新一代顯示介面之驗證與測試

Brian Chen
太克科技 應用工程師

Tektronix Innovation Forum

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Tomorrow and Beyond

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Agenda

- HDMI Overview and updates

- MHL Overview and updates

- DP overview and updates

- Tektronix Solution overview

- Additional resources

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HDMI –High Definition Multimedia Interface
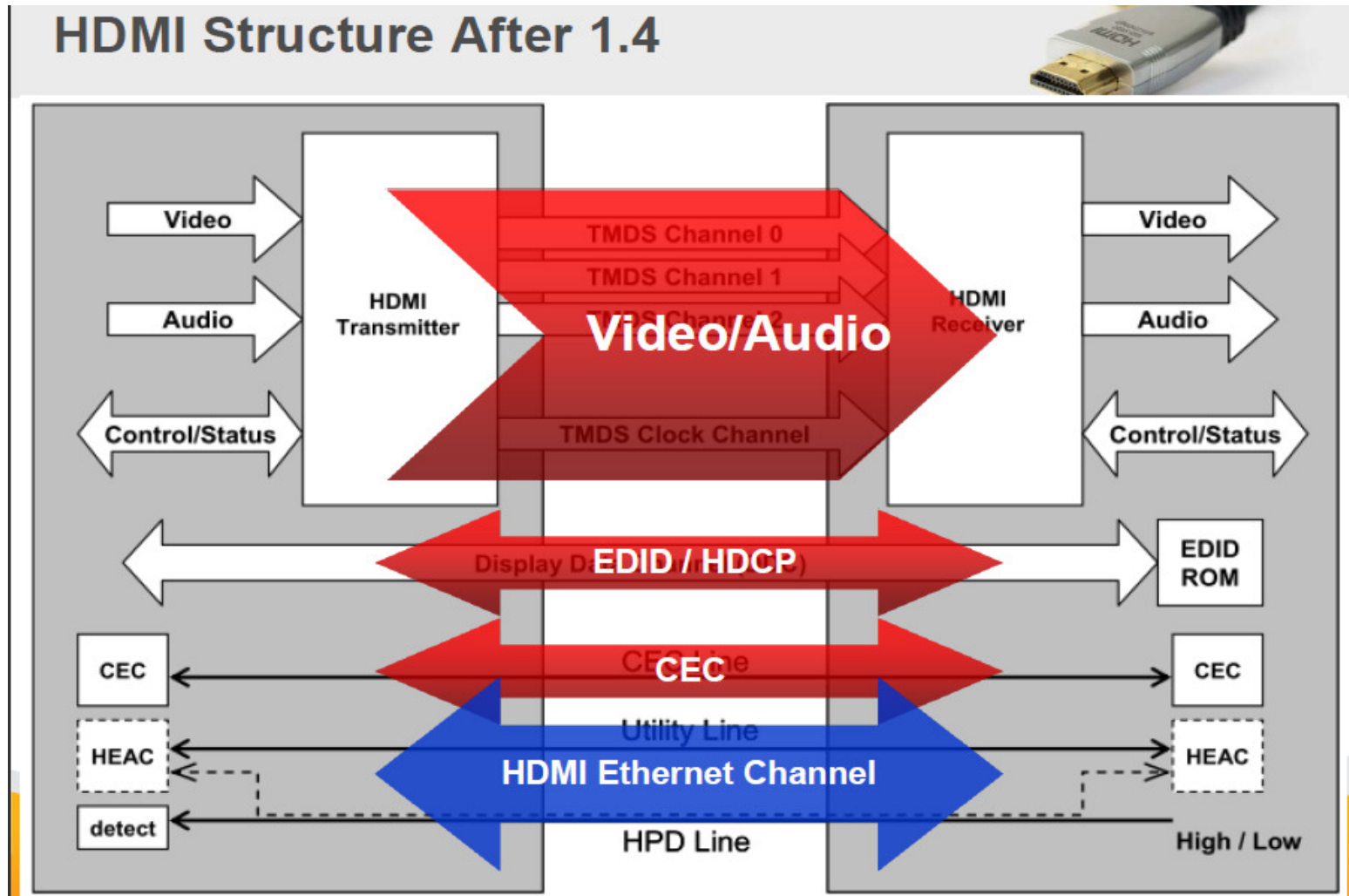
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Overview of HDMI

- Problems with the legacy display technologies
    - Unnecessary D to A and A to D components
    - Device resolution increases, display brightness reduced
    - No content protection

- What is HDMI?
    - High Definition Multimedia Interface
    - Connection standard for consumer electronics
    - Uncompressed digital video and audio content interface
    - Digital Content protection
    - Multi channel audio
    - Single cable
    - Cost effective

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HDMI Basics

HDMI Structure After 1.4

Video → HDMI Transmitter

Audio → HDMI Transmitter

Control/Status ↔ HDMI Transmitter

TMDS Channel 0
TMDS Channel 1
TMDS Channel 2
Video/Audio
TMDS Clock Channel

HDMI Receiver → Video

HDMI Receiver → Audio

HDMI Receiver ↔ Control/Status

Display Data (DDC)
EDID / HDCP
→ EDID ROM

CEC ← CEC Line CEC → CEC

HEAC — Utility Line
HDMI Ethernet Channel
→ HEAC

detect ← HPD Line — High / Low

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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
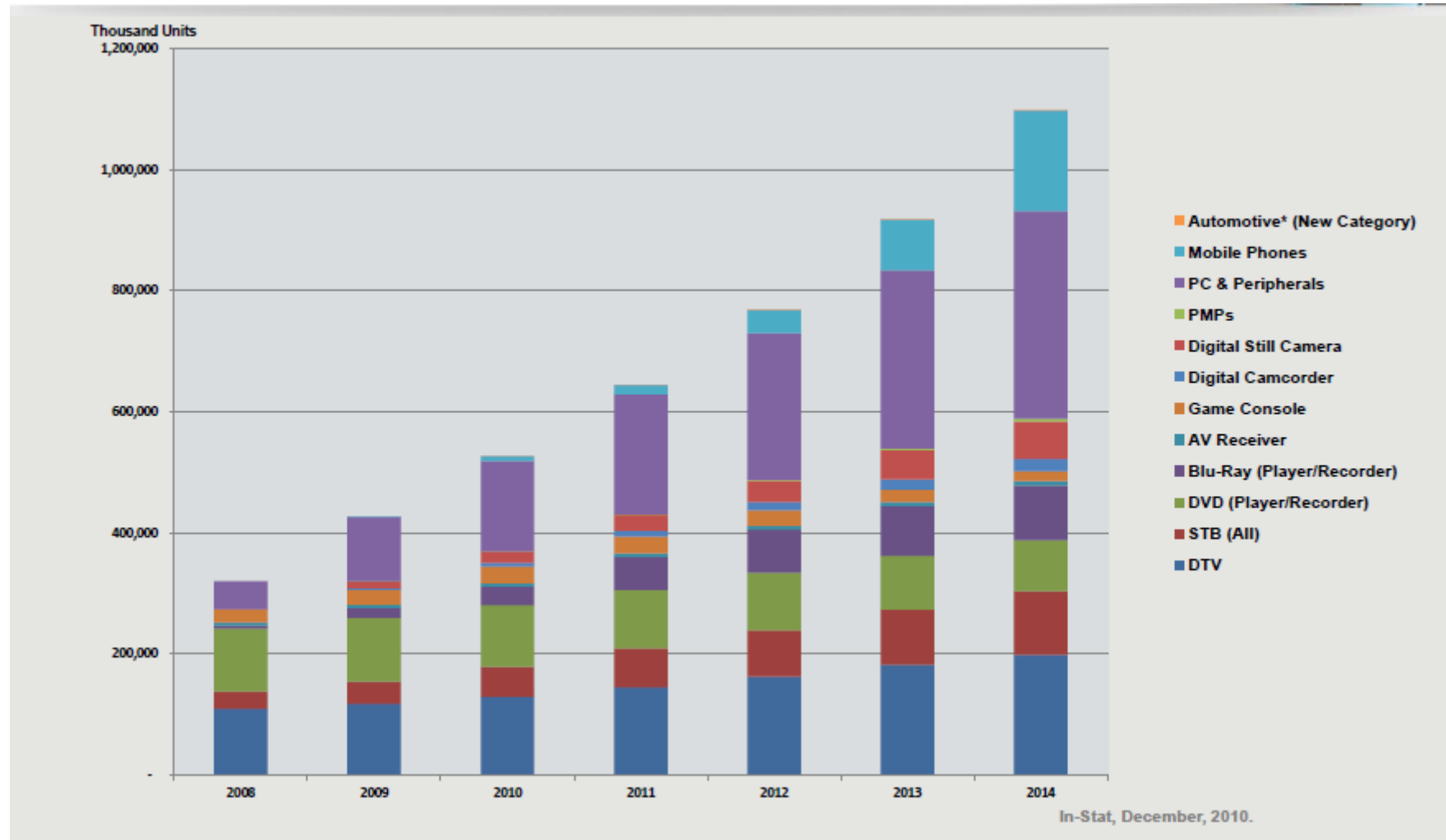 - Still camera
  - Advertising billboards

- HDMI NOW Truly Single Digital Interconnect for uncompressed Audio/Video
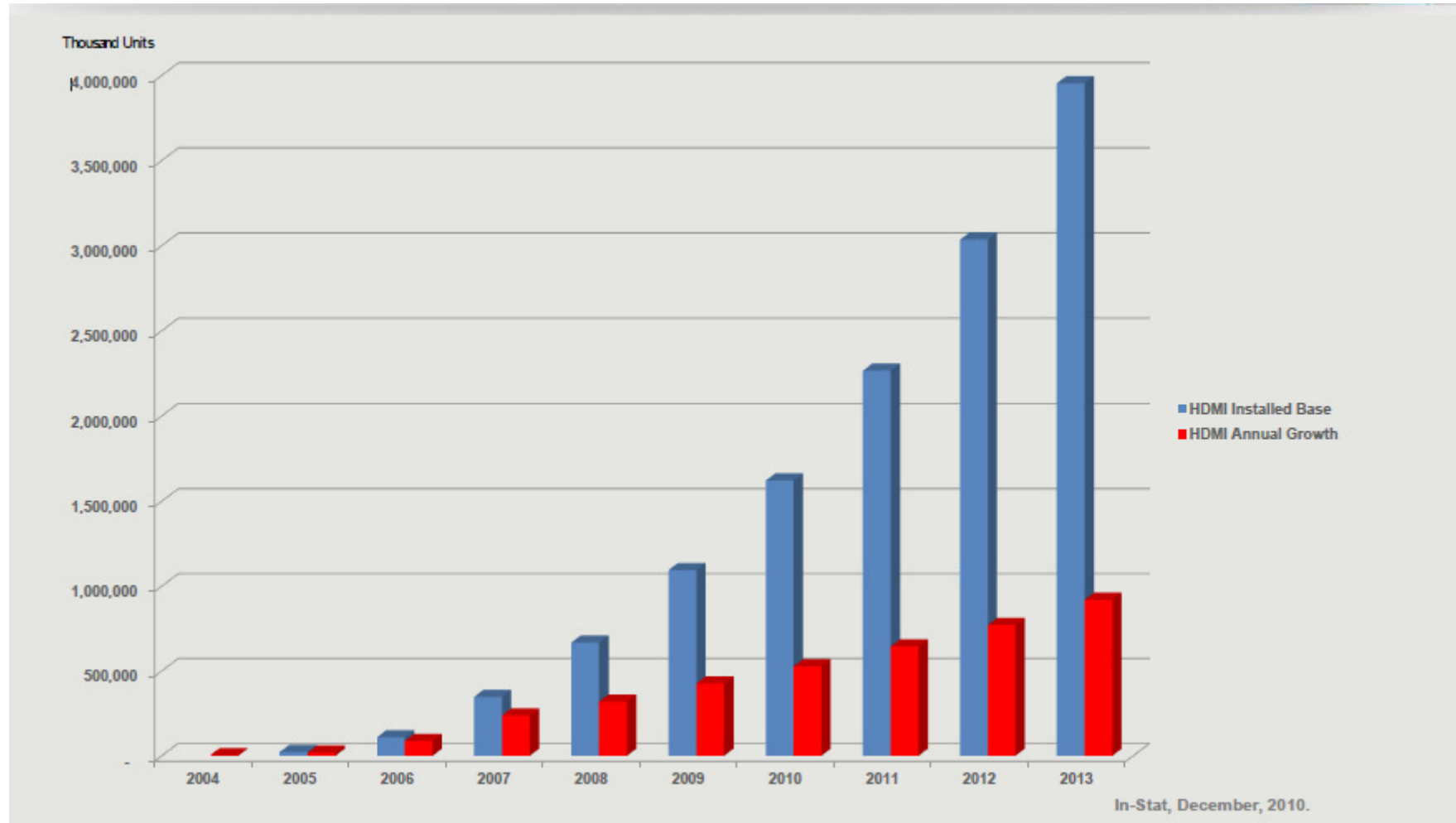 - HEAC (A R C)

HEAC Source

Ethernet up-link
Audio up-link

HEAC Sink

HEAC Cable

Ethernet down-link

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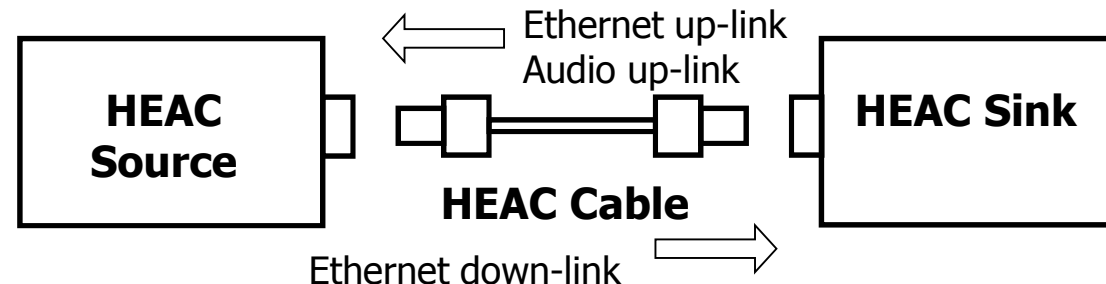
HDMI Market overview

Source: HDMI Forum

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HDMI Devices take rate

2.2B HDMI devices sold by 2011

Source: HDMI Forum

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HDMI Status

- Complementing/Competing
    - MHL (Mobile High Definition Link)

- Competing Technologies

    - Wireless HDMI (Wimedia, Wireless USB etc)
    - WiHD (60GHz LOS)!!!
    - WHDI (5GHz)
    - DP

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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

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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

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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

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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

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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.

  - Target
    - 2013 Q3 Specification
    - CTS 2013 Q4

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Possible 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

- Direct Attach device support

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HDMI 2.0 Source Testing-Advanced information

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Source Testing

- Most Source tests are likely to be same as HDMI 1.4b but for Eye Diagram test.

- Source Eye Diagram test is measured at TP2_EQ.

- TP2 is the signal after passing along a worst cable.

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Source Eye Diagram Test

Tektronix Oscilloscope
DPO/DSA/MSO70000 Series
$\geqq$ 16GHz

Include
Reference Cable Emulator (s4p)
and Reference Cable Equalizer

Diff Clk

SE Data

Clk +

Clk -

Data +

Data -

SMA Pair Cable

HDMI Source

HDMI Plug Fixture
with EDID Emulator
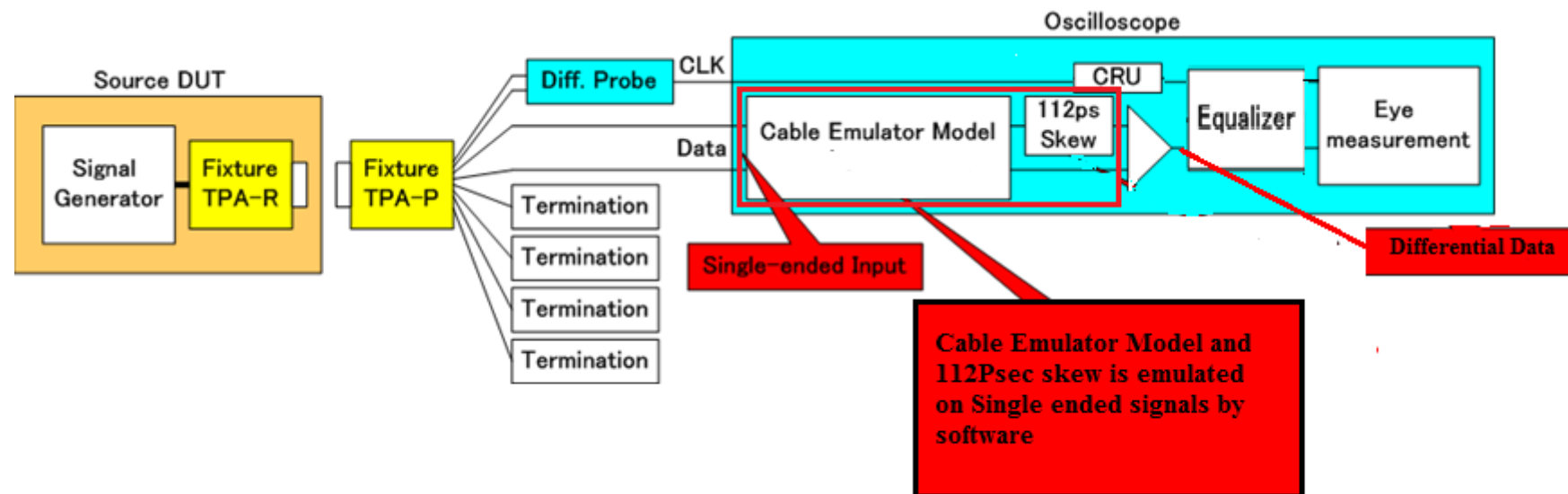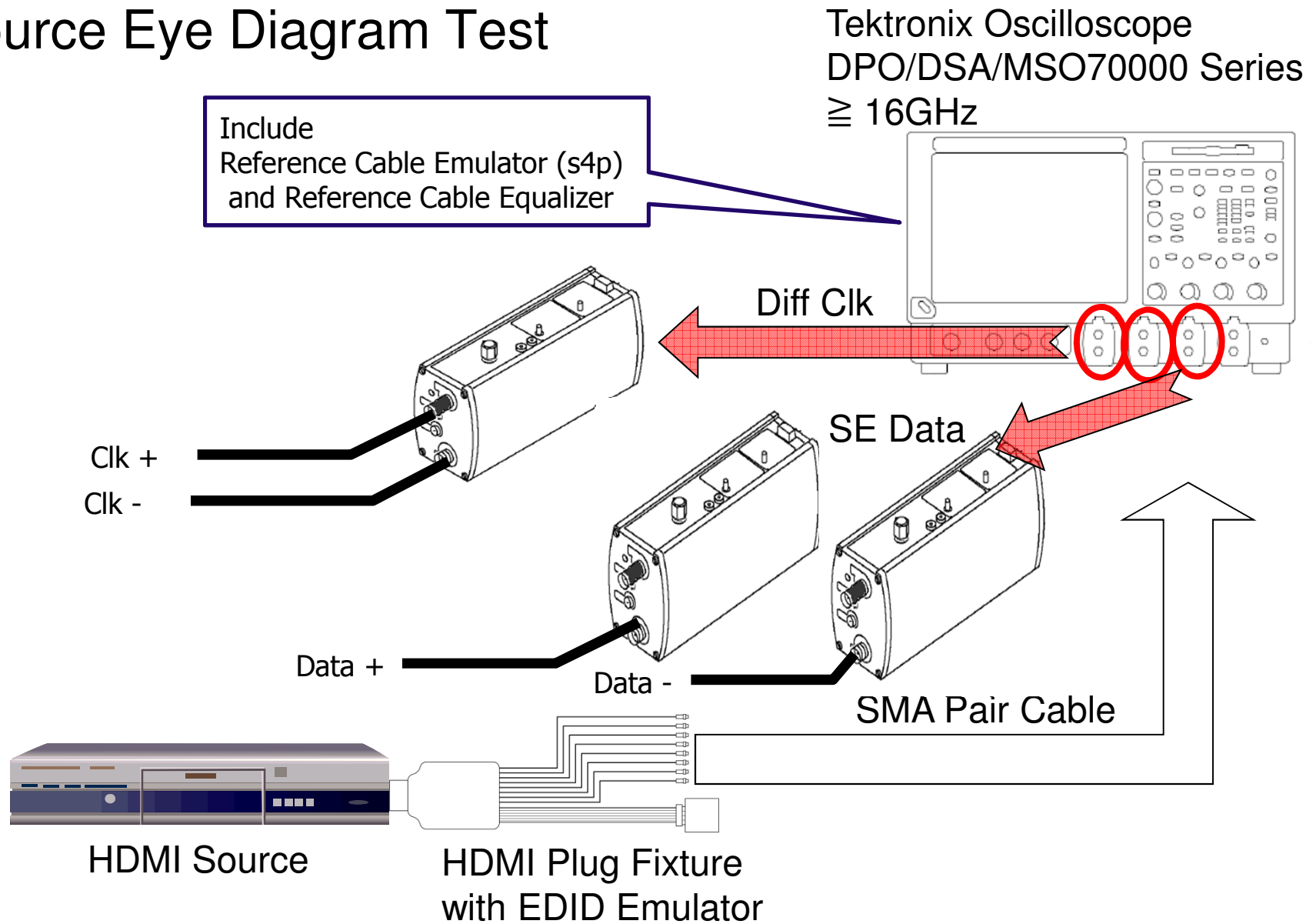
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TP2 Source Eye for HDMI 2.0 6G signal
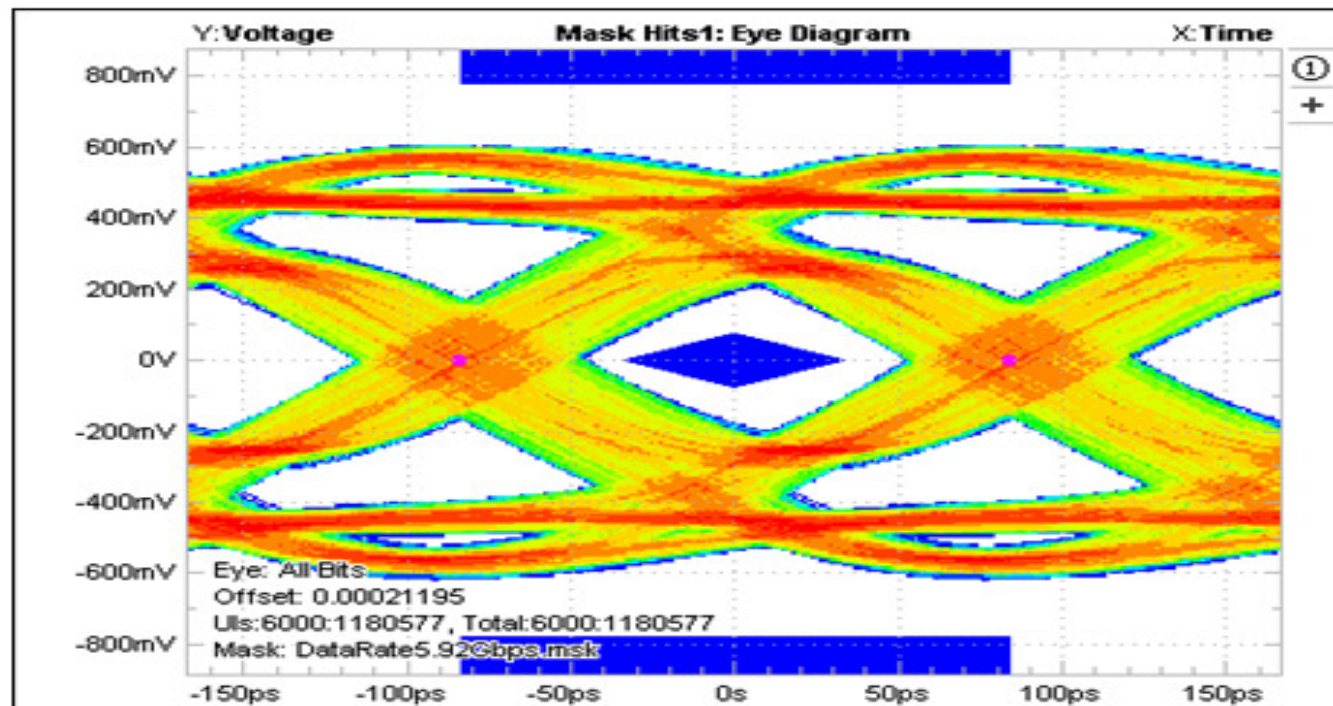
Single End Input eye rendered at Tek lab

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HDMI 2.0 Sink Testing- Advanced Information

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Requirement for Signal generation

Cable Emulation and Skew by Hardware
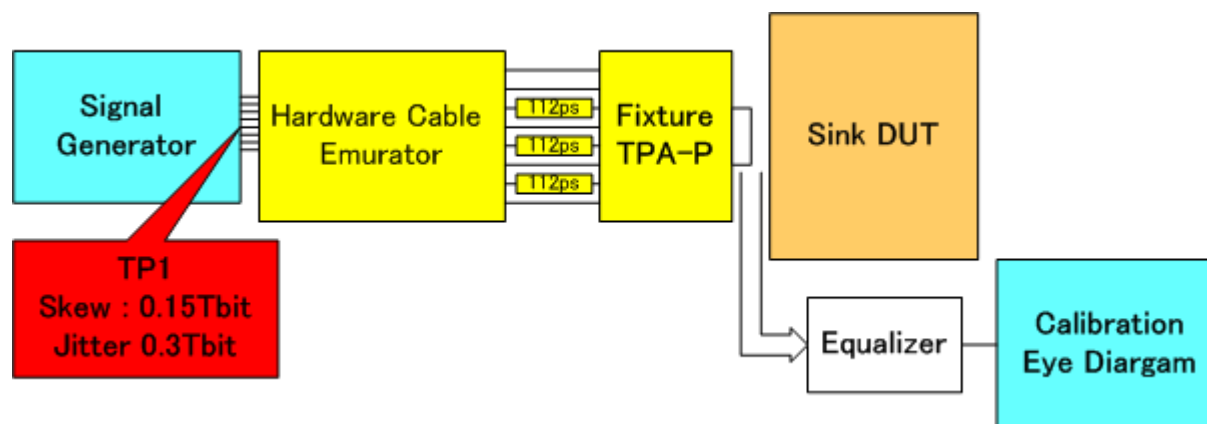
Tektronix Software Cable Emulation
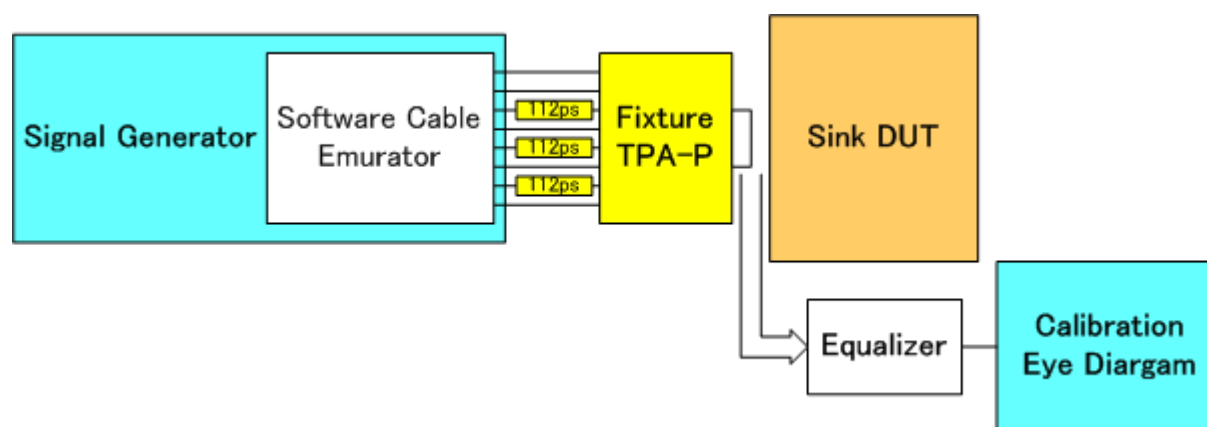
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Sink Test

Tektronix AFG3000
(Synchronize two AWGs)

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

Tektronix AWG7002A x 2

Include
Reference Cable Emulator (s2p)

SMA Pair Cable

HDMI Plug Fixture

112ps Delay Line
(Emulate Cable Skew)

HDMI Sink

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TP2 Signal with New AWG70002A

Direct Synthesis capability to add impairments in Software
   Skew effect
   Cable emulator effect
   Delay effect
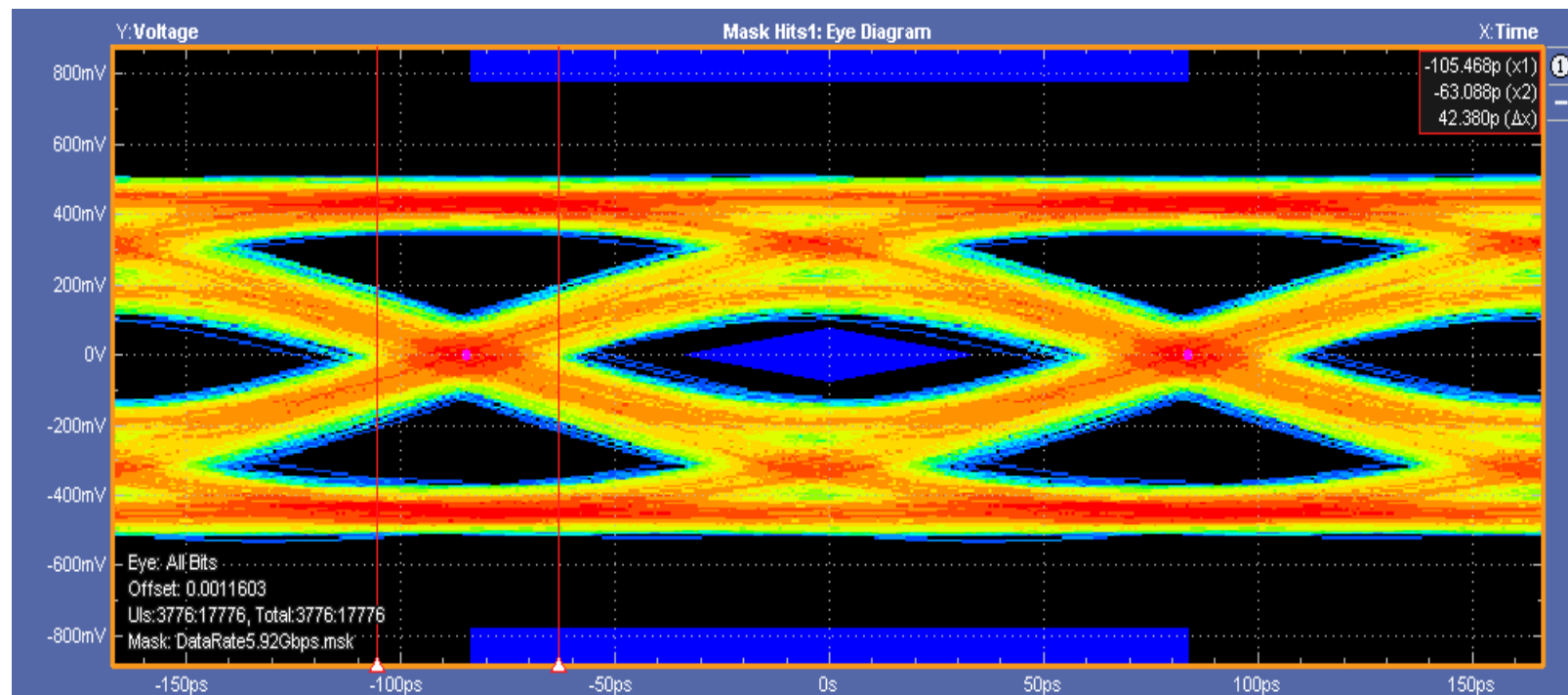
TP2 Eye after applying Cable Equalizer

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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, Sink, Cable and Protocol Solution including probes, Fixtures.

- Support for HDMI 1.4b CTS which is likely to be a pre-requiste for HDMI 2.0 testing.

- Contact local Tektronix sales team for early interaction on our HDMI 2.0 solution.

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MHL – Mobile High Definition Link
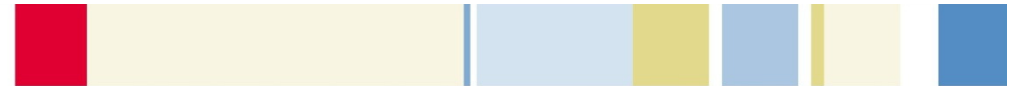
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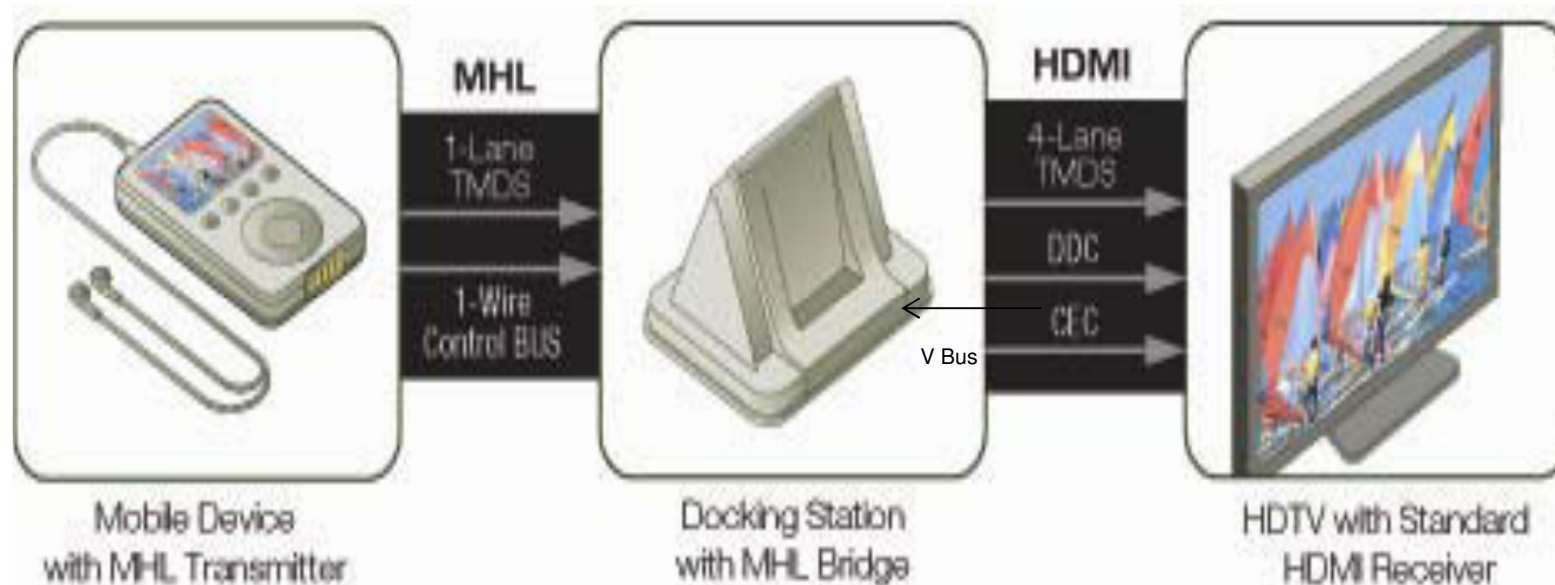
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MHL – An Introduction

- Why MHL interface?

- Application

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MHL Introduction

Mobile Device with MHL Transmitter — Docking Station with MHL Bridge — HDTV with Standard HDMI Receiver

- 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.

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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 is round the corner.

  COMPLETE TEKTRONIX SOLUTION APPROVED in CTS1.1 , CTS 1.2 and CTS 2.0.Working on approval for CTS 2.1 solution

- Tektronix is a **Contributor adapter** and actively involved in defining the CTS 2.1.
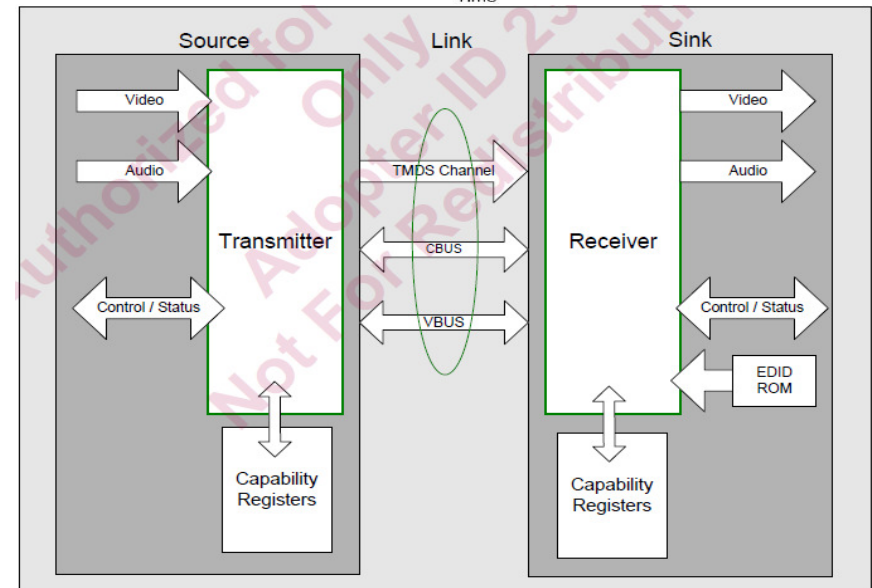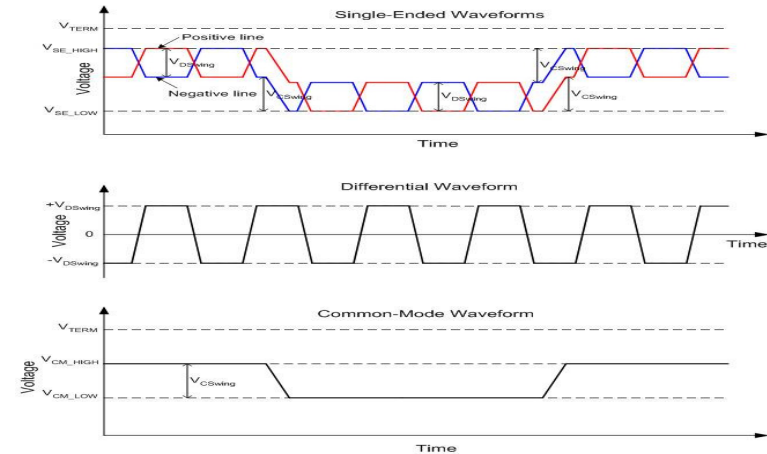
Source: MHL 1.2 specification document

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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 ???

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Tektronix MHL Solution:
Complete Solution Aligned to CTS2.1 Announcement

- 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

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DisplayPort 1.2 and eDP Testing Update

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DisplayPort 1.2 Spec Update
Agenda

- DisplayPort 1.2 Overview

- DisplayPort Transmitter Testing
    - What's New: T2, TP3, TP3EQ
    - Physical Layer Test Overview for DP1.2
        - Manual measurements / DPOJET / SDLA
        - CTLE required in Rx
    - DP-AUX: Control DUT parameters
        - Controls ALL TX. RX devices without vendor-specific control SW

- Test Automation:
    - Full Main Link testing with DP12 Automated tool set
    - DP 1.2 Tx:
        - Including Single-Ended and Diff Measurements (Intra-Pair Skew, AC Common Mode)
        - Using RF Switch Integration
        - Improved Debug Tools

- DisplayPort Sink/Receiver Testing
    - BSA125C configurations towards Rx testing
        - Jitter Impairment profile and observation times

- eDP testing for eDP 1.4 specification

Reference: VESA® DisplayPort® PHY Compliance Test Specification Version 1.2

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DisplayPort 1.2
Overview

- The DisplayPort PHY Compliance Test Specification establishes a test regimen to determine compliance of DisplayPort devices - segmented into:
    - Source
    - Receiver
    - Copper Cable
    - Hybrid devices
    - Tethered devices

- Test Point Definitions
    - TP1: at the pins of the transmitter device.
    - TP2: at the test interface on a test access fixture
    - TP3: at the test interface on a test access
    - TP3_EQ: TP3 with equalizer applied.
    - TP4: at the pins of a receiving device

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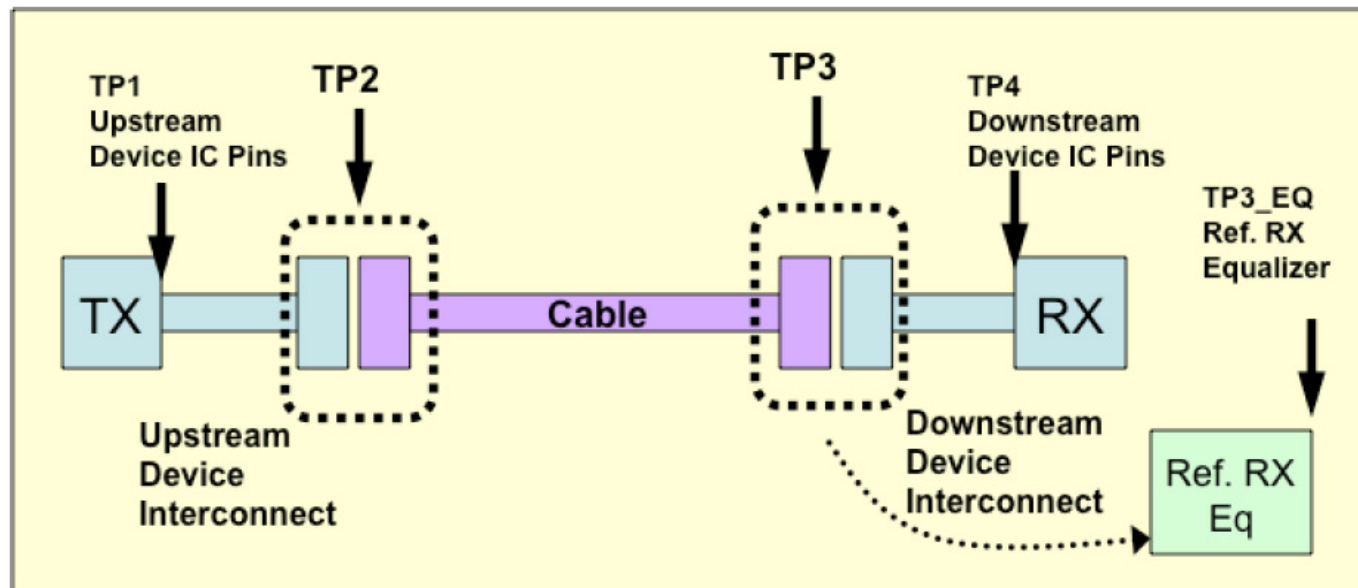
DisplayPort CTS1.2b

Source Test Suite

- 1. EYE Diagram
- 2. Non Pre-Emphasis Level Verification
- 3. Pre-Emphasis Level Verification and Maximum Differential Pk-Pk Output Voltage
- 4. Inter-pair Skew
- 5. Intra-Pair Skew
- 6. Differential Transition Time
- 7. Single Ended Rise and Fall Time Mismatch
- 8. Overshoot and Undershoot Test
- 9. Frequency Accuracy
- 10. AC Common Mode Noise
- 11. Non ISI Jitter Measurement
- 12. Total Jitter and Random Jitter Measurement
- 13. Unit Interval
- 14. Main Link Frequency Compliance Stability
- 15. Spread Spectrum Modulation Frequency
- 16. Spread Spectrum Deviation
- 17. dF/dt Spread Spectrum Deviation HF Variation
- 18. Dual-mode TMDS Clock (if supported)
- 19. Dual-mode EYE Diagram Testing (if supported)

- **DUT Configuration**
  - 1. Bit Rates: RBR, HBR or **HBR2**
  - 2. Patterns: D10.2,PRBS7, COMP, PLTPAT,PCTPAT
  - 3. FFE (Pre-Emphasis): 0dB, 3.5dB, 6dB, 9.5dB
  - 4. Output Levels: 400mV, 600mV, 800mV, 1200mV
  - 5. SSC (Spread Spectrum): On/Off
  - 6. Post-Curser2: Level 0,1,2,3
  - 7. Lane Width, 1,2,4

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Eye Diagram Test using Eye Compliance Pattern

An Eye diagram test for 800mV , 0dB pre-emphasis at TP2,TP3, TP3-EQ.
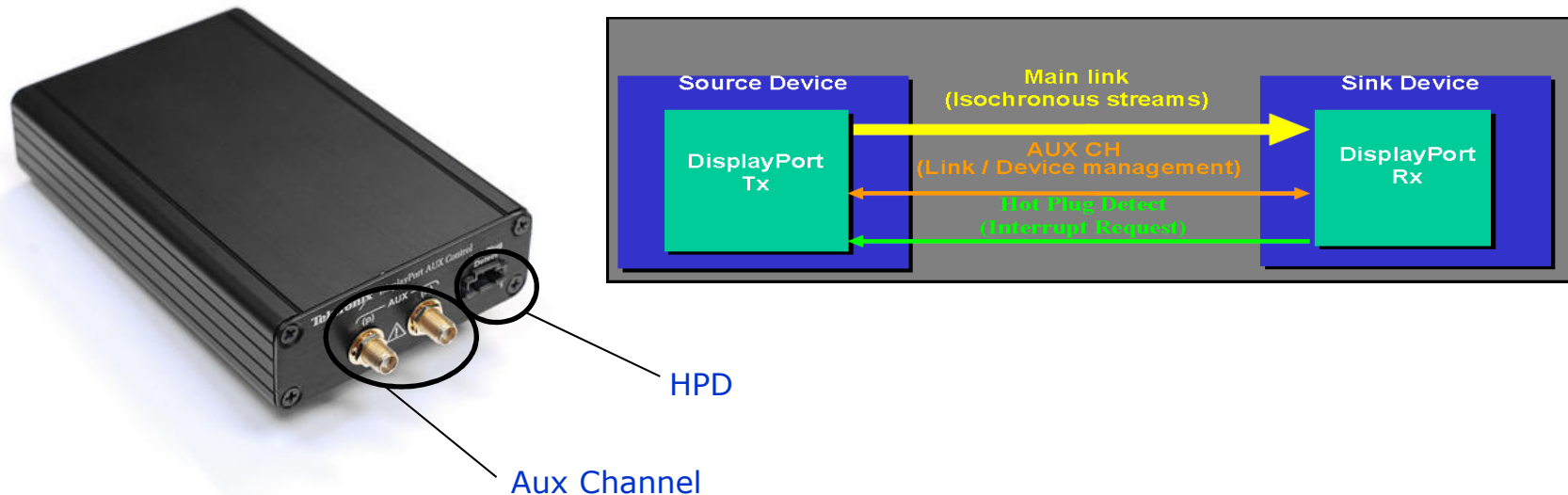
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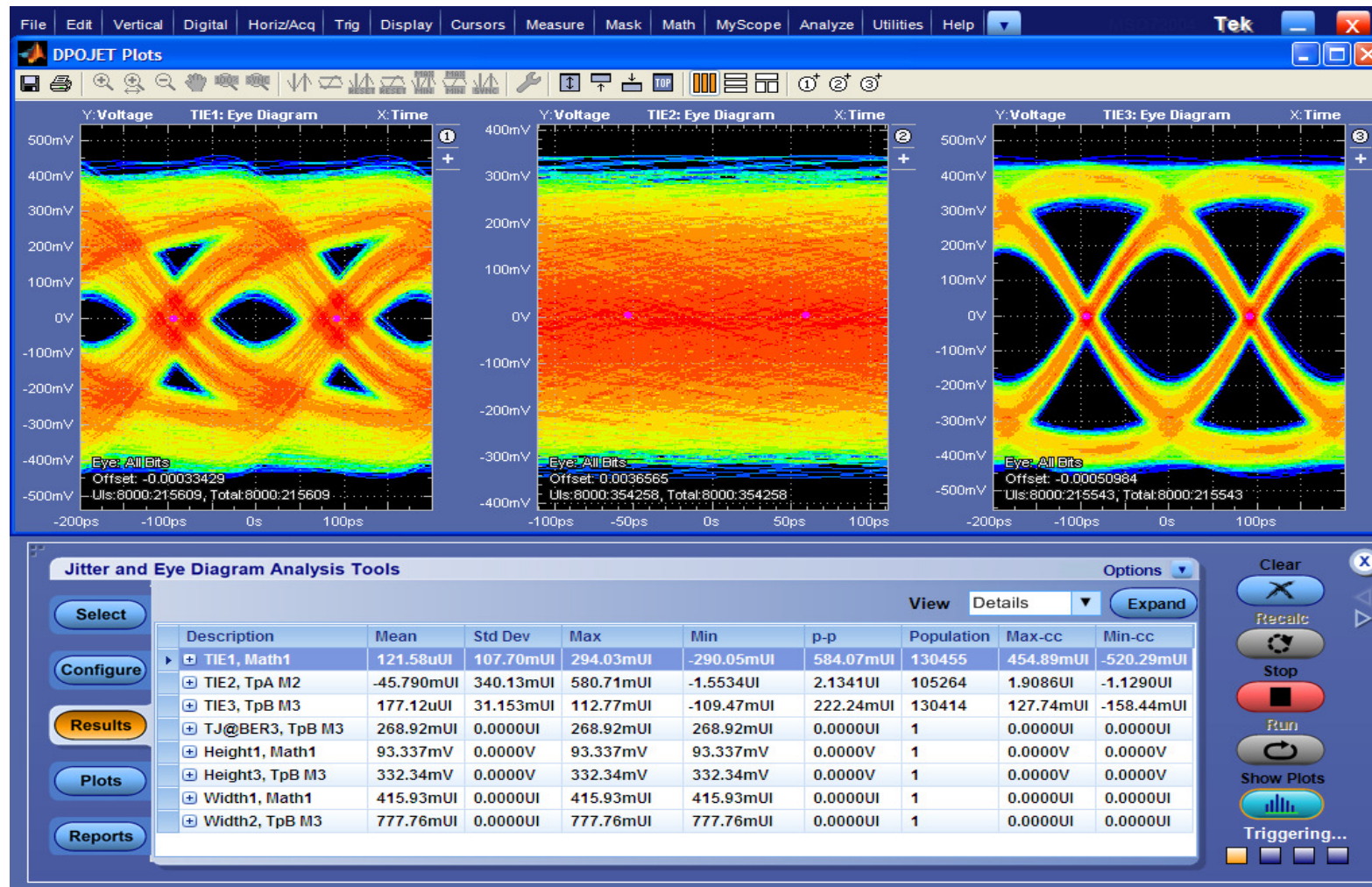
DisplayPort 1.2
CTLE Properties

1.2 CTS requires adaptive application of one of three reference equalizers to the far end signal, to find a passing condition.

Reference HBR2 Receiver Equalizer Transfer Functions

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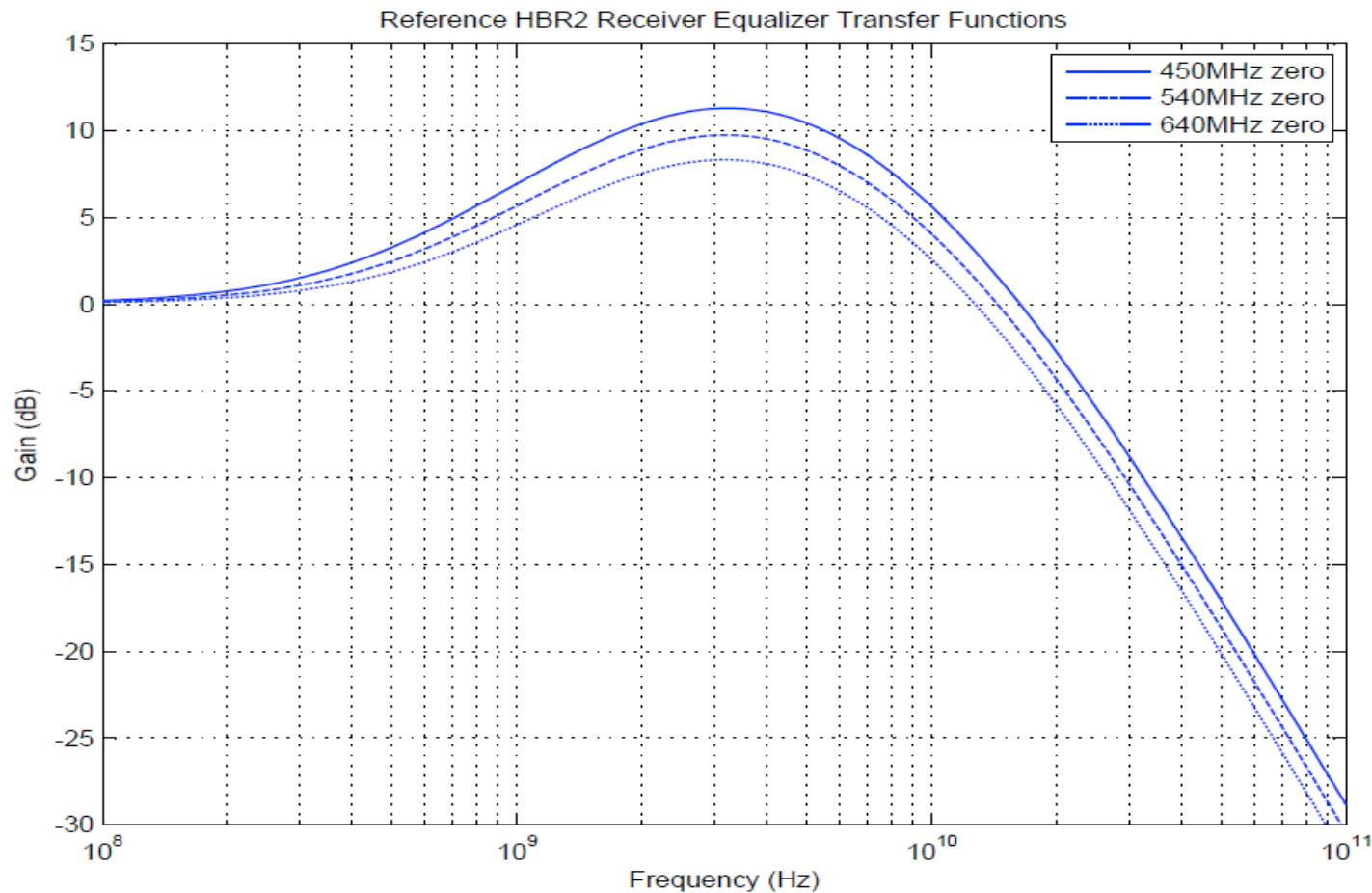
DisplayPort Auxiliary Channel Controller (DP-AUX)

Why use Aux channel controller in physical layer testing?

HPD

Aux Channel

- Speeds Up Test Time - No User Interaction is Required to Change Source Output Signal or Validate Sink Silicon State or Error Count

- No Need to Learn Vendor-specific Software - A Single GUI Supports All Vendors

- View & Log Decoded AUX Traffic and Hot Plug Detect (HPD) Events from the Device under Test to the DP-AUX DisplayPort AUX Controller

- Ability to Read and Write DPCD Registers Supports Debug Activities

- Tektronix DP-AUX can serves as a DP1.2 Sink - Enables source to transmit the required patterns for testing.

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Automation: DisplayPort testing is a large task!

Combination Parameters For DP1.2 Testing   Combination of Tests

Data Rate	- 3
Lanes	- 4
Pre-Emphasis	- 4 Levels
Voltage Swing	- 4 Levels
Post Cursor2	- 4 Levels
SSC	- 2 Levels(SSC On and Off)
Patterns	- 5 Supported Patterns

1. Differential Tests

2. Single Ended Tests

Test	Waveforms (SSC, 4 Lanes Possible Combinations)
Eye Diagram Test	80
Pre-Emphasis Test	240
Non-Pre-Emphasis	32
Total Jitter	80

~432 Acquired signals for DP1.2 Normative Measurements per lane.
X4 lanes results in 1728 Automated Acquisitions per DUT.

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TekExpress DisplayPort 1.2 Automation

- Comprehensive Display Port Version 1.2 Physical Layer Conformance and Compliance Verification Tool
  - All Core DP1.2 measurements
  - Keithley RF Switch and DP-AUX fully automated solution.
  - Selected measurements can be applied across all test permutations (SSC,CTLE's, swing, rates, pre-emphasis, etc.) translates to **1728 measurements**.   DP12 will provide full user intervention free, automated testing. This is the killer value proposition.
  - Factory Automation API for full product control in silicon automation systems.
  - Complimentary Fixtures and Compliance Interconnect Channel HW defined by VESA make this package a full customer solution with no compromises.

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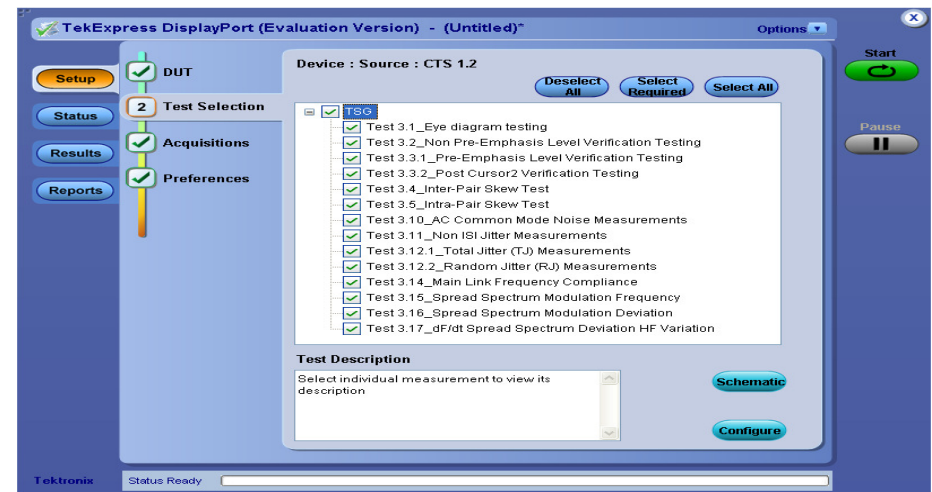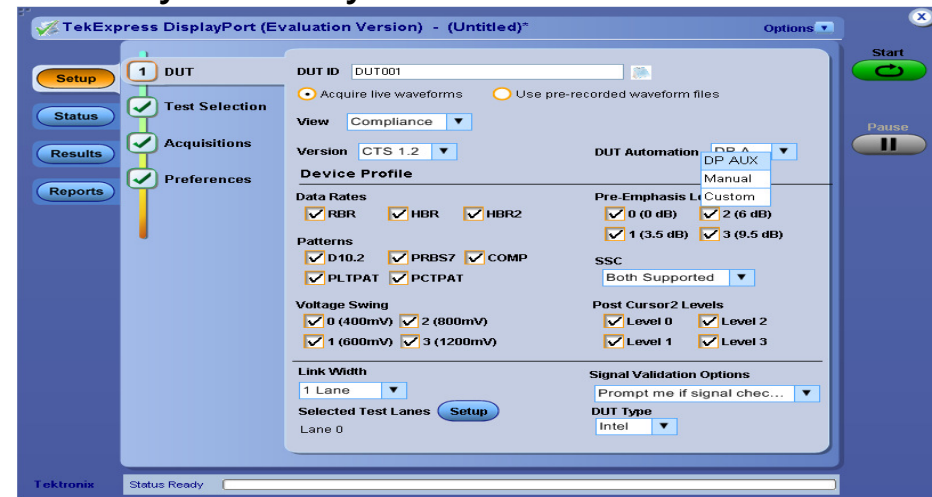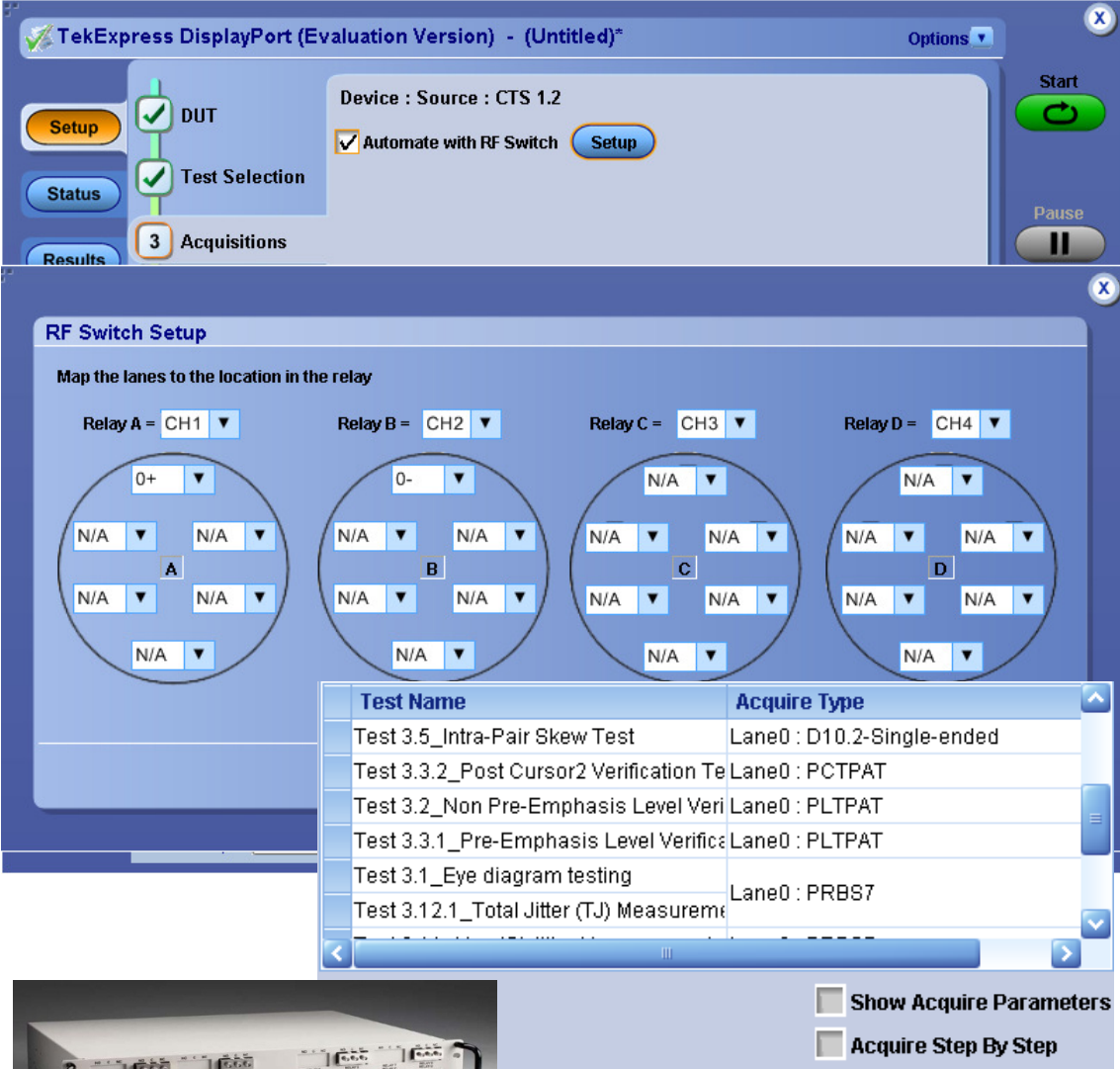
DisplayPort 1.2 Acquisitions

- DP1.2
  - Various signal interconnect methods are supported.
  - Direct TCA (SMA input) on user selected channels.
  - Differential Probe (P7313SMA) inputs for true 4 channel concurrent interconnect. (No single ended measurements)
  - 24:4 Keithley RF Switch allows fully automated control of all 8 single ended inputs for hands free comprehensive testing.

- Test Patterns
  - Automatic verification of test patterns (which can be disabled) ensures the correct patterns are used for the correct test under manual operation.

TIF - Validating Next Generation Display Interfaces

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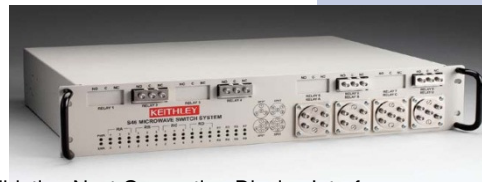
Conventional Display Port Fixtures + CIC

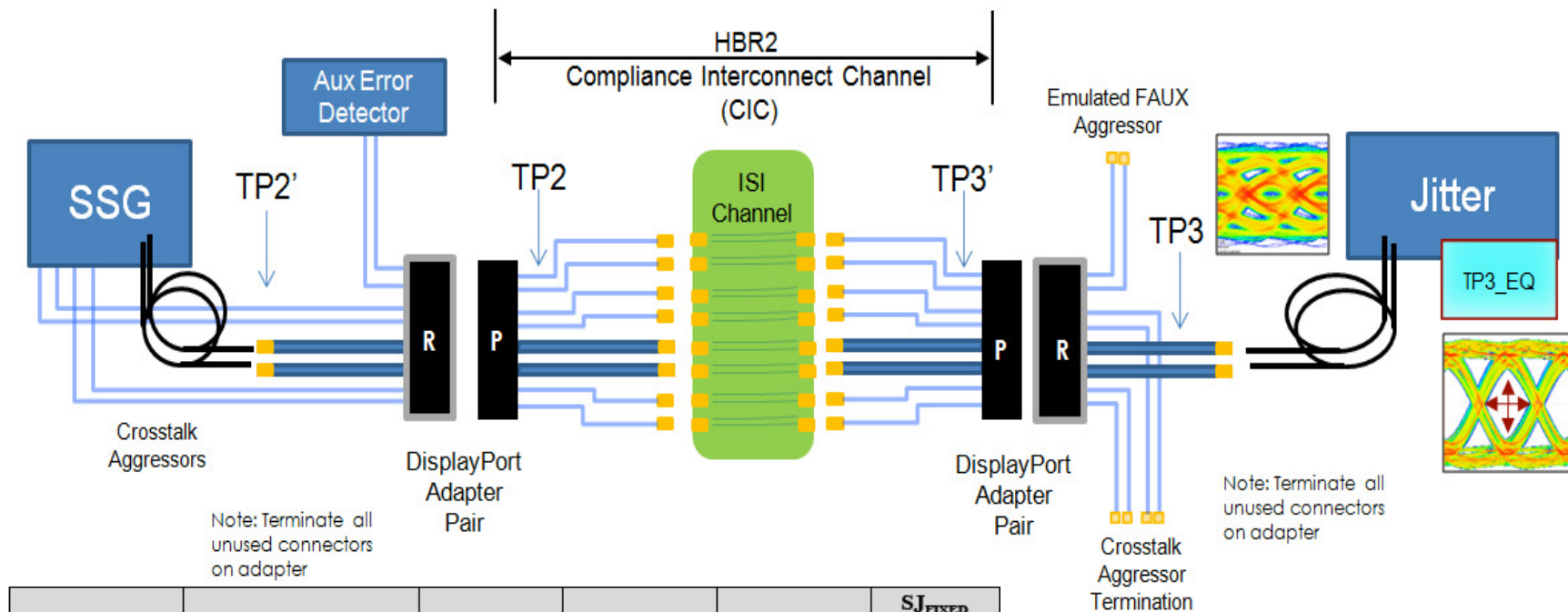- Partnership with Wilder Technologies to design and channel high performance DP fixtures
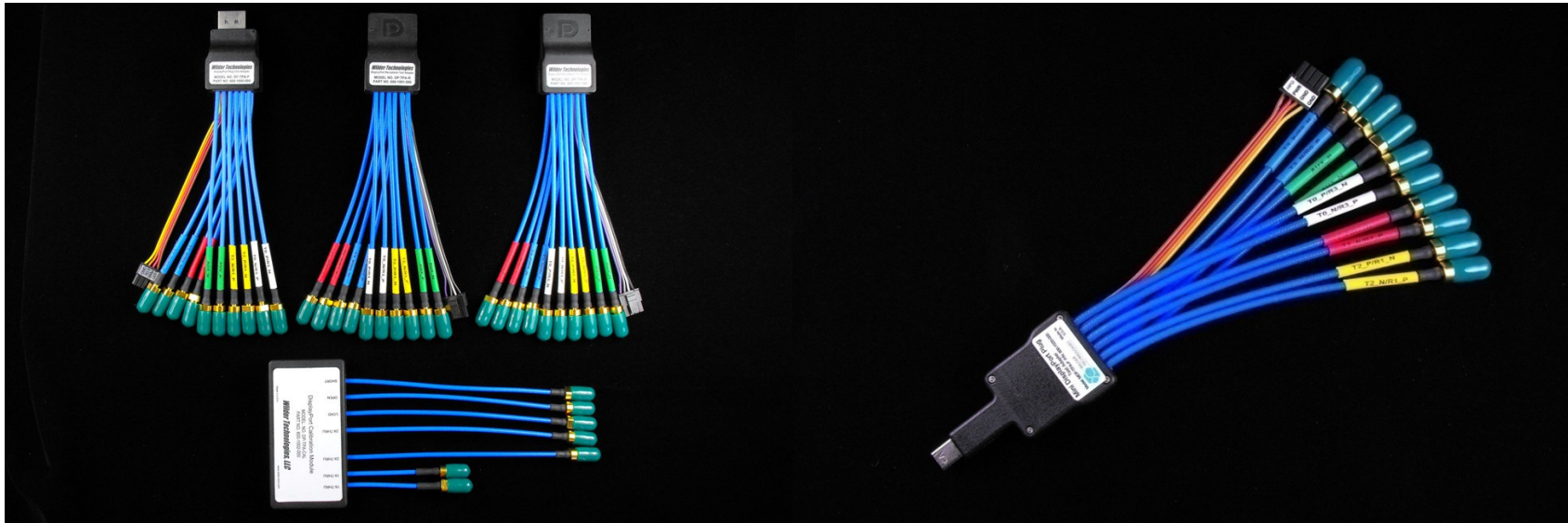
- Wilder TF-DP-TPA-PRC fixtures and CIC and fixtures

  available directly from Tektronix
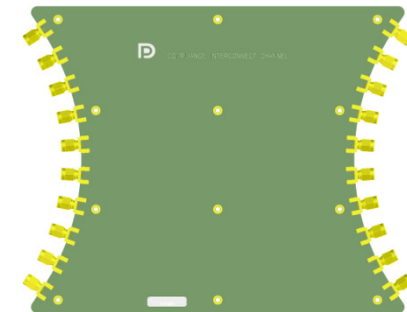
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DisplayPort 1.2
Sink (Rx) Test Overview

Receiver testing is performed with a Tektronix BSA125C BertScope and Wilder HBR2 ISI Channel.   BER observation times range from 37 seconds 10.5 minutes depending on the data rate and jitter frequency being tested. e version 1.2 CTS outlines 17 Tx validation tests which are typically evaluated with a 12.5GHz or higher bandwidth oscilloscope.

f(SJ)	TJ(JTHBR2rx)	ISI	RJ(RMS)	Approximate SJ$_{SWEEP}$	SJ$_{FIXED}$ @ 200MHz
[MHz]	[mUI]	[mUI]	[mUI]	[mUI]	[mUI]
2	1026	220	16.7	505	100
10	636	220	16.7	116	100
20	624	220	16.7	104	100
100	620	220	16.7	100	100

TIF - Validating Next Generation Display Interfaces

DisplayPort 1.2
Sink (Rx) Test Observation Time

Four Principal Test Frequencies at 2, 10, 20 and 100 MHz SJ

Table 4-1: Test Parameters for BER Measurement

| Data Rate	Jitter Frequency	Number of Bits	Max Num of Bit Errors Allowable	Observation Time[1] (seconds)	Data Rate Offset
HBR2				HBR2 =185s	
HBR	2 MHz	10^{12}	1000	HBR=370s	0
RBR				RBR=620s	
HBR2				HBR2=19s	+350ppm
HBR	10 MHz	10^{11}	100	HBR=37s	+350ppm
RBR				RBR=62s	+350ppm
HBR2				HBR2=19s	
HBR	20 MHz	10^{11}	100	HBR=37s	0
RBR				RBR=62s	
HBR2	100 MHz	10^{11}	100	HBR2=19s	0
HBR				HBR=37s	
*To evaluate multiply number of bits by the unit interval in ps. (i.e. for HBR: 10^{11} bits at HBR = 370ps/UI * 10^{11} UI = 37 seconds*					

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BertScope Receiver Test Solution

Typical Configuration

- **BertScope BSA85C**
  - Option STR
- **DPP125A (no 4T needed)**
- **BSA12500ISI**
- **DP-AUX**
- **TF-DP-CIC-C1**
  - Wilder DP 1.2 ISI Board

High End Configuration
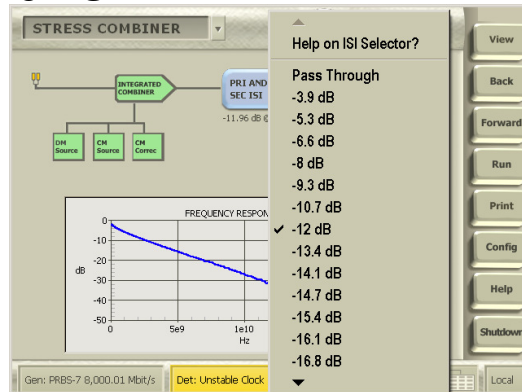

To DUT

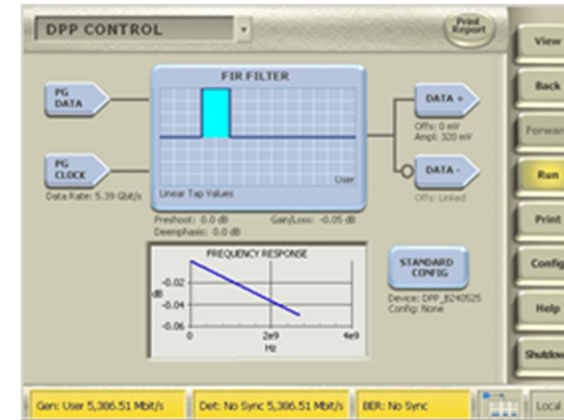TIF - Validating Next Generation Display Interfaces
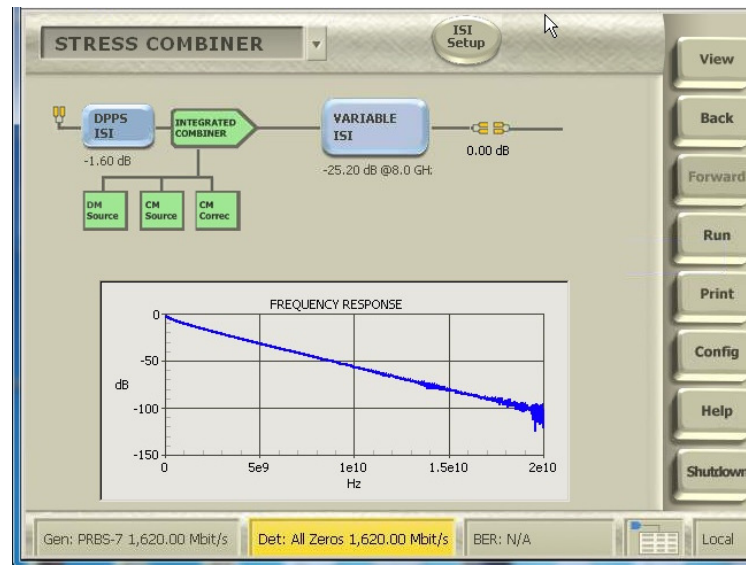
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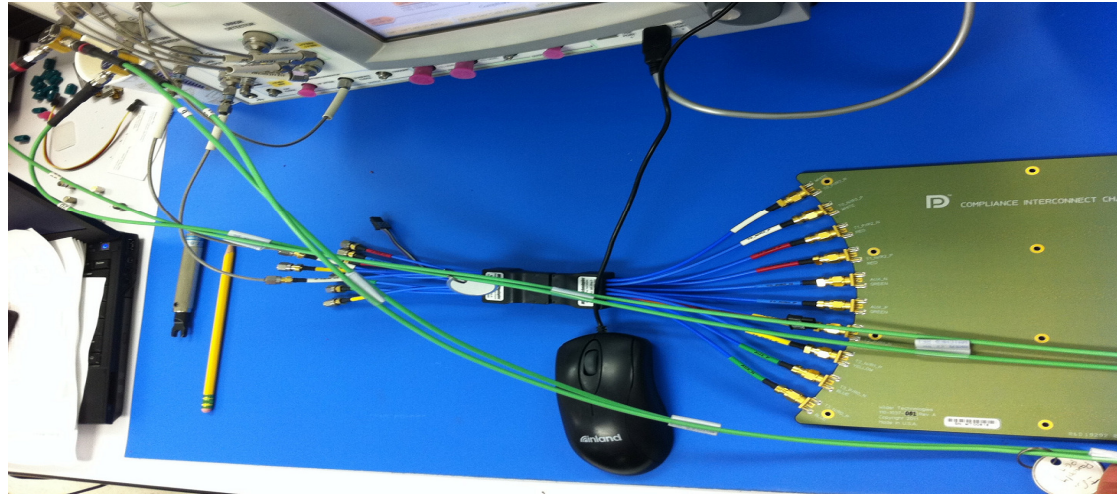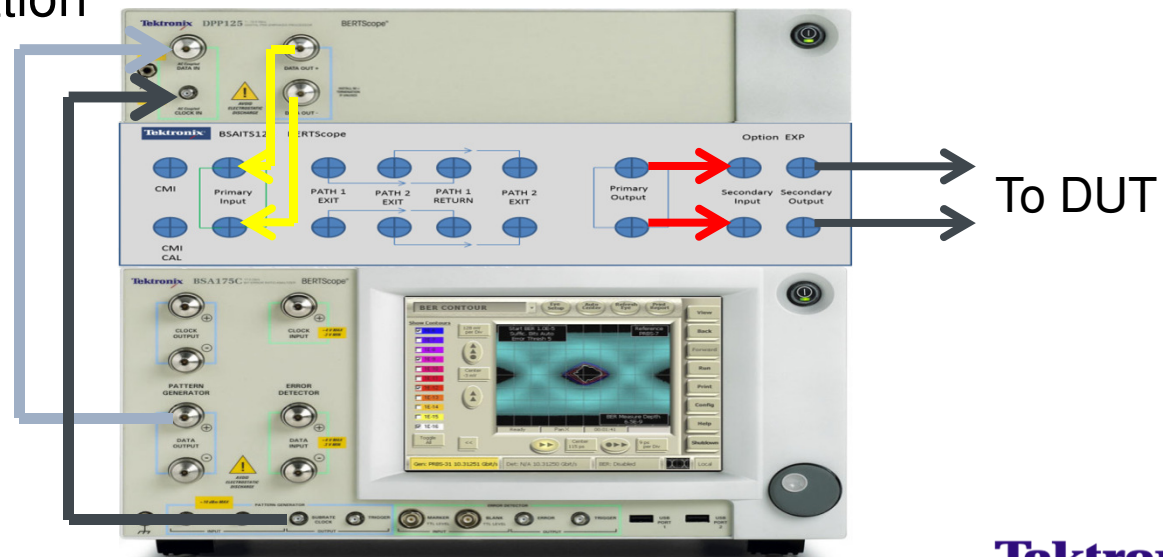
DisplayPort 1.2 -High end BeRTScope configuration

BSAITS125 generates multiple, fixed selections for ISI…

Use BERTScope DPPB or DPPC to generate low pass filter to fine tune ISI

On BSAITS GUI, you can simply dial in the amount of ISI needed…and DPP and BSAITS will adjust to generate requested ISI…

- Can automate calibration when using BSAITS with DPP
- Can precisely tune ISI at all data rates
- Can generate additional ISI to test margin of DUT

TIF - Validating Next Generation Display Interfaces

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# DisplayPort 1.2 -High end BeRTScope configuration

RBR ISI created using BSAITS
and DPP125B

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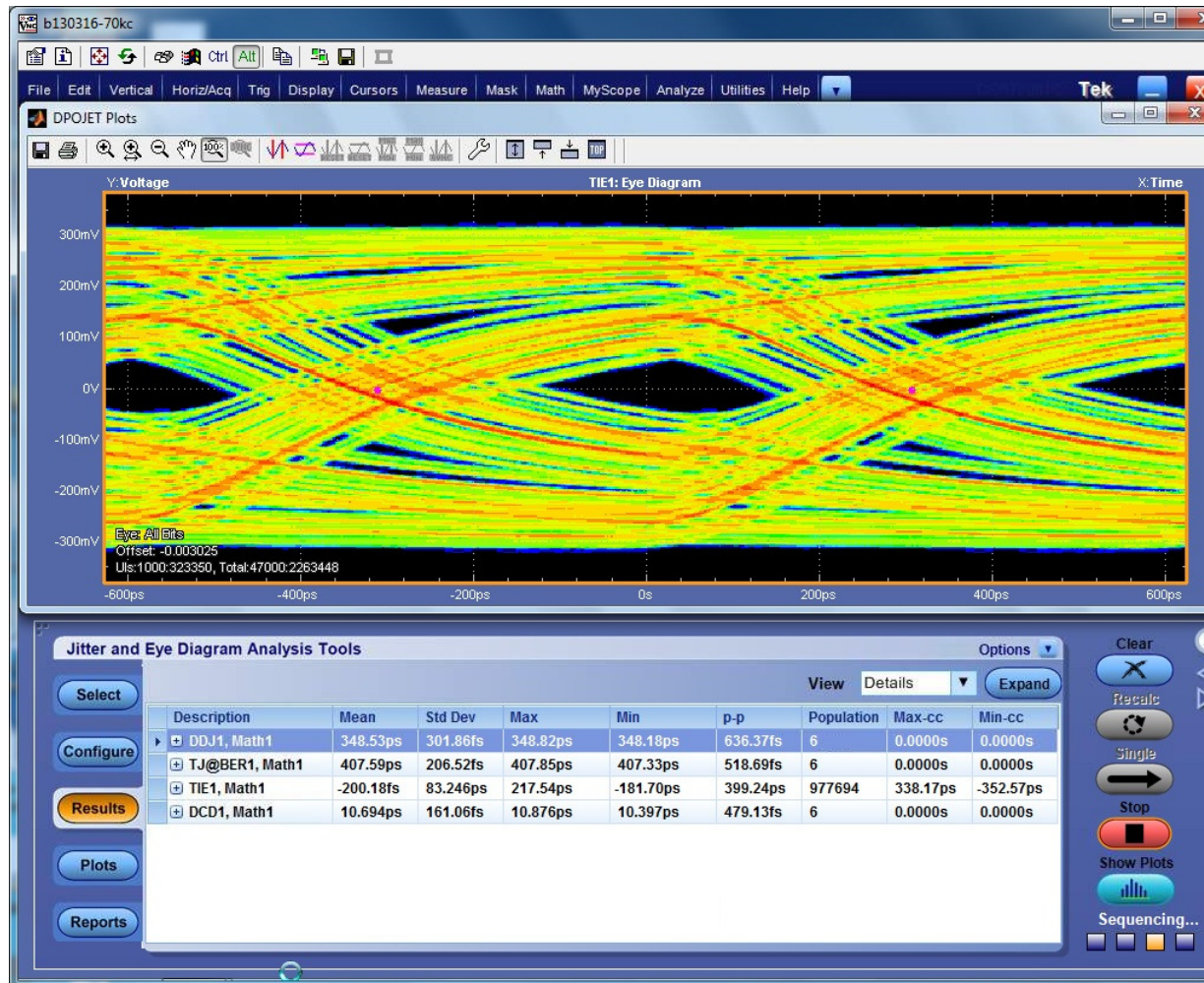
Embedded Display Port-eDP

Option EDP is designed to provide component and system designers with a comprehensive verification and debug solution the latest Embedded DisplayPort Specification 1.4.

Using the familiar DPOJET look and feel the user can select the setup based on their specific measurements requirements. In addition, as the 1.4 specification allows the data rate to be anywhere within a range of speeds from RBR to HBR2 rates opt EDP will provide the dynamic mask generation required to ensure proper testing

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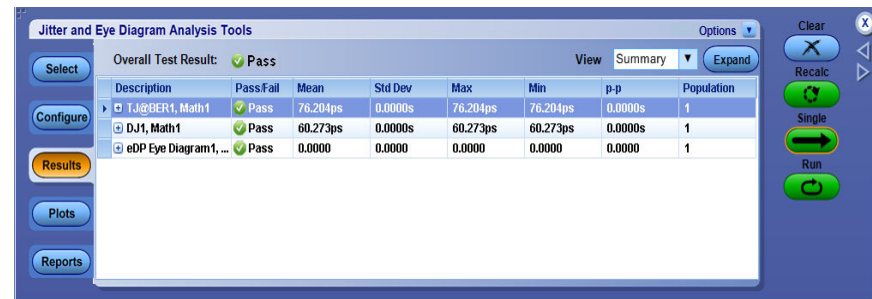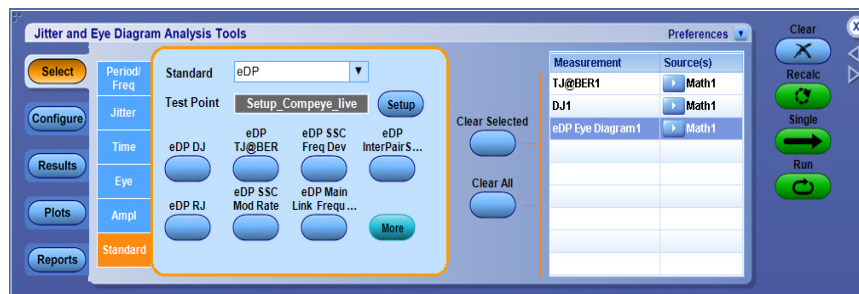
Embedded Display Port-eDP Typical connection

eDP source measurements:
Test 3.1 - Eye Diagram Test
Test 3.2 - Inter Pair Skew test
Test 3.3 - Non-ISI Jitter Measurements
Test 3.4 - Total Jitter
Test 3.5 - Deterministic jitter
Test 3.6 - Random Jitter
Test 3.7 - Main Link Frequency Stability
Test 3.8 - Spread Spectrum Modulation Frequency
Test 3.9 - Spread Spectrum Modulation Deviation

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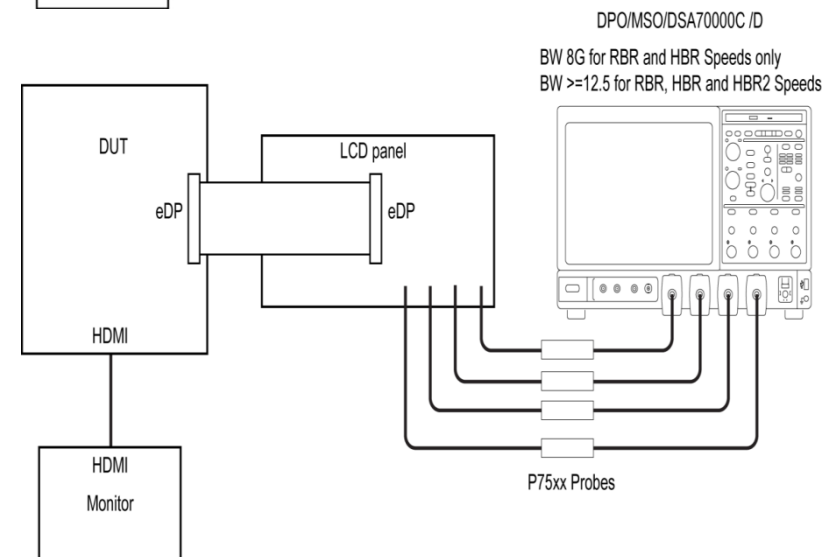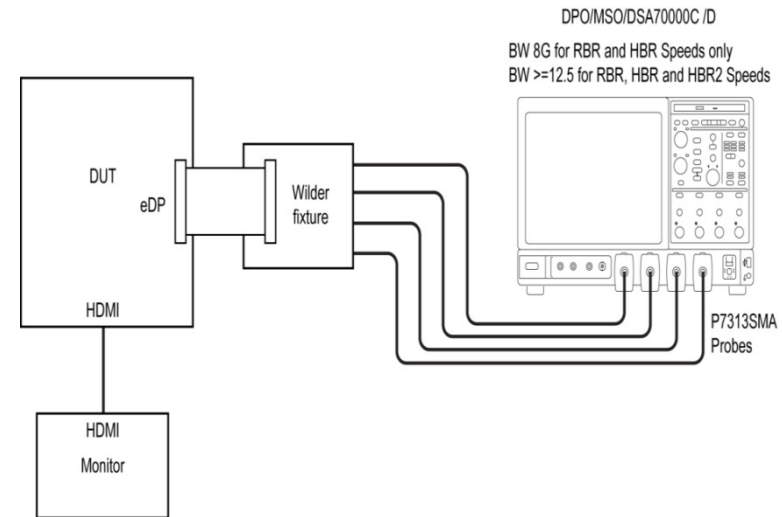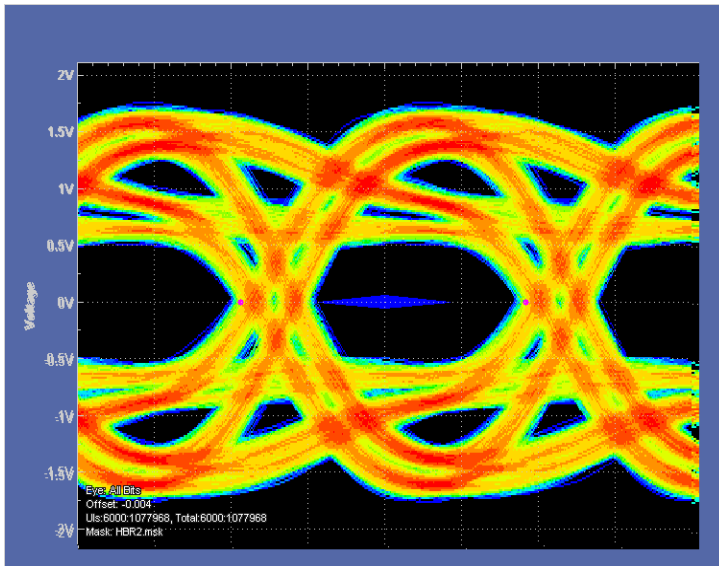
Embedded Display Port-eDP

Oscilloscope Requirements

Option EDP requires a DPO/DSA/MSO 70K scope running firmware version 6.4.0 or higher and DPOJet version 6.0 or higher.

For customers testing RBR (1.62 Gb/sec) and HBR (2.7 Gb/sec) a minimum bandwidth of 8Ghz is required.
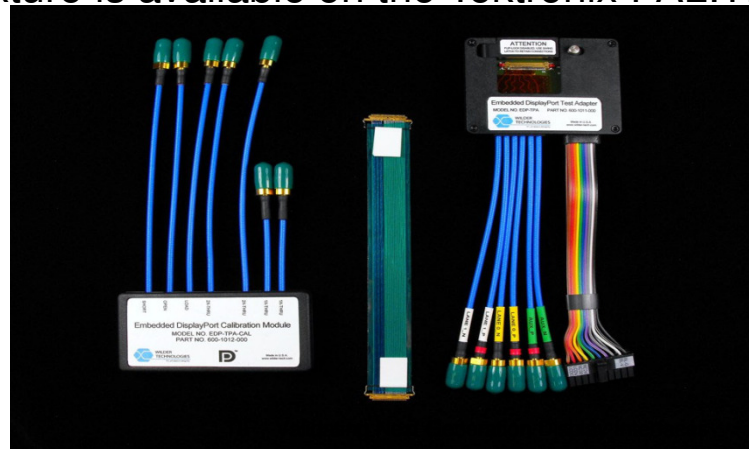
For customers testing HBR2 (5.4 Gb/sec) a minimum 12.5GHz BW is required.

Probing

For customers testing RBR (1.62 Gb/sec) or HBR (2.7 Gb/sec) Qty 4 P7380 or P7380SMA are required if testing more then two lanes at one time.

For customers testing HBR2 (5.4 Gb/sec) and HBR (2.7 Gb/sec) and RBR (1.62 Gb/sec) Qty 4 P7313 or P7313MA are required if testing more then two lanes at one time.

An optional eDP fixture is available on the Tektronix PAL:TF-EDP-TPA-PRC

Complete Tektronix DisplayPort Instrument Portfolio

Receiver/Sink Tests (Characterization) Receiver Silicon characterization and compliance testing capability to 26Gbps	**BSA125C** with JMAP and SSC and HW Options DPP 125A and CR125A provide support for future bit-rates (12-26G) with a unique portfolio of Scope and Bert combined features.	
DP Channel Tests Source and Sink electrical channel performance, Crosstalk, Impedance and return loss. High Dynamic Range instrument	**DSA8300** 80E10 TDR Sampling Module for DSA8200 Sampling Scope S-Parameter Analysis Software 80SICON Software	
Cable Tests Cable crosstalk, skew and frequency domain measurements, sdd21, sdd11.	**DSA8300** 4X 80E08 TDR Sampling Module for DSA8300 Sampling Scope	
Transmitter/Source Tests Signal timing stability and SSC analysis, Transmitter AC parametric, Jitter, Amplitude.	**DSA71254C** DPOJET Jitter Analysis software SMA Adapters TCA-SMA 2 per scope Differential SMA Probe P7313SMA (optional) + DP-AUX controller + DP12 (Sw Option)+Option eDP	

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High-Speed Serial Data Test Solutions

Design	Verification	Compliance Test

PCI EXPRESS | SERIAL ATA | SUPERSPEED USB | ddr3 | GbE DisplayPort | HDMI | MHL …

Tx + | + **Interconnect** | + | + **Rx**
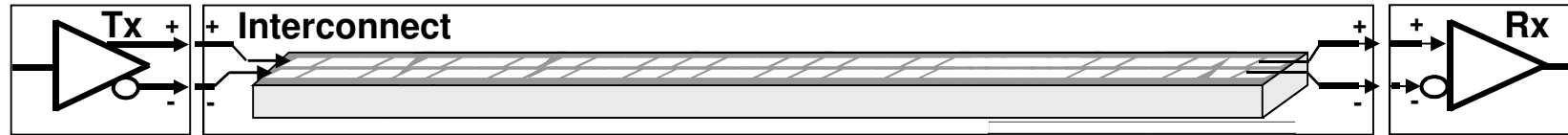
Logic Analyzers

Real-time Scopes

System Integration
Digital Validation & Debug

Transmitter Testing

Receiver Test
Margin Testing

Probing Fixtures
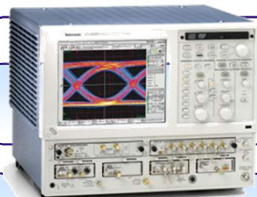
Arbitrary Waveform Generator

Interconnect Test

Sampling Scopes

Compliance Test

Compliance Test Software

TIF - Validating Next Generation Display Interfaces

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Thank You for Attending

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