Heatsink Considerations

As

Processor Power Increases

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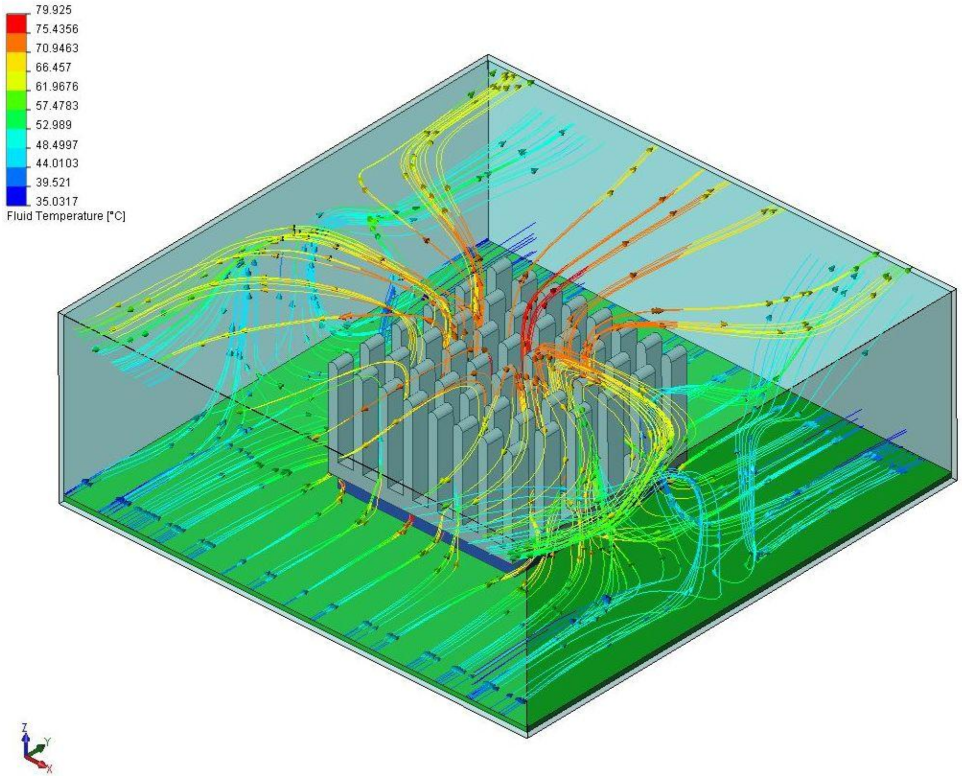

Vendors, such as Advanced Micro Devices, Inc. (AMD), offer multiple microprocessor devices with different power and performance ratings in the same package. Theoretically this allows system manufacturers the ability to upgrade existing systems by simply upgrading the processor. When considering an upgrade strategy which requires more processor power, it is important to know how it will thermally impact your system. You should know what thermal solutions will best suit your specific needs. This white paper discusses the added thermal effects of increased processor power in a system, the system's ability to remove the extra heat, and what steps should be taken to achieve proper thermal management.

BACKGROUND

As time progresses, quite often more processing power is needed to keep up the performance needs as applications are updated or new functionality is added to an existing solution. In these cases there may be a new higher performance processor available but more processor power means more work, more productivity, and more heat. When the time comes to upgrade a system from an 8W to a 9W or 10.8W processor, you need to be aware of how the extra power will impact your system. Can your current thermal solution handle the extra heat load? If you need to modify your thermal solution, can you simply use a different material or do you require a bigger heatsink? These are some of the questions you may be faced with and this paper will guide you in answering them.

This paper is a joint effort between AMD and Simon Industries and was created in an effort to help customers who are currently using the socket S1 AMD Sempron™ 2100+ processor or the socket AM2 AMD Athlon™ 2000+ 1GHz processor @ 8W, but need more performance in their current solution. AMD recently introduced the concept of using higher performance processors in their lowest power states to provide upgrade paths for an existing solution. The target processors for this solution are as follows:

AMD Turion™ 64 X2 Dual-Core Mobile Technology TL-56 1.8GHz @ 31W socket S1 processor. When running at its lowest P-state, the processor operates at 0.8GHz @ 9.4W.

AMD Athlon™ X2 Dual-Core 3400e 1.8GHz @ 22W socket AM2 processor. When running at its lowest P-state, the processor operates at 1.0GHz @ 10.8W.

In both cases moving to dual-core solutions may result in a significant performance gain depending on application, but the additional power requirements need to be addressed in the design.

SOLUTION

Knowing how much the processor case temperature will rise given an increase in power is crucial to determining how to manage the additional heat. Another key element needed is the understanding of how changes to the thermal solution will affect the temperature. The graph below in Figure 2 will help guide you by showing how material and size changes to the thermal solution affect the temperature at given power outputs.

Six scenarios were simulated with processor power ranging from 8W to 12W. The heatsink was a pin fin configuration cooled by natural convection. The processor and heatsink were aligned horizontally with the pins pointing up as this is a common orientation and a worst case situation. These simulations examined a combination of different heatsink materials and sizes. The two materials were copper (Cu) and aluminum (Al). Three different size heatsinks were chosen with wetted surface areas of 63 in^2, 52 in^2, and 39in^2. Each successively smaller size was achieved by reducing the footprint and removing one or two rows of pins. Figure 1 shows the heatsink dimensions. The three areas of the heatsink are interpreted as:

- 39 in^2 – Area 1 only
- 52 in^2 – Areas 1 and 2
- 63 in^2 – Areas 1, 2, and 3

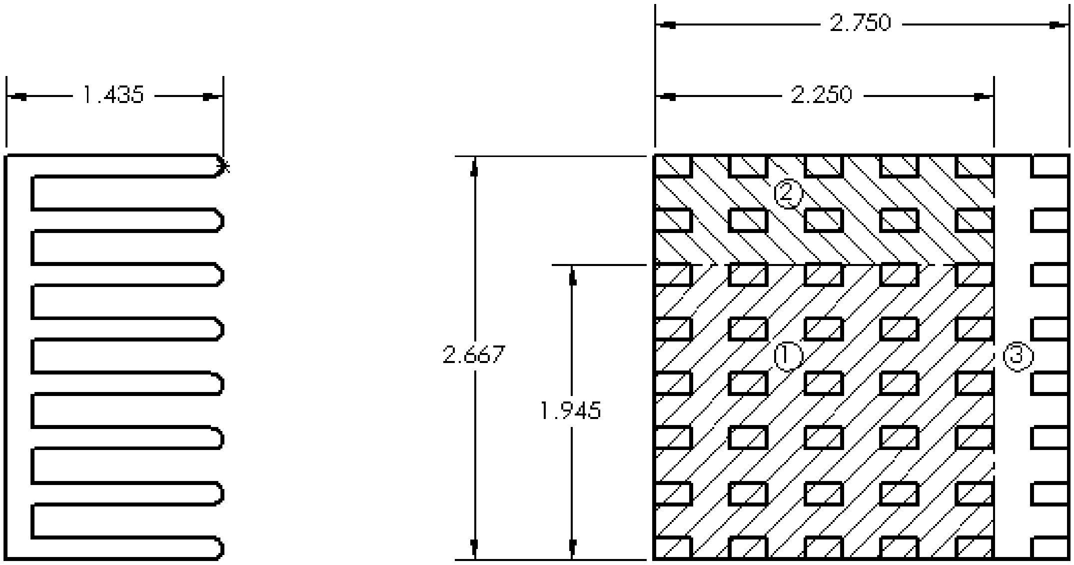

Figure 1. Heatsink Dimensions

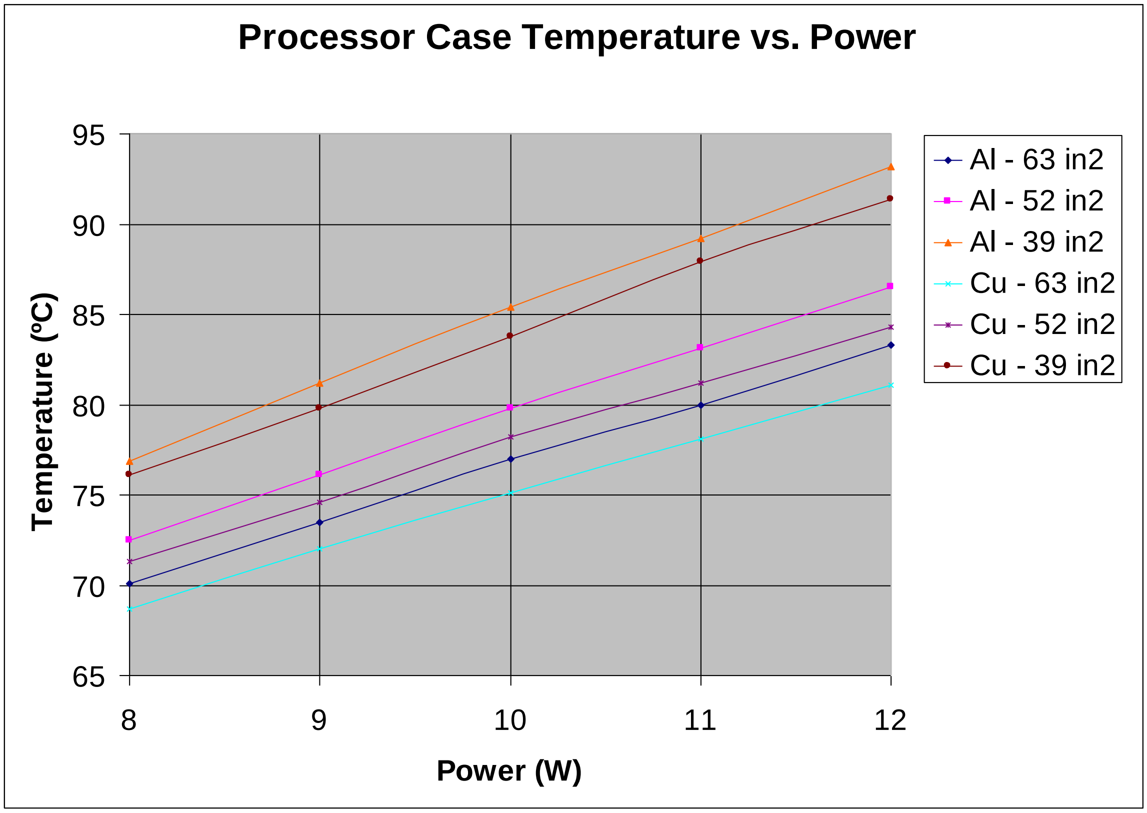

Figure 2. Processor Case Temperature Graph

The graph shows the slopes for change in temperature over the change in power for all scenarios are nearly linear and parallel to each other. This linear and parallel characteristic indicates a 3 °C/W – 4 °C/W rise is expected regardless of the thermal solution. It is important to note that this slope is valid only within the lower (8W) and upper (12W) bounds of the processor power simulated.

This graphical information is useful for answering several important questions when deciding to replace an 8W processor with a 9W or 10.8W.

1. What will the new case temperature be?
2. If the new case temperature exceeds the maximum limit of 85 °C, what changes should be made to the thermal solution?

For example, your application uses an aluminum heatsink attached to an 8W processor with a case temperature of 70 °C. Assuming the conservative estimate of 4 °C/W, a 10.8W processor will have a case temperature of 81.2 °C. Therefore, your current thermal solution is sufficient to properly manage the increased load.

A second example uses the same heatsink and 8W processor, but this time its case temperature is 75 °C. Now the 10.8W processor's case temperature will be 86.2 °C which exceeds the maximum allowable temperature. At 10.8W, the graph estimates a temperature decrease of about 1.7 °C between an aluminum and copper heatsink of the same size. Therefore, if the same heatsink is made of copper the case temperature would drop to 84.5 °C.

The same idea applies to increases in heatsink size. You can assume a decrease in temperature per increase in surface area of 0.15 °C / %SA. Thus, if the heatsink surface area in the second example was increased by 12%, it would have the same effect of as switching the same size heatsink from aluminum to copper.[1]

ABOUT SIMON INDUSTRIES

Since its founding in 1996, Simon Industries has been an industry leader in both design and manufacture of convection and conduction cooled heatsinks and related products. Our experience spans across several computing architectures, including Rugged COTS-VME/VME64x, VXS/VPX, VXI/PXI, AdvancedTCA/MicroTCA, COM Express, PC 104, and CompactPCI.

Simon's design engineers are proficient in the use of Thermal Analysis software, utilizing both EFD Labs and Algor to conduct "CFD" computational fluid dynamics and "FEA" finite element analysis simulations.

As you plan your upgrade strategy for your products using AMD processors, please consider Simon Industries for support in your heatsink design and thermal analysis requirements.

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[1] The multiplier of 0.15 °C / %SA assumes the heatsink surface area is similar to what is shown in Fig 1.