



Application of the EGS002 Module for a Single-Phase Inverter Circuit

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ARTICLE INFO	ABSTRACT
Published Online: 30 August 2025	This paper details the design and implementation of a single-phase inverter circuit utilizing the EGS002 module, engineered for effective control of low-power loads under typical Vietnamese operating conditions. The inverter's architecture is based on the H-bridge driving circuit, a configuration recognized for its efficiency and superior output signal quality. To ensure precise and flexible control, the sinusoidal pulse-width modulation (SPWM) technique was employed, with SPWM signals directly generated by the EGS002 module to drive the four power MOSFETs. The EGS002 module, incorporating the EG8010 microcontroller, IR2113S, and LM393, serves as the core in generating a pure digital sine wave with built-in dead-time control, thereby minimizing harmonic distortion and ensuring stable operation. Experimental validation was conducted using an inductive load, specifically a fan motor, to assess the inverter's performance under realistic conditions. The experimental results confirm that the single-phase inverter circuit operates stably, safely, and reliably, even under load conditions. The measured output signal consistently exhibits a pure sine waveform with a frequency of 50 Hz and an RMS voltage of 220 VAC, meeting the required standards for domestic electrical applications in Vietnam. Furthermore, the circuit incorporates over-current, over-voltage, under-voltage, and over-heat protection mechanisms, enhancing system reliability and longevity.
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KEYWORDS: inverter, EGS002 module, H-bridge, sinusoidal voltage, power electronics	

I. INTRODUCTION

In the present epoch, characterized by rapid advancements in power semiconductor manufacturing technologies, the emergence of sophisticated power conversion apparatus has become an indispensable trend [1]. Such devices play a pivotal role in optimizing electrical energy utilization, addressing the increasingly diverse requirements of various loads by modulating the supplied frequency [2]. Consequently, inverter circuits have evolved into an integral component across numerous industrial and domestic domains.

Inverters find extensive application within critical systems such as uninterruptible power supplies (UPS), alternating current motor drive systems, power regulation and stabilization solutions, renewable energy systems drawing from solar and wind resources, and even pioneering applications in electric aircraft, electromobility, and efficient long-distance high-voltage DC power transmission [3]. Among these, the single-phase inverter stands out as a prevalent and dependable solution [4].

A single-phase inverter is an electronic device designed to transform an incoming direct current (DC) source into a single-phase alternating current (AC) output, featuring

standardized voltage and frequency parameters [5]. Hence, they are frequently termed DC-AC converters. Fundamentally, single-phase inverters are categorized into two primary forms: single-phase half-bridge inverters and single-phase full-bridge inverters. The latter, often referred to as the H-bridge driving circuit, offers a multitude of compelling advantages. Specifically, they are well-suited for high input voltage scenarios, exhibit reduced oscillating circuit voltages, deliver significantly higher energy efficiency, inherently possess a circuit current rating equivalent to the load current, and yield a superior output signal quality [6].

Within the H-bridge inverter topology, electronic switches—typically MOSFETs or IGBTs—operate in synchronized pairs, alternating their conduction states to produce an alternating current waveform [7]. More precisely, during the initial half-cycle of the output waveform, two diagonally opposed switches (e.g., S1 and S3) are rendered conductive, allowing current to flow in one direction through the load. Subsequently, in the second half-cycle, the remaining two switches (e.g., S2 and S4) are activated to reverse the current direction across the load (Figure 1). This sequential switching action generates an alternating voltage

with a variable frequency, contingent upon the frequency of the waveform governing the switching devices [8].

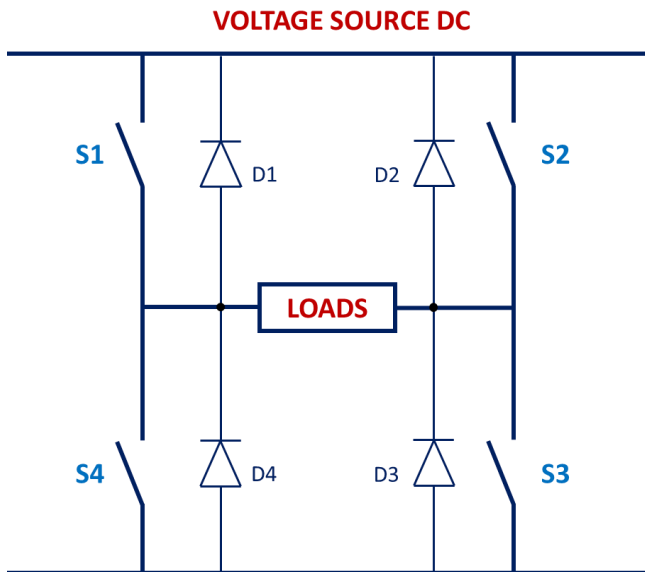


Figure 1: The single-phase inverter circuit model uses an H-bridge driver circuit

To attain a pure sinusoidal output signal, the sinusoidal pulse-width modulation (SPWM) method is widely adopted. This technique necessitates the generation of control pulses of varying widths, proportional to the instantaneous value of the desired sine wave. The precise and dependable generation of SPWM pulses is paramount for mitigating harmonic distortion and achieving high performance [6], [7], [9].

While single-phase inverters have undergone extensive research and development, the task of optimizing their design and selecting appropriate control modules remains a challenge, particularly in meeting specific regional requirements concerning voltage, frequency, and load conditions [4]. Presently, the market offers a diverse array of SPWM control modules, but the judicious selection of a module that integrates all essential functionalities, notably protection capabilities and the capacity for pure sine wave generation, is crucial to ensuring the inverter circuit's stability and operational integrity [9].

In this scholarly endeavor, our focus lies in the design and practical implementation of a single-phase inverter circuit utilizing the EGS002 module for driving low-power loads. The EGS002 module was chosen for its inherent ability to generate pure SPWM waveforms, its integrated dead-time control features, and its provision of necessary protective functions, thereby simplifying the design process and enhancing system reliability [10]. The inverter circuit's parameters have been specifically calibrated to align with Vietnamese operational standards, encompassing a 220 VAC output voltage and a 50 Hz frequency. We shall delineate the circuit's architecture, the operational principles of the EGS002 module, and the simulation and experimental results that collectively substantiate the proposed inverter circuit's stable, safe, and efficient performance with an inductive load. This

investigation not only contributes to the efficacious application of the EGS002 module but also provides a practical solution for low-power single-phase inverter applications [5], [10].

II. METHODOLOGY

To ensure a smooth and secure transition between the semiconductor switch pairs within the single-phase inverter circuit configuration, the selection of an appropriate control module is paramount. In this investigation, we designated the EGS002 module as the central control unit (Figure 2). This module is notable for its high integration level and robust features supporting the construction of pure sine wave inverters. The intrinsic constituents of the EGS002 module comprise the EG8010 microcontroller, the IR2113S gate driver, and the LM393 comparator. The primary function of the EGS002 module is to generate a pure digital sine wave signal, suitable for both two-stage DC-DC-AC conversion architectures or direct DC-AC transformation. To guarantee precision and minimize harmonic distortion, this module employs an external 12 MHz crystal oscillator, facilitating the generation of a stable 50 Hz sine waveform.

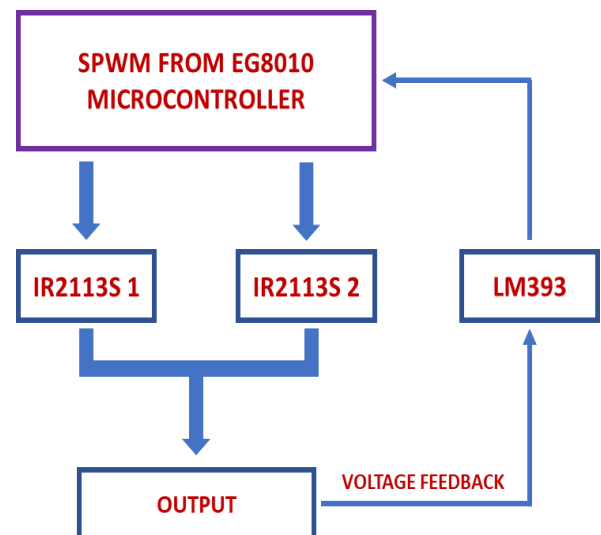


Figure 2: The components of the EGS002 module

The EG8010 microcontroller is an application-specific integrated circuit (ASIC) engineered explicitly for pure sine wave inverter applications. A key distinguishing feature of the EG8010 is its integrated dead-time control capability. Dead time refers to a brief interval during which both switches of a half-bridge branch are non-conductive, serving to avert shoot-through events that could arise if one switch activates before the other fully deactivates. Precise dead-time management is critically important for ensuring the inverter's safety and operational efficiency. The EG8010 leverages advanced CMOS technology in conjunction with a sinusoidal pulse-width modulation (SPWM) circuit to govern dead time, thereby delivering high accuracy and dependable operation.

Furthermore, the judicious selection of high-power MOSFETs is imperative to ensure reliable inverter circuit

operation under varied load conditions. The EGS002 module, when integrated into the inverter circuit, also provides comprehensive protection functionalities, including over-current, over-voltage, under-voltage, and over-temperature safeguards. These protective features are essential for component preservation and extending the system's operational lifespan.

The desired output characteristic of the inverter circuit is a standard sinusoidal signal, derived from the DC input voltage source through the sinusoidal pulse-width modulation (SPWM) technique. SPWM represents an effective methodology for inverter control, wherein the widths of the control pulses are adjusted in accordance with a sinusoidal law. This technique is considered an advanced variation of conventional pulse-width modulation (PWM). The output signal achieved via SPWM offers numerous advantages: a pure sinusoidal waveform, high smoothness with significantly reduced harmonic distortion, lower power losses, effective heat dissipation, and, crucially, the adaptable adjustment of both output frequency and amplitude.

To ensure the continuous and efficient switching operation of the electronic switches within the inverter circuit, a high-safety, high-performance gate driver component is indispensable. In this system, the IR2113S integrated circuit assumes this role. The IR2113S is a specialized gate driver IC for power devices such as MOSFETs and IGBTs, capable of handling high voltages and currents while providing rapid and accurate switching control.

Circuit protection during the inverter's operation is a fundamental requirement to prevent damage from adverse conditions. The LM393 integrated circuit, a dual voltage comparator, is employed to manage voltage and current feedback signals originating from the load. These signals are subsequently transmitted to the EG8010 microcontroller for processing and to trigger protection mechanisms as needed.

Based on the chosen principles and components, a single-phase inverter circuit model employing the EGS002 module was proposed and depicted (Figure 3). In this model, the main power stage of the inverter circuit is an H-bridge driving circuit, constructed from four N-channel IRF3205 MOSFETs. The SPWM signals, generated by the EG8010 microcontroller, are responsible for controlling these MOSFETs. Specifically, within the EGS002 module, the EG8010 produces two pairs of SPWM signals (PWM1 and PWM2) which are fed to two separate IR2113S ICs. Each IR2113S IC then drives one pair of MOSFETs (one top-side and one bottom-side MOSFET of the H-bridge), ensuring fast and efficient commutation. Following the H-bridge, a transformer is utilized to step up the output voltage to 220 VAC at a 50 Hz frequency, providing a stable AC power source for the load. Throughout operation, the inverter circuit's output parameters are continuously monitored and regulated based on the voltage feedback signals received from the load side.

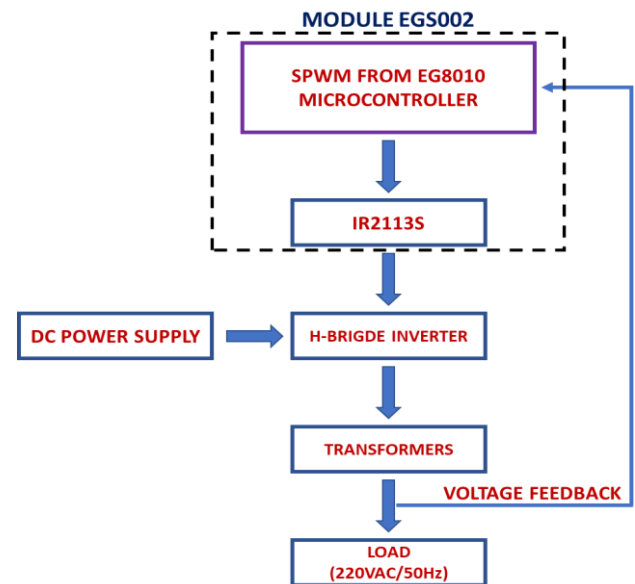


Figure 3: The single-phase inverter circuit model uses the EGS002 module

Following the finalization of the design model in the Altium Designer software, we proceeded to fabricate the printed circuit board (PCB) and generate a 3D rendition of the single-phase inverter circuit. This process allowed for a thorough examination of the component layout's logical arrangement and enabled the optimization of signal traces, contributing to a compact design and efficient heat dissipation (Figure 4, 5).

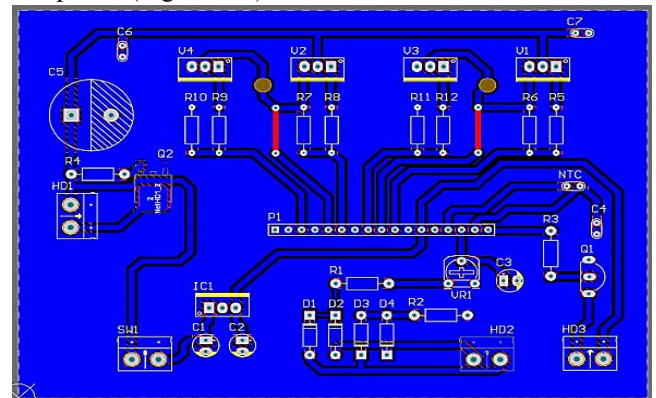


Figure 4: The Printed Circuit Board of the single-phase inverter circuit

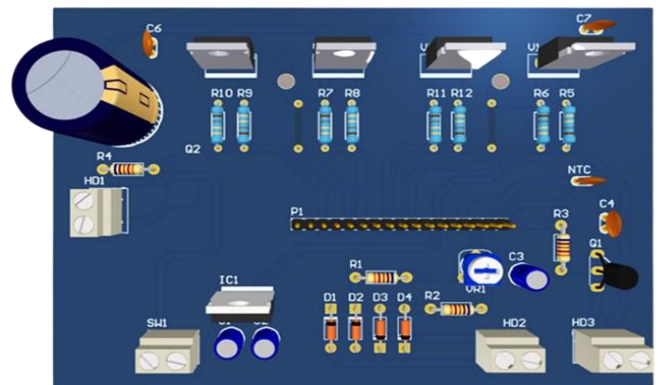


Figure 5: The 3D model of the single-phase inverter circuit

III. RESULTS

1. Simulation Results

To corroborate the design's accuracy and effectiveness, a single-phase inverter circuit model was constructed and simulated within the Matlab/Simulink environment (Figure 6). The parameters utilized in the simulation were predicated on the actual component values to ensure practical relevance. The power supply for the H-bridge circuit is a stable DC voltage source. In this simulation scenario, the load is modeled as a purely resistive element with a value of 100 ohms. Additionally, an LC filter (inductor and capacitor) is incorporated at the output to suppress higher-order harmonic components, aiding the output signal in achieving a pure sinusoidal waveform. During the simulation, the RMS voltage of the inverter was observed to maintain a stable 220 VAC, with a load current of 2.2 A. These parameters were also displayed directly on the simulation interface, allowing for convenient monitoring.

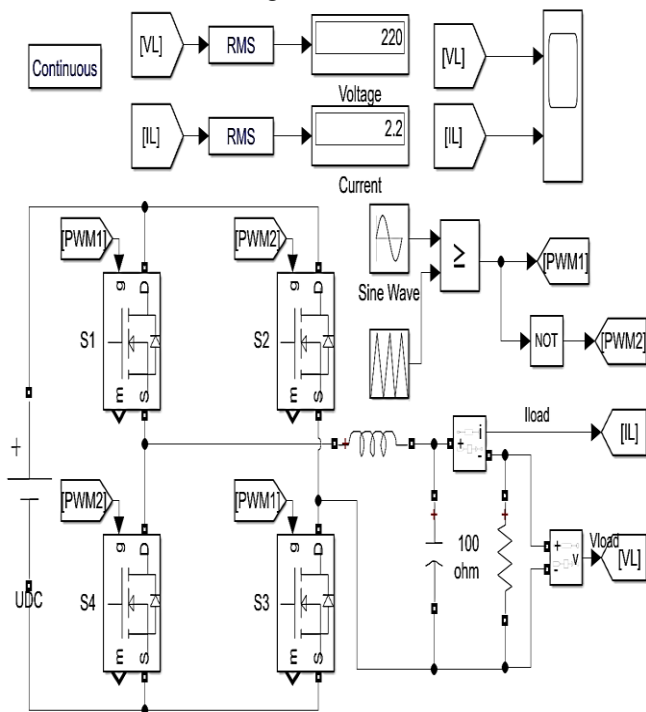


Figure 6: The simulation of the single-phase inverter circuit model

More specifically regarding control, four N-channel MOSFETs were employed. Two MOSFETs, S1 and S3, receive the PWM1 control signal from the EGS002 module, while the other two MOSFETs, S2 and S4, receive the PWM2 control signal. These PWM signals are engineered to switch the MOSFET pairs on and off in an alternating and controlled manner, thereby generating the alternating current waveform. The PWM1 and PWM2 signals are derived by comparing a standard sinusoidal signal (the modulating signal) with a high-frequency carrier signal (typically a triangular or sawtooth wave). In the simulation, the carrier signal was chosen as triangular pulses with a frequency of 10 kHz, a

frequency sufficiently high to produce smooth PWM pulses and minimize harmonic distortion (Figure 7).

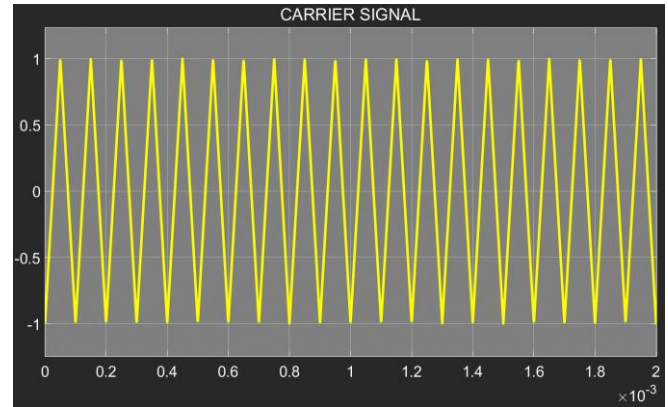


Figure 7: The simulation of the single-phase inverter circuit model

The simulation outcomes demonstrate that the voltage signal (VL) and current signal (IL) at the output exhibit a pure sinusoidal waveform (Figure 8). These signals were observed and recorded using a virtual oscilloscope within the simulation environment. Specifically, the peak voltage (VL) reached a value of 311 VAC, corresponding to an RMS voltage of 220 VAC. The peak current (IL) was 3.11 A, and the period of the output waveform was 0.02 seconds, corresponding to the standard frequency of 50 Hz. These simulation results provide a crucial foundation for proceeding with the construction and testing of the actual circuit, ensuring that theoretical design is viable and achieves the desired parameters.

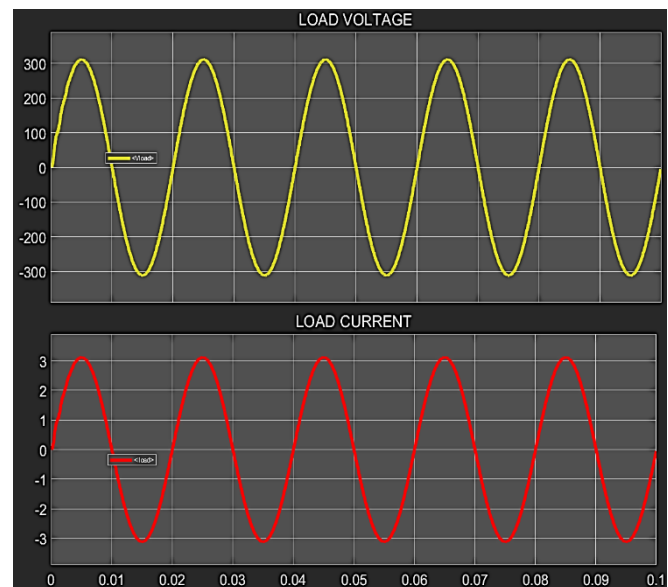


Figure 8: The output voltage and current signals of the inverter circuit model

In summary, the methodology section has elucidated in detail everything from the selection of the primary component, the EGS002 module, and an explanation of the operating principles of its internal constituents, to the construction and simulation of the complete single-phase

inverter circuit. These steps were executed meticulously to ensure that the inverter circuit not only functions efficiently but also remain safe and reliable, providing a pure sinusoidal AC source for low-power loads.

2. Experimental Results

To evaluate the circuit's performance under authentic operating conditions, we established an experimental setup. Rather than employing a purely resistive load as in the simulation, we opted for an inductive load, specifically a fan motor. The decision to use an inductive load was a crucial step to enhance the research's accuracy and practical relevance, as many common household electrical appliances possess inductive properties. The outcomes from testing with this type of load provide a more genuine reflection of the inverter circuit's capabilities when operating in a real-world environment.

During the no-load test, the single-phase inverter circuit was powered on. The voltage measured at the output using a VOM meter was a stable 220 VAC. This result confirms the precise functionality of the control circuit and transformer in producing the desired AC voltage when no current is being drawn. Upon connecting and operating the fan motor, the inverter circuit consistently maintained a stable output voltage of 220 VAC and delivered a pure sine wave signal. Despite the connected load, the circuit did not experience any significant voltage drop and successfully preserved the quality of the output signal as predicted by the simulation. The output waveform, when displayed on an oscilloscope, validated that the circuit performed exactly as designed, providing a clean power source at a frequency of 50 Hz (Figure 9). This outcome highlights the inverter's robust capacity to handle inductive loads effectively, which is particularly vital for applications like fans, pumps, or other small motors.

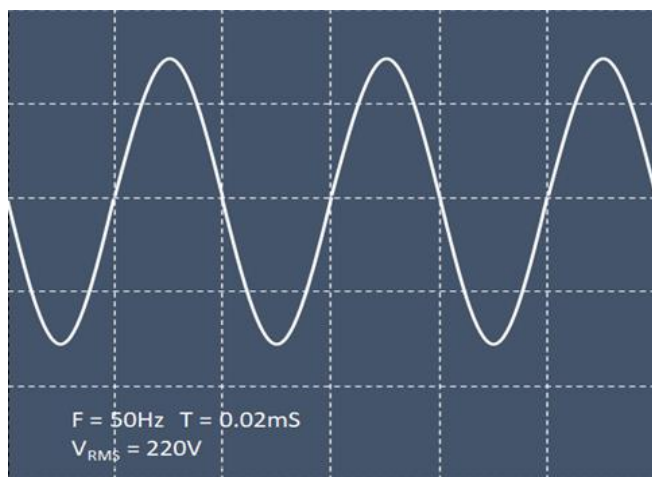


Figure 9: The single-phase inverter circuit outputs a standard sine wave signal

In conclusion, the experimental findings conclusively demonstrate that the single-phase inverter circuit utilizing the EGS002 module operates in a stable, safe, and reliable manner. The circuit provides a pure sinusoidal output with a

220 VAC RMS voltage and a 50 Hz frequency, aligning with the electrical usage standards in Vietnam. The successful verification with an inductive load underscores the high practical utility of this design for real-world electrical systems.

V. CONCLUSIONS

This paper has provided a comprehensive account of the model and empirical results of a single-phase inverter circuit that utilizes the EGS002 module, aiming to provide a viable solution for low-power loads. The findings of this study demonstrate that the proposed design fully satisfies the standard operational criteria in Vietnam, which includes supplying a stable output with an RMS voltage of 220 VAC and a frequency of 50 Hz. The EGS002 module was shown to be an effective control hub, simplifying the circuit design process while delivering high-quality sinusoidal pulse-width modulation (SPWM) signals to the H-bridge driving circuit. The role of the transformer in stepping up the output voltage to the standard usage level was also validated. Crucially, both the output voltage and frequency remained stable, irrespective of the load conditions.

In summation, the single-phase inverter circuit employing this H-bridge configuration exhibited reliable performance and fully met user requirements, proving its feasibility and efficacy in practical applications. Future research could concentrate on enhancing the circuit's efficiency for higher power loads or integrating smart features for remote monitoring and control.

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