The eGaN® FET Journey Begins

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Abstract

The intermediate bus architecture (IBA) is currently the most popular power system architecture in computing equipment. It typically consists of a +12 V system power distribution bus that feeds non-isolated, dc-dc converters. These non-isolated converters generate the low supply voltages required to power the various logic circuits. Because of their proximity to the circuits they power, these converters are commonly referred to as point-of-load converters (POLs).

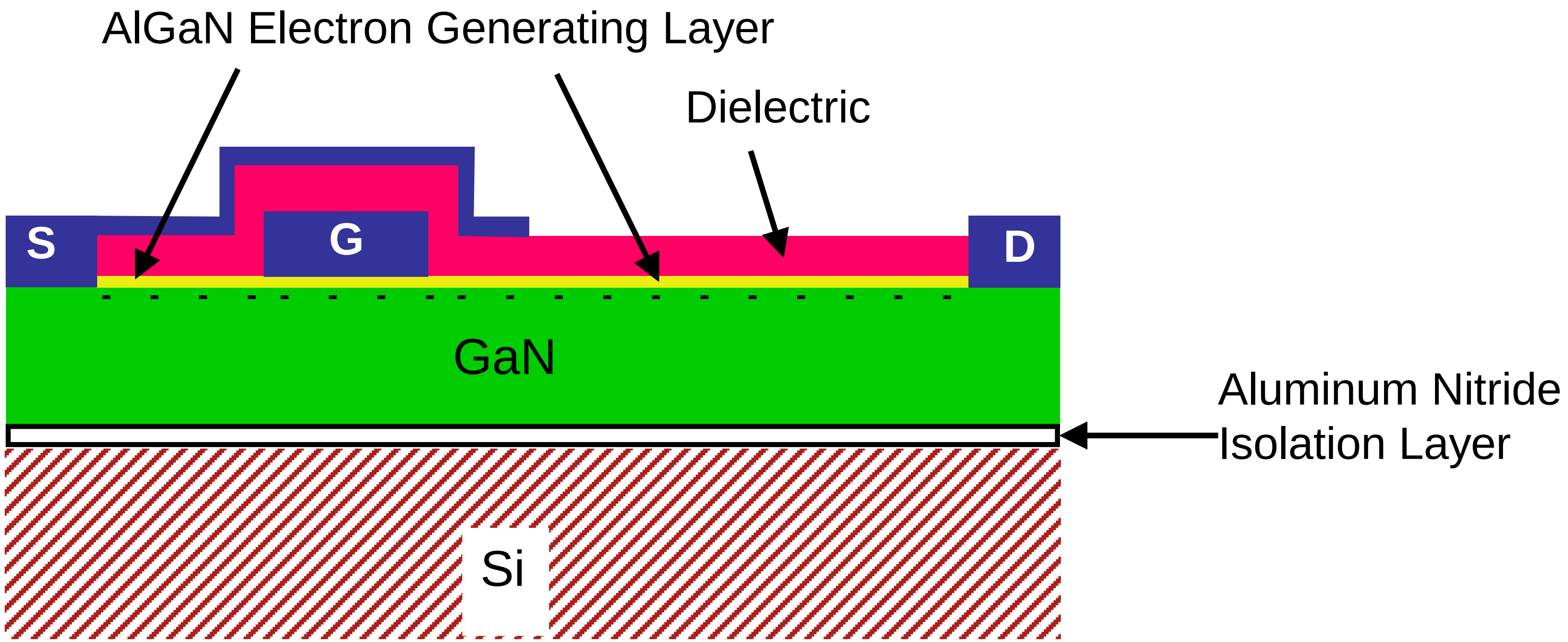
Although the 12V IBA is widely used, it is coming under scrutiny. Some companies using a +12 V system power distribution bus with on-board bus converters and POLs are wondering if they can simplify their systems or improve system efficiency. For them, a single “POL” that converts the +48 V system bus directly to the load voltages is a very interesting idea. Until now, the technical limitations of the current silicon MOSFET technology and cost concerns have made it impractical to design such a POL and produce it commercially. However, recently introduced gallium-nitride (GaN) power devices have overcome these hurdles, making it feasible to build POLs with the high step down ratios needed to generate 1 V (or less) efficiently from a 48 V bus. These converters also offer significant improvement in board space and control bandwidth, but do not necessarily improve overall system efficiency. In this presentation we explore several choices for distribution buss voltage as well as multiple-stage DC-DC conversion. The conclusion is that the designer has many options to reduce cost, power losses, and board space by transitioning from power MOSFETs to eGaN FETs.

Agenda

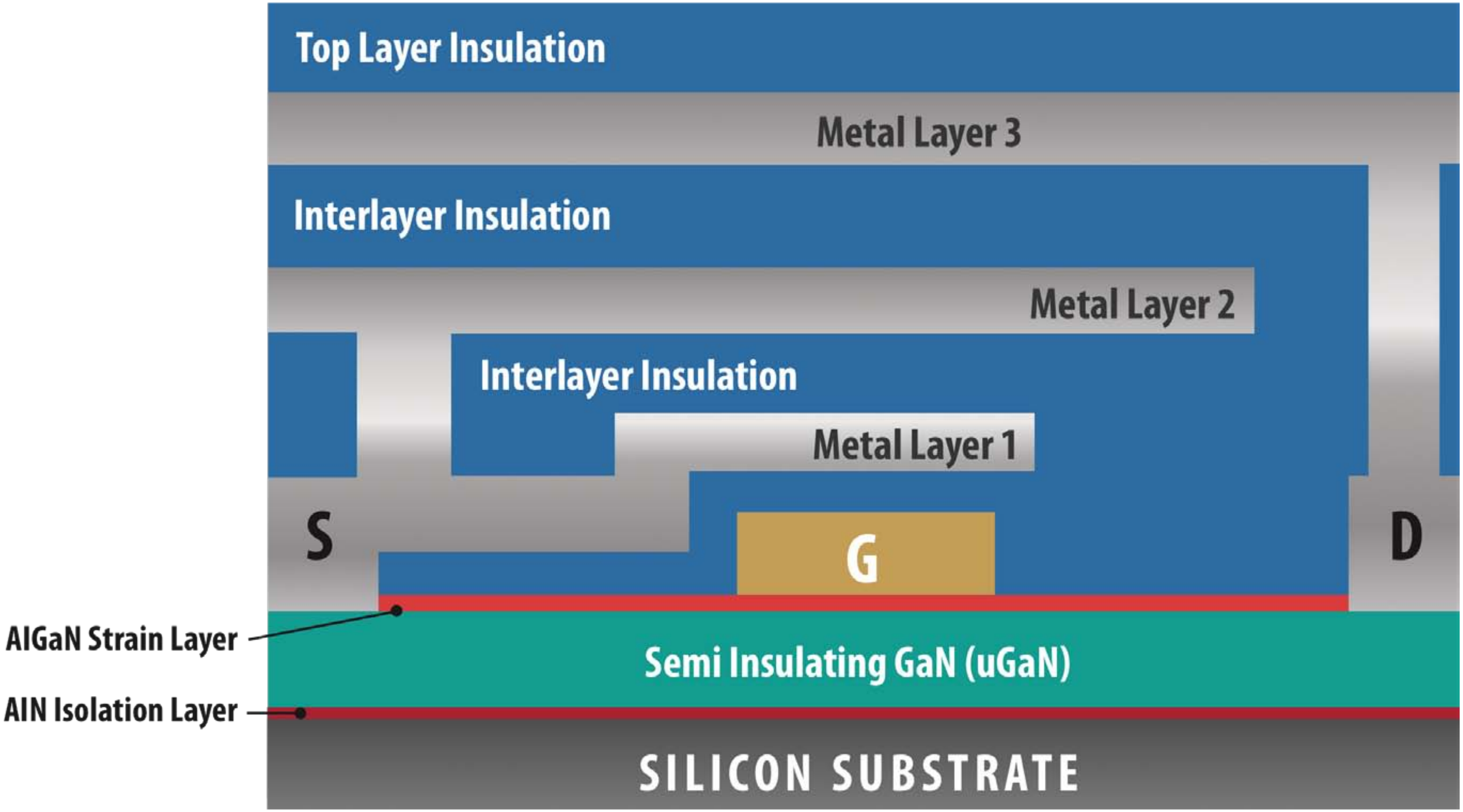
- Overview of EPC *eGaN®* FET technology
- The opportunity to improve efficiency and performance
- Future Products
- Conclusions

Overview of eGaN FET® Technology

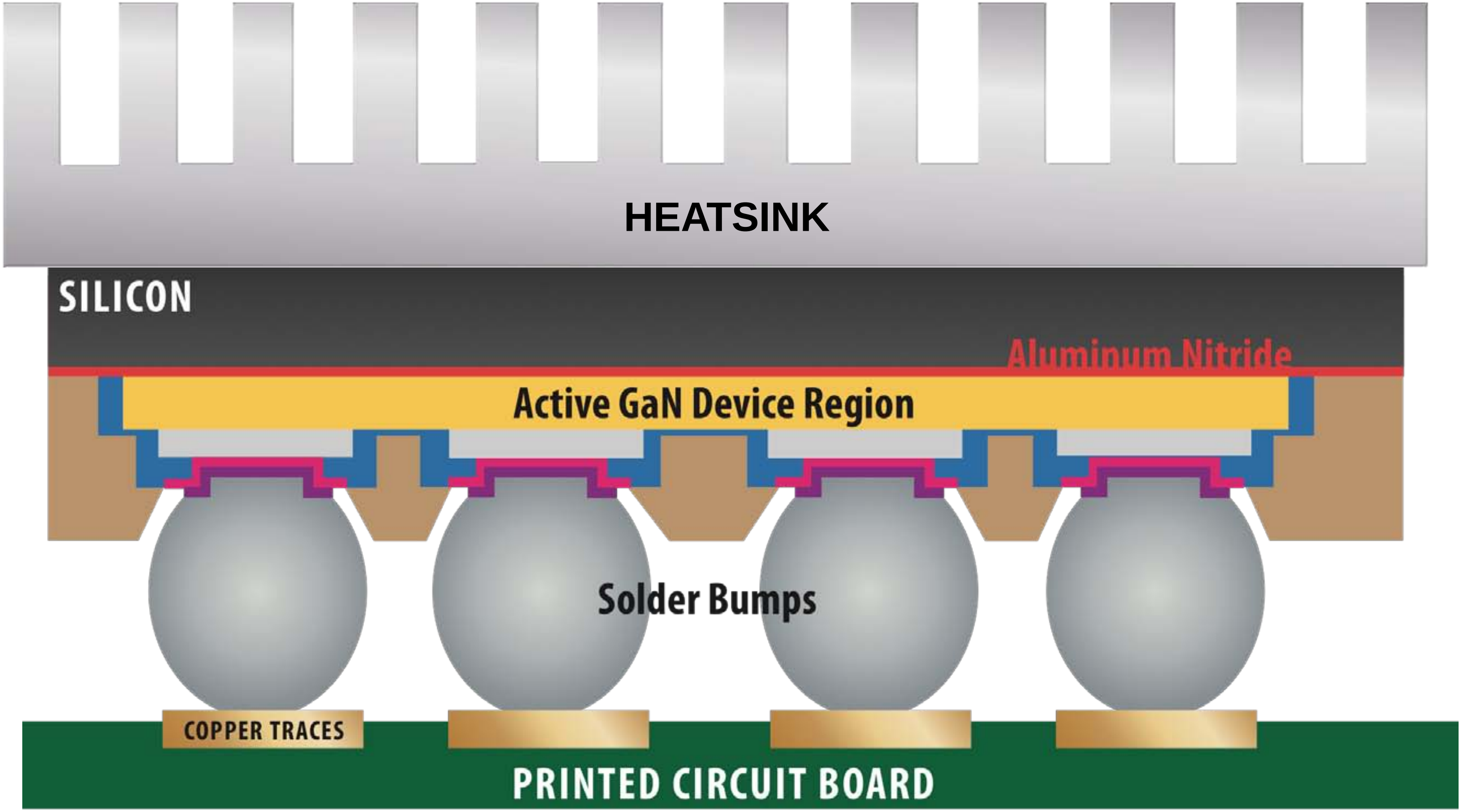
eGaN FETs Structure



eGaN FETs Structure



Flip Chip Assembly



The Opportunity to Improve Efficiency

Efficiency Comparisons

Total η

AC

92%

12 V

90%

1.2 V

81%

300 kHz

98%

eGaN FETs vs Power MOSFETs

AC

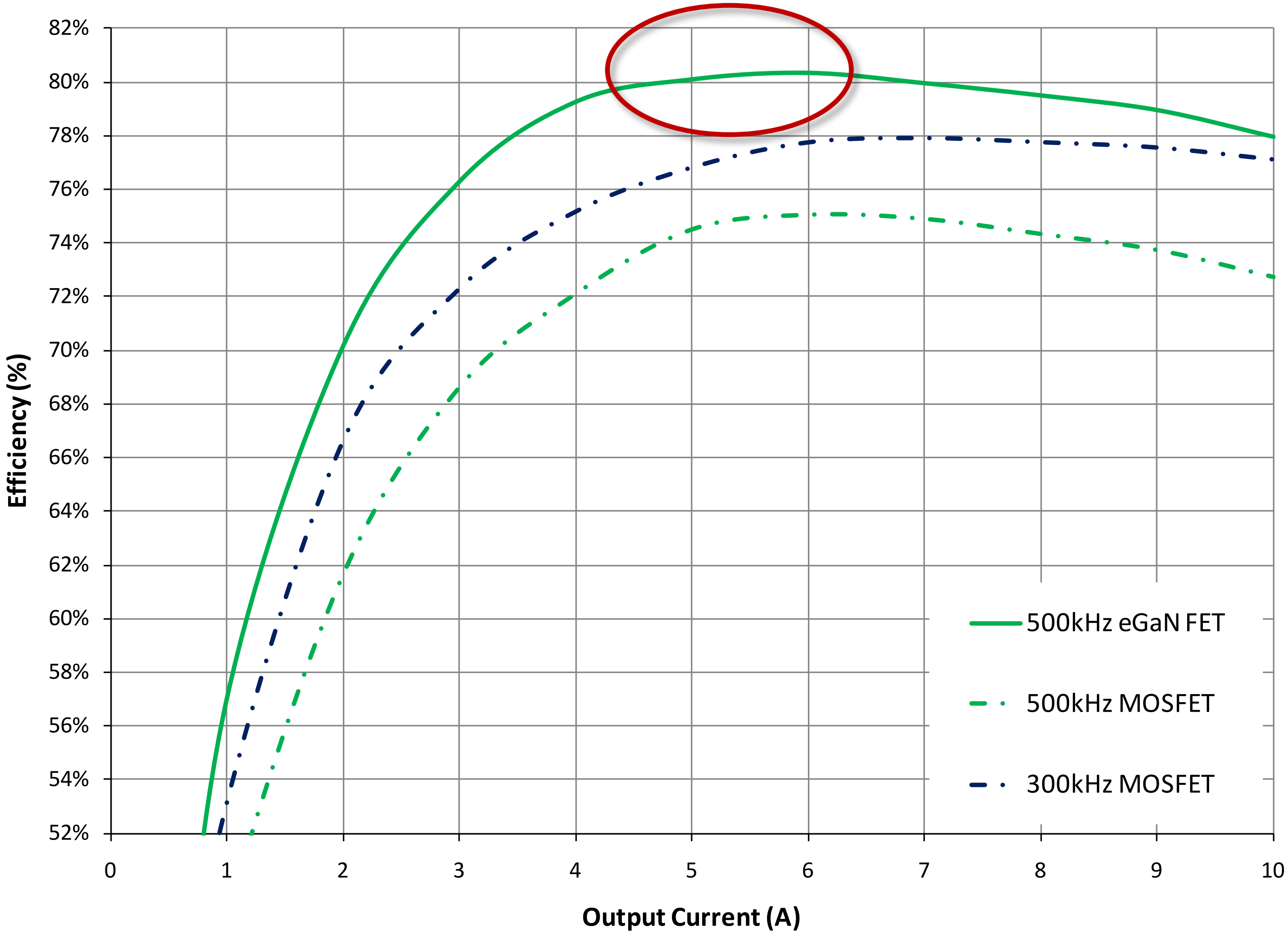
96%

48 V

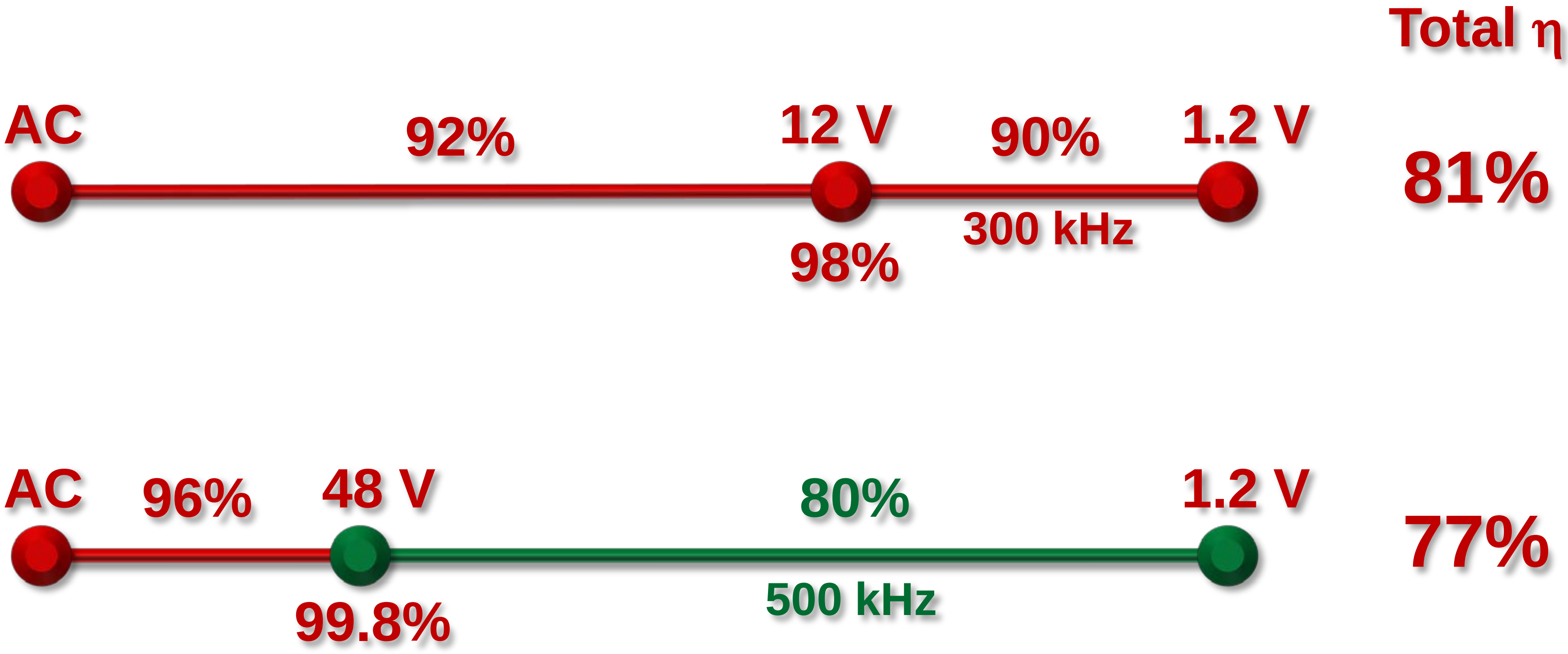
1.2 V

99.8%

48V - 1.2V Efficiency Comparison



eGaN FETs vs Power MOSFETs



Total η

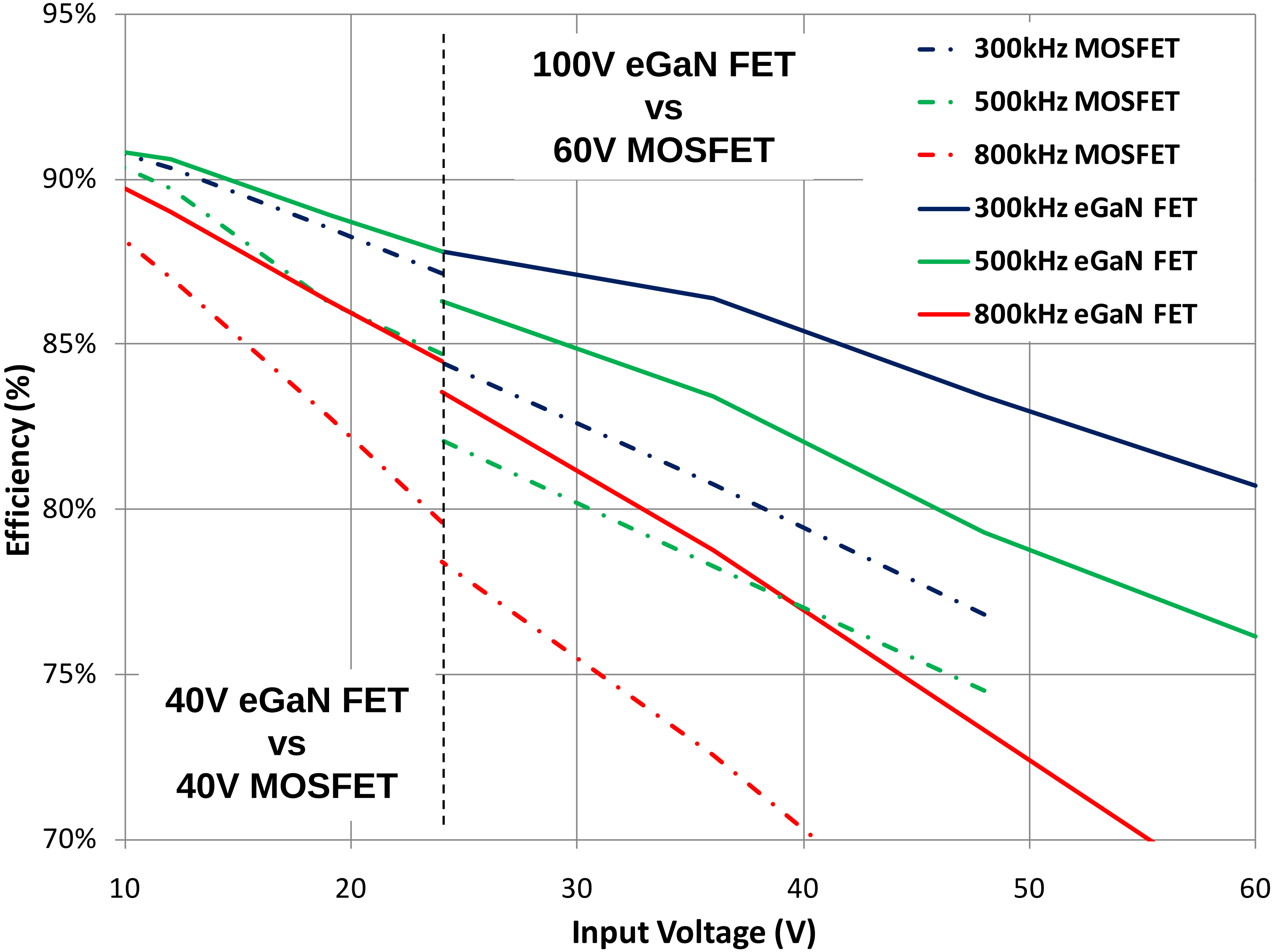
AC 92% 12 V 90% 1.2 V 81%

98% 300 kHz

AC 96% 48 V 80% 1.2 V 77%

99.8% 500 kHz

Efficiency vs V_{IN} @ V_{OUT} = 1.2 V / 5A



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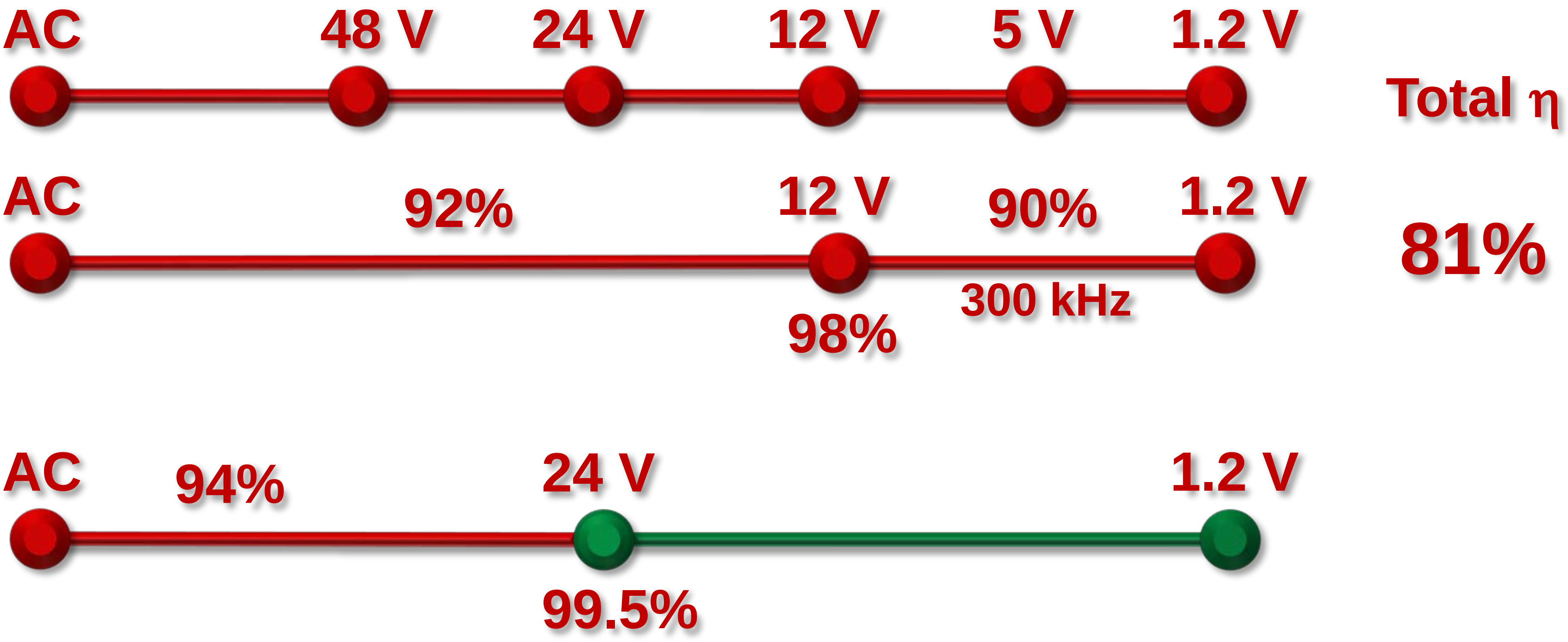
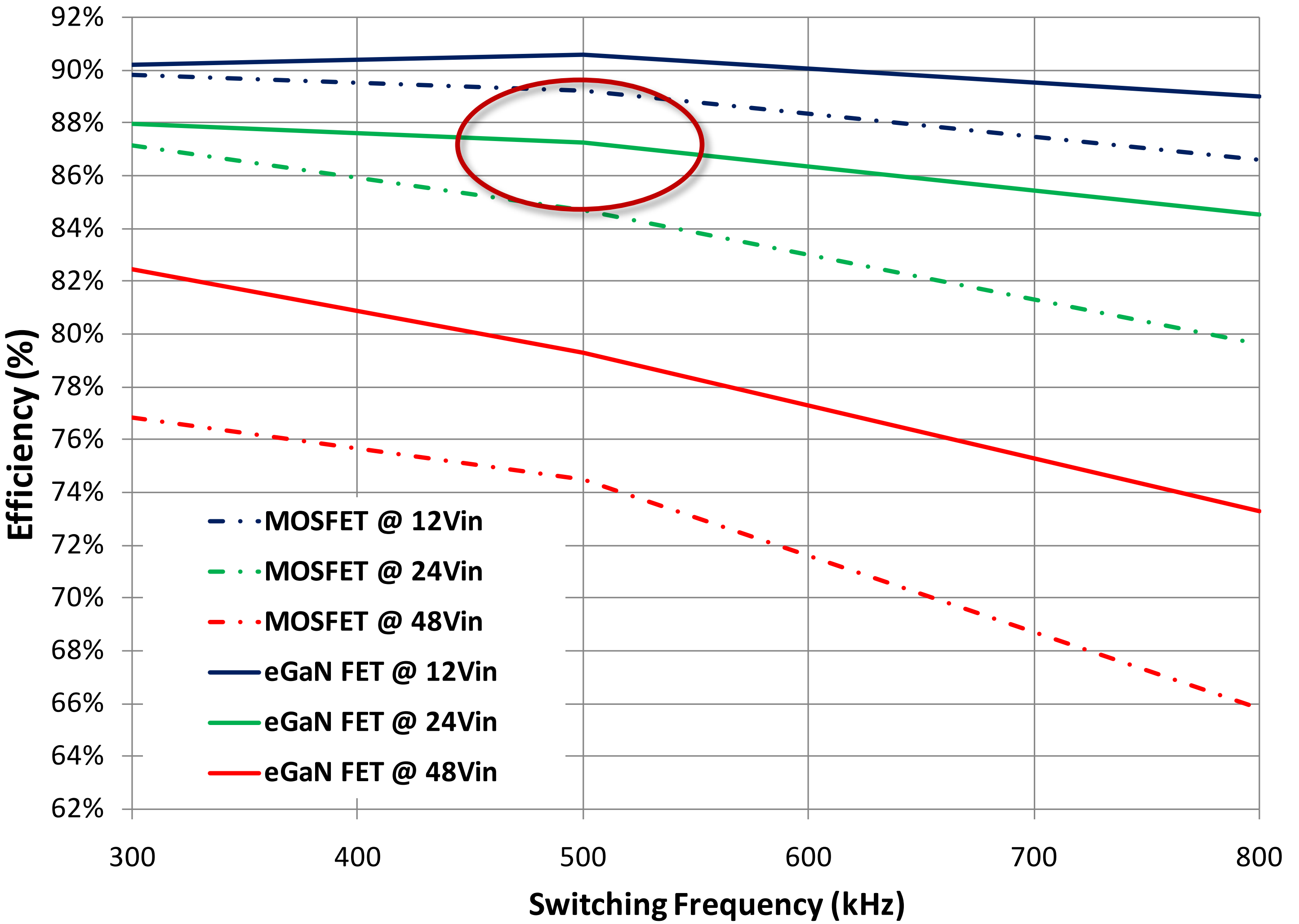
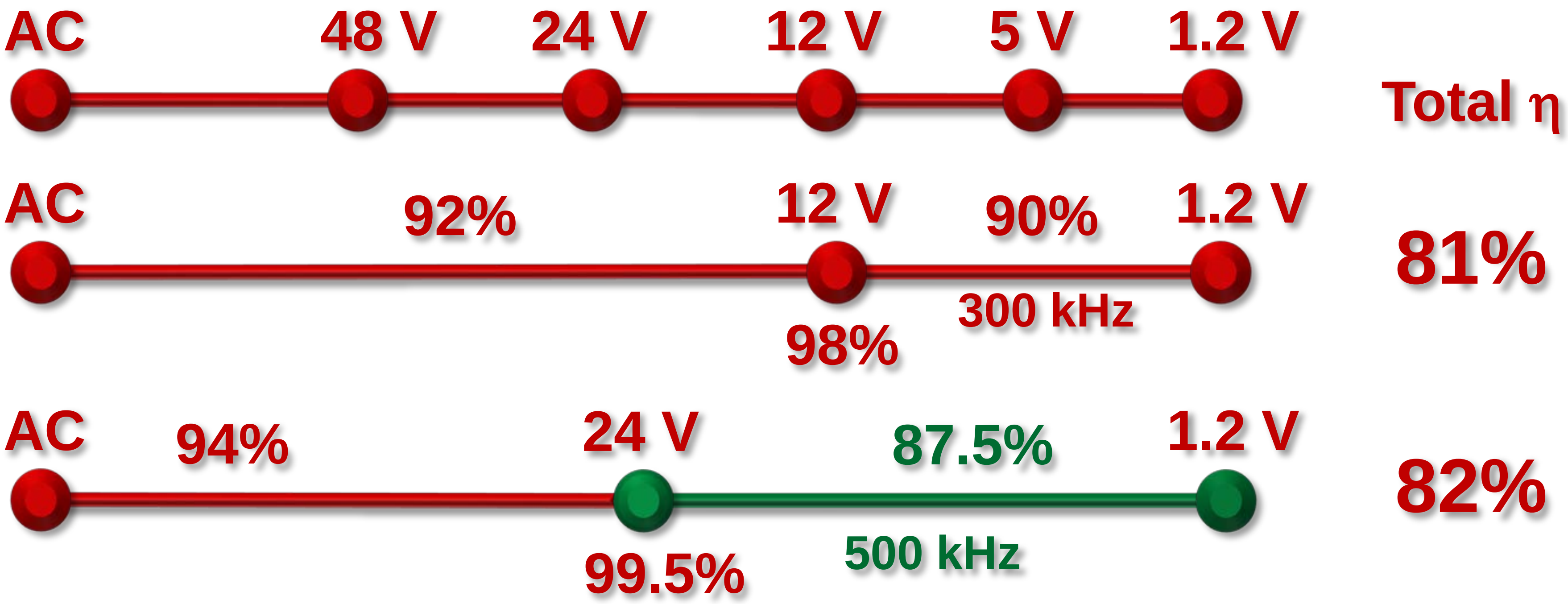


Efficiency vs Frequency @ 1.2Vout / 5A



eGaN FETs vs Power MOSFETs



AC 48 V 24 V 12 V 5 V 1.2 V

Total η

AC 92% 12 V 90% 1.2 V

98% 300 kHz

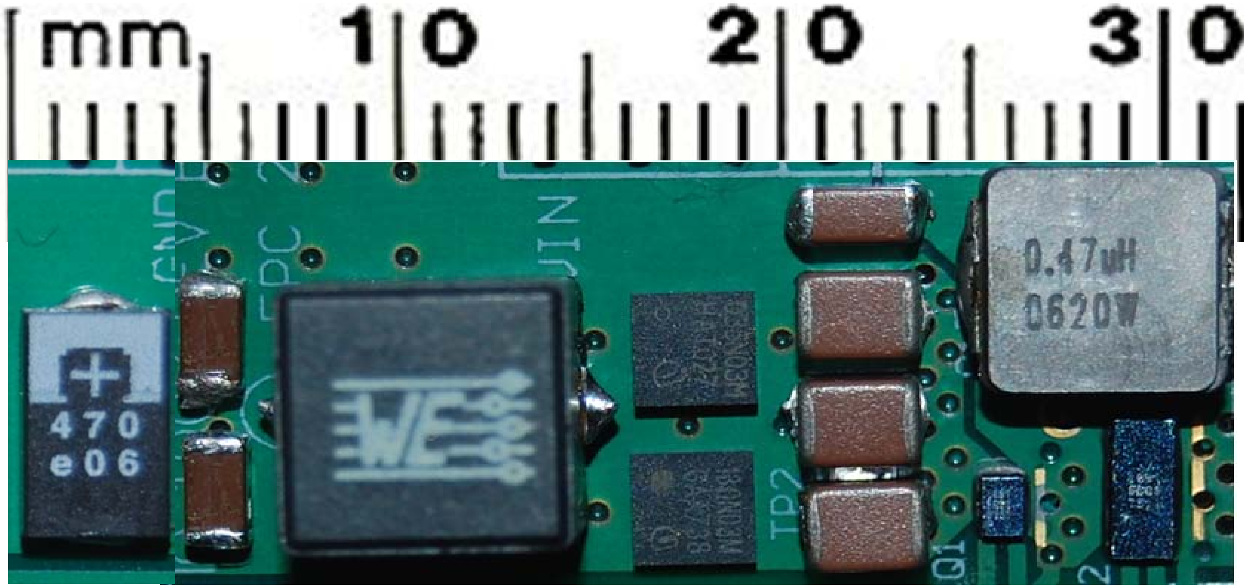
81%

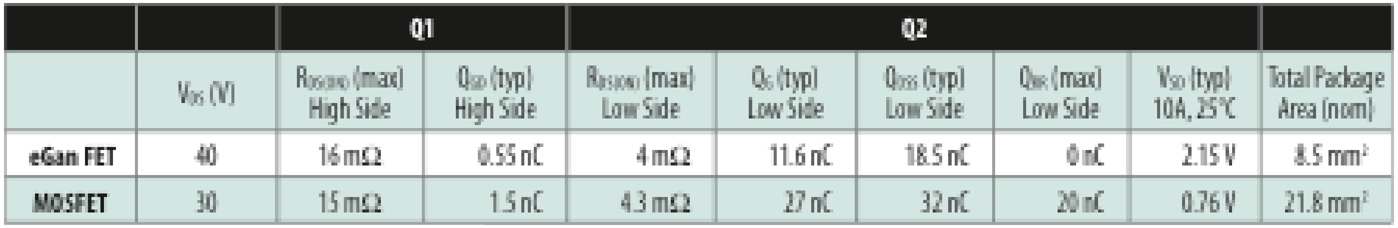
AC 94% 24 V 87.5% 1.2 V

99.5% 500 kHz

82%

Buck Size Comparison

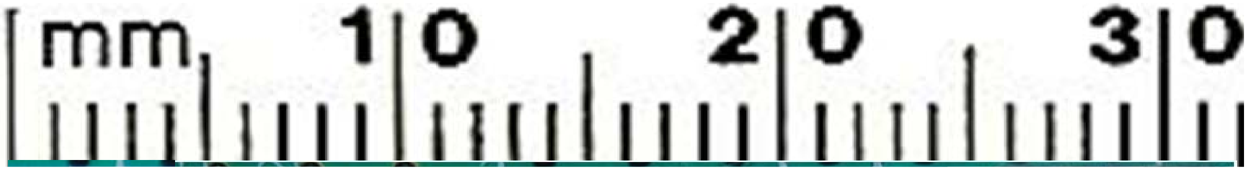




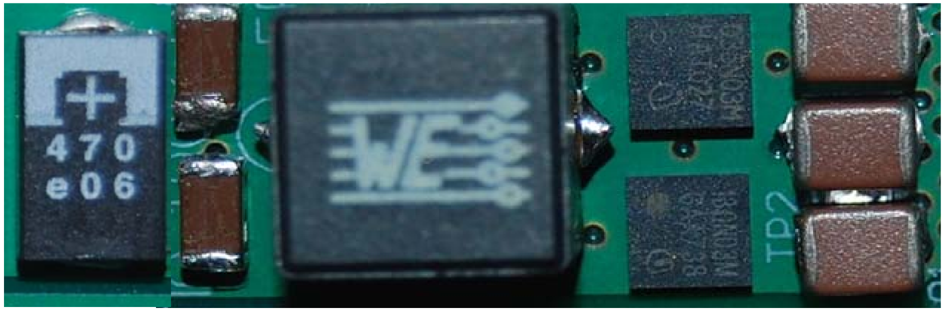
		Q1		Q2					
	V_{DS} (V)	$R_{DS(ON)}$ (max) High Side	Q_{GD} (typ) High Side	$R_{DS(ON)}$ (max) Low Side	Q_G (typ) Low Side	Q_{OSS} (typ) Low Side	Q_{RR} (max) Low Side	V_{SD} (typ) 10A, 25°C	Total Package Area (nom)
eGan FET	40	16 mΩ	0.55 nC	4 mΩ	11.6 nC	18.5 nC	0 nC	2.15 V	8.5 mm^2
MOSFET	30	15 mΩ	1.5 nC	4.3 mΩ	27 nC	32 nC	20 nC	0.76 V	21.8 mm^2

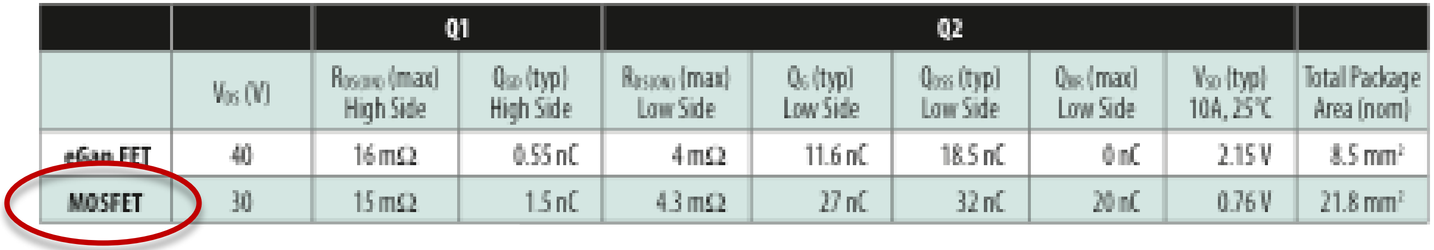
A 24V-1.2V Buck converter was built with both with eGaN FETs and state-of-the-art silicon power MOSFETs

Buck Size Comparison



184 mm^2





		Q1		Q2					
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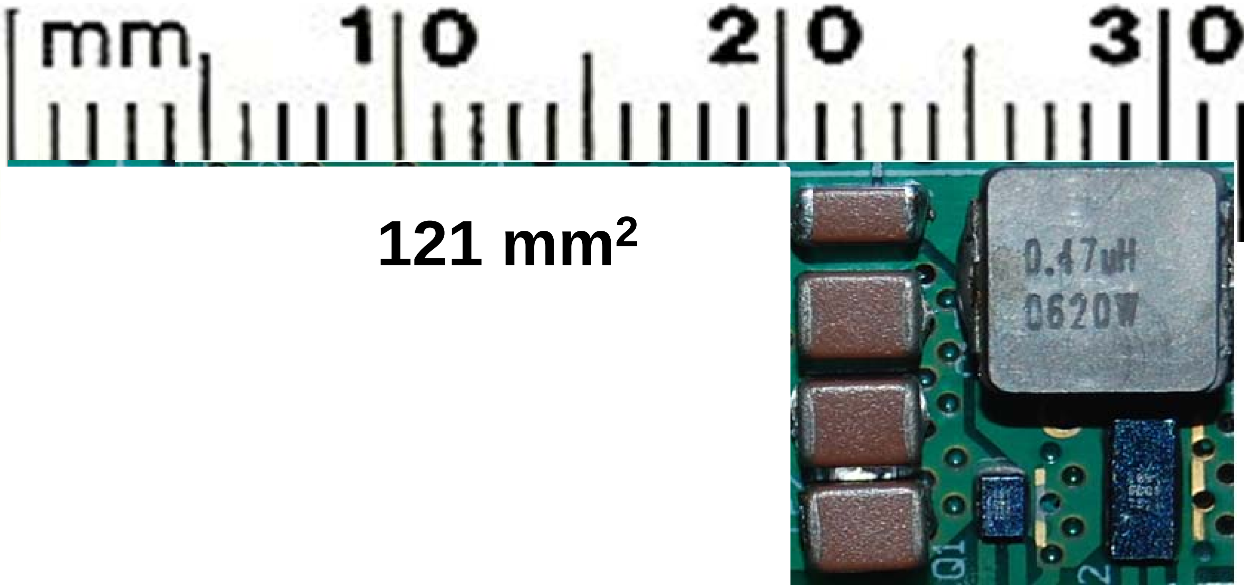
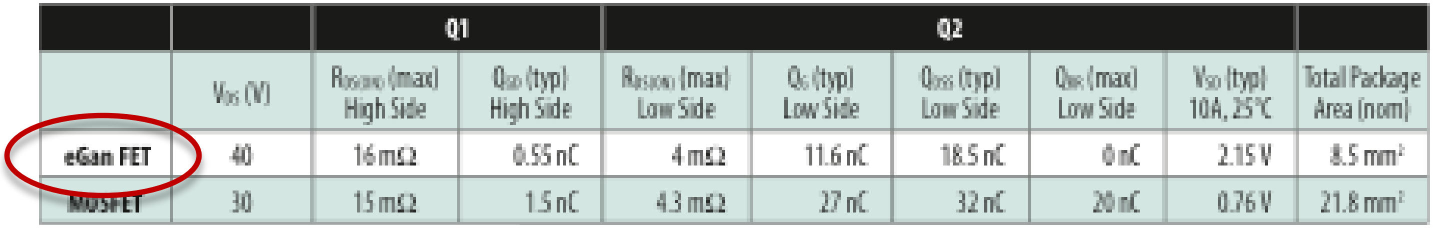
Buck Size Comparison





		Q1		Q2					
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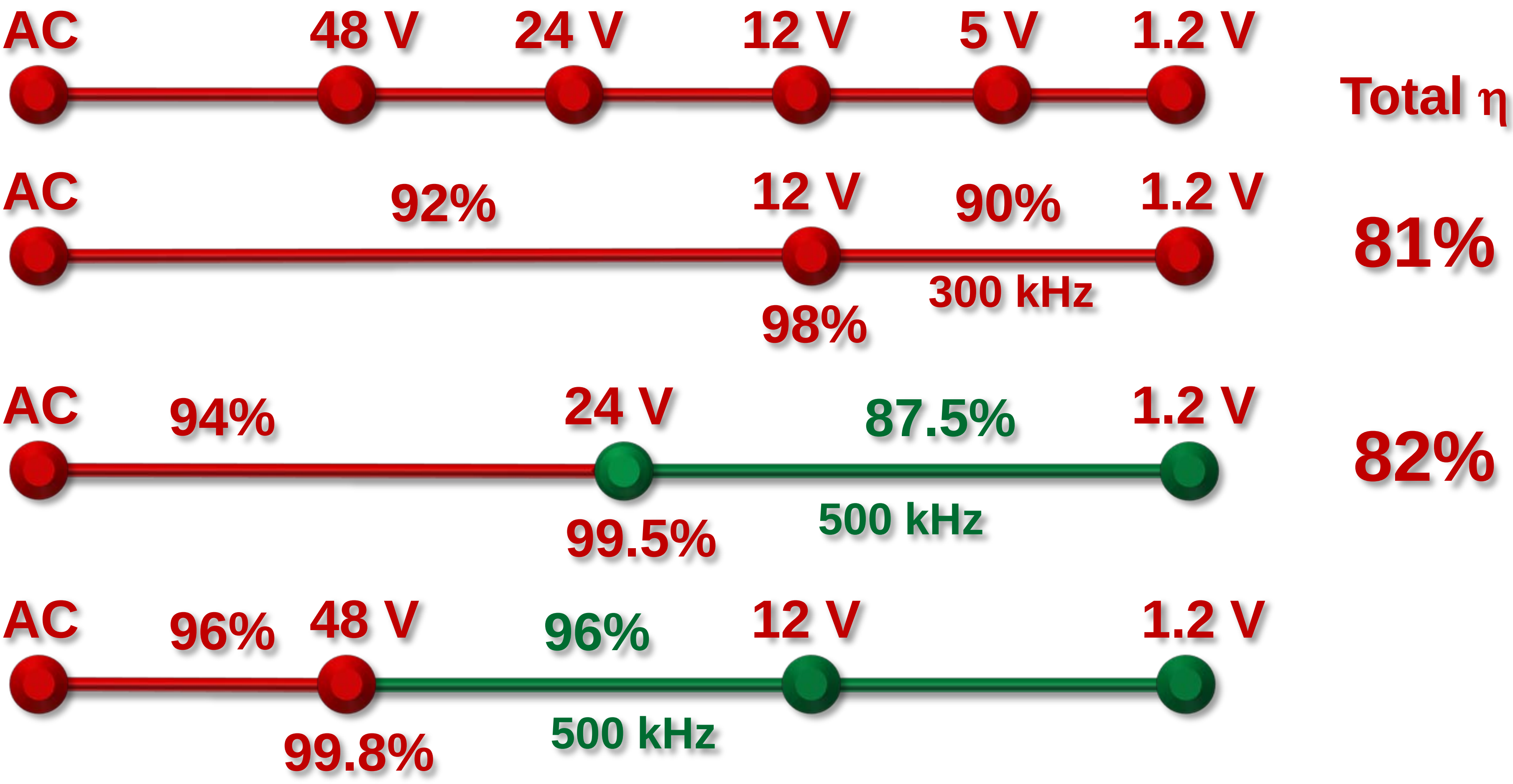
A 24V-1.2V Buck converter with eGaN FETs is 50% smaller and has 25% less power losses at 800 kHz.

eGaN FETs vs Power MOSFETs



AC 48 V 24 V 12 V 5 V 1.2 V

Total η

AC 92% 12 V 90% 1.2 V

98% 300 kHz

81%

AC 94% 24 V 87.5% 1.2 V

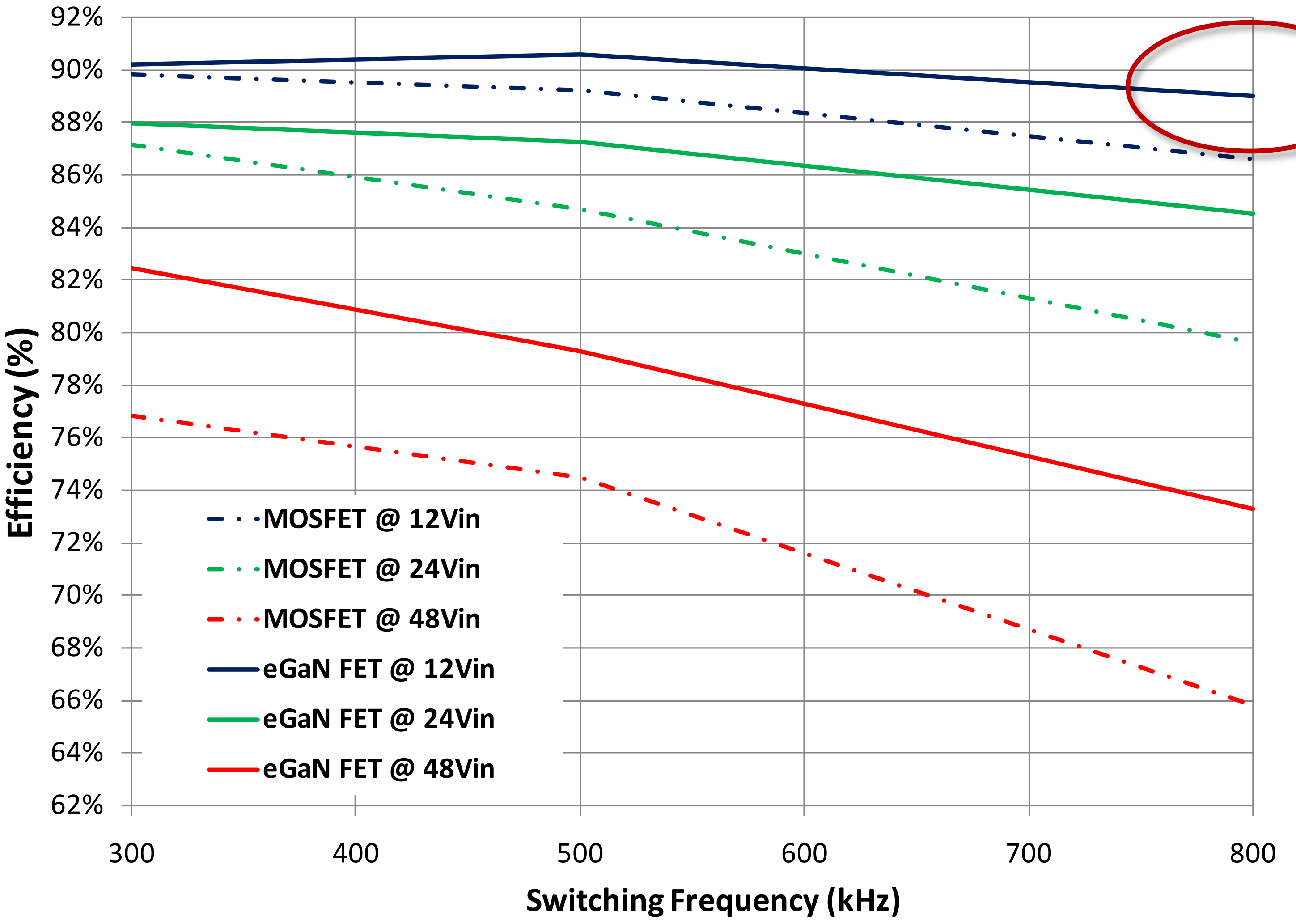
99.5% 500 kHz

82%

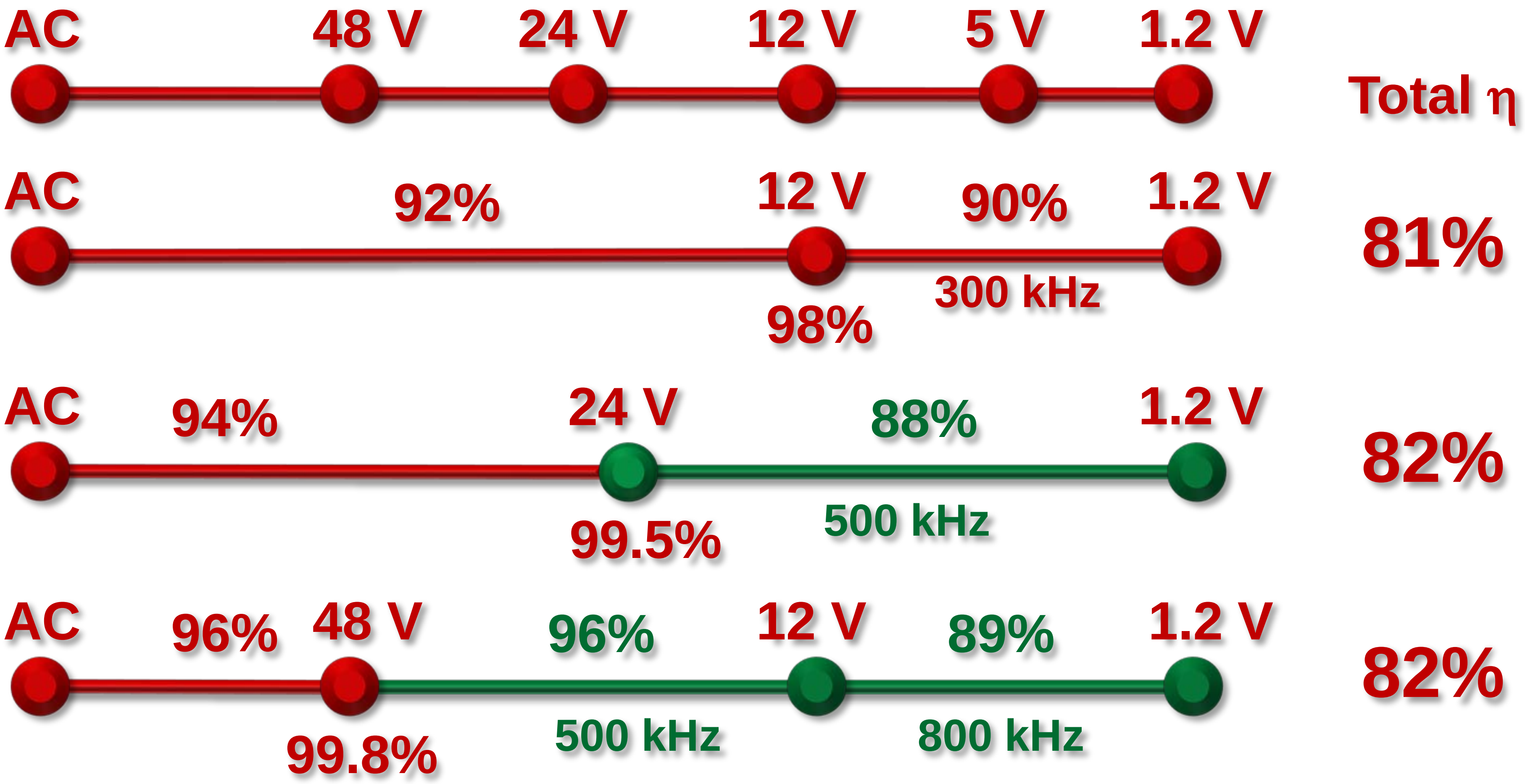
AC 96% 48 V 96% 12 V 1.2 V

99.8% 500 kHz

Efficiency vs Frequency @ 1.2Vout / 5A



eGaN FETs vs Power MOSFETs



AC 48 V 24 V 12 V 5 V 1.2 V

Total η

AC 92% 12 V 90% 1.2 V

98% 300 kHz

81%

AC 94% 24 V 88% 1.2 V

99.5% 500 kHz

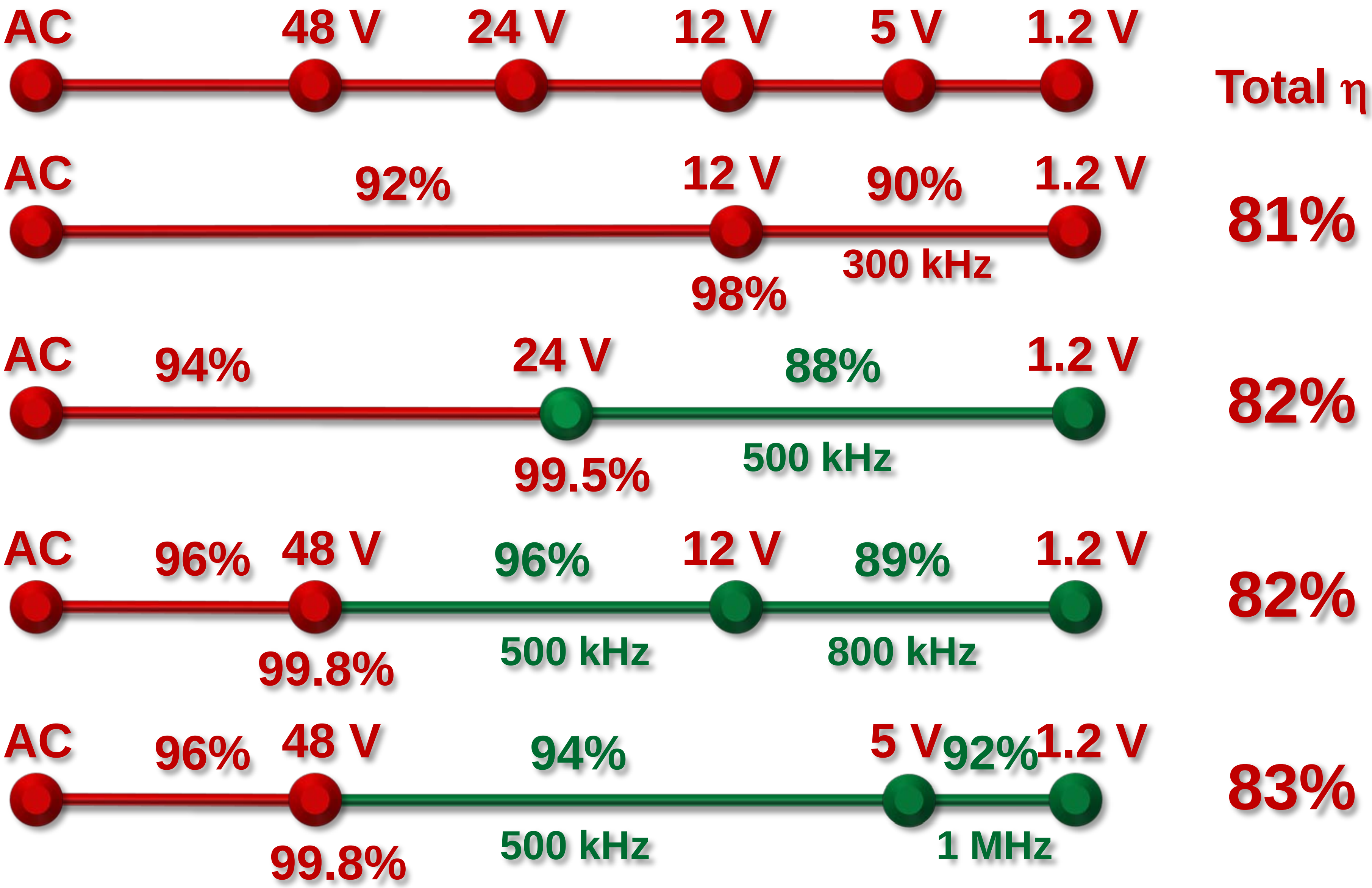
82%

AC 96% 48 V 96% 12 V 89% 1.2 V

99.8% 500 kHz 800 kHz

82%

eGaN FETs Enable New Architecture Design



AC 48 V 24 V 12 V 5 V 1.2 V

Total η

AC 92% 12 V 90% 1.2 V

98% 300 kHz

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AC 94% 24 V 88% 1.2 V

99.5% 500 kHz

82%

AC 96% 48 V 96% 12 V 89% 1.2 V

99.8% 500 kHz 800 kHz

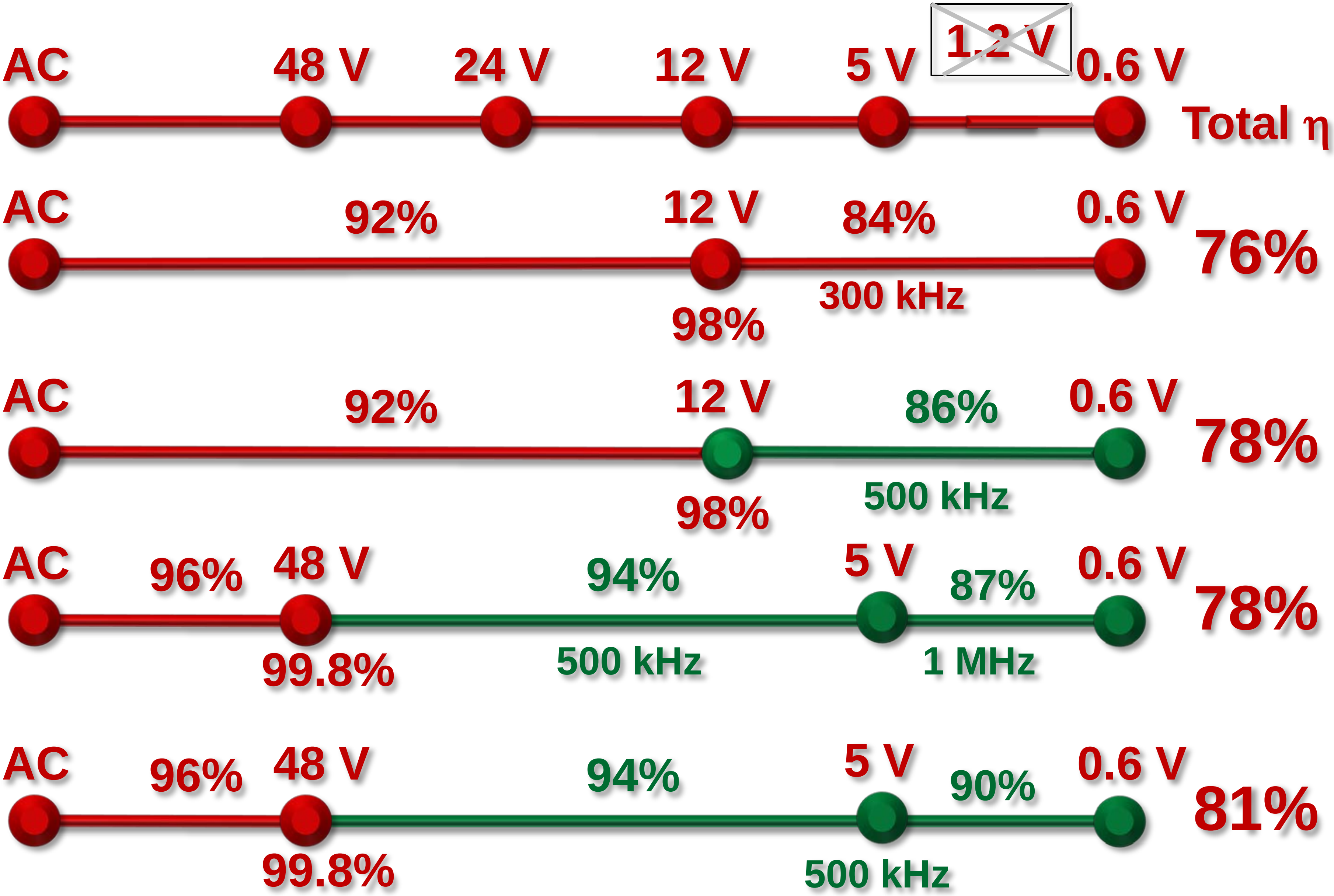
82%

AC 96% 48 V 94% 5 V 92% 1.2 V

99.8% 500 kHz 1 MHz

83%

eGaN FETs Improve Efficiencies at Digital Ouput Voltages



AC 48 V 24 V 12 V 5 V ~~1.2 V~~ 0.6 V Total η

AC 92% 12 V 84% 0.6 V 76%
98% 300 kHz

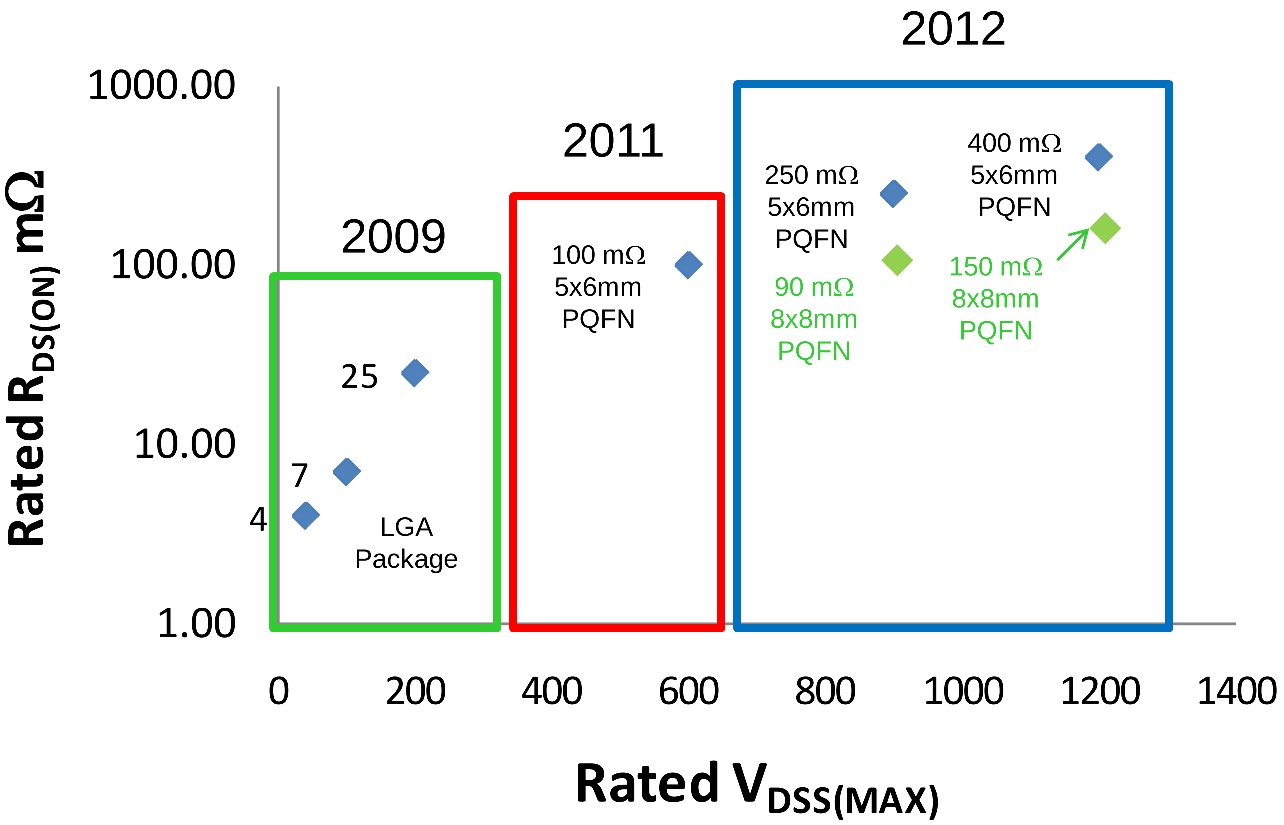
AC 92% 12 V 86% 0.6 V 78%
98% 500 kHz

AC 96% 48 V 94% 5 V 87% 0.6 V 78%
99.8% 500 kHz 1 MHz

AC 96% 48 V 94% 5 V 90% 0.6 V 81%
99.8% 500 kHz

EPC Product Plans

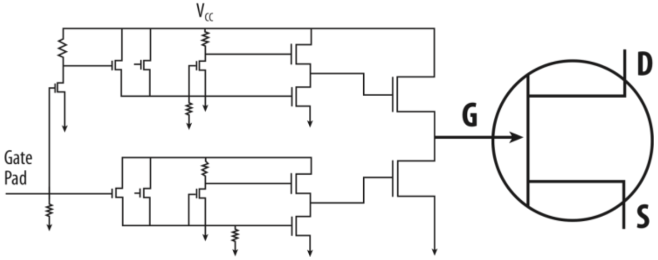
Beyond 600 Volts



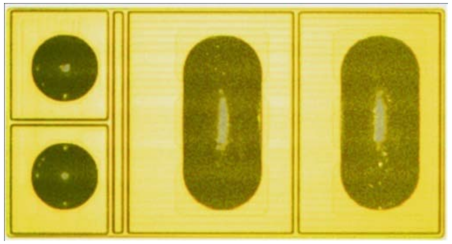
EPC's eGaN FET products will extend to 600V in 2011 and to 900V and 1200V in 2012 if there is adequate customer interest

Beyond Discrete Devices

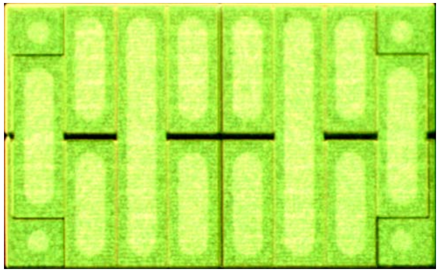
Driver On Board



Discrete FET with Driver



Full-Bridge with Driver



Conclusions

- Enhancement mode gallium nitride on silicon (eGaN®) technology opens up a new set of options for improving overall system efficiency.
- Power loss reductions of better than 10% can be realized today with improved transient response and improved power density
- As digital voltages continue to decline, the advantages of eGaN FETs compared with silicon, increases
- In the future, eGaN technology will allow even higher power density and cost reductions through higher levels of integration.

EPC
EFFICIENT POWER CONVERSION

The end of the road for Silicon ...

... is the beginning of the GaN journey!