

Thermal Evaluation of Chip-Scale Packaged Gallium Nitride Transistors

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Circa 2006

$R_{DS(on)} \sim 10 \text{ m}\Omega$
 $Q_G \sim 50 \text{ nC}$
 $\sim 65 \text{ mm}^2$



Si MOSFET

Circa 2016

$R_{DS(on)} \sim 3 \text{ m}\Omega$
 $Q_G \sim 70 \text{ nC}$
 $\sim 30 \text{ mm}^2$

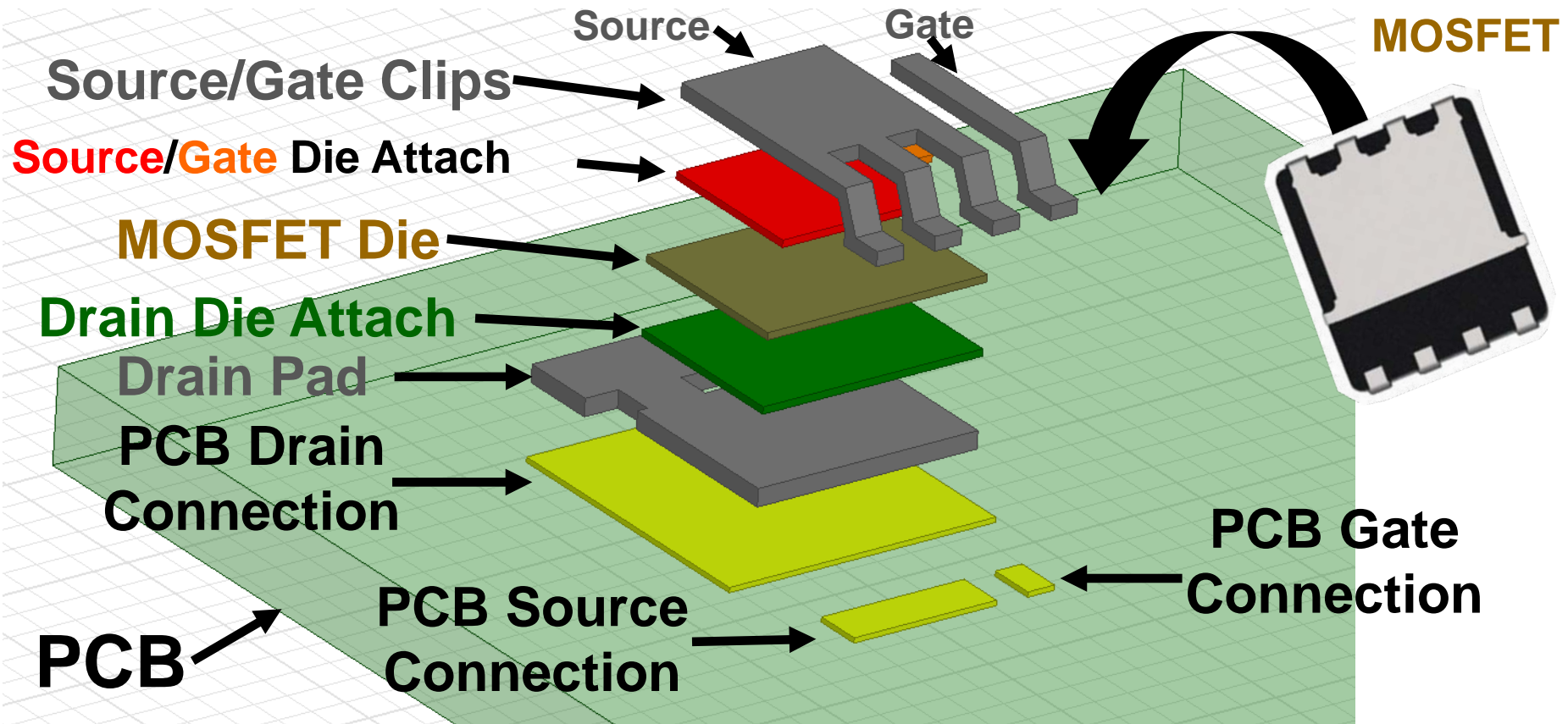


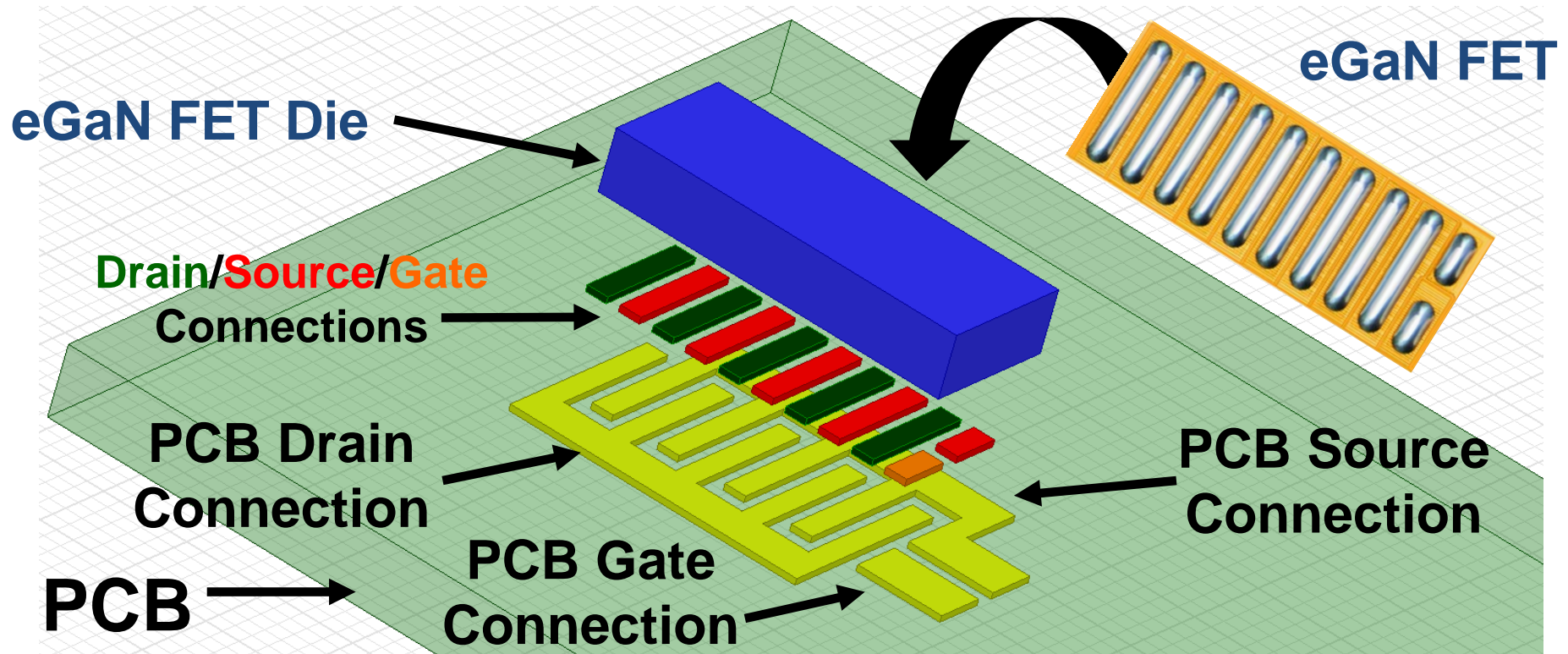
Si MOSFET

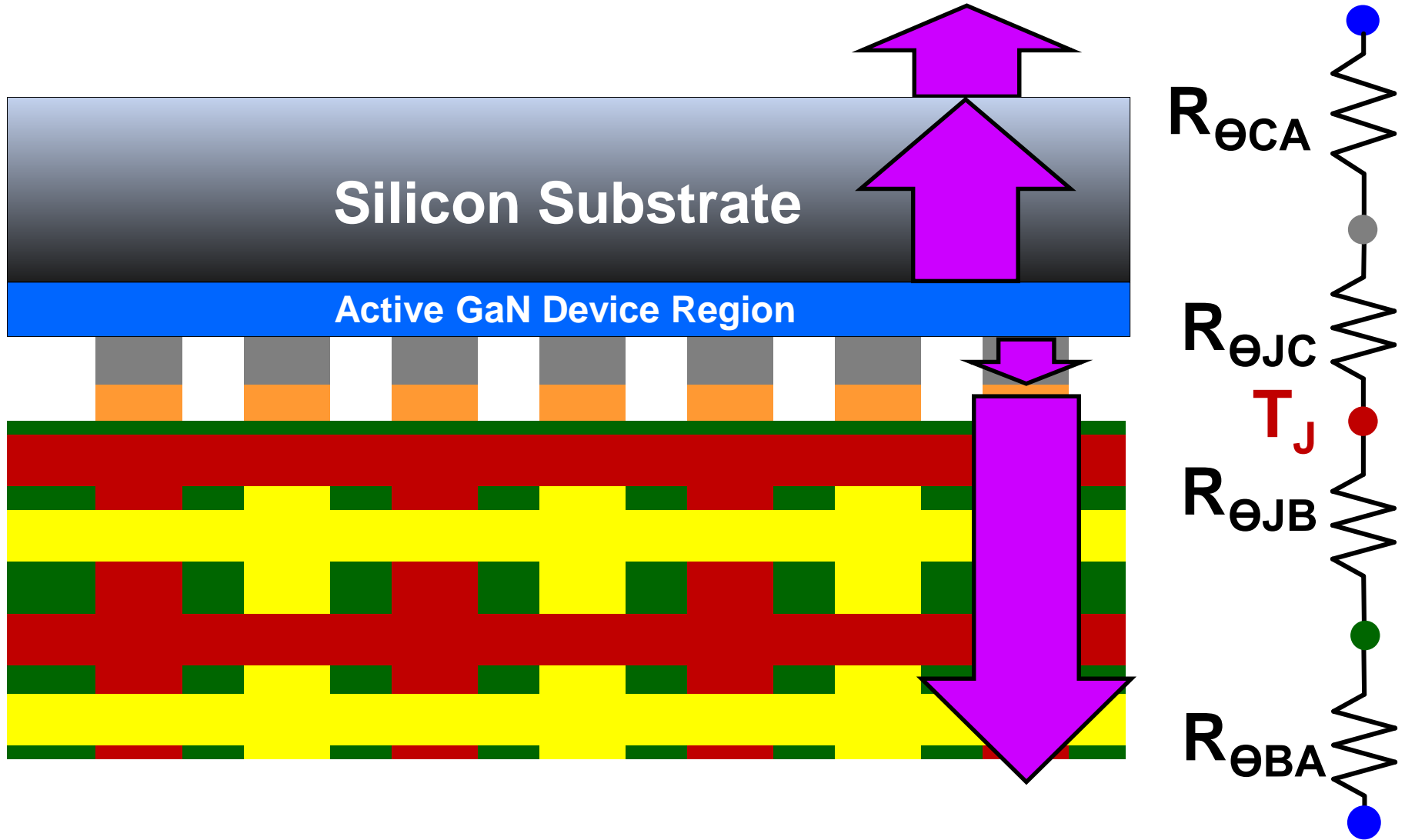
$R_{DS(on)} \sim 2.5 \text{ m}\Omega$
 $Q_G \sim 15 \text{ nC}$
 $\sim 14 \text{ mm}^2$

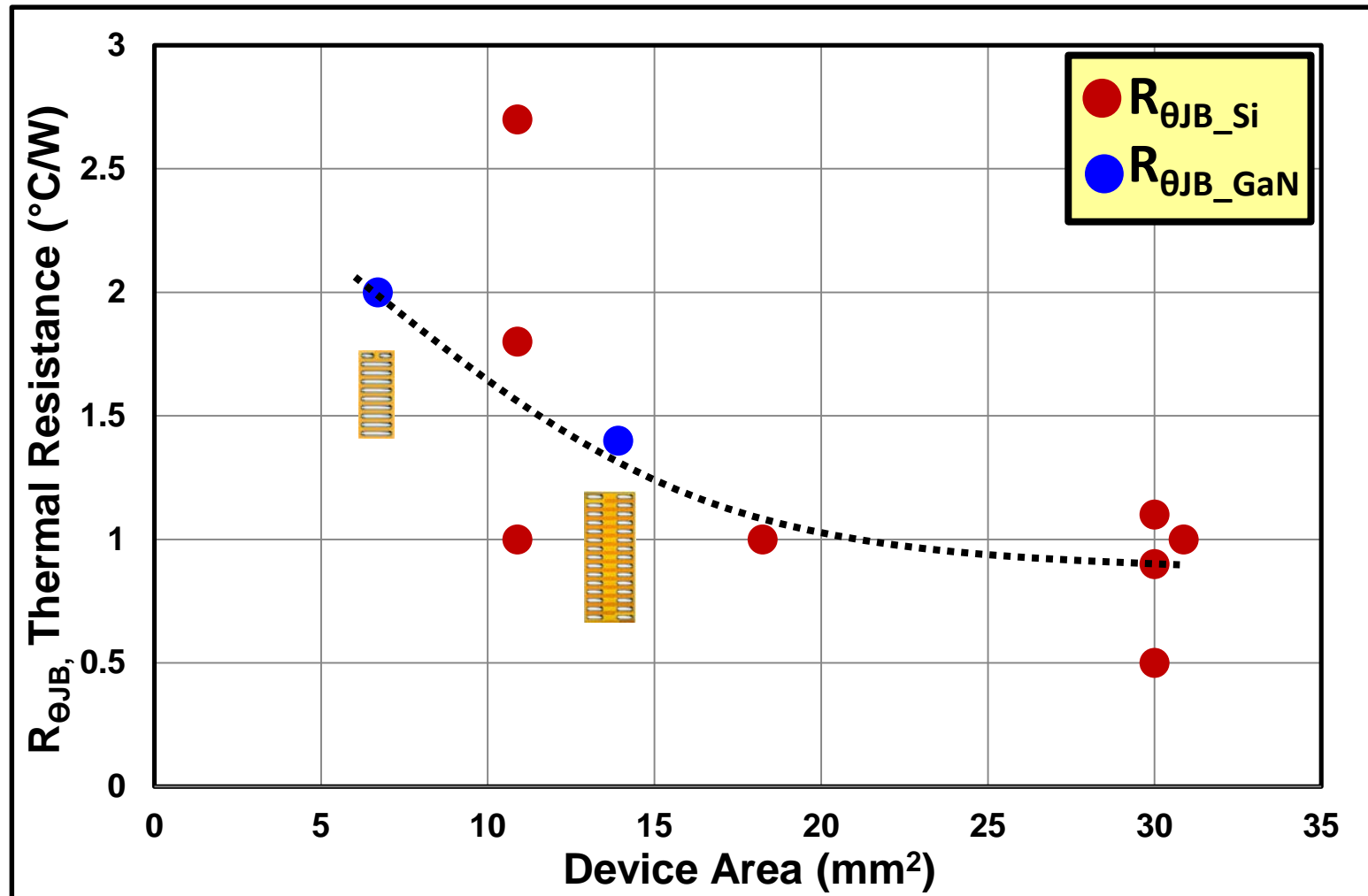


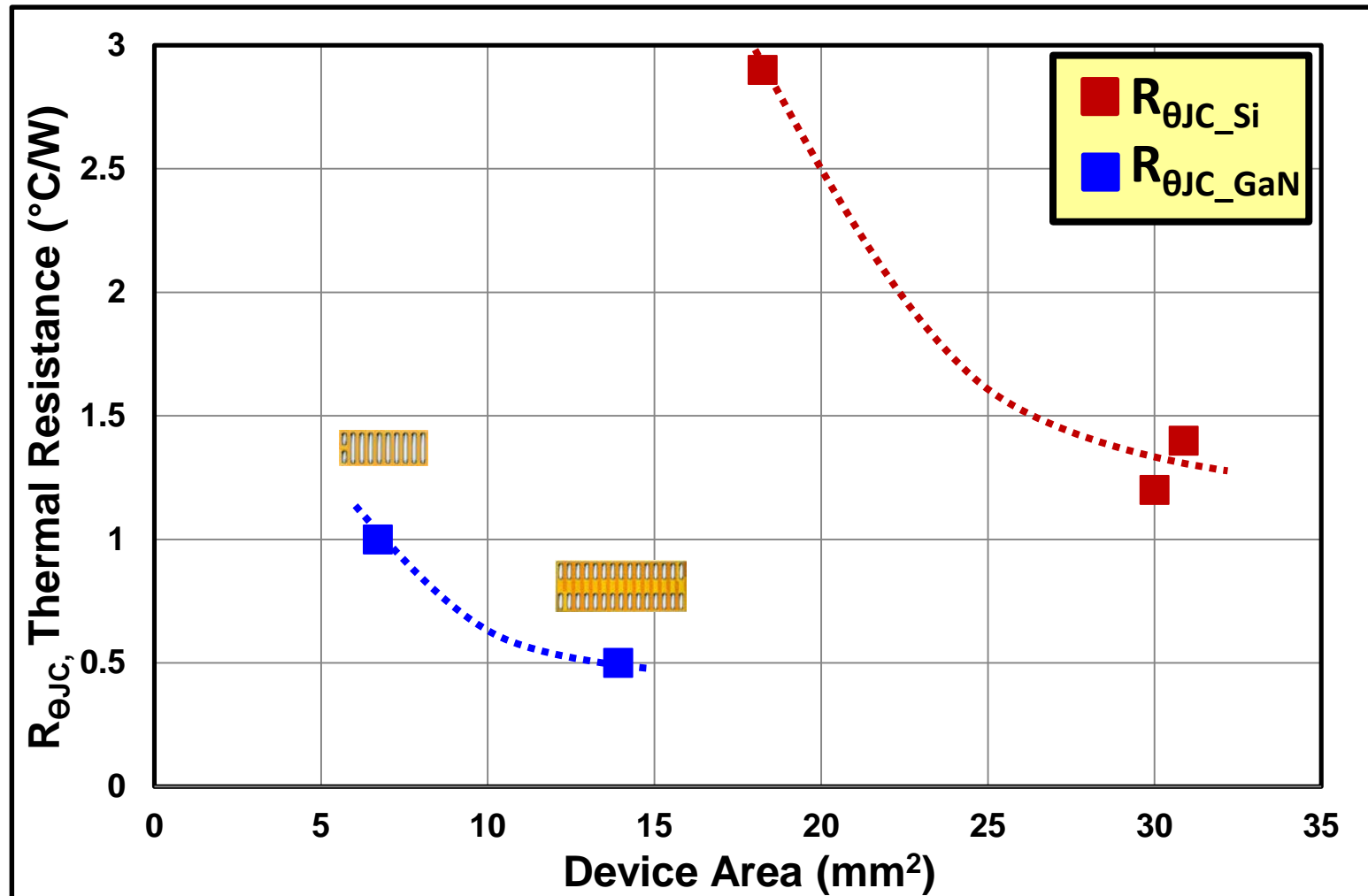
eGaN FET









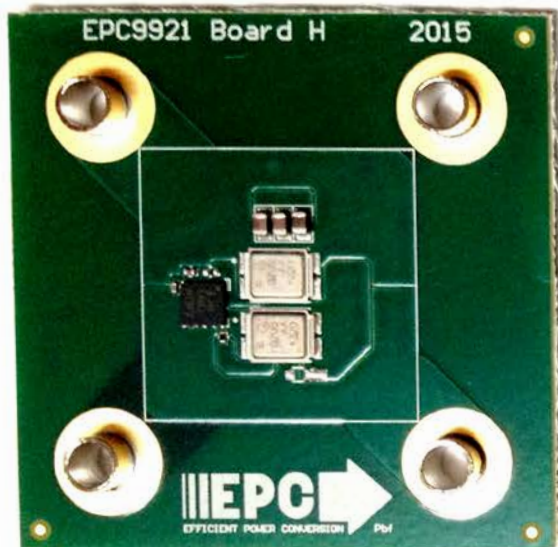


1x1 inch Buck Converter 4 Layers 2oz Copper

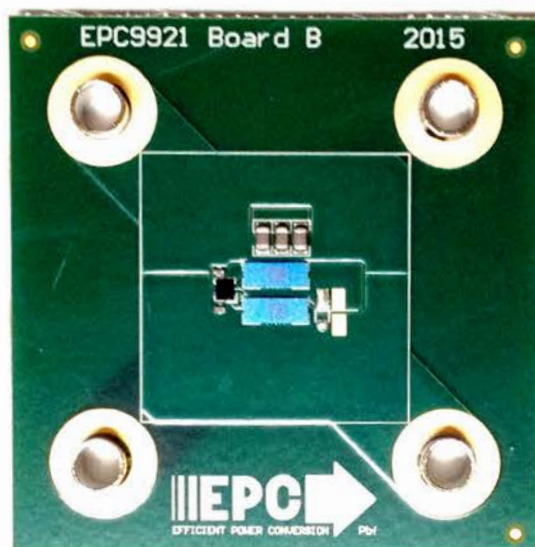
80 V 3.7 mΩ
CanPAK MOSFET

80 V 1.8 mΩ
LGA eGaN FET

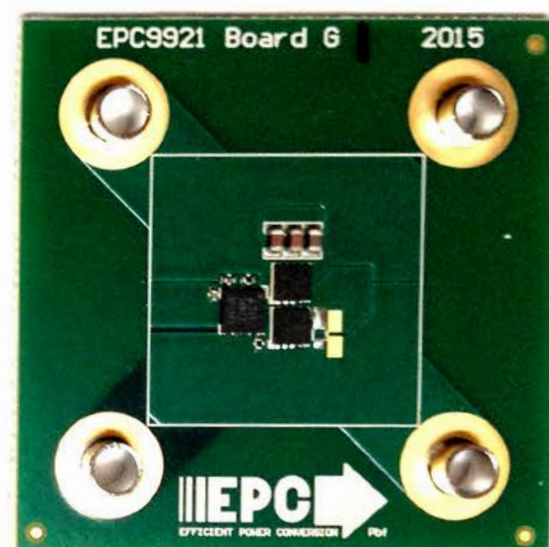
80 V 6.8 mΩ
S308 MOSFET



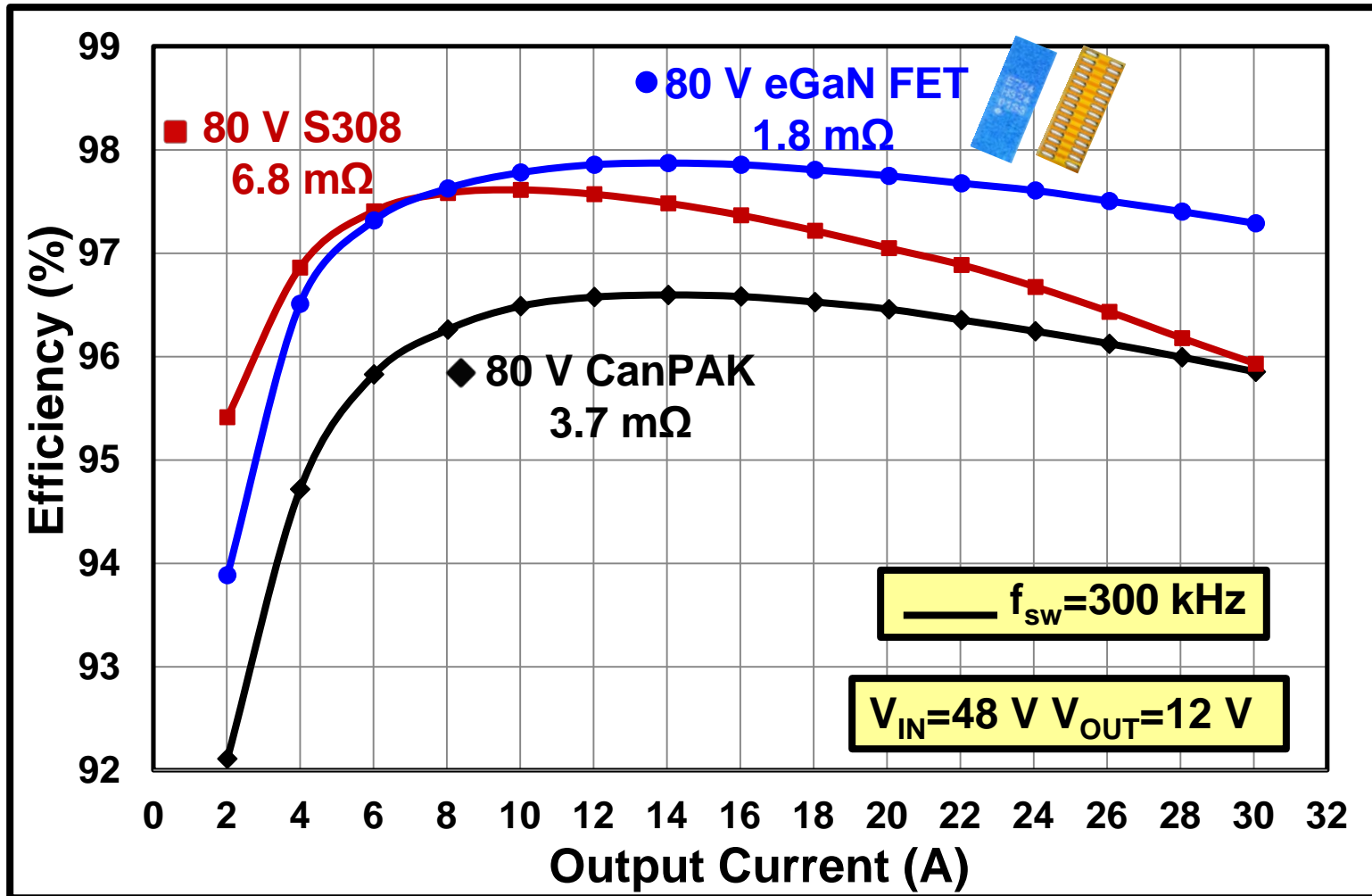
Active Area
≈150 mm²



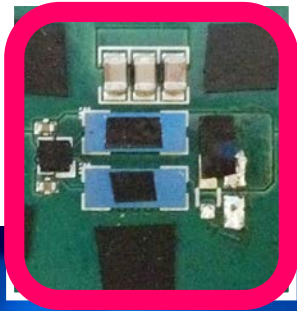
Active Area
≈60 mm²



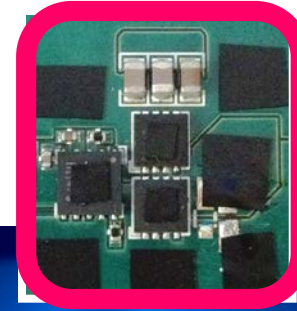
Active Area
≈132 mm²



eGaN FET and S308 MOSFET Thermal Comparison



Q1 $\approx 98^{\circ}\text{C}$
Q2 $\approx 84^{\circ}\text{C}$

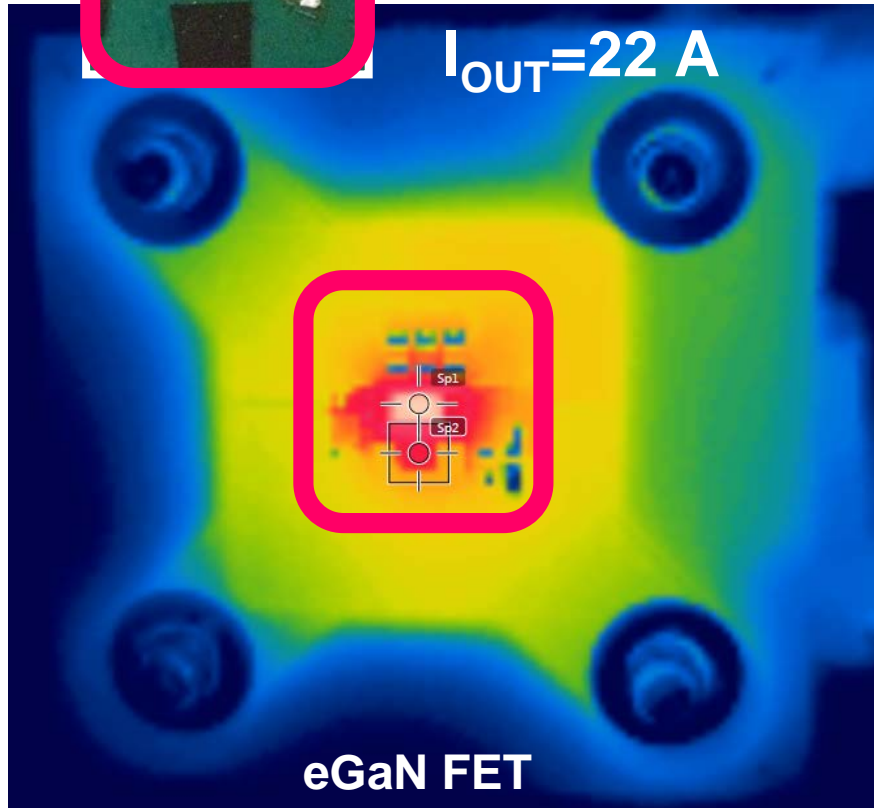


Q1 $\approx 98^{\circ}\text{C}$
Q2 $\approx 97^{\circ}\text{C}$

100°C



$I_{\text{OUT}}=22\text{ A}$



eGaN FET

$I_{\text{OUT}}=16\text{ A}$

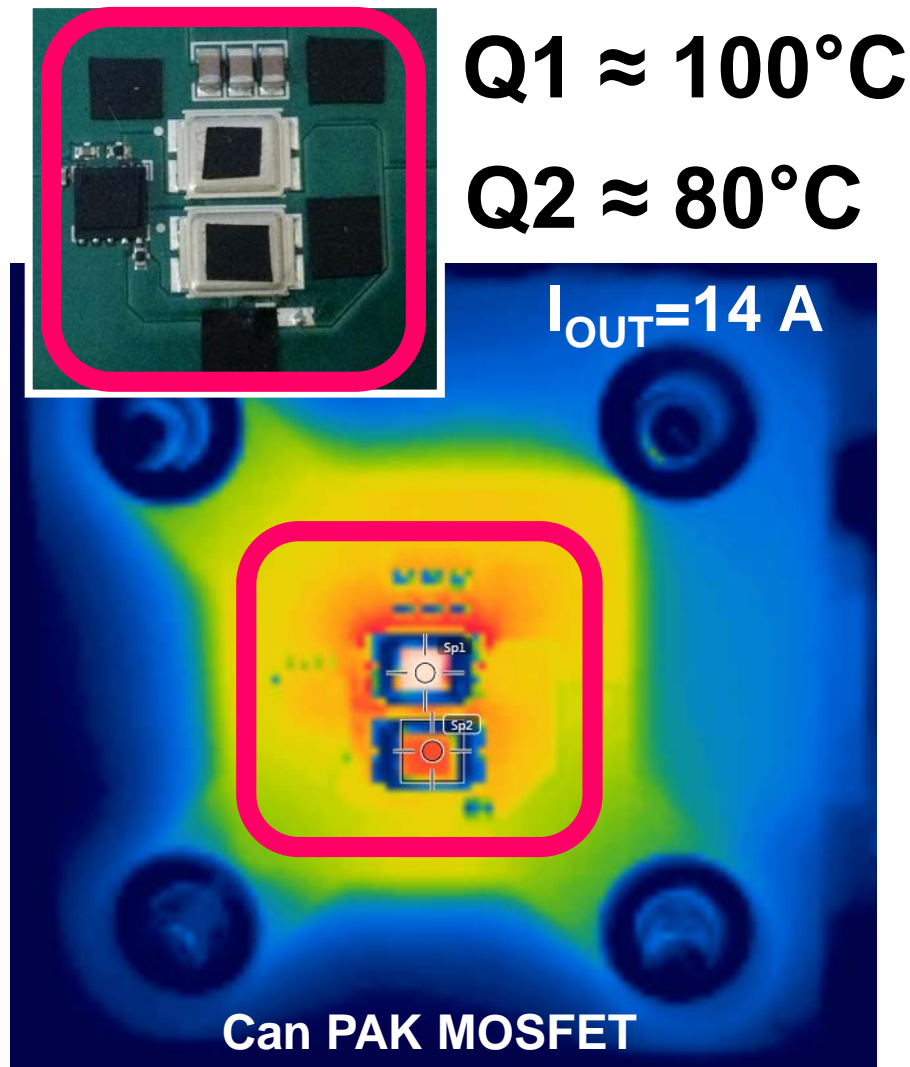
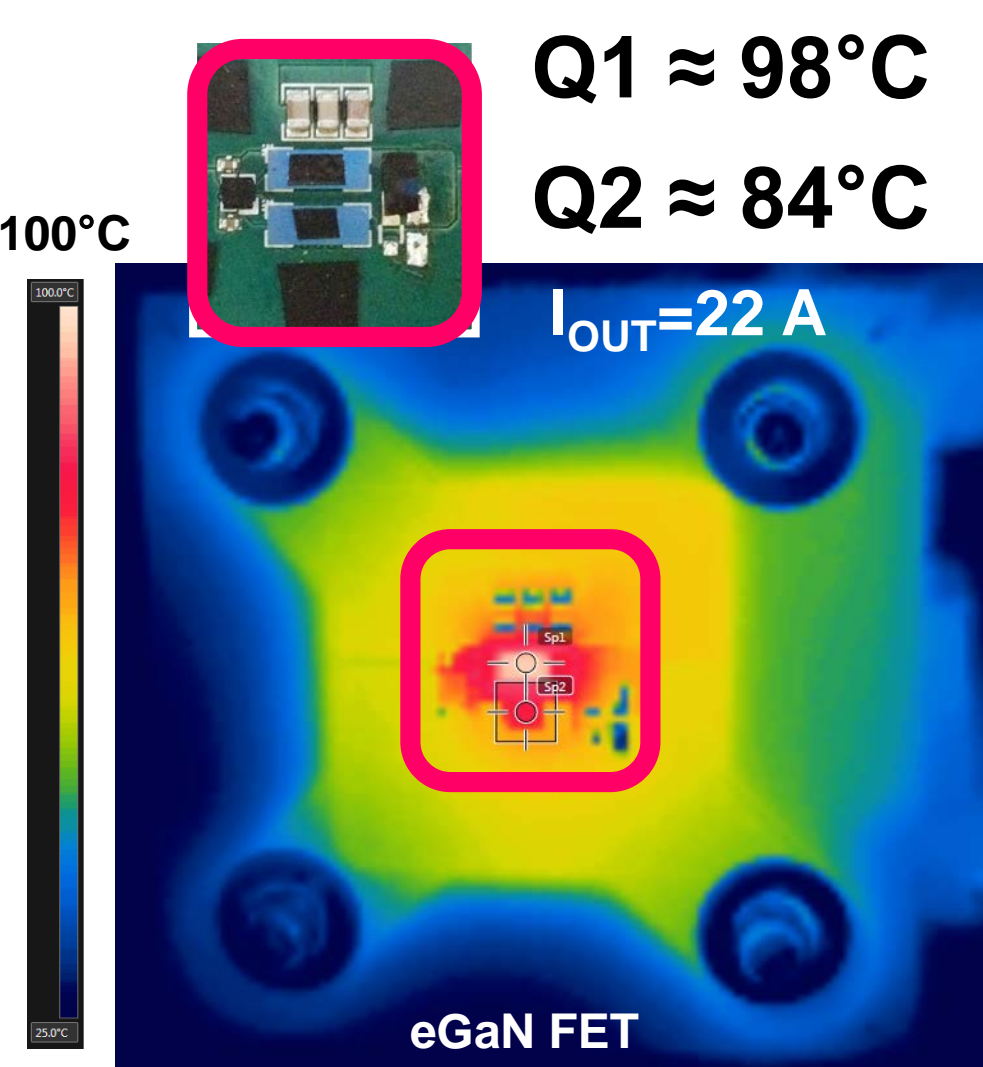


S308 MOSFET

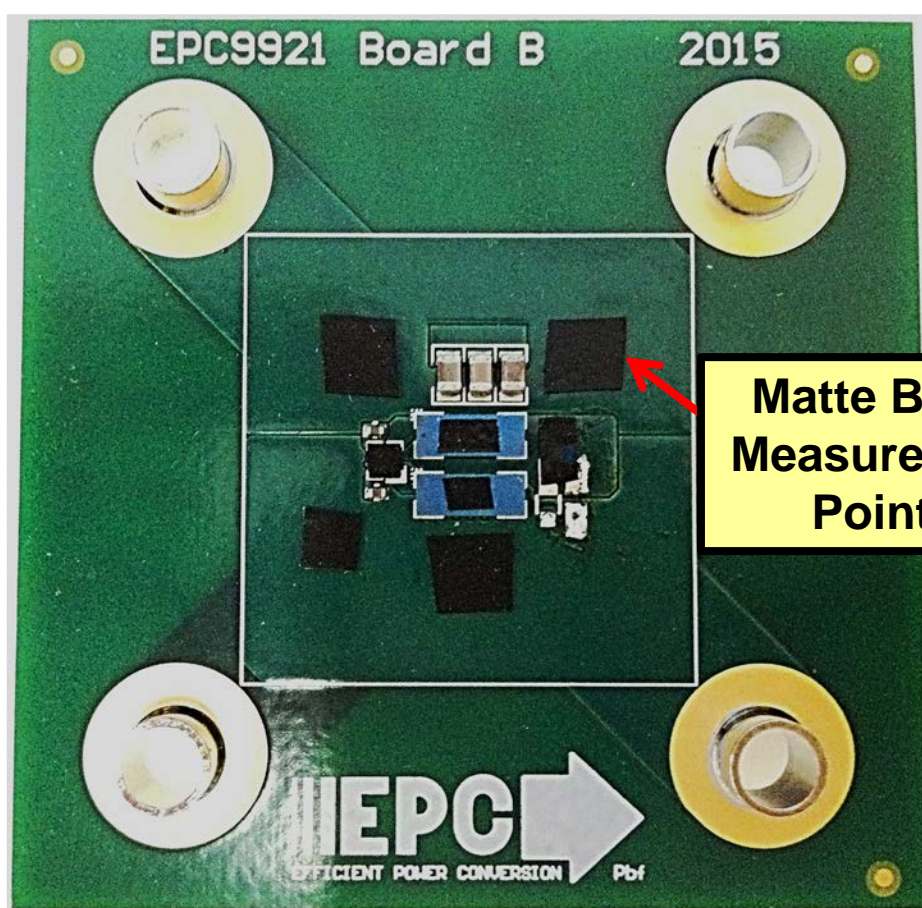
25°C

Fan Speed=200 LFM $V_{\text{IN}}=48\text{ V}$ $V_{\text{OUT}}=12\text{ V}$ $f_{\text{sw}}=300\text{ kHz}$ $L=4.7\text{ }\mu\text{H}$

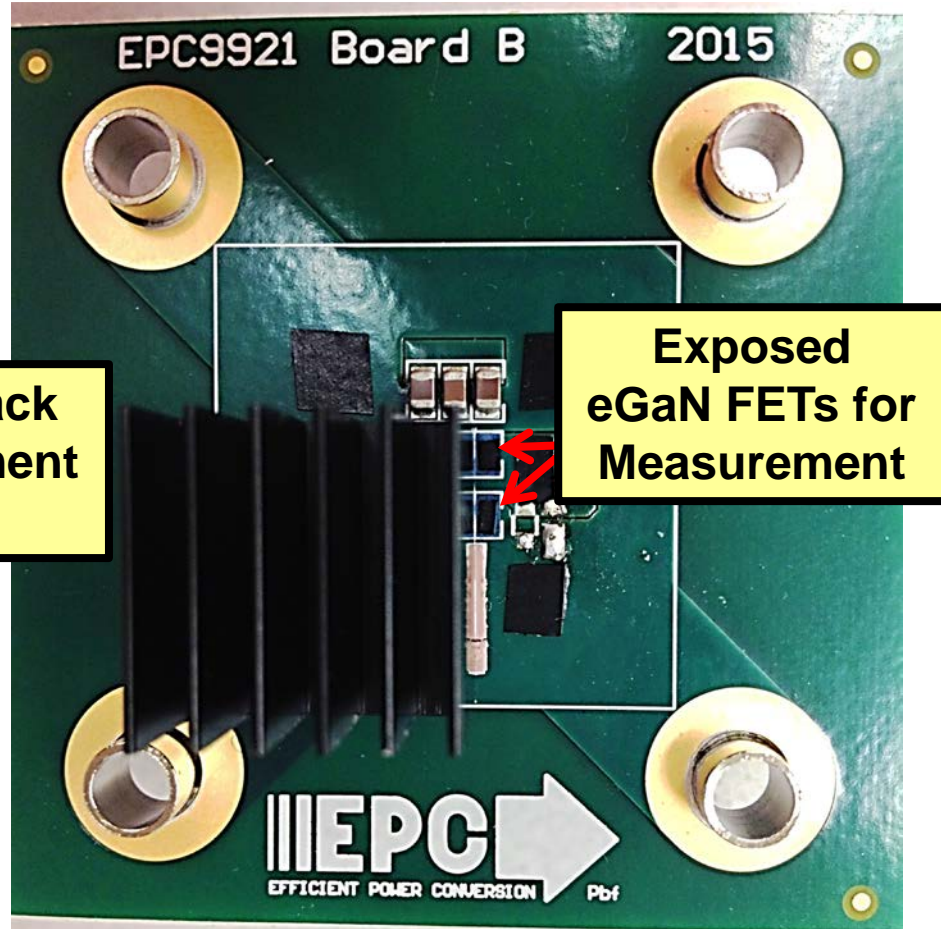
eGaN FET and CanPAK MOSFET Thermal Comparison



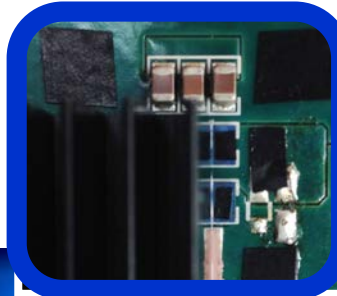
Fan Speed=200 LFM $V_{\text{IN}}=48\text{ V}$ $V_{\text{OUT}}=12\text{ V}$ $f_{\text{sw}}=300\text{ kHz}$ $L=4.7\text{ }\mu\text{H}$



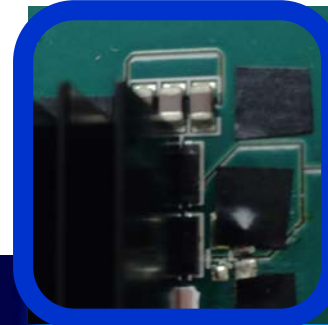
1x1 inch Buck Converter
4 Layers 2oz Copper



15x15x14.5 mm
Heat Sink



Q1 $\approx 100^{\circ}\text{C}$
Q2 $\approx 89^{\circ}\text{C}$



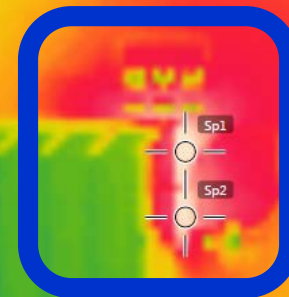
Q1 $\approx 102^{\circ}\text{C}$
Q2 $\approx 100^{\circ}\text{C}$

100°C



$I_{\text{OUT}}=30\text{ A}$

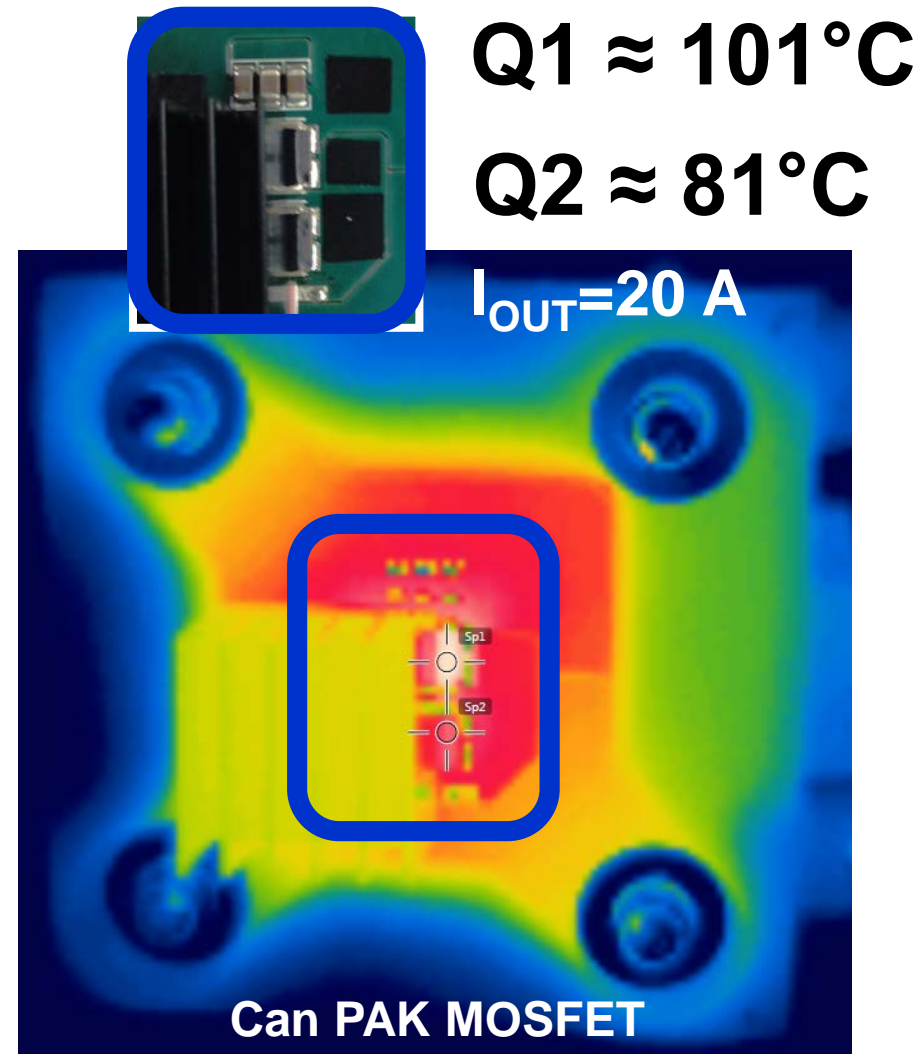
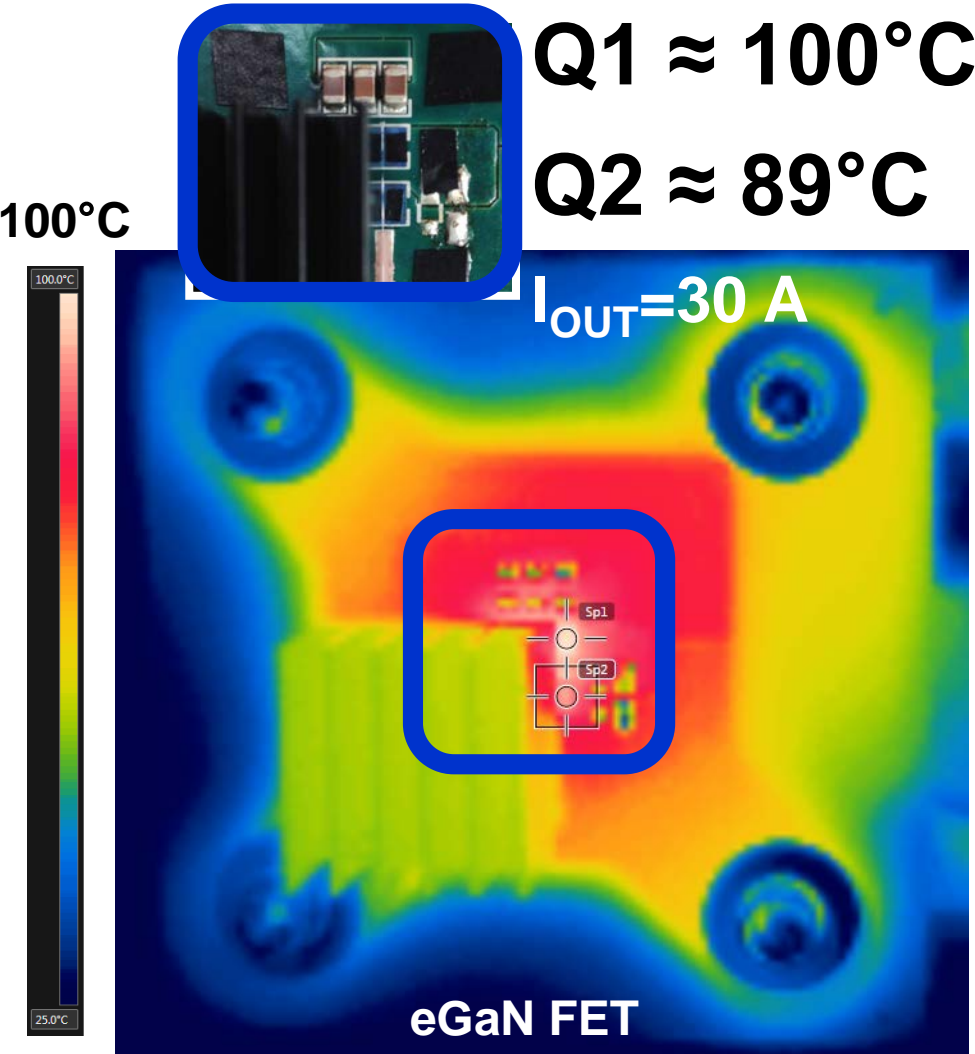
$I_{\text{OUT}}=20\text{ A}$



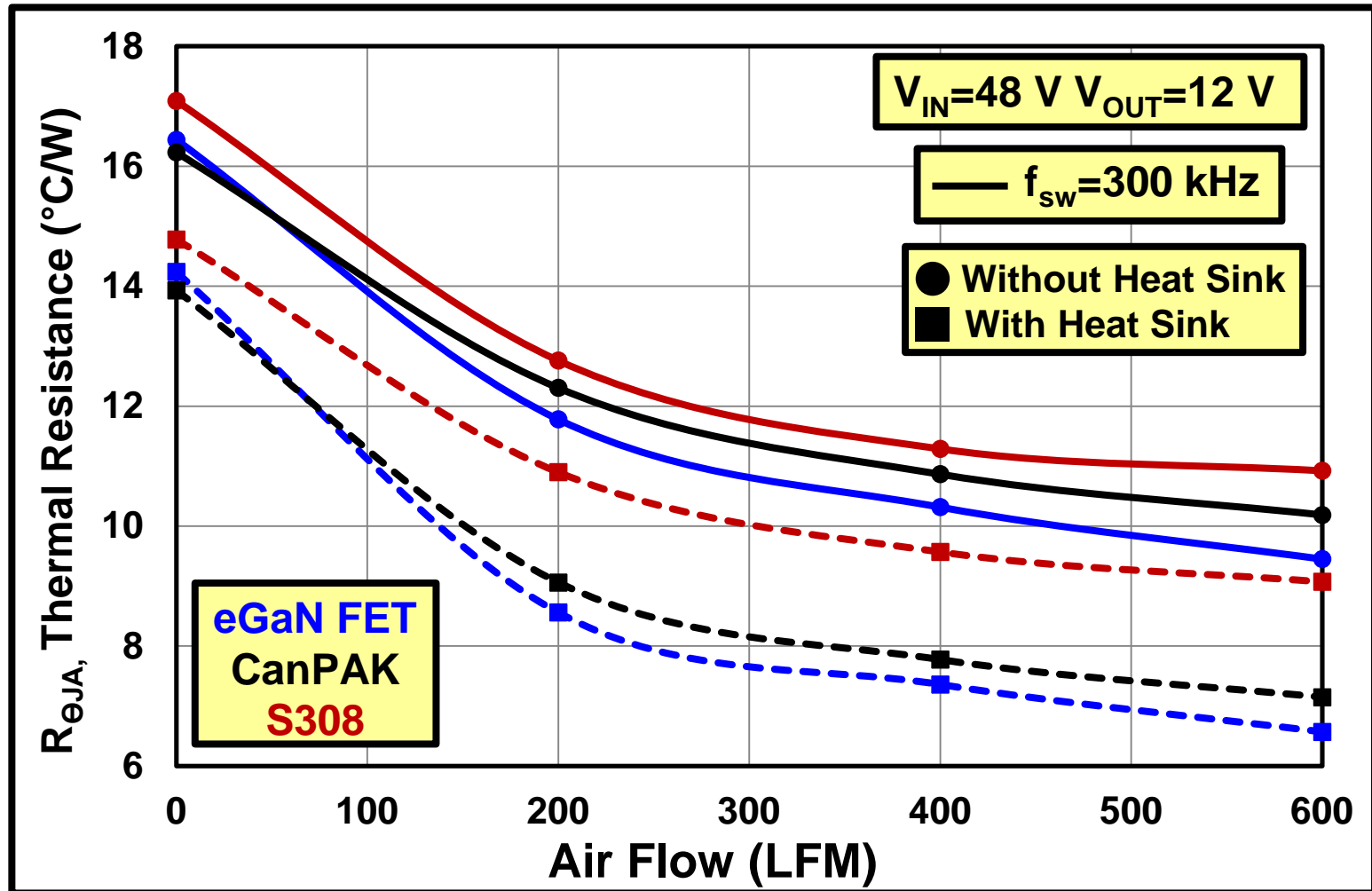
eGaN FET

S308 MOSFET

Fan Speed=400 LFM $V_{\text{IN}}=48\text{ V}$ $V_{\text{OUT}}=12\text{ V}$ $f_{\text{sw}}=300\text{ kHz}$ $L=4.7\text{ }\mu\text{H}$



Fan Speed=400 LFM $V_{\text{IN}}=48\text{ V}$ $V_{\text{OUT}}=12\text{ V}$ $f_{\text{sw}}=300\text{ kHz}$ $L=4.7\text{ }\mu\text{H}$



- Power Device Requirements are Increasing
- Packaging Improvements Must Keep Pace
- Chip-Scale ~~Packaged~~ eGaN FETs Provide Most Efficient Electrical and Thermal ~~Packaging~~ Performance
- Monolithically Integrated eGaN ICs Further Advantages of GaN Technology

Thank You For Your Time ! Questions?