# Gap Filling Elastomer Caused Coupling Effects

On flat SMD boards the housing serves is an ideal heatsink for processors or power MOSFETS. Generated dissipative power is conducted from their package backs through thermally conductive elastomers to ambient. The other part of power losses is transferred to ambient passing the soldered pins or the package baseplates, as well as by convection and radiation. Depending of the scenario, elastomers are applied to fill **the air gaps between the housing and the electronic components.** **Wilhelm Pohl, HALA Contec, and Jürgen Schmidt, ServiceForce, Germany**

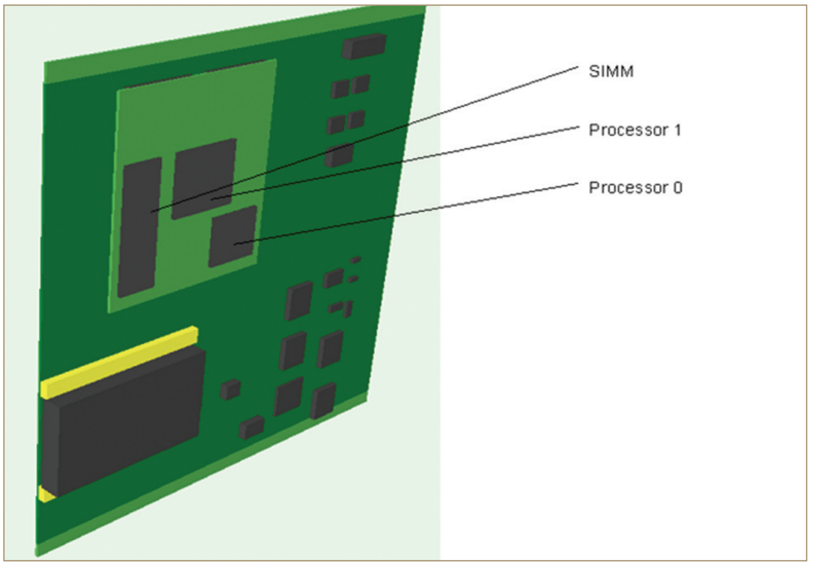


**Figure 1: Configuration to be thermally analysed**

**In the steady-state there will be an** equilibrium between the components leading to heating up of the semiconductors at high temperature gradients and high ambient temperature given the worst case. This phenomenon has to be taken into account when positionning the electronic parts, as well as for the design-in of thermally conductive elastomers and when configurating the heatsink. The behaviour of thermally conductive elastomers (gap fillers) is significantly defined by their thermal conductivity (typically in a range of 0.5 to10W/mK and up), their thickness (typically 0.5 to 10mm) and their elasto-plastic behaviour to deflect and comply with the surfaces. The following discussion is based on the results of a Computational Fluid Dynamics Simulation (CFD) considering characteristic situations at steady-state after transience of three electronic components processor 0 (package surface 7.8mm²), processor 1 (package surface 12.3mm²), and SIMM (Figure 1).

Depending of the scenario, elastomers are applied to fill the air gaps between the housing and the electronic component or there is no gap filler installed between them. The elements are assembled on a FR 4 PCB board. Two types of gap fillers having thermal conductivities of 0.5W/mK and 2W/mK with a thickness of 2mm are used. The dissipative powers of the processors are 16W (processor 1) and 2W (processor 0). Additional power dissipated to the board by other components is negligible and may be interpreted as inferior background signal without impact. The

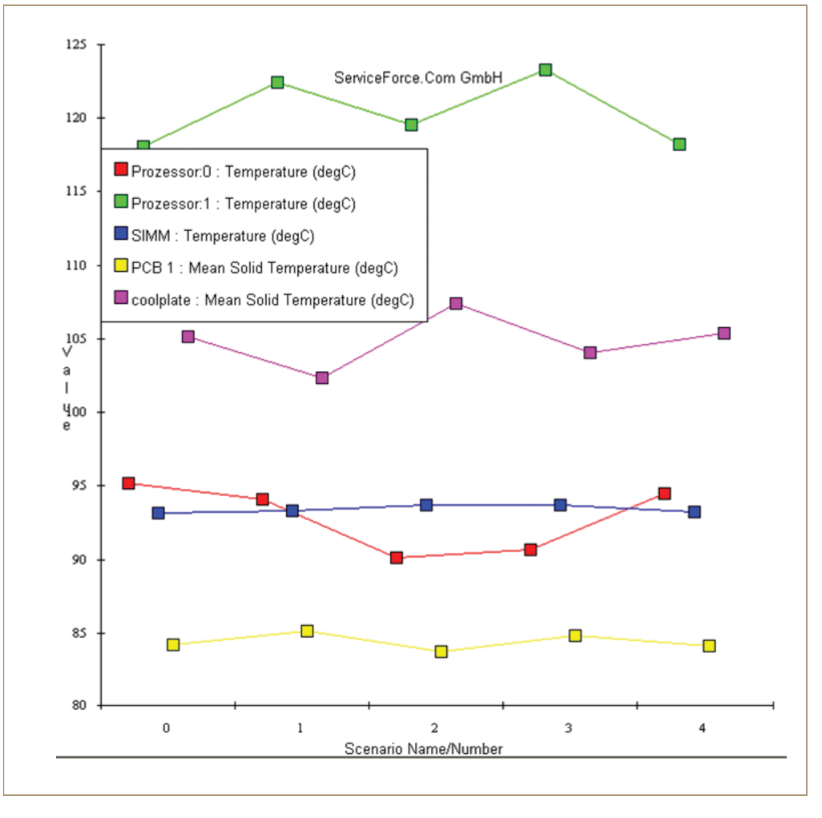


**Figure 2: Scenario based temperatures at different locations**

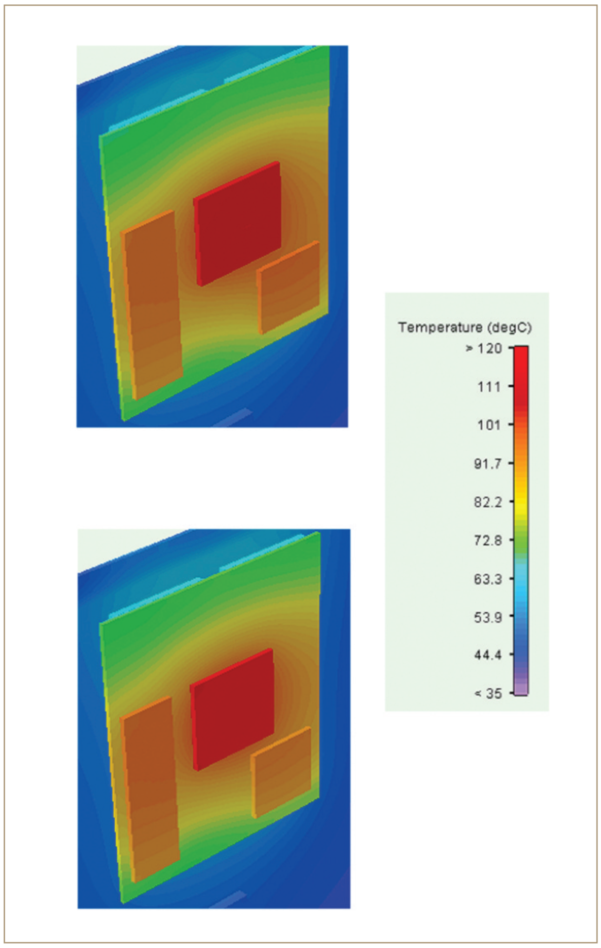


**Figure 3: Temperature distribution of scenarios 1 (upper) and 3**

ambient temperature is assumed to be constant. The housing is made of aluminum. Figure 2 compares the calculated temperatures at different locations.

## Interpretation of the results

It is shown that scenario 0 leads to the minimum temperature of processor 1 ($P_{Diss}$ = 16W) after transience. Omitting the gap filler for processor 0 as shown in scenario 2, the temperature will decrease by 5K, while the temperature of processor 1 will increase by 1.5K. Moreover, the mean PCB temperature will be the lowest of all scenarios.

The situation in scenario 1 results in an increased temperature of processor 1 by 4K and a temperature drop by 1.2K for processor 0 while using a less conductive elastomer of 0.5W/mK.

The elastomer 0 has been removed again for processor 0 in scenario 3. This results in a decreasing temperature at processor 0 by 4K and a warm-up of processor 1 by around 1K compared to scenario 1.

Both scenarios 0 and 1affect heat flows directed from the heatsink to the processor 0, hence thermal coupling repercussion. Eliminating the thermal coupling of processor 0 in scenario 2 and 3 leads to an increase of the hotter processor 1 by max. 5K. By use of two different thermal interface elastomers (scenario 4) having 2W/mK at processor 1 and 0.5W/mK at processor 0, only a negligible temperature increase occurs at processor 1, while processor 0 cooles down by almost 1K compared to scenario 0.

Therefore the implementation of thermal interface materials and their selection have impact on these coupling effects. Figure 3 clearly show the temperature distributions of scenarios 1 and 3.

## Conclusion

The results show that the coupling effects between the different electronic components on a board have to be taken into account when designing the board configuration and doing the thermal optimisation. It could happen that a inferior thermal conductivity of a thermally conductive elastomer or even no thermal connection might be advantegous, thus the component is only sligtly less cooled. On the other hand, much more sensitive components are then sufficiently cooled, regardless of thermal couplings.