ASYMMETRICAL 7 LEVEL MULTI LEVEL INVERTER FOR DYNAMIC LOADS

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***Abstract*—Asymmetric multilevel inverters (AMLIs) have received great attention in the power industry due to their ability to solve problems caused by power supply in various applications. This report explores the design, analysis and performance of AMLI's heavy-duty equipment. Dynamic loads are characterized by rapid and unpredictable changes in power demand, causing significant outages due to the limitations of traditional inverters in providing efficient power delivery and stability. The AMLI concept takes advantage of the ability to produce multiple voltage levels, providing greater flexibility to adapt to the needs of the load. This study investigates the optimization of modulation techniques to improve the efficiency and response time of the inverter in dynamically changing scenarios. In addition, factors such as harmonic distortion and power quality were also taken into account in the study, and the effect of asymmetric voltage levels on the overall system performance was examined. Simulation results and experimental results show that the effectiveness of AMLI in dynamic switching is good. The results of this study provide great insights into the use of AMLI with electronic devices, showing promise in improving power conversion and safety in real-world applications.**

Keywords: Asymmetric multilevel inverters (AMLIs), Power industry, Design, Analysis, Performance, Heavy-duty equipment.

I. INTRODUCTION

The asymmetric multilevel inverter (AMLI) is a significant technology in the field of power electronics that offers unique capabilities for dynamic load adaptation. This report discusses the design principles, operational advantages and applications of AMLIs in managing variable and unpredictable loads. As modern power systems continue to evolve and become more diverse, the need for advanced inverters that can respond to such changes is becoming increasingly apparent. Conventional inverters are efficient in producing alternating current (AC) from direct current, but they often face limitations with dynamic loads characterized by fluctuations and rapid changes in power demand. AMLI technology attempts to address these limitations by providing a flexible and adaptable platform for power conversion through the intentional design of asymmetry of voltage levels. AMLIs are versatile and find applications in various industries seeking sustainable and efficient power conversion solutions such as grid-connected systems, PV installations or electric drives. In industries with non-conventional power systems where adaptability to dynamically changing load profiles is paramount, AMLI technology is particularly emphasized. This report aims to provide a comprehensive understanding of AMLIs, including their theoretical foundations, design considerations, operational advantages and practical applications. The report explores the importance of AMLIs in the landscape of dynamic load adaptability and their potential to shape the future of power electronics by examining recent research findings, industry case studies and emerging trends.

II. OBJECTIVES

AMLI or asymmetric multilevel inverter is a type of inverter designed to meet the challenges associated with variable and unpredictable load conditions. It is characterized by intentionally uneven distribution of voltage levels, which allows for better adaptability and efficiency in dynamic load scenarios. The main objectives of using AMLI under dynamic loads are as follows: 1. Improved performance under variable loads – AMLI aims to improve overall system performance by adjusting its output to match changing load conditions, thereby minimizing energy losses and improving efficiency. 2. Optimized power quality – AMLI provides adaptive voltage distribution to alleviate problems caused by dynamic loads that lead to fluctuations in power demand and harmonic distortion in the output waveform. This optimization helps reduce harmonic content, improve current quality, and ensure stable and sinusoidal AC output even under variable load conditions. 3. Improved flexibility in voltage control – AMLI's conscious asymmetry of voltage levels gives it more flexibility in voltage control, allowing it to dynamically adjust voltage levels to match load requirements, providing better voltage management and stability. 4. Adapted response to dynamic load changes – AMLI is designed to respond adaptively to dynamic load changes by quickly adapting to changes in load conditions, providing more precise control, and contributing to power electronic component stress reduction. 5. Reduced stress on components – AMLI's ability to adjust its output voltage level based on dynamic load conditions helps reduce stress on power electronic components, extending their life and improving overall system reliability. 6. Harmonic Distortion Control – AMLI aims to control and reduce harmonic distortion in the output waveform, affecting power quality. This objective is crucial in applications where compliance with strict harmonic standards is essential, such as grid-connected systems. 7. Use in non-conventional power systems – AMLI is well suited for use in non-conventional power systems such as renewable energy systems and electric vehicles where dynamic charging is common. The goal is to adapt the transformer according to the specific characteristics and requirements of these systems, which ensures stable and efficient operation in different conditions.

III. ASYMMETRICAL MULTILEVEL INVERTER

An asymmetrical multilevel inverter (AMLI) is a type of power inverter that produces alternating current (AC) output on multiple voltage levels that are intentionally distributed non-uniformly around a reference point. Unlike symmetrical multilevel inverters that produce balanced voltage steps, AMLIs offer the flexibility to tailor the output waveform to specific application needs. The asymmetry of the voltage levels makes it possible to optimize the fulfillment of certain requirements, such as improving efficiency, reducing harmonic distortion or adjusting voltage limits. AMLIs are often implemented using a variety of configurations, including H-bridge structures or combinations of different power electronics. These inverters find applications in many fields such as renewable energy systems, engine motors and power grid connections. By strategically adjusting voltage levels during each half cycle, asymmetric multilevel inverters can improve power quality, control and overall system performance. Their adaptability to certain operating constraints makes them valuable in scenarios where adjusting the AC output waveform is essential for optimal operation and efficiency.

IV. TABLES, FIGURES, EQUATION AND METHODOLOGY

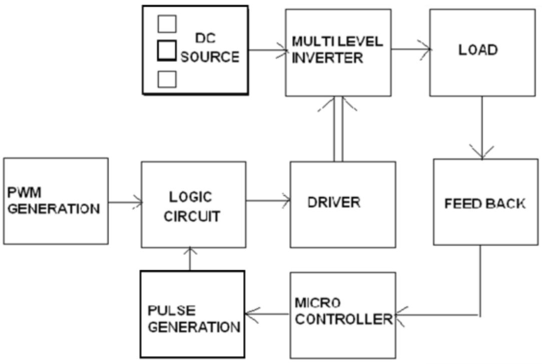


Fig 1. Block Diagram

Similar to the conventional H Bridge MLI, the reduced switch MLI has seven output levels but only needs eight switches, which allows us to lower switching losses. The suggested MLI's circuit diagram is displayed in Fig. 1. Three capacitors, designated C1, C2, and C3, are linked in series to form the input voltage divider. The divided voltage is then fed to the H-bridge, which is constructed out of four diodes and MOSFETs, after it has passed through the voltage divider. The output terminal, which has four MOSFETs, receives the voltage once it has been sent from the H-bridge.

V. MODES OF OPERATION

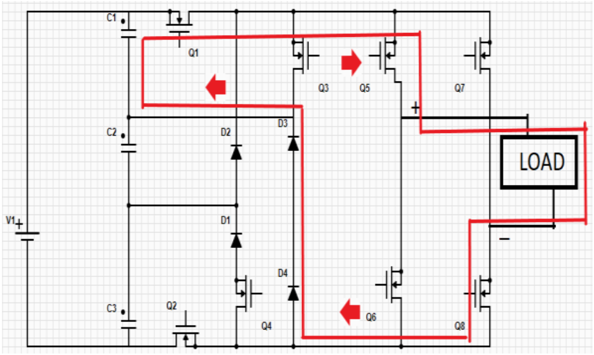
The seven levels that can be obtained with an input voltage of Vi are: 0, ⅓ Vi, ⅔ Vi, Vi, -⅓ Vi, -⅔ Vi, and - Vi. The following working principle, illustrated in fig., applies to every voltage level.

- For the positive half cycle, switch Q1 is activated for the output voltage level, Vo = ⅓ Vi. Additionally, the switches Q5 and Q8 are activated, and capacitor C1, or ⅓ Vi, provides the energy.

- Q1 and Q4 switches are on for the output voltage level, Vo = ⅔Vi. Additionally, the switches Q5 and Q8 are activated, and capacitors C1 and C2, or ⅔Vi, supply the energy.
- Q1 and Q2 switches are on for the output voltage level, Vo = Vi. Capacitors C1, C2, and C3, or Vi, supply the energy, and switches Q5 and Q8 are likewise activated.

- During the negative half cycle, switch Q2 is activated for the output voltage level Vo = -⅓ Vi. Additionally, the switches Q6 and Q7 are activated, and capacitor C3, or -⅓Vi, provides the energy.

- The switches Q2 and Q3 are activated at the output voltage level, Vo = -⅔Vi. Additionally, switches Q6 and Q7 are activated, and capacitors C3 and C2, or ⅔Vi, supply the energy.
- The switches Q2 and Q1 are open for the output voltage level, Vo = -Vi. Additionally, the switches Q6 and Q7 are activated, and capacitors C1, C2, and C3—that is, Vi—provide the energy. In the event when Vo = 0, the switches Q5 and Q7 are activated.



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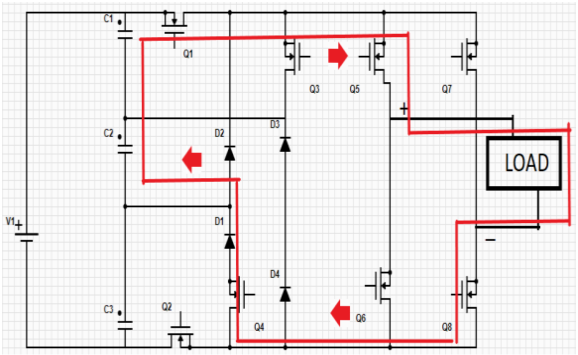

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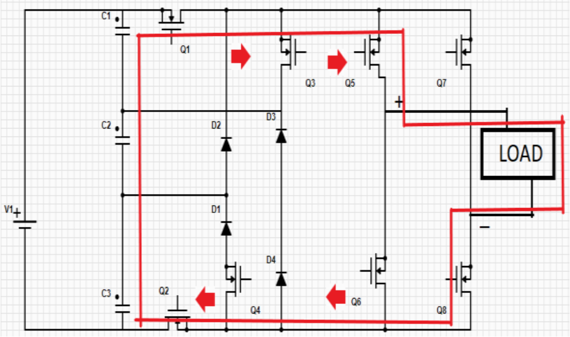

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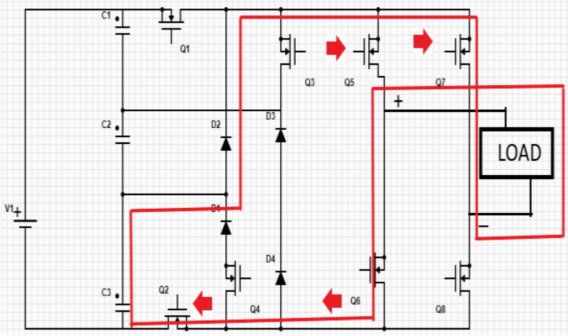

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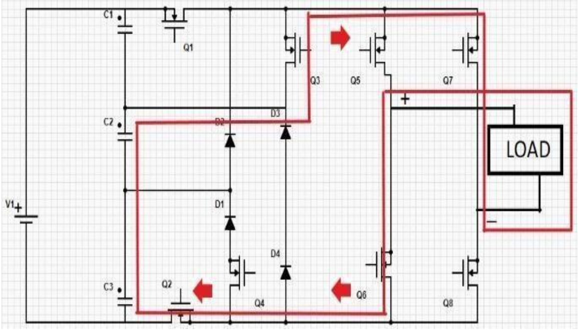

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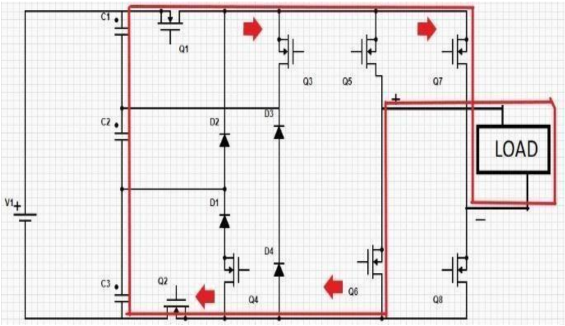

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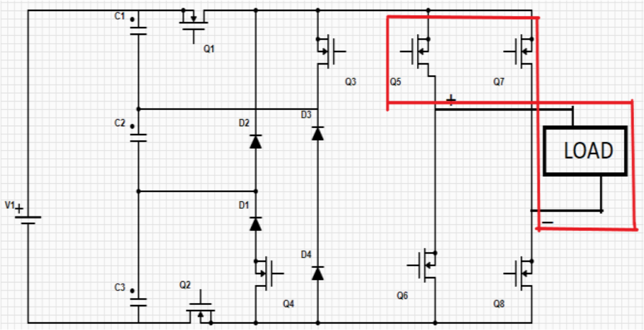

(g)

Fig. 2 Modes of operation

VI. SIMULATION

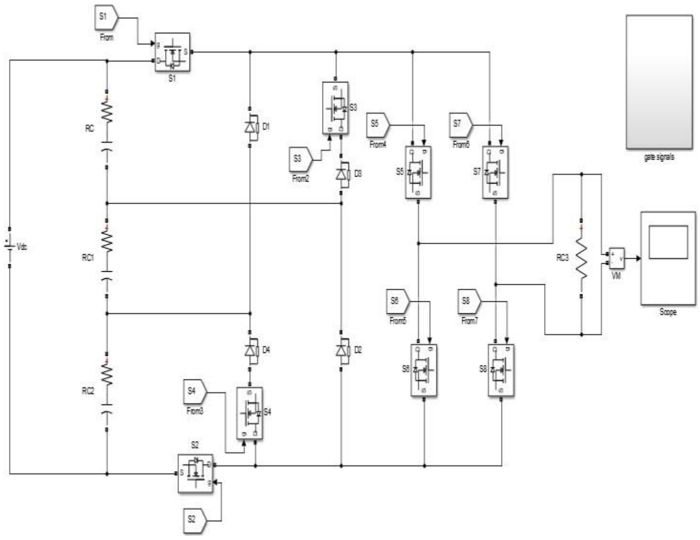

Fig. 3 Simulation

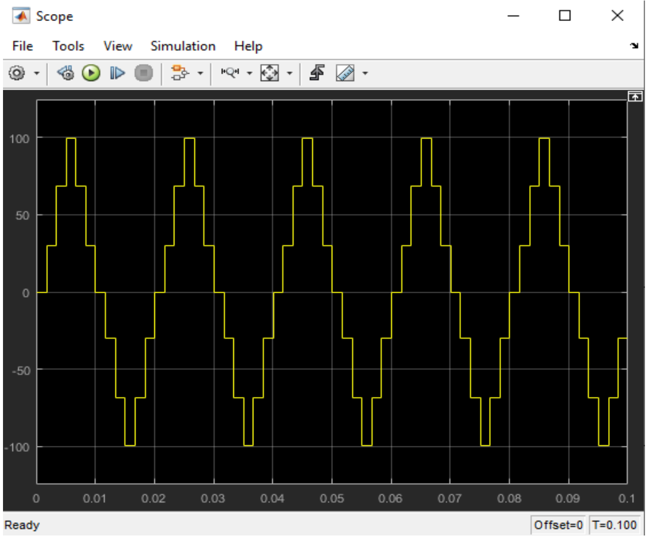

Fig. 4 Output Waveform

VII. CONCLUSION

To sum up, the investigation of asymmetric multilevel inverters (AMLIs) for dynamic load adaptation tells a fascinating tale of power electronics innovation and promise. By purposefully deviating from symmetrical designs, AMLIs may now respond to the demands of dynamic loads by dynamically adjusting voltage levels, increasing efficiency, and reducing harmonic distortion. Because of their distinct design concepts, practical benefits, and adaptability in voltage regulation placement, AMLIs are essential elements in the dynamic world of contemporary power systems. By offering a thorough overview of AMLIs, this paper closes the knowledge gap and makes it easier for researchers, engineers, and business professionals to make the most of these tools. Future sectors pertaining to electric vehicles, renewable energy integration, and other dynamic energy needs will see the emergence of AMLIs. In addition to marking a turning point in our knowledge of AMLIs' complexity, this trip has sparked a revolution in power electronics that will ultimately lead to more adaptable and sustainable energy sources.

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