

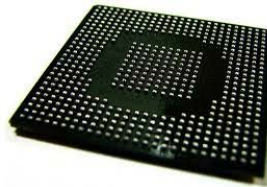
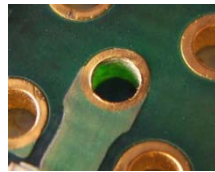
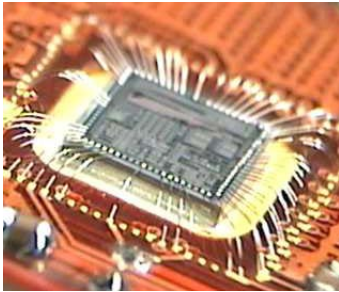
# **Thermal Management of PCBs in Embedded Systems**

# System Thermal Management

- **Improper heat management is responsible for majority of failures in electronic systems**
- **Proper cooling is essential for system reliability and longevity**
- **Thermal management is necessary at component level through system in its operating environment**
- **Features of the PCB play an important role in thermal management**
- **New thermoset materials meet the most demanding challenges by providing consistent performance vs temperature**
- **Multi-physics simulation tools in industry are applied to more easily manage the thermal challenges**

# Integrated System Approach

- Effective thermal management requires integrated systems approach



**Components**

**PCB**

**System**

**Environment**

# PCB Thermal Features

- **Effective heat dissipation in PCBs is achieved by minimizing thermal resistance**
- **Thermal resistance is proportional to the length of the thermal path**
- **Thermal resistance is inversely proportional to thermal conductivity and the cross sectional area of the thermal path**

# PCB Features and Thermal Resistance

- In PCBs, the length of the thermal path is reduced by making the board thinner
- Higher copper content and thermal vias in thickness direction (z-direction) decrease thermal resistance
- The cross section of thermal path is increased by use of larger areas in x,y for heat sink application
- Thermal vias, microvias and burried vias provide vertical heat conduction while copper foil provides horizontal heat conduction

# PCB Material Selection

- **Embedded systems present unique challenges in terms of PCB material selection**
  - Compact nature with high component density, high power density electronics, and small form factor
  - Often diverse operating environment
- **The choice of PCB material is driven by system requirements including frequency of operation, power, noise, size and type of components, layer count and operating environment**
- **PCB material selection plays an important role in achieving consistent system performance**

# PCB Material Considerations

- **Even with effective system thermal management, there can be substantial variations in the temperature of the PCB**
- **These variations in temperature can effect system performance if the proper PCB materials are not used**
- **Use of thermally-robust PCB materials mitigate risk of temperature-dependent performance and enhance system reliability**

# PCB Material Requirements

- **Stable dielectric properties over a wide range of temperature and relative humidity**
- **Consistent thermal-mechanical performance over repeated temperature cycling**
- **Thermal mechanical compatibility with other materials necessary for hybrid PCB constructions**
- **Mechanical compatibility with low-profile copper achieving high peel strength**