

**Abstract of Ph.D. Thesis**  
**“Control of Multilevel Converters for Solar Grid Interface”**  
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**ABSTRACT**

Solar multilevel converters (MLCs) enhance power transfer efficiency with lower harmonic distortion and reduced electromagnetic interference, achieved by configuring semiconductor switches in arrangements in a modular manner to handle large scale power. The goal is to generate high-voltage stepped waveforms resembling pure sine waves. Topologies such as neutral point clamped (NPC), cascaded H-bridge (CHB), and flying capacitor (FC) converters are available for grid tied systems. Conventional topologies suffer from increased switch count, raising controller complexity, losses, and costs. To address these challenges, low switching frequency medium voltage solar power converters are designed to maximize efficiency and meet IEEE/CIGRE harmonic standards. Emerging reduced-switch and Ac side isolated topologies for solar grid-tied systems aim to lower semiconductor and capacitor requirements, enhancing efficiency and affordability for practical applications. Single phase AC side single PV source configuration is tested with minimal drift technique to have lesser drift in maximum power point (MPP). This drift control with pressure gradient based new optimization methodology is adopted for better performance. To have further improvement in power quality end, single phase converter is tested with new carrier pulse width modulation that uses pulse generator and triangular generator to have minimum weighted total harmonic distortion in five-level converter voltage. Fundamental modulation is ideal for better efficiency, and tested for single phase converter using Levenberg-Marquardt methodology. New reduced switch topologies are tested in real-time, which generates five-level, seven level, nine-level, thirteen and seventeen level waveforms with improved power quality for medium voltage grid integration. In these configurations, contributions are modified carrier schemes, dominant shift factor scheme, optimal third harmonic modulation, selective harmonic elimination, equal area criteria and nearest level control are presented for better performance of medium voltage solar power converters. The irradiance profile is taken from the real-life locations for better insight of three-phase converter operation. The day and night mode of solar converters are also tested to utilize the reactive power capability in night time. Coming to the two-phase to three-phase power transfer, new nine level and twenty-seven level cascaded Scott-tied topologies are implemented with change in solar irradiances. The Scott connection made the system compact to feed power with converters, which are required only in two phases. The system become efficient with nearest level switching round function based method, which is simpler in control implementation. The galvanic isolation provide inherent safety in the converter modules from grid end faults.

Research work in the thesis focuses on new topologies and their control with enhance power quality. Recorded results from laboratory hardware setup and implementation of large scale power converters in OPAL-RT test bench shows the merits of modularity of converters in power conversion and promotes clean energy goals. New modulation techniques and control provides reduction in grid current THD, which meets the IEEE 519 standard. Individual harmonics are tested for CIGRE standards. Presented work motivates the researchers towards new intelligent and efficient renewable energy systems using different configurations of cascaded multilevel converters.