D9010MCDP

MIPI C-PHY and D-PHY protocol trigger and decode software for Infiniium oscilloscopes

KEYSIGHT

Table of Contents

Product Overview

C-PHY and D-PHY are MIPI Alliance's physical layer (PHY) standards that provide high-throughput performance over bandwidth-limited channels to connect displays and cameras to an application processor. The standards provide a PHY for the MIPI Alliance's various Camera Serial Interface (CSI) and Display Serial Interface (DSI) specifications. This enables engineers to scale their implementations to support a wide range of higher resolution image sensors and displays, while keeping power consumption low. However, because both D-PHY and C-PHY support two application layers, engineers implementing a D-PHY or C-PHY interface must be able to see a device's signal integrity and protocol data to ensure it conforms to the MIPI specification.

MIPI serial buses are the backbone for communication in mobile products. The serial bus interface provides content-rich points for debug and test. However, since these protocols transfer bits serially, using a traditional oscilloscope has limitations. Manually converting captured 1's and 0's to protocol requires significant effort, can't be done in real-time, and includes potential for human error. As well, traditional scope triggers are not sufficient for specifying protocol-level conditions.

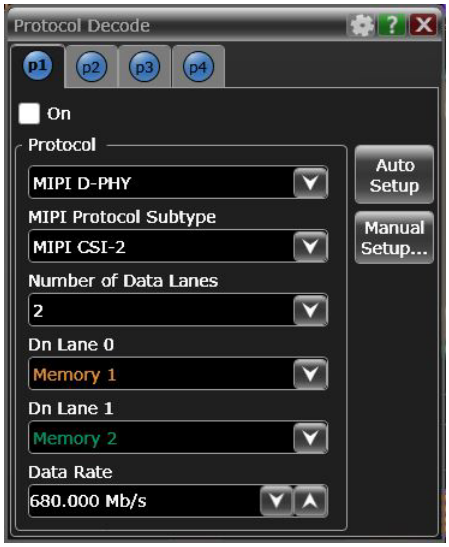


Figure 1. Configure the Infiniium oscilloscope to display D-PHY protocol decode in under 1 minute.

Key Features

Protocol searching

Included in Keysight's D9010MCDP software is a suite of configurable, protocol-level conditions for CSI-2 or DSI-2 interface buses that give engineers access to a rich set of integrated protocol-level searching capabilities. This protocol searching feature enables engineers to find and isolate error packets or specific patterns of interest from acquired data.

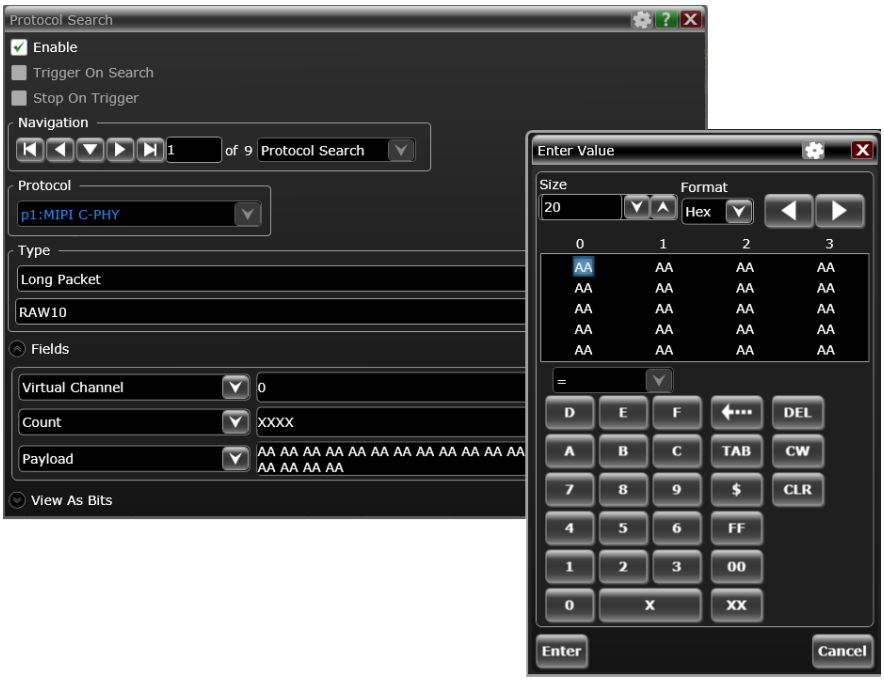


Figure 2. Search specific CSI-2 or DSI-2 packets from the acquired protocol listing.

Protocol decode

D9010MCDP supports CSI-2 and DSI-2 protocol decode based on MIPI D-PHY and C-PHY. Perform and view decode information on both live and saved waveforms. Decode up to any combination of 4 live or saved waveforms.

The protocol list window is correlated between the waveform and selected packet on the list. The selected packet (highlighted blue row), is time-correlated with the blue line in the waveform display so that engineers can easily see the signal shape of specific packet data.

Keysight provides a unique C-PHY triggered eye diagram function for simultaneously monitoring signal quality and protocol. With this feature, engineers gain greater insight into the C-PHY signal and can better determine whether issues are due to signal quality or protocol data.

Keysight MIPI D-PHY protocol decoder software provides multilane decode up to 4 data lanes. User can select number of data lane from 2 to 4 lanes. However, due to oscilloscope's channel limitation, multilane decode will use recovered clock instead of existing clock in D-PHY. Also, same reason, multilane decode will support only HS data decoding, not LP data.

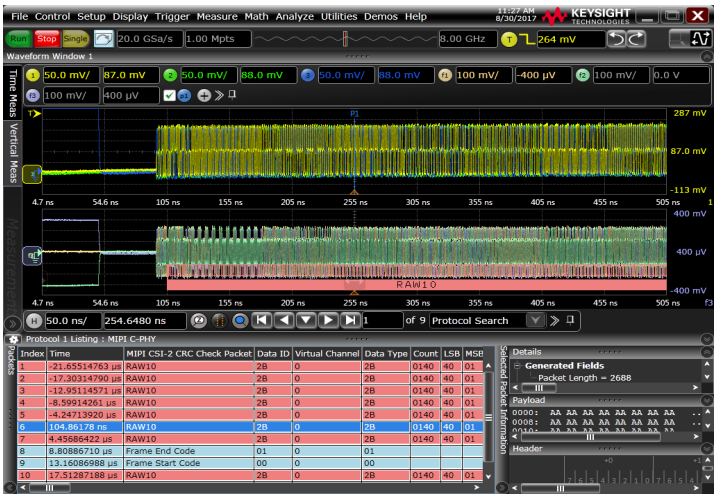


Figure 3. The C-PHY protocol list window

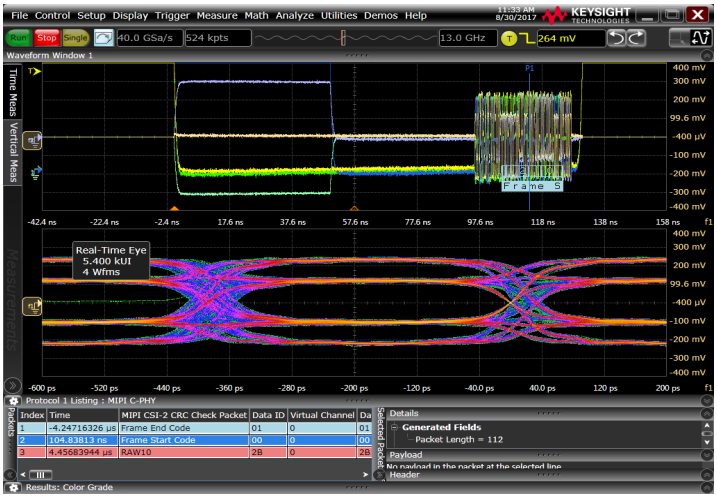


Figure 4. The C-PHY triggered eye diagram

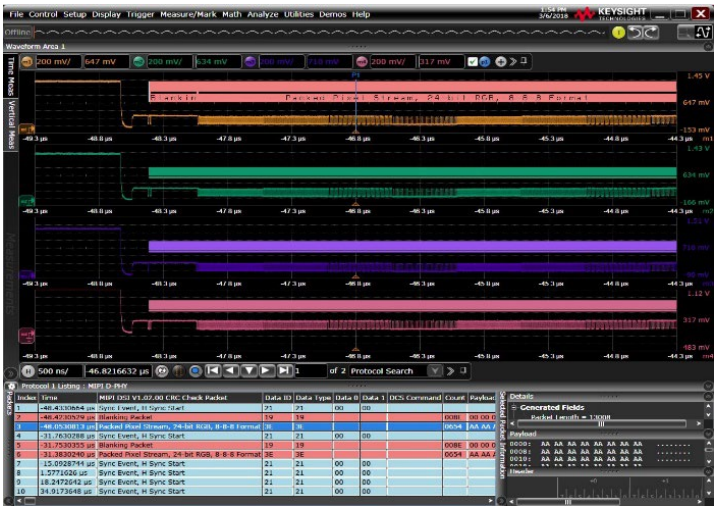


Figure 5. The MIPI D-PHY multilane can decode up to 4-lane design implementation.

MIPI C-PHY

Overview

C-PHY requires few connectors than D-PHY, also does not require a separate clock lane, and provides flexibility to assign individual lanes in any combination to any port on the application processor via software control. Due to similarities in basic electrical specifications, C-PHY and D-PHY can be implemented on the same device pins. 3-phase symbol encoding technology delivers approximately 2.28 bits per symbol over a three-wire group of conductors per lane. This enables higher data rates at a lower frequency, further reducing power.

Recommended connection

To achieve a higher symbol rate from the DUT, Keysight recommends connecting 3 differential active probes for single-end probing. It is also possible to probe differentially so that data can be obtained without having to configure functions. However, due to the long length between positive and negative pins on the differential active probe, the probe bandwidth may not fully cover the signal's bandwidth range as required to see the right signal shape.

The C-PHY decoder software requires 3 differential signals for decoding C-PHY data. A single-end probed signal must therefore be changed to a differential signal for decoding. To accomplish this, use the "Subtract" function to make 3 differential signals from a 3-wire signal before starting to decode the C-PHY protocol. The required signals will be VAB(VA-VB), VBC(VB-VC) and VCA(VC-VA).

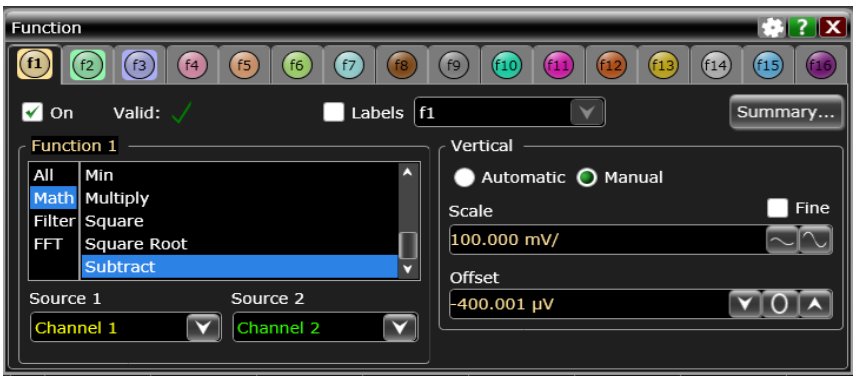


Figure 6. Channel configuration using waveform math.

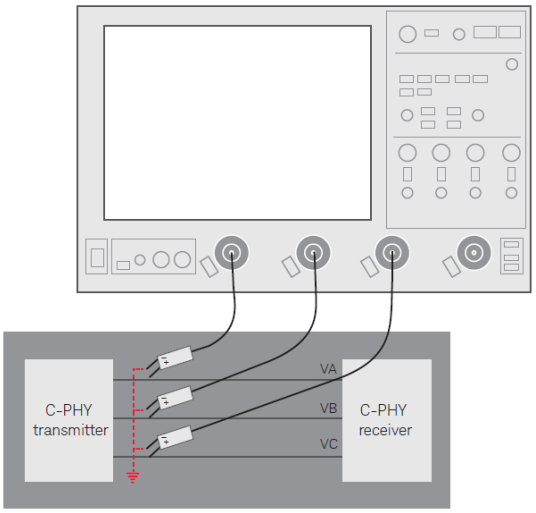


Figure 7. Recommended probe connection

MIPI C-PHY specifications and characteristics

MIPI C-PHY specifications and characteristics

Signal sources (VA, VB, VC)	Any analog channel Any waveform memory
Protocols supported	CSI-2 v1.3 DSI-2 v1.0
Data rate	Up to 3.5 Gsps
Supported lanes	One lane (3 wires) only
Auto setup	Automatically configures trigger levels, decode thresholds, sample rate, memory depth, holdoff, and trigger
Decode options (via search)	Short packet Long packet Errors: any error, bad CRC, bad PHCRC, unknown packet

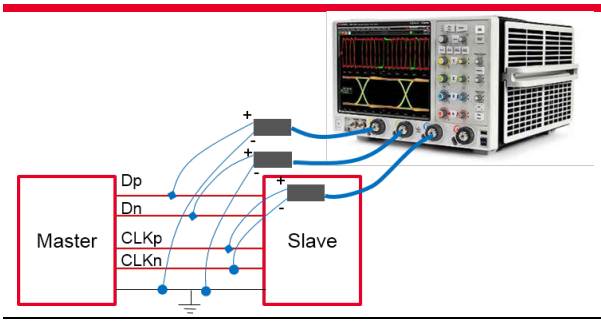
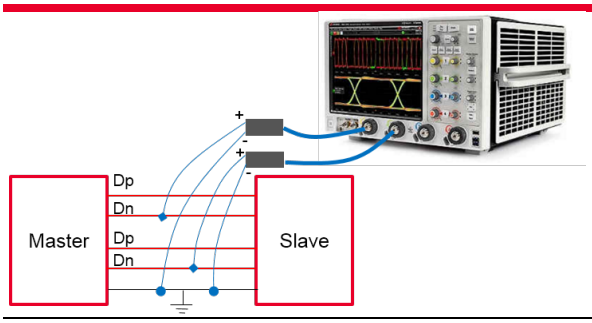
MIPI D-PHY

Overview

D-PHY is a serial interface technology using differential signaling for bandlimited channels with scalable data lanes and a source synchronous clock to support power efficient interfaces for streaming applications such as displays and cameras. It offers half-duplex behavior for applications that benefit from bidirectional communication at transmission rates up to 4.5 Gigabit per lane.

Recommended connection

Keysight MIPI D-PHY decoder supports both one lane and multilane decoding, based on your DUT configuration, each decoding mode require different connection. The table below describes each setup.

One data lane	Multilane (2-4 lanes)
	
• Data Source (Dp) - Selects the Dp (differential positive) lane data source. • Data Source (Dn) - Selects the Dn (differential negative) lane data source. • Clock - Selects the clock source.	• Dn Lane 0-3 — Selects the waveform source for the Dn (differential negative) data lane number. • Dn is used so the low power signal can be detected. • Data Rate — Specifies the data rate. • The decode requires a Low Power to High Speed transition.

For more information, please refer oscilloscope's help file within the oscilloscope software.

MIPI D-PHY specifications and characteristics

MIPI D-PHY specifications and characteristics	
Signal sources (clock, data)	Any analog channel Any waveform memory
Protocols supported	CSI-2 v1.3 DSI v1.01, v1.02, v1.30.10
Data rate	Up to 4.5 Gbps
Supported lanes	One data lane with clock (LPDT supports) 2-4 data lanes without clock (internal clock recovery)
Auto setup	Automatically configures trigger levels, decode thresholds, sample rate, memory depth, holdoff, and trigger
Decode options (via search)	Short packet Long packet Low power data transmission (one data lane case only) Errors: Any error, Bad CRC, Bad ECC, Unknown packet

Ordering Information

Recommended oscilloscopes

This protocol decode software is compatible with Keysight's Infiniium-Series oscilloscopes running software version 6.30 or higher. Bandwidth recommendations are as follows:

Standard	Data rate	Minimum bandwidth	Minimum channels	Recommended models
C-PHY	< 1.5 Gsps	4 GHz	3	MXR, EXR, or S-Series
C-PHY	< 2.5 Gsps	6 GHz	3	MXR, EXR, S, V, or UXR-Series
C-PHY	< 3.5 Gsps	10 GHz	3	V or UXR-Series
D-PHY	< 1.5 Gbps	4 GHz	3	MXR, EXR, or S-Series
D-PHY	< 2.5 Gbps	6 GHz	3	MXR, EXR, S, V, or UXR-Series
D-PHY	< 4.5 Gbps	12 GHz	3	V or UXR-Series

Recommended probes

Oscilloscope used	Probes recommended	Accessories recommended
MXR-Series EXR-Series S-Series	Model: 1169B 12 GHz InfiniiMax II C-PHY: 3 active probes D-PHY: 4 active probes	
V-Series Z-Series UXR-Series [1]		N5442A 50Ω Precision BNC adapter

Flexible software licenses and KeysightCare Software Support Subscriptions

Keysight offers a variety of flexible licensing options to fit your needs and budget. Choose your license term and license type.

License terms

Perpetual – Perpetual licenses can be used indefinitely.

Subscription – Subscription licenses can be used through the term of the license only.

[1] Depending on the bandwidth of UXR-Series, the channel connector size may vary, requiring different adapters. See UXR-Series datasheet for details.

License types

Node-locked – License can be used on one specified instrument/computer.

Transportable – License can be used on one instrument/computer at a time but may be transferred to another using Keysight Software Manager (internet connection required).

USB Portable – License can be used on one instrument/computer at a time but may be transferred to another using a certified USB dongle (available for additional purchase with Keysight part number SW1000-D10).

Floating (single site) – Networked instruments/computers can access a license from a server one at a time. Multiple licenses can be purchased for concurrent usage.

KeysightCare Software Support Subscriptions

Perpetual licenses are sold with a 12 (default) and up to 60-month software support subscription with a user-selected start and end date. Support subscriptions can be renewed for a fee after that.

Subscription licenses include a software support subscription through the term of the license, from 3 to 36 months, with a user-selected start date.

Selecting your license

Step 1. Choose your software product (e.g. D9020ASIA)

Step 2. Choose your license term: perpetual or subscription.

Step 3. Choose your license type: node-locked, transportable, USB portable, or floating.

Step 4: Depending on the license term, choose your support subscription duration.

Example

If you selected:	Your quote will look like this:	
D9020ASIA Node-locked	Part number D9020ASIA	Description Advanced Signal Integrity Software (EQ, InfiniiSimAdv, Crosstalk) Node-locked perpetual license
Perpetual license	SW1000-LIC-01 SW1000-SUP-01	Node-locked KeysightCare software support subscription with user-selected start and end dates
D9020ASIA Transportable Subscription 6-month license	Part number D9020ASIA SW1000-SUB-01	Description Advanced Signal Integrity Software (EQ, InfiniiSimAdv, Crosstalk) 6-months, transportable subscription license

To configure your product and request a quote:

http://www.keysight.com/find/software

Contact your Keysight representative or authorized partner for more information or to place an order:

www.keysight.com/find/contactus

Subscription-Based Compliance Test Software Suites

Each suite comes with a 12, 24, or 36-month software suite subscription.

Suite license	Technology generation and variants coverage (current)
SW02MIPI MIPI Full TX Test Suite	• C-PHY TX Validation (D9010CPHC) • D-PHY TX Validation (D9020DPHC) • M-PHY TX Validation, HS-GEARs 1-4 (D9040MPHC) • M-PHY TX Validation, HS-GEARs 1-5 (D9050MPHC) • C-PHY and D-PHY Protocol Validation (D9010MCDP) • M-PHY Protocol Validation (D9010MPMP) • LowSpeed Protocol Validation (D9010MPLP)

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

KEYSIGHT

This information is subject to change without notice. © Keysight Technologies, 2019 – 2023, Published in USA, October 6, 2023, 5992-3544EN