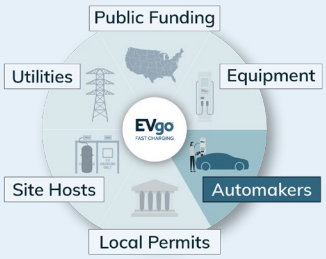
CONNECT THE WATTS™ POWERED BY EVgo

Best Practices for Enhancing Network Reliability & Customer Experience

Vehicle Interoperability



As the adoption of electric vehicles (EVs) continues to grow, one critical aspect that demands attention is the interoperability between the EV and the charging infrastructure. To ensure a seamless charging experience for EV drivers, the EV and the charging infrastructure should harmoniously work together to provide a successful charging session every time a driver plugs in. It is crucial that industry stakeholders, automakers and policymakers follow a similar framework to enhance the entire charging ecosystem's efficiency, accessibility, and customer experience.

Based on the technical expertise at its Innovation Lab in El Segundo, CA, EVgo has identified nine best practices for vehicle interoperability, including 1) Allow Ample Time for Charging Session Authentication Before Time Out, 2) DC Pin Protector Pull Force, 3) Implement Precise Inlet Locking and Unlocking Timing, 4) Respect the Status of All EV Supply Equipment (EVSE), 5) Seamless Retry of Charge Session Set Up to Ensure First-Plug Success for the Customer, 6) Matching the EV Communication Controller ID (EVCCID) and MAC Address, 7) Compatibility with Industry Charging Standards, 8) Appropriately Timed AC Proximity Response, and 9) Standardize Vehicle Port Location.

Allow Ample Time for Charging Session Authentication Before Time Out

Best Practices:

- For both DIN 70121 and ISO 15118, **vehicles shall wait at least 150 seconds in contract authentication/ authorization** before triggering a timeout. This extended timeout will help to improve first plug-in success rates for customers, as this is one of the most frequently observed errors on public fast chargers.
- Similarly, for both DIN 70121 and ISO 15118, **vehicles shall wait at least 60 seconds in cable check** before triggering a timeout.

Practices to Improve:

- Current standards call for as short as 60 second timeout for 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.).

DC Pin Protector Pull Force

Best Practices:

- **The minimum pull force on the DC pin protectors in the charging inlet shall be 40N.** 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 when inserted, forces an angle that can lead to arcing. The metal pin should include a chamfer, just past the isolation cap, to reduce the sharp edge in case the protective cap does come loose, to prevent abrasion to female pin in EVSE connector. In the figure below, red circles indicate where protective covers are currently located.

Implement Precise Inlet Locking and Unlocking Timing

Best Practices:

- The vehicle should 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.
- The vehicle should 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 these three requirements are met, 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 can choose to add a button next to the inlet as a final step to unlock the connector as long as the three conditions are met.

Respect the Status of All EV Supply Equipment (EVSE)

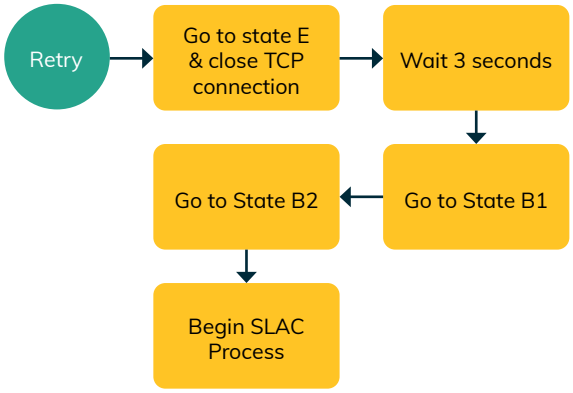
Best Practices:

- 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.
- In the event of a status code of EVSE_Shutdown or EVSE_EmergencyShutdown, 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, either a normal shutdown or an emergency shutdown.

Seamless Retry of Charge Session Set Up to Ensure First-Plug Success for the Customer

Best Practices:

- Vehicles should initiate SLAC (signal level attenuation characterization) 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.



Matching the EV Communication Controller ID (EVCCID) and MAC Address

Best Practices:

- The EVCCID shall match the MAC address of the EV communication controller (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+.

Practices to Improve:

- Do not duplicate MAC addresses.

Compatibility with Industry Charging Standards

Best Practices:

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

Appropriately Timed AC Proximity Response

Best Practices:

- **On board charger shuts down current 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.
- Vehicles should utilize 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).

Standardize Vehicle Port Location

Best Practices:

- Charging stations today must be designed to meet the needs of five different charging port locations on various vehicle models and sizes, meaning charging cables need to be longer—and therefore heavier—to meet all vehicles' charging needs.
- Heavier and longer cables are more likely to be dropped and damaged by EV drivers, including driving and tripping over. They also require more materials, making them a target for vandalism and decreasing efficiency of charging. Greater standardization of port location across vehicle models, similar to internal gasoline fuel inlets, can simplify station design and improve customer experience, especially for drivers with disabilities.

Useful Links

- EVgo Innovation Lab Webpage
- Full Vehicle Interoperability Best Practices

Protocols

Road Vehicles – Vehicle to Grid Communication Interface:

- ISO 15118-2: 2014
  https://www.iso.org/standard/55366.html
- ISO 15118-20: 2022
  https://www.iso.org/standard/77845.html

Electromobility – Digital communication between a DC EV charging station and an EV for control of DC charging in the Combined Charging System:

- DIN SPEC 70121:
  https://www.en-standard.eu/din-spec-70121-electromobility-digital-communication-between-a-d-c-ev-charging-station-and-an-electric-vehicle-for-control-of-d-c-charging-in-the-combined-charging-system-text-in-english/