

Thermal model for a TO-220 package.

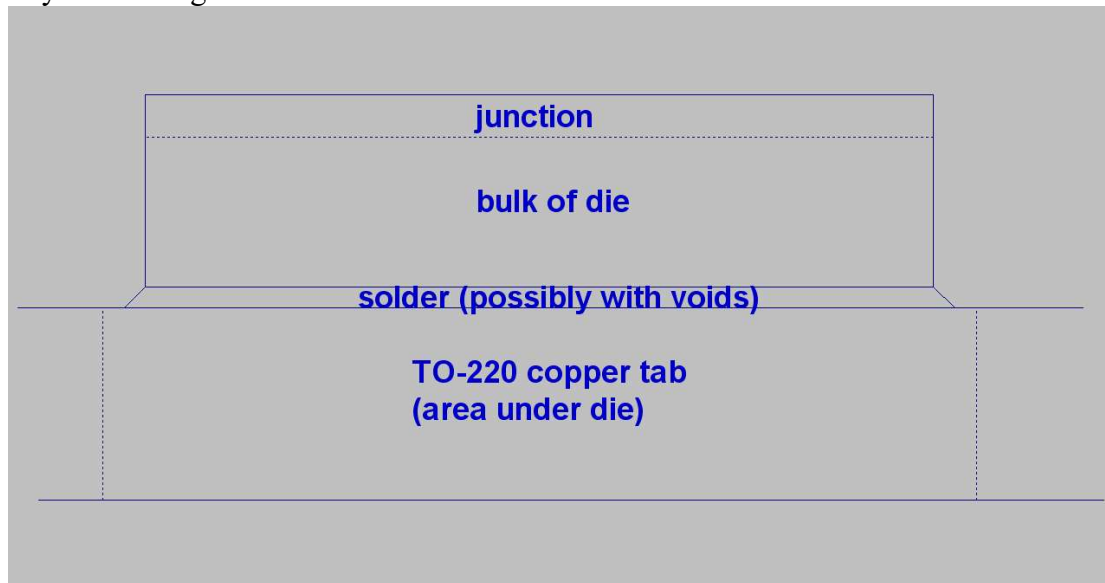
note that

from TO-220 metal tab to heatsink

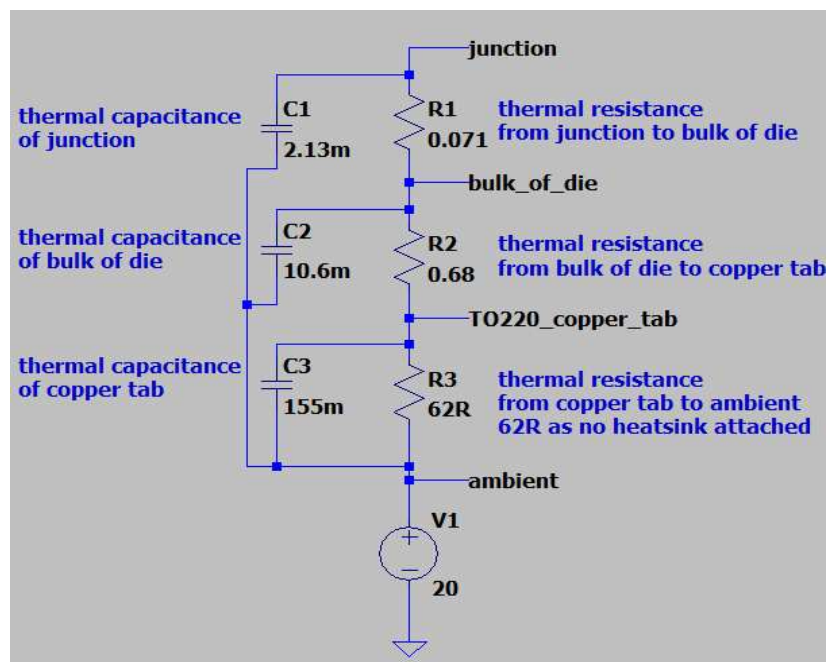
(ie thermal resistance of a silpad or similar insulator)

6 C/W is from the sil-pad 400 datasheet, for a TO-220 size area and 25psi applied pressure, and the 0.007 inch thickness material.

Physical arrangement



equivalent cct.



assumptions

the die thickness is taken as 0.30mm.

die size is taken as 5x5mm.

calculations

Thermal capacitance of junction.

Under avalanche conditions IR use a value of 320mJ/150degC = 2.13mJ/degC.

This roughly equates to the top 0.05mm of a 5x5mm silicon die.

Thermal resistance from junction to bulk of die.

$R = (1/\sigma) \times \text{half die thickness} / \text{die area}$

$= (1/84) \times 0.15 \times 10^{-3} / 25 \times 10^{-6} = 0.071$

Thermal capacitance of the bulk of the die

The volume of silicon is $5 \times 5 \times 0.25 \text{ mm}^3 = 6.25 \text{ mm}^3$

Mass of silicon = $2400 \text{ kg/m}^3 \times 6.25 \times 10^{-9} = 15 \times 10^{-6} \text{ kg}$

Thermal capacity = $710 \times 15 \times 10^{-6} = 10.6 \text{ mJ/degC}$

Thermal resistance from bulk of die to copper tab

This is taken as the worst case 0.75 junction to case value of the datasheet less the 0.07 junction to bulk silicon value calculated above. This 0.75 resistance is high as it will have an allowance for solder voiding which may cause heat conduction along the die.

Thermal capacitance of copper tab

The volume of copper is $6 \times 6 \times 1.25 \text{ mm}^3 = 45 \text{ mm}^3$

Mass of copper = $8930 \text{ kg/m}^3 \times 45 \times 10^{-9} = 402 \times 10^{-6} \text{ kg}$

Thermal capacity = $385 \times 402 \times 10^{-6} = 155 \text{ mJ/degC}$

thermal resistance from TO-220 metal tab to heatsink

I have chosen to use a silpad-400 thermally conductive electrical insulator.

(note that newer more thermally conductive materials are now available.)

6 C/W is from the sil-pad 400 datasheet, for a TO-220 size area,

25psi applied pressure, and using the 0.007 inch thickness material.

then the 20C/Watt thermal resistance from the heatsink to ambient is for a typical small TO-220 heatsink.

Note that if you don't use a heatsink then the thermal resistance from copper tab to ambient is about 60C.

This is taken as the package to ambient in free air from a TO-220 device datasheet.