

Envision X84

CSI & DSI Protocol Analyzer & Exerciser

for MIPI CSI-2v2 and DSI-2

with Analyzer Conformance Testing



With comprehensive support for MIPI CSI-2 and DSI-2 specifications, Teledyne LeCroy's Envision X84 combination Analyzer and Exerciser platform provides the industry's most complete, accurate and reliable test solution for MIPI silicon makers and integrators.

Envision X84 Analyzer

The Envision X84 Analyzer capture utility provides deep analysis for both MIPI camera and display protocols. The X84 Analyzer can be positioned either as an endpoint to test a CSI/DSI stream or tapped in between a CSI/DSI device and host for passive monitoring and analysis. The X84 ensures fast Time-to-Insight through its rich set of innovative features for debug analysis and identifying and resolving elusive protocol errors.

The Envision X84 Analyzer offers an optional integrated MIPI Conformance Test Specification (CTS) suite for both CSI and DSI. This CTS suite provides checks across all camera and display modes, packet types, and video formats, including high speed and low-power modes.

Key Features & Benefits - X84 Analyzer

- Compliant with MIPI Display Serial Interface (DSI v2.0) Specification – Capture all packet types and data formats, command and video modes, high speed and low power read and write modes, and DCS supported.
- Display Stream Compression (DSC) – Optional feature to decode incoming DSC encrypted content from a DSI host including parsing the PPS metadata parameters.
- Compliant with MIPI Camera Serial Interface (CSI-2v2) Specifications – Analyze all packet types and data formats, including video frames and timing.
- 2.5 Gbps D-PHY data transfer rate per data lane – Scalable from 1-4 data lanes.
- 2.5 GSps C-PHY data transfer rate per data lane – Scalable from 1-3 data lanes (2.28 bits per sample).
- passively tapped between device and host or capturing traffic as a DSI or CSI sink.
- Detailed protocol checking – PHY-level and protocol level events including low-power, high speed bursts and read/writes.
- Complex event-based transaction capture – with 2.5ns event timing resolution for detailed self-checking and debug.
- Statistics for received data and errors – For off-line debug and analysis.
- External Trigger In / Out - Trigger external equipment based on packet structures or event.
- Conformance Test Suite – Optional CTS for CSI-2v2 and DSI-2, for evaluating your device against specifications.
- Automation API for advanced test creation.

Envision X84 Exerciser

Teledyne LeCroy's Envision X84 Exerciser (video generator) is a versatile and flexible tool for MIPI camera and display protocols. Like the X84 Analyzer, the Exerciser offers rich suite of innovative features for generating DSI and CSI packets, frames and images. The Exerciser can be configured to generate sequences of packets or multiple images at various resolutions, color modes, sampling rates and frame timings.

Key Features & Benefits – X84 Exerciser

- MIPI Camera Serial Interface (CSI-2) Specifications – Create and generate all packet types, data formats and frame timing. Also generate Camera Control Interface (CCI) responses.
- MIPI Display Serial Interface (DSI v2.0) Specification - Generate a sequence of images and frames at various resolutions and timings.
- D-PHY support at 2.5 Gbps data transfer rate per data lane - Scalable from 1-4 lanes.
- C-PHY supports 2.28 Symbols per second per trio - Scalable from 1-3 trios or data lanes.
- Detailed protocol checking - PHY-level and protocol level events including low-power and writes/reads.
- Event Based generation with 2.5ns event resolution.
- Advanced Triggering - Start and stop generate on protocol events, data patterns, and external triggers.
- External Trigger In / Out - Use the Teledyne LeCroy X84 to generate any event and toggle a scope or logic analyzer (via SMA connectors).
- Automation API for advanced test creation.

This highly configurable, single platform solution is ideal for MIPI camera and display testing. The Envision X84 is the intelligent choice for any camera and display validation needs.

ENVISION X84 - ANALYZER

Flexible Hardware Platform

The front-end of the Envision X84 analyzer features standard MMCX connectors that support C-PHY or D-PHY signals to provide high fidelity capture of traffic from all active lanes simultaneously. Concurrent recording of PHY-level and protocol-level events allows viewing of per-lane and protocol activity to help characterize and debug interface traffic. The Envision X84 Analyzer platform includes 6GB of recording memory plus a GbE link for uploading recorded traffic to the host PC.

The heart of the Envision X84 Analyzer is a patented Test IP Transaction Processor technology. This state-of-the-art protocol-processing core incorporates a real-time recording engine and configurable tools to selectively monitor and record MIPI CSI and DSI traffic. Field upgradeable firmware allows the Transaction Processor to evolve and support new features or future changes to the MIPI CSI and DSI specifications.

The built-in triggering provides unprecedented flexibility with every possible packet type and error counts, including combinations, configurable as a trigger event. In wrap recording mode, the Envision X84 captures continuously and provides debug back tracing of events for extended debug sessions. All triggers can also generate an external trigger event for synchronizing external scopes or other instruments. An input trigger is useful for coordinating analysis with external events.

A General Purpose I/O (GPIO) connector is included for connection to the CSI or DSI device under test. This can be used for control and status. For CSI, two pins are used as Camera Control Interface (CCI). All pins are controllable via the software GUI or instrument API.

Analysis Software

The Envision X84 utilizes a software application to control the instrument. A user API is also available for automated testing if desired. The user interface uses colors and patterns to train the eye to understand information faster. When recording mixed protocol and PHY traffic, packets are color coded and interleaved in a single display.

CSI Test Configuration – Host Emulation Mode

In CSI host emulation mode, the X84 Analyzer acts as a MIPI Host connected to a camera or image sensor device under test (DUT) that provides the MIPI device interface.



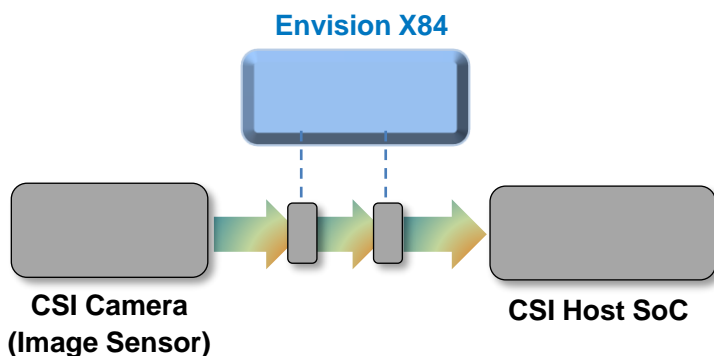
DSI Test Configuration – Device Emulation Mode

In DSI device emulation mode, the X84 Analyzer acts as a MIPI Display device connected to an SoC device under test (DUT) that provides the MIPI Host interface.



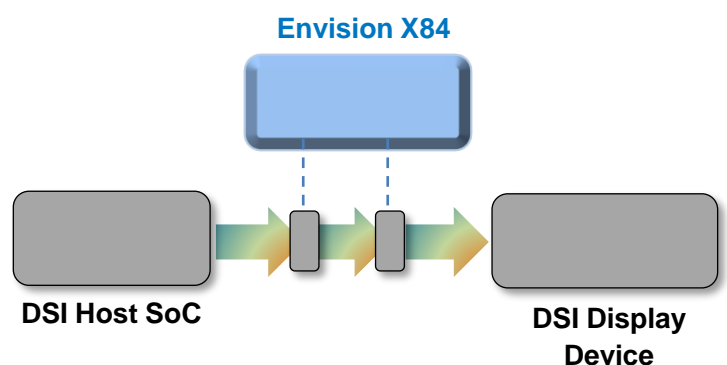
CSI Test Configuration – Passive Probing Mode

In the CSI passive probing mode, the X84 Analyzer is positioned as a passive tap between a CSI host SoC and a CSI camera to sniff traffic. This application is invaluable where the transmission path undergoes a format conversion or traverses a transport facility. By positioning the X84 passive probe elements at various points along the transport facility, the X84 can segment and isolate the point of failure.



DSI Test Configuration – Passive Probing Mode

In the DSI passive probing mode, the X84 Analyzer is positioned as a passive tap between a DSI host SoC and a DSI display device to sniff traffic. This application is invaluable where the transmission path undergoes a format conversion or traverses a transport facility. By positioning the X84 passive probe elements at various points along the transport facility, the X84 can segment and isolate the point of failure.



Envision X84 CSI/DSI Analyzer Protocol Test Suite

The Teledyne LeCroy Envision CSI/DSI Protocol Test Suite's Events tab shows each packet or PPI event on a separate row with every field labeled and color-coded. Events can be individually filtered, searched or exported from the captured trace.

For each capture, Event Statistics are shown in the summary area (top right on screen examples). The examples show cases with both Phy and protocol elements (right) and only protocol packets (below) in this case both Long and Short protocol packets. The Capture configuration that is used to acquire a capture is also provided (Capture Setup upper middle [right]).

The Event Filters area enables users to include/exclude types of protocol traffic from the various analysis tabs (Events, Video, Video Analysis, Timing, Errors). Pre-defined filters are available as well as a user-defined filter mechanism, to facilitate quick Time-to-Insight into problem areas.

Quick setup buttons enable start or stop captures, select the number of lanes, and set or detect PHY speed.

Index	Time	Delta Time	Data Type	VC	Data	Event Description
1	0.000 pS	0.000 pS				Ext HS Mode Lane 2
2	2.500 nS	2.500 nS				HS Burst End
3	2.500 nS	0.000 pS				Ext HS Mode Lane 1
4	5.000 nS	2.500 nS				Ext HS Mode Lane 0
5	55.000 nS	50.000 nS				Enter Stop State Lane 1
6	62.500 nS	7.500 nS				Enter Stop State Lane 2
7	62.500 nS	0.000 pS				Enter Stop State Lane 0
8	540.000 nS	477.500 nS				Ext Stop State Lane 0
9	540.000 nS	0.000 pS				Ext Stop State Lane 1
10	542.500 nS	2.500 nS				Ext Stop State Lane 2
11	970.000 nS	427.500 nS				Enter HS Mode Lane 0
12	970.000 nS	0.000 pS				Enter HS Mode Lane 2
13	975.000 nS	5.000 nS				Enter HS Mode Lane 1
14	977.500 nS	2.500 nS				Start of HS Burst
15	1.022 uS	45.000 nS	0x03	0	0x00FD	Line End (Line 253) VCO
16	1.022 uS	0.000 pS				HS Burst End
17	1.025 uS	2.500 nS				Ext HS Mode Lane 2
18	1.027 uS	2.500 nS				Ext HS Mode Lane 0
19	1.030 uS	2.500 nS				Ext HS Mode Lane 1
20	1.082 uS	52.500 nS				Enter Stop State Lane 1
21	1.087 uS	5.000 nS				Enter Stop State Lane 0

Index	Time	Delta Time	Data Type	VC	Data	Event Description
15	1.022 uS	1.022 uS	0x03	0	0x00FD	Line End (Line 253) VCO
30	2.050 uS	1.027 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
45	4.120 uS	2.070 uS	0x02	0	0x00FE	Line Start (Line 254) VCO
60	5.147 uS	1.027 uS	0x24	0	0x1680	RGB888 Data Payload Size: 5760 bytes VCO
75	12.902 uS	7.755 uS	0x03	0	0x00FE	Line End (Line 254) VCO
90	13.930 uS	1.027 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
105	15.995 uS	2.065 uS	0x02	0	0x00FF	Line Start (Line 255) VCO
120	17.022 uS	1.027 uS	0x24	0	0x1680	RGB888 Data Payload Size: 5760 bytes VCO
135	24.780 uS	7.757 uS	0x03	0	0x00FF	Line End (Line 255) VCO
150	25.805 uS	1.025 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
165	27.872 uS	2.067 uS	0x02	0	0x0100	Line Start (Line 256) VCO
180	28.892 uS	1.030 uS	0x24	0	0x1680	RGB888 Data Payload Size: 5760 bytes VCO
195	36.652 uS	7.750 uS	0x03	0	0x0100	Line End (Line 256) VCO
210	37.682 uS	1.030 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
225	39.750 uS	2.068 uS	0x02	0	0x0101	Line Start (Line 257) VCO
240	40.780 uS	1.030 uS	0x24	0	0x1680	RGB888 Data Payload Size: 5760 bytes VCO
255	48.530 uS	7.750 uS	0x03	0	0x0101	Line End (Line 257) VCO
270	49.560 uS	1.030 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
285	51.622 uS	2.063 uS	0x02	0	0x0102	Line Start (Line 258) VCO
300	52.657 uS	1.035 uS	0x24	0	0x1680	RGB888 Data Payload Size: 5760 bytes VCO
315	60.410 uS	7.753 uS	0x03	0	0x0102	Line End (Line 258) VCO
330	61.435 uS	1.025 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO

Intelligent Triggering

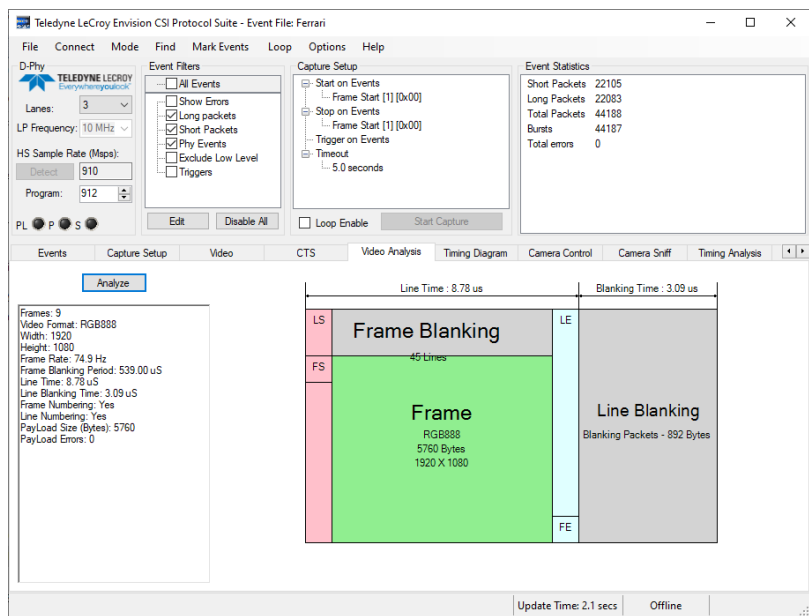
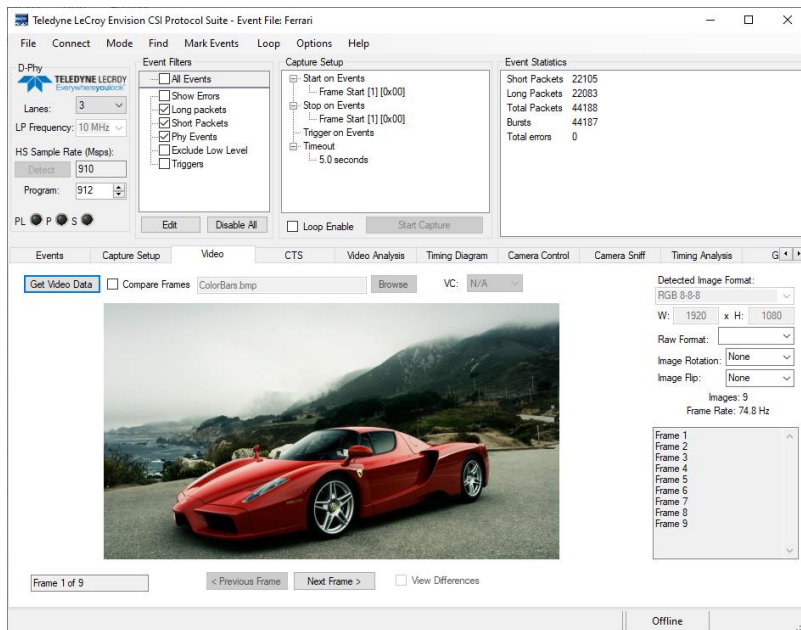
The Envision X84 Analyzer provides hardware triggering to ensure particular protocol events of interest are captured. Trigger events can be specified at the protocol level, targeting specific protocol structures, counts and errors. External triggers from a scope for example can also be used to initiate a capture.

Index	Time	Delta Time	Data Type	VC	Data	Event Description
15	1.022 uS	1.022 uS	0x03	0	0x00FD	Line End (Line 253) VCO
30	2.050 uS	1.027 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO
45	4.120 uS	2.070 uS	0x02	0	0x00FE	Line Start (Line 254) VCO
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330	61.435 uS	1.025 uS	0x11	0	0x037C	Blanking Data Payload Size: 892 bytes VCO

ENVISION X84 – VIDEO & TIMING ANALYSIS

Video Analysis

The Envision X84 Analyzer can capture and analyze all standard video and image types outlined in the MIPI CSI-2 and DSI-2 specifications. Images can be extracted and displayed for viewing on the Video tab as shown (right). The captured images can also be compared to “golden images” or validated in “Loop” mode with a Stop on Errors. The Video tab shows the color type (e.g. RGB, YUV), the chroma sampling mode (e.g. 4:4:4, 4:2:2), the frame rate and the resolution of the incoming video stream that was captured.



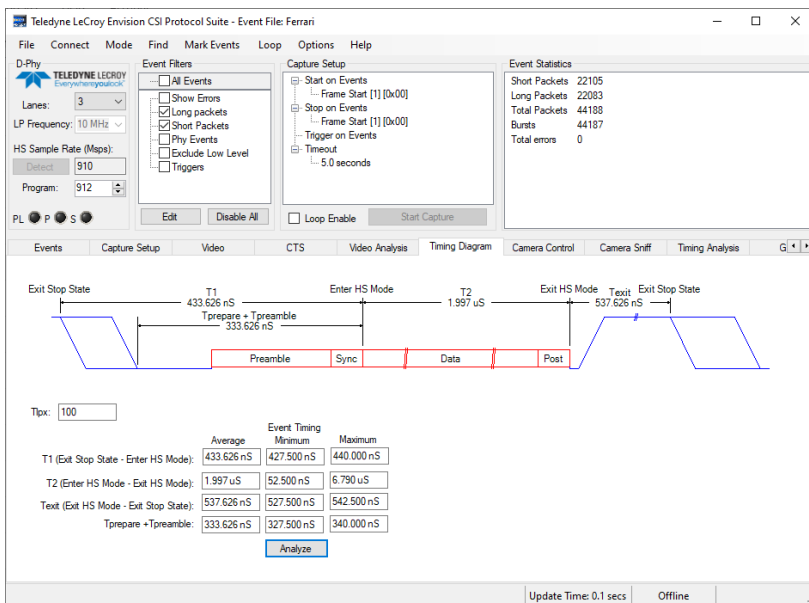
Video Frame Analysis

The Envision X84 Analyzer provides a summary view of the timing parameters and frame structure including the line and frame blanking and the front and back porch (left). The Video Analysis feature depicts the frame structure showing the active video and the blanking. The frame blanking is expressed in lines and line blanking expressed in bytes. A summary window lists the primary video frame parameters and their values.

Timing Diagram

The Envision X84 Analyzer depicts timing elements as the CSI or DSI stream transitions from Low Power mode to the High Speed burst mode (right). The Timing Diagram tab shows the timing for each transition. The relevant timing parameters are averaged over the frames capture and are presented along with the minimum and maximum times.

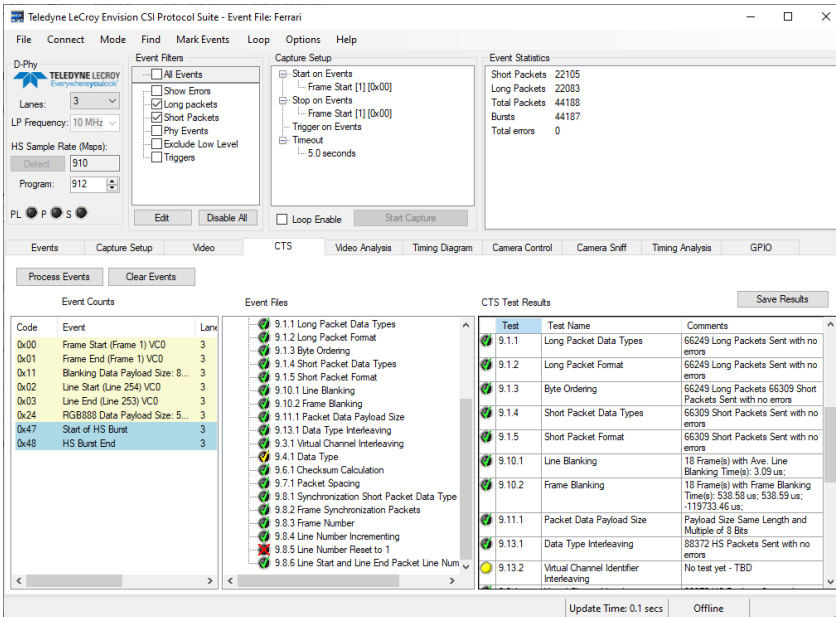
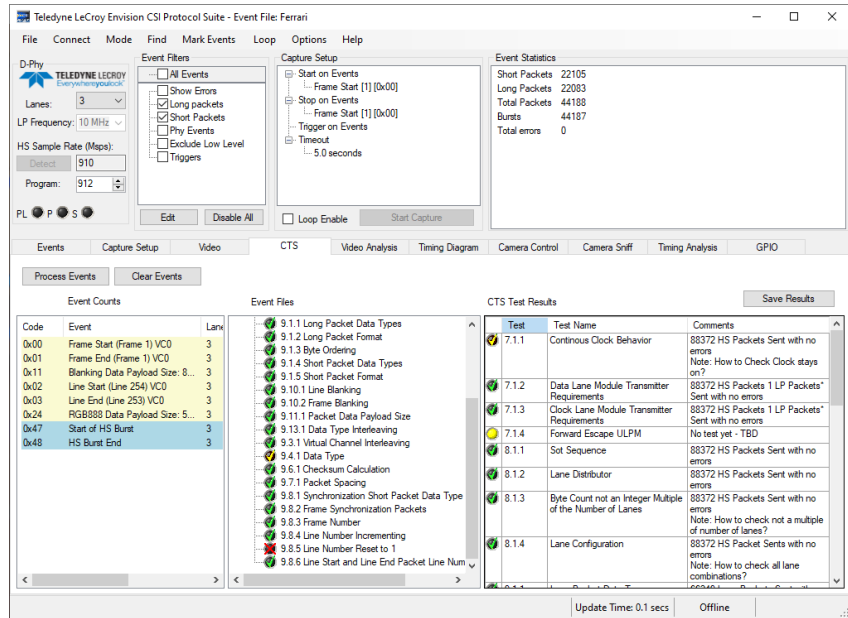
Timing Analysis (see next page)



ENVISION X84 – ANALYZER CONFORMANCE TESTING

Conformance Testing

The Envision X84 Analyzer offers a Conformance Test Suite (CTS) of the various protocol levels and elements of an incoming video stream. The CTS provides a quick assessment to help ensure that your device meets the requirements. The conformance suite provides pass/fail indication including partial results.

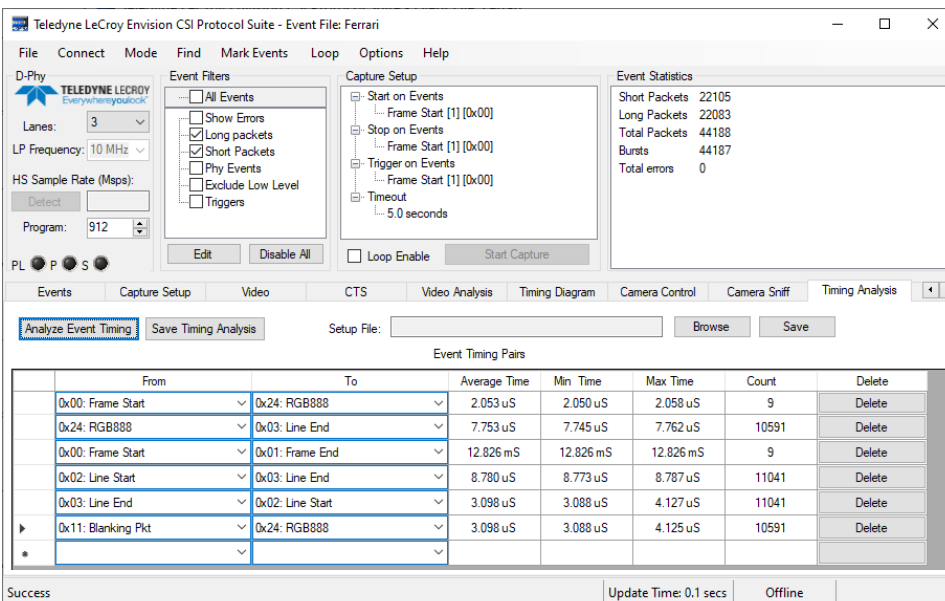


One-button Operation

The Conformance Test Suite (CTS) feature offers a one touch initiation. The CTS test suite analyzes one or more event files to determine conformance.

The application allows point-and-click selection of individual test cases to view results. Users can export test results to a spreadsheet or a CSV file.

The examples shown on this page provide a list of the individual tests in the CTS test suite. The test coverage is broad including data and clock, and protocol bytes including short and long packet structure, frame structure, timing, etc.



Timing Analysis

The Envision X84 Analyzer enables users to verify time comparisons between user specified CSI or DSI protocol elements. For example, you can view the minimum, maximum and average elapsed time between frame start and end, line start and line end, payload burst and blanking, etc.

ENVISION X84 – EXERCISER

Flexible Hardware

The Envision X84 platform conforms to the MIPI DSI and DSI-2 and the CSI-2 version 2 standards and supports both C-PHY & D-PHY standards.

The front-end of the Envision X84 Exerciser features standard MMCX connectors that support C-PHY or D-PHY signals to provide high fidelity generation of traffic from all active lanes simultaneously. Concurrent recording of PHY-level and protocol-level events during generation allows viewing of per-lane and protocol activity to help characterize and debug interface traffic going to the DUT. The Envision X84 platform includes 4GB of memory for images.

The heart of the Envision X84 Exerciser is a patented Test IP Transaction Processor technology. This state-of-the-art protocol-processing core incorporates a real-time generation and recording engine and configurable tools to selectively monitor and generate MIPI CSI and DSI traffic. Field upgradeable firmware allows the Transaction Processor to evolve and support new features or future changes to the MIPI CSI and DSI specifications.

The built-in triggering provides unprecedented flexibility to start and stop generation with every possible packet type configurable as trigger events. In Loop mode, the Envision X84 generates packets and video continuously for extended debug sessions

As the Envision X84 Exerciser generates traffic, it can be configured to also generate an external trigger on any packet or frame type. This trigger event can be used for synchronizing external scopes or other instruments. An input trigger is useful for starting and/or stopping generation.

Envision X84 Software

The Envision X84 utilizes a software graphical interface to control the instrument. A user API is available for automated testing if desired. For each generation case, event statistics are shown on the summary area on the top right. Selected triggers are shown on the middle right, to quickly view the setup selected. Quick setup buttons are at the top left to start or stop generation, select the number of lanes, and set or detect PHY speed.

CSI Test Configuration – Camera Emulation Mode

In CSI Camera emulation mode, the X84 Exerciser acts as a MIPI CSI image Sensor/Camera connected to a CSI Host/Image Processor under test (DUT).



DSI Test Configuration – Host Emulation Mode

In DSI Host emulation mode, the X84 Exerciser acts as a MIPI DSI Host SoC connected to a DSI Display Device under test (DUT).



ENVISION X84 – EXERCISER

Generation Modes

The Envision X84 Exerciser can generate all standard video and image types outlined in the MIPI CSI-2 and DSI-2 specifications. This enables you to emulate a variety of image sensors and parameters over multiple lane configurations. The Exerciser handles the lane deskewing necessary where multiple lanes are used.

The Envision X84 Exerciser software application allows the user to generate traffic in two different modes: Video Mode or Packet Mode. By using the simple drag and drop methodology, users can quickly generate their desired traffic.

Video Generation Mode

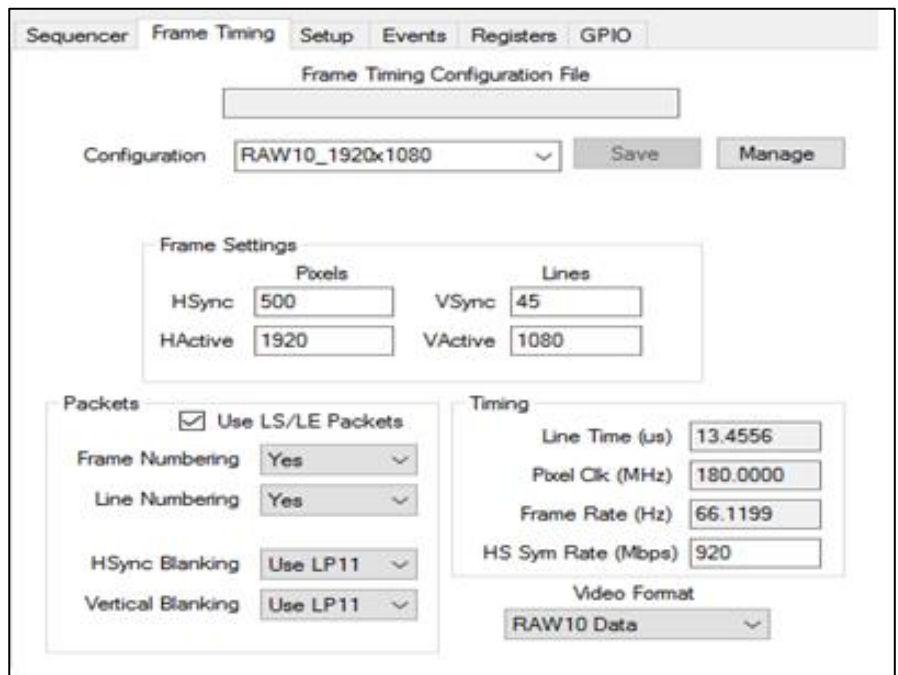
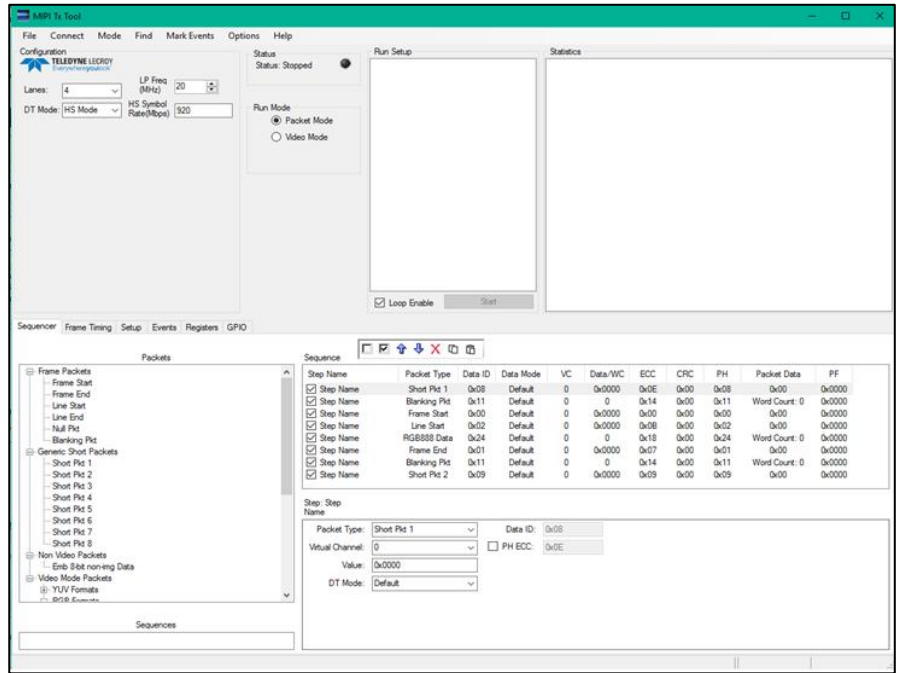
In the Video mode, users can pick and choose different frame types and define a specific image, either in binary format (.bin) or in bitmap (.bmp) format. The Envision X84 Exerciser will then create all the packets necessary to deliver a valid frame.

The user can define frame timing and resolution for each sequence of images. H-Sync and V-Sync timing can also be defined for generation.

Packet sequences and video frames can be sent as a single transmission or can be looped to generate continuous traffic. Frames can also be sequenced and/or repeated.

Packet Generation Mode

In Packet Mode, the user can select from standard packet types and define a single packet or a sequence of packets. Each packet can be modified for content as well as frame timing and resolution. Metadata packets can be sent in the blanking. Error conditions can be created with short packets for stress testing a device.



SPECIFICATIONS

General

Protocols Supported	MIPI CSI-2v2, MIPI DSI-2
Data Rates – C-Phy	3G Symbols per second; 1-3 trios of data lanes
Data Rates – D-Phy	2.5Gbps; 1-4 lanes
Analyzer Recording Memory	4-8GBytes
Exerciser memory for images	4Gbytes

Connectors – Front Panel

D-PHY & C-PHY Interconnection	(12) MMCX Jack D-Phy (4) Lanes: D0+/- D1+/- D2+/- D3+/- CK+/- C-Phy (3) Lanes: A0 B0 C0; A1 B1 C1; A2 B2 C2; Mates with MMCX Straight Male (plug)
GPIO Connector:	Molex I-Grid 2x10 connector, Part Number 5018762040 Mates with Molex I-Grid 2x10 Cable Connector, Part Number: 501646-2000 and up to (20) Crimp Contacts, Part Number: 501647-1000 Electrical Specifications: Bi-Directional GPIO Number of I/O Lines: 7 Voh: Open Collector Outputs, Require pull-up resistors to +1.8V </- Vpu </- _5.0V. Vol: +0.6V Max. @ 8mA, Vih: +1.2V Min. +5.0V Max., Vil: +0.6V Max. +3.3V @ 1.5A Output Power I2C Communication Bus Open Drain with +3.3V 5K Pull-Up Resistors 400kHz
Trigger IN Connector:	SMA Jack Input Impedance: 700 Kohms Max. Input Voltage: +3.5V Vih: +2.0V Min., Vil: +0.8V Max
Trigger OUT Connector:	SMA Jack Output Impedance: 50 ohms Max. Input Voltage: +3.3V Voh: +2.3V Min. @ 12mA

Physical/Electric/Admin

Dimensions (W x H x D)	16.0" x 1.75" x 12.75" (40.64 cm x 4.45 cm x 23.9 cm)
Weight	6.0 lbs (2.72kg)
Environmental	Operating Temperature: 0°C to 50°C (32°F to 122°F) Non-Operating Temperature: -10°C to 80°C (14°F to 176°F) Operating Temperature: 0°C to 55°C (32°F to 131°F) Humidity: 10% to 90% RH (non-condensing)
Power Requirements	External 120-220V AC Power
Warranty	12 Months Hardware Warranty

Ordering/Product Code

Description

ENV-CD01-TAA-X	Envision X84 Hardware
ENV-CD01-ANA-A	Envision X84 Analyzer License
ENV-CD01-GEN-A	Envision X84 Generator License
ENV-CD01-CPHY-A	Envision X84 - C-PHY License
ENV-CD01-DPHY-A	Envision X84 - D-PHY License
ENV-CD01-CSI-A	Envision X84 - CSI License
ENV-CD01-DSI-A	Envision X84 - DSI License
ENV-CD01-GPIO-A	Envision X84 – GPIO/CCI License
ENV-CD01-DSC-A	Envision X84 - DSC License
ENV-CD01-CSC-A	Envision CSI Compression License



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