Technical Brief No. 41

All Technical Briefs are based on past projects at RH Lyon Division

Packaging
Heat transfer
Cooling fans

Cool it Man! Quietly!

High density packaging challenges quiet cooling techniques

Convective cooling inadequate

As electronic circuits become smaller and faster and the devices they serve become more compact, the heat density produced and the need for convective cooling are increased. When other heat producing devices, such as projection lamps, are added, the situation becomes even more demanding. Fans to direct and move air through the product become necessary. The compactness of the product and the amount of air needed result in airflow noise that may be unacceptable.

How to……..

The general rules for minimizing air cooling noise in electronic equipment are:

1. Arrange the product layout to minimize pressure drop while maintaining adequate flow for cooling at critical locations. Experimental testing and computer modeling can assist in this process.
2. Select a fan so that this head loss and flow are at a stable and efficient location on its operating curve.
3. Place the fan and nearby components so that the inflow to the fan is unobstructed and as uniform as possible.
4. Keep the exit flow as uniform and free from obstruction as possible. If a volute diffuser is used, make it rounded and smooth, and separate it from the blades as much as possible.

If these rules can be followed, a product with minimal noise generation will be achieved.

Three noise sources

When air is moved through a product, there are three main contributors to the noise. The first is noise produced by turbulence as air flows in the passages of the product. This noise is mostly broadband and random and is directly related to head loss (pressure drop) in the flow, and can be reduced if flow paths are arranged to minimize head loss. Once the product is laid out, and allowable temperatures are set, then the flow velocities are essentially determined by the quantity of air that must be moved.

Turbulence generates noise

The heat is removed by turbulence, and the turbulence generates noise. This part of the noise is therefore an unavoidable consequence of the design layout and is unaffected by the choice of a fan.

The other two noise components are fan related and affected by fan selection and product layout. Assuming that the fan has been properly selected to meet the requirements of head loss and flow (it's amazing how often this is not done!), then noise is produced by the flow on both entering and exiting the fan.

Random noise is also generated by the inflow of turbulence into the fan. Periodic noise (tones) is produced by non-uniform inflow to the fan. Both the turbulent and non-uniform inflow can be controlled by the way that the flow is managed before it flows into the fan by providing some distance between upstream disturbances and the fan inlet.

Blade passage tones

The second fan related noise is related to the flow exiting the fan. A volute or scroll diffuser on a centrifugal has a "cutwater" and this will generate a tone at the blade passage frequency. The noise is caused by highly transient forces as the outer edge of the fan blade passes near to the cutwater. It is possible to make this tone very weak by shaping of the cutwater and providing as much space between it and the outer periphery of the fan as possible.

If the exit diffuser is radial, or if the fan is axial, there should be no tone. However if there is obstruction by supporting struts for the fan or diffuser, or blockage of the exit flow by nearby components, the resulting non-uniform flow will cause tones at the blade passage frequency.