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Bureau of Indian Standards

ANSI

U.S.–India Standards and Conformance Cooperation Program (SCCP), Phase II

U.S.-India Virtual Standards Workshop
The Future of Electric Vehicles in India

Session 1
EV Charging Standards and Protocol

February 18, 2021

U.S.–INDIA SCCP

U.S.-India Standards and Conformance Cooperation Program (SCCP), Phase II

Opening Remarks

United States Trade and Development Agency

Mehnaz Ansari, USTDA Representative, India, South and Southeast Asia

U.S. Department of Commerce

Aileen Nandi, Senior Commercial Officer, India

Bureau of Indian Standards

Jayanta Roy Chowdhury, Deputy Director General— Standardization (Products and Methods)

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EV CHARGING GLOBAL SAFETY REQUIREMENTS

Rich Byczek

Global Technical Director, Intertek Transportation Technologies

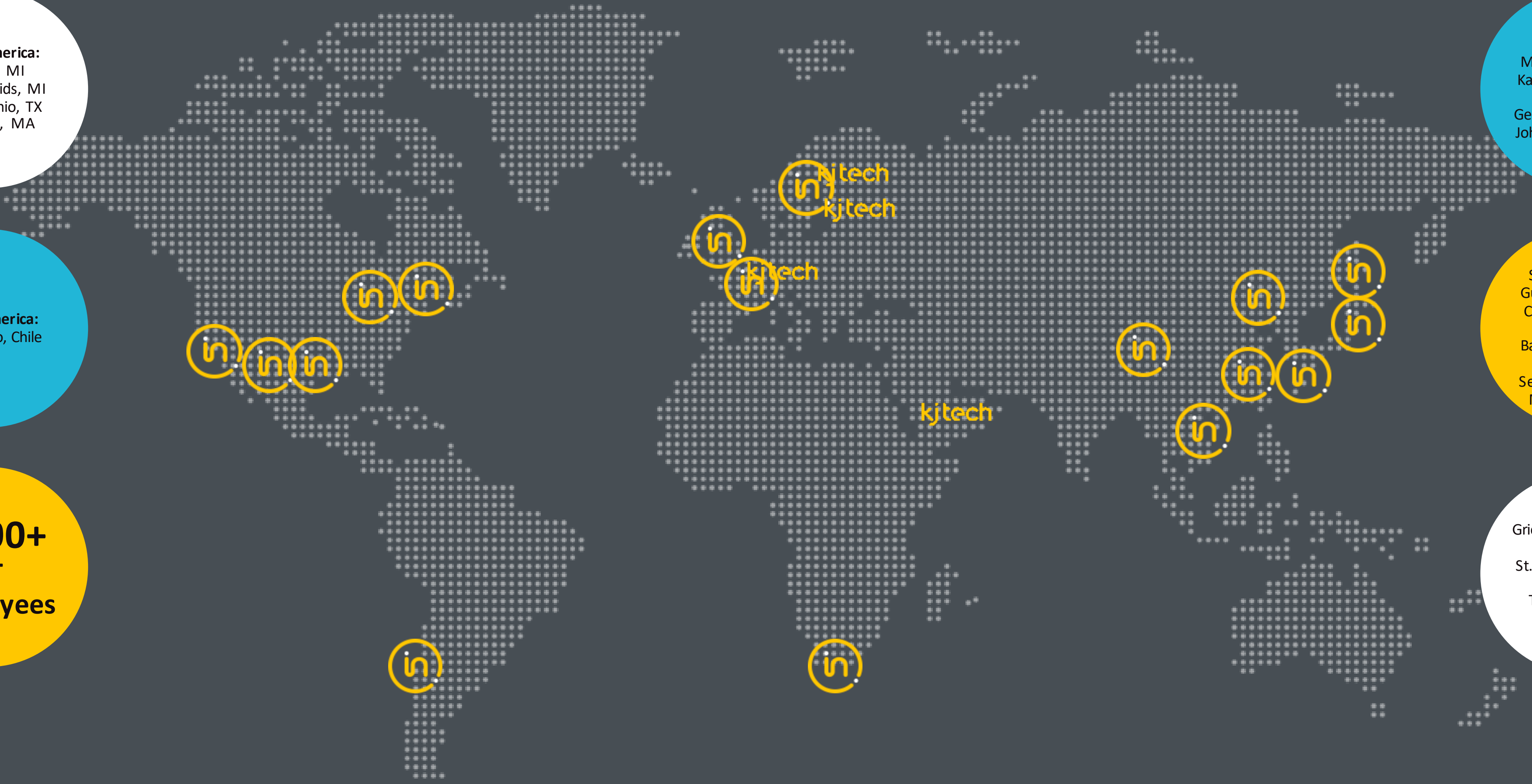
AGENDA

A GLOBAL AUTOMOTIVE AND ELECTRIC VEHICLE FOOTPRINT

North America:
Detroit, MI
Grand Rapids, MI
San Antonio, TX
Pittsfield, MA

South America:
Valparaiso, Chile

1,100+
TT
employees



EMEA:
Milton Keynes, UK
Kaufbeuren, Germ.
Kista, Sweden
Geleen, Netherlands
Johannesburg, S.A.

APAC:
Shanghai, China
Guangzhou, China
Chongqing, China
Wuhan, China
Bangkok, Thailand
Taipei, Taiwan
Seoul, South Korea
Matsuda, Japan

kjtech
Griesheim, Germany
Lulea, Sweden
St. Petersburg, Rus.
Dubai, UAE
Temporary Test
Centers

ELECTRIC VEHICLE TESTING

From battery packs to charge stations

- Battery Testing
- UNECE R100.02
- EVSE Certification
- EV Interoperability
- SAE J1772 / J2953
- CHAdeMO
- ETL Safety Mark

ETL LISTED Intertek

02

EVSE TYPES AND RELATED STANDARDS

WHAT IS EVSE?

EVSE: **E**lectric **V**ehicle **S**upply **E**quipment

The US Electrical code (NFPA 70) Article 625 gives the following definition

625.1 Scope – The provisions of this article cover the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means, and the installation of equipment and devices related to electric vehicle charging

NOTE: While vehicle on-board systems (couplers, DC-AC converters/ chargers) may perform some of these functions, they are typically considered as separate from the EVSE.

Charge Stations: AC Power Transfer

UL 2594, 2nd edition 2016, CSA 22.2 #280-13 and NMX-J-677-ANCE-2013
Safety Standard for Electric Vehicle Supply Equipment

NFPA 70
US National Electric Code, article 625

IEC 61851-1, 3rd edition 2017
Electric vehicle conductive charging system – Part 1: General requirements

IEC 62752, 1.1 edition 2018
In-Cable Control and Protection Device for mode 2 charging of electric road vehicles (IC-CPD)

Charge Stations: AC Power Transfer

Wall Mount Charge Station for homeowners – typically mounted in the homeowner or business garage or parking areas and permanently connected for high amperage charging. (US 208-240VAC 1P, elsewhere 220-250VAC 1P/3P). Often Referred as "Level 2" Charge Stations

Municipal Charge Station –. Can be mounted anywhere: parking lots, hotels, etc. May be provided with a variety of options for things such as credit card readers, I/O ports for recording data etc. Typically a "Level 2" type system.

EV CORDSETS: “IC-CPD”

IC-CPD: In-Cable Control and Protection Device

Also called: Mode 2, cordset

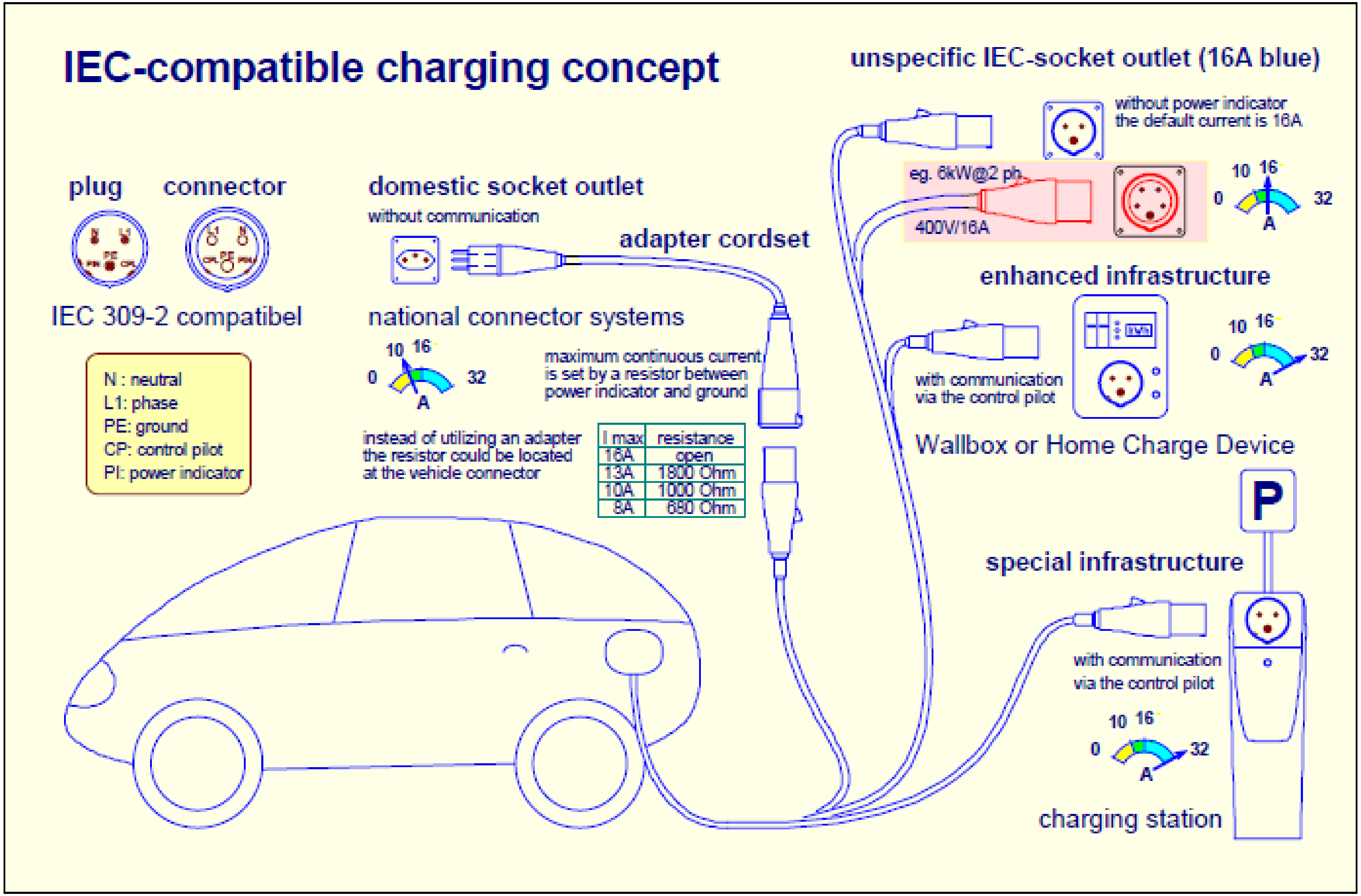
Input (Mains) Cable

EV Coupler

Mains Coupler (“plug”)

EV Output Cable

IC-CPD (control and Protection circuit)


IEC-compatible charging concept
plug
connector
IEC 309-2 compatibel
N : neutral
L1: phase
PE: ground
CP: control pilot
PI: power indicator
domestic socket outlet
without communication
adapter cordset
national connector systems
10 16
0 32
A
maximum continuous current is set by a resistor between power indicator and ground
instead of utilizing an adapter the resistor could be located at the vehicle connector
I max | resistance
16A | open
13A | 1800 Ohm
10A | 1000 Ohm
8A | 680 Ohm
unspecific IEC-socket outlet (16A blue)
without power indicator the default current is 16A
eg. 6kW@2 ph.
400V/16A
10 16
0 32
A
enhanced infrastructure
with communication via the control pilot
10 16
0 32
A
Wallbox or Home Charge Device
P
special infrastructure
with communication via the control pilot
10 16
0 32
A
charging station

EV Charger: Offboard DC Power

UL 2202, 2nd edition 2009
Standard for Electric Vehicle (EV) Charging System Equipment

CSA 22.2 #107.1-16, 2016
Power Conversion Equipment, Clause 16

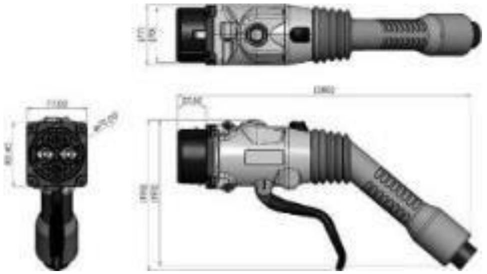
IEC 61851-1, 3rd edition 2017
Electric vehicle conductive charging system – Part 1: General requirements

IEC 61851-23, 1st edition 2014
Electric vehicle conductive charging system – Part 23:
D.C. electric vehicle charging station

IEC 61851-25, 1st edition 2020
Electric vehicle conductive charging system – Part 25: DC EV supply equipment where protection relies on electrical separation

FOCUS ON <120VDC, <100ADC

EV Charger: Offboard DC Power



Common Elements: Personnel Protection System

UL 2231-1, 2nd Edition 2012, CSA C22.2 #281.1 and NMX-J688/1-ANCE
Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements

UL 2231-2, 2nd Edition 2012, CSA C22.2 #281.2 and NMX-J688/2-ANCE
Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

IEC VARIOUS:

"RCD": Residual Current Device
"GM": Ground Monitor
"CCID": Charge Current Interrupt Device
"GFI/GFCI": Ground Fault Circuit Interrupt Device

Common Elements: Vehicle Coupler

UL 2251, 4th Edition 2017, CSA C22.2 #282 and NMX-J678-ANCE
Safety for Plugs, Receptacles and Couplers for Electric Vehicles

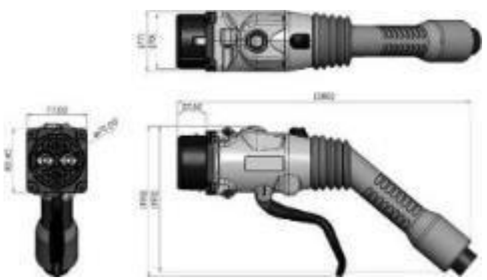
IEC 62196-1 Ed.3 (2014)
Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 1: General requirements

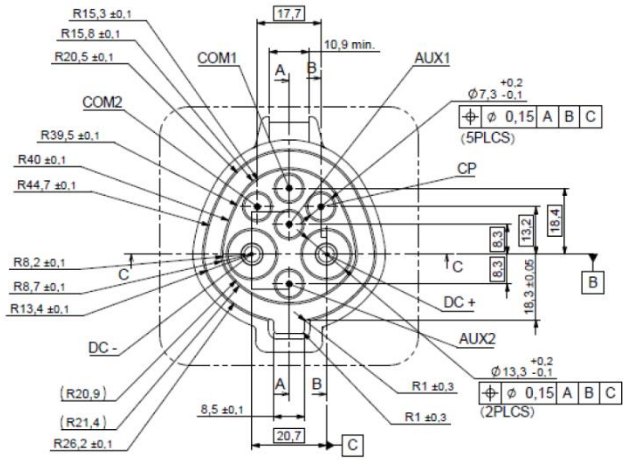
IEC 62196-2 Ed.2 (2016)
Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 2: Dimensional compatibility and interchangeability requirements for AC pin and contact-tube accessories

IEC 62196-3 Ed. 1 (2014)
Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles – Part 3: Dimensional compatibility and interchangeability

IEC 62196-6, ED1 (draft) 2021
Electric vehicle conductive charging system – Part 23:
D.C. electric vehicle charging station
FOCUS ON <120VDC, <100ADC

EV Charger: EV Couplers





MICROMOBILITY: SCOOTERS AND eBIKES

IEC 60335-2-29, Ed 5.1, 2019

Household and similar electrical appliances - Safety - Part 2-29:
Particular requirements for battery chargers

Battery chargers intended for charging batteries in a household end use application outside the scope of the IEC 60335 series of standards are within the scope of this standard.

Battery chargers not intended for normal household use, but which nevertheless may be a source of danger to the public, such as battery chargers intended for use in garages, shops, light industry and on farms, are within the scope of this standard.

03

GLOBAL CERTIFICATION PROGRAMS

EVSE CERTIFICATION – NORTH AMERICA

How do I know whether product has been certified?

- Each NRTL uses its own unique, registered certification mark(s) to designate conformance
- Each NRTL must register its certification mark(s) w/the US Patent & Trademark Office
- The manufacturer physically places the mark on the products
- An NRTL must ensure that its mark is applied to each unit, or if not feasible, to the smallest package containing each unit
- The presence of a safety mark also means the product is ‘listed’ in the NRTL’s “directory” – public record.
- And, is part of an on-going follow-up program that ensures the products continuously comply with the applicable standards

EVSE CERTIFICATION – CB SCHEME

CB Scheme?

- The CB Scheme is an international program (under IECEE) for the exchange and acceptance of product safety test results among participating laboratories and certification organizations around the world
- The CB Scheme offers manufacturers a simplified way of obtaining multiple national safety certifications for their products — providing entry into over 45 countries
- “ELVH” Category covers the EVSE-specific IEC standards

EVSE CERTIFICATION – CB SCHEME

How can I get a CB Scheme Certification

- Each member country has one or more NCB (National Certification Body)
- Each NCB overseas one or more CBTL: Certification Body Testing Laboratories.
- Each NCB and CBTL is accredited/ approved by the IECEE to issue test reports and certificates.

IEC IECEE IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE)

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About IECEE | Members | News | Testing & Certification | Committees | Peer Assessment | Documents | Events & Meetings | Search | Log in

Members > National Certification Bodies

National Certification Bodies (NCBs)

List | Statistics | Map

Total National Certification Bodies 88

National Certification Bodies (NCBs) Table search: Intertek Excel PDF Print

Country/Location	National Certification Body Name	Factory Surveillance Body (FSB)
Germany	Intertek Deutschland GmbH	
Singapore	Intertek Testing Services (Singapore) Pte Ltd	
Sweden	Intertek Semko AB	
United Kingdom	Intertek Testing & Certification Ltd.	
United States of America	Intertek Testing Services NA, Inc.	

Showing 1 to 5 of 5 entries (filtered from 88 total entries) Previous 1 Next

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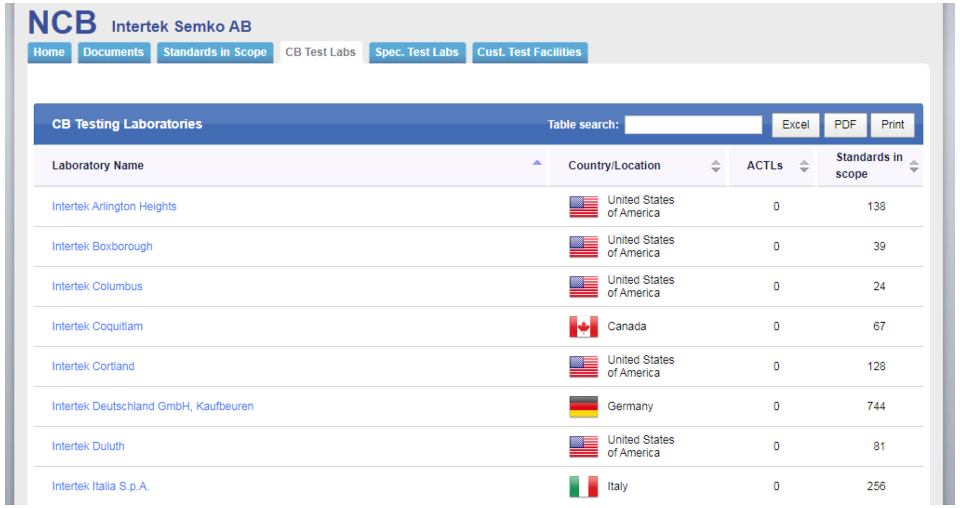

NCB Intertek Semko AB

Home | Documents | Standards in Scope | CB Test Labs | Spec. Test Labs | Cust. Test Facilities

CB Testing Laboratories Table search: Excel PDF Print

Laboratory Name	Country/Location	ACTLs	Standards in scope
Intertek Arlington Heights	United States of America	0	138
Intertek Boxborough	United States of America	0	39
Intertek Columbus	United States of America	0	24
Intertek Coquitlam	Canada	0	67
Intertek Cortland	United States of America	0	128
Intertek Deutschland GmbH, Kaufbeuren	Germany	0	744
Intertek Duluth	United States of America	0	81
Intertek Italia S.p.A.	Italy	0	256

EVSE CERTIFICATION

What about the rest of the world?

- NRTL or CE mark may be accepted in some countries
- “Mode 2” cord sets must have the appropriate plugs and couplers.
- IECEE CB SCHEME:
  - Provides a global “PASSPORT”
  - Ease of attaining local “VISA” (country-specific marks of conformity)
  - For EVSE: not harmonized to US/ CAN, Japan, China
  - Safety AND EMC Requirements Covered

SUMMARY

US / CAN NRTL Program: non Harmonized to the 250V/50Hz world

CB Scheme provides a path for the rest of the world, based on existing IEC standards

Micromobility products can use "Off The Shelf" chargers. Ride share and public access will require further development. BATTERY SWAP to be discussed.

Heavy truck not discussed here: in-house charging infrastructure vs public access charging.

Protocols and Interoperability are separate from safety requirements. To be discussed

THANK YOU!

Rich Byczek, Global Technical Director

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www.intertek.com/evse/

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EV Charging Standards for India

- Bureau of Indian Standards (BIS) Sectional Committee ETD-51
  - *National Mirror Committee for IEC TC-69, TC-23H, JWG-11, JWG-1*
  - *EV Charging Standards work has gathered momentum.*
- Specific Uses cases in the Tropical Region
  - *High Power Charging Stations (Pathway)*
  - *Light EV Charge Point (all localities)*
  - *Park Bay Charge Point (Destination)*
  - *Battery Swap Standard*
  - *Unified payment mechanism (UPI, FASTag)*

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Four Specific Use Cases

Depot Charging Station	Automated Connection
100 kW to 600 kW	Overhead Pantograph
Highway Charging Station	Plug-in Connection
50 kW to 250 kW	CCS & Chademo
Normal Power	Plug-in Connection
Park-Bay Charge Point	Type-2 | CCS & Chademo
3-ϕ supply, <22kW	Infrastructure Socket
Normal Power	Plug-in Connection
Light EV Charge Point	IEC-DC & Indian-Combined
1-ϕ supply, <7 kW	Infrastructure Socket

4 Pantograph
3 Plug-in
2 Park-Bay
1 Light EV

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Directions for Indian Charging Standards

4 Pantograph

- Pantograph for Charging from 200 kW to 1MW
- A draft IEC standard is being studied for adoption in India

3 Plug-in

- Indian Standard for Charging Stations prepared, It is being studied for use in eBus Charging.
- Upto 180 kW can be delivered with one gun; so upto 350kW can be charged using plug in connectors

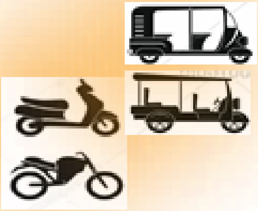
2 Park-Bay

- Parkbay Charge Point Approach Paper & City Guide for Installation, under preparation.
- Only small change required to Connection Standard

1 Light EV

- Light EV AC Charge oint - Draft Indian Standard prepared & circulated in BIS Committee.
- Light EV DC Charge Point drafts ready

Light EV } 1



Normal Power	**Plug-in Connection**
Light EV Charge Point	**IEC-DC & Indian-Combined**
1-ϕ supply, <7 kW	**Infrastructure Socket**

Scooter, Auto Rickshaw Charging

- Light EV can be charged anywhere
  - *Charge points in stores, roadside, apartments*
  - *Ubiquitous AC Charge Points*
  - *Dense network of DC Charge Points*
- Innovations are expected
  - *Battery Swapping*
  - *Fast Charging battery*
  - *Primary cells like Aluminium Air*
- Full conversion to eMobility is possible

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eMobility R&D Hubs

Light EV AC Charge Point 1Φ power supply

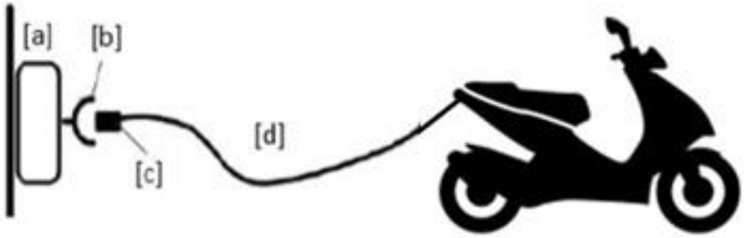

FIG. 1 CASE A CONNECTION

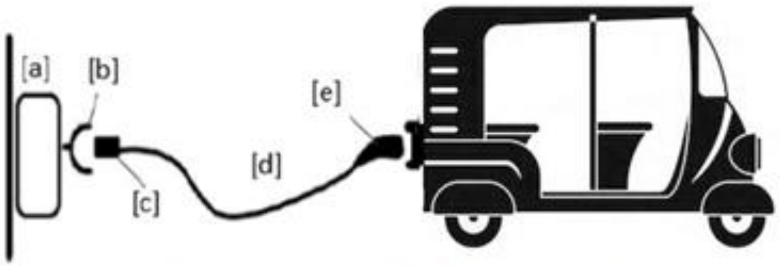

FIG. 2 CASE B CONNECTION

Bluetooth 4.0 Low Energy

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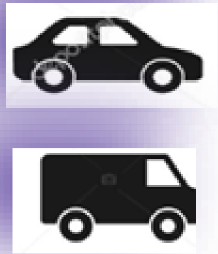
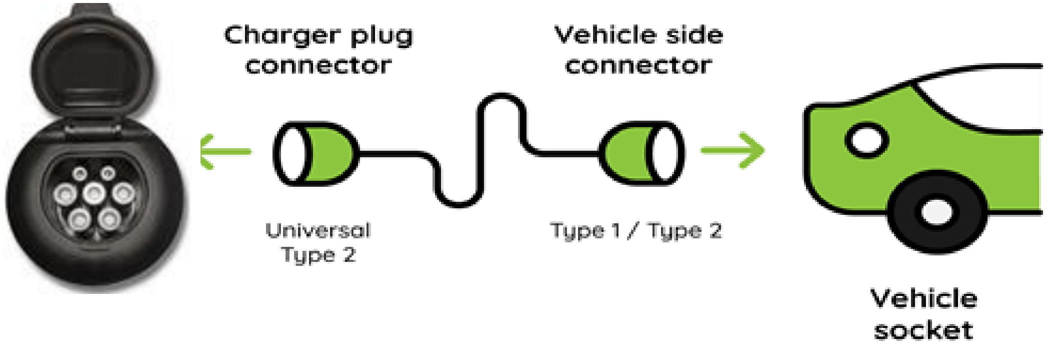
Park-Bay 2



Normal Power	**Plug-in Connection**
Park-Bay Charge Point	**Type-2 | CCS & Chademo**
3-ϕ supply, <22kW	**Infrastructure Socket**

Charge EV in the Parking itself



Charging Rate depends on the onboard charger. A small onboard charger = slow charging

Fast Charge a FAME car in parking lot with DC Unit

Examples of Park-Bay Charge Points

Examples are from Europe - cable can be detached.
System proposed for Car Parks.

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High Power Charging Stations

MoP/ DHI

Plug-in 3

Highway Charging Station	Plug-in Connection
50 kW to 250 kW	CCS & Chademo

Standards have been developed.

Device & Charging Protocol Standards

1. 17017 Part-1
2. 17017 Part-21-1
3. 17017 Part-21-2
4. 17017 Part-2-1
5. 17017 Part-2-2
6. 17017 Part-2-3
7. Draft 17017 Part-23
8. Draft 17017 Part-24

EV to Grid Communication

1. 15118 Part-1
2. 15118 Part-2
3. 15118 Part-3
4. 15118 Part-4
5. 15118 Part 5
6. 15118 Part-8

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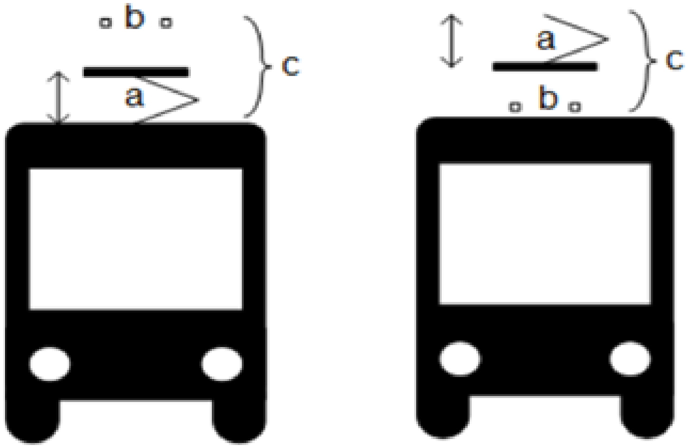
Pantograph

4

Depot Charging Station	Automated Connection

Per-trip Fast Charge eBus @ Depot.



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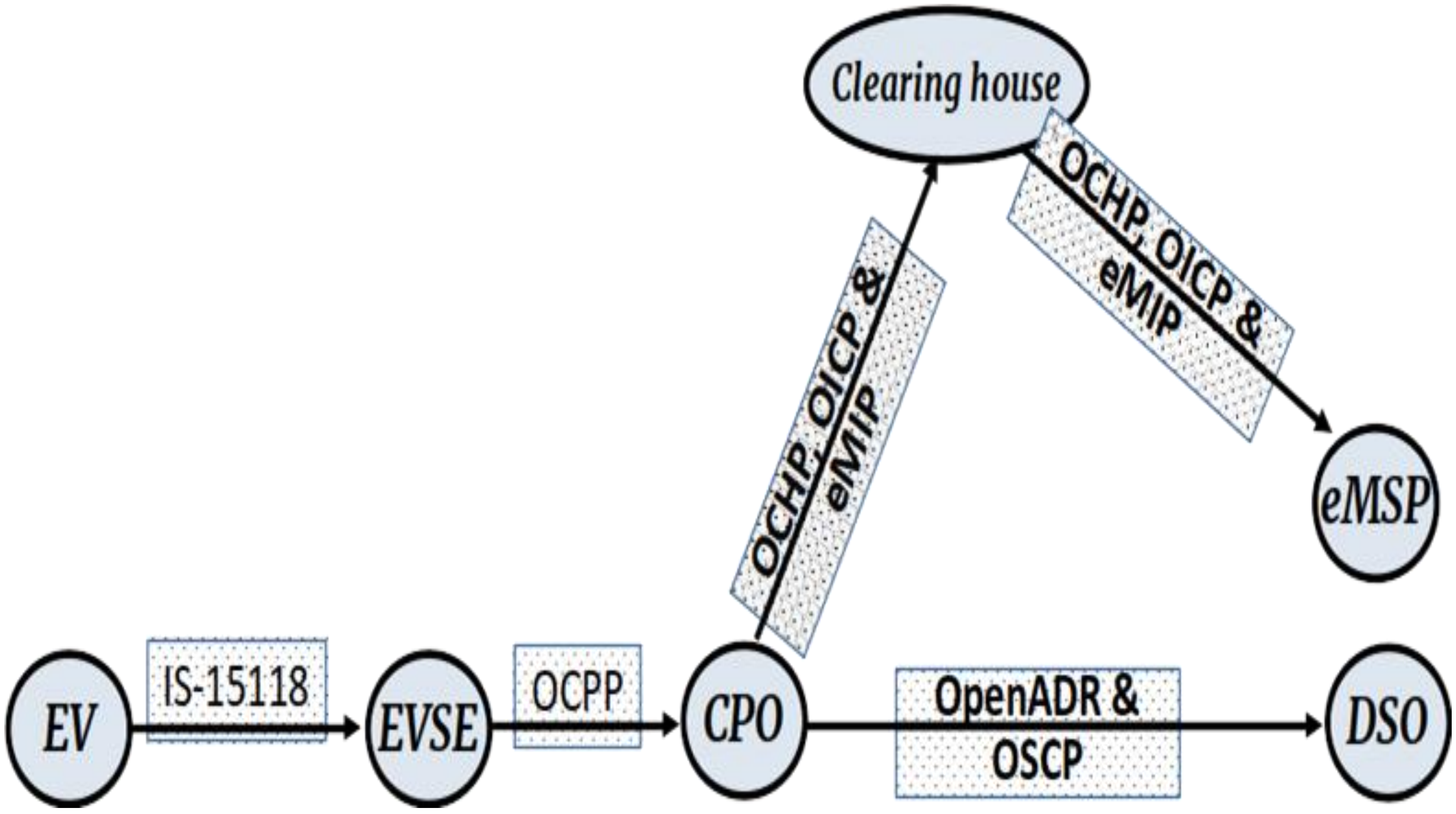
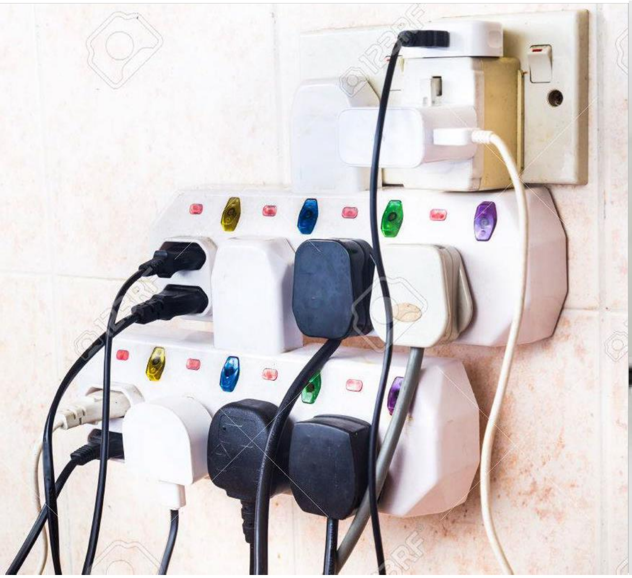
Backend Network



U.S.-India SCCP Virtual Workshop:
The Future of Electric Vehicles in India
Session 1 EV Charging Standards and Protocols

EV CHARGING PROTOCOL OPTIONS COMMUNICATION AND CONTROL FROM WATTS TO MW+ MULTIPORT ELECTRIC VEHICLE CHARGING



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February 18, 2021

This work is supported by DOE-Vehicle Technology office, Lee Slezak program manager

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OVERVIEW-SCOPE

- ANL/DOE recent work is focused on charging as many vehicles per site as possible using existing electrical distribution infrastructure (up to MW level)

- Vehicle electrification covers LEVs (hundreds of Watts) to light duty EVs (kW) to medium duty (delivery, many kW) to heavy duty-bus/truck; 20kW->200kW->2MW

- Smart Charging is required to proactively manage available electrical resources.

- Protocols, standards and interoperable solutions enable a more useful/optimized national approach to charging infrastructure planning/operation (resiliency)

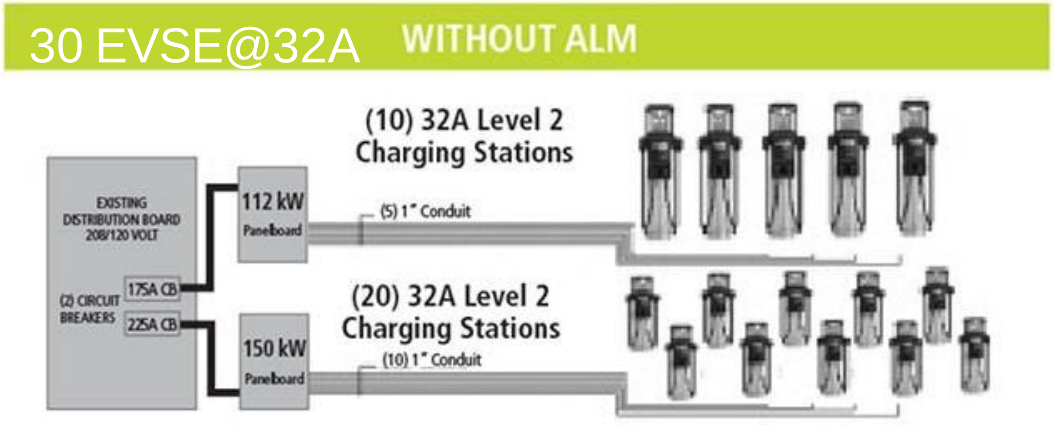
- Commercial charging transactions are covered by Weights and Measures (AHJ)

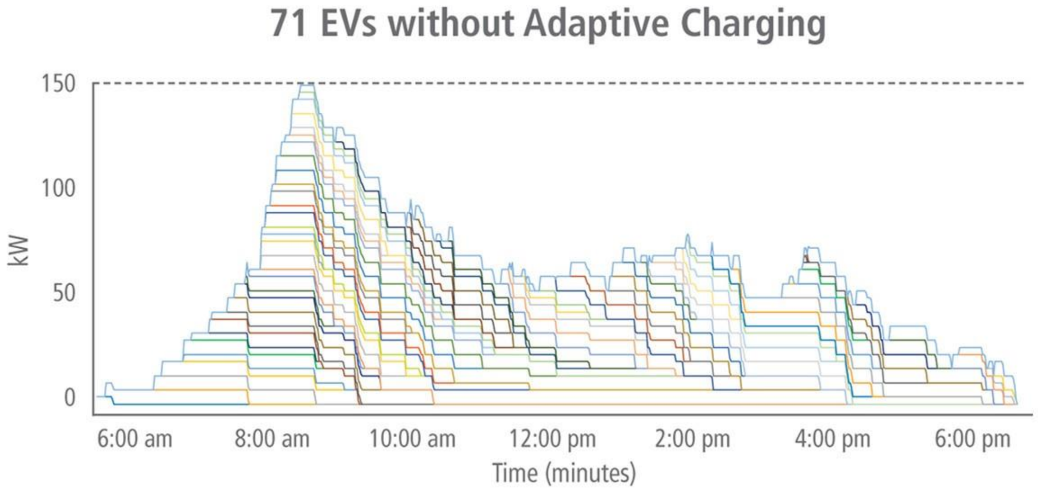
AC DISTRIBUTION VS DC DISTRIBUTION; 'SMART CHARGING'

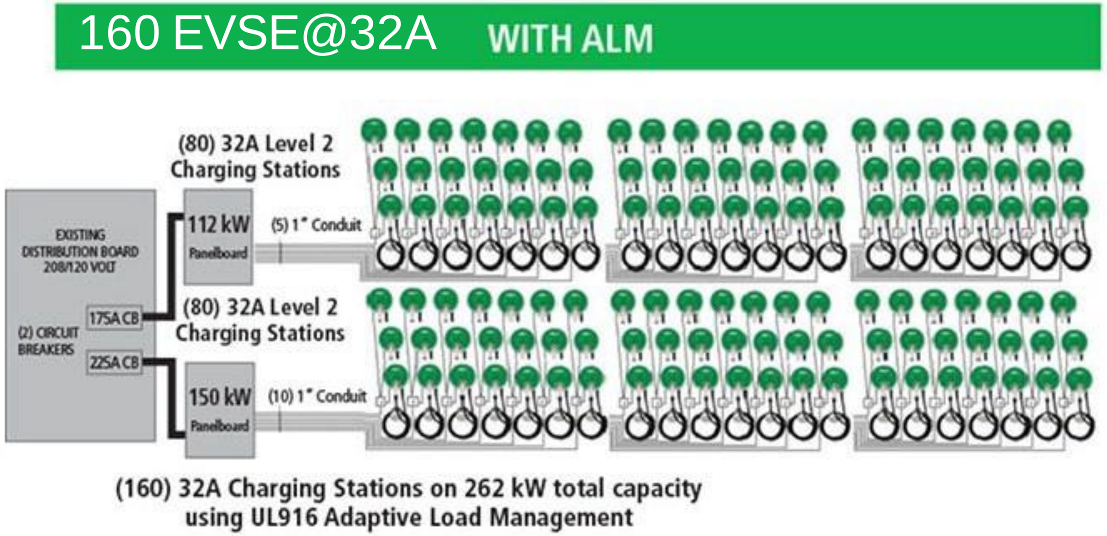
- **AC charging** in general seldom uses vehicle-EVSE communication
- **DC Charging couplers** require vehicle-EVSE communication to control power delivered. This communication can access vehicle state of charge that can be used to conduct 'flow control' to allocate charging capacity based on estimated charging completion time.
- Managed AC charging distribution system are based on maximum load at each location (covered by NEC part 625.42 for managed loads)
- DC distribution systems can more 'directly' manage local PV/storage generated charging energy, split between a few or many vehicles (DER)

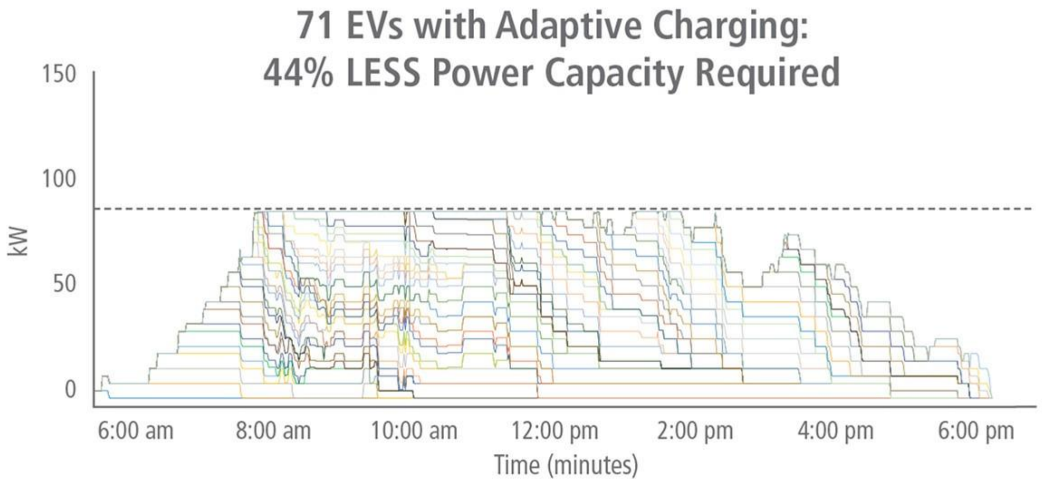
ACTIVE LOAD MANAGEMENT EXPANDS RESOURCE FROM 30 TO 160 EVSE

Powerflex Systems; **UL916 safety certified** (AC charging) https://www.powerflex.com/turnkey-solutions/







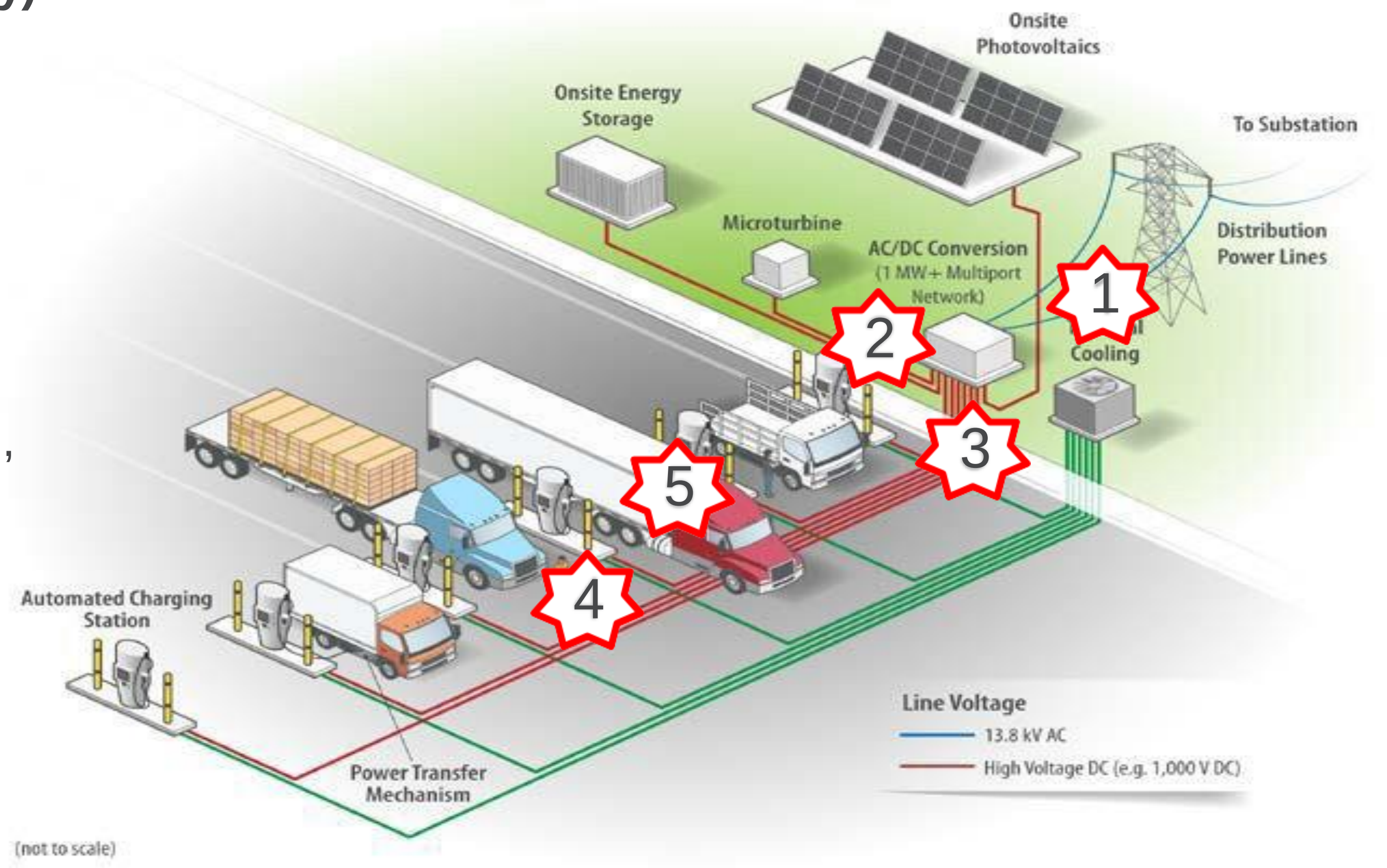


Not a single car had to stay later to receive the same amount of energy as the chart above.

MW+ MULTI-PORT EV CHARGING SYSTEM LABELED SEGMENTS

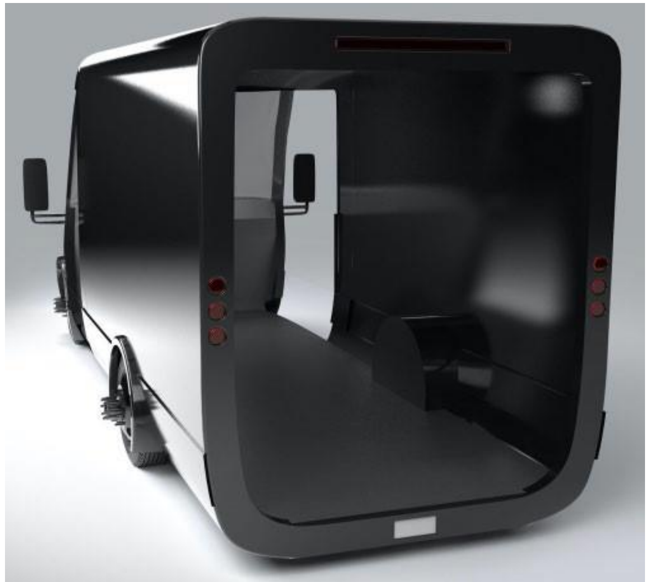
From Source to Load (grid-to battery)

1) Utility Interconnection
2) AC/DC Power Conversion
3) DC Distribution, w/DER Elements
4) DC Dispenser Electronics, Cables, Couplers, Micro-siting
5) Vehicle Inlet, Battery-BMS, Safety



BACK OF THE ENVELOPE- CLASS 4 DELIVERY VEHICLE ENERGY CONSUMPTION AND CHARGING SPEED/DURATION

- Reference observation/SCE/CALSTART study on eStar, Smith vehicles https://calstart.org/wp-content/uploads/2018/10/Battery-Electric-Parcel-Delivery-Truck-Testing-and-Demonstration.pdf
- ~5kW AC charging rate, 12-15hr recharge(60kWhr), ~ 1kWhr/mile
- Compared to Bollinger Deliver-E vehicle with 70kWhr,105, 140,175, 210 kWhr battery translates 70-210 mile range
- Basic recharge rate/duration: 20kW=20 miles/charging hour, 3.5-10.5hrs 100kW=100 miles/charging hours; <1hr-2.1hrs



BACK OF THE ENVELOPE- CHARGING CLASS 8 LINE HAUL TRACTORS

https://www.trucks.com/2019/09/05/everything-we-know-about-the-tesla-semi-truck/

- Class 8 trucks loaded to 80,000lb GVW consume ~2kWhr/mile (or more)
- Replacing 400 miles range (800kWhr) in 30 minutes requires (2C) 1.6MW
- Shorter route vehicles have smaller battery capacity, shorter recharge time
- Overnight charging (8hrs) requires {average} 100kW for 800kWhr

Volvo VNR

Tesla Semi

Freightliner eCascadia

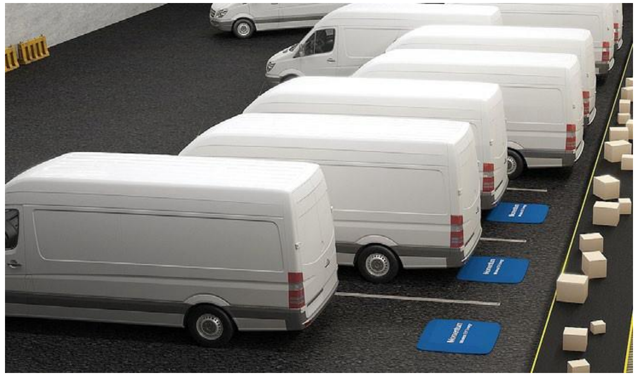
PRACTICAL EXAMPLES OF SITE PLANNING: ONTARIO CALIFORNIA

TA Petro Ontario California truck stop ~600 parking spots (on left); again as many on right. Electrifying up to 1200 parking/charging spots is both an opportunity and a challenge

BALANCING ACT; SCALING, FINANCING, EXPANDABILITY, INTEROPERABILITY

- Multi-port MD/HD electric bus and MD/HD truck charging source-to-destination (utility interconnection to battery terminal), up to 1MW or above
- More realistically multiple vehicles at a single location, addressing utility interconnection **pad mounted transformer 2.5MVA limitations.**
- At the 1MW-2.5MW level, ignoring losses this equates to simultaneous charging of

  - **1 to 2.5** charging ports at **1MW** each
  - **2 to 5** charging ports at **500kW** each
  - **10 to 25** charging ports at **100kW** each
  - **50 to 125** charging ports at **20kW** each



- One can do the math on oversubscription of 4-10x for sharing DC sources (10’s at MW level to hundreds at the 100kW/20kW per port from one 480vac/2.5MW AC-DC conversion feed (**1500vdc*1666A=2.5MW** DCaaS DC bus distribution feed)

LEV MULTI-PORT DC DISTRIBUTION (600W) SMART CHARGING

- LEV (bicycle, scooter, 3 wheeler) batteries are ~1000Whr or less
- DC charging can share common resource (PV/battery) to many LEVs
- 48v DC/DC converters as low as $30 for 480 watts; 15 vehicles=7kW

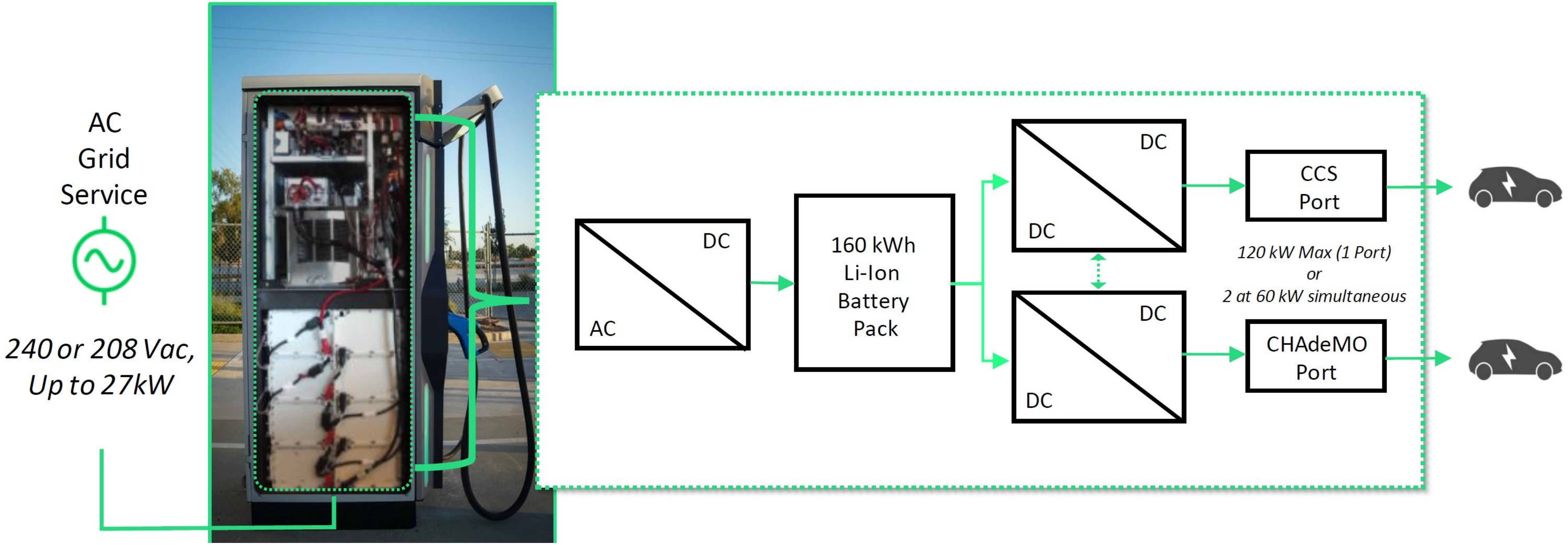
Magnetic base power w/data coupler (60v/40A)
https://www.rosenberger.com/product/ropd/

Legacy golf cart plugs (48v)

FREEWIRE BOOST CHARGER- INTEGRATED LOCAL STORAGE, 27KW INPUT DUAL 60KW (120KW SINGLE) OUTPUT

https://assets.ctfassets.net/ucu418cgcnau/56reLufWaEuOY7oYajeK2Y/08a88be7902c36bcac2a688cd622736b/D1-4_Ethan_Sprague_Freewire.pd , https://freewiretech.com/products/dc-boost-charger/

Low voltage AC power input → AC power converted to DC → Integrated battery discharges → 2 high-efficiency DC converters → Dual connectors for simultaneous fast charging



MW MULTIPORT ELECTRIC TRUCK-BUS CHARGING COUPLERS

- SAE-IEC Combination Charging System (CCS) DC couplers (w/liquid cooled cables) can deliver up to 1000v/500A (.5MW) today

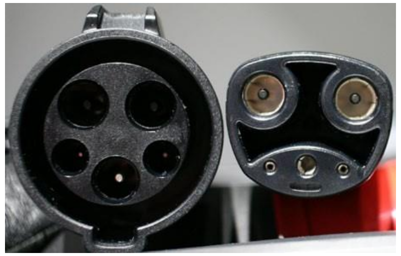
- The CharIN 'Mega Charging System' (MCS) coupler is under development; target capability of 1500v(max)/3000A(max){4.5MW}; prototype couplers under development. Lab prototypes have run at full 3000A. PLC vs CAN communication noise immunity testing.

- SAE J3105(-1, -2, -3) Overhead Pantograph; 600kW-MW+ mechanized couplers

				CharIN			Proposed
	GB/T	New GB/T	CHAdeMO	CCS1	CCS2	Tesla	MCS
							
Max Power	950V x 250A = **237.5 kW**	1500V x 600A = **900 kW**	1000V x 400A = **400 kW**	1000V x 500A = **500 kW**	1000V x 500A = **500 kW**	410V x 610A = **250 kW**	1500V x 2000A = **3 MW??**
Range add /minute charge	1.5 miles	5.8 miles	2.6 miles	3.2 miles	3.2 miles	1.6 miles	19.2 miles
Communication Protocol	CAN (SAE J1939)	CAN (SAE J1939)	CAN (ISO 11898)	PLC (ISO 15118)	PLC (ISO 15118)	CAN (SAE J2411)	CAN or Ethernet (ISO 15118)
Location Used	China, India	China	Global	US	EU, South Korea, Australia	Global	US?, EU?
Related Standards	IEC 61851	IEC 61851	IEC 61851 IEEE 2030.1	IEC 61851 SAE J1772	IEC 61851	none	none
Notes	none	Liquid Cooled under development in development	Liquid Cooled under development	Liquid Cooled	Liquid Cooled	Liquid Cooled	Liquid Cooled

GRADIENT OF EV CHARGING COUPLERS WITH POWER LEVELS/VEHICLES

- **Light duty vehicles**, some school buses use **AC SAE J1772 Level 2** (208/240vac-80A) chargers; 30A/7kW nominal; 80A/**19.2kW max.**
- **Medium Duty (commercial) vehicles** can use **SAE J3068** AC; 3-phase; 63A/480v(**53kW**)
  Advanced versions on J3068 can handle 120A/480v(**99kW**), or **Tesla** at 160A(**120kW dc**)
  Higher voltage SAE J3068-DC6 can push 320A(2x160A) **up to 1000vdc (600vdc today)**
- **Light-Medium Duty vehicles;** can use **J1772-CCS** 1000vdc/350A-500A **(up to 500kW)**
- **Medium/Heavy Duty bus** (port/drayage trucks) can use **SAE J3105 (/1, 2, 3) <600kW**
- **Medium/Heavy Duty trucks** can use CharIN **MCS;** under 1000vdc/1000A **(1MW)** today, potential for **1500v/3000A (4.5MW) in the future**



J1772->19.2kW

J3068->53kW-99kW(ac) 120kW-320kW (DC6)

J1772-CCS 350-500kW(DC)

J3105->600kW

CharIN-MCS 350kW-1.5MW

SELECT REFERENCES TO RELEVANT ROADMAPS/STANDARDS

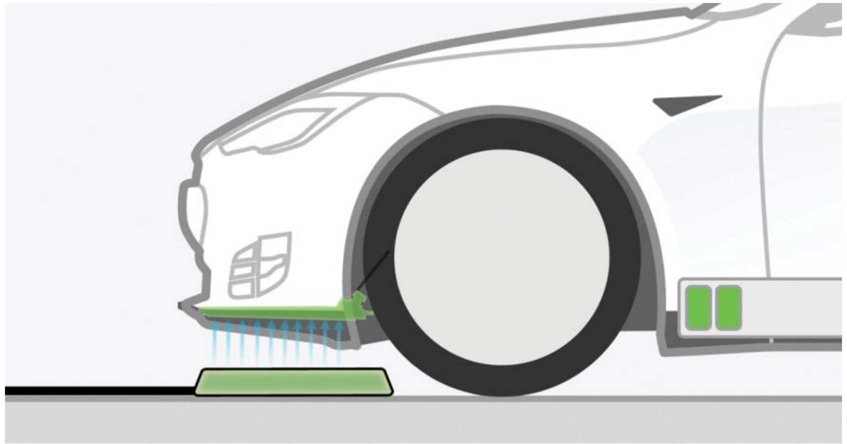
- **ABB Solar fed EV Charging stations for eRickshaws (50kW)**
  https://mercomindia.com/abb-developing-solar-charging-stations-e-rickshaws-jabalpur/

- **2012 Era ANSI EVSP Roadmap on standard; summaries of activities**
  https://share.ansi.org/evsp/ANSI_EVSP_Roadmap_Standards_Compendium.xls
- https://www.energy.gov/sites/prod/files/2014/03/f10/vss093_mccabe_2012_o.pdf
- https://www.energy.gov/sites/prod/files/2014/03/f13/vss118_wagner_2013_p.pdf

- **IEEE P2030.10; DC Microgrids for Rural/Remote Electricity Access** (w/EVs)
  https://www.slideshare.net/e4sv/kuching-2g34-off-grid-dc-microgrid-che-hang-seng

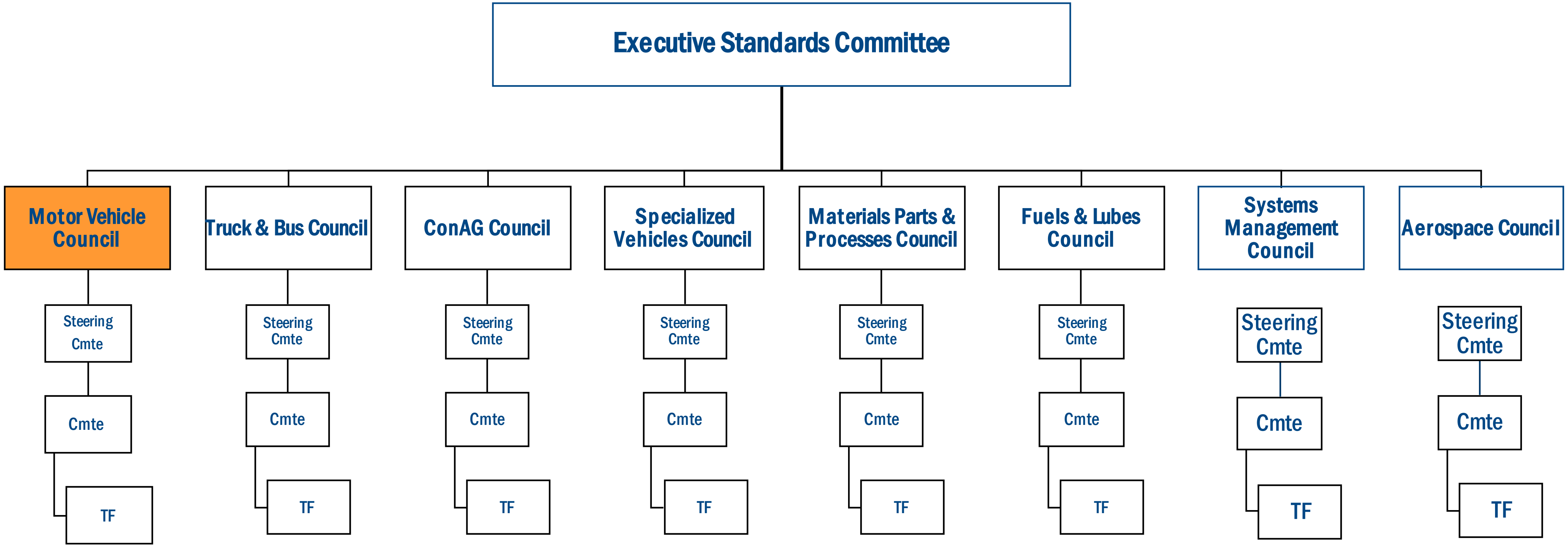
- **Tesla India manufacturing; charging subsidies**
  https://www.reuters.com/article/tesla-india-electric-idUSKBN2AD0MJ

An Overview of SAE International Standards Activities Related to Hybrid / Electric Vehicles



Keith Wilson
Technical Program Manager,
Ground Vehicle Standards
02/18/2021

Global Ground Vehicle Standards Structure



- 145,000+ SAE members worldwide
- Representatives from 100 Countries

- 8,375 GV Standards Published
- 1,817 GV Standards Maintained
- 491 GV WIP Standards

- 564 GV Technical Committees
- 8,800 GV Committee Members

- 2,900 Companies
- Representatives from 50 Countries

SAE EV, Hybrid & Fuel Cell Vehicle Standards Development

SAE EV / Hybrid Vehicle Steering Committee

- Started – 2005
- Current Committee Membership
  - > 1100 Individual Participants
  - > 500 Companies
    - OEM's
    - Suppliers
    - Government
    - Academia
- 10 EV / Hybrid Vehicle Subcommittees
- 4 Fuel Cell Standards Subcommittees
- 66 SAE EV, Hybrid, Fuel Cell Vehicle Standards Published to Date

65 SAE EV, Hybrid, Fuel Cell Vehicle Standards:

Fuel Cell Fueling: J2600, J2601, J2601/1. J2601/2, J2601/3,J2601/4, J2719, J2719/1, J2799, J1766, J2578, J2579

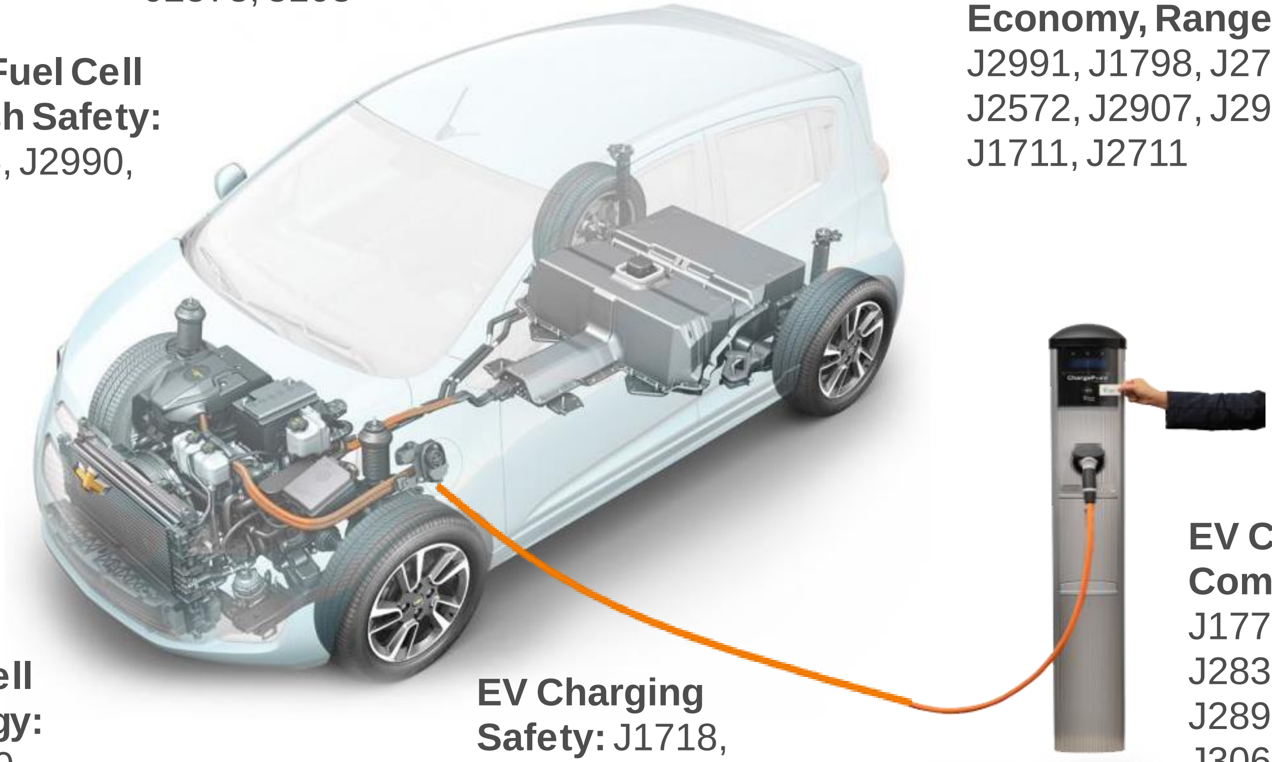
EV, Hybrid, Fuel Cell Vehicle Safety: J1766, J2344, J2910, J2990, J2990/1, J3108, J2578, 3108

EV, Hybrid, Fuel Cell Vehicle Economy, Range / Power: J2991, J1798, J2758, J2946, J2572, J2907, J2908, J1634, J1711, J2711

EV, Hybrid, Fuel Cell Vehicle Crash Safety: J3040, J1766, J2990, J2990/2

Fuel Cell Testing: J2615, J2616, J2617

Fuel Cell Systems: J2579, J2594, J3089



Energy Transfer Systems: J2293, J2293/1, J3072

EV, Hybrid, Fuel Cell Vehicle Terminology: J1715, J2574, J2760

EV Charging Safety: J1718, J2953/1, J2953/2, J2953/3

EV Charging & Grid Communications: J1772, J1773, J2293, J2836, J2841, J2847, J2894, J2931, J2954, J3068, J3105, J3105-1, J3105-2, J3105-3, J2799

https://www.sae.org/servlets/works/documentHome.do?comtID=TEVHYB

https://www.sae.org/servlets/works/documentHome.do?comtID=TEVFC

* Blue Font Denotes WIP

SAE EV, Hybrid, Fuel Cell Vehicle Standards Focused on Vehicle Safety

J2990 & J2990/1:

- Emergency Response Guides (Immobilize, Disable, Warnings)
- Vehicle Type Identification (Badging)
- High Voltage Shutdown (Disconnects, Battery & Converter Cables
- Tow & Inspection Guides (Recovery, Isolation, Inspection, Diagnostics)
- Hazard Communication

J2990 - Hybrid and EV First and Second Responder Recommended Practice

J2990/1 - Gaseous Hydrogen and Fuel Cell Vehicle First and Second Responder Recommended Practice

J3108 - xEV Labels to Assist First and Second Responders, and Others (high voltage safety info.)

J2344 - Guidelines for Electric Vehicle Safety (EV, HEV, PHEV and FCV high voltage systems)

J2578 - Recommended Practice for General Fuel Cell Vehicle Safety (fuel cell system, storage & high voltage)

J1766 - Recommended Practice for Electric, Fuel Cell and Hybrid Electric Vehicle Crash Integrity Testing

J2910 - Recommended Practice for Design & Testing Hybrid Electric/Electric Trucks/Buses for Electrical Safety

SAE J1772 Revision 8

Manual AC & DC conductive connection for low and high power levels

Auto OEMs supported moving to higher power levels for charging (8th revision)

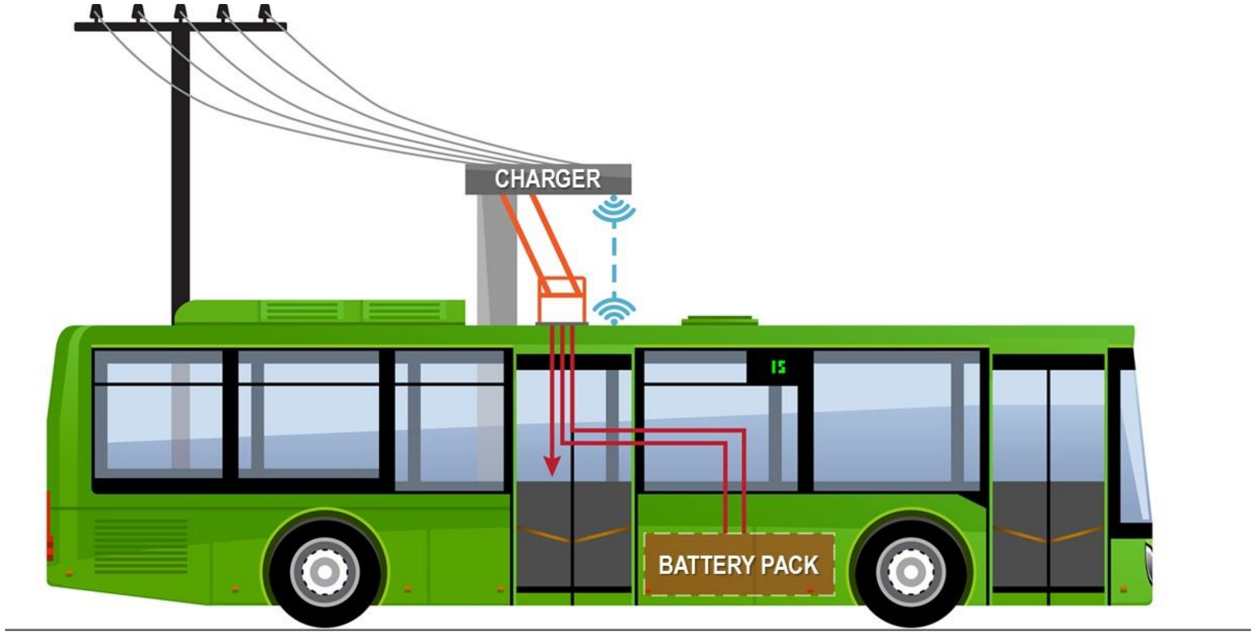
SAE J1772 Task Force has raised the voltage and current limit of the SAE Combo Connector

- Current limit from 200A to 350A
- Voltage limit from 500Vdc to 1000Vdc
- = 350kW Max Power

Publication completed: October 2017

SAE J3105 Overhead & Portal Charging

- Automated charging connection at high power- SAE J-3105
  - Document will standardize the interface between the infrastructure and the bus
  - Targeted towards in-route DC charging, for example to recharge at transit bus during a short stop
  - DC Power Levels (Voltage Range: 250-1,000 DC Volts) up to 1MW



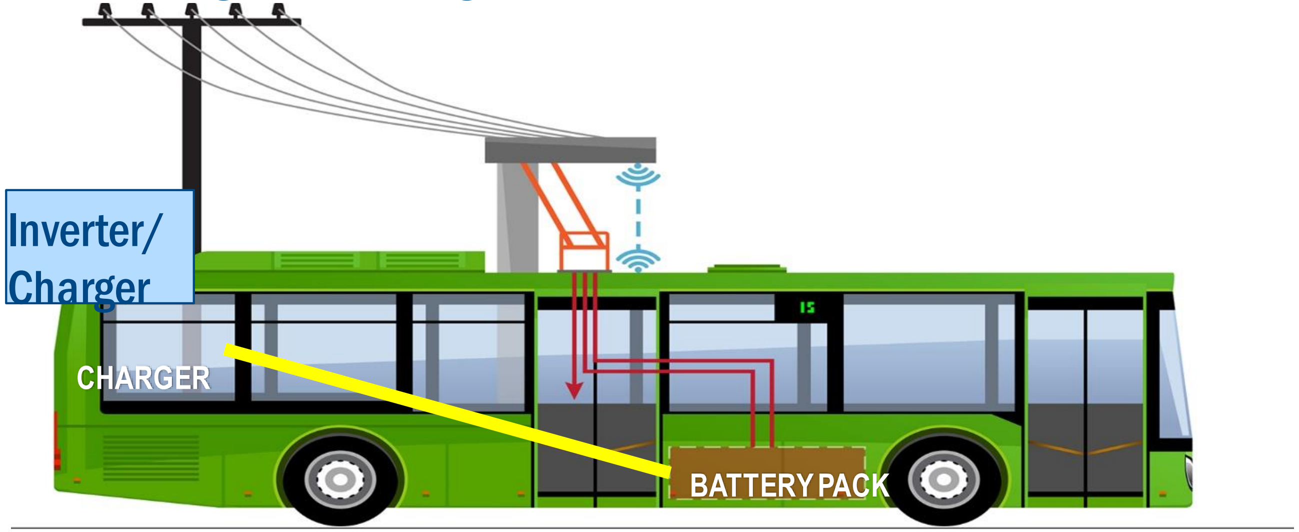
- **DC Power Levels**
- **Power Configurations**
- **Connection Points**
- **Communications**
- **Safety**
- **Alignment Protocol**

SAE J3068 AC Depot Conductive Charging

Depot Charging - 3 Phase AC (J-3068) targeted towards charging at commercial and industrial locations or other places where three-phase AC power is available and preferred such as at commercial and industrial locations (160A 480VAC 3ø = 133kW)

Defines a conductive power transfer method including the digital communication system. It also covers the functional and dimensional requirements for the vehicle inlet, supply equipment outlet, and mating housings and contacts

SAE J-3068 3 phase AC



SAE J2954 Wireless Power Transfer for Light-Duty Plug-In/Electric Vehicles

SAE J2954 establishes minimum performance, interoperability and safety criteria for wireless charging of EVs / PHEVs

SAE J2954 Standard Development

- Inductive Charging Interoperability
- Automated Charging
- Power Transfer Communications
- Smart Grid Interoperability
- Automatic Shutdown Capability
- Autonomous Parking / Charging

SAE J2954 Published October 2020

Charging Locations:

Residential
Public
On-Road
Static (parking lots, curb side)

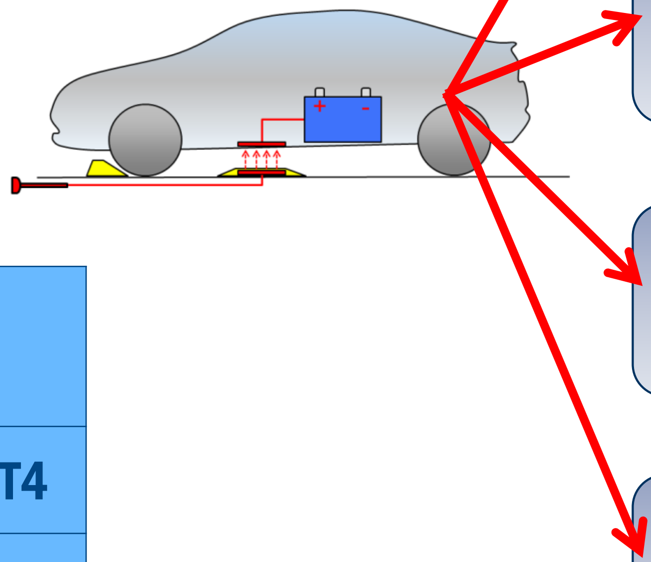
Key aspects:

- Static applications (currently)
- Efficiencies of over 85% (Aligned)
- Air gaps up to 25 cm
- Safety Limits
- Validation Tests

SAE J2954 Task Force Testing Protocols

SAE Standard will Define:

- Performance
- Safety
- Testing Methodologies
- Charge Levels
- Location & Alignment
- Communications



SAE J2954 WPT Power Classes			
WPT1	WPT2	WPT3	WPT4
3.7 kW	7.7kW	11 kW	22 kW

Safety Limits

EM Field

- EMF Limits with AAMI
- EMC Limits

Performance

- Positions / Orientations
- Efficiency Power Transfer

Durability

- SAE J1211
- ISO 16750
- USCAR 37

Safety

- Object Detection
- Temperature Test
- Automatic Shutdown

SAE Plug-In Electric Vehicle Grid Communication Standards

SAE J2836 ™ Use cases	Scope		Scope	SAE J2847 Detailed Info Messages
/1	Utility Programs *	⟷	Utility Programs *	/1
/2	Off-Board Charger Communications	⟷	Off-Board Charger Communications	/2
/3	Reverse Energy Flow	⟷	Reverse Energy Flow	/3
/4	Diagnostics	⟷	Diagnostics	/4
/5	Customer and HAN	⟷	Customer and HAN	/5
/6	Wireless Charging	⟷	Wireless Charging	/6

- **Series of Standards defining Use Cases, Information Messages and Communication formats**

SAE Grid Communication Standards

SAE J2931	Scope
/1	Power Line Carrier Communications for Plug-in Electric Vehicles
/2	In-Band Signaling Communication for Plug-in Electric Vehicles
/3	PLC Communication for Plug-in Electric Vehicles
/4	Broadband PLC Communication for Plug-in Electric Vehicles
/5	Telematics Smart Grid Communications between Customers, Plug-In Electric Vehicles (PEV), Energy Service Providers (ESP) and Home Area Networks (HAN)
/6	Digital Communication for Wireless Charging Plug-in Electric Vehicles
/7	Security for Plug-in Electric Vehicle Communications

Establishes the requirements for digital communication between Plug-In Vehicles (PEV), the Electric Vehicle Supply Equipment (EVSE) and the utility or service provider

Battery Standards Steering Committee and Technical Committees

- Started – 2009
- Committee Membership
  - >290 Individual Participants
  - >160 Companies
    - OEM's
    - Suppliers
    - Government
    - Academia
- 23 Subcommittees

NEW COMMITTEES

- 24) Electric Vehicle Battery Service
- 20) International Battery Interface

COMPONENTS & MATERIALS

- 23) Battery Systems Adhesives-Sealants-Heat Transfer Materials
- 21) Battery Thermal Management
- 19) Battery Systems Connectors
- 14) Battery Materials Testing

SUPPORT

- 4) Battery Transport
- 12) Battery Testing Equipment
- 13) Battery Terminology
- 3) Battery Labeling

LIFE MANAGEMENT

- 10) Battery Recycling
- 18) Battery Field Discharge & Disconnect
- 15) Secondary Use

PRODUCT SPECIFIC

- 2) Battery Standards Testing
- 1) Battery Safety
- 16) Start-Stop Battery
- 17) Capacitive Energy Storage
- 9) Battery Standards Future Energy Storage Systems
- 5) Battery Size Standardization
- 6) Starter Battery
- 8) Battery Standards Electronic Fuel Gauge

INDUSTRY SPECIFIC

- 11) Small Task Oriented Vehicle Batteries
- 7) Truck Batteries
- 22) Bus Battery

45 SAE Battery Standards Committee Documents

Thermal Management & Adhesives: J3073, J3178

Battery Labeling: J2936

Battery Testing Methodologies: J2758, J2380

Battery Materials Testing: J2983, J3021, J3042, J3159

Battery Secondary Use: J2997

Battery Vibration: J2380, J3060

Battery Transport: J2950

Battery Recycling: J3071, J2974, J2984

Capacitive Energy & Start/Stop: J3012, J3051

Starter & Storage Batteries: J1495, J2185, J240, J2801, J2981, J3060,J537, J930

Battery Life Assessment Testing: J240, J2185, J2288, J2801

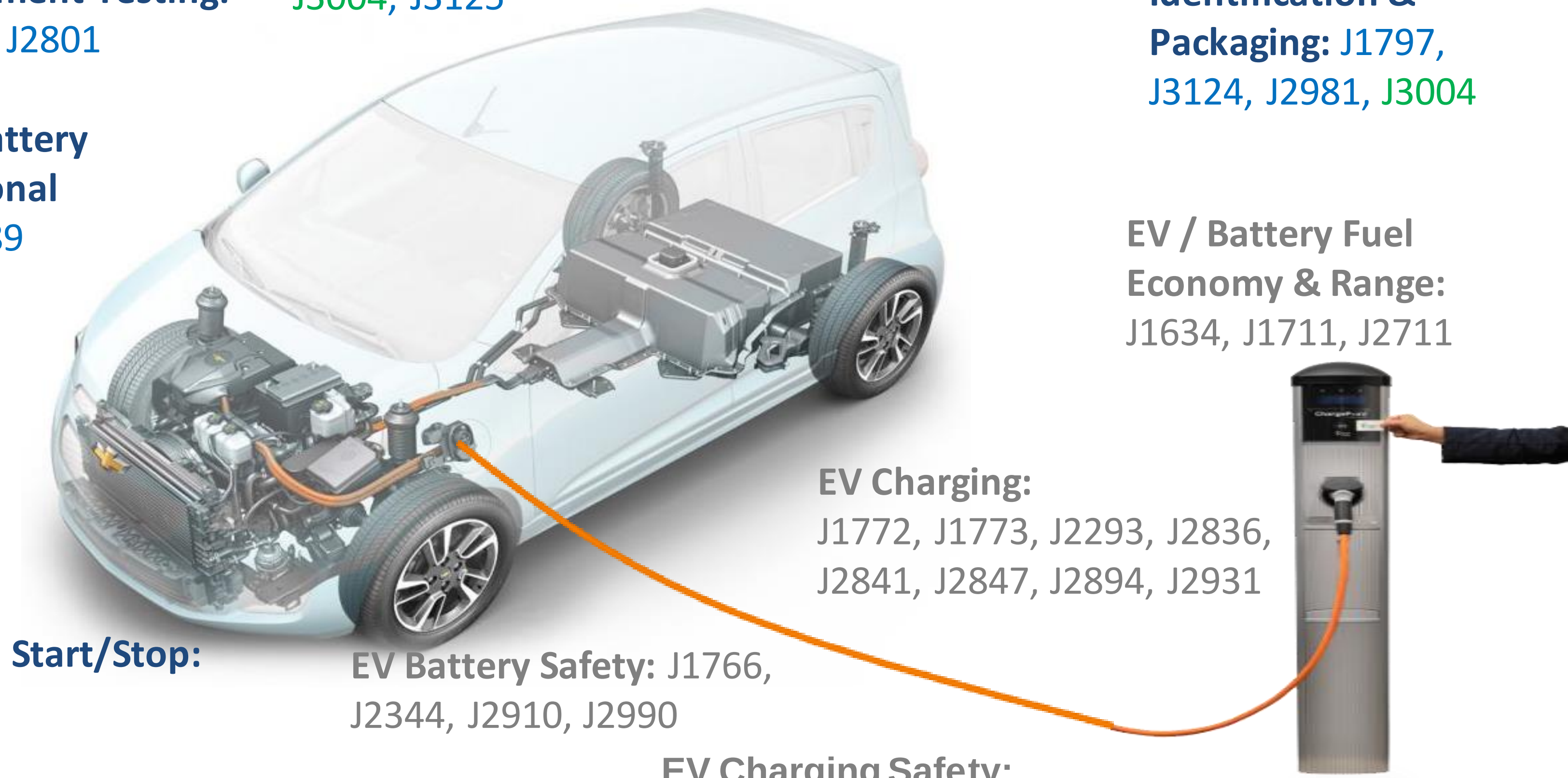
Electric Drive Battery Systems Functional Guidelines: J2289

Battery Terminology: J1715/2

Truck & Bus Batterie: J3004, J3125

Battery Safety: J2929, J2464, J3009

Battery Size, Identification & Packaging: J1797, J3124, J2981, J3004



EV / Battery Fuel Economy & Range: J1634, J1711, J2711

EV Charging: J1772, J1773, J2293, J2836, J2841, J2847, J2894, J2931

EV Battery Safety: J1766, J2344, J2910, J2990

Battery Performance & Power Rating: J1798, J2758

EV Charging Safety: J1718, J2953/1, J2953/2, J2953/3

Battery Electronic Fuel Gauging & Range: J2946, J2991

* Green Font Denotes WIP

SAE Low-Speed MicroMobility Devices Committee

New!

Electric Kick Scooter

Electric Skateboard

Segway

Electric Self-Balancing Unicycles

This committee will initially focus on low-speed personal mobility devices and the technology and systems that support them that are <u>not</u> normally subject to the United States Federal Motor Vehicle Safety Standards or similar regulations. These may be device-propelled or have propulsion assistance.

Emerging and innovative mobility vehicles and devices, sometimes referred to as micro-mobility, are proliferating in cities around the world.

These technologies have the potential to expand mobility options for a variety of people.

Recent formation of the SAE Micromobility Battery Committee which will focus specifically on battery and charging needs

Questions?

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U.S.–INDIA SCCP

U.S.-India Standards and Conformance Cooperation Program (SCCP), Phase II

Thank you!

Remember to register for our next EV webinar sessions on February 23rd and 25th