

TI Designs 48-V, 10-A, High-Frequency PWM, 3-Phase GaN Inverter Reference Design for High-Speed Motor Drives



Description

Low-voltage, high-speed drives and low-inductance brushless motors require higher inverter switching frequencies in the range of 40 kHz to 100 kHz to minimize losses and torque ripple in the motor. The TIDA-00909 reference design achieves this by using a three-phase inverter with three 60 V, 10-A half-bridge GaN power modules (LMG5200) and uses shunt-based phase-current sensing. Gallium nitride (GaN) transistors can switch much faster than silicon field-effect transistors (FETs) and integrating the GaN FET and driver in the same package reduces parasitic inductances and optimizes switching performance to reduce losses, thus allowing the designer to downsize or eliminate the heatsink. The TIDA-00909 offers a TI BoosterPack™ Plug-in Module with a compatible interface to connect to a C2000™ MCU LaunchPad™ Development Kit for easy performance evaluation.

Resources

TIDA-00909	Design Folder
LMG5200	Product Folder
INA240	Product Folder
REF3333	Product Folder
LM5018	Product Folder
TMP302	Product Folder
TIDA-00913	Design Folder
InstaSPIN™-MOTION LaunchPad™	Tools Folder

Features

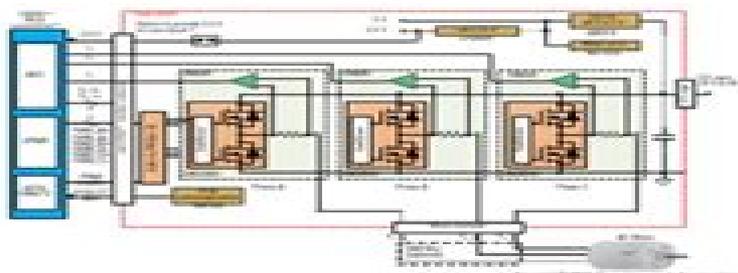
- Three-Phase GaN Inverter With Wide-Input Voltage Range 12 V to 60 V and 7 A_{max} per 10-A Peak Output Current; Tested up to 100-kHz PWM
- GaN Power Stage With Greatly-Reduced Switching Losses Allows High PWM Switching Frequencies With Peak Efficiency up to 98.5% at 100-kHz PWM
- LMG5200 GaN Half-Bridge Power Stage Simplifies PCB Layout and Reduces Parasitic Inductances for Optimized Switching Performance; Less than 2-ns Rise and Fall Time
- Very-Low Switch Node Voltage Overshoot and Undershoot With Very-Low 12.5-ns Deadband Minimizes Phase-Voltage Ringing and reduces Phase-Voltage Distortions and EMI
- Precision Shunt-Based, Phase-Current Sensing With High Accuracy (0.1%)
- TI BoosterPack™ Compatible Interface With 3.3-V I/O for Easy Performance Evaluation With C2000™ MCU LaunchPad™ Development Kit

Applications

- Servo Drives and Motion Control
- Computer Numerical Control (CNC) Drives
- Manufacturing Robots
- Service Robots
- Non-Military Drones



ASK Our E2E Experts



48 V 10 A High Frequency Pwm 3 Phase Gan Inverter

Yijin Wang



48 V 10 A High Frequency Pwm 3 Phase Gan Inverter:

GaN Power Devices for Efficient Power Conversion Alex Lidow, Michael de Rooij, John Glaser, Alejandro Pozo Arribas, Shengke Zhang, Marco Palma, David Reusch, 2024-12-31 An up to date and concise review of GaN transistor design and applications In the newly revised fourth edition of *GaN Power Devices for Efficient Power Conversion* a team of distinguished researchers and practicing engineers deliver a concise and effective new guide to designing small energy efficient and inexpensive products with GaN transistors This new edition covers all relevant new GaN technology advancements allowing students and practicing engineers to get and stay ahead of the curve with GaN device and circuit technology You ll explore applications including DC to DC converters solar inverters motor drive controllers satellite electronics and LiDAR devices The 4th edition offers critical updates for space applications vertical GaN and driving transistors and integrated circuits New chapters on reliability testing advancements device wear out mechanisms thermal management and the latest developments in monolithic integration round out the book Readers will also find The latest updates on significant technology improvements like integrated circuits reliability studies and new applications Comprehensive explorations of integrated circuit construction characteristics reliability results and applications Practical discussions of specific circuit designs layout and thermal dissipation when designing power conversion systems Chapters written by practicing expert leaders in the power semiconductor field and industry pioneers Perfect for practicing power conversion engineers *GaN Power Devices for Efficient Power Conversion* will also benefit electrical engineering students and device scientists in the field of power electronics

Soft-Switching Technology for Three-phase Power Electronics Converters Dehong Xu, Rui Li, Ning He, Jinyi Deng, Yuying Wu, 2021-12-29 *Soft Switching Technology for Three phase Power Electronics Converters* Discover foundational and advanced topics in soft switching technology including ZVS three phase conversion In *Soft Switching Technology for Three phase Power Electronics Converters* an expert team of researchers delivers a comprehensive exploration of soft switching three phase converters for applications including renewable energy and distribution power systems AC power sources UPS motor drives battery chargers and more The authors begin with an introduction to the fundamentals of the technology providing the basic knowledge necessary for readers to understand the following articles The book goes on to discuss three phase rectifiers and three phase grid inverters It offers prototypes and experiments of each type of technology Finally the authors describe the impact of silicon carbide devices on soft switching three phase converters studying the improvement in efficiency and power density created via the introduction of silicon carbide devices Throughout the authors put a special focus on a family of zero voltage switching ZVS three phase converters and related pulse width modulation PWM schemes The book also includes A thorough introduction to soft switching techniques including the classification of soft switching for three phase converter topologies soft switching types and a generic soft switching pulse width modulation known as Edge Aligned PWM A comprehensive exploration of classical soft

switching three phase converters including the switching of power semiconductor devices and DC and AC side resonance Practical discussions of ZVS space vector modulation for three phase converters including the three phase converter commutation process In depth examinations of three phase rectifiers with compound active clamping circuits Perfect for researchers scientists professional engineers and undergraduate and graduate students studying or working in power electronics Soft Switching Technology for Three phase Power Electronics Converters is also a must read resource for research and development engineers involved with the design and development of power electronics [The Engineering Index Annual](#) ,1994 Since its creation in 1884 Engineering Index has covered virtually every major engineering innovation from around the world It serves as the historical record of virtually every major engineering innovation of the 20th century Recent content is a vital resource for current awareness new production information technological forecasting and competitive intelligence The world s most comprehensive interdisciplinary engineering database Engineering Index contains over 10 7 million records Each year over 500 000 new abstracts are added from over 5 000 scholarly journals trade magazines and conference proceedings Coverage spans over 175 engineering disciplines from over 80 countries Updated weekly **International Aerospace Abstracts** ,1989 **Index to IEEE Publications** Institute of Electrical and Electronics Engineers,1998 Issues for 1973 cover the entire IEEE technical literature **Science Citation Index** ,1994 Vols for 1964 have guides and journal lists [High-Power Density Three-Phase Two-Level Inverter Using Gan Devices and Aluminum PCB Board](#) Ketan Lakhera,2021 In this master s thesis aluminum PCB and GaN devices effect on a three phase two level inverter s power density has been analyzed The mathematical expressions and simulation models for the conduction and switching losses based on the three phase two level inverter using the PWM control method are presented A detailed description of challenges faced during the implementation and testing of a three phase two level inverter has been given which could help in GaN MOSFETs driver designing for future work Several test results involving single phase inverter and three phase inverter using third harmonic injection SPWM technique have been studied to draw a knowledgeable conclusion Finally the power density of a three phase two level inverter using a third harmonic injection SPWM has been calculated and the scope for future work has been discussed *Three Phase Current Source Inverter Using GaN for High Frequency Switching* Jackie Da Pang,2021 This thesis report will explore current source inverter CSI design through simulations hardware design and hardware testing With development of wide bandgap devices and increasing commercial availabilities higher switching frequency is achievable with manageable losses Many benefits derive from higher switching frequency such as passive component size reduction by reducing energy storage requirement greater integration and faster transient response However many problems also arise with higher switching frequency using modern voltage source inverter such as greater dv dt at the output terminal and higher common mode electromagnetic interference Because of VSI limitations at higher switching frequency CSI will be explored to see whether this old topology can provide new solutions There are few

key benefits of CSI such as low output voltage dv dt boosting characteristics and limited shoot through state which will be presented in this report

High-frequency Modeling of a Three-phase Inverter with Sinusoidal Pulse Width Modulation Control, 2014

Three-phase Motor Inverter and Current Sensing GaN Power IC Stefan Moench, Richard Reiner, Michael Basler, Daniel Grieshaber, Fouad Benkhelifa, Patrick Waltereit, Rüdiger Quay, 2023 Abstract A three phase GaN based motor inverter IC with three integrated phase current mirror sensors sense FETs or sense HEMTs 1200 1 ratio a temperature sensor and an amplifier is presented and experimentally operated The three low side currents are read out by virtual grounding transimpedance amplifiers A modified summed DC current readout circuit using only one amplifier is also discussed During continuous 24 V motor operation with space vector pulse width modulation SVPWM the sensor signal is measured and a bidirectional measurement capability is verified The measured risetime of the sensor signal is 51 ns indicating around 7 MHz bandwidth without intentional optimization for high bandwidth The IC is operated up to 32 V on DC biased semi floating substrate to limit negative static back gating of the high side transistors to around 7% of the DC link voltage Analysis of the capacitive coupling from the three switch nodes to the substrate is calculated for SVPWM based on capacitance measurement resulting in four discrete semi floating substrate voltage levels which is experimentally verified Integrated advanced power converter topologies with sensors improve the power density of power electronics applications such as for low voltage motor drive

Characterization and Design of High-switching Speed Capability of GaN Power Devices in a 3-phase Inverter Rémi Perrin, 2017

The french industrial project MEGaN targets the development of power module based on GaN HEMT transistors One of the industrial applications is the aeronautics field with a high constraint on the galvanic isolation 100 kV s and ambient temperature 200 C The intent of this work is the power module block 3 phases inverter 650 V 30 A The goal is to obtain a small footprint module 30 cm² with necessary functions such as gate driver gate driver power supply bulk capacitor and current phase sensor This goal implies high efficiency as well as respect of the constraint of galvanic isolation with an optimized volume This dissertation besides the state of the art of power modules and especially the GaN HEMT ones addressed a control signal isolation solution based on coreless transformers Different prototypes based on coreless transformers were characterized and verified over 3000 hours in order to evaluate their robustness The different studies realized the characterization of the different market available GaN HEMTs in order to mature a circuit simulation model for various converter topologies In the collaborative work of the project our contribution did not focus on the gate driver chip design even if experimental evaluation work was made but a gate driver power supply strategy The first gate driver isolated power supply design proposition focused on the low voltage GaN HEMT conversion The active clamp Flyback topology allows to have the best trade off between the GaN transistors and the isolation constraint of the transformer Different transformer topologies were experimentally performed and a novel PCB embedded transformer process was proposed with high temperature capability A lamination process was proposed for its cost efficiency and for the

reliability of the prototype 1000 H cycling test between 55 200 C with 88 % intrinsic efficiency However the transformer isolation capacitance was drastically reduced compared to the previous prototypes 2 high integrated gate driver power supply prototypes were designed with GaN transistors 2 4 MHz 2 W 74 % 6 cm² and with a CMOS SOI dedicated chip 1 2 MHz 2 W 77 % 8 5 cm² In the last chapter this dissertation presents an easily integrated solution for a phase current sensor based on the magnetoresistance component The comparison between shunt resistor and magnetoresistance is experimentally performed Finally two inverter prototypes are presented with one multi level gate driver dedicated for GaN HEMT showing small switching loss performance

High-frequency GaN-based Inverter Control Design Using PSIM Ryan P.

Ready,2020 Gallium nitride GaN transistors are becoming more common in power electronics This thesis describes how they can be used to improve solar generators by improving the inverter that they contain The benefits of using GaN in an inverter include higher efficiency higher switching speeds and the ability to reduce the size of some inverter components The full bridge inverter topology was chosen for this inverter because of its favorable high frequency switching characteristics Using a full bridge GaN based inverter evaluation board from Transphorm Inc a PI control scheme was successfully designed for this inverter using the simulation software PSIM This control scheme performed satisfactorily when tested in the inverter showing that PSIM can be a useful design tool for high frequency GaN based inverters

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