List of Symbols

C_d	Output side filter capacitor of converter
C_s	Filter capacitor connected across supply terminals
D	Diode
f	Supply frequency (50 Hz)
f_c	Carrier Signal frequency
G	Gate turn off Thyristor
I_{dc}	Converter output direct current
i_p	Instantaneous current on primary side of input transformer
i_s	Instantaneous input current of converter
L_b	Boost inductor of converter
L_s	Supply short circuit inductor
m_f	Ratio of carrier signal frequency to supply frequency
Mi	Modulation index
n	Harmonic number
R_s	Supply short circuit resistor
S	Switch (Mosfet/ IGBT)
T	Thyristor
V_{dc}	Output dc voltage of converter
v_i	Input switching voltage of converter
v_p	Instantaneous voltage on primary side of input transformer
v_s	Instantaneous voltage on secondary side of input transformer or input supply voltage of converter
X_L	Supply short circuit reactor (ωL_s)
X_{L1}, X_{L2}	Boost reactor of converters
α	Switching angle of input voltage v_i of converter
ξ or δ	Power angle of converter
η	Impedance angle
θ	Notch angle in multipulse waveforms

ϕ	Power factor angle
ω or w	Supply angular frequency ($2\pi f$)
Vr, Vy, Vb	RMS Three Phase Voltages
Va, Vb, Vc	RMS Three Phase Voltages
Vm	Peak voltage
v_t	Terminal voltage
i_s	Source current
i_L	Load current
i_c	Compensating current

SYNOPSIS

Industrial growth with increased automation has made electricity as the key resource for the modern society. The demand for electricity is growing each day, even though gap between available electrical energy and demand is widening. Further, as the volume of power transmitted and distributed increases, the associated loss becomes an important issue of concern. It is to be noted that we have country goal "Electricity for all by 2012". Added to it is also the proliferation of sensitive electronics and critical processes, which impose need for high quality and reliable supply. Further, rising costs and growing environmental concerns make the process of building new power transmission and distribution lines increasingly complicated and time consuming. This has led people work on the alternative solutions. In this context, making existing lines as well as new ones more efficient and economical, becomes the most compelling alternative. Within the given constraints of power availability, transmission and distribution losses, and economics and supply of uninterrupted quality and reliable power to consumers, Power Quality (PQ) has assumed sustained concern in the present scenario.

The Power Quality from Transmission and Distribution (T&D) point of view revolves mainly around power factor of operation, supply voltage distortion, and harmonics getting introduced in the supply networks. The product offered for the Power Quality improvements also need to address the issues related to speed, accuracy, controllability and dynamic response, apart from the economics. Utilities too have been imposing restrictions and penalties in respect of the voltage and current distortion, maximum or peak reactive power, maximum kVA, low power factor of operation, and excess kW drawn by the consumer. For an end user, what matters is availability of high quality reliable power within constraints of economics, though "price and quality" are complementary. End user also has an expectation of high returns on investment.

With this as the Power Quality scenario, an optimal solution having right technology for proper operation of applied sub-systems has become the important need of an hour. Designers across the globe hence have been putting efforts to evolve novel power electronics based solutions, which can satisfy both the consumer as well as the utility while making use of state of art power electronic devices and the controllers.

Narrowing down further in respect of power quality, reactive power control and voltage distortion (caused due to weak networks and associated current harmonics) can be considered to be the most important aspects. The mitigation solutions for reactive power have seen changes over the past few decades from fixed capacitors to present day dynamic reactive power compensators (STATCOM / STATCON). Similarly, the harmonic mitigation also has seen change from passive filters to present day active filters. On power converter side, the rectifier / converter technology has moved from diode rectifiers to thyristor converters and now to present day four quadrant converters using self commutated devices such as Gate Turn off Thyristors (GTO's), Insulated Gate Bipolar Transistors (IGBT's), and Integrated gate Commutated Thyristors (IGCT's) etc. Similarly, the Control Electronics or Control Electronic Regulator design also has undergone substantial change from analog to digital controls with 8/16/32 bit Microcontrollers and Digital Signal Processors, making use of embedded software with operating speeds from few MHz to GHz offering sub cycle control responses.

Present day research, however, still continues to address power quality mitigating solutions, especially for weak networks. Thus, the research continues on mitigation of reactive power (more so dynamically varying) and current harmonics / distortion caused by them. In line with this scenario, work presented in this thesis deals with new methods / techniques for reactive power control using Pulse Width Modulation (PWM) based Voltage Source Converters (VSCs). As a part of power quality the work presented also includes economical technique for controlling sudden voltage dips/rises in the industry networks and unity power factor based Electronic Transformer.

Specific areas covered are,

1. Design, implementation and working of single-phase dynamic reactive power compensator