

Making Reliable and High-Density GaN Solutions a Reality

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Today's Topics

Why is GaN
Exciting

GaN
Fundamentals

Cost and
Reliability

Totem Pole
PFC

Isolated
LLC

Wide-Vin
DCDC

Motor
Drive

Driving
GaN

GaN Device
Examples

Choosing a
GaN Supplier

Why GaN?

Why GaN: 3x Power Density from AC-to-POL

1kW
GaN
Solution

COOLER:
99% efficient
Totem Pole PFC

FASTER:
1 MHz Isolated
DC/DC LLC

SMALLER:
Single stage
Stackable 48V-to-POL

230V
AC

400V
DC

48V
DC

1V
DC

GaN: 156 W/in³ (9.5 W/cm³)
Versus
Silicon: 55 W/in³ (3.4 W/cm³)

195 x 84 mm

GaN: 140 W/in³ (8.5 W/cm³)
Versus
Silicon: 95 W/in³ (5.8 W/cm³)

94 x 84 mm

GaN: 140 W/in³ (8.5 W/cm³)
Versus
Silicon: 40 W/in³ (2.4 W/cm³)

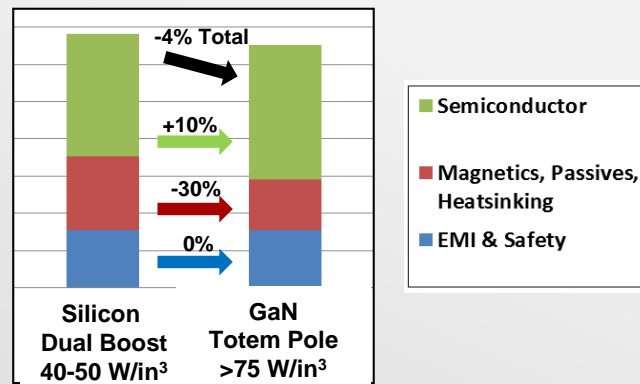
102 x 102 mm

Cost and Reliability

GaN Cost: Demystifying the Myth

- GaN is not a drop-in replacement for silicon MOSFET. FET to FET cost comparison is misleading.
- GaN achieves new levels of power density not possible by silicon, and by enabling:
 - **New topologies** eliminates costly power components
 - **10x switching frequencies** reduce the cost and size of magnetics and cooling
 - **New architectures** cuts component count by half
- In these applications GaN enables solution cost parity with silicon at a minimum 2X increase in power density.

- Example: PFC designs, GaN delivers total cost on par with silicon at double the power density



GaN Reliability: Not a Science Fiction

- After years of work by industry leaders, GaN is delivering the reliability and the ruggedness that the power supply engineers expect.
- For instance Texas Instruments has long implemented a comprehensive methodology to ensure reliable operation and lifetime of GaN devices under the harshest operating conditions
- Our >7 million device reliability includes:
 - JEDEC JESD47I test conditions for temperature, bias, and operating life test
 - Accelerated hard-switching testing
 - Power supply system-level operation
- New JEDEC committee, JC70, is working on releasing a standard on GaN reliability and qualification procedures

Example: Isolated DCDC LLC

GaN: A Superior Solution for LLC

- **Reduced Output Capacitance**

- Low COSS reduces dead-time, increasing the time when current delivered to the output
- Low COSS allows larger magnetizing inductance and lower circulating current losses as well as transformer fringe-field losses

- **Reduced Gate Driver Losses**

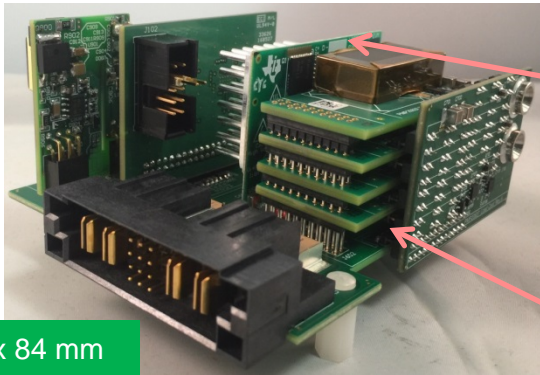
- GaN superior switching characteristics significantly reduce gate driver loss for LLC application

- **System Optimization**

- GaN enables higher switching frequency to reduce magnetic components significantly
- GaN enables LLC converter with higher efficiency and higher power density

TI-GaN: 1MHz Isolated LLC DCDC Converter

	Design Target
Input voltage (V)	380 ~ 400
Output voltage (V)	48V Nom unregulated
Power (W)	1000
Integrated Transformer size (mm)	33 x 53 x 43
Power density	140 W/in ³ (8.5 W/cm ³) High power density
Efficiency	>97% High Efficiency
Switching frequency	1 MHz High Frequency



**LMG3410
Half bridge**

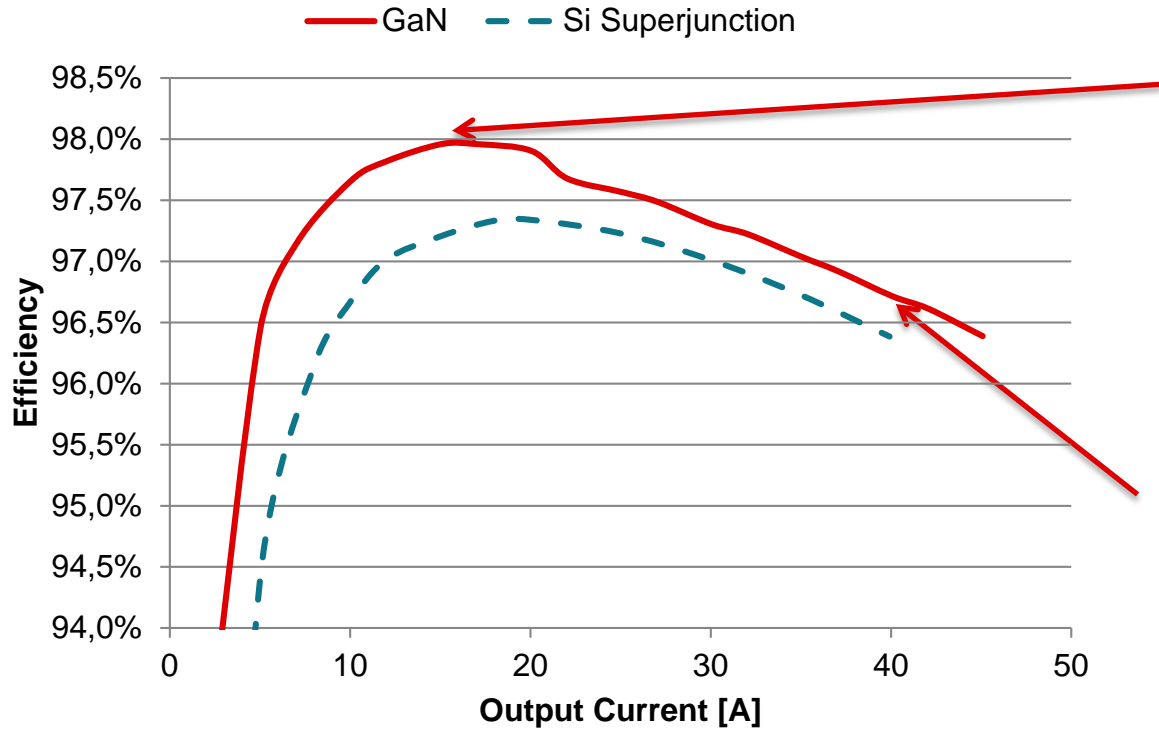
**Integrated
Transformer**

**Power Density: 140 W/in³ (8.5 W/cm³)
Versus
Silicon: 95 W/in³ (5.8 W/cm³)**

[Click Here for more information.](#)

94 x 84 mm

Efficiency: Comparison with Silicon

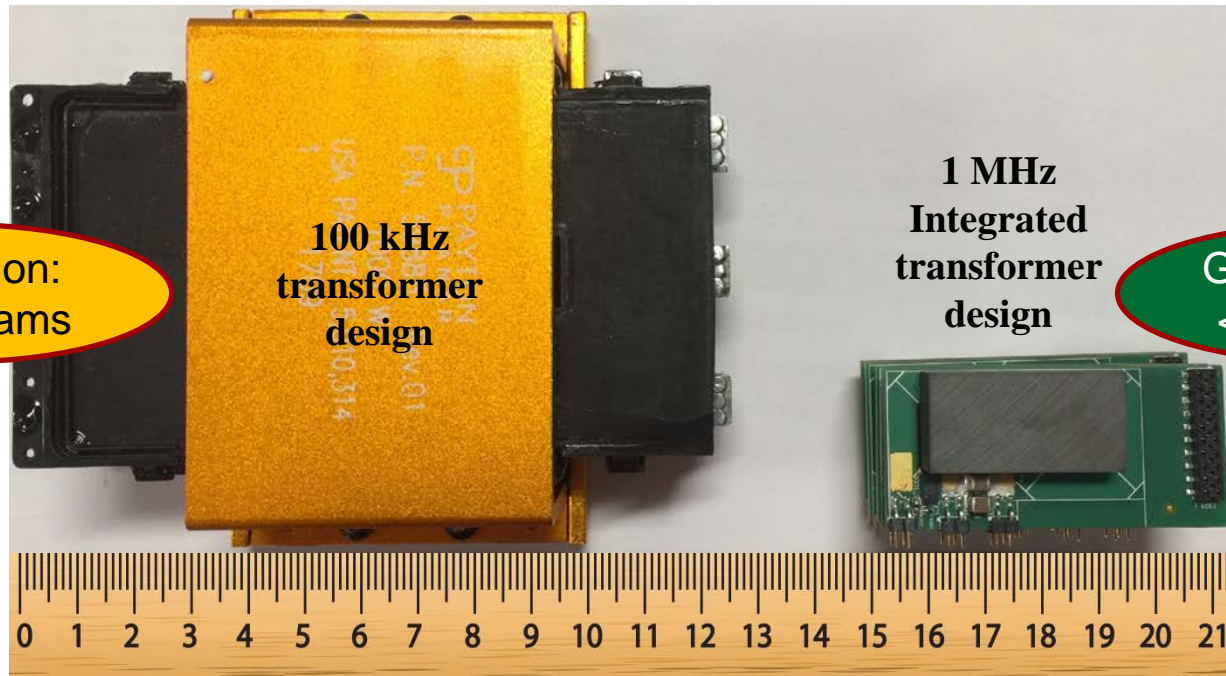


Reduced capacitance & circulating currents dramatically improve light-load efficiency

Resistance Limited (slight improvement)

GaN Solutions: 6X Smaller and Lighter Solutions

Example based on 1kW 480V:48V Isolated DCDC Design

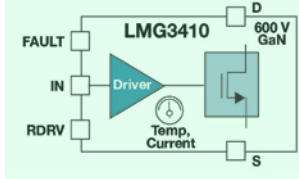


GaN Device Example

Choosing a GaN Supplier

Choosing a GaN Supplier: What Questions to Ask

GaN



- Reliable switching at 100v/ns and frequencies to 1MHz and beyond
- Robustness under short circuit and thermal conditions
- Solution size

End-to-End Solution



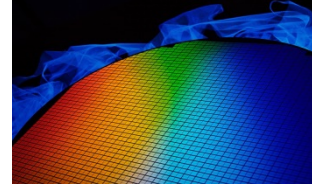
- Power managements expertise
- GaN ecosystem of advanced controllers
- Fully developed reference Designs

Reliability



- Qualification beyond JEDEC MOSFET standards
- Hard-switching and application relevant stress data

Supply Chain



- High volume supply chain to ensure continuity of supply
- Includes fab, assembly, and test strategy

Total Solution Cost



- Proven System cost parity with silicon at 2X the power density.
- Committed to long term cost reduction investments

Conclusion

- GaN is enabling a new generation of power conversion designs not possible before.
- GaN enables 3X power density improvement from AC to Point-of-Load
- 1MHz isolated LLC design delivers 6x reduction in size and weight of the solution
- GaN enables the integration of 100kHz drive and motor by reducing the solutions size and eliminating heatsink
- Integration of driver and GaN in a low inductance package provides an optimal solution for fast and reliable switching
- When selecting a GaN, we need to consider switching performance, supplier's power management expertise, reliability methodology and supply chain
- Learn more at www.ti.com/GaN