

# HDMI Solution



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Strategic Product Planner

# Agenda

- HDMI Overview and updates
- Additional resources



# HDMI –High Definition Multimedia Interface



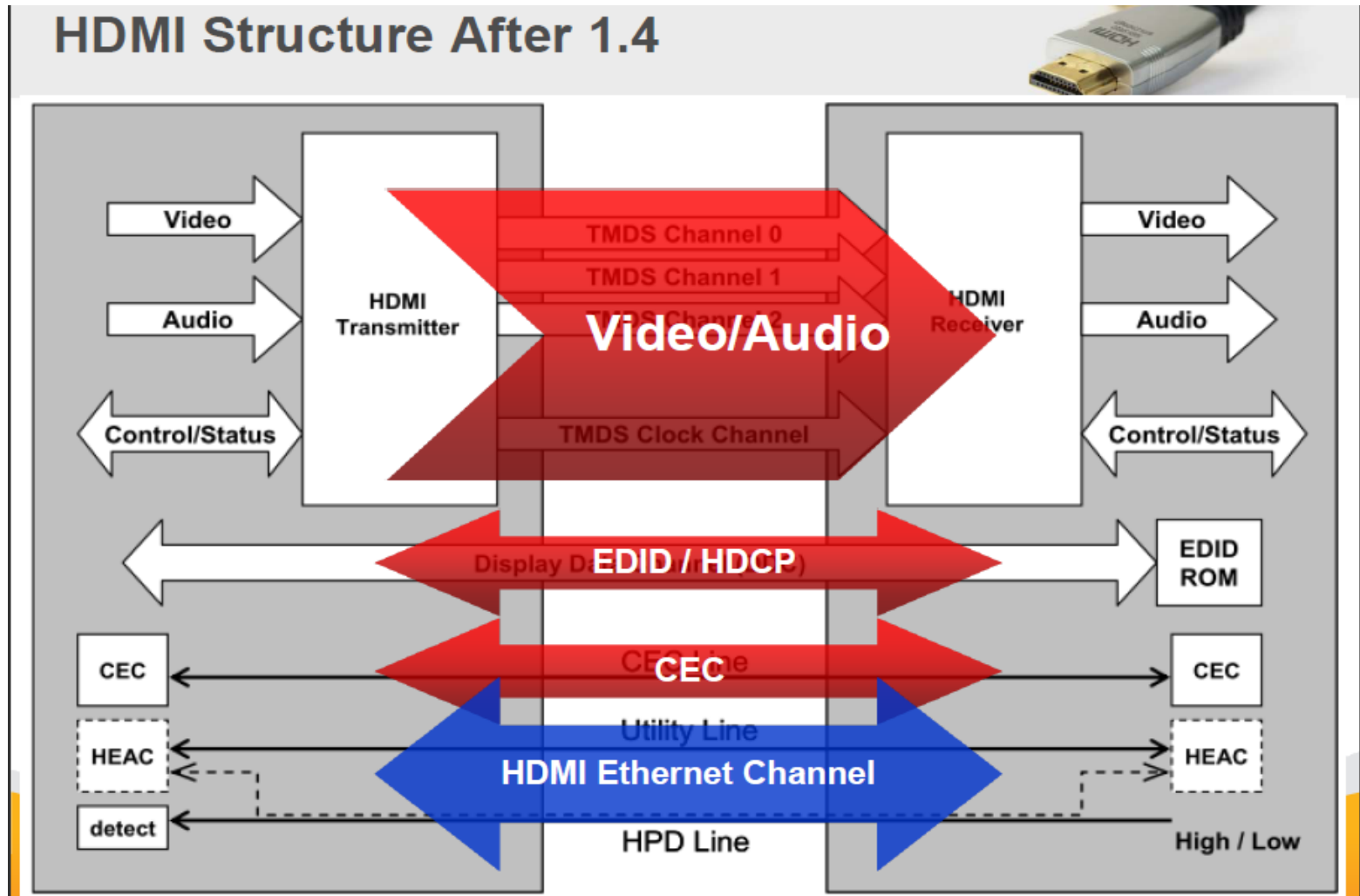
# Overview of HDMI

- From 2003 till date and looking ahead...
  - Tek only solution provide for HDMI from 2003 to 2007
  - Contributor of SoftCRU method to the Specification
  - Innovative Sink solution leveraging Direct Synthesis method of AWG
- Hdmi 1.0 ---- 1.65GBps
- Hdmi 1.4—3.4GBps
- Hdmi 2.0..... 6GBps



**HDMI**<sup>TM</sup>  
HIGH-DEFINITION MULTIMEDIA INTERFACE

# HDMI Basics

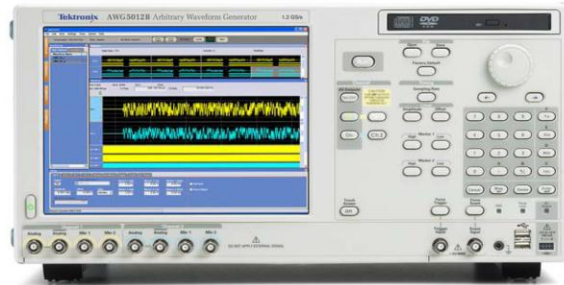


# Tektronix HDMI 1.4b Solution- Approved in CTS 1.4b

**DPO/DSA/MSO  
Real Time Oscilloscopes**



**AWG5K/B or AWG7K/B  
Arbitrary Waveform Generators**



**DSA8200 Sampling Scope  
with i-connect software**



Common Set of test equipment for HDMI and HEAC

## HDMI Fixtures:

1. Type A( TF-HDMI-TPA-S/-STX)
2. Type C(TF-HDMIC-TPA-S/-STX)
3. Type D( TF-HDMID-TPA-P/-R)
4. Type E(TF-HDMIE-TPA-KIT)
5. HEAC Fixtures(TF-HEAC-TPA-KIT)

## Probes and Accessories

HDMI Probes  
HEAC Probes  
HDMI Accessory Kit

GAME Changer - HDMI Protocol Analyzer

# Changes in HDMI Standards Body

- Due to the HDMI Specifications's overwhelming success, the HDMI Founders created an organization where interested companies can participate in the future development of the HDMI Specification.
- On October 25, 2011, the HDMI Founders announced the launch of the HDMI Forum

Source: HDMI Forum

# Tektronix and HDMI Forum

- 89 companies in the HDMI forum as of date. Source HDMI Forum
- Tektronix is member of this HDMI Forum. Actively participating in weekly/monthly calls and face-face meetings
- **Tektronix's U.N.Vasudev is co-chair for HDMI forum test subgroup**
- HDMI Forum has released the HDMI specifications 2.0 version 1.0 on 4<sup>th</sup> Sept 2013
  - Target
    - CTS 2013 Q4



# HDMI 2.0 features

- Uses same Cat 2 Cable and HDMI 1.4b connector
- Support 4K 2K 4:4:4 60/50 Hz – 594Mcsc(Mega Characters per Second per Channel)
- Support 4K 2K 4:2:0 – 297Mcsc
- 3D; 21: 9 ; Audio
- Low level Bit error rate testing
- Scrambling is introduced and mandatory for rates >340Mcsc.

# System Recommendation for HDMI 2.0 for Source Measurement



# HDMI 2.0 Source Testing Equipment Needs

- 16GHz BW scope will give 1% error and hence is recommended for HDMI 2.0 testing.
  - HDMI 2.0 RT/FT (20%-80%) data signals is 42.5ps
- P7313SMA probes ( same used in HDMI 1.4b)
- Option HDM and HDM-DS
- HDMI 2.0 Fixture set

Note- We shall also support a 12.5GHz BW scope which would result in appx. 10% inaccuracy in RT/FT results .

# HDMI 2.0 Source Testing

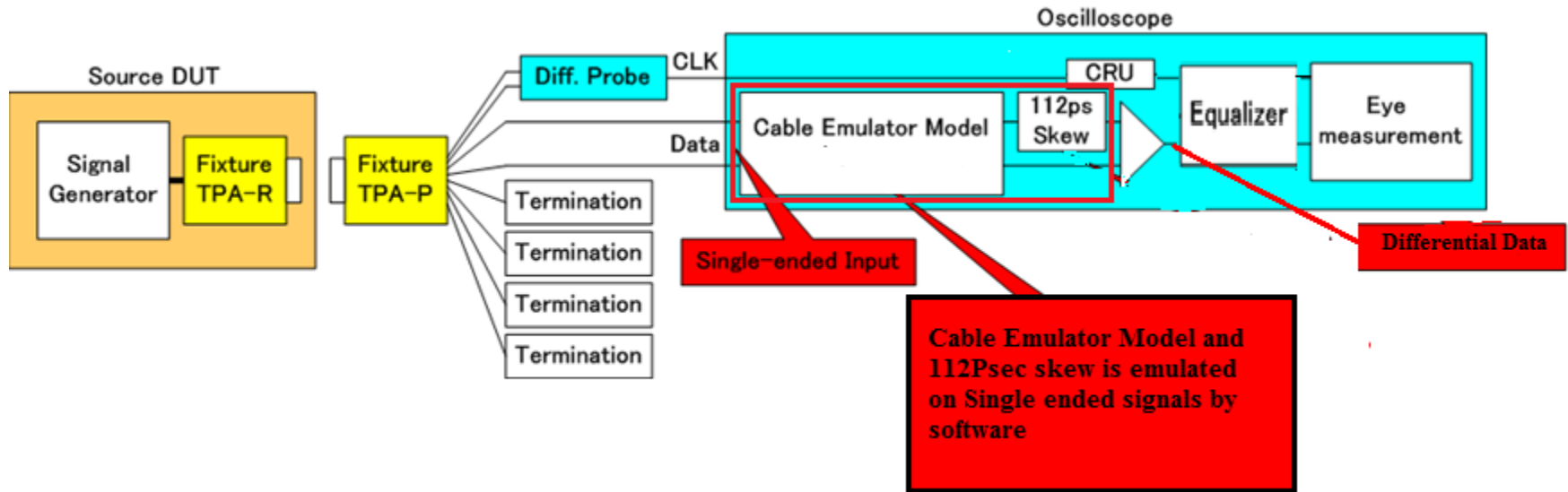


# Source Testing 1.4b Vs 2.0

- Eye Diagram and Clock Jitter test is now performed at TP2
- Rest of the tests is same as HDMI 1.4b
- 1.4b CTS test is a pre-requisite for HDMI 2.0
- Min 8GHz scope to 16GHz scope
- New Fixtures
- Same Probes
- HDM and HDM-DS Software

# Source Testing

- Source Eye Diagram test is measured at TP2\_EQ.
- TP2 is the signal after passing along a worst cable.
  - Worst cable has worst attenuation and skew of 112ps.



# Source Electrical Tests

**Test ID HF1-1: Source TMD5 Electrical – 340-600Mcsc –  $V_L$**

**Test ID HF1-2: Source TMD5 Electrical – 340-600Mcsc –  $T_{RISE}$ ,  $T_{FALL}$**

**Test ID HF1-3: Source TMD5 Electrical – 340-600Mcsc – Inter-Pair Skew**

**Test ID HF1-4: Source TMD5 Electrical – 340-600Mcsc – Intra-Pair Skew**

**Test ID HF1-5: Source TMD5 Electrical – 340-600Mcsc – Differential Voltage**

**Test ID HF1-6: Source TMD5 Electrical – 340-600Mcsc – Clock Duty Cycle**

**Test ID HF1-7: Source TMD5 Electrical – 340-600Mcsc – Clock Jitter**

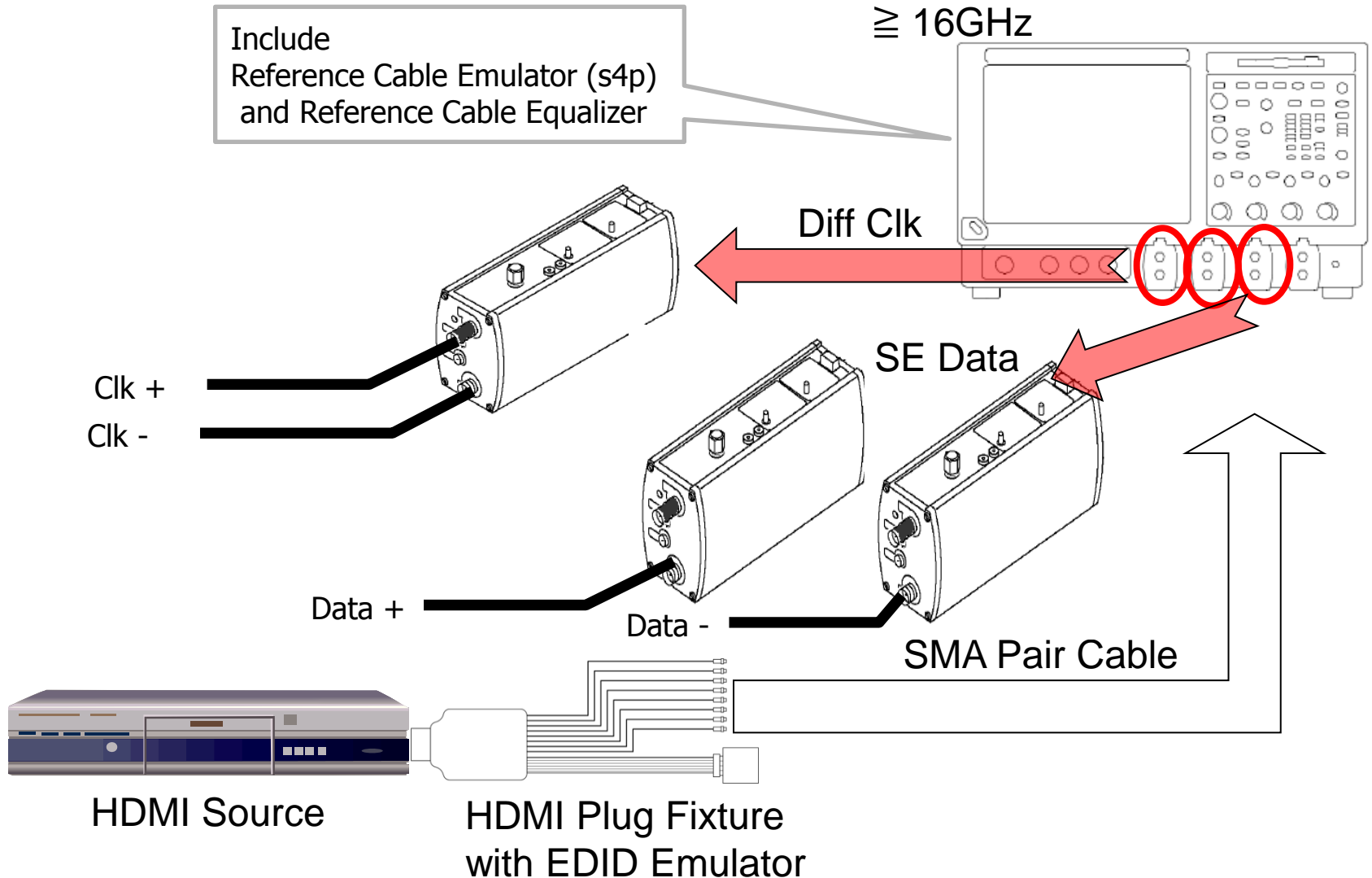
**Test ID HF1-8: Source TMD5 Electrical – 340-600Mcsc – Data Eye Diagram**

**Test ID HF1-9: Source TMD5 Electrical – 340-600Mcsc – Differential Impedance  
(to be performed using sampling scope)**

# Source Eye Diagram Test

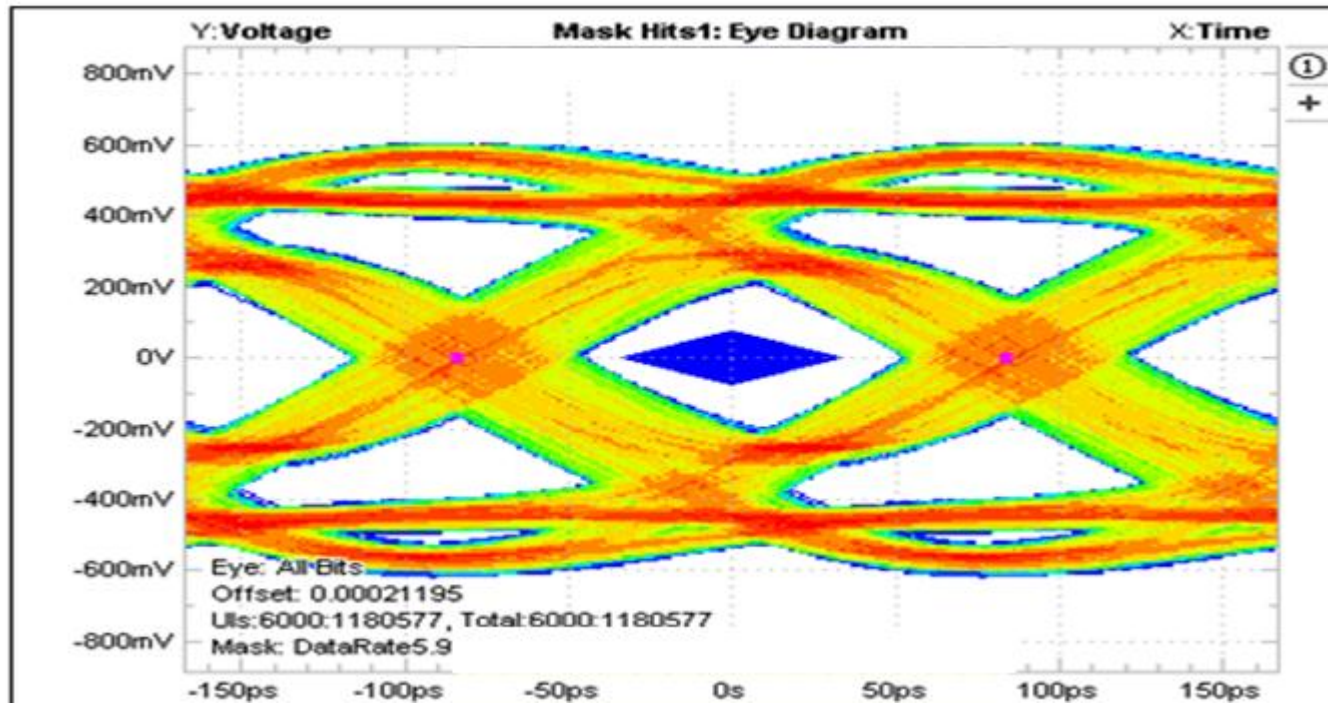
Tektronix Oscilloscope  
DPO/DSA/MSO70000 Series  
≥ 16GHz

Include  
Reference Cable Emulator (s4p)  
and Reference Cable Equalizer





# TP2 Source Eye for HDMI 2.0 6G Signal



Single End Input eye rendered at Tek lab

# HDMI 2.0 Tx Compliance Software

**TekExpress HDM - (Untitled)**

Options ▾

Start

Pause

1 DUT  
2 Test Selection  
3 Acquisitions  
4 Preferences

DUT ID: DUT001

Device: HDM Physical Layer Solution

Suite: Source Version: CTS 2.0

Acquire live waveforms  Use pre-recorded waveform files

View: Compliance

**Device Profile**

Termination Source: Internal

VTerm (V): 3.3 TBit: 0.0

Diff Probe Attenuation (X): 12.5  Recalc TBit

SE Probe Attenuation (X): 2.5

Number of Lanes to Test: 3 Lanes

Selected Test Lanes: Setup

ClockD0D1

Status Ready

**TekExpress HDM - (Untitled)**

Options ▾

Start

Pause

2 Test Selection  
3 Acquisitions  
4 Preferences

HDM Physical Layer Solution : Source : CTS 2.0

Deselect All Select All

- Differential
  - 1.2 TMDS TRise TFall
  - 1.3 TMDS Inter-Pair Skew
  - 1.5 TMDS ClockDutyCycle
  - 1.6 TMDS Clock Jitter
- Single Ended
  - 1.1 TMDS V Low
  - 1.4 TMDS Intra-Pair Skew
  - 1.7 TMDS DataEyeDiagram

Test Description

TMDS Rise Time and Fall Time measurement

Show MOI Schematic

Configure

Status Ready

**TekExpress HDM - (Untitled)**

Options ▾

Start

Pause

Test Status Log View

Test Name	Acquisition	Acquire Status	Analysis Status
<b>Clock</b>			
1.2 TMDS TRise TFall	Short Record-length for Rise Fall	To be started	
1.5 TMDS ClockDutyCycle	Short Record-length for Clock Duty Cycle	To be started	
1.6 TMDS Clock Jitter	Short Record-length for Clock Jitter	To be started	
1.1 TMDS V Low	Short Record-length for VLow	To be started	
1.4 TMDS Intra-Pair Skew	Short Record-length for Intra-Pair Skew	To be started	
<b>D0</b>			
1.2 TMDS TRise TFall	Short Record-length for Rise Fall	To be started	
1.3 TMDS Inter-Pair Skew	Short Record-length for Inter-Pair Skew	To be started	
1.1 TMDS V Low	Short Record-length for VLow	To be started	
1.4 TMDS Intra-Pair Skew	Short Record-length for Intra-Pair Skew	To be started	
1.7 TMDS DataEyeDiagram	Short Record-length for Data Eye Diagram	To be started	
<b>D1</b>			
1.2 TMDS TRise TFall	Short Record-length for Rise Fall	To be started	
1.3 TMDS Inter-Pair Skew	Short Record-length for Inter-Pair Skew	To be started	
1.1 TMDS V Low	Short Record-length for VLow	To be started	
1.4 TMDS Intra-Pair Skew	Short Record-length for Intra-Pair Skew	To be started	
1.7 TMDS DataEyeDiagram	Short Record-length for Data Eye Diagram	To be started	

Status Ready

**TekExpress HDM - (Test Results)**

Options ▾

Start

Pause

Clear

Overall Test Result Fail

Preferences ▾

Test Name	Details	TBit	Value	Units	Pass/Fail	Margin
<b>Clock</b>						
1.2 TMDS TRise TFall	Clock Rise Time	168.3498 ps	38.7089	ps	Fail	-36.2911
1.2 TMDS TRise TFall	Clock Fall Time	168.3498 ps	38.1015	ps	Fail	-36.8985
1.5 TMDS ClockDutyCycle	Maximum Duty Cycle	168.3498 ps	50.01	%	Pass	-9.99
1.5 TMDS ClockDutyCycle	Minimum Duty Cycle	168.3498 ps	49.99	%	Pass	9.99
1.6 TMDS Clock Jitter	TMDS Clock Jitter	168.3498 ps	40.1239	ps	Pass	-1.9635
1.6 TMDS Clock Jitter	TMDS VSwing	168.3498 ps	64.7812	mV	Fail	-335.22 & 1135.22
1.1 TMDS V Low	TMDS VLow for	168.3498 ps	3.2822	V	Fail	0.9822 & -0.1822
1.1 TMDS V Low	TMDS VLow for	168.3498 ps	3.1738	V	Fail	0.8738 & -0.0738
1.4 TMDS Intra-Pair Skew	TMDS Intra-Pair Skew for Clock	168.3498 ps	9.7096	ps	Pass	-15.5429
<b>D0</b>						
1.2 TMDS TRise TFall	D0 Rise Time	168.3498 ps	60.6379	ps	Pass	18.1379
1.2 TMDS TRise TFall	D0 Fall	168.3498 ps	58.5778	ps	Pass	16.0778
1.1 TMDS V Low	TMDS VLow for	168.3498 ps	3.1720	V	Fail	0.8720 & -0.2720

Status Ready

# HDMI 2.0 Sink Testing



# HDMI 2.0 Sink testing Equipment needs

- 16GHz BW scope will give 1% error and hence is recommended for HDMI 2.0 Sink testing for Jitter Verification/Calibration/Controller.
- P7313SMA probes
- Option HDM and HDM-DS
- HDMI 2.0 Fixture set
- 2# AWG7122C with Opt 01,02 or 06, 08 for **HDMI 2.0 Compliance only setup.**

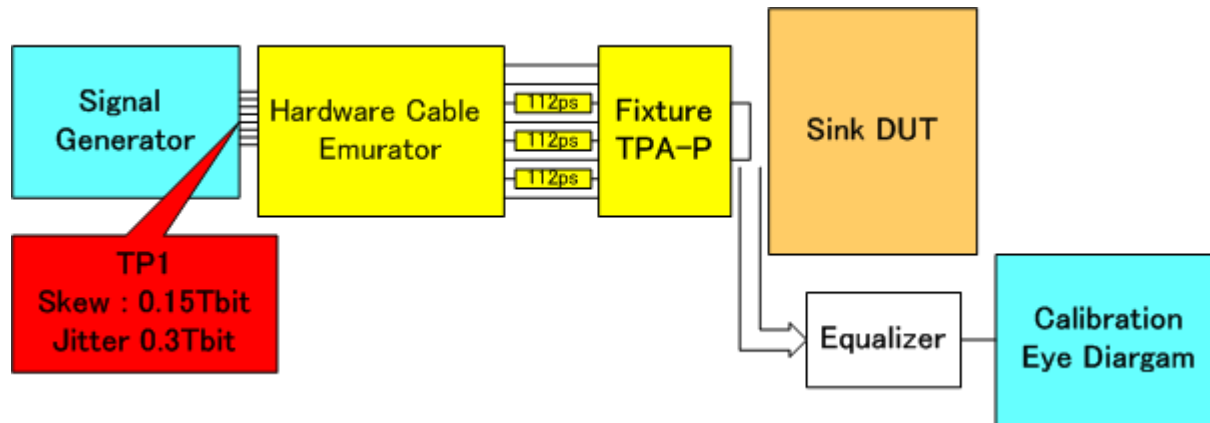
OR

- 2# AWG70002A with Opt 01,03 and 225 for **HDMI 2.0 Compliance and Margin Test setup.(Margin test feature will be available later and is part of roadmap)**

Note- We shall also support a 12.5GHz BW scope which would result in appx. 10% inaccuracy in RT/FT results .

# Requirement for Signal Generation

## Cable Emulation and Skew by Hardware



## Hardware Skew and Software Cable Emulation

# Sink Electrical tests

**Test ID HF2-1: Sink TMDS Electrical – 340-600Mcsc – Min/Max Differential Swing Tolerance**

**Test ID HF2-2: Sink TMDS Electrical – 340-600Mcsc – Intra-Pair Skew**

**Test ID HF2-3: Sink TMDS Electrical – 340-600Mcsc – Jitter Tolerance**

**Test ID HF2-4: Sink TMDS Electrical – 340-600Mcsc – Differential Impedance (performed using sampling scope)**

# HDMI 2.0 Rx solution positioning statement

- Tektronix will support HDMI 2.0 Sink Electrical and protocol tests using either AWG7122C (w/ Opt 01,02/06,08) AND AWG70002A (W/ Opt 01,03 ,225)
- Solution Positioning:
  - **Compliance solution** for HDMI 2.0 Rx
    - 2# AWG7122C with opt 01, 02/06 and 08
    - 1# AFG3102/C

Customers can use common test setup for HDMI 1.4b and HDMI 2.0 giving value for their investment in Tektronix HDMI 1.4b Rx solution.

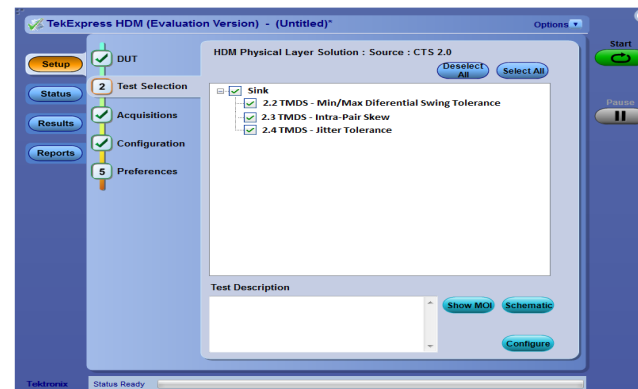
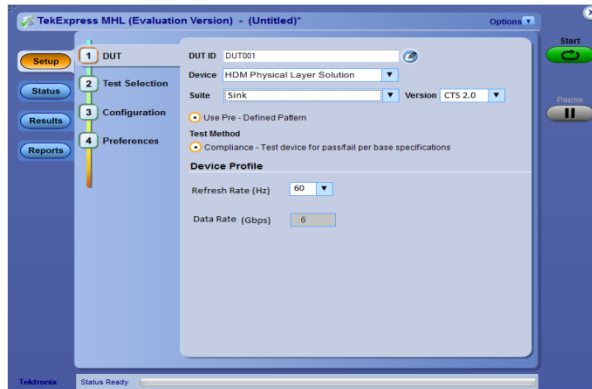
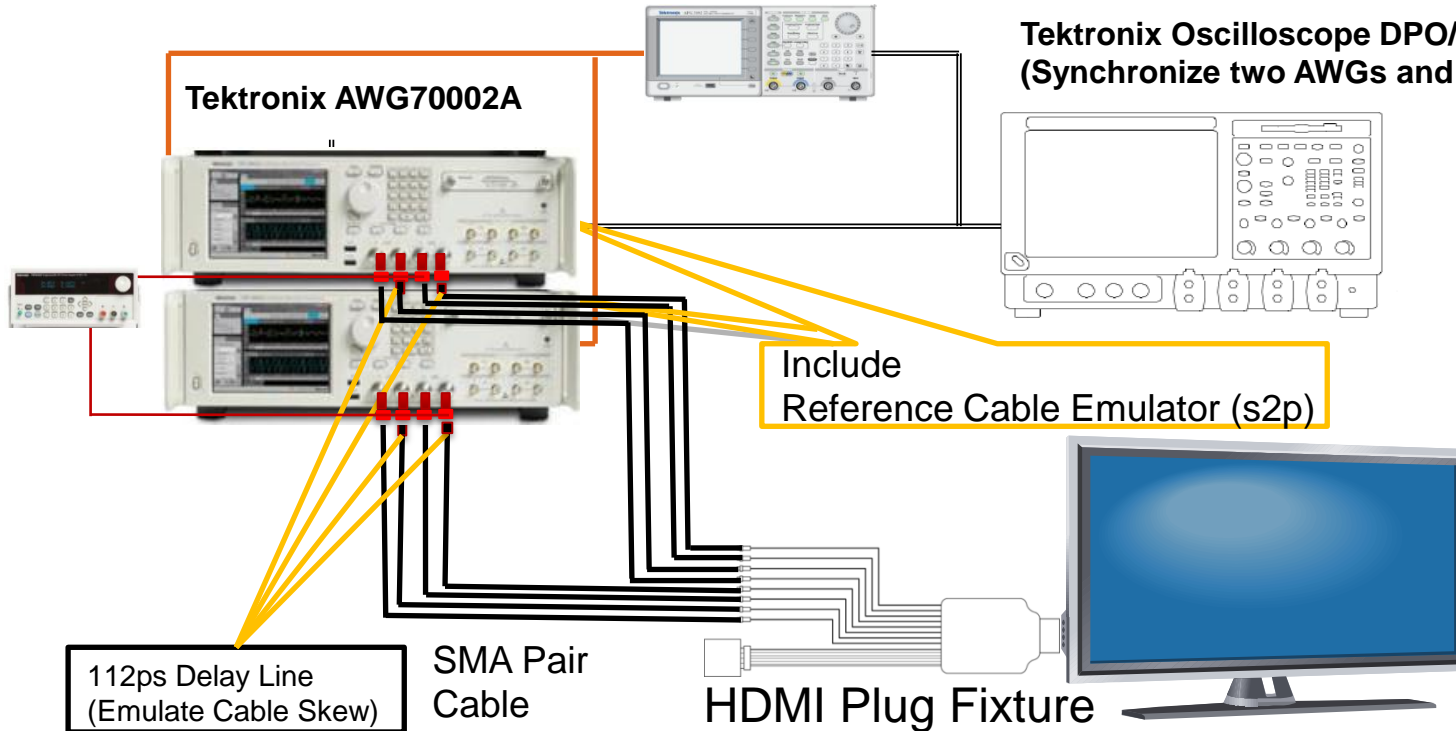
- **Compliance and Margin solution** for HDMI 2.0 Rx
  - 2# AWG70002A with Opt 01,03 and 225.
  - 1# AFG3102/C

Customers can use common test setup for HDMI 1.4b and HDMI 2.0 giving value for their investment in Tektronix HDMI 1.4b Rx solution

# HDMI 2.0 Sink Test Setup

Tektronix AFG3000 (Synchronize two AWGs)

Tektronix Oscilloscope DPO/DSA/MSO70000 Series (Synchronize two AWGs and Automation Test)

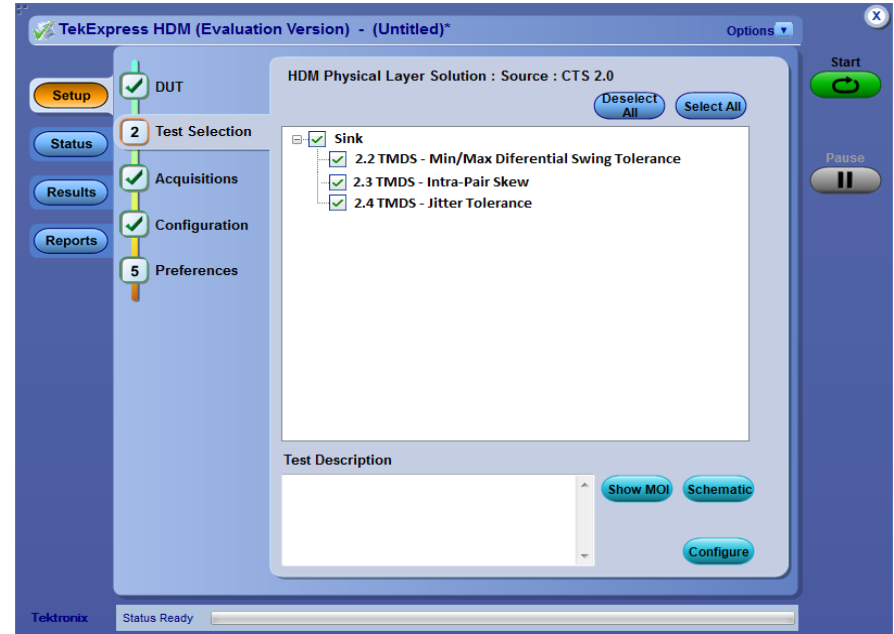
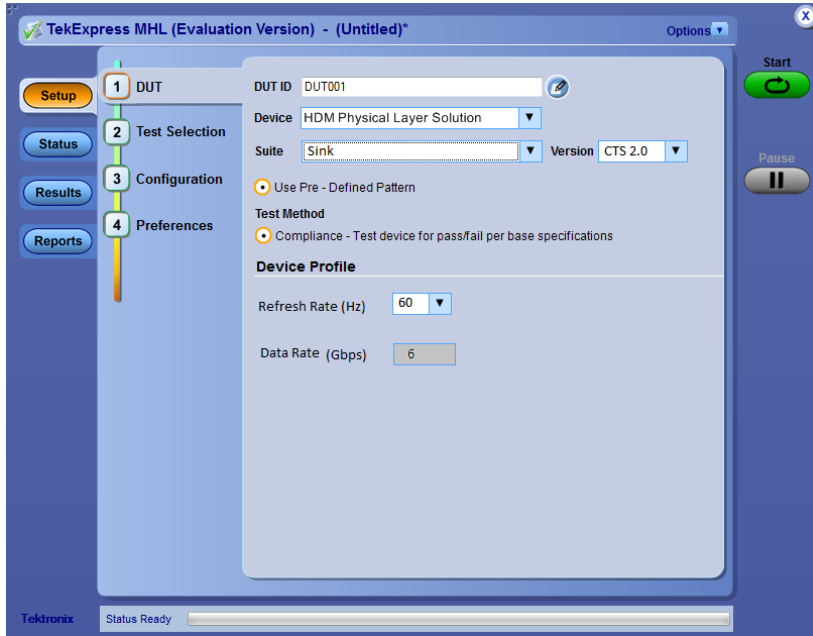




# Sink Testing 1.4b Vs 2.0

- Jitter Tolerance test needs +ve and –ve lanes tested with 112ps delay line
- Rest of the tests is similar to HDMI 1.4b tests
- 1.4b CTS test is a pre-requisite for HDMI 2.0
- Need AWG 70002A for HDMI 2.0 Compliance and Margin needs while AWG7122C is suitable for HDMI 2.0 Compliance testing only..
- Min 8GHz scope to 16GHz scope
- Fixtures and Probes
- HDM and HDM-DS Software

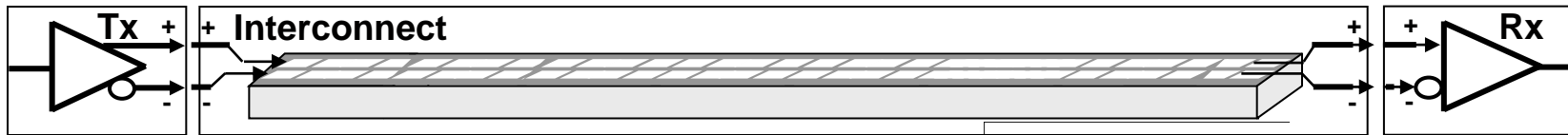
# HDMI 2.0 Rx Compliance Software



# Tektronix HDMI 2.0 Solution

- Tektronix HDMI 2.0 Solution will be available aligned to the CTS announcement from the new HDMI Forum.
- Full Source Test Solution including probes, Fixtures.
- Phased Rx Electrical solution- ensuring regular engagement with customers with pattern support added to solution.( between Dec 2013 to June 2014)
  - Release 1 HDMI 2.0 Sink Electrical tests HF2-1; HF2-2 and HF2-3 with the following VIC supported: ( Dec MOI)
    - VIC 96,VIC97, VIC 101, VIC 102 ,VIC 106, VIC 107
  - Release 1 Sink Protocol test HF2-23 supported ( Dec MOI)
  - Release 2 – 1H CY14 – remaining VICs for electrical tests- Target for next MOI approval event ( Q1 CY14)
  - Final Release - Phased Rx Protocol solution- ensuring regular engagement with customers with pattern support added to solution.( starting by Q1 CY14 and complete by end 2014)
- Support for HDMI 1.4b CTS is a pre-requisite for HDMI 2.0 testing.
- Contact local Tektronix sales team for early interaction on our HDMI 2.0 solution.

# High-Speed Serial Data Test Solutions



Real-time Scopes



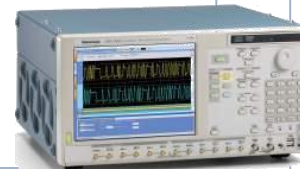
System Integration  
Digital Validation & Debug

Logic Analyzers



Transmitter Testing

Receiver Test  
Margin Testing



Arbitrary Waveform Generator



Probing  
Fixtures

Interconnect Test



Sampling Scopes

Compliance Test

Compliance Test Software



THANK YOU