DOI: 10.36108/ujees/5202.70.0111
UNIOSUN Journal of Engineering and Environmental Sciences. Vol. 7 No. 1. March. 2025

Implementation and Construction of a 1 Kva Inverter Using C++ Programming Language

Olatona, G. I., Babawale, P., Oyedokun, M. S., Adisa, A. S.

Abstract The increasing demand for reliable and efficient power conversion systems has led to significant research in inverter technology. However, many existing inverter systems lack optimized control mechanisms and efficient energy conversion, leading to power losses and reduced performance. This study addresses these challenges by implementing and constructing a 1kVA inverter using C++ programming for enhanced control and efficiency. The system is implemented using an Arduino Nano and supporting circuitry, programmed to effectively manage power conversion from a 12V DC source to a stable 220V AC output. The inverter supports loads up to 560W and features a low-battery alert system for improved energy management. Experimental results demonstrate its capability to reliable power for household and small-scale applications. Future improvements may include enhanced MOSFET configurations and advanced battery management for greater efficiency.

Keywords: Inverter, Power Conversion, Renewable Energy, Arduino, C++ Programming, Energy Efficiency

I. Introduction

Majority of the people who employ electronic appliances in their daily activities are aware, from their personal experiences, that the electrical power supply from the mains supply is epileptic. Significant electrical power supply outages, which are frequent after strong winds at the start of a severe storm, occur all over the world. Due to this power loss, appliances like refrigerators, television sets, and light bulbs cannot be operated. Also possible, is a rise in the frequency of power supply disruptions. Therefore, voltage spikes and short voltage dips are normal. These power supply interruptions can negatively affect the functionality of delicate equipment in private and business organizations, leading to a significant loss of data and perhaps damage to equipment.

Olatona, G. I., Babawale, P., Oyedokun, M. S., Adisa, A. S.
(Department of Physics, Osun State University, P.M.B. 4494, Osogbo, Osun State University.)

Corresponding Author: olatonagi@uniosun.edu.ng
Phone: +2348062181787

According to [1] recommendations, the supplies should be "continuous, uninterrupted, with constant frequency, and within the load demand in terms of voltage and current". Due to the high sensitivity and sophistication of the technological devices currently in use, there is the need to mitigate power outages and subpar power supplies, which are commonplace in Nigeria nowadays. Contributing variables to incessant power outages in Nigeria include natural calamities, vandalization of equipment and cables, insufficient sustainability and maintenance, a lack of local substance, lack of political will to invest sufficiently in the energy sector, lack of alternative policies leading to obsolete equipment, unsustainable human capacity development and inadequate reward and treatment systems to motivate human resources to perform well. [2] opined that the reliance of the maize shellers on epileptic mains supply should drastically reduce coupled with the reduction in cost of production.

In recent years, microcontroller-based inverter systems have gained attention for their efficiency in converting DC power to stable AC output. Some electronic devices run by square wave inverters will damage due to harmonic contents [3]. However, [4] highlighted the advantages of Arduino-based inverters, noting that their programmable flexibility enhances energy conversion efficiency and remote-control capabilities. Similarly, [5] emphasized that MOSFET-based inverter designs significantly reduce switching losses, making them ideal for small-scale renewable energy applications.

Beyond efficiency improvements, modern inverter systems must also ensure power stability for sensitive loads. [6] explored how stabilized voltage-source inverters can maintain consistent AC output, which is crucial for powering delicate electronic devices. As energy independence becomes a global priority, advances in inverter technology continue to provide viable alternatives to fossil fuel-dependent power sources.

This study focuses on the implementation and construction of a 1 kVA inverter programmed using C++ to optimize energy management and efficiency. The system is built around an Arduino Nano microcontroller, programmed to regulate power conversion from a 12V DC source to a stable 220V AC output. By leveraging digital control, this design enhances inverter performance, reduces power losses, and incorporates an intelligent low-battery alert system.

Energy independence (a system using energy sources other than fossil fuels) is not only feasible, but also very practical, according to recent advancements in the development of alternative energy sources. Today, a large range of equipment meant for production is accessible to enable people to utilize any renewable energy source. However, majority of these systems are created for a number of reasons.

[7] constructed and implemented a 1kVA inverter. The construction was separated into four units namely an oscillator, MOSFET assembly, transformer and battery charging monitor. Each constructed unit underwent independent testing to ensure adequate functionality before the composite coupling. Year in, year out, technology keeps advancing. [8] has developed a microcontroller-based solar inverter.

[9] designed 1 kVA inverter using "Proteus" to simulate Arduino Uno microcontroller. He used a systematic approach to designing different sections involving transistorized switches and MOSFETs. The writing of the Arduino code was achieved with Write() and delay Microseconds() functions in the integrated development environment (IDE) to generate the control waveform. The circuit was based on two square waves that are out-of-phase, generated using Arduino Uno microcontroller. A 12V-0-12V transformer with a center-tapped output in a boost configuration acts as a load for the MOSFET stage. The simulation uses Proteus ISIS code written on the Arduino integrated development environment and compiler. The paper also showed how to use an Arduino Uno microcontroller to create a sine wave modified inverter and how the use of Fourier transform allows to determine the off-time to remove the 3rd harmonic more clearly.

[10] designed and fabricated a 1 kVA inverter using pulse width modulation. In the study, the circuit plan and fabrication of a 1 kVA-inverter was carried out using pulse width modulation.

The implementation steps included an oscillator, switch, inverter transformer, battery charger, power supply, and switch. To further improve the inverter world, they simulated and designed an inverter with single-phase and digital pulse width modulation (PWM) output from an Arduino board.

The objective was to use an Arduino board to facilitate the achievement of pulse width modulation (PWM) on a single-phase inverter, replacing the analog circuit. In addition, the entire design was modeled in Proteus software and the output results were verified in practice. In their design and fabrication of a 12 V DC to 230 V AC inverter, [11] created a 12 V direct current from a 230 V alternating current inverter having a frequency of 50 Hz. While [12] designed and fabricated a 0.75 kVA inverter system with an overload control mechanism for domestic use in Nigeria. It focused on solving the problem of power supply to homes and offices. Their work aimed at implementing and constructing an automatic operation of an inverter system, which switches the supply from the mains to the batteries and back again based on the availability of a power source.

This study focuses on implementing an inverter with single-phase with high energy efficiency and low production cost through the use of a microcontroller. A power inverter, a unique device, which changes the direct current from solar panels' output to an alternating current for household use, was also considered. Pulse width modulation was used to generate specific signals, microcontrollers with efficient energy.

II. Materials and Methods

The Circuit implemented for a 1KVA inverter is shown in Figure 1.

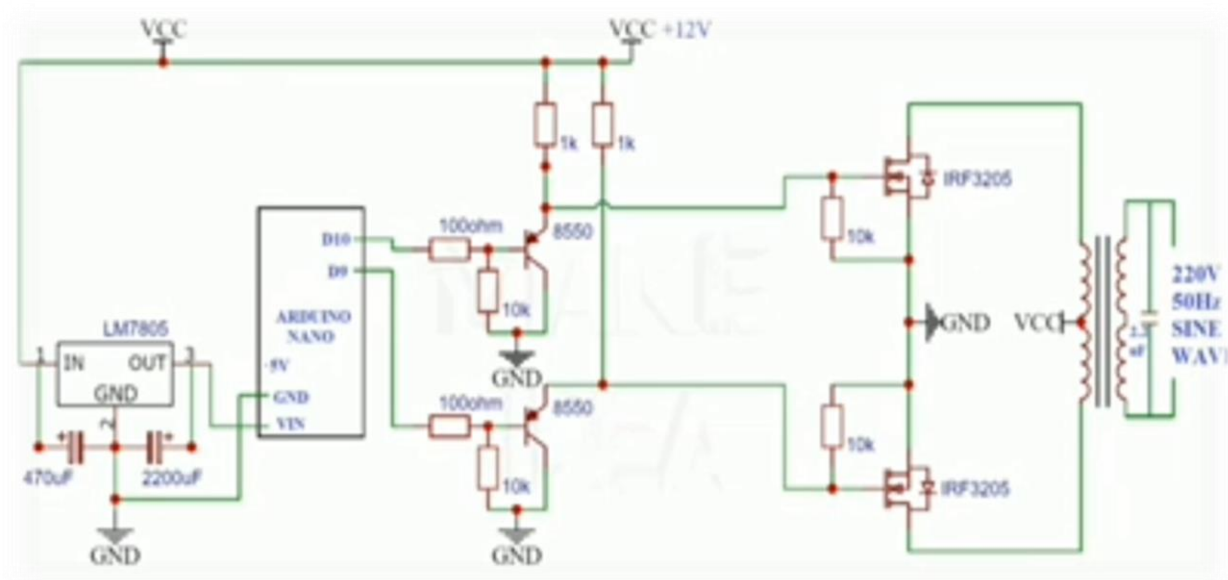

Figure 1: Circuit diagram of the 1 kVA inverter [13]

This construction converts the implemented circuit diagram into a real working electrical device on a Vero board. The circuit operates using a 220V AC, 50Hz input power supply connected to a rectifier circuit to get a 12V DC power module through a relay switch at the inverter output. It bypasses the inverter when power is detected while the battery is charging. The transformer used in this study has a tap in the middle that divides the primary coil into two equal parts. The middle part of 12V-0-12V is connected to the positive terminal of the battery. Both ends of the primary are connected to the drain of the MOSFET. The AC output provides 220V, 50Hz AC current directly from the input when AC power is available or from the inverter circuit acting on the battery when AC power is not available. Alternatively, the solar panel can be used instead of mains power to power the device.

The built-up circuit shows the connection of all the components in Figure 2;

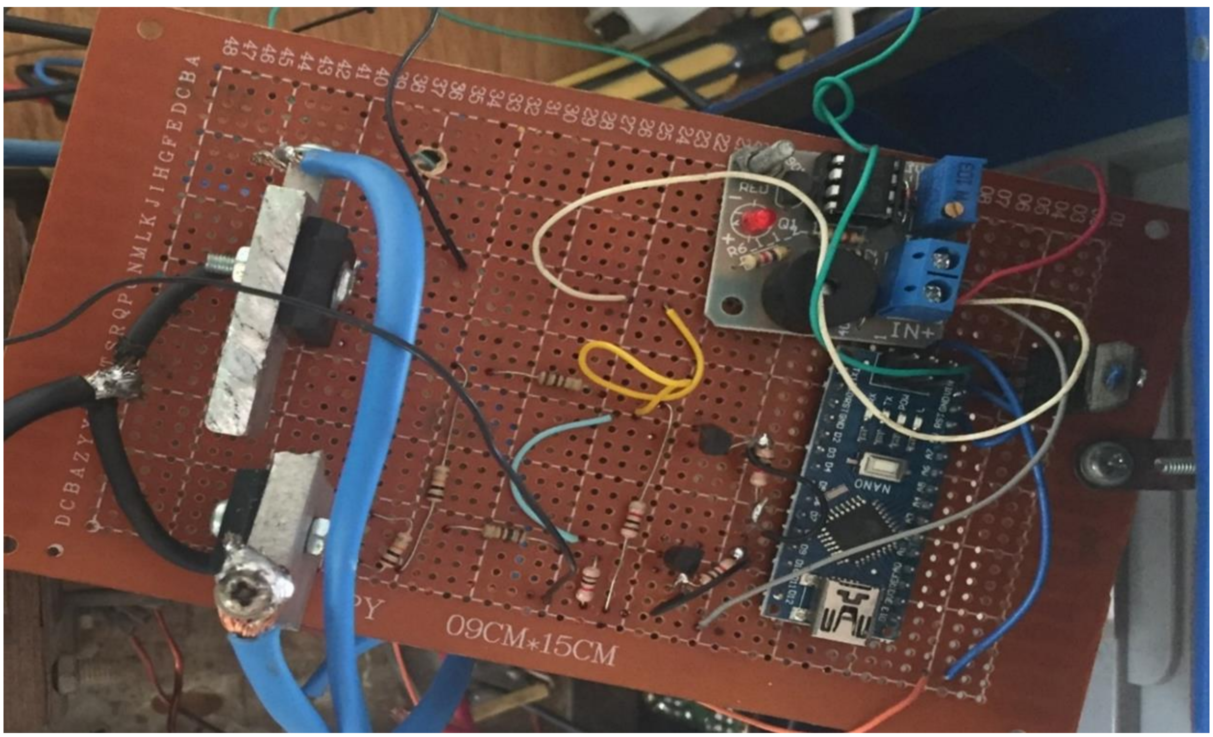

Figure 2: Circuit Board showing the coupling of various components

III. Results and Discussion

Table 1 shows the response of the inverter to progressive load increase from 80 watts to 560 watts with a view to testing its carrying capacity with respect to the power stipulated for it to bear. The device is stable as it progressively increased. When the system is loaded above 560 Watts, the fuse breaks to avoid further damage. The transformer acts as a step-down to obtain the 15V, which is rectified to charge the battery. The Arduino then takes its input from the battery and modulates it by turning it to 15 V

AC. This is then fed to the primary of the transformer, which this time acts as a step-up transformer from where the load takes its input of 240 V AC. The depth of discharge refers to the amount of energy that goes into and out of a battery in a given cycle. It expresses the percentage of the total battery capacity of a given battery.

IV. Conclusion

This study further reinstates the importance of an inverter used to convert a direct current to an alternating current that can be used to power home devices designed to operate on AC, to be powered from DC source and it can be enhanced to have a larger power rating for usage in factories. This will enhance national economic growth and electricity stability. The design of the control circuits in the 1 kVA inverter is optimized for performance. The overload and low battery warning is a control circuit that prevents damage to the inverter system. The system's overall operation involves connecting a variety of sub circuits to produce optimal performance. The oscillator stage, amplification stage, switching stage, step up stage, low battery alarm / overload shutdown circuit, and charging control are some of the sub parts. This study includes a monitoring circuit that notifies the user of the system's status using light-emitting diodes and voltmeter as visual display elements. The construction procedure typically comprises mounting, assembling, and wiring each of the chosen components in the proper location on the vero board.

It is recommended that engineers who develop and operate inverter systems choose this type of inverter system configuration because of its flexibility, dependability, availability, and high stress resistance. Each model has a variety of parts, which makes it easy to find problems and fix them without compromising other parts. Furthermore, it's best to hang the inverter from a piece of wood or a pedestal rather than setting it on the ground because the latter might expose it to water, which could lead to corrosion or damage to some of the parts of the inverter system. Later designs can have digital displays for the output parameters. It can increase its production capacity.

Acknowledgement

The authors acknowledge the contribution of the Arduino open-source platform, which was instrumental in the prototyping and implementation of the electronic components in this study.

References

[1] IEEE Std 1159-2019. IEEE Recommended Practice for Monitoring Electric Power Quality. IEEE Power&EnergySociety.2019. DOI: 10.1109/IEEESTD.209.8796486.

[2] Lawal, M.O., Idris, M.O., Obiyemi, O.O. and Olaoye, S.A. (2020). Construction and performance evaluation of a solar powered maize sheller for rural farmers. *UNIOSUN Journal of Engineering and Environmental Sciences 2*(1). https://doi.org/10.36108/ujees/0202.20.0170

[3] Qazalbash, A. Ali, Awais Amin, Abdul Manan and Mahveen Khalid, "Design and Implementation of Microcontroller based PWM technique for Sine wave Inverter", International Conference on Power engineering, Energy and Electrical Drives, POWERENG '09. 2009 pp.163-167, IEEE.

[4] Hossain, M. A., Islam, M. S., Rahman, M. T., & Rahman, M. A. (2023). Design and Implementation of an Arduino-Based Three-Phase Inverter System. IEEE International Conference on Robotics, Automation, and Signal Processing. Available at: https://ieeexplore.ieee.org/document/10717580

[5] Chowdhury, I., Hossain, S., Das, N. K., Ahmed, T., & Hasan, M. M. (2021). Arduino-Based Three-Phase Inverter Using Power MOSFET for Application in Microgrid Systems. International Journal of Engineering Research and Technology. Available at: https://www.researchgate.net/publication/355479233_Arduino-Based_ThreePhase_Inverter_Using_Power_MOSFET_for_Application_in_Microgrid_Systems

[6] Diab, M. A., El-Sayed, M. A., & Ibrahim, A. M. (2024). Stabilized Voltage Source Inverter for Sensitive Loads in Nuclear Installations. ScientificReports. Available at:https://www.nature.com/articles/s41598-024-65331-7

[7] Osuwa J. C. and C. F. Peter (2014): Construction and Implementation of 1 KVA Inverter. IOSR Journal of Applied Physics (IOSR-JAP). Volume 6, Issue 6 Ver. III (Nov.-Dec. 2014), Pg 56-58

[8] Thukral Ruchika, Ankit Gupta, Nilesh Kumar Verma, Shivanchal Asthama (2016): Microcontroller-based solar power inverter, International Journal of Engineering and Technology Volume 7 (5) Sep-Oct 2016, pp 70-78. http://www.iaeme.com/IJEET/issues.asp?JType=IJEET&VType=5 ISSN Print:0976-6445 and ISNN Online: 0976-6553.

[9] Akinwole, O. Oyewole (2018). Design and Simulation of a 1kVA Arduino Microcontroller Based Modified Sine Wave Inverter Using Proteus. Journal of Electrical & Electronic Systems. J Electr Electron Syst, Vol 7 (4).

[10] Yusuf, S.D, Adamu, I.I., Loko, A.Z. and Lucas, W.L. (2020): Design and Construction of 1KVA Inverter Using Pulse Width Modulator. International Journal of Electronics Engineering Volume 12 (1) pp. 1-12

[11] Quarcoo C. A., B. K. Banini, B. E. Mensah and Henry Obeng. Design and Construction of a 12v DC to 230v AC Power Inverter Article. Merit Research Journal of Engineering, Pure and Applied Sciences Vol.6 pp. 001-004, March 2021

[12] Nwobodo Lois O., Nkemdilim Ifeyinwa Obiokafor, Samuel C. Asogwa, Fidelis C. Obodoeze. (2021) Design and Construction of a 0.75KVA Inverter Power Supply for Nigerian Homes and Offices. International Journal of Trend in Scientific Research and Development (IJTSRD) Volume 5 (2), Pg. 807

[13] Sergey. (2021, November 18). *Инвертор 12-220 В синус на Arduino*. ZS21.RU. Retrieved January 23, 2025, from http://zs21.ru/invertor-12-220-v-sinus-na- arduino/