SPWG

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NEPP/NEPAG COTS INITIATIVE PROGRAM

(update)

Making COTS PEMS Work for NASA

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Agenda

- Introduction
- Contributing Organizations
- NEPP Roadmap
- Baseline Time Chart
- Questions to Answer
- Microcircuits Under Evaluation
- Screening/Packaging Evaluation Steps
- Preliminary Findings
- Data Process/Analysis
- Concluding Remarks

Introduction

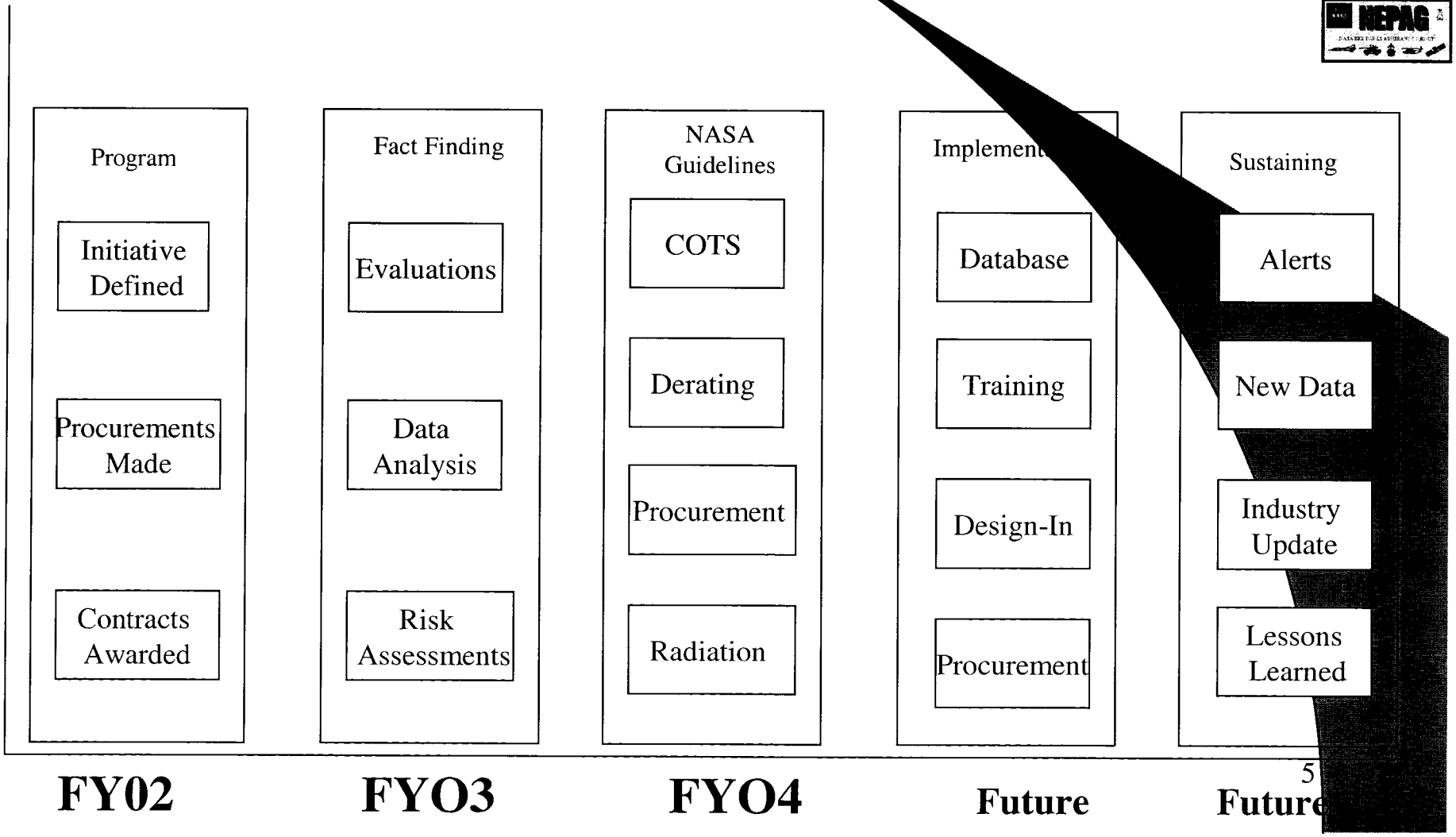
NASA's use of COTS PEMS electronic components in future Space applications has raised serious concerns & issues about their inherent reliability and quality.

To fully understand and risk rate these concerns & issues, NASA is undertaking a *comprehensive* investigation and performing *extensive* evaluations of various COTS components from selected manufactures.

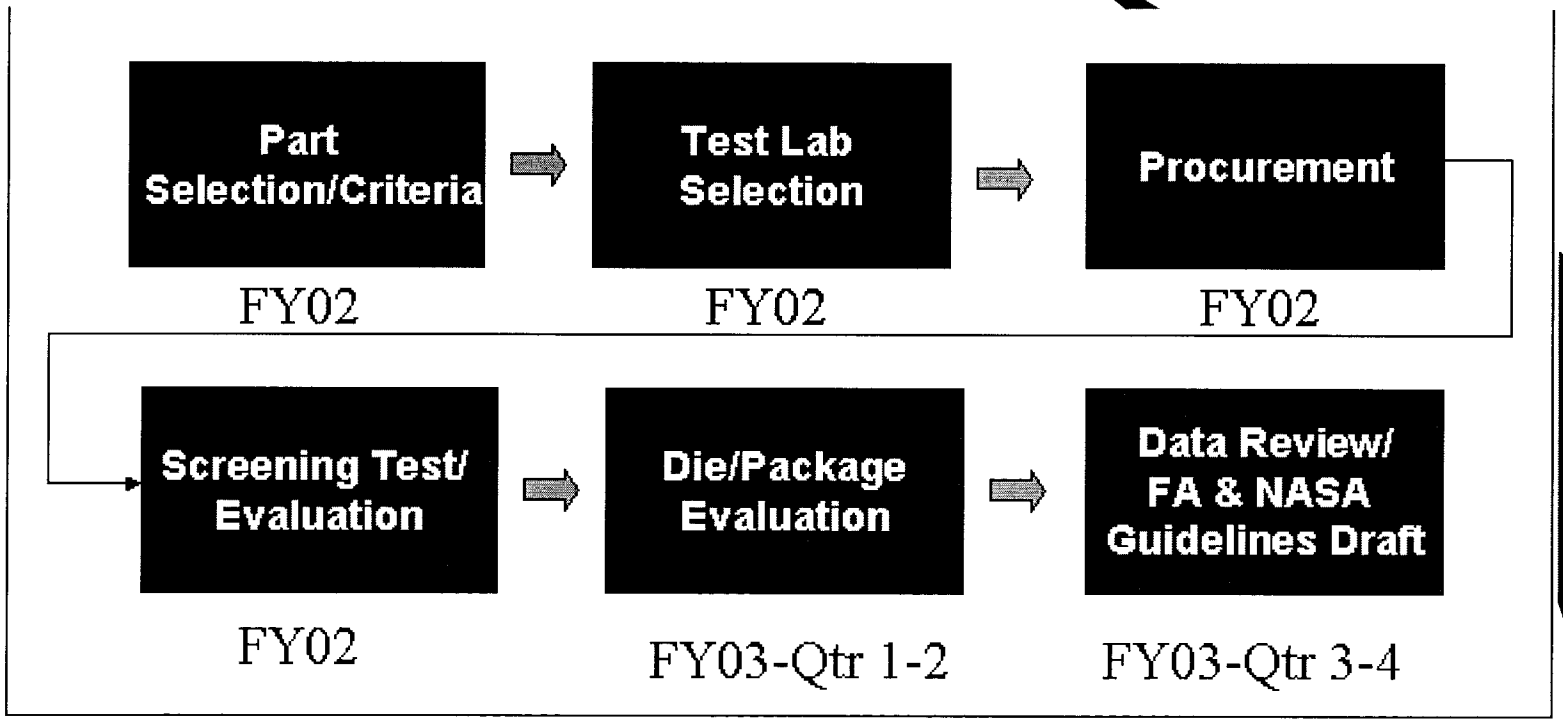
NASA EEE Parts Assurance Group Contributing Organizations

- NASA/ARC
- NASA/GRC
- NASA/GSFC
- NASA/JPL
- NASA/JSC
- NASA/KSC
- NASA/LaRC
- NASA/MSFC
- AMCOM
- NAVSEA
- USAF/Aerospace Corporation
- USAF/Northrop Grumman ICBM
- ESA
- JHU/APL
- NASDA
- CSA

NEPP's Roadmap for Insertion of Reliable COTS PEMS into NASA Hardware



Baseline Flow & Timeline Chart



Questions for NASA that the NEPP COTS PEMS Evaluations/Roadmap will answer:

- What is the inherent quality of COTS PEMS?
- What is the inherent reliability of COTS PEMS?
- What are the product variations expected with COTS PEMS?
- What Elements of COTS PEMS screening/qualifications are due (how should NASA upscreen and qualify COTS PEMS)?
- Which of the vendor's many claims are really true?
- What risks should be assigned to using COTS PEMS for typical and special unique Space applications/environments?
- Where is the optimal balance between risk and cost tradeoffs when using COTS PEMS? When does the end justify the means?
- When should derating be used?
- What is the optimum path to part procurements?
- What radiation performance precautions are necessary?

COTS PEMS Under Evaluation

- 8 Bit High Speed, Ultra Low Power A/
- 16 Channel Analog Multiplxer
- High Speed Operational Amplifier
- High Precision Reference
- High Common Mode Voltage Difference Amplifier

(Each microcircuit is from a different vendor/process with multiple date codes in some cases; ss=250 per part type.)

Screening/Evaluation Steps Include:

- DPA
- Serialization
- Electricals
- Static Burn-In
- Temperature Cycle
- X-Ray
- CSAM
- Dynamic Burn-In
- Dynamic Life Test
- FA

Planned Packaging Evaluations Include:

- ❑ Lead Solder Heat Exposure
- ❑ Extended Temperature Cycle
- ❑ HAST (no preconditioning)
- ❑ HAST (with preconditioning)
- ❑ Moisture Level Sensitivity
- ❑ Experiments with Delaminated Packages

DPA & Screening Findings

Manufacturing Variation/Defects Concerns

Package Delamination

Examples (accepted with waiver)

Topside (medium risk)

Thruscan (medium risk)

Backside (medium risk)

Examples (not accepted)

Topside (high risk)

Thruscan (high risk)

Backside (high risk)

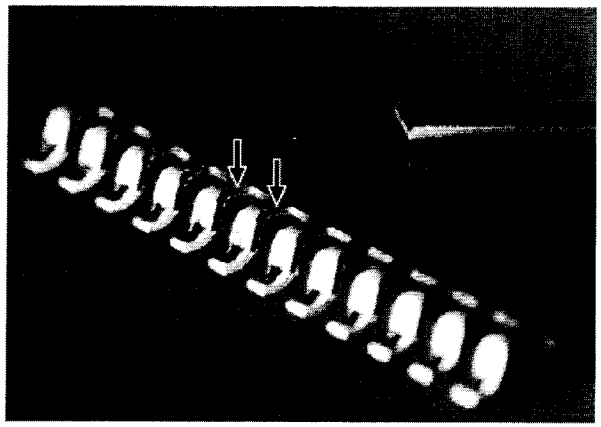
C-SAM Inspection Characteristics:

- Nondestructive Method
- Ultrasound Signal
- Ceramics, Plastics, Metals
- Voids, Cracks, Delamination, Anomalies, Defects, Dishonds
- Relatively inexpensive
- Cheap Reliability Insurance

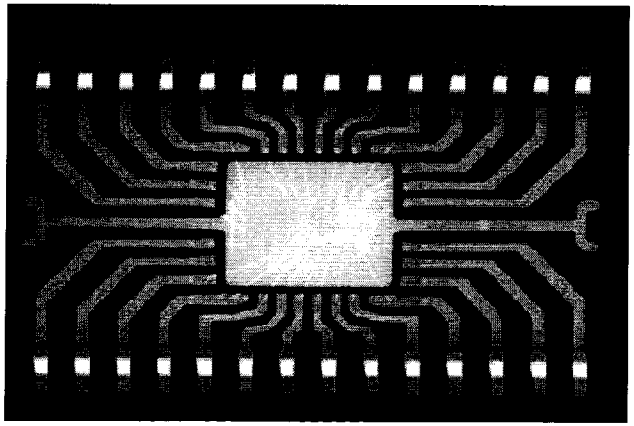
Possible Failure Mechanisms Reported:

- Stress-induced passivation damage over the die surface
- Wire bond degradation due to shear displacement
- Accelerated metal corrosion
- Die attach adhesion
- Intermittent electricals at high temperature
- Popcorn cracking
- Die cracking
- Device Latch Up

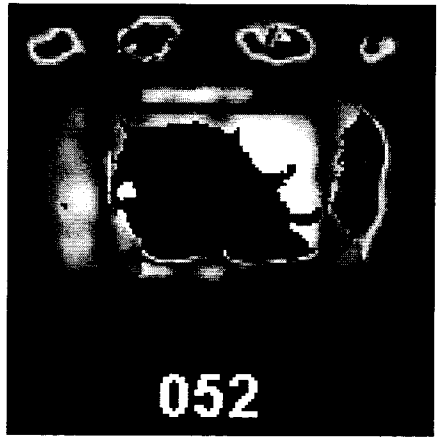
Manufacturing Variation/Defects Concerns



Exposed Base Metal on Leads

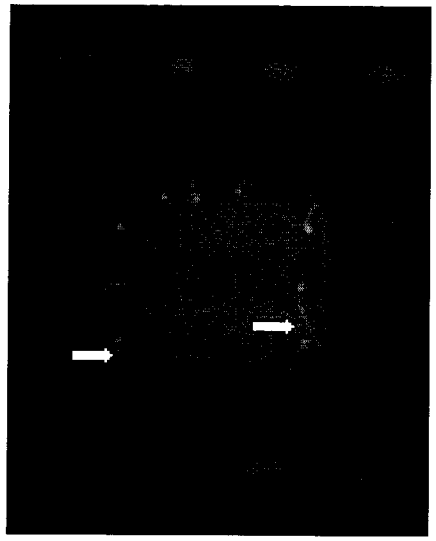


Die Attach Voiding

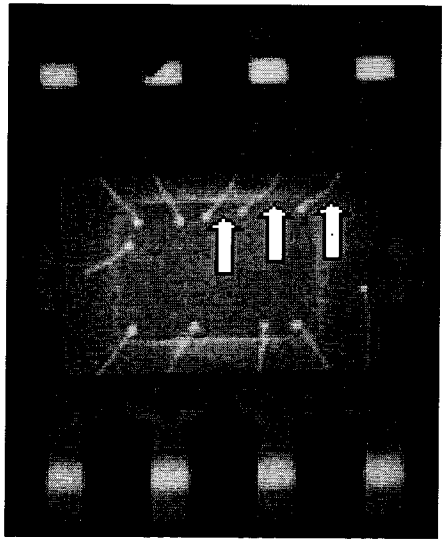


Non-uniformity of Die Coating

Manufacturing Variation/Defects Concerns



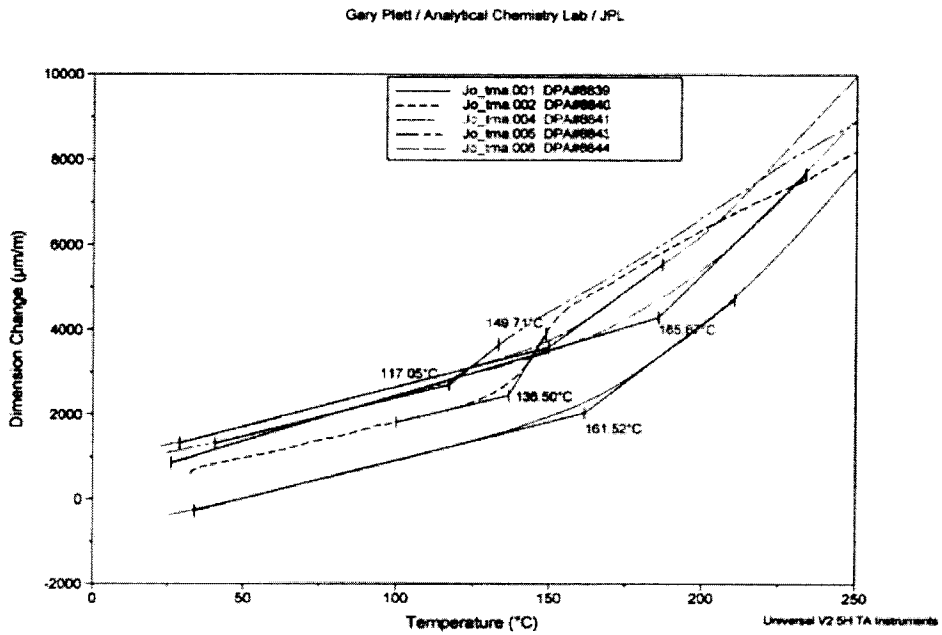
Wire Sweep

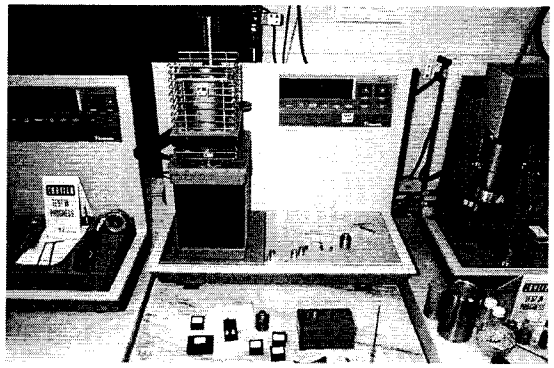


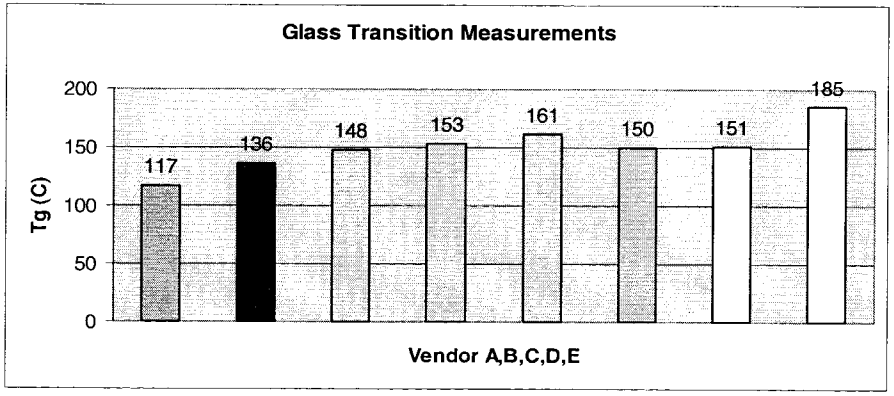
Bent Wire

Manufacturing Variation/Defects Concerns

Low Glass Transition Temperatures



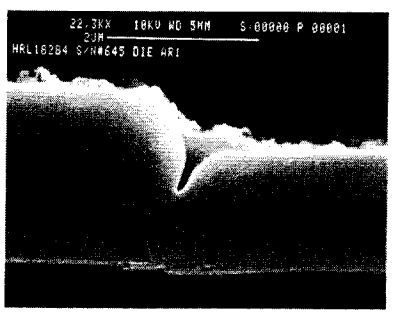




Manufacturing Variation/Defects Concerns

Other Problems

- Lack of lot traceability and part uniformity
- Purple Plague ($AuAl_2$)/ Kirkendall Voiding
- Cold Start-Up Performance
- Maximum Tj allowable with low (<125°C) and high Tg (>170°C) of molding compounds
- Performance beyond commercial/industrial temperature range
- Use of Pb free plating of leads (pure tin)
- Barrier/Aluminum/Copper Metallization Coverage



Manufacturing Variation/Defects Concerns

- Electrical Outliers (data in review)
- Electrical Failures (data in review)
- Burn-in Failures (data in review)
- Life Test Failures
- Package Evaluation Failures

Data Process Review/Parameter Analysis:

- ❑ Test house raw data approval/review
- ❑ Test data extraction into analysis format
- ❑ Review of every parameter by temperature and serial number
- ❑ Statistical summaries with graphic formats
- ❑ Selection of parts for life test and package evaluation
- ❑ Correlation of failures to all tests performed
- ❑ FA if required
- ❑ Final SN compilation and report

(Accumulated test parameters, over 6 temperatures, vary from ~ 20,000 to 90,000 per part type)

Concluding Remarks

- This is a cooperative effort undertaken by seven NASA Centers to evaluate COTS PEMS for Space applications.
- Using a Space level component (hermetic) is still the recommended choice over the equivalent non-hermetic.
- "COTS" should be approached with caution and used only with proper evaluation, testing, and or qualification (including for radiation).
- The published COTS reliability data of vendors is relative to the commercial environment and not relative to the Space environment.
- The total overall objective of this multi agency task is to facilitate insertion of COTS PEMS into NASA and other governmental agency Space systems at minimal risk and cost.