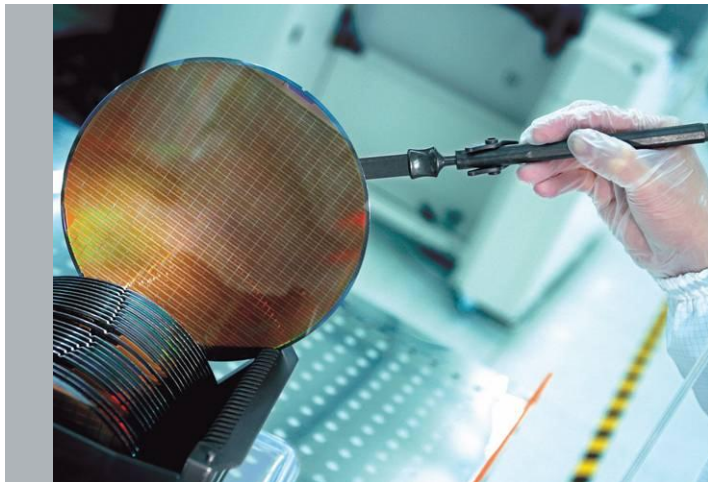


Validating Next Generation HDMI and MHL Interfaces

U N Vasudev - u.n.vasudev@tek.com
Strategic Product Planner



Tektronix[®]

Agenda

- HDMI Overview and updates
- MHL Overview and updates
- Tektronix Solution overview
- Additional resources



HDMI –High Definition Multimedia Interface



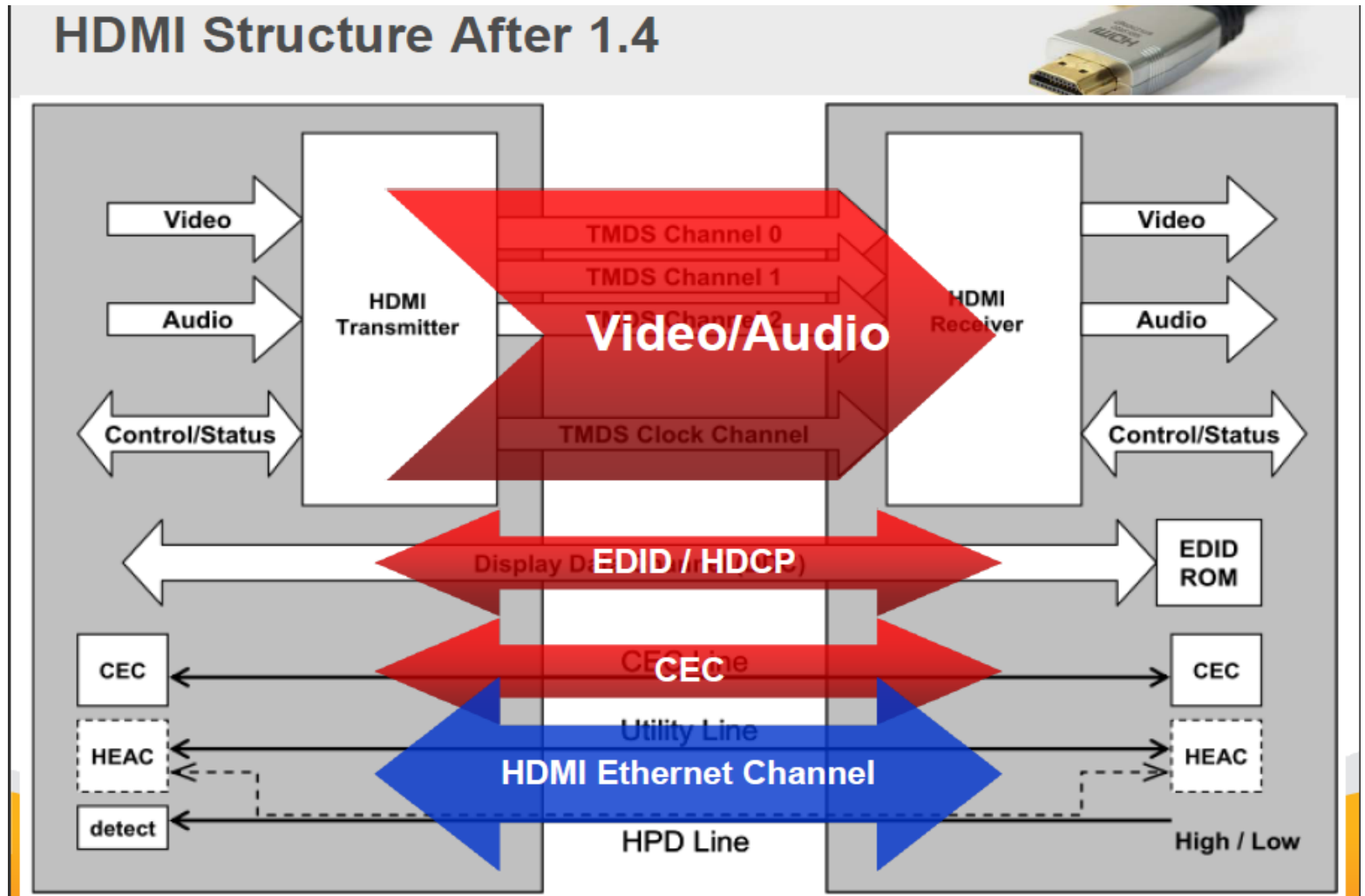
Overview of HDMI

- 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[™]
HIGH-DEFINITION MULTIMEDIA INTERFACE

HDMI Basics



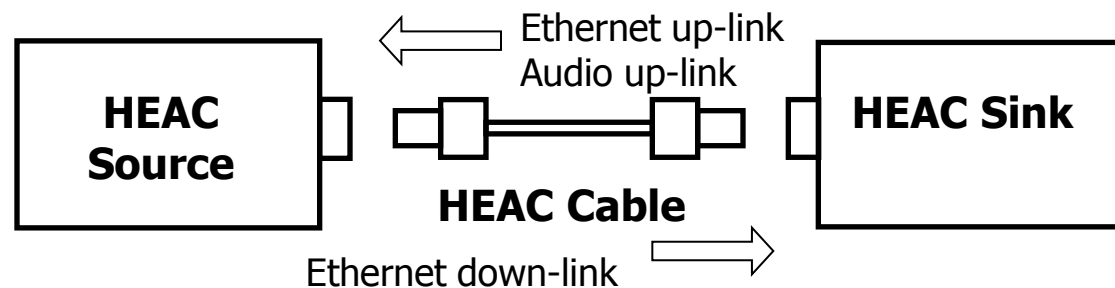
HDMI Technology and solution status

- Over 1000+ adopters till date Source: HDMI LLC
- HDMI Expands Footprint
 - HDMI has made inroads into PC industry
 - New computer platforms have HDMI interfaces
 - Hand held devices with miniature HDMI devices
 - New connectors Type C and Type D introduced
 - HDMI Forays into Automotive – Type E
 - Year 2011 – 3D Year
 - Still camera
 - Advertising billboards

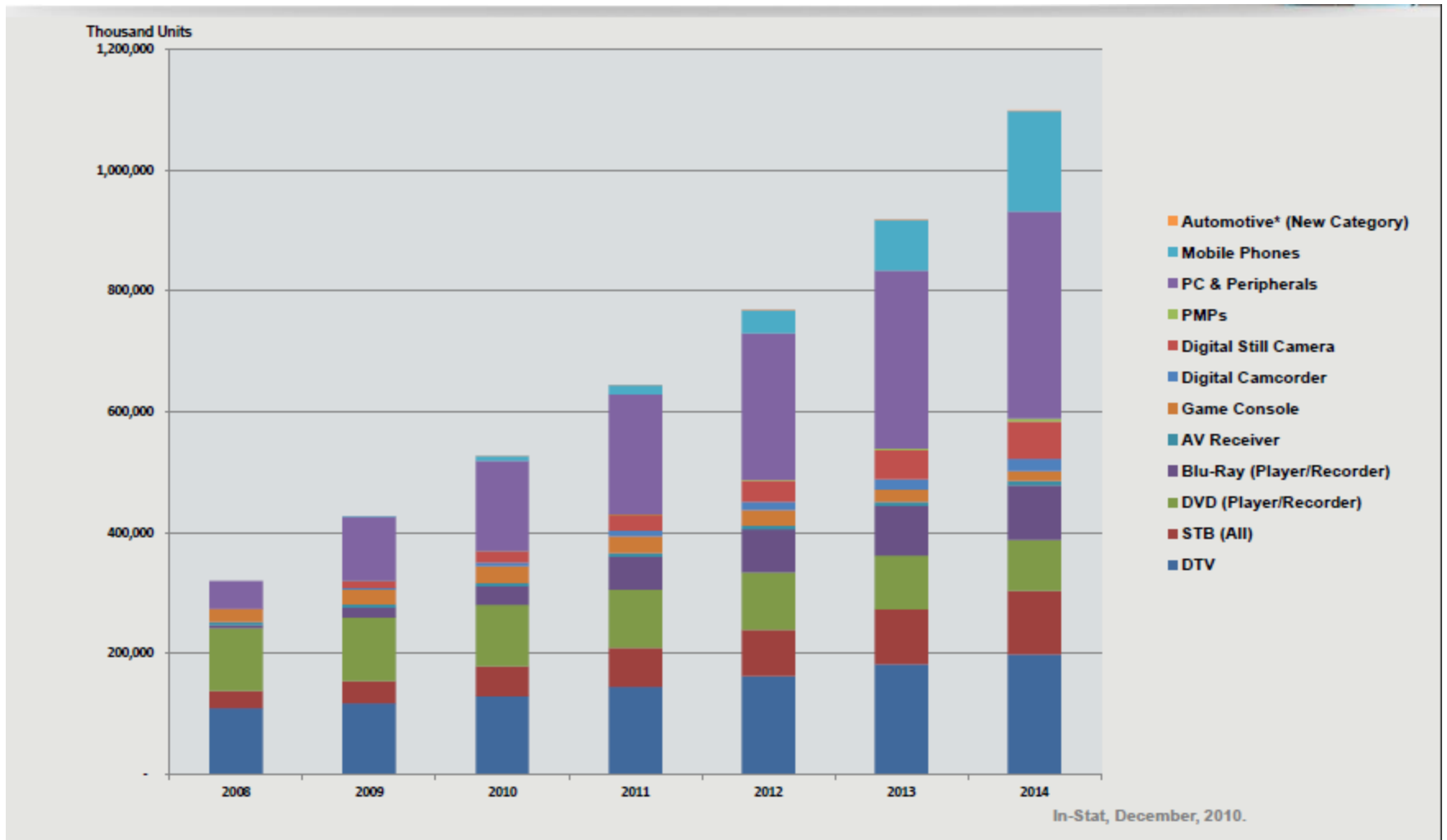


- HDMI NOW Truly Single Digital Interconnect for uncompressed Audio/Video

- HEAC (A R C)

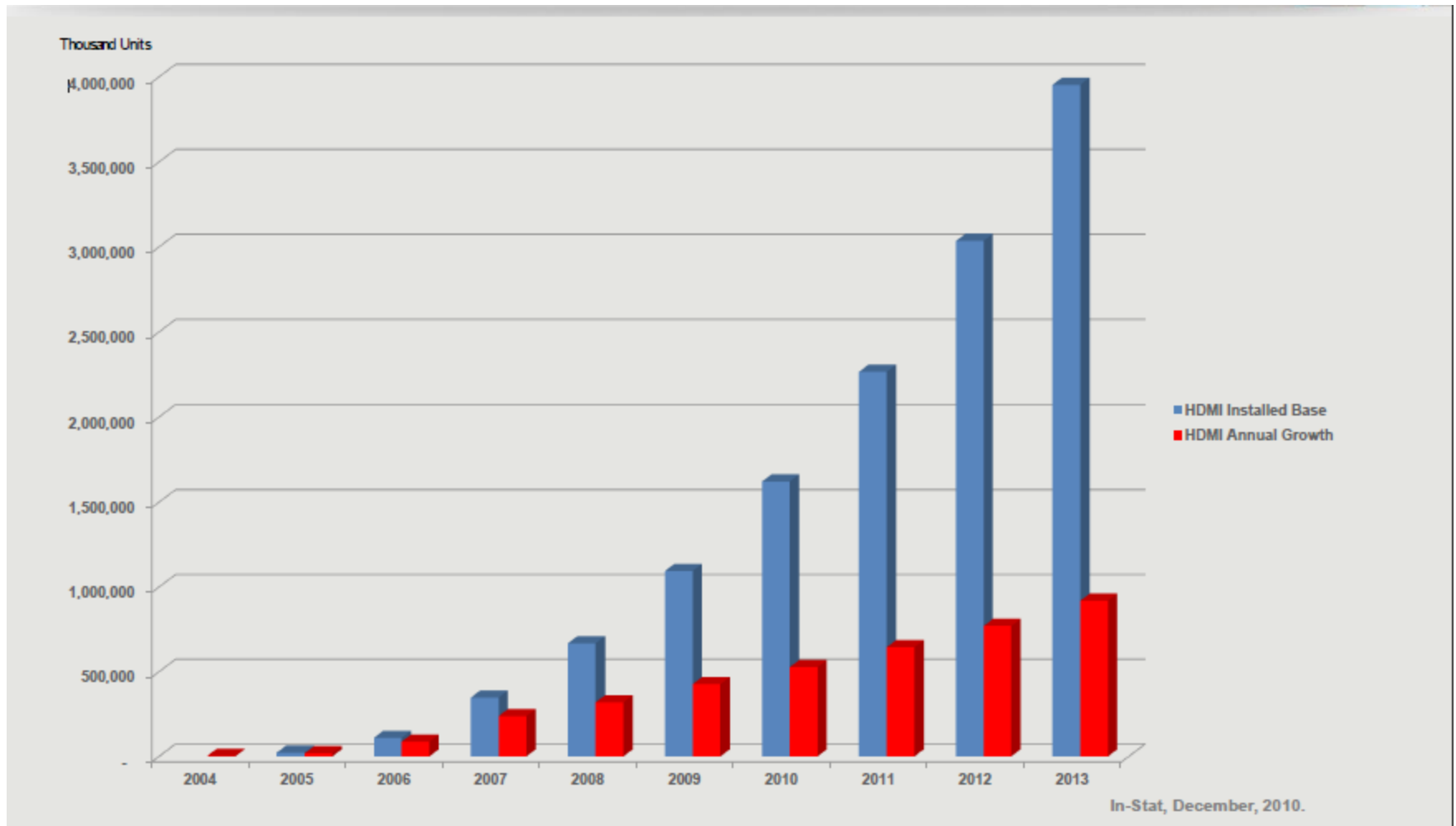


HDMI Market overview



Source: HDMI Forum

HDMI Devices take rate

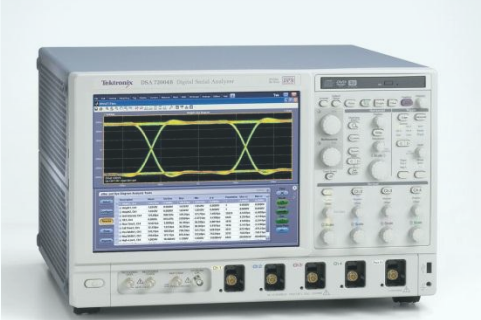


2.2B HDMI devices sold by 2011

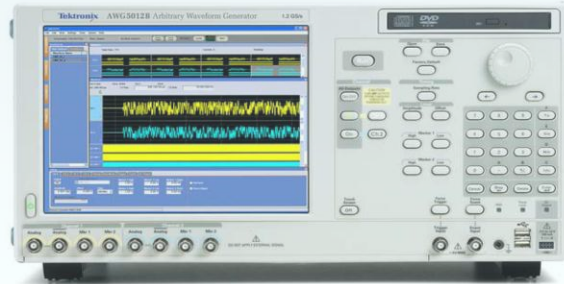
Source: HDMI Forum

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 Analyser

Changes in HDMI standards body

- Due to the HDMI Specification'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

What is HDMI Forum

- Nonprofit, mutual benefit corporation to support and develop future versions of the HDMI Specification
 - Open for participation by any entity
 - Requires acceptance of membership application, signed Participation Agreement and payment of annual membership fee
 - Members join and renew annually
 - No limit on the number of members
 - Provides open, fair, reasonable and non-discriminatory licensing
 - Governed by a membership-elected Board of Directors

Source: HDMI Forum

HDMI Forum Charter

- Support and develop future versions of the HDMI Specification
- Support and maintain the ecosystem of interoperable HDMI-enabled products
- Promote future HDMI Specifications and conduct its activities in conformance with all applicable laws, rules and regulations

Source: HDMI Forum

Tektronix and HDMI Forum

- 80+ 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 sub-group
- HDMI Forum working on next version of HDMI specifications.
 - HDMI 2.0 Specification published on Sept 4th 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 Hz – 594Mhz
- Support 4K 2K 4:2:0 – 297Mhz
- Low level Bit error rate testing
- Scrambling is likely to be introduced for rates >340Mcps.

HDMI 2.0 Source Testing-Advanced information



Source Testing 1.4b Vs 2.0

Eye Diagram test and Clock Jitter test is 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 generation AWG 70K

Likely 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

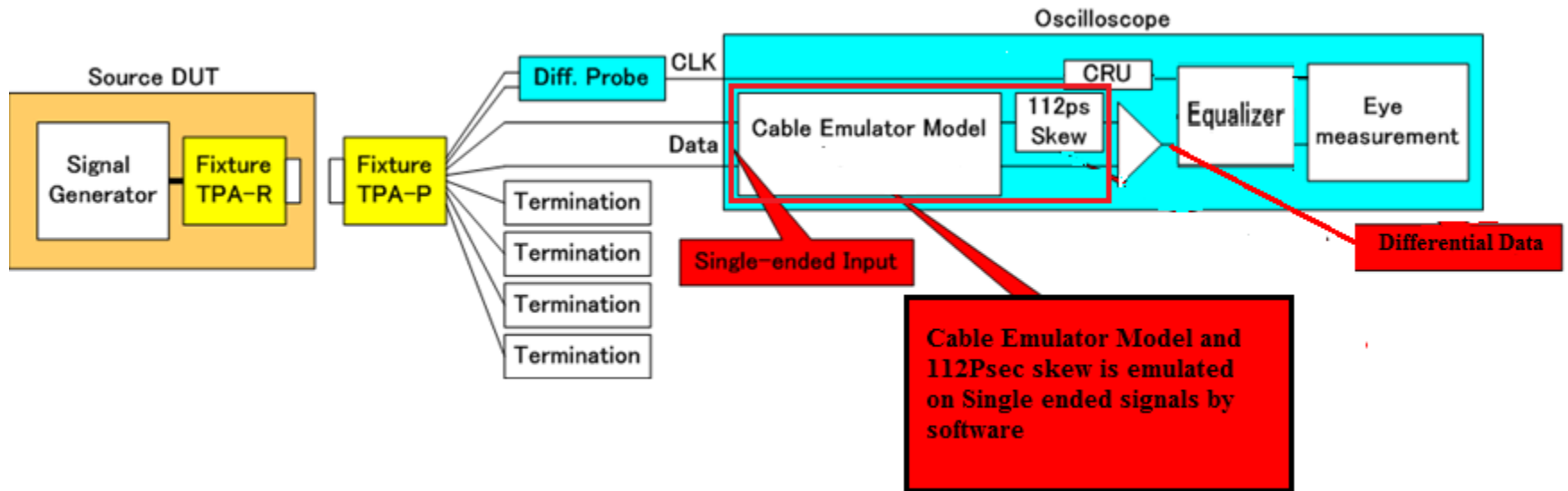
Test ID HF1-7: Source TMD5 Electrical – 340-600Mcsc – Clock Jitter

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

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

Source Testing

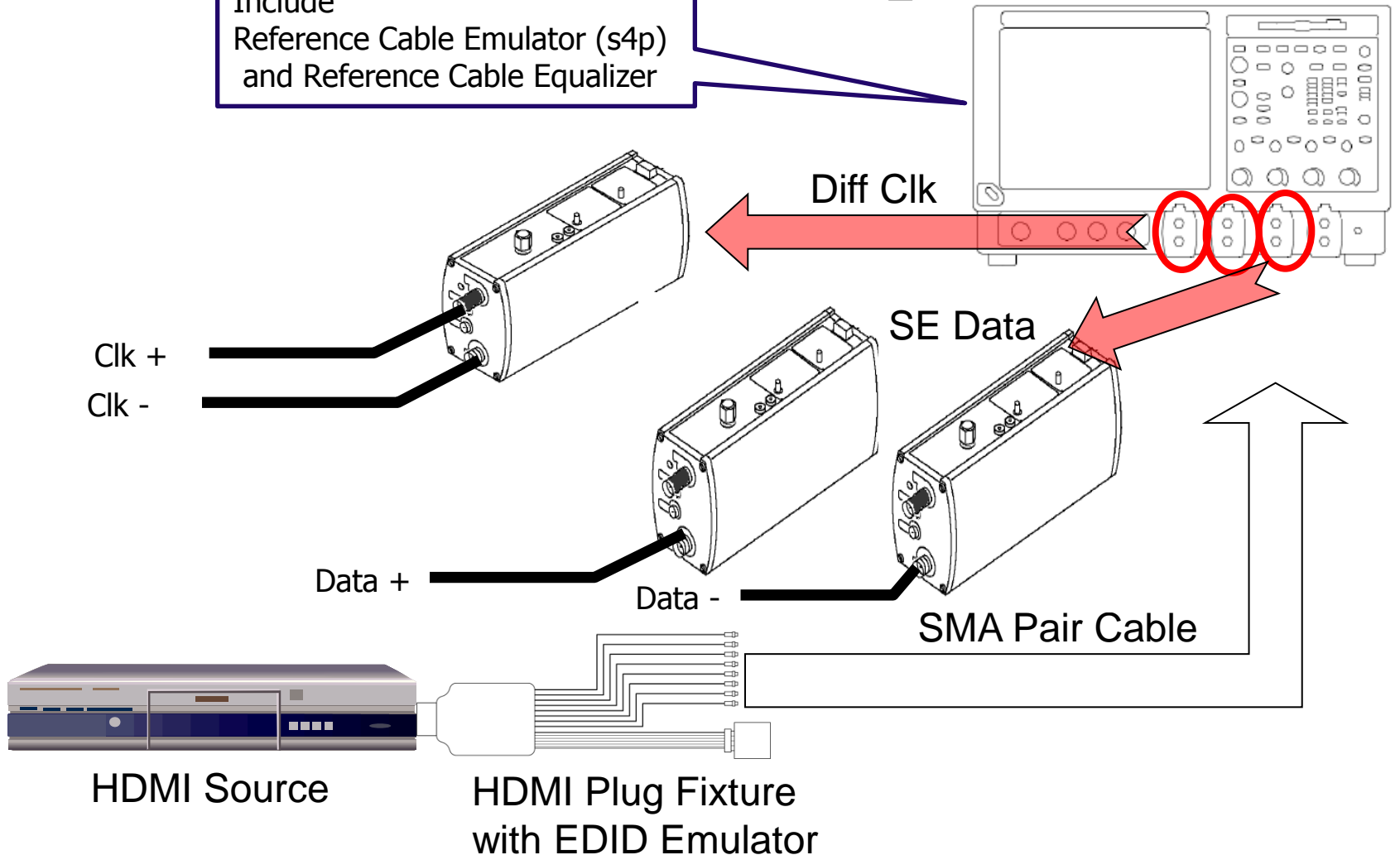
- Source Eye Diagram test is measured at TP2_EQ.
- TP2 is the signal after passing along a worst cable.
 - Worst cable has worst attenuation and skew of 112ps.



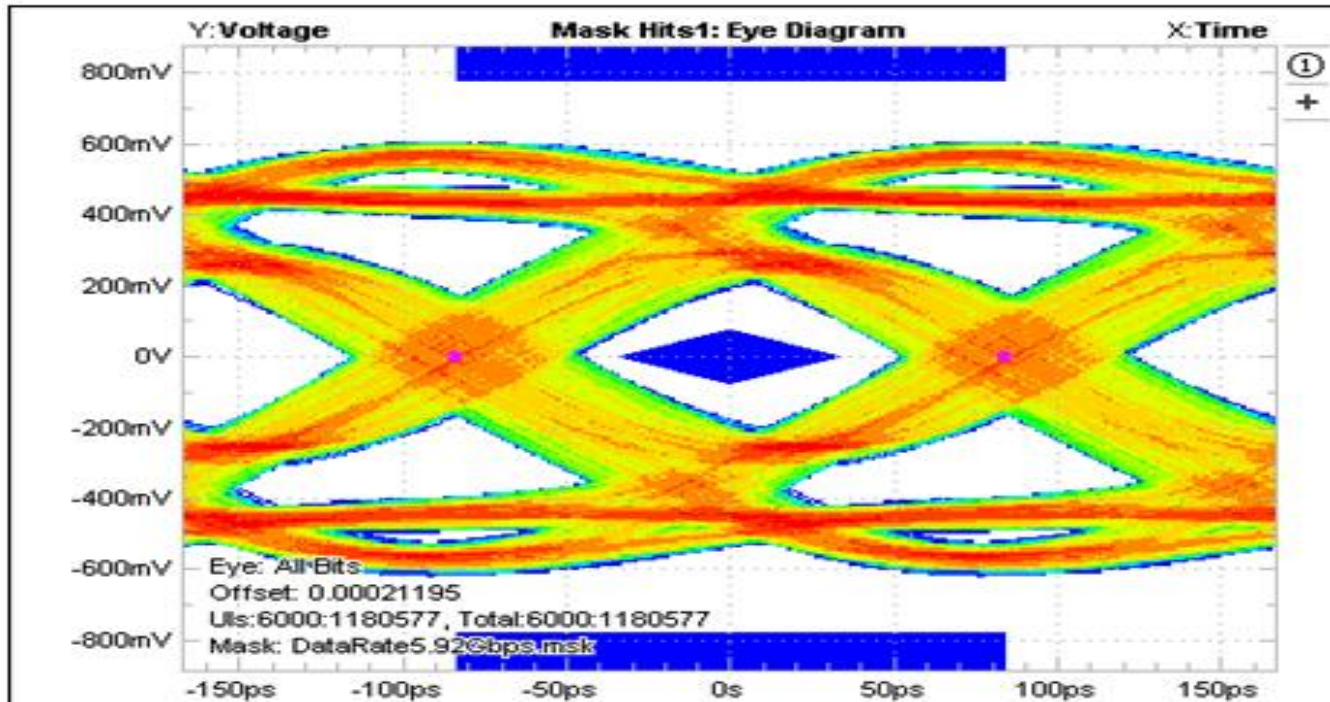
Source Eye Diagram Test

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)

1 DUT

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)

2 Test Selection

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)

Test Status Log View

Test Name	Acquisition	Acquire Status	Analysis Status
Clock			
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	
D0			
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	
D1			
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)

Overall Test Result ✖ Fail

Test Name	Details	TBit	Value	Units	Pass/Fail	Margin
Clock					✖ Fail	
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 & -0.1822
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
D0					✖ Fail	
1.2 TMDS TRise TFall	D0 Rise Time	168.3498 ps	60.6379	ps	✔ Pass	18.1379
1.2 TMDS TRise TFall	D0 Fall Time	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- Advanced Information



Likely Sink Electrical tests

Test ID HF2-1: Sink TMD5 Electrical – 340-600Mcsc – Min/Max Differential Swing Tolerance

Test ID HF2-2: Sink TMD5 Electrical – 340-600Mcsc – Intra-Pair Skew

Test ID HF2-3: Sink TMD5 Electrical – 340-600Mcsc – Jitter Tolerance

Test ID HF2-4: Sink TMD5 Electrical – 340-600Mcsc – Differential Impedance-Sampling Scope based test

Sink Test

Tektronix AFG3000
(Synchronize two AWGs)

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

Tektronix AWG70002A HDM

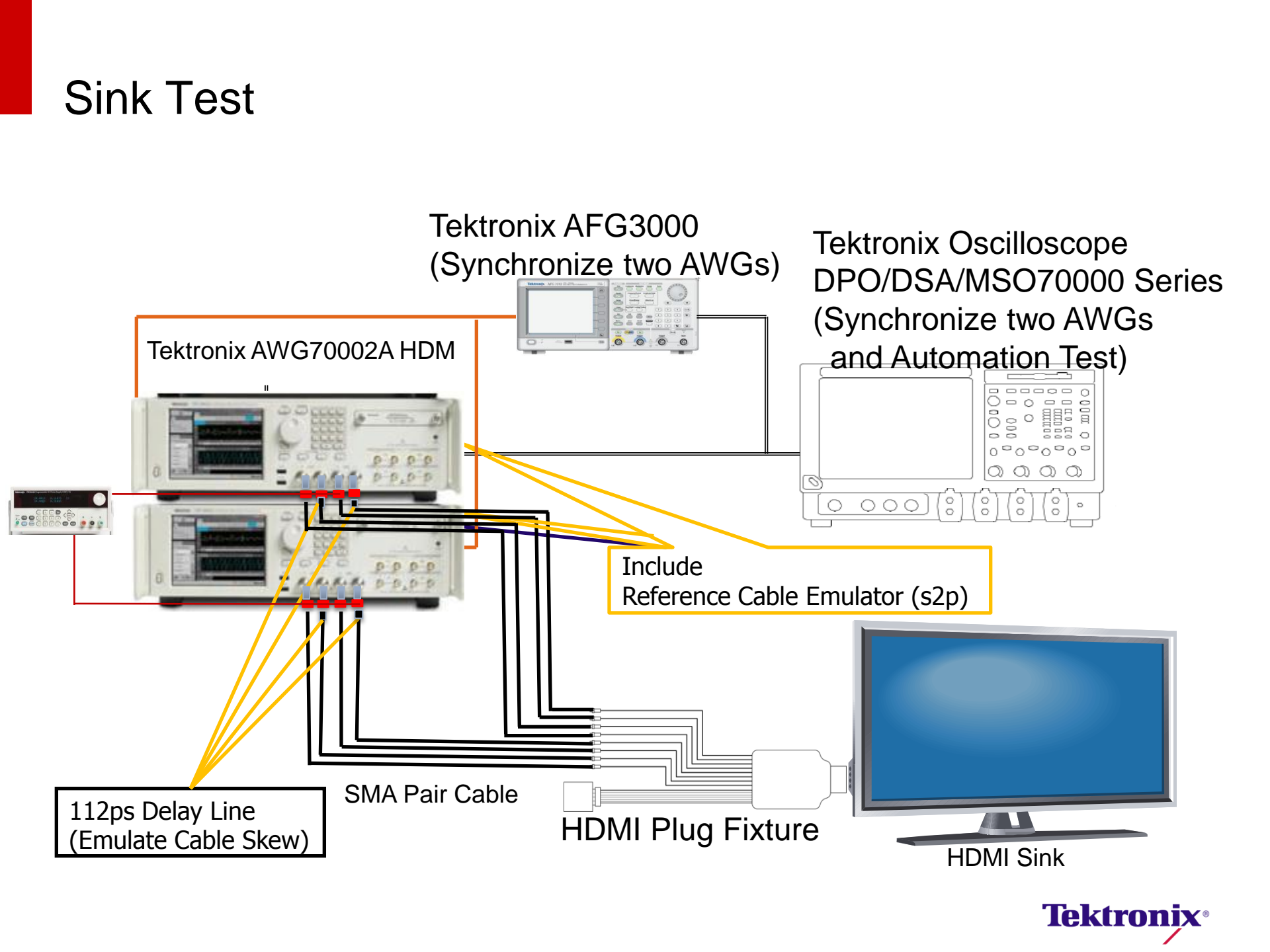
Include
Reference Cable Emulator (s2p)

112ps Delay Line
(Emulate Cable Skew)

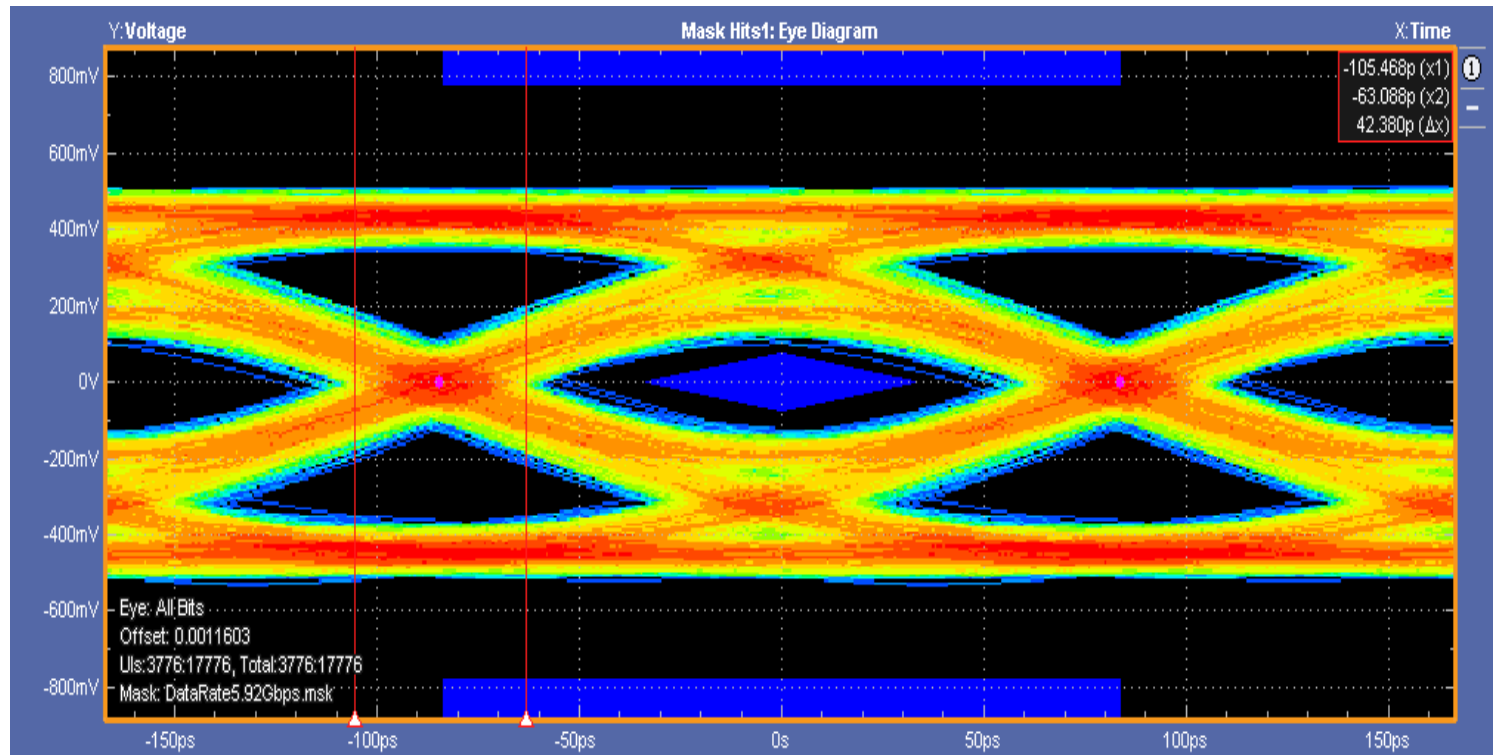
SMA Pair Cable

HDMI Plug Fixture

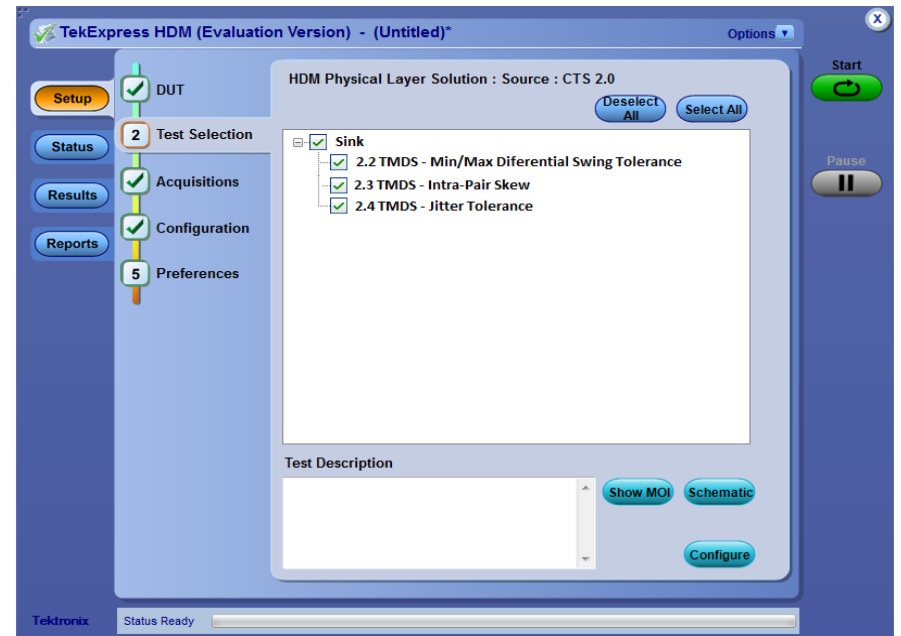
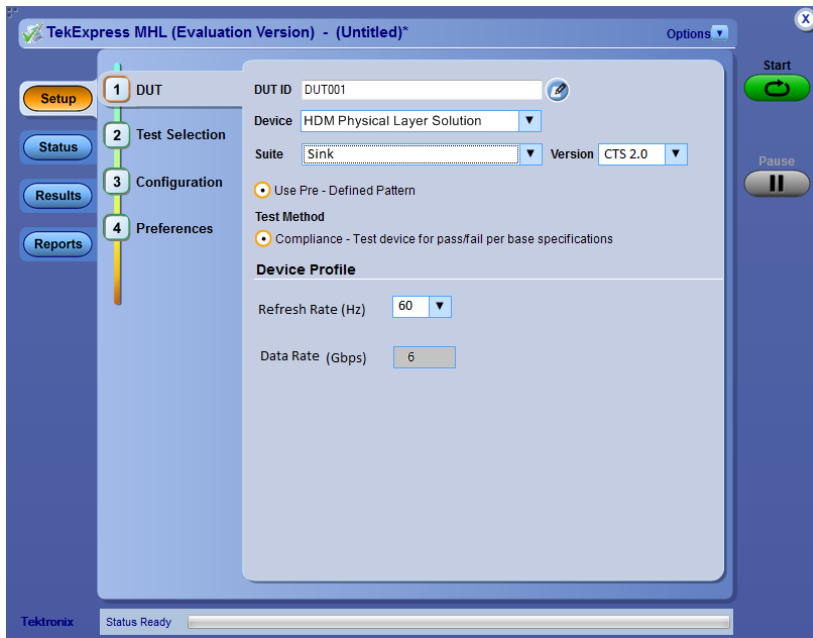
HDMI Sink



TP2 Signal with New AWG70002A



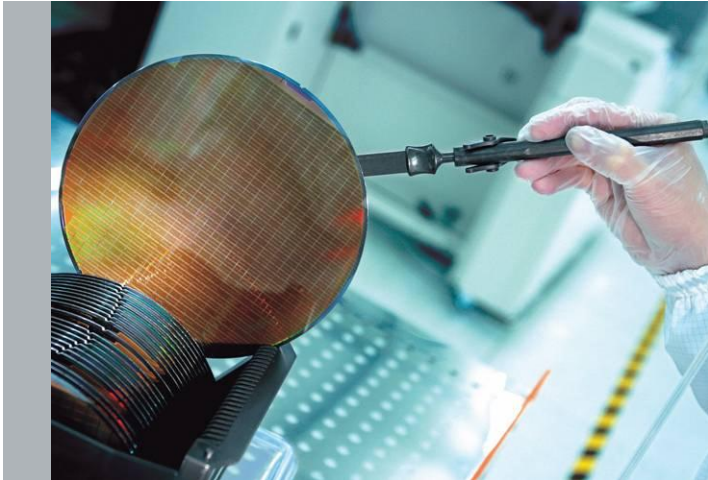
HDMI 2.0 Rx Compliance Software



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 and Sink Electrical test Solution including probes, Fixtures.
- Support for HDMI 1.4b CTS which a pre-requisite for HDMI 2.0 testing.
- Contact local Tektronix sales team for early interaction on our HDMI 2.0 solution.

Tektronix MHL 2.1 Solution



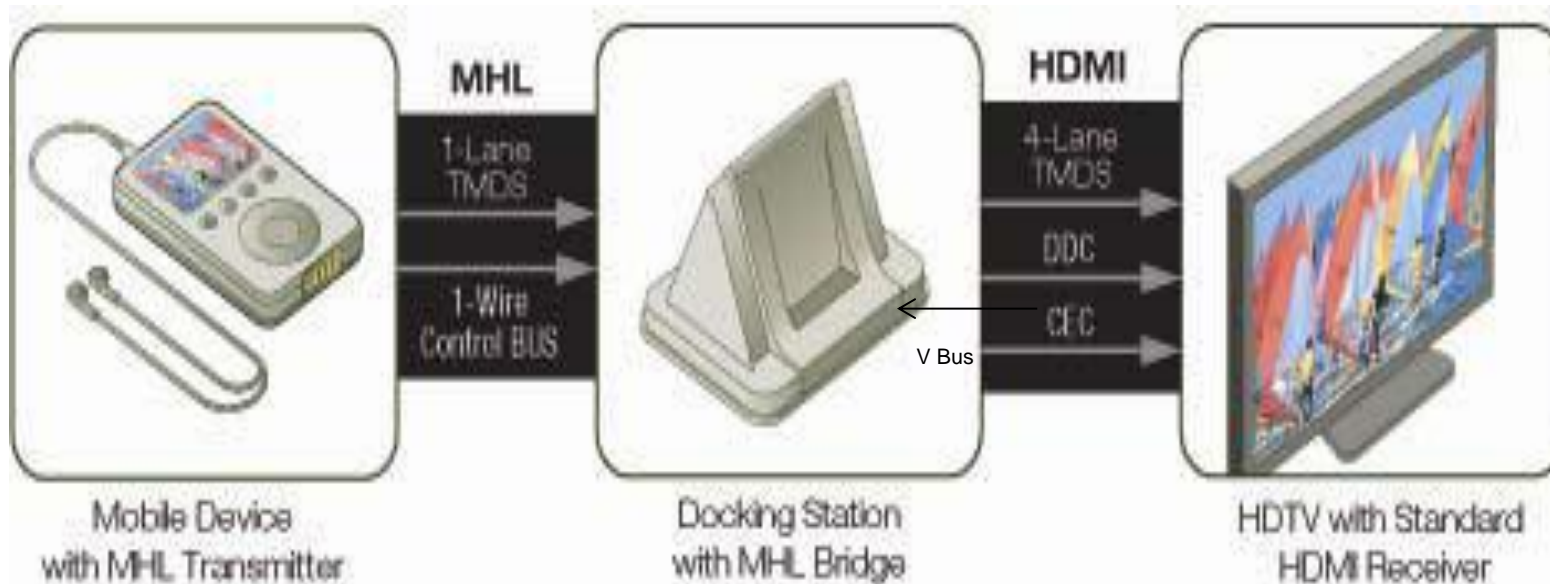
Tektronix[®]

MHL – An Introduction

- Why MHL interface?
- Application



MHL Introduction



- Mobile HD Link (MHL) technology is a low pin count HD audio and video interface that connects portable electronics devices such as mobile phones, digital cameras, camcorders and portable media players, to HDTVs.
- The technology allows mobile devices to output digital 1080 Full HD resolution via the existing mobile connector without the real estate and cost of another dedicated video connector.
- Together with an MHL-to-HDMI bridge, the MHL-enabled mobile device becomes a fully compliant HDMI source and can connect to the television's standard HDMI input port.

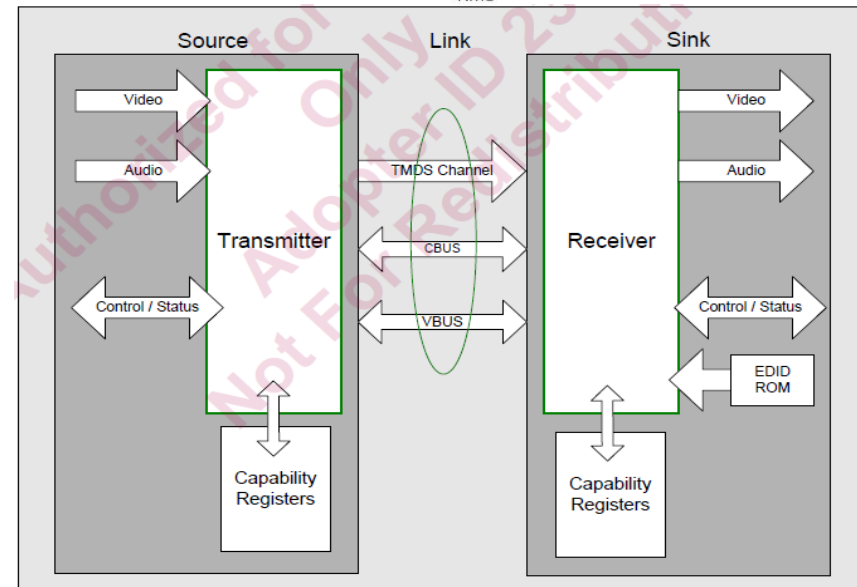
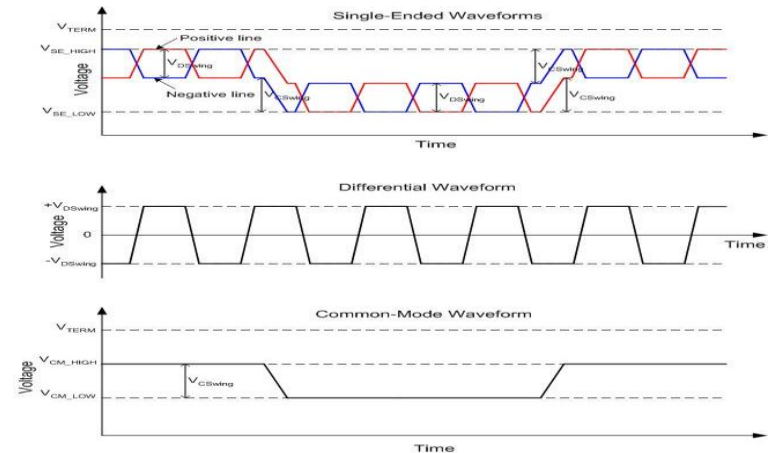
MHL Introduction

- MHL Consortium was formed in Sept 2009 with the following founding members:
 - NOKIA
 - SAMSUNG
 - Silicon Image
 - Sony
 - Toshiba
- The Specification 1.1 version was announced in Q12011 , Specification 1.2 in Dec 2011, Specification 2.0 in Feb 2012 and Specification 2.1 NOW.

The Consortium released CTS 1.1 version in June 2011, CTS 1.2 in Jan 2012, CTS 2.0 in Sept 2012 and CTS 2.1/1.3 in June 2013

COMPLETE TEKTRONIX SOLUTION APPROVED in CTS1.1 , CTS 1.2 , CTS 2.0 and CTS 2.1 /1.3

- Tektronix is a **Contributor adopter** and actively involved in defining the CTS procedures.



Source: MHL 1.2 specification document

MHL CTS 2.1 features and next steps

- New test method for Clk Jitter and Data Eye Diagram (will be Single ended connection)
- Direct Attach devices support.
- New tests for Cable testing
 - Cable Eye Diagram
 - Minimum Voltage level
- Sink testing with and without Cable emulator effect
- NEXT Steps
 - MHL Consortium working on next version MHL specifications.
 - Data rate ???

Tektronix MHL Solution: Complete Solution for CTS2.1/1.3

- Tektronix MHL Physical Layer Tx test setups are easy to use and automated
 - Simple test setups common for most tests
 - Vterm provided by scope itself
 - MHL Fixtures available from our Fixture partner Wilder Technologies
- Tektronix MHL Physical Layer Rx test setups are easy to use.
 - TRUE MHL SIGNAL Generation as there is no need for external combiners/Filters
 - No need for external ISI boards as we leverage our AWG direct Synthesis Capability with common setups for Sink and Dongle testing
- Tektronix introduces an innovative combined solution for Physical Layer Testing and Protocol Testing:
 - Providing seamless link between PHY and Link layer testing
 - An economical MHL test solution
 - **ONE BOX solution for PHY and Protocol testing**
 - Easy access to legacy P/A/V data format
- Tektronix also offers complete MHL solution with:
 - DSA8200 or Equivalent Sampling scope with 80E03/04 and I-connect Software for MHL Cable testing (performed manually using MOIs)
 - Low Bandwidth Oscilloscopes
 - Keithley Source Meter (Now part of Tektronix)
 - Programmable Power Supply and
 - Digital Millimeter

MHL – 2.1

- MHL Consortium and Tektronix has worked together on the 2.1 version MHL specifications.
 - Data rate does not change from 3Gbps.
 - Packed Pixel implementation does not change
 - 3D capability does not change
 - New test procedure introduced for Source Clock Jitter and Data Eye Diagram
 - These tests will now be Single ended tests and will have worst case skew filters in the path of the signals before we analyze.
 - Sink Jitter Tolerance now needs to be tested with and without cable emulator
 - New Cable Electrical introduced
 - Minimum CLK Swing Test
 - Eye Diagram Test
 - Support for Direct Attach Source and Sink devices



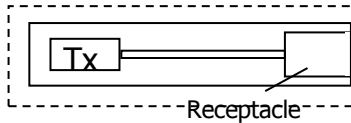
Tektronix MHL Solution

MHL Ecosystem and Tektronix Solution

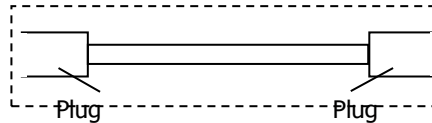
- Tektronix Offers Complete MHL 2.1 Solution.
- Industry's first 1BOX solution for Physical and Protocol testing.
 - Seamless transition between Protocol and Phy layer
 - Simple setup leads to faster test times



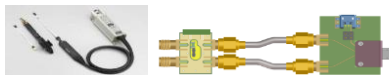
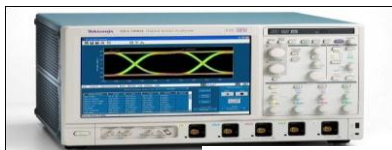
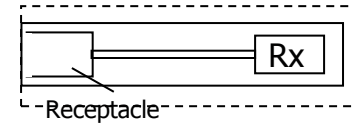
Source Devices



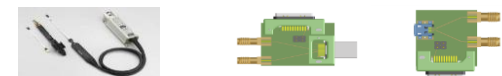
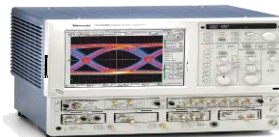
Cable Assemblies



Sink Devices



Electrical and Protocol



Electrical and Protocol

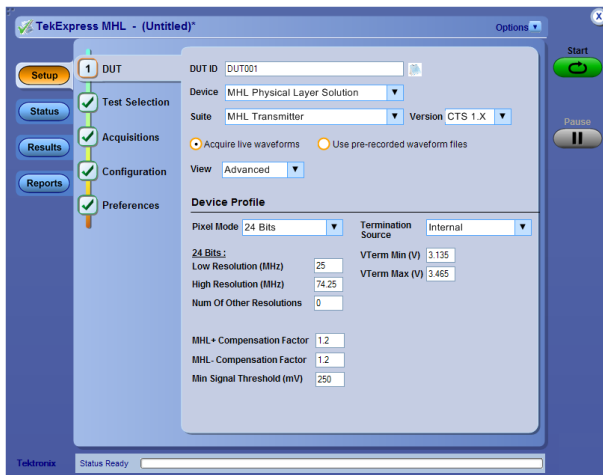


Tektronix MHL Transmitter Solution



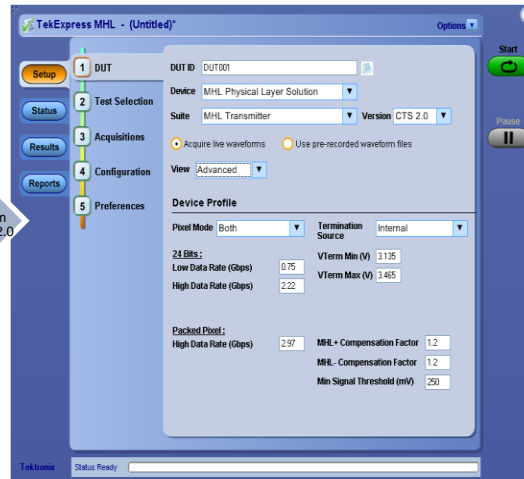
Tektronix MHL 2.1 Solution

- Tektronix has worked closely with MHL consortium to define the next CTS version 2.1 and MHL 2.1 TX SW.



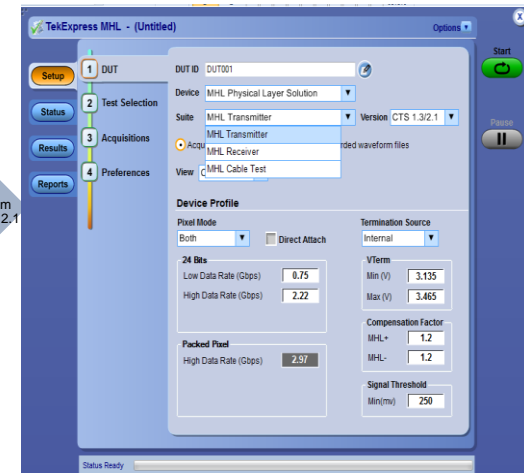
CTS 1.x

Switch from
CTS 1.x to 2.0



CTS 2.0

Switch from
CTS 2.0 to 2.1



CTS 2.1

- MHL Protocol Analyzer SW is MHL 2.1 version available
- MHL 2.1 Sink Patterns for Direct Attach Device testing is available
- MHL 2.1 Cable Electrical testing patterns are available
- No changes in test gear for MHL 2.1 only new feature support.

Tektronix MHL 2.1 Tx Solution with Direct Attach test support

The screenshot displays the TekExpress MHL software interface. The main window is titled "TekExpress MHL - (Untitled)*" and includes an "Options" dropdown in the top right corner. On the left side, there is a vertical navigation bar with four main sections: "Setup" (highlighted in orange), "Status", "Results", and "Reports". A vertical progress indicator on the left shows four steps: 1. DUT (highlighted in orange), 2. Test Selection (with a green checkmark), 3. Acquisitions, and 4. Preferences.

The main configuration area is divided into several sections:

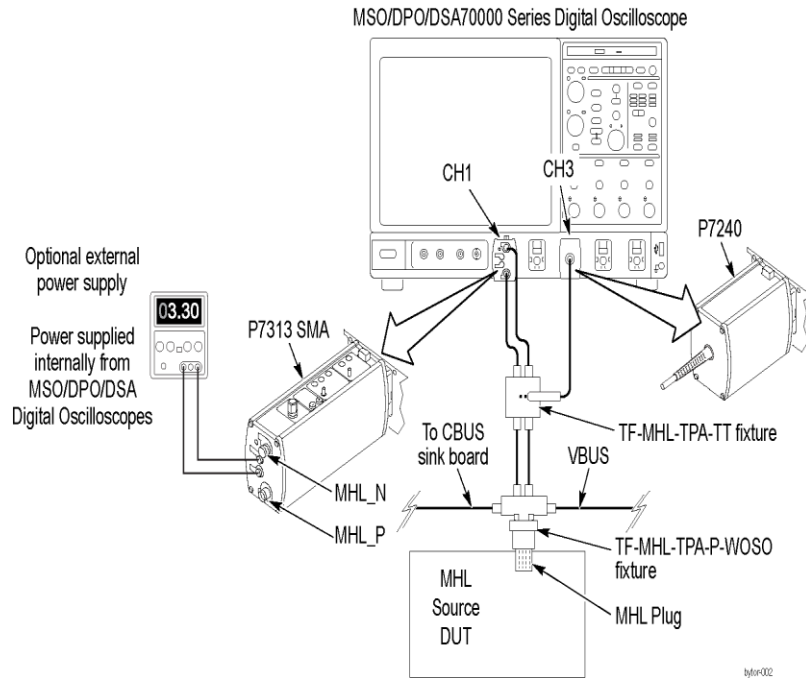
- DUT ID:** DUT001
- Device:** MHL Physical Layer Solution
- Suite:** MHL Transmitter
- Version:** CTS 1.3/2.1
- Acquire live waveforms:** (Selected)
- Use pre-recorded waveform files:**
- View:** Compliance

The **Device Profile** section is further divided into:

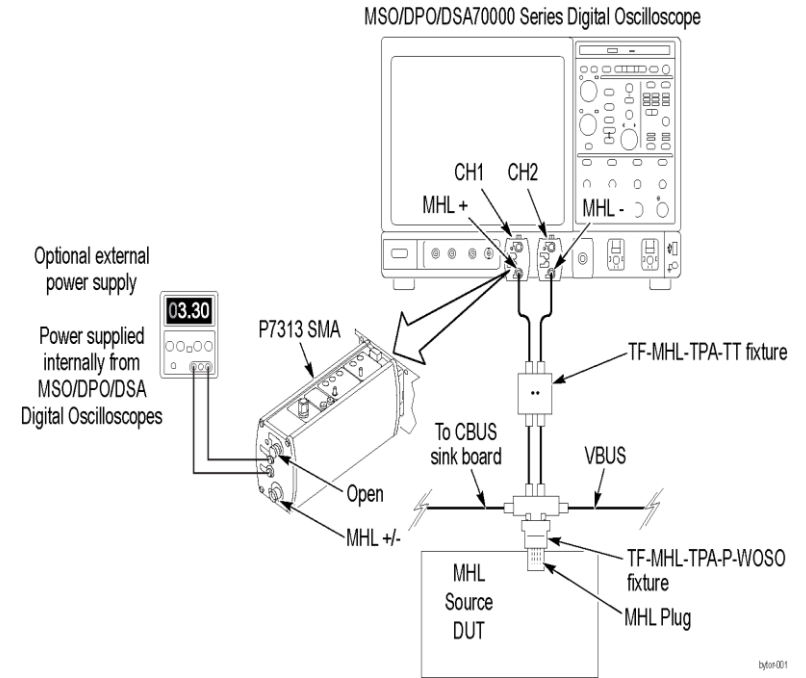
- Pixel Mode:** Both (dropdown), Direct Attach
- Termination Source:** Internal (dropdown)
- 24 Bits:**
 - Low Data Rate (Gbps): 0.75
 - High Data Rate (Gbps): 2.22
- Packed Pixel:**
 - High Data Rate (Gbps): 2.97
- VTerm:**
 - Min (V): 3.135
 - Max (V): 3.465
- Compensation Factor:**
 - MHL+: 1.2
 - MHL-: 1.2
- Signal Threshold:**
 - Min(mv): 250

On the right side of the interface, there are three control buttons: "Start" (green with a refresh icon), "Pause" (grey with a pause icon), and a close button (X). At the bottom left, a status bar shows "Status Ready" next to a progress indicator.

Tektronix MHL Tx Setup



MHL Differential and CM Test Setup
6 tests



Single Ended and Intra Pair Skew Test Setup
6Tests

Also same setup is used for MHL Protocol Testing

** C-Bus Sink and Source Board is needed for hand shaking and is available from Tektronix

MHL 2.1 Compliance Software for Automated Tx Tests: Option MHD

The screenshot displays the TekExpress MHL software interface. The main window title is "TekExpress MHL - (Untitled)". On the left, a vertical navigation bar shows four steps: 1. DUT (checked), 2. Test Selection (highlighted with a red box), 3. Acquisitions, and 4. Preferences. Below this are buttons for "Setup", "Status", "Results", and "Reports".

The central area is titled "MHL Physical Layer Solution : MHL Transmitter : CTS 1.3/2.1". It contains a tree view of test items, each with a checkmark:

- MHL Clock
 - 3.1.1.1 Standby Output Voltage-VOFF
 - 3.1.1.5 Common-mode Output Swing Voltage-V_CMSWING (Low)
 - 3.1.1.7 Common-mode Rise and Fall Times-TR_CM, TF_CM (High)
 - 3.1.1.10 MHL Clock Duty Cycle in Normal Mode (High)
 - 3.1.1.14 MHL Clock Duty Cycle in PackedPixel Mode (High)
 - 3.1.1.17 TP2 Clock Jitter in Normal Mode (Low, High)
 - 3.1.1.19 TP2 Clock Jitter in PackedPixel Mode (High)
- MHL Data
 - 3.1.1.2 Single-ended High Level Voltage-VSE_HIGH (Low)
 - 3.1.1.3 Single-ended Low Level Voltages-VSE_LOW (Low)
 - 3.1.1.4 Differential Output Swing Voltage-VDF_SWING (Low)
 - 3.1.1.6 Differential Rise and Fall Times-TR_DF, TF_DF (High)
 - 3.1.1.18 TP2 Eye Diagram in Normal Mode (Low, High)
 - 3.1.1.20 TP2 Eye Diagram in PackedPixel Mode (High)

Buttons for "Deselect All" and "Select All" are located above the tree view. Below the tree view is a "Test Description" field containing the text: "This test confirms that common-mode output voltage swing amplitude is within the specified limits when the source device operates in normal mode." To the right of the description are "Schematic" and "Configure" buttons.

On the right side of the interface, there are "Start" and "Pause" buttons. The "Start" button is green with a circular arrow icon, and the "Pause" button is grey with a double vertical bar icon. A "Status Ready" indicator is visible at the bottom left.

MHL 2.1 tests- Detailed information on MHL 2.1 TX tests

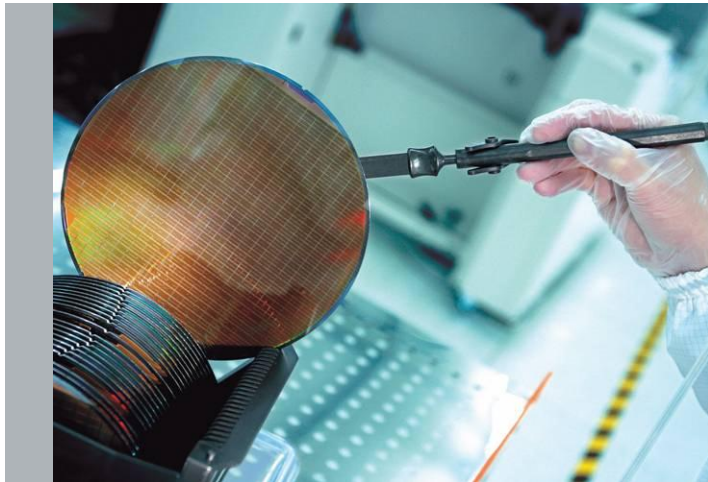
Physical Layer Tests

MHL Transmitter Tests

- 3.1.1.1 Standby Output Voltage V_{OFF}
- 3.1.1.2 Single-ended High-level Voltage V_{SE_HIGH}
- 3.1.1.3 Single-ended Low-level Voltage V_{SE_LOW}
- 3.1.1.4 Differential Output Swing Voltage $V_{ODSWING}$
- 3.1.1.5 Common Mode Output Swing Voltage $V_{COMSWING}$
- 3.1.1.6 Differential Rise and Fall Times T_{R_DF} , T_{F_DF}
- 3.1.1.7 Common Mode Rise and Fall Times T_{R_CM} , T_{F_CM}
- 3.1.1.8 Differential Intra Pair Skew T_{skew_DF}
- 3.1.1.10 MHL Clock Duty Cycle in Normal mode
- 3.1.1.11 MHL Clock Jitter in Normal mode (not needed as per CTS 2.1)
- 3.1.1.12 MHL Data Eye Diagram in Normal mode (not needed as per CTS 2.1)
- 3.1.1.14 MHL Clock Duty Cycle in PackedPixel mode
- 3.1.1.15 MHL Clock Jitter in PackedPixel mode (not needed as per CTS 2.1)
- 3.1.1.16 MHL Data Eye diagram in Packed Pixel mode (not needed as per CTS 2.1)
- 3.1.1.17 TP2 Clock Jitter in Normal Mode (new in CTS 2.1)
- 3.1.1.18 TP2 Eye Diagram in Normal Mode (new in CTS 2.1)
- 3.1.1.19 TP2 Clock Jitter in PackedPixel Mode (new in CTS 2.1)
- 3.1.1.20 TP2 Eye Diagram in PackedPixel Mode (new in CTS 2.1)

Innovative MHL Protocol Analyzer Solution

Introducing Tektronix' MHL Protocol Solution



Tektronix[®]

Tektronix MHL Protocol Analysis Solution

- MHL Protocol Analysis software running on the Tektronix REAL TIME Oscilloscope
 - Unique value proposition as the same real time scope is used for both Physical layer testing and Protocol testing.
 - Gives the seamless transition from Phy layer to Protocol.
 - Cost effective solution.
- Features
 - Multi View support
 - Bus Analysis
 - Frame Viewer
 - Event Viewer
 - Protocol Viewer
 - Linked to the analog waveform
- Tektronix Nomenclature – TEK-PGY-MHL-PA-SW

Protocol Tests for CTS 1.1/1.2/2.0 (See <http://prodigytechno.com> for more details)

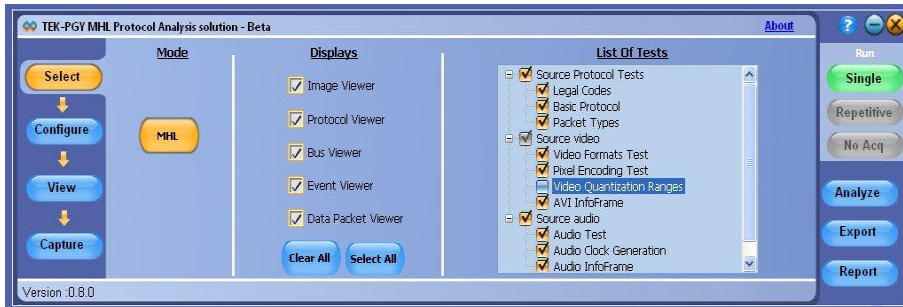
Source Protocol Tests in both Normal mode and PackedPixel mode

- Legal Codes
- Basic Protocol
- Packet Types

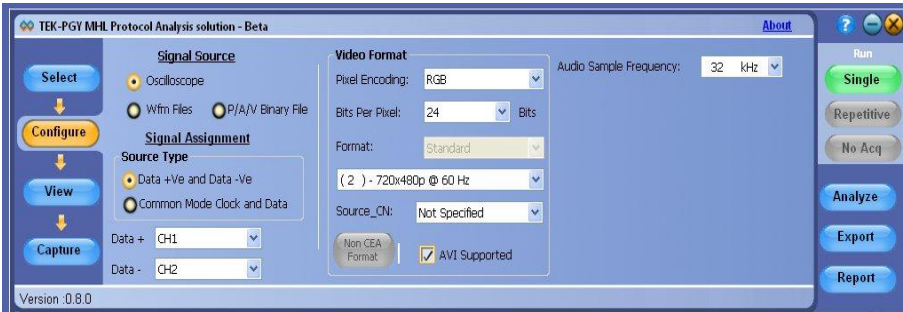
Source Video Tests in both Normal mode and PackedPixel mode

- Video Format Test
- Pixel Encoding Test
- Video Quantization Ranges
- AVI Info Frame

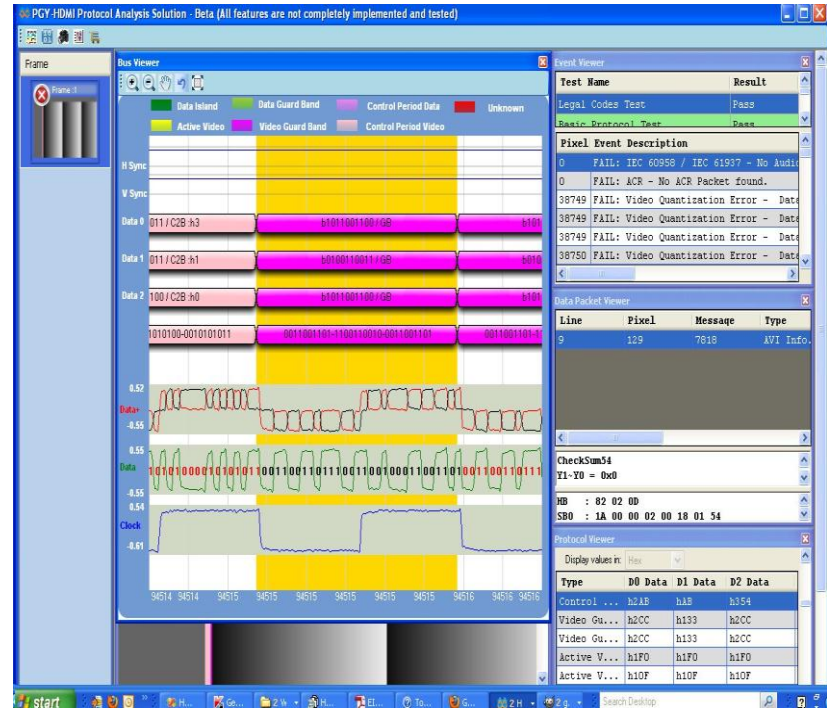
Tektronix MHL Protocol Analyzer: Seamless PHY and Link Layer Testing



SELECT



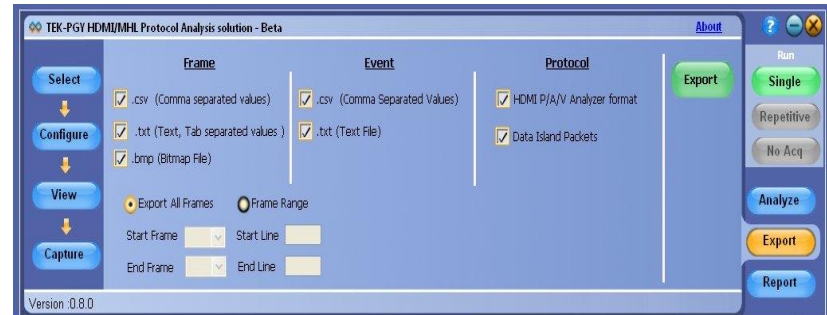
CONFIGURE



MULTI VIEW



BUS ANALYSIS-Physical Layer to Link Layer



REPORT

MHL Compliance Test Analysis

- All the tests pass/ fail depends on one frame data or maximum of two continuous frame data at a time.
- So with multiple acquisitions, the protocol analyzer can produce the same result as 2 sec data as per CTS requirement.

Source Protocol Tests	Source Video Test	Source Audio	Sink Protocol Tests
<ul style="list-style-type: none">▪ Legal Codes▪ Basic Protocol▪ Packet Types	<ul style="list-style-type: none">▪ Required Video Formats▪ Optional Video Formats▪ Required Pixel Encoding▪ Optional Pixel Encoding▪ Video Quantization Ranges▪ AVI Infoframe	<ul style="list-style-type: none">▪ IEC 60958/IEC 61937▪ Audio Clock Regeneration▪ Audio InfoFrame	<ul style="list-style-type: none">▪ Supported by AWG MHL patterns



Tektronix MHL Receiver Solution- Electrical and Protocol tests



Tektronix MHL 2.1 Rx Solution with Direct Attach test support

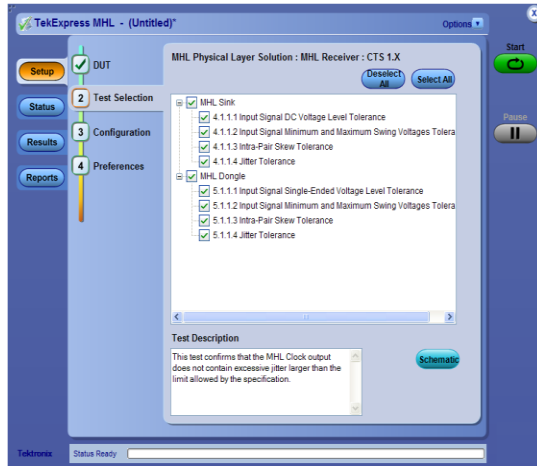
The screenshot displays the TekExpress MHL software interface. The main window is titled "TekExpress MHL - (Untitled)*" and includes an "Options" dropdown in the top right corner. On the left side, there is a vertical navigation menu with four steps: 1. DUT (highlighted in orange), 2. Test Selection, 3. Configuration, and 4. Preferences. Below this menu are buttons for "Setup", "Status", "Results", and "Reports".

The main configuration area is divided into several sections:

- DUT ID:** DUT001
- Device:** MHL Physical Layer Solution
- Suite:** MHL Receiver
- Version:** CTS 1.3/2.1
- Test Method:** Use Pre - Defined Pattern, Compliance - Test device for pass/fail per base specifications
- Device Profile:**
 - Pixel Mode:** Both
 - Refresh Rate:** 60 Hz
 - Direct Attach:**
 - 24 Bits:**
 - Low Data Rate (Gbps): 0.75
 - High Data Rate (Gbps): 2.22
 - Packed Pixel:**
 - High Data Rate (Gbps): 2.97

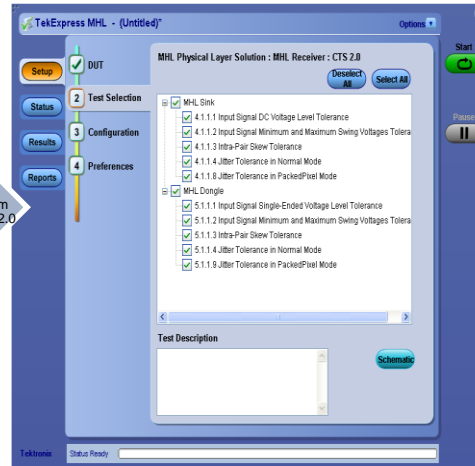
On the right side of the interface, there are three control buttons: "Start" (green with a refresh icon), "Pause" (grey with a pause icon), and a close button (X). At the bottom left, a status bar shows "Status Ready" with a progress indicator.

MHL Compliance Software for Automated Rx Tests: Option MHD



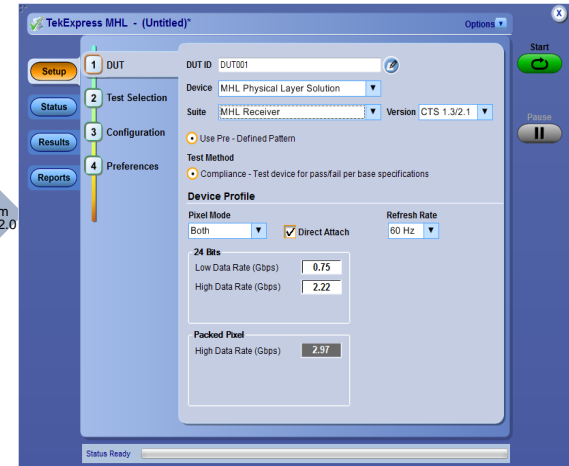
CTS 1.x

Switch from
CTS 1.x to 2.0



CTS 2.0

Switch from
CTS 1.x to 2.0



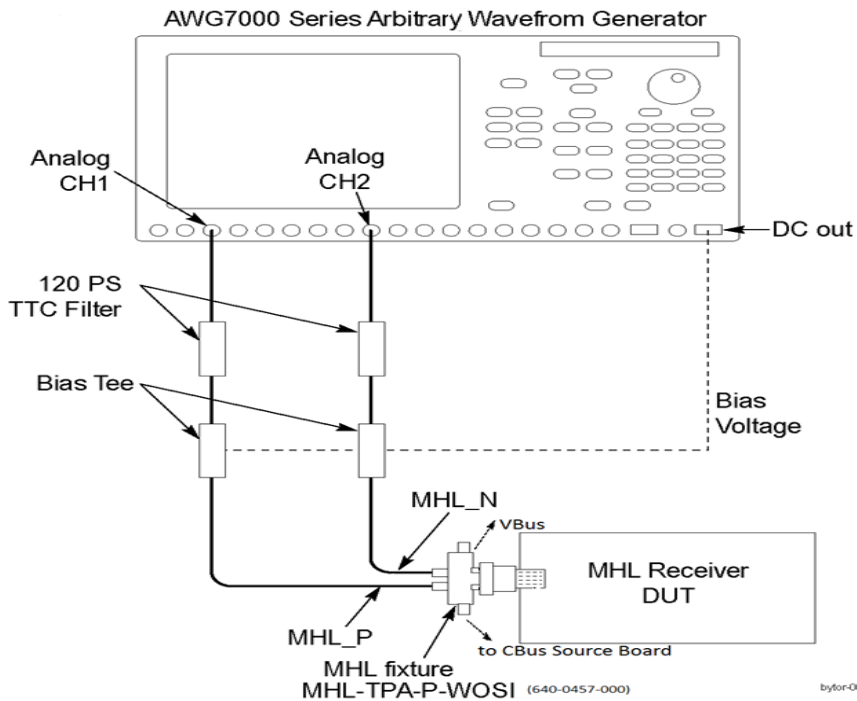
CTS 2.1

- MHL 2.1 SW version available
- MHL 2.1 Sink Protocol Patterns for Direct Attach Device testing is available
- CTS 2.1 mandates Sink Jitter Tolerance testing to be performed with and without Cable emulator.
- No changes in test gear for MHL 2.1 only new feature support.

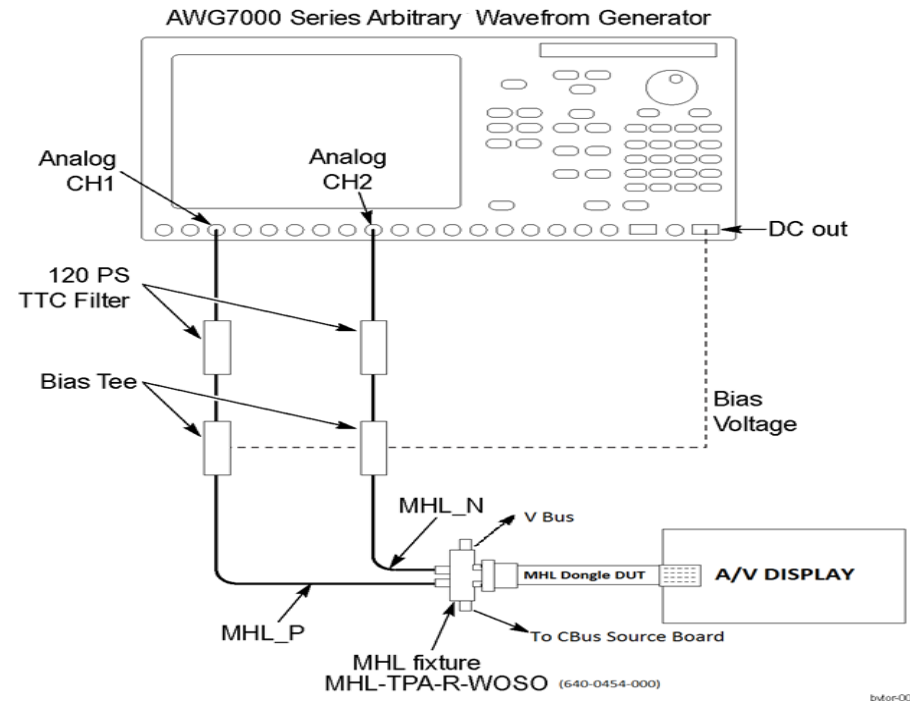
Tektronix MHL Solution Setup: Simple and Easy Sink and Dongle Testing (all tests except Min/Max test)-1

Setup based on Direct Synthesis Capability of AWG7122C Series

Test Setup for Sink Tests



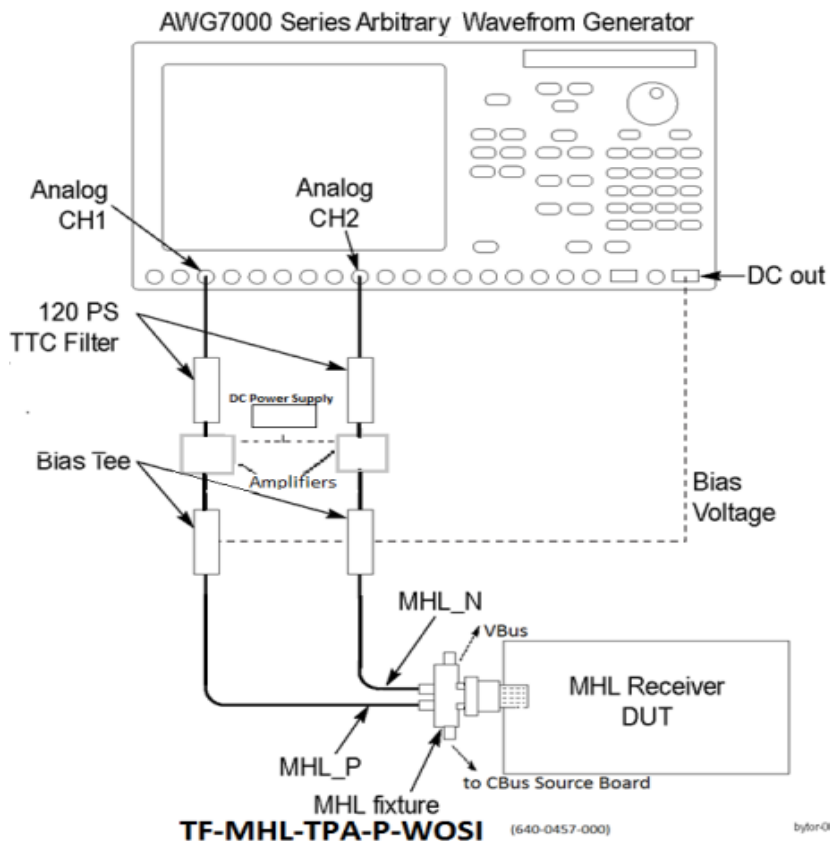
Test Setup for Dongle Tests



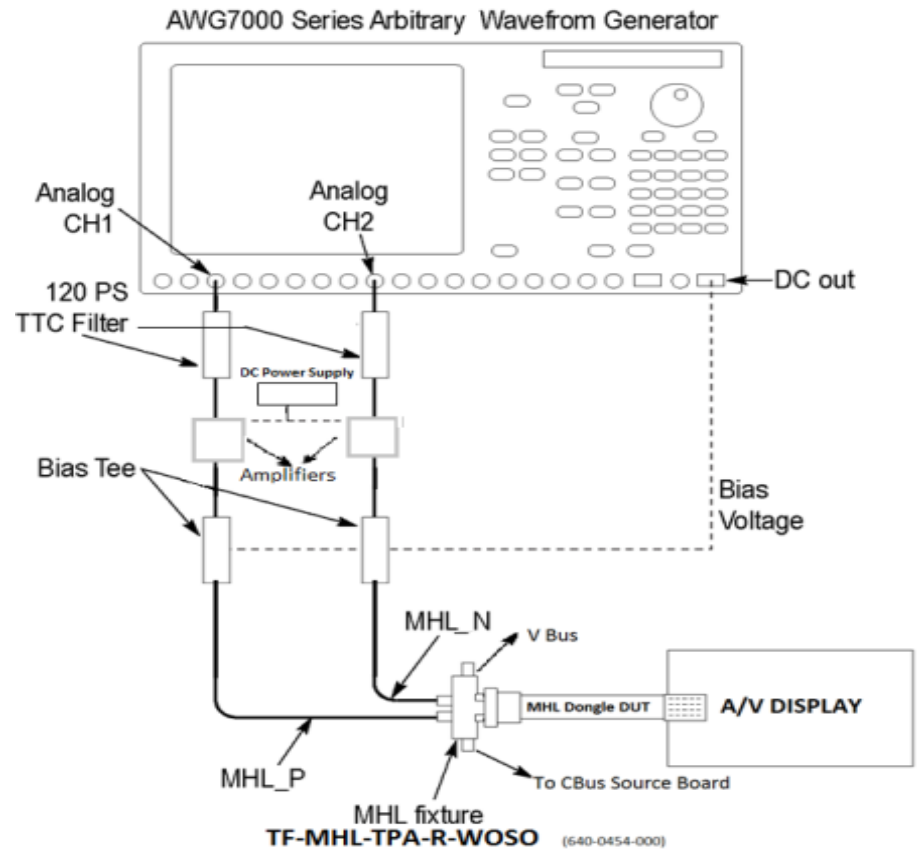
Tektronix MHL Solution Setup: Simple and Easy Sink and Dongle Min/Max Testing -2

Setup based on Direct Synthesis Capability of AWG7122C Series

Test Setup for Sink Min/Max Tests



Test Setup for Dongle Min/Max Tests



MHL 2.1 tests- Detailed information on Sink/Dongle Electrical Tests

Physical Layer Tests

MHL Receiver Tests

- 4.1.1.2 Input Signal DC Voltage Level Tolerance
- 4.1.1.3 Input Signal Minimum and Maximum Swing Voltage Level Tolerance
- 4.1.1.4 Intra Pair Skew Tolerance
- 4.1.1.5 Jitter Tolerance in Normal mode
- 4.1.18 Jitter Tolerance in PackedPixel mode

MHL Dongle Tests

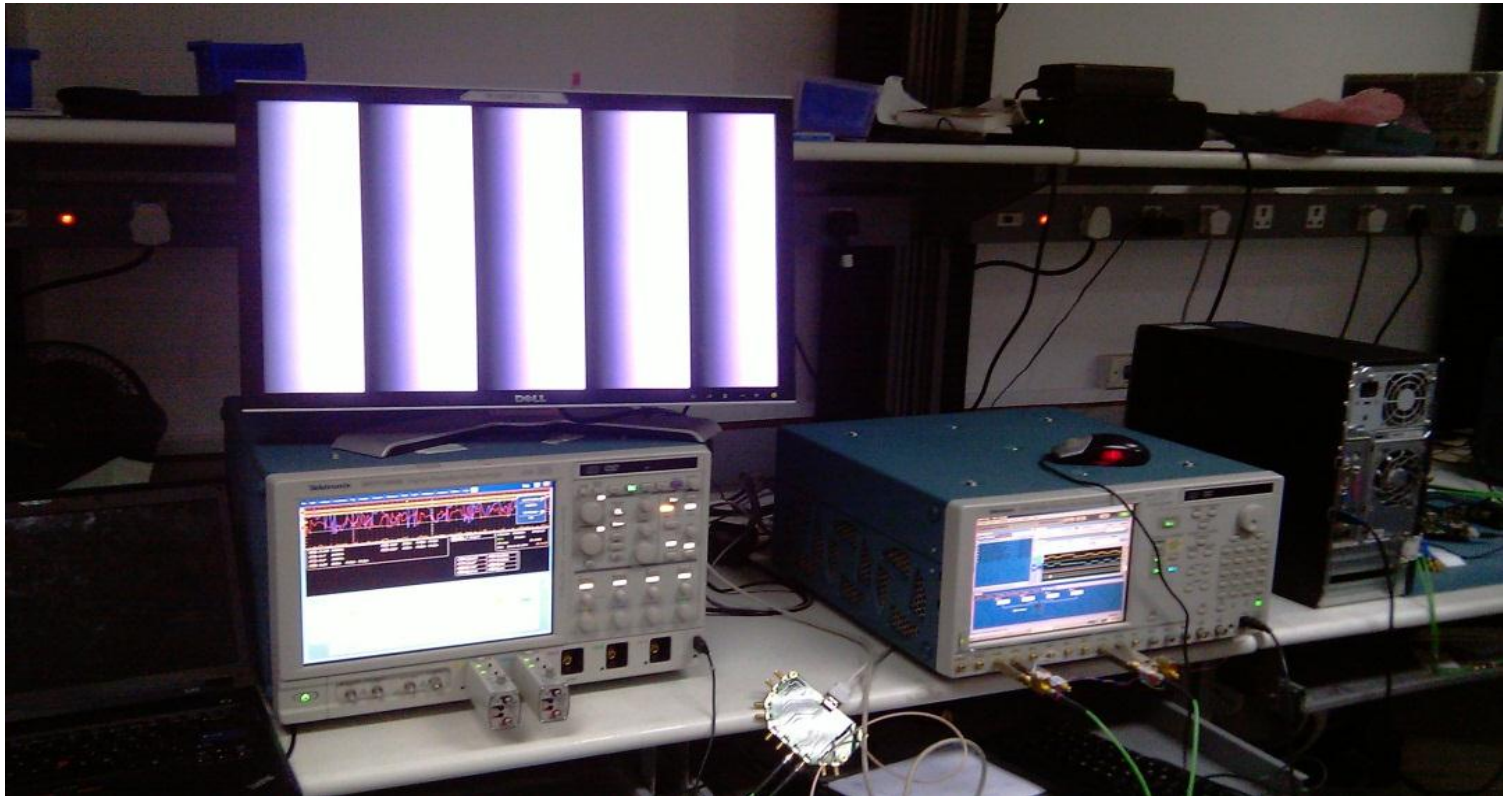
- 5.1.1.1 Input Signal Single-ended Voltage Level Tolerance
- 5.1.1.2 Input Signal Minimum and Maximum Swing Voltage Level Tolerance
- 5.1.1.3 Intra Pair Skew Tolerance
- 5.1.1.4 Jitter Tolerance in Normal mode
- 4.1.1.9 Jitter Tolerance in PackedPixel mode

The CTS 2.1 mandates Sink Jitter Tolerance test to be performed with and without Cable emulator.

Tektronix Actual Sink and Dongle Setup: Simple and Easy A Snapshot

Setup based on real-time oscilloscope and Direct Synthesis capability of AWG7122C Series.

1 BOX RX solution for Electrical and Protocol Testing



Tektronix MHL 2.1 Cable Test Solution-Electrical

Tektronix MHL 2.1 Cable Electrical Test

The screenshot displays the TekExpress MHL software interface for configuring an MHL 2.1 Cable Electrical Test. The window title is "TekExpress MHL - (Untitled)*".

Navigation Panel (Left):

- Setup (highlighted)
- Status
- Results
- Reports

Test Progress (Vertical Bar):

- 1 DUT
- 2 Test Selection (checked)
- 3 Acquisitions
- 4 Preferences

Main Configuration Area:

- DUT ID: DUT001
- Device: MHL Physical Layer Solution
- Suite: MHL Cable Test
- Version: CTS 1.3/2.1
- Acquire live waveforms (Using Pre-Defined Patterns) Use pre-recorded waveform files
- View: Compliance

Device Profile:

- Pixel Mode: Packed Pixel
- Refresh Rate: 60 Hz
- Packed Pixel High Data Rate (Gbps): 2.97

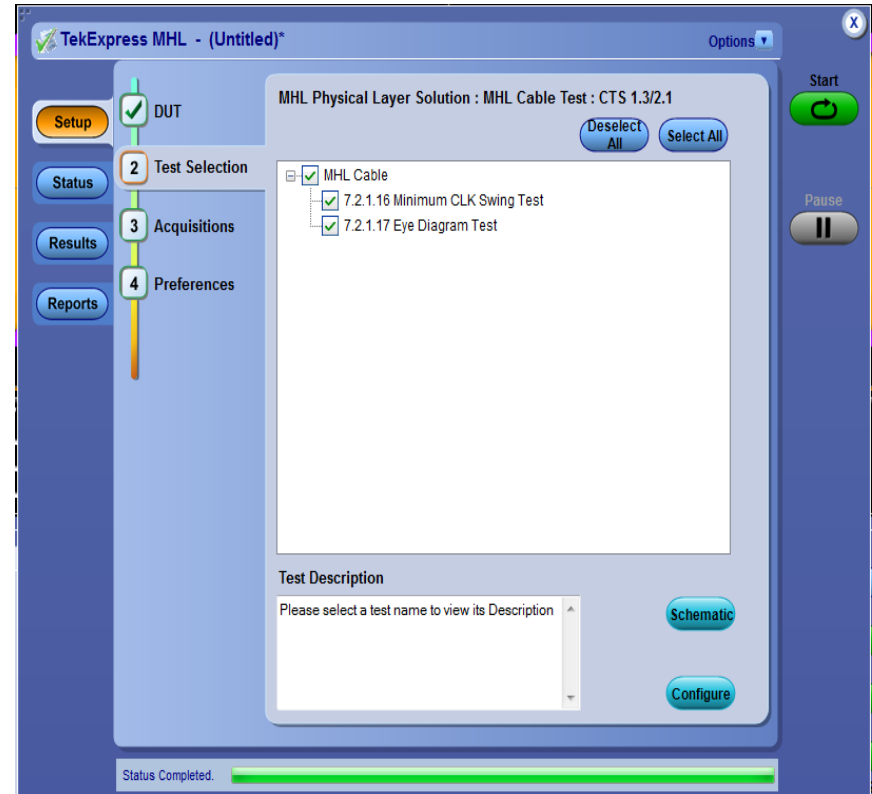
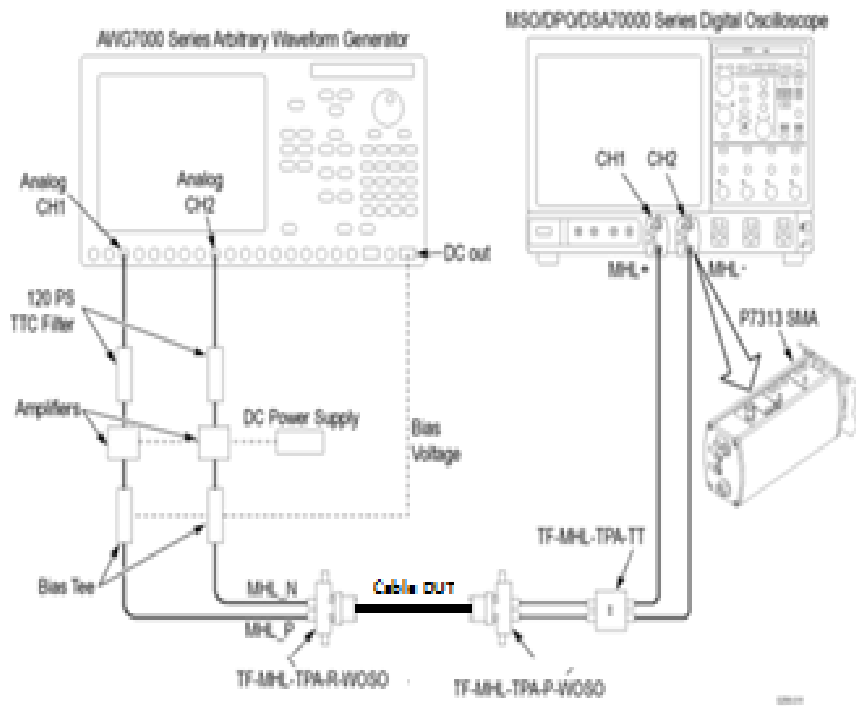
Control Panel (Right):

- Start (green button)
- Pause (grey button)

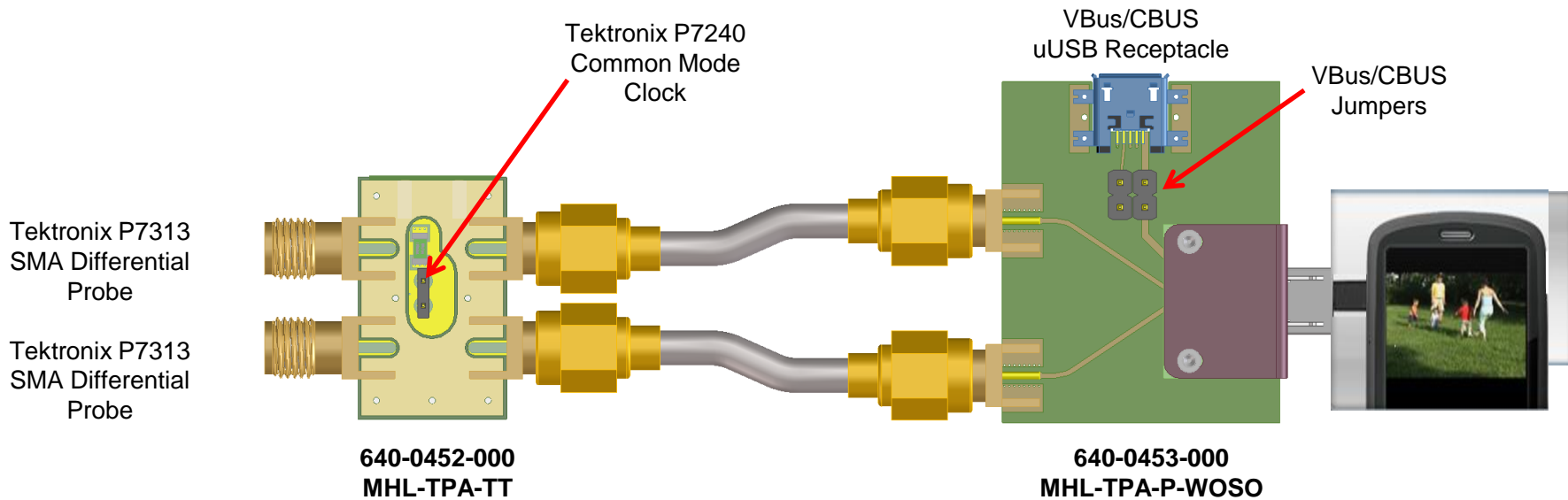
Status Bar (Bottom):

Status Completed.

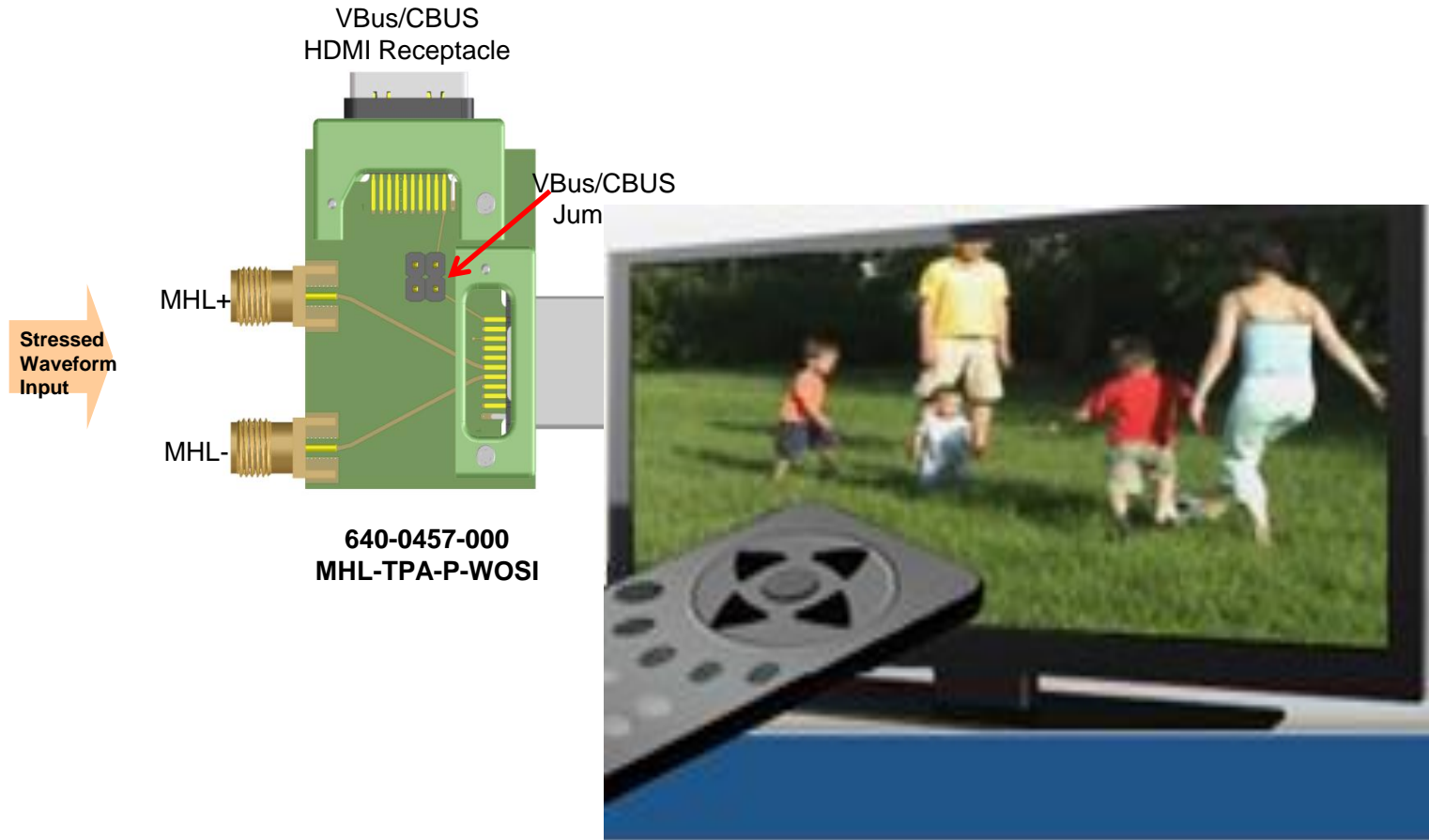
Tektronix MHL 2.1 Cable Electrical Test Selection



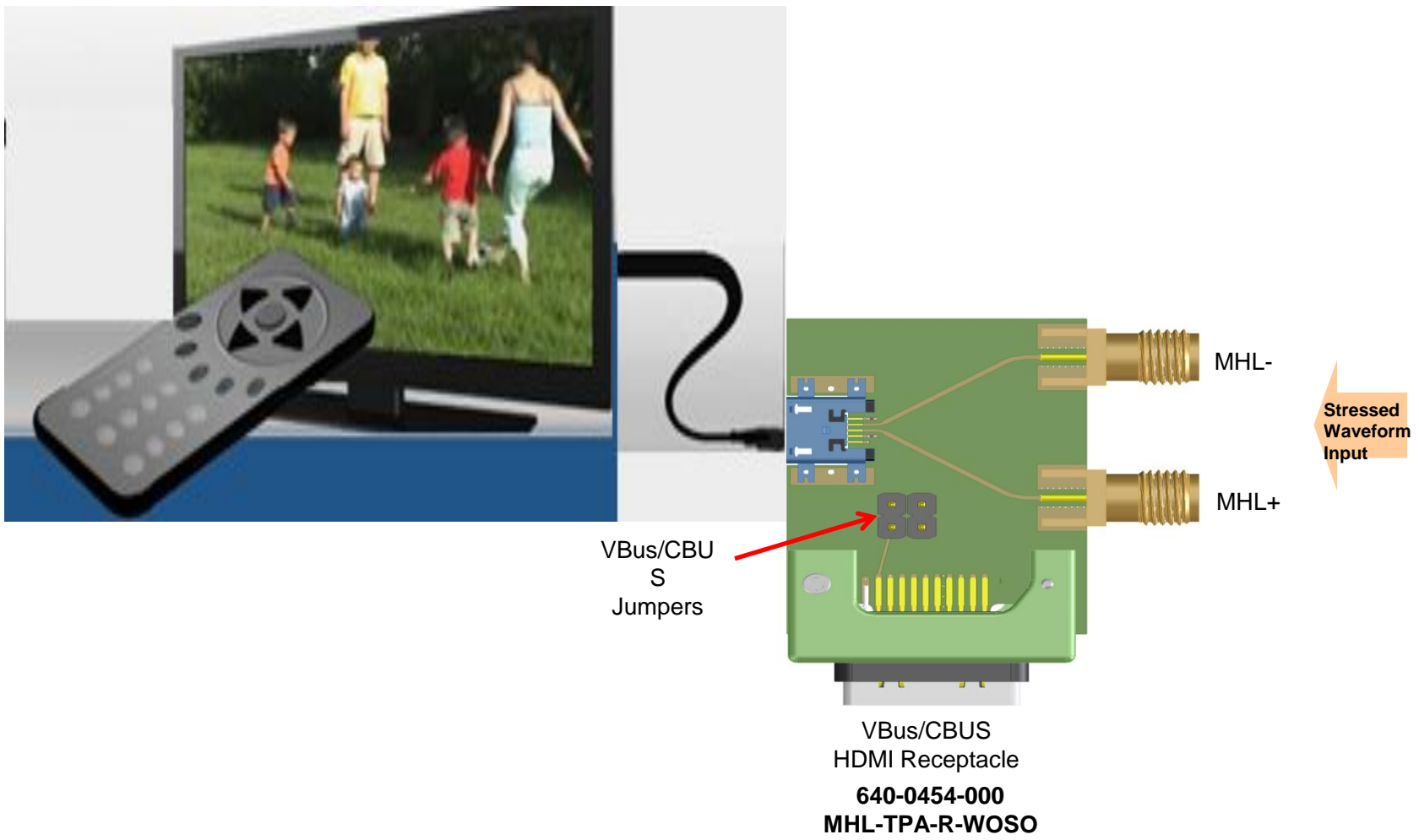
Wilder Fixtures: Tektronix MHL Source Testing Setup



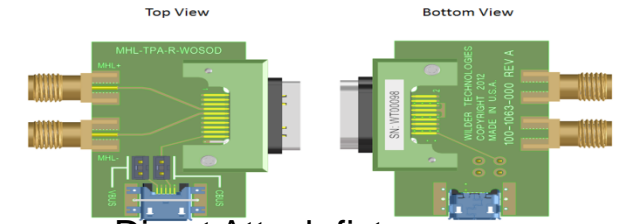
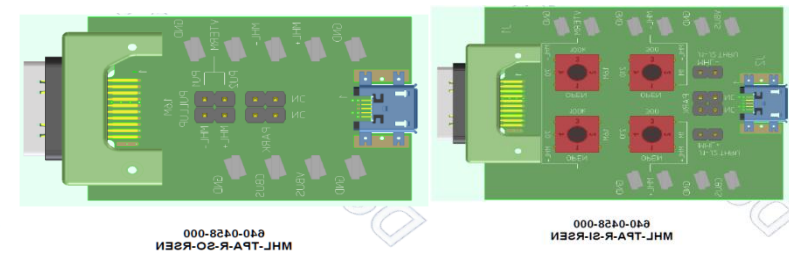
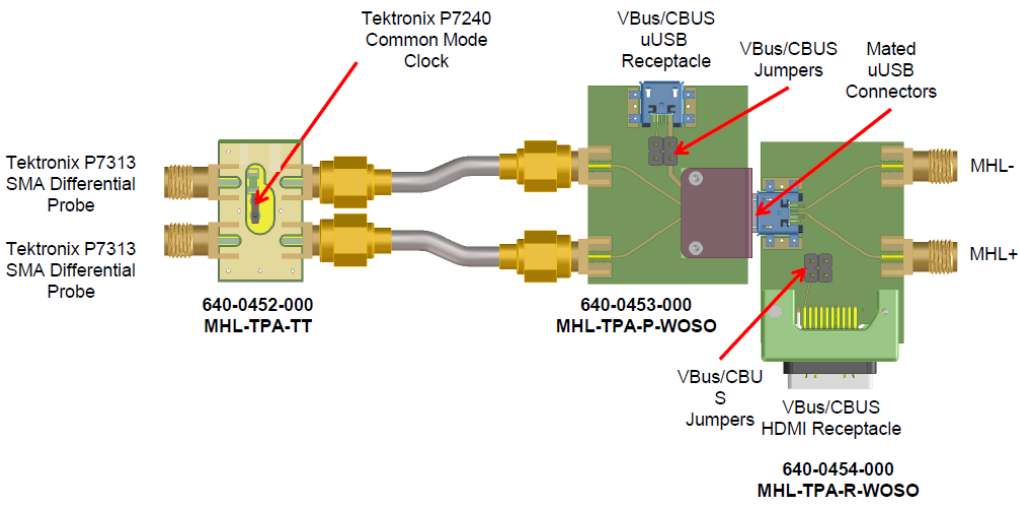
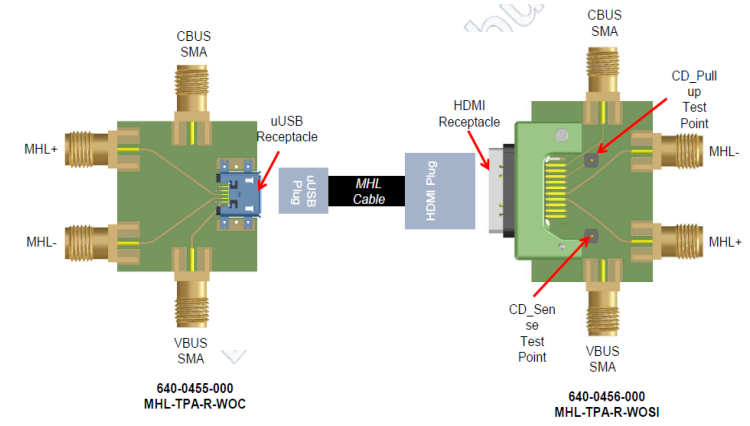
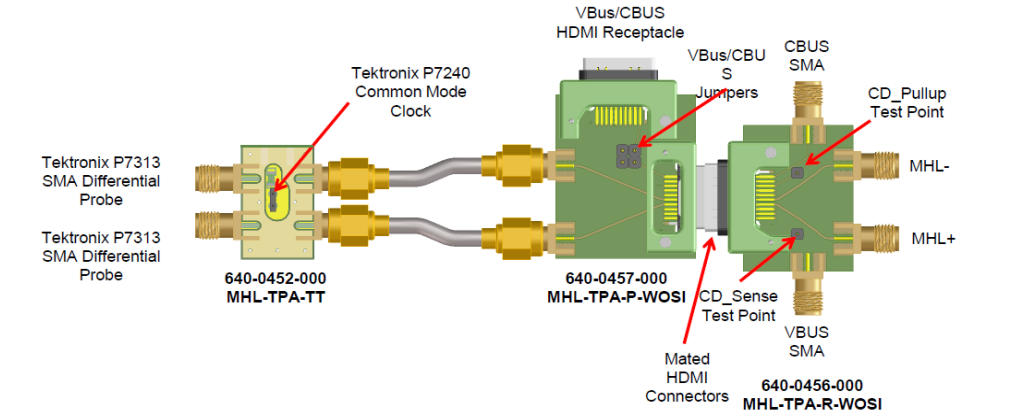
Wilder Fixtures: Tektronix MHL Sink Testing Setup



Wilder Fixtures: Tektronix MHL Dongle Testing Setup



Wilder Fixtures for Tektronix MHL Testing



Direct Attach fixture

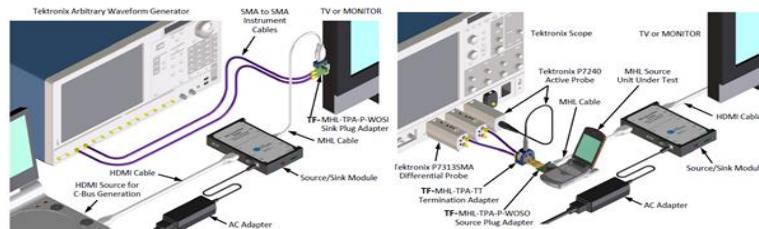
MHL-TPA-R-WOSOD 110-1063-000

Wilder Fixtures for Tektronix MHL Testing

- Source Sink Board- A low cost alternative to C-Bus analyzer(TF-MHLCBS2-SOSI)
 - The low cost SOSI board can be used for the following :
 - Source tests Electrical. 3.1.1.1 to 3.1.1.12(excluding 3.1.1.13)
 - Source System Tests: 3.2.2.1 to 3.2.2.3 ; 3.2.3.1 to 3.2.3.4 ; 3.2.4.1 to 3.2.4.3
 - Sink Tests Electrical: 4.1.1.1 to 4.1.1.6(excluding 4.1.1.7)
 - Sink System tests: 4.2.1.1 to 4.2.1.2; 4.2.2.1 to 4.2.2.3; 4.2.3.1 to 4.2.3.2
 - Dongle tests: 5.1.1.1 to 5.2.1.2 (excluding 5.1.1.7 and 5.1.1.8) ; 5.2.2.1 to 5.2.2.3; 5.2.3.1 to 5.2.3.2
 - This low cost board cannot be used for C-Bus tests: id 3.3.x.x and 4.3.x.x.



Source: Wilder SOSI user manual



SOSI board used as C-BUS Source board in Sink setup SOSI board used as C-BUS Sink board in Source setup

- Cable Calibration Fixture - TF-MHL-TPA-CBC

Tektronix MHL Solution

- DPO/DSA/MSO 70000 B/C Series Real-time Oscilloscope with **BW ≥8GHz**
- MHL Compliance software – **Option MHD**
- Innovative MHL Protocol Software – **TEK-PGY-MHL-PA-SW**
- Probes- **Qty.2 - P7313SMA** and **Qty.1 – P7240**
- MHL Test fixture- **Available from Tektronix.**
- AWG7122C with Opt 01,02 or 06 and 08 for the innovative direct Synthesis based MHL Rx/Dongle testing
- C-Bus Sink and Source Board is needed and is available from Simplay Labs. Look out for new C-Bus Source Sink board from Tek.
- DSA8200 or Equivalent with 80E03/80E04 and I-Connect Software for MHL cable testing (performed manually using MOIs)

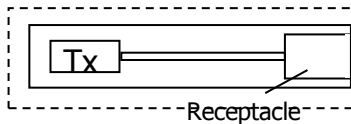
For Demos and Placing Orders - Contact Local Tektronix Account Managers

Tektronix MHL 2.1 Solution

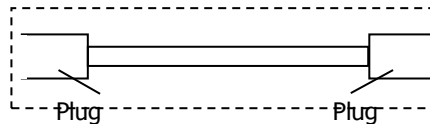
- Tektronix Offers Complete MHL 2.0 Solution.
- Industry's first 1BOX solution for Physical and Protocol testing.
 - Seamless transition between Protocol and Phy layer
 - Simple setup leads to faster test times



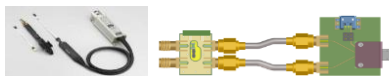
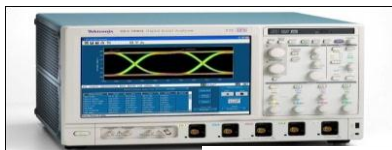
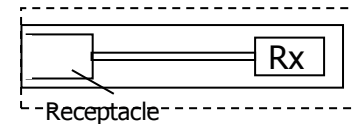
Source Devices



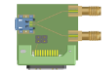
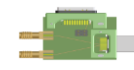
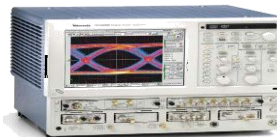
Cable Assemblies



Sink Devices



Electrical and Protocol

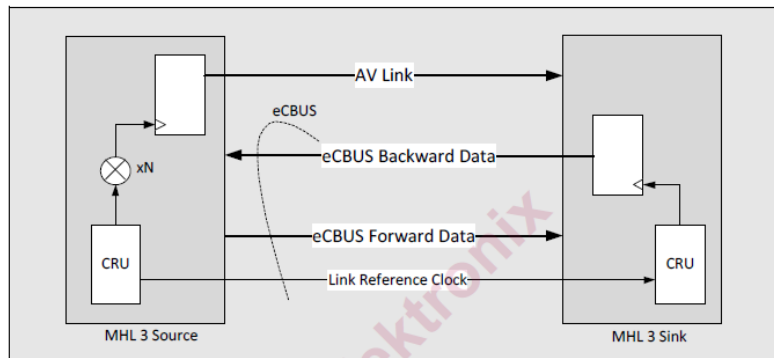
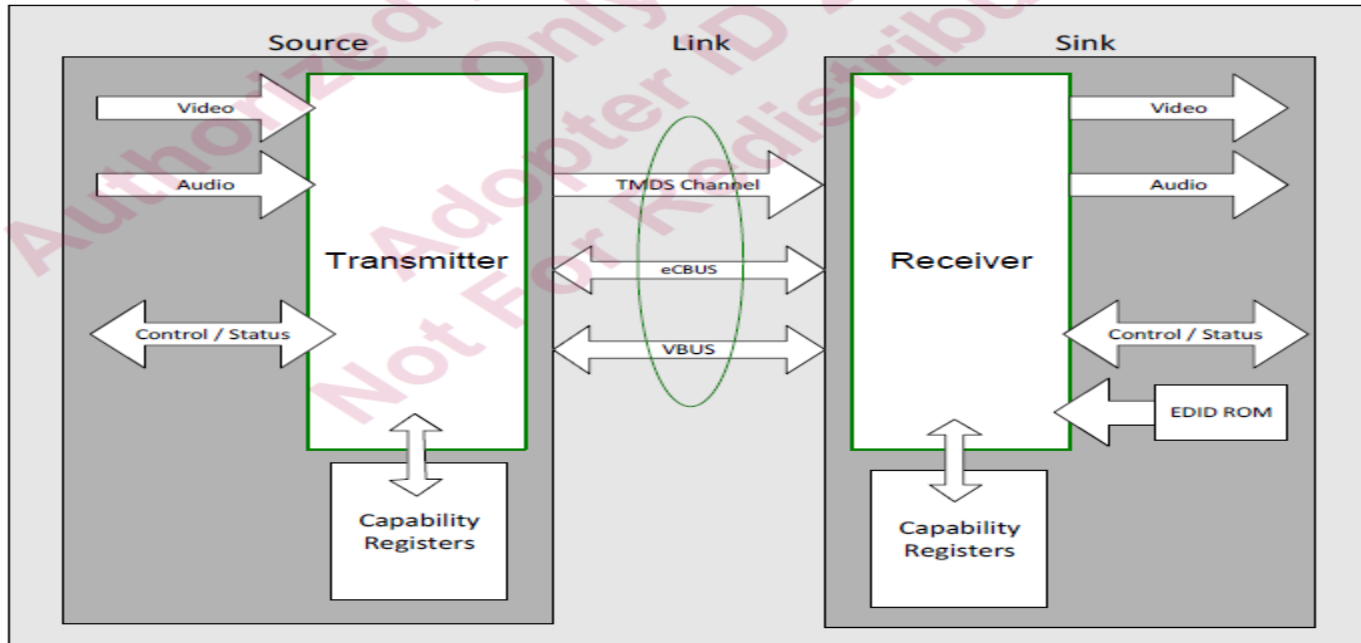


Electrical and Protocol

What Next in MHL--- MHL 3.0

Version	Highlights
3.0	<ul style="list-style-type: none"><i>Add eCBUS, with link clock separate from TMDS pair.</i><i>Add 6Gbps TMDS pair, to support High-end Video modes such as UltraHD.</i><i>Add eCBUS-S at 75Mbps; eCBUS-D at 600Mbps as virtual channels.</i><i>Add sections for discovery, including compatibility with MHL 1 and MHL 2 devices.</i><i>Add support for HDCP 2.2.</i><i>Add support for HID devices across eCBUS virtual channel.</i><i>Add support for data tunneling across eCBUS virtual channel.</i><i>Add support for xvYCC Enhanced Colorimetry. (Section 5.7.3.1)</i><i>Add RBP, RBPK, RBPE sub-commands for remote buttons. (Section 13.4)</i><i>Add ATT commands to assist in multi-view modes. (Section 7.9)</i><i>Add support for Multi-View, to one Sink with 1-3 downstream devices. (Section 5.11)</i><i>Add specific support for audio data tunneling over eCBUS. (Section 14.2)</i><i>Add support for Dolby True HD Master audio, and DTS-HD audio. (Section 6.9)</i><i>Add support for BIST commands. (Section 15)</i><i>Add PLIM2 for higher current charging with MHL 3 devices. (Table 7-30)</i><i>Require WRITE_BURST support in Dongles.</i>

MHL 3.0- An insight



Combinations of TMDS Speed and Link Reference Clock Speeds

Link Reference Clock	AV Link Speed	N
$F_{SE_MHL_CLK}$	1.5Gbps	20
	3.0Gbps	40
	6.0Gbps	80
$F_{DF_MHL_CLK}$	1.5Gbps	10
	3.0Gbps	20
	6.0Gbps	40

High-Speed Serial Data Test Solutions

Design

Verification

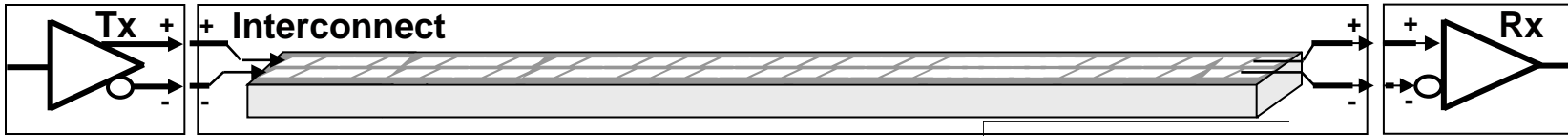
Compliance Test



GbE DisplayPort

HDMI™

MHL ...



Real-time Scopes



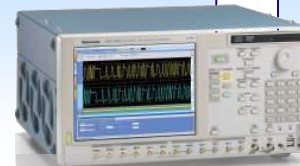
System Integration
Digital Validation & Debug

Logic Analyzers



Transmitter Testing

Receiver Test
Margin Testing



Probing
Fixtures



Arbitrary Waveform Generator

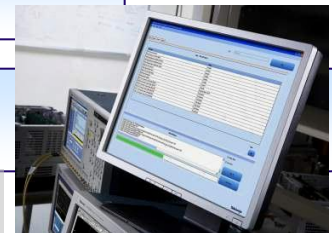
Interconnect Test

Sampling Scopes



Compliance Test

Compliance Test Software





Tektronix®