



# **PLOT 20 Year System Reliability Test, HALT & HASS**

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## Outline

- **MASER Engineering**
- **Introduction**
- **HALT**
- **HASS**
- **HALT & HASS**
- **Q&A**

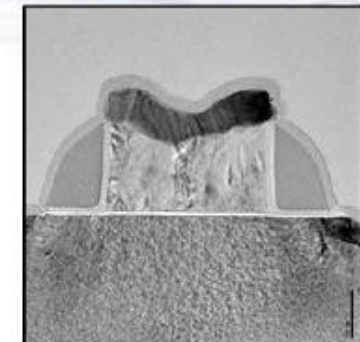
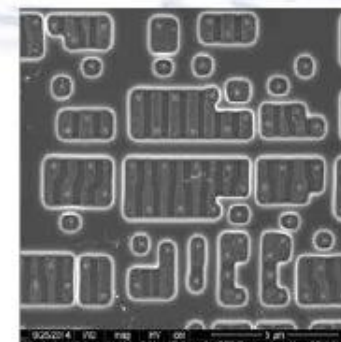
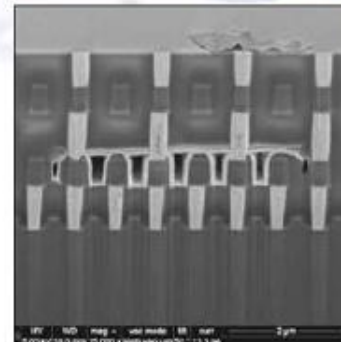
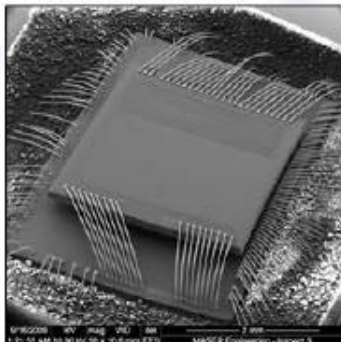
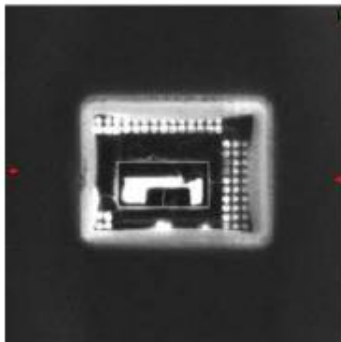
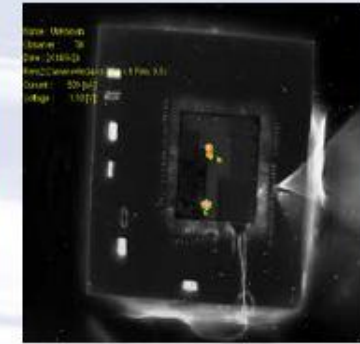
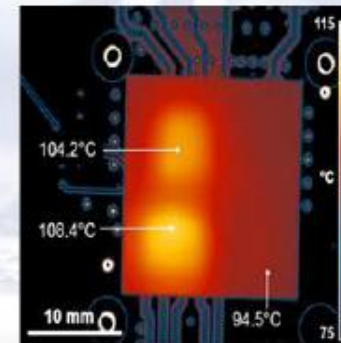
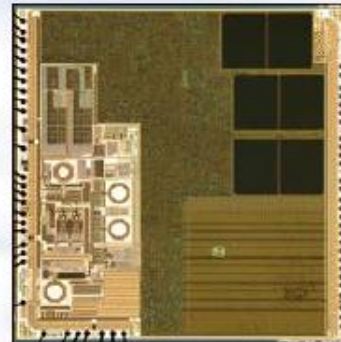
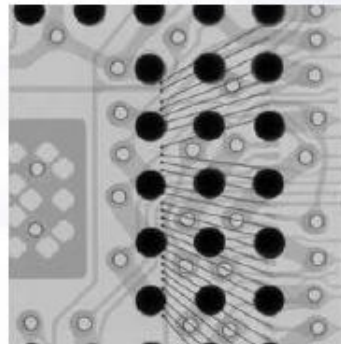
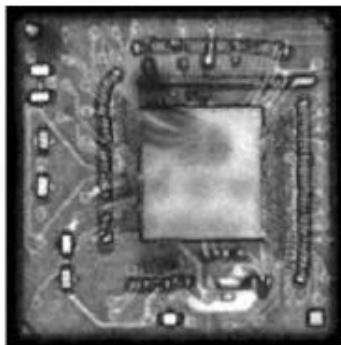
## Introduction: MASER Engineering

- MASER Engineering is a Dutch based Independent Service Provider
- Advanced Failure Analysis capabilities
- Full Reliability Testing including all climatic, structural and ESD testing
- 42 well trained and experienced employees for Test and Diagnostics services
- ISO 17025 accredited and ISO 9001 certified Lab
- Representatives covering the EMEA area
- 23 years active since 1993
- 1950 m<sup>2</sup> office and EPA test & analysis laboratories in Enschede, NL



## Product scope: Physical Analysis

- Non Destructive Analysis: E-test | 2D-XRAY | 3D-XRAY | SAM | LIT | EOTPR
- Sample Preparation: mechanical cross-sectioning | plasma | FIB
- Fault Localization: LIT | EMMI | OBIRCH | LVx | C-AFM
- Imaging & Material Analysis: Optical | SEM | TEM | FIB | AFM | SIMS | Auger
- First Silicon Circuit Edit service > 28nm, Front and Backside, CAD driven





## Product scope: Reliability Test

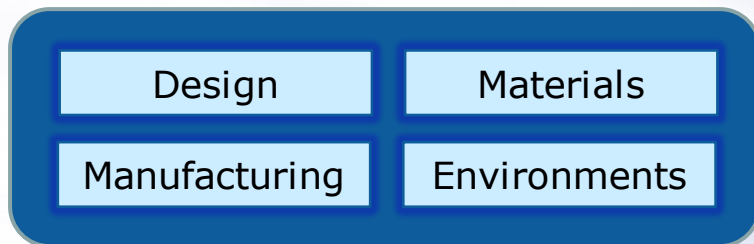
- Design and Manufacturing of R/T boards and mechanical test fixtures
- Electrical & Special Test: DC + optical parametric | Structural | ATE | LEDs
- ESD & Latch-Up test: HBM | MM | CDM | TLP | System test
- Environmental test: HTOL | THB | HAST | TCY | MSL | PTC | more
- Mechanical test: Vibration | Shock | Centrifuge | Bending | Pull/Shear | more



# Introduction: Reliability

## ■ Reliability definition

- “The probability that an item can perform its intended function for a specified interval under state conditions.” [MIL-STD-721C, 1981]



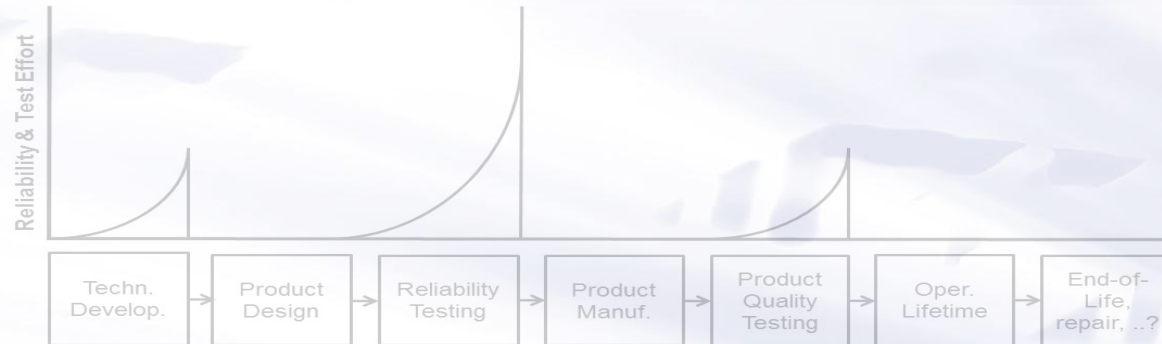
Application	Operating T [°C]	Lifetime [years]
Consumer	0 to 70	3-5
Industrial	-40 to +85	7-10
Automotive	-40 to +125	15-20
MIL / Space	-55 to +125	20-30
Medical	0 to 70	20-30

## ■ Trends that have an impact on Reliability

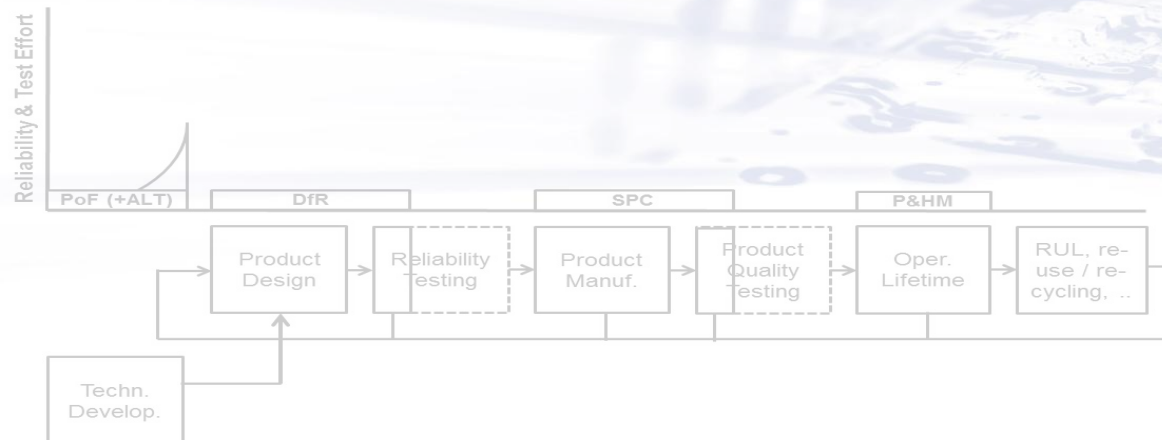
- Lifetime expectations are changing
- Interconnect complexity and density
- Miniaturization and integration require more thermal management
- Need for “alternative” materials (e.g. green, flexible, 3D printed)
- Faster pace of introduction of new materials and technologies
- Constant pressure to reduce Time-to-Market, Time-to-Volume and costs
- Less available time to test and to build confidence in new materials and techniques

# Introduction: Product Life Cycle

- Traditional Product Life Cycle
  - Based on Design → Build → Test → Fix and Test



- More advanced approach to Reliability Engineering
  - Includes important Reliability Engineering concepts



PoF= Physics of Failure  
**HALT= High Accelerated Lifetime Testing**  
 DfR = Design for Reliability  
 SPC = Statistical Process Control  
 P&HM = Prognostics & Health Management  
 RUL = Remaining Useful Lifetime

## HALT: Design validation

### ■ **Highly Accelerated Life Testing**

- Method developed in mid 70's in order to shorten DVT iterations
- Addressing interconnects intermittent defects with OVS design
- Faster feedback from material weaknesses to the design and manufacturing process
- Process drifts should become more and better visible
- Better correlation with field returns

### ■ **Where does HALT fit in the design process?**

- There has to be a functional and stable prototype
- Preferable manufactured on the final assembly line with final materials
- Functional and Parametric monitoring to be implemented in the design

### ■ **What does HALT do and what not?**

- It is not a PASS/FAIL test
- It will not generate a MTBF figure
- It allows you to make your product more robust, with faster qualification cycles



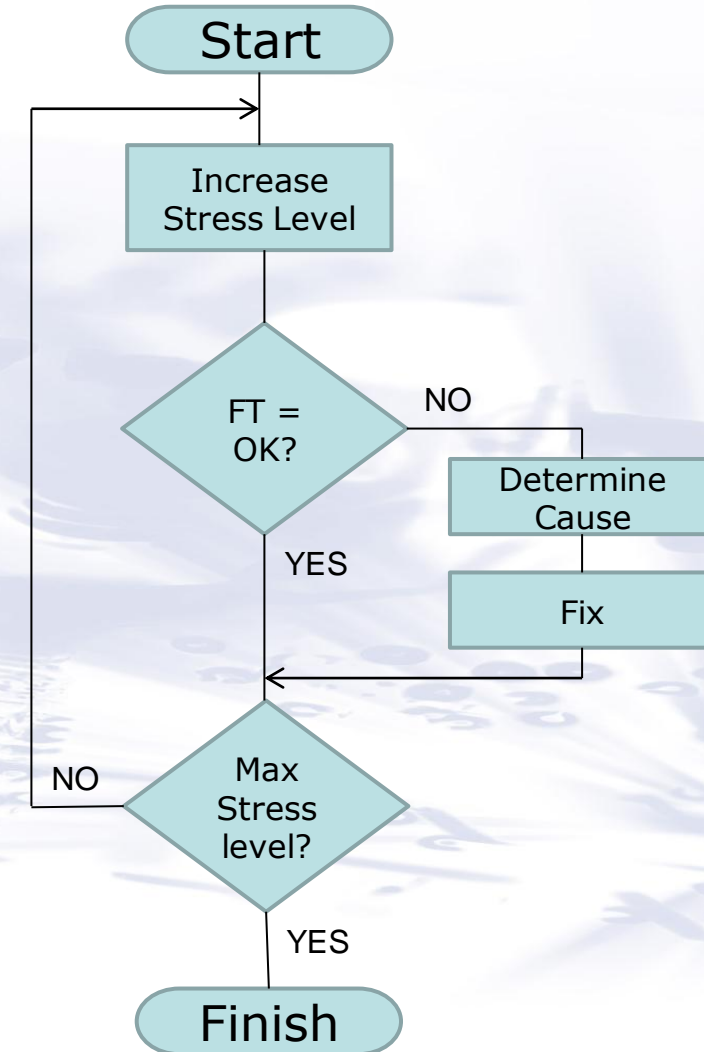
## **HALT: What is it**

- **Design tool**
- **Discovery process**
- **Step stress approach**
  - Incremental, controlled, documented
- **Multi stress test**
  - External: temperature, temperature change, vibration
  - Product specific: power, current, load, frequency, pressure, force, etc.
- **Stress product outside specifications**

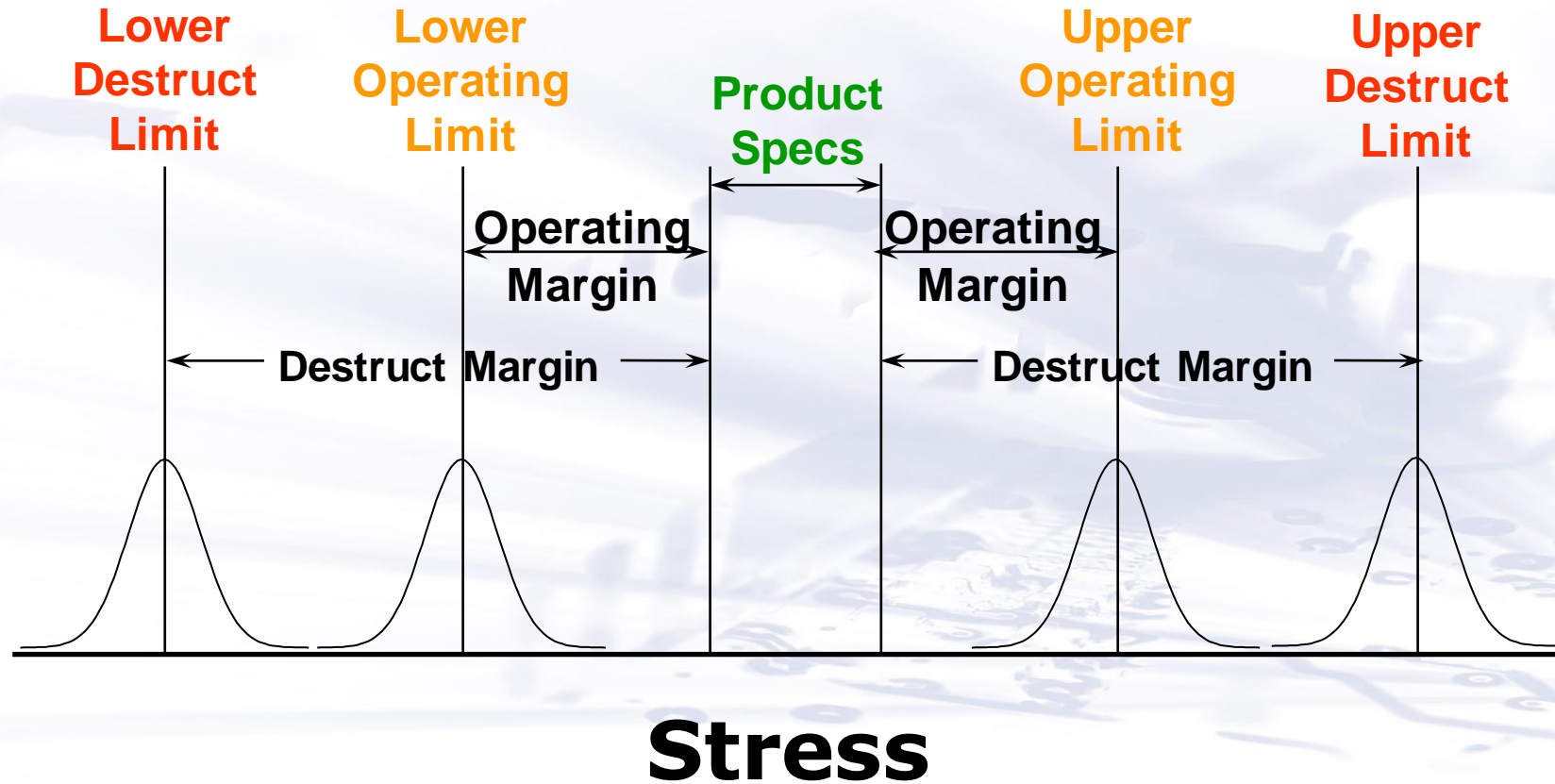
# HALT: Process

## ■ Process flow

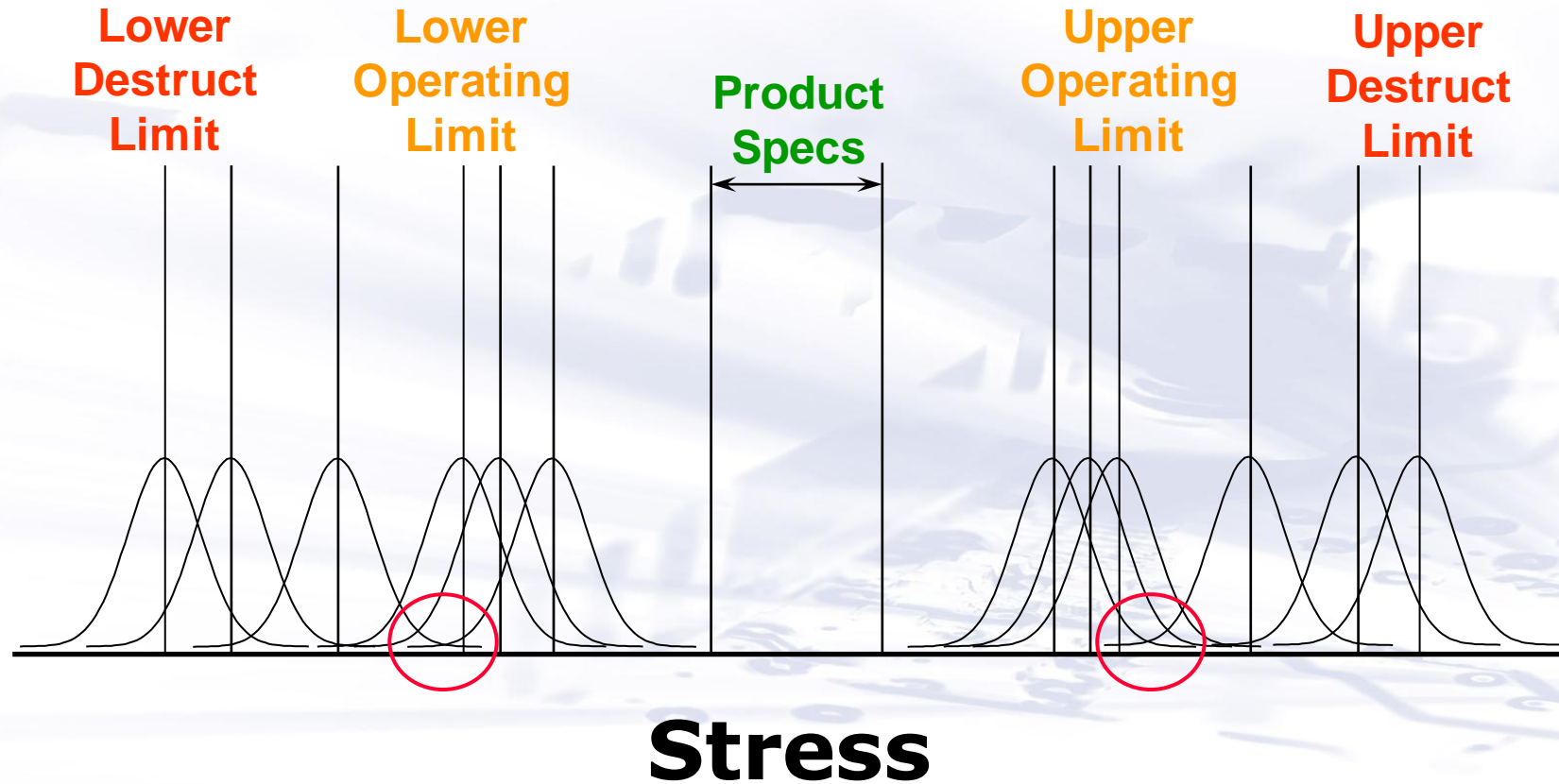
- Each stress type is applied individual and combined.
- Stress levels are stepwise increased.
- Start with the least fatal stress type.
- At each stress level a functional test is performed.
- If failure or issue is found, determine the cause and fix it 'on the fly'.
- Increase stress level, perform functional test, fix, continue.



# HALT: Product Margins

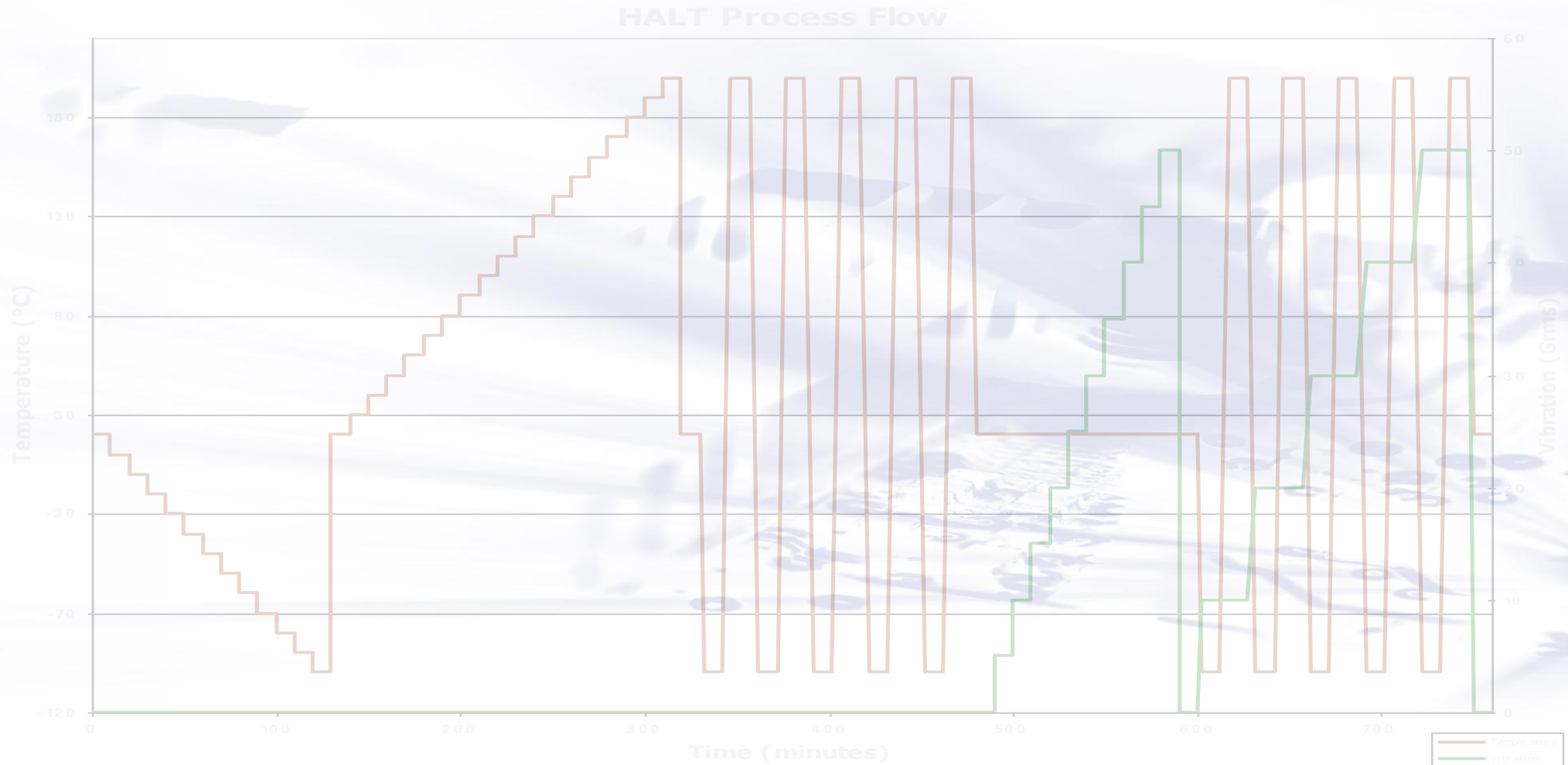


# HALT: Product Margin Aging





# HALT: Process over view

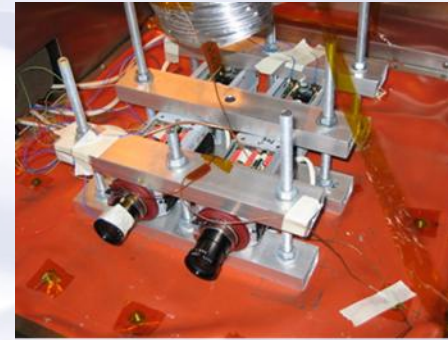
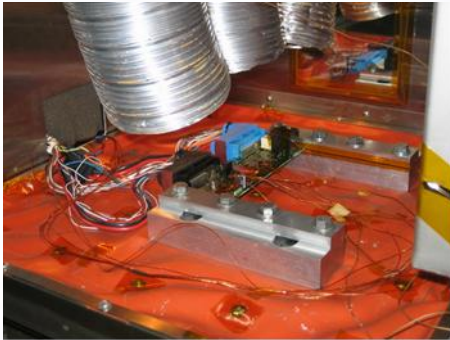


## HALT: Preparations

- **HALT can only be successful after proper preparation**
- **At what stage of design process HALT to be performed**
- **Preparation meeting with Design, Test and HALT engineer**
  - System description
  - Sample size definition, based on cost and availability
  - Functional and Parametric E-test definition
  - Mechanical / Thermal construction assessment
  - Mechanical fixture design directive
  - Parts list scan for destruct limits
  - Initial HALT limits estimation
  - Spare parts and repair guideline
  - Onsite and Standby crew definition during HALT sequence testing
  - HALT planning and quotation

## HALT: Examples of systems

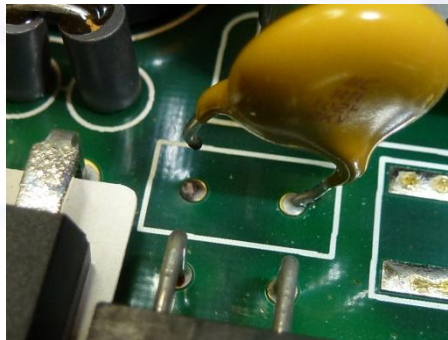
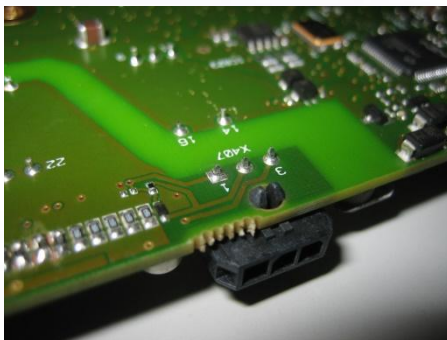
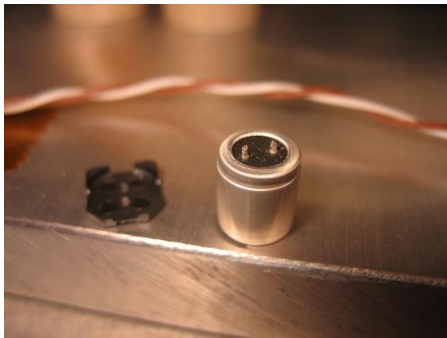
- Multiple small units for redundant behavior study
- Larger systems in partly open position





## HALT: Failures and issues

- Electrical detectable
- Visual detectable
- Hardware and software





# HASS: Production validation

## ■ **Highly Accelerated Stress Screening**

- This is a test with PASS/FAIL result
- Screening of manufacturing process and products
- Stress parameter settings based on HALT results with safe margin
- Stress parameters still outside the product specification
- Use same OVS system as HALT

## ■ **Goal of HASS**

- Find any deviation in the produced unit quality due to change of assembly process, component quality or material
- Either sampling or 100%, depending on application and lot sizes

## ■ **Implementation of HASS**

- Screening and Sampling plan
- HASS validation by 5x test execution without deterioration of the system
- Multiple unit fixture construction with fast access
- Multiple unit driver/monitoring setup
- Larger OVS system

# **HASS: Implementation**

- **Final stage of product design**
- **HALT evaluation results**
- **Fixture with multiple positions and easy access**
- **Functional test system, Pass/Fail**
- **HASS screen evaluation results**

## HALT & HASS: Users

- **Aerospace**
  - Cockpit flight information display, Passenger entertainment center, ...
- **Automotive**
  - Motor management, Sun roof control, LED-tail light, ...
- **Domestic appliance**
  - Mobile home refrigerator control, Personal care, ...
- **Telecommunication**
  - DECT and GSM base station, Burglar alarm system, ...
- **Lighting**
  - LED-light, Beamer light assembly, ...
- **Medical**
  - O<sup>2</sup>-sensor, X-ray imaging system, ...
- **Industrial**
  - Ethernet switch, Compressor management system, Power grit control, ...
- **Sensors / actuators**
  - Pressure sensor, Mass flow meter, Valve actuator, ...

## HALT & HASS: Past to future

### ■ 1999

- HALT system purchased at MASER
- Introduction and development of HALT test for customers
- Main failures / issues: Mechanical failing leads and solder joints

### ■ 1999 – 2016

- Reduction in number of mechanical failing leads and solder interconnects
- Reduction in number of mechanical failing solder joints (mature lead free process)
- Slight increase of 'real' design related issues

### ■ 2016 - ...

- Increase of HALT adoption for in depth design checks by designers
- Increase in number of designs where HALT is integrated in the design process
- HALT not being "a must" but changed to "a want to" test to improve design concepts in an early phase to minimize reliability issues and field returns



## HALT workshop offer

### ■ HALT workshop

- HALT introduction and place in the system design & manufacturing flow
- Live setup and preparation at QualMark OVS 1.5 system
- All HALT functions will be demonstrated
- Dewetron BeNeLux is partner for the data acquisition hardware and test object

### ■ Workshop location and information

- MASER Engineering, Capitoel 56, 7521 PL Enschede
- More information at Simon Bakker or Mark Gortemaker, T +31534802680
- E-mail: [simon.bakker@maser.nl](mailto:simon.bakker@maser.nl) or [mark.gortemaker@maser.nl](mailto:mark.gortemaker@maser.nl)
- Registration per e-mail at **[sales@maser.nl](mailto:sales@maser.nl)** or at our booth during this conference

**???? Questions & Answers !!!!**

**Thank you for your attention!**