Electric Vehicle Wireless Battery Charger

Mobilità sostenibile
Sustainable mobility

The battery chargers (BCs) fitted onboard today's electric vehicles (EVs) need a wired connection to draw power from the grid. They exploit a rather simple and well-grounded technology, but oblige the driver to tinker with cables and plugs, expose him to hazards especially under adverse weather conditions, and so on. Recently, BCs based on the wireless power transfer (WPT) paradigm have been proposed. They use two separate stages, one is buried in the charging area and is fed by the grid, whilst the other one is still fitted onboard EV. Both the stages have a coil, with a certain mutual inductance between them when the EV-onboard coil is over the buried one. WPT occurs thanks to the inductive coupling between the two coils. By WPT, charging of the EV battery becomes user-friendly and safe. Furthermore, WPT opens the way to the chance of charging the battery of moving EVs, thus overcoming their nowadays limitations, namely the short range and the long recharging time.
At the Laboratory of Electric System for Automation and Automotive, in the frame of a research contract with ENEA, a prototypal WPT BC for an electric city-car (ECC) with a rated BC power of 560 W has been studied, designed, built up and tested. ECC referred to above is a marketed electric vehicle, available in the Laboratory for experimental purposes. A picture of it is given in Fig. 1. The scheme of the prototype is sketched in Fig. 2. The buried and EV-onboard stages as well as their respective coil are commonly termed transmitting and receiving, respectively. To enhance the efficiency in WPT, two solutions have been adopted: i) the transmitting coil of the prototype is fed at a somewhat high frequency, set at 85 kHz according to the SAE guidelines, and ii) the reactive power associated to both the coils is compensated for by capacitor networks that make the two stages resonant. As illustrated by Fig. 2, the transmitting stage is supplied by the grid through a power factor correction (PFC) rectifier with capacitive output filter whilst the receiving stage is cascaded by a chopper that provides for proper charging the ECC battery. The transmitting stage includes a high-frequency inverter that feds the transmitting coil through a compensating network. The receiving stage includes the receiving coil that feds a diode rectifier with capacitor output filter through another compensating network. Figs. 3 and 4 show an overview of the setup of WPT BC and of a coil (without the upper cover), respectively. Fig. 5 reports the measured output-input efficiency of the two WPT stages.

Fig.1 Electric city-car

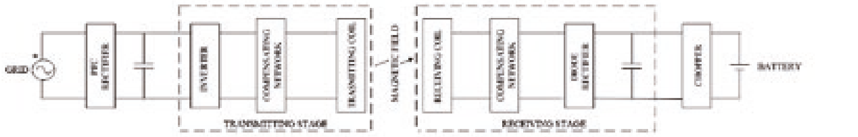

Fig.2 WPT BC scheme

Fig.3
WPT BC setup

Fig.4
Coil setup

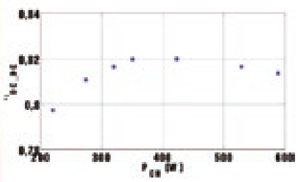

Fig.5
Power transfer efficiency vs. transferred power

DII research group
Machine Design

Giuseppe Buja
giuseppe.buja@unipd.it
Phone +39 049 827 7765

Manuele Bertoluzzo
manuele.bertoluzzo@unipd.it
Phone +39 049 827 7923

Assisted by
Kundan Kumar, PhD student
Syamnaresh Garlapati, PhD student
Hemant Dashora, PhD student
Christian Fontana, PhD student
Rupesh Jha, PhD student
Mattia Forato, PhD student

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Collaborations

- Laboratory of Electric Drives and Power Electronics, University of Trieste, (IT)
- Laboratory of Control Engineering and Power Electronics, University of Ljubljana, (SI)
- Laboratory of Power Electronics, Birla Institute of Technology, (IN)

Main research topics

- Electric vehicles (propulsion drives, wheel AC motors, storage devices, conductive charging, wireless charging)
- Semiconductor power systems (power converters, solid-state transformers, electric power conditioning, grid-connection of energy renewable sources, AC motor supply)