Vita 72 VPX Connector Update for Open Standard Module Vibration Reliability Testing

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September 19, 2012
Rev 1.1
Original VITA 46 Connector Validation

- Leveraged original testing and combined with most extreme military environments.
- Need to test at higher data rates to capture short term opens (picoseconds).

Evidence of fretting corrosion from original VITA tests

Group A – Shock & Vibration

VITA 46 “Qual” Vibration (1 UUT)
MIL-STD-1344A, Method 2005.1, Test cond. V, letter D, 1.5 hrs. each axis

VITA 46 “HALT” Vibration (1 UUT)
0.125, 0.15, 0.175 G²/Hz, 15 min. each then 0.2 G²/Hz, 45 min., each axis

Plots and images courtesy of TE, Curtis Wright and Contech Research
VPX RT2 Reliability Challenges...

- Mercury performed endurance random vibration on standard VPX RT2 connectors (VITA 46) and Viper connectors (VITA 60).
  - Exceptionally high bit errors were measured midway through the Z-axis random vibration test on the RT2 Connectors
  - LLCR measurements rose dramatically at the same time on the RT2
  - Note: Test fixture was a bolted structure lacking adequate stiffness
  - Test was run @ 2.5 G-baud and 3.125 G-baud
- Mercury engaged TE to address the issues – J.R. & D.M.
  - A cross functional team was formed at each company to review the current connector design failure data
  - A VPX Connector Test plan was generated to compare existing connector designs and alternatives to the standard VPX solution.
- The RT2 connector upgrade was initiated.
Original Test Plan Overview for Vita 72

- Testing compares performance of OPEN VPX connectors in a VITA 48.2 conduction cooled rugged environment
- VPX Backplane and XMC connectors (42 - 60) were subjected to rugged vibration according to the test schedule shown below
- Connectors evaluated on LLCR measurements, bit error rate, and mechanical performance (high magnification inspection)
  - BER testing performed at 6.25 G-baud

<table>
<thead>
<tr>
<th>Test 1</th>
<th>Duration/Exposure</th>
<th>Test 2</th>
<th>Duration/Exposure</th>
<th>Test 3</th>
<th>Duration/Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Vibe L3</td>
<td>1 hour/axis</td>
<td>Random Vibe L3</td>
<td>+3dB 1 hour/axis</td>
<td>Random Vibe L3</td>
<td>+3db 12 hour z-axis only</td>
</tr>
</tbody>
</table>

Reference Mercury PN: DOC TPN-10009
Test Backplane Design Overview

- Supports 7 differential pair signals
- 0.250 inch thick, 30 layer PCB
  - 1\textsuperscript{st} Resonance @ 944 Hz (Analysis)

LLCR Headers
1 Header is a complete loop (pin 1 to pin 2)

SMA conn
4 SMAs complete 1 differential pair loop
Schematic Interconnect Block Diagram

Hi-speed signal traces

All signals loop back through the payload/carrier card

SMA connectors

DIFFERENTIAL PAIR SIGNALS

BACKPLANE 420-1180B1-XX

CARRIER CARD
444-1181B1-XX
Schematic Interconnect Block Diagram

LLCR traces

SINGLE ENDED SIGNALS

BACKPLANE 420-1180B1-XX

JMPR1
1 2

JMPR2
1 2

JMPR3
1 2

JMPR4
1 2

JMPR5
1 2

JMPR6
1 2

JMPR7
1 2

JMPR8 = GND
JMPR9 = GND

J0  J1  J2  J3  J4  J5  J6

P0  P1  P2  P3  P4  P5  P6

CARRIER CARD
444-1181B1-XX

All signals loop back through the payload/carrier card
Test Configuration for VITA 48.2 VPX C/C Test

<table>
<thead>
<tr>
<th>UUT</th>
<th>Viper, Tyco and Tyco Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coldplate complete with wedgelocks and hardware:</td>
<td>3.08 lb (1.395 kg)</td>
</tr>
<tr>
<td>Bare board:</td>
<td>0.22 lb (0.100 kg)</td>
</tr>
<tr>
<td>Viper connector P/N:</td>
<td>400-1058-02 Weight: 0.43 lb (0.195 kg)</td>
</tr>
<tr>
<td>Tyco connector P/N:</td>
<td>400-1058-01 Weight: 0.143 lb (0.065 kg)</td>
</tr>
<tr>
<td>Tyco Extreme connector P/N: 400-1058-03 Weight: 0.37 lb (0.168 kg)</td>
<td></td>
</tr>
<tr>
<td>Communication port</td>
<td>USB port to communicate with laptop computer.</td>
</tr>
<tr>
<td>Laptop computer</td>
<td>Used to program and run the BER device and monitor the UUT through the USB ports.</td>
</tr>
<tr>
<td>Software</td>
<td>Altera Stratix IV v9.0; Mercury Signal Integrity test software</td>
</tr>
</tbody>
</table>

Test Card with loop-backs internally

Primary Coldplate

Secondary Coldplate
6U CARRIER & COLDPLATES

- Conforms to VITA 48.2
  - Uses secondary side wedgelocks
- Simplified packaging that mimics standard conduction cooled module design
- Carrier card supports two XMC cards – centered
Vibration Test Fixture Assembly

- Design leveraged from previous VITA 46 testing
Vibration Fixture FEA Analysis

- Machined from solid block of aluminum
  - 6061-T6
- Calculated Fixture 1\textsuperscript{st} mode resonance of Fixture @ 6225Hz
Mercury VPX 3.125 G-Baud Signal Verification Test during “Rugged” Vibration
Extreme Vibration Test Setup

Payload card to backplane BER setup

XMC to payload card BER setup

LLCR Meter

Altera Stratix IV Signal Integrity Test Equipment
VPX Connector Vibration Profiles

• Tested per MIL-STD-810F, Method 514.5
• Extended Duration Random Vibration Testing will be conducted
  – 1 hour per orthogonal axis at Mercury RL3 standard profile
  – 1 hour per orthogonal axis at Mercury RL3 + 3dB standard profile
  – 12 hours, Z-axis only @ +3dB over Mercury RL3 standard profile
• Failure Analysis includes high resolution / SEMS photos of contact mating surfaces on all connectors for visual comparison
Electrical – Mechanical Test Execution Overview

- Loopback differential pairs from backplane and back across mated connectors (examining multiple transitions across connectors)
- Carrier Conduction-Cooled Cold Plate Design (1st mode ~500 Hz +)
- Altera Stratix IV FPGA test station used to generate and record signals
  - Up to 7 simultaneous Channels
  - Up to 8 Gbps (test run at 6.25 Gbps)
- Low level contact resistance (LLCR) measurements taken before and after each test.
- Random Vibration environment only
- TE performed long term wear tests on the contacts to simulate 20,000 insertion and extractions
Test Results Overview
Exposed PWB. Contacts wore through Gold, Nickel, & Copper pads on wafer
Vita 60 Viper Micro Action Fretting Corrosion

- Viper had signs of fretting corrosion, but performed substantially better in the original Extreme Vibration Testing
Comparison between worst wear spot from example samples

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Date</th>
<th>Contact</th>
<th>Housing Fit</th>
<th>Guide hardware</th>
<th>Wafer pad length</th>
<th>Wafer 50 µin gold thickness</th>
<th>Wafer 30 µin gold thickness</th>
<th>Wafer Nickel thickness</th>
<th>Test location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2/22/2012</td>
<td>Standard</td>
<td>Standard</td>
<td>Standard</td>
<td>all positions</td>
<td>none</td>
<td>150 µin</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3/1/2012</td>
<td>RT2-R</td>
<td>Standard</td>
<td>Standard</td>
<td>P0,1,3,4,5</td>
<td>P2, P6</td>
<td>150 µin</td>
<td>2</td>
<td>test cables failed</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3/26/2012</td>
<td>Standard</td>
<td>Standard</td>
<td>Standard</td>
<td>all positions</td>
<td>none</td>
<td>150 µin</td>
<td>1</td>
<td>Baseline</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4/18/2012</td>
<td>RT2-R</td>
<td>Standard</td>
<td>Ruggedized</td>
<td>P0,1,2,4,5,6</td>
<td>P3</td>
<td>150 µin</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RT2-R Improved Contact Design

- 4 Points of connector contact
- Contacts have different insertion mode displacement to impact Backplane bowing
Vita 72 VPX Test Overview Summary

• Vita 46/48 RT2 “R” BER results: Pass
• Vita 60 Viper BER results: Pass
• Vita 46/48 RT2 “R” LLCR results: Pass
• Vita 60 Viper LLCR results: Pass
• Vita 46/48 RT2 “R” Fretting Corrosion results: Pass
• Vita 60 Viper Fretting Corrosion results: Some Fretting Exists

This report is over 300 + pages of data collection and please feel free to contact Mercury or TYCO and execute an NDA for specific details
Vita 72 VPX RT2 “R” Test Overview Summary

• Vita 46/48 RT2-R design provides:
  – Lower insertion force (~ 8%+ less insertion force)
  – Reduced Backplane Bowing
  – Increased Extreme Vibration Reliability
  – Performs at higher data rates (5 & 6.25 G-Baud) in rugged environments
  – Backwards/Forwards compatible with all existing VPX infrastructure
    • Intermatable
    • Intermountable

• Vita 46 - 46/48 – 60 - 63 Next Steps...
  – Execute Connector testing as they are available
  – Execute Test at PCIE 3.0 Data Rates (8 G-Baud)
  – Execute Test at 10KR Data Rates (10.3125 G-Baud)
  – Publish results under NDA’s
A special thanks to the following staff for supporting this critical VPX & XMC rugged environment reliability testing initiative:

Kevin Rock
Didier Thibaud
Leon Woo
Mike Gust
Jayne Richner
Matt M
Mike Mullen
Mike Shorey
Erica Ouellette
Herve Brunache
Steve Mariani
Keith Miller
Absu Methratta
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Questions ???

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