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Advanced DPWM Control for Voltage Symmetry in Solar-PV Fed Grid-Tied NPC Inverters

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Abstract- ***As the demand for renewable energy increases, there have been tremendous advancements in power electronics conversion, specifically in solar photovoltaics (PVs). In this research, we will explore the use of advanced discontinuous pulse width modulation (DPWM) methods on the NPC inverter that is powered from the solar PV. Our main aim is to increase efficiency while ensuring that switching losses and voltage balancing at the dc-link capacitors are maintained. Our DPWM approach provides an efficient method that increases the performance of the NPC inverter by decreasing the number of switching transitions and also optimizing the modulation process. Besides, our method also decreases stresses on switching components and ensures that better harmonic performance is achieved. Our model will be simulated to check the performance of the system at different operation conditions.***

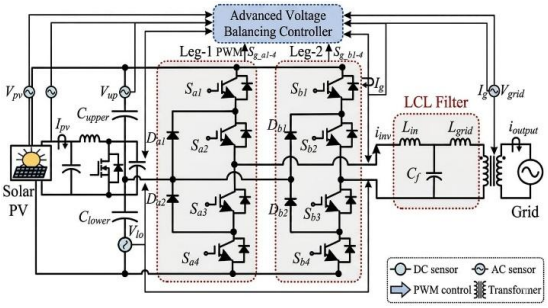
Index Terms- ***Solar Photovoltaic (PV) Systems, Grid-Tied Inverter, Neutral Point Clamped (NPC) Inverter, Discontinuous PWM (DPWM), Voltage Balancing***

I. INTRODUCTION

Due to rapid advancements in renewable energy, solar photovoltaic panels have emerged as significant components of the present-day power generation process. In the case of grid connected PV systems, the use of efficient inverters is mandatory in order to generate high-quality AC electricity from DC power generated by solar panels. The NPC type of multilevel inverters is popular among several types of inverters due to the production of high-quality output voltage with low distortion. One of the drawbacks of NPC inverter is the imbalance in DC-link capacitor voltages.

Conventional Pulse Width Modulation (PWM) schemes suffer from increased switching losses and unbalanced capacitor voltages. In order to overcome such disadvantages, a novel DPWM scheme is introduced, which lowers switching frequencies under certain time periods. The present project is concerned with development and analysis of an advanced DPWM based control scheme for grid-tied NPC inverter fed by PV array.

II. BLOCK DIAGRAM DISCRIPTION



Main Components:

1. Solar PV Array
2. DC-DC Converter (Boost Converter)
3. DC-Link Capacitors
4. NPC Multilevel Inverter
5. DPWM Control Unit
6. Grid Connection (Utility Grid).

Working Flow:

1. Solar PV generates DC power
2. Boost converter regulates voltage
3. DC-link capacitors stabilize voltage
4. NPC inverter converts DC to AC
5. DPWM controller generates switching signals
6. Output is synchronized and fed into the grid

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III. METHODOLOGY

The system will be designed through the following stages:

1.Modeling of Solar PV System

- Solar panel model based on solar radiation and temperature levels
- Analysis of output features

2. boost converter design

- Boosts PV voltage to desired dc link voltage
- Constant dc output supply

3.NPC inverter design

- Three-level NPC inverter design
- Low voltage stress for switches

4.design of DPWM control

- DPWM control approach used to generate PWM signals
- Minimizes losses due to phase clamping

5.grid synchronization

- Phase locked loop (ppl) approach employed
- Grid voltage synchronization

IV. SIMULATION AND PROCEDURE

This process is modelled using simulation software such as MATLAB/Simulink.

Procedure:

1. Design the solar PV panel model using established equation
2. Create and simulate the boost DC/DC converter
3. Design the NPC inverter using switching elements
4. Control the PWM techniques
5. Apply the grid synchronization techniques using PLL
6. Simulation with varying parameters
    - Irradiation from the sun
    - Loading variations
7. Observe the following:
    - Output voltage and current
    - THD measurement
    - Switching losses
        - DC-link capacitor

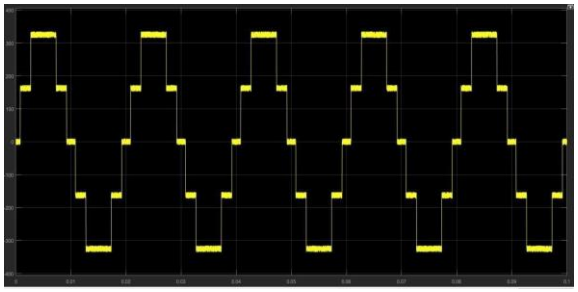
V. RESULTS

1.Simulation result indicate the following:

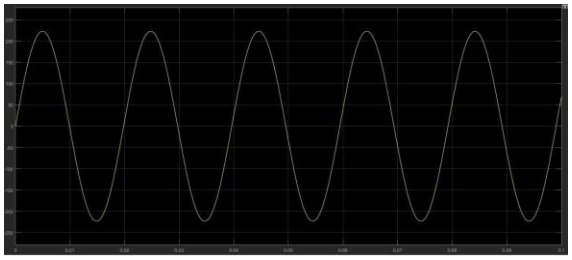
- Switching losses reduction using DPWM method
- Enhanced efficiency relative to tradition PWM
- Equalization of capacitor voltage level
- Decreased THD
- Grid synchronization stability

2.common findings:

- Significant reduction in THD
- Sinusoidal like output waveform
- Decreased switching component stress



Five level inverter voltage vs time



Filter output voltage vs time

VI. CONCLUSION

This project has succeeded in demonstrating the efficiency of DPWM control in an NPC inverter operated by solar PV. The proposed strategy increases the efficiency of the system through reduction of switching losses and balancing of

voltage in the DC link capacitors. The simulation outcomes confirm the suitability of DPWM to be used in inverter control due to its ability to improve performance of the inverters. Further studies could involve the practical application of this project.

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in identifying useful patterns that may assist in malware analysis.