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DESIGN OF THE BUCK CONVERTER FOR A CURRENT CONTROLLED PHOTOVOLTAIC EMULATOR

G.P.M. Godakumara*, E.H. Senevirathne, P.J. Binduhewa and J.B. Ekanayake

Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka
**poornika.manahari@gmail.com*

The modern developing world is inclining more towards renewable energy. Photovoltaic (PV) systems are a major renewable energy source. A number of PV panels are commercially available with different voltage and current ratings. Different PV modules should be used in different applications depending on their power demand, environmental constraints and the nature of the existing power system. It is necessary to test these systems prior to installation as well as for research purposes. It is infeasible to do this testing using actual PV panels as the PV panels are expensive. A PV emulator can be used in these testing purposes. PV emulator is an electronic device which mimics the characteristics of a PV panel under different environmental conditions. PV emulators based on various technologies have been proposed over the years. This design gives a low cost PV emulator integrating a buck converter, a current controller and a PV model. In the proposed system, a current controller takes the inductor current of the buck converter as a feedback and it compares with a reference current. The error is fed to a PI controller which is used to generate the Pulse Width Modulated (PWM) signal. The reference PV current is generates by a PV model that takes temperature, irradiance level and output voltage of the buck converter as inputs.

This paper presents the design and simulation of a buck converter for the photovoltaic emulator. The basic equation related to the components of the converter is derived. Initial design was done for a PV panel with Maximum Power Point (MPP) current of 1.1 A, MPP voltage of 17.5V, short circuit current of 1.2 A and an open circuit voltage of 22.4V. The converter was designed to operate at the MPP. The designed converter was simulated using EMTDC/PSCAD software. As the PV panel operates at two extreme conditions (open circuit condition and short circuit condition), the behavior of the converter at these two extremes were analyzed. The converter was designed to have inductor current ripple of 30% and output voltage ripple of 5%. The simulation shows that the designed buck converter can achieve the desired output current with a ripple below 30% and output voltage at a ripple below 5% throughout the characteristic curve. This concludes that the designed converter can be used to obtain the required output current and voltage in generating the current-voltage characteristics of a PV panel with an acceptable accuracy.