

## Root Cause Analysis

### Introduction and Objectives

- ◆ Importance of root cause analysis
- ◆ Areas and uses for root cause analysis
- ◆ 7-Step process
  - Define the problem
  - Gather data/evidence
  - Ask why and identify the causal relationships
  - Identify which causes will prevent recurrence if removed
  - Identify effective solutions
  - Implement recommendations
  - Observe the recommended solutions to ensure effectiveness

### Identifying/Defining Problems

- ◆ Developing and testing a hypothesis
- ◆ The need for data
- ◆ Collecting data for problem solving

### Analyzing Data for Root Cause

- ◆ Identify contributing events
- ◆ Event charting
- ◆ Available tools
  - Fault tree analysis (FTA)
  - Stress-strength analysis
  - Design of experiments (DOE)
  - Material analysis
  - Finite element analysis (FEA)
  - Dynamic load analysis
  - Thermal analysis
  - Computational fluid dynamics (CFD)
  - Probabilistic evaluations

### Identifying Root Causes

- ◆ Pareto analysis and Ishikawa (fishbone) diagrams
- ◆ Finite element analysis
- ◆ The 5 whys technique
- ◆ Workshop: applying the 5 whys technique

### Environmental Considerations and Their Role in Accelerating Failures

- ◆ Temperature
- ◆ Vibration
- ◆ Humidity
- ◆ Drop Shock

## RCA Across Different Disciplines

- ◆ Electrical
- ◆ Mechanical
- ◆ Chemical
- ◆ Materials
- ◆ Optical
- ◆ Software
- ◆ Manufacturing

## Electrical RCA: Typical Failure Modes for Different Types of Components

- ◆ Printed circuit boards
  - Manufacturing defects
  - Handling issues
  - ESD effects
  - Conductive anodic filaments
  - Plated through hole fatigue
  - Electrochemical migration
- ◆ Interconnects
  - Solderability issues
  - Overstress
  - Intermetallic formation
  - Wearout (thermal cycling, vibration)
- ◆ Die-Level
  - Passivation cracking
  - Die cracking
  - ESD/EOS
  - Electromigration
  - Dielectric breakdown
  - Hot carrier injection
  - MMIC and hybrid processes
- ◆ Passive parts
  - Resistors
  - Capacitors
  - Inductors
  - Attenuators
  - Crystals
  - Microwave components

## Mechanical RCA

- ◆ Stress analysis
- ◆ Fatigue
- ◆ Fracture mechanics and creep degradation
- ◆ Nonlinear finite element analysis (FEA)
- ◆ Computations fluid dynamics (CFD)
- ◆ Probabilistic evaluations

## Electrical and Mechanical RCA Component Level Tools

- ◆ Radiography
- ◆ 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, pull testing, etc.)
- ◆ Chemical and electrochemical processes (etching, defect enhancement, liquid crystal techniques, etc.)

## Software RCA

- ◆ Understanding similarities and differences between software RCA and hardware RCA
- ◆ Tools employed for software RCA
  - Software FMEA
  - Software FTA
  - Targeted code reviews
  - Implementation of phase containment metrics

## Root cause Analysis Programs

- ◆ Guidelines on conducting individual analyses
- ◆ Resolving recommendations
- ◆ Trending analysis results (plotting a timeline)

## Creating a Root Cause Analysis Program

- ◆ Integrating root cause analysis with other programs
- ◆ Different software packages available vs. developing a “home-grown” system
- ◆ Workshop: creating a root cause analysis program