IR-Camera **Thermal Management**

By Atsushi Ishii, Director Sensor and System Functions, FLIR Systems
and Hugo Ljunggren Falk, KTH Royal Institute of Technology

FLIR Systems develops thermal imaging cameras and components for a wide variety of commercial and government applications. Depending on the end use, a product design might be driven by economical or dimensional factors while other applications are constrained by extreme environmental operating conditions. Whether the product is designed for firefighting purposes or to monitor a datacenter, FLIR continually explores opportunities to shorten their product development cycle.

Many development cycles are shortened by integrating simulation early in the design process. In addition to the time saved, the cost of developing a product can decrease substantially by reducing the number of prototypes built and tested. In terms of sustainable energy engineering, by "streamlining" the development cycle by adding simulation, less physical resources are used to create prototypes which means a reduction in environmental footprint.

To explore the benefits of introducing simulation early in the design process, the FLIR AX8 stationary camera was used in a case study with FloTHERM™ XT. The AX8 camera has been developed to monitor apparatus in industrial sensor networks, such as telecom electrical boxes or refrigeration units in supermarkets. A rendering of the camera is provided in Figure 1.

The case study was considered in two phases, Alpha and Beta. Alpha represents the earliest part of the design process, where decisions such as board layout are considered, and Beta represents the fully detailed analysis.

The simulation during the Alpha phase only includes the PCB and is shown in Figure 2. With FloTHERM XT, when the PCB design changes, the board can simply be swapped out through the FloEDA Bridge. The initial conditions and values set will be kept for the new board. Also, parametric studies can be used to set different configurations which can range from initial conditions to changes in geometry and is useful when comparing different solutions against each other.

The Beta phase, which represents the detailed analysis, is then considered. Simulation during the Beta phase would include any thermal relevant components including the mechanical assemblies and enclosure. The simulation setup for the Beta phase is shown in Figure 3.

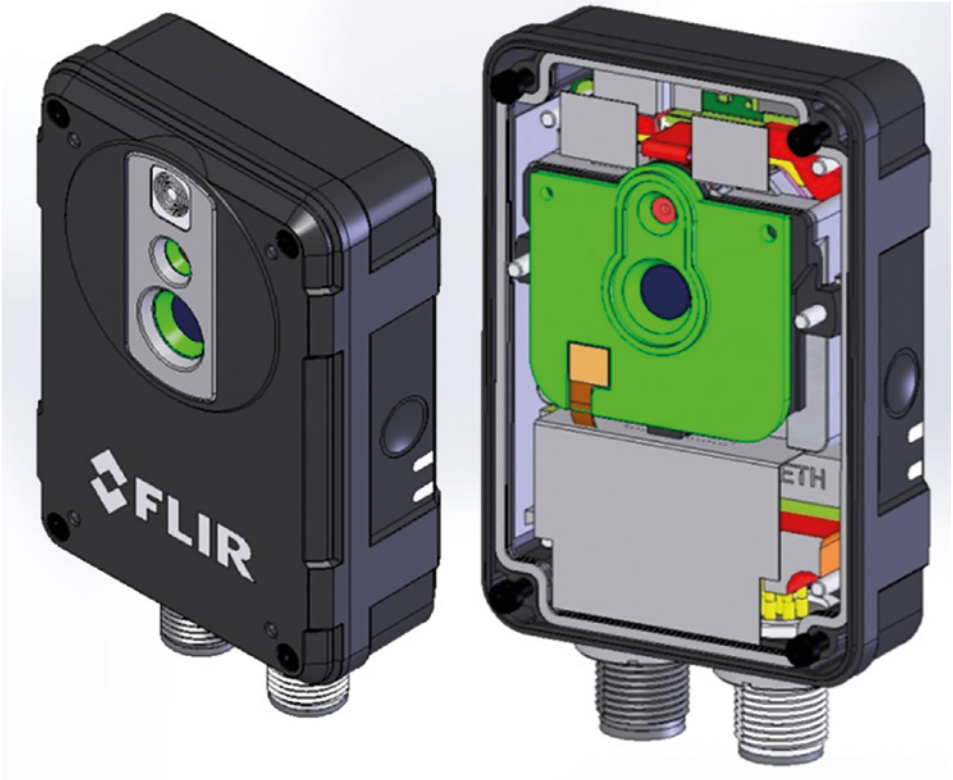

Figure 1. FLIR AX8 with and without cover

To assess the integrity of the simulations they were compared to temperature measurements of the camera in a loaded condition. Measurements during the Alpha phase were conducted using a FLIR T640 thermal imaging camera mounted on a tripod. Thermocouples were used to measure temperatures during the Beta phase.

Results Comparison: Alpha phase

The Alpha phase was used to determine if correlation between measurement and analysis could be achieved with only the PCB, in a lab environment. With correlation the analysis could be used to explore PCB design choices with respect to layout and overall PCB footprint. Figures 4 and 5 show the IR images captured with the FLIR T640 for the FLIR AX8 printed circuit board. Figures 6 and 7 show the FloTHERM XT results of the PCB in a natural convection environment. Table 1 shows a component temperature comparison of the IR image and simulation results.

The Alpha phase simulation results compare well with the bench top IR camera measurement. Any proposed board level design changes could be explored with confidence without building and testing numerous prototypes.

Result Comparison: Beta phase

The Beta phase was used to determine if correlation between measurement and analysis could be achieved when considering the full assembly. With correlation, the analysis could be used to explore thermal design choices such as materials, thermally conductive gap fillers, and venting. In addition the analysis could be used to predict performance under any environmental or usage condition. Figure 8 shows a solid temperature cross section of the simulation results and identifies the dominant heat transfer paths.

The Beta phase simulation results compare well with the bench top thermocouple measurements. This simulation model would allow a thermal design team to explore design alternatives and consider operating environments that would be too expensive or time consuming to otherwise consider.

Summary

Whether a product design is constrained by extreme operating environments, cost, or form factor, introducing simulation early in the process will shorten their product development cycle. Validated simulation processes reduce the cost of design through time savings and number of prototypes.

This article is summarized from the Master of Science Thesis: Thermal Management in An IR-Camera. Hugo Ljunggren Falk, KTH School of Industrial Engineering and Management, Stockholm

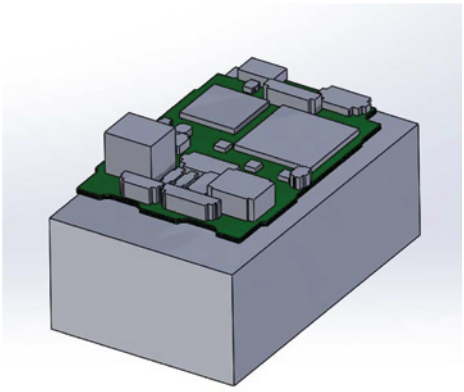

Figure 2. Alpha simulation setup

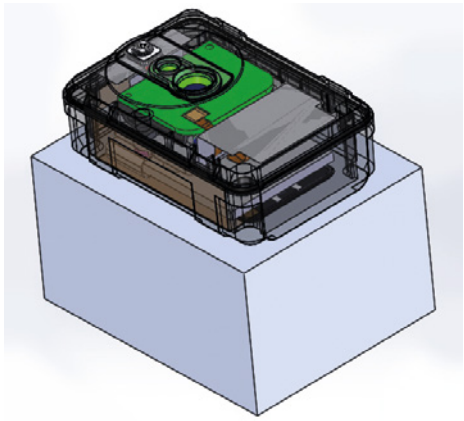

Figure 3. Beta simulation setup

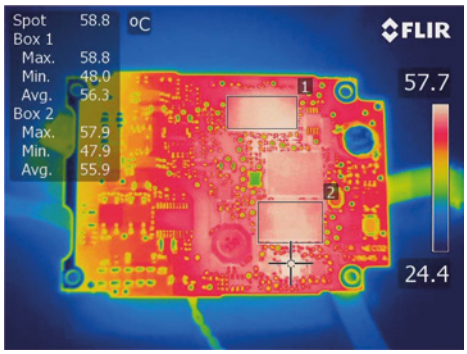

Figure 4. Alpha phase PCB top surface IR image

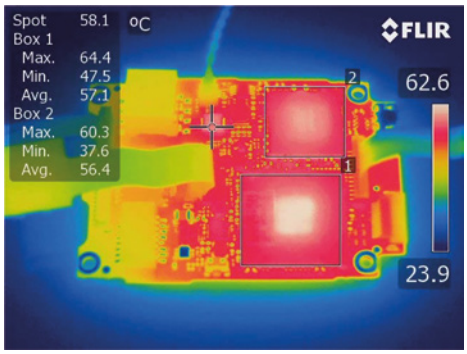

Figure 5. Alpha phase PCB bottom surface IR image

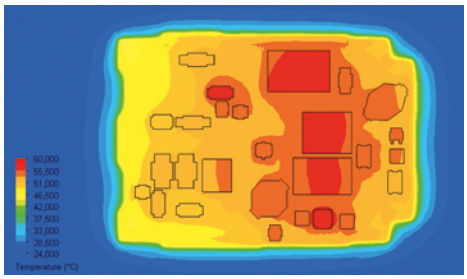

Figure 6. Alpha phase top view simulation results

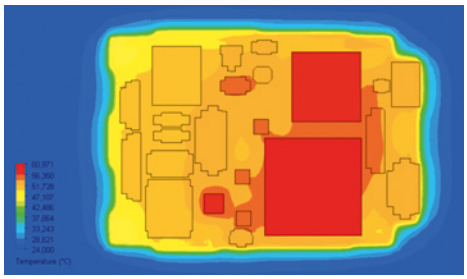

Figure 7. Alpha phase bottom view simulation results

	Temperature [°C]		
Probe	**Measurement**	**Simulation**	**+/-**
CPU	57.1	61.0	3.9
FPGA	56.4	57.7	1.3
Rectifier for PoE	58.1	55.8	-2.3
FPGA memory	55.9	55.5	-0.4
CPU memory	56.3	55.7	-0.6
Power mgmt. unit	58.8	57.0	-1.8

Table 1. Alpha phase results comparison

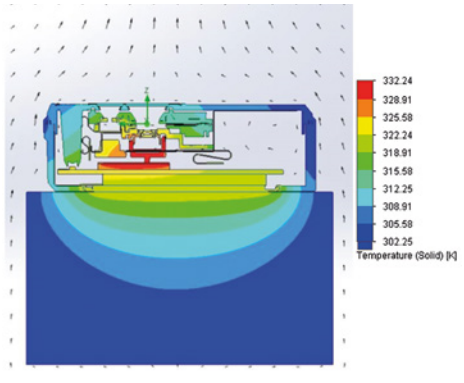

Figure 8. Beta solid temperature distribution simulation results

	Temperature [°C]		
Probe	**Measurement**	**Simulation**	**+/-**
Aluminum back plate	52.5	49.1	-3.4
CPU	58.9	58.7	-0.2
FPGA memory	55.4	49.1	-6.3
FPGA	57.1	58.1	1.0
Visual Cam	48.5	52.4	3.9
IR Sensor	47.2	48.2	1.0

Table 2. Beta phase results comparison