

STANDARDS, INTEROPERABILITY FOR COST-EFFECTIVE CONNECTIVITY AMONG EVS AND CHARGING FACILITIES, MW EVSE

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3x Field Deployed SAE J3271 MCS Couplers;
7 total at Portland EV Interoperability Testing Event

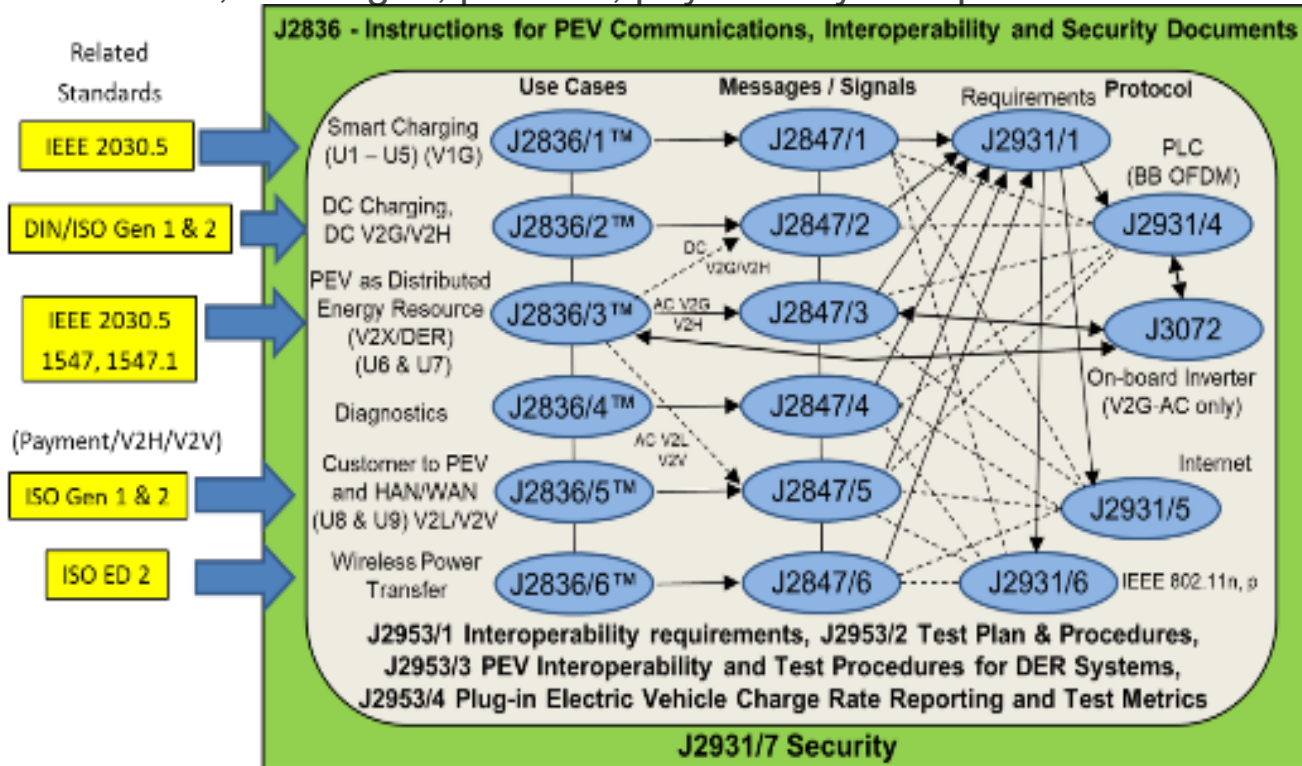
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ASEAN-US EV Workshop on Technical Standards

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Technology Office, Lee Slezak program manager

SAE EV CHARGING COMMUNICATION AND INTEROP STANDARDS

- Tan box shows J2953 series standards for interoperability covers other areas
- Use cases, messages, protocol, physical layer requirements



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 Transport:
J2950

Battery Recycling:
J3071, J2974, J2984

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

Capacitive Energy & Start/Stop:
J3012, J3051

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

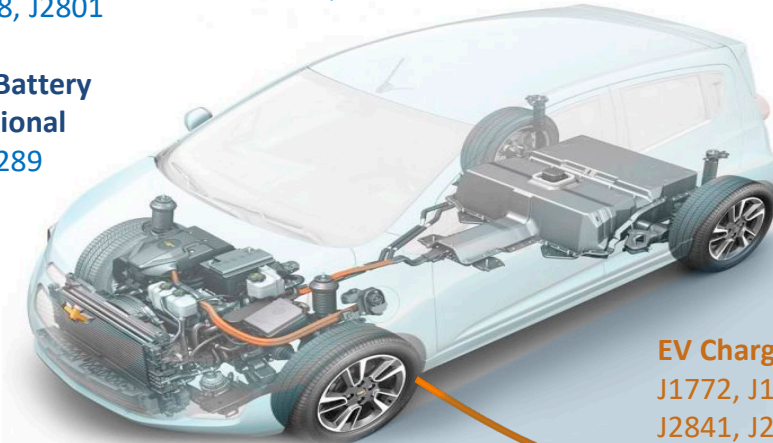
EV Charging:
J1772, J1773, J2293, J2836, J2841, J2847, J2894, J2931

EV Battery Safety: J1766, J2344, J2910, J2990

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

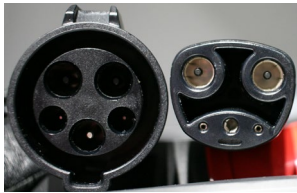
Battery Performance & Power Rating:
J1798, J2758

Battery Electronic Fuel Gauging & Range: J2946, J2991



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/drillage 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 4 Argonne  NATIONAL LABORATORY

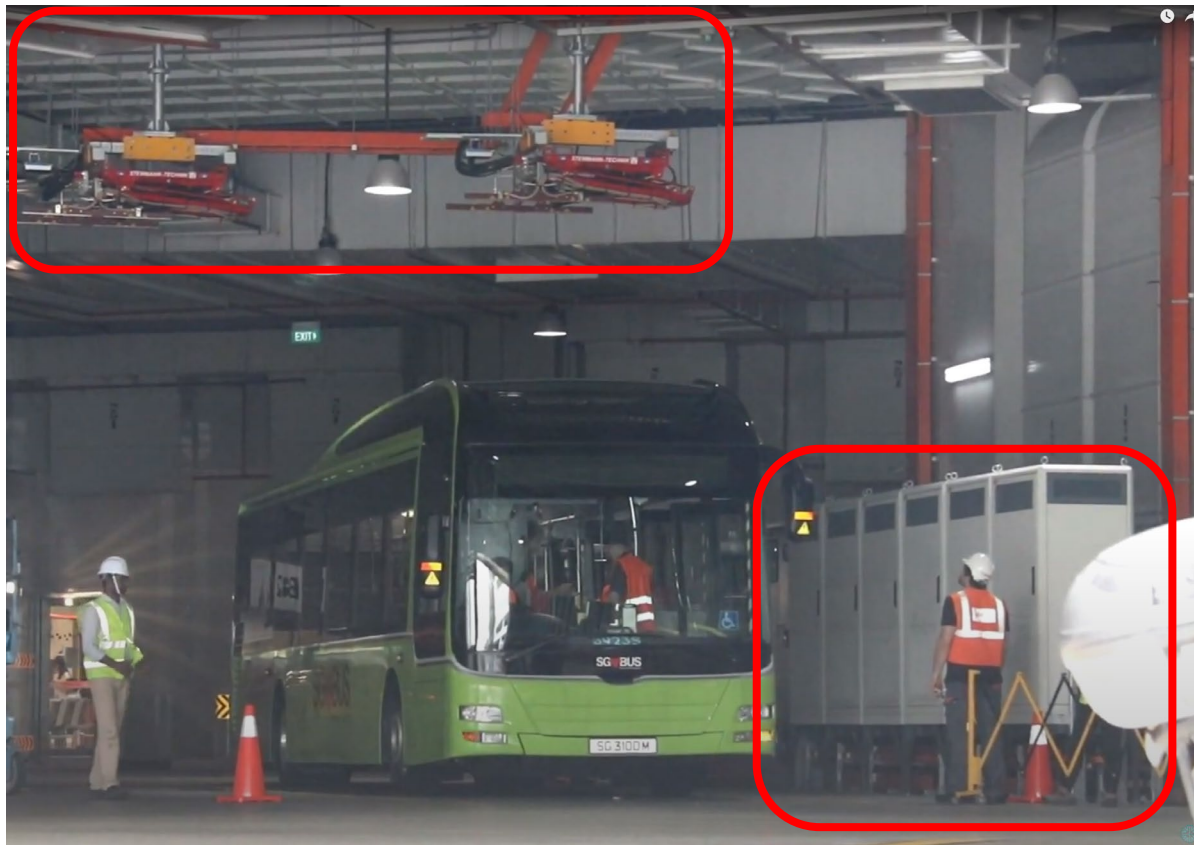
MW MULTIPOINT ELECTRIC TRUCK-BUS CHARGING COUPLERS

- 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 of 1500v(max)/3000A(max){4.5MW}; prototypes running at 3000A. PLC vs CAN comm testing. Schedule shows standard specifications set by end of 2021, public release Q1-2022? <https://www.charin.global/technology/mcs/>
- 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



Pantograph Installation Examples: ABB, Oppcharge



- Heliox and other offer sequential charging- 3x pantographs per EVSE (3 dispensers, on at a time) for depot charging overnight (slow)
- 6x175kW ABB converters here
- Orange conduit/raceway, exit out the riser on the base, up the wall across to ceiling mounted pantographs (2 shown here)
- Note clearance above the bus to pantograph while retracted

Pantograph Installation Examples: ABB, Oppcharge



- Stemmann-Technik pantograph post mounting, extended in operation here
- Fail-safe return springs
- J3105 has 4x contacts for +/- power, pilot, PE signals

INTEROPERABILITY TESTING EVENTS- PORTLAND OREGON EXAMPLE

Matrix of test stations with round robin rotation of vehicles every 30 minutes

AC			EVSE										AC
Time	Company 1	Type	ISO	PnC	EIM	EIM	PnC	ISO	Type				
	Ford Motor Company, Lightning	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Ebee Smart Technologies, Garo GLB+		Location 2	
	BMW of North America, BMW i7 (1)	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Switch, Zaptec Pro ZPR089249 Test Charger		Location 3	
	Ford Motor Company, Mach E	Electric Vehicle (EV)	X	X	X	X	X	X	Test System for (EV)	EVgo, Trialog EVSE ComboCS Simulator		Location 4	
	Lucid Motors, Lucid Air	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	IoTecha, CCS-C80C		Location 5	
	Mercedes Benz RND NA, Mercedes-Benz EQS	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Rivian Automotive, AC L2		Location 6	
(AC EV/EVSE) 0/05/2022 AM - 11:45 AM	Navistar, International eMV	Electric Vehicle (EV)							Test System for (EV)(EVSE)	Keysight, CDS		Location 12	
	Navistar, Electric IC Bus	Electric Vehicle (EV)							Test System for (EV)(EVSE)	DEKRA Certification, Keysight CDS		Location 13	
	Mercedes Benz RND NA, Mercedes-Benz EQB	Electric Vehicle (EV)											
	BMW of North America, BMW i7 (2)	Electric Vehicle (EV)	X	X	X								
	SEA Electric, SEA Electric 195/M5	Electric Vehicle (EV)											
DC													
(DC EV/EVSE) 10/05/2022 15 AM - 11:45 AM	PACCAR, Heavy Duty PACCAR Class 8 Vehicle	Electric Vehicle (EV)											
	Rivian Automotive, R1T	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Rivian Automotive, DCFC RAN		Location 7	
	Keysight, CDS	Test System for (EV)(EVSE)	X	X	X	X	X	X	Supply Equipment (EVSE)	EcoG, EcoG Starter Kit		Location 8	
	Hyundai HATCI, MV	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	POWER ELECTRONICS, NBw30		Location 9	
	Moxion Power, MP-75	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Ekoenenergyka, Plug Chager GO 30 QP-5260		Location 10	
11 (DC EV/EVSE)	Mercedes Benz RND NA, Mercedes-Benz EQB	Electric Vehicle (EV)							Test System for (EV)(EVSE)	Rhombus Energy Solutions, RES-DCVC60-480 (1)		Location 11	
	Freightliner Specialty Vehicles, MTS06 Walk-In Van	Electric Vehicle (EV)	X						Supply Equipment (EVSE)	Keysight, CDS		Location 12	
	BMW of North America, BMW i7 (2)	Electric Vehicle (EV)							Supply Equipment (EVSE)	DEKRA Certification, Keysight CDS		Location 13	
	Mack Trucks, Mack LR Electric	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	ABB, DCWB		Location 14	
	Hyundai HATCI, SX2	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Heliox Technologies, Mobile 25kW charger		Location 15	
15 (DC EV/EVSE)	Navistar, Electric IC Bus	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	BTCPower, L3A-180-480-501-013 180kW AJO Chademo-CCS Charger		Location 16	
	Rivian Automotive, R1S	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	Rhombus Energy Solutions, RES-DCVC60-480 (2)		Location 17	
	SEA Electric, SEA Electric 195/M5	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	EVgo, Delta High Power 350kW		Location 18	
	Navistar, International eMV	Electric Vehicle (EV)	X						Supply Equipment (EVSE)	ChargePoint, CPE250		Location 19	
	PACCAR, Kenworth K370 Day Cab (Class 7 Vehicle)	Electric Vehicle (EV)	X	X	X	X	X	X	Supply Equipment (EVSE)	chargebyte, SECC w/ Type 1 Plug		Location 20	
18 (DC EV/EVSE)	Freightliner Specialty Vehicles, Thomas Built Buses Saf-T-Liner® C2 Jouley™	Electric Vehicle (EV)	X						Supply Equipment (EVSE)	Trilium, RTM75		Location 21	
	Daimler Trucks North America, eCascadia	Electric Vehicle (EV)	X						Supply Equipment (EVSE)	ABB, T184		Location 22	
		Electric Vehicle (EV)	X						Supply Equipment (EVSE)	SparkCharge, Roadie V3 (2)		Location 23	
		Electric Vehicle (EV)	X						Supply Equipment (EVSE)	SparkCharge, Roadie V3 (1)		Location 4	
		Electric Vehicle (EV)	X						Test System for (EV)	EVgo, Trialog EVSE ComboCS Simulator			

INTEROPERABILITY TESTING EVENTS- PORTLAND OREGON EXAMPLE

Trucks, buses, sedans, SUVs, AC and DC charging



INTEROPERABILITY TESTING EVENTS- PORTLAND OREGON EXAMPLE

Field Testing- high accuracy test fixture on dispensed energy validation testing (meter accuracy)
6 ppm current sensors, 20 ppm meters, Labview application to collect/format test results in pdf report
- Pass through fixture for 500A CCS, 3000A MCS

