IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, May 2025
Impact Factor: 7.67

A 250W–5kW Pure Sine Wave Inverter with SPWM Control: Efficiency Optimization and Harmonic Reduction for Grid-Quality Power Conversion

Ajad Kumar Gautam[1] Gulshan Kumar[2] Dr. Malik Rafi[3]
B. Tech Students, Department of Electrical Engineering[12]
Professor, Department of Electrical Engineering[3]
R. R. Institute of Modern Technology, Lucknow

Abstract: *This paper presents the design, simulation, and implementation of a high-efficiency Pulse Width Modulation (PWM)-based DC/AC power inverter capable of delivering output power ranging from 250W to 5000W with a 220V, 50Hz/60Hz AC output. The inverter converts low-voltage DC power (12V, 24V, or 48V from batteries or solar panels) into stable household/industrial AC power using a two-stage conversion process: a DC-DC boost converter followed by a full-bridge PWM inverter with an LC filter for sine wave shaping.*

The study focuses on minimizing total harmonic distortion (THD < 5%) and maximizing efficiency (>90%) through optimized PWM control techniques. A microcontroller (or dedicated PWM IC) generates high-frequency switching signals, while feedback regulation ensures voltage stability under varying loads. Simulation results (using MATLAB/Simulink) and hardware testing validate the design, demonstrating low distortion, high efficiency, and robust protection against overloads and short circuits. This scalable inverter design is suitable for solar power systems, UPS, and off-grid applications, providing a cost-effective and reliable alternative to conventional square-wave and modified sine-wave inverters. Future improvements may incorporate digital signal processing (DSP) for enhanced dynamic response and wide-bandgap semiconductors (SiC/GaN) for higher efficiency.

Keywords: Pulse Width Modulation

DOI: 10.48175/IJARSCT-26419