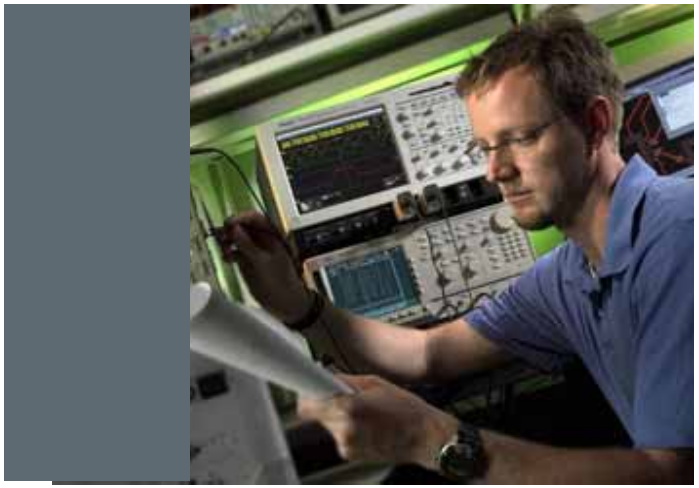
Fast, Efficient Solutions for HDMI 1.4 Compliance Measurement Challenges

- Introducing Tektronix' 1.4a Test Solutions



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Agenda

- Introduction to HDMI 1.4a
- Tektronix HDMI 1.4a Direct Synthesis Solution
- Tektronix HDMI 1.4a Physical Layer Test Solution
  - Automotive HDMI (Type E)
  - Mobile HDMI (Type D)
  - **H**DMI **E**thernet **A**udio Back **C**hannel
  - 4k x 2K resolution support
  - 3-D HDMI patterns
  - Additional Deep Color patterns
- Additional resources

What's Changed? – HDMI 1.4a

- Specification released on March 4th 2010 under adopter agreement of HDMI standards body.
- Salient Features:
  - Automotive HDMI (Type E)- added new cable emulators
  - Mobile HDMI (Type D)
  - HEAC (HDMI Ethernet Audio Back Channel)
  - 4k x 2K resolution support
  - 3-D HDMI patterns- **updated**
  - Additional Deep Color patterns
- CTS1.4a announced on March 4th 2010.

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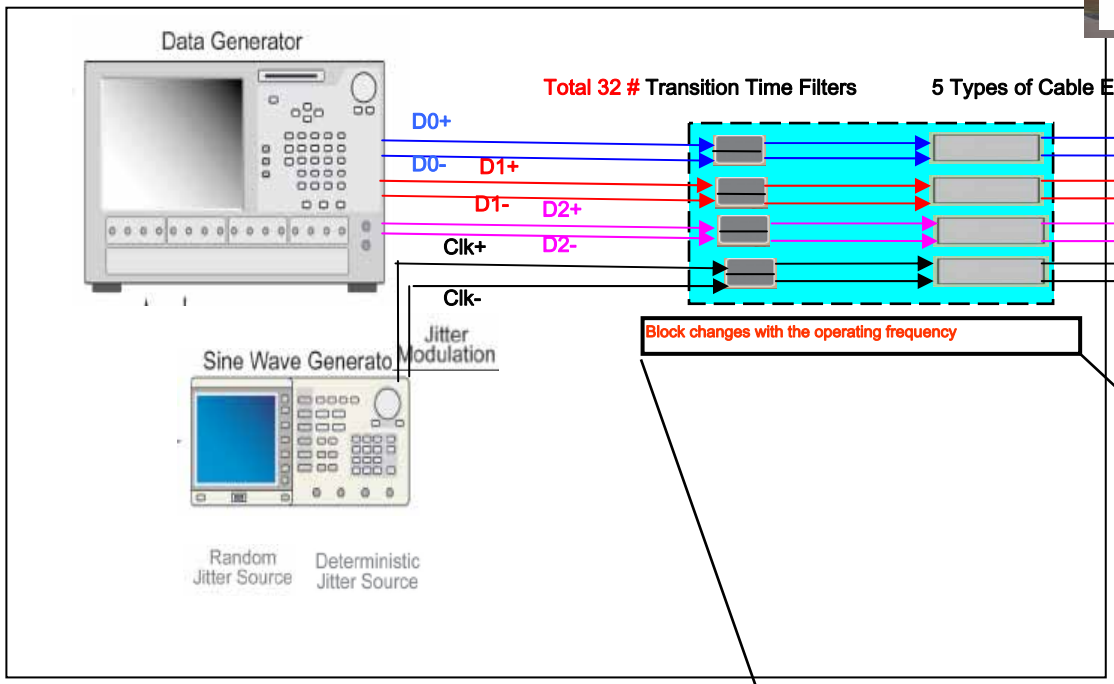
AWG7000B with Direct Synthesis Significantly Reduces Test Time

Present Solution-HDMI Sink Jitter Tolerance setup



Source CTS1.3c document

Typical (MHz)	Low (MHz)	High (MHz)	TTC (MHz)[1]	1st Cable Emulator	2nd Cable Emulator
27	>= 25	<=27.1	74.25	Type 1 Cat1+Cat2 (Agilent)[2]	Type 2 27MHz (JAE)
74.25	>= 27.1	<=74.25	74.25	Type 1 Cat1 (Agilent)	Type 2 75MHz (JAE)
148.5	>74.25	<=165	148.5	Type 1 Cat2 (Agilent)	Type 3 (Agilent)
222.75	>165	<=222.75	222.75	Type 1 Cat2 (Agilent)	Type 3 (Agilent)
340	>222.75	<=340	340	Type 1 Cat2 (Agilent)	Type 3 (Agilent)

Can we reduce the **Complexity** ?

Can we save the **setup time** ?

Can we provide cost **effective** solution ?

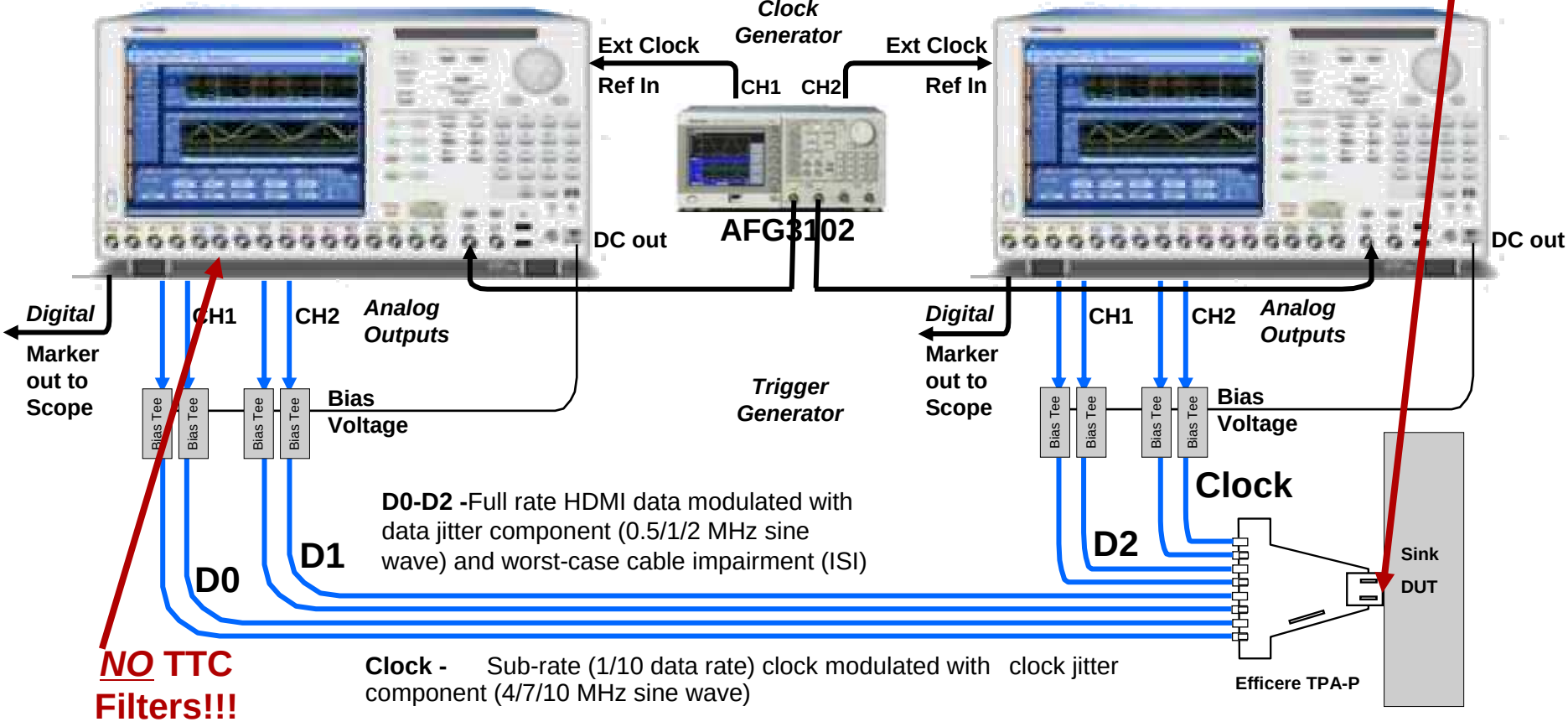
Additional hardware Cable Emulators will be introduced for Automotive HDMI support

AWG7000B with Direct Synthesis Significantly Reduces Test Time

HDMI Jitter Tolerance Test with Direct Synthesis

27 MHz to 340 MHz

NO Cable Emulator!!!



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Tektronix HDMI Direct Synthesis Solution

- Type 2 Cable Emulator support using DS **already approved** and is available in CTS1.3c released on July 25th 2008.

- Automotive HDMI (Type E)
  - DS solution for automotive **approved in CTS1.4**

- Type 1 and Type 3 CE Support
  - DS solution for Type 1 and Type 3 CE **approved in CTS1.4**

- Direct Synthesis solution **supports all Cable emulators** using the path breaking DS method which removes the need for hardware cable emulators thus enhancing the test method.

	Resolution	Cable Emulators	
General	27 MHz	Type1 Cat1+Cat2	Type2 27MHz
	74.25 MHz	Type1 Cat1	Type2 75MHz
	148.5 MHz	Type1 Cat2	Type3
	222.75 MHz	Type1 Cat2	Type3
Automotive	27 MHz	Automotive 27MHz	NA
	74.25 MHz	Automotive 74MHz	NA

Benefits of Direct Synthesis

- **Simplicity**
  - **TEKTRONIX ONLY SOLUTION PROVIDER TO SUPPORT ALL CABLE EMULATORS REQUIRED** for HDMI Sink Jitter Tolerance test.
  - Elimination Cable Emulators and TTC (Transition Time Converts)
    - Cable emulators (7 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

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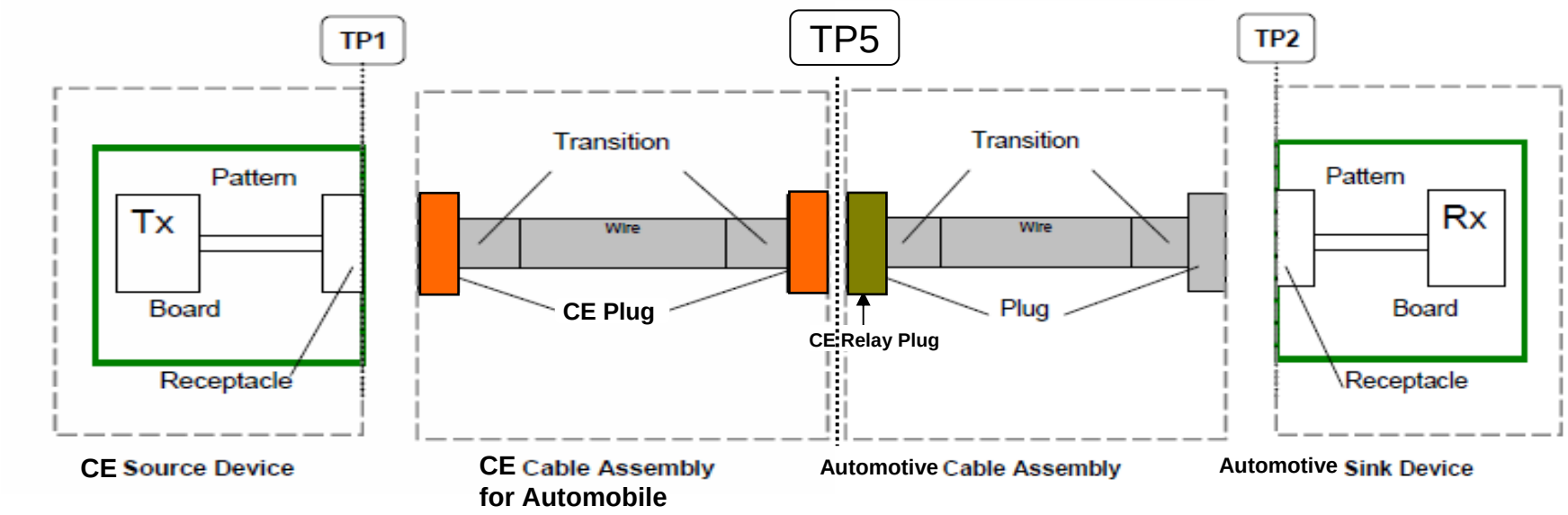
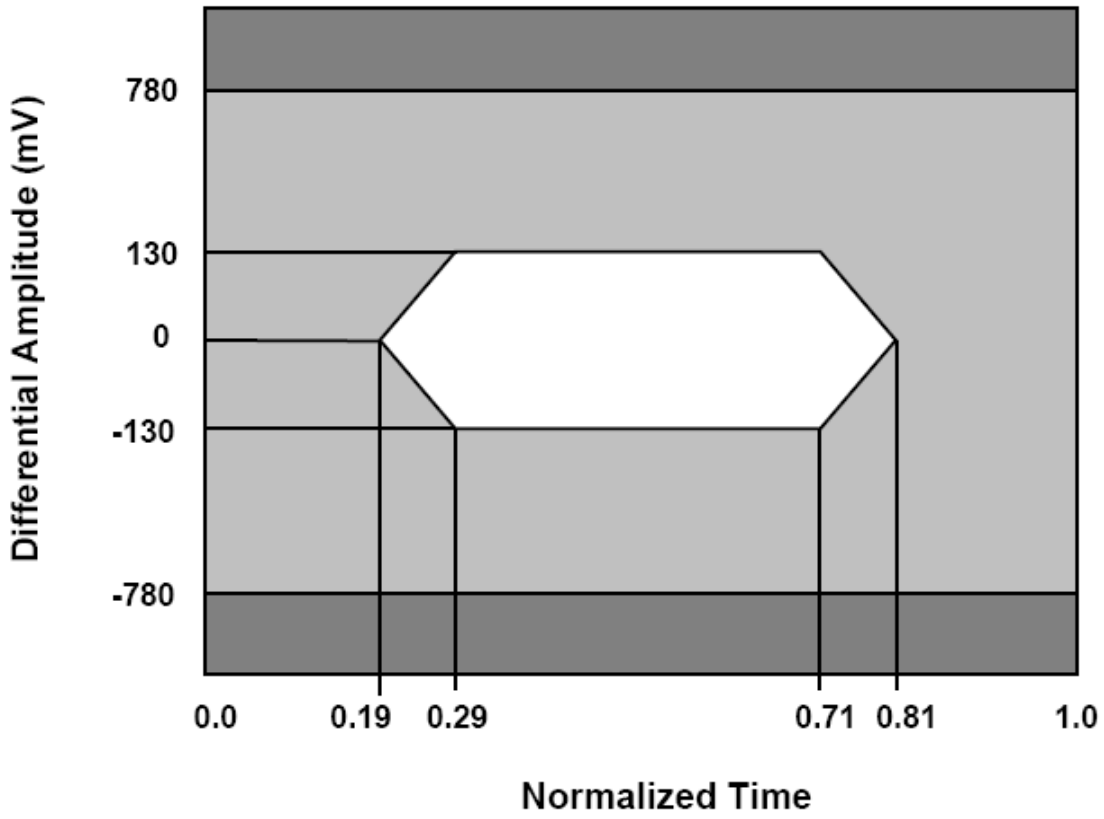
Automotive


TP1
TP5
TP2
Pattern
Tx
Board
Receptacle
Transition
Wire
CE Plug
CE Relay Plug
Transition
Wire
Plug
Pattern
Rx
Board
Receptacle
CE Source Device
CE Cable Assembly for Automobile
Automotive Cable Assembly
Automotive Sink Device

Eye Diagram Mask at TP5 and 2.3dB Equalizer

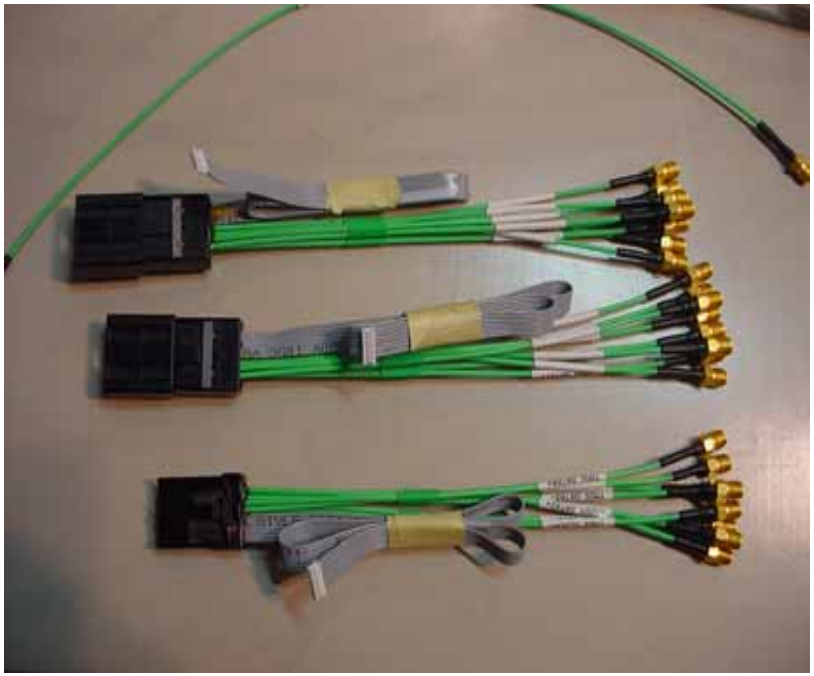


Automotive HDMI Testing needs

- Compliance Software for Type E **(approved in CTS1.4)**
  - Source test remains unchanged
  - Sink Jitter Tolerance Test for Type E
  - Cable Eye Diagram Test for type E
- Type E Fixture **approved in CTS1.4**

Automotive HDMI Solution from Tektronix

- Available in HT3 Software with Direct Synthesis capability approved by HDMI standards



-Type E Fixture from Tektronix approved by HDMI standards.

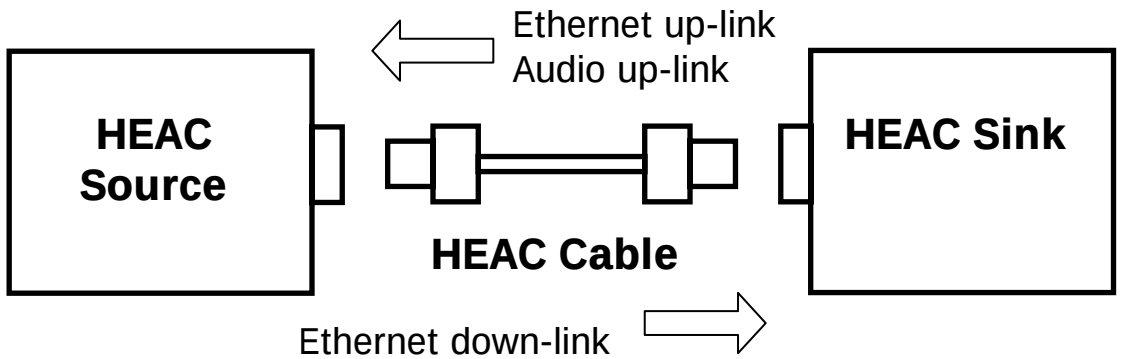
HDMI Mobile Solution – Type D

- Mobile companies will support HDMI new connectors.

- Type D Fixture will be required and **is approved by HDMI standards**.

What is HEAC?

- High Speed Network Capability
  - Provides bi-directional point-to-point communication
  - Enables building high performance home network
  - 1000 times faster than existing links using CEC
  - Utilizes widely accepted 100Base-TX Ethernet technology
- Digital Audio Stream Transfer
  - Provides SPDIF format digital audio channel
  - Enables versatile handling of digital sound by AV control center
  - Quality audio at 32k/44.1k/48k sampling rates
  - Backward transfer only (Sink to Source)
- Compatibility with Current HDMI
  - Enables inter-connection to existing HDMI devices (upward compatibility)
  - Automatic detection of HEAC enhancement
  - Utilize Hot Plug Detect & Reserve pins



HEAC Specific Signals

- Small Amplitude Ethernet Signal
  - 200mVp-p in contrast to 1Vp-p of normal Ethernet
  - In differential mode, amplitude is 400mVp-p.
  - Except for amplitude, it's an Ethernet.
  - 125Mbps bit rate including overhead
- Bi-Directional Ethernet Transfer
  - Transmitting & receiving streams superposed
  - Embedded HYBRID circuit in TRX chip
  - Software HYBRID needed in measurement instrument
- Common Mode Audio Stream
  - Digital audio stream superposed in common mode
  - 400mVp-p amplitude
  - SPDIF format at 32k/44.1k/48k samples/s rate (up to 6.144Mbps bit rate)
  - Unidirectional transfer (Sink device → Source device)
- High DC Offset
  - Approx. 4V from ground

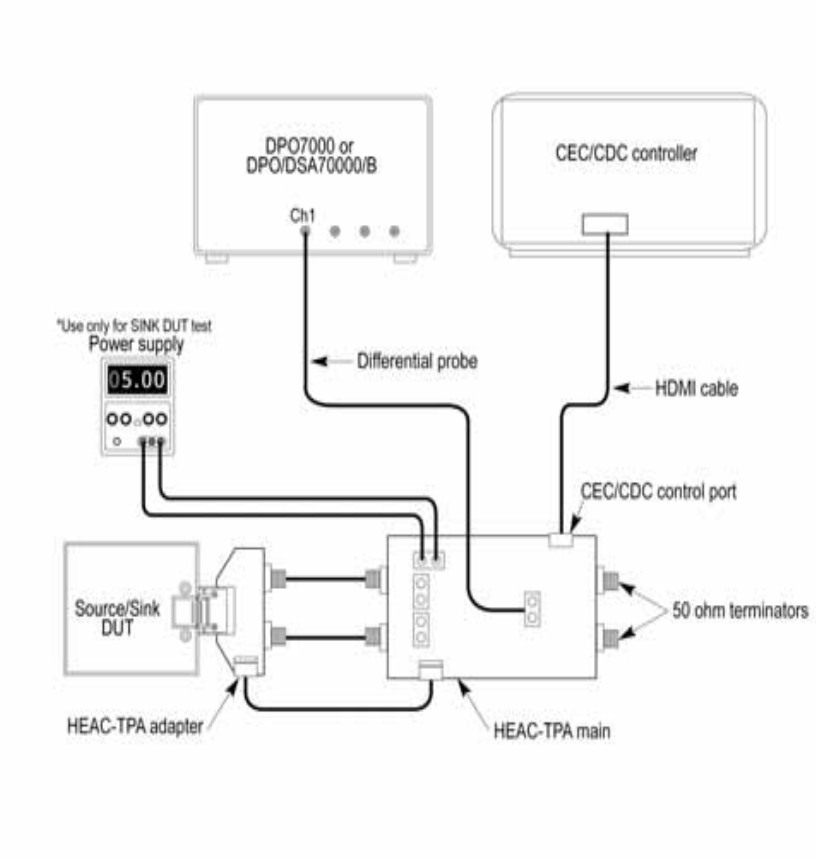
HEAC Physical Layer Test (1/2)

- Ethernet Transmitter Test
  - Similar to normal 100Base-TX test except for lower amplitude
- Ethernet Receiver Test
  - Generate test packets with stress using AWG(5K/7KB)
  - Capture and analyze response packets using oscilloscope
  - Confirm compliant packet error rate
- Audio Transmitter Test
  - SPDIF audio stream in common mode 400mVp-p amplitude
  - 32k/44.1k/48k samples/s rate (up to 6.144Mbps)
  - Measure typical pulse parameters using oscilloscope
- Audio Receiver Test
  - Generate test stream with stress using AWG
  - Listening test to regenerated audible sound

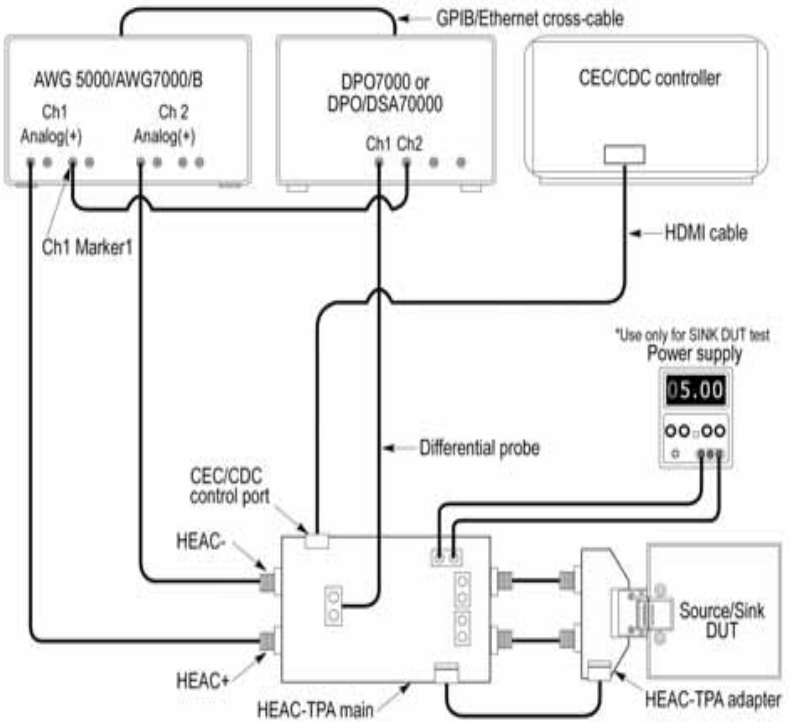
HEAC Physical Layer Test (2/2)

- Device Impedance Test
  - Measure impedance of HEAC lanes using TDR
- Cable Test
  - Measure impedance of HEAC lanes using TDR/TDT
  - Measure S-Parameters of HEAC lanes using TDT+S/W

HEAC Solution Configuration

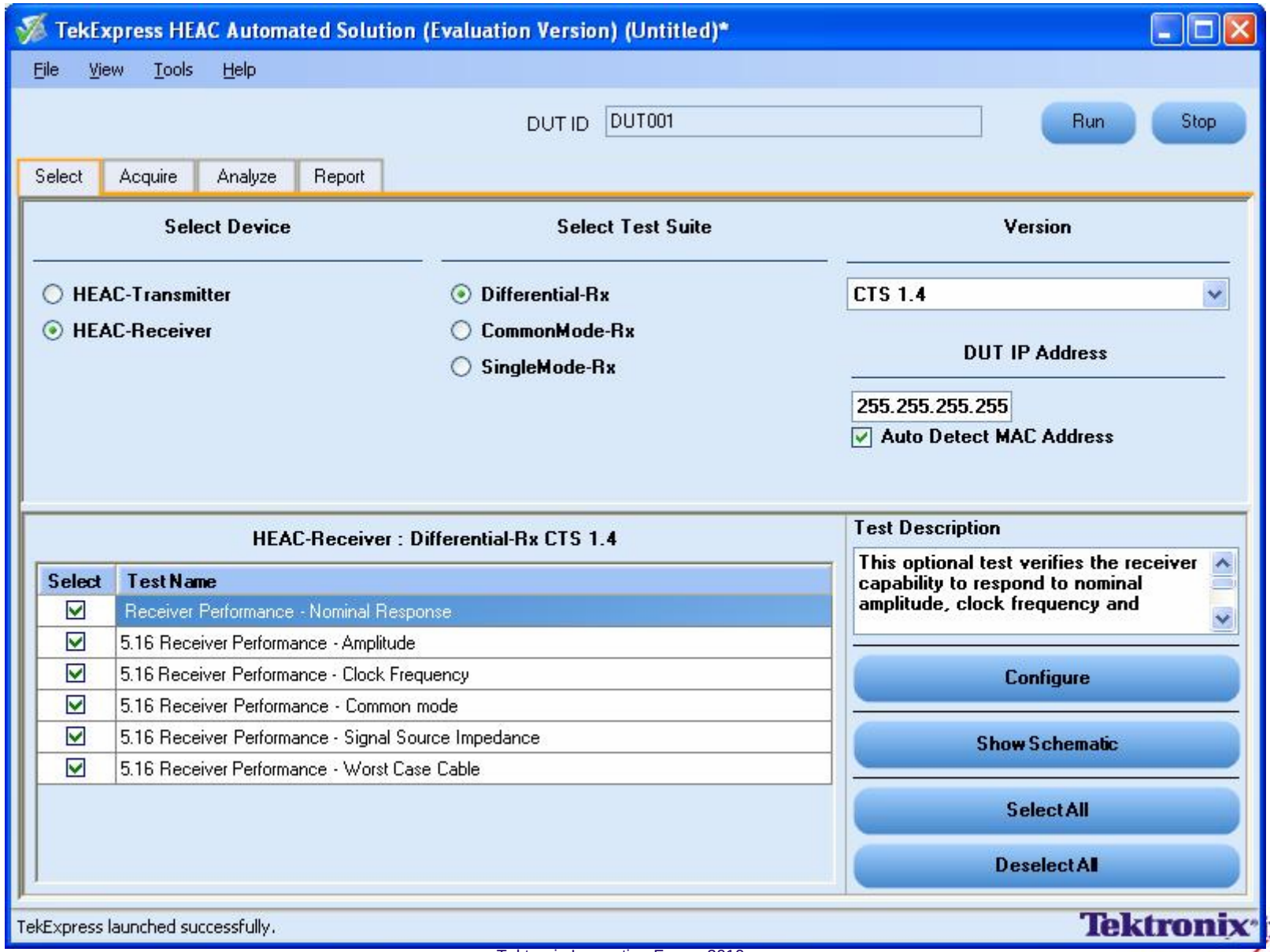


Tx Test Setup



Rx Test Setup

HEAC Software



HEAC Test Report

Tektronix
Enabling Innovation

TekExpress Automation Framework

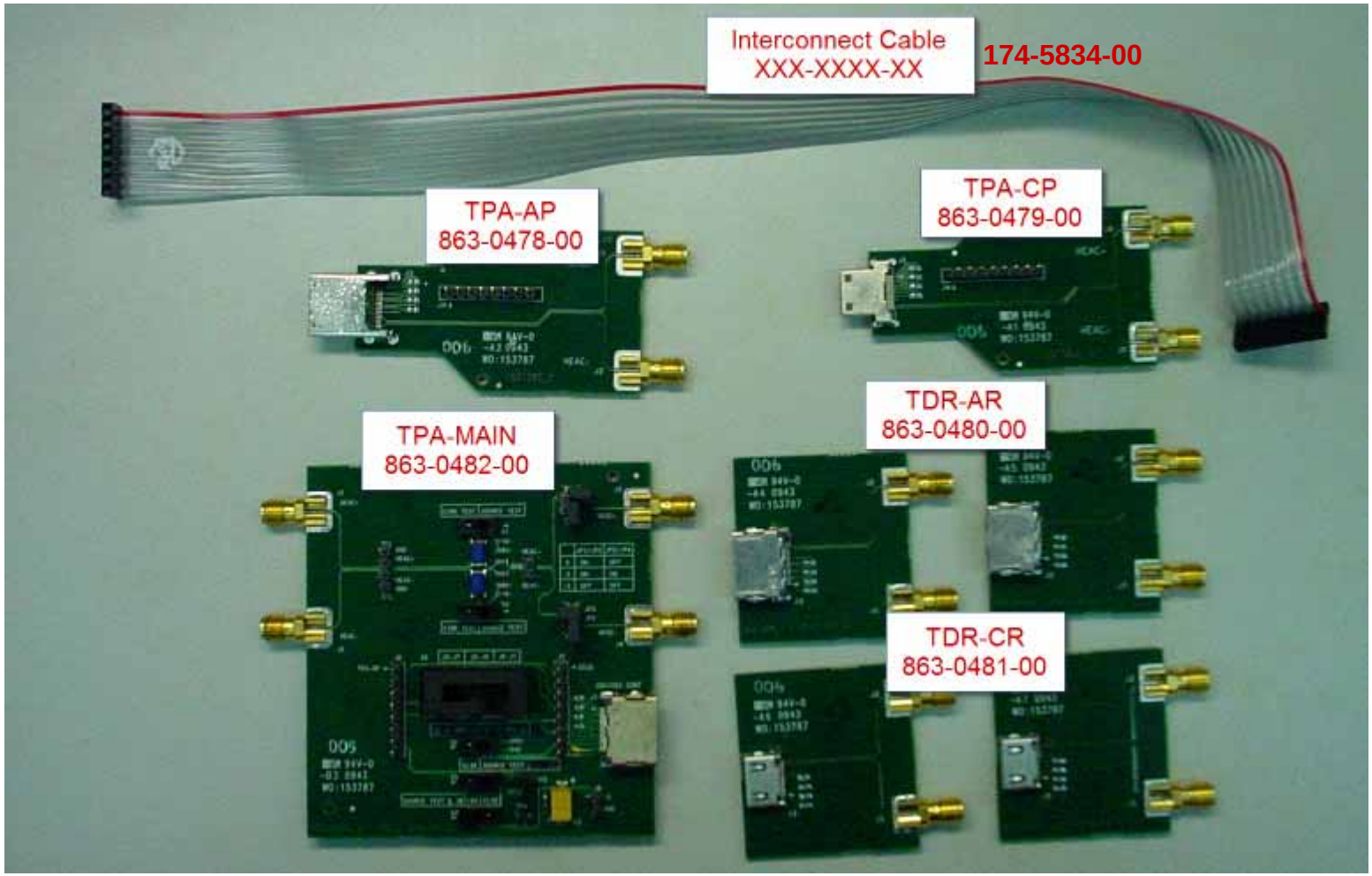
HEAC Differential TX Signal Characteristics Test Report

DUT ID : DUT001
Date/Time : 3/2/2010 12:30
Device Type : HEAC-Transmitter
Execution Time : 13 Min
CTS Version : CTS 1.4
Compliance Mode : Yes
Overall Test Result : Pass

Scope Model : DPO72004
Probe Model : P6248
Scope Serial Number : Q226
Probe Serial Number : B011054
Scope F/W Version : 5.1.0 BNSFBUILD 28
TekExpress Version : HEAC: 1.3.5.56, Framework: 1.3.4.135
SPC, FactoryCalibration : PASS;PASS

Test Name	Measurement Details	Low Limit	Measured value	High Limit	Margin	Units	Test Result	Compliance Mode	Analysis Time	Comments
5.1 Operating DC Voltage	DC Voltage : HEAC + line	>= 3.6	4.1980	<= 4.4	0.202, 0.598	V	Pass	Yes	3 Min	
	DC Voltage : HEAC - line	>= 3.6	4.1539	<= 4.4	0.2461, 0.5539		Pass			
5.2 Jitter MAX	Jitter Max Positive	-	0.9456	< 1.4	0.4544	nS	Pass	Yes	1 Min	
	Jitter Max Negative	-	1.0403	< 1.4	0.3597		Pass			
5.3 Rise-Fall Time	Rise Time Positive Pulses	>= 3	4.9251	<= 5	1.9251, 0.0749	nS	Pass	Yes	3 Min	
	Fall Time Positive Pulses	>= 3	4.7602	<= 5	1.7602, 0.2398		Pass			
	Rise Time Negative Pulses	>= 3	4.9747	<= 5	1.9747, 0.0253		Pass			
	Fall Time Negative Pulses	>= 3	4.7572	<= 5	1.7572, 0.2428		Pass			
5.4 High-Low-Center Level	High Level Voltage	>= 180	199.4449	<= 220	19.4449, 20.5551	mV	Pass	Yes	3 Min	
	Low Level Voltage	>= -220	-194.4681	<= -180	25.5319, 14.4681		Pass			
	Center Level Voltage	>= -20	3.0732	<= 20	23.0732, 16.9268		Pass			
5.5 Cycle Time	Cycle Time Positive Pulses	>= 7.875	8.0581	<= 8.125	0.1831, 0.0669	nS	Pass	Yes	2 Min	
	Cycle Time Negative Pulses	>= 7.875	8.0584	<= 8.125	0.1834, 0.0666		Pass			

HEAC Fixtures



HEAC Solution

- Real Time Oscilloscope,AWG5KB/7KB, Probes
- Test Fixture Kit(TF-HEAC-TPA-KIT)
  - One MAIN , 2 Plug (AP/CP), 4#TDR (2#AR/2#CR),
- HEAC Software
  - Ethernet Transmitter Test Software
  - Ethernet Receiver Test Software
    - Control AWG & oscilloscope
    - Setup signal (sensitivity, clock frequency, modal rejection, error rate)
    - Extract & check response signal (software HYBRID & packet analysis)
  - Audio Transmitter Test Software
    - HEAC
  - Audio Receiver Test Pattern Suite
    - AWG files (format support, modal rejection, jitter tolerance)

HDMI 1.4 Pattern Support

- 4K x 2K Resolution patterns
- 3D HDMI mandatory Patterns (updated)
- New Deep Color Patterns

- 7 New tests will be added to HT3 Sink tests to make the tests automated by HT3.(8-28,8-29, 8-30,8-31, DVI Interoperability, Audio tests)

Test Patterns: Test ID 8-29: 3D Video Format Timing

Verify that Sink DUT supports:

1.1920x1080p@23.98/24Hz.

2. 1280x720p@59.94/60Hz If Sink Supports 60HZ

3. 1280x720p@50Hz if Sink Supports 50Hz

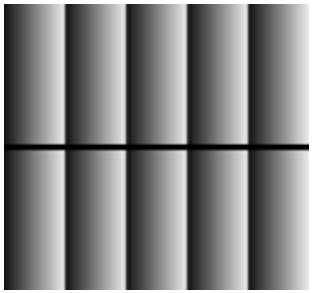
NEW:

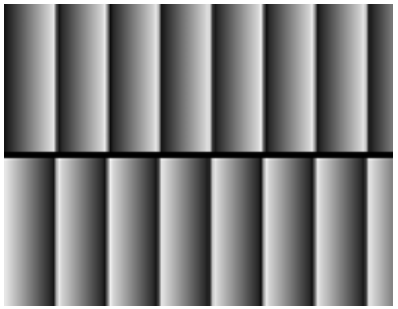
Side-by-Side Horizontal
1080i @ 50 or 59.94/60Hz

Top-and-Bottom
720p @ 50 or 59.94/60Hz
1080p @ 23.97/24Hz

Tektronix Support for 8-29

Test ID	DTG	AWG Marker	AWG DS
3D	◯	◯	◯





Test Patterns Test ID 8-30: 4K x 2K Video Format Timing

Verify that Sink DUT supports:

1. If tested HDMI_VIC_X indicates HDMI video formats 0x01 then test 4Kx2K 29.97/30Hz.
2. If tested HDMI_VIC_X indicates HDMI video formats 0x02 then test 4Kx2K 25Hz.
3. If tested HDMI_VIC_X indicates HDMI video formats 0x03 then test 4Kx2K 23.98/24Hz.
4. If tested HDMI_VIC_X indicates HDMI video formats 0x04 then test 4Kx2K24Hz (SMPTE)

Tektronix Support for 8-30

Test ID	DTG	AWG Marker	AWG DS
4K x 2K	◯	◯	◯

Tektronix HDMI 1.4a solution

HDMI Fixtures:

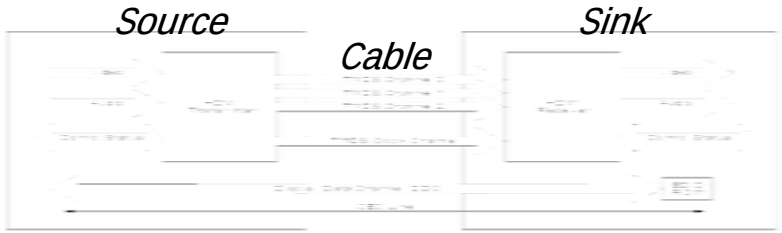
1. Type A
2. Type C
3. Type D
4. Type E
5. HEAC Fixtures

Probes and accessories

HDMI Probes
HEAC Probes
HDMI Accessory Kit

Tektronix Brings Domain Expertise to HDMI Test

- Unequaled domain expertise
  - Providing leading HDMI test solutions since original HDMI spec introduced
  - Approved direct synthesis method offers greater repeatability as dependency on hardware TTC filters and cable emulators is eliminated.
- Portfolio of test equipment for all critical tests
  - Signal generators, real-time oscilloscopes, compliance test software, sampling oscilloscopes & probing
- Cost effectiveness & Flexibility
  - More affordable upgrade path from previous HDMI test systems
  - Flexible test configuration
- Reduction of test time
  - One-button selection of multiple tests reduces the time needed for compliance testing from days to minutes

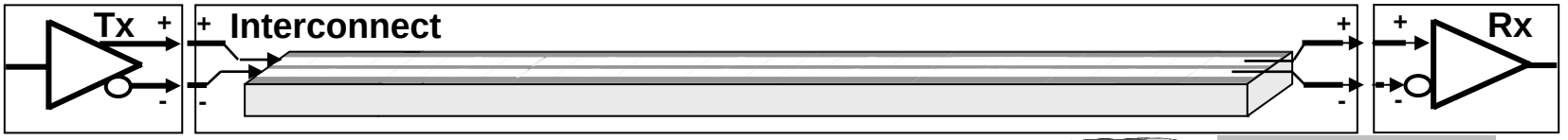


HDMI™
HIGH-DEFINITION MULTIMEDIA INTERFACE

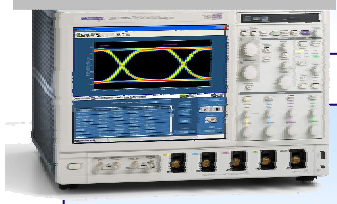
High-Speed Serial Data Test Solutions

Design → Verification → Compliance Test

PCI EXPRESS · SERIAL ATA · SUPERSPEED USB · ddr3 · IEEE GbE · DisplayPort · HDMI · DiiVA …



Real-time Scopes



System Integration
Digital Validation & Debug

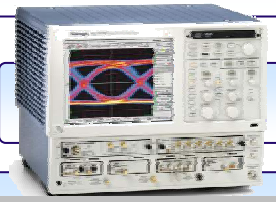
Logic Analyzers

Transmitter Testing

Receiver Test
Margin Testing

Arbitrary Waveform Generator

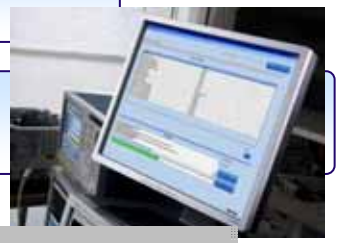
Probing Fixtures



Sampling Scopes

Interconnect Test

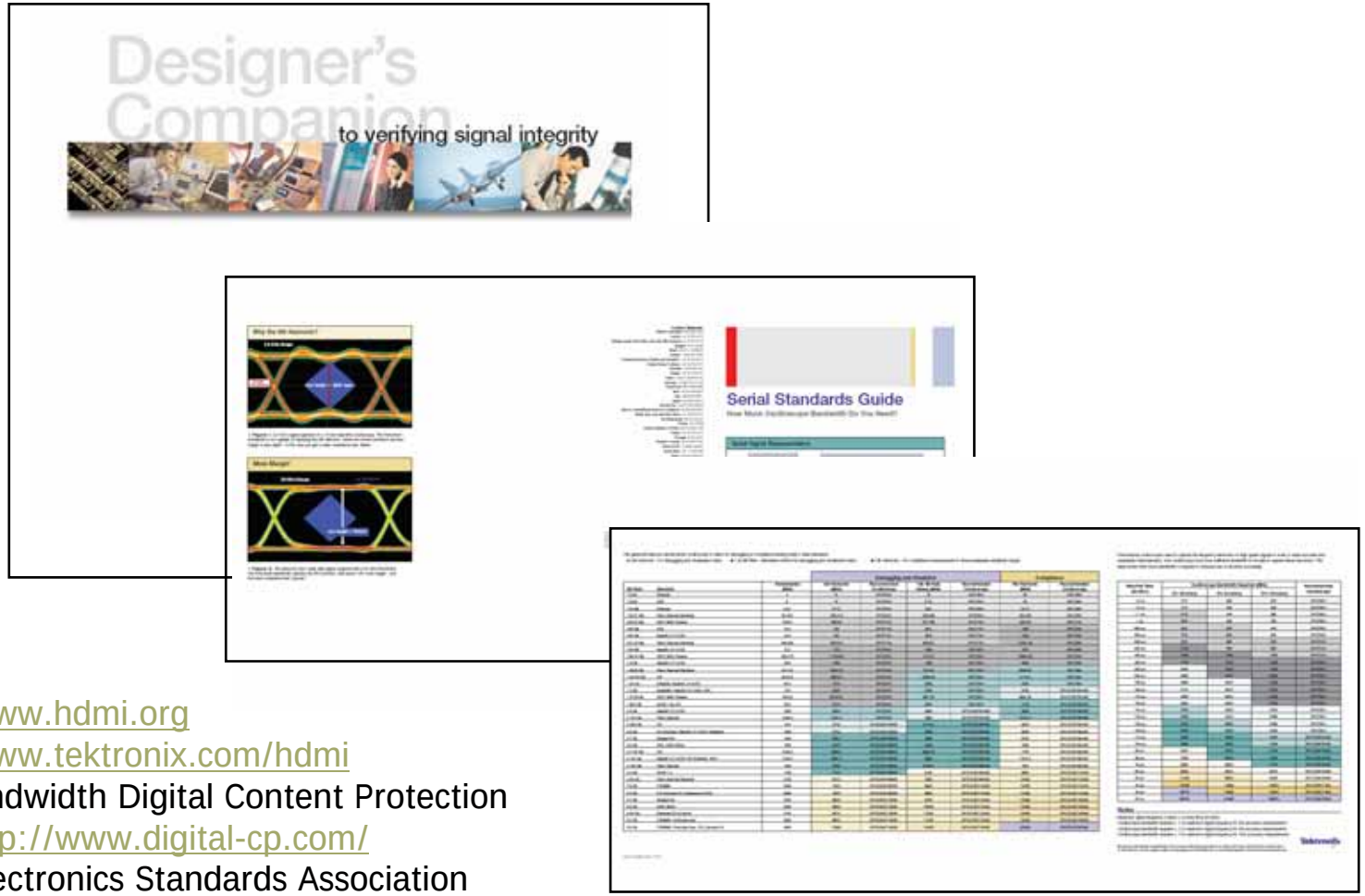
Compliance Test



Compliance Test Software

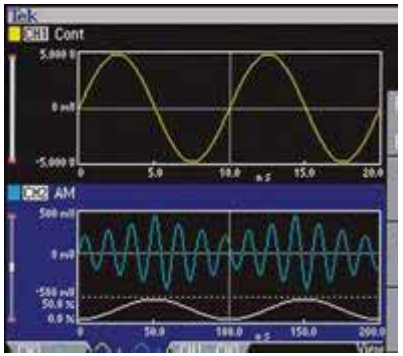
Additional Resources

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



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

Enabling Innovation in the Digital Age



Accelerating Performance

Enabled by High-speed Serial Technologies

Tektronix