Agilent HDMI Solution

Recommended in CTS 1.4!
Contents

Introduction

- HDMI 1.4 Features
  - Ethernet Channel
  - Audio Return Channel
  - 3D Support
  - 4K Support
  - New Color Spaces
  - New connectors

- HDMI 1.4 Test
  - Source Test
  - Cable Test
  - Sink Test
  - Protocol Test
  - Ethernet and Audio Return Channel Test

- Solution Details
- Solution Summary
HDMI – High Definition Multimedia Interface™

HDMI is a consumer multimedia standard ensuring the interoperability of all-digital audio and video devices

Devices
- AV Receiver
- Mobile Phones
- PC’s and Peripherals
- Game Console
- Blu-ray Player / Recorder
- DVD Player / Recorder
- ...

Pervasiveness
- Expected number of devices in 2009:
  - > 1 Billion

Functionality
- ¼ of consumer electronics requires Ethernet
- All game consoles & digital media have network capabilities
- 2/3 of Blu-ray and PVR DVR will have network capabilities

Door opener for a new connected multimedia world

Source: 12/2008 In-Stat
HDMI Success Factors

- **Simplicity**: Plug and play via single digital link
- **Performance**: Bandwidth for movies, fast gaming and rich audio
- **Intelligence**: Automatic configuration and system-wide behavior
Contents

- Introduction

HDMI 1.4 Features

- Ethernet Channel
- Audio Return Channel
- 3D Support
- 4K Support
- New Color Spaces
- New connectors

- HDMI 1.4 Test

- Source Test
- Cable Test
- Sink Test
- Protocol Test
- Ethernet and Audio Return Channel Test

- Solution Details

- Solution Summary
HDMI 1.4 Features

HDMI 1.3 Features PLUS

- Ethernet Channel
  - Audio Return Channel
  - Less cables

- 3D support
  - 4K x 2K support
  - More Color Spaces
  - State-of-the-art and life like cinema quality at home

- New Connectors
  - Reliable connections even for small devices and automotive

Nov. 20, 2009
HDMI 1.4 – Ethernet Channel (“HEC”)

- Take advantage of IP-enabled devices without the need for a separate Ethernet cable
- Up to 100 Mbit/s bi-directional (full-duplex) bandwidth
- Requires Standard HDMI Cable or High-Speed Cable with Ethernet support
HDMI 1.4 - Audio Return Channel ("ARC")

• HDTV with a built-in tuner, DVD player or other digital content sources can send audio data to your A/V receiver

• Supports all audio formats that can be sent through the traditional connection

• Supports devices featuring LipSync so that audio and video stays in sync
HDMI 1.4 - 3D Support

- Requires High Speed HDMI cable (with or without Ethernet support)
HDMI 1.4 – 4K Support

Heightened Viewing Experience: Support for 4K x 2K Resolution

Same resolution as many state of the art digital theaters
Up to 4 times the resolution of 1080p

3840x2160 24Hz | 25Hz | 30Hz
4096x2160 24Hz

4K x 2K (4096 x 2160)
HDMI 1.4 - New Color Spaces

Heightened Viewing Experience: Support for Additional Color Spaces

Supports digital still camera (DSC) - specific color spaces
  sYCC601
  AdobeRGB
  AdobeYCC601

Enables HDTV’s to reproduce the rich, natural, lifelike colors from digital still cameras (DSC)

Enables consistency and accuracy between DSCs and HDTVs
HDMI 1.4 - New Connectors

- 19 pin connector for Mobile phones, portable media players, digital cameras or any portable device where space is limited
- Supports all HDMI 1.4 features

- Designed to meet requirements of an environment like noise, vibration and heat
- Tested to higher performance standards than other cables, limited to 1080i/720p

Smaller, portable devices are becoming sources of HD content.
Summary
HDMI 1.4 in a Nutshell

Ethernet Connectivity

Audio Return Channel

HEAC+
HEAC-

HPD Reserved

HEAC+
HEAC-

HPD Reserved

Content

New Formatted Content

HDMI Interface (19 pin)

New Connector Types

Video Transmitter

Media

Video Receiver

Display

Automotive
Automotive Connector

Portable
(Micro-Connector)
Contents

- Introduction

- HDMI 1.4 Features
  - Ethernet Channel
  - Audio Return Channel
  - 3D Support
  - 4K Support
  - New Color Spaces
  - New connectors

HDMI 1.4 Test
  - Source Test
  - Cable Test
  - Sink Test
  - Protocol Test
  - Ethernet and Audio Return Channel Test

- Solution Details

- Solution Summary
HDMI 1.4 Test

• HDMI requires
  – Electrical source, cable and sink tests
  – Protocol, Ethernet and Audio Return Channel test

• HDMI link consists of three differential data lanes and a differential clock lane

• Specification 1.4 is available to adopters, Compliance Test Specification (CTS) is in progress

• Agilent is an active contributor among the 850+ adopters

• Authorized Test Centers (ATCs) perform compliance testing for all HDMI certified products
HDMI 1.4 Test Solution Overview

- **Electrical Source Test**
  - High-Speed Electrical (TMDS) Source Tests

- **Electrical Media Test**
  - High-Speed Electrical (TMDS) Cable and TDR Tests

- **Electrical Sink Test**
  - High-Speed Electrical (TMDS) Sink Tests

- **Protocol, Ethernet, Audio Return Channel Test**
  - Protocol / Audio / Video Tests
  - HDMI Ethernet and Audio Return Channel Tests
High Speed Electrical (TMDS)
Source Test Solution

Required Tests

- Low voltage, rise & fall times, overshoot/undershoot, inter-pair skew, intra-pair skew, clock duty cycle, clock jitter, data eye diagram

Recommended Test Equipment

- Realtime oscilloscope: DSO/DSA 90000A series 8GHz (DSO90804A) or higher
- Remote Programming: Opt. 011 (if used with N5990A Test Automation S/W)
- Probe Amplifier: 1169A (min. qty. 2, recommended 4)
- SMA Probe Head: N5380A (recommended) or E2695A; min. qty. 2, recommended 5
- Compliance SW: N5399A Upgrade
- TPA Fixture: N1080A

Agilent Value

- Accurate and repeatable results through lowers noise and probing systems
- Ease of use through Test Automation Software
## HDMI 1.4 Test Solution Overview

<table>
<thead>
<tr>
<th>Electrical Source Test</th>
<th>Electrical Media Test</th>
<th>Electrical Sink Test</th>
<th>Protocol, Ethernet, Audio Return Channel Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>• High-Speed Electrical (TMDS) Source Tests</td>
<td>• High-Speed Electrical (TMDS) Cable and TDR Tests</td>
<td>• High-Speed Electrical (TMDS) Sink Tests</td>
<td>• Protocol / Audio / Video Tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• HDMI Ethernet and Audio Return Channel Tests</td>
</tr>
</tbody>
</table>

Nov. 20, 2009
Cable Test Solution

Required Tests

- TMDS data eye diagram, Intra-pair skew, Inter-pair skew, differential impedance, far-end crosstalk and Attenuation

Recommended Test Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCA-J</td>
<td>86100C</td>
</tr>
<tr>
<td>TDR module</td>
<td>54754A</td>
</tr>
<tr>
<td>Dual channel electrical receiver</td>
<td>86112A</td>
</tr>
<tr>
<td>ENA Series Network Analyzer</td>
<td>E5071C</td>
</tr>
<tr>
<td>Test Set, 9 kHz to 8.5 GHz</td>
<td>Option 480</td>
</tr>
<tr>
<td>4-port RF E-Cal module</td>
<td>E4431B</td>
</tr>
</tbody>
</table>

Agilent Value

- Characterize HDMI cables quickly and accurately
HDMI 1.4 Test Solution Overview

- **Electrical Source Test**
  - High-Speed Electrical (TMDS) Source Tests

- **Electrical Media Test**
  - High-Speed Electrical (TMDS) Cable and TDR Tests

- **Electrical Sink Test**
  - High-Speed Electrical (TMDS) Sink Tests

- **Protocol, Ethernet, Audio Return Channel Test**
  - Protocol / Audio / Video Tests
  - HDMI Ethernet and Audio Return Channel Tests

Nov. 20, 2009
TMDS Sink Test Solution

Required Tests
• Receiver stress test including jitter tolerance test

Recommended Test Equipment
• E4887A-007 TMDS Signal Generator

Agilent Value
• Automated system calibration
• Independent clock and data jitter
• The only TMDS Generator covering all high-speed tests!
• Compliance and characterization Test Automation Software
• On-the-fly changes of the jitter mix and voltage levels with Frame Generator software
• Cable emulators for TP5 eye / automotive tests
Test Solution Overview

Source Test
• High-Speed Electrical (TMDS) Source Tests

Media Test
• Electrical Cable and TDR Tests

Sink Test
• High-Speed Electrical (TMDS) Sink Tests

Protocol, Ethernet, Audio Return Channel
• Protocol / Audio Video Tests
• HDMI Ethernet and Audio Return Channel Tests
Protocol Analyzer and Generator
N5998A PAG

PAG Generator

PAG Analyzer – Captured images

PAG Analyzer

 Protocol, Ethernet Audio Return Channel
3D video format information is transmitted by means of the VIC (video identification code) in conjunction with the 3D_Structure field.
HEC and ARC Physical Layer
Source Test Solution

Required Tests

• Measure eye opening, transition times etc of differential and common mode signals

Recommended Test Equipment

• Real-time oscilloscope                  DSO/DSA 80000B/90000A series
• Remote Programming                    Opt. 011 (if used with N5990A Test Automation S/W)
• Probe Amplifier                        1130A, 1168A or 1169A (qty. 2)
• SMA Probe Head                         E2678A (qty. 2)
• High Impedance Adapter                 E2697A (qty. 2)
• Compliance SW                          N5399A Upgrade
• HEC and ARC TPA Fixture                e.g. BIT-HDMI-TDPL-0001

Agilent Value

• Accurate and repeatable results through lowest noise and probing systems
• Ease of use through Test Automation Software
HEC and ARC Sink Test Solution

**Required Tests**
- Physical Layer Rx and Audio Protocol Test

**Recommended Test Equipment**
- 2-ch. Arbitrary Pulse/Function Generator
- Pattern Generator option for 81150A-002
- HEAC PHY Layer Test fixture
- Power Divider
- Oscilloscope
- Probe Head, High Impedance Adapter
- Probe Amplifier
- HEACphy HEAC Physical Layer Test Software
- HEC and ARC TPA fixture

**Agilent Value**
- Agilent 81150A with Pattern Option provides Ethernet Pattern with 3 level signals
- Glitch free change of transition times, amplitude and offset
- Clean and worst case, jittered signals (sinusoidal jitter), noise injection
Contents

- Introduction

- HDMI 1.4 Features
  - Ethernet Channel
  - Audio Return Channel
  - 3D Support
  - 4K Support
  - New Color Spaces
  - New connectors

- HDMI 1.4 Test
  - Source Test
  - Cable Test
  - Sink Test
  - Protocol Test
  - Ethernet and Audio Return Channel Test

Solution Details

- Solution Summary
HEC and ARC Sink Test Solution
Physical Layer and Audio Protocol Test Setup
Ethernet and Audio Return Channel
Backward Compatibility

- **Hot Plug Detect**
- **DC offset**

- **Ethernet Tx**
  - Differential, 3-level, 400 mVpp

- **Ethernet Rx**
  - Differential, 3-level, 400 mVpp

- **Audio Return Channel**
  - Common Mode 400 mVpp

All signals added together and transmitted on pins 14 & 19 of the HDMI connector (previously HPD & Reserved)
Hot Plug Detect

From DUT (or generated on adapter board)

- Ethernet Tx
  - Generated by 81150A (incl. distortions)

- Ethernet Rx
  - From DUT

→ Audio Return Channel
  - Generated by 81150A (incl. distortions)

HDMI 1.4 Whole Solution
Test Fixtures and Adapters
HEC and ARC PHY Layer Test

HEC and ARC Test Adapter Board
• 81150AU-EHD

Type A, C and D Test Point Access Fixtures (TPAs) supporting HEC, ARC:
• Type A fixtures, tba
• Type C (mini connector) fixture, tba
• Type D (micro connector) fixtures, see next page
Test Fixtures and Adapters
Type D, Type E TPAs (BitifEye Products)

• **High Performance Test Point Access Fixtures:**
  - Type D (micro connector) TPA-P: BIT-HDMI-TDPL-0001 (plug)
  - Type D (micro connector) TPA-R: BIT-HDMI-TDRE-0001 (receptacle)
  - Type E (automotive) TPA-P: BIT-HDMI-TEPL-0001 (plug)
  - Type E (automotive) TPA-R: BIT-HDMI-TERE-0001 (receptacle)
Test Automation Software Platform
N5990A, BIT-VF-MAIN

- Compliance Test and Characterization
- Short calibration and test times
- Easy to use
- Supporting TMDS Generator (opt. 150), N5998A PAG, Quantum Data 882EA (opt. 350) for Sink High-Speed Electrical and Protocol tests
- Supporting 81150A AWG for HEAC Physical Layer and Audio Protocol Test (opt. 351)
Compliance pattern selection
- supports more than 100 video formats

Unique on-the-fly control of the clock and data jitter mix

Stand-alone tool for manual characterization and debug, supporting:
- 3D formats
- 4K formats
- new CEA-861E formats
- HDMI 1.4 colorimetry
- Content type
Complementary BitifEye Accessories
Agilent Partner Providing Complementary Products

HDMI 1.4 HEC and ARC Kit for 81150AU-EHD

81150A #1
Ethernet Generator

81150A #2
Audio Generator

Out 2 +
Out 1 +

Out 1 -
Power divider
Out 2 +
Out 1 +

Power divider

USB

To scope ch4 (only for HEC Rx test)

BIT-HDMI-HEHD-0001 Accessory Kit (red) for 81150AU-EHD
- 2 SMA cables 0.2 m
- 2 SMA cables 0.3 m
- 8 Snap-On Connectors
- 2 Terminations (50 Ohm)
- 1 TPA low-speed break-out extension

From 81150A #1 out 2+ (only for HEC Rx test)

ch4

81150AU-EHD HEC and ARC PHY Test Board

Agilent prototype physical test board

Type A, C or D HEC and ARC fixture
Contents

- Introduction

- HDMI 1.4 Features
  - Ethernet Channel
  - Audio Return Channel
  - 3D Support
  - 4k x 2k Support
  - New Color Spaces
  - New connectors

- HDMI 1.4 Test
  - Source Test
  - Cable Test
  - Sink Test
  - Protocol Test
  - Ethernet and Audio Return Channel Test

- Solution Details

  Solution Summary
# HDMI 1.4 Whole Test Solution

## Solution Elements by Test Type

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Source Test</th>
<th>Media Test</th>
<th>Sink Test</th>
<th>Protocol, HEC, ARC, Display Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source Test</strong></td>
<td>DVD Players, Set Top Boxes, Chips</td>
<td>Cables, PC Boards, Connectors</td>
<td>Monitors, Repeaters</td>
<td>U8101A Display Tester</td>
</tr>
<tr>
<td></td>
<td>DS090000A Infiniium Real Time Oscilloscopes</td>
<td>86100C DCA-J Sampling Oscilloscope</td>
<td>E4887A TMDS Signal Generator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N5399B HDMI Compliance Test Software (incl. HEC and ARC Source Phy Test)</td>
<td></td>
<td>Cable Emulators</td>
<td>N5998A PAG and Quantum Data 882EA</td>
</tr>
<tr>
<td></td>
<td>TPA fixtures</td>
<td></td>
<td>TPA fixtures</td>
<td></td>
</tr>
<tr>
<td><strong>Media Test</strong></td>
<td></td>
<td></td>
<td></td>
<td>N2X (HEC Networking)</td>
</tr>
<tr>
<td><strong>Sink Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protocol, HEC, ARC, Display Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **New**: New items included in the solution.
- **SW Upgrade**: Software upgrades available for the solution.

---

**Note:**
- HDMI 1.4 Whole Test Solution
- N5990A Test Automation Software Platform
- Nov. 20, 2009
- Agilent Technologies
Customer Testimonials

Silicon Image ATCs and HDMI LLC:


• US semiconductor customer:
  – „We have identified [with the Agilent TMDS Signal Generator] one of our register needs to be modified, otherwise it will fail on 1080P@60 36BPP mode in either 1Mhz, 500K and 10Mhz jittering range tests (0.0 T Bit to 1.0 T Bit). The test equipment works very well to catch this problem“.
Related Products and Links

- Agilent’s HDMI Industry Web Page
  www.agilent.com/find/hdmi

- Agilent’s HDMI Sink Test
  www.agilent.com/find/hdmi_sink_test

- HDMI Analyzer
  www.agilent.com/find/hdmi_analyzer

- 81150A Pulse Function Arbitrary Noise Generator
  www.agilent.com/find/81150

- N5990A Automated Compliance and Device Characterization Tests Software
  www.agilent.com/find/automation

- Infiniium Oscilloscopes
  www.agilent.com/find/scope
## Related Literature

<table>
<thead>
<tr>
<th>Pub Number</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>5989-5537EN</td>
<td>E4887A HDMI TMDS Signal Generator - Data Sheet</td>
</tr>
<tr>
<td>5989-4959EN</td>
<td>HDMI Sink and Source Compliance Test and Characterization – Application Note</td>
</tr>
<tr>
<td>5989-5483EN</td>
<td>N5990A Test Automation Software Platform Data Sheet</td>
</tr>
<tr>
<td>5989-9188E</td>
<td>ParBERT 81250 Product Overview</td>
</tr>
<tr>
<td>5989-6433EN</td>
<td>81150A Pulse Function Arbitrary Noise Generator</td>
</tr>
<tr>
<td>5989-7819EN</td>
<td>Agilent Infiniium DSA/DSO 90000A Series Data Sheet</td>
</tr>
</tbody>
</table>
Agilent Digital Standards Program

Our solutions are driven and supported by Agilent experts involved in international standards committees:

- Joint Electronic Devices Engineering Council (JEDEC)
- PCI Special Interest Group (PCI-SIG®)
- Video Electronics Standards Association (VESA)
- Serial ATA International Organization (SATA-IO)
- USB-Implementers Forum (USB-IF)
- Mobile Industry Processor Interface (MIPI) Alliance
- Optical Internetworking Forum (OIF)

We’re active in standards meetings, workshops, plugfests, and seminars.

Our customers test with highest confidence and achieve compliance faster.
Agilent’s solutions for digital applications are driven and supported by Agilent experts that are involved in the various international standard committees. We call it the Agilent Digital Test Standards Program. Our experts are active in the Joint Electronic Devices Engineering Council (JEDEC), PCI Special Interest Group (PCI-SIG®), Video Electronics Standards Association (VESA), Serial ATA International Organization (SATA-IO), USB-Implementers Forum (USB-IF), Mobile Industry Processor Interface (MIPI) Alliance, and many others. Our involvement in these standards groups and their related workshops, plugfests, and seminars enables Agilent to bring the right solutions to the market when our customers need them.
HEC Test Solution
Networking Test

- Consists of an Agilent N2X Ethernet protocol tester connected to multiple HEAC signals using HDMI to Ethernet converter boxes – N5610A
- The N2X runs manual or automated tests to validate the Ethernet switching functionality of the DUT
- HDMI initialization procedures can be done through external CEC/CDC Controllers
- The N5610A can be configured for HDMI source or sink connection to the DUT and enabling high speed HDMI audio/video signals to pass through the N5610A
- SPDIF connections are provided on the N5610A to enable access to the audio return channel
Adding procedures to an existing subset

Adding custom procedure subsets