Thermal Management with Fusion

Introduction

As the speed of systems increases, and the relative size of systems decreases, temperature management becomes more important. This results in the need to develop effective, compact, and inexpensive methods of thermal management. This need arises not only in high speed computer systems, but also in many applications, such as industrial temperature control, portable electronics, telecom network switching boxes, biomedical devices, energy storage (battery charge), motor control, and automotive applications. For many applications, correcting the temperature change in a prompt and accurate manner is critical. For example, some industrial motor life times decrease by half if the insulation temperature increases by 10ºC.

Actel Flash-based Fusion devices have been introduced to the market with advanced thermal management features. Each device contains a 12-bit SAR ADC, a large amount of embedded Flash memory, up to 10 output gate drivers, and temperature, current, and/or voltage monitor input channels. Fusion devices are capable of temperature monitoring with 0.25ºC resolution, and allow threshold comparison, system status logging and system protection control.

Temperature Management with Fusion

Figure 1 shows the block diagram of a simple thermal management system implemented with an Actel Fusion™ device.

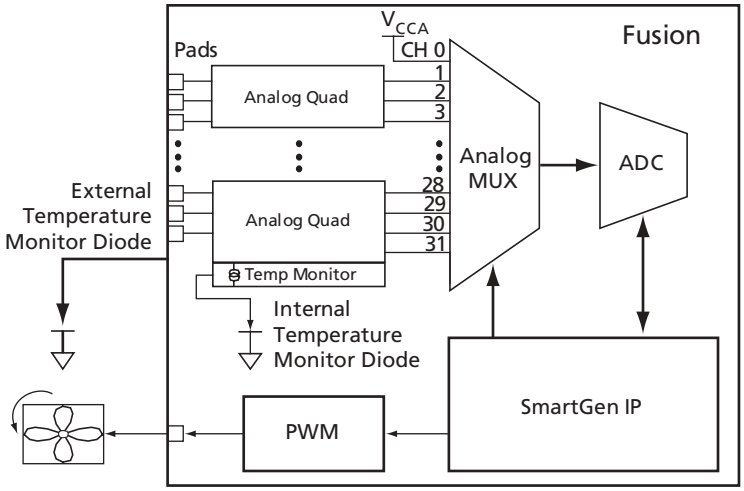

Figure 1 • **Thermal Management System Block Diagram**

Fusion devices can monitor up to 10 temperature channels with external diode connected bipolar transistors, or resistive temperature detectors (RTD). Based on the user preset threshold values stored in the embedded Flash memory, Fusion FPGAs can control multiple cooling and/or heating devices to keep systems at their desired temperature operating levels. Fusion devices offer up to 600 ksps sampling rate and an ADC with up to 12-bit resolution to convert these analog signals to digital for processing in the Fusion FPGA fabric.

In addition to thermal monitoring, Actel Fusion devices provide temperature control with dedicated gate-driver outputs that have selectable drive strengths. Users can implement a PWM soft IP core or any custom design to drive the gate driver outputs. By connecting these outputs to power MOSFETs or even

connecting them directly to loads, users can build customizable control circuits to fit a wide range of thermal management applications.

Fusion can also create a data log of the thermal system using the embedded Flash memory. A data log can be used to record alerts and any other system-critical data,. With this data, the user can decide whether or not to modify the system further by adjusting the threshold settings and changing the PWM duty cycles to achieve better system performance.

Each Fusion device also has an internal temperature diode to monitor its own junction temperature. Users can keep track of the Fusion junction temperature and include the data in the thermal management system logic.

Conclusion

Actel Fusion FPGAs allow system designers to implement tightly integrated, low cost and sophisticated temperature management systems on an FPGA. The 0.25ºC Fusion resolution, multiple temperature channel inputs, 12-bit configurable ADC, large Flash memory for data logging, and power MOSFETs to drive a load make it an ideal part for achieving high sampling accuracy with fast response times for many temperature control applications.

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