Appendix B: Diode Thermal Analysis

Diode Encapsulated in a Potting Material

The mechanical configuration of the diode in the package will also have an effect on thermal impedance. Thermal impedance may be calculated with the following formula:

$$\theta jc = \frac{L}{\sigma \times A}$$

Where "θjc" is the thermal impedance from the diode to the heat sink or outside surface, "A" is the area of the thermal path,"θ" is the thermal conductivity as given in Table 1, and "L" is the length of the thermal path from the diode to the heat sink.

In many practical cases, the area or length of a thermal path may be difficult to determine exactly. Also, in some cases there are several thermal paths that must be considered in parallel. The above formula should be used to arrive at a close approximation of the thermal impedance of the package. Calculation of thermal impedance should be followed by an actual test of the diode junction temperature in the package.

As the above formula indicates, thermal impedance is inversely proportional to the thermal area. Thus, thermal impedance and junction temperature can be reduced by increasing the thermal area. One way to increase the thermal area is to add metal heat dissipators to the diode leads. Also, the shorter the distance between the diode and the heat sink (or outside surface), the lower the thermal impedance.

In high voltage applications, the minimum distance required between the diode and outside surfaces will depend on the package voltage stress and on the dielectric strength of the potting material. See figure 4 for a typical potted rectifier configuration.

Thermal Impedance Formula (for conduction):

$$Q = \frac{\sigma \times A \times T}{L} \quad \text{or} \quad \theta = \frac{L}{\sigma \times A}$$

Q=Heat conducted (watts)
A=Cross-section area of heat path (in^2)
σ=Thermal conductivity (watts/in^{2}x°C)
L=Length of heat path (in)
T=Temperature difference (T1-T2)
θ=Thermal resistance (°C/watt)

Appendix B: Diode Thermal Analysis

Surface Mount Diode

In a surface mount application, the diode is mounted to a ceramic substrate or PC board. The heat generated in the diode junction flows through the end tabs directly to the substrate or PC board. The diode's thermal impedance (given in the diode data sheet) is added to the substrate or PC board thermal resistance to obtain the total thermal impedance of the package. See figure 5, for a typical surface mount configuration.

Typical Diode Configurations

Axial Lead Diode, PCB Mounted

Diode = 1N5550
L = .375
$\theta_{J\text{-}PCB}$ = 20°C/Watt

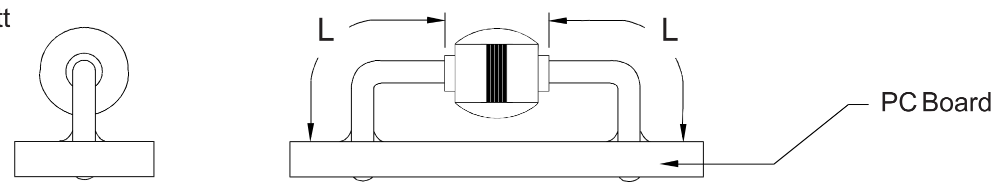

FIGURE 3

Axial Lead Diode with Copper Heat Sink

Isolation Voltage = 15kV
$\theta_{J\text{-}MS}$ = 12°C/Watt

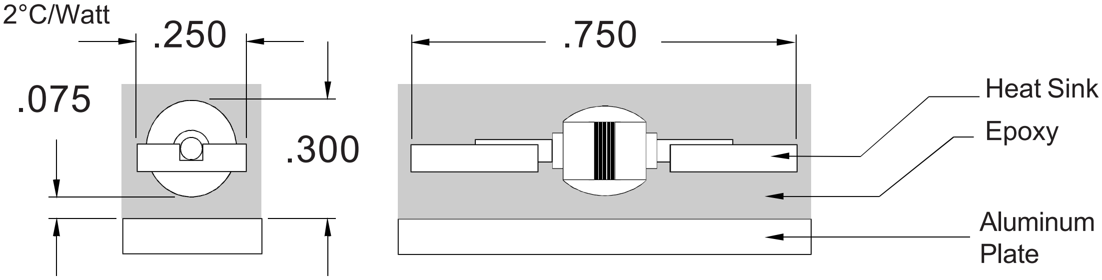

FIGURE 4

Surface Mount

Isolation Voltage = 15kV
$\theta_{J\text{-}MS}$ = 7°C/Watt

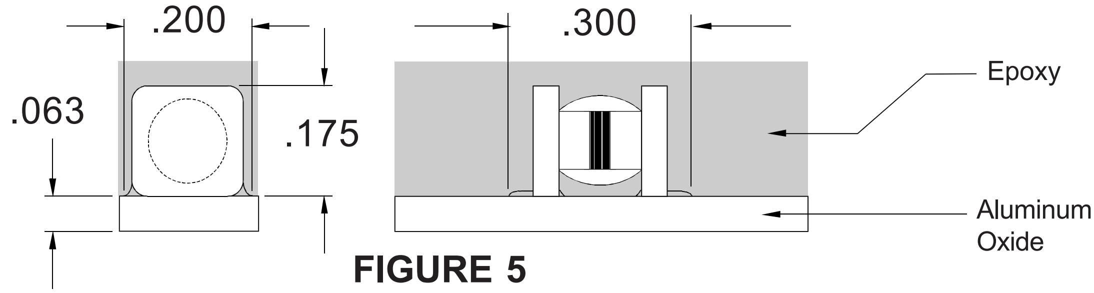

FIGURE 5