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Title of Thesis : Hybrid converter based shunt active compensators for medium voltage applications

Abstract

This thesis deals with medium voltage hybrid converter topologies for shunt active compensators. Firstly, the effect of PWM inverter and its digital controller on the performance of medium voltage shunt active harmonic compensator is analyzed. The need for non-PWM operation of the inverter for relatively higher value of medium voltage application is understood with presently available high voltage switching devices. However, the switching ripple current of this inverter needs to be minimized.

The first topology proposed is for the application of medium voltage load harmonic compensation. The basis of this topology is the separation of voltage at harmonic frequencies and voltage at grid frequency between two series connected converters. Suitable control strategies are proposed here to regulate the dc bus voltages of both the converters. Issues regarding the series connection of two converters with unequal switching frequencies are also addressed here with proposed solutions. The proposed control strategy is validated experimentally at reduced power level in the laboratory.

The next topology is a natural sinusoidal hybrid converter proposed for relatively higher value of medium voltage drives, front-end converters, and reactive power compensator applications. It introduces a natural method of elimination of voltage harmonics from a square wave inverter. Thus, it allows very high voltage switching devices, which have very low switching frequency (around few hundred Hz) to build a square wave converter. The voltage harmonics produced by this converter are compensated by several single-phase full-bridge cells connected in series with it. These series cells can operate either in PWM mode or also in non-PWM mode with very low switching losses. It has been demonstrated that the dc bus voltages of these series cells naturally converge to their desired values in both the strategies. The need for sensing the dc bus voltages of the series cells and their controllers are also completely dispensed with.

A variable reactive power compensator along with its control strategy has been proposed using this hybrid converter for medium voltage applications. Experimental results validate the theoretical performances with non PWM (square wave mode) series cells. This promises to have compensator for very high ac voltage level without transformer. However, the change of output reactive current is limited to have approximately sinusoidal voltage references.

Key words: Medium voltage converters, Hybrid converters, Shunt active compensators