Abstract

Power electronic converters have become quite popular to meet the industrial demand for better utilisation of renewable power. Among the power electronic converters, AC-AC converters are potential candidate for wind energy systems, where a low voltage variable speed generator feeds power to the higher voltage fixed frequency grid. Broadly AC-AC converters can be classified into two types, one with energy storage elements and another without energy storage elements which is knows as matrix converters (MC). Converters with energy storage such as diode bridge cascaded voltage source inverter and voltage source back to back converter are the standard solutions adopted by the industries. Aiming to reduce the usage of energy storage elements and improve the input switching characteristics, matrix converters are evolved. Matrix converters are considered as a futuristic converter with many desirable features like input power factor control, high power density, high efficiency and extended life time. On the other side, matrix converters have restriction in terms of performance parameters such as voltage transfer ratio, reactive power transfer capability and susceptibility to changes in dynamic conditions. To cater the above limitations in matrix converters, researchers have proposed inclusion of passive elements in matrix converters, which leads to hybrid matrix converters.

In this thesis, a proposition has made to investigate an ultra sparse matrix converter (USMC) topology. The USMC is a specific version of matrix converter characterised by reduced number of semiconductor switches. For enhancing the operating range of USMC, the concept of switched capacitor and switched boost networks are integrated at the DC link section of USMC. Since the established modulation scheme for USMC cannot be applied to switched capacitor ultra sparse matrix converter (SC-USMC). Therefore a modulation technique is developed to achieve high voltage gain by proper placement of switching states within a switching cycle. The SC-USMC has ad-

ditional advantage of producing balanced output voltage even under unbalanced input supply. The second version of USMC-switched boost ultra sparse matrix converter (SB-USMC) is proposed with shoot through immunity, which produces higher voltage gain with lesser number of passive elements. A modulation technique is developed to reduce the current ripple of the inductor.

To improve the output total harmonic distortion (THD) and voltage gain characteristics of USMC, a three level Z source based sparse matrix converter is proposed which has multi voltage levels along with boosted output voltage. This converter has advantage of less number of switching devices compared to multi level matrix converters. In order to control it, a modulation technique has been developed with careful insertion of shoot through period without tampering the multi level behaviour.

Comprehensive analytical derivations and simulation results are carried out to investigate the operation of the proposed converters. Performance of the proposed converters is then compared with conventional converters. The operation of the three converters are also validated experimentally using laboratory prototype.