

# UCD-4XX



## User Manual

UCD Console SW Version 3.6



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## Edition

UCD-4XX UCD Console 3.6 User Manual, Rev 14

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# 1. ABOUT THIS MANUAL

## Purpose

This guide is a User Manual of UCD-4XX test devices, that are USB-connected video interface test units for use with a computer.

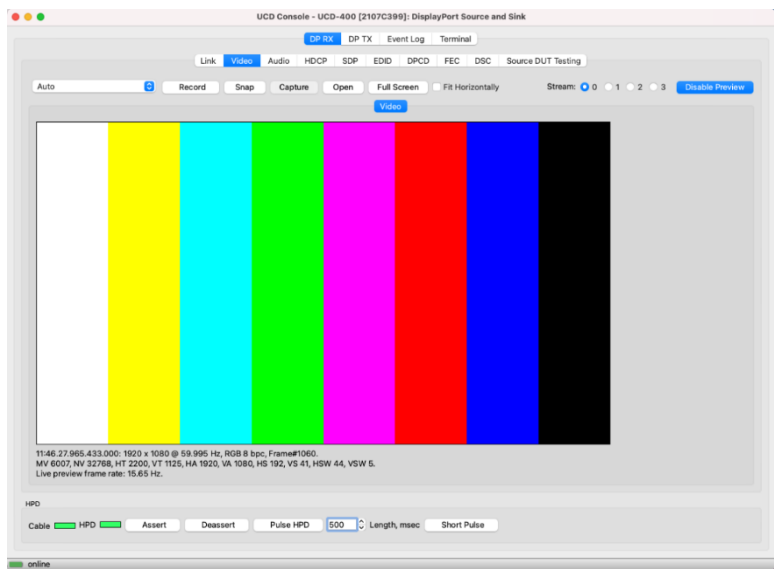
The purpose of this guide is to

- Provide an overview of the product and its features.
- Provide instructions for the user on how to install the software and the drivers.
- Provide instructions for the user on how to update the FW of the unit.
- Introduce the HW features of the UCD-4XX units.
- Provide instructions for the user on how to use UCD Console SW.

## Product and Software Version

This manual explains features found in UCD Console SW Bundle **3.5**. Please consult Unigraf for differences or upgrades of previous versions.

Please consult the Release Notes document in the installation package for details of the SW and FW versions and changes to previous releases.



## Notes

On certain sections of the manual, when important information or notification is given, text is formatted as follows. Please read these notes carefully.

|          |                                                                           |
|----------|---------------------------------------------------------------------------|
| Note:    | This text is an important note                                            |
| Warning: | This is a warning about a direct risk for the functionality of the device |

## 2. INTRODUCTION

### Product Description

#### USB-Connected Test Equipment

UCD-4XX devices are high speed, USB 3.0 connected video interface test units. UCD-4XX units include the following models:

- UCD-400 DisplayPort 1.4a Analyzer and Generator
- UCD-411 DisplayPort 1.4a Generator
- UCD-412 HDMI 2.1 Generator
- UCD-422 HDMI 2.1 Analyzer and Generator
- UCD-424 USB-C DisplayPort Alt mode Analyzer and Generator

*UCD Console SW* is a common graphical user interface (GUI) for Unigraf's UCD test devices. The outlook and details of UCD Console SW will vary depending on the capabilities of the connected unit and will reflect the features enabled.

UCD-4XX units feature a high-level Software Development Kit (SDK) called Test Software Interface (TSI) for use in automated testing. TSI allows for an easy integration of Production and R&D testing routines into an automated test system environment. Please refer to TSI documentation found in additional Unigraf manuals for more details.

#### Stand-Alone Test Equipment

In stand-alone UCD models the test equipment is built inside a PC and the control interface is a PCI bus instead of a USB connection. Please find below a list of available units:

- UCD-451 Stand-alone DisplayPort 1.4a Generator
- UCD-452 Stand-alone HDMI 2.1 Generator

## UCD-400 and UCD-411

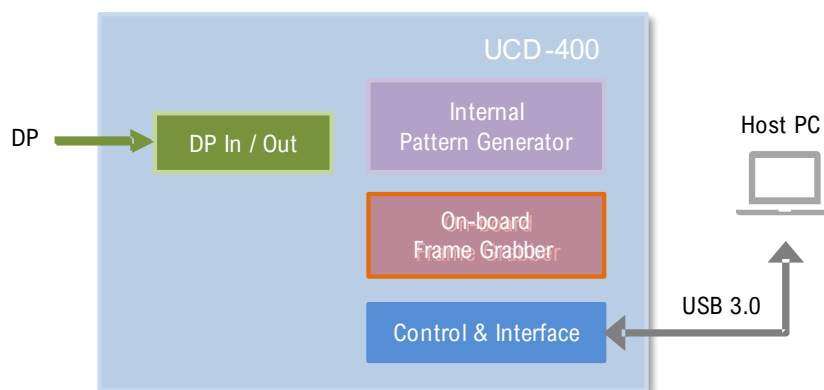
### Product Features

- UCD-400: Reference Sink and Source for verifying DP connected devices.
- UCD-411: Reference Source for verifying DP connected sinks.
- DisplayPort 1.4a compliant with HBR3 support
- High resolution video up to 8K 30 Hz, 4K / UHD 120 Hz uncompressed and audio.
- Supports MST (4 streams), Adaptive-Sync, Forward Error Correction (FEC), Display Stream Compression (DSC) and Link Training Tunable PHY Repeater (LTTPR)
- Compatible with HDCP versions 1.3 and 2.3
- 2 GB on-board high-speed video frame buffer
- High speed USB 3.0 host PC interface

Please refer to *Product Specifications* in the appendix of this document for details.

### Functional Description

UCD-400 units consist of a multimedia signal input stage with on-board frame buffer, an internal pattern generator, a control stage, and a PC interface stage. In the Input Stage the signal is conditioned and converted to desired format. The Interface and Control stages are either passing the captured data directly to the USB interface or storing it to the frame buffer. The internal pattern generator is able to source a signal for testing sink and branch units. The Interface & Control stages are receiving instructions from the host PC to configure and control the functionality of the unit.



### Delivery Content

Product shipment contains:

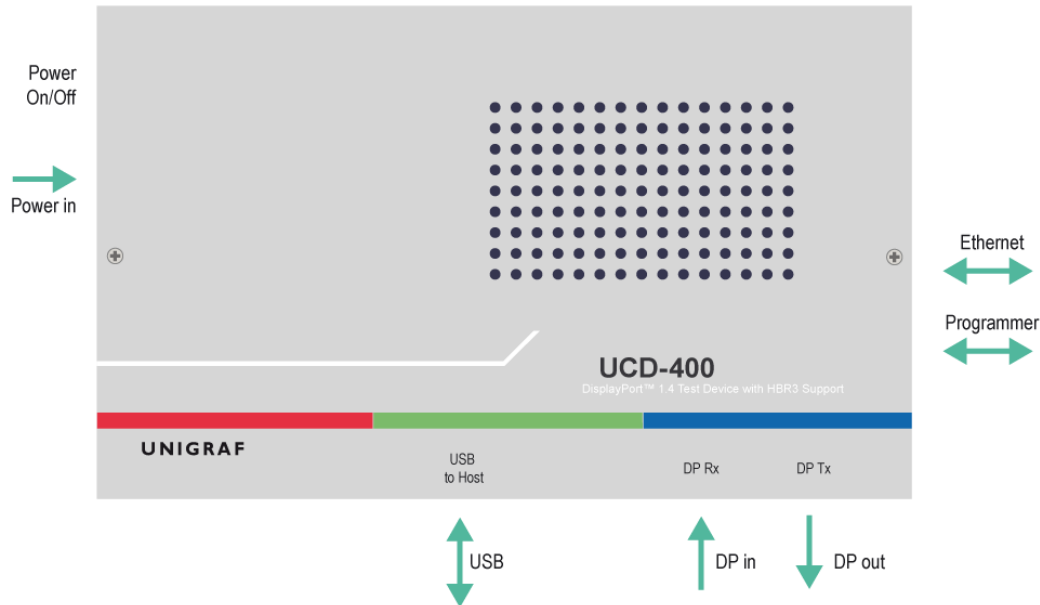
- The UCD-400 or UCD-411 unit
- AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +12 Vdc output)
- USB 3.0 compliant cable for host PC connection
- Micro-USB type B compatible cable for FW programming
- USB-C to DP Bi-directional Cable for testing USB-C sinks or sources

### USB Type-C Interface

UCD-400 and UCD-411 delivery package includes a “C to DP Bi-directional Cable” to enable testing of Sink or Source devices with USB-C interface.

## Connections

The image below indicates the connections in **UCD-400** unit and their description.



| Name         | Description                                                                        |
|--------------|------------------------------------------------------------------------------------|
| DP in        | DisplayPort™ 1.4a compliant input from the upstream Source (UCD-411 Not available) |
| DP out       | DisplayPort™ 1.4a compliant output to the downstream Sink                          |
| Power in     | +12 Vdc Power Supply Input                                                         |
| Power On/Off | Rocker power switch                                                                |
| USB          | USB 3.0 connection to the host PC                                                  |
| Programmer   | USB interface for configuring the device FW (behind a cover)                       |
| Ethernet     | Ethernet interface for updating the device FW (behind a cover)                     |

**Note:** Capturing and sourcing high resolution video modes, especially 4K video modes and the 120 Hz frame rate set stringent requirements on the video cables and connectors.

**Warning:** In order to avoid damage to the unit and the PC, please **always attach the power cord (Power In) to the unit first**, and after that connect the USB cable to the PC.

## UCD-412 and UCD-422

### Product Features

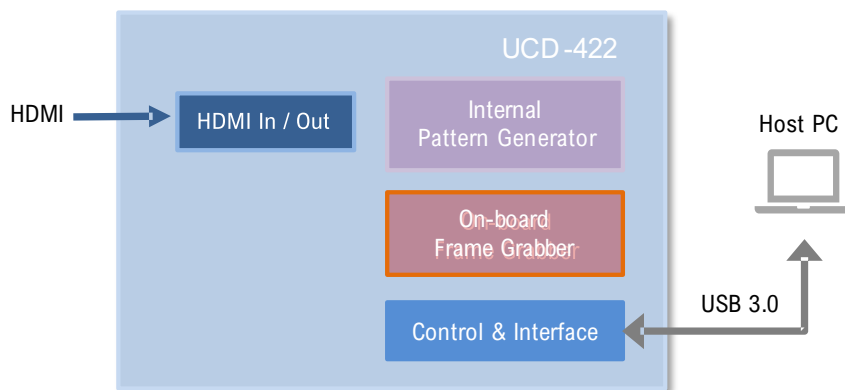
- UCD-422: Reference Sink and Source for verifying HDMI connected devices.
- UCD-412: Reference Source for verifying HDMI connected sinks.
- HDMI 2.1 compatible. Supports FRL and TMDS signaling.
- Supports HDMI video and audio up to 10K@30 Hz, 8K@60 Hz (YCbCr 4:2:0), 4K@120 Hz (YCbCr 4:2:0)
- Supports Display Stream Compression (DSC), and Enhanced Audio Return Channel (eARC)
- Compatible with HDCP versions 1.4 and 2.3
- 2 GB on-board high-speed video frame buffer
- High speed USB 3.0 host PC interface

Please refer to *Product Specifications* in the appendix of this document for details.

### Functional Description

UCD-422 units consist of a multimedia signal input stage with on-board frame buffer, an internal pattern generator, a control stage, and a PC interface stage. In the Input Stage the signal is conditioned and converted to desired format. The Interface and Control stages are either passing the captured data directly to the USB interface or storing it to the frame buffer. The internal pattern generator is able to source a signal for testing sink and branch units. The Interface & Control stages are receiving instructions from the host PC to configure and control the functionality of the unit.

Please find below logical diagram of UCD-422 unit

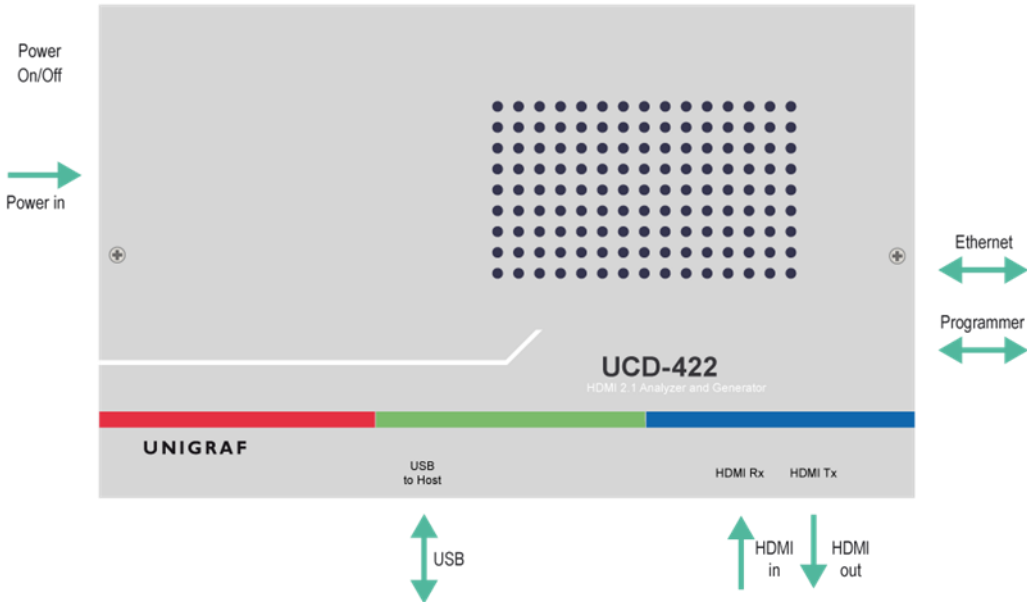


### Delivery Content

- Product shipment contains:
- The UCD-422 or UCD-412 unit
- AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +12 Vdc output)
- USB 3.0 compliant cable for host PC connection
- HDMI 2.1 grade HDMI cable
- Micro-USB type B compatible cable needed for FW programming.
- Ethernet cable needed for FW programming.

## Connections

The image below indicates the connections in **UCD-422** unit and their description.



| Name         | Description                                                  |
|--------------|--------------------------------------------------------------|
| HDMI in      | HDMI 2.1 compliant input from the upstream Source            |
| HDMI out     | HDMI 2.1 compliant output to the downstream Sink             |
| Power in     | +12 Vdc Power Supply Input                                   |
| Power On/Off | Rocker power switch                                          |
| USB          | USB 3.0 connection to the host PC                            |
| Programmer   | USB interface used in device FW update (behind a cover)      |
| Ethernet     | Ethernet interface used in device FW update (behind a cover) |

**Note:** Capturing and sourcing high resolution video modes, especially 4K 8K and 10K video modes and the 120 Hz frame rate set stringent requirements on the video cables and connectors.

**Warning:** In order to avoid damage to the unit and the PC, please **always attach the power cord (Power In) to the unit first**, and after that connect the USB cable to the PC.



## UCD-424

### Product Features

- Reference Sink and Source for verifying DisplayPort™ Alt Mode over USB-C
- USB-C v1.3 input and output with Power Delivery 3.0
- DisplayPort 1.4a compliant with HBR3 support
- High resolution video up to 8K 30 Hz, 4K / UHD 120 Hz uncompressed and audio
- Supports MST (4 streams), Adaptive-Sync, Forward Error Correction (FEC), Display Stream Compression (DSC), and Link-Training Tunable PHY Repeater (LTTPR)
- Compatible with HDCP versions 1.3 and 2.3
- 2 GB on-board high-speed video buffer
- High speed USB 3.0 host PC interface

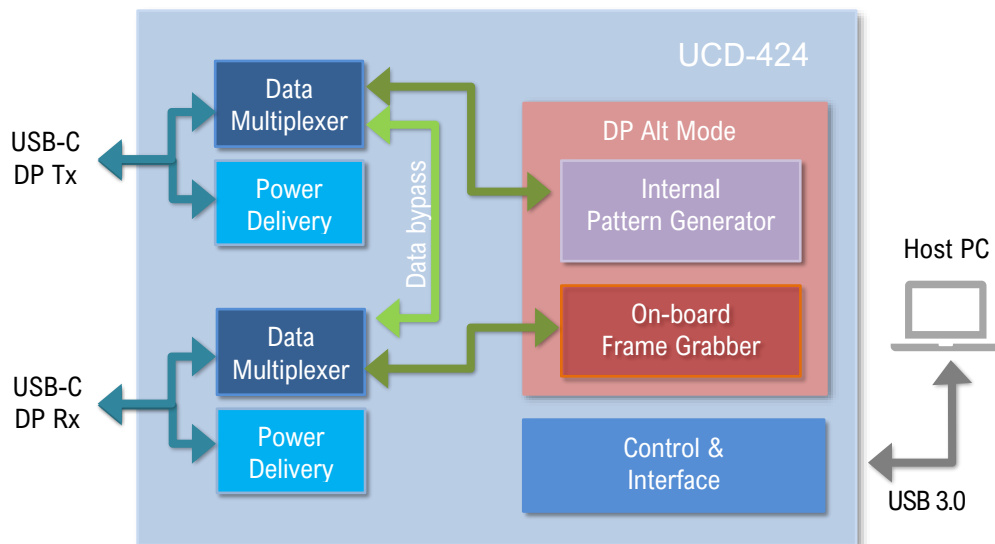
Please refer to *Product Specifications* in the appendix of this document for details.

### Functional Description

UCD-424 units consist of a multimedia signal input stage with on-board frame buffer, an internal pattern generator, a control stage, and a PC interface stage. In the Input Stage the signal is conditioned and converted to desired format. The Interface and Control stages are either passing the captured data directly to the USB interface or storing it to the frame buffer. The internal pattern generator is able to source a signal for testing sink and branch units.

USB Data bypass can be enabled between the USB-C connector attached to the DUT to an external device connected to the vacant USB-C connector.

The Interface & Control stages are receiving instructions from the host PC to configure and control the functionality of the unit.



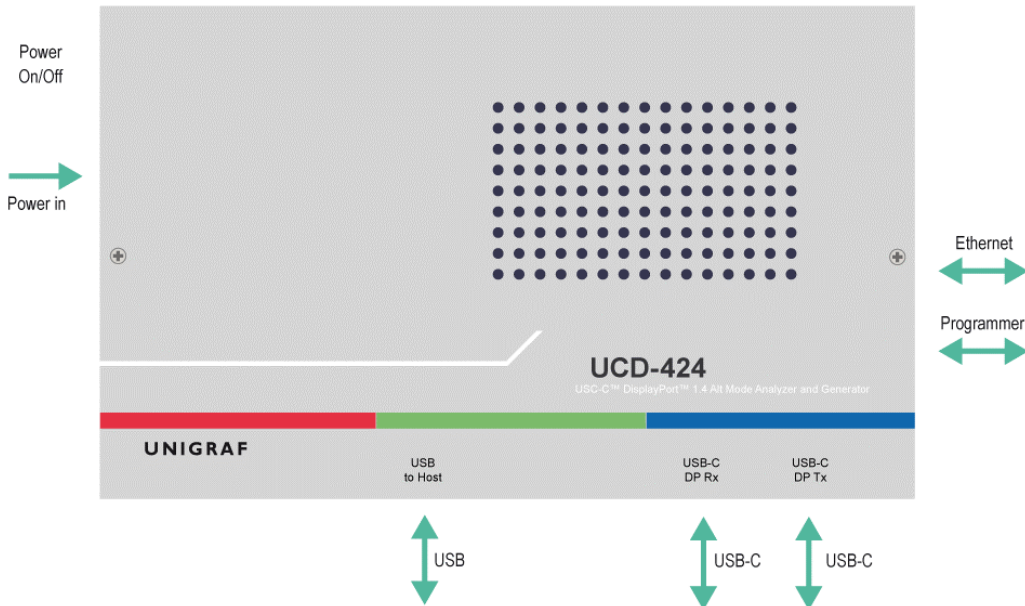
### Delivery Content

Product shipment contains:

- The UCD-424 unit
- AC/DC Power supply (100 to 240 Vac 50/60 Hz input, +12 Vdc output)
- USB 3.0 compliant cable for host PC connection
- USB-C to USB-C USB 3.2 Gen2 e-marked cable
- USB-C to DP Bi-directional Cable for testing DP sinks or sources.

## Connections

The image below indicates the connections in **UCD-424** unit and their description.



| Name         | Description                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------|
| USB-C DP Tx  | USB-C connection with DisplayPort™ 1.4a Alt Mode upstream Source capability                   |
| USB-C DP Rx  | USB-C connection with DisplayPort™ 1.4a Alt Mode downstream Sink capability                   |
| USB          | USB 3.0 connection to the host PC                                                             |
| Power in     | +12 Vdc Power Supply Input                                                                    |
| Power On/Off | Rocker power switch                                                                           |
| Programmer   | Optional USB interface for configuring the device FW (behind a cover) (Not used by default)   |
| Ethernet     | Optional Ethernet interface for updating the device FW (behind a cover) (Not used by default) |

**Note:** Capturing and sourcing high resolution video modes, especially 4K, 8K and 10K video modes and the 120 Hz frame rate set stringent requirements on the video cables and connectors.

**Warning:** In order to avoid damage to the unit and the PC, please **always attach the power cord (Power In) to the unit first**, and after that connect the USB cable to the PC.

## UCD-451

UCD-451 is a stand-alone DisplayPort interface test unit with full featured Generator functionality. UCD-451 contains a built-in PC, a DisplayPort reference source, and software for configuring the test interface and running tests.

UCD-451 is designed to specially facilitate Dolby Vision™ testing in DisplayPort interface.

### Product Features

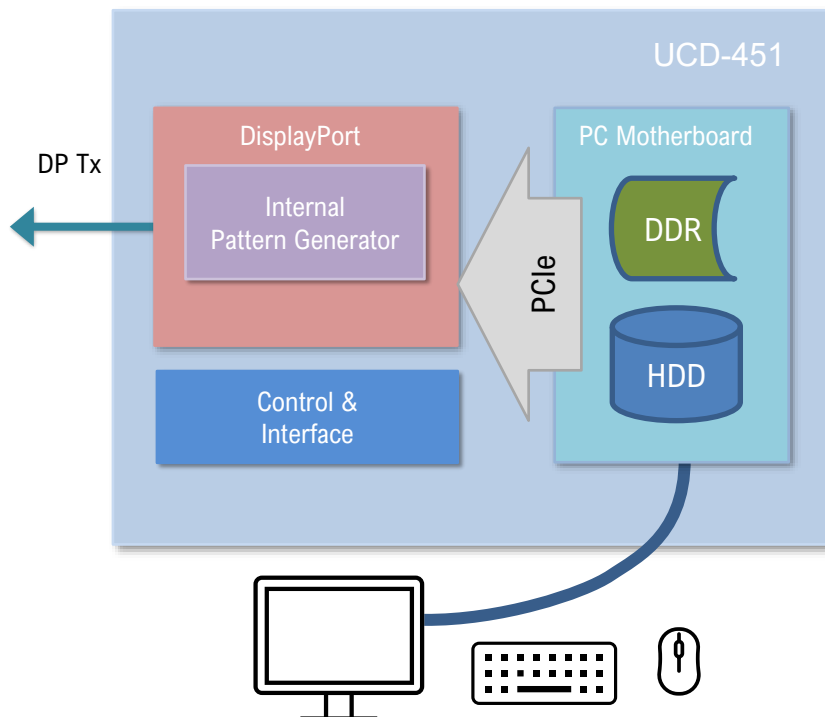
- DisplayPort 1.4a compliant with HBR3 support
- 8K Dolby Vision™ Test Tool
- High resolution video up to 8K 30 Hz, 4K / UHD 120 Hz uncompressed and audio.
- Supports MST (4 streams), Adaptive-Sync, Forward Error Correction (FEC), Display Stream Compression (DSC) and Link Training Tunable PHY Repeater (LTTPR)
- Compatible with HDCP versions 1.3 and 2.3
- Extended video memory up to 32 GBytes
- Embedded Windows PC

Please refer to *Product Specifications* in the appendix of this document for details.

### Functional Description

Part of the DDR memory in the PC motherboard is locked and reserved for storing the playback content. During playback, content is first loaded from hard disk (HDD) to the RAM memory of the PC (DDR). Video frames are then sequentially transferred from PC RAM to pattern generator's internal playback memory via PCIe bus. Pattern Generator firmware triggers a PCIe transfer to request content when needed.

Please find below logical diagram of UCD-451 unit.



## UCD-452

UCD-452 is a stand-alone HDMI interface test unit with full featured Generator functionality. UCD-452 contains a built-in PC, a HDMI reference source, and software for configuring the test interface and running tests.

UCD-452 is designed to specially facilitate Dolby Vision™ testing in HDMI interface.

### Product Features

- HDMI 2.1 compatible Test Equipment. Supports FRL and TMDS signaling.
- 8K Dolby Vision™ Test Tool
- Supports HDMI video and audio up to 10K@30 Hz, 8K@60 Hz (YCbCr 4:2:0), 4K@120 Hz (YCbCr 4:2:0)
- Supports Display Stream Compression (DSC), and Enhanced Audio Return Channel (eARC)
- Compatible with HDCP versions 1.4 and 2.3
- Extended video memory up to 32 GBytes
- Embedded Windows PC

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**Note:**

Due to HW limitations, only 2 GBytes of video memory can be used with uncompressed deep color video at 3840x2160 p144 video timing. This allows for playing sequences containing up to 40 frames.

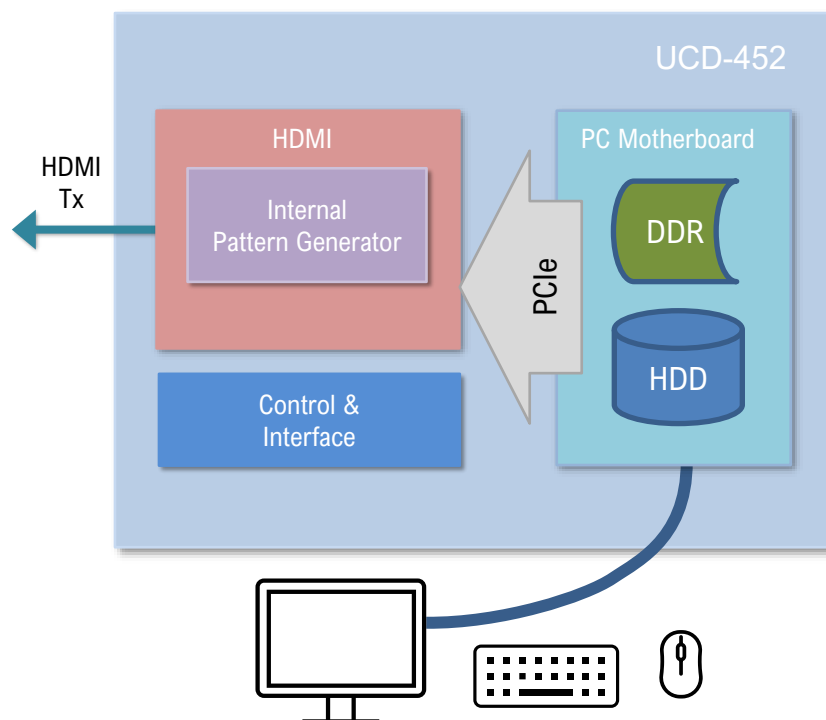
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Please refer to *Product Specifications* in the appendix of this document for details.

### Functional Description

Part of the DDR memory in the PC motherboard is locked and reserved for storing the playback content. During playback, content is first loaded from hard disk (HDD) to the RAM memory of the PC (DDR). Video frames are then sequentially transferred from PC RAM to pattern generator's internal playback memory via PCIe bus. Pattern Generator firmware triggers a PCIe transfer to request content when needed.

Please find below a logical diagram of UCD-452 unit.



## Safety and Operational Precautions

Please find below the **Safety Precautions** for using the Unigraf UCD test instrument. Please also carefully read the **Notes and Warnings** within the text of this manual.

These **Precautions and Warnings** are provided to enable a safe use of the UCD test equipment. Therefore, Unigraf assumes no liability when the user fails to follow the expressed **Precautions and Warnings**.

- Use only Unigraf provided AC/DC Power Adapter. Please make sure that connectors and cabling to the Power Adapter are intact. In case there are any doubts about the condition of the Adapter or cabling, stop using it immediately.
- It is important to ensure that the used AC input voltage is within the specified range (100 to 240 Vac 50/60 Hz) and the fuses in the AC lines are of the specified type. If in doubt, do not connect the device.
- When installing the unit, connect the Power Adapter to the UCD device first, after that connect the AC plug. Please disconnect the USB cable to the controlling PC and remove cabling to DUT while connecting the power input cables.
- It is forbidden to open the housing of the UCD device without written permission from Unigraf. Failure to comply with this rule will void the warranty of the unit.
- UCD devices are intended for use as Electrical Test Instrument only. Use for other purposes is forbidden.
- Use UCD equipment only in its specified ambient temperature and humidity.
- In order to ensure that the UCD device and associated SW will operate properly, please ensure that the PC used for controlling the UCD device complies with the minimum requirement set by Unigraf.
- Please keep UCD software updated by regularly checking the updates on Unigraf download page (<https://www.unigraf.fi/downloads/>). Please update the device firmware to match the installed software.

## 3. INSTALLATION

### Installation Package

The UCD software installation package can be obtained from Unigraf download page at <https://www.unigraf.fi/downloads/>. Please, note that there are separate packages for Windows and macOS.

The installation package is a bundle between the components needed for UCD Console SW and for TSI SDK. The bundle contains the following items:

- Drivers (installed during set up)
- UCD Console SW (installed during set up)
- License Manager (installed during set up)
- Device configuration utility (installed during set up)
- Packet Editor (installed during set up)
- TSI SDK
- User Manuals including this document.

In some cases, also the firmware of the unit needs to be updated. If in doubt, please contact Unigraf.

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**Note:** The software should be installed before connecting the UCD unit to the computer.

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**Note:** System administrator's privileges are required for performing installations.

---

### Software Installation

#### Windows

Install \*.exe file from the package.

Start installation by running application **SoftwareBundle\_X.X.XXXX**.

The welcome page is displayed and shows the software package release version.

The user is also asked if he/she wants to:

- Create a desktop shortcut
- Install the Visual C++ redistributable (needs to be present on Windows)
- Install Unigraf USB drivers
- Confirm by selecting *Next* dialog button. Select *Install* to start the installation.
- Select *Finish* to exit the installation dialog.

#### macOS

Install \*.pkg file from the package. This is a universal binary for ARM and Intel x86.

Start installation by running application **SoftwareBundle\_X.X.XXXX**.

Confirm by selecting *Next* dialog button. Select *Install* to start the installation.

Select *Finish* to exit the installation dialog.

**Note:** If you are downgrading, please remove the *Unigraf UCD Tools* folder from the *Applications* folder before starting installation.

**Note:** If installation fails, remove the *Unigraf UCD Tools* folder and any possible copies from the *Applications* directory and try again.

## Linux

Linux extract the \*.tar.gz file. You will find two install scripts (*install-libfuse.sh* and *install.sh*).

In the Files app select each script in turn, right click and select *Properties* to open the *Properties dialog*. Toggle the *Executable as Program* button.

In the Files app open a terminal window by unselecting any selected files and right clicking and selecting *Open in Terminal* to run the scripts (order is important).

In the terminal type: `sudo ./install-libfuse.sh`

You will be prompted for you password.

Type: `sudo ./install.sh`

You will be prompted with:

*Please proceed to 'Software & updates' application to tab 'Other Software' and uncheck checkboxes or remove 'cdrom' entry from /etc/apt/sources.list file. Otherwise you will have problems during UCD Console package installation. If you are already done, enter the key 'y'. If not - 'n'*

For Ubuntu just enter y. For debian follow instruction.

You will then be prompted again with:

*Please proceed to 'Software & updates' application to the first tab and set check box 'Officially supported (main)'. Otherwise you will have problems during UCD Console package installation. If you are already done, enter the key 'y'. If not - 'n'*

For Ubuntu just enter y. For debian follow instruction

Answer y for additional prompts.

The Ucd Tool Installer Setup app should now be running.

Select *Next*>

Select radio button for *Install for all users* or *Install just for me*.

You are asked to Choose Installation Directory. Do **NOT** choose the default (/root/Unigraf/Unigraf UCD Tools at time of writing). Select a directory that is easy to access and remember.

Note the warning: **Installing in existing directory. It will be wiped on uninstallation.**

Select *Next*> *Install* and *Finnish*.

Navigate to the *Unigraf UCD Tools* directory under the installation directory and double click the app you want to run (*UCDConsole.Applmage* for example).

## Firmware Update Procedures

UCD Configuration Utility is used to load firmware to a UCD device. Optionally, the UCD Configuration Utility can be used to select firmware for specific operations. Contact Unigraf for details.

### Updating from Earlier FW Versions

UCD Firmware versions prior to 1.8.52 (see Help > About on Console) do not support the procedure described here. Follow the instructions in *Appendix G Firmware Recovery Procedure with Quartus Prime* in this manual.

---

**Note:** Firmware update is a sensitive process. Please do not disconnect the device from the PC and do not power it off before the operation is completed unless specially requested. Avoid plugging and unplugging other USB devices when the firmware update is in progress.

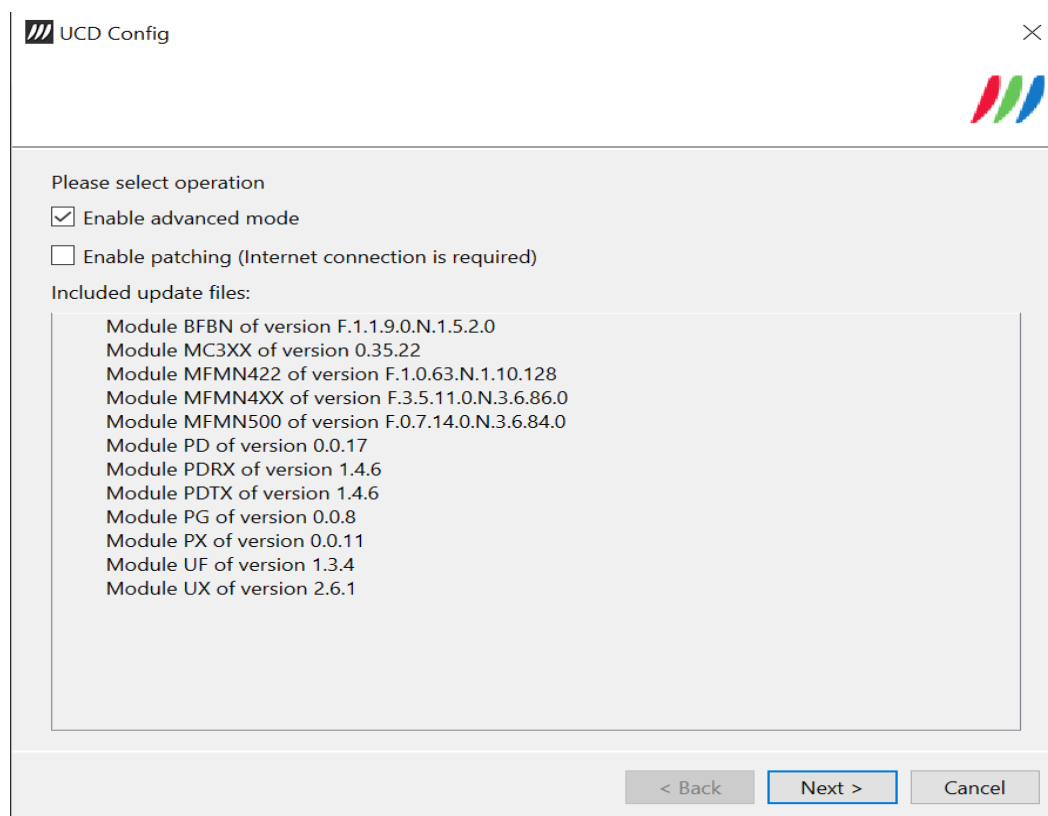
---

To update the firmware or create a new configuration on a UCD-4XX device, perform the following steps:

Connect the UCD unit to a power supply and connect the USB cable.

Open UCD Console.

Select Tools > Firmware Update.



The first page of the utility shows the firmware component versions present in the bundle package (or possible installed separately). Select *Enable advanced mode* checkbox if you want to custom install (possibly to downgrade firmware for ex.). Select *Next* to proceed.

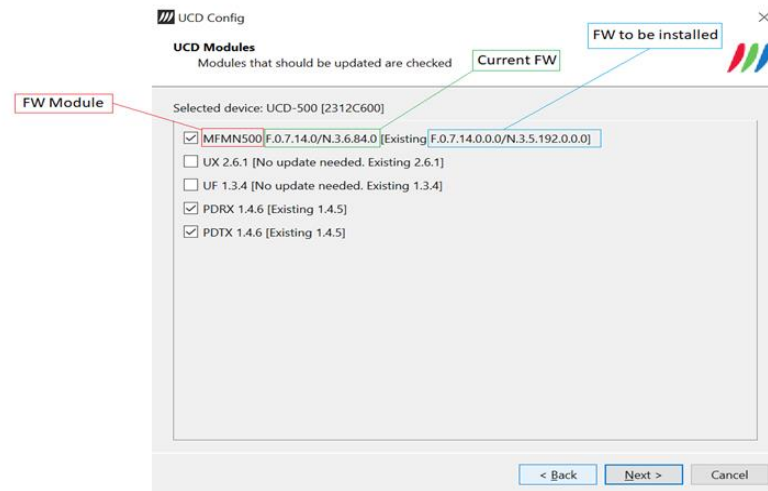
The *Enable patching (Internet connection is required)* check box is not relevant for UCD-4XX devices.

You are presented with a list of connected UCD devices. Select the device to update and *Next*.

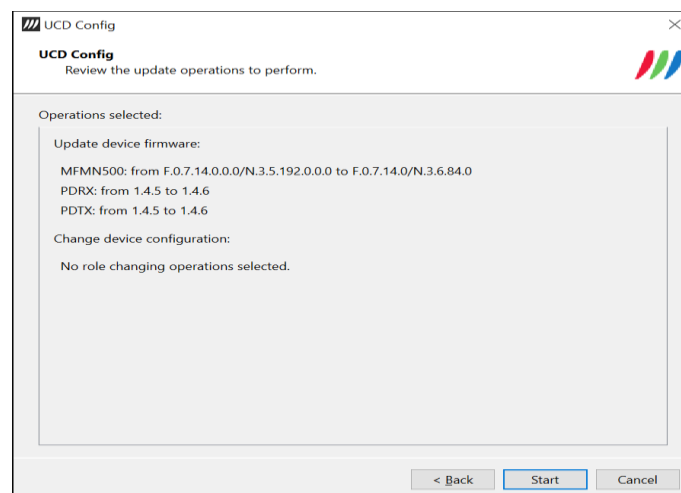


## Update UCD Modules

A dialog lists the FW components available in the UCD device, the currently programmed FW version, and the FW to be installed. Select *Next*.



You will be presented with a summary for the update procedure. Select *Start*.



During the install you will be prompted to power cycle the device (power off, wait for 10 seconds and then power the device on again). Select *OK* to proceed. After the update finished select *Next* to see a summary and select *Finish* to complete.

The update procedure may take several minutes.

## Recovering Failures in FW Update Procedure

If FW Update procedure fails (e.g., when updating from an earlier FW that does not support the procedure described here) refer to Appendix G of this manual for instructions in *Firmware Recovery Procedure with Quartus Prime*.

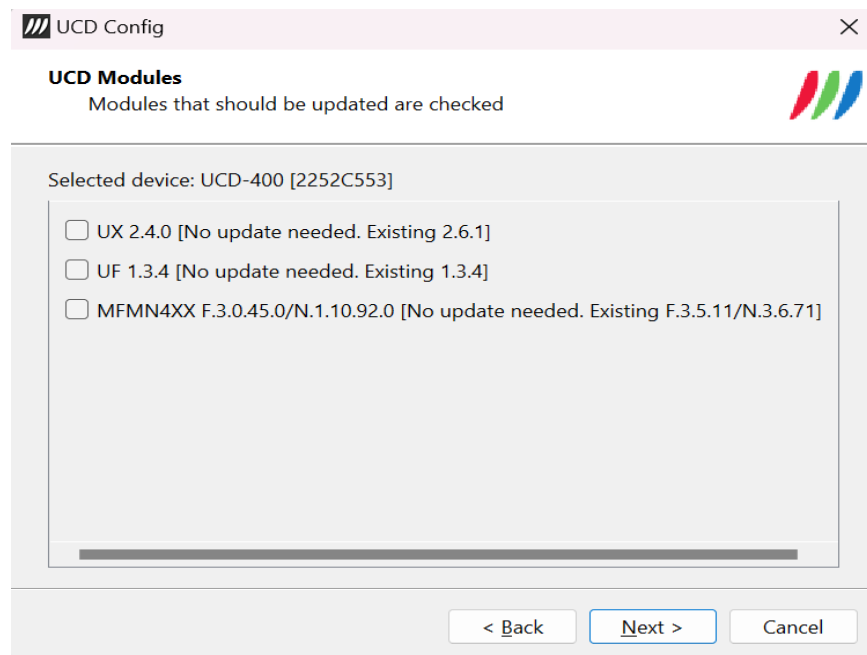
Once FW Recovery procedure has been done and a FW version supporting UCD Firmware Configuration tool has been installed, all future updates can be done using this tool.

## Firmware Downgrading

Sometimes you may need an older bundle for which the firmware is a separate download.

Follow the procedure below:

1. Download the latest *Console 2 SW Bundle (2.4.XX)* from Unigraf download page at [unigraf.fi/downloads](http://unigraf.fi/downloads).
2. Run the application *SoftwareBundle\_2.4.XX.exe* to install the package. Do not launch UCD Console application yet.
3. Download *Console 2: FW Package 2.3.38* from the same download page.
4. Run the executable *FirmwarePackage\_2.3.38.exe* to copy UCD device FW to the proper folder on your PC.
5. Launch *UCD Console*.
6. Select *Tools > Firmware Update* to start the *UCD Config* utility.
7. In UCD Config select *Enable advanced mode* (see above).
8. Select *Next* to proceed as described in *Update UCD Modules* above.
9. Select the modules to be updated (see image below).
10. Select *Next* to proceed as described above.



## License Manager

### Licensing

The features of UCD Console SW are divided into groups based on the target use of the device. Most basic features can be used by default, and more advanced feature groups are enabled by dedicated licenses. When the licenses are present, the related part of the GUI will be shown, or the related control will be enabled.

Unigraf licenses are provided as strings of characters, **License Keys**. Each License Key enables a dedicated function in one device. Each device has its dedicated **Seed Number**. Each **License Key** is tied to one **Seed Number**. License Keys can be freely used in any number of PCs

License keys are managed with **UCD License Manager**. The License Manager can be found in the **Tools** menu of UCD Console SW.

---

**Note:** System administrator's privileges are required for accessing the licenses.

---

### License Manager GUI

When run, License Manager will list the licensing enabled Unigraf devices. In the list of Devices please **Select** the device in question. The *serial number* and the *seed number* of your device are printed in a sticker attached to the bottom of the device.

The **Rescan...** button will re-scan the system for installed hardware.

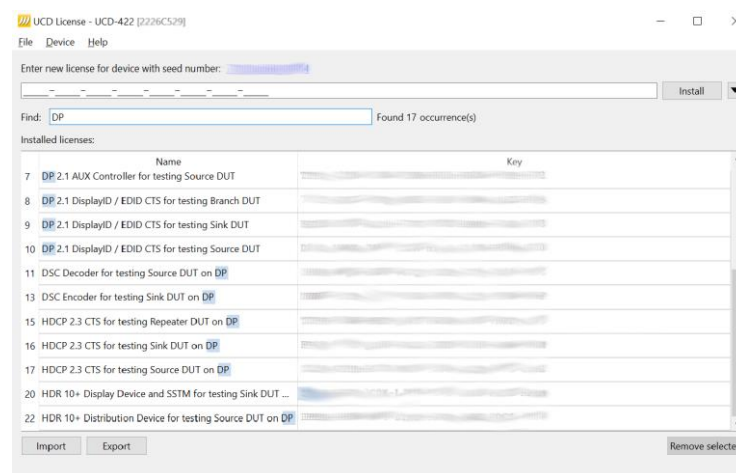
### Managing Licenses

#### Seed Number

Each license is tied to a hardware unit with the help of the **Seed Number**. Each unit has a unique Seed Number. Seed Number of the selected unit can be found in the top of the dialog.

Seed Number of the selected device can be copied from dialog link for e.g., ordering Licenses.

### Adding New License Keys



To add a new license key for a device, please enter the characters from the license sticker to the field for new licenses. The License Manager will automatically move the caret across the edit boxes during typing. If the key is given in text format, copy it and paste to the leftmost box.

Once the license key is fully entered, click Install. The license is authenticated and if it is valid, the license will appear in the list of installed licenses. If the key fails to authenticate, an error message is displayed. If this happens, please make sure that the key has been typed correctly and that the seed number on the license key sticker matches the seed number displayed in UCD License Manager.

Click the Search inverted triangle at the upper right to view the *Find* edit control. Enter a search keyword: The license list is updated to show names that contain the keyword.

Note that to avoid confusion, some letters will never appear in a license key because they resemble numbers: For example, capital 'G' and number '6' are very similar when printed with small font. When in doubt, use numbers.

Also, please note, that characters that cannot be part of valid license key are not accepted as input. When appropriate, an automatic conversion is applied while typing: For example, lower case letters are converted to upper case automatically.

### Managing Installed Licenses

The Installed licenses list shows all installed licenses for the selected device. The list shows the name of the license and the actual license key characters.

|                         |                                                                                                                                                                                                                                                                                                              |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Import:</i>          | Install licenses from an INI file for the currently selected device.                                                                                                                                                                                                                                         |
| <i>Export:</i>          | Save installed licenses for the currently selected device into an INI file for backup and distribution to other PCs.<br>To export license(s), select the license(s) to be exported and then click the Export button. Please note that licenses from multiple devices can be exported into the same INI file. |
| <i>Remove Selected:</i> | Uninstall selected licenses. To uninstall a license, click on the license and then click the Remove Selected button                                                                                                                                                                                          |

## UCD Console

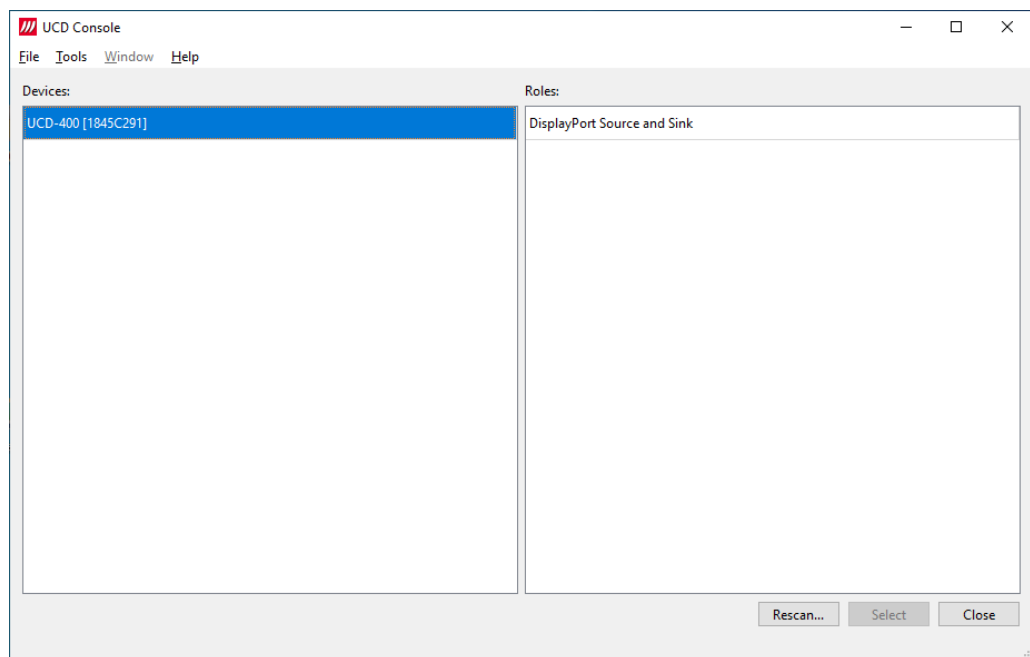
UCD Console SW is graphical user interface (GUI) for UCD family test equipment for desktop use. UCD Console provides the user access to all features of the unit. UCD Console also includes powerful debugging and analysis tools enabling the user to monitor the status of the display interfaces and assist in problem detection.

The various features of the UCD unit are divided into interface specific screens and tabs. Each tab contains data and controls for a specific feature.

### Device Selection

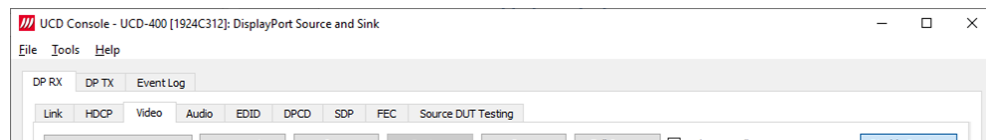
A shortcut of UCD Console can be found by default under Start Menu.

Once UCD Console is launched, the dialog provides a list of Unigraf UCD devices connected in the PC. Please select the target device by double clicking on the appropriate row. If your device cannot be found in the list, please confirm the power and USB connection to the device and click the **Rescan** ... button.



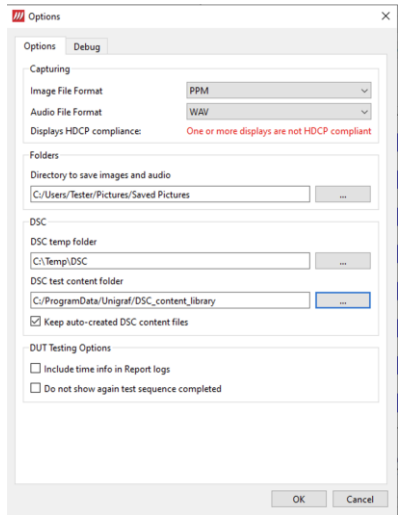
### Analyzer and Generator Operation

Most UCD devices can be used with UCD Console as Analyzer (a Sink device) and as Generator (a Source device). The functionalities of the two operation modes can be found in separate tabs. This User Manual will explain both roles and all role functionalities.



# Options

Options can be found in **Tools > Options**.



## Image File Format

You can save the captured frames either in PPM, BMP, JPG or PNG bitmap file format. In PPM format the files are stored with the captured color depth, with other formats the color depth is truncated to 8 bits per color.

## Audio File Format

Audio files are stored in WAV format.

## Displays HDCP Compliance

Information if controlling PC is HDCP compliant, i.e. if preview of HDCP encrypted content can be enabled. If the display is non-HDCP compliant or when connected to the PC using RDP (Remote Desktop Protocol) then users will be presented with a blue background with a banner stating 'HDCP unauthorized'. HDCP is currently only supported on Windows OS and not supported on MacOS and Linux.

## Folders

Please select the directories in the PC for saving the captured images and audio.

## DSC

|                                             |                                                                                                        |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------|
| <i>DSC temp folder:</i>                     | Folder for DSC Work files.                                                                             |
| <i>DSC test content folder:</i>             | Folder where DSC source bitmap files, related configuration files and DSC conversion tools are stored. |
| <i>Keep auto-created DSC content files:</i> | By default, the DSC compressed content is deleted after use. If selected, the content is not deleted.  |

Warning

Keeping the automatically created DSC compressed content will shorten the time needed for running the DSC compliance tests.

Please note, that the space needed for storing the full library **can be very large** (appr. 400 GBytes). Please make sure that the content will be stored in a medium that has the required space available.

## DUT Testing Options

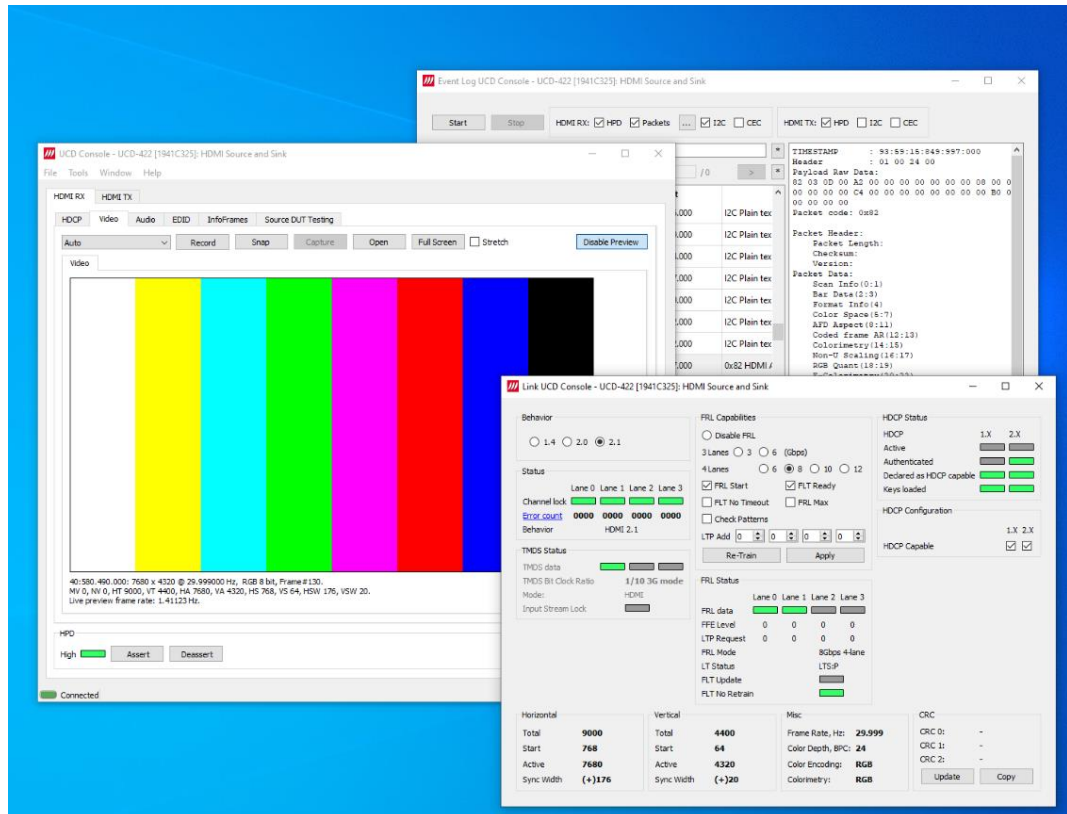
Configure DUT Testing reports.

|                                                   |                                                                                      |
|---------------------------------------------------|--------------------------------------------------------------------------------------|
| <i>Include time info in Report logs:</i>          | Include system date and time in the beginning of each event line in created reports. |
| <i>Do not show again test sequence completed:</i> | Include system date and time in the beginning of each event line in created reports. |

## Detaching and Cloning Tabs

Most of the UCD Console tabs can be detached into a separate window for monitoring and controlling separate features simultaneously. To detach a tab **Right-click** on a tab and select **Detach Window**. To glue the tab back to the main window, click on the red **Close** button in the top right-hand corner of the window or press **<Alt> + F4** on the keyboard.

Tabs can also be cloned (duplicated) in order to e.g., monitor various areas of DisplayPort DPCD simultaneously without swapping addresses. To clone a tab **Right-click** on a tab and select **Clone Tab** or **Clone and Detach** to the two actions simultaneously.



## 4. ANALYZER OPERATION

When used as an *Analyzer*, the UCD device acts as DisplayPort, HDMI or USB-C DisplayPort Alt Mode Sink or Receiver device.

Analyzer functionality related controls and dialogs can be used by selecting *DP RX* or *HDMI RX* tabs.

Please note that in most UCD-4XX Series units, *Generator* functionality is available simultaneously with Analyzer. Please find the description of Generator functionality later in this manual.

### Functionality Tabs

UCD Console features are presented in tabs. Standard tabs are similar in all functional roles, Interface Specific tabs present features and controls that are only available for a particular interface.

Some of the tabs are enabled by default, some only when an applicable license is included.

#### Standard Tabs

Analyzer role features six standard tabs:

- Video preview and saving (Video)
- Audio monitoring and saving (Audio)
- EDID editor (EDID)
- HDCP status monitor and control (HDCP)
- Source DUT Testing tab
- Event Log

#### Interface Specific Tabs

Depending on the connected UCD device, additional interface specific tabs will be available.

##### UCD-400 and UCD-424:

##### DP and USB-C DP Alt Mode Reference Sink

- Status information and control of the upstream link (Link)
- DPCD editor (DPCD)
- SDP sent by the Source device (SDP)
- Status and capabilities of the DSC feature (DSC)
- Forward Error Correction (FEC)

##### UCD-422: HDMI Reference Sink

- Status information and control of the upstream link (Link)
- Received InfoFrame packets (InfoFrame).

##### UCD-424: USB-C Reference Sink

- USB-C Monitoring (PDC)

---

**Note:**

Some of the tabs are enabled by default, some only when an applicable license is included. Please refer to Appendix B Licensing of this document for description of features and licensing.

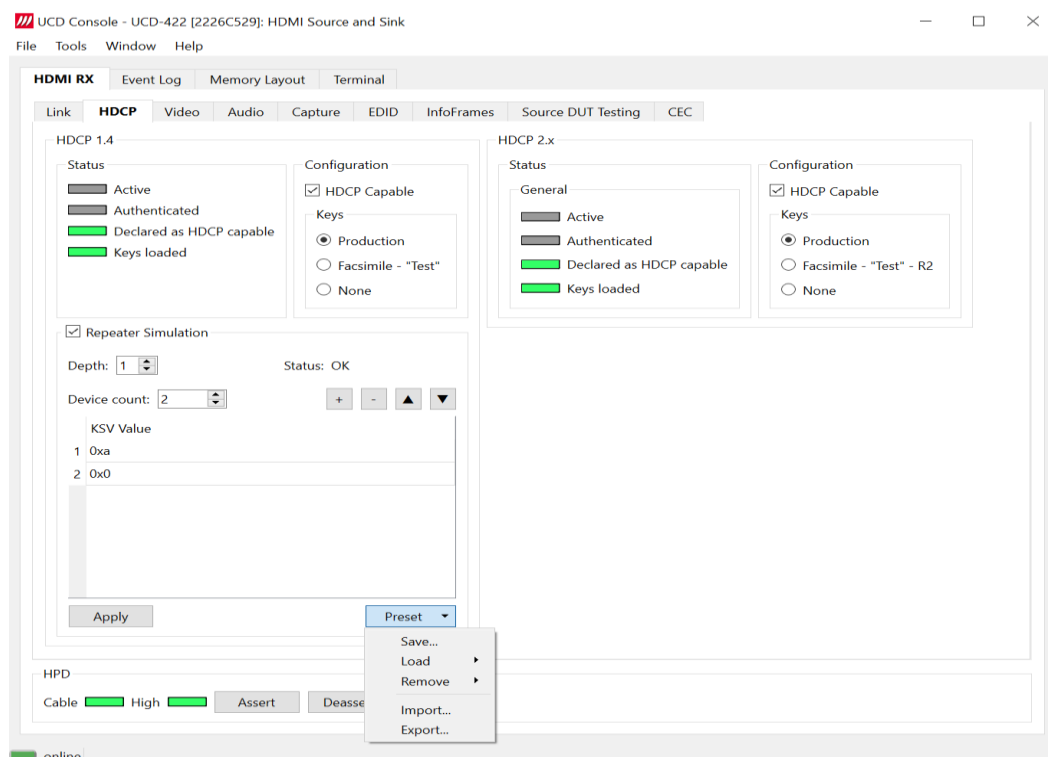
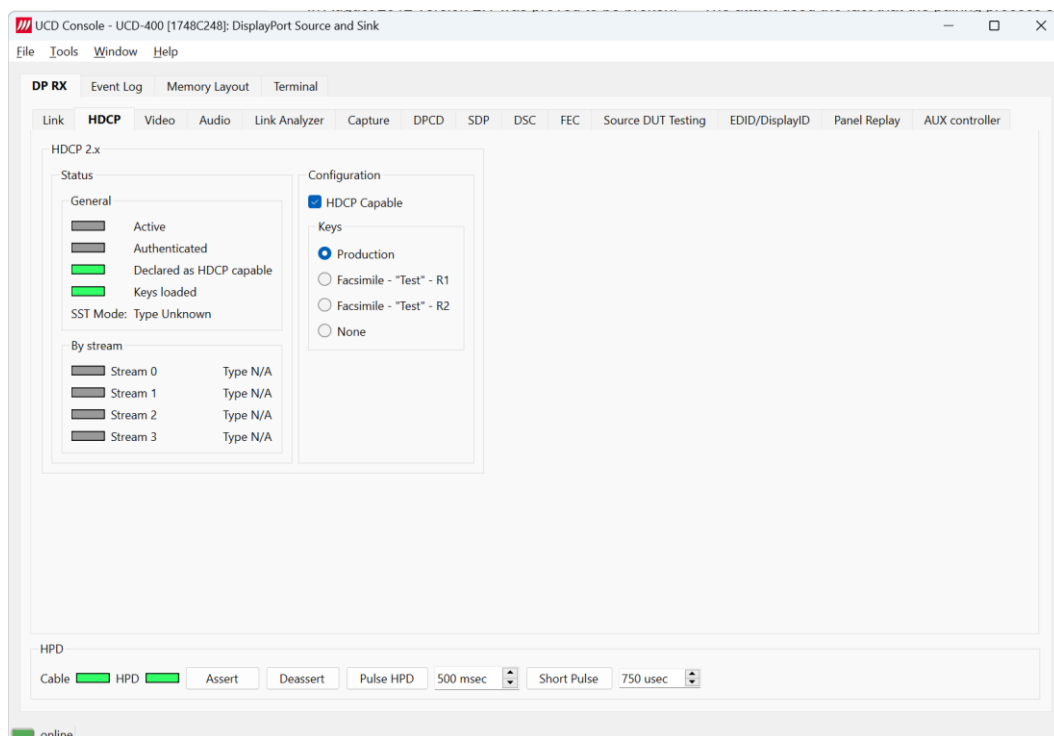
---



## Standard Tabs

### HDCC Tab

HDCC tab is the dialog for monitoring the HDCC (for *High-Bandwidth Digital Content Protection*) status and controlling the HDCC capabilities of the UCD device.



## Status

The status field indicates the HDCP status of the UCD device.

|                                  |                                                                                       |
|----------------------------------|---------------------------------------------------------------------------------------|
| <i>Active:</i>                   | The link between UCD and the upstream source has been encrypted.                      |
| <i>Authenticated:</i>            | The HDCP handshake between the UCD and the sink unit has been completed successfully. |
| <i>Declared as HDCP capable:</i> | The UCD unit recognizes HDCP handshake messages.                                      |
| <i>Keys loaded:</i>              | The HDCP keys are loaded to the UCD unit.                                             |
| <i>SST Mode Type</i>             | Type when in SST mode (DP).                                                           |

## Configuration

*HDCP Capable:* To inform source DUTs that TE (UCD device) is HPCD capable or not. Uncheck to disable.

## Repeater Simulation

For HDMI the UCD device can simulate a HDCP repeater. Check the *Repeater Simulation* box to enable the rest of the controls.

|                      |                                                           |
|----------------------|-----------------------------------------------------------|
| <i>Depth:</i>        | Depth of <i>Repeater</i> (maximum 4).                     |
| <i>Device count:</i> | The number of devices that act as repeaters (maximum 32). |
| <i>KSV Value</i>     | KSV value assigned to each device.                        |
| <i>Status</i>        | Shows HDCP authentication of repeater.                    |

The *Device count* can be change via the spinbox or the +/- buttons.

Inverted triangles are used to navigate the *KSV* rows.

Use the *Preset* dropdown to *Save*, *Load* and *Remove* named (saved internally) sets.

Use the *Import* and *Export* options to load and save to files.

Press *Apply* to apply settings.

## Keys

Select between *Production* or *Facsimile* HDCP keys. To remove the keys, select *None*.

## HDCP 1.3 / 1.4 and HDCP 2.3 Limitations

DisplayPort currently only supports HDCP 2.X.

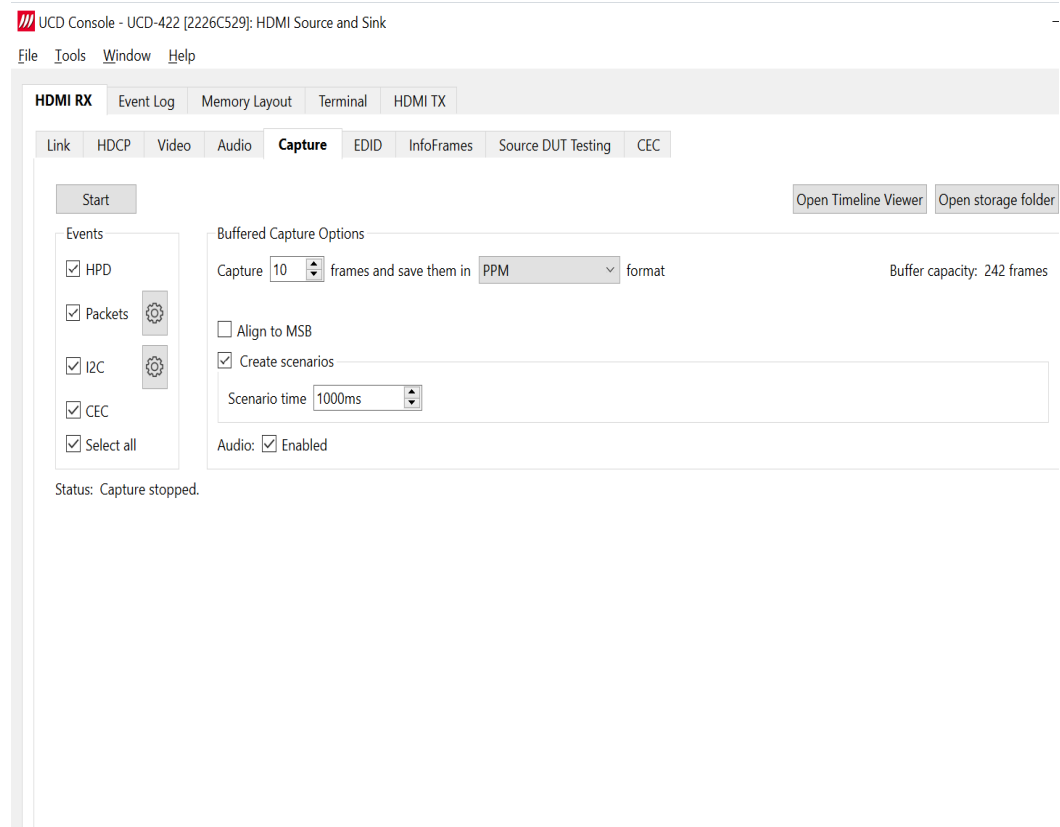
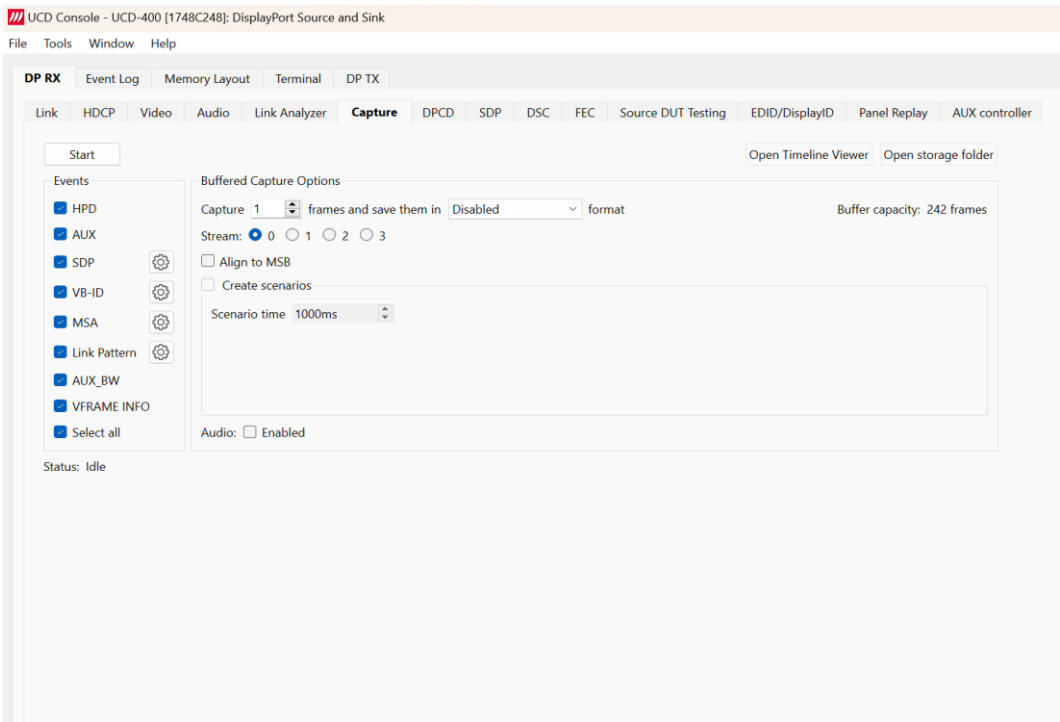
HDMI currently does not support HDCP 2.3.

See *ReleaseNotes.txt*, *Known issues (Limitations)* in bundle to see limitations:

C:\Program Files\Unigraf\Unigraf UCD Tools\documents\ *ReleaseNotes.txt* on Windows.

## Capture Tab

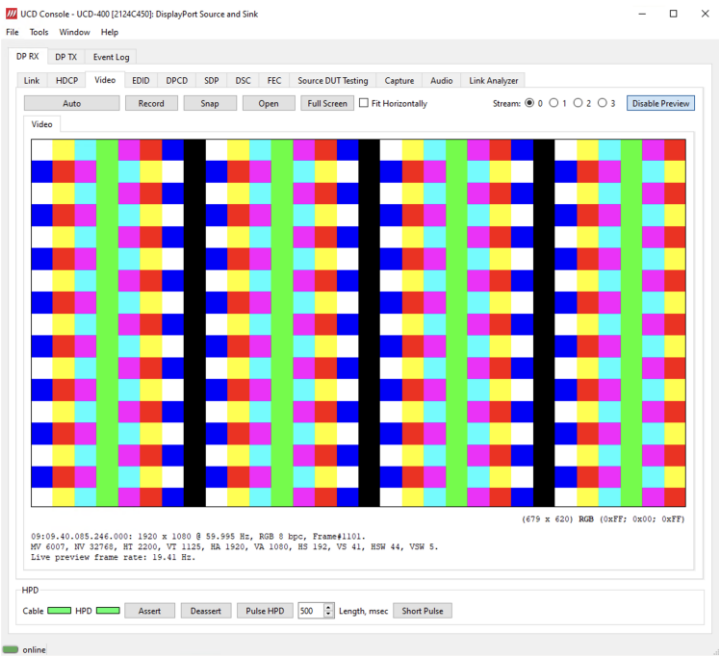
UCD device has an internal frame buffer that can be used for continuous capture of video data. In addition, audio and metadata can be captured and saved for later analysis.



|                             |                                                                                                                                                                                                                                       |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Start / Stop</i>         | Start or stop capturing. Button label changes per action.                                                                                                                                                                             |
| <i>Capture N frames:</i>    | The number of video frames to capture.                                                                                                                                                                                                |
| <i>Format:</i>              | Selection of the format of the saved video frame bitmaps. BIN, PPM, BMP, BIN + PPM, BIN + BMP.                                                                                                                                        |
| <i>Buffer capacity:</i>     | The number of video frames that can be stored to UCD frame buffer using current video signal format.                                                                                                                                  |
| <i>Align to MSB</i>         | Store binary data aligned to the Most Significant Bit (MSB). When this is left unchecked the binary data is aligned to the Least Significant Bit (LSB).                                                                               |
| <i>Create scenarios</i>     | Define the length of the scenario.                                                                                                                                                                                                    |
| <i>Events:</i>              | Please refer to chapter <a href="#">Event Log</a> for details of the captured events.                                                                                                                                                 |
| <i>Audio:</i>               | Enable audio.                                                                                                                                                                                                                         |
| <i>Status:</i>              | Status of the capture.                                                                                                                                                                                                                |
| <i>Open Timeline Viewer</i> | Open Event Timeline Viewer to view the captured data. For detailed instructions refer to chapter seven of this manual.                                                                                                                |
| <i>Open storage folder:</i> | Data save folder is defined in menu Tools > Options. Captured video, audio and data is saved in a subfolder of this folder. The name of the subfolder is "buffered_capture_yyyymmdd_hhmmss" (e.g., buffered_capture_20210301_130532). |

Video Tab

Video tab is the Preview window for the captured video stream.



Disable / Enable Preview

Click the button to start or stop capturing video frames.

Current Stream (UCD-400, UCD-424)

Stream: ☒ 0 ☐ 1 ☐ 2 ☐ 3

When Multistreaming (MST) is enabled, the monitored stream can be selected here.

Video Status

The details of the captured video are presented below the preview window.

(1427 x 915) RGB (0x00; 0x00; 0xFF)

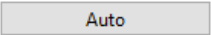
09:19:30.975.164.000: 1920 x 1080 @ 59.995 Hz, RGB 8 bpc, Frame#12404.  
MV 6007, NV 32768, HT 2200, VT 1125, HA 1920, VA 1080, HS 192, VS 41, HSW 44, VSW 5.  
Live preview frame rate: 19.55 Hz.

|             |                                                                                                                           |
|-------------|---------------------------------------------------------------------------------------------------------------------------|
| First row:  | Cursor location, pixel value at cursor location in YCbCr and RGB                                                          |
| Second row: | Time stamp, Color mode, color depth, frame counter.                                                                       |
| Third row:  | Mvid, Nvid, Horiz Total, Vert Total, Horiz Active, Vert Active, Horiz Start, Vert Start, Hor Sync Width, Vert Sync Width. |
| Fourth row: | Live preview frame rate.                                                                                                  |

**Note:** HDCP preview is only available on UCD Console for Windows operating system.

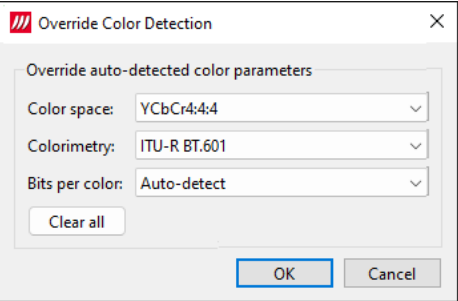
Please note that UCD test equipment are able to capture video at full frame rate. *Live preview frame rate* indicates the rate of updating captured video on UCD Console preview screen. The rate is limited e.g by the USB communication between UCD test equipment and the PC.

Override Color Detection



The captured video will be by default automatically converted to RGB 8 bpc for preview and saving based on the information in video metadata.

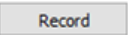
By clicking Auto button, a dialog opens for overriding the automatic conversion. Captured image data will be interpreted based on the values set in the dialog.



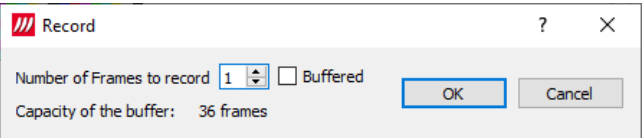
|                       |                                                                                                                     |
|-----------------------|---------------------------------------------------------------------------------------------------------------------|
| <i>Color space:</i>   | Define as which format captured data will be interpreted.<br>(Auto-detect, RGB, YCbCr4:4:4, YCbCr4:2:2, YCbCr4:2:0) |
| <i>Colorimetry:</i>   | Define as which colorimetry captured data will be interpreted.<br>(ITU-R BT.601, ITU-R BT.709, ITU-R BT.2020)       |
| <i>Bits per color</i> | Define as which color depth captured data will be interpreted.<br>(Auto-detect, 6, 8, 10, 12, 16)                   |

**Note:** Please note that the color mode selection applies to the preview window only. All internal functions use the raw image data as captured from the input channel.

Frame recording



Clicking the button opens a dialog for definition of number of frames recorded. Buffered mode can also be enabled in this dialog.

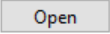


|                               |                                                                                                                                                                                                                                                                      |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Buffered</i>               | When checked, all input frames are captured non-drop until the on-board frame buffer will be full.<br>When not checked, only one input frame is buffered at a time. Frames will be skipped if the transfer of the data to the PC is slower than the input data rate. |
| <i>Capacity of the buffer</i> | Capacity of the on board frame buffer with the selected video and color mode.                                                                                                                                                                                        |

**Note:** Please note that buffered mode cannot be used when Audio preview is enabled.

Recorded frames are stored by default in C:/Users/<Current user>/Pictures. Please refer to Tools > Options where the location of this folder can be customized.

Open



Open folder where captured frames are stored. Double click or click **Open** to select a frame file for viewing. Please refer to Tools > Options where the location of this folder can be customized.

## Full Screen

Full Screen

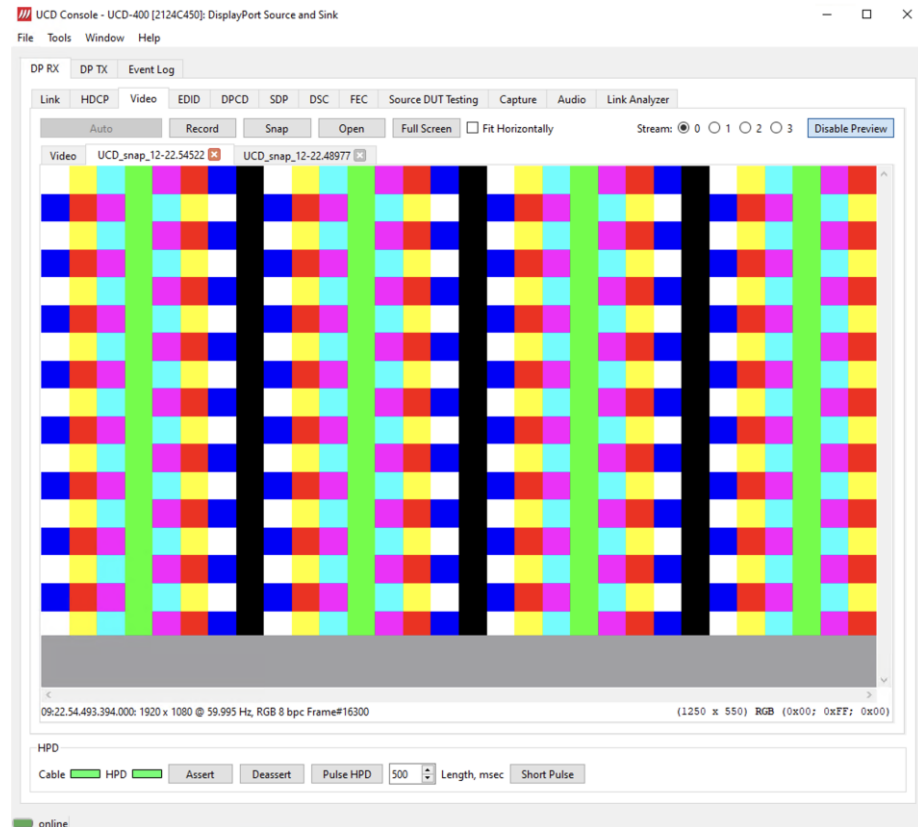
Preview captured video full screen, scaled to vertically fit the screen.

Double-click on the screen to exit full screen mode.

## Snap Frame

Snap

When clicked, one frame of the incoming video is captured and shown in a new tab. Each click captures a new frame and opens a new tab.



Color Information of the captured frame can be evaluated by placing the mouse cursor on top of the preview image.

Info field in the lower right side of the bottom panel lists:

- Location of the cross cursor on the bitmap stating from the upper left corner
- The intensity of the Red, Green and Blue components of the pixel on the cursor location in decimal values
- The HTML HEX color code of the pixel on cursor location
- In case of YCbCr color mode the intensity of the Y, Cb and Cr components of the pixel on the cursor location in decimal values

## Zoom

Zoom level of the captured frame can be altered by right clicking on top of the preview image and selecting between

- Fit Window
- Zoom 25%, 50%, 100%, 200%, and 500%

### Save Frame

The captured frame current tab can be saved to a bitmap file in the PC by right clicking on top of the preview image and selecting **Save as....** The format and storage location can be selected in the opening dialog. The available bitmap formats are BMP, JPG, PNG and PPM.

#### Note:

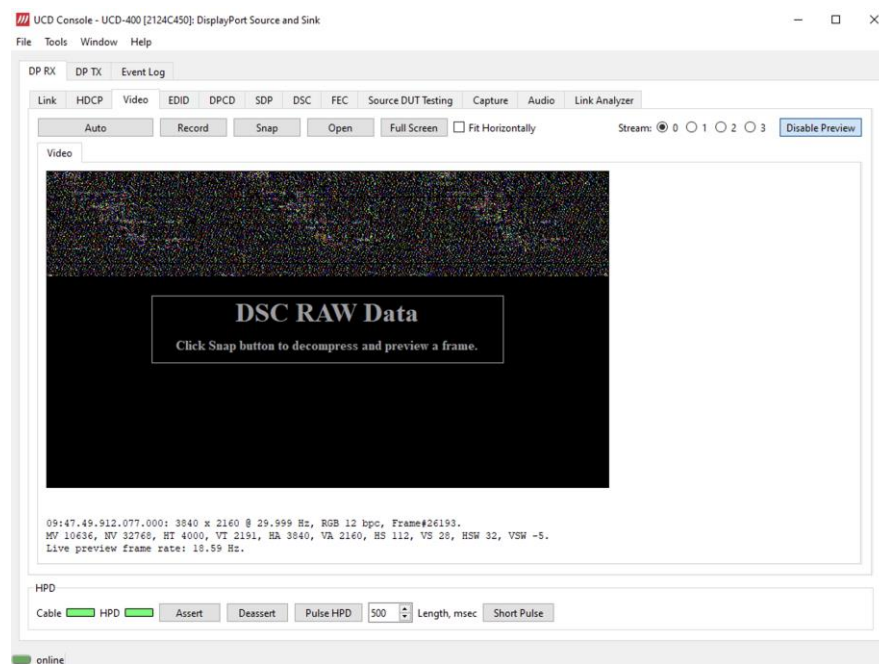
In PPM format the files are stored with the captured color depth, with other formats the color depth is truncated to 8 bits per color.

The selections in Tools > Options menu define if the frame bitmap will be stored as captured from the display interface or if the color mode conversion selected for preview will be applied.

### Previewing DSC Decompressed Stream (UCD-400, UCD-422, UCD-424)

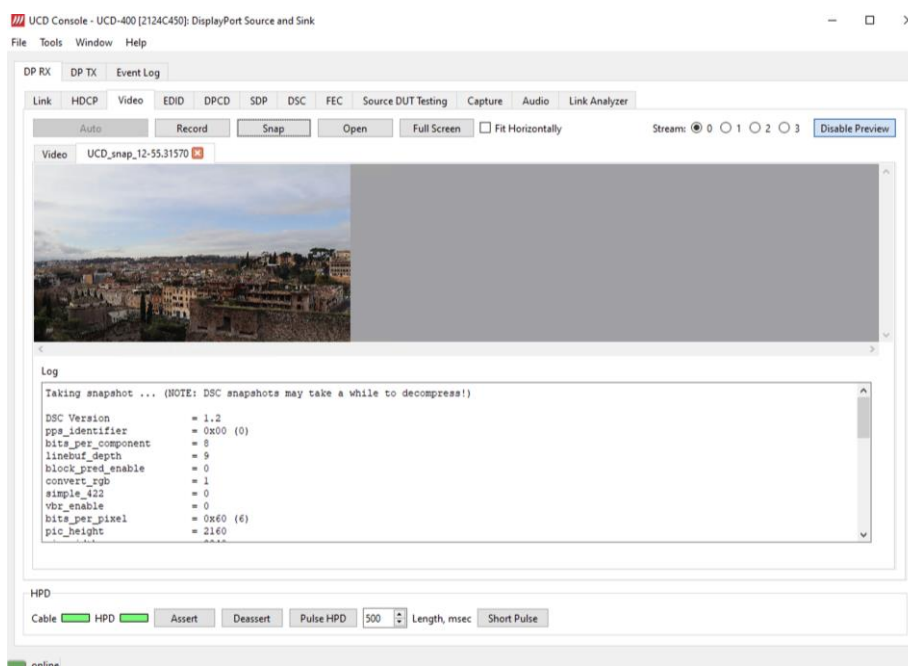
In order to capture and preview DSC compressed video DSC must be enabled in *Link Capabilities* dialog in Link tab.

Select **Enable Preview** to verify that DSC compressed stream is received.





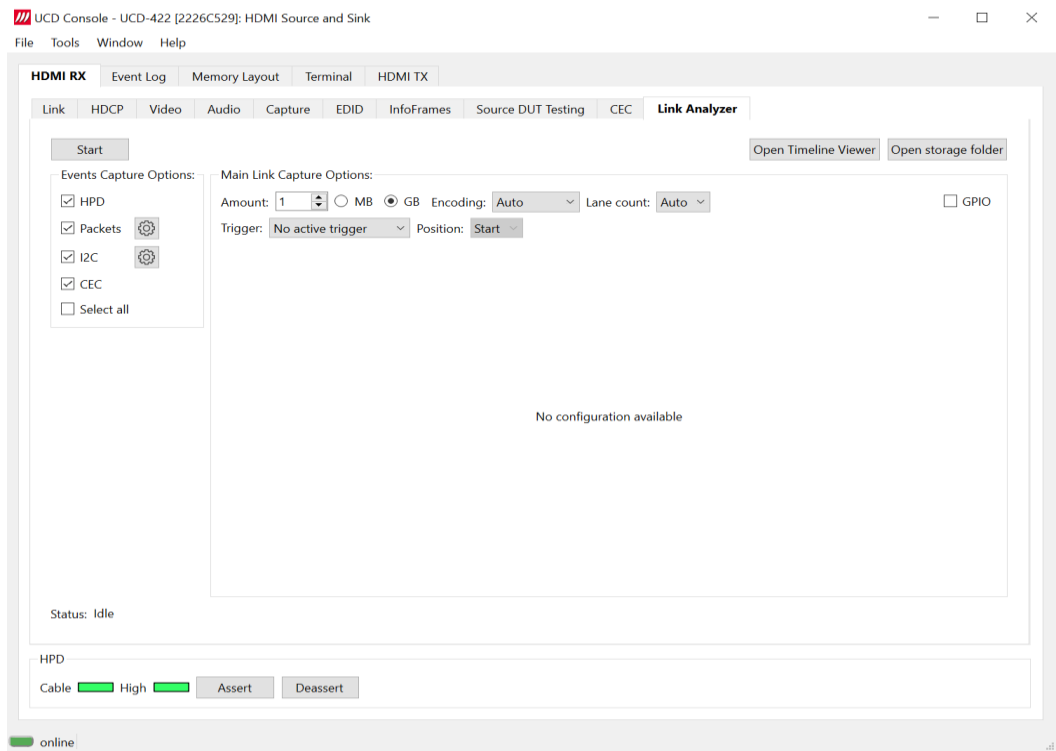
Click **Snap** button to capture one frame and start the decompressor (offline in the PC). Once the decompression is ready, the frame is shown, and *Log* lists the details of the compressed image. A snapped DSC image can be saved as a DSC-file.



# HDMI Link Analyzer Tab

Capture Data Events for analysis with *Link Timeline Viewer*. See chapter [Link Timeline Viewer](#) for details.

## Link Analyzer buttons



|                             |                                                                                                                                                                                                                                                                                                 |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Start</i>                | Start capturing main link data using <i>Main Link Capture Options</i> .                                                                                                                                                                                                                         |
| <i>Open Timeline Viewer</i> | Open Link Timeline Viewer. See <a href="#">Timeline Viewer</a> .                                                                                                                                                                                                                                |
| <i>Open storage folder</i>  | Open folder in the PC where capture data is stored. Folder is the video storage folder defined in <i>Tools &gt; Options</i> .<br>Captured video, audio and data is saved in a subfolder of this folder. The name of the subfolder is "capture_yyyymmdd_hhmmss). (e.g. capture_20210215_093351). |

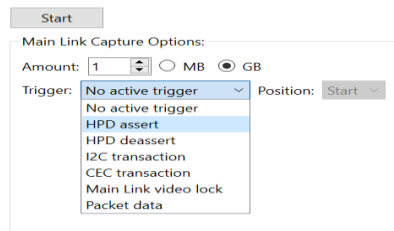
## Main Link Capture Options

*Amount:* The amount of data logged to buffer. Buffer size 2 GBytes maximum.

## Trigger Point Options

Data capture start can occur with or without defined trigger criteria.

*Trigger* criteria dropdown has four options: No active trigger, HDP assert, HDP deassert, I2C transaction, *CEC transaction*, *Main Link video lock* and *Packet data*.



When *I2C transaction* is selected, a drop down list box is enabled and visible with options: *Write*, *Read* and *Any*. Two spinboxes are enabled for *I2C Device Address* and *I2C Register Address*.

Start

Main Link Capture Options:

Amount: 1 MB GB

Trigger: I2C transaction Position: Start

Write

I2C Device Address: 7f

I2C Register Address: ff

When *CEC transaction* trigger is selected, available trigger options are shown below.

Select trigger options via checkboxes *OVERDATA\_ERROR*, *START\_TIMING\_ERROR* and/or by filling in the *CEC Template Data (hex)* values.

Start

Main Link Capture Options:

Amount: 1 MB GB

Trigger: CEC transaction Position: Start

☐ OVERDATA\_ERROR ☐ START\_TIMING\_ERROR ☐ MSG\_TIMING\_ERROR

CEC Template Data (hex):

|   |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|
| 1 | 2  | 3  | 4  | 5  | 6  | 7  | 8  |
|   |    |    |    |    |    |    |    |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|   |    |    |    |    |    |    |    |

Reset

When the *Main Link video lock* trigger is selected, available checkboxes are *GXB\_LOCK\_RISE*, *VID\_LOCK\_RISE*, and *VID\_LOCK\_FALL*.

Start

Main Link Capture Options:

Amount: 1 MB GB

Trigger: Main Link video lock Position: Start

☐ GXB\_LOCK\_RISE

☐ VID\_LOCK\_RISE

☐ VID\_LOCK\_FALL

When *Packet data* is selected: Checkbox *BCH\_ERROR*, when checked, will start capture when a *BCH\_ERROR* error has occurred (and only when one has occurred). Fill out *packet Template Data (hex)* to as needed to filter for events to start capture. Shown below is a trigger for *AVI Infoframes* in general.

Start Open Timeline Viewer

Main Link Capture Options:

Amount: 200 MB GB

Trigger: Packet data Position: Start

☐ BCH\_ERROR

Packet Template Data (hex):

|      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| HB0  | HB1  | HB2  | PB0  | PB1  | PB2  | PB3  | PB4  | PB5  | PB6  | PB7  | PB8  | PB9  | PB10 | PB11 |      |
| 82   | 02   | 0D   |      |      |      |      |      |      |      |      |      |      |      |      |      |
| PB12 | PB13 | PB14 | PB15 | PB16 | PB17 | PB18 | PB19 | PB20 | PB21 | PB22 | PB23 | PB24 | PB25 | PB26 | PB27 |
|      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

Reset

## Position

Triggered capture timepoints available are: *Start*, *25%*, *50%*, *75%*, *End*.

## Events

The following events can be selected:

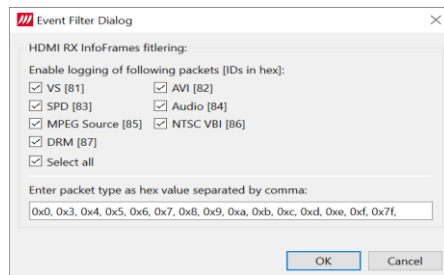
### HPD

Status and status changes of Hot Plug Detect (HPD) signal

### Packets

HDMI infoframes. Click the  button to open the *Event Filter Dialog*.

Packet events without checkboxes can be added via the *Enter packet type edit control* (0x2 for audio sample for example).



### I2C

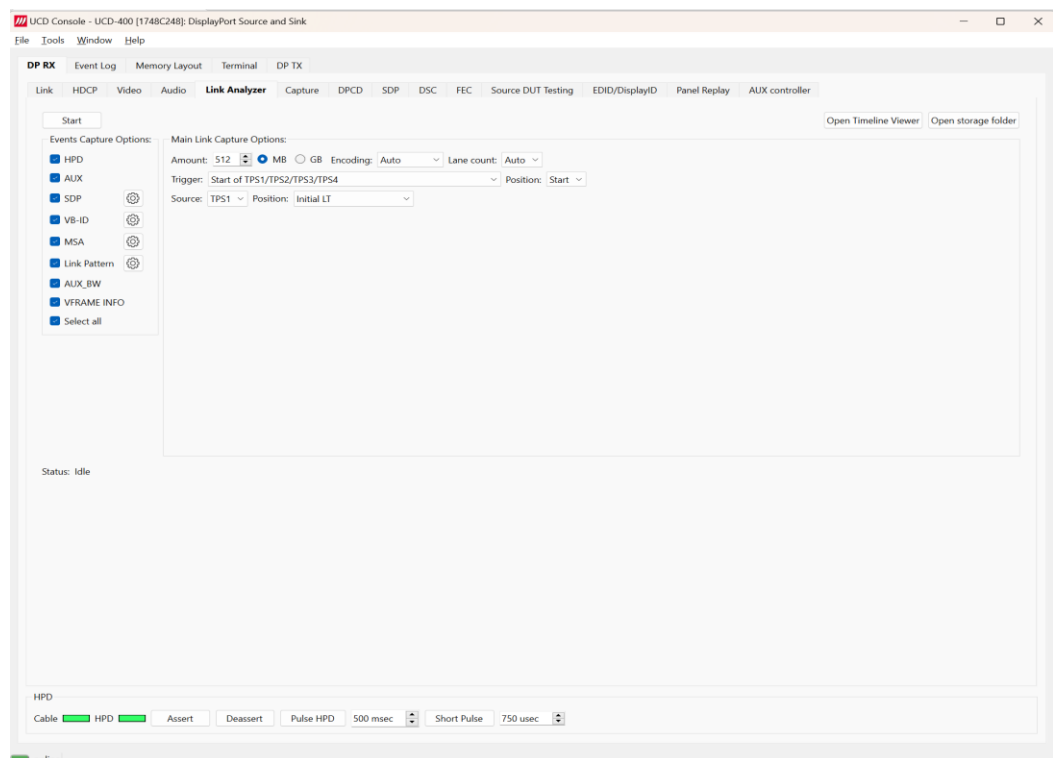
Capture I2C communication.

### CEC

Capture CEC communication.

## DP Link Analyzer Tab

Capture Main-Link Data Events and AUX Transactions for analysis with Link Timeline Viewer. See chapter [Link Timeline Viewer](#) for details.



|                             |                                                                                                                                                                                                                                                                                                 |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Start</i>                | Start capturing main link data defined by <i>Main Link Capture Options</i> .                                                                                                                                                                                                                    |
| <i>Open Timeline Viewer</i> | Open Link Timeline Viewer. For detailed description of Link Timeline Viewer, please refer to chapter six of this manual.                                                                                                                                                                        |
| <i>Open storage folder</i>  | Open folder in the PC where capture data is stored. Folder is the video storage folder defined in <i>Tools &gt; Options</i> .<br>Captured video, audio and data is saved in a subfolder of this folder. The name of the subfolder is "capture_yyyymmdd_hhmmss). (e.g. capture_20210215_093351). |

### Main Link Capture Options

|                    |                                                                    |
|--------------------|--------------------------------------------------------------------|
| <i>Amount:</i>     | The amount of data logged to buffer. Buffer size 2 GBytes maximum. |
| <i>Encoding:</i>   | Auto, 8b/10b or 128b/132b                                          |
| <i>Lane count:</i> | Auto, 1, 2 or 4                                                    |

## Trigger Point Options

Trigger: Start of TPS1/TPS2/TPS3/TPS4 Position: Start

Source: TPS1 Position: Initial LT

Start  
25%  
50%  
75%  
End

Start of data capture can occur without defined trigger or triggered by a predefined signal combination.

In the dialog, first select the event block from the upper drop-down list and from the appearing sub-menus select the detailed trigger.

| Trigger                                                          | Source                                                                                              | Position                                                                                                   |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| No active trigger                                                | —                                                                                                   | —                                                                                                          |
| Start of TPS1 / TPS2 / TPS3 / TPS4                               | TPS1, TPS2, TPS3, TPS4                                                                              | Initial LT,<br>After ALPM,<br>Initial LT or After ALPM                                                     |
| Exit of TPS1 / TPS2 / TPS3 / TPS4                                | TPS1, TPS2, TPS3, TPS4                                                                              | Initial LT,<br>After ALPM,<br>Initial LT or After ALPM                                                     |
| Trigger                                                          | Source                                                                                              | Mask (hex)                                                                                                 |
| VB-ID with the MASK – any change, match, selected bit transition | Any VB-ID change, VB-ID match with VB-ID mask, Change of any bit in VB-ID that is set in VB-ID mask | Set mask value in hex format                                                                               |
| VB-ID on TYPE – BS/SR/CPBS/CPSR                                  | BS, SR, CPBS, CPSR                                                                                  | —                                                                                                          |
| Trigger                                                          | Options                                                                                             | HB0 (hex), HB1 (hex)                                                                                       |
| SDP Type received – HB0 and/or HB1 match                         | Match on HB0, HB1 can be any value; Match on HB1, HB0 can be any value; Match on HB0 and HB1        | Set HB0/HB1 value in hex format                                                                            |
| Trigger                                                          | Source                                                                                              | Options                                                                                                    |
| MSA – any change, change by mask, match by mask                  | Any MSA change, Change of any MSA attribute set in mask, Match of any MSA attribute set in mask     | MVid, NVid, HTotal, VTotal, HActive, VActive, HSyncW, VSyncW, HSyncP, VSyncP, HSyncS, VSyncS, MISC0, MISC1 |
| Any AUX transition                                               | —                                                                                                   | Initial LT,<br>After ALPM,<br>Initial LT or After ALPM                                                     |
| Trigger                                                          | Type                                                                                                | Address (hex)                                                                                              |
| AUX read or write of specific address                            | AUX native, AUX native read                                                                         | Set address in hex format                                                                                  |

**Note:** If you want to capture during link training and you have set the trigger accordingly, you can initiate link training by clicking *Pulse HPD* at the bottom of the window.

## Events

The following events can be included in the captured data.

### HPD

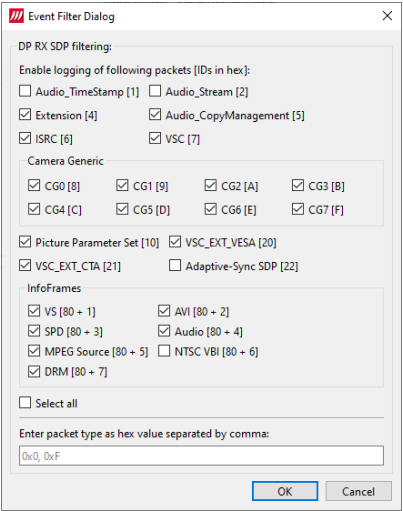
Status and status changes of Hot Plug Detect (HPD) signal

## AUX

AUX Channel transactions.

## SDP

Secondary-data Packets received in the Main-Link. Click the  button to open the *Event Filter Dialog*. The dialog enables filtering of SDP packets. In the dialog, the reference to Packet Type Value is indicated in square brackets “[ ]”.



The Event Filter Dialog for DP RX SDP filtering. It includes sections for enabling logging of various packet types, camera generic parameters, picture parameter sets, and infoframes. A 'Select all' checkbox and a text field for entering packet types are also present.

**DP RX SDP filtering:**

Enable logging of following packets [IDs in hex]:

- ☐ Audio\_TimeStamp [1] ☐ Audio\_Stream [2]
- ☒ Extension [4] ☒ Audio\_CopyManagement [5]
- ☒ ISRC [6] ☒ VSC [7]

**Camera Generic**

- ☒ CG0 [8] ☒ CG1 [9] ☒ CG2 [A] ☒ CG3 [B]
- ☒ CG4 [C] ☒ CG5 [D] ☒ CG6 [E] ☒ CG7 [F]

☒ Picture Parameter Set [10] ☒ VSC\_EXT\_VESA [20]

☒ VSC\_EXT\_CTA [21] ☐ Adaptive-Sync SDP [22]

**InfoFrames**

- ☒ VS [80 + 1] ☒ AVI [80 + 2]
- ☒ SPD [80 + 3] ☒ Audio [80 + 4]
- ☒ MPEG Source [80 + 5] ☐ NTSC VBI [80 + 6]
- ☒ DRM [80 + 7]

☐ Select all

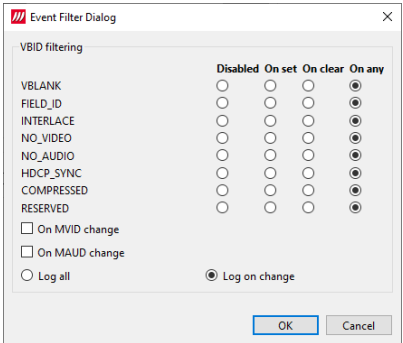
Enter packet type as hex value separated by comma:

0x0, 0xF

OK Cancel

## VB-ID

Vertical Blanking ID packets. Click the  button to open the *Event Filter Dialog*. The dialog enables definition of which bit changes will be logged.



The Event Filter Dialog for VBID filtering. It features a table with columns for 'Disabled', 'On set', 'On clear', and 'On any' for various video blanking ID types. There are also checkboxes for logging changes on MVID, MAUD, or all, and a radio button for logging on change.

**VBID filtering**

|            | Disabled              | On set                | On clear              | On any                           |
|------------|-----------------------|-----------------------|-----------------------|----------------------------------|
| VBLANK     | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| FIELD_ID   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| INTERLACE  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| NO_VIDEO   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| NO_AUDIO   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| HDCP_SYNC  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| COMPRESSED | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |
| RESERVED   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input checked="" type="radio"/> |

☐ On MVID change

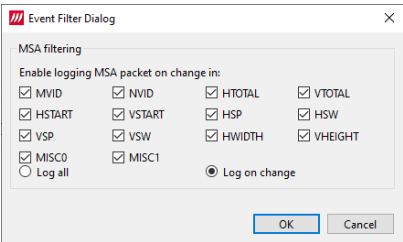
☐ On MAUD change

☐ Log all ☒ Log on change

OK Cancel

## MSA

Log Main Stream Attributes. Click the  button to open the *Event Filter Dialog*. The dialog enables definition of which events will be logged.



The Event Filter Dialog for MSA filtering. It includes a section for enabling logging of MSA packets on change in various attributes. There are checkboxes for MVID, NVID, HTOTAL, VTOTAL, HSTART, VSTART, HSP, HSW, VSP, VSW, HWIDTH, VHEIGHT, MISC0, and MISC1. A radio button for logging on change is also present.

**MSA filtering**

Enable logging MSA packet on change in:

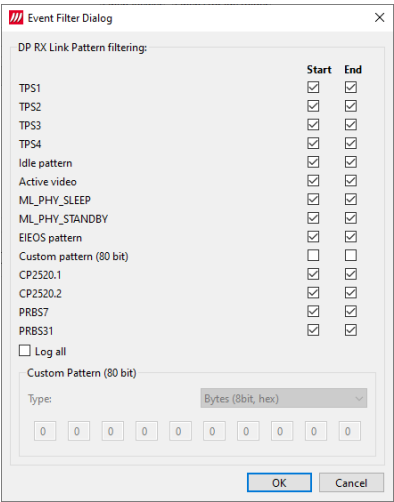
- ☒ MVID ☒ NVID ☒ HTOTAL ☒ VTOTAL
- ☒ HSTART ☒ VSTART ☒ HSP ☒ HSW
- ☒ VSP ☒ VSW ☒ HWIDTH ☒ VHEIGHT
- ☒ MISC0 ☒ MISC1

☐ Log all ☒ Log on change

OK Cancel

Link Pattern:

Detect link patterns. Click the  button to open the *Event Filter Dialog*. The dialog enables definition of which patterns will be logged.



AUX BW:

Capture AUX Channel signal details.

VFRAME INFO

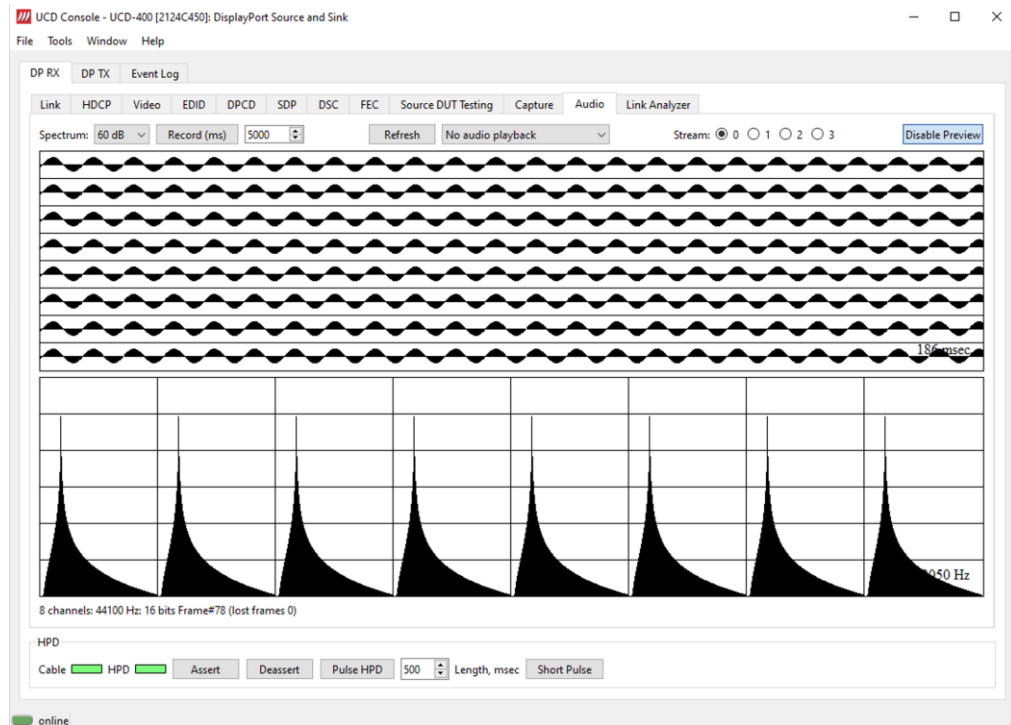
Dimensions of the catured frame measured by the Sink



## Audio Tab

Audio tab has a preview of the audio signal format and the controls for audio playback and recording. Up to eight channels will be shown based on the received audio stream.

The audio signal format is shown in three ways.



- The 'oscilloscope' panel displays the waveforms of the received audio channels.
- The frequency spectrum of the audio is shown in the lower panel. The range of the spectrum display is from 0 to 1/2 of the input sampling rate. The amplitude scale of the spectrum display can be selected between 'Linear' to 100 dB.
- The span of the oscilloscope preview window is defined with **Playback buffer** found in Tools > Options dialog. The value is given in ksamples (1024 samples). The relation between the preview window span in milliseconds (msec) and the value given in *Playback buffer* depends on the sampling frequency. Please do not exceed the *Main buffer* set in the same dialog. Please refer to description of the *Video Audio and Misc Options* earlier in this document.

### Enable Preview / Disable Preview

This button controls capturing the audio data.

### Select Monitored Stream

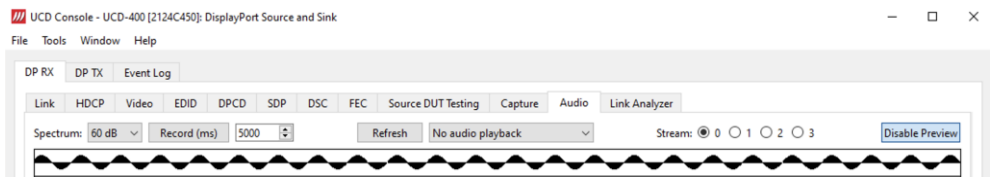
When Multistreaming (MST) is enabled, the monitored stream can be selected from **Current Stream** selection in the bottom of the dialog.

#### Note:

Please note that if the captured audio signal is constant, and audio signal frequency and audio sampling rate (e.g. 1000 Hz audio and 32 KHz sampling) match audio preview sampling rate, the 'oscilloscope' panel will seem static. Signal capture can be verified by ensuring that Frame # below the panels is increasing.

### Playback device selection

The captured audio can be played back in the PC. The combo-box defines the audio device in the host PC through which the captured audio is played. By default, *No audio playback* is selected.



**Note:** Please note that the audio capabilities of the audio playback device of the PC are not automatically reflected in the audio capabilities description in UCD-4XX EDID. Since UCD-4XX is not performing any audio format conversion, it might occur that the source provides an audio format that the selected playback device is not supporting. In case a conflict occurs, please change manually the EDID content or disable audio playback to monitor the waveforms in UCD Console.

### Refresh audio device list

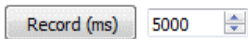


Click here to re-read the list of audio devices after making changes to the host PC configuration.

### Audio Buffer Size

The amount of buffering used in the data transfer between the UCD-4XX unit and the PC in Audio buffer size in Tools > Options dialog, Main buffer. Increased buffer size will ensure a smooth audio output but will also increase the delay between the capture of the audio stream and its playback.

### Start audio recording



The captured audio can be recorded in the PC using Waveform Audio File Format, WAV (\*.wav) format. Recording duration is defined in milliseconds (ms). The folder where the audio file will be saved can be selected in Tools > Options.

### Input audio mode

2 channels: 44100 Hz: 16 bits Frame#413 (lost frames 0)

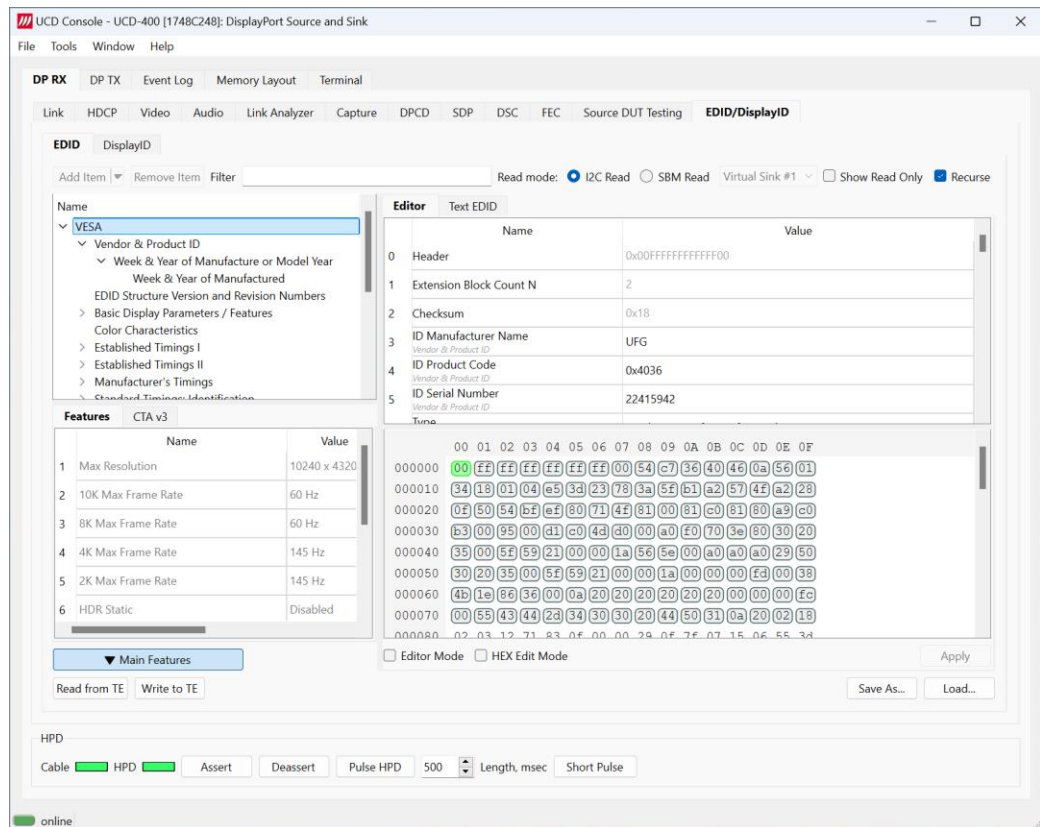
This field (in the bottom of the dialog) indicates detected audio mode in the input stream and the number of audio packets captured.

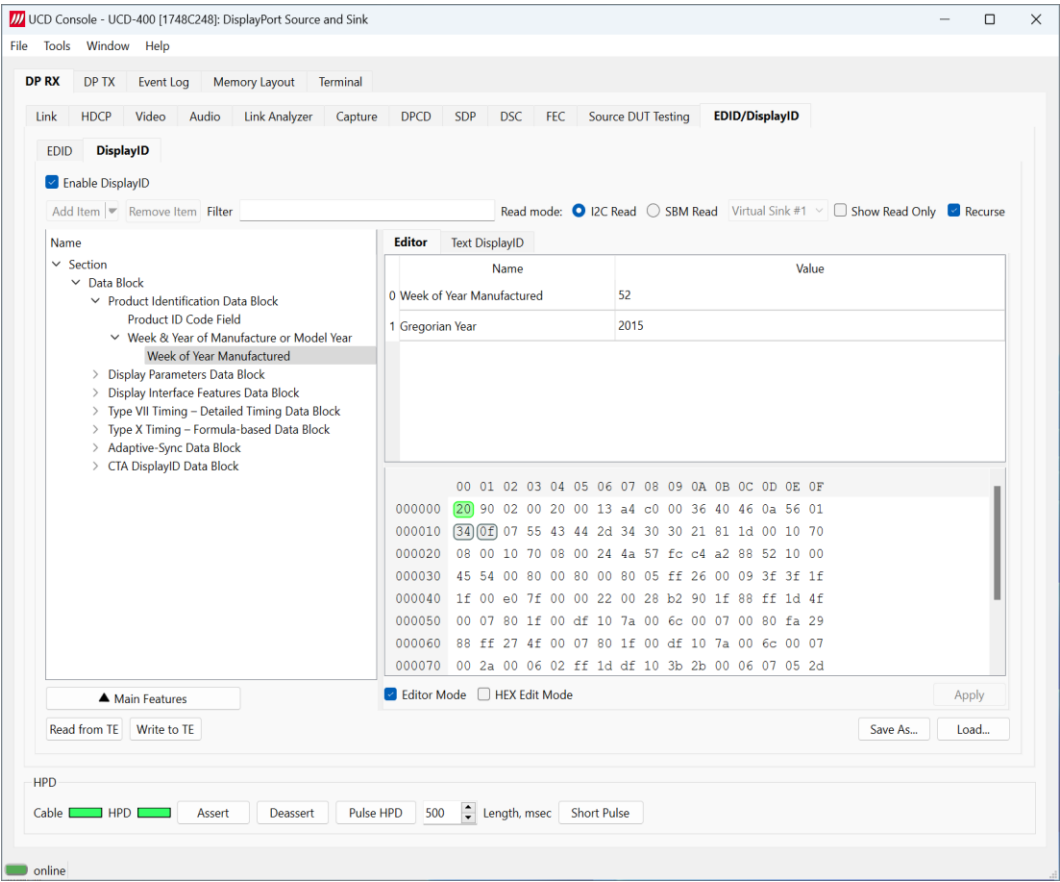
## EDID/DisplayID Tab

EDID/DisplayID Tab provides tools for accessing the EDID/DisplayID data of the UCD Sink presented to the connected Source Device. There are three basic functions:

- Load and save data files on the host PC.
- Edit contents in *Editor Mode* or the *Hex Edit Mode*.
- Read and write to EDID/DisplayID memory for up to 4 virtual ports.

### EDID/DisplayID Files





With *Load...* and *Save As...* a file can be read or written to from a PC. Please note that the program does not alter the contents of the file or verify its integrity during load and save operations.

**Note:** Four blocks (512 bytes) are read. If the device does not support all four blocks, the non-supported data is replaced with zeros.

The *Enable DisplayID* checkbox, when checked, informs generator devices that DisplayID data is available.

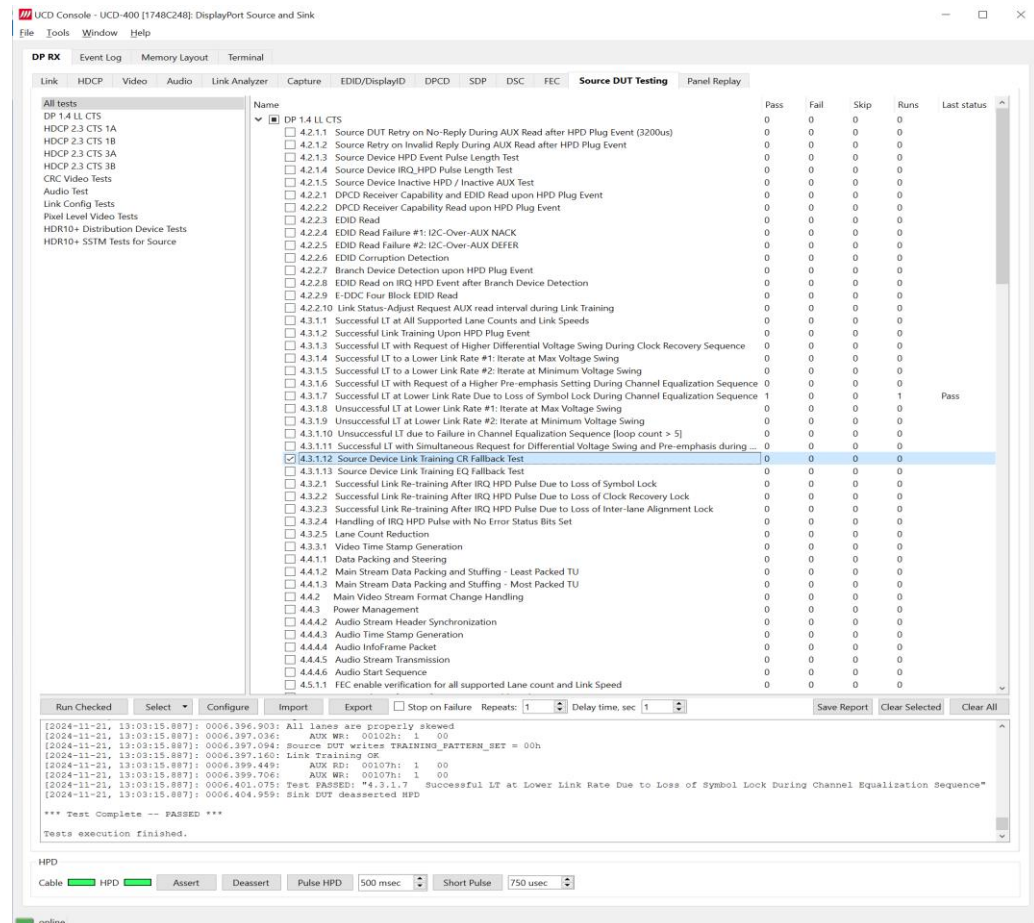
The *Text EDID* and *Text DisplayID* tabs allow viewing data in tree form.

**EDID/DisplayID Editor**

Please see the description of the EDID editor in Chapter [EDID/DisplayID Editor](#) later in this document.

## Source DUT Testing Tab

Please refer to *Appendix E* for descriptions of the tests available. The tests are presented in a split view, the right being test categories and the left being the tests in them.



Select the tests for execution by checking checkboxes or by clicking the test name. *All tests* item on the left hand side is really just for viewing all tests available. Select the desired test category (ex. *DP 1.4 LLCTS*) when running tests.

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Run/Run Checked:</b> | Select to start selected/checked tests. Once tests are running the <i>Run Checked</i> button is relabeled <i>Abort</i> to stop the test sequence if desired.                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Select:</b>          | Includes three sets of options: <i>Select All</i> , <i>Clear All</i> , <i>Invert All</i> for changing the tests current selections; <i>Save</i> (checked items), <i>Load</i> (and check relevant items), <i>Remove</i> (named tests list) for handling named templates; <i>Import</i> (check all items contained in file) and <i>Export</i> (save all checked items to file) for loading and saving file-based templates. Do not confuse <i>Import</i> and <i>Export</i> with those below: These are for setting and saving tests to run. |
| <b>Configure:</b>       | Opens a test parameters dialog for the selected test set. Make sure a test category other than <i>All</i> tests is selected. Refer to <i>Test Parameters</i> below for details.                                                                                                                                                                                                                                                                                                                                                           |
| <b>Import:</b>          | Load saved test parameter files (*.td or *.json) for into UCD Console. Select <i>Configure</i> to see current parameters. Loading *.td files to UCD Console is currently unreliable.                                                                                                                                                                                                                                                                                                                                                      |
| <b>Export:</b>          | Save test parameters for later use or for use in test automation. For saving parameters for later use in UCD Console, either format can be used. For saving parameters for TSI scripting, please use *.td files. For use with Python applications, use *.json files.                                                                                                                                                                                                                                                                      |
| <b>Stop on Failure:</b> | Stops execution of tests if one fails.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Repeats:</b>         | Number of times to repeat the selected test sequence.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Delay time:</b>      | Delay in seconds between individual tests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

On completion of each test the result of the test is displayed in the table columns on the right. For each test the table lists the number *Pass, Fail, Skips, Runs and Last Status* (status of last run).

|                       |                                                                                                                                             |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Save Report:</i>   | Select to generate a HTML report file. This will also open a tab in the default browser and display the results.                            |
| <i>Clear Selected</i> | Clear the test results of the <b>selected</b> (not checked) tests results. A subsequently saved report will not include these test results. |
| <i>Clear All:</i>     | Clear the test log view and the outstanding results.                                                                                        |

## Test Parameters

Each test suite has a dedicated set of test parameters. Select *Configure* to launch the parameters dialog for the selected tests.

See Appendix E for parameter descriptions for each test category.

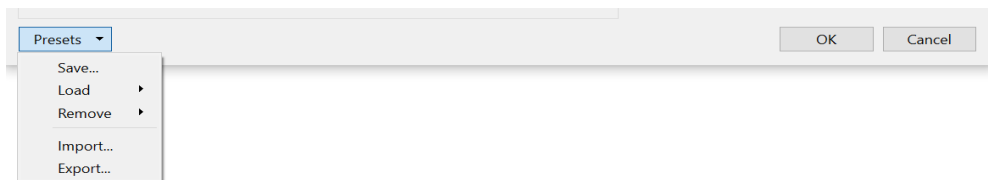
## Saving Test Parameters

Test parameters can be saved in various ways.

- Export parameters in *Sink DUT Testing* tab to a \*.td file for later use in UCD Console, to run TSI scripts, or to share test parameters with someone. Presently importing \*.td files into UCD Console is unreliable.
- Export parameters in *Sink DUT Testing* tab to a \*.json file for later use in UCD Console, to run Python scripts, or to load test parameters into UCD Console.
- Save parameters in *Configure* dialog as Presets to be later used in UCD Console. See description below.

### Presets

All *Configure* dialogs selected parameters can be saved and loaded via *Presets* dropdown menu. Select *Save* or *Load* for named internal configuration parameter sets. Select *Remove* to delete a named internal set. Select *Import* and *Export* for loading and saving parameter sets from and to external files. Note that *Importing* and *Exporting* \*.json files here have a different format than importing those described above.



## DP and DP Alt Mode Reference Sink

|                                          |          |
|------------------------------------------|----------|
| Role:                                    | Product: |
| DP Reference Sink (DP RX)                | UCD-400  |
| USB-C DP Alt Mode Reference Sink (DP RX) | UCD-424  |

When *DP Reference Sink* or *USB-C DP Alt Mode Reference Sink* role is in use, the following interface specific tabs are available.

- Status information and control of the upstream link (Link)
- DPCD editor (DPCD)
- Analyze Secondary-data Packets received (SDP)
- Display Stream Compression status and configuration (DSC)
- Forward Error Correction (FEC)

### Link Tab

Link tab contains four panels: Cable / HPD, Link Status, Link Capabilities and HDCP Status and Configuration, Video Status and HPD.

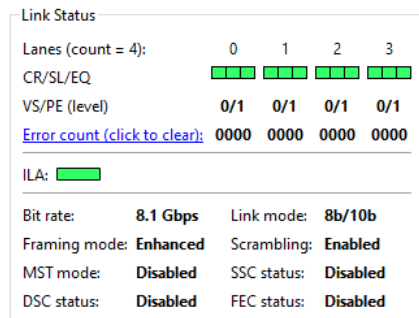
The screenshot displays the UCD Console interface for a DisplayPort Source and Sink. The 'Link' tab is active, showing the following panels:

- Link Status:** Displays link parameters such as Lanes (count = 4), CR/SL/eq, VS/PE (level), Error count, ILA, Bit rate (8.1 Gbps), Link mode (8b/10b), Framing mode (Enhanced), Scrambling (Enabled), MST mode (Enabled), SSC status (Disabled), DSC status (Disabled), and FEC status (Disabled).
- Link Capabilities:** Shows Max Lanes (4), Max Bitrate (8.10 Gbps), and various options for eDP Bitrate, Force Cable Status, and HPD pulse on Apply.
- HDCP Status:** Displays HDCP version (2.X), Active status, Authenticated status, Declared as HDCP capable, and Keys loaded.
- HDCP Configuration:** Shows HDCP Capable status and Scrambler seed (8b/10b) set to FFFFh (DP).
- VCP Table:** A table showing VCPID, Req.PBN, Alloc.PBN, First slot, and Slot num for streams 0 through 3.
- HDCP Stream Status:** A table showing Stream #, Status, and Type for streams 0 through 3.
- Stream Info:** A table showing various stream parameters including Framerate, HTotal, HStart, HActive, HSync, VTotal, VStart, VActive, VSync, CEF, BPC, CRC (RGB/CrYCb), MVID/NVID, and DSC CRC (Eng. 0 1 2).
- HPD:** A section at the bottom with buttons for Cable, HPD, Assert, Deassert, Pulse HPD, and Short Pulse, along with a 500 msec timer.



## Link Status

Link Status displays the status of the link training and the link parameters negotiated between UCD Sink and the Upstream Source. It also lists status of other link modes. The data is retrieved from the DPCD status registers of the UCD Sink. The status is updated automatically.



**Lanes:** Indicates the number of lanes used for DisplayPort or DisplayPort Alt Mode.

**CR/SL/EQ:** LED indicators for status of Clock Recovery / Symbol Lock / Channel Equalization for each of the four lanes

**VS/PE (level):** Voltage Swing / Pre-emphasis level

**Error count:** Content of DPCD Error Count registers

**ILA:** LED indicator for 'Inter lane Alignment Done'

**Bit rate:** Currently enabled link bit rate

**Link mode:** Currently enabled channel coding (8b/10b only)

**Framing mode:** Currently enabled Framing Mode (Normal or Enhanced)

**Scrambling:** Status of link data scrambling (Enabled or Disabled)

**MST mode:** Status of Multi-stream transport (Enabled or Disabled)

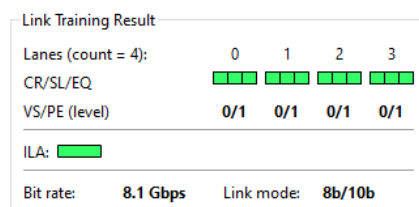
**SSC Status:** Status of Spread-Spectrum Clock (Enabled or Disabled)

**DSC Status:** Status of Display Stream Compression

**FEC status:** Status of Forward Error Correction function (Enabled or Disabled)

## Link Training Result

The result of the previous Link Training and values of some key parameters.



**Lanes:** Indicates the number of lanes used for DisplayPort or DisplayPort Alt Mode.

**CR/SL/EQ:** LED indicators for status of Clock Recovery / Symbol Lock / Channel Equalization for each of the four lanes

**VS/PE (level):** Voltage Swing / Pre-emphasis level

**ILA:** Status LED for Inter-Lane Alignment

**Bit rate:** Currently enabled link bit rate

**Link mode:** Currently enabled channel coding (8b/10b only)

## Link Capabilities

Link capabilities allows the user to change the way the Sink capabilities are announced in the DPCD capability registers of the UCD Sink. To update the new status to the DPCD registers click *Apply*.

Link Capabilities

Max Lanes

☐ 1

☐ 2

☒ 4

Max Bitrate, Gbps

☐ 1.62

☐ 2.70

☐ 5.40

☐ 6.75

☒ 8.10

☐ 0 (eDP only)

eDP Bitrate, Gbps

☐ 1.62

☐ 2.16

☐ 2.43

☐ 2.7

☐ 3.24

☐ 4.32

☐ 5.4

☐ 6.75

☐ 8.1

☐ Force Cable Status to Plugged

☐ Enable Fast LT

☐ eDP AUX Preamble

Sink count: 

2

☒ MST

☐ FEC

☒ TPS4

☒ TPS3

☐ DSC

☒ HPD pulse on Apply

Apply

|                                       |                                                                                                                                                                                                        |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Max lanes:</i>                     | Maximum lane count used                                                                                                                                                                                |
| <i>Max Bitrate, Gbps</i>              | Maximum link rate used in LT                                                                                                                                                                           |
| <i>eDP Bitrate,Gbps</i>               | Available eDP bitrates.                                                                                                                                                                                |
| <i>Force Cable Status to Plugged:</i> | UCD-400 RX device supports source device detection via AUX by default. Checking this on DPRX disables this behavior.                                                                                   |
| <i>Enable Fast LT:</i>                | Indicate support for link training without AUX transactions.                                                                                                                                           |
| <i>eDP AUX Preamble,Gbps</i>          | Use <i>eDP AUX Preamble</i> protocol.                                                                                                                                                                  |
| <i>Sink count:</i>                    | Selects the number of sinks capable of to transmitter.                                                                                                                                                 |
| <i>MST:</i>                           | Indicate support for MST mode and Sideband MSG handling.                                                                                                                                               |
| <i>FEC (8b/10b):</i>                  | Indicate support for Forward Error Correction (FEC) feature.                                                                                                                                           |
| <i>TPS4, TPS3:</i>                    | Indicate support for Link Training Pattern Sequence 4 and 3 correspondingly.                                                                                                                           |
| <i>DSC (8b/10b):</i>                  | Indicate support for Display Stream Compression (DSC) feature                                                                                                                                          |
| <i>HPD pulse on Apply:</i>            | Select to apply a Hot-Plug Detect (HPD) pulse automatically after updating the status. HPD pulse duration will be defined in the <i>Pulse HPD</i> field in <i>HPD</i> dialog in the bottom of the tab. |

## Scrambler Seed

Selection of the value to which the Linear Feedback Shift Register (LFSR) is reset during scrambler reset. Used only when 8b/10b link coding is enabled.

Scrambler seed (8b/10b)

☐ Auto

☒ FFFFh (DP)

☐ FFFFh (eDP ASSR)

☐ Custom 0x

0

## HDCP Status

Copy of the status from HDCP Tab. Please refer to chapter *HDCP Tab* later in this document for detailed description.

HDCP Status

HDCP
2.X

Active

Authenticated

Declared as HDCP capable

Keys loaded

HDCP Configuration

2.X

HDCP Capable
☒

## HDCP Configuration

Enable and disable HDCP capability of UCD Sink. Duplicates of the controls found in HDCP tab. Currently, UCD-4XX devices support only HDCP 2.3 standard.

## Stream Info

| Stream Info |        |        |         |        |        |        |         |       |                         |     |                 |               |                      |
|-------------|--------|--------|---------|--------|--------|--------|---------|-------|-------------------------|-----|-----------------|---------------|----------------------|
| Framerate   | HTotal | HStart | HActive | HSync  | VTotat | VStart | VActive | VSync | CEF                     | BPC | CRC (RGB/CrYCb) | MVID/NVID     | DSC CRC (Eng. 0 1 2) |
| 59.995      | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | YCbCr4:2:2/ITU-R BT.601 | 8   | E18E 0815 5A14  | 001777/008000 | N/A                  |
| 59.995      | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode     | 8   | B69E B33E 1AB3  | 001777/008000 | N/A                  |
| 59.995      | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode     | 8   | B69E B33E 1AB3  | 001777/008000 | N/A                  |
| 59.985      | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode     | 8   | B69E B33E 1AB3  | 001776/008000 | N/A                  |

Stream Info is achieved from the Main-Stream Attributes (MSA) of the stream.

The content of *Stream Info* table can be copied by right-clicking on the table and selecting *Copy*.

Note that the MSA information used for Video Timing Details is provided by the Upstream Source. It is not measured by the UCD Local Sink.

|                         |                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Framerate:</i>       | Vertical refresh rate                                                                                                                       |
| <i>HTotal:</i>          | Horizontal total of transmitted main video stream, measured in pixel count.                                                                 |
| <i>HStart:</i>          | Horizontal active start from leading edge of HSync, measured in pixel count.                                                                |
| <i>HActive:</i>         | Horizontal active, number of active pixels in video line                                                                                    |
| <i>HSync:</i>           | HSync width, measured in pixel count. (+)/(-) positive / negative sync.                                                                     |
| <i>VTotat:</i>          | Vertical total of transmitted main video stream, measured in line count.                                                                    |
| <i>VStart:</i>          | Vertical active start from leading edge of VSync, measured in line count.                                                                   |
| <i>VActive:</i>         | Vertical active, number of active lines in video frame                                                                                      |
| <i>VSync:</i>           | VSync width, measured in line count. (+)/(-) positive v.s. negative sync.                                                                   |
| <i>CEF:</i>             | Used color mode: Color format + subsampling / colorimetry                                                                                   |
| <i>BPC:</i>             | Color depth in bits per color (BPC)                                                                                                         |
| <i>CRC (RGB/CrYCb):</i> | 16-bit Cyclic redundancy check (CRC) value per color component calculated from active pixels. Value order in YCbCr color format: Cr, Y, Cb. |
| <i>MVID/NVID:</i>       | Mvid and Nvid video time stamp values                                                                                                       |
|                         | 16-bit Cyclic redundancy check (CRC) calculated from compressed pixel stream. Value order Engine 0, 1, 2.                                   |

## VCP Table

| VCP Table |       |         |           |            |          |
|-----------|-------|---------|-----------|------------|----------|
| Stream #  | VCPID | Req.PBN | Alloc.PBN | First slot | Slot num |
| 0         | 1     | 532     | 540       | 1          | 9        |
| 1         | 2     | 532     | 540       | 10         | 9        |
| 2         | 3     | 532     | 540       | 19         | 9        |
| 3         | 4     | 532     | 540       | 28         | 9        |

VCP table shows allocation of Virtual Channel Payload for active virtual MST channels.

The content of *VCP Table* can be copied by right-clicking on the table and selecting **Copy**.

|                    |                                                                        |
|--------------------|------------------------------------------------------------------------|
| <i>Stream #:</i>   | Port number where the virtual channel is directed.                     |
| <i>VCPID:</i>      | Stream identification number of the virtual channel                    |
| <i>Req.PBN:</i>    | Requested PBN (payload bandwidth) value for the virtual channel        |
| <i>Alloc.PBN:</i>  | PBN value allocated for the virtual channel                            |
| <i>First slot:</i> | Time slot where the first VC Payload for the virtual channel is stored |
| <i>Slot num:</i>   | Number of VC Payload slots reserved for the virtual channel.           |

## HDPC Stream Status

| HDPC Stream Status |        |        |  |
|--------------------|--------|--------|--|
| Stream #           | Status | Type   |  |
| 0                  |        | Type 0 |  |
| 1                  |        | Type 0 |  |
| 2                  |        | Type 0 |  |
| 3                  |        | Type 0 |  |

Shows the MST HDCP *Stream*, *Status* and *Type*.

## HPD

HPD

Cable HPD     Length, msec

**Cable LED:** Indicates that the hardware has detected an upstream cable.

**HPD LED:** Indicates that the HPD signal is Asserted (logical “high”).

**Deassert:** Click button to set HPD line to logical “low” (de-asserted) and hence no HPD pulse can be generated.

**Assert:** Click to re-activate the HPD line (set to logical “high”).

**Pulse HPD:** Click to apply an HPD Pulse with programmable duration. Set duration in milliseconds in adjacent edit control.

**Short Pulse:** Click to apply a short pulse. Set duration in microseconds in adjacent edit control.

## Multistreaming

When Multistreaming (MST) is enabled, the details of the received virtual channels is shown in *Stream Info* table and *VCP Table*.

**Link Status**

Lanes (count = 4): 0 1 2 3

CR/SL/EQ:

VS/PE (level): 1/0 1/0 1/0 1/0

Error count (click to clear): 0000 0000 0000 0000

ILA:

Bit rate: **8.1 Gbps** Link mode: **8b/10b**

Framing mode: **Enhanced** Scrambling: **Enabled**

MST mode: **Enabled** SSC status: **Disabled**

DSC status: **Disabled** FEC status: **Disabled**

**Link Training Result**

Lanes (count = 4): 0 1 2 3

CR/SL/EQ:

VS/PE (level): 1/0 1/0 1/0 1/0

ILA:

Bit rate: **8.1 Gbps** Link mode: **8b/10b**

**Link Capabilities**

Max Lanes: ☐ 1 ☐ 2 ☒ 4

Max Bitrate, Gbps: ☐ 1.62 ☐ 2.70 ☐ 5.40

☐ 6.75 ☒ 8.10 ☐ 0 (eDP only)

☐ eDP Bitrate, Gbps

☐ 1.62 ☐ 2.16 ☐ 2.43 ☐ 2.7 ☐ 3.24

☐ 4.32 ☐ 5.4 ☐ 6.75 ☐ 8.1

☐ Force Cable Status to Plugged

☐ Enable Fast LT

☐ eDP AUX Preamble

Sink count: 4 ☒ MST ☐ FEC ☒ TPS4 ☒ TPS3 ☐ DSC

☒ HPD pulse on Apply

**VCP Table**

| Stream # | VCPID | Req.PBN | Alloc.PBN | First slot | Slot num |
|----------|-------|---------|-----------|------------|----------|
| 0        | 1     | 528     | 540       | 1          | 9        |
| 1        | 2     | 528     | 540       | 10         | 9        |
| 2        | 3     | 528     | 540       | 19         | 9        |
| 3        | 4     | 528     | 540       | 28         | 9        |

**HDCP Stream Status**

| Stream # | Status | Type   |
|----------|--------|--------|
| 0        |        | Type 0 |
| 1        |        | Type 0 |
| 2        |        | Type 0 |
| 3        |        | Type 0 |

**Stream Info**

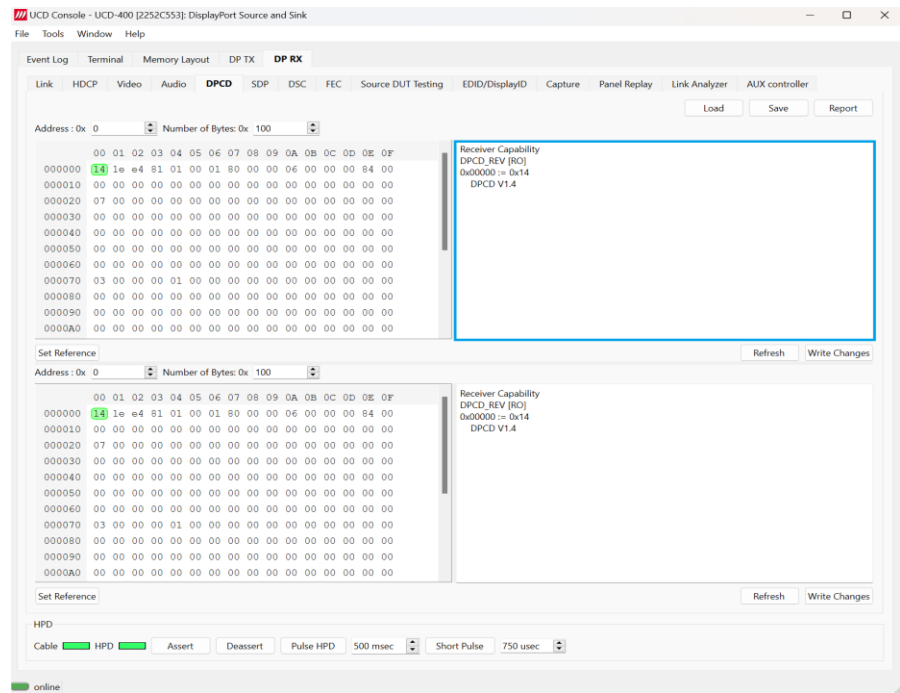
| Framerate | HTotal | HStart | HActive | HSync  | VTotol | VStart | VActive | VSync | CEF                 | BPC | CRC (RGB/CRYCb) | MVID/NVID     | DSC CRC (Eng. 0 1 2) |
|-----------|--------|--------|---------|--------|--------|--------|---------|-------|---------------------|-----|-----------------|---------------|----------------------|
| 59.995    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001776/008000 | N/A                  |
| 59.995    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001776/008000 | N/A                  |
| 59.995    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001776/008000 | N/A                  |
| 59.995    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001777/008000 | N/A                  |

**HPD**

Cable HPD     msec   usec

DPCD Tab

DPCD tab is a tool for monitoring and editing the DPCD registers of the UCD Sink.



The *DPCD Decoder* panels on the right show the interpretation of the DPCD byte selected on the monitoring windows. The selected byte is shown with a green background.

|                       |                                                                    |
|-----------------------|--------------------------------------------------------------------|
| <i>Save:</i>          | Select DPCD content to the PC (please see below).                  |
| <i>Load:</i>          | Retrieve previously saved DPCD data (please see below).            |
| <i>Report:</i>        | Save parsed content of selected DPCD register ranges as HTML file  |
| <i>Refresh:</i>       | Re-read the data from the DPCD registers to the window in question |
| <i>Write Changes:</i> | To program the data into the DPCD registers of UCD Local Sink      |
| <i>Set Reference:</i> | Store currently shown data as a reference for comparison           |

When the data is *Refreshed* from the DPCD registers the changed bytes will be highlighted with **blue** color. The fields edited by the user will be highlighted with **red** color.

Saving and Loading DPCD Content

DPCD data in the selected address areas can be saved as a file in your PC. There are three alternative formats listed below. Please select the intended format when saving:

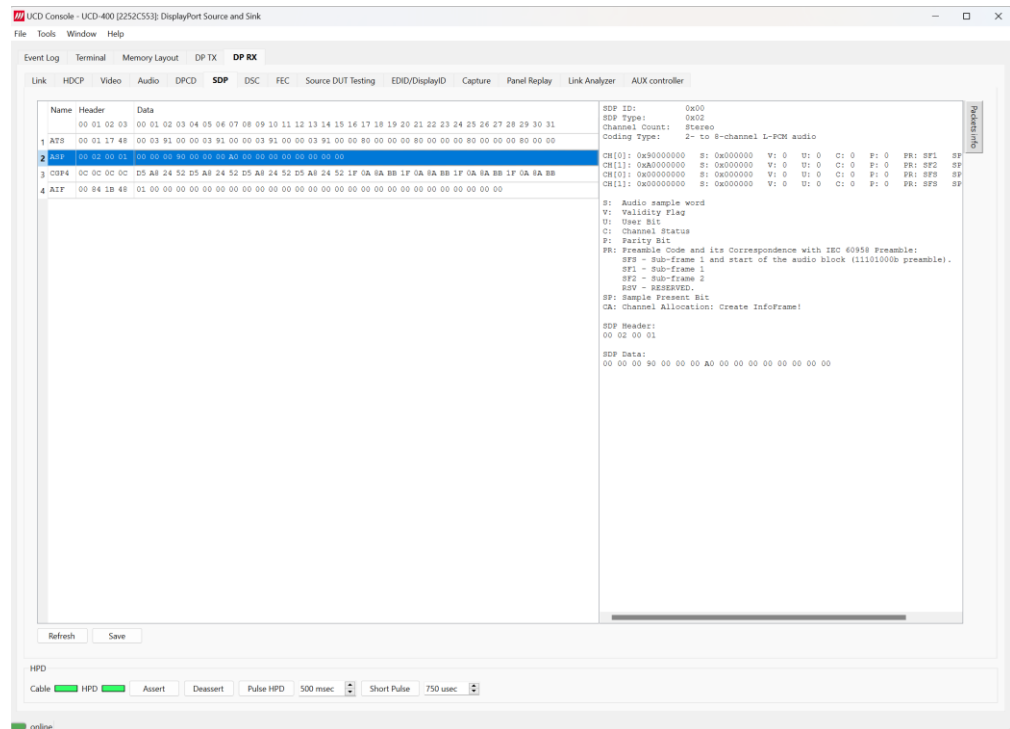
- Binary *DPCD Data File* format (\*.DPD). This is Unigraf proprietary format. You can also load the DPCD content stored in this format.
- *Comma Separated Value* format (.CSV)
- *HEX Dump* (\*.HEX) in a human readable text format.

|              |                                                                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Note:</b> | - User controls like Link Training or mode changes will modify the content of the DPCD registers<br>- During a reboot of UCD-4XX the DPCD registers will be returned to their default values |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## SDP Tab

In SDP Tab shows the *Secondary-Data Packets* sent by the Source device. Click **Refresh** to re-read the data. Show / hide the parsed data by clicking **Packets Info** in the divider bar.

The following packets are recognized:



- Audio\_TimeStamp
- Audio\_Stream
- Extension
- Audio\_CopyManagement
- ISRC (International Standard Recording Code)
- Video Stream Configuration (VSC)
- Camera Generic 0 ... 7
- Vendor-Specific InfoFrame packet
- AVI InfoFrame packet
- Source Product Descriptor InfoFrame packet
- Audio InfoFrame packet
- MPEG Source InfoFrame packet
- Dynamic Range and Mastering InfoFrame
- Picture Parameter Set (PPS)

### Saving SDP Packets

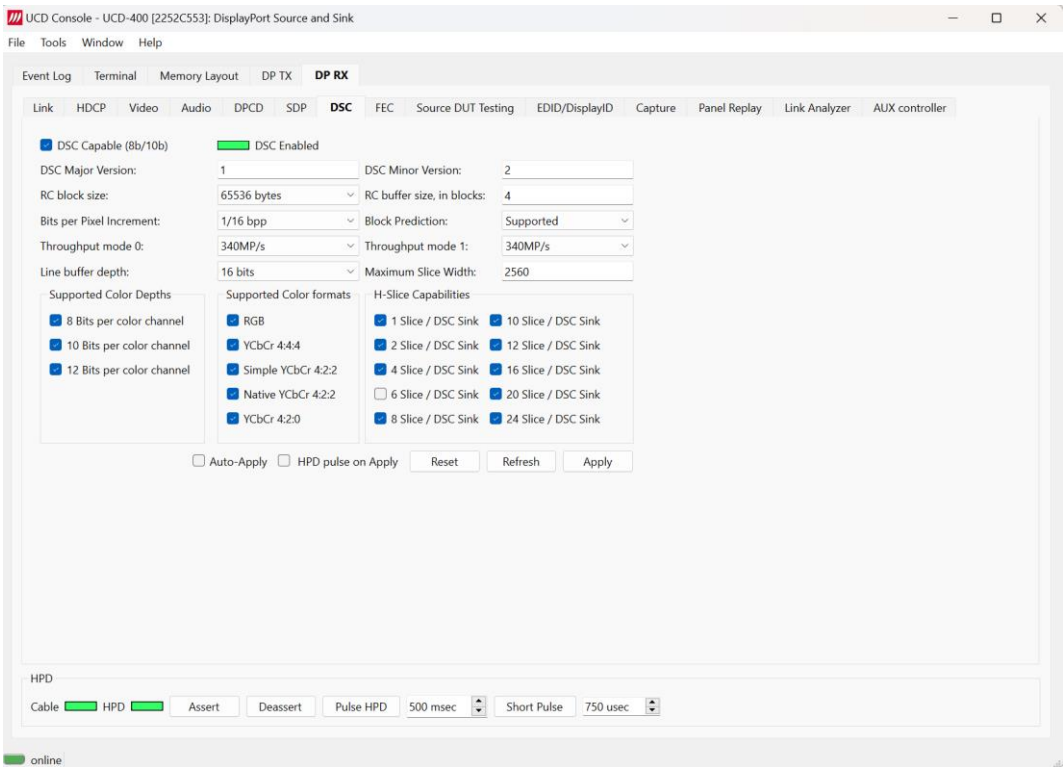
Packets can be saved in a file in binary format. Click **Save** and in the dialog select the packet types of choice. File name will be of format *ATS\_2022-07-28T15\_54\_24.bin*, where *ATS* is the packet type and *2022-07-28T15\_54\_24* the time stamp.

Saved packets can be evaluated and edited using *Packet Editor*. Please see section *Packet Editor* later in this document

DSC Tab

DSC tab contains status of the Display Stream Compression (DSC) feature, and definition of DSC support capabilities that UCD defines in its DPCD register.

Enabling DSC



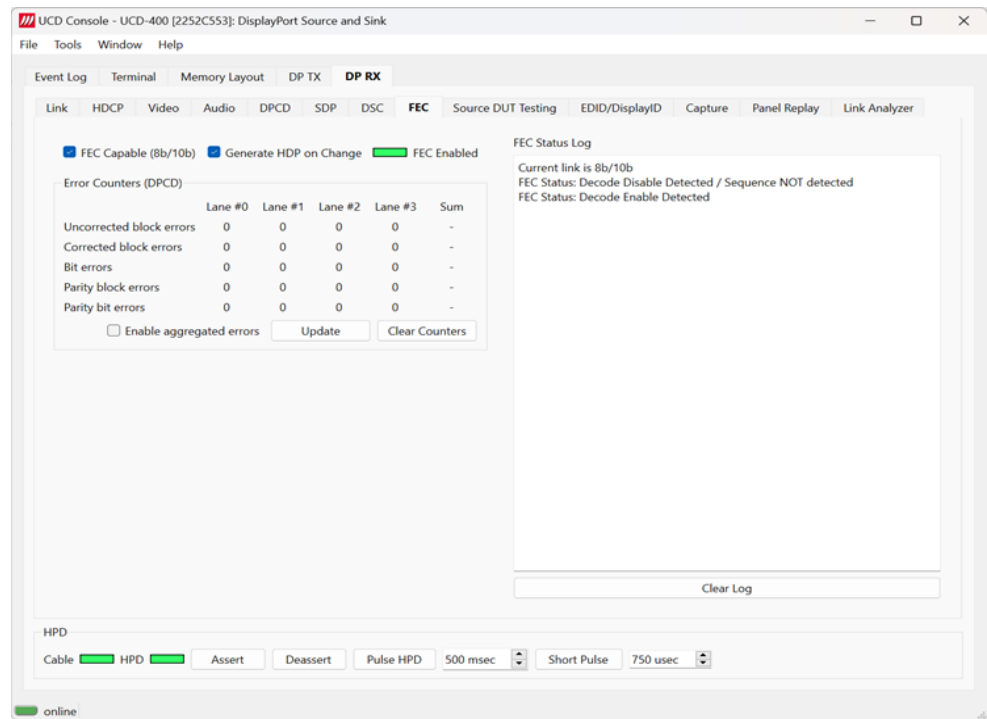
Enabling DSC feature is controlled by the connected source device. When connected, a source verifies corresponding registers in DPCD of UCD sink to find out if DSC capability is declared.

|                              |                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| <i>DSC Capable (8b/10b):</i> | UCD is declared as DSC capable. Capability can be enabled or disabled in DP RX Link tab.                                        |
| <i>DSC Enabled:</i>          | LED indicating that the connected source has enabled DSC                                                                        |
| <i>Apply:</i>                | Write changes to UCD sink DPCD registers                                                                                        |
| <i>Refresh:</i>              | Re-read the content of UCD sink DPCD and update the control status.                                                             |
| <i>Reset:</i>                | Reset the content of UCD DSC related DPCD registers (0x00060 through 0x0006F) to the default values as defined in UCD firmware. |



FEC Tab

FEC tab contains control of the FEC (Forward Error Correction) feature, Error Detection table and FEC Status Log.



Enabling FEC

Enabling FEC feature is controlled by the source device. When connected, source verifies corresponding registers in sink DPCD to find out if sink is FEC capable. This register in UCD-4XX sink can be controlled by **FEC Capable** checkbox.

Since source normally polls sink DPCD mainly after a new connection, selecting **Generate HDP on change** will force a new connection after the change of the FEC capability status.

|                        |                                   |
|------------------------|-----------------------------------|
| <i>Update:</i>         | Read FEC Error Counters from DPCD |
| <i>Clear Counters:</i> | Clear FEC Error Counters in DPCD. |

**FEC Status Log** lists FEC events.

# HDMI Reference Sink

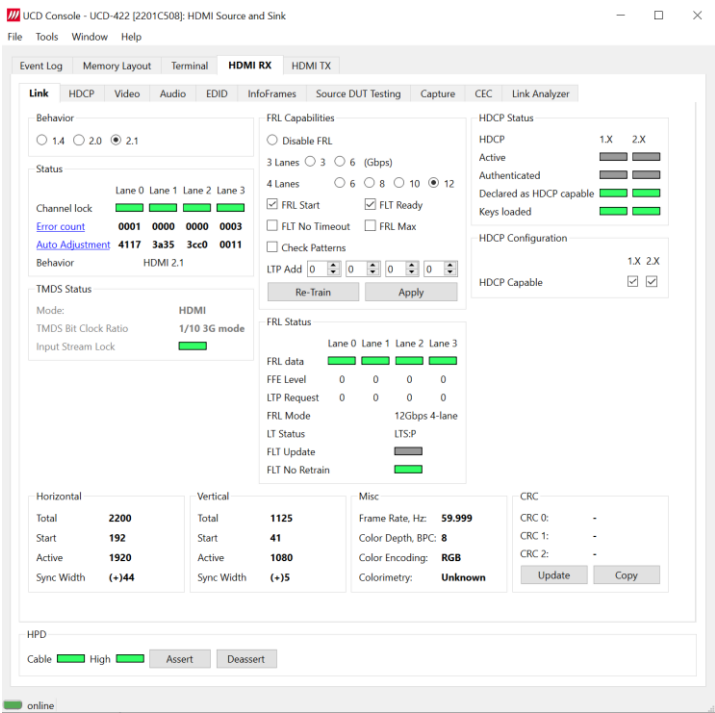
|                               |          |
|-------------------------------|----------|
| Role:                         | Product: |
| HDMI Reference Sink (HDMI RX) | UCD-422  |

When *HDMI Reference Sink* role is in use, the following interface specific tabs are available.

- Status information and control of the upstream link (Link)
- Received InfoFrame packets (InfoFrames).

## Link Tab

Link tab contains four panels: Behavior, Status, TMDS Status, FRL Capabilities, FRL Status, Audio Return Channel, HDCP Status and Configuration, Video Status and HPD.



### Behavior

Selection of HDMI operation mode: HDMI 1.4, HDMI 2.0 or HDMI 2.1.

Please perform HPD *Deassert* - *Assert* after change of mode.

### Status

|                        |                                                                           |
|------------------------|---------------------------------------------------------------------------|
| <i>Channel lock:</i>   | Status of Channel Lock in the four lanes and currently selected HDMI mode |
| <i>Error count:</i>    | Contents of the SCDC Error counter registers of the UCD-422 Sink.         |
| <i>Auto Adjustment</i> | Adjustment errors on lanes.                                               |
| <i>Behavior:</i>       | Assigned HDMI mode                                                        |

TMDS Status (Only in TMDS Mode)

TMDS Status

|                      |              |
|----------------------|--------------|
| Mode:                | HDMI         |
| TMDS Bit Clock Ratio | 1/10 3G mode |
| Input Stream Lock    | <div></div>  |

|                       |                                                          |
|-----------------------|----------------------------------------------------------|
| Mode:                 | Indication of HDMI / DVI mode                            |
| TMDS Bit Clock Ratio: | TMDS Bit Period / TMDS Clock Period ratio (1/10 or 1/40) |
| Input Stream Lock:    | Indication of TMDS character lock                        |

FRL Capabilities (Only in FRL Mode)

FRL Capabilities allows the user to change the way the Sink capabilities are announced in the SCDC capability registers of the UCD-422 Sink.

FRL Capabilities

☐ Disable FRL

3 Lanes ☐ 3 ☐ 6 (Gbps)

4 Lanes ☐ 6 ☐ 8 ☒ 10 ☐ 12

☒ FRL Start ☒ FLT Ready

☐ FLT No Timeout ☐ FRL Max

☐ Check Patterns

LTP Add 

0

0

0

0

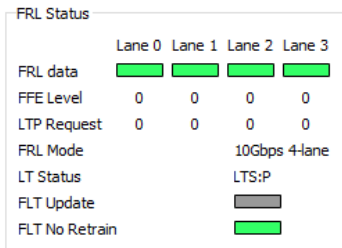
Re-Train

Apply

|                           |                                                                                                                                                                                 |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disable FRL:              | Disable FRL mode                                                                                                                                                                |
| Capability Radio Buttons: | Selection of the maximum link count and link rate capability of UCD-422 sink. Written to FLR_Rate configuration register of UCD_422 Sink. Please click <b>Re-train</b> to apply |
| FRL Start:                | Control of the HDMI sink's FRL_start bit (1/0)                                                                                                                                  |
| FLT Ready:                | Control of the HDMI sink's FLT_ready bit (1/0).                                                                                                                                 |
| FLT No Timeout:           | Status of the HDMI sink's FLT_no_timeout bit (1/0)                                                                                                                              |
| FRL Max:                  | Status of the HDMI sink's FRL_Max bit (1/0)                                                                                                                                     |
| Check Patterns:           | If Check Patterns in unselected then there's no pattern verification during link training                                                                                       |
| LTP Add:                  | Additional Requested Link Training pattern in HDMI sink's LnX_LTP_req (X=0-3) register.                                                                                         |
| Re-Train:                 | Request a new link training                                                                                                                                                     |
| Apply:                    | Store new settings                                                                                                                                                              |

FRL Status (Only in FRL Mode)

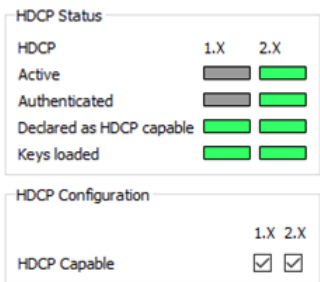
FRL Status displays the status of the link training and the link parameters negotiated between UCD-422 Sink and the Upstream Source. The status is updated automatically.



|                          |                                                                                          |
|--------------------------|------------------------------------------------------------------------------------------|
| <i>FRL Data 0/1/2/3:</i> | Indication of data flow in FRL links 0 to 3                                              |
| <i>FFE Level:</i>        | Status of Feed Forward Equalizer Level that HDMI transmitter is using (only in FRL mode) |
| <i>LTP Request:</i>      | Currently requested FRL link training pattern.                                           |
| <i>FRL Mode:</i>         | Lane count and link rate configuration used in FRL mode                                  |
| <i>LT Status:</i>        | Status of the FRL Link Training State                                                    |
| <i>FLT Update:</i>       | Status of the UCD-422 sink's FLT_update bit (1/0) (only in FRL mode)                     |
| <i>FLT No Retrain:</i>   | Status of UCD-422 Sink's FLT_no_retrain bit (1/0) (only in FRL mode)                     |

HDCP Status

Copy of the status from HDCP Tab. Please refer to chapter *HDCP Tab* later in this document for detailed description.



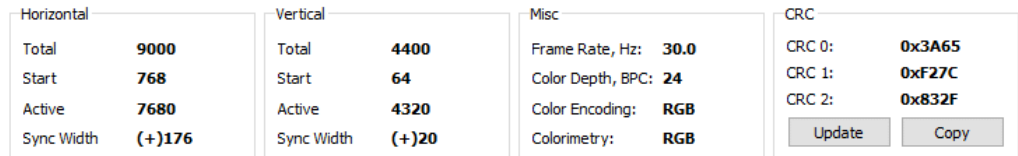
HDCP Configuration

Enable and disable HDCP 1.4 or HDCP 2.3 capability of UCD-422 Sink. Duplicates of the controls found in HDCP tab.

**Note:** HDCP is not supported in 3.5 release

Video Status

Video Timing and Color Details as retrieved from stream metadata. Frame rate is measured by UCD-422 Local Sink.



CRC

The 16-bit **CRC** (checksum, cyclic redundancy check) values of the three color components calculated by the Sink hardware. To re-calculate, click **Update**. Click **Copy** to store the information to the clipboard.

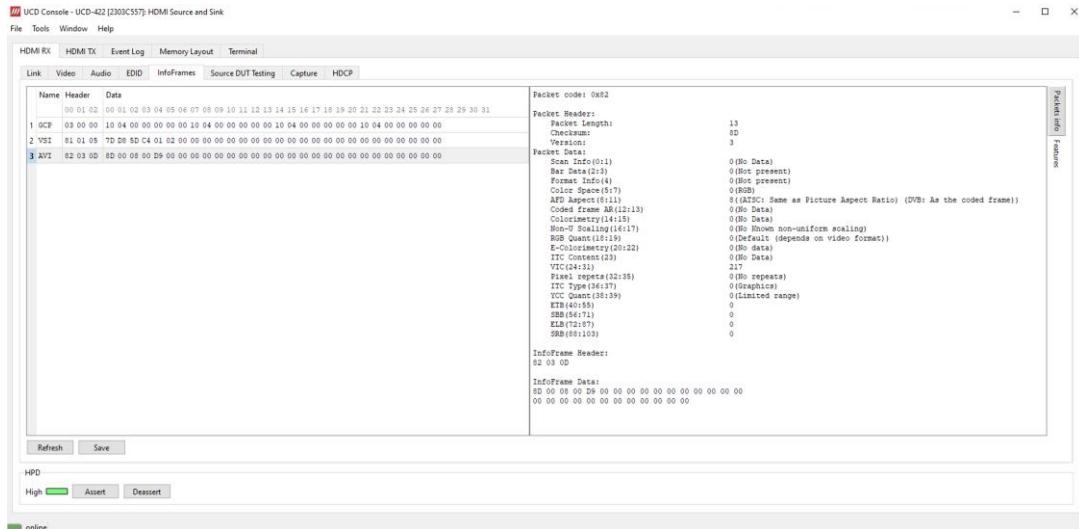
HPD

|           |                                                                                                      |
|-----------|------------------------------------------------------------------------------------------------------|
| High:     | LED indicates that the HPD signal is Asserted (logical “high”).                                      |
| Deassert: | Click button to set HPD line to logical “low” (de-asserted) and hence no HPD pulse can be generated. |
| Assert:   | Click to re-activate the HPD line (set to logical “high”).                                           |



## InfoFrame Tab

InfoFrame Tab displays received InfoFrames. Click **Refresh** to update the list. Show / hide the parsed data by selecting **Packet Info**.



### Received InfoFrames

InfoFrames tab displays in hexadecimal format the following received InfoFrames:

- ACR (Audio Clock Regeneration)
- ASP (Audio Sample Packet)
- GCP (General Control Packet)
- ACP (Audio Content Protection Packet)
- ISRC1 (International Standard Recording Code)
- ISRC2 (International Standard Recording Code)
- OBA (One Bit Audio sample packet)
- DTS (DTS Audio packet)
- HBR (High Bitrate Audio stream packet)
- GMP (Gamut Metadata packet)
- EMP (Extended Metadata Packet)
- 3D ASP (3D Audio Sample packet)
- 3D OBA (3D One Bit Audio sample packet)
- AMP (Audio Metadata Packet)
- MST\_ASP (Multi-stream audio sample packet)
- MST\_OBA (One Bit Multi-stream audio sample packet)
- VSI (Vendor Specific InfoFrame)
- AVI (Auxiliary Video Information)
- SPD (Source Product Descriptor)
- AIF (Audio InfoFrame)
- MPEG (MPEG Source InfoFrame)
- DRM (Dynamic Range and Mastering InfoFrame)

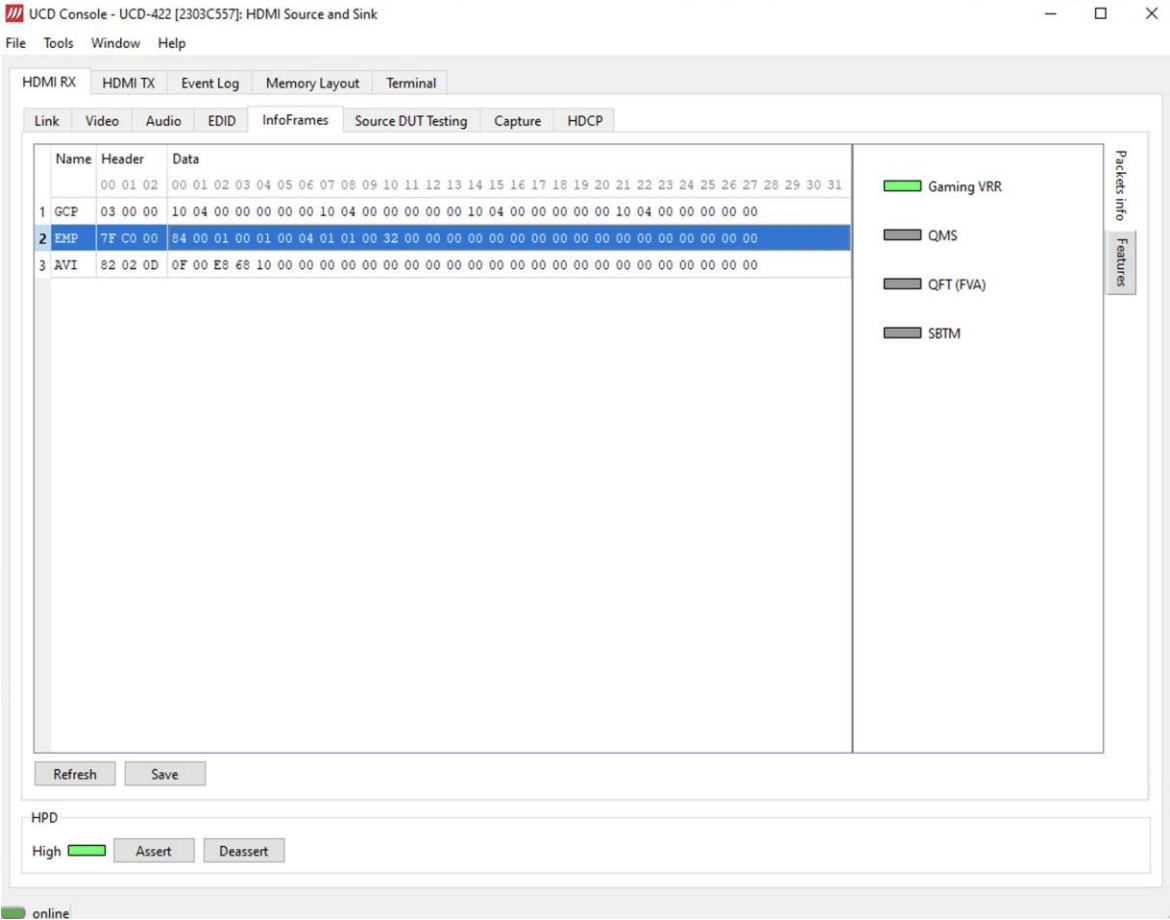
### Saving InfoFrames

Infoframe packets can be saved in a file in binary format. Click **Save** and in the dialog select the packet types of choice. File name will be of format *EMP\_2022-07-28T15\_54\_24.bin*, where *EMP* is the packet type and *2022-07-28T15\_54\_24* the time stamp.

Saved packets can be evaluated and edited using *Packet Editor*. Please see section *Packet Editor* later in this document

Infoframe Features

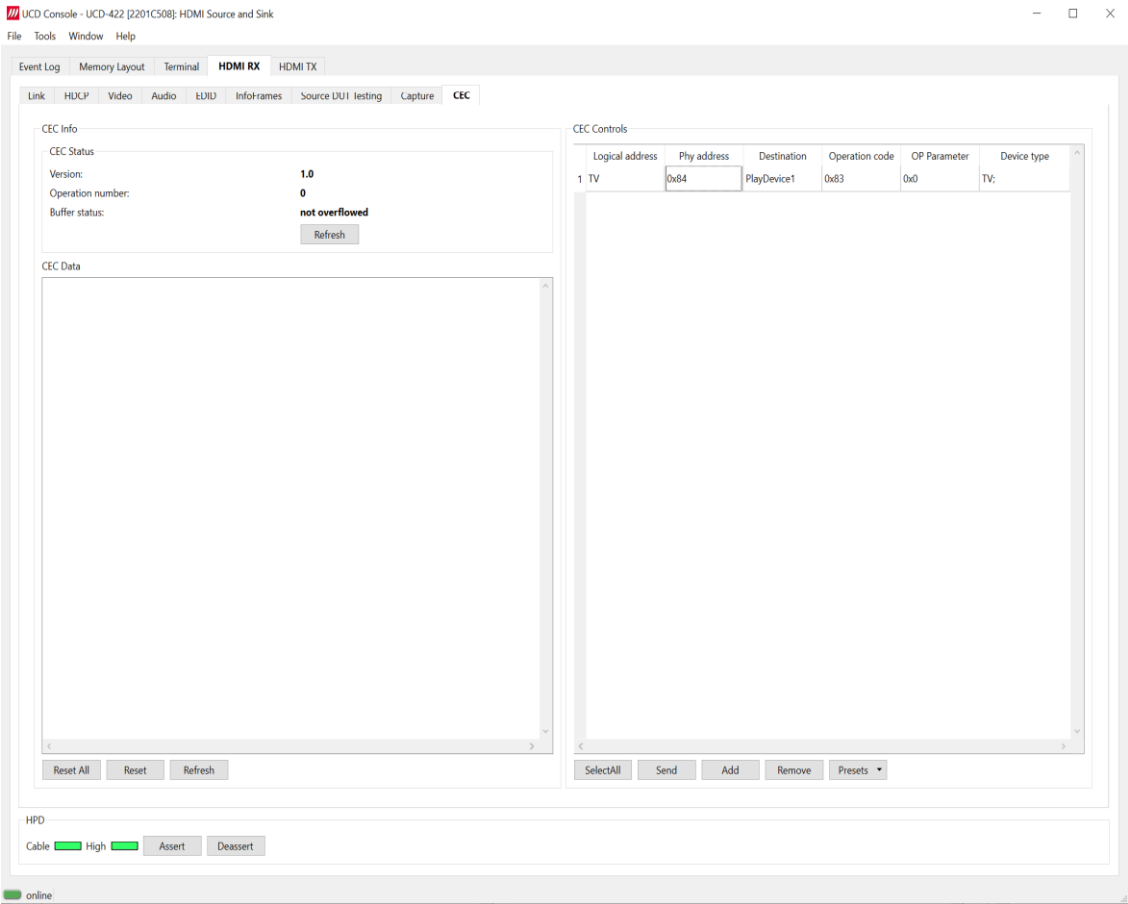
Observe features found in infoframes by selecting **Features**.



CEC Tab

The *CEC Tab* is used for sending and receiving CEC (Consumer Electronics Control) protocol messages and data.

The *CEC Tab* is grouped into two panels: *CEC Info* and *CEC Controls*.





Use *CEC Controls* to send data a HDMI follower via CEC protocol. Select *Add* button to add an *Operation code* with parameters to be sent to various devices.

CEC Controls

|   | Logical address | Phy address | Destination | Operation code | OP Parameter | Device type       |
|---|-----------------|-------------|-------------|----------------|--------------|-------------------|
| 1 | TV              | 0x84        | PlayDevice1 | 0x83           | 0x0          | TV;               |
| 2 | TV              | 0x84        | PlayDevice1 | 0x83           | 0x0          | Audio System; TV; |

Form

Logical Address: TV

Destination: PlayDevice1

Physical Address: 0x84

Operation Code: 0x83

OP code parameter: 0x0

Device Type:

☐ TV
 ☒ Rec Dev
 ☐ Tuner
 ☐ PB Device
 ☒ Audio System
 ☐ CEC Switch

Save Cancel

SelectAll Send Add Remove Presets

- Save...
- Load
- Remove
- Import...
- Export...

|                        |                                  |
|------------------------|----------------------------------|
| <b>Logical address</b> | Logical address of destination   |
| <b>Phy address</b>     | Physical address of destination  |
| <b>Destination</b>     | Destination device               |
| <b>Operation code</b>  | Operation code to send           |
| <b>OP Parameter</b>    | Operation code parameter to send |
| <b>Device type</b>     | Sender device type               |

Select the rows of items in the table (or press the *Select All* button) and press *Send* button to transmit via HDMI CEC protocol.

Select the rows of items in the table (or press the *Select All* button) and press *Remove* to delete items.

Select the *Presets* button to *Save...*, *Load*, *Remove*, *Import...*, or *Export* item sets as shown above.

CEC data and status received can be seen in the *CEC info* panel.

The screenshot shows the UNIGRAF software interface with the 'CEC' tab selected. The 'CEC Info' section displays the following status:

| CEC Status        |                |
|-------------------|----------------|
| Version:          | 1.0            |
| Operation number: | 1              |
| Buffer status:    | not overflowed |

Below the status is a 'Refresh' button. The 'CEC Data' section shows a list of data entries, currently containing '0x04, 0x83, 0x00'. At the bottom of the panel are three buttons: 'Reset All', 'Reset', and 'Refresh'.

*CEC Status* shows the CEC *Version*, *Operation number* and *Buffer status*. Press *Refresh* button to refresh.

*CEC Data* shows the CEC data received. Select *Reset All* or *Reset* to remove all or selected rows. Select *Refresh* to check for new data.

## USB-C Monitoring

|                                                                                                 |          |
|-------------------------------------------------------------------------------------------------|----------|
| Role:                                                                                           | Product: |
| USB-C DP Alt Mode Reference Source (USB-C TX) or<br>USB-C DP Alt Mode Reference Sink (USB-C RX) | UCD-424  |

When *USB-C DP Alt Mode Reference Sink* or *Source* role is in use, the following interface specific tabs are available.

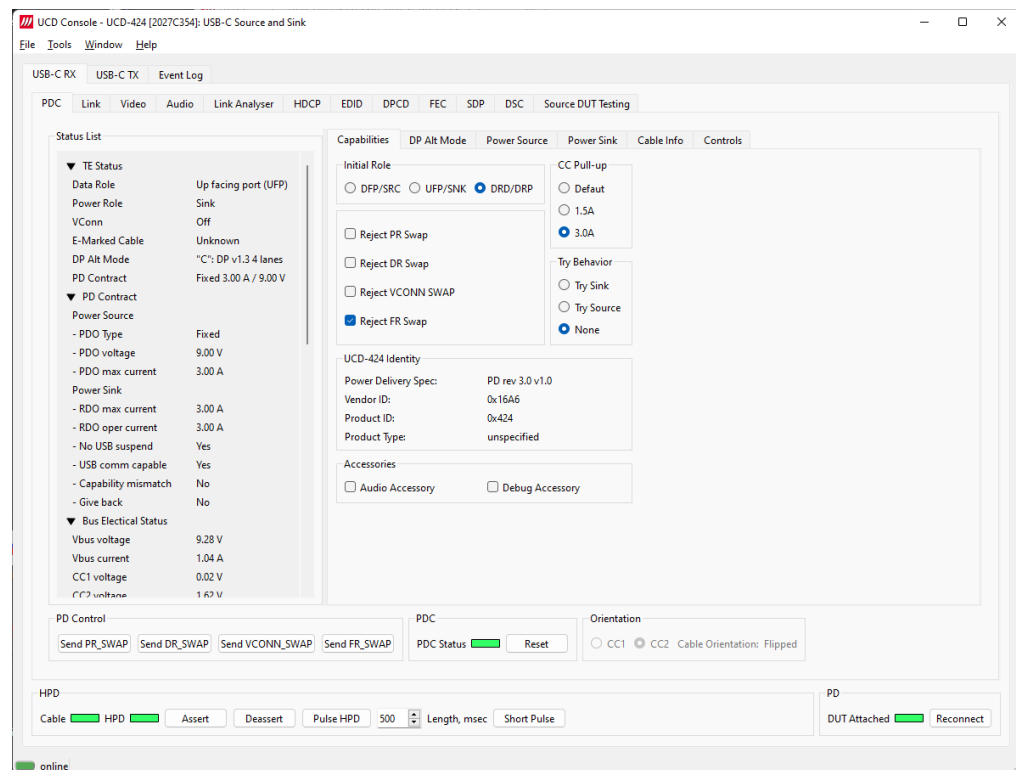
- USB-C Power Delivery (PDC)

In *USB-C Power Delivery* tab (PDC) operator can evaluate the status of the USB-C connection and USB Power Delivery Contract, the various roles adopted, and the configuration of the DP Alternate Mode. The user can set the initial roles for the UCD-424 test equipment and the optional capabilities for UCD-424 in the USB-C PD Contract. Controls allow user also to swap Power and Data roles.

USB-C Monitoring dialog is divided into four panels. The upper left panel is a Status List indicating statuses of both port partners, UCD-424 and the connected DUT.

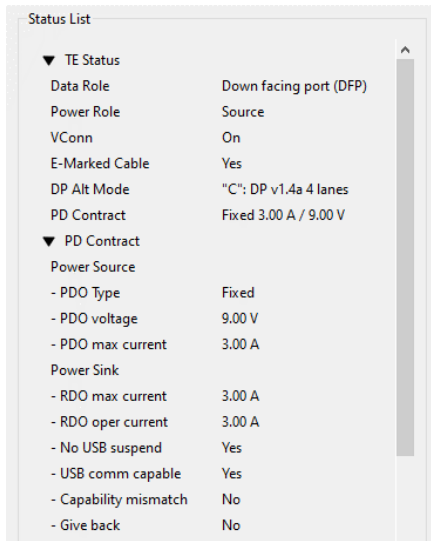
The tabs on the right panel configuration dialogs of various USB-C interface functions.

The bottom panel indicates status of the cable connection and PD Control controls for role swaps



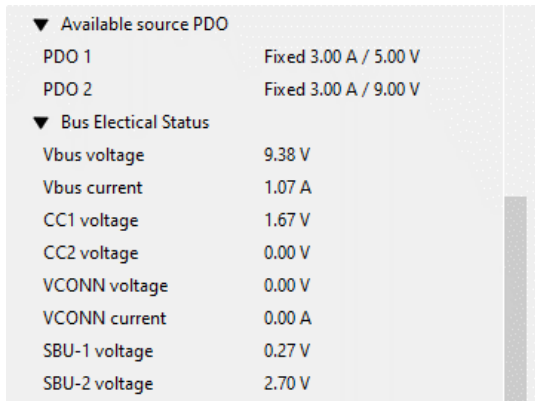
Status List

In Status List the information is presented in foldable sections. Each section contains information related to one feature of USB-C interface or PD protocol. The user can fold out the sections needed for the task in question.



*TE Status:* UCD-424 internal status (Data role, Power Role, VConn, E-marked cable, DP Alt Mode, PD Contract status)

*PD Contract:* Details of the PD Contract (Power Source: PDO Type, PDO Voltage, PDO max current; Power Sink: RDO max current, RDO operating current, USB statuses)



*Available source PDO:* (PDO 1, PDO 2)

*BUS Electrical Status:* (Vbus voltage, Vbus current, CC1 voltage, CC2 voltage, VCONN voltage, VCONN current, SBU-1 voltage, SBU-2 voltage)

|                          |                        |
|--------------------------|------------------------|
| ▼ DUT Discovery          |                        |
| Data Capable as Host     | yes                    |
| Data Capable as Device   | yes                    |
| Product Type             | N/A                    |
| USB Vendor ID            | 0x16A6                 |
| USB Product ID           | 0x424                  |
| BCD Device               | 0x710                  |
| SVID0                    | 0xFF01                 |
| SVID1                    | 0x00                   |
| ▼ DP Alt Mode support    |                        |
| Supports DP v1.3         | yes                    |
| Supports USB gen2        | no                     |
| Pin Assignment supported |                        |
| - DFP_D                  | yes                    |
| - UFP_D                  | no                     |
| - DPAM Version           | Version 2.0 or earlier |

**DUT Discovery:** DUT information (data capable as host, data capable as device, product type, USB vendor ID, USB product ID, BCD device, SVID0, SVID1)

**DP Alt Mode support:** Supported DisplayPort Alt Mode features (Supports DP v 1.3, Supports USB gen2, Pin Assignments supported as DFP\_D, UFP\_D, and DPAM Version)

|                          |                                                                        |
|--------------------------|------------------------------------------------------------------------|
| ▼ TE DP Alt Mode Status  |                                                                        |
| Status                   | Active                                                                 |
| Multi-function preferred | no                                                                     |
| HPD state                | asserted                                                               |
| Select DP v1.3           | yes                                                                    |
| Select USB gen2          | no                                                                     |
| Pin Assignment           | "C": DP v1.4a 4 lanes                                                  |
| Cable UHBR 13.5 Support  | Not Supported                                                          |
| Cable Active Component   | Passive -or- cable type is unknown                                     |
| DPAM Version             | Version 2.0 or earlier                                                 |
| ▼ DUT DP Alt Mode Status |                                                                        |
| Status                   | DFP_D is connected.                                                    |
| Multi-function preferred | not relevant                                                           |
| HPD state                | asserted                                                               |
| Power low                | Normal operation.                                                      |
| No DPAM Suspend          | UFP_U/ DP Sink device has no preference for entry into low power state |

**TE DP Alt Mode Status:** UCD-424 internal DP Alternate mode status (Status, Multi-function preferred, HPD state, Select DP v1.3, Select USB gen2, Pin Assignment, Cable UHBR 13.5 Support, Cable Active Component, DPAM Version)

**DUT Alt Mode Status:** Status of the connected USB-C port partner gained from status update messages (Status, Multi-function preferred, HPD State, Power low, No DPAM Suspend)

Capabilities

Capabilities

DP Alt Mode

Power Source

Power Sink

Cable Info

Controls

Initial Role

☐ DFP/SRC

☐ UFP/SNK

☒ DRD/DRP

☐ Reject PR Swap

☐ Reject DR Swap

☐ Reject VCONN SWAP

☒ Reject FR Swap

UCD-424 Identity

Power Delivery Spec:

PD rev 3.0 v1.0

Vendor ID:

0x16A6

Product ID:

0x424

Product Type:

unspecified

Accessories

☐ Audio Accessory

☐ Debug Accessory

CC Pull-up

☐ Default

☐ 1.5A

☒ 3.0A

Try Behavior

☐ Try Sink

☐ Try Source

☒ None

|                          |                                                                                                               |
|--------------------------|---------------------------------------------------------------------------------------------------------------|
| <i>Initial Role:</i>     | Defines the role which UCD-424 presents itself in the start PD communication (both power and data role).      |
| <i>Reject Swaps:</i>     | Allow or reject mode swap requests from the connected port partner.                                           |
| <i>CC Pull-up:</i>       | Control of Rp that Source uses to advertise the initial current source capability using USB-C Current method. |
| <i>Try Behavior:</i>     | Control the USB-C PD role that UCD-424 initially takes in the connection handshake.                           |
| <i>UCD-424 Identity:</i> | Status information provided by UCD-424.                                                                       |

Accessories

☐ Audio Accessory

☐ Debug Accessory

Accessories

|                         |                                              |
|-------------------------|----------------------------------------------|
| <i>Audio Accessory:</i> | Enable simulation of Audio Accessory support |
| <i>Debug Accessory:</i> | Enable simulation of Debug Accessory support |

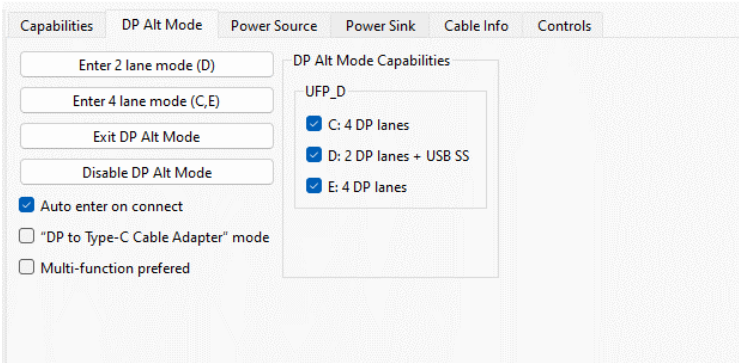
Enabling *Audio Accessory* and *Debug Accessory* extends USB Type-C Connection State Machine with \*.Accessory states. (Please refer to USB Type-C specification for details).

Note:

Please note that UCD-424 does not support any physical connections for the Accessory functions. The selections enable only behavioral simulation.

# DP Alt Mode

Controls and capability settings for DisplayPort Alternate Mode.



|                                           |                                                                                                                              |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <i>Enter 2 lane mode (D):</i>             | Restart mode discovery and advertise support for mode D (2 DP lanes + USB SS).                                               |
| <i>Enter 2 lane mode (C,E):</i>           | Restart mode discovery and advertise support for modes C and D (4 DP lanes).                                                 |
| <i>Exit DP Alt Mode:</i>                  | Exit DP Alternate mode.                                                                                                      |
| <i>Disable DP Alt Mode:</i>               | Exit DP Alternate mode and advertise no DP Alternate mode support.                                                           |
| <i>Auto enter on connect:</i>             | Start mode discovery after connection and enter DP Alternate mode if suitable configuration is found.                        |
| <i>"DP to Type-C Cable Adapter" mode:</i> | Perform an automated procedure for connecting a DP to USB-C bidirectional cable. Please find an abstract of the issue below. |
| <i>Multi-function preferred:</i>          | When entering DP Alternate Mode, select mode D.                                                                              |

## DP to Type-C Cable Adapter

USB-C to DP Bi-directional Cable contains an active converter microchip that needs to be powered from USB-C interface. Therefore UCD-424 must be initially configured in power source role for USB Default Operation where it applies vSafe5V on Vbus to power up the microchip in the cable.

USB-C to DP Bi-directional Cable uses pin assignment E when acting as a source. In order to provide the "cable" a possibility to request the configuration it needs, UCD-424 has to initiate a Data Role Swap to be in UFP, Device, data mode.

## DP Alt Mode Capabilities

Supported Pin Assignments declared in DisplayPort Capabilities discover message. Separate for UFP\_D (DisplayPort sink) and DFP\_D (DisplayPort source)

## Power Source

Definition of Power Data Objects (PDO) for UCD-424 when acting as *Power Source Port*.

Capabilities

DP Alt Mode

Power Source

Power Sink

Cable Info

Controls

SPR PDOs

| Source PDOs | PDO Type  | Max Current, mA | Voltage, mV | Peak Current, % | Max Power, mW | Max Voltage, mV | Min Voltage, mV |
|-------------|-----------|-----------------|-------------|-----------------|---------------|-----------------|-----------------|
| PDO1        | Mandatory | 3000            | 5000        | 125             |               |                 |                 |
| PDO2        | Fixed     | 3000            | 9000        | 110             | 0             | 0               | 0               |

Refresh

Apply

Send PDO

Load PDO

Save PDO

*PDO Type*: Definition of power source type (Mandatory, Disabled, Fixed, Variable or Battery)

**Note:** The requirement is that Sources shall supply at least one fixed supply capable of supplying vSafe5V

**Note:** Please note that UCD-424 is not able to simulate as Source the electrical behavior of Variable and Battery source types.

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| <i>Refresh</i>  | Re-read status from UCD-424                             |
| <i>Apply</i>    | Program new values to UCD-424                           |
| <i>Send PDO</i> | Send a Source Capabilities message                      |
| <i>Load PDO</i> | Load a stored Power Source PDO configuration from file. |
| <i>Save PDO</i> | Store current Power Source PDO configuration to a file  |



Power Sink

Controls and Definition of Power Data Objects (PDO) for UCD-424 when acting as *Power Sink Port*.

Capabilities

DP Alt Mode

Power Source

Power Sink

Cable Info

Controls

Controls

SPR PDOs

Flags

☐ Give back flag

☐ No USB suspend

PDO type priority

FR\_SWAP required current

Max Operation Current

Prefer higher current

Disable

500

|                              |                                                                                                                                                                           |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Give back flag:</i>       | UCD-424 sets <i>GiveBack</i> flag in its <i>Request Data Object</i>                                                                                                       |
| <i>No USB suspend:</i>       | UCD-424 sets No USB Suspend flag in its Request Data Object                                                                                                               |
| <i>PDO type priority:</i>    | Setting of the policy used for automatic selection from available PDOs advertised by Source Device. (Prefer higher current / Prefer higher voltage / Prefer higher power) |
| <i>Max Operation Current</i> | Setting the highest current UCD-424 will ever require when operating as a Power Sink.                                                                                     |

Capabilities

DP Alt Mode

Power Source

Power Sink

Cable Info

Controls

Controls

SPR PDOs

Sink PDOs

PDO Type

Oper Current, mA

Voltage, mV

Max Power, mW

Max Voltage, mV

Min Voltage, mV

PDO1

Mandatory

900

5000

PDO2

Variable

900

0

0

9000

5000

Refresh

Apply

Load PDO

Save PDO

|                  |                                                                        |
|------------------|------------------------------------------------------------------------|
| <i>PDO Type:</i> | Definition of power source type (Disabled, Fixed, Variable or Battery) |
|------------------|------------------------------------------------------------------------|

**Note:** The requirement is that Sources shall supply at least one fixed supply capable of supplying vSafe5V

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| <i>Refresh</i>  | Re-read status from UCD-424                             |
| <i>Apply</i>    | Program new values to UCD-424                           |
| <i>Load PDO</i> | Load a stored Power Source PDO configuration from file. |
| <i>Save PDO</i> | Store current Power Source PDO configuration to a file  |

## Cable Info

Cable Info tab displays the information received from the cable as a response to *Discover Identity* command sent to SOP'.

| Capabilities                                                         | DP Alt Mode           | Power Source | Power Sink | Cable Info                        | Controls |
|----------------------------------------------------------------------|-----------------------|--------------|------------|-----------------------------------|----------|
| A6 16 00 1C 00 00 00 00 00 00 54 85 52 20 08 00 00 00 00 00 00 00 00 |                       |              |            |                                   |          |
| <div>Refresh</div>                                                   |                       |              |            |                                   |          |
| USB Vendor ID                                                        | 16A6                  |              |            | XID Assigned by USB-IF 0x00000000 |          |
| Modal operation supported                                            | yes                   |              |            |                                   |          |
| Product Type                                                         | Passive Cable         |              |            |                                   |          |
| USB Communications Capable as USB Device                             | no                    |              |            | bcdDevice 0x0000                  |          |
| USB Communications Capable as USB Host                               | no                    |              |            | USB product ID 0x8554             |          |
| USB SuperSpeed Signalling Support                                    | USB 3.1 Gen1 and Gen2 |              |            |                                   |          |
| VBUS through cable                                                   | Yes                   |              |            |                                   |          |
| VBUS Current Handling Capability                                     | 5A                    |              |            |                                   |          |
| SSRX2 Directionality Support                                         | Fixed                 |              |            |                                   |          |
| SSRX1 Directionality Support                                         | Fixed                 |              |            |                                   |          |
| SSTX2 Directionality Support                                         | Fixed                 |              |            |                                   |          |
| SSTX1 Directionality Support                                         | Fixed                 |              |            |                                   |          |
| Cable Termination Type                                               | VCONN not required    |              |            |                                   |          |
| Cable Latency                                                        | <10ns (~1m)           |              |            |                                   |          |
| USB Type-C plug to USB Type-A/B/C/Captive                            | USB Type-C            |              |            |                                   |          |
| Firmware Version                                                     | 0                     |              |            |                                   |          |
| Hardware Version                                                     | 0                     |              |            |                                   |          |

Note:

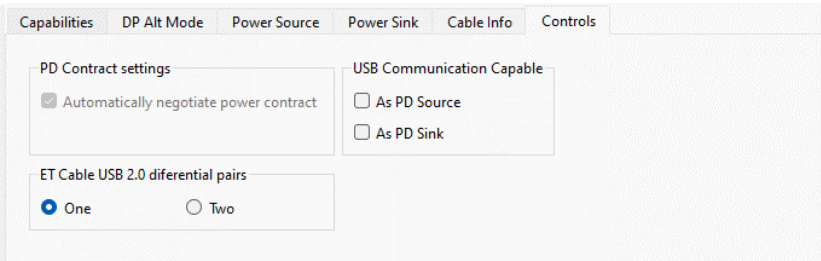
Please note that cable info can only be read when in DFP Data Role.

## Controls

Control tab includes miscellaneous controls related to UCD-424 behavior as a USB-C PD Port Partner.

### PD Contract Settings

*Automatically negotiate power contract:* When selected UCD-424 will start power contract negotiation if suitable configuration is found.



### ET cable USB2.0 differential pairs

There are two versions for Unigraf Electrical Test Cable. The difference is the number of USB D+/- pairs included in the cable. The reasoning is that if an unused pair is not terminated, it is a receiver of EMI and disturbs the electrical circuitry.

Cable with P/N 546117 has two USB2.0 pairs (A6, A7 and B6, B7), while P/N 546114 has only one pair (A6, A7). Please update the control accordingly.

If DUT has shorted USB2.0 pins A6 to B6 and A7 to B7 at the receptacle then choose cable One: In order to minimize in-cable signal coupling only one USB D+/- pair is included in the cable

If DUT has shorted USB2.0 pins routed to mux or similar, then choose cable Two: In order to enable electrical cable flip in cases where USB D+ lines and USB D- lines correspondingly have not been shorted together on Device side, both USB D+/- pairs are included in the cable. This cable marked with a label "2xUSB 2.0 PAIRS".

### USB Communication Capable

You can control the *USB Communication Capable* bit in its Request Data Object.

---

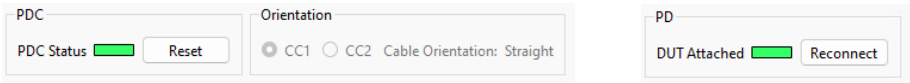
**Note:** Please click *Apply* to enable changes.

---

# Bottom Panel

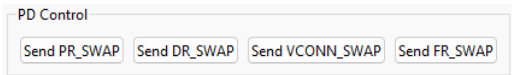
Bottom panel includes statuses and controls for the USB-C connection

## Status



|                      |                                                                                      |
|----------------------|--------------------------------------------------------------------------------------|
| <i>PDC Status</i>    | LED for USB-C Power Delivery Control                                                 |
| <i>Reset:</i>        | Reset the PD Controller in UCD-424 to overcome abnormal situations.                  |
| <i>Orientation:</i>  | Straight (CC1 terminated) or Flipped (CC2 terminated).                               |
| <i>DUT Attached:</i> | Indication that <i>Attach</i> is detected by the Source port in one of its CC lines. |
| <i>Reconnect:</i>    | Restart USB-C Source-to-Sink attach procedure.                                       |

## PD Control



|                         |                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Send PR_SWAP:</i>    | Send <i>PR_Swap</i> message to request an exchange of power roles.                                                                                      |
| <i>Send DR_SWAP:</i>    | Send <i>DR_Swap</i> message to request an exchange DFP and UFP operation between Port Partners while maintaining the direction of power flow over Vbus. |
| <i>Send VCONN_SWAP:</i> | Send <i>VCONN_Swap</i> message to request an exchange of Vconn Source.                                                                                  |
| <i>Send FR_SWAP:</i>    | Send <i>FR_Swap</i> message to request a Fast Role Swap.                                                                                                |

## 5. GENERATOR OPERATION

When used as a *Generator*, the UCD device acts as DisplayPort, HDMI or USB-C DisplayPort Alt Mode Source or Transmitter device. Generator functionality related controls and dialogs can be used by selecting *DP TX* or *HDMI TX* tabs.

Please note that in most UCD-4XX Series units *Analyzer* functionality is available simultaneously with Generator functionality. Please find description of Analyzer functionality earlier in this manual.

### Functionality Tabs

UCD Console features are presented in tabs. Standard tabs are similar in all functional roles, Interface Specific tabs present features and controls that are only available for a particular interface.

Some of the tabs are enabled by default, some only when an applicable license is included.

#### Standard Tabs

Analyzer role features six standard tabs:

- Video pattern generator (Pattern Generator).
- Content Playback (Playback)
- EDID editor (EDID)
- HDCP status monitor and control (HDCP)
- Sink DUT Testing
- Adaptive-Sync

#### Interface Specific Tabs

Depending on the connected UCD device, additional interface specific tabs will be available

[UCD-400, UCD-411, UCD-451 and UCD-424:  
DP and USB-C DP Alt Mode Reference Source](#)

- Status information and control of the downstream link (Link).
- DPCD monitor (DPCD)
- Forward Error Correction (FEC)

[UCD-422, UCD-452 and UCD-412: HDMI Reference Source](#)

- Status information and control of the downstream link (Link).
- SCDC monitor (SCDC)

[UCD-424: USB-C Reference Source](#)

- USB-C Monitoring (PDC)

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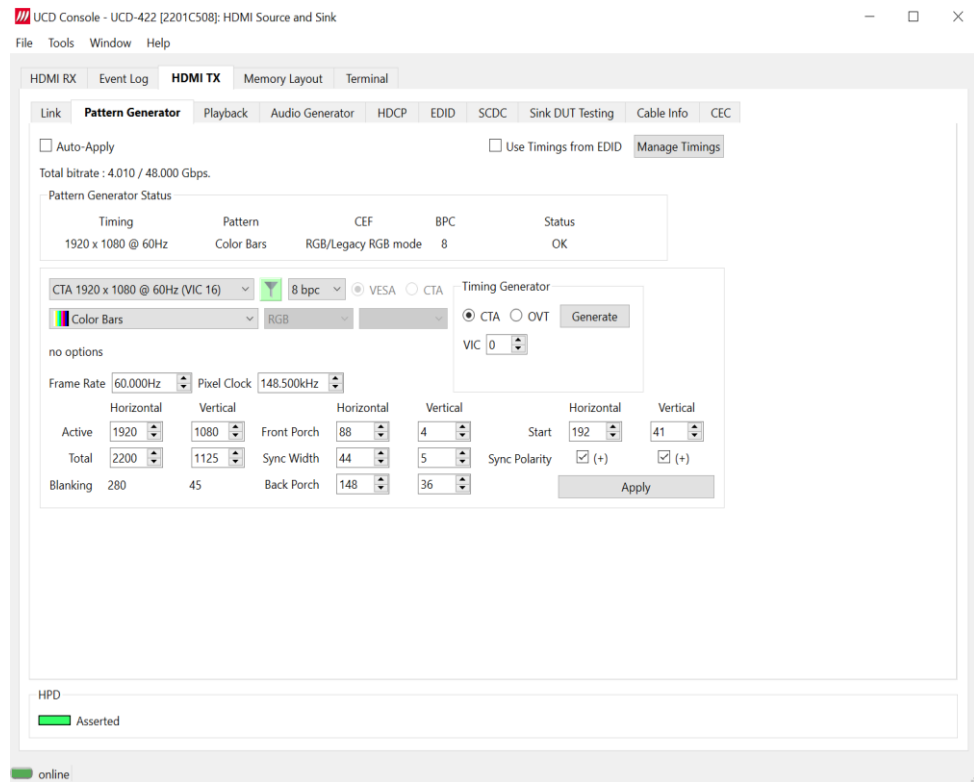
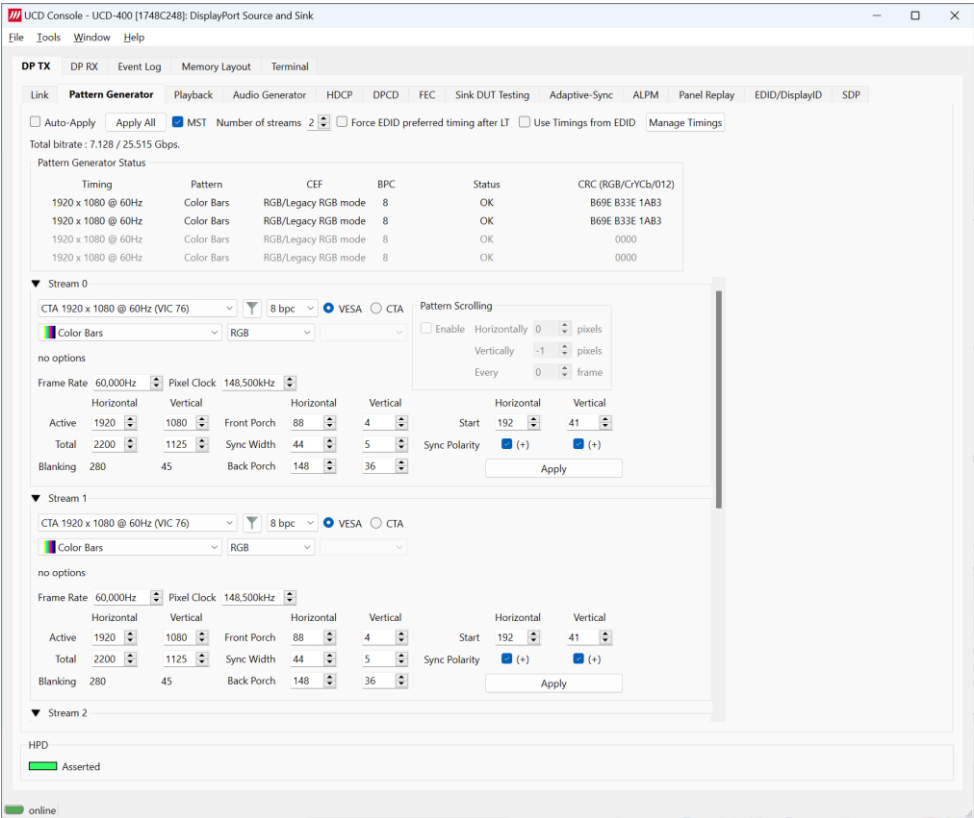
**Note:**

Some of the tabs are enabled by default, some only when an applicable license is included. Please refer to Appendix B Licensing of this document for description of features and licensing

---

# Standard Tabs

## Pattern Generator Tab



---

**Note:** The video modes that can be used in MST streams are limited by the overall capability of the DisplayPort link and the capability of the connected DisplayPort Sink or Branch device.

---

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Auto-Apply (DP):</i>                     | New settings are being validated when the user is clicks <i>Apply</i> .<br>Automatic validation is applied when <i>Auto-Apply</i> is checked.<br>When <i>Select DSC Image</i> pattern is being streamed and an incompatible <i>Horizontal and Vertical Active</i> timings are set, the user is presented with a dialog: <i>H-Active and V-Active don't match with DSC data. Do you want to upload image?</i> See <a href="#">Sourcing DSC Compressed Patterns</a> . |
| <i>Apply All (DP):</i>                      | Apply recent changes to all streams.<br>When <i>Select DSC Image</i> pattern is being streamed and an incompatible <i>Horizontal and Vertical Active</i> timings are set, the user is presented with a dialog: <i>H-Active and V-Active don't match with DSC data. Do you want to upload image?</i> See <a href="#">Sourcing DSC Compressed Patterns</a> .                                                                                                          |
| <i>MST (DP)</i>                             | Enable multi-stream transport mode. In 8b/10b link mode, select between SST and MST transport modes. In 128b/132b link coding mode, enable single stream output without stream allocation using Sideband messages if checkbox is cleared.                                                                                                                                                                                                                           |
| <i>Number of streams (DP)</i>               | Set number of steams via combo box.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>Force EDID preferred timing after LT</i> | UCD reads the EDID of the connected Sink and after next LT enables to Stream 0 the timing listed in 18-byte descriptor 1 in VESA block of the sink's EDID.                                                                                                                                                                                                                                                                                                          |
| <i>Use timings from EDID</i>                | UCD reads the EDID of the connected Sink and lists only timings that are featured there.                                                                                                                                                                                                                                                                                                                                                                            |
| <i>Manage Timings</i>                       | Please see chapter <a href="#">Manage Timings</a> later in this manual.                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Total bitrate:</i>                       | Used link payload / Total link capability in Gbps (Pls see Note below).                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Auto-Apply (DP)</i>                      | To avoid sourcing invalid video mode combinations new settings are being validated when the user is clicking <i>Apply</i> .<br>Automatic validation will be applied when <i>Auto-Apply</i> is checked.                                                                                                                                                                                                                                                              |
| <i>Apply</i>                                | Apply recent changes.                                                                                                                                                                                                                                                                                                                                                                                                                                               |

*Pattern Generator Status* panel shows the *Timing*, *Pattern* (Name), *CEF* (color format and subsampling and colorimetry), *BPC* (bits per color), *Status*, and *CRC* value, for each active stream.

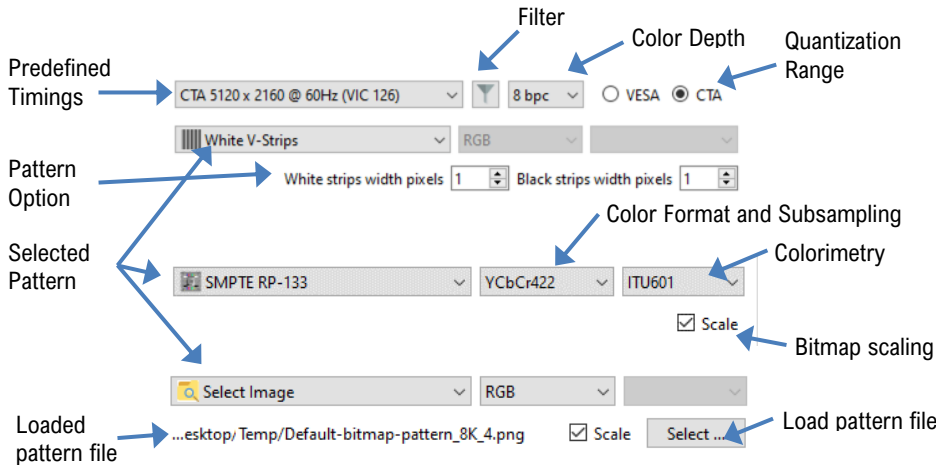
---

**Note:** A full description of Minimum link configuration combinations for UCD standard video modes is available. [Please contact Unigraf](#) for details.

---

Pattern

Configuration of the video sent in the corresponding stream  
(Controls vary between selected pattern type)



Predefined Timings

The list includes a set of common fixed video timings. Please find a list of the timings with their major details in [Appendix C](#) of this document. With *Manage Timings* function the user can add timings in the list and select which timings are shown in the selection.

Color Depth

Available color depths are: 6, 8, 10, 12 and 16 bpc. Color depth 6 bpc is only available when using RGB color format in DisplayPort or DisplayPort Alt Mode.

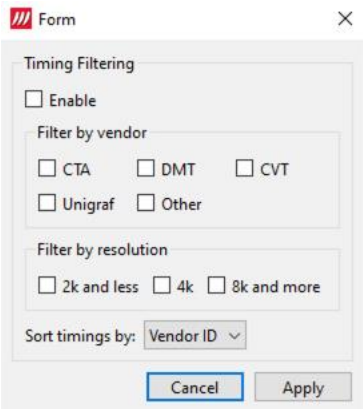
Video Pattern

The selection includes a set of predefined patterns and a possibility to load user defined custom patterns. Please find a description of the available predefined patterns in [Appendix D](#) of this document. By selecting **Disabled** you can have the links activated but no video data transferred.

**Note:** When MST mode is selected, full selection of test patterns is available only in stream 0

Filter

Filter timings by specific vendors and resolutions. Timings can be sorted by Vendor ID or width. HDMI timings are sorted by VIC number by default.



Custom Image Patterns

BMP, PNG, and JPG files can be loaded from the PC to be used as custom images.

Please refer to *Link Pattern* in description of *DP and DP Alt Mode Reference Source Link* tab later in this manual for sending special DisplayPort binary patterns in the link instead of video.



### [Bitmap Scaling](#)

When bitmap patterns are used, they can be used either in their original resolution, aligned to left top corner (=un-check *Scale*), or upscaled or downscaled to match the selected video resolution (=check *Scale*).

### [Pattern Options](#)

Some of the predefined patterns include additional configuration parameters. The controls for the parameters appear below the pattern selection when the pattern in question has been selected. Please find a description of patterns options in [Appendix D](#) of this document.

Pattern Scrolling

When Pattern Scrolling is enabled, the pattern is moved horizontally and vertically between display scans. The function is available for all patterns except the following: Color Bars, Chessboard, Solid Color, Solid colors (white, red, green, blue), White V-Strips, Motion Pattern, DSC Pattern.

Pattern Scrolling

☒ Enable

Horizontally

10

pixels

Vertically

10

pixels

Every

1

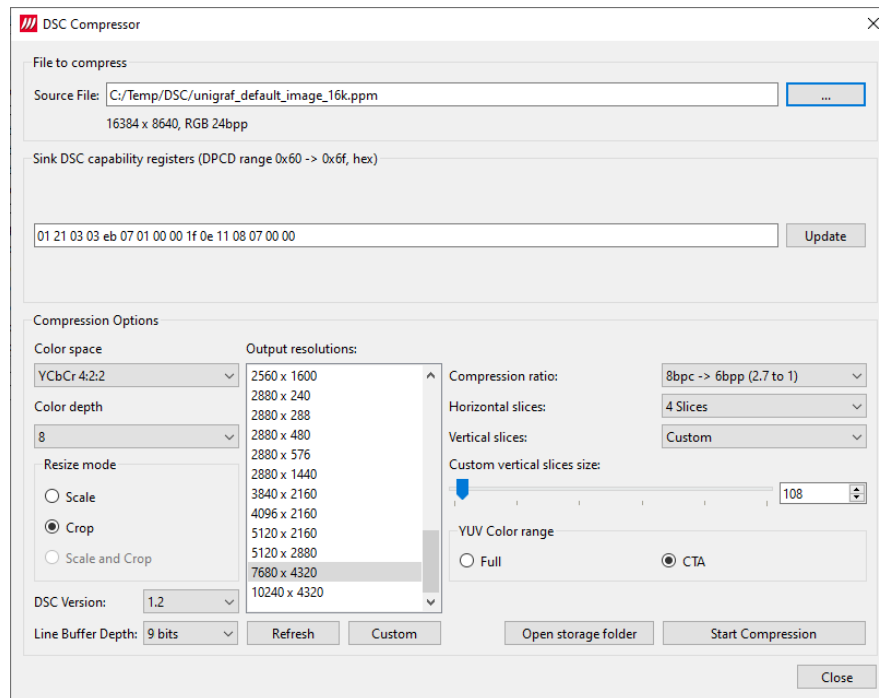
frame

|                               |                                                                                                                                                                                    |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Enable:</i>                | Enable or disable pattern scrolling                                                                                                                                                |
| <i>Horizontally X pixels:</i> | Horizontal step of the pattern movement in pixels (values in range -127...0...128, for YCbCr 4:2:2 even values).<br>0 = no movement, positive values = pattern moves to the right. |
| <i>Vertically Y pixels:</i>   | Vertical step of the pattern movement in pixels (even values in range -127...0...128, for YCbCr 4:2:0 even values).<br>0 = no movement, positive values = pattern moves up.        |
| <i>Every N frame:</i>         | Delay of pattern movement in display frames (values in range 0... 255).<br>0 = no movement, 1 = move every frame, n = move every n:th frame.                                       |

**Note:** Please click *Apply* to enable changes or check *Auto-Apply*.

## Sourcing DSC Compressed Patterns

UCD Pattern Generator function can source DSC content originating from pre-created DSC compressed files. DSC compressed pattern files can be created with a separate tool called *DSC Compressor*. It can be launched from Tools > DSC Compressor.



Select the source bitmap file in Source File field. Define the Output Resolution, the color depth, compression ratio and number of horizontal and vertical slices in the frame.

|                                       |                                                                                                                     |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| <i>Source File:</i>                   | Source bitmap file to be compressed (JPG, PNG, PPM)                                                                 |
| <i>Sink DSC capability registers:</i> | Click <i>Update</i> to read DPCD registers 0x60 to 0x6f from the connected Sink device                              |
| <i>Color Space:</i>                   | Color space of the output compressed file (RGB, YCbCr 4:4:4, 4:2:2, 4:2:0, Simple 4:2:2)                            |
| <i>Color depth:</i>                   | Color space of the output compressed file (8, 10, 12, 16)                                                           |
| <i>Output resolution:</i>             | Resolution of the output compressed file                                                                            |
| <i>Resize mode:</i>                   | The way the DSC image is created from the Source file                                                               |
| <i>Compression ratio:</i>             | Used compression ratio                                                                                              |
| <i>Horizontal slices:</i>             | Nr. of slices horizontally (1 to 24 Slices)                                                                         |
| <i>Vertical slices:</i>               | Vertical slices (1 to 24 Slices, Custom)<br>Custom vertical slices size: minimum 1, recommended 108                 |
| <i>YUV Color range:</i>               | Selection of color range between Full range (Full) (0 to 255 at 8 bpc) and Limited Range (CTA) (16 to 235 at 8 bpc) |
| <i>Refresh:</i>                       | Refresh the list after adding a custom resolution                                                                   |
| <i>Custom:</i>                        | Create a custom output resolution                                                                                   |
| <i>DSC Version:</i>                   | DSC version used (1.1, 1.2)                                                                                         |
| <i>Line Buffer Depth:</i>             | Line buffer bit depth used to generate the bitstream. (8 to 16 bits, default 9 bits)                                |
| <i>Open storage folder:</i>           | Open DSC temp folder defined in Tools > Options                                                                     |
| <i>Start Compression:</i>             | Start the compression process                                                                                       |

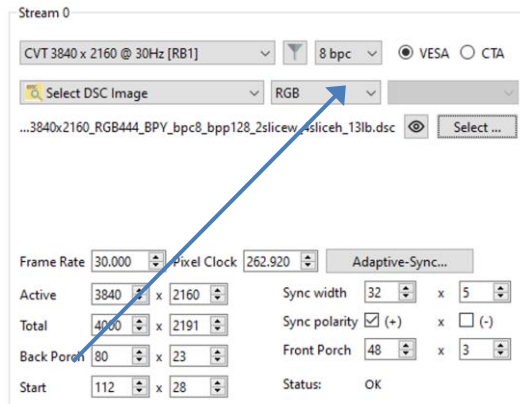
Result of the compression process is saved in the same folder as the source file. The start of the file name is the same as the source bitmap file; resolution and color format are added to the end of the file name.

Example:

```
unigraf_default_image_16k.ppm >>
```

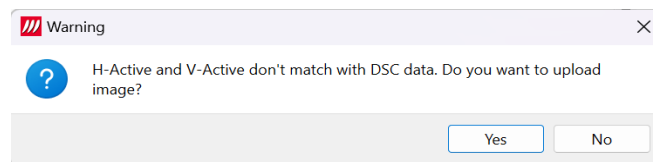
```
unigraf_default_image_16k_1920x1080_YUV422_FULL_bpc8_bpp6.dsc
```

To use the created DSC file in Pattern Generator, select pattern: *Select DSC Image* and click *Select ...* to open file selection dialog.



When a DSC image is selected as the pattern, UCD Console will automatically enable DSC, provided that the connected Sink device declares support for DSC in its DPCD.

When *Select DSC Image* pattern is being transmitted and incompatible *Horizontal and Vertical Active* timings are set (Via *Apply* or *Apply All*), the user is presented with a dialog: *H-Active and V-Active don't match with DSC data. Do you want to upload image?*



Above, “*Do you want to upload image?*” is misleading and will be changed to “*Continue to transmit image?*”.

If you select *No*, the new settings will not be applied.

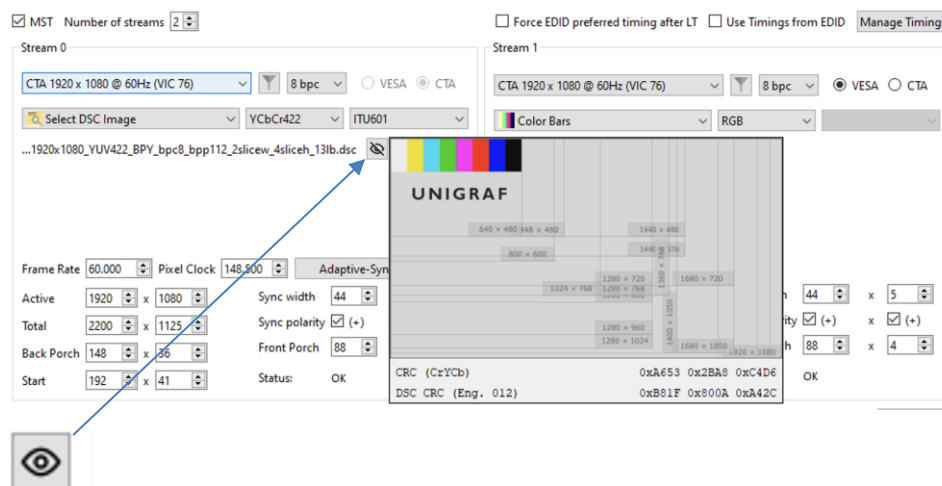
If you select *Yes*, the Pattern will continue to be transmitted. DSC data is transferred in the active window. To transfer all DSC data without loss, active video should be large enough for DSC compressed data ( $\text{DSC\_pic\_height} * \text{DSC\_pic\_length} / \text{compression\_ratio}$ ). MSA H-active should also not be less than DSC pic\_height.

MSA V-active parameters can be reduced without DSC corruption until active video area is no longer large enough to pass all DSC data.

MSA V-active and H-active can be increased until HW limitation (pixel clock limit) and link bandwidth are reached.

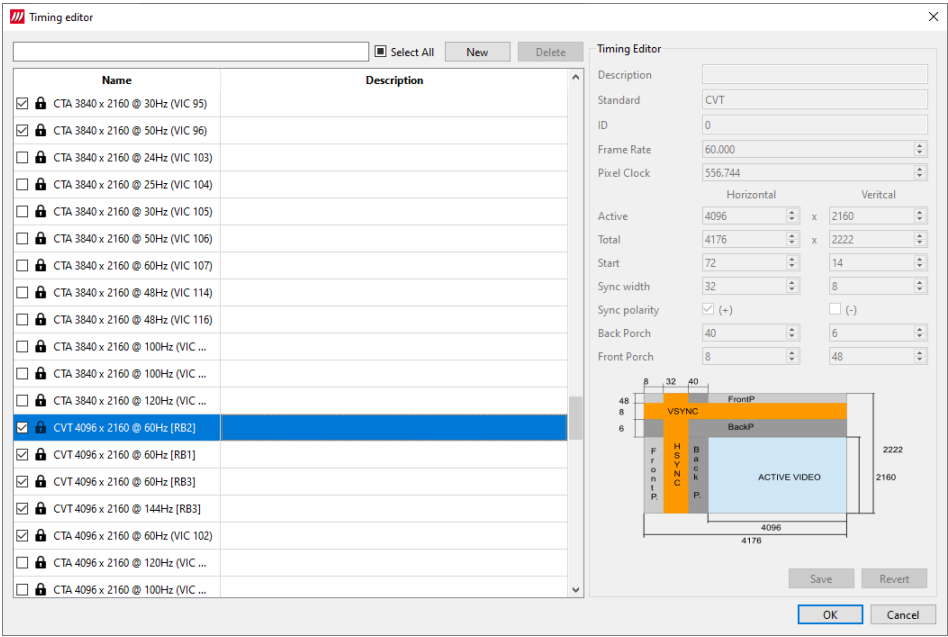
### [Preview DSC image](#)

To preview an DSC image before it is applied to the pattern generator, select the eye icon. CRC and DSC CRC values will be indicated in the preview image.



Manage Timings

Custom timings can also be created and edited with pop-up *Timing Editor*. Launch the editor by clicking *Manage Timings*.



Customizing Timings List

The list of timings that are shown on the pull-down menu in Pattern Generator and Link tabs can be limited by un-checking the checkbox in the left edge of *Name* column. The timings will remain in the list and can be brought back to the pull-down menu, when needed.

Editing Timings

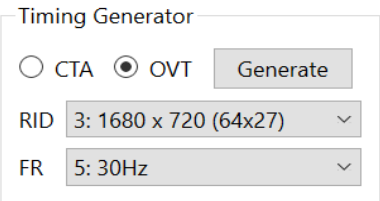
Video timing Name and Description are shown in the list. Lock icon  indicates that a timing is a fixed timing which cannot be edited or deleted. Custom timings are indicated with a head icon .

- New:* Create a new custom timing based on the selected fixed timing.
- Delete:* Delete the selected custom timing
- Save:* Save changes in the selected custom timing.
- Revert:* Undo all changes

The dialog parameters will be sanity checked and will warnings issued for illegal combinations.

HDMI Timing Generator (UCD-422, UCD-412)

HDMI Timings can be generated and applied via the *Timing Generator* group.



Timing Generator

☒ CTA

☐ OVT

Generate

VIC 

77

To do this select *CTA* or *OVT* timings radio button. Select desire *RID* and *FR* or *VIC* in combo boxes and then click the *Generate* button.

The generated values will be reflected in the Frame parameters. Click *Apply* to set timing.

Frame Rate 

30.000Hz

Pixel Clock 

44.400kHz

Horizontal

Vertical

Active

1680

720

Front Porch

256

6

Start

64

14

Horizontal

Vertical

Total

2000

740

Sync Width

32

8

Sync Polarity

☒ (+)

☒ (+)

Blanking

320

20

Back Porch

32

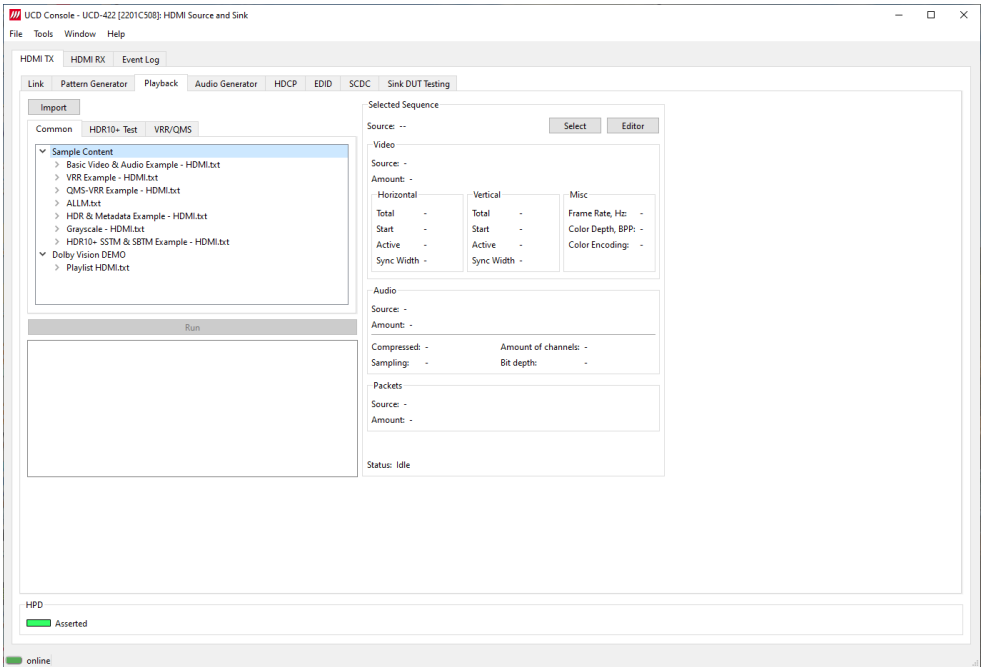
6

Apply

Playback Tab

|                                 |                           |
|---------------------------------|---------------------------|
| Role:                           | Product:                  |
| DP Reference Source (DP TX)     | UCD-424, UCD-400, UCD-411 |
| HDMI Reference Source (HDMI RX) | UCD-422, UCD-412          |

Playback allows for running predefined *Playlist* files. Playlist contains a set of *Scenarios* with definitions of the timing, video pattern, audio content and related metadata packets and their duration.



|                    |                                                                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Term               | Functionality                                                                                                                                             |
| Playlist           | <i>Playlists</i> (text files) specify the UCD devices and output protocol for transmission. It lists <i>scenarios</i> to be transmitted.                  |
| Scenario           | Scenarios (text files) allow users to select video frames, metadata packets and audio to be transmitted and their order.                                  |
| Advanced Playlists | Unigraf UCD devices can also be used as a compatibility test tools for dedicated standards such as Dolby Vision™ and HDR10+. Contact Unigraf for details. |

**Note:** Note that Playlists and Scenarios are protocol dependent. Provided examples for HDMI and DisplayPort are somewhat different.



Common Tab

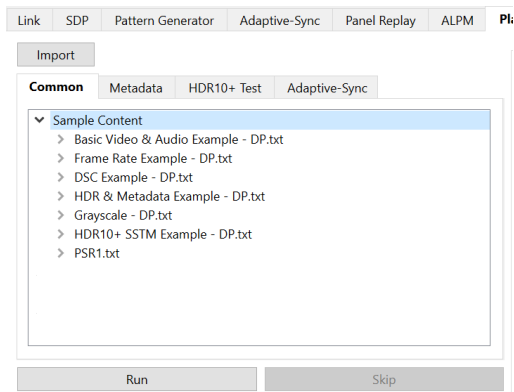
The *Import* button is for importing \*.json files into the *common* tab treeview. Sample content on windows can be found at C:\Program Files\Unigraf\Unigraf UCD Tools\Resources\playback\basic\_library.json. Be **warned** that once imported, items cannot at present be removed. Actually you can but it involves using *Windows Register Editor* to remove values from (uninstall will not help):

Computer\HKEY\_CURRENT\_USER\SOFTWARE\Unigraf\UCD Console\Playback

Computer\HKEY\_CURRENT\_USER\SOFTWARE\Unigraf\UCD Console\MetadataScenario

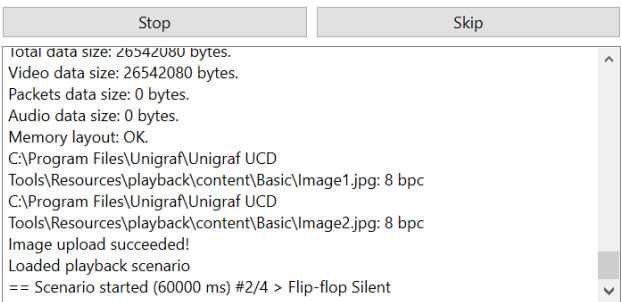
Sample playlists are included in UCD Console. Select a sequence (a scenario) from the playlists and press *Run* (or double click it) to play.

The *Run* button label changes to *Stop* as a *Scenarios* run. Press *Stop* to stop playing the scenario. Press *Skip* to skip to next scenario (available when there are multiple scenarios in a playlist) while playing. While the *scenario* is loading the *Run* button label changes to *Cancel* to allow cancelation.



Status Log

Scenario commands are listed in the *Status Log* as they are run.



## Selected Sequence

Running scenario video and audio details and their sources are shown in the *Selected Sequence* group panel.

Note that the triggered scenario or playlist to be run is the last selected: If an item was selected via the *treeview*, it is the triggered item to be run. If the *Select* button was used to select an item, it is the triggered item to be run (regardless of what is selected in the tree control).

Press the *Select* button to load a *playlist* or *scenario* to be run (selecting a sample from the *Sample Content treeview* will load them as the *playlist* or *scenario* to be run). Also it will be the *scenario* used as a template if the *Scenario Editor* is launched: default scenario values will be set if a playlist is selected.

Press the *Editor* button to launch the *Scenario Editor* (see below).

The *Selected Sequence* parameters are the transmission stream parameters.

Selected Sequence

Source: ...o & Audio Example - DP.txt (Playlist)

Select

Editor

Video

Source: ...nigraf UCD Tools/Resources/playback/content\Basic\Image1.jpg

Amount: -

|                      |                     |                               |
|----------------------|---------------------|-------------------------------|
| Horizontal           | Vertical            | Misc                          |
| Total <b>2200</b>    | Total <b>1125</b>   | Frame Rate, Hz: <b>60</b>     |
| Start <b>192</b>     | Start <b>41</b>     | Color Depth, BPP: <b>8</b>    |
| Active <b>1920</b>   | Active <b>1080</b>  | Color Encoding: <b>RGB444</b> |
| Sync Width <b>44</b> | Sync Width <b>5</b> |                               |

Audio

Source: ...nigraf UCD Tools/Resources/playback/content\Basic\Rhythm.wav

Amount: 1

|                        |                              |
|------------------------|------------------------------|
| Compressed: <b>No</b>  | Amount of channels: <b>2</b> |
| Sampling: <b>44100</b> | Bit depth: <b>16</b>         |

Packets

Source: -

Amount: -

Status: Playing 2

## Scenario Editor

Press the *Select* button above to select the scenario desired to use as a template for creating a new scenario. Press the *Editor* button to launch the *Scenario Editor*. The the dialog paramaters will be generated from the scenario file shown under the panel *Source* label (*Philips FHD.txt* as seen above).

Press the *Path* ... for setting the *Video*, *Packets* or *Audio* paths.

Press *OK* to save. Your are presented with a save dialog. You need to navigate to a directory you can save to. Run *Conssole 2* with **administration rights** if you want to save to default locations on windows such as: C:\Program Files\Unigraf\Unigraf UCD Tools\Resources\playback\content.

Refer to [Appendix H: Playlists and Scenarios](#) later in this manual for details.

**Scenario Editor**

**Video**

Path: ...goldenGate0.jpg Select

4 files found

☒ Align raw 10/12bit data to 16bit

☐ Show frame numbers during playback

CTA 3840 x 2160 @ 30Hz (VIC 95) RGB 10 bpc

DSC: HCAActive:  HCBBlank:

VTotal:  VStart:

VActive:  VSync:

Frame rate:

**Packets**

Path: ...frames\_0000.bin Select

4 files found

**Audio**

Path: ... Select

...

☐ Compress ☐ Little Endia 44100 Hz 2 channel 16 bits

**Playing order**

3:180:0,2:512;

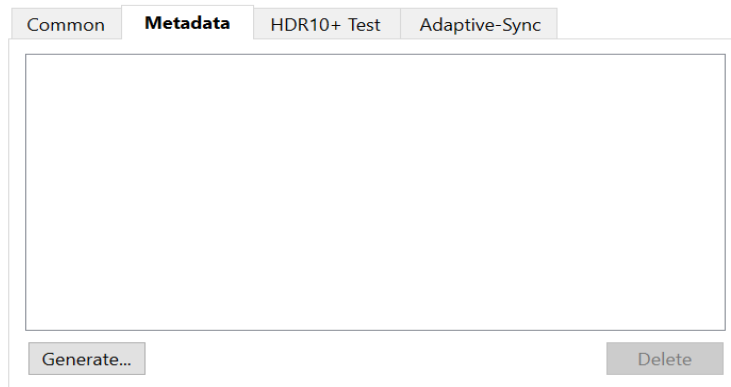
**General**

☐ Enable scrambler Loading color (R,G,B): 52,127,150 HDCP: None

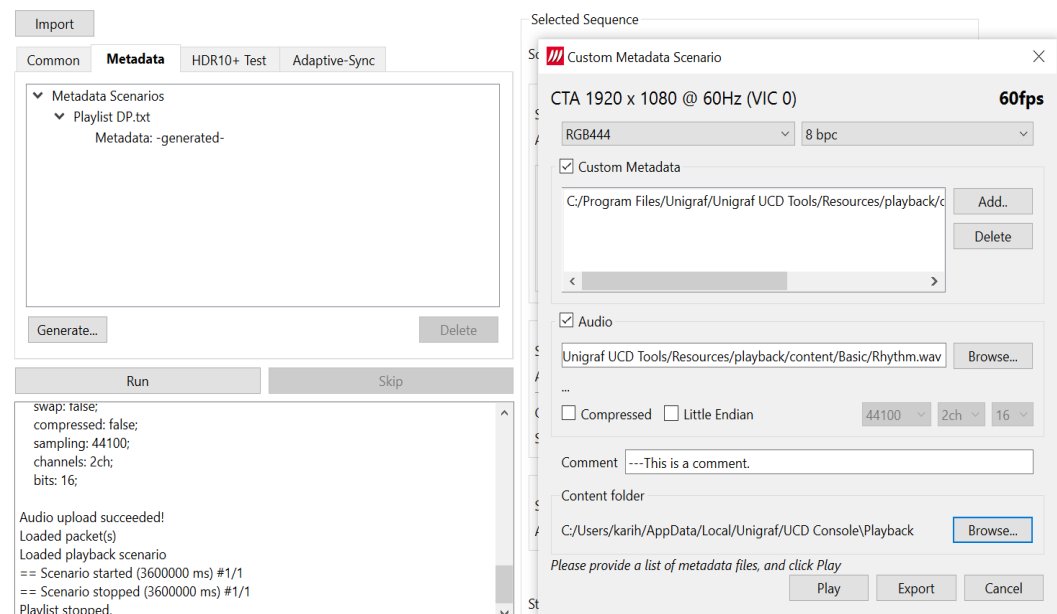
OK Cancel

## Metadata Tab

The *Metadata* tab is for creating scenarios with metadata.



Select the *Delete* button to delete a *scenario* or the *Generate* button to launch the *Custom Metadata Scenario* dialog (shown below).



Current *Pattern Generator* timing details are shown at the top. You can change the color mode (RGB444, YUV444, YUV422, YUV420) and color depth (8 bpc, 10 bpc, 12 bpc, 16 bpc) via the dropdown combo boxes.

Select the *Add* or *Delete* buttons to add or remove metadata from the scenario.

Check the *Audio* checkbox and then the *Browse...* button to add an audio file. Sampling, channels and bits can be selected via the combo boxes.

The *scenario Comment* can be added in line edit box after the three dashes (---).

Use the *Content folder Browse...* button to select save location.

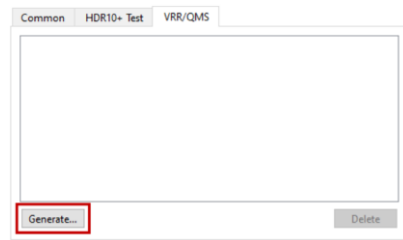
You can press *Play* to run the *scenario*, *Export* to save it or *Cancel* to cancel.

*Export* will create a folder something like *Metadata1920x1080@60-RGB444-8bpc* in the *Content folder*. In it you will find generated files *frame.svg* (displayed while running), the metadata files you selected and a *scenario.txt* file. You may edit and rename these files.

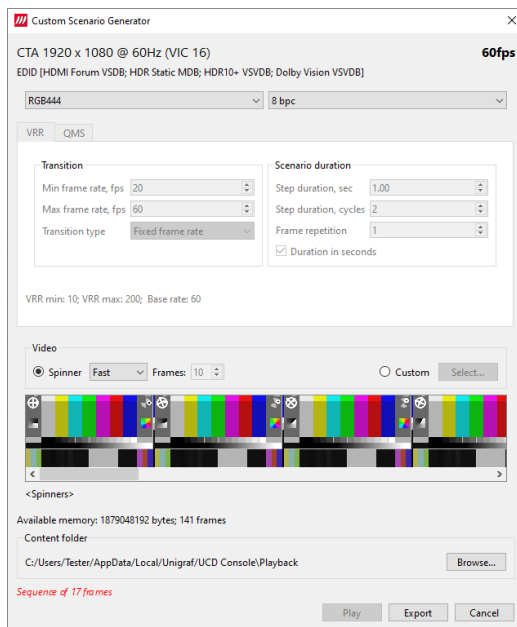
## HDR10+ Test Tab

Please refer to HDR10+ CTS User Manual for detailed description of the tab.

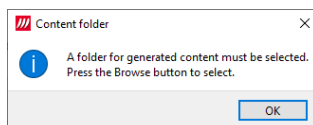
## VRR/QMS tab



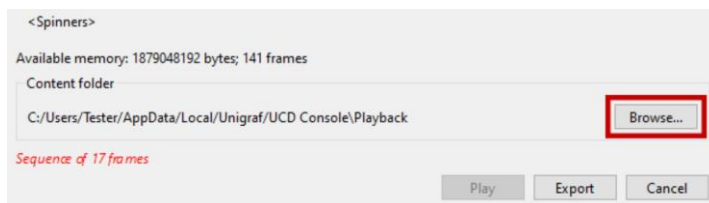
Click *Generate* to generate custom VRR and QMS scenarios. Custom Scenario Generator window will open.



First you are asked to select the folder where the generated content will be stored.

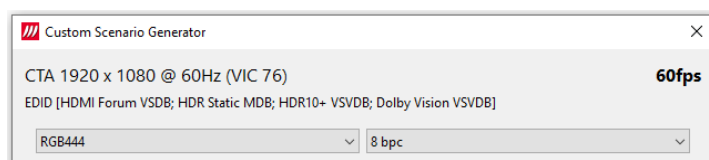


Click *Browse...* to select the folder.



## Timing details

The uppermost part of the window shows the timing details. Please, note that the timing is set on the pattern generator tab. You can change the color mode (RGB444, YUV444, YUV422, YUV420) and color depth (8 bpc, 10 bpc, 12 bpc, 16 bpc).



VRR settings

In the VRR tab you can set the transition and scenario duration parameters. Different transition types are Fixed frame rate, Min and max and Gradual. When *fixed frame rate* is selected, the scenario is played at the minimum frame rate set in the first field. Please, note that when the fixed frame rate is selected, you can only select the number of times the frame is repeated.

VRR

QMS

Transition

Min frame rate, fps20

Max frame rate, fps60

Transition typeFixed frame rate

Scenario duration

Step duration, sec1.00

Step duration, cycles2

Frame repetition1

☒ Duration in seconds

VRR min: 10; VRR max: 200; Base rate: 60

When *min and max* is selected, the output sceario will alter the framerate between the specified values. You can also set the duration for step in seconds and select how many times frames are repeated.

VRR

QMS

Transition

Min frame rate, fps20

Max frame rate, fps60

Transition typeMin and max

Scenario duration

Step duration, sec1.00

Step duration, cycles2

Frame repetition1

☒ Duration in seconds

VRR min: 10; VRR max: 200; Base rate: 60

When *gradual* is selected, the frame rate is changed with each frame. For example, when min frame rate is set at 20 and max is set at 60 and the scenario has 40 frames, frame rate would be incremented by 1 with each frame.

Info at the bottom of the segment shows the minimum and maximum values for VRR framerate defined in EDID, and the base frame rate set in the pattern generator.

VRR

QMS

Transition

Min frame rate, fps20

Max frame rate, fps60

Transition typeGradual

Scenario duration

Step duration, sec1.00

Step duration, cycles2

Frame repetition1

☒ Duration in seconds

VRR min: 10; VRR max: 200; Base rate: 60

QMS settings

In the QMS settings dialogue you find all the frame rates included in the QMS specification. Select which frame rates you want to include in your scenario. Also select the step duration in cycles. In the lower left corner details of the scenario as shown.

VRR

QMS

Next\_TFR

☒ QMS-VRR is not active

☒ 30/1.001

☐ 50

☐ 120/1.001

☒ 24/1.001

☒ 30

☐ 60/1.001

☐ 120

☒ 24

☐ 48/1.001

☐ 60

None

☒ 25

☐ 48

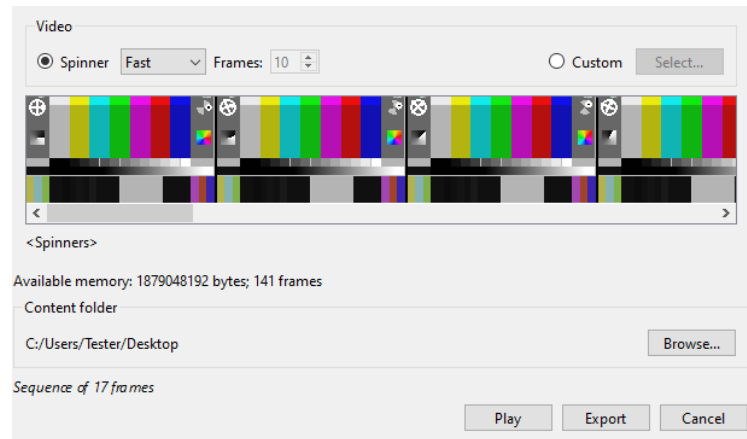
☐ 100

All

Step duration, cycles2

SCDC: QMS: 1; QMS-TFRmin: 1; QMS-TFRmax: 1

## Video



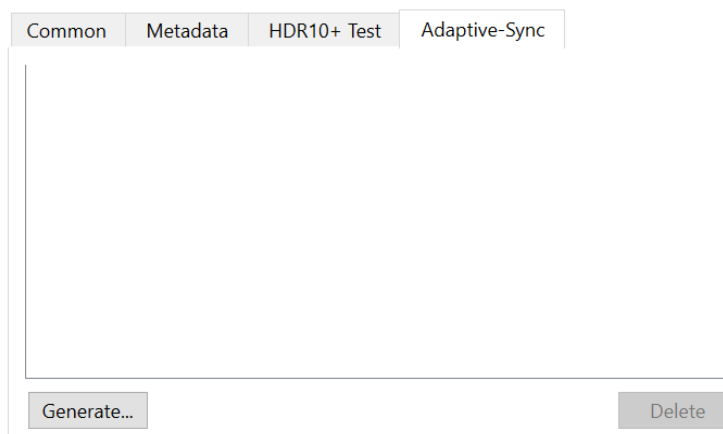
The section at the bottom shows details of the output video. The default pattern is a spinner. You can select the speed of the spinner video from the predefined options in the drop-down menu or you can set a number of frames it takes for the spinner to rotate a full circle. You can also select a custom video. The supported file types are .jpg, .png, .gif, .bmp, .tiff, .ppm and .tif

Available memory is shown in bytes and frames. Below, the folder selected for the sequence is shown. You can change the folder by clicking *Browse...* Lastly, the duration of the sequence is shown in frames.

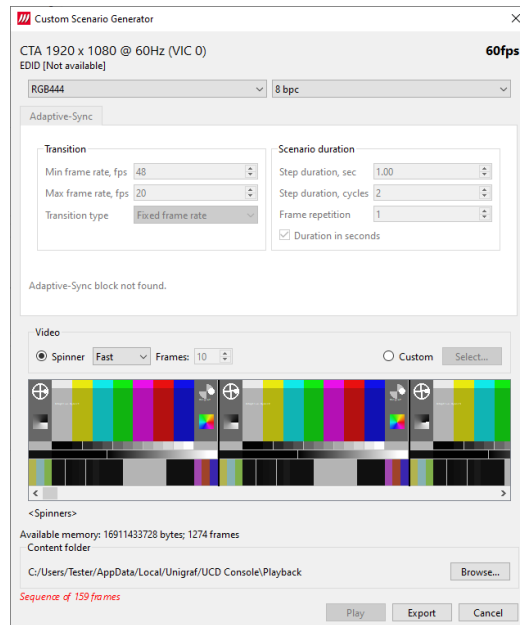
You can export the scenario by clicking *Export*. When exporting, you are asked to select a location for the export. The content folder will be automatically created in the chosen location. The folder includes the image files, packets and scenario parameters.

You can play the scenario by clicking *Play*. When the scenario is ready for playing, the scenario generator window will close. You can now inspect the progress in the log in the playback tab as shown below.

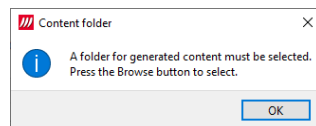
## Adaptive-Sync tab



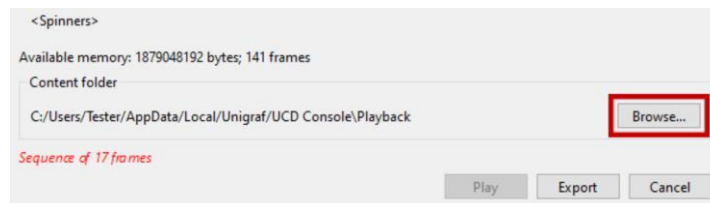
Click *Generate* to generate custom Adaptive-Sync scenarios. Custom Scenario Generator window will open.



First you are asked to select the folder where the generated content will be stored.

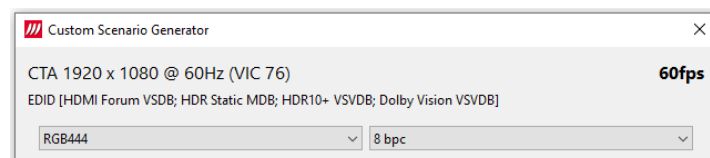


Click **Browse...** to select the folder.



### Timing details

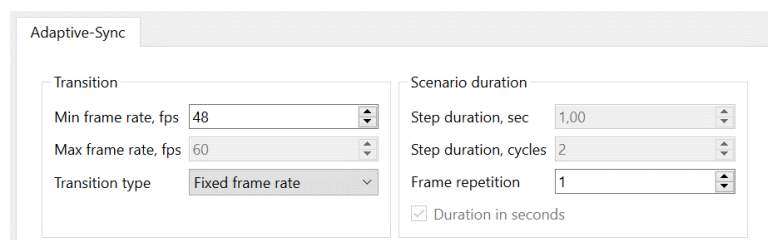
The uppermost part of the window shows the timing details. Please, note that the timing is set on the pattern generator tab. You can change the color mode (RGB444, YUV444, YUV422, YUV420) and color depth (8 bpc, 10 bpc, 12 bpc, 16 bpc).



### Adaptive-Sync settings

In the Adaptive-Sync section you can set the transition and scenario duration parameters. Different transition types are Fixed frame rate, Min and max and Gradual.

When *fixed frame rate* is selected, the scenario is played at the minimum frame rate set in the first field. In scenario duration, select how many times frame is repeated.





When *min and max* is selected, the output scenario will alter the framerate between the two values set in the drop down menus. You can also set the duration for step in seconds and select how many times frames are repeated.

The screenshot shows the 'Adaptive-Sync' window. Under the 'Transition' section, 'Min frame rate, fps' is set to 48, 'Max frame rate, fps' is set to 60, and 'Transition type' is set to 'Min and max'. Under the 'Scenario duration' section, 'Step duration, sec' is 1.00, 'Step duration, cycles' is 2, 'Frame repetition' is 1, and the 'Duration in seconds' checkbox is checked.

When *gradual* is selected, the frame rate is changed with each frame. For example, when min frame rate is set at 20 and max is set at 60 and the scenario has 40 frames, frame rate would be incremented by 1 with each frame.

Info at the bottom of the segment shows the minimum and maximum values for VRR framerate defined in EDID, and the base frame rate set in the pattern generator.

The screenshot shows the 'Adaptive-Sync' window with 'Transition type' set to 'Gradual'. All other settings, including 'Min frame rate, fps' (48), 'Max frame rate, fps' (60), 'Step duration, sec' (1.00), 'Step duration, cycles' (2), 'Frame repetition' (1), and the checked 'Duration in seconds' checkbox, remain the same as in the previous screenshot.

## Video

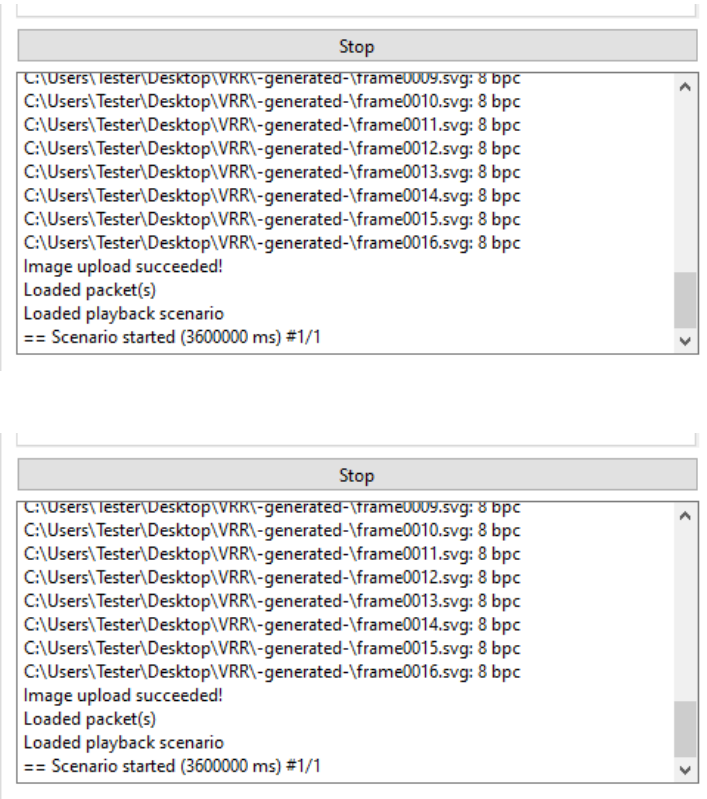
The screenshot shows the 'Video' settings window. At the top, 'Spinner' is selected with a speed of 'Fast' and 'Frames' set to 10. There is a 'Custom' option with a 'Select...' button. Below this is a preview of the spinner video pattern. Under '<Spinners>', it shows 'Available memory: 1879048192 bytes; 141 frames'. The 'Content folder' is set to 'C:/Users/Tester/Desktop' with a 'Browse...' button. At the bottom, it says 'Sequence of 17 frames' and has 'Play', 'Export', and 'Cancel' buttons.

The section at the bottom shows details of the output video. The default pattern is a spinner. You can select the speed of the spinner video from the predefined options in the drop-down menu or you can set a number of frames it takes for the spinner to rotate a full circle. You can also select a custom video. The supported file types are .jpg, .png, .gif, .bmp, .tiff, .ppm and .tif

Available memory is shown in bytes and frames. Below, the folder selected for the sequence is shown. You can change the folder by clicking Browse... Lastly, the duration of the sequence is shown in frames.

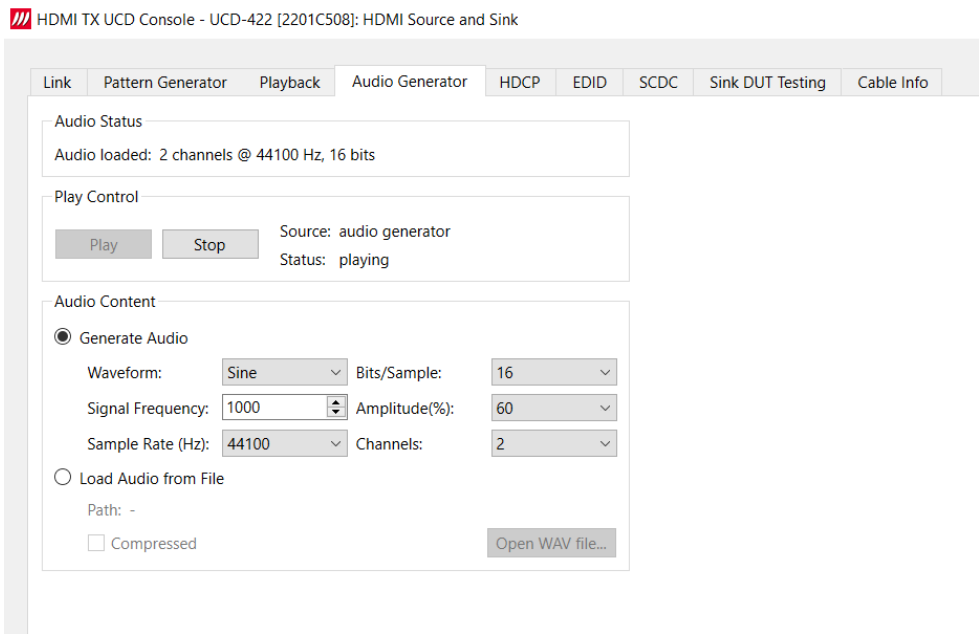
You can export the scenario by clicking *Export*. When exporting, you are asked to select a location for the export. The content folder will be automatically created in the chosen location. The folder includes the image files, packets and scenario parameters.

You can play the scenario by clicking *Play*. When the scenario starts playing, the scenario generator window will close. You can now inspect the progress in the log in the palyback tab as shown below.



# Audio Generator Tab

Audio generator allows the user to play LPCM audio generated internally or from files in WAV format. Audio is played to all active ports.



To load internally generated audio, select *Generate Audio*, and adjust the controls to the desired audio format.

To load an audio file from your PC, select *Load Audio from File*, click the *Open WAV file...* button, browse and select the file and Open.

The *Compressed* checkbox indicates that the audio loaded from the selected file is compressed.

To play the selected audio content, click the *Play*.

The content will be transmitted until the *Stop* button is clicked.

*Audio Status* displays current audio content status.

## Audio Content

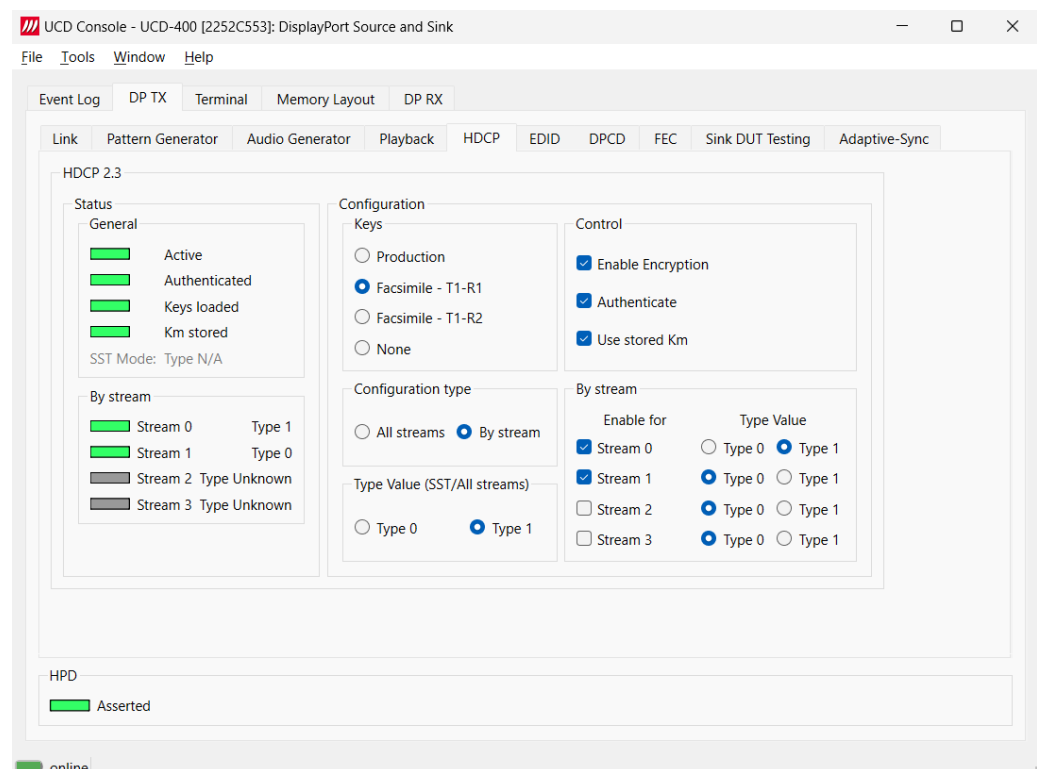
Sent audio can be generated internally or used a WAV file loaded from the PC.

In case of a WAV audio file, the parameters stored in the file will be used. When generating audio internally, the user sets the details of the LPCM Audio signal.

|                         |                                                                                                |
|-------------------------|------------------------------------------------------------------------------------------------|
| <i>Waveform</i>         | Selection of audio waveform: Sine, Sawtooth, Square, or Incremental                            |
| <i>Signal Frequency</i> | Setting audio signal frequency in Hz.                                                          |
| <i>Sample Rate (Hz)</i> | Selection of audio sampling rate: 32000, 44100 (default), 48000, 88200, 96000, 176400, 192000. |
| <i>Bits/Sample</i>      | Selection of sample bit depth: 16, 20, 24.                                                     |
| <i>Amplitude(%)</i>     | Selection of audio amplitude: 10%, 20%, ..., 90%, 100%.                                        |
| <i>Channels</i>         | Audio channels available: 1, 2, ..., 7, 8.<br>Channels transmit LPCM (uncompressed) Audio.     |

## HDCP Tab

HDCP tab is the dialog for monitoring the HDCP (for *High-Bandwidth Digital Content Protection*) status and controlling the HDCP capabilities of the UCD device.



## Status General

The status fields indicate the HDCP status of the UCD device.

|                       |                                                                                   |
|-----------------------|-----------------------------------------------------------------------------------|
| <i>Active:</i>        | The stream between UCD and the downstream sink has been encrypted.                |
| <i>Authenticated:</i> | HDCP handshake between the UCD and the sink unit has been completed successfully. |

|                      |                                       |
|----------------------|---------------------------------------|
| <i>Keys loaded:</i>  | HDCP keys are loaded to the UCD unit. |
| <i>Km is stored:</i> | Master Key (Km) is stored.            |
| <i>SST Mode Type</i> | Type when in SST mode.                |

### Status By stream

Stream status shows HDCP status on each stream.

### Configuration Control

|                           |                                                                                   |
|---------------------------|-----------------------------------------------------------------------------------|
| <i>Enable encryption:</i> | Check to enable the encryption of the stream between UCD and the downstream sink. |
| <i>Authenticate:</i>      | Perform the HDCP initiation handshake between the UCD and the sink unit.          |
| <i>Use stored Km:</i>     | Use stored Master key (Km).                                                       |

### Configuration type

Select to configure HDCP for All streams at once or By stream.

#### By stream

Select and configure streams.

#### Type Value (All streams)

Select Type 0 or Type 1. Type 1 ensures that content encryption is done with HDCP version 2.2 or higher.

### Configuration Keys

Select *Production* or *Facsimile* HDCP keys. To remove the keys, select *None*.

### HDCP 1.3 / 1.4 and HDCP 2.3

DisplayPort currently only supports HDCP 2.X.

HDMI currently does not support HDCP 2.3.

See *ReleaseNotes.txt*, *Known issues (Limitations)* in bundle to see limitations:

C:\Program Files\Unigraf\Unigraf UCD Tools\documents\ *ReleaseNotes.txt* on Windows.

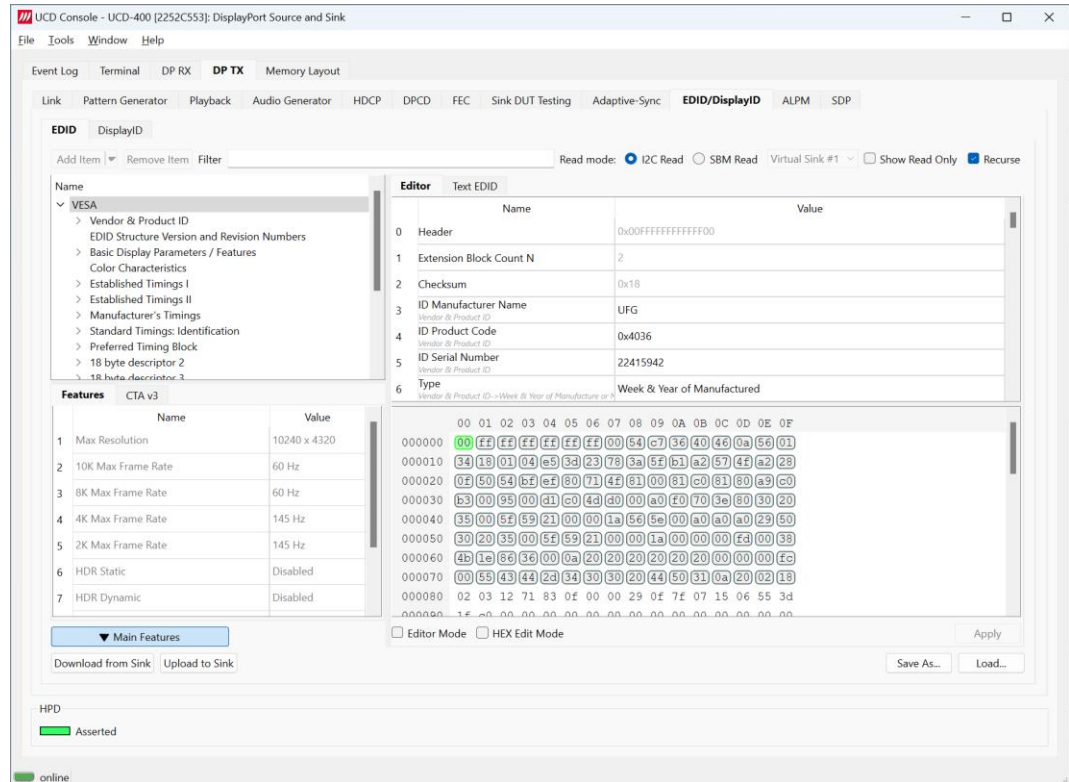
## EDID/DisplayID Tab

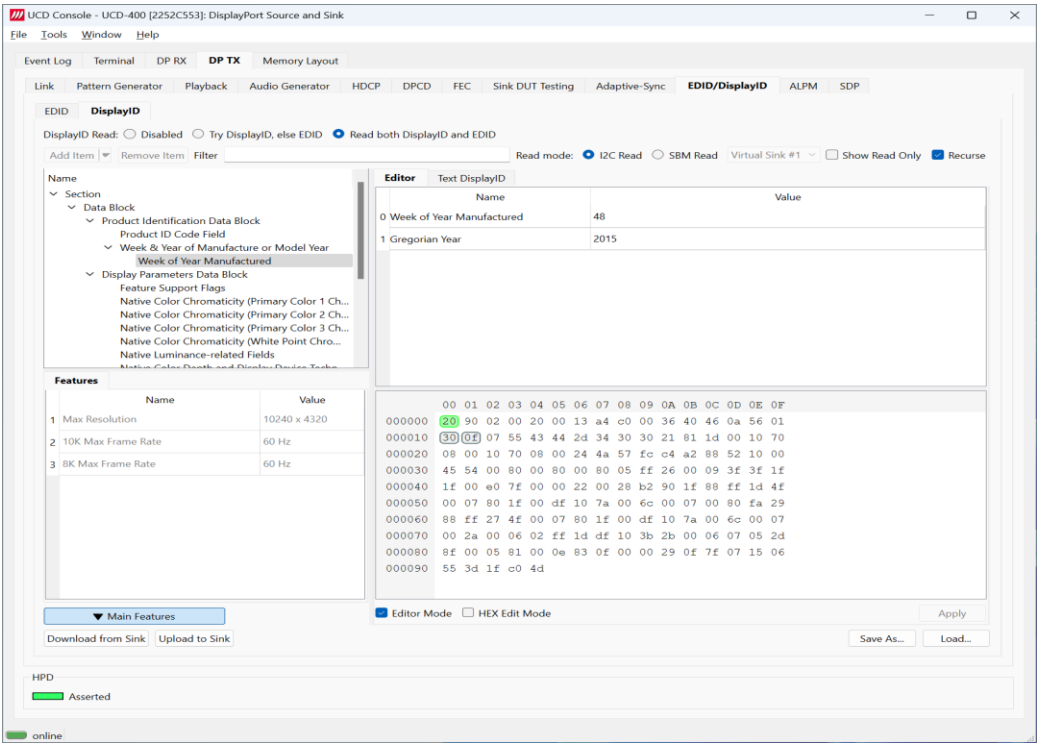
EDID/DisplayID Tab provides tools for accessing the EDID/DisplayID data of the connected sink device. There are three basic functions:

- Load and save the data files in the host PC.
- Edit the data contents either in Editor Mode or in Hex Edit Mode.
- Read and write data to the connected sink. Up to 4 virtual channels can be accessed.

### EDID/DisplayID Files

With *Load...* and *Save As...* a file can be read into the editor or written to a file from the PC.





At top the *DisplayID* tab dialog are radio buttons to control how DisplayID data is read: *Disabled*, *Try DisplayID*, *else EDID*, and *Read both DisplayID and EDID*. These have no effect when downloading from the sink unless the sink supports DisplayID.

The contents of the device EDID/DisplayID file are not modified, or integrity checked during load and save operations.

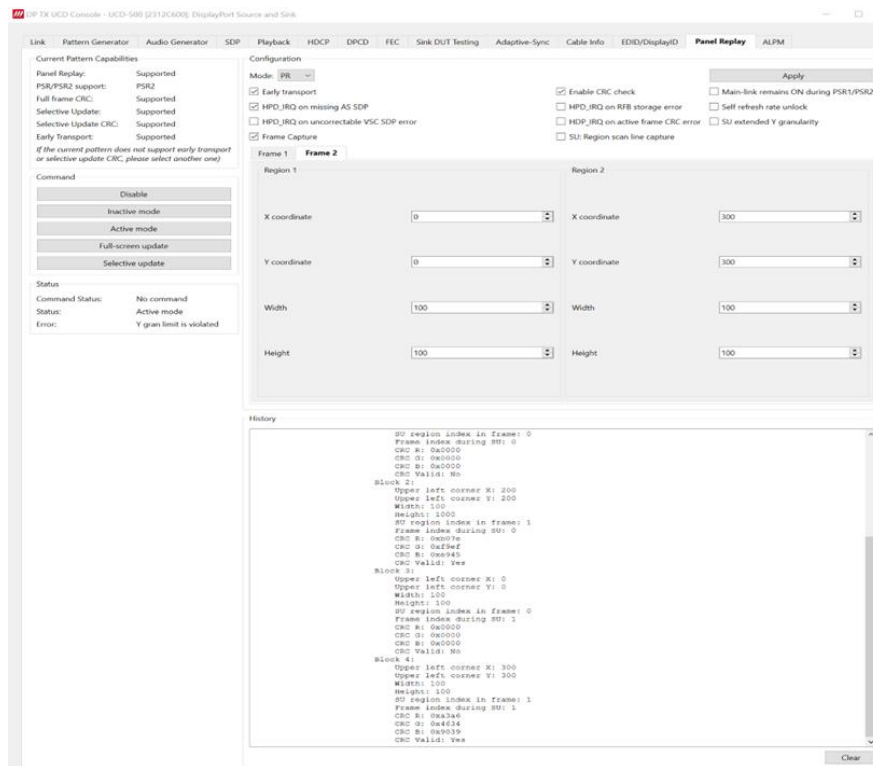
**Note:** Four blocks (512 bytes) of EDID/DisplayID code are read. If the device does not support all four blocks, the non-supported data values are set to zero.

In the Editor Panes (upper right pane), the *Text EDID* and *Text DisplayID* tabs allow viewing data in tree form.

EDID/DisplayID Editor

Please see the description of the EDID editor in Chapter [EDID/DisplayID Editor](#) later in this document.

## Panel Replay Tab



**Current Pattern Capabilities** panel displays what features are supported. Selecting different patterns in the *Pattern Generator* will affect supported features shown here. For example *Pattern Generator* pattern *Color Bars* will disable *Early Transport* capability whereas *Color Squares* will enable it.

**Command** panel has the following functions (reflected in the *Status* panel below it):

|                           |                                                                  |
|---------------------------|------------------------------------------------------------------|
| <i>Disable</i>            | Disable Panel Replay.                                            |
| <i>Inactive mode</i>      | Set mode to inactive.                                            |
| <i>Active mode</i>        | Set mode to active.                                              |
| <i>Full-screen update</i> | Transmit Full-screen update.                                     |
| <i>Selective update</i>   | Transmit selective update (shown in Command Status and History). |

**Status** panel reflects the *Command Status*, *Status* and *Error*.

*Command Status* will show *Selective update* when *Active mode* and *Selective update* buttons have been selected (see above); otherwise it will display *No command*.

*Status* will show state: *Disable*, *Inactive mode* or *Active mode*.

*Error* will show *No error*, *Incorrect command* or an error message.

**History** panel displays results from applying commands in the *command* panel (see above).

The **Configuration** panel allows users to configure *Panel Replay* behavior.

The *Mode* combo box allows mode selection: *PR*, *PSR1*, *PSR2*.

*Configuration* checkboxes available are:

*Early transport*: can be set when supported in *Current Pattern Capabilities*

*HPD\_IRQ on missing AS SDP*

*HPD\_IRQ on uncorrectable VSC SDP error*

*Enable CRC check*

*HPD\_IRQ on RFB storage error*

*HPD\_IRQ on active frame CRC error*

*Main-link remains ON during PSR1/PSR2*

*Self refresh unlock*

*SU extended Y granularity*

*Frame Capture*

*SU:Region scan line capture*

The available parameters for *Frame 1* and *Frame 2* for *Region 1* and *Region 2* are:

|                     |                        |
|---------------------|------------------------|
| <i>X coordinate</i> | X coordinate of region |
| <i>Y coordinate</i> | Y coordinate of region |
| <i>Width</i>        | Width of region        |
| <i>Height</i>       | Height of region       |

These are the transmitted blocks sent when *command Selective update* is pressed (see above).

The *Apply* button is used to set the *Configuration* panel state.



## Sink DUT Testing Tab

Refer to *Appendix E* for descriptions of the tests available. The tests are presented in a split view, the left being test categories and the right being the tests within.

DP TX UCD Console - UCD-400 [1748C248]: DisplayPort Source and Sink

Link SDP Pattern Generator Adaptive-Sync Panel Replay ALPM Playback Audio Generator HDCP EDID/DisplayID DPCD FEC Sink DUT Testing

All tests  
DP 1.4 LL CTS  
HDCP 2.3 CTS 2C  
HDCP 2.3 CTS 3C

Name

| Name                                                                                                                                  | Pass | Fail | Skip | Runs | Last status |
|---------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|-------------|
| DP 1.4 LL CTS                                                                                                                         | 0    | 0    | 0    | 0    |             |
| 5.2.1.1 Read One Byte from Valid DPCD Address                                                                                         | 1    | 0    | 0    | 1    | Pass        |
| 5.2.1.2 DPCD Receiver Capability Read (Read 12 Bytes from Valid DPCD Address)                                                         | 0    | 0    | 0    | 0    |             |
| 5.2.1.3 Write One Byte to Valid DPCD Address                                                                                          | 0    | 0    | 0    | 0    |             |
| 5.2.1.4 Write Nine Bytes to Valid DPCD Addresses                                                                                      | 0    | 0    | 0    | 0    |             |
| 5.2.1.5 Write EDID Offset (One Byte I2C-Over-AUX Write)                                                                               | 0    | 0    | 0    | 0    |             |
| 5.2.1.6 Read One EDID Byte (One Byte I2C-Over-AUX Read)                                                                               | 0    | 0    | 0    | 0    |             |
| 5.2.1.7 EDID Read (1 Byte I2C-Over-AUX Segment Write, 1 Byte I2C-Over-AUX Offset Write, 128 Byte I2C-Over-AUX Read)                   | 0    | 0    | 0    | 0    |             |
| 5.2.1.8 Illegal AUX Request Syntax                                                                                                    | 0    | 0    | 0    | 0    |             |
| 5.2.1.9 Glitch Rejection                                                                                                              | 0    | 0    | 0    | 0    |             |
| 5.2.1.10 Interleaved EDID and DPCD Receiver Capability Read                                                                           | 0    | 0    | 0    | 0    |             |
| 5.2.1.11 Downstream Stop on MOT Reset                                                                                                 | 0    | 0    | 0    | 0    |             |
| 5.2.1.12 Downstream Stop on Timeout                                                                                                   | 0    | 0    | 0    | 0    |             |
| 5.2.2.1 Sink Organizationally Unique Identifier (OUI)                                                                                 | 0    | 0    | 0    | 0    |             |
| 5.2.2.2 Sink Count                                                                                                                    | 0    | 0    | 0    | 0    |             |
| 5.2.2.3 Sink Status                                                                                                                   | 0    | 0    | 0    | 0    |             |
| 5.2.2.5 DPCD Address Range                                                                                                            | 0    | 0    | 0    | 0    |             |
| 5.2.2.6 Number of Receiver Ports                                                                                                      | 0    | 0    | 0    | 0    |             |
| 5.2.2.7 Main Link Channel Coding                                                                                                      | 0    | 0    | 0    | 0    |             |
| 5.2.2.8 ESI Field Mapping                                                                                                             | 0    | 0    | 0    | 0    |             |
| 5.2.2.9 Sink Device Symbol Error Count                                                                                                | 0    | 0    | 0    | 0    |             |
| 5.3.1.1 Successful Link Training at All Supported Lane Counts and Link Speeds                                                         | 0    | 0    | 0    | 0    |             |
| 5.3.1.2 Successful Link Training with Request of Higher Differential Voltage Swing During Clock Recovery Sequence                     | 0    | 0    | 0    | 0    |             |
| 5.3.1.3 Successful Link Training to a Lower Link Rate Due to Clock Recovery Lock Failure During Clock Recovery Sequence               | 0    | 0    | 0    | 0    |             |
| 5.3.1.4 Successful Link Training with Request of a Change to Pre-Emphasis and/or Voltage Swing Setting During Clock Recovery Sequence | 0    | 0    | 0    | 0    |             |
| 5.3.1.5 Successful Link Training at Lower Link Rate Due to Loss of Symbol Lock During Channel Equalization                            | 0    | 0    | 0    | 0    |             |
| 5.3.1.6 Lane Count Reduction                                                                                                          | 0    | 0    | 0    | 0    |             |
| 5.3.1.7 Lane Count Increase                                                                                                           | 0    | 0    | 0    | 0    |             |

Run Checked Select Configure Import Export Stop on Failure Repeats: 1 Delay time, sec 1 Save Report Clear Selected Clear All

1 tests started.  
[2024-11-22, 09:35:59.796]: 0000.000.002: Start test "5.2.1.1 Read One Byte from Valid DPCD Address"  
[2024-11-22, 09:35:59.796]: 0000.081.260: Setting 1s timeout  
[2024-11-22, 09:35:59.796]: 0000.081.329: Set Defer Retry Counter = 0  
[2024-11-22, 09:35:59.797]: 0000.082.053: Reference Source reads 1 byte from address 0000h  
[2024-11-22, 09:35:59.797]: 0000.082.116: AUX RD: 0x000000: 1  
[2024-11-22, 09:35:59.887]: 0000.082.914: AUX ACK  
[2024-11-22, 09:35:59.887]: 0000.082.958: Defer Retry Counter = 0  
[2024-11-22, 09:35:59.887]: 0000.083.015: AUX data: 14  
[2024-11-22, 09:35:59.887]: 0000.084.102: Reference source checks reply and verifies that read bytes R0 match Sink DUT's Receiver Capability Field  
[2024-11-22, 09:35:59.887]: 0000.084.163: Read byte R0 matches first byte of Sink DUT's Receiver Capabilities  
[2024-11-22, 09:35:59.887]: 0000.084.586: Test PASSED: "5.2.1.1 Read One Byte from Valid DPCD Address"  
\*\*\* Test Complete -- PASSED \*\*\*  
Test execution finished

HPD  
Asserted

UCD Console - UCD-422 [2226C529]: HDMI Source and Sink

File Tools Window Help

HDMI RX Event Log Memory Layout Terminal HDMI TX

Link Pattern Generator Playback Audio Generator HDCP EDID SCDC Cable Info Sink DUT Testing CEC

All tests  
VRR Sink DUT Tests  
HDMI TX DSC LL CTS  
Connection Test  
Cable Test

Name

| Name                                                                                     | Pass | Fail | Skip | Runs | Last status |
|------------------------------------------------------------------------------------------|------|------|------|------|-------------|
| VRR Sink DUT Tests                                                                       | 0    | 0    | 0    | 0    |             |
| VRR static test                                                                          | 0    | 0    | 0    | 0    |             |
| QMS test                                                                                 | 0    | 0    | 0    | 0    |             |
| VRR Dynamic test                                                                         | 0    | 0    | 0    | 0    |             |
| HDMI TX DSC LL CTS                                                                       | 0    | 0    | 0    | 0    |             |
| HFR2-80: Sink Video Timing (FRL w/ DSC) - Sub-4320p 4:4:4 8 bpc Primary Compressed Fo... | 0    | 0    | 0    | 0    |             |
| HFR2-81: Sink Video Timing (FRL w/ DSC) - 4320p 4:4:4 8 bpc Primary Compressed Fo...     | 0    | 0    | 0    | 0    |             |
| HFR2-82: Sink Video Timing (FRL w/ DSC) - Sub-4320p 10 bpc/12 bpc RGB Primary C...       | 0    | 0    | 0    | 0    |             |
| HFR2-83: Sink Video Timing (FRL w/ DSC) - 4320p 10 bpc/12 bpc RGB Primary Compr...       | 0    | 0    | 0    | 0    |             |
| HFR2-84: Sink Video Timing (FRL w/ DSC) - Sub-4320p 4:2:2 and 4:2:0 Primary Compr...     | 0    | 0    | 0    | 0    |             |
| HFR2-85: Sink Video Timing (FRL w/ DSC) - 4320p 4:2:2 and 4:2:0 Primary Comprese...      | 0    | 0    | 0    | 0    |             |
| Connection Test                                                                          | 0    | 0    | 0    | 0    |             |
| Continuity Connection Test                                                               | 0    | 1    | 0    | 1    | Fail        |
| Cable Test                                                                               | 0    | 0    | 0    | 0    |             |
| Cable Check Test                                                                         | 0    | 0    | 0    | 0    |             |

Run Checked Select Configure Import Export Stop on Failure Repeats: 1 Delay time, sec 1 Save Report Clear Selected Clear All

[2025-06-13, 13:24:30.552]: 0036.125.404: SCDC Lane2 Error Count(0x54, 0x55) = 0  
[2025-06-13, 13:24:30.552]: 0036.125.464: SCDC Lane3 Error Count(0x57, 0x58) is invalid!!!  
[2025-06-13, 13:24:30.552]: 0036.125.517:  
[2025-06-13, 13:24:31.546]: 0037.126.319:  
[2025-06-13, 13:24:31.546]: 0037.126.319: -----  
[2025-06-13, 13:24:31.546]: 0037.126.392: HPD is present  
[2025-06-13, 13:24:31.546]: 0037.126.858: SCDC Sink Version(0x01) = 0x01  
[2025-06-13, 13:24:31.546]: 0037.127.344: SCDC Status Flag(0x40) = 0x4F  
[2025-06-13, 13:24:31.546]: 0037.128.581: SCDC Lane0 Error Count(0x50, 0x51) = 0  
[2025-06-13, 13:24:31.546]: 0037.128.655: SCDC Lane1 Error Count(0x52, 0x53) = 0  
[2025-06-13, 13:24:31.546]: 0037.128.714: SCDC Lane2 Error Count(0x54, 0x55) = 0  
[2025-06-13, 13:24:31.546]: 0037.128.774: SCDC Lane3 Error Count(0x57, 0x58) is invalid!!!  
[2025-06-13, 13:24:31.546]: 0037.128.833:  
[2025-06-13, 13:24:32.559]: 0038.129.980:  
[2025-06-13, 13:24:32.559]: 0038.129.980: -----  
[2025-06-13, 13:24:32.559]: 0038.130.053: HPD is present  
[2025-06-13, 13:24:32.559]: 0038.130.519: SCDC Sink Version(0x01) = 0x01  
[2025-06-13, 13:24:32.559]: 0038.131.004: SCDC Status Flag(0x40) = 0x4F  
[2025-06-13, 13:24:32.559]: 0038.132.238: SCDC Lane0 Error Count(0x50, 0x51) = 0  
[2025-06-13, 13:24:32.559]: 0038.132.300: SCDC Lane1 Error Count(0x52, 0x53) = 0  
[2025-06-13, 13:24:32.559]: 0038.132.358: SCDC Lane2 Error Count(0x54, 0x55) = 0  
[2025-06-13, 13:24:32.559]: 0038.132.419: SCDC Lane3 Error Count(0x57, 0x58) is invalid!!!

HPD  
Asserted

online

Select the tests for execution by checking checkboxes or by clicking the test name. *All tests* item on the left hand side is really just for viewing all tests available. Select the desired test category (ex. *DP 1.4 LL CTS*) when running tests.

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Run/Run Checked:</i> | Select to start selected/checked tests. Once tests are running the <i>Run Checked</i> button is relabeled <i>Abort</i> to stop the test sequence if desired.                                                                                                                                                                                                                                                                                                                                                                              |
| <i>Select:</i>          | Includes three sets of options: <i>Select All</i> , <i>Clear All</i> , <i>Invert All</i> for changing the tests current selections; <i>Save</i> (checked items), <i>Load</i> (and check relevant items), <i>Remove</i> (named tests list) for handling named templates; <i>Import</i> (check all items contained in file) and <i>Export</i> (save all checked items to file) for loading and saving file-based templates. Do not confuse <i>Import</i> and <i>Export</i> with those below: These are for setting and saving tests to run. |
| <i>Configure:</i>       | Opens a test parameters dialog for the selected test set. Make sure a test category other than <i>All tests</i> is selected. Refer to <i>Test Parameters</i> below for details.                                                                                                                                                                                                                                                                                                                                                           |
| <i>Import:</i>          | Load saved test parameter files (*.td or *.json) for into UCD Console. Select <i>Configure</i> to see current parameters. Loading *.td files to UCD Console is currently unreliable.                                                                                                                                                                                                                                                                                                                                                      |
| <i>Export:</i>          | Save test parameters for later use or for use in test automation. For saving parameters for later use in UCD Console, either format can be used. For saving parameters for TSI scripting, please use *.td files. For use with Python applications, use *.json files.                                                                                                                                                                                                                                                                      |
| <i>Stop on Failure:</i> | Stops execution of tests if one fails.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Repeats:</i>         | Number of times to repeat the selected test sequence.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <i>Delay time:</i>      | Delay in seconds between individual tests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

On completion of each test the result of the test is displayed in the table columns on the right. For each test the table lists the number *Pass*, *Fail*, *Skips*, *Runs* and *Last Status* (status of last run).

|                       |                                                                                                                                             |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Save Report:</i>   | Select to generate a HTML report file. This will also open a tab in the default browser and display the results.                            |
| <i>Clear Selected</i> | Clear the test results of the <i>selected</i> (not checked) tests results. A subsequently saved report will not include these test results. |
| <i>Clear All:</i>     | Clear the test log view and the outstanding results.                                                                                        |

## Test Parameters

Each test set has its dedicated set of test parameters. To open a dialog for defining the parameters click *Configure*.

Description of parameters for each test set can be found within the description of tests in Appendix E of this document.

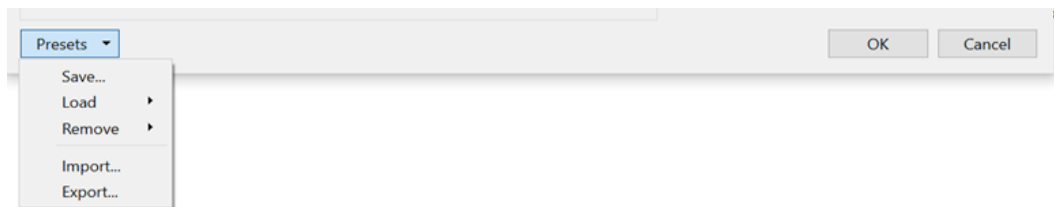
## Saving Test Parameters

Test parameters can be saved in various ways.

- Export parameters in *Sink DUT Testing* tab to a \*.td file for later use in UCD Console, to run TSI scripts, or to share test parameters with someone. Presently importing \*.td files into UCD Console is unreliable.
- Export parameters in *Sink DUT Testing* tab to a \*.json file for later use in UCD Console, to run Python scripts, or to load test parameters into UCD Console.
- Save parameters in *Configure* dialog as Presets later to be used in UCD Console. See description below.

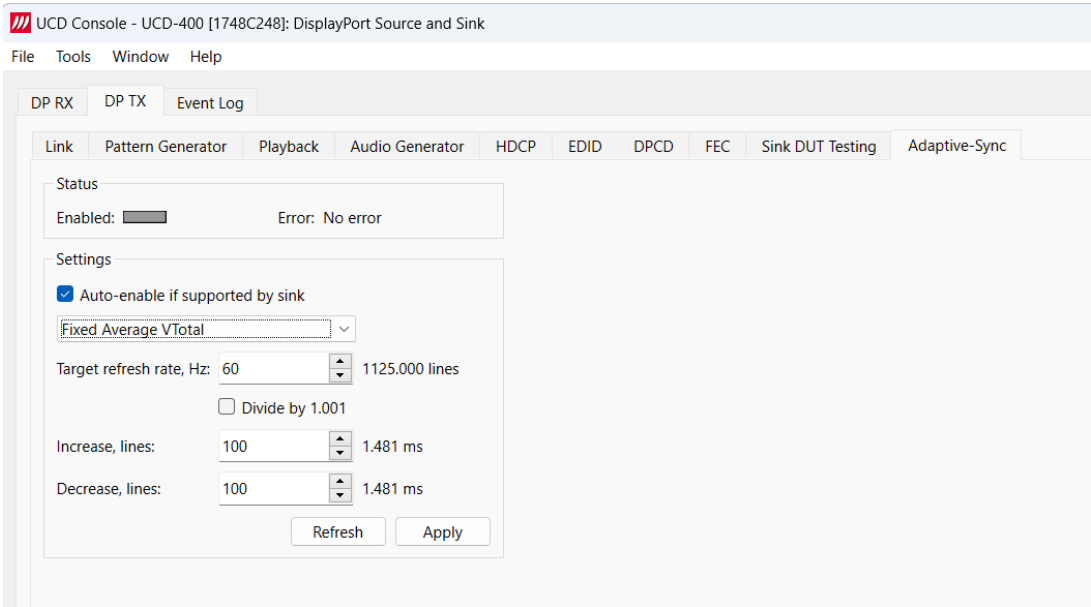
### Presets

All *Configure* dialogs selected parameters can be saved and loaded via *Presets* dropdown menu. Select *Save* or *Load* for named internal configuration parameter sets. Select *Remove* to delete a named internal set. Select *Import* and *Export* for loading and saving parameter sets from and to external files. Note that *importing* and *Exporting* \*.json files here have a different format than importing those described above.



# Adaptive-Sync Tab

Adaptive-Sync feature is available for Stream 0.



|                                               |                                                                                               |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------|
| <i>Auto enabled if supported by Sink:</i>     | The feature is enabled based on connected Sink status                                         |
| <i>Disabled:</i>                              | Feature is disabled unless <i>Auto Enabled ... box</i> is checked. Please see the note below. |
| <i>Adaptive Total, constant refresh rate:</i> | Added blank lines                                                                             |
| <i>Adaptive Total, Square pattern:</i>        | Added blank lines, min; Added blank lines, max; Period, frames.                               |
| <i>Adaptive VTotal, Zigzag pattern:</i>       | Added blank lines, min; Added blank lines, max; Increase, lines; Decrease, lines.             |
| <i>Fixed Average VTotal:</i>                  | Target refresh rate, Hz; Increase, lines; Decrease, lines                                     |

**Note:** Please note that in case *Auto enabled if supported by Sink* is selected and the connected Sink device supports Adaptive-Sync, but the selected mode is *Disabled*, then Adaptive-Sync is enabled in mode “*Adaptive Total, constant refresh rate*” with 0 (zero) added blank lines. Control dialog will be updated to indicate the status.

## DP and DP Alt Mode Reference Source

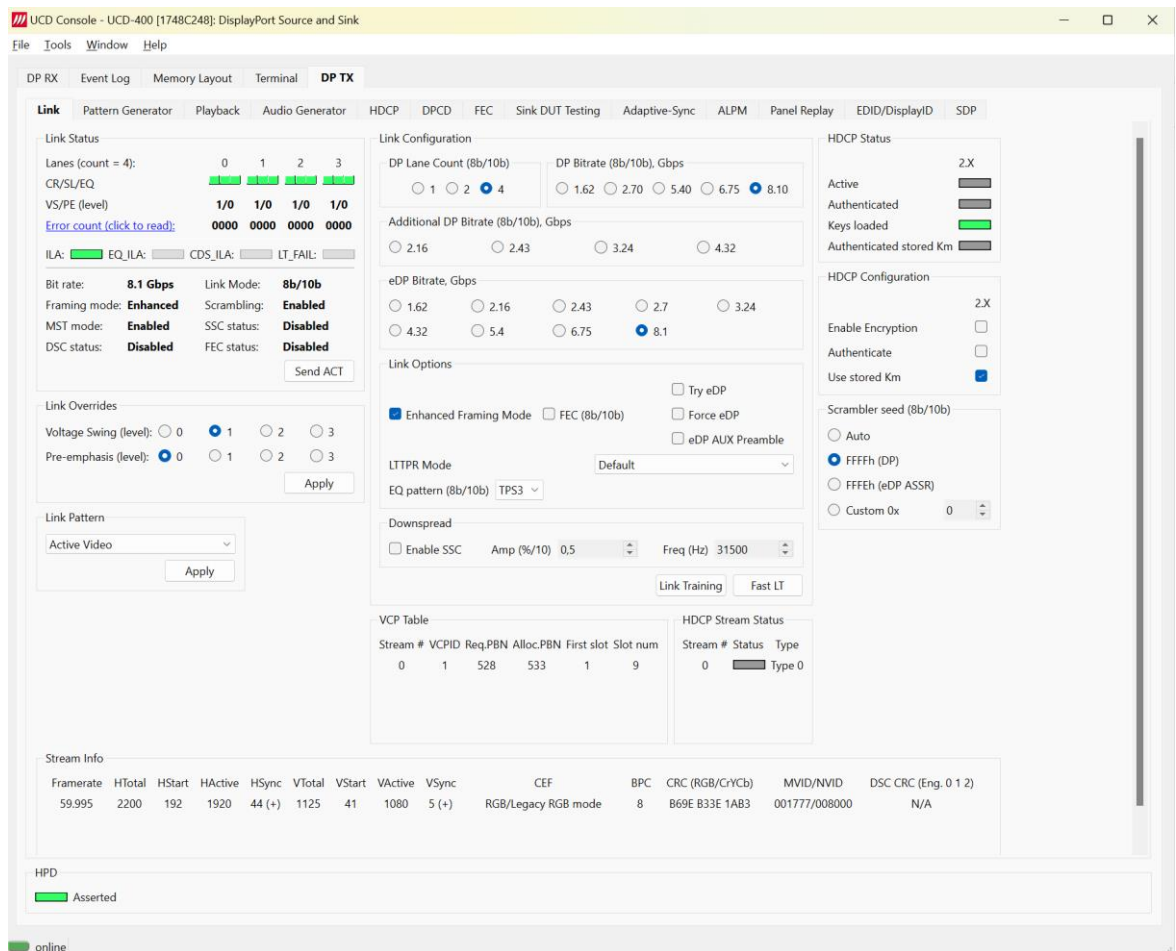
|                                            |                           |
|--------------------------------------------|---------------------------|
| Role:                                      | Product:                  |
| DP Reference Source (DP TX)                | UCD-400, UCD-411, UCD-451 |
| USB-C DP Alt Mode Reference Source (DP TX) | UCD-424                   |

When roles *DP Reference Source* or *DP Alt Mode Reference Source* are in use, the following interface specific tabs are available.

- Status information and control of the downstream link (Link).
- DPCD monitor (DPCD)
- Forward Error Correction (FEC)

### Link Tab

Link tab shows the status and control items for the DisplayPort link.



Link Status

Link Status displays the status of the link training and the link parameters negotiated between the connected Sink and UCD Source. It also lists status of other link modes. The data is retrieved from the DPCD status registers of the connected Sink. The status is updated automatically.

Link Status

|                              |             |             |             |             |
|------------------------------|-------------|-------------|-------------|-------------|
| Lanes (count = 4):           | 0           | 1           | 2           | 3           |
| CR/SL/EQ                     | <div></div> | <div></div> | <div></div> | <div></div> |
| VS/PE (level)                | 1/0         | 1/0         | 1/0         | 1/0         |
| Error count (click to read): | -           | -           | -           | -           |

ILA:  EQ\_ILA:  CDS\_ILA:  LT\_FAIL:

|               |          |             |          |
|---------------|----------|-------------|----------|
| Bit rate:     | 8.1 Gbps | Link Mode:  | 8b/10b   |
| Framing mode: | Enhanced | Scrambling: | Enabled  |
| MST mode:     | Disabled | SSC status: | Disabled |
| DSC status:   | Disabled | FEC status: | Disabled |

Send ACT

|                |                                                                                  |
|----------------|----------------------------------------------------------------------------------|
| Lanes:         | Indicates the number of lanes used for DisplayPort or DisplayPort Alt Mode.      |
| CR/SL/EQ:      | LED indicators for status of Clock Recovery / Symbol Lock / Channel Equalization |
| VS/PE (level): | Voltage Swing / Pre-emphasis level                                               |
| Error count:   | Content of DPCD Error Count registers                                            |
| ILA:           | Status LED for Inter-Lane Alignment                                              |
| Bit rate:      | Currently enabled link bit rate                                                  |
| Link mode:     | Currently enabled channel coding (8b/10b only)                                   |
| Framing mode:  | Status of Enhanced Framing symbol sequence                                       |
| Scrambling:    | Status of link data scrambling (Enabled or Disabled)                             |
| MST mode:      | Status of the Multistreaming (MST) mode                                          |
| SSC status:    | Status of down spreading of link frequency (SSC) function                        |
| DSC Status:    | Status of Display Stream Compression (DSC) function                              |
| FEC status:    | Status of Forward Error Correction (FEC) function.                               |
| Send ACT:      | Force sending an Allocation Change Trigger (ACT) sequence over the Main-Link     |

HPD

HPD

Asserted

Asserted: LED indicates status of Hot Plug Detect (HPD) signal

Link configuration

Set target capabilities for the link training. Click *Link Training* or *Fast LT* to apply.

Link Configuration

DP Lane Count (8b/10b)

1

2

4

DP Bitrate (8b/10b), Gbps

1.62

2.70

5.40

6.75

8.10

Additional DP Bitrate (8b/10b), Gbps

2.16

2.43

3.24

4.32

eDP Bitrate, Gbps

1.62

2.16

2.43

2.7

3.24

4.32

5.4

6.75

8.1

Link Options

Enhanced Framing Mode

FEC (8b/10b)

Try eDP

Force eDP

eDP AUX Preamble

LTTTPR Mode

Default

EQ pattern (8b/10b)

TPS3

Downspread

Enable SSC

Amp (%/10)

0,5

Freq (Hz)

31500

Link Training

Fast LT

|                                             |                                                                            |
|---------------------------------------------|----------------------------------------------------------------------------|
| <i>Number of Lanes</i>                      | Lane count used when 8b/10b link coding is selected in LT                  |
| <i>Bitrate, Gbps</i>                        | Link rate used when 8b/10b link coding is selected in LT                   |
| <i>Additional DP Bitrate (8b/10b), Gbps</i> | Additional bit rates available.                                            |
| <i>eDP Bitrate, Gbps</i>                    | Bitrates available for eDP.                                                |
| <i>Enhanced Framing Mode</i>                | Enable Enhanced Framing Mode.                                              |
| <i>FEC (8/10b)</i>                          | Enable Forward Error Correction feature (only in 8b/10b coding).           |
| <i>Try eDP</i>                              | Try to link with eDP.                                                      |
| <i>Force eDP</i>                            | Force eDP linking.                                                         |
| <i>eDP AUX Preamble</i>                     | Use <i>eDP AUX Preamble</i> protocol when linking.                         |
| <i>LTTTPR Mode</i>                          | Select LTTTPR mode; <i>Default, Ignore, Transparent, Non-Transparent</i> . |
| <i>EQ pattern (8b/10b)</i>                  | Pattern (8b/10b) to be used for equalization: auto, TPS2, TPS3 or TPS4.    |
| <i>Enable SSC</i>                           | Enable Downspread of link frequency (SSC).                                 |
| <i>Amp (‰)</i>                              | SSC Spreading Amplitude (0.1% to 2.5% in 0.01% steps).                     |
| <i>Freq (Hz)</i>                            | SSC Modulation frequency (30 to 33 kHz).                                   |

Link Overrides

Override Voltage Swing and Pre-emphasis levels selected during link training. Click **Apply** to validate changes. Overrides are applied immediately to DPTX transceiver when 'Apply' is clicked. Please note, that It affects main link signal amplitude and pulse shape only. No AUX exchange takes place. The change can be checked only with a scope. Overrides are removed at the beginning of the next link training.

Link Overrides

Voltage Swing (level): 

0

1

2

3

Pre-emphasis (level): 

0

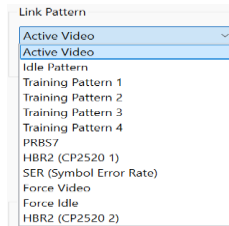
1

2

3

Apply

## Link Pattern



Select between Active video and audio, Idle pattern, or special bit patterns.

|                                |                                                                            |
|--------------------------------|----------------------------------------------------------------------------|
| <i>Active Video</i>            | Transmit Video Pattern, Audio and Metadata.                                |
| <i>Idle Pattern</i>            | Link is active but no stream data is being transmitted.                    |
| <i>Training Pattern 1</i>      | Send Link Training Pattern Sequence 1 (TPS1).                              |
| <i>Training Pattern 2</i>      | Send Link Training Pattern Sequence 2 (TPS2).                              |
| <i>Training Pattern 3</i>      | Send Link Training Pattern Sequence 3 (TPS3).                              |
| <i>Training Pattern 4</i>      | Send Link Training Pattern Sequence 4 (TPS4).                              |
| <i>PRBS7</i>                   | Send PRBS7 Link Quality Test Pattern.                                      |
| <i>HBR2 (CP2520 1)</i>         | Send HBR2 Compliance pattern <i>CP2520 1</i> .                             |
| <i>SER (Symbol Error Rate)</i> | Send Symbol Error Rate Measurement pattern                                 |
| <i>Force Video</i>             | Character error messages from sink will not interrupt video transmission.  |
| <i>Force Idle</i>              | Link Training and Active Video will not be initiated even after a re-plug. |
| <i>HBR2 (CP2520 2)</i>         | Send HBR2 Compliance pattern <i>CP2520 2</i> .                             |

### Note:

Please note that except for *Active Video* and *Idle Pattern*, Link Training will NOT be initiated on such events as cable re-plug, Long HPD pulse and IRQ\_HPDP pulse due to link loss.

After using the special bit patterns, in order to return to the default operation mode, please select *Active Video* and click *Apply*.

## Stream Info

Stream Info is achieved from the Main-Stream Attributes (MSA) of the stream.

| Stream Info | Framerate | HTotal | HStart | HActive | HSync  | VTotat | VStart | VActive | VSyn  | CEF                 | BPC | CRC (RGB/Cr/Cb) | MVID/NVID     | DSC CRC (Eng. 0 1 2) |
|-------------|-----------|--------|--------|---------|--------|--------|--------|---------|-------|---------------------|-----|-----------------|---------------|----------------------|
|             | 59.985    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001776/008000 | N/A                  |
|             | 59.995    | 2200   | 192    | 1920    | 44 (+) | 1125   | 41     | 1080    | 5 (+) | RGB/Legacy RGB mode | 8   | B69E B33E 1AB3  | 001777/008000 | N/A                  |

The content of *Stream Info* table can be copied by right-clicking on the table and selecting **Copy**.

|                  |                                                                              |
|------------------|------------------------------------------------------------------------------|
| <i>Framerate</i> | Vertical refresh rate                                                        |
| <i>HTotal</i>    | Horizontal total of transmitted main video stream, measured in pixel count.  |
| <i>HStart</i>    | Horizontal active start from leading edge of HSync, measured in pixel count. |
| <i>HActive</i>   | Horizontal active, number of active pixels in video line                     |
| <i>HSync</i>     | HSync width, measured in pixel count. (+)/(-) positive / negative sync.      |
| <i>VTotat</i>    | Vertical total of transmitted main video stream, measured in line count.     |
| <i>VStart</i>    | Vertical active start from leading edge of VSync, measured in line count.    |
| <i>VActive</i>   | Vertical active, number of active lines in video frame                       |
| <i>VSyn</i>      | VSync width, measured in line count. (+)/(-) positive v.s. negative sync.    |
| <i>CEF</i>       | Used color mode: Color format + subsampling / colorimetry                    |



|                        |                                                                                                                                             |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <i>BPC</i>             | Color depth in bits per color (BPC)                                                                                                         |
| <i>CRC (RGB/CrYCb)</i> | 16-bit Cyclic redundancy check (CRC) value per color component calculated from active pixels. Value order in YCbCr color format: Cr, Y, Cb. |
| <i>MVID/NVID</i>       | Mvid and Nvid video time stamp values                                                                                                       |
| <i>DSC CRC</i>         | 16-bit Cyclic redundancy check (CRC) calculated from compressed pixel stream. Value order Engine 0, 1, 2.                                   |

## VCP Table

| VCP Table |       |         |           |            |          |  |
|-----------|-------|---------|-----------|------------|----------|--|
| Stream #  | VCPID | Req.PBN | Alloc.PBN | First slot | Slot num |  |
| 0         | 1     | 532     | 540       | 1          | 9        |  |
| 1         | 2     | 532     | 540       | 10         | 9        |  |
| 2         | 3     | 532     | 540       | 19         | 9        |  |
| 3         | 4     | 532     | 540       | 28         | 9        |  |

VCP table shows allocation of Virtual Channel Payload for active virtual MST channels.

The content of *VCP Table* can be copied by right-clicking on the table and selecting **Copy**.

|                    |                                                                        |
|--------------------|------------------------------------------------------------------------|
| <i>Stream #:</i>   | Stream number where the virtual channel is directed.                   |
| <i>VCPID:</i>      | Stream identification number of the virtual channel.                   |
| <i>Req.PBN:</i>    | Requested PBN (payload bandwidth) value for the virtual channel        |
| <i>Alloc.PBN:</i>  | PBN value allocated for the virtual channel                            |
| <i>First slot:</i> | Time slot where the first VC Payload for the virtual channel is stored |
| <i>Slot num:</i>   | Number of VC Payload slots reserved for the virtual channel.           |

## Scrambler Seed

Scrambler seed (8b/10b)

☐ Auto  
☒ FFFFh (DP)  
☐ FFFEh (eDP ASSR)  
☐ Custom 0x

Selection of the value to which the Linear Feedback Shift Register (LFSR) is reset during scrambler reset. Used only when 8b/10b link coding is enabled.

## HDCP Status & Configuration

HDCP Status

2.X

Active ☒  
 Authenticated ☒  
 Keys loaded ☒  
 Authenticated stored Km ☒

HDCP Configuration

2.X

Enable Encryption ☐  
 Authenticate ☐  
 Use stored Km ☒

Copy of HDCP status and controls on HDCP tab.

## HDCP Stream Status

Shows HDCP stream status for each stream.

| HDCP Stream Status |                                     |        |
|--------------------|-------------------------------------|--------|
| Stream #           | Status                              | Type   |
| 0                  | <input checked="" type="checkbox"/> | Type 0 |
| 1                  | <input checked="" type="checkbox"/> | Type 0 |
| 2                  | <input checked="" type="checkbox"/> | Type 0 |
| 3                  | <input checked="" type="checkbox"/> | Type 0 |

SDP Configuration

SDP Configuration

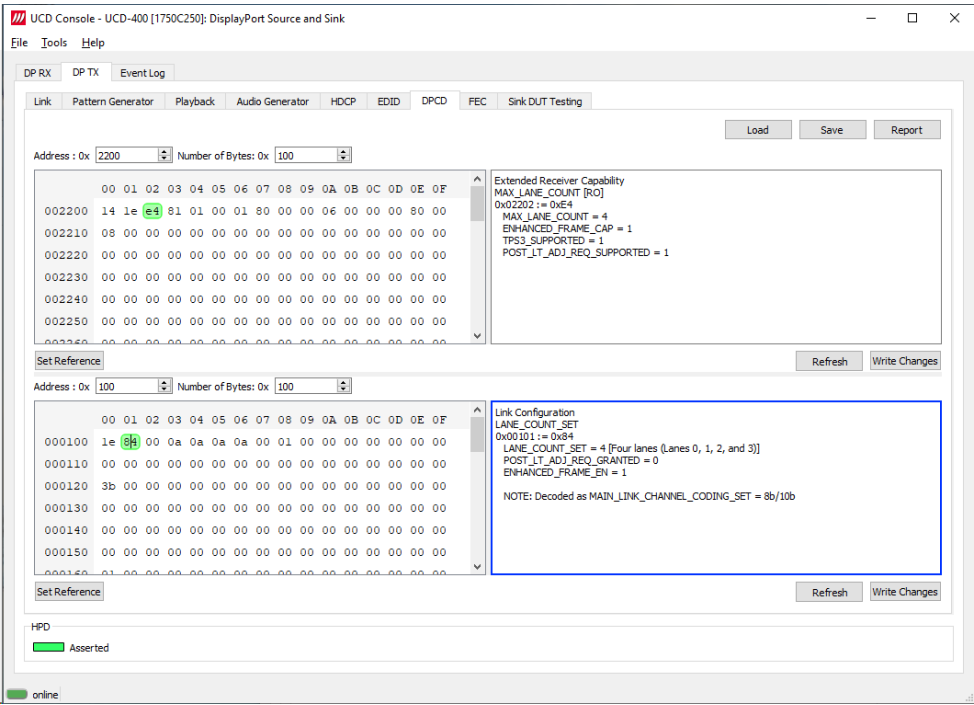
☐ Split SDP

Enable SDP Splitting.

**Note** Selecting this configuration option does not guarantee that SDP splitting will occur for a given configuration of the Video and Audio pattern generators. SDP splitting will take place when it makes sense and required for SDP splitting conditions are met.

DPCD Tab

DPCD tab is a tool for monitoring and editing the DPCD registers of the connected DisplayPort or DisplayPort Alt Mode Sink.



The *DPCD Decoder* panels on the right show the interpretation of the DPCD byte selected on the monitoring windows. The selected byte is shown with a green background.

- Save:

Select DPCD content to the PC (please see below).
- Load:

Retrieve previously saved DPCD data (please see below).
- Report:

Save parsed content of selected DPCD register ranges as HTML file
- Refresh:

Re-read the data from the DPCD registers to the window in question
- Write Changes:

To program the data into the DPCD registers of the connected Sink
- Set Reference:

Store currently shown data as a reference for comparison

When the data is *Refreshed* from the DPCD registers the changed bytes will be highlighted with **blue** color. The fields edited by the user will be highlighted with **red** color.

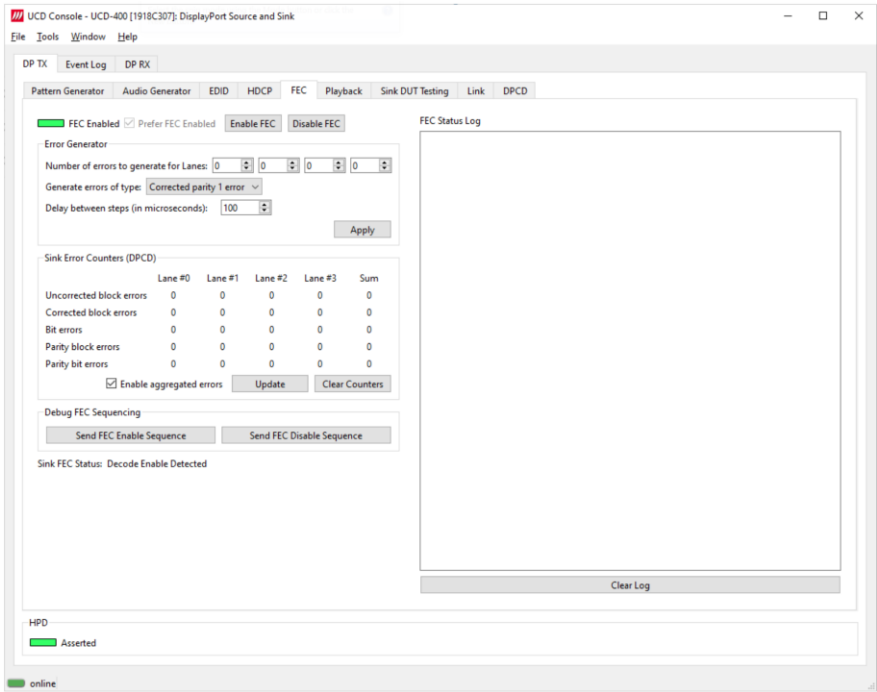
Saving and Loading DPCD Content

DPCD data in the selected address areas can be saved as a file in your PC. There are three alternative formats listed below. Please select the intended format when saving:

- Binary *DPCD Data File* format (\*.DPD). This is Unigraf proprietary format. You can also load the DPCD content stored in this format.
- *Comma Separated Value* format (.CSV)
- *HEX Dump* (\*.HEX) in a human readable text format.

FEC Tab

Forward Error Correction (FEC) can be enabled if connected sink supports it. For debug purposes, error injection to Main-link is possible. There is an error type for each standard sink DPCD error counter.



|                           |                                                                                                                         |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <i>Enable FEC</i>         | UCD will verify if connected sink supports FEC and begins the handshake for enabling FEC.                               |
| <i>Disable FEC</i>        | UCD will start the FEC disable handshake.                                                                               |
| <i>Prefer FEC Enabled</i> | If selected, and the connected sink supports FEC, UCD will start the FEC Enable Sequence after a successful connection. |

Error Generator

Selections will set how many errors will be inserted into one FEC block and to which link symbols. There are five options:

|                          |                                                 |
|--------------------------|-------------------------------------------------|
| Uncorrected block        | 3 symbol errors with 3 error bits together      |
| Corrected block          | 2 symbol errors with 2 error bits together      |
| Corrected parity         | 2 parity byte errors with 2 error bits together |
| Corrected block 1 error  | 1 symbol error with 1 error bit together        |
| Corrected parity 1 error | 1 parity byte error with 1 error bit together   |

**Note:** FEC must be enabled and running before errors can be added.  
Link training will reset sink FEC error counters.

Each lane can have its individual error amount. When only one lane is enabled, errors can be injected to even and odd decoders by using **lane #0** and **lane #1** counters.

|               |                                            |
|---------------|--------------------------------------------|
| <i>Apply</i>  | Start error injection                      |
| <i>Update</i> | Read sink DPCD FEC error counter registers |

*Clear counters*

Clear sink DPCD FEC error counter registers

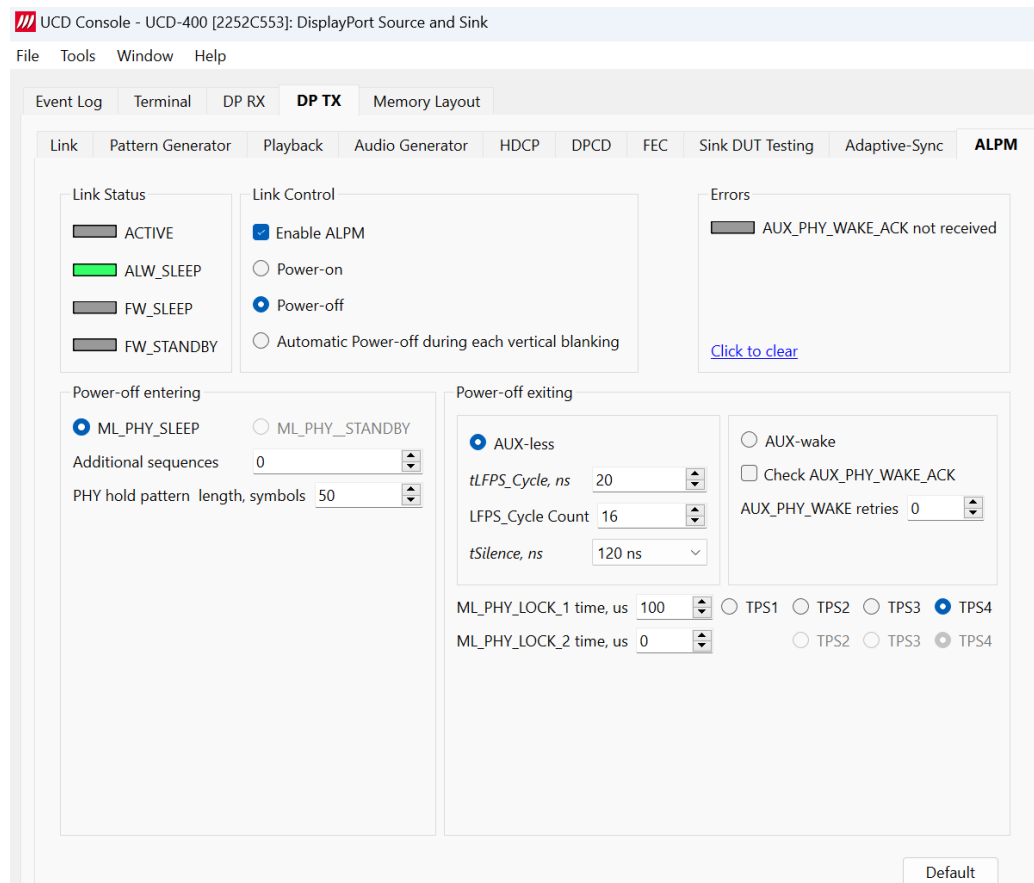
*Send FEC Enable Sequence*

UCD-4XX will start adding FEC Enable Sequence in its main link data.

*Send FEC Disable Sequence*

UCD-4XX will start adding FEC Disable Sequence in its main link data.

## ALPM Tab



*Link Status* panel shows current ALPM status.

*Link Control* panel is for enabling ALPM and for setting ALPM state.

*Power-off entering* offers two modes via radio buttons *ML\_PHY\_SLEEP* and *ML\_PHY\_STANDBY*. *Additional sequences* and *PHY hold pattern length, symbols* can be set via the combo boxes.

*Power-off exiting* offers two methods via the *AUX-less* and *AUX\_wake* radio buttons. Parameters for each can be set via the widgets in the respective groups.

If the *AUX\_wake* method is selected and *AUX\_PHY\_WAKE\_ACK* is checked and the sink does not respond with *AUX\_PHY\_WAKE\_ACK*, the *Errors* group *AUX\_PHY\_WAKE\_ACK not received* indicator will be lit.

*ML\_PHY\_LOCK\_1* and *ML\_PHY\_LOCK\_2* times may be set along with their patterns: TPS1 – TPS4. *ML\_PHY\_LOCK\_2* is available if TPS1 is selected for *ML\_PHY\_LOCK\_1*.

# HDMI Reference Source

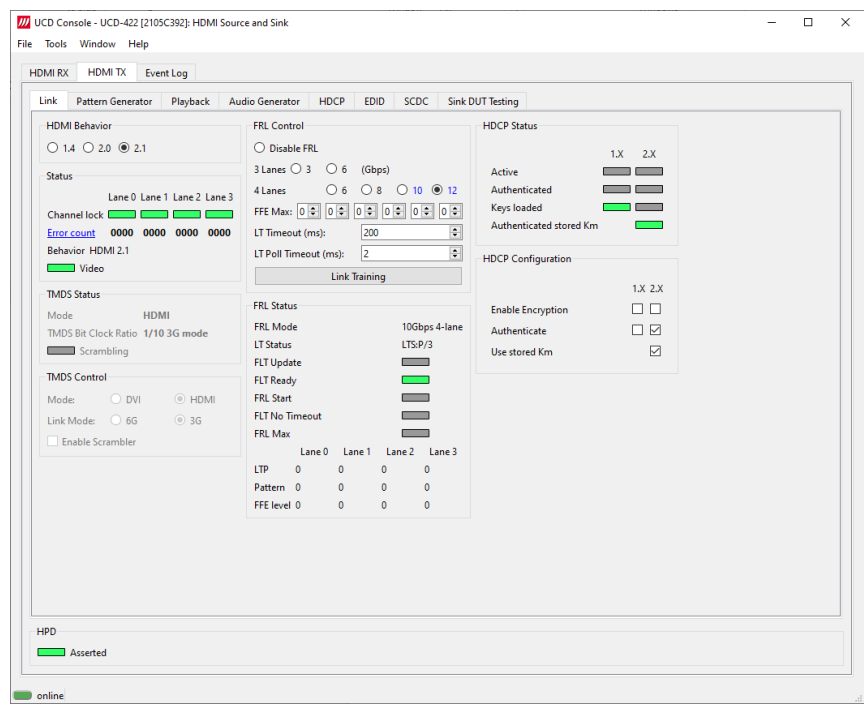
|                                 |                           |
|---------------------------------|---------------------------|
| Role:                           | Product:                  |
| HDMI Reference Source (HDMI TX) | UCD-422, UCD-412, UCD-452 |

When roles *HDMI Reference Source* is in use, the following interface specific tabs are available.

- Status information and control of the downstream link (Link)
- SCDC monitor (SCDC)

## Link Tab

Link tab shows the status and control items for the HDMI link.



## HDMI Behavior

Selection of the HDMI version to be used (HDMI 1.4 / HDMI 2.0 / HDMI 2.1).

## Status

|                      |                                                                     |
|----------------------|---------------------------------------------------------------------|
| <i>Channel lock:</i> | Status of Channel Lock in the four lanes.                           |
| <i>Error count:</i>  | Contents of the SCDC Error counter registers of the connected Sink. |
| <i>Behavior:</i>     | Assigned HDMI mode.                                                 |
| <i>Video</i>         | Video signal status.                                                |

TMDS Status (only in TMDS mode)

TMDS Status

Mode **HDMI**

TMDS Bit Clock Ratio **1/10 3G mode**

☒ Scrambling

TMDS Control

Mode: ☐ DVI ☒ HDMI

Link Mode: ☐ 6G ☒ 3G

☐ Enable Scrambler

|                       |                                                                                           |
|-----------------------|-------------------------------------------------------------------------------------------|
| Mode:                 | Status of the HDMI/TMDS mode (HDMI/DVI)                                                   |
| TMDS Bit Clock Ratio: | Status of TMDS_Bit_Clock_Ratio bit in SCDC – TMDS Configuration (1/10 or 1/40)            |
| Scrambling:           | Status of TMDS_Scrambler_Status bit in SCDC – TMDS Scrambler Status (1=LED on; 0=LED off) |

TMDS Control (only in TMDS mode)

|                   |                                                                                 |
|-------------------|---------------------------------------------------------------------------------|
| Mode:             | Selection of the HDMI/TMDS mode (HDMI/DVI)                                      |
| Link Mode:        | Selection of TMDS Bit Period / TMDS Clock Period ratio (1/10 or 1/40) (3G / 6G) |
| Enable Scrambler: | Control of Scrambling_Enable bit                                                |

FRL Control

FRL Control

☐ Disable FRL

3 Lanes ☐ 3 ☐ 6 (Gbps)

4 Lanes ☐ 6 ☐ 8 ☒ 10 ☐ 12

FFE Max:

LT Timeout (ms):

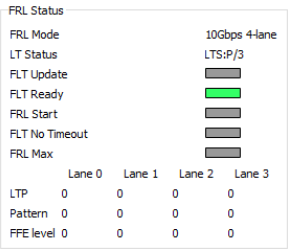
LT Poll Timeout (ms):

Link Training

|                           |                                                                |
|---------------------------|----------------------------------------------------------------|
| Disable FRL:              | Disable FRL mode                                               |
| Capability Radio Buttons: | Selection of the link mode used for FRL link training.         |
| FFE Max:                  | Set the maximum FFE level (0 to 4) supported for each FRL rate |
| LT Timeout:               | The time used for FLT Timer (default = 200 ms)                 |
| LT Poll Timeout:          | Poll interval for FLT_update flag (default = 2 ms)             |

Please click **Link Training** to apply

FRL Status

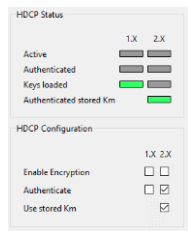


|                        |                                                                                                      |
|------------------------|------------------------------------------------------------------------------------------------------|
| <i>FRL Mode:</i>       | FRL Mode used by UCD-4XX HDMI source                                                                 |
| <i>LT Status:</i>      | FRL link training status of UCD-4XX HDMI source                                                      |
| <i>FLT Update:</i>     | Status of FLT_update flag in SCDC Update Flags register of the connected HDMI sink.                  |
| <i>FLT Ready:</i>      | Status of FLT_ready flag in SCDC Status Flags register of the connected HDMI sink.                   |
| <i>FRL Start:</i>      | Status of FLT_start flag in SCDC Update Flags register of the connected HDMI sink.                   |
| <i>FLT No Timeout:</i> | Status of FLT_no_timeout flag in SCDC Source Test Configuration register of the connected HDMI sink. |
| <i>FRL Max:</i>        | Status of FRL_Max flag in SCDC Source Test Configuration register of the connected HDMI sink.        |

Lane Status Matrix

|                   |                                                                                                    |
|-------------------|----------------------------------------------------------------------------------------------------|
| <i>LTP:</i>       | Status of Lnx_LTP_req (x = 0 to 3) fields in SCDC Status Flags register of the connected HDMI sink |
| <i>Pattern:</i>   | Link Training Pattern used (0 to 8)                                                                |
| <i>FFE Level:</i> | FFE level used (0 to 3)                                                                            |

HDCP Status



Copy of the status from HDCP Tab. Please refer to chapter *HDCP Tab* later in this document for detailed description.

HDCP Configuration

Enable and disable HDCP 1.4 or HDCP 2.3 capability of UCD-422 and UCD-412 Sink. Duplicates of the controls found in HDCP tab.

**Note:** Currently HDCP is not supported

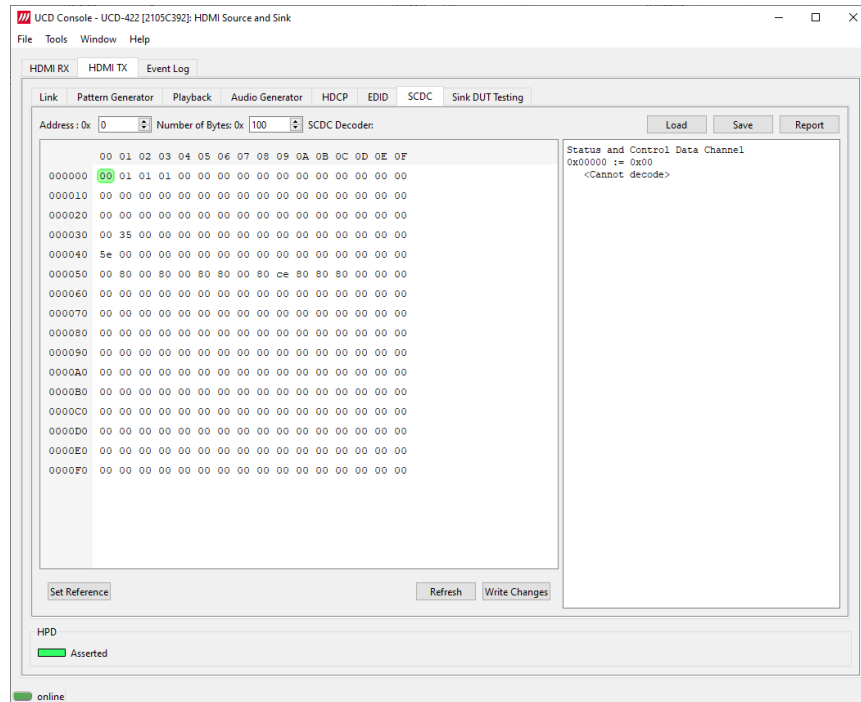
HPD (Bottom panel)

The status LED indicates the state of the HPD signal Asserted (logical “high”) or De-asserted (logical “low”).

## SCDC Monitor

SCDC monitor presents content of HDMI Status and Control Data Channel (SCDC) structured by its address range.

The *SCDC Monitor* panel on the right hand side shows the interpretation of the SCDC byte selected



on the monitoring windows. The selected byte is shown with a green outline.

**Save:** Select SCDC content to the PC (please see below).

**Load:** Retrieve previously saved SCDC data (please see below).

**Report:** Save parsed content of selected SCDC register ranges as HTML file

**Refresh:** Re-read the data from the SCDC registers to the window in question

**Write Changes:** To program the data into the SCDC registers of the connected Sink

**Set Reference:** Store currently shown data as a reference for comparison

When the data is *Refreshed* from the DPCD registers the changed bytes will be highlighted with **blue** color. The fields edited by the user will be highlighted with **red** color.

### Saving and Loading SCDC Content

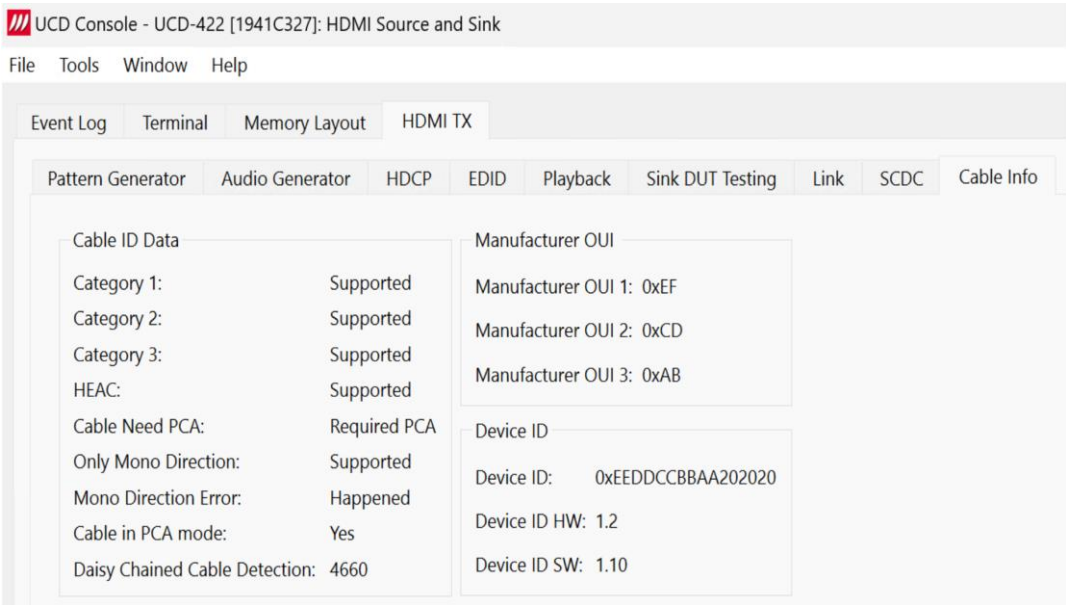
SCDC data in the selected address areas can be saved as a file in your PC. There are three alternative formats listed below. Please select the intended format when saving:

- Binary *SCDC Data File* format (\*.DPD). This is Unigraf proprietary format. You can also load the DPCD content stored in this format.
- *Comma Separated Value* format (.CSV)
- *HEX Dump* (\*.HEX) in a human readable text format.



Cable Info Tab

The *Cable Info* tab displays cable specifications.



CEC Tab

Source *CEC Tab* functions in exactly the same manner as for Sink CEC Tab [CEC Tab](#).

## USB-C Monitoring

Role:

Product:

USB-C DP Alt Mode Reference Source (USB-C TX) or

UCD-424

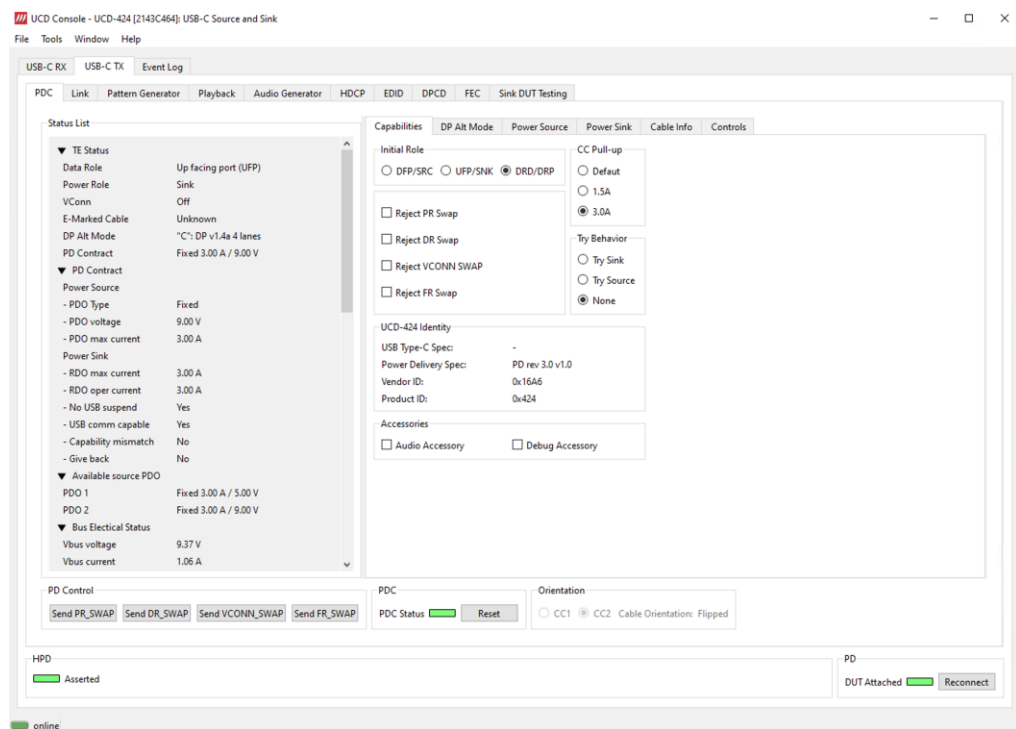
When *USB-C DP Alt Mode Reference Source* role is in use, the following interface specific tabs are available.

- USB-C Power Delivery (PDC)

## USB-C Power Delivery Tab

When UCD-424 is used in *DP Alt Mode Reference Source* role, *USB-C Power Delivery* tab is available. The content of *USB-C Power Delivery* tab is similar to the tab available when in UCD-424 is used in *DP Alt Mode Reference Sink* role.

Please refer to chapter USB-C Monitoring in section 4. Analyzer Operation earlier in this document.



## 6. HDMI LINK TIMELINE VIEWER

Role:

Product:

HDMI Reference Sink (HDMI RX)

UCD-422

*HDMI Link Timeline Viewer* is a tool for evaluating the content and timing of data captured via HDMI *Link Analyzer* functionality of UCD Console.

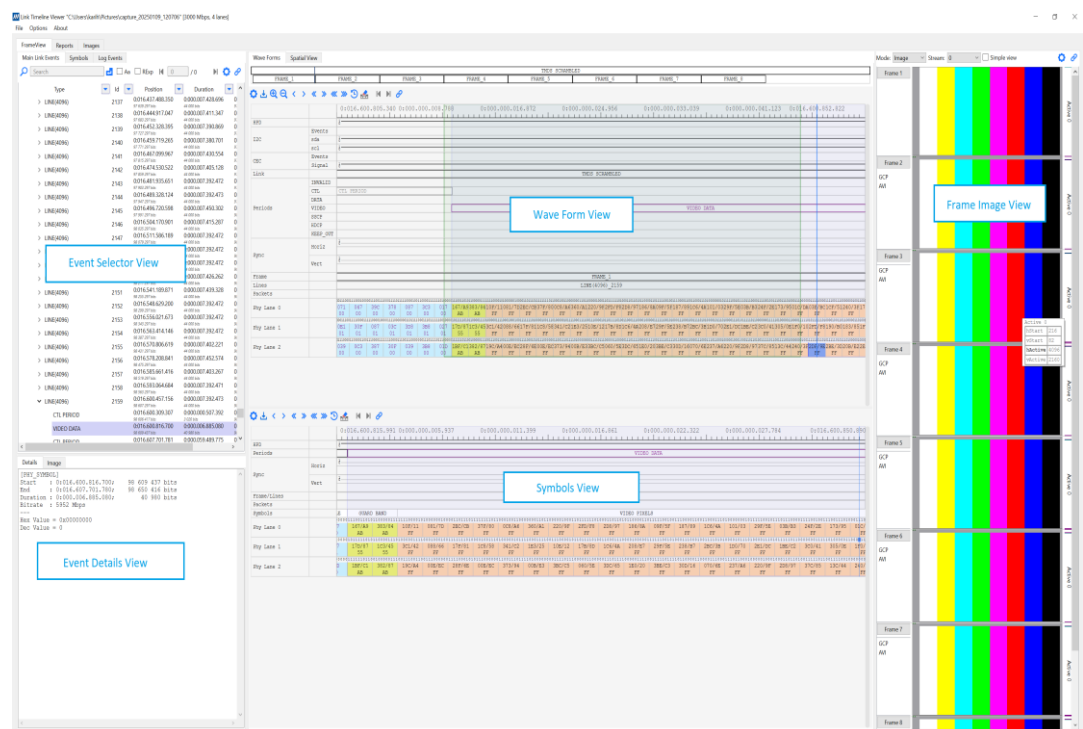
*HDMI Link Timeline Viewer* has three tabs (for three modes):

*FrameView* tab is the **primary** tab for analyzing captured events on the timeline.

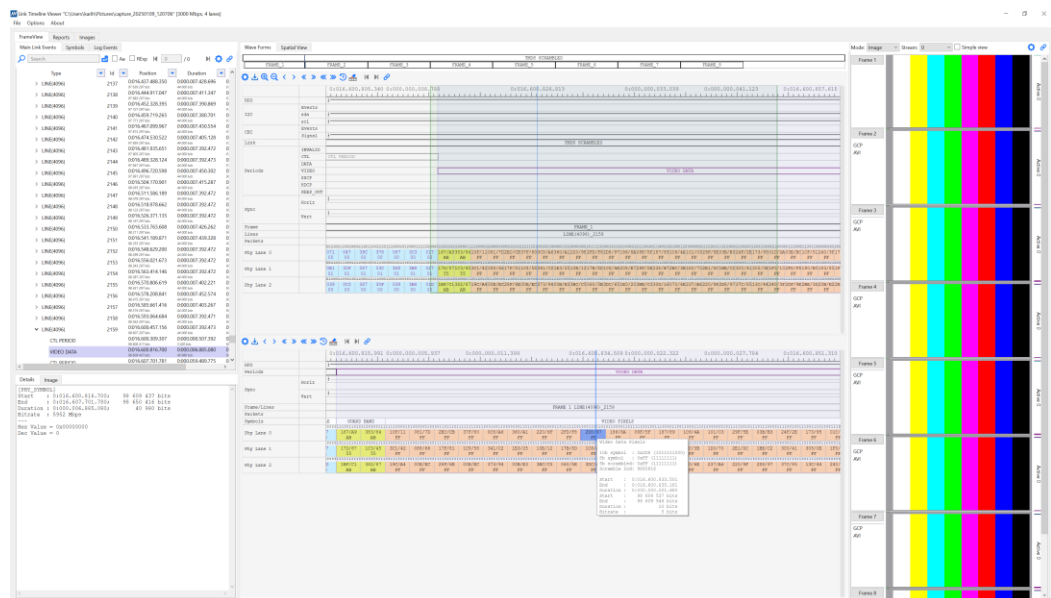
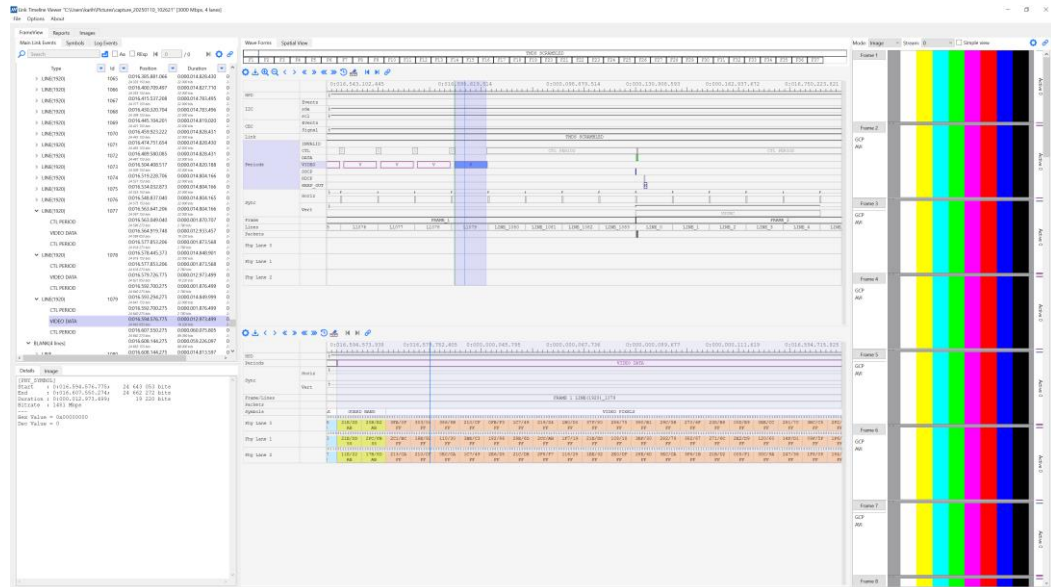
*Reports* tab can be used to summarize events (AUX at present).

*Images* tab lets the user view captured video frame images.

The *FrameView* tab and its views are shown below.

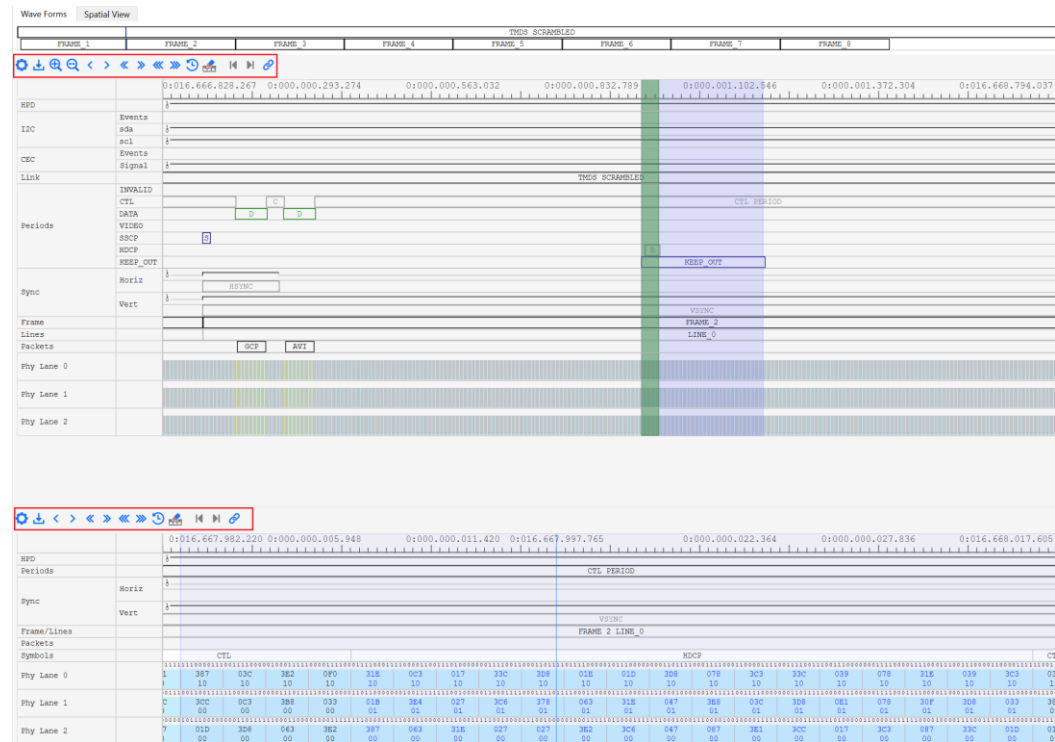


*Wave Form View* zoomed out and zoomed in views are shown below. Event periods are shown under the timeline (at the top) in their proper row as *period rectangles* with text descriptions (or abbreviations or no text, space permitting). Double-clicking a *period rectangle* will highlight the timeline portion of the rectangle and the row header(s) as shown below. To zoom the *Wave Form View*, position the cursor and use the mouse wheel to zoom in or out with respect to the cursor location. Drag to scroll the *Wave Form View* and the *Symbols View* horizontally.



## Wave Form and Symbols View Settings

Shown below are the *WaveForms View* and *Symbols Views* settings widgets.



### Gear Icon



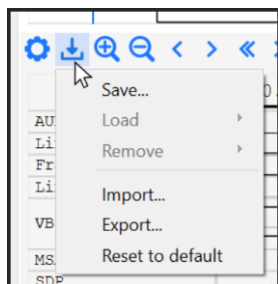
Select the *Gear* icon to select events to be displayed (+) or hidden (-). When *Gear* icon is selected, you can drag a row to reorder rows.

|                                     |            |            |
|-------------------------------------|------------|------------|
| <input checked="" type="checkbox"/> | RPD        | Events     |
| <input checked="" type="checkbox"/> | I2C        | sda        |
| <input checked="" type="checkbox"/> | I2C        | scl        |
| <input checked="" type="checkbox"/> | Link       | Events     |
| <input checked="" type="checkbox"/> | Link       | Signal     |
| <input checked="" type="checkbox"/> | Periods    | INVALID    |
| <input checked="" type="checkbox"/> | Periods    | CTL        |
| <input checked="" type="checkbox"/> | Periods    | DATA       |
| <input checked="" type="checkbox"/> | Periods    | VIDEO      |
| <input checked="" type="checkbox"/> | Periods    | SSCP       |
| <input checked="" type="checkbox"/> | Periods    | SSCP_OUT   |
| <input checked="" type="checkbox"/> | Sync       | Horiz      |
| <input checked="" type="checkbox"/> | Sync       | Vert       |
| <input checked="" type="checkbox"/> | Frame      | Frame      |
| <input checked="" type="checkbox"/> | Lines      | Lines      |
| <input checked="" type="checkbox"/> | Packets    | Packets    |
| <input checked="" type="checkbox"/> | Phy Lane 0 | Phy Lane 0 |
| <input checked="" type="checkbox"/> | Phy Lane 1 | Phy Lane 1 |
| <input checked="" type="checkbox"/> | Phy Lane 2 | Phy Lane 2 |
| <input checked="" type="checkbox"/> | CEC        | Events     |
| <input checked="" type="checkbox"/> | CEC        | Signal     |

### Save Icon



Select the *Save* icon to *Save*, *Load* or *Remove* named internal settings sets. You can also *Import* or *Export* named \*.json files containing settings or *Reset to default*.



## Zooming



Select *Zoom +* or *–* icons to zoom in and out or use the mouse wheel. The zooming in/out option applies to *Wave Form View* only.

## Scrolling



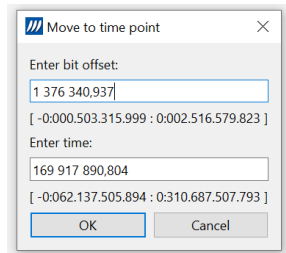
Use the arrow keys to navigate the timeline. One arrow moves the timeline one page, two arrows 10 pages and three 100 pages.

You can also scroll by dragging ( click and hold while dragging).

## Clock icon



Move to a time point. Enter values and press OK.



## Eraser



Removes all measurements on the timeline.

## Move to Previous or Next Frame



Move back or forward to the same relative location in the previous or next frame.

## Sync Data



Not synchronized.



Synchronized.

# FrameView Tab

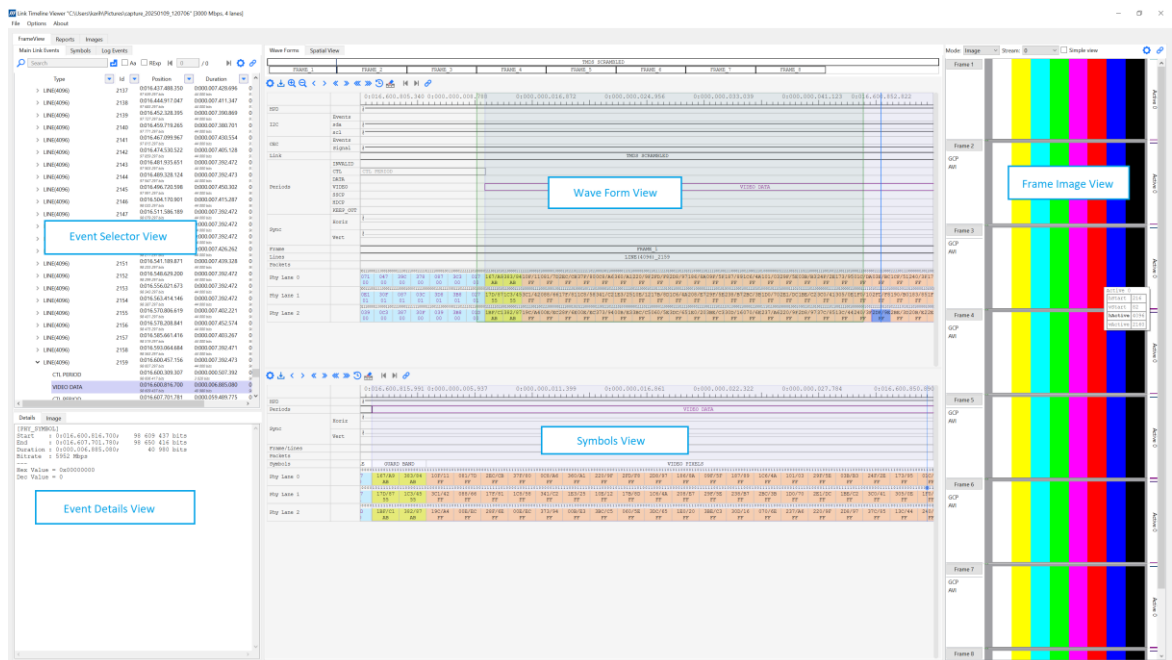
Frame View tab has three tabs: *Main Link Events*, *Symbols*, and *Log Events*.

The *Main Link Events* tab is the **primary** tab for analysis and is presented first.

## Main Link Events Tab

*Main Link Events* tab consists of five panels: Event Selector View, Event Details View, Wave Form View, Symbols View and Frame Image View.

Each of these views are synchronized and actions in one will be reflected in others.



## Event Selector View

*Event Selector View* events are presented as a folding list of *FRAMES*. Each *FRAME* contains a set of *BLANK LINES* followed by a set of *ACTIVE LINES* and finally by another short set of *BLANK LINES*. *BLANK LINES* contain items such as *CTR* periods and *DATA ISLAND* periods. *DATA ISLANDS* contain *HDMI data packets* such as *GCP* and *AVI* packets. *ACTIVE LINES* contain *CTRL* and *VIDEO DATA* items.

| Main Link Events                                                                                                             |    | Symbols                              | Log Events                           |                                      |  |  |  |  |
|------------------------------------------------------------------------------------------------------------------------------|----|--------------------------------------|--------------------------------------|--------------------------------------|--|--|--|--|
| <input type="text" value="Search"/> <input type="checkbox"/> Aa <input type="checkbox"/> RExp <input type="checkbox"/> 0 / 0 |    |                                      |                                      |                                      |  |  |  |  |
| Type                                                                                                                         | Id | Position                             | Duration                             | End                                  |  |  |  |  |
| ▼ FRAME                                                                                                                      | 1  | 0:020.239.117.146<br>30 055 212 bits | 0:016.666.598.436<br>24 750 000 bits | 0:036.905.715.582<br>54 805 211 bits |  |  |  |  |
| ▼ BLANK(41 lines)                                                                                                            |    |                                      |                                      |                                      |  |  |  |  |
| ▼ LINE                                                                                                                       | 0  | 0:020.239.117.146<br>30 055 212 bits | 0:000.607.404.920<br>902 000 bits    | 0:020.846.522.066<br>30 957 211 bits |  |  |  |  |
| CTL PERIOD                                                                                                                   |    | 0:020.179.265.539<br>29 966 332 bits | 0:000.060.107.497<br>89 260 bits     | 0:020.239.373.036<br>30 055 591 bits |  |  |  |  |
| ▼ DATA ISLAND PERIOD                                                                                                         |    | 0:020.239.373.037<br>30 055 592 bits | 0:000.000.242.422<br>360 bits        | 0:020.239.615.459<br>30 055 951 bits |  |  |  |  |
| GCP                                                                                                                          |    | 0:020.239.386.505<br>30 055 612 bits | 0:000.000.215.486<br>320 bits        | 0:020.239.601.991<br>30 055 931 bits |  |  |  |  |
| CTL PERIOD                                                                                                                   |    | 0:020.239.615.460<br>30 055 952 bits | 0:000.000.134.679<br>200 bits        | 0:020.239.750.139<br>30 056 151 bits |  |  |  |  |
| ▼ DATA ISLAND PERIOD                                                                                                         |    | 0:020.239.750.140<br>30 056 152 bits | 0:000.000.242.422<br>360 bits        | 0:020.239.992.562<br>30 056 511 bits |  |  |  |  |
| AVI                                                                                                                          |    | 0:020.239.763.608<br>30 056 172 bits | 0:000.000.215.486<br>320 bits        | 0:020.239.979.094<br>30 056 491 bits |  |  |  |  |
| CTL PERIOD                                                                                                                   |    | 0:020.239.992.563<br>30 056 512 bits | 0:000.607.808.959<br>902 600 bits    | 0:020.847.801.522<br>30 959 111 bits |  |  |  |  |
| ▶ LINE                                                                                                                       | 1  | 0:020.253.931.900<br>30 077 212 bits | 0:000.014.814.753<br>22 000 bits     | 0:020.268.746.653<br>30 099 211 bits |  |  |  |  |
| ▶ LINE                                                                                                                       | 2  | 0:020.268.746.654<br>30 099 212 bits | 0:000.014.814.753<br>22 000 bits     | 0:020.283.561.407<br>30 121 211 bits |  |  |  |  |
| ▶ LINE                                                                                                                       | 3  | 0:020.283.561.408<br>30 121 212 bits | 0:000.014.814.753<br>22 000 bits     | 0:020.298.376.161<br>30 143 211 bits |  |  |  |  |

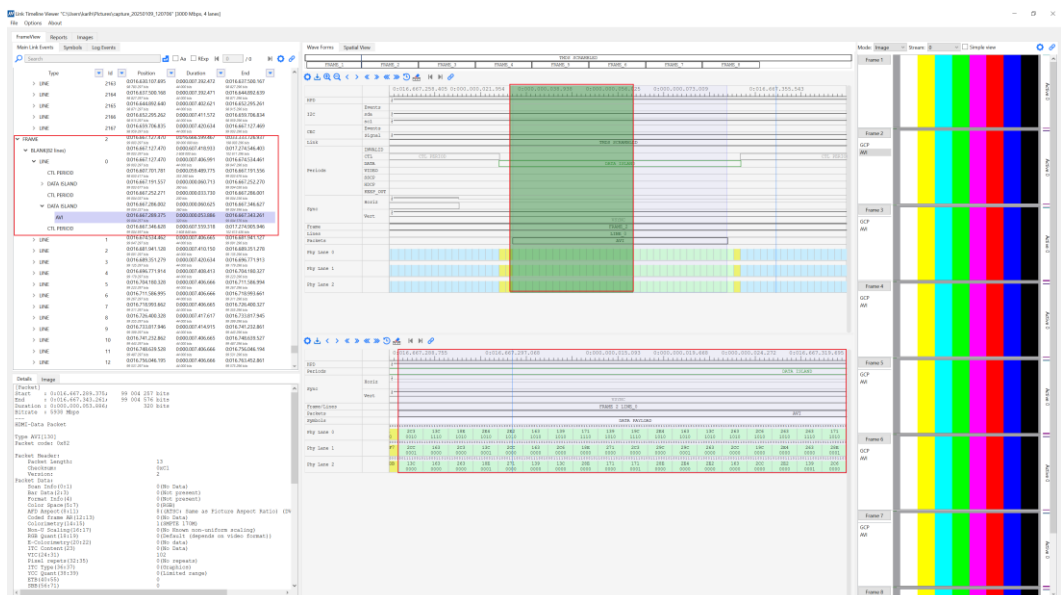
The timing format used in Link Timeline Viewer consists of two timings based on *time* and *bits*.

The time format is as follows:

*seconds:milliseconds.microseconds.nanoseconds.picoseconds*

In the image above you can see the time format on top and the bit format underneath (smaller grey font).

When clicking on a *Main Link Event*, both *Wave Form View* and *Symbol View* are focused, and the time stamp block of the item is highlighted as shown below.





Event timing details are shown in the columns are the following:

|                  |                                                    |
|------------------|----------------------------------------------------|
| <i>Type:</i>     | Type of item.                                      |
| <i>Id:</i>       | Items occurrence number.                           |
| <i>Position:</i> | Start of the event from start of the captured data |
| <i>Duration:</i> | Duration of the event                              |
| <i>End:</i>      | End of the event from start of the captured data   |

### Search

You can search events by typing its name in the Search bar and pressing *enter* or by clicking the *enter* icon. The events are highlighted and shown in *Wave Form View* and *Symbol View*.

| Type                 | Id | Position                                            | Duration                                            | End                                                 |
|----------------------|----|-----------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| ▼ FRAME              | 2  | 0:036.905.715.583<br><small>54 805 212 bits</small> | 0:016.666.598.437<br><small>24 750 000 bits</small> | 0:053.572.314.020<br><small>79 555 211 bits</small> |
| ▼ BLANK(41 lines)    |    | 0:036.905.715.583<br><small>54 805 212 bits</small> | 0:000.607.404.920<br><small>902 000 bits</small>    | 0:037.513.120.503<br><small>55 707 211 bits</small> |
| ▼ LINE               | 0  | 0:036.905.715.583<br><small>54 805 212 bits</small> | 0:000.014.814.753<br><small>22 000 bits</small>     | 0:036.920.530.336<br><small>54 827 211 bits</small> |
| CTL PERIOD           |    | 0:036.845.863.976<br><small>54 716 332 bits</small> | 0:000.060.107.497<br><small>89 260 bits</small>     | 0:036.905.971.473<br><small>54 805 591 bits</small> |
| ▶ DATA ISLAND PERIOD |    | 0:036.905.971.474<br><small>54 805 592 bits</small> | 0:000.000.242.423<br><small>360 bits</small>        | 0:036.906.213.897<br><small>54 805 951 bits</small> |
| CTL PERIOD           |    | 0:036.906.213.898<br><small>54 805 952 bits</small> | 0:000.000.134.678<br><small>200 bits</small>        | 0:036.906.348.576<br><small>54 806 151 bits</small> |
| ▼ DATA ISLAND PERIOD |    | 0:036.906.348.577<br><small>54 806 152 bits</small> | 0:000.000.242.423<br><small>360 bits</small>        | 0:036.906.591.000<br><small>54 806 511 bits</small> |
| AVI                  |    | 0:036.906.362.045<br><small>54 806 172 bits</small> | 0:000.000.215.487<br><small>320 bits</small>        | 0:036.906.577.532<br><small>54 806 491 bits</small> |
| CTL PERIOD           |    | 0:036.906.591.001<br><small>54 806 512 bits</small> | 0:000.607.808.958<br><small>902 600 bits</small>    | 0:037.514.399.959<br><small>55 709 111 bits</small> |
| ▶ LINE               | 1  | 0:036.920.530.337<br><small>54 827 212 bits</small> | 0:000.014.814.754<br><small>22 000 bits</small>     | 0:036.935.345.091<br><small>54 849 211 bits</small> |
| ▶ LINE               | 2  | 0:036.935.345.092<br><small>54 849 212 bits</small> | 0:000.014.814.753<br><small>22 000 bits</small>     | 0:036.950.159.845<br><small>54 871 211 bits</small> |

*Aa:* Makes search function case sensitive.

*RExp:* Use regular expressions.



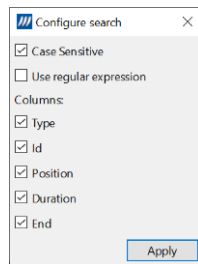
Click the enter icon to apply filters.

◀ 2 / 77 ▶

Click *Find Prev* and *Find Next* icons to navigate. Also shown is the instance (here instance 2 out of 77).



The gear icon opens *Configure search* dialog. In addition to settings described above, you can select which columns are shown in *Main Link Events* window.



Not synchronized.



Synchronized.

Click icons to synchronize data for view.

Symbols Tab

Symbols View lists all PERIODS.

Main Link EventsSymbolsLog Events

Search

Aa

RExp

0

/ 0

| Type               | Position                                            | La | Value    |
|--------------------|-----------------------------------------------------|----|----------|
| VIDEO DATA PERIOD  | 0:020.077.434.306<br><small>29 815 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.090.377.014<br><small>29 834 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.092.249.060<br><small>29 837 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.105.191.768<br><small>29 856 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.107.063.814<br><small>29 859 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.120.006.522<br><small>29 878 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.121.878.568<br><small>29 881 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.134.821.276<br><small>29 900 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.136.693.323<br><small>29 903 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.149.636.031<br><small>29 922 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.151.508.077<br><small>29 925 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.164.450.785<br><small>29 944 332 bits</small> | 0  | 00000000 |
| VIDEO DATA PERIOD  | 0:020.166.322.831<br><small>29 947 112 bits</small> | 0  | 00000000 |
| CTL PERIOD         | 0:020.179.265.539<br><small>29 966 332 bits</small> | 0  | 00000000 |
| DATA ISLAND PERIOD | 0:020.239.373.037<br><small>30 055 592 bits</small> | 0  | 00000000 |

Selection and multiview highlighting behavior is as for Main Link Events above.

Search criteria are the same as for Main Link Events above.

Each column has a sort and filter icon. Shown below is for the Type sort and filter icon.

TypePositionLa

Sort Ascending

Sort Descending

Clear Sort

Clear Filter

Search:

Select all

CTL PERIOD

DATA ISLAND PERIOD

UNKNOWN

VIDEO DATA PERIOD

Apply

Cancel

|   |   |          |
|---|---|----------|
| 6 | 0 | 00000000 |
| 4 | 0 | 00000000 |
| 0 | 0 | 00000000 |
| 8 | 0 | 00000000 |
| 4 | 0 | 00000000 |
| 2 | 0 | 00000000 |
| 8 | 0 | 00000000 |
| 6 | 0 | 00000000 |
| 3 | 0 | 00000000 |
| 1 | 0 | 00000000 |
| 7 | 0 | 00000000 |
| 5 | 0 | 00000000 |

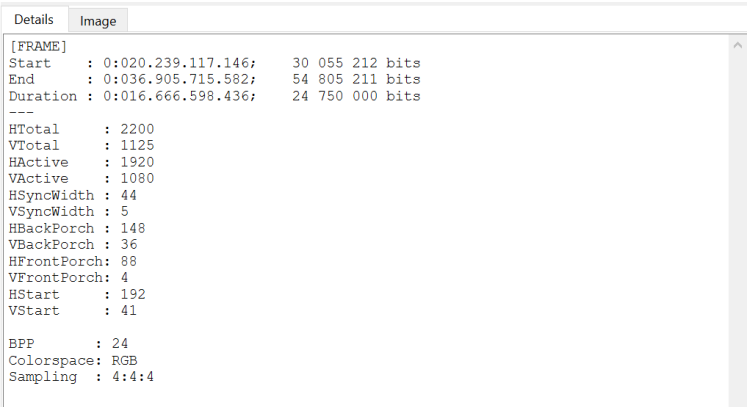
29 944 332 bits

## Event Details View

The event details are shown in the lower left panel. The event details consists of two tabs: *Image tab* and *Details tab*.

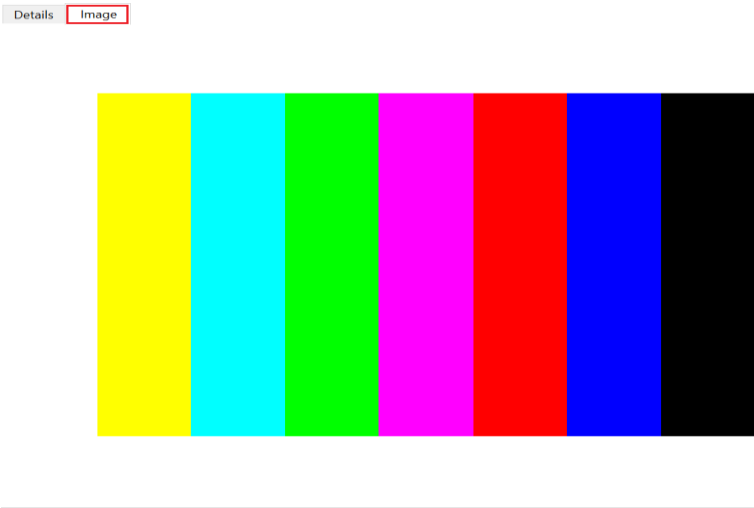
### Details Tab

The information shown in the *Details* tab depends on the selected item. A *FRAME* item is shown below.



### Images Tab

Image for currently selected *FRAME* can be viewed (only when *FRAME* is selected).



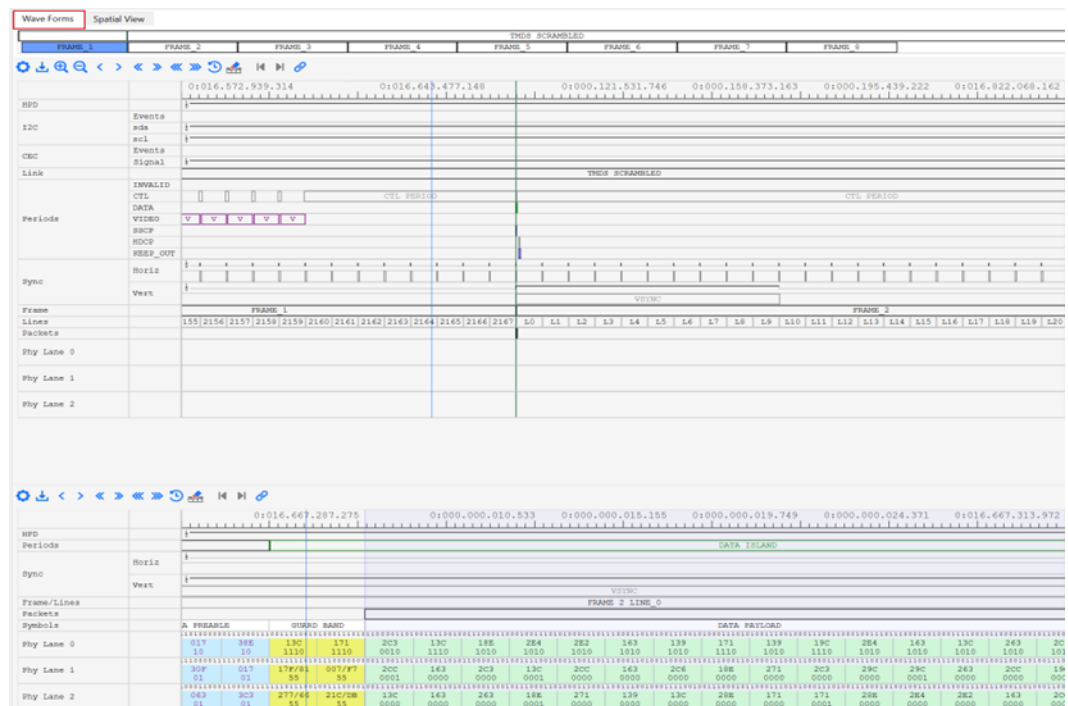
## Wave Forms View

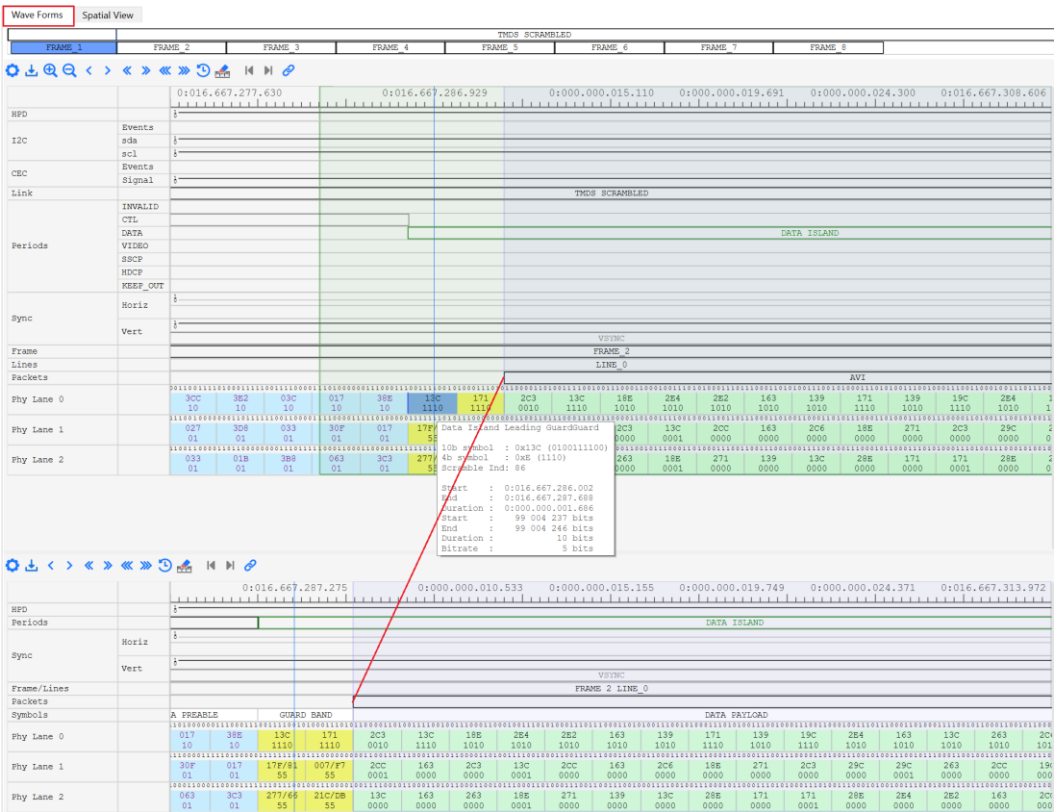
Wave Form View consists of two tabs: *Wave Forms* and *Spatial View*.

### Wave Forms Tab

Wave Form View looks different depending on zoom level. Images below show the views in zoomed out and zoomed in states.

Event periods are shown under the timeline (at the top) in their proper row as *period rectangles* with text descriptions (or abbreviations or no text, space permitting). Double-clicking a *period rectangle* will highlight the timeline portion of the rectangle and the row header(s). To zoom the Wave Form View, position the cursor and use the mouse wheel to zoom in or out with respect to the cursor location. Drag to scroll the Wave Form View and the Symbols View horizontally.

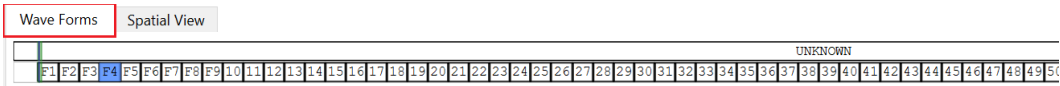




Columns are:

|                   |                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------|
| <i>HPD</i>        | Hot Plug Detect signal.                                                                                |
| <i>I2C</i>        | <i>I2C</i> Events and signals <i>sda</i> and <i>scl</i>                                                |
| <i>CEC:</i>       | <i>CEC</i> Events and <i>Signal</i>                                                                    |
| <i>Link</i>       | Link type (TMDS SCRAMBLED for ex.)                                                                     |
| <i>Periods</i>    | <i>INVALID</i> , <i>CTL</i> , <i>DATA</i> , <i>VIDEO</i> , <i>SSCP</i> , <i>HDCP</i> , <i>KEEP_OUT</i> |
| <i>Sync</i>       | <i>HSYNC</i> and <i>VSYNC</i> periods and signals                                                      |
| <i>Frame</i>      | Frame number.                                                                                          |
| <i>Lines</i>      | <i>ACTIVE</i> and <i>BLANK</i> lines                                                                   |
| <i>Packets</i>    | <i>GCP</i> and <i>AVI</i> packets                                                                      |
| <i>PHY Lane 0</i> | <i>Lane 0</i> data                                                                                     |
| <i>PHY Lane 1</i> | <i>Lane 1</i> data                                                                                     |
| <i>PHY Lane 2</i> | <i>Lane 2</i> data                                                                                     |

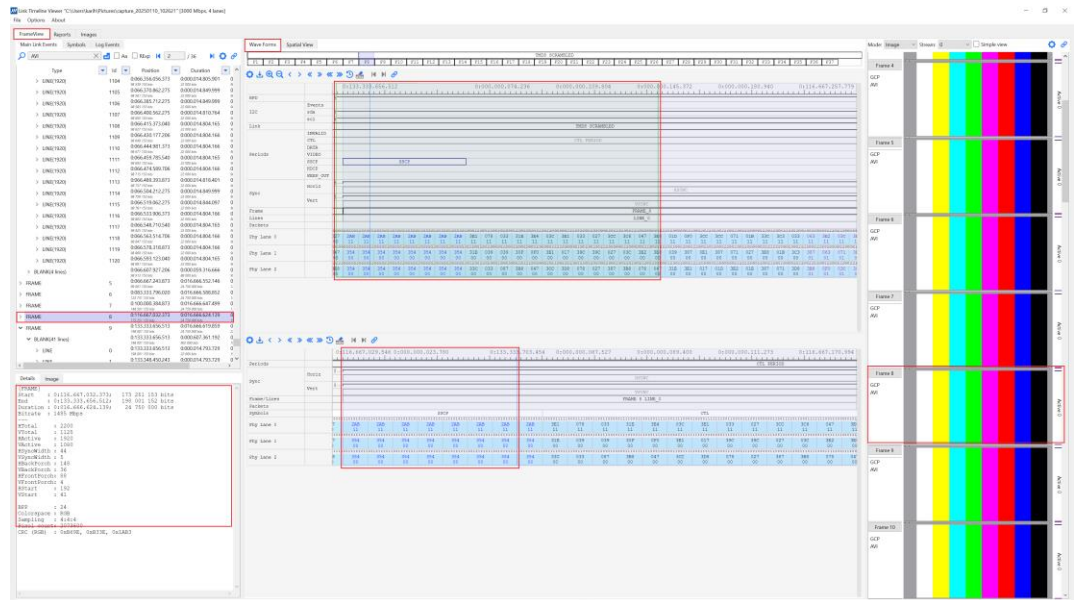
The scroll bar at the top shows all captured frames. Select a frame by double-clicking.



As you hover over the timeline, a timestamp for that position is displayed on the timeline at the cursor horizontal location.

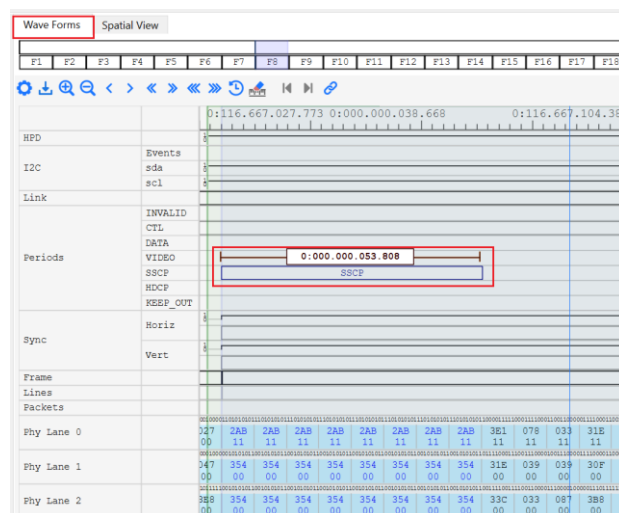
Popups show details of events as you hover over them in *Wave Form View*.

Below illustrates how the different views align when you double click in the *Wave Form View* or the *Symbols View*.



### Measuring

The ruler tool allows users to measure the time between two points on the timeline. When you right click on the timeline, a point will appear. Right click again on the timeline and the distance between the two points will be shown as illustrated below. Use the eraser tool to remove measures.



### Spatial View Tab

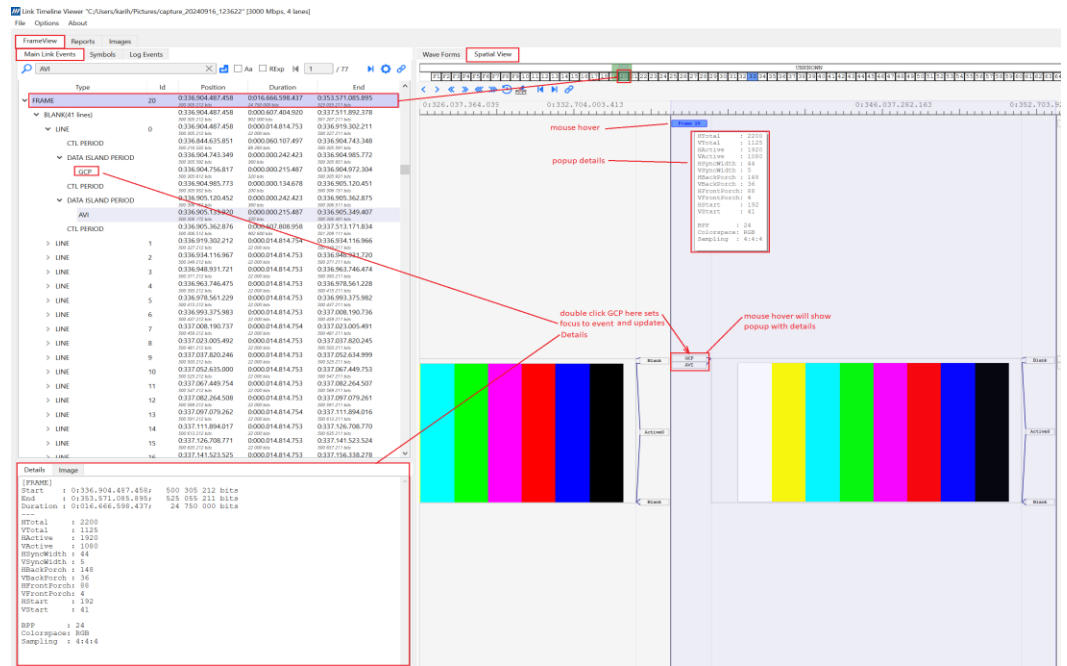
Frame pixel images are shown in *Spatial View*.

Drag to scroll *Frames*.

Double-clicking the timeline when *Spatial View Tab* is active will select the event in *Event Selector View*.

A popup showing details will be shown when hovering over a *Frame* or HDMI data packets such as *GCP* and *AVI*.

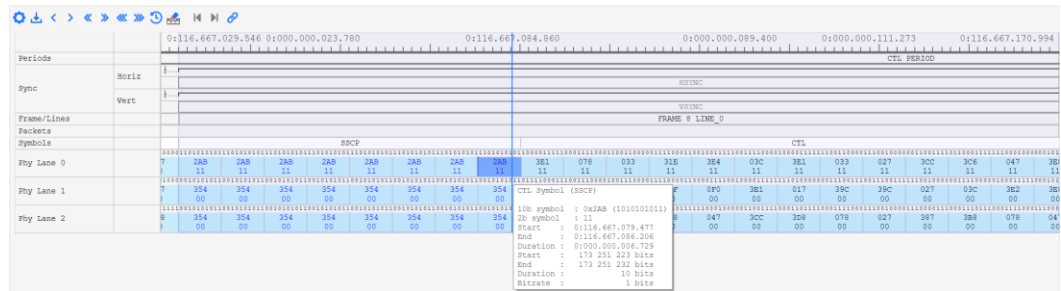
Hover over an event to see event details in a popup window. Double-click an event will to select it in and see details in *Event Details View*.





## Symbols View

Like *Wave Form View*, *Symbol View* presents HDMI transmission data and periods. As with *Wave Form View*, drag to scroll horizontally or use the *settings* ribbon arrow keys.



|                    |                                            |
|--------------------|--------------------------------------------|
| <i>Periods</i>     | <i>Transmission PERIODS</i>                |
| <i>Sync</i>        | <i>Horiz and Vert periods</i>              |
| <i>Frame/Lines</i> | <i>Frame and Line number</i>               |
| <i>Packets</i>     | <i>HTML GCP and AVI packet identifiers</i> |
| <i>Symbols</i>     | <i>HDMI transmission symbols.</i>          |
| <i>Phy Lane 0</i>  | <i>TMDS Channel 0 data.</i>                |
| <i>Phy Lane 1</i>  | <i>TMDS Channel 1 data.</i>                |
| <i>Phy Lane 2</i>  | <i>TMDS Channel 2 data.</i>                |

Illustrated below are the TMDS channel values for *PIXELS* for the color white. Note from the tool tip that the value has been scrambled.

|                                                  |                                 |                     |     |     |
|--------------------------------------------------|---------------------------------|---------------------|-----|-----|
| 000110111001000101000100100101011101010100000101 |                                 |                     |     |     |
| 1DC                                              | 2C6                             | 2C8                 | 17D | 20B |
| FF                                               | FF                              | FF                  | FF  | FF  |
| 11100000100001101100000010101100110001000101111  |                                 |                     |     |     |
| 107                                              | 10b symbol : 0x1DC (0111011100) |                     |     |     |
| FF                                               | scramble index: 90394           |                     |     |     |
| 10000100100                                      |                                 |                     |     |     |
| 090                                              | Start                           | : 0:020.847.882.330 |     |     |
| FF                                               | End                             | : 0:020.847.889.064 |     |     |
| 00000000000                                      | Duration                        | : 0:000.000.006.734 |     |     |
| 000                                              | Start                           | : 30 959 232 bits   |     |     |
|                                                  | End                             | : 30 959 241 bits   |     |     |
| LINE (1920)                                      | Duration                        | : 10 bits           |     |     |

Illustrated below are the values for a SSCP period. Note from the tooltip that this is not scrambled.

|                                                                 |     |     |     |                                 |                     |     |     |
|-----------------------------------------------------------------|-----|-----|-----|---------------------------------|---------------------|-----|-----|
| SSCP                                                            |     |     |     |                                 |                     |     |     |
|                                                                 |     |     |     |                                 |                     |     |     |
|                                                                 |     |     |     |                                 |                     |     |     |
|                                                                 |     |     |     |                                 |                     |     |     |
| CTL                                                             |     |     |     |                                 |                     |     |     |
| 011010101011101010101110101010101011010101011010101011010101011 |     |     |     |                                 |                     |     |     |
| 2AB                                                             | 2AB | 2AB | 2AB | 2AB                             | 2AB                 | 2AB | 2AB |
| 11                                                              | 11  | 11  | 11  | 11                              | 11                  | 11  | 11  |
| 000101010100101010101010101010101001010101010010101010101010110 |     |     |     |                                 |                     |     |     |
| 354                                                             | 354 | 354 | 354 | 10b symbol : 0x2AB (1010101011) |                     |     |     |
| 00                                                              | 00  | 00  | 00  |                                 |                     |     |     |
| 100101010100101010101010101010101001010101010101010101010101011 |     |     |     |                                 |                     |     |     |
| 354                                                             | 354 | 354 | 354 | Value2                          |                     |     |     |
| 00                                                              | 00  | 00  | 00  | Start                           | : 0:020.239.137.348 |     |     |
|                                                                 |     |     |     | End                             | : 0:020.239.144.082 |     |     |
| 111111111110000000000000000000000000000000000000000000000000000 |     |     |     | Duration                        | : 0:000.000.006.734 |     |     |
| 3FF                                                             | 001 | 000 | 3FE | Start                           | : 30 055 242 bits   |     |     |
|                                                                 |     |     |     | End                             | : 30 055 251 bits   |     |     |
|                                                                 |     |     |     | Duration                        | : 10 bits           |     |     |

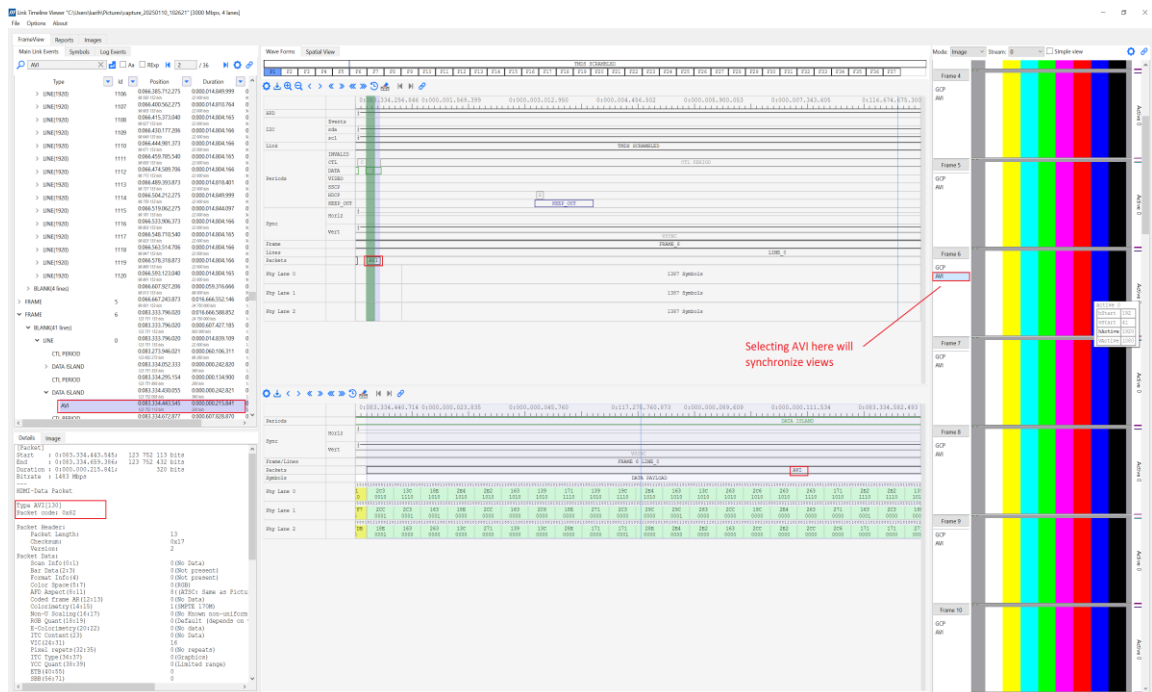
Each individual block contains the following information (tooltip also shown).

|                   |                                    |
|-------------------|------------------------------------|
| <i>First row</i>  | <i>10b/8b symbol in HEX format</i> |
| <i>Second row</i> | <i>Descrambled value.</i>          |

## Frame Image View

Frame Image View can be used to select *Frames* and GCP or AVI periods and synchronizing with other views.

As shown below, selecting the AVI event in *Frame Image View* also selects it in *Event Selector View* and synchronizes the other views. Hovering over the Active0 area will show the frame geometry details.



Mode can be *Image* or *Rect* (shows just a green rectangle to save processing time).

Stream combobox and *Simple view* checkbox do not work at present.

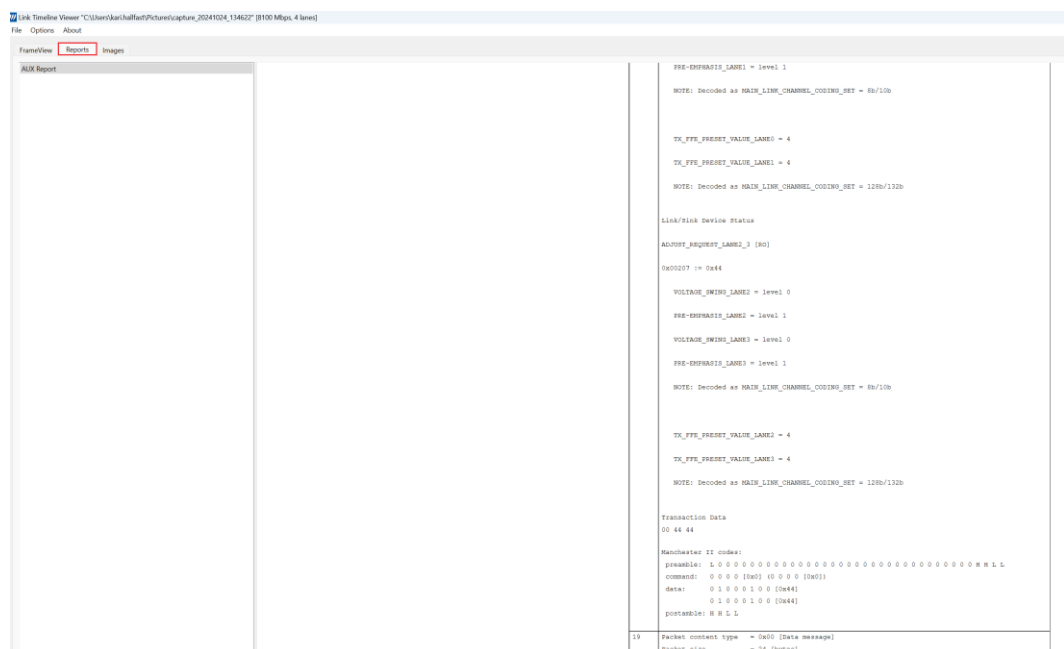
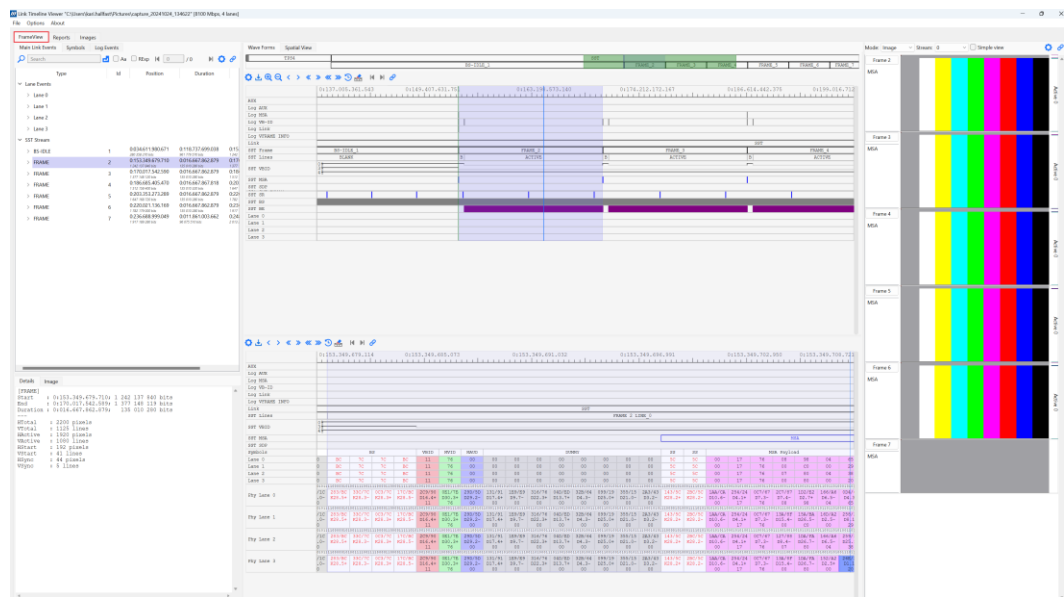
## 7. DP LINK TIMELINE VIEWER

| Role:                                    | Product: |
|------------------------------------------|----------|
| DP Reference Sink (DP RX)                | UCD-400  |
| USB-C DP Alt Mode Reference Sink (DP RX) | UCD-424  |

*Link Timeline Viewer* is a tool for evaluating the content and timing of data captured with *Link Analyzer* function of UCD Console.

Link Timeline Viewer main panel contains two tabs:

- *FrameView* provides the user ability to evaluate events within the captured data and their occurrence in time scale.
- *Reports* shows AUX channel activity at present.
- *Images* lets the user view frame images from the captured data.



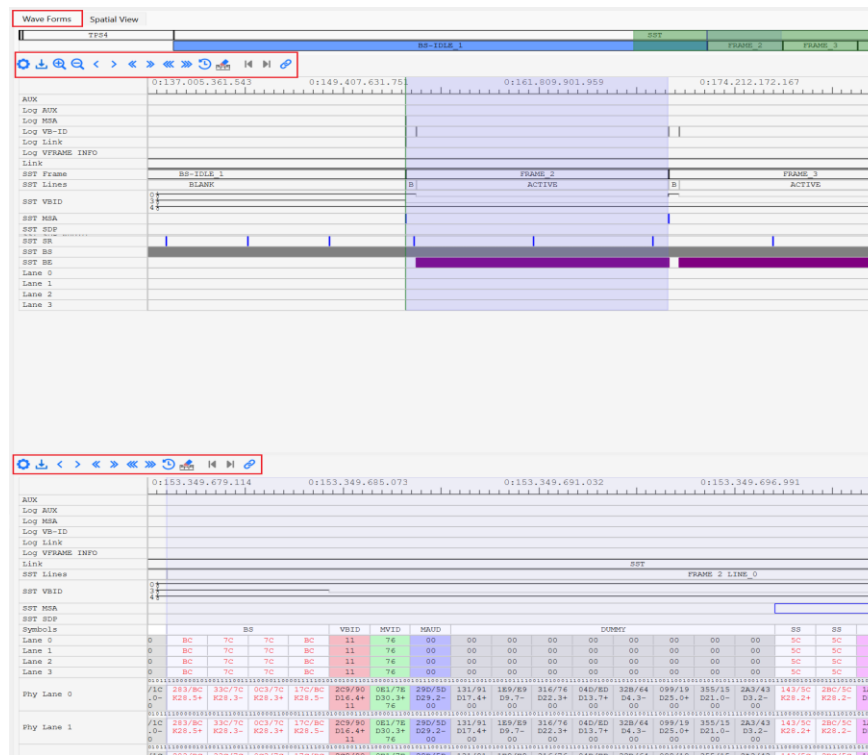


**Note:**

When using Link Timeline Viewer with MST, it's possible that all information for all streams are not visible. Different streams are shown below in the *Wave Form View* and the *Symbols View*. The view handle may be use to adjust visibility. Remove rows via the gear icon optimize screen real estate. (See the next chapter for instructions.)



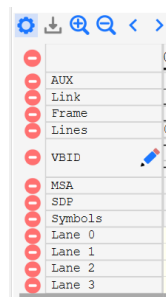
## Wave Form and Symbols View Settings



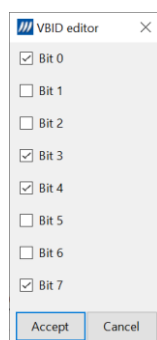
### Gear



The gear icon under the scroll bar allows users to select which events are shown in *Wave Form and Symbol Views*. Click the red circle to remove events. You can select which VBID events are shown by clicking the pen tool.



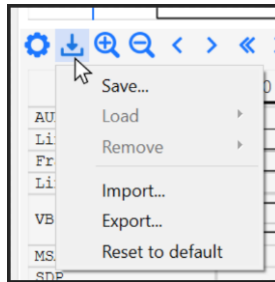
You can select which VBID bits are shown using the pen tool.



## Save



By clicking the Save icon you can save, load, and remove settings selected via the *gear* icon. You can also import and export .json files and reset settings to default.



## Zoom



You can zoom in/out with the magnifying glass icons. The zooming in/out option applies to *Wave Form View* only.

## Scroll



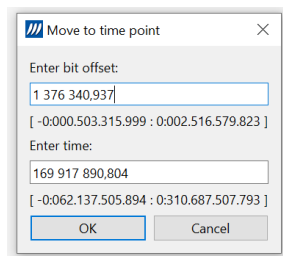
You can use the arrow keys to move in the timeline. A single arrow shifts the timeline one interval, two arrows by 10 intervals and three arrows by 100 intervals.

Alternatively, you can scroll via mouse drag (click and hold).

## Clock



With the clock icon you can move to a time point. Enter the values and press OK.



## Eraser



The eraser icon deletes all made measurements on the timeline.

## Move to Previous or Next Interval

Move back interval and Move next interval.



Sync Data

Sync data for views.

 Do not synchronized.  Synchronize.

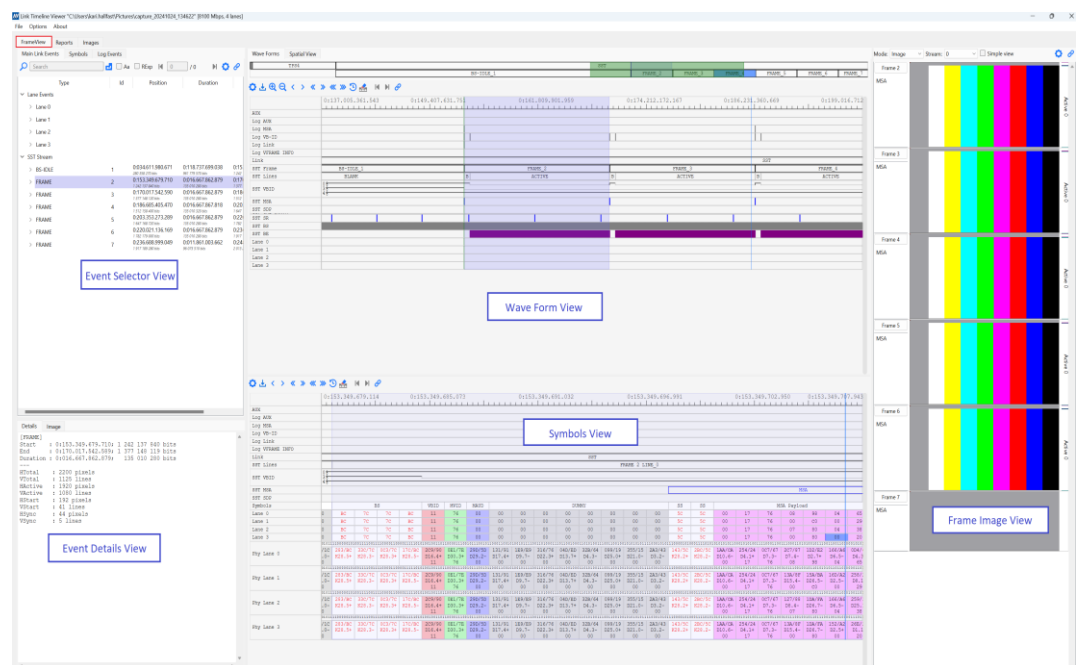


# FrameView Tab

Frame View tab consists of four areas shown below.

- Event Selector View
- Event Details View
- Wave Form View
- Symbols View
- Frame Image View

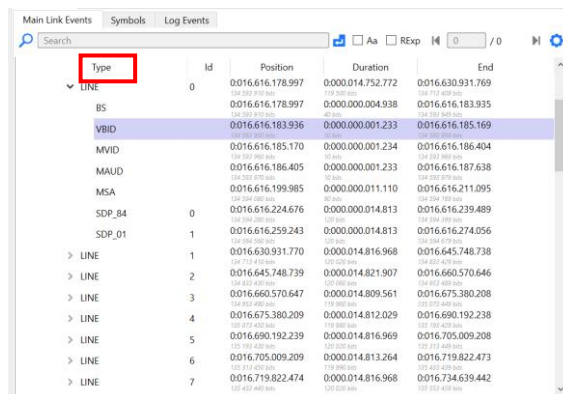
These will be described in detail. Note that all these views are synchronized (when the synchronize icons are blue).



## Event Selector View

### Main Link Events Tab

*Main Link Events* lists captured data: events, packets and symbols. Selecting items in *Main Link Events*, you can easily locate the items of interest and focus get the *Wave Form View* and *Symbols View* for items. Event Selector events are presented via a tree control. When expanded, each *FRAME* lists video *LINES* and their events.



The timing format used is text and bits formats.

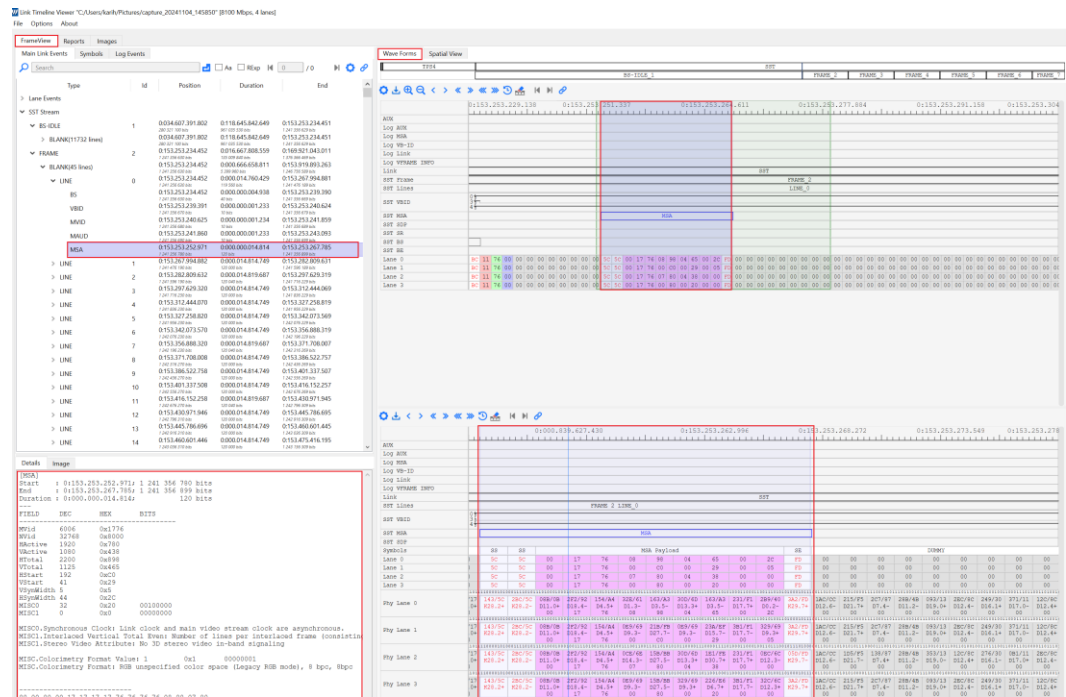
The text time format is as follows:

*seconds:milliseconds.microseconds.nanoseconds.picoseconds*

The timing format is shown below. You can see the text format on top and the bit format below (small grey font).

| Type      | Id | Position                                               | Duration                                             | End                                                    |
|-----------|----|--------------------------------------------------------|------------------------------------------------------|--------------------------------------------------------|
| > BS-IDLE | 1  | 0:034.619.841.130<br><small>280 421 940 bits</small>   | 0:118.983.568.333<br><small>963 771 120 bits</small> | 0:153.603.409.463<br><small>1 244 193 059 bits</small> |
| > FRAME   | 2  | 0:153.603.409.464<br><small>1 244 193 060 bits</small> | 0:016.667.883.866<br><small>135 010 450 bits</small> | 0:170.271.293.330<br><small>1 379 203 509 bits</small> |
| > FRAME   | -  | 0:170.271.293.331<br><small>135 010 450 bits</small>   | 0:016.667.883.866<br><small>135 010 450 bits</small> | 0:186.939.183.371<br><small>1 379 203 509 bits</small> |

Selecting a *Frame*, *Line*, *Event*, or *Symbol* will focus the *Wave Form View* and the *Symbols View*. The time stamp of the item is highlighted in light blue.



*Event Selector View* timing details columns are:

|                  |                                                             |
|------------------|-------------------------------------------------------------|
| <i>Type:</i>     | Type of item. <i>FRAME</i> , <i>LINE</i> , or name of Event |
| <i>Id:</i>       | Identification number                                       |
| <i>Position:</i> | Start of the event from start of data capture               |
| <i>Duration:</i> | Duration of the event                                       |
| <i>End:</i>      | End of the event from start of data capture                 |

Main Link Events
Symbols
Log Events

☐ Aa
☐ RExp
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| Type          | Id | Position                                | Duration                              | End                         |
|---------------|----|-----------------------------------------|---------------------------------------|-----------------------------|
| ▼ Lane Events |    |                                         |                                       |                             |
| > Lane 0      |    |                                         |                                       |                             |
| > Lane 1      |    |                                         |                                       |                             |
| > Lane 2      |    |                                         |                                       |                             |
| > Lane 3      |    |                                         |                                       |                             |
| ▼ SST Stream  |    |                                         |                                       |                             |
| > FRAME(bad)  | 1  | 0:000.004.514.795<br>36 370 bits        | 0:007.348.683.898<br>59 524 600 bits  | 0:007.351.169<br>59 581 169 |
| > FRAME       | 2  | 0:007.353.198.694<br>59 561 170 bits    | 0:016.667.892.509<br>135 010 520 bits | 0:024.02<br>194 571 680     |
| > FRAME       | 3  | 0:024.021.091.204<br>194 571 690 bits   | 0:016.667.887.570<br>135 010 480 bits | 0:040.66<br>329 582 160     |
| > FRAME       | 4  | 0:040.688.978.775<br>329 582 170 bits   | 0:016.667.887.571<br>135 010 480 bits | 0:057.35<br>464 592 640     |
| > FRAME       | 5  | 0:057.356.866.347<br>464 592 650 bits   | 0:016.667.887.570<br>135 010 520 bits | 0:074.02<br>599 603 120     |
| > FRAME       | 6  | 0:074.024.753.918<br>599 603 130 bits   | 0:016.667.892.509<br>135 010 520 bits | 0:090.65<br>734 613 640     |
| > FRAME       | 7  | 0:090.692.646.428<br>734 613 650 bits   | 0:016.667.887.570<br>135 010 480 bits | 0:107.36<br>869 624 120     |
| > FRAME       | 8  | 0:107.360.533.999<br>869 624 130 bits   | 0:016.667.887.571<br>135 010 480 bits | 0:124.02<br>1 004 634 6     |
| > FRAME       | 9  | 0:124.028.421.571<br>1 004 634 610 bits | 0:016.667.887.570<br>135 010 480 bits | 0:140.65<br>1 139 643 0     |
| > FRAME       | 10 | 0:140.696.309.142<br>1 139 645 090 bits | 0:016.667.892.509<br>135 010 520 bits | 0:157.36<br>1 274 655 6     |

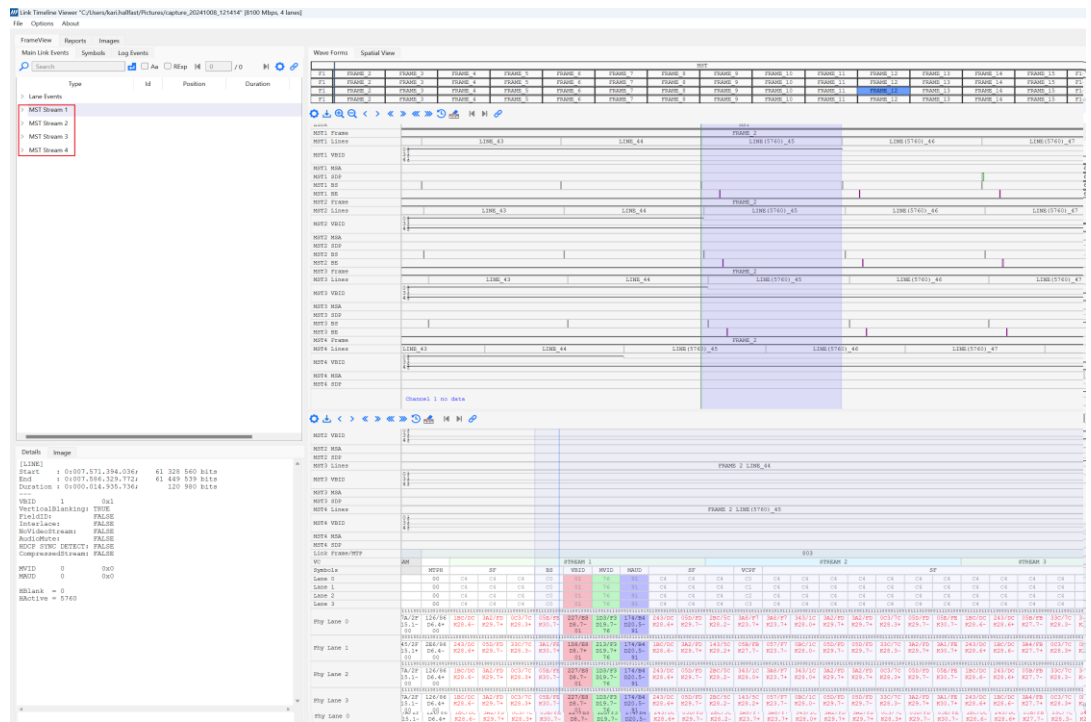
These are events occurring for each lane (such as *SST*, *TPS1*, *TPS3* and *TPS4*).

You can find all captured frames under *SST Stream*. When selecting a frame in the *Event Selector View*, it is highlighted and also focused in the *Wave Form View* and the *Symbols View* as shown below. Event details are shown in *Event Details View* in the lower left corner.

[illegible]

## MST Stream

When using *Link Timeline Viewer* in *MST* mode, streams are displayed in the *Event Selector View* as shown below. Select a stream to inspect its events. All stream events and their handling are as for *SST* mode described previously.



## Search

Search for events in *Event Selector View* by typing the event name in the search bar and pressing enter. The events found are highlighted and shown in the *Wave Form View* and the *Symbol View*.

Link Timeline Viewer "C:\Users\karhi\Pictures\capture\_20241104\_145850" [8100 Mbps, 4 lanes]

File Options About

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| Type   | Id | Position          | Duration          | End               |
|--------|----|-------------------|-------------------|-------------------|
| ▼ LINE | 1  | 0:034.617.505.338 | 0:000.010.113.535 | 0:034.627.618.873 |
|        |    | 280 403 020 bits  | 81 920 bits       | 280 484 939 bits  |
| BS     |    | 0:034.617.505.338 | 0:000.000.004.937 | 0:034.617.510.275 |
|        |    | 280 403 020 bits  | 40 bits           | 280 403 059 bits  |
| VBID   |    | 0:034.617.510.276 | 0:000.000.001.234 | 0:034.617.511.510 |
|        |    | 280 403 060 bits  | 10 bits           | 280 403 069 bits  |
| MVID   |    | 0:034.617.511.511 | 0:000.000.001.233 | 0:034.617.512.744 |
|        |    | 280 403 070 bits  | 10 bits           | 280 403 079 bits  |
| MAUD   |    | 0:034.617.512.745 | 0:000.000.001.234 | 0:034.617.513.979 |
|        |    | 280 403 080 bits  | 10 bits           | 280 403 089 bits  |
| ▼ LINE | 2  | 0:034.627.618.874 | 0:000.010.113.535 | 0:034.637.732.409 |
|        |    | 280 484 940 bits  | 81 920 bits       | 280 566 859 bits  |
| BS     |    | 0:034.627.618.874 | 0:000.000.004.937 | 0:034.627.623.811 |
|        |    | 280 484 940 bits  | 40 bits           | 280 484 979 bits  |
| VBID   |    | 0:034.627.623.812 | 0:000.000.001.234 | 0:034.627.625.046 |
|        |    | 280 484 980 bits  | 10 bits           | 280 484 989 bits  |
| MVID   |    | 0:034.627.625.047 | 0:000.000.001.233 | 0:034.627.626.280 |
|        |    | 280 484 990 bits  | 10 bits           | 280 484 999 bits  |
| MAUD   |    | 0:034.627.626.281 | 0:000.000.001.234 | 0:034.627.627.515 |
|        |    | 280 485 000 bits  | 10 bits           | 280 485 009 bits  |
| > LINE | 3  | 0:034.637.732.410 | 0:000.010.113.535 | 0:034.647.845.945 |
|        |    | 280 566 860 bits  | 81 920 bits       | 280 648 779 bits  |
| > LINE | 4  | 0:034.647.845.946 | 0:000.010.113.535 | 0:034.657.959.481 |
|        |    | 280 648 780 bits  | 81 920 bits       | 280 730 699 bits  |
| > LINE | 5  | 0:034.657.959.482 | 0:000.010.113.535 | 0:034.668.073.017 |
|        |    | 280 730 700 bits  | 81 920 bits       | 280 812 619 bits  |
| > LINE | 6  | 0:034.668.073.018 | 0:000.010.113.535 | 0:034.678.186.553 |



Click the enter icon to search.

☐ Aa ☐ RExp

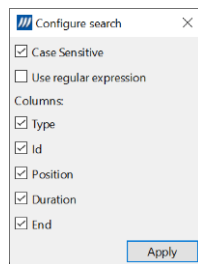
Use *Case Sensitive* and/or *Use regular expressions*.

Navigation arrows and page indicator '3 / 18154'.

Arrows navigate to next or previous filtered event.



The gear icon opens the *Configure search* dialog. Select which columns are used for searching and what criteria (*Case Sensitive* or *Use regular expression*) are used. Click the *Apply* to refresh.



Click to synchronize views.

## Symbols Tab

*Symbols* tab lists PHY level events found.

| Type | Id               | Position | Lane       | Value |
|------|------------------|----------|------------|-------|
| VBID | 0034.607.396.740 | 0        | 0x00011001 |       |
| MVID | 0034.607.397.975 | 0        | 0x00       |       |
| MAUD | 0034.607.398.209 | 0        | 0x00       |       |
| BS   | 0034.617.305.338 | 0        | 00000000   |       |
| VBID | 0034.617.510.276 | 0        | 0x00011001 |       |
| MVID | 0034.617.511.511 | 0        | 0x00       |       |
| MAUD | 0034.617.512.745 | 0        | 0x00       |       |
| BS   | 0034.627.618.874 | 0        | 00000000   |       |
| VBID | 0034.627.621.812 | 0        | 0x00011001 |       |
| MVID | 0034.627.625.047 | 0        | 0x00       |       |
| MAUD | 0034.627.626.281 | 0        | 0x00       |       |
| BS   | 0034.637.732.410 | 0        | 00000000   |       |
| VBID | 0034.637.737.348 | 0        | 0x00011001 |       |
| MVID | 0034.637.738.583 | 0        | 0x00       |       |
| MAUD | 0034.637.739.817 | 0        | 0x00       |       |
| BS   | 0034.647.345.946 | 0        | 00000000   |       |
| VBID | 0034.647.890.884 | 0        | 0x00011001 |       |

**Type:** Type of item: *FRAME*, *LINE* or Event name

**Id:** Identification number

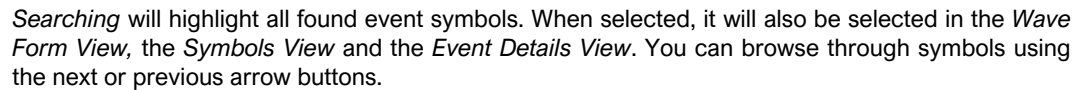
**Position:** Timestamp from start of the capture

**Lane:** The main link Symbol lane

**Value:** Symbol value

## Search

Search and filter symbols as described above for the *Main Link Events Tab*. Each column additionally has a drop down filter dialog (down arrow icon): Use these to sort and select events. The screenshots below show a *VBID* event search and a column filter dialog.



## Event Details

The event details are shown in the lower left corner. The event details are presented in two tabs: *Details* tab and *Image* tab.

### Details tab

The information shown in the *Details* tab depends on the event selected.

#### Frame

| Details           | Image                                   |
|-------------------|-----------------------------------------|
| [FRAME]           |                                         |
| Start             | : 0:203.253.553.972; 1 646 360 990 bits |
| End               | : 0:219.921.436.604; 1 781 371 429 bits |
| Duration          | : 0:016.667.882.632; 135 010 440 bits   |
| ---               |                                         |
| HTotal            | : 2200 pixels                           |
| VTotals           | : 1125 lines                            |
| HActive           | : 1920 pixels                           |
| VActive           | : 1080 lines                            |
| HStart            | : 192 pixels                            |
| VStart            | : 41 lines                              |
| HSync             | : 44 pixels                             |
| VSyn              | : 5 lines                               |
| Total pixel count | 6220800                                 |

Details shown above are *FRAME* details.

#### Line

| Details           | Image                                   |
|-------------------|-----------------------------------------|
| [LINE]            |                                         |
| Start             | : 0:153.249.911.010; 1 241 329 710 bits |
| End               | : 0:153.264.671.438; 1 241 449 269 bits |
| Duration          | : 0:000.014.760.428; 119 560 bits       |
| ---               |                                         |
| VBID              | 1 0x1                                   |
| VerticalBlanking: | TRUE                                    |
| FieldID:          | FALSE                                   |
| Interlace:        | FALSE                                   |
| NoVideoStream:    | FALSE                                   |
| AudioMute:        | FALSE                                   |
| HDCP SYNC DETECT: | FALSE                                   |
| CompressedStream: | FALSE                                   |
| MVID              | 119 0x77                                |
| MAUD              | 44 0x2c                                 |
| META              | 1 0x1                                   |
| Pixel Count       | = 0                                     |

In the image above the selected *Line* is part of blanking (*VerticalBlanking* is *TRUE*). Audio is not being streamed (*AudioMute* is *FALSE*).



[MSA](#)

| Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Image |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <pre> [MSA] Start   : 0:153.249.931.998; 1 241 329 880 bits End     : 0:153.249.943.108; 1 241 329 969 bits Duration: 0:000.000.011.110;          90 bits ----- FIELD   DEC      HEX      BITS ----- MVID    6007      0x1777 NVID    32768     0x8000 HActive 1920      0x780 VActive 1080      0x438 HTotal  2200      0x898 VTotal  1125      0x465 HStart   192      0xC0 VStart   41       0x29 VSyncWidth 5      0x5 HSyncWidth 44     0x2C MISC0    32       0x20      00100000 MISC1     0       0x0       00000000  MISC0.Synchronous Clock: Link clock and main video stream clock are asynchronous. MISC1.Interlaced Vertical Total Even: Number of lines per interlaced frame (consisting of two fields) is an odd number MISC1.Stereo Video Attribute: No 3D stereo video in-band signaling  MISC.Colorimetry Format Value: 1          0x1          00000001 MISC.Colorimetry Format: RGB unspecified color space (Legacy RGB mode), 8 bpc, 8bpc ----- 00 00 00 00 17 17 17 17 77 77 77 77 08 00 07 00 98 C0 80 80 04 00 04 00 65 29 38 20 00 00 00 00 2C 05 00 00 </pre> |       |

[SDP](#)

| Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Image |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <pre> [SDP] Start   : 0:034.894.928.816; 282 650 160 bits End     : 0:034.894.943.629; 282 650 279 bits Duration: 0:000.000.014.813; 120 bits ----- Secondary-data Packet HB0 (ID) 0x00 HB1 (Type) 0x01 Audio_TimeStamp HB2      0x17 HB3      0x48 PB0      0x00 PB1      0x67 PB2      0x35 PB3      0xD1 Header checksum OK  Data checksum OK  Maud      0x0000012C 300 Naud      0x00008000 32768  PB4      0xB4 PB5      0xB4 PB6      0xB4 PB7      0xB4 PB8      0x7F PB9      0x7F PB10     0x7F PB11     0x7F </pre> |       |

Different *SDP* events have individual details. An audio stamp event is shown above.

PHY Symbol

DetailsImage

[PHY\_SYMBOL]

Start : 0:170.271.298.270; 1 379 203 550 bits

End : 0:170.271.299.503; 1 379 203 559 bits

Duration : 0:000.000.001.233; 10 bits

---

VerticalBlanking: TRUE

FieldID: FALSE

Interlace: FALSE

NoVideoStream: FALSE

AudioMute: FALSE

HDCP SYNC DETECT: FALSE

CompressedStream: FALSE

Events such as BS, VBID and MVID are shown as *[PHY\_SYMBOL]*. A VBID event is shown above.

PHY Area

DetailsImage

[PHY\_AREA]

Start : 0:000.000.000.000; 0 bits

End : 0:000.854.703.667; 6 923 129 bits

Duration : 0:000.854.703.667; 6 923 130 bits

---

TPS1

*[PHY Area]* events are *TPS* events. A *TPS1* event is shown.

Image tab

Image tab shows the captured *FRAME* active area. Images are shown only shown when a *FRAME* is selected.

> Lane Events

> SST Stream

> FRAME(bad) 1 0:000.009.259.063 0:002.207.395.066 0:002.216.654.129

> FRAME(bad) 2 0:002.216.654.130 0:014.399.524.866 0:016.616.178.996

> FRAME 3 0:016.616.178.997 0:016.666.123.615 0:033.282.302.612

> FRAME 4 0:033.282.302.613 0:016.666.111.268 0:049.948.413.881

> FRAME 5 0:049.948.413.882 0:016.666.119.911 0:066.614.533.793

> FRAME 6 0:066.614.533.794 0:016.666.122.379 0:083.280.656.173

> FRAME 7 0:083.280.656.174 0:016.666.114.973 0:099.946.771.147

> FRAME 8 0:099.946.771.148 0:016.666.117.441 0:116.612.888.589

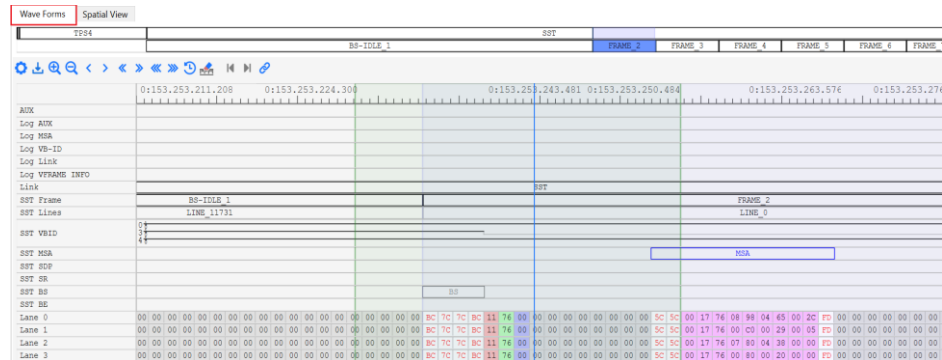
> FRAME(bad) 9 0:116.612.888.590 0:004.740.585.679 0:121.351.474.269

DetailsImage

## Wave Forms View

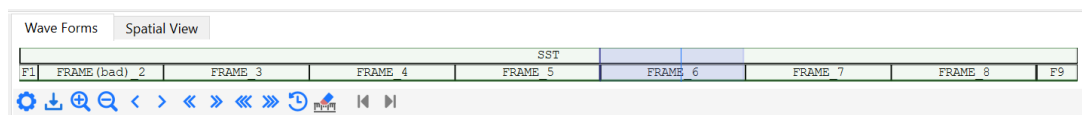
Wave Forms View consists of two tabs: *Wave Forms* and *Spatial View*.

### Wave Forms

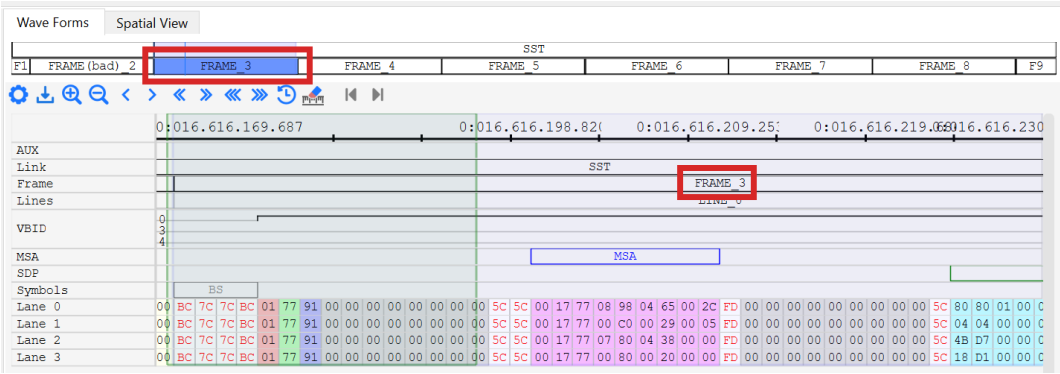


|                        |                                                         |
|------------------------|---------------------------------------------------------|
| <b>AUX:</b>            | AUX channel events                                      |
| <i>Log Aux</i>         | Log packets for AUX                                     |
| <i>Log MSA</i>         | Log packets for MSA                                     |
| <i>Log VB-ID</i>       | Log packets for VB-ID                                   |
| <i>Log Link</i>        | Log packets for Link (TPS1, TPS2, TPS3, TPS4 detection) |
| <i>Log VFRAME INFO</i> | Log video frame data                                    |
| <b>Link:</b>           | Link state (TPS1, TPS2, TPS3, TPS4, SST, MST etc.)      |
| <i>SST Frame</i>       | SST frame number                                        |
| <i>SST Lines</i>       | SST Line number                                         |
| <i>SST VBI</i>         | SST vertical blank                                      |
| <i>SST MSA</i>         | SST MSA period                                          |
| <i>SST SDP</i>         | SST SDP period                                          |
| <i>SST SR</i>          | SST SR symbol period                                    |
| <i>SST BS</i>          | SST BS symbol period                                    |
| <i>SST BE</i>          | SST BE symbol period                                    |
| <b>Lanes (0-3):</b>    | Data and control symbols                                |

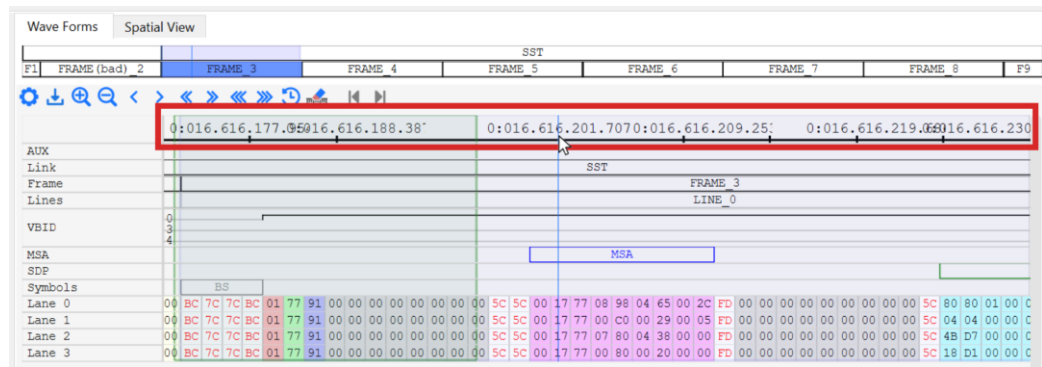
Captured FRAMES are shown at the top. As no triggers were set on the example below, the first FRAME is not fully captured.



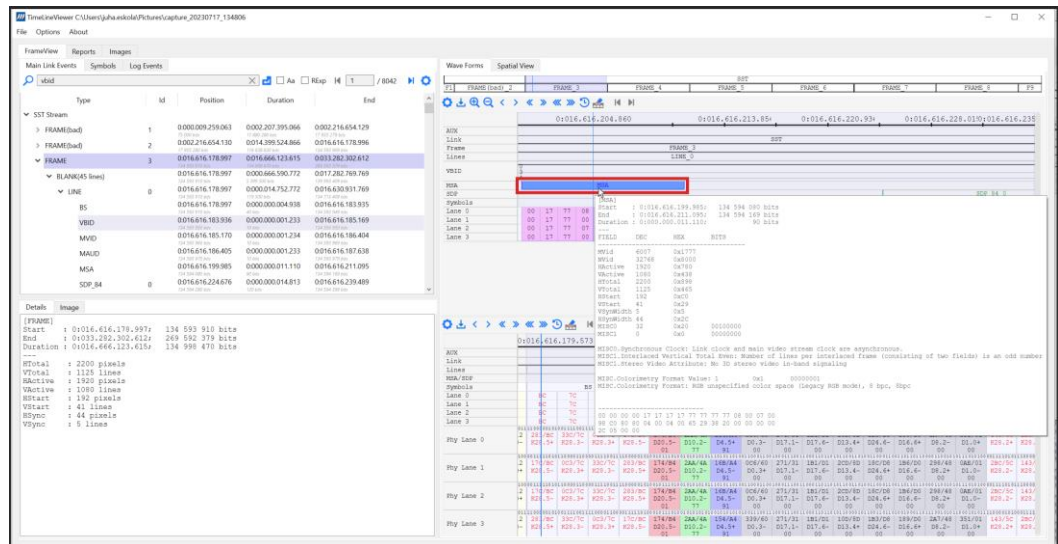
Select a frame by double-clicking it: It turns light purple and the *Wave Form View* will be focused.



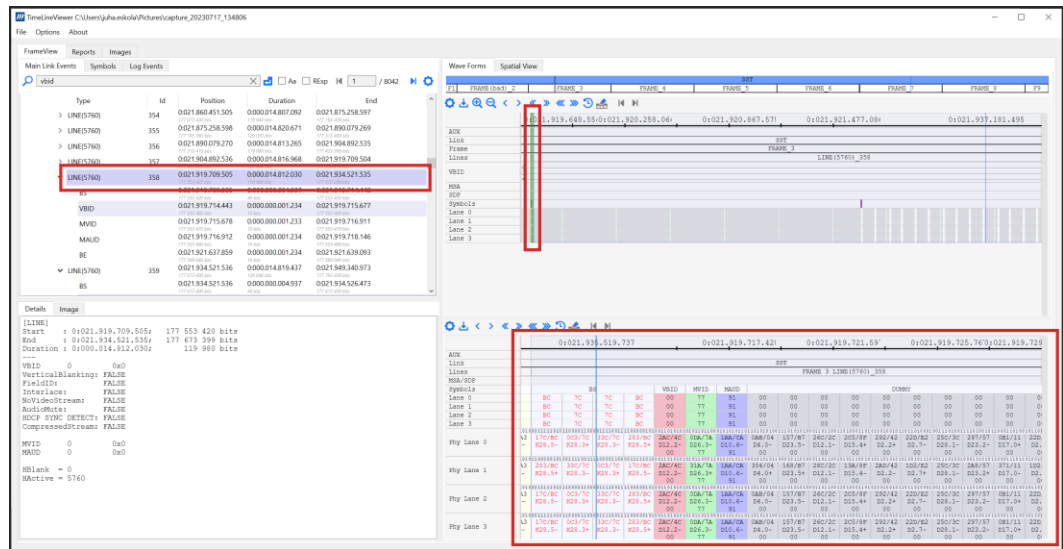
As the cursor moves over the view, the timestamp is displayed.



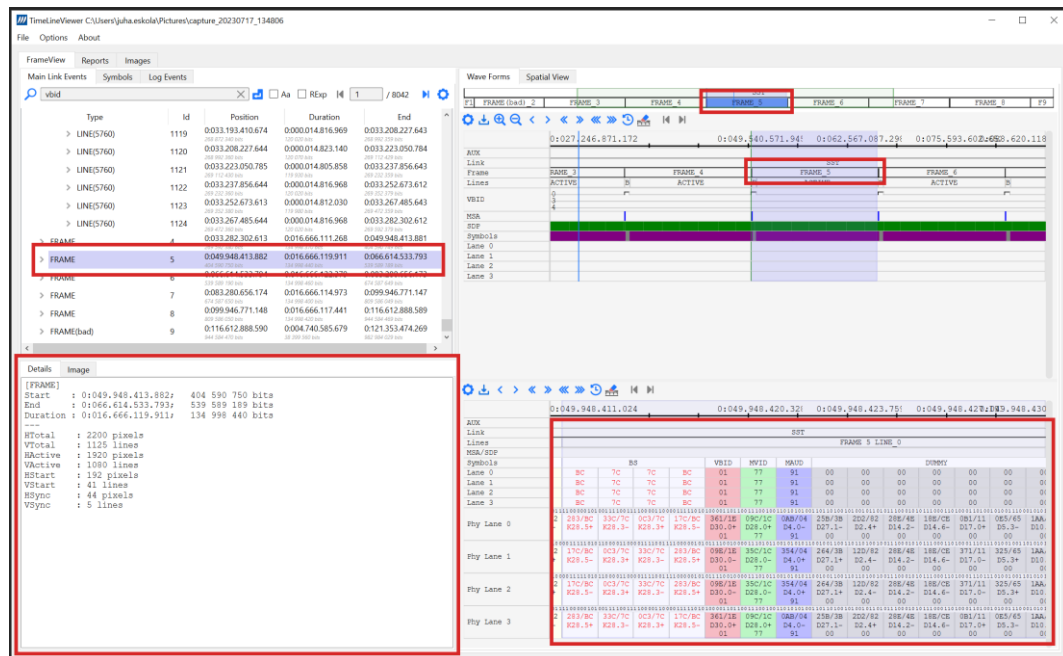
Move the mouse over an event period in *Wave Form View* to see details via a popover.



Double-clicking anywhere in the *Wave Forms View* synchronizes the *Symbols View* and the event is selected in *Event Selector* when as shown below. The green vertical area in *Wave Form View* shows the position within an event.

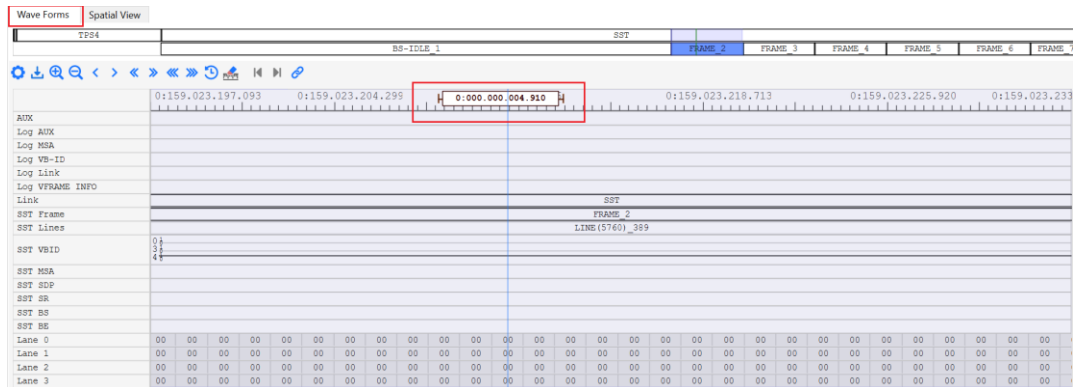


The image below shows you how the different areas of the Link Timeline Viewer synchronize when you double-click a *FRAME* in *Wave Form View*.



## Measuring

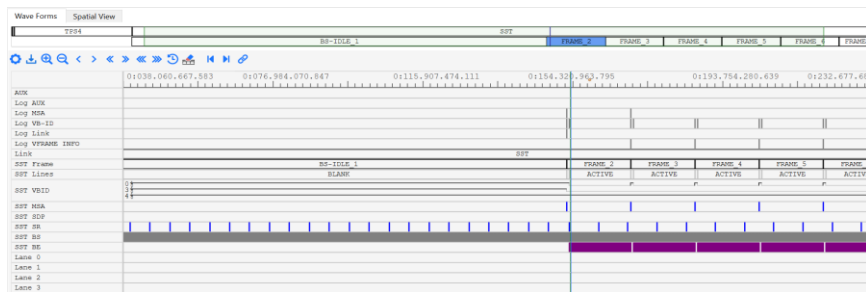
The ruler tool allows users to measure distance between two points on the timeline. Two right-clicks on the timeline (or on the same row) will display the distance between the two points as shown below.



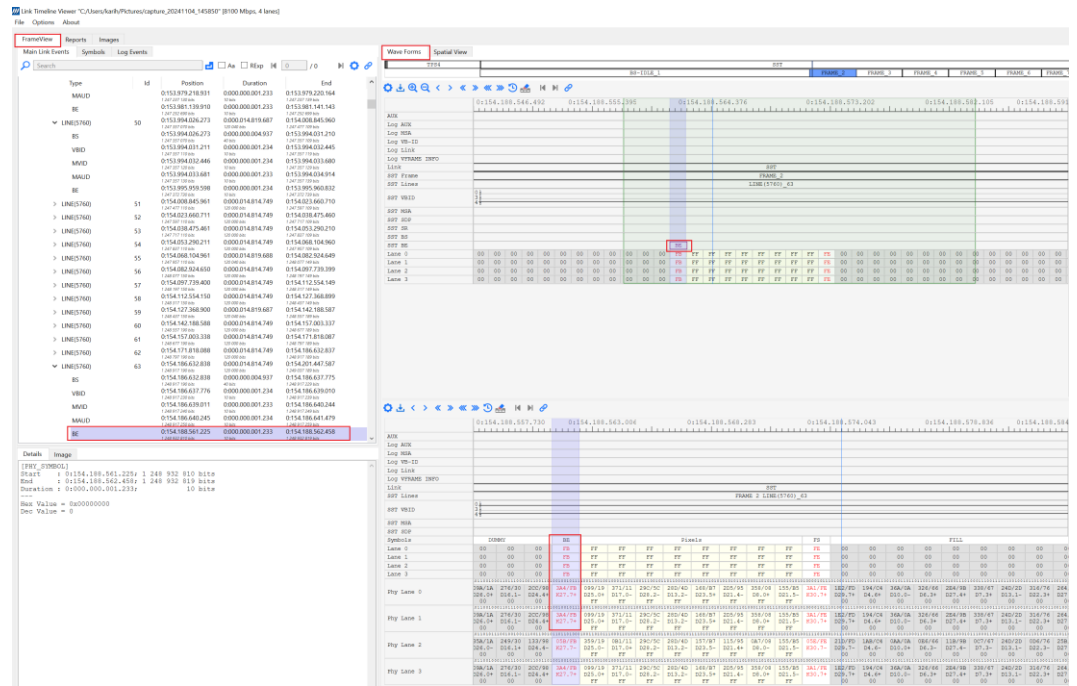
## Zooming

Zoom happens via the mouse wheel. When zooming it is important to keep the cursor centered on your point of interest. Various events appear as vertical lines or solid areas when zoomed out. As you zooming in, spans begin to appear and finally text begins to appear. Images at various stages of zoom are shown below.

Original view.

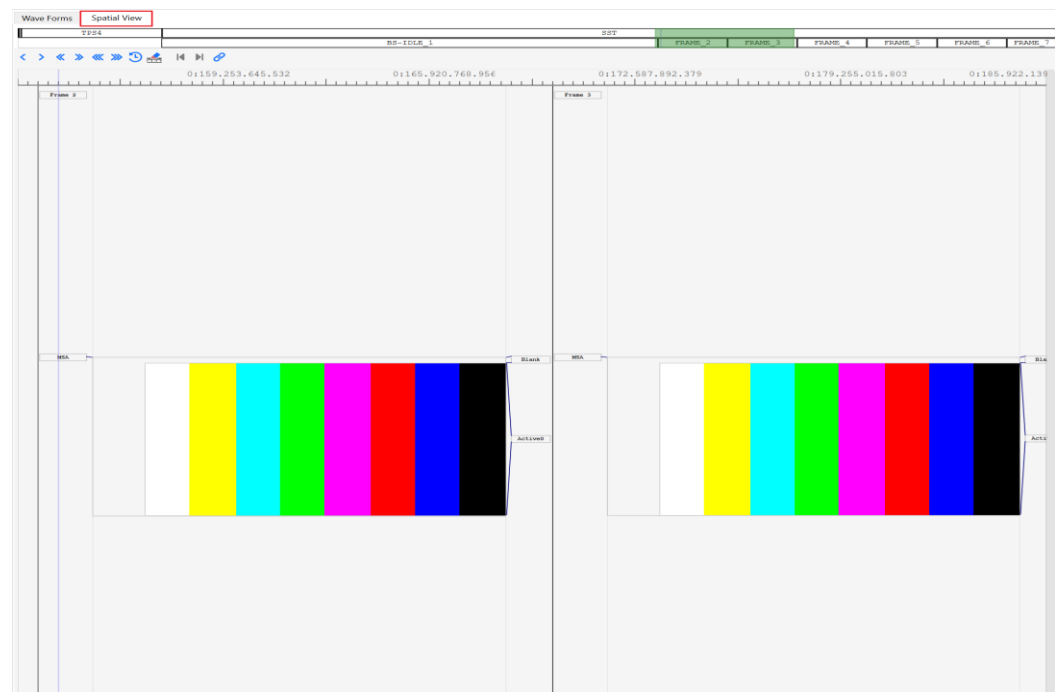


Zooming in so spans with text can be seen. Note that views are synchronized.



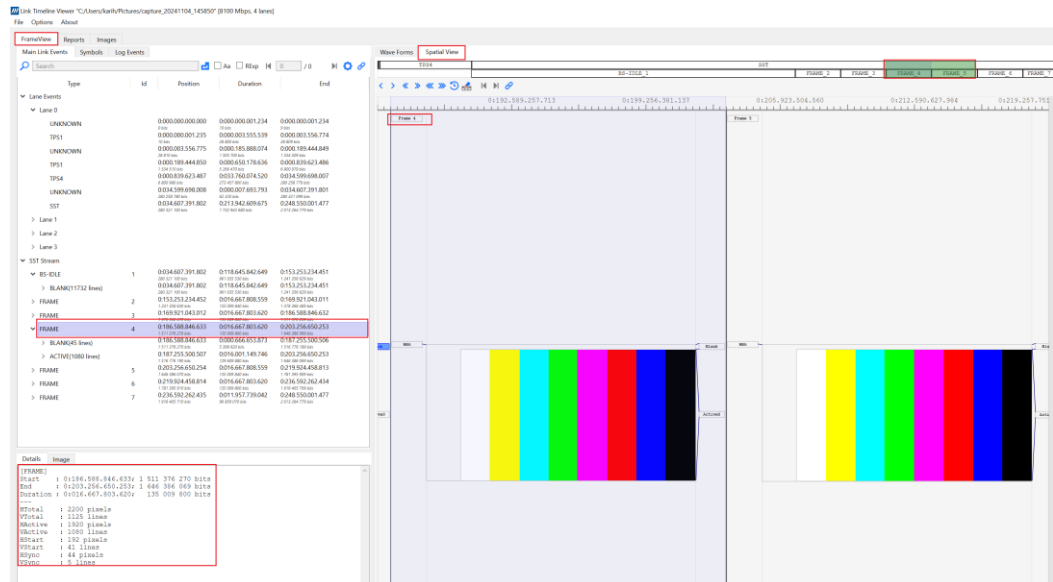
## Spatial View

*Spatial view* shows the geometry of the frame.

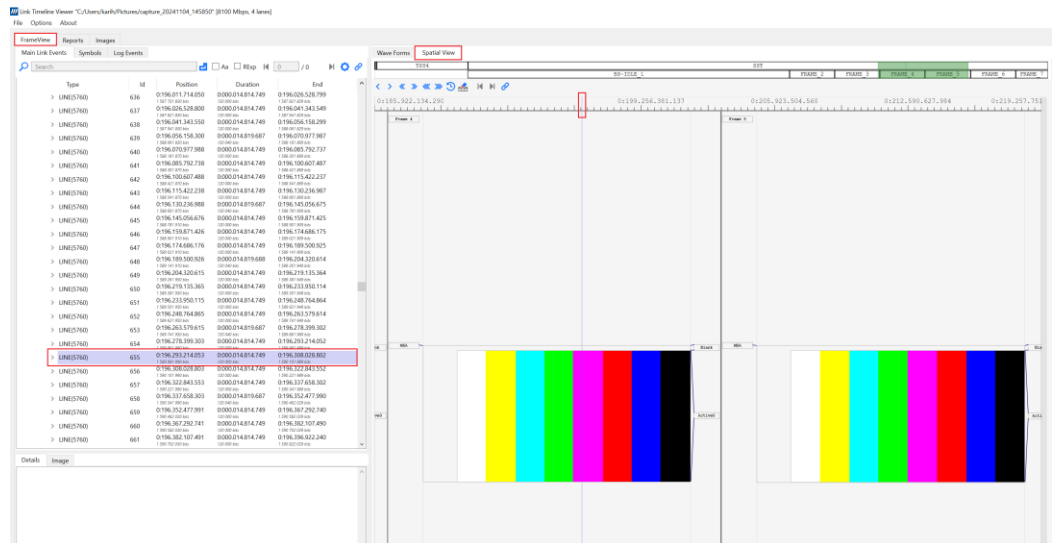




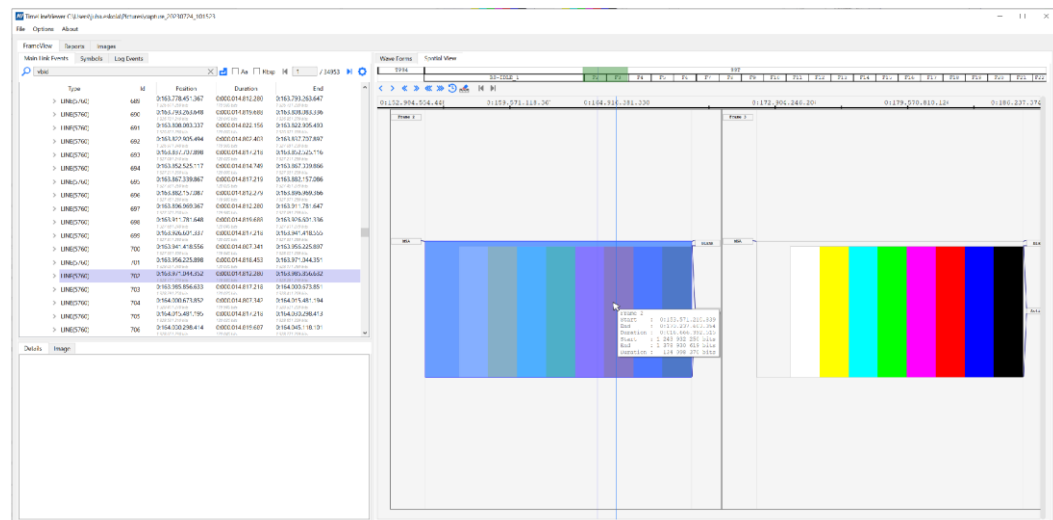
Selecting a *FRAME* in *Event Selector View* will display it in *Spatial View*.



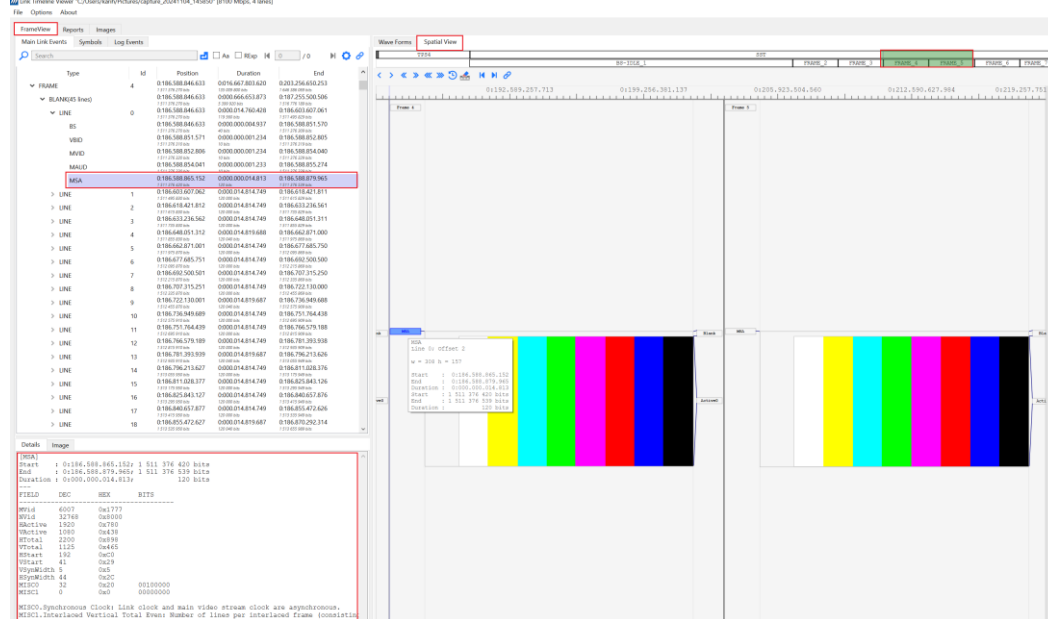
Double-clicking on the timeline, will select the *LINE* in the *Event Selector View* as shown below.



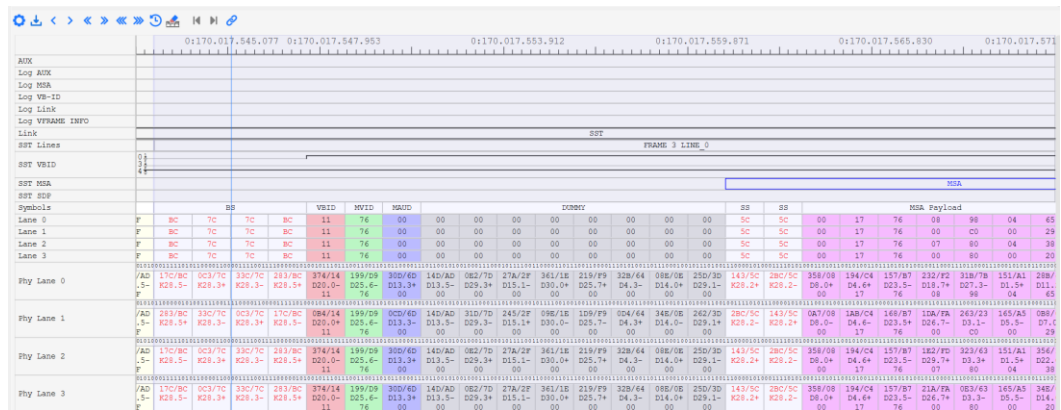
When you hover a cursor on top of the frame, its details will be shown. Frame details include the start, end and duration of the frame.



[Link Timeline Viewer](#) "C:\Users\ashb\Pictures\capture\_20241104\_145850" (8100 MB, 4 lines)



*Symbol View* shows symbols from the *PHY* lanes in addition to those shown in *Wave Form View*. Scroll *Symbols View* via drag or by using the arrow keys.



|                         |                                                                                 |
|-------------------------|---------------------------------------------------------------------------------|
| <b>AUX:</b>             | Events of the AUX channel                                                       |
| <b>Link:</b>            | Link state (TPS1, TPS2, TPS3, TPS4, SST, MST etc.)                              |
| <b>Log Aux</b>          | Log packets for AU                                                              |
| <b>Log MSA</b>          | Log packets for MS                                                              |
| <b>Log VB-ID</b>        | Log packets for VB-ID                                                           |
| <b>Log Link</b>         | Log packets for Link (TPS1, TPS2, TPS3, TPS4)                                   |
| <b>Log VFRAME INFO</b>  | Log video frame data                                                            |
| <b>Link:</b>            | Link state (TPS1, TPS2, TPS3, TPS4, SST, MST etc.)                              |
| <b>Lines:</b>           | Frame and line number                                                           |
| <b>VBID</b>             | Vertical blanking                                                               |
| <b>MSA</b>              | MSA period                                                                      |
| <b>SDP</b>              | SDP (secondary data packets)                                                    |
| <b>Symbols:</b>         | Control and special symbols periods                                             |
| <b>Lanes (0-3):</b>     | Decoded data and control symbols                                                |
| <b>PHY Lanes (0-3):</b> | Binary bit stream, 10b/8b scrambled symbols, symbol code and descrambled values |

[illegible]

The lower part of the *Symbols View* displays the values of link symbols on the physical link lanes. You can see the individual bits above the symbol blocks. When you hover your mouse over a symbol, a popover shows details of the symbol:

|                     |                                                       |
|---------------------|-------------------------------------------------------|
| <i>10b symbol:</i>  | Link symbol as sent (in this case 8b/10b link coding) |
| <i>8b symbol:</i>   | Link symbol after conversion to 8 bits                |
| <i>Symbol code:</i> | Link symbol K or D code                               |
| <i>Descrambled:</i> | Link symbol value after de-scrambling                 |
| <i>Start:</i>       | Start of the item from start of the captured data     |

|                  |                                                 |
|------------------|-------------------------------------------------|
| <i>End:</i>      | End of the item from start of the captured data |
| <i>Duration:</i> | Length of the symbols                           |

A link symbol is shown below.

|              |
|--------------|
| 001010101001 |
| 0AA/0A       |
| D10.0+       |
| 00           |

Each block contains the following information

*First row:* 10b/8b link symbol in HEX format

*Second row:* Link symbol K or D code.

*Third row:* Descrambled value if available

## Scrambling

The result of scrambling can be seen in *Symbols View*. The first row of each block below shows different 10b/8b link symbols.

|            |                                                                            |
|------------|----------------------------------------------------------------------------|
|            | 01001000110100110100010111000111100011110101010110010100101001010101101010 |
| Phy Lane 0 | 04B/EB 2CB/8B 0E8/77 15E/BE 14D/AD 14A/BF 2B5/5F                           |
|            | 011.7+ D11.4- D23.3+ D30.5- D13.5- D31.5+ D31.2-                           |
|            | 00 00 00 00 00 00 00                                                       |
| Phy Lane 1 | 01001000110100110100010111000111100011110101010110010100101001010101101010 |
|            | 04B/EB 2CB/8B 0E8/77 15E/BE 14D/AD 14A/BF 2B5/5F                           |
|            | 011.7+ D11.4- D23.3+ D30.5- D13.5- D31.5+ D31.2-                           |
|            | 00 00 00 00 00 00 00                                                       |
| Phy Lane 2 | 01001000110100110100010111000111100011110101010110010100101001010101101010 |
|            | 04B/EB 2CB/8B 0E8/77 15E/BE 14D/AD 14A/BF 2B5/5F                           |
|            | 011.7+ D11.4- D23.3+ D30.5- D13.5- D31.5+ D31.2-                           |
|            | 00 00 00 00 00 00 00                                                       |
| Phy Lane 3 | 010011101101000010111010001110000110101011001010101011101001010001010      |
|            | 0CB/EB 10B/8B 317/77 161/BE 14D/AD 175/BF 28A/5F                           |
|            | 011.7- D11.4+ D23.3- D30.5+ D13.5- D31.5- D31.2+                           |
|            | 00 00 00 00 00 00 00                                                       |

## Forward Error Correction (FEC)

FEC parity codes are highlighted in *Symbols View* in light green. CD\_ADJ symbols are highlighted in light red.

|                                                                  |        |        |        |        |        |        |  |
|------------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--|
|                                                                  | B9     | 67     | 89     | 90     | B2     | E3     |  |
|                                                                  | B1     | 3C     | 83     | 90     | 6A     | 68     |  |
|                                                                  | 94     | 42     | F8     | A0     | 2A     | 05     |  |
|                                                                  | 94     | 42     | F8     | A0     | 2A     | 05     |  |
| 01100110101011100011001001011101100100110101001101011000100011   |        |        |        |        |        |        |  |
| D                                                                | 159/B9 | 0C7/67 | 2E9/89 | 2C9/90 | 172/B2 | 223/E3 |  |
| -                                                                | D25.5- | D7.3-  | D9.4-  | D16.4+ | D18.5- | D3.7+  |  |
| 1010001110100011101001110001001001101100100101011110011100100110 |        |        |        |        |        |        |  |
| D                                                                | 171/B1 | 25C/3C | 123/83 | 136/90 | 0EA/6A | 327/68 |  |
| +                                                                | D17.5- | D28.1- | D3.4+  | D16.4- | D10.3- | D8.3-  |  |
| 1000101100101011010101010011001100110001010010101100110100110110 |        |        |        |        |        |        |  |
| D                                                                | 134/94 | 2AD/42 | 1CC/F8 | 146/A0 | 26A/2A | 365/05 |  |
| +                                                                | D20.4+ | D2.2-  | D24.7+ | D0.5+  | D10.1- | D5.0-  |  |
| 1000101100101011010101010011001100110001010010101100110100110110 |        |        |        |        |        |        |  |
| D                                                                | 134/94 | 2AD/42 | 1CC/F8 | 146/A0 | 26A/2A | 365/05 |  |
| +                                                                | D20.4+ | D2.2-  | D24.7+ | D0.5+  | D10.1- | D5.0-  |  |

## SDP

SDPs are highlighted in turquoise. You can see the start of the SDP event marked as SS and the end of the SDP event marked as SE.

| SST              |                  |                  |                  |                  |                 |                  |                  |                  |                 |                  |                 |                  |                  |
|------------------|------------------|------------------|------------------|------------------|-----------------|------------------|------------------|------------------|-----------------|------------------|-----------------|------------------|------------------|
| BS-IDLE 1 LINE_3 |                  |                  |                  |                  |                 |                  |                  |                  |                 |                  |                 |                  |                  |
| SDP_01_7         |                  |                  |                  |                  |                 |                  |                  |                  |                 |                  |                 |                  |                  |
| SS               |                  |                  |                  |                  |                 |                  |                  |                  |                 |                  |                 |                  | SE               |
| 5C               | 00               | 60               | 00               | 01               | 2C              | 00               | B4               | 00               | 80              | 00               | 00              | 7F               | FD               |
| 5C               | 01               | 07               | 00               | 01               | 2C              | 00               | B4               | 00               | 80              | 00               | 00              | 7F               | FD               |
| 5C               | 47               | D5               | 00               | 01               | 2C              | 00               | B4               | 00               | 80              | 00               | 00              | 7F               | FD               |
| 5C               | 18               | 31               | 00               | 01               | 2C              | 00               | B4               | 00               | 80              | 00               | 00              | 7F               | FD               |
| 143/5C<br>K28.2+ | 0E3/63<br>D3.3-  | 2DA/9A<br>D26.4- | 29A/5A<br>D26.2- | 19C/DC<br>D28.6- | 1D2/E2<br>D2.7+ | 2E2/9D<br>D29.4+ | 231/F1<br>D17.7+ | 29B/5B<br>D27.2- | 1A3/C3<br>D3.6- | 34A/1F<br>D31.0+ | 165/A5<br>D5.5- | 15A/BA<br>D26.5- | 3A2/FD<br>K29.7+ |
| 143/5C<br>K28.2+ | 32D/62<br>D2.3-  | 1E2/FD<br>D29.7+ | 29A/5A<br>D26.2- | 19C/DC<br>D28.6- | 1D2/E2<br>D2.7+ | 2E2/9D<br>D29.4+ | 231/F1<br>D17.7+ | 29B/5B<br>D27.2- | 1A3/C3<br>D3.6- | 34A/1F<br>D31.0+ | 165/A5<br>D5.5- | 15A/BA<br>D26.5- | 3A2/FD<br>K29.7+ |
| 143/5C<br>K28.2+ | 26B/24<br>D4.1-  | 245/2F<br>D15.1+ | 29A/5A<br>D26.2- | 19C/DC<br>D28.6- | 22D/E2<br>D2.7- | 11D/9D<br>D29.4- | 3B1/F1<br>D17.7- | 2A4/5B<br>D27.2+ | 1A3/C3<br>D3.6- | 0B5/1F<br>D31.0- | 165/A5<br>D5.5- | 15A/BA<br>D26.5- | 05D/FD<br>K29.7- |
| 2BC/5C<br>K28.2- | 0E4/7B<br>D27.3+ | 18B/CB<br>D11.6- | 29A/5A<br>D26.2- | 19C/DC<br>D28.6- | 22D/E2<br>D2.7- | 11D/9D<br>D29.4- | 3B1/F1<br>D17.7- | 2A4/5B<br>D27.2+ | 1A3/C3<br>D3.6- | 0B5/1F<br>D31.0- | 165/A5<br>D5.5- | 15A/BA<br>D26.5- | 05D/FD<br>K29.7- |

## Pixel data

Grey area is fill symbols (scrambled 00). Light yellow area is actual pixels (surrounded by fill end symbol and fill start symbol). K30.7 is fill start and K23.7 is fill end.

| Pixels           |                  |                 |                  |                  |                 |                 |                 |                  |                  |                 |                  |                  |    |
|------------------|------------------|-----------------|------------------|------------------|-----------------|-----------------|-----------------|------------------|------------------|-----------------|------------------|------------------|----|
| FE               |                  |                 |                  |                  |                 |                 |                 |                  |                  |                 |                  |                  | FS |
| F7               | 00               | 00              | 00               | 00               | 00              | 00              | 00              | 00               | 00               | 00              | 00               | 00               | FE |
| F7               | 00               | 00              | 00               | 00               | 00              | 00              | 00              | 00               | 00               | 00              | 00               | 00               | FE |
| F7               | 00               | 00              | 00               | 00               | 00              | 00              | 00              | 00               | 00               | 00              | 00               | 00               | FE |
| F7               | 00               | 00              | 00               | 00               | 00              | 00              | 00              | 00               | 00               | 00              | 00               | 00               | FE |
| 36A/0A<br>D10.0- | 3A8/F7<br>K23.7+ | 223/E3<br>D3.7+ | 25C/3C<br>D28.1- | 296/56<br>D22.2- | 269/29<br>D9.1- | 163/A3<br>D3.5- | 0C7/67<br>D7.3- | 0B6/10<br>D16.0- | 1CE/EE<br>D14.7- | 2A3/43<br>D3.2- | 3A1/FE<br>K30.7+ | 162/BD<br>D29.5+ |    |
| 0AA/0A<br>D10.0+ | 057/F7<br>K23.7- | 1E3/E3<br>D3.7- | 25C/3C<br>D28.1- | 296/56<br>D22.2- | 269/29<br>D9.1- | 163/A3<br>D3.5- | 338/67<br>D7.3+ | 349/10<br>D16.0+ | 04E/EE<br>D14.7+ | 2A3/43<br>D3.2- | 05E/FE<br>K30.7- | 15D/BD<br>D29.5- |    |
| 0AA/0A<br>D10.0+ | 057/F7<br>K23.7- | 1E3/E3<br>D3.7- | 25C/3C<br>D28.1- | 296/56<br>D22.2- | 269/29<br>D9.1- | 163/A3<br>D3.5- | 338/67<br>D7.3+ | 349/10<br>D16.0+ | 04E/EE<br>D14.7+ | 2A3/43<br>D3.2- | 05E/FE<br>K30.7- | 15D/BD<br>D29.5- |    |
| 36A/0A<br>D10.0- | 3A8/F7<br>K23.7+ | 223/E3<br>D3.7+ | 25C/3C<br>D28.1- | 296/56<br>D22.2- | 269/29<br>D9.1- | 163/A3<br>D3.5- | 0C7/67<br>D7.3- | 0B6/10<br>D16.0- | 1CE/EE<br>D14.7- | 2A3/43<br>D3.2- | 3A1/FE<br>K30.7+ | 162/BD<br>D29.5+ |    |

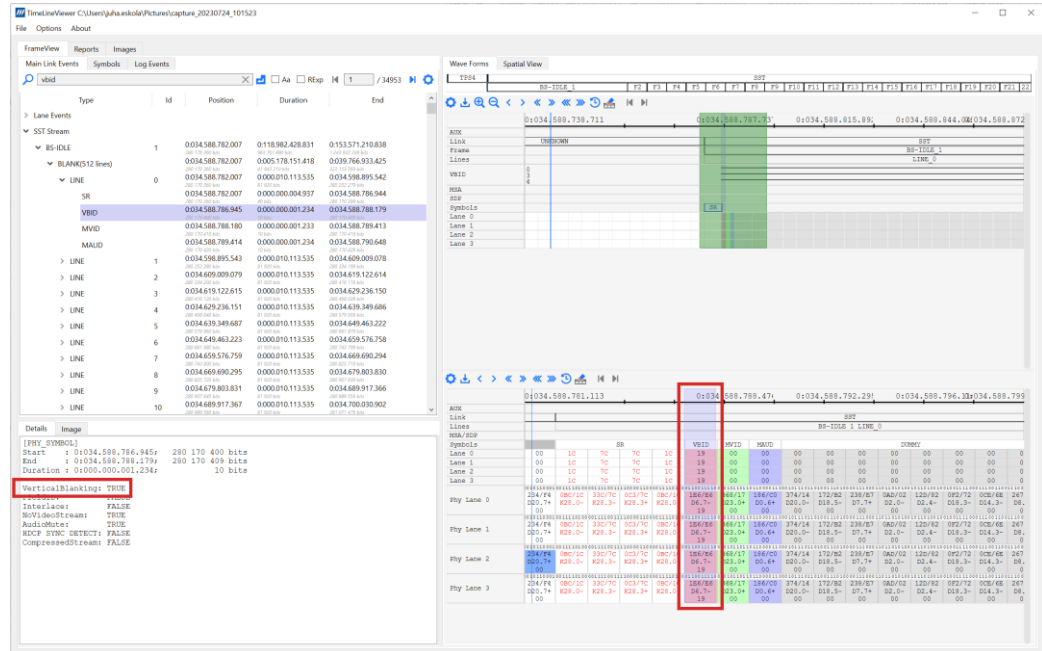
## MSA

MSA symbols are highlighted in purple color.

| SST             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| FRAME 4 LINE_0  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| MSA             |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| SS              | SS               |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  | SE               |                  |
| 00              | 5C               | 5C               | 00               | 17               | 77               | 08               | 98               | 04               | 65               | 00               | 2C               | FD               | 00               |
| 00              | 5C               | 5C               | 00               | 17               | 77               | 00               | C0               | 00               | 29               | 00               | 05               | FD               | 00               |
| 00              | 5C               | 5C               | 00               | 17               | 77               | 07               | 80               | 04               | 38               | 00               | 00               | FD               | 00               |
| 00              | 5C               | 5C               | 00               | 17               | 77               | 00               | 80               | 00               | 20               | 00               | 00               | FD               | 00               |
| 147/A7<br>D7.5- | 2BC/5C<br>K28.2- | 143/5C<br>K28.2+ | 235/FF<br>D31.7- | 19C/DC<br>D28.6- | 097/17<br>D23.0- | 1B6/D0<br>D16.6- | 171/B1<br>D17.5- | 274/34<br>D20.1- | 1AA/CA<br>D10.6- | 29C/5C<br>D28.2- | 259/39<br>D25.1- | 3A2/FD<br>K29.7+ | 196/D6<br>D22.6- |
| 178/A7<br>D7.5+ | 143/5C<br>K28.2+ | 2BC/5C<br>K28.2- | 1CA/FF<br>D31.7+ | 19C/DC<br>D28.6- | 368/17<br>D23.0+ | 18C/D8<br>D24.6+ | 1E9/E9<br>D9.7-  | 249/30<br>D16.1+ | 2E6/86<br>D6.4-  | 29C/5C<br>D28.2- | 349/10<br>D16.0+ | 3A2/FD<br>K29.7+ | 196/D6<br>D22.6- |
| 178/A7<br>D7.5+ | 143/5C<br>K28.2+ | 2BC/5C<br>K28.2- | 1CA/FF<br>D31.7+ | 19C/DC<br>D28.6- | 368/17<br>D23.0+ | 18A/DF<br>D31.6+ | 169/A9<br>D9.5-  | 274/34<br>D20.1- | 117/97<br>D23.4- | 29C/5C<br>D28.2- | 355/15<br>D21.0- | 3A2/FD<br>K29.7+ | 196/D6<br>D22.6- |
| 178/A7<br>D7.5+ | 143/5C<br>K28.2+ | 2BC/5C<br>K28.2- | 1CA/FF<br>D31.7+ | 19C/DC<br>D28.6- | 368/17<br>D23.0+ | 18C/D8<br>D24.6+ | 169/A9<br>D9.5-  | 276/30<br>D16.1- | 2C5/8F<br>D15.4+ | 29C/5C<br>D28.2- | 095/15<br>D21.0+ | 05D/FD<br>K29.7- | 196/D6<br>D22.6- |

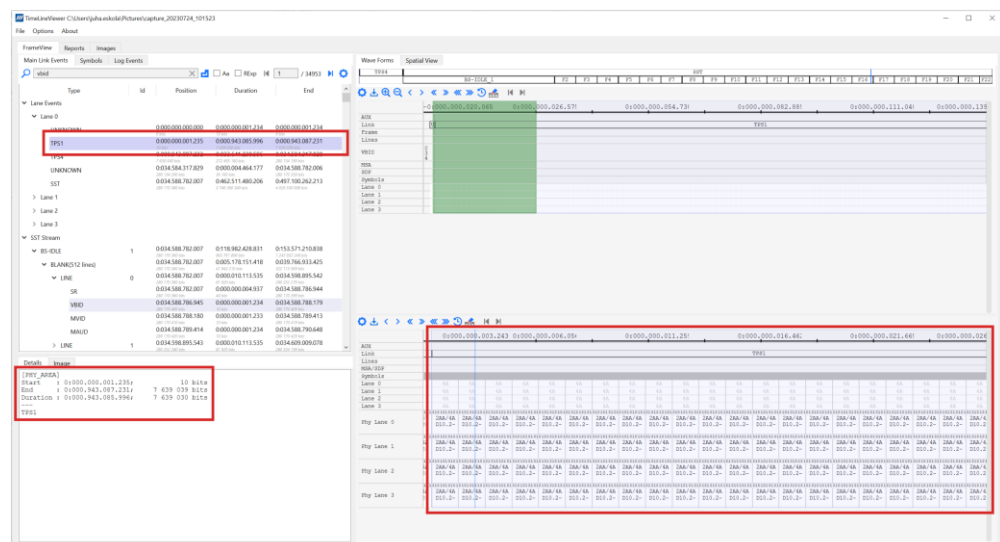
## VBID

The *Event Details* will show information of what the line will contain. In the image below you can see that the line is vertical blanking without pixel data.



## TPS Events

The image below shows how the events are shown for each lane in *Event Selector*, *Symbol View* and *Event details*. The image below shows a TPS1 event.



The image below illustrates the transition from TPS1 to TPS4.

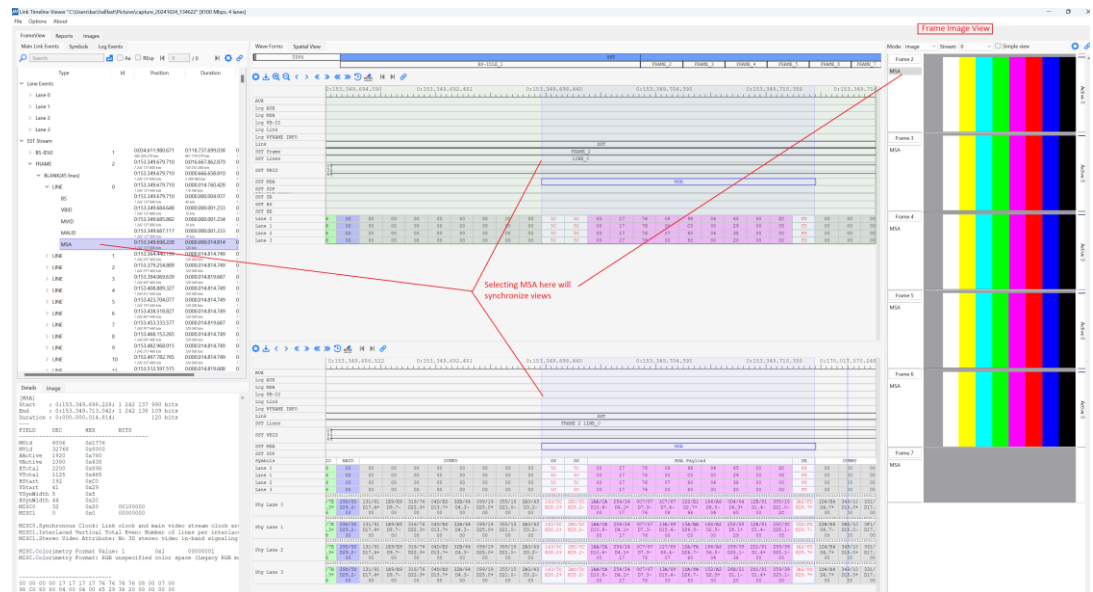
|            | 0:000,854,696.325 | 0:000,854,701.43: | 0:000,854,705.84: | 0:000,854,710.25: | 0:000,854,714 |
|------------|-------------------|-------------------|-------------------|-------------------|---------------|
| AUX        | TPS1              |                   |                   |                   |               |
| Link       | TPS4              |                   |                   |                   |               |
| MSA/SDP    |                   |                   |                   |                   |               |
| Symbols    | 4A                | 4A                | 4A                | 4A                | 4A            |
| Lane 0     | 4A                | 4A                | 4A                | 4A                | 4A            |
| Lane 1     | 4A                | 4A                | 4A                | 4A                | 4A            |
| Lane 2     | 4A                | 4A                | 4A                | 4A                | 4A            |
| Lane 3     | 4A                | 4A                | 4A                | 4A                | 4A            |
| Phy Lane 0 | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A         |
| Phy Lane 1 | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A         |
| Phy Lane 2 | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A         |
| Phy Lane 3 | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A             | 2A/4A         |





## Frame Image View

Frame Image View can be used to select frames and GCP or AVI periods in related views.



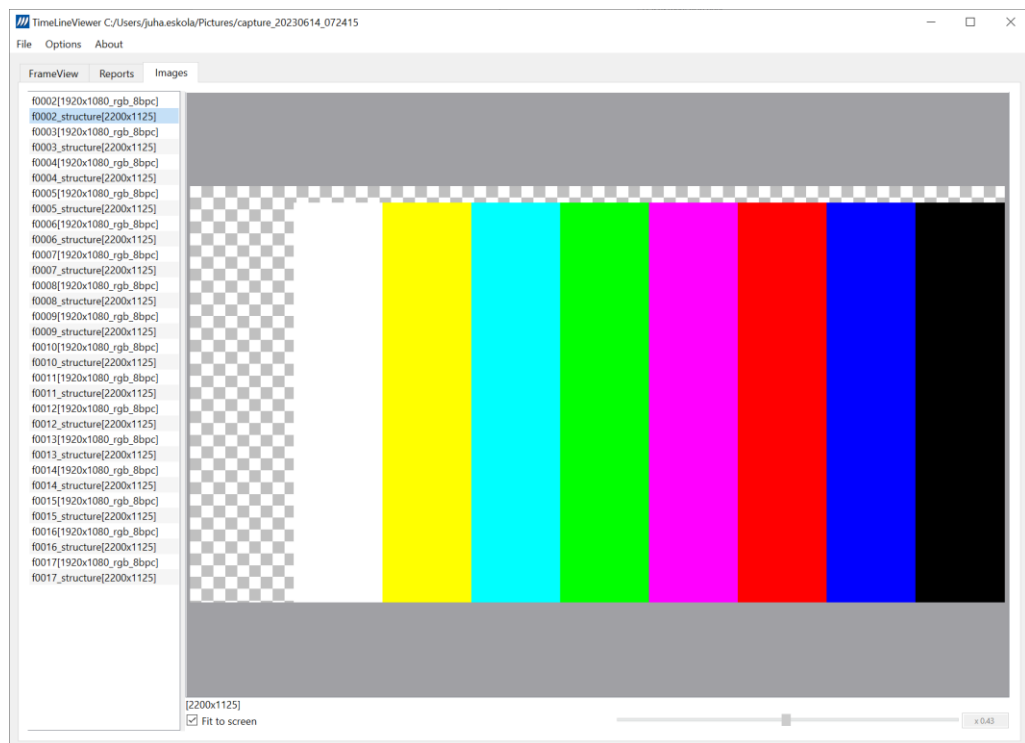
As shown below selecting the MSA event in *Frame Image View* also selects it in *Event Selector View* and synchronizes the other views. Hovering over the Active0 area will show the frame geometry details.

## Images Tab

Video frames decoded from Main Link Data Capture can be previewed in Images tab. Frames are listed on the left-hand side of the window. Each frame has two lines. The first line shows the frame with its active area only.



The second line is a structure frame, which shows total and active area.

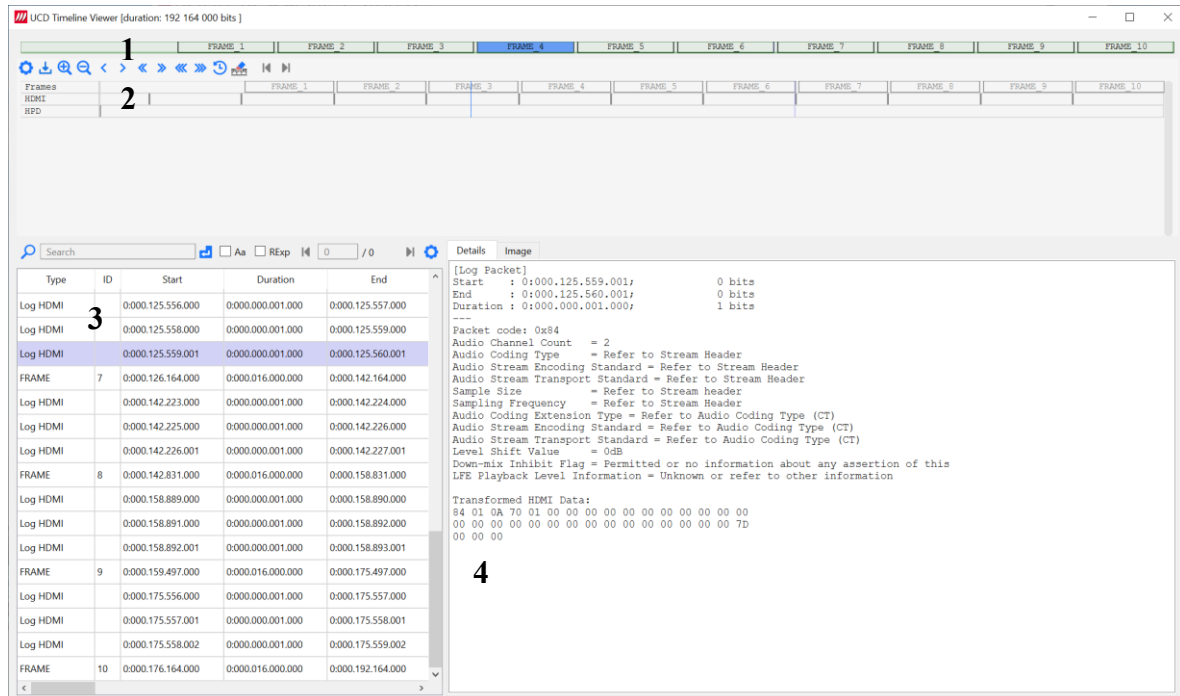


## 8. EVENT TIMELINE VIEWER

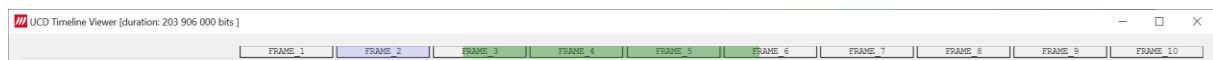
Event Timeline Viewer is an application for inspecting data captured in capture tab.

Event Timeline Viewer consists of four areas.

1. Frame View
2. Event View
3. Event Log
4. Details / Image

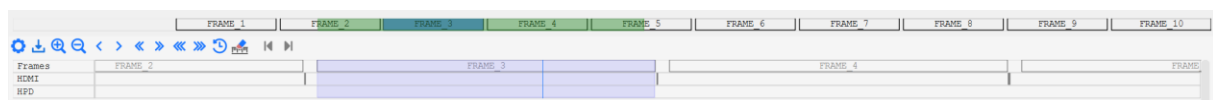


### Frame View



The uppermost panel shows the captured frames. The selected frame is highlighted in purple. You can select a frame by double-clicking it. The area highlighted in green indicates the area shown in the Events view. Please, note that you cannot zoom in or out in the frame view.

### Event View

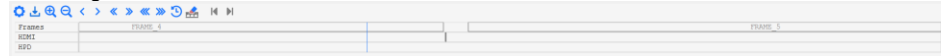


The view below shows all frames and events selected in the capture tab. The area highlighted in green in frame view indicates the area shown in events view.

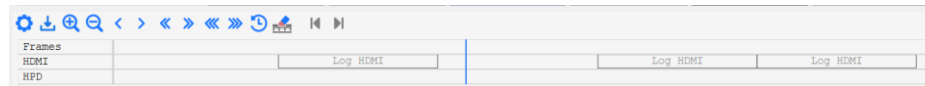
## Tools

| Tool                                                                                                     | Function                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  Gear Icon              | Hide / add events on the timeline                                                                                                                                                                                                                |
|  Save Icon              | Save, load, remove, import, export and remove presets                                                                                                                                                                                            |
|  Magnifying Glass Icons | Zoom in/out on the timeline                                                                                                                                                                                                                      |
|  Arrow Icons            | Move on the timeline. More arrows moves the timeline more. You can also move by clicking and dragging on the timeline.                                                                                                                           |
|  Move to a time point   | Move to a certain time point on the timeline by double clickin on the timeline. The selected event is highlighted in the event log. By right clicking on the timeline and right clicking again you can measure distance between two time points. |
|  Erase all rulers       | Erase all measurements made.                                                                                                                                                                                                                     |

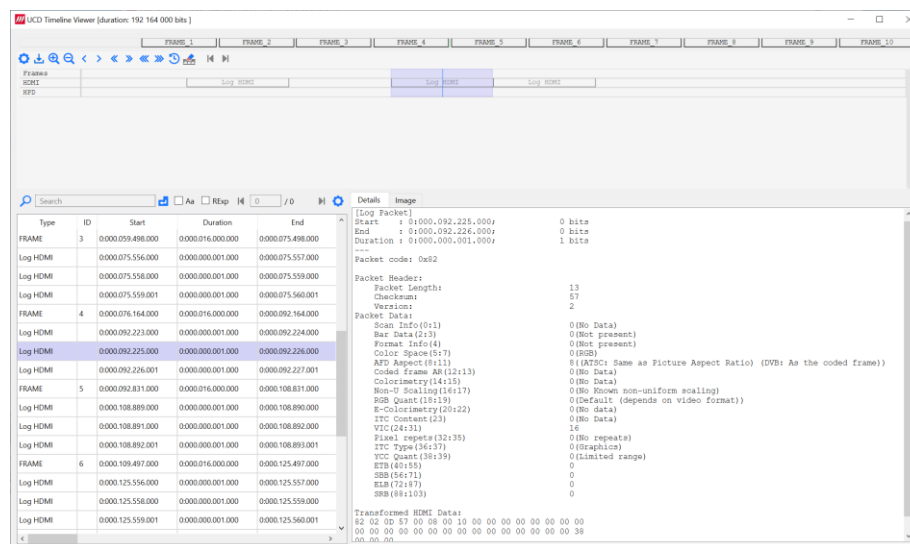
## Zooming on the timeline



When the timeline is zoomed out, you can see events as grey lines. When you zoom in you can see the event block. You can zoom in either with the magnifying glass icons or by scrolling with your mouse.



When you double click on event or frame, the corresponding event or frame is selected in the event log and highlighted in purple.



## Event Log

| Type     | ID | Start             | Duration          | End               | Info                        |
|----------|----|-------------------|-------------------|-------------------|-----------------------------|
| FRAME    | 3  | 0:000.059.498.000 | 0:000.016.000.000 | 0:000.075.498.000 |                             |
| Log HDMI |    | 0:000.075.556.000 | 0:000.000.001.000 | 0:000.075.557.000 | 0x03 HDMI GCP               |
| Log HDMI |    | 0:000.075.558.000 | 0:000.000.001.000 | 0:000.075.559.000 | 0x82 HDMI AVI [INFOFRAME]   |
| Log HDMI |    | 0:000.075.559.001 | 0:000.000.001.000 | 0:000.075.560.001 | 0x84 HDMI Audio [INFOFRAME] |
| FRAME    | 4  | 0:000.076.164.000 | 0:000.016.000.000 | 0:000.092.164.000 |                             |
| Log HDMI |    | 0:000.092.223.000 | 0:000.000.001.000 | 0:000.092.224.000 | 0x03 HDMI GCP               |
| Log HDMI |    | 0:000.092.225.000 | 0:000.000.001.000 | 0:000.092.226.000 | 0x82 HDMI AVI [INFOFRAME]   |
| Log HDMI |    | 0:000.092.226.001 | 0:000.000.001.000 | 0:000.092.227.001 | 0x84 HDMI Audio [INFOFRAME] |
| FRAME    | 5  | 0:000.092.831.000 | 0:000.016.000.000 | 0:000.108.831.000 |                             |
| Log HDMI |    | 0:000.108.889.000 | 0:000.000.001.000 | 0:000.108.890.000 | 0x03 HDMI GCP               |
| Log HDMI |    | 0:000.108.891.000 | 0:000.000.001.000 | 0:000.108.892.000 | 0x82 HDMI AVI [INFOFRAME]   |
| Log HDMI |    | 0:000.108.892.001 | 0:000.000.001.000 | 0:000.108.893.001 | 0x84 HDMI Audio [INFOFRAME] |
| FRAME    | 6  | 0:000.109.497.000 | 0:000.016.000.000 | 0:000.125.497.000 |                             |
| Log HDMI |    | 0:000.125.556.000 | 0:000.000.001.000 | 0:000.125.557.000 | 0x03 HDMI GCP               |
| Log HDMI |    | 0:000.125.558.000 | 0:000.000.001.000 | 0:000.125.559.000 | 0x82 HDMI AVI [INFOFRAME]   |
| Log HDMI |    | 0:000.125.559.001 | 0:000.000.001.000 | 0:000.125.560.001 | 0x84 HDMI Audio [INFOFRAME] |
| FRAME    | 7  | 0:000.126.164.000 | 0:000.016.000.000 | 0:000.142.164.000 |                             |

Event log shows all captured events and frames. The following info is presented in the table:

| Type     | Function                                |
|----------|-----------------------------------------|
| ID       | Number of captured frame                |
| Start    | Start of the event                      |
| Duration | Duration of the event                   |
| End      | End of the event                        |
| Info     | Additional information about the event. |

## Event Log Tools

|                                                                                                           |                                                                                      |
|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  Search                | Search events from the event log. Search results are highlighted in purple.          |
|  Apply search filters  | Apply filters.                                                                       |
| <input type="checkbox"/> Aa <input type="checkbox"/> RExp Search filters                                  | Aa filter: Make search case sensitive<br>RExp: Use regular expressions in search     |
|  7 / 12 Search results | Shows search results. Move from one search result to another by clicking the arrows. |
|  Configure             | Select which columns are shown in event log.                                         |

Details / Image

DetailsImage

[Log Packet]

Start : 0:000.092.225.000;0 bits

End : 0:000.092.226.000;0 bits

Duration : 0:000.000.001.000;1 bits

--|

Packet code: 0x82

Packet Header:

Packet Length:13

Checksum:57

Version:2

Packet Data:

Scan Info(0:1)0 (No Data)

Bar Data(2:3)0 (Not present)

Format Info(4)0 (Not present)

Color Space(5:7)0 (RGB)

AFD Aspect(8:11)8 ((ATSC: Same as Picture Aspect Ratio) (DVB: As the coded frame))

Coded frame AR(12:13)0 (No Data)

Colorimetry(14:15)0 (No Data)

Non-U Scaling(16:17)0 (No Known non-uniform scaling)

RGB Quant(18:19)0 (Default (depends on video format))

E-Colorimetry(20:22)0 (No data)

ITC Content(23)0 (No Data)

VIC(24:31)16

Pixel repets(32:35)0 (No repeats)

ITC Type(36:37)0 (Graphics)

YCC Quant(38:39)0 (Limited range)

ETB(40:55)0

SBB(56:71)0

ELB(72:87)0

SRB(88:103)0

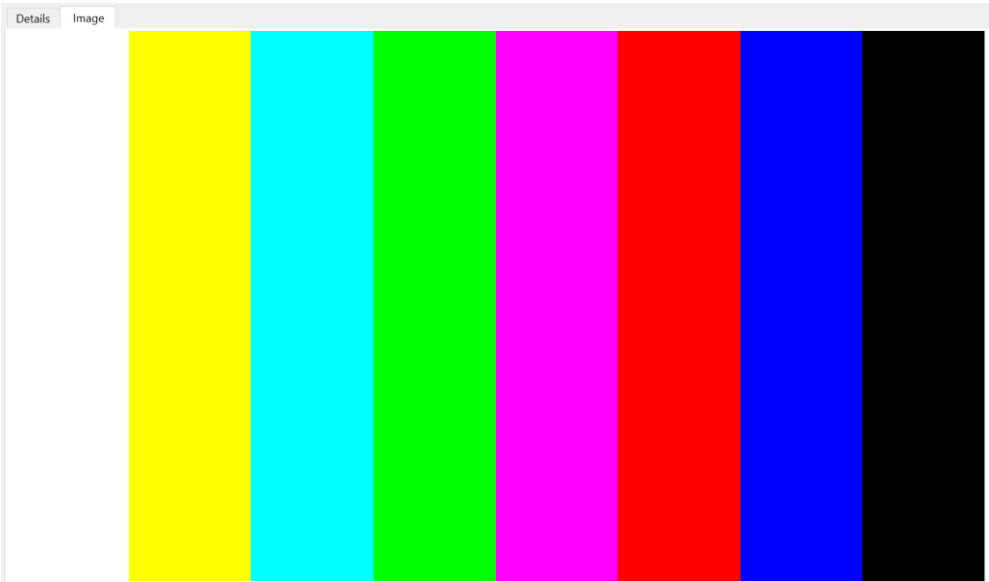
Transformed HDMI Data:

82 02 0D 57 00 08 00 10 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 38

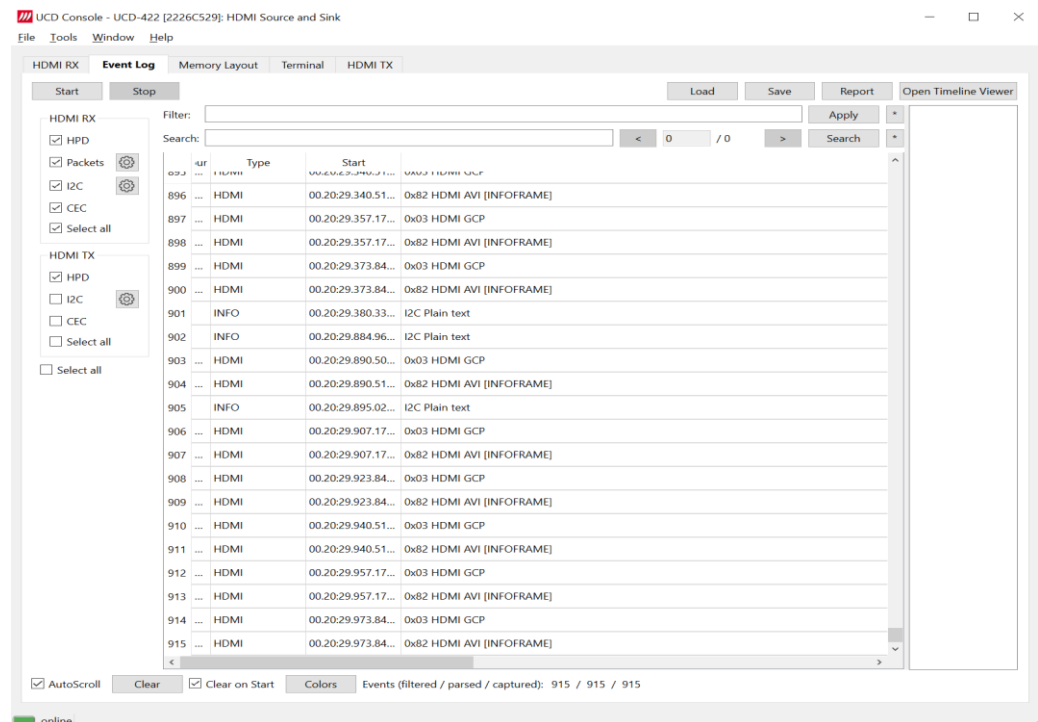
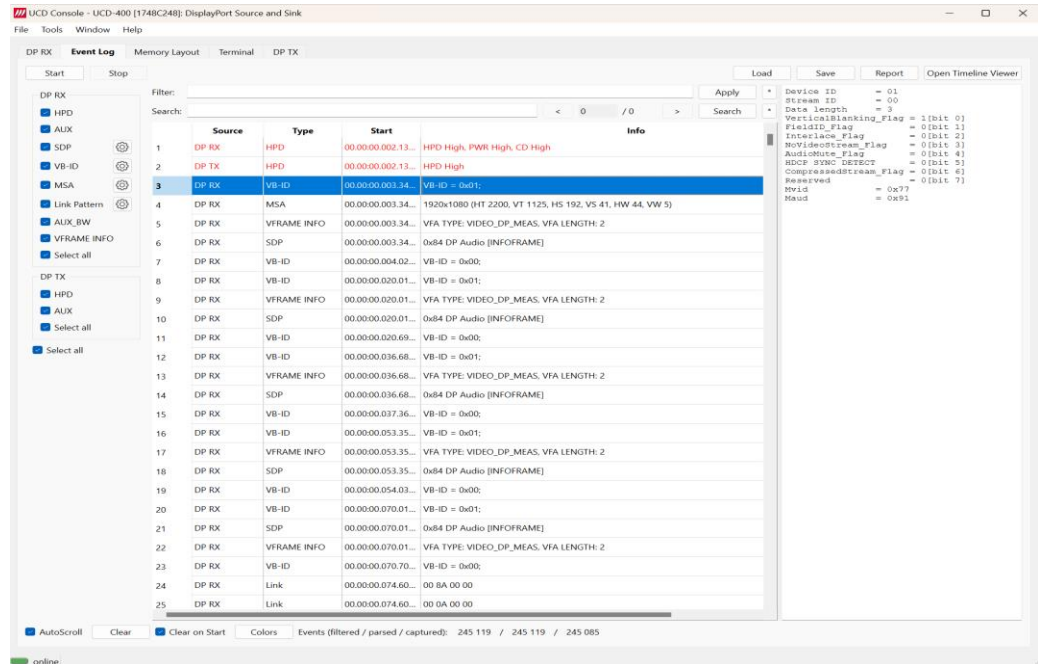
00 00 00

Details tab shows details of the selected event. When the selected event is a frame, the image tab shows the captured frame.



## 9. EVENT LOG

Event Log dialog is divided into two panels: the left panel lists all transactions, and the right panel shows the parsed transaction data for the line selected in the list on the left.



| Role                                                              | Logged Events                                                                                                                                                                                        |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DP Sink (UCD-400)<br>DP Alt Mode Sink (UCD-424)                   | HPD, AUX, SDP, VB-ID, MSA, Link Pattern, AUX_BW, VFRAME INFO                                                                                                                                         |
| HDMI Sink (UCD-422)                                               | HPD, Packets, I2C, CEC                                                                                                                                                                               |
| DP Source (UCD-400, UCD-411, 451)<br>DP Alt Mode Source (UCD-424) | HPD, AUX                                                                                                                                                                                             |
| HDMI Source (UCD-422, UCD-412, 452)                               | HPD, I2C, CEC                                                                                                                                                                                        |
| DP Alt Mode Sink (UCD-424)<br>DP Alt Mode Source (UCD-424)        | PD, LSE                                                                                                                                                                                              |
| <i>Start:</i>                                                     | Starts event logging and stop it by clicking <i>Stop</i> .                                                                                                                                           |
| <i>Save:</i>                                                      | Save transactions as Event Log data.                                                                                                                                                                 |
| <i>Load:</i>                                                      | Load Event Log data.                                                                                                                                                                                 |
| <i>Report:</i>                                                    | Store event logs as reports in HTML format.                                                                                                                                                          |
| Open Timeline Viewer                                              | Open Event timeline Viewer to inspect the captured data. For detailed instructions refer to chapters 6 and 7 of this manual.                                                                         |
| <i>AutoScroll:</i>                                                | When selected, transaction list is scrolled vertically. The latest transaction is shown as the last item of the list. When not selected, the items shown before clicking <i>Start</i> will be shown. |
| <i>Events</i>                                                     | Number of events detected.                                                                                                                                                                           |
| <i>Colors:</i>                                                    | Open configure colors dialog.                                                                                                                                                                        |
| <i>Clear:</i>                                                     | Click to clear transaction list. When <i>Clear on Start</i> is selected, the list is cleared when clicking <i>Start</i> .                                                                            |



# Logged Events

## HPD

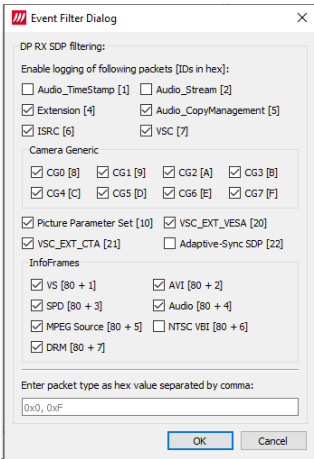
Status and status changes of Hot Plug Detect (HPD) signal, power detection status and cable connection status.

## AUX

Log DP AUX Channel transactions and Sideband Messaging.

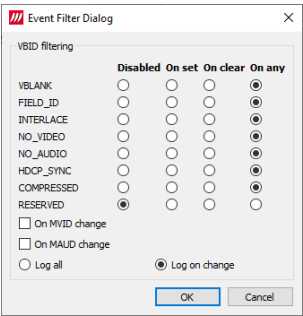
## SDP

Log DP Secondary-data Packets. Click the  button to open the *Event Filter Dialog*. The dialog enables filtering of SDP packets. In the dialog, the reference to Packet Type Value is indicated in square brackets “[ ]”.



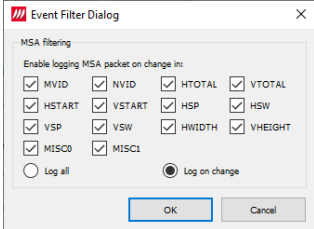
## VB-ID

Log Vertical Blanking ID packets sent in DP stream. Click the  button to open the *Event Filter Dialog*. The dialog enables definition of which events will be logged.



## MSA

Log Main Stream Attributes sent in DP stream. Click the  button to open the *Event Filter Dialog*. The dialog enables logging of all MSA:s or just changes to selected parameters.

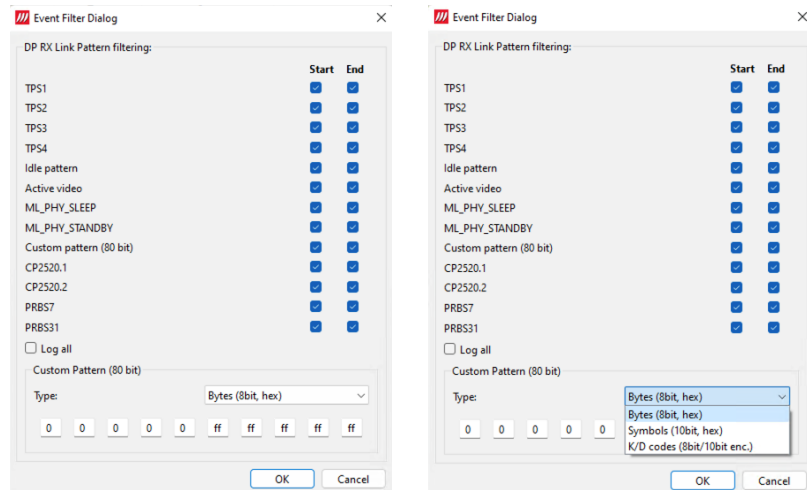


## Link Pattern

Click the  button to open the *Event Filter Dialog*.

Log link patterns. Event filter dialog sets the type of link patterns that will be captured.

Custom Pattern (80 bit) is a sequence that either splits into 10 bytes or 8b/10b encoded symbols. For 10b symbols, either K/D codes or hex values must be provided. For bytes, hex values must be provided.



## AUX\_BW

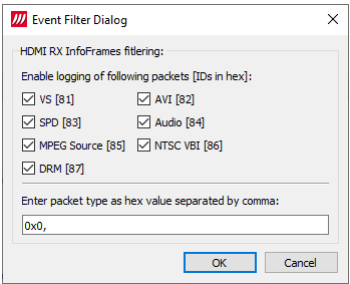
Log AUX\_Bitwise transactions as a series of Manchester II codes.

## VFRAME INFO

Dimensions of the captured frame measured by the Sink

## Packets

Log metadata sent by Source device in HDMI stream



## I2C

Log data sent over I2C communication lines of HDMI interface

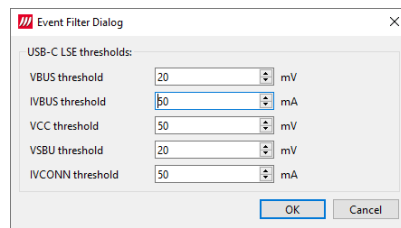
## PD

Log USB-C PD communication messages

## CEC

Log HDMI CEC communication messages

## LSE



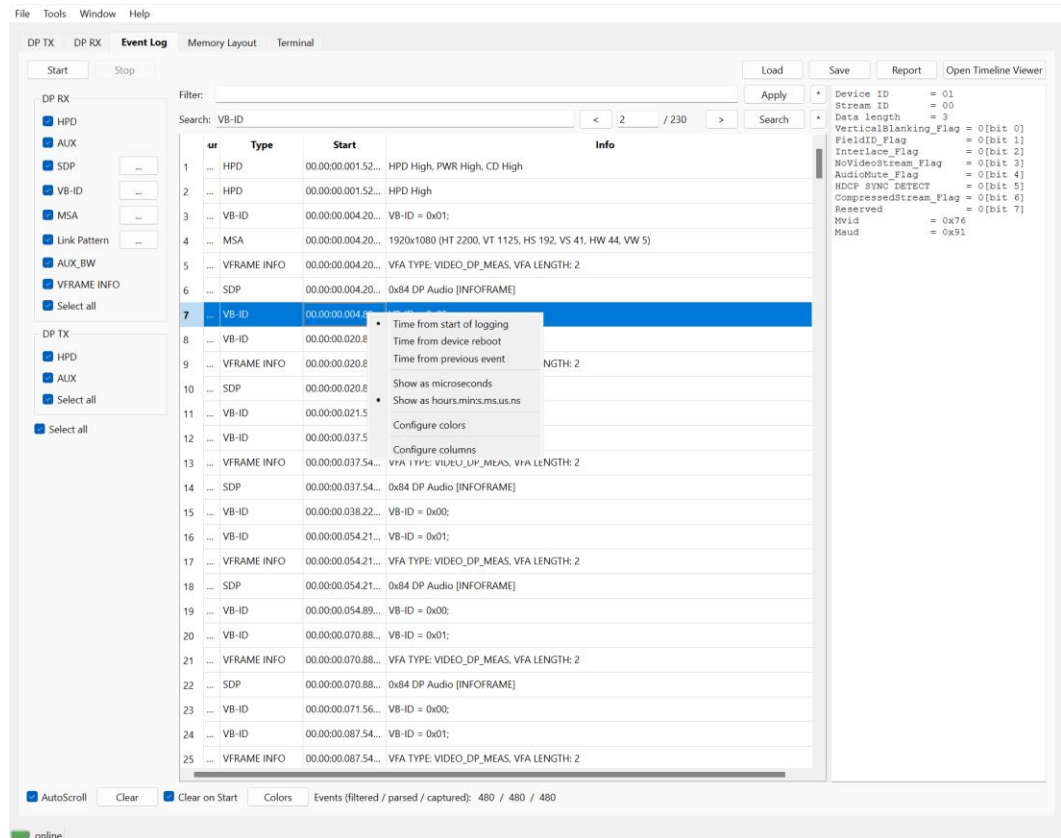
Low Speed Electrical logger captures the Voltage and Current on the low-speed lanes of the USB-C connector including CC, VBUS, VCONN, and SBU.

Event Filter Dialog sets the threshold values for capturing the changes. Parsed transaction data shows the captured data with indication of the changed values.

## Event Transaction List

Transaction data in Transaction List is ordered in columns. Each column provides additional information about the data line, facilitating its viewing and interpretation.

You can search events by typing its name in the Search bar and pressing enter or selecting the *Search* button. Pressing F3 (Ctrl+G on macos) takes you to the next found and Shift+F3 (Shift+Ctrl+G on macOS) takes you to the previous found.



**Source:** The communication port: DP RX, DP TX, HDMI RX, HDMI TX or HDCP 1.X, HDCP 2.3

**Type:** The logged item:  
HPD, AUX, SDP, VB-ID, MSA, Link Pattern, AUX\_BW, VFRAME INFO (DP or DP Alt Mode)  
HPD, Packets, I2C, CEC (HDMI)

**Start:** Each line is identified by its timestamp, marking the instant when an event or error was detected, or when a data transaction got started.  
The timestamp can be displayed as a time delay from the start of the acquisition (absolute) or from the previous line (relative). The timestamp can be displayed in milliseconds or in minutes, seconds, and microseconds.

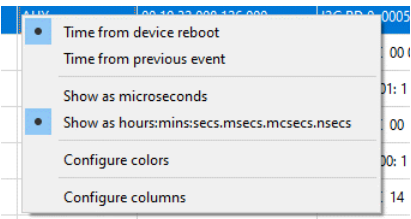
**Info:** This column provides a short description of the message content

When hovering the mouse over the transaction list, a mouse-over window will open. It provides a brief list of the content in the transaction under the mouse.

## Customizing Transaction List

User Can change what data is shown in the transaction list by adding and removing columns or limiting the transaction types in the list. User can also color highlight various types of transactions for better readability.

Right-click on the list to open the menu.



### Configure Start

The time indicated in column *Start* can be either:

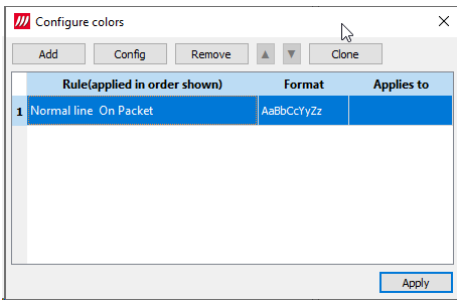
- Time from device reboot
- Time from previous event

The time can be expressed either:

- In microseconds (1/1 000 000 Second)
- Hours : minutes : seconds : milliseconds : nanoseconds

### Configure Colors

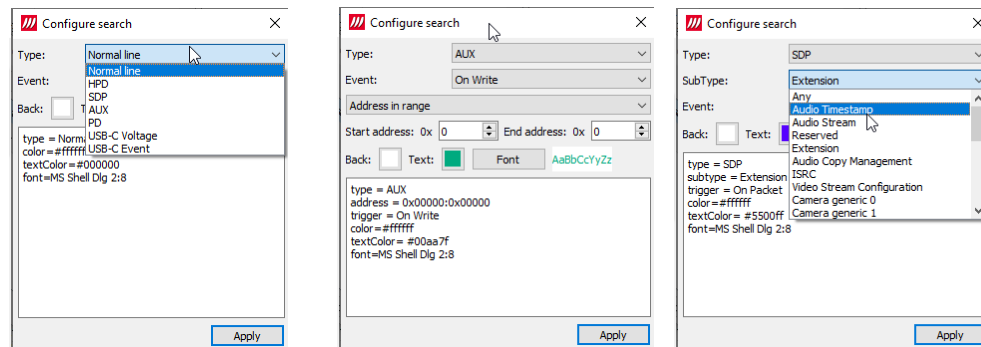
*Configure colors* dialog allows the user to highlight various types of transactions in the list by changing character color and background color of the transaction line.



|                |                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------|
| <i>Add:</i>    | Add a new color highlight rule                                                                         |
| <i>Config:</i> | Modify the selected rule                                                                               |
| <i>Remove:</i> | Delete the selected rule                                                                               |
| <i>Clone:</i>  | Duplicate the selected rule                                                                            |
| ▲ ▼:           | Change order where rules are applied.<br>The rules are applied from the bottom to the top of the list. |

## Adding Rules

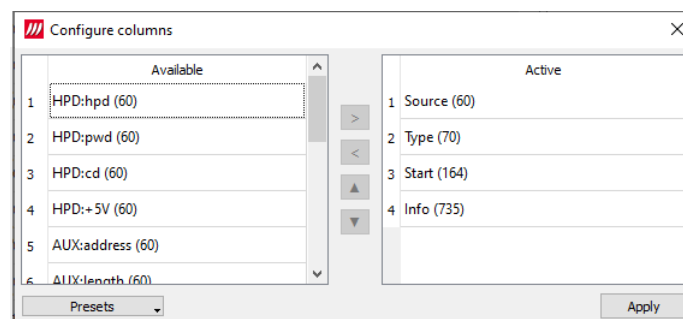
The color highlight rules are set by transaction type. The content of *Add rules* dialog is dependent on the type of item selected.



## Configure Columns

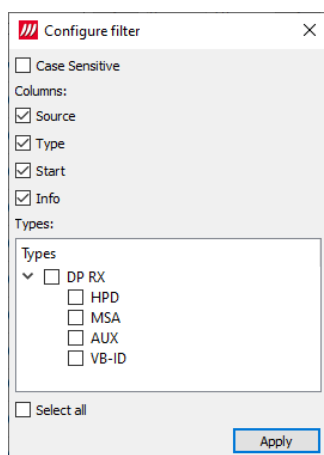
In the dialog there are two columns: *Available* and *Active*. An item from Available list can be included in Active columns by selecting it and clicking on the right arrow [>] in the middle of the two columns.

The order of Active items can be changed by selecting an item and moving its position in the list with up ▲ and down ▼ arrows.



## Type Filter

Type filter dialog lists the types of transactions found in the list and allows the user to select which



transaction lines are currently shown.

## Quick Filter

By entering a DPCD address in the Quick Filter field on top of the transaction line, the user can limit the list to show only the reads or writes to this DPCD address.

## Event Details

### HPD

HPD transactions include the following statuses:

|                               |                                                                                                |
|-------------------------------|------------------------------------------------------------------------------------------------|
| <i>Hot-Plug-Detect Level:</i> | Status of HPD signal: HIGH (Asserted), LOW (De-asserted)                                       |
| <i>PWD Level:</i>             | Status of source device detection: High (DP Tx detected), LOW (DP Tx not detected)             |
| <i>Cable Detect Level:</i>    | Status of cable detection HIGH (Cable connection detected) LOW (Cable connection not detected) |

```
Device ID           = 01 [DP RX]
Hot-Plug-Detect Level = HIGH
PWD Level           = HIGH (DP Tx is connected to Rx and has power applied to AUX pull-up resistor)
Cable Detect Level   = HIGH
```

### AUX (UCD-400, UCD-411, UCD-424, UCD-451)

Transaction list includes the following DP AUX Channel transactions. Parsed transactions panel provides details for each transaction.

|                                              |                                                                                                                                                                      |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>RD:</i>                                   | Native AUX Request Transaction for read                                                                                                                              |
| <i>WR:</i>                                   | Native AUX Request Transaction for write                                                                                                                             |
| <i>I2C RD:</i>                               | I2C-over-AUX Request Transaction for read                                                                                                                            |
| <i>I2C WR:</i>                               | I2C-over-AUX Request Transaction for write                                                                                                                           |
| <i>AUX_ACK:</i>                              | AUX Reply Transaction (Request accepted)                                                                                                                             |
| <i>AUX_NACK:</i>                             | AUX Reply Transaction (Request not accepted)                                                                                                                         |
| <i>AUX_DEFER:</i>                            | AUX Reply Transaction (Delayed, new request needed)                                                                                                                  |
| <i>Sideband REQ:</i>                         | Sideband down request message (DOWN_REQ_MSG)                                                                                                                         |
| <i>Sideband REP:</i>                         | Sideband down reply message (DOWN_REP_MSG)                                                                                                                           |
| <i>EDID Trace:</i>                           | Accumulated EDID content from I2C or sideband down messages                                                                                                          |
| <i>DisplayID:</i>                            | Accumulated DisplayID content from I2C or sideband down messages                                                                                                     |
| <i>HDCP Trace 1.X or<br/>HDCP Trace 2.3:</i> | HDCP Transmitter and HDCP Receiver communicate DPCD values over AUX Channel. Transactions are listed as DPCD Address Range Traces where HDCP Port name is indicated. |

### Native AUX Transaction Example

```

Direction          = Source to Sink
Native AUX Request  = Read
Length              = 6
Address             = 0x00200

```

```

Link/Sink Device Status
SINK_COUNT [RO]
0x00200

```

```

Link/Sink Device Status
DEVICE_SERVICE_IRQ_VECTOR
0x00201

```

```

Link/Sink Device Status
LANE0_1_STATUS [RO]
0x00202

```

```

Link/Sink Device Status
LANE2_3_STATUS [RO]
0x00203

```

```

Link/Sink Device Status
LANE_ALIGN_STATUS_UPDATED [RO]
0x00204

```

```

Link/Sink Device Status
SINK_STATUS [RO]
0x00205

```

```

Direction          = Sink to Source
Native AUX Reply    = AUX_ACK
I2C-over-AUX Reply  = AUX_ACK

```

```

Link/Sink Device Status
SINK_COUNT [RO]
0x00200 := 0x01
SINK_COUNT = 1
CP_READY = 0

```

```

Link/Sink Device Status
DEVICE_SERVICE_IRQ_VECTOR
0x00201 := 0x10
REMOTE_CONTROL_COMMAND_PENDING = 0
AUTOMATED_TEST_REQUEST = 0
CP_IRQ = 0
MCCS_IRQ = 0
DOWN_REQ_MSG_RDY = 1
UP_REQ_MSG_RDY = 0
SINK_SPECIFIC_IRQ = 0

```

```

Link/Sink Device Status
LANE0_1_STATUS [RO]
0x00202 := 0x77
LANE0_CR_DONE = 1
LANE0_CHANNEL_EQ_DONE = 1
LANE0_SYMBOL_LOCKED = 1
LANE1_CR_DONE = 1
LANE1_CHANNEL_EQ_DONE = 1
LANE1_SYMBOL_LOCKED = 1

```

```

Link/Sink Device Status

```

### Sideband Message Example

```

Sideband message header
Link_Count_Total          1
Link_Count_Remaining      0
Broadcast_Message         0
Path_Message              1
MSG_Body_Length           3
Start_Of_MT               1
End_Of_MT                 1
Message_Sequence_No       0

Sideband message validity check
MSG_Header_CRC            7[Good]
MSG_Body_CRC              95[Good]
Header Reserved (Zero) fields [Good]

Message Transaction decode
Request_Identifier         0x10[ENUM_PATH]
Port_Number                8

```

```

Sideband message header
Link_Count_Total          1
Link_Count_Remaining      0
Broadcast_Message         0
Path_Message              1
MSG_Body_Length           7
Start_Of_MT               1
End_Of_MT                 1
Message_Sequence_No       0

Sideband message validity check
MSG_Header_CRC            0[Good]
MSG_Body_CRC              20[Good]
Header Reserved (Zero) fields [Good]

Message Transaction decode
Reply_Type                 ACK
Request_Identifier         0x10[ENUM_PATH]
Port_Number                8
Full_Payload_Bandwidth_Available 7737
Payload_Bandwidth_Number   7737

```

### HDPC Trace Example

```

E(kpub)_k(m)- DPCD Address range trace

0x69220 - 0x6929F
No extended trace decoding available.
Block dump:
CD C7 90 67 D8 D9 9A BD 43 56 64 18 52 A5 73 BB
41 56 E1 FD 82 F8 3A 24 9A BB 0C FD 42 98 3B 17
D8 E6 07 14 D6 E9 CA 25 19 10 3D 26 38 F6 15 B7
5E 4F BE 8B 25 B3 CC 62 0E 1D 00 21 41 E2 DD 09
50 A2 26 E5 8F 9D A0 2F F2 18 AA 98 48 C6 6D 49
AB D8 92 7E B3 A7 F2 CC 85 55 F7 51 53 31 41 FC
68 C2 6D BF 06 5A 8B D7 B9 17 87 53 8E 16 DE 74
00 E3 96 1C 4E A8 81 30 BA 68 B8 3D D6 EE C9 F7

```



**SDP (UCD-400, UCD-424)**

DP Secondary-data Packets.

|              |                                                                   |                           |                                   |    |   |   |
|--------------|-------------------------------------------------------------------|---------------------------|-----------------------------------|----|---|---|
| SDP ID:      | 0x00                                                              |                           |                                   |    |   |   |
| SDP Type:    | 0x84                                                              |                           |                                   |    |   |   |
| SDP Length:  | 0x01B (27)                                                        |                           |                                   |    |   |   |
| SDP Version: | 0x12 (18)                                                         |                           |                                   |    |   |   |
| Data Byte 1: |                                                                   |                           |                                   |    |   |   |
| CC[2-0]:     | 0x1                                                               | Channel Count             | 2                                 |    |   |   |
| CT[7-4]:     | 0x0                                                               | Refer to Stream Header    |                                   |    |   |   |
| Data Byte 2: |                                                                   |                           |                                   |    |   |   |
| SS[1-0]:     | 0x0                                                               | Sample Size               | Refer to Stream Header            |    |   |   |
| SF[4-2]:     | 0x0                                                               | Sampling Frequency        | Refer to Stream Header            |    |   |   |
| Data Byte 3: |                                                                   |                           |                                   |    |   |   |
| CXT[4-0]:    | 0x00                                                              | Refer to CT (Data Byte 1) |                                   |    |   |   |
| Data Byte 4: |                                                                   |                           |                                   |    |   |   |
| CA[7-0]:     | 0x00                                                              | Channel Allocation        | 1                                 | 2  | 3 | 4 |
|              |                                                                   |                           | FL                                | FR | - | - |
| Data Byte 5: |                                                                   |                           |                                   |    |   |   |
| LFEPL[1-0]:  | 0x0                                                               | LFE Playback Level        | Unknown or refer to other inform  |    |   |   |
| LSV[6-3]:    | 0x0                                                               | Level Shift Value         | 0dB                               |    |   |   |
| DM_INH[7]:   | 0x0                                                               | Down-mix Inhibit Flag     | Permitted or no information about |    |   |   |
| Raw Data:    |                                                                   |                           |                                   |    |   |   |
| Head:        | 00 84 1B 48 (PB: 00 84 D7 D1)                                     |                           |                                   |    |   |   |
| Body:        | 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 (PB: 98 00 00 00) |                           |                                   |    |   |   |
|              | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 (PB: 00 00 00 00) |                           |                                   |    |   |   |

**VB-ID (UCD-400, UCD-424)**

Vertical Blanking ID packets sent in DP stream.

|                       |            |
|-----------------------|------------|
| Device ID             | = 00       |
| Stream ID             | = 00       |
| Data length           | = 3        |
| VerticalBlanking_Flag | = 1[bit 0] |
| FieldID_Flag          | = 0[bit 1] |
| Interlace_Flag        | = 0[bit 2] |
| NoVideoStream_Flag    | = 0[bit 3] |
| AudioMute_Flag        | = 1[bit 4] |
| HDCP_SYNC_DETECT      | = 0[bit 5] |
| CompressedStream_Flag | = 0[bit 6] |
| Reserved              | = 0[bit 7] |
| Mvid                  | = 0x33     |
| Maud                  | = 0x00     |

**MSA (UCD-400, UCD-424)**

Main Stream Attributes sent in DP stream.

|                                       |                                               |
|---------------------------------------|-----------------------------------------------|
| Device ID                             | = 01                                          |
| Stream ID                             | = 03                                          |
| Data length                           | = 28                                          |
| Mvid                                  | = 0x2333                                      |
| Nvid                                  | = 0x8000                                      |
| H-Total                               | = 2200                                        |
| V-Total                               | = 1125                                        |
| H-Active                              | = 1920                                        |
| V-Active                              | = 1080                                        |
| H-Sync Width                          | = 44                                          |
| V-Sync Width                          | = 5                                           |
| H-Sync Start                          | = 192                                         |
| V-Sync Start                          | = 41                                          |
| MISC0                                 | = 0x20                                        |
| MISC0.Clock                           | = Asynchronous                                |
| MISC1                                 | = 0x00                                        |
| MISC1.Interlaced Vertical Total Even: | Number of lines per interlaced frame (consist |
| MISC1.Interlaced Vertical Total Even: | No 3D stereo video in-band signaling          |

Status of link pattern detected in which lane.

Status of captured binary Manchester II codes. The duration of the preamble and postamble will be presented.

Measure dimensions of capture video frame.

190

**PD (UCD-424)**

## USB-C PD communication messages

|                                    |                               |              |
|------------------------------------|-------------------------------|--------------|
| Start of packet: SOP (S1 S1 S1 S2) |                               |              |
| Header                             | 0x21A1                        | Data Message |
| Extended(15)                       | 0                             |              |
| Data Objs(14..12)                  | 2                             |              |
| Message ID(11..9)                  | 0                             |              |
| Port Power Role(8)                 | Source (0x1)                  |              |
| Spec Rev(7..6)                     | v3.0 (0x2)                    |              |
| Port Data Role(5)                  | DFP (0x1)                     |              |
| Message Type(4..0)                 | Source_Capabilities (0x01)    |              |
| Fixed PDO - Source                 | 0x2A01912C                    |              |
| Fixed supply(31..30)               | 0x0                           |              |
| Dual-Role Power(29)                | True (0x1)                    |              |
| USB Suspend Supported(28)          | False (0x0)                   |              |
| Unconstrained Power(27)            | True (0x1)                    |              |
| USB Comm Capable(26)               | False (0x0)                   |              |
| Dual-Role Data(25)                 | True (0x1)                    |              |
| Unchunked Ext Messages Sup(24)     | False (0x0)                   |              |
| EPR Mode Capable(23)               | False (0x0)                   |              |
| Reserved(22)                       | 0x0                           |              |
| Peak Current(21..20)               | Peak current equals Ioc (0x0) |              |
| Voltage(19..10)                    | 5000mV (0x064)                |              |
| Maximum Current(9..0)              | 3000mA (0x12C)                |              |
| Fixed PDO - Source                 | 0x2A02D12C                    |              |
| Fixed supply(31..30)               | 0x0                           |              |
| Dual-Role Power(29)                | True (0x1)                    |              |
| USB Suspend Supported(28)          | False (0x0)                   |              |
| Unconstrained Power(27)            | True (0x1)                    |              |
| USB Comm Capable(26)               | False (0x0)                   |              |
| Dual-Role Data(25)                 | True (0x1)                    |              |
| Unchunked Ext Messages Sup(24)     | False (0x0)                   |              |
| EPR Mode Capable(23)               | False (0x0)                   |              |
| Reserved(22)                       | 0x0                           |              |
| Peak Current(21..20)               | Peak current equals Ioc (0x0) |              |
| Voltage(19..10)                    | 9000mV (0x0B4)                |              |
| Maximum Current(9..0)              | 3000mA (0x12C)                |              |
| CRC                                | 0x18F3953D                    |              |
| End of packet                      |                               |              |

**LSE (UCD-424)**

## Status of USB-C Low Speed Electrical signals

|                |                        |
|----------------|------------------------|
| Device ID      | = 01                   |
| Packet size    | = 40 [bytes]           |
| Data length    | = 40                   |
| Vbus TimeStamp | = 02:53:20.750.932.000 |
| Vbus voltage   | = 5420 mV [updated]    |
| Vbus currents  | = 88 mA                |
| Vcc 1          | = 5337 mV [updated]    |
| Vcc 2          | = 1680 mV [updated]    |
| Vsbu 1         | = 234 mV               |
| Vsbu 2         | = 2865 mV              |
| Ivconn         | = 5337 mA [updated]    |

## Packets (UCD-422, UCD-452)

Log metadata sent by Source device in HDMI stream

```

Packet code: 0x82

Packet Header:
  Packet Length:      13
  Checksum:           57
  Version:            2
Packet Data:
  Scan Info(0:1)      0(No Data)
  Bar Data(2:3)       0(Not present)
  Format Info(4)      0(Not present)
  Color Space(5:7)    0(RGB)
  AFD Aspect(8:11)    8((ATSC: Same as Picture Aspect Ratio) (
  Coded frame AR(12:13) 0(No Data)
  Colorimetry(14:15)   0(No Data)
  Non-U Scaling(16:17) 0(No Known non-uniform scaling)
  RGB Quant(18:19)     0(Default (depends on video format))
  E-Colorimetry(20:22) 0(No data)
  ITC Content(23)      0(No Data)
  VIC(24:31)          16
  Pixel repeats(32:35) 0(No repeats)
  ITC Type(36:37)      0(Graphics)
  YCC Quant(38:39)     0(Limited range)
  ETB(40:55)          0
  SBB(56:71)          0
  ELB(72:87)          0
  SRB(88:103)         0

Transformed HDMI Data:
82 02 0D 57 00 08 00 10 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 38
00 00 00
    
```

## I2C (UCD-422, UCD-452)

Log data sent over I2C communication lines of HDMI interface

```

Message:
HDRX CDC: RD 0x10:UPDATE[0] 0x0
    
```

## CEC (UCD-422, UCD-452)

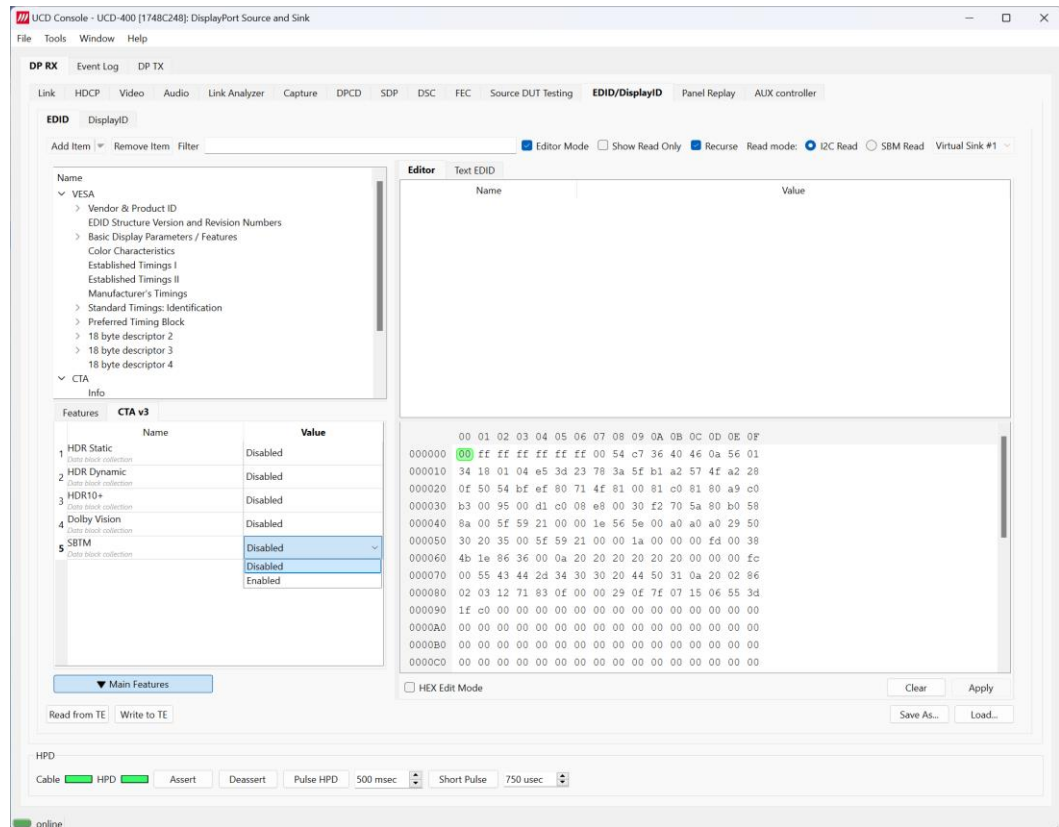
CEC messages

```

Device ID: 00
Flags: 00
Data length: 7
Acknowledges vector: 0x001F
-----
Header:
  Initiator address:      0x00
  Destination address:    0x0F
-----
Opcode Block:
  Opcode:                 <Report Physical Address>(0x84)
-----
[Physical Address]        0.0.0.0
[Device Type]             TV(0x00)
-----
    
```

## 10. EDID/DISPLAYID EDITOR

The *EDID/DisplayID Editor* main window is divided into three views. The bottom area additionally has command buttons. The top left tree view selection determines the blocks to be edited. The top right view shows data for the currently selected item in the top left view. These values may be edited when the *Editor Mode* checkbox is checked. The bottom right hex view shows that data as hex values. The hex values of the currently selected item in the top left view are highlighted. Values can be edited when the *HEX Edit Mode* checkbox is checked.



|                             |                                                                                                                                                     |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Add Item</b>             | Add a new EDID or DisplayID block. Available when in <i>Editor Mode</i> exclusively and a top node in treeview (CTA or VESA) is selected.           |
| <b>Remove Item</b>          | Delete the selected EDID or DisplayID block. Available when in <i>Editor Mode</i> exclusively and a top node in treeview (CTA or VESA) is selected. |
| <b>Filter</b>               | Show only items having the filter string in the field name.                                                                                         |
| <b>Editor Mode</b>          | See below.                                                                                                                                          |
| <b>Show Read Only</b>       | Automatically generated non-editable fields are additionally shown.                                                                                 |
| <b>Read mode</b>            | Data read mode:<br>I2C (using I2C protocol) or SBM (MST mode only): virtual channels read via SBM protocol.                                         |
| <b>Recurse</b>              | All subitems of the selected item are presented in <i>Editor View</i> .                                                                             |
| <b>Virtual Sink #1 (DP)</b> | Dropdown labeled with the currently selected virtual sink (MST).                                                                                    |

The buttons at the bottom of the dialog differ based on role: *Analyser* (*Read from TE* and *Write to TE*) or *Generator* (*Download from Sink* and *Upload to Sink*).

|                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div> <div>▼ Main Features</div> <div> <input type="checkbox"/> HEX Edit Mode         </div> <div> <div>Read from TE</div> <div>Write to TE</div> </div> <div> <div>Clear</div> <div>Apply</div> </div> <div> <div>Save As...</div> <div>Load...</div> </div> </div> |                                                                                                                                                                                                                                                                                                                                     |
| <i>Read from TE (Analyzer)</i>                                                                                                                                                                                                                                       | Read device local EDID/DisplayID blocks into editor ( <i>HEX Edit Mode</i> must be unchecked).                                                                                                                                                                                                                                      |
| <i>Write to TE (Analyzer)</i>                                                                                                                                                                                                                                        | Write editor data to device local EDID/DisplayID blocks.                                                                                                                                                                                                                                                                            |
| <i>Download from Sink (Generator)</i>                                                                                                                                                                                                                                | Read EDID/DisplayID blocks from connected sink device into editor.                                                                                                                                                                                                                                                                  |
| <i>Upload to Sink (Generator)</i>                                                                                                                                                                                                                                    | Write editor EDID/DisplayID blocks to connected sink device. See note below.                                                                                                                                                                                                                                                        |
| <i>Editor Mode</i>                                                                                                                                                                                                                                                   | Enable editing EDID/DisplayID content in top right view. For example, for testing purposes, it's possible to load invalid EDID/DisplayID data and write it to TE without modifications. Once <i>Editor Mode</i> is enabled, the validator corrects errors such as invalid checksums. Top right view name-value pairs can be edited. |
| <i>HEX Edit Mode</i>                                                                                                                                                                                                                                                 | Enable editing EDID/DisplayID content in bottom right HEX view. When enabled, HEX values may be edited. Click <i>Apply</i> to validate changes and update other views.                                                                                                                                                              |
| <i>Save As...</i>                                                                                                                                                                                                                                                    | Save the current editor data to disk in various formats: binary, hex, ecd, txt and xml.                                                                                                                                                                                                                                             |
| <i>Load ...</i>                                                                                                                                                                                                                                                      | Load EDID/DisplayID data from disk. Same formats as above available.                                                                                                                                                                                                                                                                |

**Note:** A source device is always able to read EDID data of the connected Sink device. A source device can read the DisplayID data of the sink device if the sink device permits. The connected sink device may or may not allow its EDID/DisplayID content to be modified.

Select the *Main Features* button to view items of common interest. For example, whether the sink is capable of HDR, or Dolby Vision, etc.

| Features |                    |              | CTA v3 |
|----------|--------------------|--------------|--------|
|          | Name               | Value        |        |
| 1        | Max Resolution     | 10240 x 4320 |        |
| 2        | 10K Max Frame Rate | 60 Hz        |        |
| 3        | 8K Max Frame Rate  | 60 Hz        |        |
| 4        | 4K Max Frame Rate  | 145 Hz       |        |
| 5        | 2K Max Frame Rate  | 145 Hz       |        |
| 6        | HDR Static         | Disabled     |        |
| 7        | HDR Dynamic        | Disabled     |        |
| 8        | HDR10+             | Disabled     |        |
| 9        | Dolby Vision       | Disabled     |        |
| 10       | SBTM               | Disabled     |        |
|          |                    |              |        |

The *Main Features* view *CTA v3* tab (available only in EDID tab not DisplayID tab) allows enabling/disabling features. You enable/disable a feature by selecting the *Value* field with *Editor Mode* enabled (*AND* HEX Edit Mode disabled). When a value is disabled and you want to enable it, the *Editor View* will be blank as focus has been set on the values to be enabled (and are zero when disabled). New highlighted hex values will be added and highlighted in the lower right *Hex View*. New node data will also appear under the CTA node in the top left tree view.

| Features |                                                      |          | CTA v3 |
|----------|------------------------------------------------------|----------|--------|
|          | Name                                                 | Value    |        |
| 1        | HDR Static<br><small>Data block collection</small>   | Disabled |        |
| 2        | HDR Dynamic<br><small>Data block collection</small>  | Disabled |        |
| 3        | HDR10+<br><small>Data block collection</small>       | Disabled |        |
| 4        | Dolby Vision<br><small>Data block collection</small> | Disabled |        |
| 5        | SBTM<br><small>Data block collection</small>         | Enabled  |        |
|          |                                                      | Disabled |        |
|          |                                                      | Enabled  |        |

EDID Editor Features

A practically unlimited number of extension blocks may exist in a single collection. The number of blocks is limited by VESA Specifications and possibly by available system resources. Most EDID/DisplayID blocks contain a structure that is very similar to a tree structure. The Editor decodes each block into a tree view of the block. The tree view then contains all values within the data block. Contents can be browsed. The Editor has a support for automatic variables, such as the block checksum. When a value in a block is modified, the checksum will be updated. Automatic variables are read only. A log print will be made when an automatic variable is updated by the editor.

Editing Tips

- Editing is straightforward:
- Select property fields to edit.
- Red values in *HEX View* show that values have been modified.
- Press *Enter* to apply edit values and combo box selections.

In CTA-861 blocks, you can add and remove 18-byte descriptors and CEA data blocks by setting the values “18-byte Descriptors in this block” and “CEA Data block count”.

Enter hex values with prefixes “0x” or “\$”. No prefix represents a decimal value.

Values may be entered as hexadecimal or decimal regardless of presentation.

Floating point values must have a period “.” decimal separator.

Click *Set* after changing a bit-value presented as a single checkbox if you want the new value applied.

---

**Note:**

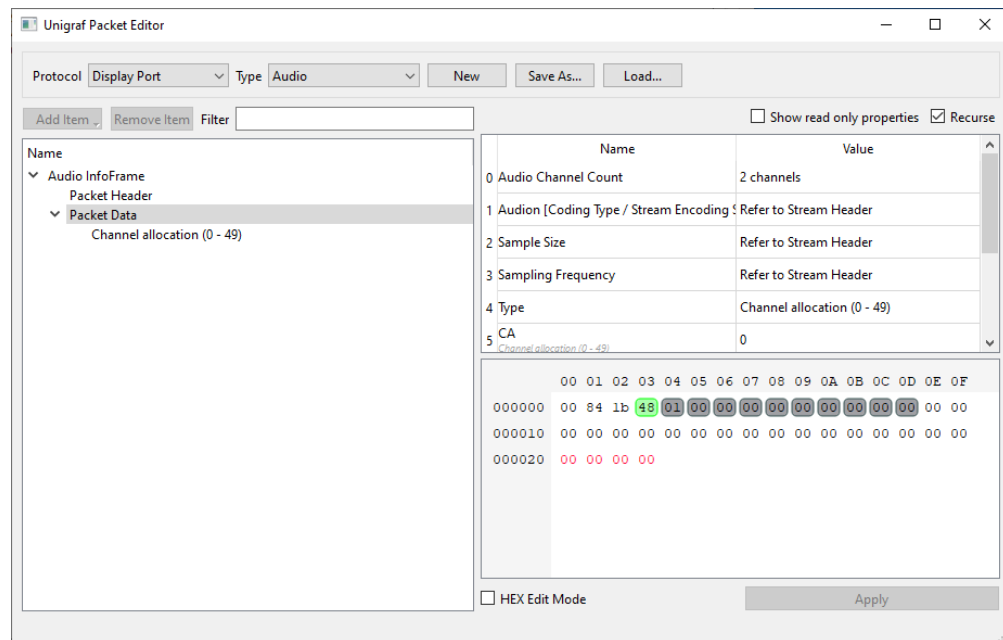
EDID Editor does not have an *Undo* function. Therefore, it is highly recommended that you back up un-edited EDID contents to a file before editing it.

---



# 11. PACKET EDITOR

Packet Editor enables creation and editing metadata packets.



The types of supported packets are:

- Audio InfoFrame (Audio)
- AVI InfoFrame (AVI)
- Custom InfoFrame (Custom) (HDMI)
- Custom Packet (Custom) (DP)
- DR&M InfoFrame (DR&M) (HDMI)
- DR&M Packet (DR&M) (DP)
- EMP-VRR (EMP-VRR)
- GCP InfoFrame (GCP)
- SBTMEM Source-Based Tone Mapping Extended Metadata (HDMI)
- SPD InfoFrame (SPD)
- Vendor-Specific InfoFrame (VS) (HDMI)\*
- Vendor-Specific SDP (VS) (DP)\*

\*) Please select from available VS packet types in field “4: Type” in the packet editor.

## 12. PATTERN EDITOR

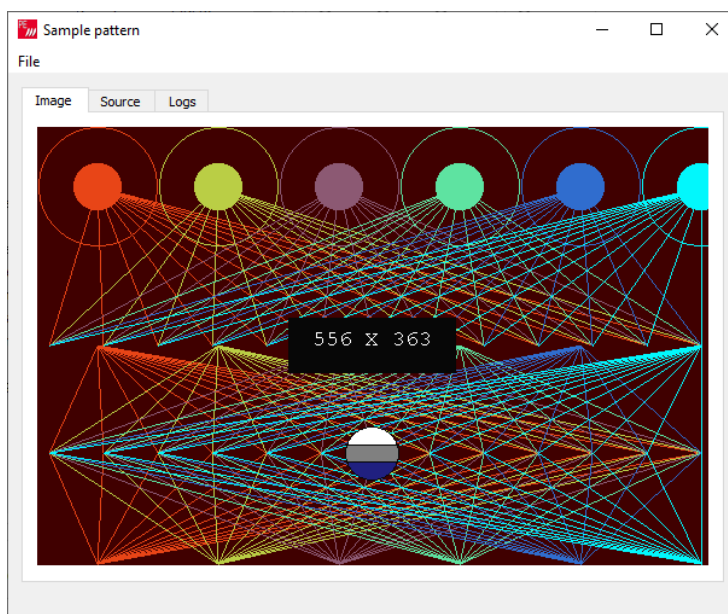
Pattern Editor is a tool for editing and debugging Unigraf Custom VTP Pattern scripts.

Please refer to APPENDIX F: VTP PATTERN LANGUAGE later in this document for description of the VTP Pattern Language syntax.

Pattern Editor consists of three tabs:

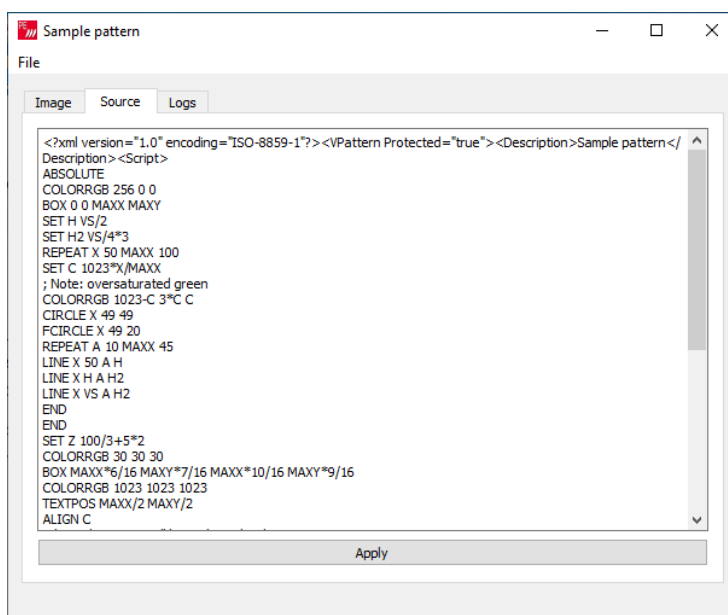
### Image Tab

Monitoring the rendering of the VTP pattern script.



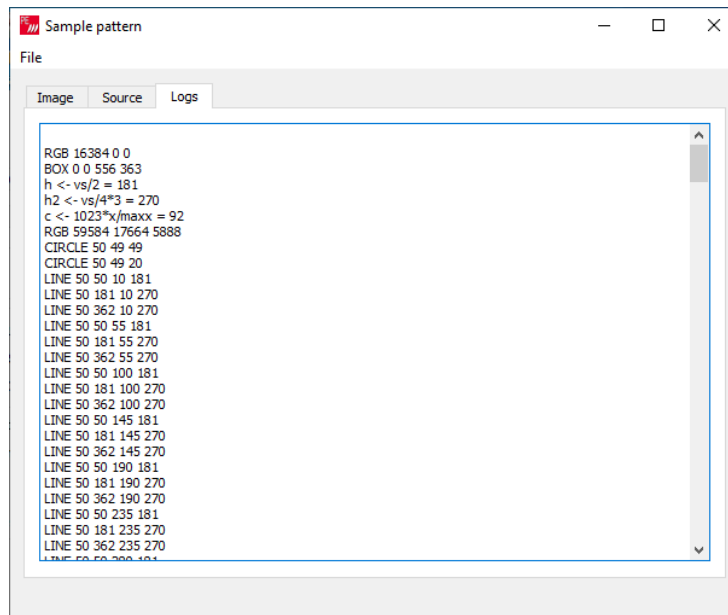
### Source Tab

Tool for editing VTP Pattern Language script. Click Apply to render the code in the resolution of the preview image in *Image* tab.



## Logs Tab

Log of the pattern code parsing indicating the values assigned to logical variables and the actual parameter values used for render instructions.



## Saving and Recalling the Script

In File pull-down menu the user can save his work.

*Open:* Open a VTP language script from PC

*Save Script:* Save the script currently in Source tab to PC

*Save Image:* Save a rendered pattern in PNG, BMP, JPG or PPM format

*Select Save Resolution:* Select from six common resolutions the size in which the pattern script will be rendered when saved.

13. IMAGE CONVERTER

Image Converter is a tool for converting images from one color format to another. This kind of conversion is typically needed when creating YCbCr test images from RGB bitmaps.

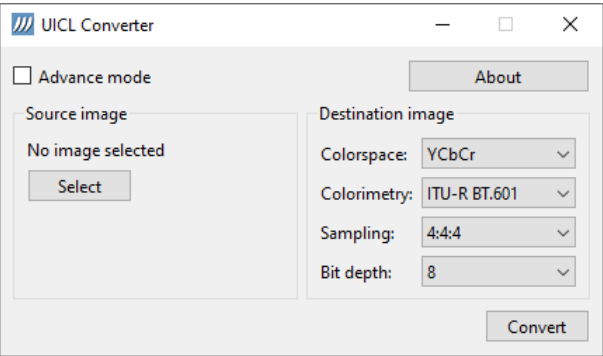
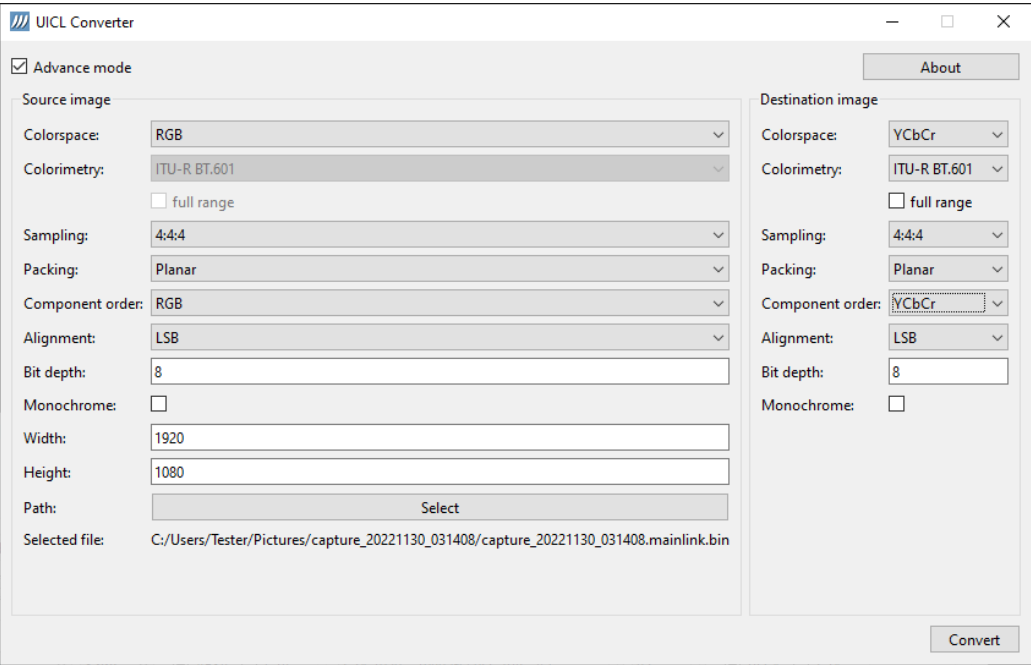


Image Converter has two operating modes: Standard mode and Advanced mode. In Standard mode typical image file formats are used as Source image and the user sets basic color formats for the Destination image. In Advanced mode, the user is able to define the Source and Destination image parameters in detail.

Click **Select** to load the Source image. Click **Convert** to store the Destination image. File name for



the Destination image is of form:

```
Source_image_1920x1080_8bits_yuv444_lsb.bin
```

|                     |                                                   |
|---------------------|---------------------------------------------------|
| <i>Source_image</i> | Name of the image file used as Source image       |
| <i>1920x1080</i>    | Resolution of the Source Image                    |
| <i>8bits</i>        | Bit depth of the Destination image                |
| <i>yuv444</i>       | Color space and sampling of the Destination image |
| <i>lsb</i>          | Data alignment of the Destination image           |

## APPENDIX A: PRODUCT SPECIFICATION

### UCD-400 and UCD-411

|                     |                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Input               | DisplayPort™ 1.4a compliant (DP Rx) ( <i>UCD-400 only</i> )                                                                     |
| Output              | DisplayPort™ 1.4a compliant (DP Tx)                                                                                             |
| Max video mode      | 7680 × 4320 p30 input and output<br>3840 × 2160 p120 input and output                                                           |
| Audio               | LPCM, 2 – 8 channels, 44.1 to 192 kHz                                                                                           |
| Content Protection  | HDCP 2.3, HDCP 1.3                                                                                                              |
| DSC Capability      | DSC Sink with off-line decompression<br>DSC Source using pre-compressed content                                                 |
| Additional features | FEC, LTTPR, DSC<br>DP 1.4a LL CTS, DP DSC CTS<br>HDCP 2.3 CTS                                                                   |
| Computer interface  | USB 3.0                                                                                                                         |
| Operating System    | Debian 11.0 or higher.<br>Ubuntu 20.04.4 LTS or higher.<br>MacOS Big Sur 11.7.10 or higher.<br>Windows 10 10.0.19045 or higher. |
| Power supply        | AC/DC Power supply<br>(100 to 240 Vac 50/60 Hz input, +12 Vdc output)                                                           |
| Environmental       | Operating temperature: 15 to 35 deg C<br>Storage temperature: 0 to 50 deg C<br>Humidity 30% to 70% RH, non-condensing           |
| Mechanical Size     | 280 × 200 × 80 mm                                                                                                               |
| Weight              | 1.2 kg w/o power supply                                                                                                         |

### UCD-422 and UCD-412

|                     |                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Input               | HDMI 2.1 (10K@30Hz) (HDMI Rx) ( <i>UCD-422 only</i> )                                                                           |
| Output              | HDMI 2.1 (10K@30Hz) (HDMI Tx)                                                                                                   |
| HDMI 2.1 Features   | FRL, TMDS, ALLM, VRR, QMS-VRR, SBTM                                                                                             |
| Content Protection  | HDCP 2.2, HDCP 2.3                                                                                                              |
| Additional features | eARC, DSC*, FEC*                                                                                                                |
| Computer interface  | USB 3.0                                                                                                                         |
| Operating System    | Debian 11.0 or higher.<br>Ubuntu 20.04.4 LTS or higher.<br>MacOS Big Sur 11.7.10 or higher.<br>Windows 10 10.0.19045 or higher. |
| Power supply        | AC/DC Power supply<br>(100 to 240 Vac 50/60 Hz input, +12 Vdc output)                                                           |
| Environmental       | Operating temperature: 15 to 35 deg C<br>Storage temperature: 0 to 50 deg C<br>Humidity 30% to 70% RH, non-condensing           |
| Mechanical Size     | 272 × 170 × 60 mm                                                                                                               |
| Weight              | 1.2 kg w/o power supply                                                                                                         |

\*) Please contact Unigraf for detailed availability

## UCD-424

|                     |                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Input               | USB-C DP Alt Mode 1.4a compliant (USB-C Rx)                                                                                     |
| Output              | USB-C DP Alt Mode 1.4a compliant (USB-C Tx)                                                                                     |
| Max video mode      | 7680 × 4320 p30 input and output<br>3840 × 2160 p120 input and output                                                           |
| Audio               | LPCM, 2 – 8 channels, 44.1 to 192 kHz                                                                                           |
| Content Protection  | HDCP 2.3, HDCP 1.3                                                                                                              |
| DSC Capability      | DSC sink with off-line decompression<br>DSC source using pre-compressed content                                                 |
| Additional features | FEC, LTTPR*, DSC<br>DP 1.4a LL CTS, DP DSC CTS<br>HDCP 2.3 CTS                                                                  |
| Computer interface  | USB 3.0                                                                                                                         |
| Operating System    | Debian 11.0 or higher.<br>Ubuntu 20.04.4 LTS or higher.<br>MacOS Big Sur 11.7.10 or higher.<br>Windows 10 10.0.19045 or higher. |
| Power supply        | AC/DC Power supply<br>(100 to 240 Vac 50/60 Hz input, +12 Vdc output)                                                           |
| Environmental       | Operating temperature: 15 to 35 deg C<br>Storage temperature: 0 to 50 deg C<br>Humidity 30% to 70% RH, non-condensing           |
| Mechanical Size     | 280 × 200 × 80 mm                                                                                                               |
| Weight              | 1.2 kg w/o power supply                                                                                                         |

## UCD-451

|                     |                                                                                                                                 |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Output              | DisplayPort™ 1.4a compliant (DP Tx)                                                                                             |
| Max video mode      | 7680 × 4320 p30<br>3840 × 2160 p120                                                                                             |
| Content Protection  | HDCP 2.3, HDCP 1.3                                                                                                              |
| Additional features | FEC, LTTPR, DSC<br>DP 1.4a LL CTS, DP DSC CTS*<br>HDCP 2.3 CTS*                                                                 |
| DSC Capability      | DSC source using pre-compressed content                                                                                         |
| User Interface      | Computer with monitor, keyboard and mouse                                                                                       |
| Operating System    | Debian 11.0 or higher.<br>Ubuntu 20.04.4 LTS or higher.<br>MacOS Big Sur 11.7.10 or higher.<br>Windows 10 10.0.19045 or higher. |
| Video memory        | Extended video memory up to 32 GBytes                                                                                           |
| Connections         | 6 x USB 3.0, 2 x Ethernet, 1 x HDMI                                                                                             |
| Power supply        | AC/DC Power supply<br>(100 to 240 Vac 50/60 Hz input, +12 Vdc output)                                                           |
| Environmental       | Operating temperature: 15 to 35 deg C<br>Storage temperature: 0 to 50 deg C<br>Humidity 30% to 70% RH, non-condensing           |
| Mechanical Size     | 329 × 188 × 215 mm                                                                                                              |
| Weight              | 3.9 kg w/o power supply                                                                                                         |

\*) Please contact Unigraf for availability

## UCD-452

|                    |                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Output             | HDMI 2.1 (HDMI Tx)                                                                                                              |
| Max video mode     | 10240 x 4320 @ 30Hz<br>10240 x 4320 @ 60Hz with DSC                                                                             |
| HDMI 2.1 Features  | FRL, TMDS, ALLM, VRR, QMS-VRR, SBTM<br>DSC 1.2a, FEC, eARC*                                                                     |
| Content Protection | HDCP 2.3, 1.4                                                                                                                   |
| User Interface     | Computer with monitor, keyboard and mouse                                                                                       |
| Operating System   | Debian 11.0 or higher.<br>Ubuntu 20.04.4 LTS or higher.<br>MacOS Big Sur 11.7.10 or higher.<br>Windows 10 10.0.19045 or higher. |
| Video memory       | Extended video memory up to 32 GBytes                                                                                           |
| Connections        | 6 x USB 3.0, 2 x Ethernet, 1 x HDMI                                                                                             |
| Power supply       | AC/DC Power supply<br>(100 to 240 Vac 50/60 Hz input, +12 Vdc output)                                                           |
| Environmental      | Operating temperature: 15 to 35 deg C<br>Storage temperature: 0 to 50 deg C<br>Humidity 30% to 70% RH, non-condensing           |
| Mechanical Size    | 329 × 188 × 215 mm                                                                                                              |
| Weight             | 3.9 kg w/o power supply                                                                                                         |

\*) Please contact Unigraf for availability





# APPENDIX B: PRODUCT FEATURES

## UCD-400, UCD-411, UCD-424 and UCD-451 Features

| Input / Output Role                                        | UCD-4XX Default | DSC Decoder | DP 1.4a Link Analyzer | Panel Replay | eDP Support | DP 1.4a LL CTS | DP 1.4a DSC CTS | DisplayID / EDID CTS | Adaptive-Sync CTS | HDCP 2.3 CTS Source DUT | HDCP 2.3 CTS Sink, Source & Repeater DUT | TSI Basic |
|------------------------------------------------------------|-----------------|-------------|-----------------------|--------------|-------------|----------------|-----------------|----------------------|-------------------|-------------------------|------------------------------------------|-----------|
| DP Reference Sink (UCD-400 and UCD-424)                    |                 |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Video status, preview and saving                           | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Buffered capture                                           | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Audio monitoring, graphical preview and saving             | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Link status                                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Link control                                               | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| HPD status and control                                     | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Fast Link Training (Link Training without AUX Transaction) | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| MST Feature (up to 4 streams)                              | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| FEC Feature                                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| DSC Decoder, DSC Control                                   | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Adaptive-Sync Feature                                      | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| DPCD editor                                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Monitor InfoFrame Status (SDP)                             | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| EDID read and write                                        | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| EDID / DisplayID Editor                                    | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| HDCP 1.3 status and control                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| HDCP 2.3 status and control                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Event Log, AUX Analyzer                                    | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Source DUT Testing (Link and CRC test)                     | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          | ▲         |
| Playback                                                   | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Main Link Analyzer                                         |                 |             | •                     |              |             |                |                 |                      |                   |                         |                                          |           |
| eDP Reference Sink                                         |                 |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| eDP Link Training & Link Rate Support                      |                 |             |                       |              | •           |                |                 |                      |                   |                         |                                          |           |
| Alternate Scrambler Seed Reset (ASSR)                      | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Ability to Ignore Certain MSA Data Fields                  | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| OUI Support                                                | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| GUID Register Support                                      | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Source Device Detection by way of the AUX_CH               | •               |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Panel Replay, PSR, ALPM                                    |                 |             |                       |              |             |                |                 |                      |                   |                         |                                          |           |
| Panel Replay                                               |                 |             |                       | •            |             |                |                 |                      |                   |                         |                                          |           |
| PSR1                                                       |                 |             |                       |              | •           |                |                 |                      |                   |                         |                                          |           |
| PSR2                                                       |                 |             |                       |              | •           |                |                 |                      |                   |                         |                                          |           |

|                                                    |  |  |  |   |   |   |   |   |   |   |   |  |
|----------------------------------------------------|--|--|--|---|---|---|---|---|---|---|---|--|
| Early Transport                                    |  |  |  | • | • |   |   |   |   |   |   |  |
| Selective Update                                   |  |  |  | • | • |   |   |   |   |   |   |  |
| AUX-less ALPM                                      |  |  |  | • | • |   |   |   |   |   |   |  |
| AUX-wake ALPM                                      |  |  |  |   | • |   |   |   |   |   |   |  |
| DP 1.4 / 2.1 Link Layer CTS for testing Source DUT |  |  |  |   |   |   |   |   |   |   |   |  |
| DP 1.4a LL, Audio, FEC CTS                         |  |  |  |   |   | • |   |   |   |   |   |  |
| DP 1.4a DSC CTS for testing Source DUT             |  |  |  |   |   |   | • |   |   |   |   |  |
| DisplayID / EDID CTS for testing Source DUT        |  |  |  |   |   |   |   | • |   |   |   |  |
| Adaptive-Sync CTS for testing Source DUT           |  |  |  |   |   |   |   |   | • |   |   |  |
| HDCP 2.3 CTS for testing DP Source DUT             |  |  |  |   |   |   |   |   |   | • | • |  |
| HDCP 2.3 CTS for testing DP Repeater DUT           |  |  |  |   |   |   |   |   |   |   | • |  |

## UCD-400, UCD-411, UCD-424 and UCD-451 Features (cont.)

| Input / Output Role                                        | UCD-4XX Default | DSC Encoder | LTPR | Panel Replay | eDP Support | DP 1.4a LL CTS | DP 1.4a DSC CTS | DisplayID / EDID CTS | Adaptive-Sync CTS | HDCP 2.3 CTS Sink DUT | HDCP 2.3 CTS Sink, Source and Repeater DUT | TSI Basic |
|------------------------------------------------------------|-----------------|-------------|------|--------------|-------------|----------------|-----------------|----------------------|-------------------|-----------------------|--------------------------------------------|-----------|
| DP Reference Source                                        |                 |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Video pattern generator (fixed patterns and timings)       | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Custom video patterns and timings                          | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Audio generator                                            | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Playback                                                   | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Link status                                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Link control                                               | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| HPD status                                                 | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| EDID read and write                                        | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| EDID / DisplayID Editor                                    | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Fast Link Training (Link Training without AUX Transaction) | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| MST Feature (up to 4 streams)                              | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| FEC Feature                                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| DSC Encoder                                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Adaptive-Sync Feature                                      | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| DPCD editor                                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| LTPR Feature                                               | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| HDCP 1.3 status and control                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| HDCP 2.3 status and control                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            | ▲         |
| Event Log, AUX Analyzer                                    | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Sink DUT Testing                                           | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| eDP Reference Source                                       |                 |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| eDP Link Training & Link Rate Support                      |                 |             |      |              | •           |                |                 |                      |                   |                       |                                            |           |
| Alternate Scrambler Seed Reset (ASSR)                      | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| OUI Support                                                | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| GUID Register Support                                      | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Live Frame Mode                                            | •               |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Panel Replay, PSR, ALPM                                    |                 |             |      |              |             |                |                 |                      |                   |                       |                                            |           |
| Panel Replay                                               |                 |             |      | •            |             |                |                 |                      |                   |                       |                                            |           |
| PSR1                                                       |                 |             |      |              | •           |                |                 |                      |                   |                       |                                            |           |
| PSR2                                                       |                 |             |      |              | •           |                |                 |                      |                   |                       |                                            |           |
| Early Transport                                            |                 |             |      | •            | •           |                |                 |                      |                   |                       |                                            |           |
| Selective Update                                           |                 |             |      | •            | •           |                |                 |                      |                   |                       |                                            |           |
| AUX-less ALPM                                              |                 |             |      | •            | •           |                |                 |                      |                   |                       |                                            |           |
| AUX-wake ALPM                                              |                 |             |      |              | •           |                |                 |                      |                   |                       |                                            |           |

| DP 1.4 / 2.1 Link Layer CTS for testing Sink DUT     |  |  |  |  |  |   |   |   |   |   |  |   |  |
|------------------------------------------------------|--|--|--|--|--|---|---|---|---|---|--|---|--|
| DP 1.4a LL, Audio and FEC CTS for testing Sink DUT * |  |  |  |  |  | • |   |   |   |   |  |   |  |
| DP 1.4a DSC CTS for testing Sink DUT*                |  |  |  |  |  |   | • |   |   |   |  |   |  |
| DisplayID / EDID CTS for testing Sink DUT*           |  |  |  |  |  |   |   | • |   |   |  |   |  |
| Adaptive-Sync CTS for testing Sink DUT*              |  |  |  |  |  |   |   |   | • |   |  |   |  |
| HDCP 2.3 CTS for testing DP Sink DUT*                |  |  |  |  |  |   |   |   |   | • |  | • |  |
| HDCP 2.3 CTS for testing DP Repeater DUT*            |  |  |  |  |  |   |   |   |   |   |  | • |  |

\* Check availability for UDC-451 from Unigraf.

## UCD-422, UCD-412 and UCD-452 Features

| Input / Output Role                            | UCD-4XX Default | HDMI 1.4 Link Analyzer | TSI Basic |
|------------------------------------------------|-----------------|------------------------|-----------|
| HDMI Reference Sink (UCD-422 only)             |                 |                        |           |
| Video status, preview and saving               | •               |                        | ▲         |
| Buffered capture                               | •               |                        |           |
| Audio monitoring, graphical preview and saving | •               |                        | ▲         |
| Link status                                    | •               |                        | ▲         |
| Link control                                   | •               |                        |           |
| HPD status and control                         | •               |                        | ▲         |
| EDID read and write                            | •               |                        | ▲         |
| EDID Editor                                    | •               |                        |           |
| HDCP 1.4 status and control*                   | •               |                        | ▲         |
| HDCP 2.3 status and control*                   | •               |                        | ▲         |
| FEC Feature                                    | •               |                        | ▲         |
| DSC Decoder, DSC Control                       | •               |                        |           |
| ALLM, VRR                                      | •               |                        | ▲         |
| Event Log                                      | •               |                        |           |
| InfoFrame status                               | •               |                        | ▲         |
| eARC                                           | •               |                        | ▲         |
| Source DUT Testing                             | •               |                        | ▲         |
| HDMI 1.4 Link Analyzer                         |                 | •                      |           |

\*) HDCP is currently not supported. It will be supported in later 3.X release package

|                                                      |   |  |   |
|------------------------------------------------------|---|--|---|
| HDMI Reference Source                                |   |  |   |
| Video pattern generator (fixed patterns and timings) | • |  | ▲ |
| Custom video patterns and timings                    | • |  | ▲ |
| Playback                                             | • |  | ▲ |
| Audio Generator                                      | • |  | ▲ |
| Link status                                          | • |  | ▲ |
| Link control                                         | • |  | ▲ |
| EDID read and write                                  | • |  | ▲ |
| EDID Editor                                          | • |  |   |
| DSC Encoder                                          | • |  |   |
| SCDC Editor                                          | • |  |   |
| Event Log                                            | • |  |   |
| Sink DUT Testing                                     | • |  |   |
| HDCP 1.4 status and control*                         | • |  | ▲ |
| HDCP 2.3 status and control*                         | • |  | ▲ |

\*) HDCP is currently not supported. It will be supported in later 3.X release package

## UCD-424 USB-C Features

| Input / Output Role                                  | UCD-4XX Default | TSI Basic |
|------------------------------------------------------|-----------------|-----------|
| USB-C Modes Common                                   |                 |           |
| USB-C Data Role status & control                     | •               | ▲         |
| USB-C Power Role status & control                    | •               | ▲         |
| USB-C Vbus / CC / Vconn voltage / current monitoring | •               | ▲         |
| Power Delivery protocol monitoring                   | •               | ▲         |
| Cable Info (E-marker details)                        | •               | ▲         |
| Event Logger                                         | •               |           |
| Support for USB-C Power for 5V/3A                    | •               | ▲         |
| Support for USB-C Power for 9V/3A                    | •               | ▲         |
| DP Alt Mode Common                                   |                 |           |
| USB-C DP ALT Mode status                             | •               | ▲         |
| USB-C DP ALT Mode control                            | •               | ▲         |

## Product Options

### UCD-400, UCD-411 and UCD-424 Product Options

| Product                                                     | P/N    | Product                                                         | P/N    |
|-------------------------------------------------------------|--------|-----------------------------------------------------------------|--------|
| HDCP 2.3 CTS for testing Source DUT on DP                   | MT6634 | DSC Decoder for testing Source DUT on DP                        | MT6670 |
| HDCP 2.3 CTS for testing Sink DUT on DP                     | MT6636 | DSC Encoder for testing Sink DUT on DP                          | MT6671 |
| HDCP 2.3 CTS for testing Repeater DUT on DP                 | MT6638 | DP 2.1 Adaptive-Sync CTS for testing Source DUT (8b/10b)        | MT6648 |
| DP 1.4a LL CTS for testing Sink DUT                         | MT6635 | DP 2.1 Adaptive-Sync CTS for testing Sink DUT (8b/10b)          | MT6649 |
| DP 1.4a LL CTS for testing Source DUT                       | MT6637 | HDR 10+ Display Device and SSTM Test for testing Sink DUT on DP | MT6676 |
| DP 1.4a DSC CTS for testing Source DUT                      | MT6642 | HDR 10+ Distribution Device for testing Source DUT on DP        | MT6678 |
| DP 1.4a DSC CTS for testing Sink DUT                        | MT6643 | DP 1.4a Link Analyzer                                           | MT6655 |
| DP 2.1 DisplayID / EDID CTS for testing Source DUT (8b/10b) | MT6646 | DP 2.1 Panel Replay support for testing Sink & Source DUT       | MT6685 |
| DP 2.1 DisplayID / EDID CTS for testing Sink DUT (8b/10b)   | MT6647 | eDP support for testing Sink & Source DUT                       | MT6686 |

### UCD-412, UCD-422 Product Options

| Product                                    | P/N    | Product                                      | P/N    |
|--------------------------------------------|--------|----------------------------------------------|--------|
| DSC Decoder for testing Source DUT on HDMI | MT6672 | HDR10+ DD and SSTM Tests for HDMI Sink DUT   | MT6675 |
| DSC Encoder for testing Sink DUT on HDMI   | MT6673 | HDR10+ DD and SSTM Tests for HDMI Source DUT | MT6677 |
| HDMI 1.4 Link Analyzer                     | MT6658 |                                              |        |

## APPENDIX C: PREDEFINED TIMINGS

| Description*                           | HA   | VA   | HT   | VT   | HST | VST | HSYN | VSYN | FR  | Pixel Clock (MHz) |
|----------------------------------------|------|------|------|------|-----|-----|------|------|-----|-------------------|
| CVT 640 × 480 @ 60 Hz                  | 640  | 480  | 800  | 525  | 144 | 35  | 96   | 2    | 60  | 25,20             |
| CTA 640 × 480 @ 60 Hz (VIC 1)          | 640  | 480  | 800  | 525  | 144 | 35  | 96   | 2    | 60  | 25,17             |
| CTA 720 × 480 @ 60 Hz (VIC 2)          | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 60  | 27,03             |
| CTA 720 × 480 @ 60 Hz (VIC 3)          | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 60  | 27,00             |
| CTA 720 × 576 @ 50 Hz (VIC 17)         | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 50  | 27,00             |
| CTA 720 × 576 @ 50 Hz (VIC 18)         | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 50  | 27,00             |
| CTA 720 × 576 @ 100 Hz (VIC 42)        | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 100 | 54,00             |
| CTA 720 × 576 @ 100 Hz (VIC 43)        | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 100 | 54,00             |
| CTA 720 × 480 @ 120 Hz (VIC 49)        | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 120 | 54,00             |
| CTA 720 × 480 @ 120 Hz (VIC 48)        | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 120 | 54,05             |
| CTA 720 × 576 @ 200 Hz (VIC 52)        | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 200 | 108,00            |
| CTA 720 × 576 @ 200 Hz (VIC 53)        | 720  | 576  | 864  | 625  | 132 | 44  | 64   | 5    | 200 | 108,00            |
| CTA 720 × 480 @ 240 Hz (VIC 56)        | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 240 | 108,00            |
| CTA 720 × 480 @ 240 Hz (VIC 57)        | 720  | 480  | 858  | 525  | 122 | 36  | 62   | 6    | 240 | 108,00            |
| DMT 800 × 600 @ 60 Hz (ID Eh)          | 800  | 600  | 1056 | 628  | 216 | 27  | 128  | 4    | 60  | 39,79             |
| DMT 848 × 480 @ 60 Hz (ID 14)          | 848  | 480  | 1088 | 517  | 224 | 31  | 112  | 8    | 60  | 33,75             |
| DMT 1024 × 768 @ 60 Hz (ID 10h)        | 1024 | 768  | 1344 | 806  | 296 | 35  | 136  | 6    | 60  | 65,00             |
| CTA 1280 × 720 @ 50 Hz (VIC 19)        | 1280 | 720  | 1980 | 750  | 260 | 25  | 40   | 5    | 50  | 74,25             |
| CTA 1280 × 720 @ 100 Hz (VIC 41)       | 1280 | 720  | 1980 | 750  | 260 | 25  | 40   | 5    | 100 | 148,50            |
| CTA 1280 × 720 @ 24 Hz (VIC 60)        | 1280 | 720  | 3300 | 750  | 260 | 25  | 40   | 5    | 24  | 59,40             |
| CTA 1280 × 720 @ 25 Hz (VIC 61)        | 1280 | 720  | 3960 | 750  | 260 | 25  | 40   | 5    | 25  | 74,25             |
| CTA 1280 × 720 @ 30 Hz (VIC 62)        | 1280 | 720  | 3300 | 750  | 260 | 25  | 40   | 5    | 30  | 74,25             |
| CTA 1280 × 720 @ 24 Hz (VIC 65)        | 1280 | 720  | 3300 | 750  | 260 | 25  | 40   | 5    | 24  | 59,40             |
| CTA 1280 × 720 @ 25 Hz (VIC 66)        | 1280 | 720  | 3960 | 750  | 260 | 25  | 40   | 5    | 25  | 74,25             |
| CTA 1280 × 720 @ 30 Hz (VIC 67)        | 1280 | 720  | 3300 | 750  | 260 | 25  | 40   | 5    | 30  | 74,25             |
| CTA 1280 × 720 @ 50 Hz (VIC 68)        | 1280 | 720  | 1980 | 750  | 260 | 25  | 40   | 5    | 50  | 74,25             |
| CTA 1280 × 720 @ 60 Hz (VIC 69)        | 1280 | 720  | 1650 | 750  | 260 | 25  | 40   | 5    | 60  | 74,25             |
| CTA 1280 × 720 @ 100 Hz (VIC 70)       | 1280 | 720  | 1980 | 750  | 260 | 25  | 40   | 5    | 100 | 148,50            |
| CTA 1280 × 720 @ 120 Hz (VIC 71)       | 1280 | 720  | 1650 | 750  | 260 | 25  | 40   | 5    | 120 | 148,50            |
| CTA 1280 × 720 @ 48 Hz (VIC 108)       | 1280 | 720  | 2500 | 750  | 260 | 25  | 40   | 5    | 48  | 90,00             |
| CTA 1280 × 720 @ 48 Hz (VIC 109)       | 1280 | 720  | 2500 | 750  | 260 | 25  | 40   | 5    | 48  | 90,00             |
| CTA 1280 × 720 @ 60 Hz (VIC 4)         | 1280 | 720  | 1650 | 750  | 260 | 25  | 40   | 5    | 60  | 74,25             |
| CTA 1280 × 720 @ 120 Hz (VIC 47)       | 1280 | 720  | 1650 | 750  | 260 | 25  | 40   | 5    | 120 | 148,50            |
| CVT 1280 × 768 @ 60 Hz [RB1]           | 1280 | 768  | 1440 | 790  | 112 | 19  | 32   | 7    | 60  | 68,26             |
| DMT 1280 × 768 @ 60 Hz (ID 17h)        | 1280 | 768  | 1664 | 798  | 320 | 27  | 128  | 7    | 60  | 79,67             |
| DMT 1280 × 800 @ 60 Hz (ID 1Bh) [RB1]  | 1280 | 800  | 1440 | 823  | 112 | 20  | 32   | 6    | 60  | 71,11             |
| DMT 1280 × 800 @ 60 Hz (ID 1Ch)        | 1280 | 800  | 1680 | 831  | 328 | 28  | 128  | 6    | 60  | 83,76             |
| DMT 1280 × 960 @ 60 Hz (ID 20h)        | 1280 | 960  | 1800 | 1000 | 424 | 39  | 112  | 3    | 60  | 108,00            |
| DMT 1280 × 1024 @ 60 Hz (ID 23h)       | 1280 | 1024 | 1688 | 1066 | 360 | 41  | 112  | 3    | 60  | 107,96            |
| DMT 1360 × 768 @ 60 Hz (ID 27h)        | 1360 | 768  | 1792 | 795  | 368 | 24  | 112  | 6    | 60  | 85,48             |
| DMT 1400 × 1050 @ 60 Hz (ID 29h) [RB1] | 1400 | 1050 | 1560 | 1080 | 112 | 27  | 32   | 4    | 60  | 101,09            |
| DMT 1400 × 1050 @ 60 Hz (ID 2Ah)       | 1400 | 1050 | 1864 | 1089 | 376 | 36  | 144  | 4    | 60  | 121,79            |

\*) CVT: Coordinated Video Timings (CVT; VESA-2021-09-27 v2.0)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings

CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)

| Description*                           | HA   | VA   | HT   | VT   | HST | VST | HSYN | VSYN | FR  | Pixel Clock (MHz) |
|----------------------------------------|------|------|------|------|-----|-----|------|------|-----|-------------------|
| CTA 1440 × 240 @ 60 Hz (VIC 8)         | 1440 | 240  | 1716 | 263  | 238 | 18  | 124  | 3    | 60  | 27,00             |
| CTA 1440 × 240 @ 60 Hz (VIC 9)         | 1440 | 240  | 1716 | 263  | 238 | 18  | 124  | 3    | 60  | 27,00             |
| CTA 1440 × 480 @ 60 Hz (VIC 14)        | 1440 | 480  | 1716 | 525  | 244 | 36  | 124  | 6    | 60  | 54,00             |
| CTA 1440 × 480 @ 60 Hz (VIC 15)        | 1440 | 480  | 1716 | 525  | 244 | 36  | 124  | 6    | 60  | 54,00             |
| CTA 1440 × 576 @ 50 Hz (VIC 22)        | 1440 | 576  | 1728 | 625  | 264 | 22  | 126  | 3    | 50  | 54,00             |
| CTA 1440 × 288 @ 50 Hz (VIC 23)        | 1440 | 288  | 1728 | 314  | 264 | 22  | 126  | 3    | 50  | 27,00             |
| CTA 1440 × 288 @ 50 Hz (VIC 24)        | 1440 | 288  | 1728 | 314  | 264 | 22  | 126  | 3    | 50  | 27,00             |
| CTA 1440 × 576 @ 50 Hz (VIC 29)        | 1440 | 576  | 1728 | 625  | 264 | 44  | 128  | 5    | 50  | 54,00             |
| CTA 1440 × 576 @ 50 Hz (VIC 30)        | 1440 | 576  | 1728 | 625  | 264 | 44  | 128  | 5    | 50  | 54,00             |
| CVT 1600 × 1200 @ 60 Hz [RB1]          | 1600 | 1200 | 1760 | 1235 | 112 | 32  | 32   | 4    | 60  | 130,42            |
| DMT 1600 × 1200 @ 60 Hz (ID 33h)       | 1600 | 1200 | 2160 | 1250 | 496 | 49  | 192  | 3    | 60  | 162,00            |
| CTA 1680 × 720 @ 24 Hz (VIC 79)        | 1680 | 720  | 3300 | 750  | 260 | 25  | 40   | 5    | 24  | 59,40             |
| CTA 1680 × 720 @ 25 Hz (VIC 80)        | 1680 | 720  | 3168 | 750  | 260 | 25  | 40   | 5    | 25  | 59,40             |
| CTA 1680 × 720 @ 30 Hz (VIC 81)        | 1680 | 720  | 2640 | 750  | 260 | 25  | 40   | 5    | 30  | 59,40             |
| CTA 1680 × 720 @ 50 Hz (VIC 82)        | 1680 | 720  | 2200 | 750  | 260 | 25  | 40   | 5    | 50  | 82,50             |
| CTA 1680 × 720 @ 100 Hz (VIC 84)       | 1680 | 720  | 2000 | 825  | 260 | 100 | 40   | 5    | 100 | 165,00            |
| CTA 1680 × 720 @ 48 Hz (VIC 110)       | 1680 | 720  | 2750 | 750  | 260 | 25  | 40   | 5    | 48  | 99,00             |
| CTA 1680 × 720 @ 60 Hz (VIC 83)        | 1680 | 720  | 2200 | 750  | 260 | 25  | 40   | 5    | 60  | 99,00             |
| CTA 1680 × 720 @ 120 Hz (VIC 85)       | 1680 | 720  | 2000 | 825  | 260 | 100 | 40   | 5    | 120 | 198,00            |
| DMT 1680 × 1050 @ 60 Hz (ID 39h) [RB1] | 1680 | 1050 | 1840 | 1080 | 112 | 27  | 32   | 6    | 60  | 119,23            |
| DMT 1680 × 1050 @ 60 Hz (ID 3Ah)       | 1680 | 1050 | 2240 | 1089 | 456 | 36  | 176  | 6    | 60  | 146,36            |
| DMT 1792 × 1344 @ 60 Hz (ID 3Eh)       | 1792 | 1344 | 2448 | 1394 | 528 | 49  | 200  | 3    | 60  | 204,75            |
| DMT 1856 × 1392 @ 60 Hz (ID 41h)       | 1856 | 1392 | 2528 | 1439 | 576 | 46  | 224  | 3    | 60  | 218,27            |
| CTA 1920 × 1080 @ 50 Hz (VIC 31)       | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 50  | 148,50            |
| CTA 1920 × 1080 @ 24 Hz (VIC 32)       | 1920 | 1080 | 2750 | 1125 | 192 | 41  | 44   | 5    | 24  | 74,25             |
| CTA 1920 × 1080 @ 25 Hz (VIC 33)       | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 25  | 74,25             |
| CTA 1920 × 1080 @ 100 Hz (VIC 64)      | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 100 | 297,00            |
| CTA 1920 × 1080 @ 24 Hz (VIC 72)       | 1920 | 1080 | 2750 | 1125 | 192 | 41  | 44   | 5    | 24  | 74,25             |
| CTA 1920 × 1080 @ 25 Hz (VIC 73)       | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 25  | 74,25             |
| CTA 1920 × 1080 @ 30 Hz (VIC 74)       | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 30  | 74,25             |
| CTA 1920 × 1080 @ 50 Hz (VIC 75)       | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 50  | 148,50            |
| CTA 1920 × 1080 @ 60 Hz (VIC 76)       | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 60  | 148,50            |
| CTA 1920 × 1080 @ 100 Hz (VIC 77)      | 1920 | 1080 | 2640 | 1125 | 192 | 41  | 44   | 5    | 100 | 297,00            |
| CTA 1920 × 1080 @ 120 Hz (VIC 78)      | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 120 | 297,00            |
| CVT 1920 × 1080 @ 30 Hz [RB1]          | 1920 | 1080 | 2080 | 1096 | 112 | 13  | 32   | 5    | 30  | 68,39             |
| CVT 1920 × 1080 @ 30 Hz [RB2]          | 1920 | 1080 | 2000 | 1096 | 72  | 14  | 32   | 8    | 30  | 65,76             |
| CVT 1920 × 1080 @ 144 Hz [RB3]         | 1920 | 1080 | 2080 | 1157 | 152 | 14  | 32   | 8    | 144 | 346,66            |
| CVT 1920 × 1080 @ 200 Hz [RB3]         | 1920 | 1080 | 2080 | 1190 | 152 | 14  | 32   | 8    | 200 | 495,21            |
| CTA 1920 × 1080 @ 30 Hz (VIC 34)       | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 30  | 74,25             |
| CVT 1920 × 1080 @ 60 Hz [RB1]          | 1920 | 1080 | 2080 | 1111 | 112 | 28  | 32   | 5    | 60  | 138,65            |
| CVT 1920 × 1080 @ 60 Hz                | 1920 | 1080 | 2000 | 1111 | 72  | 14  | 32   | 8    | 60  | 133,32            |
| DMT 1920 × 1080 @ 60 Hz (ID 52h)       | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 60  | 148,50            |
| CTA 1920 × 1080 @ 60 Hz (VIC 16)       | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 60  | 148,50            |
| CVT 1920 × 1080 @ 120 Hz [RB1]         | 1920 | 1080 | 2080 | 1144 | 112 | 61  | 32   | 5    | 120 | 285,54            |
| CVT 1920 × 1080 @ 120 Hz [RB2]         | 1920 | 1080 | 2000 | 1144 | 72  | 14  | 32   | 8    | 120 | 274,56            |
| CTA 1920 × 1080 @ 120 Hz (VIC 63)      | 1920 | 1080 | 2200 | 1125 | 192 | 41  | 44   | 5    | 120 | 297,00            |

\*) CVT: Coordinated Video Timings (CVT; VESA-2021-09-27 v2.0)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings

CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)



| Description*                           | HA   | VA   | HT   | VT   | HST  | VST | HSYN | VSYN | FR  | Pixel Clock (MHz) |
|----------------------------------------|------|------|------|------|------|-----|------|------|-----|-------------------|
| CTA 1920 × 1080 @ 48 Hz (VIC 111)      | 1920 | 1080 | 2750 | 1125 | 192  | 41  | 44   | 5    | 48  | 148,50            |
| CTA 1920 × 1080 @ 48 Hz (VIC 112)      | 1920 | 1080 | 2750 | 1125 | 192  | 41  | 44   | 5    | 48  | 148,50            |
| DMT 1920 × 1200 @ 60 Hz (ID 45h)       | 1920 | 1200 | 2592 | 1245 | 536  | 42  | 200  | 6    | 60  | 193,62            |
| DMT 1920 × 1440 @ 60 Hz (ID 49h)       | 1920 | 1440 | 2600 | 1500 | 552  | 59  | 208  | 3    | 60  | 234,00            |
| CVT 2048 × 1536 @ 60 Hz [RB1]          | 2048 | 1536 | 2208 | 1580 | 112  | 41  | 32   | 4    | 60  | 209,32            |
| CTA 2560 × 1080 @ 24 Hz (VIC 86)       | 2560 | 1080 | 3750 | 1100 | 192  | 16  | 44   | 5    | 24  | 99,00             |
| CTA 2560 × 1080 @ 25 Hz (VIC 87)       | 2560 | 1080 | 3200 | 1125 | 192  | 41  | 44   | 5    | 25  | 90,00             |
| CTA 2560 × 1080 @ 30 Hz (VIC 88)       | 2560 | 1080 | 3520 | 1125 | 192  | 41  | 44   | 5    | 30  | 118,80            |
| CTA 2560 × 1080 @ 50 Hz (VIC 89)       | 2560 | 1080 | 3300 | 1125 | 192  | 41  | 44   | 5    | 50  | 185,63            |
| CTA 2560 × 1080 @ 100 Hz (VIC 91)      | 2560 | 1080 | 2970 | 1250 | 192  | 166 | 44   | 5    | 100 | 371,25            |
| CVT 2560 × 1440 @ 60 Hz [RB2]          | 2560 | 1440 | 2640 | 1481 | 72   | 14  | 32   | 8    | 60  | 234,59            |
| CVT 2560 × 1440 @ 60 Hz [RB1]          | 2560 | 1440 | 2720 | 1481 | 112  | 38  | 32   | 5    | 60  | 241,70            |
| CVT 2560 × 1440 @ 144 Hz [RB3]         | 2560 | 1440 | 2720 | 1543 | 152  | 14  | 32   | 8    | 144 | 604,57            |
| CVT 2560 × 1440 @ 200 Hz [RB3]         | 2560 | 1440 | 2720 | 1586 | 152  | 14  | 32   | 8    | 200 | 863,09            |
| CTA 2560 × 1080 @ 48 Hz (VIC 113)      | 2560 | 1080 | 3750 | 1100 | 192  | 16  | 44   | 5    | 48  | 198,00            |
| CVT 2560 × 1080 @ 60 Hz                | 2560 | 1080 | 3424 | 1120 | 704  | 37  | 272  | 10   | 60  | 230,09            |
| CVT 2560 × 1080 @ 60 Hz [RB1]          | 2560 | 1080 | 2720 | 1111 | 112  | 28  | 32   | 10   | 60  | 181,32            |
| CVT 2560 × 1080 @ 144 Hz [RB3]         | 2560 | 1080 | 2720 | 1157 | 152  | 14  | 32   | 8    | 144 | 453,33            |
| CVT 2560 × 1080 @ 200 Hz [RB3]         | 2560 | 1080 | 2720 | 1190 | 152  | 14  | 32   | 8    | 200 | 647,59            |
| CTA 2560 × 1080 @ 60 Hz (VIC 90)       | 2560 | 1080 | 3000 | 1100 | 192  | 16  | 44   | 5    | 60  | 198,00            |
| CTA 2560 × 1080 @ 120 Hz (VIC 92)      | 2560 | 1080 | 3300 | 1250 | 192  | 16  | 44   | 5    | 120 | 495,00            |
| DMT 2560 × 1600 @ 60 Hz (ID 4Dh)       | 2560 | 1600 | 3504 | 1658 | 752  | 55  | 280  | 6    | 60  | 348,58            |
| DMT 2560 × 1600 @ 60 Hz (ID 4Ch) [RB1] | 2560 | 1600 | 2720 | 1646 | 112  | 43  | 32   | 6    | 60  | 268,63            |
| CTA 2880 × 240 @ 60 Hz (VIC 12)        | 2880 | 240  | 3432 | 263  | 476  | 18  | 248  | 3    | 60  | 54,00             |
| CTA 2880 × 240 @ 60 Hz (VIC 13)        | 2880 | 240  | 3432 | 263  | 476  | 18  | 248  | 3    | 60  | 54,00             |
| CTA 2880 × 288 @ 50 Hz (VIC 27)        | 2880 | 288  | 3456 | 314  | 528  | 22  | 252  | 3    | 50  | 54,00             |
| CTA 2880 × 288 @ 50 Hz (VIC 28)        | 2880 | 288  | 3456 | 314  | 528  | 22  | 252  | 3    | 50  | 54,00             |
| CTA 2880 × 480 @ 60 Hz (VIC 35)        | 2880 | 480  | 3432 | 525  | 488  | 36  | 248  | 6    | 60  | 108,00            |
| CTA 2880 × 480 @ 60 Hz (VIC 36)        | 2880 | 480  | 3432 | 525  | 488  | 36  | 248  | 6    | 60  | 108,00            |
| CTA 2880 × 576 @ 50 Hz (VIC 37)        | 2880 | 576  | 3456 | 625  | 528  | 44  | 256  | 5    | 50  | 108,00            |
| CTA 2880 × 576 @ 50 Hz (VIC 38)        | 2880 | 576  | 3456 | 625  | 528  | 44  | 256  | 5    | 50  | 108,00            |
| 2880 × 1440 @ 60 Hz                    | 2880 | 1440 | 2976 | 1456 | 48   | 8   | 8    | 1    | 60  | 259,98            |
| CVT 3440 × 1440 @ 60 Hz                | 3440 | 1440 | 4688 | 1493 | 992  | 50  | 368  | 10   | 60  | 419.951           |
| CVT 3440 × 1440 @ 60 Hz [RB1]          | 3440 | 1440 | 3600 | 1481 | 112  | 38  | 32   | 10   | 60  | 319.896           |
| CVT 3440 × 1440 @ 60 Hz [RB2]          | 3440 | 1440 | 3520 | 1481 | 72   | 14  | 32   | 8    | 60  | 312.787           |
| CVT 3440 × 1440 @ 120 Hz               | 3440 | 1440 | 4800 | 1545 | 1064 | 102 | 384  | 10   | 120 | 889.92            |
| CVT 3440 × 1440 @ 120 Hz [RB1]         | 3440 | 1440 | 3600 | 1525 | 112  | 82  | 32   | 10   | 120 | 658.80            |
| CVT 3440 × 1440 @ 120 Hz [RB2]         | 3440 | 1440 | 3520 | 1525 | 72   | 14  | 32   | 8    | 120 | 644.16            |
| CVT 3440 × 1440 @ 165 Hz               | 3440 | 1440 | 4832 | 1588 | 1080 | 145 | 384  | 10   | 165 | 1266.081          |
| CVT 3440 × 1440 @ 165 Hz [RB1]         | 3440 | 1440 | 3600 | 1559 | 112  | 116 | 32   | 10   | 165 | 926.046           |
| CVT 3440 × 1440 @ 165 Hz [RB2]         | 3440 | 1440 | 3520 | 1559 | 72   | 14  | 32   | 8    | 165 | 905.467           |
| CVT 3440 × 1440 @ 200 Hz               | 3440 | 1440 | 4848 | 1622 | 1088 | 179 | 384  | 10   | 200 | 1572.691          |
| CVT 3440 × 1440 @ 200 Hz [RB1]         | 3440 | 1440 | 3600 | 1586 | 112  | 143 | 32   | 10   | 200 | 1141.92           |
| CVT 3440 × 1440 @ 200 Hz [RB2]         | 3440 | 1440 | 3520 | 1586 | 72   | 14  | 32   | 8    | 200 | 1116.544          |
| CVT 3440 × 1440 @ 240 Hz               | 3440 | 1440 | 4848 | 1663 | 1088 | 220 | 384  | 10   | 240 | 1934.934          |
| CVT 3440 × 1440 @ 240 Hz [RB1]         | 3440 | 1440 | 3600 | 1619 | 112  | 176 | 32   | 10   | 240 | 1398.816          |
| CVT 3440 × 1440 @ 240 Hz [RB2]         | 3440 | 1440 | 3520 | 1619 | 72   | 14  | 32   | 8    | 240 | 1367.731          |
| CVT 3840 × 2160 @ 30 Hz [RB1]          | 3840 | 2160 | 4000 | 2191 | 112  | 28  | 32   | 5    | 30  | 262,92            |
| CVT 3840 × 2160 @ 30 Hz [RB2]          | 3840 | 2160 | 3920 | 2191 | 72   | 14  | 32   | 8    | 30  | 257,66            |
| CVT 3840 × 2160 @ 60 Hz [RB1]          | 3840 | 2160 | 4000 | 2222 | 112  | 59  | 32   | 5    | 60  | 533,28            |
| CVT 3840 × 2160 @ 60 Hz [RB2]          | 3840 | 2160 | 3920 | 2222 | 72   | 14  | 32   | 8    | 60  | 522,61            |

|                                   |      |      |      |      |     |    |    |    |    |        |
|-----------------------------------|------|------|------|------|-----|----|----|----|----|--------|
| CVT 3840 × 2160 @ 60 Hz [RB3]     | 3840 | 2160 | 4000 | 2222 | 152 | 14 | 32 | 8  | 60 | 533,47 |
| CTA 3840 × 2160 @ 60 Hz (VIC 97)  | 3840 | 2160 | 4400 | 2250 | 384 | 82 | 88 | 10 | 60 | 594,00 |
| CTA 3840 × 2160 @ 24 Hz (VIC 93)  | 3840 | 2160 | 5500 | 2250 | 384 | 82 | 88 | 10 | 24 | 297,00 |
| CTA 3840 × 2160 @ 25 Hz (VIC 94)  | 3840 | 2160 | 5280 | 2250 | 384 | 82 | 88 | 10 | 25 | 297,00 |
| CTA 3840 × 2160 @ 30 Hz (VIC 95)  | 3840 | 2160 | 4400 | 2250 | 384 | 82 | 88 | 10 | 30 | 297,00 |
| CTA 3840 × 2160 @ 50 Hz (VIC 96)  | 3840 | 2160 | 5280 | 2250 | 384 | 82 | 88 | 10 | 50 | 594,00 |
| CTA 3840 × 2160 @ 24 Hz (VIC 103) | 3840 | 2160 | 5500 | 2250 | 384 | 82 | 88 | 10 | 24 | 297,00 |
| CTA 3840 × 2160 @ 25 Hz (VIC 104) | 3840 | 2160 | 5280 | 2250 | 384 | 82 | 88 | 10 | 25 | 297,00 |
| CTA 3840 × 2160 @ 30 Hz (VIC 105) | 3840 | 2160 | 4400 | 2250 | 384 | 82 | 88 | 10 | 30 | 297,00 |

\*) CVT: Coordinated Video Timings (CVT; VESA-2021-09-27 v2.0)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings

CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)

| Description*                       | HA   | VA   | HT   | VT   | HST | VST | HSYN | VSYN | FR  | Pixel Clock (MHz) |
|------------------------------------|------|------|------|------|-----|-----|------|------|-----|-------------------|
| CTA 3840 × 2160 @ 50 Hz (VIC 106)  | 3840 | 2160 | 5280 | 2250 | 384 | 82  | 88   | 10   | 50  | 594,00            |
| CTA 3840 × 2160 @ 60 Hz (VIC 107)  | 3840 | 2160 | 4400 | 2250 | 384 | 82  | 88   | 10   | 60  | 594,00            |
| CTA 3840 × 2160 @ 48 Hz (VIC 114)  | 3840 | 2160 | 5500 | 2250 | 384 | 82  | 88   | 10   | 48  | 594,00            |
| CTA 3840 × 2160 @ 48 Hz (VIC 116)  | 3840 | 2160 | 5500 | 2250 | 384 | 82  | 88   | 10   | 48  | 594,00            |
| CTA 3840 × 2160 @ 100 Hz (VIC 117) | 3840 | 2160 | 5280 | 2250 | 384 | 82  | 88   | 10   | 100 | 1188,00           |
| CTA 3840 × 2160 @ 100 Hz (VIC 119) | 3840 | 2160 | 5280 | 2250 | 384 | 82  | 88   | 10   | 100 | 1188,00           |
| CTA 3840 × 2160 @ 120 Hz (VIC 120) | 3840 | 2160 | 4400 | 2250 | 384 | 82  | 88   | 10   | 120 | 1188,00           |
| CVT 4096 × 2160 @ 60 Hz [RB2]      | 4096 | 2160 | 4176 | 2222 | 72  | 14  | 32   | 8    | 60  | 556,74            |
| CVT 4096 × 2160 @ 60 Hz [RB1]      | 4096 | 2160 | 4256 | 2222 | 112 | 59  | 32   | 10   | 60  | 567,41            |
| CVT 4096 × 2160 @ 60 Hz [RB3]      | 4096 | 2160 | 4256 | 2222 | 152 | 14  | 32   | 8    | 60  | 567,61            |
| CTA 4096 × 2160 @ 60 Hz (VIC 102)  | 4096 | 2160 | 4400 | 2250 | 216 | 82  | 88   | 10   | 60  | 594,00            |
| CTA 4096 × 2160 @ 120 Hz (VIC 219) | 4096 | 2160 | 4400 | 2250 | 216 | 82  | 88   | 10   | 120 | 1188,00           |
| CTA 4096 × 2160 @ 100 Hz (VIC 218) | 4096 | 2160 | 5280 | 2250 | 384 | 82  | 88   | 10   | 100 | 1188,00           |
| CTA 4096 × 2160 @ 50 Hz (VIC 101)  | 4096 | 2160 | 5280 | 2250 | 216 | 82  | 88   | 10   | 50  | 594,00            |
| CTA 4096 × 2160 @ 48 Hz (VIC 115)  | 4096 | 2160 | 5500 | 2250 | 384 | 82  | 88   | 10   | 48  | 594,00            |
| CTA 4096 × 2160 @ 24 Hz (VIC 98)   | 4096 | 2160 | 5500 | 2250 | 384 | 82  | 88   | 10   | 24  | 297,00            |
| CTA 4096 × 2160 @ 25 Hz (VIC 99)   | 4096 | 2160 | 5280 | 2250 | 216 | 82  | 88   | 10   | 25  | 297,00            |
| CTA 4096 × 2160 @ 30 Hz (VIC 100)  | 4096 | 2160 | 4400 | 2250 | 216 | 82  | 88   | 10   | 30  | 297,00            |
| CVT 3840 × 2160 @ 120 Hz [RB1]     | 3840 | 2160 | 4000 | 2287 | 112 | 124 | 32   | 5    | 120 | 1097,76           |
| CVT 3840 × 2160 @ 120 Hz [RB2]     | 3840 | 2160 | 3920 | 2287 | 72  | 14  | 32   | 8    | 120 | 1075,80           |
| CTA 3840 × 2160 @ 120 Hz (VIC 118) | 3840 | 2160 | 4400 | 2250 | 384 | 82  | 88   | 10   | 120 | 1188,00           |
| CVT 5120 × 2160 @ 30 Hz [RB1]      | 5120 | 2160 | 5280 | 2191 | 112 | 28  | 32   | 10   | 30  | 347,05            |
| CVT 5120 × 2160 @ 30 Hz [RB2]      | 5120 | 2160 | 5200 | 2191 | 72  | 14  | 32   | 8    | 30  | 341,80            |
| CTA 5120 × 2160 @ 30 Hz (VIC 123)  | 5120 | 2160 | 6000 | 2200 | 216 | 32  | 88   | 10   | 30  | 396,00            |
| CVT 5120 × 2160 @ 60 Hz [RB1]      | 5120 | 2160 | 5280 | 2222 | 112 | 59  | 32   | 10   | 60  | 703,93            |
| CVT 5120 × 2160 @ 60 Hz [RB2]      | 5120 | 2160 | 5200 | 2222 | 72  | 14  | 32   | 6    | 60  | 693,26            |
| CTA 5120 × 2160 @ 60 Hz (VIC 126)  | 5120 | 2160 | 5500 | 2250 | 216 | 82  | 88   | 10   | 60  | 742,50            |
| 5120 × 2880 @ 60 Hz                | 5120 | 2880 | 5280 | 2962 | 112 | 79  | 32   | 5    | 60  | 938,36            |
| 5120 × 2880 @ 60 Hz                | 5120 | 2880 | 5200 | 2962 | 72  | 14  | 32   | 8    | 60  | 924,14            |
| 5120 × 2880 @ 60 Hz                | 5120 | 2880 | 5280 | 2962 | 152 | 14  | 32   | 8    | 60  | 938,69            |
| CTA 5120 × 2160 @ 48 Hz (VIC 124)  | 5120 | 2160 | 6250 | 2475 | 384 | 307 | 88   | 10   | 48  | 742,50            |
| CTA 5120 × 2160 @ 50 Hz (VIC 125)  | 5120 | 2160 | 6600 | 2250 | 384 | 82  | 88   | 10   | 50  | 742,50            |
| CTA 5120 × 2160 @ 100 Hz (VIC 127) | 5120 | 2160 | 6600 | 2250 | 384 | 82  | 88   | 10   | 100 | 1485,00           |
| CTA 5120 × 2160 @ 25 Hz (VIC 122)  | 5120 | 2160 | 7200 | 2200 | 384 | 32  | 88   | 10   | 25  | 396,00            |
| CTA 5120 × 2160 @ 24 Hz (VIC 121)  | 5120 | 2160 | 7500 | 2200 | 384 | 32  | 88   | 10   | 24  | 396,00            |
| CVT 7680 × 4320 @ 30 Hz [RB2]      | 7680 | 4320 | 7760 | 4381 | 72  | 14  | 32   | 8    | 30  | 1019,90           |

|                                    |      |      |      |      |     |     |     |    |     |         |
|------------------------------------|------|------|------|------|-----|-----|-----|----|-----|---------|
| CVT 7680 × 4320 @ 30 Hz [RB1]      | 7680 | 4320 | 7840 | 4381 | 112 | 58  | 32  | 5  | 30  | 1030,41 |
| CVT 7680 × 4320 @ 60 Hz [RB2]      | 7680 | 4320 | 7760 | 4443 | 72  | 14  | 32  | 8  | 60  | 2068,66 |
| CVT 7680 × 4320 @ 100 Hz [RB2]     | 7680 | 4320 | 7760 | 4529 | 72  | 14  | 32  | 8  | 100 | 3514,50 |
| CVT 7680 × 4320 @ 60 Hz [RB1]      | 7680 | 4320 | 7840 | 4443 | 112 | 120 | 32  | 5  | 60  | 2089,99 |
| CVT 7680 × 4320 @ 100 Hz [RB1]     | 7680 | 4320 | 7840 | 4529 | 112 | 206 | 32  | 5  | 100 | 3550,74 |
| CTA 7680 × 4320 @ 120 Hz (VIC 201) | 7680 | 4320 | 8800 | 4500 | 768 | 164 | 176 | 20 | 120 | 4752,00 |
| CTA 7680 × 4320 @ 120 Hz (VIC 209) | 7680 | 4320 | 8800 | 4500 | 768 | 164 | 176 | 20 | 120 | 4752,00 |
| CTA 7680 × 4320 @ 30 Hz (VIC 204)  | 7680 | 4320 | 9000 | 4400 | 768 | 64  | 176 | 20 | 30  | 1188,00 |
| CTA 7680 × 4320 @ 30 Hz (VIC 196)  | 7680 | 4320 | 9000 | 4400 | 768 | 64  | 176 | 20 | 30  | 1188,00 |
| CTA 7680 × 4320 @ 60 Hz (VIC 207)  | 7680 | 4320 | 9000 | 4400 | 768 | 64  | 176 | 20 | 60  | 2376,00 |
| CTA 7680 × 4320 @ 60Hz (VIC 199)   | 7680 | 4320 | 9000 | 4400 | 768 | 64  | 176 | 20 | 60  | 2376,00 |

\*) CVT: Coordinated Video Timings (CVT; VESA-2021-09-27 v2.0)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings

CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)

| Description*                        | HA    | VA   | HT    | VT   | HST | VST | HSYN | VSYN | FR  | Pixel Clock (MHz) |
|-------------------------------------|-------|------|-------|------|-----|-----|------|------|-----|-------------------|
| CTA 7680 × 4320 @ 100 Hz (VIC 208)  | 7680  | 4320 | 10560 | 4500 | 768 | 164 | 176  | 20   | 100 | 4752,00           |
| CTA 7680 × 4320 @ 100 Hz (VIC 200)  | 7680  | 4320 | 10560 | 4500 | 768 | 164 | 176  | 20   | 100 | 4752,00           |
| CTA 7680 × 4320 @ 25 Hz (VIC 203)   | 7680  | 4320 | 10800 | 4400 | 768 | 64  | 176  | 20   | 25  | 1188,00           |
| CTA 7680 × 4320 @ 25 Hz (VIC 195)   | 7680  | 4320 | 10800 | 4400 | 768 | 64  | 176  | 20   | 25  | 1188,00           |
| CTA 7680 × 4320 @ 50 Hz (VIC 198)   | 7680  | 4320 | 10800 | 4400 | 768 | 64  | 176  | 20   | 50  | 2376,00           |
| CTA 7680 × 4320 @ 50 Hz (VIC 206)   | 7680  | 4320 | 10800 | 4400 | 768 | 64  | 176  | 20   | 50  | 2376,00           |
| CTA 7680 × 4320 @ 24 Hz (VIC 194)   | 7680  | 4320 | 11000 | 4500 | 768 | 164 | 176  | 20   | 24  | 1188,00           |
| CTA 7680 × 4320 @ 48 Hz (VIC 197)   | 7680  | 4320 | 11000 | 4500 | 768 | 164 | 176  | 20   | 48  | 2376,00           |
| CTA 7680 × 4320 @ 24 Hz (VIC 202)   | 7680  | 4320 | 11000 | 4500 | 768 | 164 | 176  | 20   | 24  | 1188,00           |
| CTA 7680 × 4320 @ 48 Hz (VIC 205)   | 7680  | 4320 | 11000 | 4500 | 768 | 164 | 176  | 20   | 48  | 2376,00           |
| Unigraf 10240 x 4320 @ 30 Hz [RB1]  | 10240 | 4320 | 11000 | 4500 | 112 | 58  | 32   | 5    | 30  | 1485,00           |
| Unigraf 10240 x 4320 @ 30 Hz [RB2]  | 10240 | 4320 | 11000 | 4500 | 72  | 14  | 32   | 8    | 30  | 1485,00           |
| CTA 10240 x 4320 @ 24 Hz (VIC 210)  | 10240 | 4320 | 12500 | 4950 | 768 | 614 | 176  | 20   | 24  | 1485,00           |
| CTA 10240 x 4320 @ 25 Hz (VIC 211)  | 10240 | 4320 | 13500 | 4400 | 768 | 64  | 176  | 20   | 25  | 1485,00           |
| CTA 10240 x 4320 @ 30 Hz (VIC 212)  | 10240 | 4320 | 11000 | 4500 | 472 | 164 | 176  | 20   | 30  | 1485,00           |
| CTA 10240 x 4320 @ 48 Hz (VIC 213)  | 10240 | 4320 | 12500 | 4950 | 768 | 614 | 176  | 20   | 48  | 2970,00           |
| CTA 10240 x 4320 @ 50 Hz (VIC 214)  | 10240 | 4320 | 13500 | 4400 | 768 | 64  | 176  | 20   | 50  | 2970,00           |
| CTA 10240 x 4320 @ 60 Hz (VIC 215)  | 10240 | 4320 | 11000 | 4500 | 472 | 164 | 176  | 20   | 60  | 2970,00           |
| CTA 10240 x 4320 @ 100 Hz (VIC 216) | 10240 | 4320 | 13200 | 4500 | 768 | 164 | 176  | 20   | 100 | 5940,00           |
| CTA 10240 x 4320 @ 120 Hz (VIC 217) | 10240 | 4320 | 11000 | 4500 | 472 | 164 | 176  | 20   | 120 | 5940,00           |

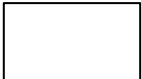
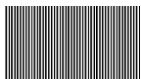
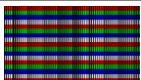
\*) CVT: Coordinated Video Timings (CVT; VESA-2021-09-27 v2.0)

DMT: VESA and Industry Standards and Guidelines for Computer Display Monitor Timings

CTA: A DTV Profile for Uncompressed High Speed Digital Interfaces (CTA-861-H)

## APPENDIX D: PREDEFINED PATTERNS

### Fixed Patterns

| Selection       | Pattern                                                                             | Description                                                                                                                                                                                                                                               |
|-----------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Disabled        |    | The links are activated but no video data transferred                                                                                                                                                                                                     |
| Color Bar       |    | 100% intensity color bars of all primaries and mixed combinations.                                                                                                                                                                                        |
| Chessboard      |    | 8 by 8 chessboard with black (0%) and 100% intensity white                                                                                                                                                                                                |
| Solid Color     |    | Solid color. User selected RGB values                                                                                                                                                                                                                     |
| Solid White     |    | 100% white                                                                                                                                                                                                                                                |
| Solid Red       |    | 100% red                                                                                                                                                                                                                                                  |
| Solid Green     |   | 100% green                                                                                                                                                                                                                                                |
| Solid Blue      |  | 100% blue                                                                                                                                                                                                                                                 |
| White V-Strips  |  | Vertical stripes of black (0%) and white (100%).<br>Parameters set the widths of the black and white stripes in pixels respectively. Default black / white = 20 / 20 pixels. Parameter range 1 to 1000.                                                   |
| RGB Wide Strips |  | 16 pixels high horizontal red, green, blue and white stripes.<br>Intensity is increased from 0 to 100% with steps defined by the given parameter (Color Step = cs) and selected color.<br>(step = cs*color_depth/256). "n" range 0 to 5000 (default 100). |
| Color Ramp      |  | Color Ramp test pattern defined by VESA DisplayPort Link Layer Compliance Test Specification.                                                                                                                                                             |
| Color Square    |  | Color Square test pattern defined by VESA DisplayPort Link Layer Compliance Test Specification. Color mode can be selected between RGB, YCbCr 4:4:4, 4:2:2, 4:2:0 (ITU Rec 601 / 709)                                                                     |
| Motion Pattern  |  | Horizontally moving color bar pattern. The pattern is shifted to left one pixel in each frame in a sequence. The length of the sequence is defined with parameter. Range 0 to 34 (default is 20)                                                          |
| Square Window   |  | 100% intensity white square horizontally and vertically centered.<br>Height and width defined by parameter as the percentage of height and width of the frame (default 30).                                                                               |

## Extended Patterns

| Selection            | Icon                                                                                | Description                                                                                                           |
|----------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Select Image         |    | Custom image uploaded by the user. Click on Select ... to browse.                                                     |
| Select DSC Image     |    | Custom DSC compressed image file uploaded by the user. Click on Select ... to browse.                                 |
| Unigraf PM5544       |    | Vpattern vector pattern based on PM5544                                                                               |
| Color Web            |    | Vpattern vector pattern.                                                                                              |
| Chinese Town Full HD |    | JPG Bitmap image (1920 x 1080 px)                                                                                     |
| UG-2111 HLG Narrow   |    | Software generated pattern. HLG Narrow dynamic range.                                                                 |
| UG-2111 PQ Narrow    |    | Software generated pattern. PQ Narrow dynamic range.                                                                  |
| UG-2111 PQ Full      |    | Software generated pattern. PQ Full dynamic range.                                                                    |
| Multi                |    | Vpattern vector pattern. Multi-purpose pattern w square grid, cross-grids, 1x1 cross-hatches, circles, and color bars |
| SMPTE RP-133         |   | Vpattern vector pattern based on SMPTE RP-133                                                                         |
| SMPTE 303M           |  | Vpattern vector pattern. SMPTE 303M; Full Range; RGB values before gamma correction based on D65 and PAL primaries    |
| Blue                 |  | Vpattern vector pattern. 100% Blue                                                                                    |
| CirclesW             |  | Vpattern vector pattern. Concentric circles                                                                           |
| Complex              |  | Vpattern vector pattern. Complex Pattern w 64 steps                                                                   |
| Green                |  | Vpattern vector pattern. 100% Green                                                                                   |
| Hor1W-Even           |  | Vpattern vector pattern. Horizontal 1 px wide White bars in even rows                                                 |
| Hor1W-Odd            |  | Vpattern vector pattern. Horizontal 1 px wide White bars in odd rows                                                  |
| Hor4W                |  | Vpattern vector pattern. Horizontal 4 px high White bars                                                              |
| Hor10W               |  | Vpattern vector pattern. Horizontal 10 px high White bars                                                             |
| Hor-10xB             |  | Vpattern vector pattern. 10 pcs horizontal Blue bars                                                                  |
| Hor-10G              |  | Vpattern vector pattern. 10 pcs horizontal Green bars                                                                 |

## Extended Patterns (cont.)

| Selection       | Icon                                                                                | Description                                                            |
|-----------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Hor-10xR        |    | Vpattern vector pattern. 10 pcs horizontal Red bars                    |
| Hor-10xW        |    | Vpattern vector pattern. 10 pcs horizontal White bars                  |
| HorRainbow-1024 |    | Vpattern vector pattern. Horizontal Rainbow Ramps 1024 steps           |
| HorRGBW-1024    |    | Vpattern vector pattern. Horizontal RGBW Ramps 1024 steps              |
| HorScale9       |    | Vpattern vector pattern. Nine Horizontal Color Ramps                   |
| HorScaleW-64    |    | Vpattern vector pattern. Horizontal White ramp 64 steps                |
| HorScaleW-128   |    | Vpattern vector pattern. Horizontal White ramp 128 steps               |
| HorScaleW-X2    |    | Vpattern vector pattern. Horizontal White ramp w edges 128 steps       |
| InnerBox-BKtoB  |    | Vpattern vector pattern. InnerBox pattern from Black to Blue           |
| InnerBox-BKtoG  |   | Vpattern vector pattern. InnerBox pattern from Black to Green          |
| InnerBox-BKtoR  |  | Vpattern vector pattern. InnerBox pattern from Black to Red            |
| InnerBox-BKtoW  |  | Vpattern vector pattern. InnerBox pattern from Black to White          |
| InnerBoxMIX     |  | Vpattern vector pattern. InnerBox pattern mixed hues.                  |
| InnerBox-RtoB   |  | Vpattern vector pattern. InnerBox pattern from Red to Blue             |
| Red             |  | Vpattern vector pattern. 100% Red                                      |
| Ver1W-Even      |  | Vpattern vector pattern. Vertical 1 px wide White bars in even columns |
| Ver1W-Odd       |  | Vpattern vector pattern. Vertical 1 px wide White bars in odd columns  |
| Ver4W           |  | Vpattern vector pattern. Vertical 4 px wide White bars                 |
| Ver10W          |  | Vpattern vector pattern. Vertical 10 px wide White bars                |
| Ver-10xG        |  | Vpattern vector pattern. 10 pcs Vertical Blue bars                     |
| Ver-10xR        |  | Vpattern vector pattern. 10 pcs Vertical Blue bars                     |
| Ver-10xB        |  | Vpattern vector pattern. 10 pcs Vertical Blue bars                     |
| Ver-10xW        |  | Vpattern vector pattern. 10 pcs Vertical Blue bars                     |

## Extended Patterns (cont.)

| Selection    | Icon                                                                                | Description                                                                       |
|--------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| VerBars75%   |    | Vpattern vector pattern. Vertical 75% intensity Color bars                        |
| VerBars100%  |    | Vpattern vector pattern. Vertical 100% intensity Color bars                       |
| VerRGBW-1024 |    | Vpattern vector pattern. Vertical RGBW Ramps 1024 steps                           |
| X-HatchBK-C  |    | Vpattern vector pattern. Black 16 x12 Grid w Circle on White background           |
| X-HatchW     |    | Vpattern vector pattern. White 16 x12 Grid on Black background                    |
| X-HatchW-C   |    | Vpattern vector pattern. White 16 x12 Grid w Circle on Black background           |
| X-HatchW-CC  |    | Vpattern vector pattern. White 16 x12 Grid w Ellipses, Circle and 100% color bars |
| Gray Box 10  |    | Vpattern vector pattern. China 5.6 White Window 10%                               |
| Gray Box 20  |    | Vpattern vector pattern. China 5.6 White Window 20%                               |
| Gray Box 30  |   | Vpattern vector pattern. China 5.6 White Window 30%                               |
| Gray Box 40  |  | Vpattern vector pattern. China 5.6 White Window 40%                               |
| Gray Box 50  |  | Vpattern vector pattern. China 5.6 White Window 50%                               |
| Gray Box 60  |  | Vpattern vector pattern. China 5.6 White Window 60%                               |
| Gray Box 70  |  | Vpattern vector pattern. China 5.6 White Window 70%                               |
| Gray Box 80  |  | Vpattern vector pattern. China 5.6 White Window 80%                               |
| Gray Box 90  |  | Vpattern vector pattern. China 5.6 White Window 90%                               |
| Gray Box 100 |  | Vpattern vector pattern. China 5.6 White Window 100%                              |
| 8 Level Gray |  | Vpattern vector pattern. China 5.5 Ultimate 8 Level Grayscale                     |

## Extended Patterns (cont.)

| Selection                 | Icon                                                                                | Description                                                         |
|---------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Black'n'White Window HDTV |    | Vpattern vector pattern. China 5.8 Black and White Window(FOR HDTV) |
| Black'n'White Window SDTV |    | Vpattern vector pattern. China 5.8 Black and White Window(FOR SDTV) |
| Black Line HDTV           |    | Vpattern vector pattern. China 5.10 Black Line HDTV                 |
| Black Line SDTV           |    | Vpattern vector pattern. China 5.10 Black Line SDTV                 |
| Black Window              |    | Vpattern vector pattern. China 5.7 Black Window                     |
| Check Board               |    | Vpattern vector pattern. China 5.9 Check Board                      |
| Line'n'Window             |    | Vpattern vector pattern. China 5.11 Line and Window                 |
| Narrow White Window       |    | Vpattern vector pattern. China 5.19 Narrow White Window             |
| Single Dot                |   | Vpattern vector pattern. China Single Dot                           |
| White Line HDTV           |  | Vpattern vector pattern. China 5.10 White Line for HDTV             |
| White Line SDTV           |  | Vpattern vector pattern. China 5.10 White Line for SDTV             |

More test patterns can be downloaded e.g. from [www.icdm-sid.org/](http://www.icdm-sid.org/)



## APPENDIX E: SINK, SOURCE AND REPEATER TESTS

| Source DUT Testing                                                                                 |                                                                                                                                                                                                     | Default | DP 1.4a LL CTS* | DP 1.4a DSC CTS | DP 2.1 DisplayID / EDID CTS (8b/10b)* | DP 2.1 Adaptive-Sync CTS (8b/10b)* | HDCP 2.3 CTS* | HDR10+ Distribution Device Tests |
|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|---------------------------------------|------------------------------------|---------------|----------------------------------|
| Audio Test                                                                                         | Validate audio signal frequency and glitch-free audio reproduction                                                                                                                                  | ●       |                 |                 |                                       |                                    |               |                                  |
| CEC Functional Test Set (HDMI) (UCD-422)                                                           | CEC functional test, CEC PHY Addr test, CEC Complete test, CEC Wake up test, CEC Standby test                                                                                                       | ●       |                 |                 |                                       |                                    |               |                                  |
| CRC Video Tests (UCD-400, UCD-422, UCD-424)<br><i>Will be available in future UCD-4XX versions</i> | CRC based single frame reference video test, CRC based single frame stability test, CRC based sequence of frames reference video test, CRC based continuous sequence of frames reference video test | ●       |                 |                 |                                       |                                    |               |                                  |
| Link Config Tests (DP) (UCD-400, UCD-424)                                                          | Link Training at All Supported Lane Counts and Link Rates                                                                                                                                           | ●       |                 |                 |                                       |                                    |               |                                  |
| Pixel Level Video Tests                                                                            | Compare video frame sequence with a single reference                                                                                                                                                |         |                 |                 |                                       |                                    |               |                                  |
| VRR Source DUT Tests (HDMI) (UCD-412, UCD-422)                                                     | VRR static test, QMS Test, VRR Dynamic test                                                                                                                                                         | ●       |                 |                 |                                       |                                    |               |                                  |
| DP 1.4a Link Layer CTS (UCD-400, UCD-424)                                                          | 4.2.1.1 – 4.2.1.5, 4.2.2.1 – 4.2.2.10, 4.3.1.1 – 4.3.1.13, 4.3.2.1 – 4.3.2.5, 4.3.3.1, 4.4.1.1 – 4.4.1.3, 4.4.2, 4.4.3, 4.4.4.1 – 4.4.4.6, 4.5.1.1 – 4.5.1.2                                        |         | ●               |                 |                                       |                                    |               |                                  |
| DP 1.4 DSC CTS (UCD-400, UCD-424)                                                                  | 4.6.1.1 – 4.6.1.9                                                                                                                                                                                   |         |                 | ●               |                                       |                                    |               |                                  |
| DP 1.4 DisplayID-EDID CTS (UCD-400, UCD-424)                                                       | 4.7.1.1 – 4.7.1.4, 4.7.2.1 – 4.7.2.2, 4.7.3.1 – 4.7.3.3, 4.7.4.1, 4.7.5.1, 4.7.6.1 – 4.7.6.4, 4.7.7.1 – 4.7.7.2                                                                                     |         |                 |                 | ●                                     |                                    |               |                                  |
| DP Adaptive-Sync CTS (UCD-400, UCD-424)                                                            | 4.8.1.1 – 4.8.1.2, 4.8.2.1 – 4.8.2.3                                                                                                                                                                |         |                 |                 |                                       | ●                                  |               |                                  |
| DP HDCP 2.3 CTS 1A Test Set (UCD-400, UCD-424)                                                     | HDCP2.3 CTS 1A-01 – HDCP2.3 CTS 1A-12                                                                                                                                                               |         |                 |                 |                                       |                                    | ●             |                                  |
| DP HDCP 2.3 CTS 1B Test Set (UCD-400, UCD-424)                                                     | HDCP2.3 CTS 1B-01 – HDCP2.3 CTS 1B-10                                                                                                                                                               |         |                 |                 |                                       |                                    | ●             |                                  |
| HDR10+ Distribution Device Tests (HDMI RX / DP RX) (UCD-400, UCD-422, UCD-424)                     | Tests from:<br><i>HDR10+ TEST SPECIFICATION, HDR10+ Distribution Device</i>                                                                                                                         |         |                 |                 |                                       |                                    |               | ●                                |
| HDR10+ SSTM Tests for Source (HDMI RX / DP RX) (UCD-400, UCD-422, UCD-424)                         | Tests from:<br><i>HDR10+ TEST SPECIFICATION, Source Side Tone Mapping for Source Device</i>                                                                                                         |         |                 |                 |                                       |                                    |               | ●                                |

\*) Separate licenses for testing Sink, Source, Branch DUT (LL CTS, DSC, DisplayID, Adaptive-Sync)

| Sink DUT Testing                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Default | DP 1.4a LL CTS* | DP 1.4a DSC CTS Sink DUT* | DP 2.1 DisplayID / EDID CTS (8b/10b)* | DP 2.1 Adaptive-Sync CTS (8b/10b)* | DP HDCP 2.3 CTS* | HDR10+ DD & SSTM CTS |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|---------------------------|---------------------------------------|------------------------------------|------------------|----------------------|
| VRR Sink DUT Tests (HDMI) (UCD-412, UCD-422)              | VRR static test, QMS Test, VRR Dynamic test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ●       |                 |                           |                                       |                                    |                  |                      |
| DP 1.4a Link Layer CTS (UCD-400, UCD-411, UCD-424)**      | 5.2.1.1 – 5.2.1.12, 5.2.2.1 – 5.2.2.9, 5.3.1.1 – 5.3.1.9, 5.3.2.1 – 5.3.2.2, 5.4.1.1 – 5.4.1.4, 5.4.2, 5.4.3.1 – 5.4.3.2, 5.4.4.1 – 5.4.4.6, 5.5.1.1 – 5.5.1.7                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | ●               |                           |                                       |                                    |                  |                      |
| DP 1.4a DSC CTS (UCD-400, UCD-411, UCD-424)**             | 5.6.1.1 – 5.6.1.26, 5.6.2.1 – 5.6.2.14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         |                 | ●                         |                                       |                                    |                  |                      |
| DP 1.4a DisplayID-EDID CTS (UCD-400, UCD-411, UCD-424)**  | 5.7.1.1 – 5.7.1.2, 5.7.1.3.1 – 5.7.1.3.4, 5.7.1.4.1 – 5.7.1.4.9, 5.7.1.5 – 5.7.1.6, 5.7.2.1 – 5.7.2.2, 5.7.2.3.1 – 5.7.2.3.5, 5.7.2.4.1 – 5.7.2.4.2, 5.7.2.5.1 – 5.7.2.5.2, 5.7.2.6.1 – 5.7.2.6.2, 5.7.2.7.1, 5.7.2.8, 5.7.3.1 – 5.7.3.5, 5.7.4.1 – 5.7.4.3, 5.7.4.5, 5.7.5.1, 5.7.6.1 – 5.7.6.5, 5.7.7.1 – 5.7.7.6, 5.7.8.1 – 5.7.8.6, 5.7.9.1 – 5.7.9.3, 5.7.10.1 – 5.7.10.3, 5.7.11.1 – 5.7.11.5, 5.7.12.1 – 5.7.12.4, 5.7.13.1 – 5.7.13.2, 5.7.14.1 – 5.7.14.6, 5.7.15.1 – 5.7.15.9, 5.7.16.1 – 5.7.16.7, 5.7.17.1 – 5.7.17.5, 5.7.18.1, 5.7.19.1 – 5.7.19.6, 5.7.20.1 – 5.7.20.3, 5.7.21.1 – 5.7.21.5, 5.7.22.1 – 5.7.22.7 |         |                 |                           | ●                                     |                                    |                  |                      |
| DP Adaptive-Sync CTS (UCD-400, UCD-411, UCD-424)**        | 5.8.1.1 – 5.8.1.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         |                 |                           |                                       | ●                                  |                  |                      |
| DP HDCP 2.3 CTS 2C Test Set (UCD-400, UCD-411, UCD-424)** | HDCP2.3 CTS 2C-01 – HDCP2.3 CTS 2C-06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |                 |                           |                                       |                                    | ●                |                      |
| HDR10+ CTS Tests (HDMI & DP)                              | HDR10+ Display Device and SSTM Tests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |                 |                           |                                       |                                    |                  | ●                    |
| Cable test (UCD-422)                                      | Cable Test Check                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ●       |                 |                           |                                       |                                    |                  |                      |

\*) Separate licenses for testing Sink, Source, Branch DUT (LL CTS, DSC, DisplayID, Adaptive-Sync)

\*\*) Please check availability for UCD-451 from Unigraf

| Repeater DUT Testing                                       |                                       | Default | DP HDCP 2.3 CTS* |
|------------------------------------------------------------|---------------------------------------|---------|------------------|
| DP HDCP 2.3 CTS 3A Test Set<br>(UCD-400, UCD-411, UCD-424) | HDCP2.3 CTS 3A-01 – HDCP2.3 CTS 3A-06 |         | ●                |
| DP HDCP 2.3 CTS 3B Test Set<br>(UCD-400, UCD-411, UCD-424) | HDCP2.3 CTS 3B-01 – HDCP2.3 CTS 3B-07 |         | ●                |
| DP HDCP 2.3 CTS 3C Test Set<br>(UCD-400, UCD-411, UCD-424) | HDCP2.3 CTS 3C-01 – HDCP2.3 CTS 3C-25 |         | ●                |

\*) Separate licenses for testing Sink, Source and Repeater DUT (HDCP)

## Compliance Tests

|                             |                                     |
|-----------------------------|-------------------------------------|
| Role:                       | Product:                            |
| DP Reference Sink (DP RX)   | UCD-400, UCD-424                    |
| DP Reference Source (DP TX) | UCD-400, UCD-411, UCD-424, UCD-451* |

\*) Please check availability for UCD-451 from Unigraf

Compliance test capability is a license enabled add-on to UCD Console.

The tests are included in the GUI software, license codes enable the tests for use. Please refer to *Appendix B Licensing* for details. The list of compliance tests that UCD Console supports, please refer to document *DP CTS Tool Options for Unigraf UCD-400.pdf*. It can be downloaded in Unigraf Document Center at <https://www.unigraf.fi/documents/>. If you have any additional questions, please contact Unigraf or your local representative.

Compliance tests (CTS Tests) are part of tests included in **Source DUT Testing** tab of **DP RX** and **Sink DUT Testing** tab of **DP TX**.

The tests cases are divided to test categories as described in *Appendix E* of this document. Test categories are placed in sub-tabs. Test category tabs are enabled based on licenses present. Please refer to chapter 3 *License Manager* earlier in this document.

### Test Parameters

Before running the tests, capabilities of the DUT have to be defined for the test engine. Each test category has its dedicated test parameter dialog. Click **Configure** in *Source DUT Testing* or *Sink DUT Testing* tab to open the parameter dialog.

**DP 1.4 Link Layer Source DUT CTS**

General | Audio | DSC | DisplayID | Adaptive-Sync

**Test Timeouts**

Test Timeout (ms): 5000

Long HPD pulse duration (ms): 1000

**Colorimetry**

RGB: ☒ 6 bpc VESA ☐ 8 bpc CTA (ITU.601) ☐ 8 bpc CTA (ITU.601)

☒ 8 bpc VESA ☐ 10 bpc CTA (ITU.601) ☐ 10 bpc CTA (ITU.601)

☐ 10 bpc VESA ☐ 8 bpc CTA (ITU.709) ☐ 8 bpc CTA (ITU.709)

☐ 6 bpc CTA ☐ 10 bpc CTA (ITU.709) ☐ 10 bpc CTA (ITU.709)

☐ 8 bpc CTA

☐ Select All

**Test Automation**

☐ TEST\_LINK\_TRAINING

☒ TEST\_EDID\_READ

☐ TEST\_VIDEO\_PATTERN

☐ TEST\_AUDIO\_PATTERN

Event indicating DUT ready: Always ready

**DUT Capabilities**

Max lanes supported: 4

Max Bitrate supported: HBR3 (8.10 Gbps)

☒ Voltage Swing level 3 (1.2V) supported

☒ Pre-Emphasis level 3 (9.5dB) supported

☐ Fixed timing DUT

☐ Spread Spectrum Supported

☒ Video format change without LT supported.

☒ Lane count reduction without LT supported.

☒ E-DDC supported

☐ Audio Info Frame supported for 2 channel audio

☐ DUT is Type-C Device

☒ FEC supported

☐ FEC disable sequence supported

☒ Audio without Video supported

**Video Modes**

Fail-safe video mode: 640 x 480 @ 60Hz 6 BPC

Maximum supported video mode: 3840 x 2160 @ 60Hz 8 BPC

**Most Packed Timings**

1 Lane: DMT 1280 x 768p @ 60Hz, RB1, 6 bpc

2 Lanes: DMT 1400 x 1050p @ 60Hz, RB1, 8 bpc

4 Lanes: CTA 1920 x 1080p @ 60Hz, 10 bpc

**Time-stamp generation**

|      | 1 lane                   | 2 lanes                  | 4 lanes                   |
|------|--------------------------|--------------------------|---------------------------|
| RBR  | 848 x 480 @ 60Hz 8 BPC   | 1280 x 720 @ 60Hz 8 BPC  | 1920 x 1080 @ 60Hz 8 BPC  |
| HBR  | 1280 x 720 @ 60Hz 8 BPC  | 1280 x 960 @ 60Hz 8 BPC  | 1920 x 1080 @ 60Hz 8 BPC  |
| HBR2 | 1280 x 960 @ 60Hz 8 BPC  | 1920 x 1080 @ 60Hz 8 BPC | 1920 x 1080 @ 120Hz 8 BPC |
| HBR3 | 1920 x 1440 @ 60Hz 8 BPC | 3840 x 2160 @ 30Hz 8 BPC | 3840 x 2160 @ 60Hz 8 BPC  |

Presets

OK Cancel

For a detailed description of capabilities listed on the tab please refer to Chapter 3 Compliance Test Operation of document VESA DisplayPort v1.4a Link Layer Compliance Test Specification.

#### Note:

Please make sure that the capability tables are completed before running the tests. The result of the test might be misleading if the DUT capabilities and the table do not match.

DSC Test Content

When running DSC Compliance Tests, Console needs to have access to DSC content used as test patterns. This content will be automatically created during test execution. Creation of the test content takes time and considerably slows down the execution of the test. To avoid this after the first test run, users are able to save the created DSC content by selecting the option *Keep auto-created DSC content files* described below.

Warning

Please note, that the space needed for storing the full library **can be very large** (appr. 400 GBytes). Please make sure that the content will be stored in a medium that has the required space available.

Options

In Tools > Options menu you can define DSC Work folder and DSC test content directory.

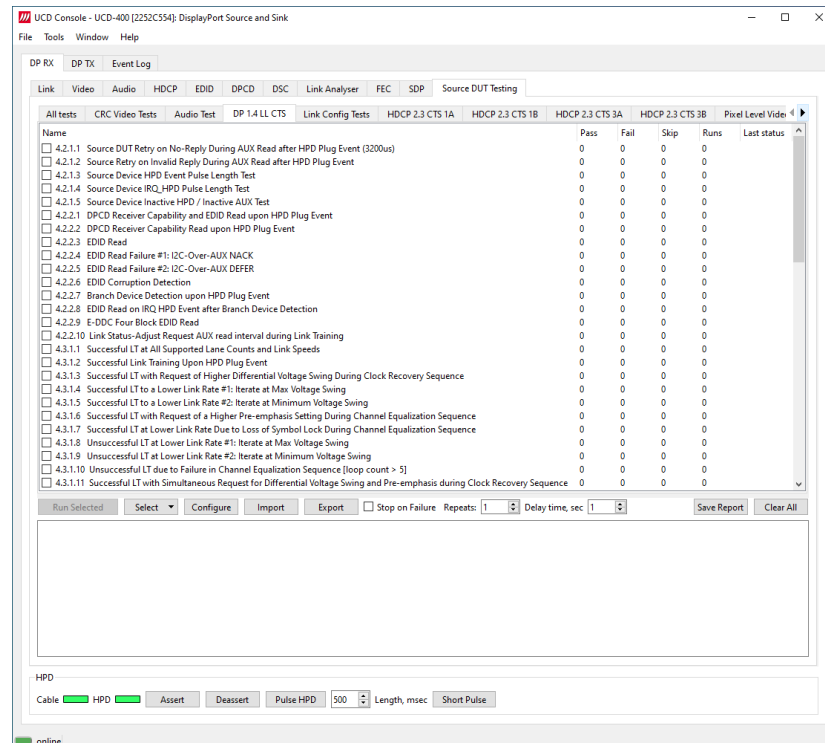
|                                             |                                                                                                        |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------|
| <i>DSC temp folder:</i>                     | Folder for DSC Work files.                                                                             |
| <i>DSC test content folder:</i>             | Folder where DSC source bitmap files, related configuration files and DSC conversion tools are stored. |
| <i>Keep auto-created DSC content files:</i> | By default, the DSC compressed content is deleted after use. If selected, the content is not deleted   |

## Running CTS Tests

*Source DUT Testing* and *Sink DUT Testing* tabs include the tests enabled with the set of licenses present in UCD Console grouped in test set tabs. In tabs the tests are listed by the test name and reference number as in applicable compliance test specification. UCD-400 firmware implements the test according to the test specification.

For running a test, select it and click **Run selected**. For selecting multiple consecutive tests in the list hold down the **Shift** key of your keyboard while selecting the tests. For selecting multiple individual tests hold down the **Ctrl** key in your keyboard while selecting.

Test flow parameters like **Test timeout** and **Test cycle delay** can be defined in *Test Parameter* dialog launched by clicking **Configure**.



|                         |                                                                                                                                                                                                                                                                             |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Run Selected</b>     | Click to start selected tests. By clicking <i>Abort</i> the sequence is stopped.                                                                                                                                                                                            |
| <b>Select:</b>          | Includes the following options for creating templates for tests execution: Select All, Clear All, Invert All, Save, Import and Export                                                                                                                                       |
| <b>Configure</b>        | Clicking opens a dialog for defining the test parameters for that set. Please refer to <i>Test Parameters</i> below for description.                                                                                                                                        |
| <b>Import:</b>          | Load saved test parameter files (*.td or *.json).                                                                                                                                                                                                                           |
| <b>Export:</b>          | Save test parameters for later use or for use in test automation. For saving parameters for later use in UCD Console, either format can be used. For saving parameters for TSI scripting, please use *.td files. For use with Python applications, please use *.json files. |
| <b>Stop on Failure:</b> | Stops execution of the selected tests if one of the tests fail                                                                                                                                                                                                              |
| <b>Repeats:</b>         | Repeat the selected test several times.<br>When repeating a sequence of tests, all selected tests are performed in each repetition. E.g., when you repeat tests 1, 2 and 3 two times, the sequence is: 1, 2, 3, 1, 2, 3.                                                    |
| <b>Delay time</b>       | Delay in seconds between individual tests.                                                                                                                                                                                                                                  |
| <b>Save Report:</b>     | Click to generate a report file in HTML format for sharing the results with other parties for viewing without UCD Console.                                                                                                                                                  |
| <b>Clear Log</b>        | Clear the test log and the results matrix                                                                                                                                                                                                                                   |

## Saving Test Parameters

Test parameters can be saved in various ways.

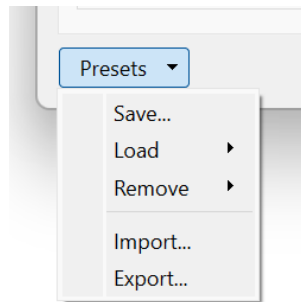
Export parameters in *Sink DUT Testing* tab to a \*.td file for later use in UCD Console or with TSI scripting or sharing.

Export parameters in *Sink DUT Testing* tab to a \*.json file for later use in UCD Console or with Python applications or sharing.

Save parameters in *Configure* dialog as Presets to be later used in UCD Console. Please find a description below.

### Presets

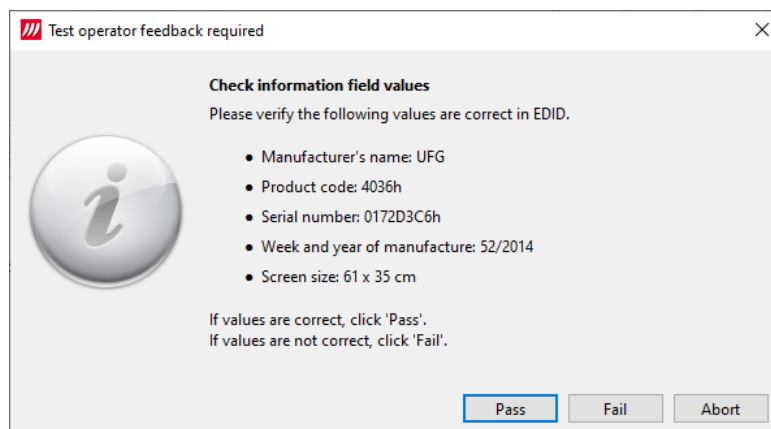
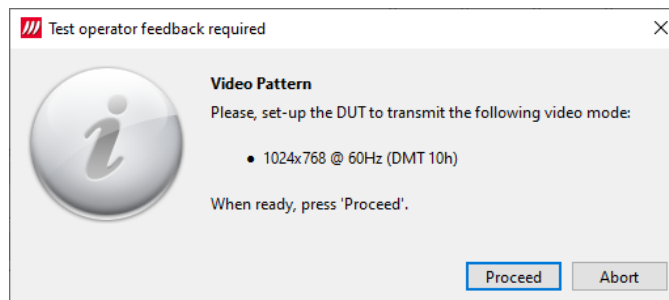
In all *Configure* dialogs the selected parameters can be saved as Presets. Please click **Presets...** to save or recall a configuration. Click Save first to assign the configuration a name, and after that you can e.g. Export it to a file.



## Operator Feedback

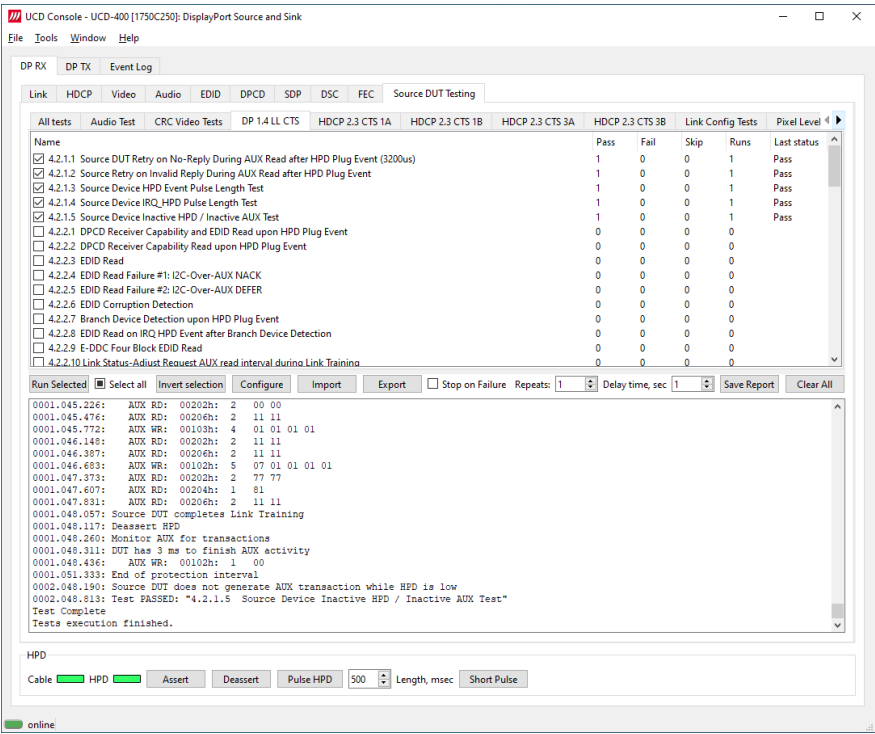
In some compliance tests operator action or feedback is required for items that the test itself cannot perform or confirm. In these cases test opens a pop-up dialog. In the dialog the operator is instructed about items to do or to be verified and buttons for providing the “Proceed” instruction or “Pass” and “Fail” feedback.

Clicking “Abort” stops execution of the test.



Evaluating CTS Test Results

The test procedure advancement can be monitored in the *Test Log* panel. It describes the steps of each individual test in the way defined in the corresponding VESA Compliance Test Specification. Please use the Status Log and Specification side by side when interpreting the results.



At the completion of each test the result of the test is indicated in the matrix on the right hand side of the test panel. For each test the matrix lists the number of occurrences of each result and the number of tries performed.

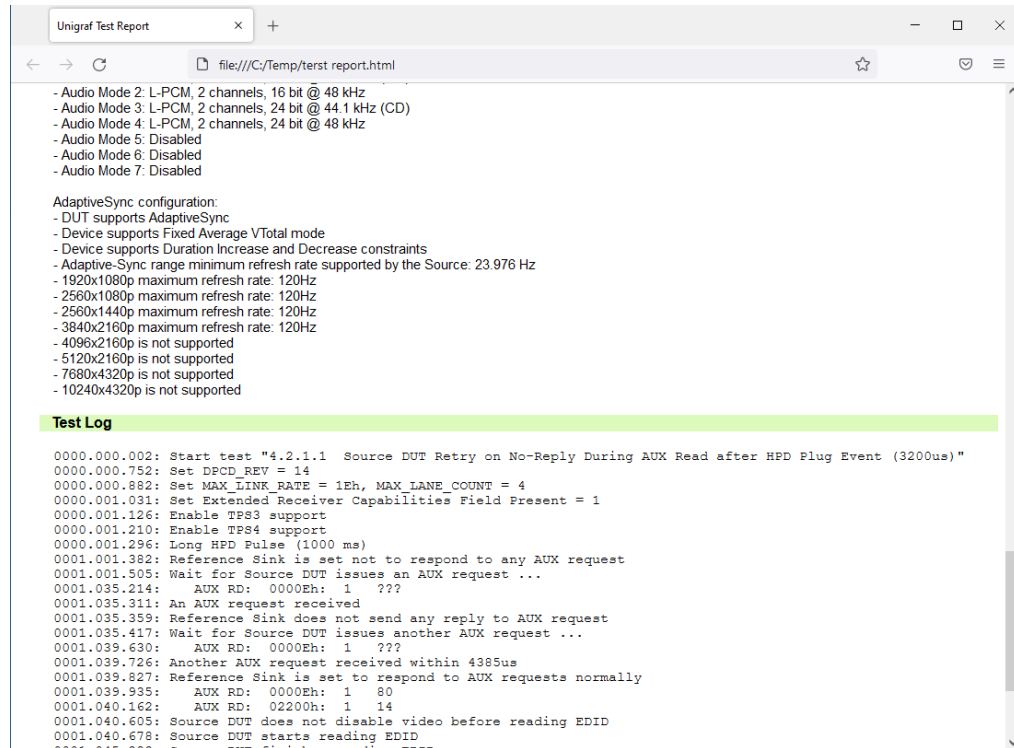


## Test Report

Results of the test can be saved as a report in HTML format by clicking **Save Report**.

### Viewing the CTS Test Report

The report file can be viewed with any HTML browser. The report has built-in views for Report Summary, Test Summary



## Audio Test Set

|                                    |          |
|------------------------------------|----------|
| Role:                              | Product: |
| DP Reference Sink (DP RX)          | UCD-400  |
| HDMI Reference Sink (HDMI RX)      | UCD-422  |
| DP Alt Mode Reference Sink (DP RX) | UCD-424  |

### Validate audio signal frequency and glitch-free audio reproduction

Perform frequency check on the digital audio content and verify the content to be glitch-free. This test assumes that a pure sine-wave audio signal content is being transmitted to the test equipment.

The test will first capture minimum of one second of audio content. The audio is then analyzed in two stages.

First, the power spectrum is calculated, and the highest peak must be within the defined window. Resolution of the peak frequency check is better than  $\pm 1$  Hz.

In the second stage, received audio is checked for random glitches, such as dropped or duplicated samples. This is achieved by examining how the RDV ("Relative Distortion Value") changes over time within the sampled audio.

The test is considered passed if power of audio content spectrum has its maximum within the defined window, and the number of detected audio glitches does not exceed programmed limit.

| Name                                             | Value     |
|--------------------------------------------------|-----------|
| Expected sampling rate of audio signal           | 44100     |
| Expected audible (sine) frequency as Hz          | 1000      |
| Allowed deviation from expected frequency as Hz  | 1         |
| Number of audio glitches allowed per test        | 0         |
| Tested audio save conditions                     | Save none |
| Location where the captured audio is to be saved | 0         |

Presets ▼ OK Cancel

### Parameters in use

- Expected sampling rate of audio signal (default 44 100 s/sec)
- Expected audible (sine) frequency in Hz (default 1000 Hz)
- Allowed deviation from expected frequency in Hz (default 1 Hz)
- Number of audio glitches allowed per test (default 0)

Click **Location where the captured audio is to be saved** to browse for the folder to store tests.

## CEC Functional Tests Set

|                               |          |
|-------------------------------|----------|
| Role:                         | Product: |
| HDMI Reference Sink (HDMI RX) | UCD-422  |

### Parameters in use

- Test timeout, in milliseconds
- Local CEC physical address

| Name                          | Value   |
|-------------------------------|---------|
| Test timeout, in milliseconds | 5000    |
| Local CEC physical address    | 4.0.0.0 |

Presets ▼ OK Cancel

### CEC Functional Test

Test is intended to check that DUT does CEC initialization correctly after HPD. TE initialize EDID with configured address. Apply HPD and expected that Logical Physical addresses that presented in EDID will be applied with Report Physical Address message to inform TE about the mapping Logical and Physical addresses. That is expectation of CEC behavior.

### CEC Phy Address test.

Test is intended to check that CEC line is working properly, and DUT can receive CEC Report Physical Address or customized OP Code. TE checks that HPD is high and CEC line available and send Report Physical Address (or customized OP Code) message in broadcast mode (or with specific destination).

### CEC Wake Up test

Test is intended to check that CEC line is working properly, and DUT can send CEC Wake Up command. TE checks that HPD is high and CEC line available and wait for Wake Up message.

### CEC Stand By test

Test is intended to check that CEC line is working properly, and DUT can send CEC Stand By command. TE checks that HPD is high and CEC line available and wait for Stand By message.

### CEC Complete test

Test is intended to check that CEC line is working properly, and DUT can send sequence of commands from Stand By mode. TE checks that HPD is high and CEC line available. TE waiting for sequence of commands from DUT Wake UP and then again Stand By.

---

**Note:** The default physical address in UCD EDID is 1:0:0:0. In order to simulate a change in the address, please use another address range

---



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**Note:** As a side effect, the CEC will also verify functionality of HPD and EDID reading if the test passes.

---

## CRC Based Video Test Set

|                                    |          |
|------------------------------------|----------|
| Role:                              | Product: |
| DP Reference Sink (DP RX)          | UCD-400  |
| HDMI Reference Sink (HDMI RX)      | UCD-422  |
| DP Alt Mode Reference Sink (DP RX) | UCD-424  |

### Configuration

|                                              |                                                                                                                             |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <i>Test timeout:</i>                         | If enabled test will abort when the time has elapsed                                                                        |
| <i>Repeat until timeout:</i>                 | Omit "Test length" parameter                                                                                                |
| <i>Test length (# frames):</i>               | Number of captured frames to test                                                                                           |
| <i>Errors allowed (# frames):</i>            | Number of failing frames allowed before test Fails                                                                          |
| <i>Repeat "Sequence Test" until timeout:</i> | Repeat test sequence until the timeout set (length parameter below omitted)                                                 |
| <i>"Sequence Test" length</i>                | Repeat count of the "Sequence Test"                                                                                         |
| <i>Expected Video Format</i>                 | Format of the signal expected                                                                                               |
| <i>Expected Frame Rate:</i>                  | Verify stability of the video signal. Verification disabled if Expected Frame Rate is set to "0"                            |
| <i>Number of captured reference frames:</i>  | Number of frames stored as reference                                                                                        |
| <i>Capture Reference Frames:</i>             | Capture reference frames for the test                                                                                       |
| <i>Folder to save failed frames:</i>         | PC folder where failed frames are stored.                                                                                   |
| <i>Max number of saved frames:</i>           | Maximum number of failed frames stored to PC                                                                                |
| <i>Format of saved frames:</i>               | Select saved image format (Binary file, PPM image, BMP image)                                                               |
| <i>Align 12</i>                              | 12bpc values are be shifted to MSB of a 16bits container. If not checked, 12 LSB are used to store colour component values. |
| <i>Presets:</i>                              | Store and recall settings                                                                                                   |

### CRC Based Single Reference Frame Video Test

The test compares captured frames to a captured reference. In Configure dialog, please select 1 to *CRC Capture length* and click *Capture Now*.

TE compares the video mode (Frame Width, Height, BPP and optionally Frame rate) to provided parameters and after that captures frames and compares the CRC (check sum) of their three color components to the provided reference until the number of bad frame limit provided is detected or the provided total number of frames is reached.

The test is judged FAIL if video mode does not match, or the number of bad frames is exceeded.

The test optionally captures the failed frames as bitmap images and stores them into the hard disc.

#### Parameters in use

- Test Timeout (default 10 000 ms)
- Total number of frames (default 2 00 ms)
- Number of bad frames allowed (default 20)
- Reference width (default 1920)
- Reference height (default 1080)
- Reference BPP (default 24)
- Expected frame rate (mHz, 1/1000 Hz)
- Frame rate tolerance (mHz, 1/1000 Hz)
- Reference CRCs (R, G, B)

### CRC Based Single Frame Video Stability Test

The test verifies that the captured video is stable.

TE captures a frame and sets the CRC of its color components as reference. After that TE captures frames and compares their CRC (check sum) to the reference until the number of bad frame limit provided is detected or the provided total number of frames is reached.

The test is judged FAIL if the number of bad frames is exceeded.

The test optionally captures the failed frames as bitmap images and stores them into the hard disc.

#### Parameters in use

- Test Timeout (default 100 00 ms)
- Total number of frames (default 200 ms)
- Number of bad frames allowed (default 20)

### CRC Based Sequence of Reference Frames Test

The verifies that a sequence of frames is captured in the right order.

TE compares the video mode (frame Width, Height, BPP and optionally Frame rate) to provided parameters. After that captures frames to find a frame with matching CRC (check sum) of their three color components to the first provided reference. After the first matching CRC is found it compares the CRC of the following frames until the Number of frames tested parameter is reached.

The test is judged FAIL if video mode does not match, the first frame in the list is not found or the CRC of the following frames do not match the provided list.

The test optionally captures the failed frames as bitmap images and stores them into the hard disc.

#### Parameters in use

- Test Timeout (default 10 000 ms)
- Number of frames to be tested (default 20)
- Reference width (default 1920)
- Reference height (default 1080)
- Reference BPP (default 24)
- Expected frame rate (mHz, 1/1000 Hz)
- Frame rate tolerance (mHz, 1/1000 Hz)
- Reference CRCs (R, G, B)

---

**Note:** Please note that in order for the TE to maintain the sequence, all CRCs in the reference frame list should be different.

---

### CRC Based Continuous Sequence of Reference Frames Test

The test verifies that a sequence of frames is captured in the right order many times repeatedly.

TE compares the video mode (frame Width, Height, BPP and optionally Frame rate and Color format) to provided parameters. After that captures frames to find a frame with matching CRC (check sum) of their three color components to the first provided reference. After the first matching CRC is found it compares the CRC of the following frames until the Number of frames tested parameter is reached. After that it resets the list and starts from the first CRC. The list is repeated until timeout or until the provided number of repetitions is reached.

The test is judged FAIL if video mode does not match, the first frame in the list is not found or the CRC of the following frames do not match the provided list.

The test optionally captures the failed frames as bitmap images and stores them into the hard disc.

#### Parameters in use

- Test Timeout (default 10 000 ms)
- Number of frames to be tested (default 20)
- Number of iterations
- Reference width (default 1920)
- Reference height (default 1080)
- Reference BPP (default 24)
- Expected frame rate (mHz, 1/1000 Hz)
- Frame rate tolerance (mHz, 1/1000 Hz)
- Expected color format
- Reference CRCs (R, G, B)

---

**Note:** Please note that in order for the TE to maintain the sequence, all CRCs in the reference frame list should be different.

---

## Pixel Level Video Tests

| Role:                              | Product: |
|------------------------------------|----------|
| DP Reference Sink (DP RX)          | UCD-400  |
| HDMI Reference Sink (HDMI RX)      | UCD-422  |
| DP Alt Mode Reference Sink (DP RX) | UCD-424  |

### Compare video frame sequence with a single reference

The test compares captured frames to the provided reference image at the pixel level by buffering the indicated number of captured frames first in the local UCD device frame buffer and after that downloads them to the PC for evaluation.

The test compares the captured frames to a provided reference image on pixel level.

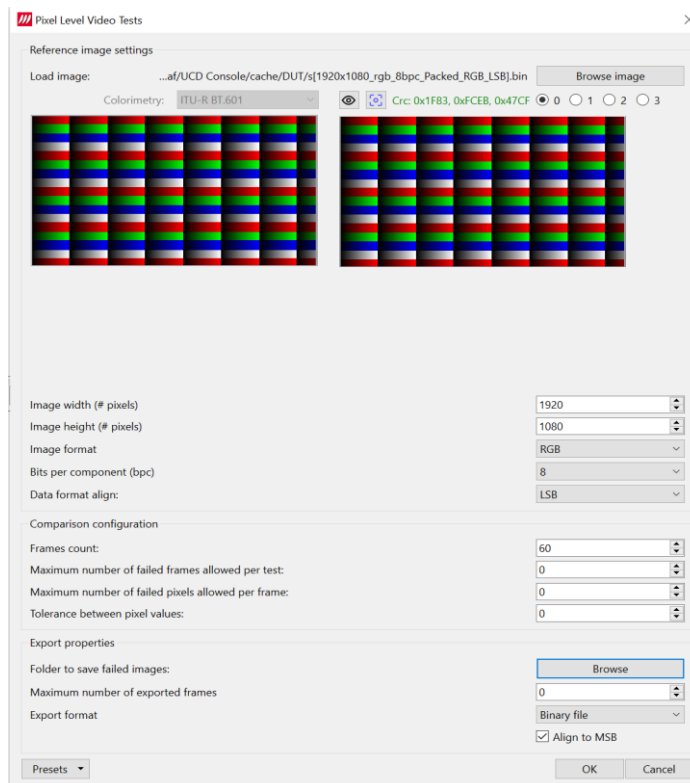
- The color component values of each pixel in the captured frame is compared to the corresponding pixels in the reference image.
- If the difference is larger than the provided tolerance, the pixel is considered failed.
- If the number of failed pixels in a frame is larger than the provided tolerance, the frame is considered failed.
- If the number of failed frames in the test is larger than the provided tolerance, the test is considered failed.
- Failed frames can be stored for evaluation.

|                                                          |                                                                                                                             |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <i>Browse image:</i>                                     | Load reference image from disk                                                                                              |
| <i>Image width:</i>                                      | Width expected                                                                                                              |
| <i>Image height:</i>                                     | Height expected                                                                                                             |
| <i>Image format:</i>                                     | Image format expected                                                                                                       |
| <i>Bits per component:</i>                               | Bits per component expected                                                                                                 |
| <i>Data format align:</i>                                | Video data alignment expected                                                                                               |
| <i>Frames count:</i>                                     | Number of frames buffered for testing                                                                                       |
| <i>Maximum number of failed frames allowed per test:</i> | Number of failed frames allowed totally                                                                                     |
| <i>Maximum number of failed frames allowed per test:</i> | Number of failed pixels allowed per buffered frame                                                                          |
| <i>Tolerance between pixel values:</i>                   | The allowed difference between a color component of pixel in the captured frame to the reference bitmap.                    |
| <i>Folder to save failed images:</i>                     | PC directory where failed frames are stored.                                                                                |
| <i>Maximum number of exported frames:</i>                | Maximum number of failed frames stored to PC                                                                                |
| <i>Export format:</i>                                    | Format of exported image: Binary file, PPM image, BMP image                                                                 |
| <i>Align to MSB</i>                                      | 12bpc values are be shifted to MSB of a 16bits container. If not checked, 12 LSB are used to store colour component values. |
| <i>Presets:</i>                                          | Store and recall settings                                                                                                   |

### Capturing Reference Image

User can capture received video as reference:

1. In *Settings* dialog click the enable live preview icon .





2. When the preview has been enabled click the *Capture reference* icon  to store a frame and use it as reference. Before accepting the frame, stability of the video is verified with a CRC stability check. Captured CRC can also be verified by the user.

## Link Config Tests

|                                    |          |
|------------------------------------|----------|
| Role:                              | Product: |
| DP Reference Sink (DP RX)          | UCD-400  |
| DP Alt Mode Reference Sink (DP RX) | UCD-424  |

### Link Training at All Supported Lane Counts and Link Rates

Test requests link training on all supported lane counts and link rates. Each link training must be successfully completed in order to pass the test.

In Configure, please define the parameters for the test.

| Name                                         | Value    |
|----------------------------------------------|----------|
| Test timeout, in milliseconds                | 5000     |
| Max lanes count supported by DUT             | 4        |
| Max lane rate supported by DUT               | 5.4 Gbps |
| Long HPD pulse duration, in milliseconds     | 1000     |
| Link training start timeout, in milliseconds | 5000     |
| Delay between test cycles, in milliseconds   | 3000     |
| Reserved                                     | 0        |

Presets ▼ OK Cancel

### Parameters in use

- Test Timeout (default 5 000 ms)
- Max lane count supported by DUT (default 4)
- Max lane rate supported by DUT
- Long HPD pulse duration (default 1 000 ms)
- Link training start timeout (default 5 000 ms)
- Delay between test cycles (default 3 000 ms)

# VRR Source DUT Tests – HDMI Rx

|                               |          |
|-------------------------------|----------|
| Role:                         | Product: |
| HDMI Reference Sink (HDMI RX) | UCD-422  |

Configure

VRR Source DUT Tests

| Name                          | Value |
|-------------------------------|-------|
| Test timeout, in milliseconds | 10000 |
| VRR Max value                 | 60    |
| VRR Min value                 | 30    |
| VRR Static value              | 45    |
| VRR Step value                | 1     |
| VRR Time step value           | 1000  |
| VRR Enable and M_CONST        | 3     |
| VFront value                  | 0     |
| Base Refresh Rate             | 50    |

Presets

OK

Cancel

|                                |                                                                        |
|--------------------------------|------------------------------------------------------------------------|
| <i>VRR Max value:</i>          | Maximum VRR frame rate                                                 |
| <i>VRR Min value:</i>          | Minimum VRR frame rate                                                 |
| <i>VRR Static value:</i>       | Static VRR frame rate                                                  |
| <i>VRR Step value:</i>         | Change of current VRR value during a test                              |
| <i>VRR Time step value:</i>    | Change of current VRR value during a test                              |
| <i>VRR Enable and M_Const:</i> | Click to open dialog for enabling <i>VRR Enable</i> and <i>M_CONST</i> |
| <i>VFront value:</i>           | Click to open dialog for enabling <i>Base VFront</i> and <i>RB</i>     |
| <i>Base Refresh Rate:</i>      | Set Base Refresh Rate                                                  |

## VRR Static Test

Test verifies that DUT Source applies expected static VRR value.

After configuring the parameters operator starts the test. Test waits until DUT Source starts VRR mode. When VRR mode is detected, test verifies that received timing matches the VRR Value parameter and the data in received EMP packets match the timing.

## Quick Media Switching (QMS) Test

Verify that VRR is set correctly when frame rate is changing with a set time interval. For example, change VRR from 30 to 60 Hz with step for each 1 second.

After configuring the parameters operator starts the test. Test waits until DUT Source starts VRR mode. When VRR mode is detected, test verifies that VRR is changed after each time interval set by VRR Time parameter, and the applied VRR change is as set in the parameter. Test also verifies that data in received EMP packets match with applied VRR.

## VRR Dynamic Test

Verify that VRR is set correctly when frame rate is changing with each frame. For example, change VRR from 60 to 120 Hz with step 1 each frame.

After configuring the parameters operator starts the test. Test waits until DUT Source starts VRR mode. When VRR mode is detected, test verifies that VRR is changed between each frame. Test also verifies that data in received EMP packets match with applied VRR.

# VRR Sink DUT Tests – HDMI Tx

|                                 |                           |
|---------------------------------|---------------------------|
| Role:                           | Product:                  |
| HDMI Reference Source (HDMI TX) | UCD-422, UCD-412, UCD-452 |

Configure

VRR Sink DUT Tests

| Name                          | Value |
|-------------------------------|-------|
| Test timeout, in milliseconds | 10000 |
| VRR Max value                 | 60    |
| VRR Min value                 | 30    |
| VRR Static value              | 45    |
| VRR Step value                | 1     |
| VRR Time step value           | 1000  |
| VRR Enable and M_CONST        | 3     |
| VFront and RB                 | 0     |
| Base Refresh Rate             | 50    |

Presets

OK

Cancel

|                                |                                                                        |
|--------------------------------|------------------------------------------------------------------------|
| <i>VRR Max value:</i>          | Maximum VRR frame rate                                                 |
| <i>VRR Min value:</i>          | Minimum VRR frame rate                                                 |
| <i>VRR Static value:</i>       | Static VRR frame rate                                                  |
| <i>VRR Step value:</i>         | Change of current VRR value during a test                              |
| <i>VRR Time step value:</i>    | Change of current VRR value during a test                              |
| <i>VRR Enable and M_Const:</i> | Click to open dialog for enabling <i>VRR Enable</i> and <i>M_CONST</i> |
| <i>VFront value:</i>           | Click to open dialog for enabling <i>Base VFront</i> and <i>RB</i>     |
| <i>Base Refresh Rate:</i>      | Set Base Refresh Rate                                                  |

Static VRR Test

Test verifies that DUT Sink correctly applies a static VRR value.

After configuring the parameters operator starts the test. Operator verifies that DUT Sink has applied VRR correctly and provides the information in the dialog of the test.

Quick Media Switching (QMS) Test

Verify that VRR is set correctly when frame rate is changing with a set time interval. For example, change VRR from 30 to 60 Hz with step 1 each 1 second.

After configuring the parameters operator starts the test. Operator verifies that DUT Sink has applied VRR correctly and frame rate is changing as expected. Operator provides the information in the dialog of the test.

Dynamic Test

Verify that VRR is set correctly when frame rate is changing with each frame. For example, change VRR from 60 to 120 Hz with step 1 each frame.

After configuring the parameters operator starts the test. Operator verifies that DUT Sink has applied VRR correctly and frame rate is changing as expected. Operator provides the information in the dialog of the test.

## Cable Test

|                                 |          |
|---------------------------------|----------|
| Role:                           | Product: |
| HDMI Reference Source (HDMI TX) | UCD-422  |

### Cable Check Test

Test is intended to check that cable can be properly used with UCD-422. Cable should be connected in loopback mode.

Test tries to pass Link training on different rates. If errors are presented on the lanes, then TE applies different FFE level to find configuration where is the best quality (minimum of errors). If Link training can be done without errors on all link rates then cable qualified as acceptable for usage with UCD-422.

### Configure

| Name                                     | Value      |
|------------------------------------------|------------|
| Test timeout, in seconds                 | 120        |
| Cable test mode                          | All        |
| Minimum FRL rate                         | 3G 3 Lane  |
| Maximum FRL rate                         | 12G 4 Lane |
| Threshold of allowed errors per lane     | 10         |
| Timeout for capturing errors, in seconds | 5          |
| Low Speed Line Select                    | 31         |

Presets ▼ OK Cancel

|                                                  |                                                                                                                                                                                  |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Test timeout, in seconds:</i>                 | Timelimit for the test                                                                                                                                                           |
| <i>Cable test mode:</i>                          | High speed can include detection errors on the high speed lanes. Low speed - detect that i2c and ddc lanes are working properly. All modes checks both High speed and low speed. |
| <i>Minimum FRL rate:</i>                         | Determine minimum of range for detection of cable quility                                                                                                                        |
| <i>Maxmum FRL rate:</i>                          | Determine maximum of range for detection of cable quility                                                                                                                        |
| <i>Threshold of allowed errors per lane:</i>     | Determine allowed number of errors                                                                                                                                               |
| <i>Timeout for capturing errors, in seconds:</i> | Determine period for screening errors                                                                                                                                            |
| <i>Low speed line select:</i>                    | Configure witch lines of Low speed will be checked.                                                                                                                              |

## APPENDIX F: VTP PATTERN LANGUAGE

### General

The Vpattern definition language (in the following simply “VTP”) is a straightforward yet flexible way of describing test patterns for UCD Generators. This description is providing an introduction and examples of the most usable instructions and parameters.

The VTP language uses text command syntax. Each row represents one drawing instruction. The coordinate system can be either absolute or scaled. In the absolute mode the actual pixel position is referred while in the scaled mode the coordinates refer to the “Drawing resolution” used while drawing. For both absolute and scaling coordinates the origin is the upper left hand corner of the screen.

### Terminology

The following terms are used in this document:

*Coordinate system*: two numerical ranges of integer, positive numbers. E.g. {0,799},{0,599} or {0,10000},{0,10000}.

*Coordinates*: a tuple of integer, positive numbers used to address a position on an image, e.g. (100,250). The first number is the horizontal position, the second one the vertical position. The actual position is always related to the coordinate system currently in use.

*Drawing resolution*: the width and height of the space that can be used for drawing, expressed in pixels. E.g., 2560 by 1600.

*Drawing area*: a 2-dimensional area spanning all of the drawing resolution, expressed in the current coordinate system notation. E.g., if the drawing resolution is 800 x 600 pixels, the drawing area includes all points (x,y) where x = 0 to 799 and y = 0 to 599 in ABSOLUTE mode or x = 0 to 10000 and y = 0 to 10000 in SCALED mode.

### Notation

The following notation is used in this document:

- A token is enclosed by characters ‘<’ and ‘>’. For instance, <variable> represents a generic variable.
- Different legal choices for a command parameter are separated by character ‘|’. For instance, <variable> | <number> means that either variable or number can be used as parameters.
- Items that can be repeated 0, 1 or more times are preceded by ‘{’ and followed by ‘\*’. For instance {<number>}\* means zero, one or more occurrences of a number.

### Syntax rules

The following general syntax rules apply to VTP language files:

- The VTP is a text-based, interpreted language.
- Commands, variables, and constant names are not case-sensitive.
- All text to the right of a semicolon (;) is treated as a comment.
- All strings are delimited by quotation marks (“a string”).
- Quotation mark and backslash characters must be prefixed by a backslash character (a quotation mark character = \”) (a backslash character = \\).
- Filenames cannot contain pathnames.

## Commands

### Scaling commands

All drawing commands using coordinates can refer either to absolute or scaled coordinates. The absolute coordinate system starts at 0 and its measurement unit is the pixel (vertically the line). It extends up to the maximum drawing resolution in use minus one, expressed in pixels too.

Conversely, the scaled coordinate system ranges from 0 to 10000, independently from the drawing resolution. Its measurement unit is thus a flexible, virtual pixel.

Absolute coordinates provide the fastest drawing speed, but they are resolution specific. Scaled coordinates are resolution independent while introducing a slight speed penalization.

For both systems, the origin (0,0) refers to the upper left hand corner of the screen.

#### ABSOLUTE

Syntax: ABSOLUTE

This command is normally used in the beginning of the VTP file. All drawing commands issued after ABSOLUTE will have absolute coordinate values, i.e., their coordinates will be interpreted as pixels and lines.

The allowed coordinate values are from 0 to the maximum drawing resolution minus one. For instance, for a drawing resolution of 2560 x 1600 pixels, the allowed coordinate range (x,y) for x is 0 to 2559 and for y 0 to 1599.

Constants MAXX and MAXY can be used in place of the numeric values to achieve basic scaling capabilities.

#### SCALED

Syntax: SCALED

All drawing commands issued after the SCALED command will have their coordinates interpreted as within a range from 0 to 10000 (10001 possible coordinate values), regardless of the current drawing resolution. Positioning can be calculated as percentages. If you wanted to address a point at 50% of the drawing resolution, then you would use the number 5000. If you wanted 75% you would simply use the 7500.

## Graphics Drawing Commands

All of the following graphics drawing commands use the currently selected foreground color for shape perimeter and filling.

### LINE

Syntax: `LINE x1 y1 x2 y2`

Draws a line from point (x1,y1) to point (x2,y2).

Example:

You can draw a white diagonal cross using either ABSOLUTE and SCALED coordinate mode and get the same result.

*ABSOLUTE ; Set scaling mode to absolute*

*COLORDEPTH 8 ; 8 bits per color*

*COLORRGB 255 255 255 ; white*

*LINE 0 0 MAXX MAXY ; Draw a line from upper left to lower right corner*

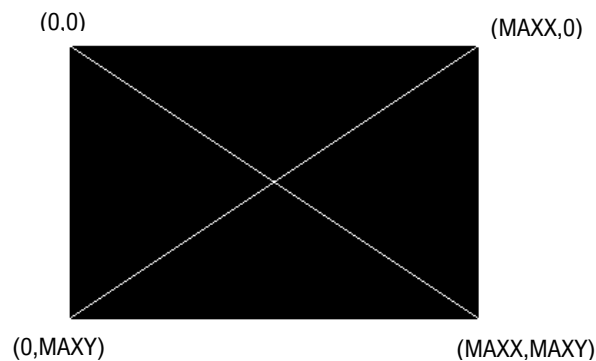
*LINE 0 MAXY MAXX 0 ; Draw a line from lower left to upper right corner*

*Or if you want a fixed size for 640 x 480 resolution*

*LINE 0 0 639 479*

*LINE 0 479 639 0*

The pattern will look like this:



Using SCALED instead of ABSOLUTE.

*SCALED*

*COLORDEPTH 8*

*COLORRGB 255 255 255*

*LINE 0 0 10000 10000*

*LINE 0 10000 10000 0*

### BOX

Syntax: `BOX x1 y1 x2 y2`

Draws a filled rectangle with upper left corner (x1,y1) and lower right corner (x2,y2).

Example:

This code will create a full white screen with all resolutions.

*SCALED*

*COLORDEPTH 8*

*COLORRGB 255 255 255*

*BOX 0 0 10000 10000*



### DOT

```
Syntax: DOT x y
```

Draws a single dot at location (x,y).

### FILL

```
Syntax FILL x y
```

Initiates a flood fill (or seed fill) with foreground color starting from position (x,y).

### CIRCLE

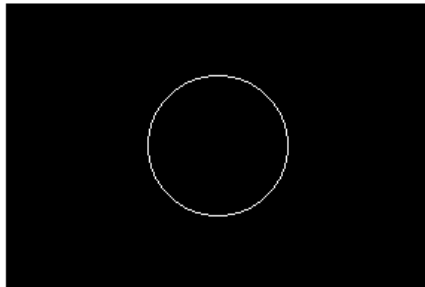
```
Syntax: CIRCLE x y r
```

Draws a circle with center point at (x,y) and radius r. Please, note that when using SCALED coordinates radius r is expressed using reference to vertical maximum.

Example:

```
SCALED  
COLORDEPTH 8  
COLORRGB 255 255 255  
CIRCLE 5000 5000 2500
```

The pattern will look like this:

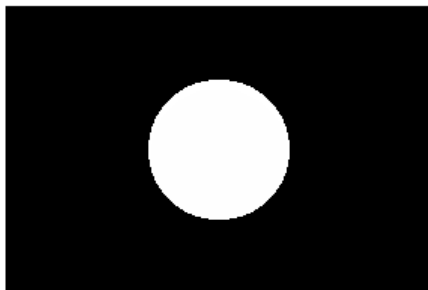


### FCIRCLE

```
Syntax: FCIRCLE x y r
```

Draws a circle with center point at (x,y) and radius r. Filled with foreground color. Please, note that when using SCALED coordinates radius r is expressed using reference to vertical maximum.

The pattern will look like this:



### ELLIPSE

```
Syntax: ELLIPSE x y hr vr
```

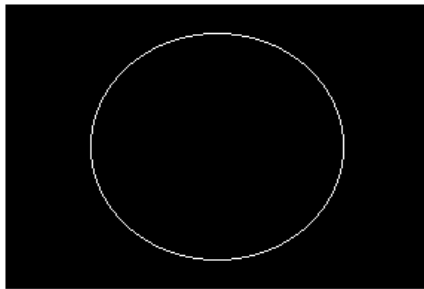
Draws an ellipse with center point at (x,y), horizontal radius hr and vertical radius vr.

You can use ELLIPSE instead of CIRCLE for example for compensating the stretching in applications where the displayed pixel is not square.

Example:

```
SCALED
COLORDEPTH 8
COLORRGB 255 255 255
ELLIPSE 5000 5000 3000 4000
```

The pattern will look like this:



### Text Drawing Commands

All of the following commands use the currently selected foreground color for the “foreground” pixels of the font and the currently selected background color for “background” pixels.

#### TEXTPOS

```
Syntax: TEXTPOS x y
```

Sets the text drawing position to point (x,y).

#### TEXT

```
Syntax: TEXT <string> | <var> | <const> { <string> | <var> | <const> }*
```

The command executes a CR and LF (carriage return and line feed) and then draws a text string <string>, a variable <var>, a constant <const> or a combination of them starting from the current text position.

<string> parameter is a quoted sequence of characters. If the string contains a quote character (") or a backslash character (\) then it must be preceded with a back slash character (\).

<var> is a parameter variable (A – Z, MAXX, MAXY) defined by SET command.

<const> one of the Timing Variables. Timing variables are defined by currently loaded timing parameters. Please refer to Chapter 3.

Example:

```
ABSOLUTE
COLORDEPTH 8
COLORRGB 255 255 255
TEXTPOS 100 100           ; Text starting point 100 pixels from left edge and
                          ; 100 display lines down from top
TEXT "HRES=" HR " PIXELS" ; This will draw the text HRES then the value of variable HR
                          ; and PIXELS
TEXT "Quote character \" and backslash \\"
```

## Program Flow Commands

### REPEAT

Syntax: REPEAT <variable> a b s

All commands after between REPEAT and END command are repeated the number of times defined by <variable>. <variable> is set to value a before starting the first iteration loop. At the end of each iteration, variable is incremented by s (variable = variable + s). The REPEAT is terminated when variable reaches or exceeds value b, and the execution continues from the command following the END command. For example:

```
SCALED
COLORDEPTH 8
COLORRGB 255 255 255
REPEAT W 0 10000 200
LINE W 0 W 10000
END
```

A maximum of 2 REPEAT loops can be nested (placed inside each other).

### END

Syntax: END

This command follows a REPEAT command and defines a group of instructions to be repeated.

## Color Commands

The user can assign the used colors in two basic ways: either by giving the actual Red, Green and Blue (or R, G and B) color component values or using pre-defined color palettes. The first method is referred as True Color Mode and the latter as Palette Mode.

In True Color Mode the numerical values given for R, G and B will be the actual output signal intensity values for the pixel in question. The numerical color value in Palette Mode will act as an address (or index) to a pre-defined color in a 256 color table. The output signal intensity will be the R, G and B value entry in the cell where the address points to.

Palette mode can only be used with True Color Mode is .

### COLORDEPTH

Syntax: COLORDEPTH n

The command is used in True Color Mode (COLORMODE 2), to define the number of bits used for each color component (R, G and B) of the data to be displayed. Possible values for the parameter n are 6, 8, 10 and 12. If COLORDEPTH command is not used, 10 bits per color is used.

Example: To display a bitmap that uses 8 bits for r, g and b (24-bit colors) you have to use COLORDEPTH 8.

| Command       | Nr of color bits | Range of values for R, G and B |
|---------------|------------------|--------------------------------|
| COLORDEPTH 6  | 18               | 0 to 63                        |
| COLORDEPTH 8  | 24               | 0 to 255                       |
| COLORDEPTH 10 | 30               | 0 to 1023                      |
| COLORDEPTH 12 | 36               | 0 to 4095                      |

COLORDEPTH can be used only once in a VTP file, and it has to be placed before all drawing instructions it is supposed to affect.

### COLORRGB

Syntax: COLORRGB r g b

The command defines the foreground color used for the following drawing commands. The command is used in True Color Mode only.

The range of values for r, g and b depends on the bits per color used. If not changed with COLORDEPTH command, 10 bits per color is used. Please refer to COLORDEPTH command for range of values.

## Various Commands

### SET

Syntax: SET <variable> n

Assigns value n to programming variable called variable. n must be a positive number or zero.

## Variables

### Timing Variables

| Timing Variable | Value name                                            |
|-----------------|-------------------------------------------------------|
| HF              | Drawing resolution horizontal size minus one          |
| HP              | Drawing resolution vertical size minus one            |
| HR              | Current timing horizontal frequency (MHz?)            |
| HA              | Current timing horizontal period (pixels)             |
| HS              | Current timing horizontal resolution (pixels)         |
| HBP             | Current timing horizontal active time (pixels)        |
| HFP             | Current timing horizontal sync length (pixels)        |
| VF              | Current timing horizontal back porch length (pixels)  |
| VP              | Current timing horizontal front porch length (pixels) |
| VR              | Current timing vertical frequency (MHz?)              |
| VA              | Current timing vertical period (lines)                |
| VS              | Current timing vertical resolution (lines)            |
| VBP             | Current timing vertical active time (lines)           |
| VFP             | Current timing vertical sync length (lines)           |
| PF              | Current timing vertical back porch length (lines)     |
| HLB             | Current timing vertical front porch length (lines)    |
| HRB             | Pixel frequency (Mpps?)                               |
| VTB             | Drawing resolution horizontal size minus one          |
| VBB             | Drawing resolution vertical size minus one            |

### Expressions

Any command numeric parameter can be replaced by an expression, according to the syntax below:

`<term> ::= <variable> | <constant> | <number>`

`<expression> ::= <term> { '+' | '-' | '*' | '/' | '%' } <term>`

`<parameter> ::= <term> | <expression>`

Some example of legal parameter values:

*B*

*MAXX*

*342*

*B + MAXX*

*B / 2*

*B \* C*

Expressions have always positive integers or zero value. When an expression evaluates to a negative value, it is set automatically to zero. Number values are also always positive integers or zero.

## Assignments

A variable can be assigned a numerical value by using the SET command.

The second parameter of the SET command can be replaced by an expression thus allowing commands like those here below:

```
SET C B+MAXX
```

```
SET K K+1
```

```
SET K A+B
```

## Default state at VTP execution startup

|                           |                                       |
|---------------------------|---------------------------------------|
| <i>Coordinate system:</i> | ABSOLUTE                              |
| <i>Foreground color:</i>  | 1023 1023 1023                        |
| <i>Background color:</i>  | 0 0 0                                 |
| <i>Image:</i>             | Output image is cleared (all black)   |
| <i>Variables:</i>         | All variables are initialized to zero |
| <i>Color depth:</i>       | COLORDEPTH 10                         |

# APPENDIX G: FIRMWARE UPDATE WITH QUARTUS

The chapter below describes a procedure for updating UCD-4XX Series Firmware when the normal FW Update procedure fails.

## Note

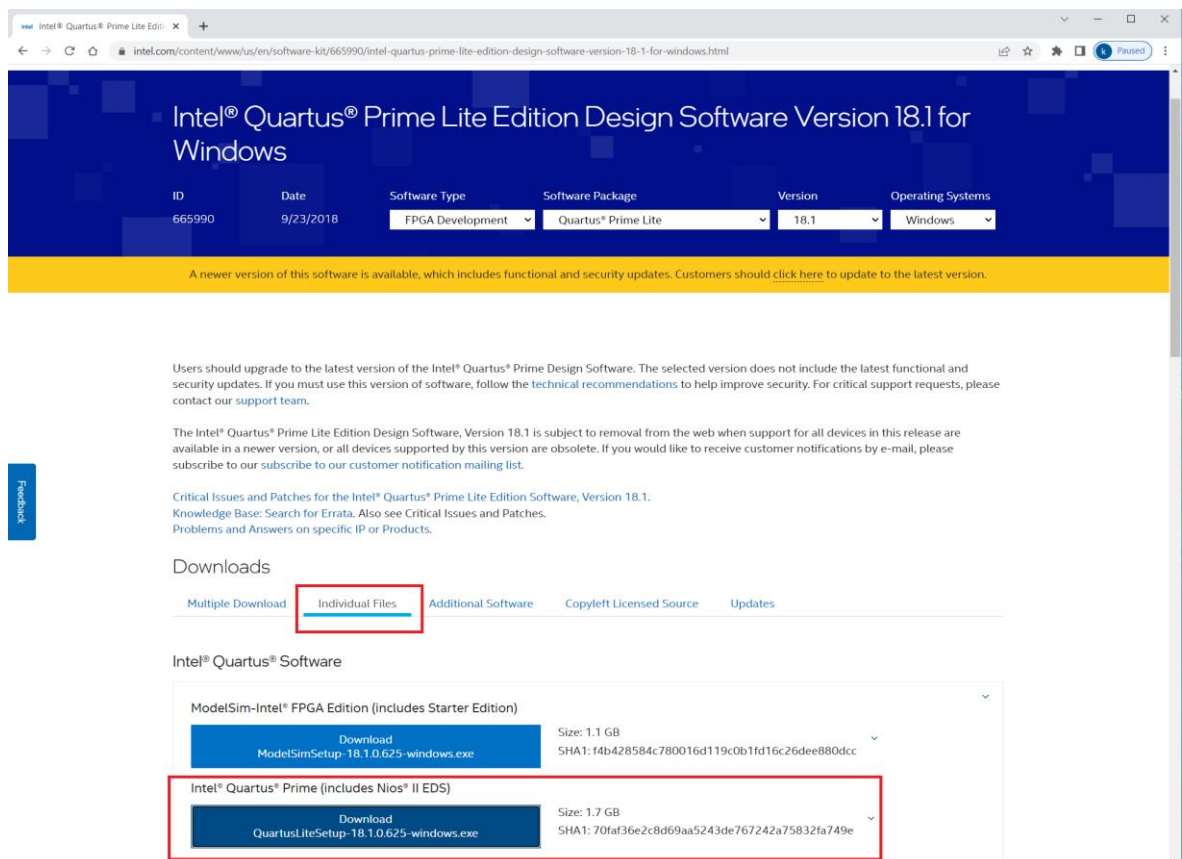
The firmware recovery procedure is only available for Windows operating system.

## Downloading Tools

The Recovery patch is programmed to UCD Device with a separate tool called **Intel® Quartus® Prime Lite Edition Design Software Version 18.1 for Windows**. The tool can be downloaded from the **Intel® FPGA** website:

<https://www.intel.com/content/www/us/en/software-kit/665990/intel-quartus-prime-lite-edition-design-software-version-18-1-for-windows.html>

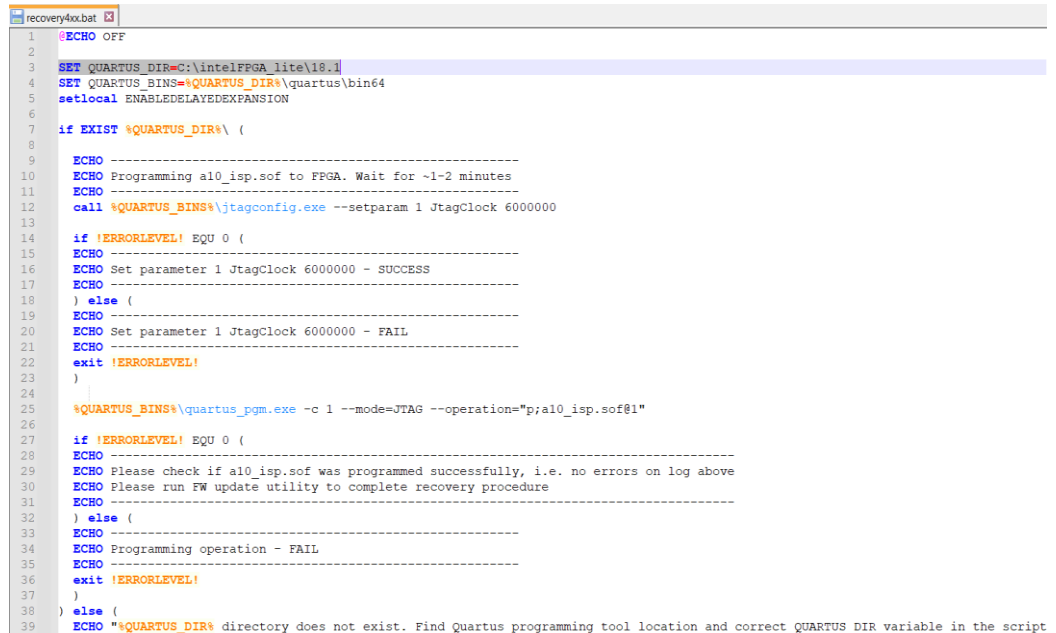
1. On the download page, please select section “**Individual Files**”. Please download the software under “**Intel® Quartus® Prime (includes Nios® II EDS)**”.
2. Please download and install the tool using defaults on the PC.



## Step 1

1. Connect the UCD device to the power supply and switch on power.
2. Connect the UCD device with a USB cable to the PC through USB connector (Please refer to chapter **Product Description > Connections** earlier in this document).
3. Please locate the *UCD-4xx\_recovery.zip* file. By default the file is at C:\Program Files\Unigraf\Unigraf UCD Tools\recovery.

4. Extract the content of the ZIP file in a folder on your PC (e.g., C:\Temp).
5. Open Windows **Command Prompt** application.
6. Navigate to the directory to where the ZIP file was extracted (e.g. `cd \Temp`).
7. Connect a micro-USB cable to the **JTAG** connector on the UCD device (Please refer to chapter **Product Description > Connections** earlier in this document).
8. In the directory where the ZIP file was extracted (e.g. c:\Temp) please edit file **recovery.bat**
9. On line three, the parameter “QUARTUS\_DIR” is set to point to the folder where the Quartus Programmer was installed (by default **C:\intelFPGA\_lite\18.1**). Edit and save as needed.



```

1 @ECHO OFF
2
3 SET QUARTUS_DIR=C:\intelFPGA_lite\18.1
4 SET QUARTUS_BINS=%QUARTUS_DIR%\quartus\bin64
5 setlocal ENABLEDELAYEDEXPANSION
6
7 if EXIST %QUARTUS_DIR% (
8
9     ECHO -----
10    ECHO Programming a10_isp.sof to FPGA. Wait for ~1-2 minutes
11    ECHO -----
12    call %QUARTUS_BINS%\jtagconfig.exe --setparam 1 JtagClock 6000000
13
14    if !ERRORLEVEL! EQU 0 (
15        ECHO -----
16        ECHO Set parameter 1 JtagClock 6000000 - SUCCESS
17        ECHO -----
18    ) else (
19        ECHO -----
20        ECHO Set parameter 1 JtagClock 6000000 - FAIL
21        ECHO -----
22        exit !ERRORLEVEL!
23    )
24
25    %QUARTUS_BINS%\quartus_pgm.exe -c 1 --mode=JTAG --operation="p;a10_isp.sof@1"
26
27    if !ERRORLEVEL! EQU 0 (
28        ECHO -----
29        ECHO Please check if a10_isp.sof was programmed successfully, i.e. no errors on log above
30        ECHO Please run FW update utility to complete recovery procedure
31        ECHO -----
32    ) else (
33        ECHO -----
34        ECHO Programming operation - FAIL
35        ECHO -----
36        exit !ERRORLEVEL!
37    )
38 ) else (
39    ECHO "%QUARTUS_DIR%" directory does not exist. Find Quartus programming tool location and correct QUARTUS_DIR variable in the script

```

10. In the **Command Prompt** application make sure that the current directory is still the same (e.g. C:\temp).
11. Launch batch **recovery.bat** by typing “recovery.bat” at the prompt.
12. Please wait until the batch file has been completed (may take up to several minutes).

## Step 2

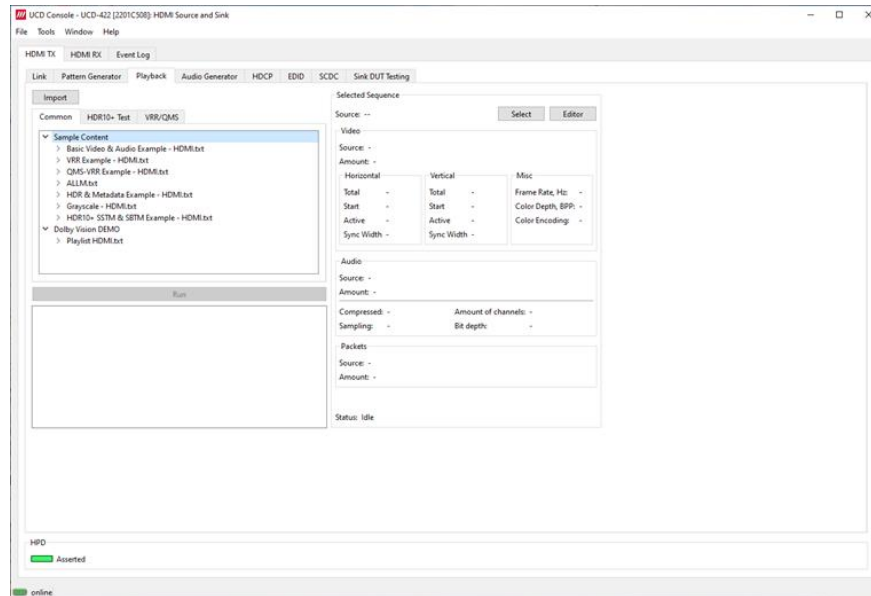
Perform FW update procedure as described in section **Installation > Firmware Update Procedure** earlier in this manual.

After Recovery procedure has completed, you can delete the files (in e.g., C:\Temp).



## APPENDIX H: PLAYLISTS AND SCENARIOS

UCD Console's Playback enables you to run scripts called playlists. Use playlists to stream video, audio and metadata. See the Unigraf UCD Console Playback Tutorial at [www.unigraf.fi/resource/tutorial-run-edit-and-create-sdr-and-hdr-scenarios-with-unigraf-s-playback-tool/](http://www.unigraf.fi/resource/tutorial-run-edit-and-create-sdr-and-hdr-scenarios-with-unigraf-s-playback-tool/)



### Playlist

A *Playlist* is a text script consisting of a *[Device]* block and *[Scenario]* block(s). A *[Device]* block lists the serial number of the device and *connectortype* (such as a displayport transmitter). *[Scenarios]* blocks have a *caption* (which are used to display sample content), a period (*Scenario* duration in milliseconds) and a relative path to a script text file (ex. Scenario\_PSR1\_Entry\_N.txt). Scenarios are played in sequence.

### Scenario

A *scenario* is a script text file to specify a sequence of video frames, metadata packets and audio to be transmitted.

### Frame Memory

Before transmission content is loaded to frame memory buffer of the UCD device. Frame buffer memory limits content (number of frames) that can be played. UCD-5XX devices by default feature 16 gigabytes of memory. This enables loading up to 320 4K or 80 8K video frames. Contact Unigraf for information for larger frame buffer sizes.

### Sample Content

You can use sample content as a basis for creating custom test sequences: see UCD Console *Playback* tab. Sample content is stored by default (on Windows) at *C:\Program Files\Unigraf\Unigraf UCD Tools\Resources\playback\content*. See [Sample Content in Playback](#) in this Appendix.

## Playlists

A *playlist* defines the UCD device to be used and the output destination for transmission. It lists *scenarios* the played (video and audio sequences including metadata) to be transmitted and their duration.

**Note:** *Playlists* and *Scenarios* are technology dependent. Metadata (or packets) differ for HDMI and DisplayPort.

### Device block

Section describes what device and what output connector to use.

| Key           | Description                                                                                                                             | Possible values                               |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| [Device]      | Required. Start of the Device block.                                                                                                    |                                               |
| serialnumber  | Required. Specifies serial number of the UCD device. The '*' wildcard can be used if only one UCD source device is connected to the PC. | '*'<br>'1722C333'                             |
| connectortype | Required. Specifies output connector type to be used. Playlists shall not contain scenarios for different connector types.              | 'HDMI Out'<br>'DisplayPort Out'<br>'USBC Out' |
| reset         | Only applies to UCD-323.                                                                                                                |                                               |

### Scenario block

Section describes selected scenario and its playback parameters. Playlist runs scenarios in the order they are listed.

| Key                  | Description                                                                                                                                        | Possible values                                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| [Scenario]           | Required. Start of a <i>Scenario</i> block. <i>Playlists</i> can have multiple <i>Scenario</i> blocks.                                             |                                                |
| caption              | Optional. Title. Any character string accepted.                                                                                                    | 'Scenario 1'                                   |
| path                 | Required. Specifies relative path to scenario file.                                                                                                | Any valid path                                 |
| period               | Required. Duration of Scenario in msec. The duration is ignored if close-after-upload is set to '1'.                                               | '60000'<br>'5000'                              |
| close-after-upload   | Optional. When set to '1', command line version of the Playback tool will exit after loading scenario content and starting playback.               | '0' or '1'<br>Default '0'                      |
| execute-after-upload | Optional. Executes provided command in cmd.exe or bash and waits for its completion. Calculation of 'period' starts after the command is executed. | 'script.bat && dir'<br>'rmdir /home/user/test' |

## Scenarios

A Scenario is text file for specifying a specific sequence of video frames, events (packets) and audio to be played in order. *Scenarios* also set up the device state for transmission.

## Parameters

Scenario parameters are defined below. items.

| Scenario item                | Description                                                                                                                                                        |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>video</i>                 | Path and file name format of video frame files                                                                                                                     |
| <i>audio</i>                 | Path and file name of the audio file                                                                                                                               |
| <i>packets</i>               | Path and file name format of metadata packet files                                                                                                                 |
| <i>porder</i>                | Content Playing Order. Please see <i>Content Playing Order</i> below.                                                                                              |
| <i>mappin</i>                |                                                                                                                                                                    |
| <i>align1</i>                | Alignment of 12-bit binary pixel data. '1' aligned to LSB; '0' aligned to MSB.                                                                                     |
| <i>audioswap</i>             | '1' for Little Endian audio samples                                                                                                                                |
| <i>audiocompressed</i>       | '1' compressed audio; '0' uncompressed audio                                                                                                                       |
| <i>audiosampling</i>         | Audio sampling rate. E.g., 44100                                                                                                                                   |
| <i>audiochannels</i>         | Nr. of audio channels                                                                                                                                              |
| <i>audiobits</i>             | Audio bits per sample (usually 16 or 24)                                                                                                                           |
| <i>scrambler</i>             | '1' scrambling enabled; '0' scrambling disabled                                                                                                                    |
| <i>audiosync</i>             | Audio sync                                                                                                                                                         |
| <i>colorspace</i>            | Video color space: RGB; YUV444; YUV422; YUV420                                                                                                                     |
| <i>bitspercolor</i>          | Video color depth (bits per color)                                                                                                                                 |
| <i>timing.hactive</i>        | Timing: Horizontal active                                                                                                                                          |
| <i>timing.vactive</i>        | Timing: Vertical active                                                                                                                                            |
| <i>timing.htotal</i>         | Timing: Horizontal total                                                                                                                                           |
| <i>timing.vtotal</i>         | Timing: Vertical total                                                                                                                                             |
| <i>timing.hstart</i>         | Timing: Horizontal start                                                                                                                                           |
| <i>timing.vstart</i>         | Timing: Vertical start                                                                                                                                             |
| <i>timing.hsync</i>          | Timing: Horizontal sync width                                                                                                                                      |
| <i>timing.vsync</i>          | Timing: Vertical sync width                                                                                                                                        |
| <i>timing.frate</i>          | Timing: frame rate                                                                                                                                                 |
| <i>hdcp</i>                  | HDCP version used (can be 1.4 2.3 or 'none')                                                                                                                       |
| <i>loadingRGB</i>            | The R, G and B color components of solid color pattern shown when content is being uploaded to the device before playback (e.g., 0,0,0)                            |
| <i>linkRate</i>              | Default link rate.<br>HDMI: 0 = TMDS; 1 – 5 = FRL with 3, 6, 8, 10 and 12 Gbps link rate.<br>DP: Link rate = Value × 0.27 Gbps. (E.g., 20 = 5.4 Gbps/lane (HBR2)). |
| <i>linkRateMin</i>           | Minimum link rate desired. <i>Scenario</i> will fail if not achieved                                                                                               |
| <i>DSC timing parameters</i> | Parameters are different for DP and HDMI. See below.                                                                                                               |

DSC Timing parameters for HDMI

|              |                                     |
|--------------|-------------------------------------|
| dscFrameRate | DSC Timing: Frame rate [fps] × 1000 |
| dscHcactive  | DSC Timing: Horizontal active       |
| dscHcblank   | DSC Timing: Horizontal blank        |
| dscVtotal    | DSC Timing: Vertical total          |
| dscVsync     | DSC Timing: Vertical sync           |
| dscVstart    | DSC Timing: Vertical start          |
| dscVactive   | DSC Timing: Vertical active         |

DSC Timing parameters for DP

|              |                                     |
|--------------|-------------------------------------|
| dscFrameRate | DSC Timing: Frame rate [fps] × 1000 |
| dscVtotal    | DSC Timing: Vertical total          |
| dscVsync     | DSC Timing: Vertical sync           |
| dscVstart    | DSC Timing: Vertical start          |
| dscVactive   | DSC Timing: Vertical active         |
| dscHtotal    | DSC Timing: Horizontal total        |
| dscHsync     | DSC Timing: Horizontal sync         |
| dscHstart    | DSC Timing: Horizontal start        |
| dscHactive   | DSC Timing: Horizontal active       |

## Content Playing Order

Play order is a sequence of steps. Steps are delimited with semicolons (;).

Each step has:

- Range (possibly numbered e.g. allm\_000.jpg, allm\_001.jpg, ...) of video frame(s)
- How many times the frame(s) are played
- Packet(s) (possibly numbered e.g. allm\_0.bin, allm\_1.bin, ...) indices to be sent during the video frame(s) transmission
- Color format
- Optional frame rate when VRR/Adaptive-Sync is enabled

## Format

Each scenario step is of the form :

```
pV:R:E:FvXX;
```

## Parameters

Please see table below for description of used parameters.

| Char | Description                                                                                                                                                                                                                                                                                                           | Possible values                 | Examples                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------------------------------------------------|
| :    | Separator between step parameters.                                                                                                                                                                                                                                                                                    | ','                             | See below                                                                |
| ;    | Step delimiter.                                                                                                                                                                                                                                                                                                       | ','                             | See below                                                                |
| p    | Optional. Indicates assertion of a HPD pulse on HDMI RX connector of UCD device during current step. Preceding video frame index. Only for HDMI playback.                                                                                                                                                             | 'p'                             | 'p1:60:1:256;'<br>'p0-59:60:1:256;'                                      |
| V    | Required. Video frame indices (zero based). Parameters are applied to all frames in the step. Images (possibly numbered) are loaded from the <i>video</i> file path.                                                                                                                                                  | '1'<br>'1,2,5'<br>'0-59'        | '1:60:16:256;'<br>'1,2,5:60:16:256;'<br>'0-59:60:16:256;'                |
| R    | Required. Repetitions of current step.<br>For example, '1' with 60 FPS frame rate means that current step will be played only for 1/60 of a second.                                                                                                                                                                   | '30'<br>'1'                     | '1:30:16:256;'<br>'1:1:16:256;'                                          |
| E    | Optional. Metadata packet indices (zero based): A single packet or a comma separated list of packets.<br>The index may be of the form 3l15 (lower case 'l').<br>At which vertical line do we want to put our packet in.<br>3l15 means insert packet 3 at line 15.<br>Packets are loaded from the <i>packets</i> path. | '0'<br>'4,1,29'<br>none<br>3l15 | '1:30:0:256;'<br>'1:30:4,1,29:256;'<br>'1:30::256;'<br>0:10000:3l15:256; |
| F    | Required. Color format and color depth.<br>See <a href="#">Color Format</a> below.                                                                                                                                                                                                                                    | '256'<br>'513'                  | '1:30:0:256;'<br>'1:30:0:513;'                                           |
| vXX  | Optional. Control of frame rate when VRR/Adaptive-Sync is enabled. To enable VRR/Adaptive-Sync, the corresponding HDMI VSIF event must be included. The parameter is in the form 'vXX', where 'XX' is the frame rate.                                                                                                 | 'v60'<br>'v30'                  | '1:30:0:256v60;'<br>'1:30:0:256v30;'                                     |

### Color Format

Color format is a two-byte value presented in decimal. The lower byte provides an index to used color space and the higher byte an index to the color depth. Please find the indexes in the table below.

| Index | Color Depth<br>(bits/color) | Color Space |
|-------|-----------------------------|-------------|
| 0     | 6                           | RGB         |
| 1     | 8                           | YCbCr 4:4:4 |
| 2     | 10                          | YCbCr 4:2:2 |
| 3     | 12                          | YCbCr 4:2:0 |
| 4     | 16                          | –           |

The parameter value is encoded as follows:

$[\text{Color Depth}] \times 256 + [\text{Color Space}]$ ,

where  $[\text{Color Depth}]$  and  $[\text{Color Space}]$  are indexes obtained from the table above.

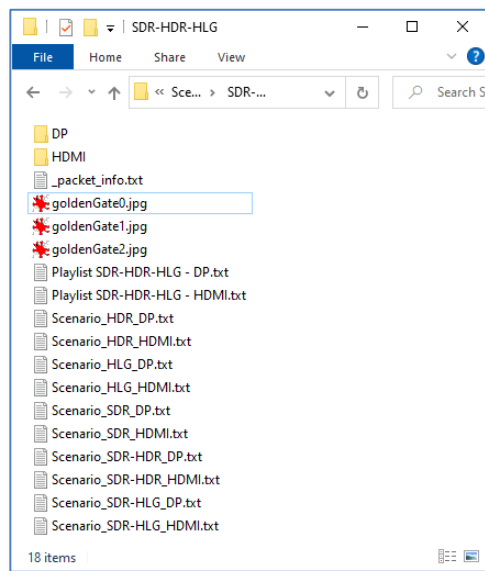
For example, parameter for YCbCr 4:4:4, 10 bits is  $(2 \times 256 + 1) = 513$ .

Pre-calculated values for available color formats are shown below:

|             | 6 BPC | 8 BPC | 10 BPC | 12 BPC | 16 BPC |
|-------------|-------|-------|--------|--------|--------|
| RGB         | 0     | 256   | 512    | 768    | 1024   |
| YCbCr 4:4:4 | N/A   | 257   | 513    | 769    | 1025   |
| YCbCr 4:2:2 | N/A   | 258   | 514    | 770    | 1026   |
| YCbCr 4:2:0 | N/A   | 259   | 515    | 771    | 1027   |

## Example

Please find below description of Playlist SDR-HDR-HLG – HDMI.



### Playlist file (Playlist SDR-HDR-HLG - HDMI.txt)

| Playlist item and example content | Description                                                |
|-----------------------------------|------------------------------------------------------------|
| [Device]                          | Start of device section                                    |
| serialnumber=*                    | Only one UCD device present.                               |
| connectortype=HDMI Out            | HDMI output                                                |
| [Scenario]                        | Start of Scenario 1                                        |
| caption = SDR                     | Scenario title "SDR"                                       |
| period = 10000                    | Duration 10 sec                                            |
| path = Scenario_SDR_HDMI.txt      | Scenario file: Scenario_SDR_HDMI.txt in current folder     |
| [Scenario]                        | Start of Scenario 2                                        |
| caption = HDR                     | Scenario title "HDR"                                       |
| period = 10000                    | Duration 10 sec                                            |
| path = Scenario_HDR_HDMI.txt      | Scenario file: Scenario_HDR_HDMI.txt in current folder     |
| [Scenario]                        | Start of Scenario 3                                        |
| caption = HLG                     | Scenario title "HLG"                                       |
| period = 10000                    | Duration 10 sec                                            |
| path = Scenario_HLG_HDMI.txt      | Scenario file: Scenario_HLG_HDMI.txt in current folder     |
| [Scenario]                        | Start of Scenario 4                                        |
| caption = SDR – HDR               | Scenario title "SDR – HDR"                                 |
| period = 10000                    | Duration 10 sec                                            |
| path = Scenario_SDR-HDR_HDMI.txt  | Scenario file: Scenario_SDR-HDR_HDMI.txt in current folder |
| [Scenario]                        | Start of Scenario 5                                        |
| caption = SDR – HLG               | Scenario title "SDR – HLG"                                 |
| period = 10000                    | Duration 10 sec                                            |
| path = Scenario_HDR_HDMI.txt      | Scenario file: Scenario_SDR-HLG_HDMI.txt in current folder |

## Scenario File (Scenario\_SDR-HDR-HDMI.txt)

| Scenario item and example content | Description                                                                                                             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| video=goldenGate0.jpg             | Video files in current folder, file name format goldenGate0.jpg (0...)                                                  |
| audio=<Audio not selected>        | Audio not selected                                                                                                      |
| packets=HDMI\Infoframes_0000.bin  | Packet files in folder HDMI\, file name format Infoframes_0000.bin (0...)                                               |
| porder=0:180:2:256;1:180:2,0:256; | 180 frames of image index 0, Packet index 2, RGB 8 bpc<br>180 frames of image index 1, Packets index 2 and 0, RGB 8 bpc |
| align12=1                         | Pixel data is aligned to LSB                                                                                            |
| audioswap=0                       | -                                                                                                                       |
| audiocompressed=0                 | -                                                                                                                       |
| audiosampling=0                   | -                                                                                                                       |
| audiochannels=0                   | -                                                                                                                       |
| audiobits=0                       | -                                                                                                                       |
| scrambler=0                       | scrambling disabled                                                                                                     |
| colorspace=RGB444                 | Video color space: RGB 4:4:4                                                                                            |
| bitspercolor=8                    | Video color depth: 8 (bpc)                                                                                              |
| timing.hactive=1920               | Timing: Horizontal active                                                                                               |
| timing.vactive=1080               | Timing: Vertical active                                                                                                 |
| timing.htotal=2200                | Timing: Horizontal total                                                                                                |
| timing.vtotal=1125                | Timing: Vertical total                                                                                                  |
| timing.hstart=192                 | Timing: Horizontal start                                                                                                |
| timing.vstart=41                  | Timing: Vertical start                                                                                                  |
| timing.hsync=44                   | Timing: Horizontal sync width                                                                                           |
| timing.vsync=5                    | Timing: Vertical sync width                                                                                             |
| timing.frate=60000                | Timing: Frame rate 60 fps                                                                                               |
| hdcg=none                         | HDCP not enabled                                                                                                        |
| loadingRGB=52,127,150             | Solid color pattern shown when content is being uploaded to the device before playback is R=52, G=127, B=150.           |



## Sample Content in Playback Tab

Use UCD Console's Playback examples to create custom test content. On Windows, examples can typically be found at C:\Program Files\Unigraf\Unigraf UCD Tools\Resources\playback\content.

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**Note:** Playlists and Scenarios are interface technology dependent.  
The provided examples are different for HDMI and DisplayPort.

---

Provided examples include:

### HDMI

| Playlist Name               | Description                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------------------|
| Basic Video & Audio Example | Example playlist for demonstrating the use of video and audio files.                                    |
| VRR Example                 | Playlist for demonstrating Variable Refresh Rate (VRR) capability of a DUT monitor.                     |
| QMS-VRR Example             | Playlist for demonstrating Quick Media Switching VRR (QMS-VRR) capability of a DUT monitor.             |
| ALLM                        | Playlist for demonstrating Auto Low-latency Mode (ALLM) capability of a DUT monitor                     |
| HDR & Metadata Example      | Example playlist that demonstrates the use of video files and metadata packets in testing a DUT monitor |

### DP

| Playlist Name               | Description                                                                                             |
|-----------------------------|---------------------------------------------------------------------------------------------------------|
| Basic Video & Audio Example | Example playlist for demonstrating the use of video and audio files.                                    |
| HDR & Metadata Example      | Example playlist that demonstrates the use of video files and metadata packets in testing a DUT monitor |
| Frame Rate Example          | Playlist for demonstrating use of multiple frame rates with FHD and UHD resolution.                     |

## Playlist: Basic Video & Audio Example

The playlist transmits video and audio as described below.

### Video

Frames used for Scenario 1 and Scenario 2 (Image1.jpg, Image 2.jpg)



Frame used for Scenario 3 and Scenario 4 (Philips.svg)



### Description of Scenarios

|   | Name                      | Duration | Repeated sequence                                                                                                                               |
|---|---------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Flip-flop with LPCM Audio | 60 s     | CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, 60 frames Image1.jpg, 60 frames Image2.jpg, Audio: Rhythm.wav                                          |
| 2 | Flip-flop with AC3 Audio  | 60 s     | CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, 60 frames Image1.jpg, 60 frames Image2.jpg, Audio: 44100Hz_16bit_AC3_2channels_60sec_sine.iec61937.bin |
| 3 | Flip-flop Silent          | 60 s     | CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, 60 frames Image1.jpg, 60 frames Image2.jpg, No Audio.                                                  |
| 4 | Philips 1920x1080p + 1kHz | 60 s     | CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, 60 Frames Philips.svg, Audio: 1 kHz sine wave (1kHz.wav)                                               |
| 5 | Philips 3840x2160p + 1kHz | 60 s     | CTA 3840 x 2160 @ 60Hz (VIC 97), RGB 8 BPC, 60 Frames Philips.svg, Audio: 1 kHz sine wave (1kHz.wav)                                            |

## Playlist: HDR & Metadata Example

Example demonstrates the use of metadata packets.

### Video:

The Scenarios use four versions of the same image: GoldenGate0.jpg, GoldenGate1.jpg, GoldenGate2.jpg and GoldenGate3.jpg.

All four images use the same dynamic range in pixel data but contain a text label indicating pixel dynamic range applied in the metadata. If DUT behaves correctly, applying different metadata changes the appearance of the image on DUT screen.



### Scenarios for HDMI Output

Video mode in all steps: CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, No audio.

| Name         | Duration | Repeated sequence                                                                                                                              |
|--------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------|
| SDR          | 10 sec   | 180 frames GoldenGate0.jpg, Packet: Infoframes_0002;                                                                                           |
| HDR          | 10 sec   | 180 frames GoldenGate1.jpg, Packets: Infoframes_0002, Infoframes_0000                                                                          |
| HLG          | 10 sec   | 180 frames GoldenGate2.jpg, Packets: Infoframes_0001, Infoframes_0002                                                                          |
| HDR10+       | 10 sec   | 180 frames GoldenGate3.jpg, Packets: Infoframes_0002, Infoframes_0003, Infoframes_0000                                                         |
| SDR – HDR    | 10 sec   | 180 frames GoldenGate0.jpg, Packets: Infoframes_0002;<br>180 frames GoldenGate1.jpg, Packets: Infoframes_0002, Infoframes_0000                 |
| SDR – HLG    | 10 sec   | 180 frames GoldenGate0.jpg, Packet: – ;<br>180 frames GoldenGate2.jpg, Packets: Packets: Infoframes_0001, Infoframes_0002                      |
| SDR – HDR10+ | 10 sec   | 180 frames GoldenGate0.jpg, Packet: Infoframes_0002;<br>180 frames GoldenGate3.jpg, Packets: Infoframes_0002, Infoframes_0003, Infoframes_0000 |

## Playlist: VRR Example (HDMI)

Playlist demonstrates controlling VRR (Variable Refresh Rate) in Scenarios when using HDMI output.

### Video

The image used for the test contains a combination of color bars, gray scales, and rotating items. The test uses a sequence of images creating a full rotation in 60 frames.



**Scenario with Video Mode 1920×1080 60 Hz**

The scenario uses 1920×1080 59.94/60 Hz video timing (VIC 16). No audio.

|   | Name                  | Duration | Repeated sequence                                                                                                                     |
|---|-----------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1 | FHD VRR 48..59 switch | 60 s     | VRR enabled. RGB 8 BPC. Packets: infoframe_00, infoframe_01<br>300 frames with 48 Hz frame rate,<br>300 frames with 59 Hz frame rate. |

**Scenario with Video Mode 3840×2160 60 Hz**

The scenario uses 3840×2160 59.94/60 video timing (VIC 97). No audio.

|   | Name                  | Duration | Repeated sequence                                                                                                                        |
|---|-----------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | UHD VRR 48..59 switch | 60 s     | VRR enabled. RGB 8 BPC.<br>Packets: infoframe_00, infoframe_02<br>300 frames with 48 Hz frame rate,<br>300 frames with 59 Hz frame rate. |

## Playlist: Frame Rate Example (DP)

Playlist for demonstrating use of multiple frame rates with FHD and UHD resolution when using DisplayPort output.

### Video

The image used for the test contains a combination of color bars, gray scales, and rotating items. The test uses a sequence of images creating a full rotation in 60 frames



### Executed Scenarios

The test is using four scenarios (RGB 8 BPC, No audio)

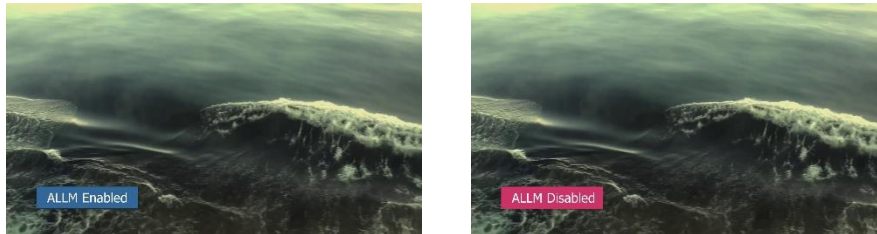
|   | Name                | Duration | Repeated sequence                                                                                |
|---|---------------------|----------|--------------------------------------------------------------------------------------------------|
| 1 | Spinners FHD 59fps  | 60 s     | 1920×1080 59.94/60 Hz video timing (VIC 16), 60 frames 'colorBarsSpinning-X.svg' X= 0 to 59      |
| 2 | Spinners FHD 119fps | 60 s     | 1920×1080 119.88/120 Hz video timing (VIC 63), 60 frames 'colorBarsSpinning-X.svg' X= 0 to 59    |
| 3 | Spinners UHD 59fps  | 60 s     | 3840×2160 59.94/60 Hz video timing (VIC 97) 60 frames 'colorBarsSpinning-X.svg' X= 0 to 59       |
| 4 | Spinners UHD 119fps | 60 s     | 3840×2160 119.88/120 Hz Hz video timing (VIC 120) 60 frames 'colorBarsSpinning-X.svg' X= 0 to 59 |

## Playlist: ALLM (HDMI)

Playlist for demonstrating Auto Low-latency Mode (ALLM) capability of a DUT monitor.

### Video:

The Scenarios use a series of images: allm\_on\_off\_000.jpg to allm\_on\_off\_0011.jpg. Text panel on the images indicate if ALLM is enabled or not. The first scenario is presented with ALLM enabled and the second by switching ALLM on and off sequentially.



### Scenarios for HDMI Output

Video mode in all steps: CTA 1920×1080 60 Hz (VIC 16), RGB 8 BPC, No audio.

| Name        | Duration | Repeated sequence                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ALLM Static | 60 sec   | 10 frames allm_on_off_000.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_001.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_002.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_003.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_004.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_005.jpg, Packet: allm_0.bin                                                                                                                                                                                                                                                                                                                                       |
| ALLM Toggle | 60 sec   | 10 frames allm_on_off_000.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_001.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_002.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_003.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_004.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_005.jpg, Packet: allm_0.bin;<br>10 frames allm_on_off_006.jpg, Packet: allm_1.bin;<br>10 frames allm_on_off_007.jpg, Packet: allm_1.bin;<br>10 frames allm_on_off_008.jpg, Packet: allm_1.bin;<br>10 frames allm_on_off_009.jpg, Packet: allm_1.bin;<br>10 frames allm_on_off_0010.jpg, Packet: allm_1.bin;<br>10 frames allm_on_off_0011.jpg, Packet: allm_1.bin |