最新高速串行接口的规范以及测试方法

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2014.10
Agenda

- Industry Trend
- HDMI – Introducing new HDMI 2.0
- MHL – HDMI for Mobile
- MIPI – D-Phy to M-Phy, C-Phy is coming soon
High-Speed Serial Test
Trends and Implications

Industry/Technology Trends

- 100 GbE is becoming more relevant as data centers and communications networks ask for more bandwidth
- SAS 12G is needed by data centers for efficient transport of internet traffic (YouTube, Facebook, Smart Phone, etc)
- High-Speed FPGA's are increasing in complexity to support early designs above 28Gb/sec
- Proliferation of 10+ Gb/sec signaling in the communications network

Implications

- Closed data eyes requiring new techniques for transmitter and receiver equalization
- Higher data rate signals have less margin – requires de-embedding
- Edge/Slew rate speeds are difficult to characterize
- New Jitter Separation Measurements are required
- Complex 8b/10b signaling difficult to verify in PHY
HDMI – Introducing new HDMI 2.0
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 Basics

HDMI Structure After 1.4

- Video
- Audio
- Control/Status

HDMI Transmitter

- TMDS Channel 0
- TMDS Channel 1
- TMDS Clock Channel

Video/Audio

HDMI Receiver

- Video
- Audio
- Control/Status

Display Data Channel (EDID / HDCP)

CEC

HDMI Ethernet Channel

HPD Line

Utility Line

EDID ROM

CEC

HEAC

detect

SalesU 2014 - SOL210 HDMI Solutions
HDMI Technology and solution status

- Over 1000+ adopters till date
- 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)

Source: HDMI LLC

SalesU 2014 - SOL210 HDMI Solutions
HDMI Market overview

Source: HDMI Forum
Tektronix HDMI 1.4b solution- Approved in CTS 1.4b

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
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 sub-group

- HDMI Forum released HDMI 2.0 specifications on Sept 4th 2013
  - Target
    - CTS 2013 Q4
    - MOI Q4 2013
HDMI 2.0 features

- Uses same Cat 2 Cable and HDMI 1.4b connector

- Support 4K 2K 4:4:4 60 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 MUST for rates >340Mcsc.

- Direct Attach Device support

- HDMI 2.0 products must pass HDMI 1.4 CTS testing
Ecosystem update

- Same HDMI customers for Source Devices, Sink Devices, Cable, Repeater

- Direct Attach Devices – New category devices
  - Roku
  - Apple TV

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

Cable Assemblies
- Cables

Sink Devices
- TVs, Monitors, Repeaters, etc.
HDMI 2.0 Solutions Portfolio
(Source setup, Sink Setup, Protocol Decode, Probes)
Rise time Needs

- HDMI 1.4b, should be capable of measuring 75 psec, but no word about the System Rise time.
- **HDMI 2.0** should be capable of measuring 42.5 psec, but no word about System Rise time.

- The Error contribution of RT measurement due to System and DUT generally not accounted when we refer to specification.
What is the system bandwidth needed to measure 42.5 (20-80%) psec or less DUT Rise time

- System bandwidth should be around \((42.5/1.5) \) 28 psec
- Scope bandwidth of 16 Ghz and 16 Ghz DSP enhanced probe has System Rise time of about 23 psec. It can measure the DUT Rise time of 42.5 psec with error of 1%. And can measure DUT Rise time of 37 psec with error of 7%.
- We can indicate Pass or fail confidently only when the System bandwidth is close to 16 Ghz scope.
- Is it fact for all scope vender ??
  - Spec says it should not be less than 42.5 psec.
  - Max Rise time is limited by Eye diagram slope.
  - Both scope and Probe rise time cannot be less or equal to the DUT rise time because it can measure the signal rise time accurately only if DUT RT is slower than system rise time by 1.5 X times.
- How it is handled in HDMI 1.4b today???
  - We recommend 8Ghz scope and 13 Gz probe, then system rise time is 38 psec which is close 2X faster than 75 psec
Conclusion

- 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

Note: We also support 12.5GHz BW scope for HDMI 2.0 but will have a 10% error in RT/FT measurements
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 TMDS Electrical – 340-600Mcsc – $V_L$
Test ID HF1-2: Source TMDS Electrical – 340-600Mcsc – $T_{RISE}, T_{FALL}$
Test ID HF1-3: Source TMDS Electrical – 340-600Mcsc – Inter-Pair Skew
Test ID HF1-4: Source TMDS Electrical – 340-600Mcsc – Intra-Pair Skew
Test ID HF1-5: Source TMDS Electrical – 340-600Mcsc – Differential Voltage
Test ID HF1-6: Source TMDS Electrical – 340-600Mcsc – Clock Duty Cycle
Test ID HF1-7: Source TMDS Electrical – 340-600Mcsc – Clock Jitter
Test ID HF1-8: Source TMDS Electrical – 340-600Mcsc – Data Eye Diagram
Test ID HF1-9: Source TMDS Electrical – 340-600Mcsc – Differential Impedance
Source Eye Diagram Test

Include Reference Cable Emulator (s4p) and Reference Cable Equalizer

HDMI Source

HDMI Plug Fixture with EDID Emulator

SMA Pair Cable

Tektronix Oscilloscope
DPO/DSA/MSO70000 Series ≥ 16GHz

SalesU 2014 - SOL210 HDMI Solutions
TP2 Source Eye for HDMI 2.0 6G signal

Single End Input eye rendered at Tek lab
HDMI 2.0 Tx Compliance Software
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 > 3

- 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 HF2-4: 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 2# AWG7122C (w/ Opt 01,02/06,08) OR 2# 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)

Tektronix AWG70002A

Include Reference Cable Emulator (s2p)

112ps Delay Line (Emulate Cable Skew)

SMA Pair Cable

HDMI Plug Fixture
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
HDMI 2.0 Equipment List

- DPO/DSA /MSO 70004C/B/D/DX with 10XL-Minimum 16GHz BW (we also support 12.5GHz BW scope) - needs Opt DJA, Opt SR-EMBD and SR-CUST.
  - Option HDM
  - Option HDM-DS

- AWG70002A With Option 01, 03 and 225
  - Rack Mount Kit
  - AFG3102/C
  - OR
  - AWG7122C with Option 01, 02/06 and 08
  - AFG3102/C

- HDMI 2.0 Fixture set

- Termination Fixture (TF-HDMI-TPA-T)

- P7313SMA probes –Quantity 4

- HDMI DS accessory kit (Same 1.4b DS accessory kit is good enough)

- Programmable Dual Channel Power supply
MHL – HDMI for Mobile
Welcome MHL Adopters
BizLink Technologies, Inc.
www.bizlinktech.com
Cable Assemblies and Wiring Harnesses
Compal Electronics Inc.
www.compal.com
Electronics manufacturer of notebook computers and monitors
Explore Microelectronics, Inc.
http://www.epmi.com.tw
Fabless company developing high-speed interface ICs
Fairchild Semiconductor
www.fairchildsemi.com
Delivers semiconductor solutions for power and mobile designs
Hosiden Corporation
www.hosiden.com
Manufactures and sells electronic components, electromechanical parts and LCD elements
Johnson Component and Equipment Co., Ltd.
www.jcecable.com
Cable Manufacturer
Niketech Electronic Corporation
www.niketech.com.tw
Provider of connectors for the electronics industry
Parade Technologies, Inc.
www.paradetech.com
Develops and supplies advanced and cost-effective high-speed display interface solutions
Sumitomo Electric Industries, Ltd.
global-sei.com
Designs, manufactures and sells cable and components and advanced electronic devices
Sunplus Technology Co., Ltd.
www.sunplus.com
Provider of multimedia IC solutions
Sure-Fire Electrical Corporation
www.sure-fire.com.tw
Global OEM/ODM supplier of cables, connectors and devices
Synopsys
www.synopsys.com
Provider of electronic design automation (EDA) software, IP and services
Tektronix
www.tek.com
Test, measurement and monitoring solutions
YFC-BonEagle Electric Co., Ltd.
www.cables.com.tw
Manufactures power cord sets, LAN cable, patch cords and networking accessories
Tektronix is a Contributor Adopter for MHL CTS

148 Adopters till now and growing
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 Q1 2011, 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 is just announced.

COMPLETE TEKTRONIX SOLUTION APPROVED in CTS 1.1, CTS 1.2, CTS 2.0 and CTS 2.1 solution

- Tektronix is a Contributor adopter and actively involved in defining the CTS 2.1.
MHL Encoder/Decoder Overview – 24 bit mode

Source: MHL 1.1 specification

MHL Encoder/Decoder Overview – 24 bit mode

Source: MHL 1.1 specification
MHL Encoder/Decoder Overview – PackedPixel mode

Source: MHL 1.1 specification
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 2.1 Transmitter Solution

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

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 Solution

- DPO/DSA/MSO 70804B/C Series Real Time Oscilloscope with BW ≥ 8GHz
- MHL Compliance Software – Option MHD
- Innovative MHL Protocol Software from Third party – TEK-PGY-MHL-PA-SW
- Probes – P7313SMA (two) and P7240 (one)
- MHL Test Fixture including Direct Attach 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 Tektronix
- DSA8200 or Equivalent with 80E03/80E04 and I-Connect Software for MHL cable testing ( performed manually using MOIs)

Please contact local Tektronix account managers for further details.
Tektronix MHL 2.1 Tx Solution with Direct Attach Test Support
Tektronix MHL Tx Setup

MHL Differential and CM Test Setup
6 tests

Single Ended and Intra Pair Skew Test Setup
6 Tests

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

Test Description

This test confirms that common-mode output voltage swing amplitude is within the specified limits when the source device operates in normal mode.
MHL 2.0 Tests – Detailed Information on MHL 2.0 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 $V_{DFSWING}$
- 3.1.1.5 Common Mode Output Swing Voltage $V_{CMSWING}$
- 3.1.1.6 Differential Rise and Fall Times $T_{R,CF}, T_{F,CF}$
- 3.1.1.7 Common Mode Rise and Fall Times $T_{R,CM}, T_{F,CM}$
- 3.1.1.8 Differential Intra Pair Skew $T_{SKEW,CF}$
- 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)
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
Tektronix MHL Protocol Analyzer - Seamless PHY and Link Layer Testing
Advanced Analysis and Debug of MHL

- MHL Compliance Software provides the user defined mode which can be used for advanced analysis needs as it allows changes to the settings.

- Clock Jitter and Data Eye leverages DPOJET so we can use DPOJET for debug needs.

- Option MHD allows saving of sessions file which has all the wfms of the session which can be used for debug needs.

- On the Protocol analyzer we have wfms saved on scope hard disk to enable advanced debug and the PA SW provides exhaustive information on why a test failed.
Tektronix MHL 2.1 Rx Solution with Direct Attach Test 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
MHL 2.1 Tests – Detailed Information on Sink/Dongle Electrical Tests

The CTS 2.1 mandates Sink Jitter Tolerance test to be performed with and without Cable emulator.
Tektronix Actual Sink and Dongle Setup – Simple & Easy
A Snapshot

Setup based on real-time oscilloscope and Direct Synthesis capability of AWG7122C Series
Tektronix MHL 2.1 Cable Electrical Test
Tektronix MHL 2.1 Cable Electrical Test Selection
## MHL Fixture Kits

<table>
<thead>
<tr>
<th>Wilder P/N</th>
<th>Wilder Model #</th>
<th>Tektronix nomenclature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>640-0475-000</td>
<td>MHL-TPA-TEK(Complete MHL Fixture kit w/ Cbus Board)</td>
<td>TF-MHL-TPA-TEK(Complete MHL Fixture kit w/ Cbus board)</td>
<td><strong>MHL Test Kit</strong> includes 640-0452-000 thru 640-0459-000 and 640-0485-000 with associated power cords per country code</td>
</tr>
<tr>
<td>640-0476-000</td>
<td>MHL-TPA-TEK-SO(Source Fixture Only Kit)</td>
<td>TF-MHL-TPA-TEK-SO(Source Fixture Only Kit)</td>
<td><strong>MHL Source Test Kit</strong> includes 640-00452 and 640-0453-000</td>
</tr>
<tr>
<td>640-0477-000</td>
<td>MHL-TPA-TEK-SI(Sink Fixture Kit)</td>
<td>TF-MHL-TPA-TEK-SI(Sink Fixture kit)</td>
<td><strong>MHL Sink Test Kit</strong> includes 640-0452-000, 640-0456-000, 640-0457-000</td>
</tr>
<tr>
<td>640-0478-000</td>
<td>MHL-TPA-TEK-DG(Dongle Fixture Kit)</td>
<td>TF-MHL-TPA-TEK-DG(Dongle Fixture Kit)</td>
<td><strong>MHL Dongle Test Kit</strong> includes 640-0452-000, 640-0453-000, 640-0454-000</td>
</tr>
<tr>
<td>640-0479-000</td>
<td>MHL-TPA-TEK-CB(Cable Fixture Kit)</td>
<td>TF-MHL-TPA-TEK-CB(Cable Fixture Kit)</td>
<td><strong>MHL Cable Test Kit</strong> includes 640-0455-000, 640-0456-000</td>
</tr>
<tr>
<td>640-0480-000</td>
<td>MHL-TPA-TEK-RSEN(RSEN Kit)</td>
<td>TF-MHL-TPA-TEK-RSEN(RSEN Kit)</td>
<td><strong>MHL Rx Sonso KIt</strong> includes 640-0458-000 and 640-0459-000</td>
</tr>
</tbody>
</table>
Wilder Fixtures - Tektronix MHL Source Testing Setup

Tektronix P7240 Common Mode Clock

Tektronix P7313 SMA Differential Probe
Tektronix P7313 SMA Differential Probe

640-0452-000 MHL-TPA-TT

640-0453-000 MHL-TPA-P-WOSO

VBus/CBUS uUSB Receptacle

VBus/CBUS Jumpers

Tektronix P7240

KEITHLEY
A Tektronix Company
Wilder Fixtures - Tektronix MHL Sink Testing Setup

- HDMI Plug
- VBus/CBUS
- HDMI Receptacle
- 640-0457-000 MHL-TPA-P-WOSI
- MHL+ Jumpers
- Stressed Waveform Input

TV display with children running in a field.
Wilder Fixtures - Tektronix MHL Dongle Testing Setup
Wilder Fixtures for Tektronix MHL Testing
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.

- **Cable Calibration Fixture - TF-MHL-TPA-CBC**
Tektronix MHL 2.1 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
MIPI – D-Phy to M-Phy, C-Phy is coming soon
MIPI Technologies Overview

Example of a Mobile Platform

Source: MIPI Alliance
Tek Strategic Involvement
With MIPI Alliance & UNH-IOL

- Tektronix is a **Contributor Member** of the MIPI Alliance
- M-PHY Tx/Rx CTS Test Document “**Co-Authored**” by Tektronix
- Tektronix has a close working relationship with UNH-IOL.
- **Joint Press-Announcements** of Tek with MIPI Alliance and UNH.
  
  - "As an active MIPI contributor, Tektronix products speed the assessment of D-PHY and M-PHY performance and signal integrity. Tektronix is helping to simplify physical-layer test and validation."
    - Joel Huloux, Chairman of the MIPI Alliance, Sept’2011
  
  - http://www2.tek.com/cmswpt/prdetails.lotr%3Fct%3DPR%26cs%3DNews%2BRelease%26ci%3D17639%26lc%3DEN&urlhash=HZu6
  - “…Tektronix spurring the adoption of D-PHY and M-PHY specifications..”
    - Joel Huloux, Chairman of the MIPI Alliance, Sept’2010
  
  - “Tektronix has been supportive of UNH-IOL’s collaborative efforts of physical layer measurement methodologies”
    - Andy Baldman, MIPI Interop - R&D Technical Staff, UNH-IOL, Sept’2010
Tek Strategic Involvement
Tek Tools listed on MIPI Official Webpage, UNH Webpage & CTS Spec

UNH (University of New Hampshire) is a 3rd party test house using Tektronix setup
What is D-PHY?

- It’s a PHY standard for interfacing Camera (CSI) & Display (DSI)
- Two modes of transmission
  - High Speed (HS) and Low Power (LP)
- Modes are mixed during the operation
  - Transitions from LP to HS and back to LP on the fly
- Maximum Data Rate
  - High Speed mode: 80 Mbps – 1 Gbps, Typically at ~500 Mbps.
  - Low Power mode: Up to 10 Mbps
- Bus termination
  - 50 ohms in HS
  - Hi-Z in LP
D-PHY Testing Challenges

- Logo testing is not required, but Optional.
  - MIPI is Chip-to-Chip/ Chip-to-Peripheral interface, similar to a DDR bus.
  - Mobile Phones do not need compliance logo, unlike USB/SATA devices.

- No two MIPI devices are the same
  - Variable Data Rates
  - Up to 4 lanes of Data traffic,
  - Multiple different data formats
  - Specification enables custom limits.

- Characterization is significantly important
  - Mobile OEMs select the suppliers based on characterization reports.

- Several measurements (Total 49) to be performed.
  - Clock Lane
  - Data Lane
  - Clock-Data Timing
D-PHY Tx : Opt.D-PHYTX Conformance Test Solution

  - TekExpress option for Fully-Automated testing
  - Provides Conformance and Characterization Testing
  - Runs on 7K/C and 70K/B/C/D scopes
  - Opt.TEKEXP is Pre-Requisite

- **Differentiation**
  - **Un-parallel** Automation (Auto-Cursors)
  - **100%** Widest Test Coverage
  - Fully-Automated for Multi-lane DUTs
  - Fully-Automated Temperature Chamber
  - Conformance to Latest CTS (v1.0)
  - Based on Latest Base spec (v1.0)

- **Value proposition**
  - Custom-limits/ Limits-Editing
  - Test Reports with Pass/Fail summary, margins, & ”Zoom-in” Waveform Captures
  - Tek 3.5GHz scope is the minimal configuration for accurate testing
  - D-PHY extension spec (1.5G) ready
Multi-lane Automation Setup using Keitley S46-6666A/ any RF Switch

Only solution for Single-button automation of “multi-lane” DUTs.

 Provision to Load Filter-files for Temperature Chamber or Channel De-embedding

D-PHY Tx : Opt.D-PHYTX Features

S46-6666A Switch

Tektronix Oscilloscope

Socket Cable XL (020-2958-00) with High Temperature Tips (020-2958-00) or other on F70xx
D-PHY Tx : Opt. D-PHYTX Features

Test Reports with "ZOOM-IN" screenshots of the cursors placement for each test.

Switch between Automatic and Manual cursor placement. In Automatic mode, software can find the LP/HS regions automatically. Switch to Manual for debug or if your signal is too noisy.

Simultaneous Acquisition

- Probe using Analog, Digital or Mixed Channels
- Simultaneous probing of DSI & CSI using MSO channels
- Working on multi-lane support, using high performance MSO digital channels
- Supported on all 7KC, 70KC and MSO70K scopes. (Win7-OS only)
  - Option key bit #25
- Software installed as part of TekScope firmware v6.1.2.4 or later.
  - Browse to TekScope Menu --> Vertical --> Bus Setup --> Select Bus Type as Serial-- > Select MIPI DSI or CSI from the drop down list.

Errors/ Warnings indicated in Decode waveform & Event Table

- Missing Sync
- Checksum Error
- ECC error

Errors and Warnings indicated in event table
D-PHY Tx & Decode: Recommended Test Setup

www.Tek.com/MIPI

- **Scope**
  - DPO7354/C or DPO/DSA/MSO70404/B/C/D or higher for rise time accuracies

- **Probes**
  - For 7Ks: 4x TAPxx/ P6245/ P6249, or 4x TDP3500/P73xx (clock is non-continuous), or 3x TDP3500/P73xx (clock is continuous).
  - For 70Ks: 4xP7240, or 4xP73xx (clock is non-continuous), or 3xP73xx (clock is continuous).

- **Scope Software**
  - Opt.D-PHYTX on TEKEXP for Conformance Test
  - Opt.D-PHY on DPOJET for Debug, Analysis & Characterization
  - Opt.SR-DPHY for Decoding CSI-2 and DSI traffic

- **Fixtures**
  - As MIPI is a chip-to-chip interface, most DUT setups are LIVE with Master-Slave/Receiver-end connected.
  - For live-setups: No Fixtures required.
  - For non-live setups: We recommend following UNH-IOL Termination board
    - [http://www.iol.unh.edu/services/testing/mipi/fixtures.php](http://www.iol.unh.edu/services/testing/mipi/fixtures.php)
    - [www.iol.unh.edu/services/testing/mipi/MIPI_Test_Fixture_Order_Form.doc](www.iol.unh.edu/services/testing/mipi/MIPI_Test_Fixture_Order_Form.doc)
D-PHY Tx: Optional Accessories
Optional Based on DUT Scenarios (i.e. SMA/ Non-live setup/ Multi-lane)

- UNH-IOL RTB Reference Termination Board (list price: $2,895.),
  UNH-IOL Probing Board (list price: $450.), and Capacitive Load Board
  for Clock and Data Lane LP-TX Signaling tests (list price: $295.).
  - [http://www.iol.unh.edu/services/testing/mipi/fixtures.php](http://www.iol.unh.edu/services/testing/mipi/fixtures.php)
  - [www.iol.unh.edu/services/testing/mipi/MIPI_Test_Fixture_Order_Form.doc](http://www.iol.unh.edu/services/testing/mipi/MIPI_Test_Fixture_Order_Form.doc)

- RF Switch,
  - Keithley S46-6666A, for multi-lane automation:
D-PHY Decoder Features Highlights

- Up to 4 data lanes and 1 clock lane. Data rate operation up to 1.5 Gb/s
- Connection to the DUT is via 5 active solder-down probes (supplied), one per lane
- Sophisticated real-time triggering
- real-time record filtering
- status monitoring
- activity statistics
- status LED indicators
- active probes, solder-down, for minimal loading of the device under test
- Configuration control
- Disassembly of the captured information in a logic analyzer-like format
- Reassembly and display of any video information captured
- Storage of captured video frame(s) to a file(s)
D-PHY Rx : Test Solution Overview
Manual Setup based on PG with PGRemote Software

- 100% Coverage to Rx CTS
  - Meets all the requirements in UNH-IOL CTS document (v0.98)

- Quick and Easy setup
  - No complex VXI system, just stand alone instruments, and a probe.

- Cost effective solution
  - 70% Lower list price vs Competition

- Re-usable for Protocol tests
  - PG3A is the Only 4 channel solution for CSI &DSI test

- PG3A Pattern Generator
  - Controls clock and signaling to establish link with DUT
  - Adjusts voltage levels, packet type, etc to stress test receiver

- AWG7082C Generator
  - Adds jitter and interference to the D-PHY signals

Recommended Manual Setup

*These Moving Pixel products are available as Tektronix part number
**Tektronix part number not available yet. Expected Soon.
D-PHY Rx : Test Solution Overview
100% Test Coverage to CTS v0.98

<table>
<thead>
<tr>
<th>Group 1 LP - RX voltage and timing requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>2.1.1</td>
</tr>
<tr>
<td>2.1.2</td>
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<td>2.1.3</td>
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<tr>
<td>2.1.4</td>
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<td>2.1.5</td>
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<td>2.1.6</td>
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<td>2.1.7</td>
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<td>2.1.8</td>
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</table>

<table>
<thead>
<tr>
<th>Group 2 LP - RX Behavioral Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
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<tr>
<td>2.2.1</td>
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<td>2.2.2</td>
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<tr>
<td>2.2.3</td>
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<tr>
<td>2.2.4</td>
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<td>2.2.6</td>
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<td>2.2.7</td>
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<td>2.2.8</td>
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</table>

<table>
<thead>
<tr>
<th>Group 3: HS - RX Voltage and Setup/Hold Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>2.3.1</td>
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<tr>
<td>2.3.2</td>
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<tr>
<td>2.3.3</td>
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<td>2.3.4</td>
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<td>2.3.7</td>
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<tr>
<td>2.3.8</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Group 4: HS - RX Timer Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test No.</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>2.4.1</td>
</tr>
<tr>
<td>2.4.2</td>
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<td>2.4.3</td>
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<tr>
<td>2.4.4</td>
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<td>2.4.5</td>
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<td>2.4.7</td>
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<td>2.4.9</td>
</tr>
<tr>
<td>2.4.10</td>
</tr>
<tr>
<td>2.4.11</td>
</tr>
</tbody>
</table>
PG3A and P338 MIPI D-PHY Rx Solution

Key Features

- MIPI D-PHY Probe for use with PG3AMOD and PG3ACAB
- Generate CSI2 and DSI data over D-PHY
- 4-Data Lanes and 1-Clock lane
- 1.5Gbps @ 4Lane and 800Mbps @ 8 lanes
- 1.5Gbps @ 8Lanes if using two PG3A
- SMA outputs for each lane
- LP and HS Voltage and Timing adjustable on a each lane separately

Preserve your investment with the ONLY >4 lane, 1.5Gbps stimulus solution in the market.
Practice Connection
PGRemote
Push Button Interface to generate CSI2 / DSI Vectors

- Define CSI/DSI commands and arguments
- Configuration Parameters for PG playback, and D-PHY
- Status Bar
- PGRemote Main Window
- Command Buttons
- PG, probe status and operational controls
What is M-PHY?

- M-PHY is a high-speed serial interface to the DigRFv4, UniPro, LLI, CSI-3 and DSI-2 interconnect standards of the MIPI Alliance, and the UFS and SSIC protocol standards of JEDEC and USB-IF respectively.

- M-PHY is a flexible architecture that allows the implementer to support high data rates at minimal power, cost & I/O redesign, for applications such as High Definition Video.

- A Fast, Scalable, Serial Communications Architecture
  - Link – Connects M-PHY Transmitter to an M-PHY Receiver
  - Sub-link – Manage one or more lanes
  - Lane – Operation defined in the protocol (DSI, CSI, UniPro, DigRF)
M-PHY Transmitter Testing Challenges

- Higher data rate will increase importance of Signal Integrity of links
  - More emphasis on timing/jitter and noise (signal integrity)
  - Receiver testing will be needed to stress-test resulting BER
- 1000+ tests per lane, covering multiple Gears, Terminations, Amplitudes.
- Termination – Restive or not Terminated.
  - LS mode can operate either of them
  - HS mode it is always terminated, so swings are halved.
- Type-I and Type-II are Low speed modes, and are NOT interoperable
  - Type-I operates on independent local clocks. Type-II requires a shared Ref-clock.
  - DUTs may support both

### M-PHY Signal Characteristics

<table>
<thead>
<tr>
<th>Signaling mode</th>
<th>Datarates</th>
<th>Amplitudes</th>
<th>Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gears</td>
<td>A (Gbps)</td>
<td>B (Gbps)</td>
</tr>
<tr>
<td>High Speed (HS)</td>
<td>G1</td>
<td>1.25</td>
<td>1.45</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>2.5</td>
<td>2.91</td>
</tr>
<tr>
<td></td>
<td>G3</td>
<td>5</td>
<td>5.83</td>
</tr>
<tr>
<td></td>
<td>Gears</td>
<td>Min (Mb/s)</td>
<td>Max (Mb/s)</td>
</tr>
<tr>
<td></td>
<td>G0</td>
<td>0.01</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>G1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>G3</td>
<td>12</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>G4</td>
<td>24</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>G5</td>
<td>48</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>G6</td>
<td>96</td>
<td>288</td>
</tr>
<tr>
<td></td>
<td>G7</td>
<td>192</td>
<td>576</td>
</tr>
<tr>
<td>PWM (ie. TYPE-I)</td>
<td>Gears</td>
<td>Min (Mb/s)</td>
<td>Max (Mb/s)</td>
</tr>
<tr>
<td>SYS (ie. TYPE-II)</td>
<td>Gears</td>
<td>0.01</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>G0</td>
<td>0.01</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>G1</td>
<td>3</td>
<td>9</td>
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<tr>
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<td>6</td>
<td>18</td>
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<td>G6</td>
<td>96</td>
<td>288</td>
</tr>
<tr>
<td></td>
<td>G7</td>
<td>192</td>
<td>576</td>
</tr>
</tbody>
</table>

- 50 ohms
- 10k ohms
M-PHY Tx : Opt.M-PHYTX Automation Features

M-PHYTX – HS Test Configurations

Transmitter : HS : CTS v0.8

Test Description:
To verify that the length of the DUT’s transmitted HS-PREPARE period is consistent with the value indicated by its TX_HS_PREPARE_LENGTH configuration attribute.
M-PHY Tx : Opt.M-PHYTX Automation Features

Comprehensive Test Reports

Single-printable report covering results from Multiple lane, Multiple Gears, Amplitudes, etc

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Lane</th>
<th>Termination</th>
<th>Gear</th>
<th>Measurement Details</th>
<th>Measured Value</th>
<th>Units</th>
<th>Test Result</th>
<th>Margin</th>
<th>Lower Limit</th>
<th>High Limit</th>
<th>Compliance Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1.1.1-HS-TX (Unipolar and Frequency Offset)</td>
<td>L0-1</td>
<td>MT</td>
<td>GearA</td>
<td>Measured Voltage</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Test 1.1.4-HS-TX Common Mode DC Offset</td>
<td>L0-1</td>
<td>RT</td>
<td>GearA</td>
<td>Measured Voltage</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Test 1.5.5-HS-TX Differential DC Output Voltage Amplitude</td>
<td>L0-1</td>
<td>RT</td>
<td>GearA</td>
<td>Measured Voltage</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
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</tr>
<tr>
<td>Test 1.5.6-HS-TX Differential AC Eye Opening</td>
<td>L0-1</td>
<td>RT</td>
<td>GearA</td>
<td>Test HS Duration</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Test 1.1.9-HS-TX 2:3 Rise and Fall Time</td>
<td>L0-1</td>
<td>MT</td>
<td>GearA</td>
<td>Test HS Duration</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Test 1.2.1-PWM TI Transmit Bit Duration</td>
<td>L0-1</td>
<td>RT</td>
<td>GearA</td>
<td>Test HS Duration</td>
<td>3.25 V</td>
<td>ppm</td>
<td>Test Result</td>
<td>Margin</td>
<td>1.2 G</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Results from multiple test-configuration, of a single-test
M-PHY Rx : Based on Scope built-in Error Detector
Scope-Integrated M-PHY BER using Opt.ERRDT Shipping Today

- 8B/10B Data:
  - Hardware Serial trigger: 1.25 Gb/s to 6.25 Gb/s
  - BER covers PRBS 312Mbs and above data rates.

MIPI® M-PHY Receiver
Methods of Implementation (MOI)

MIPI M-PHY Receiver - TEKTRONIX MOI
RX ERROR DETECTOR

Overview:
This section of test verifies the M-PHY receiver error detection mechanism as defined in the M-PHY Specification.

GROUP 1: M-RX Error Detection Requirements

Overview:
This group of tests verifies various requirements of error detection on MIPI M-PHY receiver. Scope error detector is used for this purpose. For M-PHY error detector, ERRST and STU option should be enabled in scope and Tekscope firmware v0.1.32 or later is required.

Status:
The test descriptions contained in this group are considered to be in initial draft form. Additional modifications to both the test descriptions and implementations are expected.

Pay Load:
Continuous PRBS 7PRBS 5 Pattern with NRZ signaling (1G Gb/s, 1G Gb/s and 2G B/s data rates)
Custom bursts pattern with 8B/10B encoded with NRZI/PWM/3Y5 signaling.

Note:
Please refer to the M-PHY specification ver. 0.0
M-PHY Rx : Opt.M-PHYRX Automated Solution

- **Opt.M-PHYRX**
  - TekExpress (2.0) option for Fully-Automated receiver testing
  - Provides Conformance Testing
  - Based on Latest M-PHY Base Spec v1.0 & UNH’s Conformance Test Suite
  - Runs on DPO/DSA70KB/C or MSO70K/C scopes
  - TekExpress framework is included.

- **Differentiation**
  - Simply 2-box setup.
  - Built upon Scope ErrorDetector ERRDT.
  - Wide HS test coverage

- **Value proposition**
  - Test Reports with Pass/Fail summary, with Bit-Error counts
M-PHY Tx & Rx Recommended Test Setup (www.tek.com/MIPI)

- **Scopes**
  - DPO70604/B/C or above, for HS-Gear1 Only (Tx & Rx).
  - DPO70804/B/C or above, for HS-Gear1&2 Only (Tx & Rx).
  - DPO71254/B/C or above, for All HS-Gears (Rx Only).
  - DPO72004/B/C or above, for All HS-Gears (Tx & Rx).

- **Probes**
  - 2x P73xxSMA/P73xx, for Tx HS upto Gears2, or 2x P75xx with P75LRST for Tx HS upto Gear3.
  - 2x P73xxSMA/P73xx, for Tx PWM All Gears.
  - 1x P73xxSMA, for Rx.

- **Signal Generators for Rx**
  - AWG7082C, AWG7102 or above, for HS-Gear1 Only.
  - AWG7122C without Interleave, for HS-Gear1&2 Only.
  - AWG7122C with Interleave (option 06), for All HS-Gears.

- **Software**
  - Opt.SR-810B, for 8b-10b Decode.
  - MPHVIEW, for DigRFv4 Protocol Decode.
  - Optional: Opt.M-PHY Essentials based on DPOJET.
  - Optional: SerialXpress for custom-patterns using AWG.

- **Fixtures**
  - As MIPI is chip-to-chip interface, most DUT setups are LIVE with Master-Slave/Receiver-end connected. For live-setups: No Fixtures required. For non-live setups UNH-IOL Termination boards expected to be available soon.
M-PHY Rx Recommended Test Setup – Continued

- **Recommended Accessories, for opt.M-PHYRX Receiver Automation setup**
  - 2x Matched pair of SMA cables
  - 1x GPIB Cable
  - 2x Rise Time Filter – 120 ps (part number 5915-121-120PS from Picosecond) with barrel connectors

- **Optional: Accessories for Rx “custom-patterns” using SerialXpress (manual setup)**
  - 2x Matched pair of SMA cables, for AWG custom patterns creation
  - 2x Rise Time Filter – 120 ps (part number 5915-121-120PS from Picosecond) with barrel connectors
  - 2x BiasTee (part number 5542 from Pico Second), for AWG Interleave Option (for HS-Gear3)
  - 2x TCA-SMA Connectors, for AWG custom patterns creation
  - Option 01 – Memory expansion to 64 M enabled on AWG
  - Option 08 – Fast Sequence Switching enabled on AWG
  - Option 09 – Subsequence and Dynamic Jump enabled on AWG.
CPHY Solution Offering in 2014-15 - Details

- Scope analysis software
- 4-lane probing & termination board
- New solder-in scope probe tips
- AWG pattern and stress software – C-PHYXpress
- Python automation conformance software
  - Source TX
  - Sink RX
  - RF switch control
- 4-lane pattern generator
- 1-lane scope-based packet decoder
- 4-lane protocol analyzer
CPHY Signal Levels

- VA, VB, VC
  - HS Line Voltage { High, Low, Mid }
  - { V, 0, V/2 }

- VAB, VBC, VCA – Differential Signals

Source: MIPI Workgroup Proceedings
CPHY Eye Diagrams

- CPHY uses a “triggered eye” method to render eye diagrams for analysis
  - Specified to model how three CPHY differential receivers work
- “Trigger” refers to the first crossing of Vab, Vbc, or Vca across the 0V threshold per UI
- This “trigger” is used as a reference point for plotting the eye diagram
Example:
Embed Results Verification

- Results can be quickly verified by using DPOJET jitter & eye diagram software
- CPHY analysis is then performed on these signals in accordance with spec requirements.
Example Setup Dual AWG70000
Generate CPHY Traffic
LP-HS Transition – (LP swing 0V up to 1V, HS swing 50mV up to 435mV)
Thanks!