The GaN journey begins...
Agenda

• Intro to EPC
• Why it’s the end of the line for silicon in high frequency power conversion
• Why GaN?
• Overview of EPC eGaN technology
• Applications Examples
• EPC’s product offering
Mission and Purpose

We enable the most efficient energy conversion using superior semiconductor materials

EPC designs, develops, markets, and sells Gallium Nitride based power management devices
Background for the Strategy

- Silicon has reached performance limits in power management
- New materials now enable a game-changing price/performance ratio
Why Gallium Nitride?

• GaN offers superior performance compared with both silicon and silicon carbide
  – $R_{D_{SON}} \times \text{Area}$
  – Very high switching speed
  – Body Diode has no $Q_{RR}$
  – High Voltage Capability at low $R_{DS(ON)}$
Why Gallium Nitride?

- Device-grade gallium nitride can be grown on top of silicon wafers and processed in standard CMOS facilities.
- GaN-on-silicon offers the advantage of self-isolation and therefore efficient power devices can now be made monolithically.
- EPC has developed proprietary technology for the first *enhancement-mode* devices (eGaN) to be offered on the market!
The on-resistance ($R_{DS(ON)}$) for a given device area is a key determinant of product cost.
Why eGaN?

Smaller Die Sizes

EPC’s products have the same on-resistance and are significantly smaller than the best silicon parts available.

200V Silicon Device (30 mΩ)

200V eGaN Device (25 mΩ)
eGaN can enable applications beyond the range of silicon
200 V Figure of Merit

FOM = $R_{DS(ON)} \times Q_G$

eGaN can enable applications beyond the range of silicon
Converter Efficiency

250 kHz

Eff(%) vs. I_{OUT} (A_{DC})

- 12V-1V
- 24V-1V
- 48V-1V

eGaN can enable applications beyond the range of silicon
DC-DC converters using EPC’s eGaN transistors have power losses that are more than 50% less than the closest competitive solution.
POE – 12 A
Full Bridge

Power Dissipation Per Leg

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<th>Cond</th>
<th>Vin (V)</th>
<th>Vout (V)</th>
<th>freq (MHz)</th>
<th>Vgs (V)</th>
<th>Rsrc (Ω)</th>
<th>Rsnk (Ω)</th>
<th>L (nH)</th>
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# Hard Switched PFC

## Table

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<th>Part Number</th>
<th>Package</th>
<th>Mode</th>
<th>Configuration</th>
<th>Vds</th>
<th>Vgs</th>
<th>Rdson (mΩ) 5V</th>
<th>Rdson (mΩ) 100C</th>
<th>Q5</th>
<th>Qgs (nC)</th>
<th>Qqd (nC)</th>
<th>Vgth (V)</th>
<th>Rg (Ω)</th>
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## Diagram

- **PFC Switch Losses**
  - **Output**
  - **Gate**
  - **Switching**
  - **On State**

- **180V**
  - **450V**
- 100kHz
- 3A
- **Q Control**
eGaN Structure

- AlGaN Electron Generating Layer
- Dielectric
- Aluminum Nitride Isolation Layer
- GaN
- Si
Flip Chip Assembly
eGaN Characteristics

No Negative Temp Coef region like MOSFETs

Fully enhanced at 5V

V_TH essentially FLAT

Compared with MOSFET

Very low Q_G

R_DS(ON) rise lower than MOSFET for similar temp rise
Is eGaN easy to use?

It’s just like a MOSFET except for **TWO** things

(1) The high frequency capability makes circuits using eGaN transistors very sensitive to layout

(2) eGaN transistors are more sensitive to gate rupture than power MOSFETs
### EPC Shortform

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package (mm)</th>
<th>Mode Ch</th>
<th>Vds</th>
<th>Vgs</th>
<th>Max. (R_{dson}) (mΩ) @5V</th>
<th>(Q_g) @5V</th>
<th>(Q_{gs}) Typ.</th>
<th>(Q_{gd}) Typ.</th>
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Preliminary information subject to change

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**Lead Free Available December 2010**

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EPC - The Leader in eGaN
EPC MOSFET Killer Products

LGA 4.1x1.6 x0.8

LGA 3.6x1.6 x0.8

LGA 1.7x1.1x0.8

LGA 1.7x0.9x0.8

Development Board available
EPC’s products will cover 90% of the existing power MOSFET market by the end of 2010.
EPC’s 600V eGaN Products will be packaged in this industry standard package
## Silicon Vs eGaN Costs

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<tr>
<td><strong>OVERALL</strong></td>
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...Silicon has reached the end of the road.