Effectively Paralleling Gallium Nitride Transistors for High Current and High Frequency Applications

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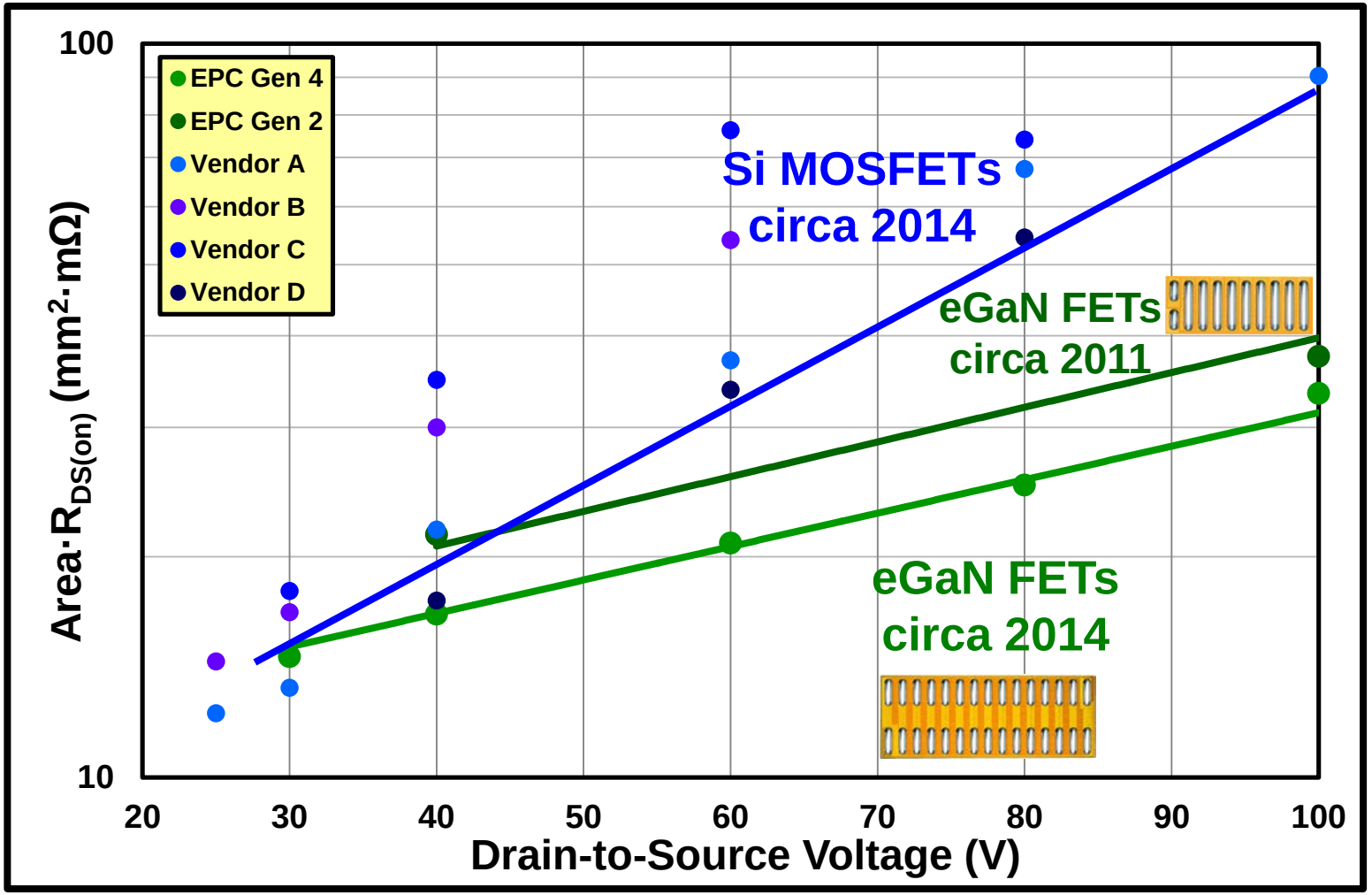
Efficient Power Conversion

Agenda

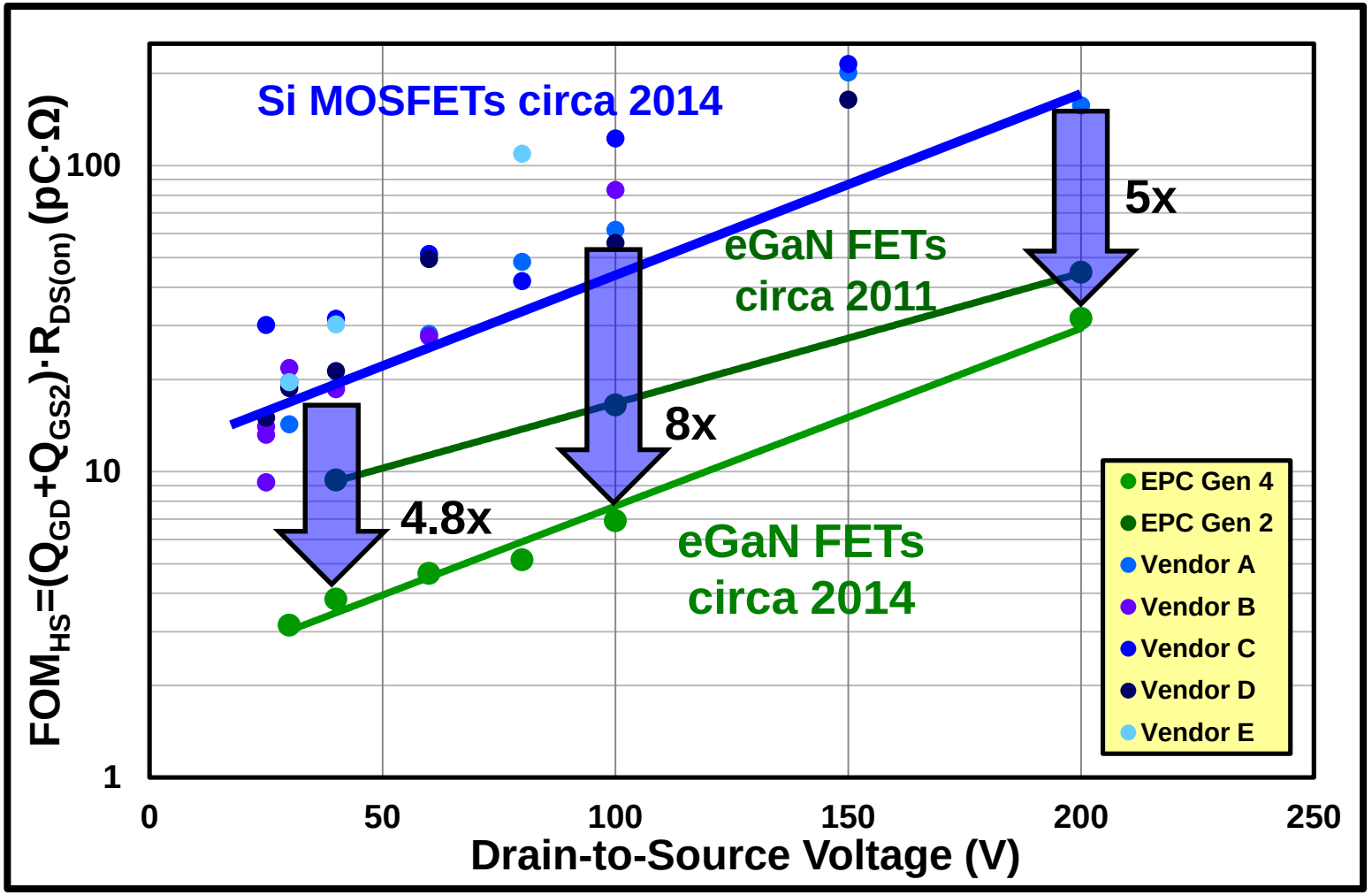
- Why GaN?
- Issues for Paralleling High Speed GaN Transistors
- Method for Effectively Paralleling GaN Transistors
- Further Increasing Current Capability
- Summary

Smaller Size



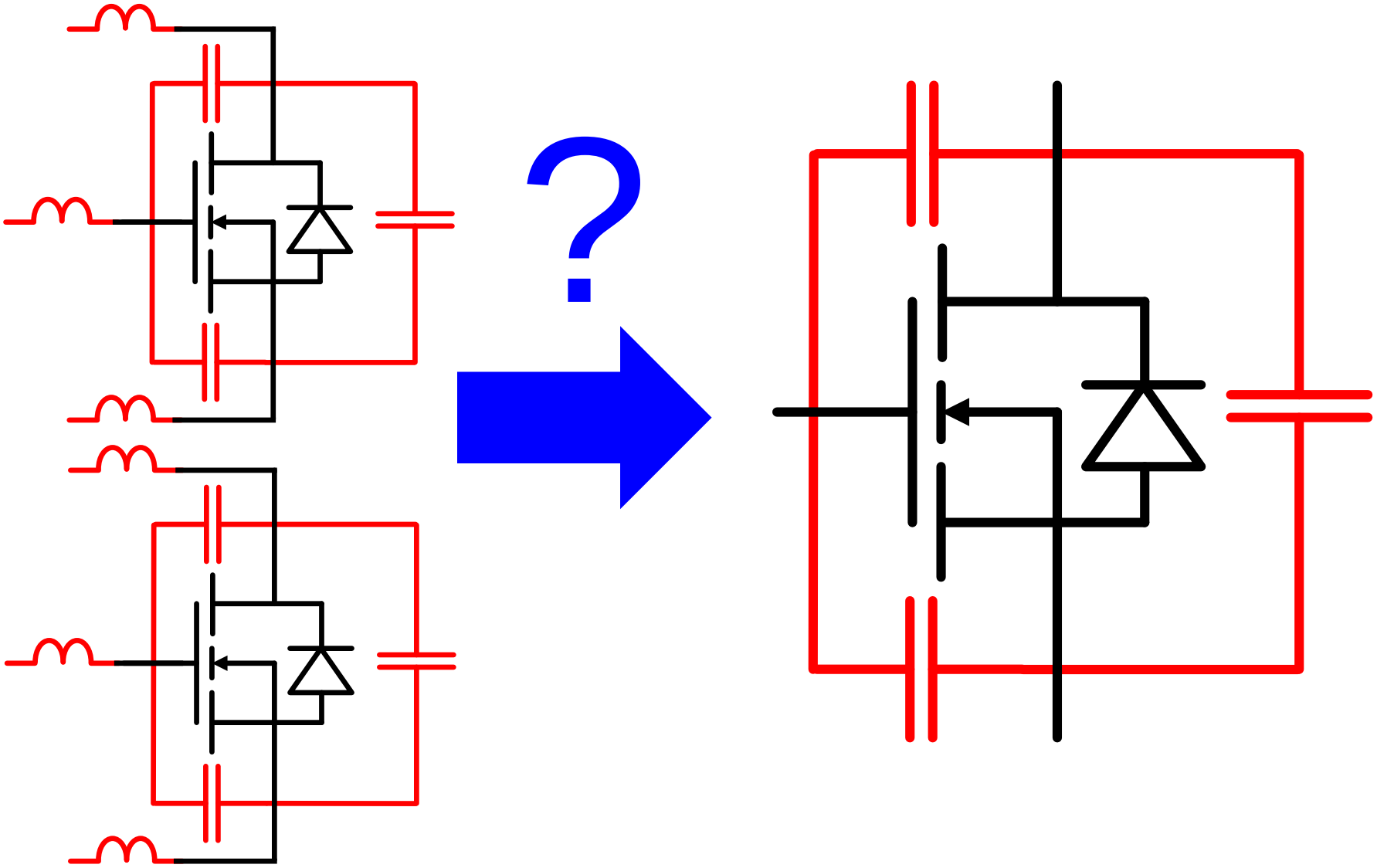
Actual Product Resistance

Lower Loss

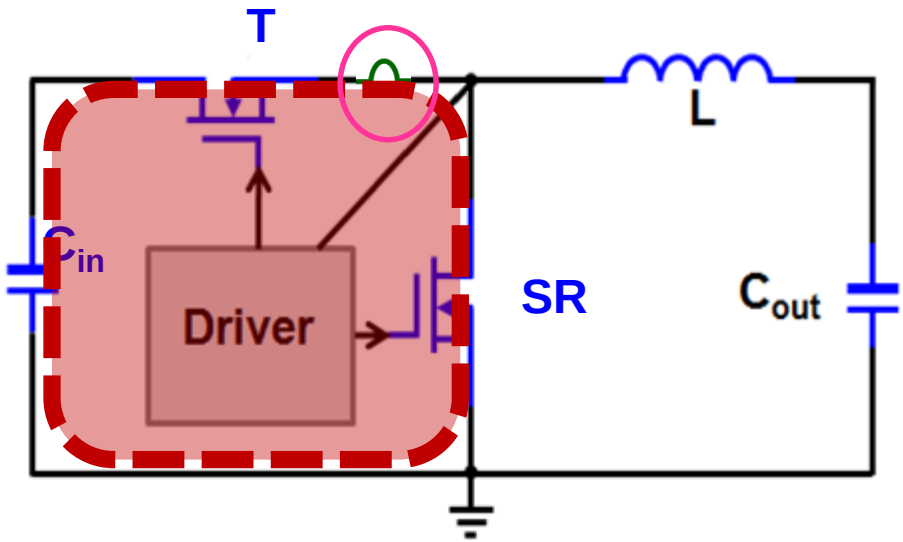


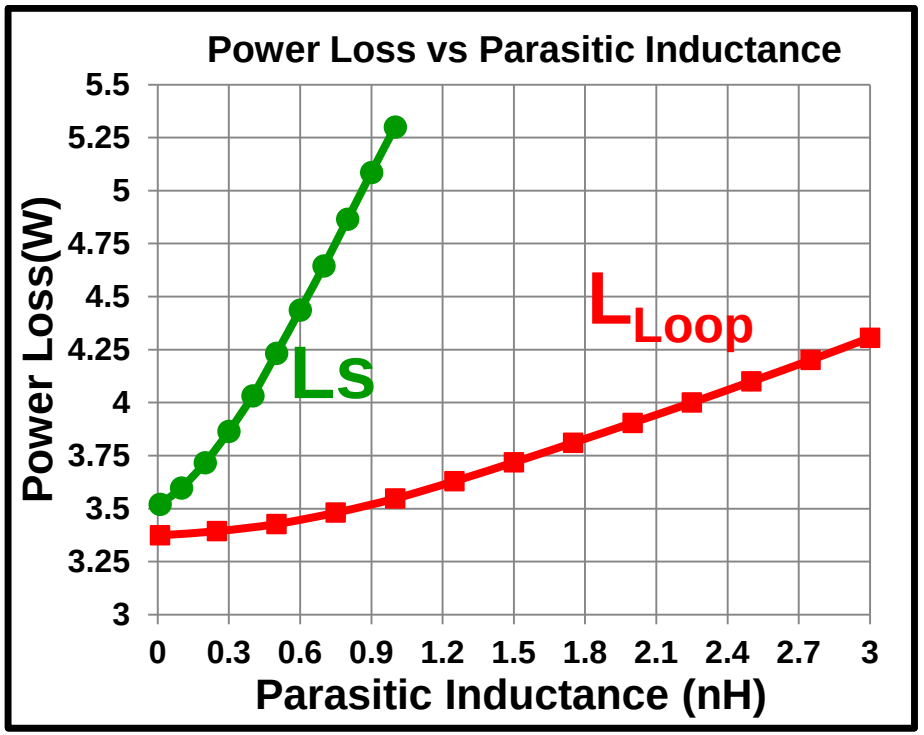
V_{DS}=0.5·V_{DSS}, I_{DS}=20 A

Parallel Power Devices



Converter Parasitics





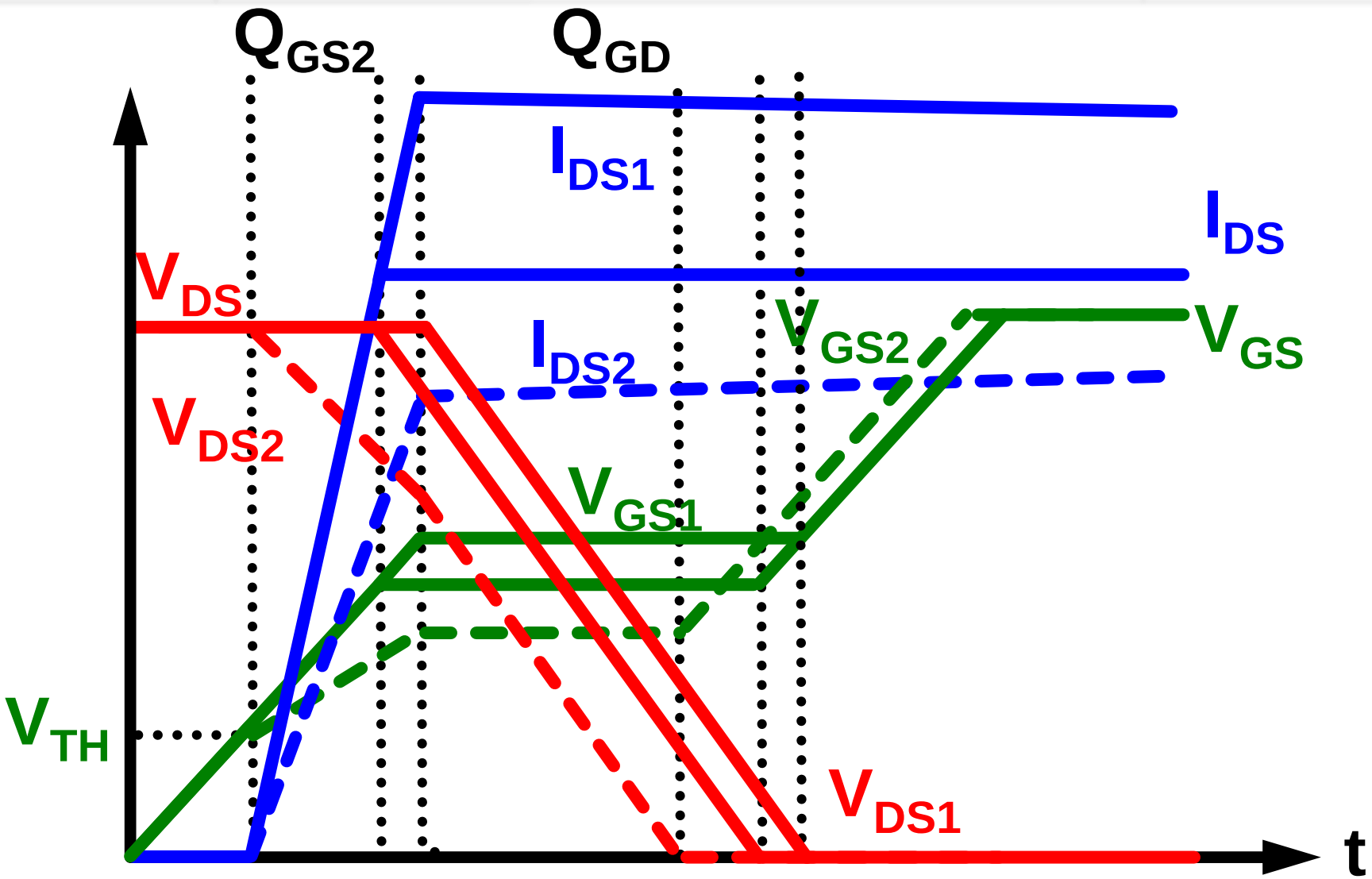
L_S: Common Source Inductance

L_{Loop}: High Frequency Power Loop Inductance

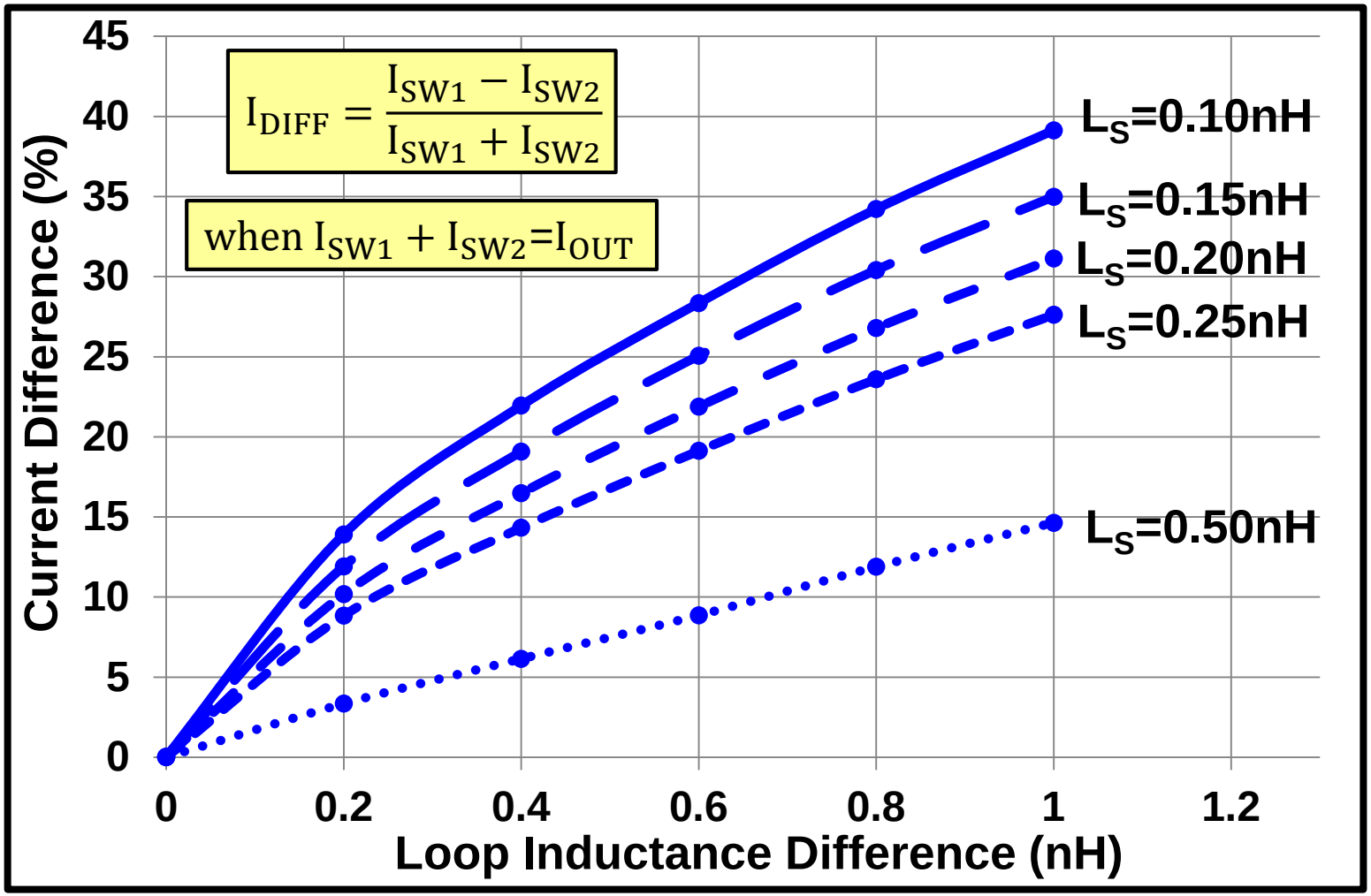
V_{IN}=12 V, V_{OUT}=1.2 V,
f_{sw}=1 MHz, I_{OUT}= 20 A

D. Reusch, D. Gilham, Y. Su, and F.C. Lee, C, "Gallium Nitride Based 3D Integrated Non-Isolated Point of Load Module", APEC 2012

Parasitic Imbalance



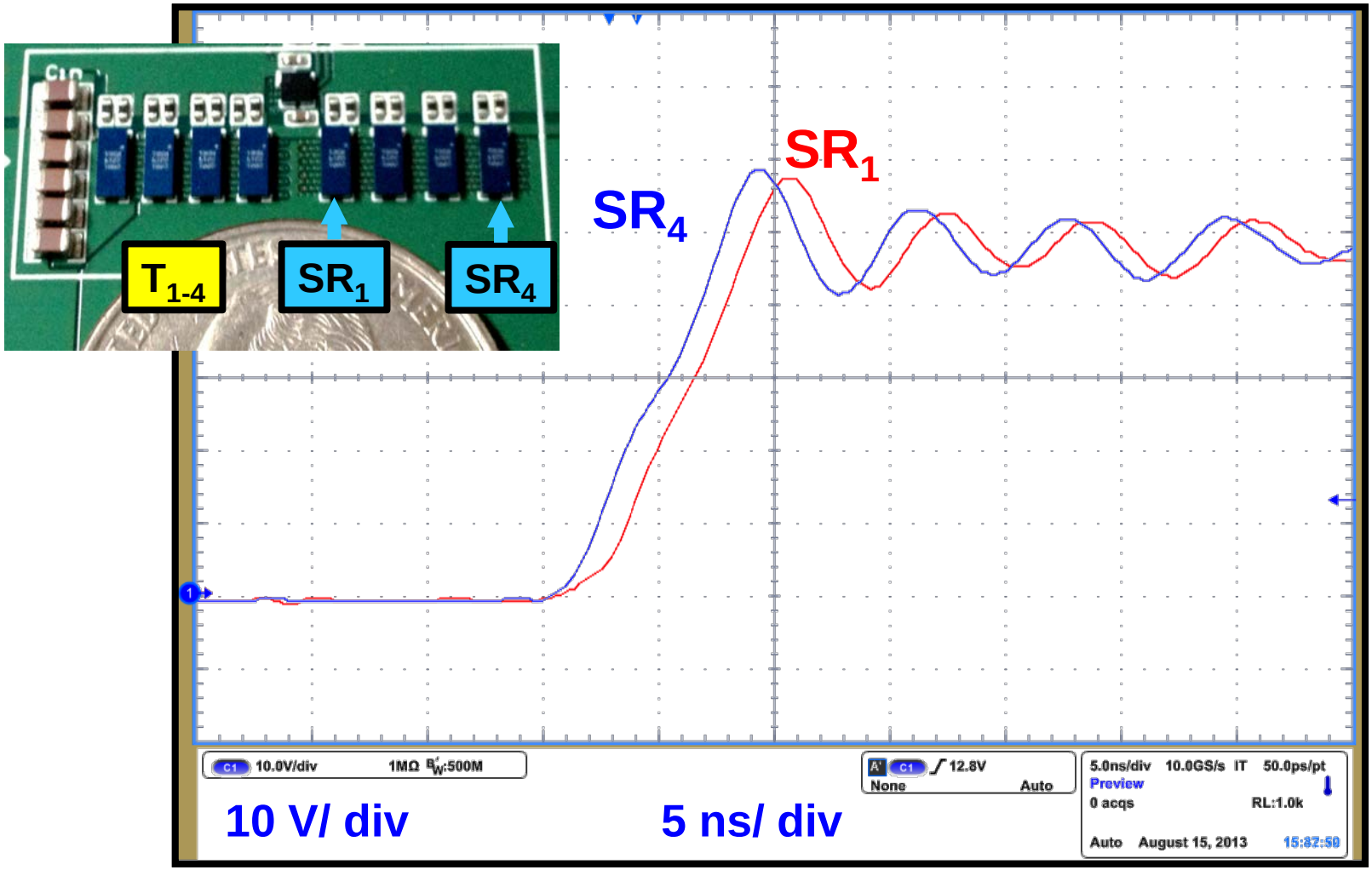
Loop Inductance Impact



V_{IN}=48 V I_{OUT}=25 A eGaN FET T/SR: 100 V EPC2001

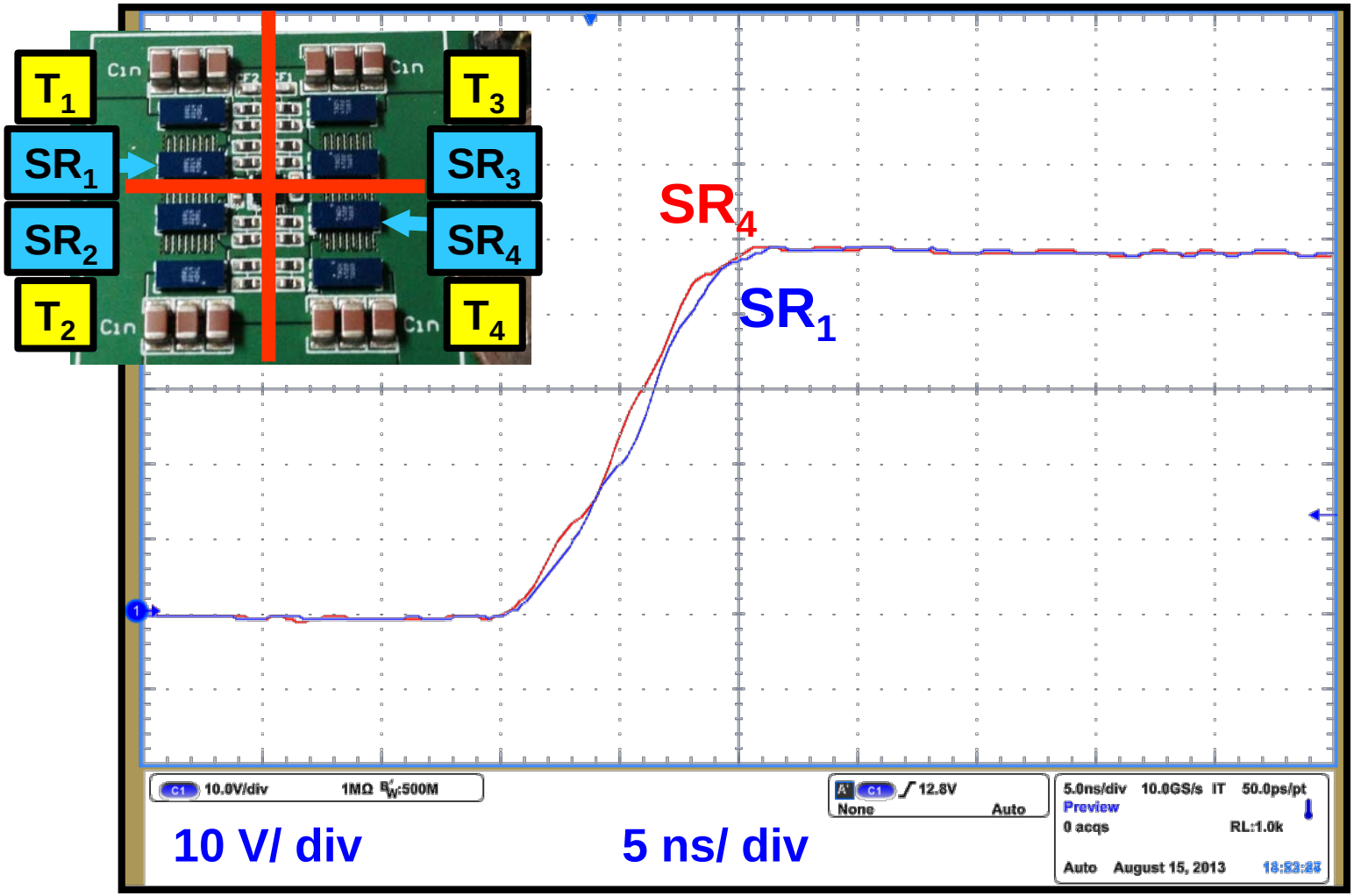
. Nominal Drain Inductance $L_D = L_{LOOP} - L_S$=0.3 nH

Conventional Parallel Layout



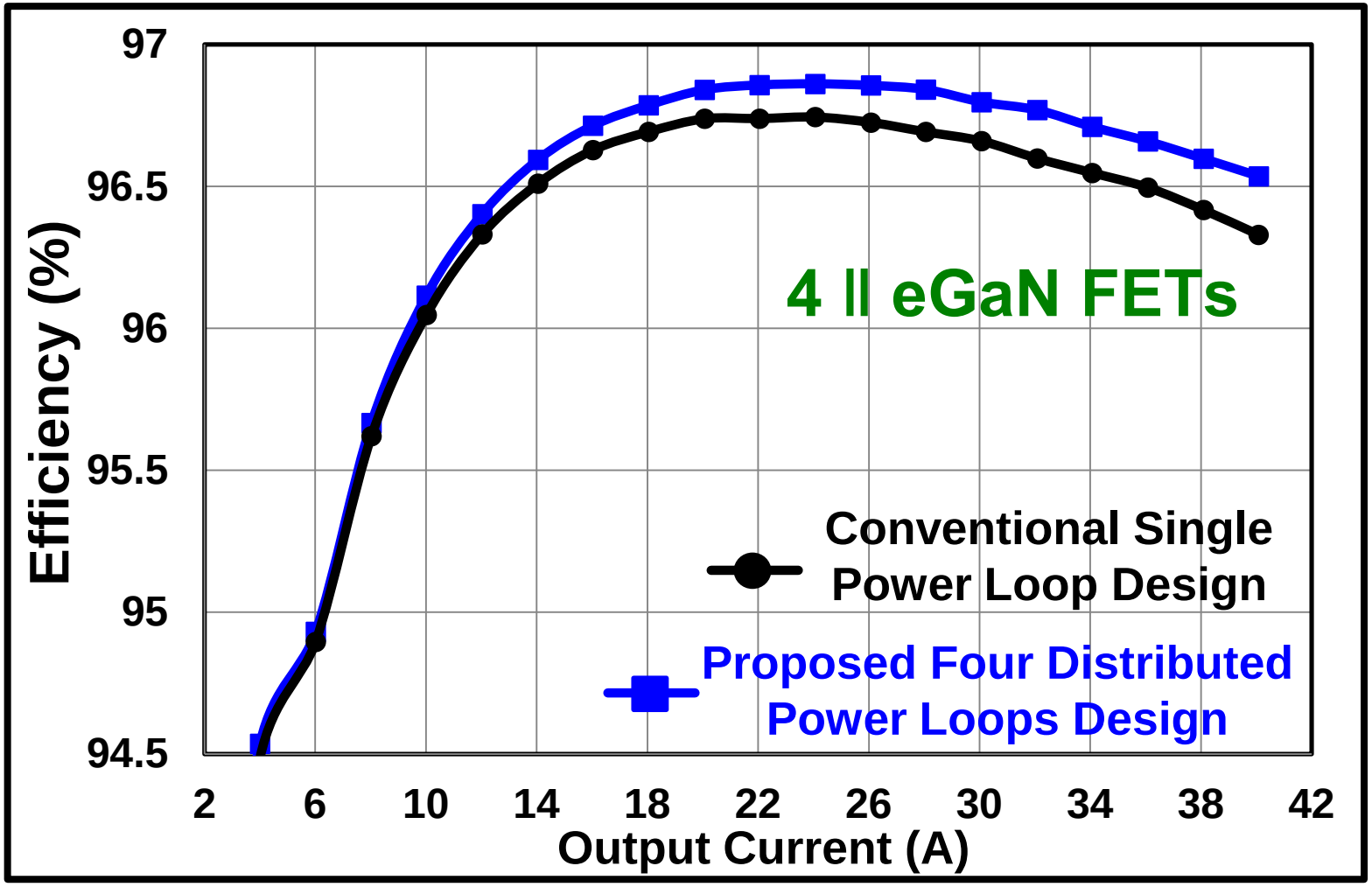
V_{IN}=48 V V_{OUT}=12 V I_{OUT}=30 A f_{sw}=300 kHz L=3.3 µH GaN FET T/SR: 100 V EPC2001

Optimal Parallel Layout



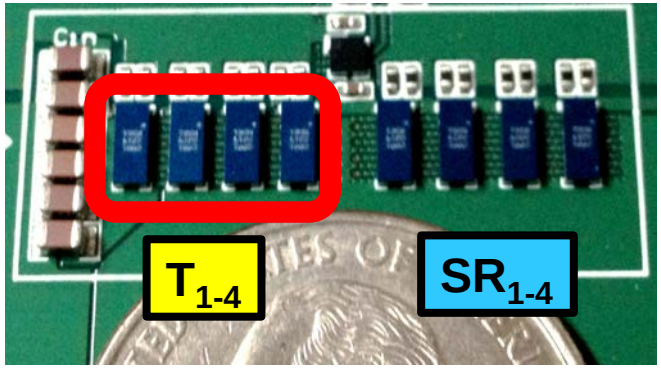
V_{IN}=48 V V_{OUT}=12 V I_{OUT}=30 A f_{sw}=300 kHz L=3.3 µH GaN FET T/SR: 100 V EPC2001

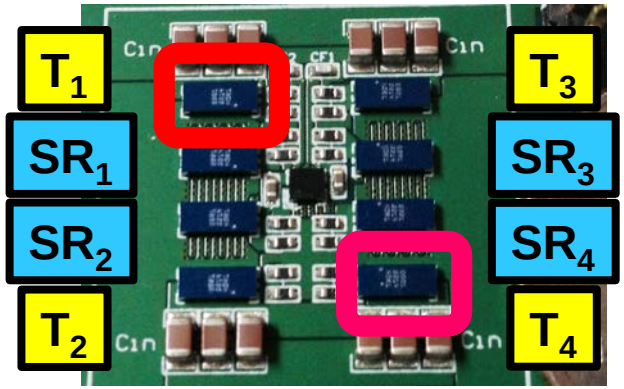
Parallel Layout Performance

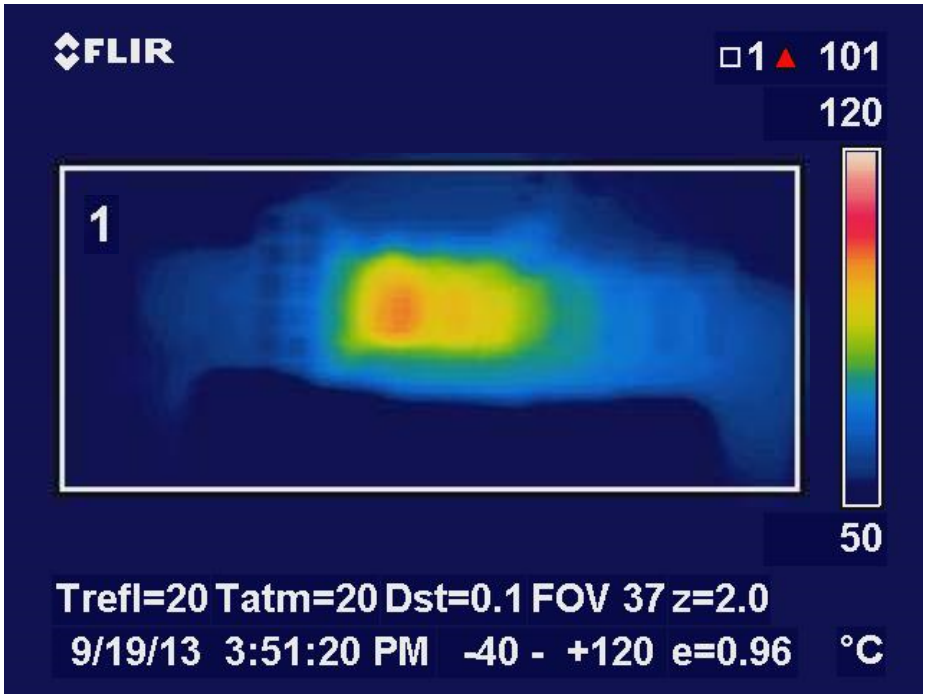


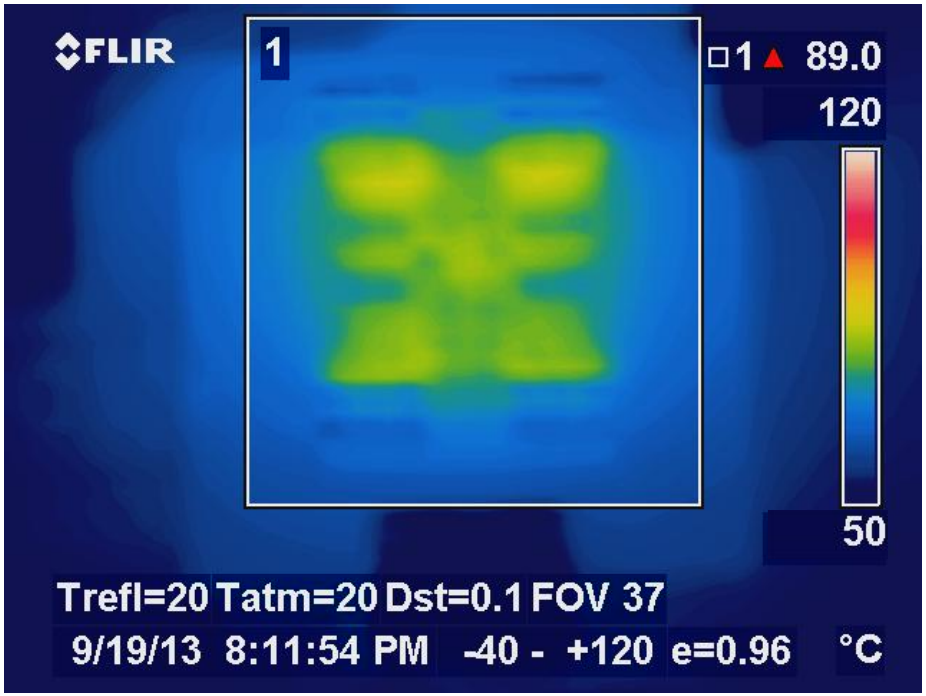
V_{IN}=48 V V_{OUT}=12 V f_{sw}=300 kHz L=3.3 µH GaN FET T/SR: 4x100 V EPC2001
4 Layer 2 oz PCB

Parallel Layout Implementation



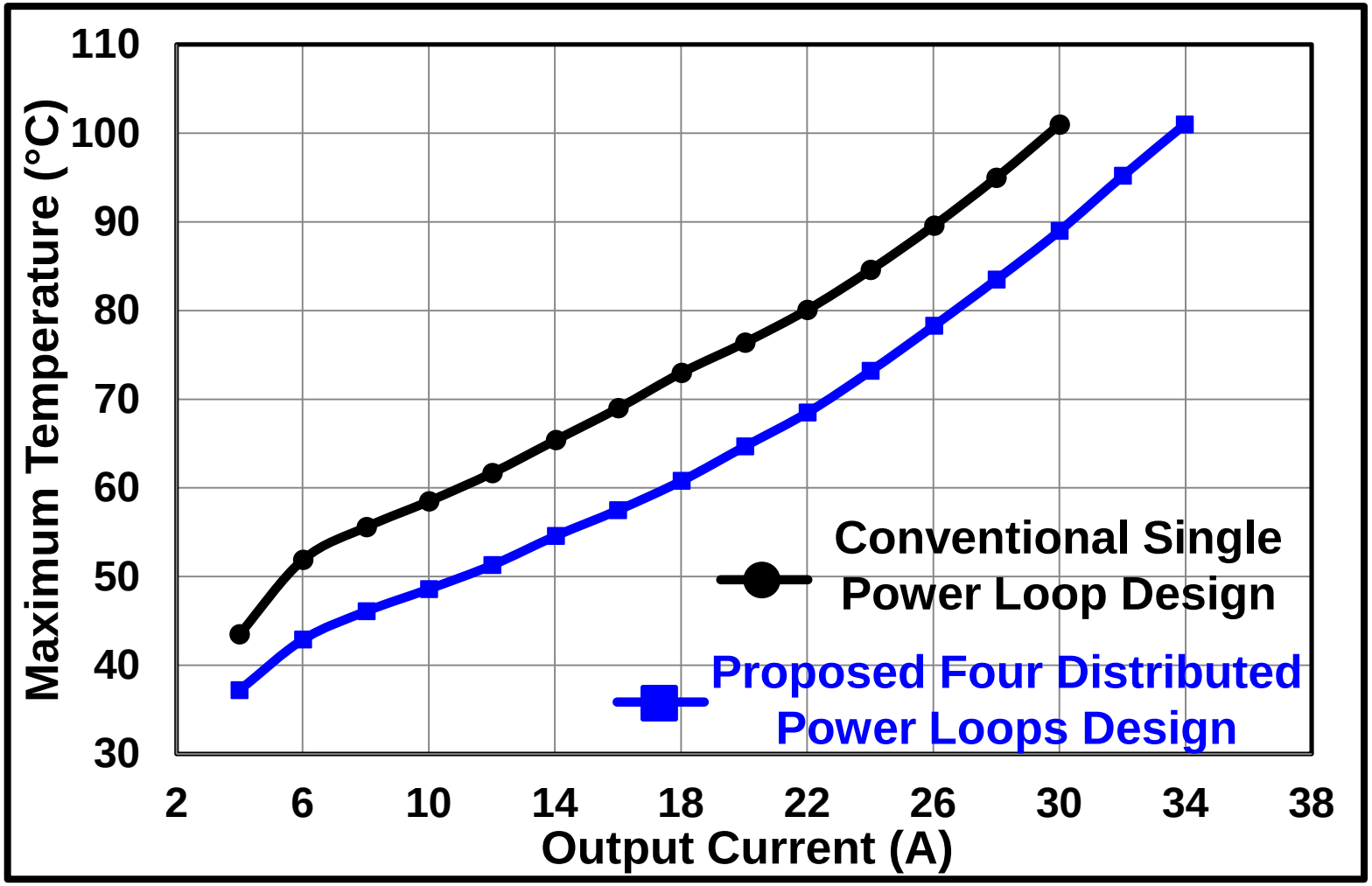






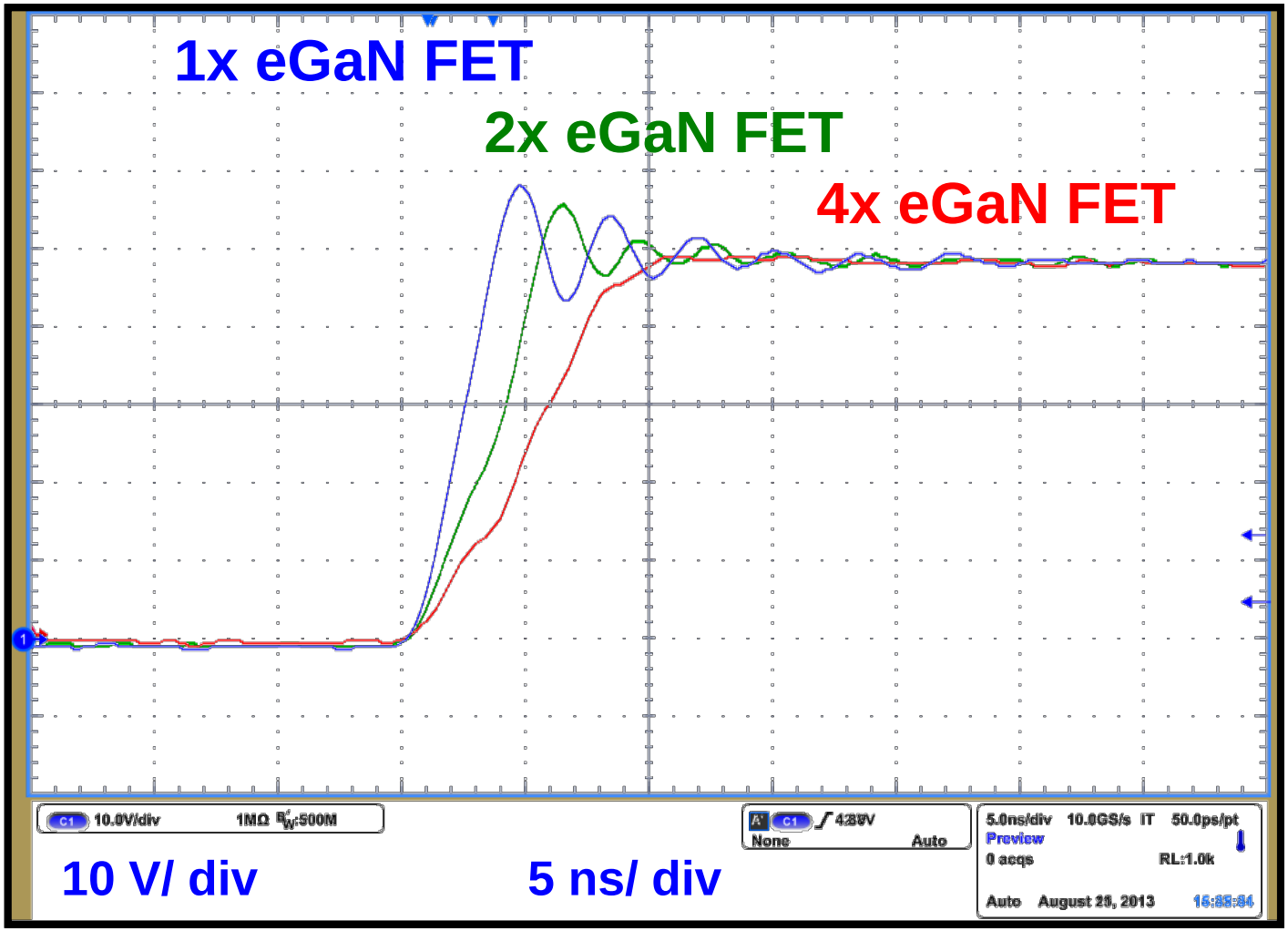
V_{IN}=48 V V_{OUT}=12 V I_{OUT}=30 A f_{sw}=300 kHz L=3.3 µH GaN FET T/SR: 100 V EPC2001

Parallel Layout Performance



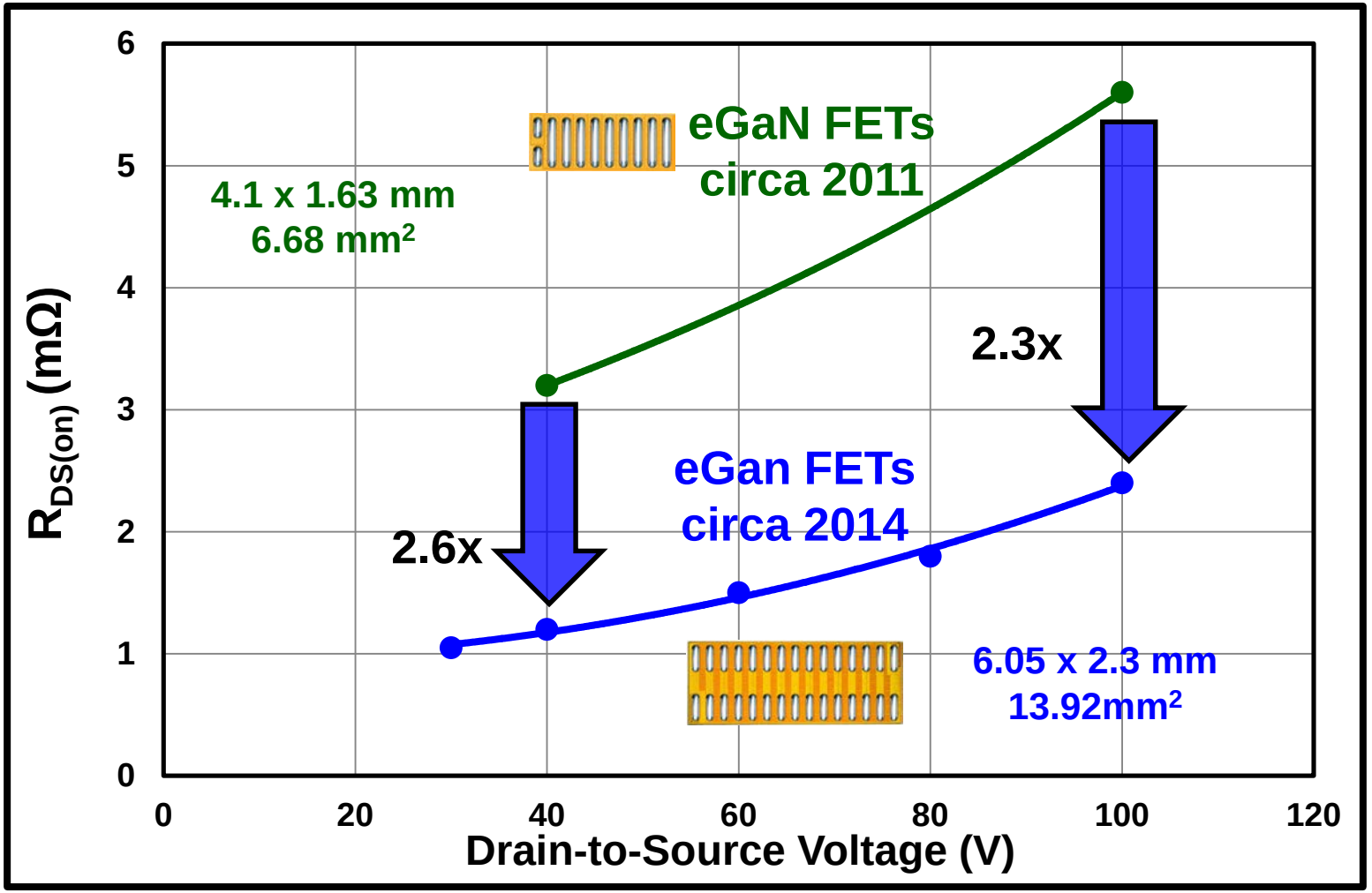
V_{IN}=48 V V_{OUT}=12 V f_{sw}=300 kHz L=3.3 µH GaN FET T/SR: 100 V EPC2001
Fan Speed 200 LFM 4 Layer 2 oz PCB

Parallel eGaN FET Swithcing



V_{IN}=48 V V_{OUT}=12 V I_{OUT}=30 A/ number of devices f_{sw}=300 kHz GaN FET T/SR: 100 V EPC2001

Further Increasing Current



V_{GS}=5 V

Summary

- GaN is Rapidly Improving
- High Speed GaN Transistors can be Effectively Paralleled
  - Minimize Parasitics
  - Balance Parasitics
- Proper Paralleling Improves Electrical and Thermal Performance
- Lower Resistance Devices Enables Higher Power

Thank You For Your Time ! Questions?