TIME BOUND MATTER

F.No.7 (8)/215-AEI (Pt.) [11976]
Government of India
Ministry of Heavy Industries & Public Enterprises
Department of Heavy Industry
*****

Dated the 15th May 2017

Subject: Standardization of protocol for charging Infrastructure – Comments Regarding.

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The Department of Heavy Industry, Ministry of Heavy Industries & Public Enterprises have constituted a Committee for standardization for protocol of charging infrastructure under the chairmanship of Dr. Ashok Jhunjhunwala, Adviser to Ministry of New & Renewable Energy (MNRE) vide ORDER of even number dated 15th February 2017. The Committee has since now submitted its report on Standardization of Public EV Chargers to the Department of Heavy Industry, which is being placed in public domain [at DHI's website: www.dhi.nic.in] for seeking comments from stakeholders. It has been desired to finalise the same and to notify by the Government shortly.

2. All concerned are, therefore, requested to kindly peruse the said Report and submit their comments, if any, positively within 7 days i.e. by 22nd May 2017 to the undersigned.

Encl: As Above.

Pravin Agrawal 15/5/17

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Copy with the similar request to:-

1. Society of Indian Automobile Manufacturers (SIAM), Core 4-B, 5th Floor, India Habitat Centre, Lodhi Road, New Delhi-110003.
2. Society of Manufacturers of Electric Vehicles (SMEV), 50, Okhla Industrial Estate – III, New Delhi – 110020.
3. Automotive Component Manufacturers Association of India (ACMA), 6th Floor, The Capital Court, Munirka, New Delhi – 110067.
4. Electric Mobility Alliance (EMA), 1002 & 1003, 10th Floor, Tower B, SAS Tower, Medcity, Sector-38, Gurgaon, Haryana-122001.
5. Indian Electrical & Electronics Manufacturers Association (IEEMA), 1st Floor, Rishyamook Building, 85 A, Panchkuian Road, New Delhi-110001.

Copy to:-

The Joint Secretary (Transport), Ministry of Road Transport & Highways, Transport Bhawan, New Delhi 110001.

2017

Committee Report on Standardization of Public EV Chargers

PUBLIC AC METERED OUTLETS AND PUBLIC DC FAST CHARGERS SPECIFICATIONS

Contents

Chapter1: Introduction

1.1 EV Charger

An EV charger, also called Electric Vehicle Supply Equipment (EVSE) is an element in EV infrastructure that supplies electric energy for recharging the electric vehicles. As proliferation of EVs depends on access to the charging infrastructure, the nation needs to follow common specifications and standards for the infrastructure be used for all categories of vehicles and help it scale seamlessly.

This document details on the classification of EVSE and provides the detailed specification for AC and DC public chargers.

1.2. Charger Type

1.2.1. Private charger

The home private chargers are generally used with 230V/15A single phase plug which can deliver a maximum of up to about 2.5KW of power. Thus, the vehicles can be charged only up to this rate. The billing for the power is part of home-metering. *This will be continued till a policy evolves to charge the home users differently for EV use, however, inclusion of RCD (Residual Current Devices) should be ensured.* IEC 60309 Industrial connector to be used from both ends. The existing Indian safety guidelines should be followed.

1.2.2. Public charger

For charging outside the home premises: the electric power needs to be billed and payment needs to be collected. Further, the charges may depend on state of grid (whether it is power-surplus or is in power-deficit state). The power utilities may also want to manage power drawn by these chargers from time to time. *This document will here-on deal with only Public Chargers.*

1.3. Charger Classification

With reference to the charger types discussed above, it is more appropriate to **classify chargers based on power rating** instead of the rate of charging vis-à-vis "slow-chargers" or fast-chargers". The definition of "slow chargers" and "fast chargers" is not sufficient, as the same charger should be acting as a slow charger or a fast charger depending upon the vehicle to be charged. For example, a 2.5KW charger will be slow charger for a 4-wheeler but could be a fast charger for a 2-wheeler.

1.4. AC Chargers

Batteries are DC and needs DC power for charging it. If the public chargers (also known as **off-board chargers**) are DC chargers, the batteries / vehicles could be charged directly. For public outlets feeding AC supply to the EV, the chargers are on-board and these **on-board chargers** are supplied by vehicle manufacturer. The specifications here deals with only **Public off-board chargers**.

The electric 2-wheeler, 3-wheeler and 4-wheeler vehicles in India do not have an **on-board charger** beyond 2.5kW or 3kW. This is to save or minimize costs in vehicle. This is likely to continue. 4-wheeler manufacturer may not even have a *higher power* **on-board charger.** In Europe, Vehicles have on board chargers with higher power ratings (for example Tesla have a 16KW charger).However, as India is unlikely to have on board chargers with higher rating in near future, definition and building of AC fast charger beyond 2.5 / 3kW is not taken up in this document. As and when one sees vehicles in India which have higher-power on-board chargers, higher power AC chargers can be defined.

This document therefore defines specifications of **AC Public off-board Chargers** up to a maximum charging rate of 2.5 kW or 3 kW. For such chargers, the charging point needs to be only 230V single phase. The detailed specifications are given in Chapter 2

These AC 2.5KW or 3KW Chargers could fast charge a 2-wheeler (for a battery capacity of 2.5KW if they have appropriate on-board charger) in an hour's time; 4-wheeler or larger vehicles with batteries of 12 KWh or more will be charged in five to six hours.

1.5. DC Public off-board Chargers

Depending on the nature of battery and vehicles used, different sizes of higher capacity DC fast chargers are required. Some basic variations in charging rate and voltage rating may be

i. 10kKW/15kW/30kW/50kW or even higher capacity DC fast chargers
ii. Voltage Rating at which charging has to be carried out:
    a. 48V/72V for 2W, 3W, small and medium 4W.
    b. Up to 750V or even higher for medium to high end 4W
iii. Costs associated with chargers of different voltages and powers are very different,
iv. Cost of DC Chargers below 100V and charge rate of 10 kW to 15kW may be USD2000 to USD2500 in volumes.
v. Above 100V and charge rate between 30kW to 50kW. The costs may be higher. They may be required in select places.

Therefore, DC Public off-board Chargers are classified as follows:

1.5.1. Level 1 DC Chargers

Public off-board DC Chargers at output voltage of 48V / 72V, with power outputs of 10 kW / 15 kW with maximum current of up to 200A. These will be called **Level 1 DC Chargers.** The specifications of Level I DC Chargers are defined in detail in Chapter 3

1.5.2. Level 2 DC Chargers

Public off-board DC Chargers at output voltage up to 1000V, with power outputs of 30 kW / 150 kW. These will be called **Level 2 DC Chargers.** The specifications for Level II DC chargers will be specified in due course.

1.6. Requirements for DC Public Chargers

The architecture for the whole EV infrastructure as shown in Fig. 1. All public chargers should be as follows:

1.6.1. Communication for Chargers, also called EV Supply Equipment (EVSE)

i. EVSE needs to communicate with BMS of battery pack in EV, to enable it to charge at right rate for maintaining SOH of batteries. **Physical layer for this communication will be CAN, as it is commonly used by vehicle manufacturers in India**.

ii. Communication between EVSE and Central management system (CMS) located at power utility company, so as to

a. Enable maximum charging rate to be controlled depending upon the rates of grid supply

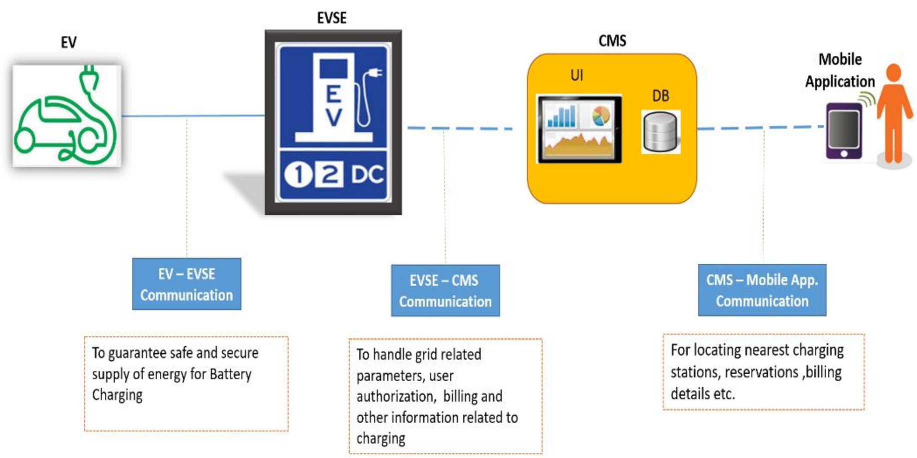


Figure 1: Architecture for EV and Charging Infrastructure

b. This will also enable metering at different rates. This is critical as whenever vehicles consume large currents and grid should be able to supply it
c. This will also enable reservation of chargers by users.

For all Public off-board chargers, the communication protocol used will be OCPP. This will be carried on Internet, using wired media or wireless (Wi Fi or GPRS or 3g/4g wireless).

iii. Communication between CMS and user / charging operator mobiles.

1.6.2. Billing and Payment

The customers need to be billed for the charging and payment needs to be made. There are multiple options, including debiting the user's account based on VIN (vehicle identification number). **Direct debiting the funds to user's equipment based on VIN will be adopted**. Alternately a mobile application to be defined, which allows a user to charge using BHIM or Bharat QR code or other digital payment schemes specified by Indian Government, to be used both for AC as well as DC chargers.

I. Displays and keypads should be kept to minimum to minimize costs. Communication with mobiles is encouraged.
II. EVSE should have right safety systems built-in and environmental protection.

1.7. Economic Models for Public Chargers (EVSE)

A preliminary economic model for AC Chargers and for DC L1-Chargers has been carried out. As volume prices fall, the chargers can be stand-alone business. Besides the capital costs of chargers and cost of provision of electrical line, space cost-sharing and manpower costs dominate. If the number of vehicles being charged per day falls, the business is dicey. The computation shows that it may be best to enter into revenue sharing arrangement with space providers and with those who supervise.

CHAPTER 2: Bharat EV AC Charger (BEVC-AC001)

This chapter presents the specifications of a Public metered AC outlet (PMAO) which is to provide AC input to the vehicle which has on-board chargers. This document applies to electric road vehicles for charging at 230V standard single phase AC supply with a maximum output of 15A and at a maximum output power of 3.3kW. PMAO is a slow charger for low-power vehicles.

2.1 General Requirements

The EV shall be connected to PMAO for conductive energy transfer function. The system will have following general specifications:

i. PMAO is supplied with three phase AC power and outputs single phase AC power.
ii. Energy Transfer Mode is Conductive.
iii. Each outlet will have up to three independent charging sockets.
iv. The PMAO has built-in metering, safety & monitoring.
v. PMAO and Central Management System communicate with each other to serve purposes of firmware, reservation, cancellation, addition and deletion of PMAOs etc.

2.2. Input Requirements

i. A.C. Supply System is 3 phase, 5 wire AC system (3 phases + N + PE)
ii. Nominal Input Voltage is 415V (+6% and -10%)as per IS 12360
iii. Input Frequency is 50Hz ± 1.5 Hz
iv. Input Supply Failure back-up: Battery backup for minimum 1 hour for the control system and billing unit. Data logs should be synchronized with CMS during back up time, in case battery drains out.

2.3. Output Requirements

i. Number of Outputs: 3
ii. Type of each output: A.C., 230V (+6% and -10%) single phase as per IS 12360
iii. Output Details: 3 Independent charging sockets as per IEC 60309, given in Annex A. Female connector to be used on the PMAO Side
iv. Output Current: Three vehicles charging simultaneously, each at 15A current
v. Output Connector Compatibility: IEC 60309 Industrial Blue connectors to be used.
vi. Connector Mounting: Angled connector mounted looking downwards for outdoor use.
vii. Double-pole breaking RCD (IEC 60309 Blue connector) of less than 30mA (As per section 7.4 of AIS 138 Part 1) is recommended.

viii. Limiting Output Current: Circuit breaker for each outlet limited to 15A current output. Breaker should be reset to resume operation.
ix. Output selection: the breaker inside to be energized in sequence - one round of all three phases before the second round.
x. Socket readiness: An LED to indicate that the socket is ready.
xi. Isolation: Input and outputs should be isolated. Outputs should be isolated from each other to avoid cross talk (insulation as defined in AIS 138 Part 1, clause 3.3.1).

2.4. User Interface and Display requirements

i. Visual Indicator: Error indication, Presence of input supply indication, Charge process indication and other relevant information.
ii. Display Messages: PMAO should display appropriate messages for user during the various charging stages like
iii. Vehicle plugged in / Vehicle plugged out
iv. Duration since start of charge, Time to charge, kWh
v. Authorization status
vi. Idle / Charging in progress: SOC
vii. Fault conditions
viii. ON- OFF (Start-Stop) switches are simple push button type
ix. Emergency Stop Switch is mushroom headed push button type (Red color)
x. Display and Touch Screen Size is minimum 6 inches with720x480 pixels
xi. User Authentication is by using mobile application or user interface (OCPP gives only a field mandate, media to be used is open).
xii. Metering Information: Consumption Units

2.5. Billing and Payment Requirements

i. Metering - metering as per units consumed for charging the battery of each vehicle as per Indian standards.
ii. Billing – Grid Responsive Billing
iii. Payment – BHIM complaint mobile application payment

2.6 Protection and Safety Requirements

2.6.1. Safety Parameters

Safety and protection to be ensured for India specific environment (As per AIS 138 Part1).

2.6.2. Start of Charging

The outlet will be locked and covered, the connector will be exposed to charging only after user authentication using user interface or mobile application. Only when the lock opens and connector is properly connected, the switch/relay will turn ON to feed power to EV.

i. Lock will be opened only after full charging and authentication by user or the operator
ii. Once disconnected, the charging session terminates.

2.6.3. Power failure

If there is a power failure, user is indicated

i. If the user wants to terminate the session, the user can shut-off the switch and remove the plug
ii. If user does not remove the plug, the charging resumes when power comes back.

2.6.4. Interruption of Charging

i. Connector terminals to be mounted with temperature sensors to avoid burning of connectors. Safety mechanism to trigger switching off of the charging >80°C. In such situation, an appropriate signal will be sent to turn the switch/relay OFF in order to stop the charging. Once disconnected, the charging session terminates.
ii. If plug is taken out (for more than 2 seconds) and then reinserted for charging, the charging-session will disconnect. A new session will be required to continue charging.
iii. These shall ensure that no one can remove a vehicle being charged and insert their own cable and use the infrastructure without paying or at someone else's account

2.7 Mechanical Requirements

2.7.1. Suggested Cable Security

PMAO should have locking mechanism for the connector while charging.

i. The vehicle may also have locking mechanism during charging to ensure the safety of the cable (Suggestion to OEM to have shutter lock for security purpose of the cable during charging session).

2.7.2. Mechanical Stability

i. Shall not be damaged by mechanical impact energy: 20 J (5 kg at 0.4 m) (Section 11.11.2.2. of AIS 138 Part 1).
ii. IP Ratings: IP 54 (Section 11.11.2.4. of AIS 138 Part 1).
iii. Cooling: Air cooled or forced air cooled to protect the equipment against temperature hazards.

2.8 Environment Requirements

i. Ambient Temperature Range: 0 to 55°C
ii. Ambient Humidity: 5 to 95% as per AIS 138 Part 1 section 11.2
iii. Ambient Pressure: 86 kpa to 106 kpa as per AIS 138 Part 1 section 11.11.2.4
iv. Storage temperature: 0 to 60°C

2.9 Communication Requirements

i. Communication between PMAO and Central Management System: Open Charge Point Protocol (OCPP) 1.5 protocol.
   a. Should be upgradable to next version of OCPP whenever it is released
   b. Should enable handshaking between PMAO and CMS for discovery.

c. It should authorize the operation, before electric vehicle can start or stop charging
d. PMAO should respond to CMS for various queries and commands like reservation, cancellation and other functions specified on OCPP.

ii. Metering: Grid responsive metering as per units consumption of each vehicle
iii. Interface between charger and central management system(CMS): Reliable Internet Connectivity

2.10. AC001 Specification Summary

The specifications discussed in Chapter 2 are summarized in Table 1.

TABLE 1: SUMMARY OF AC001 SPECIFICATIONS

#	Parameter	Requirement
	General Requirements	
1	EVSE Type	AC
2	Energy Transfer Mode	Conductive
	Input Requirements	
1	AC Supply System	Three-Phase, 5 Wire AC system (3Ph.+N+PE)
2	Nominal Input voltage	415V (+6% and -10%) as per IS 12360
3	Input Frequency	50Hz, ±1.5Hz
4	Input Supply Failure backup	Battery backup for minimum 1 hour for the control system and billing unit. Data logs should be synchronized with CMS during back up time, in case battery drains out.
	Environmental Requirements	
1	Ambient Temperature Range	0 to 55°C
2	Ambient Humidity	5 to 95%
3	Ambient Pressure	86 kpa to 106 kpa
4	Storage temperature	0 to 60°C
	Mechanical Requirements	
1	Suggested Cable Security	PMAO and the vehicle connector outlet to have provision for locking mechanism during charging to ensure the safety of the cable
2	Mechanical Stability	Shall not be damaged by mechanical impact impact energy : 20 J (5 kg at 0.4 m)
3	IP Ratings	IP 54
4	Cooling	Air cooled or forced air cooled to protect the equipment against temperature hazards
	Output Requirements	
1	Number of outputs	3
2	Type of each output	230V (+6% and -10%) single phase, 15A as per IS 12360A.C.
3	Output Details	3 Independent charging sockets, given in Annex-A

4	Output Current	Three Vehicles charging simultaneously, each at 15A current
5	Output Connector Compatibility	IEC 60309
6	Limiting output current	Circuit breaker for each outlet limited to 15A current output. Breaker should be reset to resume operation
7	Connector Mounting	Angled connector mounted looking downwards for outdoor use
8	Isolation	Between Input & Output; Between all outlets with proper insulation
	User Interface & Display Requirements	
1	ON- OFF (Start-Stop) switches	Simple Push button type
2	Emergency stop switch	Mushroom headed Push button type (Red color)
3	Visual Indicators	Error indication, Presence of input supply indication, Charge process indication and other relevant information
4	Display & touch-screen size	Minimum 6 inches with 720 x 480 pixels
5	Display Messages	EVSE should display appropriate messages for user during the various charging states like • Vehicle plugged in / Vehicle plugged out • Idle / Charging in progress - SOC • Fault conditions; metering: units consumption; Duration since start of charge, Time to charge, kWh
6	User Authentication	Using mobile application or User interface (OCPP gives only a field mandate, media to be used is open)
7	Metering Information	Consumption Units
	Billing & Payment Requirements	
1	Metering	Metering as per units' consumption for charging each vehicle
2	Billing	Grid responsive billing
3	Payment	BHIM and Bharat QR compliant mobile application payment
	Communication Requirements	
1	Communication between EVSE and Central Server	Open Charge Point Protocol (OCPP) 1.5 protocol. Should be upgradable to next version of OCPP whenever it is released including OCPP 2.0 which is a draft version now Should enable handshaking between EVSE and CMS for discovery. It should authorize the operation, before electric vehicle can start or stop charging. EVSE should respond to CMS for various queries and commands like reservation, cancellation.
2	Metering	Grid responsive metering as per units' consumption of each vehicle
3	Interface between charger and central management system(CMS)	Reliable Internet Connectivity
	Protection & Safety Requirements	

1	Safety Parameters	Safety and protection to be ensured for India specific environment (As per AIS 138 Part1)
2	Start of Charging	The outlet will be locked and covered, the connector will be exposed to charging only after user authentication using user interface or mobile application. Only when the lock opens and connector is properly connected, the switch/relay will turn ON to feed power to EV. Lock will be opened only after full charging and authentication by user or the operator. Once disconnected, the charging session terminates
3	Power failure	If there is a power failure, user is indicated about this. The charging resumes when power comes on. If the user wants to terminate the session during power failure, the user can shut-off the switch and remove the plug
4	Interruption of Charging	O Connector terminals to be mounted with temperature sensors to avoid burning of connectors. Safety mechanism to trigger switching off the charging at temp.>80°C.In such situation, an appropriate signal will be sent to turn the switch/relay OFF to stop the charging. Once disconnected, the charging session terminates. O If the above locking mechanism is mandated then the following point won't be required: If plug is taken out (for more than 2 seconds) and then reinserted for charging, the charging-session will disconnect. A new session will be required to continue charging to ensure that no one can remove a vehicle being charged and insert their own cable and use the infrastructure without paying or at someone else’s account

CHAPTER 3: Bharat EV DC Charger (BEVC-DC001)

This chapter prescribes the definition, requirements and specifications for low voltage DC electric vehicle (EV) charging stations in India, herein also referred to as "DC charger", for conductive connection to the vehicle, with an AC input voltage of 3-phase, 415 V.

It also specifies the requirements for digital communication between DC EV charging station and electric vehicle for control of DC charging.

3.1. General Requirements

The method for charging an EV is to use an off-board charger for delivering direct current. The EV shall be connected to the EVSE so that in normal conditions of use, the conductive energy transfer function operates safely.

i. Energy transfer mode: Conductive
ii. EVSE type: Dual-connector DC EVSE
iii. No. of outputs: 2
iv. Charging mode: Mode 4 – DC Charging [DC charging is defined as Mode 4 as per IEC61851-1 section6.2]

3.2. System Structure

The System requirement parameters are derived from Table D1 of Annex DD of IEC 61851-23.

i. Regulation: Regulated DC EV Charging station with combination of the modes: controlled voltage charging (CVC) and controlled current charging (CCC)
ii. Isolation: Isolated DC EV charging station, according to the type of insulation between input and output: a) Basic insulation, b) Reinforced insulation, c) Double insulation
Each DC output should be isolated from each other [Section 7.5.101 of IEC 61851-23].

iii. Environmental conditions: Outdoor use. EVSEs classified for outdoor use can be used for indoor use, provided ventilation requirements are satisfied.
iv. Power supply: AC mains to DCEV charging station
v. DC output voltage rating: Up to and including 100 V
vi. Charge control communication: Communicate by digital and analog signals
vii. Output Current: 200A
viii. Interface Inter-operability: Interoperable with any EV (non-dedicated, can be used by any consumer).
ix. Operator: Operated by a trained operator or EV owner

3.3. Input Requirements

3.3.1. Rating of the AC supply voltage

I. The AC supply system would be 3-Phase, 5 Wire AC system (3Ph+N+E)
Nominal Input Voltage is 415V (+6% and -10%) as per IS 12360

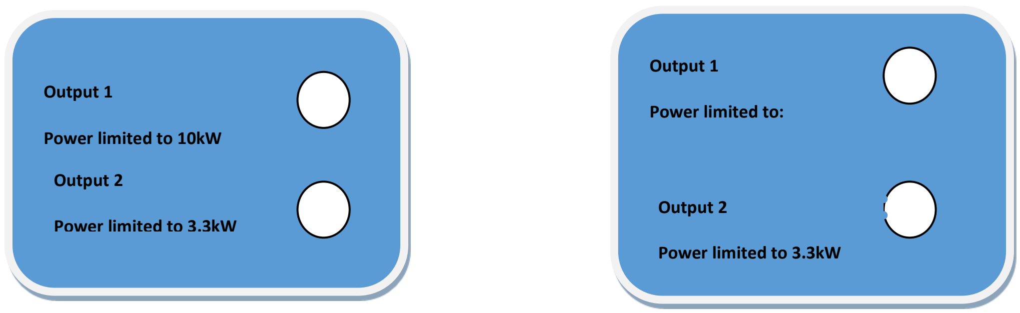
II. The Rated value of the frequency is 50 Hz ± 1.5Hz.

3.3.2. Battery back-up

The Input supply system to have a battery backup for minimum 1 hour for control and billing unit. The data logs should be synched with CMS during back-up time, in case battery drains out.

3.4. Output Requirements

The Charger can provide two DC outputs suitable for 48V and 72V vehicle battery configurations. There can be two categories of chargers based on the limit on output power of the chargers as shown in Figure 2 below.



(a) (b)

Figure 2: a) Charger with Power Limited to 10kW (Type 1)
b) Charger with Power limited to 15kW (Type 2)

The chargers should allow charging of one vehicle with maximum power (10 kW or 15 kW) or 2W vehicle with limited power (3.3 kW at 48V only) as per the output configurations types given in section 3.4.1

i. DC Output voltage: 48V or 72 V
ii. Output current: limited to 200A
iii. Converter Efficiency: > 92% at nominal output power
iv. Power factor: > 0.90 (Full Load)

The service life of coupler and breaking capacity of the coupler as defined in Section 9 of IEC 61851-23.

3.4.1. Charger Configuration Types

i. **Type 1**: Single vehicle charging at 48V or 72V with a maximum of 10kW power, or a 2W vehicle charging at 48V with maximum power of 3.3 kW.
ii. **Type 2**: Single vehicle charging at 48V with a maximum of 10kW power or 72V with a maximum of 15 kW power or a 2W vehicle charging at 48V with maximum power of 3.3 kW.

3.4.2. Output Connector Requirements

i. Number of Outputs: 2 outputs
ii. Output 1: to be used for 10 kW or 15 kW charging, Connector is GB/T20234.3. The Connector details are provided in Annex B1
iii. Output 2: connector to be used for 3.3 kW charging will be defined in due course of time.

3.5. Cable Requirements

i. Charging Cable Assembly: As per Section 10 of AIS 138 Part 1, except the functional characteristics defined as below
   a. Functional characteristics: The maximum cord length will be 5 meter, straight cable
ii. Cable Connection Type: supply cable will be with EVSE as per Case C defined in section 6.3.1 of IEC61851-1.
iii. Cord Extension Set: No extension cord to be used, as per Section 6.3.1. of AIS 138 Part 1
iv. Adaptors: No adapters to be used as per Section 6.3.2 of AIS 138 Part 1
v. Storage means of the cable assembly and vehicle connector: EVSE should have storage for cable and connector when not in use, at a height between 0.4m to 1.5m above ground level, as per IEC 61851-23 Section 101.1.3

3.6. Environmental Requirements

i. Ambient Temperature Range: 0°C to 55°C as per 11.11.1.2 of AIS 138 Part 1
ii. Ambient Humidity: 5% to 95% as defined in Section 11.2 of AIS 138 Part 1
iii. Ambient Pressure: 86 kpa to 106 kpa as defined in Section 11.11.2.4. of AIS 138 Part 1
iv. Storage Temperature:0°C to 60°C

3.7. Mechanical Requirements

i. Ingress Protection: The minimum IP degrees for ingress of objects is IP 54
ii. Mechanical Impact: As per IEC 61851-1 Section 11.11.2
iii. Mechanical Stability: As per section 11.11.2.2. of AIS 138 Part
iv. Cooling: Air cooled or forced cool for protection and safety of equipment from any fire hazards

3.8. Protection Requirements

i. Protection against Electric Shock: As per AIS 138 Part 1, Section 7.0
ii. Effective earth continuity between the enclosure and the external protective circuit, as per AIS 138 Part 1 Section 6.4.1.2

3.9. Specific Requirements

DC FC shall have provision of emergency switching, protection against uncontrolled reverse power flow from vehicle, Output current regulation in CCC, Output voltage regulation in CVC, Controlled delay of charging current in CCC, limited periodic and random deviation (current ripple) and limited periodic and random deviation (voltage ripple in CVC), as per Section 102.2 of IEC 61851-23.

The specific requirements defined in Section 102.2 of IEC 61851-23 except for the functions provided with descriptions:

i. Rated outputs and maximum output power: The clause from Section 101.2.1.1 of IEC 61851-23 is applicable except for the ambient temperature range to be 0 °C to 55 °C for Indian climatic conditions.
ii. Descending rate of charging current: In case of normal condition, DCFC should be able to reduce the descending current at a rate of 100A per second or more as per Section 101.2.1.4 IEC 61851-23.
iii. Load dump: In any case of load dump, voltage overshoot shall not exceed 110% of the maximum voltage limit of the battery systems, as per Annex BB 3.8.3 of IEC61851-23.

3.10. Functional Requirements

The functional requirements should be as per Section 6.4.3 of IEC 61851-1 and Section 6.4.3 of IEC 61851-23 except for the following functions, to be implemented as follows.

i. Measuring current and voltage: The accuracy of output measurement of system B shall be within the following values:
   - Voltage measurement: ± 0,5%
   - Current measurement: ±1 A if the actual current is less than or equal to (≤) 50 A

ii. Protection against overvoltage at the battery: The DC EV charging station shall reduce the DC output current to less than 5 A within 2 s, to prevent overvoltage at the battery, if the output voltage exceeds the maximum voltage limit of the battery system for 1 s

3.11. Communication Requirements

3.11.1. EV – EVSE Communication

A dedicated CAN communication is used for digital communication between a DC EV charging station and an EV for control of DC charging.

The physical layer shall be CAN bus over twisted pair cable and should comply with requirements defined in ISO 11898 -2:2003. The communication shall use the CAN framing format at a rate of 250 kbps, using 29-bit identifier of CAN extended frame. The CAN specifications and framing details are provided in Annex B2.

The system definition for communication between DC EV charging station and electric vehicle shall follow IEC61851-24B. The application layer for this pair of communication is derived from GB/T 27930 protocol. The amendments in messages for control of DC charging are as below.

Below parameter specified as optional parameters in GB/T 27930 protocol **should be made mandatory**

1. Vehicle Identification Number (VIN)

Additional changes are as given in Annex B3

3.11.2. EVSE – CMS Communication

The EVSE should be able to communicate with CMS using Open Charge Point Protocol (OCPP) 1.5.

i. Communication interface: Reliable Internet connectivity
ii. Should enable handshaking between EVSE and CMS for its discovery, firmware version, vendor Version, vendor etc. It should authorize the operation, before electric vehicle can start or stop charging. EVSE should respond to CMS for the queried parameters. Reservation, cancellation addition and deletion of EVSE should be possible from CMS.
iii. Metering: Grid responsive metering as per units consumption of the vehicle
iv. Should be upgradable to next version of OCPP whenever it is released.

3.12. Billing and Payment Requirements

i. Billing: Based on grid responsive metering
ii. Payment: BHIM compliant mobile payment
iii. Metering: As per Indian metering standard

3.13. User Interface and Display Requirements

1	ON- OFF (Start-Stop) switches	Simple Push button type
2	Emergency stop switch	Mushroom headed Push button type in Red Color
3	Visual Indicators	Error indication, Presence of input supply indication, State of charge process indication and other relevant information
4	Display	Minimum 6 inches with 720 x 480 pixels TFT LCD Touch Screen
5	Support Language	English
6	Display Messages	EVSE should display appropriate messages for user during the various charging states like: ➢ Vehicle plugged in / Vehicle plugged out ➢ Duration since start of charge, Time to charge, kWh. ➢ User authorization status ➢ Idle / Charging in progress: SOC ➢ Fault conditions ➢ Metering Information: Consumption Units
8	User Authentication	As per OCPP (through mobile application or card reader). OCPP gives only a mandate field, media to be used is open

3.1.4. Summary of BEVC-DC001 Specification

The specifications given in chapter 3 are summarized in Table 2.

TABLE 2: BEVC-DC001 SPECIFICATIONS SUMMARY

#	Parameter	Description
General Requirements		
1	EVSE Type	Dual-connector DC EVSE
2	Energy Transfer Mode	Conductive
3	Charging mode	Mode 4
7	Reliability and Serviceability	Modularity, self-diagnostic features, fault codes and easy serviceability in the field
System Structure		
1	Regulation Method	Regulated d.c EV charging station with combination of CVC or CCC but not simultaneously

2	Isolation	Each output isolated from each other with proper insulation
3	Environmental conditions	Outdoor use
4	Power supply	d.c. EV charging station connected to a.c. mains
5	DC output voltage rating	Up to and including 100 V
6	Charge control communication	Communicate by digital and analog signals
7	Interface inter-operability	Inter-operable with any EV(non-dedicated, can be used by any consumer)
8	Operator	Operated by a trained person or EV Owner
Input Requirements		
1	AC Supply System	3-Phase, 5 Wire AC system (3Ph+N+E)
2	Nominal Input voltage	3Ø, 415V (+6% and -10%) as per IS 12360
3	Input Frequency	50Hz, ±1.5Hz
4	Supply side AC Connector for Input	IEC 62196 Type 2 as per Annex 1
5	Input Supply Failure backup	Battery backup for minimum 1 hour for control system and billing unit, to enable activities such as billing, to be provided.
Output Requirements		
1	Output Details	Suitable for 48V and 72V vehicle battery configuration
2	Charger Configuration Types	i. Type 1: Single vehicle charging at 48V or 72V with a maximum of 10kW power, or a 2W vehicle charging at 48V with maximum power of 3.3 kW. ii. Type 2 : Single vehicle charging at 48V with a maximum of 10kW power or 72V with a maximum of 15 kW power or a 2W vehicle charging at 48V with maximum power of 3.3 kW.
3	Output Current	200 Amp Max
4	Number of Outputs	2
5	Output Connectors	2 output connectors
6	Output Connector Compatibility	one connector with GB/T 20234.3 as per Annex 1 + 1 connectors to be defined
7	Converter Efficiency	> 92 % at nominal output power
8	Power factor	≥ 0.90 (Full load)
Cable Requirements		
1	Charging Cable Length	5 Meter, Straight Cable
2	Cable Type	Charging cable and connector permanently attached to DC FC
Environmental Requirements		

1	Ambient Temperature Range	0°C to 55°C
2	Ambient Humidity	5 to 95%
3	Ambient Pressure	86 kpa to 106 kpa
4	Storage Temperature	0 to 60°C
Mechanical Requirements		
1	Ingress Protection	IP 54
2	Mechanical Stability	Shall not be damaged by mechanical impact as defined in Section 11.11.2 of IEC 61851-1
3	Cooling	Air Cooled
4	Mechanical Impact	Shall not be damaged by mechanical impact as defined in Section 11.11.3 of IEC 61851-1
5	Dimension(W*H*D)/Weight	To be decided e.g W*H*D mm, xxx Kg
User Interface & Display Requirements		
1	ON- OFF (Start-Stop) switches	Simple Push button type
2	Emergency stop switch	Simple Push button type in Red Color
3	Visual Indicators	Error indication, Presence of input supply indication, State of charge process indication
4	Display	Minimum 6 inches with 720 x 480 pixels TFT LCD Touch Screen
5	Support Language	English
5	Display Messages	EVSE should display appropriate messages for user during the various charging states like: • Vehicle plugged in / Vehicle plugged out • Duration since start of charge, Time to charge, kWh. • User authorization status • Idle / Charging in progress: SOC • Fault conditions • Metering Information: Consumption Units
7	Authentication	As per OCPP (through mobile application or card reader)
Performance Requirements		
1	DC Output voltage and current tolerance	DC Output current regulation in Constant Current Charging (CCC): ± 2.5 A for the requirement below 50 A, and ± 5 % of the required value for 50 A or more DC Output voltage regulation in Constant Voltage Charging (CVC): Max. 2 % for the max rated voltage of the EVSE

2	Control delay of charging current in CCC	DC output current Demand Response Time: <1 s Ramp up rate: 20 A/s or more Ramp Down rate: 100 A/s or more
3	Descending rate of charging current	EVSE should be able to reduce DC current with the descending rate of 100 A/s or more
4	Periodic and random deviation (current ripple)	DC output current ripple limit of EVSE: 1.5 A below 10 Hz, 6 A below 5kHz, 9A below 150 kHz
5	Periodic and random deviation (voltage ripple)	Max. ripple voltage: ±5 V. Max slew rate: ±20 V/ms
Communication Requirements		
1	Communication between EVSE and Vehicle	CAN based as per IEC 61851-24 Annex 3
2	Communication interface between charger and central management system(CMS)	Ethernet(Standard), Wi-Fi
3	Communication between EVSE and Central Server	Open Charge Point Protocol (OCPP) 1.5 protocol. Should be upgradable to next version of OCPP whenever it is released including OCPP2.0 which is a draft version now Should enable handshaking between EVSE and CMS for discovery. It should authorize the operation, before electric vehicle can start or stop charging. EVSE should respond to CMS for various queries and commands like reservation, cancellation. Metering: Grid responsive metering
Billing Requirements		
1	Billing	Grid responsive metering
2	Payment	BHIM and Bharat QR compliant mobile application payment
Protection & Safety Requirements		
1	Safety Parameters	Over current, under voltage, over voltage, Residual current, Surge protection, Short circuit, Earth fault at input and output, Input phase reversal, Prevention of vehicle movement during charging, Emergency shut-down with alarm, Over temperature, Protection against electric shock

4. REFERENCES

The following referenced documents are indispensable for the application of this document.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61851-1: Edition 2.0 2010-11, Electric vehicle conductive charging system–Electric vehicle conductive charging system –Part 1: General Requirements

IEC 61851-23: Edition 1.0 2014-03, Electric vehicle conductive charging system–Electric vehicle conductive charging system –Part 23: DC electric vehicle charging station

IEC61851-24:2014, Electric vehicle conductive charging system–Part 24: Digital communication between a DC EV charging station and an electric vehicle for control of DC8 charging

IEC 62196-3, Plugs, socket-outlets, and vehicle couplers–Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability requirements for DC and AC / DC pin and tube-type contact vehicle couplers

ISO 11898-2, Road vehicles–Controller area network (CAN)–Part 1: Data link layer and physical signaling

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

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

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

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

IEC 61557-8, Electrical safety in low voltage distribution systems up to 1 000 V AC and1 500 VDC – Equipment for testing, measuring or monitoring of protective measures – Part8: Insulation monitoring devices for IT systems

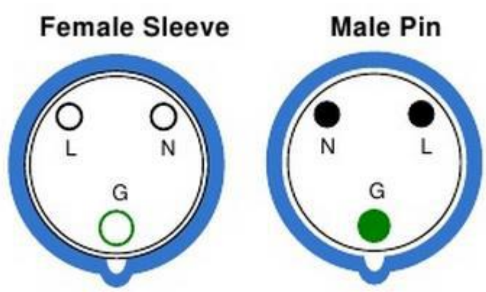
IEC 61558-1:2005, Safety of power transformers, power supplies, reactors and similar products– Part 1: General requirements and tests

ANNEX A: Output Connector for PMAO

AC Slow: The connector on the PMAO side and the mating connector are as below:

IEC 60309 Female Connector (PMAO side)

IEC 60309 Male Connector (Cable with EV)



Pins	Functions
1	L
2	N
3	Protective Earth

For details, refer **IS 60309(Part 1): 2002/ IEC 60309-1:1999,** Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories.

Cable Assembly for AC Slow Charging

Type of cable assembly for charging option in AC slow is Cable B, which has an industrial plug IEC 60309 (15 A, single-phase) on the PMAO side and a suitable charging connector on the vehicle side.

ANNEXB1: Output Connectors for Low voltage DC FC

B1.2. Output Connectors: GB/T 20234.3

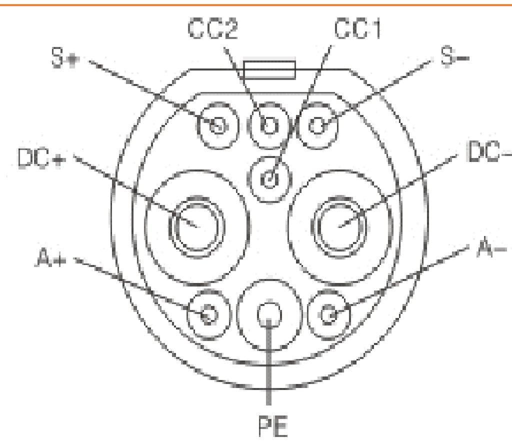
The Connector (female) to be used on the EVSE Side for low voltage DCFC is GB/T20234.3.The connector on the EVSE side and the mating connector are as below:

B1.2.1. EVSE Plug

B1.2.2. EV Socket

B1.2.3. Pin Details

DC+ : Positive DC power
CC2 : Connection confirmation 1
DC– : Negative DC power
CC1 : Connection confirmation 2
PE : Protective ground cable
A+ : Positive Low auxiliary power
S+ : Charging Communication CAN–H
A– : Negative Low auxiliary power
S– : Charging Communication CAN–L



ANNEXB2: CAN Specifications and framing details

B2.1. Physical Layer

CAN 2.0 complies to ISO 11898-2

B2.2. Application Layer

Extended CAN frame using 29-bit identifier

B2.3. Extended CAN Frame

SO F	11-bit Identifier	S R R	I D E	18 bit Identifier	RT R	R 1	R 0	DLC (4)	Data Field 0 - 8 Bytes	CRC 15 bit	D E L	A C K	D E L	E O F

SOF	– Start of Frame
11-bit ID	– 11-bit Identifier
IDE	– Identifier Extension
29-bit ID	– 29-bit Identifier
SRR	– Substitute Remote Request
RTR	– Remote Transmission Request
R0	– Reserved Bit
R1	– Reserved Bit
DLC	– Data Length Code
CRC	– Cyclic Redundancy Check
DEL	- Acknowledgment Delimiter
ACK	- Acknowledgment Bit
EOF	- End of Frame

ANNEXB3: Digital communication for control of DC EV charging system (normative) – Modified Messages

B3.1. PGN 9728 Charger Handshake Message (CHM)

Message function: when the charger and electric vehicles have been subjected to physical connection and charged and the voltage is normal when detected, the charger will send charger handshake message every other 250ms to the BMS to determine whether they shake hands normally. PGN 9728 message format is detailed in Table B.3.1. The messages added/modified are highlighted in Italics.

TABLE B.3.1 PGN9728 MESSAGE FORMAT

Start byte or bit	Length	SPN	SPN definition	Delivery option	Remarks
1	3 bytes	2600	In this standard, as for the charger communication protocol version No., its current version is specified as V1.1 and is expressed as: byte3, byte2--0001 H; byte 1--01H.*To differentiate pure GB/T and proposed Indian specification BEVC, the protocol will use the MSB as 1 and hence the byte3,2 and 1 values will respectively be 80H 01H 01H.* *To differentiate between public charging station and swapping station, second MSB of third byte is used.* *Third Byte 80H indicates Public charger, C0H indicates swapping station*	Mandatory	GB/T protocol specifies 3 byte version number as 000101H. The version number has to be differentiated between pure GB/T and the proposed Indian version of the standard. This is done by modifying the MSB of the third byte and making it 800101H. Based on public charging or battery charging at swapping station, VIN or Swapping

					station charger code(SSCC) will be communicated, as referred in SPN 2563(Refer Table B3.3 and 2575 (Refer Table B3.2)

B3.2. PGN512 BMS and vehicle Recognition Message (BRM)

Message function: Send BMS and vehicle recognition information to the charger at the charging handshake stage. When BMS receives the charger recognition message of SPN2560=0x00, it will send message to the charger once every other 250ms; if the data field length exceeds 8 bytes, it will transport by using the transport protocol function, with the format as detailed in 6.5 and the inter-frame sending interval of 10 ms, until it receives the charger recognition message of SPN2560=0xAA over a 5s period. The PGN 512 modified message format is detailed in Table B.3.2

TABLE B.3.2 PGN512 MESSAGE FORMAT

Start byte or bit	Length	SPN	SPN definition	Delivery option	Remarks
1	3 bytes	2565	In this standard, as for the BMS communication protocol version No., its current version is specified as V1.1 and is expressed as: byte3, byte2--0001 H; byte 1--01H.*To differentiate pure GB/T and this Indian specification XXX, will use the MSB as 1 and hence the byte3,2 and 1 values will respectively be 80H 01H 01H*	Mandatory	GB/T protocol specifies 3 byte version number as 000101H. The version number has to be differentiated between pure GB/T and the proposed Indian version of the standard. This is done by modifying the MSB of the third byte and making it 800101H

4	1 byte	2566	Battery type, 01H: lead acid battery; 02H: nickel hydrogen battery; 03H: lithium iron phosphate battery; 04H: lithium manganite battery; 05H: cobalt based lithium battery; 06H: ternary material battery; 07H: polymer lithium-ion battery; 08H: lithium ion battery; *09H: NMC (Lithium Nickel Manganese Cobalt Oxide)* *0AH: NCA(Lithium Nickel Cobalt Aluminum Oxide)* *0BH: Lithium titanate oxide (LTO)* *0CH: Lithium Nickel cobalt manganese* *FFH: other batteries*	*Mandatory*	List of battery types will be added as and when available. (Total 255 types are possible)
5	2 bytes	2567	Power storage battery system of whole vehicle, with rated capacity/Ah, 0.1 Ah/bit; 0Ah offset	Mandatory	
7	2 bytes	2568	Power storage battery system of whole vehicle, with rated total voltage/V, 0.1 V/bit; 0V offset	Mandatory	
9	4 bytes	2569	Battery manufacturer name and standard ASCII code. The charger may be configured to charge batteries only from a known set of Battery manufacturer name and standard ASCII code. Refer table	Optional	

			A.3.3’s Fault cause for charger suspending charging bits 15,16		
13	4 bytes	2570	Battery pack No., which is reserved and will be defined by the manufacturer	Optional	
17	1 byte	2571	Battery set production date: years, 1 year/bit; offset in 1985; data scope: 1985~2235	Optional	
18	1 byte		Battery set production date: months, 1 month/bit; offset of 0 month; data scope: January~December	Optional	
19	1 byte		Battery set production date: days, 1 day/bit; offset of 0 day; data scope: the 1st day ~ the 31st day	Optional	
20	3 bytes	2572	Battery set charging frequency: 1 time/bit, offset of 0 times, which is subject to BMS statistics.	Optional	
23	1 byte	2573	Battery set property right mark (<0>: = lease; <1>: existing on vehicle)	Optional	
24	1 byte	2574	Reserve	Optional	
25	17 bytes	2575	Vehicle identification number (VIN)	*Mandatory*	*VIN is mandatory for public charging. In case of SSCC, all bytes shall be filled with FFH.*

42	8 bytes	2576	BMS software version number 8byte represents current BMS version information, determined according to hexadecimal coding. Hereinto, Byte8, byte7, byte6-000001H~FFFFFEH, reserved, fill in FFFFFFH;Byte5-byte2, as BMS software version compilation time information marker, Byte 5,Byte4-0001H~FFFEH represents "year" (e.g. The year of 2015: fill in Byte5-DFH, byte4-07H);Byte3-01H~0CH represents "month" (e.g. November: fill in Byte 3 0BH); Byte2-01H~1FH represents "day" (e.g. the 10the day: fill in Byte 2 0AH); Byte1-01H~FEH represents edition serial number (e.g. 16: fill in Byte 1-10H). The above value represents: BMS uses 16th version on November 10, 2015 and not fill in certification authorization code)	Optional	
50	*8*	*2577*	*Last charge status* *Last Recharge Date: 6 Bytes, DD MM YY HH mm SS* *DD - 1 day/bit; offset of 0 day; data scope: the 1st day ~ the 31st day* *MM - months, 1 month/bit; offset of 0 month; data scope: January~December* *YY - 1 year/bit; offset in2000; data scope: 2017~2267* *HH - the 1st hour ~ the 24th hour* *mm – 00 to 59* *SS– 00 to 59*	*Mandatory*	*This field indicates the last charge date and the duration of charge. (Justification provided along with Byte 58)*

			Duration of last charging: 2-bytes, Duration in minutes 0 ~ 600		
58	*6*	*2578*	*Start SoC during last Charging: 2 Bytes, Data resolution: 0.1 % /bit, 0% offset; data scope: 0~100%;* *End SoC during last Charging: 2 Bytes, Data resolution: 0.1 % /bit, 0% offset; data scope: 0~100%;* *Distance travelled since last charge: 2Bytes, distance in km*	*Mandatory*	*This field indicates the start SoC and end SoC.* *With the combination of SOC changed and information from Byte 50 (above e.g. duration of charge), the charger can get crucial information of health of battery. The charger can do some extra checks in some special cases to ascertain if the charging can be continued or not, e.g. how soon the battery is discharging, residual capacity of battery etc.* *Will also enable the second use of battery along with byte 63.*

64	*1*	*2579*	*Last Charging End Reason, 1 byte: 00 <Normal>, 01<Charger Terminated>, 10 <BMS Terminated>*	*Mandatory*	*This parameter can help in deciding whether to proceed with charging or do some diagnostics test if last charging was terminated by charger, before proceeding with charging*
65	*1*	*2580*	*Continuous charge failure due to battery count: 1 byte, the number of consecutive times the charging session was terminated because of a BMS error. If this number reaches a threshold, the charger will not attempt to charge the battery and will indicate same in CST Fault case bits 13 and 14 as 01. (Refer table A.3.3.)*	*Mandatory*	*If the charging fails continuously and upon reaching certain threshold number, the charger can generate fault case as indicated in bits 13 and 14 of CST.*
66	4	2581			

* Optional parameters can be mandated based on the class of vehicles by power regulatory.

B3.3. PGN256Charger Recognition Message (CRM)

TABLE B.3.3: CHARGER RECOGNITION MESSAGE (CRM) FORMAT

Start byte or bit	Length	SPN	SPN definition	Delivery option
1	1 byte	2560	Recognition result, (<0x00>:=BMS recognizable; <0xAA>: =BMS recognizable)	Mandatory
2	4 bytes	2561	Charger No., 1/bit; 0 offset; data scope:0~0 xFFFFFFFF	Mandatory
6	3 bytes	2562	Charger/charging station location code, standard ASCII code	Mandatory
9	*4 bytes*	*2563*	*Swapping Station charger code (SSCC) indicating Unique serial number of the vendor. Charging starts upon acceptance of SSCC by BMS. If not, charging is suspended as per BST (PGN6400)*	*SSCC is mandatory for swapping stations. In case of public charging, all bytes shall be filled with FFH.*

B3.4. PGN6656Charger Suspending Message (CST)

TABLE B.3.4 PGN6656 MESSAGE INTERPRETATION

SPN	SPN Definition	Start bit	Stop bit	Meaning	Bit-1	Bit-2	Meaning	Justification
3521	Cause for charger suspending charging	1	2	suspends due to reaching the condition set by charger	0	0	Normal	
					0	1	suspends due to reaching the condition set by charger	
					1	0	untrusted state	
		3	4	suspends artificially	0	0	Normal	
					0	1	artificial suspension	
					1	0	untrusted state	
		5	6		0	0	Normal	

				fault suspension	0	1	Fault	
					1	0	untrusted state	
		7	8	BMS actively suspends	0	0	Normal	
					0	1	BMS suspension (receive BST frame);	
					1	0	untrusted state	
3522	Fault cause for charger suspending charging	1	2	charger over temperature	0	0	charger temperature normal	
					0	1	charger over temperature	
					1	0	untrusted state	
		3	4	charging connector fault	0	0	charging connector normal	
					0	1	charging connector fault	
					1	0	untrusted state	
		5	6	charger is over temperature at the internal part	0	0	internal charger temperature normal	
					0	1	internal charger over temperature	
					1	0	untrusted state	
		7	8	the required electric quantity cannot be transmitted	0	0	electric quantity is transmitted normally	
					0	1	electric quantity cannot be transmitted;	
					1	0	untrusted state	
		9	10		0	0	normal	

				sudden stop of charger	0	1	sudden stop of charger	
					1	0	untrusted state	
		11	12	other faults	0	0	normal	
					0	1	fault	
					1	0	untrusted state	
		13	*14*	*abort on continuous failure threshold breach*	*0*	*0*	*normal*	Abort when the charger had failed to charge the battery continuously due to the threshold breach or the BMS manufacturer not in the white list(as an option if only certain manufacturers are allowed or not allowed)
					0	*1*	*fault*	
					1	*0*	*untrusted state*	
		15	*16*	*abort on BMS manufacturer code not in white list of Charger*	*0*	*0*	*BMS manufacturer ASCII code present in allowed list*	
					0	*1*	*BMS manufacturer ASCII code not present in allowed list*	
					1	*0*	*untrusted state*	
3523	Error cause for charger suspending charging	1	2	current mismatching	0	0	current is normal	
					0	1	current matching	
					1	0	current mismatching	
		3	4	voltage is abnormal	0	0	normal	
					0	1	abnormal	
					1	0	untrusted state	

B3.5. PGN6400BMS Suspending charging Message (BST)

TABLE B.3.5 PGN6656 – BMS SUSPENDING CHARGING MESSAGE INTERPRETATION

PGN	SPN	SPN Definition	Start bit	Stop bit	Meaning	Bit -1	Bit -2	Meaning	Comments
6400 (BST)	3511	Cause for BMS suspending charging	1	2	reach the required SOC target value	0	0	fails to reach the required SOC target value	
						0	1	reach the required SOC target value	
						1	0	untrusted state	
			3	4	reach the setting value of total voltage	0	0	fails to reach the setting value of total voltage	
						0	1	reach the setting value of total voltage	
						1	0	untrusted state	
			5	6	reach the setting value of single voltage	0	0	fails to reach the setting value of single voltage	
						0	1	reach the setting value of single voltage	
						1	0	untrusted state	
			7	8	charger actively suspends	0	0	Normal	
						0	1	Charger suspension (receive CST frame);	
						1	0	untrusted state	
	3512	fault cause for BMS suspending charging	1	2	insulation fault	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
			3	4	output connector over temperature	0	0	normal	
						0	1	fault	
						1	0	untrusted state	

			5	6	BMS component and output connector over temperature	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
			7	8	charging connector fault	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
			9	10	battery set over temperature	0	0	normal	
						0	1	over temperature	
						1	0	untrusted state	
			11	12	high voltage relay fault	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
			13	14	voltage detection fault at check point 2	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
			15	16	other faults	0	0	normal	
						0	1	fault	
						1	0	untrusted state	
	3513	error cause for BMS susp	1	2	excessive current	0	0	current is normal	
						0	1	current exceeds the demand value	
						1	0	untrusted state	

		ending charging	3	4	voltage is abnormal	0	0	normal	
						0	1	abnormal	
						1	0	untrusted state	
			5	*6*	*Vendor code is not matching*	*0*	*0*	*normal*	Abort when the vendor code is not available in the BMS list of acceptable vendors
						0	*1*	*abnormal*	
						1	*0*	*untrusted state*	