

SAE TIR J2954:

**“Wireless Charging of Electric and
Plug-in Hybrid Vehicles”**

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Overview SAE J2954

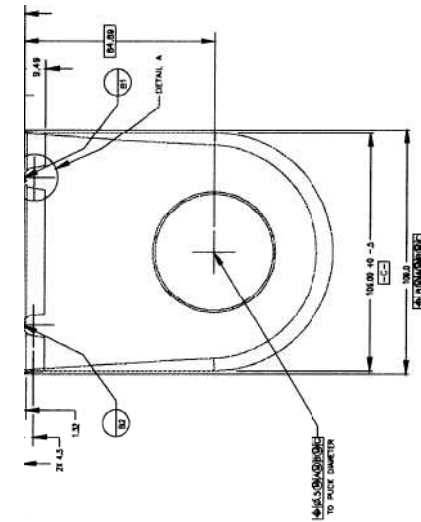
- Why?
- What's out there already regarding wireless charging?
- SAE Existing Inductive Charging
- Approach and Proposal for SAE Taskforce
- Feedback & Working together

Why?

- Customer transparency and seamlessness for EV/PHEV charging without having to physically connect.
- Smart Grid programmability
- Harmonization for wireless power transfer (SAE as a focal point for North America)
- For this reasons, **SAE J2954** was started in November, 2010 (Monthly meetings)

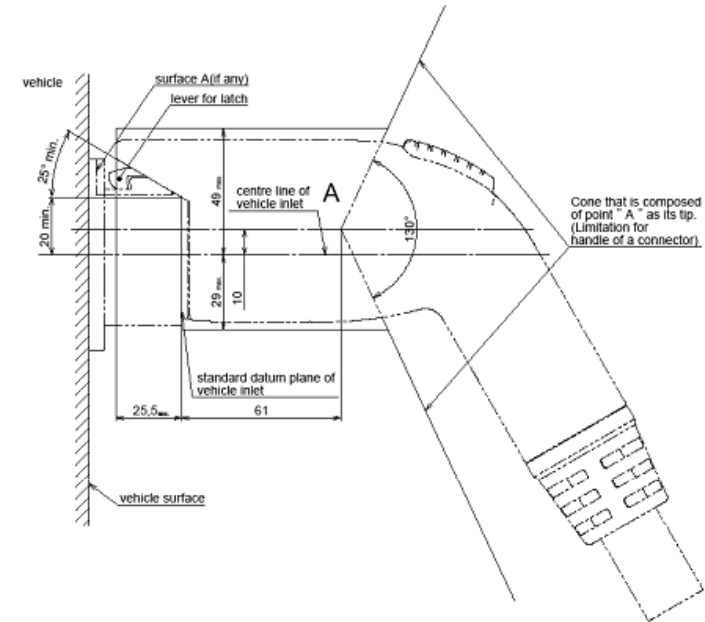
Present SAE 1773

- Original Title: “Electric Vehicle Inductive Coupled Charging”
- Scope: Based upon Magne Charger (“Paddle Charger”) used In EV-1
- Specific hardware, software based on one design and technology
- Good general information on Inductive Charging
- Vehicle-Station bidirectional communications either RF or IrDA



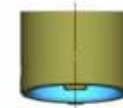
SAE J1772

- SAE Electric Vehicle and Plug In Hybrid Electric Vehicle Conductive Charge Coupler
- Standard Conductive Charging Connector in North America
- Not compatible to ISO Standards adopted in Europe

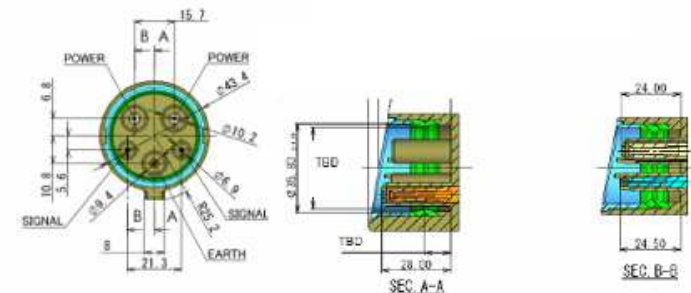


STANDARD SHEET 2-1
(continuation 1)

VEHICLE CONNECTOR



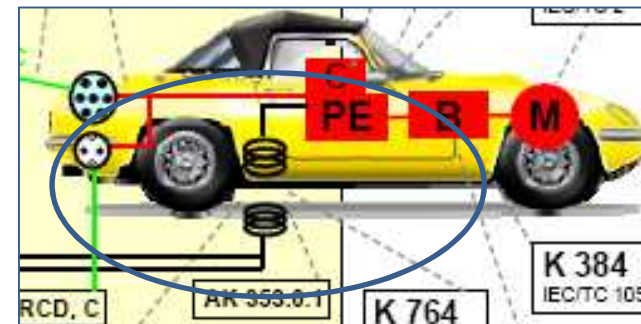
Third angle projection
Dimensions in millimeters



Wireless Charging Forum: DKE in Germany

- AK 353.0.1: “Wireless charging of electric vehicles”
- Scope: Fundamental Requirements for Wireless Electric Vehicle Charging
- Participants: OEM and Inductive Charging Producers
- Industry forum “By Invitation Only”

The screenshot shows the DKE website interface. At the top, there are logos for VDE, DIN, and DKE. Below the logos, there are navigation tabs for 'VDE', 'DIN', 'finden & beziehen', 'DKE-WebConferencing', and 'DKE-Dokumentenserver'. The main content area is titled 'DKE-Startseite' and includes a search bar, a 'DKE-Gremium auf einen Blick' section, and a 'Tätigkeitsbericht 2009' section. The 'DKE-Gremium auf einen Blick' section lists 'DKE/K 353 Elektrostraßenfahrzeuge' under 'Fachbereich 3'. The 'Tätigkeitsbericht 2009' section provides details about the work done on AK 353.0.1, including the development of a VDE application rule for inductive charging.



UL Standard for “Low Energy” Wireless Charging

- UL creating Standard for induction power transmitters, such as wireless battery chargers, employing magnetic induction coils that transmit energy to receiving coils in low-energy devices, such as cell phones, etc.
- Open to all industry to participate



The screenshot shows a web page from Underwriters Laboratories (UL) Newsroom. The page features a red header with the UL logo and the tagline "the standard in safety". Below the header, there is a navigation menu with "Perspectives", "Industries", and "Services" dropdowns. The main content area displays a news item titled "UL developing first-edition standard for wireless charging devices for use with low-energy products". The article text discusses the development of a first-edition standard for induction power transmitters and receivers for use with low-energy products, mentioning that the standard applies to devices like wireless battery chargers and portable media players. It also includes a quote from Carlos Correia, Vice President of UL High-Tech Division, and a list of requirements for the proposed standard.

UL the standard in safety

MyHome @UL Login

Underwriters Laboratories
Newsroom

Perspectives Industries Services

Home > Newsroom > News Item

UL developing first-edition standard for wireless charging devices for use with low-energy products

NORTHBROOK, Ill., June 28, 2010 - Underwriters Laboratories (UL), a world leader in safety testing and certification, is developing a first-edition standard for induction power transmitters and receivers for use with low-energy products. UL 2738 applies to induction power transmitters, such as wireless battery chargers, employing magnetic induction coils that transmit energy to receiving coils in low-energy devices, such as cell phones, portable media players and global positioning devices. The new requirements will not apply to these products powered by the induction transmitters or receivers.

While the popularity of wireless devices has multiplied, so too have extension cords, wires and chargers around the home and office. Ultimate mobility has remained elusive, creating a demand among consumers to eliminate "the last wire." As a result, wireless charging options are rapidly emerging, and wireless power interoperability across rechargeable electronic devices will be expected.

"UL understands the market need for wireless charging options, and is making sure safety stays a primary focus as the technology becomes more commonplace," said Carlos Correia, Vice President, UL High-Tech Division. "Our goal is to help manufacturers consider safety even before they begin the product development phase."

The new proposed UL requirements for induction powered transmitters and receivers for use with low-energy products will apply to:

- Induction power transmitters intended to be supplied by a branch circuit of 600 volts or less;
- Induction receivers intended for use with specific induction power transmitters; and
- Induction receivers intended for use with induction power transmitters conforming to industry accepted interoperability specifications.

Before becoming a standard, these requirements will undergo a comprehensive review process by a global Standards Technical Panel (STP), open to product manufacturers, supply chain personnel, government representatives, consumers, and those responsible for enforcing the requirements of codes or standards. Candidates who would like to be considered for membership on the STP should send their inquiries to Jonette.A.Herman@us.ul.com.

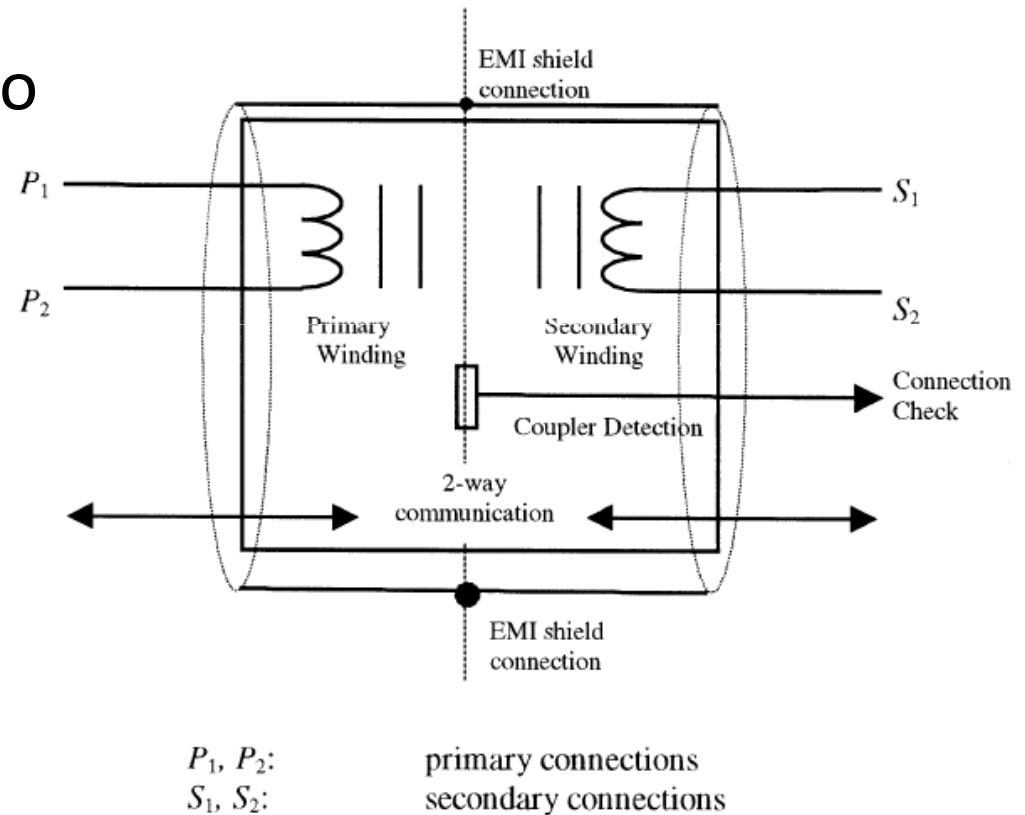
UL → WORLDWIDE

Mission Statement J2954

This SAE document defines acceptable criteria for minimum performance, safety and testing for wireless charging of electric and plug-in electric vehicles (light duty and heavy duty). It establishes AC Level 1,2,3 and DC Level 1,2,3 charge levels and specifies a location for wireless charging. Adoption of a standard for wireless power transfer based on charge level will enable selection of an appropriate charging based on vehicle requirements thus allowing for better vehicle packaging, and ease of customer use.

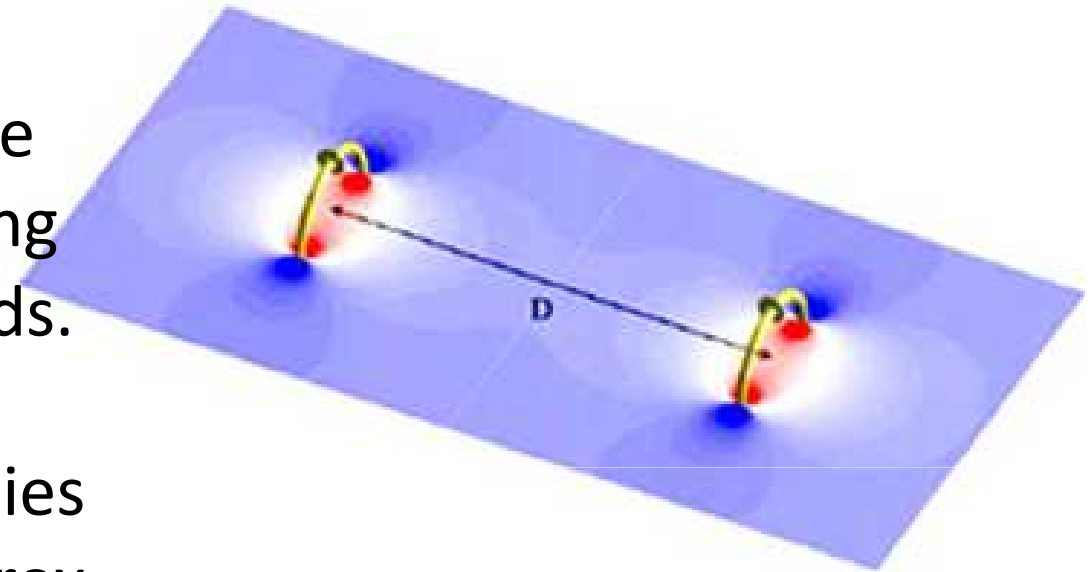
What is Inductive Charging?

Inductive charging uses the electromagnetic field to transfer energy between two objects in close proximity. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries.



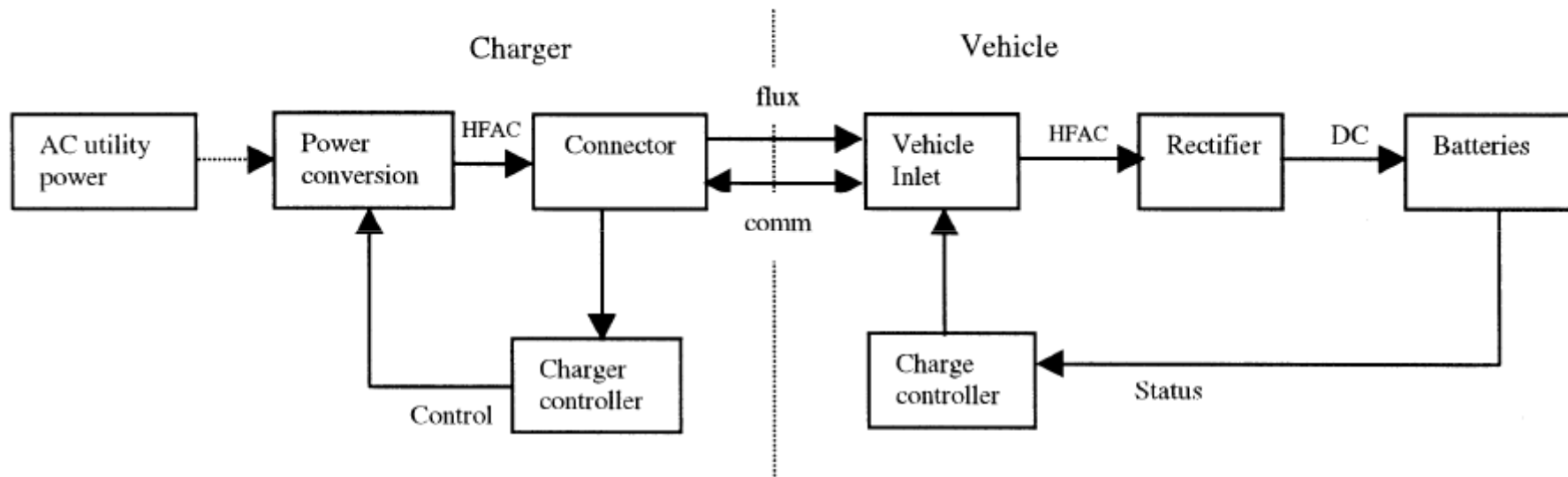
Magnetic Resonance

Magnetic coupling occurs when two objects exchange energy through their varying or oscillating magnetic fields. Resonant coupling occurs when the natural frequencies of the two objects are approx. the same. Two idealized resonant magnetic coils, shown in yellow. The blue and red color bands illustrate their magnetic fields.

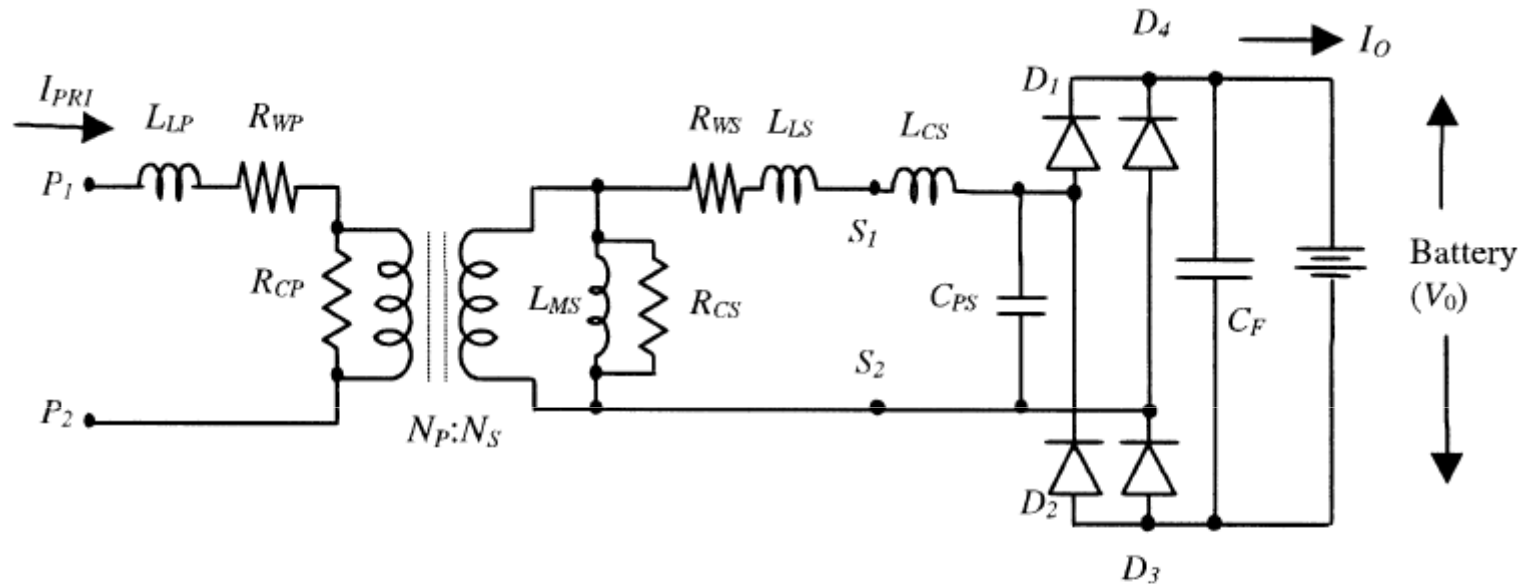


The coupling of their respective magnetic fields is indicated by the connection of the colorbands. Note: larger charging distances are possible lower efficiency

Closed Loop Charging Diagram



Inductive Interface Equivalent Circuit



P_1, P_2 primary connections
 L_{LP} connector leakage inductance
 R_{WP} connector winding resistance
 R_{CP} ferrite core loss resistance
 N_P primary turns

L_{MS} magnetizing inductance
 R_{CS} ferrite core loss resistance
 R_{WS} winding resistance
 L_{LS} inlet leakage inductance
 L_{CS} secondary cable leakage inductance
 C_{PS} parallel capacitor
 S_1, S_2 output connections
 D_{1-4} rectifier diodes
 C_F output filter capacitor
 N_S secondary turns

Wireless Suppliers and Infrastructure involved in Wireless Charging J2954

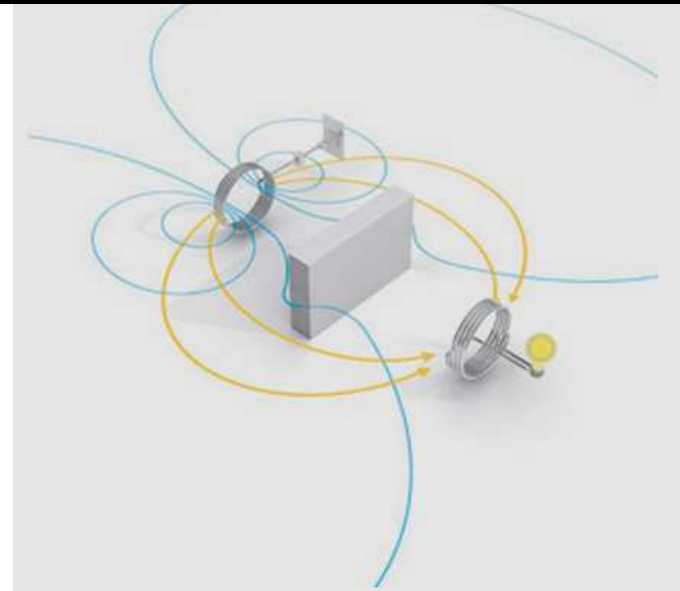
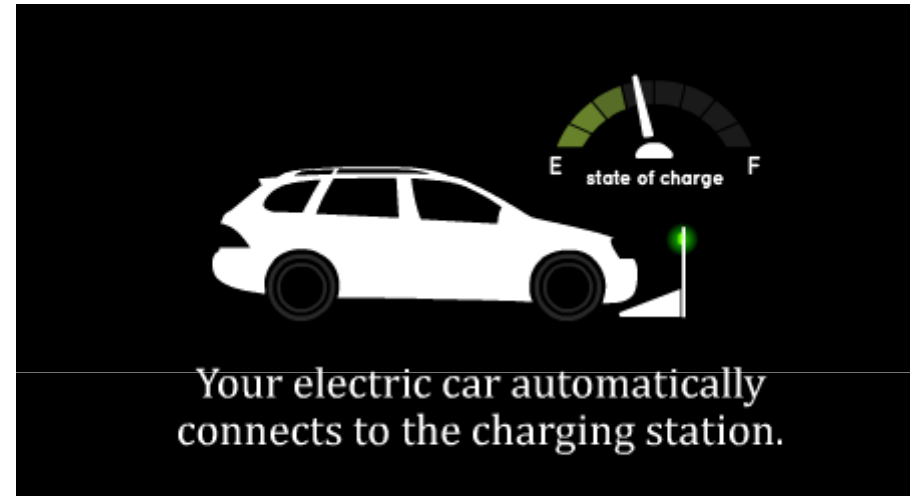
Wireless Power Transfer

Suppliers:

- Conductix Wampfler
- Evatran
- HaloIPT
- SEW
- WiTricity

Infrastructure Companies

- Better Place
- NRG Energy
- Qualcomm



Companies Involved in J2954

(Note: Status 12/2010, Other companies in process to join group)

Auto OEMs:

- BMW
- Chrysler
- Fisker
- Ford
- GM
- Honda
- Mitsubishi
- Nissan
- Phoenix
- Toyota

Bus OEMs:

- Proterra

Tier 1

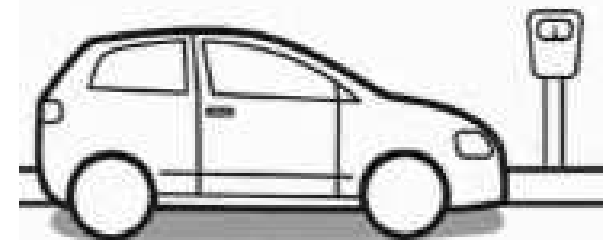
- Delphi
- Magna
- Maxwell
- Panasonic

Organisations:

- Argonne National Laboratory
- EPA
- EPRI
- University of Tennessee
- UL (presently low power IPT)
- TÜV North America

SAE TIR J2954

- Title: “**Wireless Charging of electric and Plug-in hybrid vehicles**”
- Scope: Safety and Performance targets in TIR. Team initially evaluate multiple technologies (Inductive, Magnetic resonance, etc.) and eventually end up on common approach. Interoperability!
- Charging Locations: Residential, On-Road (Parking Lot, Roadway)
- Wireless Communications
- Level 1,2,3 Charging
- Light & Heavy Duty



Types of Charging

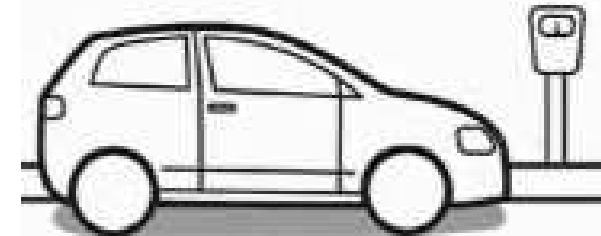
•A: Residential:

> Efficiency, Performance Oriented (Technology Neutral regarding interoperability): For example 95% Efficiency...



•B: On-Road Static:

<Efficiency, Interoperability Oriented (Standard Area of Charging, Defined Location, etc.): I.E. 90% Efficiency...



•C: On-Road Dynamic:

<<Efficiency, Interoperability Oriented (Standard Area of Charging, Defined Location, etc.): I.E. <<90% Efficiency...

Note: Potentially For Next Generation Document



Topics for J2954

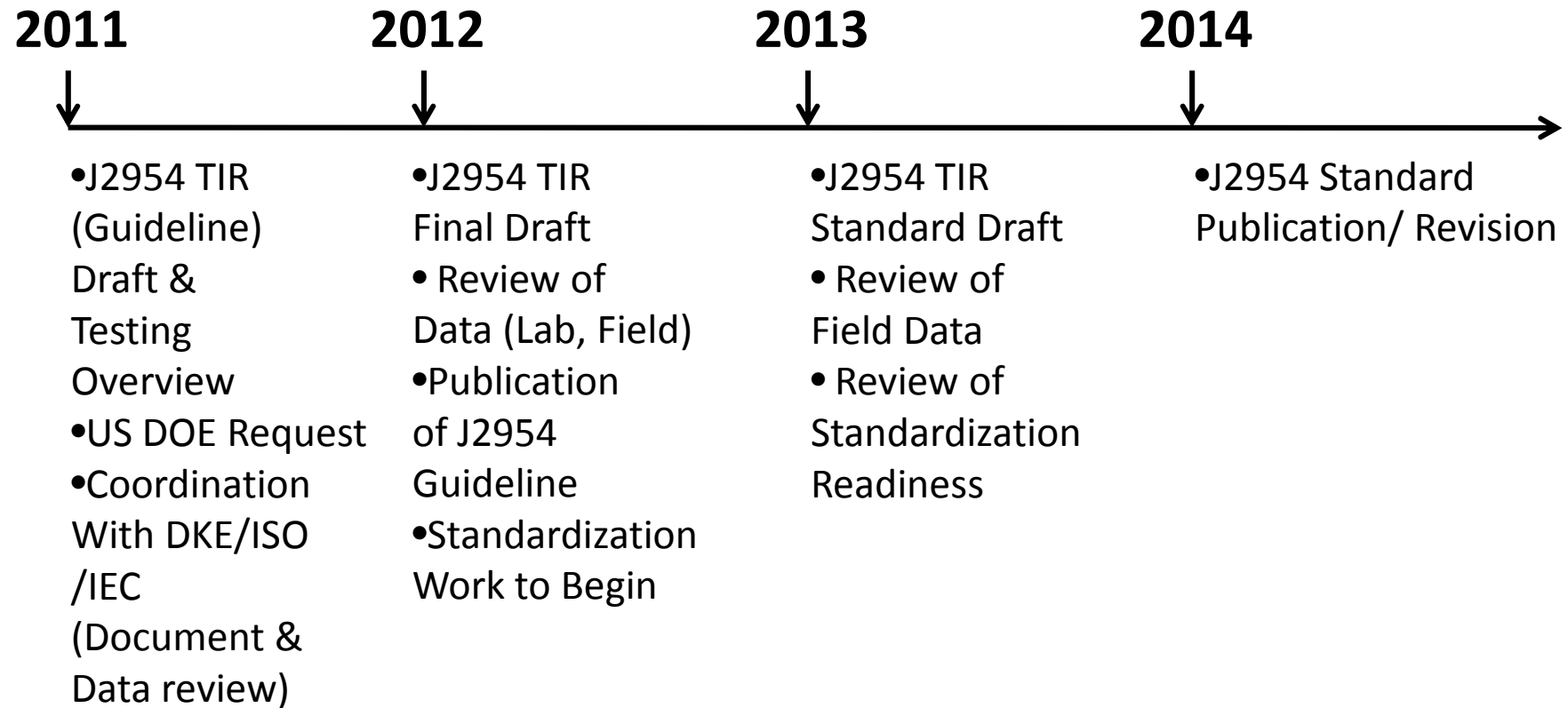
General:

- Testing (Vehicle, Charger, System)
- Minimum Efficiency
- Positioning on vehicle, charging unit
- Potential common location for residential/ onroad charging
- Frequency (Band)
- Wireless Communications & software
- Interoperability

Safety:

- Magnetic Field
- Charging SOC
- At Level 1,2,3 charging
- Temperature
- Shock

SAE J2954 Milestone Timeline



Participation

- Industry members from OEMs, Wireless Charging Suppliers, government labs, utilities etc.
- Coordinated between SAE Hybrid & Battery Committees
- Harmonize between international activities (UC Davis, etc.) to not duplicate efforts
- Discuss with US DOE related to data generation projects
- Work with UL/ TÜV to harmonize with high energy charging standards

Approach to J2954

- Determine Minimum Performance Criteria for charging (Efficiency) through team consensus with input from industry studies
- Develop Safety Criteria also by coordinating with data gathering
- Develop Testing Protocol for Safety and Performance of wireless charging
- Create a Matrix of available wireless charging technologies also through supplier presentations
- Develop a common interface for vehicle side charging to assist in interoperability of wireless charging

SAE J2954 Outline Part 1 (Draft)

- Scope/References/ Definitions
- General vehicle and charger system requirements and interface
- Types of Charging
- SYSTEM DESCRIPTION
- Voltage Requirements
 - AC SUPPLY VOLTAGE
 - Output Voltage Range
- INTEROPERABILITY
 - Automatic Tuning
- Electromagnetic Compatibility (EMI,C)

SAE J2954 Outline Part 2 (Draft)

- Magnetic Field Definition, Standard
- Functional/Physical Requirements
- CONNECTION CHECK
- General Wireless Charging System Req.
- Electric Shock
- Testing
 - Dielectric tests requirements
 - Environmental tests
 - Mechanical tests
- Marking & Identification