Chapter 4

CONCLUSIONS

This thesis has presented an analysis of the modeling, control and stability issues present when integrating a PEBB (Power Electronic Building Block) based DC Distribution Power System (DPS). A comprehensive analysis of a sample DC DPS comprising of a Front End Boost Rectifier, DC-DC Buck Converter and 3 phase 4 leg Inverter has been performed. System interaction issues present when integrating the sample DC DPS have been introduced and the ability of a PEBB based system in dealing with these issues has been brought out.

Chapter 2 of the thesis presented the modeling and control of a PEBB based Boost Rectifier and Four Leg Inverter. A three level modeling approach was used to model the PEBB based converters. An approach for the control loop design of rectifier and inverter was outlined. The closed loop performance of the rectifier and inverter were verified using simulation. The ability of a three phase four leg inverter in dealing with unbalanced and non-linear load was presented. It was seen that the PEBB based rectifier and inverter have the same general purpose controller configuration, and it showed the generic nature of the PEBBs. The fault tolerance capability in a PEBB based rectifier was established by ensuring stable system operation, with one leg of the rectifier failed open-circuited.

Chapter 3 of the thesis presented the issues in integrating the PEBB based power converters to form the sample DC DPS. The effect of impedance overlap on the system and individual sub-systems was examined. It was found that a lightly damped EMI filter can cause interaction between the filter and Boost Rectifier. It was shown that a PEBB based rectifier can stabilize the system by actively doubling the switching frequency and changing the controller parameters, which resulted in an increase in rectifier bandwidth.

It was shown that problems can occur when separately designed rectifier and inverter are connected together to form the DC DPS. From the analysis of the impedance ratio Z_{out}/Z_{in}, it was seen that the system performance is degraded. The DC link voltage was found to be oscillatory. Three methods of avoiding stability problems were outlined namely, increasing the DC link capacitance, increasing the filter damping and decreasing the load inverter bandwidth.

It was seen that a PEBB based converter has the ability to stabilize the integrated system by actively changing the inverter bandwidth. It was shown that when a DC-DC buck converter is added to the DC DPS, possible interactions can occur. A possible approach to stabilize the DC DPS by changing the damping in the buck converter input filter was presented.

Overall, the PEBB based system was found to be superior to the conventional system in terms of performance and system stability. It was found that a PEBB based converter can assure reliable delivery of electric power to the loads, high system efficiency and flexibility in system operation. Also, digital implementation of the controller allowed flexibility in actively changing the controller parameters, control structure and the switching frequency. The local-controller was field-programmable to implement the desired control strategy. The local controller had communication ports to receive information regarding the system state and fault situation from the system controller and it could reconfigure the system in case one of the PEBB cells failed open-circuited.