How To Keep Your Electronics Cool Without Really Trying

In the design of electronic equipment such as communications chassis, power supplies, and amplifiers, thermal considerations are generally an afterthought. Why? Most electronics designers have their hands full just handling the electrical issues that drive the design.

Thermal effects, in large part, drive the life of electronic systems. The effects of heat determine reliability and cause, directly or indirectly, a large number of the failure modes. Initial testing may not identify these thermal issues, and as a result, failures are not discovered until a substantial number of units are built and fielded. The result: unexplained errors, failures in the field, unhappy customers, and redesigns.

So how do you build electronics to minimize heat problems? You address the thermal issues during design, not after the system design is complete. You minimize thermal issues in conjunction with the hardware design to ensure that the system lifetime is not compromised.

Follow the basic rules below, and you'll minimize problems later on.

Design to vent heat. Include large openings for air to enter and exhaust chassis. For shielded chassis, size air intakes to limit RF leakage while allowing airflow. Take advantage of the natural flow of hot air from bottom to top and locate air intakes at the bottom, with the exhaust at the top. For sealed systems, provide a conduction path to the chassis exterior.

Locating components that dissipate the most heat near the exhaust. This means near the top for most systems, including those that are sealed. This avoids heating of other components.

Locate fans and filters at the air intake. Air should be pushed into the system by fans, not exhausted. This pressurizes the interior of the assembly and limits dust and unfiltered air in the assembly.

Orient boards and heat sinks with the air flow. While this seems obvious, it is a rule often ignored. In assemblies that rely on natural convection, the fins should run vertically.

Locate temperature sensitive components near the intake. Parts whose performance is affected by temperature should be directly in the fan air stream or close to the air entrance for enclosures that rely on natural convection.

Provide guards for hot components. Parts that reach over 50^0C can cause burns. They must include warnings and provisions to protect maintenance personnel from burns. This is especially true for systems that allow hot swapping of subassemblies.

De-rate fan air flow. Fans are advertised with a flow rate for free air. This means the flow rate is specified for the case with no downstream restriction on the flow of air. But if you want your fan to cool, you'll have something in the airflow. This in turn causes flow restrictions and pressure drops that severely reduce the airflow capacity of the fan. Which means your 50 cfm fan may only produce 15 cfm.

Use thermal sensors. Some systems use airflow sensors to determine indirectly if the fans are still operating. Which means if the ambient air increases in temperature, the sensor indicates everything is ok. The important issue, however, is temperature, not airflow. And while they usually go hand in hand, temperature sensors will give a more direct indication of problems for your electronics.

While these guidelines won't eliminate all heat-related problems, they will mitigate potential issues. With analysis tools now available, systems can be designed to minimize the effect of heat. The end result: longer life for your electronics. And happier customers.