STS-117 MDM OA2 Card 5 Failure
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Issue
• Card 5 on MDM OA2 failed at GMT 163/07:54:41

Concerns
• Loss of functions on card 5
• Implications to other cards within OA2
• Implications to software processing as a result of card 5 failure
Timeline

- GMT 163/07:54:41 - Card 5 in MDM OA2 fails
  - All data on card 5 (48 discretes) after the event are invalid
  - MDM sets BITE word to indicate a failure

- GMT 163/07:54:43 - SM alert “S62 BCE BYP OA” annunciated
  - Triggered by MDM OA2 BITE

- GMT 163/07:55:06 SM alert “S86 APU GBX P 2” annunciated
  - Measurement is not located on card 5

Why did we get the second SM alert and why did it occur 23 seconds later?
If S,E,V bits from MDM are not 101, then PCMMU indicates Invalid Data (BITE bit 10) and flags data as Invalid in Data RAM.

If PASS SM or BFS fetches data from the Data RAM flagged as Invalid, all data in that read is commfaulted.

Data from the Data RAM, if included in the TFL, appears in the downlink, invalid or not.
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**BFS GPC**

**SM GPC**

90 words

31 words

**Validity check**

**RAM**

<table>
<thead>
<tr>
<th>Addr</th>
<th>Data</th>
<th>V-bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>xxxx</td>
<td>0</td>
</tr>
<tr>
<td>2328</td>
<td>xxxx</td>
<td>0</td>
</tr>
<tr>
<td>2349</td>
<td>invalid</td>
<td>1</td>
</tr>
<tr>
<td>2350</td>
<td>invalid</td>
<td>1</td>
</tr>
<tr>
<td>2351</td>
<td>invalid</td>
<td>1</td>
</tr>
<tr>
<td>2358</td>
<td>xxxx</td>
<td>0</td>
</tr>
<tr>
<td>4095</td>
<td>xxxx</td>
<td>0</td>
</tr>
</tbody>
</table>

**MDM OA2**

**TLM Format Control**

**Output telemetry**

**Other OI MDMs**

**DATA RAM**

**MDM Datablock**

For PASS

SM Read #1

31 words

**MDM OA2**

CD 5 data

**OI PCMMU**

**TLM**

**PCMMU**

**OI**

**SM GPC**

**BFS GPC**
Explanation of the two SM alerts and their relative timing

- At GMT 163/07:54:41, card 5 in MDM OA2 fails (BITE failed)
- At GMT 163/07:54:43, SM alert “S62 BCE BYP OA” annunciated
  - All OA2 SM read 1 words (31) are commfaulted and bypassed
  - Parameters from cards 2, 4, & 6 are also in this read
    - Included in this effect is V46R0235A (APU 2 turbine speed) from card 6
- Commfaulted V46R0235A (APU 2 turbine speed) triggers limit set change for V46P0253A (APU 2 gearbox lube oil press)
  - Limit set change in effect after defined delay of 9.6 seconds
- New limit set is nominal ascent/entry limits for V46P0253A (APU 2 gearbox lube oil press) - Current value at that time violated lower limit
  - Noise filtering delays annunciation for 13.4 seconds
- At GMT 163/07:55:06, PASS SM annunciates “S86 APU GBX P 2”
  - Total delay 9.6 + 13.4 = 23 seconds from “S62 BCE BYP OA”
- Given this multi-card scenario, further investigations into all potential PASS and BFS effects were initiated
• PASS assessment – Cory Driskill

• BFS assessment – Terry McClain
Safety Assessment

- Evaluated 31 Affected PASS parameters & Card 5 MSIDs.
  - Worst Case MDM OA2 Failure addressed in ORBI 038 Cause G.
    - Loss of Vehicle Due to MDM or EMDM (Loss of output from OA1, OA2, or OA3)
    - No additional hazard impacts identified at this time.
  - MDM OA2 Card 5 failure is loss of insight onboard. Other data exists to assess subsystem health.
- BFS impacts are similar to PASS
  - Worse case is LOS and a subsystem failure during the LOS
Summary

- MDM OA2 card 5 declared failed, downlink is invalid
- Remaining MDM OA2 cards and their downlink are good
- SM alerts at time of failure are understood and expected
- System impacts for PASS SM and BFS have been assessed and communicated to MOD
  - PASS – no more messages/alarms
  - BFS – upon activation, crew will receive 1 alarm/message for the card failure and 1 I/O error message will be logged in the downlist
- Integrated hardware and software team are unanimous that no action should be taken to attempt to recover OA2 card 5
  - Low likelihood of success
  - Current posture is stable and understood
  - Available options for recovery are very disruptive to other functions
Backup
Failure History

• 20 reports found searching the failure history for the flight OA MDMs, P/N MC615-0004-6410
  • One failure of this particular MDM, S/N 127
    • AC4870 – Isolated to a connector problem (circa 1982)

• Further flight DIH failure history searches revealed:
  • 9 failures related to flight DIH modules (2 in-flight)
    • 09F031(OA1 S/N 18) – Measurement V42S2345E “RCS LEFTAFT TANK ISOLATION VALVES 3/4/5 A OPERATE” failed OFF
    • 66RF20 (FA3 S/N 65) – Measurement V56X1365X “ET UMB DR LCH 2 IND2” failed ON
      • Both were single bit failures, not entire card

• Per the Reliability and Maintainability Report.
  • MTBF for the flight DIH is 1,792,727 hours
  • Failure rate of 5.58E-7