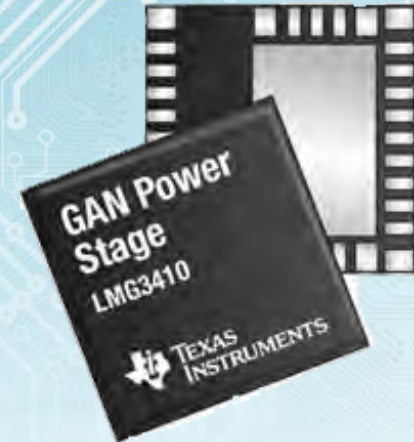
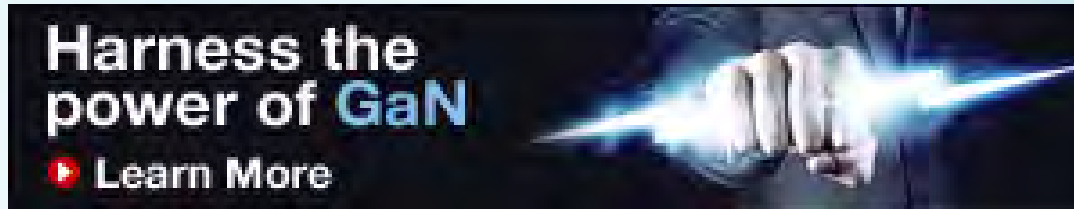


# *Rethink Your Power*

## with TI's 80V / 600V GaN Power Stages

### The LMG5200 / LMG3410



# Rethink Your GaN with TI

## Maximum power density

Delivers half the power losses and enables a reduction in power-supply size of as much as 50 percent.

## Reduced packaging parasitic inductance

The integration of a driver and FET in a single QFN packaging allows decreased power loss, component voltage stress and electromagnetic interference (EMI).

## Manufacturing and Reliability

Building on years of expertise in manufacturing and process technologies, TI has established a GaN-specific qualification methodology and application-relevant testing.

## Expanding the GaN ecosystem

Complete Range of analog and digital power conversion controllers

**Over 3 million hours of reliability testing**

# Applications

Server/telecom  
POL and  
AC-DC supplies



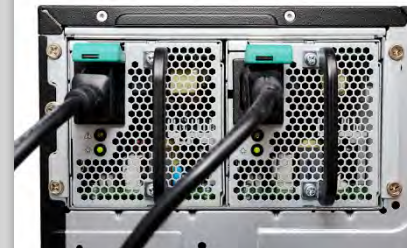
Motor drives



Solar inverters



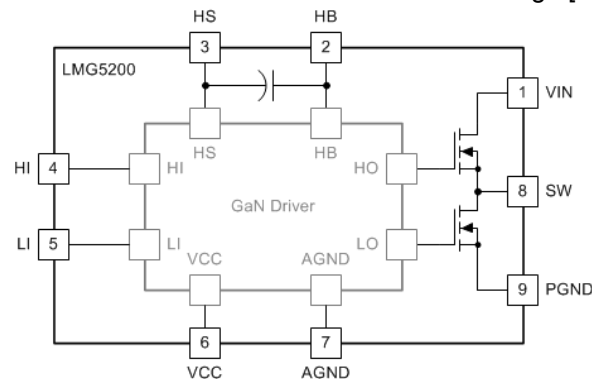
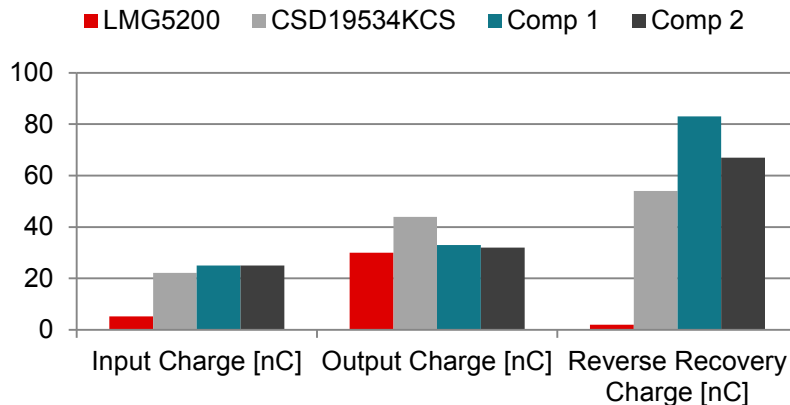
Rack-mount DC  
power distribution



**TI GaN** is aimed at high-performance power conversion applications where switching performance and fault protection are important.

# Advantages of TI GaN over Silicon

- Zero reverse-recovery enables efficient CCM half-bridge converters
- Lower output capacitance enables faster switching speeds to increase power density
  - reduces switch charging losses
  - reduces circulating current in LLC and Quasi-Resonant Converters
- Low input capacitance reduces gate drive losses enabling higher switching frequency in LLC and Quasi-Resonant converters
- Low distortion in class-D amplifiers and inverters
- Reduced cooling can eliminate heat sinking



# Advantages of TI GaN over Discrete GaN

- **Easy System Design**

- Optimized Integrated driver with zero common-source inductance enables high-speed low loss switching
- Regulated gate drive bias provides reliable GaN switching
- Low inductance package reduces power loop ringing
- Ease of board layout



**Simplify the Design**

- **Higher Efficiency**

- ZERO reverse-recovery losses in hard-switched, half-bridge converters
- Low output capacitance,  $C_{oss}$
- Low switch ringing



**Save Time and Resources**

- **Ecosystem**

- Complete range of digital and analog controllers, and complementary analog and power solutions



**Improve system performance**

- **Reliability**

- Over 3 million device hour of application reliability testing beyond JEDEC

# LMG3410 - 600V 12A Single-Channel GaN Power Stage

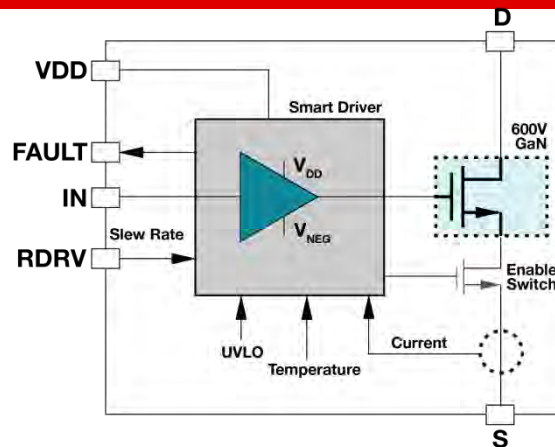
## Features

- Integrated 70-m $\Omega$  600-V GaN and Driver in a thermally enhanced package
- Single package for ease of design and layout
- Up to 1-MHz operation frequency
- 20-ns Typical Propagation Delay
- ZERO reverse recovery current
- Operates from a Single Unregulated 12-V Supply
- Externally-Adjustable Drive Strength for Switching slew rate
  - Performance and EMI Control
  - Supports 25 to 100 V/ns
- Internally Generated Negative Drive Voltage
- Fault Output Ensures Safety
  - UVLO Protection
  - Over-current Protection
  - Over-temperature Protection

## Applications

- Server/telecom AC rectifier to 12V/48V
- High-voltage DC distribution in server/telecom
- Industrial AC/DC
- Photo-voltaic inverters

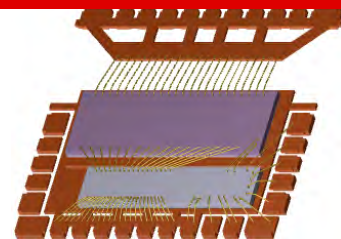
## Functional Block Diagram



## Packaging



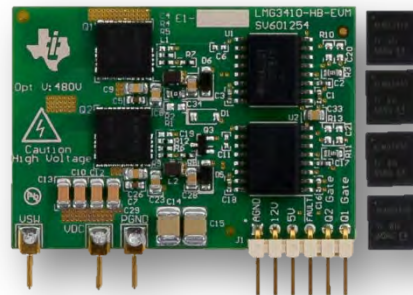
8mm x 8mm QFN



# LMG3410 EVM Kits

- Half-bridge Daughtercard
  - Suited for evaluation on motherboard EVM
  - Suited to integrate into customer eval
    - Totem-pole PFC, LLC, full bridge
  - Includes power and signal isolation
  - Includes 4 LMG3410 ICs
- Motherboard EVM
  - Socketed daughtercard connection
  - Open loop buck or boost board
  - 480V, 6A capable at 100kHz

LMG3410-HB-EVM



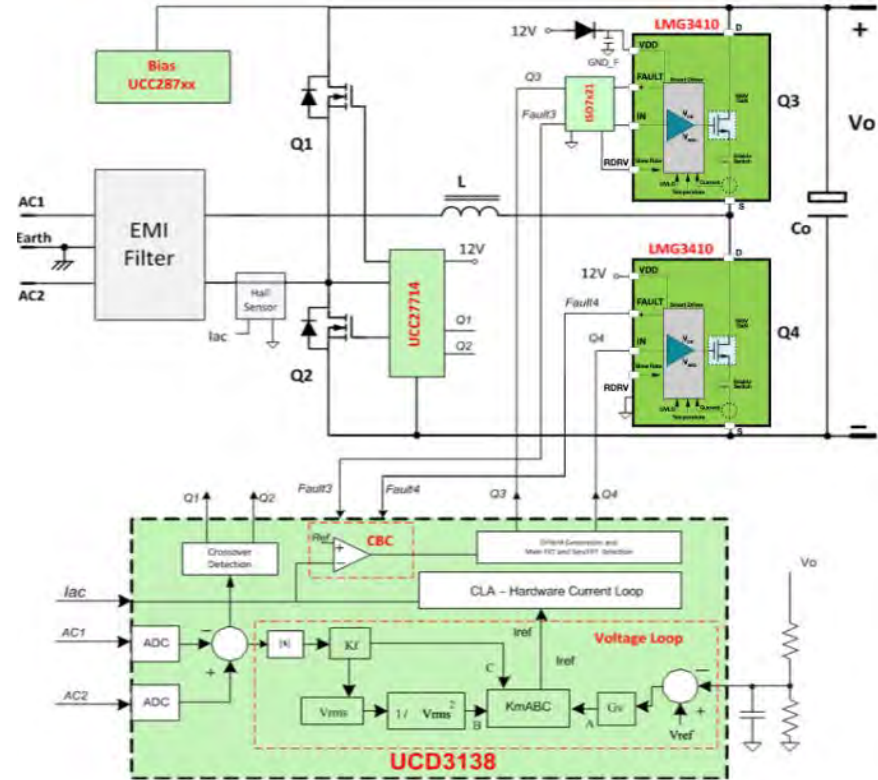
LMG34XX-BB-EVM



# LMG3410: Enabling new topologies

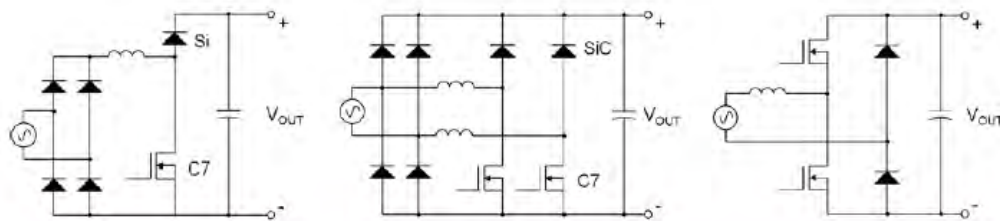
## Compared to silicon:

- The 12-A LMG3410 provides superior performance especially in hard-switching applications where it can dramatically reduce switching losses by as much as 80 percent.
- GaN devices, such as the LMG3410 have zero reverse-recovery charge, which is well-suited for hard-switched half-bridge applications, such as a totem-pole bridgeless PFC circuit and LLC resonant converter.



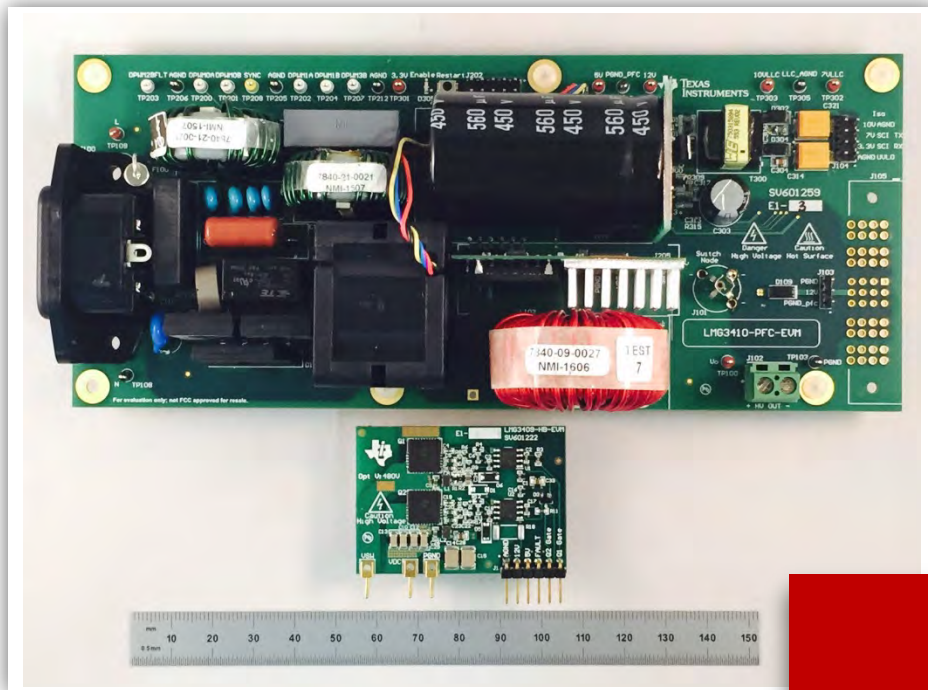


# PFC topology comparison



Loss Mechanism	Standard Boost	Dual Boost	Totem-Pole GaN
Switching Stage	SJ Mosfet + SiC diode	SJ Mosfet + SiC diode	GaN Half Bridge
Rectifier Stage	Silicon Bridge Rectifier	Active-switched MOSFET	Active-switched MOSFET
FET + Diode Conduction	6.59 W	6.59 W	4.40 W
$Q_{oss} / E_{oss} + Q_{rr}$	1.37 W	1.37 W	1.58 W
Switching I-V	0.95 W	0.94 W	0.87 W
Rectifying Diodes / FETs	7.74 W	0.84 W	0.83 W
Inductor Loss	3.67 W	3.67 W	3.67 W
<b>Total</b>	<b>20.3 W</b>	<b>13.4 W</b>	<b>11.35 W</b>
<b>Efficiency</b>	<b>98.0 %</b>	<b>98.7 %</b>	<b>&gt;99%</b>

# LMG3410 Design Example: 1kW 99.3% Efficient PFC



99.3% efficient totem pole PFC with GaN and digital control

- 600V TI GaN FET with integrated driver in 8x8 QFN package
- Adaptive deadtime control due to UCD digital controller
- Low THD and harmonics

99% 1kW Totem-Pole PFC  
100-kHz frequency enables 30% lower volume vs. traditional designs

LMG3410 power stage  
TI attach: UCD Digital Controller, UCC27714, UCC28740, ISO7831

# LMG5200 80V/10A GaN Half-Bridge Module with Integrated Gate Driver

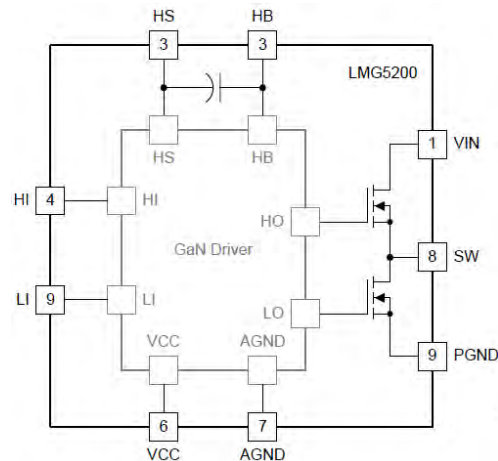
## Features

- Integrated High-side/Low-side GaN driver + GaN FETs
- Operates up to 80V input
- Integrated bootstrap diode
- 18 mΩ devices rated for 10A DC
- Independent TTL Inputs
- Integrated bootstrap diodes
- Short Propagation delay (25ns)
- Bootstrap Voltage Clamped to 5.2V
- Vcc UVLO optimized for GaN FETs (3.8V)
- Package: 6x8mm QFN

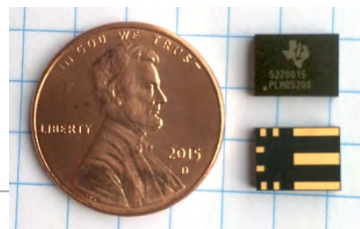
## Applications

- MHz-speed 48V buck converters
- Isolated 48V bus converters
- 48V to 1V conversion: isolated and non-isolated
- Industrial DC/DC

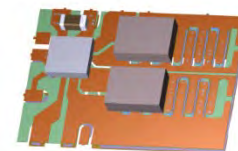
## Block Diagram



## Packaging

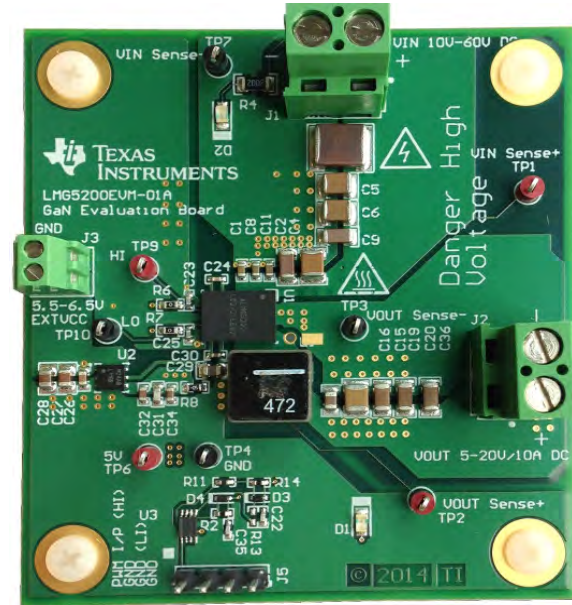


6mm x 8mm QFN

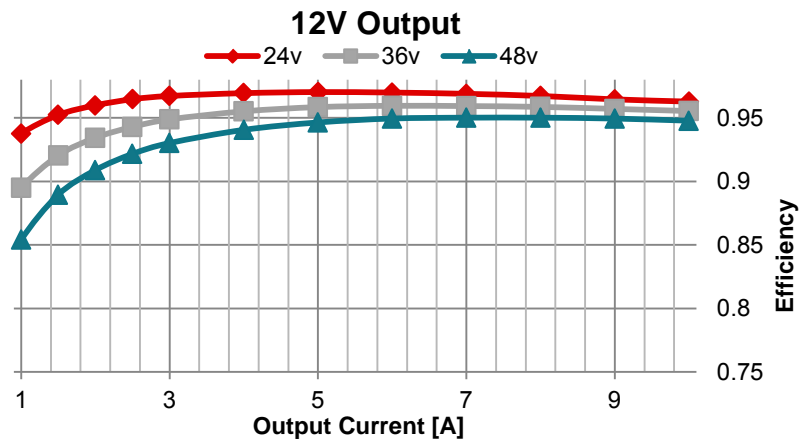


# LMG5200 EVM - 48V Buck Converter

- Buck converter power stage
- Single or Dual PWM Input with optional tunable deadtime
- 10-75V input
- Up to 5-10A output current with thermally limit above 5A
- Supports up to 5 MHz switching

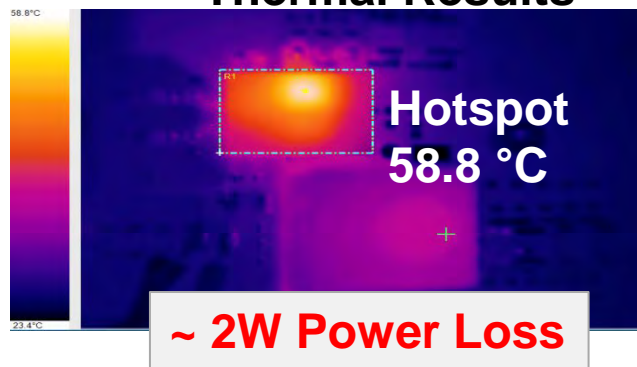


# LMG5200 1MHz Buck Converter



$f_{sw} = 1 \text{ MHz}$

## Thermal Results



$V_{IN} = 48V$   
 $V_{OUT} = 12V$   
 $I_{OUT} = 5A$   
 $f_{sw} = 1 \text{ MHz}$

### Notes:

- Data taken on EVM board at  $V_{in}$  24-60V
- Includes driver losses
- Efficiency data taken with air flow

## Features

- LMG5200 GaN FET module
- Single stage Half-Bridge Current-Doubler topology
- Extra high Efficiency up to 89.9% with full load@48VIn
- DCAP+ Controlling with the TPS53632G
- Compact size: 45mm\*26mm\*11mm

## Applications

- Computer & Server application
- Telecom & Industry application

## Tools & Resources

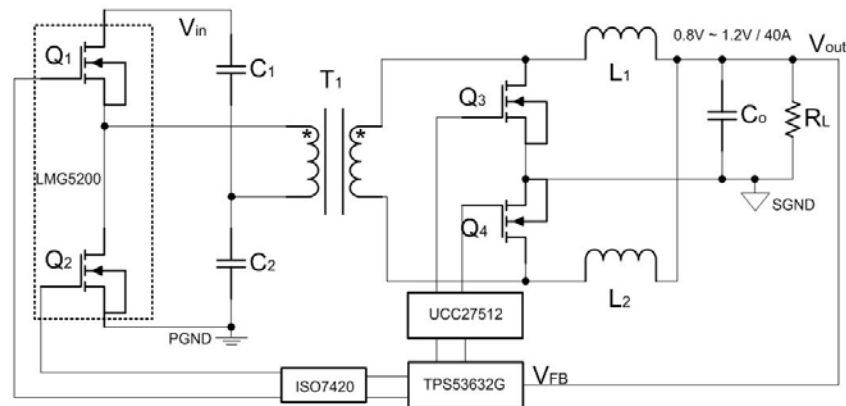
- [PMP4497 Tools Folder](#)
- [Design Guide](#)
- **Design Files:** Schematics, testing report, BOM, Gerber etc.

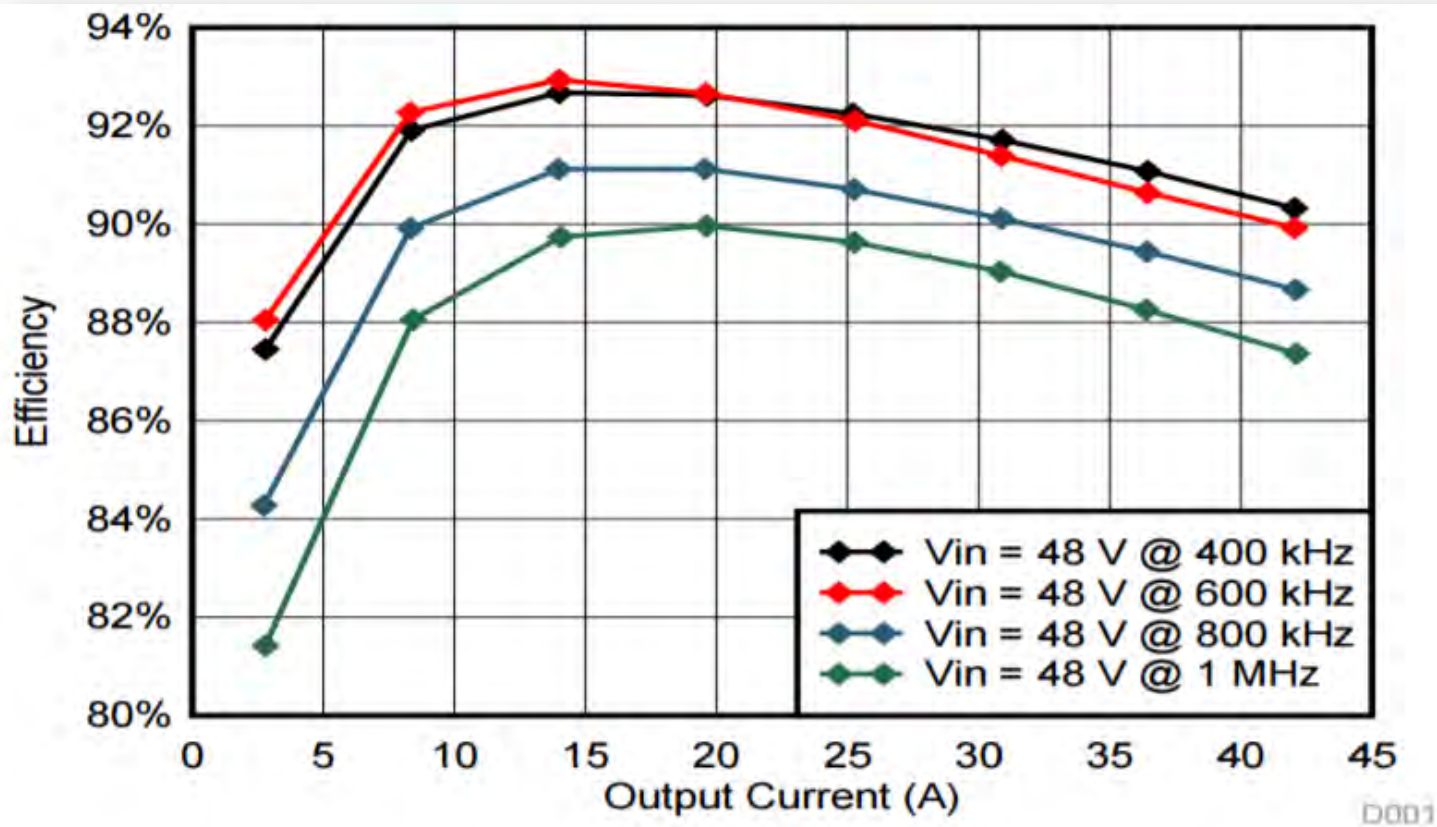
### Device Datasheets:

- [LMG5200](#)
- [TPS53632G](#)
- [ISO7420FEDR](#)
- [TLV70450DBVR](#)
- [TLV70433DBVR](#)
- [UCC27512DRSR](#)

## Benefits

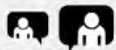
- Excellent efficiency & thermal performance
- Compact size and high power density
- Lower switching loss and driver loss, no reverse recovery
- Excellent dynamic response
- Less components comparing to traditional 2 stage solution





# Helpful information

## TI E2E™ community



TI E2E™  
Community

As a member of my.TI you can join the TI E2E™ Community where you can ask questions, share ideas and collaborate with fellow engineers and TI experts

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• Blogs  
• Cloud

TI E2E Community >

Support forums

Blogs

Groups

Videos

Blogs > Power House

### GaN to the rescue! Part 1: Body-diode reverse recovery

As power engineers, we can recall our first [exposure to the idealized buck and boost power stages](#). Remember how the voltage and current waveforms were nice and simple (Figure 1), and how it was easy to calculate average values and determine the transfer functions relating inputs and outputs?

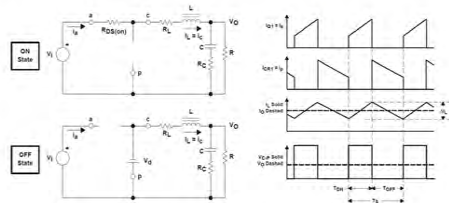


Figure 1: The idealized buck and boost power stages: these look great!

- View the:
  - [LMG3410 Product folder](#)
  - [LMG5200 Product folder](#)
- Learn more about TI's [GaN portfolio](#) and find technical resources.
- Explore GaN blog posts on the [Power House blog](#).
- Download the following white papers:
  - [“Optimizing GaN performance with an integrated driver.”](#)
  - [“GaN FET-Based CCM Totem-Pole Bridgeless PFC.”](#)
- Join the [TI E2E™ Community Gallium Nitride \(GaN\) Solutions forum](#)