TELEDYNE LECROY
Everywhereyoulook™
quantumdata

quantumdata™ M41h
48G Video Analyzer/Generator
for HDMI® Testing
Deep Analysis & Generation of HDMI 2.1 Fixed Rate Link (FRL) w/ Forward Error Correction (FEC)
Entry Level Tester for Upgradable to Full Compliance
NEW! Video Analyzer-only or Video Generator-only Configurations for cost savings

Key Features

- Verify the 16b/18b encoding for Fixed Rate Link (FRL) Packets in both 3 and 4 lane configurations
- Use generator or analyzer in three (3) Lane configuration mode at 3Gbps & 6Gbps data rates and four (4) Lane configurations at 6Gbps through 12Gbps (48Gbps aggregate)
- Video generator function supports TMDS and FRL for video resolutions up to 8K and 10K
- Certified "Test Device Approved for Dolby Labs, Inc." for HDMI & eARC Dolby audio generation & analysis including Source Led Dolby Vision tests.
- Evaluate 4K & 8K HDR10 UHDTVs w/HDR Lab
- View captured FRL and TMDS data elements graphically in Event Plot and in Data Decode table; use searching and filtering to find data
- View FRL packet mapping into Character Blocks and Character Block mapping into Super Blocks
- Verify Display Stream Compression (DSC) on FRL, DSC capable source or sink devices.
- Run FRL & DSC source & sink compliance tests
- Run eARC the full suite of compliance tests on an eARC Tx or Rx device
- Run TMDS source & sink compliance tests
- Run HDCP 2.3 source, sink & repeater compliance tests
- View TMDS video, protocol, data island, preamble and control elements
- Monitor of FRL Link Training transactions in the Auxiliary Channel Analyzer utility to show SCDC reads and writes over the DDC channel
- Run pixel error test on incoming TMDS
- Passively monitor DDC channel in TMDS or FRL mode (FRL mode requires custom cable)
- Passively monitor the TMDS Video and metadata (without HDCP) and DDC channel between a source and sink
- View Lane Error Counts and Reed Solomon Corrections Count in the SCDC CED registers
- Verify the eARC common mode channel on either an eARC Tx or Rx device
- NEW! Run Gaming-VRR, FVA and QMS-VRR
- Run HDR10+ Source Side Tone Mapping (SSTM) tests on UHDTVs
- Tests Power Cable Assemblies for power requests
- Run test automation for compliance tests with API

The Teledyne LeCroy quantumdata M41h 48Gbps Video Analyzer / Generator *for* HDMI® testing is a compact, versatile test instrument that can be easily extended from an entry level functional tester with both video analysis and video generation function or NEW! either video analyzer-only or video generator-only to a full certified source and sink compliance tester. The M41h is equipped with both HDMI Tx and Rx ports supporting HDMI 2.1a Fixed Rate Link and FEC capture analysis and decode up to 48Gbps (12Gbps/ Lane). The HDMI Rx analyzer port provides visibility into the Fixed Rate Link packetization—super blocks, character blocks and FRL packets and underlying TMDS video, protocol, control and metadata elements. The HDMI Tx video generator port transmits Fixed Rate Link video streams with embedded TMDS video, protocol, control and metadata elements. The M41h also supports the full suite of FRL source and sink compliance tests as well as Enhanced Audio Return Channel (eARC) compliance testing for both Tx and Rx devices. An extensive Application Programming Interface (API) for automated testing systems is available through a command line interface.

Operation

The M41h supports video generation and analysis of the FRL/FEC HDMI data streams through the user-friendly GUI Manager which presents the data in an easy to understand way. The GUI can be controlled either via a laptop connected to the M41h or through a USB keyboard and mouse and a connect-ed UHD HDMI admin display.

Admin display for ATP Mgr

M41h 48Gbps Video Analyzer / Generator

Keyboard & mouse for ATP Manager control

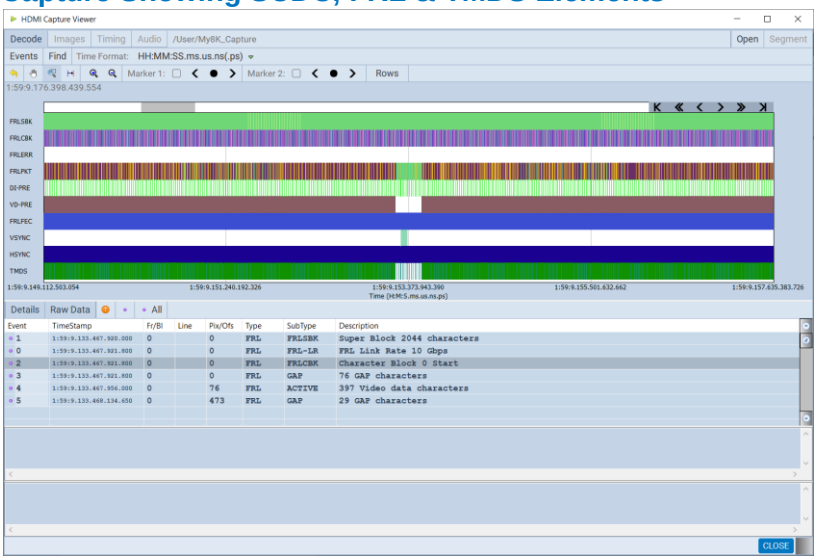
FIXED RATE LINK (FRL) ANALYSIS

Capture and Decode (FRL & FEC)

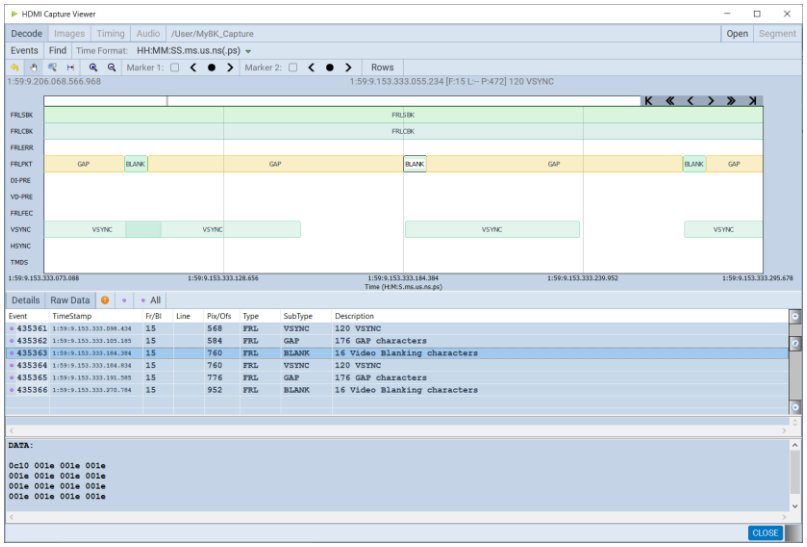
The M41h analyzer captures & decodes incoming HDMI® 2.1 streams (HDCP encrypted or unencrypted) that have been packetized with FRL packet structures. These FRL data elements are depicted graphically in the Event Plot. The decoded data is shown in table form in the Data Decode window. The Forward Error Correction (FEC) characters are also shown as well. The module reports the Lane Error Counts and the FEC Reed Solomon Corrections Count in the SCDC registers. The underlying tri-byte video and protocol elements, e.g. active video, data island and preamble blocks, are also depicted and decoded. Each element is assigned a precise time stamp. Users can search and filter the FRL captured data by type.

Test Setup for Source Test

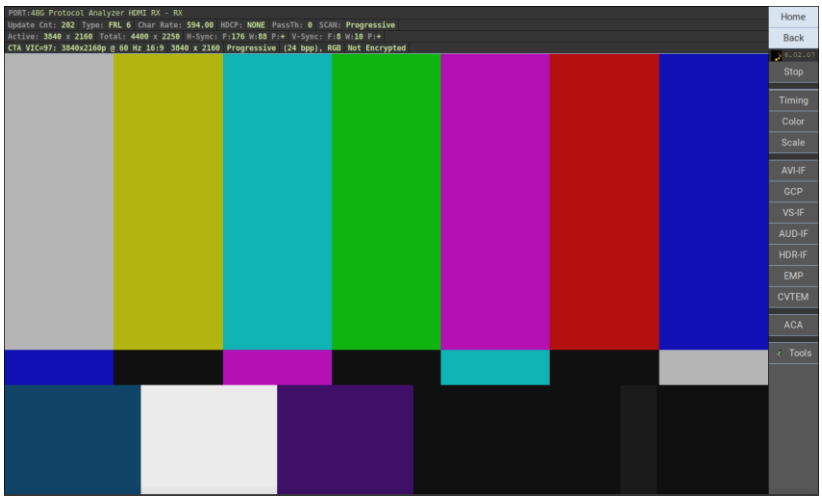
Capture Showing SCDC, FRL & TMDS Elements



Capture Showing FRL Packets, Character & Super Blocks



Real Time Analysis



Real Time Analysis

The M41h's Real Time analysis feature enables you to monitor the incoming TMDS and FRL video and metadata, data islands and InfoFrames including High Dynamic Range (HDR) InfoFrames. A status bar at the top of the window provides an at-a-glance view of the essential incoming video parameters.

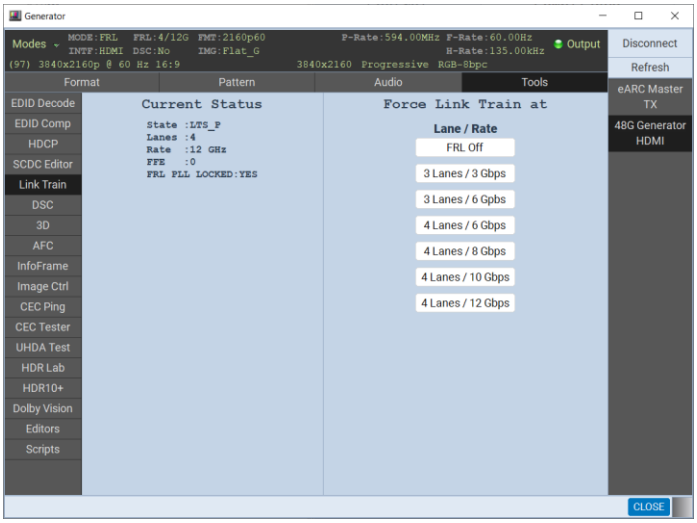
FIXED RATE LINK (FRL) LINK TRAINING ANALYSIS

Link Training

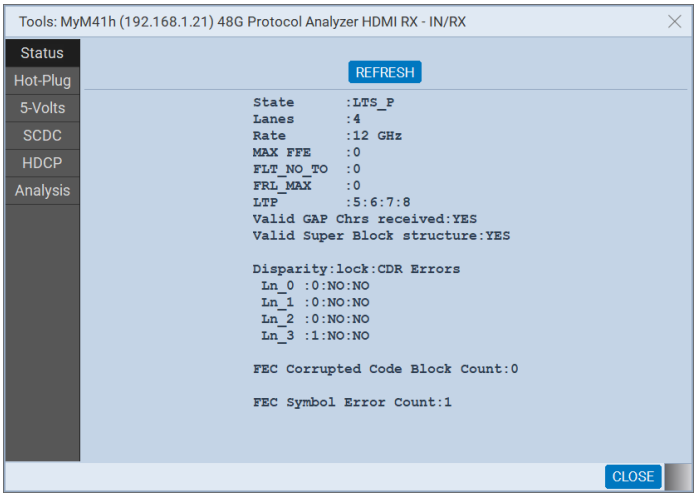
The M41h supports Link Training configuration and control. The module emulates an HDMI® 2.1 sink indicating the max FRL rate in the HF-VSDB of the EDID and various other essential link training parameters in the SCDC control registers.

Test Setup for Source Test

Generator Link Training Status & Control Screen



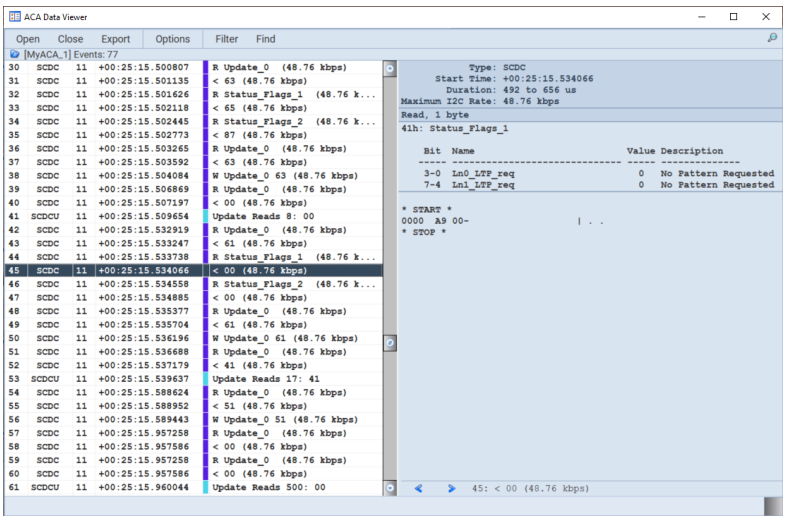
Analyzer Link Training Status Screen



Auxiliary Channel Analyzer

You can use the M41h to monitor the Link Training transactions—EDID exchange and reads and writes to the SCDC registers over the DDC channel--with the Aux Channel Analyzer (ACA) utility. This enables you to verify link training functions to identify potential interoperability problems.

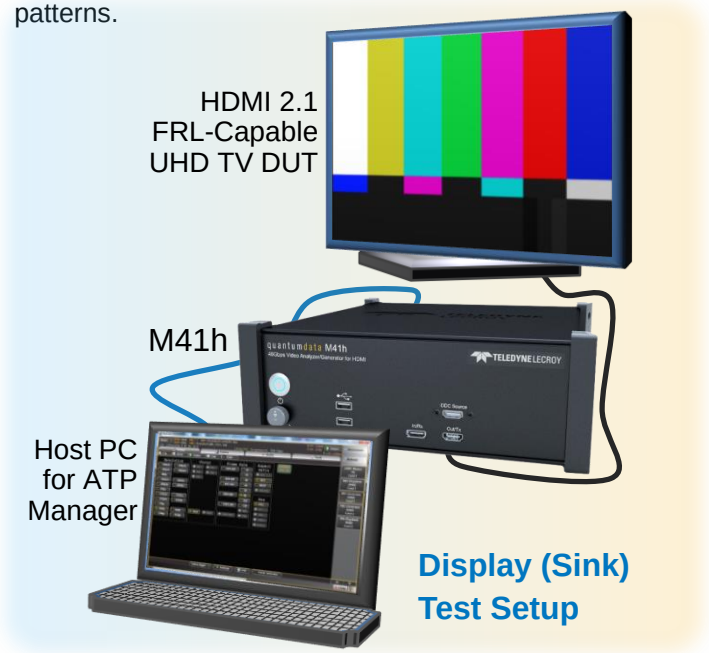
Auxiliary Channel Analyzer (Link Training over DDC)



FIXED RATE LINK (FRL) VIDEO GENERATION

FRL Video Generation

The M41h for HDMI® enables developers of HDMI and TMDS FRL-capable sink devices and silicon makers to run functional tests on their FRL-capable display devices by rendering uncompressed, unencrypted or encrypted FRL streams at up to 8K and 10K video resolutions at lane rates up to 12Gb/s and at an aggregate link rate of 48Gb/s. The enhanced video generator function enables specific selections of video formats, colorimetry, bit depth, chroma subsampling, color space and test patterns.



Display (Sink) Test Setup

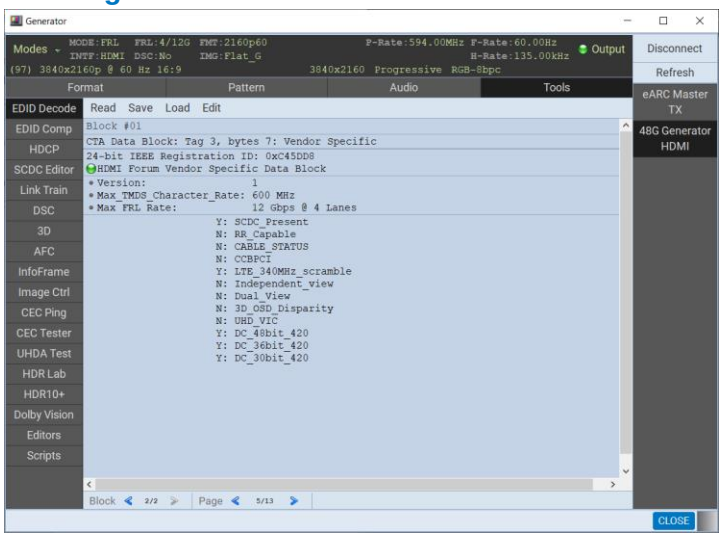
Link Training Configuration

The M41h ‘s video generation function enables you to configure the lane rate and number of lanes for transmission of the FRL stream.

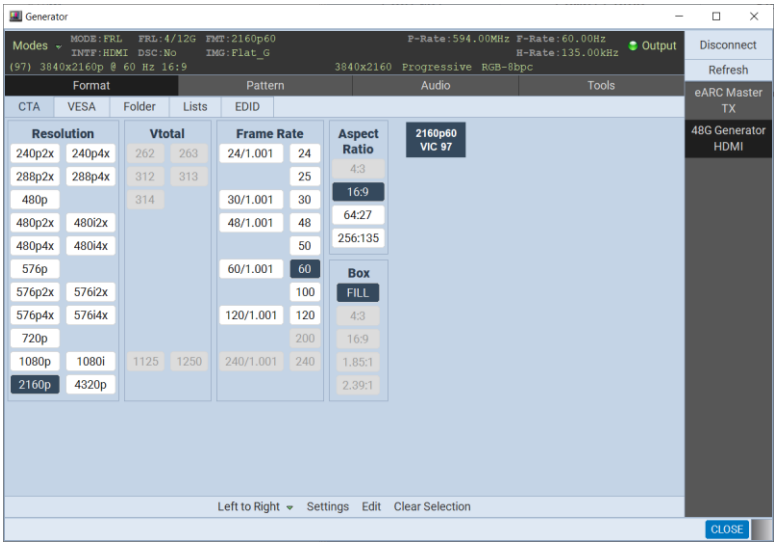
EDID Read

The M41h enables you to view the EDID of the connected display (below). You can page through each block and save for later viewing.

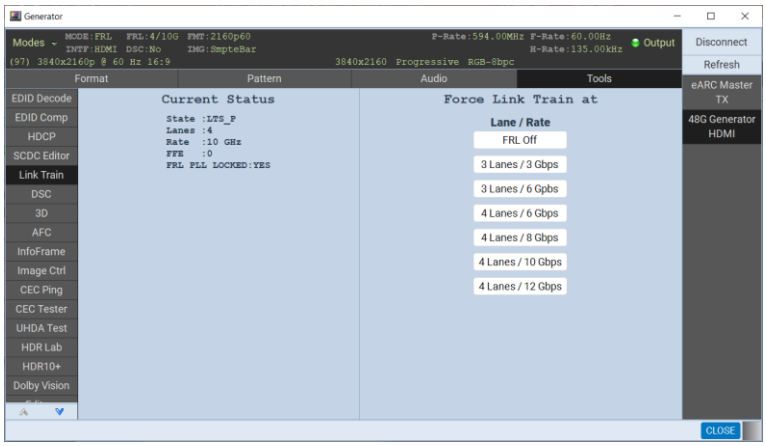
Reading the EDID



Selection of FRL and TMDS Video Resolutions



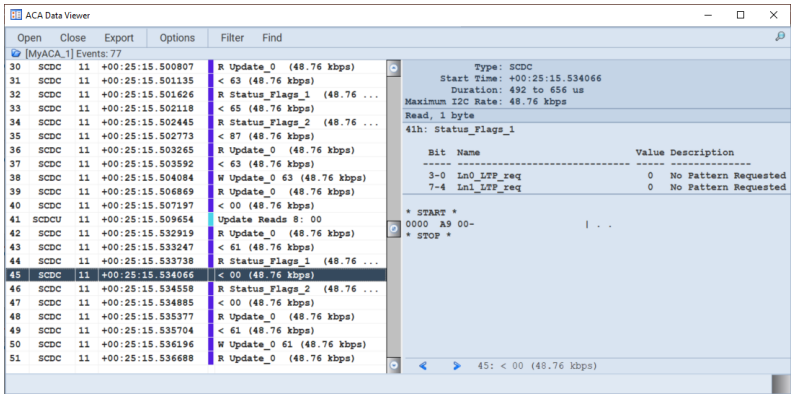
Link Training Configuration



Auxiliary Channel Analyzer (ACA)

You can use the M41h to monitor the Link Training transactions—EDID exchange and reads and writes to the SCDC registers over the DDC channel--with the Aux Channel Analyzer utility. The FRL link training transactions enable developers to verify that their displays are properly conducting their role in the link training process.

Auxiliary Channel Analyzer (Link Training)

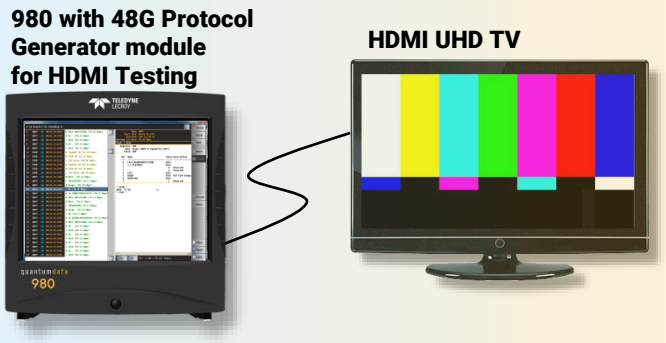


HDR FUNCTIONAL TESTING – HDR LAB, DOLBY VISION, HLG

HDR Lab

The "HDR Lab" test option was developed jointly with industry expert Joe Kane. HDR Lab is a suite of 4K and 8K test patterns and reference images for evaluating HDR10 displays (examples at right) that address the following:

- HDR End-to-End Validation in Post Production – Verifies HDR metadata, color grading and color decoding throughout the post production process.
- HDR Display Test Suite – Verifies various HDR attributes such as: peak brightness, native contrast, average brightness level, signal clipping, and color gamut on an HDR-capable UHD TV using a variety of test patterns.



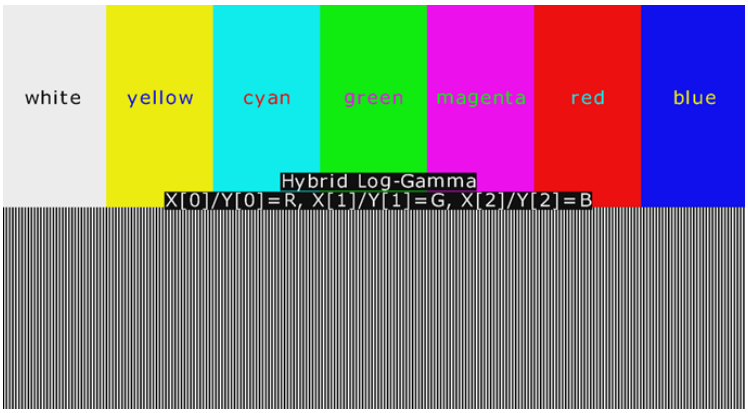
Setup for HDR Functional Tests

Dolby Vision & Hybrid Log Gamma Test Pattern

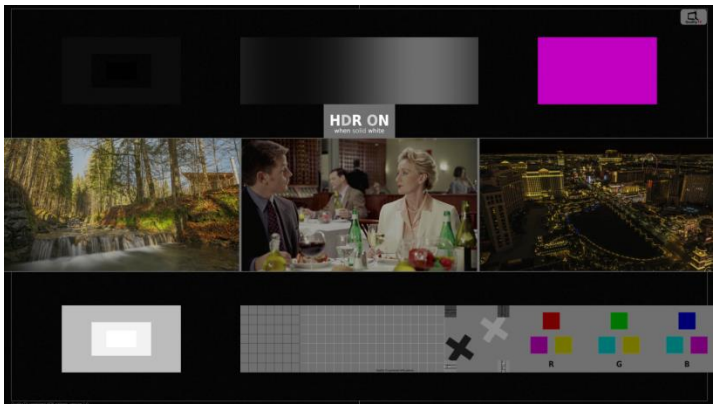
The Dolby Vision test image verifies a Dolby Vision display's Dolby Vision-specific EDID data, its response to the Dolby Vision protocol handshake and its handling of the Dolby Vision signal and metadata. The Dolby Vision test image will be rendered with a checkmark in the proper location if the display has properly interpreted the color space, metadata and checksum correctly.

The Hybrid Log Gamma (HLG) test image provides an assurance that the HLG metadata is not impeding the ability of the display to render the image.

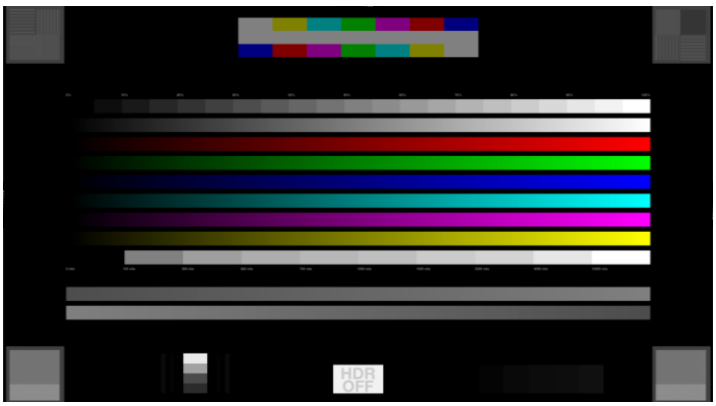
HLG Test Image



HDR Lab (Sample Test Pattern - Combination)

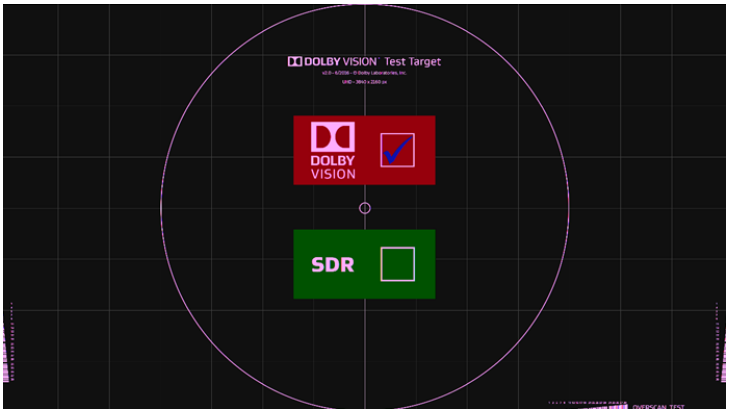


HDR Lab (Sample – Universal Test Pattern)



HDR Lab (Sample Test Pattern – Flower Montage)

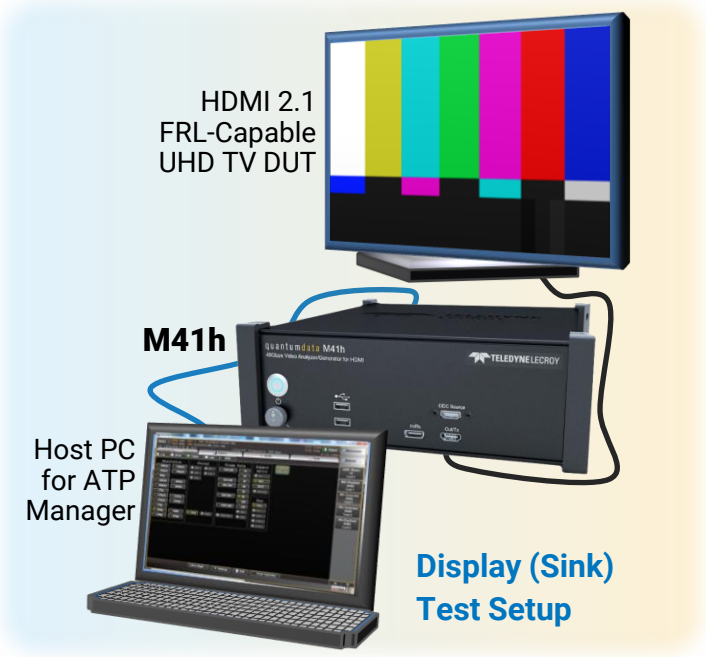
Dolby Vision Test Image



DISPLAY STREAM COMPRESSION (DSC) TESTING

DSC Video Generation

The M41h for HDMI® testing enables developers of HDMI DSC-capable sink devices and silicon makers to run Display Stream Compression (DSC) functional and compliance tests on their FRL-capable display devices by rendering compressed, unencrypted or encrypted FRL streams at up to 8K video resolutions at lane rates up to 12Gb/s. The test patterns and formats necessary to run the DSC sink compliance tests are pre-cached for fast rendering.



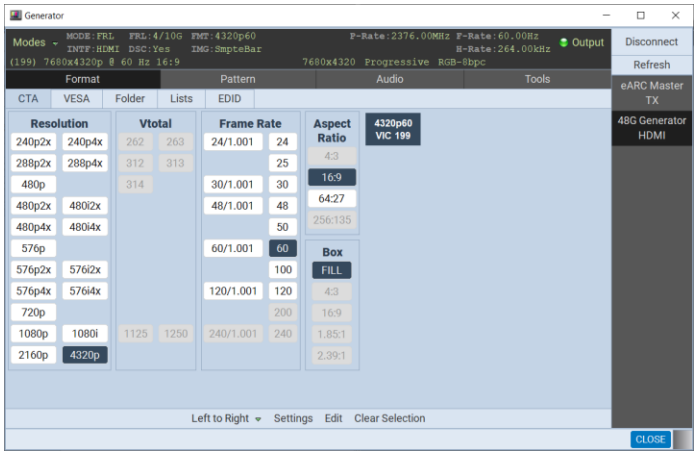
Display (Sink) Test Setup

Display Stream Compression Video Analysis

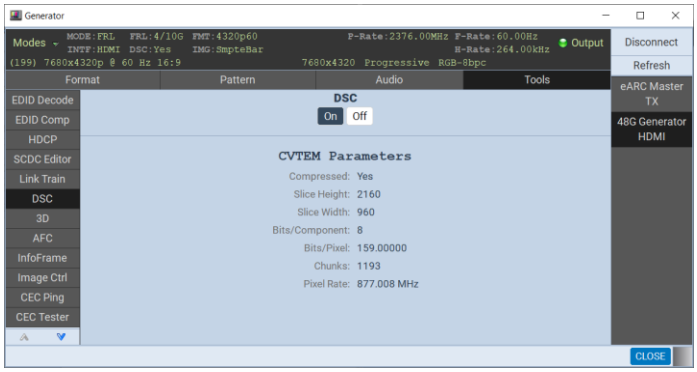
The M41h for HDMI Testing enables developers of HDMI DSC-capable source devices and silicon makers to run Display Stream Compression (DSC) functional and compliance tests on their FRL-capable source devices by rendering compressed, unencrypted or encrypted FRL streams at up to 8K and 10K video resolutions at lane rates up to 12Gb/s. There is a new "No Video" mode that enables you quickly verify the incoming DSC timing and metadata. You can then choose to view the uncompressed video frames.

DSC Real Time Analysis

DSC Video Generation Selection



DSC Video Generation Setup



Test Setup for Source Test

FIXED RATE LINK (FRL) SOURCE COMPLIANCE

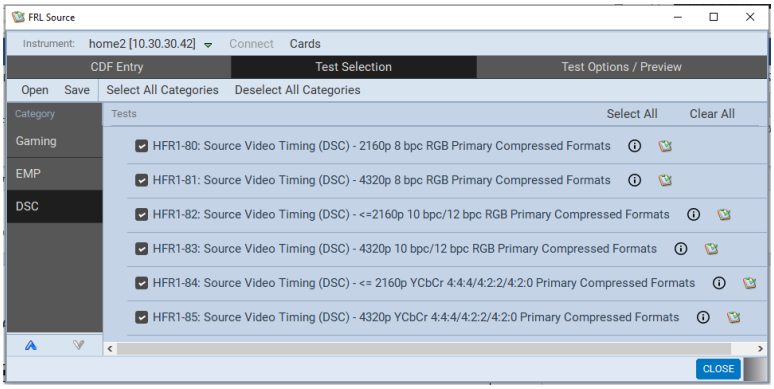
FRL & DSC Source Compliance Testing

The M41h for HDMI® testing enables developers of HDMI FRL-capable source devices and silicon makers to run compliance tests on their FRL-capable source devices on FRL streams at up to 8K video resolutions at lane rates up to 12Gb/s and at an aggregate link rate of 48Gb/s. All compliance test data, including the captured data, is exportable and can be disseminated to colleagues and other subject matter experts.

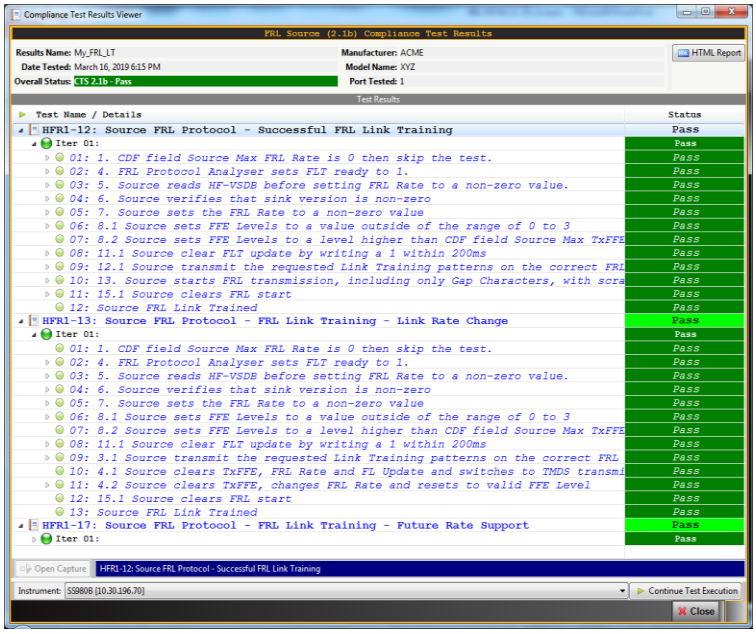
Test Setup for Source Test

Selection of FRL Source Compliance tests

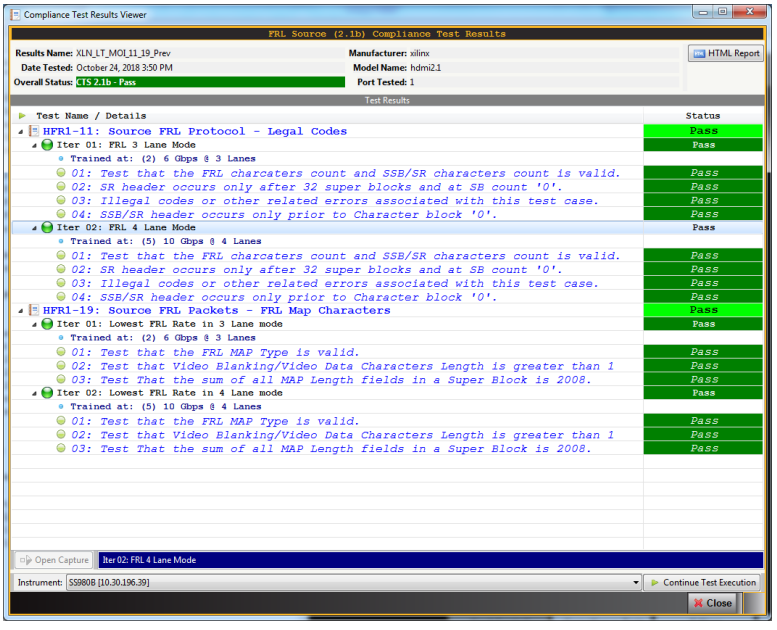
Selection of FRL DSC Source Compliance tests



Sample FRL Source Compliance (Link Training Tests)



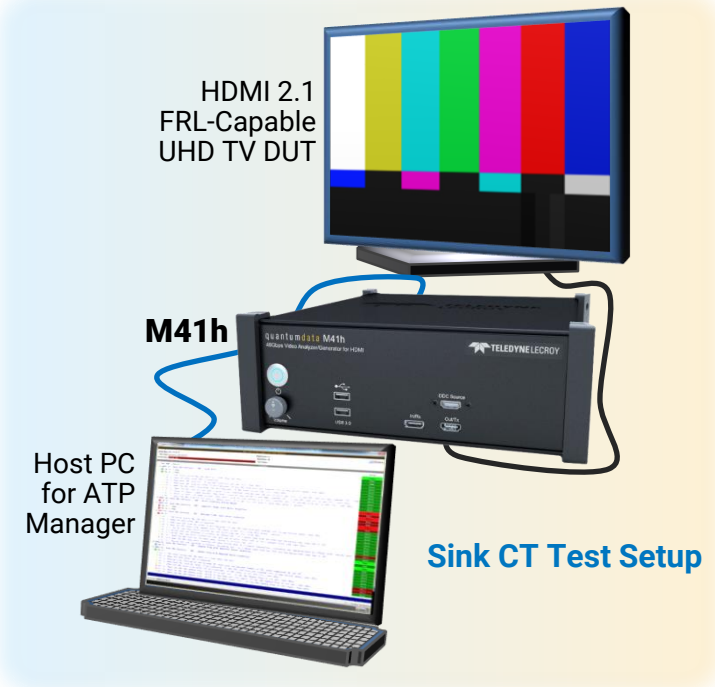
Sample FRL Source Compliance (Protocol Tests)



FIXED RATE LINK (FRL) & DSC SINK COMPLIANCE

FRL & DSC Sink Compliance Testing

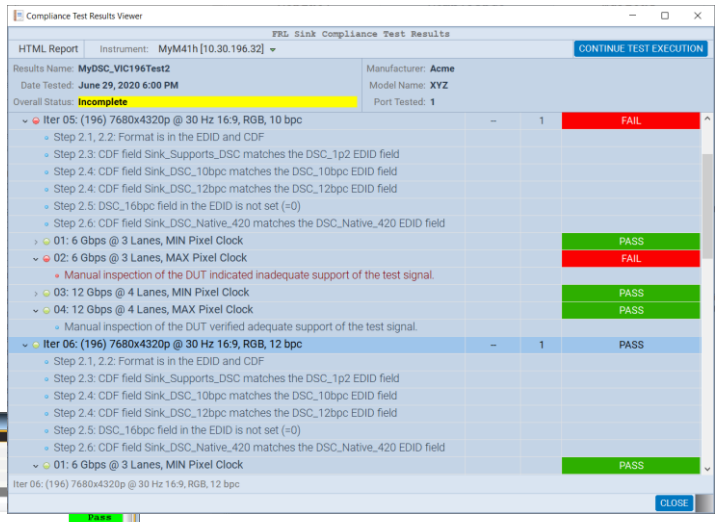
The M41h for HDMI® testing enables developers of HDMI FRL and DSC-capable sink devices and silicon makers to run compliance tests on their FRL-capable sink devices with FRL streams at up to 8K and 10K video resolutions at lane rates up to 12Gb/s and at an aggregate link rate of 48Gb/s. All compliance test data, including the captured data, is exportable and can be disseminated to colleagues and other subject matter experts. The test patterns and formats necessary to run the DSC sink compliance tests are pre-cached for fast rendering.



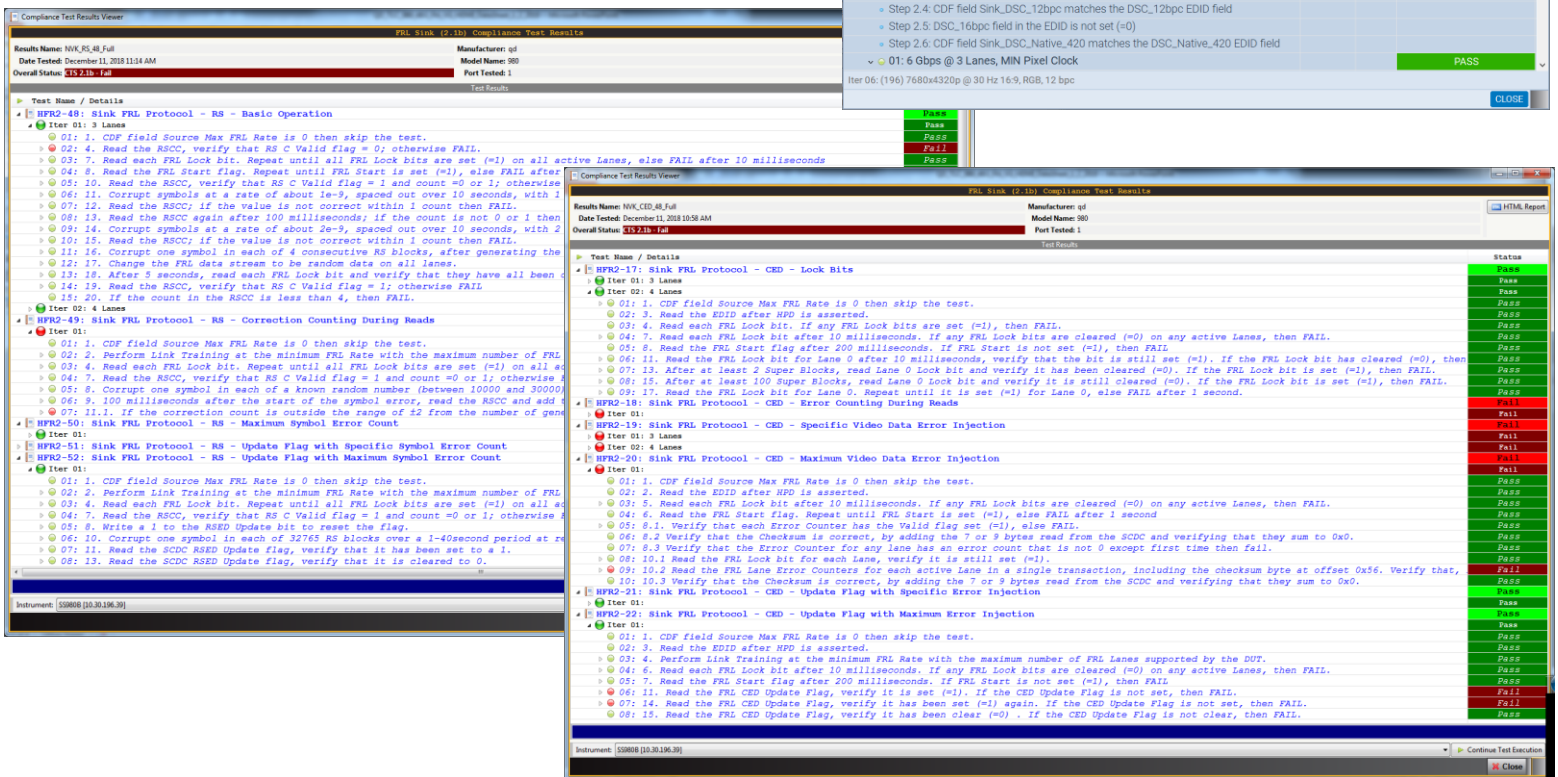
Sink CT Test Setup

Selection of FRL Sink & DSC Compliance tests

Sample DSC Sink Compliance Test Results



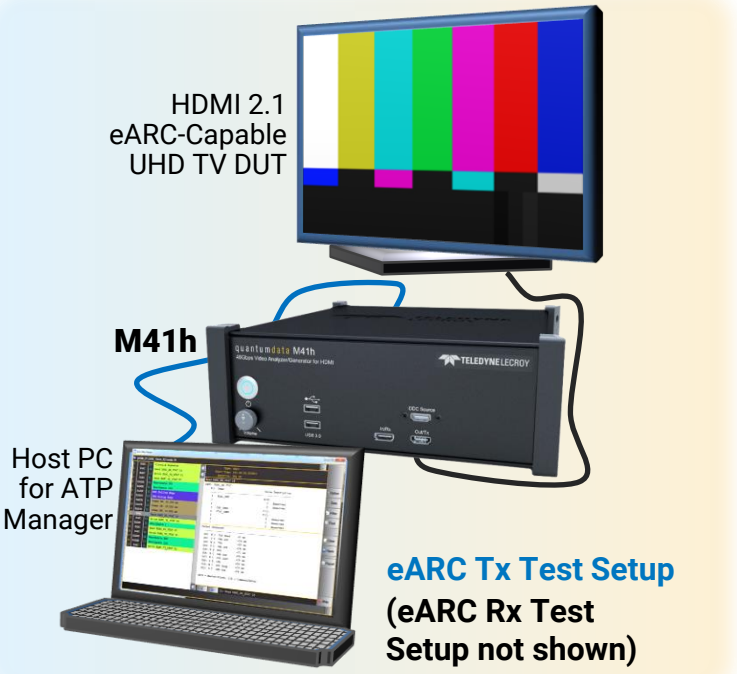
Sample Test Results of FRL Sink Compliance tests



eARC FUNCTIONAL AND COMPLIANCE TESTING

eARC Functional Testing

The 48G Video Analyzer / Generator is also supports enhanced Audio Return Channel (eARC) Tx/Rx functional testing. The solution provides emulation of an eARC Tx and Rx functions over the eARC Common Mode and Differential mode data channels. Solution supports discovery and disconnect, heartbeat, status and capabilities data structure and transmission over the differential channel. (Sample screen showing monitoring incoming audio stream, right.)

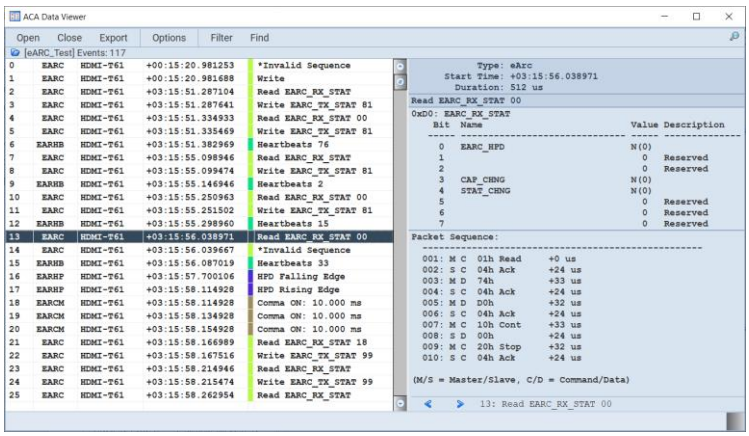


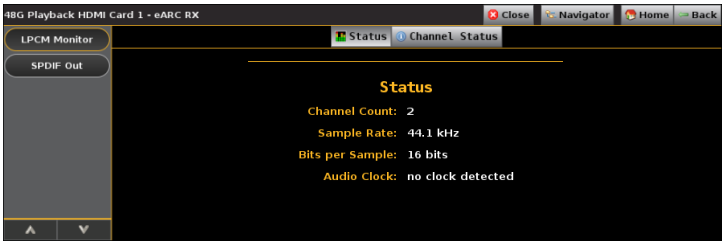
eARC Tx Test Setup (eARC Rx Test Setup not shown)

Auxiliary Channel Analyzer (ACA)

The M41h can monitor the Link Training transactions—EDID exchange and reads and writes to the SCDC registers over the DDC channel -with the Aux Channel Analyzer (ACA) utility. Viewing the FRL link training transactions enables developers to verify their displays are properly conducting the link training process properly.

Aux Chan Analyzer Traces (Common Mode Discovery)

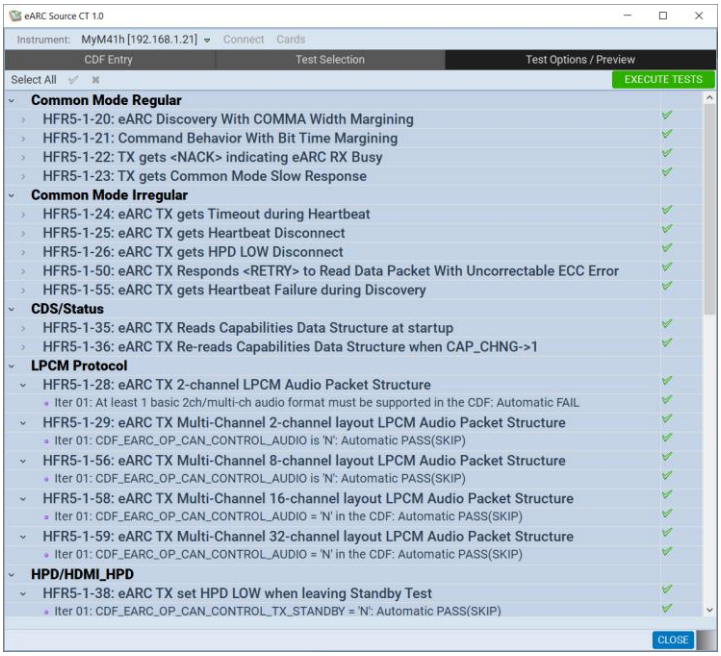




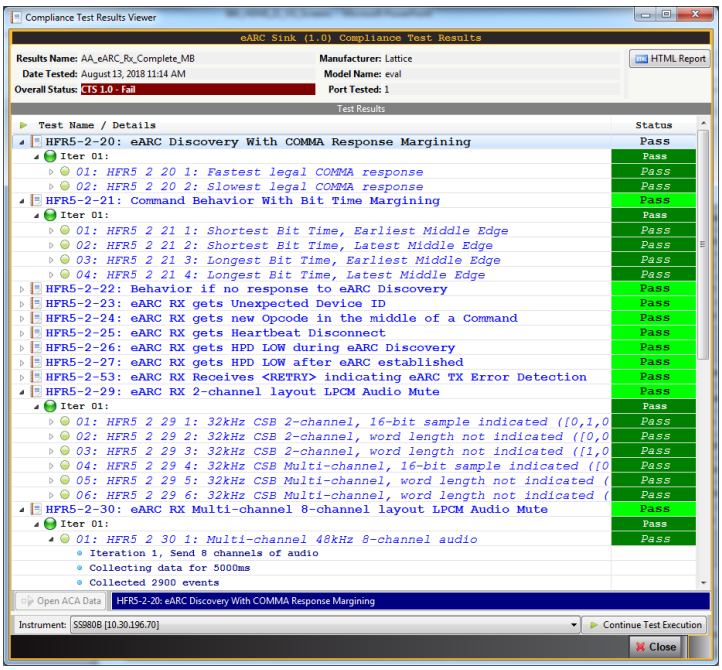
eARC Compliance Testing

The M41h enables developers of HDMI® eARC Tx and Rx devices to run compliance tests on their eARC-capable. The compliance tests run with little or no human interaction. Detailed results are provided for each test to help identify the root cause of failures. The reports can be exported and disseminated to colleagues and other subject matter experts.

Test Suite (eARC Tx Test Suite Example Shown)



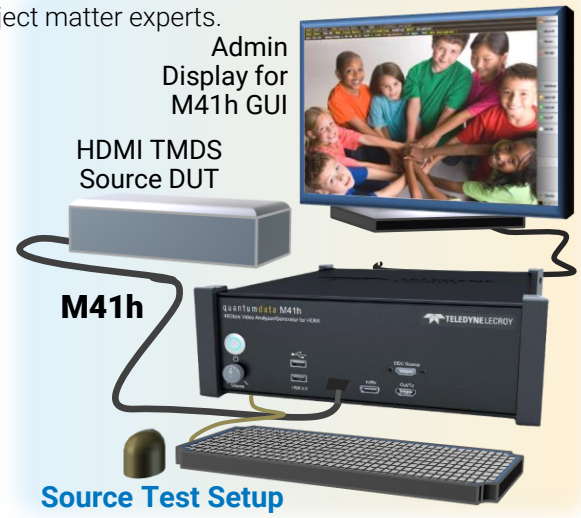
Sample eARC Test Results (eARC Rx Tests Shown)



HDMI® 2.0 SOURCE, SINK TMDS COMPLIANCE TESTS

HDMI TMDS Source Compliance

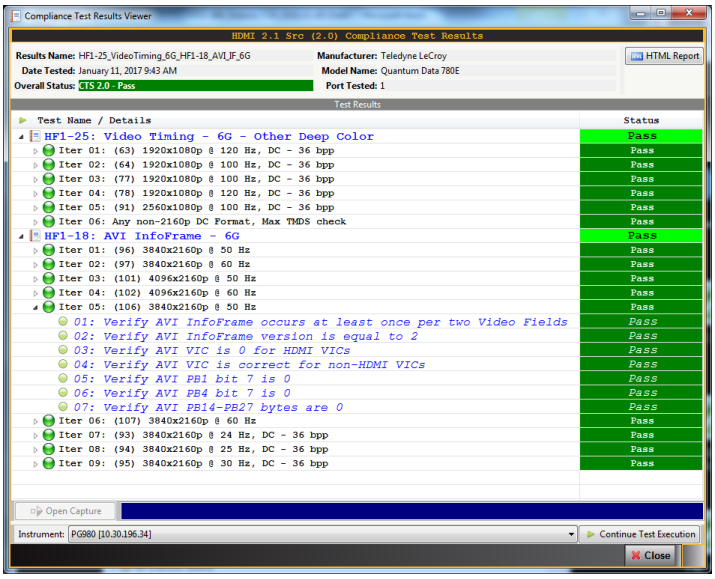
The M41h for HDMI® testing enables developers of HDMI source devices and silicon makers to run compliance tests on their TMDS source devices on streams at up to 4K video resolutions. All compliance test data, including the captured data, is exportable and can be disseminated to colleagues and other subject matter experts.



Source Test Setup

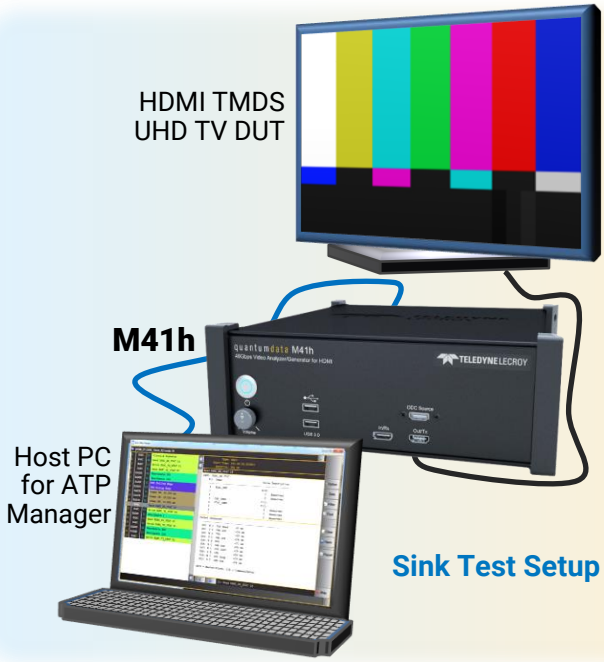
HDMI TMDS Source – Partial List of Supported Tests

HDMI TMDS Test Results – Video Tests



HDMI TMDS Sink Compliance

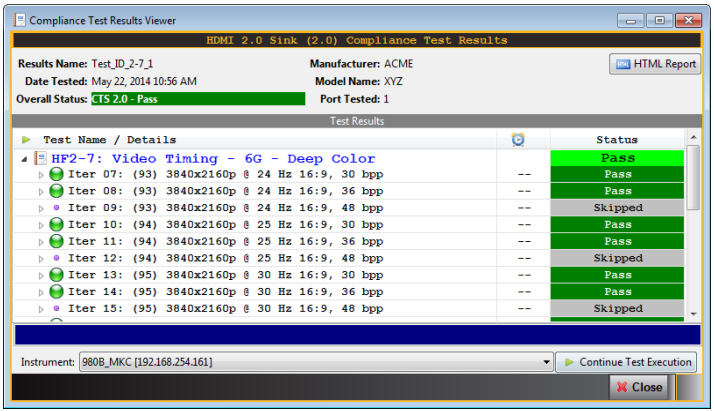
The M41h for HDMI Testing enables developers of HDMI sink devices and silicon makers to run compliance tests on their TMDS sink devices at up to 4K video resolutions. All compliance test data is exportable and can be disseminated to colleagues and other subject matter experts.



Sink Test Setup

HDMI TMDS Sink – Partial List of Supported Tests

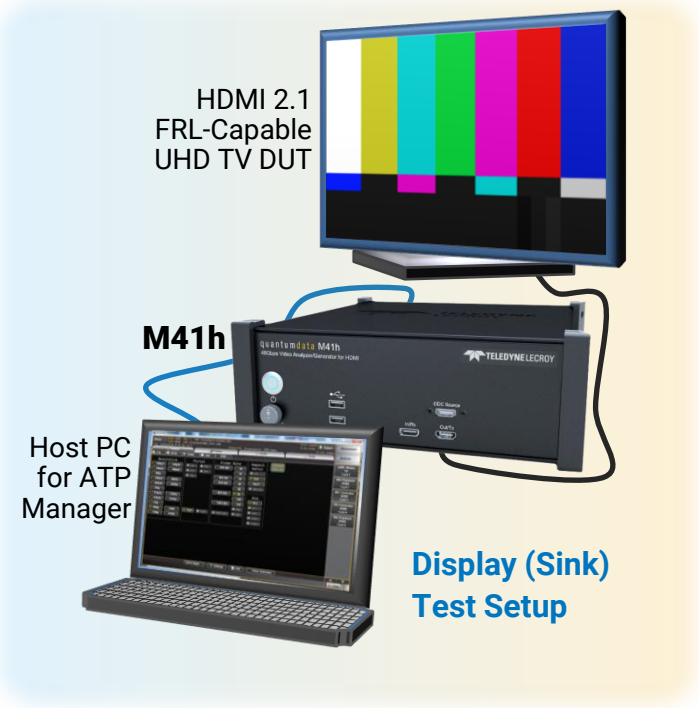
HDMI TMDS Test Results – Video Tests



HDCP 2.3 SOURCE, SINK, REPEATER COMPLIANCE TESTS

HDCP 2.3 Compliance

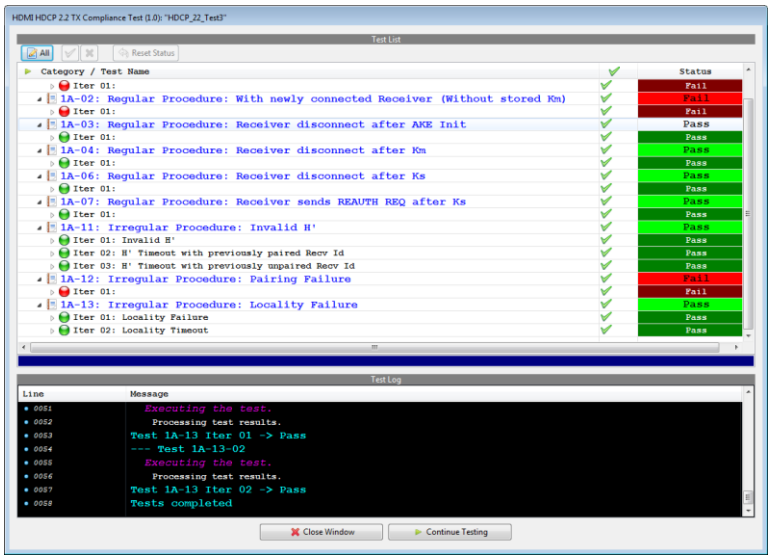
The M41h HDCP 2.3 compliance tests are ideal for pre-testing your HDMI® source, sink or repeater product prior to submission to an Authorized Test Center for approval. Pre-testing provides assurance that your product will pass at the ATC when submitted. The compliance tests enable you to view the auxiliary channel analyzer traces logged during the test to help diagnose the cause of compliance test failures.



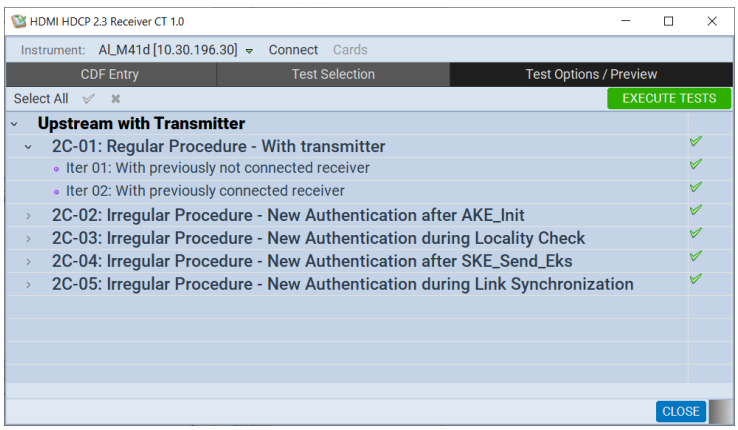
Display (Sink) Test Setup

HDCP 2.3 Test Selection – Source Tests

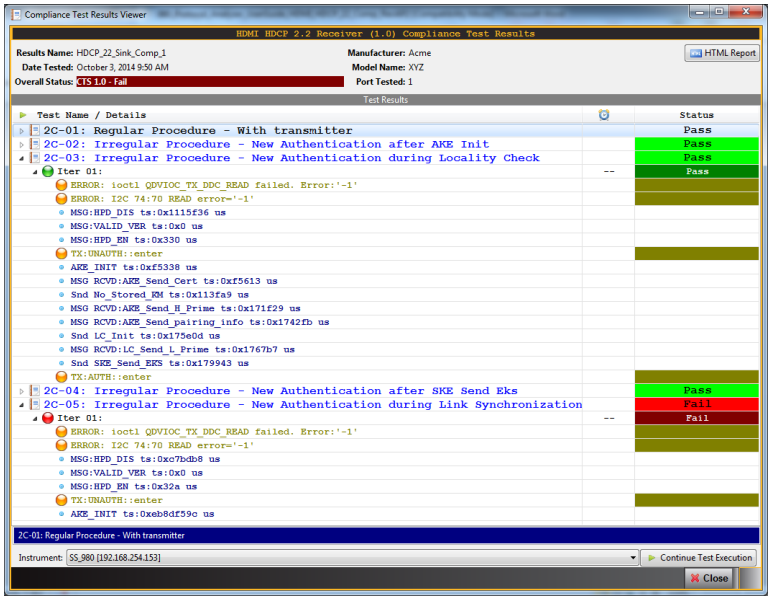
HDCP 2.3 Test Results– Source Tests



HDCP 2.3 Test Selection – Sink Tests



HDCP 2.3 Test Results – Sink Tests



SPECIFICATIONS

HDMI® Capabilities

Version	Up to HDMI 2.1a
Standard Formats	CEA, VESA
Protocols	FRL with FEC, DSC; TMDS, HDCP 1.4, HDCP 2.3, eARC
FRL bit rates	3Gbps; 6Gbps; 8Gbps; 10Gbps; 12Gbps (48Gbps aggregate)
Max Resolution	Up to 8K and 10K with DSC compression
Capture memory	8 GBytes

Connectors - Front

HDMI Connectors (2)	In/Rx HDMI Type A; Category 3; Out/Tx HDMI Type A: Category 3
DDC Source	Used for eARC Tx EDID test
USB (2)	For connecting keyboard/mouse for ATP Manager control or external storage

Connectors - Back

HDMI - Admin Connector	HDMI Port for M41h ATP Manager for external 4K UHDTV at Admin HDMI port
USB (2); USB-C (2)	Keyboard / mouse connected to USB ports;
RJ45 E1	For admin control over LAN from computer running M41h ATP Manager
RCA (2)	SPDIF IN for injecting audio; SPDIF OUT for extracting incoming audio
BNC (2)	Trigger IN / OUT for triggering captures
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)
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 UHDTV at Admin HDMI port
Environmental	Operating Temp: 32 to 104 (F); 0 to 40 (C)

Ordering - Product Code	Description
00-00258	M41h base System – Includes Video Generation, Basic Analysis, Aux Channel Analyzer
00-00265	M41h base System – Basic Analysis, Aux Channel Analyzer
00-00266	M41h base System – Includes Video Generation, Aux Channel Analyzer
95-00271	M41h upgrade from Basic Analysis (00-00265) to full base system (00-00258)
95-00272	M41h upgrade from Video Generator (00-00266) to full base system (00-00258)
95-00209	M41x rack-mount kit
95-00195	Source Enhanced Functional test – Includes Capture Analysis, Gaming Compliance, DSC Functional testing, HDR10+ and Cable ID Compliance and UHDA Compliance Tests
95-00201	Sink Enhanced Functional test – Includes UHDA Patterns, DSC Functional Test, CEC ITE & Gaming and Cable ID Compliance Tests
95-00230	Passive DDC monitoring in FRL mode (requires custom cable)
95-00204	eARC Tx (Sink) functional test
95-00199	eARC Rx (Source) functional test
95-00196	FRL & DSC Source compliance tests (req's 95-00195)
95-00202	FRL & DSC Sink compliance tests (req's 95-00201)
95-00205	eARC Tx (Sink) compliance tests (required 95-00204)
95-00200	eARC Rx (Source) compliance tests (requires 95-00199)
95-00198	HDCP 2.2 Source compliance (requires 95-00195)
95-00206	HDCP 2.2 Sink compliance (requires 95-00201)
95-00197	TMDS Source compliance tests (requires 95-00195)
95-00203	TMDS Sink compliance tests (requires 95-00201)
95-00207	Sink HDR Tests (Dolby, HDR Lab]) (requires 00-00258)

TELEDYNE LECROY
Everywhereyoulook™
1-800-909-7211
teledynelecroy.com

Local sales offices are located throughout the world.
Visit our website to find the most convenient location.

v0320