Abstract

This research has contributed to the advancement of the Personal Consumer (PeCo) grid concept and has furthered the technology from a conceptual prototype to becoming a viable rural electrification solution. The PeCo grid is a conceptual ad-hoc, 12V, DC distributed grid aimed at providing an electrification solution for singe rural households. The grid is composed of an interconnection of renewable energy sources, battery storage and loads. A shortcoming of the PeCo grid, exposed on the first experimental prototype grid, was that undesirable over-voltages occurred during load removal events due to an over-supply of power to the grid after the load was disconnected. This research entails the development of an interface for a photovoltaic (PV) module to the PeCo grid that aims to overcome this shortcoming and to extend the capabilities of and further the technology. At the interface, the voltage of the PV module is matched to the grid voltage. Power flow from the PV module to the grid is controlled according to a control strategy modelled as a state diagram and executed by a micro controller unit (MCU). The power converter at the interface is a Flyback converter operating in discontinuous conduction mode (DCM). A model was derived to estimate the primary-side inductor current of a DCM Flyback converter and applied to perform model-based maximum power point tracking (MPPT). This obviated the need for any current sensors at the interface. The response of the MCU to a load removal event was tested and validated to overcome the shortcoming of the experimental grid. The model-based MPPT solution was tested using the PeCo grid as a test platform and validated to successfully perform MPPT. The real world application of the interface was validated and the technology deemed suitable for rural electrification.