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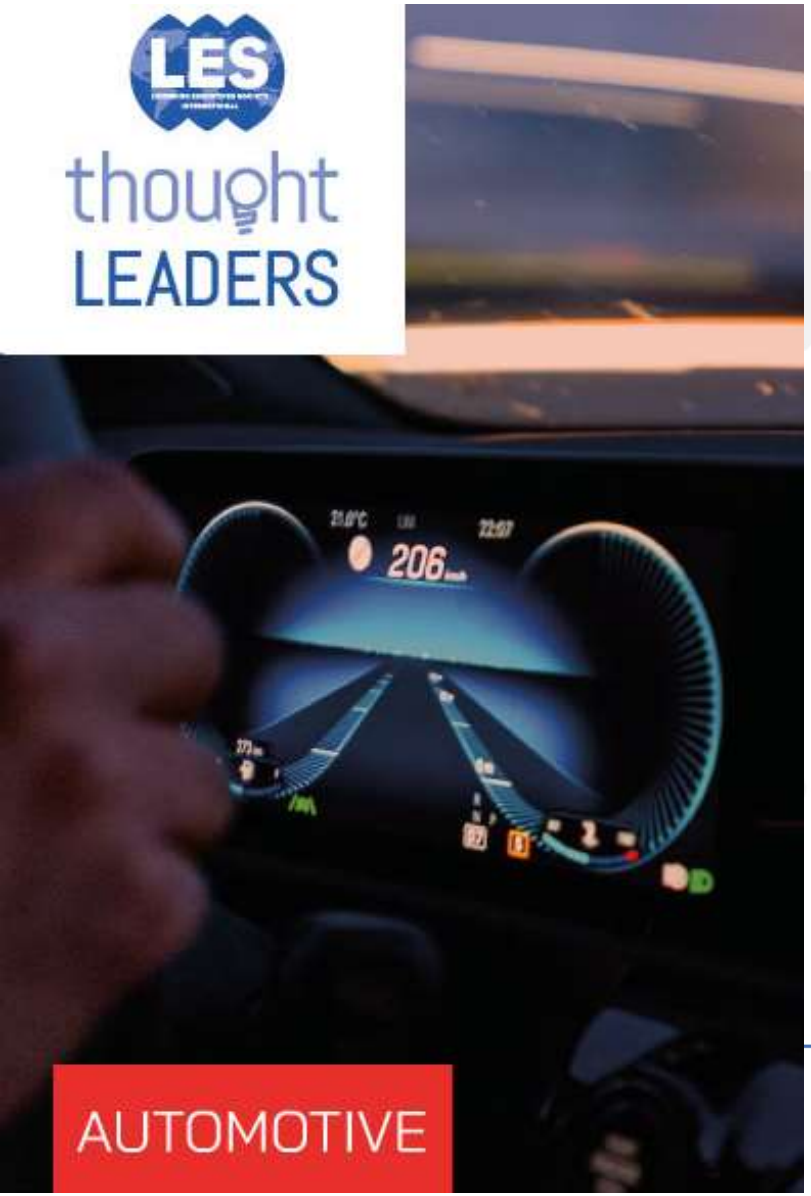
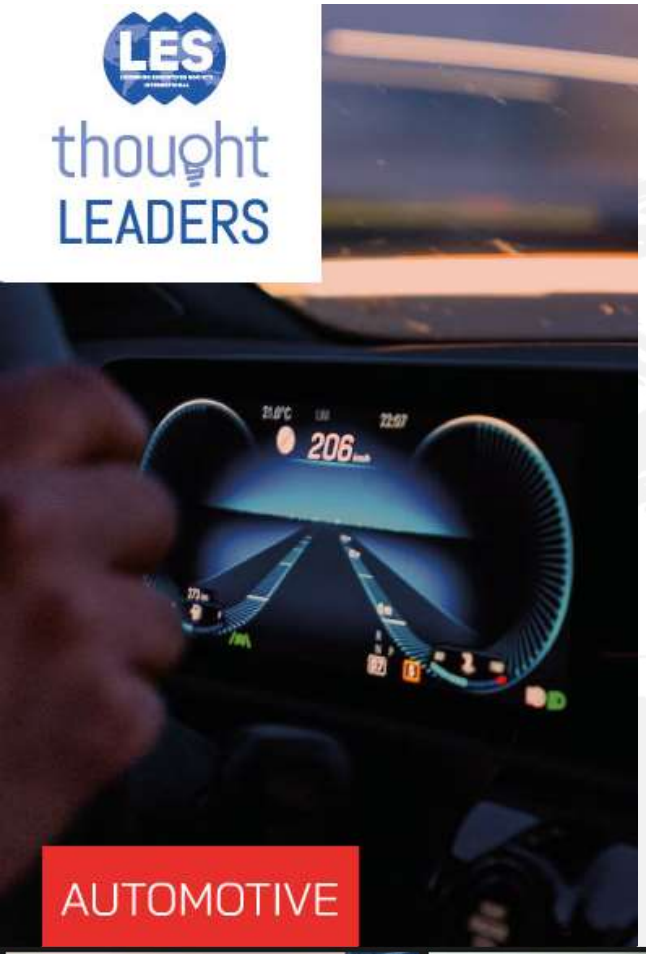


LESI Thought Leadership Program - Track 2, Session #3:

Vehicle Electrification

February 23, 2022

Licensing Executives Society International
Advancing the Business of IP Globally



Panelists

- **John Carney** - Chair of the LESI Automotive IAB (Moderator)
- **Eugene Hyun** – Global Head of IP Activity, ABB E-mobility *(a major systems supplier for grid-based EV charging and power distribution systems)*
- **Eric Gottschling** – Global Director – Licensing & Commercialization, Borg Warner *(a major supplier of EV Power electronics for EV power management)*
- **Dr. Yansong Chen** - SVP for Global Technology, Marketing and Strategy, Ricardo Strategic Consulting *(a major engineering development firm specializing in electric and advanced gas/diesel vehicle powertrain technology)*
- **Jacky Gu** – Director of Electric Powertrain Engineering, Xiaopeng *("Xpeng" - a major Chinese EV manufacturer)*

EV Charging – From Slow to Fast

Charge Capability	
20 Hours **120-mile range** →	**Level 1 Chargers: Your Basic Wall Plug** Type 1 chargers are just regular wall outlets, the same thing you'd plug your phone into to charge. As you might expect, it takes a very long **time to charge an EV's battery with a type 1 charger — about 20 hours for a 120-mile charge**. Type 1 chargers use AC (alternating current) power, and range in output from 1kW to 7.5 kW. They're also called "single-phase" plugs, and type 1 connectors are standard for EVs made in the U.S. and Japan.
3 Hours **250 + mile range** →	**Level 2 Chargers: Found at Most Public Charging Stations** Type 2 chargers also use AC power and allow for increased charging speed due to their increased power output. These chargers deliver around **240 volts of power and can charge an EV battery anywhere from five to seven times faster than a type 1 charger**. Type 2 chargers use a different type of plug to connect than a type 1 charger because they require a connector plug with additional wires to carry the additional power. That plug is called an SAE J1772 connector and is the standard for all EVs produced in North America as of this writing. Many EVs sold today come packaged with some kind of J1772 connector.
30 Minutes **200 + mile range** →	**Level 3 Chargers: The Road Trip EV Charger** Type 3 chargers, also known as DC fast charging or DCFC chargers, will get you the quickest juice-up of any charging station out there. They use DC (direct current) energy, and require special plugs to connect that are different from the J1772 standard. use a different plug construction. **A type 3 charging station can get an EV's battery to around the 80 percent mark in roughly half an hour.**

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CCS - Combined Charging Systems – Level #3

Combo 1 – US Version

By Mariordo (Mario Roberto Durán Ortiz) - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=115882524

A CCS1 (Combined Charging Standard 1) DC charging connector, which is used in North America. It is an extension of the J1772 standard AC charging connector.

CCS Combo 1 vehicle inlet showing the J1772 and the two DC fast-charging pins

The **Combined Charging System** (**CCS**) is a standard for charging electric vehicles. It can use **Combo 1** or **Combo 2** connectors to provide power at up to 350 kilowatts. These two connectors are extensions of the IEC 62196 Type 1 and Type 2 connectors, with two additional direct current (DC) contacts to allow high-power DC fast charging.

The Combined Charging System allows AC charging using the Type 1 and Type 2 connector depending on the geographical region. This charging environment encompasses charging couplers, charging communication, charging stations, the electric vehicle and various functions for the charging process such as load balancing and charge authorization.

Electric vehicles or electric vehicle supply equipment (EVSE) are CCS-capable if they support either AC or DC charging according to the standards listed by the CCS. Automobile manufacturers that support CCS include BMW, Daimler, FCA, Ford, Jaguar, General Motors, Groupe PSA, Honda, Hyundai, Kia, Mazda, MG, Polestar, Renault, Rivian, Tesla, Mahindra, Tata Motors and Volkswagen Group.[1][2]

Competing charging systems for high-power DC charging include CHAdeMO (Japanese), Guobiao recommended-standard 20234 (Chinese), and Tesla Supercharger (Tesla).[3]

Combo 2 – European Version

By Paul Sladen - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=61915514

Connectors: Combo 2 (left), compared to IEC Type 2 (right). Two large direct current (DC) pins are added below, and the four alternating current (AC) pins for neutral and three-phase are removed.

Typical Combined Charging System (Combo 2) vehicle inlet

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Other Fast Charging Systems

- China - The **GB/T charging standard** is a set of GB/T standards, primarily in the GB/T 20234 family, for electric vehicle AC and DC fast charging used in China. The standards were revised and updated most recently in 2015 by the Standardization Administration of China.

- **Tesla Supercharger** - A Tesla Supercharger is a 480-volt direct current fast-charging technology built by American vehicle manufacturer Tesla, Inc. for electric cars. The Supercharger network was introduced on September 24, 2012, with six Supercharger stations.[1] As of December 2022, Tesla operates 40,432 Superchargers in 4,470 stations worldwide, an average of over 9 chargers per station. There are 1,772 stations in North America, 1,801 in the Asia/Pacific region, and 897 in Europe.[2] Supercharger stalls have a connector to supply electrical power at maximums of 72 kW, 150 kW or 250 kW.[3]

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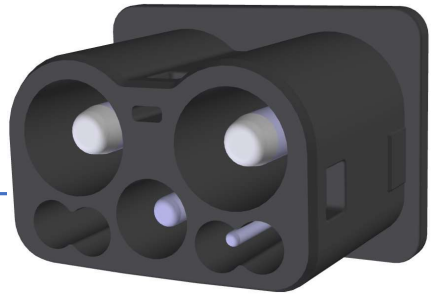
CHAdeMO

CHAdeMO 3.0 released: the first publication of ChaoJi, the new plug harmonized with China's GB/T

Operating under CHAdeMO communication protocol, CHAdeMO 3.0 is the first publication of the next-generation ultra-high-power charging standard, being co-developed by China Electricity Council (CEC) and CHAdeMO Association with the working name "ChaoJi." The Chinese version, operating under the GB/T communication protocol, is also planned to be released next year.

This latest version of CHAdeMO protocol enables DC charging with the power over 500kW (maximum current 600A), while ensuring the connector to be light and compact with a smaller diameter cable, thanks to the liquid-cooling technology as well as to the removal of locking mechanism from the connector to the vehicle side. Backward compatibility of the CHAdeMO 3.0-compliant vehicles with the existing DC fast charging standards (CHAdeMO, GB/T, and possibly CCS) is ensured; in other words, today's CHAdeMO chargers can feed power to both the current EVs as well as the future EVs via an adapter or with a multi-standard charger.



CCS Standards

High-Power DC Couplers

- CCS - standard **IEC TS 62196-3-1** describes the requirements for high-power DC couplers including thermal sensing, cooling and silver-plating of contacts.[29] CharIN are investigating versions over 2 MW for electric trucks, and equipment is being tested.[30][31]

Charging communication

- Unlike the connector and inlet, which depend on the geographical location, the charging communication is the same around the globe. Generally two types of communication can be differentiated.
- **Basic signaling (BS)** is done using a pulse-width modulation (PWM) signal which is transferred over the control pilot (CP) contact according to **IEC 61851-1**. This communication is used for safety-related functions, indicating for example if the connector is plugged in, before contacts are made live (or energized) and if both charging station and electric vehicle are ready for charging. AC charging is possible using the PWM signal only. In this case the charging station uses the duty cycle of the PWM to inform the onboard charger of the maximum available current at the charging station (A pulse width of 5% indicates that HLC shall be used).
- High-level communication (HLC) is done by modulating a high-frequency signal over the CP contact (also known as Power Line Communication or PLC) to transfer more complex information, which may be used e.g. for DC charging or for other services such as "plug and charge" or load balancing. **High-level communication** is based on the standard **DIN SPEC 70121** and the **ISO/IEC 15118-series.**

Other Emerging Standards

- **Open Charge Point Protocol** - an open-source communication standard for EV charging stations that would let operators mix and match hardware and software
- **ISO15118** international standard defining V2G communication interfaces, tariff handling and securing communication from the EV through the charging station and on to the charging service

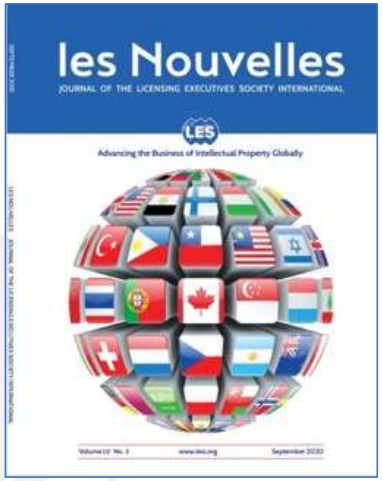
Thank you for joining!

LESI Thought Leadership Program
2023-2023
lesi.org/thoughtleadership

A professional learning series, providing a “deep dive” on three topical tracks starting leading up to LESI2023 in Montreal. Organized and facilitated by licensing industry experts and allowing LESI to lead and inform business conversations related to intellectual property policy.

Who is LESI?

The Licensing Executives Society International (LESI) is a global association, established in 1973, of 33 national and regional Member Societies, in more than 90 countries, serving more than 6500 individuals.



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- Creating, protecting, and commercializing innovation, and managing and monetizing IP
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