Improving System Performance with eGaN® FETs in DC-DC Applications

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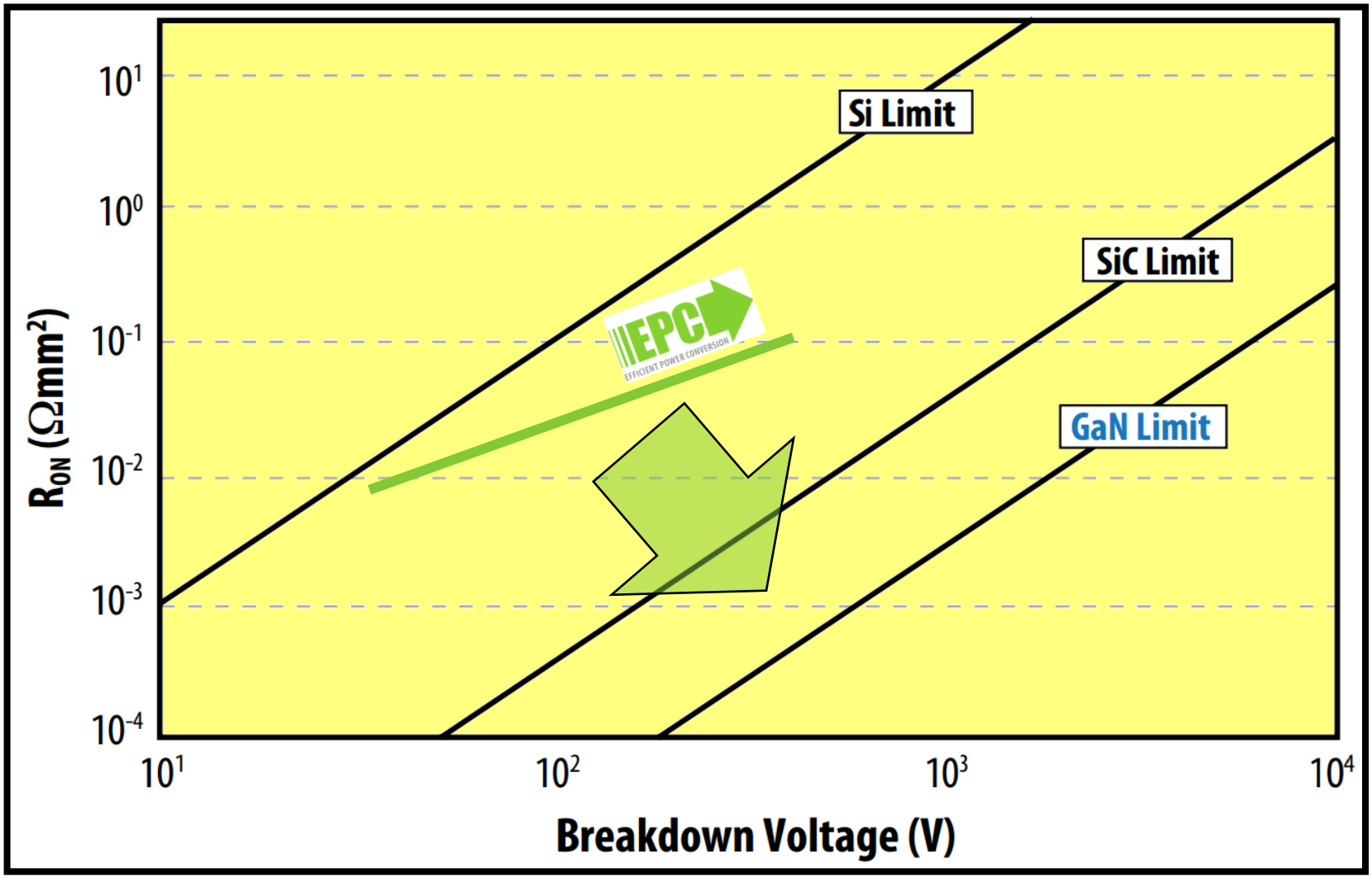
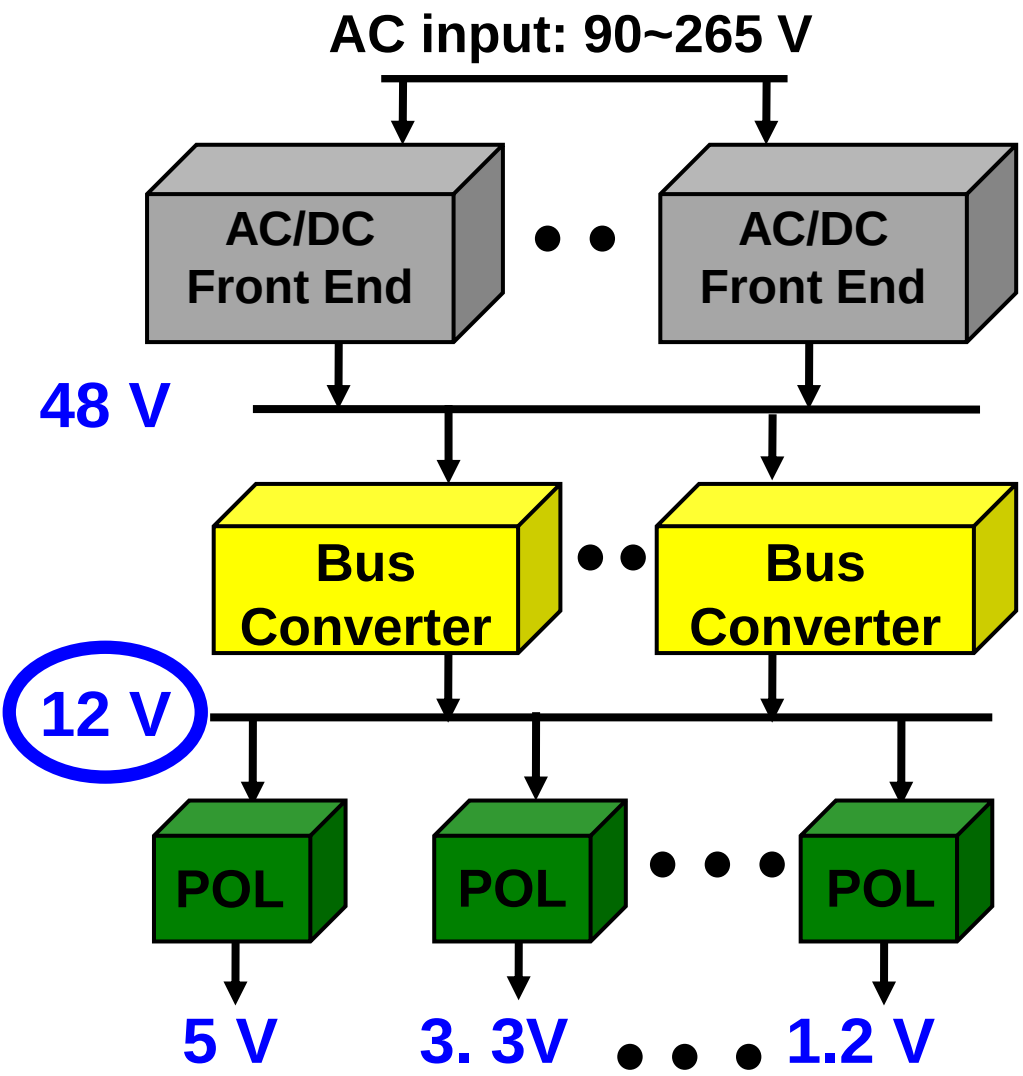
Why Gallium Nitride?

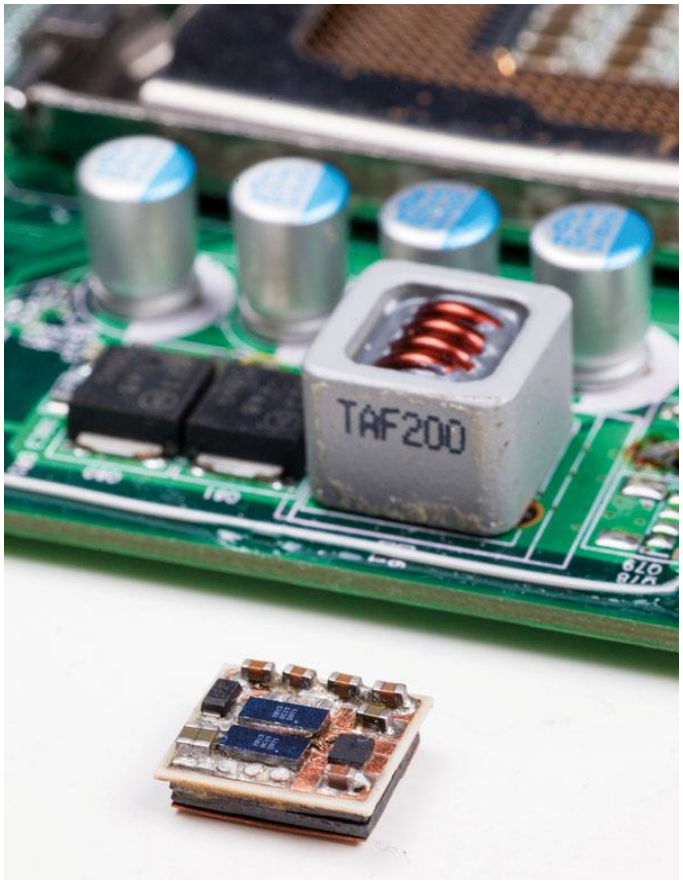


Where Gallium Nitride?

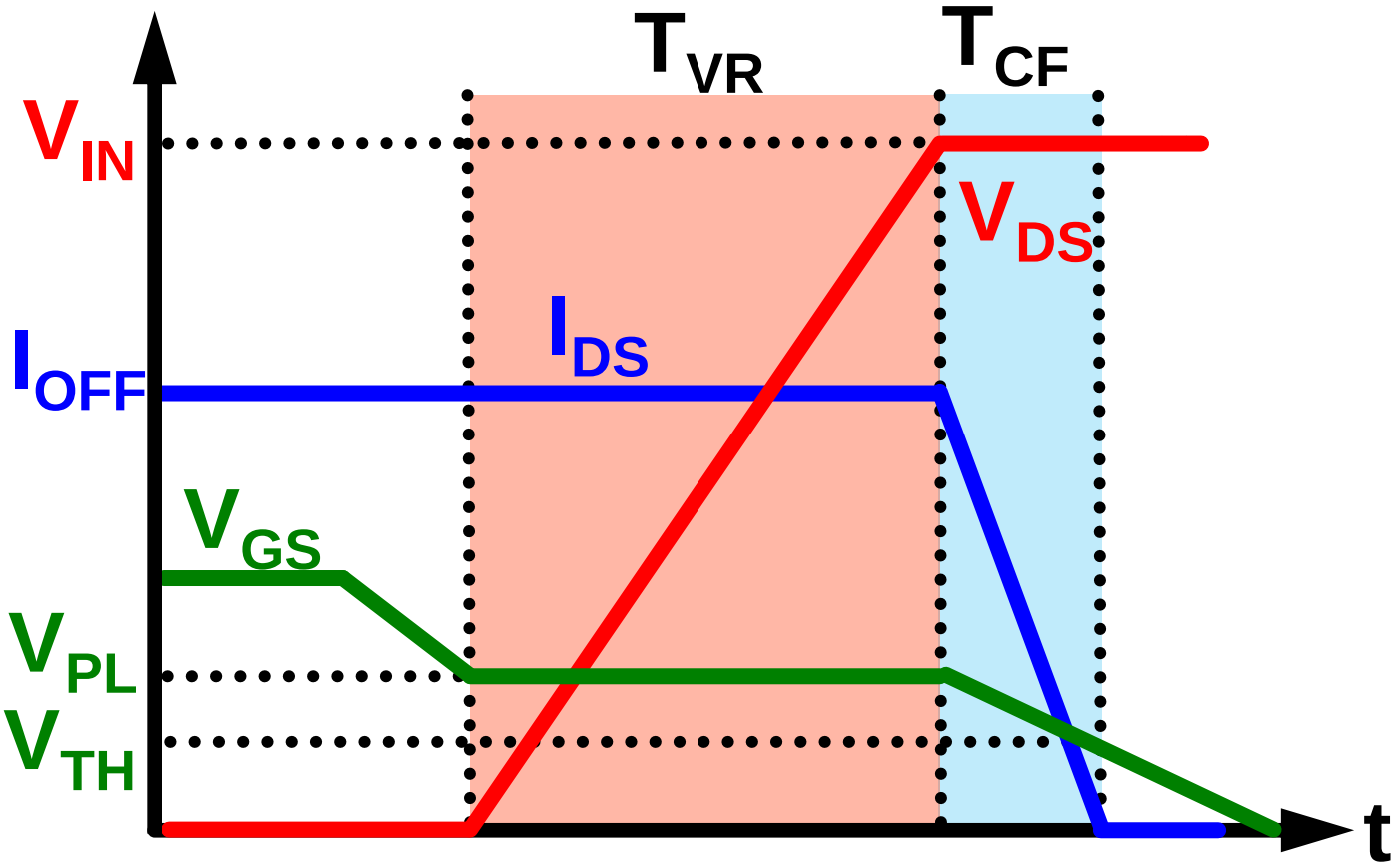


2MHz GaN Based 12 V 3D POL

Ref: ece.vt.edu



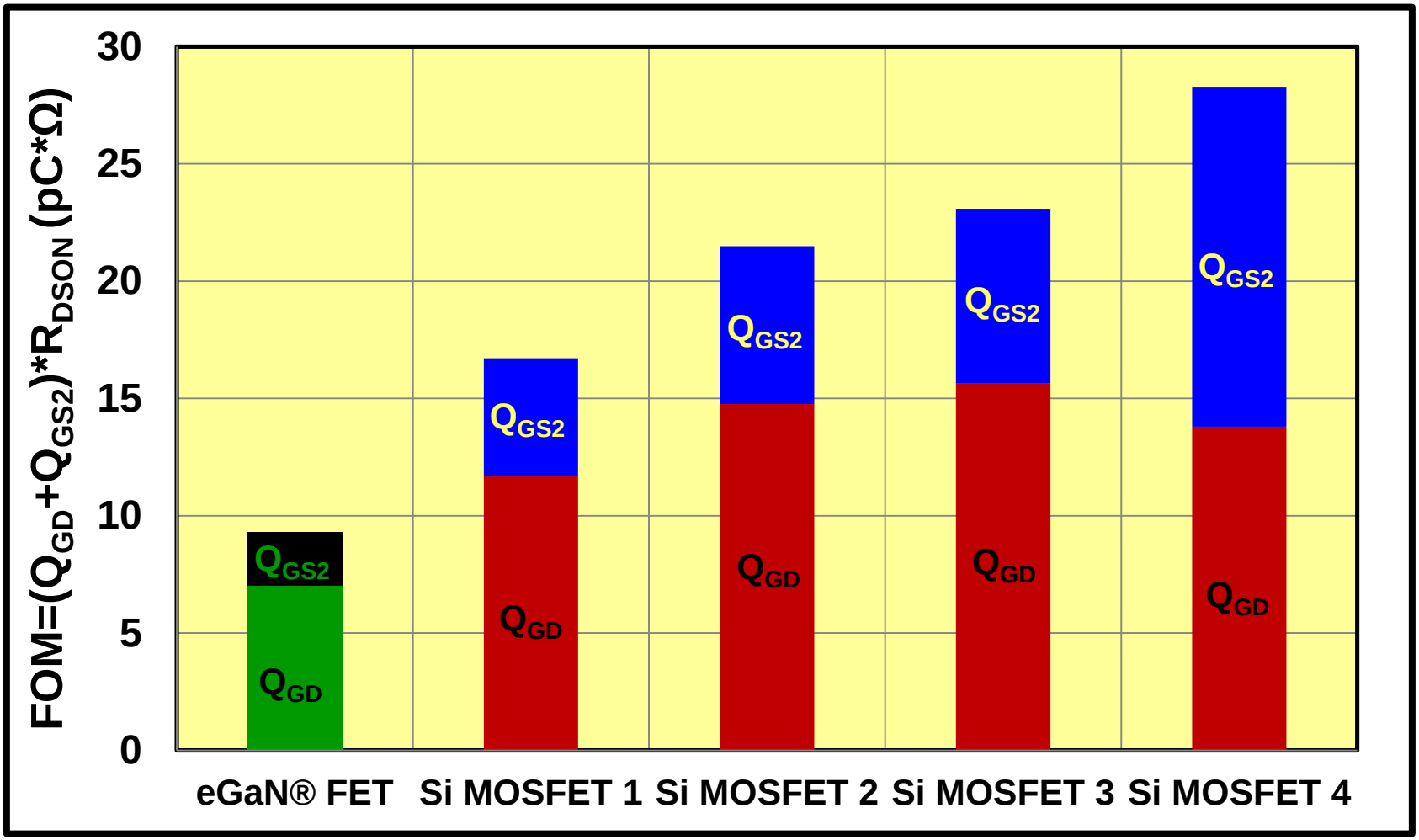
Ideal Hard Switching



$$P_{T_{VR}} \approx \frac{V_{IN} * I_{OFF} * Q_{GD}}{2 * I_G}$$

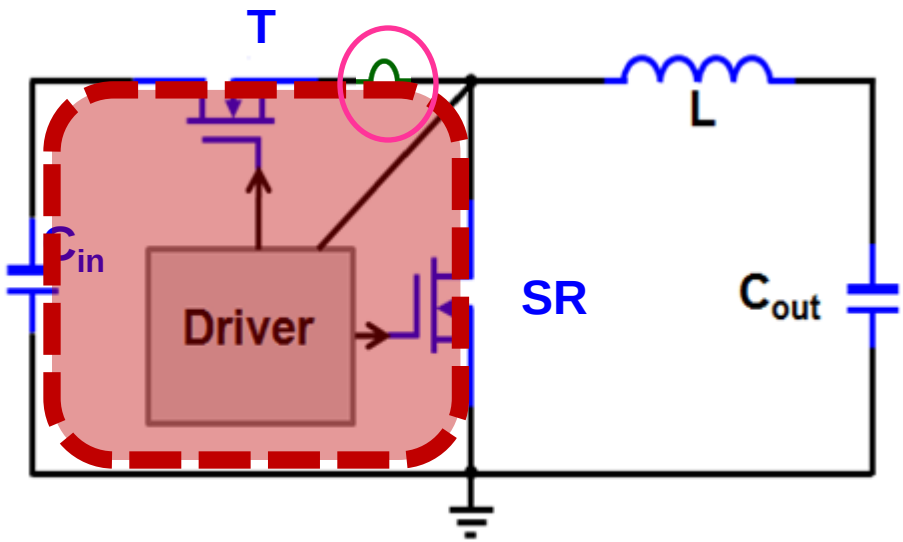
$$P_{T_{CF}} \approx \frac{V_{IN} * I_{OFF} * Q_{GS2}}{2 * I_G}$$

40V Device Comparison



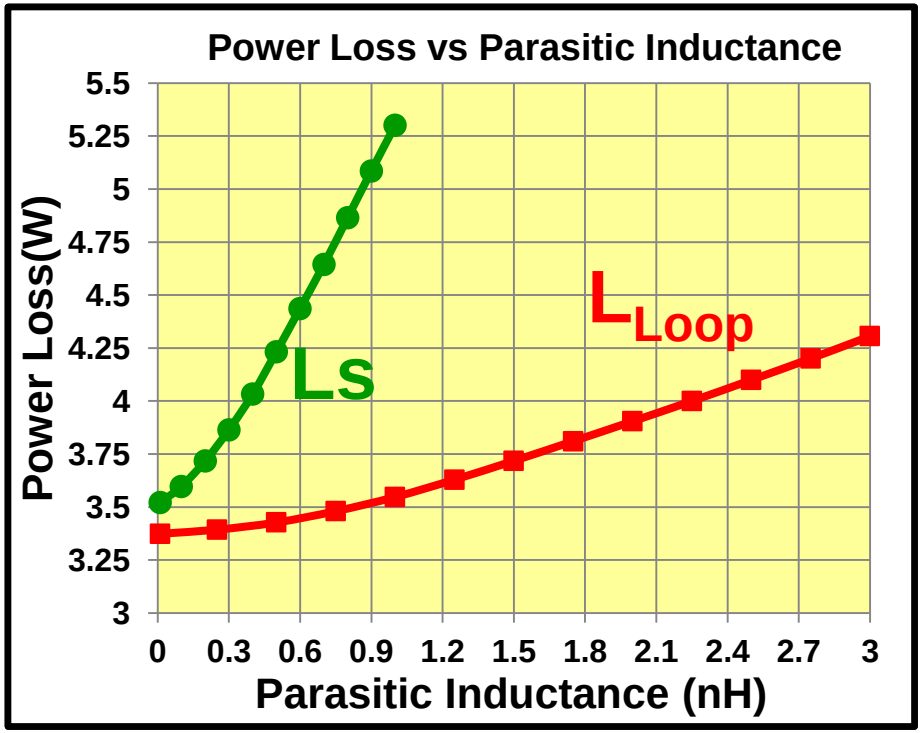
V_{DS}=20 V, I_{DS}= 20 A

Buck Converter Parasitics



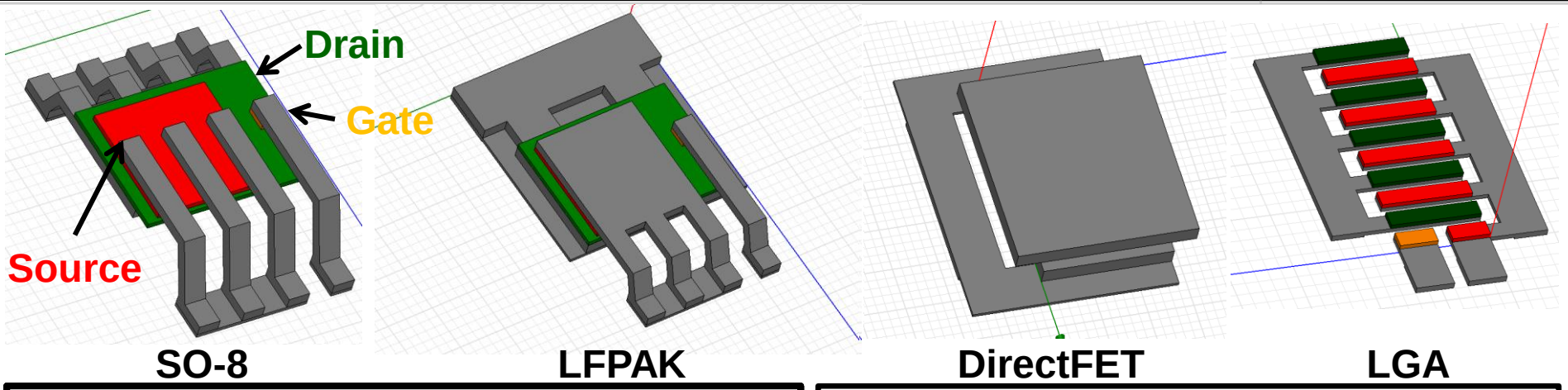
L_S: Common Source Inductance

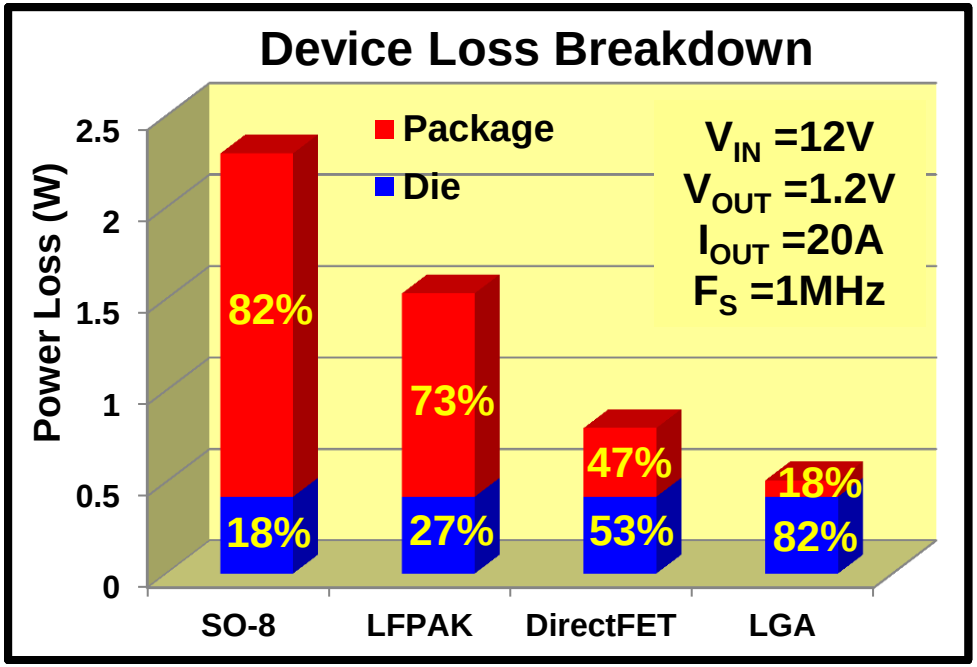
L_{Loop}: High Frequency Power Loop Inductance

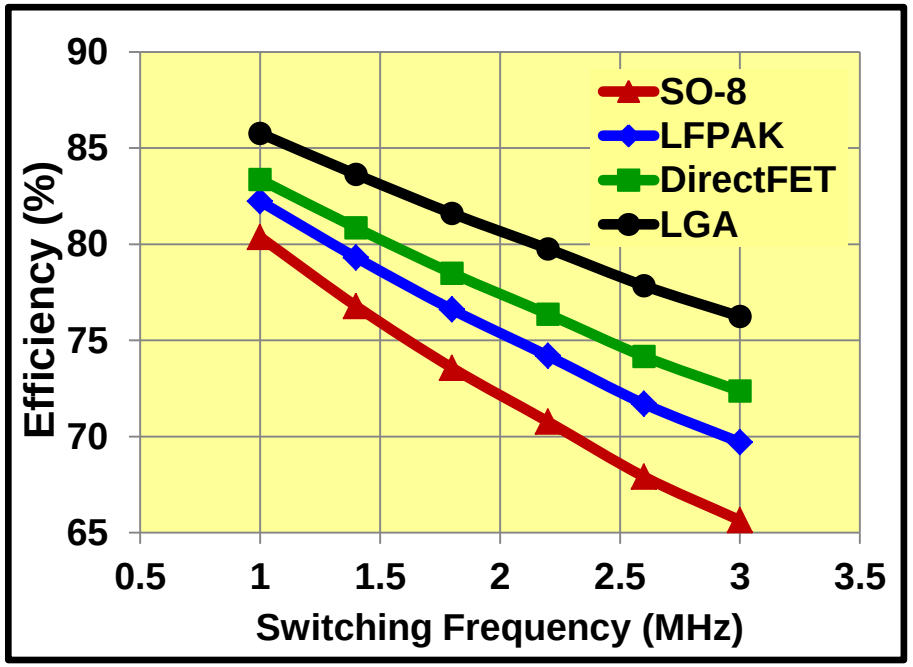


V_{IN}=12 V, V_{OUT}=1.2 V,
F_S=1 MHz, I_{OUT}= 20 A

Packaging Evolution

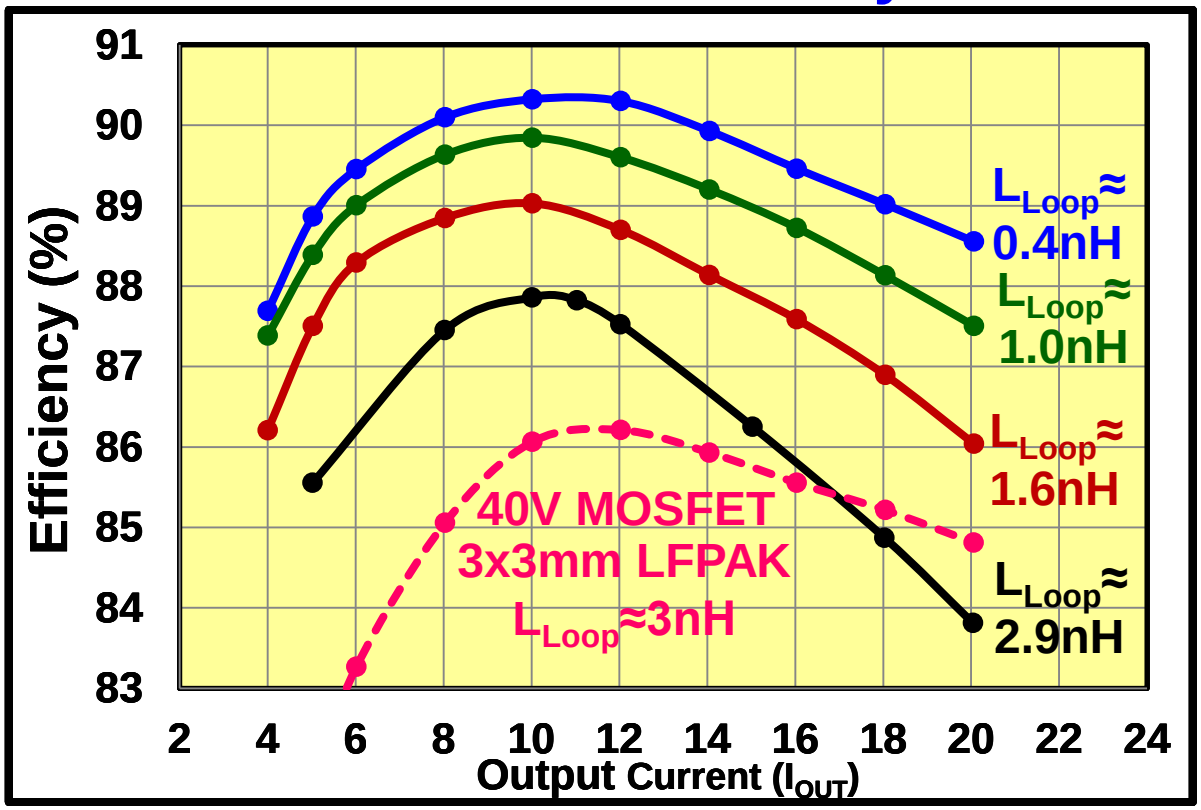






Layout Impact on Efficiency

Measured Efficiency



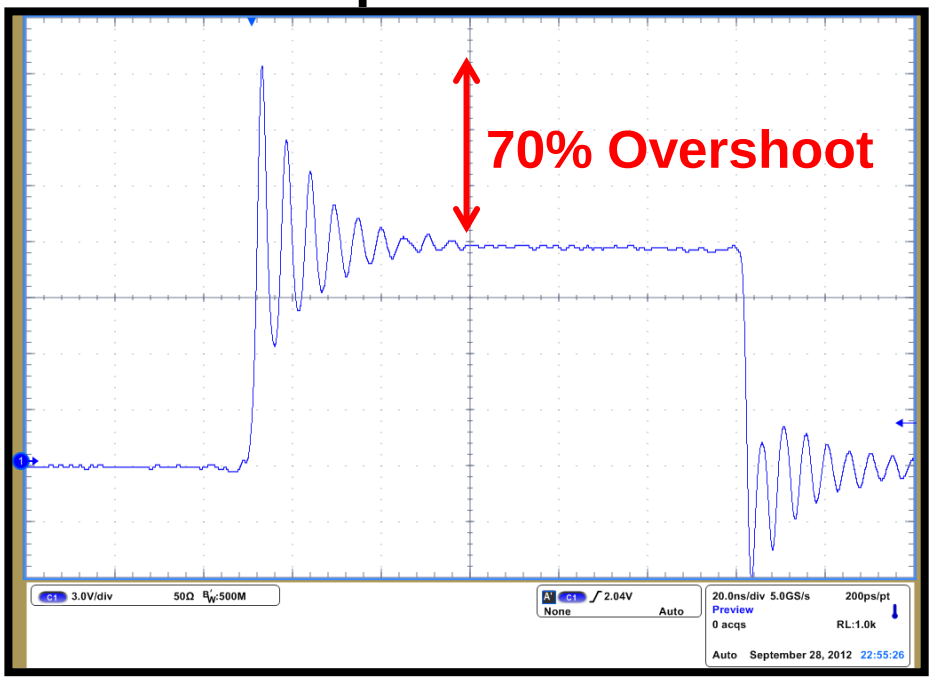
Experimental Prototype

L_{LOOP}≈0.4 nH

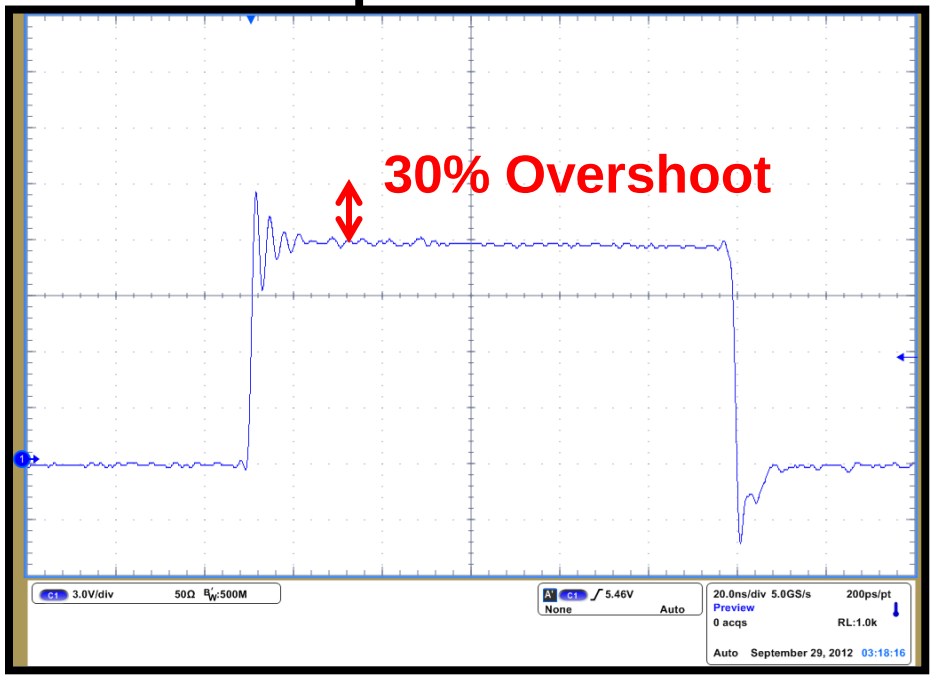
V_{IN}=12 V, V_{OUT}=1.2 V,
F_S=1 MHz, L=150 nH

Layout Impact on Peak Voltage

L_{Loop}≈1.0 nH



L_{Loop} ≈ 0.4 nH



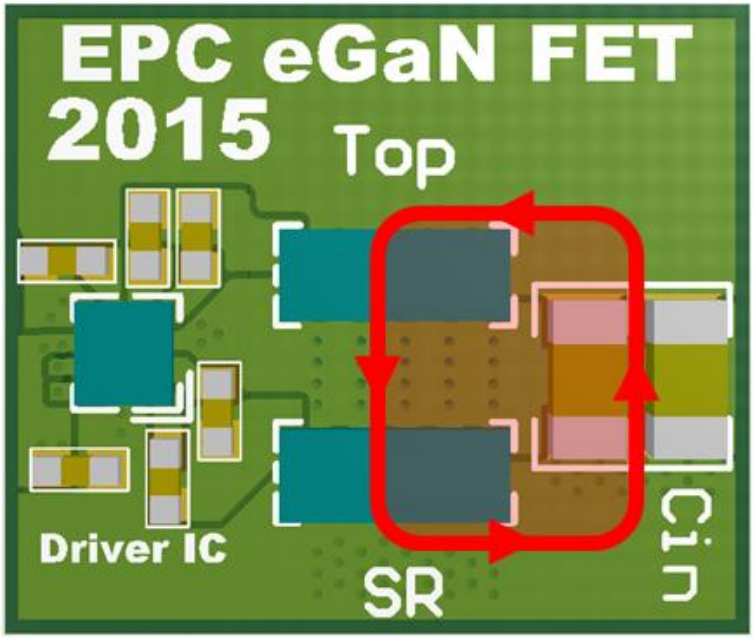
Switching Node Voltage

V_{IN}=12 V V_{OUT}=1.2 V I_{OUT}=20 A

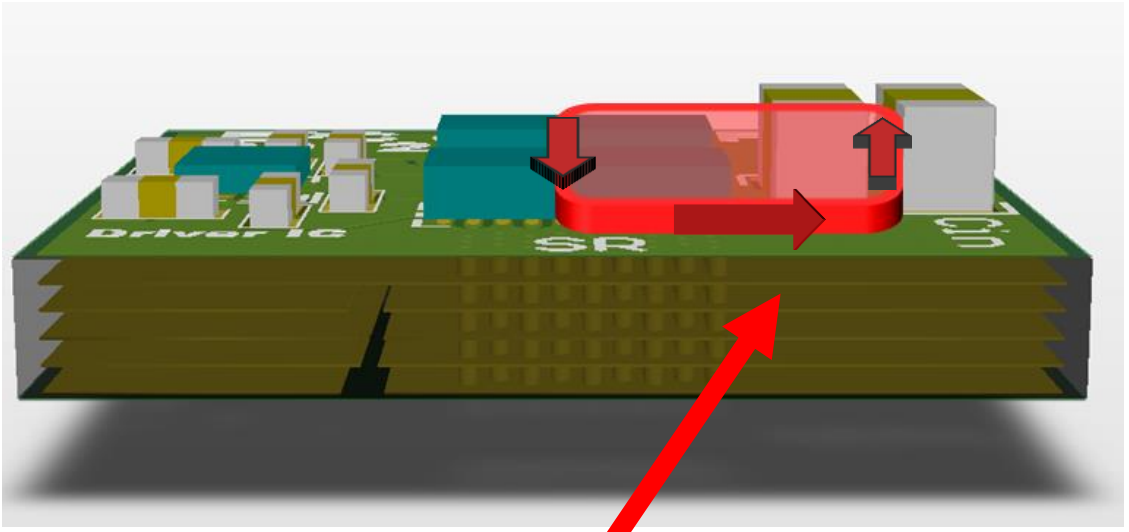
F_S=1 MHz L=150 nH

Conventional Lateral Layout

Top View

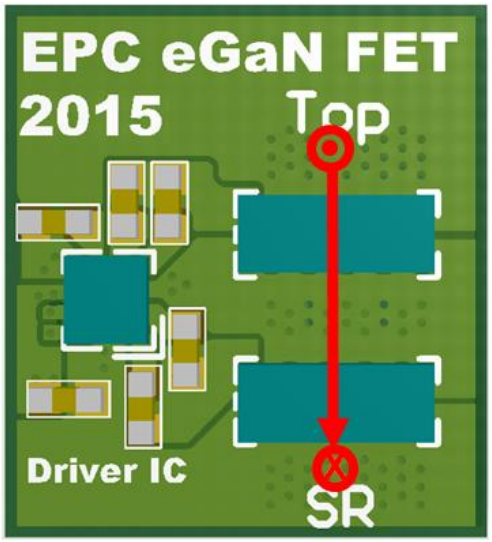


Side View



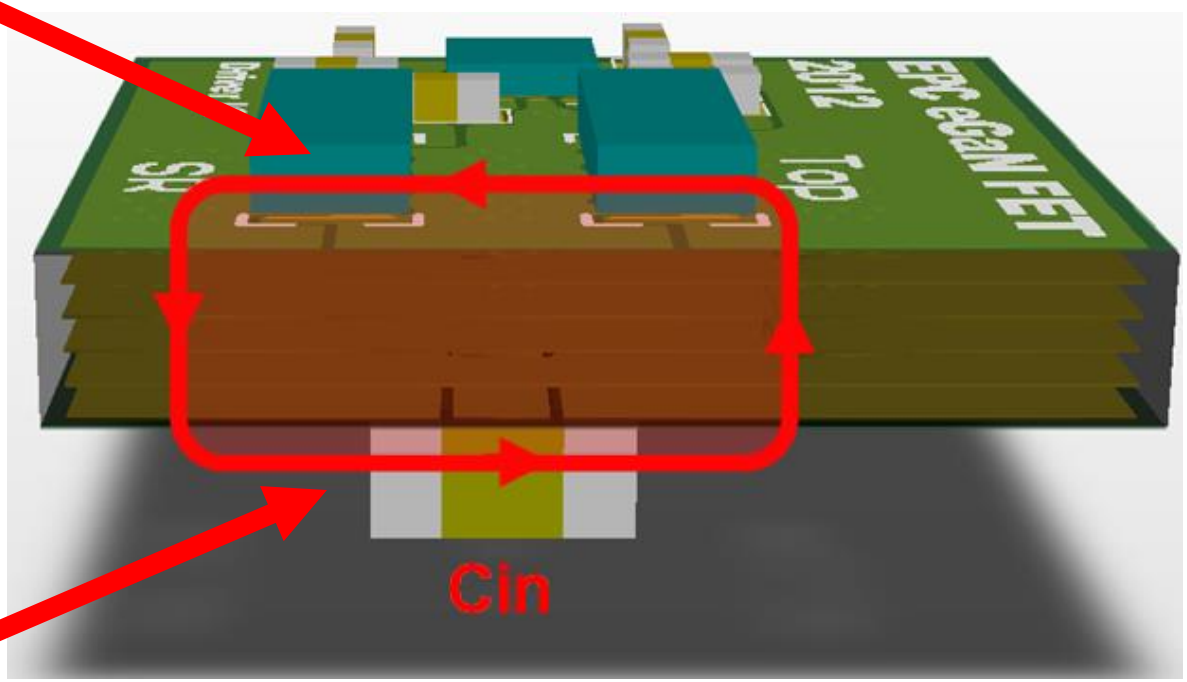
Shield Layer

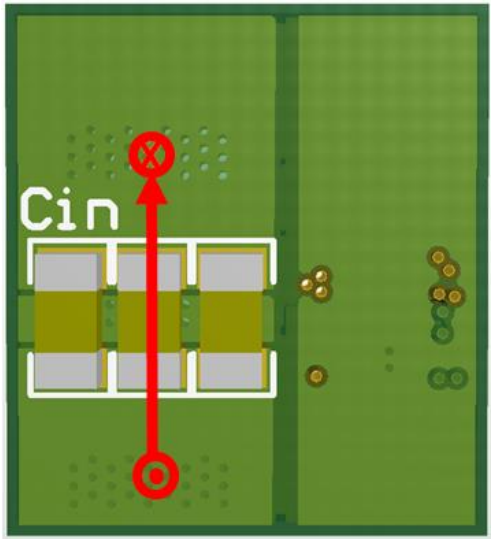
Conventional Vertical Layout



Top View

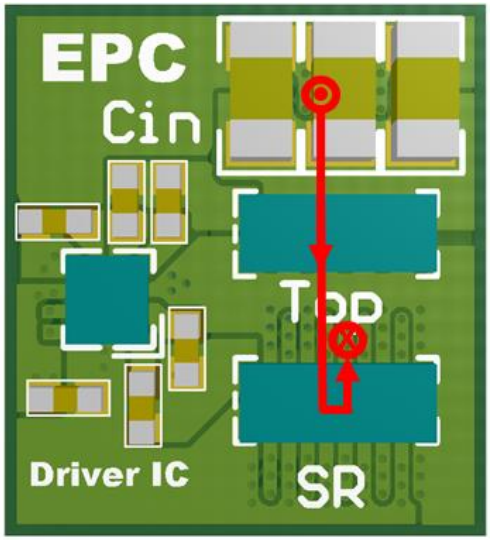
Side View





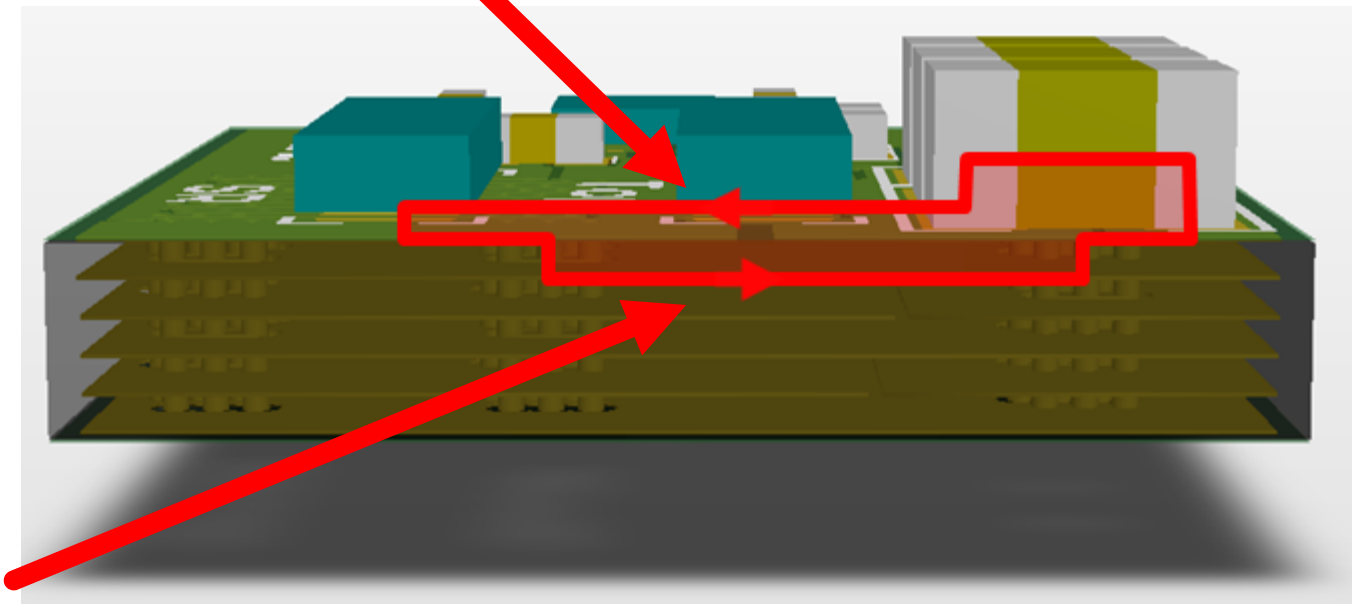
Bottom View

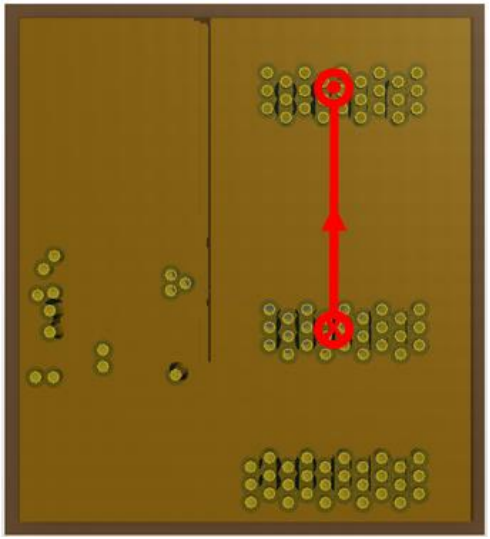
EPC Optimal Layout



Top View

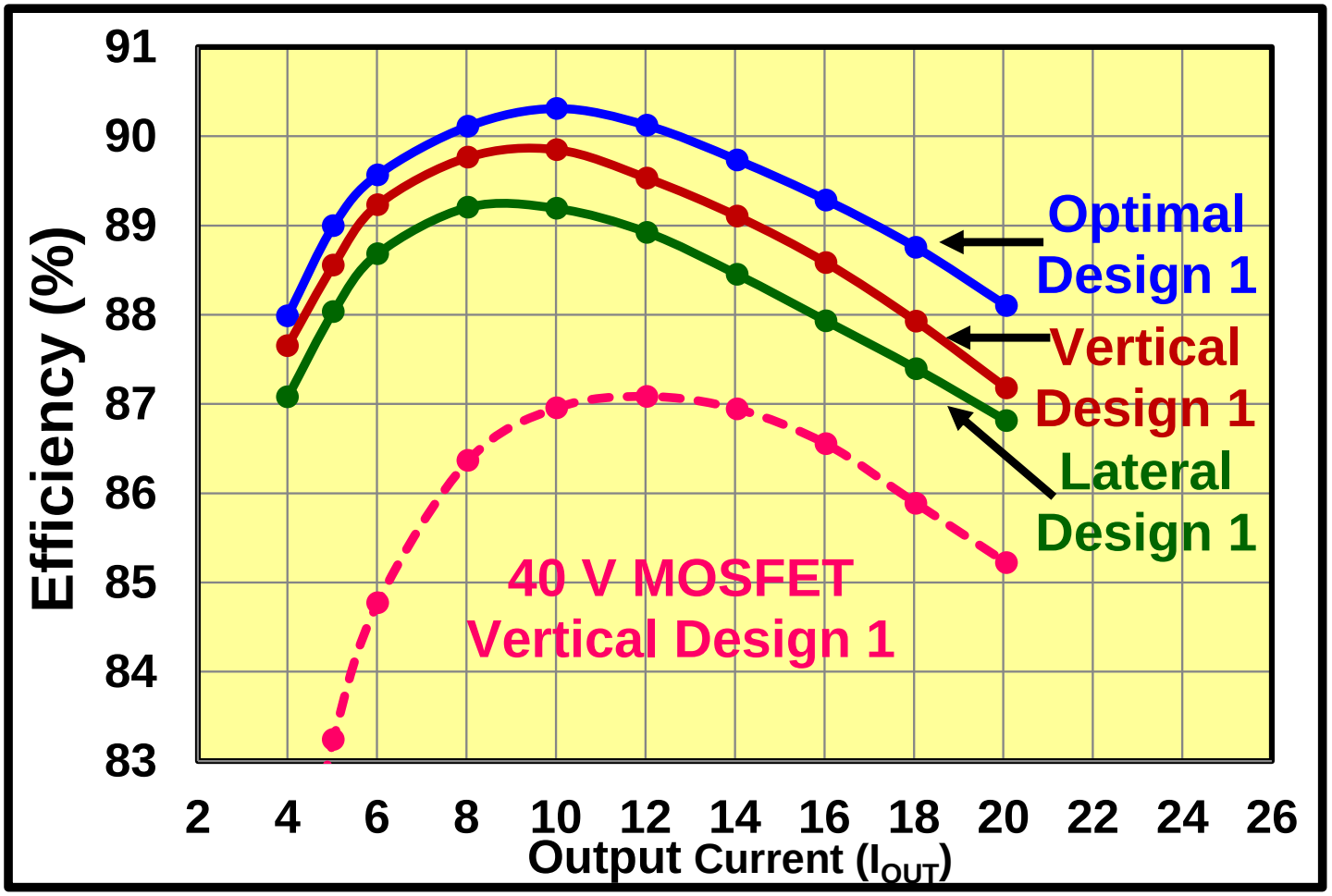
Side View





Top View
Inner Layer 1

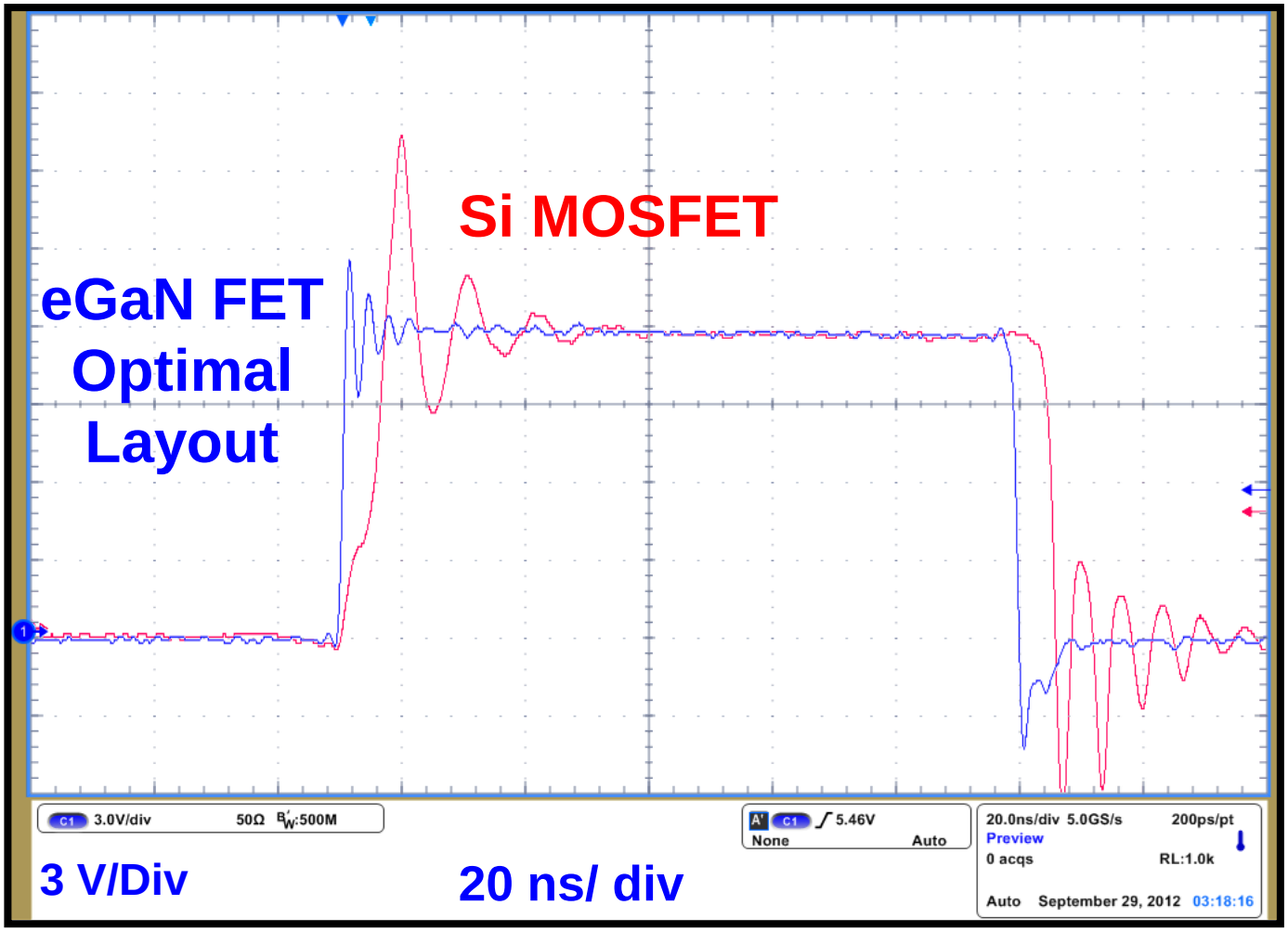
Efficiency Comparison



V_{IN}=12 V V_{OUT}=1.2 V F_S=1 MHz L=300 nH

GaN T/SR: EPC2015 Driver LM5113

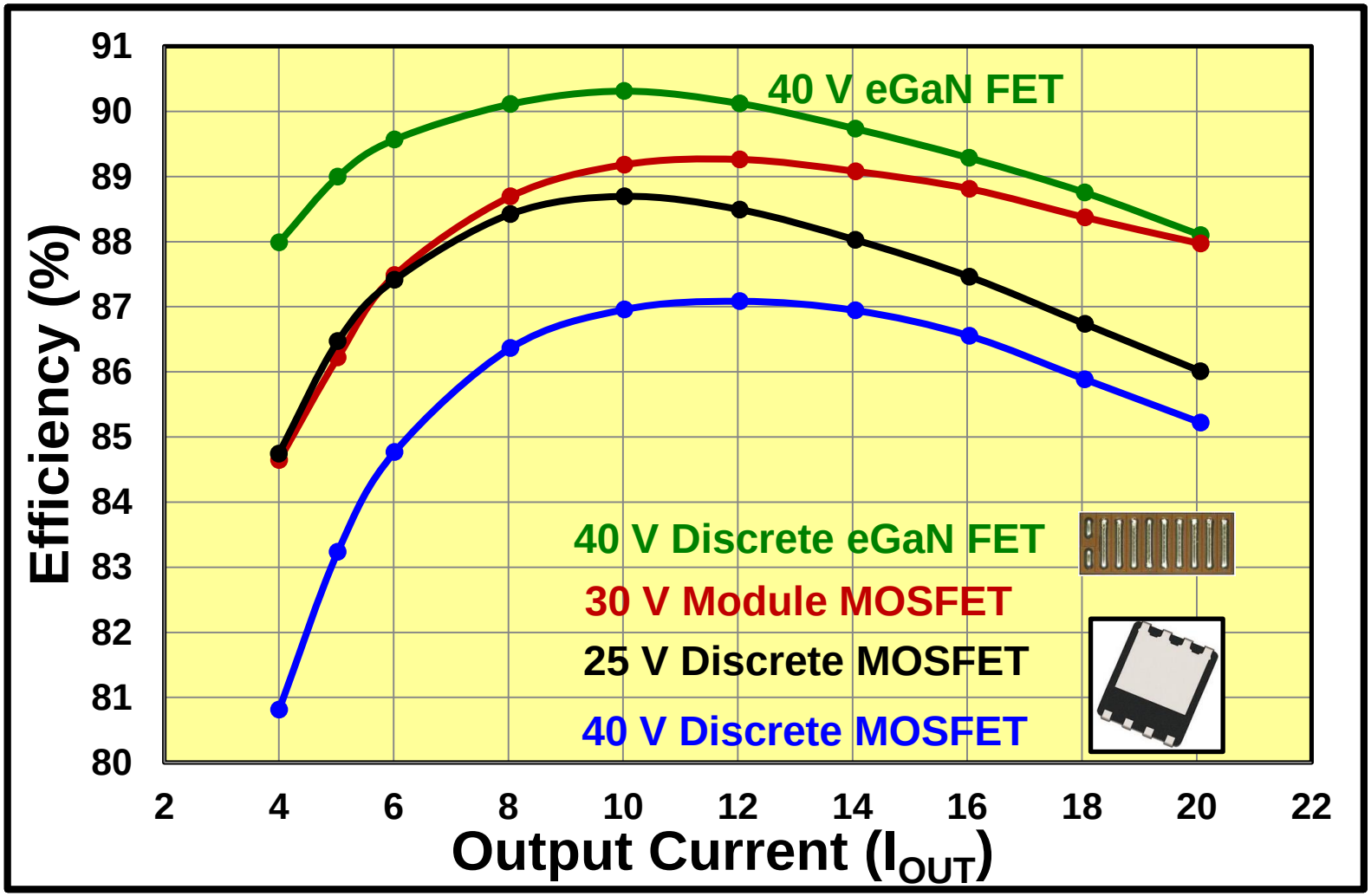
40 V eGaN FET vs. 40 V Si MOSFET



V_{IN}=12 V V_{OUT}=1.2 V I_{OUT}=20 A F_S=1 MHz L=300 nH eGaN FET

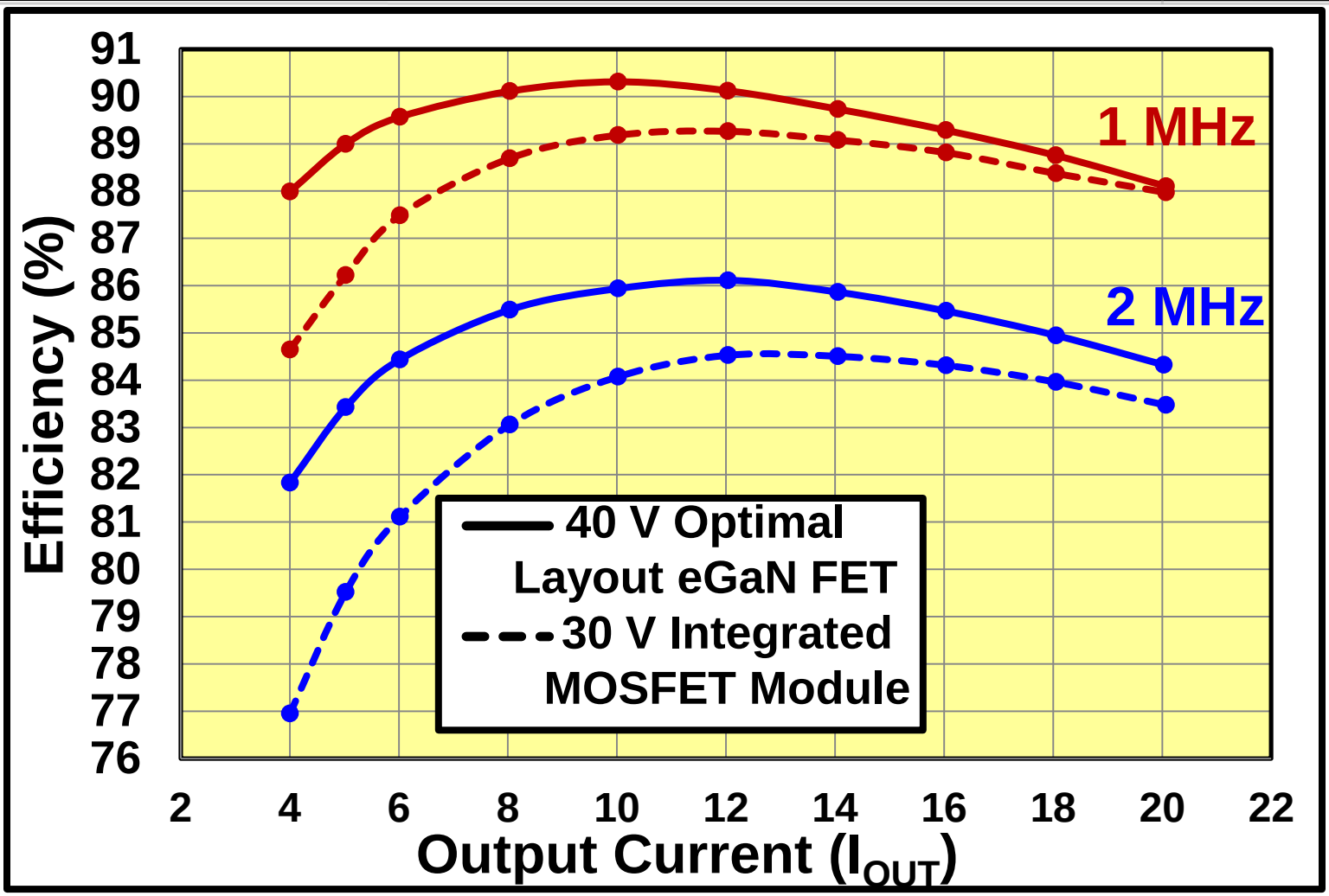
T/SR: EPC2015 MOSFET T:BSZ097N04 SR:BSZ040N04

eGaN FET vs. MOSFET Efficiency



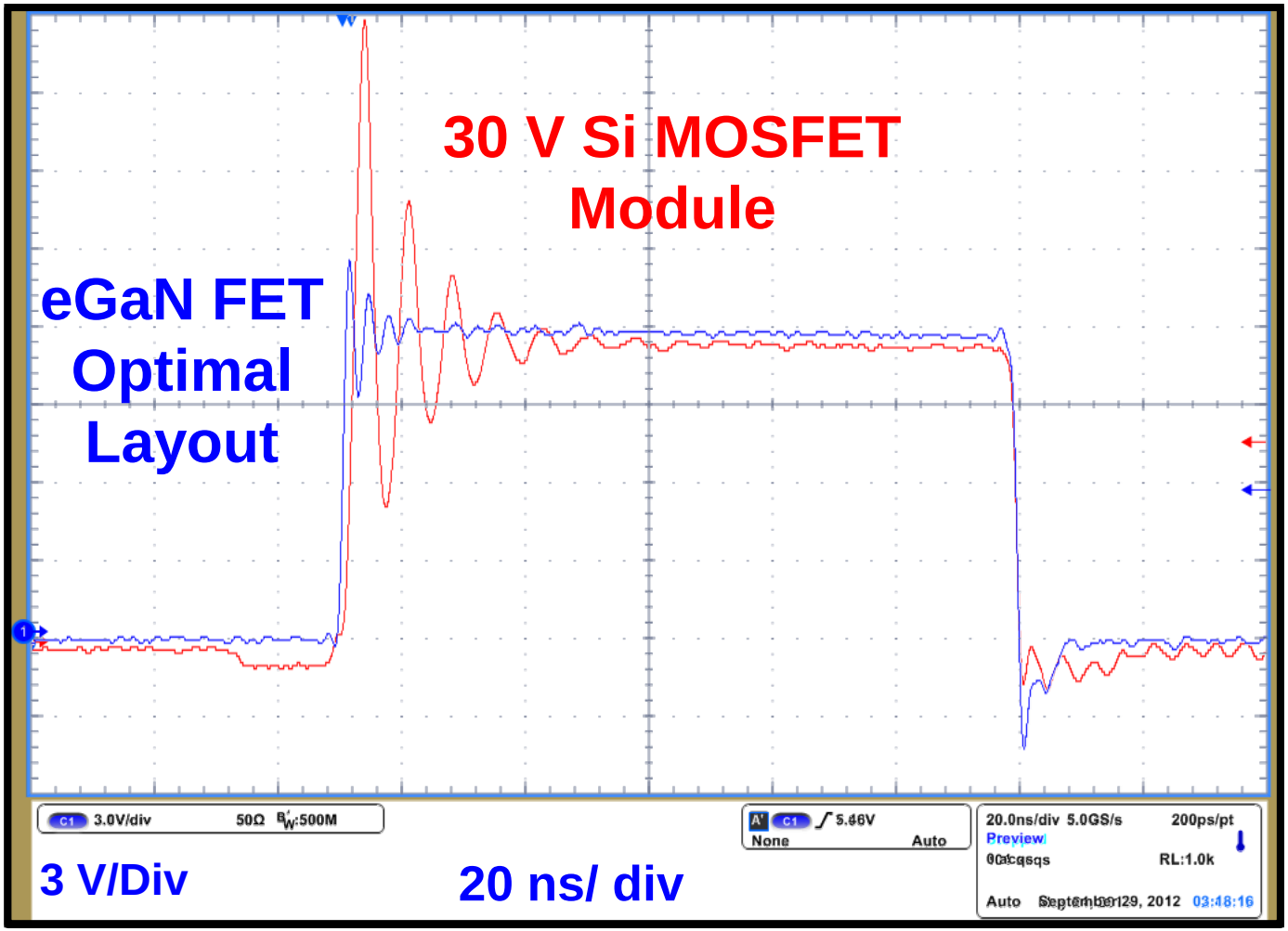
V_{IN}=12 V V_{OUT}=1.2 V F_S=1 MHz L=300 nH

Pushing Frequency with eGaN FETs



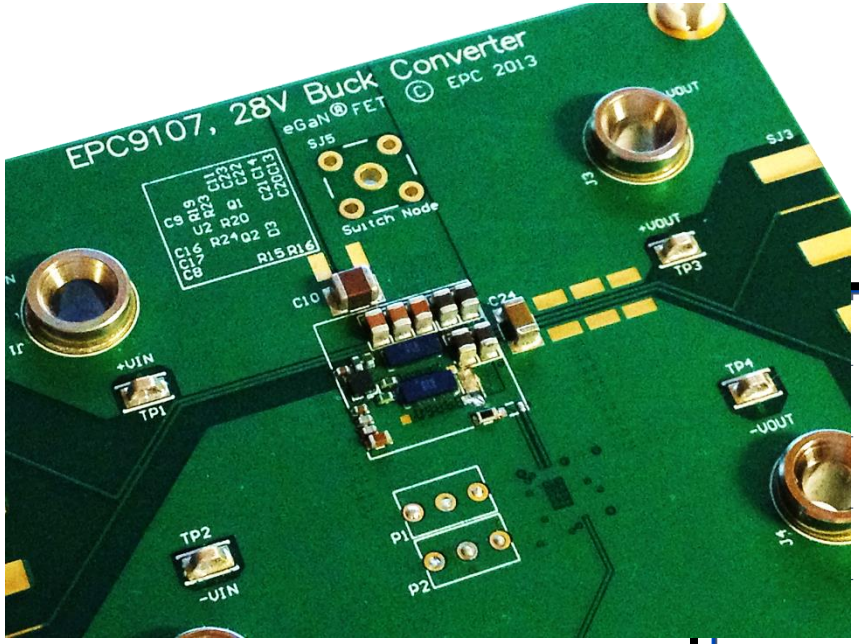
V_{IN}=12 V V_{OUT}=1.2 V L=300 nH

eGaN FET vs. Si MOSFET Module

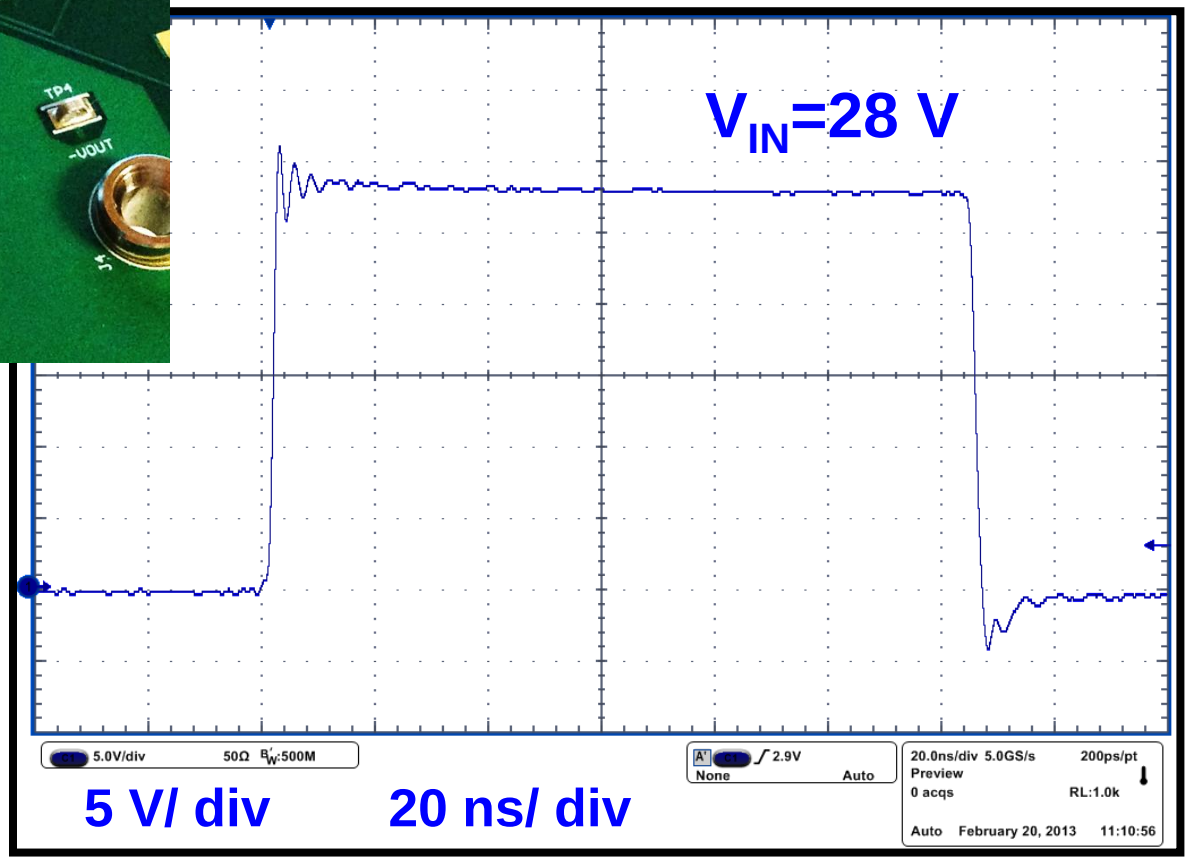


V_{IN}=12 V V_{OUT}=1.2 V I_{OUT}=20 A F_S=1 MHz L=300 nH eGaN FET T/SR: EPC2015 MOSFET Module: CSD97370Q5M

EPC9107 Demonstration Board



V_{IN}=12-28 V V_{OUT}=3.3 V
I_{OUT}=15 A F_S=1 MHz
2 x EPC2015



Switching Node Voltage

V_{IN}=28 V I_{OUT}=15 A

Summary

eGaN FETs improve performance in high switching frequency converters:

- **Lower FOM (Q_{GD}+Q_{GS2})*R_{DSON}**
- **Lower Package Parasitics**
- **PCB Layout Limits Performance**
- **Optimizing Layout Enhances Performance**

Thank you for your time! Questions?

EFFICIENT POWER CONVERSION

The end of the road for silicon…..

is the beginning of the eGaN FET journey!

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