Choosing a Fan That Best Fits Your Application

To meet the consumer's ever-increasing demand for faster, more advanced technology, design engineers are creating systems that maximize power while minimizing space. Yet this additional power provides design engineers with a new problem...heat. Without a proper cooling mechanism, a system can overheat and malfunction. To protect the design, the engineer must select the right fan for the application.

Before deciding the optimal cooling unit for the system, the design engineer must consider the following factors: mechanical electronic packaging, heat sources, the cooling air path, system impedance, noise, fan performance, the operating point, the fan performance curve, fan structure, fan reliability, and fan cost.

Once the electronic packaging is designed, the engineer must perform a preliminary thermal analysis. This will ensure that "patchwork" will not be required at the end of the design process.

To determine the volume of air required to cool a system, the packaging engineer must first identify the main heat sources. Temperature, thermal resistance and heat dissipation will dictate the airflow that is necessary to cool sources. The amount of heat that each source generates must be calculated. Case temperature, also known as the operating junction temperature, must be determined. By calculating the maximum and minimum values for the case or the operating junction, the packaging engineer can examine a range of operating conditions. Thermal resistance from case-to-air and/or from junction-to-case resistance must also be determined. Likewise, the engineer must evaluate the source's typical and worst case heat dissipation.

Critical heat sources need sufficient airflow to maintain proper cooling. Mapping the cooling air path will ensure that major heat components will have the air required to cool the equipment. Some systems will need an air baffle to aid the cooling process. This device can be used alone or in conjunction with an air duct to maximize airflow. Now, the engineer is ready to propose locations for the system cooling fan(s) and the opening area for air inlet vents and air exhaust vents.

Having calculated the required airflow and having mapped the cooling air path, the engineer needs to calculate the system impedance. As air travels between air inlet vents and air exhaust vents, air pressure drops. The system impedance is the **sum** of these pressure drops. To calculate system impedance, the design engineer must measure the pressure drop between each air path, then total the data. Using an airchamber to create a mock system is another method to determine system impedance. After identifying the system impedance and the overall required airflow, the operating point that indicates the system static pressure at the required airflow can be gauged. The operating point is the single most important factor in determining the proper cooling solution.

After determining these crucial factors, the engineer is ready to decide whether to use an axial fan or a blower. A blower is typically used in telecommunications and high-end servers because these systems operate under high system impedance. A blower has a more concentrated airflow in which the equipment pulls air in from the sides and forces it out at a concentrated 90° angle. Blowers also typically generate more audible noise. An engineer must use an axial fan when systems have low back pressures and there are concerns about noise.

In order to determine the appropriate fan or blower size and speed, the engineer must now examine the fan performance curve. The fan performance curve indicates the airflow quantity variation, revolution or fan speed, static pressure, and current for a specific voltage. Usually the voltage that is graphed is the nominal voltage. The fan performance curve is plotted by tracking airflow quantity on the horizontal axis and static pressure on the vertical axis. Most manufacturers provide this data for their fan equipment. By selecting a fan that has a performance curve that matches the proposed operating point, the engineer can be assured that the fan will sufficiently cool the electronic system.

After examining universal criteria for fan selection, the engineer must focus on application specific features. The structure or the frame size, material, mounting method and hardware, and termination are all factors that determine the type of fan an engineer must select. It is important to investigate these factors before purchasing a cooling system. Depending on the environment, some systems will require special mounting for noise reduction, vibration isolation, EMI or the design of the enclosure for the electronic system.

Fans are critical in maintaining a system's ability to operate; yet, because of their bearing assemblies, fans are more susceptible to failure than any other part. If a fan fails, the system can overheat and malfunction. However, there are features that an engineer may use to ward against fan failure and extend fan longevity and thereby the system's longevity. By installing a fan fail monitoring circuit, an engineer can track a fan's performance and detect any malfunctions that may threaten the system. Some fan performance monitoring circuits include a thermal shut down feature to turn off the electronic system when prolonged overheating is detected.

The fan speed control circuit can be used to maximize a fan's longevity. The faster a fan runs, the faster it will wear out. By manipulating fan speed, the engineer can control fan life expectancy. Also, since fan speed is the primary contributor to fan noise, the speed control circuit can be used to minimize sound. There are four major types of fan monitors and fan controllers. They are the fan speed monitor, the fan fail monitor, the fan speed control, and the fan fail shutdown.

The fan speed monitor requires a third lead from the fan as a tachometer signal output. This feature allows the system to monitor fan performance (speed).

Most fan suppliers install a built-in locked rotor protection circuit known as a fan fail. A third lead will issue a locked rotor alarm signal output alerting the system if the fan rotor locks.

Using a third lead from the fan system as a tachometer output, the fan fail shutdown monitors for any abnormal signal from the fan. If a problem is detected, the device will utilize a preset time delay and force the system to shutdown.

Fan speed control is another precautionary device used to guard against system shut-down and increase fan performance. Depending on the electronic system, a design engineer must select a speed control to best fit the electronic system. The most common fan speed controls are the temperature step speed control and the temperature on/off speed control. High-end PCs, servers, and telecommunication equipment commonly use temperature proportional speed controls. Of the temperature proportional speed controls, PWM and the linear voltage speed control are the most popular. If a designer prefers not to use one of these speed controls, a DC fan with a tachometer output and internal or external (remote) temperature sensor can be used for the same purpose.

Now that the engineer has selected the necessary fan features, the engineer must select a specific fan. While there are many types of fans that a design engineer may choose, ball bearing fans are the most reliable bearing technologies.

To meet an application's cooling needs, it is critical that the system's fan has a high level of reliability. Ball bearing fans can endure intense levels of heat. Using the L10 method to compare life expectancy at temperatures ranging from 25° C to 60° C, ball bearing fans, on average, out-lasted sleeve bearing fans by 50%. When evaluating these fans at 70° C, the ball bearing fan lasted 45K hours, while sleeve bearing fans were inoperable at this temperature. Also, variations in mounting do not shorten the life-span of ball bearing fans, where mounting can decrease the life expectancy for other types of fans. Because ball bearing fans have longer lives, and are more versatile, they are often the best cooling choice for design engineers. By selecting ball bearing fans, an engineer can protect the electrical system and safeguard against overheating and application failure.

Choosing a fan that best fits an application is an important and critical decision. There are many factors to consider and picking the right one can mean the difference between a successful and efficient PC, or one that results in an over-heated system. As with other PC components, choosing the proper cooling system is a decision that should not be considered trivial, as it ultimately represents maintaining a long-term computer system.

# # #

Word Count: 1,396