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Bidirectional Vehicle-to-Grid Interface under a Microgrid Project

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ABSTRACT

In the emergent deployment of smart grids, storage systems play an important role into assets utilization optimization, providing backup power and peak-shaving. This concept becomes more critical in the context of microgrids with a high penetration of renewable energy resources. Plug-in electric vehicles provide an enormous distributed storage capability, which favours the technical and economical exploitation of such systems. This paper presents a comprehensive implementation and control of a bidirectional power converter for vehicle-to-grid integration, based on a bidirectional DC/DC converter followed by a full bridge DC/AC converter.

1. THE MICROGRID PROJECT

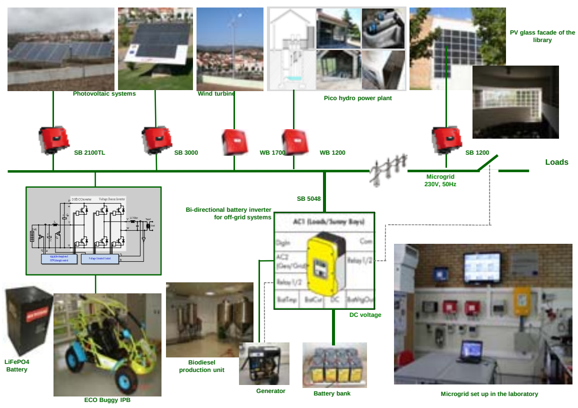

Fig. 1. The bidirectional power converter for V2G/G2V integration with a small microgrid.

2. BIDIRECTIONAL POWER TOPOLOGY

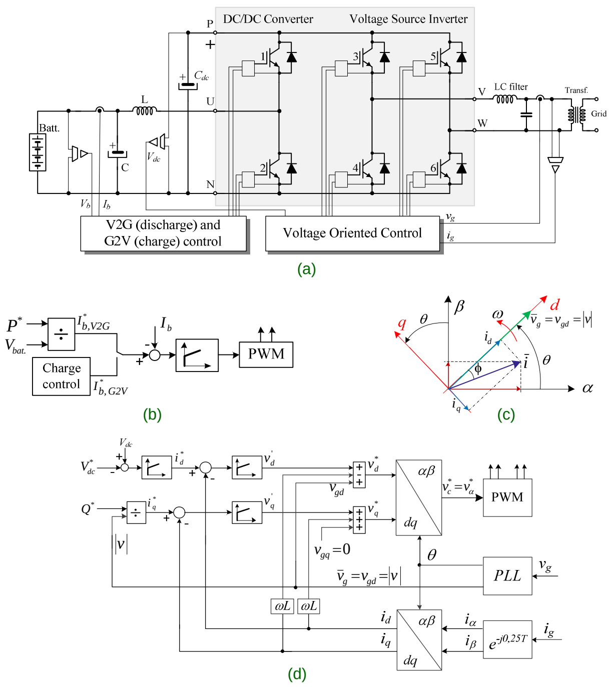

Fig. 2. Converter topology for V2G/G2V integration (a) and control schemes: (b) V2G (discharge) and G2V (charge) control; (c) Voltage oriented control of the VSI; (d) VOC scheme.

3. SIMULATION RESULTS

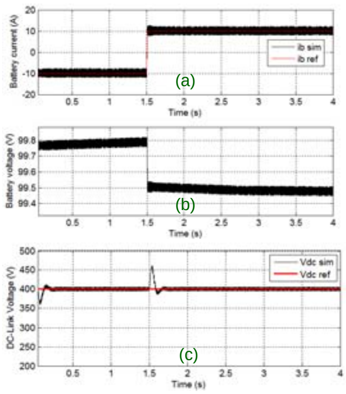

Fig. 3. Battery current (a) and voltage (b); Voltage across the DC-Link capacitor (c).

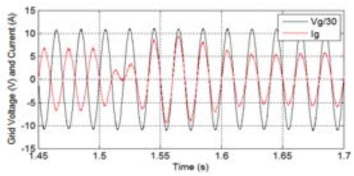

Fig. 4 Grid voltage (scaled) and grid current before and after the change from G2V to V2G mode of operation.

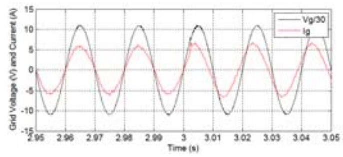

Fig. 5 Grid voltage (scaled) and grid current before and after to change the reactive power from 0 to -400 var.

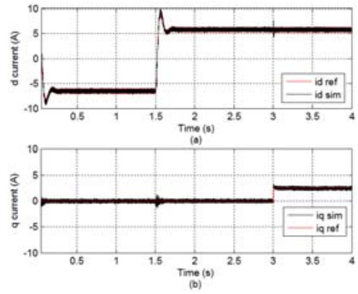

Fig. 6 Grid current components in synchronous reference frame: (a) d component and (b) q component.

4. EXPERIMENTAL RESULTS

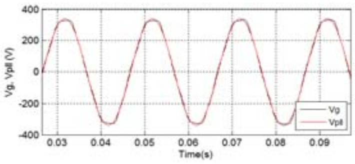

Fig. 7. Grid voltage and PLL output.

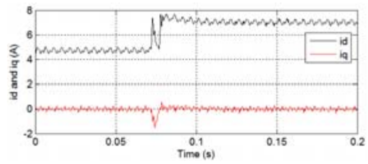

Fig. 8. Grid current dq components.

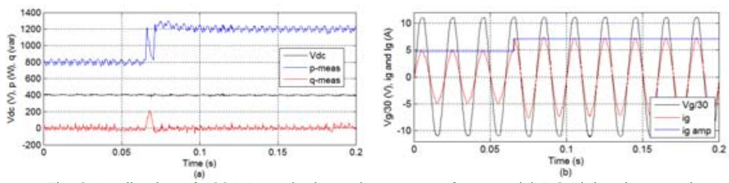

Fig. 9. Application of 400 W step in the active power reference: (a) DC-Link voltage and measured active and reactive powers; (b) grid voltage (scaled), grid current and reference amplitude of the grid current.

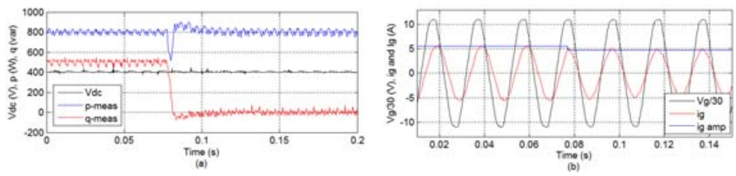

Fig. 10. Application of a -500 var step in the reactive power reference: (a) DC-Link voltage and measured active and reactive powers; (b) grid voltage (scaled), grid current and reference amplitude of grid current.

5. CONCLUSIONS

This paper presented an on-going implementation and validation of a power converter topology for a V2G/G2V interface, for a microgrid project of 5 kW and a light electric vehicle with a lithium ion phosphate battery.

Simulation and experimental results showed that the adopted topology is able to manage bidirectional active and reactive power flow, allowing the battery to behave as an electric load or generator and also to perform power factor compensation of the microgrid.