UNIVERSITA' DI FIRENZE

Alberto Reatti, Rosa Anna Mastromauro, Fabio Corti, Lorenzo Bongini

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RESEARCH TOPICS

- Innovative, power saving oriented design of technological plants for the renovation of University of Florence buildings, including the applications of renewable power sources and the design of smart e-mobility facilities
- Design, assembly and experimental testing power converters for wireless power transfer and its application to electric, hybrid and plug-in vehicles recharge.
- "Universal" operation of the power converters in AC Smart Grids
- Power-Electronics-Based DC Multibus for DC Smart Grids
- Power Converters for high frequency, high power and transportation applications

INNOVATIVE, POWER SAVING ORIENTED DESIGN OF TECHNOLOGICAL PLANTS FOR THE RENOVATION OF UNIVERSITY OF FLORENCE BUILDINGS, INCLUDING THE APPLICATIONS OF RENEWABLE POWER SOURCES AND THE DESIGN OF SMART E-MOBILITY FACILITIES

Keywords: Power Saving, Renewable power sources, e-mobility.

Energy Saving oriented design of some buildings of University of Florence as follows

a) new Buildings at Sesto Fiorentino Campus hosting research and teaching facilities which are now at Piazzale delle Cascine;
b) new building hosting teaching facilities to be built in Viale Pieraccini (CUBO 4);
c) renovation of Engineering School located in Via di Santa Marta;
d) renovation of the “Anatomia Patologica” building inside the Hospital Campus in Careggi;
e) New building hosting student facilities in Vittoria della Rovere.

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DESIGN, ASSEMBLY AND EXPERIMENTAL TESTING POWER CONVERTERS FOR WIRELESS POWER TRANSFER AND ITS APPLICATION TO ELECTRIC, HYBRID AND PLUG-IN VEHICLES RECHARGE

The activity involves the instigation on dc-ac and ac-dc resonant converter suitable to be utilized in Inductive Wireless Power Transfer (I-WPT). Activity also involves the study and the design of coupled inductors suitable for a wireless energy transfer from the dc-ac inverter to the ac-dc rectifier feeding the load.

Design criteria of the circuits suitable to achieve the resonance aver a wide load range,, so that the circulating reactive power is reduced and the power transfer transmission over relatively large distances among the primary and secondary coils is achieved at increased efficiencies. Depending on the connections between the capacitors and coils, several compensating networks are investigated as follows: Series - Series, Series - Parallel, Parallel - Series, and Parallel - Parallel.

The applications of these circuits to the to electric, hybrid and plug-in vehicles recharge is also included.

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"UNIVERSAL" OPERATION OF THE POWER CONVERTERS IN AC SMART GRIDS

Due to the spread of distributed power generation systems, a lot of portions of the distribution network are becoming bidirectional or "active". In this scenario the AC Smart Grid concept was born considering that small parts of the grid can operate stand-alone. However the Smart Grid loads can be affected by overvoltages or undervoltages in absence of a proper power management strategy. Hence the role of power converters may guarantee "universal" operation allowing both grid-connection and stand-alone operation with the possibility to share the load demand among different power generation sources and with the need to maintain voltage and frequency in acceptable range.

Power converters and control systems for AC Smart Grids have been proposed. A combined centralized/decentralized reactive power control strategy has been developed. The proposed solution is based on a centralized control performed by the Distribution System Operator (DSO) coordinated with a local/decentralized control operated at the converter level. It ensures high performance in terms of proper voltage regulation both in the overall network (considering the voltage in every node) and locally (controlling the voltage at the point of common coupling).

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POWER-ELECTRONICS-BASED DC MULTIBUS FOR DC SMART GRIDS

In the last years a growing interest towards DC Smart Grids has been registered due to high penetration of distributed generation systems with embedded storage. Trying to foresee the possible future scenarios of the power systems, it can be noticed that DC Smart Grids can be even preferable to AC Smart Grids in terms of flexibility and

redundancy since they are compatible with the achievement of a DC Multibus working at different voltage levels. The Single-Star Bridge Cells Modular Multilevel Cascade Converter (SSBC MMCC) can be used to create a DC Multibus. The SSBC MMCC can be combined with isolated DC/DC converters such as Dual Active Bridge (DAB) converters in order to extent the operating voltage range. A proper control system has to be designed in order to manage voltage regulation and power sharing.

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POWER CONVERTERS FOR HIGH FREQUENCY, HIGH POWER AND TRANSPORTATION APPLICATIONS

Considering that traditional power converters can exhibit low performances when the power rate is increased, some topologies based on multilevel converters, modular topologies with interleaved modulations or new topologies based on “wide bandgap” semiconductors are currently under study for application to More-Electric-Aircrafts (MEA) and All-Electric-Ships (AES). In particular the use of parallel converters with interleaved modulation is proposed for a Ground Power Unit (GPU), an advanced active rectifier is modeled for MEA and AES onboard applications showing excellent performances, DAB converters based on SiC Mosfets are investigated in case of harsh environment operation (high temperatures).

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