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# PWM Control of Dual Active Bridge Converters

A dual active bridge (DAB) DC-DC converter is ideally suited for high-power, galvanically isolated DC-DC conversion. The DAB DC-DC converter has advantages of high power density, Zero Voltage Switching (ZVS), bidirectional power transfer capability, a modular and symmetric structure, and simple control requirements. The DAB DC-DC converter can also be used for multi-port operation, which is a feature that is useful in interfacing several DC sources and loads using a single converter. Notwithstanding all of the advantages of the conventional DAB converter, for applications requiring wide voltage variations, such as an interface for energy storage, fuel cells, or photovoltaics, the DAB converter has limited ZVS range and high circulating currents at low loads. The high circulating currents at low loads results in poor efficiency when the DAB converter is under a low load condition. Thus, there is a need for an improved DAB converter that provides an increased ZVS range and/or increased efficiency particularly at low load conditions.
To address these issues, researchers at Arizona State University have developed novel control schemes for bidirectional dc-dc dual active bridge converters. The proposed control schemes combine the traditional method of phase shift control with Pulse Width Modulation (PWM) of one single H-bridge and two converter bridges simultaneously in a composite control scheme that depends on the input to output voltage ratio and the load condition. One key element is that the scheme automatically transitions between dual PWM, single PWM, and only phase shift control by utilizing directly measured input and output voltages, and using the load information implicit in the required phase shift.

Potential Applications

- Uninterruptible Power Supplies (UPS)
- Grid Tie Renewable Resources (Photovoltaic Energy)
- Fuel Cells

Benefits and Advantages

- Extends the soft-switching range down to zero load condition
- Reduces rms and peak currents
- Results in significant size reduction of the transformer
- Lower magnetic core losses
- As an example, the efficiency at 3% load and half nominal output voltage is increased from 25% with phase shift control alone to 77% with the proposed scheme. The transformer size is also reduced by 33%.