

## Best Accelerated Life Tests

### Introduction

- ◆ HALT and HASS as part of an overall reliability program
  - Elements of a reliability program
  - Basic definitions
  - Reliability vs. cost
  - Product life cycle matrix
  - Why HALT and HASS?
- ◆ Evolution of HALT
  - Probability ratio sequential testing (PRST)
  - Stress for life (STRIFE)
- ◆ Evolution of HASS
  - Run-in / burn-in
  - Environmental stress screening (ESS)

### Highly accelerated life testing (HALT)

- ◆ HALT: How it works
- ◆ HALT: Why it works
- ◆ Benefits of HALT
- ◆ Margin discovery process
- ◆ Failure modes / mechanisms
- ◆ Testing to the fundamental limit of technology (FLT)
- ◆ Fatigue vs overstress / stress vs. cycles plot
- ◆ Rules of thumb for HALT limits
- ◆ Root cause analysis during HALT / Ask why 5 times
- ◆ Verification of HALT
- ◆ Common design problems
- ◆ Sample size for HALT
- ◆ Commercial vs. industrial vs. military grade components
- ◆ Case studies
- ◆ Summary of results based on 100 HALTs
- ◆ Fixturing
  - How to fixture
  - Examples
  - Fixturing when portions of product are remoted outside chamber
    - Power supply from rest of product
    - Hard drive from rest of PC
  - Fixturing when portions of product are remoted but still inside chamber
    - PCI card separated from motherboard
    - Hard disk heads separated from controller

- ◆ Equipment used during HALT / how to choose a chamber
- ◆ HALT stresses beyond temperature and vibration
  - Humidity
  - Shock
  - Drop
  - Frequency margining
  - Voltage margining (AC/DC)
  - Power cycling
  - Twisting / bending
  - Corrosion
- ◆ HALT return on investment (ROI) calculations
- ◆ Classroom exercises

## **Reliability demonstration test (RDT) / accelerated life test (ALT)**

- ◆ Definitions
- ◆ Types of demonstration tests
  - Failure free testing
  - Sequential testing
    - Time terminated tests
    - failure terminated tests
  - Accelerated life testing
    - Statistics for ALT
      - Exponential distribution
      - Weibull distribution
    - ALT parameters
      - Length of test
      - Number of samples
      - Goal of test
      - Confidence desired
      - Accuracy desired
      - Cost
      - Acceleration factor
        - Field vs. test environment
        - Acceleration factor calculation
      - Wearout factor
  - Acceleration factor models
    - Arrhenius model
    - Eyring model
    - Coffin-Manson
    - Norris-Lanzberg
    - Others

- Determining acceleration factor by experimentation
- ◆ HALT vs. ALT: When to use which technique
  - Comparison between HALT and ALT
  - Combining ALT with HALT
  - Developing ALT from HALT
  - Examples of products for HALT and ALT
- ◆ Ongoing reliability testing
  - Comparison between ORT and HASA
- ◆ Integrating RDT into a reliability program
  - How to use the results of HALT in planning an RDT
  - How to use the results of reliability predictions in planning an RDT

## Highly accelerated stress screening (HASS)

- ◆ HASS: How it works
- ◆ HASS: Why it works
- ◆ Benefits of HASS
- ◆ When to start planning for HASS
  - HASS process steps before HALT is complete
  - HASS process steps after HALT is complete
- ◆ Screen tuning / assuring an effective screen
- ◆ Precipitation / detection screen examples
- ◆ How to avoid wearout
- ◆ Fixturing
  - How to fixture for HASS
  - Examples of fixturing for high volume
  - Examples of fixturing for low volume
- ◆ Sample size for HASS development
- ◆ What to do with soft failures during HASS
- ◆ Rules of thumb for HASS profile limits
- ◆ HASS development: 4 different options
  - High volume / small HASS development sample
  - Low volume / small HASS development sample
  - Low volume / large HASS development sample
  - Low volume / using no trouble found samples
- ◆ HASS profile examples
  - HASS for wide operating limits
  - HASS for narrow operating limits
  - Precipitation-detection screens
- ◆ Root cause analysis during HASS
- ◆ HASS results: examples of failures
- ◆ When to change a HASS profile
- ◆ Alternatives to HASS
  - Burn-in
  - ESS
  - System level vibration

- 5DX x-ray
- Acoustic testing
- ◆ HASS / ESS hybrids
  - Board level HASS / system level vibration only
  - Temperature cycling / vibration separated
- ◆ HASS return on investment (ROI) calculations

## Highly accelerated stress auditing (HASA)

- ◆ HASA: How it works
- ◆ HASA: Why it works
- ◆ Benefits of HASA
- ◆ Steps to HASA
- ◆ When to switch from HASS to HASA
- ◆ HASA example
- ◆ Statistics behind HASA
- ◆ HASA return on investment (ROI) calculations

## General information

- ◆ Thermocouples / Accelerometers
- ◆ Support equipment
  - Vibration analyzers
  - Dataloggers
- ◆ Troubleshooting equipment
  - Strobes
  - Hand-held vibration tools
  - Scopes
- ◆ Setting up a HALT lab
  - Writing a plan
  - Writing a report
  - List of the best HALT labs for reference
  - Equipment needed for calibration

## Summary of HALT, HASS, and HASA

- ◆ What is required for a successful program
- ◆ Champion
- ◆ Training
- ◆ Commitment
- ◆ Management support
- ◆ Root cause analysis

## Integrating HALT, HASS, and HASA with the rest of your reliability program

- ◆ Analytical tools that support the HALT, HASS, and HASA planning process
  - Predictions, derating, FMECAs
  - Designs of experiments (DoEs)
  - Finite element analysis
- ◆ Analytical tools that can be used in conjunction with HALT, HASS, and HASA

- Failure reporting analysis and corrective action process (FRACAS)
- Root cause analysis process
- ◆ Analytical and testing tools that can be used after completion of HALT
  - Designs of experiments (DoEs)
  - Reliability demonstration tests (RDTs)
- ◆ Analytical and testing tools that can be used to determine when to transition from HASS to HASA
  - Reliability statistics
  - Control charts, paretos
    - Root cause analysis