Is it the End of the Road for Silicon in Power Conversion?

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Paper 7.1

Is This the End of The Road for Silicon in Power Conversion?

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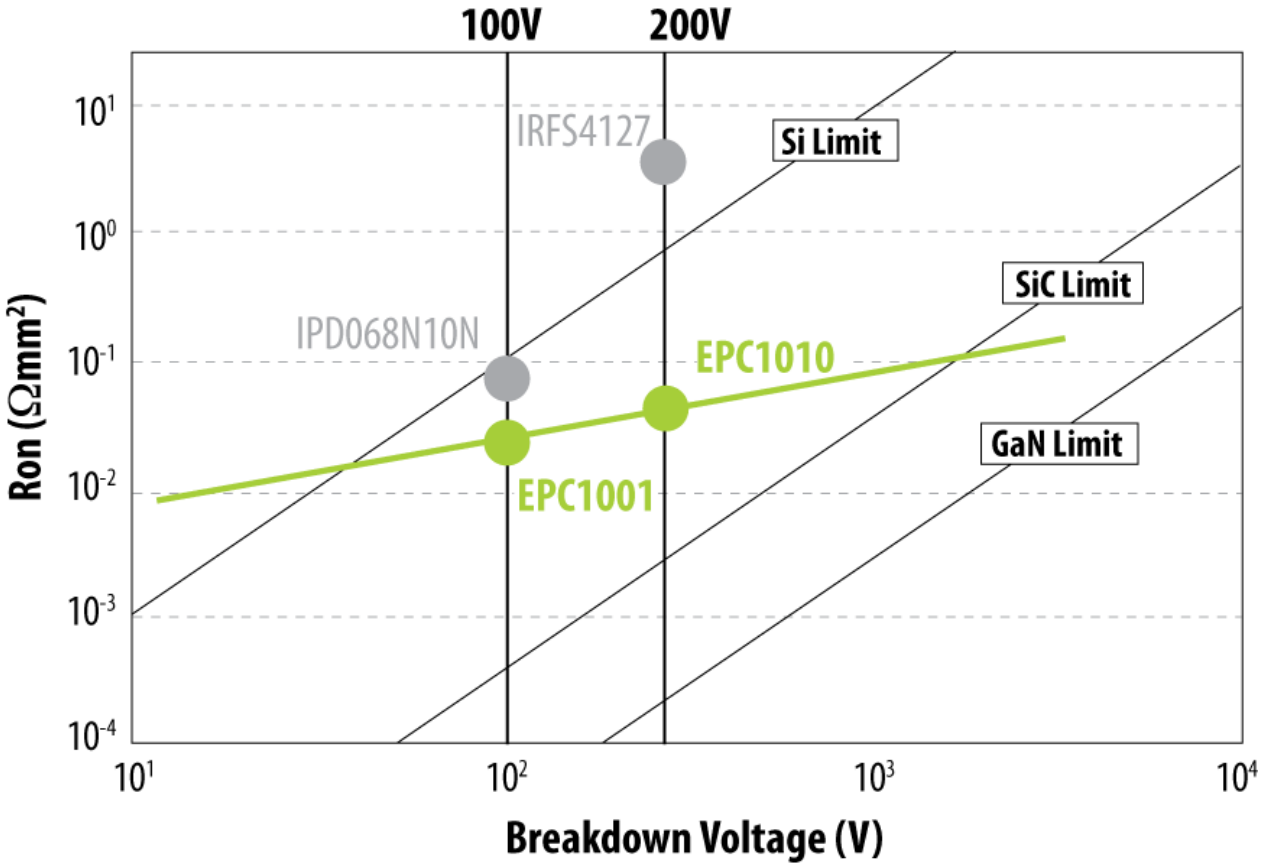
Agenda

- **Why Gallium Nitride?**
- **Breaking down the barriers**
- **What the future might hold**
- **Conclusion**

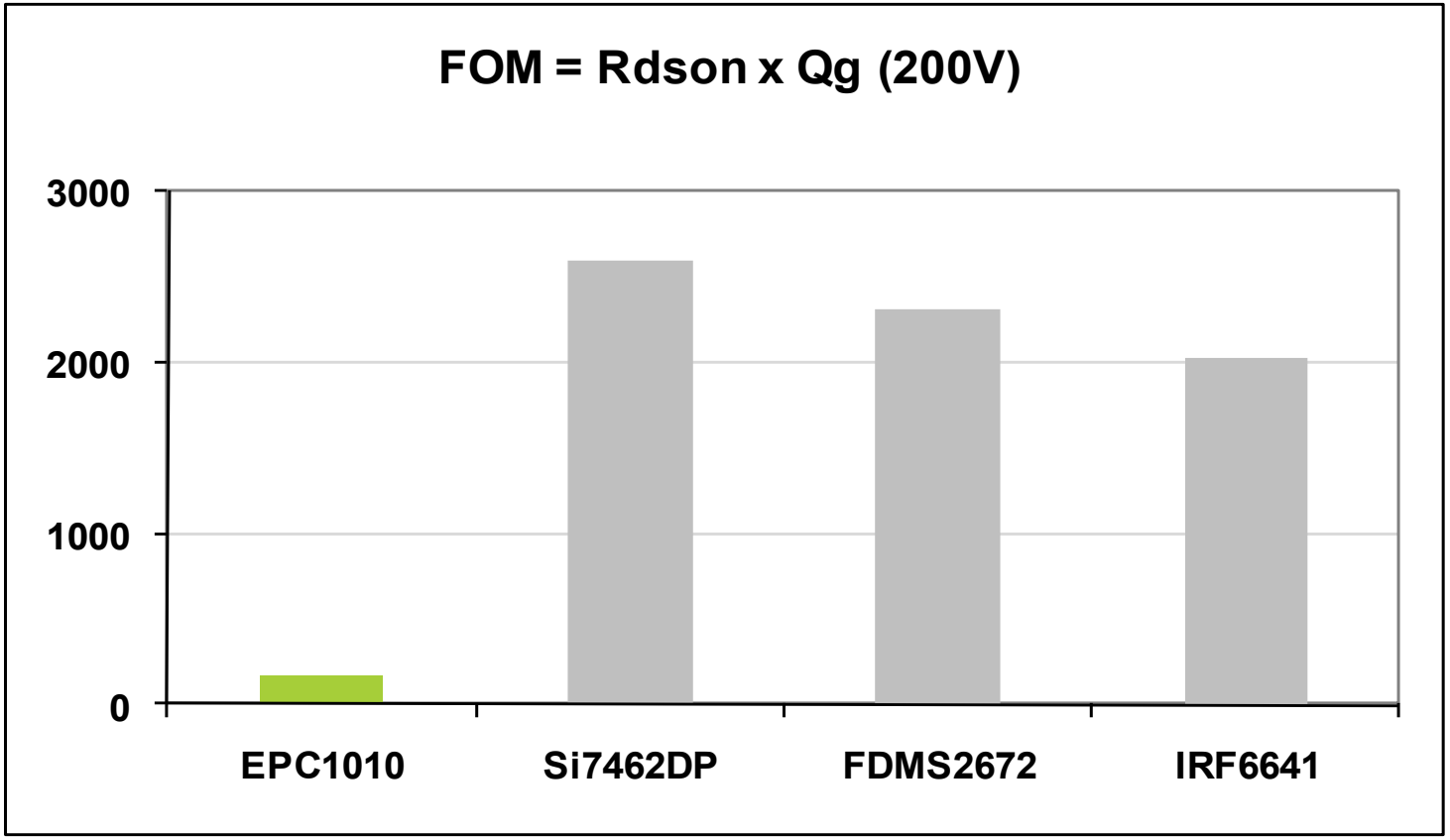
Why Gallium Nitride?

Smaller Die Sizes

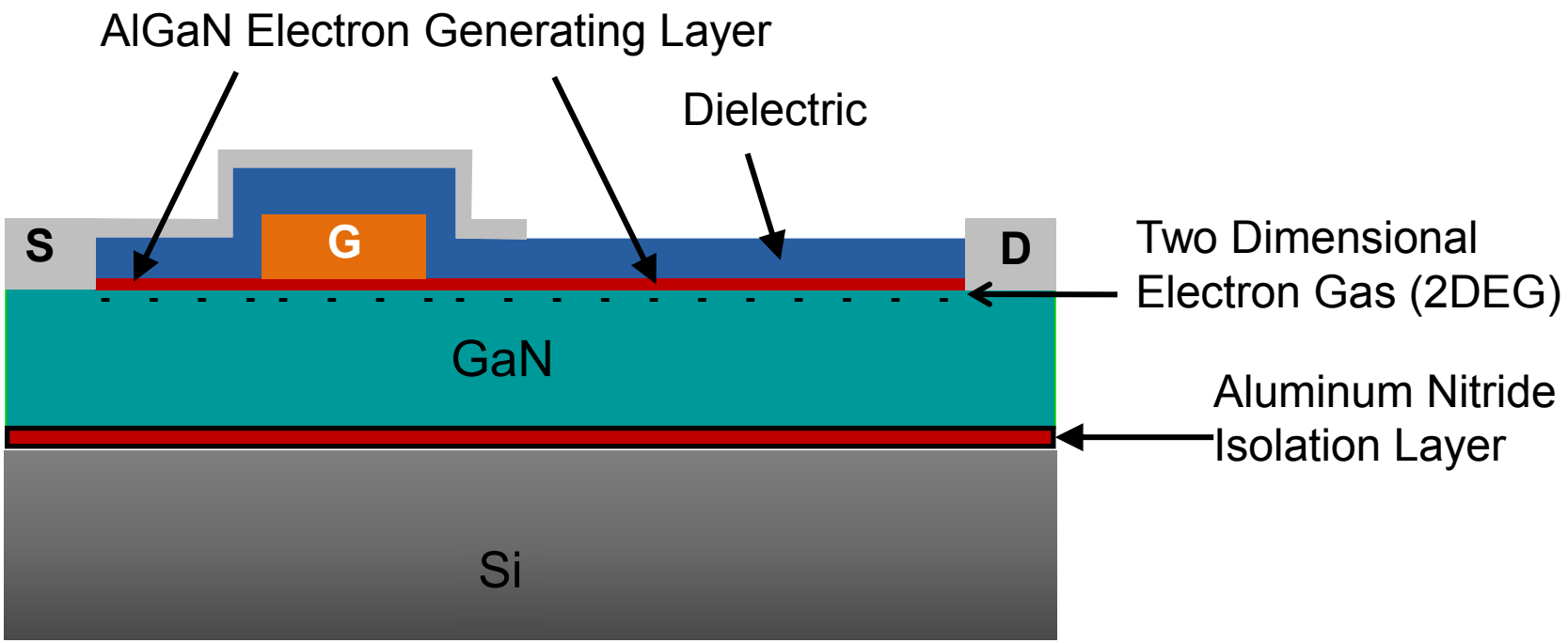


Why Gallium Nitride?

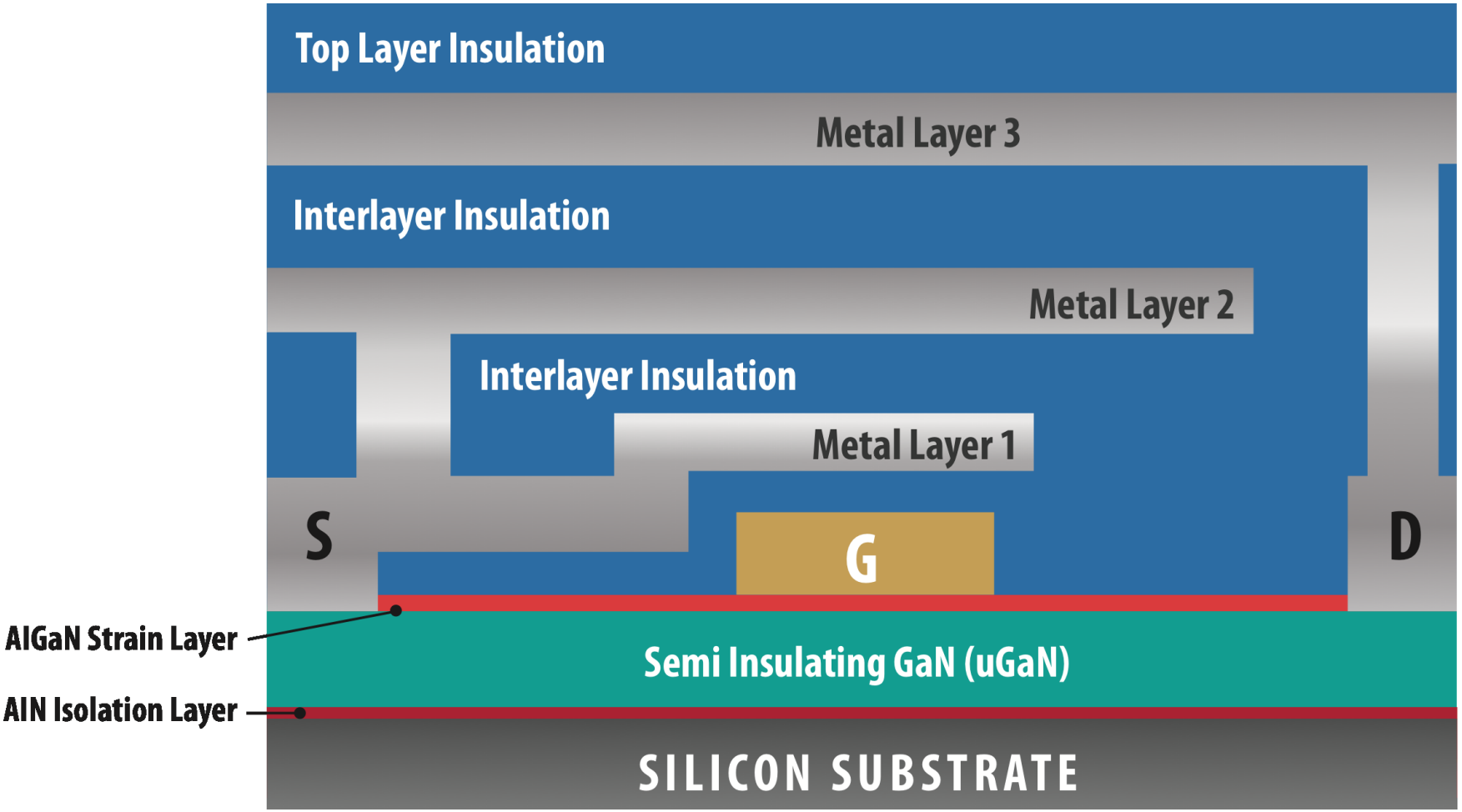
Better Figure of Merit



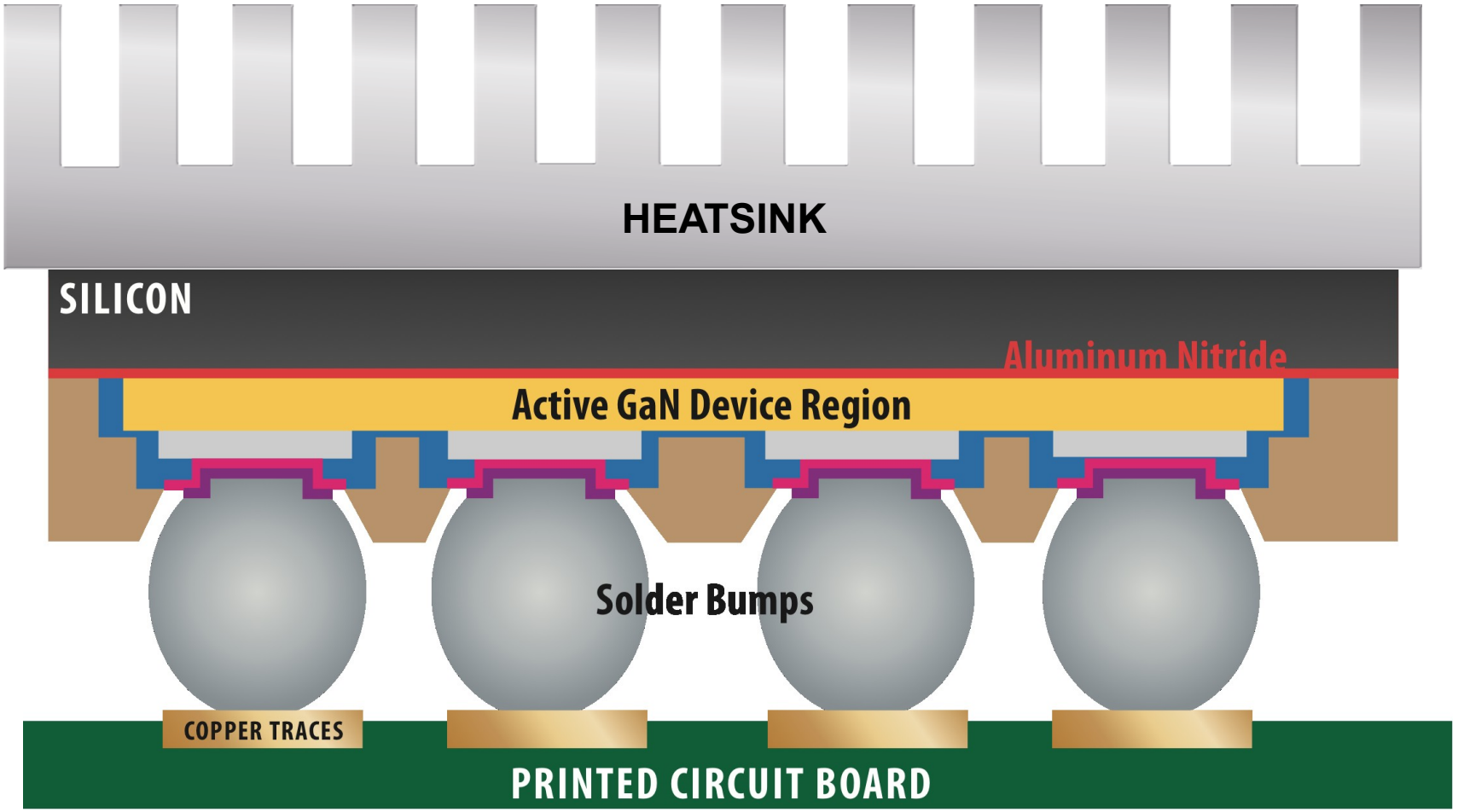
eGaN FET Structure



eGaN FET Structure



Flip Chip Assembly



Breaking Down the Barriers

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

Advantage:

- **High power density and high efficiency**

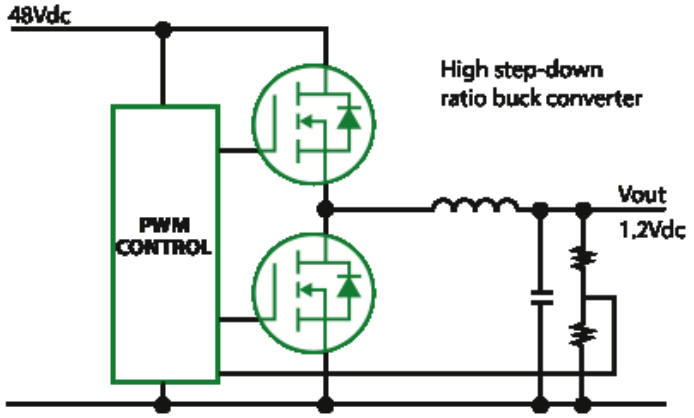
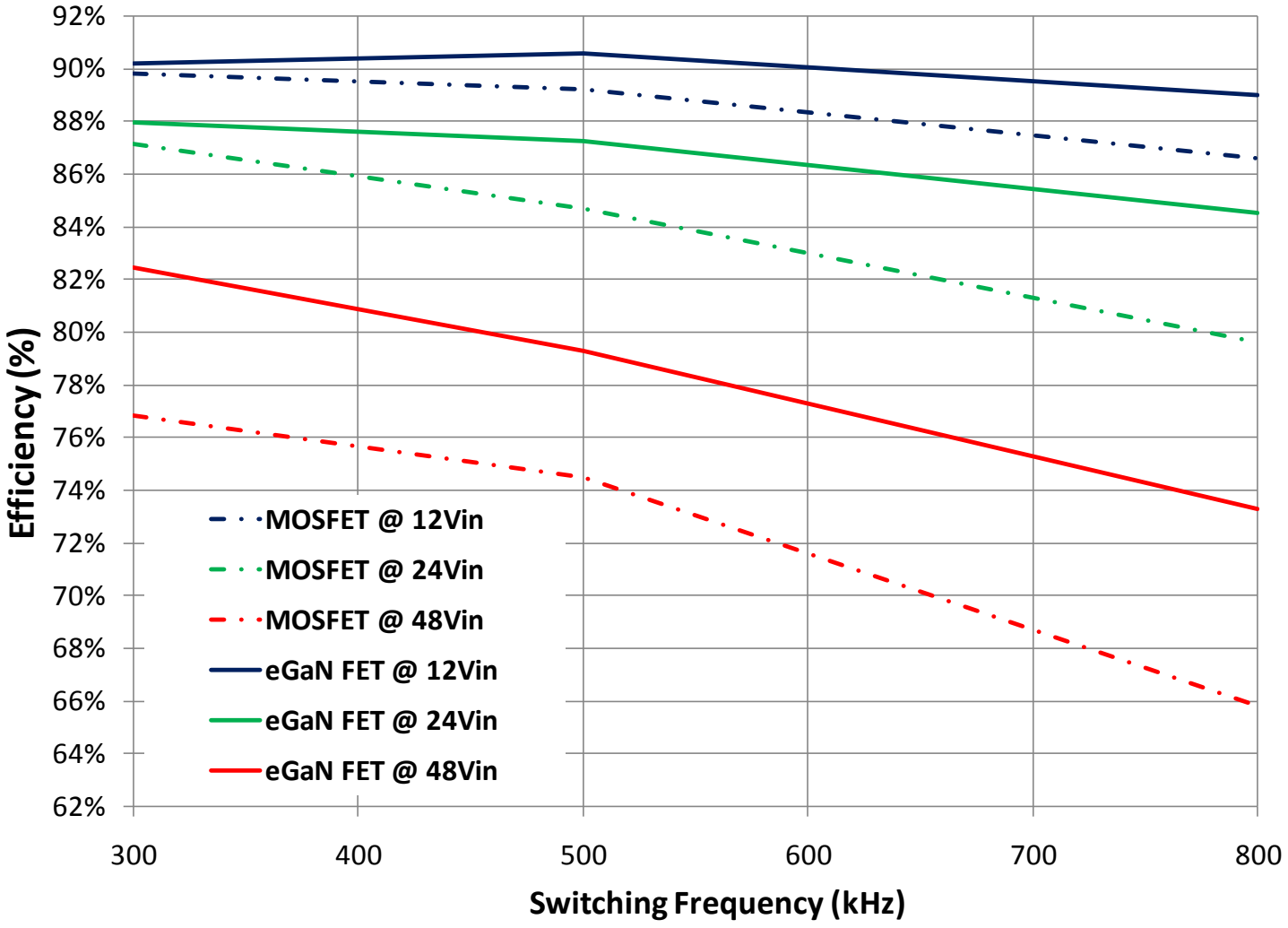


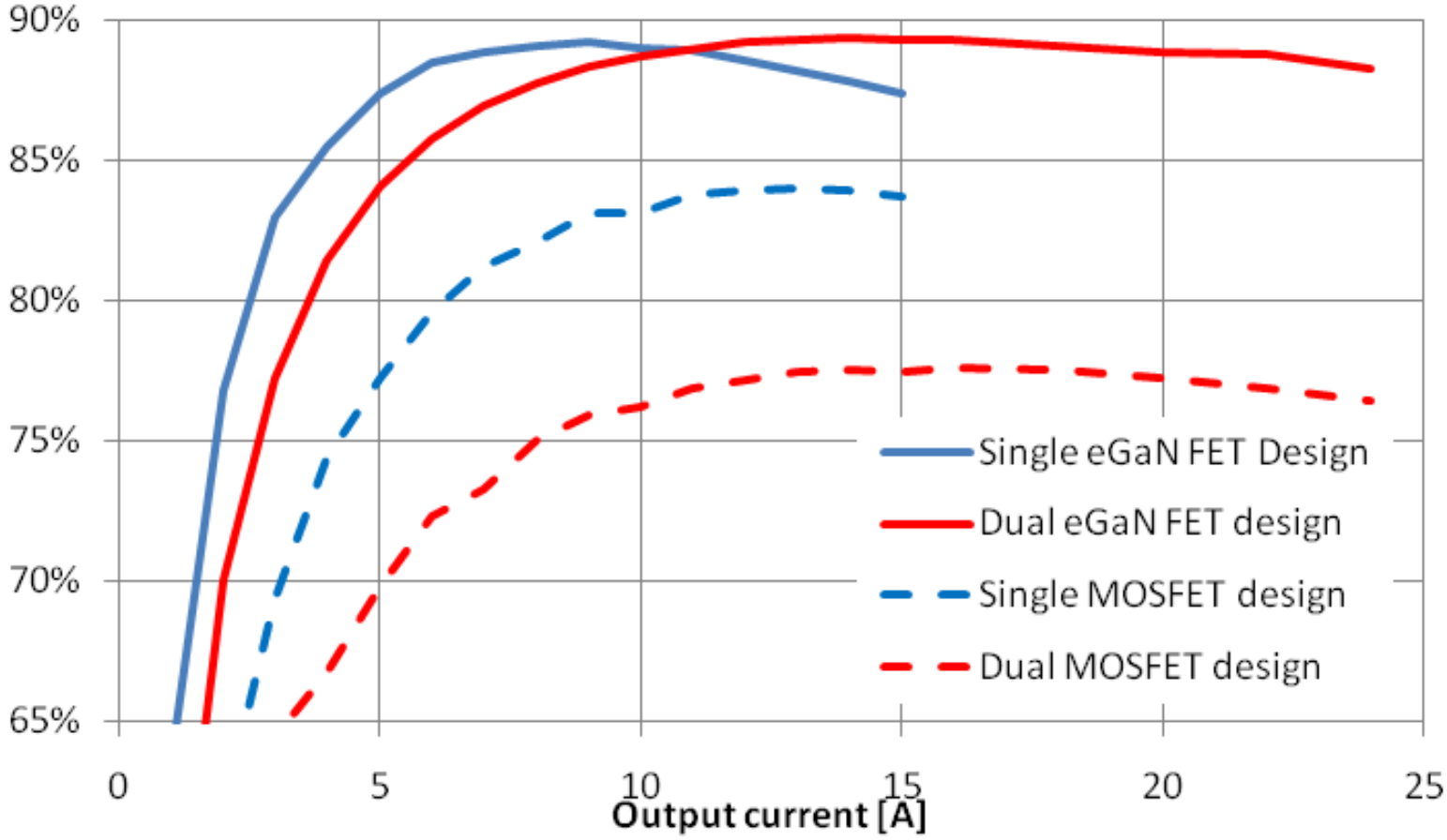
Figure 7 – Buck converter with an input voltage of 48 VDC and output voltage of 1.2 VDC

Efficiency vs Frequency @ 1.2Vout / 5A



$12V_{IN}$ – 1.2 V_{OUT} Buck Converter

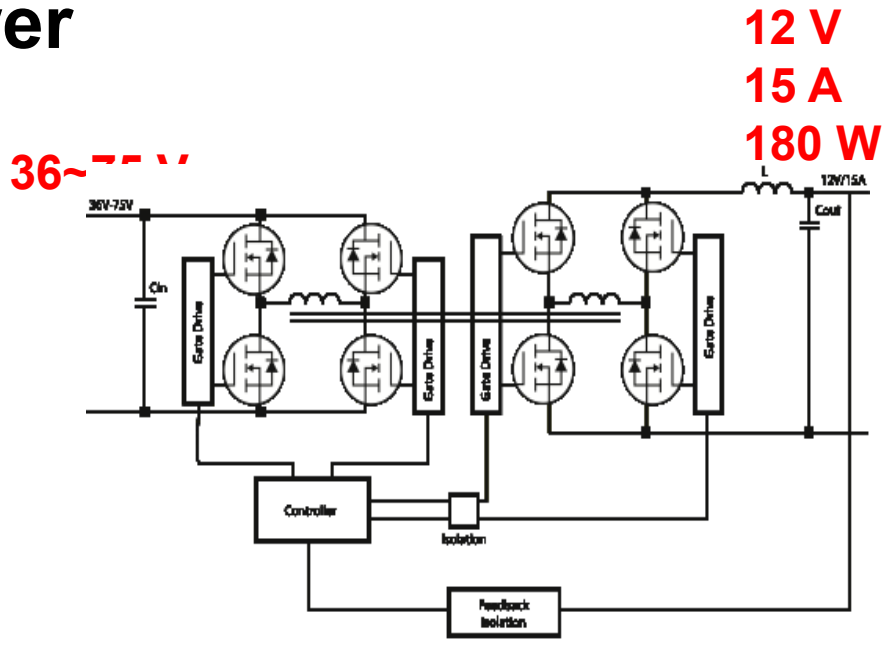
Efficiency at 1 MHz



Isolated Full Bridge Converter

Advantage:

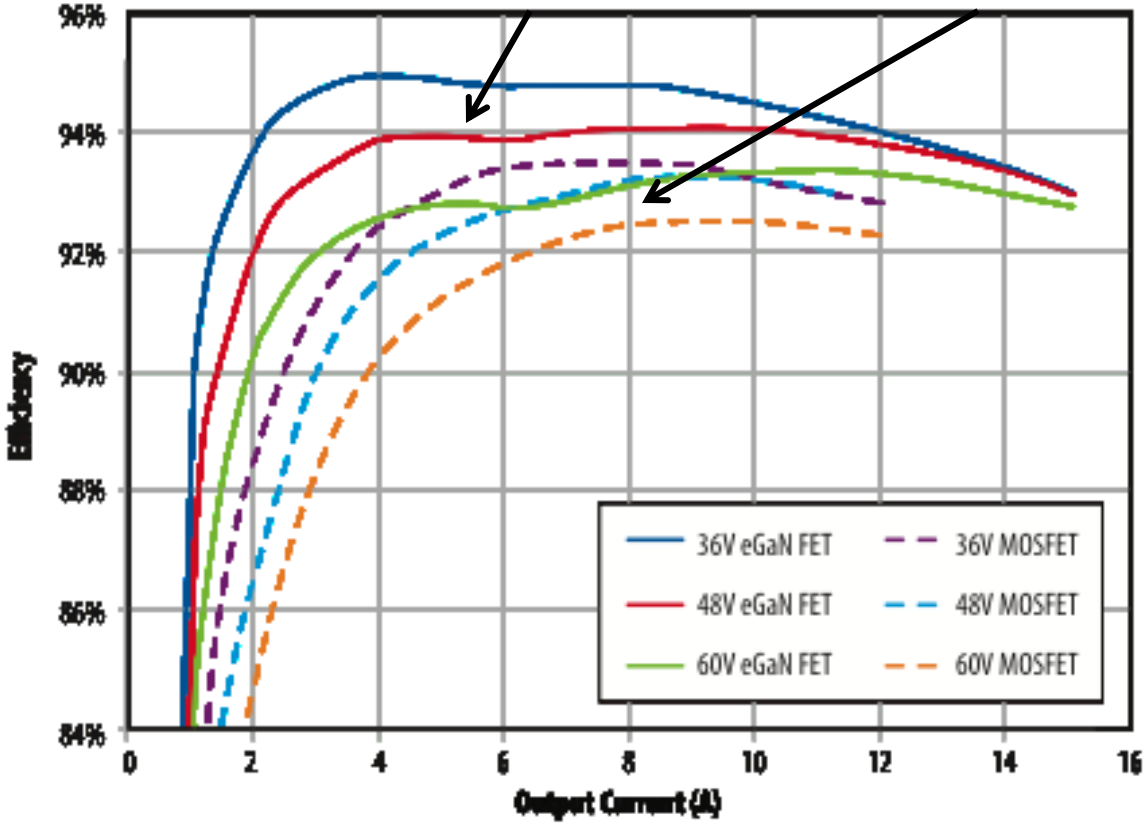
- **Isolation and high power density at high power**



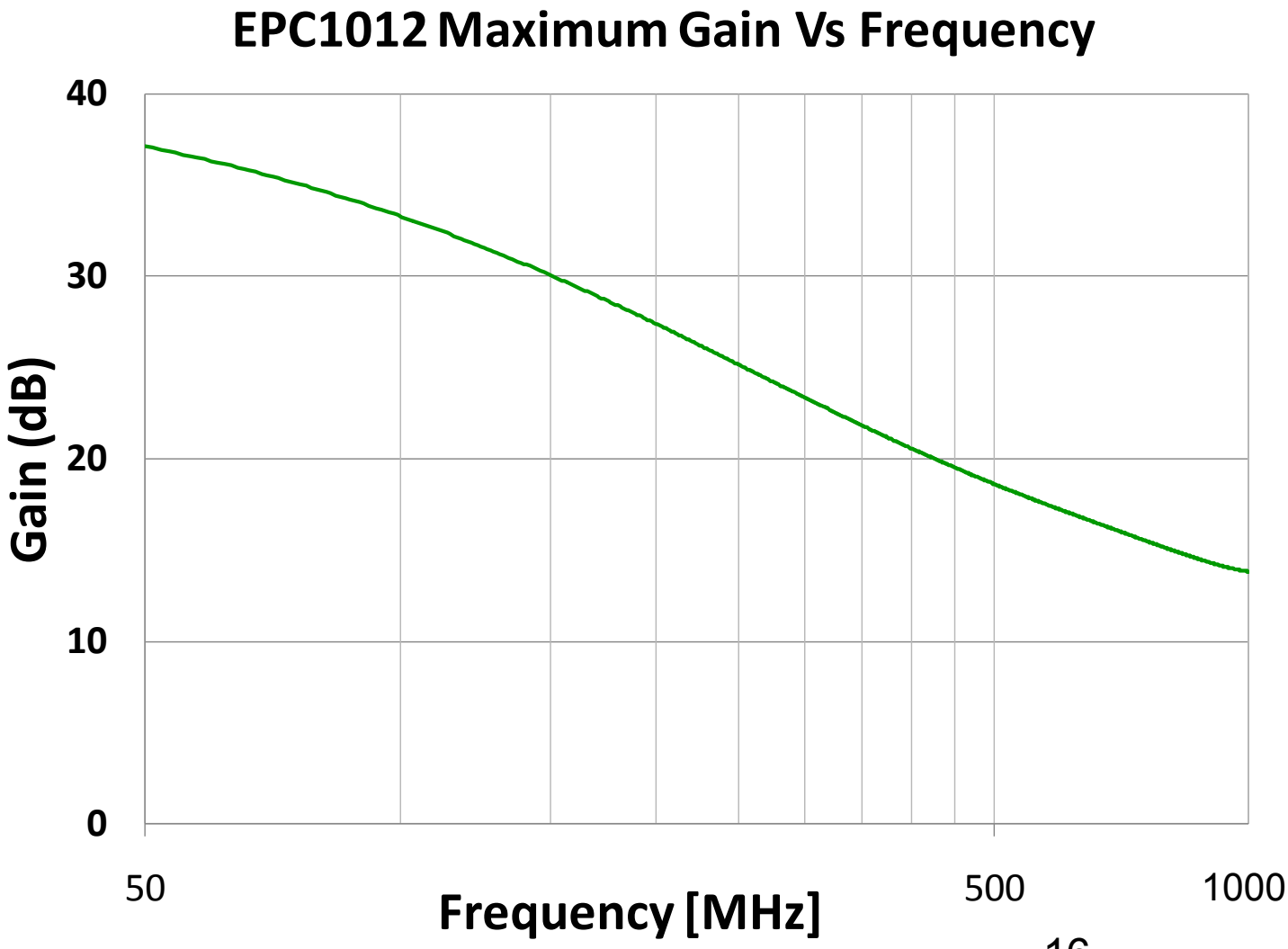
Isolated Full Bridge Converter

Efficiency comparison @ 12 V_{OUT}

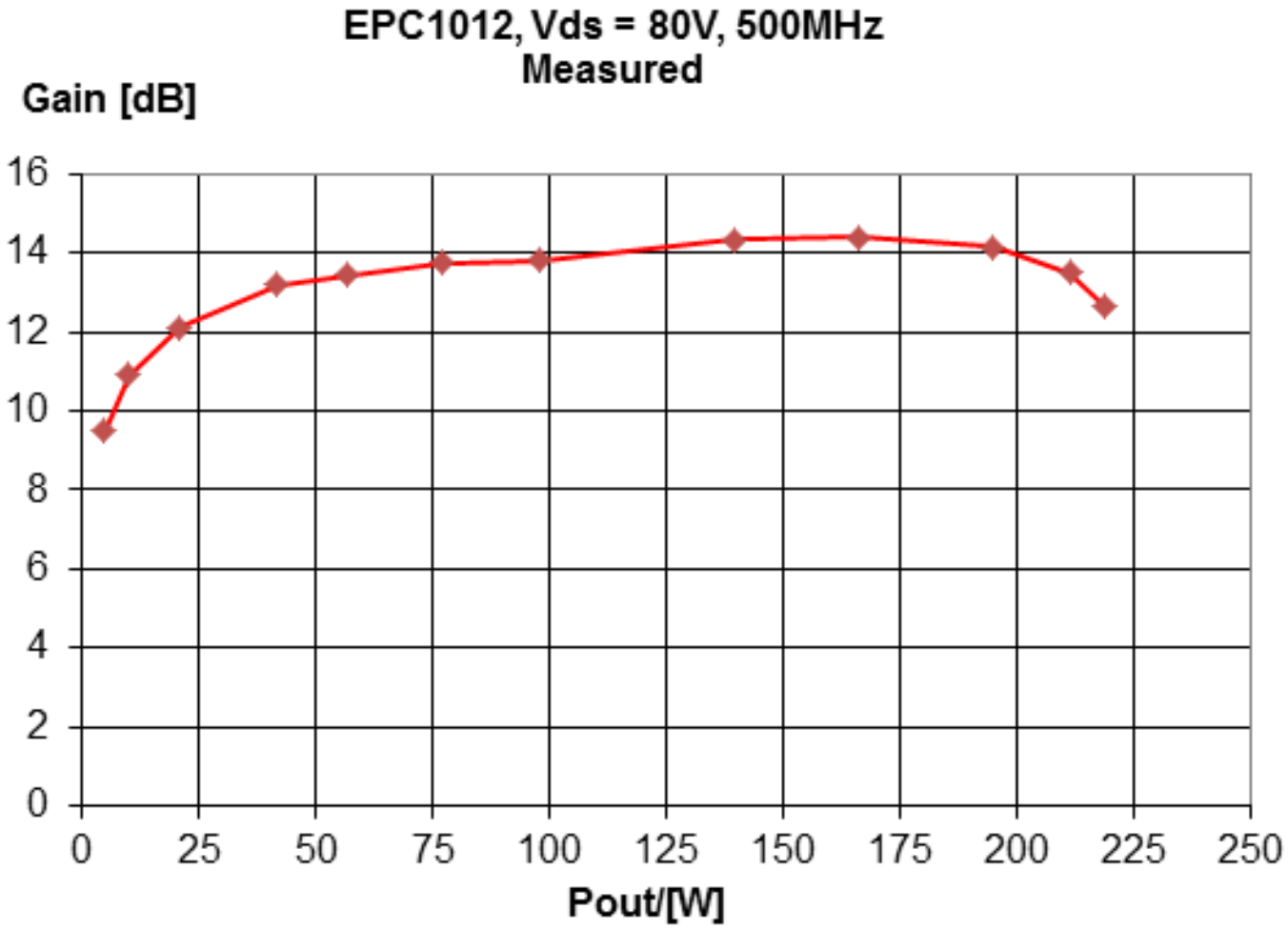
eGaN FET @ 333 kHz vs MOSFET @ 250 kHz



High Frequency Capabilities



High Frequency Capabilities



Breaking Down the Barriers

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- Is it easy to use?
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- Is it reliable?

Is it easy to use?

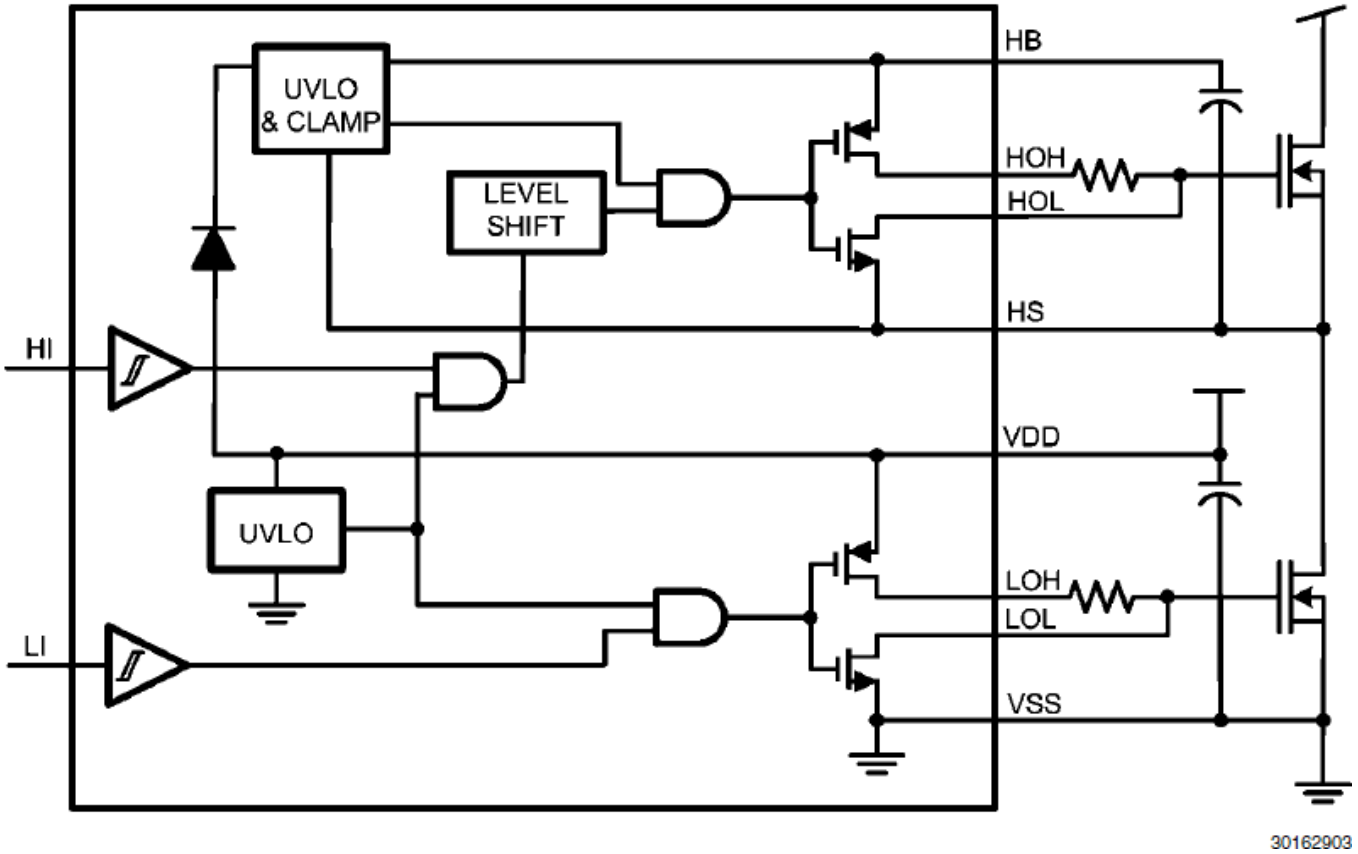
It's just like a MOSFET

except for TWO things

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

(2)
eGaN FETs have a lower maximum gate voltage than power MOSFETs

Integrated Gate Driver Solution



LM5113 from National Semiconductor

Breaking Down the Barriers

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Silicon Vs eGaN Wafer Costs

	2010	2015
Starting Material	same	same
Epi Growth	***higher***	***~same?***
Wafer Fab	same	lower
Test	same	same
Assembly	lower	lower
OVERALL	**higher**	***lower!***

Breaking Down the Barriers

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Reliability Key Issues

- Current Collapse
- Temperature Cycling and Humidity Sensitivity
- Operating Life

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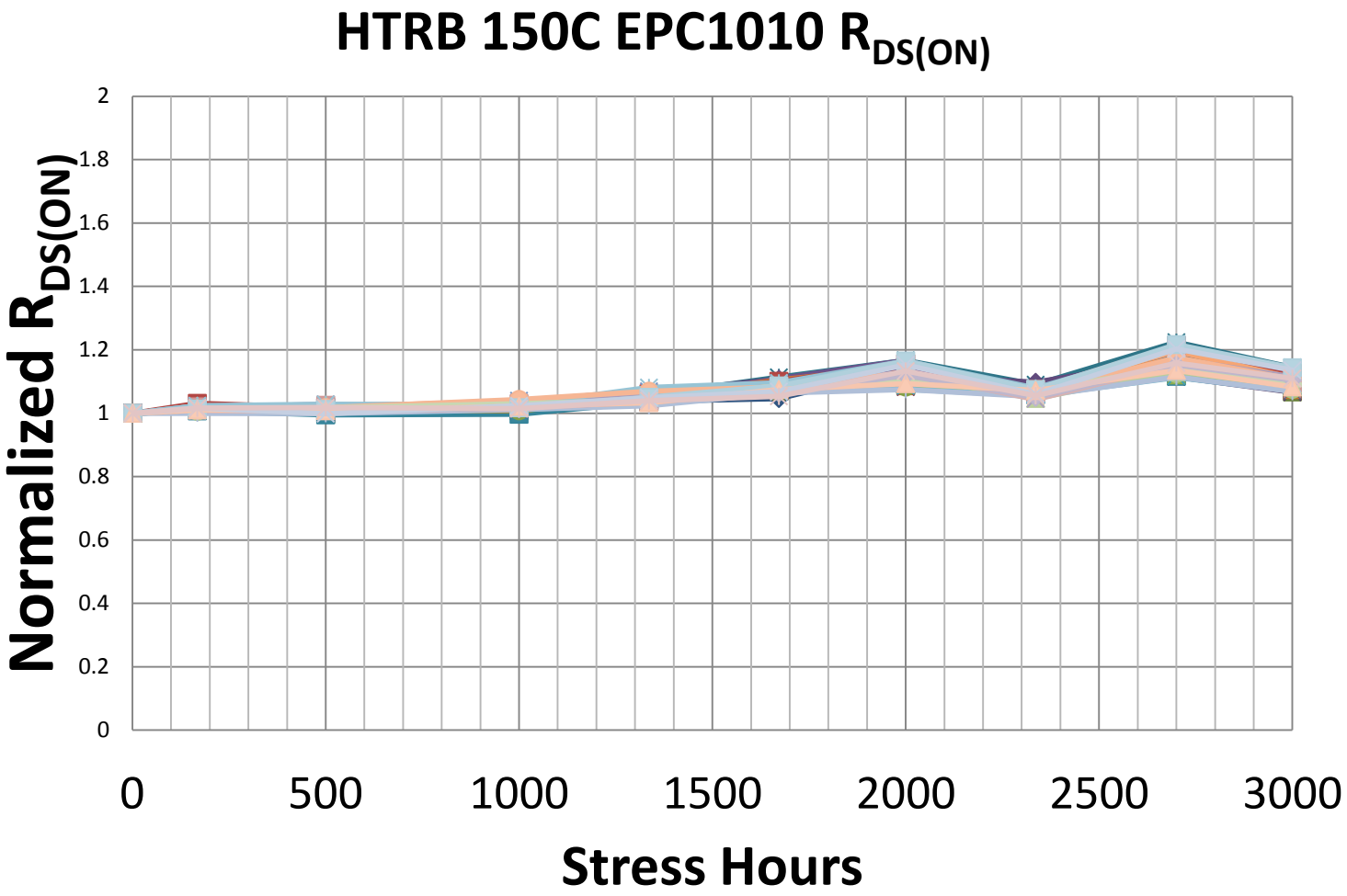
No Current Collapse

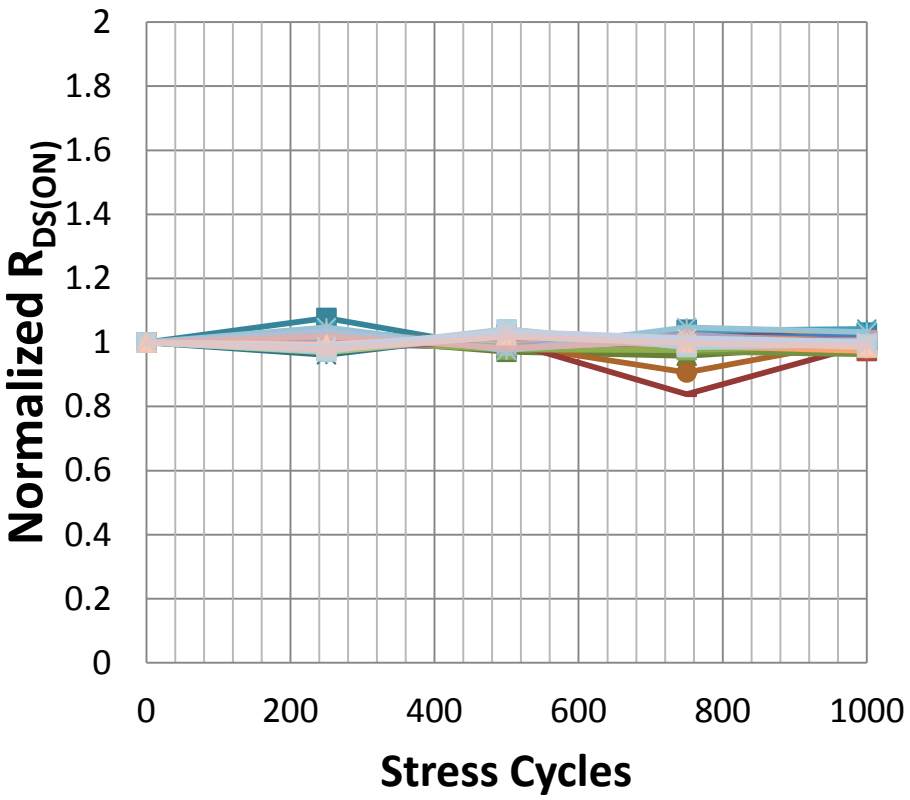


Reliability Key Issues

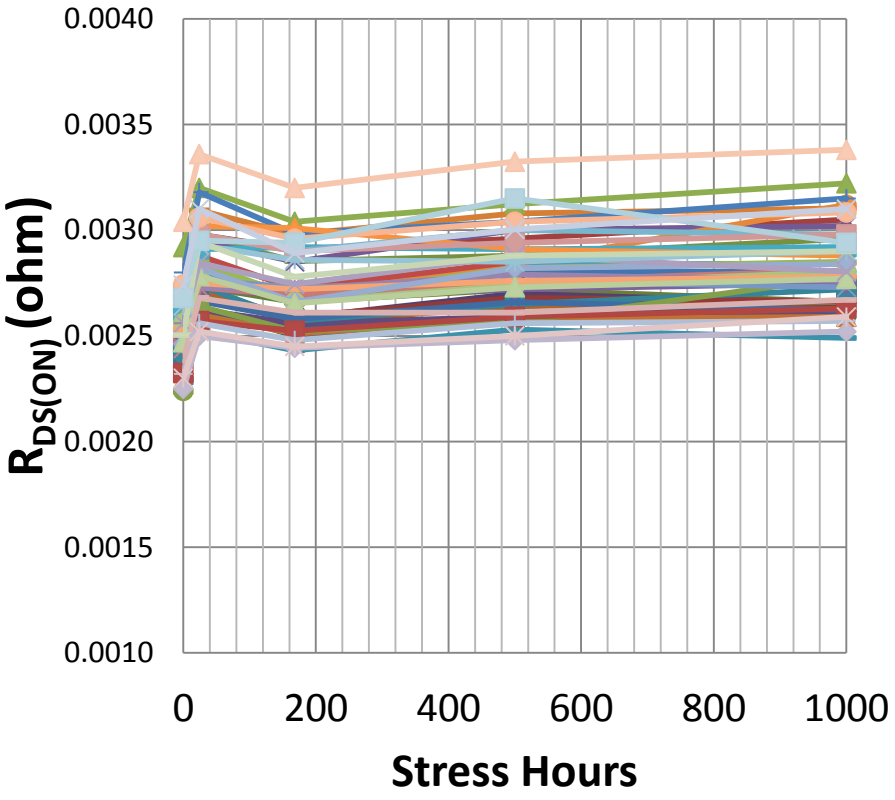
- Current Collapse
- Temperature Cycling and Humidity Sensitivity
- Operating Life

TC and H3TRB

EPC2001 $R_{DS(ON)}$ after TC -40 to 125°C



EPC2015 $R_{DS(ON)}$ after 40V at 85°C/85%RH



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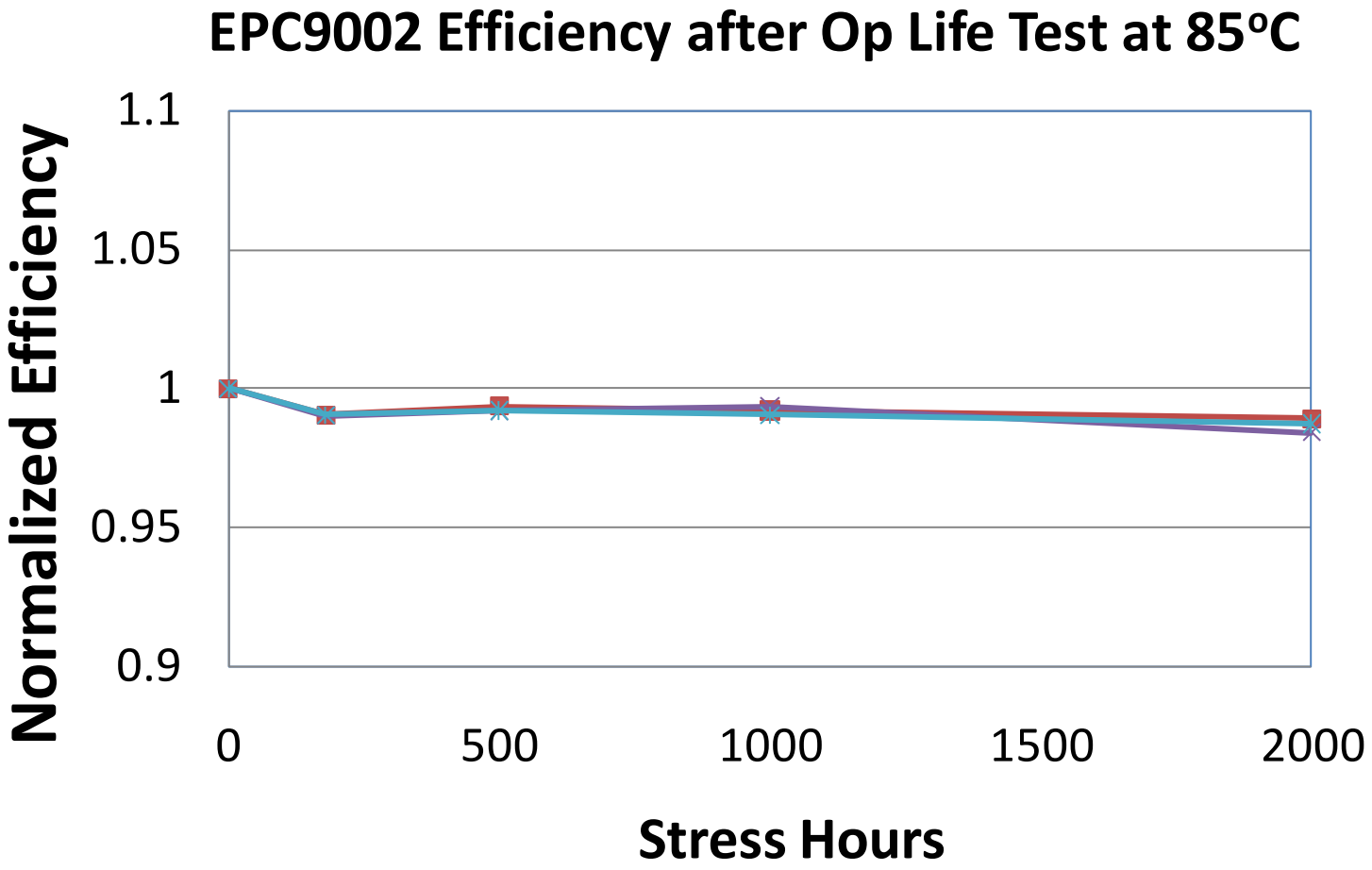
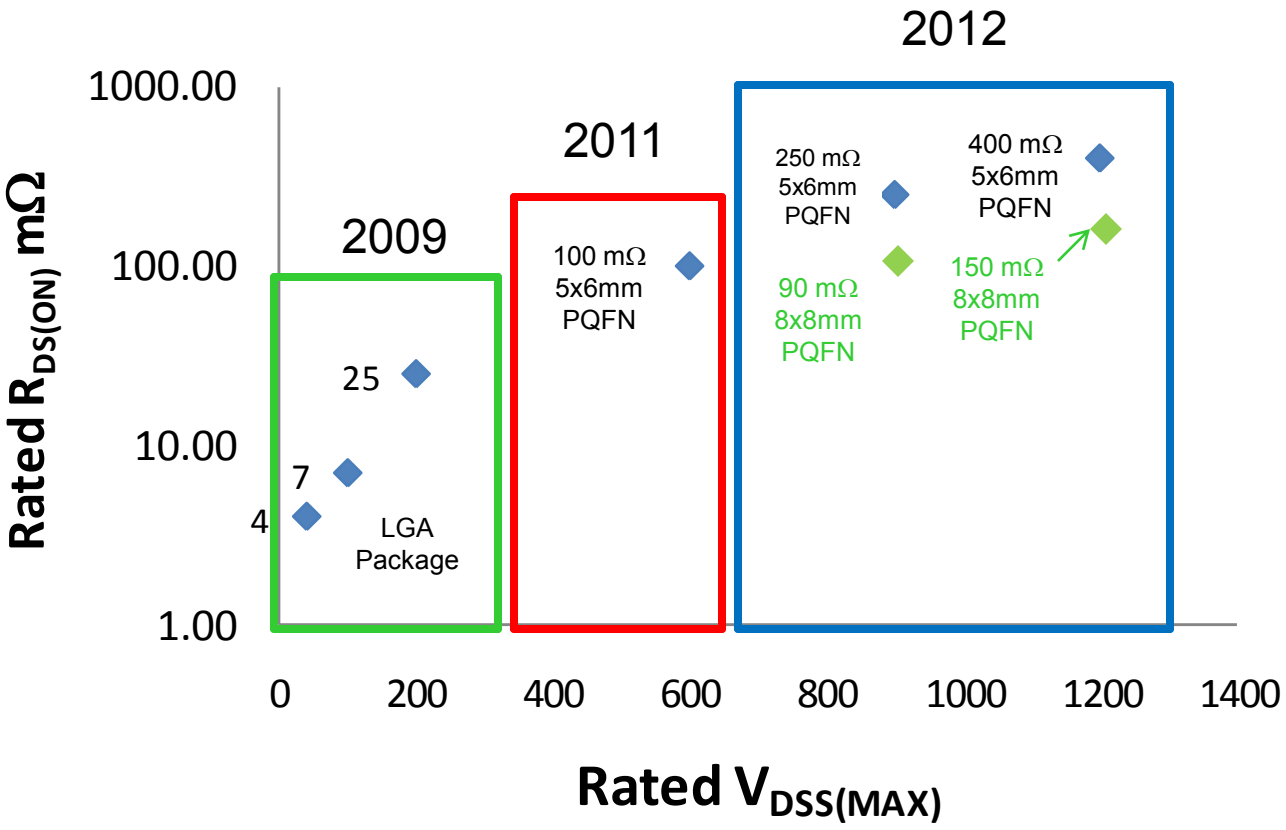
Operating Life



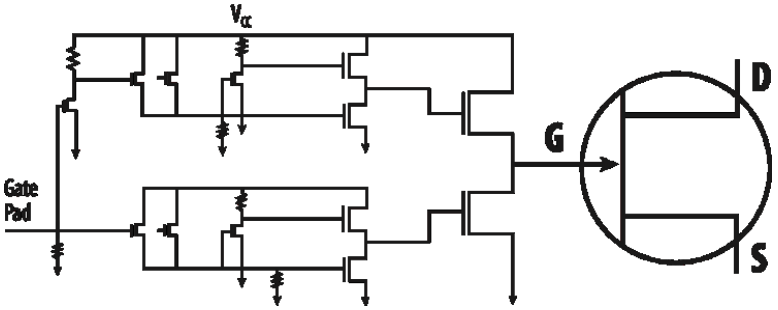
Beyond 600 Volts



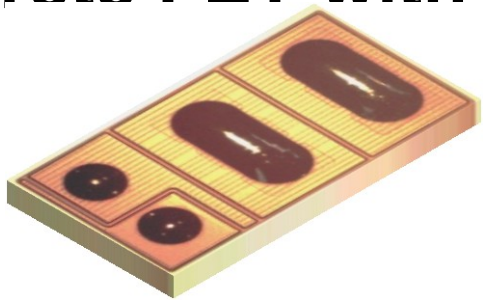
EPC's eGaN FET products will extend to 600V in 2011 and to 900V and 1200V in 2012 if there is adequate customer interest

Beyond Discrete Devices

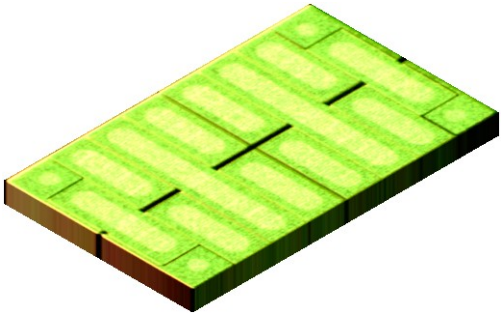
Driver On Board



Discrete FET with Driver



Full-Bridge with Driver and Level Shift



Is it the end of the road for Silicon?

- Many new applications are enabled due to quantum leap in frequency capability
- Devices are easy to use because they are similar to a power MOSFETs and commercial IC drivers are available
- The technology will soon be lower cost-per-function than silicon.
- Reliability testing shows that parts are capable in commercial applications.

EPC
EFFICIENT POWER CONVERSION

The end of the road for silicon…..

is the beginning of the eGaN FET journey!