WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

5 Level Inverter

Prof. DR. R.N. Patil , Nikhil Sutar, Mujjmil Hidaytulla Attar

Department of Electrical Engineering, DKTE, Ichalkaranji, Kolhapur, India.
nikhilsutar114@gmail.com

A B S T R A C T

This project presents the design and simulation of a five-level multilevel inverter (MLI) using MOSFETs as switching devices and a pulse generator block for gate signal control in MATLAB Simulink. The multilevel inverter topology enhances the output waveform quality by producing stepped AC voltage with reduced total harmonic distortion (THD), making it suitable for medium to high-power applications. The proposed system is modeled using a cascaded H-bridge configuration, where each level contributes to a more sinusoidal output. A synchronized pulse generator block is employed to provide the precise gating signals required for switching control. The simulation results confirm the effectiveness of the design in generating a five-level output with improved voltage profile and minimized harmonic content, demonstrating the viability of the inverter in renewable energy and industrial drive applications.

Keywords: multilevel inverter, MATLAB Simulink.

Introduction

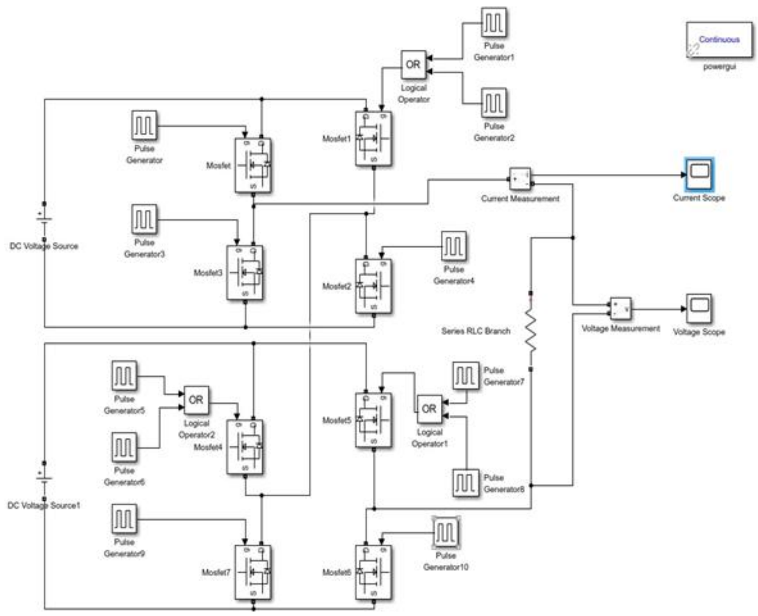
In today's rapidly evolving industrial landscape and technological era, a wide range of advanced machines and devices demand various types of power supply, among which AC (Alternating Current) supply plays a particularly vital role, especially in the operation of industrial machinery. The generation of AC supply can be achieved through several methods; however, one of the most widely adopted and efficient solutions is the use of an inverter, a power electronic device that converts DC (Direct Current) supply into AC supply with the assistance of various semiconductor components and control systems. Inverters have been extensively used for decades across diverse sectors such as manufacturing, automation, energy production, and service industries, including power plants, where they serve as a fundamental means of delivering electrical energy tailored to specific application needs.

While conventional two-level inverters have been commonly implemented in these areas, they are often accompanied by significant drawbacks such as reduced efficiency, increased stress on switching devices, the potential for damaging sensitive electronic equipment due to high voltage swings, the requirement for costly and bulky filter circuits to mitigate harmonic distortion, and overall higher system costs. To overcome these limitations, the concept of multilevel inverters has emerged as a highly effective and modern alternative. A multilevel inverter is a sophisticated power electronic converter capable of generating a desired AC voltage output using multiple low-voltage DC sources as inputs, thereby improving waveform quality, enhancing efficiency, and enabling the safe operation of high-performance loads. Although two-level inverters are still frequently used for basic DC to AC-conversion tasks, multilevel inverters offer substantial advantages in terms of voltage handling, thermal performance, and power quality, making them highly suitable for high-power and high-precision industrial applications.

LITERATURE REVIEW

The concept of this inverter is based on connecting 5- 5-level Hbridge inverters in series to get a sinusoidal voltage output. The output voltage is the sum of the voltage that is generated by each cell. Single-phase full-bridge, or H-bridge inverter. The inverter level generates three different voltage outputs, +Vdc, 0, and –Vdc by connecting the DC source to the AC output by different combinations of the four switches, S 1 , S 2 , S 3, and S 4 . To obtain +Vdc switches S 1 and S 2 are turned on, whereas –Vdc can be obtained by turning on switches S 3 and S4 . By turning S1 and S2 or S3 and S4 switches, the output voltage is 0. Similarly, S5 and S6 for +Vdc, switches S 7 and S 8 are turned on for –Vdc. The AC outputs of each of the different full-bridge inverter levels are connected in cascade such that the voltage waveform is the sum of the outputs. The output voltage is sum of the voltage that is generated by each cell. The number of output voltage levels is 2n+1, where n is the number of cells. The switching angles can be chosen in such a way that the total harmonic distortion is minimized. An n-level cascaded H bridge multilevel inverter needs 2(n-1) switching devices where n is the number of the output voltage tidal, etc.

1.1 Block Diagram



1.2 Construction and Working

This project focuses on the design and simulation of a five-level inverter using a cascaded H-bridge topology in MATLAB/Simulink, where the primary objective is to convert a DC supply into an AC output by utilizing various essential components such as MOSFETs, pulse generators, DC sources, voltage and current measurement blocks, scopes, and the PowerGUI block. In this configuration, two H-bridge circuits are connected in series to form the cascaded structure, and each H-bridge consists of four MOSFETs acting as high-speed switching devices, resulting in a total of eight MOSFETs used for the entire inverter system.

An independent DC voltage source powers each H-bridge, and the output from both bridges is connected to a common load, To facilitate the required switching sequence that generates the five discrete voltage levels pulse generator blocks are employed to provide gate pulses to each MOSFET, ensuring proper timing for turning the switches on and off by the desired output waveform. As the simulation begins, the DC supply energizes the H-bridges, and the pulse generators begin delivering gate signals to the MOSFETs, which in turn start switching according to the defined sequence, thereby producing a multilevel stepped AC voltage at the output terminals of the inverter. This AC voltage is then supplied to the load, and the voltage and current measurement blocks are used to monitor the corresponding electrical parameters in real-time. These measured values are subsequently sent to the scope block, which visually displays the voltage and current waveforms, allowing for analysis of the inverter's performance and confirmation of the generation of a five-level AC output waveform.

The PowerGUI block plays a crucial role in enabling the simulation and facilitating the proper functioning of all power electronic components within the MATLAB/Simulink environment. Overall, this project successfully demonstrates the working principle of a five-level inverter based on cascaded H-bridge architecture, showcasing its ability to produce a high-quality output waveform with reduced harmonic distortion compared to conventional two-level inverters, and serves as an effective model for understanding multilevel inverter systems in power electronics.

1.3 Advantages

- Improve waveform:- provides waveform close to a sinewave.
- Reduced losses:- reduced losses .
- Improve efficiency:- as waveform is pure and losses are less it improves the working efficiency of equipment and machine.
- Additional circuit:- An additional circuit is not required.
- Sensitive electronic:- sensitive electronic components don't get affected
- Cost:- as circuit requirement is less cost is reduced.

1.4 Applications

- .Renewable Energy Systems
- Regenerative Braking
- Automobile
- Photovoltaic Generation

Conclusion

The MATLAB Simulink simulation of the five-level multilevel inverter successfully demonstrated the effective conversion of a DC input into a stepped AC output waveform using a cascaded H-bridge topology. The use of key components such as MOSFETs, DC voltage sources, and pulse generator blocks enabled precise switching control and efficient power conversion. The multilevel structure of the inverter not only provided improved power quality by producing output waveforms closer to a pure sine wave but also contributed to reduced total harmonic distortion and lower switching losses compared to conventional two-level inverters. This simulation highlights the advantages of using multilevel inverter technology in terms of enhanced performance, better voltage control, and increased compatibility with industrial and sensitive electronic applications.

References

1. [1] Mohammad Ahmad and B.H. Khan, Senior Member, IEEE “New Approaches for a harmonic reduction in solar inverters”.
2. [2] J. Rodriguez. J.-S. Lai, and F.Z. Peng, “Multilevel inverters: A survey of topologies, controls, and applications,” IEEE Trans. Ind. Electron ., vol. 49, No. 4,pp. 724-738, Aug.
3. [3] EbrahimBabaei, Member, IEEE, Sara Laali, Student Member, IEEE, and Zahra Bayat ”A single phase cascaded multilevel inverter based on a new basic unit with reduced number of power switches. ”
4. [4] MariuszMalinowaski, Senior Member, IEEE, K.Gopakumar, Senior Member, IEEE, Jose Rodriguez, Senior Member, IEEE, and Marcelo A.Perez, Member IEEE “A Survey on Cascaded Multilevel Inverters”. Switching Hybrid-Modulation Techniques for Cascaded Multilevel Inverters”vol. 26, no. 6, june 2011