Tektronix, Inc.



# DisplayPort<sup>TM</sup> Standard

September 29, 2014

## Tektronix MOI for DisplayPort PHY CTS 1.2b Source Testing Using DSA/DPO/MSO70000 Series Oscilloscopes with TekExpress<sup>™</sup> DisplayPort Software

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## **MODIFICATION RECORD**

May 26, 2012 Version 0.8 (Draft1) – Initial draft submitted to VESA Test Implementation Group Dec 28, 2012 Draft 2 – Updated with Dual Mode and changes due to DP1.2b CTS release.

Sep 29, 2014 Draft 3 – Updated with AUX Eye Tests.

## **INTRODUCTION**

These Methods of Implementations describe the step-by-step calibration and procedures to perform DP 1.2 Source tests of the VESA DisplayPort Logo Compliance Program using the DSA/DPO/MSO 70000 Series Oscilloscopes by Tektronix in conformance with the DP1.2b Compliance Test Specification (CTS). Source tests are required to qualify a Sink product or silicon building block for Logo certification and listing on the DP Integrators List.

Formally, each test description in the CTS contains the following sections:

#### **Test Objective**

**Interoperability statement** 

**Test conditions** 

#### Measurement requirements and

#### Pass/fail criteria

1) This MOI reduces the CTS test description to practice using the specified test equipment and procedures.

## REFERENCES

The following specification is referenced in this document:

• DP PHY CTS1.2b, October, 2012

The most current version of above document is available to VESA members at the following website: <u>http://www.vesa.org/join-vesamemberships/member-downloads/</u>

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### Source PHY Tests (CTS1.2b Section 3)

#### 1. Introduction

This MOI (Method of Implementation) provides the test procedures for testing DisplayPort Source to the DP1.2b Compliance Test Specification (CTS). The purpose of the document is to provide the approved test equipment, test connections and setup, and procedures for the DP1.2 compliance program. Review and approval of compliance test procedures for DisplayPort is the responsibility of VESA's DisplayPort Test Implementation Subgroup.

The test procedures in this document are only the Normative (or required) tests in the DP 1.2b PHY CTS. For informational tests, refer to the test equipment vendor's documentation.

#### 2. Test Pre-test Procedures

Prior to making any measurements, the following steps must be taken to assure accurate measurements:

- Allow a minimum of 20 minutes warm-up time for oscilloscope.
- Run scope SPC calibration routine. It is necessary to remove all probes from the scope before running SPC.
- If using probes, perform the probe calibration defined for the specific probes being used.
- Perform deskew to compensate for skew between measurement channels.
- Make sure you use a torque wrench to make all SMA connections.

#### 3. PHY CTS 1.2b Source Testing Overview

This section describes the procedure for testing the DisplayPort Source electrical parameters. This testing is required for all ports on a device under test. The DP electrical parameters are as specified by Section 3 of the CTS. The PHY CTS 1.2b is available to VESA members at <u>www.vesa.org</u>.

Tektronix offers probing and automation software used for testing DisplayPort, which is used for this procedure.

This document covers the following PHY CTS1.2b tests:

- 3.1. EYE Diagram Testing
- 3.2. Non Pre-Emphasis Level Verification Testing
- 3.3. Pre-Emphasis Level Verification and Maximum Differential Pk-Pk Output Voltage
- 3.4. Inter-Pair Skew Test
- 3.11. Non ISI Jitter
- 3.12. Total Jitter (TJ) and Random Jitter (RJ/DJ)
- 3.14. Main Link Frequency
- 3.15. Spread Spectrum Modulation Frequency (If DUT supports SSC)
- 3.16. Spread Spectrum Modulation Deviation (If DUT supports SSC)
- 3.18. Dual-mode TMDS Clock (If DUT supports Dual-mode)
- 3.19. Dual-mode EYE Diagram (If DUT supports Dual-mode)

#### 4. Test Objective

Refer to the DisplayPort PHY CTS 1.2b for detailed test objectives for each test. Each section of the CTS links back to the DisplayPort 1.2 Standard.

#### 5. Test Conditions

The PHY CTS describes in detail the test requirements and algorithms required for meeting the specification. The following table summarizes the test conditions for the tests in CTS 1.2b.

Test ID	RBR (1.62Gb/s)	HBR (2.7Gb/s)	HBR2 (5.4Gb/s)
3.1 Eye Diagram Test			
Test Point	TP2	TP2	TP3_Eq
Pattern	PRBS-7	PRBS-7	2520 Bit HBR2 Compliance Eye
			Pattern
Swing/Pre-Emphasis /PostCursor2	2/0/0	2/0/0	Provided by DUT Owner for
			Passing Condition
SW Channel	NA	NA	0 Length & Worst Case
SSC	On and Off if DUT Supports	On and Off if DUT Supports	On and Off if DUT Supports
3.2 Non-Pre-Emphasis Level			
Test Point	TP2	TP2	TP2
Pattern	PRBS-7	PRBS-7	80 Bit PLTPAT
Swing/Pre-Emphasis /PostCursor2	A11/0/0	All/0/0	A11/0/0
SSC	Both On/Off if DUT Supports	Both On/Off if DUT Supports	Both On/Off if DUT Supports
3.3.1 Pre-Emphasis Level			
Maximum Differential Pk-Pk			
Output Voltage			
Test Point	TP2	TP2	TP2
Pattern	PRBS-7	PRBS-7	80 Bit PLTPAT
Swing/Pre-Emphasis /PostCursor2	All/All/0	All/All/0	All/All/0
SSC	On and Off if DUT Supports	On and Off if DUT Supports	On and Off if DUT Supports
3.4 Inter-pair Skew			
Bit Rate	Highest Bit Rate Supported		

Test Point	TP2		
Pattern	PRBS-7 or DUT dependent custom pattern		
Swing/Pre-Emphasis /PostCursor2	2/0/0		
SSC	On and Off if DUT Supports On and Off if DUT Supports On and Off if DUT Supports		
3.11 Non-ISI Jitter		·	
Test Point	TP2	TP2	NA
Pattern	PRBS-7	PRBS-7	NA
Swing/Pre-Emphasis /PostCursor2	All/All/0	All/All/0	NA
SSC	On and Off if DUT Supports	On and Off if DUT Supports	NA
<b>3.12.1 Total (TJ) and</b>			
Deterministic (DJ) Jitter			
Test Point	TP2	TP2	TP3 Eq
Pattern	PRBS-7	PRBS-7	2520 Bit HBR2 Compliance Eye
			Pattern
Swing/Pre-Emphasis /PostCursor2	2/0/0	2/0/0	Provided by DUT Owner for
			Passing Condition
SW Channel	NA	NA	0 Length & Worst Case
SSC	On and Off if DUT Supports	On and Off if DUT Supports	On and Off if DUT Supports
3.12.2 HBR2 D10.2 TJ/RJ/DJ			
Test Point	NA	NA	TP3 Eq
Pattern	NA	NA	D10.2
Swing/Pre-Emphasis /PostCursor2	NA	NA	Same Setting as Passing Eye/Jitter
SW Channel	NA	NA	0 Length & Worst Case
SSC	NA	NA	On and Off if DUT Supports
3.14 Main Link Frequency			••
Test Point	TP2	TP2	TP2
Pattern	D10.2	D10.2	D10.2
Swing/Pre-Emphasis /PostCursor2	2/0/0	2/0/0	2/0/0
SSC	On and Off if DUT Supports	On and Off if DUT Supports	On and Off if DUT Supports
			••
3.15 SSC Modulation Frequency	NA if SSC not supported	NA if SSC not supported	NA if SSC not supported
3.16 SSC Modulation Deviation			
Test Point	TP2	TP2	TP3 Eq
Pattern	D10.2	D10.2	D10.2
Swing/Pre-Emphasis /PostCursor2	2/0/0	2/0/0	2/0/0
SSC	On	On	On
3.18 Dual Mode TMDS Clock			
3.19 Dual Mode Eye Diagram			
Test Point	TP2		
Pattern	TMDS		
TMDS Clock Rate	Maximum TMDS Frequency Supported		

#### Table 1: PHY CTS 1.2b Source Test Conditions

#### 6. Required Equipment for DP1.2b PHY CTS Source Testing

The Following Equipment is required for DisplayPort Source Testing:

- 1 ea. Tektronix DSA/MSO/DPO70000 Series Oscilloscope (8GHz and above) with the following software:
  - DPOJET (Jitter and Eye Analysis Tools) software
  - TekExpress<sup>TM</sup> DisplayPort automation Software Opt. DP12

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

- 4 ea. pairs of 1 meter, phase-matched SMA cables for a four lane Source. The number of phasematched cables is equivalent to the number of lanes the Source supports.
- 1 ea. pair of SMA cables, phase matching not required.
- 4 ea. P7380SMA or P7313SMA Differential Probes.

- Alternatively, lanes can be tested one at a time using direct SMA input to the Oscilloscope or automated with an RF Switch.
- 1 ea. Wilder, LUXSHARE-ICT, or equivalent VESA approved DP test fixture.
  - Note: If the DUT supports Dual Mode, then a 6-pin Low Speed Connector is required on the fixture. For Example: Wilder DPI-TPA Adapter. This will be used for Dual Mode testing later in this MOI.
- 1 ea. DP-AUX Controller if the Source DUT supports automated testing using DPCD-based control.



6.1. DSA/MSO/DPO70000 Series Oscilloscope (8GHz or above)

Figure 1: DSA/MSO/DPO70000 Series Oscilloscope

#### 6.2. TekExpress DP Automation SW and DPOJET

The TekExpress DP SW-DP12 automates all the measurements in the CTS. In two port TBT devices, Reduced Bit Rate (RBR - 1.62Gb/s) and High Bit Rate (HBR - 2.7Gb/s) 'tunneling' is supported. The TekExpress DP automation software -DP12 also supports High Bit Rate 2 (HBR2- 5.4Gb/s), which is not supported by Thunderbolt.

#### 6.3. P7313SMA Differential Probes

The P7313SMA or P7380SMA probe provides differential SMA input to the Tektronix 70000 Series scope. Either probe can be used for DisplayPort and DP++ testing. However, if you intend on testing HDMI sources as well, the P7313SMA probe is required as it provides the 3.5V termination voltage required for HDMI signals. An alternative to differential probes is to use a RF Switch to automatically switch between acquisition channels. The TekExpress SW supports differential probes or Keithley RF Switch for Automation.



#### Figure 2: P7313SMA Probe

#### 6.4. VESA Approved Test Fixtures

The following diagram shows approved test fixtures for DP Source testing as of the writing of this document. Refer to the following website for a full list of approved fixtures: http://www.vesa.org/displayport-developer/certified-components/

Approved Mini-DP Fixtures:

- Wilder: mDP-TPA-P or RevA DPI-TPA-P with DPI-TPA-A Aux Control Board
- LUXSHARE-ICT: TFD-3P38

Approved Standard DP Fixtures:

- Wilder: DP-TPA-P or RevA mDPI-TPA-P with DPI-TPA-A Aux Control Board
- LUXSHARE-ICT: TFP-13P3



mDP-TPA-P



DPI-TPA-P





Figure 4: LUXSHARE-ICT DP Plug Adapters

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#### 6.5. TekExpress DP Automation SW and DPOJET

The TekExpress DP SW-DP12 automates all the measurements in the DP1.2 CTS Specification. In two port TBT devices, Reduced Bit Rate (RBR - 1.63Gb/s) and High Bit Rate (HBR - 2.7Gb/s) 'tunneling' is supported. The TekExpress DP automation software -DP12 also supports High Bit Rate 2 (HBR2 - 5.4Gb/s), which is not supported by Thunderbolt.

V TekExpress DisplayPort -	(Untitled) Options	8
Setup 1 DUT Status 2 Test Selection 3 Acquisitions 4 Preferences	DUT ID DUT001       Image: Compliance in the second decision of the second	Pauge
Tektronix Status Ready		

Figure 5: TekExpress DisplayPort Software-DP12

6.6. DP-AUX Controller and SW Utility

	DisplayPort AUX Control 0: Ready	🔀 💝 DP-AUX Debug Console 📃 🗖 🔀
	Ele Command Debug Test Help	File Edit
	Source Test         Sink Test         Diagnostics         AUX Debug           Silicen Type         Ext Test Mode           DUT Settings         Ext Test Mode           - Data Rate         @ 400 mV         600 mV           Q 27/Cbap (HBR2)         Q 400 mV         1200 mV           1 6 Gole (RBR)         0 1 9 mV         1200 mV	03. Flag: F > 151K Mem Wr. Addr: 02248. 1 Byte. ▲ 0. 1 Bay P 1 Bay P 1 Bay P 1 Bay P 1 Bay P 1 Bay P 1 Bay P 2 Strike Mem Wr. Addr: 0003. 1 Byte. 0 0000 0 0 0000 M 1 Bay P 2 Strike Mem Wr. Addr: 00205. 1 Byte. 0 1 Flag: P 2 Strike Mem Wr. Addr: 00201. 1 Byte. 0 Flag: F 0 Flag: F 0 Strike Mem Wr. Addr: 00201. 1 Byte.
Contract of the second second	Otas Patem         Pie emphasis                ● D102             ● None             ● O 35.68               ○ 55.68                 ● PRBS7          ● St.68               55.68                 ● PCTPAT          ● Post Cursor2 Level               bevel 3                 ● HTPAT          ● Level 3               Level 3	<pre>&gt;: 3 Dic Mem Wr, Addr: 00218 : 1 Byte. &gt;: 1 Byte. Mem Wr, Addr: 00219 : 1 Byte. 4 : Flag: F : 1 Byte. : 2 : 1 Byte. : 3 : 1 K Mem Wr, Addr: 00109 : 1 Byte. : 3 : 1 K Mem Wr, Addr: 00109 : 1 Byte. : 3 : 1 K Mem Wr, Addr: 00109 : 1 Byte. : 3 : 1 K Mem Wr, Addr: 00100 : 1 Byte. : 5 : 1 K Mem Wr, Addr: 00100 : 1 Byte. : 5 : 1 K Mem Wr, Addr: 00100 : 1 Byte. : 5 : 1 K Mem Wr, Addr: 00100 : 1 Byte. : 5 : 1 K Mem Wr, Addr: 00100 : 1 Byte. : 5 : 1 K Mem Wr.</pre>
Community instruments and the community of the community	SSC © Enable Deable Executing Source Test: Completed	<pre>-&gt; : Sink Men Wr. Addr: 00218, 1 Byte. 02, Flag: F &gt;: Sink Men Wr. Addr: 00218, 1 Byte. &gt;&gt; : Sink Men Wr. Addr: 00218, 1 Byte. &gt;&gt; : Sink Men Wr. Addr: 00246, 1 Byte. 01, Flag: F &gt;: Reg Wr. Addr: 07, Data: 00 00 00 01 4</pre>

Figure 6: DP-AUX Controller and SW Utility

#### 7. DP Source Test Setup

The following diagram shows the connections for mini-DP DUT, Fixture, Oscilloscope, and AUX controller for automated testing. Connection for standard DP testing will follow the same connection diagram only with the appropriate adapter.



Figure 7: DUT Connection Example for DP Testing

#### 8. Connecting to the DUT for testing

- 1. Plug HPD Connection from DP test adapter (Wilder as an example) into the Hot Plug Detect connector on DP-Aux controller.
- 2. Connect the differential SMA pairs on the DP test adapter to the oscilloscope using SMA cables as in the following table:

Oscilloscope Connection	Oscilloscope Probe	Wilder Adapter Cable/Connection
-	SMA Connection	Pairs
Channel 1	Channel 1 – '+'	$T0_P/R3_N$ – Positive White
	Channel 1 – '-'	$T0_N/R3_P$ – Negative White
Channel 2	Channel 2 – '+'	$T1_P/R2_N$ – Positive Red
	Channel 2 – '-'	T1_N/R2_P- Negative Red
Channel 3	Channel 3 – '+'	$T2_P/R1_N$ – Positive Yellow
	Channel 3 – '-'	T2_N/R1_P- Negative Yellow
Channel 4	Channel 4 – '+'	$T3_P/R0_N - Positive Blue$
	Channel 4 – '-'	T3_N/R0_P- Negative Blue
USB Connected DP-AUX	AUX(p)	AUX_P – Positive Green
	AUX(n)	AUX_N – Negative Green

- 3. Ensure the DUT is powered.
- 4. Attach USB cable from Oscilloscope USB port to DP-AUX controller.
- 5. Use DP-AUX SW utility on the scope to ensure that DPCD commands are properly controlling the DUT.

#### 9. Running the DisplayPort Compliance Tests

The following is the recommended test flow for a 4 lane Source that supports all swing and preemphasis levels. The testing is broken up into the following sub-sections.

- 1. **RBR/HBR Measurements** this section takes advantage of the DPCD Control over the AUX channel to capture all waveforms and performs all the required tests for RBR and HBR.
- 2. **HBR2 Measurements -** this section takes advantage of the DPCD Control over the AUX channel to capture all waveforms and performs all the required tests for HBR2 except for EYE and Jitter tests, which require a separate setup.
- 3. **HBR2 Eye and Jitter Measurements** this section uses the automation software to choose the Swing Level, Pre-Emphasis setting and PostCursor2 setup that is known by the DUT owner to pass the HBR2 Eye and Jitter Compliance limits.
- 4. **Dual Mode Measurements** this section describes how to put the DUT in a TMDS signaling mode at the proper resolution in order to make the Dual Mode (DP++) compliance measurements.

#### 9.1. RBR/HBR Measurements

This section takes advantage of the DPCD Control over the AUX channel to capture all waveforms and performs all the required tests for RBR and HBR. It is highly desirable to perform these tests with automation due to the number of test conditions that need to be performed. Full automation takes of an engineer's time to execute and removes human error from the DUT setup during testing. However, not all Sources support full automation. Thus, both automated and non-automated procedures are outlined below.

#### 9.1.1. RBR/HBR Measurements if the DUT supports Automation

If using full automation, execute the RBR/HBR/HBR2 tests as follows:

- 1. Connect the DUT as in Figure 5 above.
- 2. Select Analyze > TekExpress DisplayPort from the oscilloscope main menu.
- 3. From the (1) TekExpress DUT menu's default configuration, make the following selections:
  - a. Give the DUT an ID number, eg: DUT ID: HBR2\_DP\_DUT001
  - b. Under Data Rates, **Deselect HBR2**. HBR2 will be tested in the next sections.
  - c. Under Patterns, **Deselect COMP**, **PLTPAT**, and **PCTPAT**. These are the patterns associated with HBR2 testing; so do not need to be selected.
  - d. Deselect PostCursor2 Levels (all accept Level0).
  - e. Select Both Supported under SSC if the device supports SSC.
  - f. Select Link Width that the Device supports, e.g. if the device supports 4 lanes then select 4
  - g. Select DUT Automation to be DPAUX
  - h. Select DUT Type e.g. Intel, AMD or Default

The TekExpress DUT menu should look like the following diagram.

Stup 1 DUT   1 Dut	TekExpress DisplayPort - (	DP Dual Mode MOI Develp)*	Options •	) ×
Lane0Lane1Lane2Lane3	Setup 1 DUT Status Results Reports 1 DUT Test Selection 3 Acquisitions 4 Preferences	DUT ID HBR2_DP_DUT	Pre-Emphasis Levels         ✓ 0 (0 dB)       ✓ 1 (3.5 dB)         ✓ 2 (6 dB)       ✓ 3 (9.5 dB)         SSC       Both Supported         ✓ Level 0       Level 2         Level 1       Level 3	Pause
		Lane0Lane1Lane2Lane3		J

Figure 8: TekExpress DP DUT Setup For RBR/HBR Automated Tests

- 4. Select (2) Test Selection from the TekExpress DisplayPort menu and make the following selections:
  - a. **Deselect Test 3.17 dF/dT SSC.** This test is not required by the PHY CTS 1.2b.

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- b. **Deselect DisplayPort++.** This test will be made later in the procedure.
- c. Deselect Aux Channel Test. This test will be made later in the procedure.

*Note: If HBR2 is the highest supported rate then deselect test 3.4, 3.15 and 3.16 these test will be done at the HBR2 rate.* 

The TekExpress Test Selection menu should look like the following diagram.



#### Figure 9: TekExpress Test Selection Menu for RBR/HBR Tests

5. Press the Start button in TekExpress. This starts the automated testing.



Figure 10: TekExpress Start Button

6. Click ok after verifying user action required is completed (lane to channel connections).



Figure 11 - User action required

- 7. From this point on, all the waveforms and measurements will be made automatically.
- 8. Skip to Section 9.1.3 to save and report results.

#### 9.1.2. RBR/HBR Measurements without Automation

If using the DP-AUX controller with manual control or DUT vendor specific tool for controlling Data Rate, Swing, and Pre-Emphasis Levels, follow this procedure:

1. Follow all the steps in the previous section up to Step 6 with the exception of in Step 3, Select **Manual** under DUT Automation in the (1) **DUT** menu.

DUT Automat	ion
Manual	v

Figure 12: Select Manual under DUT Automation in the DUT Menu

- 2. After the Start Button is pressed, and the SW initializes, the following dialog will appear.
- 3. Ensure that the probes are connected as described in the following figure.
- 4. Press OK



Figure 13: TekExpress Probe Connection Dialog

**NOTE:** Make sure that the proper polarity is observed between the fixture and the probes, otherwise the SW will not recognize the proper pattern for testing.

5. Set DisplayPort DUT's *Bit rate, Swing, Pre-emphasis,* and *Test Pattern* values as requested in the *TekExpress: User action required* pop-up dialog shown in the following figure:

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ess DisplayPort - (Untitled)*			Options
Test Status Log View			
Test Name	Acquisition	Acquire Status	Analysis Statu
Lane0			
Test 3.1.2_Max Differential Voltage	COMP-EYE	To be started	To be started
Test 3.1_Eye diagram testing	COMP-EYE	To be started	To be started
Test 3.12.1_Total Jitter (TJ) Measurements	COMP-EYE	To be started	To be started
Test 3.14_Main Link Frequency Compliance	010.2	To be started	To be started
Test 3.15_Spread Spectrum Modulation	D10.2		To be studied
Frequency	User action required		to be started
Test 3.16_Sprea			To be started
	and the full the low south the fail	and the second se	
Test 3.2_Non Pr Verification Test	ure the DUT to transmit the folk S7 at 2.7Gb/s dB Level 0. SSC: NoSSC	owing:	To be started
Test 3.2_Non Pr Verification Test Test 3.3.1_Pre-E Testing	ure the DUT to transmit the folk S7 at 2.7Gb/s : dB Level 0, SSC: NoSSC g: Swing Level 2, PostCursor2 k	owing: rvel: Level0	To be started
Test 3.2_Non Pr Verification Test Test 3.3.1_Pre-E Testing Test 3.1_Eye de	ure the DUT to transmit the folk S7 at 2.73b/s dB Level 0, SSC: NoSSC g: Swing Level 2, PostCursor2 k	oving: ovet: LevelO	To be started To be started To be started
Test 3.2_Non Pr Verification Test Test 3.3.1_Pre-E Test 3.1_Eye de Test 3.11_Non IS	ure the DUT to transmit the folk \$7 at 2.7Gb/s 48 Level 0, SSC: NoSSC g: Swing Level 2, PostCursor2 k	owing: rvel: LevelO	To be started To be started To be started To be started
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Test 3.2_Non Pr Verification Test Test 3.3.1_Pre- Test 3.11_Von IS Test 3.21_Non Pr Verification Test Test 3.21_Totarten vor instruction Test 3.12_Totarten vor instruction Test 3.12_Max Differential Voltage	Jure the DUT to transmit the folk 57 at 27.8b/s dB Level 0, SSC: NoSSC g: Swing Level 2. PostCursor2 k	oving: ovel: LevvelO To be started	To be started To be started To be started To be started To be started To be started To be started
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Test 3.2_Non Pr Verification Test Test 3.3.1_Pre-E Test 3.1_Eye de Test 3.11_Eye de Test 3.11_Non B Test 3.2_Non Pr Verification Test Test 3.12_IT other and rest intervention Test 3.12_IT other and rest intervention Test 3.1_Inter-Emphasis Level Verification Test 3.1_Inter-Par Skew Test Lenel Test 3.1_Max Differential Voltage Test 3.1_Inter-Par Skew Test Lenel Test 3.1_Pre-Emphasis Level Verification Testing Test 3.1_Max Differential Voltage Test 3.1_Max Differential Voltage Test 3.1_Pre-Emphasis Level Verification Testing	PRBS7 PRBS7 PRBS7 PRBS7 PRBS7 PRDS7 PRBS7	To be started Started acquisito	To be started To be started
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Figure 14: User Action Required Dialog Box

**NOTE:** The TekExpress SW uses DP1.1 Standard language to describe the signal to be sent to the scope while the Calibrator software uses DP1.2 Standard language. The following figure shows how to translate DP1.1 to DP1.2 language:

DD1 1 I	DD1 A I
DP1.1 Language	DP1.2 Language
(Used by TekExpress prompts)	(Used by ThunderBolt
	Calibrator prompts)
Patterns:	
D10.2	D10.2
PRBS7	PRBS7
Data Rate:	
RBR	1.6G
HBR	2.7G
PreEmphasis dB:	PreEmphasis Level:
0 dB	0
3.5 dB	1
6 dB	2
9 dB	3
Voltage Swing Voltage:	Voltage Swing Level:
400 mV	0
600 mV	1
800 mV	2
1.2 V	3

#### Figure 15: User Prompts TekExpress vs. PHY CTS 1.2b

6. After entering the proper setting on the DUT Control SW, Press **OK** on the TekExpress Dialog.

- 7. After the first set of waveforms is captured on all channels, another 'User Action Required' dialog will appear asking you to setup the DUT for the next waveform.
- 8. Alternate between the DUT Control SW and the TekExpress dialog until all requested waveforms are captured. It will take approximately 30min. to capture all the waveforms needed for RBR/HBR.
- 9. From this point on, all the measurements will be made automatically.
- 10. Continue to Section 9.1.3 to save and report results.

#### 9.1.3. Saving and Reporting RBR/HBR Measurement Results

1. When all tests are completed, the Report will appear in the MS Explorer window on the oscilloscope.

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Innovation	IEKEX	Report					
DUT	D DUTADA	Report		2.2	Device		
Date/Time	April 28 2012 / 18:47-14		Execu	ition Time:	2 Hrs. 12 Min		
CTS Versio	1.2		200623			3.1	
<b>Overall Compliance Mode</b>	: TRUE						
Overall Test Resul	t Pass						
Scope Model	: DSA72004B		Scope F	/W Version:	5.3.4 BUILD 25	5	
Scope Serial Number	r: B110332	SPC, Factory Calibration: PASS;PASS					
Probe Model (CH1	): "P/313388	TekExpres	s version	(FW, App):	2.0.0.137, 1.1.0		
Probe Serial Number (CH1	- D021236		DPOL	et version.	3.3.0 Build 1/	105	
Probe Serial Number (CH2	: "B021252"						
Probe Model (CH3	0: "P7313 SMA"						
Probe Model (CH3 Probe Serial Number (CH3	): "P7313SMA" : "B021256"						
Probe Model (CH3 Probe Serial Number (CH3 Probe Model (CH4	): "P73135MA" : "B021256" : "P73135MA"						
Probe Model (CH3 Probe Serial Number (CH3 Probe Model (CH4 Probe Serial Number (CH4	9: "P73135MA" : "B021256" : "F73135MA" : "B021252"						
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Probe Model (CH3 Probe Serial Number (CH3 Probe Model (CH4 Probe Serial Number (CH4	1; P7313584* : P8021256* ; P79313584* : "B021252*						
Probe Model (CH) Probe Serial Number (CH3 Probe Serial Number (CH4 Probe Serial Number (CH4 Ints	: 'P7315844" : 'B021252' : 'P79315844' : 'B021252' Messurement Details	Measured value	Units	Test Result	Margin	Low	High
Probe Model (CH Probe Serial Number (CH Probe Serial Number (CH Probe Serial Number (CH Ints Test Name		Measured value	Units	Test Result Pass	Margin	Low Limit	High Limit
Probe Model (CHL Probe Serial Number (CHL Probe Serial Number (CHL Probe Serial Number (CHL Ints	1: P73135Ma* : P8021255* :: P793135Ma* :: P802252* Messurement Details Lane0 PRB57 RBR 05B NdSSC 800mV Lave0 Totaliv 20set MASKHITS TP2 (Fb;-1) Lane0 PRB57 RBR 05B NdSSC 800mV Lave0 Totaliv 20set MASKHITS TP2 (Fb;-1)	Measured value 0 0.872578272	Units #	Test Result Pass Pass	Margin 0 0.453	Low Limit	High Limit <= 0
Probe Model (CHI Probe Serial Number (CHI Probe Model (CHI Probe Serial Number (CHI Trost Name		Measured value 0 0.872579272 0.148013207	Units # UI UI	Test Result Pass Pass Pass	Margin 0 0.453	Low Limit	High Limit <= 0 <= 0.27
Probe Model (CHL Probe Serial Number (CHL Probe Model (CHL Probe Serial Number (CHL Ints Test Name	i: P73135Ma* ; P301255* ; P301255* ; P301255* ; P301252*  Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set MASKHITS TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set WASKHITS TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set UIDTH TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR TP2 (Fb-1) Lane0 PRB37 RBR 058 NSSC 500m/Level 10x4/v 20set TBBR 708 NSC 500m/Level 10x4/v 20set 708 NSC 500m/Level 10x4/v 20set 708 NSC 500m/Level 10x4/v 20set	Measured value 0 0.872579272 0.149013207 530.1977	Units # UI UI mV	Test Result Pass Pass Pass Pass	Margin 0 0.453 0.121 406,198	Low Limit 	High Limit <= 0 - -
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Probe Model (CHI Probe Model (CHI Probe Model (CHI Probe Serial Number (CHI Probe Serial Number (CHI Test Name	I: P7213 SMA* I	Measured value 0 0.872579272 0.146013207 0.0272124085 0.2508408	Units # UI UI mV # UI UI	Test Result Pass Pass Pass Pass Pass Pass Pass Pas	Margin 0.453 0.121 406.198 0.0301 0.129	Low Limit > 0.42 - > 124 - -	High Limit <= 0 <= 0.27 <= 0.4
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Probe Model (CHL Probe Serial Number (CHL Probe Serial Number (CHL Probe Serial Number (CHL Test Name	P2913584     P2921354     P2921354     P2921355     P2913584     P2921357     P2913584     P2921357     P2913584     P2921357     P2913584     P2921357     P2913584     P292     P291358     P29135     P2913     P291     P29     P2     P29     P2     P29     P2     P	Measured value 0.673278272 0.14013278272 0.14013278408 0.22005408 44282779 4528779 0.089524674 0.14149128 0.1689 0.74148962 0.7414962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.74148962 0.7414962 0.74148962 0.74148962 0.74148962 0.74148962 0.7414497 0.7414497 0.7414497 0.7414497 0.741449	Units, UI UI UI WV # UI UI UI UI UI UI UI UI UI UI	Test Result Pass Pass Pass Pass Pass Pass Pass Pas	Margin 0 0.453 0.121 406,188 0.0 228,878 0.0,45 0.127 492 0.124 9 0.221 0.135	Low Limit - > 0.42 - - > 124 - - > 124 - - - > 124 - - - - - - - - - - - - - - - - - - -	High Limit <= 0.27 <= 0.42 - <= 0.42 - <= 0.42 - <= 0.42 - <= 0.27 - <= 0.27 - = 0.27 - = 0.27 - = 0.27 - = 0.27 - = 0.27 - 0 - 0.27 - - 0.27 - - 0.27 - - 0 - 0.27
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Figure 16: DP Source Results Report Example

- 2. Save the DP source test results:
  - d. In the TekExpress menu, select **Options**.
  - e. Select Save Test Setup As
  - f. Give the file a name appropriate to the test being performed on the device.
  - g. Results will appear in the folder **My Documents > My TekExpress > DisplayPort** folder on the oscilloscope.
- 3. Record the Pass/Fail results for each measurement in the PHY section of the VESA CDF for the DUT.

Note: TekExpress also saves the waveforms from the testing for future reference.

#### 9.2. HBR2 Measurements

This section takes advantage of the DPCD Control over the AUX channel to capture all waveforms and performs all the required tests for HBR2 except for EYE and Jitter tests which require a separate setup and are made in the following section.

- 1. After Saving the RBR/HBR data from Section 9.1.3, return to the TekExpress (1) DUT menu.
  - a. Under Data Rates, Deselect RBR/HBR and Select HBR2.
  - b. Under Patterns, **Select PLTPAT** and **PCTPAT**. These are the patterns associated with all HBR2 testing except HBR2 EYE and Jitter that will be measured in the next section.
    - c. Select All PostCursor2 Levels.
    - d. Select DPAUX under DUT automation

The TekExpress DUT menu should look like the following figure.

V TekExpres	s DisplayPort - (D	P Dual Mode MOI Develp)* Options *	8
Setup Status Results Reports	DUT Test Selection Acquisitions Preferences	DUT ID       HBR2_DP_DUT            • Acquire live waveforms       Use pre-recorded waveform files         View       Compliance         Version       CTS 1.2         Device Profile         Data Rates       Pre-Emphasis Levels         RBR       HBR         Patterns       ✓ 0 (0 dB)       ✓ 1 (3.5 dB)         ✓ D10.2       ✓ PRBS7       COMP         ✓ PLTPAT       Post Cursor2 Levels       ✓         ✓ 0 (400mV)       ✓ 2 (800mV)       ✓         ✓ 1 (600mV)       ✓ 3 (1200mV)       ✓         Link Width       DUT Automation       DP AUX         Selected Test Lanes       Setup       DUT Type	Pause
Teldronix Sta	tus Stopped.	Lane0Lane1Lane2Lane3	

#### Figure 17: TekExpress DP DUT Setup For HBR2 Measurements

- 2. Select (2) Test Selection from the TekExpress DisplayPort menu and make the following selections:
  - a. Verify test 3.3.2 Post Cursor2 Verification testing is not selected. This test is not required by the PHYCTS 1.2b.
  - b. Verify Test 3.12.2\_Random Jitter (RJ) Measurements is not selected. This test will be made in the following section.
  - c. Verify Test 3.17 dF/dT SSC is not selected. This test is not required by the PHYCTS 1.2b.

- d. **Deselect test 3.18 Dual Mode TMDS Clock.** This test will be made in the following section.
- e. **Deselect test 3.18 Dual Mode Eye Diagram Testing.** This test will be made in the following section.
- f. Deselect Test 8.1 Aux Manchester Channel Eye test. This test will be made in the following section.
- g. **Deselect test 8.2 Aux Manchester Channel Sensitivity test.** This test will be made in the following section.

The TekExpress Test Selection menu should look like the following figure.

Setup	Untitled)* Options   Device : Source : CTS 1.2  Deselect Select All  Select All	Start
Status Results Reports 2 Test Selection Acquisitions 4 Preferences	DisplayPort Tx Test 3.2_Non Pre-Emphasis Level Verification Testing Test 3.3.1_Pre-Emphasis Level Verification Testing Test 3.3.2_Post Cursor2 Verification Testing Test 3.4_Inter-Pair Skew Test Test 3.12_Random Jitter (RJ) Measurements Test 3.12_Random Jitter (RJ) Measurements Test 3.15_Spread Spectrum Modulation Frequency Test 3.16_Spread Spectrum Modulation Deviation Test 3.17_dF/dt Spread Spectrum Deviation HF Variation DisplayPort ++ Test 3.18_Dual-mode TMDS Clock Test 3.19_Dual-mode TMDS Clock Test 3.19_Dual-mode TMDS Clock Test 3.19_Dual-mode TMDS Clock Test 3.14_JUX Manchester Channel EYE Test Test 4.4UX Manchester Channel EYE Test	Pause
	Test Description	
	Ensures that the average data rate does not deviate beyond the VESA Displayport 1.2 Standard.	
Tektronix Status Stopped		

#### Figure 18: TekExpress Test Selection Menu for HBR2 Measurements

- 3. Press the Start button in TekExpress.
- 4. Click ok after verifying user action required is completed (lane to channel connections).
- 5. This starts the automated testing. From this point on, all the waveforms and measurements will be made automatically.
- 6. If the DUT does not support automation follow the same steps as outlined in Section 9.1.2.
- 7. After HBR2 Measurements are complete, follow the steps as outlined in Section 9.1.3 to save the results.

#### 9.3. HBR2 Eye and Jitter Measurements

This section uses the automation software to choose the Swing Level, Pre-Emphasis setting and PostCursor2 setup that is known by the DUT owner to pass the HBR2 Eye and Jitter Compliance limits.

For this example, the following setting were provided by the DUT Owner:

Swing Level:	Level 2
Pre-Emphasis Level:	Level 1
PostCursor2 Level:	Level 0

- 1. After Saving the HBR Measurement data, return to the TekExpress (1) DUT menu.
  - a. Under Patterns, **Deselect PRBS7**, **PLTPAT**, **and PCTPAT**. **Select COMP**. This is the pattern associated with HBR2 EYE and Jitter that will be measured in the next section.
  - b. Select only the Voltage Swing Level, Pre-Emphasis Level, and Post Cursor2 Level that is known to pass the HBR2 EYE test.

The TekExpress DUT menu should look like the following figure.

V TekExpress DisplayPort -	(Untitled)*	Options •	×
Setup 1 DUT 1 DUT Test Selection 3 Acquisitions Results 4 Preferences	DUT ID HBR2_DP-DUT3	Pre-recorded waveform files	Pause
	Data Rates RBR HBR HBR HBR2 Patterns D10.2 PRBS7 COMP PLTPAT PCTPAT Voltage Swing 0 (400mV) 2 (800mV) 1 (600mV) 3 (1200mV)	Pre-Emphasis Levels          0 (0 dB)       1 (3.5 dB)         2 (6 dB)       3 (9.5 dB)         SSC       Both Supported         Post Cursor2 Levels         V       Level 0         Level 1       Level 3	
	Link Width 4 Lanes  Selected Test Lanes Lane0Lane1Lane2Lane3	DUT Automation DP AUX V DUT Type Default V	

#### Figure 19: TekExpress DP DUT Setup for HBR2 EYE and Jitter

2. Select (2) Test Selection from the TekExpress DisplayPort menu and make the following selections:

#### Deselect all measurements except the following:

- a. 3.1\_Eye Diagram Test
- b. 3.1.1 Zero Cable Test
- c. 3.12.1 Total Jitter (TJ) Measurements
- d. 3.12.2 Random Jitter (RJ) Measurements

The TekExpress Test Selection menu should look like the following figure.

Setup Status Results Reports DUT 2 Test Selection 3 Acquisitions 4 Preferences	Device : Source : CTS 1.2	Pause
	Test Description	
	Evaluate DisplayPort system BER in data transmission of the waveform. It uses visual tool like Eye Diagram to measure amplitude and timing attributes of the signal.	

#### Figure 20: TekExpress Test Selection Menu for HBR2 EYE and Jitter

- 3. Press the Start button in TekExpress.
- 4. Click ok after verifying user action required is completed (lane to channel connections).
- 5. This starts the automated testing. From this point on, all the waveforms and measurements will be made automatically.
- 6. If the DUT does not support automation follow the same steps as outlined in Section 9.1.2.
- 7. After HBR2 EYE and Jitter Measurements are complete, follow the steps as outlined in Section 9.1.3 to save the results.

Note: the complete DP Signaling test results for DUT HBR2\_DP\_DUT are the combination of the reports saved in Sections 9.1, 9.2 and 9.3.

#### 9.4. Dual Mode Measurements (if the DUT supports Dual-Mode)

This section describes the procedure for running Dual Mode Display Port (DP++) tests as called out in Sections 3.18 and 3.19 of the DP1.2b CTS.

#### 9.4.1. Dual Mode (D++ Test Setup)

For Dual Mode testing, the DP-AUX Controller shown in Figure 7 is replaced by a Wilder AUX Control Board. The DP plug adapter must have a 6-wire sideband connector available so that Config1,2 can be properly configured by the EDID chip on the Aux board. The Wilder AUX Control board emulates a downstream Dual Mode Sink device and will present itself as such on system under test.

The setup is shown in the following figure.



Figure 21: Dual Mode Test Setup

In this example, the Wilder AUX adapter needs to be changed to the correct jumper settings for Dual Mode testing. The following figure shows the correct jumper settings.

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Wilder AUX Controller Board



**Dual Mode Test Jumper Location** 

#### Figure 22: Wilder AUX Control Board configured for Dual Mode Testing

#### 9.4.2. Tek Express Dual Mode Setup (If supported by DUT)

- 1) After saving the HBR2 data return to TekExpress (1) DUT
  - a) Select rate of HBR2
  - b) Select Pattern COMP
  - c) Select Voltage 2 (800mV)
  - d) Select 0 pre-emphasis
  - e) De-select all Post Cursor
  - f) Select 4 lanes

Note: 4 Lanes selection is required for test 3.19. All other selections do not impact the signaling for DP++ testing.

- 2) Next (2) Test Selection
  - a) Click on the Deselect all Button
  - b) Select Test 3.18 Dual-mode TMDS Clock
  - c) Select Test 3.19\_Dual-mode Eye Diagram Testing

#### 9.4.3. Dual Mode (D++) Test Procedure

The following procedure is to be used for Dual Mode testing using TekExpress DisplayPort. Connect the DUT, fixtures, and probes as shown in Figure 21.

- 1. Press the Start button. This will start the automation testing process.
- 2. Connect Differential clock signal to Ch. 4 then press OK



Figure 23: Connecting Clock signal to Ch4

3. Connect D0 Signal to Ch3, D1 to Ch2 and D2 to Ch1 Then press OK



Figure 24 - Connecting D0-D2 to Ch3-CH1

4. After Dual Mode Clock and Eye diagram tests are complete, follow the steps as outlined in Section 9.1.3 to save the results.

#### 9.5 AUX Manchester - Channel EYE Test

This section describes the procedure for running Aux Manchester Channel EYE tests as called out in Sections 8.1 of the DP1.2b CTS.

#### 9.5.1 AUX Manchester - Channel EYE Test Setup

The setup is shown in the following figure.



Figure 25 – Connection Setup for AUX Manchester – Channel EYE Test

#### 9.5.2 AUX Manchester - Channel EYE Test Procedure

- 1) After saving the Dual Mode data, return to the Test Selection Menu.
- 2) Next Test Selection
  - a) Click on the Deselect all Button
  - b) Select Test 8.1\_AUX Manchester Channel EYE Test
- 3) Press the Start button. This will start the automation testing process.
- 4) Connect AUX+ Signal to Ch1 and AUX- Signal to Ch2 then press OK.

	AUX Channel Eye Diagram Configuration
1	Connect AUX+ Signal to CH1 and AUX- Signal to CH2
	OK

Figure 26 – Connecting AUX Signal to Ch1 and Ch2

5) After AUX Manchester – Channel EYE tests are complete, follow the steps as outlined in Section 9.1.3 to save the results.