”

Original requirement:

[V2G2-504] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or “ResponseCode = FAIL” of “ContractAuthenticationRes” according to Table 103.

Deviation:

[V2G2-OC-504_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or “ResponseCode = FAIL” of “ContractAuthenticationRes.”

Original requirement:

[V2G2-506] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or “ResponseCode = FAIL” of “ChargeParameterDiscoveryRes” according to Table 103.

Deviation:

[V2G2-OC-506_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when

V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "ChargeParameterDiscoveryRes."

Original requirement:

[V2G2-507] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "sessionStopRes" according to Table 103.

Deviation:

[V2G2-OC-507_1] The EVCC shall continue to send a new SessionStopReq, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "sessionStopRes."

[V2G2-OC-507_2] If EVCC does not receive a SessionStop response within V2G_EVCC_MSG_Timeout, EVCC shall stop the communication session but not release the immobilization.

New requirements:

[V2G2-OC-720] After the first SessionStop response with "ResponseCode = OK," EVCC may send further SessionStop requests with the same session_id. In that case the SECC may continue answering with SessionStop response and "ResponseCode = OK."

[V2G2-OC-721] All ResponseCodes of SessionStop response other than "OK" are handled like "ResponseCode = FAILED" (e.g., Handling of ResponseCodes FAILED_SequenceError).

[V2G2-OC-722] If EVCC receives a response message with a different SessionID than the SessionID it received in the SessionSetupRes, it shall ignore the message.

Restriction:

Requirements [V2G2_489], [V2G2_491], [V2G2_493], [V2G2_494], [V2G2_495], [V2G2_496], [V2G2_497], [V2G2_498], [V2G2_499], [V2G2_500], [V2G2_501], [V2G2_502], [V2G2_503], [V2G2_683], [V2G2_684], and [V2G2_685] are not applicable for connection.

8.8.4.2.2 AC Specific Requirements

This clause of ISO 15118-2 does not apply. Connection does not use AC power transfer.

8.8.4.2.3 DC Specific Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-524] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "CableCheckRes" according to Table 103.

Deviation:

[V2G2-OC-524_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46, or "ResponseCode = FAIL" of "CableCheckRes," or EVSEProcessing = Finished, but EVSEIsolationStatus = Fault.

NOTE: [V2G2-OC-713] states out that CableCheckRes sends "ResponseCode = FAIL" in case of an isolation fault. It is recommended to use the ResponseCode for error handling. That allows a uniform error handling to all messages.

Original requirement:

[V2G2-526] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "PreChargeRes" according to Table 103.

Deviation:

[V2G2-OC-526_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "PreChargeRes."

Original requirement:

[V2G2-529] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "PowerDeliveryRes" according to Table 103.

Deviation:

[V2G2-OC-529_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "PowerDeliveryRes."

Original requirement:

[V2G2-532] The EVCC shall stop the V2G_Communication_Session when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout or "ResponseCode = FAIL" of "CurrentDemandRes" according to Table 103.

Deviation:

[V2G2-OC-532_1] The EVCC shall send a SessionStopReq to stop the V2G_Communication_Session, when V2G_EVCC_Msg_Timer is equal to or larger than V2G_EVCC_Msg_Timeout according to Table D46 or "ResponseCode = FAIL" of "CurrentDemandRes."

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Restriction:

Requirements [V2G2_533], [V2G2_534], [V2G2_620], [V2G2_535], and [V2G2_686] are not applicable for connection.

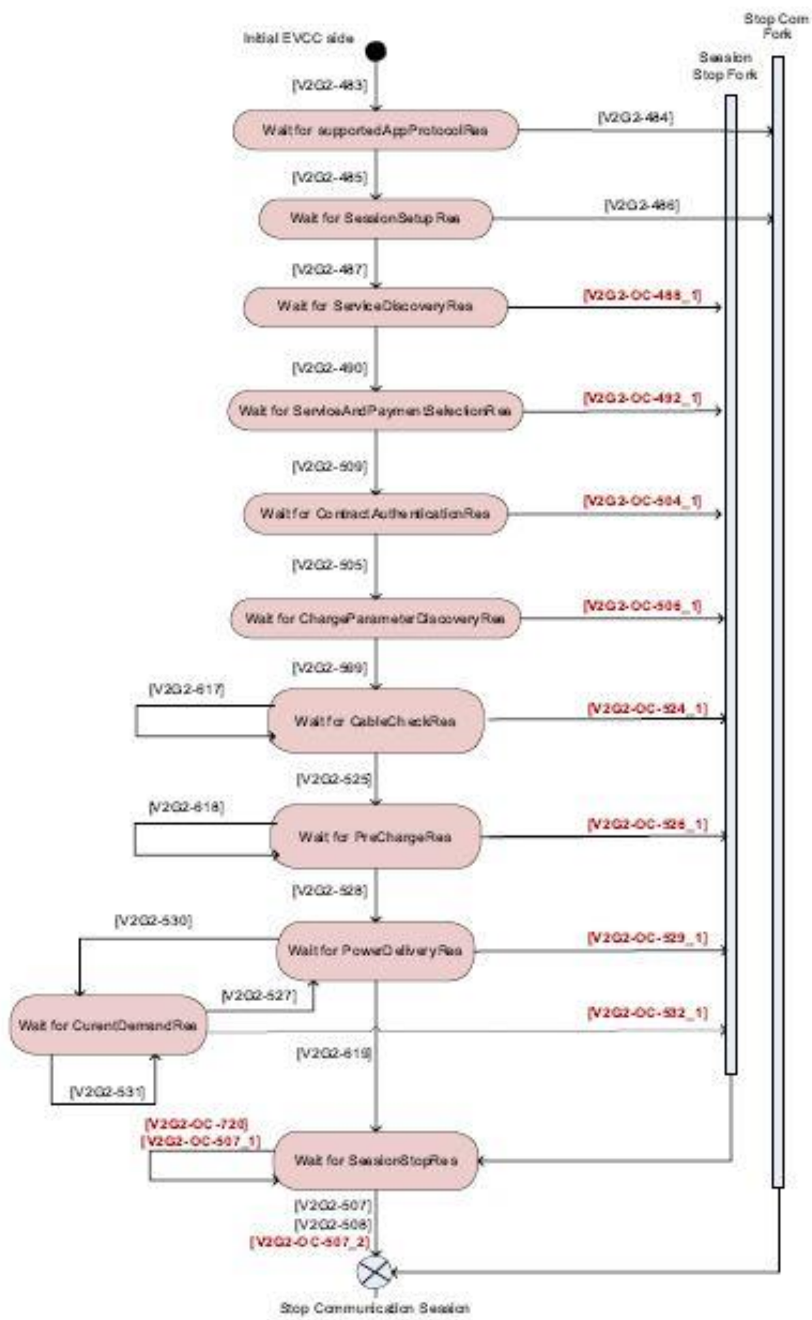

Figure D2 - EVCC communication states for connection V2G messaging

8.8.4.3 SECC

The SECC behavior defining all valid request-response message sequences for connection is shown in Figure D3:

8.8.4.3.1 Common Requirements

This clause of ISO 15118-2 is applicable, except as follows:

[V2G2-536] The SECC shall enter a wait state for supportedAppProtocolReq, set the timeout V2G_SECC_Sequence_Timeout to the value MessageType as defined in Table 1 03, reset the V2G_SECC_Sequence_Timer and start monitoring the V2G_SECC_Sequence_Timer.

Deviation:

[V2G2-OC-536_1] The SECC shall enter a wait state for supported AppProtocolReq without timeout handling. The SECC continuously waits for supportedAppProtocolReq.

Original requirement:

[V2G2-537] The SECC shall Stop the V2G Communication Session when V2G_SECC_Sequence_Timer is equal to or larger than V2G_SECC_Sequence_Timeout according to Table 103.

Addition:

[V2G2-OC-537_1] When V2G_SECC_Sequence_Timer is equal to or larger than V2G_SECC_Sequence_Timeout according to Table D46 then the SECC shall wait for SessionStopReq

Original requirement:

[V2G2-538] The SECC shall respond with the corresponding response message containing a “ResponseCode = FAILED_SequenceError” within V2G_SECC_Msg_Performance_Time according to Table 1 03 if request message was received that the SECC does not expect in the wait state.

Deviation:

[V2G2-OC-538_1] The SECC shall respond with the corresponding response message containing a “ResponseCode=FAILED_SequenceError” within V2G_SECC_Msg_Performance_Time according to Table D46, if request message was received that the SECC does not expect in the wait state. The SECC shall then wait for SessionStopReq.

Original requirement:

[V2G2-545] The SECC shall respond with a ServiceDiscoveryRes containing “ResponseCode = OK” within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is passed successfully. The allowed next request shall be ServiceDetailReq and ServiceAndPaymentSelectionReq and the V2G_SECC_Sequence_Timeout is set according to Table 103.

Deviation:

[V2G2-OC-545_1] The SECC shall respond with a ServiceDiscoveryRes containing “ResponseCode = OK” within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is passed successfully. The allowed next request shall be ServiceAndPaymentSelectionReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-546] The SECC shall respond with a ServiceDiscoveryRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-546_1] The SECC shall respond with a ServiceDiscoveryRes containing "ResponseCode = FAI L" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-551] The SECC shall respond with a ServicePaymentSelectionRes containing "ResponseCode = OK" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is successfully passed. The allowed next request shall be PaymentDetailReq, CertificateInstallationReq and CertificateUpdateReq if Message Set "AC Charging Pnc" is selected and ContractAuthenticationReq if Message Set "AC Charging EIM" is selected. V2G_SECC_Sequence_Timeout is set according to Table 103.

Deviation:

[V2G2-OC-551_1] The SECC shall respond with a ServicePaymentSelectedRes containing "ResponseCode = OK" within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed. The allowed next request shall be ContractAuthenticationReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-552] The SECC shall respond with a ServicePaymentSelectionRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-552_1] The SECC shall respond with a ServicePaymentSelectionRes containing "ResponseCode = FAI L" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-564] The SECC shall respond with ContractAuthenticationRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-564_1] The SECC shall respond with ContractAuthenticationRes containing "ResponseCode = FAI L" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-566] The SECC shall respond with CharingParameterDiscoveryRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-566_1] The SECC shall respond with ChargingParameterDiscoveryRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-572] The SECC shall respond with SessionStopRes containing "ResponseCode = FAILED" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successful.

Addition:

[V2G2-OC-572_1] In case of connection the SECC shall respond with SessionStopRes containing "ResponseCode = FAILED," if the pantograph is going to be raised and not in the upper home position.

New requirements:

[V2G2-OC-723] If SECC does not receive a SessionStop request within V2G_SECC_Sequence_Timeout, SECC shall command the ACD to its home position (if not already done) and stop the communication session. After the ACD has reached its home position SECC shall accept new sessions.

[V2G2-OC-724] If SECC does not detect ACD in its home position within V2G_SECC_ACD_Disconnection_Timeout, it shall change to error mode and keep sending SessionStop response with "ResponseCode = FAILED" when a SessionStop request is received.

Restriction:

Requirements [V2G2_547], [V2G2_548], [V2G2_549], [V2G2_553], [V2G2_554], [V2G2_555], [V2G2_556], [V2G2_557], [V2G2_558], [V2G2_559], [V2G2_560], [V2G2_561], [V2G2_567], [V2G2_568], [V2G2_569], [V2G2_687], and [V2G2_688] are not applicable for connection.

NOTE: Requirements [V2G2_567], [V2G2_568], and [V2G2_569] are applicable for AC, but the standard refers to it in the common chapter.

8.8.4.3.2 AC Specific Requirements

This clause of ISO 15118-2 does not apply. Connection does not use AC power transfer.

8.8.4.3.3 DC Specific Requirements

This clause of ISO 15118-2 is applicable, except as follows:

Original requirement:

[V2G2-582] The SECC shall respond with ChargeParameterDiscoveryRes containing “ResponseCode = OK” and "EVSEProcessing=Finished" and a valid parameter SASchedule within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is successfully passed. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according to Table 103.

Deviation:

[V2G2-OC-582_1] The SECC shall respond with ChargeParameterDiscoveryRes containing “ResponseCode = OK” and "EVSEProcessing=Finished" within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-658] The SECC shall measure state C or D as defined in IEC 61851-1 (IO-SET_CPSTATE. indication (CPState=C or D)) before receiving a Cable Check Request for sending a Cable Check Response Message with parameter ResponseCode set to “OK” otherwise it shall send ResponseCode set to“FAILED.”

Restriction:

[v2G2-658] is not applied for connection. See 8.4.3.2.3 for related

requirements for cable check handling. Original requirement:

[V2G2-584] The SECC shall respond with CableCheckRes containing ResponseCode = OK” and “EVSEProcessing=Finished” within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is successfully passed and calble check is finished. The allowed next request shall be PreChargeReq and the V2G_SECC_Sequence_Timeout is set according toTable 103.

Deviation:

[V2G2-OC-584_1] The SECC shall respond with CableCheckRes containing ResponseCode = OK, ” “EVSEProcessing=Finished, ” EVSEStatusCode = EVSE_Ready, EVSEI solationStatus = Safe within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed and calble check is finished as defined in 8.4.3.2.3. The allowed next request shall be PreChargeReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-621] The SECC shall respond with CableCheckRes containing ResponseCode = OK" and "EVSEProcessing=Ongoing" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is successfully passed and calble check is ongoing. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according toTable 103.

Deviation:

[V2G2-OC-621_1] The SECC shall respond with CableCheckRes containing ResponseCode = OK, " "EVSEProcessing=Ongoing, " EVSEStatusCode = Reserved_8, EVSEI solationStatus = I nvalid within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed and the pantograph has not reached the end position yet as defined in 8.4.3.2.1. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

[V2G2-OC-621_2] The SECC shall respond with CableCheckRes containing ResponseCode = OK, " "EVSEProcessing=Ongoing," EVSEStatusCode = EVSE_IsolationMonitoringActive, EVSEIsolationStatus = I nvalid within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed and the isolation test has not completed yet as defined in 8.4.3.2.1. The allowed next request shall be CableCheckReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-585] The SECC shall respond with CableCheckRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-585_1] The SECC shall respond with CableCheckRes containing "ResponseCode = FAI L" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-588] The SECC shall respond with PreChargeRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-588_1] The SECC shall respond with a PreChargeRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-601] The SECC shall respond with a PowerDeliveryRes containing "ResponseCode = OK" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is successfully passed and the request contained "ReadyToCharge = FALSE. " The allowed next request shall be ChargeParameterDiscoveryReq and

WeldingDetectionReq and SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table 103.

Deviation:

[V2G2-OC-601_1] The SECC shall respond with a PowerDeliveryRes containing "ResponseCode = OK" within V2G_SECC_Msg_Performance_Time according to Table D46, if the processing of the information is successfully passed and the request contained "ReadyToCharge = FALSE." The allowed next request shall be SessionStopReq and the V2G_SECC_Sequence_Timeout is set according to Table D46.

Original requirement:

[V2G2-591] The SECC shall respond with PowerDeliveryRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-591_1] The SECC shall respond with PowerDeliveryRes containing "ResponseCode = FAI L" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Original requirement:

[V2G2-595] The SECC shall respond with CurrentDemandRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table 103 if the processing of the information is not successfully.

Deviation:

[V2G2-OC-595_1] The SECC shall respond with a CurrentDemandRes containing "ResponseCode = FAIL" within V2G_SECC_Msg_Performance_Time according to Table D46; if the processing of the information is not successful, then wait for SessionStopReq.

Restriction:

Requirements [V2G2_596], [V2G2_597], and [V2G2_598] are not applicable for connection.

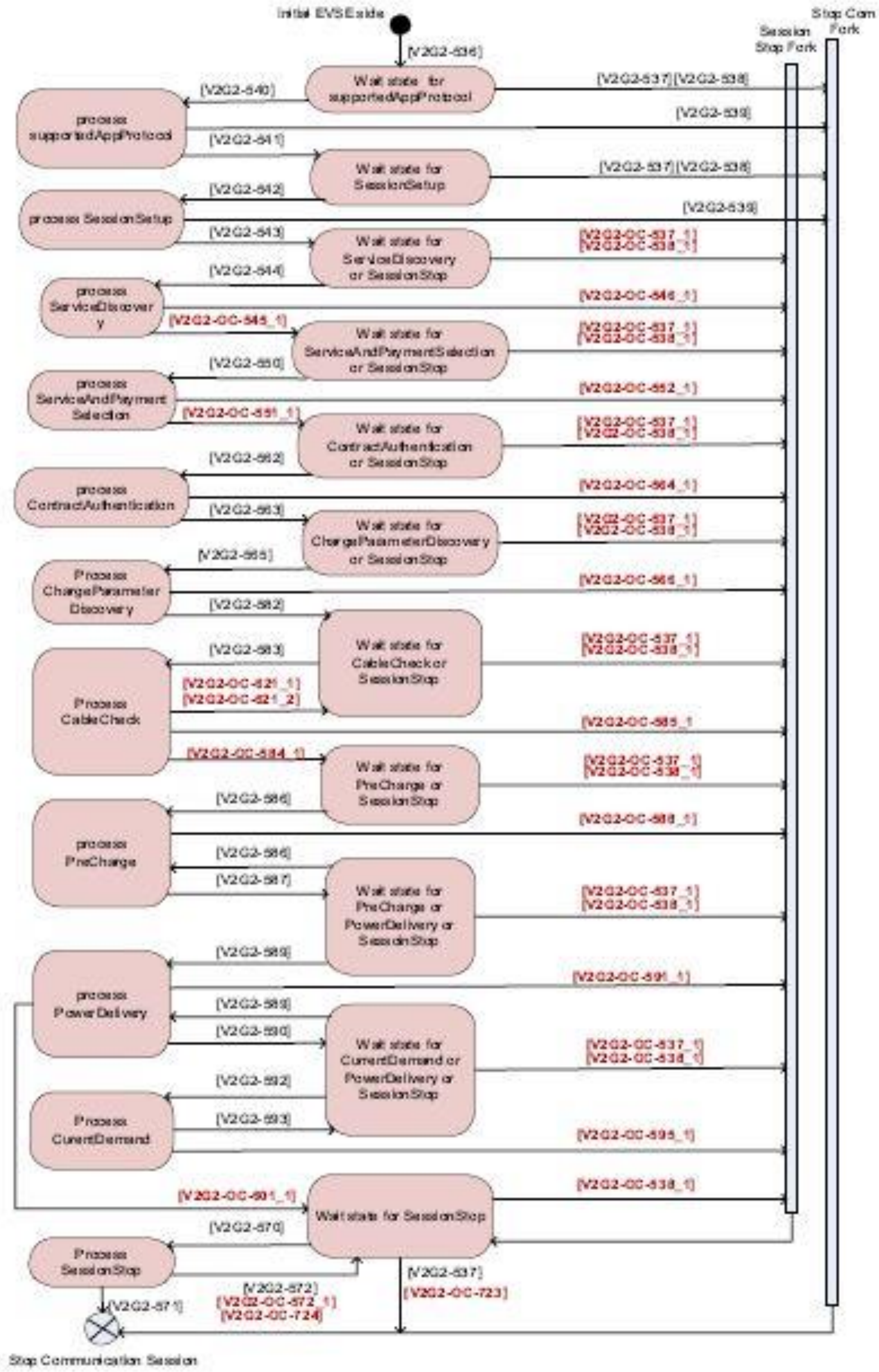

Figure D3 - SECC communication states for DC V2G messaging

8.9 Request-Response Message Sequence Examples

8.9.1 AC

This clause of ISO 15118-2 does not apply. Connection does not use AC power transfer.

8.9.2 DC

8.9.2.1 EIM

This clause of ISO 15118-2 is not applicable for connection.

8.9.2.2 PnC

This clause of ISO 15118-2 is not applicable for connection.

8.9.2.3 Message Sequence

Figure D4 depicts an example for a request-response message sequence for the connection without any errors.

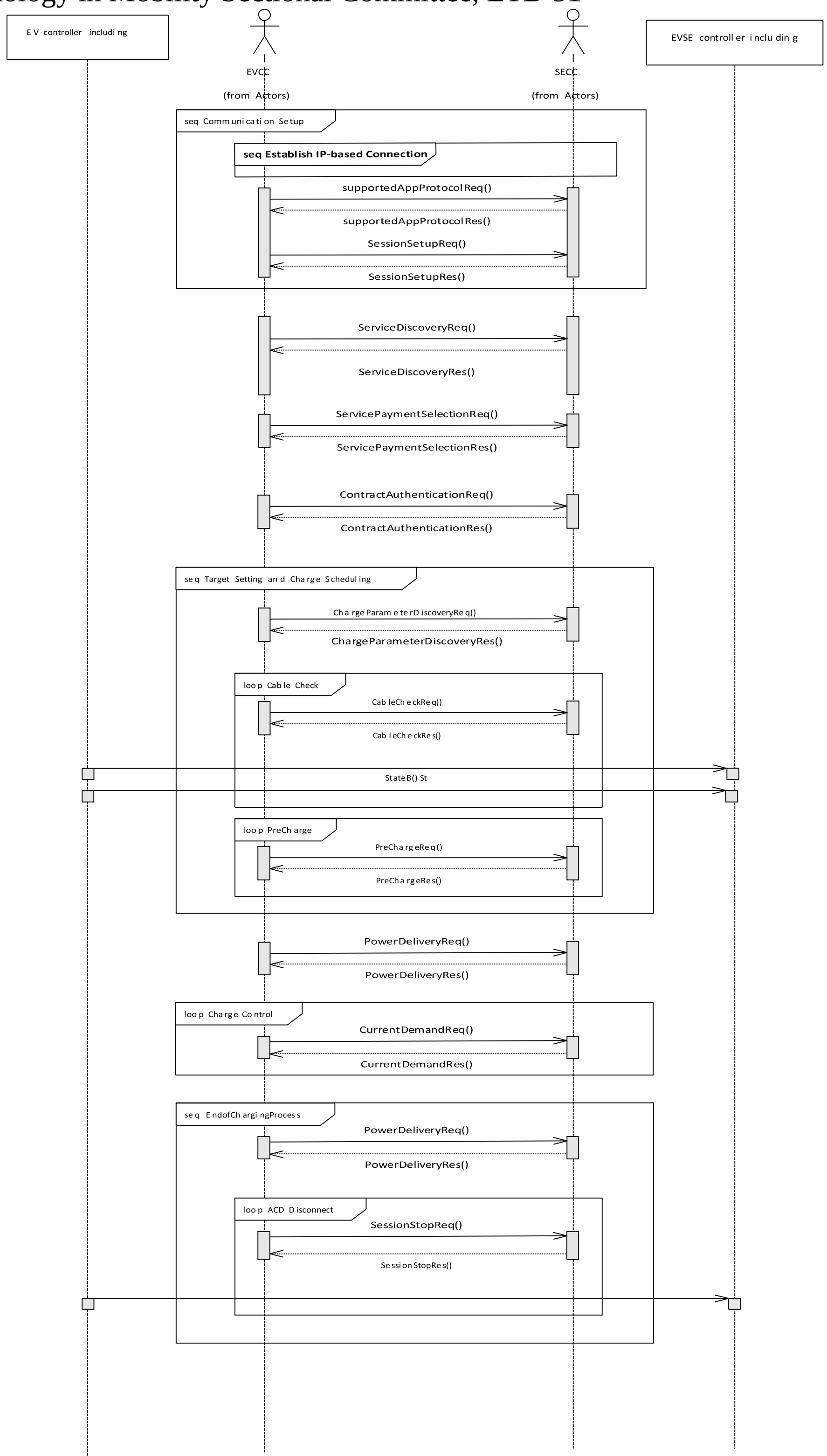

Figure D4 - Connection V2G message sequence example

D.2.1 Additional Items

Table A1 of ISO 15118-2 is not applicable for connection and has not been updated.

Mapping of ISO 15118 message element names to SAE J2847/2 terms is applicable.

Application of certificates (and security appliances and their associated certificates) do not apply since certificates are not used.

Updated Schema is to be added to the appendix with the ACD changes.

APPENDIX E - SCHEMA DEFINITION

E.1 OVERVIEW

The V2G application layer message specification consists of four XML schema documents with the following scope:

- "V2G_CI_AppProtocol": Defines the protocol handshake messages
- "V2G_CI_MsgDef": Defines the message structure definition
- "V2G_CI_MsgHeader": Defines the message header
- "V2G_CI_MsgBody": Defines the message body
- "V2G_CI_MsgDataTypes": Defines the data types

Figure E1 shows the dependency graph for all five XML schema documents.

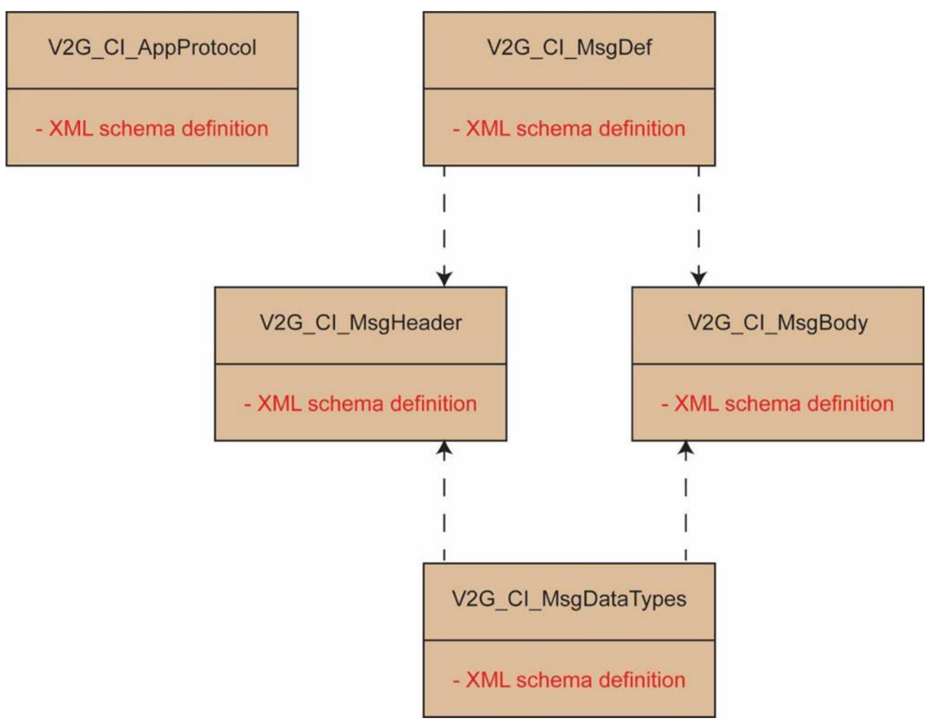

FIGURE E1 - DEPENDENCY CHART OF THE V2G CI XML SCHEMA DEFINITIONS

E.2 V2G_CI_APPPROTOCOL.XSD

```
<xs:schema xmlns:xs="http://www.w3.org/2001
/XMLSchema" xmlns="urn:iso:15118:2:2010:AppProtocol"
targetNamespace="urn:iso:15118:2:2010:AppProtocol">

<xs:element name='supportedAppProtocolReq">
                <xs:complexType>
                        <xs:sequence>
                                <xs:element name="AppProtocol" type="AppProtocolType" maxOccurs="20"/>
                        </xs: sequence>
                </xs:complexType>
        </xs:element>
<xs:element name='supportedAppProtocolRes">
                <xs:complexType>
                        <xs:sequence>
                                <xs:element name="ResponseCode" type="responseCodeType"/>
                                <xs:element name='schemaID" type="idType" minOccurs="0"/>
                        </xs: sequence>
                </xs:complexType>
        </xs:element>
<xs:complexType name="AppProtocolType">
                <xs:sequence>
                        <xs:element name="ProtocolNamespace" type="protocolNamespaceType"/>
                        <xs:element name="VersionNumberMajor" type="xs:unsignedInt"/>
                        <xs:element name="VersionNumberMinor" type="xs:unsignedInt"/>
                        <xs:element name='schemaID" type="idType"/>
                        <xs:element name="Priority" type="priorityType"/>
                </xs: sequence>
</xs:complexType>
<xs:simpleType name="idType">
    <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
<xs:simpleType name="protocolNameType">
    <xs:restriction base="xs:string">
        <xs:maxLength value="30"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="protocolNamespaceType">
```

```
<xs:restriction base="xs:anyURI">
<xs:maxLength value="100"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="priorityType">
<xs:restriction base="xs:unsignedByte">
<xs:minInclusive value="1"/>
<xs:maxInclusive value="20"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="responseCodeType">
<xs:restriction base="xs:string">
<xs:enumeration value="OK_SuccessfulNegotiation"/>
<xs:enumeration value="OK_SuccessfulNegotiationWithMinorDeviation"/>
<xs:enumeration value="Failed_NoNegotiation"/>
</xs:restriction>
</xs:simpleType>
</xs:schema>
```

E.3 V2G_CI_MSGDEF.XSD

```
<xs:schema xmlns:xs="http://www.w3.
org/2001/XMLSchema"
targetNamespace="urn:iso:15118:2:2010:
MsgDef"
xmlns="urn:iso:15118:2:2010:MsgDef"
xmlns:v2gci_h="urn:iso:15118:2:2010:MsgHeader"
elementFormDefault="qualified"
attributeFormDefault="unqualified">
<xs:import namespace="urn:iso:15118:2:2010:MsgHeader" schemaLocation="V2G_CI_MsgHeader.xsd"/>
<!-- Message Structure -->
<xs:element name="V2G_Message">
<xs:complexType>
<xs:sequence>
<xs:element name="Header" type="v2gci_h:MessageHeaderType"/>
<xs:element name="Body" type="BodyType"/>
</xs: sequence>
```

```
</xs:complexType>
</xs:element>
<!-- Body -->
<xs:complexType name="BodyType">
<xs:sequence>
<xs:element ref="BodyElement" minOccurs="0"/>
</xs:sequence>
</xs:complexType>
<xs:element name="BodyElement" type="BodyBaseType"/> <xs:complexType name="BodyBaseType" abstract='true"/>
</xs: schema>
```

E.4 V2G_CI_MSGHEADER.XSD

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" targetNamespace="urn:iso:15118:2:2010:
MsgHeader" xmlns="urn:iso:15118:2:2010:MsgHeader"
xmlns:v2gci_d="urn:iso:15118:2:2010:MsgDef"
xmlns:v2gci_t="urn:iso:15118:2:2010:
MsgDataTypes" xmlns:xmlsig=http://www.w3.
org/2000/09/xmldsig#
elementFormDefault="qualified"
attributeFormDefault="unqualified">
<xs:import namespace="urn:iso:15118:2:2010:MsgDef" schemaLocation="V2G_CI_MsgDef.xsd"/>
<xs:import namespace="urn:iso:15118:2:2010:MsgDataTypes" schemaLocation="V2G_CI_MsgDataTypes.xsd"/>
<xs:import namespace="http://www.w3.org/2000/09/xmldsig#" schemaLocation="xmldsig-core-schema.xsd"/>
<!-- Message Header -->
<xs:complexType name="MessageHeaderType">
<xs:sequence>
<xs:element name="sessionID" type="v2gci_t:sessionIDType"/>
<xs:element name="Notification" type="v2gci_t:NotificationType" minOccurs="0"/>
<xs:element ref="xmlsig:Signature" minOccurs="0"/>
</xs: sequence>
</xs:complexType>
</xs:schema>
```

E.5 V2G_CI_MSGBODY.XSD

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="urn:iso:15118:2:2010:MsgBody"

xmlns="urn:iso:15118:2:2010:MsgBody"

xmlns:v2gci_d="urn:iso:15118:2:2010:MsgDef"

xmlns:v2gci_t="urn:iso:15118:2:2010:MsgDataTypes"
elementFormDefault="qualified"

attributeFormDefault="unqualified">

<xs:import namespace="urn:iso:15118:2:2010:MsgDef" schemaLocation="V2G_CI_MsgDef.xsd"/>

<xs:import namespace="urn:iso:15118:2:2010:MsgDataTypes" schemaLocation="V2G_CI_MsgDataTypes.xsd"/>

<!-- ………………….. -->

<!-- Common Messages (AC/DC) -->

<!-- ………………….. -->

<!--                    -->

<!-- Session Setup -->

<!--                    -->

<xs:element name="sessionSetupReq" type="sessionSetupReqType" substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="sessionSetupReqType">

<xs:complexContent>

    <xs:extension base="v2gci_d:BodyBaseType">

                        <xs:sequence>

                                <xs:element name="EVCCID" type="v2gci_t:evccIDType"/>

                        </xs: sequence>

    </xs:extension>

 </xs:complexContent>

</xs:complexType>

<xs:element name="sessionSetupRes" type="sessionSetupResType" substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="sessionSetupResType">

<xs:complexContent>

                        <xs:extension base="v2gci_d:BodyBaseType">

                        <xs:sequence>

                                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>

                                <xs:element name="EVSEID" type="v2gci_t:evseIDType"/>

                                <xs:element name="DateTimeNow" type="xs:long" minOccurs="0"/>

                        </xs: sequence>

                        </xs:extension>
```

```
</xs:complexContent>
</xs:complexType>
<!--                          -->
<!-- Service Discovery -->
<!--                          -->
<xs:element name="serviceDiscoveryReq" type="serviceDiscoveryReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="serviceDiscoveryReqType">
<xs:complexContent>
                <xs:extension base="v2gci_d:BodyBaseType">
                    <xs:sequence>
                        <xs:element name="serviceScope" type="v2gci_t:serviceScopeType" minOccurs="0"/>
                        <xs:element name="serviceCategory" type="v2gci_t:serviceCategoryType" minOccurs="0"/>
                    </xs: sequence>
                </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="serviceDiscoveryRes" type="serviceDiscoveryResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="serviceDiscoveryResType">
<xs:complexContent>
                <xs:extension base="v2gci_d:BodyBaseType">
                    <xs:sequence>
                        <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                        <xs:element name="PaymentOptions" type="v2gci_t:PaymentOptionsType"/>
                        <xs:element name="ChargeService" type="v2gci_t:ServiceChargeType"/>
                        <xs:element name="serviceList" type="v2gci_t:ServiceTagListType" minOccurs="0"/>
                    </xs: sequence>
                </xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                    -->
<!-- Service Detail   -->
<!--                    -->
<xs:element name="serviceDetailReq" type="serviceDetailReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="serviceDetailReqType">
<xs:complexContent>
                <xs:extension base="v2gci_d:BodyBaseType">
                    <xs:sequence>
```

```
                <xs:element name="serviceID" type="v2gci_t:serviceIDType"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="serviceDetailRes" type="serviceDetailResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="serviceDetailResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                <xs:element name="serviceID" type="v2gci_t:serviceIDType"/>
                <xs:element name="serviceParameterList" type="v2gci_t:ServiceParameterListType"
                minOccurs="0"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                -->
<!-- Service Payment & Selection -->
<!--                -->
<xs:element name="servicePaymentSelectionReq" type="servicePaymentSelectionReqType"
substitutionGroup="v2gci_d:BodyElement"/>
    <xs:complexType name="servicePaymentSelectionReqType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name='selectedPaymentOption" type="v2gci_t:paymentOptionType"/>
                <xs:element name='selectedServiceList" type="v2gci_t:SelectedServiceListType"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="servicePaymentSelectionRes" type="servicePaymentSelectionResType"
substitutionGroup="v2gci_d:BodyElement"/>
      <xs:complexType name="servicePaymentSelectionResType">
           <xs:complexContent>
```

```
<xs:extension base="v2gci_d:BodyBaseType">
                        <xs:sequence>
                            <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                        </xs: sequence>
    </xs:extension>
 </xs:complexContent>
</xs:complexType>
<!--                  -->
<!-- Payment Details -->
<!--                  -->
<xs:element name="PaymentDetailsReq" type="PaymentDetailsReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PaymentDetailsReqType">
<xs:complexContent>
                    <xs:extension base="v2gci_d:BodyBaseType">
                        <xs:sequence>
                            <xs:element name="ContractID" type="v2gci_t:contractIDType"/>
                            <xs:element name="ContractSignatureCertChain" type="v2gci_t:
                            CertificateChainType"/>
                        </xs: sequence>
                        </xs:extension>
 </xs:complexContent>
</xs:complexType>
<xs:element name="PaymentDetailsRes" type="PaymentDetailsResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PaymentDetailsResType">
<xs:complexContent>
                    <xs:extension base="v2gci_d:BodyBaseType">
                        <xs:sequence>
                            <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                            <xs:element name="GenChallenge" type="v2gci_t:genChallengeType"/>
                            <xs:element name="DateTimeNow" type="xs:long"/>
                        </xs: sequence>
                        </xs:extension>
 </xs:complexContent>
</xs:complexType>
<!--                  -->
<!-- Contract Authentification -->
<!--                  -->
```

```
<xs:element name="ContractAuthenticationReq" type="ContractAuthenticationReqType"
substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="ContractAuthenticationReqType">

                    <xs:extension base="v2gci_d:BodyBaseType">

                        <xs:sequence>

                            <xs:element name="GenChallenge" type="v2gci_t:genChallengeType"
                            minOccurs="0"/>

                        </xs: sequence>

                        <xs:attribute name="Id" type="xs:IDREF" use="required"/>

                        </xs:extension>

 </xs:complexContent>

</xs:complexType>

<xs:element name="ContractAuthenticationRes" type="ContractAuthenticationResType"
substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="ContractAuthenticationResType">

<xs:complexContent>

                    <xs:extension base="v2gci_d:BodyBaseType">

                        <xs:sequence>

                            <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>

                            <xs:element name="EVSEProcessing" type="v2gci_t:EVSEProcessingType"/>

                        </xs: sequence>

                        </xs:extension>

 </xs:complexContent>

</xs:complexType>

<!--                    -->

<!-- Charge Parameter Discovery -->

<!--                    -->

<xs:element name="ChargeParameterDiscoveryReq" type="ChargeParameterDiscoveryReqType"
substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="ChargeParameterDiscoveryReqType">

<xs:complexContent>

                    <xs:extension base="v2gci_d:BodyBaseType">

                        <xs:sequence>

                        <xs:element name="EVRequestedEnergyTransferType" type="v2gci_t:
                        EVRequestedEnergyTransferType"/>

                        <xs:element ref="v2gci_t:EVChargeParameter"/>

                        </xs: sequence>

                    </xs:extension>
```

```
:
</xs:complexContent>
</xs:complexType>
<xs:element name="ChargeParameterDiscoveryRes" type="ChargeParameterDiscoveryResType"
substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="ChargeParameterDiscoveryResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                <xs:element name="EVSEProcessing" type="v2gci_t:EVSEProcessingType"/>
                <xs:element ref="v2gci_t:SASchedules"/>
                <xs:element ref="v2gci_t:EVSEChargeParameter"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<!--        -->
<!-- Power Delivery-->
<!--        -->
<xs:element name="PowerDeliveryReq" type="PowerDeliveryReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PowerDeliveryReqType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ReadyToChargeState" type="xs:boolean"/>
                <xs:element name="ChargingProfile" type="v2gci_t:ChargingProfileType" minOccurs="0"/>
                <xs:element ref="v2gci_t:EVPowerDeliveryParameter" minOccurs="0"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="PowerDeliveryRes" type="PowerDeliveryResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PowerDeliveryResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
```

```
                <xs:element ref="v2gci_t:EVSEStatus"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                -->
<!-- Charging Status-->
<!--                 -->
<xs:element name="ChargingStatusReq" type="ChargingStatusReqType" substitutionGroup="v2gci_d:BodyElement"/>
<!--   <xs:element name="MeteringStatusReq" type="MeteringStatusReqType" substitutionGroup="v2gci_d:BodyElement"/> -->
<xs:complexType name="ChargingStatusReqType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence/>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="ChargingStatusRes" type="ChargingStatusResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="ChargingStatusResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                <xs:element name="EVSEID" type="v2gci_t:evseIDType"/>
                <xs:element name='sAScheduleTupleID" type="v2gci_t:SAIDType"/>
                <xs:element name="EVSEMaxCurrent" type="v2gci_t:PhysicalValueType" minOccurs="0"/>
                <xs:element name="MeterInfo" type="v2gci_t:MeterInfoType" minOccurs="0"/>
                <xs:element name="ReceiptRequired" type="xs:boolean"/>
                <xs:element name="AC_EVSEStatus" type="v2gci_t:AC_EVSEStatusType"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                -->
```

```
<!-- Metering Receipt-->
<!--                    -->
<xs:element name="MeteringReceiptReq" type="MeteringReceiptReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="MeteringReceiptReqType">
<xs:complexContent>
                        <xs:extension base="v2gci_d:BodyBaseType">
                            <xs:sequence>
                                <xs:element name="sessionID" type="v2gci_t:sessionIDType"/>
                                <xs:element name='sAScheduleTupleID" type="v2gci_t:SAIDType" minOccurs="0"/>
                                <xs:element name="MeterInfo" type="v2gci_t:MeterInfoType"/>
                            </xs: sequence>
                            <xs:attribute name="Id" type="xs:IDREF"/>
                        </xs:extension>
<!-- only needed if receipt is required -->
                    </xs:complexContent>
                </xs:complexType>
                <xs:element name="MeteringReceiptRes" type="MeteringReceiptResType"
                substitutionGroup="v2gci_d:BodyElement"/>
                <xs:complexType name="MeteringReceiptResType">
                    <xs:complexContent>
                        <xs:extension base="v2gci_d:BodyBaseType">
                            <xs:sequence>
                                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                                <xs:element name="AC_EVSEStatus" type="v2gci_t:AC_EVSEStatusType"/>
                            </xs: sequence>
                            </xs:extension>
 </xs:complexContent>
</xs:complexType>
<!--              -->
<!-- SessionStop-->
<!--              -->
<xs:element name="sessionStopReq" type="sessionStopType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="sessionStopType">
<xs:complexContent>
                        <xs:extension base="v2gci_d:BodyBaseType">
                            <xs:sequence/>
                        </xs:extension>
```

```
 </xs:complexContent>
</xs:complexType>
<xs:element name="sessionStopRes" type="sessionStopResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="sessionStopResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
            </xs: sequence>
        </xs:extension>
 </xs:complexContent>
</xs:complexType>
<!--                    -->
<!-- Certificate Update-->
<!--                    -->
<xs:element name="CertificateUpdateReq" type="CertificateUpdateReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CertificateUpdateReqType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
            <xs:sequence>
                <xs:element name="ContractSignatureCertChain" type="v2gci_t:
                CertificateChainType"/>
                <xs:element name="ContractID" type="v2gci_t:contractIDType"/>
                <xs:element name="ListOfRootCertificateIDs" type="v2gci_t:ListOfRootCertificateI
                DsType"/>
                <xs:element name="DHParams" type="v2gci_t:dHParamsType"/>
                <!-- new -->
            </xs: sequence>
            <xs:attribute name="Id" type="xs:IDREF"/>
            </xs:extension>
 </xs:complexContent>
</xs:complexType>
<xs:element name="CertificateUpdateRes" type="CertificateUpdateResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CertificateUpdateResType">
<xs:complexContent>
        <xs:extension base="v2gci_d:BodyBaseType">
```

```
<xs:sequence>
<xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
<xs:element name="ContractSignatureCertChain" type="v2gci_t:
CertificateChainType"/>
<xs:element name="ContractSignatureEncryptedPrivateKey" type="v2gci_t:
privateKeyType"/>
<xs:element name="DHParams" type="v2gci_t:dHParamsType"/>
<xs:element name="ContractID" type="v2gci_t:contractIDType"/>
<xs:element name="RetryCounter" type="xs:short"/>
</xs: sequence>
<xs:attribute name="Id" type="xs:IDREF" use="required"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                    -->
<!-- Certificate Installation-->
<!--                    -->
<xs:element name="CertificateInstallationReq" type="CertificateInstallationReqType"
substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CertificateInstallationReqType">
<xs:complexContent>
<xs:extension base="v2gci_d:BodyBaseType">
<xs:sequence>
<xs:element name="OEMProvisioningCert" type="v2gci_t:certificateType"/>
<xs:element name="ListOfRootCertificateIDs" type="v2gci_t:ListOfRootCertificateIDsType"/>
<xs:element name="DHParams" type="v2gci_t:dHParamsType"/>
</xs: sequence>
<xs:attribute name="Id" type="xs:IDREF"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="CertificateInstallationRes" type="CertificateInstallationResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CertificateInstallationResType">
<xs:complexContent>
<xs:extension base="v2gci_d:BodyBaseType">
<xs:sequence>
<xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
<xs:element name="ContractSignatureCertChain" type="v2gci_t:CertificateChainType"/>
<xs:element name="ContractSignatureEncryptedPrivateKey" type="v2gci_t:privateKeyType"/>
```

```
<xs:element name="DHParams" type="v2gci_t:dHParamsType"/>
<xs:element name="ContractID" type="v2gci_t:contractIDType"/>
</xs: sequence>
<xs:attribute name="Id" type="xs:IDREF" use="required"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<!-- ………………….. -->
<!-- DC-Messages-->
<!-- ………………….. -->
<!--                  -->
<!-- Cable Check   -->
<!--                  -->
<xs:element name="CableCheckReq" type="CableCheckReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CableCheckReqType">
<xs:complexContent>
<xs:extension base="v2gci_d:BodyBaseType">
<xs:sequence>
<xs:element name="DC_EVStatus" type="v2gci_t:DC_EVStatusType"/>
</xs: sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="CableCheckRes" type="CableCheckResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CableCheckResType">
<xs:complexContent>
<xs:extension base="v2gci_d:BodyBaseType">
<xs:sequence>
<xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
<xs:element name="DC_EVSEStatus" type="v2gci_t:DC_EVSEStatusType"/>
<xs:element name="EVSEProcessing" type="v2gci_t:EVSEProcessingType"/>
</xs: sequence>
</xs:extension>
</xs:complexContent></xs:complexType>
<!--                -->
```

```xml
<!--   Pre-Charge -->
<!--                  -->
<xs:element name="PreChargeReq" type="PreChargeReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PreChargeReqType">
<xs:complexContent>
                                <xs:extension base="v2gci_d:BodyBaseType">
                                       <xs:sequence>
                                              <xs:element name="DC_EVStatus" type="v2gci_t:DC_EVStatusType"/>
                                              <xs:element name="EVTargetVoltage" type="v2gci_t:PhysicalValueType"/>
                                              <xs:element name="EVTargetCurrent" type="v2gci_t:PhysicalValueType"/>
                                       </xs: sequence>
                                       </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="PreChargeRes" type="PreChargeResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="PreChargeResType">
<xs:complexContent>
                                            <xs:extension base="v2gci_d:BodyBaseType">
                                                   <xs:sequence>
                                                          <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                                                          <xs:element name="DC_EVSEStatus" type="v2gci_t:DC_EVSEStatusType"/>
                                                          <xs:element name="EVSEPresentVoltage" type="v2gci_t:PhysicalValueType"/>
                                                   </xs: sequence>
                                                   </xs:extension>
 </xs:complexContent>
</xs:complexType>
<!--                    -->
<!--  Current  Demand    -->
<!--                    -->
<xs:element name="CurrentDemandReq" type="CurrentDemandReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="CurrentDemandReqType">
<xs:complexContent>
                                            <xs:extension base="v2gci_d:BodyBaseType">
                                                   <xs:sequence>
                                                          <xs:element name="DC_EVStatus" type="v2gci_t:DC_EVStatusType"/>
                                                          <xs:element name="EVTargetCurrent" type="v2gci_t:PhysicalValueType"/>
                                                          <xs:element name="EVMaximumVoltageLimit" type="v2gci_t:PhysicalValueType"
                                                          minOccurs="0"/>
```

```
<xs:element name="EVMaximumCurrentLimit" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="EVMaximumPowerLimit" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="BulkChargingComplete" type="xs:boolean" minOccurs="0"/>

<xs:element name="ChargingComplete" type="xs:boolean"/>

<xs:element name="RemainingTimeToFullSoC" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="RemainingTimeToBulkSoC" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="EVTargetVoltage" type="v2gci_t:PhysicalValueType"/>

</xs: sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<xs:element name="CurrentDemandRes" type="CurrentDemandResType" substitutionGroup="v2gci_d:BodyElement"/>

<xs:complexType name="CurrentDemandResType">

<xs:complexContent>

<xs:extension base="v2gci_d:BodyBaseType">

<xs:sequence>

<xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>

<xs:element name="DC_EVSEStatus" type="v2gci_t:DC_EVSEStatusType"/>

<xs:element name="EVSEPresentVoltage" type="v2gci_t:PhysicalValueType"/>

<xs:element name="EVSEPresentCurrent" type="v2gci_t:PhysicalValueType"/>

<xs:element name="EVSECurrentLimitAchieved" type="xs:boolean"/>

<xs:element name="EVSEVoltageLimitAchieved" type="xs:boolean"/>

<xs:element name="EVSEPowerLimitAchieved" type="xs:boolean"/>

<xs:element name="EVSEMaximumVoltageLimit" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="EVSEMaximumCurrentLimit" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

<xs:element name="EVSEMaximumPowerLimit" type="v2gci_t:PhysicalValueType"
minOccurs="0"/>

</xs:   sequence>

</xs:extension>

</xs:complexContent>

</xs:complexType>

<!--                    -->
```

```
<!-- Welding Detection -->
<!--                    -->
<xs:element name="WeldingDetectionReq" type="WeldingDetectionReqType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="WeldingDetectionReqType">
<xs:complexContent>
                <xs:extension base="v2gci_d:BodyBaseType">
                    <xs:sequence>
                        <xs:element name="DC_EVStatus" type="v2gci_t:DC_EVStatusType"/>
                    </xs: sequence>
                    </xs:extension>
 </xs:complexContent>
</xs:complexType>
<xs:element name="WeldingDetectionRes" type="WeldingDetectionResType" substitutionGroup="v2gci_d:BodyElement"/>
<xs:complexType name="WeldingDetectionResType">
<xs:complexContent>
                <xs:extension base="v2gci_d:BodyBaseType">
                    <xs:sequence>
                        <xs:element name="ResponseCode" type="v2gci_t:responseCodeType"/>
                        <xs:element name="DC_EVSEStatus" type="v2gci_t:DC_EVSEStatusType"/>
                        <xs:element name="EVSEPresentVoltage" type="v2gci_t:PhysicalValueType"/>
                    </xs: sequence>
                    </xs:extension>
</xs:complexContent>
</xs:complexType>
</xs: schema>
```

E.6 V2G_CI_MSGDATATYPES.XSD

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"

targetNamespace="urn:iso:15118:2:2010:
MsgDataTypes"xmlns="urn:iso:15118:2:201
0:MsgDataTypes"

xmlns:v2gci_b="urn:iso:15118:2:2010:
MsgBody"

elementFormDefault="qualified"

attributeFormDefault="unqualified">

<xs:import namespace="urn:iso:15118:2:2010:MsgBody" schemaLocation="V2G_CI_MsgBody.xsd"/>

<!-- ==================    -->

<!-- Complex types-->
```

```
<!-- ==================    -->
<!--                       -->
<!-- service-related types -->
<!--                    -->
<xs:complexType name="serviceType">
        <xs:sequence>
            <xs:element name="serviceTag" type="serviceTagType"/>
            <xs:element name="FreeService" type="xs:boolean"/>
        </xs: sequence>
</xs:complexType>
<xs:complexType name="serviceTagListType">
        <xs:sequence>
            <xs:element name="service" type="serviceType" maxOccurs="unbounded"/>
        </xs: sequence>
</xs:complexType>
<xs:complexType name="serviceTagType">
        <xs:sequence>
            <xs:element name="serviceID" type="serviceIDType"/>
            <xs:element name="serviceName" type="serviceNameType" minOccurs="0"/>
            <xs:element name="serviceCategory" type="serviceCategoryType"/>
            <xs:element name="serviceScope" type="serviceScopeType" minOccurs="0"/>
        </xs: sequence>
</xs:complexType>
<xs:complexType name='selectedServiceListType">
        <xs:sequence>
            <xs:element name='selectedService" type='selectedServiceType" maxOccurs="unbounded"/>
         </xs: sequence>
</xs:complexType>
<xs:complexType name='selectedServiceType">
        <xs:sequence>
            <xs:element name="serviceID" type="serviceIDType"/>
            <xs:element name="ParameterSetID" type="xs:short" minOccurs="0"/>
        </xs: sequence>
</xs:complexType>
<xs:complexType name="serviceParameterListType">
        <xs:sequence>
```

```
        <xs:element name="ParameterSet" type="ParameterSetType" maxOccurs="unbounded"/>
    </xs: sequence>
</xs:complexType>
<xs:complexType name="ParameterSetType">
    <xs:sequence>
        <xs:element name="ParameterSetID" type="xs:short"/>
        <xs:element name="Parameter" type="ParameterType" maxOccurs="unbounded"/>
    </xs: sequence>
</xs:complexType>
<xs:complexType name="ParameterType">
    <xs:choice>
        <xs:element name="boolValue" type="xs:boolean"/>
        <xs:element name="byteValue" type="xs:byte"/>
        <xs:element name='shortValue" type="xs:short"/>
        <xs:element name="intValue" type="xs:int"/>
        <xs:element name="physicalValue" type="PhysicalValueType"/>
        <xs:element name='stringValue" type="xs:string"/>
     </xs:choice>
            <xs:attribute name="Name" type="xs:string" use="required"/>
            <xs:attribute name="ValueType" type="valueType" use="required"/>
</xs:complexType>
<xs:simpleType name="valueType">
 <xs:restriction base="xs:string">
                <xs:enumeration value="bool"/>
                <xs:enumeration value="byte"/>
                <xs:enumeration value='short"/>
                <xs:enumeration value="int"/>
                <xs:enumeration value="physicalValue"/>
                <xs:enumeration value='string"/>
</xs:restriction>
</xs:simpleType>
<xs:element name="serviceCharge" type="serviceChargeType"/>
<xs:complexType name="serviceChargeType">
<xs:complexContent>
                <xs:extension base="serviceType">
                    <xs:sequence>
```

```
<xs:element name="EnergyTransferType"
type="EVSESupportedEnergyTransferType"/>
</xs: sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                    -->
<!-- security related types -->
<!--                    -->
<xs:complexType name="CertificateChainType">
<xs:sequence>
<xs:element name="Certificate" type="certificateType"/>
<xs:element name=‘subCertificates" type=‘subCertificatesType" minOccurs="0"/>
</xs: sequence>
</xs:complexType>
<xs:complexType name=‘subCertificatesType">
<xs:sequence>
<xs:element name="Certificate" type="certificateType" maxOccurs="unbounded"/>
</xs: sequence>
</xs:complexType>
<xs:complexType name="ListOfRootCertificateIDsType">
<xs:sequence>
<xs:element name="RootCertificateID" type="rootCertificateIDType" maxOccurs="unbounded"/>
</xs: sequence>
</xs:complexType>
<!--                    -->
<!-- metering related types -->
<!--                    -->
<xs:complexType name="MeterInfoType">
<xs:sequence>
<xs:element name="MeterID" type="meterIDType"/>
<xs:element name="MeterReading" type="PhysicalValueType" minOccurs="0"/>
<xs:element name=‘sigMeterReading" type=‘sigMeterReadingType" minOccurs="0"/>
<xs:element name="MeterStatus" type="meterStatusType" minOccurs="0"/>
<xs:element name=‘tMeter" type="xs:long" minOccurs="0"/>
</xs: sequence>
```

```
</xs:complexType>
<xs:simpleType name="meterStatusType">
<xs:restriction base="xs:short"/>
</xs:simpleType>
<!--                                  -->
<!-- Physical value type   -->
<!--                                  -->
<xs:complexType name="PhysicalValueType">
<xs:sequence>
<xs:element name="Multiplier" type="unitMultiplierType"/>
<xs:element name="Unit" type="unitSymbolType" minOccurs="0"/>
<xs:element name="Value" type="xs:short"/>
</xs: sequence>
</xs:complexType>
<!--                           -->
<!-- header related types   -->
<!--                           -->
<xs:complexType name="NotificationType">
<xs:sequence>
<xs:element name="FaultCode" type="faultCodeType"/>
<xs:element name="FaultMsg" type="faultMsgType" minOccurs="0"/>
</xs: sequence>
</xs:complexType>
<!--                  -->
<!-- Tariff related types   -->
<!--                  -->
<xs:complexType name='sASchedulesType" abstract='true"/>
<xs:element name='sASchedules" type='sASchedulesType"/>
<xs:element name='sAScheduleList" type='sAScheduleListType" substitutionGroup='sASchedules"/>
<xs:complexType name='sAScheduleListType">
<xs:complexContent>
<xs:extension base='sASchedulesType">
<xs:sequence>
<xs:element name='sAScheduleTuple" type='sAScheduleTupleType" maxOccurs="unbounded"/>
</xs:   sequence>
</xs:extension>
```

```
</xs:complexContent>
</xs:complexType>
<xs:complexType name=‘sAScheduleTupleType">
        <xs:sequence>
            <xs:element name=‘sAScheduleTupleID" type=‘sAIDType"/>
            <xs:element name="PMaxSchedule" type="PMaxScheduleType"/>
            <xs:element name=‘salesTariff" type=‘salesTariffType" minOccurs="0"/>
        </xs: sequence>
</xs:complexType>
<xs:complexType name=‘salesTariffType">
        <xs:sequence>
            <xs:element name=‘salesTariffID" type=‘sAIDType"/>
            <xs:element name=‘salesTariffDescription" type=‘tariffDescriptionType" minOccurs="0"/>
            <xs:element name="NumEPriceLevels" type="xs:unsignedByte"/>
            <xs:element ref=‘salesTariffEntry" maxOccurs="unbounded"/>
        </xs: sequence>
        <xs:attribute name="Id" type="xs:IDREF" use="required"/>
</xs:complexType>
<xs:complexType name="PMaxScheduleType">
        <xs:sequence>
            <xs:element name="PMaxScheduleID" type=‘sAIDType"/>
            <xs:element ref="PMaxScheduleEntry" maxOccurs="unbounded"/>
        </xs: sequence>
</xs:complexType>
<xs:element name="Entry" type="EntryType"/>
<xs:complexType name="EntryType" abstract=‘true">
        <xs:sequence>
            <xs:element ref=‘timeInterval"/>
        </xs: sequence>
    </xs:complexType>
    <xs:element name=‘salesTariffEntry" type=‘salesTariffEntryType" substitutionGroup="Entry"/>
    <xs:complexType name=‘salesTariffEntryType">
        <xs:complexContent>
            <xs:extension base="EntryType">
                <xs:sequence>
```

```
<xs:element name="EPriceLevel" type="xs:unsignedByte"/>
<xs:element name="ConsumptionCost" type="ConsumptionCostType" minOccurs="0"
maxOccurs="unbounded"/>
</xs: sequence>
</xs:
extension>
</xs:
complexCont
ent>
</xs:complexType>
<xs:element name="PMaxScheduleEntry" type="PMaxScheduleEntryType" substitutionGroup="Entry"/>
<xs:complexType name="PMaxScheduleEntryType">
<xs:complexContent>
<xs:extension base="EntryType">
<xs:sequence>
<xs:element name="PMax" type="PMaxType"/>
</xs: sequence>
</xs:
extension>
</xs:
complexCont
ent>
</xs:complexType>
<xs:complexType name="IntervalType" abstract='true"/>
<xs:element name='timeInterval" type="IntervalType"/>
<xs:element name="RelativeTimeInterval" type="RelativeTimeIntervalType" substitutionGroup='timeInterval"/>
<xs:complexType name="RelativeTimeIntervalType">
<xs:complexContent>
<xs:extension base="IntervalType">
<xs:sequence>
<xs:element name='start" type="xs:unsignedInt"/>
<xs:element name="duration" type="xs:unsignedInt" minOccurs="0"/>
</xs: sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="ConsumptionCostType">
<xs:sequence>
<xs:element name='startValue" type="xs:unsignedInt"/>
<xs:element name="Cost" type="CostType" minOccurs="0" maxOccurs="unbounded"/>
```

```
                                </xs: sequence>
</xs:complexType>
<xs:complexType name="CostType">
                                <xs:sequence>
                                      <xs:element name="costKind" type="costKindType"/>
                                      <xs:element name="amount" type="xs:unsignedInt"/>
                                      <xs:element name="amountMultiplier" type="unitMultiplierType" minOccurs="0"/>
                                </xs: sequence>
</xs:complexType>
<!--                  -->
<!-- EV/EVSE related types  -->
<!--                  -->
<xs:complexType name="EVSEStatusType" abstract='true"/>
<xs:element name="EVSEStatus" type="EVSEStatusType"/>
<xs:element name="AC_EVSEStatus" type="AC_EVSEStatusType" substitutionGroup="EVSEStatus"/>
<xs:complexType name="AC_EVSEStatusType">
<xs:complexContent>
                                      <xs:extension base="EVSEStatusType">
                                            <xs:sequence>
                                                  <xs:element name="PowerSwitchClosed" type="xs:boolean"/>
                                                  <xs:element name="RCD" type="xs:boolean"/>
                                                  <xs:element name="NotificationMaxDelay" type="xs:unsignedInt"/>
                                                  <xs:element name="EVSENotification" type="EVSENotificationType"/>
                                            </xs: sequence>
                                            </xs:extension>
 </xs:complexContent>
</xs:complexType>
<xs:complexType name="EVStatusType" abstract='true"/>
<xs:element name="EVStatus" type="EVStatusType"/>
<xs:element name="DC_EVSEStatus" type="DC_EVSEStatusType" substitutionGroup="EVSEStatus"/>
<xs:complexType name="DC_EVSEStatusType">
<xs:complexContent>
                                  <xs:extension base="EVSEStatusType">
                                            <xs:sequence>
                                                  <xs:element name="EVSEIsolationStatus" type="isolationLevelType" minOccurs="0"/>
                                                  <xs:element name="EVSEStatusCode" type="DC_EVSEStatusCodeType"/>
```

```
<xs:element name="NotificationMaxDelay" type="xs:unsignedInt"/>
<xs:element name="EVSENotification" type="EVSENotificationType"/>
</xs: sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:element name="DC_EVStatus" type="DC_EVStatusType" substitutionGroup="EVStatus"/>
<xs:complexType name="DC_EVStatusType">
<xs:complexContent>
<xs:extension base="EVStatusType">
<xs:sequence>
<xs:element name="EVReady" type="xs:boolean"/>
<xs:element name="EVCabinConditioning" type="xs:boolean" minOccurs="0"/>
<xs:element name="EVRESSConditioning" type="xs:boolean" minOccurs="0"/>
<xs:element name="EVErrorCode" type="DC_EVErrorCodeType"/>
<xs:element name="EVRESSSOC" type="percentValueType"/>
</xs: sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>
<!--                -->
<!-- EVSE/EV Charge Parameter related types  -->
<!--                -->
<xs:complexType name="EVChargeParameterType" abstract='true"/>
<xs:element name="EVChargeParameter" type="EVChargeParameterType"/>
<xs:element name="AC_EVChargeParameter" type="AC_EVChargeParameterType" substitutionGroup="EVChargeParameter"/>
<xs:complexType name="AC_EVChargeParameterType">
<xs:complexContent>
<xs:extension base="EVChargeParameterType">
<xs:sequence>
<xs:element name="DepartureTime" type="xs:unsignedInt"/>
<xs:element name="EAmount" type="PhysicalValueType"/>
<xs:element name="EVMaxVoltage" type="PhysicalValueType"/>
<xs:element name="EVMaxCurrent" type="PhysicalValueType"/>
<xs:element name="EVMinCurrent" type="PhysicalValueType"/>
</xs: sequence>
</xs:extension>
```

```
</xs:complexContent>
</xs:complexType>
<xs:element name="DC_EVChargeParameter" type="DC_EVChargeParameterType" substitutionGroup="EVChargeParameter"/>
<xs:complexType name="DC_EVChargeParameterType">
<xs:complexContent>
        <xs:extension base="EVChargeParameterType">
            <xs:sequence>
                <xs:element name="DC_EVStatus" type="DC_EVStatusType"/>
                <xs:element name="EVMaximumCurrentLimit" type="PhysicalValueType"/>
                <xs:element name="EVMaximumPowerLimit" type="PhysicalValueType" minOccurs="0"/>
                <xs:element name="EVMaximumVoltageLimit" type="PhysicalValueType"/>
                <xs:element name="EVEnergyCapacity" type="PhysicalValueType" minOccurs="0"/>
                <xs:element name="EVEnergyRequest" type="PhysicalValueType" minOccurs="0"/>
                <xs:element name="FullSOC" type="percentValueType" minOccurs="0"/>
                <xs:element name="BulkSOC" type="percentValueType" minOccurs="0"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
<xs:complexType name="EVSEChargeParameterType" abstract=‘true"/>
<xs:element name="EVSEChargeParameter" type="EVSEChargeParameterType"/>
<xs:element name="AC_EVSEChargeParameter" type="AC_EVSEChargeParameterType"
substitutionGroup="EVSEChargeParameter"/>
<xs:complexType name="AC_EVSEChargeParameterType">
<xs:complexContent>
        <xs:extension base="EVSEChargeParameterType">
            <xs:sequence>
                <xs:element name="AC_EVSEStatus" type="AC_EVSEStatusType"/>
                <xs:element name="EVSEMaxVoltage" type="PhysicalValueType"/>
                <xs:element name="EVSEMaxCurrent" type="PhysicalValueType"/>
                <xs:element name="EVSEMinCurrent" type="PhysicalValueType"/>
            </xs: sequence>
            </xs:extension>
</xs:complexContent>
</xs:complexType>
```

```
<xs:element name="DC_EVSEChargeParameter" type="DC_EVSEChargeParameterType"
substitutionGroup="EVSEChargeParameter"/>

<xs:complexType name="DC_EVSEChargeParameterType">

<xs:complexContent>

        <xs:extension base="EVSEChargeParameterType">

            <xs:sequence>

                <xs:element name="DC_EVSEStatus" type="DC_EVSEStatusType"/>

                <xs:element name="EVSEMaximumCurrentLimit" type="PhysicalValueType"/>

                <xs:element name="EVSEMaximumPowerLimit" type="PhysicalValueType" minOccurs="0"/>

                <xs:element name="EVSEMaximumVoltageLimit" type="PhysicalValueType"/>

                <xs:element name="EVSEMinimumCurrentLimit" type="PhysicalValueType"/>

                <xs:element name="EVSEMinimumVoltageLimit" type="PhysicalValueType"/>

                <xs:element name="EVSECurrentRegulationTolerance" type="PhysicalValueType"
                minOccurs="0"/>

                <xs:element name="EVSEPeakCurrentRipple" type="PhysicalValueType"/>

                <xs:element name="EVSEEnergyToBeDelivered" type="PhysicalValueType" minOccurs="0"/>

            </xs: sequence>

            </xs:extension>

</xs:complexContent>

</xs:complexType>

<!--                    -->

<!-- EV Power Delivery related types-->

<!--                    -->

<xs:complexType name="EVPowerDeliveryParameterType" abstract='true"/>

<xs:element name="EVPowerDeliveryParameter" type="EVPowerDeliveryParameterType"/>

<xs:element name="DC_EVPowerDeliveryParameter" type="DC_EVPowerDeliveryParameterType"
substitutionGroup="EVPowerDeliveryParameter"/>

<xs:complexType name="DC_EVPowerDeliveryParameterType">

<xs:complexContent>

       <xs:extension base="EVPowerDeliveryParameterType">

            <xs:sequence>

                <xs:element name="DC_EVStatus" type="DC_EVStatusType"/>

                <xs:element name="BulkChargingComplete" type="xs:boolean" minOccurs="0"/>

                <xs:element name="ChargingComplete" type="xs:boolean"/>

            </xs: sequence>

        </xs:extension>

</xs:complexContent>

</xs:complexType>
```

```
<!--                    -->
<!-- ChargingProfileType-->
<!--                    -->
<xs:complexType name="ChargingProfileType">
        <xs:sequence>
            <xs:element name='sAScheduleTupleID" type='sAIDType"/>
            <xs:element name="ProfileEntry" type="ProfileEntryType" maxOccurs="unbounded"/>
        </xs:sequence>
</xs:complexType>
<xs:complexType name="ProfileEntryType">
        <xs:sequence>
            <xs:element name="ChargingProfileEntryStart" type="xs:unsignedInt"/>
            <xs:element name="ChargingProfileEntryMaxPower" type="PMaxType"/>
        </xs: sequence>
</xs:complexType>
<!-- ===================    -->
<!-- Simple types-->
<!-- ===================    -->
<!--                  -->
<!-- General Types -->
<!--                  -->
<xs:simpleType name="PMaxType">
<xs:restriction base="xs:short"/>
</xs:simpleType>
<xs:simpleType name="percentValueType">
<xs:restriction base="xs:byte">
<xs:minInclusive value="0"/>
<xs:maxInclusive value="100"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="faultMsgType">
<xs:restriction base="xs:string">
<xs:maxLength value="64"/>
</xs:restriction>
</xs:simpleType>
```

```
<xs:simpleType name="EVSEProcessingType">
        <xs:restriction base="xs:string">
                <xs:enumeration value="Finished"/>
                <xs:enumeration value="Ongoing"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="EVSENotificationType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="None"/>
                <xs:enumeration value=‘stopCharging"/>
                <xs:enumeration value="ReNegotiation"/>
            </xs:restriction>
</xs:simpleType>
<!--          -->
<!-- service related types -->
<!--           -->
<xs:simpleType name=“serviceNameType">
             <xs:restriction base="xs:string">
                 <xs:maxLength value="32"/>
            </xs:restriction>
</xs:simpleType>
<xs:simpleType name=“serviceCategoryType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="EVCharging"/>
                <xs:enumeration value="Internet"/>
                <xs:enumeration value="ContractCertificate"/>
                <xs:enumeration value="OtherCustom"/>
            </xs:restriction>
</xs:simpleType>
<xs:simpleType name=“serviceScopeType">
      <xs:restriction base="xs:string">
        <xs:maxLength value="32"/>
      </xs:restriction>
</xs:simpleType>
<!--           -->
<!--  EnergyTransferType   -->
<!--           -->
```

```
<xs:simpleType name="EVSESupportedEnergyTransferType">
  :
        <xs:restriction base="xs:string">
            <xs:enumeration value="AC_single_phase_core"/>
            <xs:enumeration value="AC_three_phase_core"/>
            <xs:enumeration value="DC_core"/>
            <xs:enumeration value="DC_extended"/>
            <xs:enumeration value="DC_combo_core"/>
            <xs:enumeration value="DC_dual"/>
            <xs:enumeration value="AC_core1p_DC_extended"/>
            <xs:enumeration value="AC_single_DC_core"/>
            <xs:enumeration value="AC_single_phase_three_phase_core_DC_extended"/>
            <xs:enumeration value="AC_core3p_DC_extended"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="EVRequestedEnergyTransferType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="AC_single_phase_core"/>
            <xs:enumeration value="AC_three_phase_core"/>
            <xs:enumeration value="DC_core"/>
            <xs:enumeration value="DC_extended"/>
            <xs:enumeration value="DC_combo_core"/>
            <xs:enumeration value="DC_unique"/>
        </xs:restriction>
</xs:simpleType>
<!--                -->
<!-- security types-->
<!--                 -->
<xs:simpleType name="genChallengeType">
         <xs:restriction base="xs:string"/>
</xs:simpleType>
<xs:simpleType name="certificateType">
        <xs:restriction base="xs:base64Binary">
            <xs:maxLength value="1200"/>
        </xs:restriction>
</xs:simpleType>
```

```
<xs:simpleType name="rootCertificateIDType">
                        <xs:restriction base="xs:string">
                               <xs:maxLength value="40"/>
                        </xs:restriction>
</xs:simpleType>
                 <xs:simpleType name="dHParamsType">
                        <xs:restriction base="xs:base64Binary">
                               <xs:maxLength value="256"/>
                        </xs:restriction>
                 </xs:simpleType>
                 <xs:simpleType name="privateKeyType">
       <xs:restriction base="xs:base64Binary">
              <xs:maxLength value="128"/>
       </xs:restriction>
                 </xs:simpleType>
                 <xs:simpleType name='sigMeterReadingType">
       <xs:restriction base="xs:base64Binary">
              <xs:maxLength value="32"/>
       </xs:restriction>
                 </xs:simpleType>
                 <!--                          -->
                 <!-- Identification Numbers    -->
                 <!--                             -->
              <xs:simpleType
   name="sessionIDType">
     <xs:restriction base="xs:
                   hexBinary">
                               <xs:length value="8"/>
                        </xs:restriction>
                 </xs:simpleType>
                 <xs:simpleType name="evccIDType">
                        <xs:restriction base="xs:hexBinary">
                               <xs:maxLength value="8"/>
                        </xs:restriction>
                 </xs:simpleType>
                 <xs:simpleType name="evseIDType">
                        <xs:restriction base="xs:hexBinary">
```

```
            <xs:maxLength value="32"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="serviceIDType">
        <xs:restriction base="xs:unsignedShort"/>
    </xs:simpleType>
    <xs:simpleType name="contractIDType">
            <xs:restriction base="xs:string">
                <xs:maxLength value="24"/>
            </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="meterIDType">
            <xs:restriction base="xs:string">
                <xs:maxLength value="32"/>
            </xs:restriction>
        </xs:simpleType>
        <!--                    -->
        <!-- Tariffs and payment     -->
        <!--                         -->
        <xs:simpleType name='sAIDType">
            <xs:restriction base="xs:short"/>
        </xs:simpleType>
        <xs:simpleType name='tariffDescriptionType">
            <xs:restriction base="xs:string">
                <xs:maxLength value="32"/>
            </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="costKindType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="relativePricePercentage"/>
                <xs:enumeration value="RenewableGenerationPercentage"/>
                <xs:enumeration value="CarbonDioxideEmission"/>
            </xs:restriction>
        </xs:simpleType>
        <xs:complexType name="PaymentOptionsType">
            <xs:sequence>
```

```
                <xs:element name="PaymentOption" type="paymentOptionType" maxOccurs="unbounded"/>
            </xs: sequence>
        </xs:complexType>
        <xs:simpleType name="paymentOptionType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="Contract"/>
                <xs:enumeration value="ExternalPayment"/>
            </xs:restriction>
        </xs:simpleType>
        <!--                    -->
<!-- Fault and Response Codes        -->
        <!--                         -->
        <xs:simpleType name="faultCodeType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="ParsingError"/>
                <xs:enumeration value="NoTLSRootCertificatAvailable"/>
                <xs:enumeration value="UnknownError"/>
            </xs:restriction>
        </xs:simpleType>
        <xs:simpleType name="responseCodeType">
            <xs:restriction base="xs:string">
                <xs:enumeration value="OK"/>
                <xs:enumeration value="OK_NewSessionEstablished"/>
                <xs:enumeration value="OK_OldSessionJoined"/>
                <xs:enumeration value="OK_CertificateExpiresSoon"/>
                <xs:enumeration value="FAILED"/>
                <xs:enumeration value="FAILED_SequenceError"/>
                <xs:enumeration value="FAILED_ServiceIDInvalid"/>
                <xs:enumeration value="FAILED_UnknownSession"/>
                <xs:enumeration value="FAILED_ServiceSelectionInvalid"/>
                <xs:enumeration value="FAILED_PaymentSelectionInvalid"/>
                <xs:enumeration value="FAILED_CertificateExpired"/>
                <xs:enumeration value="FAILED_SignatureError"/>
                <xs:enumeration value="FAILED_NoCertificateAvailable"/>
                <xs:enumeration value="FAILED_CertChainError"/>
                <xs:enumeration value="FAILED_ChallengeInvalid"/>
                <xs:enumeration value="FAILED_ContractCanceled"/>
```

```
                <xs:enumeration value="FAILED_WrongChargeParameter"/>
                <xs:enumeration value="FAILED_PowerDeliveryNotApplied"/>
                <xs:enumeration value="FAILED_TariffSelectionInvalid"/>
                <xs:enumeration value="FAILED_ChargingProfileInvalid"/>
                <xs:enumeration value="FAILED_EVSEPresentVoltageToLow"/>
                <xs:enumeration value="FAILED_MeteringSignatureNotValid"/>
                <xs:enumeration value="FAILED_WrongEnergyTransferType"/>
            </xs:restriction>
        </xs:simpleType>
:
    <!--                   -->
    <!-- Multiplier and Unit Types -->
    <!--                        -->
    <xs:simpleType name="unitMultiplierType">
        <xs:restriction base="xs:byte">
            <xs:minInclusive value="-3"/>
            <xs:maxInclusive value="3"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="unitSymbolType">
        <xs:restriction base="xs:string">
  <xs:enumeration value="h">
      <xs:annotation>
          <xs:documentation>Time in hours</xs:documentation>
      </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="m">
                <xs:annotation>
                    <xs:documentation>Time in minutes</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value='s">
                <xs:annotation>
                    <xs:documentation>Time in seconds</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
```

```xml
<xs:enumeration value="A">

    <xs:annotation>
        <xs:documentation>Current in Ampere</xs:documentation>
    </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="Ah">
                <xs:annotation>
                    <xs:documentation>Ampere hour</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="V">
                <xs:annotation>
                    <xs:documentation>Voltage in Volt</xs:documentation>
                </xs:annotation>

            </xs:enumeration>
            <xs:enumeration value="VA">
                <xs:annotation>
                    <xs:documentation>Apparent power in Volt Ampere</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="W">
                <xs:annotation>
                    <xs:documentation>Active power in Watt</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="W/s">
                <xs:annotation>
                    <xs:documentation>Watt per second</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
            <xs:enumeration value="Wh">
                <xs:annotation>
                    <xs:documentation>Real energy in Watt hours</xs:documentation>
                </xs:annotation>
            </xs:enumeration>
```

```
</xs:restriction>
</xs:simpleType>
<!--                    -->
<!-- only DC related  -->
<!--                    -->
<xs:simpleType name="DC_EVSEStatusCodeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="EVSE_NotReady"/>
        <xs:enumeration value="EVSE_Ready"/>
        <xs:enumeration value="EVSE_Shutdown"/>
        <xs:enumeration value="EVSE_UtilityInterruptEvent"/>
        <xs:enumeration value="EVSE_IsolationMonitoringActive"/>
        <xs:enumeration value="EVSE_EmergencyShutdown"/>
        <xs:enumeration value="EVSE_Malfunction"/>
        <xs:enumeration value="Reserved_8"/>
            <xs:enumeration value="Reserved_9"/>
            <xs:enumeration value="Reserved_A"/>
            <xs:enumeration value="Reserved_B"/>
            <xs:enumeration value="Reserved_C"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="isolationLevelType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="Invalid"/>
            <xs:enumeration value='safe"/>
            <xs:enumeration value="Warning"/>
            <xs:enumeration value="Fault"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="DC_EVErrorCodeType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="NO_ERROR"/>
            <xs:enumeration value="FAILED_RESSTemperatureInhibit"/>
            <xs:enumeration value="FAILED_EVShiftPosition"/>
            <xs:enumeration value="FAILED_ChargerConnectorLockFault"/>
            <xs:enumeration value="FAILED_EVRESSMalfunction"/>
            <xs:enumeration value="FAILED_ChargingCurrentdifferential"/>
```

```
<xs:enumeration value="FAILED_ChargingVoltageOutOfRange"/>        <xs:enumeration
value="Reserved_A"/>

<xs:enumeration value="Reserved_B"/>

<xs:enumeration value="Reserved_C"/>

<xs:enumeration value="FAILED_ChargingSystemIncompatibility"/>        <xs:enumeration
value="NoData"/>

</xs:restriction>

</xs:simpleType>

</xs:schema>
```

E.7 XMLDSIG-CORE-SCHEMA.XSD

```
<?xml version="1.0" encoding="UTF-8"?>

<!DOCTYPE schema PUBLIC "-//W3C//DTD XMLSchema 200102//EN" "http://www.w3.org/2001/XMLSchema.dtd" [

<!ATTLIST schema

  xmlns:ds CDATA #FIXED "http://www.w3.org/2000/09/xmldsig#">

 <!ENTITY dsig "http://www.w3.org/2000/09/xmldsig#">

 <!ENTITY % p "">

 <!ENTITY % s "">

]>

<!-- Schema for XML Signatures

  http://www.w3.org/2000/09/xmldsig#

  $Revision: 1.1 $ on $Date: 2002/02/08 20:32:
  26 $ by $Author: reagle $ Copyright 2001 The I
  nternet Society and W3C (Massachusetts I
  nstitute

of Technology, Institut National de Recherche
  en Informatique et en Automatique, Keio
  University). All Rights Reserved.

  http://www.w3.org/Consortium/Legal/

  This document is governed by the W3C
Software License [1] as described in the FAQ [2].

  [1] http://www.w3.org/Consortium/Legal/copyright-software-19980720

  [2] http://www.w3.org/Consortium/Legal/IPR-FAQ-20000620.html#DTD

-->

<schema xmlns="http://www.w3.org/2001/XMLSchema" xmlns:ds="http://www.w3.
org/2000/09/xmldsig#" targetNamespace="http://www.w3.org/2000/09/xmldsig#"
elementFormDefault="qualified" version="0.1">

    <!-- Basic Types Defined for Signatures -->

    <simpleType name="CryptoBinary">
```

```
<restriction base="base64Binary"/>
</simpleType>
<!-- Start Signature -->
<element name='signature" type="ds:SignatureType"/>
<complexType name='signatureType">
<sequence>
<element ref="ds:SignedInfo"/>
<element ref="ds:SignatureValue"/>
<element ref="ds:KeyInfo" minOccurs="0"/>
<element ref="ds:Object" minOccurs="0" maxOccurs="unbounded"/>
</sequence>
<attribute name="Id" type="ID" use="optional"/>
</complexType>
<element name='signatureValue" type="ds:SignatureValueType"/>
<complexType name='signatureValueType">
<simpleContent>
<extension base="base64Binary">
<attribute name="Id" type="ID" use="optional"/>
</extension>
</simpleContent>
</complexType>
<!-- Start SignedInfo -->
<element name='signedInfo" type="ds:SignedInfoType"/>
<complexType name='signedInfoType">
<sequence>
<element ref="ds:CanonicalizationMethod"/>
<element ref="ds:SignatureMethod"/>
<element ref="ds:Reference" maxOccurs="unbounded"/>
</sequence>
<attribute name="Id" type="ID" use="optional"/>
</complexType>
<element name="CanonicalizationMethod" type="ds:CanonicalizationMethodType"/>
<complexType name="CanonicalizationMethodType" mixed='true">
<sequence>
<any namespace="##any" minOccurs="0" maxOccurs="unbounded"/>
```

```
            <!-- (0,unbounded) elements from (1,1) namespace -->
        </sequence>
        <attribute name="Algorithm" type="anyURI" use="required"/>
</complexType>
<element name=‘signatureMethod" type="ds:SignatureMethodType"/>
<complexType name=‘signatureMethodType" mixed=‘true">
        <sequence>
            <element name="HMACOutputLength" type="ds:HMACOutputLengthType" minOccurs="0"/>
            <any namespace="##other" minOccurs="0" maxOccurs="unbounded"/>
            <!-- (0,unbounded) elements from (1,1) external namespace -->
        </sequence>
        <attribute name="Algorithm" type="anyURI" use="required"/>
</complexType>
<!-- Start Reference -->
<element name="Reference" type="ds:ReferenceType"/>
<complexType name="ReferenceType">
        <sequence>
            <element ref="ds:Transforms" minOccurs="0"/>
            <element ref="ds:DigestMethod"/>
            <element ref="ds:DigestValue"/>
        </sequence>
        <attribute name="Id" type="ID" use="optional"/>
        <attribute name="URI" type="anyURI" use="optional"/>
        <attribute name=‘type" type="anyURI" use="optional"/>
</complexType>
<element name=‘transforms" type="ds:TransformsType"/>
<complexType name=‘transformsType">
        <sequence>
            <element ref="ds:Transform" maxOccurs="unbounded"/>
        </sequence>
</complexType>
<element name=‘transform" type="ds:TransformType"/>
<complexType name=‘transformType" mixed=‘true">
        <choice minOccurs="0" maxOccurs="unbounded">
            <any namespace="##other" processContents="lax"/>
            <!-- (1,1) elements from (0,unbounded) namespaces -->
            <element name="XPath" type=‘string"/>
```

```
</choice>
<attribute name="Algorithm" type="anyURI" use="required"/>
</complexType>
<!-- End Reference -->
<element name="DigestMethod" type="ds:DigestMethodType"/>
<complexType name="DigestMethodType" mixed='true">
<sequence>
<any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
</sequence>
<attribute name="Algorithm" type="anyURI" use="required"/>
</complexType>
<element name="DigestValue" type="ds:DigestValueType"/>
<simpleType name="DigestValueType">
<restriction base="base64Binary"/>
</simpleType>
<!-- End SignedInfo -->
<!-- Start KeyInfo -->
<element name="KeyInfo" type="ds:KeyInfoType"/>
<complexType name="KeyInfoType" mixed='true">
<choice maxOccurs="unbounded">
<element ref="ds:KeyName"/>
<element ref="ds:KeyValue"/>
<element ref="ds:RetrievalMethod"/>
<element ref="ds:X509Data"/>
<element ref="ds:PGPData"/>
<element ref="ds:SPKIData"/>
<element ref="ds:MgmtData"/>
<any namespace="##other" processContents="lax"/>
<!-- (1,1) elements from (0,unbounded) namespaces -->
</choice>
<attribute name="Id" type="ID" use="optional"/>
</complexType>
<element name="KeyName" type='string"/>
<element name="MgmtData" type='string"/>
<element name="KeyValue" type="ds:KeyValueType"/>
<complexType name="KeyValueType" mixed='true">
```

```
        <choice>
            <element ref="ds:DSAKeyValue"/>
            <element ref="ds:RSAKeyValue"/>
            <any namespace="##other" processContents="lax"/>
            </choice>
            </complexType>
<element name="RetrievalMethod" type="ds:RetrievalMethodType"/>
<complexType name="RetrievalMethodType">
        <sequence>
            <element ref="ds:Transforms" minOccurs="0"/>
        </sequence>
        <attribute name="URI" type="anyURI"/>
        <attribute name=‘type" type="anyURI" use="optional"/>
</complexType>
<!-- Start X509Data -->
<element name="X509Data" type="ds:X509DataType"/>
<complexType name="X509DataType">
        <sequence    maxOccurs="unbounded">
            <choice>
                <element name="X509IssuerSerial" type="ds:X509IssuerSerialType"/>
                <element name="X509SKI" type="base64Binary"/>
                <element name="X509SubjectName" type=‘string"/>
                <element name="X509Certificate" type="base64Binary"/>
                <element name="X509CRL" type="base64Binary"/>
                <any namespace="##other" processContents="lax"/>
            </choice>
        </sequence>
</complexType>
<complexType name="X509IssuerSerialType">
        <sequence>
            <element name="X509IssuerName" type=‘string"/>
            <element name="X509SerialNumber" type="integer"/>
        </sequence>
</complexType>
<!-- End X509Data -->
<!-- Begin PGPData -->
<element name="PGPData" type="ds:PGPDataType"/>
```

```
<complexType name="PGPDataType">
  <choice>
    <sequence>
      <element name="PGPKeyID" type="base64Binary"/>
      <element name="PGPKeyPacket" type="base64Binary" minOccurs="0"/>
      <any namespace="##other" processContents="lax" minOccurs="0"
      maxOccurs="unbounded"/>
    </sequence>
    <sequence>
      <element name="PGPKeyPacket" type="base64Binary"/>
      <any namespace="##other" processContents="lax" minOccurs="0"
      maxOccurs="unbounded"/>
    </sequence>
  </choice>
:
</complexType>
<!-- End PGPData -->
<!-- Begin SPKIData -->
<element name='sPKIData" type="ds:SPKIDataType"/>
<complexType name='sPKIDataType">
  <sequence   maxOccurs="unbounded">
    <element name='sPKISexp" type="base64Binary"/>
    <any namespace="##other" processContents="lax" minOccurs="0"/>
  </sequence>
</complexType>
<!-- End SPKI Data -->
<!-- End KeyInfo -->
<!-- Start Object (Manifest, SignatureProperty) -->
<element name="Object" type="ds:ObjectType"/>
<complexType name="ObjectType" mixed='true">
  <sequence minOccurs="0" maxOccurs="unbounded">
    <any namespace="##any" processContents="lax"/>
  </sequence>
  <attribute name="Id" type="ID" use="optional"/>
  <attribute name="MimeType" type='string" use="optional"/>
  <attribute name="Encoding" type="anyURI" use="optional"/>
  <!-- add a grep facet -->
```

```
</complexType>
<element name="Manifest" type="ds:ManifestType"/>
<complexType name="ManifestType">
    <sequence>
        <element ref="ds:Reference" maxOccurs="unbounded"/>
    </sequence>
    <attribute name="Id" type="ID" use="optional"/>
</complexType>
<element name=‘signatureProperties" type="ds:SignaturePropertiesType"/>
<complexType name=‘signaturePropertiesType">
    <sequence>
        <element ref="ds:SignatureProperty" maxOccurs="unbounded"/>
    </sequence>
    <attribute name="Id" type="ID" use="optional"/>
</complexType>
<element name=‘signatureProperty" type="ds:SignaturePropertyType"/>
<complexType name=‘signaturePropertyType" mixed=‘true">
    <choice maxOccurs="unbounded">
        <any namespace="##other" processContents="lax"/>
        <!-- (1,1) elements from (1,unbounded) namespaces -->
    </choice>
    <attribute name=‘target" type="anyURI" use="required"/>
    <attribute name="Id" type="ID" use="optional"/>
</complexType>
<!-- End Object (Manifest, SignatureProperty) -->
<!-- Start Algorithm Parameters -->
<simpleType name="HMACOutputLengthType">
    <restriction base="integer"/>
</simpleType>
<!-- Start KeyValue Element-types -->
<element name="DSAKeyValue" type="ds:DSAKeyValueType"/>
<complexType name="DSAKeyValueType">
    <sequence>
        <sequence minOccurs="0">
            <element name="P" type="ds:CryptoBinary"/>
            <element name="Q" type="ds:CryptoBinary"/>
        </sequence>
```

```
                <element name="G" type="ds:CryptoBinary" minOccurs="0"/>


                <element name="Y" type="ds:CryptoBinary"/>
                <element name="J" type="ds:CryptoBinary" minOccurs="0"/>
                <sequence minOccurs="0">
                    <element name='seed" type="ds:CryptoBinary"/>
                    <element name="PgenCounter" type="ds:CryptoBinary"/>
                </sequence>
            </sequence>
        </complexType>
        <element name="RSAKeyValue" type="ds:RSAKeyValueType"/>
        <complexType name="RSAKeyValueType">
            <sequence>
                <element name="Modulus" type="ds:CryptoBinary"/>
                <element name="Exponent" type="ds:CryptoBinary"/>
            </sequence>
        </complexType>
        <!-- End KeyValue Element-types -->
        <!-- End Signature -->  </schema
```

APPENDIX F - TEST PROCEDURE

F.1 Introduction

F.1 .1 Background/Rationale

The testing appendix applies to all products included in the IS 17017-3-1 Recommended Practice. The intent of this appendix is to define the proper methodology for evaluating safe charging systems. The overall test regime can be found in Appendices G and H for an overview and results table, respectively.

F.2 General

F.2.1 Atmospheric

All testing, unless otherwise specified, shall be conducted in standard temperature and pressure.

F.2.2 Specimen Condition

Unless otherwise specified, test specimens shall be unused and assembled to the manufacturer's recommendations. The test specimen shall conform to all internal quality specifications.

Individual components, or subsystems, may be evaluated where noted.

F.2.3 Number of Specimens

The number or specimens shall be one, unless otherwise specified.

F.2.4 Calibration of Equipment

Calibration of equipment shall be current per the test equipment manufacturer's recommendations.

F.2.5 Failure Criteria

The product shall comply with the failure criteria outlined in the respective sections. Specimens are deemed not to comply with this standard if they do not conform to any test. If the product fails initial testing, a retest is permissible. The new specimens shall pass the repeated tests, otherwise the product is deemed not to comply.

F.2.6 Visual Examinations

All visual examinations shall be performed with the naked eye, unless otherwise specified.

F.3 Validation

F.3.1 Markings

Visual confirmation shall be made that all markings are clearly legible and in their appropriate location.

F.3.2 Creepage and Clearance Dimensions

Minimum creepage and clearance distances to maintain safety shall be confirmed per IEC 60664, UL 2202, or UL 840.

F.3.3 Cable Sizing

Cable sizing shall be confirmed to comply with the existing manufacturer's specification.

F.3.4 Unimpeded Movement

The ACD shall be fully extended and fully retracted at normal operating speed to confirm that normal movement is not impeded.

F.3.5 Cable Fixation

All cable terminations shall be confirmed to be fastened to their respective terminals and torqued to their intended value by means of a calibrated torque wrench.

F.3.6 Unintentional Power Loss to Actuator

Under accidental power loss to the ACD actuator, the EV supply equipment shall perform an emergency stop. The unit shall fully retract to its home position within 60 seconds automatically or, if manually actuated, within 5 minutes.

F.3.7 Nominal Static Force Test

The ACD shall be confirmed to supply a force within its given specification. The ACD shall be extended to its normal mated position. The force shall then be validated on each individual contact surface.

For pin and socket applications, the assembly shall be confirmed to be fully inserted.

F.3.8 Duration of Actuation

The ACD shall be confirmed to move from the home position to full extension within the specifications of the supplier. The ACD shall be confirmed to move from full extension to the home position within the specification of the supplier.

F.4.1 Electrical

F.4.1 .1 Contact Resistance

The system shall be evaluated per IEC 60512-2-2. Contact resistance shall be determined through testing and used as an evaluation for acceptance of the connection before and after tests. One sample shall be used to verify the contact resistance in the new state.

The measurements points shall be as close to the contact points as possible, not to exceed 10 mm. If the contact area is not easily accessible, the measurement points can be moved, so long as the bulk resistivity of the conductor is removed from the overall resistance measurement. Bulk resistivity can be calculated from the following equation:

$$R = \frac{\rho l}{A}$$

where:

R = overall resistance

ρ = resistivity of material

l = length of material

A = cross sectional area

The measuring current shall be nominal operating current, or 1 0 A if the nominal operating current is not yet determined or otherwise specified.

The allowable initial contact resistance in the new state is determined by the contact resistance in the temperature rise testing or derating testing.

F.4.1.2 Dielectric Withstand

The ACD assembly shall be confirmed to withstand the necessary test voltage using a power unit, supplying an essentially sinusoidal wave form at 50 to 60 Hz. The applied voltage shall be increased by no more than 500 V/s until the maximum voltage is reached. There is no requirement for the ramp down of voltage.

The ACD equipment shall be configured in a manner to allow for the applied voltage to reach all components for which the voltage was designed. Components not designed or intended to be introduced to higher voltages need not be connected to the test circuit. Low voltage components should be present to best represent possible fault paths.

The applied test voltage shall be two times (U + 1 200 V) for 1 minute.

No breakdown or flash over shall occur. There shall be no deformation or degradation of parts that would inhibit normal use or compromise of safety.

F.4.1.3 Insulation Resistance

The system shall be tested per IEC 60512-3-1, Method B. The insulation resistance shall be measured at 500 VDC applied between all inputs/outputs connected together, including the power source, and the accessible parts shall be >5 MΩ. Circuits not designed to accommodate the applied voltage can be omitted. Testing should be carried out with protective impedances omitted.

The test voltage shall be applied for 1 minute. The final reading shall be taken only when the reading is stable.

Insulation resistance readings below 5 MΩ are considered to be a failure.

F.4.1.4 Derating

Three specimens shall be evaluated for derating per IEC 60512-5-2 to determine the temperature rise values under defined ambient conditions and applied load. This test will allow the end user to accurately specify the contact resistance across the upper temperature working range and to apply those limits to subsequent tests.

If the upper current limit of the device is not known, this test should be executed first to determine the maximum current carrying ability at the upper ambient temperature.

Thermal measurements shall be taken at the crimp areas, as close to the contact points as possible (not to exceed 2 mm), and at the center point of the cable runs. Measurement devices shall have a thermal mass small enough to not affect the heat rise of the unit. Voltage drop shall be monitored during the steady state temperature of the system, at a minimum using the technique in 4.1 .1.

The unit shall be mounted in a manner analogous to its end use application. Measures shall be taken to limit the heat transfer to the surrounding area through the mounting points.

The wire size for connection of the ACD to the power supplies shall be equal in size to the connection wires of the device.

At a minimum, the least 1 .4 m of conductor attached to the ACD shall meet this requirement. Circuits not intended to receive nominal current can be omitted.

The upper ambient temperature to be evaluated shall be 55 °C.

Upon completion of this test, the contact resistance shall be determined from the voltage drop across the connection. The contact resistance that yields maximum temperature shall be considered the failure criteria for subsequent tests. A factor of 0.8 shall be applied to the upper limit of the current rating, unless otherwise specified by the manufacturer, up to a factor of 0.9. This value shall be used as the upper limit for rating purposes of the system.

F.4.1.5 Temperature Rise

The ACD shall be tested per IEC 60512-5-1. The system shall be introduced to its nominal operating current to determine the resultant temperature rise of the fully assembled system. A single, fully assembled ACD unit shall be used to validate the performance.

The specimen should be wired with a minimum of 1 .4 m at the power supply connection to the ACD. Circuits not intended to receive nominal current load can be omitted.

Means to determine voltage drop across the connection point shall be implemented per 4.1.1.

The supply current shall be applied to all contacts of the specimen simultaneously for a period of at least one-hour after steady state conditions have occurred. Steady state is defined as three consecutive temperature measurements, taken 5 minutes apart, not exceeding 2 °C.

Thermal measurements shall be taken at the crimp areas, as close to the contact points as possible (not to exceed 2 cm) and at the center point of the cable runs. Measurements devices shall have a thermal mass small enough to not affect the heat rise of the unit. Voltage drop shall be monitored during the steady state temperature of the system using the requirements of 4.1.1.

Under nominal load the device shall not produce temperatures that would adversely affect the surrounding materials or impair any safety or continued function of the unit. The maximum contact resistance shall be determined per 4.1.1.

F.4.1.6 Reliability of PE Contact

The specimen shall be tested per IEC 61984, section 7.3.1.3, to determine the quality of the protective earth contact. A current of 25 A from a source having an open voltage of 12 V, maximum, shall be applied through each accessible live part and the protective earth contact.

The test shall be carried out on a fully engaged system at nominal working force for that system type.

Resistance from accessible live parts to earth ground shall not exceed 0.1 Ω.

F.4.2 Mechanical

F.4.2.1 Endurance Test with Intermittent Load

A single, fully assembled ACD shall withstand the mechanical, electrical, and thermal stresses occurring in normal use.

The ACD unit shall be fully extended in the intended manner to emulate its normal operation and then completely withdrawn, either manually or automatically. The ACD shall be actuated at nominal operating speed.

Initial voltage drop measurements should be taken before the start of test per 4.1.1 and at intervals of 1000 mating cycles.

The applied current shall be 10 A. The measured voltage drop shall be projected to represent the voltage drop value at full load. Voltage drop shall be measured and recorded. The application of voltage need only be sufficient to pass the nominal current. I f at any point the contact resistance, derived from the measured voltage drop, exceeds the upper limit, the test shall be stopped.

A cycle consists of a single actuation and retraction cycle.

The test shall be conducted using DC current.

The CP should be included in the endurance testing at nominal operating current or 1 A.

After the test, the ACD shall successfully complete 4.1 .6., reliability of PE contact.

During test, no sustained arcing shall occur. After test, the devices shall not show:

a) Wear impairing further use of the device.
b) Deterioration of enclosures or barriers that would sacrifice the safety of operation.
c) Wear or damage to the electrical contacts resulting in a voltage drop that exceeds the values set in 4.1 .4.
d) Loosening of the mechanical or electrical connections.

F.4.3 Environmental

F.4.3.1 Thermal Cycling

The specimen shall be subjected to a change of temperature test per IEC 60068-2-1 4, test Nb. The specimen shall be subjected to a preconditioning of 2 hours at 25 °C (±5 °C). Contact resistance shall be evaluated before start of test per 4.1.4.

The test shall be comprised of the following parameters:

a) Cycles: 1 0
b) Lower Temperature, TA: -40 °C (±3 °C)
c) Upper temperature, TB: 55 °C (±3 °C)
d) Exposure time, t1: 2 hours, minimum
e) Ambient temperature rate of change: 2 °C/min ± 1 °C/min

During the increase and maintenance at the upper temperature, the unit shall be subjected to its nominal rated current.

The specimen shall be mounted in a manner analogous to its end use application that limits the transfer of heat through the mounting points.

Final measurements shall be taken after the specimen has remained at ambient laboratory conditions for at least 2 hours.

After conditioning, the unit shall be subjected to contact resistance, dielectric, and insulation resistance testing per 4. 1 .1, 4.1 .2, and 4. 1 .3, respectively.

F.4.3.2 Damp Heat

The specimen shall be subjected to damp heat conditioning per IEC 60068-2-30 to determine its performance under damp heat environmental conditions. The unit shall undergo 12 cycles per test Db. Variant 1 and Variant 2 are permissible. The specimen shall be subjected to a preconditioning of 2 hours at 25 °C (±5 °C). Contact resistance shall be evaluated before start of test per 4. 1 .4.

The test shall be subjected to the contact resistance test per 4.1 .1 before the start of test.

The test shall be comprised of the following parameters:

a) Upper Temperature: 55 °C (±3 °C)
b) Lower Temperature: 25 °C (±3 °C)
c) Exposure time: 12 hours, minimum.

During test the unit shall be mounted in a manner analogous to its end use application.

After conditioning, the unit shall be subjected to contact resistance, dielectric, and insulation resistance testing per 4. 1 .1, 4.1 .2, and 4. 1 .3, respectively. Insulation resistance testing shall be completed within 8 hours after conditioning.

F.4.3.3 Resistance to Corrosion

The specimen shall be subjected to a salt spray test per IEC 60068-2-11. The salt spray test will determine the corrosive influence of normal operation and storage environments. Only specimens that are susceptible to salt corrosion are required to be evaluated. At a minimum, all contact elements subjected to the nominal power loads shall be tested. Contact resistance shall be evaluated before start of test per 4.1 .4.

The total duration shall be 672 hours (28 days).

After conditioning, the unit shall be subjected to contact resistance, dielectric, and insulation resistance testing per 4. 1 .1, 4.1 .2, and 4. 1 .3, respectively. Insulation resistance testing shall be completed within 8 hours after conditioning.

F.4.3.4 Ingress Protection

Ingress protection shall be evaluated to the stated protection level per IEC 60529 or UL 50. Table F.1 specifies the minimum IP ratings required for the major components of the system.

TABLE F.1 – IP RATINGS FOR ACD SYSTEM COMPONENTS

S.no	Component	Minimum required IP rating
1	HV Terminal box	IP 66
2	Heater Terminal box	IP 66
3	Drive unit	IP 65

APPENDIX G - TEST OVERVIEW

The table below can be used to evaluate the general requirements of the tests. This table should be used as an overview and quick reference guide to determine when to perform which tests and the requirements of those tests. The order presented below should be used as a guideline for the order of test.

Section	Evaluation	Standard	Description	Assessment Criteria	Type Test	Serial Test
F.3.1	Markings		Visual examination.	Markings present and clearly legible.	X	X
F.3.2	Creepage		Dimensional evaluation.	All distances must conform to minimum required spacings.	X	X
F.3.3	Cable Sizing		Sizing evaluation.	All cables shall be properly sized for the rated load.	X	X
F.3.4	Unimpeded Movement		Movement of the ACD unit.	ACD shall move to the maximum extension and retraction without being hindered.	X	X
F.3.5	Cable Fixation		Installment of cable in their appropriate locations.	Cables shall be fixed to their appropriate locations and torqued to their intended values.	X	X
F.3.6	Unintentional Power Loss		Retraction to home after power loss.	ACD shall be able to be fully retracted to home after power failure.	X	X
F.3.7	Nominal Static Force		Normal force validation/complete insertion.	ACD shall provide its intended normal force or be fully inserted.	X	X
F.3.8	Duration of Actuation		Time to move to and from home position.	ACD shall move from home to full extension and back within the specified time or be fully mated.	X	X
F.4.1.1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		X
F.4.1.5	Temperature Rise	IEC 6051 2-5-1	Evaluation of the temperature rise at ambient temperature.	Verification that upper temperature limits and contact resistance is not exceeded.		X
F.4.1.1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.	X	

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F.4.1.2	Dielectric Withstand	IEC61 851 -1 section 12.7	Applied test voltage to be (Un + 1200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.	X	
F.4.1.3	Insulation R	I EC60309-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.	X	

Section	Evaluation	Standard	Description	Assessment Criteria	Type Test	Serial Test
F.4.2.1	Endurance with Intermittent Load		Evaluation of the mechanical life of the unit from cycling.	. Wear impairing further use of the device. . Deterioration of enclosures or barriers that would sacrifice the safety of operation. . Wear or damage to the electrical contacts resulting in a voltage drop of >50 mV. . Loosening of the mechanical or electrical connections. . Voltage drop shall not exceed the values set in 5.2.	X	
F.4.1.6	Reliability of PE Contact	IEC61 984	Apply current of 25 A between each accessible live part and ground.	Resistance from accessible live part to ground shall not exceed 0.1 mΩ.	X	
F.4.1.1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.	X	X
F.4.3.2	Damp Heat Test	IEC 60068-2-30	Evaluation of performance under high humidity environments.	No degradation of materials that would impair the functionality and safety of the part. Contact resistance, dielectric withstand, and insulation resistance pass per their respective requirements.	X	X
F.4.1.1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.	X	X

F.4.1 .2	Dielectric Withstand	IEC 61 851 -1 section 12.7	Applied test voltage to be (Un + 1200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.	X	X
F.4.1 .3	Insulation R	IEC 60309-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.	X	X
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.	X	

Section	Evaluation	Standard	Description	Assessment Criteria	Type Test	Serial Test
F.4.3.3	Resistance to Corrosion	IEC 60068-2-52	Evaluation of material and electrical performance under high salt atmospheres.	No degradation of materials that would impair the functionality and safety of the part. Contact resistance, dielectric withstand, and insulation resistance pass per their respective requirements.	X	
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.	X	
F.4.1 .2	Dielectric Withstand	IEC 61 851 -1 section 12.7	Applied test voltage to be (Un + 1200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.	X	
F.4.1 .3	Insulation R	IEC 60309-1	Apply 500V AC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.	X	
F.4.3.4	Ingress Protection	IEC 60529 or UL 50e	Protection from ingress of foreign objects.	Evaluation of environmental protection per the relevant standard.	X	X

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APPENDIX H - TEST RESULTS

The tables below can be used to collect results and catalogue comments during the execution and finalization of each test. The order presented below should be used as a guideline for the order of test.

Section	Evaluation	Standard	Description	Assessment Criteria	Results	Comments
F.3.1	Markings		Visual examination.	Markings present and clearly legible.		
F.3.2	Creepage		Dimensional evaluation.	All distances must conform to minimum required spacings.		
F.3.3	Cable Sizing		Sizing evaluation.	All cables shall be properly sized for the rated load.		
F.3.4	Unimpeded Movement		Movement of the ACD unit.	ACD shall move to the maximum extension and retraction without being hindered.		
F.3.5	Cable Fixation		Installment of cable in their appropriate locations.	Cables shall be fixed to their appropriate locations and torqued to their intended values.		
F.3.6	Unintentional Power Loss		Retraction to home after power loss.	ACD shall be able to be fully retracted to home after power failure.		
F.3.7	Nominal Static Force		Normal force validation/complete insertion.	ACD shall provide its intended normal force or be fully inserted.		
F.3.8	Duration of Actuation		Time to move to and from home position.	ACD shall move from home to full extension and back within the specified time or be fully mated.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.1 .4	Derating	IEC 6051 2-5-2	Evaluation of the temperature rise at increasing ambient temperatures.	0.8 reduction factor applied after execution of test.		

F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.1 .5	Temperature Rise	IEC 6051 2-5-1	Evaluation of the temperature rise at ambient temperature.	Verification that upper temperature limits and contact resistance is not exceeded.		

Section	Evaluation	Standard	Description	Assessment Criteria	Results	Comments
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.1 .2	Dielectric Withstand	IEC61 851 -1 section 12.7	Applied test voltage to be (Un + 1 200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.		
F.4.1 .3	Insulation R	I EC60309-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.		
F.4.2.1	Endurance with Intermittent Load		Evaluation of the mechanical life of the unit from cycling.	. Wear impairing further use of the device. . Deterioration of enclosures or barriers that would sacrifice the safety of operation. . Wear or damage to the electrical contacts resulting in a voltage drop of >50 mV. . Loosening of the mechanical or lectrical connections. e. Voltage drop shall not exceed the values set in 5.2.		
F.4.1 .6	Reliability of PE Contact	IEC61 984	Apply current of 25 A between each accessible live part and ground.	Resistance from accessible live part to ground shall not exceed 0.1 mΩ.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		

F.4.3.1	Thermal Cycling	IEC 60068-2-1 4, Test Nb	Evaluation of performance across the allowable ambient temperature range.	No degradation of materials that would impair the functionality and safety of the part. Contact resistance, dielectric withstand, and insulation resistance pass per their respective requirements.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		

Section	Evaluation	Standard	Description	Assessment Criteria	Results	Comments
F.4.1 .2	Dielectric Withstand	IEC 61 851 -1 section 1 2.7	Applied test voltage to be (Un + 1 200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.		
F.4.1 .3	Insulation R	IEC 6051 2-3-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.3.2	Damp Heat Test	IEC 60068-2-30	Evaluation of performance under high humidity environments.	No degradation of materials that would impair the functionality and safety of the part. Contact resistance, dielectric withstand, and insulation resistance pass per their respective requirements.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.1 .2	Dielectric Withstand	IEC 61 851 -1 section 1 2.7	Applied test voltage to be (Un + 1 200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.		
F.4.1 .3	Insulation R	IEC 60309-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.		

F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		
F.4.3.3	Resistance to Corrosion	IEC 60068-2-52	Evaluation of material and electrical performance under high salt atmospheres.	No degradation of materials that would impair the functionality and safety of the part. Contact resistance, dielectric withstand, and insulation resistance pass per their respective requirements.		
F.4.1 .1	Contact Resistance	IEC 6051 2-5-2	Evaluation of the voltage drop at the contact interface at rated load.	Determination of contact resistance from measured voltage drop.		

Section	Evaluation	Standard	Description	Assessment Criteria	Results	Comments
F.4.1 .2	Dielectric Withstand	IEC 61 851 -1 section 12.7	Applied test voltage to be (Un + 1 200 V) x 2 to validate material resistance to insulation breakdown.	No flashover or breakdown of the insulating material may occur.		
F.4.1 .3	Insulation R	IEC 60309-1	Apply 500 VAC to determine resistance of insulation.	Minimum insulation resistance to be >5 MΩ.		
F.4.3.4	Ingress Protection	IEC 60529 or UL 50e	Protection from ingress of foreign objects.	Evaluation of environmental protection per the relevant standard.		

Preliminary Draft Indian Standard

ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES

Infrastructure – mounted pantograph (cross rail) connection

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Preliminary Draft Indian Standard

ELECTRIC VEHICLE POWER TRANSFER SYSTEM USING CONDUCTIVE AUTOMATED CONNECTION DEVICES

Infrastructure – mounted pantograph (cross rail) connection

1 SCOPE

1.1 This document details one of the connections of the IS 17017-3-1 document. The connections are referenced in the scope of the main document IS 17017-3-1. IS 17017-3-2 details the infrastructure-mounted pantograph, or cross-rail connection. All the common requirements are defined in the main document; the current document provides the details of the connection.

1.2 This document covers the connection interface relevant requirements for an electric vehicle power transfer system using a conductive ACD based on a cross-rail design. To allow interoperability for on-road vehicles (in particular, buses and coaches), one configuration is described in this document. Other configurations may be used for non-standard applications (for example, mining trucks or port vehicles).

2 REFERENCES

Refer to the main IS 17017-3-1 Recommended Practice.

3 DEFINITIONS

Refer to the main IS 17017-3-1 Recommended Practice.

4 ABBREVIATIONS AND SYMBOLS (ALL)

Refer to the main IS 17017-3-1 Recommended Practice.

5 GENERAL SYSTEM REQUIREMENTS AND INTERFACE

5.1 General ACD Charging System Requirements

According to IS 17017-3-1, the infrastructure-mounted pantograph is one type of ACD charging system that transfers power between the infrastructure and the vehicle. This power transfer occurs when the correct alignment is complete and the ACD moves into place to electrically connect the infrastructure and the vehicle through conductive connection.

To accommodate all the needs of the fleet, two power levels are required for the infrastructure-mounted pantograph (cross-rail) system:

a) Level 1: The current capability is up to 800 A.
b) Level 2: The capability will be up to 1200 A.

Both levels will be compatible with one another.

Level 2 is not documented in IS 17017-3-1. It is reserved for a future revision.

The ISC will have the moving connection on the infrastructure. The VSC will be stationary on the roof of the vehicle.

5.2 Functional/Physical Requirements of the VSC

5.2.1 Vehicle Rail Dimensioning

Rail dimensioning shall be according to the measurements outlined in Fig. 1.

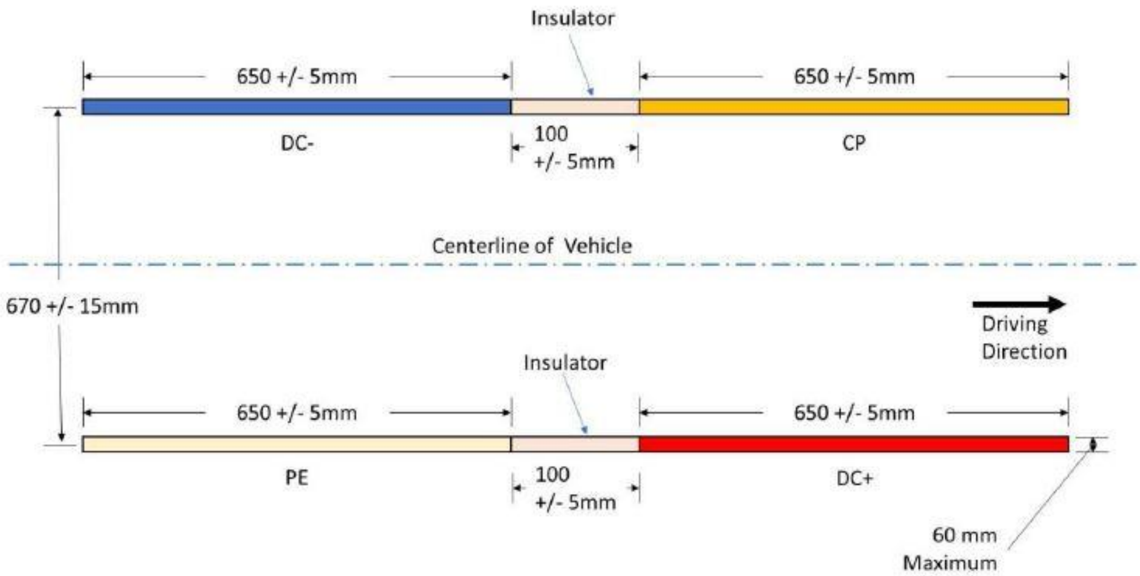

FIG. 1 – VSC RAIL DIMENSIONING

The contact surface of the roof rails shall be rounded with radius R (4 to 100 mm) (see Fig. 2).

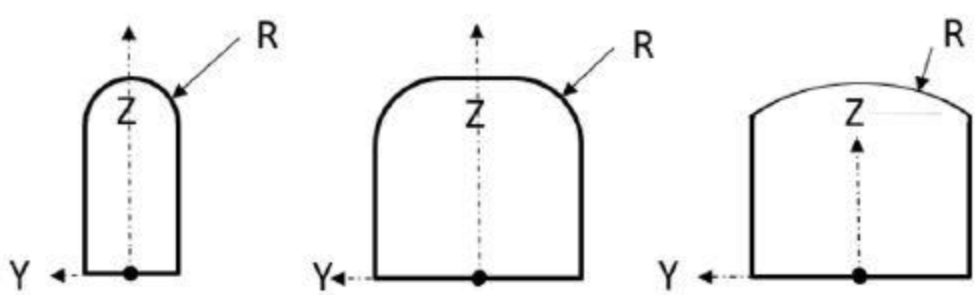

FIG. 2 – ROOF RAIL SHAPES WITH ROUNDED SURFACE

Each rail consists of two conductors and an insulator between them.

The cross-section of the roof rai ls shall be able to transmit requested current to the electric vehicle.

The vehicle will communicate the maximum power rating to the ISC to help prevent the rail rating from being exceeded.

Nominally, the rails shall be parallel with the centerline of the vehicle (see Fig. 1).

Each rail conductor is separated by a gap with a minimum dielectric strength of 19 MV/m.

The rail material composition shall be such that it maintains compatibility with any silver-coated copper contact system.

5.2.2 Vehicle Rail and Positioning

In the longitudinal direction, the centerline of the rails shall be aligned with the centerline of the vehicle front axle. See Fig. 3.

NOTE: In the event of the rails going beyond the edge of the front roof of the vehicle, the rails shall be moved backwards, in a manner, so as to be placed closely within the edge of the front roof. Suitable arrangements for enabling the driver to align with the Infrastructure mounted Pantograph, may be evolved by the Operator, at his discretion.

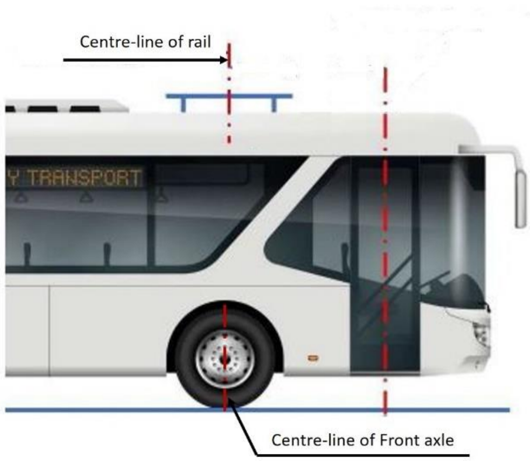

FIG. 3 – LONGITUDINAL VEHICLE RAIL POSITIONING

In the latitudinal direction, the transverse center of the rails shall be positioned in the direct centerline of the vehicle with a location of “B”. See Fig. 4 and Table 1.

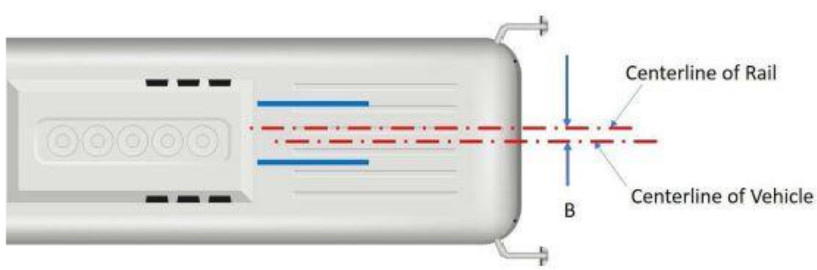

FIG. 4 – LATITUDINAL VEHICLE RAIL POSITIONING

Table 1 provides dimensions for Fig. 4.

TABLE 1 – DIMENSIONS FOR FIG. 4

	Dimension (mm)	Tolerance (mm)
B	0	±25

Fig. 5 and 6 illustrate front and side views, respectively, of the keep-out zone on the roof of the vehicle.

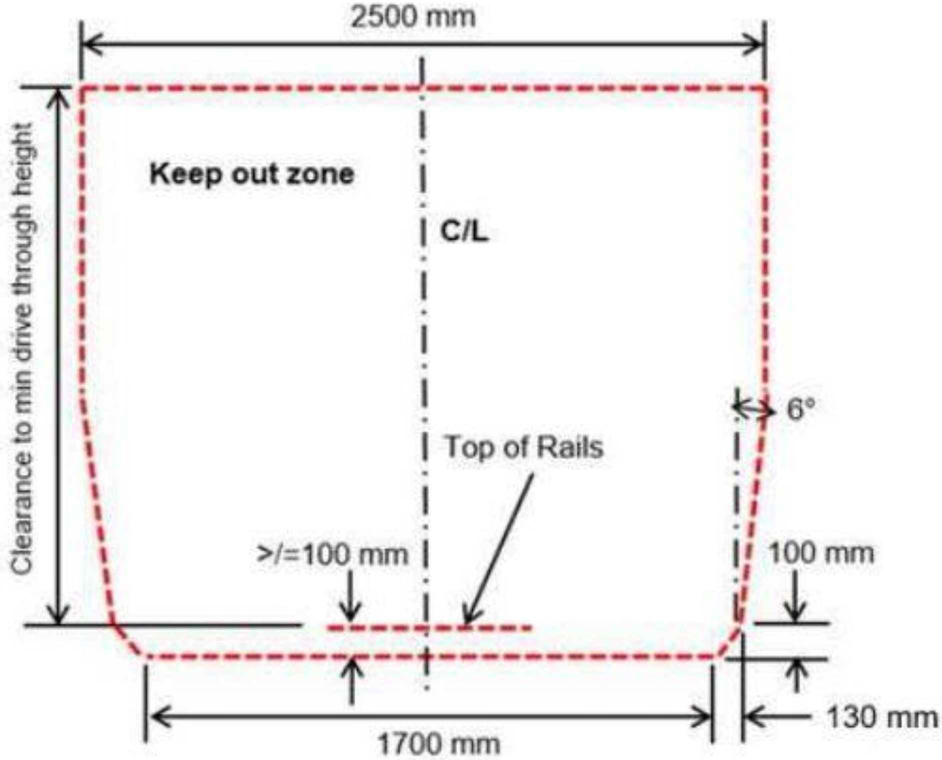

FIG. 5 – KEEP-OUT ZONE ON ROOF OF VEHICLE (FRONT VIEW)

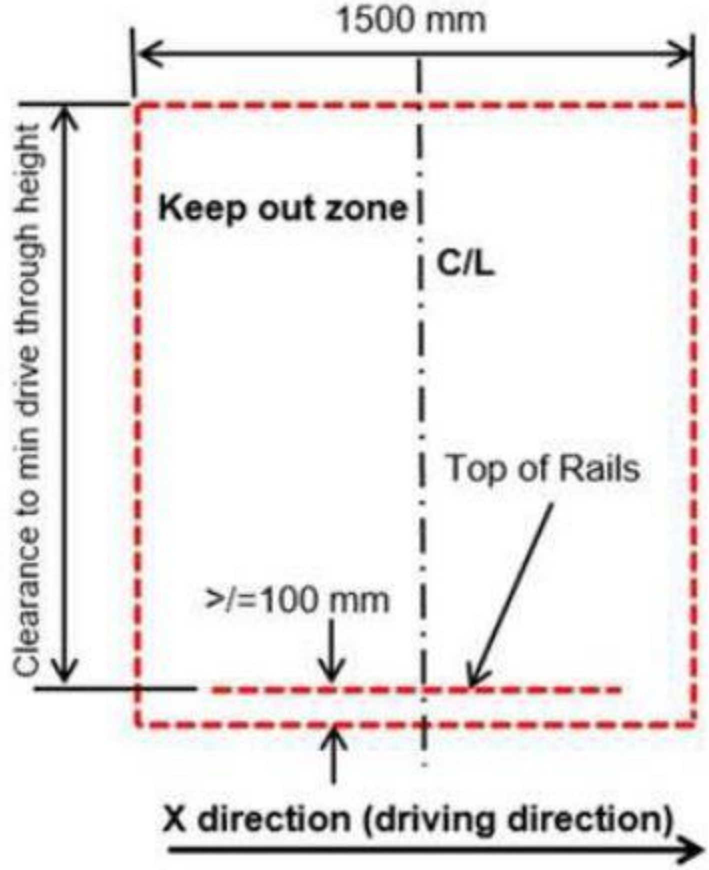

FIG. 6 – KEEP-OUT ZONE ON ROOF OF VEHICLE (SIDE VIEW)

5.3 Functional/Physical Requirements of VSC Unidirectional Antenna

The unidirectional WLAN patch antenna should be installed on the roof near the onboard DC conduction rails. Its location should consider alignment with the off-board antenna on the ISC side. Fig. 7 and 8 provide the onboard vehicle positioning requirements of the unidirectional WLAN patch antenna relative to the DC conduction rails.

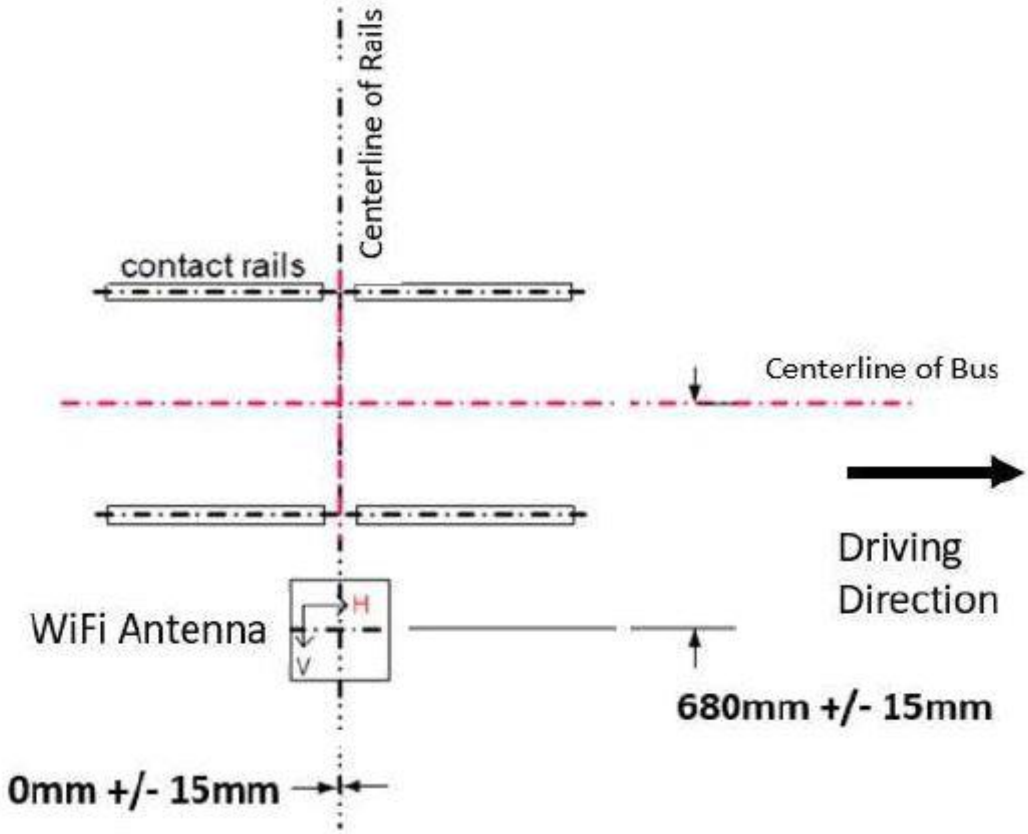

FIG. 7 – ONBOARD VEHICLE POSITIONING OF UNIDIRECTIONAL WLAN PATCH ANTENNA (TOP VIEW)

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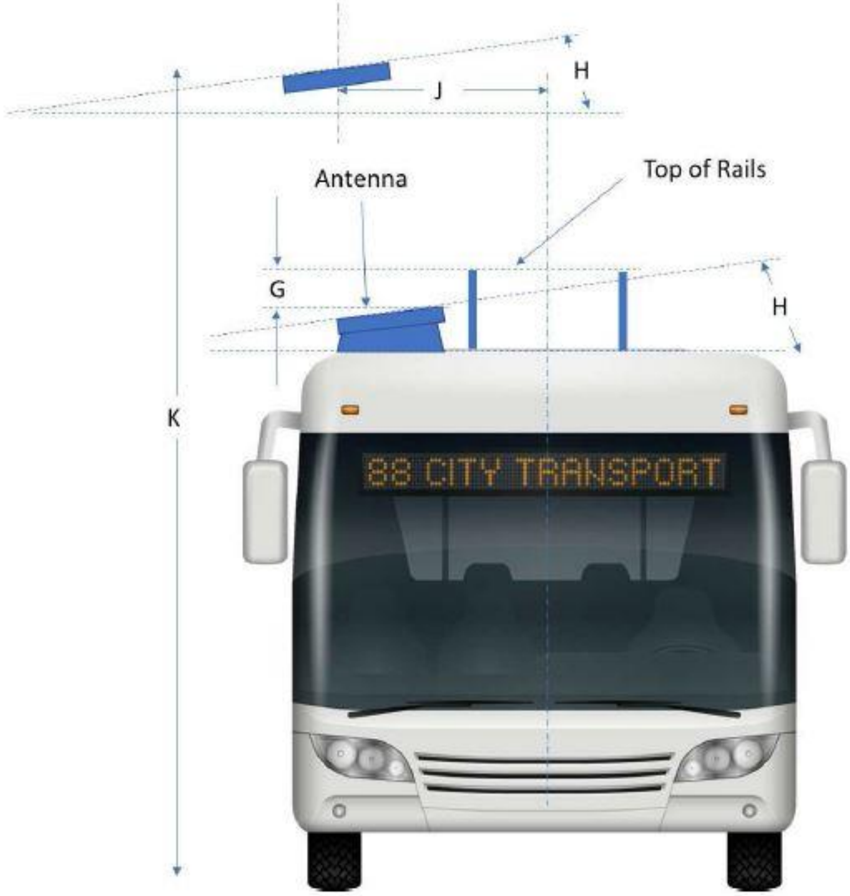


FIG. 8 - ON-BOARD AND OFF-BOARD VEHICLE POSITIONING OF UNIDIRECTIONAL WLAN PATCH ANTENNA (FRONT VIEW)

Table 2 provides dimensions for Fig. 8.

Table 2 – DIMENSIONS FOR FIG. 8

	Dimension	Tolerance
G	>50 mm	
H	4 degrees	±1 degrees
J	785 mm	±150 mm
K	4.6 m	+0.1 m/-1 .0m

Table 3 and Fig. 9 provide the electrical specifications and the radiation patterns, respectively, for the unidirectional WLAN patch antenna.

Table 3 – ELECTRICAL SPECIFICATIONS FOR UNIDIRECTIONAL WLAN PATCH ANTENNA

	Band 1	Band 2
Frequency (MHz)	5150-5350	5470-5875
VSWR	1.7	1.7
Gain (dBi)	18 to 25	18 to 25
3 dB beam width (h) (degrees)	8 to 20	8 to 20
3 dB beam width (v) (degrees)	8 to 20	8 to 20
Front to back ratio (dB)	30	30
Vertical electrical tilt (degrees)	0	0
Nominal impedance	50 Ω	
DC grounded	Yes	
Polarization	Vertical	
Composite power max	6 W at ambient temperature 25 °C	

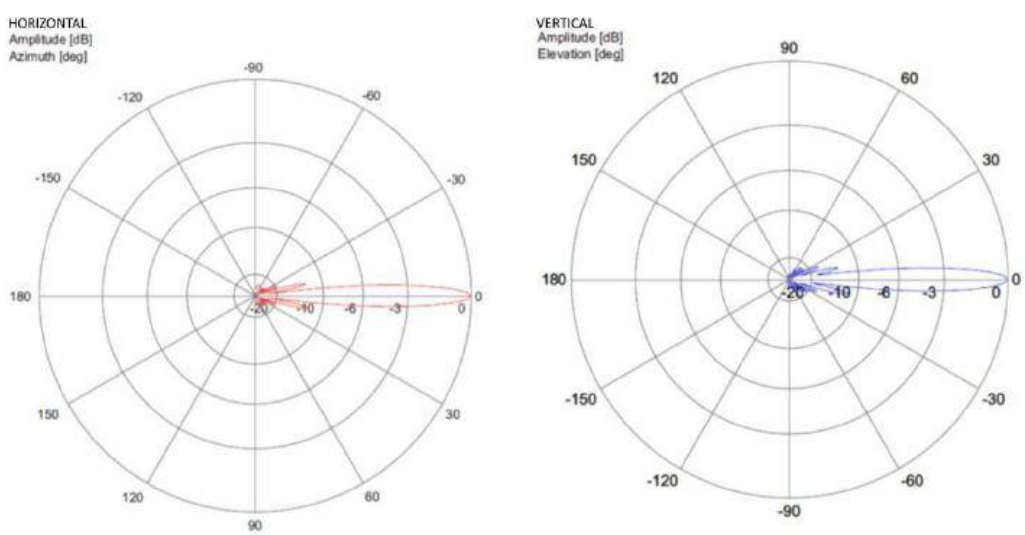


FIG. 9 - RADIATION PATTERNS FOR UNIDIRECTIONAL WLAN PATCH ANTENNA

5.4 Functional/Physical Requirements of ISC

5.4.1 Infrastructure Rai l Dimensioning

Rail dimensioning shall be according to the measurements outlined in Fig. 10.

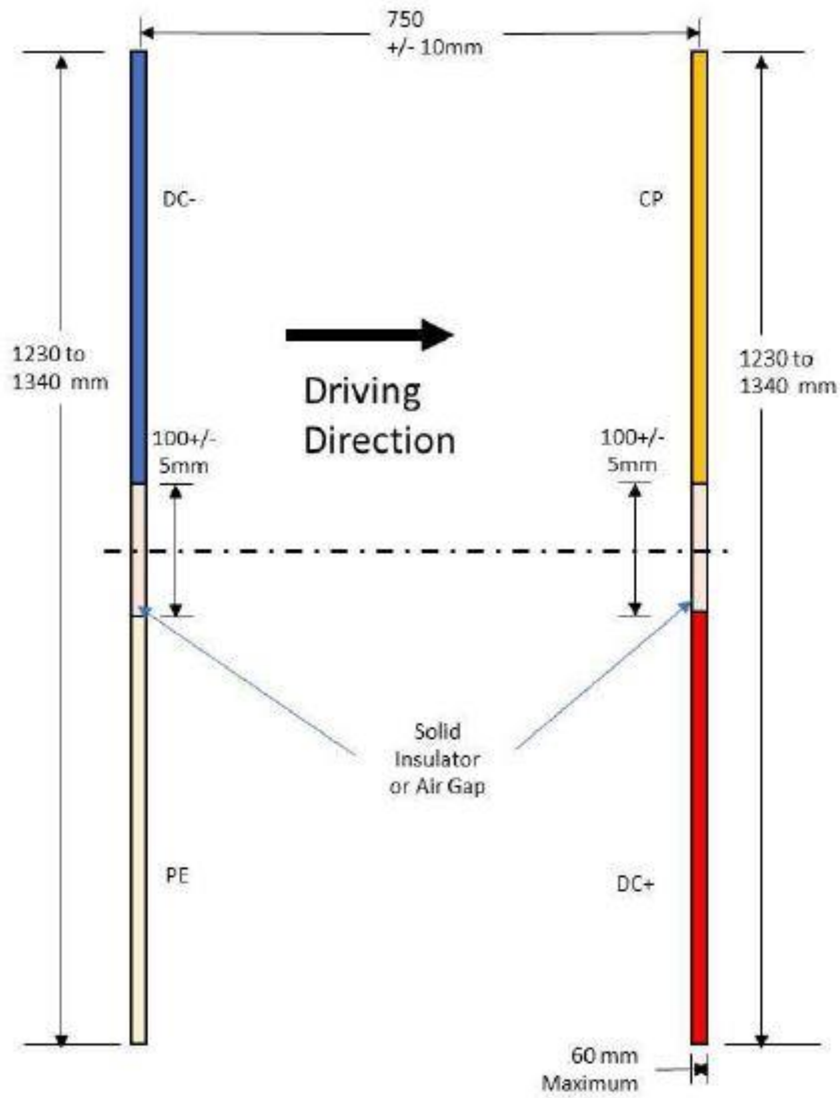


FIG. 10 – ISC INFRASTRUCTURE RAIL DIMENSIONING

Note: DC+, DC-, CP and PE are all the identical lengths

The rails shall be parallel to one another.

Nominally, the rails shall be perpendicular with the sides of the vehicle.

The cross-section of the pantograph rails shall be able to transmit rated current of the EVSE.

Each ISC rail conductor is separated with a minimum dielectric strength of 19 MV/m.

The rail material composition shall be such that it maintains compatibility with any silver-coated copper contact system.

5.4.2 Minimum Articulation Span

As installed, the system shall be capable of interfacing with the appropriate forces, through a range of 1.5 m. Additionally, the system may be capable of operating at much greater distances from the driving surface.

5.4.3 Functional/Physical Requirements of ISC Unidirectional Antenna

The unidirectional WLAN patch antenna should be installed on the off-board ISC in alignment with the onboard vehicle antenna on the VSC side.

The electrical specifications and radiation patterns shall be as defined in Table 3 and Fig. 9.

Fig. 8 provides the off-board infrastructure positioning requirements of the unidirectional WLAN patch antenna relative to the DC conduction rails.

5.4.4 Contact Sequencing

Mechanical connection and disconnection sequences are not required as long as an arc that occurs from an unintentional disconnect does not cause a dangerous situation.

Mechanical contact sequencing on initial contact to EV or after a charging event is not addressed in IS 17017-3-2.

NOTE: Fault testing for unintentional disconnection, performed at the direction of the committee, indicates that there is no concern with regard to arcing.

5.5 Alignment

5.5.1 Maximum Slope of the Vehicle in Sideways Direction

The maximum slope of the road in the sideways direction will be Angles A and B in Fig. 11, including the kneeling of the bus. This will shift the top of the bus relative to the centerline, so the displacement caused by the road angle or kneeling should be considered while calculating the maximum and minimum distance between the pole and the street curb. Table 4 defines the angular dimensions.

NOTE: Assumes a level roadway.

Table 4 – ANGULAR DIMENSIONS FOR FIG. 11, 12 AND 13

Angle	Maximum Degrees
A	3.5
B	3.5
C	5.0
D	5.0
E	5.0

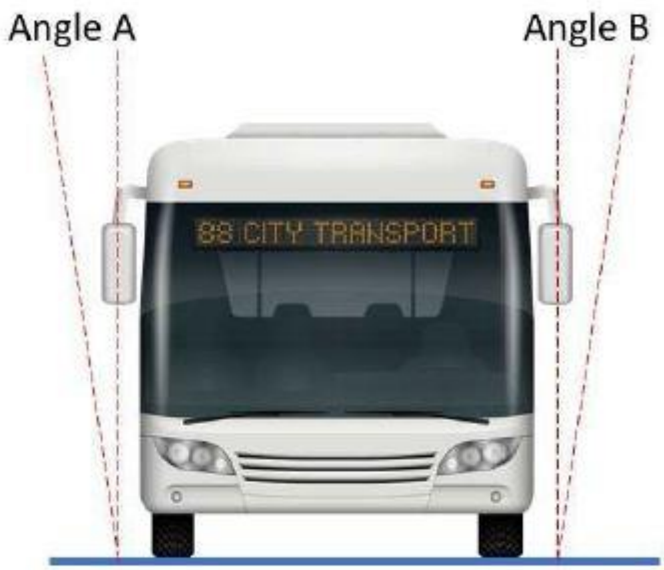


FIG. 11 – SIDEWAYS SLOPE DIRECTION

5.5.2 Maximum Ramp Angles

The maximum slope of the road in the driving direction will be Angles C and D in Fig. 12. In general, the lower plane of the contact strips used on the off-board equipment should be as parallel as possible to the road in the driving direction. Table 4 defines the angular dimensions.

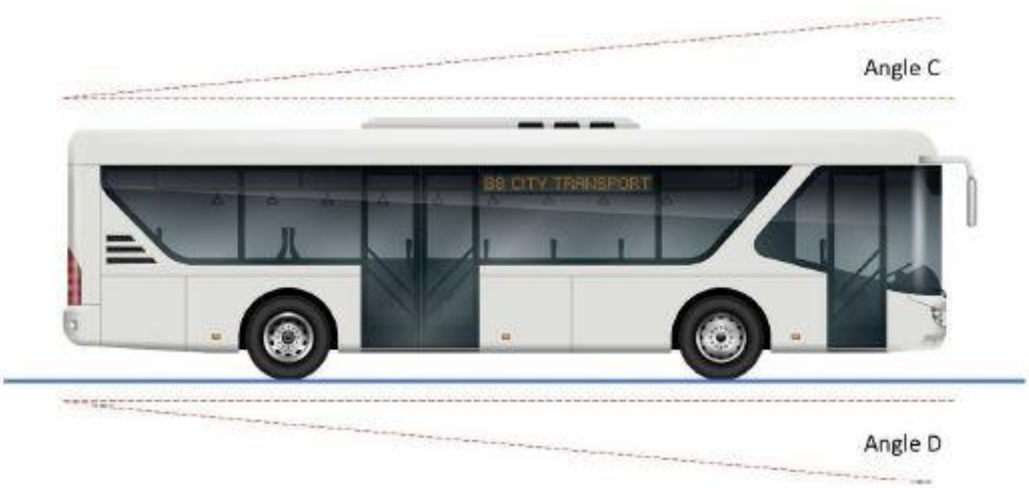


FIG. 12 – DRIVING RAMP ANGLES

5.5.3 Maximum Vehicle Offset Angle to Off-Board Equipment

The maximum permitted vehicle offset angle to establish curb or station stop will be Angle E in Fig. 13. Vehicle and off-board equipment must still allow for successful charging at this offset angle. Table 4 defines the angular dimensions.

FIG. 13 – MAXIMUM VEHICLE OFFSET ANGLE

6 CONNECTION CONFIGURATION

6.1 Contact Size and Electrical Ratings

The general contact sizes at the ISC interface shall comply with the dimensions as specified in Table 5.

Table 5 – CONTACT SIZE AND ELECTRICAL RATINGS

Contact #	Function	Current Rating (A)	DC Voltage Rating (V)
1	DC+ Power	Up to 800 (Level 1) Up to 1200 (Level 2)	250 min, up to 1000
2	DC- Power	Up to 800 (Level 1) Up to 1200 (Level 2)	250 min, up to 1000

3	PE	Per coupler rating as defined in "ground path current test" of UL 2251	
4	Control Pilot	Up to 2	30 VDC

6.2 Contact Quality

To ensure stable, long-term performance the contact resistance of the ACD will be evaluated by the individual manufacturers per the testing requirements in testing Appendix F of IS 17017-3-1.

The measurement shall be conducted under the maximum specified current across the connection of both automatic coupler parts under conditions identical to those in the end use.

Impact of ambient conditions and aging shall be fully considered in the design of the contact implementation, along with defined criteria for replacement. The final interface will be type tested as appropriate for the given application.

6.3 Contact Retention Force

The ISC and indicated components shall not have any mechanical damage that will affect the functionality after performing the following tests.

6.3.1 Connection Force

6.3.1.1 Magnitude of Breaking Capacity

The ISC power contacts are not rated for current interruption. Disconnection shall not intentionally occur under load.

6.3.1.2 Mechanical Roof Force

The mechanical vertical force applied to the vehicles during connecting and disconnecting the automatic coupler shall be limited to 600 N.

6.3.1.3 Minimum Contact Force

Minimum contact force shall not be less than 30 N.

6.4 Contact Surface Temperature

The contacts of the automated connection and the rails have a temperature rise based on the charging current (rated continuous current or intermittent current). This temperature shall not have any damaging influence on materials or devices in the surrounding area of the ACD. These surrounding materials or devices must tolerate a maximum temperature of 125 °C.

भारतीय मानक

विद्युतीय वाहन चालकता चार्जिंग पद्धति
भाग 23 डी सी विद्युतीय वाहन प्रदाय उपकरण

Indian Standard

Electric Vehicle Conductive Charging Systems
Part 23 d.c. Electric Vehicle Supply Equipment

ICS 43.120

B U R E A U O F I N D I A N S T A N D A R D S
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

……….2021 **Price Group.....**

Electrotechnology in Mobility Sectional Committee, ETD 51

FOREWORD

This Indian Standard 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 provides guidance to Industry for setting up charging stations and to the electric vehicle manufactures to prepare the vehicles to charge the batteries, from these charging stations.

Considerable assistance has been obtained from IEC 61851-23 Edition 2 CDV while preparing this standard. This standard corresponds to the requirements of IEC 61851-23 Edition 2 CDV in the requirements it contains, but certain modifications have been done in relation to the crossreferred standards, including content, and ambient conditions.

The cross references of IEC have been modified to refer 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 committee had agreed to inclusion of System A and System C defined in IEC standards, and as such the references to other types and systems have not been retained in this edition. The notation of using commas for separation of decimals has been replaced by the decimal point as followed in India. Notes related to other countries are not retained. The ambient temperature has been modified, and system voltages have been aligned as per IS 12360.

This standard is to be read in conjunction with IEC 17017-1:2018.

The composition of the committee responsible for formulation of this standard is given at Annex G.

For the purpose of deciding whether a particular requirement of this temporary 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 : 1960 ‘Rules for rounding of numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

Indian Standard

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM

Part 23 d.c. Electric Vehicle Supply Equipment

1 SCOPE

This document applies to the d.c. electric vehicle supply equipment for charging electric road vehicles, with a rated supply voltage up to 1 000 V a.c. or up to 1 500 V d.c and a rated output voltage up to 1 500 V d.c.

This document specifies the d.c. electric vehicle supply equipment of systems A and C as defined in Annex A and Annex B. Requirements for systems that do not comply with Systems A or C are not covered by this standard.

This document also provides the requirements for bi-directional power flow for System A as specified in Annex A, with reverse power flow with voltage up to 1 000 V a.c. or 1 500 V d.c.

Requirements for non-isolated system are under consideration, and are not specified in this standard.

The requirements for digital communication between d.c. electric vehicle supply equipment and electric vehicle for control of d.c. charging are defined in IS 17017(Part 24) : 2021.

Non-regulated d.c. electric vehicle supply equipment is not covered by this standard.

NOTES

1 The reverse output voltage up to 1 500 V d.c. is under consideration.

2 The requirements for bi-directional power flow for System C are under consideration. Annex C also provides information about bi-directional power flow.

3 This document includes information on electric vehicle fo conductive connection, but limited to the necessary content for describing the power and signalling interface.

4 Typical diagrams and variation of d.c. charging systems are shown in Annex D.

2 REFERENCES

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

Addition:

IEC Guide 115	Applicaton of uncertainity of measurment to conformity assessment activities in the electrotechnical sector.
IS 732:2019	Code of practice for electrical wiring installations.
IS 10810(Part 11)	Methods of test for cables: Part 11 Thermal ageing in air.

IS 12360:1988	Voltage bands for electrical installations including preferred voltages and frequency.
IS 12640(Part 1) : 2016	Residual current operated circuit-breakers without integral overcurrent protection for household and similar users(RCCBs): Part 1 General rules.
IS 12640(Part 2) : 2016	Residual current operated circuit-breakers with integral overcurrent protection for household and similar users(RCBOs): Part 1 General rules.
IS 13947(Part 1):1993	Low-voltage switchgear and controlgear assemblies: Part 1 General rules.
IS/ISO 15118-2:2014	Road vehicles – Vehicle-to-grid communication interface: Part 2 Network and application protocol requirements.
IS/ISO 15118-3:2015	Road vehicles – Vehicle-to-grid communication interface: Part 3 Physical and ata link layer requirements.
IS/ISO 15118-8:2018	Road vehicles – Vehicle-to-grid communication interface: Part 3 Physical and ata link layer requirements for wireless communication
IS 15382(Part 1): 2014	Insulation coordination for equipment with low-voltage systems: Part 1 Principles, requirements and tests.
IS 16463(all parts)	Low-voltage surge protective devices.
IS 17017(Part 1):2018	Electric vehicle conductive charging system: Part 1 General requirements
IS 17017(Part 2/Sec 1):2020	Electric vehicle conductive charging system: Part 2 Plugs, socket-otlets, vehilce connectors and vehicle inlets: Section 1 General requirements.
IS 17017(Part 2/Sec 3):2020	Electric vehicle conductive charging system: Part 2 Plugs, socket-otlets, vehilce connectors and vehicle inlets: Section 3 Dimensional compatibility and interchangeability requirements for d.c and a.c/d.c pin and contact-tube vehicle couplers,
IS 17017(Part 21/Sec 2):2019	Electric vehicle conductive chargaing system: Part 21Electromagnetic compatibility (EMC) requirements: Section 2 Off-board chargers.
IS 17017(Part 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.

IS/ISO/IEC 17025: 2017	General requirements for the competence of testing and calibration laboratories.
IS 17050:2018	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts(IK code)
IS/IEC 60479-1:2005	Effects of current on human beings and livestock: Part 1 General aspects.
IS/IEC 60479-2: 2007	Effects of current on human beings and livestock: Part 2 Special aspects.
IEC 60695-10-3:2016	Fire hazard testing: Part 10 Abnormal heat: Section 3 Mould stress relief distortion test.
IS/IEC 60695-11-10: 2013	Fire hazard testing: Part 11 Test flames: Section 10 50 W horizontal and vertical flame test methods.
IS/IEC 60947-2 : 2016	Low-voltage switchgear and controlgear : Part 2 Circuit breakers.
IS/IEC 60990 : 2016	Methods of measurement of touch current and protective conductor current.
IS/IEC 62305-4:2010	Protection against lightning – Part 4: Electrical and electronic systems within structures
IS/IEC 62368-1:2014	Audio, video and communication technology equipment - Part 1: Safety requirements
IEC 60245-1	Rubber insulated cables - Rated voltages up to and including 450/750 V: Part 1 General requirements
IEC 60227-1	Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V: Part 1 General requirements
IEC 61439-7:2018	Low-voltage switchgear and controlgear assemblies: Part 7 Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations.
IEC 61540 : 1998	Electrical accessories — Portable residual current devices without integral overcurrent protection for household and similar uses.
IEC 61557-8	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures: Part 8 Insulation monitoring devices for IT systems.

IEC 62477-1:2016	Safety requirements for power electronic converter systems and equipment: Part 1 General
IEC 62909-1:2017	Bi-directional grid connected power converters: Part 1 General requirements.
ISO 11898-1:2015	Road vehicles – Controller area network (CAN): Part 1 Data link layer and physical signalling
ISO/QC 302400:1994	Fixed capacitors for use in electronic equipment sectional specification for fixed capacitors for electromagnetic interference suppression and connection to the supply mains.
DIN SPEC 70121	Electromobility - Digital communication between a DC EV supply equipment and an electric vehicle for control of DC charging in the Combined Charging System

3 TERMINOLOGY

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

Addition:

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

3.1 Electric Supply Equipment

3.1.101 d.c. *EV Charging System*
A system composed of a d.c. charger, cable assembly and the equipment on electric vehicle that is required to fulfil the charging function including digital communication for charging control

3.1.102 *Isolated d.c. EV Supply Equipment*
d.c. electric vehicle supply equipment where the d.c. output circuit is separated by at least basic insulation from other circuits

NOTE—See **8** for the requirements of separation between each circuit.

3.1.103 *Non-Isolated d.c. EV Supply Equipment*
d.c. electric vehicle supply equipment where the d.c. output circuit is not separated by protective separation from the a.c. supply network

3.1.104 *Regulated d.c. EV Supply Equipment*

d.c. electric vehicle supply equipment that supplies vehicle battery with a charging current or charging voltage in accordance with the request from vehicle

3.1.105 *Non-Regulated d.c. EV Supply Equipment*

Under consideration

3.1.106 *Plug and Cable d.c. EV Supply Equipment*
d.c. electric vehicle supply equipment which is intended to be connected to the a.c. supply network using a cable and plug according to IS/IEC 60309-1 and IS/IEC 60309-2 for industrial type, IS 1293 for domestic type, relevant national standards, or other standard plugs and socket outlets

3.1.107 *d.c. EV Discharging Equipment*
Equipment specifically designed for electric vehicle discharging, for example a portable Vehicle-to-Load (V2L) power supply

3.1.108 *Charging/Discharging Station*

A system composed of an EVPS and cable assembly that is required to fulfil the charging and discharging functions including digital communication for charging and discharging control

3.1.109 *Electric Vehicle Power System(EVPS)*
Equipment or a combination of equipment providing dedicated functions to provide a.c. or d.c. reverse power to socket-outlets or a bi-directional grid-connected power converter according to IEC 62909-1 from an electric vehicle. It can provide dedicated functions to supply electric energy from a fixed electrical installation or a.c. supply network to an electric vehicle for the purpose of charging.

3.1.110 *Charging State*
A physical status of d.c. electric vehicle charging system

3.1.111 *Discharging Mode*
Method necessary to condition energy of the rechargeable energy storage systems (RESS) to a regulated voltage/current level to external electrical circuit

3.1.112 *Maximum Current Control(MCC)*
Control mode where a d.c. electric vehicle charging/discharging supply equipment regulates charging/discharging current according to the maximum current value communicated by the vehicle

3.1.113 *Controlled Current Charging(CCC)*
Energy transfer method where the d.c. electric vehicle supply equipment regulates charging current according to the current value requested by the vehicle

3.1.114 *Controlled Voltage Charging(CVC)*
Energy transfer method where the d.c. electric vehicle supply equipment regulates charging voltage according to the voltage value requested by the vehicle

3.1.115 *Constant Current Control Mode(CCCM)*
A control mode of electric vehicle supply equipment that regulates the output current as constant during the control process according to the target-current value requested by the vehicle or the other sources such as thermal management unit of electric vehicle supply equipment

3.1.116 *Constant Voltage Control Mode(CVCM)*
A control mode of electric vehicle supply equipment that regulates the output voltage as constant during the control process according to the target-voltage value requested by the vehicle

3.1.117 *Constant Power Control Mode(CPCM)*
A control mode of electric vehicle supply equipment that regulates the output power as constant during the control process according to the target-power value requested by the vehicle or the other sources such as the demand management of the grid

3.1.118 *Electric Vehicle Supply Equipment(EVSE)*
conductors, including the phase(s), neutral and protective earth conductors, the electric vehicle couplers, attached plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle and allowing communication between them as necessary

3.1.119 *Supply Equipment Communication Controller(SECC)*
entity which implements the communication to one or multiple electric vehicle communication controllers (EVCCs) according to IS/ISO 15118-2 and which may be able to interact with secondary actors

3.2 Insulation

3.2.101 *Isolation*

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

3.2.102 *(Electrically) Protective Separation*
Separation of one electric circuit from another by means of:

a) double insulation; or

b) basic insulation and protective screening (shielding); or

c) reinforced insulation

3.3 Functions

3.3.101 *Control Circuit*

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

3.3.102 *d.c. Charging Control Function(DCCCF)*

A function embedded in a d.c. electric vehicle supply equipment which controls d.c. power output following VCCF direction

3.3.103 *d.c. Charging/Discharging Control Function(DCCDCF)*

A function embedded in a d.c. electric vehicle charging/discharging supply equipment which controls d.c. power input/output following VCDCF request

3.3.104 *Vehicle Charging Control Function(VCCF)*

A function in a vehicle which controls the charging parameters of off-board d.c. electric vehicle supply equipment

3.3.105 *Vehicle Charging/Discharging Control Function(VCDCF)*

A function in a vehicle which controls the charging/discharging parameters of off-board d.c. electric vehicle charging/discharging supply equipment

3.3.106 *Normal Shutdown*
Termination of the charging process initiated by the user, by the vehicle or by the d.c. electric vehicle supply equipment, and not caused by a failure

3.3.107 *Error Shutdown*
Termination of the charging process caused by a failure detected by the d.c. electric vehicle supply equipment or the vehicle

3.3.108 *Emergency Shutdown*

Urgent termination of the charging process caused by a failure detected by the d.c. electric vehicle supply equipment or the vehicle, that may present a safety hazard

NOTE— It may be done by disconnecting the d.c. electric vehicle supply equipment from supply network.

3.3.109 *Thermal Sensing*
Method for obtaining temperature data of accessories, cable assemblies or parts thereof

3.3.110 *Thermal Transport*
Method for managing the heat dissipation of accessories, cable assemblies or parts thereof, independent of changing the current

3.3.111 *Thermal Sensing Device*
Means for providing temperature data of accessories, cable assemblies or parts thereof

3.3.112 *Thermal Transport Device*
Means for managing heat dissipation of accessories, cable assemblies or parts thereof, independent of changing the current

3.3.113 *Thermal Exchange*
Method for cooling and dissipating thermal energy from the thermal transport

3.3.114 *Thermal Exchange Device*
Means for cooling and dissipating thermal energy from the thermal transport

3.3.115 *Thermal Management System*
System having thermal sensing, thermal exchange and thermal transport in order to keep the temperature in the allowed limit

3.3.116 *High Level Communication (HLC)*
Bi-directional digital communication using protocol and messages and physical and data link layers specified in IS 17017(Part 24).

3.4 Vehicle

3.4.101 *Maximum Voltage Limit*

Upper limit value of charging voltage sent by the vehicle to the d.c. electric vehicle supply equipment

3.4.102 *Maximum Discharging Current of the Vehicle*
Maximum limit of the discharging current of the vehicle which may change over time

3.4.103 *Maximum Charging Current of the Vehicle*
Maximum limit of the charging current of the vehicle which may change over time

3.5 Cords, Cables and Connection Means

3.5.101 *Y-Capacitance*
Total capacitance bridging the isolation barriers of the d.c. output to other circuits and earth

NOTES

1 The capacitors are of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock.

2 The total capacitance is commonly distributed equally between the two d.c. rails.

3.6 Service and Usage

3.6.101 *Ordinary Person*

Person who is neither a skilled person nor an instructed person

NOTE —Ordinary persons include users of the d.c. electric vehicle supply equipment, persons who may have access to the d.c. electric vehicle supply equipment, and who may be in the vicinity of the d.c. electric vehicle supply equipment. Under normal operating conditions, ordinary persons should not be exposed to energy sources causing startle reaction, pain or injury.

3.6.102 *Skilled Person*

Person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create

3.6.103 *Instructed Person*

Person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create

3.6.104 *Restricted Access*

Access to the d.c. electric vehicle supply equipment, limited for example by private housing, private camping areas or similar places

3.6.105 *Non-Restricted Access*

Unlimited access to the d.c. electric vehicle supply equipment for all persons for example public areas

3.7 General Terms

3.7.101 *Primary Circuit*

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

3.7.102 *Secondary Circuit*

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

3.7.103 *Rated Current*
Input or output current under normal operating conditions assigned by the manufacturer

3.7.104 *Contact Assembly*

Power contact with a terminal and additional componenst if any

NOTE — for example, termination, contact support, thermal sensing, thermal transport etc.

3.7.105 *Sleep Mode*
Deactivation or performance reduction of internal subsystem in order to minimize power consumption

3.7.106 *d.c. Output Voltage*

Voltage between d.c. power line terminals, that is between positive terminal DC+ and negative terminal DC–.

3.7.107 *Touch Current*
Electric current passing through a human body or through livestock when it touches one or more accessible parts of an installation or of equipment

3.7.108 *Touch Voltage*
Voltage between conductive parts when touched simultaneously by a human or livestock

NOTE — The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the livestock in electric contact with these conductive parts.

3.7.109 *Fire Enclosure*
Part of the equipment intended to minimize the spread of fire or flames from within

3.7.110 *Enhanced Protection*
Protective provision having a reliability of protection not less than that provided by two independent protective provisions

3.7.111 *PELV (System)*
Electric system in which the voltage cannot exceed the value of extra low voltage under normal conditions and under single fault conditions, except earth faults in other electric circuits

NOTE — PELV is the abbreviation for protective extra low voltage.

3.7.112 *SELV (System)*

Electric system in which the voltage cannot exceed the value of extra-low voltage under normal conditions and under single fault conditions, including earth faults in other electric circuits

NOTE — SELV is the abbreviation for safety extra low voltage.

3.7.113 *Power Electronic Converter System(PECS)*
One or more power electronic converters intended to work together with other equipment

3.7.114 *Protective Impedance*
Impedance connected between hazardous live parts and accessible conductive parts, of such value that the current, in normal use and under likely fault conditions, is limited to a safe

value, and which is so constructed that its ability is maintained throughout the life of the equipment

3.7.115 *Protective-Equipotential-Bonding*

Equipotential bonding for purposes of safety (for example protection against electric shock)

3.7.116 *(Electrically) Protective Screening*

Separation of circuits from hazardous live-parts by means of an interposed conductive screen, connected to the means of connection for a PE conductor, either directly or via protective equipotential bonding

3.7.117 *Single Fault Condition*

Condition in which one failure is present, which could cause a hazard covered by this document

NOTES

1 If a single fault condition results in other subsequent failures, the set of failures is considered as one single fault condition

2 Examples of hazards include, but are not limited to electric shock, fire, energy, mechanical, sonic pressure etc.

3.7.118 *Startle Reaction*

Physiological reaction due to a minimum derived value of touch voltage for a population for which a current flowing through the body is just enough to cause involuntary muscular contraction to the person through which it is flowing

3.7.119 *Working Voltage*

Voltage, at rated supply conditions (without tolerances) and worst case operating conditions, that occurs by design in a circuit or across insulation

NOTE — The working voltage can be d.c. or a.c. Both the r.m.s. and recurring peak values are used.

3.7.120 *Insulation Monitoring Device(IMD)*

Device which permanently monitors the insulation resistance to earth of unearthed a.c. IT systems, a.c. IT systems with galvanically connected d.c. circuits having nominal voltages up to 1 000 V a.c., as well as monitoring the insulation resistance of unearthed d.c. IT systems with voltages up to 1 500 V d.c., independent from the method of measuring

3.7.121 *Earth Leakage Current Monitoring Device*

Passive electrical device for monitoring insulation resistance of unearthed d.c. system by measuring leakage current between live parts and exposed conductive part or earth.

4 GENERAL REQUIREMENTS

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

Replacement:

4.6 Not applicable.

5 CLASSIFICATION

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

Addition:

5.101 Category

5.101.1 According to the type of insulation between a.c. supply network and d.c. output circuit:

a) basic insulation with conductive protective screening (shielding) that is provided with a means for electrical connection to the protective earthing conductor;

b) reinforced insulation, and

c) double insulation.

5.101.2 According to system control:

a) regulated d.c. electric vehicle supply equipment:

1) controlled current charging,

2) controlled voltage charging, or

3) combination of a) and b), and

b) non-regulated d.c. electric vehicle supply equipment.

5.101.3 According to the system used:

a) system A (see Annex A), or

b) system C (see Annex B).

5.101.4 According to thermal management system:

a) using thermal sensing;

b) using thermal sensing and thermal transport; or

c) none

6 CHARGING MODES AND FUNCTIONS

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

Replacement:

6.2 Charging Modes

6.2.1 *Mode 1*

Not applicable

6.2.2 *Mode 2*

Not applicable

6.2.3 *Mode 3*

Not applicable

Replacement:

6.3 Functions Provided in Mode 4

6.3.1 *Mandatory Functions in Mode 4*

6.3.1.1 *General*

The d.c. electric vehicle supply equipment shall supply a d.c. current or voltage to the vehicle battery in accordance with a VCCF request.

The following functions shall be provided by d.c. electric vehicle supply equipment as given below:

a) continuous continuity checking of the protective conductor according to **6.3.1.2**;

b) verification that the electric vehicle is properly connected to the electric vehicle supply equipment according to 6.3.1.3 of IS 17017(Part 1);

c) energization of the power supply to the electric vehicle according to **6.3.1.4**;

d) de-energization of the power supply to the electric vehicle according to **6.3.1.5**;

e) maximum allowable current according to 6.3.1.6 of IS 17017(Part 1);

f) d.c. supply for electric vehicle according to **6.3.1.101**;

g) measuring current and voltage according to **6.3.1.102**;

h) latching of the vehicle coupler according to **6.3.1.103**;

j) compatibility assessment according to **6.3.1.104**;

k) insulation check before charging according to **6.3.1.105**;

m) protection against over voltage at the interface according to **6.3.1.106**;

n) verification of vehicle connector latching according to **6.3.1.107**;

p) control circuit supply integrity according to **6.3.1.108**;

q) short circuit test before charging according to **6.3.1.109**;

r) user initiated shutdown according to **6.3.1.110**;

s) overload protection for parallel conductors (conditional function) according to **6.3.1.111**;

t) voltage limitation between d.c. output and protective conductor according to **6.3.1.112** and **6.3.1.113**; and

u) shutdown of d.c. electric vehicle supply equipment according to **6.3.1.114**, **6.3.1.115**, **6.3.1.116**, and **6.3.1.117**.

Replacement:

6.3.1.2 Continuous continuity checking of the protective conductor

The protective conductor continuity between the d.c. electric vehicle supply equipment and the vehicle shall be monitored continuously. For the rated voltage of d.c. 60 V or higher, the d.c. electric vehicle supply equipment shall trigger and completely execute an emergency shutdown within the time specified by Table 1 after a loss of electrical continuity of the protective conductor between d.c. electric vehicle supply equipment and electric vehicle.

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.4**.

This test case applies to d.c. electric vehicle supply equipments with the maximum output voltage ≥ 60 V. The test system is shown in Fig. 1.

KEY

K	switch or relay	L1, L2, L3	power line
CP	control pilot	I_{EVSE}	output current of electric vehicle supply equipment
PE	protective conductor	V_{EVSE}	output voltage of electric vehicle supply equipment
N	neutral contact		

NOTE– Artificial load refers to Figure 26 and is specified in **102.2.3** unless otherwise specified.

FIG. 1 EFFECTIVE EARTH CONTINUITY TEST SYSTEM

The test shall be performed according to the following procedure:

a) Connect the d.c. electric vehicle supply equipment to an artificial load with dedicated electric vehicle simulator for each system. For System A, electric vehicle simulator which has control pilot circuits shown in Fig. 29 shall be used. The control pilot circuits of test load shall comply with the requirement in **A-3.14**.

b) Measure the voltage ($V_{EVSE\ output}$) and current ($I_{EVSE\ output}$) of the power line continuously.

c) Start charging with the procedure specified by charger manufacturer.

d) Confirm that the power flow of d.c. power line is at OP4 specified in Fig. 27.

e) Open the relay K.

f) Check that the d.c. electric vehicle supply equipment terminates the charging process and transfers to shutdown stage, displaying a relevant alarm or error information, if any.

g) Check the result in Table 1.

Table 1 – Verification criterion

(Clause 6.3.1.2*)*

S yste	**Verification criterion**

m	
A	See Table 24

h) Confirm that the d.c. power line between d.c. electric vehicle supply equipment and electric vehicle is de-energized to voltage less than 60 V.

NOTE — Protective conductor continuity is monitored by the control pilot, *see* **A-3.2** and **A-3.8.2** for System A and **B-4.3** for System C.

6.3.1.4 *Energization of the power supply to the EV*

Addition:

Compliance is checked by the following test.

The test system is shown in Fig. 2.

Key

J	switch or relay	L1, L2, L3	power line
CP	control pilot	I_{EVSE}	output current of electric vehicle supply equipment
PE	protective conductor	V_{EVSE}	output voltage of electric vehicle supply equipment
N	neutral contact	B	voltage between DC+ and DC- at the input of electric vehicle simulator

FIG. 2 CONTROL PILOT TEST SYSTEM

The test shall be performed according to the following procedure:

a) Connect the d.c. electric vehicle supply equipment to an artificial load with dedicated electric vehicle simulator for each system.

b) Measure the voltage (V_{EVSE}) of the power line continuously.

c) Simulate the open circuit of control pilot by opening the relay J. The control pilot lines to be tested for each system are shown below:

1) System A: CP3 (*see* Fig. 29)

2) System C: CP (*see* **A-2** of IS 17017(Part 1):2018)

d) Start charging with the procedure specified by the manufacturer.

e) Confirm that the power line at point B has not been energized.

6.3.1.5 *De-energization of the power supply to the EV*

Addition:

Compliance is checked for system A by the test in **A-3.2** and for system C by the test in **B-9.3.3**.

In the case of failure in control circuit of d.c. electric vehicle supply equipment, such as short-circuit, earth leakage, CPU failure or excess temperature, the d.c. electric vehicle supply equipment shall terminate the supply of charging current, and disconnect the supply of control circuit.

In the case where earth fault or overcurrent is detected, the conductor shall be disconnected from its supply.

Compliance is checked according to ISO 26262 or IEC 61508.

Addition:

6.3.1.101 ***d.c. Supply for EV***

The d.c. electric vehicle supply equipment shall supply regulated d.c. voltage or current (not simultaneously, but as requested by the vehicle during charging) to the vehicle battery in accordance with VCCF's controlling. Requirements for charging performance of regulated d.c. current / voltage are given in **101.2.1**, **101.2.2**, **101.2.3**, **101.2.4**, **101.2.5** and **101.2.6**.

In either case mentioned above, the maximum ratings of the d.c. electric vehicle supply equipment shall not be exceeded.

Compliance is checked by measurement.

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

> NOTE — Electric vehicles are equipped with different technologies and different voltages of battery. In order to avoid any error during charging and to guarantee that the d.c. electric vehicle supply equipment will be able to charge all existing and future batteries, any charging process is controlled by the vehicle. Any vehicle that is to be connected to a d.c. electric vehicle supply equipment is equipped with a VCCF for controlling the charging process.

6.3.1.102 ***Measuring current and voltage***

The d.c. electric vehicle supply equipment shall measure the output current and output voltage that is supplied to the electric vehicle. The accuracy of these measurements shall meet the defined accuracy for each system in **A-4.4** and **B-6.5**.

The measured values of voltage and current shall be provided by the d.c. electric vehicle supply equipment to the electric vehicle through digital communication.

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.12** and **B-9.3.13**.

The test system is shown in Fig. 3.

FIG. 3 D.C. SUPPLY TEST SYSTEM

KEY

A	Current measuring device
V	Volttage measuring device

The test shall be performed according to the following procedure:

a) Connect the d.c. electric vehicle supply equipment to an artificial load with a dedicated electric vehicle simulator for each system.

NOTE — Artificial load indicates Fig. 26 unless otherwise specified.

b) Start charging with the procedure specified by the manufacturer of d.c. electric vehicle supply equipment.

c) Set the CCC target values at I_{max}, I_{avg} and I_{min} of the d.c. electric vehicle supply equipment.

d) Set the CVC target values at V_{max}, V_{ave} and V_{min} of the d.c. electric vehicle supply equipment. For System A, the output voltage is set to V_{max}, V_{ave} and V_{min} of the d.c. electric vehicle supply equipment by one of the following measures:

1) the output current shall be adjusted to set the output voltage at V_{max}, V_{ave} and V_{min} of the d.c. electric vehicle supply equipment with either the electronic load U1 operating at constant resistance mode or using the resistors R1 and R2 to set the voltage point; or

2) electronic load U1 shall be operated under the constant voltage mode.

e) Trend chart of output voltage and current which is measured at output terminals of the d.c. electric vehicle supply equipment and vehicle coupler.

f) Check that the difference between the measured values of the d.c. electric vehicle supply equipment and the measuring instrument are within the limits specified in **A-4.4** or **B-6.5**.

I_{max}, I_{avg}, I_{min}, V_{max}, V_{ave} and V_{min} are defined by each system.

System A:

I_{max} = Rated current specified by each manufacturer

$I_{avg} = I_{max} / 2$

$I_{min} = 5A$

V_{max} = Maximum voltage specified by the manufacturer

$V_{ave} = (V_{max}+V_{min}) / 2$

V_{min} = Minimum voltage specified by the manufacturer

6.3.1.103 ***Latching of the vehicle coupler***

A vehicle connector used for d.c. charging shall be latched on a vehicle inlet if the d.c. output voltage is higher than 60 V between DC+ and DC-, or higher than 28 V between DC+ and earthing terminal, and DC- and earthing terminal.

The vehicle connector shall not be unlatched (if the latching mechanism is engaged) when voltage exceeding 60 V d.c. is detected through the charging process including after the end of charging. In case of charging system malfunction, a means for safe disconnection may be provided.

NOTES

1 The actuation portion of the latching function can be in either the vehicle connector or the vehicle inlet.

2 Voltage criteria for latching / unlatching function can be lower than 60 V d.c.; for example, 10 V in System A.

The d.c. electric vehicle supply equipment shall have the following functions when the latching is done by the d.c. electric vehicle supply equipment:

a) electrical or mechanical latching function to retain the latched status, and

b) function to detect the disconnection of the electrical circuits for the latching function.

Compliance is checked by the following tests c) and d).

c) Normal condition test — Simulate a normal charging operation. Check that the vehicle connector is latched on the vehicle inlet whenever the voltage at the inlet is higher than or equal to 60 V d.c. between DC+ and DC-, or higher than or equal to 28 V between DC+ and earthing terminal, and DC- and earthing terminal.

d) Abnormal condition test Simulate a condition in which the voltage at the vehicle inlet remains higher than or equal to 60 V d.c. between DC+ and DC-, or higher than or equal to 28 V between DC+ and earthing terminal, and DC- and earthing terminal after the end of charging, for example by forcibly keeping the electric vehicle contactors closed. Check that the vehicle connector is latched on the vehicle inlet whenever the voltage at the inlet is higher than or equal to 60 V d.c. between DC+ and DC-, or higher than or equal to 28 V between DC+ and earthing terminal, and DC- and earthing terminal.

Additional requirements are given in **A-3.6** and **B-4.2**.

Vehicle connectors and vehicle inlets shall comply with the requirements of IS 17017(Part 2/Sec 1) and IS 17017(Part 2/Sec 3). *See also* **9.101**.

6.3.1.104 *Compatibility assessment*

Compatibility of electric vehicle and d.c. electric vehicle supply equipment shall be checked with the information exchanged at the initialization phase of communication and charging process.

For system A, the d.c. electric vehicle supply equipment shall check the condition which the target battery voltage sent from electric vehicle is between the available output voltage and the minimum rated voltage specified by the manufacturer. In case this condition is not met, the d.c. electric vehicle supply equipment shall terminate the charging process.

For system C, the d.c. electric vehicle supply equipment checks that its minimum voltage is less than the maximum voltage of the electric vehicle battery. In case this condition is not met, the d.c. electric vehicle supply equipment terminates the charging process.

NOTE— General information of charging control and commuination are described in Annex F.

The compliance is checked by the following test.

a) Connect the d.c. electric vehicle supply equipment to an artificial load with a dedicated electric vehicle simulator for each system.

b) Start charging with the procedure specified by charger manufacturer.

c) Using the electric vehicle simulator, transmit the data or message in Table 2 to the d.c. electric vehicle supply equipment via digital communication.

d) For each case, check that the d.c. electric vehicle supply equipment terminates the charging process and transfers to shutdown stage, displaying a relevant alarm or error information, if any.

e) For System A, perform the test separately for each case.

f) For System C, *see* **B-9.3.1**.

g) Confirm that the d.c. power line between the d.c. electric vehicle supply equipment and the electric vehicle is de-energized to voltage less than 60 V between DC+ and DC-, or less than 28 V between DC+ and earthing terminal, and DC- and earthing terminal.

Table 2 - Data/message for transmission test

(*Clause* 6.3.1.104)

System	**Data /Message** (refer to IS 17017(Part 24)	**Value**
A (Case 1)	Target battery voltage	420 V
	Maximum battery voltage	410 V
A (Case 2)	Target battery voltage	min (available output voltage +10 V, 595) V
	Maximum battery voltage	600 V
C	*see* **B-9.3.1**	

6.3.1.105 Insulation Check before Charging

The d.c. electric vehicle supply equipment shall confirm the insulation resistance between its d.c. output circuit and protective conductor to the vehicle chassis, including any exposed conductive part of the d.c. electric vehicle supply equipment, before the electric vehicle contactors are allowed to close.

If the required value is not met, the d.c. electric vehicle supply equipment shall trigger and perform an error shutdown, and indicate to the vehicle that the charging is not allowed.

For System A insulation resistance shall be measured as follows. For System C, see **B-4.1.3**.

For each output circuit, the appropriate relays in the d.c. output circuit of the d.c. electric vehicle supply equipment shall be closed during the insulation check.

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

$$R \geq 100\ \Omega/\mathrm{V} \times U \tag{1}$$

where

U is rated output voltage of the d.c. electric vehicle supply equipment or maximum battery voltage of electric vehicle.

Details are specified in **A-4.3.3.**

Compliance is checked by the tests in **A-4.3.3.**

6.3.1.106 *Protection against overvoltage between positive terminal DC+ and negative terminal DC- at the interface*

The d.c. electric vehicle supply equipment shall trigger an error shutdown within the maximum time given in Table 3 to prevent overvoltage at the interface after occurrence of the fault.

Specific requirement for detection and shutdown are defined in Table 21.

NOTE−The vehicle can change the maximum voltage limit during charging process. The vehicle should consider some margin between the target battery voltage and maximum voltage limit communicated to the d.c. electric vehicle supply equipment to avoid unwanted stop of the charging process.

Table 3 – Error shutdown trigger timing

(*Clause* 6.3.1.106)

System	**Fault**	**Maximum time after occurrence of the fault to trigger error shutdown**
A	Output voltage exceeds the maximum voltage limit sent by the vehicle	2 s
C	Output voltage exceeds the maximum voltage limit sent by the vehicle for 400 consecutive milliseconds	10 ms

a) Connect the d.c. electric vehicle supply equipment to an artificial load with a dedicated electric vehicle simulator appropriate for the system under test. The setup of the test load in Fig. 26 is in Table 4.

Table 4 - Test load setup

(*Clause* 6.3.1.106)

System	**Switches**					**Circuit parameter setup**
	S0	S1	S3	Sa	Sb	

A	close	close	open	open	close	L1: 0 H R1, R5: 0 Ω(bypassed) V1: Not used U1: An electronic load operating under constant voltage mode shall be used.

b) Measure the voltage ($V_{EVSE\ output}$) and current ($I_{EVSE\ output}$) of the power line continuously.

c) Start charging with the procedure specified by charger manufacturer.

d) Using the electric vehicle simulator, transmit the data or message in Table 5 to the d.c. electric vehicle supply equipment via digital communication.

Table 5 - Data/message for transmission test

(*Clause* 6.3.1.106)

System	Data /Message Name	Value
A	Target battery voltage	410 V
	Maximum battery voltage	420 V
	Target battery current	$I_{EVSE\ max}$

e) Confirm that the d.c. power line between the d.c. electric vehicle supply equipment and the electric vehicle is energized at the rated voltage and the d.c. electric vehicle supply equipment is operating at the designated voltage and current.

f) Simulate overvoltage at the interface by the method(s) in Table 6 and check the results.

Table 6 - Charging stop method

(*Clause* 6.3.1.106)

System	Method(s) to simulate overvoltage at the interface	Verification criterion
A	Set U1 = voltage higher than the maximum battery voltage	*see* Table 21.

g) Check that the d.c. electric vehicle supply equipment terminates the charging process and transfers to shutdown stage, displaying a relevant alarm or error information, if any.

6.3.1.107 *Verification of vehicle connector latching*

This clause is only applicable for supply equipments which are responsible for latching of vehicle connector, such as System A

The d.c. electric vehicle supply equipment shall not energize the charging cable when the vehicle connector is unlatched.

Compliance is checked by inspection, operation and, for System A, the following test.

a) A vehicle inlet shall be prepared with a modification in which the latch holder (hole) of the inlet is covered by a metal plate or an equivalent hard material that inhibits the latch holding of the vehicle connector (*see* Fig. 4).

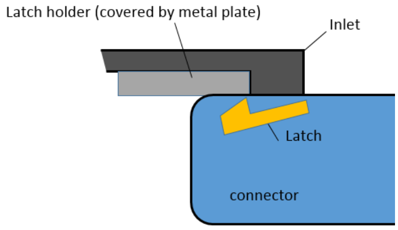


FIG. 4 EXAMPLE OF VEHICLE INLET WITH THE LATCH HOLDER COVERED BY A METAL PLATE THAT INHIBITS LATCH HOLDING

b) Connect the d.c. electric vehicle supply equipment to an artificial load and a dedicated electric vehicle simulator.

c) Start charging with the procedure specified by the manufacturer.

d) Confirm that the d.c. output voltage does not exceed 60 V, and 28 V between DC+ and earthing terminal and DC- and earthing terminal, and the d.c. electric vehicle supply equipment terminates the charging process and transfers to shutdown stage, displaying a relevant alarm or error information, if any.

6.3.1.108 Control Circuit Supply Integrity

If an earth fault, short circuit or overcurrent is detected in the output circuit of d.c. electric vehicle supply equipment, the power circuit shall be disconnected from its supply, but the power supply for control circuit shall not be interrupted until the charging sequence is completed and the vehicle coupler is safely unlatched.

The compliance is checked by the following tests according to Table 7.

Table 7 – Control circuit supply integrity test

(*Clause* 6.3.1.108)

Fault Scenario	**System A**	**System C**
Earth fault	Test a)	**B-9.3.16.2**
Short circuit	Test b)	**B-9.3.18**
Overcurrent	Design review	**B-9.3.18**

a) Earth-fault test

The test system is shown in Fig. 5.

Key

A	voltage of the power supply for control circuit	N	DC-
B	d.c. output voltage	P	DC+
E	earth	PE	protective conductor
L	selector switch	Rt	earth-fault resistance
1	terminal 1 to replicate earth-fault between P and E		
2	terminal 2 to replicate earth-fault between N and E		
3	open position of selector switch L		

FIG. 5 EARTH-FAULT TEST SYSTEM

The test shall be performed according to the following procedure.

1) An artificial load (*see* **102.2.3**) with a dedicated electric vehicle simulator for each system is connected to d.c. electric vehicle supply equipment correctly under normal operation.

2) d.c. output voltage is at the rated value.

3) The d.c. electric vehicle supply equipment is operated in the constant voltage control mode (in case of System C) and constant current control mode (in case of System A).

4) Simulate the earth-fault by changing the position of the relay or switch L from open to 1.

5) Check that the earth-fault is detected properly and the d.c. electric vehicle supply equipment transfers to a fault state.

6) Confirm that the voltage of the power supply for control circuit at point A remains the same or within a specified range that ensures the normal operation of the control circuit.

7) Check that the d.c. electric vehicle supply equipment terminates the charging process and transfers to the error shutdown stage according to **6.3.1.116**.

8) Repeat the procedures 1) to 7) for the case in which the position of the relay or switch L is changed from open to 2 in 4).

b) Short-circuit test

The test system is shown in Fig. 6.

Key

A voltage of the power supply for control circuit

B voltage of the power line

M switch or relay to replicate short-circuit

Rs short circuit resistor (100 mΩ)

FIG. 6 SHORT-CIRCUIT TEST SYSTEM FOR TESTING CONTROL CIRCUIT INTEGRITY

The test shall be performed according to the following procedure.

1) An artificial load with dedicated electric vehicle simulator for each system is connected to the d.c. electric vehicle supply equipment correctly under normal operation. If an electronic load is used, it shall not interfere with the measurement.

2) The power line (B) is energized at the rated voltage.

3) The d.c. electric vehicle supply equipment is operated in the constant voltage control mode (in case of System C) and constant current control mode (in case of System A).

4) Simulate the short circuit by closing the relay or switch M.

5) Check that the short circuit is detected properly and the d.c. electric vehicle supply equipment transfers to a fault state.

6) Confirm that the voltage of the power supply for control circuit at point A remains the same or within a specified range that ensures the normal operation of the control circuit.
7) Check that the d.c. electric vehicle supply equipment terminates the charging process and transfer to error shutdown for System A. Confirm that the measured d.c. voltage at point B is less than 60 V within 1 s for System A after the d.c. electric vehicle supply equipment detects the short circuit in 5).

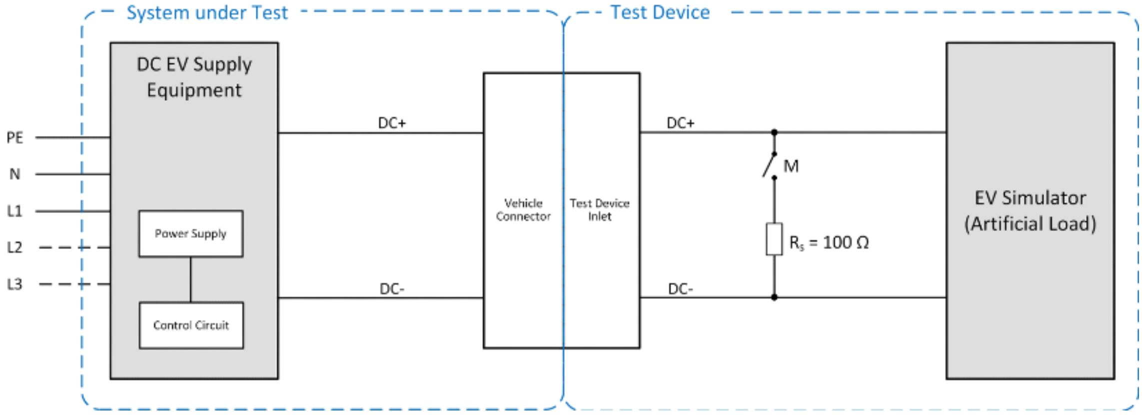
6.3.1.109 *Short-Circuit check before charging*

With the electric vehicle connected to the d.c. electric vehicle supply equipment and before the electric vehicle contactor is closed, the d.c. electric vehicle supply equipment shall have a means to check for a short circuit between d.c. output circuit positive and negative up to the electric vehicle contactor.

If short circuit is detected, the d.c. electric vehicle supply equipment shall trigger and perform an error shutdown.

Compliance for System A is checked by the following test. For system C, see **B-9.3.21.**

The test system is shown in Fig. 7.



Key
M switch or relay
Rs short-circuit resistance

FIG. 7 SHORT CIRCUIT TEST SYSTEM TO CHECK THE SHORT CIRCUIT BEFORE CHARGING

The test shall be performed according to the following procedure.

a) Connect the d.c. electric vehicle supply equipment to an artificial load with dedicated electric vehicle simulator for each system.

b) The electric vehicle contactors are open.

c) The short-circuit resistance Rs shall be 100Ω.

d) Switch M is open.

e) Simulate the short circuit of the power line by closing the switch M.

f) Start charging with the procedure provided by charger manufacturer.

g) The d.c. electric vehicle supply equipment shall terminate charging process by error shutdown before electric vehicle contactors are allowed to close.

6.3.1.110 *User initiated Shutdown*

The d.c. electric vehicle supply equipment shall have a means to allow the user to initiate the normal shutdown.

NOTE — For System A, a means to trigger an error shutdown is also possible.

Compliance is checked by the tests in **A-8**, or **B-9.3.20**.

6.3.1.111 Overload Protection for Parallel Conductors (Conditional Function)

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

Compliance is checked by design review.

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

6.3.1.112 Maximum voltage between DC+/- and protective conductor in conditions without earth fault

Under normal operation no voltage higher than the d.c. output voltage plus 50 V shall occur between d.c. power line terminals (DC+ as positive terminal, and DC- as negative terminal) and protective conductor at the output of the d.c. electric vehicle supply equipment. This voltage limitation does not apply for transient overvoltages (*see* Fig. 8 and Fig. 9).

Components of d.c. electric vehicle supply equipment, for example an IMD, may superimpose a common mode voltage to protective conductor onto the d.c. output. At low output voltage this may shift the d.c. rails up to d.c. output voltage + 50 V compared to protective conductor.

Component of d.c. electric vehicle supply equipment may shift each d.c. output rail up to protective conductor through a resistor, which results in a large common mode output voltage swing.

The measurement circuits might introduce a larger common mode voltage offset if connected to an intermediate bus voltage. These circuits shall not cause a voltage shift that exceeds the requirements in **6.3.1.112**.

Fig. 9 shows an example of an incorrect implementation.

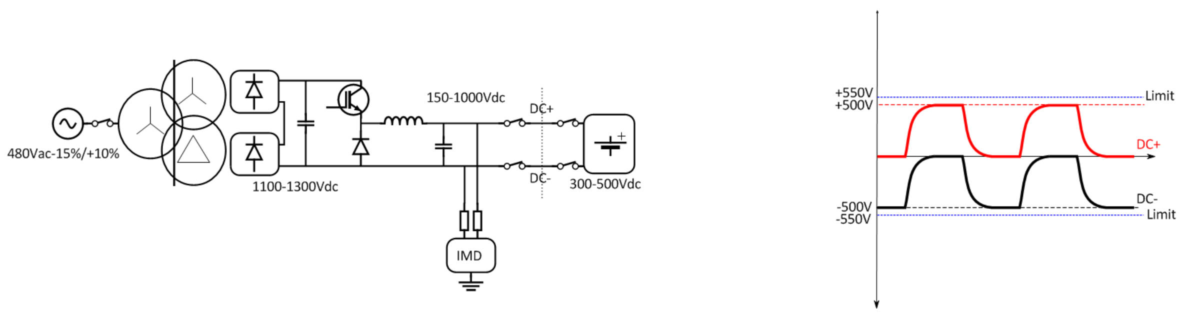


FIG. 8 TYPICAL VOLTAGES BETWEEN DC+/- AND PROTECTIVE CONDUCTOR IN CONDITIONS WITHOUT EARTH FAULT

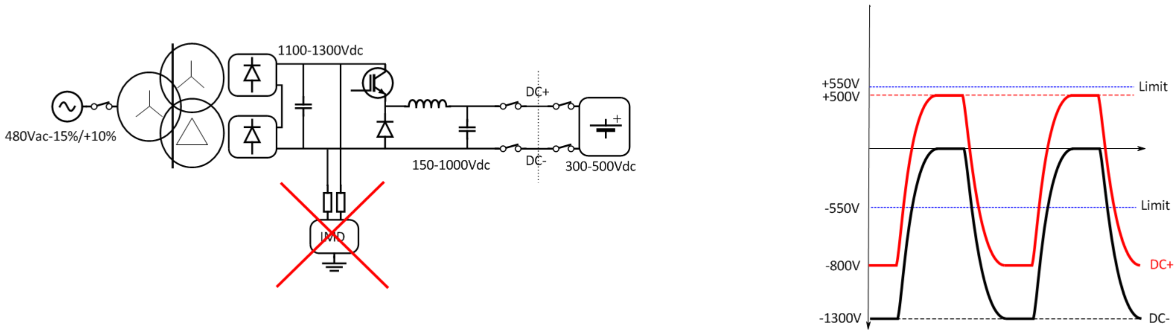


FIG. 9 IMD CONNECTION WHICH RESULTS IN EXCEEDANCE OF MAXIMUM VOLTAGE LIMITS

6.3.1.113 Maximum voltage between DC+/- and protective conductor in conditions with a single earth fault

For d.c. electric vehicle supply equipments serving a maximum rated output voltage up to 500 V, no voltage higher than 550 V shall occur for more than 5 s at the output between DC+ and protective conductor or between DC- and protective conductor (*see* Fig. 10).

If a voltage higher than 550 V is present for more than 1 s between DC+ and protective conductor or between DC- and protective conductor, the d.c. electric vehicle supply equipment shall have completed an error shutdown within 5 s after occurence of the overvoltage.

For d.c. electric vehicle supply equipments serving a maximum output voltage above 500 V and up to 1 000 V, no voltage higher than 110 percent of d.c. output voltage shall occur for more than 5 s at the output between DC+ and protective conductor or between DC- and protective conductor.

If a voltage higher than 110 percent of the d.c. output voltage is present for more than 1 s between DC+ and protective conductor or between DC- and protective conductor, the d.c. electric vehicle supply equipment shall have completed an error shutdown within 5 s after occurence of the overvoltage.

For voltage above 1 000 V, under consideration.

Within the first 5 s of an earth fault condition, the d.c. electric vehicle supply equipment shall limit the temporary overvoltage V_{tov} as defined in ISO 6469-3 and IS 15382(Part 1) between DC+/- and protective conductor to:

$(2\ U\text{min} + 1\ 000) \times 1.41$ V or;

$(U\text{min} + 1\ 200) \times 1.41$ V, whichever is less.

where

*U*min is the minimum rated d.c. output voltage.

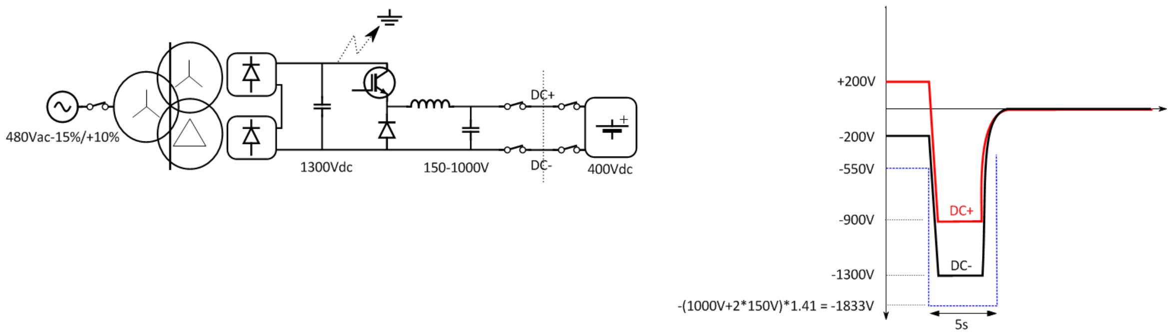


FIG. 10 MAXIMUM VOLTAGE BETWEEN DC+/- AND PROTECTIVE CONDUCTOR IN CONDITIONS WITH A SINGLE EARTH FAULT

Fig. 11 shows an example of temporary voltage waveform and the maximum voltage limit at the d.c. output.

EXAMPLE

[a] Lightning surge appears at the common-mode d.c. output as a result of its input to the a.c. input circuit of d.c. electric vehicle supply equipment.

FIG. 11 EXAMPLES OF TEMPORARY VOLTAGE WAVEFORM AND THE MAXIMUM VOLTAGE LIMIT AT THE d.c. OUTPUT

6.3.1.114 Shutdown of d.c. EV Supply Equipment

At the end of a shutdown sequence, the d.c. electric vehicle supply equipment shall reduce d.c. output current to equal to or less than 5 A, and shall be designed such that d.c. output voltage remains equal to or less than 60 V between DC+ and DC-, and equal to or less than 28 V between DC+ and earthing terminal, and DC- and earthing terminal.

6.3.1.115 Normal Shutdown

Normal shutdown occurs as a result of an intrinsic reaction of the vehicle or the d.c. electric vehicle supply equipment or a user interaction, for other reasons than the presence of a failure.

At the end of the normal shutdown sequence, the d.c. electric vehicle supply equipment shall reduce its output as follows:

a) d.c. output current ≤ 5 A;

b) d.c. output voltage remains ≤ 60 V between DC+ and DC- and remains ≤ 28 V between DC+ and earthing terminal, and DC– and earthing terminal.

Further requirements are specified in **A-4.3.5.1** and **B-3.3**.

6.3.1.116 Error Shutdown

After the error shutdown is triggered by the d.c. electric vehicle supply equipment, the d.c. electric vehicle supply equipment shall reduce its output as follows:

a) d.c. output current ≤ 5 A;

b) d.c. output voltage remains ≤ 60 V between DC+ and DC- and remains ≤ 28 V between DC+ and earthing terminal, and DC- and earthing terminal, within times as specified in Annex A and Annex B.

Timing and further requirements to initiate an error shutdown are specified:

a) for System A in **A-4.3.5.2**, Table 21 and Table 22;

b) for System C in **B-3.4.**

NOTE−The compliance test verifies the shutdown time which consists of performance time plus trigger time as defined in the Clauses referring to error shutdown. The trigger time does not need to be verified provided shutdown time complies with the specific requirement.

6.3.1.117 Emergency Shutdown

After the emergency shutdown is triggered by the d.c. electric vehicle supply equipment, the d.c. electric vehicle supply equipment shall reduce its output as follows:

a) d.c. output current ≤ 5 A within 30 ms;

b) d.c. output voltage ≤ 60 V between DC+ and DC-, and ≤ 28 V between DC+ and earthing terminal, and DC- and earthing terminal within 1 s for Systems A and C

NOTES

1 The compliance checks the total time, which consists of the timings above plus triggering time as defined in the Clauses referring to emergency shutdown. The trigger time does not need to be verified provided shutdown time complies with the specific requirement.

2 A welded contactor on the vehicle can prevent the d.c. electric vehicle supply equipment to reduce the voltage

Further requirements are specified in **A-4.3.5.3** and **B-3.4**.

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.7** and **B-9.3.8**.

The test system is shown in Fig. 12.

Key

J	switch or relay	L1, L2, L3	power line
CP	control pilot	I_{EVSE}	output current of electric vehicle supply equipment
PE	protective conductor	V_{EVSE}	output voltage of electric vehicle supply equipment
N	neutral contact		

FIG. 12 EMERGENCY SHUTDOWN TEST SYSTEM

The test shall be performed according to the following procedure.

a) Connect the d.c. electric vehicle supply equipment to an artificial load with dedicated electric vehicle simulator with load for each system.

b) Start charging with the procedure specified by the manufacturer of d.c. electric vehicle supply equipment.

c) Confirm that the d.c. power line between d.c. electric vehicle supply equipment and electric vehicle is energized at the rated voltage and the d.c. electric vehicle supply equipment is operating at the maximum rated output current.

d) Initiate emergency shutdown for System A, according to Table 24 and Table 25

e) The d.c. electric vehicle supply equipment shall terminate the charging process and transfer to shutdown stage, displaying a relevant alarm or error information, if any.

f) The d.c. output voltage shall be less than 60 V within 1 s, and the voltage between DC+ and earthing terminal, and voltage between DC- and earthing terminal shall be less than 28 V.

Replacement of title 6.3.2:

6.3.2 *Optional Functions for Mode 4*

6.3.2.1 *General*

The following functions, if provided by the d.c. electric vehicle supply equipment, shall comply with applicable Clauses as given below:

a) ventilation during supply of energy according to **6.3.2.2**;

b) Mode 4 using the combined charging system according to **6.3.2.4**;

c) wake up of d.c. electric vehicle supply equipment by electric vehicle according to **6.3.2.101**;

d) detection/adjustment of the real time available load current of the d.c. electric vehicle supply equipment according to **6.3.2.102**.

Other additional functions may be provided.

NOTES
1 Un-intentional live disconnect avoidance functions may be incorporated in the latching function interlock system.
2 A positive means to prevent unintentional disconnect is required.
3 Primary protection against overvoltage and overcurrent of vehicle battery is the responsibility of the vehicle.

Addition:

6.3.2.101 Wake Up of d.c. EV Supply Equipment by EV

The d.c. electric vehicle supply equipment may support a sleep mode to minimize power consumption. In this case, the d.c. electric vehicle supply equipment shall be able to be woken up by the electric vehicle.

For System A, the d.c. electric vehicle supply equipment shall be woken up by receiving the specific CAN ID from the vehicle.

Compliance is checked by the following test.

a) Set d.c. electric vehicle supply equipment in sleep mode.

b) Send a proper signal from electric vehicle simulator to d.c. electric vehicle supply equipment.

c) The d.c. electric vehicle supply equipment shall:

1) for System A, transmit CAN message ID: H’708 after receiving H'700 from the electric vehicle simulator as indicated in Table A.2 and Table A.3 of IS 17017(Part 24).

2) for System C, *see* **B-5.2**.

6.3.2.102 Detection/Adjustment of the Real Time Available Load Current of the d.c. EV Supply Equipment

The d.c. electric vehicle supply equipment may change the available current and shall transmit it to vehicle via digital communication. The vehicle should limit the current request value in accordance with the change in the available current. The current request value shall be less than or equal to the available current.

For specific requirements, *see* **A-7**.

7 COMMUNICATIONS

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

7.1 Digital Communication Between the EV Supply Equipment and the EV

Addition:

Protective measures defined in this document shall not rely on communicated values between the d.c. electric vehicle supply equipment and electric vehicle.

Annex F provides general information on the communication and charging process between electric vehicle and d.c. electric vehicle supply equipment.

Requirements on the communication for bi-directional power flow control for System A are specified in Annex A.

Addition:

7.1.101 Basic Communication Interface

Typical interfaces of control pilot function on d.c. electric vehicle charging systems are specified in Annex A and Annex B. Each system carries out control pilot function through the control pilot conductors and terminals specified in IS 17017(Part 2/Sec 3).

8 PROTECTION AGAINST ELECTRIC SHOCK

Replacement:

8.101 General Provisions

8.101.1 *General*

Requirements for protection against electric shock shall be according to 4.4 of IEC 62477-1: 2016, which provides safety requirements for power electronic converter systems (PECS) and equipment.

For the purposes of this document, the d.c. electric vehicle supply equipment is considered to be a type of PECS equipment.

Hazard based safety models according to IS/IEC 62368-1:2014 may be used to evaluate protection against electric shock.

Protection against the risk of electric shock and the hazard including the output circuit of d.c. electric vehicle supply equipment under conditions of intended use and reasonably foreseeable misuse shall be provided at least by one of the following measures.

a) Basic protection and fault protection, *see* **8.102** and **8.103**;
b) Enhanced protection, *see* **8.104**.

Protection under normal operating conditions is provided by basic protection, and protection under single fault conditions is provided by fault protection.

Specific protective measures for the secondary circuit supplying the d.c. output are provided in **8.105**.

Protection of the a.c. primary circuits of d.c. electric vehicle supply equipment may include an RCD according to **8.105.7**.

Specific requirements for protective measures for d.c. electric vehicle supply equipment having non-isolated d.c. output circuits are under consideration.

8.101.2 *Intended Use and Reasonably Foreseeable Misuse*

Considering intended use and reasonably foreseeable misuse:

a) hazardous-live-parts shall not be accessible and accessible-conductive-parts shall not be hazardous live; and

b) hazardous currents shall not be disconnected with the vehicle connector.

Compliance for hazardous-live-parts is checked according to **8.102**, **8.103** and **8.104**.

Compliance for hazardous currents is checked according to **6.3.1.103**.

8.101.3 *Limitation of Touch Current or Touch Voltage*

Under normal operating conditions and single fault conditions, an ordinary person shall be protected against a harmful electric shock by either:

a) limiting the touch currents, or

b) limiting the touch voltage.

Body impedance corresponding to water wet conditions in 3.1.8 of IS/IEC 60479-1 shall be considered under the normal operation conditions and single fault conditions.

Compliance for hazardous-live-parts is checked according to **8.102**, **8.103**, **8.104** and **8.105**.

NOTE — The skin of a sweating person or a person after immersion in seawater is not considered.

8.101.4 *Threshold of Perception and Startle Reaction*

Protective measures shall be provided to prevent startle reactions during intended use, before, during and after an energy transfer session, under normal conditions and during single fault conditions. During the normal operating conditions, perception may be possible.

For the current path, finger-to-feet at the interface and hand-to-feet at the chassis shall be considered.

Protection by means of limitation of touch current shall be provided, such that a steady-state touch current flowing between simultaneously accessible conductive parts shall not exceed:

a) 0.5 mA a.c. / 2 mA d.c. under normal operation, and

b) 3.5 mA a.c./ 10 mA d.c. under single fault condition

Additional protection shall be provided, such that in case of a double fault, touch current does not exceed the DC2 limit (line B) in Fig. 22 and Table 13 of IEC 60479-1:2018.

Compliance is checked by measurement according to **12.6**.

Protection by means of limitation of discharge energy shall be provided, such that discharge energy shall not exceed:

a) 5 µJ under normal operation;

b) 0.5 mJ under single fault condition.

Additional protection shall be provided, such that in case of a double fault, the discharge energy does not exceed the C1 limit in Fig. 23 of IEC 60479-2:2017.

Compliance is checked by design review.

8.102 Basic Protection

8.102.1 *General*

Basic protection in d.c. electric vehicle supply equipment is employed to prevent persons from touching hazardous live parts. It shall be provided by one or more of the measures given in **8.102.2**, **8.102.3**, **8.102.4**, and **8.102.5**.

8.102.2 *Protection by Means of Basic Insulation of Live Parts*

Protection by means of basic insulation of live parts in d.c. electric vehicle supply equipment shall be according to 4.4.3.2 of IEC 62477-1:2016.

Basic insulation shall be provided by solid insulation or clearance and/or creepage distance.

Any accessible conductive part is considered to be a hazardous live part if not separated from the live parts by required insulation.

Basic insulation shall be designed and tested to withstand the impulse voltages and temporary overvoltages for the circuits to which they are connected.

Compliance is checked by inspection and test.

Test shall be conducted according to 5.2.3.2 and 5.2.3.4 of IEC 62477-1:2016.

8.102.3 *Protection by Means of Enclosures or Barriers*

Protection by means of enclosures or barriers in d.c. electric vehicle supply equipment shall be according to 4.4.3.3 of IEC 62477-1: 2016.

Enclosures shall be suitable for use in their intended environments.

The d.c. electric vehicle supply equipment shall have adequate mechanical strength and shall be so constructed that no hazard occurs when subjected to intended use and expected misuse over the expected lifetime.

It shall only be possible to open enclosures or remove barriers:

a) with the use of a tool or key; or

b) after de-energization of hazardous live parts.

For constructional requirements, see **12.109**.

8.102.4 *Protection by Means of Limitation of Voltage*

Basic protection by the provision of limitation of voltage is fulfilled where the following conditions are met:

a) Steady-state touch voltage under normal operation does not exceeds the values in Table 8;

b) Steady- state touch voltage under single fault condition does not exceed the values in Table 9;

c) A non-recurring d.c. touch voltage under normal operation does not exceed the limit of Fig. A.11 of IEC 62477-1:2016;

d) A non-recurring d.c. touch voltage under single fault condition does not exceed the limit of Fig. A.8 of IEC 62477-1:2016;

e) The voltage is supplied by one of the following sources:

1) a safety isolating transformer for the auxiliary circuit including control pilot.

NOTE — Safety isolating transformers are those that comply with IEC 61558-2-6.

2) a source of voltage providing a degree of safety equivalent to that of a safety isolating transformer;

3)electrochemical (for example battery).

Table 8 – Touch Voltage under normal operation (Water Wet)

(*Clause* 8.102.4)

Body Contact Area	a.c. (rms)	d.c.
Part of body	Basic protection required	
Hand		
Finger tip	8.0 V	22.0 V
NOTE−Values are derived from Fig. A.8, Fig. A.11, Table A.3 and Table 5 of IEC 62477-1:2016. The values are based on a current path from the contact area of the body to feet, with the person in standing position.		

Table 9 – Touch Voltage under single fault conditions (Water Wet)

(*Clause* 8.102.4)

Body Contact Area	a.c. (rms)	d.c.
Part of body	Basic protection required	
Hand		
Finger tip	12.0 V	28.0 V
Hand-to-feet	-	22.0 V
NOTES **1** Values are derived from Fig. A.8, Fig. A.11, Table A.2 and Table 5 of IEC 62477-1:2016. The values are based on a current path from the contact area of the body to feet, with the person in standing position. **2** If these values cannot be met under single fault conditions, protective separation is needed.		

Compliance is checked by inspection and measurement.

8.102.5 *Protection by Means of Limitation of Steady-State Touch Current*

Limitation of steady-state touch current is a provision whereby touch current is limited to non-hazardous values. The limits are provided in **8.101.4**.

The protective impedance limiting the touch current shall comply with 4.4.5.4 of IEC 62477-1: 2016.

The protective impedance shall be so designed and tested to withstand the impulse voltages and temporary overvoltages as tested according to 5.2.3.2 and 5.2.3.4 of IEC 62477-1: 2016.

Compliance is checked by measurement according to **12.6**.

8.103 Fault Protection

8.103.1 *General*

Fault protection provides protection against bodily harm due to contact with hazardous electrical energy during and after failure of the basic protection.

Fault protection shall be provided by one or more of the following measures:

a) protective equipotential bonding in **8.103.2** in combination with the protective conductor,

b) automatic disconnection of supply in **8.103.4**,

c) supplementary insulation in **8.103.5**, and

d) electrically protective screening in **8.103.6**.

Fault protection shall be independent and additional to those for basic protection.

In case the d.c. electric vehicle supply equipment or the d.c. charging/discharging station can supply more than one vehicle simultaneously, independent protection means (overcurrent and fault current) for each vehicle connector shall be provided in accordance with one or more of the provisions in **8.103.2**, **8.103.3**, **8.103.4**, **8.103.5** and **8.103.6**.

8.103.2 *Protective-Equipotential-Bonding*

Protective-equipotential-bonding is a provision whereby items are bonded together to avoid hazardous touch voltages.

Protective-equipotential-bonding in d.c. electric vehicle supply equipment shall be according to 4.4.4.2 of IEC 62477-1:2016.

Compliance is checked by inspection.

8.103.3 *Effective Earth Continuity between the Enclosure and the External Protective Circuit*

Exposed conductive parts of the d.c. electric vehicle supply equipment shall be effectively connected to the terminal for the external protective earthing conductor, and the resistance from the conductive part to the terminal of the external protective earthing conductor shall not exceed 0.1 Ω.

Compliance is checked by the following test.

a) Make verification using a resistance measuring instrument which is capable of driving a current of at least 10 A (a.c. or d.c..). Pass the current between each exposed conductive part and the terminal for the external protective conductor.

b) Confirm that the resistance does not exceed 0.1 Ω.

NOTES

1 It is recommended to limit the duration of the test where low-current equipment otherwise may be adversely affected by the test.

2 Routine testing can be performed according to 5.2.3.11.4 of IEC 62477-1: 2016.

8.103.4 *Automatic Disconnection of Supply*

Automatic disconnection of supply in d.c. electric vehicle supply equipment shall be according to 4.4.4.4 of IEC 62477-1: 2016 except as follows:

The protective device may be provided in any suitable upstream part of the installation or d.c. electric vehicle supply equipment. The manufacturer of d.c. electric vehicle supply equipment shall give appropriate information for the installation of external protection. The information may be provided in a detailed electric diagram.

Compliance is checked by inspection and measurement.

8.103.5 *Supplementary Insulation*

Supplementary insulation in d.c. electric vehicle supply equipment shall be according to 4.4.4.5 of IEC 62477-1: 2016.

Compliance is checked by inspection.

8.103.6 *Electrically Protective Screening*

Electrically protective screening in d.c. electric vehicle supply equipment shall be according to 4.4.4.7 of IEC 62477-1:2016. Electrically protective screening shall consist of a conductive screen interposed between hazardous-live-parts of the d.c. electric vehicle supply equipment and the part being protected, whereby the screen is separated from live parts by at least basic insulation.

The protective screen shall:

a) be connected to the protective-equipotential-bonding system of the d.c. electric vehicle supply equipment and that interconnection shall comply with the requirements of 4.4.4.2 of IEC 62477-1: 2016, and

b) comply with the requirements for elements of the protective-equipotential-bonding system according to 5.3.3.3, 5.3.3.4 and 5.3.3.5 of IEC 61140:2016.

Compliance is checked by inspection.

8.104 Enhanced Protection

8.104.1 *General*

An enhanced protective provision shall provide both basic protection under normal conditions and protection under single fault conditions in accordance with one or more of the provisions specified in **8.104.2** and **8.104.3**.

8.104.2 ***Reinforced Insulation***

Reinforced insulation in d.c. electric vehicle supply equipment shall be according to 4.4.5.2 of IEC 62477-1: 2016.

Compliance is checked by inspection.

8.104.3 ***Protective Separation between circuits***

Protective separation between circuits in d.c. electric vehicle supply equipment shall be according to 4.4.5.3 of IEC 62477-1: 2016.

Compliance is checked by inspection

8.105 Requirements of the Isolated d.c. EV Supply Equipment

8.105.1 *General*

Between the d.c. circuit and the ordinary person, double insulation, reinforced insulation, or basic insulation and electrically protective screening (shielding), shall be used as basic and fault protection.

For System A and C, insulation monitoring or leakage current monitoring in the d.c. electric vehicle supply equipment shall detect the first fault and disconnect the supply or shutdown the transfer of energy. This is not protection against electric shock but can prevent a hazardous electric shock on a second fault.

For detailed description, refer to **A-3.1** and **B-4.1**.

The reaction time of the insulation monitoring device or earth leakage current monitoring device shall be according to **A-3.1.2** and **B-4.1.4**. The value of the Y capacitances shall ensure that the reaction time of the insulation monitoring device or earth leakage current monitoring device is not exceeded. In any case, Y capacitance shall be less than 500 nF per rail for d.c. electric vehicle supply equipment.

The limitation of stored energy in the Y-capacitors shall not be used as fault protection for the d.c. electric vehicle supply equipment.

Additional protection may be provided by limited impedance between the d.c. output and the protective conductor, including the connected electric vehicle (*see* **8.101.4** for the requirements for additional protection).

Requirements for the isolated d.c. electric vehicle supply equipment for protection against electric shock hazard are defined for each system in **A-3.1** and **B-4.1.**

Outside of a fire enclosure, DC+ and DC- shall be separated by double or reinforced insulation from each other and other circuits.

In case the d.c. electric vehicle supply equipment can supply more than one vehicle simultaneously, independent protection means (overcurrent and fault current) for each vehicle connector shall be used in order to ensure selectivity.

In addition, if the d.c. electric vehicle supply equipment has multiple d.c. outputs designed for simultaneous operation, each output circuit shall be isolated from each other by basic insulation, double or reinforced insulation.

NOTE — System A requires limitation of Y-capacitance of electric vehicle with battery voltage up to 500 V, such that the total stored energy per rail to protective conductor of charging system does not exceed 0.2 J under the worst case scenario.

8.105.2 *Degrees of Protection Against Access to Hazardous-Live-Parts*

IP ratings for enclosures of d.c. electric vehicle supply equipment shall fulfil at least IPXXC.

Compliance is checked by inspection and measurement.

8.105.3 *Insulation Barriers*

The d.c. electric vehicle supply equipment shall have insulation barriers as shown in Fig. 13. The d.c. electric vehicle supply equipment shall provide the minimum protective measures as defined in Table 10.

Key

PE protective conductor

FIG. 13 INSULATION BARRIERS

Table 10 – Minimum protective measures

(*Clause* 8.105.3)

	d.c.	**SELV**	**Protective conductor**	**Ordinary person**
a.c.	Protective separation	Protective separation	Single insulation [a]	Protective separation
d.c.	-	Protective separation [b]	Single insulation (< 600 V) Double insulation (> 600 V) [c]	Protective separation
SELV	-	-	Functional insulation [d]	None
Protective conductor	-	-	-	None

[a] Local regulations may require double insulation. In some countries, extra monitoring of protective conductor is required when using single insulation. For some system, for example TT systems, double insulation to protective conductor is required up to the RCD, if one is installed in the d.c. electric vehicle supply equipment

[b] If the SELV circuit is connected to protective conductor and will not be damaged by the fault current, no hazardous voltages shall occur in the SELV circuit, and the IMD or earth leakage current monitoring device will detect the failure and trigger an error shutdown within 10 s (*under consideration*), single insulation between d.c. and SELV is allowed for some components, for example: contactors.

[c] If on the secondary (d.c.) side, there is a circuit with a working voltage greater than 600 V, double insulation to the protective conductor is required. Additional protective measures are taken to limit the impedance to the protective conductor.

[d] SELV may be connected to the protective conductor. If SELV is floating a 500 V r.m.s. test voltage may be applied to test the insulation

8.105.4 *Stored Energy*

8.105.4.1 *Disconnection of plug and cable connected d.c. EV supply equipment*

For plug and cable connected d.c. electric vehicle supply equipment, where the connection pins are accessible after unplugging, one second after disconnecting the standard plug from the standard socket-outlet, for instance as described in IEC TR 60083:2015 or IEC 60309-1, the voltage between any combination of accessible contacts of the standard plug shall be less than or equal to 28 V d.c. and 12 V a.c. (r.m.s.) or the stored energy available shall be less than 0.5 mJ.

Compliance is checked by inspection and by test with the electric vehicle disconnected according to 2.1.1.5 of IEC 60950-1:2005.

8.105.4.2 *Loss of supply voltage to permanently connected d.c. EV supply equipment*

The voltage between power lines or power lines and protective earthing conductor, when measured at the input supply terminals of the d.c. electric vehicle supply equipment, shall be less than or equal to 28 V d.c. and 12 V a.c. (r.m.s.) or the stored energy shall be less than or equal to 0.5 mJ within 5 s after disconnecting the power supply voltage to the d.c. electric vehicle supply equipment.

Compliance is checked by inspection and by test with no electric vehicle connected to the d.c. electric vehicle supply equipment according to 2.1.1.7 of IEC 60950-1:2005.

8.105.5 *Disconnection from Vehicle*

If the voltage between any contacts at the vehicle connector exceeds 28 V d.c. or 12 V a.c. (r.m.s.) during charging, the electric vehicle supply equipment shall comply with at least one of the following requirements:

a) The energy between any contacts shall be below 0.5 mJ within 1 s after disconnection of the vehicle connector from the vehicle inlet (Case 1), and

b) The voltage between any contacts shall be below or equal to 28 V d.c. and 12 V a.c. (r.m.s.) within 1 s after disconnection of the vehicle connector from the vehicle inlet (Case 2).

The voltage or energy shall be measured at the unmated vehicle connector.

The test shall be performed according to the following procedure.

a) The d.c. electric vehicle supply equipment is connected to an artificial load as defined in **102.2.3**.

b) The power line is energized at the maximum output voltage of the d.c. electric vehicle supply equipment.

c) Start the measurement of voltage between each contact (P-N, P-GND and N-GND).

1) Stop charging based on the stop sequence defined by each system.

2) The test is passed:

i) for Case 1, if the stored energy at 1 s after disconnecting all the signal lines or the connector-latch circuit, if any, is less than the defined value. The energy is calculated by using the corresponding values of capacitances determined before and the documented voltage 1 s after triggering. *See* Formula (2).

$$E = 0.5 \times C \times V^2 \qquad (2)$$

where

E is the energy 1 s after triggering in Joule;

C is the capacity in Farad;

V is the voltage 1 s after triggering in Volt.

ii) for Case 2, if the voltage values between any contacts fall to less than 28 V in 1 s or less after disconnecting all the signal lines or the connector latch circuit, if any. For System A, the stored energy calculated by Formula (2) in the output circuit of d.c. electric vehicle supply equipment also needs to be less than the value specified for Case 1.

8.105.6 *Protective Earthing Conductor from Supply Network*

The protective earthing conductor and the protective conductor from the supply network shall be of sufficient rating in accordance with requirements of 543.1.2 of IEC 60364-5-54:2011.

The d.c. electric vehicle supply equipment shall provide either:

a) a protective earthing conductor from the input earthing terminal of the a.c. supply network to the d.c. electric vehicle supply equipment; or

b) a protective conductor from the d.c. electric vehicle supply equipment to the electric vehicle if fault protection is based on protective separation. See requirements in **8.105.9**.

For permanently connected d.c. electric vehicle supply equipment, protective earthing conductors shall not be switched.

Protection Class II d.c. electric vehicle supply equipment shall have a lead-through protective conductor with double insulation or reinforced insulation for earthing the electric vehicle chassis.

Compliance is checked by inspection.

8.105.7 *Residual Current Protective Devices*

The d.c. electric vehicle supply equipment intended for fixed installation may rely on RCD(s) incorporated in the d.c. electric vehicle supply equipment and/or provided upstream by the installation as defined in the installation manual of the d.c. electric vehicle supply equipment and relevant wiring diagrams.

Plug and cable d.c. electric vehicle supply equipment shall be provided with RCD(s) within the d.c. electric vehicle supply equipment or on the cable or plug, and double insulation to the protective conductor is required between the plug and any parts not protected by RCD(s).

RCDs incorporated in d.c. electric vehicle supply equipment shall be at least of type A and comply with one of the following standards: IS 12640(Part 1), IS 12640(Part 2), or IS/IEC 60947-2.

RCDs incorporated on the cable, if any, shall be at least of type A and comply with IEC 61540.

RCDs shall disconnect all live conductors.

Manufacturer shall check compliance with RCDs incorporated in the d.c. electric vehicle supply equipments, or to be provided by the installation, by simulation or calculation of current in the protective conductor under normal and single fault conditions according to the guideline provided in Annex H of IEC 62477-1:2016.

Plug and cable d.c. electric vehicle supply equipments shall always be designed such that under normal and fault conditions any resulting d.c. component of the current in the protective conductor never exceed 6 mA.

Compliance is checked by inspecting the construction and documents provided by the manufacturer.

NOTE — Limitation of d.c. component of the current in the protective conductor can be achieved by double or reinforced insulation of the circuit that can cause a d.c. leakage current to any other circuit and protective conductor, or d.c. leakage detection that disconnects the circuit that causes excessive d.c. leakage current.

8.105.8 *Safety Requirements for Signalling Circuits between the d.c. EV Supply Equipment and the EV*

Any circuit for signalling, which extends beyond the d.c. electric vehicle supply equipment enclosure for connection with the electric vehicle, for example control pilot circuit, shall be extra low voltage (SELV or PELV) according to IEC 62477-1.

Compliance is checked by inspection.

8.105.9 *Protective Conductor Dimension Cross-Sectional Area*

The protective earthing conductor or protective conductor of the secondary circuit of d.c. electric vehicle supply equipment shall be designed according to **A-3.1.1** or **B-4.7**.

Compliance is checked by inspection and measurement.

9 CONDUCTIVE ELECTRICAL INTERFACE REQUIREMENTS

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

9.1 General

Replacement:

The physical conductive electrical interface requirements between the vehicle and the d.c. electric vehicle supply equipment are as defined in IS 17017(Part 2/Sec 3).

9.2 Functional Description of Standard Accessories

Not applicable.

9.7 Wiring of the Neutral Conductor

Not applicable except the following:

Wiring instructions shall be provided in the manual (*see* **16.1**).

Addition:

9.101 Avoidance of Breaking Under Load

For d.c. charging, the vehicle couplers are rated "not for current interruption." A disconnection shall not take place under load.

In addition to latching mechanism defined in **6.3.1.103**, in case of unintended disconnection of the vehicle coupler, the output current of the d.c. electric vehicle supply equipment shall be turned off within a defined time to contain a possible arc within the vehicle coupler housing.

This turn-off time shall comply with the value specified in **A-3.8.2**, **B-4.3** using a speed of separation of the vehicle connector of 0.8 ± 0.1 m/s according to IS 17017(Part 2/Sec 1).

Disconnection of vehicle coupler shall be detected by interruption of interlock circuit(s), for example control pilot, proximity circuit, to mitigate electrical arcing and shock hazards.

Compliance is checked by the test in **6.3.1.117**.

The system specific requirement for breaking capacity and system redundancy are defined in **A-3.6** and **A-3.8.2** for System A and **B-4.3** for System C.

10 REQUIREMENTS FOR ADAPTORS

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

11 CABLE ASSEMBLY REQUIREMENTS

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

Addition:

11.101 Cable Breakaway

The cable shall be connected to the enclosure in such a way that, if the cable anchorage fails, the conductors break in the following sequence:

a) first, the control pilot conductor/conductors;

b) second, the current carrying conductors;

c) third, the protective earthing conductor, if any.

12 EV SUPPLY EQUIPMENT CONSTRUCTIONAL REQUIREMENTS AND TESTS

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

12.1 General

Addition:

The d.c. electric vehicle supply equipment shall comply with the restrictions/limitations as specified in the data sheet of the cable assembly manufacturer.

Compliance is checked by inspection.

12.3 Clearances and Creepage Distances

Replacement of the First paragraph:

The clearance and creepage distances in the electric vehicle supply equipment, installed as intended by the manufacturer, shall be in accordance with the requirements specified in IEC 62477-1.

Addition:

The d.c. output circuit of a d.c. electric vehicle supply equipment shall be designed according to a rated impulse voltage of at least 2 500 V.

Compliance is checked according to 12.7 of IS 17017(Part 1):2018.

12.4 IP Degrees

12.4.1 *Degrees of Protection Against Solid Foreign Objects and Water for the Enclosures*

Addition:

For the d.c. electric vehicle supply equipment of stationary type, the test conditions can be defined in accordance with installation conditions.

12.5 Insulation Resistance

Addition:

Insulation resistance does not include components bridging insulation according to **12.109** and IMD or earth leakage current monitoring device.

When the d.c. output is energized, the actual total physical insulation resistance of the d.c. electric vehicle supply equipment between DC+/- to protective earthing conductor,that will not result in a shutdown, shall limit the touch current within the DC-2 area of Fig. 22 of IEC 60479-1:2018.

NOTES

1 The test is made without an insulation monitoring system.

2 The actual total physical insulation resistance is a combination of the impedance of the all components within the d.c. electric vehicle supply equipment and the electric vehicle.

3 The measured insulation resistance does not include the impedance of the insulation resistance measurement device.

12.6 Touch Current

This clause of IS 17017(Part 1) does not apply except Table 1.

Addition:

12.6.101 *Touch-Current Limit*

The touch current between any ca.c supply network poles and the accessible metal parts connected with each other and with a metal foil covering insulated external parts shall not exceed the values indicated in Table 1 of IS 17017(Part 1).

The test shall be made when the d.c. electric vehicle supply equipment is functioning with an artificial load according to Fig. 26 at rated output power.

For permanently connected Class I d.c. electric vehicle supply equipment, if the test touch current exceeds 3.5 mA, 12.6.103 is applicable.

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

Compliance is checked by the test in **12.6.102.**

12.6.102 *Test*

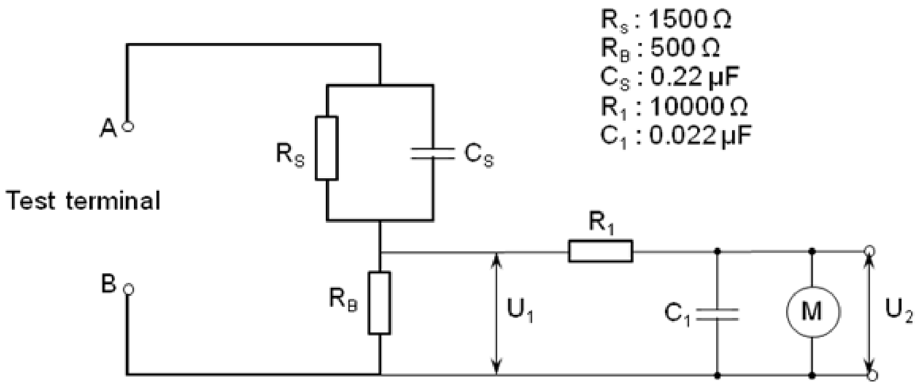
12.6.102.1 *Test configuration*

Test configurations for measurement of leakage current shall be according to **5.4.1** of IEC 60990:2016.

12.6.102.2 Application Of Measuring Network

The measuring network is defined in Fig. 14. Terminal A of the measuring network is connected to each conductive or unearthed accessible surface in turn. For each application of the terminal A electrode, the terminal B electrode is applied to earth, then to each of the other accessible parts in turn. All accessible conductive or unearthed surfaces are to be tested for touch currents.

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



Key

A, B	terminal of the measuring network	U_1, U_2	output voltage
C_1, C_S	capacitor	R_1, R_B, R_S	resistor
		M	measuring instrument

FIG. 14 MEASURING NETWORK OF TOUCH CURRENT WEIGHTED FOR PERCEPTION OR REACTION

For accuracy of touch current measuring instruments, *see* G.3 of IS/IEC 60990:2016.

12.6.102.3 *Test condition*

The touch current shall be measured after the damp heat test, with the d.c. electric vehicle supply equipment connected to a.c. supply network in accordance with 6 of IS/IEC 60990:2016. The supply voltage shall be 1.1 times the nominal rated voltage.

Measurements shall be made with each of the applicable fault conditions in accordance with 6.2.2 of IEC 60990:2016.

12.6.102.4 *Test measurements*

The r.m.s. value of the voltage, *U*2, shall be measured using the measuring instrument in Fig. 14. Formula (3) shall be used to calculate the touch current:

$$\text{Touch Current(A)} = U2 / 500 \tag{3}$$

None of the values measured in accordance with **12.6.102.2** shall exceed the relevant limits specified in **12.6.101**.

12.6.103 *Protection Measures for the Touch Current Exceeding* 3.5 mA

For the a.c. supply circuit of a Class I d.c. electric vehicle supply equipment, if the test touch current exceeds 3.5 mA r.m.s, one of the following requirements shall be met. The touch current shall be measured under the fault condition with earthing conductor closed.

a) The protective earthing conductor shall have a cross-sectional area of at least 10 mm2 Cu or 16 mm2 Al, through its total run;

b) Where the protective earthing conductor has a cross-sectional area of less than 10 mm2 Cu or 16 mm2 Al, a second protective earthing conductor of at least the same cross-sectional area shall be provided up to a point where the protective earthing conductor has a cross-sectional area not less than 10 mm2 Cu or 16 mm2 Al;

NOTE — (b) can require that the d.c. electric vehicle supply equipment has a separate terminal for a second protective earthing conductor.

c) Automatic disconnection of the supply in case of loss of continuity of the protective earthing conductor.

A caution symbol ⚠ shall be placed on the outside of the d.c. electric vehicle supply equipment, visible to the user.

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

12.7 Dielectric Withstand Voltage

Addition:

12.7.101 *Suppression of Transient Overvoltage at Input (Insulation Coordination)*

When applying the test setup of IS 17017(Part 21/Sec 2):2019, Annex E, with an impulse voltage according to Table F.1 of IS 15382(Part 1):2014 at the input of the d.c. electric vehicle supply equipment, the d.c. electric vehicle supply equipment shall limit the output voltage to:

a) 2 500 V between DC+ and protective earthing conductor;

b) 2 500 V between DC- and protective earthing conductor; and

c) output voltage of d.c. electric vehicle supply equipment plus 500 V, between DC+ and DC-.

The d.c. electric vehicle supply equipment shall operate at its rated output voltage during the test.

Compliance is checked by applying the test setup of IS 17017(Part 21/Sec 2):2019, Annex E, with a voltage according to Table F.1 of IS 15382(Part 1):2014 at the input of the d.c. electric vehicle supply equipment.

NOTES

1 The overvoltage reduction can be achieved by combination of one or more attenuation means in accordance with 4.3.3.6 of IS 15382(Part 1):2014.

2 For specification of the overvoltage category (OVC) of the primary circuit of the d.c. electric vehicle supply equipment, *see* 12.3 of IS 17017(Part 1):2018.

12.7.102 *Protection against Transient Overvoltages of Atmospheric Origin or due to switching*

Any power or data line cable connected to the d.c. electric vehicle supply equipment may be protected against lightning or switching events by the use of appropriate surge protective devices according to IS 16463 series. The test class and the surge/impulse current requirement (In and/or Iimp) for these devices may be determined according to the IS/IEC 62305-4. The voltage protection level (Up) for these devices may be determined according to the requirements of IS/IEC 62305-4:2010, **B-2.1** in conjunction with the overvoltage categories as specified in **12.3** of IS 17017(Part 1):2018, when applicable.

12.11 Mechanical Strength

Replacement:

For ground mounted and wall mounted d.c. electric vehicle supply equipment in locations with restricted access, the minimum degree of protection against mechanical impact shall be IK07 according to IS 17050:2018.

For ground mounted and wall mounted d.c. electric vehicle supply equipment in locations with non-restricted access, the minimum degree of protection against mechanical impact shall be IK08 according to IS 17050:2018.

For moveable d.c. electric vehicle supply equipment under 18 kg in locations with non-restricted access, the minimum degree of protection against mechanical impact shall be IK08 according to IS 17050:2018.

Moveable d.c. electric vehicle supply equipment under 18 kg shall comply with 4.4.4.3 of IS/IEC 62368-1:2014.

Addition:

12.101 Input Current

The steady state input current of the d.c. electric vehicle supply equipment shall not exceed the rated input current by more than 10 percent under the most onerous charging conditions.

Compliance is checked by measuring the input current of the d.c. electric vehicle supply equipment under the operating point (*see* **102.2.4**) which produces the highest value of input current.

Each measurement of the input current shall be taken when the input current has stabilized.

NOTES

1 When the d.c. electric vehicle supply equipment has more than one voltage rating, the input current is measured at each voltage rating;

2 When the d.c. electric vehicle supply equipment has one or more rated voltage ranges, the input current is measured at the extremes of each rated voltage range.

12.102 Specific Requirements for Liquid Cooled d.c. EV Supply Equipment

A d.c. electric vehicle supply equipment employing liquid cooling as an element of the thermal management system shall comply with the additional requirements for liquid cooling according to 4.7.2 of IEC 62477-1:2016.

12.103 Power Supply Cords

12.103.1 *General*

A power supply cord of d.c. electric vehicle supply equipment shall be of the sheathed type.

Rubber sheathed power supply cords shall be of synthetic rubber and not lighter than ordinary tough rubber sheathed flexible cord according to IEC 60245-1:2008, designation 60245 IEC 53;

PVC sheathed power supply cords shall comply with the following:

a) for equipment provided with a non-detachable power supply cord and having a mass not exceeding 3 kg, be not lighter than light PVC sheathed flexible cord according to IEC 60227-1:2007, designation 60227 IEC 52;

b) for equipment provided with a non-detachable power supply cord and having a mass exceeding 3 kg, be not lighter than ordinary PVC sheathed flexible power supply cord according to IEC 60227-1:2007, designation 60227 IEC 53;

NOTE − There is no limit on the mass of the equipment if the equipment is intended for use with a detachable power supply cord.

c) for equipment provided with a detachable power supply cord, be not lighter than light PVC sheathed flexible cord according to IEC 60227-1:2007, designation 60227 IEC 52.

For plug and cable d.c. electric vehicle supply equipment that has protective earthing, a protective earthing conductor shall be included in the supply cord.

Compliance is checked by inspection.

12.103.2 *Cross Sectional Area*

The supply cords shall have conductors with cross-sectional areas not less than those specified in Table 11.

Table 11 – Sizes of conductors of power supply cord

(*Clause* 12.103.2)

Rated current of the equipment [a] A up to and including	Minimum conductor sizes Cross-sectional area mm^2
3	0.5 [b]
6	0.75
10	1.00 (0.75) [c]
16	1.50 (1.0) [d]
25	2.5
32	4
40	6
63	10
80	16
100	25
125	35
160	50
190	70
230	95
260	120
300	150
340	185
400	240
460	300

NOTES

1 IEC 60320-1 specifies acceptable combinations of appliance couplers and flexible cords, including those covered by footnotes [b], [c] and [d]. However, a number of countries have indicated that they do not accept all of the values listed in this table, particularly those covered by footnotes [b], [c] and [d].

2 For higher currents *see* the IEC 60364 series.

[a] The rated current includes currents that can be drawn from a socket outlet providing mains power for other equipment.

[b] For rated current up to 3 A, a nominal crosssectional area of 0.5 mm^2 may be used in some countries provided that the length of the cord does not exceed 2 m.

[c] The value in parentheses applies to detachable power supply cords fitted with the connectors rated 10 A in accordance with IEC 60320-1 (types C13, C15, C15A and C17) provided that the length of the cord does not exceed 2 m.

[d] The value in parentheses applies to detachable power supply cords fitted with the connectors rated 16 A in accordance with IEC 60320-1 (types C19, C21 and C23) provided that the length of the cord does not exceed 2 m.

Compliance is checked by inspection.

12.103.3 *Cord Anchorages and Strain Relief for Non-Detachable Power Supply Cords — Cord Strain Relief*

12.103.3.1 *General*

Protective measures against strain being transmitted to the equipment terminations of the conductors of the supply cord are specified below.

A knot shall not be used as a strain relief mechanism.

A screw that bears directly on the cord or cable shall not be used as a strain relief mechanism unless the cord anchorage, including the screw, is made of insulating material and the screw is of comparable size to the diameter of the cord being clamped.

When a pull force and a torque are applied to a non-detachable power supply cord or cable, a basic safeguard shall minimize strain from being transmitted to the cord or cable terminations.

The pull force applied to the cord or cable is specified in Table 12. The force is applied in the most unfavourable direction for 1 s and repeated 25 times.

Table 12 - Cord strain relief pull force

(*Clause* 12.103.3.1)

Mass of the equipment kg	**Force** N
Up to and including 1	30
Over 1 up to and including 4	60
Over 4	100

A torque of 0.25 Nm is applied for 1 min to the cord or cable immediately after the pull force application. The torque is applied as close as practicable to the strain relief mechanism and is repeated in the opposite direction.

Compliance is determined by measurement and visual inspection. There shall be no damage to the cord or conductors and the displacement of the conductors shall not exceed 2 mm. Stretching of the cord outer jacket without displacement of the conductors is not considered displacement.

12.103.3.2 *Strain relief mechanism failure*

If the basic protective measure (strain relief mechanism) should fail and strain is transmitted to the non-detachable power supply cord or cable terminations, a supplementary protective measure shall ensure that the earth termination is the last to take the strain.

Compliance is determined by inspection and, if necessary, by defeating the basic protective measure and inspecting the conductor slack while applying the force in Table 12.

12.103.3.3 *Cord sheath or jacket position*

The cord or cable sheath or jacket shall extend from the basic safeguard (strain relief mechanism) into the equipment at least one-half the diameter of the cord or cable.

Compliance is checked by inspection.

12.103.3.4 *Strain relief and cord anchorage material*

The cord anchorage shall either be made of insulating material or have a lining of insulating material complying with the requirements for basic insulation. Where the cord anchorage is a bushing that includes the electrical connection to the screen of a screened power cord, this requirement shall not apply.

If the basic protective means (strain relief mechanism) is made of polymeric material or if the basic protective means is mounted in an enclosure consisting of polymeric material, the basic protective means shall retain its structural properties following the mould stress relief according to **12.104**.

Compliance is determined by inspection and by applying the force and torque tests of **12.103.3.1** after the basic protective means has come to room temperature.

12.104 Stress Relief Test

Stress relief is checked by the mould stress relief test of IEC 60695-10-3 or by the test procedure described below or by the inspection of the construction and the available data where appropriate.

One sample consisting of the complete equipment, or of the complete enclosure together with any supporting framework, is placed in a circulating air oven at a temperature 10 K higher than the maximum temperature observed on the sample during the heating test of **12.108.2.2**, but not less than 70 °C, for a period of 7 h, then cooled to room temperature.

For large equipment where it is impractical to condition a complete enclosure, a portion of the enclosure representative of the complete assembly with regard to thickness and shape, including any mechanical support members, may be used.

NOTE — Relative air humidity need not be maintained at a specific value during this test.

12.105 Abnormal Operation and Simulated Fault Condition Tests

12.105.1 *General*

Protection against the risk of thermal, electric shock and energy hazards in the case of an abnormal operating or simulated fault condition of d.c. electric vehicle supply equipment shall be evaluated by tests defined in this Clause. Testing may be performed on sub-assemblies while positioned and operated under end use conditions.

Simulated abnormal operating and fault conditions shall be applied one at a time. Faults that are a direct consequence of a simulated fault or abnormal operating condition are considered to be a part of that simulated fault or abnormal operating condition.

Cheese cloth and/or surgical cotton are to be used as indicators for risk of fire. These indicators shall be placed at all openings on the outside of the enclosure in a manner which will not significantly affect cooling.

Where the installation manual requires external means of protection against faults, these specific means shall be provided for the test.

The voltages of accessible SELV circuits as well as accessible earthed and unearthed conductive parts shall be monitored.

The test shall be performed until terminated by activation of a protective device or mechanism (internal or external), a component failure occurs that interrupts the fault condition, temperatures stabilize, or a risk of fire and/or electric shock hazard occurs.

12.105.2 *Pass Criteria*

As a result of testing, the d.c. electric vehicle supply equipment shall comply with the following:

a) there shall be no emission of flame, burning particles or molten metal;

b) the cheese cloth or surgical cotton indicator shall not have ignited;

c) the earth connection and protective equipotential bonding shall not have opened;

d) doors and covers shall remain in place;

e) during and after the test, accessible SELV circuits and accessible conductive parts shall not exhibit voltages exceeding the touch voltages specified in 12.6 of IS 17017(Part 1);

f) dielectric withstand voltage test specified in 12.7 of IS 17017(Part 1);

g) devices/components used for the mounting of live parts shall not break away from their initial position; and

h) no conductor shall be pulled out of its terminal conductor.

The d.c. electric vehicle supply equipment is not required to be operational after testing and it is possible that the enclosure can become deformed. Overcurrent protection integral to the d.c. electric vehicle supply equipment, or specified by the installation manual to be used with the equipment is allowed to open.

12.105.3 *Output Short-Circuit Test*

The d.c. output of the charging cable shall be connected to an appropriate switching means that will not limit the short circuit current.

The equipment under test shall be supplied with mains power and the output shall be connected to an artificial load with a dedicated electric vehicle simulator for each system and operated under rated output conditions prior to closing the switching means that causes the short circuit.

Compliance is checked by application of the pass criteria in 12.105.2. This test is not applicable to System C.

12.105.4 *Breakdown of Components Test*

12.105.4.1 *Load conditions*

The breakdown of a component, identified by circuit analysis, shall be tested with the d.c. electric vehicle supply equipment connected to an artificial load with a dedicated electric vehicle simulator for each system at full load or light load whichever creates the more severe condition.

Testing may be conducted using the sub-assembly in which the identified component is located. In this case, the sub-assembly shall be loaded to simulate normal operating conditions.

12.105.4.2 *Application of short circuit or Open Circuit*

The short circuit shall be applied with test leads of a cross section appropriate for the current that normally flows through the component, but not less than 2.5 mm^2. Then length of the loop shall be as short as practical to perform the test. Short circuits and open circuits are applied using an appropriate switching device.

Each identified component shall be subjected to only one simulation of breakdown unless both open- and short circuit failure modes are likely in that component.

12.105.4.3 *Test sequence*

For the breakdown of components test, identified components shall be short circuited or open circuited, whichever creates the worst hazard, one at a time.

Compliance is checked by the application of the pass criteria in **12.105.2**. In addition, during and after the application of the short circuit or open circuit, any flame inside the equipment shall extinguish within 10 s and no surrounding parts shall have ignited.

12.105.5 *Loss of a.c. Supply Phase Test*

A multi-phase d.c. electric vehicle supply equipment shall be operated with each phase (including neutral, if used) disconnected in turn at the supply input. The test shall be performed by disconnecting one phase with the equipment connected to an artificial load with a dedicated electric vehicle simulator for each system operating at maximum rated output. The test is repeated by initially energizing the d.c. electric vehicle supply equipment with one lead disconnected.

The test shall continue until terminated by a protective mechanism, a component failure occurs, or the temperature stabilizes.

Compliance is checked by the application of the pass criteria in **12.105.2**.

12.105.6 *Inoperative Blower/Fan Motor Test*

d.c. electric vehicle supply equipment having forced ventilation shall be connected to an artificial load with a dedicated electric vehicle simulator for each system while operating at maximum rated current and power output with fan or blower motor or motors made inoperative either singly or in combination from a single fault. The fan or blower motor shall be made inoperative by either physically preventing rotation or by disconnecting its power source.

Compliance is checked by the application of the pass criteria in **12.105.2**.

12.105.7 *Clogged Filter Test*

d.c. electric vehicle supply equipment having filtered ventilation openings shall be connected to an artificial load with a dedicated electric vehicle simulator for each system while operating at maximum rated current and power output with the openings blocked to represent clogged filters. The test shall be performed initially with 50 percent of the ventilation openings surface blocked. The test shall be repeated under a full blocked condition.

Compliance is checked by the application of the pass criteria in **12.105.2**.

12.106 Protection against Electrically Caused Fire

12.106.1 *General*

The protective measure to reduce the risk of the spread of fire under normal operating conditions and single fault conditions to the environment from within is two-fold:

a) implementation of a fire enclosure, and

b) selection of internal combustible parts with a low flammability classification.

NOTE —Normally, abnormal operating and fault condition testing (for example open- and short-circuit of electronic components) would be required to demonstrate the potential risk of fire. However, this protective measure is designed to facilitate the use of low flammability classification internal materials and a fire enclosure (external or internal or a combination of both) to provide containment of fire originating from within.

12.106.2 *Fire Enclosure*

Fire enclosures are used to reduce the risk of the spread of fire to the environment from within, independent of the location where they are installed. An overall fire enclosure shall be provided for d.c. electric vehicle supply equipment unless internal fire enclosure(s) are provided.

The fire enclosure shall be designed according to 4.6.3 of IEC 62477-1: 2016. Flammability of fire enclosure materials in d.c. electric vehicle supply equipment shall be according to 4.6.3.2 of IEC 62477-1: 2016.

For general information on openings of fire enclosures, *see* 4.6.3.3.1 of IEC 62477-1:2016.

Openings in the top surface of the fire enclosure shall be according to 4.6.3.3.2 of IEC 62477-1:2016, and the corresponding test shall comply with 5.2.2.2 of IEC 62477-1:2016.

Openings in the sides of the fire enclosure shall be according to 4.6.3.3.2 of IEC 62477-1: 2016.

Openings in the bottom of the fire enclosure shall be according to 4.6.3.3.3 of IEC 62477-1: 2016.

The flaming oil test shall comply with 5.2.5.6 of IEC 62477-1: 2016.

Fire enclosure bottom openings for ground mounted d.c. electric vehicle supply equipment in fixed installations shall comply with 6.4.8.3.5 of IEC 62368-1:2014.

Doors or covers in fire enclosures shall comply with 4.6.3.3.4 of IEC 62477-1:2016.

Materials for components that fill an opening in a fire enclosure shall comply with 4.6.3.2 of IEC 62477-1:2016 or with IS/IEC 60695-11-10 flammability requirements for V-1 material.

Provision of internal fire enclosure(s) as the protective measure against the spread of electrically-caused fire leads to consideration of any external combustible parts, for example decorative in function, located outside of the internal fire enclosure and not required as part of the protective measure. These external parts are not required to meet the - 5 VA flammability class requirement and need only have a V-2 minimum classification.

Internal fire enclosure construction and internal combustible material considerations are the same as described.

Combustible materials located within the fire enclosure shall comply with 4.6.2.2 of IEC 62477-1:2016.

Compliance is checked by inspection.

12.107 Protection against Chemical Hazards

12.107.1 *Type of Coolant*

The liquid coolant utilized shall be non-hazardous to the environment according to the Globally Harmonized System for the Classification and Labelling of Chemicals. The biodegradability of the liquid coolant shall be ≥ 60percent tested according to OECD 301 B and stated into the data sheet.

Warnings shall be provided in the installation manual or data sheet indicating that leaking or material degradation shall occur if a coolant other than that specified by the manufacturer is used.

Compliance is checked by inspection.

12.107.2 *Environmental Considerations*

The liquid coolant utilized shall be non-hazardous in accordance with local regulations. The liquid coolant shall be non-hazardous for the environment or shall be used in a manner such that any spills are contained within the equipment and isolated against the environment in accordance to the local regulations.

Environmental safety data sheet shall be provided for all specified liquid coolant approved the cable assembly manufacturer.

Compliance is checked by inspection.

12.107.3 *Flammability*

The liquid coolant shall not lead to a fire hazard if leaked onto exposed electrical parts. The minimum flashpoint of the liquid coolant shall be 135°C.

Compliance is checked by inspection of the material safety data sheets or by the test according to ISO 2719.

12.107.4 *Conductivity*

The d.c. electric vehicle supply equipment already has protection against electric shock, for example, insulation monitoring device (IMD, System C) or leakage current device (System A). Also, during normal operation, no leakage of coolant is allowed (*see* **12.102**). Therefore no requirements or tests shall be necessary for the conductivity of the liquid coolant.

12.107.5 *Material Compatibility*

All liquid coolant confining parts of the liquid handling system shall be resistant to the action of the liquid coolant and shall not degrade over time due to the exposure to heat. Non-metallic parts shall be able to maintain their physical properties after being exposed to the liquid coolant and air oven ageing as follows:

Compliance is checked by the tests of **12.107.5.1, 12.107.5.2**, and **12.107.5.3**.

12.107.5.1 *Air oven aging plastic parts and gaskets*

Six specimens are aged in an air circulating oven at 121 °C for 7 days and shall maintain the physical properties of tensile strength and elongation. The tensile strength and ultimate elongation shall not be less than 60 % of the tensile strength and ultimate elongation of the as-received sample. The test method of IEC 60811-501 shall be followed.

12.107.5.2 *Liquid coolant exposure*

Other specimens are to be immersed in the liquid coolant at 80°C ± 2.0K for 70 ± 0.5 h.

Six samples of each material, 25.4 mm wide and 203 mm long and not thicker than the thinnest part in the application are required for this test. Three are tested as-received and three are tested following immersion.

The tensile strength and ultimate elongation shall not be less than 60 percent of the tensile strength and ultimate elongation of the as-received samples.

12.107.5.3 *Creep resistance test*

Two samples of each non-metallic part of the liquid coolant confining system shall be conditioned for 14 days at a temperature of 87°C and placed in a full draft air-circulating oven. Following the conditioning, the parts shall show no sign of deterioration such as cracking and embrittlement.

12.108 Enclosures

12.108.1 *General*

Enclosures shall be designed according to 4.12 of IEC 62477-1:2012 except for the requirements for IP degrees in 12.4.

12.108.2 *Strength of Materials and Parts*

12.108.2.1 *General*

Strength of materials and parts of d.c. electric vehicle supply equipment shall be according to **10.2** of IEC 61439-7:2018.

The d.c. electric vehicle supply equipment shall be constructed of materials capable of withstanding the mechanical, electrical, thermal and environmental stresses that are likely to be encountered in anticipated service conditions.

12.108.2.2 *Properties of insulating materials — thermal stability*

For enclosures or parts of enclosures made of insulating materials, thermal stability shall be verified by the dry heat test.

Compliance is checked by inspection and test in accordance with 10.2.3.1 of IEC 61439-1.

12.108.2.3 *Properties of insulating materials — resistance to heat and fire*

Resistance of insulating materials to heat and fire shall be according to 8.1.3.2 of IEC 61439-1:2011.

Compliance is checked by inspection of manufacturer's test data or test.

12.108.3 *Enclosure Integrity Tests*

The enclosure integrity tests shall be according to 5.2.2.4 of IEC 62477-1:2016.

NOTE — The enclosure integrity tests specified in IEC 62477-1:2012 include the tests for deflection, steady force, impact, drop, stress relief, stability, wall or ceiling mounted equipment, handles, and manual controls securement test.

12.109 Components Bridging Insulation

12.109.1 *General*

Components bridging insulation shall comply with the requirements of the level of insulation, for example basic, reinforced or double, they are bridging.

12.109.2 *Isolating Transformers*

Isolating transformers, excluding safety isolating transformers used for signalling, shall comply with the requirements of G.5.3 of IEC 62368-1:2014 or IEC 61558-1 and IEC 61558-2-4.

Compliance is checked by inspection.

12.109.3 *Capacitors*

Capacitors bridging isolation barriers shall comply with ISO/QC 302400.

13 OVERLOAD AND SHORT CIRCUIT PROTECTION

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

Replacement:

13.2 Overload Protection of the Cable Assembly

Not applicable.

13.3 Short-Circuit Protection of the Charging Cable

Not applicable.

Addition:

13.101 Short-Circuit Protection of the d.c. Connection

For a short-circuit supplied by the d.c. electric vehicle supply equipment, the d.c. electric vehicle supply equipment shall fulfil all of the following requirements:

a) limit the peak current, including transient effects, to:

1) 30 kA or less at the contacts of the vehicle connector without short-circuit protection device, and 10 kA (or less) at the contacts of the vehicle connector equipped with short-circuit protection device for System A; and
2) 10 kA or less at the contacts of the vehicle connector for System C.

b) limit the I^2t value to:

1) 400 000 A^2s or less at the contacts of the vehicle connector for System A; and
2) 1 000 000 A^2s or less at the contacts of the vehicle connector for System C.

c) trigger an

1) error shutdown within 1 s after the detection of the short-circuit condition for System A; and
2) emergency shutdown within 1 s after the start of the short-circuit condition for System C.

d) disable its d.c. output until the d.c. electric vehicle supply equipment has been inspected and repaired, if needed.

e) The power supply circuit of the d.c. electric vehicle supply equipment shall have a short-circuit current withstand rating (I^2t) according to the values as specified in ISO DIS 17409:2019 for the different systems. The minimum cross-sectional area of the line conductors shall be calculated according to Equation (3) of IS 732:2019.

f) An overcurrent protection device shall be provided in the power supply circuit of the d.c. electric vehicle supply equipment. The overcurrent protection device shall withstand a peak current according to the values as specified in ISO 17409:2020 for the different systems. The section of the power supply circuit which is protected by this protection device shall be designed according to the characteristics of this over-current protection device. The section of the power supply circuit which is not protected by this over-current protection device shall comply with requirement e).

For System A the compliance is demonstrated by design review.

For System C, the compliance is tested according to **B-9.3.18**.

For a short-circuit supplied by the electric vehicle the requirements in e) or f) shall be fulfilled.

If the short-circuit current supplied by the d.c. electric vehicle supply equipment is not sufficient to trip a fuse, if any, within the required time to limit the I^2t value, the d.c. electric vehicle supply equipment shall provide an alternative means to interrupt the short-circuit current.

NOTE — The current peak is a result of the discharge of the capacitance of the d.c. electric vehicle supply equipment. The capacitive discharge is a transient phenomenon in the range of milliseconds.

14 AUTOMATIC RECLOSING OF PROTECTIVE DEVICES

This clause of IS 17017(Part 1) is not applicable except for plug and cable connected d.c. electric vehicle supply equipment.

15 EMERGENCY SWITCHING OR DISCONNECT (OPTIONAL)

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

16 MARKING AND INSTRUCTIONS

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

16.1 Installation Manual of EV Charging Stations

Addition:

For system A, not applicable.

For Systems C,

a) If coolant is used, for example for thermal management system, the installation manual of the d.c. electric vehicle supply equipment shall include information about the coolant properties according to **101.2** of IEC TS 62196-3-1:.
b) A standard sign "Refer to instruction manual" according to ISO 7010 shall be visibly attached to the thermal exchange: and
c) The name of the coolant shall be visible attached at the enclosure of the cooling unit.

Compliance is checked by inspection.

For d.c. electric vehicle supply equipments intended for fixed installation, the installation manual shall include information about the protective measure to be provided by the installations. If under normal and fault conditions any resulting d.c. component of the current in the protective conductor may exceed 6 mA, a caution notice and the symbol W001 of IS 16451 shall be provided in the installation manual, and the symbol shall be placed on the product. The caution notice shall be

"CAUTION: This product can cause a d.c. current in the protective conductor. Where a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is allowed on the supply side of this product." or equivalent (*see also,* 6.3.7.5 and 4.4.8 of IEC 62477-1: 2016).

NOTE –Symbol denotes caution, please refer to documentation.

The manufacturer shall recommend a preventative maintenance program for the replacement of the cable assembly following, for example, a predetermined period of time in service and/or number of charging sessions.

Compliance is checked by inspection of the program established by the manufacturer.

16.4 Marking of Charging Cable Assemblies Case B

Not applicable.

Addition:

101 SPECIFIC REQUIREMENTS FOR D.C. EV SUPPLY EQUIPMENT

101.1 Protection Against Uncontrolled Reverse Power Flow from Vehicle

The d.c. electric vehicle supply equipment shall be equipped with a protective means against the uncontrolled reverse power flow from vehicle. Uncontrolled power flow does not include instantaneous reverse power flow, which may occur with closing of contactors within the tolerances and duration specified in **A-3.9**, **A-6.2.8** and **B-6.2**.

101.2 Specific Requirements for Isolated Systems

101.2.1 *Operating Ranges for Output Voltage, Output Current, and Output Power*

The manufacturer of the d.c. electric vehicle supply equipment shall specify the operating range using the following parameters, and indicate them in the user manual and the installation manual:

a) output voltage range [V_{min}, V_{max}];
b) output current range [I_{min}, I_{max}];
c) maximum output power $P_{max;}$
d) ambient operating temperature range; and
e) maximum operating altitude above sea level.

NOTE — IS 17017(Part 24) specifies which of these parameters shall be communicated to the electric vehicle using digital communication, and how this is carried out.

The ambient operating temperature range shall at least cover the range from – 5°C to + 55°C.

The maximum operating altitude above sea level shall not be less than 1 000 m above sea level.

The manufacturer of the d.c. electric vehicle supply equipment may specify one or more additional operating ranges of the d.c. electric vehicle supply equipment by specifying:

a) an ambient operating temperature range wider than the one referred to above, and/or
b) a maximum operating altitude above sea level higher than the one referred to above.

In such a case, the other parameter ranges applicable for those/this additional operating range(s) may deviate from the ones referred to above, for examplefor example

a) an output voltage range smaller than the one referred to above, and/or
b) an output current range smaller than the one referred to above, and/or
c) a maximum output power smaller than the one referred to above.

The d.c. electric vehicle supply equipment shall be able to provide electrical energy with an output quality as specified in **101.2.2** within each operating range specified in such a way, in particular with the output voltage request from the electric vehicle being in the range [V_{min}, V_{max}] and the output current request from the electric vehicle being in the range [I_{min}, I_{max}], and the output power not exceeding P_{max}.

The d.c. electric vehicle supply equipment shall not exceed its specified maximum output power, even if the power requested by the electric vehicle is beyond the maximum output power of d.c. electric vehicle supply equipment.

The d.c. electric vehicle supply equipment may also be able to operate below the lower limit of a specified operating range, that is provide output current less than given by I_{min} or output voltage less than given by V_{min}, without the need to fulfil all requirements given in **101.2**.

101.2.2 *Output Voltage and Current Tolerance*

101.2.2.1 *Output current regulation in CCC*

Requirements for output current regulation in CCC are specified in **A-3.10** and **B-6.4**.

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.12**.

The test shall be performed according to the following procedure:

a) Connect the d.c. electric vehicle supply equipment to an artificial load with a dedicated electric vehicle simulator appropriate for the system. The setup of the test load for each system is shown in Table 26

b) Measure the voltage ($V_{EVSE\ output}$) and current ($I_{EVSE\ output}$) of the power line continuously.

c) Start charging with the procedure specified by charger manufacturer.

d) Record current command value $I_{EV\ target}$ and $I_{EVSE\ output}$ at the operating points as specified in Annex A. For operating point, see **102.2.4**. $I_{EV\ target}$ is the output current requested by the test load, which is sent to the d.c. electric vehicle supply equipment via digital communication.

During the voltage/current sweep (transition from one OP to another) and for each operating point, check that the difference between the measured current values and the required value sent by the electric vehicle simulator are within the limits specified in **101.2.2.1**.

101.2.2.2 *Output voltage regulation in CVC*

For CVC, the maximum voltage deviation during pre-charge state and during charging of the vehicle/*traction* battery shall not exceed ±5 percent of the requested voltage, or ± 2 percent of the maximum rated voltage of the d.c. electric vehicle supply equipment, whichever deviation is smaller (*see* Fig. 15).

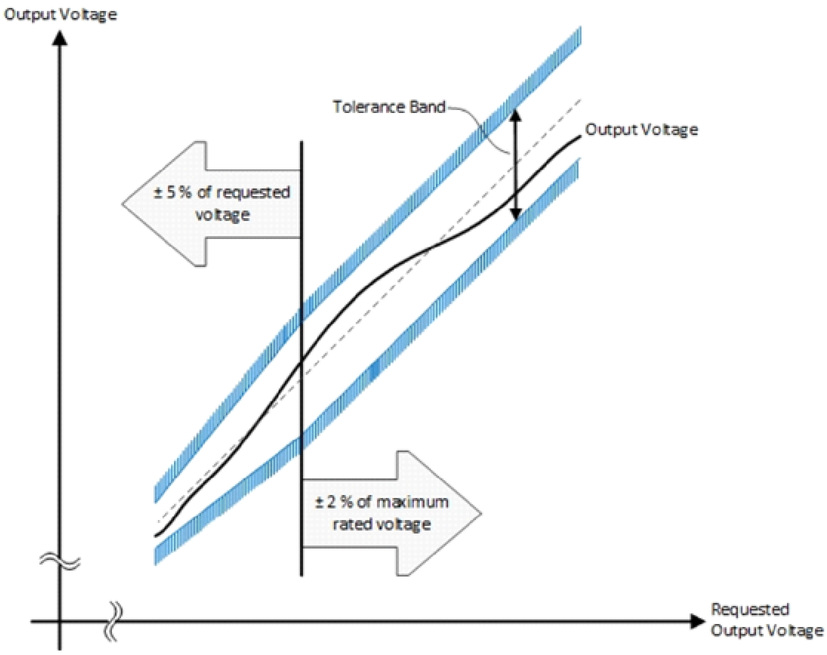


FIG. 15 VOLTAGE TOLERANCES

These requirements are for System C.

Compliance is checked by the tests in **B-9.3.13**.

NOTES

1 The current ripple is not specified within the CVC mode as it depends on the impedance between the d.c. output and the electric vehicle battery, which is not defined in ISO 17409.

2 The current requirements of CCC mode like regulation (*see* **101.2.2.1**) and control delay (see **101.2.3**) are not applicable in CVC mode, which leads to undefined current behaviour within the CVC mode.

The electric vehicle can prevent the d.c. electric vehicle supply equipment from unintentionally entering the CVC mode during charging as this can lead to large current ripples when the battery is attached or it can lead to no current if the requested voltage minus the voltage deviation is below the battery voltage. When the electric vehicle battery is attached to the d.c. output, the CVC mode can be avoided by requesting a voltage of at least $V_{Compensation}$ above the battery voltage.

$$V_{EV\ target} > V_{Compensation} + V_{Battery}$$
$$V_{Compensation} = V_{Deviation} + V_{rip} + V_{EV\_drop} + V_{Margin}$$
$$V_{Deviation} = \min(2\text{percent} \times V_{Rated}, 5\text{percent} \times V_{EV\ target})$$
$$V_{rip} = \max(5\ \text{V}, 1\text{percent} \times V_{EV\ target})$$
$$V_{EV\_drop} = I_{Output} \times Z_{EV}(I_{Output})$$

where

$V_{EV\ target}$ is the voltage request coming from the electric vehicle
$V_{Compensation}$ is the voltage the electric vehicle should add to prevent CVC mode
$V_{Battery}$ is the voltage of the electric vehicle battery
$V_{Deviation}$ is the deviation on the output voltage
V_{rip} is the ripple on the d.c. output
V_{EV_drop} is the voltage drop between the d.c. output and the vehicle battery
V_{Margin} is a voltage margin chosen by the electric vehicle manufacturer

V_{Rated} is the rated output voltage of the d.c. electric vehicle supply equipment
I_{Output} is the d.c. output current of the d.c. electric vehicle supply equipment
Z_{EV} (I_{Output}) is the impedance of the electric vehicle at the d.c. output current

$V_{Deviation} + V_{rip}$ is 30 V at 1000 V.

101.2.3 *Control delay of charging current in CCC*

The d.c. electric *vehicle* supply equipment shall control the output current within 1 s after acknowledging reception of the request from the vehicle according to IS 17017(Part 24), with a current control accuracy specified in **101.2.2.1**, and with a changing rate dI_{min} of 20 A/s or more.

If the vehicle requests a target current I_N, which shows deviation lower than or equal to 20 A compared to the base current value I_0, the output current of d.c. electric vehicle supply equipment shall be within the tolerance limits given in **101.2.2.1** within a delay time of 1 s after acknowledging reception of the request from the vehicle according to IS 17017(Part 24).

If the vehicle requests any target current I_N, which shows deviation higher than 20 A compared to the base current value I_0, the output current of d.c. electric vehicle supply equipment shall be within the tolerance limits given in **101.2.2.1** within a delay time T_d as defined in Formula (4), and as shown in Fig. 16.

$$T_d \leq \frac{| I_N - I_0 |}{dI_{min}} \text{ for } | I_N - I_0 | \geq 20A \quad (4)$$

where

T_d is the control delay of charging current;
I_N is the value for the target current;
I_0 is the value for the base current, that is output current at the time of new request;
dI_{min} is the minimum current change rate.

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

FIG. 16 STEP RESPONSE FOR CONSTANT VALUE CONTROL

Compliance for System A is checked by the following test. For system C, see **B-9.3.14.**

a) The d.c. electric vehicle supply equipment is connected to an artificial load with a dedicated electric vehicle simulator appropriate for the system, and operating in CCC mode.
b) The time of the electric vehicle simulator sending the output current command shall be recorded, and the actual value of output current in a certain period of time shall be also recorded.
c) The vehicle requests a target current
   1) deviation lower than or equal to 20 A; and
   2) deviation higher than 20 A.
d) For System A, change the operating point (*see* Fig. 27) from
   1) OP1 to OP3, OP4, OP5, OP6;
   2) OP2 to OP3, OP4, OP5, OP6;
   3) OP3, OP4, OP5, OP6 to OP1; and
   4) OP3, OP4, OP5, OP6 to OP2.
e) The d.c. electric vehicle supply equipment shall control the output current,
   1) within 1 s after the request; and
   2) within a delay time T_d as defined in Formula (4), and as shown in Fig. 16.

101.2.4 *Descending Rate of Charging Current*

The descending rates for error shutdown and emergency shutdown shall be according to **A-3.8.2** and **A-5** for System A, and **B-3.4** and **B-3.5** for System C.

Compliance for System A is checked by the following test. For System C, *see* **B-9.3.15.**

This test shall simulate the stop charge command from electric vehicle, to detect the actual output current changes of d.c. electric vehicle supply equipment during the normal charging process.

The test shall be performed according to the following procedure:

a) The d.c. electric vehicle supply equipment is connected to the vehicle control simulator or artificial load, and operating in CCC mode.
b) The time of the vehicle control simulator sending the output current command shall be recorded, and the actual value of output current in a certain period of time shall be also recorded.
c) For normal operation
   for System A, change the operating point from OP1, OP2, OP3, OP4, OP5 and OP6 to current < 5A
d) For error shutdown, perform the emergency shutdown from OP1, OP2, OP3, OP4, OP5 and OP6 (for System A)
e) Check that the system specific requirements for error or emergency shutdown test are met.

101.2.5 *Periodic and Random Deviation（Current Ripple）*

Current ripple of d.c. electric vehicle supply equipment during current regulation shall not exceed the limit as defined in Table 13. Measurement shall be made at maximum rated power and rated current, or in the worst case where the output voltage and output current correspond theoretically to the maximum current ripple. The current ripple is not included in the tolerance defined in **101.2.2.1**.

The artificial load according to Fig. 26 shall be used.

Table 13 - Current ripple limit of d.c. EV supply equipment

(*Clause* 101.2.5)

Limit [a]	Frequency
1.5 App	frequency band above 0 Hz and below 10 Hz
6 App	frequency band above 0 Hz and below 5 kHz
9 App	frequency band above 0 Hz and below 150 kHz

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

NOTE−The upper value of each frequency band (10 Hz, 5 kHz and 150 kHz) is the cut-off frequency (- 3.0 dB) of first order low-pass filter.

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.12**.

The d.c. electric vehicle supply equipment is connected to an artificial load and a designated smoothing capacitor.

The d.c. electric vehicle supply equipment shall operate at proper operating points for the test (*see* Fig. 27).

Measure the current ripple of each frequency bands specified in Table 13.

See **A-3.11** for specific test condition for system A,

101.2.6 *Periodic and Random Deviation (Voltage Ripple in CVC)*

For requested output voltage up to 500 V, the maximum voltage ripple in normal operation and precharge, if applicable, shall not exceed ±5 V.

For requested output voltage above 500 V, the maximum voltage ripple in normal operation and precharge, if applicable, shall not exceed ±1 percent of the requested output voltage.

The maximum voltage slew rate in normal operation shall not exceed ±20 V/ms.

For explanation of terms, *see* Fig. 17
.

FIG.17 MAXIMUM RATINGS FOR VOLTAGE DYNAMICS

Compliance is checked by the test in **B-9.3.13**.

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

101.2.7 *Load Dump*

If the vehicle contactors open while the vehicle is being charged at the maximum current of the d.c. electric vehicle supply equipment, the output voltage shall not exceed the limit specified for each system in **A-3.12** or **B-6.2**.

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

Compliance for System A is checked by the following test. Compliance for System C is checked by **B-9.3.9**.

Refer to Fig. 26 for the setup of artificial load.

The test shall be performed according to the following procedure.

a) Connect the d.c. electric vehicle supply equipment to artificial load.
b) Measure the voltage ($V_{EVSE\ output}$) of the power line continuously.
c) Start charging with the procedure specified by charger manufacturer.
d) Confirm that the d.c. power line between d.c. electric vehicle supply equipment and electric vehicle is energized at the rated voltage, and the d.c. electric vehicle supply equipment is operating at the operating point OP4 in Fig. 27.
e) Simulate the disconnection of the vehicle battery by opening S0.
f) Check that the d.c. electric vehicle supply equipment terminates the charging process and transfers to shutdown stage, displaying a relevant alarm or error information, if any.
g) For each system, check the parameters in Table 14.

Table 14 - Parameter for load dump test

(*Clause* 101.2.7)

Parameter	Requirement through 4) to 6)
	System A

The maximum voltage of $V_{EVSE\ output}$	*see* Table 29
The maximum slew rate $dV_{EVSE\ output}/dt$	≤ 250 V/ms

101.3 Specific Requirement for Multiple d.c. Outputs

The specific requirements for the multiple d.c. outputs are provided in Annex E.

101.4 Specific Requirement for Charging with Thermal Management System

This Clause is applicable for System A and System C.

For charging with thermal management system, the d.c. electric vehicle supply equipment shall be equipped with a cable assembly according to IEC TS 62196-3-1.

101.4.1 *Temperature Limits and Self-Diagnostics*

101.4.1.1 *Temperature of the d.c. contact assembly of the vehicle connector*

The d.c. electric vehicle supply equipment shall ensure that the temperature of the d.c. contact assembly of the vehicle connector complies with the following requirements under the operating ambient temperature up to 55°C.

a) The absolute temperature of the d.c. contact assembly shall not exceed 90 °C;
b) The surface temperature of the cable assembly shall not exceed the temperature limits according to 16.5 of IS 17017(Part 2/Sec 1); and
c) If a thermal sensing providing temperature values is implemented in the attached vehicle connector, the d.c. electric vehicle supply equipment shall evaluate the measured values of the thermal sensing device at each d.c. contact assembly.

101.4.1.2 *Requirements for self-diagnostics function for thermal management system*

The d.c. electric vehicle supply equipment manufacturer shall provide a FMEA according to IEC 60812.

The d.c. electric vehicle supply equipment shall provide appropriate means to reduce the likelihood of a hazard occurring in case of a first fault in the thermal management system, for example, by double or reinforced insulation, flow rate, pressure, temperature, level of coolant, etc.

In case of a thermal exchange device or thermal transport device failure (for example failure of cooling pump, jammed cooling hose), the d.c. electric vehicle supply equipment shall either stop operation or reduce the available current to value for operation without thermal exchange and/or thermal transport, if such a value is given by the cable assembly manufacturer. The d.c. electric vehicle supply equipment shall transmit it to vehicle via digital communication.

In case of a thermal sensing fault, *see* **101.4.2.3.**

Compliance is checked by inspection and test in **101.4.3.4.**

101.4.2 *Temperature Monitoring*

101.4.2.1 *General*

The d.c. electric vehicle supply equipment, using cable assembly providing thermal sensing data, shall have measures to continually monitor the provided temperature data.

The d.c. electric vehicle supply equipment shall continually monitor the temperature data of the d.c. contact assemblies during the complete charging sequence.

101.4.2.2 *Overtemperature handling*

If the measured temperature at one or both d.c. contact assemblies exceeds 90°C, the d.c. electric vehicle supply equipment shall trigger an error shutdown sequence within 9 s according to **A-4.3.5** for System A and **B-3.4** for System C.

Compliance is checked by test in **101.4.3.3.**

If three consecutive error shutdowns occur due to temperature exceeding 90 °C at one or both d.c. contacts, the d.c. electric vehicle supply equipment shall not start a new supply process until serviced.

Compliance is checked by inspection and measurement.

101.4.2.3 *Check of the plausibility of the values provided by the thermal sensing devices*

A plausibility check of the thermal sensing devices of the vehicle connector shall be done prior to each charging session. If the plausibility check fails, the d.c. electric vehicle supply equipment shall:

a) only operate under the current assigned by the manufacturer of the cable assembly for operation without thermal exchange and/or thermal transport;
b) not start a new supply process until serviced (for System C only).

Compliance is checked by inspection and test in **101.4.3.6**.

If the thermal sensing of a d.c. contact assembly sends no or an implausible signal during charging, the d.c. electric vehicle supply equipment shall:

a) reduce output current to the current assigned by the manufacturer of the cable assembly for operation without thermal exchange and/or thermal transport or trigger an error shutdown according to **A-3.8.1** within 9 s after the occurrence of the fault;
b) trigger an error shutdown according to **B-3.4** within 9 s after the occurrence of the fault.

Compliance is checked by inspection and test in **101.4.3.7**.

101.4.3 *Tests for Thermal Management System Performance of the d.c. EV Supply Equipment*

101.4.3.1 *General*

For all tests, thermal stabilisation is considered to have occurred when three successive readings, taken at intervals not less than 10 min, indicate no increase greater than 2 K.

The test current is the rated current according to the device under test (DUT) manufacturer’s data sheet, if not stated otherwise.

The DUT for these tests is the d.c. electric vehicle supply equipment.

A system specific vehicle simulator equipped with a current sink shall be used for all tests in this Clause.

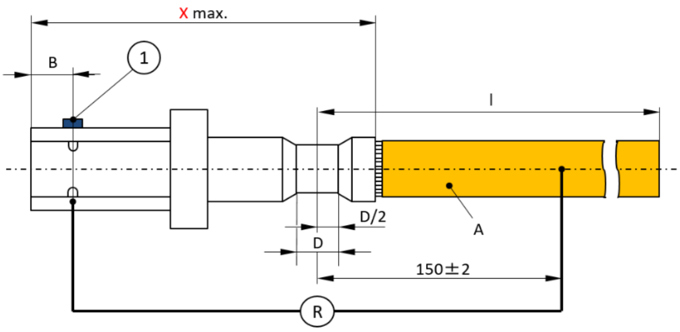
Each test shall be performed with a corresponding test accessory, called reference device (RD), which mates with the vehicle connector.

The material for all reference devices shall be Cu-ETP.

For System A, all tests, except the test of overtemperature handling according to **101.4.3.3**, shall be performed with a RD according to Figure 18 and a test arrangement according to Fig. 19. The test for overtemperature handling according to **101.4.3.3** shall be performed with a RD according to Fig. 20 and a test arrangement according to Fig. 21.

For System C, all tests, except the test of overtemperature handling according to **101.4.3.3**, shall be performed with a RD according to Fig. 22 and a test arrangement according to Fig. 23. The test for overtemperature handling according to **101.4.3.3** shall be performed with a RD according to Fig. 124 and a test arrangement according to Fig. 26.

The contact resistances of the reference devices, including d.c. contact, contact body, mechanical joining and 150 mm of the attached conductor, measured by four-terminal sensing according to Fig. 18 and Fig. 22 shall comply with the values indicated in Table 15.

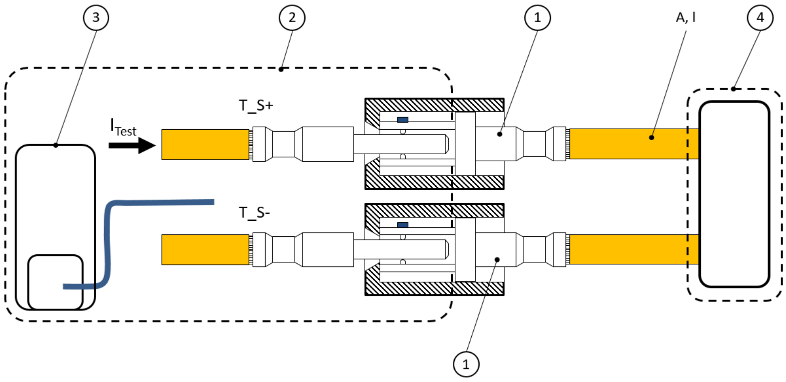


Key

①	Reference temperature sensor
A	Conductor cross-section (depending on the test current, *see* Table 15)
B	To be determined by the manufacturer
D	To be determined by the manufacturer
l	Length of attached conductor (*see* Table 15)
R	Resistance measurement (*see* Table 15 for values)

NOTE–For missing dimensions, *see* Standard sheet 3-Ia of IS 17017(Part 2/Sec 3):2020.

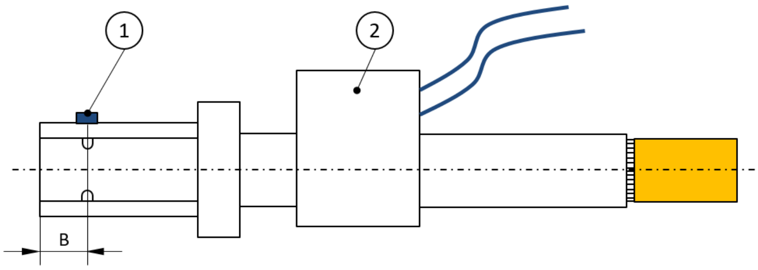
FIG. 18 REFERENCE DEVICE A_0



Key

①	Reference device A_0
②	DUT
③	d.c. electric vehicle supply equipment with thermal exchange and thermal transfer, if any
④	Vehicle simulator with current sink
A	Conductor cross-section (depending on the test current, *see* Table 15)
l	Length of attached conductor (*see* Table 15)
I_{Test}	Test current
T_S+ , T_S-	Thermal sensing device inside vehicle connector at DC+ and DC-

FIG. 19 TEST ARRANGEMENT A_0

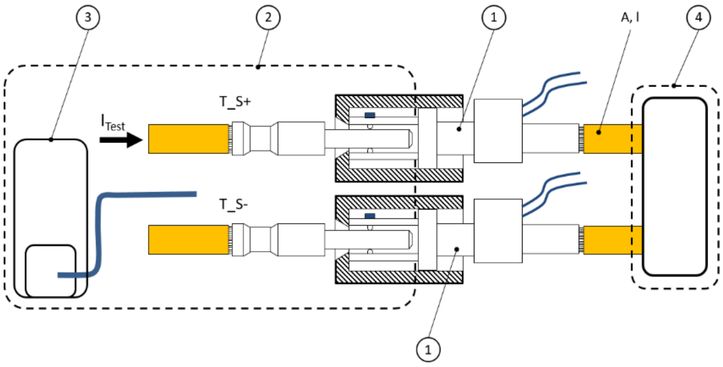


Key

①	Reference temperature sensor
②	Heating unit
B	To be determined by the manufacturer

NOTE For missing dimensions, *see* standard sheet 3-Ia of IS 17017(Part 2/Sec 3):2020.

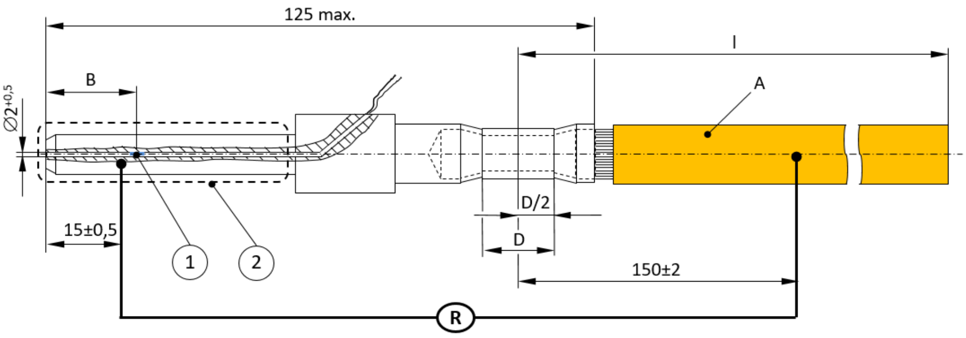
FIG. 20 REFERENCE DEVICE A_1



Key

①	Reference device A_1
②	Device under test (DUT)
③	d.c. electric vehicle supply equipment with thermal exchange and thermal transfer – if any
④	Vehicle simulator with current sink
A	Conductor cross-section (depending on the test current, *see* Table 15)
l	Length of attached conductor (*see* Table 15)
I_{Test}	Test current
T_S+ , T_S-	Thermal sensing device inside vehicle connector at DC+ and DC-

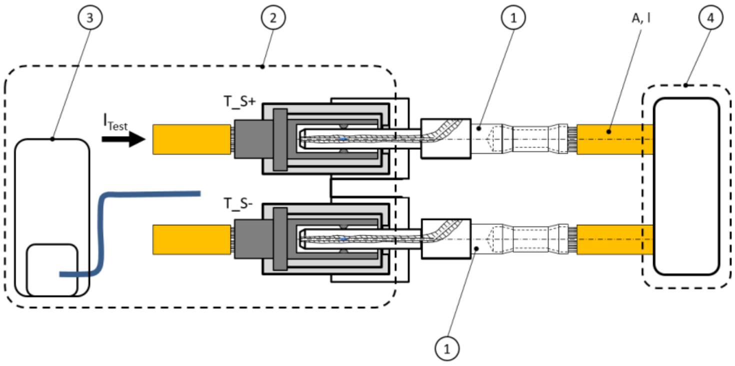
FIG. 21 TEST ARRANGEMENT A_1



Key

①	Reference temperature sensor
②	d.c. power contact according to standard sheet 3-IVa (configuration FF) of IS 17017(Part 2/Sec 3).
A	Conductor cross-section (depending on the test current, *see* Table 15)
B	18±1 mm for configuration FF
D	To be determined by the manufacturer
l	Length of attached conductor (*see* Table 15)
R	Resistance measurement (*see* Table 15 for values)

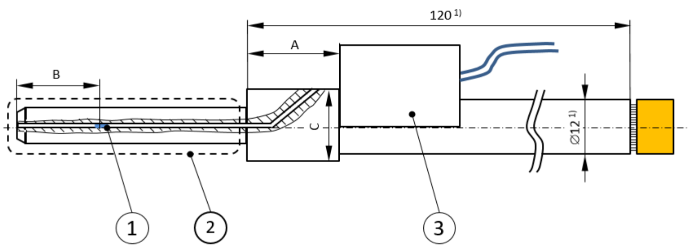
FIG. 22 REFERENCE DEVICE C_0



Key

①	Reference device C_0
②	DUT
③	d.c. electric vehicle supply equipment with thermal exchange and thermal transfer, if any
④	Vehicle simulator with current sink
A	Conductor cross-section (depending on the test current, *see* Table 15)
l	Length of attached conductor (*see* Table 15)
I_{Test}	Test current
T_S+, T_S-	Thermal sensing device inside vehicle connector at DC+ and DC-

FIG. 23 TEST ARRANGEMENT C_0

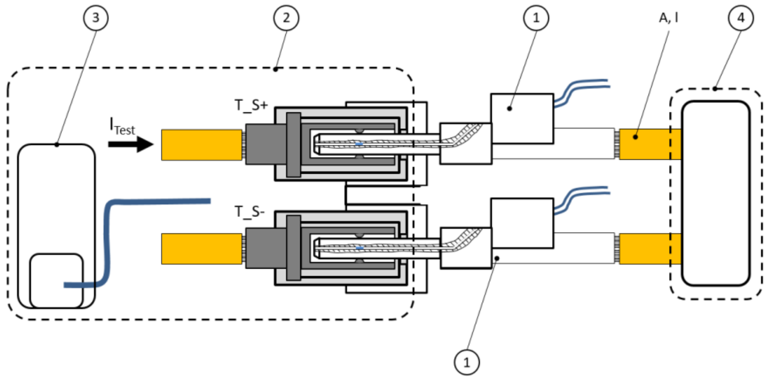


Key

①	Reference temperature sensor
②	d.c. power contact according to standard sheet 3-IVa (configuration FF) of IS 17017(Part 2/Sec 3):2020.
③	Heating unit
A	To be determined by the manufacturer
B	18±1 mm for configuration FF
C	To be determined by the manufacturer

1) The diameter and length of termination (Ø12 and 120) are recommended values.

FIG. 24 REFERENCE DEVICE C_1



Key

①	Reference device C_0
②	DUT
③	d.c. electric vehicle supply equipment with thermal exchange and thermal transfer, if any
④	Vehicle simulator with current sink
A	Conductor cross-section (depending on the test current, *see* Table 15)
l	Length of attached conductor (*see* Table 15)
I_{Test}	Test current
T_S+, T_S-	Thermal sensing device inside vehicle connector at DC+ and DC-

FIG. 25 TEST ARRANGEMENT C_1

Values for wiring cross section and cable length are specified in Table 15.

Table 15 - Values for parameter A, l and R

(*Clause* 101.4.3.1)

Parameter	Description	Value	Rated current [A max]			Resistance [µΩ]	
			System A		System C	System A	System C
			Non-cooled DUT	Cooled DUT			
A	Conductor cross section	35 mm²	125 *(under consideration)*	150	100	*(under consideration)*	*(under consideration)*
		50 mm²	150 *(under consideration)*	200	200	*(under consideration)*	123-128
		60 mm²	-	-	250	*(under consideration)*	91-96
		70 mm²	200 *(under consideration)*	300	300		
		95 mm²	300*(under consideration)*	400	400	*(under consideration)*	65-70
		12	350	-	500	*(under*	57-

		0 mm²				*considerati on)*	62
		15 0 mm²	400	-	-	*(under considerati on)*	
1	Cable length	2 m					

101.4.3.2 *Thermal management system performance test*

This test is applicable for d.c. electric vehicle supply equipments according to System A and System C using a thermal management system.

For System A, the test is performed with a RD according to Fig. 18 and a test arrangement according to Fig. 19.

For System C, the test is performed with a RD according to Fig. 22 and a test arrangement according to Fig. 23.

The DUT shall be stored for at least 2 h at (55 ± 4)°C.

The test shall be executed at rated current and may be executed at the minimum output voltage of the DUT.

Once thermal stabilisation has been reached, the DUT shall be operated at rated current and may be operated at the minimum output voltage for an additional 60 min.

Then the current shall be reduced to less than 2 A.

The temperatures measured by the reference temperature sensors of the reference devices shall be monitored with one or more samples per second throughout the test.

This test is passed, if:

a) the d.c. electric vehicle supply equipment performs the supply process without any errors, and
b) the measured temperatures by the reference temperature sensors do not exceed 90°C, and
c) the temperature limits according to 16.5 of IS 17017(Part 2/Sec 1):2020 are not exceeded at any touchable and graspable surface of the DUT (for system C only) or the temperature limits according to **A-9.1** are not exceeded (for system A only).

101.4.3.3 *Tests of overtemperature handling*

This test is applicable for d.c. electric vehicle supply equipment according to system A using thermal management system and according to system C.

For System A, the test is performed with a RD according to Fig. 20 and a test arrangement according to Fig. 21.

For System C, the test is performed with a RD according to Fig. 24 and a test arrangement according to Fig. 25.

The DUT shall be stored for at least 2 h at 55 ± 4 °C

The test shall be executed at rated current and may be executed at the minimum output voltage of the DUT.

The test shall be executed as follows:

a) Once thermal stabilization has been reached, the over-temperature of the vehicle connector is stimulated by applying heat power ensuring a constant temperature rise of 2.5 ± 0.5 K/min (measured by the reference temperature sensor) on the DC+ contact.
b) The test shall be stopped if the temperature as measured by the reference temperature sensor reaches 95 °C.
c) The test shall be repeated with applying heat power on the DC- contact

This test is passed, if one of the following requirements is fulfilled:

a) The d.c. electric vehicle supply equipment performs an error shutdown sequence according to **A-4.3.5** for System A and **B-3.4** for System C within 9 s after the reference temperature sensor signals a temperature of more than 90 °C; or
b) The d.c. electric vehicle supply equipment reduces the output current (less than 2 A) before the temperature measured by the reference temperature sensor reaches 90°C.

The test shall be performed two consecutive times.

101.4.3.4 *Test for self-diagnostics function for thermal management system*

For System A, the test is performed with a RD according to Fig. 18 and a test arrangement according to Fig. 19.

For System C, the test is performed with a RD according to Fig. 22 and a test arrangement according to Fig. 23.

The DUT shall be stored for at least 2 h at 55 ± 4)°C

The test shall be executed at rated current and may be executed at the minimum output voltage of the DUT.

The test shall be executed for the following test sequences:

a) Once thermal stabilization has been reached, the thermal transport device, for example cooling pump, shall be switched off; and

b) Once thermal stabilization has been reached, the thermal exchange device, for example cooling unit, shall be switched off.

After switching off the corresponding device, the DUT shall be operated for an additional 60 min.

This test is passed if:

a) the measured temperatures by the reference temperature sensors do not exceed 90 °C and;
b) the temperature limits according to 16.5 of IS 17017(Part 2/Sec 1):2020 are not exceeded at any touchable and graspable surface of the DUT (for system C only) or the temperature limits according to **A-9.1** are not exceeded (for system A only).

NOTE — Pass criteria can be achieved by reducing the available output current.

101.4.3.5 *Test for availability of thermal sensing devices — General*

For System A, the test is performed with a RD according to Fig. 18 and a test arrangement according to Fig. 19.

For System C, the test is performed with a RD according to Fig. 22 and a test arrangement according to Fig. 23.

The DUT shall be equipped with a disconnecting device in each signalling path of thermal sensing.

Tests shall be conducted for each of the following test setups:

a) signalling path of thermal sensing on DC+ contact open and signalling path of thermal sensing on DC- contact closed; and
b) signalling path of thermal sensing on DC+ contact closed and signalling path of thermal sensing on DC- contact open

101.4.3.6 *Test for availability of thermal sensing devices before charging*

The availability of each thermal sensing device shall be checked before each charging session.

After setting the disconnecting devices in the positions according to **101.4.3.5**, a charging session shall be initiated.

This test is passed if:

a) the DUT starts a supply process with the current assigned by the manufacturer of the cable assembly for operation without thermal exchange and/or thermal transport or the DUT does not start a supply process until serviced (for System A only)
b) the DUT does not start a supply process until serviced (for System C only).

101.4.3.7 *Test for availability of thermal sensing devices during charging*

The DUT shall be operated at rated current and may be operated at the minimum output voltage.

Then the disconnecting devices shall be set in the positions according to **101.4.3.5**.

This test is passed if:

a) the DUT reduces output current to the current assigned by the manufacturer of the cable assembly for operation without thermal exchange and/or thermal transport or trigger an error shutdown according to **A-4.3.5** within 9 s after the occurrence of the fault (for System A only)
b) trigger an error shutdown according to **B-3.4** within 9 s after the occurrence of the fault (for System C only)

101.5 Specific Requirements for Temperature Controlled Charging

The d.c. electric vehicle supply equipment may allow a boost current exceeding the rated current of the cable assembly based on agreement between cable assembly manufacturer and d.c. electric vehicle supply equipment manufacturer as long as the temperature requirement of the d.c. contact assembly according to **101.4.1.1** is fulfilled for the condition required by the d.c. electric vehicle supply equipment manufacturer. The boost current shall not exceed the maximum rated current for each system according to Table 108 in IEC TS 62196-3-1:2020.

Temperature controlled charging shall be mutually agreed between manufacturers of the d.c. electric vehicle supply equipment and the cable assembly.

Compliance is checked by inspection and test in **101.4.3.2**.

This clause is applicable for System A and System C.

102 TEST REQUIREMENTS

102.1 Technical Data

The following information from the manufacturer shall be provided for compliance test:

a) operating points (**102.2.4**);
b) operating temperature range;
c) operating humidity range; and
d) a.c. supply voltage.

In addition to above, the information on additional operating points with a maximum output ripple, if any, shall be provided for System C,

102.2 General Test Conditions

102.2.1 *Ambient Test Conditions*

102.2.1.1 *Environmental 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:10 percent to 90 percent (without condensation).

102.2.1.2 *Test power requirements*

Power to the tested device shall be according to IS 12360, if designed to be supplied by utility supply network.

a) a.c. power frequency: 50 ± 0.5 Hz;
b) a.c. power voltage: 240/415 V ±10 percent;
c) d.c. component on a.c. power: the offset less than 2 percent of the peak value;
d) degree of voltage unbalance on a.c. power: less than 5 percent; and
e) a.c. power waveform: sinusoidal, with a distortion factor less than 8 percent.

102.2.2 *Measuring Instruments*

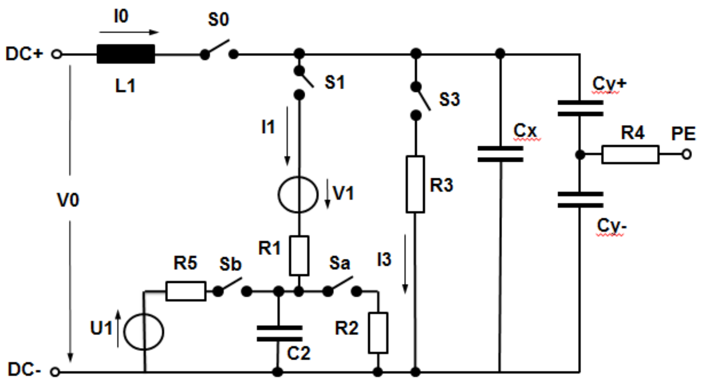
The characteristics of the measuring equipment shall be suitable to verify the specified values in the corresponding test items.

The equipment for measurement of voltage, current, temperature and time shall be according to IS/ISO/IEC 17025 and IEC Guide 115.

102.2.3 *Test Load*

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

Unless otherwise specified, a resistive load or an electronic load shall be used for the compliance tests. An example of the test load, represented by a simplified equivalent circuit diagram, is shown in Fig. 126.



KEY

Cx	X-capacitor (positive-negative)	I1	emulated current to traction battery
Cy+	Y-capacitor (positive-earth)	I3	emulated current to auxiliary load
Cy-	Y-capacitor (negative-earth)	L1	inductor
C2	capacitor for emulating traction battery	R3	resistor for emulating auxiliary load
I0	output current of d.c. electric vehicle supply equipment	R5	current-limiting resistor for U1
U1	electronic load/controlled voltage source	PE	protective conductor
V1	ideal voltage source	S0, S1, S3, Sa, Sb	contactor (switch)
V0	output voltage of d.c. electric vehicle supply equipment		
R1, R2	variable resistor to set operating voltage point		
R4	resistor for emulating the voltage surge between positive-negative, positive-earth and negative-earth		

FIG. 26 EXAMPLE OF ARTIFICIAL LOAD

NOTE — The simplified equivalent circuit diagram of the charging circuitry in Figure 26 is used for specifying the test conditions relevant to the test cases contained in this document, e. g. present voltage and internal resistance of the electric vehicle battery. Only those electric properties of the electric vehicle charging circuitry are modelled that are relevant for checking conformity of an d.c. electric vehicle supply equipment with the requirements in this document. Properties of the charging circuitry of a real electric vehicle which are not relevant for checking conformity are not modelled by this diagram. It is important to note that this diagram does not mandate how a real test bench implements the electrical properties of the electric vehicle charging circuitry that are relevant for a specific test case. It is rather recommended to use a battery simulator to implement these properties, but it needs to be ensured that the test conditions given in the test case specifications are obeyed.

Recommended circuit parameters of the test load for each system are shown in Table 16.

Table 16 - Recommended circuit parameters of the test load

(*Clause* 102.2.3)

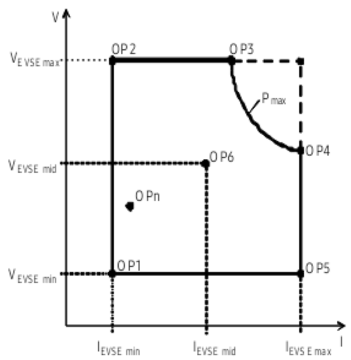
Symbol	**System A**	**System C**
L1	0 H	0 H
Cx	Not used	470 μF
Cy+/-	4.7 nF	2 μF
C2	5600 μF	5600 μF
S0	As specified in respective test	As specified in respective test
S1	As specified in respective test	As specified in respective test
S3	Open	As specified in respective test
Sa	Open	Closed
Sb	Closed	Open
R1	Variable (10 - 2 000 mΩ)	Variable (50 - 100 mΩ)
R2	Variable (Set by the required voltage operating point)	Variable (0.1 - 2 mΩ)
R3	Not used	10 Ω (up to 500 V) 50 Ω (500 - 1 000 V)
R4	50 Ω	50 Ω
R5	Variable	Not used
U1	0 - 1 000 V	Not used
V1	Not used	0 - 1 000 V

102.2.4 *Testing Point*

102.2.4.1 *Definition*

Fig. 27 shows the range of operating voltage and current which can be output by the d.c. electric vehicle supply equipment, and some specific operating points OP1, OP2, OP3, OP4, OP5 and OP6 used as testing points in **101.2.1**.

If the d.c. electric vehicle supply equipment shows any discontinuous behaviour in its operating range, for example in case of cascaded architecture of power modules, it might be necessary to add additional testing points OPn.



KEY

$I_{EVSE\ max}$	maximum operating current of d.c. electric vehicle supply equipment	OP1	$V_{EVSE\ min}$ and $I_{EVSE\ min}$
$I_{EVSE\ mid}$	$(I_{EVSE\ max} + I_{EVSE\ min}) / 2$	OP2	$V_{EVSE\ max}$ and $I_{EVSE\ min}$
$I_{EVSE\ min}$	minimum operating current of d.c. electric vehicle supply equipment	OP3	$V_{EVSE\ max}$ and P_{max}
$V_{EVSE\ max}$	maximum operating voltage of d.c. electric vehicle supply equipment	OP4	$I_{EVSE\ max}$ and P_{max}
$V_{EVSE\ mid}$	$(V_{EVSE}\ max + V_{EVSE}\ min) / 2$	OP5	$V_{EVSE\ min}$ and $I_{EVSE\ max}$
$V_{EVSE\ min}$	minimum operating voltage of d.c. electric vehicle supply equipment	OP6	$V_{EVSE\ mid}$ and $I_{EVSE\ mid}$
OP	operating point		
OPn	voltage and current depending on test conditions		

FIG. 27 OPERATING POINTS

ANNEX A

(*Clause* 1, 6.3.113.3, 7.1 ,7.1.101 *and* 16.2.1.2)

D.C. EV SUPPLY EQUIPMENT OF SYSTEM A

A-1 GENERAL

This annex provides the specific requirements for the d.c. electric vehicle supply equipments of System A (hereinafter also referred to as "System A station" or "station"), in addition to the general requirements as defined in the body text of this document.

System A is a regulated d.c. charging system using a dedicated CAN communication circuit for digital communication between a d.c. electric vehicle supply equipment and an electric vehicle for control of d.c. charging. The vehicle coupler of Configuration AA as specified in IS 17017(Part 2/Sec 3):2020 is applicable to System A. The specific requirements for digital communication and details of the communication actions and parameters of System A are defined in Annex A of IS 17017(Part 24).

Rated output voltage of system A station does not exceed 1000 V d.c..

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

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

This annex is also applicable to the d.c. electric vehicle charging/discharging station of System A. Unless otherwise provided for, the requirements for System A station in this document is also applicable to the charging/discharging station. For general information regarding bi-directional power flow, refer to Annex C.

More detailed information on System A is defined in IEEE 2030.1.1.

A-2 SCHEMATIC AND INTERFACE CIRCUIT DIAGRAM

The schematic block diagram of System A is given in Fig. 28. The interface circuit between the station and the vehicle for charging control is shown in Fig. 29. CAN-bus circuit is provided for digital communication with the vehicle. The definition and description of symbols and terms in Fig. 28 and Fig. 29 are given in Table 17. The values of the parameters for the interface circuit are given in Table 18.

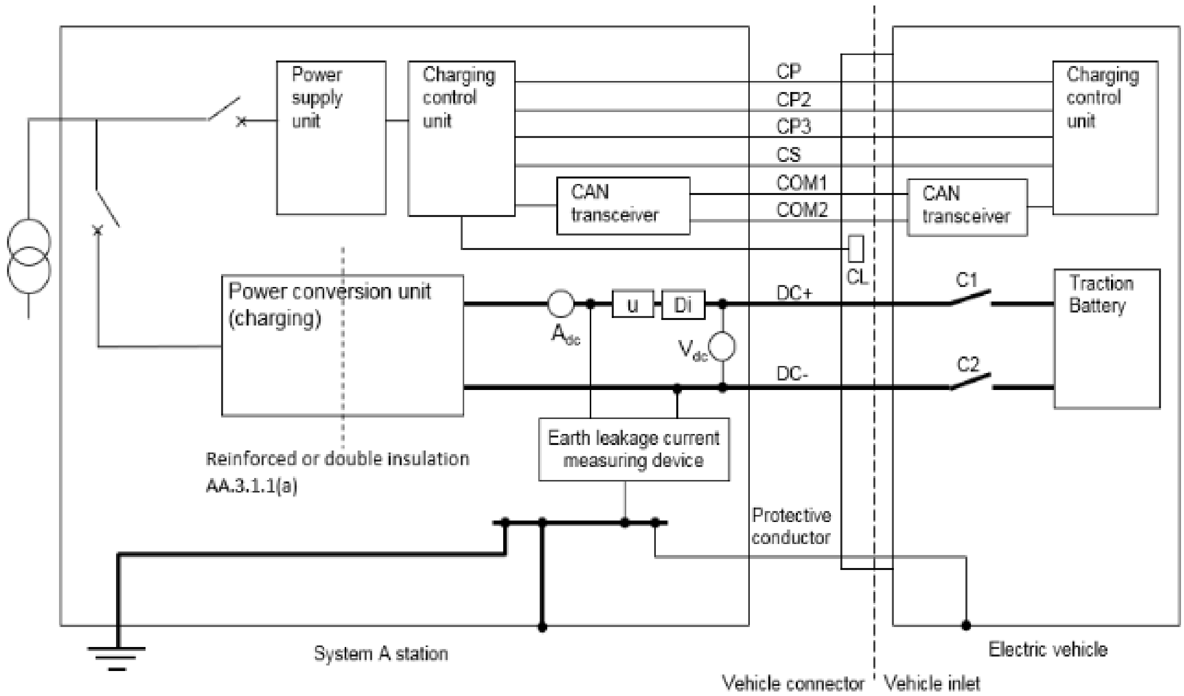


FIG. 28 OVERALL SCHEMATIC OF SYSTEM A STATION AND EV

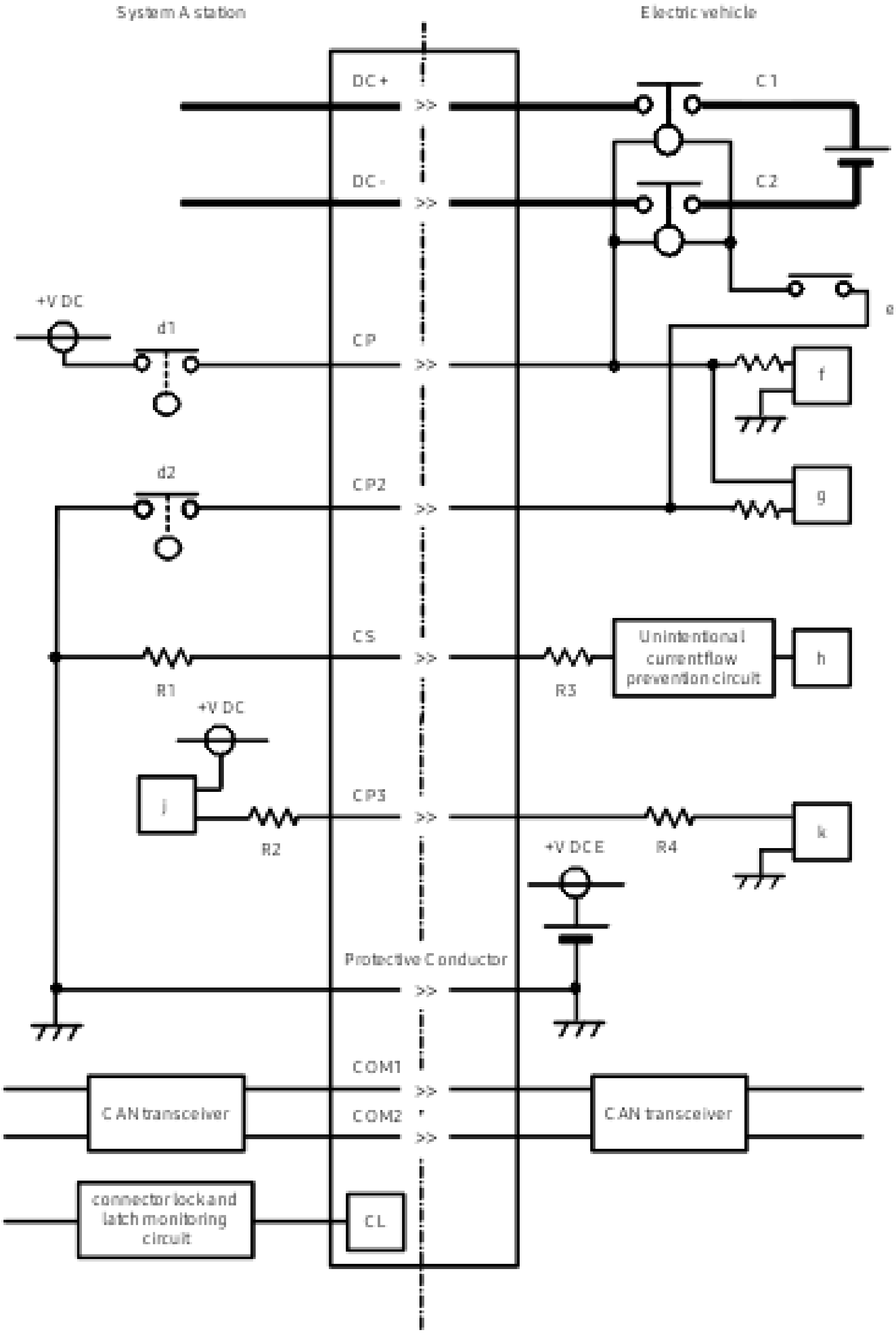


FIG. 29 INTERFACE CIRCUIT FOR CHARGING CONTROL OF SYSTEM A STATION

Table 17 - Definition of symbols of overall schematics of System A station

(*Clause* A-2**)**

	Symbols	**Definitions**	**Requirements**
System A station	Di	Reverse-current-prevention device (for example diode: cathode on the vehicle side, anode on the station side)	**101.1**
	d1	Switch on CP for controlling the charging start/stop signals from the station to the vehicle	Table 18, **A-3.7**, **A-4**
	d2	Switch on CP for controlling the charging start/stop signals from the station to the vehicle	Table 18, **A-3.7**, **A-4**
	j	Signal sensing device to detect vehicle ready/not ready to accept energy	**A-4**
	Vdc	Voltage measurement device	**A-3.3**, **A-4.4**
	Adc	Current measurement device	**A-4.4**
	u	Short-circuit protection device (for example current limiting fuse) In case the vehicle connector has the short-circuit protection device, station A may not have the one.	**A-3.5**
	R1	Resistor	Table 18
	R2	Resistor	Table 18
	. V DC	d.c. power supply to electric vehicle contactors	Table 18, **A-3.12**
Electric vehicle	C1,C2	Disconnection switch for d.c. power lines (electric vehicle contactors)	**A-3.7**, **A-3.8**, **A-3.15**, **A-4**
	e	Relay for turning on electric vehicle contactors	**A-4**
	f	Signal sensing device to detect the status of d1	**A-4**
	g	Signal sensing device to detect the status of d2	**A-4**
	h	Signal sensing device to detect connection / disconnection of vehicle coupler	**A-4**
	k	Switch to give the go ahead / stop to charge	**A-4**
	R3	Resistor	Table 18
	R4	Resistor	Table 18
	+V	d.c. power supply in the vehicle	Table 18

	DCE		
Terminal and wire	DC+	d.c. power supply (positive)	**A-3.15**
	DC-	d.c. power supply (negative)	**A-3.15**
	CP	Control pilot which indicates the start/stop status of station	Table 18
	CP2	Control pilot which indicates the start/stop status of station	Table 18,
	CS	Pilot wire which indicates the status of vehicle coupler connection	Table 18, **A-3.14**
	CP3	Control pilot which confirms that the vehicle is ready for charging	Table 18, **A-3.2**, **A-3.8.2**
	COM1 COM2	Signal line pair for digital communication	**A-3.2**, **A-4**, Annex A of-IS 17017(Part 24).
	protective conductor	Protective conductor between the station and electric vehicle for detecting the first d.c. earth fault	**A-3.1.1**, **A-3.8.2**
	AS1	Auxiliary power supply from the vehicle (in-connector terminal)	Table 18, **A-6.2.10**
	AS2	Auxiliary power supply from the vehicle (external terminal)	Table 18, **A-6.2.10**
Vehicle connector	CL	Connector latching and latching mechanism	**A-3.3**, **A-3.6**

Table 18 - Parameters and values for interface circuit of system A station

(*Clause* A-2**)**

System A station					
Terminal/ Wire	**Parameters**	**Minimum value**	**Typical value**	**Maximum value**	**Unit**

CP	+V DC	10.8	12.0	13.2	V
CS	Resistor R1	190	200	210	Ω
CP3	Resistor R2	950	1 000	1 050	Ω
CP	Load current of switch d1	2		2 000	mA
CP2	Load current of switch d2	2		2 000	mA
AS1	Voltage		12	16	V
	Current			6.4	A
AS2	Voltage		12	16	V
	Current			6.4	A
Electric vehicle					
CP	Load current (when d1 and d2 closing)	10		2 000	mA
CP2	Load current (when d1 and d2 closing)	10		2 000	mA
CS	Resistor R3	950	1 000	1 050	Ω
	+V DCE	8	12	16	V
CP3	Resistor R4	190	200	210	Ω
AS1	Voltage		12	16	V
	Current			6.4	A
	Rated fuse			10	A
	Voltage		12	16	V
NOTE – Voltage of AS1 or AS2 is different from +V d.c.					

For bi-directional power flow application, resistance of AS1, AS2 and protective conductor: Each resistance shall be less than the line resistance equivalent to the one on the conditions of conductor temperature 80 °C, 1.25 mm^2 and 7.5 m (15 m for round-trip).

A-3 SPECIFIC SAFETY REQUIREMENTS

A-3.1 Fault Protection in the Secondary Circuit

A-3.1.1 *General*

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

a) reinforced or double insulation between the a.c. supply circuit and the d.c. output circuit according to 4.4.7 of IEC 62477-1:2016. If the a.c. supply circuit and the d.c. output circuit are insulated at the commercial frequency input port of power converter, an isolating transformer according to IEC 61558-2-4 may be used;

NOTE — (a) includes the isolating transformer and all associated circuits of the secondary circuit.

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

When protective conductor forms part of a charging cable, the cross-sectional area of protective conductor shall be determined by the formula in 543.1.2 of IEC 60364-5-54:2011. The minimum cross-sectional area of the protective conductor of charging cable shall be 0.75 mm^2.

Table 19 shows the principle of fault protection. System A station shall comply with case 1.

Table 19 - Principle of fault protection

(*Clause* A-3)

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

The requirements in **A-3.1** also apply to the bi-directional power flow system.

A-3.1.2 *Automatic Disconnection and Earth Fault Monitoring*

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

The station shall detect the first earth fault before and during charging within 1 s, and then shall perform an error shutdown.

The procedure of earth fault detection before charging is provided in **A-4.3.3**.

Specific requirements on the timing criteria for the error shutdowns are given in Table 21.

Fault current detection principle and performance requirements are defined in Fig. 30 and Table 20.

KEY

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

R: grounding resistor to detect and limit the first fault current

I_g: earth leakage current at the first earth fault

FIG. 30 FAILURE DETECTION PRINCIPLE BY DETECTION OF d.c. LEAKAGE CURRENT

Table 20 - Requirements for earth fault monitoring

(*Clause* A-3.1.2**)**

Item	Detection performance
Maximum detection time a	Less than 1 s
Nuisance trip prevention	Minimum response time shall be more than 0.2 s with continuous threshold monitoring
Sensitivity b	Sensitivity of earth leakage current measuring device and grounding resistor of 'R' shall be designed so that the body current of human at the first earth fault is within DC-2 zone in Fig. 22 of IEC 60479-1:2005.

a The detection time does not include shutdown time of d.c. output current.

b The actual body current may differ from the measured leakage current Ig, which should be taken into account when designing the station.

Example

Set-up condition 1: When the body current Ih exceeds DC-2 zone calculated by Formula (5), a measurement device is designed to detect the deterioration of insulation resistance Rf as the first earth fault by measuring earth leakage current shown in Formula (6).

$$I\mathrm{h}=V\mathrm{dc} \times (R + R\mathrm{f})/(R \times R\mathrm{f}) \qquad (5)$$

where

Ih is the body current

Vdc is the line to line voltage of d.c. output circuit

R is a grounding resistor

Rf is an insulation resistance

$$I\mathrm{g} = V\mathrm{dc} / (R + 2 \times R\mathrm{f}) \qquad (6$$

where

Ig is the measuring current

Set-up condition 2: The measurement device is designed to detect the body current within DC-2 zone, except the set-up condition 1.

A-3.2 De-Energization of the Power Supply to the EV

The compliance to **6.3.1.5** shall be checked according to the following tests.

a) TEST 1; and
1) Connect the d.c. electric vehicle supply equipment to an artificial load;
2) Start charging with the procedure specified by charger manufacturer;
3) Stop digital message transmission from electric vehicle simulator; and
4) Check the d.c. electric vehicle supply equipment initiates error shutdown after 1 s elapsed from (3).

b) TEST 2.
1) Connect the d.c. electric vehicle supply equipment to an artificial load;
2) Start charging with the procedure specified by charger manufacturer;
3) Turn off CP3 signal between the station and electric vehicle; and
4) Check the d.c. electric vehicle supply equipment triggered emergency shutdown after (3).

NOTE — The compliance can also be checked according to the test specified by the manufacturer.

A-3.3 Voltage Measurement of d.c. Power Line for Vehicle Connector Unlatch

According to **6.3.1.103**, the vehicle connector shall not be unlatched when hazardous voltage is detected. To unlatch the vehicle connector, the voltage of d.c. power line shall be measured at V_{dc} in Fig. 28, and be confirmed to be within safe levels, that is 10 V or less.

Compliance is checked by the following test:

a) Connect the d.c. electric vehicle supply equipment to a test load with a dedicated electric vehicle simulator. The setup of the test load in Fig. 26 is in Table 16;
b) Start charging with the procedure specified by charger manufacturer;
c) Confirm that the vehicle connector is latched on a vehicle inlet before insulation check;
d) After insulation check, close switch S0;
e) Stop charging with the procedure specified by charger manufacturer;
f) Open switch Sa; and
g) Confirm that the vehicle connector remains latched on a vehicle inlet while the voltage at the inlet terminals is higher than 10 V.

A-3.4 Overcurrent Protection of the d.c. Connection

The d.c. electric vehicle supply equipment shall provide an overcurrent protection to protect the power supply circuit of the d.c. electric vehicle supply equipment and the vehicle. If the following condition is continuously fulfilled for a duration of 5 s, the d.c. electric vehicle supply equipment shall trigger an error shutdown

a) at current ≥ 50 A: current is exceeding 120 percent of the request value from theelectric vehicle; and
b) at current < 50 A: current is exceeding the request value from the electric vehicle by 10 A or more.

Compliance is demonstrated by design review.

A-3.5 Short-Circuit Protection of d.c. Connection

Short circuit protection means, such as current-limiting fuse u, shall be provided in the output circuit of System A station in order to protect the circuits of the station and the vehicle from short circuit.

The short-circuit protection device shall meet the following requirements:

a) quick-break type; and
b) normal melting rating: not higher than 400 000 A^2s.

The cross sectional area of main conductors of charging cable shall have a short-circuit current withstanding rating (I^2t) at least 6 400 000 A^2s.

When the vehicle connector is equipped with short circuit protection means, the short circuit withstand rate of the charging cable may be reduced.

NOTES

1 Vehicle battery short circuit, by reverse connection of the cable etc., causes huge short circuit current.

2 The system A electric vehicle provides short circuit protection device which protects the charging cable assembly with I^2t of 2 500 000 A^2s (*see* ISO 17409).

Compliance is checked by inspection.

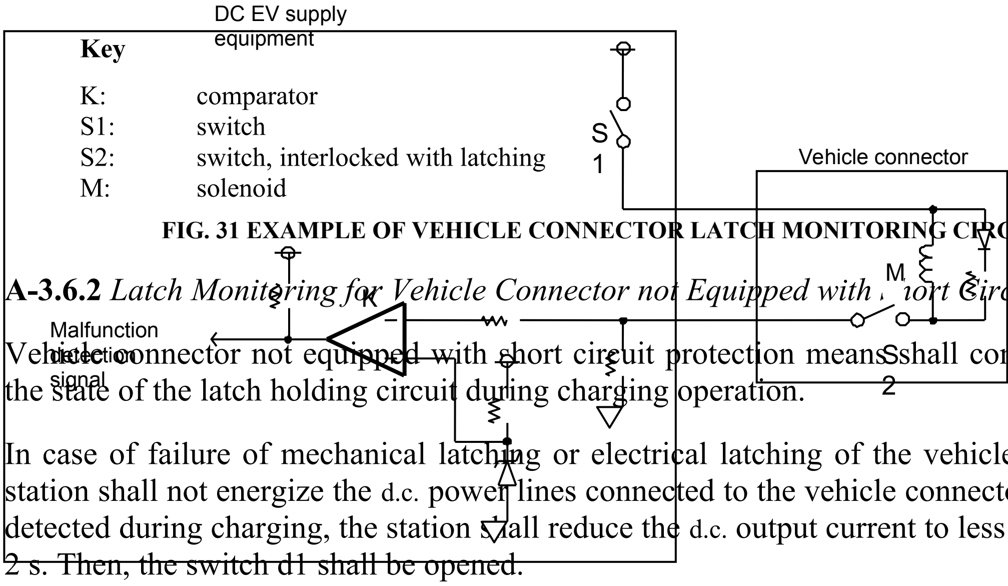
A circuit block diagram indicating that the control circuit power supply is separated from the a.c. supply network and from the power line shall be provided by the manufacturer.

A-3.6 Latch Monitoring for Vehicle Connector

A-3.6.1 *General*

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

It shall also have a means to provide System A station with information on anomaly detection in monitoring of latch and electrical latching. Fig. 31 shows an example of a detection means in vehicle connector and System A station.



Key

K: comparator
S1: switch
S2: switch, interlocked with latching
M: solenoid

FIG. 31 EXAMPLE OF VEHICLE CONNECTOR LATCH MONITORING CIRCUIT

A-3.6.2 *Latch Monitoring for Vehicle Connector not Equipped with Short Circuit Protection*

Vehicle connector not equipped with short circuit protection means shall constantly monitor the state of the latch holding circuit during charging operation.

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

A-3.6.3 *Latch Monitoring for Vehicle Connector Equipped with Short Circuit Protection*

The vehicle connector equipped with short circuit protection means shall have a latching device with self-holding mechanism. When hazardous voltage is present at the contact terminals of vehicle connector, the vehicle connector shall be kept latched to the vehicle inlet if the latch holding circuit of the vehicle connector fails.

The vehicle connector which has the self-holding mechanism does not need to constantly monitor the state of, or detect an error in, the latch holding circuit during charging operation.

A-3.7 Protection of EV Contactor

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

A-3.8 Fault Conditions and Criteria for Transfer to Error and Emergency Shutdown

A-3.8.1 *Error Shutdown*

System A station shall perform an error shutdown according to **6.3.1.116.**

Table 21 provides the shutdown times and criteria of error shutdown.

Table 21 - Error shutdown times and criteria

(*Clause* A-3.8.1)

Fault	Response time of station to start shutdown	Output current descending rate	Shutdown triggered by	General	Output voltage descending rate	Condition to unlatch vehicle connector
Loss of CAN communication [a] (**6.3.1.5**, **A-3.2**)	1 s	ΔIout > 200 A/s	Station	The station shall reduce its output to: Output current ≦5A [c] Output voltage ≦60V between DC+ and DC- and ≤ 28 V between DC+ and earthing terminal, and DC- and earthing terminal [d] (*see* Fig. 32)	(*see* **A-3.15)**	After shutdown process is completed and output voltage ≦10V (*see* Fig. 32).
Overvoltage at the interface (**6.3.1.106**)	2 s					
Overvoltage between DC+/- and PE in case of single first earth fault (**6.3.1.113**)	5 s					
Over temperature of d.c. contact assemblies (**101.4.2.2**, **101.4.3.3**, **A-9.2**)	9 s					
Thermal sensing fault (**101.4.2.3**)	9 s					
Insulation fault between DC+ or DC- and protective conductor (**A-3.2**)	1 s					
Over current of d.c. power line (**A-3.4**)	5 s					
Malfunction of latch device (latch position) (**A-3.6.1**, **A-3.6.2**)	0.1 s					
Malfunction of latch device (latch holding circuit) (**A-3.6.1**, **A-3.6.2**)	0.1 s					
Error shutdown specified by the manufacturer including earth fault on the AC primary circuit, and short circuit on the a.c. primary circuit	Specified by manufacturer					
Under-voltage at the interface [b] (**A-6.2.12**)	2 s					
Short circuit of d.c. power line (**13.3**)	3 s	Specified by manufacturer. *see* **A-3.3**				
Vehicle requested error shutdown by sending: H'102.4.X = 1, or H'102.5.2 = 1, or switch k = OFF	1 s: CAN 0.1 s: switch K	$\Delta I_{out} > 200$ A/s	Vehicle			

[a] Loss of CAN communication means 1 s continuous disruption and no data frame of CAN communication.

b Mandatory for bi-directional systems

c electric vehicle should disconnect the power circuit between station and electric vehicle by opening electric vehicle contactor when the output current of station is decreased less than or equal to 5A.

d Voltage at the vehicle connector terminals. The station can reduce the voltage after the electric vehicle contactor is opened.

After detection of errors, System A station shall send the messages to the vehicle by digital communication [refer to Table A.3 of IS 17017(Part 24)].

Table 22 and Table 23 provide the message parameter exchanges and relevant actions of error shutdown.

Table 22 - Action and message parameter for error shutdown triggered by the station

(*Clause A-3.8.1*)

Step	Action	Message parameter	Criterion
1	Fault detected		
2	Start error shutdown process and notification to the vehicle	H’109.5.1 = 1 or H’109.5.4 = 1 & H’109.5.5 = 1	Send message parameters to the vehicle
3	Charging current control		< 3 s and ΔI_{out} > - 200 A/s
4	Notification to the vehicle and move to step 6, when the station cannot allow welding detection by the vehicle.	H’108.0.0=0 & H’109.5.0=1	Send message parameter to the vehicle when the current reached 5 A or less
5	Notification to the vehicle and move to step 6 of Table 23, when the station can allow welding detection by the vehicle.	H’108.0.0=1 & H’109.5.0=1	Send message parameter to the electric vehicle when the current has reached 5 A or less
6	D1, D2 = OPEN		≤ 1 s from step 4
7	Voltage removal		≤ 2 s and V_{dc} < 10 V from the end of the step 5
8	Unlatched or remain latched		Specified by the manufacturer

Table 23 - Action and message parameter for error shutdown triggered by the vehicle

(*Clause* A-3.8.1)

STEP	Vehicle			Station		
	Action	**Message parameter**	**Criterion**	**Action**	**Message parameter**	**Criterion**
1	Fault detected					
2	Request for error shutdown	H'102.4.X = 1 or H'102.5.2 = 1 or switch (k)=OFF				
3				Start error shutdown process	H'109.5.5= 1	Send message parameters to the vehicle
4				Charging current control		≤ 3 s and $\Delta I_{out} \geq$-200 A/s
5				Notification to the vehicle	H'108.0.0= 1 H'109.5.0= 1	Send message parameters to the vehicle when the current reached 5 A or less
6	Welding detection	H'102.5.3 = 1	welding detection time ≤ 4s send the message to the station after finishing welding detection			
7				D1, D2 = OPEN		≤ 1 s from step 6
8				Voltage removal		≤ 2 s and $V_{dc} \leq$ 10 V from the end of the step 7

9				Unlatched or remain latched		Specified by manufacturer

A-3.8.2 *Emergency Shutdown after Control Pilot Disconnection*

The Systm A station shall decrease the output current to 5 A or less within 30 ms after the loss of the continuity (disconnection) of the control pilot CP3.

Table 24 and Table 25 provide the emergency shutdown times, actions and criteria.

Table 24 - Emergency shutdown times and criteria

(*Clause* A-3.8.2)

Fault	**Trigger of emergency shutdown**	**Response time of station to start emergency shutdown process**	**Maximum time to near zero current (5 A) from fault occurrence**	**Maximum time to reach safe voltage from fault occurrence**
Loss of electrical continuity of protective conductor (**6.3.1.2**) Disconnection of vehicle coupler during charge (**9.101**, **A-4.3.5.3**)	Loss of continuity of the control pilot CP3	Immediately after the fault	< 30 ms	< 1 s < 60V between DC+ and DC- and ≤ 28 V between DC+/- and earthing terminal

Table 25 - Actions and criteria for emergency shutdown

(*Clause* A-3.8.2)

Step	**Action**	**Criterion**
1	Fault detected CP3 loss	
2	Charging current shutoff	≤ 5 A & ≤ 30ms from step 1
3	V_{dc} < 60 V between DC+ and DC- and ≤ 28 V between DC+/- and earthing terminal	≤ 1 s from step 1

A-3.9 Turn on Inrush Current for Vehicle Circuit

When electric vehicle contactor is closed, inrush current on d.c. power line of System A station shall not exceed 20 A at vehicle connector.

A-3.10 Output Current Regulation in CCC

The variation of the output current of the d.c. electric vehicle supply equipment from the required value (target current) sent by the electric vehicle in steady state operation shall be less than or equal to ± 2.5 A for the requirement below 50 A, and less than or equal to ± 5 percent of the required value of 50 A or more.

System A specific test conditions for compliance test in **101.2.2.1** are as shown below.

The setup of the test load is shown in Table 26 and Fig. 26.

Table 26 - System A setup of the test load for output current regulation in CCC

(*Clause* A-3.10)

Switches					Circuit parameter setup
S0	S1	S3	Sa	Sb	
close	close	open	open	close	L1: 0 H R1, R5: 0Ω (bypassed) V1: Not used U1: An electronic load operating under constant voltage mode shall be used.

For 4) in **101.2.2.1**, record I_{EV} target and I_{EVSE} output at the following operating points: OP1, OP2, OP3, OP4, OP5 and OP6.

Recommended steps for sweeping the output voltage and current of the d.c. electric vehicle supply equipment are shown in Table 27.

Table 27 - System A recommended steps for output current regulation in CCC

(*Clause* A-3.10)

Step	Action	Description
1	Set U1 = V_{EVSE} min.	Transmit; Target battery current = 0(A)
2	Set I_{EV} target = $I_{EVSE\ min}$ to check OP1.	Transmit; Target battery current = 5(A)
3	Set I_{EV} target = $I_{EVSE\ max}$ to check OP5.	Transmit; Target battery current = $I_{EVSE\ max}$ (A)
4	Increase U1 up to V_{EVSE} output = $P_{EVSE\ max}/I_{EVSE\ max}$ to check OP4.	-
5	Set U1 to $V_{EVSE\ max}$ to check OP3	Before setting U1 to $V_{EVSE\ max}$, transmit; Target battery current = $P_{EVSE\ max}/V_{EVSE\ max}$ -5(A)
6	Set U1 = $V_{EVSE\ min}$ to check OP2.	-

A-3.11 Periodic and Random Deviation (Current Ripple)

The compliance to **101.2.5** shall be checked according to the following tests.

a) Connect the artificial load with electric vehicle simulator to the station. Select the value of R2 in accordance with $I_{EVSE\ max}$ and the voltage at which the OP4 in Fig. 27 shall be operated. for example if $I_{EVSE\ max}$ = 200 A and the voltage at OP4 = 400 V, R2 = 400 V / 200 A = 2 Ω;
b) Connect a current probe to the measuring instrument (oscilloscope of 20 MHz) and clamp the current probe to the d.c. power line in the output of the station;
c) Start charging according to the procedure specified by the station manufacturer, with $I_{EV\ target1}$ = $I_{EVSE\ min}$, where $I_{EV\ target1}$ is the initial current command value from electric vehicle simulator for OP1 in Fig. 27.
d) Wait for T_{dmax1} until the steady state operation is reached.

$$T_{dmax1} > 1 + \frac{I_{EV\ target1}}{20}$$

where T_{dmax1} is the time for the output current of station to reach $I_{EV\ target1}$ and the steady state, expressed in seconds (s).

e) Set the current command value = $I_{EV\ target2}$ in electric vehicle simulator to operate the station at OP4.

f) Wait for T_{dmax2} until the steady state operation is reached.

$$T_{dmax2} > 1 + \frac{I_{EV\ target2} - I_{EV\ target1}}{20}$$

where T_{dmax2} is the time for the output current of station to reach $I_{EV\ target2}$ and the steady state, expressed in seconds (s).

g) Measure the maximum peak-to-peak value of the output current after the first order low pass filtering (LPF).

h) Check that the maximum peak-to-peak value is within the limit for each cut-off frequency in Table 13.

The measuring instrument and conditions shall comply with the requirements specified in Table 28.

Table 28 - Specification of measuring instrument

(*Clause A-3.11*)

Item	Performance
Oscilloscope	Bandwidth: 0 - 20 MHz or more Sampling rate: 1 MS/s or more Record length: 1 M point or more Record span: 1.1 s or more Vertical resolution: 12 bits or more
Current probe	Rated current: Maximum output current of the station or more Bandwidth: 0 - 300 kHz or more Measurement accuracy: within ± 1percent

A-3.12 Load Dump

In any case of load dump, voltage overshoot of d.c. output of the station shall not exceed the voltage limit specified in Table 29.

Table 29 - Voltage limit for load dump

(*Clause* A-3.12)

Target battery voltage [a] of vehicle (U)	Voltage limit in case of load dump V
U ≤ 500 V	600
500 V < U ≤ 750 V	900
750 V < U ≤ 1 000 V	1 200
[a] Table A.2 of IS 17017(Part 24).	

A-3.13 Power Supply to Vehicle for Actuation of EV Contactors

System A station shall provide a power supply to the vehicle via terminal d1 for the actuation of electric vehicle contactors C1 and C2, with a rated voltage of 12 V and the maximum rated output power of more than 24 W.

Instead of using the 12 V power supply from the station, the vehicle may provide the power source for the actuation of the electric vehicle contactors. In such case,

a) The vehicle should be capable of reducing the voltage of the d.c. power line terminals of the vehicle inlet to less than 60 V between DC+ and DC- and less than 28 V between DC+ and earthing terminal, and DC- and earthing terminal within 1 s after the disconnection of the charging connector from the vehicle inlet.

NOTES – By using the 12 V power supply from the station as a power source for the actuation of the electric vehicle contactors, the unexpected closure of the electric vehicle contactors when the charging connector is not mated to the vehicle inlet can be prevented.

b) The vehicle should not close the electric vehicle contactors when the vehicle connector is not mated to the vehicle inlet.

NOTES –The vehicle can continuously monitor the status of charging connector proximity by checking the condition of one or more of the signals CP, CP2, COM1 and COM2.

A-3.14 Pilot Wire for Monitoring Vehicle Coupler Connection

The pilot wire (CS) shall be electrically or mechanically disconnected from the vehicle control circuit during the period from a) to b):

a) the closure of switch k (after Handshaking)
b) the opening of the electric vehicle contactor C1 and C2 (after Energy transfer).

NOTES

1 The requirement is achieved by the unintentional current-flow prevention circuit on the vehicle. *See* Fig. 29 and Fig. 38.

2 Vehicle may connect CS to the vehicle control circuit before the closure of the switch k and after the opening of the electric vehicle contactor C1 and C2, (DC-B'3 and DC-B'4). By monitoring CS, the vehicle can prevent the unexpected drive when the vehicle connector is mated to the vehicle inlet, before and after the charging.

A-3.15 Impedance of Output Circuit

In the time period between T3 and T4 in Fig. 33, the line impedance between DC+ and DC- from the reverse current prevention device Di in the output circuit of System A station to the vehicle connector shall be as follows:

a) capacitance: 1 μF or less; and
b) resistance: 40 kΩ or more.

A-3.16 Assistance of Welding Detection

The station shall fulfil the following conditions when, from the vehicle inlet to the open electric vehicle contactor, the capacitance between DC+ and DC- is less than or equal to 1 μF:

a) Within 1 s after opening the electric vehicle contactor, the voltage at vehicle connector shall be less than 25 percent of the d.c. output voltage at the end of the charging;
b) Within 2 s after opening the electric vehicle contactor, the voltage at vehicle connector shall be less than 10 V.

A-4 CHARGING PROCESS AND COMMUNICATION BETWEEN d.c. EV SUPPLY EQUIPMENT AND ELECTRIC VEHICLE FOR CHARGING CONTROL

A-4.1 Charging State

Table 30 defines the charging state of d.c. electric vehicle supply equipment. The charging states show physical status of d.c. electric vehicle charging system. The d.c. electric vehicle supply equipment and the vehicle can exchange their charging state through the signal communication and the digital communication.

Table 30 - Charging state of d.c. EV supply equipment

(*Clause* A-4.1)

State		Vehicle connected	Vehicle contactor	Charging possible	Description
DC-A	Not connected	No	Open	No	Vehicle unconnected
DC-B1	Initialization	Yes	Open	No	Vehicle connected / not ready to accept energy / communication not established / connector unlatched or latched / vehicle contactor open
DC-B2		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector unlatched or latched / vehicle contactor open
DC-B3		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector latched / vehicle contactor open / other supplemental processes not completed
DC-C	Energy transfer	Yes	Close	Yes	Vehicle connected / ready to accept energy / indoor charging area ventilation not required / communication established / connector latched / vehicle contactor close / other supplemental processes completed
DC-D		Yes	Close	Yes	Vehicle connected / ready to accept energy / indoor charging area ventilation required / communication established / connector latched / vehicle contactor close / other supplemental processes completed
DC-B'1	Shutdown	Yes	Close	Yes	Vehicle connected / charging finished / communication maintained / connector latched / vehicle contactor close
DC-B'2		Yes	Open	No	Vehicle connected / charging finished / communication maintained / connector latched / vehicle contactor open / other supplemental processes completed
DC-B'3		Yes	Open	No	Vehicle connected / charging finished / communication maintained / connector unlatched / vehicle contactor open
DC-B'3-1		Yes	Open	No	Vehicle connected / charging finished / communication maintained / connector latched / vehicle contactor open
DC-B'4		Yes	Open	No	Vehicle connected / charging finished / communication finished / connector unlatched / vehicle contactor open
DC-B'4-1		Y	O	N	Vehicle connected / charging finished

		es	pen	o	/ communication finished / connector latched / vehicle contactor open
DC-B'4-2		Yes	Open	No	Vehicle connected / charging finished / communication finished / connector unlatched / vehicle contactor open
DC-E	Error	Yes	Open	No	d.c. electric vehicle supply equipment disconnected from vehicle / d.c. electric vehicle supply equipment disconnected from utility, d.c. electric vehicle supply equipment loss of utility power or control pilot short to control pilot reference.
DC-F	Malfunction	Yes	Open	No	Other d.c. electric vehicle supply equipment problem

Charging control process as system action level is shown in Table 31.

Table 31 - Charging control process of d.c. EV supply equipment at system action level

(*Clause* A-4.1)

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

	B1	
a The order of actions does not refer to the procedure of charging control process. b In some use cases, such as billing service, the vehicle connector can continue to be latched after the charge is finished.		

A-4.2 Communication Measures

Communication between the station and the vehicle is carried out through the control pilots CP, CP2 and CP3, proximity circuit CS, and the digital communication circuits COM1 and COM2. CP and CP2 transmit signals such as "ready to charge" and "end of charge" from the station to the vehicle. CP3 is used to transmit instructions to start charging or shutdown, from the vehicle to the station. Numerical parameters in Annex A of IS 17017(Part 24). such as output rating of station and maximum voltage of battery are exchanged through COM1 and COM2.

A-4.3 Charging Control Process

A-4.3.1 State Transition Diagram and Sequence Diagram

The charging process of System A shall conform to the state transition diagram as shown in Fig. 32. Fig. 33 gives the charging control sequence under normal conditions.

FIG. 32 STATE TRANSITION DIAGRAM OF CHARGING PROCESS

FIG. 33 SEQUENCE DIAGRAM OF CHARGING

A-4.3.2 *Start of Charging*

When the charging process is initiated by System A station, d1 shall be closed. The switch d2 shall be open until the end of insulation check in **A-4.3.3**.

A-4.3.3 *Insulation Check before Charging*

The insulation check shall not start until the vehicle provides System A station with a permission signal through CP3, and permission parameters by digital communication as shown in Annex A of IS 17017(Part 24). Before the insulation check, System A station shall inform the vehicle through digital communication that vehicle connector is latched.

The insulation check shall be performed in accordance with **6.3.1.105** and as the following procedure:

a) Before the insulation check, the station shall measure V_{dc} of d.c. power line and confirm that electric vehicle contactors are open. The voltage of d.c. power line, measured at V_{dc}, shall be less than 10 V. If the measured voltage is more than or equal to 10 V, the charging process shall be shut down (*see* Fig. 32).

b) The voltage *U* that is applied to the d.c. power line shall be Target battery voltage (H'102.1, H'102.2) or Available output voltage (H'108.1, H'108.2), whichever is lower. Voltage accuracy shall be within +/- 5 percent. If the voltage is less than 500 V, it shall be set to 500 V +/- 5 percent. After the insulation check, it shall be confirmed that the voltage at V_{dc} is less than or equal to 20 V. Then, the station shall inform the vehicle of the termination of insulation check with closing d2 switch. During the insulation check, the earth fault shall be monitored in accordance with **A-3.1.2**. When earth fault is detected, error shutdown shall be performed.

The compliance of the insulation check function shall be confirmed with the following test.

a) Test Setup

Connect test load (Fig. 26) and fault resitance Rt to the station (DUT) according to Fig. 5. Switch S0 in the Test load shall remain open during the test.

b) Test Scenarios

The DUT shall be checked under all test scenarios specified in Table 32.

Table 32 - Test scenarios

(*Clause* A-4.3.3)

Test scenarios	Fault resistance (Rt)	Location of Rt
Scenario 1	Not used	-
Scenario 2	U[1]×100	Between DC+ and PE [3]
Scenario 3	Sufficiently low resistance [2]	Between DC+ and PE [3]
Scenario 4	U[1]×100	Between DC- and PE [3]
Scenario 5	Sufficiently low resistance [2]	Between DC- and PE [3]
[1] According to **A-4.3.3 b)**		

[2] Select sufficiently low resistance to represent 0 Ω insulation fault. Examiner can select the appropriate value for the resistance. [3] In this Table, PE means "protective conductor".

c) Result

The DUT shall satisfy the following requirements

1) Insulation check voltage shall comply with the requirement in item (b) of **A-4.3.3** in test scenario 1. DUT shall keep the insulation check voltage U for more than 0.2 s after the voltage reached U.

2) In the scenarios 2, 3, 4, and 5, the DUT shall judge the insulation failure within 1 s after the insulation check voltage reached U.

3) For scenario 1, DUT shall transition to the next charging state.

4) For scenarios 2,3,4, and 5, DUT shall perform the following process.

i) DUT shall notify electric vehicle (electric vehicle simulator) the insulation failure by CAN communication. The DUT shall use data bit "H'109.5.1" specified in Annex A of IS 17017(Part 24). DUT shall stop applying insulation check voltage within 1 s.

ii) DUT shall transit to shutdown state.

NOTE — Some DUT needs a certain time period to reach the insulation check voltage U.

A-4.3.4 *Energy Transfer*

System A shall continuously monitor the charging current value requested by the vehicle. The charging current shall be changed responding to the vehicle requested value, in accordance with CCC requirements in **101.2.2.1** and **101.2.3**. The characteristics of charging current control shall meet **A-5**.

A-4.3.5 *Shutdown*

A-4.3.5.1 *Normal shutdown*

System A station shall comply with the following procedure for normal shutdown:

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

b) The station shall reduce the output current to 5 A or less with the current descending speed specified in Table 36.

c) Switches d1 and d2 shall not be open until the welding detection of electric vehicle contactor by vehicle is finished.

d) After d1 and d2 open, it shall be confirmed that the voltage at V_{dc} is 10 V or less. The station shall keep connector latched, if the voltage at V_{dc} is more than 10 V.

Table 33 and Table 34 define the normal shutdown time, actions and criteria.

Table 33 - Normal shutdown times and criteria

(*Clause* A-4.3.5.1)

Trig ger	**Response time of station to start normal shutdown process**	**Maximum time to near zero current (5 A) from the start of normal**	**Maximum time to reach connector**

		shutdown process	**unlatched**
Vehicle	$\leq$ 0.5 s from trigger	$\leq$ 3 s and $\Delta I_{out} \geq$ -100 A/s	$\leq$ 7.5 s
Station	According to the specification given by the manufacturer		

Table 34 - Actions and message parameters for normal shutdown

(*Clause* A-4.3.5.1)

STEP	Vehicle			Station		
	Action	**Message parameter**	**Criterion**	**Action**	**Message parameter**	**Criterion**
1	Request of normal shutdown	H'102.5.0=0 or H'102.5.1 =1 & H'102.3=0	Send the parameters to the station			
2[a]				Notify the vehicle of start of normal shutdown	H'109.5.5 =0	Send the parameter to the vehicle
3				Charging current control		≤ 3 s and $\Delta I_{out} \geq -100$ A/s
4				Notification to the vehicle	H'109.5.0 =1	Send the message to the vehicle when the current reached 5 A or less
5	Welding detection	H'102.5.3 = 1	Welding detection time ≤ 4 s Send the message to the station after finishing welding detection			
6				d1, d2 = OPEN		≤ 1.5 s from the end of step 5
7				Voltage removal		≤ 2 s and $V_{dc} \leq 10$ V from the end of the step 6
8				Unlatched or remain latched		Specified by the manufacturer

[a] When the station triggers normal shutdown, the shutdown process starts from step 2.

A-4.3.5.2 *Error shutdown*

System A station shall comply with the following procedure for error shutdown:

a) The station shall notify the vehicle of start of shutdown process by digital communication.
b) The station shall reduce the output current to 5 A or less with the current descending speed specified in Table 36.
c) If the shutdown is triggered by electric vehicle, switches d1 and d2 shall not be open until the welding detection of electric vehicle contactor by vehicle is finished.
d) If the shutdown is triggered by System A station, switches d1 and d2 shall be opened within 0.5 s or less after b).
e) After d1 and d2 open, it shall be confirmed that the voltage at V_{dc} is 10 V or less. The station shall keep connector latched, if the voltage at V_{dc} is more than 10 V.

A-4.3.5.3 *Emergency shutdown*

System A station shall start emergency shutdown as follows, when detecting the loss of CP3 signal.

a) The station shall reduce the output current to 5 A or less within 30 ms;
b) If the station uses CP3 signal as emergency shutdown detection, switches d1 and d2 shall not be open until the welding detection of electric vehicle contactor by vehicle is finished;
c) If the station uses CP or CP2 signal as emergency shutdown detection, switches d1 and d2 shall be opened within 0.5 s or less after b); and
d) After d1 and d2 open, it shall be confirmed that the voltage at V_{dc} is 10 V or less. The station shall keep connector latched, if the voltage at V_{dc} is more than 10 V.

A-4.4 Measuring Current and Voltage

The voltage and current shall be continuously monitored and reported within 0.5 s including measurement delay and digital communication (CAN) transmission delay.

The accuracy of output measurement reported via digital communication of system A shall be within the following values:

a) Current: ± (1.5 percent of actual output current + 1) A
b) Voltage: ± 5 V

Refer to Figure 34 for a more precise definition of the accuracy of output measurement with respect to the target current and the actual output current defined in **101.2.2.1.**

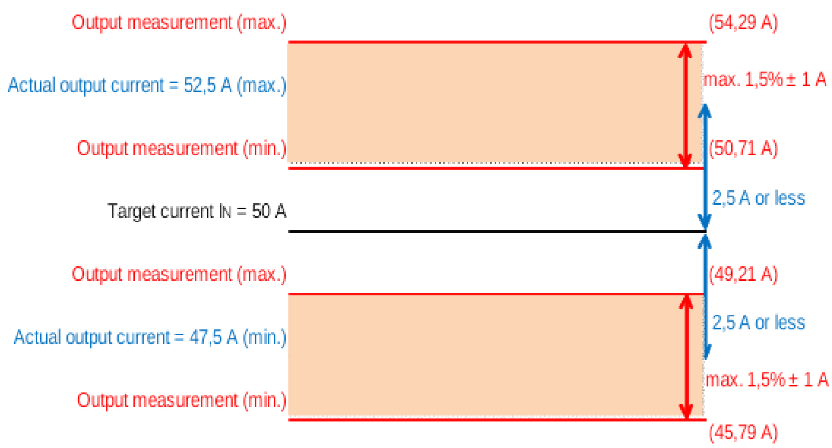


FIG. 34 ACCEPTABLE RANGE OF OUTPUT MEASUREMENT (TARGET CURRENT *I*N:50A)

A-5 RESPONSE TO VEHICLE COMMAND ON CHARGE CURRENT

System A station shall supply d.c. current to the vehicle using CCC with the vehicle as the master and d.c. electric vehicle supply equipment as the slave. Recommended specification for the charge current request from the vehicle and the response performance of System A station are given in Table 35 and Fig. 35 for the vehicle, and in Table 36 and Fig. 36 for system A station.

NOTE — Table 35 and Fig. 35 also apply to the maximum available current in bi-directional flow system operating under charging/discharging seamless-switchover mode.

Table 35 - Recommended specification of charging current requested by the vehicle

(*Clause* A-5**)**

Item	Symbol	Condition	Specification		
			Minimum	Maximum	Unit
Charging current request range	I_{req}		0	Available output current (IS 17017(Part 24) -Annex A)	A
Rate of demand value change	ΔI_{req1}		– 20	20	A/s

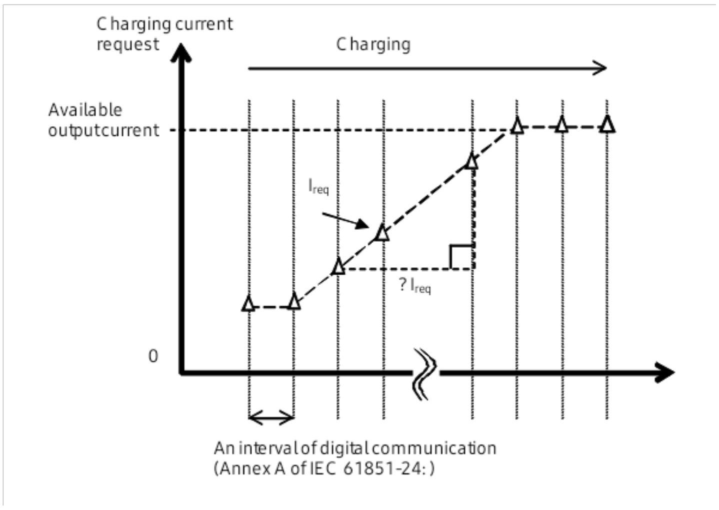


FIG. 35 CHARGING CURRENT VALUE REQUESTED BY THE VEHICLE

Table 36 - Requirements for the output response performance of d.c. EV supply equipment

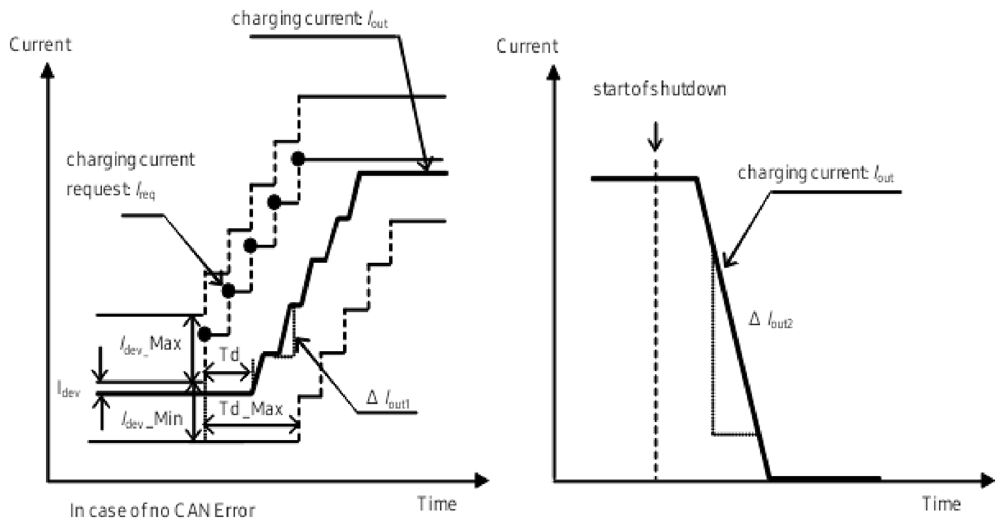
(*Clause* A.5)

Item	Symbol	Condition		Specification		
				Minimum	Maximum	unit
Output accuracy	I_{dev}	Charging current request	0 to 5 A	0 (I_{dev}_Min)	I + 2.5 A (I_{dev}_Max)	A
			5 to 50 A	I – 2.5 A (I_{dev}_Min)	I + 2.5 A (I_{dev}_Max)	
			50 A to 400 A	I × 95 percent (I_{dev}_Min)	I × 105 percent (I_{dev}_Max)	

Control delay to vehicle request	T_d		-	1.0 (T_d _Max)	s
Output response speed	ΔI_{out1}	At charging	20	-	A/s
Output current descending speed [b]	ΔI_{out2}	normal shutdown	100	200	
		error shutdown	200	-	
		emergency shutdown	200 a	-	

a In case of disconnection of CP, CP2 or CP3 during charging, faster termination of charging current is required. *See* **A-3.8.2**.

b The requirement for the output current descending speed also applies to the bi-directional power flow system. All the other values in this table are not applicable to the bi-directional power flow system.



a) Energy transfer b) Shutdown

FIG. 36 OUTPUT RESPONSE PERFORMANCE OF d.c. EV SUPPLY EQUIPMENT

A-6 BI-DIRECTIONAL POWER FLOW (OPTIONAL)

A-6.1 Schematic and Interface Circuit Diagram

The schematic block diagrams of the charging/discharging station of System A are given in Fig. 37 and Fig. 38.

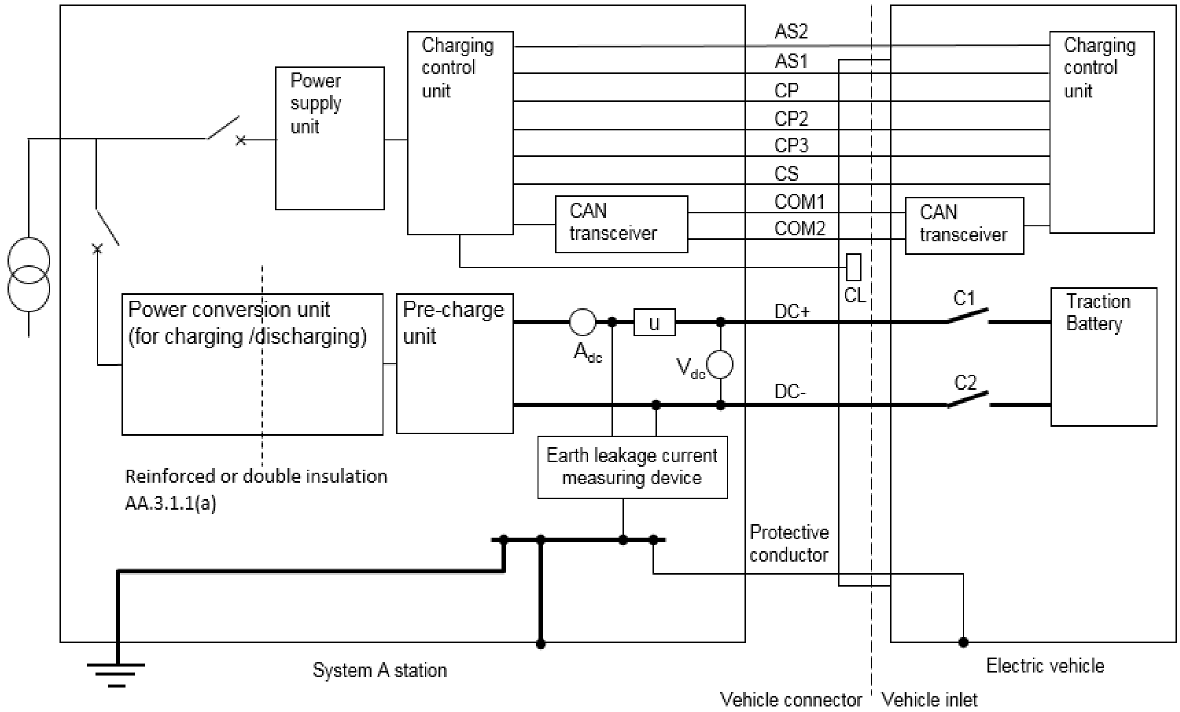


FIG. 37 OVERALL SCHEMATIC OF SYSTEM A CHARGING/DISCHARGING STATION AND EV (CHARGING/DISCHARGING INTEGRATION TYPE)

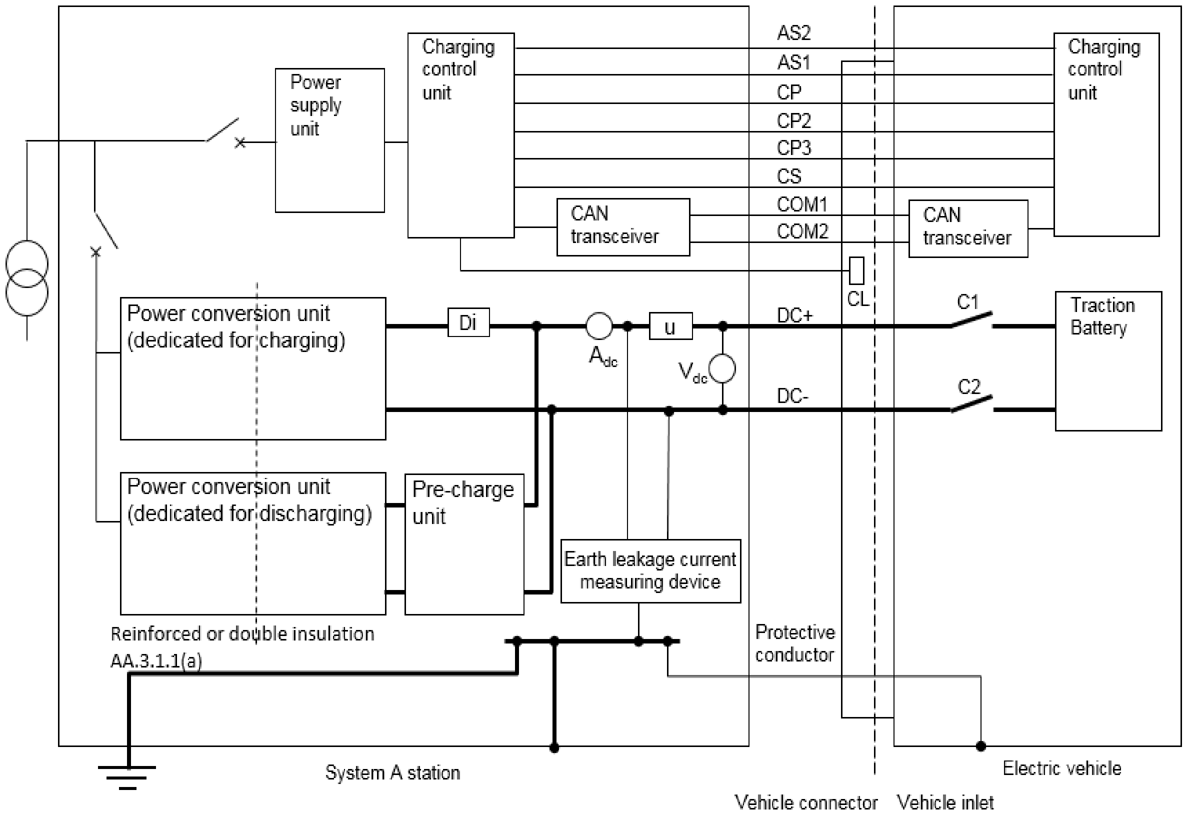


FIG. 38 OVERALL SCHEMATIC OF SYSTEM A CHARGING/DISCHARGING STATION AND EV (CHARGING/DISCHARGING SEPARATION TYPE)

The interface circuit between the station and the vehicle for charging/discharging control is shown in Fig. 39. The definition and description of symbols and terms in figures are given in Table 17. The values of the parameters for the interface circuit are given in Table 18.

NOTES

1 AS2 (optional) to which the power is supplied from cigarette socket.

2 The fuse is a reference example, for example a fuse in a cigarette socket.

3 The diode is a reference example. It prevents reverse current to the auxiliary battery.
4 AS1 is optional.

FIG. 39 INTERFACE CIRCUIT FOR CHARGING/DISCHARGING CONTROL OF SYSTEM A STATION

A-6.2 Functional Requirements

A-6.2.1 *General*

In addition to the functional requirements specified in **6.3.1.1**, the d.c. electric vehicle charging/discharging station shall draw a current from the vehicle in electric vehicle discharging mode, of which the maximum value is limited by the maximum available current of the vehicle battery in electric vehicle discharging mode.

The following functions shall be provided by the d.c. electric vehicle charging/discharging station:

a) verification that the vehicle is compatible with the discharging process (**A-6.2.2**);
b) information that the station is compatible with the discharging process (**A-6.2.2**, **A-6.2.3**); and
c) specific requirements for the latching of the coupler (**A-3.6**).

A-6.2.2 *Compatibility Check with Bi-Directional Power Flow*

The charging and discharging processes shall be managed by both the vehicle and the d.c. electric vehicle charging/discharging station. The bi-directional power flow control shall only be activated when both the vehicle and the d.c. electric vehicle charging/discharging station are compatible with the electric vehicle discharging process. The compatibility shall be checked by both sides during the initialization stage of the establishment of digital communication. Both the station and the vehicle shall also implement a means to disable the bi-directional power flow control in case the user does not wish the vehicle to be discharged.

A-6.2.3 *Control States for EV Charging/Discharging Mode*

In electric vehicle charging/discharging mode, the d.c. electric vehicle charging/discharging station should either;

a) control the current drawn from the vehicle within the limit of the maximum available current of the vehicle battery specified by the vehicle; or
b) control the current supplied to the vehicle within the limit of the VCCF request.

The transition between the two states should be performed seamlessly or sequentially, and may be requested by vehicle, user, d.c. electric vehicle charging/ discharging station or utility.

A-6.2.4 *Seamless State Transition*

In electric vehicle charging/discharging seamless-switchover mode, the d.c. electric vehicle charging/discharging station should transit between charging and discharging without changing the energy transfer state defined in Table 37.

A-6.2.5 ***Sequential State Transition***

The d.c. electric vehicle charging/discharging station should first transfer to the shutdown states as defined in Table 30 and Table 37 before transiting from one mode to the other.

NOTE — **101.2.2.1** and **101.2.3** are not applicable to the bi-directional power flow system operating in electric vehicle charging/discharging seamless-switchover mode.

A-6.2.6 *Specific Requirements for Connection with a Vehicle which does not Support EV Discharging*

Unless otherwise specified, the d.c. electric vehicle charging/discharging station shall be capable of charging a vehicle which does not support electric vehicle discharging.

A d.c. electric vehicle charging/discharging station which does not meet this requirement should display a written label that clearly indicates the incapability.

NOTE — This subClause is not applicable to the station or equipment specifically designed for electric vehicle discharging for example a portable Vehicle-to-Load (V2L) power supply.

A-6.2.7 *Description of Process of Shutdown*

Normal shutdown should occur when the vehicle battery state of charge reaches a certain limit, or when the charging/discharging process is stopped by the user with a normal stop means.

Error shutdown or emergency shutdown should occur under a fault condition (see **6.3.1.114**). After completion of charging/discharging session, the shutdown phase allows the vehicle and the d.c. electric vehicle charging/discharging station to return to the conditions so that the user can safely handle the charging cable and the vehicle connector.

When the end of charging/discharging is notified by the vehicle, the d.c. electric vehicle charging/discharging station should reduce the charge/discharge current to zero. The vehicle side contactors open at near zero current. The d.c. electric vehicle charging/discharging station may unlatch the vehicle connector if the voltage at the inlet between DC+ and DC- reaches less than 60 V, and less than ≤ 28 V between DC+ and earthing terminal, and DC- and earthing terminal (*see* **6.3.1.107**).

A-6.2.8 *Pre-Charge when EV Contactor is Closed*

The pre-charge circuit shall be designed so that the inrush current shall not exceed 20 A when electric vehicle contactors are closed (*see* **A-3.9**).

A-6.2.9 *Power Supply for Control Circuit of Charging/Discharging Station*

The auxiliary power supply for the control circuit of d.c. electric vehicle charging/discharging station shall be isolated from the power line DC+ and DC- by basic insulation, except the connection circuit for earth-fault detection.

Double or reinforced insulation is required in case that a single fault as defined in IEC 61140 causes an electric shock hazard.

Except those that are specifically designed for discharging and are not intended to be connected to an a.c. supply network, for example a portable Vehicle-to-Load (V2L) power supply, the station shall have means to supply auxiliary power to its control circuit in case of an unexpected loss of a.c. input power such as blackout, and shall remain operational under such condition as defined in **A-6.2.10**.

In order to avoid any nuisance to the vehicle, the internal d.c. to d.c. converter for auxiliary power supply, if any, shall be activated at least 1 s after the closure of the electric vehicle contactors.

A-6.2.10 *Auxiliary Power Supply from the Vehicle (Optional)*

The vehicle may provide an optional function in which the auxiliary power to the station is supplied through the optional pin of the charging connector, or the cigarette lighter socket. In such cases, charging/discharging control of the station may be started (and operated) by the auxiliary power supplied from the vehicle, and the station shall draw the auxiliary power through the terminals AS1 or AS2 shown in Fig. 37 and Fig. 38.

Additional requirements for actuating the unintended current flow prevention circuit are shown in Fig. 39. If the optional function is used, the charging/discharging station shall monitor the status of the unintentional current flow prevention circuit during the electric vehicle discharging process. If the requirements are not satisfied, the station shall transfer to shutdown sequence.

A-6.2.11 *Control Circuit Supply Integrity*

If an earth fault, short circuit or overcurrent is detected in the d.c. circuit of charging/discharging station, the power circuit shall be disconnected from its supplies (supply network and electric vehicle), but the power supply for control circuit shall not be interrupted.

In addition, the power supply for the control circuit of the charging/discharging station shall not be interrupted by the loss of a.c. supply to which it may be connected. In case of the loss of a.c. supply, the control functions of the charging/discharging station, including digital communication with the vehicle and protection/monitoring of the system, shall remain operational until the completion of the charging/discharging control process BDC-B'4 as defined in **A-6.3.2**.

NOTE — If a d.c. electric vehicle charging/discharging station has grid-independent operating function, means such as battery backup or an a.c. power supply for the control circuit can be implemented.

A-6.2.12 *Protection against Under-Voltage at the Interface*

The d.c. electric vehicle charging/discharging station shall perform an emergency error shutdown and disconnect its supply to prevent under-voltage at the battery, if output withdrawal voltage drops below minimum limit sent by the vehicle.

A-6.3 Charging/Discharging Control Process

A-6.3.1 *Charging/Discharging State*

Table 37 defines the charging/discharging state of d.c. electric vehicle charging/discharging station. The charging/discharging states show physical status of d.c. electric vehicle charging system. The d.c. electric vehicle charging/discharging station and the vehicle can exchange their charging state through the signal communication and the digital communication.

Table 37 - Charging/discharging states of d.c. EV charging/discharging station

(*Clause* A-6.3.1)

State		Vehicle connected	Vehicle contactor	Charging/ discharging possible	Description
BDC-A	Not connected	No	Open	No	Vehicle unconnected
BDC-B1	Initialization	Yes	Open	No	Vehicle connected / not ready to accept energy / communication not established / connector unlatched or latched / vehicle contactor open
BDC-B2		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector unlatched or latched / vehicle contactor open
BDC-B3		Yes	Open	No	Vehicle connected / not ready to accept energy / communication established / connector latched / vehicle contactor open / other supplemental processes not completed
BDC-C	Energy transfer	Yes	Close	Yes	Vehicle connected / ready to accept or deliver energy / indoor charging area ventilation not required / communication established / connector latched / vehicle contactor close / other supplemental processes completed
BDC-D		Yes	Close	Yes	Vehicle connected / ready to accept or deliver energy / indoor charging area ventilation required / communication established / connector latched / vehicle contactor close / other supplemental processes completed
BDC-B'1	Shutdown	Yes	Close	Yes	Vehicle connected / charging or discharging finished / communication maintained / connector latched / vehicle contactor close
BDC-B'2		Yes	Open	No	Vehicle connected / charging or discharging finished / communication maintained / connector latched / vehicle contactor open / other supplemental processes completed
BDC-B'3		Yes	Open	No	Vehicle connected / charging or discharging finished / communication maintained / connector unlatched or latched / vehicle contactor open
BDC-B'4		Yes	Open	No	Vehicle connected / charging or discharging finished / communication

					finished / connector unlatched or latched / vehicle contactor open
BDC-E	Error	Yes	Ope n	N o	EVPS disconnected from vehicle / d.c. EVPS disconnected from utility, d.c. EVPS loss of utility power or control pilot short to control pilot reference.
BDC-F	Malfunc tion	Yes	Ope n	N o	Other d.c. EVPS problem
NOTE–The control pilot functions can be achieved using PWM pilot control as described in Part 1 or any other system that provides the same results.					

A-6.3.2 Charging/discharging control process and state

Table 38 defines the charging/discharging control process as system action level of d.c. electric vehicle charging/discharging station. For charging control process, *see* **A-4.1**.

Table 38 – Charging/discharging control process of d.c. EV charging/discharging station at system action level

(*Clause* A-6.3.2)

Charging/discharging control stage (process)		**State**	**High level action a**
Initializatio n	Handshaking	BDC-A	Vehicle unconnected
		BDC-B1	Connector plugged in
		BDC-B1	Wake up of DCCDCF and VCDCF
		BDC-B1	Communication data initialization
		BDC-B1→ BDC-B2	Communication established, parameters exchanged, and compatibility checked
	Charge/ discharge preparation	BDC-B2→ BDC-B3	Connector latched
		BDC-B3	Insulation check for d.c. power line
Energy transfer		BDC-C or BDC-D	Vehicle side contactors closed
		BDC-C or BDC-D	Pre-charge
		BDC-C or BDC-D	Charging by current demand (CCC) or discharging by the maximum available current of the vehicle battery (for MCC, see **A-6.3.3**)
		BDC-C or BDC-D	Charging by voltage demand (CVC)
		BDC-C or BDC-D→ BDC-B'1	Current suppression

	BDC-C or BDC-D	Renegotiate parameter limits (option)
Shutdown	BDC-B'1	Zero current confirmed
	BDC-B'1→ BDC-B'2	Welding detection (by vehicle, option)
	BDC-B'2	Vehicle side contactors open
	BDC-B'2	d.c. power line voltage verification
	BDC-B'3	Connector may be unlatched
	BDC-B'4	End of charge/discharge at communication level
	BDC-A	Connector unplugged
a The order of actions does not refer to the procedure of charging/discharging control process.		

A-6.3.3 *Description of the Process During Discharging (Energy Transfer)*

In this process, the vehicle continues to send the maximum available current value of discharging current or the minimum allowable voltage to the d.c. electric vehicle charging/discharging station throughout discharging process. The following algorithms shall be taken.

MCC (Maximum Current Control)

a) The EVPS can regulate the drawn current using MCC under both electric vehicle constraints and supply network needs;
b) The d.c. electric vehicle charging/discharging station should receive the maximum available current value the vehicle transmitted (the maximum limit), throughout the discharging control process;
c) The d.c. electric vehicle charging/discharging station should set the control target based on the utility requirement, and regulate the d.c. discharging current within the maximum limit; and
d) The d.c. electric vehicle charging station should regulate the d.c. discharging current responding to the change of the maximum limit of the vehicle, if the maximum limit drops below the utility requirement.

A-6.3.4 *State Transition Diagram and Sequence Diagram*

The charging/discharging process of System A shall conform to the state transition diagram as shown in Fig. 40. Fig. 41 gives the charging/discharging sequence diagram under normal conditions.

NOTE — Italic means the parameters exchanged via digital communications as defined in Annex A of IS 17017(Part 24).

FIG. 40 STATE TRANSITION DIAGRAM OF CHARGING/DISCHARGING PROCESS

FIG. 41 CHARGING/DISCHARGING SEQUENCE DIAGRAM

A-6.4 Additional Requirements for d.c. EV Discharging Equipment

A-6.4.1 *General*

d.c. electric vehicle discharging equipment specifically designed for electric vehicle discharging, for example a portable Vehicle-to-Load (V2L) power supply, shall meet the requirements in **A-6.4**.

A-6.4.2 *Protective Earthing Conductor*

Under consideration

A-6.4.3 *IP Degrees*

The d.c. electric vehicle discharging equipment shall have IP degrees as defined in 12.4.1 of IS 17017(Part 1):2018 except for the standard socket-outlet.

A-6.4.4 *a.c. Leakage Current Detection*

Under consideration

A-6.4.5 *a.c. Power Quality*

The Category 0 station or equipment shall output an a.c. voltage/current waveform with a power quality specified under the regulations/norms/standards/guidelines endorsed in each country.

A-6.4.6 *Connection to Household a.c. Cabling/Supply Network*

The d.c. electric vehicle discharging equipment shall have a visible label on its surface and/or provide an instruction manual indicating that the connection of its a.c. output to the household a.c. cabling or supply network via a.c. mains socket-outlet or by other means is strictly forbidden.

A-7 OPTIONAL FUNCTIONS

A-7.1 General

System A station may have some optional functions, for example dynamic control in which the available output current transmitted to an electric vehicle is dynamically controlled during the charging process.

A-7.2 Compatibility Check

System A station shall satisfy the following requirements in the charging state of initialization 1:

a) notify the vehicle that the station is compatible with each optional function as defined in Annex A of IS 17017(Part 24), and
b) check that the vehicle is compatible with each optional function.

Each optional function shall be performed only if both the station and the vehicle are compatible with the optional function.

A-7.3 Dynamic Control

Station A shall satisfy the following requirements in the charging state of energy transfer:

a) change the available output current to a designated value in a single-step process for example from 120 A to 60 A without any delay. Once the value has been increased or decreased, the station shall hold the same value for at least 10 s before changing the available output current again; and
b) not detect any errors associated with the dynamic control within the 10 s period specified above.

In response, the vehicle will change the charging current request to a value less than or equal to the available output current with the rate of change defined in **A-5**. If the available output current is increased, the vehicle may also increase the charging current request up to the available output current.

Station A shall then output charging current according to the charging current request from the vehicle (*see* Fig. 42).

FIG. 42 TRANSITION OF AVAILABLE OUTPUT CURRENT AND CHARGING CURRENT REQUEST DURING DYNAMIC CONTROL

A-7.4 High Current Control

System A station shall use appropriate messages for high current control according to-Annex A of IS 17017(Part 24).

A-7.5 High Voltage Control

System A station shall use appropriate messages for high voltage control according to Annex A of IS 17017(Part 24).

A-8 COMPLIANCE TEST FOR USER INITIATED SHUTDOWN

This test shall evaluate the behaviour of the d.c. electric vehicle supply equipment in case that the charging session is terminated by user-initiated shutdown, in accordance with the requirements in **6.3.1.110**.

The test shall be performed according to the following procedure:

a) Connect the d.c. electric vehicle supply equipment to an artificial load;
b) Start charging with the procedure specified by charger manufacturer;
c) Confirm that the d.c. power line between d.c. electric vehicle supply equipment and electric vehicle is energized at the rated voltage and the d.c. electric vehicle supply equipment is operating normally;
d) Stop charging by the method specified by charger manufacturer, for example press the stop button;
e) Check that the d.c. electric vehicle supply equipment stops charging without displaying any alarm or error information; and
f) Confirm that the d.c. power line between d.c. electric vehicle supply equipment and electric vehicle is de-energized to 10 V or less.

A-9 SPECIFIC REQUIREMENT FOR CHARGING WITH THERMAL MANAGEMENT SYSTEM

A-9.1 Surface Temperature of the Charging Cable

The surface temperature of the charging cable shall not exceed the temperature rating of the insulation used or shall comply with the following requirements under the normal operating ambient temperature, whichever is less.

a) The graspable part shall not exceed 60°C; and
b) The touchable part shall not exceed 85°C.

A-9.2 Functional or Performance Requirements to be Implemented for Protection Against Over-Temperature

System A shall provide one of the protection cases in Table 39 for protection against over-temperature of d.c. contact assembly of the vehicle connector and charging cable assembly according to the output current range of station. Table 40 provides the requirements of each measure in Table 39.

Table 39 - Selection of protection measures against over-temperature

(*Clause* A-9.2)

Output current range	Protectio n case	Required measures (see Table 36)			
		a	b	c	d
0 - 200 A	A	R	NR	R	NR
0 - 200 A	B1	NR	R	R	NR
0 - 200 A	B2	NR	R[a]	NR	R
0 - 400 A	C1	R	NR	NR	R
0 - 400 A	D1	NR	R	R	NR
0 - 400 A	D2	NR	R[a]	NR	R

Key

R	Required (mandatory)
NR	Not required
R[a]	Requirement 'b' may be omitted if a charging cable is also protected concurrently by the protective means of the vehicle coupler (requirement 'd')

Table 40 - Protection measures against over-temperature

(*Clause* A-9.2**)**

Type	Protection measures
a	A charging cable having a rated current more than or equal to the maximum current of the d.c. electric vehicle supply equipment shall be used.
b	By using either monitoring or estimating the surface temperature of the charging cable, the output current shall be limited or stopped to prevent an over-temperature. For the limitation of the output current, the dynamic control function defined in A-7 shall be applied.
c	A vehicle connector having a rated current (specified by each connector manufacturer) more than or equal to the maximum current of the d.c. electric vehicle supply equipment shall be used.
d	By monitoring the temperature of both the P and N terminals of the vehicle connector, with a temperature sensor or an equivalent means [1], the output current shall be reduced or stopped to prevent an over-temperature. For the limitation of the output current, the dynamic control function defined in A-7 shall be applied. [1] Example of an equivalent means: a vehicle connector with a function to open the latch circuit (for example temperature fuse, relay) in case the terminal temperature exceeds the design limit value

A-9.3 Marking

If the surface temperature of the charging cable is expected to exceed 60°C under certain condition, a warning label should be attached on the cable as shown in Fig. 43.

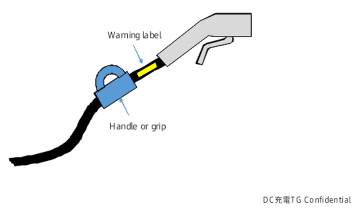


FIG. 43 EXAMPLE OF WARNING LABEL

ANNEX B

(*Clause* 1, 6.3.1.116 *and* 7.1.101)

d.c. EV SUPPLY EQUIPMENT OF SYSTEM C

B-1 GENERAL

This annex provides specific requirements for d.c. electric vehicle supply equipments for use with System C (hereinafter also referred to as "d.c. charger"). System C is a mode 4 charging system. The maximum system output voltage shall be limited to 1 000 V d.c. or less dependent on the components of the system.

Table 41 - d.c. couplers for combined charging system

(*Clause* B-1)

Sr. No.	d.c. couplers for combined charging system
a)	Configuration FF according to IS 17017(Part 2/Sec 3):2020.
b)	Autoconnect Charging Device (*see* IEC 61851-23-1 (*under preparation*))

B-2 COMMUNICATION

The general definitions and functions of the proximity pilot (PP) and control pilot (CP) – signals / contacts are according to IS 17017(Part 1):2018 (including detailed resistor definitions in Table 41 and Table 42) with the specific resistor value for configuration FF given in Table 42. A CP duty cycle of 5 percent shall be used according Annex A of IS 17017(Part 1):2018.

Table 42 - Definition of proximity resistor for configuration FF

(*Clause* B-2)

Proximity Resistor (Rc as per **IS 17017(Part 1):2018)**	**Maximum current for a.c. charging**	**d.c. connector**
1 500 Ω	not applicable	Configuration FF

Charge control communications between the d.c. electric vehicle supply equipment and the electric vehicle shall comply with IS 17017(Part 24).

The physical layer for charge control communications shall comply with IS/ISO 15118-3.

Contact assignments of the different connectors are in IS 17017(Part 2/Sec 3):2020.

Charge control communications shall comply with DIN SPEC 70121. Charge control communications shall also comply with IS/ISO 15118-2.

For automatic connection systems, the proximity pilot function is not required and communication can be carried out on a wireless physical layer, according to ISO 15118-6, ISO 15118-7 and IS/ISO 15118-8.

The interface circuit of Fig. 44 shall be used for configuration FF.

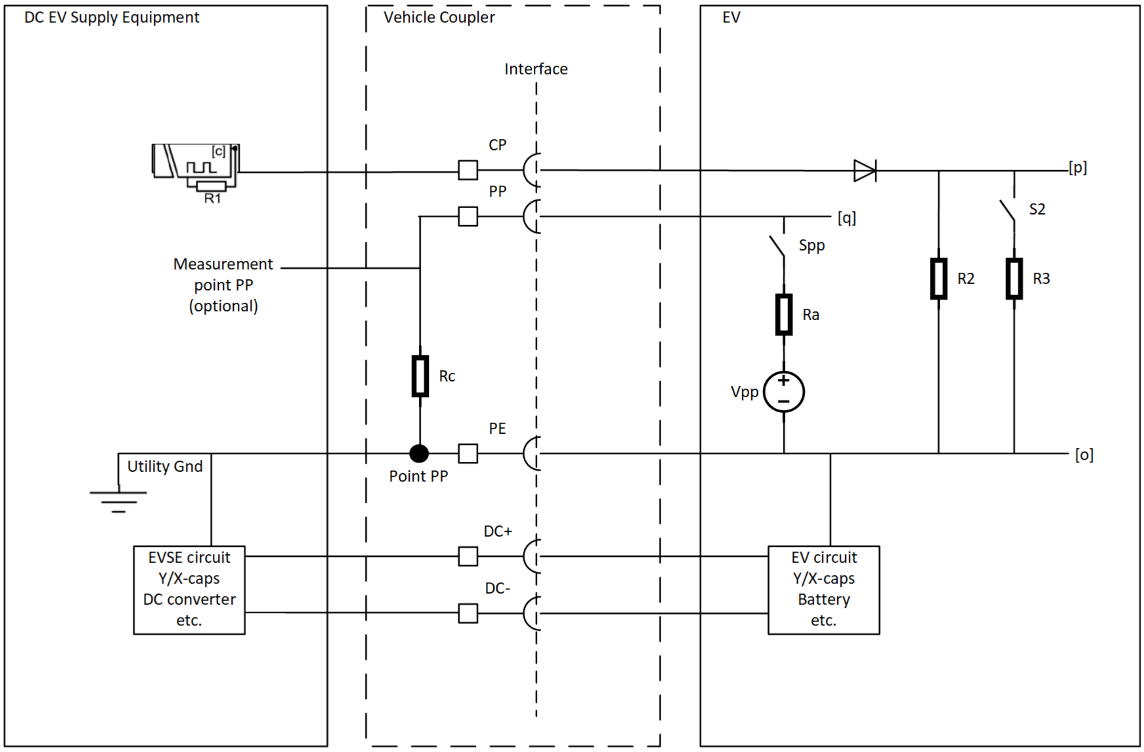


FIG. 44 INTERFACE COMPONENTS FOR CONFIGURATION FF

The switch S_{pp} is optional for the electric vehicle to implement depending on its strategy to detect PE loss (*see* **B-4.9**).

B-3 PROCESS OF ENERGY SUPPLY

B-3.1 General

The process of supplying energy to the electric vehicle by the d.c. electric vehicle supply equipment is initiated and controlled by the messages sent over HLC and shall follow the sequences shown in Fig. 46, Fig. 47, Fig. 48 and Fig. 49. For normal start up, normal shutdown, d.c. electric vehicle supply equipment and electric vehicle initiated error shutdown, d.c. electric vehicle supply equipment initiated error or emergency shutdown and electric vehicle initiated error shutdown. Electric Vehicle Initiated error shutdown shall also comply with the requirements of DIN SPEC 70121.

The messages described in DIN SPEC 70121:2014 and IS/ISO 15118-2:2014 are abbreviated in the sequence diagrams with numbers (*see* Table 43).

Table 43 - Message mapping for sequence diagram

(*Clause* B-3.1)

Phase	Message No.	DIN Spec 70121:2014 /IS/ISO 15118-2:2014
Data-link	SLAC	SLAC messages
Initialization	SDP	sdp messages
	0a	supportedAppProtocolReq
	0b	supportedAppProtocolRes

	1a - Xa	The electric vehicle messages requests concerning session setup, services, authentication, payment options and value added services (if supported by the negotiated application layer protocol).
	1b - Xb	The EVSE messages respond concerning session setup, services, authentication, payment options and value added services (if supported by the negotiated application layer protocol).
	3a	ChargeParameterDiscoveryReq
	3b	ChargeParameterDiscoveryRes
Insulation Check & Pre-Charge	4a	CableCheckReq
	4b	CableCheckRes
	5a	PreChargeReq
	5b	PreChargeRes
	6a	PowerDeliveryReq
	6b	PowerDeliveryRes
Energy Transfer	7a	CurrentDemandReq
	7b	CurrentDemandRes
	8a	PowerDeliveryReq
	8b	PowerDeliveryRes
Welded Check & Unlocking	9a	WeldingDetectionReq
	9b	WeldingDetectionRes
	10a	SessionStopReq
	10b	SessionStopRes

Example of charging sequence and description are shown in Fig. 45 and Table 47.

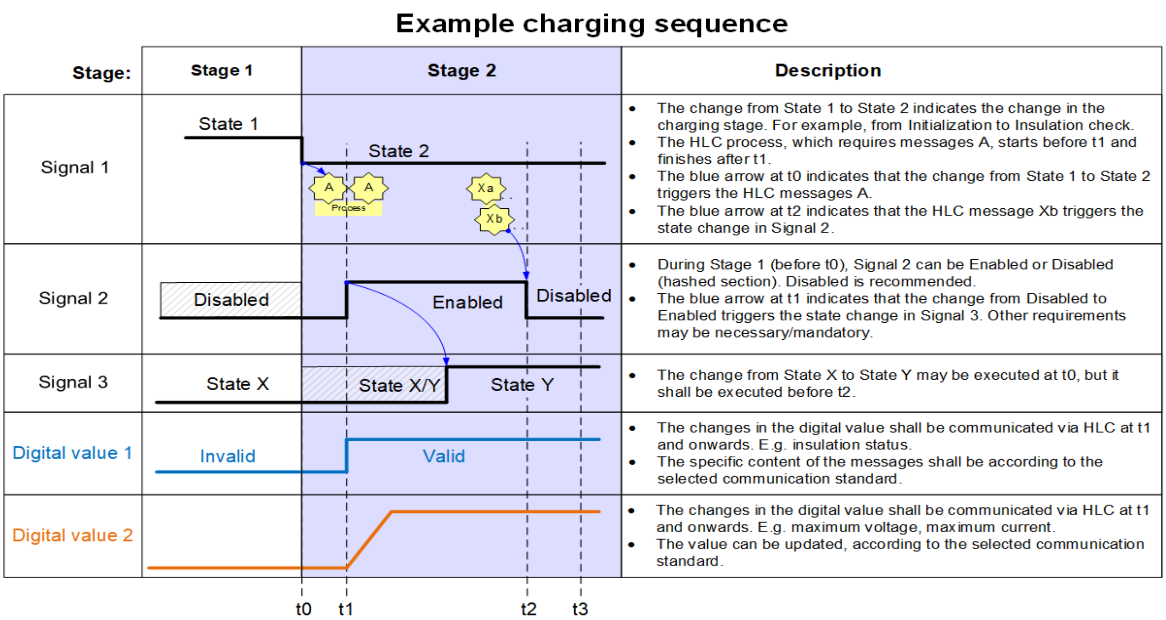


FIG. 45 EXAMPLE CHARGING SEQUENCE

Table 44 - Example of sequence description

(*Clause* B-3.1)

Timestamp	Description: Explanation charge sequence
► ta	• Events executed before reaching ta.
ta	• Events that shall be executed at ta. • The events executed at this timestamp shall be completed before reaching the next timestamp.
ta ► tb	• Events that shall be executed between ta and tb. • The events inside a timeframe (between ta and tb) shall be executed in any order and completed before reaching the next timestamp if they do not have a time constraint (indicated with within). • If the event within a timeframe has a time constraint (within), then tb is the moment that this event is executed.
tb ►	• Events that shall be executed from tb onwards in any order

B-3.2 Normal Start Up

Sequence diagram and description for normal start up are shown in Fig. 46 and Table 45.

FIG. 46 SEQUENCE DIAGRAM FOR NORMAL START UP

Table 45 - Sequence description for normal start up (1 of 2)

(*Clause* B-3.2)

Timestamp	Sequence description for normal start up
► t0	• The EVSE shall check if the d.c. output voltage is less than 60 V and shall not allow to start a supply session if 60 V is exceeded. See B-4.5.
t0	• The vehicle connector is plugged into the electric vehicle inlet, which changes the CP state from A to B.
	• After the CP state changed to B, the electric vehicle may lock the vehicle connector in its inlet.
	• After the CP state changed to B, the EVSE Insulation Monitoring device shall stop.
	• After the CP state changed to B, the electric vehicle may try to set up a data link as defined in IS 17017(Part 24).
t1	• The EVSE shall turn on its CP oscillator if the EVSE is ready to charge and if it not already turned on.
t1 ► t2	• The electric vehicle shall establish the data link as defined in the IS 17017(Part 24) after it has verified that the EVSE has turned on its CP oscillator.
	• High level communication (V2G) starts by the negotiation of an appropriate application layer protocol between the electric vehicle <0a> and EVSE <0b>.
	• The electric vehicle and EVSE exchange messages pairs concerning session setup, services, authentication, payment options and value added services (if supported by the negotiated application layer protocol).
t2	• The electric vehicle sends its electric vehicle Maximum Voltage limit and electric vehicle Maximum Current limit (amongst other parameters) for d.c. supply output current and voltage with ChargeParameterDiscoveryReq <3a>.
t2 ► t3	• The minimum and maximum values of the EVSE are sent to the electric vehicle with ChargeParameterDiscoveryRes <3b>.
	• The EVSE shall check if the d.c. output voltage is less than 60 V and shall trigger an error shutdown if 60 V is exceeded. See B-4.5.
	• The compatibility check is performed by the EVSE. The result (Response Code = "OK" or "FAILED_WrongChargeParameter") and status ("EVSEProcessing" = 'Ongoing' or 'Finished') shall be sent to the electric vehicle with ChargeParameterDiscoveryRes <3b>.
	• After alignment of all parameters, the EVSE responds with Parameter "EVSEProcessing" = 'Finished' in ChargeParameterDiscoveryRes <3b>.
t3	• If the electric vehicle and EVSE are not compatible, then the electric vehicle shall not go to Ready and will transfer to step t107 in the normal shutdown sequence.
	• The electric vehicle shall lock the vehicle connector in its inlet before changing the CP to state C or D.
	• The electric vehicle shall stop its insulation monitoring device, if any.
t4	• After the electric vehicle has stopped its insulation monitoring device and after checking that the vehicle connector is locked, the electric vehicle changes the CP state from B to C/D by closing S2.
t4 ► t5	• After checking that the vehicle connector is locked, The electric vehicle requests cable and insulation check before pre-charge with CableCheckReq <4a>. See Cable check B-4.1.3.
	• The EVSE checks if the CP state changed to state C or D before sending the first CableCheckRes <4b> message and before applying a voltage higher than 60V on the d.c.

	Output.
	• The EVSE checks the insulation of the d.c. Output and continuously reports the insulation state with the parameter "EVSE insulation status" in CableCheckRes<4b>.
t5	•The EVSE determines that the insulation resistance of the d.c. Output is ≥ 100 kΩ.
t5 ► t6	• After having successfully finished the insulation check, the EVSE indicates with parameter "EVSE insulation status"='Valid' in subsequent messages, starting with CableCheckRes <4b>
t6	• The EVSE shall send the result of the cable check by changing the parameters "EVSE StatusCode" to "Ready" and "EVSEProcessing" to 'Finished' in CableCheckRes <4b>.
t6 ► t7	• The EVSE may keep the voltage on the d.c. output.
t7	• Pre-charge starts when the electric vehicle sends PreChargeReq <5a>, which contains the requested d.c. current ≤ 2 A (maximum inrush current acc. to B-6.2) and the requested d.c. voltage. See Pre-charge (B-5.1).
	• During pre-charge, the EVSE shall be able to supply a d.c. output current as defined in B-5.1, limit the output current to 2A (see B-6.2) and ignore the current request of the electric vehicle.

Table 45 (2 of 2)

(*Clause* B-3.2**)**

Timestamp	**Sequence description for normal start up**
t7 ► t8	• The EVSE adapts the d.c. output voltage to the requested value in <5a> and sends the corresponding PreChargeRes <5b>.
t8	• The d.c. output voltage reaches the voltage requested by the electric vehicle within the tolerances given in section **101.2.2**.
t8 ► t9	• The electric vehicle may adapt the requested d.c. output voltage with cyclic messages PreChargeReq <5a> (*See* Note in **B-5.1**). NOTE−To obtain an inlet voltage within the +/-20V of the battery voltage, the electric vehicle can adjust the pre-charge voltage request to compensate for tolerances and steady state errors.
t9	• The electric vehicle shall close its disconnection device only after verifying that the absolute voltage difference between the electric vehicle inlet and the electric vehicle battery is less than 20 V (*See* 9.2 in ISO 17409). NOTE−The electric vehicle should be protected against the case that the polarity of the d.c. output is reversed.
t9 ► t10	• The electric vehicle sends PowerDeliveryReq <6a> with "ReadyToChargeState"='True' to enable the electric vehicleSE Output.
	• After disabling the pre-charge circuit, if any, and switching ON its power supply output, the EVSE communicates that it is Ready for energy transfer with PowerDeliveryRes <6b>.
t10	• During charging, the EVSE continuously monitors the insulation of the d.c. Output (*See* **B-4.1.4**).
	• The electric vehicle sets the electric vehicleTargetCurrent with CurrentDemandReq <7a> to start the energy transfer phase.
t10 ► t11	• The EVSE adapts its d.c. output current and voltage to the requested values in CurrentDemandReq <7a>.
	• The EVSE reports the following information to the electric vehicle with CurrentDemandRes<7b>: -Its present d.c. output current and voltage, -Its present limits for d.c. output current and voltage, and -Its present status.
	NOTE −Electric vehicle may change its d.c. current and voltage request even if the d.c. output current has not reached the values in the previous request.
t11	• The d.c. output current reaches the d.c. output current request within the time delay (Td) defined in **101.2.3**.
t11 ►	• The electric vehicle adapts its d.c. current and voltage request according to its charging strategy with cyclic CurrentDemandReq <7a> messages.

B-3.3 Normal Shutdown

Sequence diagram and description for normal shutdown are shown in Fig. 47 and Table 46.

After the completion of normal shutdown, the electric vehicle shall not induce voltages above the values specified in **6.3.1.115**.

FIG. 47 SEQUENCE DIAGRAM AND DESCRIPTION FOR NORMAL SHUTDOWN BY EV/EVSE

Table 46 - Sequence description for normal shutdown (1 of 2)

(*Clause B-3.3*)

Timestamp	**Sequence description for normal shutdown by EV/EVSE**
► t100	• Cyclic CurrentDemand messages between the electric vehicle <7a> and EVSE <7b>
	• If the electric vehicle wants to stop a charge session for a non-critical reason, it shall reduce the current request <7a> to terminate the energy transfer. Reduction is done on electric vehicle charging strategy.
t100	• If the EVSE wants to stop a charge session for a non-critical reason, it shall: - ramp down the output current, and - adjust its maximum output current (EVSEMaxCurrentLimit), which is communicated to the electric vehicle, according to this, in order to inform the electric vehicle that the d.c. output current will reduce.
	NOTES **1** This informs the electric vehicle that the d.c. output current is being reduced. **2** Legacy vehicles might directly go to t101 without reducing the current request. This will be interpreted as an electric vehicle-initiated error shutdown by the EVSE (see "EV error shutdown table")
t100 ► t101	• The d.c. output current shall decrease to less than 5A and remain below 5 A.
t101	• When the d.c. output current is below 5 A, the next CurrentDemandRes <7b> message, shall set the Parameter EVSE StatusCode to "EVSE_Shutdown" if the EVSE wants to stop the charge session.
t102	• The electric vehicle requests the EVSE to disable its output by sending message PowerDeliveryReq <8a> with ReadyToChargeState set to False.
t102 ► t104	• The electric vehicle may open its disconnection device after the d.c. output current is below 5A and after the message <8a> has been sent.
	• The EVSE shall disable its output and open its disconnection device, if any.
	• The EVSE Insulation Monitoring device shall be disabled.
t103	• The EVSE shall start to actively discharge any internal capacitance on its output.
	• The EVSE shall not discharge the electric vehicle with more than 0.15 A (*see* **B-5.5.1** "0A mode")
	• The EVSE reports "EVSE Status Code"='EVSE_Shutdown' with message <8b>, to indicate it has disabled its output.
t104	• The electric vehicle may activate its insulation monitoring device, if any.
	NOTE −The common mode and differential mode influences from the EVSE should be removed before sending the message <8b>.
t105	• The electric vehicle changes CP state to B after receiving message <8b>.
	NOTE−If the electric vehicle decides not to perform welding detection, it proceeds with t107.
t105 ► t106	• The electric vehicle sends initial welding detection request <9a>.
t106	• The electric vehicle may perform its welding detection check after receiving message WeldingDetectionRes <9b>.
	• electric vehicle may actuate its disconnection device to perform welding detection.

t106 ► t107	• The electric vehicle may send multiple <9a> requests in order to read the d.c. supply output voltage measured by the EVSE in the response message <9b>.
	• The electric vehicle completes welding detection, if performed.
t107	• The electric vehicle shall open its disconnection device.
	NOTE−This starts the reduction of the d.c. output voltage by passive discharge.
	• The electric vehicle shall send the SessionStopReq <10a> message when it has confirmed that its disconnection device is open.
t108	• The SessionStopReq <10a> message initiates termination of HLC through PLC.
	• The EVSE shall start to reduce the d.c. output voltage to less than 60 V within 1s and remain below 60 V.
t108 ► t109	• The EVSE shall send the message SessionStopRes <10b>.
t109	• The EVSE shall turn off its CP oscillator according to IS 17017(Part 24)

Table 46 (2 of 2)

(*Clause B-3.3*)

Timestamp	Sequence description for normal shutdown by EV/EVSE
t109 ► t110	• The electric vehicle shall only unlock the connector if the d.c. output voltage is below 60 V.
	• The electric vehicle should wait to receive message SessionStopRes <10b> before unlocking.
	NOTES **1** If digital communication according to IS/ISO 15118 is used, the EV may request a pause according to IS/ISO 15118-2:2018. If supported by the EVSE, the EV can wake up the EVSE and re-initiate a charging session (*see* **B-5.2**). The communication session will re-start after the wake up process. **2** If the EVSE is ready for re-initiation of a new charging session, use the sequence described in **B-5.2**.
t110	• Disconnecting of vehicle connector changes CP state from B to A.

B-3.4 Error and Emergency Handling

d.c. electric vehicle supply equipment and electric vehicle shall have means to initiate error or emergency shutdowns.

NOTE−Error Shutdown is to prevent damage to the equipment. While Emergency Shutdown is to protect the user from a hazardous situation.

During an error or emergency shutdown, the electric vehicle shall open its disconnection device within 100 ms after the EVSE has turned off its CP oscillator or the electric vehicle has triggered the emergency shutdown.

Table 47 gives an overview of the error and emergency shutdown cases defined in this document.

Table 47 - Overview of error and emergency shutdown cases

(*Clause* B-3.4)

Cases for error shutdown	Cases for emergency shutdown
- message sequence error	- CP loss reaction (**B-4.3**)
- cable check errors (**B-4.1.3**)	- Overcurrent protection (**B-6.5**)
- Insulation monitoring during charging (**B-4.1.4**)	- Continuous continuity checking of the protective conductor (**6.3.1.2**)
- Protection against overvoltage between positive terminal d.c.+ and negative terminal DC- at the interface (**6.3.1.106**)	- control circuit supply integrity (**6.3.1.108**)
- Load dump (**101.2.7**)	Maximum voltage between DC+/- and protective conductor in conditions with a single earth fault (**6.3.1.113**)
- Overtemperature handling (**101.4.2.2**)	- Short-circuit protection (**13.101**)
- Check of the plausibility of the values provided by the thermal sensing (**101.4.2.3**)	- if error shutdown doesn't work properly

B-3.5 d.c. EV Supply Equipment and EV Initiated Error Shutdown

Sequence diagrams and descriptions for d.c. electric vehicle supply equipment and electric vehicle initiated error shutdown are shown in Fig. 48 and Table 48.

During an error shutdown, the electric vehicle could enter the welding detection phase and perform a welding detection if the HLC support this and is available (*see* **B-4**).

After the completion of an error shutdown, the electric vehicle shall not induce voltages above the values specified in **6.3.1.116**.

FIG. 48 SEQUENCE DIAGRAM FOR D.C. EV SUPPLY EQUIPMENT AND EV INITIATED ERROR SHUTDOWN

Table 48 - Sequence description for d.c. EV supply equipment and EV initiated error shutdown

(*Clause* B-3.5**)**

Timestamp	Sequence description for Error Shutdown for any stage by EVSE or by EV (Excluding Table 46)
► t300	• General pre-condition: High Level Communication messages between the electric vehicle <Xa> and EVSE <Xb> . • Preconditions for electric vehicle initiated error shutdown: CP state B, C or D. • Preconditions for EVSE initiated error shutdown: CP Oscillator ON.
t300	• Occurrence of error shutdown condition detected by the electric vehicle or EVSE (for example the electric vehicle triggers an error shutdown via HLC, communication loss or closing of the data link or TCP connection). • The trigger time starts from this moment. • The electric vehicle may open its disconnection device (for the electric vehicle-initiated error shutdown). NOTES **1** Error Shutdown is to prevent damage to the equipment. **2** The trigger time for electric vehicle initiated error shutdown depends on communication requirements.
t301	• The EVSE performs the error shutdown. • The timing requirements of **6.3.1.116** (performance time) starts from this moment. • The EVSE shall disable its insulation monitoring device.
t301 ► t302	• The EVSE shall reduce its d.c. output current to less than 5A and disable its output within 1s.
t301 ► t306	• The EVSE shall, within 2.5 s: - reduce the d.c. output voltage to less than 60 V between DC+ and DC-; and - reduce the d.c. output voltage to less than 28 V between DC+ and earthing terminal, and between DC- and earthing terminal.
t302	• The d.c. output current shall be less than 5A and remain at less than 5A. • The EVSE shall disable its output. • EVSE initiated Error Shutdown: - The EVSE shall send ResponseCode 'Failed' in the next response messages (*see* IS 17017(Part 24) • Electric vehicle initiated Error Shutdown if the HLC is still operational (*see* IS/.ISO15118-2 for the exception case): - The EVSE shall reply with message SessionStopRes <10b> (*see* DIN 70121).
t302 ► t303	• The EVSE shall turn off its CP oscillator within 200ms
t303	• The EVSE is turning off its CP oscillator NOTES **1** Turning off the CP oscillator without sending a message <Xb> containing a `Failed` ResponseCode will trigger an Emergency Shutdown (See **6.3.1.117**). The delay of 200ms should be sufficient for the electric vehicle to receive this message **2** If the EVSE has not turned OFF its CP oscillator 1 s after the Error Shutdown has started (t300), the electric vehicle and EVSE shall trigger an Emergency Shutdown. See **6.3.1.117**. for the timing requirements for the EVSE regarding d.c. output current, disconnection device and oscillator.

t303 ► t304	• The electric vehicle shall open its disconnection device within 100 ms after the EVSE has turned off its CP oscillator.
t304	• The electric vehicle is opening its disconnection device.
t305	• The electric vehicle shall change the CP state to B when it has opened its disconnection device. • The electric vehicle may activate its insulation monitoring device.
t306	• The d.c. output voltage shall be: - less than 60 V between DC+ and DC- ; and - less than 28 V between DC+ and PE, and between DC- and PE. NOTE The d.c. output voltages shall be at these values 2.5 s after the Error Shutdown was triggered at t300. See **6.3.1.116**. for the timing requirements for the EVSE regarding d.c. output voltage.
t307	• The electric vehicle shall not unlock the connector unless the d.c. output voltage has dropped below 60 V. (See **6.3.1.103**)
t308	• Disconnecting of vehicle connector changes CP state from B to A.

B-3.6 d.c. EV Supply Equipment AND EV Initiated Emergency Shutdown

Sequence diagrams and descriptions for d.c. electric vehicle supply equipment and electric vehicle initiated emergency shutdown are shown in Fig. 49 and Table 49.

After the completion of an emergency shutdown, the electric vehicle shall not induce voltages above the values specified in **6.3.1.117**.

NOTE — The electric vehicle cannot enter the welding detection phase nor can it perform a welding detection based on voltages above the values specified in **6.3.1.117**.

FIG. 49 SEQUENCE DIAGRAM FOR d.c. EV SUPPLY EQUIPMENT AND EV INITIATED EMERGENCY SHUTDOWN

Table 49 - Sequence description for d.c. EV supply equipment and EV initiated emergency shutdown

(*Clause* B-3.5)

Timestamp	Sequence description for Emergency Shutdown by EV or EVSE
► t400	• General pre-condition: High Level Communication messages between the electric vehicle <Xa> and EVSE <Xb>. • Pre-condition for EVSE-initiated emergency shutdown: CP oscillator on • Pre-condition for electric vehicle-initiated emergency shutdown: CP state C/D
t400	• Occurrence of emergency shutdown condition (for example the CP state changes from C/D to state B or A/E/F/invalid, PE loss). NOTES **1** Emergency Shutdown is to protect the user from a hazardous situation **2** Emergency shutdown initiated by the electric vehicle is performed by changing CP state from C/D to B • The trigger time starts from this moment. • The electric vehicle may open its disconnection device (for the electric vehicle-initiated emergency shutdown).
t400 ► t401	• The EVSE shall turn off its CP oscillator within the trigger time
t401	• The EVSE is turning off its CP oscillator which indicates an Emergency Shutdown. NOTE−The timing requirements of **6.3.1.117** (performance time) start from this moment. • The EVSE shall disable its insulation monitoring device.
t401 ► t402	• The EVSE shall reduce its d.c. output current to less than 5 A and disable its output within 30 ms.
t401 ► t403	• The electric vehicle shall open its disconnection device within 100 ms after the CP oscillator is turned off or if it detected an "occurrence of the emergency shutdown condition"
t401 ► t404	• The electric vehicle shall go to CP state B within 100 ms after the CP oscillator is turned off or if it detected an "occurrence of the emergency shutdown condition"
t401 ► t405	• The EVSE shall, within 1 s: - reduce the d.c. output voltage to less than 60 V between DC+ and DC-; and - reduce the d.c. output voltage to less than 28 V between DC+ and earthing terminal, and between DC- and earthing terminal.
t401 ►	• Both the electric vehicle and EVSE may try to keep communicating if possible • If the electric vehicle or EVSE send a message, then it shall send a `Failed` ResponseCode
t402	• The EVSE has reduced its d.c. output current to less than 5 A. • The EVSE shall disable its output
t403	• Latest point in time the electric vehicle disconnection device is opened.
t404	• For EVSE-initiated emergency shutdown: The electric vehicle shall change the CP state to B to indicate that the electric vehicle opened its disconnection device. • The electric vehicle may activate its insulation monitoring device, if any.
t405	• The d.c. output voltage shall be: - less than 60V between DC+ and DC- ; and

	- less than 28V between DC+ and PE, and between DC- and PE.
t406	• The electric vehicle shall not unlock the connector unless the d.c. output voltage has dropped below 60 V.
t407	• Disconnecting of vehicle connector changes CP state from B to A.

B-4 SAFETY MEASURES

B-4.1 IT(Isolated Terra) System Requirements

B-4.1.1 *General*

The secondary circuit (output side) of the d.c. electric vehicle supply equipment shall be designed as an IT system and protection measures in accordance with 411 of IEC 60364-4-41:2005 shall be applied.

An insulation monitoring device (IMD) according to IEC 61557-8 or equivalent shall be used to perform insulation monitoring between DC+ and PE as well as DC- and PE during supply process and communicate the current state (Valid, Fault) of the system periodically to the electric vehicle.

The d.c. electric vehicle supply equipment shall react according to Table 50.

Table 50 - Insulation states and d.c. EV supply equipment reaction based on the measured insulation resistance

(*Clause* B-4.1.1)

Condition 1	Condition 2	Insulation state	d.c. EV supply equipment reaction
Above 150 kΩ	Above 300 kΩ	Valid	Allow Charging
From 100 kΩ to 150 kΩ	From 100 kΩ to 300 kΩ	Valid or Fault	Allow charging or error shutdown
Below 100 kΩ	Below 100 kΩ	Fault	Error shutdown
Condition 1: External insulation resistance at the d.c. output either between DC+ and PE or between DC- and PE (but not at the same time). Condition 2: External insulation resistance at the d.c. output both between DC+ and PE as well as between DC- and PE (at the same time).			

B-4.1.2 *Functional Test of Insulation Monitoring Device*

The functionality of the insulation monitoring device (IMD) shall be tested during the functional test of the IMD, for example by actuating a test device or by inserting a defined test resistor.

The functional test of the IMD shall detect if the IMD is connected to the d.c. output conductors (DC+/DC-) and protective earth (PE) and that the IMD is capable of measuring the insulation resistances between DC+ and PE and DC- and PE.

The functional test of the IMD shall not deteriorate the IMD.

NOTE –During the functional test of the IMD, the requirements of **12.5** are applicable.

The functional test of the IMD shall be executed and finished during the cable check phase.

The functional status of the IMD can be as follows:

a) Unknown: Functional test of the IMD has not been executed yet. In this state charging shall not be allowed.
b) OK: After the functional test of the IMD has been passed the station shall go into the OK state.
c) Failed: The functional test of the IMD has failed. In this state, entering the pre-charge phase shall not be allowed.

NOTES

1 The purpose of this functional test of the IMD is to check whether the insulation monitoring device is capable of fulfilling its monitoring function on the d.c. output of the d.c. electric vehicle supply equipment and not to check if the insulation of the system is below a certain threshold. By checking the measurement connections of the IMD to the system conductors and to earth, the complete measurement circuit of the IMD can be tested.

2 During the activation of the functional test of the IMD, the response time of the insulation monitoring device can be extended as long this does not happen during the energy transfer stage.

Compliance is checked by design review.

B-4.1.3 Cable Check

Prior to each pre-charge phase a cable check has to be performed. During the cable check, the d.c. electric vehicle supply equipment shall apply on the d.c. output the lower value of the following two voltages:

a) 110 percent of the maximum voltage communicated by the electric vehicle to the EVSE during initialization phase; and
b) Maximum output voltage of the d.c. electric vehicle supply equipment.

Requirements for protection against overvoltage at the interface according to **6.3.1.106** do not apply during cable check.

The d.c. electric vehicle supply equipment shall perform a short circuit detection according to **6.3.1.109** during the cable check phase.

During the cable check, the d.c. electric vehicle supply equipment shall limit the output current to a maximum of 5 A.

The d.c. electric vehicle supply equipment may perform a welding detection during the cable check phase. If the d.c. electric vehicle supply equipment performs a welding detection, then it shall still comply with the requirements of **6.3.1.112** and **6.3.1.113**.

NOTE — The electric vehicle should take care not to be influenced by the common mode influences which the d.c. electric vehicle supply equipment can produce during its welding detection

The functional test of the IMD (*see* **B-4.1.2**) shall be executed and finished during the cable check phase.

During cable check the insulation resistance shall be continuously monitored. The insulation states can be as follows:

a) Invalid: The functional test of the IMD (*see* **B-4.1.2**) has not resulted in the OK state and/or the IMD has not finished the measurement of the insulation resistance. The d.c. electric vehicle supply equipment shall trigger an error shutdown if the IMD remains in invalid state until the end of the cable check phase;

b) Valid: The measured insulation resistance between DC+/DC- and PE is above or equal to a value of 100 kΩ (without negative tolerance);

c) Fault: The measured insulation resistance between DC+/DC- and PE is below a value of 100 kΩ (without negative tolerance). The d.c. electric vehicle supply equipment shall trigger an error shutdown before or at the end of the cable check phase and send a fault message to electric vehicle if necessary according to IS 17017(Part 24);

d) In order to fulfil the timing requirements of the digital communication according to IS 17017(Part 24), the EVSE shall be able to detect a valid state within V2G_SECC_CableCheck_Performance (= 38 s according to IS/ISO 15118).

Compliance is checked by **B-9.3.16.1**.

B-4.1.4 Insulation Monitoring During Charging

During charging the insulation resistance of the system shall be continuously monitored. The insulation states can be as follows:

a) Valid: The measured insulation resistance between DC+/DC- and PE is above or equal to a value of 100 kΩ (without negative tolerance); and

b) Fault: The measured insulation resistance between DC+/DC- and PE is below a value of 100 kΩ (without negative tolerance). The d.c. electric vehicle supply equipment shall trigger an error shutdown within 10 s and send a fault message to electric vehicle if necessary according to IS 17017(Part 24)

NOTES

1 The d.c. electric vehicle supply equipment can issue an optical and /or acoustical signal to the user.

2 The electric vehicle takes responsibility for the time coordination of its IMD. Prior to closing its electric vehicle disconnection devices (cf. time t7 in Fig. 46.) the electric vehicle either turns off its IMD or it is guaranteed that no interference with the station's IMD occurs.

Compliance is checked by **B-9.3.16.2.**

B-4.2 Combined Coupler Latching Function

For all types of d.c. connectors according to Table 41, the vehicle inlet shall provide a latching function to mitigate unintentional disconnecting of the vehicle connector from the vehicle inlet during energy supply.

Requirement for latching function is stated in ISO 17409.

B-4.3 CP Loss Reaction

When an unintended transition from CP state C / D to state B / A, any other or an unknown state occurs, the d.c. electric vehicle supply equipment and the electric vehicle shall trigger an emergency shutdown within 10 ms.

B-4.4 Voltage Check At Initialization

At beginning of supply session, with CP state A or B, the d.c. electric vehicle supply equipment shall check if voltage on the cable is less than 60 V and shall terminate supply session if 60 V is exceeded.

B-4.5 d.c. EV Supply Equipment Maximum Output Y Capacitance

The maximum total parallel Y capacitance shall not exceed 1 μF. This implies ≤ 500 nF Y capacitance across each d.c. rail and ground for a d.c. electric vehicle supply equipment with Y capacitance equally distributed between each d.c. rail and ground.

B-4.6 Minimum Cross-Sectional Area of Protective Conductor

The minimum cross-sectional area of the protective conductor shall be 6 mm².

B-4.7 Leakage and Charge Limitation of Touch Current

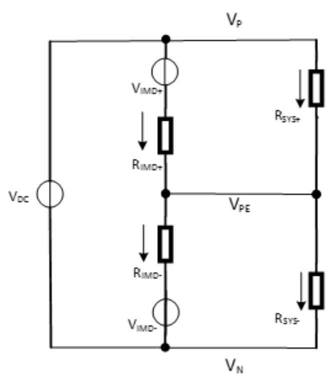
The d.c. electric vehicle supply equipment shall limit the steady-state leakage current and the charge to DC-2 according to IEC 60479-1, and C1 according to IEC 60479-2, in accordance with **8.102.4**.

The following shall be considered to meet the requirements above:

a) a human body impedance of 500 Ω;
b) the maximum y-capacitances of the electric vehicle according ISO 17409; and
c) a worst-case asymmetric leakage resistance of the electric vehicle where charging is still possible.

Compliance is verified using a calculation, for instance using the following example (*see* Fig. 50, Fig. 51 and Table 51) or an equivalent simulation or measurement.

FIG. 50 CIRCUIT DIAGRAM WITH COMPONENTS INFLUENCING THE TOUCH CURRENT



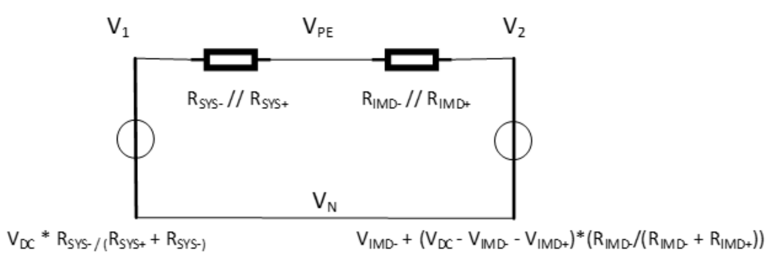


FIG. 51 EQUIVALENT CIRCUITS FOR EXAMPLE IN FIGURE 50

Table 51 - Exemplary determination if touch current limit is fulfilled by design
(Clause *B-4.8*)

Vdc	Maximum output voltage		920	V	
Vimd+	IMD measurement voltage		50	V	
Vimd-	IMD measurement voltage	=-Vimd+	-50	V	
Rimd+	IMD measurement resistance		120000	Ω	
Rimd-	IMD measurement resistance		120000	Ω	
Rds+_EVSE	Designed resistance EVSE +		1000000	Ω	
Rds-_EVSE	Designed resistance EVSE -		1000000	Ω	
Rlk+_EVSE	Leakage resistance EVSE +		1000000	Ω	
Rlk-_EVSE	Leakage resistance EVSE -		1000000	Ω	
Rds+_EV	Designed resistance EV +		1000000	Ω	
Rds-_EV	Designed resistance EV -		1000000	Ω	
Rlk+_EV	Leakage resistance EV +		1000000	Ω	
Rlk-_EV	Leakage resistance EV -		100000	Ω	
Rh	Human body representation		500	Ω	
Cy+EV	Y capacitance EV +		2.00E-06	F	
CY-EV	Y capacitance EV -		2.00E-06	F	
Cy+EVSE	Y capacitance EVSE +		5.00E-07	F	
CY-EVSE	Y capacitance EVSE -		5.00E-07	F	
Ctot	Total Y capacitance system	=Cy+EV+CY-EV+Cy+EVSE+CY-EVSE	5.00E-06	F	
Rsys+	System resistance +	=1/((1/Rds+_EVSE)+(1/Rlk+_EVSE)+(1/Rds+_EV)+(1/Rlk+_EV)+(1/Rh))	499	Ω	
Rsys-	System Resystance -	=1/((1/Rdc-_EVSE)+(1/Rlk-_EVSE)+(1/Rds-_EV)+(1/Rlk-_EV))	76923	Ω	
Rsys+nh	Rsys+ without human	=1/((1/Rds+_EVSE)+(1/Rlk+_EVSE)+(1/Rds+_EV)+(1/Rlk+_EV))	250000	Ω	
Rsys	Total system resistance	=1/((1/Rsys+)+(1/Rsys-))	495.785	Ω	
Rimd	Total IMD resistance	=1/((1/Rimd+)+(1/Rimd-))	60000	Ω	
Rsys_nh	Rsys without human	=1/((1/Rsys+_nh)+(1/Rsys-))	58823.5	Ω	
V1	Thevenin equiv. V1	=Vdc*(Rsys-/(Rsys++Rsys-))	914.07	V	
V2	Thevenin equiv. V2	=Vimd-+(Vdc-Vimd+-Vimd-)*(Rimd-/(Rimd++Rimd-))	410	V	
V1_nh	V1 without human	=Vdc*(Rsys-/	216.470	V	

		(Rsys+nh+Rsys-))			
Vpe	Vpe vs VDC-	=V2+(V1-V2)*(Rimd/ (Rsys+Rimd))	909.939	V	
Vpe_nh	Vpe withouth human	=V2+(V1_nh- V2)*(Rimd/ (Rsys_nh+Rimd))	312.277	V	
Ih	Steadystate body current	=(Vdc-Vpe)/Rh	0.02012	A	25 mA, *Max*
Ipk	Peak body current	=(Vdc-Vpe_nh)/Rh	1.21544	A	
Ipk_rms	RMS body current	=Ipk/sqrt(6)	0.49620	A	0.5 A *Max,* for >4 ms, See Figure 20 of IEC 60479-2
T3RC	Duration of impulse	=3*(1/((1/Rsys)+(1/ Rimd)))*Ctot	7.38E-03	s	
E	Energy through body	=((Vdc-V1_nh)^2-(Vdc- V1)^2)*0.5*Ctot	1.24	J	

B-4.8 PE Loss Reaction

The d.c. electric vehicle supply equipment shall trigger an emergency shutdown within 70 ms if a loss of electrical continuity of the protective conductor occurs anywhere from the inside of the d.c. electric vehicle supply equipment up to the point PP (*see* Fig. 44).

The electric vehicle shall monitor the electrical continuity of the protective conductor from point PP to the electric vehicle by doing the following:

a) The electric vehicle shall check before each initiation of charging the PP circuit for correct values, this includes the continuity of the PE from the point PP up to the electric vehicle; and
b) The electric vehicle shall either open switch Spp when it changes the CP state from B to C or the electric vehicle shall check the PP circuit during charging and in case of a PE loss, the electric vehicle shall trigger an emergency shutdown within 70 ms.

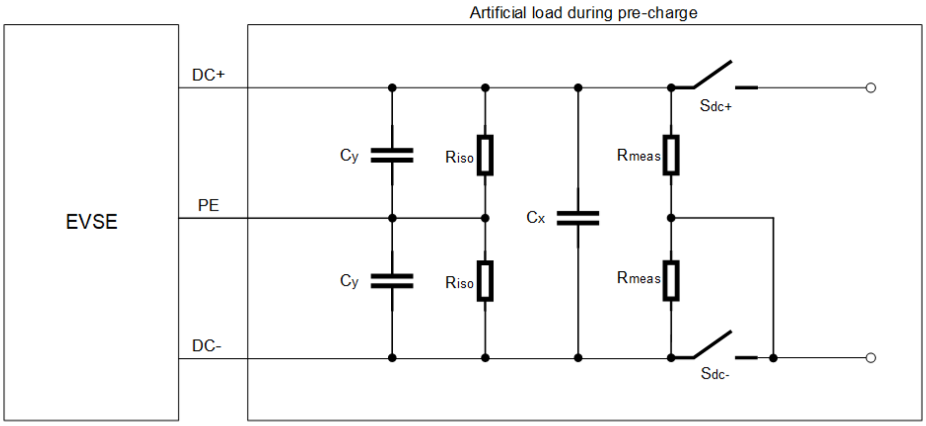
B-5 ADDITIONAL FUNCTIONS

B-5.1 Pre Charging

While executing the pre-charge sequence, the EVSE shall comply with the pre-charge request process as stated in the communication protocol but the current request of the electric vehicle shall be ignored and the output current shall be limited to 2 A.

During pre-charge, the EVSE shall:

a) be able to pre-charge the circuit defined in Fig. 52 with the values according to Table 52 for its entire operating range within 3 s; and subsequently
b) follow the voltage request from the electric vehicle according to **101.2.2.2** and **101.2.6** within 1 s.



KEY

C_y	Maximum electric vehicle Y-Capacitor on inlet
C_x	Maximum electric vehicle X-Capacitor on inlet
R_{iso}	Minimum insulation resistance (due to an error) on inlet
R_{meas}	Minimum resistance for electric vehicle measurement circuit on inlet
S_{dc-}	DC- disconnection device of the electric vehicle
S_{dc+}	DC+ disconnection device of the electric vehicle

FIG. 52 WORST CASE EQUIVALENT CIRCUIT FOR THE EV DURING THE PRE-CHARGE PROCESS

Table 52 – Values to design the EV and EVSE during pre-charge based on Fig. 52

(*Clause* B-5.1)

Symbol	Value used by EVSE	Value used by Electric Vehicle
C_y	2 µF	≤ 2 µF
C_x	10 nF (tbc)	≤ 10 nF
R_{iso}	≥ 100 kΩ	See ISO 17409
R_{meas}	500 kΩ	≥ 500 kΩ
S_{dc-}	closed	
S_{dc+}	open	

During pre-charge, the electric vehicle shall limit its current draw to an equivalent of the circuit defined in Fig. 52 and Table 52.

This is needed to charge all the elements within the d.c. bus of the EVSE and electric vehicle connection (Y Caps, cable caps, and other components).

According to ISO 17409, the electric vehicle shall close its disconnection device only after verifying that the absolute voltage difference between the electric vehicle inlet and the electric vehicle battery is less than 20 V.

The electric vehicle should be protected against the case that the polarity of the d.c. output is reversed and shall not close its disconnection device.

The electric vehicle shall measure the d.c. bus voltage at its inlet and could use the measured voltage as feedback for the pre-charge request adjustments.

The electric vehicle shall not solely use the voltage measurements communicated by the EVSE to check if the EVSE output and battery voltages are within this limit. As the voltage across the electric vehicle contactors are leading for closing the electric vehicle contactors.

Fig. 53 shows the schematics for the voltage measurement points.

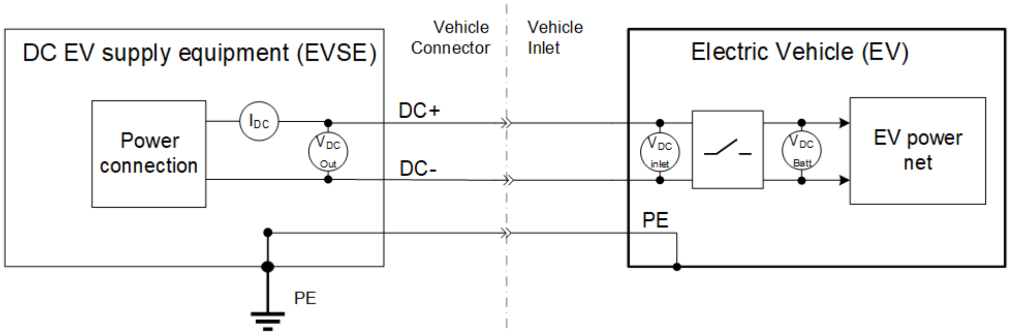


FIG. 53 VOLTAGE MEASUREMENT POINTS FOR THE PRE-CHARGE PROCESS

The electric vehicle could consider to do pre-charge voltage request adjustment to compensate for tolerances and steady state errors to get the inlet voltage within ±20 V of the battery voltage.

Compliance is checked by **B-9.3.13**

B-5.2 Wake Up

The d.c. electric vehicle supply equipment may support a sleep mode according to IS/ISO 15118-3:2015 to minimize power consumption as described as an optional function in **6.3.2.101**.

The d.c. electric vehicle supply equipment may enter a sleep mode, if:

a) the vehicle attached to the d.c. electric vehicle supply equipment has not changed the control pilot from state B2 to C2 or D2 for more than 2 min without the occurrence of any communication-based timeout; and
b) the vehicle commands a paused V2G charging session according to 8.4.2 of IS/ISO 15118-2:2018.

During sleep mode the PWM oscillator shall be off while CP voltage is set to constant voltage (CP state x1) in order to allow:

a) waking up the d.c. electric vehicle supply equipment by the electric vehicle using B1 – C1 – B1 toggling according to IS/ISO 15118-3. After a successful wake up, the d.c. electric vehicle supply equipment shall enable the PWM oscillator with a duty cycle of 5 percent; and
b) waking up the electric vehicle by the d.c. electric vehicle supply equipment using B1 – B2 change, according to Table A-6 sequence and 3.1 of Annex A of IS 17017(Part 1):2018, If the d.c. electric vehicle supply equipment has turned off its CP oscillator then it shall stay in B1 for at least 3 s according to Table A-6 sequence 9.2 of Annex A of IS 17017(Part 1):2018. After a successful wake up, the electric vehicle resumes digital communication. The d.c. electric vehicle supply equipment may additionally consider **A-5.3** of IS 17017(Part 1):2018 (Information on difficulties encountered with some legacy electric vehicles for wake-up after a long period of inactivity).

Compliance is checked by **B-9.3.2**.

B-5.3 Handling of operating ranges

B-5.3.1 *0A Mode During Energy Transfer*

If the d.c. electric vehicle supply equipment cannot deliver any current, it shall send 0A as its maximum output current limit to the electric vehicle within the next communicated message. The 0A mode initiated by the d.c. electric vehicle supply equipment shall not trigger an immediate shutdown by the electric vehicle. The electric vehicle should continue the charging session for at least 5 minutes.

If the electric vehicle requests 0A or the d.c. electric vehicle supply equipment is limited to 0A, then the d.c. electric vehicle supply equipment shall reduce and maintain its d.c. output current to below 0.15 A with a minimum of -0.15 A, to prevent reverse power flow from the electric vehicle to the d.c. electric vehicle supply equipment. See **B-5.3.5** regarding the 0A request from the electric vehicle.

NOTE — The 0A mode is used to temporarily charge without current being delivered. For example: when there are power fluctuations in the electric grid, or there is no power available.

B-5.3.2 *Changing Maximum Output Current*

The d.c. electric vehicle supply equipment is allowed to deliver less current than the requested current by the electric vehicle if its maximum output current limit is below the electric vehicle current request.

The d.c. electric vehicle supply equipment shall communicate the change of maximum output current limit in the next communicated message.

B-5.3.3 *Changing Maximum Output Power*

The d.c. electric vehicle supply equipment is allowed to deliver less current than the current requested by the electric vehicle if the d.c. electric vehicle supply equipment's maximum output power limit drops below the present output power delivered to the electric vehicle.

The EVSE shall communicate the change of the maximum output power limit in the next communicated message.

B-5.3.4 d.c. *EV supply equipment delivers less current than EV current request*

If the d.c. electric vehicle supply equipment delivers less current than the target current request from the electric vehicle, this shall not result in a shutdown triggered by the electric vehicle.

NOTE — This decrease in output current can be caused by grid dips, CVC mode or a change in maximum output current. See **B-5.3.2**.

B-5.3.5 *EV Requests a Current below* **d.c.** *EV Supply Equipment Minimum Output Current*

The d.c. electric vehicle supply equipment shall go into 0A mode (see **B-5.3.1**), as if the electric vehicle requested 0A, when the d.c. electric vehicle supply equipment receives a current request below its minimum output current.

$$I_{EVSE\_Out} = 0 \text{ if } I_{EV\_Req} < I_{EVSE\_Min}$$

where

I_{EVSE_Out}: Output current of the d.c. electric vehicle supply equipment.

I_{EVSE_Min}: Minimum output current limit of the d.c. electric vehicle supply equipment.

I_{EV_Req}: Target current request from the electric vehicle

B-5.3.6 *EV Requests a Current above* d.c. *EV Supply Equipment Maximum Output Current*

The d.c. electric vehicle supply equipment shall continue the charge session with its maximum output current or the maximum current from the electric vehicle, whichever is less, if the electric vehicle requests a current higher than these maximum current limits:

$$I_{EVSE\_Out} = MIN(I_{EV\_MAX}, I_{EVSE\_MAX}) \text{ if } I_{EV\_req} > MIN(I_{EV\_MAX}, I_{EVSE\_MAX})$$

where

I_{EVSE_Out}: Output current of the d.c. electric vehicle supply equipment

I_{EVSE_MAX}: Maximum output current from the d.c. electric vehicle supply equipment

I_{EV_MAX}: Maximum input current from the electric vehicle

I_{EV_req}: Target current request from the electric vehicle

B-5.3.7 *Output Voltage d.c. EV Supply Equipment Higher than Maximum Output Voltage*

The d.c. electric vehicle supply equipment shall trigger an error shutdown within 10 ms if the measured output voltage is equal or higher than the maximum output voltage of the d.c. electric vehicle supply equipment for more than 400 ms

$$\text{Error Stop if } V_{EVSE\_measured} \geq V_{EVSE\_MAX} \text{ for more than 400 ms}$$

where

$V_{EVSE\_Measured}$: Output voltage measured by the d.c. electric vehicle supply equipment

V_{EVSE_MAX}: Maximum output voltage of the d.c. electric vehicle supply equipment

B-5.3.8 *Output Voltage of* ***d.c.*** *EV Supply Equipment is below its Minimum Output Voltage*

The d.c. electric vehicle supply equipment shall trigger an error shutdown within 10 ms if the measured output voltage or the requested output voltage by the electric vehicle is lower than the minimum output voltage of the d.c. electric vehicle supply equipment for more than 3 s.

$$\text{Error Stop if } MIN(V_{EVSE\_measured}, V_{EV\_req}) < V_{EVSE\_MIN} \text{ for more than 3 s}$$

where

$V_{EVSE\_Measured}$: Output voltage measured by the d.c. electric vehicle supply equipment

V_{EVSE_MIN}: Minimum output voltage of the d.c. electric vehicle supply equipment
V_{EV_Req}: Target voltage request from the electric vehicle

NOTE — This case could be detected during the pre-charge stage, as the d.c. electric vehicle supply equipment cannot supply the correct voltage for pre-charge.

B-5.3.9 *EV Requests a Voltage above the Maximum Voltage Limits*

The d.c. electric vehicle supply equipment shall continue the charge session with the maximum output voltage if the electric vehicle requests a voltage higher than the maximum output voltage of the d.c. electric vehicle supply equipment.

The d.c. electric vehicle supply equipment shall continue to charge with the requested output voltage from the electric vehicle or the d.c. electric vehicle supply equipment's maximum output voltage, whichever is less, if the electric vehicle requests a voltage higher than the maximum battery voltage:

$$V_{EVSE\_Out} = MIN(V_{EV\_Req}, V_{EVSE\_Max}) \quad \text{if } V_{EV\_req} > V_{EV\_Max}$$

where

V_{EVSE_Out}: Output voltage of the d.c. electric vehicle supply equipment

V_{EVSE_Max}: Maximum output voltage of the d.c. electric vehicle supply equipment.

V_{EV_Req}: Target voltage request from the electric vehicle

V_{EV_Max}: Maximum battery voltage of the electric vehicle

NOTE — The d.c. electric vehicle supply equipment can remain in CCC mode until the maximum battery voltage is reached. See overvoltage protection in **6.3.1.106**, which prevents overcharging the electric vehicle battery.

B-5.3.10 *Limitations Minimum Power*

The d.c. electric vehicle supply equipment shall go into 0A mode (see **B-5.3.1**), as if the electric vehicle requested 0A, if:

a) the requested power by the electric vehicle is below the minimum output power of the d.c. electric vehicle supply equipment; or
b) for more than 3 s, the measured output voltage multiplied by the requested output current is below the minimum output power of the d.c. electric vehicle supply equipment.

$$I_{EVSE\_Out} = 0 \quad \text{if } P_{EV\_Req} < P_{EVSE\_MIN}, \text{ or}$$
$$I_{EVSE\_Out} = 0 \quad \text{if } V_{EVSE\_Measured} * I_{EV\_Req} < P_{EVSE\_MIN} \text{ for more than 3s}$$

where

I_{EVSE_Out}: Output current of the d.c. electric vehicle supply equipment

I_{EV_Req}: Target current requested by the electric vehicle

$V_{EVSE\_Measured}$: Output voltage measured by the d.c. electric vehicle supply equipment

P_{EV_Req}: Power requested by the electric vehicle

P_{EVSE_MIN}: Minimum power output of the d.c. electric vehicle supply equipment

NOTE — P_{EVSE_MIN} is the internal minimum power that the d.c. electric vehicle supply equipment can deliver, as this value is not handled by the communication, but is restricting the output. The d.c. electric vehicle supply equipment cannot know the minimum and actual battery voltages as these are not communicated through HLC.

B-5.3.11 *Limitations due to Maximum Power*

If the electric vehicle requests a power output or current multiplied by the measured voltage that is higher than the power limits of the electric vehicle or d.c. electric vehicle supply equipment, then the d.c. electric vehicle supply equipment shall continue the charge session and limit its output power to the minimum of the following values:

a) Electric vehicle maximum power, and
b) d.c. electric vehicle supply equipment maximum power output

$$P_{EVSE\_out} = MIN(P_{EV\_MAX}, P_{EVSE\_MAX}), \text{ if } MIN(V_{EVSE\_measured} * I_{EV\_req}, P_{EV\_req}) > MIN(P_{EV\_MAX}, P_{EVSE\_MAX})$$

where

$V_{EVSE\_Measured}$: Output voltage measured by the d.c. electric vehicle supply equipment

I_{EV_Req}: Target current requested by the electric vehicle

P_{EVSE_out}: Output Power delivered by the d.c. electric vehicle supply equipment

P_{EVSE_MAX}: Maximum power output of the d.c. electric vehicle supply equipment

P_{EV_Req}: Power requested by the electric vehicle

P_{EV_MAX}: Maximum Power requested by the electric vehicle

NOTE — According to IS/ISO 15118-2, the PEV_Req is the electric vehicle Maximum Power Limit within the CurrentDemand messages and the PEV_MAX is the electric vehicle MaximumPowerLimit communicated.

B-6 SPECIFIC REQUIREMENTS

B-6.1 Turn on Inrush Current (d.c. Output)

Any inrush current on d.c. output in both directions when closing of electric vehicle disconnection device and d.c. electric vehicle supply equipment contactors, if any, shall be limited by the d.c. electric vehicle supply equipment to 2 A, for example by applying a pre-charging circuit as shown in Figure 48.

NOTE — Higher current values for short time under 1 ms can appear for charging and discharging of cable capacitance.

B-6.2 Requirements for Load Dump

In any case of load dump, voltage overshoot shall not exceed 110 percent of the maximum voltage limit of the vehicle, as communicated during the initialisation phase, or maximum voltage limit of the vehicle, as communicated during the initialisation phase, + 50 V whichever is higher. (*see* **101.2.7**)

If the electric vehicle battery gets disconnected from the d.c. output during charging, the electric vehicle shall perform an error shutdown before re-initiating charging.

B-6.3 d.c. Output Current Regulation

When in current regulation mode, the d.c. electric vehicle supply equipment shall provide direct current to the vehicle. The maximum allowable error between the output current and the target current requested by the vehicle is:

a) ±150 mA when the commanded current value is less than or equal to 5 A;
b) ±1.5 A when the commanded current value is greater than 5 A but less than or equal to 50 A;
c) ±3 percent of the d.c. electric vehicle supply equipment's maximum current output when the commanded current value is greater than 50 A.

B-6.4 Measuring Current and Voltage

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

a) Voltage: within ±10 V; and
b) Current: within ±1.5 percent of reading or within ±0.5 A, whichever is higher

After a value is measured by the d.c. electric vehicle supply equipment, it shall be send within 200 ms to the electric vehicle or it is remeasured before sending it to the electric vehicle.

The electric vehicle should not solely rely on the voltage and current measurements from the d.c. electric vehicle supply equipment for charge session control.

B-6.5 Overcurrent Protection of d.c. Connection

The d.c. electric vehicle supply equipment shall provide an over-current protection to protect the power supply circuit of the d.c. electric vehicle supply equipment and the vehicle.

If one or both of the following conditions are continuously fulfilled for a duration of 0.5 s, the d.c. electric vehicle supply equipment shall trigger an emergency shutdown within 0.5 s:

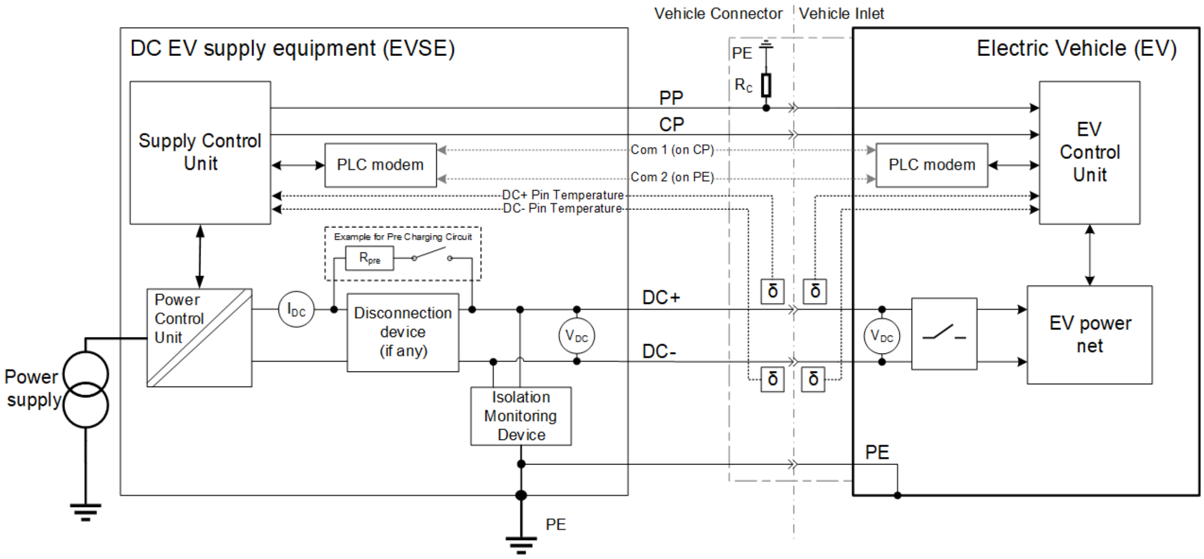
a) current is exceeding 120 percent of the maximum operating current of the station;
b) during energy transfer the voltage is dropping below 80 percent of the minimum operating voltage of the station.

NOTE — For the protective measures in the vehicle see 6.2 of ISO 17409:2020.

Compliance is tested by **B-9.3.18**.

B-7 SCHEMATICS AND DESCRIPTION

Schematics of system C for d.c. electric vehicle supply equipment is given in Fig. 54, as well definition and description of symbols and terms in Table 53.



NOTES

1 The supply disconnection device may be substituted by a diode, while the inrush current requirements in **B-6** have to be fulfilled.

2 Diagram shows functional description of interface. Contact assignment of vehicle coupler is done in IS 17017(Part 2/Sec 3)..

3 PP line from vehicle connector to d.c. electric vehicle supply equipment is optional for configuration FF couplers.

FIG. 54 SYSTEM SCHEMATIC EXAMPLE OF SYSTEM C

Table 53 - Definition and description of symbols / terms

(*Clause* B-7)

d.c. EV supply equipment		Electric Vehicle (EV)		Interface Circuit	
Symbols/ Terms	Definitions	Symbol s/ Terms	Definitions	Symbols / Terms	Definitions
V_DC	Voltage Measurement at output of d.c. electric vehicle supply equipment	PLC Modem (Electric vehicle)	electric vehicle Communication interface between PLC and internal electric vehicle communication	PE	Protective conductor
I_DC	Current Measurement (on DC+ or DC- or both)	Electric vehicle Control Unit	Unit for communicating from electric vehicle to the d.c. electric vehicle supply equipment and verifying safety procedure	DC+	d.c. power supply (positive)
Power Conversi on Unit	Isolated power stage for converting a.c. supply network into regulated d.c. power for electric vehicle supplying	Electric vehicle Power Net	Subsystem within the electric vehicle related to be supplied with energy from the d.c. electric vehicle supply equipment.	DC-	d.c. power supply (negative)
Disconne ction device	Device to connect and disconnect d.c. output of d.c. electric vehicle supply equipment to Power conversion unit a)			Com1	(positive) Line for (PLC) c)
PLC Modem (Supply)	Supply communication interface between PLC and internal supply communication			Com2	(negative) Line for PLC
Supply Control Unit	Unit for control of supply process within d.c. electric vehicle supply equipment and communicating with electric vehicle			PP (Proximity)	General functions acc. to IS 17017(Part 1):2018 with definition of values in Table 42 for configurations FF
R_pre	Resistor for pre charging circuit b)			CP (Control Pilot)	Function acc. to IS 17017(Part 1):2018 Also used for emergency shutdown of d.c. electric vehicle supply equipment by electric vehicle going into state B or interruption of control pilot for CP lost shutdown.
IMD	Insulation Monitoring Device			RC	Proximity-Resistor used for coding of cable current capability in case of a.c. supply acc. values in IS 17017(Part 1) :2018.
				CCL (Correct Contact& Latching)	Feedback of correct contact and latching of d.c. vehicle connector
					Thermal sensing
a The disconnection device may be substituted by a diode.					

b	Switch and resistor are recommended for implementation of mandatory pre charging function.
c	Refer to Table 41 for different connectors.

B-8 REQUIREMENTS FOR HIGH-LEVEL COMMUNICATION OF d.c. EV SUPPLY EQUIPMENTS USING CHARGING WITH THERMAL MANAGEMENT SYSTEM

For charging with thermal management system, the high-level communication shall be implemented according to IS/ISO 15118-2 to exchange additional information.

B-9 GENERAL TEST CONDITIONS

B-9.1 Operating Range

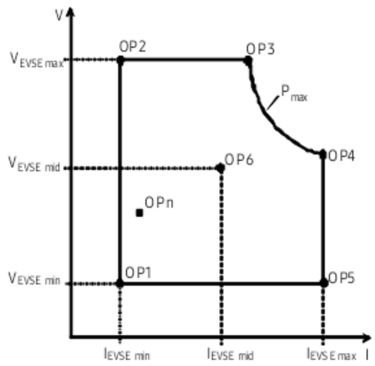
B-9.1.1 *Definition*

Definitions of variables are as follows:

$V_{EVSE\ intended}$	voltage value of testing point
$I_{EVSE\ intended}$	current value of testing point
$V_{EV\ target}$	requested output voltage by the testing system, sent to the d.c. electric vehicle supply equipment via digital communication
$I_{EV\ target}$	requested output current by the testing system, sent to the d.c. electric vehicle supply equipment via digital communication
$V_{EVSE\ output}$	output voltage of the d.c. electric vehicle supply equipment measured by the testing system
$I_{EVSE\ output}$	output current of the d.c. electric vehicle supply equipment measured by the testing system
$V_{EV\ max}$	maximum operating voltage of electric vehicle
$I_{EV\ max}$	maximum operating current of electric vehicle

The values for $V_{EV\ max}$ and $I_{EV\ max}$ shall be set to the maximum corresponding values of the d.c. electric vehicle supply equipment transferred via digital communication (for example ChargeParameterDiscoveryRes) unless otherwise specified.

If the d.c. electric vehicle supply equipment shows any discontinuous behaviour in its operating range, for example in case of cascaded architecture of power modules, it might be necessary to add additional testing points. In case that the operating area boundaries are reached, additional operating points or shifting of existing points shall be performed in order to fulfil the test requirements.



KEY

$I_{EVSE\ max}$	maximum operating current of electric vehicle supply equipment	OP1	$V_{EVSE\ min}$ and $I_{EVSE\ min}$
$I_{EVSE\ mid}$	$(I_{EVSE\ max} + I_{EVSE\ min}) / 2$	OP2	$V_{EVSE\ max}$ and $I_{EVSE\ min}$
$I_{EVSE\ min}$	minimum operating current of electric vehicle supply equipment	OP3	$V_{EVSE\ max}$ and P_{max}
$V_{EVSE\ max}$	maximum operating voltage of electric vehicle supply equipment	OP4	$I_{EVSE\ max}$ and P_{max}
$V_{EVSE\ mid}$	$(V_{EVSE\ max} + V_{EVSE\ min}) / 2$	OP5	$V_{EVSE\ min}$ and $I_{EVSE\ max}$
$V_{EVSE\ min}$	minimum operating voltage of electric vehicle supply equipment	OP6	$V_{EVSE\ mid}$ and $I_{EVSE\ mid}$
OP	operation point		
OPn	voltage and current depending on test conditions		

NOTE — The defined operating range (OP1 - OP5) specifies the possible range for the electric vehicle to request values for voltage and/or current. Within the tolerances, the d.c. EV supply equipment however is allowed to deliver values for current or voltage that are outside of this operating range.

FIG. 55 OPERATING POINTS

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CC.102.3.
CC.102.4.
CC.102.5.
CC.102.6.
CC.102.7.
CC.102.8.
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CC.102.1.4

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CC.102.1.6
CC.102.1.7

B-9.2 Test Setup

B-9.2.1 *Standard Test Setup*

Fig. 56 shows standard test setup.

FIG. 56 STANDARD TEST SETUP CIRCUIT DIAGRAM

B-9.3 Test Cases

B-9.3.1 *Compatibility Assessment*

The compliance test is shown in Table 54.

Table 54 - Compliance test for compatibility assessment

(*Clause* B-9.3.1)

Matching to requirement (chapter)	**6.3.1.104** Compatibility assessment **102.5.2** Description of the process before the start of charging (initialization) **B-3.2** normal start up **B-3.3** normal shut down
Short description	
Test, if d.c. electric vehicle supply equipment will not proceed with the charging process in case of: – $V_{EVSE\ min} > V_{EV\ max}$	
Pre-conditions	
for IS/ISO 15118, message “AuthorisationRes” was successfully received by electric vehiclesimulator	
Test setup	
Standard test setup, additionally measurement equipment for output voltage $V_{EVSE\ output}$ (continuously measured)	
Action(s)	
for IS/ISO15118-2: send message “ChargeParameterDiscovery.req” containing the following specific value for DC_EVChargeParameterType: Electric vehicle MaximumVoltageLimit = max ($V_{EVSE\ min}$ -10V, 0V) proceed with the digital communication according to each standard.	

Expected results
d.c. electric vehicle supply equipment will not proceed with the next message via digital communication according to each standard. ChargeParameterDiscovery.res contain an EVSEStatusCode = ”EVSE_Shutdown” $V_{EVSE\ output} < 60$ V d. c.
Post conditions
none

B-9.3.2 *Wake up of d.c. EV Supply Equipment by EV*

The compliance test is shown in Table 55.

Table 55 - Compliance test for wake up of d.c. EV supply equipment by EV

(*Clause* B-9.3.2)

Matching to requirement (chapter)	**B-5.2** Wake up of d.c. electric vehicle supply equipment by electric vehicle
Short description	
Reaction on wake up action performed by electric vehicle after d.c. electric vehicle supply equipment fell asleep.	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during pre-charging: $V1 = V_{EVSE\ min} – (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “$EV_{TargetVoltage}$” in message “PreChargeReq” (according to IS/ISO 15118): $EV_{TargetVoltage} = V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup	
ActAction(s)	
In each test step, the EV-simulator shall issue current requests and, if applicable voltage requests. The message “CurrentDemandReq” according to IS/ISO 15118-2 shall contain the following parameters: $EV_{TargetCurrent} = I_{EV\ target}$ $EV_{TargetVoltage} = V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set: $V1 = V_{EVSE\ min} – (R1+R2) \times I_{EVSE\ max}$ If $V_{EVSE\ min} – (R1+R2) \times I_{EVSE\ max} \geq 0V$ 2) Send: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = \min (P_{EVSE\ max}/I_{EVSE\ max}; V_{EVSE\ max})$	

3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring $T_{wait} = 2\text{ s} + 1.1 \times I_{EVSE\ max} / 20\text{ A/s}$ 4) The test system sends message "PowerDeliveryReq" according to IS/ISO 15118-2 with the parameter "ChargeProgress" set to "Stop" and waits for "PowerDeliveryRes" 5) After receiving "PowerDeliveryRes" the test system sends message "SessionStopReq" according to IS/ISO 15118-2 with the parameter "ChargingSession" set to "Pause" 6) Test system pauses the Data-Link (D-LINK_PAUSE.request()) after receiving SessionStopRes 7) d.c. EV supply equipment changes to sleep mode, which is indicated by a disabled PWM oscillator while CP voltage is set to constant +12 V. 8) Test system performs one B1-C1-B1 toggle according to IS/ISO 15118-3:2015.
Expected results
d.c. EV supply equipment signals wake up by enabling the PWM oscillator with a duty cycle of 5 percent.

B-9.3.3 *Details of Pilot Function*

The compliance test is shown in Table 56.

Table 56 - Compliance test for details of pilot function
(*Clause* B-9.3.3)

Matching to requirement (chapter)	**6.3.1.5** De-energization of the power supply to the EV
Short description	
Start of d.c. charging impossible in case of CP lost	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t = t1 according to Fig. 46.	
Test setup	
Standard test setup, additional relay for opening CP	
Action(s)	
Interrupt control pilot	
Expected results	
The d.c. electric vehicle supply equipment shall stop the ongoing charging session.	

B-9.3.4 *Protective Conductor Continuity Checking*

The compliance test is shown in Table 57.

Table 57 - Compliance test for protective conductor continuity checking
(*Clause* B-9.3.4)

Matching to requirement (chapter)	**6.3.1.2** Continuous continuity checking of the protective conductor **6.3.1.112** and **6.3.1.113** Voltage limitation between d.c. output and protective conductor
Short description	
Emergency shutdown in case of loss of protective conductor continuity. This test case applies to d.c. electric vehicle supply equipments with a maximum output voltage ≥ 60 V.	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): $EV_{TargetVoltage} = V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup with additional relay for interruption of protective conductor continuity. The maximum emergency shutdown time $t_{shutdown}$ is determined by the following equation: $t_{shutdown} = t_{trigger} + t_{perform}$ with: $t_{trigger}$ = 10 ms for isolated systems $t_{perform}$ = 30 ms	
Action(s)	
In each test step, the EV-simulator shall issue current requests and, if applicable voltage requests. The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters: $EV_{TargetCurrent} = I_{EV\ target}$ $EV_{TargetVoltage} = V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set: $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max}$ If $V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max} \geq 0\ V$	

2)Send: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = \min (P_{EVSE\ max}/I_{EVSE\ max};\ V_{EVSE\ max})$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$ 4) Interrupt protective conductor inside EV-simulator
Expected results
The electric vehicle supply equipment shall turn off the CP oscillator. After $t_{shutdown}$ = 40 ms the output current of the d.c. electric vehicle supply equipment ($I_{EVSE\ output}$) shall be < 5 A. 1.01 s after the occurrence of the fault the output voltage of the d.c. electric vehicle supply equipment ($V_{EVSEoutput}$) shall be < 60 V.

B-9.3.5 *Rated Outputs and Maximum Output Power*

The compliance test is shown in Fig. 57 and Table 58.

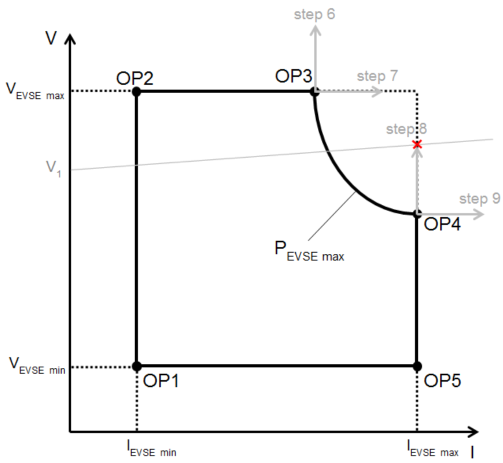


FIG. 57 TEST POINT GRID

Table 58 - Compliance test for rated outputs and maximum output power

(*Clause B-9.3.5*)

Matching to requirement (chapter)	**101.2.1** Operating ranges for output voltage, output current, and output power
Short description	
1. Test if the d.c. electric vehicle supply equipment does not exceed its maximum rated power, even if the maximum power request by the electric vehicle is beyond the rated maximum power of the d.c. electric vehicle supply equipment. 2. Test if the d.c. electric vehicle supply equipment is able to deliver d.c. power in the voltage range [*V*min, *V*max] and the regulated current range [*I*min, *I*max] within the limit of its maximum rated power [*P*max] at the ambient temperature –5 °C to 55°C below 1 000 m above sea level.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Figure 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during	

precharging:
$V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$
and:
$V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$
and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118):
$EV_{TargetVoltage} = V_{EV\ target} = V_{EVSE\ min}$

Test setup

Standard test setup, additionally:

To avoid dynamical influence by unknown inductances in the electric vehicle supply equipment, the test shall be executed in a stationary set point. Measure in this stationary phase for a duration of 3 s with a measurement rate of 100 ms or better.

Stationary ambient temperature (as specified at **101.2.1**):

Case 1: Minimum ambient temperature as specified by manufacturer

Case 2: – 5 °C

Case 4:+ 22°C

Case 3: + 55°C

Case 4: Maximum ambient temperature as specified by manufacturer

Action(s)

This test case shall be executed in single steps as indicated below.
In each test step, the EV-simulator shall issue current / voltage requests (that is “CurrentDemandReq” in case of plc communication according to IS/ISO 15118) with the parameter as given in the list below according to the specifications of :
$EV_{targetCurrent} = I_{EV\ target}$;
$EV_{targetVoltage} = V_{EV\ target}$.

The evaluation of the expected results shall be done in steady state operation.
The order of sequence of test points can be optimized for the used load. Delay times between the test points can be used e. g. for cooling down the load.
For each step the following description uses indices m and n.
m: The consecutive index is used to identify the value of the intended current respectively target current.
n: This consecutive index is used to identify the value of the voltage V1, respectively intended voltage or target voltage.

Main actions to be performed for all test points:
1. set V1 to the values as defined below.
2. For each test point TP request $I_{EV\ target}$ and $V_{EV\ target}$ with the values as defined below.
3. Wait T_{delay} (see definition below) in order to reach steady state operation before measuring.
4. Measure electric vehicle supply equipment output current $I_{EVSE\ output\ m,n}$ and output voltage $V_{EVSE\ output\ m,n}$.

Calculations:
Determine active output power
$P_{EVSE\ output\ m,n} = I_{EVSE\ output\ m,n} \times V_{EVSE\ output\ m,n}$

Definitions:
$T_{delay} = 2\ s$ for current steps of < 20 A
$T_{delay} = 2\ s + 1.1 \times (\left| I_{EVSE\ intended\ m,n} - \text{previous } I_{EVSE\ output} \right|) / 20\ A/s$ for current steps of ≥ 20 A

Target values requested to set test point $TP_{m,\ n}$:

Steps 1-9 shall be tested at each case listed above:

Step 1: (see OP5 in Fig. 55)
$I_{EV\ target} = I_{EVSE\ max}$
$V_{EV\ target} = V_{EVSE\ min}$

Step 2: (see OP4 in Fig. 55)
$I_{EV\ target} = I_{EVSE\ max}$
$V_{EV\ target} = P_{EVSE\ max}/I_{EVSE\_max}$

Step 3: (see OP3 in Fig. 55)
$I_{EV\ target} = P_{EVSE\ max}/V_{EVSE\_max}$
$V_{EV\ target} = V_{EVSE\ max}$

Step 4: (see OP2 in Fig. 55)
$I_{EV\ target} = I_{EVSE\ min}$
$V_{EV\ target} = V_{EVSE\ max}$

Step 5: (see OP1 in Fig. 55)
$I_{EV\ target} = I_{EVSE\ min}$
$V_{EV\ target} = V_{EVSE\ min}$

Step 6:
$I_{EV\ target} = P_{EVSE\ max}/V_{EVSE\_max}$
$V_{EV\ target} = V_{EVSE\ max}$

Step 7:
$I_{EV\ target} = 1.2\ (P_{EVSE\ max}/V_{EVSE\_max})$
$V_{EV\ target} = V_{EVSE\ max}$

Step 8:
$I_{EV\ target} = 1.2 \times I_{EVSE\ max}$
$V_{EV\ target} = P_{EVSE\ max}/I_{EVSE\_max}$

Step 9:
$I_{EV\ target} = I_{EVSE\ max}$
$V_{EV\ target} = 1.2\ (P_{EVSE\ max}/V_{EVSE\_max})$

Configuration of the test bench for all steps:
$V1 = V_{EV\ target} - (R1 + R2) \times I_{EV\ target}$
With
$V1 \geq 0$ V

Expected results

All Cases, all Steps:
All measured current and voltage values shall be positive (> 0) in steady state operation.
This test case is passed if each of the following test criteria is fulfilled for all measurements in steady state operation:

Step 1:
$V_{EVSE\ output} > 0$

Steps 2-4:
$V_{EVSE\ output} > 0$
$I_{EVSE\ output} > 0$
Step 5:
$V_{EVSE\ output} > 0$
Steps 6-9:
The d.c. electric vehicle supply equipment shall not exceed its maximum rated power and shall stop the charging process.

B-9.3.6 *Protection against Overvoltage at the Interface*

The compliance test is shown in Table 59.

Table 59 - Compliance test for protection against overvoltage at the battery
(*Clause* B-9.3.6)

Matching to requirement (chapter)	**6.3.1.106** Protection against overvoltage at the interface **6.3.1.114** Shutdown of d.c. electric vehicle supply equipment

Short description

Emergency shutdown in case of an overvoltage at the interface and disconnection of the d.c. electric vehicle supply equipment´s supply.

Pre-conditions

The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator:

$V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$

The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging:

$V1 = V_{EVSE\ min} – (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$

and:

$V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$

and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118):

EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$

Test setup

Standard test setup.

The maximum error shutdown time $t_{shutdown}$ is defined as follows:
$t_{shutdown}$ = 1.01 s ($t_{trigger}$ =10 ms, $t_{perform}$ = 1 s)

Action(s)

In each test step, the EV-simulator shall issue current requests and, if applicable voltage requests.

The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters:

EVTargetCurrent = $I_{EV\ target}$

EVTargetVoltage = $V_{EV\ target}$

EVMaximumVoltageLimit = $V_{EV\ max}$

Definition of intended test point:

$I_{EVSE\ intended} = I_{EVSE\ min}$

$V_{EVSE\ intended} = V_{EVSE\ min} + (V_{EVSE\ max} - V_{EVSE\ min})/ 2$

1) Set:

$V1= V_{EVSE\ min}$

2) Send:

$I_{EV\ target} = I_{EVSE\ min}$

$V_{EV\ target} = V_{EVSE\ min}$

$V_{EV\ max} = V_{EVSE\ min} + (V_{EVSE\ max} - V_{EVSE\ min})/ 2$

3) Wait for T_{wait} (see definition below) in order to reach steady state operation

T_{wait} = 2 s

4) Set: $V1 = V_{EV\ max} + 10\ V$ for 400 ms Editor´s NOTE: According to **6.3.1.106** the vehicle shall be able to change the maximum voltage limit during charging process.
Expected results
The electric vehicle supply equipment shall turn off the CP oscillator. After $t_{shutdown}$ = 1.01 s the output current of the d.c. electric vehicle supply equipment (IEVSE output) shall be < 5 A.

B-9.3.7 *Emergency Shutdown in case of Control Pilot Disconnection*

The compliance test is shown in Table 60.

Table 60 - Compliance test for emergency shutdown in case of control pilot disconnection

(*Clause* B-9.3.7)

Matching to requirement (chapter)	**6.3.1.114** Shutdown of d.c. electric vehicle supply equipment **B-4.3** CP lost shutdown
Short description	
Emergency shutdown in case of CP lost.	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): $EVTargetVoltage = V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup with additional relay for opening CP: The maximum emergency shutdown time $t_{shutdown}$ is defined as follows: $t_{shutdown} = t_{trigger} + t_{perform}$ = 40 ms after control pilot interruption with: $t_{trigger}$ = 10 ms $t_{perform}$ = 30 ms The de-energization time $t_{de\text{-}energization}$ is defined as follows: $t_{de\text{-}energization}$ = 100 ms after control pilot interruption	

Action(s)
In each test step, the EV-simulator shall issue current requests and, if applicable voltage requests. The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters: EVTargetCurrent = $I_{EV\ target}$ EVTargetVoltage = $V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set: $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max}$ If $V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max} < 0$, then set V1 = 0V 2) Send: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = \min(P_{EVSE\ max}/I_{EVSE\ max};\ V_{EVSE\ max})$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$ 4) Interrupt control pilot inside EV-simulator 5) Initiate charging process after emergency shutdown has been performed
Expected results
After $t_{shutdown}$ = 40 ms the output current of the d.c. electric vehicle supply equipment ($I_{EVSE\ output}$) shall be < 5 A 1.01 s after the occurrence of the fault the output voltage of the d.c. electric vehicle supply equipment ($V_{EVSEoutput}$) shall be < 60 V. After $t_{de\text{-}energization}$ = 100 ms the output voltage of the d.c. electric vehicle supply equipment ($V_{EVSE\ output}$) shall be < 60 V The d.c. electric vehicle supply equipment does not go into ready mode until the station is serviced. (The message "ChargeParameterDiscoveryRes" according to IS/ISO 15118 shall contain DC_EVSEStatusCode ≠ EVSE_Ready).

B-9.3.8 *Load Dump*

The compliance test is shown in Table 61.

Table 61 - Compliance test for load dump

(*Clause* B-9.3.8)

Matching to requirement (chapter)	101.2.7 Load dump
Short description	

Check if d.c. electric vehicle supply equipment will limit the voltage overshoot to the specified values for each system in case of load dump.
Pre-conditions
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message "PowerDeliveryReq" (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters "EVTargetVoltage" in message "PreChargeReq" (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$
Test setup
Standard test setup Switch S3 closed
Action(s)
The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters: EVTargetCurrent = $I_{EV\ target}$ EVTargetVoltage = $V_{EV\ target}$ EVMaximumVoltageLimit = $V_{EV\ max}$ Definition of intended test point: $I_{EVSE\ intended} = I_{EVSE\ min}$ $V_{EVSE\ intended} = 1.1 \times V_{EVSE\ min}$ 1) Set: $V1 = 1.1 \times V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max}$ if $1.1 \times V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max} \geq 0$ V 2) Send: $I_{EV\ target} = I_{EVSE\ min}$ $V_{EV\ target} = 1.1 \times V_{EVSE\ min}$ $V_{EV\ max} = 1.2 \times V_{EVSE\ min}$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20$ A/s Main action to be performed: Open S1 (*see* Fig. 26)
Expected results
$V_{EVSE\ output} \leq 1.1 \times V_{EV\ max}$ $dV_{EVSE\ output}/dt \leq 250$ V/ms

B-9.3.9 *Protection Against Uncontrolled Reverse Power Flow From Vehicle*

The compliance test is shown in Table 62.

Table 62 - Compliance test for protection against uncontrolled reverse power flow from vehicle
(*Clause* B-9.3.9)

Matching Requirement (Chapter)	**101.1** Protection against uncontrolled reverse power flow from vehicle
Short description	
Test if electric vehicle supply equipment will prevent any reverse power flow from the vehicle.	
Pre-conditions	
The charging sequence shall be successfully done until t=t8 according to Fig. 46, including the message "PowerDeliveryReq" (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters "EVTargetVoltage" in message "PreChargeReq" (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$ The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters: EVTargetCurrent = $I_{EV\ target}$ EVTargetVoltage = $V_{EV\ target}$ $I_{EV\ target} = I_{EVSE\ min}$ $V_{EV\ target} = V_{EVSE\ min} + (V_{EVSE\ max} - V_{EVSE\ min})/ 2$ Setting of the test bench: $V1 = V_{EV\ target} - (R1 + R2) \times I_{EV\ target}$	
Test setup	
Standard test setup	
Action(s)	
The EV-simulator shall issue the identical values for current and, if applicable voltage requests as send in the pre-conditions. 1. set $V1 = V_{EV\ target} + 10\ V$ 2. wait 250 ms to start current measurement for $I_{EVSE\ output}$	
Expected results	
$I_{EVSE\ output} \geq 0$ for a duration of 3 s	

B-9.3.10 *Limiting Inrush Current by d.c. EV Supply Equipment to 2A*

The compliance test is shown in Table 63.

Table 63 - Compliance test for limiting the inrush current by d.c. electric vehicle supply equipment to 2A
(*Clause* B-9.3.10)

Matching Requirement (Chapter)	**B-6.2** Turn on inrush current
Short description	
Check if the d.c. electric vehicle supply equipment limits the inrush current to max. 2A in case of closing the electric vehicle disconnecting device after pre-charge sequence.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The message “PrechargeReq” according to IS/ISO 15118 shall contain the following parameter: EVTargetVoltage = $V_{EV\ target}$ with: $V_{EV\ target} = V_{EVSE\ max}$ Precharge sequence shall be successfully done until: $V_{EVSE\ output} = [0.95 \times V_{EV\ target,}\ V_{EV\ target}]$	
Test setup	
Standard test setup	
Action(s)	
1. Set V1 = $V_{EVSE\ output}$ -20V 2. Close S0 3. Measure $I_{EVSE\ output}$ 1ms after closing S0 until first CurrentDemandRes message.	
Expected results	
0A ≤ IEVSE output ≤ 2 A	

B-9.3.11 *Output Current Regulation in CCC Including Static Deviation and Ripple*

The compliance test is shown in Fig. 58 and Table 64.

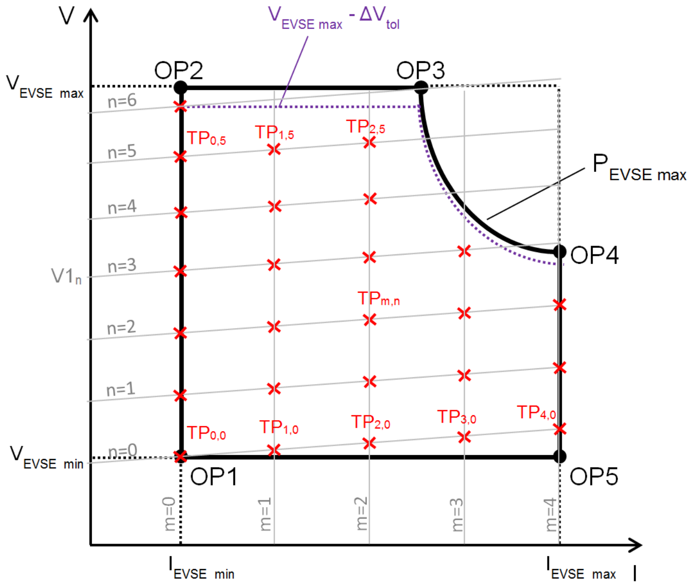


FIG. 58 TEST POINT GRID FOR OUTPUT CURRENT REGULATION IN CCC INCLUDING STATIC DEVIATION AND RIPPLE

Fig. 58 shows a simplified example of the test point grid with indices m = 0…4 and n = 0…6 in order to visualize the principal testing sequence of this test case. However, the test point grid that shall actually be used for this test case shall cover indices m = 0…20 and n = 0…20, with some additional restrictions as described below.

The correlation between current and voltage is given by the following formula:

$$V_{EVSE,\,m,\,n} = V1_n + (R1 + R2) \times I_{EVSE,\,m,n}$$

Table 64 - Compliance test for output current regulation in CCC (including static deviation and ripple) and measurement accuracy
(*Clause* B-9.3.11)

Matching to requirement (chapter)	**101.2.1** Rated outputs and maximum output power **101.2.2**.1 Output current regulation in CCC **101.2.5** Periodic and random deviation (current ripple) **6.3.1.102** Measuring current and voltage
Short description	
Check if the current regulation fulfils the requirements for static, periodic and random deviation. Check accuracy of current measurement.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameter “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118):	

EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$
Test setup
Standard test setup, additionally: Measure in the stationary phase for a duration of 3 seconds. All measurements during this time shall be used for calculation and for expected results.
Action(s)

In the steps of this test case, certain properties of the EVSE are tested at specific test points in the operating range of the EVSE. The indices m and n are used as follows to refer to a specific test point $TP_{m,n}$:

m: This consecutive index is used to identify the value of the intended current, or the target current, respectively.

n: This consecutive index is used to identify the value of the voltage V1, or – together with index m – the intended voltage, respectively.

The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters:

EVTargetCurrent = $I_{EV\ target\ m,n}$

EVTargetVoltage = $V_{EV\ target\ m,n}$

Definition of test point grid $TP_{m,n}$:

Indices range:

m = 0 ... 20, n = 0 ... 20

with:

$\Delta V_{tol} = 0.02 \times V_{EVSE\ max} + 5\ V$ derived from **101.2.2.2** and **101.2.6**

NOTE: ΔV_{tol} is needed in order to achieve current regulation (CCC)

Test point $TP_{m,n} = (I_{EVSE\ intended,\ m,\ n} \mid V_{EVSE\ intended,\ m,\ n})$ with:

$$I_{EVSE\ intended,\ m,\ n} = I_{EVSE\ min} + m/20 \times (I_{EVSE\ max} - I_{EVSE\ min}) \quad (1)$$

$$V_{EVSE\ intended,\ m,\ n} = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - \Delta V_{tol} - V_{EVSE\ min}) + (R1 + R2) \times (I_{EVSE\ intended,\ m,\ n} - I_{EVSE\ min}) \quad (2)$$

$$V_{EVSE\ intended,\ m,\ n} + \Delta V_{tol} \leq V_{EVSE\ max} \quad (3)$$

$$(V_{EVSE\ intended,\ m,\ n} + \Delta V_{tol}) \times I_{EVSE\ intended,\ m,\ n} \leq P_{EVSE\ max} \quad (4)$$

All equations (1) to (4), where applicable, shall be fulfilled for each $TP_{m,n}$. If any of the equations (1) to (4) is not fulfilled for certain values of m and/or n, $(I_{EVSE\ intended\ m,\ n} \mid V_{EVSE\ intended\ m,\ n})$ is *not* a test point $TP_{m,n}$.

Target values requested to set test point $TP_{m,n}$:

$$I_{EV\ target\ m,\ n} = I_{EVSE\ intended\ m,\ n} \quad (5)$$

$$V_{EV\ target\ m,\ n} = \min (P_{EVSE\ max} / I_{EV\ target\ m,\ n}\ ;\ V_{EVSE\ max}) \quad (6)$$

Configuration of the test bench for test point $TP_{m,n}$:

$$V1_n = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - \Delta V_{tol} - V_{EVSE\ min}) - (R1 + R2) \times I_{EVSE\ min} \quad (7)$$

with:

$$V1_n \geq 0\ V \quad (8)$$

If (7) results in $V1_n < 0$ V, $V1_n$ shall be set to $V1_n = 0$ V.

Calculations done continuously during for the measurement duration of each $TP_{m,\,n}$ (3 s):

Determine active output power:

$$P_{EVSE\ output\ m,n} = I_{EVSE\ output\ m,n} \times V_{EVSE\ output\ m,n} \qquad (9)$$

Determine the absolute static current deviation value of the 0 Hz component (that is pure d.c.) of the output current $I_{EVSE\ output\ m,n}$:

$$I_{dev\ abs\ m,n} = \left| I_{EVSE\ output\ m,n} - I_{EV\ target\ m,n} \right| \qquad \text{for } I_{EV\ target\ m,n} < 50\text{A} \qquad (10)$$

Determine the relative static current deviation value of the 0 Hz component (that is pure d.c.) of the output current $I_{EVSE\ output\ m,n}$:

$$I_{dev\ rel\ m,n} = \left| I_{EVSE\ output\ m,n} - I_{EV\ target\ m,n} \right| / I_{EV\ target\ m,n} \qquad \text{for } I_{EV\ target\ m,n} \geq 50\text{A} \qquad (11)$$

Determine the maximum amplitude value ($I_{rip\ low\ m,n}$) of all current ripple components of the output current $I_{EVSE\ output\ m,n}$ in the frequency band above 0 Hz and below 10 Hz

Determine the maximum amplitude value ($I_{rip\ mid\ m,n}$) of all current ripple components of the output current $I_{EVSE\ output\ m,n}$ in the frequency band above 0 Hz and below 5 kHz

Determine the maximum amplitude value ($I_{rip\ high\ m,n}$) of all current ripple components of the output current $I_{EVSE\ output\ m,n}$ in the frequency band above 0 Hz and below 150 kHz

Determine the absolute static current deviation value of the value measured by the d.c. electric vehicle supply equipment and transmitted via digital communication from the 0 Hz component (that is pure d.c.) of the output current $I_{EVSE\ output\ m,n}$:

$$I_{dev\ measure\ m,n} = \left| I_{EVSE\ measure\ m,n} - I_{EVSE\ output\ m,n} \right| \qquad (11a)$$

Determine necessary wait time:

for m = 0:

$T_{wait} = I_{EVSE\ min} / (20\ \text{A/s})$ for $I_{EVSE\ min} \geq 20$ A

$T_{wait} = 1$ s for $I_{EVSE\ min} < 20$ A

for m > 0:

$T_{wait} = \left| I_{EV\ target\ m,\,n} - I_{EVSE\ output\ m\text{-}1,\,n} \right| / (20\ \text{A/s})$ for $\left| I_{EV\ target\ m,\,n} - I_{EVSE\ output\ m\text{-}1,\,n} \right| \geq 20$ A

$T_{wait} = 1$ s for $\left| I_{EV\ target\ m,\,n} - I_{EVSE\ output\ m\text{-}1,\,n} \right| < 20$ A

Main actions to be performed:

The test points $TP_{m,\,n}$ shall be covered in sequences generated by two tested loops. The outer loop shall cover the index range of index n (n = 0 ... 20) and therefore step through the different values of the voltage V1. The inner loop shall cover the index range of index m (m = 0…20) and therefore step through the different values of the intended output current (“current-step-sequence”), taking into account the maximum output power of the d.c. electric vehicle supply equipment.

All equations (1) to (4), where applicable, shall be fulfilled for each $TP_{m,\,n}$, so for some values of n, the index range of the inner loop might not reach all values of m.

In each current-step-sequence, a series of current values (indicated by index m) for a constant value of V1, that is for a fixed value of index n, shall be used for the test.

Within each current-step-sequence (for example m = 0…20, n = 0, $TP_{0..mmax,\ 0}$), only the value of the current demand $I_{EV\ target\ m,\ n}$ shall be altered for the individual test points, the value of V1 shall remain constant (for example for n = 0: $V1_0$ to be used for $TP_{0…20,\ 0}$). After each current-step-sequence (that is after testing $TP_{20,\ n}$), the current demand $I_{EV\ target\ m,n}$ shall be set to 0 A and communicated to the electric vehicle supply equipment in order to stop the energy flow from the electric vehicle supply equipment. Then, index n shall be incremented by 1, that is V1 shall be adjusted to the voltage value of the following sequence (for example for n = 1: $V1_1$ to be used for $TP_{0...20,\ 1}$) and then the following current-step-sequence shall be started (for example m = 0…20, n = 1, $TP_{0…20,\ 1}$).

The following pseudo code structure shows the actions to be taken during the execution of this test case. Please refer to the equations above for information on the individual values.

Set n = 0

Start outer loop

Set $V1_n$

Set m = 0

Start inner loop (current-step-sequences)

Determine necessary wait time T_{wait}

Request target values to set test point $TP_{m,\ n}$ by sending the message "CurrentDemandReq" according to IS/ISO 15118

Wait for T_{wait}

Measure $I_{EVSE\ output\ m,\ n}$ and $V_{EVSE\ output\ m,n}$

Get $I_{EVSE\ measure\ m,n}$ from digital communication

Perform calculations to be done for each test point $TP_{m,n}$

Check if expected results are achieved

Increment m by 1

If m ≤ 20 and equations (1) to (5) are fulfilled, jump to beginning of inner loop

Request target value $I_{EV\ target}$ = 0 A by sending the message "CurrentDemandReq"

Wait for 1.1 × $I_{EVSE\ output\ m-1,n}$ / (100 A/s)

Increment n by 1

If n ≤ 20, jump to beginning of outer loop

End Test

NOTE– The slew rate of 100 A/s was chosen based on "**101.2.4** Descending rate of charging current". The factor 1.1 was chosen to provide an additional 10 percent margin.

Expected results

This test case is passed if each of the following test criteria is fulfilled for each tested $TP_{m,n}$:

$$V_{EVSE\ output\ m,n} > 0 \tag{12}$$

$$I_{EVSE\ output\ m,n} > 0 \tag{13}$$

$$P_{EVSE\ output\ m,n} \leq P_{EVSE\ max} \tag{14}$$

$$I_{rip\ low\ m,n} \leq 0.75A \tag{15}$$

$$I_{rip\ mid\ m,n} \leq 3A \tag{16}$$

$$I_{rip\ high\ m,n} \leq 4.5A \tag{17}$$

$$I_{dev\ measure\ m,n} \leq \max\ (0.5A \mid 0.015 \times I_{EVSE\ output\ m,n}) \tag{17a}$$

For $I_{EVSE\ target\ m,n} \leq 50A$ All calculated values for $I_{dev\ abs\ m,n} \leq 2.5A$	(18)
For $I_{EVSE\ target\ m,n} \geq 50A$ $I_{dev\ rel\ m,n} \leq 0.05$	(19)

B-9.3.12 *Output Voltage Regulation in CVC During Pre-Charging*

The compliance test is shown in Fig. 59 and Table 65.

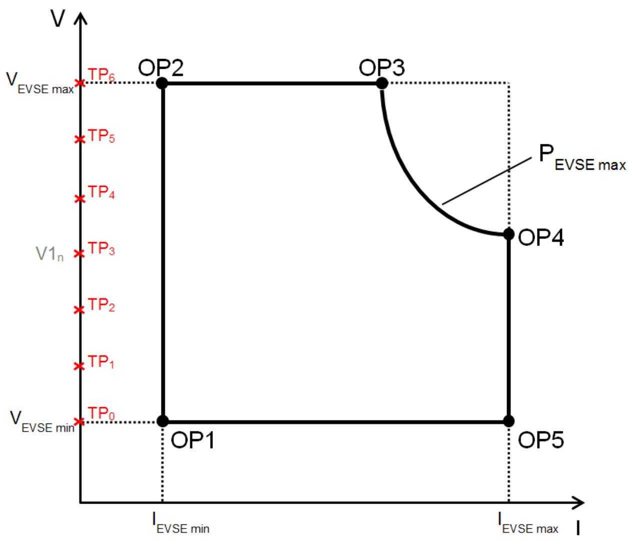


FIG. 59 TEST POINT GRID FOR OUTPUT VOLTAGE REGULATION IN CVC DURING PRE-CHARGING

Fig. 59 shows a simplified example of the test point grid with indices n = 0…6 in order to visualize the principal testing sequence of this test case. However, the test point sequence that shall actually be used for this test case shall cover indices n = 0 ... 20, with some additional restrictions as described below.

Table 65 - Compliance test for output voltage regulation in CVC during pre-charging and measurement accuracy

(*Clause* B-9.3.12)

Matching to requirement (chapter)	**101.2.2.2** Output voltage regulation in CVC **101.2.6** Periodic and random deviation **6.3.1.102** Measuring current and voltage
Short description	
Check if static voltage regulation during pre-charging fulfills the tolerance requirements. Check accuracy of voltage measurement.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the electric vehicle: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t6 according to Fig. 46.	

Test setup
Standard test setup, but S0 is open, additionally: Measure in the stationary phase for a duration of 3 seconds
Action(s)
In each test step, the EV-simulator shall issue current / voltage requests. The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters: EVtargetCurrent = $I_{EV\ target}$ EVtargetVoltage = $V_{EV\ target}$ For each step the following description uses index n. n: This consecutive index is used to identify the value of the voltage V1, respectively intended voltage or target voltage. Definition of test point grid TP_n: n = 0 ... 20 $TP_n = (I_{EVSE\ intended} \mid V_{EVSE\ intended\ m,\ n})$ with $I_{EVSE\ intended} = 0$ A (1) $V_{EVSE\ intended,\ n} = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - V_{EVSE\ min})$ (2) Calculations: Determine active output power $P_{EVSE\ output\ n} = I_{EVSE\ output\ n} \times V_{EVSE\ output\ n}$ (3) Determine the absolute static deviation $V_{dev\ abs\ n} = \lvert V_{EVSE\ output\ n} - V_{EV\ target\ n} \rvert$ (4) Determine the relative static voltage deviation $V_{dev\ rel\ n} = \lvert V_{EVSE\ output\ n} - V_{EV\ target\ n} \rvert / V_{EV\ target\ n}$ (5) Determine the peak voltage ripple $V_{rip\ n}$ up to a frequency of 150 kHz (see Figure 15) $V_{rip\ n}$ = peak value of $(V_{EVSE\ output\ rip\ n} - V_{EVSE\ output\ n})$ (6) Determine the absolute static voltage deviation value of the value measured by the d.c. electric vehicle supply equipment and transmitted via digital communication from the 0 Hz component (that is pure d.c.) of the output voltage $V_{EVSE\ output\ n}$: $V_{dev\ measure\ n} = \lvert V_{EVSE\ measure\ n} - V_{EVSE\ output\ n} \rvert$ (6a) Definitions: $T_{wait} = 7$ s NOTE: According to **B-2** the charge control communication shall comply with IS/ISO 15118. which specifies a pre-charge timeout of 7 s. Main actions to be performed: For each test point TP_n request $I_{EV\ target\ n}$ and $V_{EV\ target\ n}$ with the values as defined below. Wait for T_{wait} (see definition above) in order to reach steady state operation before measuring. Measure electric vehicle supply equipment output current $I_{EVSE\ output\ n}$ and output voltage $V_{EVSE\ output\ m,\ n}$. Get $V_{EVSE\ measure\ m,n}$ from digital communication

Target values requested to set test point TP_n:

$$V_{EV\ target\ n} = V_{EVSE\ intended\ n} \quad (7)$$

$$I_{EV\ target\ m,\ n} = 0\ A \quad (8)$$

Configuration of the EV-simulator for test point TP_n :

$V1_n = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - \Delta V_{tol} - V_{EVSE\ min}) - (R1 + R2) \times I_{EVSE\ min}$ (9)

with:

$V1_n \geq 0\ V$ (10)

NOTE If (9) results in $V1_n < 0$ V, $V1_n$ shall be set to $V1_n = 0$ V.

Expected results

This test case is passed if each of the following test criteria is fulfilled for each TP_n:

$V_{EVSE\ output\ n} > 0$ (11)

$I_{EVSE\ output\ n} = 0$ (12)

$\left| V_{EVSE\ output\ n} - V_{EV\ target\ n} \right| / V_{EV\ target\ n} \leq 0.05$ (13)

$\left| V_{EVSE\ output\ n} - V_{EV\ target\ n} \right| \leq 0.02 \times V_{EVSE\ max}$ (14)

$V_{rip\ n} \leq 5\ V$ (15)

$V_{dev\ measure\ n} \leq 10\ V$ (16)

B-9.3.13 *Control Delay of Charging Current in CCC*

The compliance test is shown in Fig. 60 and Table 66.

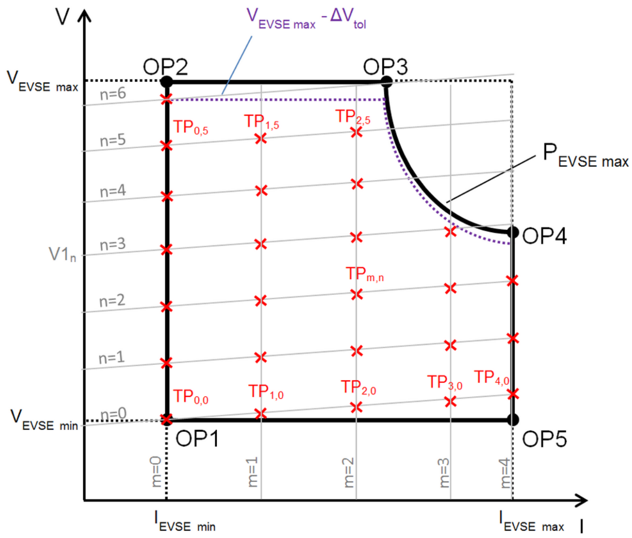


FIG. 60 TEST POINT GRID FOR CONTROL DELAY OF CHARGING CURRENT IN CCC

Fig. 60 shows a simplified example of the test point grid with indices m = 0…4 and n = 0…6 in order to visualize the principal testing sequence of this test case. However, the test point grid that shall actually be used for this test case shall cover indices m = 0 ... 20 and n = 0 ... 20, with some additional restrictions as described below.

The correlation between current and voltage is given by the following formula:

$V_{EVSE, m, n} = V1_n + (R1 + R2) \times I_{EVSE, m,n}$

Table 66 - Compliance test for control delay of charging current in CCC

(*Clause* B-9.3.13)

Matching to requirement (chapter)	**101.2.3** Control delay of charging current in CCC
Short description	
Check the control delay of the charging current in CCC for the largest possible change of the requested current.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): $EVTargetVoltage = V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup for d.c. charging EV-simulator, additionally: ● Determine the 0 Hz (i. e. pure d.c.) component of the EV supply equipment output current $I_{EVSE\ output\ m,\ n}$ at the point in time defined in the respective test step.	
Action(s)	
In the steps of this test case, certain properties of the electric vehicle supply equipment are tested at specific test points in the operating range of the electric vehicle supply equipment. The indices m and n are used as follows to refer to a specific test point $TP_{m,\ n}$: m: This consecutive index is used to identify the value of the intended current, or the target current, respectively. n: This consecutive index is used to identify the value of the voltage V1, or – together with index m – the intended voltage, respectively. The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters: $EVTargetCurrent = I_{EV\ target\ m,\ n}$ $EVTargetVoltage = V_{EV\ target\ m,\ n}$ Definition of test point grid $TP_{m,\ n}$: Indices range: m = 0 ... 2, n = 0 ... 20	

with:

$\Delta V_{tol} = 0.02 \times V_{EVSE\ max} + 5\ V$ derived from **101.2.2.2** and **101.2.6**

NOTE ΔV_{tol} is needed in order to achieve current regulation (CCC)

Test point $TP_{m,\ n} = (I_{EVSE\ intended\ m,\ n} \mid V_{EVSE\ intended\ m,\ n})$ with:

$I_{EVSE\ intended\ 0,\ n} = I_{EVSE\ min}$ for $m = 0$ (1)

$I_{EVSE\ intended\ 1,\ n} = \min (I_{EVSE\ max} ; I_{EVSE\ Pmax\ n})$ for $m = 1$ (2)

$I_{EVSE\ intended\ 2,\ n} = I_{EVSE\ min}$ for $m = 2$ (3)

$V_{EVSE\ intended\ m,\ n} = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - \Delta V_{tol} - V_{EVSE\ min}) + (R1 + R2) \times (I_{EVSE\ intended\ m,\ n} - I_{EVSE\ min})$ (4)

$V_{EVSE\ intended\ m,\ n} + \Delta V_{tol} \leq V_{EVSE\ max}$ (5)

$(V_{EVSE\ intended,\ m,\ n} + \Delta V_{tol}) \times I_{EVSE\ intended,\ m,\ n} \leq P_{EVSE\ max}$ (6)

For $m = 1$, $I_{EVSE\ intended\ 1,\ n} = I_{EVSE\ max}$ shall be used for all n = 0 ... n' as long as (4), (5), and (6) are fulfilled.

For m = 1 and n = n'+1 ... 20, $I_{EVSE\ intended\ 1,\ n} = I_{EVSE\ Pmax\ n}$ shall be used and $I_{EVSE\ Pmax\ n}$ shall be selected as large as possible such that (4), (5), and (6) are fulfilled, that is in particular:

$(V_{EVSE\ intended,\ 1,\ n} + \Delta V_{tol}) \times I_{EVSE\ Pmax\ n} = P_{EVSE\ max}$ (7)

All equations (1) to (6), where applicable, shall be fulfilled for each $TP_{m,\ n}$. If any of the equations (1) to (6) is not fulfilled for certain values of m and/or n, $(I_{EVSE\ intended\ m,\ n} \mid V_{EVSE\ intended\ m,\ n})$ is not a test point $TP_{m,\ n}$.

Target values requested to set test point $TP_{m,\ n}$:

$I_{EV\ target\ m,\ n} = I_{EVSE\ intended\ m,\ n}$ (8)

$V_{EV\ target\ m,\ n} = \min (P_{EVSE\ max} / I_{EV\ target\ m,\ n} ; V_{EVSE\ max})$ (9)

Configuration of the test bench for test point $TP_{m,\ n}$:

$V1_n = V_{EVSE\ min} + n/20 \times (V_{EVSE\ max} - \Delta V_{tol} - V_{EVSE\ min}) - (R1 + R2) \times I_{EVSE\ min}$ (10)

with:

$V1_n \geq 0\ V$ (11)

If (10) results in $V1_n < 0\ V$, $V1_n$ shall be set to $V1_n = 0\ V$

Calculations to be done for test point $TP_{m,\ n}$:

Determine active output power:

$P_{EVSE\ output\ m,\ n} = I_{EVSE\ output\ m,\ n} \times V_{EVSE\ output\ m,\ n}$

Determine absolute static current deviation of 0 Hz (i. e. pure d.c.) component:

$I_{dev\ abs\ m,\ n} = \left| I_{EVSE\ output\ m,\ n} - I_{EV\ target\ m,\ n} \right|$ for $I_{EV\ target\ m,\ n} < 50\ A$

Determine relative static current deviation of 0 Hz (i. e. pure d.c.) component:

$I_{dev\ rel\ m,\ n} = \left| I_{EVSE\ output\ m,\ n} - I_{EV\ target\ m,\ n} \right| / I_{EV\ target\ m,\ n}$ for $I_{EV\ target\ m,\ n} \geq 50\ A$

Determine necessary wait time:

for $m = 0$:

$T_{wait} = I_{EVSE\ min} / (20\ A/s)$ for $I_{EVSE\ min} \geq 20\ A$

T_{wait} = 1 s for $I_{EVSE\ min} < 20$ A

for m > 0:

$T_{wait} = |I_{EV\ target\ m,\ n} - I_{EVSE\ output\ m\text{-}1,\ n}|$ / (20 A/s) for $|I_{EV\ target\ m,\ n} - I_{EVSE\ output\ m\text{-}1,\ n}| \geq 20$ A

T_{wait} = 1 s for $|I_{EV\ target\ m,\ n} - I_{EVSE\ output\ m\text{-}1,\ n}| < 20$ A

Main actions to be performed:

In this test case, the electric vehicle supply equipment shall be tested at each test point $TP_{m,\ n}$ with m > 0. The test points $TP_{0,\ n}$ (that is m = 0) are only needed as starting points for the current change. The test points $TP_{m,\ n}$ shall be covered in sequences generated by two nested loops. The outer loop shall cover the index range of index n (n = 0 ... 20) and therefore step through the different values of the voltage V1. The inner loop shall cover the index range of index m (m = 0..2) and therefore alternate between the minimum and the maximum value of the intended output current ("current-step-sequence"), taking into account the maximum output power of the electric vehicle supply equipment. (All equations (1) to (6), where applicable, shall be fulfilled for each $TP_{m,\ n}$.)

In each current-step-sequence, a series of current values (indicated by index m) for a constant value of V1, that is for a fixed value of index n, shall be used for the test.

Within each current-step-sequence (for example m = 0..2, n = 0, $TP_{0..2,\ 0}$), only the value of the current demand $I_{EV\ target\ m,\ n}$ shall be altered for the individual test points, the value of V1 shall remain constant (for example for n = 0: $V1_0$ to be used for $TP_{0..2,\ 0}$). After each current-step-sequence (that is after testing $TP_{2,\ n}$), the current demand $I_{EV\ target}$ shall be set to 0 A and communicated to the electric vehicle supply equipment in order to stop the energy flow from the electric vehicle supply equipment. Then, index n shall be incremented by 1, that is V1 shall be adjusted to the voltage value of the following sequence (for example for n = 1: $V1_1$ to be used for $TP_{0..2,\ 1}$) and then the following current-step-sequence shall be started (for example m = 0..2, n = 1, $TP_{0..2,\ 1}$).

The following pseudo code structure shows the actions to be taken during the execution of this test case. Please refer to the equations above for information on the individual values.

Set n = 0

Start outer loop

Set $V1_n$

Set m = 0

Start inner loop (current-step-sequences)

Determine necessary wait time T_{wait}

Request target values to set test point $TP_{m,\ n}$ by sending the message "CurrentDemandReq" according to IS/ISO 15118

Wait for T_{wait}

Measure $I_{EVSE\ output\ m,\ n}$ and $V_{EVSE\ output\ m,\ n}$

If m > 0 Then

Perform calculations to be done for each test point $TP_{m,\ n}$

Check if expected results are achieved

End if

Increment m by 1

If m ≤ 2 and (5) is fulfilled, jump to beginning of inner loop

Request target value $I_{EV\ target}$ = 0 A by sending the message "CurrentDemandReq"

Wait for 1.1 × $I_{EVSE\ output\ m\text{-}1,\ n}$ / (100 A/s)

Increment n by 1

If n ≤ 20, jump to beginning of outer loop

End Test

NOTE The slew rate of 100 A/s was chosen based on "**101.2.4** Descending rate of charging current". The factor 1.1 was chosen to provide an additional 10percent margin.
Expected results
This test case is passed if each of the following test criteria is fulfilled for each $TP_{m,n}$: $V_{EVSE\ output\ m,n} > 0$ (10) $I_{EVSE\ output\ m,n} > 0$ (11) $P_{EVSE\ output\ m,n} \leq P_{EVSE\ max}$ (12) For $I_{EV\ target\ m,n} < 50$ A: $I_{dev\ abs\ m,n} \leq 2.5$ A (16) For $I_{EV\ target\ m,n} \geq 50$ A: $I_{dev\ rel\ m,n} \leq 0.05$ (17)

B-9.3.14 *Descending Rate of Charging Current*

The compliance test is shown in Fig. 61 and Table 67.

Table 67 - Compliance test for descending rate of charging current
(*Clause* B-9.3.14)

Matching to requirement (chapter)	**101.2.4** Descending rate of charging current
Short description	
Check the descending rate of the charging current in CCC.	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t9 according to Fig. 46, including the message "PowerDeliveryReq" (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters "EVTargetVoltage" in message "PreChargeReq" (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup	
Action(s)	
In each test step, the EV-simulator shall issue current requests and, if applicable voltage requests.	

The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters:

EVTargetCurrent = $I_{EV\ target\ m,\ n}$

EVTargetVoltage = $V_{EV\ target\ m,\ n}$

1) Set:

$V1_n = V_{EV\ target\ m,\ n} - (R1 + R2) \times I_{EVSE\ min}$

if $V_{EV\ target\ m,\ n} - (R1+R2) \times I_{EVSE\ min} \geq 0$

2) Send (message CurrentDemandReq according to IS/ISO 15118): :

$I_{EV\ target\ m,\ n} = I_{EVSE\ max}$

$V_{EV\ target\ m,\ n} = \min (P_{EVSE\ max} / I_{EV\ target\ m,\ n}\ ;\ V_{EVSE\ max}) - \Delta V_{tol}$

3) Wait for T_{wait} (see definition below) in order to reach steady state operation

$T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$

4) Measure $I_{EVSE\ output}$,store value as “$I_{EVSE\ output,1}$”

5) Send $I_{EV\ target\ m,\ n} = I_{EVSE\ min}$ and start timer (timestamp t_1)

6) If $I_{EVSE\ output} \leq I_{EVSE\ min} + \Delta I_{tol}$:

Measure $I_{EVSE\ output}$,store value as “$I_{EVSE\ output,2}$” and stop timer (timestamp t_2)

Expected results

This test case is passed if the following test criteria is fulfilled:

$((I_{EVSE\ output,\ 1} - I_{EVSE\ output,\ 2})/(100\ A/s)) \geq (t_2 - t_1)$,

with $(t_2 - t_1)$ = time elapsed between start and stop of the timer.

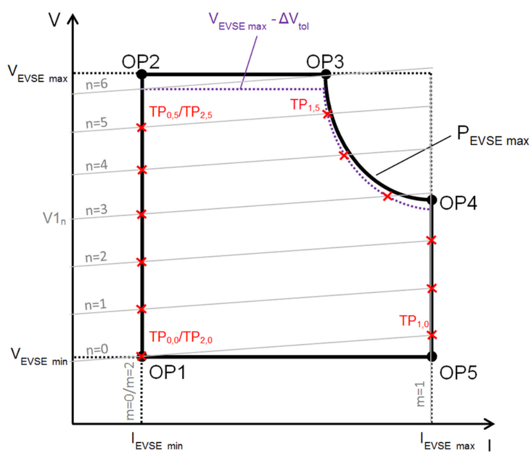


FIG. 61 TEST POINT GRID FOR DESCENDING RATE OF CHARGING CURRENT

Fig. 61 shows a simplified example of the test point grid with indices m = 0 ... 2 and n = 0 ... 6 in order to visualize the principal testing sequence of this test case. However, the test point grid that shall actually be used for this test case shall cover indices m = 0 ... 2 and n = 0 ... 20, with some additional restrictions as described below.

The correlation between current and voltage is given by the following formula:

$$V_{EVSE\ m,\ n} = V1_n + (R1 + R2) \times I_{EVSE\ m,\ n}$$

B-9.3.15 Insulation Checks

B-9.3.15.1 I*nsulation checks before pre-charge (cable check)*

The compliance test is shown in Table 68.

Table 68 - Compliance test for insulation check to detect low insulation resistance before pre-charge

(*Clause* B-9.3.15.1)

Matching to requirement (chapter)	**B-4.1.3** Cable check
Short description	
Reaction on low insulation resistance condition	
Pre-conditions	
– Insulation monitoring device according **B-4.1** IT (isolated terra) system requirements	
Test setup	
1.Symmetrical test: Two test resistors with each R = 99.5 kΩ 2.Asymmetrical test for failure between DC+ and PE: Test resistor R = 99.5 kΩ 3.Asymmetrical test for failure between DC- and PE: Test resistor R = 99.5 kΩ NOTE – The requirement requests an insulation resistance of ≥ 100 kΩ. Therefore the injected fault condition should be close to the limit (--> 99.5 kΩ).	
Action(s)	
This test case shall be executed in single steps as indicated below: 1a) Connect test resistors between DC+ and PE as well as DC- and PE 1b) The charging sequence shall be done until t = t4 (according to Fig. 46) 1c) The EV-simulator shall issue a pre-charge request (that is “PrechargeReq” according to IS/ISO 15118) with EVTargetVoltage = $V_{EV\ target}$ = $V_{EVSE\ min.}$ 2a) Connect test resistor between DC+ and PE 2b) The charging sequence shall be done until t = t4 (according to Fig. 46) 2c) The EV-simulator shall issue a pre-charge request (that is “PrechargeReq” according to IS/ISO 15118) with EVTargetVoltage = $V_{EV\ target}$ = $V_{EVSE\ min}$. 3a) Connect test resistor between DC- and PE 3b) The charging sequence shall be done until t = t4 (according to Fig. 46) 3c) The EV-simulator shall issue a pre-charge request (that is “PrechargeReq” according to IS/ISO 15118) with EVTargetVoltage = $V_{EV\ target}$ = $V_{EVSE\ min}$.	
Expected results	
At t = t4 according to Fig. 46 (reception of CableCheckRes with parameter EVSEProcessing equal to "Finished"): ● The EVSE shall have turned off the CP oscillator. ● $V_{EVSE\ output}$ shall be ≤ 60 V at t = t4 (according to Fig. 46) + 1 s	

B-9.3.15.2 *Insulation check to detect fault state*

The compliance test is shown in Table 69 and Table 70.

Table 69 - Compliance test for insulation check to detect fault state during charging
(*Clause* B-9.3.15.2)

Matching to requirement (chapter)	**B-4.1.4** Insulation monitoring during charging
Short description	
Reaction on low insulation resistance condition (R ≤ 100 Ω/V) during current demand phase	
Pre-conditions	
The EVSE has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Figure 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} – (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$ Insulation monitoring device according **B-4.1** IT (isolated terra) system requirements	
Test setup	
Standard test setup 1. Configuration for symmetrical test: Two test resistors with each R = 99.5 kΩ 2.Configuration for 1st asymmetrical test for fault between DC+ and PE: Test resistor R = 99.5 kΩ 3.Configuration for 2nd asymmetrical test for fault between DC- and PE: Test resistor R = 99.5 kΩ NOTE The requirement requests an insulation resistance of ≥ 100 kΩ. Therefore the injected fault condition should be close to the limit (--> 99.5 kΩ).	
Action(s)	
The complete sequence of test steps shall be executed with all three resistor configurations as described in the test setup (symmetrical and asymmetrical). The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters: **EVtargetCurrent =** $I_{EV\ target}$ **EVtargetVoltage =** $V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax}$ If $V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax} \geq 0$	

2) Send $V_{EV\ target} = \min (P_{EVSE\ max} / I_{EVSE\ max}; V_{EVSE\ max})$ $I_{EV\ target} = I_{EVSE\ max}$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring. $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$ 4) Connect test resistors according to the respective configuration. The maximum error shutdown time $t_{shutdown}$ is defined as follows: $t_{shutdown} = t_{trigger} + t_{perform} = 11$ s after occurrence of insulation fault with: $t_{trigger} = 10$ s $t_{perform} = 1$ s
Expected results

Table 70 - Compliance test 2 for self-test after fault state
(*Clause* B-9.3.15.2)

Matching to requirement (chapter)	**B-4.1** IT (isolated terra) system requirements
Short description	
Reaction on self test after emergency shutdown due to low insulation resistance condition ($R \leq 100\ \Omega/V$). The insulation fault condition shall be removed before self test starts.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t8 according to Figure 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): $EVTargetVoltage = V_{EV\ target} = V_{EVSE\ min}$ Insulation monitoring device according **B-4.1** IT (isolated terra) system requirements	
Test setup	
Standard test setup 1. Configuration for symmetrical test: Two test resistors with each $R = 99\ \Omega/V \times V_{EVSE\ max}$ 2.Configuration for 1^{st} asymmetrical test for fault between DC+ and PE: Test resistor $R = 99\ \Omega//V \times V_{EVSE\ max}$ 3.Configuration for 2^{nd} asymmetrical test for fault between DC- and PE: Test resistor $R = 99\ \Omega/V \times V_{EVSE\ max}$ NOTE–The requirement requests an insulation resistance of $\geq 100\ \Omega/V$. Therefore the injected fault	

condition should be close to the limit (--> 99 Ω/V).
Action(s)
The complete sequence of test steps shall be executed with all three resistor configurations as described in the test setup (symmetrical and asymmetrical). The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters: EVtargetCurrent = $I_{EV\ target}$ EVtargetVoltage = $V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax}$ If $V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax} \geq 0$ V 2) Send $V_{EV\ target} = \min (P_{EVSE\ max} / I_{EVSE\ max};\ V_{EVSE\ max})$ $I_{EV\ target} = I_{EVSE\ max}$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring. $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$ 4) Connect test resistors according to the respective configuration. 5) Wait until EV supply equipment has turned off CP oscillator. 6) Disconnect test resistors. 7) Change CP state to state A, wait for 1 min (to allow the station to perform a self test) and change CP state to state B. 8) Set $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax}$ If $V_{EVSE\ min} - (R1+R2) \times I_{EVSEmax} < 0$ V then set V1 = 0 V 9) Send $V_{EV\ target} = \min (P_{EVSE\ max} / I_{EVSE\ max};\ V_{EVSE\ max})$ $I_{EV\ target} = I_{EVSE\ max}$ 10) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring. $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$
Expected results
The charging sequence shall be successfully done until t=t9 according to Fig. 46, that is energy transfer in steady state.

B-9.3.16 *Short-Circuit between CP and PE*

The compliance test is shown in Table 71.

Table 71 - Compliance test for short-circuit between CP and PE

(*Clause* B-9.3.16)

Matching to requirement (chapter)	Table 2 (state DC-E)
Short description	
Check if d.c. electric vehicle supply equipment will perform an emergency shutdown in case of: Short circuit between CP and PE	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t9 according to Fig. 46, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} – (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup, additionally relay to short circuit CP and PE	
Action(s)	
The EV-simulator shall issue current requests and, if applicable voltage requests. The message “CurrentDemandReq” according to IS/ISO 15118 shall contain the following parameters: EVTargetCurrent = $I_{EV\ target}$ EVTargetVoltage = $V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set: $V1 = V_{EVSE\ min} – (R1+R2) \times I_{EVSE\ max}$ If $V_{EVSE\ min} – (R1+R2) \times I_{EVSE\ max} \geq 0$ V 2) Send: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = \min (P_{EVSE\ max}/I_{EVSE\ max}; V_{EVSE\ max})$	

3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20\ A/s$ 4) Close relay between CP and PE
Expected results
After 1 s the output current of the d.c. electric vehicle supply equipment ($I_{electric\ vehicleSE\ output}$) shall be < 5 A

B-9.3.17 *Short-Circuit and Overcurrent Protection During Charging*

The compliance test is shown in Table 72.

Table 72 – Compliance test for short-circuit and overcurrent protection
(*Clause* B-9.3.17)

Matching to requirement (chapter)	**13.101** Short-circuit protection of the d.c. connection **B-6.6** Overcurrent protection of the d.c. connection

Short description

Reaction on over-current condition caused by external or internal faults

Pre-conditions

The electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator:

$V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$

The charging sequence shall be successfully done until t=t9 according to Fig. 46, including the message "PowerDeliveryReq" (according to IS/ISO 15118), with the following values used during precharging:

$V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$

and

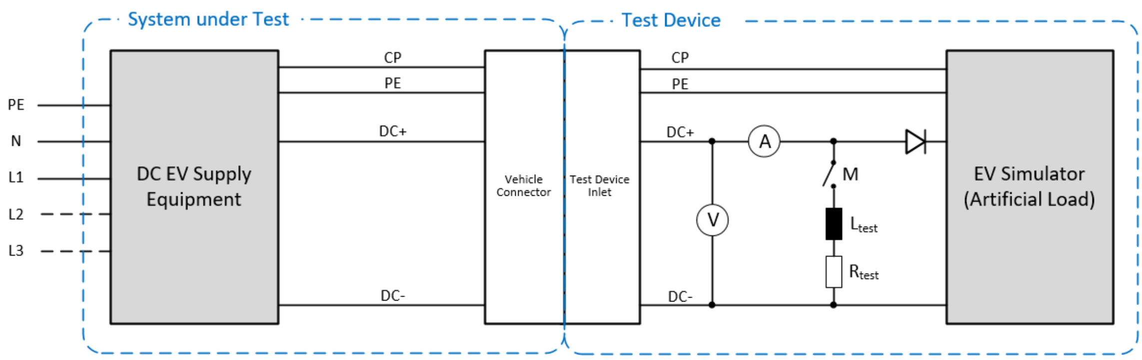
$V1 = 0\ V$ if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$

and the parameters "EVTargetVoltage" in message "PreChargeReq" (according to IS/ISO 15118)

EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$

Test setup

The following figure shows a test setup with additional means to create over-current conditions (fault insertion).



The test device shall be configurable with following characteristics:

	Resistance R_{test}	Inductance L_{test}
Configuration 1	10 mΩ ± 15 percent	$2\ \mu H \leq L_{test} \leq 5\ \mu H$
Configuration 2	100 mΩ ± 10 percent	$2\ \mu H \leq L_{test} \leq 5\ \mu H$
Configuration 3	250 mΩ ± 10 percent	$2\ \mu H \leq L_{test} \leq 5\ \mu H$

R_{test} is the resistance of the short-circuit loop of the test device. It shall be measured between the DC+ and DC- contact of the test device inlet at a frequency of f_{meas} = 1 kHz (EV-simulator disconnected).

L_{test} is the inductance of the short-circuit loop of the test device. It shall be measured between the DC+ and DC- contact of the test device inlet at a frequency of f_{meas} = 1 kHz (EV-simulator disconnected).

The bandwidth of the current and voltage measurement shall be at least 500 kHz.

Contact bouncing of the switching device M shall be avoided by selecting an appropriate switching device.

Action(s)
This test case shall be executed in single steps as indicated below. In each test step, the EV-simulator shall issue current / voltage requests (that is "CurrentDemandReq" in case of PLC communication according to IS/SO 15118) with the parameter as given in the list below: EVtargetCurrent = $I_{EV\ target}$ EVtargetVoltage = $V_{EV\ target}$ Main actions to be performed for all test points: For each test point TP conduct three single tests using the settings 1, 2 and 3 of the test device as specified in the test setup. 1. Set V1 to the values as defined below. 2. For each test point TP request $I_{EV\ target}$ and $V_{EV\ target}$ with the values as defined below. 3. Wait until steady state operation is reached 4. Close switch M. 5. Measure and log EV supply equipment output current $I_{EVSE\ output}$ and output voltage $V_{EVSE\ output}$ from the point in time when switch M is closed until the point in time when the d.c. EV supply equipment has shut down. 6. Open switch M Calculations: Determine $$\sum_n i_n{}^2 \Delta t_{sample}$$ from the point in time when switch M is closed until the point in time when the d.c. electric vehicle supply equipment has shut down. Target values requested to set test points: Step 1: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = P_{EVSE\ max} / I_{EVSE\ max}$ Step 2: $I_{EV\ target} = P_{EVSE\ max} / V_{EVSE\ max}$ $V_{EV\ target} = V_{EVSE\ max}$ Configuration of the test bench for all steps: $V1 = V_{EV\ target} - (R1 + R2) \times I_{EV\ target}$ with $V1 \geq 0$ V
Expected results
- Short-circuit peak current ≤ 10 kA. - $\sum_n i_n{}^2 \Delta t_{sample} \leq 1\ 000\ 000\ A^2s$ - d.c. output current drops below 5 A within 1.03 s after closing of switch M.

B-9.3.18 *Test of Measured Voltage Values During Welding Detection*

The compliance test is shown in Table 73.

Table 73 - Compliance test for measured voltage values during welding detection

(*Clause* B-9.3.18)

Matching to requirement (chapter)	Table 46 - Sequence description for normal shutdown (t106--> t107) **B-6.5** Measuring current and voltage
Short description	
Check if the voltage values measured by the d.c. electric vehicle supply equipment and transferred via digital communication are correct.	
Pre-conditions	
The d.c. electric vehicle supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t105 according to Fig. 47, including the message “PowerDeliveryReq” (according to IS/ISO 15118), with the following values used during precharging and current demand: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters “EVTargetVoltage” in message “PreChargeReq” and “CurrentDemandReq” (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup	
Action(s)	
1) a. set: $V1 = V_{EVSE\ min}$ b. send: WeldingDetectionReq (according to IS/ISO 15118) c. receive WeldingDetectionRes d. compare received value “EVSEPresentVoltage” with V1 2) a. set: $V1 = V_{EVSE\ max} - (V_{EVSE\ max} - V_{EVSE\ min})/2$ b. send: WeldingDetectionReq (according to IS/ISO 15118) c. receive WeldingDetectionRes d. compare received value “EVSEPresentVoltage” with V1 3) a. set: $V1 = V_{EVSE\ max}$ b. send: WeldingDetectionReq (according to IS/ISO 15118)	

c. receive WeldingDetectionRes d. compare received value "EVSEPresentVoltage" with V1
Expected results
All received values for "EVSEPresentVoltage" > 0; $\lvert V1 - EVSEPresentVoltage \rvert \leq 10$ V

B-9.3.19 *User Initiated Shutdown*

The compliance test is shown in Table 74.

Table 74 - Compliance test for user initiated shutdown

(*Clause* B-9.3.19)

Matching to requirement (chapter)	**6.3.1.110** User initiated shutdown
Short description	
Check if d.c. EV supply equipment performs an user initiated shut down.	
Pre-conditions	
The EV supply equipment has successfully transmitted its following properties to the EV-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t9 according to Figure 46, including the message "PowerDeliveryReq" (according to IS/ISO 15118), with the following values used during precharging: $V1 = V_{EVSE\ min} - (R1 + R2) \times I_{EVSE\ min}$ if $V_{EVSE\ min} \geq (R1 + R2) \times I_{EVSE\ min}$ and: $V1 = 0$ V if $V_{EVSE\ min} < (R1 + R2) \times I_{EVSE\ min}$ and the parameters "EVTargetVoltage" in message "PreChargeReq" (according to IS/ISO 15118): EVTargetVoltage = $V_{EV\ target} = V_{EVSE\ min}$	
Test setup	
Standard test setup	
Action(s)	
The EV-simulator shall issue current requests and, if applicable voltage requests. The message "CurrentDemandReq" according to IS/ISO 15118 shall contain the following parameters: EVTargetCurrent = $I_{EV\ target}$ EVTargetVoltage = $V_{EV\ target}$ Definition of intended test point (OP5): $I_{EVSE\ intended} = I_{EVSE\ max}$ $V_{EVSE\ intended} = V_{EVSE\ min}$ 1) Set: $V1 = V_{EVSE\ min} - (R1+R2) \times I_{EVSE\ max}$	

If $V_{EVSE\ min} – (R1+R2) \times I_{EVSE\ max} \geq 0$ V 2) Send: $I_{EV\ target} = I_{EVSE\ max}$ $V_{EV\ target} = \min (P_{EVSE\ max}/I_{EVSE\ max}; V_{EVSE\ max})$ 3) Wait for T_{wait} (see definition below) in order to reach steady state operation before measuring $T_{wait} = 2\ s + 1.1 \times I_{EVSE\ max} / 20$ A/s 4) Activate the customer means to shut down the charging process.
Expected results
electric vehicle supply equipment sends a "CurrentDemandRes" containing the parameter "EVSEStatusCode = EVSE_Shutdown"

B-9.3.20 *Short Circuit Test Before Charging*

The compliance test is shown in Table 75.

Table 75 - Compliance test for short circuit test before charging

(*Clause* B-9.3.20)

Matching Requirement (Chapter)	**6.3.1.109** Short circuit check before charging
Short description	
Reaction on short circuit between DC+/DC- before charging.	
Pre-conditions	
The electric vehicle supply equipment has successfully transmitted its following properties to the electric vehicle-simulator: $V_{EVSE\ min}$, $V_{EVSE\ max}$, $I_{EVSE\ min}$, $I_{EVSE\ max}$, $P_{EVSE\ max}$ The charging sequence shall be successfully done until t=t4 according to Fig. 46.	
Test setup	
Standard test setup with additional contactor to short circuit DC+/DC-	
Action(s)	
1) Close the contactor between DC+ and DC- 2) The EV-simulator shall perform the Cable Check sequence (that is send "CableCheckReq" according to IS/ISO 15118).	
Expected results	
● The electric vehicle supply equipment shall turn off the CP oscillator.	

ANNEX C
(*Clause* 1 *and* Annex A)

BI-DIRECTIONAL POWER FLOW CONTROL

C-1 GENERAL

This annex provides basic information on the functional requirements for bi-directional power flow between the d.c. electric vehicle charging/discharging station and the electric vehicle. An example of block diagram of bi-directional power flow system is shown in Fig. 62.

In bi-directional power flow, the electric current flows in the opposite direction to that of the charging process that is power is delivered from the electric vehicle battery to electrical loads and/or the a.c. power grid connected to the supply network.

Although the direction of the current flow is reversed, the system architecture and the hardware interface/connection to the vehicle of the d.c. electric vehicle discharing/charging station are identical to that of the d.c. electric vehicle supply equipment, with some difference in the installed components, the reverse-current protection diode in the d.c. output circuit of the electric vehicle supply equipment, if any, has to be replaced by a pre-charge circuit, otherwise a dedicated d.c./a.c. inverter circuit with its own pre-charge circuit needs to be provided separately in addition to the existing a.c./d.c. converter circuit.

Another important aspect of the birectional power flow is the ability of the d.c. electric vehicle charging/discharging station to switch between charging and discharging mode or to remain idle that is stop the current flow, anytime during the charging/discharging session. This can be achieved by the implementation of the two operation modes as described in **C-2**.

The requirements for grid-connection including bi-directional inverter are provided in IEC 62909-1.

FIG. 62 EXAMPLE OF BLOCK DIAGRAM OF BI-DIRECTIONAL POWER FLOW SYSTEM

C-2 CHARGING/DISCHARGING MODE

In addition to the requirements in **6.3.1** which defines the electric vehicle charging in mode 4, the following operation modes can be applied to the d.c. electric vehicle charging/discharging station (*see* Fig. 63):

a) Electric vehicle charging/discharging dynamic mode

In this mode, the electric vehicle and the d.c. electric vehicle charging/discharging station will exchange information about voltage, current and/or power limits before and during the sequence through digital communication.

The d.c. electric vehicle charging/discharging station will deliver current to the electric vehicle or draw current from the electric vehicle within the limits communicated and inform the electric vehicle about the actual voltage and current during the sequence.

The two processes (charging and discharging) can be switched over seamlessly anytime that is without transferring to shutdown sequence.

b) Electric vehicle charging/discharging scheduled mode

In this mode, the d.c. electric vehicle charging/discharging station will propose charging/discharging schedules to the electric vehicle and the electric vehicle will communicate back a charging/discharging profile to the d.c. electric vehicle charging/discharging station. This profile will always stay within the voltage, current and/ or power limits communicated by both sides before charging.

During the sequence, the d.c. electric vehicle supply equipment will deliver current to the electric vehicle or draw current from the electric vehicle in respect to the charging/discharging profile communicated and will always inform the electric vehicle about the actual voltage and current during the sequence.

The two processes (charging and discharging) can be switched over seamlessly anytime that is without transferring to shutdown sequence.

c) electric vehicle discharging mode

This mode can exist independently from charging mode if the d.c. electric vehicle charging/discharging station or equipment is specifically designed for electric vehicle discharging, for example a portable Vehicle-to-Load (V2L) power supply.

FIG. 63 EV CHARGING AND DISCHARGING MODES

ANNEX D
(*Clause* 1)

TYPICAL D.C. CHARGING SYSTEMS

This annex shows typical diagrams and configuration of d.c. EV charging systems.

Examples of typical isolated system, non-isolated system, simplified isolated system and d.c. supply network system are shown in Fig. 64, Fig.65, Fig.66 and Fig.67.

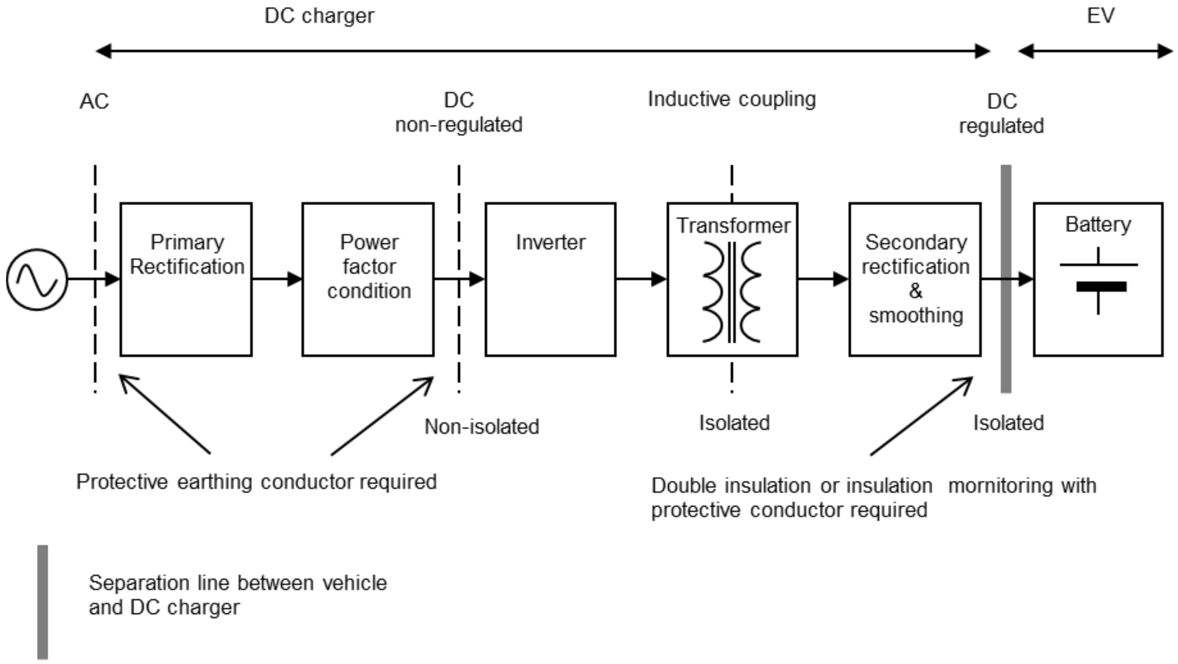


FIG. 64 EXAMPLE OF TYPICAL ISOLATED SYSTEM

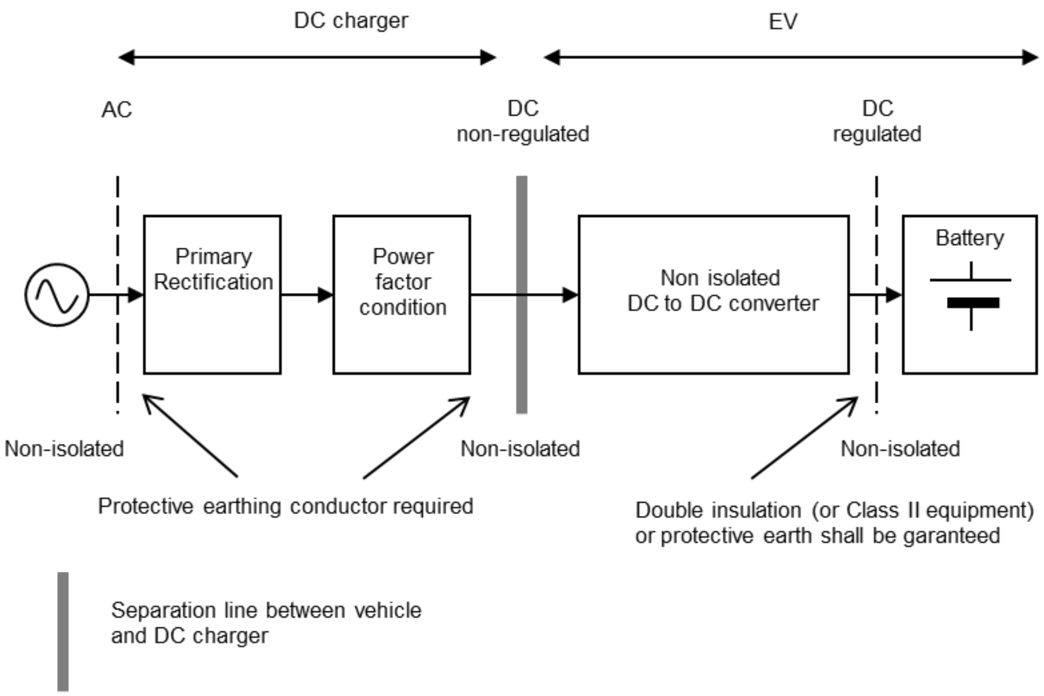


FIG. 65 EXAMPLE OF TYPICAL NON-ISOLATED SYSTEM

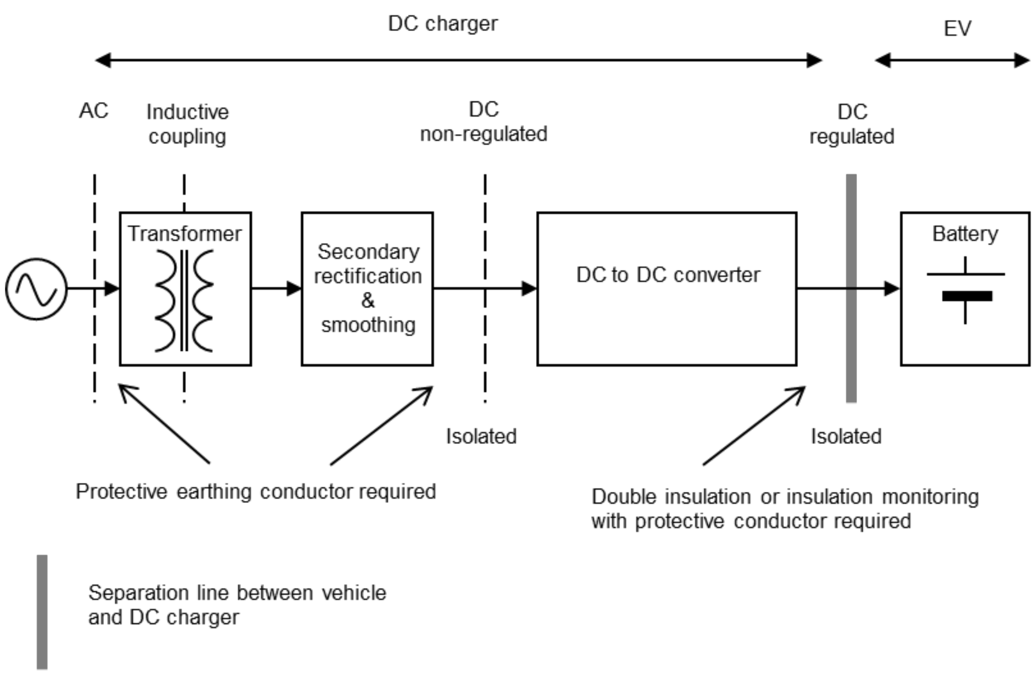


FIG. 66 EXAMPLE OF SIMPLIFIED ISOLATED SYSTEM

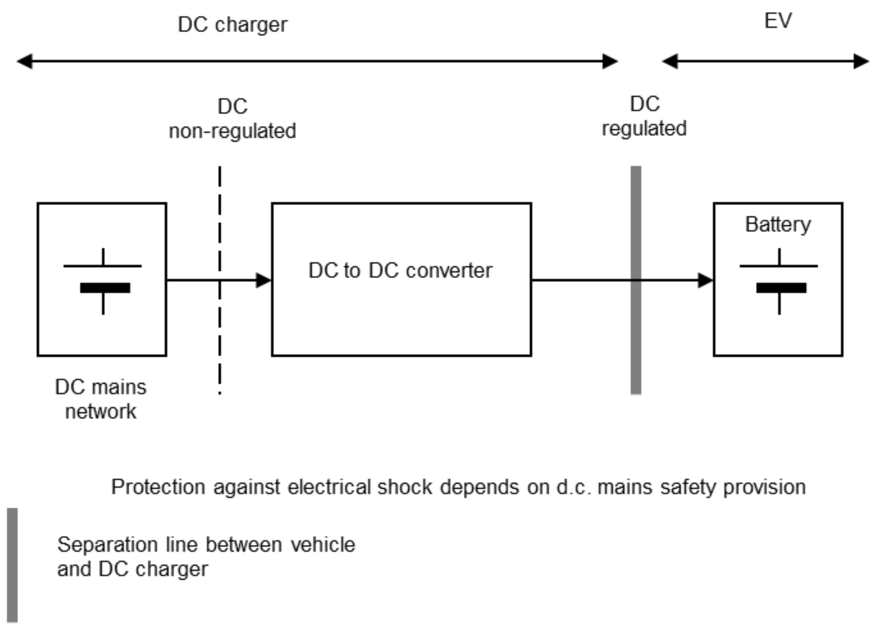
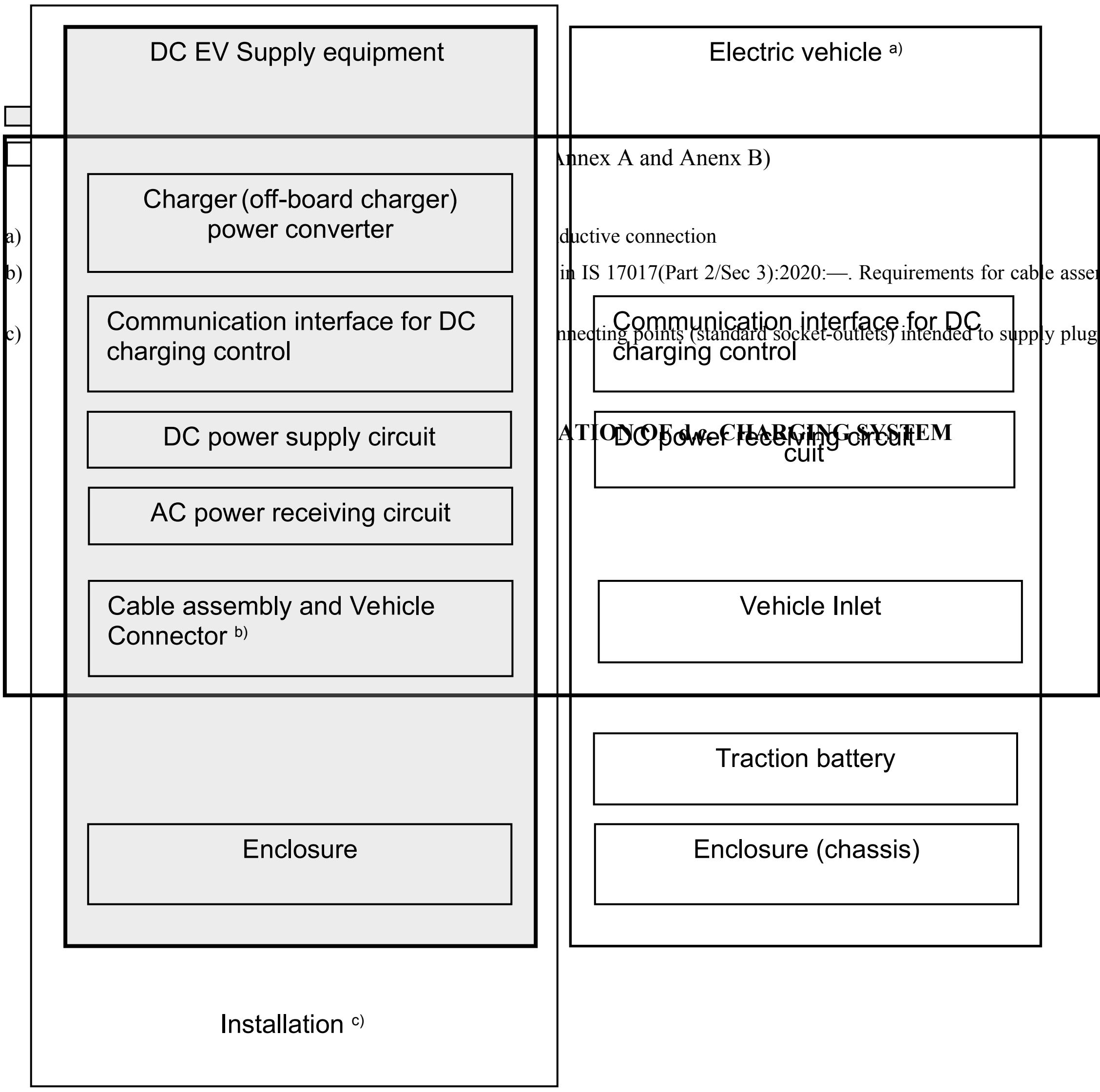


FIG. 67 EXAMPLE OF d.c. SUPPLY NETWORK SYSTEM

Fig. 68 shows the typical configuration of d.c. charging system.



Annex A and Anenx B)

a) ductive connection

b) in IS 17017(Part 2/Sec 3):2020:—. Requirements for cable assemblies are

c) nnecting points (standard socket-outlets) intended to supply plug and cable

ATION OF d.c. CHARGING SYSTEM

ANNEX E
(*Clause* 101.3)

MULTIOUTLET (A.C./D.C. ISOLATED) D.C. EV SUPPLY EQUIPMENT

E-1 GENERAL

This annex provides specific requirements for d.c. charging by using a multi-outlet d.c. EV supply equipment. Multi-outlet d.c. electric vehicle supply equipments are d.c. electric vehicle supply equipment with two or more d.c. connecting points. As a part of the d.c. electric vehicle supply equipment, all general requirements for d.c. electric vehicle supply equipments in the body text of this document also apply to the multi-outlet d.c. electric vehicle supply equipment unless otherwise specified in this annex.

E-2 CLASSIFICATION AND USE CASE OF MULTI-OUTLET d.c. EV SUPPLY EQUIPMENT

E-2.1 System Operation

a) Multi-outlet d.c. electric vehicle supply equipment with non-simultaneous operation; and
b) Multi-outlet d.c. electric vehicle supply equipment with simultaneous operation.

E-2.2 Output System

a) Multi-System A;
b) Multi-System C ; and
c) System A and System C.

E-2.3 Configuration

a) Multi-outlet d.c. electric vehicle supply equipment with single power unit; and
b) Multi-outlet d.c. electric vehicle supply equipment with multiple (two or more) power units.

The possible combinations for multi-outlet d.c. electric vehicle supply equipments with respect to the classification are shown in Table 76.

Table 76 - The possible combinations for multi-outlet d.c. electric vehicle supply equipments
(*Clause* E-2.3)

Use case							Configuration				Schematic
System operation		Output system					Power unit		galvanic isolation		
Non-simultaneous	Simultaneous	A	B	C	A & B	A & C	Single	multiple	primary	secondary	
x		x					x				
x			x				x				
x				x			x		x		7
x					x		x				
x						x	x				
x		x						x			
x			x					x			
x				x				x	x		10
x					x			x			
x						x		x			
x		x						x			
x			x					x			
x				x				x	x		9, 12
x					x			x			
x						x		x			
x		x						x			
x			x					x			
x				x				x	x		8, 11
x					x			x			
x						x		x			
x	x	x						x			
x	x		x					x			
x	x			x				x		x	3, 6
x	x				x			x			
x	x					x		x			
x		x						x			
x			x					x			
x				x				x		x	2, 5
x					x			x			
x						x		x			
x		x						x			
x			x					x			
x				x				x		x	1, 4
x					x			x			
x						x		x			
x	x	x						x			
x	x		x					x			
x	x			x				x	x	x	13
x	x				x			x			
x	x					x		x			

Examples of system schematics for the use cases derived from Table 76 are shown in Table 77.

Table 77 - Example of system schematic for each use case (1 of 4)
(*Clause* E-2.3)

Table 77 (2 of 4)
(*Clause* E-2.3)

Table 77 (3 of 4)
(*Clause*E.2.3)

Table 77 (4 of 4)
(*Clause* E-2.3)

E-3 CONSTRUCTIONAL REQUIREMENTS

E-3.1 Constructional Requirements of d.c. Output System

The d.c. output system shall be equipped with a vehicle connector according to IS 17017(Part 2/Sec 3) and a non-detachable charging cable.

A storage means according to Clause **11.7** shall be provided for all vehicle connectors when not in use. The maximum cable length shall be in accordance with national codes. Clearance and creepage distance of contactors in open state shall be at least basic insulation.

The d.c. output system shall also be equipped with a mechanical disconnection device such as relay/contactor. The device shall be installed in each of the positive and negative power line of the d.c. output circuit of the supply equipment, and be capable of disconnecting the power line of the d.c. electric vehicle supply equipment from the electric vehicle when the system is operating under the maximum rated charging current in simultaneous operation.

E-3.1.1 *Constructional Requirements of d.c. Output System According to Annex A*

The d.c. output system shall be equipped with a vehicle connector according to IS 17017(Part 2/Sec 3), configuration AA. To ensure proper functionality, the d.c. output system shall be equipped with the necessary hardware for communication and power transmission (for example CAN transceiver, resistors, switches, contactors), according to Annex A, Fig. 28 and Fig. 29. System A output circuits shall be equipped with contactors on d.c. output.

E-3.1.2 *Constructional Requirements of d.c. Output System According to Annex B*

The d.c. output system shall be equipped with a vehicle connector according to IS 17017(Part 2/Sec 3), configuration FF. To ensure proper functionality, the d.c. output system shall be equipped with the necessary hardware for communication and power transmission (for example PWM oscillator, PLC chip, contactors), according to Annex B, Fig. 54 and Fig. A-1 of IS 17017(Part 1):2018.

E-4 D.C. OUTPUT SYSTEM PERFORMANCE

E-4.1 General Performance Requirements

The output systems shall be System A–System C or both System A and C. The d.c. output performance shall comply with the requirements in the body text of this document and with the requirements in the applicable annexes. If two or more outputs can be used simultaneously, mutual interference shall not occur.

E-4.2 Performance of Multi-Outlet d.c. EV Supply Equipments Providing Simultaneous Operation

If the sum of the rated powers of each output circuit exceeds the power rating of the multi-outlet d.c. EV supply equipment, the manufacturer has to specify the possibilities of power distribution in the user´s manual (for example priority charging or evenly distributed power on each output circuit).

E-5 SAFETY REQUIREMENTS

E-5.1 General Safety Requirements

The protective conductor in each charging cable of the multi-outlet d.c. electric vehicle supply equipment shall be connected to a common protective earthing conductor.

All output circuits shall be individually equipped with a means of insulation monitoring or d.c. leakage current monitoring, between d.c. power conductor and enclosure of d.c. EV supply equipment, as specified in Annex A or C. Y capacitance at the output terminal of each output circuit shall comply with the requirement in **8.105.1**.

The reaction time of an IMD shall not be influenced during simultaneous operation with an earth leakage current measuring device or other insulation monitoring device.

Circuit components including devices used for isolation shall be rated for the maximum voltage including all specified tolerances of the power output circuits taking into account both normal and single insulation fault.

E-5.2 Short-Circuit Protection

Each connecting point of a multi-outlet d.c. EV charging shall have individual short-circuit protection means. Such means shall comply with the requirement of respective output system given in **13.101**.

E-5.3 Overload Protection

Each connecting point of a multi-outlet d.c. electric vehicle supply equipment shall individually provide overload protection according to **13.2**.

E-5.4 Access to Energized Part Through Unmated Vehicle Connector During Charge

During charge, conductor connected to the accessible unmated vehicle connector shall be isolated by basic or reinforced insulation from the energized d.c. output.

If isolation is achieved by basic insulation, the energy or voltage between a contact of unmated vehicle connector and earth shall be less than or equal to 0.5 mJ or 28 V d.c. continuously in normal operation and after 1 s under a first fault.

Requirement for the insulation barrier specified in **8.105.3** shall be applied to each d.c. output circuit.

E-5.5 Additional Safety Requirements for Multi-Outlet d.c. EV Supply Equipments Providing Simultaneous Operation

If the output systems are equipped with switch components, such as contactors, measures shall be taken to prevent unintended electrical connection of vehicles caused by the failure of switch component. These measures shall prevent the short circuit between batteries of different vehicles. The protection can be achieved by one or combination of the following measures:

a) Allocation of diode to each output circuit. The diode shall be installed between switch component and output terminal of each outlet;
b) Allocation of fuse to the circuit equipped with switch component; and
c) Electrical or mechanical interlock of contactors for preventing simultaneous closure.

If a fault is detected in one output circuit, the multi-outlet d.c. EV supply equipment shall terminate the supply of charging current in all output circuits.

E-5.6 Diagnostic Check of Mechanical Disconnection Device in d.c. Output System

The multi-outlet d.c. electric vehicle supply equipment shall perform the diagnostic check of the mechanical disconnection device installed in the d.c. output system to prevent unexpected power flow from a vehicle to the d.c. electric vehicle supply equipment, or between the two or more vehicles simultaneously connected to the d.c. electric vehicle supply equipment in case the mechanical disconnection device is welded (ON stuck) , and to prevent hazardous voltage at the unmated vehicle connector.

As the minimum requirement, the diagnostic shall check the welding (ON stuck) of the mechanical disconnection device. Diagnostic checks of other failures such as OFF stuck and erratic actuation are not mandatory but still recommended.

If the diagnostic check is performed before the start of charging and the ON stuck failure is detected, the charging process shall be terminated and the system shall transfer to shutdown sequence

If the diagnostic check is performed after the completion of a single charging event and the ON stuck failure is detected, the d.c. electric vehicle supply equipment shall prohibit further charging events until the mechanical disconnection device is properly replaced or repaired.

E-5.7 Safety Requirements for Multi-Outlet d.c. Electric Vehicle Supply Equipments with Shared d.c.-

Under consideration

ANNEX F
(*Clauses* 6.3.1.104 *and* 7.1)

COMMUNICATION AND CHARGING PROCESS BETWEEN d.c. ELECTRIC VEHICLE SUPPLY EQUIPMENT AND ELECTRIC VEHICLE

F-1 DIGITAL COMMUNICATION BETWEEN THE EV SUPPLY EQUIPMENT AND THE ELECTRIC VEHICLE

F-1.1 General

This Annex F provides the general information on the communication and charging process between d.c. electric vehicle supply equipment and electric vehicle.

The requirements of digital communication of charging control between d.c. electric vehicle supply equipment and electric vehicle are defined in IS 17017(Part 24).

Electric vehicles are equipped with propulsion batteries with different technologies and voltage. Accordingly, the charging process is managed by the vehicle in order to ensure the charging of different types of on-board energy storage systems.

Electric vehicles are equipped with VCCF for charging process management. The d.c. electric vehicle supply equipments have a means allowing the vehicles to control the charging parameters of d.c. electric vehicle supply equipment.

F-1.2 System Configuration

The communication between the d.c. electric vehicle supply equipment and the vehicle can be established via basic communication and high level communications.

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

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

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

F-1.3 Charging Control Process and State

F-1.3.1 *General*

Charging control process of d.c. electric vehicle supply equipments consists of the following three stages:

a) process before the start of charging (initialization): Initialization includes pre-charge if required. Pre-charge is the final stage of initialization.;
b) process during charging (energy transfer); and
c) process of shutdown (shutdown).

The d.c. electric vehicle supply equipment and the vehicle synchronize control process with each other. The following signals and information are used for the synchronization:

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

The d.c. electric vehicle supply equipment and the vehicle preserve specified time constraints and control timings for ensuring smooth charging control and operation.

Charging sequence diagrams are system specific and described in Annex A and Annex B. Digital communication parameters, formats, and other communication requirements are specified in IS 17017(Part 24).

F-1.3.2 *Description of the Process before the Start of Charging (Initialization)*

In this process, the vehicle and the d.c. electric vehicle supply equipment exchange their operational limitations and relevant parameters for charging control. Messages, such as the voltage limit, maximum charging current, etc. are also transferred to each other. Circuit voltage is measured for checking whether the batteries and the d.c. electric vehicle supply equipment are connected before the start of charging and whether the batteries and the d.c. electric vehicle supply equipment are disconnected after the end of charging. The d.c. electric vehicle supply equipment is not to proceed with the next stage of charging process unless it verifies the compatibility with the vehicle. After compatibility check, the d.c. electric vehicle supply equipment conducts the insulation check between the d.c. power lines and the enclosures, including vehicle chassis. The vehicle connector is latched before the insulation check.

F-1.3.3 *Description of the Process During Charging (Energy Transfer)*

In this process, the vehicle continues to send a setting value of charging current or voltage to the d.c. electric vehicle supply equipment throughout charging process. Either of the following two algorithms is taken.

a) CCC
1) The vehicle battery can be charged using CCC with the vehicle as master and the d.c. electric vehicle supply equipment as slave;
2) The d.c. electric vehicle supply equipment receives the charging current value the vehicle requested (command value), throughout the charging control process;
3) The d.c. electric vehicle supply equipment sets the command value as control target, and regulate the d.c. charging current;
4) The command value from the vehicle is notified to the d.c. electric vehicle supply equipment at regular intervals according to the system requirements; and
5) The d.c. electric vehicle supply equipment regulates the d.c. charging current responding to the change of command value of the vehicle.

b) CVC

1) The vehicle battery can be charged using CVC with the vehicle as master and the d.c. electric vehicle supply equipment as slave.;
2) The d.c. electric vehicle supply equipment receives the charging voltage value the vehicle requested (command value) throughout the charging process;
3) The d.c. electric vehicle supply equipment sets the command value as control target, and regulate the d.c. charging voltage;
4) The command value from the vehicle is notified to the d.c. electric vehicle supply equipment at regular intervals according to the system requirements; and
5) The d.c. electric vehicle supply equipment regulates the d.c. charging voltage responding to the change of command value of the vehicle.

F-1.3.4 *Description of Process of Normal Shutdown*

After completion of the charging session, the normal shutdown phase allows the d.c. electric vehicle supply equipment to return to the conditions prior to charging. When the vehicle or d.c. electric vehicle supply equipment indicates the end of charging, the d.c. electric vehicle supply equipment reduces the charge current to zero. The vehicle side contactors open at near zero current. The d.c. electric vehicle supply equipment or the vehicle unlatches the vehicle connector only if the voltage at the inlet between DC+ and DC- is less than 60 V d.c. (*see* **6.3.1.107**).

ANNEX G

(*Foreword*)

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Electrotechnology in Mobility Sectional Committee, ETD 51

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Member Secretary

MS. SHIKHA GOYAL

Scientist C, BIS

IS 17017 (Part 24) :2021

भारतीय मानक

विद्युतीय वाहन चालकता चार्जिंग पद्धति
भाग 24 डी सी चार्जिंग के नियंत्रण के लिए विद्युतीय वाहन एवं विद्युतीय वाहन प्रदाय उपकरण के बीच अंकीय संचार

Indian Standard

Electric Vehicle Conductive Charging Systems
Part 24 Digital Communication between a DC Electric Vehicle Supply Equipment and an Electric Vehicle for control of DC Charging

ICS 43.120

B U R E A U O F I N D I A N S T A N D A R D S
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

……….2021 **Price Group.....**

CONTENTS

Electrotechnology in Mobility Sectional Committee, ETD 51

NATIONAL FOREWORD

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

This standard provides guidance to Industry for setting up charging stations and to the electric vehicle manufactures to prepare the vehicles to charge the batteries, from these charging stations.

Considerable assistance has been obtained from IEC 61851-24 Edition 2 CDV while preparing this standard. This standard corresponds to the requirements of IEC 61851-24 Edition 2 CDV in the requirements it contains, but certain modifications have been done in relation to the cross referred standards, included content, and ambient conditions.

The cross references of IEC have been modified to refer Indian Standards wherever 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 committee had agreed to inclusion of System A and System C defined in IEC standards, and as such the references to other types and systems have not been retained in this edition. The notation of using commas for separation of decimals has been replaced by the decimal point as followed in India. Notes related to other countries are not retained. The ambient temperature has been modified, and system voltages aligned as per IS 12360.

This standard is to be read in conjunction with IS 17017(Part 23).

The composition of the committee responsible for formulation of this standard is given at Annex D.

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 : 1960 ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

ELECTRIC VEHICLE CONDUCTIVE CHARGING SYSTEM –

PART 24 : DIGITAL COMMUNICATION BETWEEN A DC ELECTRIC VEHICLE SUPPLY EQUIPMENT AND AN ELECTRIC VEHICLE FOR CONTROL OF DC CHARGING

1 Scope

This standard applies to digital communication between a DC EV supply equipment and an electric road vehicle (EV) for control of conductive DC power transfer, with a rated supply voltage up to 1 000 V AC or up to 1 500 V DC and a rated output voltage up to 1 500 V DC.

This part also applies to digital communication between the DC EV charging/discharging station and the EV for System A, as specified in Annex A.

The EV charging mode specified is mode 4, according to IS 17017(Part 23).

Annex A and Annex C give descriptions of digital communications for control of DC charging specific to DC EV charging system A and system C as defined in IS 17017(Part 23).

2 Normative references

This clause of Part 23 is applicable except as follows:

Addition:

ISO 11898-1:2003	Road vehicles – Controller area network (CAN) – Part 1: Data link layer and physical signaling
ISO 11898-2:2003	Road vehicles - Controller area network (CAN) - Part 2: High-speed medium access unit
ISO 15118-1	Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition
ISO 15118-2	Road vehicles – Vehicle to grid communication interface – Part 2: Network and application protocol requirements
ISO 15118-3	Road vehicles – Vehicle to grid communication interface – Part 3: Physical and data link layer requirements

3 Terms and definitions

This clause of Part 23 is applicable except as follows:

Addition:

3.101
digital communication
digitally encoded information exchanged between a DC EV supply equipment and an EV, as well as the method by which it is exchanged.

3.102

parameter

single piece of information relevant to charging control, and that is exchanged between a DC EV supply equipment and an EV using a form of digital communication

3.103

signal

a data element that is communicated between a DC EV supply equipment and an EV using any means other than digital communication

4 System configuration

The system configuration shall be in accordance with **F-1.2** of IS 17017(Part -23):2021.

5 Digital communication architecture

In this document, two digital communication architectures are used:

– based on CAN using a dedicated data communication circuit; CAN protocol is given in ISO 11898-1. Refer to Annex A for specific implementation details.

– based on Homeplug® Green PHY™ (*see* IEEE 1901) over the control pilot line; refer to Annex C for specific implementation details.

6 Charging control process

F-1.3 of 17017(Part 23):2021 provides general information on the charging process and the state of DC EV supply equipment.

Specific requirements of charging process are given in **A-4** and **A-6.3** for System A and **B-3** for System C of 17017(Part 23):2021 respectively.

7 Overview of charging control

The digital communication of DC charging control covered by this standard is as shown in Fig. 1. This document does not cover the control protocol internal to the DC EV supply equipment, nor the vehicle, such as power control protocol for AC/DC inverter of DC EV supply equipment and battery management control in the vehicle.

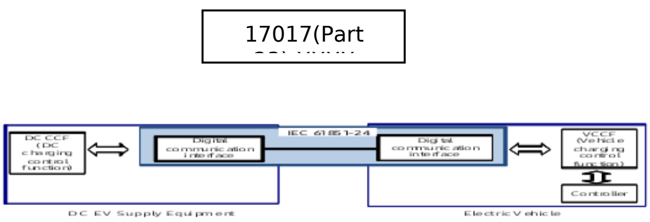


FIG. 1 – DIGITAL COMMUNICATION BETWEEN A DC EV SUPPLY EQUIPMENT AND AN ELECTRIC VEHICLE FOR CONTROL OF DC CHARGING

8 Exchanged information for DC charging control

This clause describes information which shall be exchanged between a DC EV supply equipment and a vehicle during the charging process according to 17017(Part 23).The information in Table 1 is common to all systems described in Annex A and Annex C. Each information listed in Table 1 is defined as a parameter in each annex. Each system may need additional parameters, and these parameters are defined in each annex.

Table 1 Exchanged Information for DC Charging Control

(*Clause* 8)

No.	Information	Description	Relevant requirement in 17017(Part 23):2021
a-1	Current request for the controlled current charging (CCC) system	Exchange of current value requested by EV	**6.3.1.101**
a-2	Voltage request for the controlled voltage charging (CVC) system	Exchange of voltage value requested by EV	
a-3	Maximum rated voltage of DC EV supply equipment	Exchange of maximum rated voltage value of DC EV supply equipment	**6. 3.1.101** **6. 3.1.104**
a-4	Maximum rated current of DC EV supply equipment	Exchange of maximum rated current value of DC EV supply equipment	**6. 3.1.101** **6. 3.1.104**
b-1	Communication protocol	Exchange of software version of a charging system	**6. 3.1.104** **6. 3.1.106**
b-2	Maximum voltage limit of EV	Exchange of maximum voltage limit value of vehicle.	
b-3	EV minimum current limit, only for the controlled voltage charging (CVC) system	Under consideration	
b-4	Implementation of optional control function	Exchange information about available optional function, such as high current control and dynamic control.	**6.3.1.104** **6.3.2.102**
c	Insulation check result	Exchange of the result of insulation check before charging - If insulation check fails, a signal is sent that charging is not allowed.	**6. 3.1.105**
d	Short circuit test before charging	Exchange of information on short circuit test before charging	**6.3.1.109**
e	Charging stopped by user	Exchange of information on charge stop command by the user of DC EV supply equipment	**6.3.1.110**
f	EV supply equipment real time available load current (optional)	Exchange of EV supply equipment real time available load current for demand management. Required for system providing that function.	**6.3.2.102**
g	Loss of digital communication	Detection of loss of digital communication - If a receiver does not get information expected to receive within time out period, it is considered as loss of digital communication.	**9.101**
h-1	Zero current confirmed	Notification of zero current confirmed - Station informs EV that low current condition has been met (to allow the opening and welding check of EV contactors by EV)	**6.3.1.107** **F-1.3.4**
h-2	Welding detection	Exchange of information on the whole process of welding detection	
i-1	Normal shutdown	Termination of the charging process not caused by a failure	**6.3.1.115**
i-2	Error shutdown	Termination of the charging process caused by a failure	**6.3.1.116**

ANNEX A
(*normative*)

DIGITAL COMMUNICATION FOR CONTROL OF DC EV CHARGING SYSTEM A

A-1 GENERAL

This annex shows the specification of digital communication for control of the DC EV supply equipment of system A (in this annex, referred to as "System A station" or "station") as specified in Annex A of IS 17017(Part 23): 2021. More detailed information on System A is defined in IEEE 2030.1.1.

This annex is also applicable to the DC EV charging/discharging station of System A.

A-2 DIGITAL COMMUNICATION ACTIONS DURING CHARGING CONTROL PROCESS

The communication actions and parameters according to the charging control process as defined in Table 31 of IS 17017(Part 23):2021 are shown in Table A.1.

Table A.1 Communication Actions And Parameters during DC Charging Control Process between System A Station and Vehicle

Charging control stage		State	High level action at system level a	Digital communication action	Parameter	
					From DC EV supply equipment	From vehicle
Initialization	Handshaking	DC-A	Vehicle unconnected	None	N/A	N/A
		DC-B1	Connector plugged in	None	N/A	N/A
		DC-B1	Wake up of DCCCF and VCCF	None	None	(default CAN)
			Communication data initialization	Preparation for digital communication	(default CAN)	(default CAN)
		DC-B1→DC-B2	Communication established, parameters exchanged, and compatibility checked	Exchange of charging control parameters	– Control protocol number – Available output voltage – Available output current – Battery incompatibility – Energizing state – Identifier of welding detection – Threshold voltage – Charging stop control	– Control protocol number – Total capacity of battery – Maximum battery voltage – Maximum charging time – Target battery voltage – Vehicle charging enabled – Minimum charge current – Estimated charging time – Vehicle status – Charged rate
	Charge preparation	DC-B2 →DC-B3	Connector latched	Notification of state of charging progress	– Energizing state	None
		DC-B3	Insulation check for DC power line	None	– Charging system error	None
		DC-B3	Pre-charge (depending on the system architecture)	N/A	N/A	N/A

Table A.1 *(Continued)*

Charging control stage	State	High level action at system levela	Digital communication action	Parameter	
				From DC EV supply equipment	From vehicle
Energy transfer	DC-C or DC-D	Vehicle side contactors closed	Notification of vehicle main contactor closed status	None	– Vehicle status
	DC-C or DC-D	Charging by current demand (for CCC)	Notification of request value of charging current (or voltage)	– Station status – Output voltage – Output current – Remaining charging time – Station error – Charging system error – Charging stop control	– Charging current request – Charging system error – Parking status of the vehicle
	DC-C or DC-D	Charging by voltage demand (for CVC)	N/A	N/A	N/A
	DC-C,(D) →DC-B'1	Current suppression	Request of energy transfer shut-off	– Station status – Charging stop control – Output voltage – Output current	- Vehicle charging enabled
Shutdown (case 1)	DC-B'1	Zero current confirmed	Notification of energy transfer shut-off	– Station status – Charging system error	
	DC-B'1→ DC-B'2	Welding detection (by vehicle)		None	None
	DC-B'2	Vehicle side contactors open	None	None	– Vehicle status
	DC-B'2	DC power line voltage verification	Notification of present voltage	- Output voltage - Energizing state	None
	DC-B'3	Connector unlatched	Notification of connector unlatch status	None	None
	DC-B'4	End of charge at communication level	Terminate the digital communication	None	None
	DC-A	Connector unplugged		N/A	N/A

Table A.1 *(concluded)*

Charging control stage	State	High level action at system levela	Digital communication action	Parameter	
				From DC EV supply equipment	From vehicle
Shutdown (case 2)	DC-B’1	Zero current confirmed	Notification of energy transfer shut-off	– Station status – Charging system error	
	DC-B’1→ DC-B’2	Welding detection (by vehicle)		None	None
	DC-B’2	Vehicle side contactors open	None	None	- Vehicle status
	DC-B’2	DC power line voltage verification	Notification of present voltage	- Output voltage - Energizing state	None
	DC-B’3-1	Connector remain latched	Notification of connector unlatch status	None	None
	DC-B’4-1	End of charge at communication level	Terminate the digital communication	None	None
	DC-B’4-2	Connector unlatched or remain latched		N/A	N/A
	DC-A or DC-B1	Connector unplugged or remain plugged in		N/A	N/A

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

A-3 DIGITAL COMMUNICATION OF DC CHARGING CONTROL

The parameters for digital communication of DC charging control shall be exchanged according to the sequence diagram as shown in Fig. A.1.

NOTE−For symbols, see Table 17 of IS 17017(Part 23):2021

FIG. A.1 SEQUENCE DIAGRAM OF DC CHARGING CONTROL COMMUNICATION FOR SYSTEM A

A-4 PARAMETER DEFINITION

The definition of parameters during DC charging control process are shown in Table A.2 and Table A.3. Table A.2 and Table A.3 include the mandatory parameters and the optional parameters. The optional parameters are applied to the optional charging functions, such as dynamic control (see **A-7.3** of IS 17017(Part 23):2021) and charging with thermal management system (see **A-9** of IS 17017(Part 23):2021). The optional charging functions may be used when the station and the vehicle confirm the availability, specification and compatibility of functions by exchanging the optional parameters each other.

Table A.2 Exchanged Parameter during DC Charging Control Process from Vehicle to System A Station

CAN ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
100	100	8	0	0-7	Minimum charging current	The minimum current value to conduct charging.	U	A	1	0	0	254	a-1	—
			1-3	0-7	—	—	—	—	—	—	—	—	—	—
			4	0-7	Maximum battery voltage	The maximum voltage value at the vehicle inlet terminals, at which the station stops charging to protect the vehicle battery	U	V	1		0	1200	b-2	—
			5	0-7										
			6	0-7	Constant of charging rate indication	Fixed value for charging rate indication, which is the maximum charging rate (100 %) of vehicle battery	U	-	1	100	0	255	b-2	—
			7	0-7	—	—	—	—	—	—	—	—	—	—
101	100	8	0	0-7	—	—	—	—	—	—	—	—	—	—
			1	0-7	Maximum charging time (set by 10 s)	Maximum charging time permitted by EV, set by 10 s	U	s	10	0	0	2540	b-2	—
			2	0-7	Maximum charging time (set by 1 min)	Maximum charging time permitted by EV, set by minute	U	min	1	0	0	255	b-2	—
			3	0-7	Estimated charging time (set by 1 min)	Estimated remaining time before the end of charging calculated by EV	U	min	1		0	254	b-2	—
			4	0-7	—	—	—	—	—	—	—	—	—	—
			5	0-7	Rated capacity of battery	Rated capacity of battery	U	kWh	0.1		0	6553.5	b-2	—
			6											
			7	0-7	—	—	—	—	—	—	—	—	—	—

Table A.2 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table1	Status flag
102	100	8	0	0-7	Control protocol number	Software version of control sequence to which EV corresponds	U	—	1		0	255	b-1	—
			1	0-7	Target battery voltage	Targeted charging voltage at the vehicle inlet terminals	U	V	1		0	1200	b-2	—
			2	0-7										
			3	0-7	Charging current request	Current value requested by EV during charging	U	A	1	0	0	200	a-1	—
			4	0	Battery overvoltage	Status flag indicating whether or not the vehicle battery voltage exceeds the maximum limit specified by EV	—	—	1	0	0	1	i-2	0: normal 1: fault
				1	Battery undervoltage	Status flag indicating whether or not the vehicle battery voltage is less than the lower limit specified by EV	—	—	1	0	0	1	i-2	0: normal 1: fault
				2	Battery current deviation error	Status flag indicating whether or not the output current deviates from EV requested current	—	—	1	0	0	1	i-2	0: normal 1: fault
				3	High battery temperature	Status flag indicating whether or not the temperature of vehicle battery exceeds the maximum limit	—	—	1	0	0	1	i-2	0: normal 1: fault
				4	Battery voltage deviation error	Status flag indicating whether or not the vehicle battery voltage deviates from the output voltage measured by the station	—	—	1	0	0	1	i-2	0: normal 1: fault
				5-7	—	—	—	—	—	—	—	—	—	—

Table A.2 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
102	100	8	5	0	Vehicle charging enabled	Status flag indicating charge permission status of EV	—	—	1	0	0	1	i-1	0: disabled 1: enabled
				1	Parking status of the vehicle	Status flag indicating the parking status of the vehicle	—	—	1	0	0	1	i-1	0: vehicle in parking position 1: vehicle not in parking position
				2	Charging system error	Status flag indicating a malfunction caused by EV or the station, and detected by EV	—	—	1	0	0	1	i-2	0: normal 1: fault
				3	Vehicle status	Status flag indicating the EV contactor status	—	—	1	1	0	1	h-2	0: EV contactor closed or during welding detection 1: EV contactor open or welding detection finished
				4	Normal stop request before charging	Status flag indicating the request of EV to stop charging control	—	—	1	0	0	1	i-1	0: no request 1: request to stop
				5-7	—	—	—	—	—	—	—	—	—	—
			6	0-7	Charging rate	Charging rate of battery	U	%	1		0	100	a-1	—
			7	0-7	—	—	—	—	—	—	—	—	—	—

Table A.2 *(concluded)*

Optional parameters														
ID (H')	**Period (ms)**	**DLC**	**Byte**	**Bit**	**Parameter**	**Content**	**Signed or Unsigned**	**Unit**	**LSB**	**Initial**	**Min**	**Max**	**Item in Table1**	**Status flag**
100	100	8	2 3	0-7	Minimum battery voltage	The minimum voltage value at the vehicle inlet terminals, at which the station stops discharging to protect the vehicle battery.	U	V	1		0	1200	b-2	-
110	100	8	0	0	Dynamic control	Flag indicating vehicle that is compatible with dynamic control.	-		1	0	0	1		0: Incompatible 1: Compatible
				1	High current control	Flag indicating vehicle that is compatible with high current control.	-		1	0	0	1		0: Incompatible 1: Compatible
				2	High voltage control	Flag indicating vehicle that is compatible with high voltage control.	-		1	0	0	1		0: Incompatible 1: compatible
				2-7	-	-	-	-	-	-	-	-	-	-
			1-2	0-7	Request charging current (extended)	Current value that vehicle requests the station during charging.	U	A	1	0	0	1023	a-1	-
			3-7	0-7	-	-	-	-	-	-	-	-	-	-
700	100	8	0	0-7	EV manufacturer code	Number assigned for each EV manufacturer using the option code.	-		1		0	255		-
			1-7	0-7	Option code	Data area exchanged between EV supply equipment and EV for specific control or function defined by the EV manufacturer	-	-	-	-	-	-		-

Key

DLC: Data length code

U: Unsigned

LSB: Least significant bit

Table A.3 Exchanged Parameter during DC Charging Control Process from System A Station to Vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
108	100	8	0	0-7	Identifier of welding detection	Identifier indicating whether or not the station deals with EV contactor welding detection	—	—	1		0	255	h-2	0: not supporting vehicle welding detection 1 or more: supporting vehicle welding detection
			1	0-7	Available output voltage	Maximum output voltage value at the vehicle connector terminals	U	V	1		0	1200	a-3	—
			2	0-7										
			3	0-7	Available output current	Maximum output current value of the station	U	A	1		0	255	a-4	—
			4	0-7	Threshold voltage	Threshold voltage to stop the charging process in order to protect vehicle battery	U	V	1		0	1200	b-2	—
			5	0-7										
			6-7	0-7	—	—	—	—	—	—	—	—	—	—
109	100	8	0	0-7	Control protocol number	Software version number of control protocol or charging sequences that the station deals with	U	—	1		0	255	b-1	—
			1	0-7	Output voltage	Supply voltage value of the output circuit in the station	U	V	1	0	0	1200	b-1	—
			2	0-7										
			3	0-7	Output current	Supply current value of the output circuit in the station	U	A	1	0	0	255	b-1	—
			4	0-7	—	—	—	—	—	—	—	—	—	—

Table A.3 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content		Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
109	100	8	5	0	Station status	Status flag indicating the energy transfer from the station		—	—	1	0	0	1	ch-1	0: standby 1: charging
				1	Station malfunction	Status flag indicating whether or not there is a malfunction caused by the station		—	—	1	0	0	1	ch-1	0: normal 1: fault
				2	Energizing state	Status flag indicating a state in which voltage can be applied from the station or a state in which output charging is permitted		—	—	1	0	0	1	ch-1	0: disable 1: enable
				3	Battery incompatibility	Status flag indicating the compatibility of vehicle battery with the output voltage of station		—	—	1	0	0	1	ch-1	0: compatible 1: incompatible
				4	Charging system error	Status flag indicating whether or not there is a problem with EV, such as improper connection		—	—	1	0	0	1	d	0: normal 1: malfunction
				5	Charging stop control	Status flag indicating whether or not the station proceeds with shutdown process		—	—	1	0	0	1	e	0: operating, 1: shutdown or stop charging
				6-7	—	—		—	—	—	—	—	—	—	—
			6	0-7	Remaining charging time (counted by 10 s)	Remaining time before the end of charging (counted by 10 s)		U	s	10		0	2540	b-1	—
			7	0-7	Remaining charging time (counted by min)	Remaining time before the end of charging (counted by min)		U	min	1		0	255	b-1	—

Table A.3 *(continued)*

Optional parameters

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
118	100	8	0	1	High current control	Flag indicating station that is compatible with high current control.	-		1	0	0	1		0: Incompatible 1: compatible
				2	High voltage control	Flag indicating station that is compatible with high voltage control.	-		1	0	0	1		0: Incompatible 1: compatible
			0	0	Dynamic control	Flag indicating station that is compatible with dynamic control.	-		1	0	0	1		0: Incompatible 1: Compatible
			1-2	0-7	Available output current (extended)	Maximum output current value of the station	U	A	1	0	0	1023	a-4	
			3-4	0-7	Present charging current (extended)	Measured current value of the output circuit in the station	U	A	1	0	0	1023	a-4	
			5	0	Operating condition	A flag indicating operating condition of a station.	-		1	0	0	1		0: Standard 1: Specific
				1	Cooling function (for charging cable)	A flag indicating the charging cable is compatible with the cooling function which retains the temperature rise of the charging cable	-		1	0	0	1		0: Not operated 1: Operating
				2	Current limiting function (for charging cable)	A flag indicating the charging cable is compatible with a function which retains the charging current based on measured result of surface temperature of the charging cable	-		1	0	0	1		0: Not installed 1: Installed
				3	Cooling function (for charging connector)	A flag indicating the charging connector is compatible with the cooling function which retains temperature rise of the charging connector	-		1	0	0	1		0: Not operated 1: Operating

Table A.3 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table 1	Status flag
Optional parameters														
118	100	8		4	Current limiting function (for charging connector)	A flag indicating the charging connector is compatible with the function which retains charging current based on measured result of terminal temperature of the charging connector	-		1	0	0	1		0: Not installed 1: Installed
				5	Over-temperature protection (for charging connector)	A flag indicating the charging connector is compatible with the function of over-temperature protection of the charging connector	-		1	0	0	1		0: Not installed 1: Installed
				6	Functional safety	A flag indicating the charging cable and the charging connector are compatible with functional safety	-		1	0	0	1		0: Not applied 1: Applied
708	100	8	0	0-7	EV manufacturer code	The EV supply equipment shall set the EV manufacture code as communicated by the EV (H'700.0)'	-		1		0	255		-
			1-7	0-7	Option code	Defined by EV manufacturers and EVSE manufacturers	-	-	-	-	-	-		-

Key

DLC: Data length code

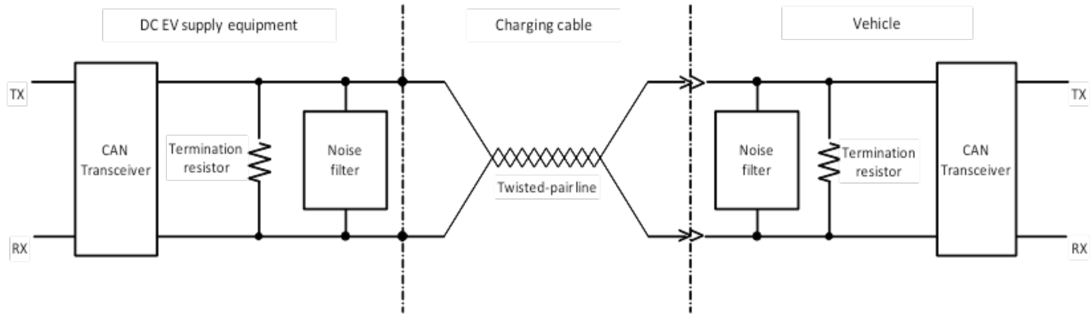
U: Unsigned

LSB: Least significant bit

A-5 PHYSICAL/DATA LINK LAYER

A-5.1 Communication circuit

A data communication circuit for CAN communication shall be equipped to exchange parameters for charging control. It shall facilitate one-on-one communication between the vehicle and the DC EV supply equipment.



Key

TX	transmitter
RX	receiver

FIG. A.2 CAN COMMUNICATION CIRCUIT

A-5.2 Terminating resistor

The CAN communication circuit shall be equipped with a terminating resistor (nominal resistance: 120 Ω, its tolerance in compliance with ISO 11898-2).

A-5.3 Noise filter

The CAN communication circuit shall be equipped with separate noise filters to reduce conducted noise in common mode and differential mode.

A-5.4 CAN transceiver

The CAN communication circuit shall be equipped with CAN transceiver which is in compliance with ISO 11898.

A-5.5 Twisted-pair line

Twisted pair line shall be used as the communication line that links the DC EV supply equipment with the vehicle so as to reduce differential mode noise.

A-5.6 Overvoltage protection for the CAN communication circuit

A means of overvoltage protection, such as surge protective devices and zener diode, may be added to the CAN communication circuit.

A-5.7 Communication protocol

The physical/data link layer specifications are shown in Table A.4.

Table A.4 The Physical Link Layer Specification for System A

Specification of communication control item	Requirements
Communication standard	ISO 11898-1, ISO 11898-2
Protocol	CAN 2.0B Active
Format	Standard format: ID length 11 bits Extended format: not used
Communication speed	500 kbps
Bit sample point	72.5 % to 87.5 %

A-5.8 CAN bus

The DC EV supply equipment and vehicle shall be equipped with a dedicated CAN communication circuit which is independent from each unique network and shall perform the charging control defined in this specification.

Key

CPU central processing unit

FIG. A.3 CAN BUS

A-5.9 Transmission process

The DC EV supply equipment and vehicle shall meet the requirements in Table A.5.

Table A.5 Specification of Data Transmission

Item		Requirements
Transmission order	Data frame	ID shall be sent in the ascending order.

	Data byte	Byte shall be sent in the ascending order from 0 byte.
	Data bit	Bit shall be sent in the descending order from MSB.
Synchronization		Synchronization during the transmission cycle is unnecessary.
Transmission cycle		100 ms ± 10 [%] (*see* Fig. A.4)

FIG. A.4 TRANSMISSION CYCLE

A-5.10 CAN reception error

After the establishment of CAN communication, the DC EV supply equipment shall stop charging if the data frames cannot be received for 1 s or more.

Any IDs can be used for detecting the non-reception of data frames. The value of the most recently-received normal data shall be used while the non-reception of data frames continues.

However, the following cases are not interpreted as a reception error:

- incorrect ID order (when data frames are not received in the ascending order)
- out of the transmission cycle (when the transmission cycle deviates beyond the margin of 10 % from 100 ms)
- reception of other than data area

A-6 BI-DIRECTIONAL POWER FLOW

A-6.1 Digital communication actions during charging/discharging control process

The communication actions and parameters according to the charging/discharging control process as defined in Table 38 of IS 17017(Part 23):2021 are shown in Table A.6.

Table A.6 Communication Actions and Parameters during DC Charging/Discharging Control Process between System A and Vehicle

<table>
<tr><th colspan="2" rowspan="2">Charging / discharging control stage</th><th rowspan="2">State</th><th rowspan="2">High level action at system level [a]</th><th rowspan="2">Digital communication action</th><th colspan="2">Parameter</th></tr>
<tr><th>From DC EV charging/discharging station</th><th>From vehicle</th></tr>
<tr><td rowspan="8">Initialization</td><td rowspan="6">Handshaking</td><td>BDC-A</td><td>Vehicle unconnected</td><td>None</td><td>N/A</td><td>N/A</td></tr>
<tr><td>BDC-B1</td><td>Connector plugged in</td><td>None</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="2">BDC-B1</td><td>Wake up of DCCDCF and VCDCF</td><td>None</td><td>None</td><td>(default CAN)</td></tr>
<tr><td>Communication data initialization</td><td>Preparation for digital communication</td><td>(default CAN)</td><td>(default CAN)</td></tr>
<tr><td>BDC-B1→BDC-B2</td><td>Communication established, parameters exchanged, and compatibility checked</td><td>Exchange of charging control parameters</td><td>– Control protocol number
– Available input/output voltage
– Available input/output current
– Battery incompatibility</td><td>– Control protocol number
– Rated capacity of battery
– Maximum/minimum battery voltage
– Maximum charging time
– Target battery voltage
– Vehicle charging enabled</td></tr>
<tr><td>BDC-B2→BDC-B3</td><td>Connector latched</td><td>Notification of connector latch status</td><td>– Vehicle connector latch</td><td>None</td></tr>
<tr><td>Charge/discharge preparation</td><td>BDC-B3</td><td>Insulation check for DC power line</td><td>None</td><td>- Charging/discharging system malfunction</td><td>None</td></tr>
</table>

Table A.6 (*concluded)*

Charging /discharge control stage	State	High level action at system levela	Digital communication action	Parameter	
				From DC EV charging/discharging station	From vehicle
Energy transfer	BDC-C or BDC-D	Vehicle side contactors closed	Notification of vehicle main contactor closed status	None	None
	BDC-C or BDC-D	Pre-charge	N/A	N/A	N/A
	BDC-C or BDC-D	Charging/discharging by the maximum available current of the vehicle battery (for MCC)	Notification of limit value of charging/discharging current (or voltage)	– Station status – Input/output voltage – Input/output current – Remaining charging time (sent , but not effective) – Station malfunction – Charging/discharging system malfunction	– Charging/discharging current limit – Charging/discharging system fault – Parking status of the vehicle
	BDC-C or BDC-D	Charging by voltage demand (for CVC) or discharging by the minimum allowable voltage of the vehicle battery (for MVC)	N/A	N/A	N/A
	BDC-C,(D) →BDC-B'1	Current suppression	Request of energy transfer shut-off	– Station status - Charging/discharging stop control – Input/output voltage – Input/output current	- Vehicle charging/discharging enabled
Shutdown	BDC-B'1	Zero current confirmed	Notification of energy transfer shut-off	– Station status - Charging/discharging system malfunction	
	BDC-B'1→ BDC-B'2	Welding detection (by vehicle)		None	None
	BDC-B'2	Vehicle side contactors open	None	None	None
	BDC-B'2	DC power line voltage verification	Notification of present voltage	- Input/output voltage	None
	BDC-B'3	Connector may be unlatched	Notification of connector unlatched status (if required)	- Vehicle connector latch	None
	BDC-B'4	End of charge/discharge at communication level	Terminate the digital communication	None	None
	BDC-A	Connector unplugged		N/A	N/A

[a] The order of actions does not refer to the procedure of charging/discharging control process.

A-6.2 Digital communication of DC charging/discharging control

The parameters for digital communication of DC charging/discharging control shall be exchanged according to the sequence diagram as shown in Fig. A.5.

FIG. A.5 SEQUENCE DIAGRAM OF DC CHARGING/DISCHARGING CONTROL COMMUNICATION FOR SYSTEM A

A-6.3 Parameter definition

The definition of parameters during DC charging/discharging control process are shown in Table A.7 and Table A.8.

Table A.7 Exchanged Parameter during DC Charging/Discharging Control Process from Vehicle to System A Station

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
100	100	8	0	0-7	Minimum charging current	Minimum current necessary for charging without depleting the high-voltage traction battery, considering the power consumption of the vehicle accessories	U	A	1	0	0	254	a'-1	—
			1-3	0-7	—	—	—	—	—	—	—	—	—	—
			4	0-7	Maximum battery voltage	The maximum voltage value at the vehicle inlet terminals, at which the station stops charging to protect the vehicle battery	U	V	1		0	1200	b'-2	—
			5	0-7										
			6	0-7	Constant of charging rate indication	Fixed value for charging rate indication, which is the maximum charging rate (100 %) of vehicle battery	U	—	1	100	0	255	b'-2	—
			7	0-7	—	—	—	—	—	—	—	—	—	—
101	100	8	0	0-7	—	—	—	—	—	—	—	—	—	—
			1	0-7	Maximum charging time (set by 10 s)	Maximum charging time permitted by EV, set by 10 s (sent, but not effective)	U	s	10	0	0	2540	b'-2	—
			2	0-7	Maximum charging time (set by 1min)	Maximum charging time permitted by EV, set by minute (sent, but not effective)	U	min	1	0	0	255	b'-2	—
			3	0-7	Estimated charging time (set by 1min)	Estimated remaining time before the end of charging calculated by EV, set by minute (sent, but not effective)	U	min	1		0	254	b'-2	—
			4	0-7	—	—	—	—	—	—	—	—	—	—
			5	0-7	Rated capacity of battery	Rated capacity of battery	U	kWh	0.1		0	6553.5	b'-2	—
			6											
			7	0-7	—	—	—	—	—	—	—	—	—	—

Table A.7 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
102	100	8	0	0-7	Control protocol number	Software version of control sequence to which EV corresponds	U	—	1		0	255	b'-1	—
			1	0-7	Target battery voltage for charging	Targeted charging voltage at the vehicle inlet terminals	U	V	1		0	1200	b'-1	—
			2	0-7										
			3	0-7	Maximum available current for charging	Current value limited by the EV during charging	U	A	1	0	0	255	a'-1	—
			4	0	Battery overvoltage	Status flag indicating whether or not the vehicle battery voltage exceeds the maximum limit specified by EV	—	—	1	0	0	1	g'	0: normal 1: fault
				1	Battery undervoltage	Status flag indicating whether or not the vehicle battery voltage is less than the lower limit specified by EV	—	—	1	0	0	1	g'	0: normal 1: fault
				2	Battery overcurrent	Status flag indicating whether or not the input/output current exceeds the EV limited current	—	—	1	0	0	1	g'	0: normal 1: fault
				3	High battery temperature	Status flag indicating whether or not the temperature of vehicle battery exceeds the maximum limit	—	—	1	0	0	1	g'	0: normal 1: fault
				4	Battery voltage deviation error	Status flag indicating whether or not the vehicle battery voltage deviates from the output voltage measured by the station	—	—	1	0	0	1	g'	0: normal 1: fault
				5-7	—	—	—	—	—	—	—	—	—	—

Table A.7 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
102	100	8	5	0	Vehicle charging/discharging enabled	Status flag indicating charge/discharge permission status of EV	—	—	1	0	0	1	g'	0: disabled 1: enabled
				1	Parking status of the vehicle	Status flag indicating the parking status of the vehicle	—	—	1	0	0	1	g'	0: vehicle in parking position 1: vehicle not in parking position
				2	Charging/discharging system fault	Status flag indicating a malfunction caused by EV or the station, and detected by EV	—	—	1	0	0	1	g'	0: normal 1: fault
				3	Vehicle status	Status flag indicating the EV contactor status	—	—	1	1	0	1	g'	0: EV contactor closed or during welding detection 1: EV contactor open or welding detection finished
				4	Normal stop request before charging/discharging	Status flag indicating the request of EV to stop charging/discharging control	—	—	1	0	0	1	g'	0: no request 1: request to stop
				5-6	—	—	—	—	—	—	—	—	—	—
				7	Vehicle discharge compatibility flag	Status flag indicating discharge compatibility of the EV	—	—	1	1	0	1	b'-1	0: incompatible 1: compatible
			6	0-7	Charging rate	Charging rate of battery	U	%	1		0	100	a'-1	—
			7	0-7	—	—	—	—	—	—	—	—	—	—

Table A.7 *(concluded)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
200[a]	100	8	0	0-7	Maximum available current for discharging	Current value limited by EV during discharging (offset: -255)	U	A	1	0	-255	0	a'-1	—
			1-3	0-7	—	—	—	—	—	—	—	—	—	—
			4	0-7	Target battery voltage for discharging	Targeted discharging voltage at the vehicle inlet terminals	U	V	1		0	1200	b'-1	—
			5	0-7										
			6	0-7	Minimum charging rate	Minimum charging rate of the EV battery limited by the EV during discharging	U	%	1		0	100	b'-3	—
			7	0-7	Maximum charging rate (optional)	Maximum charging rate of the EV battery limited by the EV during charging	U	%	1		0	100	b'-3	—
201	100	8	0	0-7	Control sequence number of charging/discharging	Software version of control sequence to which EV corresponds	U	—	1		0	255	b'-1	—
			1	0-7	Estimated discharging time (optional)	Estimated remaining time before the end of discharging calculated by the EV for only display	U	min	1		0	65534	b'-2	—
			2	0-7										
			3	0-7	Available vehicle energy (optional)	Available energy value (including fuel battery and/or power generated by gasoline, etc) supplied by the EV for only display	U	kWh	0.1		0	6553.4	b'-2	—
			4	0-7										
			5-7	0-7	—	—	—	—	—	—	—	—	—	—

[a] For ID109, from the station to the vehicle, see Table A.8.

Table A.8 – Exchanged Parameter during DC Charging/Discharging Control Process from System A Station to Vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
108	100	8	0	0-7	EV contactor welding detection support identifier	Identifier indicating whether or not the station deals with EV contactor welding detection	—	—	1		0	255	h'-2	0: not supporting vehicle welding detection 1 or more: supporting vehicle welding detection
			1	0-7	Available output voltage	Maximum output voltage value at the vehicle connector terminals	U	V	1		0	1200	a'-3	—
			2	0-7										
			3	0-7	Available output current	Maximum output current value of the station	U	A	1		0	255	a'-4	—
			4	0-7	Threshold voltage for charging	Threshold voltage to stop the charging process in order to protect vehicle battery	U	V	1		0	1200	b'-2	—
			5	0-7										
			6-7	0-7	—	—	—	—	—	—	—	—	—	—
109	100	8	0	0-7	Control protocol number	Software version number of control protocol or charging sequences that the station deals with	U	—	1		0	255	b'-1	—
			1	0-7	Output voltage	Supply voltage value of the output circuit in the station	U	V	1	0	0	1200	b'-1	—
			2	0-7										
			3	0-7	Output current	Supply current value of the output circuit in the station	U	A	1	0	0	255	b'-1	—
			4	0	Station discharge compatibility flag	Status flag indicating discharge compatibility of the station	—	—	1	0	0	1	b'-1	0: incompatible 1: compatible
				1-7	—	—	—	—	—	—	—	—	—	—

Table A.8 *(continued)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
109	100	8	5	0	Station status	Status flag indicating the energy transfer from the station	—	—	1	0	0	1	c' h'-1	0: standby 1:charging/ discharging
				1	Station malfunction	Status flag indicating whether or not there is a malfunction caused by the station	—	—	1	0	0	1	c' h'-1	0: normal 1: fault
				2	Vehicle connector latch	Status flag indicating the electromagnetic latch status of vehicle connector	—	—	1	0	0	1	c' h'-1	0: unlocked 1: locked
				3	Battery incompatibility	Status flag indicating the compatibility of vehicle battery with the output voltage of station	—	—	1	0	0	1	c' h'-1	0: compatible 1: incompatible
				4	Charging/discharging system malfunction	Status flag indicating whether or not there is a problem with EV, such as improper connection	—	—	1	0	0	1	d'	0: normal 1: malfunction
				5	Charge/discharge stop control	Status flag indicating whether or not the station proceeds with shutdown process	—	—	1	0	0	1	e'	0: operating 1: shutdown or stop charging/discharging
				6-7	—	—	—	—	—	—	—	—	—	—
			6	0-7	Remaining charging time (counted by 10 s)	Remaining time before the end of charging (counted by 10 s)	U	s	10		0	2540	b'-1	—
			7	0-7	Remaining charging time (counted by min)	Remaining time before the end of charging (counted by min)	U	min	1		0	255	b'-1	—

Table A.8 *(concluded)*

ID (H')	Period (ms)	DLC	Byte	Bit	Parameter	Content	Signed or Unsigned	Unit	LSB	Initial	Min	Max	Item in Table A.9	Status flag
208[a]	100	8	0	0-7	Input current	Draw current value of the input circuit in the station (offset:-255)	U	A	1	0	-255	0	b'-1	—
			1	0-7	Available input voltage	Minimum input voltage value at the vehicle connector terminals	U	V	1		0	1200	a'-3	—
			2	0-7										
			3	0-7	Available input current	Minimum input current value of the station (offset:-255)	U	A	1		-255	0	a'-4	—
			4-5	0-7	—	—	—	—	—	—	—	—	—	—
			6	0-7	Threshold voltage for discharging	Threshold voltage to stop the discharging process in order to protect vehicle battery	U	V	1		0	1200	b'-2	—
			7	0-7										
209	100	8	0	0-7	Control sequence number of charging/discharging	Software version number of control sequence or charging/discharging sequences that the station deals with	U	—	1		0	255	b'-1	—
			1	0-7	Remaining discharging time	Remaining time before the end of discharging	U	min	1		0	65534	b'-1	—
			2	0-7										
			3-7	0-7	—	—	—	—	—	—	—	—	—	—

[a] For ID200 and ID201, from the vehicle to the station, see Table A.7.

A-6.4 Charging/discharging control process

The charging/discharging control process shall be in accordance with **A-6.3** of IS 17017(Part 23):2021.

A-6.5 Exchanged information for DC charging/discharging control

This clause describes information which shall be exchanged between a DC EV charging/discharging station and a vehicle during the charging/discharging process according to IS 17017(Part 23):2021. Table A.9 shows exchanged information for DC charging/discharging control.

Table A.9 Exchanged Information for DC Charging/Discharging Control

No.	Information	Description	Relevant requirement in IS 17017(Part 23)
a’-1	Current limit for the maximum current control (MCC) system	Exchange of current value limited by EV	**A-6.3.4**
a’-3	Maximum/minimum rated voltage of the DC EV charging/discharging station	Exchange of maximum/minimum rated voltage value of DC EV charging/discharging station	**6.3.1.101** **6.3.1.104** **6.3.1.106**
a’-4	Maximum rated current of the DC EV charging/discharging station	Exchange of maximum rated current value of DC EV charging/discharging station	**6.3.1.101** **6.3.1.104**
b’-1	Communication protocol	Exchange of software version of a charging/discharging system	**6.3.1.104** **A-7.1** -
b’-2	Maximum/minimum voltage limit of the EV	Exchange of maximum/minimum voltage limit value of vehicle.	
b’-3	Maximum/minimum charging rate limit of the EV battery	Exchange of maximum/minimum charging rate limit value of the vehicle battery.	
c’	Insulation check result	Exchange of the result of insulation check before charging/discharging - If insulation check fails, a signal is sent that charging/discharging is not allowed.	**- 6.3.1.105**
d’	Short circuit test before charging/discharging	Exchange of information on short circuit test before charging/discharging	**6.3.1.109**
e'	Charging/discharging stopped by user	Exchange of information on charge/discharge stop command by the user of DC EV charging/discharging station	**6.3.1.110**
f’	DC EV charging/discharging station real time available load current (optional)	Exchange of DC EV charging/discharging station real time available load current for demand management. Required for system providing that function.	**6.3.2.102**
g’	Loss of digital communication	Detection of loss of digital communication - If a receiver does not get information expected to receive within time out period, it is considered as loss of digital communication.	**A-3.2**
h’-1	Zero current confirmed	Notification of zero current confirmed - Station informs EV that low current condition has been met (to allow the opening and welding check of EV contactors by EV)	**F-1.3.4**
h’-2	Welding detection	Exchange of information on the whole process of welding detection	
I‘-1	Normal shutdown	Termination of the charging process not caused by a failure	**6.3.1.115**
I‘-2	Error shutdown	Termination of the charging process caused by a failure	**6.3.1.116**

ANNEX C
(*normative*)

DIGITAL COMMUNICATION FOR CONTROL OF DC CHARGING SYSTEM C (COMBINED SYSTEM)

C-1 General

The digital communication for the DC EV supply equipment of system C as specified in Annex B of IS 17017(Part 23):2021 is defined in the following standards: DIN 70121, IS/ISO 15118-1, IS/ISO 15118-2 and IS/ISO 15118-3.

Systems implementing these specifications incorporate the following features:

- security concept including encryption, signing, key management, etc.
- robust PLC-based communications,
- automatic address assigning and association,
- IPv6-based communications,
- compressed XML messages,
- client-server approach,
- safety concept including cable check, welding detection, etc.
- extension concept for added-value services.

C-2 Required exchange parameters

The parameters to be exchanged for DC charging control are shown in Table C.1, corresponding to Table 1. Additional parameters can be found in DIN SPEC 70121 and IS/ISO 15118-2.

Table C.1 Required Exchanged Parameters for DC Charging Control for System C

(*Clause* C.1 *and* Table 1)

Item in Table 1	Information	Parameter name (IS/ISO 15118-2:2014)
a-1	Current request for the controlled current charging (CCC) system	CurrentDemandReq/EVTargetCurrent
a-2	Voltage request for the controlled voltage charging (CVC) system	CurrentDemandReq/EVTargetVoltage
a-3	Maximum rated voltage of DC EV supply equipment	CurrentDemandRes/ EVSEMaximumVoltageLimit
a-4	Maximum rated current of DC EV supply equipment	CurrentDemandRes/ EVSEMaximumCurrentLimit
b-1	Communication protocol	supportedAppProtocol{Req,Res}
b-2	Maximum voltage limit of EV	CurrentDemandReq/EVMaximumVoltageLimit
b-3	EV minimum current limit, only for the controlled voltage charging (CVC) system	ChargeParameterDiscoveryRes / DC_EVSEChargeParameter / EVSEMinimumCurrentLimit
c	Insulation check result	{PowerDeliveryRes, CableCheckRes, PreChargeRes, CurrentDemandRes, WeldingDetectionRes} / DC_EVSEStatus / EVSEIsolationStatus
d	Short circuit test before charging	CableCheck{Req,Res}
e	Charging stopped by user	{ChargeParameterDiscoveryRes,PowerDelivery Res, CableCheckRes, PreChargeRes, CurrentDemandRes, WeldingDetectionRes} / DC_EVSEStatus / EVSEStatusCode / EVSE_Shutdown {ChargeParameterDiscoveryRes, PowerDeliveryRes, CableCheckRes, PreChargeRes, CurrentDemandRes, WeldingDetectionRes} / DC_EVSEStatus / EVSENotification / StopCharging
f	EV supply equipment real time available load current (optional)	CurrentDemandRes/ EVSEMaximumCurrentLimit
g	Loss of digital communication	Message timers Control pilot state
h-1	Zero current confirmed	PowerDeliveryRes/ResponseCode CurrentDemandRes/EVSEPresentCurrent
h-2	Welding detection	WeldingDetection{Req, Res}

ANNEX D

(*Foreword*)

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MS. SHIKHA GOYAL

Scientist C, BIS

Bibliography

IEEE 1901-2011 Standard for broadband over power line networks: medium access control and physical layer specifications. Institute of Electrical and Electronics Engineers.

IEEE 2030.1.1-2015 IEEE standard technical specifications of a dc quick charger for use with electric vehicles. Institute of Electrical and Electronics Engineers.

DIN SPEC 70121 January 2014 Electromobility - digital communication between a d.c. ev charging station and an electric vehicle for control of d.c. charging in the combined charging system. Deutsches Institut Fur Normung.

SAE J2836/2™ September 2011 Use cases for communication between plug-in vehicles and off-board DC charger. SAE International.

SAE J2847/2 October 2011 Communication between plug-in vehicles and off-board DC chargers. SAE International.

SAE J2931/1 December 2014 Digital communications for plug-in electric vehicles. SAE International.

SAE J2931/4 October 2014 Broadband PLC communication for plug-in electric vehicles. SAE International.