ABSTRACT

The work presented in this thesis mainly addresses the design and analysis of new dc-dc boost converter topologies which provide higher voltage gain at lower duty ratio. The traditional Z-source and quasi-Z-source dc-dc converter topologies exhibit voltage gain of 1/(1-2D) which is low. In an attempt to increase the voltage gain, firstly two new high gain topologies are evolved in this thesis. The basis for these evolutions is the quasi-Z-source dc-dc converter. The first topology is switched-inductor switched-capacitor based quasi-Z-source dc-dc converter (SLSCQZSC) which is evolved by replacing the inductors of the quasi-Z-source dc-dc converter with switched-inductor cells. While the second topology formulated is L-C-L cell based Z-source dc-dc converter (LCLZSC) which is obtained after replacing the inductor of the traditional Z-source dc-dc converter with an L-C-L cell. Both these topologies exhibit high voltage gain due to the term 1/(1-3D). Detailed steady-state and small-signal analysis is established for both these topologies and illustrative simulation and experimental results are presented to validate the topological features.

The above introduced two topologies (i.e. SLSCQZSC and LCLZSC) though exhibit high voltage gain but use more number of components. Additionally, the source current is discontinuous in nature. To alleviate the problem of discontinuous input current and to also minimize the number of components, two more topologies are formulated on the basis of quasi-Z-source dc-dc converter with embedded switched-capacitor cell. These are quasi-Z-network plus switched-capacitor dc-dc boost converter (ZSCBC) and L-C-L cell based quasi-Z-network dc-dc boost converter (LCLQZSC). The maximum voltage gain achieved with these topologies is (3-3D)/(1-3D). Detailed steady-state and small-signal analysis is established. Parameter selection for simulations and prototype development, the design expressions are formulated for inductors and capacitors. To validate the analytical findings, experimental results are presented. Exhaustive investigation revealed that these topologies are better than the traditional Z-source dc-dc converter topologies as they exhibit low stress on the devices in addition to having the feature of common ground between the source and load.

The ZSCBC and LCLQZSC topologies draw pulsating input current and thus exhibit higher source current ripple. With the motivation to reduce this source current ripple and yet to realize high voltage gain, four quasi-Z-source equivalent dc-dc converters are evolved. The basis for all these topologies is the fourth-order quasi-z-source equivalent dc-dc boost converter (FOEBC) which essentially ensures low source current ripple. To enhance the voltage gain, a switched-capacitor cell is integrated on the up-stream side. Detailed steady-state and small-signal analysis is established and sample experimental results are presented. The comparison of proposed converters is also presented to highlight their merits and de-merits. Detailed investigation revealed that these quasi-Z-source equivalent dc-dc converter topologies exhibit the following features: (i) low voltage stress on the devices to improve the reliability, (ii) fewer number of components to increase the efficiency and (iii) continuous input current to reduce source current ripple leading to lower electro-magnetic interference problems.