	Document Title: Best Practices for Vehicle Manufacturers - Interoperability			Classification : EXTERNAL	
Document No	DOC-EVSE-016	Last edit date	8/15/2023	Revision	A00
Issuing department	Hardware Engineering		Status of document	RELEASED	
Affecting product ID(s):	CCS Capable Electric Vehicles				
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Distribution control	Hardware Engineering				
Approved by:	Keith Beckstead		Final Approval Date:	8/15/2023	

Best Practices for Vehicle Manufacturers - Interoperability

OEM, SPEC

Revision: A00

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Revision History

Rev #	Revision Description	Updated by	Approved by	Date
A00	Initial Revision	Jeremy Bibeau	Keith Beckstead	8/15/2023

1. Introduction

1.1. Purpose/Objective:

The purpose of this document is to define a set of hardware and software best practices for electric vehicles to ensure seamless interoperability between electric vehicles (EV) and electric vehicle supply equipment (EVSE), specifically on the EVgo network. Many of the requirements listed in this document are either not included in any widely recognized standards or left for interpretation. Some requirements highlight existing standards requirements that are often not properly implemented. The requirements laid out help to improve either the safety or convenience of the charging experience.

1.2. Scope:

The requirements in this document apply to all battery electric vehicles (BEV) that are capable of DC fast charging via a CCS1 connector.

1.3. Documentation:

ISO 15118-2:2014	Road vehicles - Vehicle-to-Grid Communication Interface - Part 2: Network and application protocol requirements
ISO 15118-20:2022	Road vehicles - Vehicle to Grid Communication Interface - Part 20: 2nd generation network layer and application layer requirements
DIN 70121:2012	Electromobility - Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging
SAE J1772:2017	SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler
IEC 61851-23:2014	Electric vehicle conductive charging system - Part 23: DC electric vehicle charging station

1.4. Definitions:

BEV	Battery Electric Vehicle
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
SLAC	Signal Level Attenuation Characterization

2. Best Practices

2.1. Accepted Protocols

Vehicles shall be capable of communicating using the DIN 70121 and ISO 15118-2 protocols.

Supporting these protocols will help to promote interoperability with all generations of DC fast chargers. In the future, it will also be recommended that all vehicles are capable of using ISO 15118-20.

2.2. SLAC Timing

Vehicles shall send CM_SLAC_PARM.REQ as quickly as possible after a state change to B2, waiting no longer than 3 seconds.

Although the requirement for beginning SLAC is a maximum of 10 seconds, it is ideal to have this initiate as quickly as possible. This helps to reduce the overall time that customers wait before charging begins. Additionally, SLAC shall initiate no sooner than 200ms to avoid communication problems.

2.3. Authentication Timeout

For both DIN 70121 and ISO 15118, vehicles shall wait at least 150 seconds in contract authentication/authorization before triggering a timeout.

Authentication timeout is one of the most frequently observed errors on the EVgo network. Relevant standards specify timeouts as short as 60 seconds for contract authentication. After plugging in their vehicle, many customers take more than a minute to authenticate for a variety of reasons (app download, searching for credit card/RFID card, etc.). Extending this timeout will help to improve first plug-in success rates for customers.

2.4. Cable Check Timeout

For both DIN 70121 and ISO 15118, vehicles shall wait at least 60 seconds in cable check before triggering a timeout.

For EVSEs that power share, additional time is required to reallocate power modules between dispensers. As a result, a timeout level of 60 seconds will provide adequate time for this process to complete.

2.5. Inclusion of Maximum Power Limit

Vehicles shall include the maximum power rating of the vehicle in charge parameter discovery and current demand.

In DIN 70121 (Table 71) and ISO 15118-2 (Table 101), maximum power limit is considered an optional parameter. However, this parameter can be useful for the EVSE to provide accurate power allocation. The parameter is mandatory in ISO 15118-20.

2.6. Charge Parameter Discovery Matches Current Demand

The maximum voltage, current, and power limits provided in charge parameter discovery shall match the values provided in current demand.

Similar to §2.4, these values are used for power sharing and can negatively impact charger behavior if they are not consistent.

2.7. Respect EVSEIsolationStatus

In the event of a "Fault" isolation status, the vehicle shall perform a normal shutdown, if not already initiated by the EVSE.

Although the EVSE is designed to initiate a normal shutdown in the case of an isolation fault, the vehicle should also detect this status and perform a shutdown in the case that an EVSE does not properly shutdown.

2.8. Respect EVSEStatusCode

In the event of an EVSE_Shutdown or EVSE_EmergencyShutdown status code, the vehicle shall stop sending current demand requests and send a power delivery request.

It is important that the vehicle halt any further current demand requests once a shutdown is requested by the EVSE, whether it be a normal shutdown or an emergency shutdown.

2.9. Target Voltage

The target voltage given in Current Demand shall be 20 to 30 volts higher than the actual battery voltage.

By giving a buffer of 20 to 30 volts, the EV ensures that the EVSE will not enter voltage mode.

2.10. Current Demand Slew Rate

Once current demand begins, the vehicle's current requests shall increase by at least 10A per second until desired current is reached.

To improve customer experience, it is important to reach full load in a reasonable amount of time (for the appropriate point of the charge curve). EVgo chargers are designed to be able to react quickly to changes in current demand levels.

2.11. Seamless Retry

Vehicles shall initiate SLAC based on the following state change sequence: Any State → E → B1 → B2. The vehicle shall be capable of following this sequence at least five times without unplugging the cable.

In the case of non-emergency failures, EVgo EVSEs will perform a "seamless retry" by changing to state E, then to state B1, and finally to state B2. The vehicle must reinitiate SLAC in order to restart the charge without the need for a cable re-plug. This helps to ensure first-plug success for the customer.

2.12. EVCCID and MAC Address

The EVCCID shall match the MAC Address of the EVCC.

Per DIN 70121 and ISO 15118, the EVCCID shall contain the MAC address of the EVCC. On the EVgo network, this is important for the proper function of Autocharge.

2.13. Inlet Locking

The vehicle shall wait to lock the inlet until after Charge Parameter Discovery is finished.

Per J1772 F.1.1, it is recommended that the vehicle wait until after charge parameters have been exchanged to lock the inlet.

2.14. Inlet Unlocking

The vehicle shall unlock the inlet when the current is near zero, voltage at the inlet is below 60VDC, and the EVSE performs a state change to B1.

As long as the current is near zero, voltage is below 60VDC, and the EVSE has transitioned to state B1, the EV and EVSE will be in a safe state to unlock the inlet and allow the customer to remove the cable. Keeping the cable locked with these conditions can cause confusion. Vehicle manufacturers may opt to utilize a button next to the inlet as a final step to unlock the connector, provided the aforementioned conditions are met.

2.15. Stuck Cable Information

EVgo is requesting the following information on all vehicles in order to rectify issues involving a stuck connector.

1. Send instructions to follow on site when a CCS1 vehicle will not release the receptacle latch.
2. Does the vehicle use a linear actuator or receptacle locking mechanism?
3. Is there a mechanical pull cable that will allow for moving the linear actuator back? If so, please send instructions on how to access this.
4. Will a 12V disconnect and reconnect allow for the linear actuator to withdraw?
    a. Send instructions on how the 12V auxiliary battery can be disconnected (or related fuse).
    b. After reconnecting 12V, what is the amount of time before the linear actuator will withdraw?
5. Are there known conditions where the vehicle receptacle will keep the vehicle connector latched even though charge has completed?

2.16. AC Proximity Response

Vehicles shall terminate the charge during AC charging within 100ms of an S3 button press.

Per J1772 Table 14, the EV shall terminate the charge within 100ms of the proximity circuit opening (S3 button press). This helps to prevent arcing between the inlet and connector when the cable is removed during active charging. It is also recommended that the vehicle utilizes an inlet lock for AC charging. Since AC pins can break within less than 100ms from losing proximity and pilot, this will

help to avoid arcing. A button next to the charge port provides a convenient way for a customer to stop the charge and prompt the vehicle to release the lock. The 100ms requirement still applies to vehicles that lock the inlet during AC charging (in case of broken latch).

2.17. Onboard Boost Converter

Onboard boost converters for low voltage EVSEs will require up to 50kW.

On the EVgo network, the only EVSEs that stop at 500VDC have a maximum output of 50kW. Therefore, it is necessary for an onboard boost converter to be rated for up to 50kW.

2.18. Onboard Boost Control System

Control systems for onboard boost converters shall be fixed duty or feedforward.

In order to improve line regulation of the output voltage, control systems shall utilize fixed duty or feedforward circuitry.

2.19. DC Pin Protector Pull Force

The minimum pull force on the DC pin protectors in the charging inlet shall be 40 N.

Compliance to the 40N pull force requirement should be tested after the thermal cycling described in IEC 62196-1 ed 2022. A buildup of foreign objects in a connector can potentially cause damage to pins and forces an angle when inserted that can lead to arcing. The metal pin should include a chamfer just past the isolation cap to reduce the sharp edge, in the event the protective cap does come loose, to prevent abrasion to female pin in EVSE connector. See Figure 1 for a depiction of these protective covers.

Figure 1: DC Pin Protectors