Control and Design of Software-Defined Power Electronics for Electric Vehicle Energy Conversion System

We introduce a software-defined architecture for the purpose of improving the electric vehicle energy conversion system. The proposed structure is composed of three layers for the interfaces with various types of electrified loads/sources and the corresponding control functions, such as single/three-phase grid, battery, motor and DC supplies.

SUMMARY

We introduce a software-defined architecture for the purpose of improving the electric vehicle energy conversion system. The proposed structure is composed of three layers for the interfaces with various types of electrified loads/sources and the corresponding control functions, such as single/three-phase grid, battery, motor and DC supplies. The merits of the designed architecture include the reconfigurability to be suitable for different types of EV applications, all non-isolated topologies with common mode noise attenuation capability, improved efficiency and dynamic performance by VFSS and MPC of the elementary power module, high accuracy and robustness of the multi-layer control without being influenced by the parametric modeling error from various applications.

For the EV charger design case based on our techniques, we achieved efficiency >99%, power density >10kW/L, with frequency up to 1MHz. We will firstly introduce the configuration of the proposed software-defined EV energy conversion system. Secondly, several design cases, such as the single/three-phase grid connection, DC battery connection, a EV charger that can be reconfigured for 3 phase / 1 phase / split phase and motor connection, are illustrated in details with the control and switching strategies. Thirdly, the hardware design and magnetic component considerations are presented.

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ITEC is aimed at helping the industry in the transition from conventional vehicles to advanced electrified vehicles. The conference is focused on components, systems, standards, and grid interface technologies, related to efficient power conversion for all types of electrified transportation, including electric vehicles, hybrid electric vehicles, and plug-in hybrid electric vehicles (EVs, HEVs, and PHEVs) as well as heavy-duty, rail, and off-road vehicles and airplanes and ships.

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