IEEE PEMC 2026

22nd International Power Electronics and Motion Control Conference

Sept. 23–25, 2026 — Tallinn, Estonia

Power Electronics and Motion Control Conference

PEMC

Tutorial Proposal:

Wireless Charging of Electric Vehicles: Design for Battery Interoperability and High Efficiency Wide Range Operation

Duration: 120 minutes

Abstract. Wireless power transfer (WPT) technologies have been gaining interest as convenient charging solutions for future electric vehicles (EVs). As vehicle platforms, battery architectures, and charging infrastructures grow increasingly diverse, interoperability has emerged as a central challenge in wireless charging system design. This tutorial lecture provides a comprehensive overview of static and dynamic wireless charging for EVs, emphasizing design methodologies that enable interoperable operation across different vehicles and charging scenarios. The lecture begins by introducing the fundamental design choices for EV wireless charging systems, including coil and magnetic-coupler topologies, selection of compensation networks, and power-converter stages. These elements critically affect efficiency, power capability, tolerance to misalignment, and system robustness. The role of industrial standards is then examined, with particular attention to how standardization constraints shape both electromagnetic and power electronic design decisions. Static wireless charging is addressed as the most mature application. The tutorial focuses on the interface between the wireless power transfer stage and the EV battery, presenting a voltage/current doubler converter architecture as an effective solution for achieving battery interoperability across a wide voltage range while maintaining high efficiency and relatively low hardware complexity. Building on these foundations, the tutorial further examines how to maintain high efficiency operation through modulation and tuning effort, without altering conventional charging pad topologies, while the charging power and output voltage are both varying. The content will focus on the hybrid modulation and switch-controlled-capacitors based methods which introduce variable voltage gains through the power conversion train. By integrating fundamentals, standards, and advanced applications, this tutorial equips attendees with a coherent understanding of interoperable wireless charging technologies for current and future electric vehicle systems.

Content Outline

Duration	Topics covered
5 min	Introduction
15 min	***Fundamentals of EV wireless charging:*** This section provides an overview of industrial standards, coil and magnetic-coupler topologies, selection of compensation networks, and power-converter stages.
15 min	***Static EV wireless charging:*** This section describes typical EV wireless charging architectures and designs for static wireless charging.
15 min	***Voltage/current doubler converter for battery interoperability:*** This section showcases a voltage/current doubler converter architecture as an effective solution for achieving EV battery interoperability across a wide voltage range while maintaining high efficiency and relatively low hardware complexity.
5 min	Break
15 min	***Hybrid modulation for efficiency boost at partial load:*** This section provides an overview of the operation principles of the triple-phase-shift method and hybrid modulation method to improve the DC-DC power efficiency for battery charging at low load.
15 min	***Switch-controlled-capacitor based tuning and cooperative control:*** This section introduces the operating principles of dual-side capacitor tuning and cooperative control method to maintain high efficiency of the double-side LCC compensated wireless charging system.
15 min	***Overview of alternative solutions and outlook:*** This section provides a general overview of other endeavour for wide-range high efficiency operation of wireless charging and looks forward to future research directions.
5 min	Conclusions
15 min	Q&A Session

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Short bio of the instructors

Francesca Grazian (Member, IEEE) received her B.Sc. degree in Electrical Engineering from the University of Bologna, Italy, in 2016, followed by her M.Sc. and Ph.D. degrees in Electrical Engineering from the Delft University of Technology, The Netherlands, in 2018 and 2023, respectively. Her Ph.D. research focused on power electronics for wireless charging of electric vehicles. From 2023 to 2024, she gained experience in the railway industry as a Lead Electrical Engineer at Laser Precision Solutions in Amsterdam, the Netherlands. Since May 2024, Francesca Grazian has been an Assistant Professor at the TU/e Power Electronics Lab (PELe), the Netherlands. Her research focuses on innovative wireless power transfer systems, industrial electrification, and the environmental impact of power electronics. Email: f.grazian@tue.nl

Jianning Dong (Senior member, IEEE) received the B.Sc. and Ph.D. degrees in electrical engineering from Southeast University, Nanjing, China, in 2010 and 2015, respectively. In 2016, he worked at the McMaster Automotive Resource Centre, McMaster University, Hamilton, ON, Canada, as a Post-Doctoral Researcher. Since October 2016, he has been an Assistant Professor, and then from 2025 an Associate Professor with the DC Systems, Energy Conversion and Storage (DCE&S) Group, Delft University of Technology, Delft, The Netherlands. His research interests include electromechanical energy conversion and contactless power transfer, through which he applies knowledge to applications such as transportation electrification and renewable energy generation/utilization.. Email: J.Dong-4@tudelft.nl