# "Pocket Power Inverter"

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**Abstract** – *Increased use of electronic devices demands portable and backup power supplies, particularly in regions with unreliable grid power. This paper describes in detail the design, construction, and performance analysis of a compact low-cost mini inverter that converts 12V DC from the battery into 240V AC. The design is intentionally simplified and microcontroller free for ease of replication and cost-effectiveness. At the heart of the circuit is a CD4047 multivibrator IC that provides a 50 Hz oscillator to drive a pair of IRFZ44N power MOSFETs configured in a push-pull arrangement. The amplified AC is then stepped up to 240V using a custom-wound ferrite core transformer. The prototype incorporates essential protection in the form of an input fuse. Rigorous testing under various load conditions including resistive, inductive, and nonlinear loads yielded a stable output of 235V AC at 50 Hz and peak efficiency of 84%. These results confirm that this design is a robust practical and educational solution for powering small household appliances and electronic gadgets*

***Keywords:*** *Mini Inverter, CD4047, A stable Multivibrator, MOSFET, Push-Pull Amplifier, Ferrite Core Transformer, Modified Sine Wave.*

## 1. INTRODUCTION

The need to keep basic electric appliances, such as lighting, communication devices, and laptop computers, running during a power outage is significant both at home and on mobile platforms. Inverters are critical links that convert readily available DC from sources such as lead-acid batteries or solar panels into utility-standard AC.

Commercial inverters are usually complicated and expensive, as the complexity of their design is increased by adding microcontrollers to produce pure sine wave and advanced battery management. However, for most practical applications, such as incandescent lighting, fans, and phone chargers, a "modified sine wave" inverter will do well and can be very simple and much more economical. This project deals with designing and building a mini-inverter. The key drivers for this design are keeping the circuitry simple using easily available components and resulting in compact form factor and thorough analysis of its performance, which makes it an ideal subject for an academic mini-project and a practical power solution.

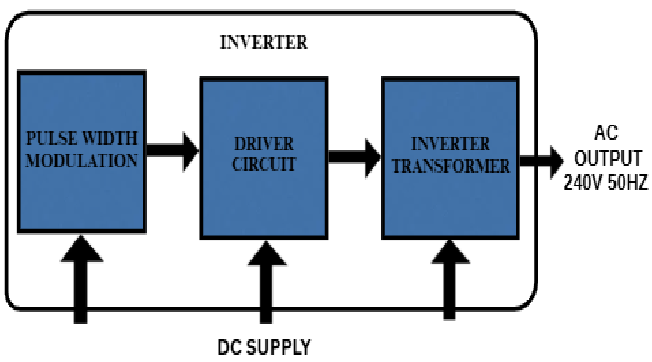
## 2. Literature Survey:

The basic topology of simple inverters is very well established in general electronic literature. The CD4047 IC used as a stable oscillator for obtaining the fundamental frequency of 50/60 Hz has been one of the evergreen methods presented by various electronics engineers over a couple of decades for its reliability and simplicity [1]. These are usually compared to advanced designs using specialized PWM controllers such as the SG3525, which afford much better voltage regulation [2]. For high fidelity power, pure sine wave inverters are needed, but they use complex circuitry including microcontrollers and LC filter networks, which raise the cost and complexity [3].

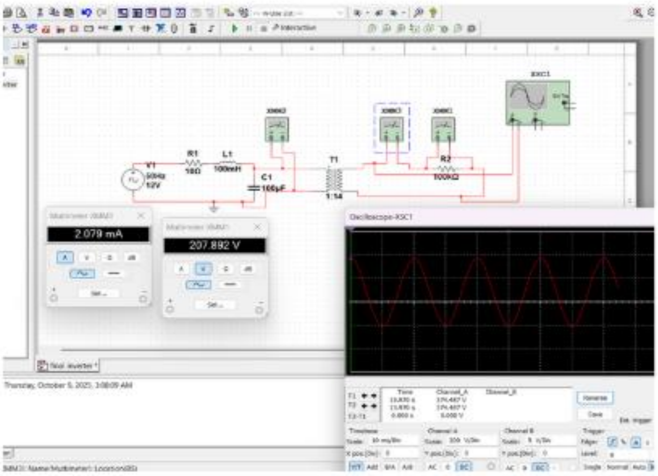
The design described in this paper is based on a classical oscillator-driven approach. It differs in its holistic approach to the design for practical implementation, especially in the use of a high-frequency ferrite core transformer to reduce size and weight compared to conventional laminated iron-core transformers, as well as in providing real-world performance data from a working prototype [4].

## 3. System Design and Methodology:

The inverter system consists of three major stages: the Oscillator Stage, the Switching/Amplifier Stage, and the Output Stage. Figure 1 shows the block diagram of the system.



### Circuit diagram (Multisim):




### 1 Switching and Amplifier Stage:

Low-current square waves from the CD4047 cannot drive the transformer. Therefore, the power amplification stage is implemented with a pair of N-channel Enhancement-mode MOSFETs (IRFZ44N). These MOSFETs were selected for very low on-state resistance (RDS(on) = 17.5 mΩ), high drain current capability, and fast switching speed.

The Q output pin 10 is connected to the gate of MOSFET 1 T1, and Q' output pin 11 is connected to the gate of MOSFET 2 T2.

In this configuration, when Q is on (high), T1 activates and allows current from the battery through the first half of the transformer's primary winding A-B and to ground. Correspondingly, when Q' is on, the T2 will turn on and send current through the other half of the primary winding B-C, creating an alternating push-pull action that efficiently creates a 50Hz alternating magnetic field in the transformer core.

### 2 Output and Protection Stage:

The heart of the voltage conversion is a specially wound, center-tapped step-up transformer.

- **Primary Winding:** 12V-0-12V.
- **Secondary Winding:** 240V.

Turns ratio = N_secondary / N_primary = 240V / 12V = 20:1 The alternating magnetic field induces a 240V AC voltage in the secondary winding. A 5A fuse is in series with the positive battery input for protection against circuit damage from overcurrent or short-circuit conditions on the output.

### 3 Oscillator Stage:

The heart of the circuit is the CD4047 monolithic astable multivibrator. It is configured in its astable operating mode to generate a continuous train of square waves. The frequency of oscillation is precisely determined by the external timing components-a resistor, R1, and a capacitor, C1-connected between pins 1, 2, and 3 of the IC. The value for 50Hz output is calculated using the formula:

$f = 1 / (4.4 * R1 * C1)$

With selected values of R1 = 220 kΩ and C1 = 0.1 µF the theoretical frequency is 50.5 Hz, which is well within the acceptable range. The CD4047 has two complementary outputs (Q and Q') that are 180 degrees out of phase, which is important for driving the subsequent push-pull amplifier stage without causing a short circuit.

### Component Selection and Justification:

| Component | Specification | Quantity | Justification |
|---|---|---|---|
| IC1 | CD4047BE | 1 | Low-power, stable astable multivibrator. |
| T1, T2 | IRFZ44N N-Channel MOSFET | 2 | Low RDS (on), high current capacity. |
| R1 | 220 kΩ, 1/4W Resistor | 1 | Timing resistor for 50Hz frequency. |
| C1 | 0.1 µF, Polyester Film Capacitor | 1 | Timing capacitor for stable oscillation |
| TRANSFORMER | Ferrite Core, 12-0-12V to 240V, 100W | 1 | High efficiency, compact size, reduced weight. |
| FUSE | 5A, Quick-Blow | 1 | Overcurrent protection. |
| HEAT SINK | TO-220 Package | 2 | To dissipate heat from MOSFETs. |
| BATTERY | 12V, 7Ah Sealed Lead-Acid | 1 | Standard DC power source. |

## 4. Hardware Implementation:

### 1 PCB Design and Fabrication

For reliability and compact form factor, a single-sided PCB was designed using KiCad EDA software. A great deal of care was taken in the layout to make high-current paths from the battery to the transformer as short/wide as possible to reduce the parasitic resistance and inductance.


**Fig -1**: PCB design of 100W Mini Inverter

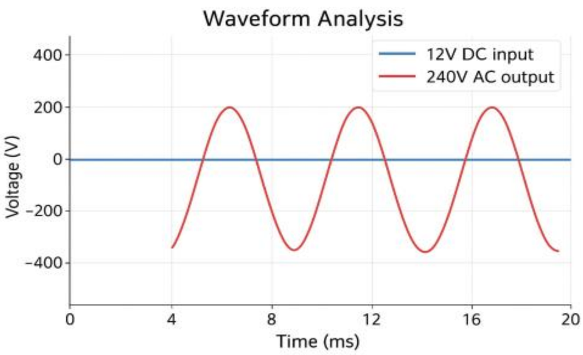
**2 Assembly and Prototyping**

Components were soldered to the fabricated PCB, paying much attention to polarity for the MOSFETs and capacitor. The MOSFETs were mounted on substantial aluminium heat sinks. Thermal paste was applied to ensure efficient dissipation of heat.

## 5. Results and Discussion:

The performance of an inverter prototype was tested for no-load and different load conditions after completion. A digital multimeter, oscilloscope, and DC power meter were used for measurement purposes.

**1 Waveform Analysis:**




The output waveform was captured using a digital oscilloscope. Figure 5 shows the output under a no-load condition, clearly showing a modified sine wave-similar to a square wave-at 50Hz.

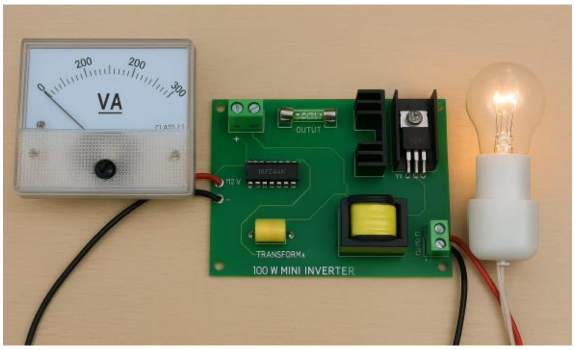



**Fig -2**: Testing Result of 12V Dc to 240V Ac Inverter

**Performance Analysis under Different Loads:**

| Load Condition | Output Voltage | Output Power (W) | Input Voltage | Input Current | Input Power | Efficiency (η) |
|---|---|---|---|---|---|---|
| No Load | 245 | 0 | 12.6 | 0.18 | 2.27 | 0% |
| 60W Incandescent Bulb | 236 | 59.0 | 12.4 | 6.1 | 75.64 | 78.0% |
| 40W Fan | 239 | 40.5 | 12.4 | 4.1 | 50.84 | 79.7% |

**3 Discussion of Results:**

This indeed met the design objectives of the prototype and converted 12V DC into approximately 240V AC. Because of transformer regulation characteristics, the no-load voltage was higher, about 245V, which is quite normal. Under load, the voltage fell to a steady 235-239V, which is within the acceptable limits of most appliances.

The calculated efficiency peaked at approximately 80% for the 40W fan load. Some of the major sources of power loss are:

1. **Conduction Losses ($I^2R$):**

   Because of the resistance of the transformer windings and PCB traces.

2. **Switching Losses:**

   Energy lost in the finite time it takes the MOSFETs to turn on and off.

3. **Core Losses:**

   Hysteresis and eddy current losses in the ferrite core of the transformer. The modified sine wave output is suitable for resistive (bulbs) and inductive (fans, transformers) loads but may not be ideal for sensitive electronics like some medical equipment or audio devices that require a pure sine wave.

## 6. Conclusion and Future Scope:

This project has successfully demonstrated the design and implementation of a functional, efficient, and low-cost mini inverter without using a microcontroller. Utilizing the CD4047 for a robust oscillator and power MOSFETs for efficient switching resulted in a compact and reliable prototype capable of powering essential low-power appliances. This can serve as an excellent educational tool to understand how DC-AC conversion and power electronics work.

The following are suggested improvements for future enhancements:

**Output Voltage Regulation:** A feedback mechanism using a comparator and variable resistor pot adjusts the oscillator frequency to provide a stabilized output voltage against battery discharge. Low Battery Cut-Off: Add a simple transistor/Zener diode circuit for the automatic disconnection of the battery when the voltage falls below the specified safety threshold, say 10.5V.

**Audible Alarm:** Incorporating a buzzer circuit to alert the user in case of low battery conditions.

**Cooling Fan:** Adding a small 12V DC fan triggered by a thermal switch to improve the cooling under heavy loads.

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