Research Article

Development of SG3525 PWM Inverter Circuit 12V to 220V, 50Hz

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Abstract: *This project focuses on designing and fabricating a SG3525 PWM inverter circuit that converts9 12V DC to a stable 220V AC with a frequency of 50Hz. The circuit can regulate output voltage and frequency by using PWM controller IC to meet diverse application demands such as lighting, fan, motor control, and uninterruptible power supply (UPS). The hardware implementation emphasizes reliability, efficiency, and safety to address challenges such as voltage instability and harmonic distortion, which could impact performance and application suitability. Previous switching circuits have always suffered from output voltage fluctuations, high power dissipation, and low efficiency due to inconsistent switching regulation or poor switching control. Furthermore, many designs are not appropriate for various applications, their practicality is limited. The project highlights practical considerations in hardware assembly, including component selection, PCB fabrication, and system testing. By transitioning from simulation to a physical prototype, this project aims to deliver a user-friendly, durable inverter capable of consistent voltage output and safe operation for diverse applications, such as renewable energy systems and portable power solutions. Key components include the SG3525 PWM controller, MOSFETs, transformers, capacitors, resistors, a lithium-ion battery, switches, and output loads like a fan and LED bulb. The completed inverter prototype demonstrates improved performance and adaptability, offering a reliable solution for home appliances. With continued enhancement, this design is ideal for market deployment, such as for portable power solutions, backup power sources, which contribute to sustainable energy advancement.*

Keywords: inverter; PWM; energy.

1. INTRODUCTION

Power electronics converters are electrical circuits designed to modify voltage, current, and frequency by using power switching components to facilitate efficient energy conversion (Tonsy, Sipin & Shaika 2019). The reliability and efficiency of inverters, which are essential for many applications, such as emergency power supply and renewable energy systems, are threatened by voltage instability in DC-to-AC power conversion systems (Lee, 2022). Resolving this issue is necessary to maintain consistent performance and safeguard linked loads. The goal of this research is to find and apply workable ideas that can reduce voltage instability and enhance the SG3525 PWM inverter circuit's overall performance and dependability. These problems can be fixed to increase the inverter's durability and adaptability for a range of real-world applications. This project addresses the challenge of output voltage instability in the hardware implementation of an SG3525 PWM inverter circuit, which converts 12V DC to 220V AC. Voltage instability poses significant risks to the inverter's reliability, efficiency, and the safety of connected loads, potentially causing operational disruptions or damage to sensitive electronics. The research emphasizes understanding the causes of this instability and implementing hardware-based mitigation strategies, such as optimized circuit design, component selection, and precise control mechanisms. By focusing on physical construction, this project aims to deliver a robust hardware prototype capable of consistent performance under varying load conditions. The hardware development is particularly relevant for applications in renewable energy systems and portable electronics, where dependable DC to AC conversion is essential. This research aligns with the broader context of smart technology in home applications, where clarity and reliability in power conversion are crucial in smart home technology, and its implications for building research (Darby, 2017).

2. METHOD & MATERIAL

2.1 System Operation

A 12V DC input is transformed into a 220V AC output by the SG3525 PWM inverter. The SG3525 IC initiates the process by generating PWM signals following the specifications set by the external resistors and capacitors. The MOSFETs, which function as high-speed switches to power the transformer, amplify these impulses. For common appliances, the transformer raises the low-voltage AC to 220V AC. The output frequency can be changed between 50 and 60 Hz based on what the linked devices need. Capacitors stabilize the signal, resistors control the current, and the transformer isolates the voltage. These are important components of the operation.

2.2 Block Diagram and Circuit Diagram

Figure 1 shows a block diagram of this project. It indicates a 12V DC input converted to 220V AC, which powers a step-up transformer. With the use of transistors and other components, the inverter swiftly converts DC to AC. After that, the transformer boosts the voltage to 220V by passing AC through it. This voltage serves power source to the connected loads, ensuring optimal operation and functionality. The loads are approximately 300W.

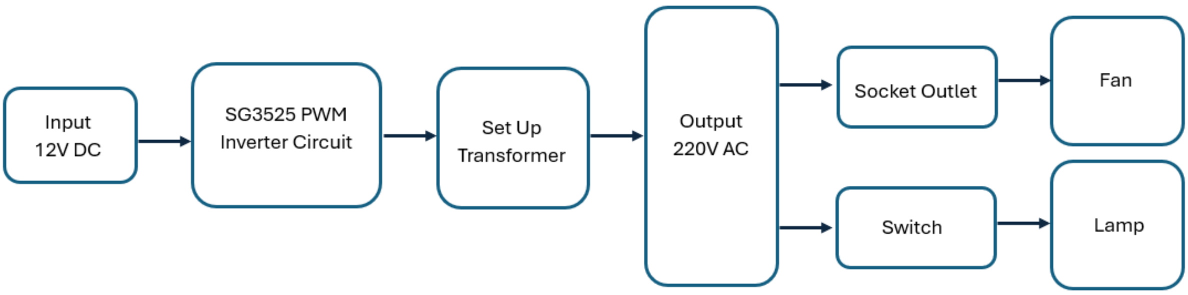


Figure 1. Block Diagram

2.3 Software and Hardware Development

Proteus is a software application that is highly valued and frequently used in the design and testing of electrical circuits. It allows for the virtual simulation and testing of the SG3525 PWM inverter circuit, which is intended to convert a 12V DC input into a 220V AC output at almost 300W at a frequency of 50Hz. The fundamental part of producing PWM signals and regulating the inverter circuit's duty cycle is the SG3525 PWM controller IC. A transformer raises the voltage to 220V AC, while MOSFETs are utilized to switch the 12V DC input. For stability and control, resistors and capacitors are used, and a variable resistor enables the modification of parameters. In addition, the main power supply is a 12V lithium-ion battery. For testing, output loads like fans and LED lights can be incorporated. Figure 2 shows the circuit diagram using Proteus.

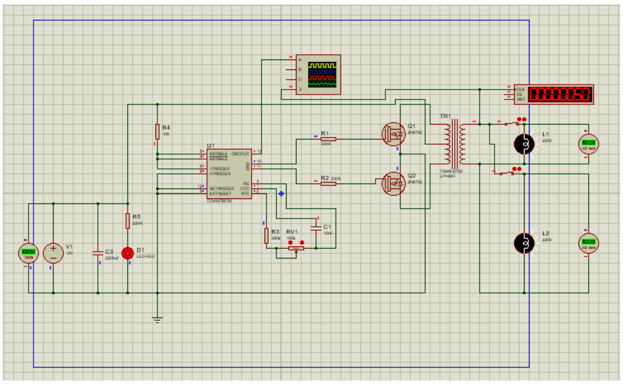


Figure 2. Circuit Diagram Using Proteus.

The SG3525 PWM inverter circuit's hardware implementation entails putting together essential parts such as the SG3525 PWM controller IC, MOSFET, a transformer, capacitors, resistors, and a 12V DC power supply. To guarantee proper operation, the circuit is first designed and simulated before being assembled on a PCB or breadboard. The SG3525 IC is attached to a battery that provides a 12V DC input. The MOSFETs are driven by the PWM signals produced by the SG3525, and they then switch the transformer to increase the voltage to 220V AC. The MOSFETs, resistors, and capacitors are connected correctly to stabilize the circuit. A multimeter and oscilloscope are then used to examine the output for voltage, frequency, and waveform quality. To evaluate the inverter's efficiency, voltage stability, and waveform integrity, performance is tested both with and without load. Figure 3 shows the hardware implementation.

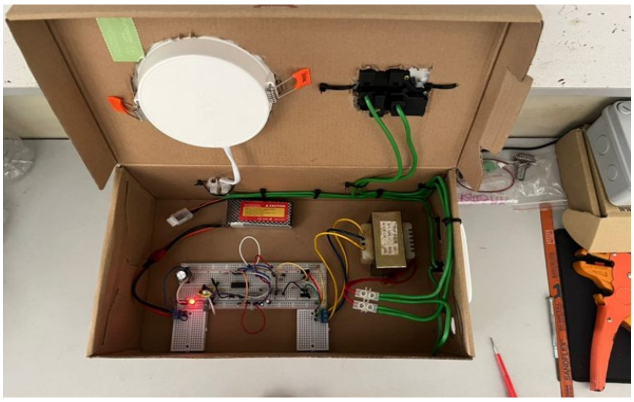


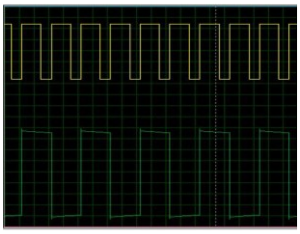
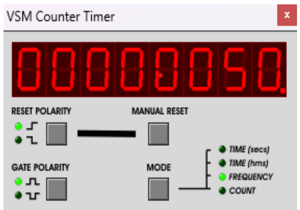
Figure 3. Hardware Implementation.

3. FINDINGS

3.1 Simulation Results

The SG3525 PWM inverter circuit simulation offers important insights into its operation and performance. It shows how the circuit converts a low voltage 12V DC into a higher voltage 220V AC, generating approximately 300W of load wattage at a frequency of 50Hz. This circuit is an essential component as it produces steady square wave signals that regulate the switching of MOSFETs and IGBTs, among other components. The efficiency, stability, and conformance of the circuit to the intended specifications can be evaluated utilizing waveform analysis and parameter evaluation. Indirectly, the simulation would enhance the design for the hardware construction circuit. **Table 1** shows simulation test results.

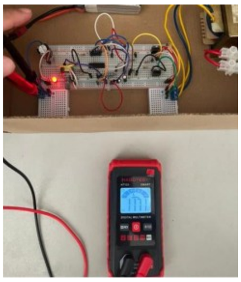
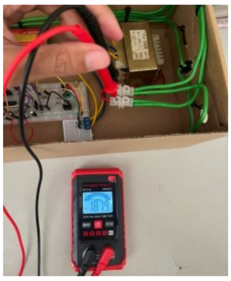
Table 1. Simulation Results

Input DC Voltage (V)	Output AC Voltage (V)	Output Waveform	Frequency Display
12	220		

3.2 Hardware Results

To assess the SG3525 PWM inverter circuit's functionality in practical situations, it was put through load testing. The transformer, SG3525 IC, MOSFETs, and 12V battery were all checked for correct connections. Up to 300W loads, including fans or LED lights, were connected to the inverter's output. Using a 50W transformer, the circuit generated 200V AC at 50Hz. By monitoring the load current and comparing the output power to the input power, efficiency was evaluated. To get the desired 220V AC output, a 60W transformer must be used in its place. **Table 2** shows hardware test results.

Table 2. Hardware Results

Input DC Voltage (V)	Output AC Voltage (V)	LED ON, Fan ON
11.71 	187.9 	

4. DISCUSSION

The SG3525 PWM inverter circuit is an essential component of power electronics, converting 12V DC to 220V AC at 300W and a frequency of 50Hz. Its design, performance analysis, and future improvements provide important insights. Important factors include careful component selection, circuit topology, and control strategies to ensure efficient and reliable power conversion. Studies on voltage regulation, efficiency, and waveform quality demonstrate its effectiveness, particularly in applications such as renewable energy systems and UPS. Future developments concentrate on increasing efficiency, integrating cutting-edge control algorithms, and reducing size, which could expand its use in grid-tied inverters, microgrids, and electric vehicles. All things considered, the SG3525 PWM inverter circuit is well-positioned to influence the direction of energy conversion and utilization in the future.

5. CONCLUSION

Designing and implementing an SG3525 PWM inverter at 50Hz and the ability to convert 12V DC to 220V AC was the main goal of this project. The project effectively illustrated the circuit's capacity to generate steady voltage and dependable functioning across a range of load circumstances through careful component selection, modelling, and hardware testing. Achieving an output that is nearly in line with the intended requirements is one of the major accomplishments; however, modifications such as swapping out the 50W transformer for a 60W type were noted for more optimization. This study provided insightful information on real-world DC-to-AC conversion issues and emphasized the significance of hardware accuracy and efficiency in inverter design. In summary, this project advances power electronics, especially for uses such as portable power solutions and renewable energy systems. The SG3525 PWM inverter circuit has the potential to be more versatile and perform better in a range of applications with suggested future improvements in heat management, waveform optimization, and component efficiency

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