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Transformer Less Three-Level Flying-Capacitor Step-Up PV Micro Inverter without Electrolytic Capacitor

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ABSTRACT: This project presents a control strategy of a fly back micro inverter with hybrid operation mode for PV AC modules. The project also includes the power generation by means of Peltier modules which generated DC power from the Heat emitted from the Solar panel. The proposed control strategy consists of two components: the proportional-resonant (PR) controller with the harmonic compensator (HC), and the hybrid nominal duty ratio. Compared to the conventional control strategy using the proportional-integral (PI) controller, the PR controller with HC provides higher system gain at the fundamental and harmonic frequencies of the grid without using high proportional gain in both operation modes. Then, it enhances tracking speed and disturbance rejection performances satisfying the desired stability. Moreover, by applying the hybrid nominal duty ratio yielded from the proposed operation mode selection, the disturbance rejection is achieved more effectively, and the control burden is reduced. Finally, the simulation and experiment results were shown to verify the tracking speed and disturbance rejection performance of the proposed control strategy

KEYWORDS: Solar panel, Micro inverter, Peltier modules

I. INTRODUCTION

Introducing a transformer less three-level flying-capacitor step-up PV microinverter without electrolytic capacitors presents a significant advancement in photovoltaic (PV) technology. By eliminating electrolytic capacitors, which are prone to degradation and have limited lifespans, this innovative design enhances the reliability and longevity of microinverters used in solar energy systems. The utilization of three-level flying-capacitor topology offers improved efficiency, reduced voltage stress on components, and enhanced power conversion capabilities, making it a promising solution for grid-tied solar applications. This novel approach not only addresses the limitations associated with traditional PV microinverters but also paves the way for more sustainable and resilient solar power systems.

1.1 PROBLEM STATEMENT

The problem statement for designing a transformerless three-level flying-capacitor step-up PV microinverter without electrolytic capacitor involves addressing challenges such as voltage boosting, capacitor balancing, efficiency optimization, and reliability enhancement, while ensuring compatibility with photovoltaic systems and meeting safety standards. The objective is to develop a reliable and efficient microinverter solution for PV systems that eliminates the need for electrolytic capacitors, which are prone to degradation and failure over time.

1.2 OBJECTIVE

The objective in designing a transformer less three-level flying-capacitor step-up photovoltaic (PV) microinverter without electrolytic capacitors is likely to achieve high efficiency, reduced size, and improved reliability. By eliminating electrolytic capacitors, which are prone to degradation over time, the design aims to enhance the longevity and robustness of the microinverter. Additionally, by utilizing a three-level flying-capacitor topology, the

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inverter can achieve higher voltage conversion ratios while minimizing switching losses, leading to improved efficiency, particularly in PV applications where maximizing power output is crucial.

1.3 SCOPE AND STUDY

Efficiency Improvement: Continuously enhancing the efficiency of the microinverter to maximize energy harvesting from the PV panels Miniaturization Developing smaller and more compact designs to increase integration flexibility and ease of installation. Cost Reduction: Finding ways to lower the manufacturing cost of the microinverter to make solar energy more affordable for consumers.Reliability Enhancement: Ensuring long-term reliability and durability of the microinverter, especially in harsh environmental conditions. Grid Interaction: Integrating advanced grid interaction features such as grid support functionalities and smart grid capabilities.Energy Management: Incorporating intelligent energy management algorithms to optimize energy usage and storage within the system. Communication and Monitoring: Improving communication protocols and monitoring systems for better remote management and diagn ostics .Compatibility: Ensuring compatibility with emerging PV technologies and standards to stay relevant in the evolving solar energy market.

II. COMPONENTS

2.1 COMPONENTS AND SPECIFICATIONS:

- Flying Capacitors
- High-Frequency Switching Devices
- Control Circuitry
- Filtering Components
- Gate Drivers
- DC-Link Capacitors

III. BLOCK DIAGRAM

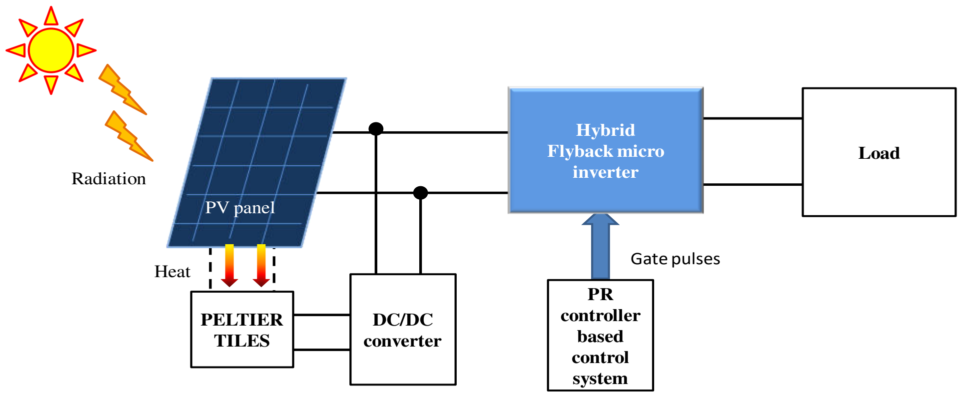

Fig -1: Block Diagram of System

3.1 WORKING

The Transformer less Three-Level Flying-Capacitor Step-Up PV Microinverter without Electrolytic Capacitor project utilizes a novel topology to efficiently convert photovoltaic (PV) panel output to grid-compatible voltage levels without the need for electrolytic capacitors. Through a three-level flying-capacitor structure, it achieves higher voltage conversion ratios while minimizing size, cost, and reliability concerns associated with traditional electrolytic capacitors. By leveraging this innovative design, the microinverter efficiently steps up the PV panel's output voltage to grid-compatible levels, enabling seamless integration of solar power into the electrical grid with enhanced reliability and reduced component degradation over time.

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IV. CIRCUIT DIAGRAM

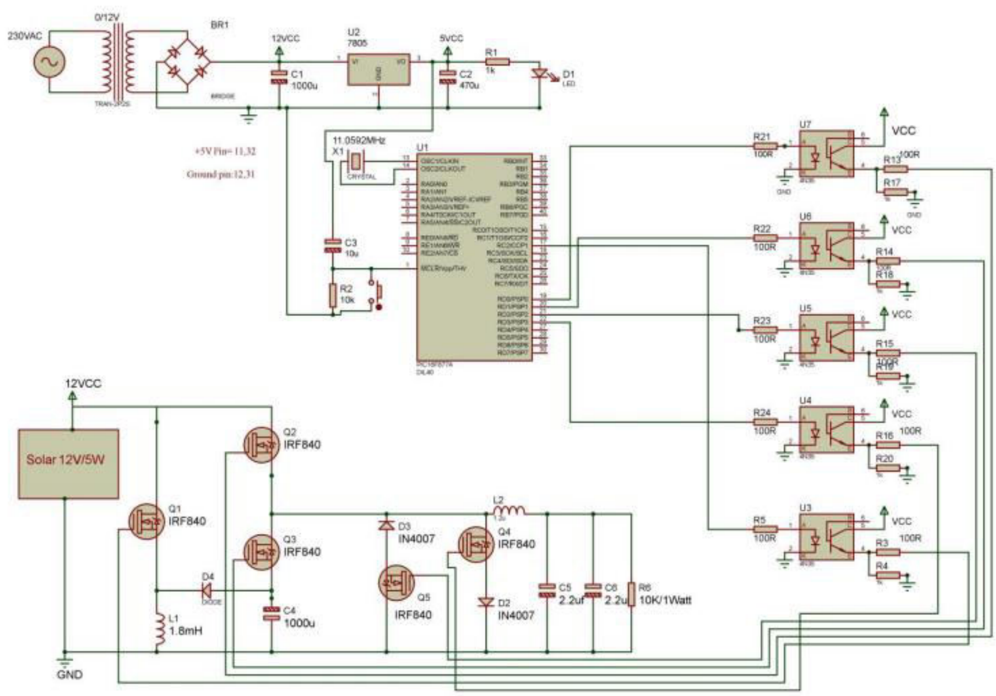

Fig -2: Circuit Diagram of the system

V. RESULT AND DISCUSSIONS

Enhanced reliability: Elimination of electrolytic capacitors reduces the risk of failure and extends the lifespan of the microinverter. Improved efficiency: The three-level flying-capacitor topology enables higher efficiency compared to traditional designs, contributing to increased energy harvest from PV modules.Reduced harmonic distortion: The microinverter design achieves lower harmonic distortion, ensuring cleaner power output and compliance with grid regulations. Experimental validation: Results from simulation and experimental testing confirm the feasibility and effectiveness of the proposed design, validating its performance under real-world conditions.Suitable for various PV applications: The reliability, efficiency, and harmonic performance make the microinverter suitable for a wide range of grid-connected PV systems, including residential, commercial, and utility-scale installations.

VI. CONCLUSION

The current control strategy of the fly back micro inverter with hybrid mode for PV ac module has been introduced and verified by the analysis, simulation, and experimental results. In the proposed control strategy, the PR controller with HC provides the high system gain at fundamental and harmonic frequencies in both operation modes without using high proportional gain. The characteristic alleviates the trade-off between the control performance in DCM and stability in CCM when the conventional PI controller is used. In addition, the proposed hybrid nominal duty ratio yielded from the proposed operation mode selection eliminates the disturbance more effectively and reduces the burden of the feedback controller. From the simulation and experiment results, it is verified that the proposed control strategy shows faster reference tracking and better disturbance rejection than those of the conventional strategy. Finally, the proposed control strategy encourages the many advantages of the fly back inverter with hybrid mode and makes it to be used in the industrial field

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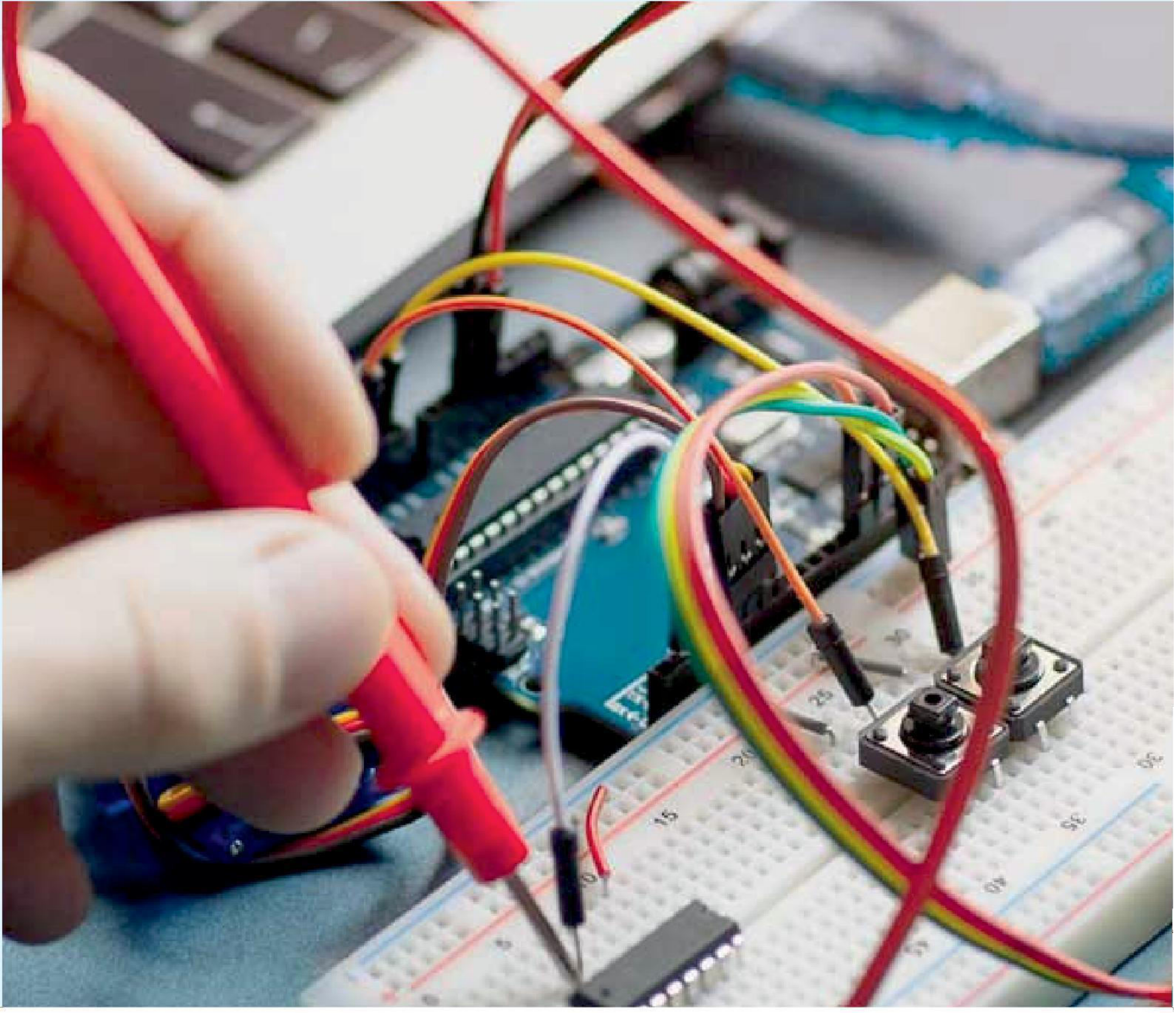

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