Thermal Design of a PCB

TI Precision Labs – Motor Drivers

Presented and prepared by:

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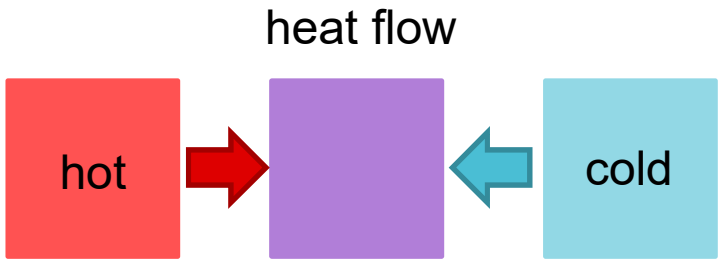
We will learn

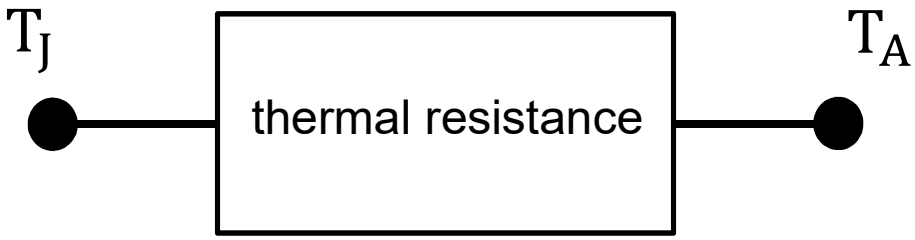
- The importance of proper heat regulation
- Methods
  - Strategic PCB layout
  - Via farms
  - Dog bones
  - Heat sinks

Heat flow

- Heat is trying to reach equilibrium with the room temperature
- Data sheets include thermal information and calculations

$$T_J = (P_D \times \theta_{JA}) + T_A$$

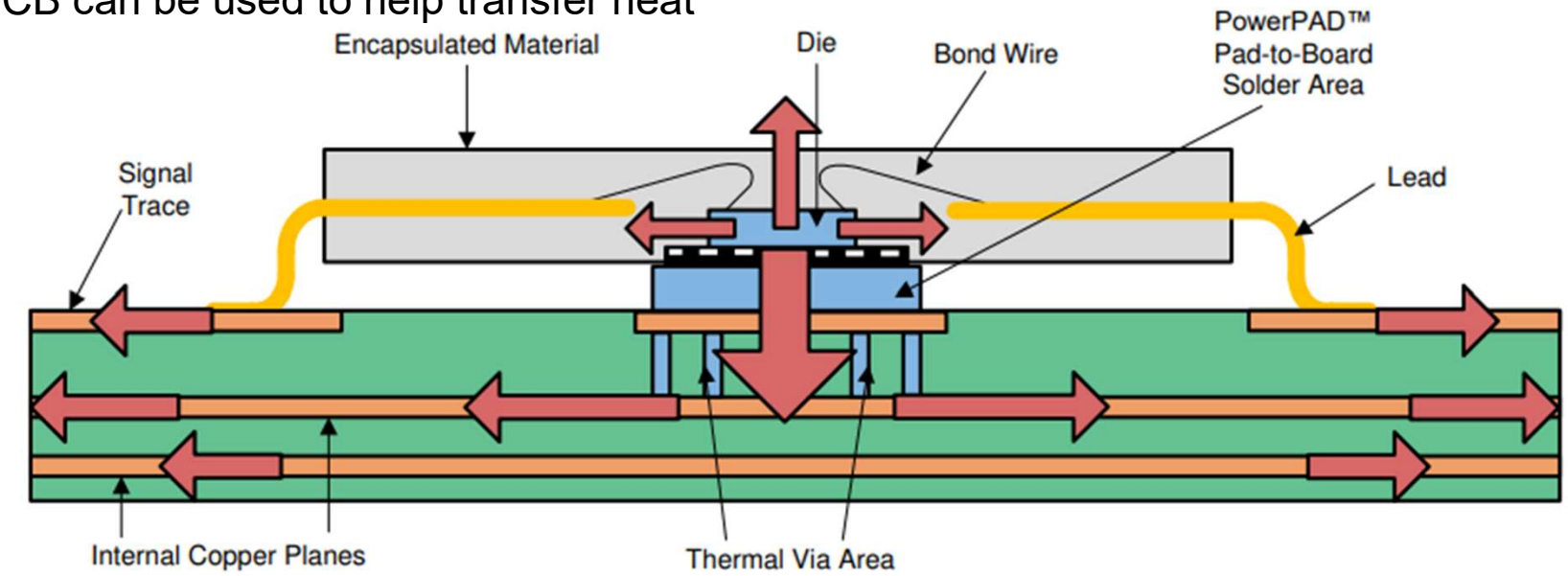




TI training: 5.3 Thermal dynamics: https://training.ti.com/thermal-dynamics?context=1147983-1148063-1148066

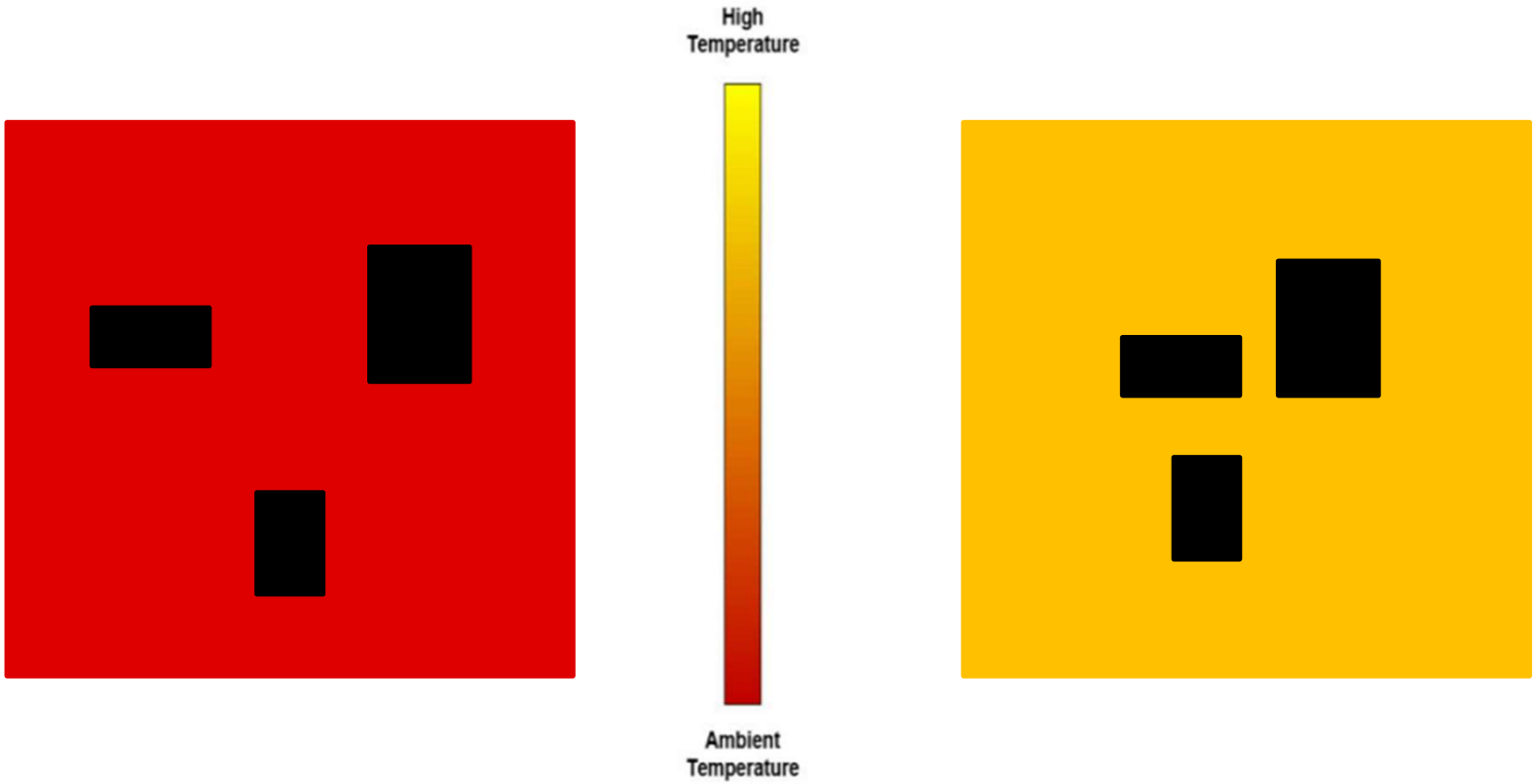
PCB heat distribution

- Identify major heat sources [i.e. drivers, microcontrollers, etc]
- PCB can be used to help transfer heat



PowerPAD™ Thermally Enhanced Package App Note:
https://www.ti.com/lit/an/slma002h/slma002h.pdf?ts=1658425063570&ref_url=https%253A%252F%252Fwww.google.com%252F

Device placement and heat concentration



DRV8899 data

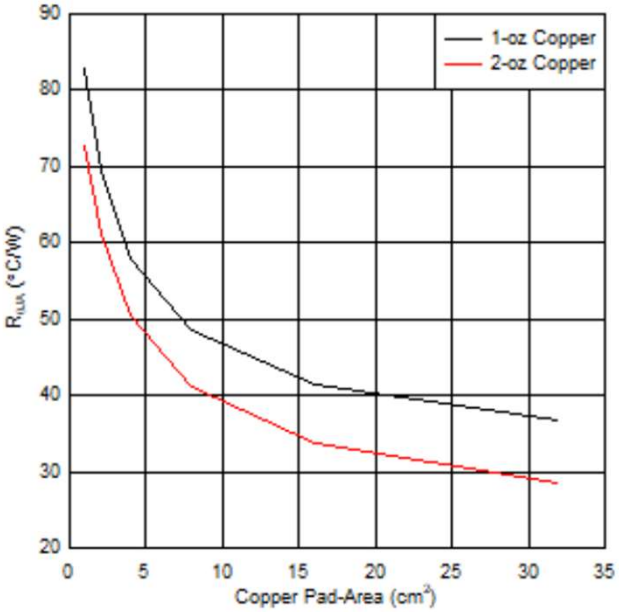


Figure 8-12. 2-Layer PCB Junction-to-Ambient Thermal Resistance ($R_{\theta JA}$) vs Copper Area

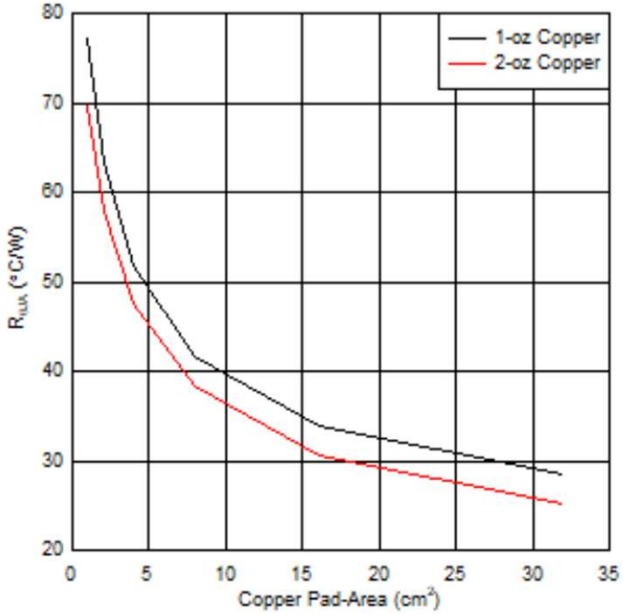
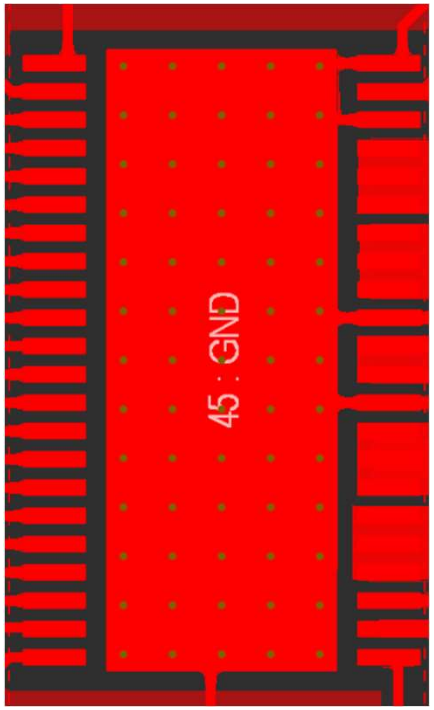


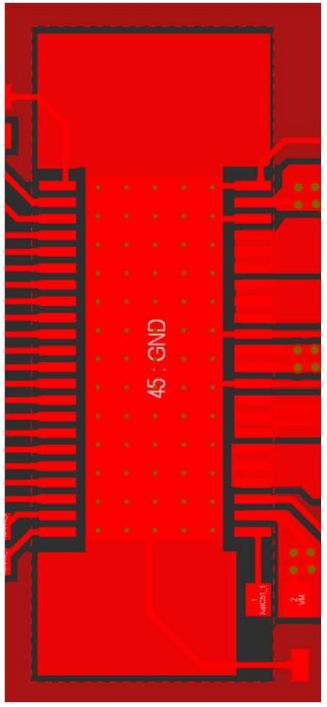
Figure 8-14. 4-Layer PCB Junction-to-Ambient Thermal Resistance ($R_{\theta JA}$) vs Copper Area

Ground pours

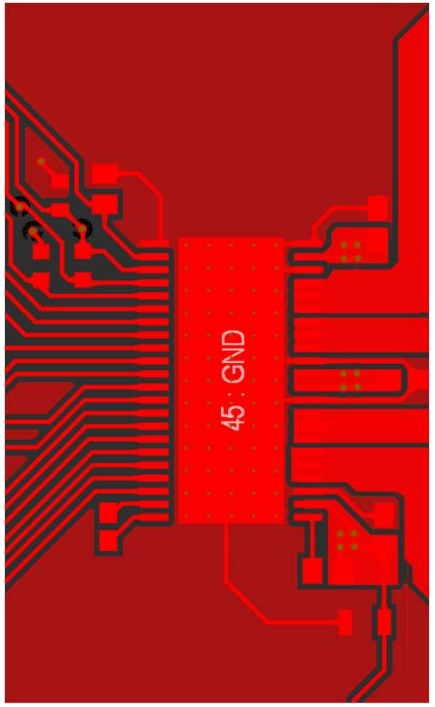
worst



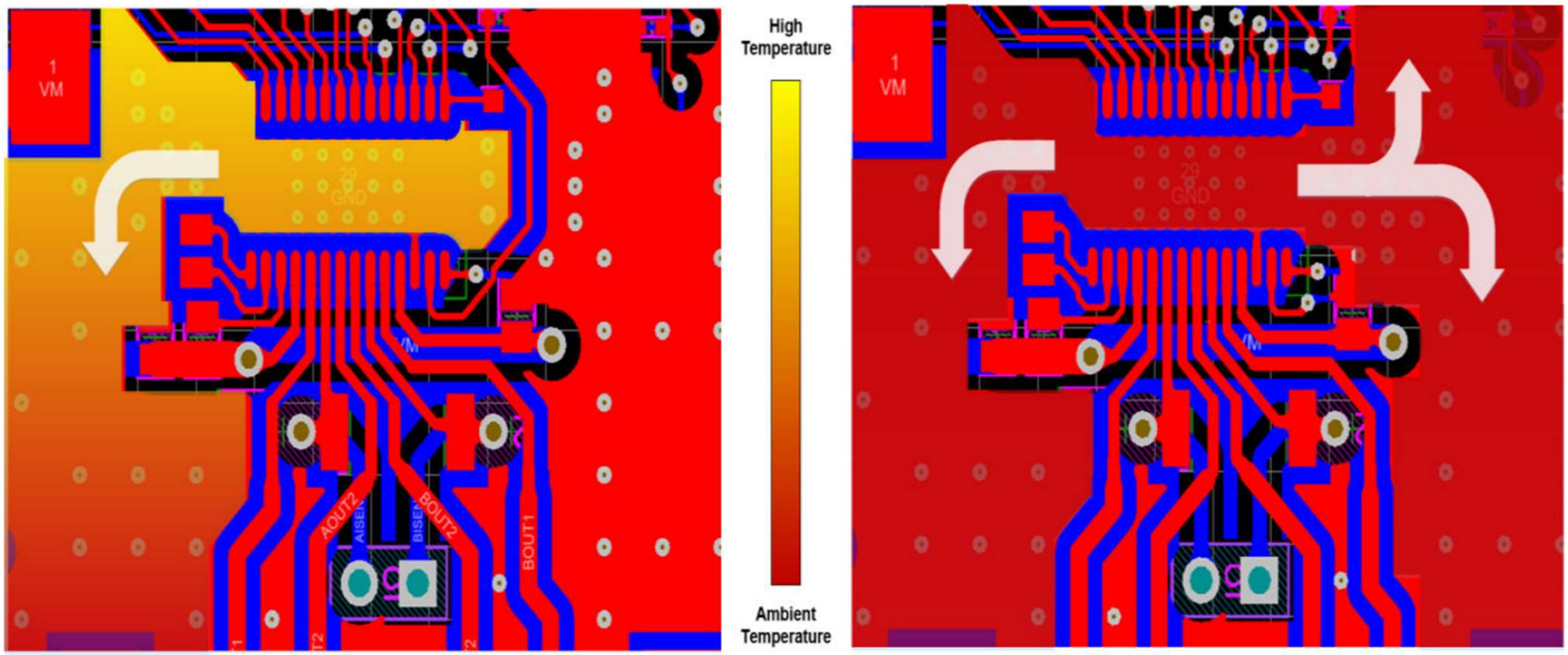
better



best



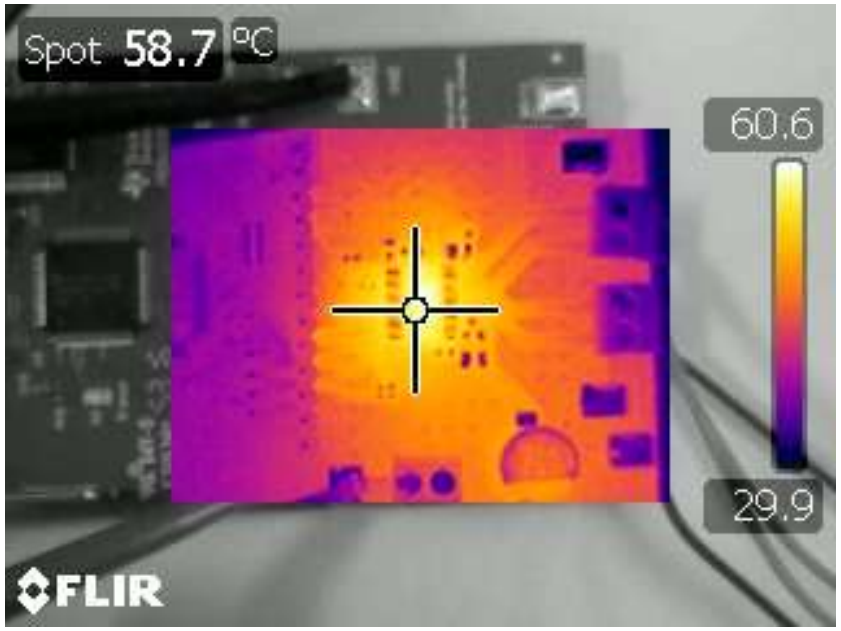
Ground pours on both sides



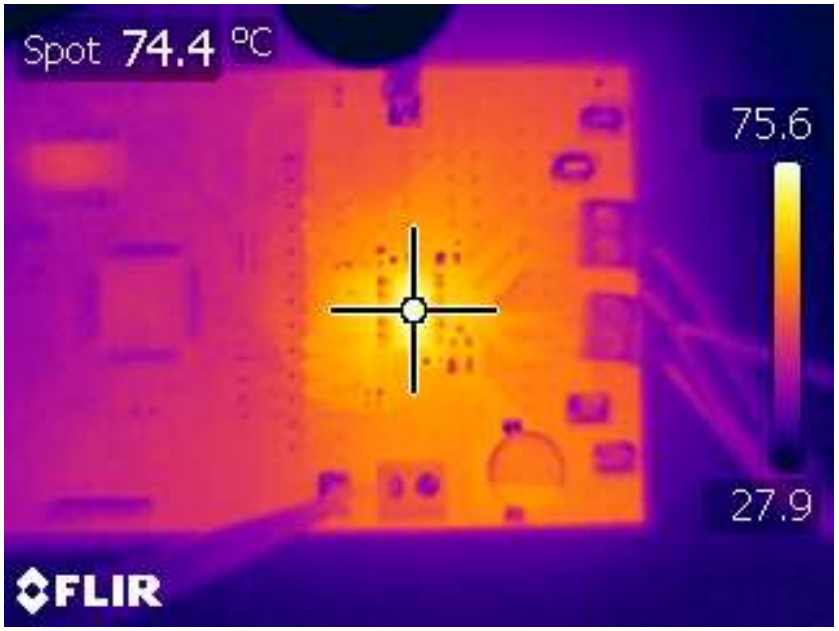
Best Practices for Board Layout of Motor Drivers:
https://www.ti.com/lit/an/slva959b/slva959b.pdf?ts=1658420607773&ref_url=https%253A%252F%252Fwww.google.com%252F

Ground pours 8V

Continuous

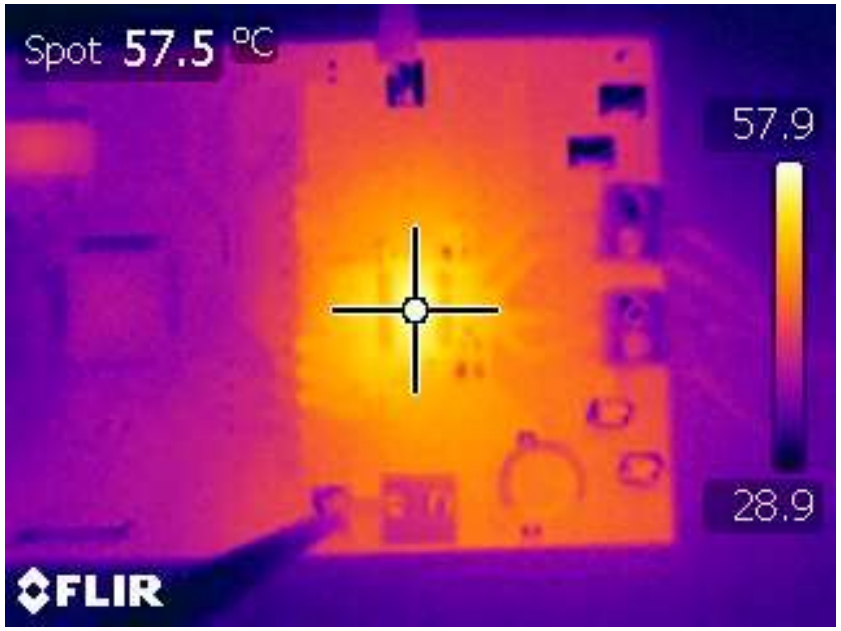


Broken / isolated

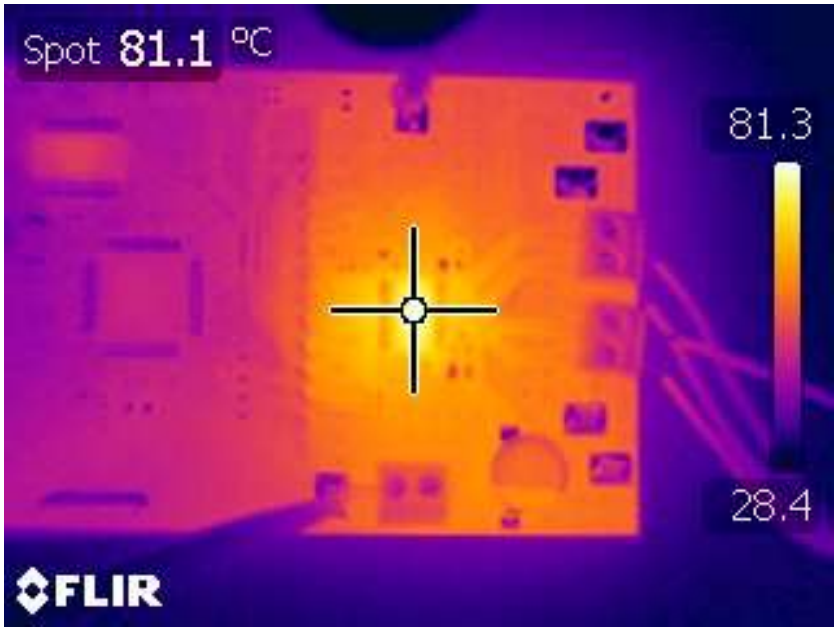


Ground pours 25V

Continuous

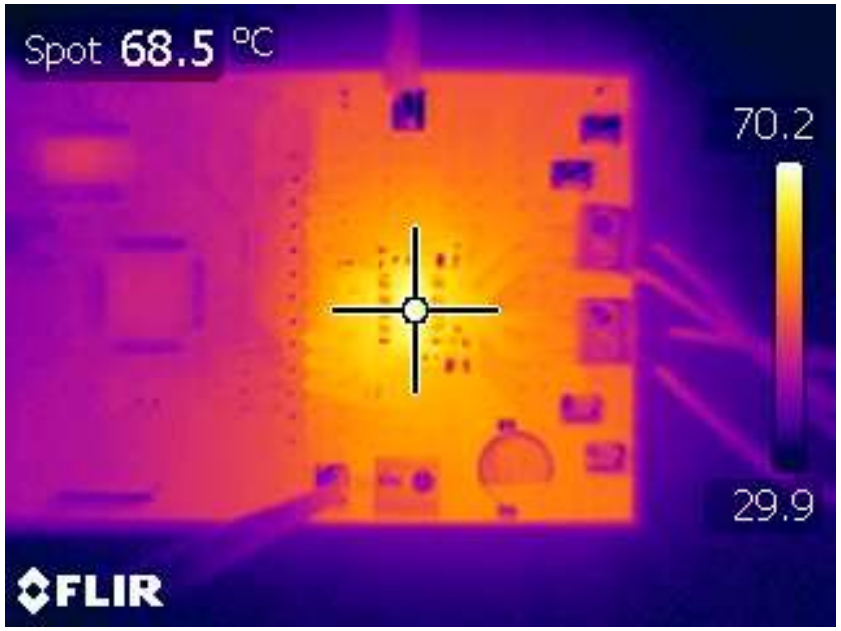


Broken / isolated



Ground pours 37V

Continuous



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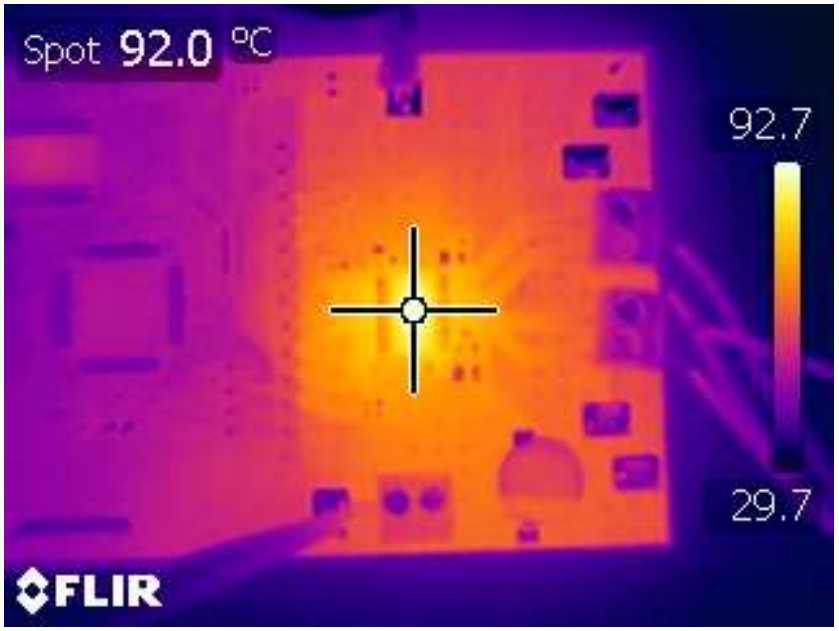
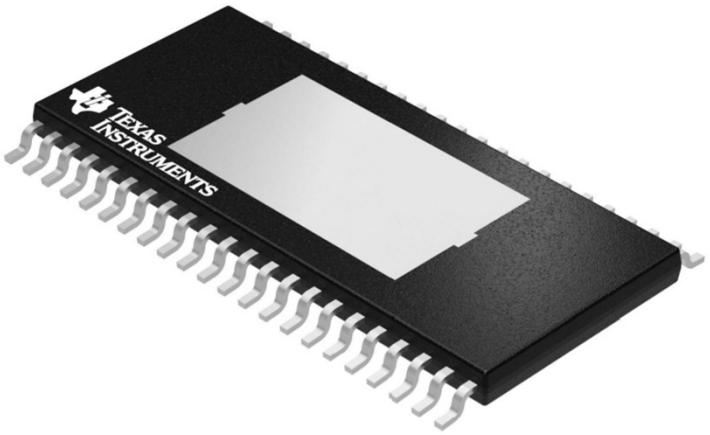
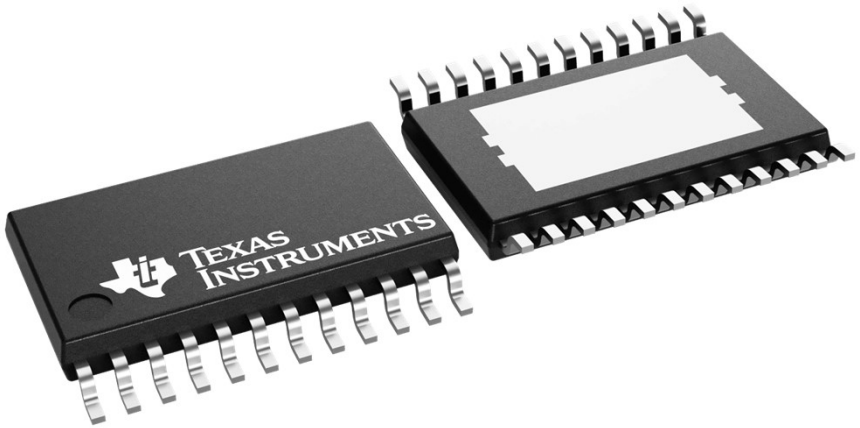


Thermal pads

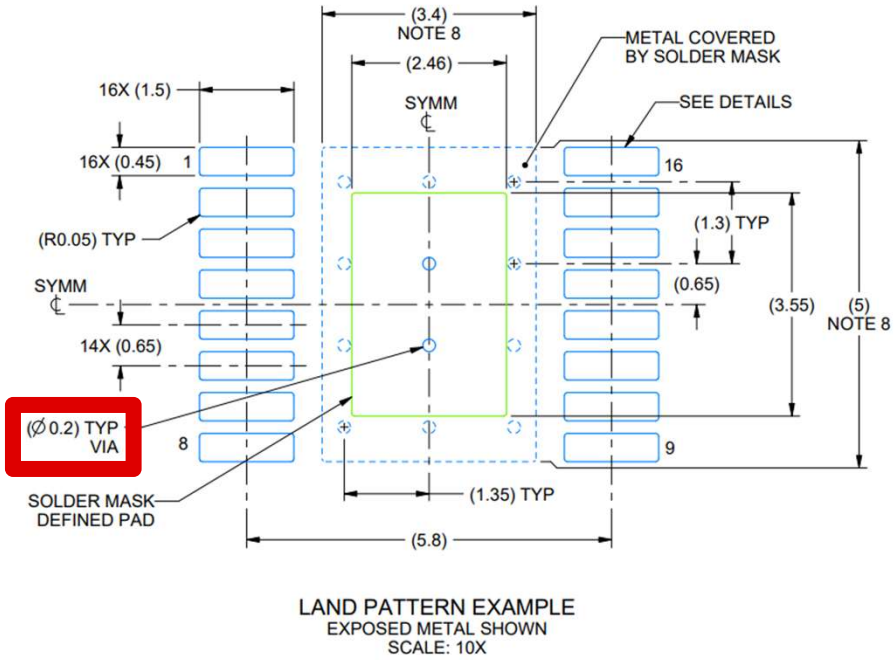
- Exposed thermally conductive material
- Can be above or below device depending on the package



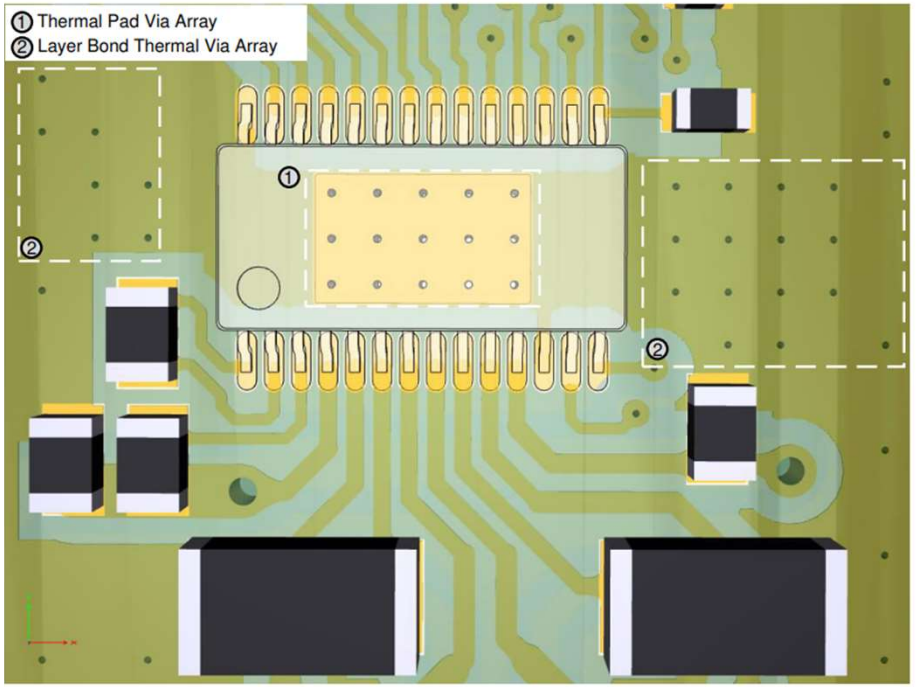


Via farms

DRV8874



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



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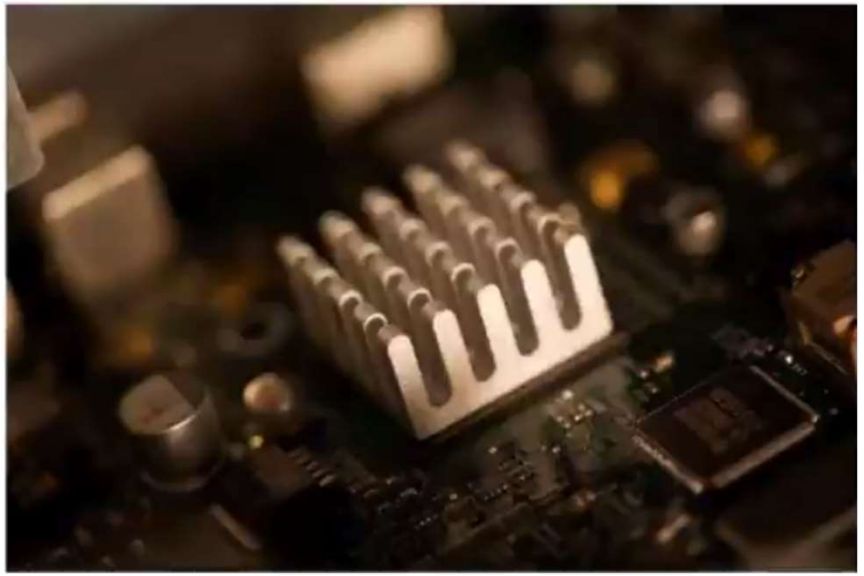
Heat sink

- Thermally conductive metal
- Cut to maximize surface area for better heat transfer
- Commonly used with top-side thermal pads but can be used for bottom-side
- Heat sink drawing



TI training: 5.4 Heat sinks and isolation: https://training.ti.com/heat-sinks-and-isolation?context=1147983-1148063-1148067

Key takeaways

- Always have heat in mind
- Common methods to use
  - Strategic PCB layout
  - Via farms
  - Dog bones
  - Heat sinks