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In Space Applications
Encapsulated Microcircuits (PEMS)
Performance/Reliability of Plastic
Different Approaches for Ensuring
Significant Findings

APL: APEX & TIMED
JPL: MARSO1 Pancam

Deringing Practices

Tailored Testing Approach

JPL's & APL's Experiences with PEMS

Outline
Visual & Mechanical Inspection
Electrical Measurements, Radiographic Inspection,

Screening Process

Must Meet Specific Mission Requirements

Application for PEM
Space Environment, Not Intended

Mitigating Risk
Obtained From Manufacturer
Humidity Bias Only Performed If Data Can Not Be
Temperature Cycling & Steady-State Temperature

Quantification Process

Mitigating Risk
Followed recommended industry guidelines for PEMs

Proximity of PEMs to Optics

Approximately 365

-50°C to +10°C

1500 Hours Operating

JPL - MARS01 Pancam

Program Results
Converter (A-D), & DC-DC Converter (DC-DC)

3 Vendors / 3 Part Types: Amplifier, Analog-Digital

Spellout:

- Ready
- Flight
- Qualification
- Assembly
- Test
- Hardware
- Assembly
- Mini Part Qual
- Screening
- Part Level
- Electrical
- Bump
- Electrical
- Electrical
- C-SAM
- Temp Cycle
- Electrical
- DPA
- Identify & Review Requirements
- Custom Tailor Objectives

Program Results

JPL - MARS20 PanCam Test Flow:
C-SAM: Reject Criteria Defined by JPL

Contact Windows

SEM: Voids in The Side-wall Metallization at

3 8 16
30 1

Test Amplifier A-D DC-DC

JPL - MARSOI PanCAM Test Results

Program Results
Program Results
No Special Handling Precautions Taken

Due to Short Duration of Mission

Black Brant XLI Sounding Rocket

0°C to +25°C

17 Minutes Operating

APL - APEX Program
"Plug-in Test"

Sinusoidal & Random

10 Powerled Temperature Cycles, -10°C to +60°C

APL - Apex Program Test Flow:

Program Results
Met or exceeded
All Science Goals
Successfully Launched on January 22, 1999

APL - APEX Program Test Results: Program Results
Use of Dry-Box, Bake-Out & Conformal Coat

All Parts Assessed and/or Tested

0°C to +50°C

-40°C to +100°C

2 Years Operating

APL - TIMED Program

Program Results
Qualification

Op. Life
High Temp
Hum. Bias Life
Steady-State
Cycle
Temperature

DPA
(C-SAM)
Rad

 Ihr reg'd

Results

Part Levels
Screening
X-Ray
Reel-Time
Mechanical
Visual &
Electrical

Identity & Review Requirements

Cost & Timer Objectives

APL - TIMEED Program Test Flow:
Test

Int-Ckt Res-Net Xistor

APL - TIMED Program Screening Results:

Program Results
16 Rejected for loss of traceability
Only 2 of 18 Radiographic Failures legitimate
Additional Tolerance can lead to false readings
Fixture Limitations suspected for high failure rate
36 Pieces exceeded resistance All 3 Temperatures
Electrical Failures attributable to single Line Item

Lot Not Tested at Temperature (Fixture Limitations)
All +25°C Parametric (3 PRR; 1 AOL)
4 Electrical Failures attributable to single Line Item

Program Results:

APL - TIMED Program Screening Results:
Results of 1 Xistor Test Pending

100 Hours Exceeds 2X Mission Life (N, Sinhmadari, Fg)
Passed Post-100 Hour Measurements
Failed Functionally Post-200 Hour Measurements
Failure attributable to Single Line Item

Results of 1 Xistor Test Pending
Reworked Parts Passed
Parts Not Properly Soldered to Test Board
Failure attributable to Single Line Item

APL - TIMED Program Qualification Results:

Program Results
Mitigated by Conformal Coating

- Small Edge Delamination: These were T/C units
- Lead-Frame Element Delamination (top & back side)

2 Int-Ckt Line Items Had Questionable C-SAM Results

Mitigated by Program Life Testing

Commercial Products Not Designed to 50% Criteria

- 50% Minimum: 30% With Cavities
- All For Not Meeting MIL-STD-883 Step-Coverage Reg.

Failures Attributable to 15 Line Items

Program Results:

- APR - TIME Program Qualification Results
Delta ≈ 0.3%
Parts Rated to +70°C
Exceeded Resistance at +100°C
Failures Attributable to Single Line Item

Res-Net:
Delta > 10%
Devices at Threshold at Start of Test
Exceeded +100°C Limit for ICCL
Failures Attributable to Single Line Item

Int-CTC:

APL - TIMED Program Qualification Results:

Program Results
Delta Not Available

Parts Rated to +70°C

1 Device Exceeded +100°C Limit for ICBO

1 Device Exceeded -40°C Limit for HFE

Failures Attributable to Single Line Item

Xistor:

APL - TIMED Program Qualification Results:

Program Results
Reassess Testing; Consider Sampling

By some

Benefit of Performing Test is Considered Subjective

Alternate: Develop New Industry Standard

Accommodate Commercial Design Practices

Revision to MIL-STD-883, on Step-Coverage, to

Significant Test Result Findings:

Program Results
Areas That Need to be Addressed

• JPL & APL Test Results Have Identified Two Key

Screeining, Qualification, Environmental Stress Screening

Requirements

• Use of PEMS Tailored Around Individual Mission

• Commercial Parts Are "Mission Enabling"