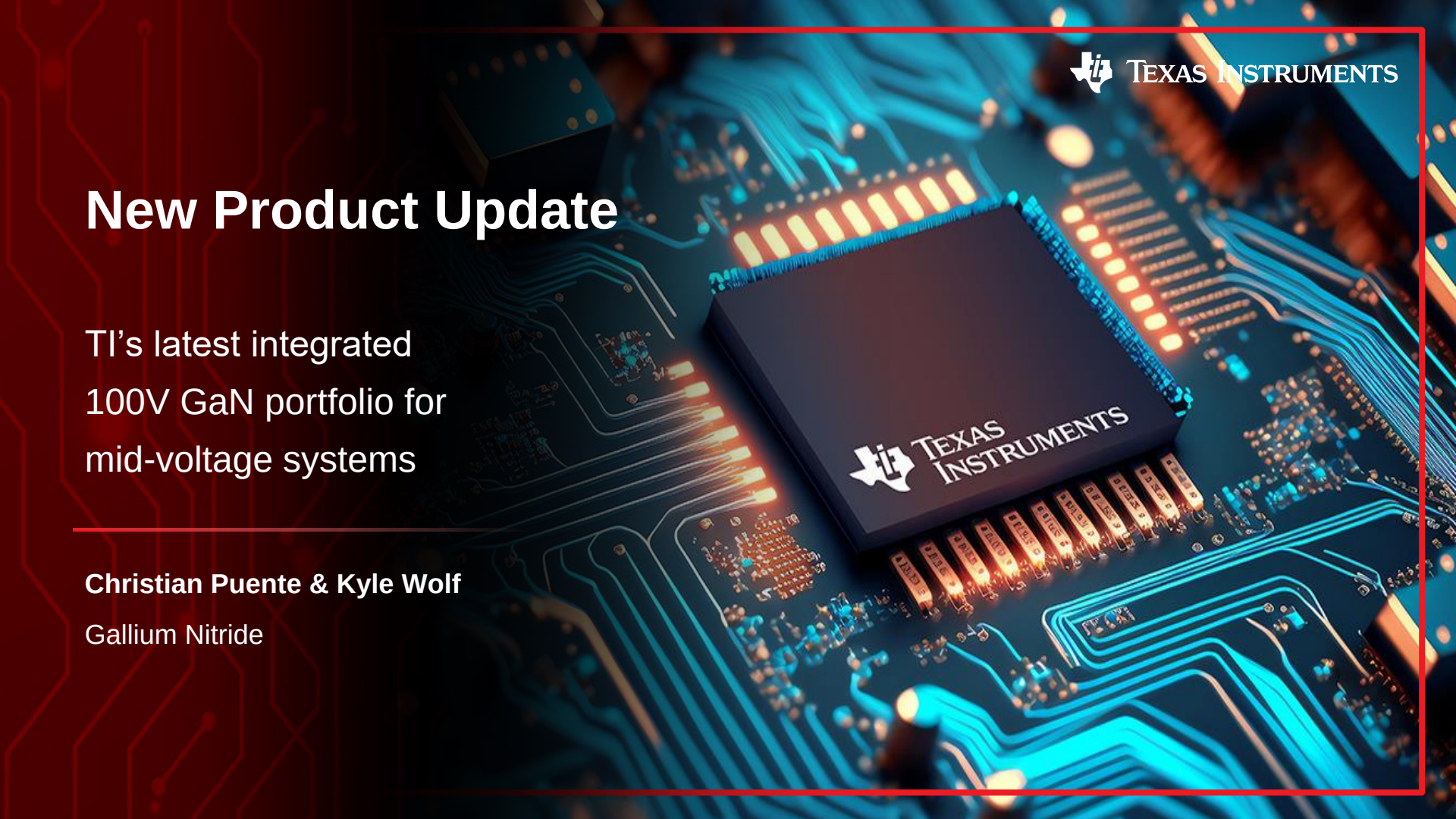
New Product Update

TI’s latest integrated 100V GaN portfolio for mid-voltage systems

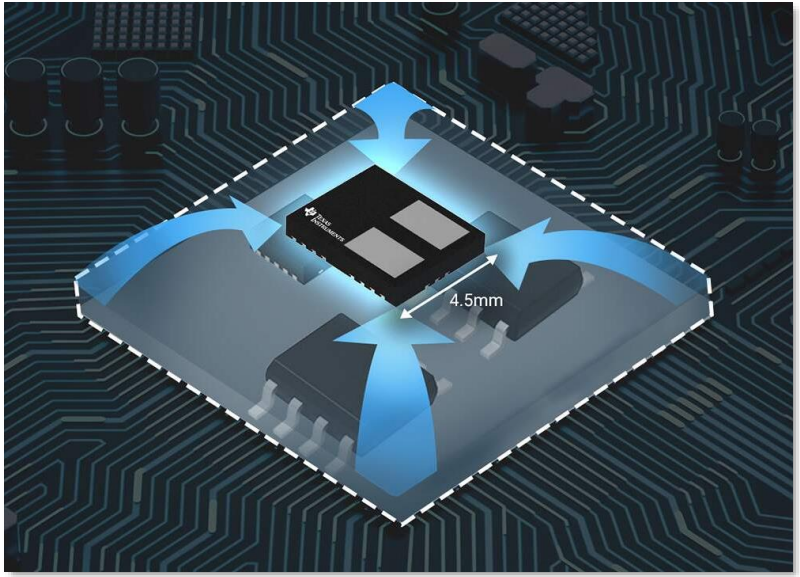
Christian Puente & Kyle Wolf

Gallium Nitride



Agenda

- 100V integrated GaN portfolio overview
- LMG210x product overview
- LMG310x product overview
- Benefits of integrated features
- Design examples



New TI 100V integrated GaN power stages

**Top Side Cooled (exposed pad) with extended ground pads at the bottom for effective cooling*

	GaN half-bridge with gate driver	Single GaN FET with gate driver
GPN	LMG2100R044	LMG3100R017
Package details	QFN 4.5x5.5mm	QFN 6.5x4.0mm
Vds (max.)	100V	100V
Protection Features	UVLO	UVLO
Advanced features	Integrated bootstrap	Integrated bootstrap
< 1kW	4.4mΩ Sampling Now, RTM Mar'24	
1kW – 2kW		1.7mΩ Sampling Now, RTM Jul'24

LMG210x 100V Integrated GaN half bridge overview

Features

- **GaN half-bridge with integrated gate-driver, level-shifter and synchronous bootstrap diode**
  - >200 V/ns CMTI and 10 MHz switching frequency
- 100V AbsMax (100ms, 1k pulse), 90V operational
- 35A (operational), 125 A (100us pulse)
- Only single V_dd supply 4.5V to 5.5V
- 3.3V or 5V logic inputs
- UVLO protection
- **4.4 mΩ** typ **5.7 mΩ** max $R_{DS(on)}$ drain to source at 25°C
- **Package**: QFN with top-side cooling: 5.5 mm x 4.5 mm

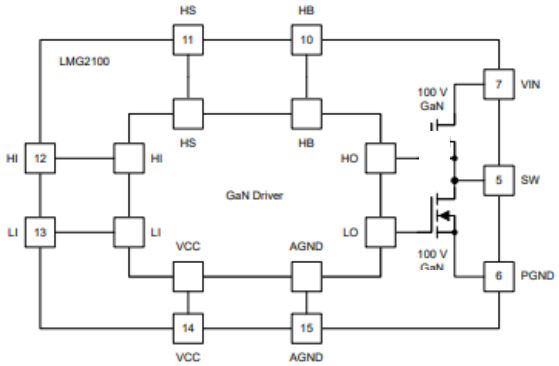
Applications

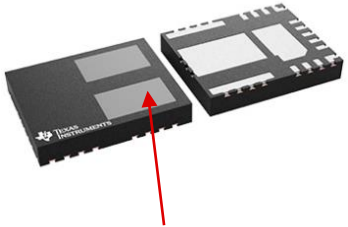
- 48-V DC-DC converters in Server and Telecom Power
- Solar Inverters
- Class D Audio
- Test and Measurement power supplies and DC sources
- Motor Drives

Benefits

- Easy to use complete power solution
- Does not need separate GaN gate-driver or bootstrap switch
- Easy layout, less dependence on board parasitics
- In-built protection features

Functional Block Diagram & Package





Exposed GaN dies for heat sink

LMG310x 100-V Integrated GaN power stage overview

Features

- **100V GaN FET with Integrated Driver**
  - >200 V/ns CMTI and 10 MHz switching frequency
  - Only single V_dd supply 4.5V to 5.5V
  - 1.8V, 3.3V or 5V logic inputs
  - UVLO protection
- **Level shift to high-side and bootstrap included**
  - Low-side LMG3100 provides bootstrap supply and level shifted input to high-side LMG3100
  - Mix and match R044 and R017 for asymmetric buck/boost
- 100V AbsMax (100ms, 1k pulse), 90V operational
- R017: **1.7 mΩ** typ **2.2 mΩ** max $R_{DS(on)}$ drain to source at 25°C
- R044: **4.4 mΩ** typ **6 mΩ** max $R_{DS(on)}$ drain to source at 25°C
- **Package**: QFN with top-side cooling: 6.5 mm x 4.0 mm

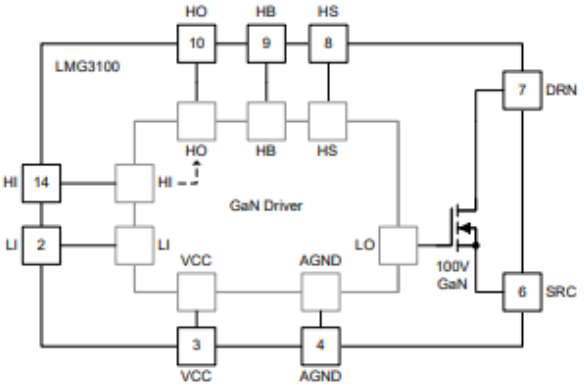
Applications

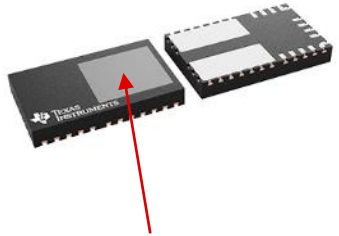
- 48-V DC-DC converters in Server and Telecom Power
- Solar Inverters
- Class D Audio
- Automotive Power
- Test and Measurement power supplies and DC sources
- Motor Drives

Benefits

- Easy to use complete power solution
- Does not need separate GaN gate-driver or bootstrap switch
- Easy layout, less dependence on board parasitics
- In-built protection features

Functional Block Diagram & Package

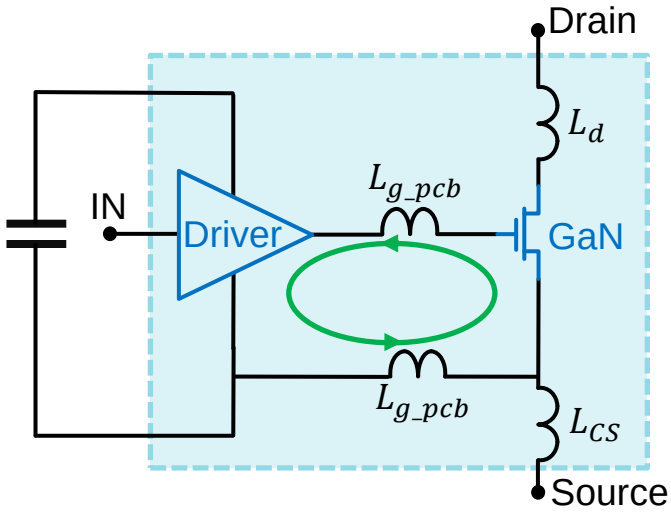




Exposed GaN dies for heat sink

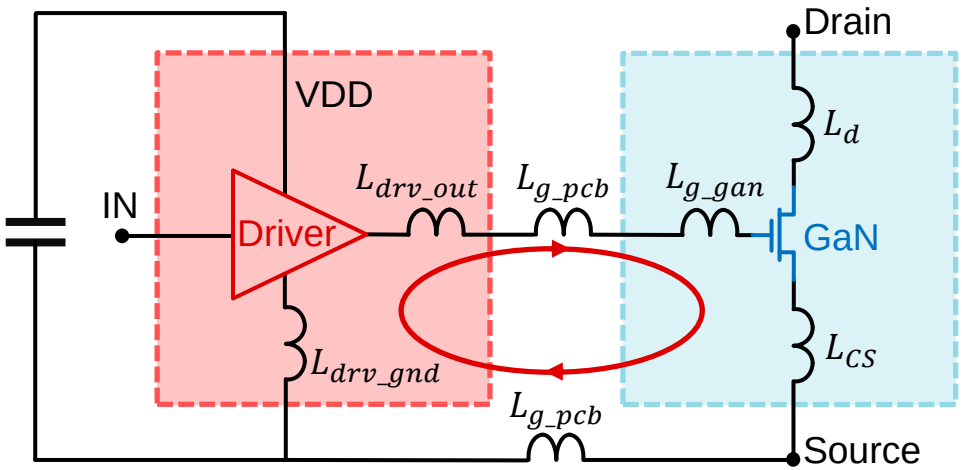
Integrated gate driver

TI driver + GaN



Minimized switching loop, maximum efficiency
Faster turn-on and turn-off

Discrete GaN with external driver

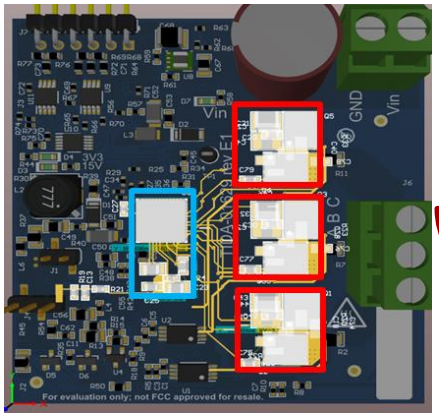


Large parasitic inductances, increased switching losses

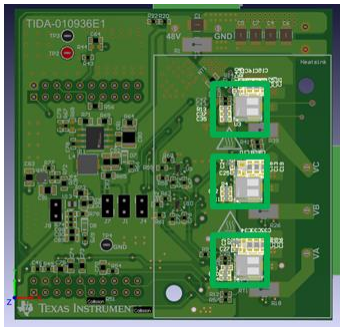
Texas Instruments

Achieve a high power density with TI GaN

- ✓ Integrated power stages increase ease of design/layout
- ✓ Integrated driver eliminates need for external circuitry for diagnostics
- ✓ Switching frequency up to 10MHz reduces ripples hence size of passives
- ✓ Overall enhances power density by ~40% reducing system size & cost



~50% reduced!



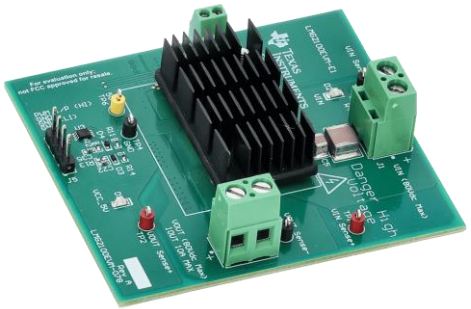
TIDA-01629: 48V/500W MOSFET solution
Size: 719mm²

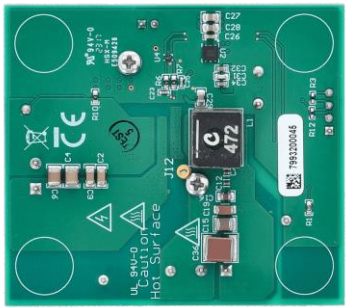
TIDA-010936: 48V/15A 3 phase GaN inverter
Size: **317mm²**

LMG2100 EVM 500W Buck/Boost Power Stage

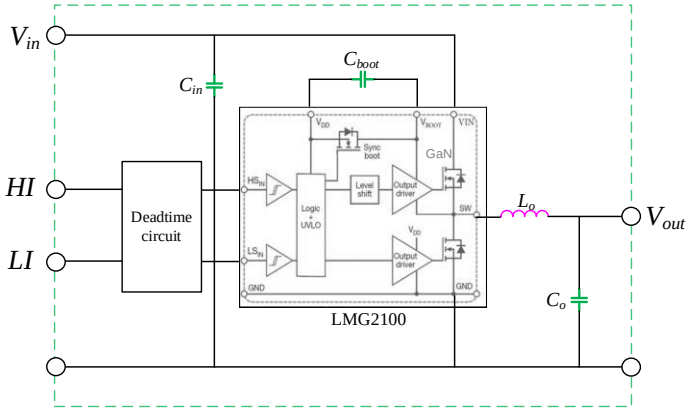
Features & benefits

- Buck/Boost stage using only **1x LMG2100 Half Bridge** in top-side cooled package
- **90V** Max Vin
- **Open loop control** with single or dual PWM
- Onboard dead-time generator or external independent gate signals
- LDO for generating regulated 5V supply
- Heatsink for better thermal performance
- Slew rate adjustment using series resistor along with C_{boot}





LMG2100EVM-078

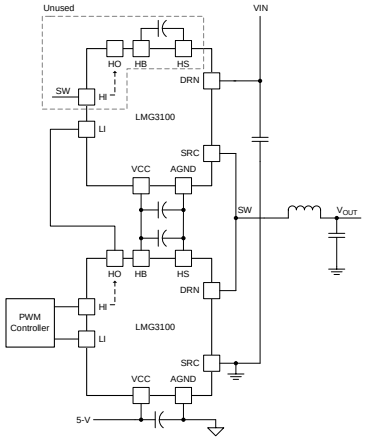


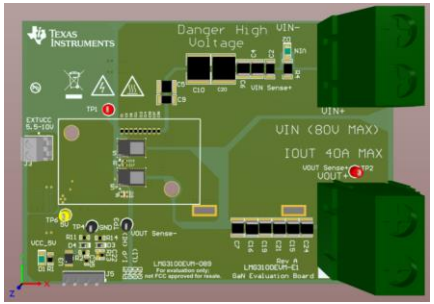
Parameter	Specifications
VIN Input	0V-90V
VCC Input	5V-9V
Vout	0-90V
Maximum Power	0.5kW
Switching frequency	**500kHz**
Dimensions	38mm x 66mm x 250mm

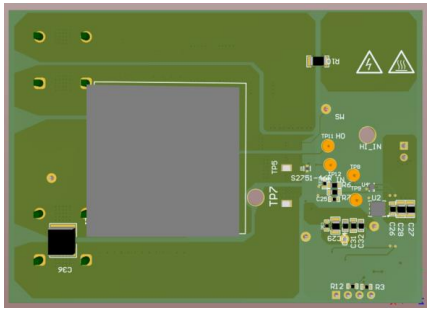
LMG3100 EVM 2kW Buck/Boost Power Stage

Features & benefits

- Buck/Boost stage using **2x LMG3100 GaN FET + integrated driver** in top-side cooled package
- **90V** Max Vin
- **Open loop control** with single or dual PWM
- Onboard dead-time generator or external independent gate signals
- LDO for generating regulated 5V supply
- Heatsink for better thermal performance
- Slew rate adjustment using series resistor along with C_{boot}







Parameter	Specifications
VIN Input	0V-90V
VCC Input	5V-9V
Vout	0-90V
Maximum Power	2kW
Switching frequency	**500kHz**
Dimensions	64mm x 90mm x 50mm

PMP23340 | 1/8 Brick, 1.1KW Medium Voltage GaN Module

Features

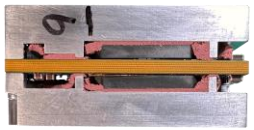
System Specifications:

- Output: 10-15V
- DC Input: 40-60V (48V nominal)
- Sw. frequency: **1 MHz**
- Topology: Full Bridge open loop LLC
- Form Factor: **22.9 mm x 58.4 mm**
- Protections: OCP, OTP, OVP and UVLO
- Peak Efficiency: **97.7%**

Typical application

- Enterprise and Telecom Server 48-12V conversion

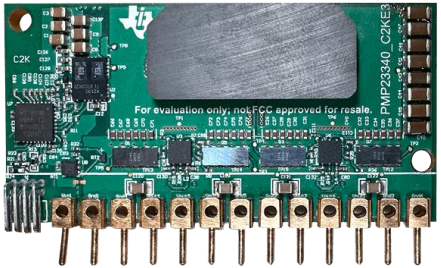
Tools & resources

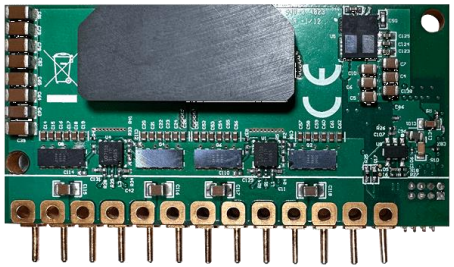


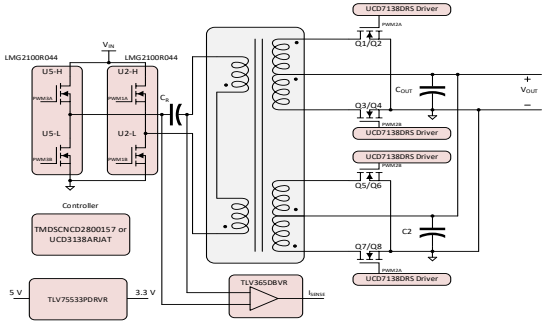
- **Design Files:** Schematics, BOM, Gerber, GUI for parameter management for the controller
- **Device Datasheets:**
  - LMG2100R044
  - UCD3138
  - F2800157

Benefits

- High power density **>1.4Kw/in^3** with a high peak and full load efficiency (~96.5%)
- Integrated half bridge GaN based design at high switching frequency enables planar transformer design increasing power density
- 2 versions available: with UCD3138 and C2000 microcontroller (F2800157)







TIDA-010933 | 1.6kW 1-phase Microinverter based on GaN

Features

- System Specifications:
  - Output 110-230VAC 50/60 Hz
  - PV Input 25V-60VDC (1 panel)
  - BAT Input 48V nominal
  - DC/AC Efficiency > 98.5% efficiency
  - PV Boost DC/DC Efficiency > 96.5% efficiency
  - PWM frequency
    - AC/DC 125kHz
    - DC/DC boost 250kHz
    - DC/DC CLLLC 500kHz
- 1.6kW Totem Pole PFC Inverter 1-Phase operation
- 4 x 0.4kW (total 1.6kW) DC/DC Boost with MPPT with 1, 2 or 4 PV panels or battery in/output

Tools & resources

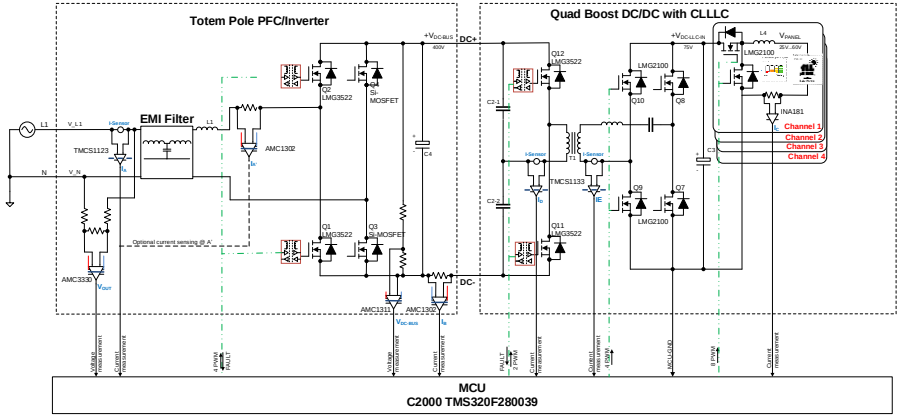
- **TIDA-010933 Tools Folder**
- **C2000 Digital Power SDK**
- **Design Files:** Schematics, BOM and BOM Analysis, Design Files
- **Key TI Devices:** TMS320F280039, LMG3522R0x0, LMG2100, TMCS1123, AMC1302, AMC3330, AMC1311, INA181, LM321LV, OPAx350, ISO6742, UCC14130

Typical application

- Microinverter
- Energy Storage Systems (48V)

Benefits

- High switching frequency to enable small passive EMI filter components
- Good common model isolation with Isolated DC/DC boost topology
- High power density because of small passive components
- Small form factor (25cm x 25cm x 4cm / L x W x H)
- High PWM at AC/DC for low EMI and small boost inductor
- Single chip controller with one C2000 MCU (DC/AC, DC/DC, MPPT)

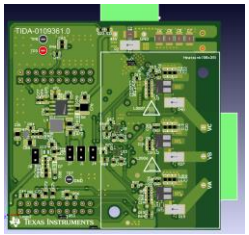


TIDA-010936 | 48V/15A 3-Phase GaN based Motor Drive

Features

- Wide input voltage 20-V to 80-V 3-phase GaN inverter with **15A$_{rms}$** output current, tested up to **100-kHz** PWM
- LMG2100 half-bridge power stage with 100V-4.4mOhm GaN FET
- Protection against short-circuit and over-temperature
- 2 x phase current sensing with INA241; 3rd phase with AMC0106
  - INA241 non-isolated current sense amplifier with PWM rejection
  - Functional isolated delta-sigma modulator for continuous in-phase current sensing.
- Prepared to support STO with external board to cut-off PWM and gate drive power
- **TI BoosterPack compatible** with a C2000 MCU LaunchPad.

Tools & resources



Main devices

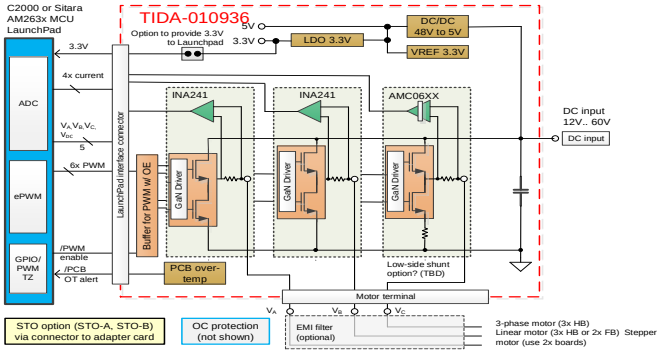
-LMG2100: 100V/35A HB GaN integrated driver
-TMS320F28P650DK: C2000™ 32-bit MCU, 2x C28x+CLA CPU, Lock Step
-INA241: 110V, Bi-directional, Ultra-Precise Current Sense Amplifier
-AMC1106: ±50 mV Input Functionally Isolated Delta-Sigma Modulator

Benefits

- GaN half-bridge module **integrated driver** reduce PCB size simplify layout.
- GaN power stage enables **Higher PWM switching further reduce current/torque ripple** & reduces the DC link Capacitance
- Very low deadtime almost eliminate dead-time distortions for smoother current control.
- Nearly no reverse-recovery losses during hard-switching yield to clean switch node signals and improve EMI.

Typical application

Collaborative robot, servo drives, linear motor transport systems, stepper, drones, AGV/AMR



Getting started

You can start evaluating these devices leveraging the following:

Content type	LMG210x, LMG310x	Link to content or more details
Product folder	100-V GaN Half bridge/FET with integrated driver, level-shifter & synchronous bootstrap diode	LMG2100R044, LMG3100R017
Reference design	1.6kW 1-phase GaN based Micro Inverter, 1/8th 1.1KW Brick mid-voltage GaN Module	TIDA-10933, PMP23340C2K, PMP23340UCD
Technical blog content or white paper	4 mid-voltage applications where GaN will transform electronic designs	Technical article
Selection and design tools and models	GaN LLC resonant converter device loss calculator for mid-voltage applications	LMGXX-GAN-LLC-CALC
Development tool or evaluation kit	LMG210x- 500W Buck/Boost Power Stage LMG310x- 2KW Buck/Boost Power Stage	LMG2100EVM-078 LMG3100EVM-089
Portfolio page	Gallium Nitride ICs portfolio	TI.com/GaN

Visit www.ti.com/npu

For more information on the New Product Update series, calendar and archived recordings

Texas Instruments

© Copyright 2024 Texas Instruments Incorporated. All rights reserved.

This material is provided strictly “as-is,” for informational purposes only, and without any warranty.
Use of this material is subject to TI’s **Terms of Use**, viewable at TI.com

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated