ABSTRACT

The main objective of this research work is to design and implement a direct control DC-DC Cuk converter-based Maximum Power Point Tracking (MPPT) system to extract maximum power from a solar PV module which uses Adaptive Perturb and Observer (APAO) algorithm. This algorithm is simulated in MATLAB/Simulink and implemented using an ATMEGA16 micro-controller. The nominal duty cycle of the main switch in the Cuk converter is adjusted to a value so that the input resistance of the converter is equal to the equivalent output resistance of solar PV module to ensure maximum power extracted from solar PV module. The effectiveness of the APAO algorithm is tested for the change in irradiation. Hardware validation is carried out for the converter with the solar PV module with a rating of 37Wp, and operating at 25 kHz.

The efficiency of solar PV system used in space satellite mainly depends on the efficiency of DC-DC power conditioning process. High efficient DC-DC converter has to be designed which is more suitable in solar PV application. This work also proposes to design different control methods, i.e., traditional PWM with periodic carrier, Zero Voltage Switching (ZVS), Zero Current Switching (ZCS) and PWM with chaotic carrier are simulated and implemented in terms of their performance in suppressing ripples, reducing peaky electro-magnetic inference and increasing converter
conversion efficiency in MPPT circuits of the solar PV powered system. The spectral performance comparison of different control methods have been carried out experimentally.

The performance of solar PV system is affected due to non-linear dynamics in DC-DC converter used in MPPT system, and leads to undesirable operation in solar PV system. The DC-DC converter used in solar PV system should be stable and the input voltage is kept within the specified range under disturbances at the source voltage and the change in irradiation. Input voltage (output voltage of the solar PV module) of Cuk converter-based solar PV system is regulated for the change in irradiation. The research work proposes to design a voltage controller to regulate the input voltage of the converter for the change in irradiation. The voltage controller (PI compensator) improves the transient response on the input voltage of the converter and avoids oscillation and overshoot, making easier the functioning of MPPT methods.

Also this research work reports an experimental study with the investigation of non-linear dynamics such as chaos during the regulation of output voltage of solar photovoltaic module. The non-linear dynamics is experimentally analyzed in voltage mode controlled Cuk converter-based solar PV system. To ensure period-1 operation for parameter variations, an adaptive controller is designed so that the input voltage of the Cuk converter is chaotic free.