Alexander Lidow PhD

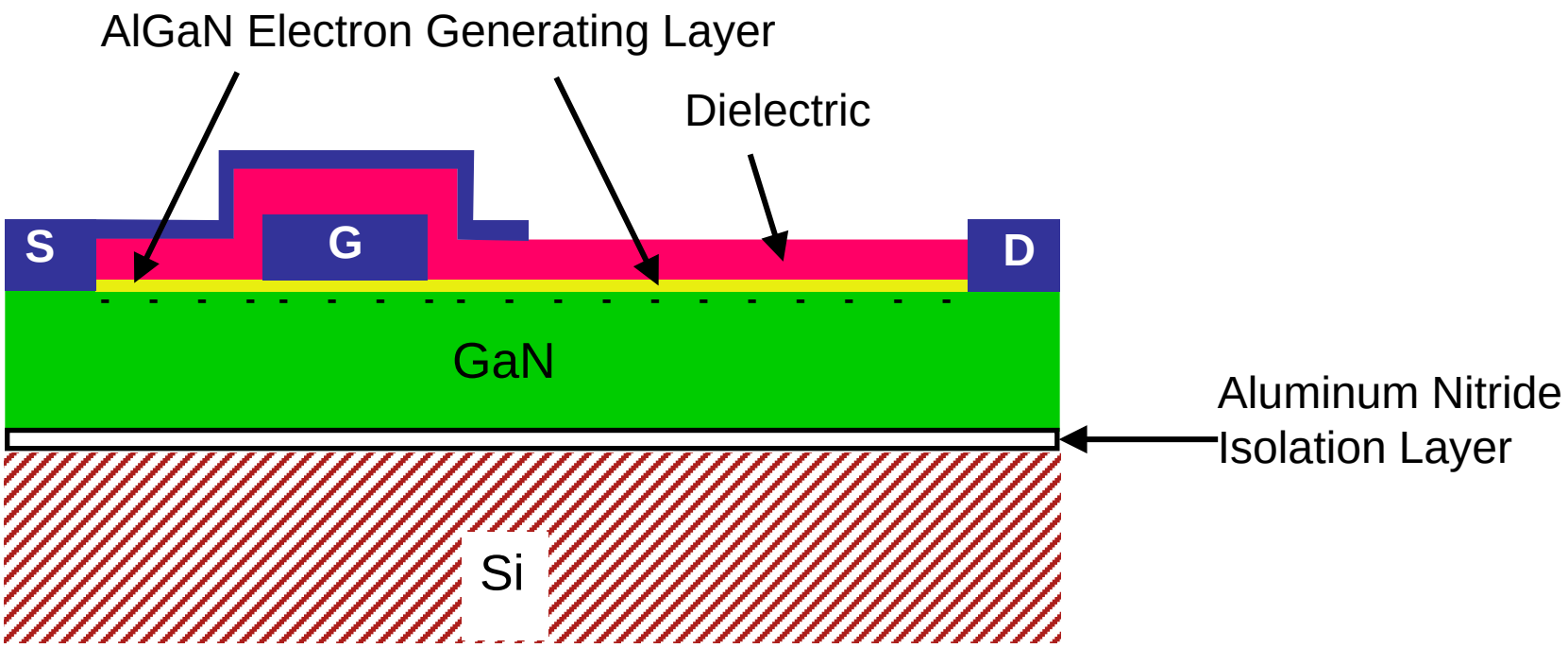
Efficient Power Conversion Corporation

Agenda

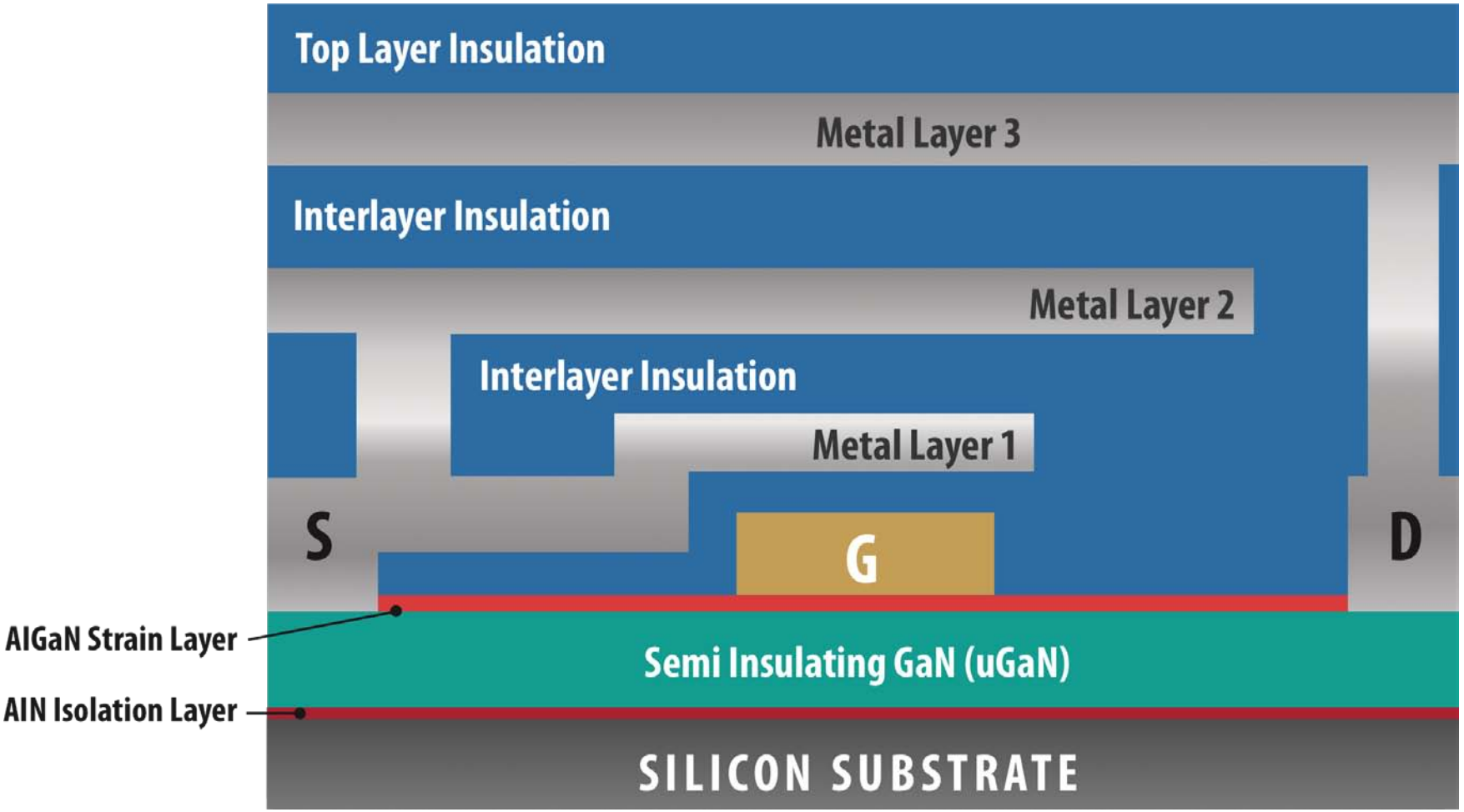
- Overview of EPC *eGaN*® FET technology
- The opportunity to improve efficiency and performance
- Future Products
- Conclusions

Overview of eGaN FET Technology

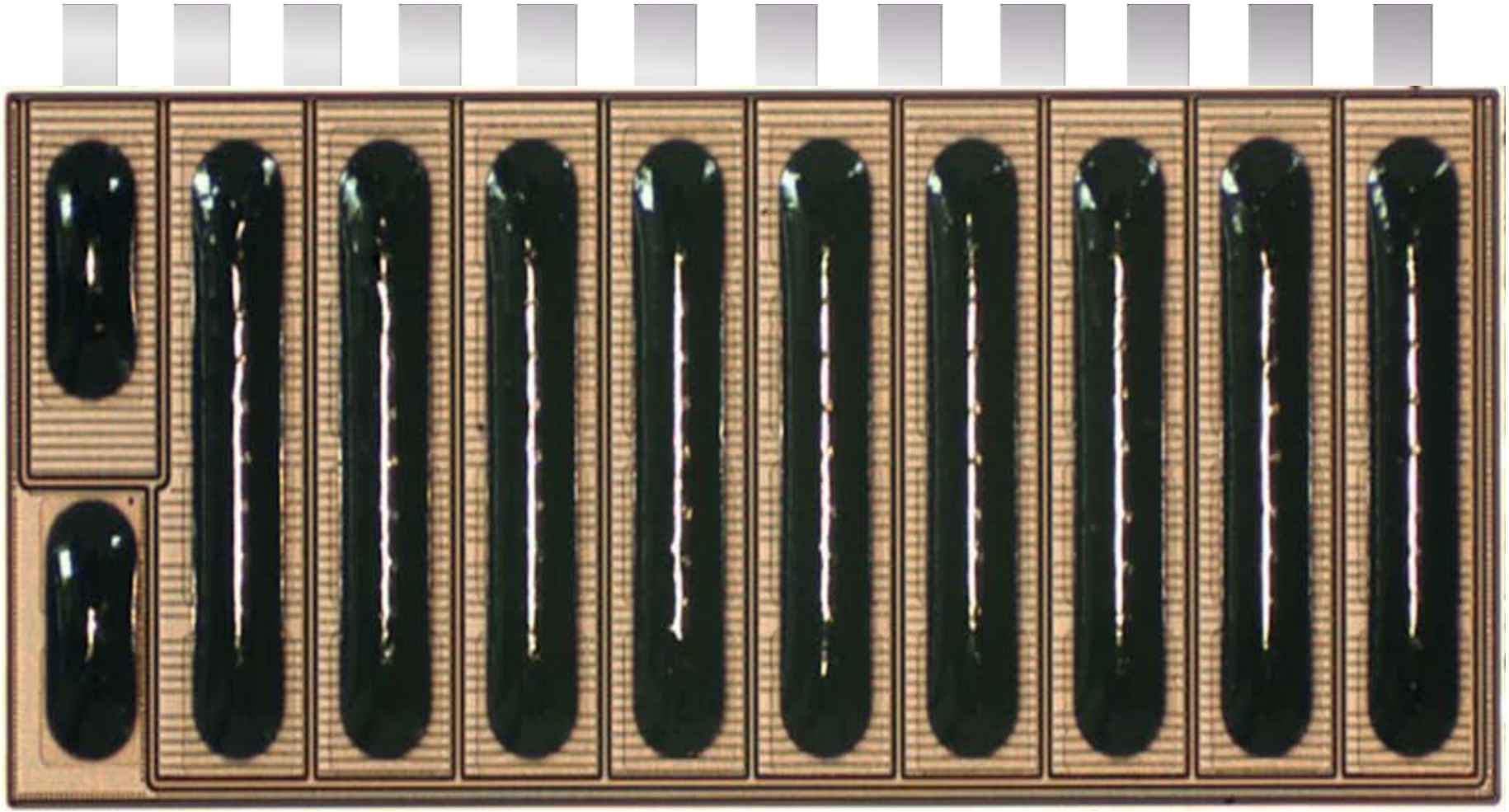
eGaN FETs Structure



eGaN FETs Structure



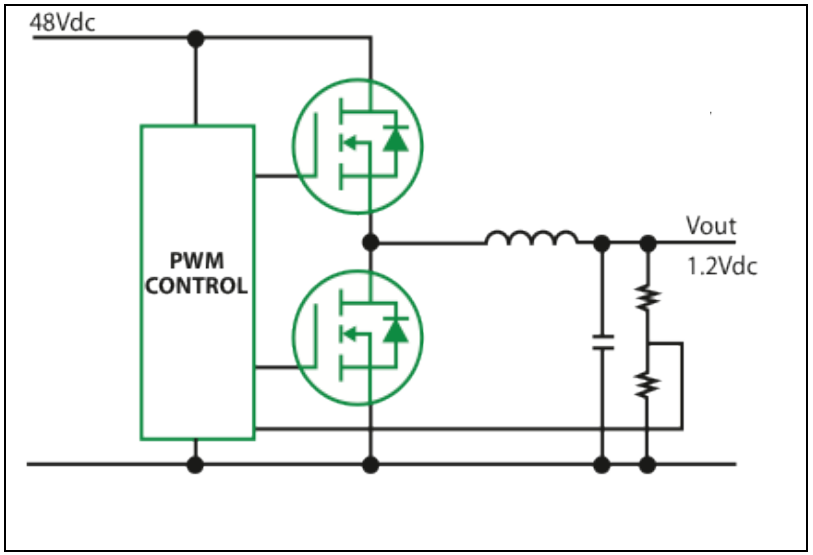
Flip Chip Assembly



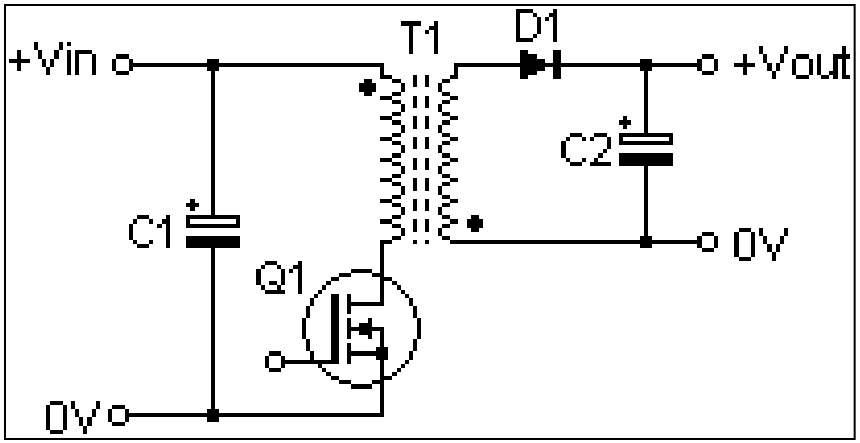
The Opportunity to Improve Efficiency

Topologies Explored

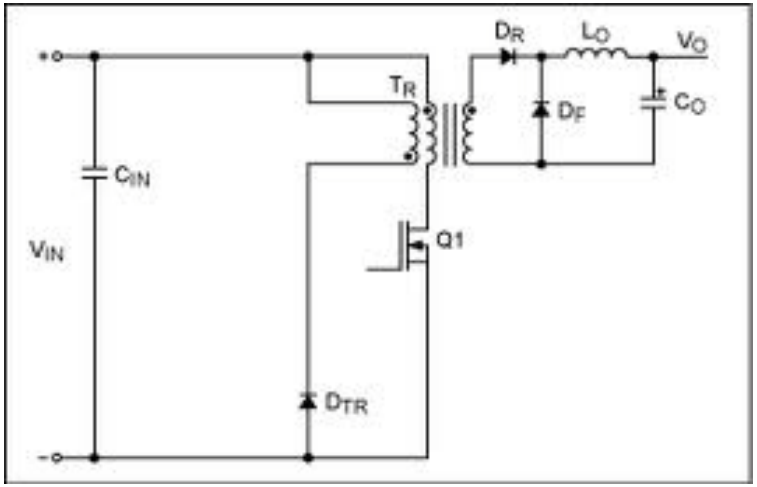
Buck Converter



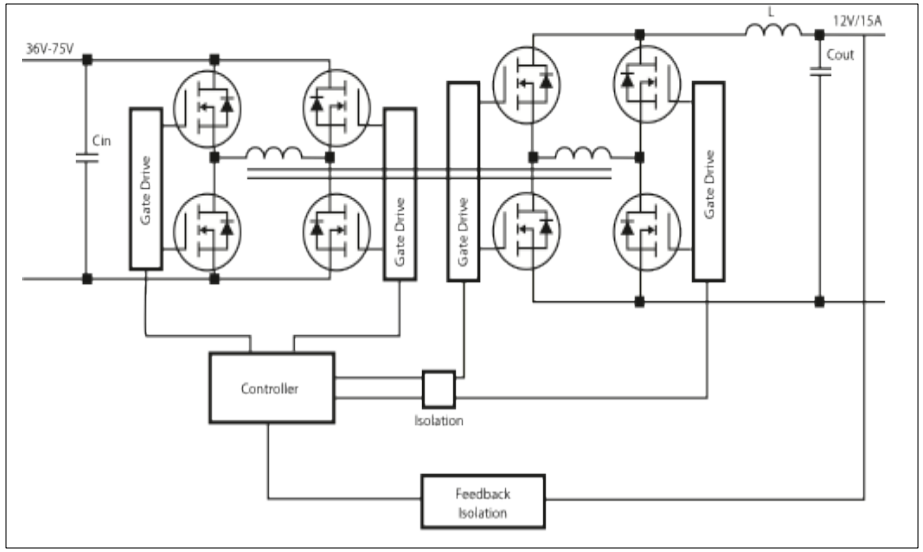
Flyback Converter



Forward Converter



Full Bridge Isolated Converter



Buck Converter

Advantage:

- **High power density and high efficiency**

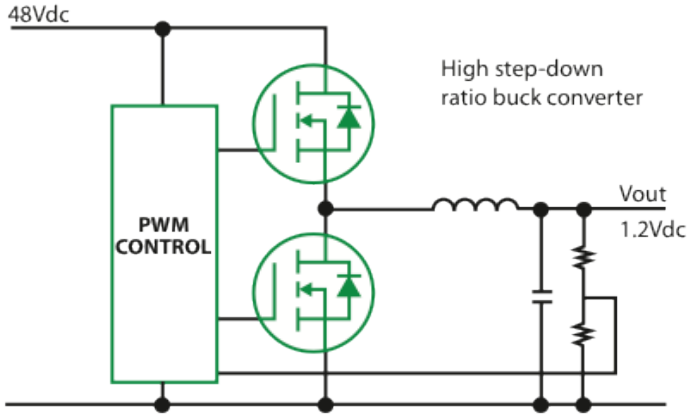
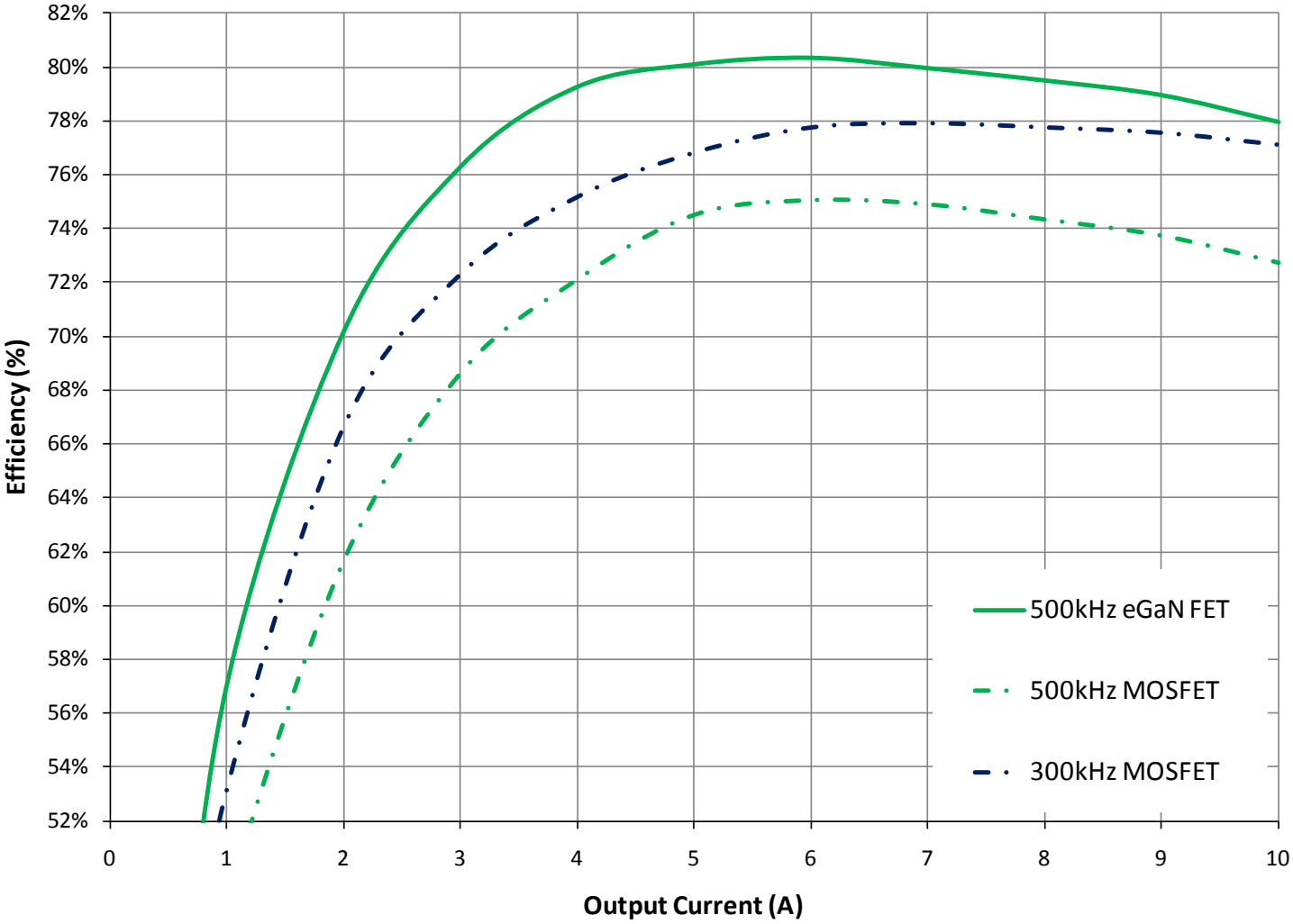
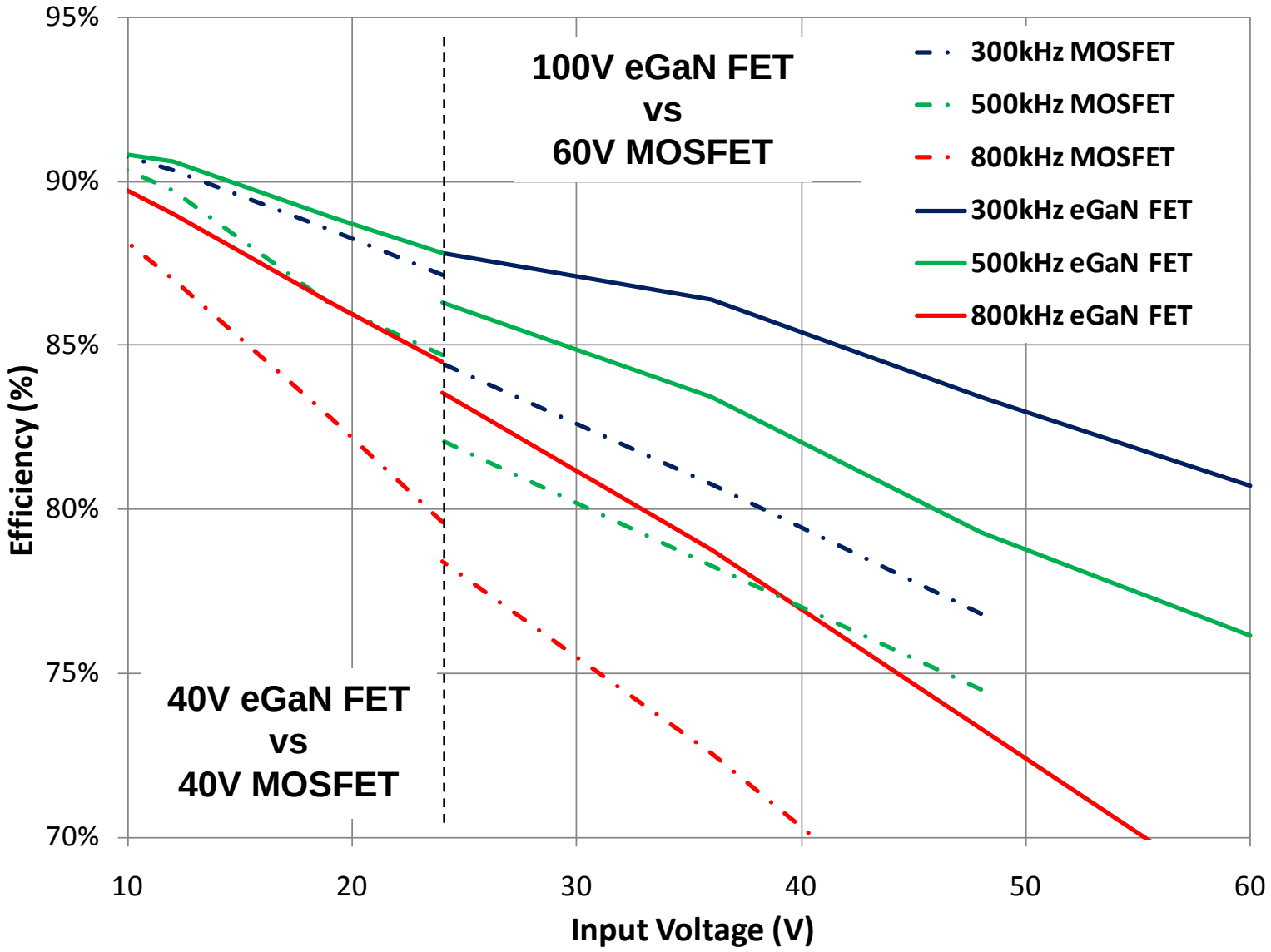


Figure 7 – Buck converter with an input voltage of 48 VDC and output voltage of 1.2 VDC

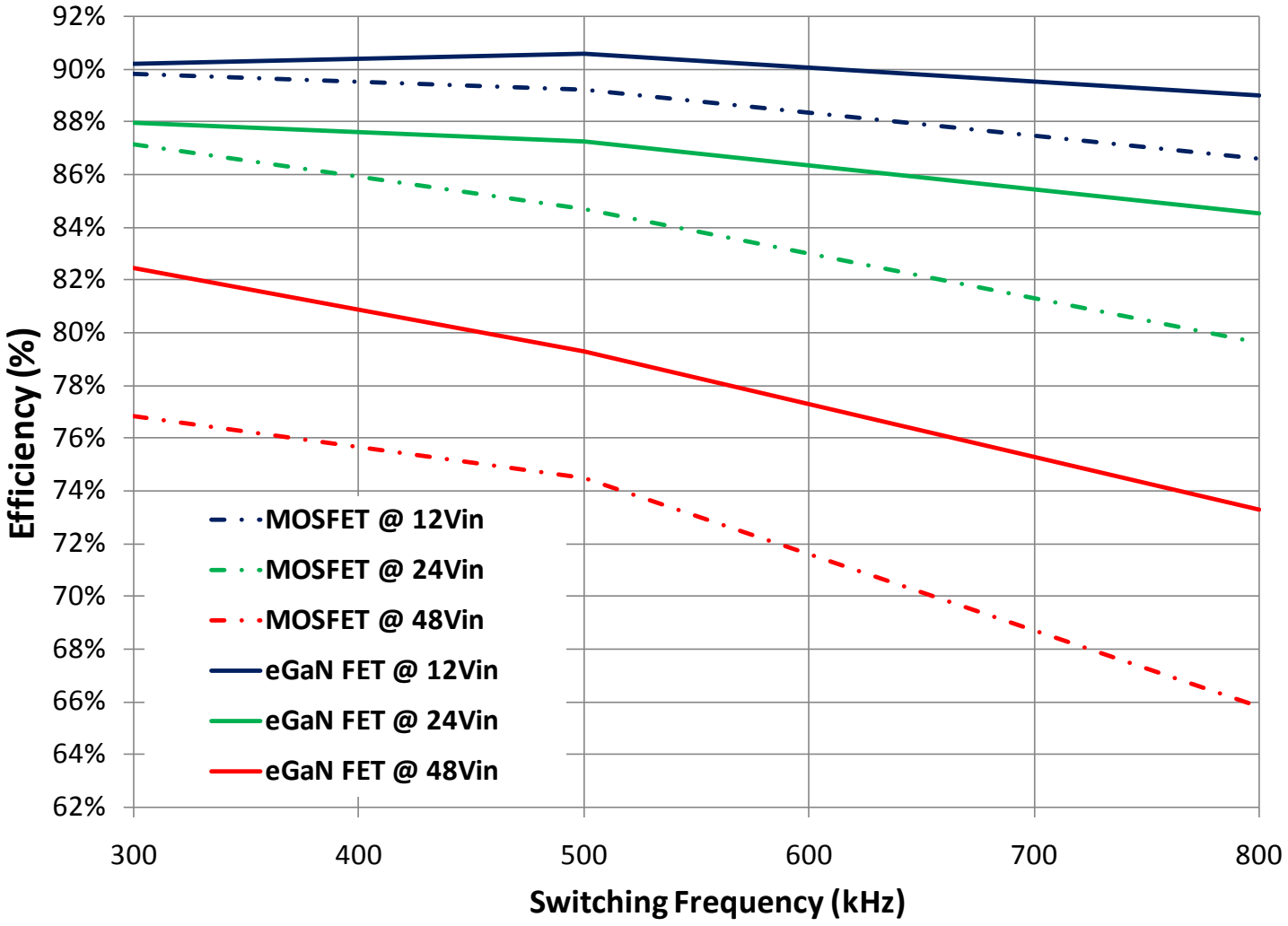
48V - 1.2V Efficiency Comparison



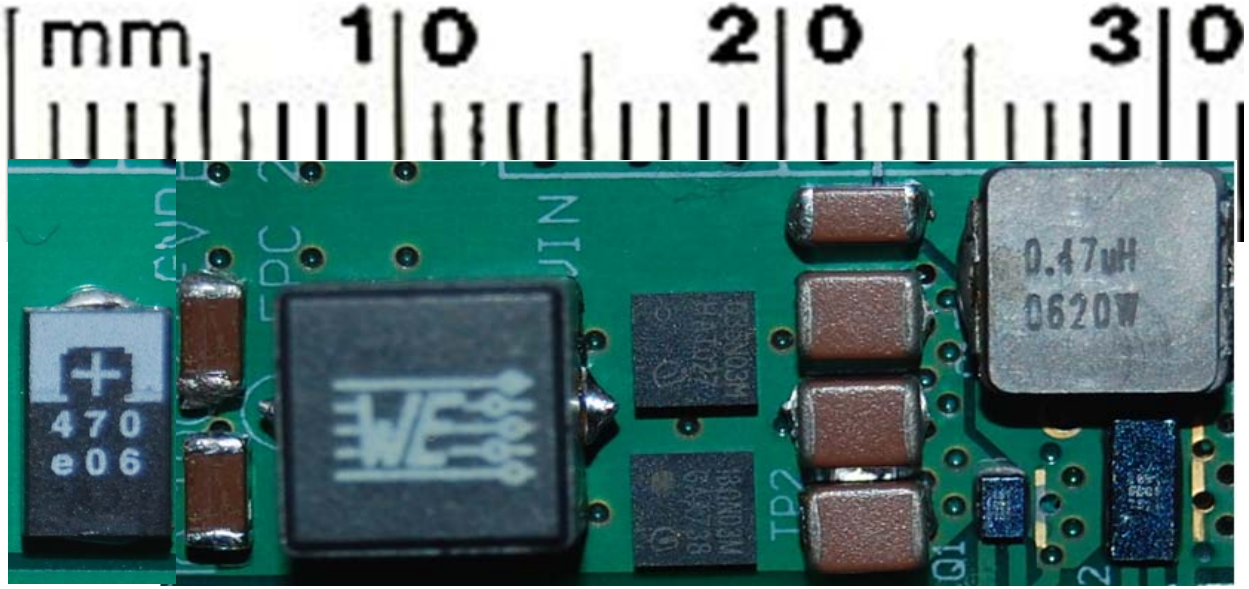
Efficiency vs V_{IN} @ V_{OUT} = 1.2 V / 5A



Efficiency vs Frequency @ 1.2Vout / 5A



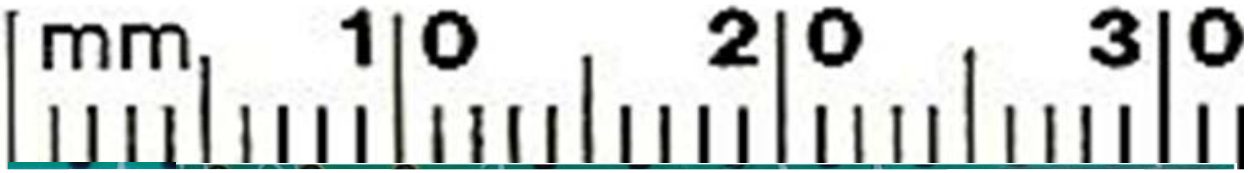
Buck Size Comparison



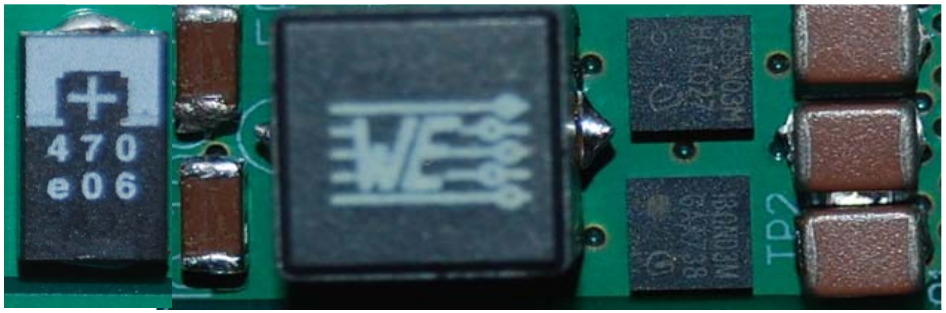
		Q1		Q2					
	V_{DS} (V)	$R_{DS(ON)}$ (max) High Side	Q_{GD} (typ) High Side	$R_{DS(ON)}$ (max) Low Side	Q_G (typ) Low Side	Q_{GS2} (typ) Low Side	Q_{RR} (max) Low Side	V_{SD} (typ) 10A, 25°C	Total Package Area (nom)
eGaN FET	40	16 mΩ	0.55 nC	4 mΩ	11.6 nC	18.5 nC	0 nC	2.15 V	8.5 mm²
MOSFET	30	15 mΩ	1.5 nC	4.3 mΩ	27 nC	32 nC	20 nC	0.76 V	21.8 mm²

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 mm²



		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_{GS2} (typ) Low Side	Q_{RR} (max) Low Side	V_{SD} (typ) 10A, 25°C	Total Package Area (nom)
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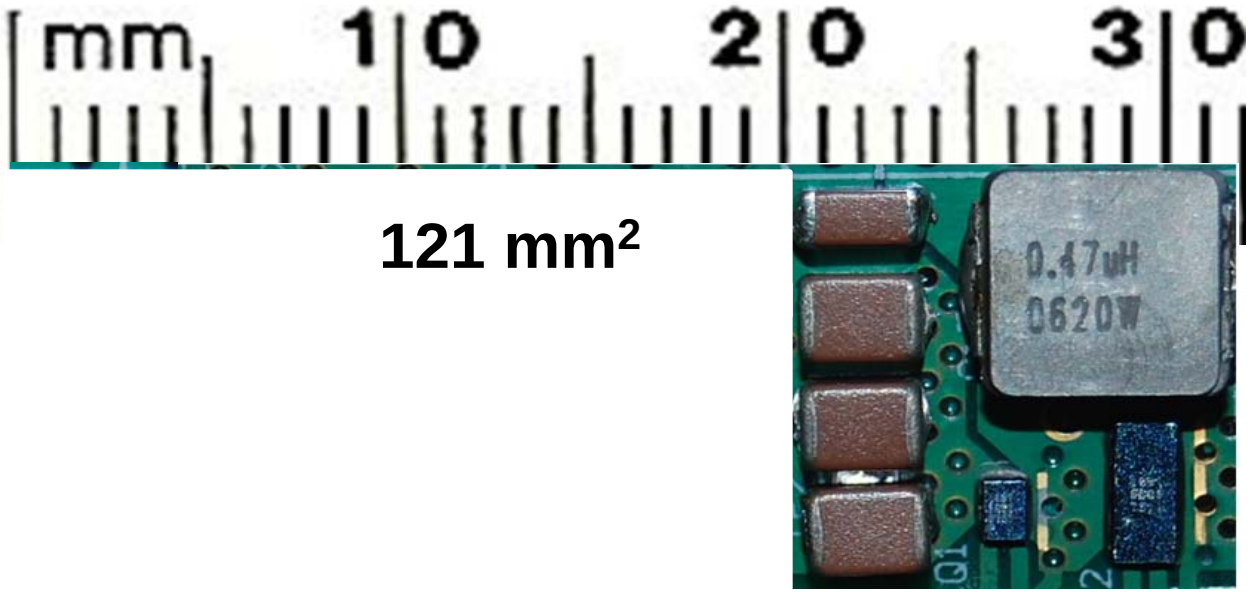
Buck Size Comparison



121 mm²

		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_{GS2} (typ) Low Side	Q_{RR} (max) Low Side	V_{SD} (typ) 10A, 25°C	Total Package Area (nom)
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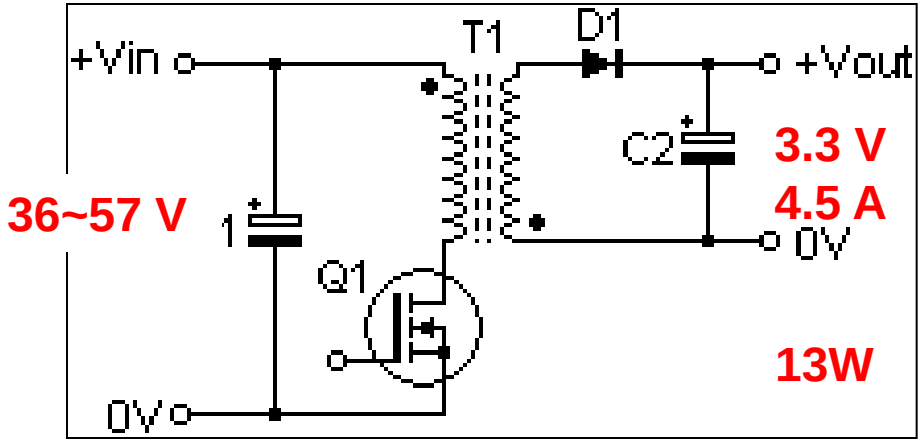
MOSFET	30	15 mΩ	1.5 nC	4.3 mΩ	27 nC	32 nC	20 nC	0.76 V	21.8 mm²

A 24V-1.2V Buck converter with eGaN FETs is 50% smaller and has 30% less power losses at 800 kHz.

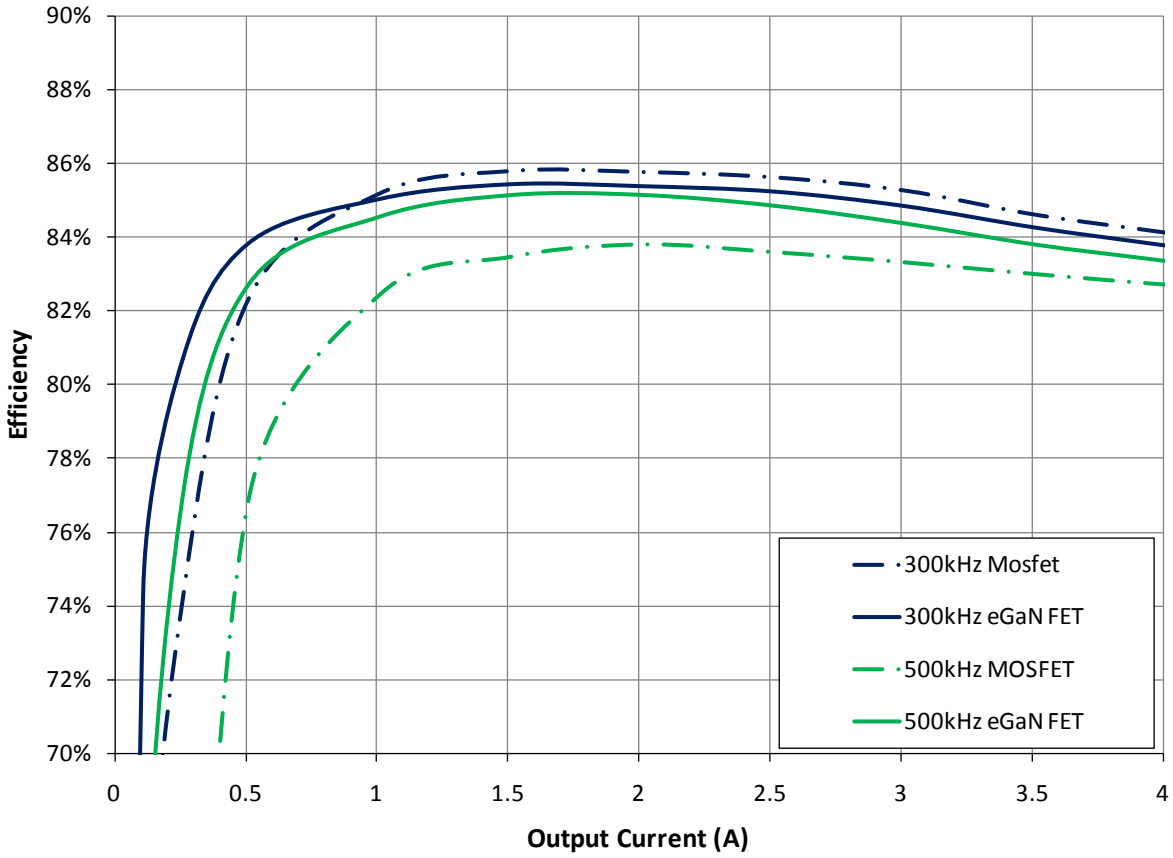
Flyback Converter

Advantage:

- **Low cost at low power density**



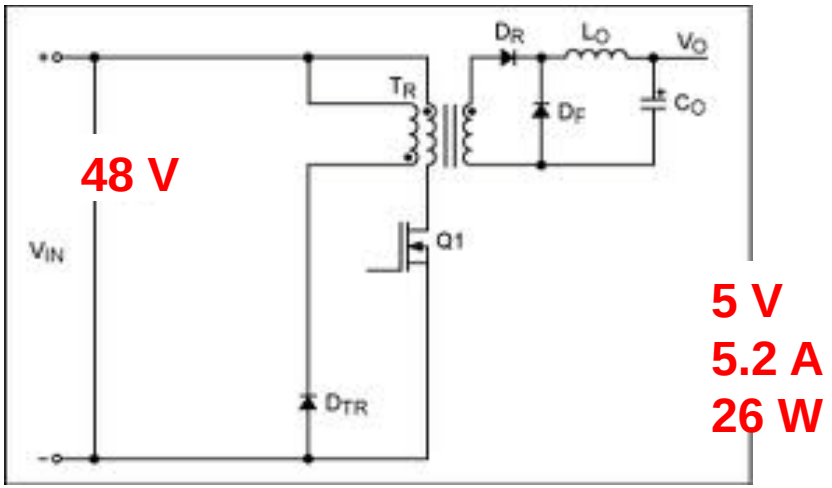
Flyback Converter



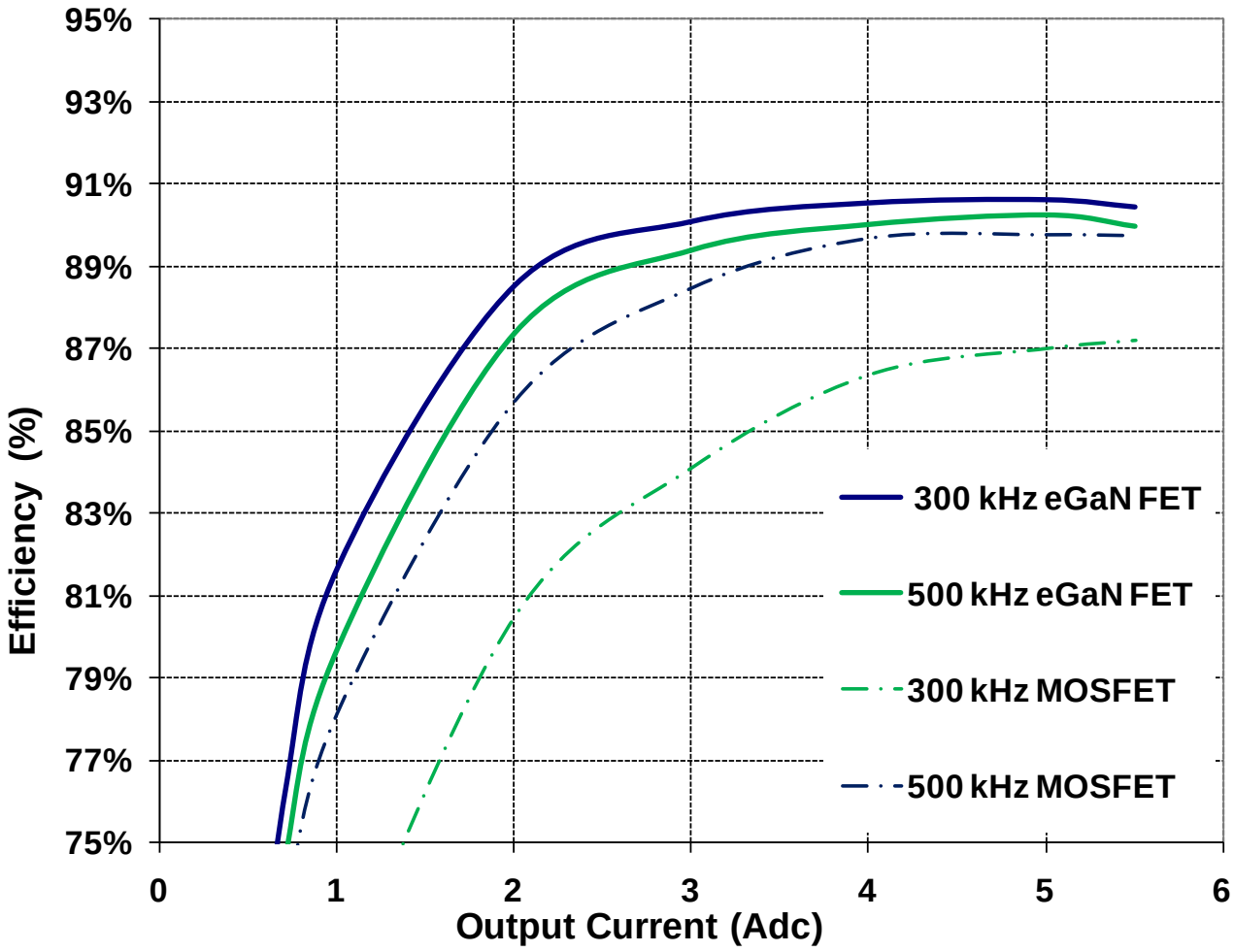
Forward Converter

Advantage:

- **High power density at lower power**



Forward Converter



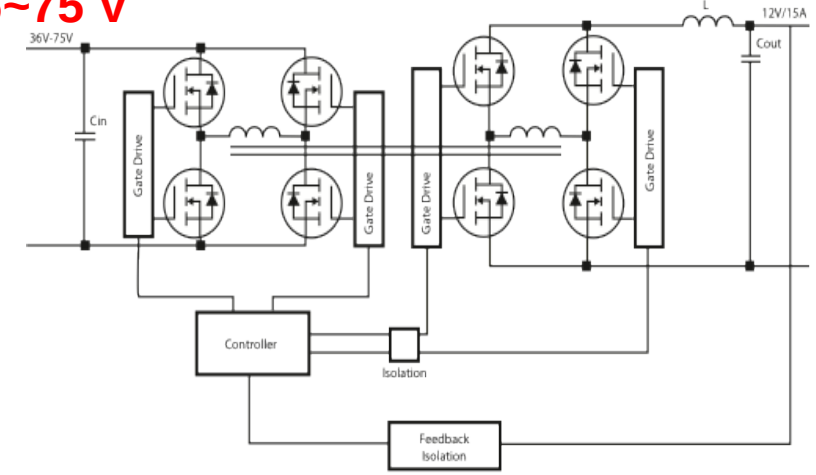
Isolated Full Bridge Converter

Advantage:

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

12 V
15 A
180 W

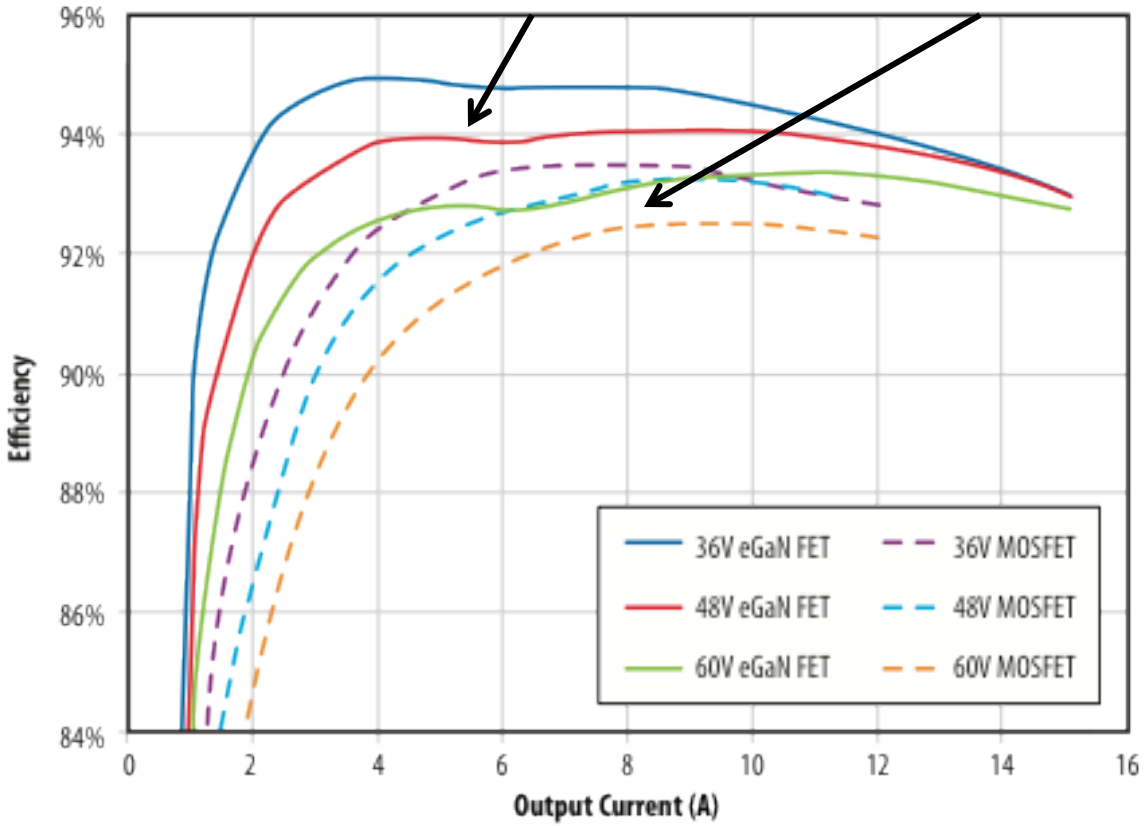
36~75 V



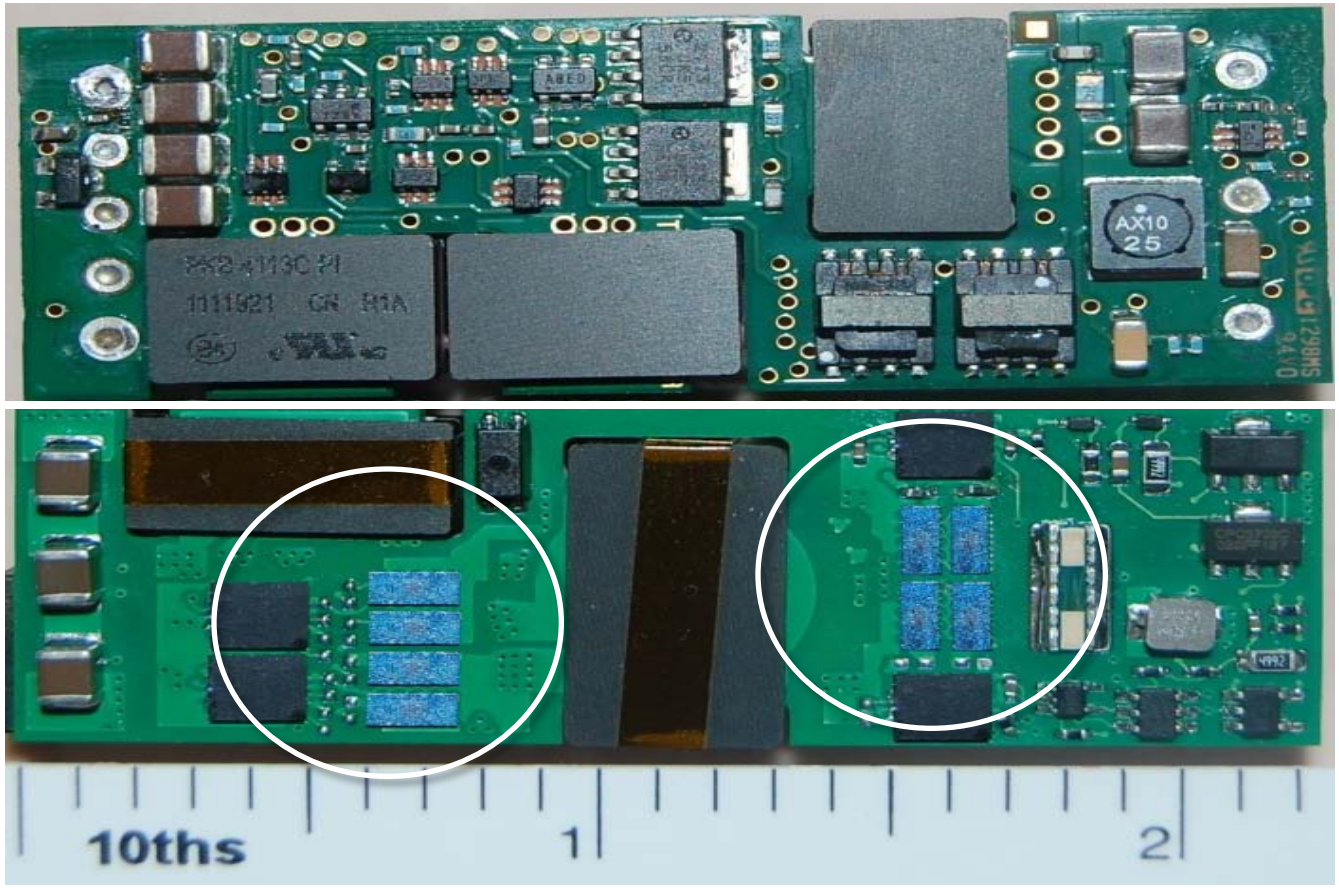
Isolated 1/8 Brick

Efficiency comparison @ 12 V_{OUT}

eGaN FET @ 333 kHz vs MOSFET @ 250 kHz

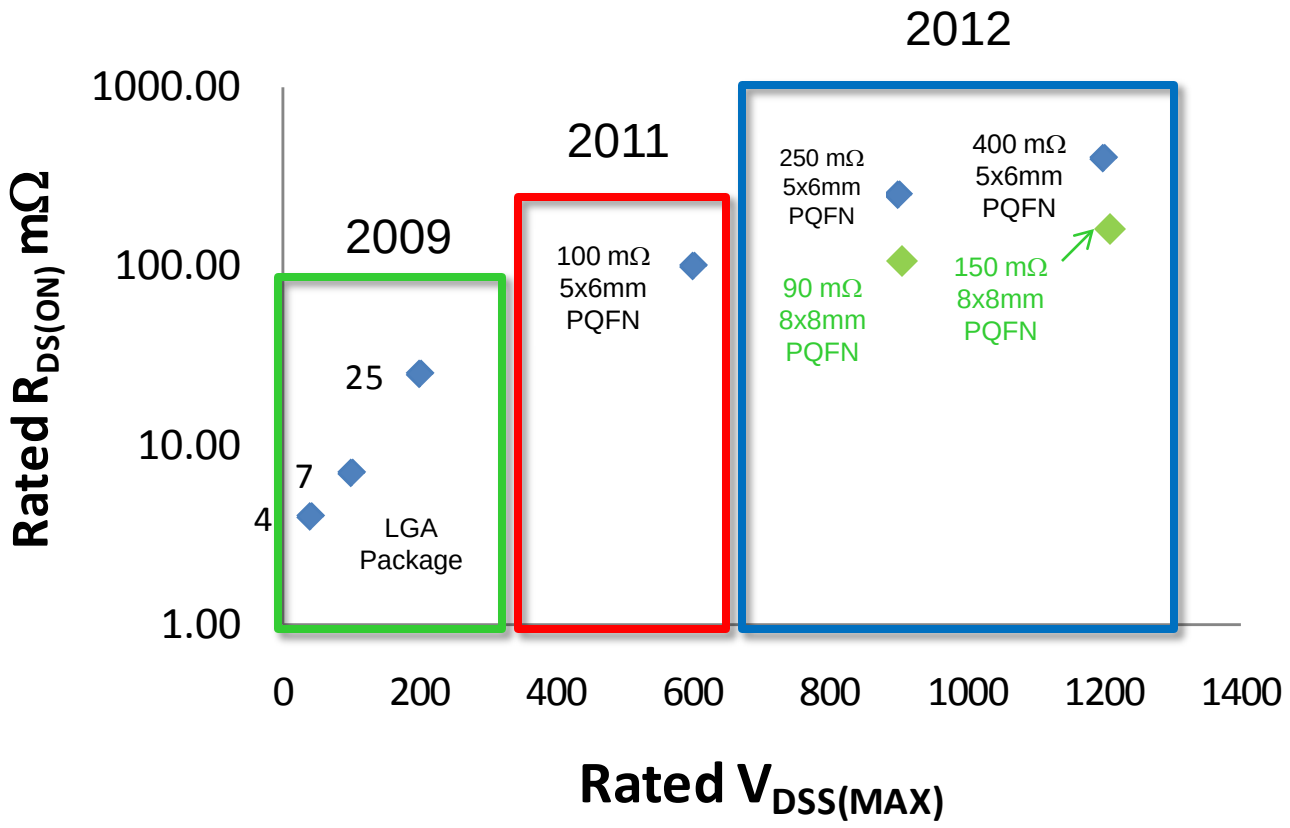


Isolated 1/8 Brick



EPC Product Plans

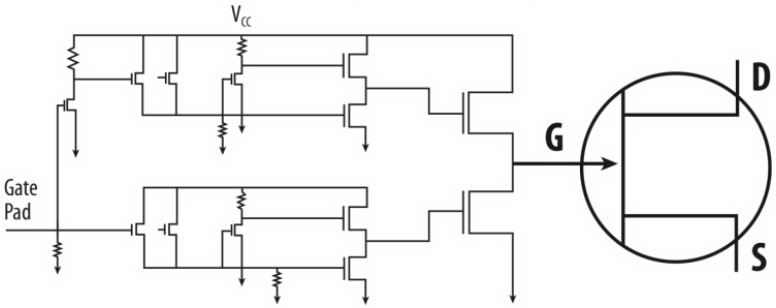
Beyond 600 Volts



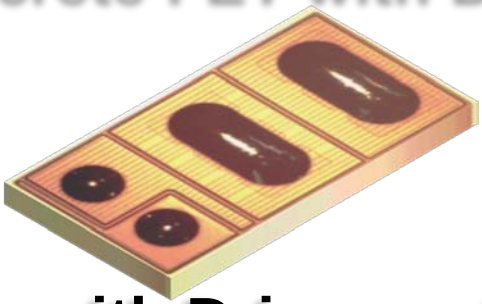
EPC's eGaN FET products will extend to 600V in 2011 and to 900V and 1200V in 2012 if there is adequate customer interest

Beyond Discrete Devices

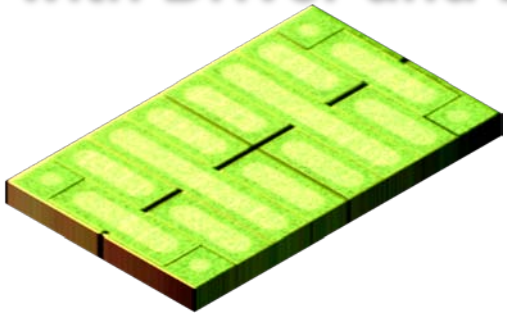
Driver On Board



Discrete FET with Driver



Full-Bridge with Driver and Level Shift



Conclusions

- **Enhancement mode gallium nitride on silicon (eGaN®) technology opens up a new set of options for improving overall system efficiency.**
- **For each of the four most common topologies for low voltage power conversion, eGaN FETs demonstrated significant improvement in performance compared with the best power MOSFETs**
- **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!