Agilent Digital Measurement Forum

HDMI 1.3
Agilent Solution Overview

Video Transmitter  
Media  
Video Receiver
Agilent HDMI Solution

Solution Overview

Solution Specifics

✓ Agilent Total Solutions
✓ Test Point Access Assemblies (TPAs)
✓ Source Tests & Software
✓ Sink Tests Software
✓ Cable Tests
✓ Protocol Tests
✓ EDID, HDCP and CEC Tests
High-Definition Multimedia Interface™

- Consumer Multimedia standard
- Ensures interoperability of all-digital audio/video devices. E.g. set-top boxes, DVD players, A/V receivers, DTV
- HDMI requires
  - electrical source, cable and sink tests
  - protocol tests
- HDMI link consists of three differential data lanes and one differential clock lane
- HDMI and compliance test specification specification (CTS) now at version 1.3c
- Authorized Test Centers (ATCs) perform compliance testing for all HDMI certified products
Lets talk reality....

Authorized Test Center commitments to Agilent HDMI 1.3 Solution!!

HDMI 1.2

Before

Competitor Installations

Panasonic(Japan): has Agilent Tx solution. Committed to Tek for Sink Test

Sony(Japan), SL(Shenzhen, Shanghai, Germany, Sunnyvale), NXP(France), Philips(India)

Any Questions?
## Total Test Solution for HDMI CTS 1.3c
### Solution Elements by Test Type

<table>
<thead>
<tr>
<th>Source Test Solution</th>
<th>Media Test Solution</th>
<th>Sink Test Solution</th>
<th>Protocol Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVD Players, Set Top Boxes, Chips</td>
<td>Cables, PC Boards, Connectors</td>
<td>HDTV Monitors, Repeaters</td>
<td>Sink and Source Devices</td>
</tr>
<tr>
<td>DSO80000B Infiniium Real Time Oscilloscopes</td>
<td>86100C DCA-J Sampling Oscilloscope</td>
<td>E4887A TMDS Signal Generator, N5998A PAG and Cable Emulator</td>
<td>N5998A Protocol / Audio / Video Analyzer and Generator</td>
</tr>
<tr>
<td>N5399A HDMI Compliance Test SW</td>
<td>E5071C Vector Network Analyzer</td>
<td>N5998A HDMI Protocol Analyzer</td>
<td>Quantum Data 882EA Video Test Instrument</td>
</tr>
<tr>
<td>N5998A HDMI Protocol Analyzer</td>
<td>N1080A TPA fixtures</td>
<td>N1080A TPA fixtures</td>
<td>N5990A Software</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NEW!</td>
</tr>
</tbody>
</table>
Solution Specifics: Test Access Fixture

- High Performance Test Point Access Adapters
  - TPA-P: N1080A H01 (plug)
  - TPA-R: N1080A H02 (receptacle)
- Low Frequency Test Board: N1080A H03
Solution Specifics: HDMI Source Testing and TMDS Signal Generator Calibration

- Real-time oscilloscope
  - DSO90000 series 8GHz (DSO90804A) or higher
- Probe Amplifier
  - 1169A (2x)
- SMA Probe Head
  - N5380A (recommended) or E2695A (5x)
- Source Compliance SW
  - N5399A
### Summary of Results

<table>
<thead>
<tr>
<th>Margin Thresholds</th>
<th>Critical</th>
<th>Warning</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;= 0 %</td>
<td>&lt;= 2 %</td>
<td></td>
</tr>
</tbody>
</table>

#### Test Configuration Details

- **Device ID**: HDMI Device 1
- **Last Test Date**: 10-Feb-05 8:53:27 PM
- **Model Number**: 54955A
- **Serial Number**: No Serial
- **Infinium SW Version**: 03.96.0031R

#### Test Results

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Spec Range</th>
<th>Measured Value</th>
<th>Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0 - Eye Pattern</td>
<td>Zero Mask Failures</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Clock - Jitter</td>
<td>&lt;= 153.74ps</td>
<td>33.56ps</td>
<td>35.4%</td>
</tr>
<tr>
<td>Raw Clock - RiseTime</td>
<td>[75.00ps to 247.21ps]</td>
<td>240.47ps</td>
<td>3.9%</td>
</tr>
<tr>
<td>D0 - RiseTime</td>
<td>[75.00ps to 246.30ps]</td>
<td>146.98ps</td>
<td>42.0%</td>
</tr>
<tr>
<td>D0 - FallTime</td>
<td>[75.00ps to 245.11ps]</td>
<td>150.43ps</td>
<td>44.1%</td>
</tr>
<tr>
<td>Raw Clock - FallTime</td>
<td>[75.00ps to 247.64ps]</td>
<td>237.02ps</td>
<td>6.1%</td>
</tr>
<tr>
<td>D0/D1 - Skew</td>
<td>[-0.20000 Tpixel to 0.20000 Tpixel]</td>
<td>-0.01346 Tpixel</td>
<td>46.8%</td>
</tr>
<tr>
<td>D0 - Over/Undershoot</td>
<td>Overshoot &amp; Undershoot</td>
<td>1.041866e-6 ±0.01% &amp; 1.041867e-6 ±0.01%</td>
<td>N/A</td>
</tr>
<tr>
<td>Clock Duty Cycle</td>
<td>Tduty(MIN) &amp; Tduty(MAX)</td>
<td>5.117453e-6 ±0.01% &amp; 5.219032e-6 ±0.01%</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- **Overall Results**: Pass (0 of 9 Tests Failed)

---

### Compliance Report Details:

- Summary of Device and Configuration
- Summary of all Test Results with Margin Alerts
- Details of every Test for diagnostics
Detailed Results for Diagnostics

Test Details:
- Name of Test
- Test Description
- Intermediate
- Measurement Results
- Screen Captures
Solution Specifics: TMDS Signal Generator

Clock Jitter
- E4438C 4 GHz

Data Jitter
- E4438C 4 GHz

10MHz Ref
- 30 cm BNC

10Base-T LAN

Switching HUB

LAN

EE1394

PC for 81250A software (E4875A)

N5990A Test Automation Software

& HDMI Frame Generator Software

N4871A (Matched Pair Cable 3.5 mm (m-m))

TPA-R (Receptacle)

HDMI Fixtrue

SMA

81250A 7 Gbps

Agilent Technologies
Cable Emulator Test Setup

- **TMDS Signal Generator**
- **1 m standard cables**
- **SMA push-on adapters**

Measured without reference equalizer

Measured with reference equalizer
Solution Specifics: Sink Test Setup
Example Jitter Tolerance Test

Picture taken from CTS 1.3c
Automated HDMI Compliance and Characterization

Based on Agilent/BitifEye High-Speed Bus Compliance Test Platform N5990A

- Custom Solution
- Test Sequencer
- Legacy Code
- Source-Test Software
- Sink-Test Software
- Instrument Software
- Standard Instruments
- Services (Partner Company BitifEye)
- N5990A Test Automation Software Platform (Opt. 010, Base Product)
- HDMI-Source N5399A
- HDMI-Sink (Opt. 150)
- HDMI-Cable (Opt. 350)
- HDMI Low-speed (Opt. 450)
- Interface to N5399A (N5990A Opt. 250)
- C++
- C#
- LabView, VEE...
- N5990A Opt. 500 (MS .NET dlls)
- Real-time Oscilloscope
- TMDS Sig. Generator
- TDR, ENA
- Multimeter
- Voltmeter
- LCR-meter

NEW!

Investigation
Test Automation Software Platform Specifics
N5990A HDMI Configuration

- Compliance Test and Characterization
- Short calibration and test times
- Easy to use
Optional User Programming (N5990A opt. 500)

Additional Features

Adding procedures to an existing subset

Adding custom procedure subsets
Solution Specifics: HDMI Frame Generator Software
E4887A Opt. 207

- Stand-alone tool for manual characterization and debug

- Compliance pattern selection
  - supports about 80 most important display formats
- Parametric (stress) test
- Pattern loading into ParBERT memory
Solution Specifics: Cable and Receiver TDR Tests

- DCA-J
- TDR module
- Second electrical receiver for cable test
- TDR and S-parameter application S/W*
- Cal kit
- TPA-P and TPA-R

86100C
54754A
54754A or 86112A (dual channel)
86100C Option 202
N1024A
N1080A H01 and H02

* Recommended
N5998A HDMI 1.3 Protocol Analyzer and Generator
Block Diagram

N5998A

Sink Board
(HDMI Rx)

FPGA Board

Source Board
(HDMI Tx)

PC

USB 2.0

HDMI IN

HDMI OUT

SDRAM

SRAM
Features and Benefits

- HDMI 1.3b compliance measurement instrument
  - CTS high-speed reference Protocol / Audio / Video Analyzer (CTS chapter 4.2)
    - Unique Selling Point: section 4.2.4.2 (Protocol Analyzer)
      - Predecessor instrument Panasonic UITA-1000 can still be used up to 74.25 MHz
      - No alternate recommended instrument for data rates > 74.25 MHz
      - Mandatory for global ATCs
    - Source Tests: 7-16 – 7-37, with the exception of 7-20 – 7-22
  - Protocol / Audio Data Generator
    - Sink Tests: 8-16, 8-21, 8-23, 8-25
      - Note: 8-25 in conjunction with the E4887A-007 TMDS Signal Generator
- Deep Color Support (Source, Sink)
- EDID (Monitor and Extended Display Identification) Writing
  - writes EDID data block0 and block1 (256 Byte) for capturing HDMI data
    - 4-block EDIDs not supported
1. Open captured file
2. Select Video Format Timing
3. Select Test-ID
4. Press Start to run tests
5. Output written to textbox (left side of the window) and to a text file (in same directory as data file)
N5990A Test Automation Software Option 350

Interface to Quantum Data 88 2EA

Integrated EDID, HDCP and CEC Compliance Tests

Approved by DCP LLC
Automated HDMI Tests

- **Custom Solution**
- **Test Sequencer**
- **Legacy Code**
- **Source-Test Software**
- **Sink-Test Software**
- **Instrument Software**
- **Standard Instruments**

**Services (BitifEye)**

**N5990A Test Automation Software Platform (Opt. 010, Base Product)**

- **C++**
- **C#**
- **LabView, VEE**
- **...**

**NEW! Interface to N5399A (N5990A Opt. 250)**

**HDMI Source N5399A**

**HDMI Sink (Opt. 150)**

**HDMI Video (Opt. 350)**

**HDMI-Cable (Opt. 450)**

**Real-time Oscilloscope**

**TMDS Sig. Generator**

**Video Test Instrument**

**TDR, ENA**

**Multimeter, Voltmeter**

**LCR-meter**
### N5990A Quantum Data 882EA Support

#### Compliance Test Coverage

- Sink – EDID / E-DDC
- Sink – Video
- HDCP Source
- HDCP Sink
- CEC

<table>
<thead>
<tr>
<th>CTS Test Section / ID</th>
<th>Test Name CTS Test Section / ID</th>
<th>Test Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2 Source - EDID / E-DDC / HPD</td>
<td>CEC Tests</td>
<td></td>
</tr>
<tr>
<td>7-1</td>
<td>NOT YET SUPPORTED!</td>
<td>CECT 7-1</td>
</tr>
<tr>
<td>8.2 Sink - EDID / E-DDC</td>
<td>CECT 7-2</td>
<td>CEC Maximum Rise Time and Fall Time</td>
</tr>
<tr>
<td>8-1</td>
<td>EDID Readable</td>
<td>CECT 8.1</td>
</tr>
<tr>
<td>8-2</td>
<td>EDID VESA Structure</td>
<td>CECT 8.2</td>
</tr>
<tr>
<td>8-3</td>
<td>CEA Timing Extension Structure</td>
<td>CECT 9.1</td>
</tr>
<tr>
<td>8.5 Sink - Video</td>
<td>CECT 9.2</td>
<td>Header Block</td>
</tr>
<tr>
<td>8-17</td>
<td>861B Format Support Requirements</td>
<td>CECT 9.3</td>
</tr>
<tr>
<td>8-18</td>
<td>HDMI Format Support Requirements</td>
<td>CECT 9.4</td>
</tr>
<tr>
<td>8-19</td>
<td>Pixel Encoding Requirements</td>
<td>CECT 9.5</td>
</tr>
<tr>
<td>8-20</td>
<td>Video Format Timing</td>
<td>CECT 9.6</td>
</tr>
<tr>
<td>10 HDCP Source</td>
<td>CECT 9.7</td>
<td>Signal Free Time</td>
</tr>
<tr>
<td>1A-01</td>
<td>Regular procedure:With HDMI capable Receiver</td>
<td>CECT 10.1</td>
</tr>
<tr>
<td>1A-02</td>
<td>Regular procedure:HPD after writing Aksv</td>
<td>CECT 10.2</td>
</tr>
<tr>
<td>1A-03</td>
<td>Regular procedure:HPD after starting 3rd part of auth.</td>
<td>CECT 11.1</td>
</tr>
<tr>
<td>1A-04</td>
<td>Irregular procedure:HDCP port access</td>
<td>CECT 11.2</td>
</tr>
<tr>
<td>1A-05</td>
<td>Irregular procedure:Verify Bksv</td>
<td>CECT 11.3</td>
</tr>
<tr>
<td>1A-06</td>
<td>Irregular procedure:Verify R0'</td>
<td>CECT 12-1</td>
</tr>
<tr>
<td>1A-07</td>
<td>Irregular procedure:Verify Ri'</td>
<td>CECT 12-2</td>
</tr>
<tr>
<td>1A-08</td>
<td>Irregular procedure:SRM</td>
<td>CECT 12-3</td>
</tr>
<tr>
<td>1A-09</td>
<td>Regular procedure:With DVI Receiver</td>
<td>CECT 12-4</td>
</tr>
<tr>
<td>1B-01</td>
<td>Regular procedure:With Repeater</td>
<td></td>
</tr>
<tr>
<td>1B-02</td>
<td>Regular procedure:HPD after Reading R0'</td>
<td></td>
</tr>
<tr>
<td>1B-03</td>
<td>Irregular procedure:Timeout of KSV list READY</td>
<td></td>
</tr>
<tr>
<td>1B-04</td>
<td>Irregular procedure:Verify V'</td>
<td></td>
</tr>
<tr>
<td>1B-05</td>
<td>Irregular procedure:MAX.DEVS.EXCEEDED</td>
<td></td>
</tr>
</tbody>
</table>
Usage
Test Automation

The Protocol tests are listed under the „Protocol“ node.

Select tests
Hit „Start button“
Follow the instructions
Test result summary

Shows the test results as an overview

<table>
<thead>
<tr>
<th>Test name</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 8-3 CEA Timing Extension</td>
<td>Passed</td>
</tr>
<tr>
<td>HDCP 2C 04 SR Trail.</td>
<td>Passed</td>
</tr>
<tr>
<td>CEC9.4</td>
<td>Passed</td>
</tr>
</tbody>
</table>
## Excel Test Results Report – HDCP Example

**Product Number:** HDMI  
**SN:** Port:1  
**HDMI Test Station 1**  
**Unknown User**  
**9/30/2008 5:13:12 PM**

### HDCP Sink Test

| Sink support | True  
| HDCP 1.1 Features | True  

<table>
<thead>
<tr>
<th>Result</th>
<th>Result String</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pass</td>
<td>TE detected hot plug from DUT.</td>
<td>27.1862 sec</td>
</tr>
<tr>
<td>pass</td>
<td>DUT is in DVI mode after HPD. Bstatus (MSB): 0x00 Frame counter = 0</td>
<td>27.1878 sec</td>
</tr>
<tr>
<td>pass</td>
<td>DUT responded with a Bksv with value (MSB-&gt;LSB) 0x09ADF9291D. Frame counter = 0</td>
<td>27.1905 sec</td>
</tr>
<tr>
<td>pass</td>
<td>All reserved ports and bits are zero.</td>
<td>27.2191 sec</td>
</tr>
<tr>
<td>pass</td>
<td>KSV FIFO contains no non-zero bytes.</td>
<td>27.2210 sec</td>
</tr>
<tr>
<td>pass</td>
<td>DUT is in DVI mode. Bstatus (MSB): 0x00</td>
<td>27.7259 sec</td>
</tr>
<tr>
<td>pass</td>
<td>DUT read Bcaps with value 0x80. Frame counter = 0</td>
<td>29.7267 sec</td>
</tr>
<tr>
<td>pass</td>
<td>TE read Bcaps (0x80), wrote An (0x9FE97C93B547E44C), wrote Aksv (0xFA476D1AC0). Frame counter = 0</td>
<td>29.7879 sec</td>
</tr>
<tr>
<td>pass</td>
<td>DUT responded with a Bksv with value (MSB-&gt;LSB) 0x09ADF9291D. Frame counter = 0</td>
<td>29.7907 sec</td>
</tr>
<tr>
<td>pass</td>
<td>R0 (MSB-&gt;LSB) 0x82C8 matched R0' (MSB-&gt;LSB) 0x82C8. Frame counter = 0</td>
<td>29.9051 sec</td>
</tr>
<tr>
<td>pass</td>
<td>TE enabled HDCP Encryption.</td>
<td>29.9857 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0x42A7 matched Ri' (MSB-&gt;LSB) 0x42A7. Frame counter = 0</td>
<td>32.0292 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0x8DAC matched Ri' (MSB-&gt;LSB) 0x8DAC. Frame counter = 0</td>
<td>34.1624 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0xC5B6 matched Ri' (MSB-&gt;LSB) 0xC5B6. Frame counter = 0</td>
<td>36.2953 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0xB0E4 matched Ri' (MSB-&gt;LSB) 0xB0E4. Frame counter = 0</td>
<td>38.4344 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0x0ABE matched Ri' (MSB-&gt;LSB) 0x0ABE. Frame counter = 0</td>
<td>40.5613 sec</td>
</tr>
<tr>
<td>pass</td>
<td>Ri (MSB-&gt;LSB) 0x8152 matched Ri' (MSB-&gt;LSB) 0x8152. Frame counter = 0</td>
<td>42.6942 sec</td>
</tr>
<tr>
<td>pass</td>
<td>User indicated that the video did look good.</td>
<td>50.2864 sec</td>
</tr>
</tbody>
</table>

**PASS**