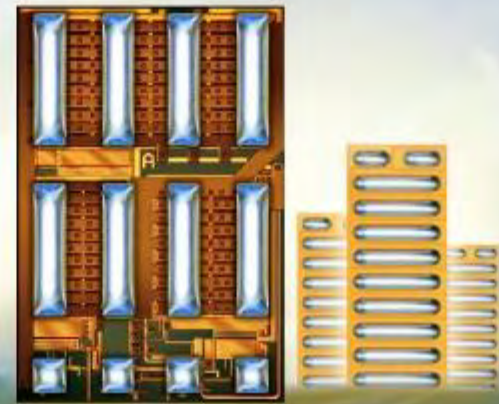


*The eGaN[®] Technology
Journey Continues*



利用简单实用的设计技巧
发挥您的氮化镓设计的最高性能

高级FAE经理 Henry Qiu

- 栅极驱动
- 布局
- PCB 设计
- 散热管理
- 电磁干扰 (EMI)

对栅极驱动器的要求

非常简单！

- 调节栅极驱动器的电源电压
 - 理想范围是5 V 至 5.5 V，最高 6 V
- 最小化栅极功率环路电感
- 噪声免疫

eGaN[®] FET的栅极驱动器

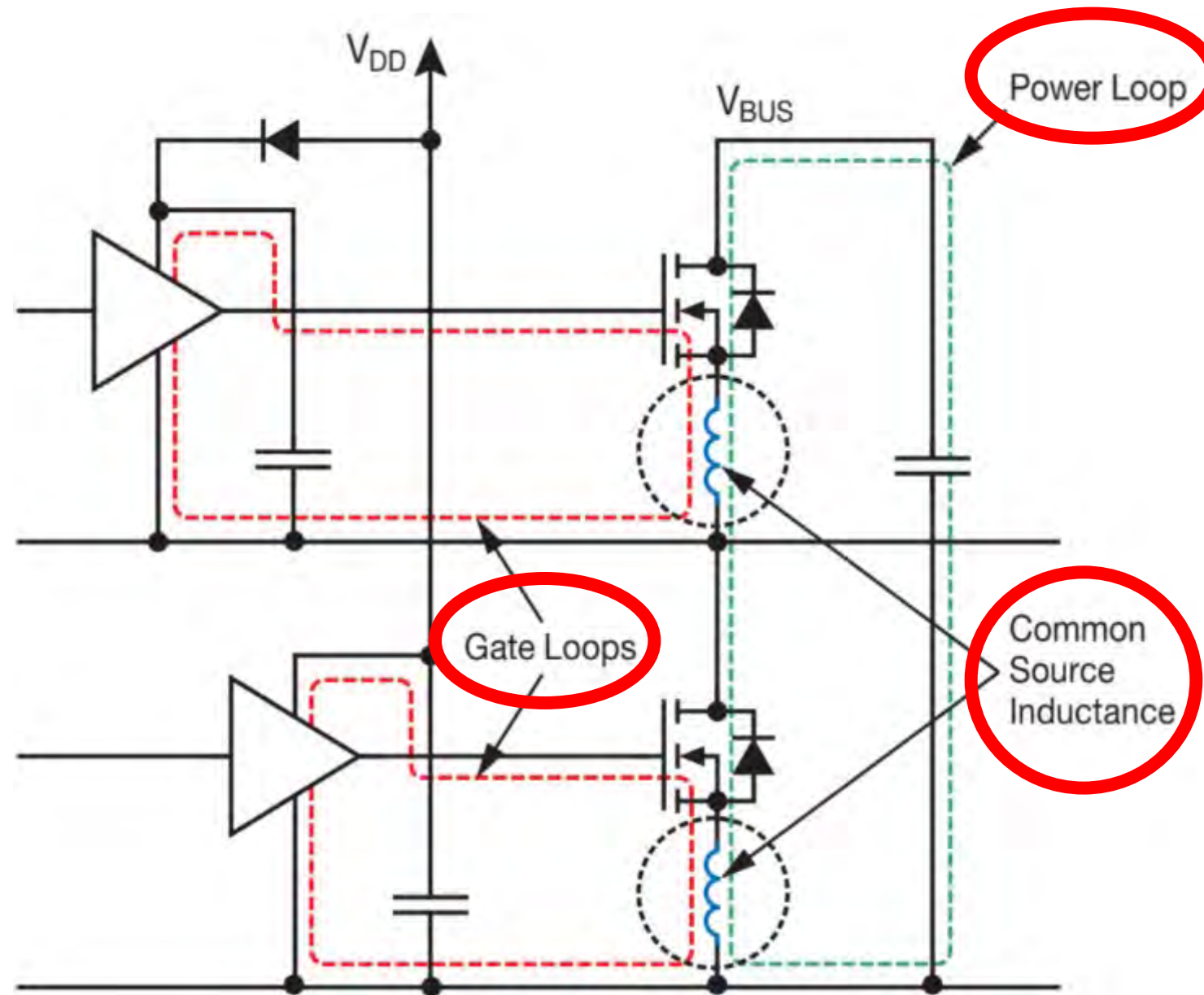


- 低側栅极驱动器
- 半桥栅极驱动器
- 耐辐射栅极驱动器
- 同步整流器的控制器
- 降压转换器的控制器

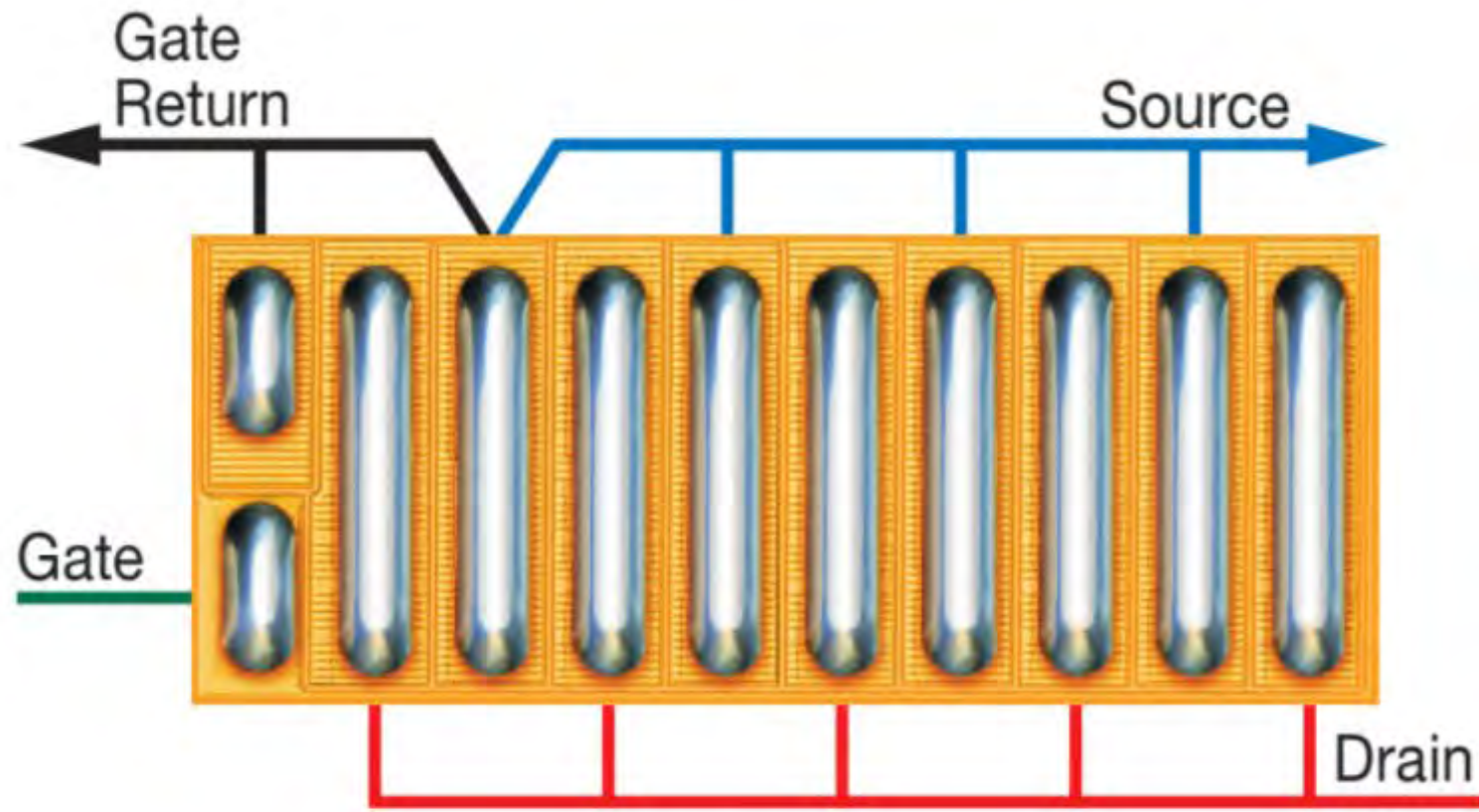


- 共源电感 (CSI)
- 高频功率环路电感
- 栅极驱动环路电感
- 最优布局

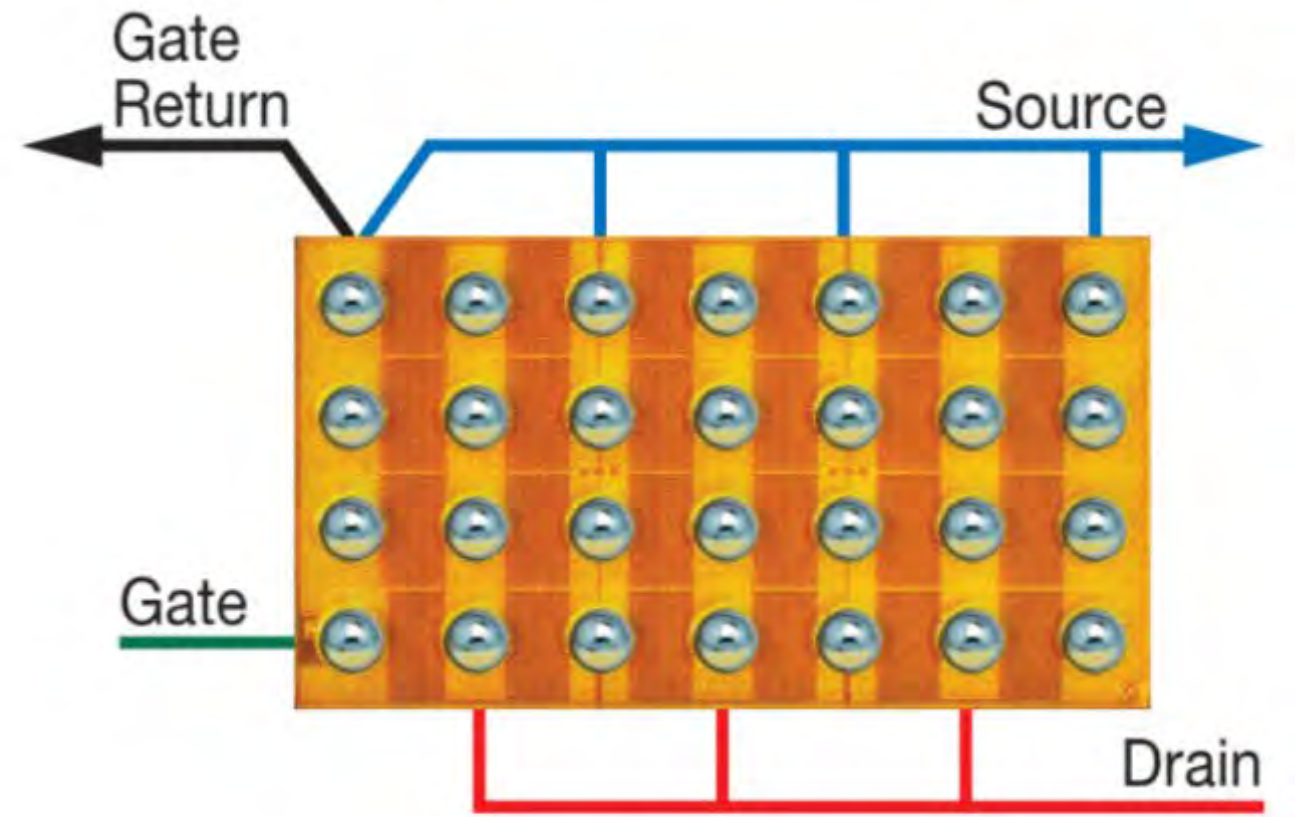
寄生电感



最小化寄生电感

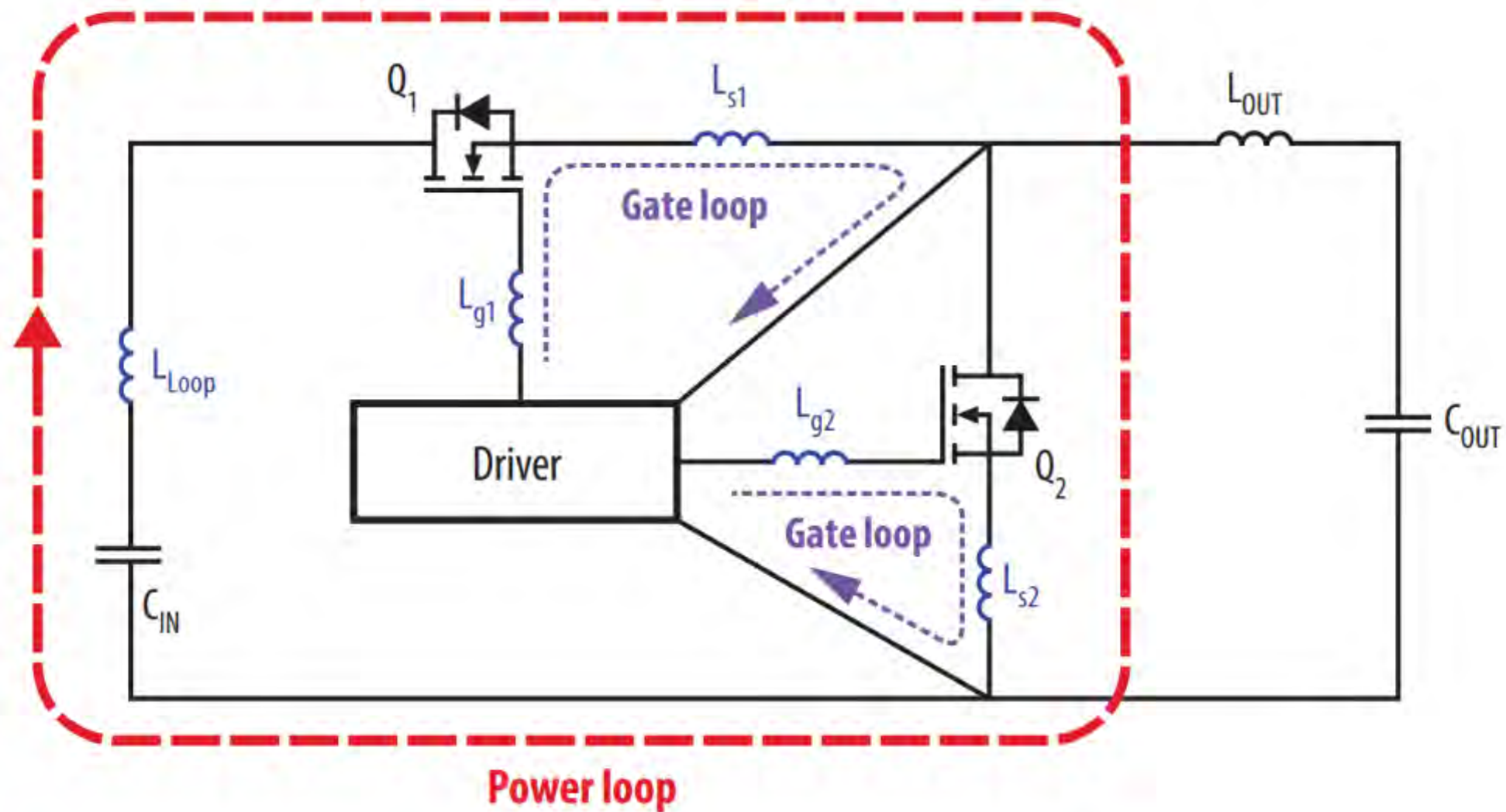


(a)

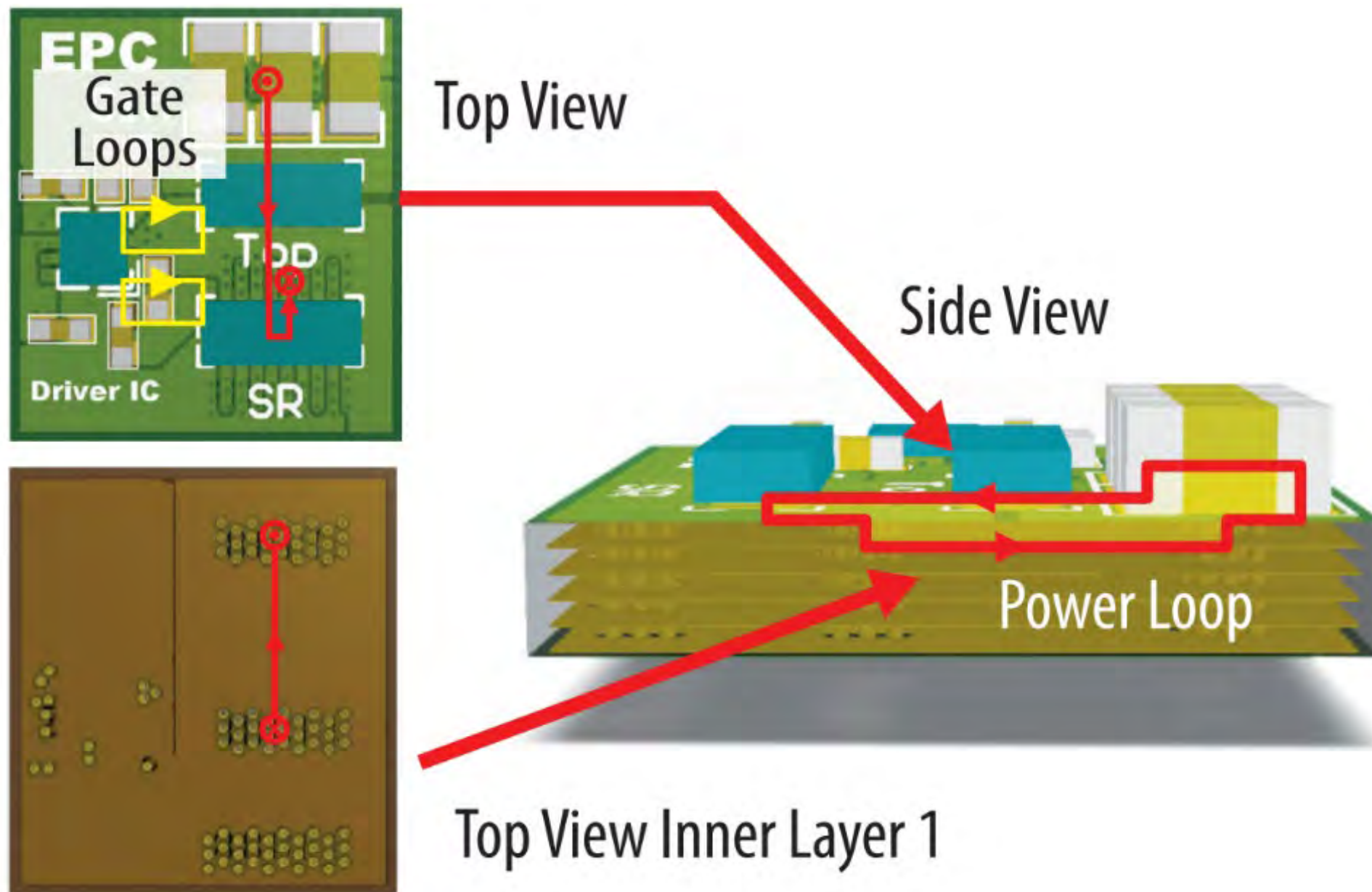


(b)

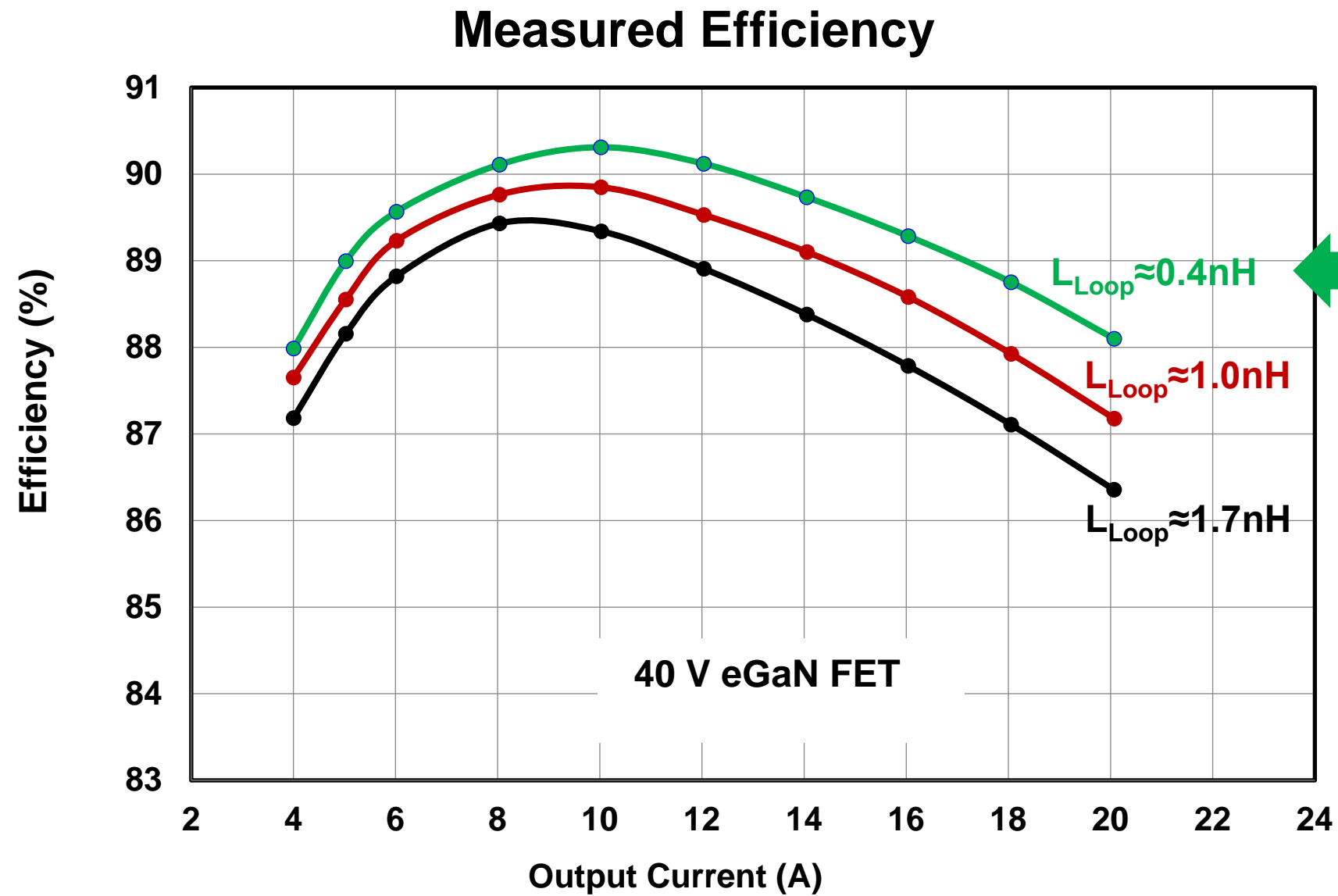
栅极驱动环路电感



最优布局



最优布局 - 效率



Optimal Layout

$V_{IN}=12\text{ V}$, $V_{OUT}=1.2\text{ V}$, $f_{sw}=1\text{ MHz}$, $L=300\text{ nH}$

关于PCB设计的考虑因素

- 金属铜垫的设计
- 丝印板的设计
- 通孔

金属铜垫的设计



Asymmetrical solder ball
(Sensitive to registration)
Non-solder mask defined

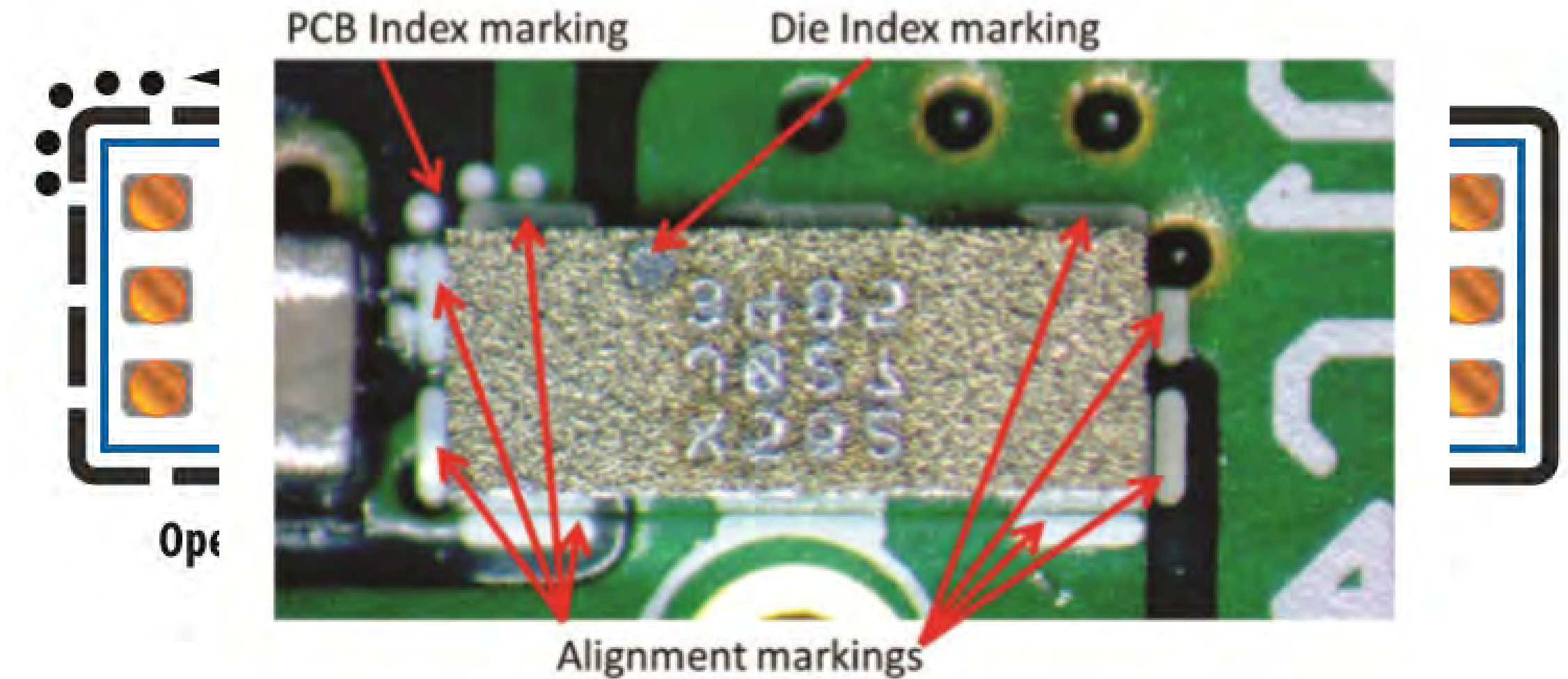
不推荐



Symmetrical solder ball
(Regardless of registration)
Solder mask defined

推荐

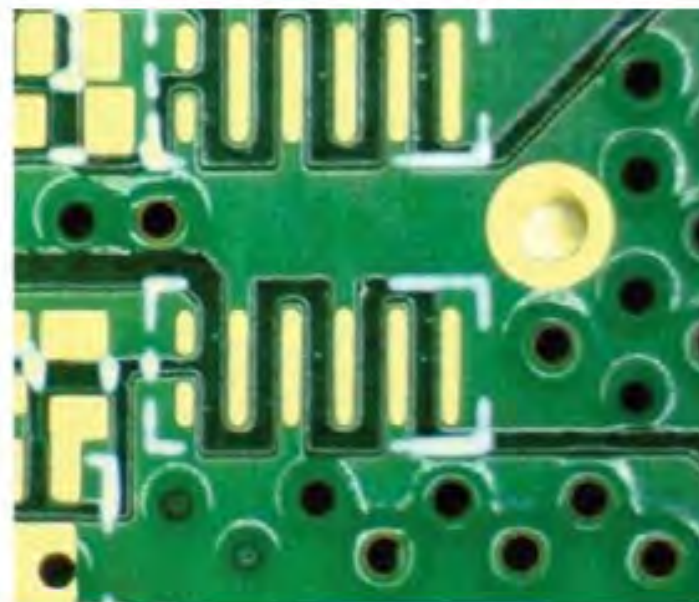
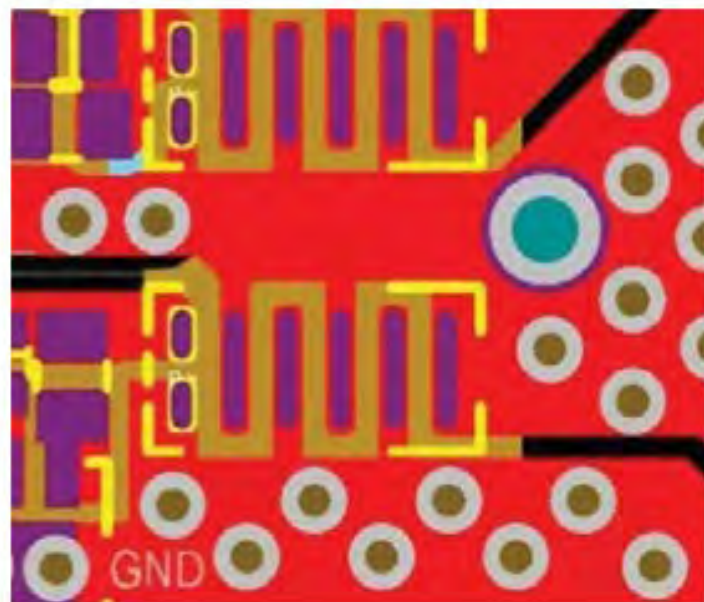
丝印板的设计



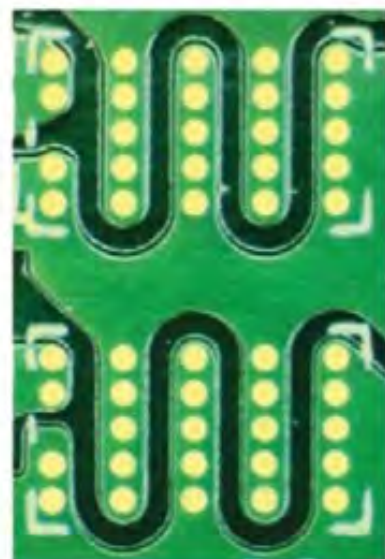
通孔

PCB 布局

PCB 照片

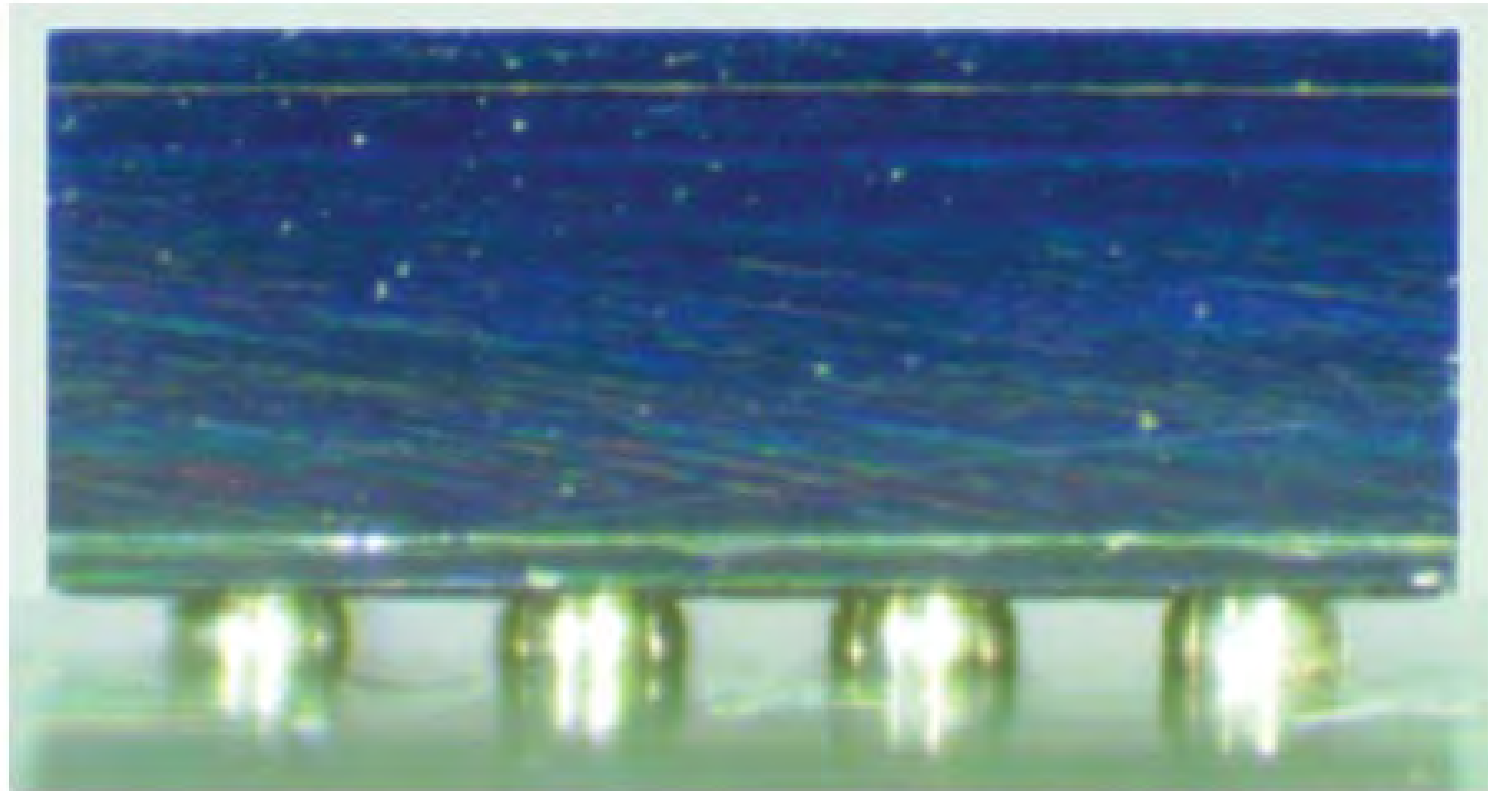


Vias next to pad design



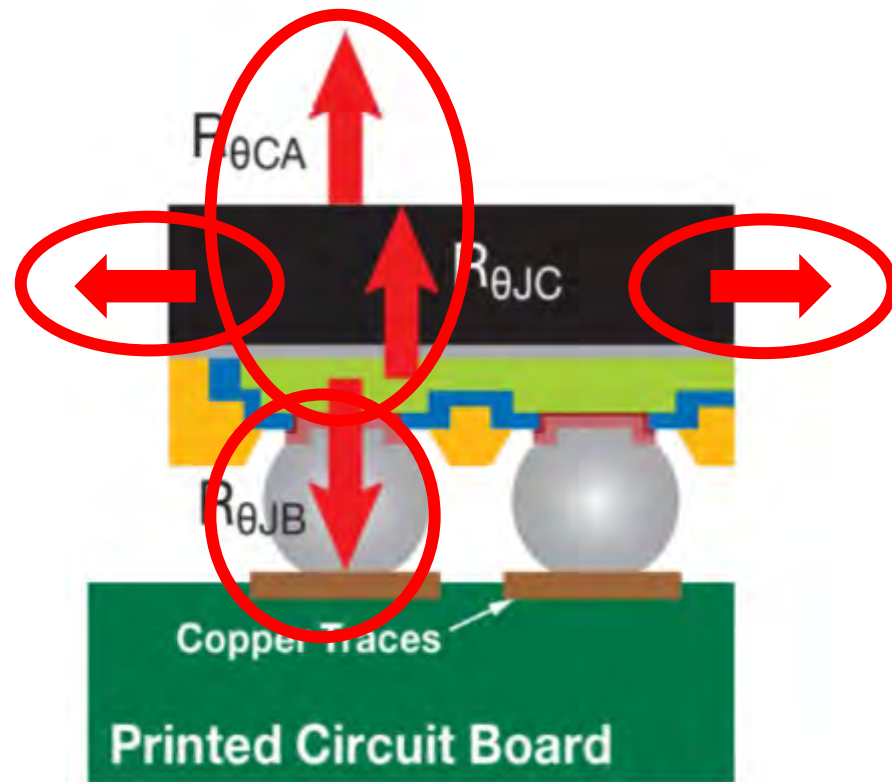
Vias in pad design – vias are filled

实现可靠及具高良率的组装

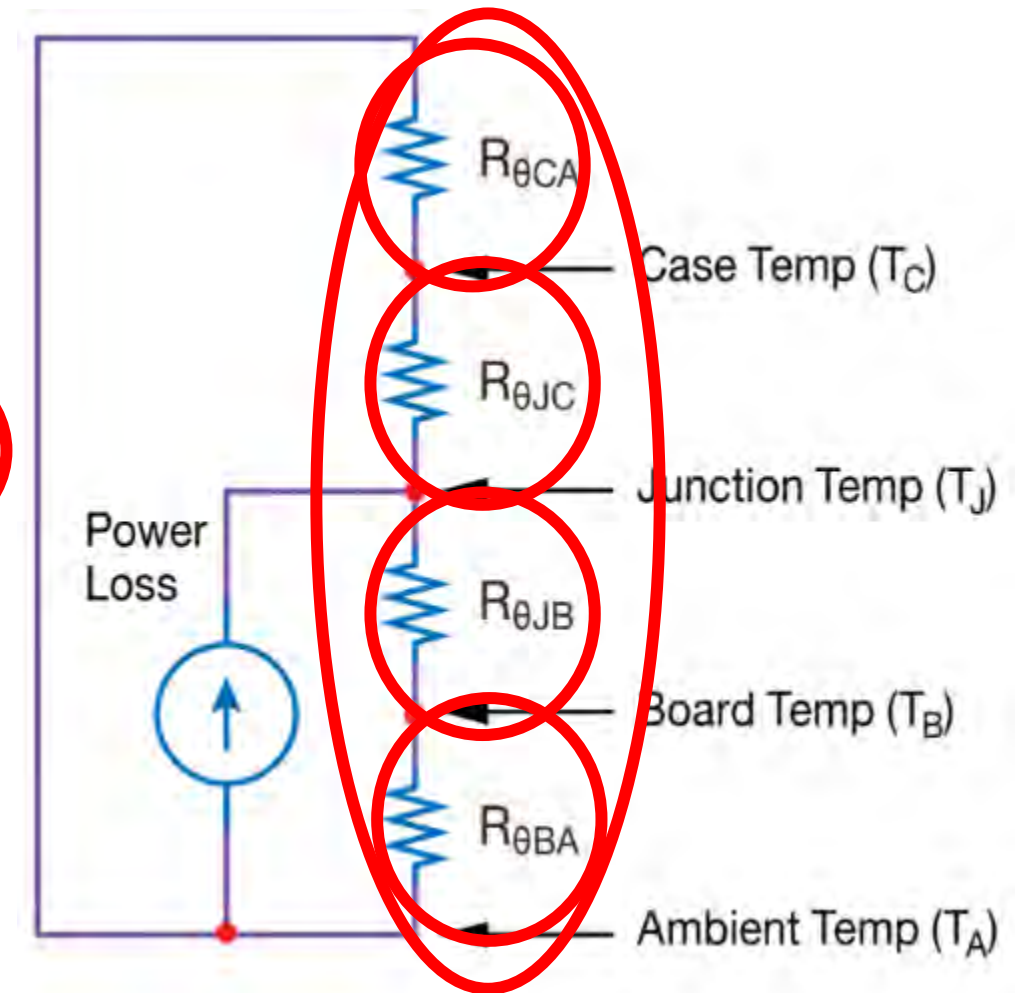


- 氮化镓器件的散热模型
- 散热技术
- 简单的散热解决方案
- 性能

氮化镓器件的散热模型



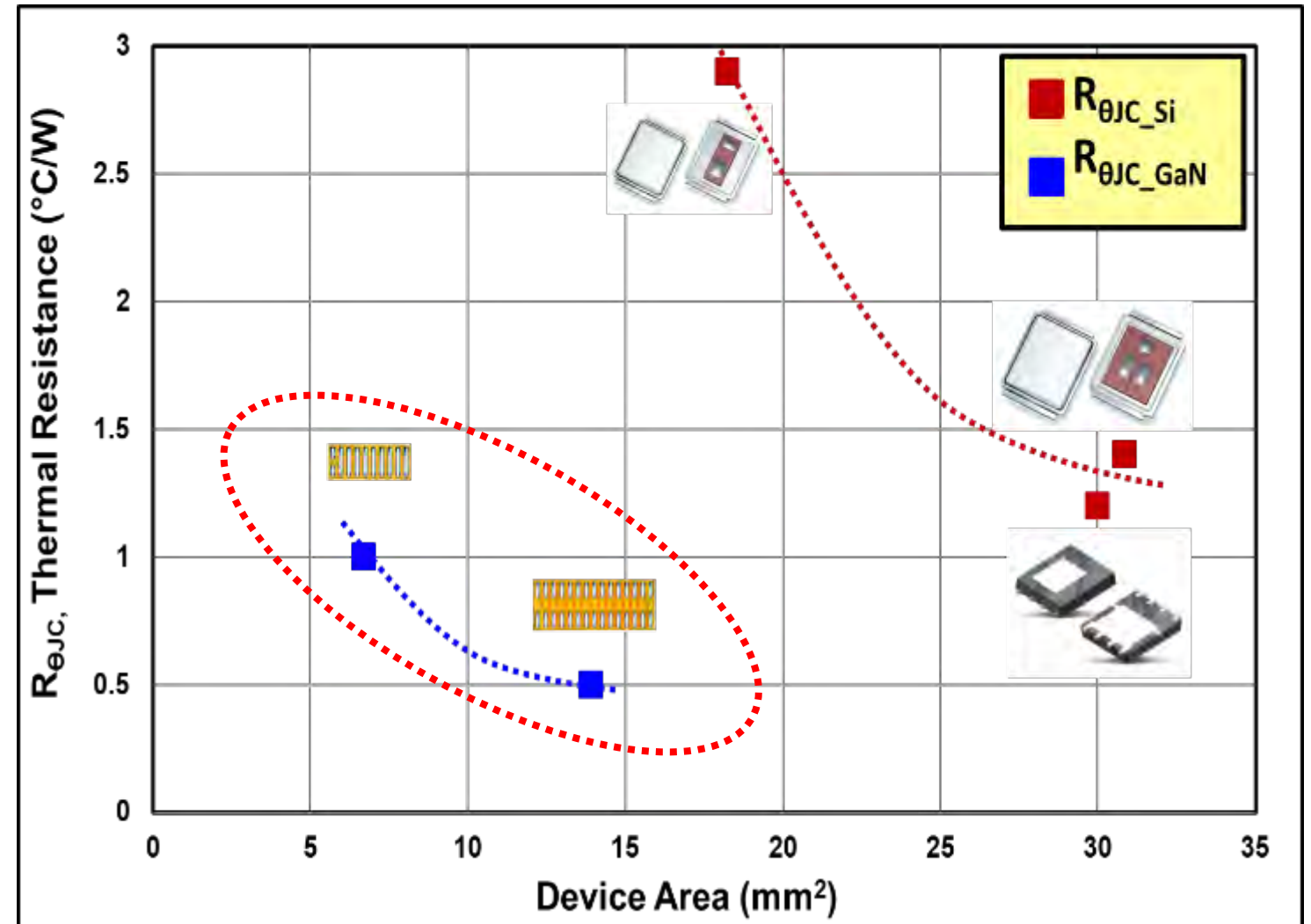
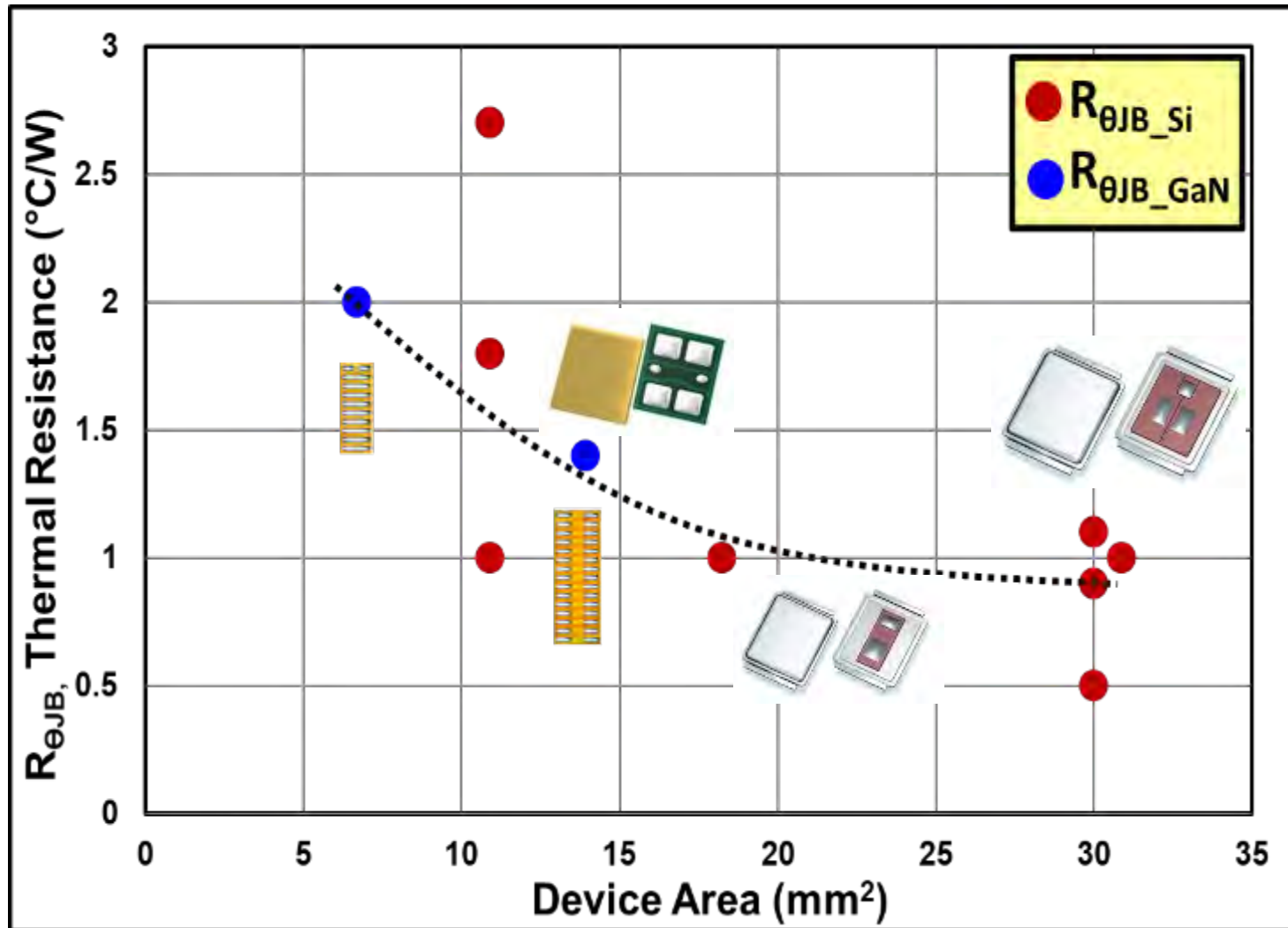
$R_{\theta JA}$



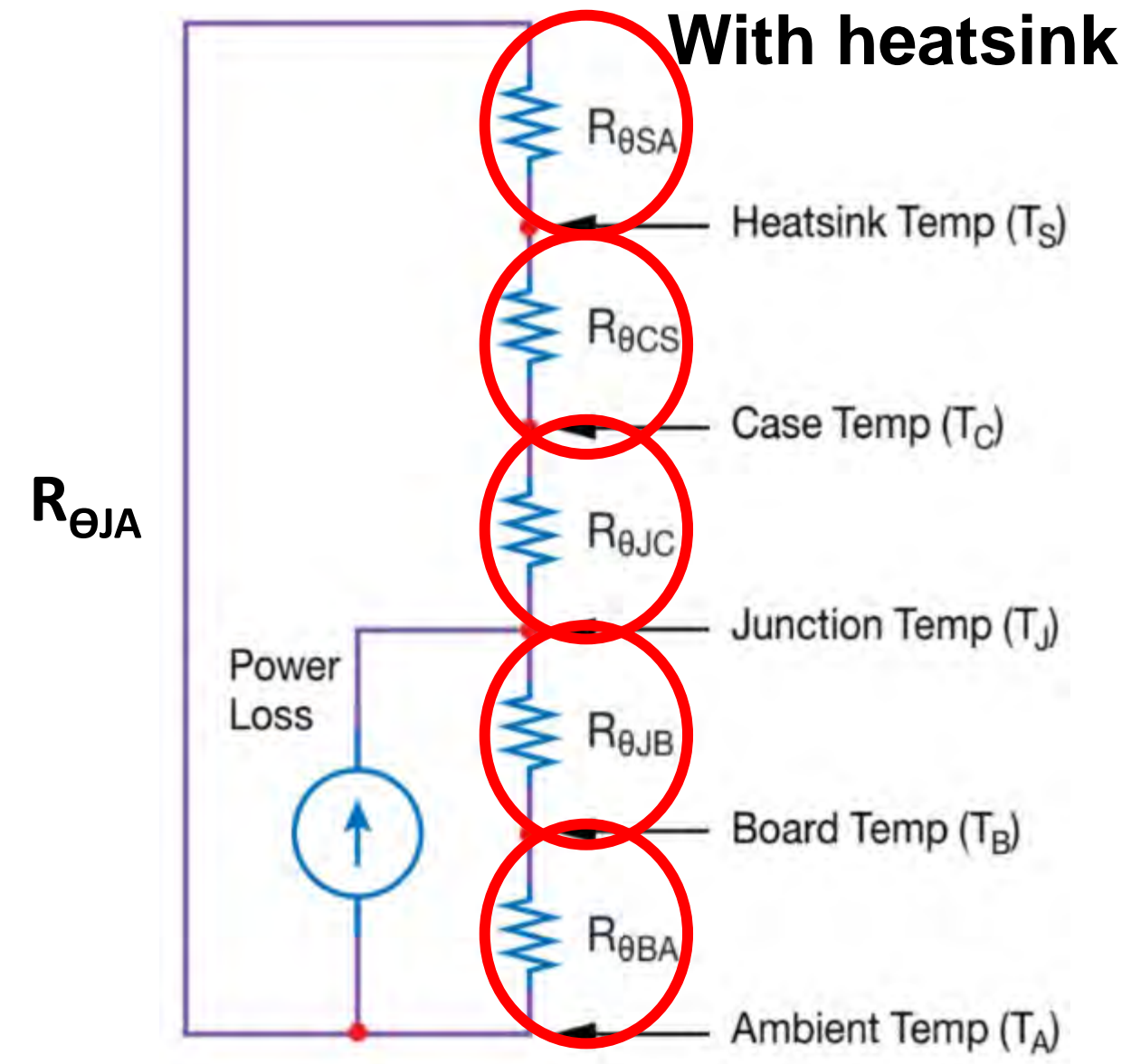
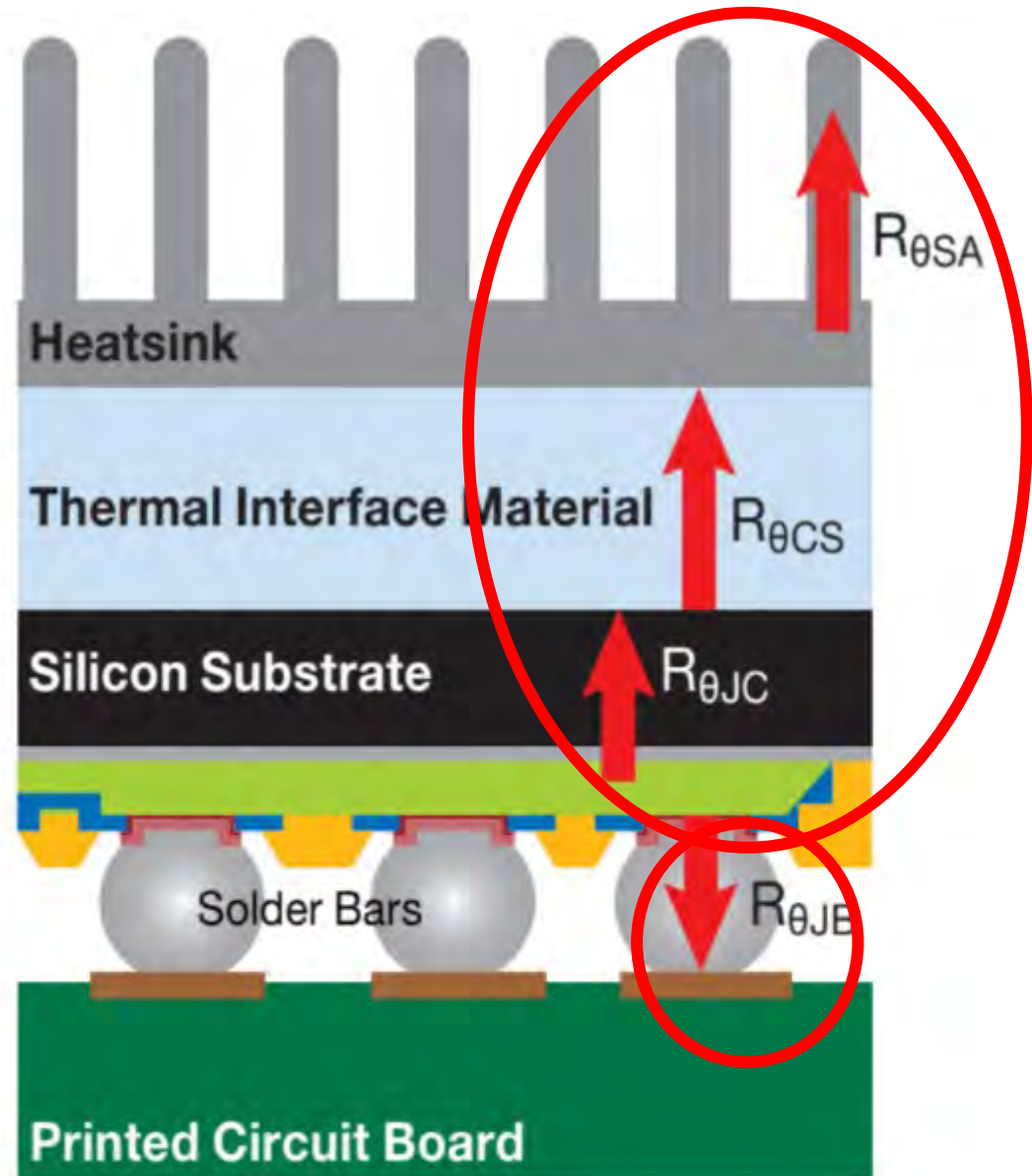
eGaN FET器件的双面冷却方式

Heat transfer to PCB $R_{\theta JB_{board}}$

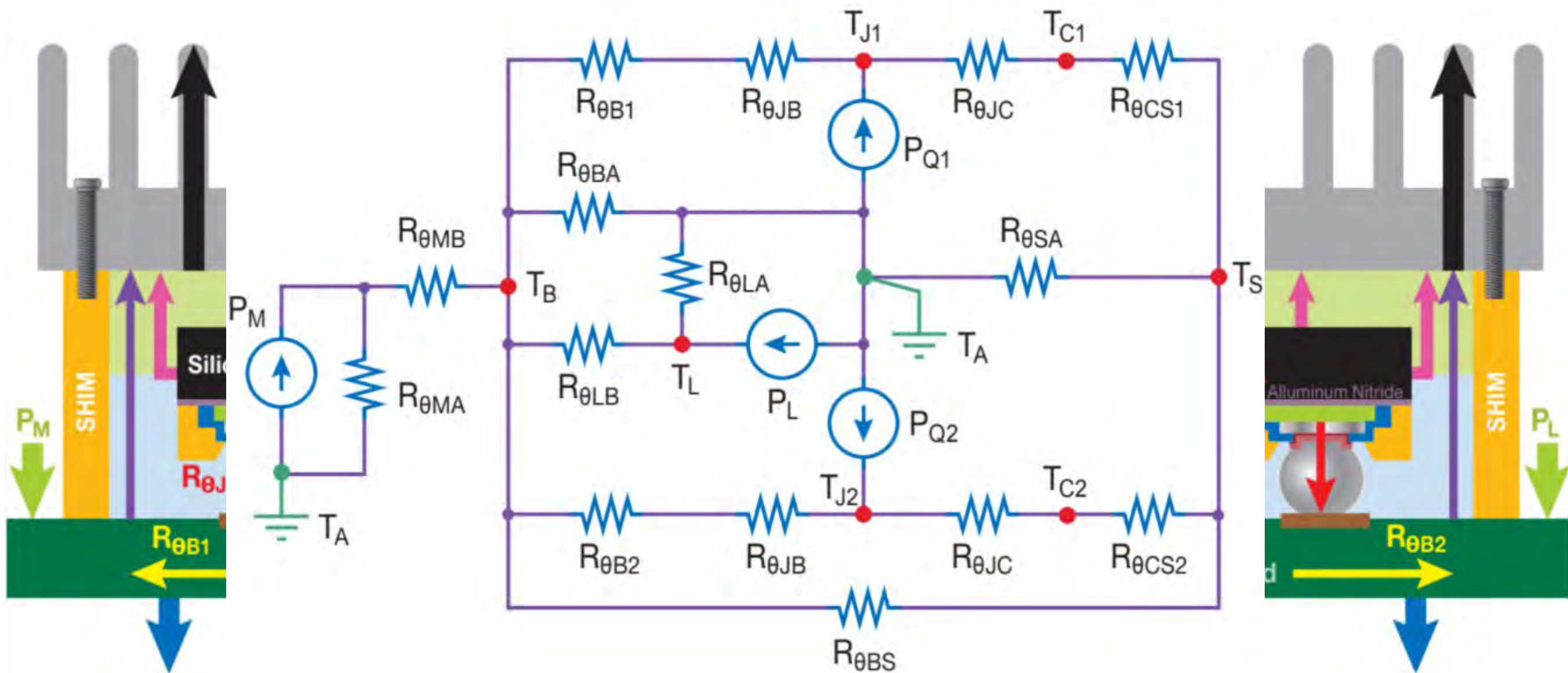
Heat transfer to top Si substrate $R_{\theta JC_{case}}$



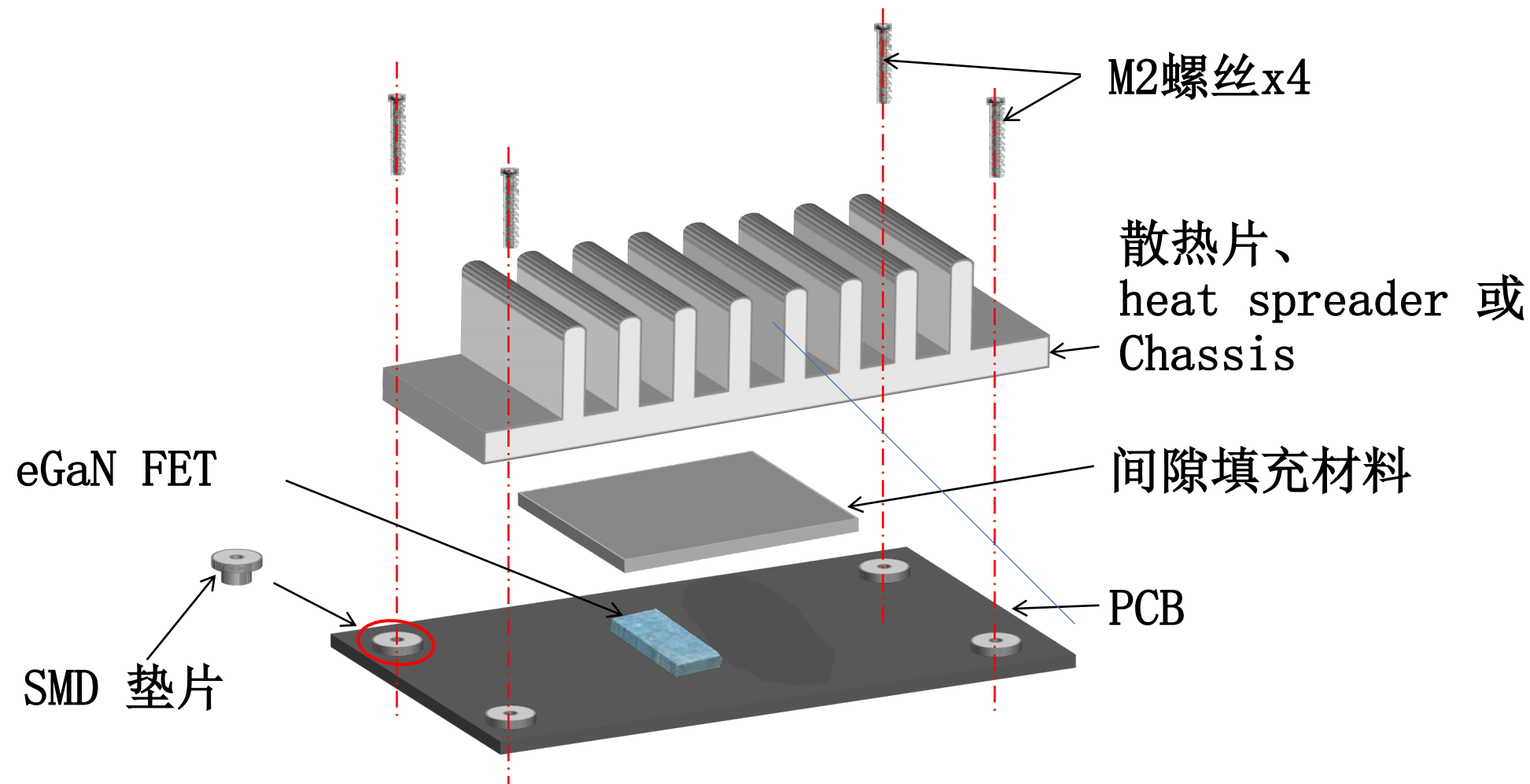
带散热器的氮化镓晶体管的散热模型



功率级的散热模型

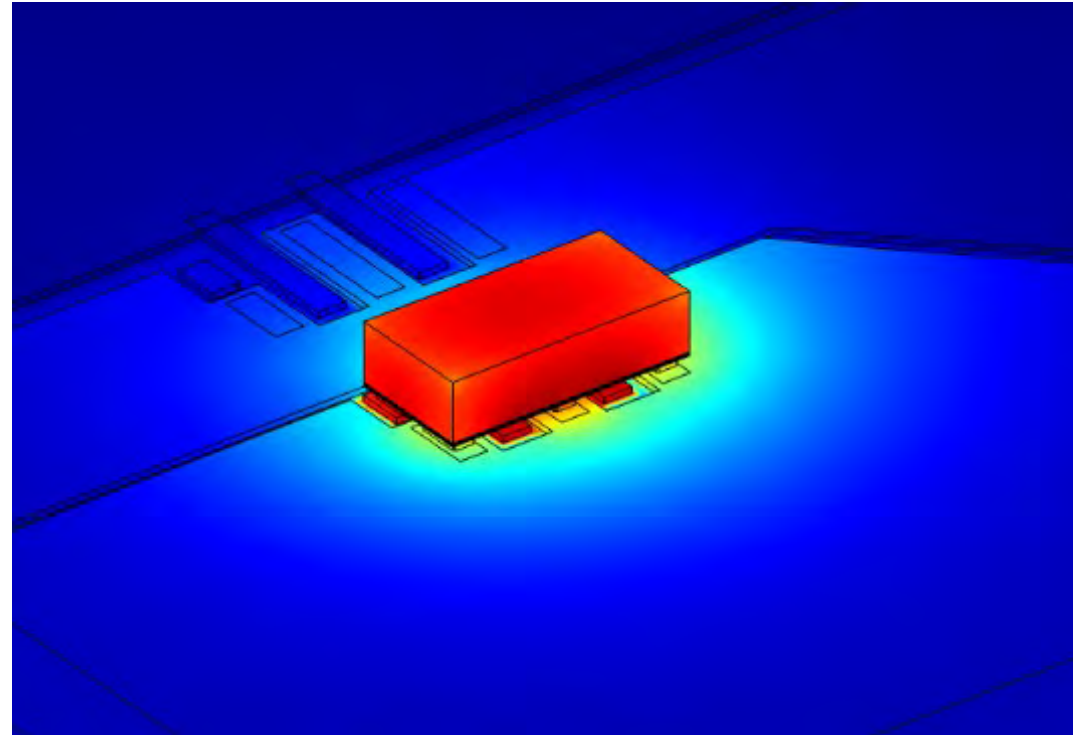


散热系统的范例



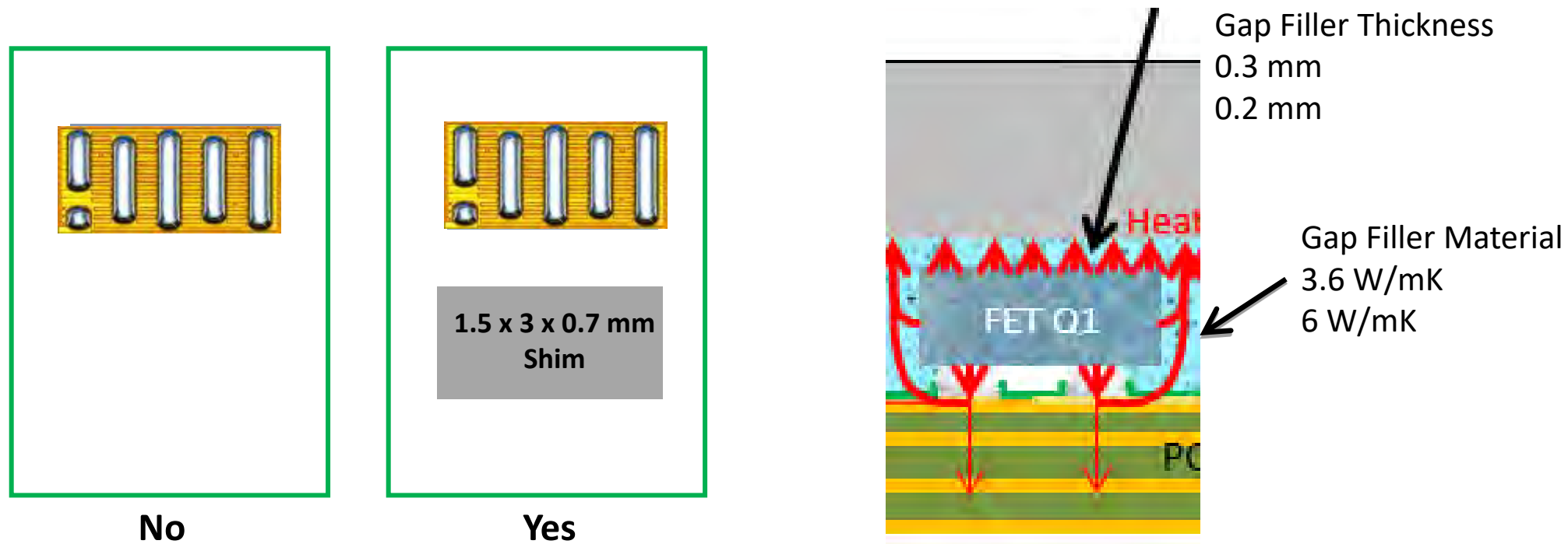
- 间隙填充材料用了Bergquist 3500 S35，导热性为3.6 W/mK
- 间隙填充材料的厚度是0.1 毫米至0.3 毫米
- 铜厚度为2 盎司

基准：4mm²芯片、6.3 °C/W、6 W功耗



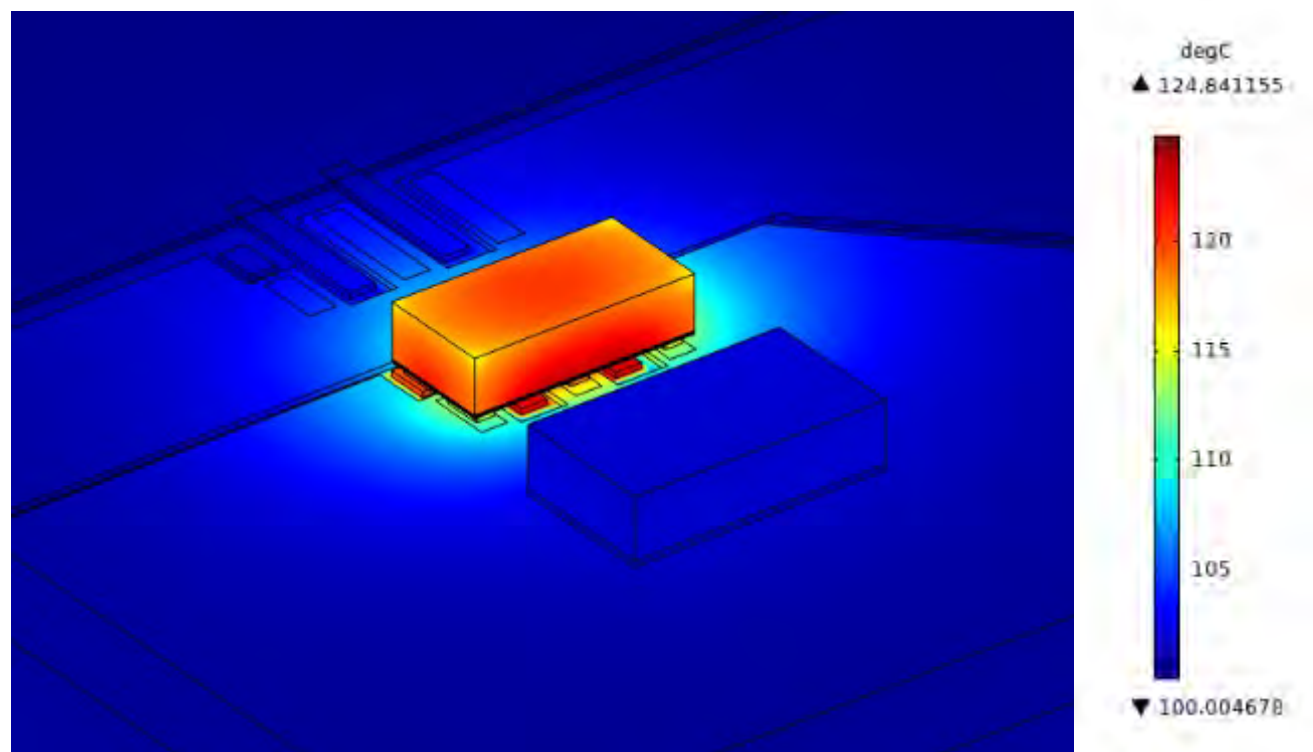
- 间隙填充材料的导热性为3.6 W/m K 、距离散热器的间距为0.3毫米
- 平均 T_J 为137.8° C 、散热器预设设在100° C

构建散热系统的几种方法



Option	Shim	Thickness	Filler	$R_{th(JS)}$ ($^{\circ}C/W$)	P_D (W @ $dT_{JS} = 25^{\circ}C$)
Baseline	No	0.3 mm max	3.6 W/mK	6.3	4.0
1	Yes	0.3 mm max	3.6 W/mK	6.1	4.1
2	No	0.2 mm max	3.6 W/mK	5.4	4.6
3	No	0.3 mm max	6 W/mK	4.6	5.4
4	Yes	0.2 mm max	6 W/mK	3.9	6.4

最优的散热系统 - 4 mm²、3.9 ° C/W @ 6 W

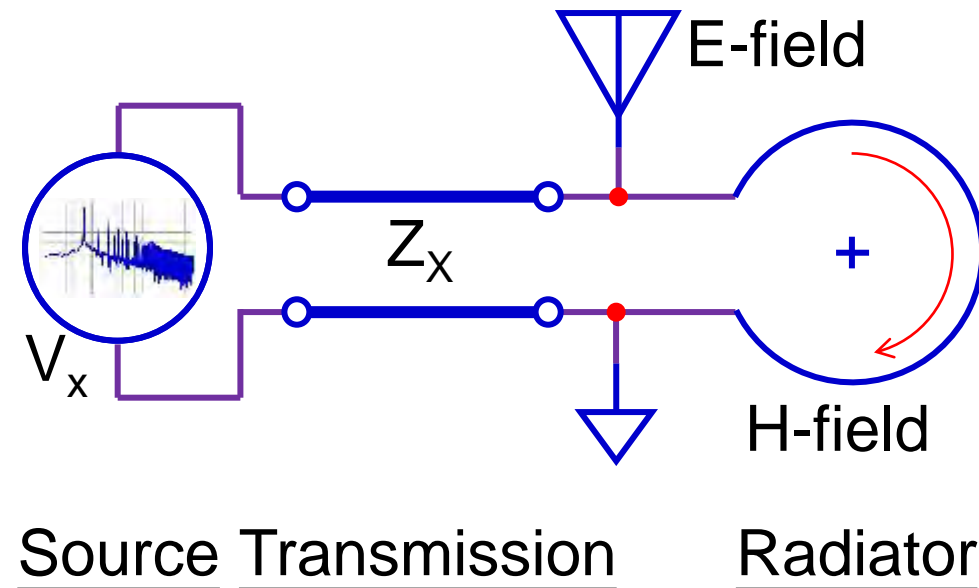


- 1.5 毫米 x 3 毫米 x 0.7 毫米尺寸的散热垫片、使用 6 W/mK 的间隙填充材料、距离散热器的间距为0.2 毫米
- 平均 T_J 为123.4 ° C、散热器预设设在100 ° C

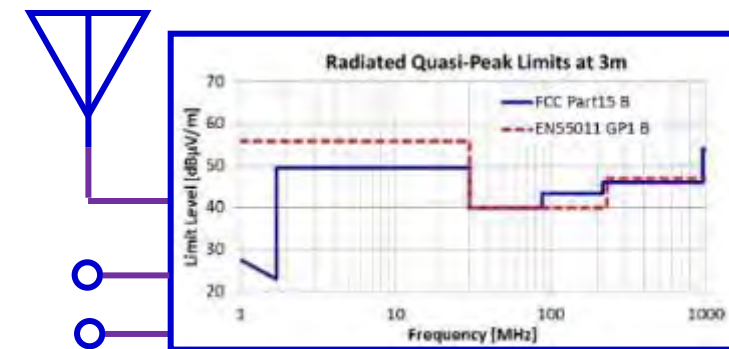
关于EMI的考虑因素

- EMI系统概述
- 布局的影响
- 上升沿/下降沿时间的影响
- 反向恢复的影响

EMI 系统概述



Radiated
or
Conducted
→



Receiver

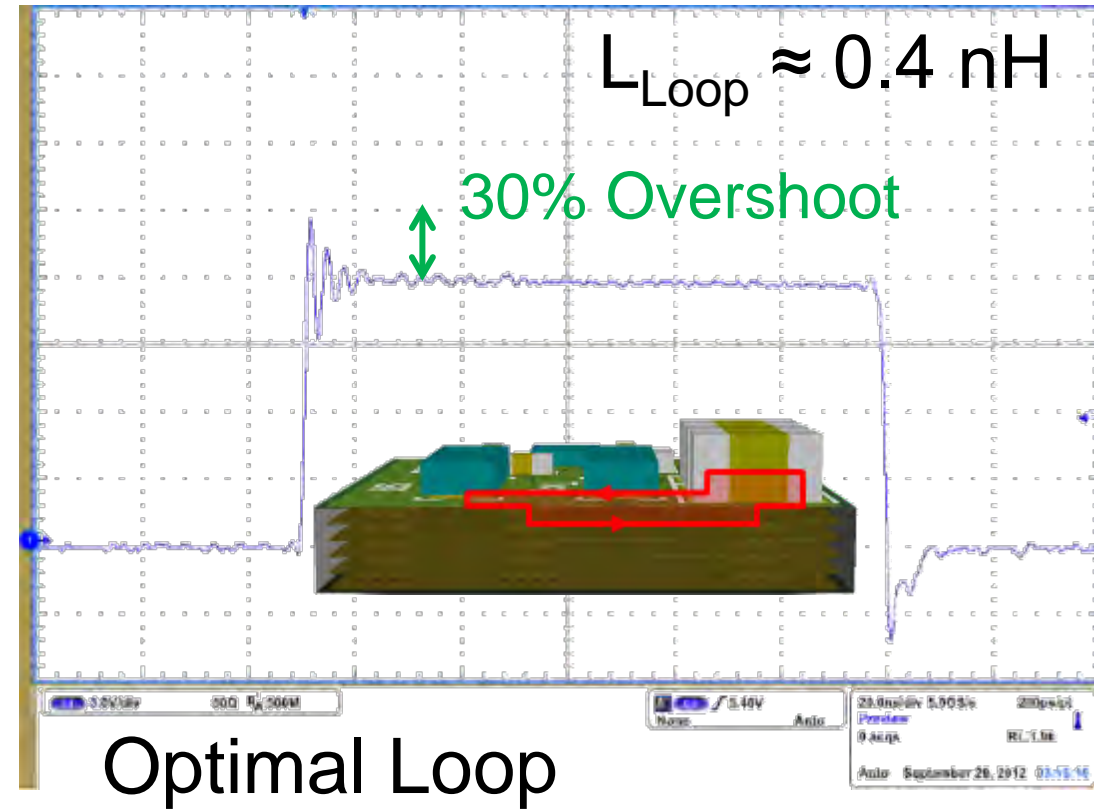
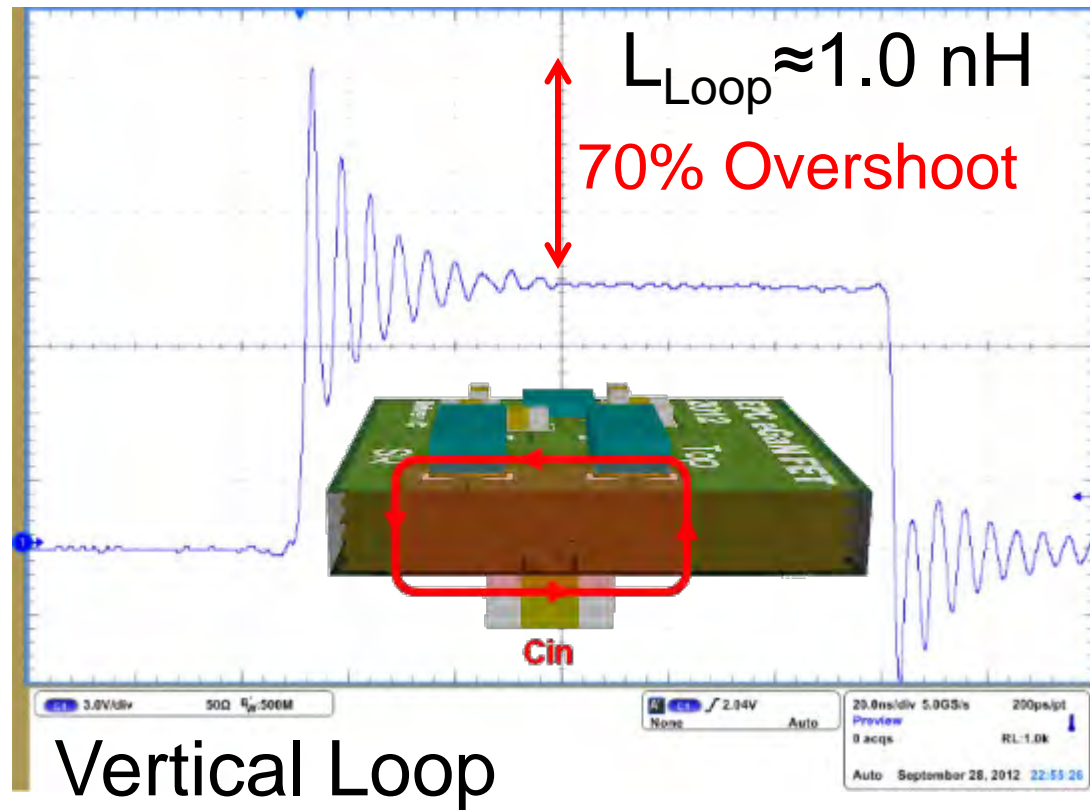
- 电路损坏
- 受EMI标准规范

← 减少EMI的成本下降

布局对过冲的影响

EMI energy \propto to:

- V^2 of overshoot magnitude \rightarrow E-field
- I^2 of current in power loop \rightarrow H-field



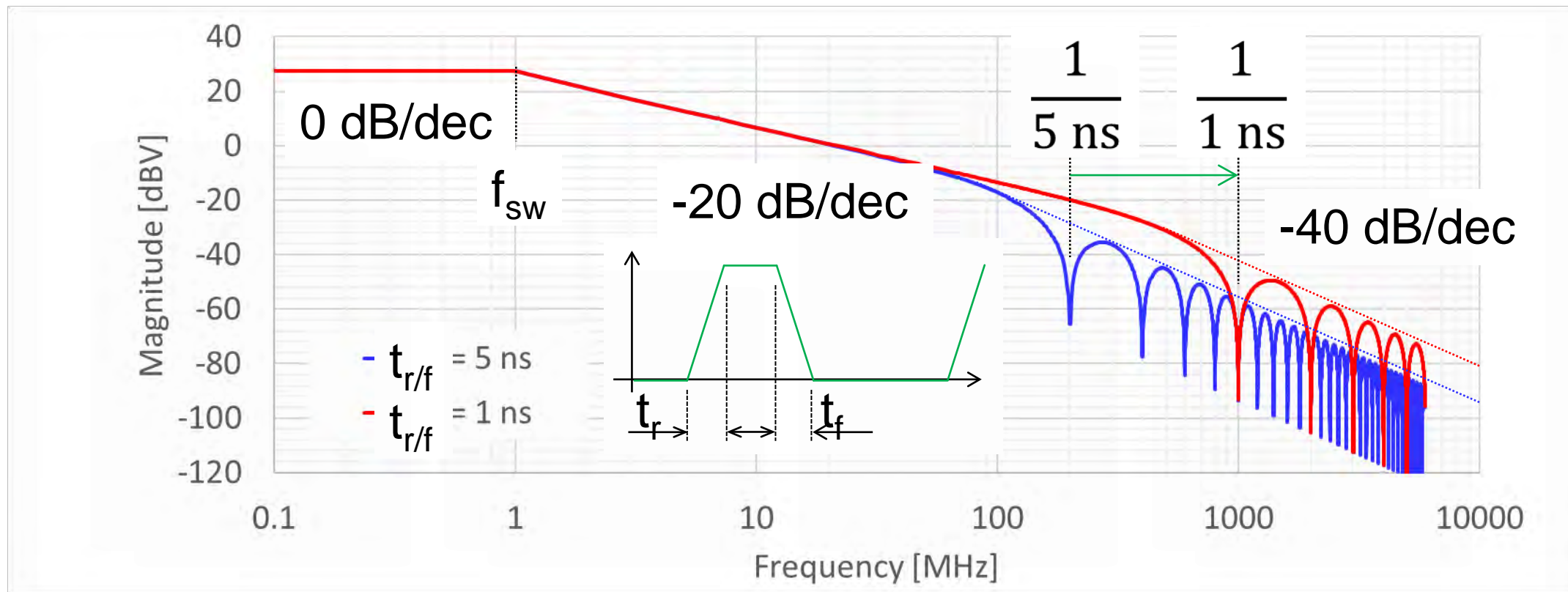
D. Reusch, J. Strydom, "Understanding the Effect of PCB Layout on Circuit Performance in a High Frequency Gallium Nitride Based Point of Load Converter," Applied Power Electronics Conference, APEC 2013, pp. 649–655, 16–21 March 2013.

上升沿/下降沿时间的影响

降压转换器开关节点：

- $V_{IN} = 48\text{ V}$, $V_{OUT} = 12\text{ V}$, $f_{SW} = 1\text{ MHz}$
- 不包括电压过冲和振铃
- 开关节点主要以电场E-field辐射

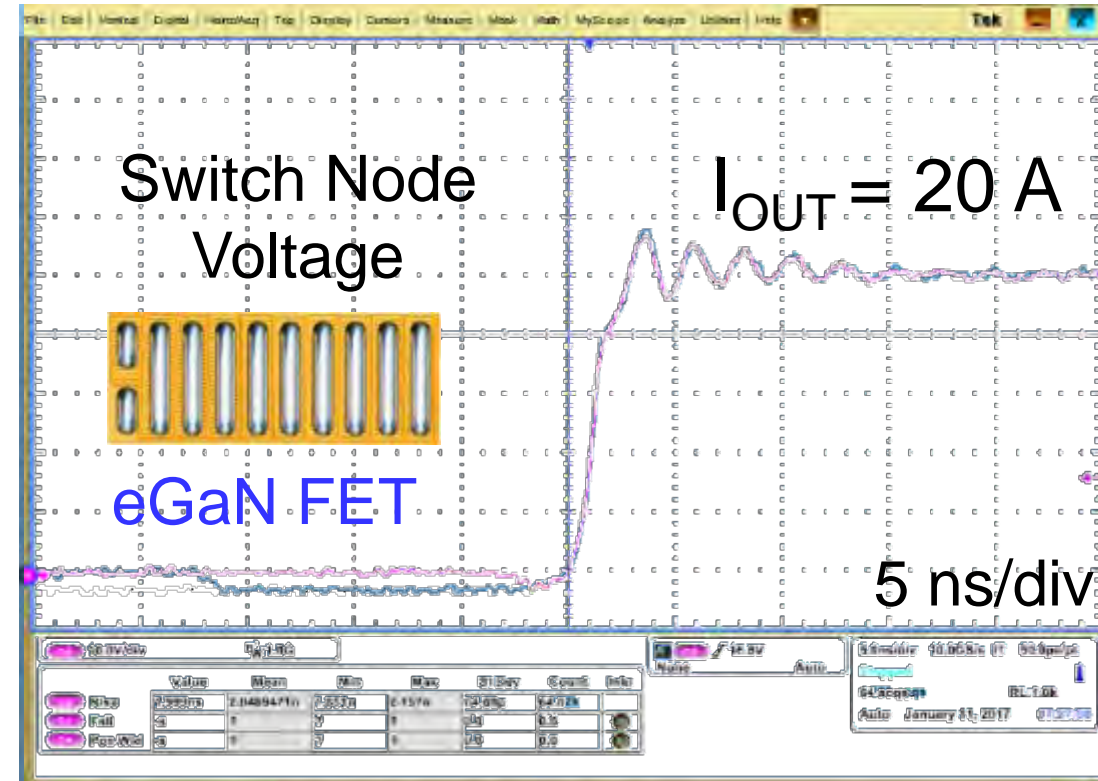
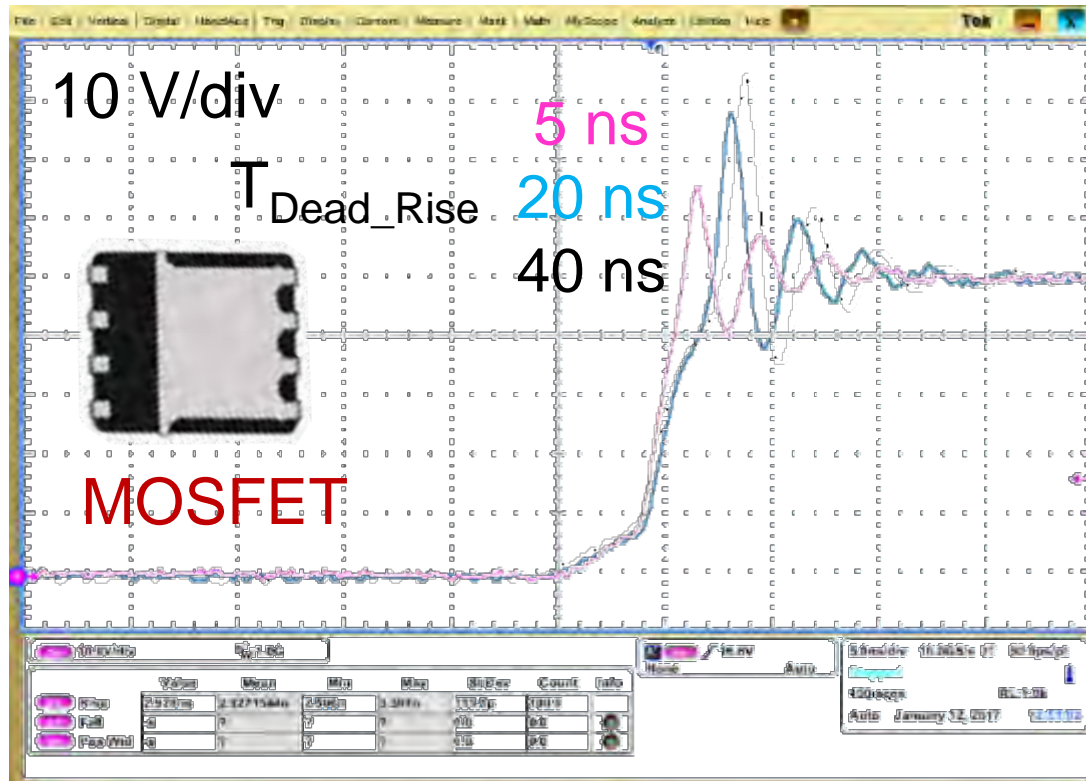
eGaN[®] FET
开关更快



<https://incompliancemag.com/article/spectra-of-digital-clock-signals/>

反向恢复的影响 (Q_{RR})

- Q_{RR} = 功率环路的击穿 (shoot-through)
- EMI与反向恢复电流的 I^2 成正比
- eGaN FET 没有反向恢复 Q_{RR}



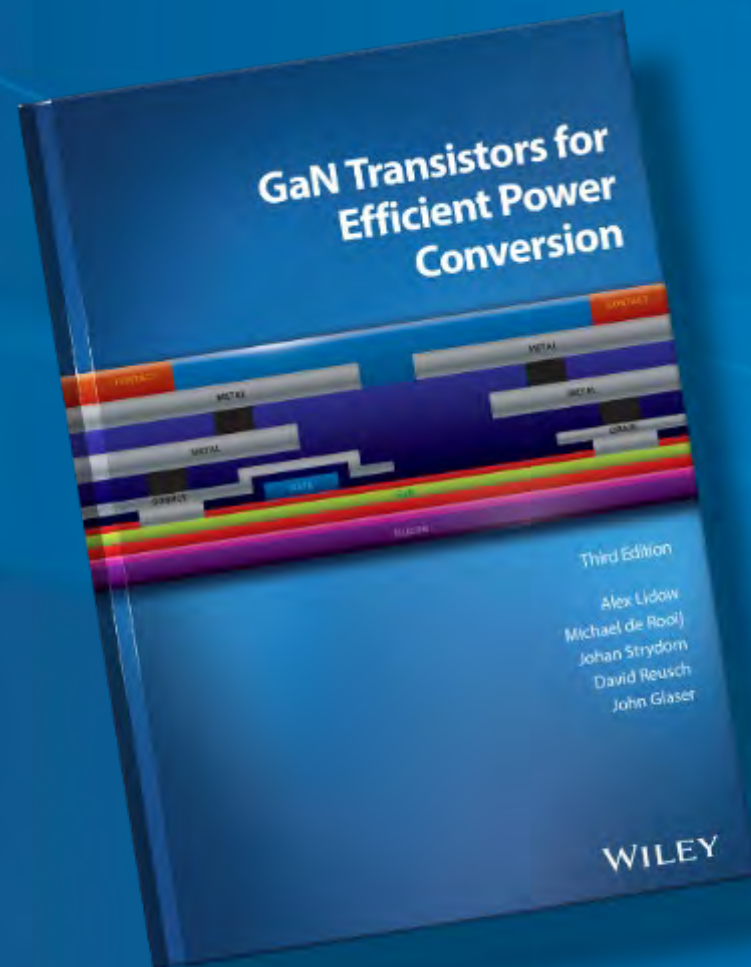
Glaser, J. S. & Reusch, D., "Comparison of deadtime effects on the performance of DC-DC converters with GaN FETs and silicon MOSFETs," 2016 IEEE Energy Conversion Congress and Exposition (ECCE), 2016.

- 通过简单的布局技巧可以降低EMI
- 较短的开关时间会改变频率和降低EMI
- 零反向恢复会产生更少的EMI

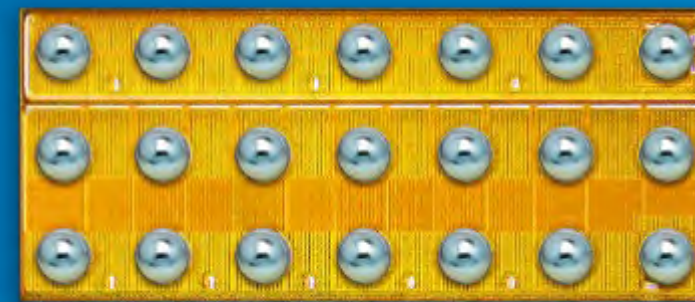
- 栅极驱动 - 不断强大的生态圈
- 布局 - 提高效率
- PCB 设计 - 可靠及具有高良率的组装
- 散热管理 - 简单、不昂贵
- eGaN FET的EMI比MOSFET更低!



How To GaN Video Series

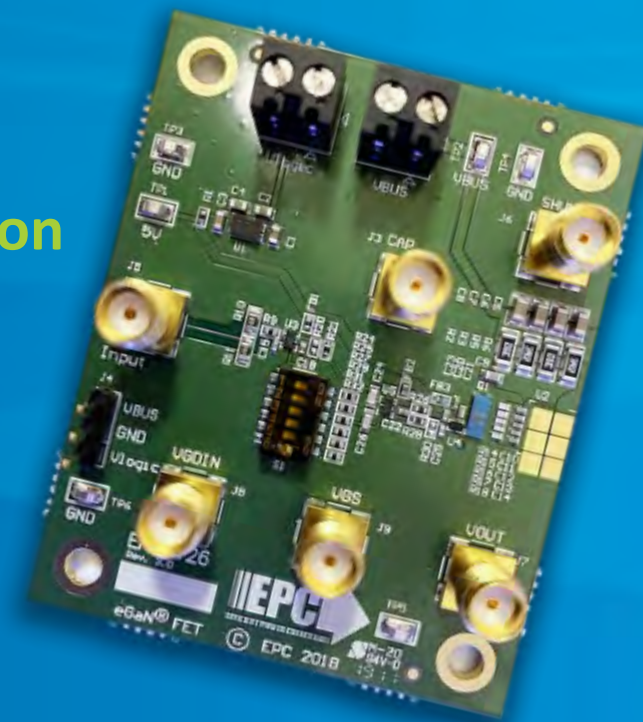


3rd Edition Textbook



eGaN[®] FETs and ICs

Evaluation Kits



epc-co.com

关注微信 - EPC宜普电源转换



成为我们的粉丝，紧贴宜普的最新动向！

