AC-to-Processor: Powering Tomorrow’s Datacenters with TI GaN

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For questions please contact masoud@ti.com
AC-to-Processor at Over 2X the Power Density

- **TI GaN** enables **>2X power density improvements from AC to point-of load**, by solutions that are:
  - **Cooler**: 99% Efficient Totem Pole PFC scalable to 3kW
  - **Faster**: 1MHz - 140W/in³ isolated DC/DC LLC converter
  - **Smaller**: 2x75A stackable, single-stage 48V-to-POL solution
  - **Easier**: Industry most integrated GaN with the largest ecosystem and solution footprint

Learn more at www.ti.com/GaN
TI GaN: *Rethink* your AC to PoL Power Design

**Current Solution (MOSFET)**

85-265 V\(_{AC}\) → **Dual Boost PFC** → 400V\(_{DC}\) → **LLC** → 36-60V\(_{DC}\) → **Intermediate DC/DC** → 12V\(_{DC}\) → **PoL DC/DC** → 1.0V/1.8V

- **CPU, FPGA, memory**

**High Density Approach (GaN)**

85-265 V\(_{AC}\) → **Totem Pole PFC** → 400V\(_{DC}\) → **LLC** → 36-60V\(_{DC}\) → **PoL DC/DC** → 1.0V/1.8V

- **CPU, FPGA, memory**

- **99% efficient 1kW scalable to 3kW, and up to 3X the switching frequency of traditional topologies**

- **1MHz isolated DC/DC converter, delivering power density of over 140W/in\(^3\), >1.5x of today’s MOSFET solutions**

- **Stackable single-stage architecture, reducing component count 50% by eliminating intermediate bus**

Learn more at [www.ti.com/GaN](http://www.ti.com/GaN)
PFC Solution: 1kW 140kHz Totem-Pole CCM

Specifications

– Continuous Conduction Mode PFC
– Universal AC line input
– 385V DC bus output
– 1 kW output across universal input

Features

– **LMG3410** GaN FET implemented with **LMG3410-HB-EVM**
– Highly integrated UCD3138A digital solution offering superior performance
– Advanced control algorithm
– Adaptive dead time control
– Excellent THD and PF

Increase Density by 2X to 125 w/in³

Excludes EMI
PFC Solution: 1kW 140kHz Totem-Pole CCM

Power Stage and Inductor

**LMG3410** 600V 70 mΩ
8 mm x 8 mm GaN FET

GaN FET
Daughter Card
LMG3410-HB-EVM

Learn more at www.ti.com/GaN
PFC Solution: Switching Node Waveform

Zero to 400V in 4ns
With TI-GaN

<25V voltage ringing

102V/ns

Learn more at www.ti.com/GaN
PFC Solution: Efficiency

Learn more at www.ti.com/GaN
LLC Solution: 1MHz Isolated DC/DC Converter

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage (V)</td>
<td>380 ~ 400</td>
</tr>
<tr>
<td>Output voltage (V)</td>
<td>48V Nom unregulated</td>
</tr>
<tr>
<td>Power (W)</td>
<td>1000</td>
</tr>
<tr>
<td>Size (in)</td>
<td>2 x 2.1 x 1.7</td>
</tr>
<tr>
<td>Power density (W/in^3)</td>
<td>140 High power density</td>
</tr>
<tr>
<td>Efficiency</td>
<td>&gt;97% High Efficiency</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>1 MHz</td>
</tr>
</tbody>
</table>

Increase Density by 1.5X to 140 w/in^3

Learn more at www.ti.com/GaN
LLC Solution: 1MHz Isolated DC/DC Converter

LMG3410
Half bridge

Integrated Transformer

Learn more at www.ti.com/GaN
LLC Solution: Efficiency

Output Power (W)

Eff w/o bias
Eff w/ bias

Learn more at www.ti.com/GaN
48V-to-POL: 2x75A Stackable Single-Stage Solution

Single vs Two-Stage Solution:

- GaN enables an efficient hard-switched converters at higher voltages
- The **LMG5200** is ideal for single-stage power conversion. Applications include server and telecom POL, as well wide Vin industrial power supplies
- The single conversion reduces component count in half, and increases power density by 4X

Increase Density by 4X to 160 w/in³
**48V-to-POL: 2x75A Stackable Single-Stage Solution**

Eliminate the Intermediate Bus Converter (IBC)

Learn more at [www.ti.com/GaN](http://www.ti.com/GaN)
48V-to-POL: Efficiency
AC-to-Processor: Powering Tomorrow’s Datacenters with TI GaN

1kW PFC, LLC, 48:POL

3kW PFC (static)

Learn more at www.ti.com/GaN
Product Information
LMG3410: 600 V GaN Power Stage

Features

- 70mΩ RDSon Drain to Source
- Integrated GaN Gate Driver
  - TI Direct-Driver technology switches the GaN directly
  - Internal buck-boost generates negative drive voltage
  - Only single +12V unregulated supply needed
  - 5V LDO to power external isolator
- External resistor sets drive strength (RDRV pin)
  - 30 V/ns to 100 V/ns adjustability
  - No compromise in gate-drive inductance
- Fault monitoring and protection
  - UVLO protection
  - Over-current protection (20nS)
  - Over-temperature protection
- SPICE model and EVM at ti.com
- Package: 8 x 8 mm QFN

Applications

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

Functional Block Diagram

Packaging

8mm x 8mm QFN

Learn more at www.ti.com/GaN
**Features**

- 80-V 18 mΩ devices for 10 A DC operation
- Integrated High-side and Low-side GaN driver and FETs
- Internal bootstrap supply voltage clamping to prevent GaN FET overdrive (5.2 V)
- Fast Propagation delay (25 ns)
- Excellent HS and LS matching (2 ns)
- Package: 6 x 8 mm QFN
- SPICE model at ti.com
- EVM available at ti.com

**Applications**

- High speed synchronous buck converters
- Wide $V_{IN}$ to point-of-load single step converters
- Isolated DC/DC
- Class D Audio Amp
- 48-V Motor drive

**Packaging**

Learn more at www.ti.com/GaN
UCD3138: Advanced Digital Power Controller

Key Features

- 3 Independent, Multi-Nestable Feedback Loops
- 16MHz Error Analog to Digital Converter (EADC)
- 14-bit (effective) DAC for control loop reference
- Dedicated PID hardware, 2p/2z configurable
- 8 High Resolution DPWM Outputs with Leading, Trailing or Dual Edge (Triangular) Modulation
- 4ns Freq resolution, 250ps Pulse Width resolution
- 2MHz Max Switching Frequency

- High-Performance 31.25MHz, 32-bit ARM7 Processor
- On-Chip Program & Data Flash, RAM and ROM
- 14 Channel, 12-bit, 267ksp general purpose ADC
- 2 UART’s + PMBus Interface + JTAG Debug port
- 7 50ns Analog Comparators, Cycle-by-cycle ILIMIT
- On-chip (BOD / POR), Single Supply Operation (3.3V)
- External Interrupt + Fault Input & Output
- Bootload using ROM (PMBUS) and Program Flash (UART)

- Configurable Feedback Control
  - Voltage Mode
  - Average Current Mode
  - Peak Current Mode with slope compensation and programmable blanking time
  - Constant Current, Constant Power

- Configurable Modulation Methods
  - Multiple Light Load Efficiency Modes
  - Integrated Copper Trace Current Sensing

- -40° C to +125° C Extended Temp Range
- 64pin and 40pin QFN packages
• White papers
• Applications notes
• Device samples and EVM
• Spice models
• Online “E2E” community forums

Learn more at www.ti.com/GaN
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