# Vehicle Electrification System Standards

## IX. On-Board High Voltage Battery Charging Systems

# IX.d On-Board High Voltage Battery Charging Systems Operation

Overview:

On-Board High Voltage Battery Charging Systems Operation

- Level 1 On-Board Charging & Battery Pack Charging Control
  - On-Board Charger Connection Diagram
  - Charger kW Ratings
  - On-Board Charger Connection to Utility Power
  - On-Board Charger Contactor Connection to Battery Pack
  - The BMS and Charging Systems Relationship
  - Battery Charge Time vs. Charger kW Rating
  - Actual SOC% vs. Vehicle Displayed SOC%
  - SAE J1772 Charger Controls
  - On-Board Charger Charging Algorithms (CC/CV & Others)
  - Advanced Charging Methods: Pulse Charging
  - Battery Balancing During Charging
  - Battery Cell/Module Diagnostics During Charging & Rest
  - On-Board Charger Cooling Systems
- Air/Liquid Cooling System
- Air Cooling System & Ducting
- Liquid Cooling System
- Components
- Routing

- Level 2 On-Board Charging & Battery Pack Charging Control
  - On-Board Charger Connection Diagram
  - Charger kW Ratings
  - On-Board Charger Connection to Utility Power
  - On-Board Charger Contactor Connection to Battery Pack
  - Battery Charge Time vs. Charger kW Rating
- Air/Liquid Cooling System
- Air Cooling System & Ducting
- Liquid Cooling System
- Components
- Routing

- Level 3 On-Board Charging & Battery Pack Charging Control
  - On-Board Charger Connection Diagram
  - Charger kW Ratings
  - On-Board Charger Connection to DCFC
  - Contactor Connection to Battery Pack
  - Battery Charge Time vs. Charger kW Rating
  - CHdeMO Charger Controls
  - SAE CCS Charger Controls
  - Tesla Charger Controls(?)
  - Advanced Charging Methods:  Pulse Charging
- Liquid Cooling System
- Components
- Routings

## Description:

The High Voltage On-Board Battery Charger (OBC) provides a charging interface between Utility AC electrical power and the DC high voltage battery.  The input voltage to the OBC is Utility power @ 220/240Vac and the DC output varies, depending on the required voltage to charge the DC high voltage battery pack.  The output current of the OBC will determine how fast the high voltage battery pack can be charged.  The OBC CC/CV charging algorithms provide targeted charging

controls. Students need to compare and contrast the differences in SAE J1772 & CCS, CHAdeMO, and Tesla charging connector architecture that comprise the mainstream charging mechanizations. Locations of the OBC vary with each OEM.

## Outcome (Goal):

High Voltage battery pack charging is one of the most critical systems on PHEV and BEV systems. The OBC kW rating determines how fast the high voltage battery will be charged. Students will be able to identify components in circuit diagrams and how each stage of the OBC operates. The understanding of electrical power for charging a high voltage battery is a critical element of student education, relative to educating customers about OEM vehicle charging systems. Learning how charging times and necessary kW, how CC/CV charging strategies are utilized, charging connector configurations, and diagnosing high voltage battery pack and charging systems failure modes are essential educational elements..

## Objective:

Students shall be able to:

1. Describe how the charging function is enabled by the software control system
2. Explain the CC/CV charging function and the rationale of why this strategy is utilized for charging a Lithium battery
3. Explain the function of each electrical terminal for SAE, CHAdeMO, and Tesla charging connector configurations
4. Explain how OBC kW rating effects the overall high voltage battery pack charging time
5. Fundamentally describe how the battery cell balancing is achieved during battery charging
6. Describe the difference between Displayed SOC% vs. Actual SOC%.
7. Describe the functional operation of the SAE, CHAdeMO, and Tesla OBC charging control systems.

Task:

1. When students are presented with various internal OBC system failure scenarios, documentation, and associated circuit diagrams, they will provide the expected output results
2. When the students are presented with specific OBC charging connector failure modes the student will utilize a charging connector diagnostic tool to confirm the operation of the connector
3. When provided a vehicle with a charging system failure, Students will diagnose the root cause of the failure
4. Students will be able compare and contrast the differences between Level 1, 2, & 3 Charging system operation
5. Students will perform a high voltage battery pack liquid cooling system coolant service using the tools and procedures outlined in the OEM service information
6. Using a worksheet and a live lab vehicle, Students will document Displayed vs. Actual SOC%
7. Students will use OEM service information, supplier technical documents, instructor provided materials, and online documents to complete each task.

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To comment or offer suggestions on this standard, contact Ken Mays:

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