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 buried vias provide vertical heat conduction while copper foil provides horizontal heat conduction.
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