Chapter 6. Conclusions and Future Work

6.1 Conclusions

Soft-switched inverter topology will replace the conventional hard-switched inverters in UPS systems to improve the performance and efficiency of the system. This will become a necessity for low power applications and inverters used in photovoltaic system whose efficiency is very low. Also in active filtering where inverter plays an important role, soft-switched inverters are likely to replace the conventional hard-switched inverters. Advancement in signal processing area with increased speed of processors, digital systems are replacing analog ones with higher accuracy and more control over the system performance. Intelligent controllers using neural networks, fuzzy logic and other optimization tools are successfully implemented in power system and power electronics based equipments. Keeping this advancement in view, this thesis presents a combined work of soft-switching technology with advanced analysis tool based on wavelet transform.

The major contribution of this thesis is summarized as follows. First, a detailed analysis of hard-switched SPWM inverter is discussed. Two methods of SPWM generation namely stored waveform technique and sine triangle comparison technique have been presented. The performance of inverter in terms of THD of output voltage waveform is evaluated and output filter is designed to limit the total harmonic distortion to less than 3%. In sine-triangle comparison method higher order frequency spectrum is centered around twice the switching frequency and its multiple, reducing the filter component size.

Also, a simple control scheme using variable modulation index is proposed to keep the output voltage constant with variations in input or source voltage.

Second, a suitable topology of soft-switching inverter for UPS application is selected and detailed analysis is done. The topology is based on ZVT concept where the devices are switched on at zero voltage condition to achieve soft-switching. Snubber capacitors and resonant inductor are designed with design equations and the effect is analyzed with various operating modes.

Third, a wavelet based idea of switching loss analysis is proposed for a soft-switching converter. Wavelet based analysis of transient signals in power systems are very common and are reported in literature in sufficient detail. Even, the power definitions based on DWT have been reported recently. However, these definitions are limited to sinusoidal voltage and current with a set pattern of harmonic contents. Power loss analysis in case of transients, with unknown frequencies is still not reported with sufficient detail. This thesis brings the wavelet based switching loss idea to solid-state device switching and verifies the power loss calculated by DWT with the experimental data obtained by the captured waveforms. Frequency content of voltage and current waveforms during transient is shown using MRA approach. This will also be helpful in the analysis of EMI in hard and soft-switching conditions.

Experiment is performed on a single phase SPWM inverter with reduced voltage and current rating with filter design to meet the requirement of THD less than 3%. Also, to verify the zero voltage turn-on condition for on pair of switches, experiment is performed on a ZVT converter topology with reduced voltage and current rating.

Experimental results are verified with simulated results to see the effectiveness of the design. With suitable choice of snubber capacitor and resonant inductor values, the system with this topology can work well for a wide range of loading conditions.

6.2 Future Work

Author plans to implement the idea of soft switching inverter based UPS systems in photovoltaic (PV) systems. The PV industry is experiencing a rapid growth due to improving technology, lower costs, government subsidies, standardized interconnection, and general public enthusiasm for an environmental friendly energy source. Including an UPS function as a part of PV system, it is possible to improve power reliability at a site while sharing the inverter cost with that of the UPS. Spectral analysis of solar irradiance and singularity detection of solar radiation signal using wavelet transform have been already reported. Utilization of active power filtering in PV system using wavelet transform is the other future work to be implemented by the author.

Also, a detailed analysis of MOSFET switching loss in terms of individual frequency components, obtained by wavelet based analysis is to be reported. This analysis will be helpful in designing the snubber for main devices and also can be used for EMI analysis.