

Understanding Failure and Root-Cause Analysis in Electronics

1 or 2 Day Course

ABSTRACT

Increasing needs for performance, low cost, and a constant turnover in the electronics industry makes improving functionality a constant topic of interest. However, restrictions on machine performance (is your computer much better than the one 2 years ago?) and cost (how many more companies can move to China?) have made quality/reliability a critical differentiator in today's crowded marketplace. How to ensure optimum quality/reliability of your product? It all starts with root-cause analysis, which is the fundamental exercise in understanding how electronic products can and will fail.

This course will provide an in-depth understanding of the common mechanisms that initiate failure in electronics and provides a comprehensive review of the tools and techniques to identify those mechanisms. Mechanisms are addressed based upon the packaging level in which they are affiliated, including die, component packaging, discrete components, printed circuit board, interconnect, and separable connector. A physics of failure (PoF) based approach to the mechanisms are taken, with an outline of drivers of these mechanisms, including defect-driven, overstress, and wearout, and how an understanding of these stress-strength interactions can provide guidance on the appropriate corrective and preventative action.

Once the participants have an understanding of failure mechanism behavior, a systematic process of proceeding with a root-cause analysis is provided. An overview of current and effective strategic and physical tools and techniques are provided within progressing stages of least-destructive to more destructive analysis and evaluation. A wide variety of case studies, including red phosphorus in epoxy encapsulants and bulging electrolytic capacitors, are provided as valuable teaching examples.

OUTLINE

- Failure Mechanisms
 - On-Die
 - Overstress (Passivation Cracking, Die Cracking, ESD/EOS)
 - Wearout (Electromigration, Dielectric Breakdown, Hot Carrier Injection)
 - Packaging (Wirebonds, Die Attach, Epoxy Encapsulant)
 - Discrete Components (Capacitors, Resistors, Magnetic components, etc.)
 - Dielectric Breakdown
 - Oxygen Vacancy Migration
 - Insulation Breakdown
 - Hot spot creation
 - Interconnects
 - Solderability Issues
 - Overstress (Mechanical Shock, Bending)
 - Intermetallic Formation
 - Wearout (Thermal Cycling, Vibration)
 - Printed Circuit Boards
 - Manufacturing Defects
 - Conductive Anodic Filaments
 - Plated through hole fatigue
 - Electrochemical migration
- Management
 - Failure Analysis Management and Reporting
 - Documentation (5-Phase, 8-D)

- Tools
 - X-ray Microscopy
 - Acoustic Microscopy
 - Electrical Characterization
 - Visual Inspection
 - Thermal Imaging
 - Mechanism identification (Fishbone, Stress-Strength, Fault Tree)
 - Cross-Sectioning
 - Decapsulation
 - Optical Microscopy
 - Electron Microscopy
 - Ion Chromatography
 - Surface Analysis Techniques (FTIR, EDS, XRF, etc.)
 - Material Analysis Techniques (DSC, TMA, TGA, etc.)
 - Mechanical Analysis Techniques (Microtester, Bend Testing, etc.)
- Case Studies

Who Should Attend?

This PDC is intended as an introductory to intermediate level course for board-level designers, component engineers, quality engineers, reliability engineers, and their managers.

