FUV Detector System
Printed Wiring Assembly Qualification Status

Mr. Geoff Gaines
FUV Detector Systems Engineer
## FUV Board Qualification Status

### COS Flight Board Qualification Testing

<table>
<thead>
<tr>
<th>Unit</th>
<th># of Units</th>
<th># at a time</th>
<th>Process</th>
<th>Power?</th>
<th>High Temp</th>
<th>Low Temp</th>
<th>Duration</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVPC</td>
<td>2</td>
<td>1</td>
<td>Hot Survival</td>
<td>N</td>
<td>75</td>
<td>N/A</td>
<td>1hr</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Turnon</td>
<td>Y</td>
<td>65</td>
<td>-40</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td>HVPS</td>
<td>2</td>
<td>1</td>
<td>Hot Survival</td>
<td>N</td>
<td>75</td>
<td>N/A</td>
<td>1hr</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Cold Turnon</td>
<td>Y</td>
<td>N/A</td>
<td>-25</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td>HVFM</td>
<td>2</td>
<td>1</td>
<td>Hot Survival</td>
<td>N</td>
<td>75</td>
<td>N/A</td>
<td>1hr</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Cold Turnon</td>
<td>Y</td>
<td>N/A</td>
<td>-25</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Turnon</td>
<td>Y</td>
<td>65</td>
<td>N/A</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td>Amplifier</td>
<td>4</td>
<td>4</td>
<td>Survival</td>
<td>N</td>
<td>75</td>
<td>-20</td>
<td>1hr each temp</td>
<td>Done</td>
<td>+/-7% of +5.5V Supply voltage</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>Turnon</td>
<td>Y</td>
<td>65</td>
<td>-20</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>Thermal Cycle</td>
<td>Y</td>
<td>65</td>
<td>-20</td>
<td>6 cycles</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>Soak/Burnin</td>
<td>Y</td>
<td>65</td>
<td>N/A</td>
<td>144hrs</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td>DCE</td>
<td>1</td>
<td>1</td>
<td>Voltage Margin</td>
<td>Y</td>
<td>Ambient</td>
<td>Ambient</td>
<td>N/A</td>
<td>Done</td>
<td>+/-7% of 5V Supply voltage</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>Freq Margin</td>
<td>Y</td>
<td>Ambient</td>
<td>Ambient</td>
<td>N/A</td>
<td>Done</td>
<td>+/-10% Frequency</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Survival</td>
<td>N</td>
<td>75</td>
<td>-25</td>
<td>1hr each temp</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Turnon</td>
<td>Y</td>
<td>65</td>
<td>-20</td>
<td>N/A</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Thermal Cycle</td>
<td>Y</td>
<td>65</td>
<td>-20</td>
<td>6 cycles</td>
<td>Done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>Soak/Burnin</td>
<td>Y</td>
<td>65</td>
<td>N/A</td>
<td>144hrs</td>
<td>Done</td>
<td>Or 1000hrs at ambient</td>
</tr>
<tr>
<td>TDC (XY pair)</td>
<td>1</td>
<td>1</td>
<td>Voltage Margin</td>
<td>Y</td>
<td>Ambient</td>
<td>Ambient</td>
<td>N/A</td>
<td>Done</td>
<td>+/-7% of Supply voltage</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>Freq Margin</td>
<td>Y</td>
<td>Ambient</td>
<td>Ambient</td>
<td>N/A</td>
<td>Done</td>
<td>+/-10% Frequency</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>Survival</td>
<td>N</td>
<td>75</td>
<td>-25</td>
<td>1hr each temp</td>
<td>In Prog</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>Turnon</td>
<td>Y</td>
<td>65</td>
<td>-20</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>Soak/Burnin</td>
<td>Y</td>
<td>65</td>
<td>N/A</td>
<td>144hrs</td>
<td>Done</td>
<td>Or 1000hrs at ambient</td>
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</tbody>
</table>
FUV Subassembly Run Time as of 11/1/2000
Reported in hours

<table>
<thead>
<tr>
<th>Subassembly</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplifiers</td>
<td>1026</td>
<td>985</td>
</tr>
<tr>
<td>DCE</td>
<td>807</td>
<td>728</td>
</tr>
<tr>
<td>LVPC</td>
<td>437</td>
<td>6</td>
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<tr>
<td>TDCs</td>
<td>232</td>
<td>1</td>
</tr>
<tr>
<td>HVPS</td>
<td>175</td>
<td>1</td>
</tr>
<tr>
<td>HVFM</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
**FUV Electronics Board Temperature Profile**

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**COS Board Test Temperature Profile**

- **Turnon**
- **Turnoff**
- **Func**

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**Space Telescope Programs**

**Hubble Observatory**

**HST-COS FUV**

**PER 11/8/00**
Amplifier Functional Test Summary

Amplifier Functional Test Procedure COS-UCB-PRO-1093

- Static Tests (resistances)
- Current measurements
- Pulses of varying amplitude applied to each input
- Scope traces captured on each of the four outputs
- Output pulses characterized for timing amplitude, charge amplitude, and pulse width
- Charge output characterized vs. input
- RMS noise of fast outputs
- RMS noise of charge outputs
Amplifier Qualification Test Summary

- Amplifier Qualification Tests Performed (all four units):
  - Voltage Margin test at 5.115V and 5.885V
  - Hot Survival Soak, 2 hrs at 75C (unpowered)
  - Hot Turnon Test at 65C
  - Cold Survival Soak, 2 hrs at -25C (unpowered)
  - Cold Turnon Test at -20C
  - 5 Additional cycles between -20C and 65C
  - Powered Hot Soak at 65C for 696 hrs total (two separate soaks)
Amplifier Test Results/Issues

- Amplifiers perform in all test environments:
  - <4.5ns FWHM fast output pulse width exceeds specification of 5ns max in all environments
  - Max RMS noise for fast output is met with 1.5mV max for all amp units

- Closeouts
  - Waiver for de-rating of filter feedthru capacitor is pending approval
DCE-A Functional Test Procedure COS-UCB-PRO-1113A

- Static Tests (resistances)
- Current measurements
- Verify all Counter and Round-Robin ACTEL functions
- Verify Pulse-Height-Histogramming function
- Verify Science Data communications channels
- Characterize science data event loss under burst conditions
  - Segment A, Segment B, Both
- Verify no corruption of science data under burst conditions
DCE-B Functional Test Summary

DCE-B Functional Test Procedure COS-UCB-PRO-1109

- Static Tests (resistances)
- Current measurements
- Verify CPU ACTEL functions
- Verify Command and Housekeeping communications Channels
- Verify Address decoding
- Verify control of DCE-A and DCE-C board functions
DCE-C Functional Test Summary

DCE-C Functional Test Procedure COS-UCB-PRO-1124A

- Static Tests (resistances)
- Current measurements
- Verify High Voltage command logic
- Verify collection and reporting of analog housekeeping
- Verify bi-level command registers and talkbacks
DCE Qualification Test Summary

- DCE Qualification Tests Performed:
  - Voltage Margin test at 4.65V and 5.35V
  - Frequency Margin test from 14.4MHz to 17.6MHz
  - Hot Survival Soak, 2 hrs at 75C (unpowered)
  - Hot Turnon Test at 65C
  - Cold Survival Soak, 2 hrs at -25C (unpowered)
  - Cold Turnon Test at -20C
  - 5 Additional cycles between -20C and 65C
DCE Test Results

- DCEs perform over all environments tested:
  - Science data uncorrupted, data rates exceed specification
  - Processor and memories functioned without incident in all cases
  - Housekeeping analogs steady

![Graphs showing DCE tests results]
DCE Issues/Closeouts

• Issues
  – The redundant Command and Housekeeping channel ("B" side) was not handling housekeeping properly. PFR#007 was filed, and DCE testing continued on the “A” side. It was determined shortly thereafter that there was an incompatibility between the new BOOT code and OPERATE. A fix was applied to OPERATE, was verified, and the PFR closed.
  – After completion of the second DCE board qualification, several enhancements to the Power-On-Reset circuit were suggested by J&T. UCB agrees that the enhancements are a good idea, and would improve the robustness of the circuit.

• Closeouts
  – Apply minor enhancements suggested by J&T. This can be done with minimal impact if folded in with qualification of the TDC boards. Changes described in EC#0051.
TDC Functional Test Summary

TDC Functional Test Procedure COS-UCB-PRO-1121

- Static Tests (resistances)
- Current measurements
- Measure State Machine clocks
- Verify, Characterize stim function
- Verify TDC Data interface
- Verify commanded and power-on-resets
- Verify TDC commanding, DACs, and MUXs
- Measure imaging linearity
- Verify characterize charge thresholds
- Measure imaging resolution
TDC Qualification Test Summary

- **TDC Qualification Tests Performed:**
  - Voltage Margin test (one unit)
    - $V_{cc} = +4.65V$ to $+5.35V$
    - $V_{ee} = -4.85V$ to $-5.55V$
    - “$+15V$” = $+13.5V$ to $+16.5V$
    - “$-15V$” = $-13.5V$ to $-16.5V$
  - Frequency Margin test (one unit only)
    - ISM Clock Period = 342ns to 274ns
    - OSM Clock Period = 305ns to 180ns
- **TDC Qualification Tests to be Performed:**
  - Hot Survival Soak, 2 hrs at 75C (unpowered)
  - Hot Turnon Test at 65C
  - Cold Survival Soak, 2 hrs at -25C (unpowered)
  - Cold Turnon Test at -20C
  - 5 Additional cycles between -20C and 65C
TDC Test Results/Issues

- Preliminary result: TDCs pass voltage and frequency margin testing
  - Data reduction in progress

- TDC’s give excellent results with flight detector, see McPhate presentation

- TDC Actels not yet officially approved, in review. TDC testing is underway with a single pair of flight Actels.
Contamination Control Measures

- All FUV hardware (DVA & DEB) cleanliness requirements outlined in COS Cleanliness & Contamination Control Plan (IN0090-111)
- Materials selection conforms to RP 1124 & GSFC materials selection guide (TML< 1%, CVCM < 0.1%)
- Mechanical Parts:
  - All metal piece parts precision solvent cleaned per UCB-COS-PRO-1008
  - Door motor assemblies have been disassembled, solvent cleaned, and vacuum baked. Motors assembled into Drive Unit and certified with a TQCM at CASA
- Electrical
  - Cables: solvent cleaned under a black lamp then vacuum baked at 90C, and “tube” bagged for handling and test prior to delivery. Harnesses will be cleaned again with a clean room vacuum under UV black lamp.
Contamination Control Measures (cont)

<table>
<thead>
<tr>
<th>Item</th>
<th>Stage</th>
<th>Requirements</th>
<th>Tests Performed</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC Board</td>
<td></td>
<td>Certifications, PCB Bake @ 12hrs @ 80C; Test Sub-Assembly Unit File; Schematic, Parts List, EE Assembly Procedure</td>
<td>Coupon Test, Visual Inspection</td>
<td>Goddard Space Flight Center (GSFC) Test of PCB Coupons</td>
</tr>
<tr>
<td>PCB Population</td>
<td></td>
<td>Parts Kit, E-Box Unit File</td>
<td>W Cronmanship QA Inspection</td>
<td>NASA-FOD-5739-X</td>
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<tr>
<td>Sub-Assembly: Electronic Assembly (for e)</td>
<td></td>
<td>Mechanical Drawing, Torque Value List, Assembly Procedure, Sub-Assembly Unit File</td>
<td>Visual Inspection</td>
<td>Documentation Results</td>
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<tr>
<td>Electronic Functional Testing of PCB</td>
<td></td>
<td>Test Procedure, Sub-Assembly Unit File</td>
<td>Electronic Functional Test of Individual E-Box Unit</td>
<td>Documentation Results</td>
</tr>
<tr>
<td>Voltage Margin Test</td>
<td></td>
<td>Board or Sub-Assembly Level Test Procedure, Sub-Assembly Unit File</td>
<td>+65C to -25C, Regulated Supply 1% Accuracy Test at Both Temp Extremes +/- 7% Supply Voltage, Documentation Results</td>
<td></td>
</tr>
<tr>
<td>Trim Set</td>
<td></td>
<td>Trim Set Documentation, Sub-Assembly Unit File</td>
<td>Electronic Functional Test of Individual E-Box Unit</td>
<td>Documentation Results</td>
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<tr>
<td>Thermal Cycle DRY</td>
<td></td>
<td>Sub-Assembly Level Test, Sub-Assembly Unit File</td>
<td>6 to 12 cycles, 2C per minute, 96 hrs. Soak for 24 hrs. at each extreme</td>
<td>-20C to 65C</td>
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<tr>
<td>Thermal Soak ACTIVE</td>
<td></td>
<td>Sub-Assembly Level Test, Sub-Assembly Unit File</td>
<td>Vacuum: +65C max for 144 hrs., -25C min for 24 hrs. Non-Vacuum: +80C max for 144 hrs. -25C min for 24 hrs</td>
<td>Non-thermalVac</td>
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<tr>
<td>Alcohol Spary, Vapor Degrass</td>
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<td>Cleaning and Degreasing Procedure, Sub-Assembly Unit File</td>
<td>Visual Inspection</td>
<td>Documentation Results</td>
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<tr>
<td>Staking, Coating</td>
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<td>Staking and Coating Procedure, Sub-Assembly Unit File</td>
<td>Visual Inspection (Day- and UV Light Source)</td>
<td>MPD-313-008 GSFC</td>
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<tr>
<td>Component Assembly</td>
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<td>Start Component Assembly File, Mechanical Assembly Drawing, Electrical Cable Drawing</td>
<td>Visual Inspection</td>
<td>QA Inspection GSFC</td>
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<td>Form Validation Testing Component Level</td>
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<td>Verification Test Procedure, Component Assembly File</td>
<td>Verification Test</td>
<td>Documentation Results</td>
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<td>Thermal Vacuum Bake</td>
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<td>Test Procedure, Component Assembly File</td>
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<tr>
<td>Vibration</td>
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<td>Vibration Test (Outsourced) Documentation, Component Assembly File</td>
<td>Vibration Test</td>
<td>Vibration Test Approval by GSFC</td>
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<tr>
<td>Component Cleaning</td>
<td></td>
<td>Cleaning and Degreasing Procedure</td>
<td>Visual Inspection</td>
<td></td>
</tr>
<tr>
<td>Sub-System: EM &amp; EMC</td>
<td></td>
<td>Test Procedure, Component Assembly File</td>
<td>EM 311C</td>
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<tr>
<td>Thermal Vacuum Sub-System Level</td>
<td></td>
<td>DDL Vacuum Assembly (DVA) and Detector Electronics Box (DEB), Component Assembly File</td>
<td>Subsystem ThermalVac -6 cycles, Total Duration 96 hrs (optional); ALM mechanism operated at specified extremes (one hot and one cold start required).</td>
<td>See Thermal Vacuum Procedures (+65C for 144 hrs., -25C for 24 hrs)</td>
</tr>
<tr>
<td>Ship Sub-System Level</td>
<td></td>
<td>Component Assembly File</td>
<td></td>
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<tr>
<td>Thermal Balance Sub-System Level</td>
<td></td>
<td>Component Assembly File</td>
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<td></td>
</tr>
</tbody>
</table>

Note: All assembly work requires an ESD safe assembly area. All actions performed are documented and added to the individual E-Box unit file or the flight system E-Box.

Space Telescope Programs
Hubble Observatory
HST-COS FUV
PER 11/8/00
### Unit Cleanliness Processing Matrix

**as of 11/4/00**

<table>
<thead>
<tr>
<th>Process</th>
<th>Amps</th>
<th>HVFM s</th>
<th>LVPC s</th>
<th>HVPS s</th>
<th>TDC s</th>
<th>DCE s</th>
<th>Harness</th>
<th>Motor</th>
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</thead>
<tbody>
<tr>
<td>Vacuum Bake</td>
<td>T</td>
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<td>X</td>
<td>X</td>
<td>T</td>
<td>T</td>
<td>X</td>
<td>X</td>
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<td>TQCM measure</td>
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<td>X</td>
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<td>T</td>
<td>T</td>
<td>X</td>
<td>X</td>
</tr>
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<td>Vapor Degrease</td>
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<td>T</td>
<td>T</td>
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<td>T</td>
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<td>X</td>
<td>T</td>
<td>T</td>
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</tr>
<tr>
<td>Solvent wipe</td>
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<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Blacklight Clean</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>X</td>
</tr>
</tbody>
</table>

**X** - Work Performed  **T** - Work to be Performed
Power System Cleanliness Processing

- HVFMds do not degrade system resolution (test UCB-COS-PRO-1085)
- HVFMs Rough vacuum baked to 60C (10^{-2} Torr)
  - 76 hrs for unit 1 and 162 hrs for unit 2
- HVFMs, LVPCs, and HVPSs high vacuum baked together at 60C (4e-5Torr) for 144 hrs, all six units
- TQCM measurements give an OGR of 1.43e-14 gm/cm^2/s
  - Exceeds COS spec of 4.3e-13 gm/cm^2/s
  - Measurements made prior to conformal coating, and were for early detection of any EN-11 potting outgassing problems, not to certify these components. Certification occurs at system level.
- TQCM measurements and calculations recorded in UCB-COS-PRO-1103
- HVFMs precision cleaned, conformal coated, and air-cured 24 hrs 60C.
- 1 LVPC and 1 HVPS cleaned and conformal coated.
- Remaining electronics to be conformal coated, cured and vacuum baked.
Electrical Harness Cleanliness Processing

- Flight harnesses built clean
- Rung out by independent technician
- Solvent wiped with Isopropyl Alcohol
- Blacklight inspected and cleaned
- Vacuum baked at 90C for 72 hours
- Harness bagged for lab environment prior to ship
- Bagging removed prior to final pre-ship blacklight inspection