Abstract

Modular Multilevel converters are getting attention in industry and academia as the preferred choice of electronic power conversion for high power applications. They have a wide application area in a variety of industries involving transmission of power, grid interconnection, renewable integration, rail transportation and fast electric vehicle charging.

One key challenge of half-bridge based modular multilevel converter (HB-MMC) is the protection of the converter during fault conditions. This thesis developed a new class of half bridge sub-module (HB-SMs) based modular multilevel converter (MMC) topologies using passive filters for high power direct current applications like HVDC, fast and multiple EV charging, rail traction from MVDC grid. The use of passive filters in conventional HB-MMC has provided various possible advantages like Fault current limiting/ blocking features, pre-charging features, reduced arms and switch counts. This thesis contributes two major sections: (i) Protection of conventional MMC using passive filter from DC and AC short circuit faults and (ii) A new reduced arms MMC topologies using passive filters for different MVDC applications.

Using MMC in high power direct current applications needs proper understanding of the converter topology, its working and protection w.r.t the required application in terms of power electronics and power systems. This thesis provides the required depth of understanding in power electronics for HVDC/MVDC technologies, including their architectures, operation, control and various topologies. The system level work is performed in EMTP-RV/ Matlab-simulink platform to validate the working of proposed techniques. A scaled-down laboratory prototype is build to validate the effectiveness of the proposed topology.

This work introduces a new protection methodology using passive filters in case of DC and AC faults, that involves the fault current limiting capability of HB-MMC based HVDC. The main focus is the adaption of the MMC topology with reduced number arms to achieve similar fault limiting/blocking capability using HB-SMs in various MVDC applications.