One-Page Thermal Reference Sheet, Revised Sept 2013

Thermal Calculations

Measuring parts on a PCB:

Using Case temperature → $T_J = T_C + Power * \psi_{JT}$

Estimating Tj for a new design (options):

Using PCB temperature → $T_J = T_B + Power * \Psi_{JB}$

System thermal modeling

PCB calculator

2R or Delphi model

Approximations based on existing device/system

Where:

Tj= Junction Temp: max for performance, reliability, etc.

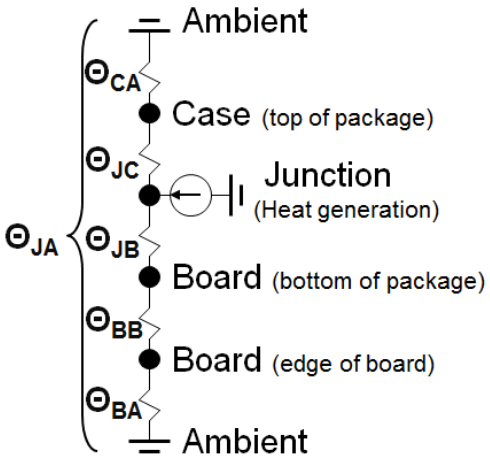
Tc= Case Temperature (measured)

Power: estimated or measured power

Psi-JT/Ψ_{JT}: Thermal delta, device to case/top, in system

Psi-JB/Ψ_{JB} :Thermal delta, device to PCB, in system, near device

Thermal Path

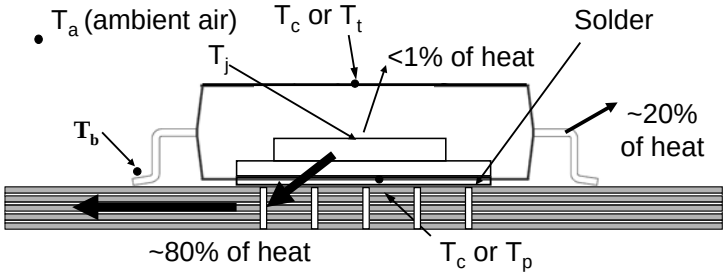


Note: In the equivalent electrical circuit:
Power (W) = Current (A)
Δ Temperature (C or K) = Voltage Drop (V)
Thermal Resistance (C/W) = Resistance (Ω)
ΔT = PΘ is the equivalent of ΔV = IR

Useful Links:

- www.ti.com/thermal
- **TI Apps note:** SPRA953A
- **PCB Apps note:** SLMA002
- **TI E2E Community**
- **JEDEC JESD51 Specs**

Thermal "Nodes" and Typical Heat Flow



Description and Use of Common Terms:

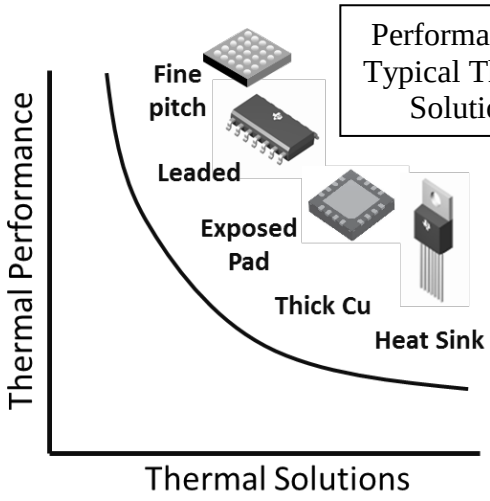
Theta-JA: (Tj – Ta) / Power. Defined by JEDEC 51-2A. Unique for each device. For comparison of devices and/or packages in a standardized environment. Not for calculation of Tj.

Theta-JA,effective: Non-JEDEC custom environment, such as EVM or specific end application.

Theta-JC,top: (Tj – Tc) / Power. True thermal resistance to top of part. Only used with a heat sink.

Psi-JT: (Tj – Tc) / Power. Measurement parameter. Used to calculate Tj based on a measured Tc.

Theta-JB/Psi-JB: (Tj – Tb) / Power. Resistance or measurement parameter based on board temperature. Useful for early estimates of a new part in a known end application.



System Thermal Enhancements

- Spread out hot devices on PCB
- Maximize GND layer in PCB
- No breaks in heat flow through planes
- Increase PCB layers or thickness
- Widen PCB traces near device
- PCB vias under or near device
- System air vents near to device
- Airflow (global and local)
- Heat sink (individual, group, chassis)
- Gap filler material up to chassis

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