COTS at JPL

Jeff Sokol
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What is a COTS part?

- Generally, a COTS part can be considered to be any part that does not come off a government monitored/certified fabrication line.
  - PEMs
  - Commercial grade ceramics
  - 883b
Some COTS Issues

- **Reliability**
  - COTS parts may or may not be as reliable as QML product

- **Useful life**
  - COTS parts with inadequate burn-in may result in degraded circuit design margins during deployment

- **Non-homogeneity**
  - COTS parts tend to have a higher degree of non-homogeneity than QML (particularly when compared to Class S product) parts
    - Lot qualification becomes more problematic as a function of the degree of non-homogeneity

- **Up-screening temperatures may result in damage to PEMs**
  - Glass transition temperature of plastic encapsulant needs to be addressed
PEM Reliability Performance

PEM Assessment Results
(1997-1999 data)

- Pass: 70%
- Fail: 17%
- Marginal: 13%
Life of a Part

<table>
<thead>
<tr>
<th>1-20 wks</th>
<th>10-20 yrs</th>
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early life mortality  
(normal lifetime) useful life steady state  
(old age wearout)  

(slightly decreasing)
Homogeneity Control

* = Radiation Test Sample

Class "S"

Class "B"
Glass Transition Temperature

Required $T_j$(Burn-In/operating) or Storage Temperature($T_s$) vs Recorded $T_g$

$T_j$ or $T_s$ should be 20°C min. below the recorded $T_g$ to mitigate any reliability failure modes:

- The measurement error using TMA method is ±2°C
- The beginning of $T_g$ phase change can be up to 10°C or more below the recorded $T_g$. 

Presentation date

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
How Rigorous Does the COTS Upgrade Regimen Need to be?

- There is no one universal Upgrade Regimen for all space missions
- Which ever regimen you pick must consider the following
  - Part application
    - Mission impacting application (e.g. ACS) vs. non-mission impacting application (e.g. instrument)
  - Cost vs. risk reduction
    - At what point does risk reduction bang for the buck fall below a reasonable level for the intended part’s application?
  - Potential Schedule slip vs. risk reduction
    - When does potential schedule slip impact offset the return from the risk reduction regimen?
Comparative PEMs Suggested Upgrade Regimen as a Function of Mission Duration

<table>
<thead>
<tr>
<th>COTS (1)**</th>
<th>COTS (3)**</th>
<th>COTS (19)**</th>
<th>COTS (1G)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Time</td>
<td>&lt;1 yr (1500hrs)</td>
<td>3 yr (4300hrs)</td>
<td>10 yr (8700hrs)</td>
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**Recommended**
- EPA (Sample)
- External Visual
- Radiographic
- Internal Visual
- SEM
- Metallization
- Suspension Imaging
- Cross-sections
- Scan Pad
- Valve Transfer Tool
- Lead Free Solder
- Udderseal (1G)
- Baskets
- Electrodes
- Temperature Cycle
- X-ray
- C-SAM
- Electrodial
- Electrical
- Dynamic Test (H2O)
- Electronic
- Pen Life Bend-Put
- Outgassing if required
- ESD
- PDA
- Interface (WEL)
- PMD
- Hand Soldering Scape-Pair
- Temperature Cycling
- Translucency (SOM)
- Contact Density Cell
- DFA on Life Samples
- Upshot Residues
- Par Residue Load-Life if Required
- Packaging/Handling
- Moisture Control
- ESD Control
- Concentration Control
- Documentation
- Data R/B (Remain)
- QA, C of C

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Conclusion

• Be very careful when utilizing COTS parts!
  - Not all COTS parts manufactures were created equal
    • Not all COTS parts manufactures remain equal with time
  - Understand the parts application in the intended mission
    • Just because it flew on some mission that was successful doesn’t mean it is qualified for all missions
  - Understand the parts inherent residual risk as a function of the upgrade regimen instituted
  - Be careful of the potential for significant cost growth due to the upgrading regimen when COTS parts are to be used in very high reliability applications
Remember!

Characterize your COTS parts over the "full environment" or you're just hiding your head in the sand.