ABSTRACT

The Buck converters are widely used in low power portable electronic devices, which require control circuits to obtain overload protection, improved dynamic performance and increased efficiency. The control circuits can be implemented using Observer controller which acts as a sensorless current mode controller to reduce the circuit complexity and provides a solution for the current imbalances caused mainly due to the intrinsic device parameter variations. A state feedback gain matrix is derived using Pole Placement method for the Buck converter under continuous time domain, to achieve the stability of the converter and to ensure the robustness of the controller. The characteristics of the digital controller are low sensitivity to variations, robustness to ageing and environmental changes, noise immunity and ease of programming. In order to utilize the digital system, a digital state feedback matrix has been derived for the Buck converter using Pole Placement method. Load estimator for the Buck converter is designed under both continuous and discrete time domain to estimate the unmeasurable state variables and to obtain zero output voltage error. Using Separation Principle the state feedback matrices and the load estimators obtained for the Buck converter under both continuous and discrete time domain are combined together to design an Observer Controller.

The Boost converters exhibit the complex dynamic behaviour by toggling between two different sets of linear and non linear characteristics
which require a stronger and an effective feedback control action. The required Observer based controller has been designed for the Boost converter under both continuous and discrete time domain in two steps. In the first step, the state feedback gain matrix is derived using the pole placement method and in the second step, a load estimator is derived in order to ensure the robustness of the state feedback control and also to estimate the unmeasurable state variables. Finally a robust Observer controller for the Boost converter under both continuous and discrete time domain is obtained by combining the state feedback matrices and load estimators using Separation Principle.

When the Buck and Boost converters are used in high voltage applications, they cannot withstand the voltage stress and in order to overcome this drawback, the converters are connected in parallel called Interleaved Buck and Boost converters. The interleaved converters are highly reliable with good current sharing among the converter modules, but the main challenge is emphasized more on the control aspects of these types of interleaved converters. An Observer based controller for the Interleaved Buck and Boost converters has been derived and carried out in two fold. First, state feedback matrix is designed using pole placement technique and appropriate load estimation is done and the Observer controller is designed by combining the state feedback control and load estimator. Next the state feedback matrix obtained for the interleaved converters are optimized by deriving Riccati matrix and using the same load estimator as mentioned in the first step, a Linear quadratic optimal regulator is designed by combining these two using Separation Principle.
The simulation and experimental verification were carried out to validate the designed Observer Controller. The Observer controller designed for the Buck, Boost, Interleaved Buck and Interleaved Boost converters gives an excellent output voltage regulation, improved dynamic response, robust, rejects the disturbances, highly efficient with much lesser settling time in the range of milli seconds and good current sharing among the converter modules. In addition to the above, an effective voltage regulator for the Photovoltaic system using Interleaved Boost converter is achieved using the Observer controller designed. The Interleaved Boost converter with Observer controller in photovoltaic system reduces the deprivation of the performances caused due to the non ideal conditions of the solar panel, withstands parameter deviations, highly efficient and tracks the maximum power out of the solar panels.