Simplify the Latest HDMI Compliance Testing

name
title

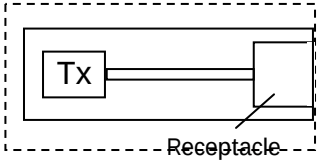
Tektronix
Innovation Forum

Agenda

- HDMI Overview and Updates
- Compliance Test Solution
  - Source Tests
  - Sink Tests
    - Direct Synthesis HDMI Sink Solutions
  - Cable Tests
- Solution Details
  - Tektronix HDMI 1.4 Solutions
- Additional resources

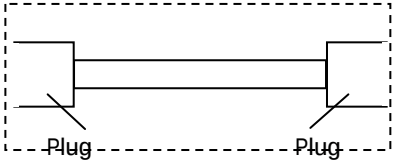
HDMI – System Overview

Source Devices



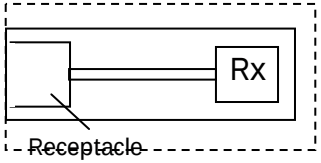
- Set-top Boxes, DVDs, Repeaters, Gaming devices

Cable Assemblies



- Cables

Sink Devices



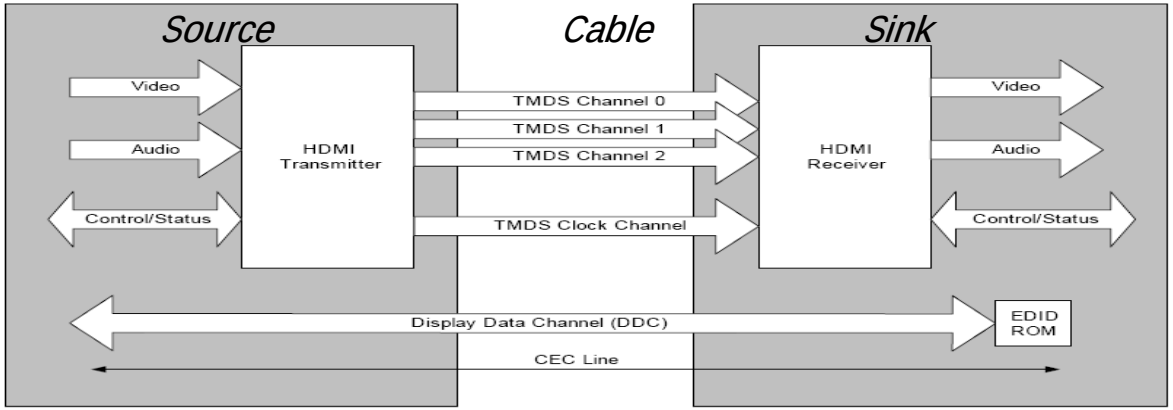
- TVs, Monitors, Repeaters, etc.

HDMI v1.4 Specifications and Compliance Test Specifications – What's Changed

- Compliance Test Specification
  - CTS1.3c announced on July 25th 2008 – Approves Direct Synthesis method for Sink testing
  - CTS1.4 - Awaiting release
- Key improvements in HDMI v1.4
  - HEAC (HDMI Ethernet Audio Back Channel)
  - Automotive HDMI (Type E)
  - Support for micro HDMI connector for mobile devices (Type D)
  - 3D HDMI and 4K x2K patterns support.
  - New Deep color patterns support
- Updated testing requirements
  - New 2.3dB equalization mandated for cable tests and Sink tests for Automotive HDMI (Type E)
  - Mandatory 3D and 4K x 2K pattern support
  - Included Direct Synthesis Solution in CTS1.3c

Tektronix Brings Domain Expertise to HDMI Test

- Unequaled domain expertise
  - Providing leading HDMI test solutions since original HDMI spec introduced
- Portfolio of solutions
  - Signal generators, real-time oscilloscopes, compliance test software, TDR, sampling oscilloscopes & probing
- Cost effectiveness & Flexibility
  - More affordable upgrade path from previous HDMI test systems
  - Flexible test configuration
- Reduce test time
  - Automation of the more challenging tests
  - Four-lane Sink Intra-Pair Skew Test



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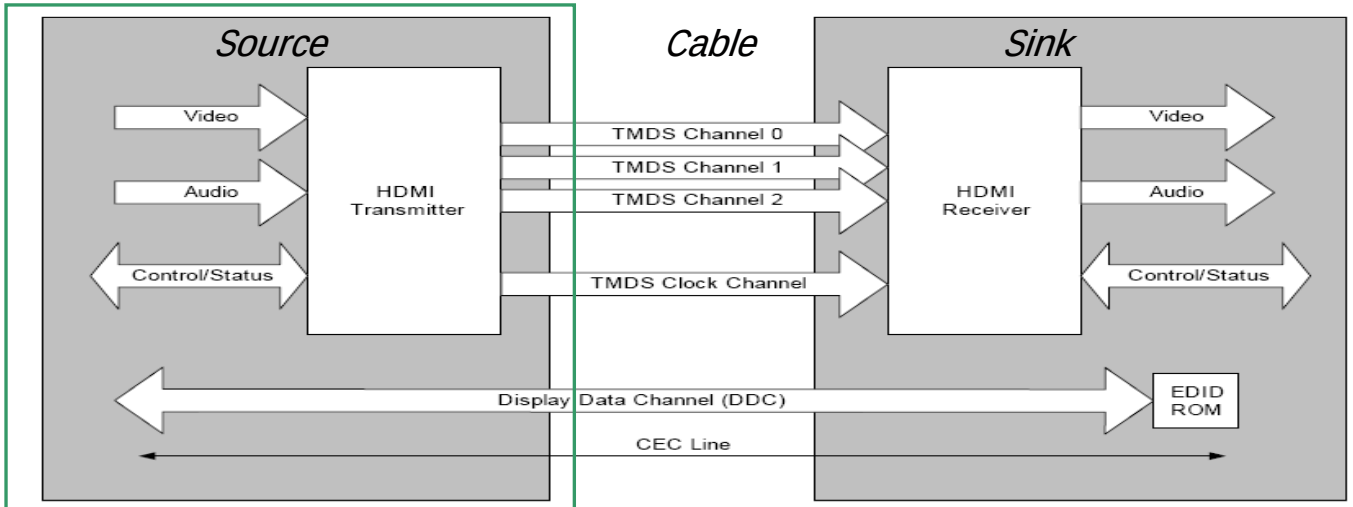
HDMI Source Testing



- Rise/Fall Time
- Inter-pair Skew
- Clock Duty Cycle
- Clock Jitter
- Eye Diagram

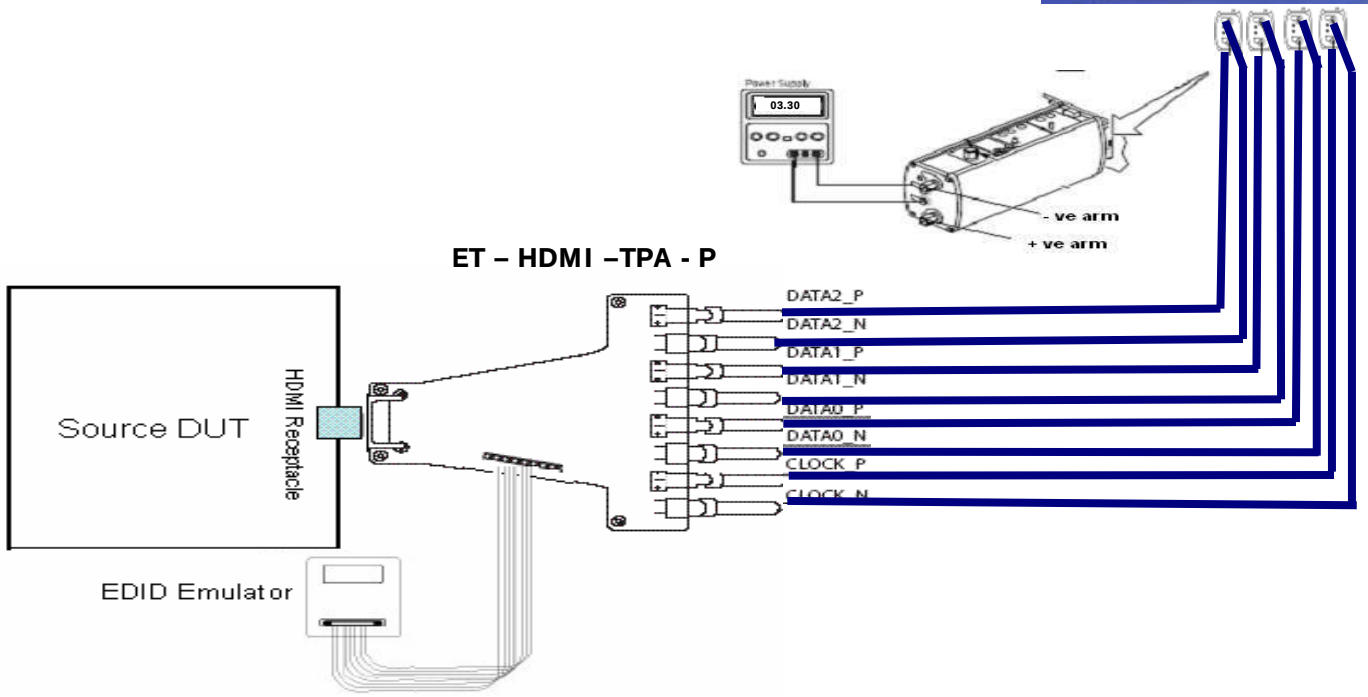
Differential

- Voltage VL
- Intra-pair Skew

Single-ended

Typical Source Test Configuration - *Differential Measurement*

Introducing 4 channel support for Differential measurement leveraging DPO/DSA scope capability



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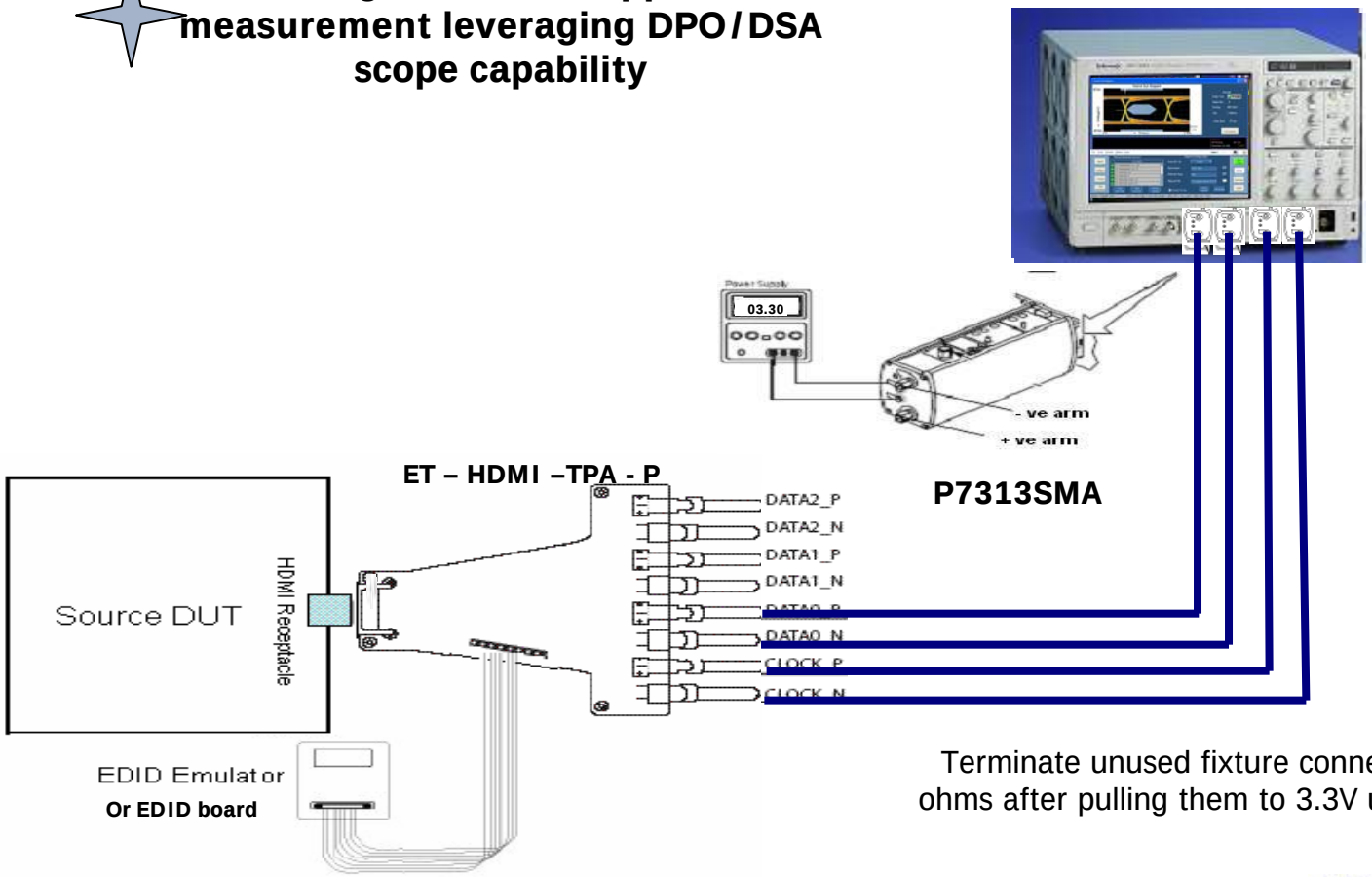
Typical Source Test Configuration
- *Single-ended Measurement*

Introducing 2 channel support for SE measurement leveraging DPO/DSA scope capability



Terminate unused fixture connectors with 50 ohms after pulling them to 3.3V using Bias-Tees

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Recommended Tektronix Equipment
for HDMI Compliance Testing per CTS V1.3c

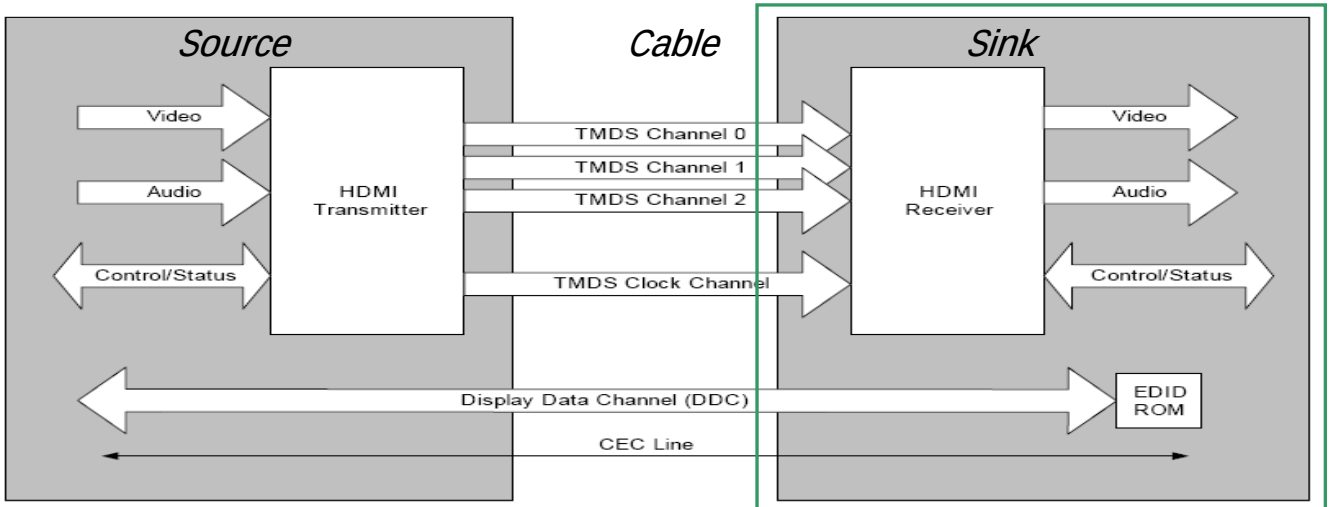
- ***More detail at www.tektronix.com/hdmi***

Recommended Test Equipment for HDMI Compliance Testing per CTS (Compliance Test Specification) V1.3c

HDMI Source Test

Recommended Equipment		Quantity
Oscilloscope	DSA70804B, DSA71254B, DSA71604B or DSA72004B with Opt 2XL; or DPO70804B, DPO71254B, DPO71604B, or DPO72004B with Opt 2XL	1
Other Supported Oscilloscopes [1,2]	TDS6804B, TDS6124C and TDS6154C	1
Software	TDSHT3 – HDMI compliance software (option HT3) (support for CTS V1.3b requires software Version 3.3.0 or higher). Support for CTS V1.3b1 and support of 4-channel measurement requires software Version 4.0 or higher)	1
Probes	P7313SMA differential SMA probe - use for all differential and single-ended measurements.	2 or 4[3]
Test Fixtures	ET-HDMI-TPA-STX - HDMI Type A fixture set for Transmitter Test.	1 set
Power Supply	3.3V power supply[4]	1
Connector	Bias-Tees to terminate the unused fixture ports with 50 Ohms after pulling the DC of the Bias-Tees to 3.3V. Order individually as ZX85-12G-S+ from Mini-Circuits[4]	8 pcs

HDMI Sink Testing



- Jitter Tolerance
- Min/Max Differential Swing
- Intra-Pair Skew
- Differential Impedance

Sink Testing
- *Jitter Tolerance Test*

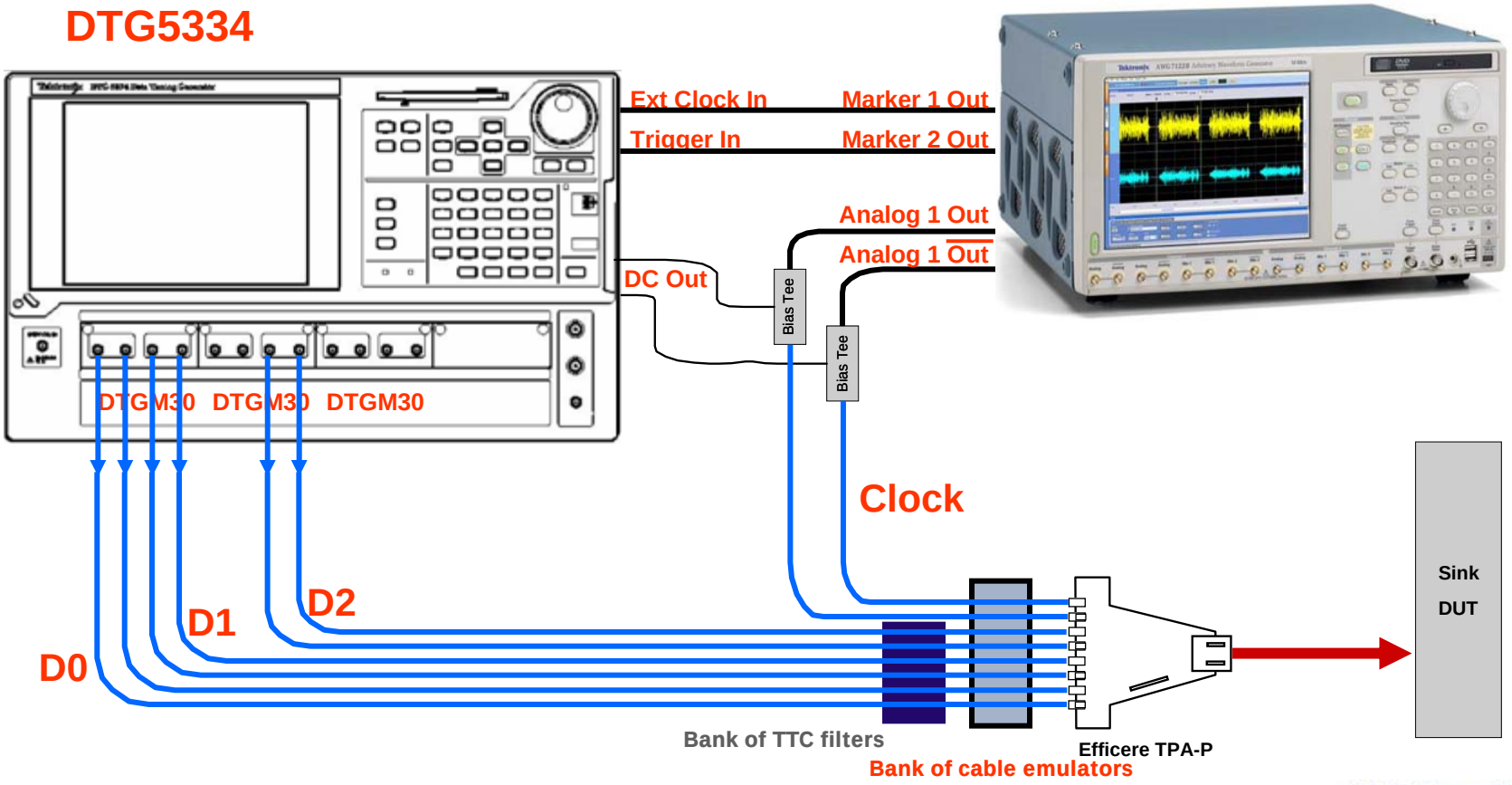
Introducing margin test capability for SJT with Max of 0.5TBit Jitter for Cj and Dj

- Test sequence has been simplified
  - Requires fewer iterations to complete a test (eliminated Djw procedure)
  - CTS1.3c adds TP2 testing
- Supports two alternative methods of jitter injection
  - Standard Jitter insertion method
    - Combines both clock and data jitter components and modulates them both on the clock signal
    - Minimum test requirement of CTS - HDMI customers
  - Optional Jitter Insertion method
    - Modulates clock signal only with clock jitter component
    - Modulates all data signals with data jitter component
- Tektronix' HDMI compliance solution supports both methods
  - The standard method is supported at minimal cost using an AFG3102 or AWG710/B for customers who already have them
  - The new AWG7102 with Option 01 supports both methods

Jitter Generation with DTG & AWG7102
- *combined clock/data jitter*

27 MHz to 340 MHz

AWG CH1 - Sub-rate (1/10 data rate) clock modulated with both clock jitter component (10 MHz/7 MHz) and data jitter component (500 KHz/1 MHz)
AWG MK1 - Full rate clock to DTG



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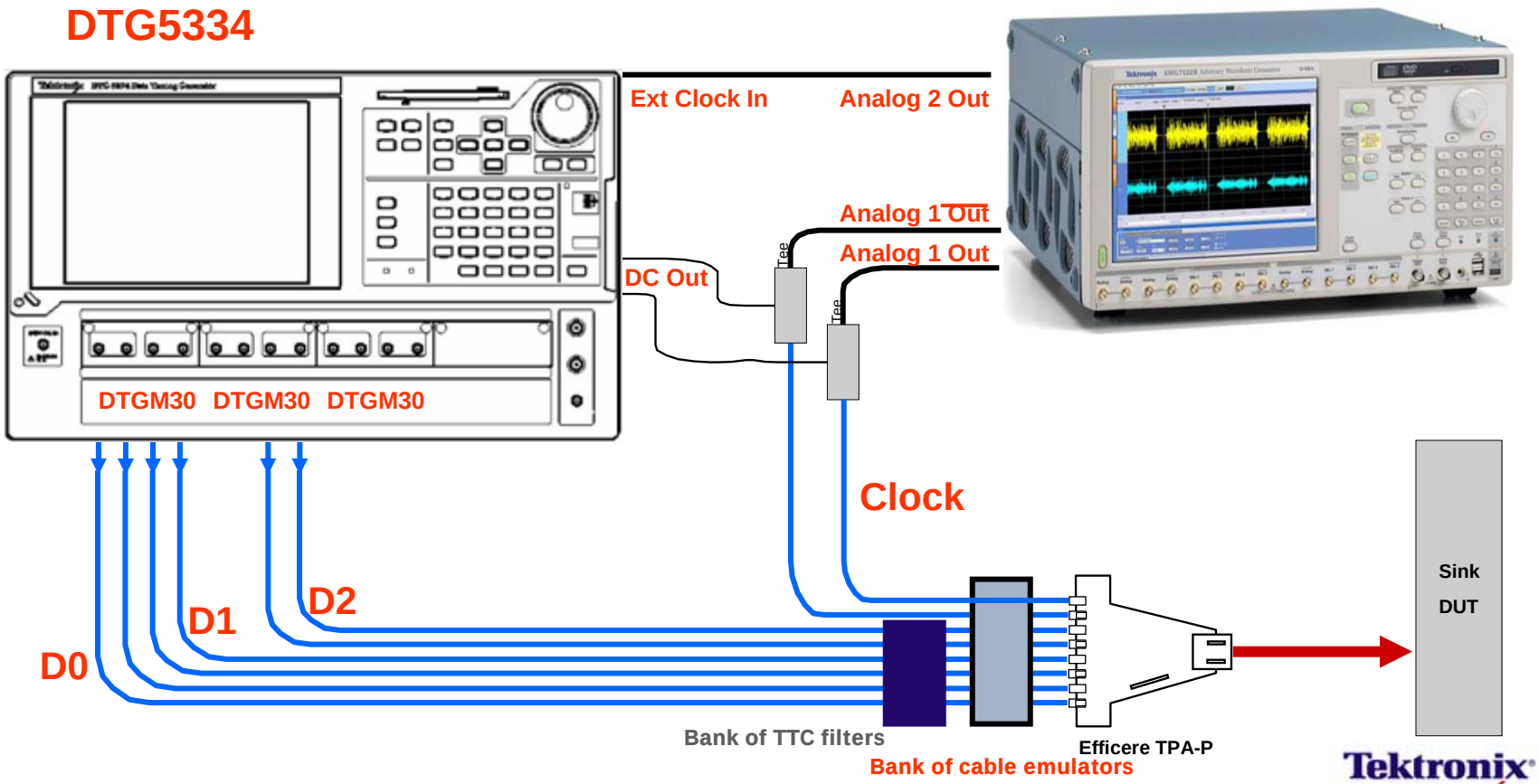
Jitter Generation with *New* Equipment
- *separate clock/data jitter*

27 MHz to 340 MHz

AWG CH1 - Sub-rate (1/10 data rate) clock modulated with clock jitter component (10 MHz/7 MHz)

AWG CH2 - Full rate clock to DTG modulated with data jitter component (500 KHz/1 MHz)



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Recommended Tektronix Equipment
for HDMI Compliance Testing per CTS V1.3c

- ***More detail at www.tektronix.com/hdmi***

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Tektronix » Applications » Serial Data » HDMI/DVI » HDMI Sink Test Recommended Equipment

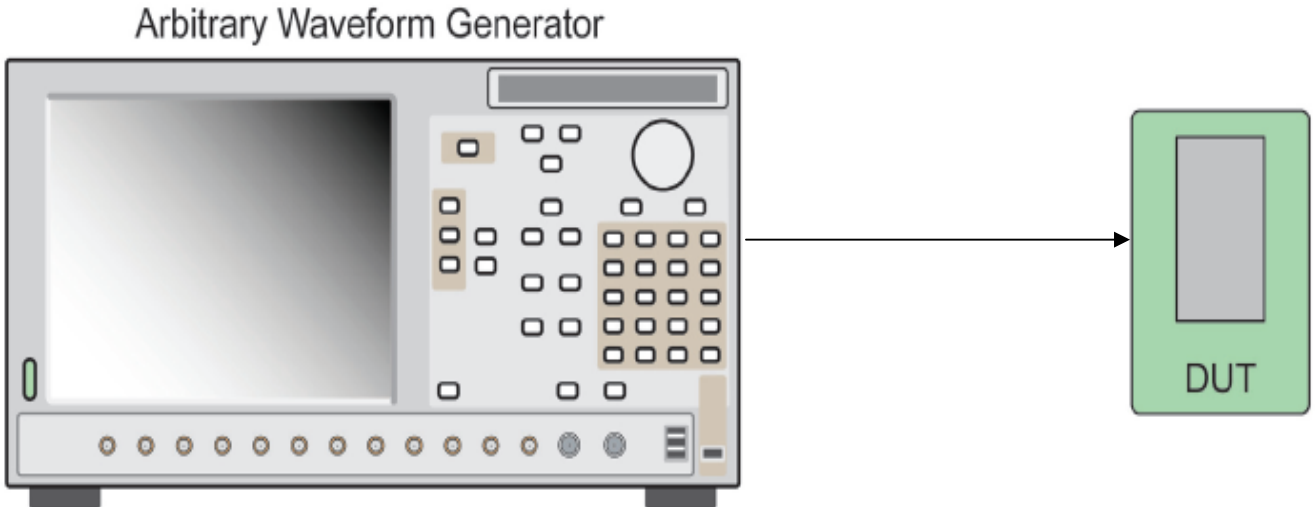
Recommended Test Equipment for HDMI Compliance Testing per CTS (Compliance Test Specification) V1.3c

HDMI Sink Test

Recommended Equipment		Quantity
Oscilloscope	DSA70804B, DSA71254B, DSA71604B or DSA72004B with Opt 2XL; or DPO70804B, DPO71254B, DPO71604B, or DPO72004B with Opt 2XL	1
Other Supported Oscilloscopes [1, 2]	TDS6804B, TDS6124C and TDS6154C	1
Software	TDSHT3 - HDMI compliance software (option HT3 for DSA/DPO, support for CTS V1.3b requires software Version 3.3.0 or higher. Support for CTS V1.3b1 and support of 4-channel measurement requires software Version 4.0 or higher)	1
Probes	P7313SMA differential SMA probe - use for all differential and single-ended measurements	2
Data Generator	DTG5334 with (3) DTGM30 modules	1 set
Other Supported Data Generators[3]	DTG5274 with (3) DTGM30 modules can be used but will only support HDMI testing at limited resolution and clock/data rate	1 set
Jitter Generator	AWG7122B with opt 01 - supports both standard (combined) and Optional (separate clock/data) jitter insertion methods	1
Other Supported Jitter Generators	AFG3102 - this support only the standard (combined clock/data) jitter insertion method	1
TDR System	DSA8200 with (1) 80E03 and (1) 80E04 module (for SINK Differential Impedance test)	1
Connector	Bias-Tees to shift AWG7122B direct clock output to TMDS levels. Order individually as ZX85-12G-S+ from Mini-Circuits	2
Cables	Tektronix SMA cables (174-1428-00)	12
Adapter	BNC to SMA Adapter (015-0554-00)	1
Interface	NI-GPIB-USB -A/B/HS with Driver Software from National Instruments. *Type B/HS is recommended for use with DPO/DSA70000 Series oscilloscopes.*	1
Power Supply	Power supply 5V	1
Filters	Transition Time Converters from Picosecond Pulse Labs **Ordering information:** Clock Speed / Rise Time / Filter Part Number 27 MHz / 430 ps / 5915-100-430PS 74.25 MHz / 430 ps / 5915-100-430PS 148.5 MHz / 200 ps / 5915-100-200PS 222.75 MHz / 120 ps / 5915-100-120PS 335.00 MHz / No filter required Please note that 5915-100-xxx type filter has Female connectors (jack) on both input and output sides. One Male-Male (plug-plug) adapter will be needed for each TTC unit to be connected to DTG output or cable emulator unit directly. Unit with different shape of connectors Female-Male (jack-plug) is available by ordering as 5915-110-xxx, but will be less flexible in connection.	6 sets

Introducing Direct Synthesis HDMI Sink Solution- Now approved in CTS1.3c

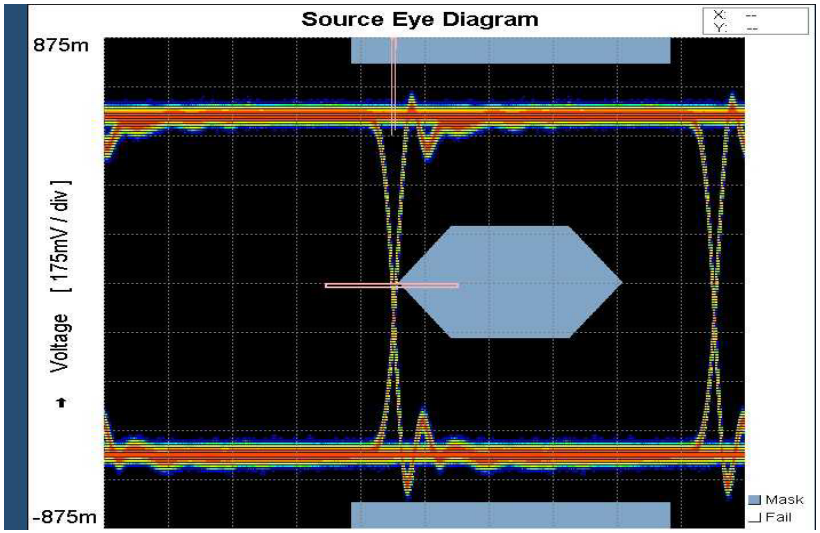
Present Solution
- HDMI Sink Jitter Tolerance setup



- **No Hardware Cable emulator**
- **No Hardware TTC filters**
- **Synthesize directly using the next gen DS method**

Signal Generation Solution with Direct Synthesis

- HDMI requires more channels and more complex waveforms
  - HDMI Configuration is two AWG7102 units plus AFG3000
- DS for all tests requiring TMDS Signal Generation
  - Cable Eye Diagram
  - Sink Jitter Tolerance
  - Sink Min/Max Differential Swing Tolerance
  - Sink Intra-pair Skew



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Recommended Tektronix Equipment
for HDMI Compliance Testing per CTS V1.3c

- ***More detail at www.tektronix.com/hdmi***

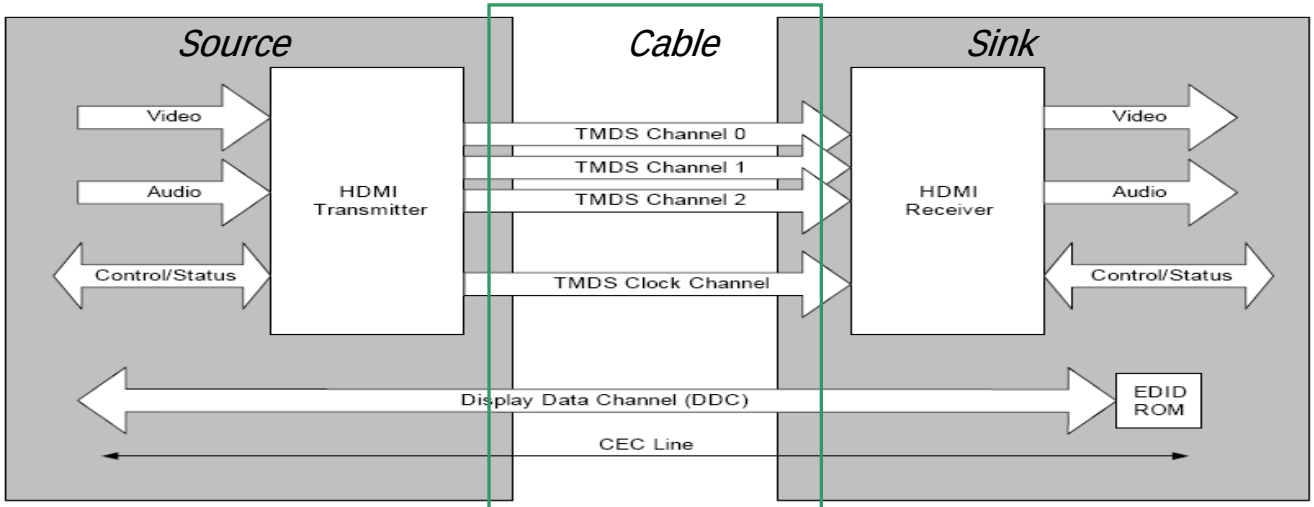
For testing with a Type 2 cable emulator used in Jitter Tolerance Test (Test ID 8-7)

Recommended Equipment		Quantity
Oscilloscope	DSA70804B, DSA71254B, DSA71604B or DSA72004B with Opt 2XL; or DPO70804B, DPO71254B, DPO71604B, or DPO72004B with Opt 2XL	1
Arbitrary Waveform Generator	Tektronix AWG7102 Arbitrary Waveform Generators (AWG) with Opt 01 and 06.	2
Arbitrary Function Generator	Tektronix AFG3102 Arbitrary Function Generators (AFG)	1
	Mini Circuits Bias Tee model number ZX-85 12G+ needed to connect to the output of the AWG analog ports	8
SMA Cables	Tektronix 174-1428-00 (1.5 meters), as needed to connect output of Bias Tees to Efficere TPA boards	10 or 12
DC Power Supply	To Connect 5V to the +5V Power (P_5V) and DDC/CEC Ground (P_GND) on TPA-P	1
	Tektronix HDMI Fixture Set ET-HDMI-TPA-S	1
Software	TDSHT3 software (option HT3 for DSA/DPO)	1

Benefits of Direct Synthesis

- Simplicity
  - Elimination Cable Emulators and TTC (Transition Time Converts)
    - Cable emulators (8 channels x 2 cable types)
    - ~40 transition time filters
  - Greatly reduces the opportunity for operator error
- Performance
  - Generates a wide range of rise-times without different filters
  - Supports both the Combined and the Separate clock/data jitter insertion methods
  - Synthesizes any/all Cable Emulator with any requirements
  - Enables customers to perform their own margin testing
- Flexibility
  - The test repeatability across multiple labs/locations
  - Pre-compensates waveforms to produce signals at the DUT launch point
  - Emulates any impairment the CTS requires in the future
- Direct Synthesis method has been approved in CTS 1.3

HDMI Cable Testing



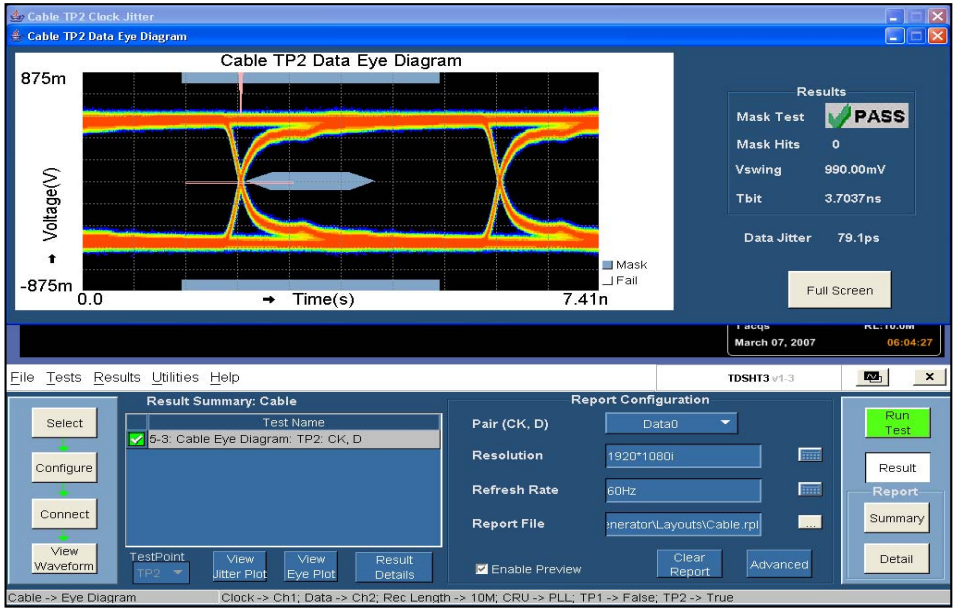
- TMDS Data Eye Diagram
- Inter-pair and Intra-pair Skew
- Impedance
- FEXT (Far End Crosstalk)
- Attenuation

Cable Tests

- TMDS Data Eye Diagram

Introducing AFG support for Jitter insertion for Cable Eye Diagram test

Introducing 4 channel support for TP2 Eye Diagram test leveraging DPO/DSA capability



- Others
  - Inter-pair and Intra-pair Skew
  - Impedance
  - FEXT (Far End Crosstalk)
  - Attenuation

Performed Using TDR Oscilloscope

Performed Using Network Analyzers

Can be accomplished with TDR/IConnect (pending approval for inclusion in CTS)

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Recommended Tektronix Equipment
for HDMI Compliance Testing per CTS V1.3c

- ***More detail at www.tektronix.com/hdmi***

Tektronix » Applications » Serial Data » HDMI/DVI » HDMI Cable Test Recommended Equipment

Recommended Test Equipment for HDMI Compliance Testing per CTS (Compliance Test Specification) V1.3c

HDMI Cable Test

Recommended Equipment		Quantity
Oscilloscope	DSA70804B, DSA71254B, DSA71604B or DSA72004B with Opt 2XL; or DPO70804B, DPO71254B, DPO71604B, or DPO72004B with Opt 2XL	1
Other Supported Oscilloscopes [1,2]	TDS6804B, TDS6124C and TDS6154C	1
Arbitrary Waveform Generator	AWG7122B with Options 1, 6, 8 or AWG7102 with Options 01 and 06	2
Arbitrary Function Generator	AFG3102	1
Software	TDSHT3 - HDMI compliance software (option HT3 for DSA/DPO) (support for CTS V1.3b requires software Version 3.3.0 or higher. Support for CTS V1.3b1 and support of 4-channel measurement requires software Version 4.0 or higher)	1
Probes	P7313SMA differential SMA probe - use for all differential and single-ended measurements	2 or 4[3]
TDR System	DSA8200 with (1) 80E03 and (1) 80E04 module (for Cable Inter-pair Skew and Far-End Crosstalk tests)	1 set
Test Fixtures	ET-HDMI-TPA-S - HDMI Type A fixture set for Transmitter Test, Receiver Test, and Cable Test. Order from Efficere Technologies.	1 set
Test Fixtures	ET-HDMI-TPA-S - HDMI Type A fixture set for Transmitter Test, Receiver Test, and Cable Test. Order from Efficere Technologies.	1 set
Cables	SMA cables. 10 - 12 174-1428-00 (1.5 m) to connect Bias Tee mini circuits to Efficere TPA boards.	14 - 16
Modules	DTG5334 with 3 DTGM30 modules	1 set
Filters	Transition Time Converters from Picosecond Pulse Labs **Ordering information:** Clock Speed / Rise Time / Filter Part Number 74.25 MHz (Cat 1 cable) / 430 ps / 5915-100-430PS 165 MHz (Cat 2 cable) / 150 ps / 5915-100-150PS 335 MHz / No filter required TTC hardware filters for cable test will not be required as TDSHT3 provides the software TTC filters.	Minimum 2 sets
Interface	NI-GPIB-USB - A/B/HS with Driver Software from National Instruments. *Type B/HS is recommended for use with DPO/DSA70000 Series scopes.*	1
Mini Circuits	Bias T model ZX-85 12G+ needed for AWG analog ports	8

Tektronix Solution Details

Real-Time Oscilloscopes & Probes

- Multiple performance offerings
  - ≥ 8 GHz bandwidth for testing at all rates covered in CTS v1.3c
  - ≥ 4 GHz bandwidth for testing clock rates up to 148.5 MHz
- Real-time oscilloscope needed for Source, Sink and Cable testing
  - 8 GHz: DSA70804B, or DPO70804B w/Opt 2XL
  - 4 GHz: DSA70404B, or DPO70404B w/Opt 2XL
- P7313SMA Differential SMA probe
  - Performance specifically designed for HDMI testing
  - For all differential and single ended measurements

Choosing Real-Time Scope Bandwidth		
Video Format	**Bit Rate**	**R-T Scope BW**
1080i 24bit-Color (8bit/Ch)	742.5Mbps	4 GHz
1080p 24bit-Color (8bit/Ch)	1.485Gbps	4 GHz
1080p 30bit-Color (10bit/Ch)	1.86Gbps	8 GHz
1080p 36bit-Color (12bit/Ch)	2.23Gbps	8 GHz
1080p 48bit-Color (16bit/Ch)	2.97Gbps	8 GHz

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Signal Sources

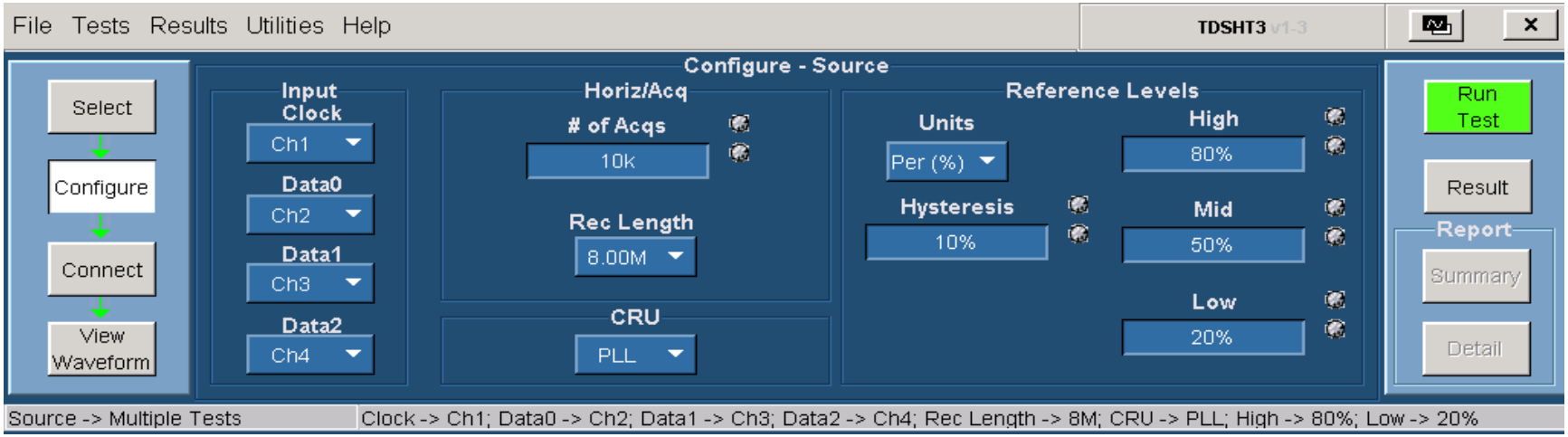
- HDMI Pattern Generation
  - DTG5334 mainframe
  - DTGM30 modules (three required)
  - DTGM32 (for use with AWG710/B or AFG3102 only)

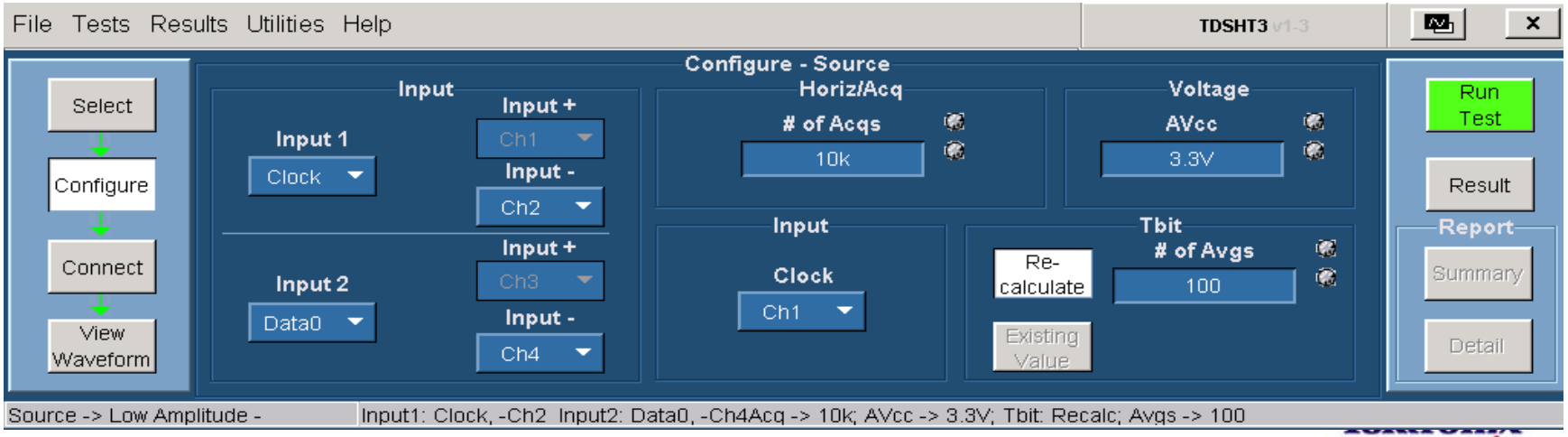
- Sink Tests - Jitter Injection
  - AWG7102/7122B - Supports both separate jitter insertion and composite jitter insertion
  - AFG3102 - Low cost solution but only for composite jitter insertion
  - AWG710/B - Only for composite jitter insertion

TDSHT3 v4.0.0 or above version Software

- Source Test

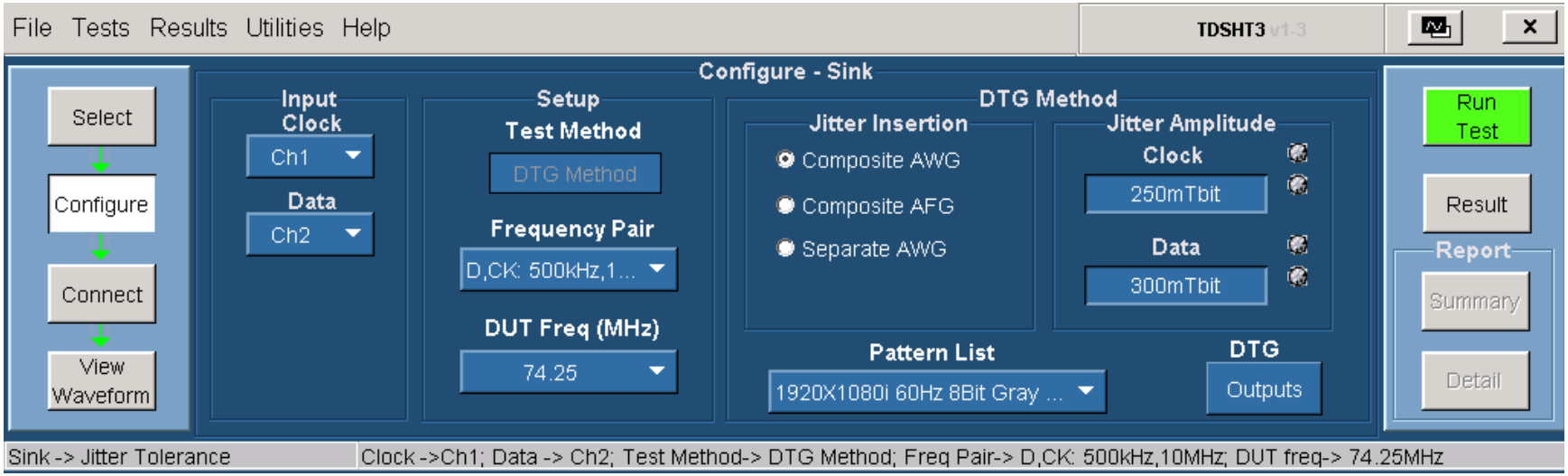
Introducing 4 channel support for Differential measurement & 2 channel SE measurement leveraging DPO/DSA capability





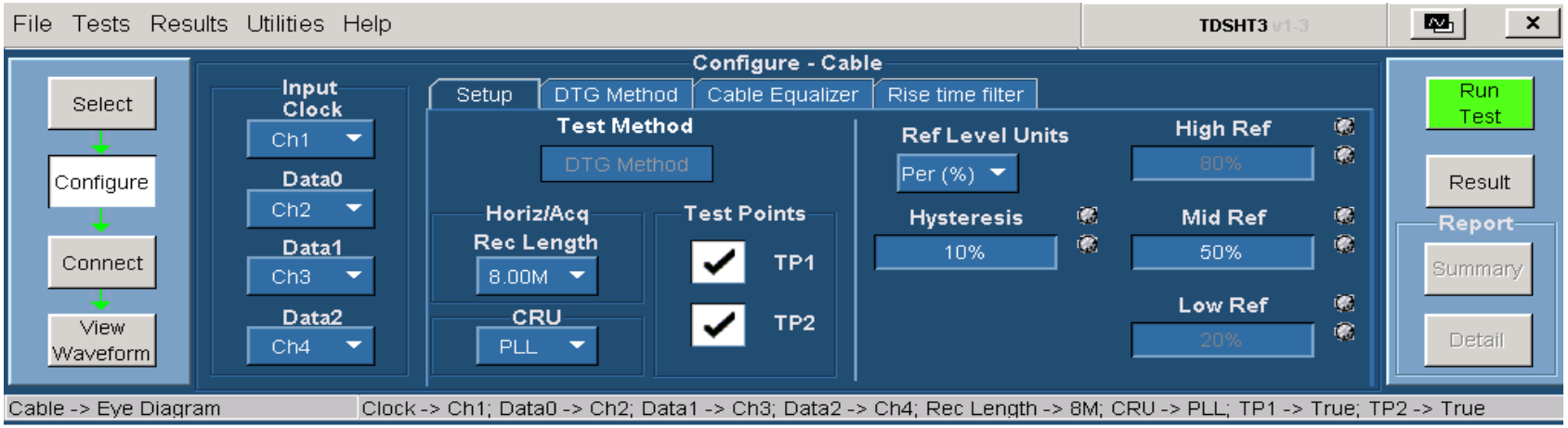
TDSHT3 v4.0.0 or above Software

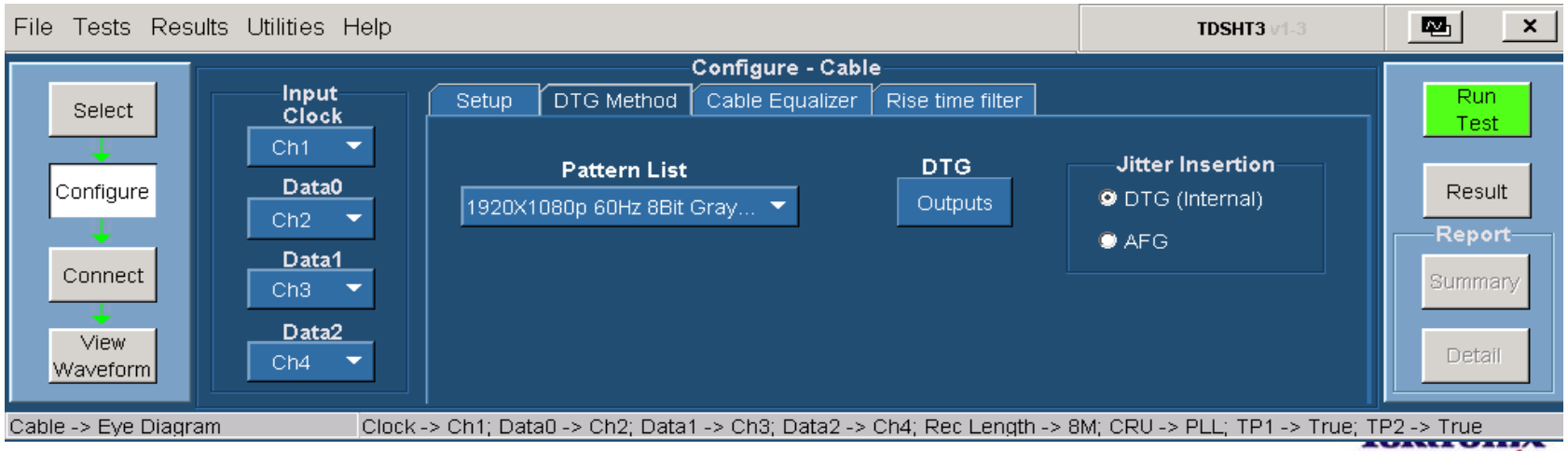
- Sink Test
  - Sink setup pane with selection of separate and combined jitter insertion and AWG/AFG selection
  - Drop down menu for pattern selection



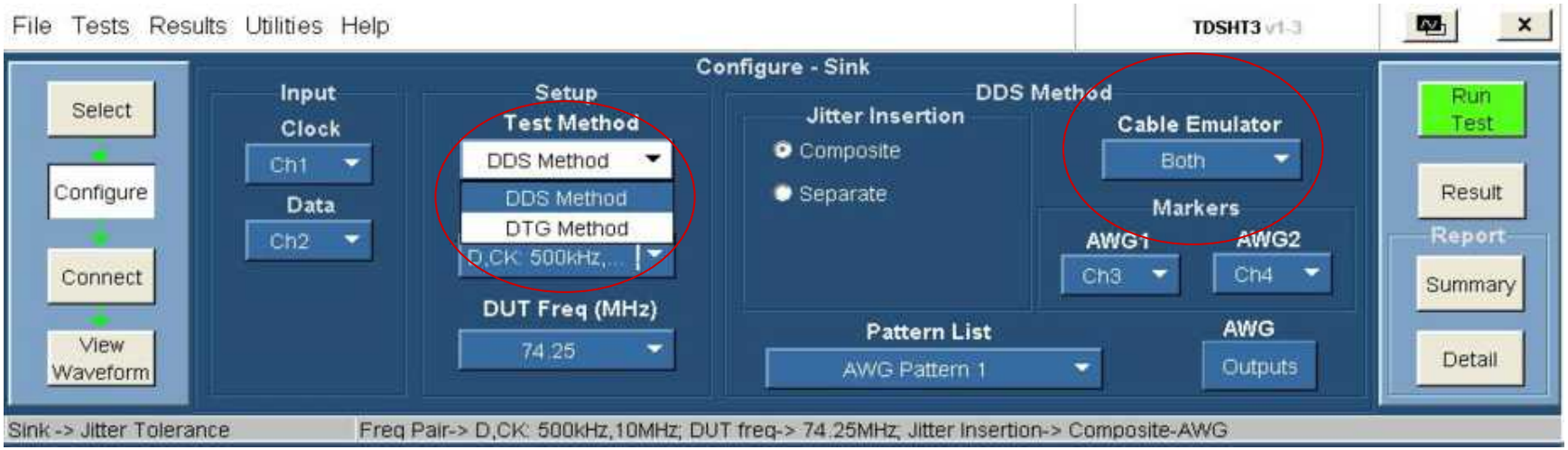
TDSHT3 v4.0.0 or above Software

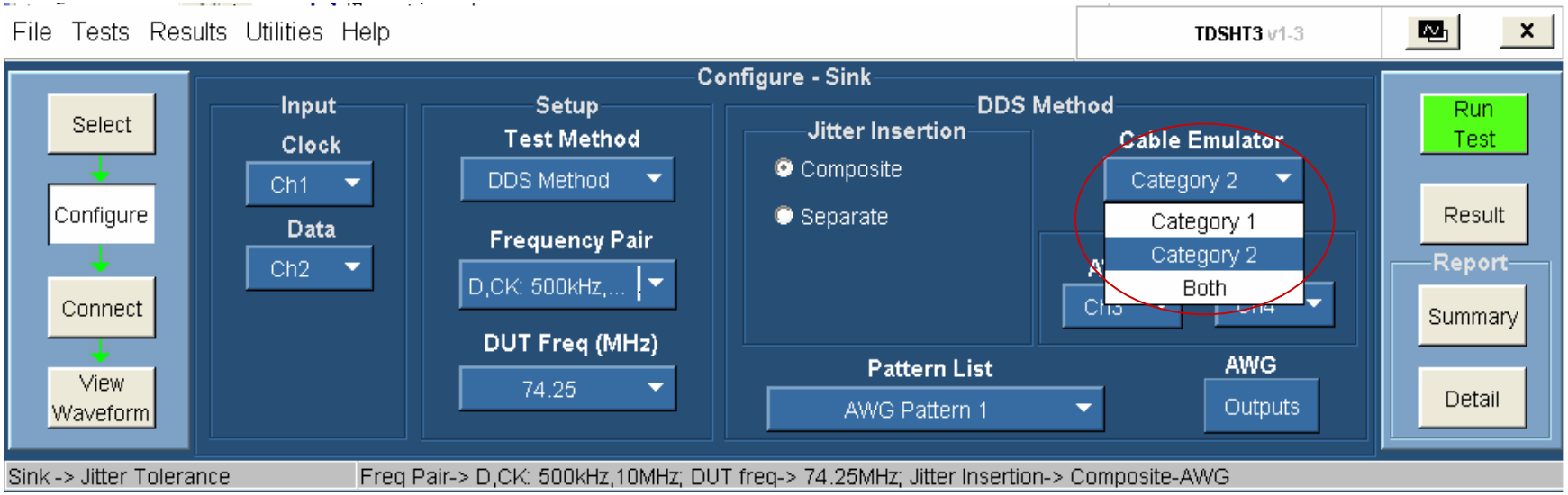
- Cable Test
  - Cable test with Rise time filter selection (in place of hardware TTC filters) and Cable equalization filter selection





HDMI Direct Synthesis method will be available under HT3 software





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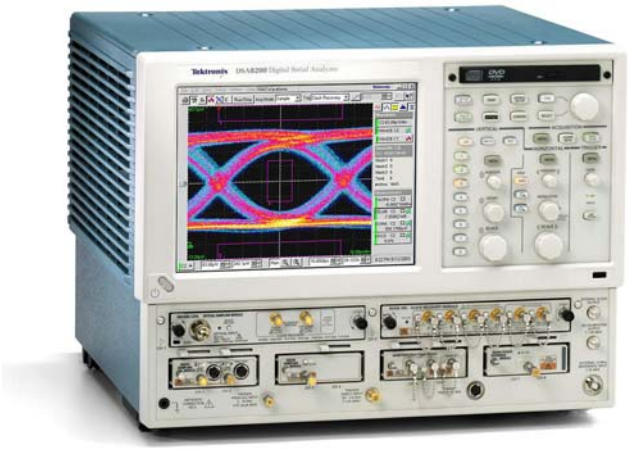
Sampling Oscilloscope

- Sampling Oscilloscope for TDR Measurements
  - DSA8200/TDS8200 sampling mainframe
  - Innovative capabilities using i-Connect software
  - 80E03 Sampling Module (1)
  - 80E04 TDR/T Module (1)
- Cable tests
  - Cable inter-pair and intra-pair skew
  - Impedance test
- Sink tests
  - Differential impedance test



HDMI Test Point Adapters from Efficere Technologies or from Tektronix

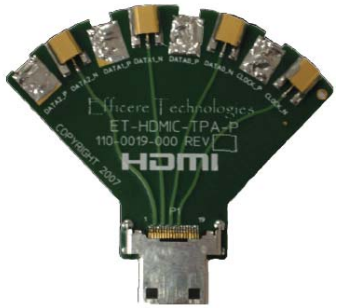
- Order a complete set as ET-HDMI-TPA-S *www.efficere.com*

TPA-P (Plug fixture)

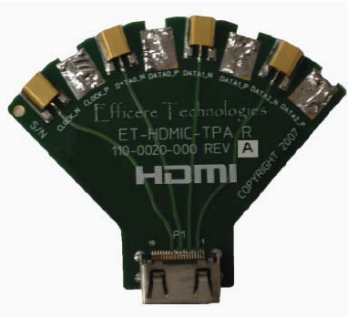
TPA-R (Receptacle fixture with TDR calibration traces)

Breakout Board with EDID ROM

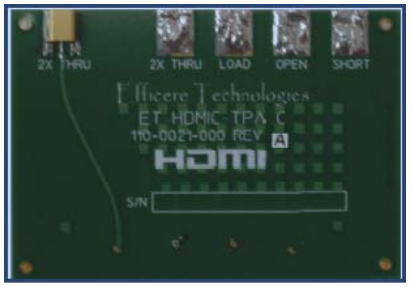
- Mini Type C set as ET-HDMIC-TPA-S



TPA-P (Plug fixture)



TPA-R (Receptacle fixture)



TPA-C (Calibration fixture)

Tektronix HDMI 1.4 solutions

- Our planned solution includes:
  - Oscilloscopes: DPO/DSA7K series scopes to 70K series scopes for HEAC and 8GHZ and above BW scopes for Direct Synthesis
  - Signal Generators: AWG5K/B and AWG7K/B series Arbitrary Waveform Generators for HEAC and AWG7K/B series AWGs for Direct Synthesis
  - Software
    - Type E Direct Synthesis Compliance software
    - HEAC Compliance Software
  - Fixtures
    - Type E Fixtures (for AUTOMOTIVE HDMI)
    - Type D Fixtures (For Mobile HDMI)
    - HEAC fixtures
  - DSA8200 with I-Connect and 80E03 and 80E04 modules for cable testing

- Tektronix HDMI 1.4 solution will be made available to coincide with CTS1.4 announcement

Additional Resources

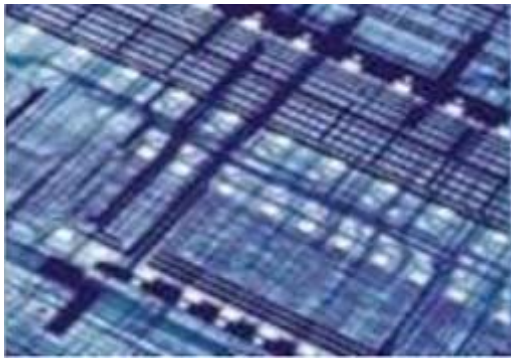
- http://www.hdmi.org
- http://www.tektronix.com/hdmi
- High-bandwidth Digital Content Protection
  - http://www.digital-cp.com/
- Video Electronics Standards Association
  - www.vesa.org

Additional Resources

- http://www.tektronix.com/serial_data

Tektronix Innovation Forum

Enabling Innovation in the Digital Age



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