ABSTRACT

In this thesis, power management aspects of non-isolated two-input integrated dc-dc converters are investigated. The two integrated converters considered for the investigation are: (i) two-input fourth-order integrated converter, and (ii) two-input sixth-order integrated converter. From voltage conversion point of view, both these converters belongs to a class of buck or buck-boost type of conversion. Both these topologies are capable of drawing power from two different input dc-sources and feeding to a common load. Though these integrated converters are able to achieve desired voltage conversion ratios along with feasible load power management with reduced number components, but stability and robustness related issues are more prominent (i.e. control-loops are more than one) if multi-loop control strategies are adopted in the load management. These issues primarily arise due to the integrated structure of the converter and transfer of power to load which is drawn from multiple sources has to flow through common energy storage elements. In order to address the stability and robustness issues in the two-input integrated converters as discussed above, firstly the cause of interactions is identified and thereafter interaction quantification methods are adopted to explore the degree of interactions among the control-loops and their quantification. On the basis of this quantification, pairing between the controlling input and the controlled output variables is formulated.

Two different control strategies are investigated in this thesis to achieve reliable power conversion with two-input integrated converters, which are: (i) decentralized control strategy with two diagonal controllers, and (ii) centralized control strategy with full-order controller. For the decentralized controller design, firstly an effective transfer function method is extended. In the process of design, it has been identified that through this method, the final resulting controller accuracy depends on the plant interactions and how effectively they are included in the diagonal non-interactive transfer functions. Though the decentralized control strategy is simple to implement but the control-loop dynamic performance may not be sufficient and it depends on the operating point dependent plant interactions. In an attempt to enhance the control-loop performance and to achieve feasible power management of integrated converters, an H_∞ loopshaping based centralized (full-order) controller is designed.

Both the controllers introduced above (decentralized and centralized controller) ensures the integrated converters stabilization but exhibits differences in terms of performance due to the presence of interactions within the integrated converters. To ascertain these performance aspects of integrated converters, the stability and robustness issues are addressed in this thesis by introducing a singular value analysis. The μ-plots of integrated converters for different operating conditions pertaining to nominal performance, robust stability and robust performance are generated for both the decentralized and centralized controllers. For all these cases, the ISE performance indices are also computed. These singular value analysis investigations revealed that the TIFOI converter along with centralized converter yields not only the robust performance feature but also exhibits better dynamic performance. Finally, the decentralized and centralized controllers effectiveness is demonstrated.