



The eGaN[®] FET
Journey Continues

GaN Transistors for Efficient Power Conversion

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CEO

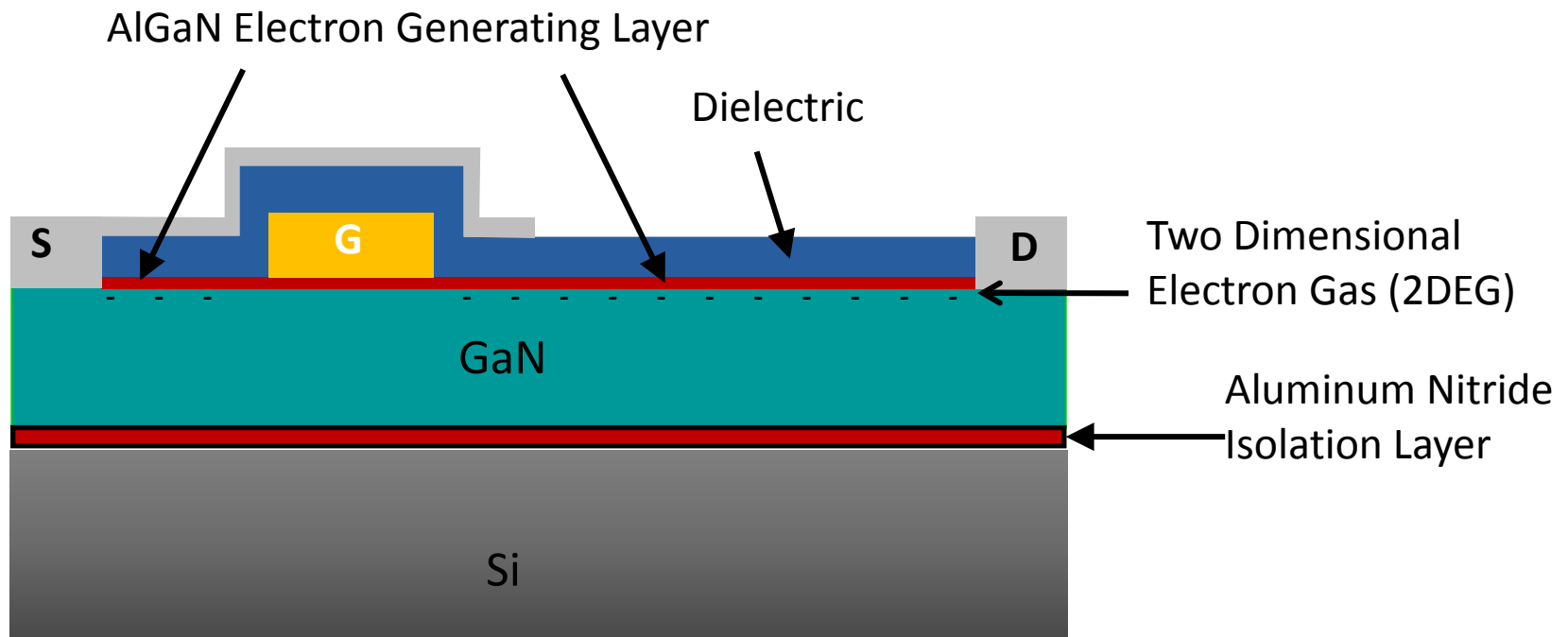
Efficient Power Conversion Corporation

Agenda

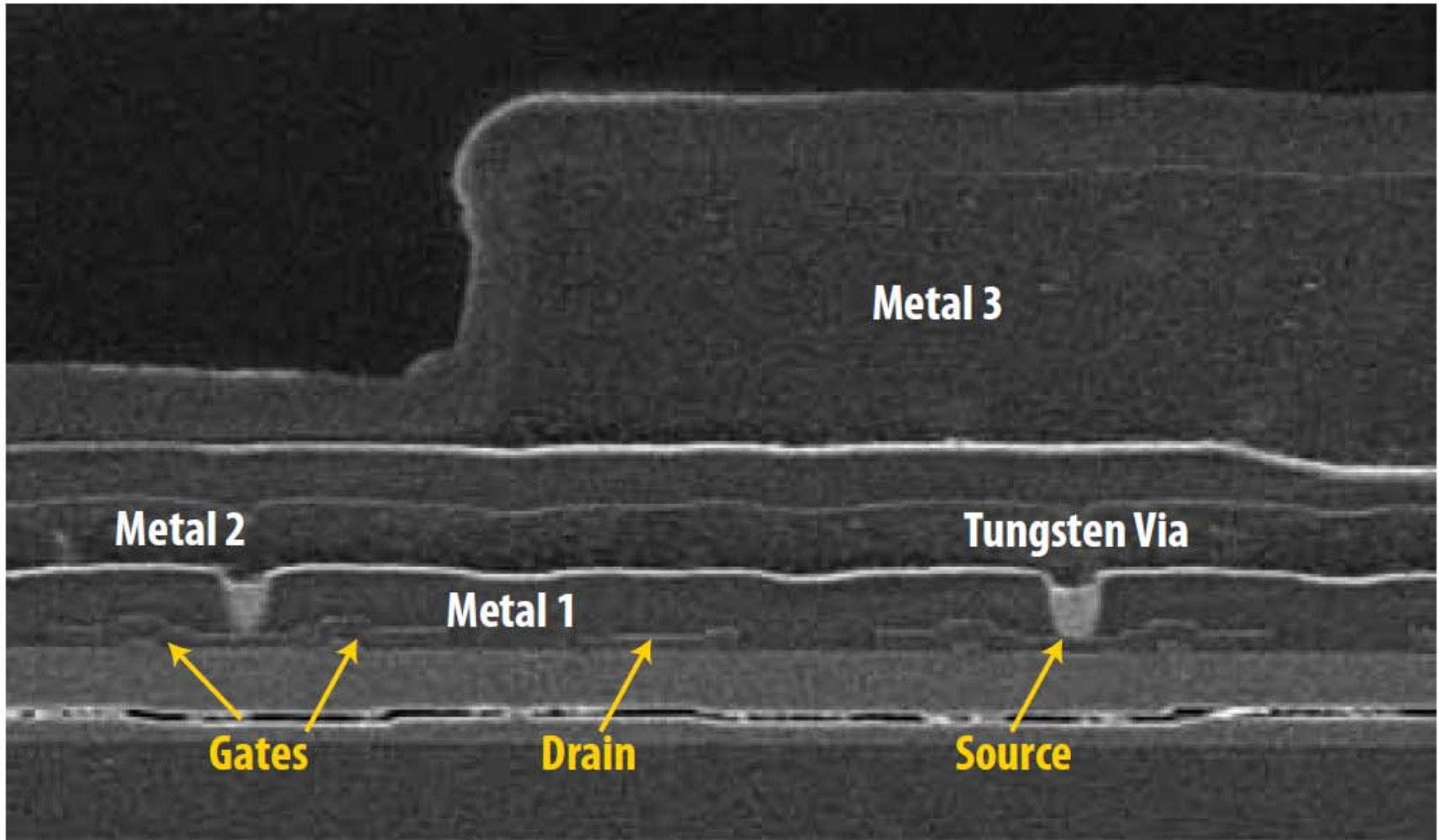
- Overview of eGaN FET Technology
- Improving Power Conversion Efficiency
- What is in the future?

Overview of eGaN[®] FET Technology

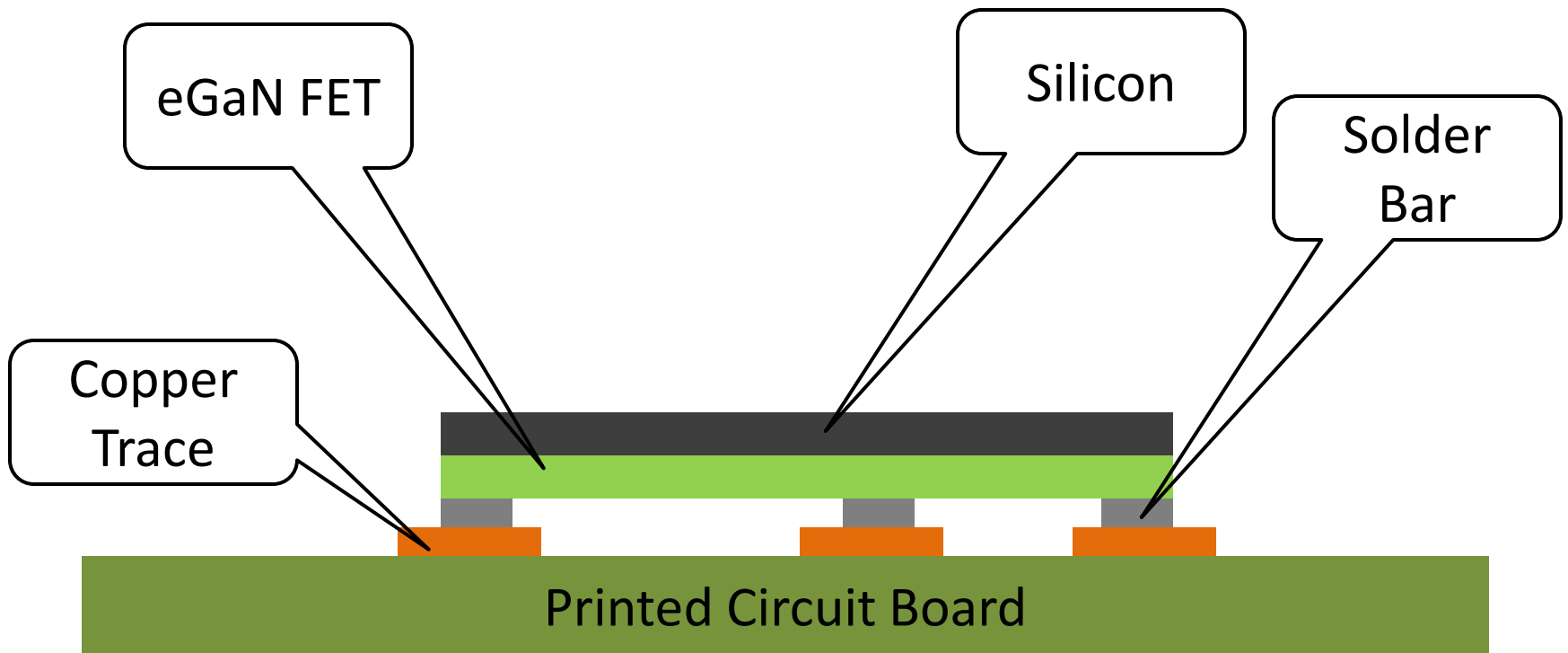
eGaN[®] FET Structure



SEM of an eGaN[®] FET



Flip-Chip LGA Construction



**Absolute Minimum
Lead Resistance and Inductance!**

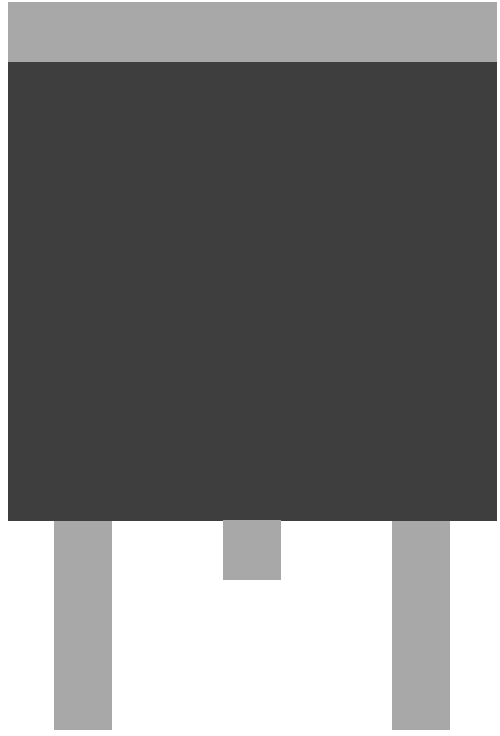
Size Comparison

eGaN[®] FET



5.76 mm²

D-PAK

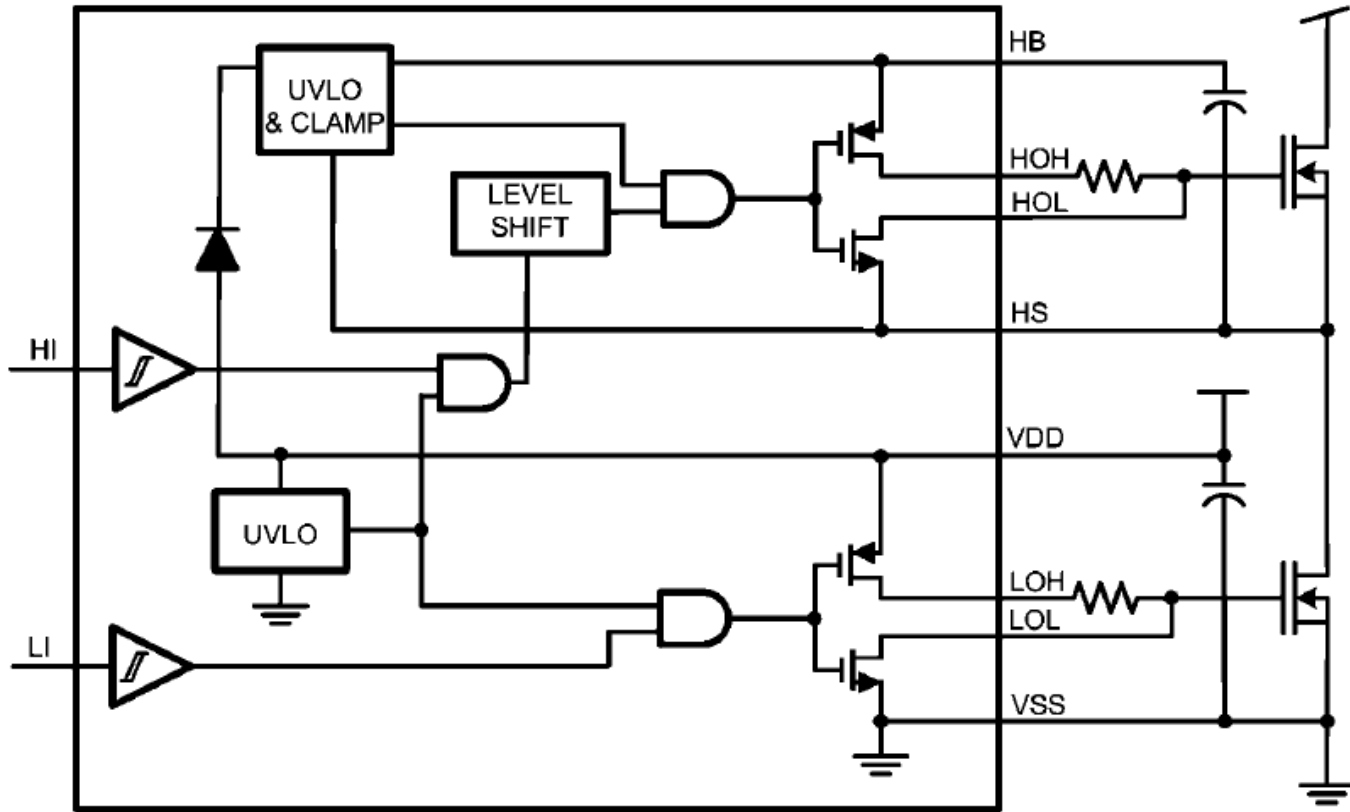


65.3 mm²

Drawn To Scale

Opportunity to Improve DC-DC Efficiency

Integrated Gate Driver Solution



30162903

LM5113 from Texas Instruments

Buck Converter

Advantage:

- **High power density and high efficiency**

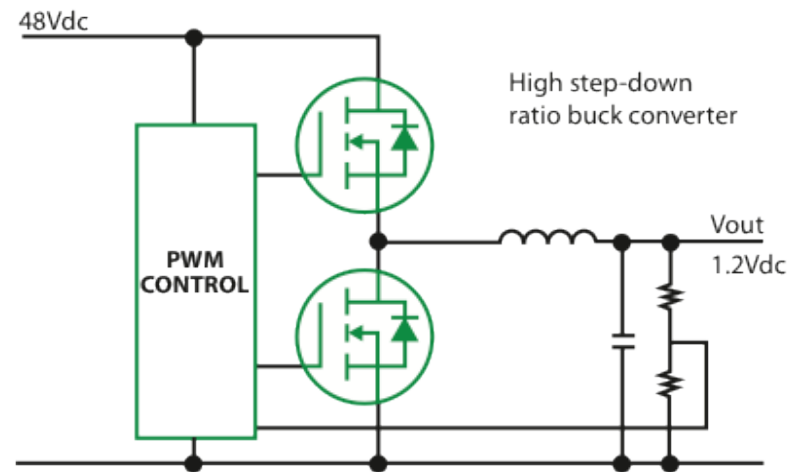
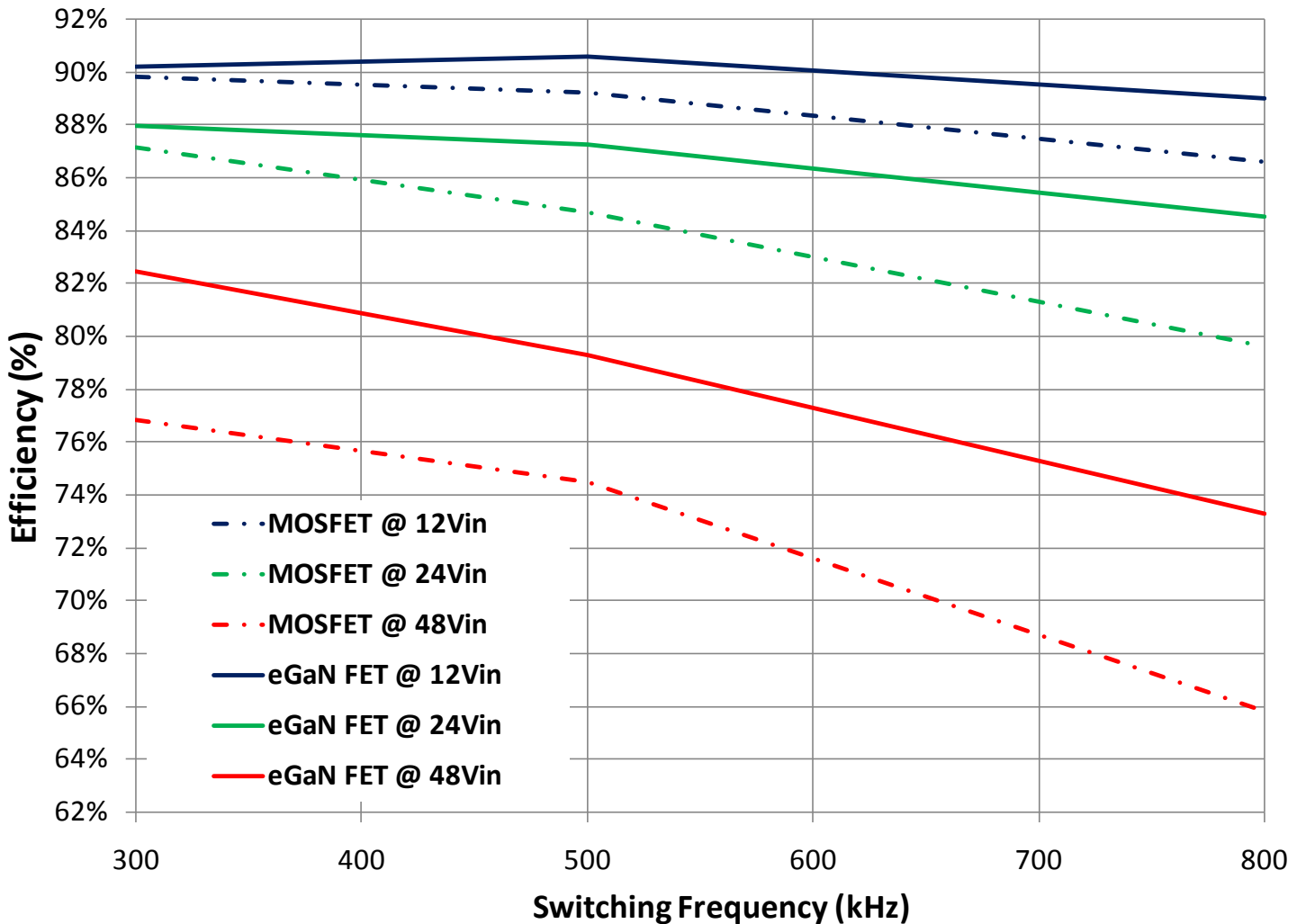


Figure 7 – Buck converter with an input voltage of 48 VDC and output voltage of 1.2 VDC

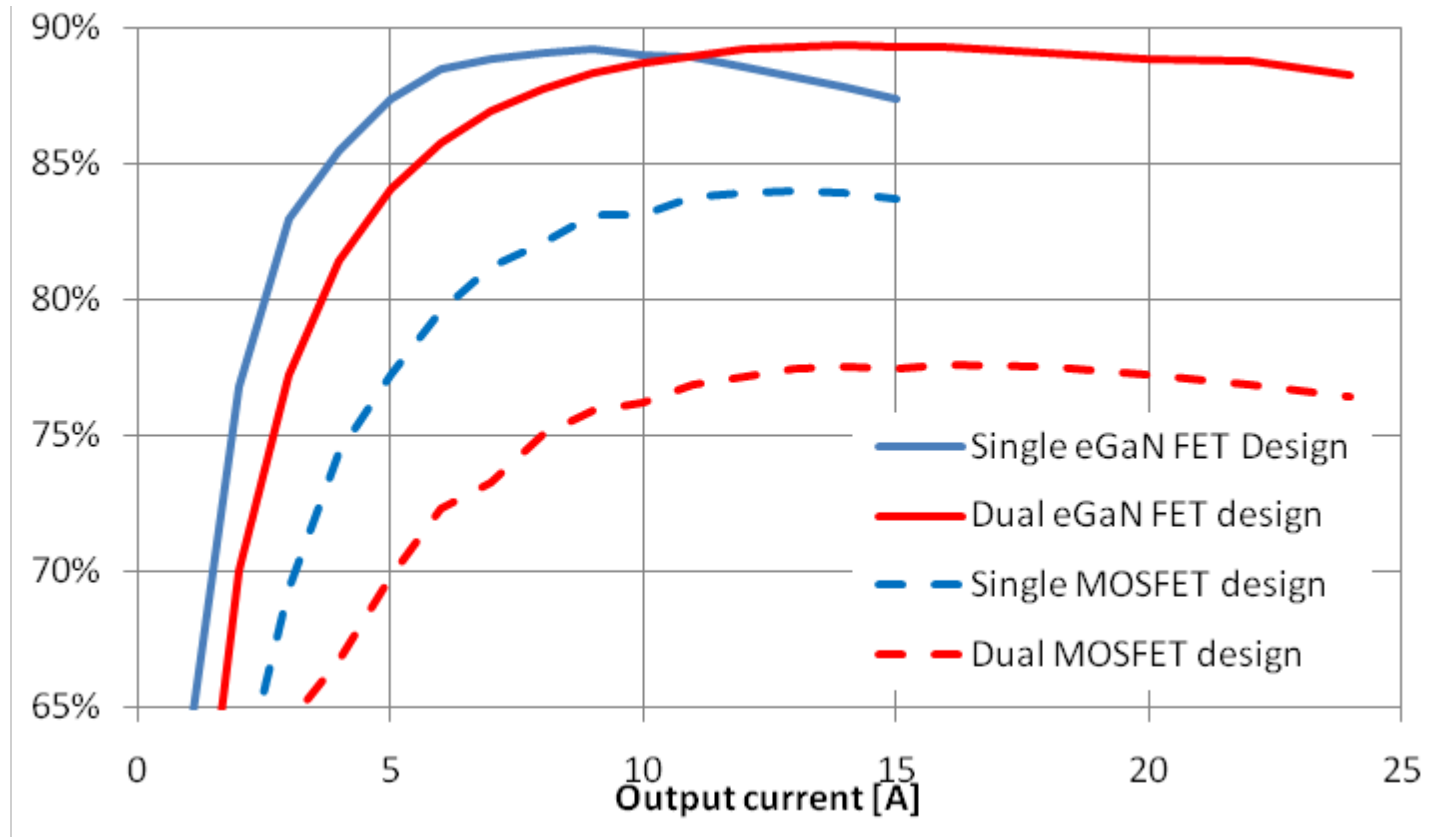
Efficiency vs Frequency

1.2 Vout / 5A



Parallel FET Buck Converter

Efficiency at 1 MHz

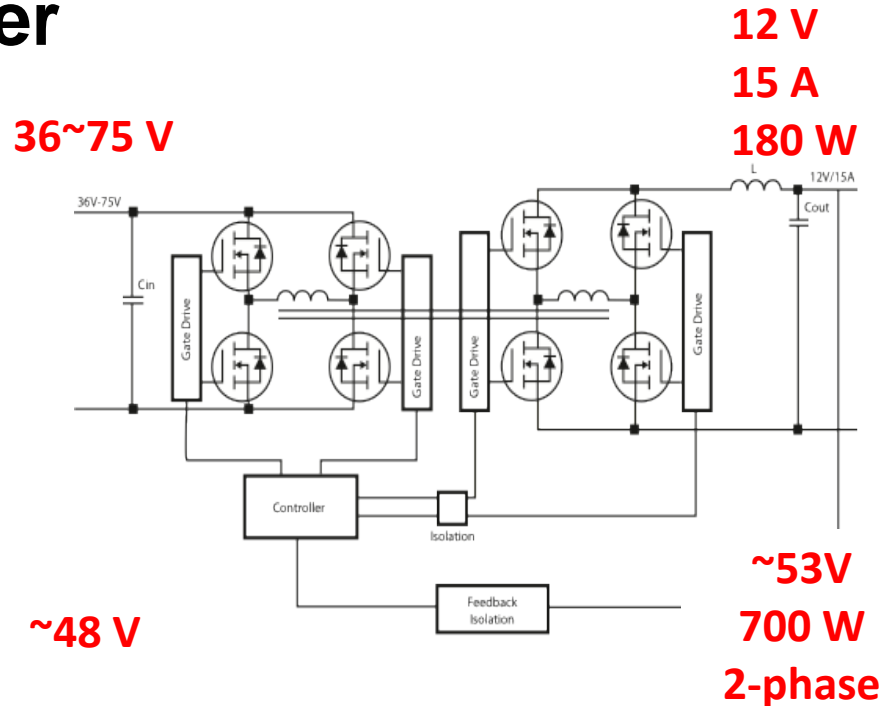


$$12 V_{IN} - 1.2 V_{OUT}$$

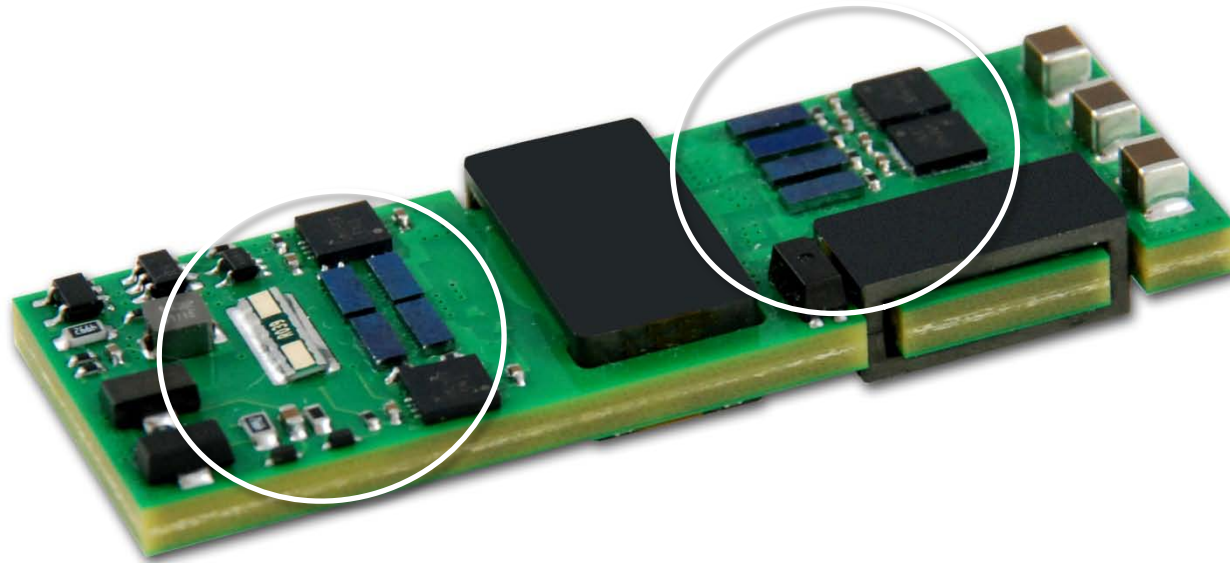
Isolated Full Bridge Converter

Advantage:

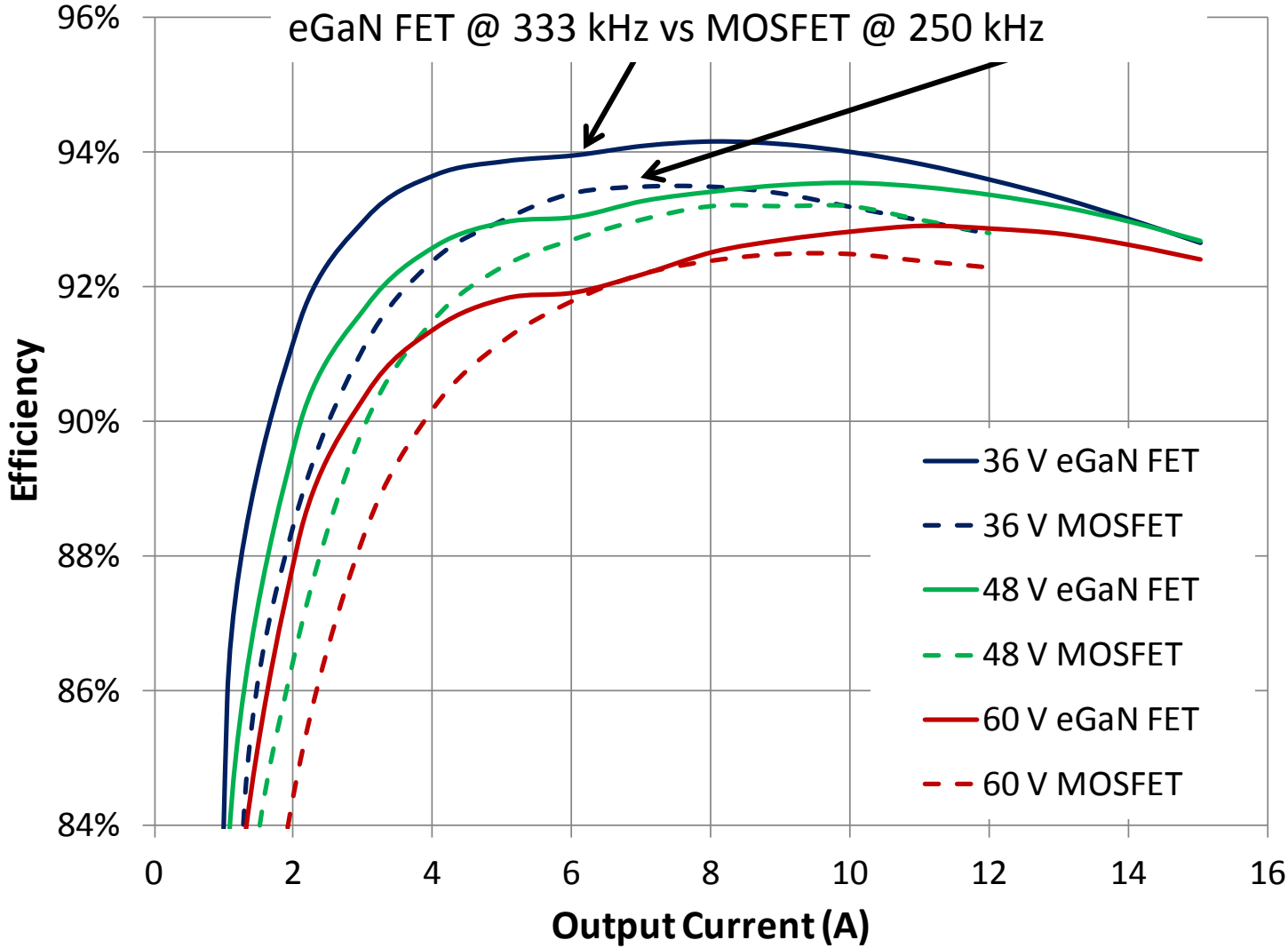
- Isolation and high power density at high power



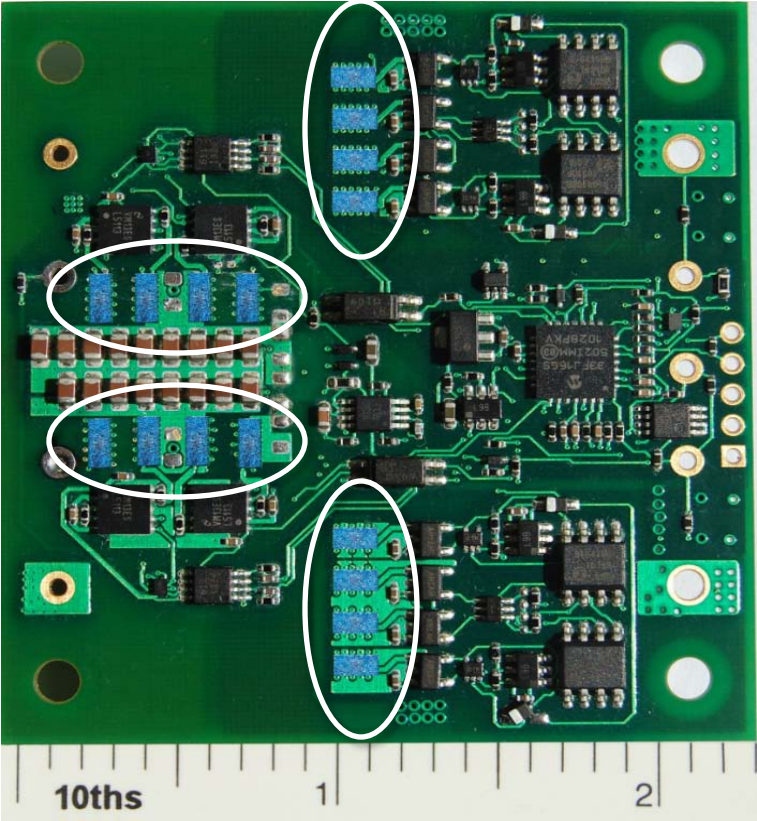
Isolated Full Bridge Converter



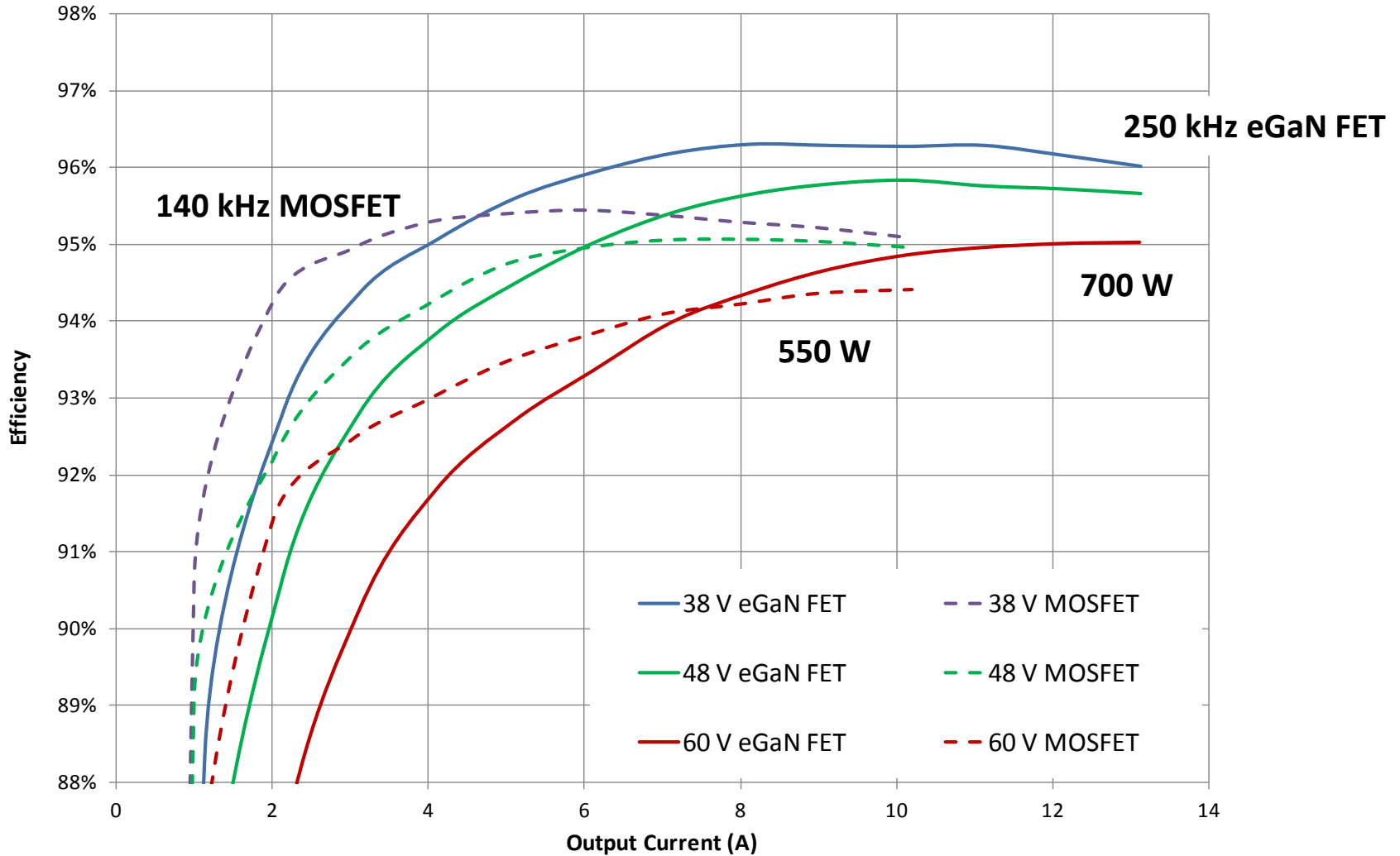
Isolated Full Bridge Converter



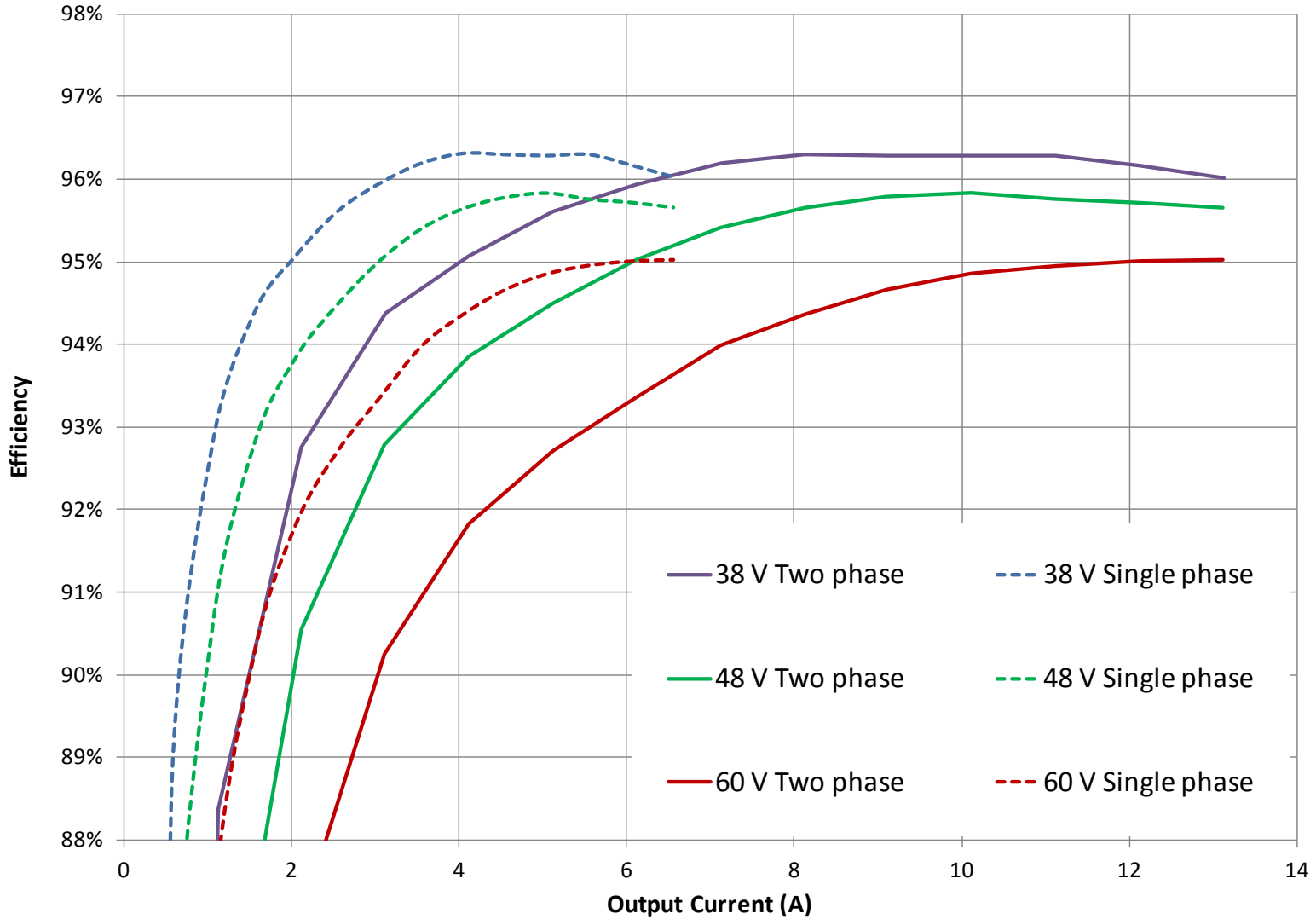
PoE-PSE Full Bridge Converter



PoE-PSE Full Bridge Converter



PoE-PSE Full Bridge Converter



What is in the Future?

Breaking Down the Barriers

- Does it enable significant new capabilities?
- Is it easy to use?
- Is it **VERY** cost effective to the user?
- Is it reliable?

Breaking Down the Barriers

- Does it enable significant new capabilities?
- Is it easy to use?
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Applications for eGaN[®] FETs



- Power Over Ethernet
- Wireless power transmission
- RF DC-DC “Envelope Tracking”
- RF Transmission
- Network and Server Power Supplies
- Solar Microinverters
- LED Lighting
- Class D Audio
- Notebook Power Supply

In China Today



Solar



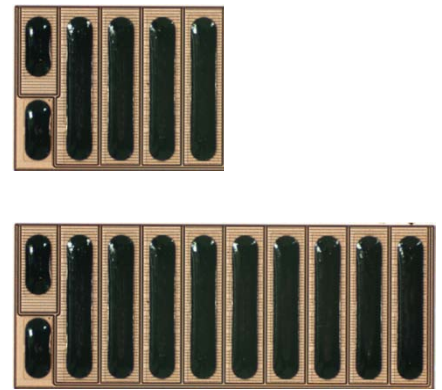
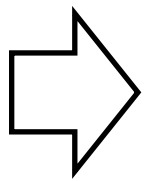
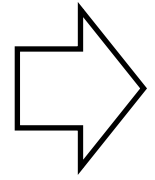
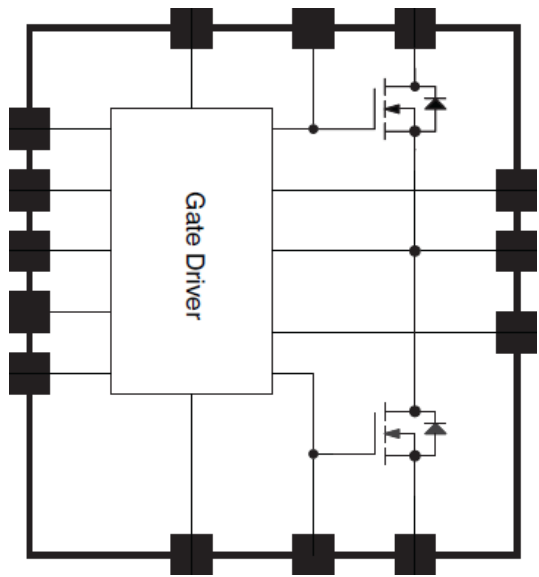
Lighting



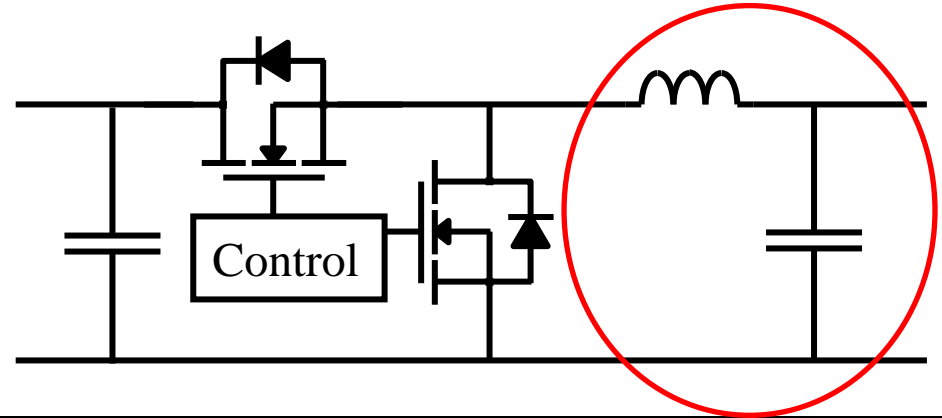
Telecom Power

Application Success Story

Faster Transient Response



4x Frequency



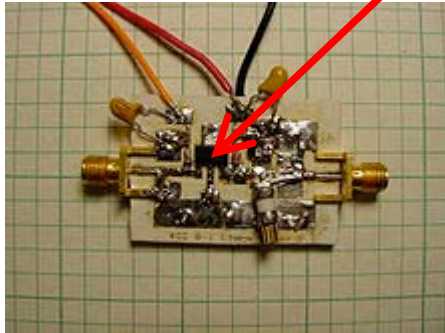
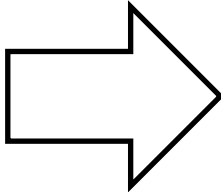
75% Reduction

Another Success Story

RF Power – Medical Radiation



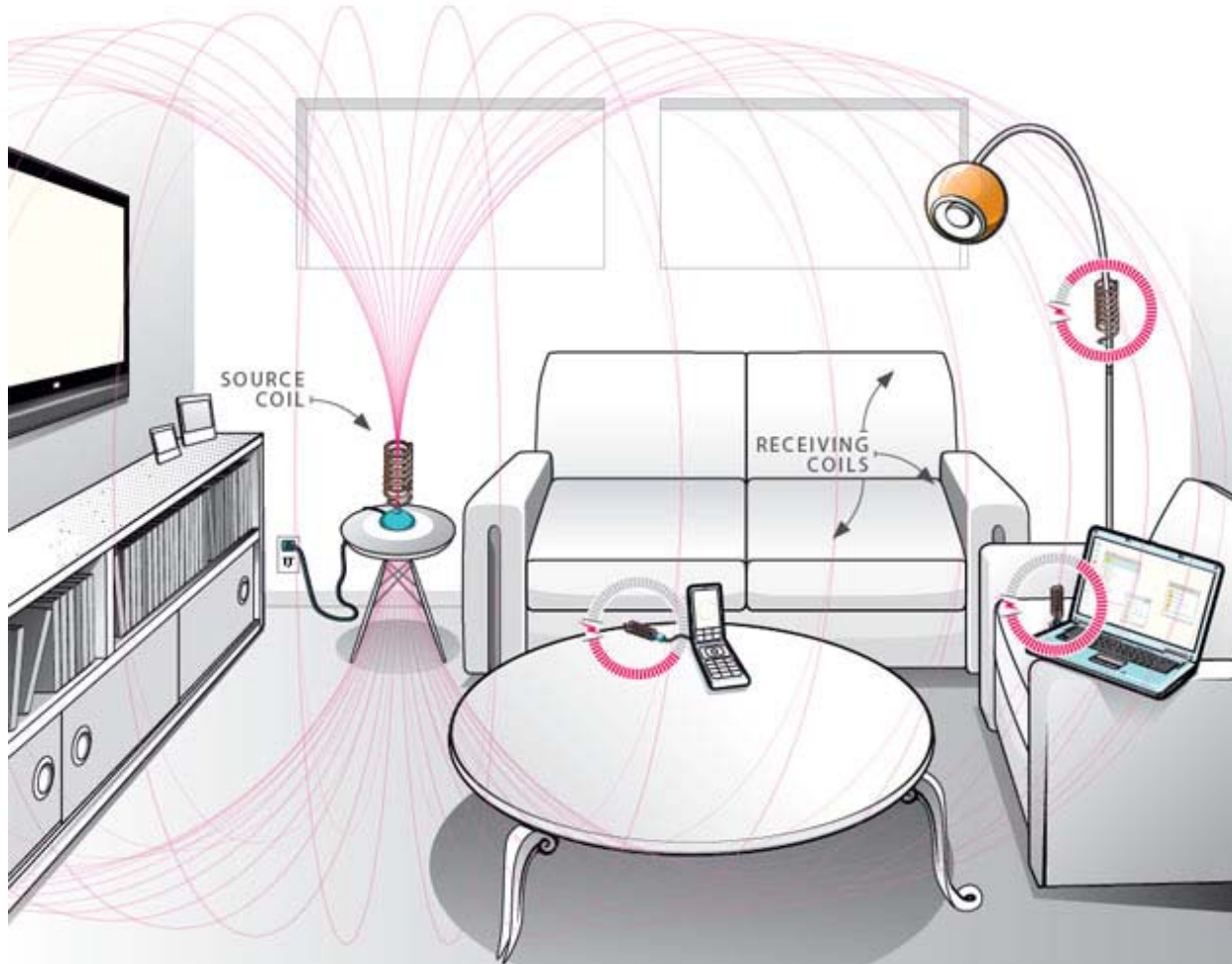
Magnetron
500 MHz



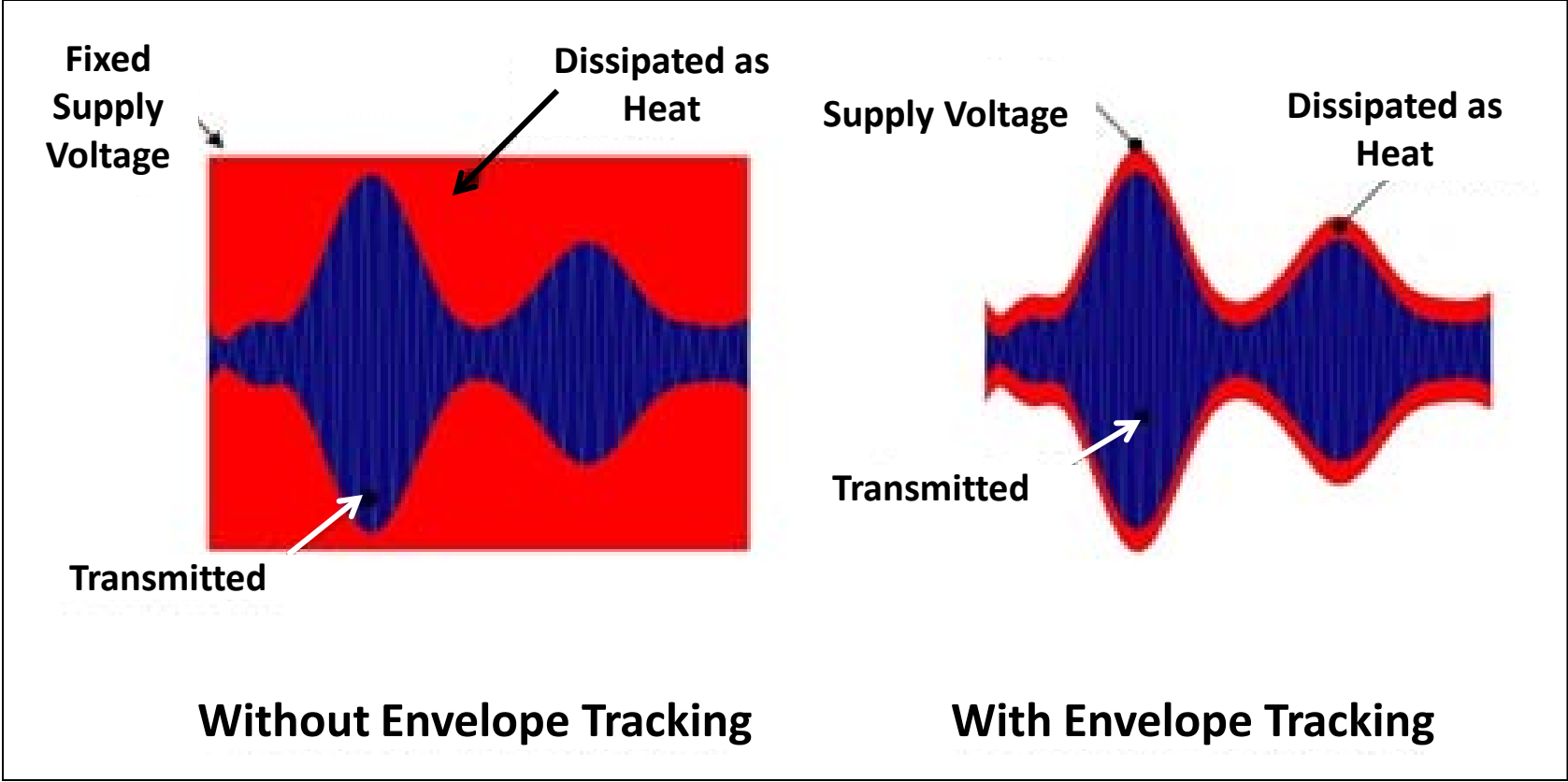
eGaN FET PA
1GHz



Wireless Power



RF Envelope Tracking



Breaking Down the Barriers

- Does it enable significant new capabilities?
- **Is it easy to use?**
- Is it VERY cost effective to the user?
- Is it reliable?

Is it easy to use?

It's just like a MOSFET

except

The high frequency capability makes circuits using eGaN FETs sensitive to layout

The lower $V_{G(MAX)}$ of 6 V makes it advisable to have V_{GS} regulation in your gate drive circuitry

The ultra-small LGA increases the concentration of heat on the PCB

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Silicon vs eGaN[®] FET Wafer Costs

	2010	2015
Starting Material	same	same
Epi Growth	<i>higher</i>	<i>~same?</i>
Wafer Fab	same	lower
Test	same	same
Assembly	lower	lower
OVERALL	higher	<i>lower!</i>

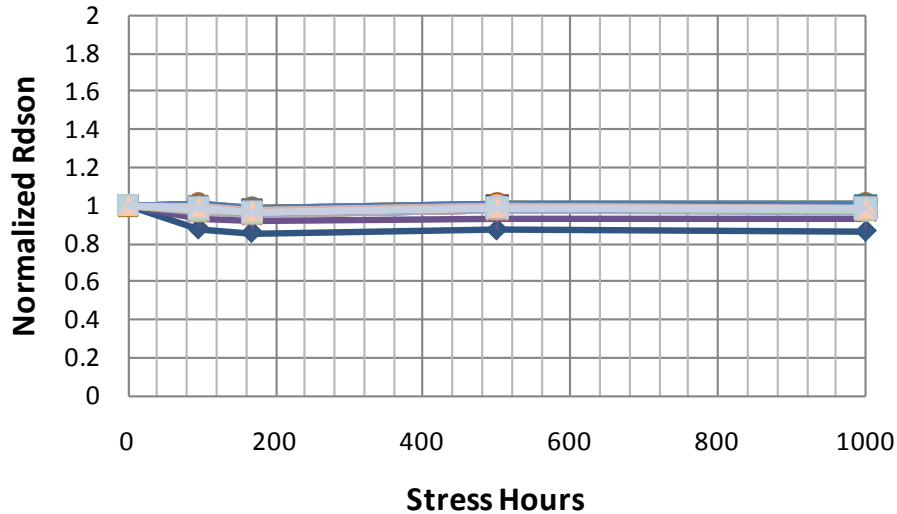
Breaking Down the Barriers

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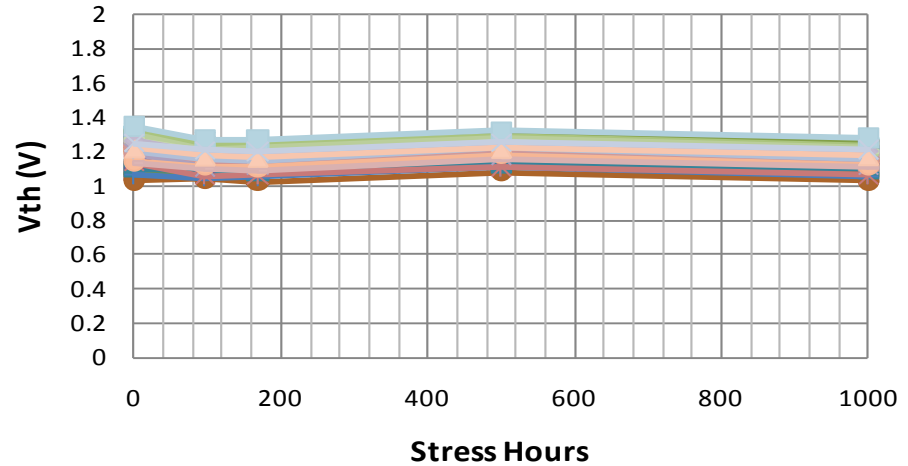
eGaN[®] FETs are Reliable



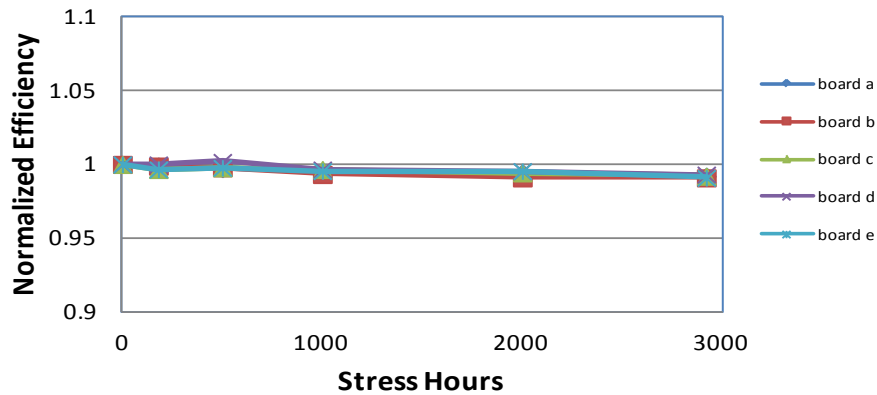
EPC2001 $R_{DS(ON)}$ after $100V_{DS}$ HTRB at $125^{\circ}C$



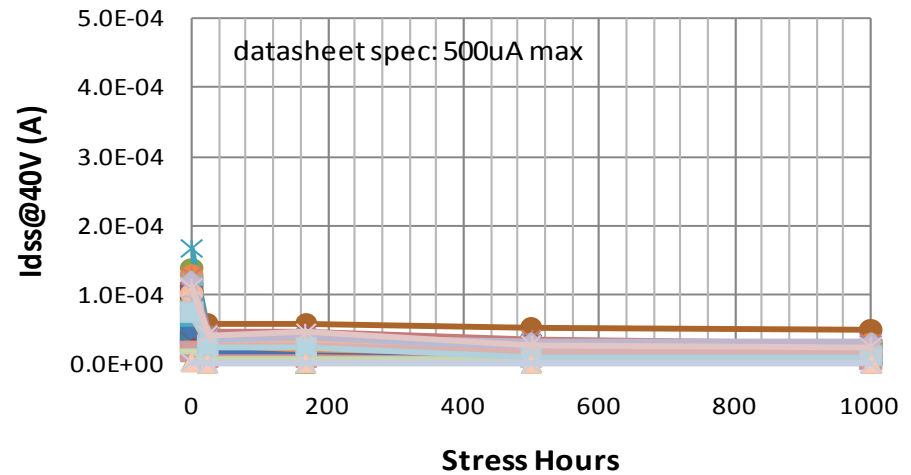
EPC2001 $V_{GS(TH)}$ after $100V_{DS}$ HTRB at $125^{\circ}C$



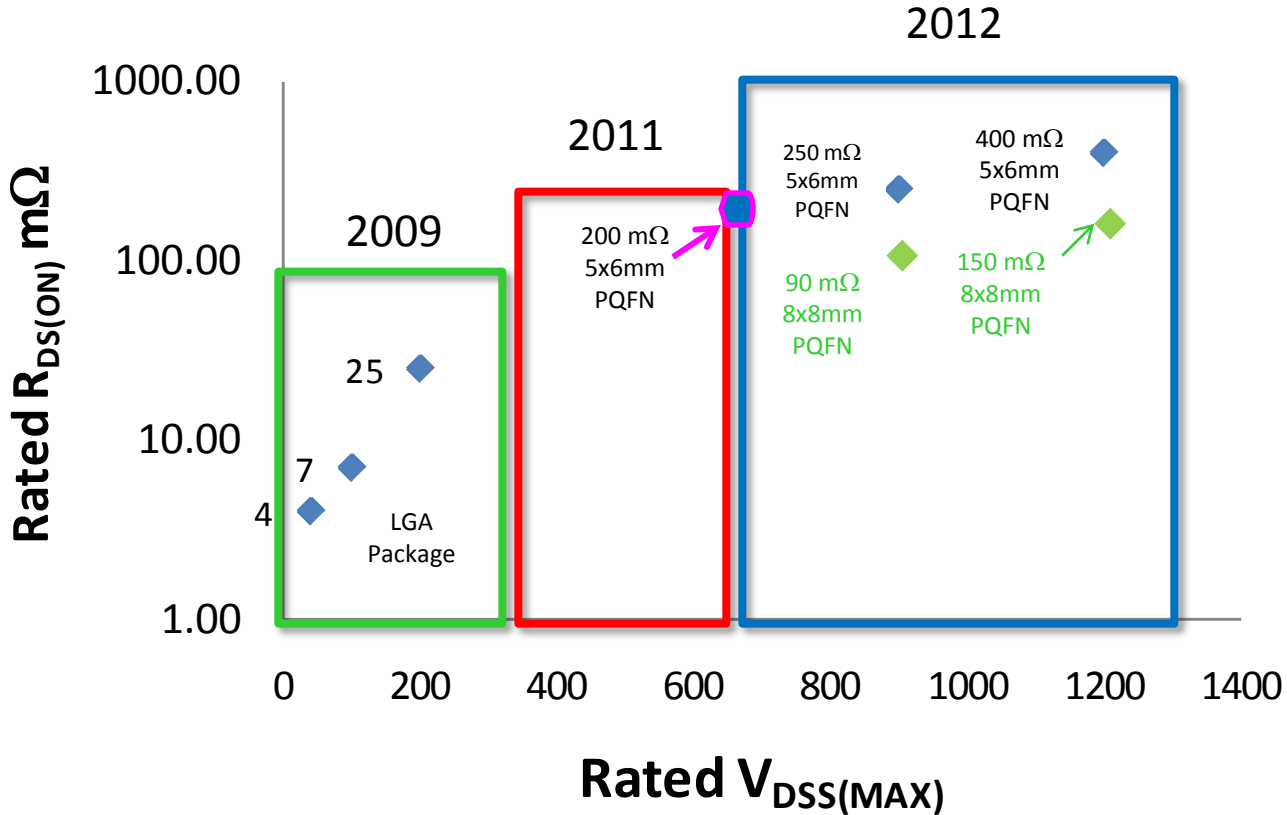
EPC9001 Efficiency after Op Life Test at $85^{\circ}C T_j$



EPC2015 I_{dss} after $40V$ H3TRB at $85^{\circ}C/85\%RH$

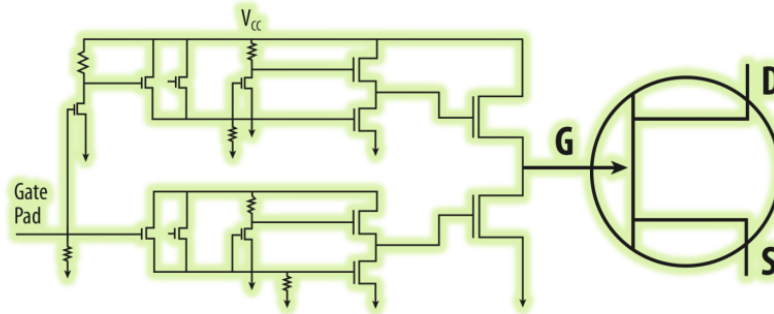


Beyond 600 Volts

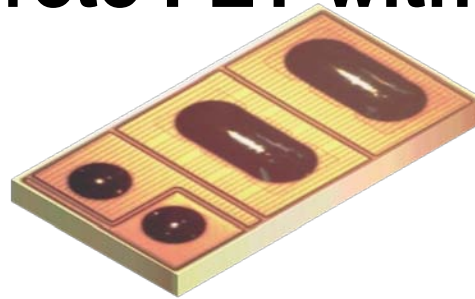


Beyond Discrete Devices

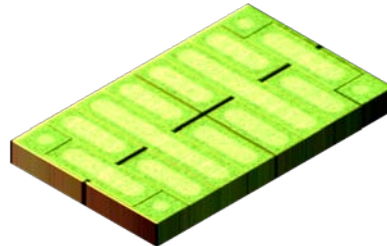
Driver On Board



Discrete FET with Driver



Full-Bridge with Driver and Level Shift



Summary

- eGaN FETs are easy to use but care must be taken due to the higher switching speeds compared with power MOSFETs
- eGaN FETs will replace silicon power MOSFETs in power conversion applications with a low-cost and higher efficiency solution
- Higher voltage devices and the integration of analog plus power will enhance the performance and cost-effectiveness of eGaN FETs



*The end of the road
for silicon.....*

*is the beginning of
the eGaN FET
journey!*

