A New Switched-Capacitor based Multilevel Inverter Topology used to generate Single-phase AC Output for Renewable Energy Applications.

Abstract

Multi-level inverters are increasingly used in industrial applications due to their ability to generate output voltages with reduced harmonic content. The output voltages of multilevel inverters can be higher than the blocking voltage of the transistors used, and the output voltage shape resembles a sine wave. Their main disadvantage is the increased number of power electronic switches used.

This project aims to develop a new multilevel inverter topology and the development of an optimized modulation technique to produce 9-levels of output voltage using fewer semiconductor elements. The envisaged configuration includes two cells, designated as main and auxiliary cells. The main cell includes a standard H-bridge, and the auxiliary cell is switched capacitor-based 5-level inverter to generate single-phase AC output voltage. Both cells are supplied from a single input dc source. The output voltage of the auxiliary is added to the output voltage of the main cell using a single-phase isolation transformer. The proposed single-phase converter requires reduced switches to generate 9-level of single-phase ac output voltage with higher voltage gain. Comparatively, the switches connected in the proposed converter undergo less voltage stress as compared to the MLIs reported in the literature.

The configuration of the developed inverter ensures the maximum number of levels in the AC output voltage using a lower number of circuit elements. In this topology, 12 switches, a single-phase transformer, and one switched capacitor are used, which are fed from a single input dc source. The major objective of the present work is to introduce a new inverter based on a switched-capacitor-based multilevel inverter with the following salient features:

- The configuration requires a single dc input source to produce a 9-level of single-phase ac output voltage.
- The proposed topology requires switches with reduced voltage ratings and ensures balancing of the voltage across the capacitor under different loading conditions.
- Inherent capability of boosting output voltage.

The main goal of the project is to conduct research, both theoretical and practical, in order to develop and test new inverter structures, made of fewer semiconductor elements and with lower losses than the solutions presented so far in the literature. In addition, algorithms controlling the voltage on the DC-link capacitor will be developed. The proposed inverter belongs to the group of multi-level inverters and can be used in applications where the output voltages are higher than the blocking voltages of the semiconductors. In addition, the proposed inverter has the potential to replace typical low-voltage inverters, as it uses cheaper transistors with lower blocking voltage and provides a quasi-sinusoidal output voltage waveform. Due to the above features, the solution can be used in industrial applications, such as power inverters cooperating with photovoltaic panels or fuel cells.

The project includes the following research hypothesis:

A new switched-capacitor-based multilevel inverter topology capable of generating the maximum number AC output voltage levels using a lower number of circuit elements with switched capacitor balance and higher overall efficiency.