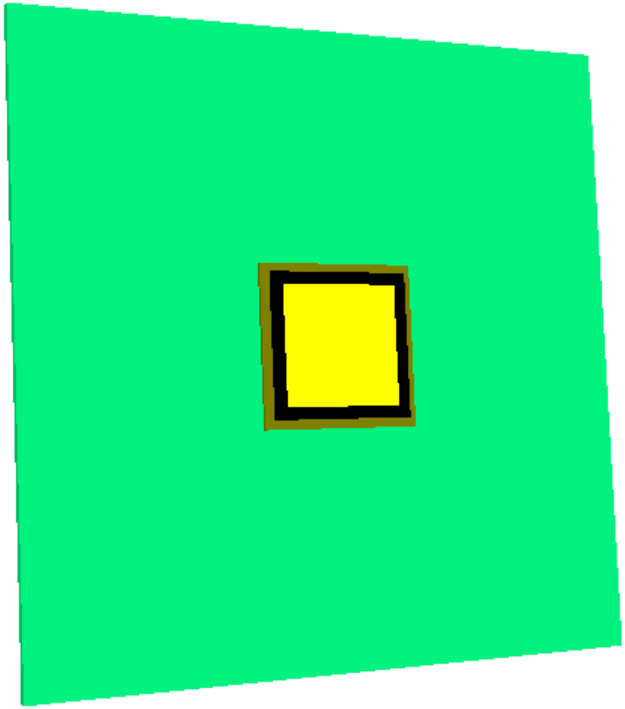
Thermal Modeling for 292L TE-PBGA on JEDEC std and Typical Customer PCB

Problem Description

The power consumption of device ADC10D1500 in the package 292L TE-PBGA is up to 4W. So, its thermal performance is of concern. The purposes of the thermal simulation are as follows:

1. To obtain the typical thermal data, i.e., Theta JA on 4L JEDEC board, and Theta JC with case at package top and at package bottom thermal balls.
2. To simulate the thermal performance of the package on a typical customer board.
3. To find out the conditions (airflow and heat sink) needed to meet the thermal requirement of the package in application (This is added and done after reviewing the results of purpose 1 and 2.).

Thermal Model of 292L TE-PBGA on 4-layer JEDEC Board



Simplification in the model:

1: circular heat spread is simplified as a square shape.

2: thermal vias in substrate and PCB are lumped as a block.

3: bonding wires are replaced with effective block.

Package information are as follows:

Package size: 27x27mm

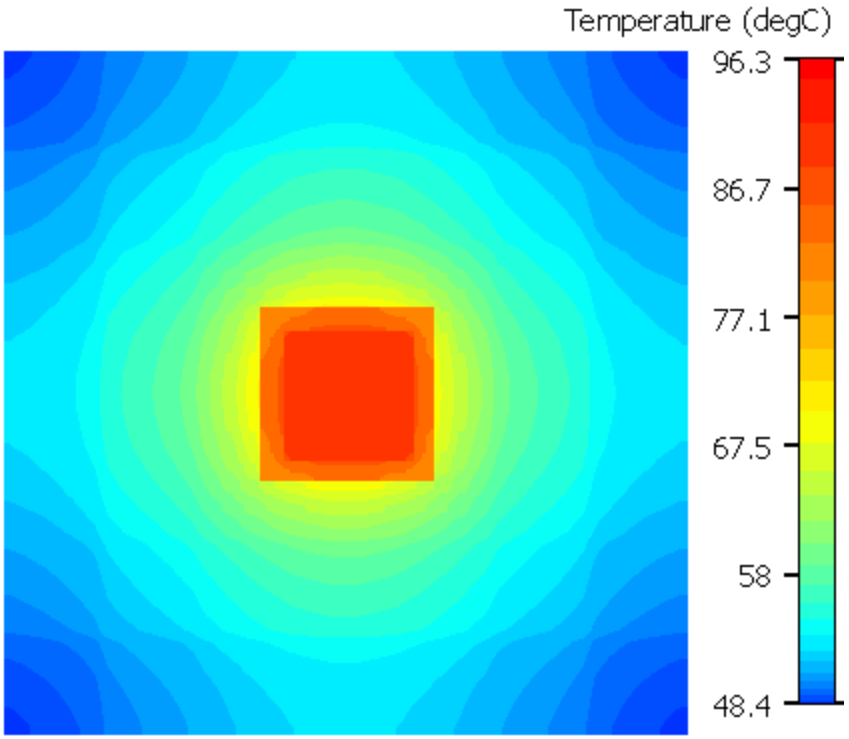
Power: 4W

Mold compound: CEL-9750HF10F-H

Die attach material: 2100A

substrate has 7x7 thermal vias underneath die

Theta JA of 292L TEPBGA on 4-Layer JEDEC Board



Temperature Plots

4-layer JEDEC board:

Size: 4x4 inches

Thickness: 1.6mm

Top and bottom layers for traces

2nd layer is power plane with 1oz thick

3rd layer is ground plane with 1oz thick

Environment condition:

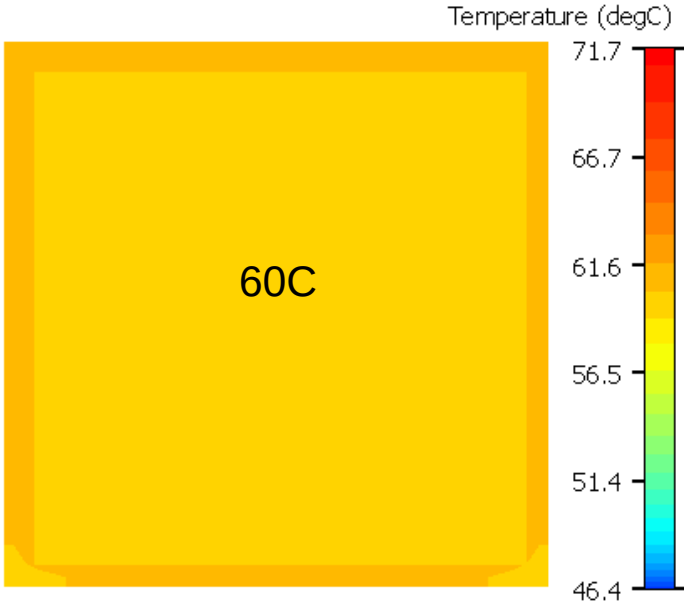
Ambient temp 25C and natural convection

Results of simulation:

Die temp: 96.3

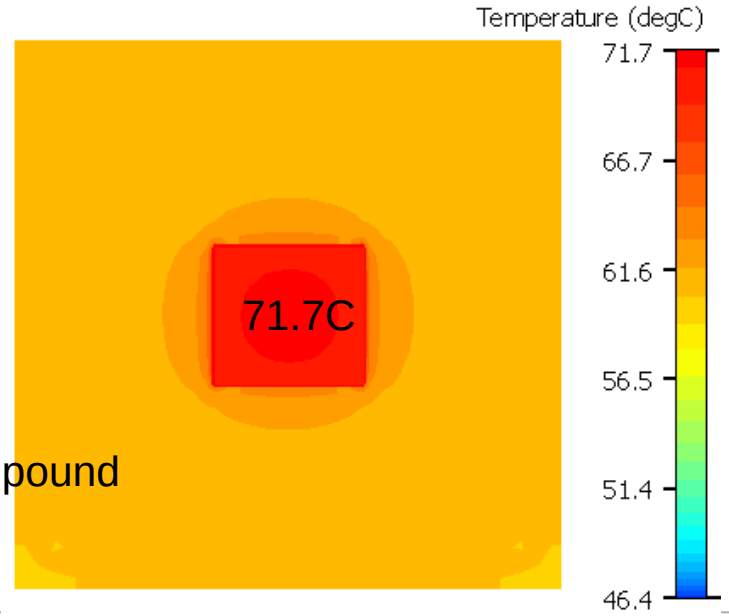
Theta JA =(96.3-25)/4=17.8C/W

Theta JC of 292L TEPBGA



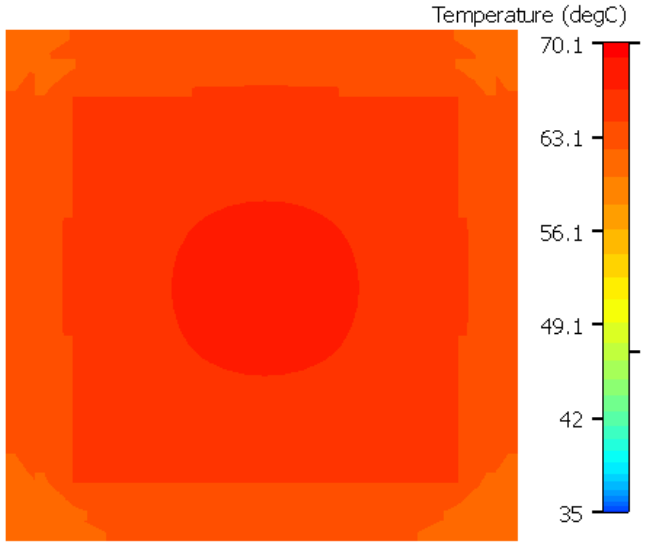
Theta JC on top = (71.7-60)/4=2.9C/W

Package top is set at 60C when modeling Theta JC on top



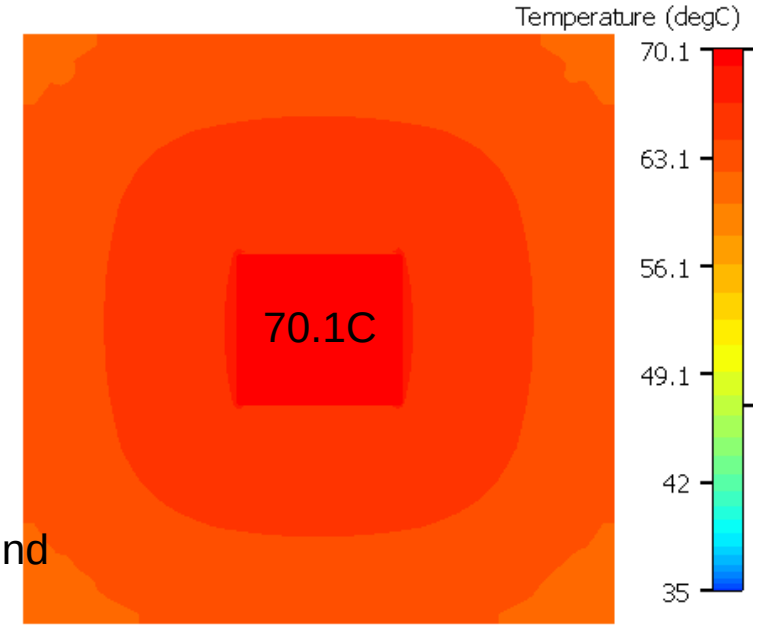
Temp plot where mold compound removed to see die temp

Theta JC of 292L TEPBGA



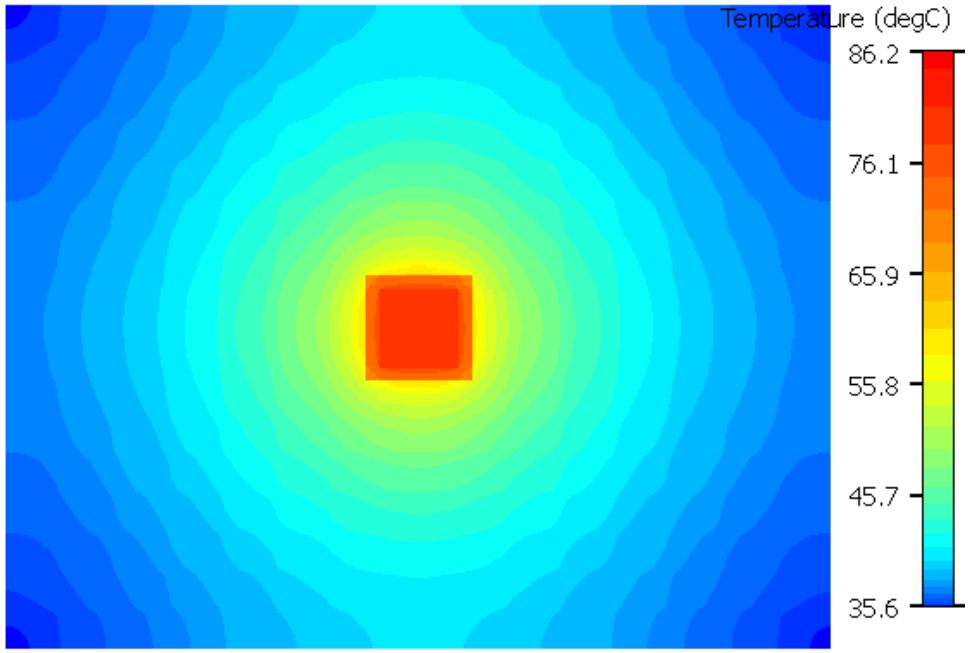
Theta JC on bottom = (70.1-60)/4=2.5C/W

Package bottom is set at 60C when modeling Theta JC on bottom



Temp plot where mold compound removed to see die temp

Theta JA of 292L TEPBGA on A Customer Board



Temperature Plots

10-layer customer board:

Size: 8.25x6.46 inches

Thickness: 1.6mm

Layer stack showed in following slide

Environment condition:

Ambient temp 25C and natural convection

Results of simulation:

Die temp: 86.2

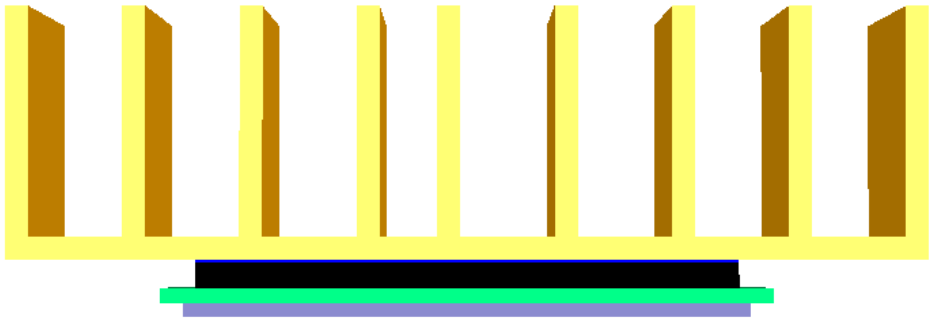
Theta JA =(86.2-25)/4=15.3C/W

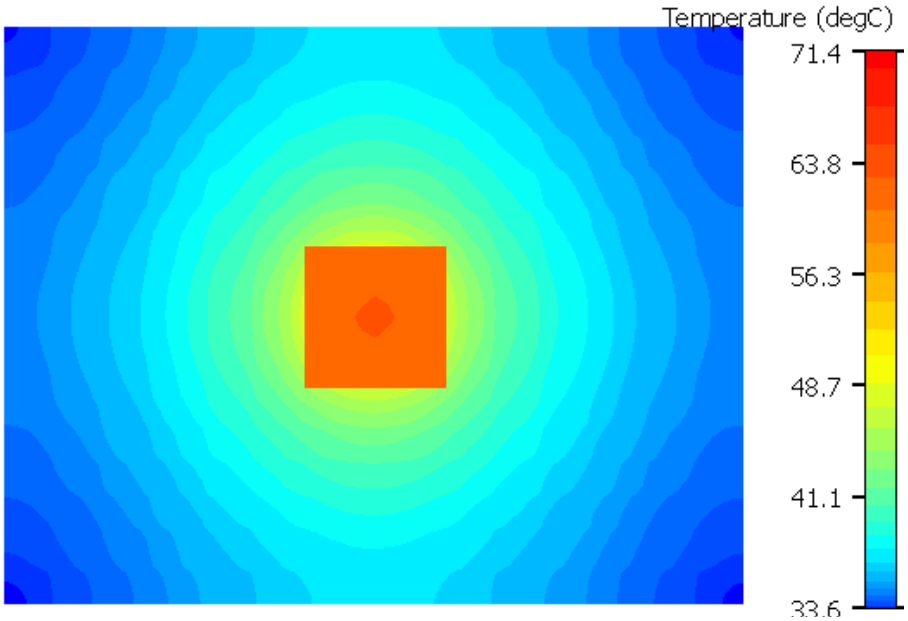
10 Layer Stack of A Customer Board

Layer	Typical Usage	Typical/ Minimum Track- Width	Basematerial: FR4	Thickness (mm after pressing)
			Soldermask	**0.020**
L01	**TOP-Signal**	**0,15mm**	**Copper Foil - 35µ**	**0.050**
			3 X *Prepreg - 106*	*0.150*
L02	**GND-Plane**		**Copper - 18 µm**	**0.018**
			Core - 150µ/18µ	*0.150*
L03	**Signal**	**0,1mm**	**Copper - 18 µm**	**0.018**
			3 X *Prepreg - 106*	*0.150*
L04	**Power-Plane**		**Copper - 18 µm**	**0.018**
			Core - 150µ/18µ	*0.150*
L05	**GND-Plane**		**Copper - 18 µm**	**0.018**
			3 X *Prepreg - 106*	*0.150*
L06	**Signal**	**0,1mm**	**Copper - 18 µm**	**0.018**
			Core - 150µ/18µ	*0.150*
L07	**Power-Plane**		**Copper - 18 µm**	**0.018**
			3 X *Prepreg - 106*	*0.150*
L08	**Signal**	**0,1mm**	**Copper - 18 µm**	**0.018**
			Core - 150µ/18µ	*0.150*
L09	**GND-Plane**		**Copper - 18 µm**	**0.018**
			3 X *Prepreg - 106*	*0.150*
L10	**BOTTOM-Signal**	**0,15mm**	**Copper Foil - 35µ**	**0.050**
			Soldermask	**0.020**
			Thickness after pressing Cu - Cu:	**1.594**
			Total Thickness after pressing (+/-10%):	**1.634**

Theta JA of 292L TEPBGA on A Customer Board

w/ heat sink , w/o airflow





Temperature Plots

Heat Sink:

Size: 40x40x10mm

10-layer customer board:

Size: 8.25x6.46 inches

Thickness: 1.6mm

Layer stack showed in following slide

Environment condition:

Ambient temp 25C and natural convection

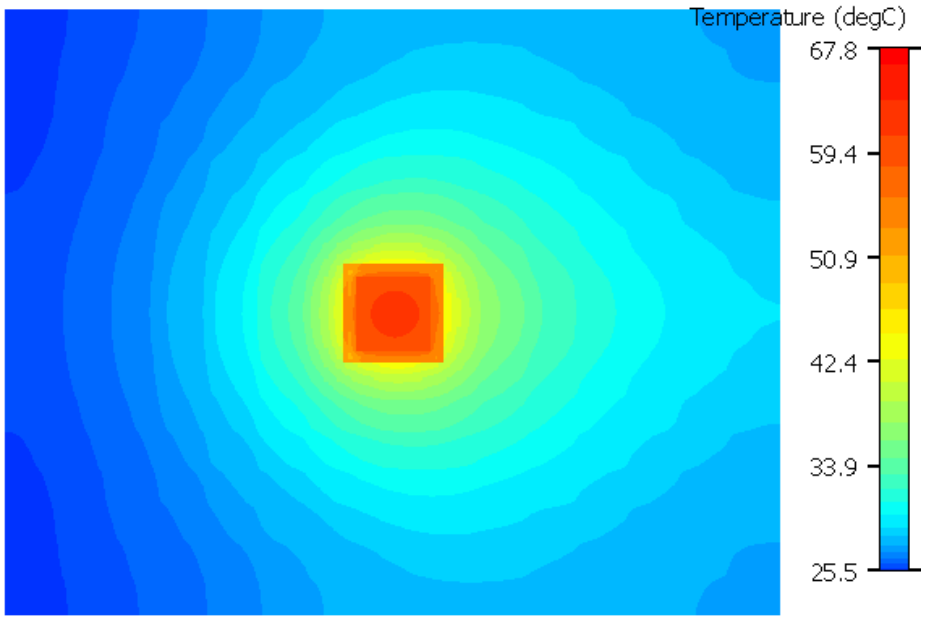
Results of simulation:

Die temp: 71.4

Theta JA =(71.4-25)/4=11.6C/W

Theta JA of 292L TEPBGA on A Customer Board

w/o heat sink , w/ airflow



Temperature Plots

10-layer customer board:

Size: 8.25x6.46 inches

Thickness: 1.6mm

Environment condition:

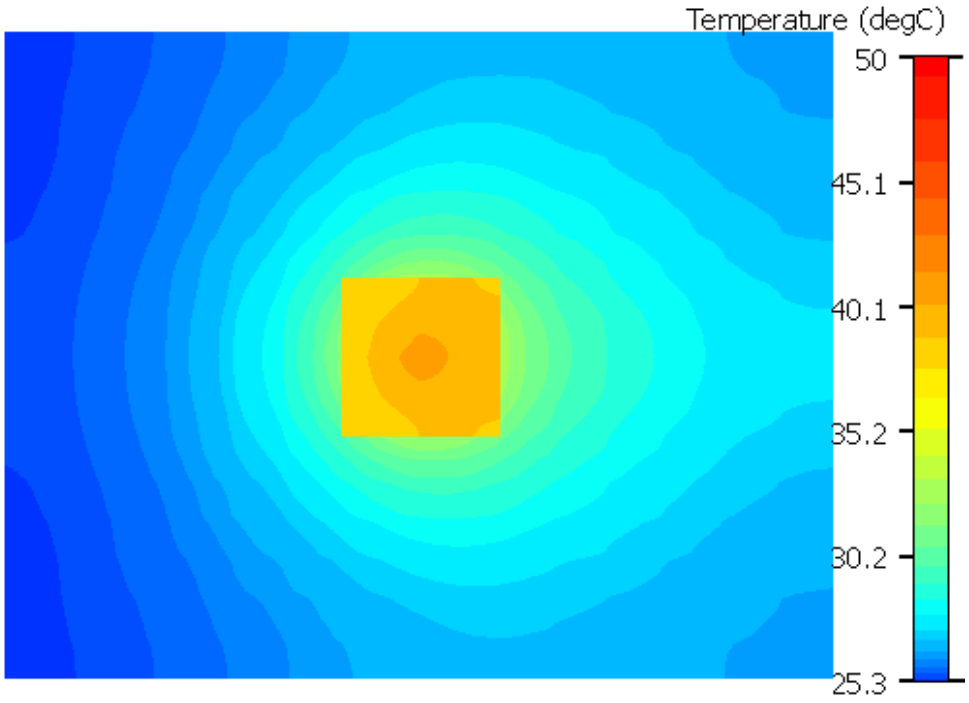
Ambient temp 25C and 1m/s forced airflow

Results of simulation:

Die temp: 67.8

Theta JA =(67.8-25)/4=10.7C/W

Theta JA of 292L TEPBGA on A Customer Board
w/ heat sink and w/ airflow (1m/s)



Temperature Plots

10-layer customer board:

Size: 8.25x6.46 inches

Thickness: 1.6mm

Environment condition:

Ambient temp 25C and 1m/s forced airflow

Results of simulation:

Die temp: 50.0

Theta JA =(50.0-25)/4=6.25/W

Summary of Simulation Results

Thermal data of 292L TE-PBGA:

Theta JA (C/W)	PCB	Airflow	Heat sink
17.8	4-layer JEDEC	natural convection	no
15.3	10-layer custom	natural convection	no
11.6	10-layer custom	natural convection	yes
10.7	10-layer custom	1m/s forced airflow	no
6.25	10-layer custom	1m/s forced airflow	yes

Theta JC on top: 2.9C/W

Theta JC on bottom: 2.5C/W