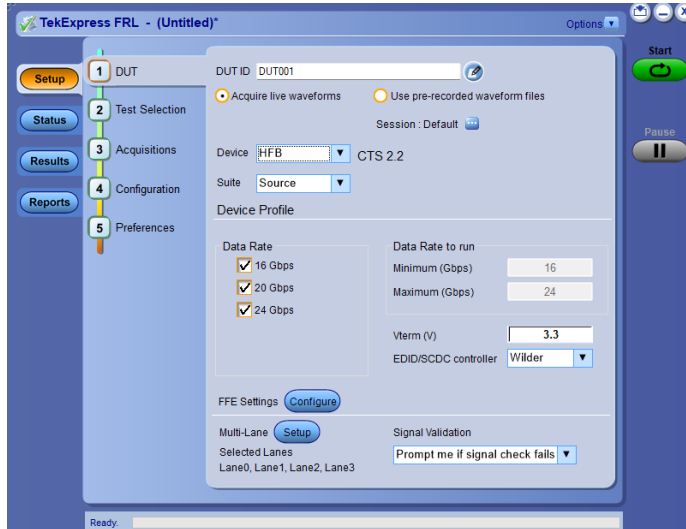
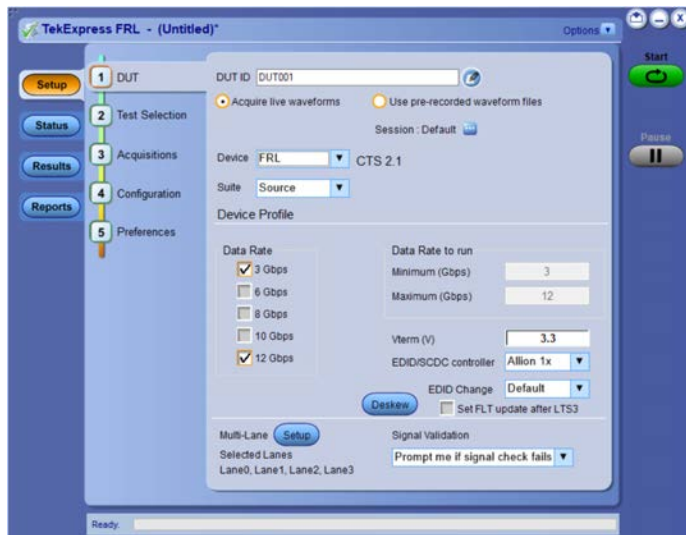


## TekExpress HDMI Source Compliance Test Application Datasheet (HDMI 2.2/HDMI 2.1/HDMI 2.0/HDMI 1.4)



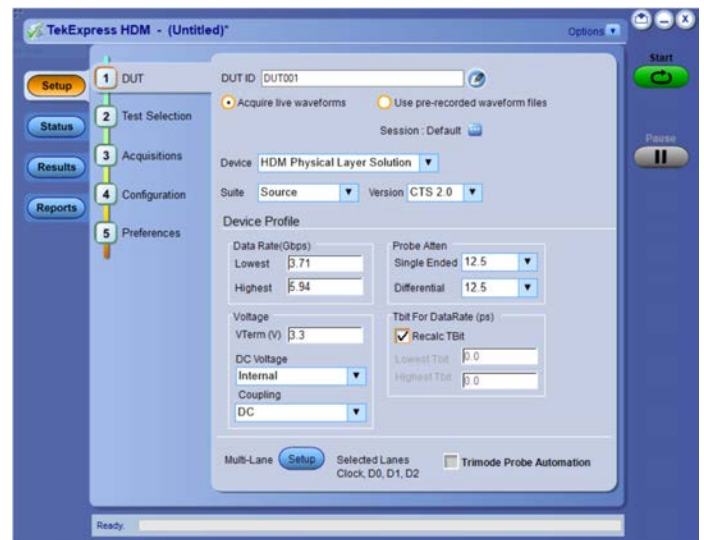
### Home page: HDMI 2.2

**HDMI 2.2:** The HDMI 2.2 specification marks a significant leap in the display interface technology, delivering 24 Gbps/lane with throughput of 96 Gbps transmitted over a Ultra High Speed HDMI 2.2 cable. The HDMI 2.2 ecosystem is designed to support a wide range of data-intensive applications. The Tektronix compliance solution helps engineers to develop, validate, and deploy next-generation HDMI technologies with confidence. It combines automated workflows, advanced measurement capabilities, and deep standards expertise to simplify the complexities of modern HDMI design and bring cutting-edge products to market quickly.



### Home page: HDMI 2.1

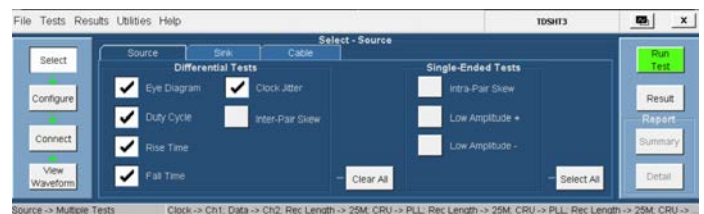
**HDMI 2.1:** Engineers design and validate the HDMI physical layer of their devices, face constant pressure to improve efficiency. Designers need to perform a wide range of compliance tests quickly and reliably at their bench. The HDMI 2.1 is known for Fixed Rate Link (FRL), which supports up to 4K at 120 Hz or 8K at 60 Hz for both compressed and uncompressed video content. The FRL supports only at predefined data rates of 3 Gbps, 6 Gbps, 8 Gbps, 10 Gbps, and 12 Gbps on each of its 4 lanes, which means the FRL supports a post encoded link bandwidth of up to 48 Gbps.



### Home page: HDMI 2.0

**HDMI 2.0:** HDMI 2.0 supports features like 2160p (also known as Ultra HD/4K 2K 60/50 Hz), operating at 5.94 Gbps.

Option HDM compliance software automates a comprehensive range of tests according to CTS 2.0.



**HDMI 1.4:** TDSHT3 automates a comprehensive range of tests according to CTS 1.4b - enabling unprecedented efficiency with reliable results. HDMI 1.4b compliance testing is a prerequisite for HDMI 2.0 testing.

## Key features

### HDMI 2.2 (Opt. HD22)

- Supports automated compliance testing aligned with HDMI Compliance Test Specification (CTS) 2.2.
- Uses advanced jitter analysis methodologies for improved measurement accuracy.
- TriMode probes enable complete DUT automation without connection changes, helping to avoid additional channel losses.
- Delivers fast analysis performance.
- Provides a waveform capture mode that enables waveform acquisition for offline analysis at a later time.
- Generates statistical pass/fail report with detailed limit analysis for clear compliance result.
- Enables seamless workflow integration, reducing setup complexity and manual intervention.

### HDMI 2.1 FRL (Opt. HD21)

- Conformance to HDMI 2.1 standards and CTS 2.1.
- Provides simple and easy setup to perform measurements.
- The TekExpress based software solution allows to completely automate the execution of all source measurements.
- Fully integrated with EDID/SCDC emulators.
- Generates statistically based Pass/Fail results with limit margin and quick results with Pass/Fail notification.

### HDMI 2.0 HDM (Opt. HDM)

- Conformance to HDMI 2.0 CTS.
- Accurate source tests using precise measurement techniques.
- Quick results with automatic mask fit, measurements and Pass/Fail notification. Also provides in-depth results with statistical analysis and mask margins.
- Quick testing with one-button selection of multiple tests and generates CSV-format test summary and reports.
- Comprehensive HDMI 2.0 solution that includes test fixtures and support for DPO/DSA/MSO70000.

### HDMI 1.4 TDSHT3 (Opt. HT3)

- Conformance to HDMI 1.4a/b standards and 1.4a/b CTS.
- Accurate source tests using precise measurement techniques.
- Quick results with automatic mask fit, measurements and Pass/Fail notification. Also provides in-depth results with statistical analysis and mask margins.
- Quick testing with one-button selection of multiple tests and generates CSV-format test summary and reports.
- Comprehensive HDMI 1.4a/b solution including test fixtures and support for DPO/DSA/MSO70000.

## Test descriptions

### Source Electrical Test List

#### HDMI 2.2 FRL

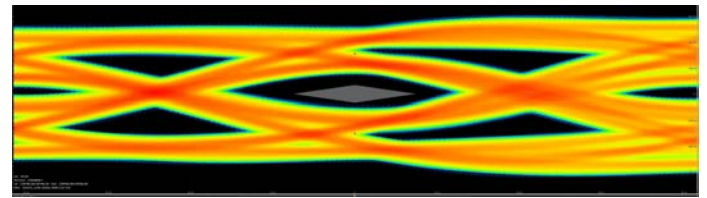
| Test ID | Test point    | Measurement                                                                           |
|---------|---------------|---------------------------------------------------------------------------------------|
| HFB1-1  | TP1           | DC common-mode voltage for 16, 20, and 24 Gbps FRL rates                              |
| HFB1-2  |               | VSE max and VSE min for 16, 20, and 24 Gbps FRL rates                                 |
| HFB1-3  |               | Slew rate for 16, 20, and 24 Gbps FRL rates                                           |
| HFB1-4  |               | Inter-pair skew for 16, 20, and 24 Gbps FRL rates                                     |
| HFB1-5  |               | FRL rates above 12 Gbps                                                               |
| HFB1-6  | TP1 or TP2_EQ | Random jitter and uncorrelated deterministic jitter for 16, 20, and 24 Gbps FRL rates |
| HFB1-7  | TP2_EQ        | Data lane eye diagram for 16, 20, and 24 Gbps FRL rates                               |
| HFB1-8  | TP1           | AC common-mode noise for 16, 20, and 24 Gbps FRL rates                                |
| HFB1-9  |               | FFE monotonicity for 16, 20, and 24 Gbps FRL rates                                    |

#### HDMI 2.1 FRL

| Test ID | Test point | Measurement          |
|---------|------------|----------------------|
| HFR1-1  | TP1        | DC Common Mode       |
| HFR1-2  |            | Vse_max, Vse_min     |
| HFR1-3  |            | TRISE, TFALL         |
| HFR1-4  |            | Inter-Pair Skew      |
| HFR1-5  |            | FRL Rate             |
| HFR1-6  | TP1/TP2    | Data Jitter (Rj)     |
| HFR1-7  | TP2_EQ     | Data Eye Diagram     |
| HFR1-8  | TP1        | AC Common Mode Noise |
| HFR1-9  |            | FFE                  |

## HDMI 2.0 HDM

| Test ID                    | Test point | Test Mode    |
|----------------------------|------------|--------------|
| HF1-1 VL and Vswing        | TP1        | Single-ended |
| HF1-2 Rise and Fall times  | TP1        | Differential |
| HF1-3 Inter pair skew      |            |              |
| HF1-4 Intra-pair skew      | TP1        | Single-ended |
| HF1-6 Clock Duty cycle     | TP1        | Differential |
| HF1-7 Clock Jitter         | TP2_EQ     | Differential |
| HF1-8 Data Eye Diagram     | TP2_EQ     | Single-ended |
| HF1-5 Differential Voltage | TP1        | Differential |

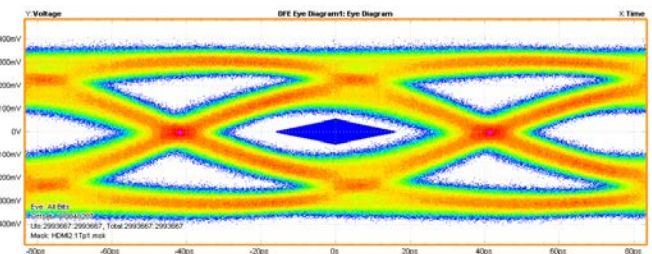


*Eye diagram analysis for HDMI 2.2, 24 Gbps signal*

## HDMI 2.1 eye diagram capability

HDMI 2.1 eye diagram capability displays the eye diagram of a high-speed signal when option DJA enabled on the oscilloscope for test HFR1-7 data lane eye diagram. This test evaluates the waveform parameters over a significant interval of time to verify that, with proper clock recovery and equalization there is no signal incursion into regions defined by a mask to result in correct demodulation of data.

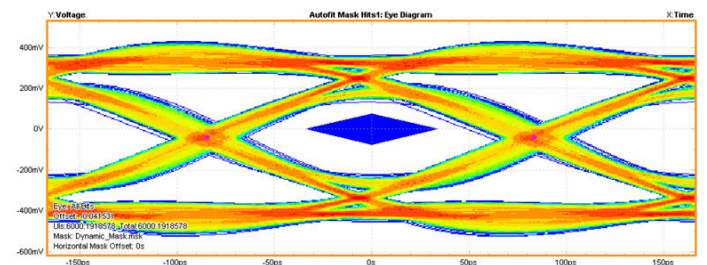
The CTLE and DFE equalization are applied for data rate equal to 12 Gbps, while only CTLE is applied for any other data rate, resulting summed waveform for a wider eye-opening.



*Eye diagram analysis for HDMI 2.1, 12Gbps signal*

## HDMI 2.0 Eye diagram capability

Displays the eye diagram of the high-Speed 6 Gbps signal with option HDM and DJA enabled on the oscilloscope for test HF1-8 data lane eye diagram. Software automatically applies WCM and CTLE to render HDMI 2.0 HF1-8 eye diagram measurement.



*Eye diagram analysis for HDMI 2.0, 6Gbps signal: Single Ended Input eye rendered at Tek lab with auto-mask adjust feature*

## HDMI 1.4 TDSHT3

| Test ID                      | Test point | Test Mode    |
|------------------------------|------------|--------------|
| 7-2 TMDS VL                  | TP1        | Single-ended |
| 7-4 TMDS Rise and Fall Times |            | Differential |
| 7-6 TMDS Inter pair skew     |            |              |
| 7-7 TMDS Intra-pair skew     |            | Single-ended |
| 7-8 TMDS Clock Duty cycle    |            | Differential |
| 7-9 TMDS Clock Jitter        |            |              |
| 7-10 TMDS Data Eye diagram   |            |              |
| 7-3 Voff                     |            | Single-ended |

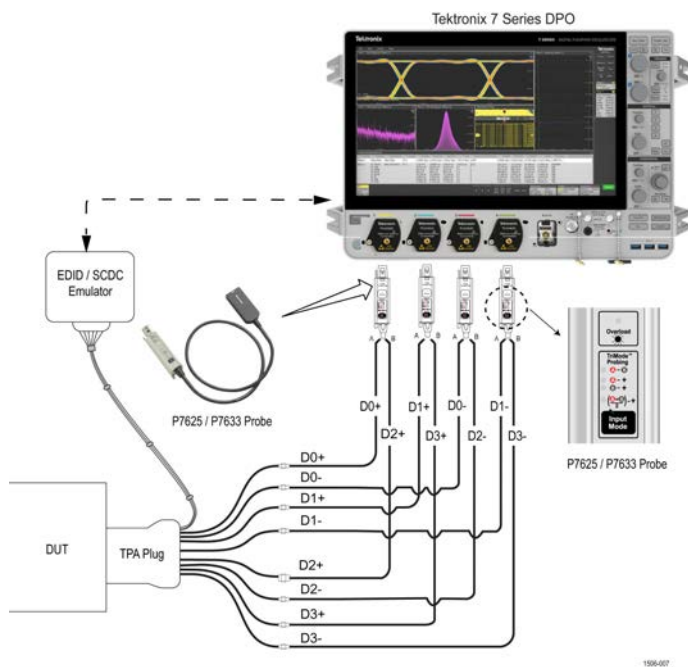
## Eye diagram analysis

### HDMI 2.2 eye diagram capability

The HDMI 2.2 eye diagram capability displays the eye diagram of a high-speed signal when option DJA enabled on the oscilloscope. It supports HFB1-7 data lane eye diagram test for 16 Gbps, 20 Gbps, and 24 Gbps FRL rates. This test evaluates the waveform parameters over a significant interval of time to verify that, with proper clock recovery and equalization there is no signal incursion into regions defined by a mask to result in correct demodulation of data.

The measurement workflow automates fixture de-embedding, application of cable loss models and crosstalk effects, followed by equalization processing. CTLE and DFE equalization are applied at 16Gbps, 20Gbps, and 24 Gbps. The equalized waveform is then combined to produce a wider eye opening.

## Source schematic with trimode differential probes



**7 Series DPO with triMode differential probes**

## Ordering information

### Required software

| Product     | Description                                                                                                                                                                                                                                                                           |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Opt. HD22   | TekExpress HDMI 2.2 Automated Compliance Solution for Tx tests                                                                                                                                                                                                                        |
| Opt. HD21   | TekExpress HDMI 2.1 Advanced Analysis and Compliance Software for Tx tests                                                                                                                                                                                                            |
| Opt. DJA    | DPOJET-Advanced Jitter Analysis                                                                                                                                                                                                                                                       |
| Opt. SDLA64 | Serial Data Link Analysis                                                                                                                                                                                                                                                             |
| Opt. HDM    | HDMI 2.0 Advanced Analysis and Compliance Software for Source testing. <ul style="list-style-type: none"> <li>Prerequisite for HDMI 2.0 is HDMI 1.4b testing; hence TDSHT3 is required.</li> <li>Prerequisite is Option DJA, Opt 10XL (required for 100M RL), and SR-CUST.</li> </ul> |
| Opt. HT3    | HDMI 1.4b Compliance Test Software                                                                                                                                                                                                                                                    |
| DPOFL-HD22  | HDMI 2.2 (Tx) Automated Compliance Solution; floating license                                                                                                                                                                                                                         |
| DPOFL-HD21  | HDMI 2.1 (Tx) Automated Compliance Solution; floating license                                                                                                                                                                                                                         |
| DPOFL-HDM   | HDMI 2.0 (Tx) Automated Compliance Solution; floating license                                                                                                                                                                                                                         |
| DPOFL-HT3   | HDMI 1.4 (Tx) Automated Compliance Solution; floating license                                                                                                                                                                                                                         |

### Software upgrades

| Product            | Description              |
|--------------------|--------------------------|
| DPO/MSO70000 SX/DX | Order DPO-UP – Opt. HD22 |
| DPO/MSO70000 SX/DX | Order DPO-UP – Opt. HD21 |
| DPO/MSO70000 SX/DX | Order DPO-UP – Opt. HDM  |
| DPO/MSO70000 SX/DX | Order DPO-UP – Opt. HT3  |

## Recommended equipment and accessories

### HDMI 2.2/2.1/2.0/1.4 source single oscilloscope

| Accessory              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Real time oscilloscope | <ul style="list-style-type: none"> <li>HDMI 2.2: DPO/MSO70000 SX/DX series oscilloscopes with bandwidth <math>\geq</math> 25 GHz; 4 Ch and 100 M record length for UDJ measurement.</li> <li>HDMI 2.1: DPO/MSO70000 series real-time oscilloscopes: DPO72304SX with bandwidth <math>\geq</math> to 23 GHz; 4 Ch, 23 GHz, 50 GS/s or 2 Ch, 23 GHz, 100 GS/s.</li> <li>HDMI 2.0: DPO/MSO70000 SX/DX series real-time oscilloscopes with min 16 M record length Opt. 2 XL on and DX series oscilloscopes (For eye diagram and jitter tests) and 100 M record length Opt 10 XL.</li> </ul> |

| Accessory | Description                                                                                                                                                |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Probes    | <ul style="list-style-type: none"> <li>P7625/P7633/P7720/P7630 (HDMI 2.2 needs <math>\geq 25</math> GHz) Tri-mode probe with P76CA-292C (4 Nos)</li> </ul> |

## Recommended test fixtures cables and tools

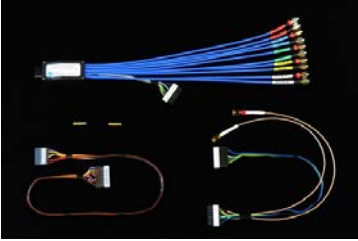
### Recommended test fixture cables and tools

| Description                                                                                                                                                   | Image                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p><b>Description:</b> Cable assembly: Phase matched pair, SMA plug to SMA plug, 1 meter</p> <p><b>Part number:</b> 174-5771-xx</p> <p><b>Quantity:</b> 2</p> |   |
| <p><b>Description:</b> SMA female to female adapter, 0.500 L</p> <p><b>Part number:</b> 015-1012-xx</p> <p><b>Quantity:</b> 8</p>                             |  |

## HDMI fixtures

| Fixture Type      | Nomenclature                                                                                  |
|-------------------|-----------------------------------------------------------------------------------------------|
| HDMI 2.2 Fixtures | Wilder HDMIA2.2-TPA-P (1 Qty) / Luxshare HDMI 2.2 Type-A Plug Test Fixture TFHD-A22PA (1 Qty) |
| HDMI 2.1 EDID     | Allion AJSC-1X or AJSC-1 (1 Qty) / Wilder HDMI FRL/EDID V2.1 (1 Qty)                          |
| HDMI 2.2 EDID     | Allion AJSC-1X or AJSC-1 (1 Qty)                                                              |
| HDA 2.1-TPA-P     | HDMI 2.1 Type A Plug Adapter (1 Qty) / Wilder HDMID2-TPA-P (1 Qty)                            |
| HD-EDID-TEMSS     | HDMI EDID Controller Kit Wilder (1 Qty)                                                       |



| Fixture Type                                                                      | Nomenclature                                                                       |                                                                                     |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| HDMI 2.0 Type-A                                                                   | TF-HDMI-TPA-P plug fixture                                                         |                                                                                     |
|                                                                                   | TF-HDMI-TPA-T                                                                      |                                                                                     |
|                                                                                   | HD-EDID-TEMSS or AJSC-1<br>(HDMI EDID Controller Kit /Allion SCDC/EDID Controller) |                                                                                     |
| HDMI 1.4b Type-A                                                                  | TF-HDMI-TPA-P plug fixture                                                         |                                                                                     |
|                                                                                   | TF-HDMI-TPA-CE EDID board with EDID EEPROM                                         |                                                                                     |
| <b>Model number:</b> HDMIA2.1-TPA-P<br><b>Part number:</b> 640-0860-000           | <b>Model number:</b> HDMIA2-TPA-12P<br><b>Part number:</b> 640-0770-200            | <b>Model number:</b> HDMI-TPA-T<br><b>Part number:</b> 640-0408-000                 |
|  |   |  |

## Supported Tektronix instruments

### Real-time oscilloscopes

#### HDMI 2.2 Tx compliance software

- DPO/MSO70000 SX/DX series real-time oscilloscopes with bandwidth ≥ 25 GHz; 4 Ch.
- DPS 70000 SX (Two Stack, 4 Ch) series: DPO75002SX, DPO75902SX, and DPO77002SX.

**NOTE:** DPO75002SX, DPO75902SX, and DPO77002SX supports two stack series with 50 GHz and above ATI scopes with 4 x probes for HDMI 2.2 compliance testing.

### HDMI 2.1 Tx compliance software

- DPO/MSO70000 series real-time oscilloscopes: DPO72304SX with bandwidth  $\geq 23$  GHz; 4 Ch, 23 GHz, 50 GS/s or 2 Ch, 23 GHz, 100 GS/s support HDMI 2.1 FRL compliance software.
- DPS 70000 SX (Two Stack) series: DPO75002SX, DPO75902SX, and DPO77002SX.

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**NOTE:** DPO75002SX, DPO75902SX, and DPO77002SX supports two stack series with 50 GHz and above ATI scopes with 4 x probes for HDMI 2.1 compliance testing.

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### HDMI 2.0 and HDMI 1.4 Tx compliance software

- DPO/MSO70000 series real-time oscilloscopes supports for HDMI 2.0 HDM and HDMI 1.4 TDSHT3 compliance softwares.

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**NOTE:** The recommended oscilloscope bandwidth for HDMI 2.0 is  $\geq 16$  GHz. Although a 12.5 GHz bandwidth oscilloscope is supported, it will have as much as a 10% variation in test results.

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- DPS 70000 SX (Two Stack) series: DPO75002SX, DPO75902SX, and DPO77002SX.

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**NOTE:** DPO75002SX, DPO75902SX, and DPO77002SX supports two stack series with 50 GHz and above ATI scopes with 4 x probes for HDMI 2.0, and 1.4 compliance testing.

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Tektronix is registered to ISO 9001:2015 and ISO 14001:2015.



Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.



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