

Abstract of Ph.D. Thesis
“Analysis And Development of Current Fed Dual Active Bridge Based Converter For
Battery Charging Application”
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ABSTRACT

A conventional voltage fed dual active bridge (VFDAB) converter poses as a prominent solution for bidirectional DC-DC power conversion in high gain high power region. It presents multiple advantages like high power density, wide ZVS operation, high voltage gain and isolation. However, it suffers from high output ripple current, which is undesirable, particularly for low voltage high current applications. In this regard, interleaved current fed dual active bridge (CFDAB) converter is a potential converter for low voltage battery charging applications. The output inductors, which are present on the low voltage side of CFDAB, provide ripple-free battery current and shoot through protection under fault conditions. The behaviour of this converter slightly differs from the conventional voltage fed dual active bridge converter and is less studied in literature. In this thesis, an accurate steady state model and simplified small signal model are developed for the CFDAB converter under PWM plus Phase shift (PPS) modulation. Using the steady state model, behaviour of the converter for entire range of operation in terms of some important electrical quantities are presented. The effect of carrier signal on the power characterization of the CFDAB converter under PPS modulation is also studied. It is observed that the triangular carrier provides correct phase shift measurement than the sawtooth carrier.

Then the small signal analysis of the converter is performed using the improved HSS model. The improved HSS model considers only the effect on the dominant harmonics for the small signal perturbation. It discusses the presence of two resonances in the small signal model of CFDAB. One of them lies at switching frequency while other lies at converter natural frequency. The latter resonance either increases the steady state ripple or decreases the bandwidth of the conventional closed loop current controller. Hence, it presents adaptive notch integrated PI controller to overcome above drawbacks of simple PI controller.

Finally, a new perspective of considering EV as power transport device to underprivileged households is considered in this work. A converter solution is presented that enables battery charging of light electric vehicle (LEV) from AC as well as DC supply. Besides that, it is also capable to power the rural household appliances from the LEV battery. The converter system comprises of active bridge based single stage AC/DC converter with auxiliary DC port. The merit of the converter is that it provides solutions for multiple applications with reduced switch count. The single stage power conversion reduces the high frequency switch count for AC/DC conversion. The DC/DC interface utilizes partial circuitry to achieve the desired operation without any need for additional high frequency switches. The operation of the converter is categorized in three modes. Mode I comprises of LEV battery charging from AC grid. Mode II comprises of LEV battery charging from another EV or battery. Mode III conducts powering of household appliances by the LEV battery. The performance of the converter system is analysed under individual modes independently. The AC/DC interfacing supports unity power factor operation within the standard of IEC61000-3-2.