

ABSTRACT

The Vehicle to Grid (V-G) system is a crucial component in the smart grid and Electric Vehicles (EVs), enabling bidirectional power flow and meeting power quality requirements. For V-G systems, a three-phase bidirectional grid-connected AC-DC converter that enables bidirectional power flow between EVs and the grid, provides reactive power compensation, and smooths power grid fluctuations.

The configuration of V-G systems is introduced, and a mathematical model of the AC-DC converter is built. The grid voltage feed-forward decoupling scheme is applied, and the analysis of the Proportional-Integral (PI) control strategy is proposed. The controller is designed to achieve bidirectional power flow between EVs and the grid. A bidirectional converter is the primary requirement for advanced charging modes like V-G. Common building modules for such a charger include an AC-DC converter at the front end and a DC-DC converter at the back end. The system simulation model is established using MATLAB Simulink, and the experiment platform is designed in the lab. Simulation and experiment results evaluate the effectiveness of the model and the performance of the applied control strategy. Advancements in power electronics have improved the functionality and efficiency of bidirectional converters, utilising semiconductor materials like Silicon Carbide (SiC) and Gallium Nitride (GaN). These converters have higher switching frequencies, reduced losses, and improved thermal management, making them compact and reliable for applications like electric vehicle charging stations and renewable energy systems.

The development of single-phase bidirectional grid-connected AC-DC converters has emerged as a critical area of research, enabling seamless integration of renewable energy sources into existing power grids and facilitating bidirectional power flow between the grid and local energy storage systems.