



Electric Vehicle Supply Equipment Basics Review

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What's What? Understanding Terminology



Hybrid Electric Vehicle



Plug-in Hybrid Electric Vehicle



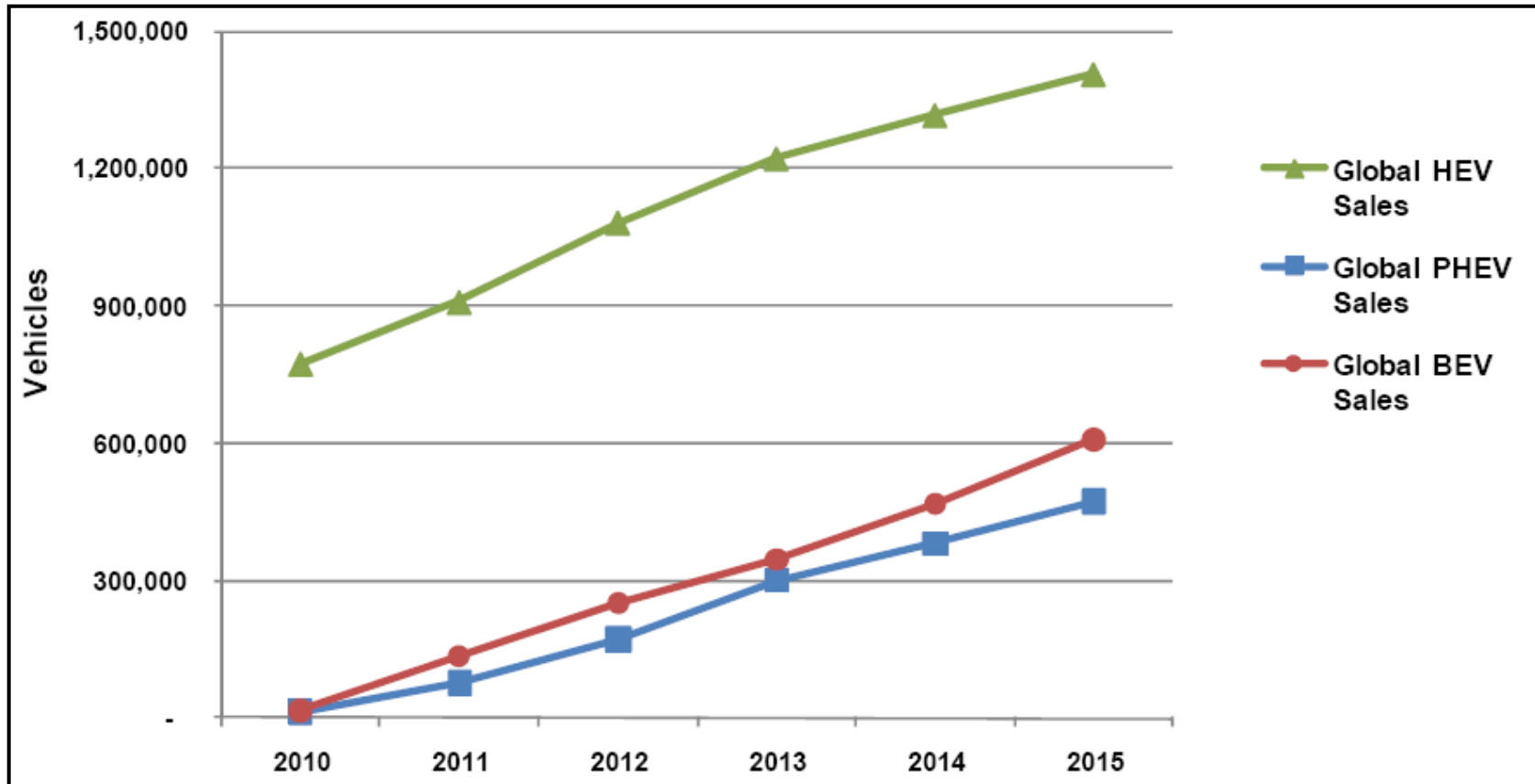
Electric Vehicle



Here come the EV's.....

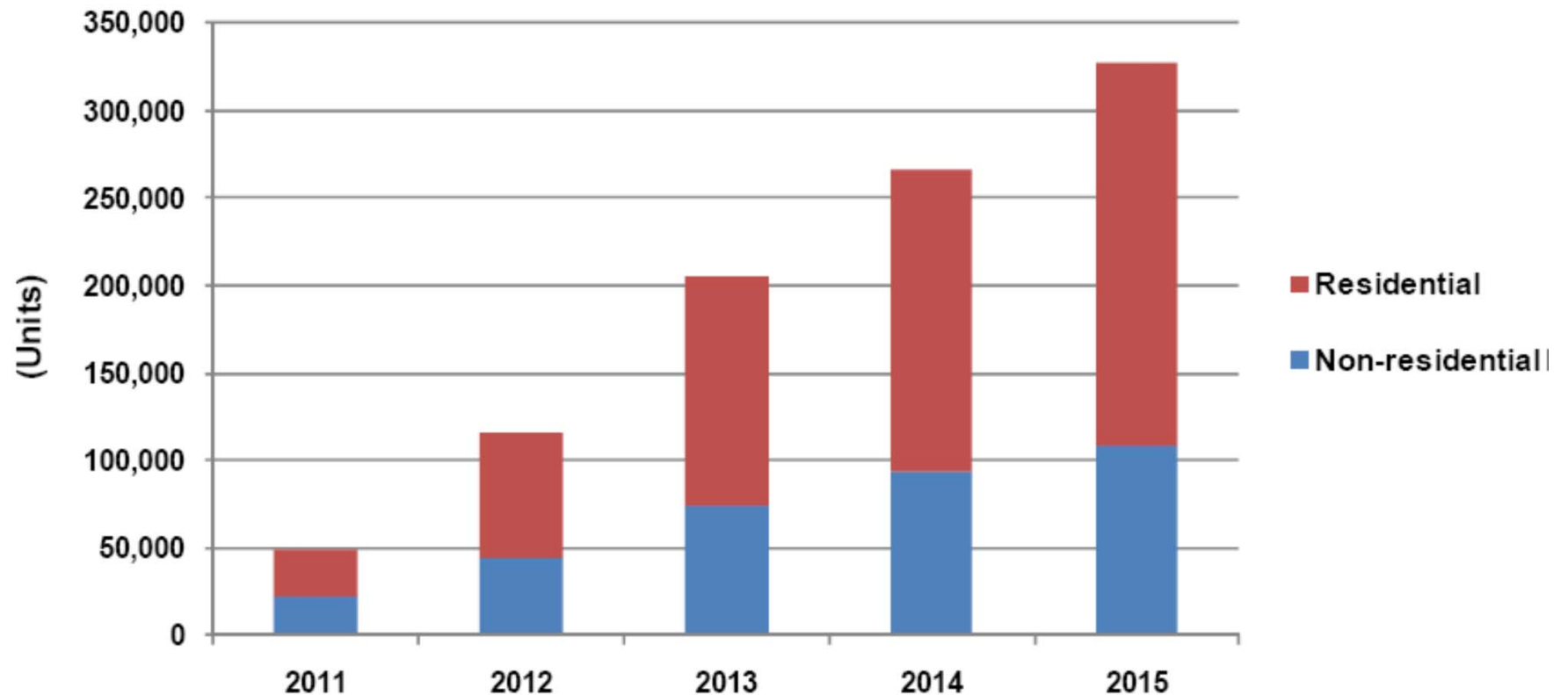


Total Electrified Vehicle Sales, World Markets: 2010 - 2015



Source: Pike Research, Published 3Q 2010

Annual EV Charging Equipment Sales, United States: 2011-2015



Source: Pike Research, Published 3Q 2010

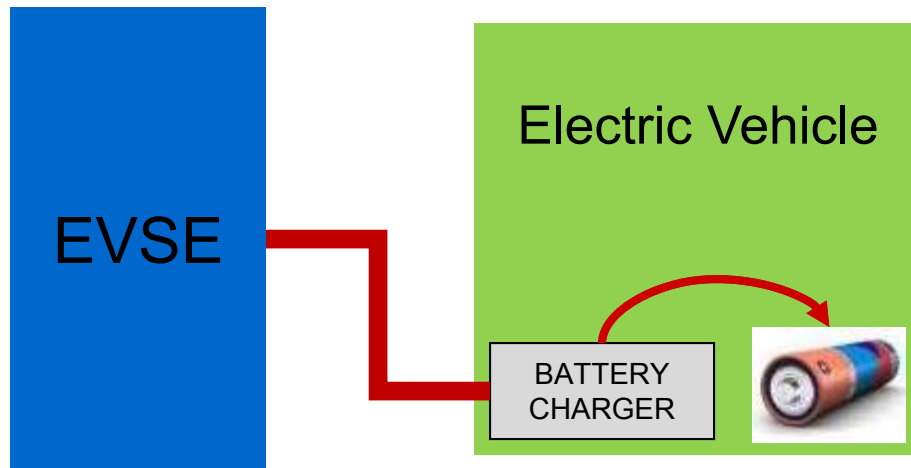
Government Support

- Federal Government
 - Tax credits
 - EV or Plug-in Hybrid (with minimum 4kWH batteries) up to \$7,500
 - Alternative Fuel Vehicle Refueling Property
 - 30% up to \$30,000 for businesses
 - 30% up to \$1,000 for residences
- Check your local and state government incentives. Many were set to end in 2011

Electric Vehicle Supply Equipment (EVSE)

- EVSE
 - Electric Vehicle Supply Equipment
 - General term used for all of the equipment used to supply electricity to the car
 - In most cases, the battery charger resides in the vehicle. EV Supply Equipment is simply regulating the flow of AC power to vehicle charger
 - Only in DC charging is the EVSE equipment directly charging the batteries

How does EVSE work?

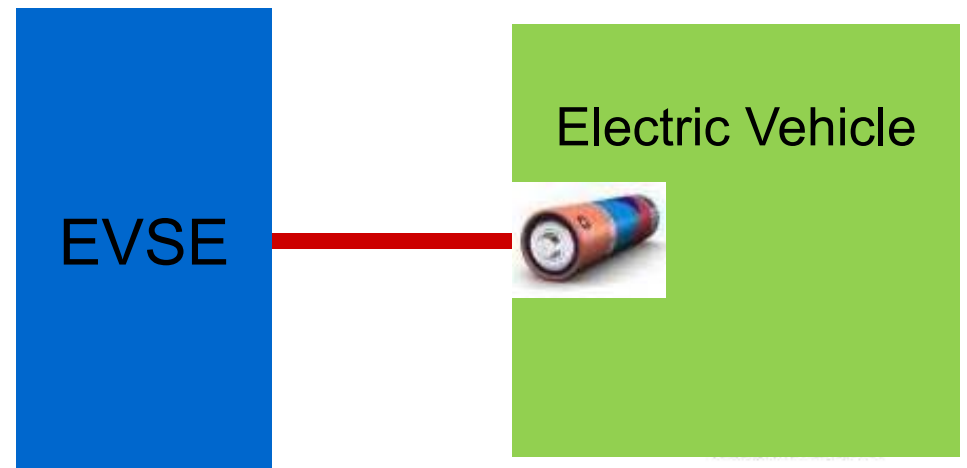


AC Charging

Powers the car's onboard battery charger

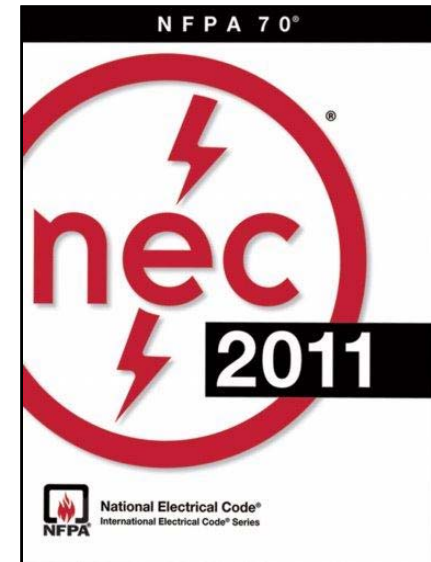
DC Charging

Direct charge to the car's battery



Level Terminology – NEC 2011

- **Article 625 – Electric Vehicle Charging System**
 - **Level 1**
 - 120Vac, 12-16A (up to 2 kW)
 - 15amp or 20amp receptacle
 - **Level 2**
 - 208 or 240Vac, 30-80A (up to 20 kW)
 - **Level 3**
 - DC (undefined)
 - Power requirements specified by equipment manufacturer



Level Terminology – Society of Automotive Engineers (SAE)

- **AC Level 1 – 120V**
 - Single Phase 2kW
- **AC Level 2 – 240V**
 - Single Phase ~20kW
- **AC Level 3 – Undefined**
 - Single or 3 Phase
- **DC Level 1 – 200-450V**
 - $\leq 20\text{kW}$
- **DC Level 2 – 200-450V**
 - ~80kW
- **DC Level 3 – 200-450V**
 - ~120kW



EVSE Overview

Eaton Pow-R-Station™ EVSE Family

Level 1 AC
16amp Receptacle



12 - 18
Hours

Level 1&2 AC
16 & 30amp



4 - 8 Hours

Level 2 AC
30-75amp



4 - 8 Hours

DC Quick
Charger
(Level 2)



20 - 30
Minutes

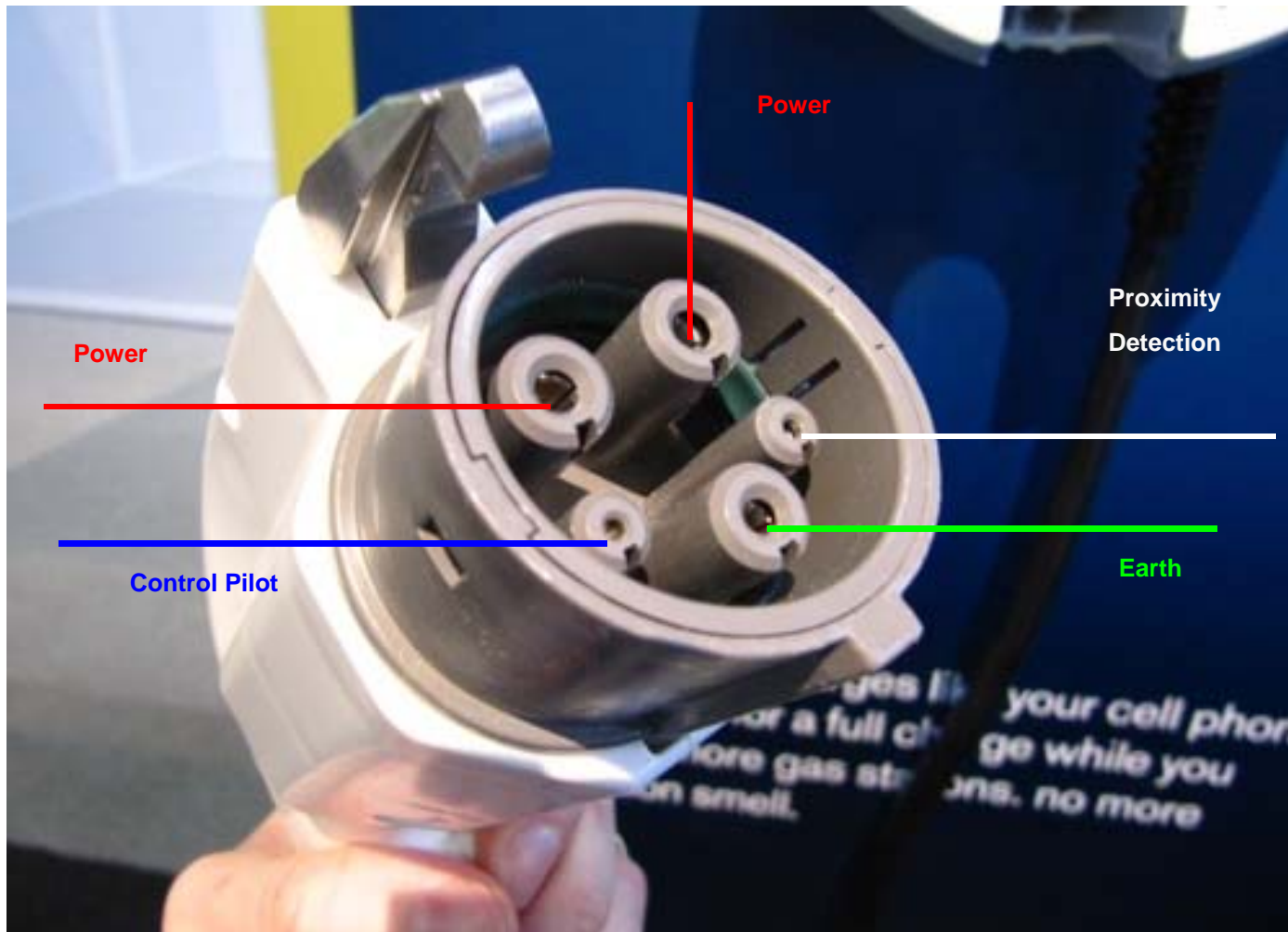
Codes and Standards

- **UL 2594, UL 2231-1, UL2231-2, UL 1998**
- **NFPA NEC Article 625** – Electric Vehicle Charging System
 - Defines the Electrical Code and Requirements around the installation of Electric Vehicle Supply Equipment
 - Considered “continuous loads”
- **SAE J1772™** – Conductive Charging Connector
 - Society of Automotive Engineers J1772 Standards defines the physical medium by which the connection between the EVSE and vehicle is established
 - Defines the details of how the vehicle and EVSE interact during a charging sequence
- **SAE J2836 / J2847 / J2931** –Electric Vehicle Communication
 - Defines communication and messaging between the vehicle and EVSE
 - These standards are in the beginning phases of being drafted
- **CHAdeMO**
 - Association formed by The Tokyo Electric Power Company, Nissan, Mitsubishi and Fuji Heavy Industries; later joined by Toyota using a standard connector for DC quick charging

Lithium-Ion Battery Basics

- **They are lighter. Typical lithium-ion battery can store 150 watt-hours of electricity in 1 kilogram of battery. (6 times as much as Lead Acid and 2x as much as Nickel-metal Hydride (NiMH))**
- **They hold their charge. A lithium-ion battery pack loses only about 5 percent of its charge per month, compared to a 20 percent loss per month for NiMH batteries.**
- **They have no memory effect, which means that you do not have to completely discharge them before recharging, as with some other battery chemistries**
- **Lithium-ion batteries can handle hundreds of charge/discharge**

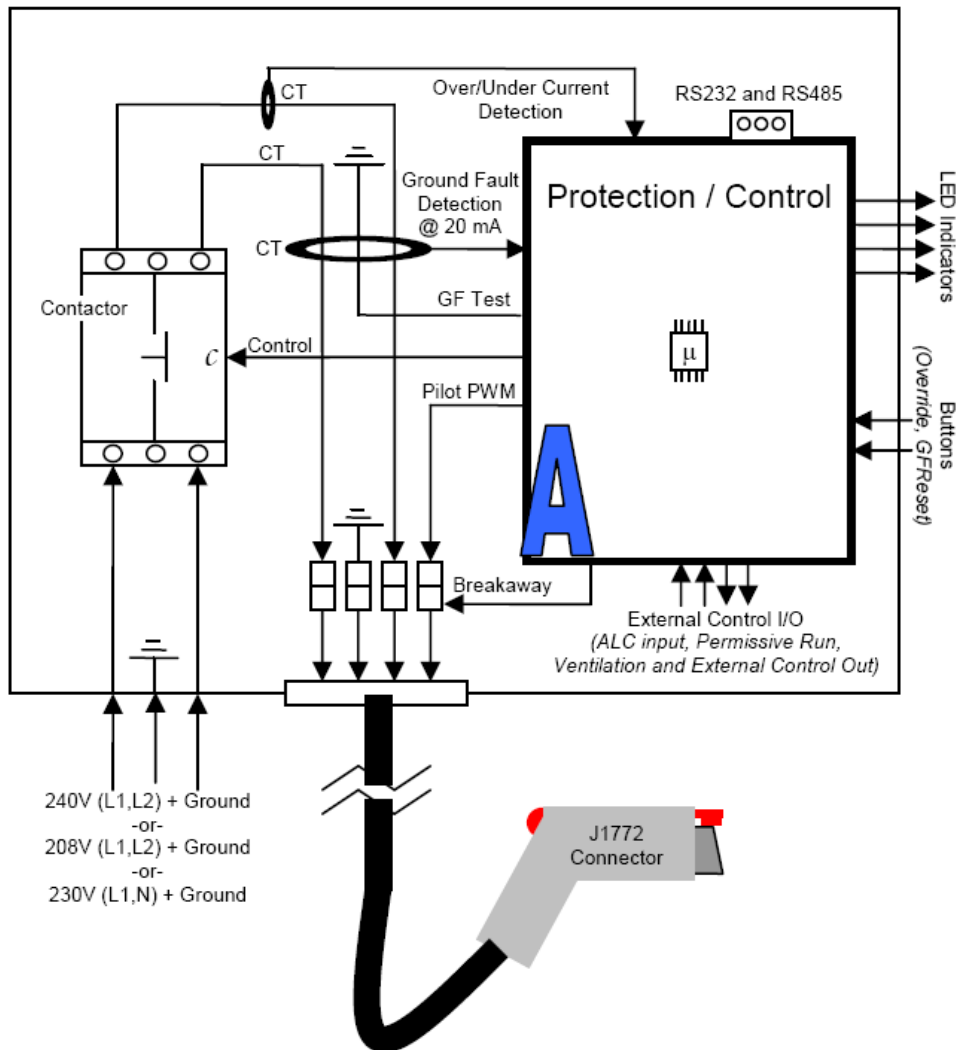
SAE J1772™ Connector



SAE J1772 Handshake – High Level - How Does It Work?

- **Step 1:** Driver plugs J1772™ connector into the inlet located on EV
- **Step 2:** EVSE confirms that it is a car by waking it up through one of the pins in the connector
 - Note: Five pins on the connector have no AC power to them at this point - safe to touch
- **Step 3:** EV tests to make sure it is connected to an EVSE, and then tells the EVSE whether the battery needs ventilation
 - Note: Ventilation in most cases is not necessary
- **Step 4:** EVSE responds by telling the EV the EVSE's available line current (ALC)
 - Note: Maximum current that the EV is allowed to draw
- **Step 5:** EV's onboard battery charger uses this information to compare to its own maximum current to find the lesser of the two
- **Step 6:** Power is turned on by the EVSE to the connector

AC Level 2 EVSE Overview









- Protection and Control Board
 - Handles hand-shaking with the EV
 - Monitors, stops/starts flow of electricity
 - Protects from over/under current, ground fault, breakaway, etc
 - SAE J1772 Compliant
- Electrically operated Contactor sends power to the EV

AC Level 2



Understanding the User Interface

	Blink	Steady
	Payment / Authorization Needed	Unit Ready for Charge Session
	Vehicle Connected, EVSE Ready, Waiting on Vehicle	Vehicle Charging
	N/A	Vehicle Has Ended Charge (May begin again at anytime)
	Rate of Charge Controlled Remotely and Charging Set to INACTIVE	Rate of Charge Controlled Remotely and Charging ACTIVE
	Temporary Fault. (Usually vehicle related) Press the reset button on the bottom right of the interface to retry charge session	
	Internal Charging Station Error. Discontinue Use	

Level 2 DC – Commercial / Fleet

- CHAdeMO protocol
- Output: 50 kW, 400 VDC at 125 ADC
- Can charge a 16kWh battery to 80% capacity in 20 minutes
- Outdoor rated cable
- Compatible with LEAF and i-Miev
- GM and Ford do not have a DC inlet as of yet

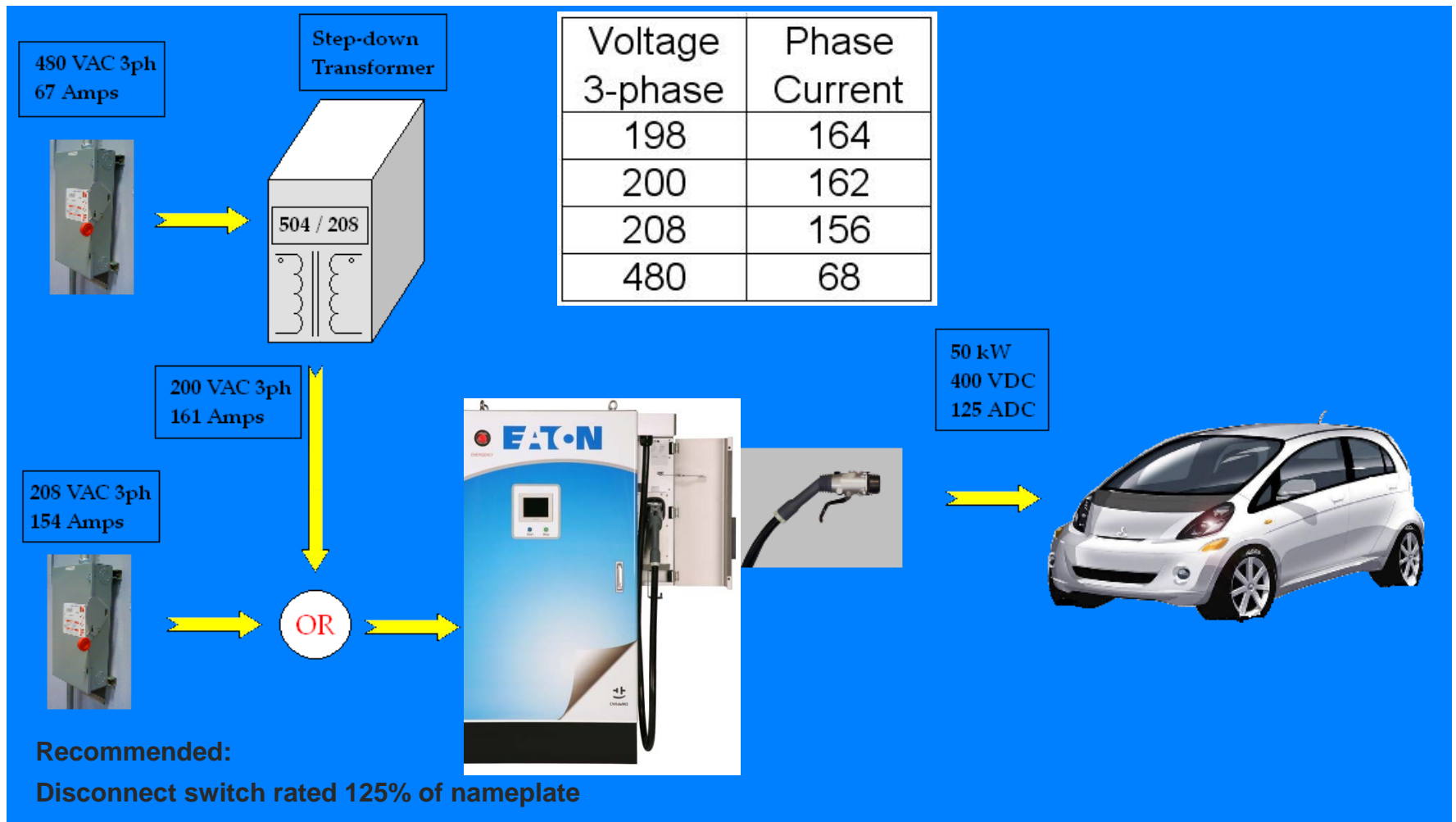


Power Flow with 208 VAC Input

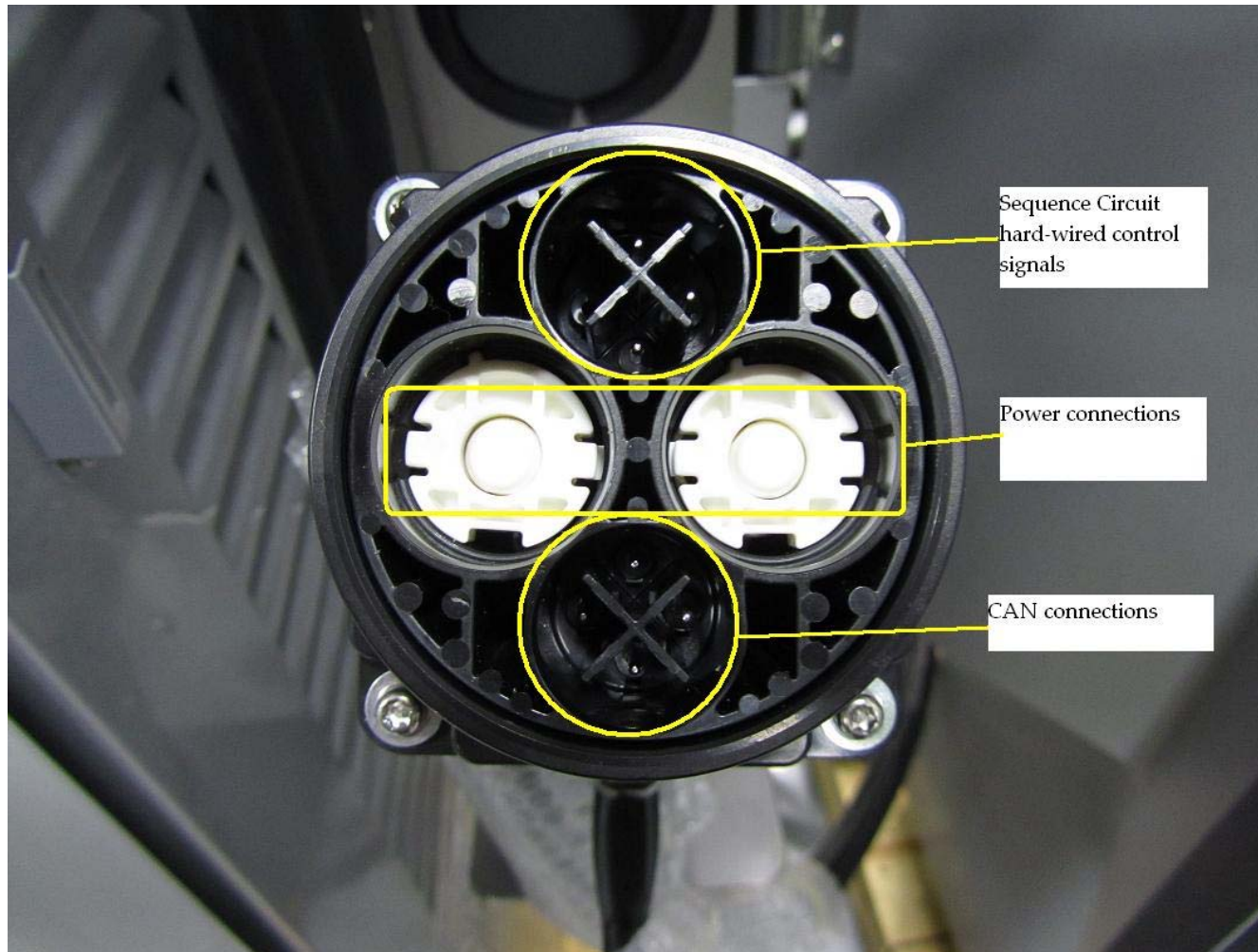


Power Requirements

Eaton's 50kW DC Quick Charger



CHAdeMO Quick DC Charge Connector

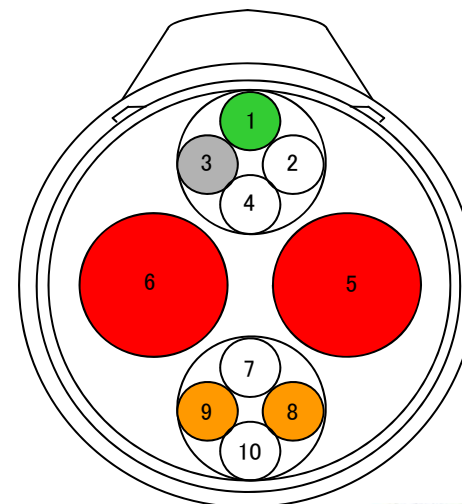
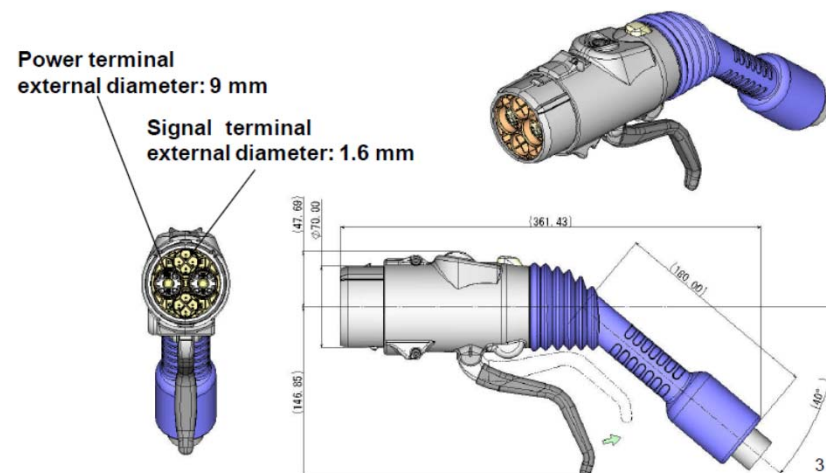




CHAdeMO

CHAdeMO Overview

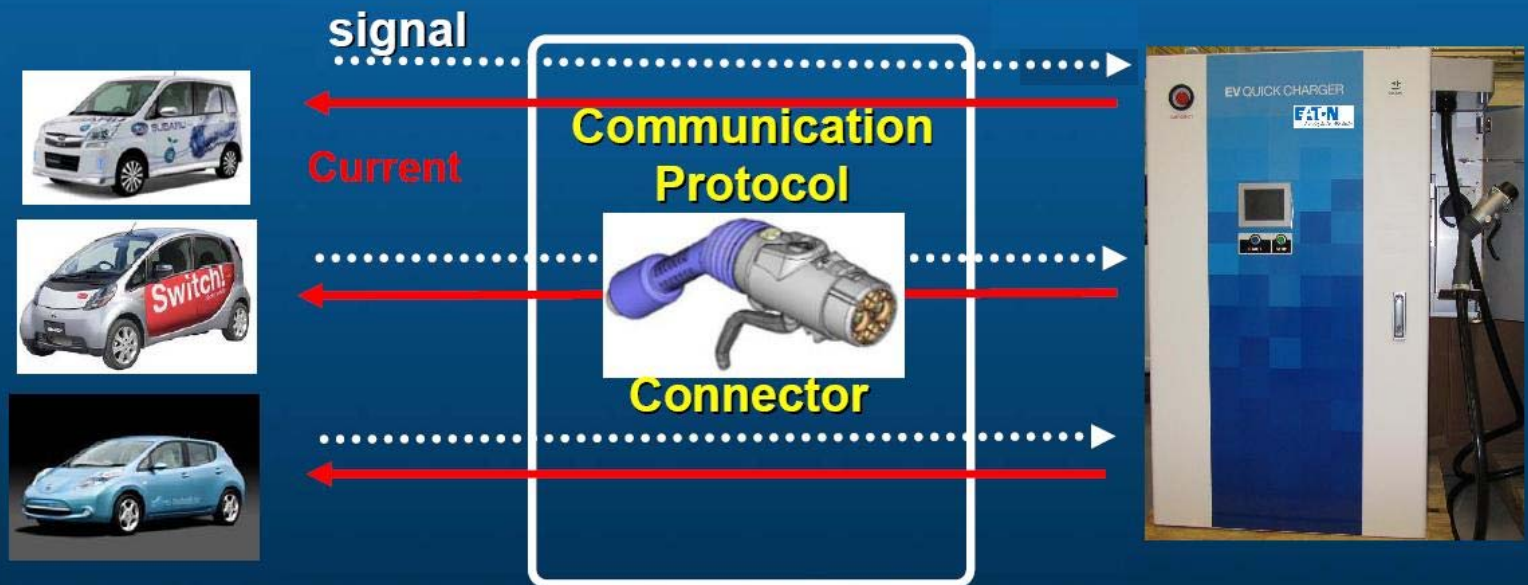
- JARI-specified connector and system
- TEPCO-specified communications and system requirements
- 125A and 500V (60kW)
- 10-pin connector
 - 2 power pins
 - 2 communication pins (CAN-bus)
 - 2 charger start/stop pins (EV Contactor Control)
 - 1 proximity detection pin
 - 1 charging enable/disable pin
 - 1 ground reference pin
 - 1 unused pin



CHAdeMO Basic Description of DCQC Operation

How CHAdeMO charger works:

- **EV computer unit decides** charging speed based on BMS observation.
- Charging current signal is sent to charger using CAN bus.
- Charger supplies DC current following the request from EV.



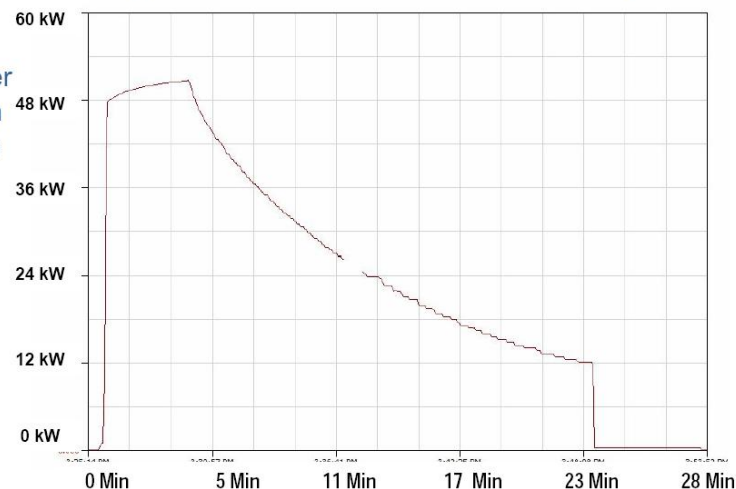
CHAdeMO is More Than a Connector Specification

- Includes basic electrical safety and structure
- Safety interlock to avoid energizing the connector before it's safe (similar to [SAE J1772](#))
- EV transmits battery parameters to the charging station:
 - voltage at which to stop charging
 - target voltage
 - total battery capacity
 - while charging the station has to vary its output current according to signaling from the car

- 50 kW peak

- Roughly 5 miles per minute of charge in the first 10 minutes of charge

- 6 kWh delivered in the first 10 min; 5 kWh in the remaining 13 minutes



Electric Vehicles with CHAdeMO Interfaces



Subaru Plug-in Stella

Passengers: 4
Weight: 1010kg
Driving range: 90km(10-15 mode)
Battery: 9.2kWh



Protoscar LAMPO2

Passengers: 2
Weight: 1580kg
Driving range: 200km
Battery: 32kWh



Mitsubishi i-MiEV

Passengers: 4
Weight: 1100kg
Driving range: 160km(10-15 mode)
Battery: 16kWh



Peugeot iON

Passengers: 4
Weight: 1100kg
Driving range: 160km(10-15 mode)
Battery: 16kWh




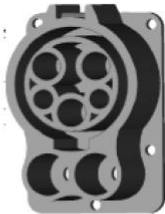
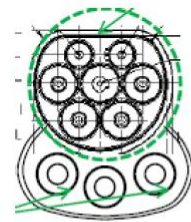

Nissan LEAF

Passengers: 5
Weight: 1520kg
Driving range: 200km(JC08 mode)
Battery: 24kWh

TEPCO Shows DCQC Connector Proposals at CHAdeMO Meeting

Main topic of IEC62196-3 and IEC61851-24

Type of coupler (62196-3)

Japan	US	Germany	China
CHAdeMO	COMBO of AC type 1	COMBO of AC type 2	DC dedicated
			

Communication method and protocol (IEC 61851-24)

Japan	US/Europe		China
CAN	PLC	In-band	CAN

- There are four different proposals of connector shape.
- There are four different proposals of communication protocol, however the U.S. is also considering CAN.
- Only CHAdeMO is available in the market. Other proposals are just design/prototype, not existing.

EVSE Revenue and Fleet Management



Wide Variety of Implementation Schemes

Credit Card Processing

Basic RFID – lock & key access

User Authentication with RFID

Synchronous code generation

keypad – stored codes, time based codes, pay by phone service

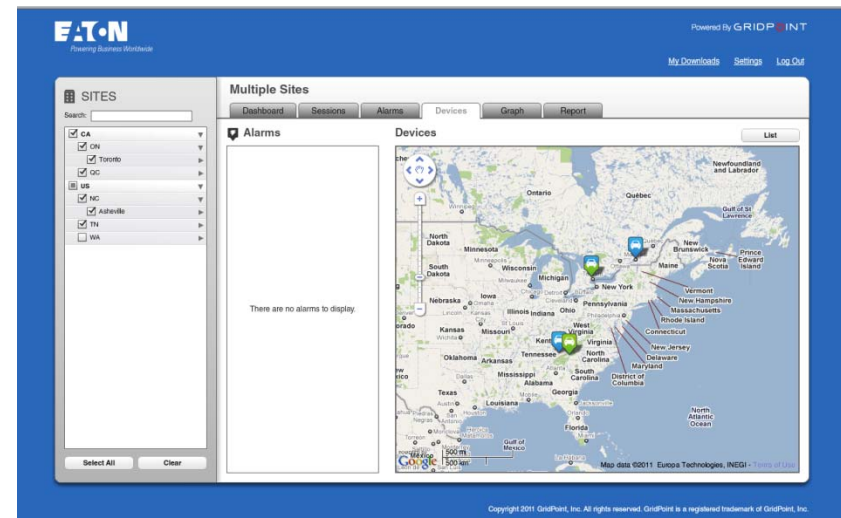
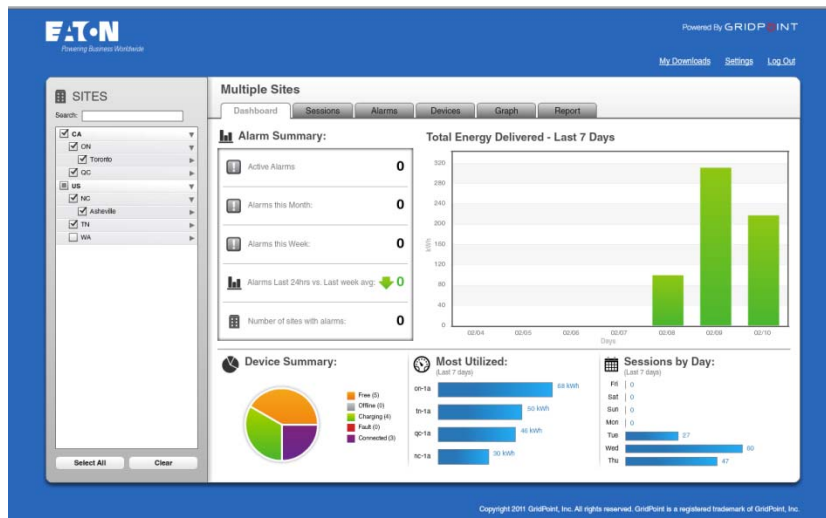
Pow-R-Station™ Network Manager Software

Web Portals for:

- User Authentication
- Fleet, EVSE & Load Management
- Network Provisioning
- Real Time Reporting & Monitoring

Deploy *your* network to:

- Increase System Uptime
- Reduce energy costs
- Maximize charger reliability





Questions?

Website

www.eaton.com/plugin

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