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Guest Editorial

Fast, superfast, and ultra-superfast Intelligent and Smart Charging Solutions for Electric Vehicles

Irfan Khan, Atif Iqbal, P. Sanjeevikumar, Massimo Mitolo, Mohammad Shahidehpour, Josep M. Guerrero, Jens Bo Holm-Nielsen, John Lam, Mousa Marzband

To promote and meet the projected levels of electric vehicle (EV) penetration, the development of charging infrastructure, i.e., both slow charging and dc-fast charging, is essential. Slow/onboard chargers pose weight, efficiency, and thermal management challenges to the designers, while the off-board fast/superfast/ultra-superfast chargers pose efficiency, power rating, and control challenges. In particular, the installation of dc fast chargers (including fast/superfast/ultra-superfast) is also dictated by the impact on the utility grid and the existing loads. New installation or retrofitting of the existing infrastructure is another significant investment challenge jointly explored by stakeholders, utility companies, and car/charger manufacturers. Another primary concern is battery life management limiting the charging current intake by the EV battery.

Many research areas are currently contributing toward a sustainable and cost-effective solution. These areas include wide-band-gap devices-based power converters, renewable-powered charging stations, wireless charging solutions, strategies to minimize grid impact and associated infrastructure cost of fast-charging stations, solid-state transformer topologies, and implementation of advanced control algorithms for effective battery management, predicting grid response and demand-side management through EVs. Both academia and industry have responded excellently to this timely challenge by proposing practical and cost-effective solutions.

This special issue invited contributions from researchers in the field of dc fast /superfast charging, focusing primarily on power dense and efficient charging solutions, high-frequency transformer-based topologies, advanced control strategies for bidirectional power flow, and energy management strategies. This Special Issue includes nine prominent expert papers addressing the aforementioned critical applications. The papers can be categorized into five areas:

- 1) An exciting article presenting the PV-powered multifunctional off-board EV charger is detailed, offering power quality improvement of the utility grid.
- 2) Two technical articles presenting novel soft-switching topologies details the fast-charging operation for high-voltage EV battery systems are presented.
- 3) A novel topology is presented with a current intensive buck converter to support e-mobility applications.
- 4) A technical review presents the design challenges for a

high-power differential-mode EV universal battery supercharger.

- 5) The other papers focus heavily on using advanced control methods, such as extended chaotic maps, hierarchical energy management approaches, and multi-objective-based smart charge controllers to facilitate the superfast charging of EVs. Last, a high-quality paper presenting self-aligning capable IPT pads for wireless power transfer is detailed.

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