# Heat Sink Calculator
# Version 1.0

Heat Sink Model
Steady Rans Simulation

Thu Dec 23 13:49:05 2010

*Product of CFDCalc*

http://www.cfdcalc.com

# Contents

# 1 Problem Description

Heatsink design is one of the most important part of electronic design. This report presents parametric heatsink solutions based on AcuSolve software suite for advanced CFD simulations. A series of test cases can be computed with multiple airflow simulations, at variour flow rates. The simulations can help you choose the best heatsink solution, whether hermal performance or a combination of factors such as cost, weight, or influence on the overall system pressure drop.

# 2 Model Setup

The geometry CAD files are created using

## 2.1 CAD Properties

In this section, you can see the CAD properties and views as well as an interactive view of the heat sink problem.
The following are the user input data for heat sink problem:

| | |
|---|---|
| Tunnel Dimensions: | 304.10 x 152.10 x 152.10 $mm^3$ |
| Board Dimensions: | 76.21 x 114.31 x 1.61 $mm^3$ |
| Chip Dimensions: | 12.10 x 12.10 x 1.10 $mm^3$ |
| Heat Sink Type: | Cross Cut |
| Heat Sink Dimensions: | 25.41 x 25.41 x 10.10 $mm^3$ |
| Heat Sink Base Height: | 2.10 mm |
| Fin X-Width: | 2.10 mm |
| Fin X-Gap: | 2.10 mm |
| Number of X-Fins: | 6 |
| Side X-Gap: | 1.16 mm |
| Fin Y-Width: | 2.10 mm |
| Fin Y-Gap: | 2.10 mm |
| Number of Y-Fins | 6 |
| Side Y-Gap: | 1.16 mm |
| Mesh Density: | Coarse |
| Package Theta JC: | 3.10 |
| Package Theta JB: | 3.10 |
| Fluid Material Model: | Air |
| Heat Sink Material model: | Copper |
| Board Layer Parameters: | [ 1.40000000e-03 9.90000000e+01] |
| Solution Cases, Air Speed: | [ 1.1 2.1 1.1] m/sec |
| Solution Cases, Temperature: | [ 293.25 293.25 313.25] K |
| Solution Cases, Chip Power: | [ 10.1 10.1 10.1] W |

### 2.1.1 CAD View

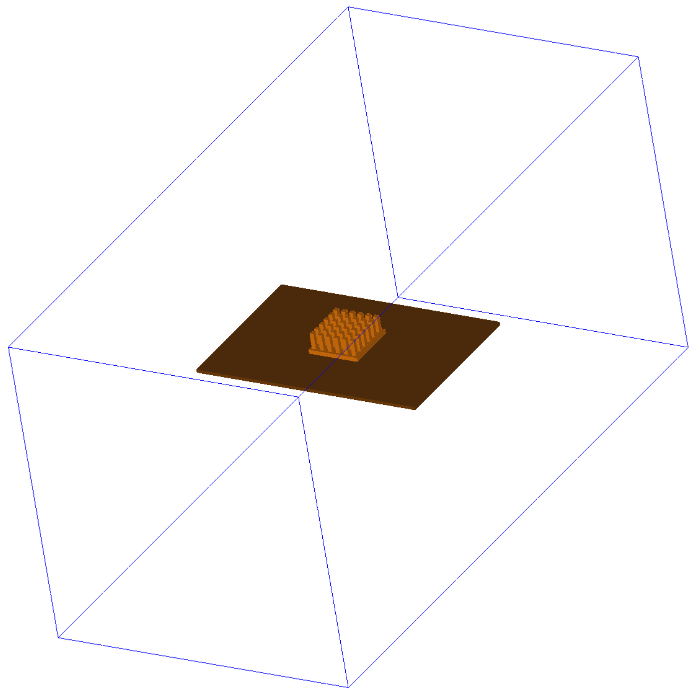


Figure 1: Isometric View

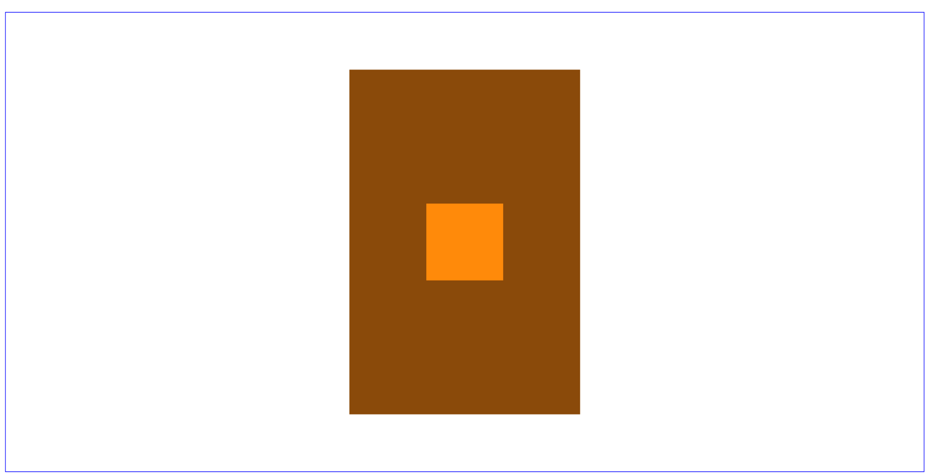


Figure 2: Top View

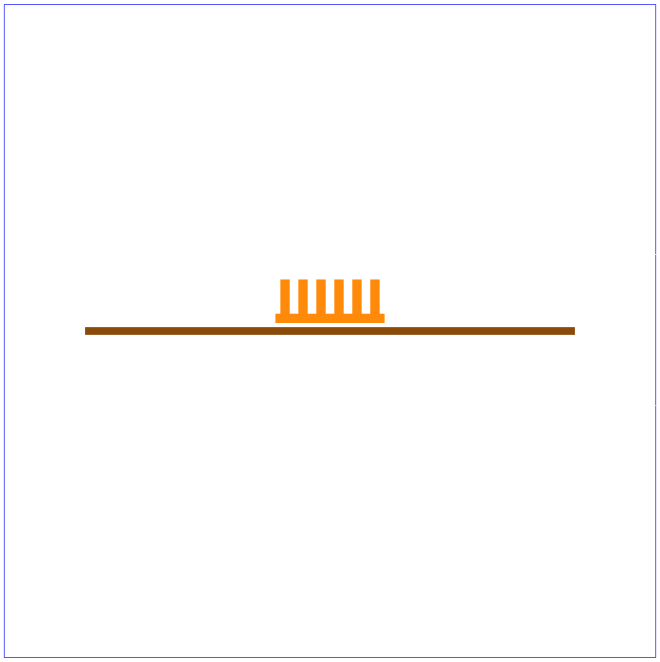


Figure 3: Front View

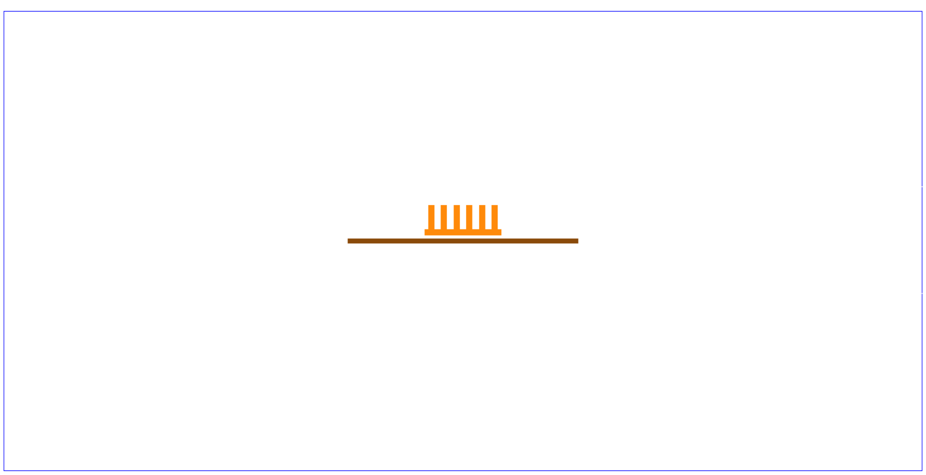


Figure 4: Side View

### 2.1.2 Interactive View

Click on the following control to activate it. You may use mouse buttons or toolbar controls to manipulate the interactive 3D model of the heat sink problem.
Please review the footnote comment[1]to find out how to use the following control.

## 2.2 Mesh Generation

The quality of grid in general plays an important role on the flow and thermal physics for a CFD solver. Once the CAD model of the heatsink had been created, we discretize the geometry to form a grid that is reasonable to capture the dominant flow features. In particular, we need to pay attention in the meshing near the wall of heatsink and the optimized volumetric mesh distribution.

[1]To start, click on the control to activate it.

- **If you cannot see the model properly, click on the *Model Tree* from the *Navigation Panels*, then right click on the root node and choose either *Zoom to Part* or *Fit Visible*.**
- To enable double-sided rendering, go to *Edit* → *Preferences* → *3D* and check the *Enable double-sided rendering* option.
- You can toggle between the perspective and orthographic views by clicking in the *Cube* icon on the control toolbar.
- You may use mouse buttons or toolbar controls to manipulate the interactive 3D model.

# 3 Results

Estimating how much the processor case temperature will rise given an increase in power to determining how to manage the additional heat.

We will consider different scenarios....

The cases results of temperature is given in Table 1.

| Case | A. Speed (m/sec) | A. Temp. (oC) | C. Power (W) | C./S. Heat Flux (W) | C./B. Heat Flux (W) | C./S. Temp. (oC) | C./B. Temp. (oC) | S. Temp. (oC) | J. Temp. (oC) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.10 | 293.25 | 10.10 | 4.74 | 0.31 | 94.47 | 123.49 | 44.06 | 109.15 |
| 2 | 2.10 | 293.25 | 10.10 | 4.74 | 0.31 | 74.54 | 104.00 | 24.08 | 89.24 |
| 3 | 1.10 | 313.25 | 10.10 | 4.72 | 0.33 | 51.77 | 79.42 | 22.19 | 66.40 |

Table 1: Cases Results of Temperature

- *The Legend of Table 1:*
  A. : Air
  C. : Chip
  S. : Sink
  B. : Board
  J. : Junction
  Temp. : Temperature

$$\theta_{sa} = (sinkTemp - airTemp)/chipSinkHeat \quad (1)$$

The cases results of $\theta$ is given in Table 2.

| Case | A. Speed (m/sec) | A. Temp. (oC) | C. Power (W) | $\theta_{JC}$ (oC/W) | $\theta_{JB}$ (oC/W) | $\theta_{CS}$ (oC/W) | $\theta_{SA}$ (oC/W) | $\theta_{CA}$ (oC/W) | $\theta_{JA}$ (oC/W) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.10 | 293.25 | 10.10 | 3.10 | 3.10 | 10.64 | -52.62 | -41.97 | -18.23 |
| 2 | 2.10 | 293.25 | 10.10 | 3.10 | 3.10 | 10.64 | -56.76 | -46.12 | -20.20 |
| 3 | 1.10 | 313.25 | 10.10 | 3.10 | 3.10 | 6.27 | -61.67 | -55.41 | -24.44 |

Table 2: Cases Results of $\theta$

- *The Legend of Table 2:*
  A. : Air
  C. : Chip
  Temp. : Temperature

The "Temperature" vs. "Case Number" curve is given in Figure 5.

The graph shows the slopes for change in temperature over the range ...for ...nearly linear and parallel to each other...

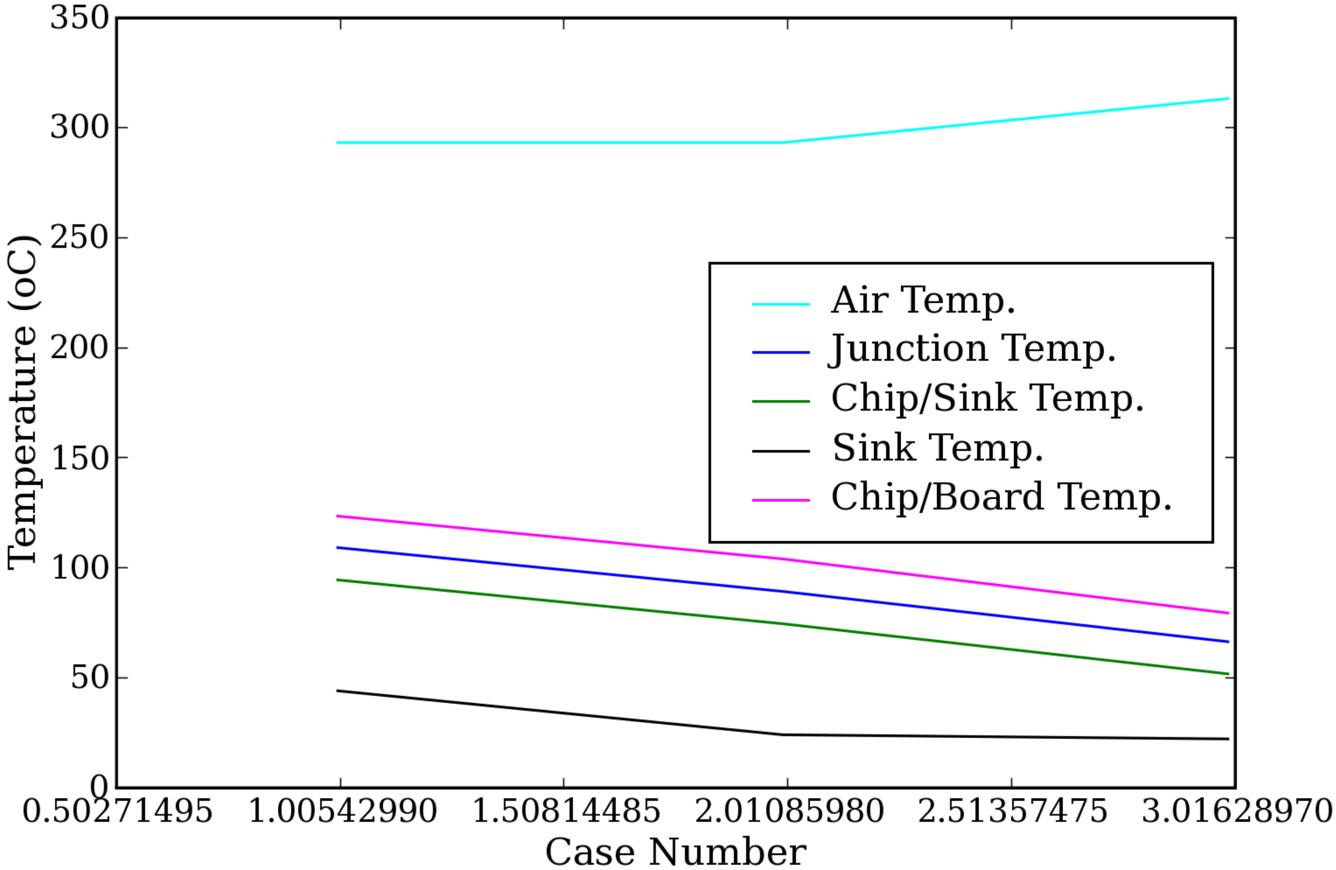



Figure 5: Temperatures

The "Thermal Resistance" vs. "Case Number" curve is given in Figure 6.

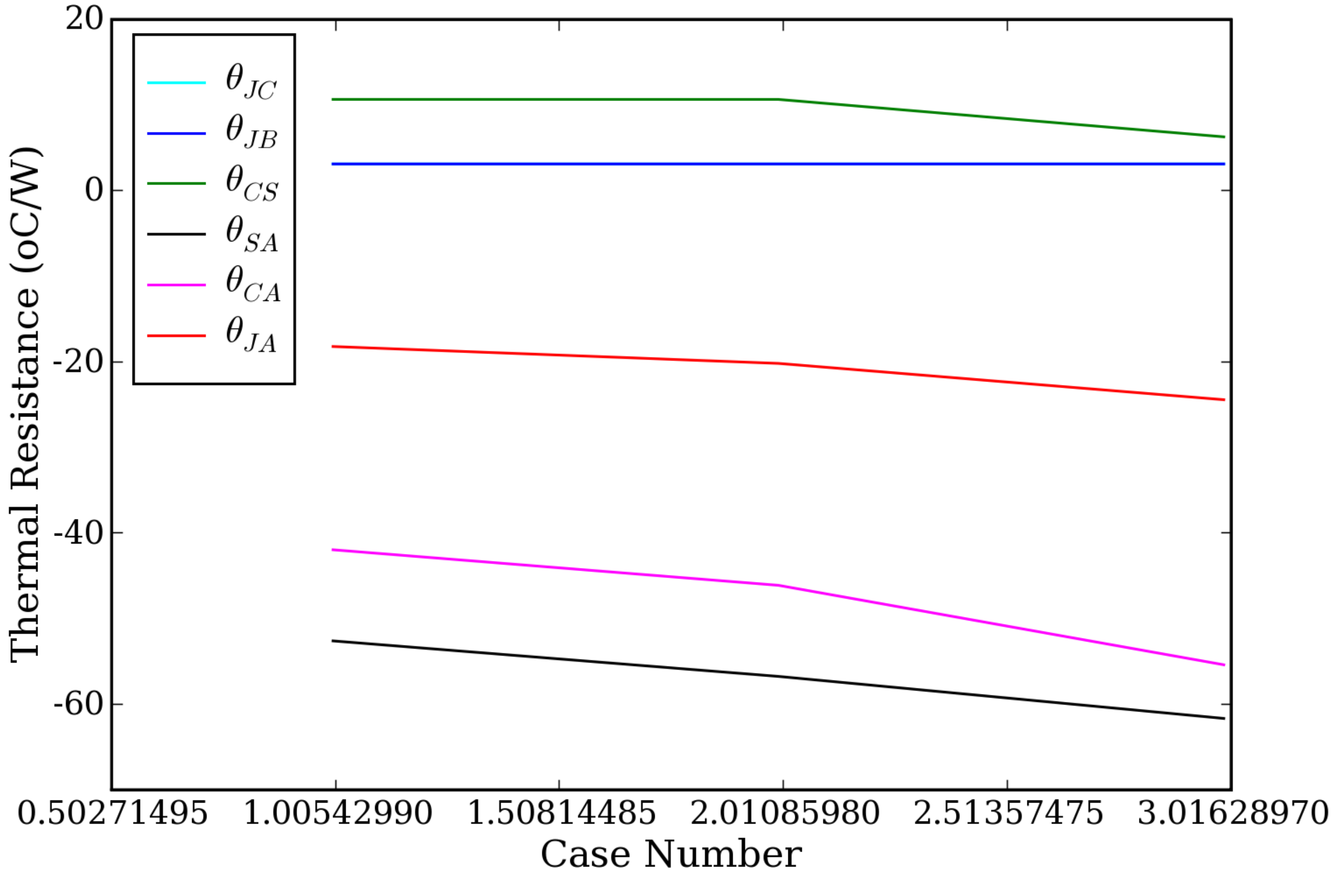
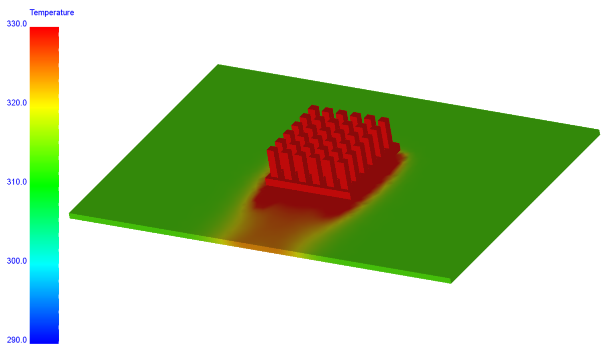



Figure 6: Thermal Resistances

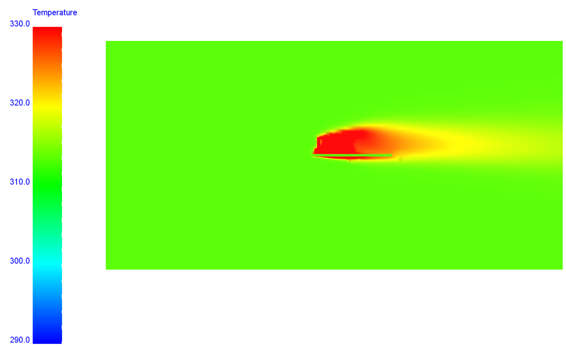
## 3.1 Case 1 Results

The results of case 1 are given in Figure 7.

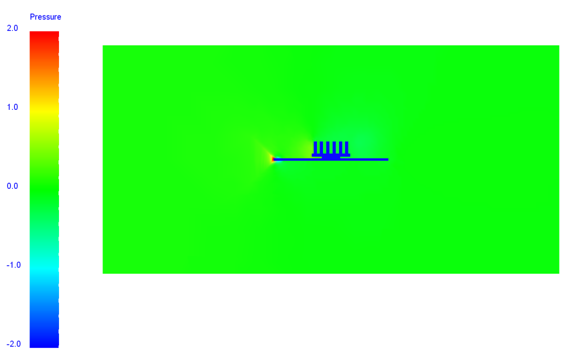
- *Air Speed: 1.10 m/sec*
- *Air Temperature: 293.25 oC*
- *Chip Power: 10.10 W*
- *Junction Temperature: 109.15 oC*




Case 1. Surface Temperature




Case 1. Temperature on Cut Plane



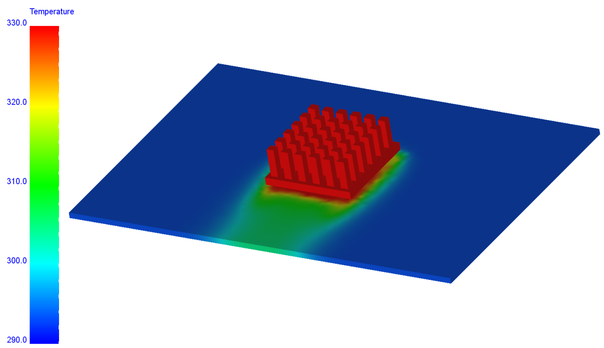

Case 1. Pressure on Cut Plane

Figure 7: Case 1

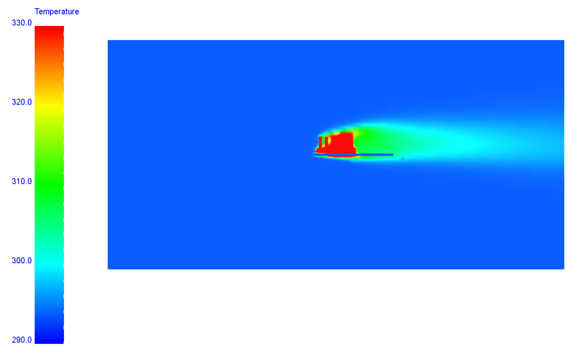
### 3.2 Case 2 Results

The results of case 2 are given in Figure 8.

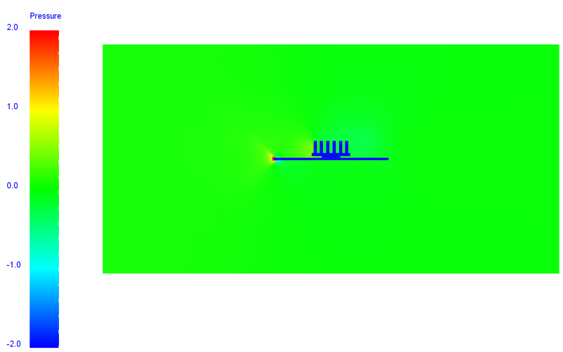
- *Air Speed: 2.10 m/sec*
- *Air Temperature: 293.25 oC*
- *Chip Power: 10.10 W*
- *Junction Temperature: 89.24 oC*




Case 2. Surface Temperature




Case 2. Temperature on Cut Plane



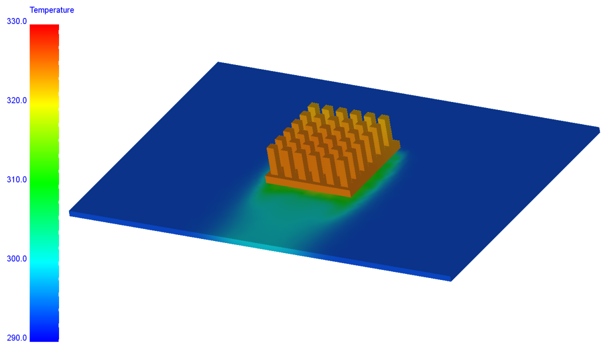

Case 2. Pressure on Cut Plane

Figure 8: Case 2

### 3.3 Case 3 Results

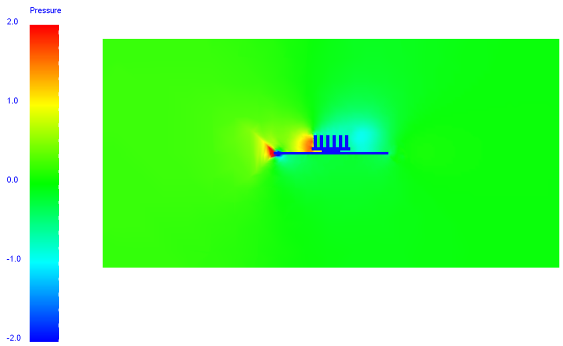
The results of case 3 are given in Figure 9.

- *Air Speed: 1.10 m/sec*
- *Air Temperature: 313.25 oC*
- *Chip Power: 10.10 W*
- *Junction Temperature: 66.40 oC*




Case 3. Surface Temperature


Case 3. Temperature on Cut Plane




Case 3. Pressure on Cut Plane

Figure 9: Case 3

# 4 Conclusions

Successful CFD modeling of heatsink.