Designing the energy management unit for a back-up photovoltaic system capable of grid-connected and stand-alone operations

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The ever-increasing use of renewable energies has opened doors to new opportunities in the area of power quality. One of these opportunities is the possibility of supplying the load during 'islanding' state, when the electrical distribution network fails. In order to make benefit from the generating capacity of the distributed renewable energy sources for supplying the local loads during such failures, the distributed generation (DG) unit should be capable of timely detection of the islanding occurrence. In addition, the unit should successfully switch from the current source (CS) operating mode to the voltage source (VS) mode. Systems with such a capability can be called backup units. In this thesis, a backup photovoltaic (PV) system is designed. The industrial samples of backup PV systems are surveyed to gain a good overview of the capabilities that are expected from a typical backup PV system. Using this information, the specifications of the unit to be designed are selected. Due to the inherent unpredictability of energy output of PV systems, a complimentary source of generation or energy storage would be required in order to make the PV unit capable of feeding a constant load during the stand-alone mode. The PV array and the battery units are designed using the existing standards. The power circuit of the backup PV system is designed. An isolated half-bridge DC/DC converter is proposed as the bidirectional battery power processor, and a novel control scheme for this converter is proposed. This scheme addresses the problem associated with the transition from the boost to buck mode in isolated half-bridge converters. The control scheme for grid-connected and stand-alone modes of the system is presented. Finally, the operation of the designed system and the proposed control schemes are simulated and verified using PSCAD software.