

# White Paper

## Upgrading of Plastic Axial Fans

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## Upgrading of Plastic Axial Fans

The use of fans for active cooling of electronic products is a standard practice throughout the electronics industry. A fan is a device that is designed to move a specific volume of air (flow) against moderate pressure (resistance). A fan induces airflow by virtue of its blades; a blade moves air by generating a lift force when in motion through the air. A standard fan found in the electronics industry is a 60 mm axial fan with plastic blades and housing.

An axial flow fan is a fan in which the flow of air is substantially parallel to the axis of rotation. The operation of the fan at extreme temperatures will be limited by the materials used in the construction of the fan. An example of an axial fan construction is shown in Figure 1. While temperature ratings for fans are not always provided in a datasheet, standard axial plastic fans are typically specified to operate between -10 and 70°C. This is most likely due to the limitations of the plastic, lubrication and the brushless motor control circuitry.

Functional parameters specified in an axial fan datasheet tend to be limited to pressure as a function of air flow. This behavior is not expected to vary with temperature except to the point of breakdown or failure. Instead, the user needs to be aware of the various components of the fan and how their elements could lead to failure when the axial fan is used outside its specified temperature range.

### Impeller and Housing Plastic

The standard plastic used in the construction of axial fans is a fiber reinforced polybutylene terephthalate (PBT) plastic which is flame rated UL-94V-O. A typical glass transition temperature for this polymer is between 60 and 80°C at which use of the polymer in a structural application may be problematic. The centrifugal forces that the fan blades are subjected to may be sufficient to cause excessive deflection of the blades such that interference with the housing occurs. This can lead to stalling or breakage of the fan.

### Lubrication

The bearings of the fan are coated in a lubricant to reduce wear and extend life. This lubricant may become gummy at low temperature causing the fan to stall. At elevated temperatures the lubricant's viscosity may decrease to the point at which it no longer provides adequate lubrication to the bearings. This will lead to premature wear-out of the bearings. A fan with a lubricant specified to the operating temperature range must be used by the fan manufacturer.

### Electronics

Since axial fans tend to be brushless, there is control circuitry present that is necessary for it to operate. These electronics may have circuit or component limitations that prevent it from operating beyond the operating range specified by the fan manufacturer.

### Risk of Overstress Events

The only rating of value for the fan is voltage and this rating is not expected to change with temperature. Therefore, the risk of overstress failure mechanisms will not increase when operating the fan outside its specified temperature range.

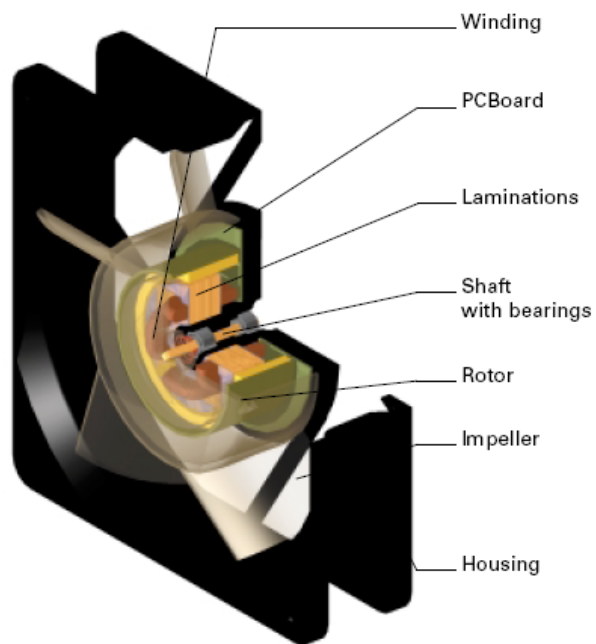
### **Risk of Wearout Events**

The life of an axial fan will shorten as the ambient temperature increases. An example of this degradation is shown in Figure 2. This life testing was only conducted up to 70°C, but it can be seen that the life decreases rapidly once the ambient temperature rises above 40°C. The reduction in design life can be as much as factor of 5X. As a general statement, ball bearing fans have a longer life than sleeve bearing fans at both room and elevated temperatures.

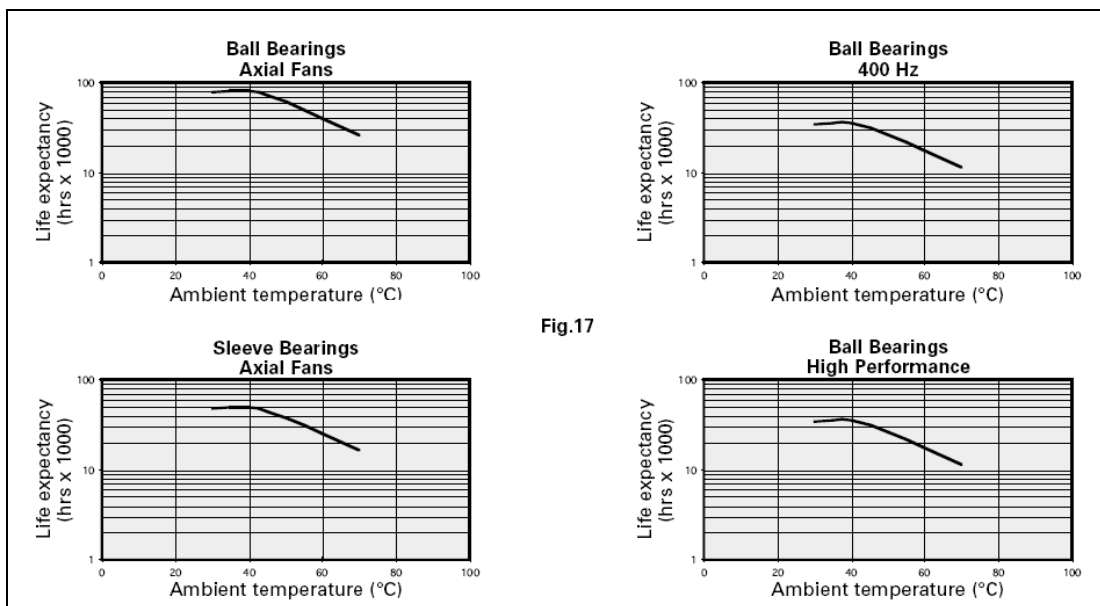
To insure long-term reliability in elevated temperature environments, such as Class II telecommunications, a fan that is rated to 85°C or above must be used. Some fan companies offer a high temperature option (Sofasco) that extends the temperature range to -10 to 90°C. However, this still does not meet the cold temperature requirement of -40°C for the same Class II telecommunication environments.

### **Conclusion**

Standard plastic axial fans have a very limited capability to go beyond the temperature range specified by the manufacturer. If the expected operating environment is beyond the standard -10 to 70°C part, plastic axial fans will likely not be sufficiently reliability and should be either be replaced by enhanced plastic axial fans with a broader temperature range or axial fans constructed of metal.



**Figure 1: Axial fan construction**



**Fig.17**

**Figure 2: Fan life as a function of temperature**

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