

# quantumdata™ M41d DisplayPort HBR3 Video Analyzer/Generator

Testing up to 8.1Gb/s Link Rates

Entry Level Functional Tester Upgradable to Full Compliance



## Key Features

- Run DisplayPort functional tests upgradable to full protocol compliance tests up to full DP 1.4 specification
- Equipped with both DP standard and USB-C ports for Tx and Rx function—all test features supported through either type of connector
- View Power Delivery (PD) negotiations for USB-C DP Alt Mode
- Run functional tests on displays and monitors up to 8.1 Gb/s link rates with large format and test pattern library
- Generate Display Stream Compression (DSC) select patterns and configure slices and video parameters
- Configure link training parameters to test display's handling
- View EDID and DPCD registers
- Access DSC Test CRC registers for automated verification of source DSC compression
- Test DP sources up to 8.1 Gb/s link rates; view incoming video and meta-data—including DSC compressed—from a source device in real time
- Capture and decode incoming video, protocol and control packets—including Display Stream Compression (DSC)
- **UPDATE!** Run Pixel Error tests on cables and distribution equipment
- Monitor Aux Channel transactions as a DP source or sink
- Passively monitor Aux Channel between a source & display even at 8.1Gb/s link rates
- Run DP 1.4 Link Layer compliance tests on sources and sinks up to 8.1 Gb/s link rates
- **UPDATE!** Run DP 1.4 EDID compliance tests on sink devices
- Run DP 1.4 Forward Error Correction (FEC) compliance tests
- Run DP 1.4 Display Stream Compression (DSC) compliance tests for sources & sinks
- Run HDCP 2.2 compliance tests on DisplayPort sources, sinks and repeaters
- Run audio tests using programmable LPCM sine wave audio tones and compressed formats
- Run tests on embedded DisplayPort (eDP) 1.4b sources and panels using fast link training and ALPM
- Test eDP backlight control functions on panel using either backlight control pins or Aux Channel control commands

The Teledyne LeCroy quantumdata M41d Video Analyzer/Generator provides an unprecedented combination of functional and compliance testing for video, audio and protocol of DisplayPort devices. The M41d supports HBR3 1.62, 2.7, 5.4 & 8.1 Gb/s data rates on 1, 2 & 4 lanes on its Tx video generator port and its Rx analyzer port for both the standard DP ports and the new USB-C ports with DP Alt Mode. The protocol analyzer provides real time analysis and deep analysis using captures of incoming DisplayPort streams from source devices including DSC/FEC compressed streams. The M41d's video generator can be used for testing displays, USB-C adapters, extenders, etc. The M41d is equipped with all the standard video timings and test patterns necessary for testing modern displays. The M41d supports a full suite of link layer compliance tests for both sources and sinks including compliance tests for forward error correction (FEC). **NEW!** EDID compliance tests are also supported.

The Tx and Rx ports support Auxiliary Channel analysis of the DP aux channel, and the USB-C ports support aux channel analysis of the USB-C Configuration Channel. The adjunct Aux Channel monitoring board supports passive monitoring of the DisplayPort aux channel via full-size DisplayPort connectors, between a source and display. This enables analysis of link training and HDCP interoperability between devices.

For developers of Embedded DisplayPort (eDP), the M41d offers the hardware necessary to support a variety of optional eDP features. Initial support includes fast link training, alternate scrambler seed, Advanced Link Power Management (ALPM) and Tx backlight control. A pin header is available to provide access to the backlight Tx control test feature.

## Operation

The M41d supports video generation and analysis of the FRL/FEC HDMI data streams through the user friendly ATP Manager which presents the data in an easy to understand way. The ATP Manager can be controlled either via a laptop connected to the M41d RJ45 LAN port or through a USB keyboard and mouse and a connected UHD HDMI admin display.



**M41d DP Video  
Analyzer/Generator**

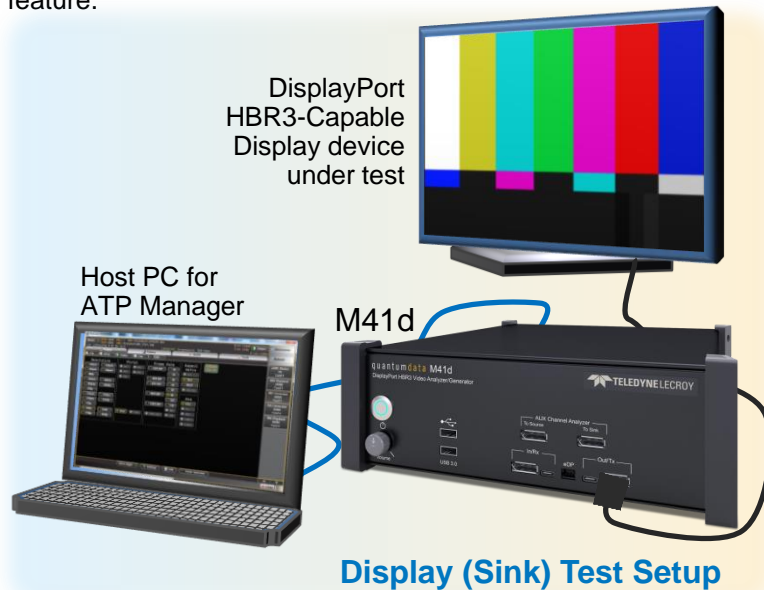
Keyboard & mouse  
for M41d ATP  
Manager Control



# DISPLAY TESTS – VIDEO/AUDIO TESTING

## Video Generation

The quantumdata M41d supports video and audio functional testing at link rates up to 8.1 Gb/s on 1, 2 and 4 lanes to support high resolution formats. The M41d has an extensive set of video formats and library of test patterns. You can set any pattern in motion to test motion artifacts with the Image Shift feature.



## Link Training Control and Configuration

The M41d's link training control feature enables you to configure the link training parameters. You can set limits on the lane count and link rate and allow the link training engine to establish link training based on those limitations or you can force link training parameters—lane count, link rate, voltage swing, pre-emphasis.

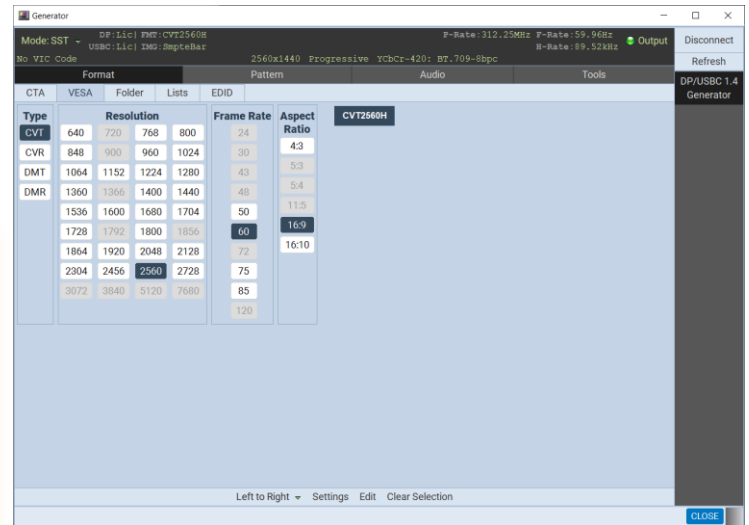
## Link Training Control and Configuration



## Alt Mode Negotiation

The USB Type C Transmit connector participates in discovery, power contract negotiation, and DP Alt Mode negotiation. The protocol messages can be monitored on the Auxiliary Channel Analyzer (right).

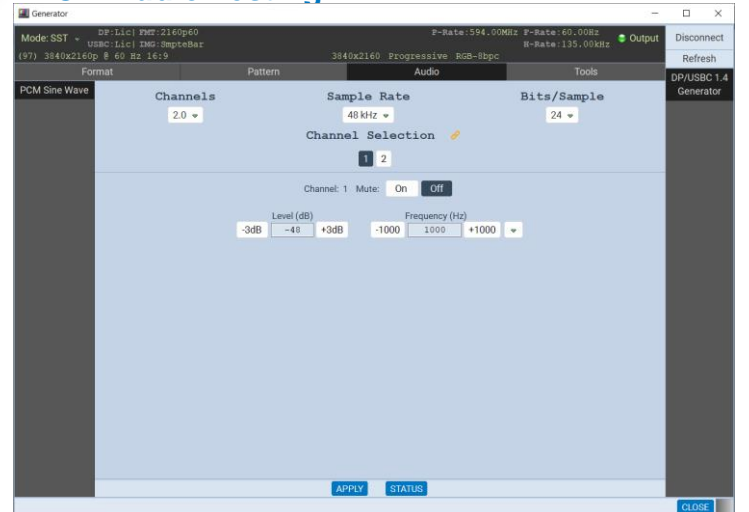
## Format Selection



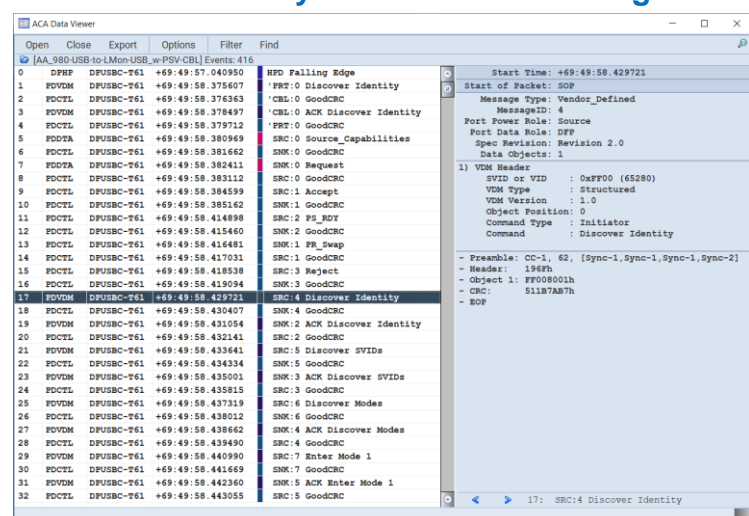
## Audio Testing

The M41d offers a programmable LPCM audio sine wave generator enabling you to set the number of channels (up to 8), the amplitude, frequency, sampling rate and bit depth for uncompressed formats.

## LPCM Audio Testing



## Aux Channel Analyzer – DP Alt Mode Negotiation

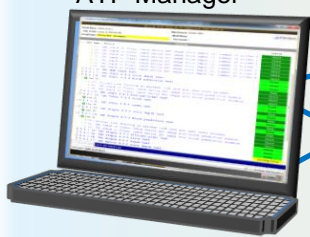


## Protocol Testing

DisplayPort  
HBR3-Capable  
Display device  
under test



Host PC for  
ATP Manager



M41d

## Display (Sink) Test Setup

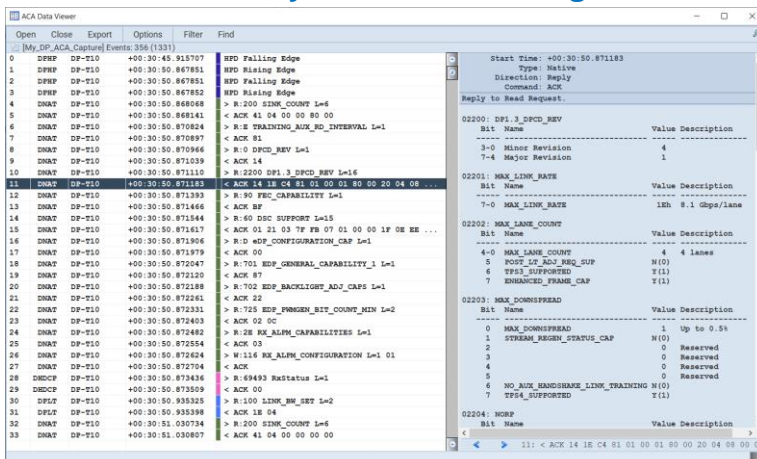
## Multi-Stream Transport

The M41d emulates an MST source for testing an MST branch device or MST-capable monitor. Up to four (4) streams are supported with a depth of one. The Auxiliary Channel Analyzer (ACA) utility depicts the MST negotiations with the connected MST Rx device.

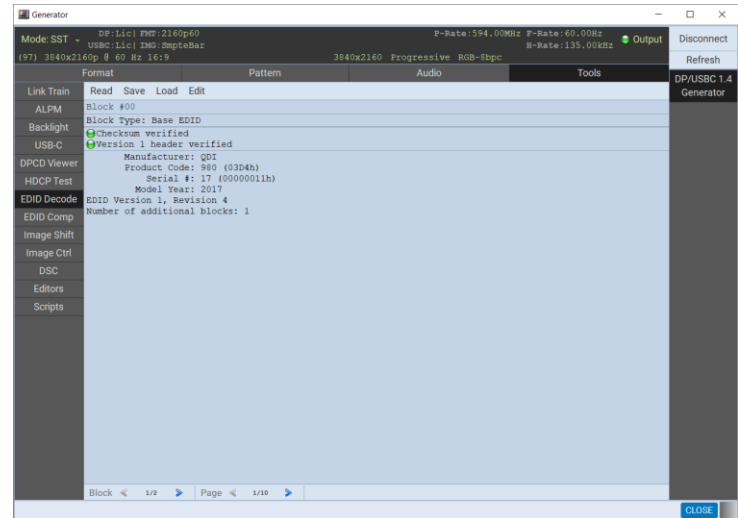
## Auxiliary Channel Analyzer

The M41d 's Auxiliary Channel Analyzer (ACA) feature enables you to monitor the DP Aux Channel for link training and MST negotiations, HDCP transactions and EDID exchanges between the M41d and a connected display. The ACA logs these events and assigns precise timestamps to them. You can view the details of each transaction. These ACA logs can be saved and disseminated for further analysis by colleagues and other subject matter experts.

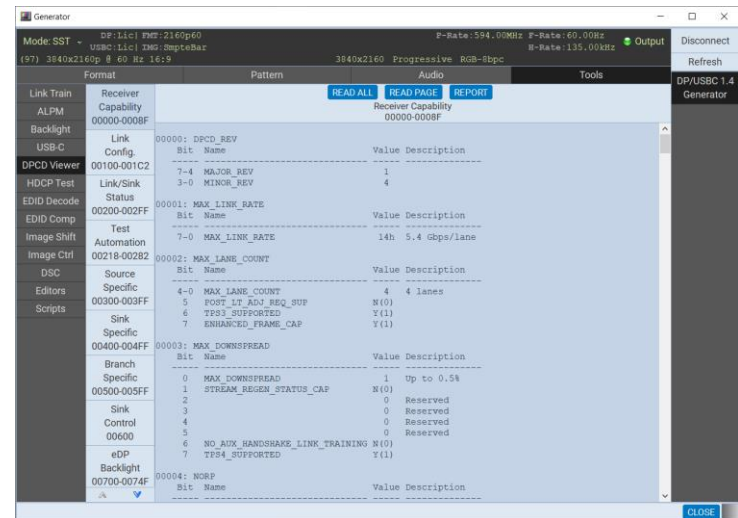
## Aux Channel Analyzer – Link Training



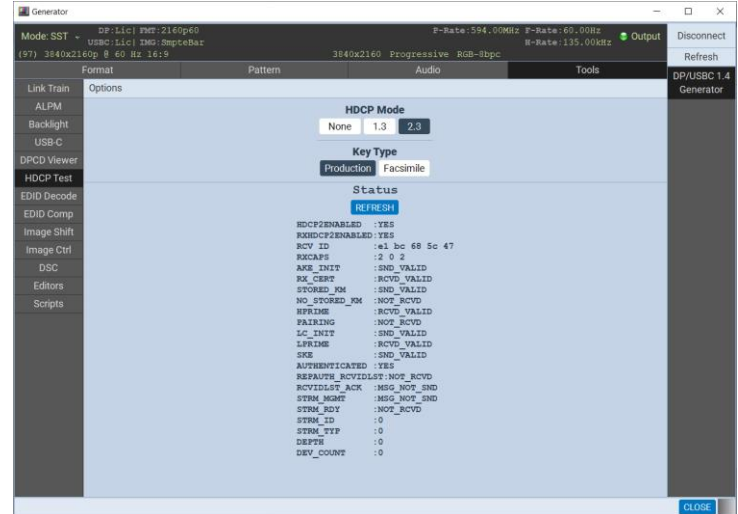
## EDID Decode View



## DPCD Register View



## HDCP 2.2 Test

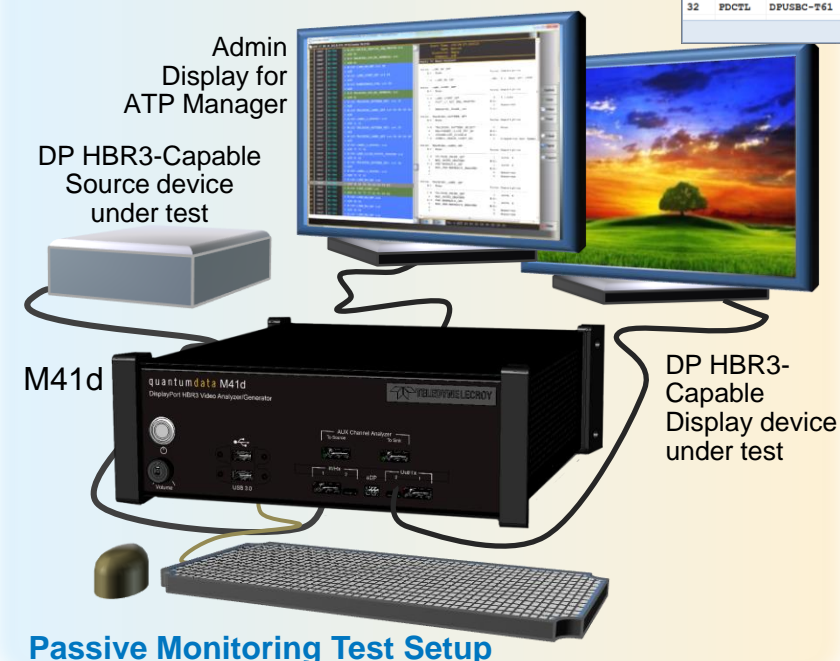
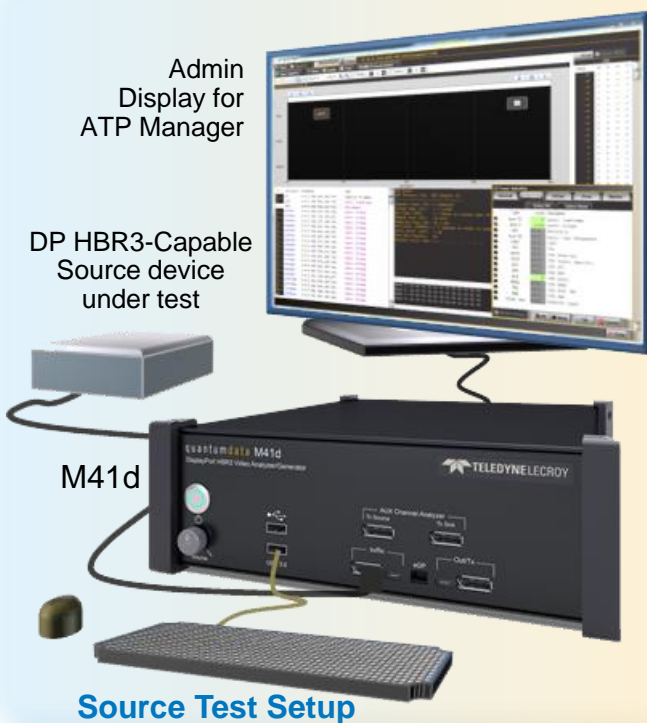




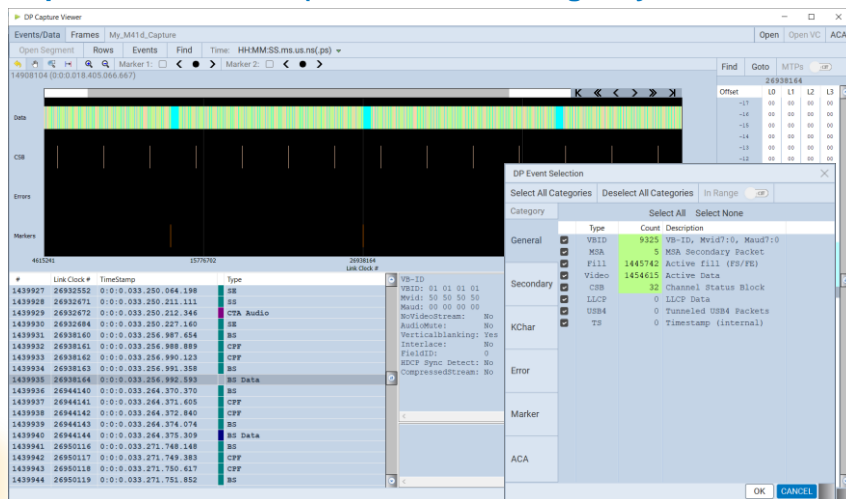
# SOURCE TESTS – CAPTURE & DECODE FOR DEEP

## Capture and Decode

The M41d captures and decodes the main link attributes in order to diagnose interoperability issues related to them. The Protocol Analyzer captures & stores main link data and provides visibility into main stream attributes, second-ary data elements, K-Characters and protocol errors. The Protocol Analyzer presents these elements on a graphical timeline and in a table. You can search for data and select any transaction in the table to view its details. The capture utility also enables you to capture specific MST streams from the source.

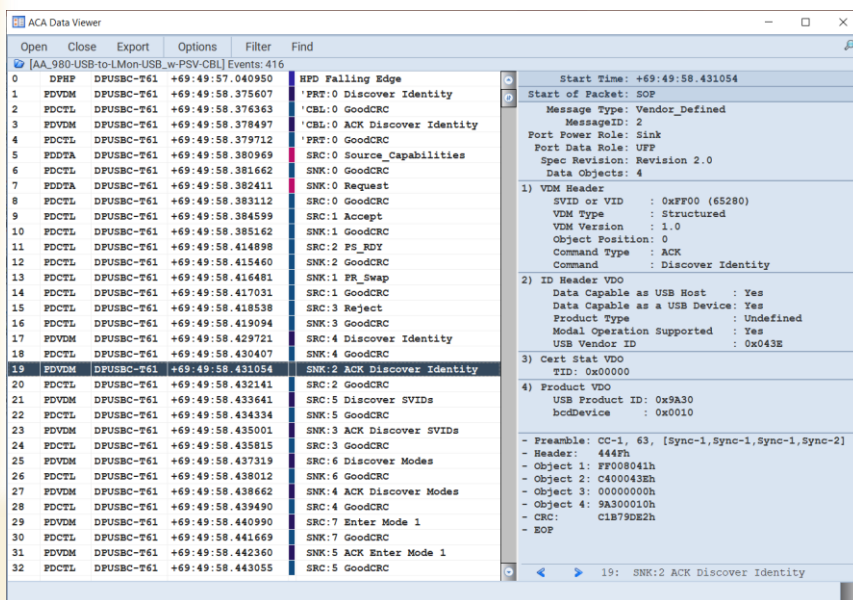


## Capture and Decode (Filter View showing only Audio Packets)



## DP Alt Mode Negotiation

The M41d's USB-C Rx connector participates in discovery, power contract negotiation, and DP Alt Mode negotiation. The protocol messages can be monitored on the Auxiliary Channel Analyzer.



## (Passive) Auxiliary Channel Analyzer

The M41d's Adjunct Auxiliary Channel Analyzer board enables you to monitor the DP Aux Channel for link training and MST negotiations, HDCP transactions and EDID exchanges between a DisplayPort source and display device. This enables developers to investigate interoperability problems between DP devices involving link training, HDCP and EDID. Solution is provided using a custom cable (provided).. The ACA logs these events and assigns precise timestamps to them. You can view the details of each transaction.

Pixel Error Test

×

Continuous: ☒ Yes ☐ No

Number of Frames:

Max Recorded Errors:  (1 - 255)

Reference Frame

Auto: ☐ ON ☒ OFF

Name: <Captured>

Frames Analyzed: 0

Total Errors: 0

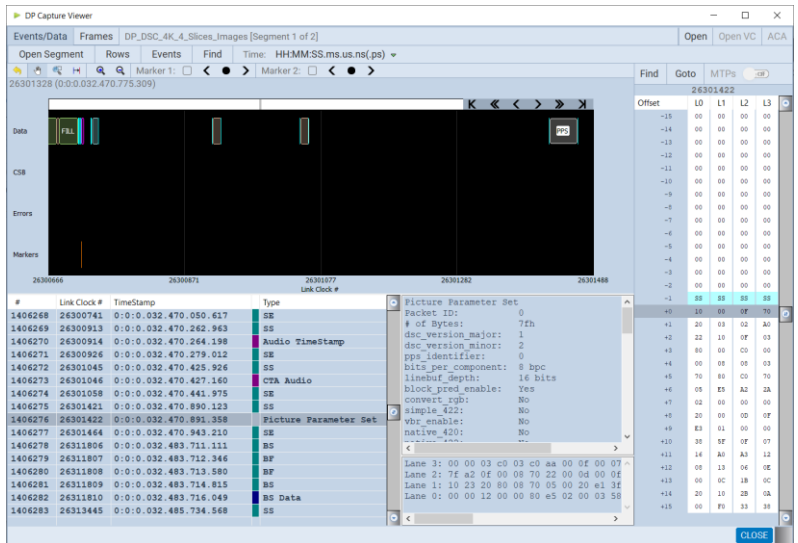


# DISPLAY STREAM COMPRESSION (DSC) SOURCE

## DSC Analysis

The M41d's DSC analysis feature enables developers to view the DisplayPort DSC related protocol elements such as the picture parameter set, end of chunk packets and compression flag settings in the VBI to ensure that these elements are occurring in the video stream and that they are occurring in the proper sequence. The DSC analysis feature also captures and decompresses the video frames enabling developers to examine them for compression artifacts. The Forward Error Correction (FEC) transport mechanism, which ensures reliable, error free video transport, can also be verified.

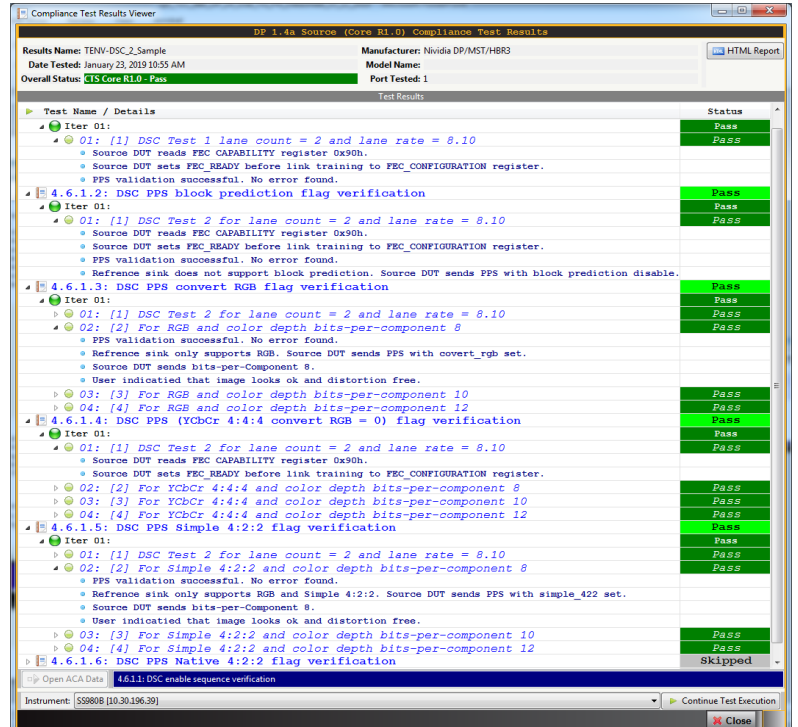
## DSC Analysis showing Picture Parameter Set (PPS)



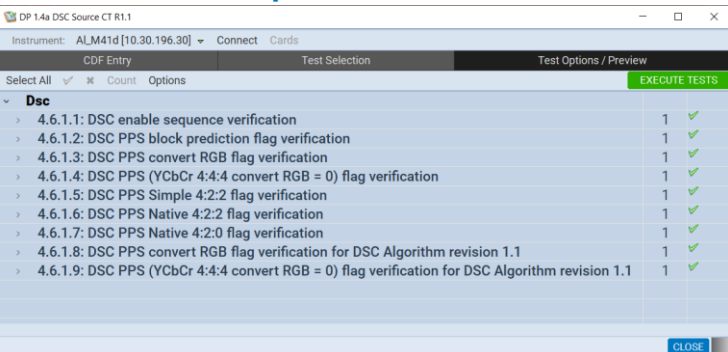
## DSC Source Compliance

The DSC source compliance tests are ideal for pre-testing your DisplayPort source product prior to submission to an Authorized Test Center for approval. Pre-testing provides assurance that your product will pass at the ATC when submitted. The compliance tests enable you to view the auxiliary channel analyzer traces logged during the test to help diagnose the cause of compliance test failures.

## DSC Source Tests - Test Results



## DSC Source Compliance Tests



Admin  
Display for  
ATP Manager

DP HBR3-Capable  
Source device  
under test

M41d

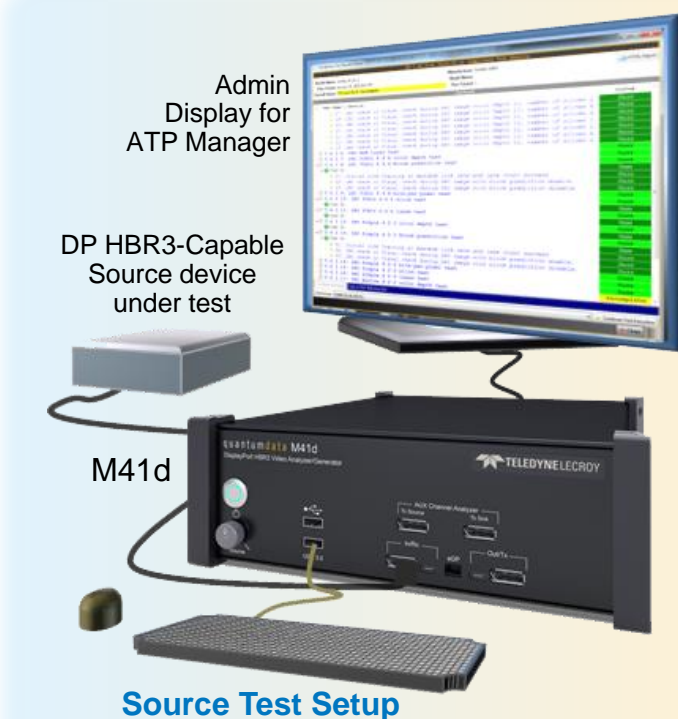
Source Test Setup

The M41d's ACA utility provides a log of the Aux Channel transactions. The link training can be viewed as well as the DPCD register reads and writes involved in the setup and maintenance of Display Stream Compression (DSC) and Forward Error Correction (FEC).

# DP 1.4 LINK LAYER SOURCE COMPLIANCE

## Source Link Layer Compliance

The DP source HBR3 link layer compliance are ideal for self-testing or pre-testing your HBR3-capable DisplayPort 1.4 source product prior to submission to an Authorized Test Center for approval. Pre-testing provides added assurance that your product will pass at the ATC when submitted. The compliance tests (below right) enable you to view the captured data and detailed test results which help pinpoint the cause of compliance test failures. The link layer compliance test suite now includes tests for forward error correction (FEC). You can link to the aux channel traces in the Aux Channel Analyzer (ACA) to view the root cause of failures (below).



## DP Aux Channel Traces – From LLC Test

ACA Data Viewer			
Open	Close	Export	Options
Filter Find			
[ACA-4.3.1.10.01] Events: 266			
39	DPFL	DP-R31	< ACK
40	DPFL	DP-R31	> R:R TRAINING_AUX_RD_INTERVAL L=1
41	DPFL	DP-R31	< ACK R1
42	DPFL	DP-R31	> W:100 LINK_BW_SET L=1 06
43	DPFL	DP-R31	< ACK
44	DPFL	DP-R31	> W:101 LANE_COUNT_SET L=1 R1
45	DPFL	DP-R31	< ACK
46	DPFL	DP-R31	> W:102 TRAINING_PATTERN_SET L=1 21
47	DPFL	DP-R31	< ACK
48	DPFL	DP-R31	> W:103 TRAINING_LANE_SET L=4 00 00 00 00
49	DPFL	DP-R31	< ACK
50	DPFL	DP-R31	> R:202 LANE0_I_STATUS L=2
51	DPFL	DP-R31	< DEFER
52	DPFL	DP-R31	> R:202 LANE1_I_STATUS L=2
53	DPFL	DP-R31	< DEFER
54	DPFL	DP-R31	> R:202 LANE2_I_STATUS L=2
55	DPFL	DP-R31	< DEFER
56	DPFL	DP-R31	> R:202 LANE3_I_STATUS L=2
57	DPFL	DP-R31	< DEFER
58	DPFL	DP-R31	> R:202 LANE4_I_STATUS L=2
59	DPFL	DP-R31	< DEFER
60	DPFL	DP-R31	> R:202 LANE5_I_STATUS L=2
61	DPFL	DP-R31	< DEFER
62	DPFL	DP-R31	> R:202 LANE6_I_STATUS L=2
63	DPFL	DP-R31	< DEFER
64	DPFL	DP-R31	> W:102 TRAINING_PATTERN_SET L=1 07
65	DPFL	DP-R31	< ACK
66	DPFL	DP-R31	> W:103 TRAINING_LANE_SET L=4 00 00 00 00
67	DPFL	DP-R31	< ACK
68	DPFL	DP-R31	> R:202 LANE0_I_STATUS L=3
69	DPFL	DP-R31	< ACK 01 00 00
70	DPFL	DP-R31	> R:204 LANE_ALIGN_STATUS_UPDATED L=2
71	DPFL	DP-R31	< ACK C0 C3
72	DPFL	DP-R31	> R:204 ACTIVE_REQUEST_LANE0 L=2
73	DPFL	DP-R31	< ACK 44 44

## DP 1.4 Source Link Layer Compliance - Test Selection

DP 1.4a Source CT Core R1.0			
Instrument: ALM41d [10.30.196.30]		Connect	Cards
CDF Entry		Test Selection	Test Options / Preview
Select All	▼	Count	Options
EXECUTE TESTS			
AUX Rd. after HPD			
> 4.2.1.1: Source DUT Retry on No-Reply During AUX Read after HPD Plug Event		1	✓
> 4.2.1.2: Source Retry on Invalid Reply During AUX Read after HPD Plug Event		1	✓
> 4.2.1.3: Source Device HPD Event Pulse Length Test		1	✓
> 4.2.1.4: Source Device IRQ_HPDP Pulse Length Test		1	✓
> 4.2.1.5: Source Device Inactive HPD / Inactive AUX Test		1	✓
EDID and DPCD Rd.			
> 4.2.2.1: DPCD Receiver Capability and EDID Read upon HPD Plug Event		1	✓
> 4.2.2.2: DPCD Extended Receiver Capability and EDID Read upon HPD Plug Event		1	✓
> 4.2.2.3: EDID Read		1	✓
> 4.2.2.4: EDID Read Failure #1: I2C-Over-AUX NACK		1	✓
> 4.2.2.5: EDID Read Failure #2: I2C-Over-AUX DEFER		1	✓
> 4.2.2.6: EDID Corruption Detection		1	✓
> 4.2.2.7: Branch Device Detection upon HPD Plug Event		1	✓
> 4.2.2.8: EDID Read on IRQ HPD Event after Branch Device Detection		1	✓
> 4.2.2.9: E-DDC Four Block EDID Read		1	✓
> 4.2.2.10: Link Status/Adjust Request AUX read interval during Link Training		1	✓
Link Training			
> 4.3.1.1: Successful Link Training at All Supported Lane Counts and Link Speeds		1	✓
> 4.3.1.2: Successful Link Training Upon HPD Plug Event		1	✓
> 4.3.1.3: Successful Link Training (Higher Differential Voltage Swing during Clock Recovery)		1	✓
> 4.3.1.4: Successful Link Training to a Lower Link Rate #1: Iterate at Maximum Voltage Swing		1	✓
> 4.3.1.5: Successful Link Training to a Lower Link Rate #2: Iterate at Minimum Voltage Swing		1	✓

## DP 1.4 Source Link Layer Compliance Test

Compliance Test Results Viewer

DP 1.4 Source (1.4 Core R1.0) Compliance Test Results

Results Name: 03\_27\_2018\_15\_33\_45

Manufacturer:

Date Tested: March 27, 2018 3:33 PM

Model Name:

Overall Status: CTS 1.4 Core R1.0 - Pass

Port Tested: 1

HTML Report

Test Results

Test Name / Details	Status
4.3.2.1: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Symbol	Pass
Iter 01:	Pass
01: [1] Link Maintenance test for lane count = 4 and lane rate = 8.10	Pass
02: [2] After Sym lock error on lane 1, Link Maintenance test for lane cou	Pass
03: [3] After Sym lock error on lane 2, Link Maintenance test for lane cou	Pass
04: [4] After Sym lock error on lane 3, Link Maintenance test for lane cou	Pass
05: [5] After Sym lock error on lane 4, Link Maintenance test for lane cou	Pass
After loss of Symbol Lock on lane 4.	
Link re-training starts after IRQ pulse.	
Source DUT reads DPCD address 0200-0205h.	
Source DUT read link status within 100ms.	
Source DUT start link training..	
Source DUT sets link bw and lane count before TPI is set.	
Source DUT sets TPI on all active lanes.	
CR Lock succeeded on all active lanes.	
Training pattern 2 or 3 or 4 detected after Training pattern 1.	
For HBR3 source Training pattern 4 detected.	
Equalization succeeded on all active lanes.	
Symbol lock succeeded on all active lanes.	
All Lanes are Aligned and skewed.	
Link compliance training test completed successfully.	
Link training completed in 19.76 ms, which exceeds the 10ms guideline.	
4.3.2.2: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Clock R	Pass
4.3.2.3: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Inter-l	Pass
4.3.2.4: Handling of IRQ HPD Pulse with No Error Status Bits Set.	Pass
4.3.2.5: Lane Count Reduction and Increase.	Pass

Open ACA Data 4.3.2.1: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Symbol Lock.

Instrument: S9808 [10.30.196.30]

Continue Test Execution

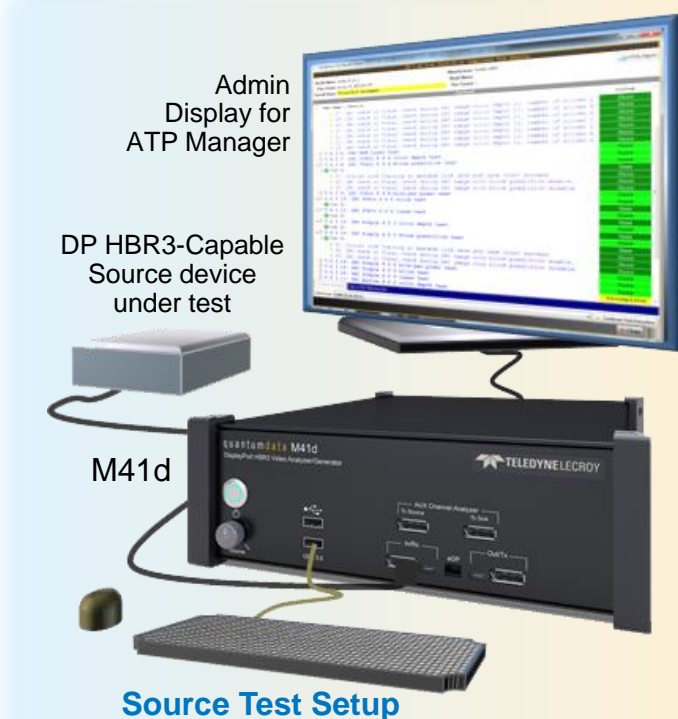
Close



# DP 1.4 LINK LAYER SOURCE COMPLIANCE

## Source Link Layer Compliance

The DP source HBR3 link layer compliance are ideal for self-testing or pre-testing your HBR3-capable DisplayPort 1.4 source product prior to submission to an Authorized Test Center for approval. Pre-testing provides added assurance that your product will pass at the ATC when submitted. The compliance tests (below right) enable you to view the captured data and detailed test results which help pinpoint the cause of compliance test failures. The link layer compliance test suite now includes tests for forward error correction (FEC). You can link to the aux channel traces in the Aux Channel Analyzer (ACA) to view the root cause of failures (below).



## DP Aux Channel Traces – From LLC Test

Open	Close	Export	Options	Filter	Find
[ACA-4.3.1.10.01] Events: 266					
39	DPFLZ	DP-R31	+00:08:26.992423	< ACK	
40	DPFLZ	DP-R31	+00:08:26.992464	> R:R TRAINING_AUX_RD_INTERVAL L=1	
41	DPFLZ	DP-R31	+00:08:26.992564	< ACK R1	
42	DPFLZ	DP-R31	+00:08:26.000182	> W:100 LINK_BW_SET L=1 06	
43	DPFLZ	DP-R31	+00:08:26.000262	< ACK	
44	DPFLZ	DP-R31	+00:08:26.000332	> W:101 LANE_COUNT_SET L=1 R1	
45	DPFLZ	DP-R31	+00:08:26.000412	< ACK	
46	DPFLZ	DP-R31	+00:08:26.196611	> W:102 TRAINING_PATTERN_SET L=1 21	
47	DPFLZ	DP-R31	+00:08:26.196866	< ACK	
48	DPFLZ	DP-R31	+00:08:26.197116	> W:103 TRAINING_LANE0_SET L=4 00 00 00 00	
49	DPFLZ	DP-R31	+00:08:26.197415	< ACK	
50	DPFLZ	DP-R31	+00:08:26.201412	> R:202 LANE0_I_STATUS L=2	
51	DPFLZ	DP-R31	+00:08:26.201679	< DEFERR	
52	DPFLZ	DP-R31	+00:08:26.202147	> R:202 LANE0_I_STATUS L=2	
53	DPFLZ	DP-R31	+00:08:26.202414	< DEFERR	
54	DPFLZ	DP-R31	+00:08:26.202679	> R:202 LANE0_I_STATUS L=2	
55	DPFLZ	DP-R31	+00:08:26.203146	< DEFERR	
56	DPFLZ	DP-R31	+00:08:26.203614	> R:202 LANE0_I_STATUS L=2	
57	DPFLZ	DP-R31	+00:08:26.203881	< DEFERR	
58	DPFLZ	DP-R31	+00:08:26.204349	> R:202 LANE0_I_STATUS L=2	
59	DPFLZ	DP-R31	+00:08:26.204615	< DEFERR	
60	DPFLZ	DP-R31	+00:08:26.205080	> R:202 LANE0_I_STATUS L=2	
61	DPFLZ	DP-R31	+00:08:26.205347	< DEFERR	
62	DPFLZ	DP-R31	+00:08:26.205820	> R:202 LANE0_I_STATUS L=2	
63	DPFLZ	DP-R31	+00:08:26.206087	< ACK 01 00	
64	DPFLZ	DP-R31	+00:08:26.206229	> W:102 TRAINING_PATTERN_SET L=1 07	
65	DPFLZ	DP-R31	+00:08:26.206309	< ACK	
66	DPFLZ	DP-R31	+00:08:26.206389	> W:103 TRAINING_LANE0_SET L=4 00 00 00 00	
67	DPFLZ	DP-R31	+00:08:26.206493	< ACK	
68	DPFLZ	DP-R31	+00:08:26.211601	> R:202 LANE0_I_STATUS L=3	
69	DPFLZ	DP-R31	+00:08:26.210673	< ACK 01 00 00	
70	DPFLZ	DP-R31	+00:08:26.210791	> R:204 LANE_ALIGN_STATUS_UPDATED L=2	
71	DPFLZ	DP-R31	+00:08:26.211045	< ACK C0 C3	
72	DPFLZ	DP-R31	+00:08:26.211974	> R:204 ACTIVE_REQUEST_LANE0 L=2	
73	DPFLZ	DP-R31	+00:08:26.211046	< ACK 44 44	

## DP 1.4 Source Link Layer Compliance - Test Selection

DP 1.4a Source CT Core R1.0		
Instrument: ALM41d [10.30.196.30] Connect Cards		
CDF Entry		Test Options / Preview
Select All	Count Options	EXECUTE TESTS
AUX Rd. after HPD		
> 4.2.1.1: Source DUT Retry on No-Reply During AUX Read after HPD Plug Event	1	✓
> 4.2.1.2: Source Retry on Invalid Reply During AUX Read after HPD Plug Event	1	✓
> 4.2.1.3: Source Device HPD Event Pulse Length Test	1	✓
> 4.2.1.4: Source Device IRQ_HPDP Pulse Length Test	1	✓
> 4.2.1.5: Source Device Inactive HPD / Inactive AUX Test	1	✓
EDID and DPCD Rd.		
> 4.2.2.1: DPCD Receiver Capability and EDID Read upon HPD Plug Event	1	✓
> 4.2.2.2: DPCD Extended Receiver Capability and EDID Read upon HPD Plug Event	1	✓
> 4.2.2.3: EDID Read	1	✓
> 4.2.2.4: EDID Read Failure #1: I2C-Over-AUX NACK	1	✓
> 4.2.2.5: EDID Read Failure #2: I2C-Over-AUX DEFER	1	✓
> 4.2.2.6: EDID Corruption Detection	1	✓
> 4.2.2.7: Branch Device Detection upon HPD Plug Event	1	✓
> 4.2.2.8: EDID Read on IRQ HPD Event after Branch Device Detection	1	✓
> 4.2.2.9: E-DDC Four Block EDID Read	1	✓
> 4.2.2.10: Link Status/Adjust Request AUX read interval during Link Training	1	✓
Link Training		
> 4.3.1.1: Successful Link Training at All Supported Lane Counts and Link Speeds	1	✓
> 4.3.1.2: Successful Link Training Upon HPD Plug Event	1	✓
> 4.3.1.3: Successful Link Training (Higher Differential Voltage Swing during Clock Recovery)	1	✓
> 4.3.1.4: Successful Link Training to a Lower Link Rate #1: Iterate at Maximum Voltage Swing	1	✓
> 4.3.1.5: Successful Link Training to a Lower Link Rate #2: Iterate at Minimum Voltage Swing	1	✓

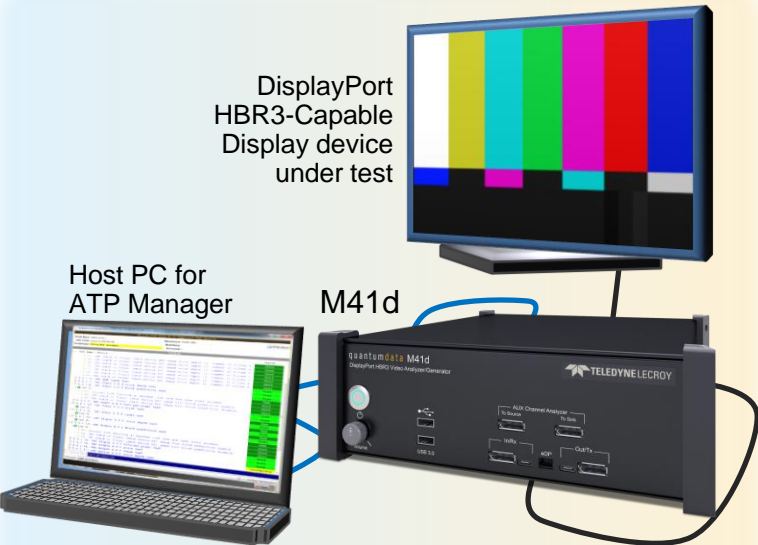
## DP 1.4 Source Link Layer Compliance Test

Compliance Test Results Viewer		
DP 1.4 Source (1.4 Core R1.0) Compliance Test Results		
Results Name: 03_27_2018_15_33_45	Manufacturer:	
Date Tested: March 27, 2018 3:33 PM	Model Name:	
Overall Status: <b>CTS 1.4 Core R1.0 - Pass</b>	Port Tested: 1	<a href="#">HTML Report</a>
Test Results		
Test Name / Details	Status	
4.3.2.1: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Symbol	Pass	
Iter 01:	Pass	
01: [1] Link Maintenance test for lane count = 4 and lane rate = 8.10	Pass	
02: [2] After Sym lock error on lane 1, Link Maintenance test for lane cou	Pass	
03: [3] After Sym lock error on lane 2, Link Maintenance test for lane cou	Pass	
04: [4] After Sym lock error on lane 3, Link Maintenance test for lane cou	Pass	
05: [5] After Sym lock error on lane 4, Link Maintenance test for lane cou	Pass	
After loss of Symbol Lock on lane 4.		
Link re-training starts after IRQ pulse.		
Source DUT reads DPCD address 0200-0205h.		
Source DUT read link status within 100ms.		
Source DUT start link training..		
Source DUT sets link bw and lane count before TPI is set.		
Source DUT sets TPI on all active lanes.		
CR Lock succeeded on all active lanes.		
Training pattern 2 or 3 or 4 detected after Training pattern 1.		
For HBR3 source Training pattern 4 detected.		
Equalization succeeded on all active lanes.		
Symbol lock succeeded on all active lanes.		
All Lanes are Aligned and skewed.		
Link compliance training test completed successfully.		
Link training completed in 19.76 ms, which exceeds the 10ms guideline.		
4.3.2.2: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Clock R	Pass	
4.3.2.3: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Inter-l	Pass	
4.3.2.4: Handling of IRQ HPD Pulse with No Error Status Bits Set.	Pass	
4.3.2.5: Lane Count Reduction and Increase.	Pass	
Open ACA Data 4.3.2.1: Successful Link Re-training After IRQ HPD Pulse Due to Loss of Symbol Lock.		
Instrument: S9808 [10.30.196.30]	Continue Test Execution	
Close		

# HD CD P 2.2 SOURCE, SINK & REPEATER COMPLIANCE

## HD CD P 2.2 Compliance

The HDCP 2.2 compliance tests are ideal for pre-testing or self-testing your DisplayPort source, sink or repeater product prior to submission to an Authorized Test Center for approval. Pre-testing provides assurance that your product will pass at the ATC when submitted. The compliance tests enable you to view the auxiliary channel analyzer traces logged (not shown) during the test to help diagnose the cause of compliance test failures.



Display (Sink) Test Setup



Source Test Setup

## HD CD P 2.2 Source Tests - Test Selection

DP HDCP 2.2 TX CT 1.1	
Instrument: ALM41d [10.30.196.30] Connect Cards	
CDF Entry	
Test Selection	
Select All	EXECUTE TESTS
<b>TX with Receiver</b>	
1A-01: Regular Procedure: With previously connected Receiver (With stored Km)	✓
1A-02: Regular Procedure: With newly connected Receiver (Without stored Km)	✓
1A-03: Regular Procedure: Receiver disconnect after AKE_Init	✓
1A-04: Regular Procedure: Receiver disconnect after Km	✓
1A-05: Regular Procedure: Receiver disconnect after locality check	✓
1A-06: Regular Procedure: Receiver disconnect after Ks	✓
1A-07: Regular Procedure: Receiver sends REAUTH_REQ after Ks	✓
1A-08: Irregular Procedure: Verify Receiver Certificate	✓
1A-09: Irregular Procedure: SRM	✓
1A-10: Irregular Procedure: Invalid H'	✓
Iter 01: Invalid H'	✓
Iter 02: H' Timeout with previously paired Recv Id	✓
Iter 03: H' Timeout with previously unpaired Recv Id	✓
1A-11: Irregular Procedure: Pairing Failure	✓
1A-12: Irregular Procedure: Locality Failure	✓
1A-13: Regular Procedure - Encryption Disable Bootstrapping	✓
Iter 01: Encryption Disable Bootstrapping not supported: Automatic PASS(SKIP)	✓
<b>TX with Repeater</b>	
1B-01: Regular Procedure: With Repeater	✓
1B-02: Irregular Procedure: Timeout of Receiver ID list	✓
1B-03: Irregular Procedure: Verify V'	✓

## HD CD P 2.2 Source Tests - Test Results

Compliance Test Results Viewer	
DP HDCP 2.2 TX (1.0) Compliance Test Results	
Results Name: Acme_DP_HDCP_Src_Results_3	Manufacturer: Acme
Date Tested: January 20, 2017 6:59 PM	Model Name: XYZ
Overall Status: <b>CIS 1.0 - Incomplete</b>	Port Tested: 1
<b>Test Name / Details</b>	<b>Status</b>
1A-01: Regular Procedure: With previously connected Receiver (With stored Km)	Pass
Iter 01:	Pass
1A-02: Regular Procedure: With newly connected Receiver (Without stored Km)	Pass
1A-03: Regular Procedure: Receiver disconnect after AKE Init	Pass
Iter 01:	Pass
TX AUTH:MSG RD:DIS ts:7561890365.44 us	
TX UNAUTH:ENTER	
TX UNAUTH:MSG RD:DIS ts:0.00 us	
TX UNAUTH:MSG RD:INVALID_VER ts:32966933792173888.00 us	
RX UNAUTH:ENTER Rep:ne DevCnt:0 Dep:0	
RX UNAUTH:MSG VIDEO Present	
TX UNAUTH:MSG RD:VALID_VER ts:7563890841.60 us	
TX UNAUTH:MSG RD:RSP_KM ts:7565890877.44 us	
TX UNAUTH:AKE_INIT ts:7565891379.20 us	
TX UNAUTH:MSG RD:AKE_Init ts:7565891379.20 us	
RX UNAUTH:RCVD:AKE_Init ts:7565891317.76 us	
RX UNAUTH:**Test Cond.** lpgd	
TX UNAUTH:MSG RD:RSP_DIS ts:7565893928.96 us	
TX UNAUTH:MSG RCVD:AKE_Send_Cert ts:0.00 us	
Meta:AKE SEND CERT not recvd within 100ms of AKE_INIT	
TX UNAUTH:RxCaps 2 0 2	
Failed to verify the signature on Receiver certificate	
TX UNAUTH:MSG RD:VALID_VER ts:7567892224.00 us	
TX UNAUTH:MSG RD:RSP_KM ts:7569892382.72 us	
RX UNAUTH:RCVD:AKE_Init ts:7569892833.28 us	
RX UNAUTH:**Test Cond.** ake_init	
RX UNAUTH:Encryption Disabled	
RX AKE:enter	
1A-04: Regular Procedure: Receiver disconnect after Km	Pass
1A-05: Regular Procedure: Receiver disconnect after locality check	Pass
1A-06: Regular Procedure: Receiver disconnect after Ks	Pass
1A-07: Regular Procedure: Receiver sends REAUTH_REQ after Ks	Pass
1A-08: Irregular Procedure: Verify Receiver Certificate	Pass
1A-09: Irregular Procedure: SRM	Incomplete
1A-10: Irregular Procedure: Invalid H'	Pass
1A-11: Irregular Procedure: Pairing Failure	Pass
1A-12: Irregular Procedure: Locality Failure	Pass
1A-13: Regular Procedure - Encryption Disable Bootstrapping	Incomplete

## HD CD P 2.2 Sink Tests - Test Results

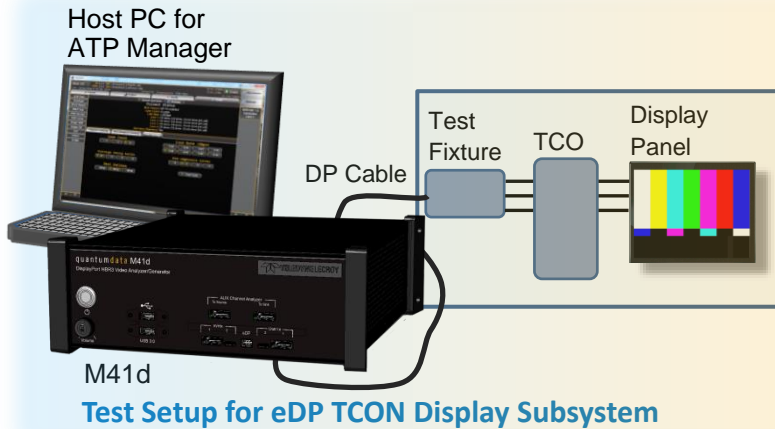
Compliance Test Results Viewer	
DP HDCP 2.2 Receiver (1.0) Compliance Test Results	
Results Name: Acme_XYZ_HDCP_22_DP_Sink_1	Manufacturer: Acme
Date Tested: January 24, 2017 11:51 AM	Model Name: XYZ
Overall Status: <b>CIS 1.0 - Incomplete</b>	Port Tested: 1
<b>Test Name / Details</b>	<b>Status</b>
2C-01: Regular Procedure - With transmitter	Pass
2C-02: Irregular Procedure - New Authentication after AKE Init	Pass
2C-03: Irregular Procedure - New Authentication during Locality Check	Pass
2C-04: Irregular Procedure - New Authentication after SKE Send Eks	Pass
Iter 01:	Pass
TX:RSP:ENTER	
TX:RSP:**Test Cond.** ake_init	
TX UNAUTH:ENTER	
RX MSG RD:ENC_DIS ts:92078933053.44 us	
Encryption Disabled	
TX UNAUTH:AKE_INIT ts:92080432230.40 us	
TX UNAUTH:MSG RD:AKE_Init ts:92080432230.40 us	
RX AUTH:MSG RCVD:AKE_Init ts:92080432179.20 us	
HDCP2RX:UNAUTH Rep:no DevCnt:31 Dep:4	
MSG RCVD:AKE_Init ts:92080432179.20 us	
RX MSG:WROTE to DPCD:AKE_Send_Cert:534 ts:92080432414.72	
TX UNAUTH:MSG RCVD:AKE_Send_Cert ts:92080491886.64 us	
TX UNAUTH:Rx ff,oa,f8,b,25,72,82,f2	
TX UNAUTH:RxCaps 2 0 2	
RX:AKE:MSG SND:AKE_Send_Cert ts:92080505088.00 us	
MSG RCVD:AKE_Stored_Km ts:92080506019.84 us	
TX AKE:Send Stored Km ts:92080506081.28 us	
RX MSG:WROTE to DPCD:AKE_Send_H_prime:33 ts:92080506091.52	
TX AKE:MSG:AKE_Stored_Km ts:92080506081.28 us	
TX AKE:MSG RCVD:AKE_Send_H_prime ts:92080510832.64 us	
TX LC:Send LC_Init ts:92080511948.80 us	
TX LC:MSG:LC_Init ts:92080511948.80 us	
MSG RCVD:LC_Init ts:92080511887.36 us	
RX MSG:WROTE to DPCD:LC_Send_L_prime:33 ts:92080512256.00	
RX:SKR:MSG SND:AKE_Send_H_prime ts:92080511887.36 us	



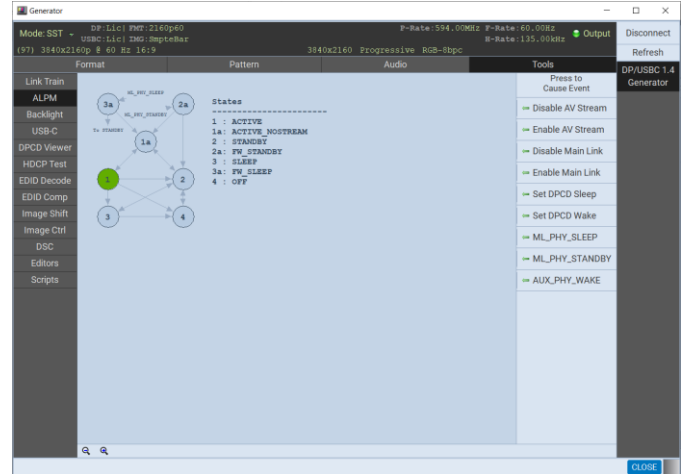
# EMBEDDED DISPLAYPORT (EDP) 1.4B TESTING

## Embedded DisplayPort eDP - ALPM

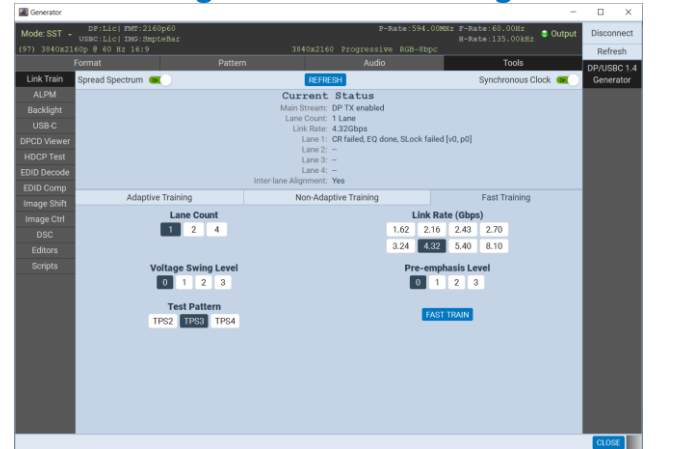
The M41d supports testing of both eDP source and display subsystems. A standard DP connection from the M41d to a test fixture is required to enable connection to the eDP subsystem. For display panel TCON testing, once the connection is made, you can use the Advanced Link Power Management (ALPM) feature to test the display's ALPM function (right) and run any other video tests using the M41d's Video Generation function. For eDP source subsystem testing, you can monitor the link training and ALPM state and run captures for analysis, etc. The test setups are depicted below.



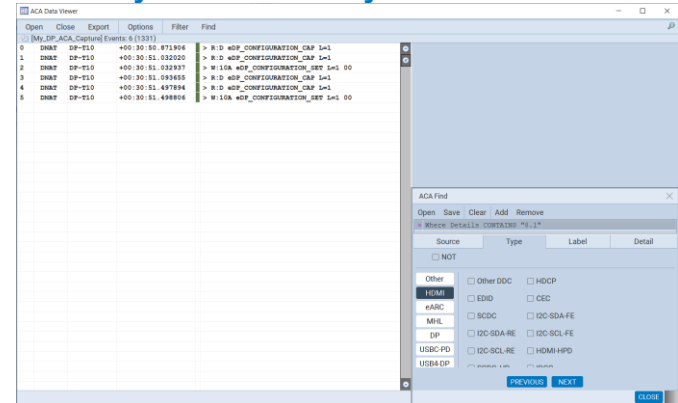
## Advanced Link Power Management (ALPM)



## Link Training Control and Configuration



## Auxiliary Channel Analyzer – Fast Link Train



## eDP Fast Link Training

The M41d supports fast link training acting either as an eDP source subsystem or an eDP display subsystem. The module emulates the necessary Fast Link training DPCD registers. When testing a display you can select the Lane Count, Link rate (including “intermediate “eDP lane rates), Voltage Swing, Pre-Emphasis and Training Test Pattern. You can monitor the Aux Channel transactions with the Aux Channel Analyzer utility. (eDP Fast Link Training Source test not shown.)

## eDP Tx Backlight Control

The M41d supports testing of the eDP backlight control function on eDP TCON display subsystems. Backlight control is supported through the Aux Channel and the backlight control lead. The connection is made through the module's eDP header pins on the faceplate. You can select between High and Low backlight enable, set the PWM duty cycle, pre-scaling and PWM generator divider.

## eDP Tx Backlight Control



# SPECIFICATIONS

## DisplayPort 1.4 / USB-C/ eDP Capabilities

Version	DisplayPort 1.4a
Standard Formats	VESA, CTA
Video Data Rates	1.62, 2.7, 5.4, 8.1 Gb/s Link rates 1, 2, 4 Lanes
Color Depths	8, 10, 12, 16 bits
Video Encoding	RGB, YCbCr
Video Sampling Modes	4:4:4, 4:2:2, 4:2:0
HDCP	Versions 2.2 & (1.3 on 1 & 2 lanes only)
Audio	8 Channel LPCM programmable sine wave
Capture memory	8 GBytes

## Connectors - Front

DP Full-Size	Tx (1) DP Full-size; Rx (1) DP Full-size
USB-C	Tx (1) USB-C with DP Alt Mode; Rx (1) USB-C with DP Alt Mode
Aux Chan Adjunct Board	Tx (1) DP Full-size; Rx (1) DP Full-size
eDP Header	Pins to access eDP Tx backlight controls
USB (2)	For connecting keyboard and mouse for ATP Manager control

## Connectors - Back

HDMI - Admin Connector	HDMI Port for ATP Manager
USB (2); USB-C (2)	Keyboard / mouse connected to USB ports; External 4K UHD TV at Admin HDMI port
RJ45 E1	For admin control over LAN from computer running ATP Manager
All other connectors	Not used

## Physical / Electrical / Admin

Power	100-240 VAC, 50-60 Hz, 200 Watts
Weight	11.15 LBS; 5.057 Kg
Size	Height: 3.44 in. (8.74 cm) Width: 9.57 in. (24.30 cm) Depth: 10.94 in. (27.79 cm)
Rack mountable	2 RU mounts in 19 inch rack with rack mounting brackets (provided)
Internal speaker	Speaker with volume control for monitoring incoming audio
Command Line Control	Ethernet (RJ-45) for external GUI and telnet
GUI Control	Either through External PC connected over LAN to Ethernet RJ45 or: Keyboard / mouse connected to USB ports; External 4K UHD TV at Admin HDMI port
Environmental	Operating Temp: 32 to 104 (F); 0 to 40 (C)

## Ordering - Product Code

## Description

00-00260	M41d hardware and base functional unit – Entry Level with full sized DP connectors activated
95-00209	M41x rack-mount kit
95-00211	USB-C Port activation for DP Alt Mode function
95-00219	Source enhanced functional test – Includes Capture Analysis, Aux Chan Analyzer, Passive Monitoring
95-00220	Sink enhanced functional test - Includes Aux Channel Analyzer
95-00213	Source Link Layer compliance (requires 95-00219)
95-00216	Sink Link Layer compliance (requires 95-00220)
95-00227	<b>NEW!</b> Sink EDID compliance (requires 95-00220)
95-00215	DSC/FEC Source functional test (requires 95-00219)
95-00218	DSC/FEC Sink functional test (requires 95-00220)
95-00214	HDCP 2.2 Source compliance (requires 95-00213)
95-00217	HDCP 2.2 Sink compliance (requires 95-00218)
95-00212	Embedded DisplayPort (eDP)



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