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Full abstract

Abstract

Strategic use of energy storage systems alleviates imbalance between energy generation and consumption. Battery storage of various chemistries is favorable for its relatively high energy density and high charge and discharge rates. Battery voltage is in dc, while the distribution of electricity is still predominantly in ac. To effectively harness the battery energy, a dc-ac inverter is required. A conventional inverter contains two high frequency switching stages. The battery-interfacing stage provides galvanic isolation and switches at high frequency to minimize the isolation transformer size. The grid-interfacing stage also operates at high frequency to obtain sinusoidal grid currents and the desired power. A negative consequence of high frequency switching is increased switching loss and the generation of large voltage harmonics that requires filtering. This dissertation proposes an alternative two-stage inverter topology aimed at reducing converter size and weight. This is achieved by reducing the number of high frequency switching stages and associated filter requirements. The grid-interfacing stage is operated at the line frequency, while only the battery-interfacing stage operates at high frequency to shape the line currents and control power flow. The line-frequency operation generates negligible switching loss and minimal current harmonics in the grid-interfacing stage. As a result, the required filter is reduced in size. Hardware designs are performed and compared between the conventional and proposed converters to quantify expected size reduction. Control methods are developed and verified in simulation and experiment to obtain high quality line currents at all power factors.